COMMITTEE ON HYDROLOGY

REPORT ON

ADMINISTRATION

OF THE

APPORTIONMENT AGREEMENT

APRIL, 1980

PPWB REPORT #58

PRAIRIE PROVINCES WATER BOARD

CANADA ALBERTA SASKATCHEWAN MANITOBA

PRAIRIE PROVINCES WATER BOARD
ROOM 306, MOTHERWELL BUILDING, 1901 VICTORIA AVENUE, REGINA, SASKATCHEWAN S4P 3R4 522-6671

April 14, 1980

Mr. J. P. Bruce,
Chairman,
Prairie Provinces Water Board,
Environmental Management Service,
Environment Canada,
Ottawa, Ontario.
K1A 0E7

Dear Mr. Bruce:

Re: The Administration of Apportionment Agreement

The Study to report on Administration of the Apportionment Agreement was assigned to the Committee on Hydrology on June 10, 1975. The assignment has since been discussed at some fourteen Committee on Hydrology meetings. This report is the result of these discussions.

The Committee on Hydrology believes that equitable apportionment of inter-provincial eastward flowing waters can best be achieved if all three prairie provinces continue to consult and cooperate among themselves and with the cooperating federal agencies to ensure that the best interests of all parties are served.

The recommendations of this report should be reviewed when requested by any member agency in order to keep the administrative arrangements current. When major reservoirs are built and/or diversions constructed the effects of these changes on the downstream apportionment points should be evaluated by the Board through its standing committees.

Storage and diversion are, in general, beneficial to all jurisdictions but it is the responsibility of each province to manage its storage facilities so that equitable apportionment is achieved.

Forecasting is a management tool and is, primarily, the responsibility of each province. While the Board and its Secretariat should be prepared to coordinate forecasting activities when required, the provinces should prepare such water supply and discharge forecasts needed to determine if

... 2

a low flow situation is imminent. Water Survey of Canada has a related and ongoing responsibility to ensure that sufficient discharge measurements are made during low flow periods to accurately determine natural streamflow at interprovincial apportionment points.

Recommendations are made:

(1) concerning audit periods for the South Saskatchewan and Qu'Appelle Rivers,

(2) that no balance periods of less than twelve months be established, and

(3) that apportionment periods continue to be reported for the calendar year, as defined in Schedule A, and for the twelve month period of April 1 to March 31 of the following year as defined in Schedule B of the 1969 Agreement.

The roles and duties of the various jurisdictions associated with the Board are discussed and it is recognized that, if apportionment is to succeed, all jurisdictions must continue to maintain their present spirit of cooperation.

Procedures have also been recommended for use in the event of shortages.

Submitted by -

the COMMITTEE ON HYDROLOGY

V. M. Austford, Manitoba, Member

G. H. Morton, Canada, DOE-IWD Member

D. L. MacLeod, Saskatchewan, Member

D. W. Lawson, Canada, PFRA, Member

R. K. Deeprose, Alberta, Member

R. F. Hopkinson, Canada, DOE-AES, Member

A. Coulson, Canada, DOE-IWD, Alternate Member

R. B. Godwin, PPWB, Chairman

REPORT

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Prepared by:

THE COMMITTEE ON HYDROLOGY
OF THE
PRAIRIE PROVINCES WATER BOARD

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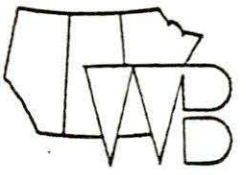


PRAIRIE PROVINCES WATER BOARD

Chapter I

INTRODUCTION

On October 30, 1969, Canada, Alberta, Saskatchewan and Manitoba signed the Master Agreement on Apportionment. This Agreement sets down the principles by which interprovincial eastward flowing waters shall be shared by the three prairie provinces. The Agreement also establishes an apportionment period for each boundary crossing.

In the third section of Schedule A between Alberta and Saskatchewan, it was agreed that "...*the actual flow shall be adjusted from time to time on an equitable basis...*". Similarly, the third section of Schedule B between Saskatchewan and Manitoba stated that "...*the actual flow shall be adjusted from time to time by mutual agreement on an equitable basis...*".

Presumably the Agreement did not lay down more specific rules because it was realized that equitable division of flow is a function of the basin's current state of regulation and the current use of water. Thus, an equitable basis today may not be equitable in the future.

A quote by one of the authors of the Agreement, Judge Harold W. Pope, gives a glimpse of the background views and intent behind the words finally chosen for use in the agreement:

> "...*There is no question, of course, but that a Province has complete jurisdiction and control over the water of a river which is wholly situated within its territory.*

Until such time as the Government of Canada assumes jurisdiction and control over interprovincial rivers no rights can be given by one Province which will affect in any way the rights of another Province to the use and enjoyment of an interprovincial river except in accordance with its consent and approval.

In dealing with this whole water problem we must not forget that narrow provincialism could destroy the proper development of our water resources and result in substantial loss to each of the Prairie Provinces...".

(October 20, 1964)
Sector Discussions - Water
Saskatchewan Resources Conference

The 1969 Master Agreement on Apportionment was based on this spirit of cooperation and on the premise that the overall intent of the Master Agreement, rather than individual words or phrases, would be used to guide the administration of interprovincial water matters. A basic assumption was that the provinces would consult with each other for the most effective, economical, and beneficial use of interprovincial waters. It is important to realize that the Agreement solidifies the general principle that flows be shared on an equitable basis, and sets up a mechanism to enable interprovincial cooperation and the resolution of disputes. Because of the difficulty in preparing a document that would adequately address all existing and future areas of concern, terms such as *"equitable"* were used to provide latitude in future negotiations. The Agreement did, however, establish a commitment for all parties to work together and cooperate to the fullest extent to solve existing and future problems.

Sections 1(a) of both Schedule A and Schedule B state that *"'natural flow' means the quantity of water which would naturally flow in any watercourse...".* Thus in all rivers being considered, the term natural flow refers to a volume of water being apportioned on a periodic basis and not to the apportionment of a rate of discharge. However,

specific mention is made of the one minimum flow constraint involving discharge. On the South Saskatchewan River, where the level of development inhibits an equitable distribution based solely on volume, there is reference in the Agreement to a minimum discharge requirement.

Practically, if both the timing and volume of flow are to be equitable, a downstream province should first determine both its minimum allowable discharge and volumetric water use requirements. The upstream province should then determine if these requirements can be met. Differences between the requirements of the upstream and downstream provinces could than be settled by negotiation. The results obtained by this process, while not binding for all time, would be suitable until requirements in one or both provinces change, necessitating a new round of negotiations. Thus, both the division of flow volumes and the timing of discharges could be kept equitable based on current needs.

The Agreement stresses the intergovernmental cooperation required to achieve equitable apportionment. This is exemplified by a quotation from the preamble to the Master Agreement:

> *"...And whereas the parties hereto recognize the continuing need for consultation and cooperation as between themselves with respect to the matters herein referred to so that the interests of all the parties are best served..."*.

The Board, in dealing with the terms of the 1969 Master Agreement, determined that detailed study was required to administer certain aspects of the Agreement. The Board directed the Committee on Hydrology to prepare a report on Administration of the Apportionment Agreement based on Terms of Reference established at Board meeting No. 12 on June 10, 1975.

TERMS OF REFERENCE

ADMINISTRATION OF APPORTIONMENT AGREEMENT

The purpose of the study shall be to investigate and report, with recommendations, on the mechanism required to administer the Apportionment Agreement. The study shall be based on the basic principles stated in the Apportionment Agreement. The study shall be restricted to apportionment of surface waters only.

The PPWB Committee on Hydrology shall be responsible for the study, and shall report to the board by March 31, 1978.

In the conduct of the study, all pertinent factors shall receive considerations including:"

1. *The identification and definition of the frequency with which flows shall be monitored and balanced to achieve an equitable apportionment; audited to enable interim flow adjustments; measured and reported; and the length of time allowed for deficits to be reconciled;*

2. *The effect of storage and diversion on equitable apportionment;*

3. *The role forecasting could, or should play in the administration of apportionment;*

4. *The role of the Board, the Secretariat, and the various agencies concerned with the administration of the Apportionment Agreement.*

Approved at Board Meeting No. 12
June 10, 1975.

The Terms of Reference do not specifically mention water quality. The Committee on Hydrology has interpreted these terms to be directed specifically to the consideration of water quantity problems only. Therefore, the report deals only with the quantitative aspects of the Administration of Apportionment and does not address quality of water implications except as they apply to storage and diversion in Chapter VII.

This report has been prepared to answer the aforementioned Terms of Reference. Chapter II provides a listing of definitions for many of the terms used in this report. Chapters III to VIII deal, respectively, with the role of each jurisdiction, apportionment periods, procedures in the event of shortages, forecasting, storage and diversion, and the duties of each jurisdiction. Chapter IX, the last chapter, summarizes the recommendations made in Chapters IV to VIII inclusive.

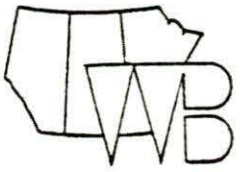
The five apportionment points considered in this report are:

1. The North Saskatchewan River at the Alberta-Saskatchewan boundary,
2. The South Saskatchewan River immediately below its junction with the Red Deer River,
3. The Saskatchewan River at the Saskatchewan-Manitoba boundary,
4. The Churchill River at the Saskatchewan-Manitoba boundary,
5. The Qu'Appelle River at the Saskatchewan-Manitoba boundary.

Natural flow computational procedures have been developed for each of these five locations. These procedures are reported in PPWB report No. 48 entitled "Determination of Natural Flow for Apportionment Purposes". Similarly, PPWB report No. 47 entitled "Streamflow Forecasting for Water Management and Flood Control" identifies forecasting procedures for these five sites. The recommendations from these two reports provide background material related to this report and have been summarized in Appendices I and II.

The role and duties of the Board and participating agencies are discussed in Chapters III and VIII. The discussions refer to the four Committees now associated with Board work and the Terms of Reference of each of these four Committees as presented in Appendix III.

In the early planning stages of this study, a working document was prepared which briefly summarized several U.S. compacts, treaties, and agreements pertaining to the sharing of water between adjoining jurisdictions. A limited number of copies of this document have been reproduced, and bound separately as Appendix IV to this report for the benefit of Board members and Committee members.



PRAIRIE PROVINCES WATER BOARD

Chapter II

DEFINITIONS

Many of the words and phrases used have specific meanings that must be defined for the purposes of this report. They are:

Agreement - means the Master Agreement on Apportionment (including Schedules A to D inclusive) executed the Thirtieth day of October, 1969, A.D. by Canada, Alberta, Saskatchewan and Manitoba.

Apportionment Flow - is the volume of flow subject to apportionment. In the case of the Saskatchewan River at the Saskatchewan-Manitoba boundary it is the sum of the water received by Saskatchewan from Alberta and natural flow rising in Saskatchewan.

Apportionment Period - The Agreement states in Section 3 of Schedule A that the Apportionment Period for volumetric flow between Alberta and Saskatchewan shall be the calendar year. Similarly, Section 3 of Schedule B specifies that the apportionment period between Saskatchewan and Manitoba is the period from April 1 of each year to March 31 of the year following.

Audit Period - is a specified period of less than twelve months for which natural flows are calculated and comparisons with actual flows are made to determine the flow adjustments necessary to effect apportionment.

Balance Period - is the period, following an audit period, within which the flow adjustments necessary to effect apportionment are made. This period may not extend beyond the current apportionment period.

Board - means the Prairie Provinces Water Board (P.P.W.B.).

Chairman - means the Chairman of the Prairie Provinces Water Board.

COH - means the Committee on Hydrology.

COIAA - means the Committee on Interjurisdictional Agreements Administration.

Consumptive Use - includes all water used or diverted and not returned to the stream.

COWD - means the Committee on Water Demand.

COWQ - means the Committee on Water Quality.

Discharge - means a rate of streamflow.

Diversion - means a man-made transfer of water from a stream for use at some other location. Three types of diversions are discussed in more detail in this report:

(a) Diversion for Consumptive Use - diversion of water for such uses as irrigation, industrial or municipal uses. These diversions will usually develop some return flow after consumptive use requirements are met.

(b) Intrabasin Diversion - diversion of water from one stream to another with both the donor and receiving stream being in the same tributary basin with respect to the interprovincial apportionment point.

(c) Interbasin Diversion - diversion of water from one drainage basin

to another such that the water reaching the receiving stream will cross the interprovincial boundary at a different point than water in the donor stream.

Executive Director - means the senior officer of the Board Secretariat.

Flow - means a volume of flow.

Interim Audit Period - means an audit period established temporarily to deal with a specific apportionment problem.

Master Agreement - means the Master Agreement on Apportionment not including Schedules A to D inclusive.

Member - means Member of the Prairie Provinces Water Board.

Ministers - means the responsible ministers of the governments which are party to the Agreement.

Monitor - the term *"monitor"* when used in the Master Agreement has two distinct meanings. Section 7 of the Master Agreement states that *"...the parties agree that the monitoring of the quantity and quality..."* will be the responsibility of Canada. The term *"monitoring"* in this context means the actual measurement of flow or the measurement of the concentration of various constituents in the water bodies crossing the interprovincial boundaries. In Section 10 of the Master Agreement the term *"monitoring"* is used as follows: *"...The Prairie Provinces Water Board shall monitor and report on the apportionment of water..."*. In this context monitor means review or administer.

Natural Flow - means the quantity of water which would naturally flow in any watercourse had the flow not been affected by human interference of human intervention.

PFRA - means the Prairie Farm Rehabilitation Administration.

River Discharge Forecasts - means forecasts of the streamflow discharges that are expected to occur at given locations on specific dates in the immediate future.

Secretariat - means the operational unit established by the Board to carry out the day-to-day affairs of the Board.

Schedule A - means the Agreement between Alberta and Saskatchewan apportioning eastward flowing water between Alberta and Saskatchewan.

Schedule B - means the Agreement between Saskatchewan and Manitoba apportioning eastward water between Saskatchewan and Manitoba.

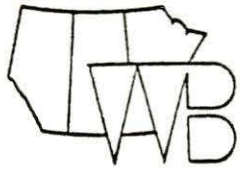
Schedule C - means the Prairie Provinces Water Board Agreement between Canada, Alberta, Saskatchewan and Manitoba reconstituting the Prairie Provinces Water Board.

Shortage - a shortage has occurred if, at the end of an apportionment period, the terms of the 1969 Agreement have not been met at a specific apportionment point or if a discharge criterion has not been met.

Streamflow Forecasts - is a general term including both river discharge forecasts and water supply forecasts.

Water Supply Forecasts - means forecasts of the volume of water that may be expected at given locations during a specific period of time such as the spring-summer period, winter period, or, in some cases, a spring only period.

WSC - means the Water Survey of Canada.



PRAIRIE PROVINCES WATER BOARD

Chapter III.

THE ROLE OF THE BOARD AND PARTICIPATING AGENCIES

The role of the Prairie Provinces Water Board is defined in Schedule C of the Master Agreement on Apportionment. This schedule defines the functions, composition, duties, authority and operation of the Board. Schedules A and B define the responsibilities of the participating jurisdictions with respect to their commitments for delivering flows in a suitable quantity and of an acceptable quality. Clauses in the Agreement recognize the fact that the three provinces share many of the same river systems and that cooperation is necessary to ensure that the interests of all parties are best served.

Section 2 in Schedule C of the Agreement gives the Board the responsibility to:

> *"...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...".*

The following information summarizes the roles that the Board, the Secretariat, and the various jurisdictions associated with the Board take in fulfilling this responsibility.

THE BOARD

The primary role of the Board is to see that the 1969 Agreement is

administered. This requires that both streamflow and water use in eastward flowing streams be adequately monitored to enable the Board to certify that apportionment of flow is achieved.

The parties to the Agreement have agreed that, through the Board, the Agreement will be monitored, problems examined, studies undertaken and recommendations made on the apportionment of water.

Cooperation

The Board is composed of senior water managers from Alberta, Saskatchewan, Manitoba, PFRA, and Environment Canada and provides a forum for discussion of mutual water quantity and quality problems. The fact that the Board has a long history and the participants have known each other for a number of years gives rise to a cooperative spirit which is characteristic of Board affairs. Such cooperation has in the past averted jurisdictional problems between the provinces and if future water problems are to be aired in an open forum and dealt with before they become serious, the Board affords the logical opportunity for such discussion. A principle responsibility of the Board is that of fostering continuing cooperation so that the individual aims and desires of each province and of Canada with respect to water resource management may be realized.

Forecasting

The only direct reference to forecasting that appears in the Agreement is contained under Section 4(f) of Schedule C of the Master Agreement which states that one of the duties of the Board is:

> *"...to ensure the coordination of such technical programs as water quantity and quality monitoring and streamflow forecasting required for the effective apportionment of water...".*

It is recognized that all three provincial jurisdictions are now actively involved in preparing streamflow forecasts. The role of the Board would appear to be in ensuring a continuing coordination of streamflow forecasting and information exchanges between all jurisdictions.

Monitoring and Reporting

Section 10 of the Master Agreement states:

> *"...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...".*

Monitoring in this sense means to review. The Board's role in monitoring and reporting is exercised primarily through the Secretariat by the preparation of annual reports and by members reporting to their own jurisdictions.

Revisions to the Agreement

The Board should be involved in any recommendation for change to the Agreement including any suggestion for changes in Schedules A and B. Any such revision must be ratified by all four jurisdictions involved in the Agreement. This is specified in Section 4 of the Master Agreement which states:

> *"...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...".*

THE SECRETARIAT

The role of the Secretariat is to serve the Board. As the operational arm of the Board its role is to carry out the duties that are delegated to the Secretariat by the Board. Specifically, the Secretariat has a continuing responsibility for overseeing, and reporting on, the apportionment of waters as set out in Schedules A and B of the Agreement, and for providing advice and recommendations to the Board.

PARTICIPATING AGENCIES

The member agencies of the Board provide expertise to the technical advisory groups of the Board and participate in, and undertake, studies and tasks connected with Board activities.

The role of federal and provincial agencies connected with these activities is discussed in more detail in the following sections.

Provincial Agencies

Each provincial jurisdiction is responsible for managing water resources in its own province to meet the terms of apportionment. Each province operates projects to manage water with due regard to the requirements of the Agreement. In doing this they have a continuing responsibility to determine their own provincial needs and when those needs conflict with water use in adjacent provinces to negotiate equitable sharing of flow subject to apportionment.

Each provincial member has a responsibility to keep the Board informed of all prospective developments in that member's jurisdiction to ensure that such developments will not adversely affect the apportionment of interprovincial water or the integrated development of water resources of interprovincial streams.

The way in which this responsibility could best be met by member provinces was discussed in PPWB meeting No. 17 on November 9, 1977. The Board agreed:

> *"...that for all future projects on interprovincial rivers a statement of the effects of the project at the downstream (or upstream if applicable) boundary will be tabled with the Board by the Board member representing the proponent province...".*
>
> (Minute 17-25, PPWB Meeting No. 17)

This procedure should bring to the attention of the Board any project that might have an effect on interprovincial streams.

Federal Agencies

Two federal agencies, Environment Canada and PFRA have responsibilities in the Administration of Apportioment.

Environment Canada provides the monitoring required for the implementation and maintenance of the Agreement.

The two federal members, one of whom is the Chairman of the Board, have a continuing responsibility to keep the Board informed of any federal action or policy that might affect apportionment. They also ensure that national interest are considered as they pertain to Board responsibilities. Both federal agencies are frequently asked to play an active role in undertaking studies to facilitate the implementation of apportionment on interprovincial streams.

COMMITTEES OF THE BOARD

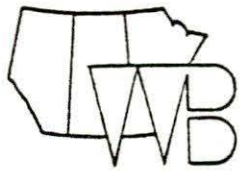
Each of the four Committees of the Board has specific Terms of Reference describing its duties (see Appendix III). The Committees are of two types; one type is formed to perform a specific task, and one type fulfills a continuing need of the Board to receive advice on broad water management aspects of Apportionment and has a continuing mandate and a membership composed of all Board agencies. There are valid reasons for both types of Committees. For example, Section 13 of the Master Agreement provides that:

> *"...the parties agree...to work together and to cooperate to the fullest extent...".*

The Committee on Hydrology concludes that there is a continuing need for both standing committees (with a continuing mandate to provide technical advice to the Board) and special purpose committees (for individual assignments).

> *It is recommended that the Committee on Hydrology and the Committee on Water Quality continue to be utilized as standing committees for purposes of administering apportionment.*

It is further recommended that the COWD and the COIAA Committees, because they have been formed to perform a specific task, be classified as special purpose committees.



PRAIRIE PROVINCES WATER BOARD

Chapter IV

APPORTIONMENT, BALANCE AND AUDIT PERIODS

This chapter deals with the frequency with which flows should be measured and reported, and the length of time to be allowed for flows to be balanced for all five basins under study, at the present level of development.

The terms Apportionment Period, Balance Period and Audit Period were defined in Chapter II. Some further comment on the way they are used in this chapter is also required.

Apportionment Period

The Agreement states in Section 3 of Schedule A that the Apportionment Period between Alberta and Saskatchewan shall be the calendar year. Similarly, Section 3 of Schedule B specifies that the apportionment period between Saskatchewan and Manitoba is the period from April 1 of each year to March 31 of the year following.

Balance Period

It may be necessary, in order to achieve equitable apportionment, to balance volumes of flow for periods of less than the apportionment period. The possibility is addressed in a general manner in the Agreement by phrases such as:

> *"...flow shall be adjusted from time to time by mutual agreement on an equitable basis..."*
>
> (Section 3, Schedule B)

and

> *"...consumption or diversion...shall be made equitably...depending on the actual flow of water...and the requirements of each Provinces from time to time...".*
>
> (Section 4(b), Schedule A, and Section 4, Schedule B)

The Agreement thus provides for flexibility within each twelve month period for upstream water management tempered by a commitment that provinces will respect each other's requirements fairly.

Audit Period

An *"audit period"* as defined in Chapter II is that period within the apportionment period for which natural flow is calculated and compared with actual flow to determine the flow adjustments that would be needed to effect apportionment.

BASIN CONSIDERATIONS

Each of the five basins studies is discussed in detail in the following section. Recommendations on audit periods and minimum discharge requirements are based on the present level of development in each basin. Significant changes to these conditions, either major or gradual, may necessitate a review and evaluation of the recommendations. Therefore;

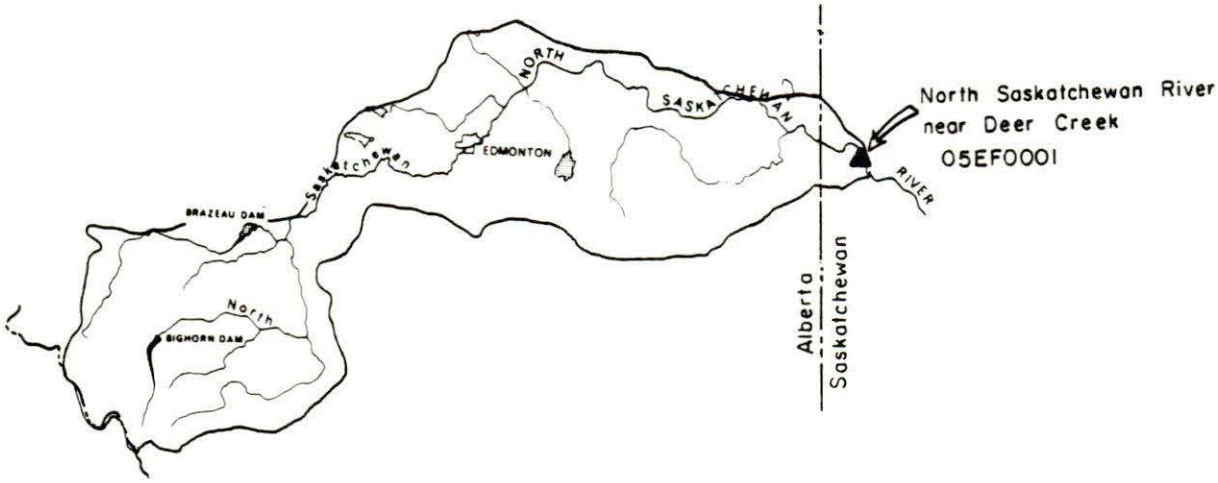
> *It is recommended that the Board review balance periods, audit periods, or the minimum discharge criterion, for specific basins at the request of any member agency.*

North Saskatchewan River

The apportionment period for the North Saskatchewan River at the Alberta-Saskatchewan boundary is the calendar year as specified in Schedule A of the Agreement. The balance of flow for apportionment is calculated at the hydrometric station North Saskatchewan River near Deer Creek (see Figure 1). A report on apportionment is prepared for each calendar year using monthly streamflow values and is presented in the PPWB Annual Report.

FIGURE 1.

NORTH SASKATCHEWAN RIVER DRAINAGE BASIN TRIBUTARY
TO THE ALTERTA-SASKATCHEWAN BOUNDARY



The need for audit periods, or balance periods, of less than one year is examined below using suitably appropriate flow data.

The monthly flow volumes for the five year period from 1974 to 1978 inclusive, shown in Table 1, are representative of present operational policies in Alberta because the two major reservoirs in the upstream basin (Brazeau and Bighorn) were both in operation and there have been no changes in either upstream basin uses or operating policies since 1978. When 1974-78 flow volumes are compared to natural flows from 1912 to date, it is apparent that these five years are the most extreme streamflow drought period on record. In only one year (1949) was the annual natural flow volume lower then the 4 550 000 dam^3 calculated for 1975. Futhermore, the total volume for the three years 1975, 1976 and 1977 is 1 230 000 dam^3 lower than the volume for the previously lowest three consecutive years 1949, 1950 and 1951. During the three year low flow period of 1975 to 1977 inclusive, recorded flow totalled 101% of natural flow and in 1975 the most extreme year, it was 105% of natural flow because some of the water released from Brazeau and Bighorn reservoirs was water originally stored in 1974. Therefore, it is concluded that apportionment is not a problem at the

present time and neither audit periods nor balance periods of less than twelve months are required for the North Saskatchwan River basin.

TABLE 1

NORTH SASKATCHEWAN RIVER AT THE ALBERTA-SASKATCHEWAN BOUNDARY

(Monthly Volumes in dam^3 x 1000)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1974													
Recorded Flow	195	321	275	1 630	1 860	1 260	1 180	578	557	518	396	405	9 170
Natural Flow	50	74.6	94.5	1 520	1 870	1 750	1 710	1 000	630	408	227	176	9 410
% of Natural Flow	390	430	291	107	99	72	69	58	88	126	174	230	97
1975													
Recorded Flow	333	267	289	566	746	567	546	373	328	258	195	306	4 770
Natural Flow	43.2	35.1	82.2	348	667	732	1 150	710	416	228	49.3	90.6	4 550
% of Natural Flow	771	761	351	163	112	77	48	53	79	113	396	338	105
1976													
Recorded Flow	292	325	355	576	521	538	516	689	440	442	368	346	5 410
Natural Flow	63.8	101	146	422	535	668	1 100	1 280	684	329	81.4	10.9	5 420
% of Natural Flow	458	323	244	128	97	80	47	54	79	133	402	324	100
1977													
Recorded Flow	304	238	269	464	789	1 080	640	672	625	504	244	363	6 190
Natural Flow	39.4	50.2	119	342	977	1 370	922	1 020	731	424	53.7	124	6 170
% of Natural Flow	772	474	226	136	81	79	69	66	85	119	454	293	100
1978													
Recorded Flow	326	318	253	561	704	1 410	1 330	663	789	567	450	381	7 750
Natural Flow	54.8	97.4	68.3	482	752	1 690	1 810	1 050	1 060	528	205	96.8	7 890
% of Natural Flow	594	326	370	116	93	83	73	63	74	107	220	393	98

The agreement does not specify a minimum discharge requirement for the North Saskatchewan River at the Alberta-Saskatchewan boundary and, based on current use patterns, there have been no downstream uses that now require balance periods of less than one year or guaranteed minimum discharges. The major downstream use in winter periods is for hydroelectric power generation and winter releases from upstream power reservoirs support this use. Similarly, the maintenance of high minimum discharges at Edmonton provides a stable low discharge regime in the downstream basin as illustrated in Table-2. Occasionally, as can be seen in Table 2, the discharge falls below 85.0 m^3/s but it should be noted that even in these drier than average years the recorded minimum daily discharge for the months of December to March inclusive is measurably larger than the natural monthly mean discharge. Recorded monthly mean discharges also exceed natural discharges in every month

from October to March inclusive. Furthermore, even in 1975, the second lowest streamflow year since 1912, the monthly mean discharge for November was 75.3m^3/s compared to a natural monthly mean discharge of 19.0m^3/s.

TABLE 2

NORTH SASKATCHEWAN RIVER AT THE ALBERTA-SASKATCHEWAN BOUNDARY

(Monthly discharge in m^3/s)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Minimum
1974													
Recorded Monthly Mean	72.8	133	103	626	696	487	440	216	215	193	153	151	72.8
Natural Monthly Mean	18.7	30.9	35.4	585	696	674	638	374	243	152	87.6	65.4	18.7
Recorded Minimum Daily Discharge	44.7	83.8	89.8	95.1	498	351	246	182	148	161	96.3	111	44.7
1975													
Recorded Monthly Mean	124	111	108	218	278	219	204	139	126	96.2	75.1	114	75.1
Natural Monthly Mean	16.1	14.5	30.6	134	249	282	428	265	160	85.3	19.0	33.8	14.5
Recorded Minimum Daily Discharge	83.0	84.1	85.5	123	187	147	122	116	94.6	88.3	32.3	66.3	32.3
1976													
Recorded Monthly Mean	109	130	132	222	194	207	193	257	209	165	142	129	109
Natural Monthly Mean	23.8	40.2	54.4	163	200	257	410	479	264	123	31.4	40.6	23.8
Recorded Minimum Daily Discharge	71.9	82.1	95.1	133	136	120	125	132	157	93.4	83.0	57.5	57.5
1977													
Recorded Monthly Mean	114	98.6	100	179	294	416	239	251	241	188	94.3	136	94.3
Natural Monthly Mean	14.7	20.7	44.5	128	365	529	343	382	282	158	20.7	46.4	14.7
Recorded Minimum Daily Discharge	79.3	89.5	65.1	91.5	110	230	173	191	163	136	29.4	92.0	29.4
1978													
Recorded Monthly Mean	122	132	94.4	216	263	544	496	248	304	212	173	142	94.4
Natural Monthly Mean	20.4	40.2	25.5	186	281	652	676	391	408	197	79.6	36.2	20.4
Recorded Minimum Daily Discharge	105	106	75.3	151	181	354	289	192	152	162	67.7	108	67.7

The data in Table 2 indicates that upstream reservoirs presently maintain a consistently high level of minimum discharge at the Alberta-Saskatchewan boundary for the entire year.

It is recommended that no audit or balance periods of less than twelve months, and no minimum discharge criterion, be established at present for the North Saskatchewan River at the Alberta-Saskatchewan boundary.

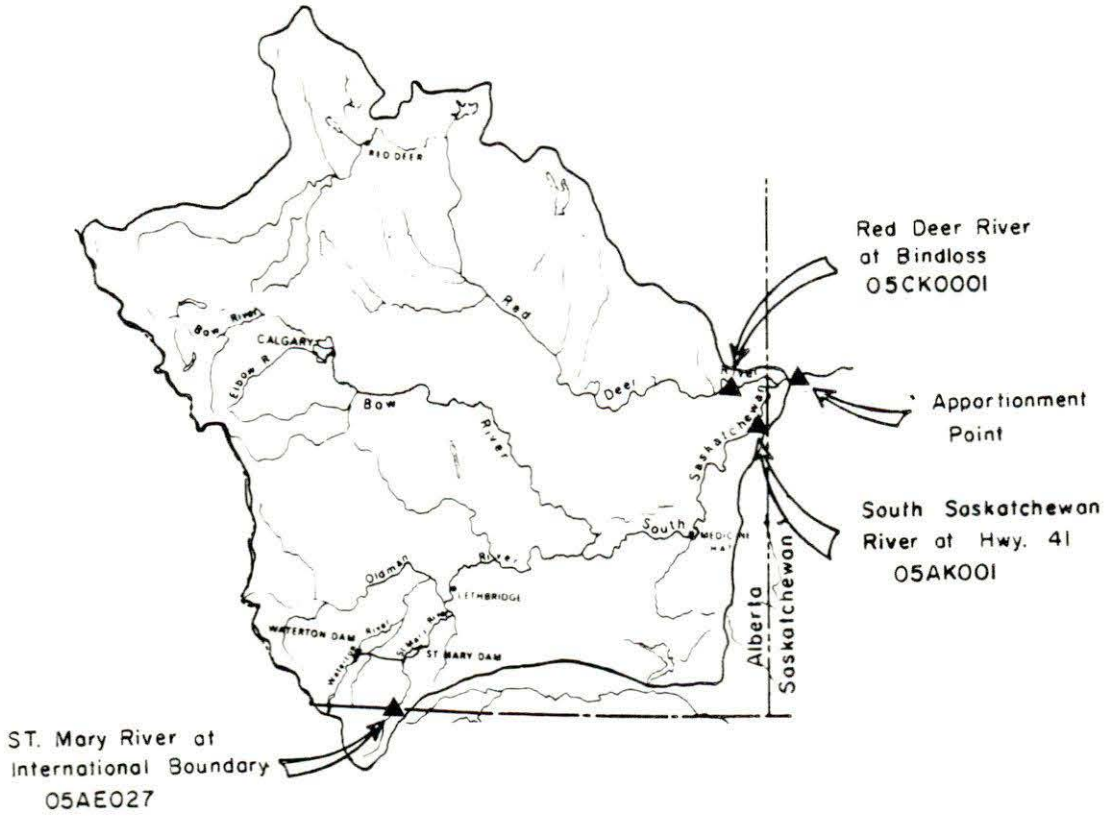
It is further recommended that apportionment flows at this site continue to be reported on a calendar year basis.

South Saskatchewan River

The apportionment period for the South Saskatchewan River below its junction with the Red Deer River, as specified in Schedule A of the Agreement, is the calendar year. The balance of flow for apportionment is calculated from the sum of recorded flow at two hydrometric stations; the South Saskatchewan River at Highway No. 41 and the Red Deer River near Bindloss (see Figure 2).

FIGURE 2.

SOUTH SASKATCHEWAN RIVER DRAINAGE BASIN TRIBUTARY TO A POINT IMMEDIATELY BELOW ITS JUNCTION WITH THE RED DEER RIVER



An audit period is prepared for the Secretariat by Water Survey of Canada at the end of each quarter, using monthly values, so that management decisions can be made to effect a balance by the end of December. An

apportionment report is also prepared for each calendar year and is included in the PPWB Annual Report.

Apportionment at this point is subject to two specific constraints as described in Section 4 of Schedule A:

"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 [1] *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* [2] *cubic feet per second.*

(b) The consumption or diversion by Alberta provided for under the preceding subparagraph 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".

[1] 2,100,000 acre-feet = 2,590,000 dam^3.

[2] 1,500 cubic feet per second = 42.5 cubic meters per second.

At the present level of development there are no uses downstream of the Alberta-Saskatchewan boundary that would significantly benefit from a balance period of less than one year. Lake Diefenbaker's winter operation is primarily hydroelectric power generation with a general rule of fill in the spring and summer (when other consumptive uses occur) for release in the fall and winter. Annual balancing will satisfy this use and, based on present operating experience, Saskatchewan's share will be delivered by the end of the fourth quarter.

At the present level of development, consumptive uses such as irrigation from Lake Diefenbaker and releases to the Qu'Appelle River are relatively small when compared to hydropower use (as shown in Table 3).

TABLE 3

WATER USE FROM DIEFENBAKER LAKE

(Monthly Volumes in dam^3)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1974													
Irrigation	0	0	0	0	0	5 200	13 200	5 100	200	3 800	0	0	27 500
Release to Qu'Appelle	3 300	800	100	100	100	100	500	1 600	100	100	8 900	4 900	20 600
Total	3 300	800	100	100	100	5 300	13 700	6 700	300	3 900	8 900	4 900	48 100
Hydro Power	928 000	745 000	904 000	793 000	867 000	1 020 000	691 000	533 000	445 000	346 000	545 000	734 000	8 551 000
1975													
Irrigation	0	0	0	0	6 700	12 000	17 000	7 500	9 400	0	0	0	52 600
Release to Qu'Appelle	3 800	2 900	100	100	100	1 100	2 500	5 300	5 800	4 300	4 300	4 200	34 500
Total	3 800	2 900	100	100	6 800	13 100	19 500	12 800	15 200	4 300	4 300	4 200	87 100
Hydro Power	882 000	778 000	584 000	318 000	547 000	931 000	981 000	330 000	265 000	532 000	658 000	868 000	7 674 000
1976													
Irrigation	0	0	0	0	7 500	9 000	12 000	13 100	1 900	0	0	0	43 500
Release to Qu'Appelle	4 100	900	100	100	300	500	1 300	2 100	7 100	3 800	4 500	4 000	28 800
Total	4 100	900	100	100	7 800	9 500	13 300	15 200	9 000	3 800	4 500	4 000	72 300
Hydro Power	973 000	842 000	643 000	355 000	183 000	155 000	185 000	576 000	543 000	536 000	585 000	929 000	6 505 000
1977													
Irrigation	0	0	0	0	11 400	16 800	33 700	14 300	11 100	0	0	0	87 300
Release to Qu'Appelle	2 900	2 700	3 100	3 200	9 900	9 900	8 200	9 300	8 700	8 900	3 900	3 300	74 000
Total	2 900	2 700	3 100	3 200	21 300	26 700	41 900	23 600	19 800	8 900	3 900	3 300	161 300
Hydro Power	966 000	593 000	272 000	161 000	152 000	117 000	118 000	119 000	114 000	140 000	483 000	597 000	10 340 000
1978													
Irrigation	0	0	0	0	10 300	21 600	28 000	16 400	12 300	0	0	0	88 600
Release to Qu'Appelle	3 200	2 300	200	100	1 400	2 300	7 200	10 300	9 800	5 000	3 400	3 600	48 800
Total	3 200	2 300	200	100	11 700	23 900	35 200	26 700	22 100	5 000	3 400	3 600	137 400
Hydro Power	590 000	431 000	431 000	298 000	147 000	647 000	402 000	428 000	608 000	569 000	568 000	623 000	5 742 000

Major changes in the timing of water deliveries from Alberta would be of little benefit to Saskatchewan. However, adherence to the minimum discharge criterion is important and Saskatchewan has identified several

uses that are directly affected by discharge in the South Saskatchewan River. The uses are:

1. Riparian and licensed uses above Lake Diefenbaker,
2. Ferry crossings both above and below Lake Diefenbaker that require at least 42.5 m^3/s to be operable.
3. Fish population above Lake Diefenbaker,
4. Municipal supply intakes above Lake Diefenbaker requiring at least 42.5 m^3/s to be operable.
5. A downsteam minimum flow commitment of 42.5 m^3/s below Lake Diefenbaker combined with a continuing summer requirement of about 56.6 m^3/s to meet evaporative and other losses in the lake means that disruption of the 42.5 m^3/s discharge would hasten lake drawdown in direct proportion to the amount of discharge not passing the boundary.

All calculation related to the minimum flow criterion must use tentative discharge data to determine if the criterion is being violated. There are also operational constraints on the ability of Water Survey of Canada to measure and interpret streamflow and to calculate natural flow. They make it impractical to treat the 42.5 m^3/s (or 50% of natural flow when natural flow is less than 85.0 m^3/s) constraint as an instantaneous discharge. It would appear to be more practical to deal with it operationally as a daily mean discharge.

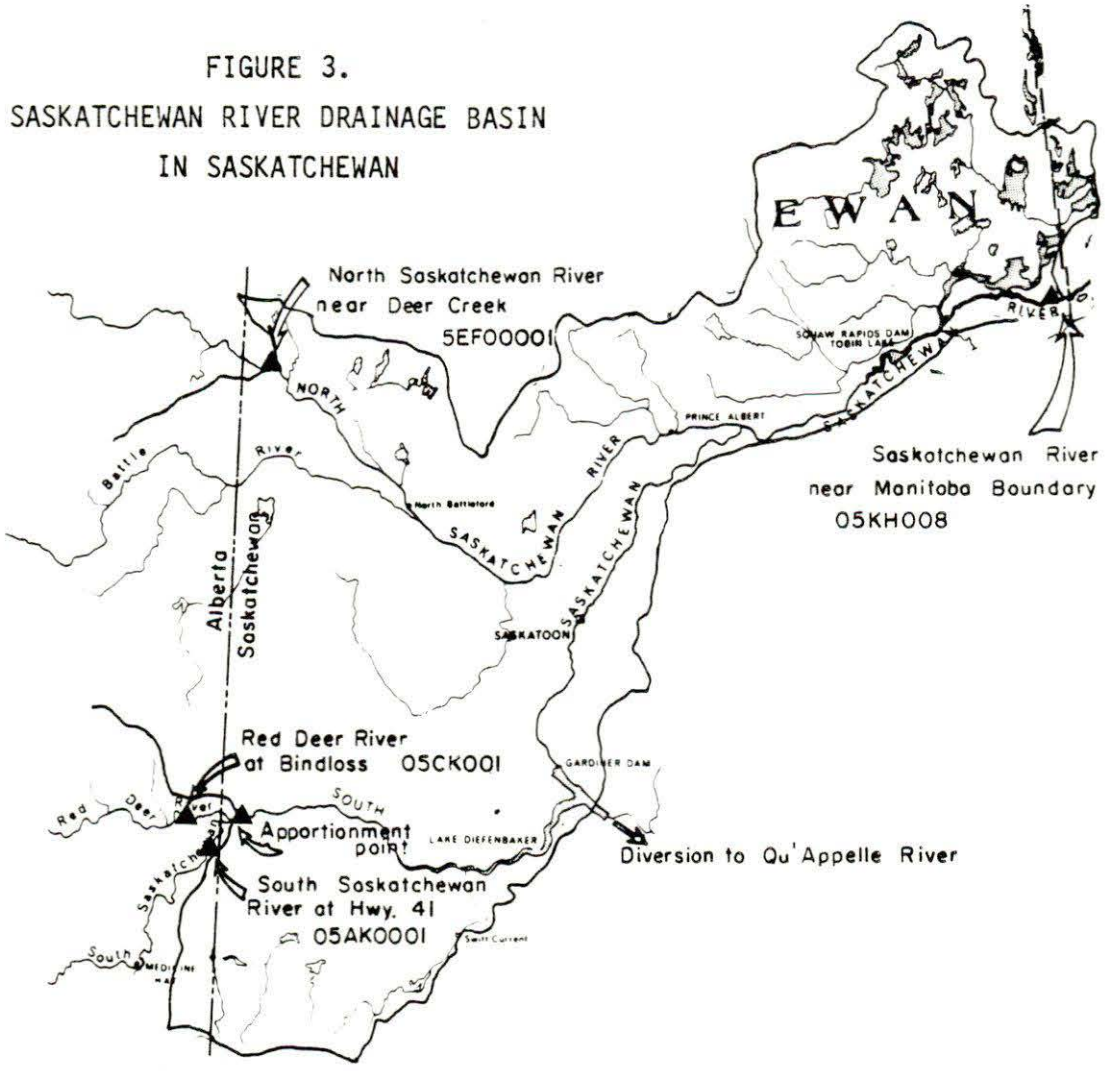
It is recommended that the South Saskatchewan River near the Alberta-Saskatchewan boundary be audited on a quarterly basis reverting to one month or less basis when recorded flow drops below 42.5 m^3/s, but that no balance period of less than twelve months be established at this time. It is also recommended that the minimum discharge criterion be interpreted as daily mean discharge, not as instantaneous discharge, and that in low flow situations, Water Survey of Canada take more frequent discharge measurements as deemed necessary to monitor the Apportionment Agreement.

It is further recommended that apportionment flows at this site continue to be reported on a calendar year basis.

Saskatchewan River

The apportioment period for the Saskatchewan River at the Saskatchewan-Manitoba boundary, as specified in Schedule B of the Agreement, is April 1 of one year to Marh 31 of the following year. The balance of flow is calculated at the hydrometric station Saskatchewan River near the Saskatchewan-Manitoba boundary (see figure 3).

FIGURE 3.
SASKATCHEWAN RIVER DRAINAGE BASIN
IN SASKATCHEWAN



The flow subject to apportionment at this point is the total volume of water received by Saskatchewan from Alberta and the natural flow volume arising in Saskatchewan. Manitoba should recieve 50% of the flow subject to apportionment.

An informal report on apportionment at this point is now prepared for the calendar year using monthly values and is included in the PPWB Annual Report. The Committee suggests that, in future Annual Reports, this report should be based on the twelve month period of April 1 to March 31 of the following year.

The five year period shown in Table 4 is representative of the *"present"* level of upstream development in the Saskatchewan River basin. The flow volumes are also characteristic of an extreme streamflow drought period. An examination of natural flow estimates for the period 1912 to date indicates that in only four years was the annual apportionment flow lower than the apportionment flow in 1977-78. Futhermore, in two of these twelve month periods the annual volume was within 2% of the 1977-78 volume.

TABLE 4

SASKATCHEWAN RIVER AT THE SASKATCHEWAN-MANITOBA BOUNDARY

(Monthly Volumes in dam^3 x 1000)

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1973-74													
Recorded Flow	1 790	2 440	2 530	2 350	1 440	1 360	1 230	851	1 040	1 320	1 320	1 640	19 300
Apportionment Flow	2 220	2 890	3 370	3 140	1 760	1 290	1 270	412	638	647	567	885	19 100
% of Apportionment Flow	80	84	75	75	81	105	97	206	163	204	232	185	101
1974-75													
Recorded Flow	2 450	5 960	4 270	3 270	2 320	2 040	1 780	1 340	1 160	1 320	1 530	1 610	29 000
Apportionment Flow	3 250	6 880	5 290	4 170	2 530	2 050	1 690	1 140	670	615	857	103	29 200
% of Apportionment Flow	75	87	81	78	92	100	105	117	173	215	178	156	99
1975-76													
Recorded Flow	1 650	2 850	2 550	2 520	1 480	1 080	1 080	1 060	913	1 180	1 360	1 460	19 200
Apportionment Flow	1 750	3 720	3 700	3 170	1 750	1 170	987	587	438	618	800	945	19 600
% of Apportionment Flow	94	77	69	79	84	92	109	181	208	191	170	154	98
1976-77													
Recorded Flow	1 990	1 160	862	1 030	1 200	1 210	1 230	771	846	1 200	1 200	968	13 700
Apportionment Flow	2 310	1 850	1 560	1 690	1 730	1 350	1 110	360	255	476	774	843	14 300
% of Apportionment Flow	86	63	55	61	69	90	111	214	332	252	155	115	96
1977-78													
Recorded Flow	1 340	1 230	1 500	1 100	970	1 130	944	617	724	1 040	904	946	12 400
Apportionment Flow	1 580	1 440	1 780	1 300	1 160	1 190	1 110	381	356	499	620	879	12 300
% of Apportionment Flow	85	85	84	85	84	95	85	162	203	208	145	108	102

During this period 1973-74 to 1977-78 recorded monthly flow was never less than 55% of the monthly flow subject to apportionment. The recorded annual flow volume exceeded Manitoba's estimated annual apportionment by 100 000 dam^3 in the low flow period of 1977-78 and the total recorded flow volume in the five year period was 97% of the total volume of flow subject to apportionment.

At the present level of development, no downstream uses have been identified that would significantly benefit from a balance period of less than one year. The primary downstream use is hydroelectric power generation and both the North and South Saskatchewan Rivers are regulated for the same purpose. Therefore, the monthly flow volumes in Table 4 illustrate that apportionment is presently not a problem and that neither audit periods nor balance periods of less than twelve months need be established at this location.

A minimum discharge requirement has not been specified for the Saskatchewan River at the Saskatchewan-Manitoba boundary. The discharge values in Table 5 indicate that upstream regulation of streamflow consistently improves the low discharge characteristics of the river during the months of November to March inclusive.

TABLE 5

SASKATCHEWAN RIVER AT THE SASKATCHEWAN-MANITOBA BOUNDARY

(Monthly discharge in m^3/s)

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Minimum
1973-74													
Recorded Monthly Mean	691	913	-	-	-	-	461	328	387	493	545	614	-
Natural Monthly Mean	856	1 080	1 302	1 171	658	499	475	158	238	241	234	330	158
Recorded Minimum Daily Discharge	462	742	-	-	-	-	411	226	282	456	498	566	-
1974-75													
Recorded Monthly Mean	946	2 230	1 650	1 220	868	783	665	517	434	494	634	604	434
Natural Monthly Mean	1 260	2 570	2 040	1 560	944	790	631	439	250	230	354	383	230
Recorded Minimum Daily Discharge	566	2 010	1 470	997	745	697	572	394	377	357	583	473	357
1975-76													
Recorded Monthly Mean	637	1 060	983	940	555	416	401	411	341	442	544	543	341
Natural Monthly Mean	674	1 390	1 430	1 180	654	452	369	226	163	230	319	353	163
Recorded Minimum Daily Discharge	462	988	844	804	374	334	317	255	272	351	510	456	255
1976 77													
Recorded Monthly Mean	768	431	333	383	447	466	460	298	316	447	498	362	298
Natural Monthly Mean	892	692	602	631	647	522	413	138	95	177	320	314	95
Recorded Minimum Daily Discharge	476	266	226	303	262	388	311	228	264	343	439	300	226
1977-78													
Recorded Monthly Mean	519	459	579	409	362	436	352	238	270	389	374	353	238
Natural Monthly Mean	608	537	687	485	433	460	412	147	132	186	256	328	132
Recorded Minimum Daily Discharge	253	326	405	328	272	337	264	159	184	272	311	328	159

Similarly, high monthly flows for April to September are consistently decreased by upstream reservoir storage and consumptive use.

A discharge of 283 m^3/s is needed to enable barge traffic to operate between Cumberland and Cedar Lakes. In the fall of 1976 and 1977, when low discharge conditions were experienced that inhibited this barge travel, Manitoba officials, through Saskatchewan Environment, were able to have discharges improved sufficiently to maintain barge operations by releases of additional water from Lake Diefenbaker.

It is recommended that no audit or balance periods of less than twelve months be established for the Saskatchewan River at the Saskatchewan-Manitoba boundary and that there is presently no need to establish a minimum discharge criterion at this location.

It is also recommended that apportionment flows at this site now be reported on the basis of a twelve month period from April 1 to March 31 of the following year.

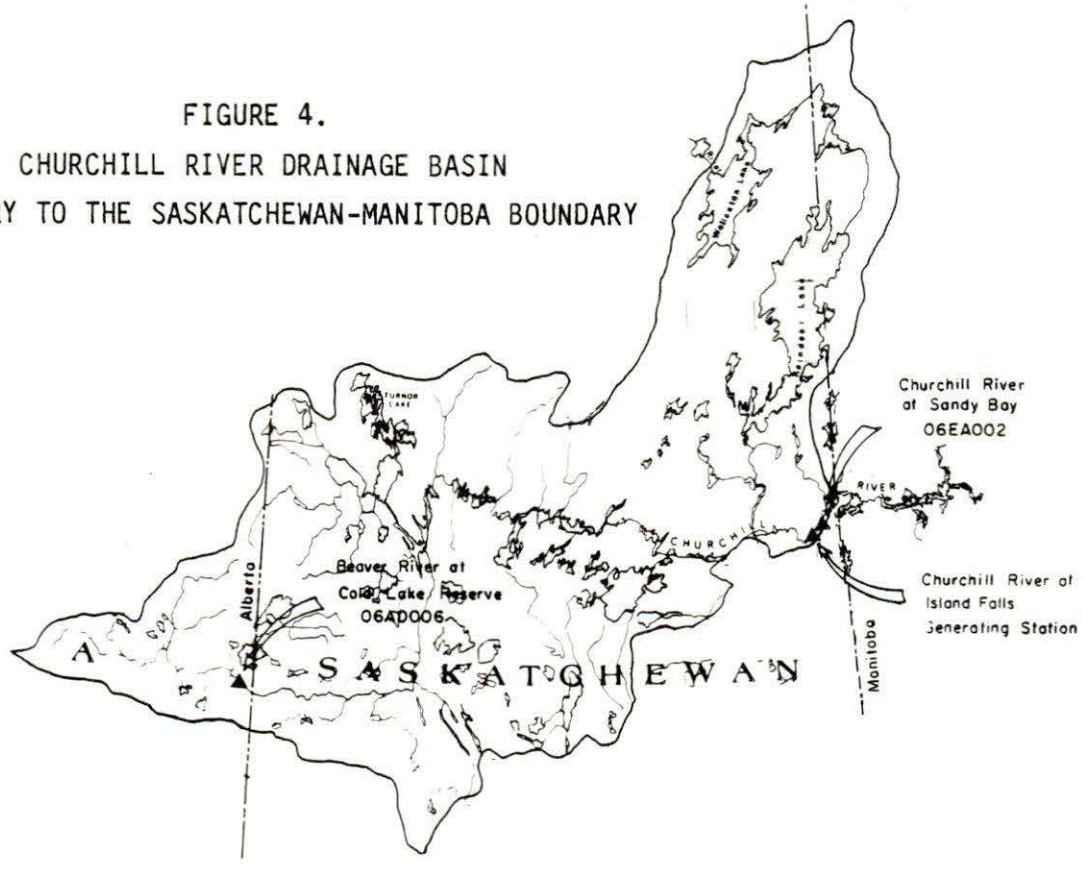
Churchill River

The apportionment period for the Churchill River at the Saskatchewan-Manitoba boundary, as specified in Schedule B of the Agreement, is April 1 of one year to March 31 of the following year. The balance of flow for apportionment is calculated at the hydrometric station Churchill River at Sandy Bay (see Figure 4). An informal report on apportionment at this point is now prepared for the calendar year using monthly values and is included in the PPWB Annual Report. The Committee suggests that, in future Annual Reports, this report should be based on the twelve month period of April 1 to March 31 of the following year.

A comparison between recorded and natural streamflow for Churchill River at Island Falls for the five year period 1965-66 to 1969-70 is shown in Tables 6 and 7. This period covers a lower than average (22 million dam^3).

natural streamflow sequence. Recorded streamflow is not available at the Saskatchewan-Manitoba boundary station (Churchill River at Sandy Bay) for this period, but the Island Falls station may be used for comparative purposes because local inflow between the two stations is less than 2% of recorded monthly streamflow at the Island Falls site.

FIGURE 4.
CHURCHILL RIVER DRAINAGE BASIN
TRIBUTARY TO THE SASKATCHEWAN-MANITOBA BOUNDARY



The monthly flow volumes shown in Table 6 illustrate that apportionment is not a problem in this basin and that neither audit periods nor balance periods of less than one year are presently needed. During the five year period natural streamflow was below normal in three twelve month periods, the lowest of which was 1968-69. In all three of these twelve month periods over 100% of natural flow was passed into Manitoba by utilizing water previously stored in Reindeer Lake. Furthermore, in April 1968, the lowest natural streamflow month in the five year period, 168% of natural flow was passed. The combined effect of present operating procedures at the Island Falls hydropower plant, primarily due to the use of storage in Reindeer Lake, is to modify both peak flows and below normal flows to create a continuous, relatively uniform flow throughout the year.

TABLE 6

CHURCHILL RIVER AT ISLAND FALLS

(Monthly Volumes in dam^3 x 1000)

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1965-66													
Recorded Flow	1 810	2 220	2 330	2 390	2 420	2 330	2 400	2 230	2 140	2 020	1 750	2 090	26 100
Natural Flow	1 540	2 320	2 540	2 620	2 650	2 520	2 540	2 330	2 220	1 940	1 620	1 710	26 600
% of Natural Flow	118	95	92	91	91	92	94	96	96	104	108	122	98
1966-67													
Recorded Flow	1 940	1 900	2 140	2 210	1 930	1 610	1 740	1 530	1 520	1 680	1 580	1 680	21 500
Natural Flow	1 660	1 730	2 210	2 510	2 230	1 810	1 650	1 500	1 430	1 300	1 190	1 250	20 500
% of Natural Flow	117	110	97	88	87	89	105	102	106	129	133	134	105
1967-68													
Recorded Flow	1 600	1 740	1 960	2 220	2 170	1 640	1 570	1 720	1 790	1 880	1 820	1 900	22 000
Natural Flow	1 160	1 550	2 080	2 530	2 620	2 100	1 790	1 480	1 470	1 360	1 110	1 140	20 400
% of Natural Flow	138	112	94	88	83	78	88	116	121	138	164	167	108
1968-69													
Recorded Flow	1 750	1 860	1 640	1 630	1 610	1 580	1 700	1 610	1 750	1 810	1 620	1 710	20 300
Natural Flow	1 040	1 400	1 350	1 490	1 400	1 470	1 680	1 580	1 590	1 500	1 320	1 340	17 200
% of Natural Flow	168	133	121	109	115	107	101	102	110	121	123	128	118
1969-70													
Recorded Flow	1 840	1 770	1 670	1 570	1 610	1 760	1 800	1 690	1 780	1 770	1 570	1 710	20 500
Natural Flow	1 470	1 640	1 730	1 610	1 560	1 920	2 090	1 710	1 620	1 410	1 170	1 150	19 100
% of Natural Flow	125	108	97	98	103	92	86	99	110	126	134	149	107

There was a more severe streamflow drought recorded some forty years ago. The annual natural flow of the Churchill River was below normal for eleven consecutive years from 1936 to 1946. This eleven year period cannot, however, be compared to present operating conditions because the Reindeer Lake control was built during the drought. It is interesting to note that annual recorded flow in that period was never less than 75% of natural flow. In 1940-41, the driest year, natural flow totaled 11 100 000 dam^3, recorded annual flow exceeded that volume by 123 000 dam^3. In that extremely low runoff period, recorded discharges exceeded natural discharges by from 28.3 m^3/s to 56.6 m^3/s from October 1940 to March 1941.

TABLE 7

CHURCHILL RIVER AT ISLAND FALLS

(Monthly discharges in m^3/s)

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Minimum
1965-66													
Recorded Monthly mean	700	829	901	891	904	899	895	860	798	753	725	783	700
Natural Monthly Mean	596	866	978	980	988	973	950	899	828	724	668	638	596
Recorded Minimum Daily Discharge	654	722	869	855	861	878	867	807	728	697	685	731	654
1966-67													
Recorded Monthly Mean	748	707	823	826	723	622	650	591	569	629	651	629	569
Natural Monthly Mean	641	645	853	938	831	700	617	579	535	486	493	466	466
Recorded Minimum Daily Discharge	651	674	688	742	654	572	566	558	549	564	626	595	549
1967-68													
Recorded Monthly Mean	616	651	757	829	810	634	586	665	668	703	725	709	586
Natural Monthly Mean	449	577	803	946	977	811	660	572	550	509	444	427	427
Recorded Minimum Daily Discharge	589	589	705	762	688	552	532	620	544	643	671	663	532
1968-69													
Recorded Monthly Mean	675	695	633	608	602	613	635	619	654	677	672	641	602
Natural Monthly Mean	401	522	521	556	523	568	628	611	592	558	545	501	401
Recorded Minimum Daily Discharge	648	592	586	572	564	558	603	555	589	623	643	592	555
1969-70													
Recorded Monthly Mean	711	631	645	586	601	680	670	650	665	659	650	637	586
Natural Monthly Mean	567	612	668	600	584	742	780	660	605	526	484	428	428
Recorded Minimum Daily Discharge	617	589	583	515	544	609	631	558	612	623	617	586	515

The difference between natural and recorded streamflow is illustrated in Table 7. Note that in 1967 although the natural monthly discharge fluctuated widely, from 449 m^3/s in April to 946 m^3/s in July of 1967, the recorded minimum daily discharge ranged from 589 m^3/s to 762 m^3/s in the same months, an example of the modifying effect of reservoir storage in Reindeer Lake. Thus it is concluded that a minimum discharge criterion is not required.

It is recommended that no audit or balance periods of less than twelve months be established for the Churchill River at the Saskatchewan-Manitoba boundary and that a minimum discharge criterion at this location not be established at present.

It is also recommended that apportionment flows at this site now be reported on the basis of a twelve month period from April 1 to March 31 of the following year.

Qu'Appelle River

The apportionment period for the Qu'Appelle River at the Saskatchewan-Manitoba boundary is April 1 to March 31 of the following year, as specified in Schedule B of the Agreement. The balance of flow for apportionment is calculated at the hydrometric station Qu'Appelle River near Welby (see Figure 5). Due to operational constraints, based primarily on the seasonal nature of flows in the Qu'Appelle River basin, Water Survey of Canada computes streamflow for the following four periods:

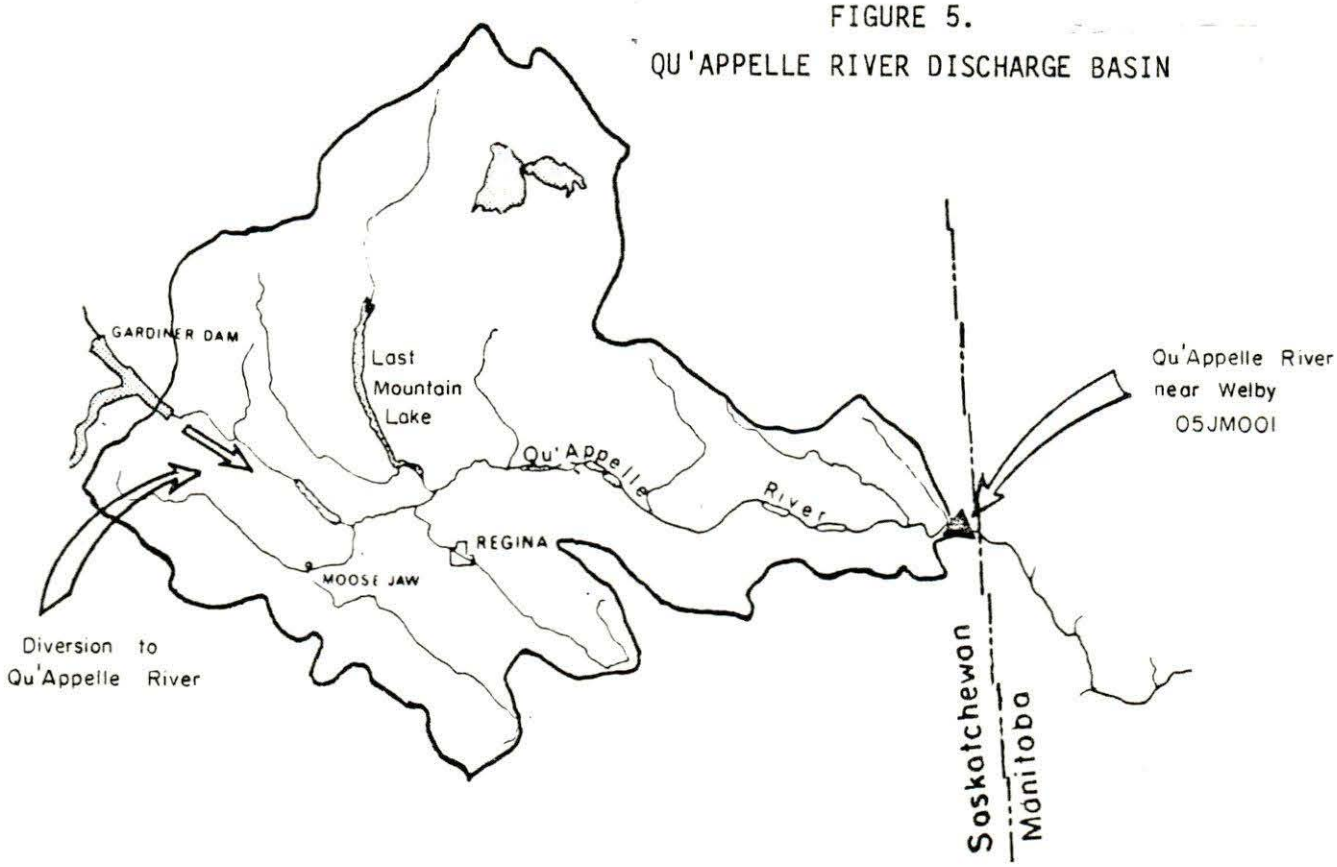
(a) March to May inclusive,

(b) June and July,

(c) August to October inclusive,

(d) November to February inclusive.

FIGURE 5.
QU'APPELLE RIVER DISCHARGE BASIN



Based on these periods, audit reports are submitted at the end of May, July, October and February of each year. The first three audit reports permit Saskatchewan to review these flows and to ensure that management decisions can be made to effect a balance by the end of the apportionment period. The February audit report, while it is not usable for operational purposes, provides a check on the balance of flow being passed to Manitoba.

In lower than average runoff years, such as occurred in the 1930s and again in the late 1950s, these audit periods should enable management agencies to identify years when apportionment could be a problem. During the twelve month periods of 1958-59, 1959-60, 1961-62, and 1962-63, under pre-agreement conditions, less that 50% of natural flow was recorded at the Saskatchewan-Manitoba boundary (see Table 8). In each of these four years the sum of recorded flow in April and May was less than half of the

TABLE 8

QU'APPELLE NATURAL AND RECORDED FLOWS

(Monthly Volumes in dam^3)

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total	Recorded Flow as a Percentage of Natural Flow
1958-59														
Natural Flow	34 000	32 800	15 500	14 000	11 400	1 600	71	0	0	0	0	1 980	111 000	
½ Natural Flow	17 000	16 400	7 740	7 000	5 710	798	37	0	0	0	0	988	55 700	
Recorded Flow	9 320	16 800	1 330	1 870	856	1 060	881	1 020	76	37	0	3 670	36 900	33%
½ of Nat. Flow- Rec. Flow	7 680	-391	6 420	5 120	4 860	-259	-844	-1 020	-76	-37	0	-2 680	18 800	
1959-60														
Natural Flow	6 770	7 140	9 980	8 660	6 680	947	86	0	0	0	0	3 694	44 000	
½ Natural Flow	3 390	3 570	4 990	4 330	3 340	472	42	0	0	0	0	1 847	22 000	
Recorded Flow	4 940	1 130	2 330	805	64	328	1 732	844	1 050	759	577	1 490	16 000	36%
½ of Nat. Flow- Rec. Flow	-1 550	2 440	2 660	3 530	3 280	144	-1 690	-844	-1 050	-759	-588	357	5 940	
1960-61														
Natural Flow	56 500	54 800	36 500	24 700	23 300	4 110	247	10	0	0	0	4 400	205 000	
½ Natural Flow	28 300	27 400	18 200	12 400	11 700	2 060	122	5	0	0	0	2 200	102 000	
Recorded Flow	55 300	42 800	10 600	3 430	1 490	357	460	604	460	658	54	1 200	117 000	57%
½ of Nat. Flow- Rec. Flow	-27 000	-15 400	7 580	8 930	10 200	1 700	-338	-599	-460	-658	-54	998	-15 100	
1961-62														
Natural Flow	7 680	7 170	7 760	6 430	4 940	1 050	54	0	0	0	0	5 160	40 200	
½ Natural Flow	3 840	3 580	3 880	3 220	2 470	526	27	0	0	0	0	2 580	20 100	
Recorded Flow	3 650	2 890	1 140	44	0	0	225	0	0	0	0	269	8 210	20%
½ of Nat Flow- Rec. Flow	196	697	2 740	3 170	2 470	526	-198	0	0	0	0	2 310	11 900	
1962-63														
Natural Flow	12 800	9 300	14 400	9 490	7 100	1 660	88	0	0	0	0	480	55 300	
½ Natural Flow	6 390	4 650	7 180	4 750	3 550	829	44	0	0	0	0	240	27 600	
Recorded Flow	6 580	3 380	4 490	1 720	482	157	306	0	0	0	0	3 080	20 200	37%
½ of Nat. Flow- Rec. Flow	-196	1 270	2 690	3 030	3 070	673	-262	0	0	0	0	-2 843	7 430	

cumulative natural flow. This information could be used to establish a *"low year"* criterion. Whenever the sum of recorded flow is less than half of the sum of natural flow for April and May, monthly audits of flow should be made for the remainder of the apportionment period to ensure management decisions can be made to effect a balance by the end of the apportionment period. Decisions could be made early in the year so as to permit water to pass through the river system prior to freeze-up in the fall. This procedure would also help Manitoba to plan early in the year to fully utilize alternate storage such as Lake of the Prairies and Rivers Reservoir to meet needs engendered by the low flow situation in the Qu'Appelle River basin.

The natural flow of the Qu'Appelle River falls to zero in the fall of most years so it is impractical to consider a minimum flow criterion for this basin.

It is recommended that flow of the Qu'Appelle River at the Saskatchewan-Manitoba boundary be aduited each year at the end of May, July, October and February. It is further recommended that whenever the sum of recorded flow for April and May is less than one-half of the cumulative natural flow for those two months, monthly audits of streamflow be made for the remainder of the apportionment period or until one-half of natural flow for the audited period has been passed to Manitoba.

It is further recommended that apportionment flow at this site continue to be reported on the basis of the twelve month period from April 1 to March 31 of the following year.

It is also recommended that no minimum discharge criterion be established at this location at present.

GENERAL COMMENTS

No recommendations for balancing periods shorter than twelve months have been made because currently demonstrated needs for such have not been identified. If future studies should determine that flows resulting from shorter balancing periods would be beneficial, the commitment of the provinces to work together for *"the most effective, economical and beneficial use of water"* presumably will guide water managers in agreeing on an *"equitable basis"*. Similarly, if the provinces involved are mutually agreed, the balance periods within individual years might be varied within reasonable limits if it is to the mutual advantage of all parties. To date, however, no problems requiring such arrangements have been identified.

No audit periods have been recommended for the North Saskatchewan, Saskatchewan or Churchill Rivers apportionment points. A quarterly audit is recommended for the South Saskatchewan and an audit at the end of May, July, October, and February is recommended for the Qu'Appelle River. These conclusions are based on current conditions and, in the case of the Qu'Appelle basin, on the constraints of the basin.

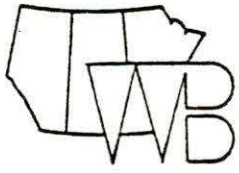
The apportionment period in Schedule A (between Alberta and Saskatchewan) is based on the calendar year and in Schedule B (between Saskatchewan and Manitoba) on the twelve month period of April 1 to March 31 of the following year. The difference in reporting dates does not create problems in balancing streamflow.

It has been stated in this chapter that the PPWB Annual Report is used to report on the balance of flow for apportionment at the end of each apportionment period. The bylaws of the PPWB state:

> *"16. Annual Report*
>
> *Within three (3) months after the end of the financial year, the Chairman shall submit to the ministers the Annual Report of the Board".*

In order to meet this deadline, it is necessary to use preliminary WSC data to report the balance of flow for apportionment. This is undesirable because two sets of data are published - preliminary data by the PPWB and final data by the WSC. If the period were extended to six months, WSC could provide final data for inclusion in the Annual Report. Therefore:

It is recommended that Bylaw 16 be revised to provide a period of six (6) months after the end of the Board's financial year for preparation of the Annual Report.



PRAIRIE PROVINCES WATER BOARD

Chapter V

PROCEDURES IN THE EVENT OF SHORTAGES

Schedules A and B of the 1969 Apportionment Agreement make no provision for replacing shortages after the end of an apportionment period. The parties have agreed that such shortages will not be allowed to occur because the upstream provinces *"shall"* permit one-half of the apportionment flow to be passed to the downstream province in an *"equitable"* manner. With the degree of cooperation that exists between the jurisdictions represented on the Board it is improbable that volumetric shortages will ever occur. It is noted that the International St. Mary-Milk Reference has been operating for sixty years with no significant final apportionment shortages, apparently due both to good faith and good management on the part of the cooperating agencies. There is every reason to believe that the PPWB will operate with the same degree of success.

Good water management by cooperatng agencies, and the continuance or implementation of the recommendations contained in this report, should enable the Board to prevent shortages from developing on interprovincial streams. Furthermore, any minor shortages should be quickly resolved with a minimum of difficulty. However, if shortages do arise which create problems that cannot readily be resolved, the routing sequence for reporting streamflow balances will not be adequate and more detailed procedures will be required.

The types of shortage to be dealt with may be divided into four

categories:

1. Anticipated Volumetric Shortages - based on forecast information during the apportionment period,
2. Real Volumetric Shortages - based on recorded data to the end of the apportionment period,
3. Anticipated Discharge Shortages (applicable only to the South Saskatchewan River) - based on forecast information,
4. Real Discharge Shortages (appliable only to the South Saskatchewan River) - based on recorded discharge records and computed natural flow.

ANTICIPATED VOLUMETRIC SHORTAGES

It is the responsibility of the Secretariat, based on monitoring information from the WSC and forecast information from provincial jurisdictions, to identify anticipated shortages. The Secretariat will inform the Board of the anticipated shortage and will discuss the matter individually with the jurisdictions directly affected.

The upstream province, in consultation with the downstream province, or provinces, will determine what action is needed to satisfactorily rectify the problem and will inform the Secretariat of the action to be taken. If necessary, the Secretariat may then call a meeting of the COH to further discuss the problem.

The Secretariat will prepare a report documenting the problem and the proposed course of action and will circulate the report to all Board members. If any Board member so requests, a special meeting will be held to discuss the problem and the proposed solution. The Board may also wish to take further action or to make further recommendations regarding the resolution of the problem.

The Secretariat will then, through WSC, regularly monitor the needed streamflow elements and prepare regular audit reports to all Board members on a prearranged frequency until the problem has been solved.

REAL VOLUMETRIC SHORTAGES

The identification, and the subsequent rectification, of anticipated volumetric shortages, should ensure that a real shortage does not occur at the end of an apportionment period. If such a shortage does occur the Secretariat will immediately inform all Board members and the COH that a shortage has occurred.

The Board members for the upstream and downstream provinces will jointly discuss the situation and will attempt to arrive at a mutually satisfactory agreement as to what should be done. They might agree to release sufficient water at a later date to compensate for the shortage, to take no action other than agreeing on means to prevent future similar shortages or select some other course of action. If agreement is reached the members will inform the Secretariat who will, in turn, inform all other Board members.

If the provinces involved cannot reach agreement the Board should meet to discuss the matter further. Prior to this meeting the Secretariat should prepare a report, in consultation with the COH, documenting the shortage and alternate solutions. If the Board cannot reach agreement further action is the responsibiliy of individual jurisdictions.

ANTICIPATED DISCHARGE SHORTAGES

Alberta, Saskatchewan, or WSC may, by observation or by forecasting, detect a possible failure in the minimum flow criterion of the South Saskatchewan River at the Alberta-Saskatchewan boundary. It is their immediate responsibility to advise the Secretariat of the anticipated shortage and the Secretariat will advise the other two parties and the COH of the problem.

Alberta should then advise the Secretariat of the steps it is taking to prevent the shortage and the Secretariat should provide this information to the Board and to the COH. WSC should increase its monitoring activities until there is no further immediate potential for a discharge shortage.

REAL DISCHARGE SHORTAGES

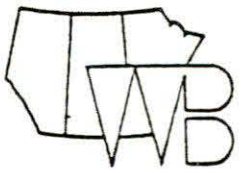
The case when a minimum flow criterion is not met is different from the case where a volumetric shortage exists at the end of an apportionment period. By mutual agreement a volumetric shortage might be compensated for in the next period but once the daily flow falls below the minimum flow criterion, it cannot be made up. During the period that the minimum flow criterion is being violated, the Secretariat shall keep all parties informed on a daily basis of plans and progress being made to rectify the situation. During the period of shortage Saskatchewan should have the opportunity to participate in planing to eliminate the problem. Finally, when the problem has been eliminated the Secretariat should so inform the Board and the COH.

GENERAL

As indicated above, after real shortages have been dealt with, it will be an important further responsibility of the Secretariat, in consultation with the COH, to suggest ways that future such occurrences can be prevented or minimized.

With the present degree of cooperation that exists between the jurisdictions represented on the Board and its committees it is unlikely that major shortages will occur. Furthermore, if infrequent shortages do occur the Board will probably reach an equitable solution. Therefore, the Committee on Hydrology makes the following recommendation concerning Procedures in the Event of Shortages:

It is recommended that the general procedures described in Chapter V of the report be followed to deal with both anticipated and real shortages.



PRAIRIE PROVINCES WATER BOARD

Chapter VI

FORECASTING

One of the duties of the Board is defined in Schedule C, Section 4(f) as:

> *"...to ensure the coordination of such technical programs as water quantity and quality monitoring and streamflow forecasting required for the effective apportionment of water..."*

This duty is recognized in term three of the Terms of Reference for this study as follows:

> *"...The role forecasting could, or should, play in the administration of apportionment..."*.

The two main types of streamflow forecasts, water supply and river discharge, were defined in Chapter II. This chapter discusses their relative value to the PPWB and to the member agencies in effecting apportionment.

WATER SUPPLY FORECASTS

Water supply forecasts provide estimates of the volume of water expected to be available for use during the forthcoming season. This knowledge is essential for planning the operation of hydroelectric generating plants, irrigation projects, municipal and industrial water supplies, and recreation and wildlife developments. Water supply forecasts are required by all agencies in the three prairie provinces which have responsibilities for water management.

In years of above normal runoff, there is little need for water supply forecasts as a direct aid to apportionment; however, in years when below normal runoff is expected, these forecasts serve as a warning that there may be apportionment problems. The degree to which water supply forecasts are useful in apportionment activities is dependent both on the volume of runoff and on consumptive use. Presently, with balance periods of twelve months, the benefits of forecasting, with the exception of the Qu'Appelle and South Saskatchewan River basins, are marginal from an apportionment viewpoint.

The examples which follow illustrate historical events during several low flow periods on the prairies. In the case of the Qu'Appelle River, a clear illustration of the worth of water supply forecasts in managing for apportionment is shown. In case of the South Saskatchewan River the historical circumstances only illustrate the potential for an apportionment problem and the value of forecasting in managing water under such circumstances.

Qu'Appelle River (1958 - 1963)

The Qu'Appelle River is regulated and, by releasing water from Lake Diefenbaker, an additional supply of water can be made available to the basin. The first such releases were made in the summer of 1967. The time of travel from Lake Diefenbaker to the Manitoba boundary is about two months, and present channel capacities restrict in-channel discharges from Lake Diefenbaker to less than 4.25 m^3/s. Completion of proposed conveyance works would raise the channel capacity to about 14.2 m^3/s below Buffalo Pound Lake but the channel upstream of Buffalo Pound Lake will not pass this rate of discharge.

Table 9 shows that during the low flow period from 1958 to 1962 less than 50% of the natural flow was delivered to Manitoba in four of five years. The largest annual deficit was 18 800 dam^3 in 1958-59. Assuming no losses, this deficit could have been eliminated by releasing 1.41 m^3/s from Lake Diefenbaker for the five months of June to October inclusive (assuming that water released in October would cross the Saskatchewan- Manitoba boundary before the end of the apportionment period).

TABLE 9.

QU'APPELLE RIVER NEAR WELBY

APPORTIONMENT SHORTAGES OCCURRING FROM APRIL 1958 to MARCH 1963

(All Volumes in $dam^3 \times 10^3$)

Apportionment Period	Natural Flow	50% of Natural Flow	Recorded Flow	Apportionment Shortages
1958-59	111.4	55.7	36.9	18.8
1959-60	44.0	22.0	16.0	6.0
1960-61	204.6	102.3	117.5	-
1961-62	40.2	20.1	8.2	11.9
1962-62	55.2	27.6	20.2	7.4

With the availability of water from Lake Diefenbaker, it would have been possible to decrease the deficit deliveries that occurred during the period 1958-59 to 1962-63 by making prompt management decisions after anticipated shortages were identified but, because of long travel times and restricted channel capacities, forecasting is needed to efficiently manage the resource manager to identify an anticipated shortage early in the year and, by forecasting flows for the remainder of the year, to eliminate that shortage.

A monthly forecast of flows starting in March or April would have enabled Saskatchewan Environment to formulate plans and to take action to ensure that the terms of the Apportionment Agreement were met.

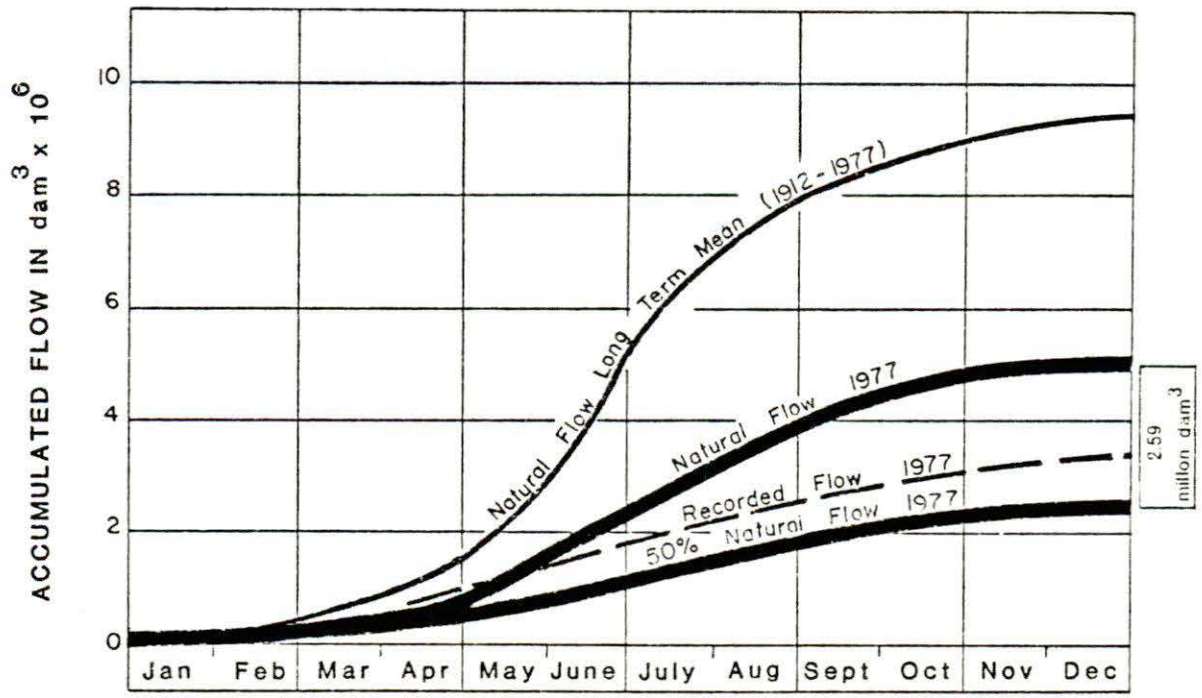
The Committee on Hydrology concludes, based on the above examples, that the jurisdiction managing the system, should undertake such water supply forecasts as are required to effect an equitable apportionment for the Qu'Appelle River basin.

South Saskatchewan River (1977)

Events during the spring and summer of 1977, a low runoff period, provide an example of the potential value of water supply forecasting for apportionment. Water supply forecasts prepared on February 1 and March 1 indicated that flows on major tributaries of the South Saskatchewan River would be 45% to 70% of normal due to an almost record low snowpack. Based on these forecasts, the Board and the Province of Alberta initiated several measures to ensure that apportionment criteria would be met. The Board agreed that the situation should be monitored closely by the Secretariat and reported monthly to the participating agencies. The Committee on Hydrology provided a forum in which water managers of the three prairie provinces could confer on low flow problems and consider remedial water management measures. Alberta used the forecasts in the planning and management of storage and diversions to satisfy irrigation and hydro demands and still allow the terms of the Apportionment Agreement to be met. Monthly forecasts were used throughout the summer to modify plans as required.

FIGURE 6.

SOUTH SASKATCHEWAN RIVER BELOW JUNCTION WITH RED DEER RIVER 1977 (ACCUMULATED FLOW IN $dam^3 \times 10^6$)



Alberta Delivered 3.3 million dam^3 to Saskatchewan in 1977, about 65% of annual natural flow. The net depletion for the year in Alberta was 1.7 million dam^3 (two-thirds of the 2.59 million dam^3 reserve in Schedule A). Although less than 50% of natural flow was passed to Saskatchewan for three consecutive months (May, June and July), Figure 6 illustrates that the accumulated balance of flow during the apportionment period never dropped below 50% of natural flow. The satisfactory apportionment of water on a volume basis was, therefore, never in doubt even in this year, the lowest year on record.

Figures 7 and 8, on page 48, provide similar information for the low flow years of 1941 and 1979.

A future drought situation of this magnitude might be accompanied by water demands which would make good forecasting and careful management crucial. The consumptive use by Alberta of a full 2.59 million dam^3 of water as allowed for in Schedule A would test that province's ability to manage for both internal water uses and apportionment. Reservoir operations would become increasingly difficult if two low-flow/high-demand years were to follow one another. Similarly, should a significant man-induced change in flow regime occur or a shortening of the balance period become desirable, the physical possibilities for control inherent in a forecasting, reservoir regulation, process would become an essential factor in regulating storage to meet all uses.

The Committee on Hydrology concludes, based on the above example, that the jurisdictions managing the system should undertake such water supply forecasts as are needed to effect an equitable apportionment for the South Saskatchewan River basin.

RIVER DISCHARGE FORECASTS

River discharge forecasts are useful for flood control and flood warning. They are not required for apportionment during flood periods; the problem then is how to deal with too much water, rather than the equitable apportionment of too little water.

FIGURE 7.

SOUTH SASKATCHEWAN RIVER BELOW JUNCTION WITH RED DEER RIVER 1941 (ACCUMULATED FLOW IN $dam^3 \times 10^6$)

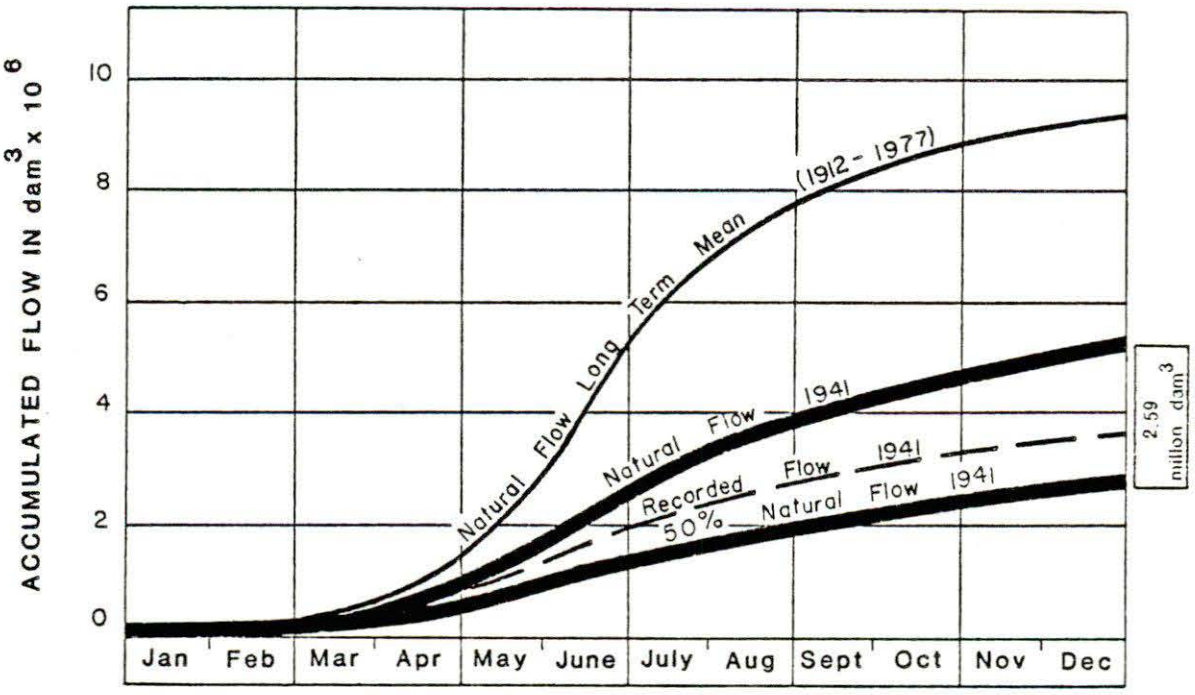
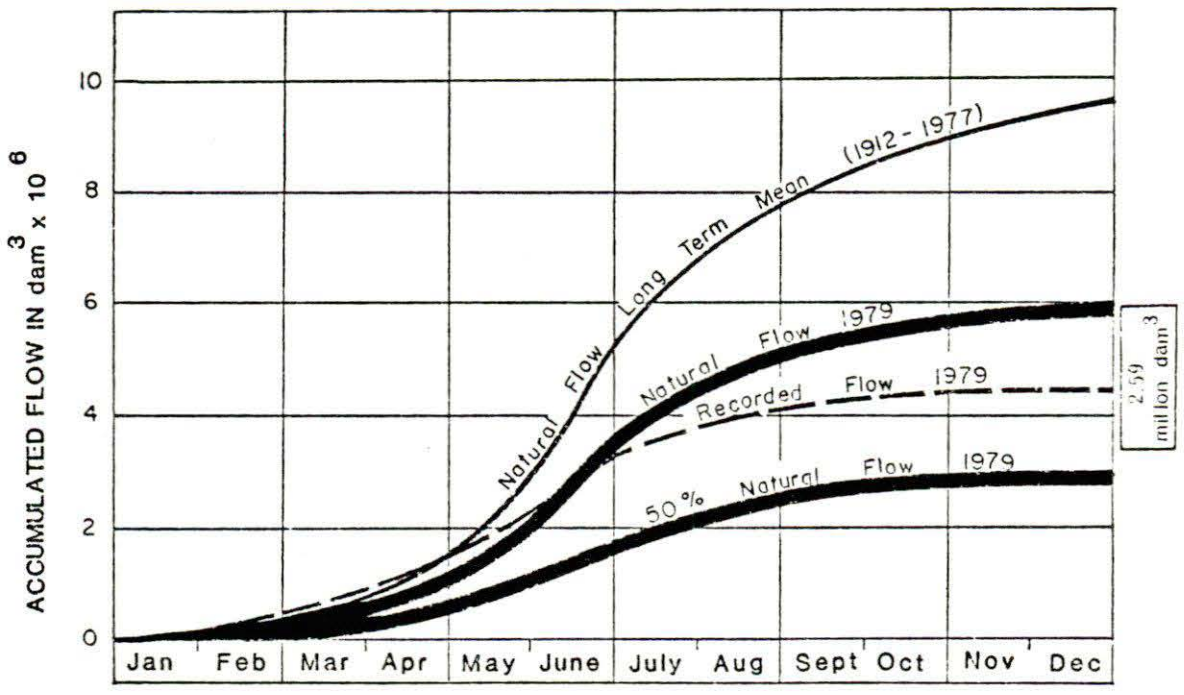


FIGURE 8.

SOUTH SASKATCHEWAN RIVER BELOW JUNCTION WITH RED DEER RIVER 1979 (ACCUMULATED FLOW IN $dam^3 \times 10^6$)



Forecasts of river discharge are of value for the South Saskatchewan River during low flow years when competing demands for water force a tight control on storages and diversions and, under such conditions, river discharge forecasts are employed in the day-to-day operation of water use projects.

During late April, 1977, for example, an unexpected major withdrawal of water from the Bow River created a potential apportionment problem for a few days. When this situation arose, Alberta took immediate steps to ensure that the Apportionment Agreement would be satisfied. The steps included a combination of making releases from storage, decreasing some diversions and preparing daily river discharge forecasts.

Based on the experience of 1977, improvements were made in forecasting procedures, in diversion control, and in the precise information of flow rates at key stations during critical times.

When discharges again approached critically low levels at the Alberta-Saskatchewan boundary during August, September and October of 1979, Alberta was in a position to ensure that both the Apportionment Agreement requirements and the needs of water users in Alberta were satisfied.

The Committee on Hydrology concludes that in open water low flow situations it is essential to have river discharge forecasts for the South Saskatchewan River below Red Deer River and that Alberta Environment should undertake such forecasts as are required.

RECOMMENDATIONS ON STREAMFLOW FORECASTING

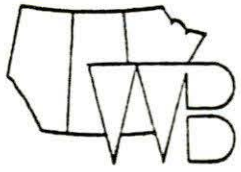
Good water management and effective administration of the Apportionment Agreement are inseparable. Forecasting aids routine operational activities carried on to ensure wise water use and to meet the legal requirements of the Apportionment Agreement. In addition, downstream provinces benefit from good water management practices in an upstream province, and consequently benefit from forecasting. Water supply forecasts would be particularly important in this regard if balance periods of less than one

year were to be implemented in the future. Therefore,

It is recommended that Alberta and Saskatchewan prepare such water supply forecasts as are required to enable the operating jurisdictions to more efficiently manage water supplies for interprovincial apportionment purposes.

River discharge forecasts are of lesser importance in most basins. In open water low flow situations in the South Saskatchewan River basin it is essential that river discharge forecasts be made if the low flow criterion at the Alberta-Saskatchewan boundary is to be met. Therefore,

It is recommended that Alberta prepare discharge forecasts whenever discharge conditions in the South Saskatchewan River at the Alberta-Saskatchewan boundary indicate that the low flow criterion may not be met.



PRAIRIE PROVINCES WATER BOARD

Chapter VII

EFFECTS OF STORAGE AND DIVERSION

Section 5 of both Schedules A and B of the 1969 Master Agreement on Apportionment states;

> *"...The parties hereto shall work together and cooperate to the fullest extent, each with the other,...including the construction and operation of approved projects of mutual advantage...".*

Water passed from upstream to downstream provinces to achieve an equitable balance of flow is not normally adversely affect by internal provincial operation of reservoirs and diversion. The Apportionment Agreement was entered into so that the three Prairie Provinces would be able to plan and manage their water resources based on a prior knowledge of the quantity of water available to them. However, storage and diversion may affect downstream provinces both positively and negatively.

STORAGE

The usual net effect of storage facilities in a river system is to even out flow during the year. Generally such a result is desirable and the presence of storage in a river system would seem to be beneficial to all jurisdictions. However, this general statement must be qualified to reflect the use of such storage to regulate flow for identifiable downstream uses.

Storage may enhance the ease with which water can be apportioned.

Reservoirs in an upstream province may afford that province the ability to manipulate flows to maintain desired minimum flows by release of water from storage. On the other hand, storage in a downstream province reduces that province's day-to-day flow problems downstream from the reservoir. In the first case then, the ability to control downstream flows is enhanced, and in the second case the immediate need for upstream flow is reduced. In the longer term, the requirement for an adequate volume of water to meet downstream needs remains. If there were no storage projects or consumptive uses on interprovincial rivers an apportionment agreement would not be necessary. Storage projects have been built, however, and are now operating regulative capabilities on interprovincial streams. As the number of storage projects increases, possibilities for more regulation and for more flexible operation will be enhanced but increased consultation and cooperation may be required.

When considering consumptive uses in connection with storage projects it must be remembered that when natural flow is calculated for apportionment purposes, evaporation from man-made storages is computed and charged to the owner jurisdiction. Thus the province in which the reservoir is built uses some water consumptively even if the reservoir has no other uses.

Storage may trap the river's sediment load thereby causing undesirable changes in the river regime downstream. For example, releases from a reservoir of relatively *"clean"* water could cause increased erosion downstream of the dam until the river's regime is stabilized.

Hydroelectric Power Generation

Upstream hydroelectric power operations usually benefit downstream hydroelectric producers but controlled releases could be detrimental if there are major weekly, monthly or seasonal variations in flow. Effects may also be felt on transportation, urban water supplies, and water quality and there may be related problems associated with abnormal ice buildup, break up and jamming.

Flood Control Operations

Reservoirs with storage available in the spring may be used to reduce peak flows during the runoff period. However, untimely releases may aggravate downstream flooding conditions, emphasizing the need for continued coordination of operation between the upstream and downstream jurisdictions. In the future, joint studies of the optimum equitable operation of multi-reservoir systems may be required.

Ecological and Environmental Considerations

Any man-made storage in a river basin has the potential to cause some change to the basin's ecosystem, as has occurred in the Peace Athabasca delta and the Saskatchewan River delta.

The specific long-term problems related to these changes probably vary with every river. Specific effects may not be fully evident until years after the initial change occurs.

The presently recognized principles of cooperation among members of the PPWB should enable the various jurisdictions to identify and solve these problems as they arise.

Water Quality Aspects

Storage facilities usually tend to even out seasonal river discharge by increasing low winter flows and decreasing high spring flows. The quality of the river water is influenced to a large degree both by the rate of flow and by the volume of water, so the operation of storage facilities directly affects the quality of water both in reservoirs and in rivers downstream from major impoundments. These effects are dicussed in very general terms in the following sections.

On Site Storage

During spring and summer, when peak flows are captured and modified, reservoirs act both as large settling ponds and as flushing tanks. Streams deposit their suspended sediment and

nutrient concentrations are reduced because spring and summer flows are usually much lower in dissolved ion concentrations than waters which flow into the reservoir during the winter. Turbidity is reduced and, during the summer, temperature stratifications tend to provide an environment that is conducive to algae growth. Other limnological processes, particularly spring and fall turnover, tend to mix the water stored in the reservoir, reducing natural seasonal variations in downstream water quality when reservoir releases are made.

If streams are used to disperse wastes, problems may occur if these wastes accumulate in a reservoir. Potential problems of this type include reservoir eutrophication, bioamplification of trace amounts of toxic substances, changes in the ecosystem and seasonal fluctuations in concentrations of dissolved oxygen and other constituents.

Increased Downstream Flows

In winter, water released from storage generally enhances the quality of river waters downstream of reservoirs. This is primarily because the increased flows supplement the dissolved oxygen resources of the stream. Increased flows also dilute constituents present in the stream to a greater degree than would occur naturally.

In summer, during periods of low flow, releases from reservoirs generally enhance the quality of river waters downstream of reservoirs. The relatively cool water released tends to reduce water temperature immediately downstream of the reservoirs, to dilute constituents in the stream and to help minimize stagnant conditions which favour excessive algae growths. If the discharge outlet is located deep in the reservoir, and if its water becomes thermally stratified, it may release oxygen depleted water. This type of problem may be eliminated by adequate hydraulic design in the planning stages.

Reduced Downstream Flows

Storage during high flow periods reduces downstream flows, stream velocities, turbidity, and suspended sediment which are very high during spring freshets on most prairie rivers. Associated benefits in high flow periods may include reduced municipal and industrial water treatment costs and reduced bank and stream bed erosion. Conversely, storage during the low flow periods has a detrimental effect because it reduces the stream's capacity to dilute its natural and man-induced wastes.

Other Considerations

Reservoir storage in upstream jurisdictions may affect several other uses such as recreation, downstream municipal uses, irrigation, industrial uses, transportation needs (including both navigation and ferry crossing) and riparian uses. While these are not discussed in detail they are mentioned to indicate that the effects of upsteam storage are not limited to power, flooding, ecological and water quality concerns.

DIVERSIONS

Diversions, as defined in Chapter II, may be of two types; interbasin or intrabasin. The effects of interbasin diversions are the same as intrabasin diversions as long as apportionment criteria are satisfied. Diversions may enhance an upstream province's ability to manage flows both for its own benefit and to satisfy the terms of Section 3 (Schedules A and B) which stipulate that the upstream province shall be permitted to divert

> *"...water to which it is entitled of comparable quality from other streams or rivers into such watercourse to meet its commitments...".*

Diversions within a downstream province might tend to lessen its dependence on uniform deliveries from upstream provinces, due to the availability of diverted water from other source. Many of the effects of diversions between interprovincial basins are similar to the effects associated with storage reservoirs.

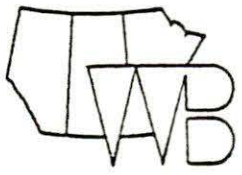
If diversions were to be made from interprovincial rivers to rivers which did not cross an interprovincial boundary the diversions would be treated as consumptive uses.

Water Quality

The Agreement states that water diverted to meet apportionment requirements must be of *"comparable quality"* to that of the receiving stream. It is recognized that it will be the continuing responsibility of the Board and upstream province to ensure, in consultation with the downstream provinces, that diverted water is of an acceptable quality when it crosses the interprovincial boundary.

Biota Transfer

One of the issues raised in diversion assessments is the potential for transfer of biota and the impact that this may have on both donor and receiver basins. The fundamental concern is that imported organisms may alter the ecosystems and result in disbenefits to either the donor or receiver basin, or to both, by migrating upstream or downstream through the diversion system. The Agreement does not deal directly with this problem but it should be assumed that the intent of Sections 3 and 5 in Schedule A and B was that the possibility of biota transfer as well as quality of water consideration was to be considered.



PRAIRIE PROVINCES WATER BOARD

Chapter VIII

THE DUTIES OF THE BOARD AND PARTICIPATING AGENCIES

The role of the Board and its participating agencies was discussed in Chapter 3. There are also duties connected with this role that each agency must assume if administration of the Apportionment Agreement is to succeed.

The duties of the Board are outlined in Section 4(c) of Schedule C as follows:

> *"...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...".*

These duties may be divided into two broad areas. The first area relates to the analyzing and collating of data and reporting on streamflow. The second area relates to the studies required in response to requests from the participating jurisdictions and/or agencies.

The parties to the Master Agreement on Apportionment, in Section 13 of the Master Agreement have agreed;

> *"...to work together...for the integrated development and use of water and related resources...".*

THE BOARD

It is the duty of individual Board members, provincial or federal, to bring to the attention of the Board any proposed project that might affect interprovincial eastward flowing waters. The Board has agreed (see Board Minute 17-25).

> *"...that for all future projects on interprovincial rivers a statement of the effects of the project at the downstream (or upstream if applicable) boundary will be tabled with the Board by the Board member representing the proponent province...".*

This procedure should bring to the attention of the board any project that might have an adverse effect on interprovincial streams. The Board also agreed, in Minute 19-51, that the Secretariat, through the Committee on Hydrology and the Committee on Water Quality, would evaluate any project brought before the Board and would report to the Board on any interprovincial concerns that might arise from the construction and/or operation of the project.

Each of the Board members also has responsibilities with respect to apportionment at the five sites described in Chapter IV. These duties or responsibilities, have not been repeated in this chapter.

THE SECRETARIAT

The Secretariat, in dealing with the administration of the Agreement has several specific continuing duties.

1. It is the Secretariat's responsibility to analyze and collate data for apportionment purposes. Thus, it is the responsibility of the Secretariat, either directly or by contract, to compute natural flow both for audit periods and apportionment periods at designated sites and to disseminate such information.

2. The Secretariat reports on streamflow through quarterly reports and an annual report. These reports provide a media for reporting the balance at the end of audit periods and identifying shortages

and anticipated shortages in apportionment periods. A final report on the apportionment period for all five apportionment sites is prepared for each annual report and distributed to all Board members prior to publication.

3. The Secretariat has an ongoing duty to ensure the coordination of streamflow forecasts for eastward flowing streams.

4. When the Board's attention is drawn to a proposed project by a provincial member, the Secretariat is responsible for having each such project evaluated through the Committee on Hydrology and the Committee on Water Quality. It is the Secretariat's duty to report to the Board on points of concern expressed by these Committees.

5. The Secretariat's ongoing duties include the continued maintenance of streamflow data banks, natural flow files and similar data connected with the SNBB Study completed in 1972, the current Water Demand Study and similar streamflow data required for apportionment purposes.

6. It is the duty of the Secretariat to prepare reports commissioned by the Board to answer ongoing concerns and specific problems.

7. The Secretariat also has a continuing responsibility to participate in studies required in response to requests from participating jurisdictions. Such studies will include proposed projects being referred to the COH and COWQ, natural flow studies, and definitive studies such as this study and the partially completed studies on westward flowing tributaries and westward flowing streams.

The conduct of the above studies is a continuing responsibility but should not interfere with the ongoing responsibilities of the Secretariat with respect to monitoring the Apportionment Agreement.

PARTICIPATING AGENCIES

Provincial Agencies

Each provincial agency has a duty to manage the water within its jurisdiction and to issue streamflow forecasts thereby determining whether the apportionment of flow might be a problem. Also each provincial agency, as described in the responsibilities of the Board, has an ongoing duty to keep the Board informed of proposed projects that might have interprovincial implications and, on a contractual basis, to perform studies for the Board.

Committees of the Board

The standing Committees on Hydrology and Water Quality provide technical support to the Board in matters concerning the quantity and quality of water in eastward flowing interprovincial streams and the special purpose committees give similar technical support on individual problems. Each Board agency has a continuing responsibility to ensure that membership on these committees is maintained and that the members are prepared to devote time and agency resources to the work of these two committees.

Water Survey of Canada

Canada has a continuing responsibility to make sufficient streamflow measurements to ensure that the Prairie Provinces Water Board Master Agreement on Apportionment is adequately monitored. This responsibility is described in Section 7 of the Master Agreement as follows:

> *"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".*

Thus, Canada has the responsibility for providing current streamflow and water level data from designated PPWB hydrometric stations and this responsibility has been assigned to the Water Survey of Canada.

If, for any reason, one or more of the hydrometric stations cannot be accurately and effectively operated, the Secretariat should be notified immediately. Possible changes to the network could then be considered and implemented by consultation through the Secretariat. The funding for additional hydrometric stations needed for apportionment purposes is a federal responsibility as defined in Section 7 of the Master Agreement.

Water Survey of Canada, as part of its continuing responsibility:

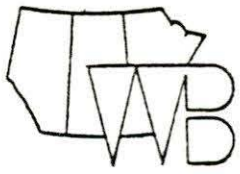
1. Monitors streamflow as required to provide the basic field data from PPWB hydrometric stations requirement for apportionment purposes.
2. Assembles raw field data from PPWB designated hydrometric gauging stations or contributed record points.
3. Provides current streamflow and water levels in the format required for natural flow computations.
4. Estimates missing records at PPWB designated hydrometric gauging stations where actual record is not available.
5. Transmits the resulting data to the Secretariat, or whatever agency is contracted to make natural flow computations, within three weeks after the end of each audit period. (Audit periods are presently required only on the South Saskathewan River and Qu'Appelle River Basins.)
6. Takes such measurements as are required to adequately define streamflow during low flow periods.
7. Establishes and operates hydrometric stations needed for apportionment purposes.

Atmospheric Environment Service

The Atmospheric Environment Service of Environment Canada (AES) has a continuing duty to provide evaporation estimates at project sites where such estimates are needed for the apportionment of streamflow. The agency has also accepted the responsibility of maintaining the meteorological stations and providing the data required for natural flow purposes (see Appendix 1).

Prairie Farm Rehabilitation Administration

PFRA has the same duty as provincial agencies to keep the Board informed of proposed future projects involving federal government participation. The Hydrology Division of PFRA has, in past years, undertaken several prairie wide and interprovincial studies directly related to Board interests and it is anticipated that this type of involvement will continue. For example, the Hydrology Division has standardized gross and effective drainage area estimates for the prairie provinces, determined river distances for the Saskatchewan-Nelson drainage basin, and contractually undertaken natural flow studies for several small interprovincial streams.



PRAIRIE PROVINCES WATER BOARD

Chapter IX

RECOMMENDATIONS

The Committee on Hydrology, has made several recommendations in this report. Two deal with administrative practices that should be continued to administer the Agreement, one with the procedures to be followed in the event of a shortage, one with a proposed change to the bylaws, and two with forecasting. The remaining five deal directly with the apportionment of streamflow at the five sites being studied. The recommendations are repeated here to summarize the content of the previous chapters of the report.

RECOMMENDED ADMINISTRATIVE PRACTICES

In dealing with the role of committees in connection with apportionment, consideration was given as to whether Board committees should be permanent, or whether special purpose committees should be formed each time a new task is identified.

It is recommended that the Committee on Hydrology and the Committee on Water Quality continue to be utilized as standing Committees for the purposes of administering apportionment.

It is further recommended that the COWD and the COIAA Committees, because they have been formed to perform a specific task, be classified as special purpose committees.

The content of this report and its recommendations are based on present conditions. The conditions may, and will, change as basin uses and concerns change. A formalized updating procedure is desirable to ensure that such changes are recognized and incorporated into the administration of the Apportionment Agreement.

It is recommended that the Board review balance periods, audit periods, or the minimum discharge criterion for specific basins at the request of any member agency.

STREAMFLOW APPORTIONMENT

Specific recommendations have been made for each of the five sites presently being considered for apportionment purposes. These recommendations are as follows:

North Saskatchewan River

It is recommended that no audit or balance periods of less than twelve months, and no minimum discharge criterion, be established at present for the North Saskatchewan River at the Alberta-Saskatchewan boundary.

It is further recommended that apportionment flows at this site continue to be reported on a calendar year basis.

South Saskatchewan River

It is recommended that the South Saskatchewan River near the Alberta-Saskatcehwan boundary be audited on a quarterly basis reverting to a one month or less basis when recorded flow drops below 42.5m^3/s but that no balance period of less than twelve months be established at this time. It is also interpreted as daily mean discharge criterion be interpreted as daily mean discharge, not as instantaneous discharge, and that in low flow situations, Water Survey of Canada take more frequent discharge measurements as deemed necessary to monitor the Apportionment Agreement.

It is further recommended that apportionment flows at this site continue to be reported on a calendar year basis.

Saskatchewan River

It is recommended that no audit or balance periods of less than twelve months be established for the Saskatchewan River at the Saskatchewan-Manitoba boundary and that there is presently no need to establish a minimum discharge criterion at this location. It is also recommended that, because minimum flow problems are experienced only intermittently, Manitoba continue to resolve its minimum flow requirements on a direct province-to-province basis with Saskatchewan when such problems occur.

Churchill River

It is recommended that no audit or balance periods of less than twelve months be established for the Churchull River at the Saskatchewan-Manitoba boundary and that a minimum discharge criterion at this location not be established at present.

It is also recommended that apportionment flows at this site now be reported on the basis of a twelve month period from April 1 to March 31 of the following year.

Qu'Appelle River

It is recommended that flow of the Qu'Appelle River at the Saskatchewan-Manitoba boundary be audited each year at the end of May, July, October and February. It is further recommended that whenever the sum of recorded flow for April and May is less than one-half of cummulative natural flow for those two months, monthly audits of streamflow be made for the remainder of the apportionment period or until one-half of natural flow for the audited period has been passed to Manitoba.

It is further recommended that apportionment flows at this site continue to be reported on the basis of the twelve month period from April 1 to March 31 of the following year.

It is also recommended that no minimum discharge criterion be established at this location at present.

PROPOSED CHANGE TO BYLAW 16

The use of the Annual Report to record the balance of flow at the end of an apportionment period will necessitate a change in Bylaw 16 to enable the Secretariat to use final WSC data. Therefore:

It is recommended that Bylaw 16 be revised to provide a period of six (6) months after the end of the Board's financial year for preparation of the Annual Report.

PROCEDURES IN THE EVENT OF A SHORTAGE

It is unlikely, with the present spirit of cooperation between the three prairie provinces, that major shortages will ever become a frequent occurrence. However, procedures to prevent, to minimize and to rectify such occurrences have been described in Chapter V.

It is recommended that the general procedures described in Chapter V of the report be followed to deal with both anticipated and real shortages.

FORECASTING

Forecasting is, primarily, a managerial responsibility of provincial agencies. The preparation of forecasts is desirable and it is recognized that such forecasts will benefit both the upstream and downstream jurisdictions.

It is recommended that Alberta and Saskatchewan prepare such water supply forecasts as are required to enable the operating jurisdictions to more efficiently manage water supplies for interprovincial apportionment purposes.

Discharge forecasts are needed on the South Saskatchewan River during low flow situations. Therefore:

It is recommended that Alberta prepare discharge forecasts whenever discharge conditions in the South Saskatchewan River at the Alberta-Saskatchewan boundary indicate that the low flow criterion may not be met.

APPENDIX 1

NATURAL FLOW FOR APPORTIONMENT PURPOSES

(A Summary of the Recommendations in PPWB Report #48)

APPENDIX I

In 1976 the Calgary District Office of the Water Survey of Canada, under contract to the Prairie Provinces Water Board, completed a study to develop procedures for the determination of natural flows of the South Saskatchewan and North Saskatchewan Rivers at the Alberta-Saskatchewan boundary points and the Saskatchewan, Qu'Appelle, and Churchill Rivers at the Saskatchewan-Manitoba boundary points. The study is described in detail in PPWB Report No. 45 and the results are summarized in a Committee on Hydrology report to the Board entitled "Determination of Natural Flows for Apportionment Purposes" PPWB Report No. 48, May 1976.

The recommendations arising from that study have formed the basis for several of the recommendations in the Administration of the Apportionment Agreement report and hence are summarized in this Appendix to serve as a convenient reference to readers of the main reports.

Two recommendations are common to all five of the above Apportionment Points:

1. ACCURACY OF FLOW DETERMINATION

   It is recommended that the error limits for monthly hydrometric record at the point of apportionment be less than 4% under open water and 10% under ice conditions. The accuracy of related hydrometric data at other monitoring points should be commensurate with the use of the information and the relative impact on the accuracy of computations for the apportionment flow.

2. EFFECTS OF LAND USE CHANGES

   It is recommended that effects on runoff of changing land use patterns not be considered in the computation of natural flow.

The remainder of the recommendations are summarized briefly as

follows:

GROUNDWATER

For the North and South Saskatchewan, the Saskatchewan, and the Churchill basins, it is recommended that changes in natural flow due to groundwater inflow or recharge not be considered in the computations. In the Qu'Appelle River basin, it is recommended that changes in natural flow due to groundwater inflow or recharge be considered to the extent utilized in the natural flow routing model developed in PPWB Report No. 45.

ROUTING

In routing flows for the North and South Saskatchewan Rivers and the Saskatchewan River, it is recommended that calculated depletions due to consumptive use, diversion, and reservoir storage and evaporation be routed to the point of apportionment and applied to the recorded flow in order to determine natural flow.

For the Churchill River, it is recommended that, at the present time, calculated depletions not be routed to the point of apportionment.

For the Qu'Appelle River, it is recommended that the routing procedure as described in PPWB Report No. 45 be adopted.

METHOD OF CALCULATING NATURAL FLOW

The Project Depletion Method described in PPWB Report No. 45 is recommended for all five apportionment points listed below. In the case of the Qu'Appelle River, it is recommended that the Project Depletion Method, supplemented by the routing capabilities of the Streamflow Synthesis and Reservoir Regulation (SSARR) Model be used.

POINT OF APPORTIONMENT

The point of apportionment for each basin was selected as follows:

North Saskatchewan River Basin at the Alberta-Saskatchewan Boundary

It is recommended that the point of apportionment of the North Saskatchewan River at the Alberta-Saskatchewan boundary be the gauging station, North Saskatchewan River near Deer Creek.

South Saskatchewan River Basin Below Its Confluence With the Red Deer River

It is recommended that the point of apportionment of the South Saskatchewan at the Alberta-Saskatchewan boundary be a point at or as near as reasonable below the confluence of the South Saskatchewan and Red Deer Rivers and that the combined recorded flow of the South Saskatchewan at Highway #41 and the Red Deer River near Bindloss be used to indicate recorded flow at this point.

Saskatchewan River Basin at the Saskatchewan-Manitoba Boundary

It is recommended that the point of apportionment on the Saskatchewan River at the Manitoba-Saskatchewan boundary be the gauging station designated as the Saskatchewan River near Manitoba boundary.

Churchill River Basin at the Saskatchewan-Manitoba Boundary

It is recommended that the point of apportionment of the Churchill River be the gauging station Churchill River at Sandy Bay.

Qu'Appelle River Basin at the Saskatchewan-Manitoba Boundary

It is recomended that the point of apportionment of the Qu'Appelle River at the Saskatchewan-Manitoba boundary be the

gauging station Qu'Appelle River near Welby.

FREQUENCY OF REPORTING

The PPWB Report No. 48 recommended that natural flow calculations should be based on monthy means and that the results should be reported annually for the North Saskatchewan, Saskatchewan and Churchill Rivers and quarterly for the Qu'Appelle River. On the South Saskatchewan River, it is recommended that natural flow computations be reported quarterly, based on monthly means, reverting to a one month reporting period when recorded flow drops below 42.5 m^3/s.

HYDROMETRIC, METEOROLOGIC AND EVAPORATION STATIONS

The stations required to calculate natural for the five basins studied were listed in PPWB Report No. 48. A total of 83 hydrometric, nine meteorologic, and five evaporation stations are required to calculate natural flow at all apportionment points. The individual basin requirements are summarized as follows:

TABLE I - 1

Total Station Requirements to Calculate Natural Flow for Apportionment Purposes

	Station Requirements		
Apportionment Points	Hydrometric	Meteorologic	Evaporation
North Saskatchewan River near Deer Creek	5	0	0
South Saskatchewan River below its junction with Red Deer River	47	3	2
Saskatchewan River near the Saskatchewan-Manitoba boundary	11	6	3
Churchill River at Sandy Bay	3	0	0
Qu'Appelle River near Welby	17	0	0 *
TOTAL	83	9	5

* Evaporation on the Qu'Appelle Lakes is calculated using modified Lake Diefenbaker evaporation estimates.

APPENDIX II

STREAMFLOW FORECASTING FOR WATER MANAGEMENT

AND

FLOOD CONTROL

(A Summary of the Recommendations in PPWB Report #47)

APPENDIX II

In 1977 the Calgary District Office of the Water Survey of Canada, under contract to the Prairie Provinces Water Board, completed a study to develop streamflow forecasting procedures for the North Saskatchwan River and South Saskatchewan River above the Alberta-Saskatchewan boundary; and the Saskatchewan River, Churchill River, and Qu'Appelle River above the Saskatchewan-Manitoba boundary. The study is described in PPWB Report No. 44 and the results are summarized in a Committee on Hydrology report to the Board titled "Streamflow Forecasting for Water Management and Flood Control" PPWB Report No. 47, September 1977.

The recommendations arising from that report are summarized in this Appendix. They provide background material related to Chapter VI, "Forecasting", in the main report.

The result of the study was the development of procedures for both water supply forecasting and river discharge forecasting and the identification of hydrometric and meteorologic networks required to provide data for these forecasts.

Water supply forecasts are forecasts of the volume of water which may be expected at a given location during a given period of time. Procedures were developed to provide such forecasts for a spring-summer period, a winter period and, in some cases, a spring only period. A total of 35 points were identified where spring-summer forecasting was needed and 13 where winter forecasts were required.

River discharge forecasts are forecasts of the discharges that will occur at a given point as a result of snowmelt runoff or rainfall events. Procedures were developed to forecast discharge during normal periods as well as during high discharge periods. Normal discharge forecasting usually involves routing recorded upstream values to downstream forecast locations, while basin simulation techniques are used during extreme discharge

periods to provide greater forewarning of flood crests. Normal discharge forecasting is required at 37 locations and extreme or high discharge forecasts are needed at 40 sites.

Water supply and river discharge forecasting needs have been summarized in Table II-1.

TABLE II-1

Number of Locations Where Forecasting is Needed *

Drainage Basin	Water Supply Forecast			River Discharge Forecast	
	Spring-Summer	Spring Only	Winter	Normal Discharge	High Discharge
North Saskatchewan	4	0	2	3	6
South Saskatchewan	9	0	2	13	18
Saskatchewan	4	3	3	5	0
Churchill	7	0	5	7	0
Qu'Appelle	0	8	1	9	16
TOTAL	24	11	13	37	40

* See PPWB Report No. 47 for Listings of Individual Locations.

The methods used to obtain forecast information, generally speaking, involve using regression equations and indexing procedures to make water supply forecasts. Recognized routing procedures such as graphical routing, the SSARR model, the Stanford model, and similar basin simulation models are recommended to forecast peak discharge and the shape of the flood hydrograph.

The hydrometric and meteorologic networks required to produce water supply and discharge forecasts were summarized in PPWB Report No. 47 and are shown in Table 11-2.

SUMMARY OF IDENTIFIED NETWORK REQUIREMENTS

GAUGING REQUIREMENTS	SOUTH SASK			NORTH SASK			SASKATCHEWAN			QU'APPELLE			CHURCHILL			TOTALS		
	W.S.	R.F.	BOTH	W.S.	R.F.	BOTH	W.S.	R.F.	BOTH	W.S.	R.F.	BOTH	W.S.	R.F.	BOTH	W.S.	R.F.	BOTH
Existing Hydrometric Gauges	13	35	40	8	12	16	6	15	17	8	28	33	8	26	29	42	115	133
Hydrometric Gauges Requiring Data Transmission Upgrading	0	10	10	0	3	3	0	10	10	0	7	7	0	9	9	0	39	39
New Hydrometric Gauges	0	0	0	0	0	0	0	2	2	0	3	3	0	2	2	0	7	7
Existing Storage-Precipitation Gauges	25	-	25	13	-	13	0	-	0	0	-	0	0	-	0	35	0	35
New Storage-Precipitation Gauges	3	-	3	0	-	0	0	-	0	0	-	0	5	-	5	8	0	8
Existing Climatological Stations	18	-	18	13	-	13	10	-	10	16	12	21	14	-	14	66	12	71
New Climatological Stations	0	-	0	0	-	0	0	-	0	0	0	0	0	-	0	0	0	0
Existing Snow Courses	0	-	0	0	-	0	0	-	0	3	26	29	19	-	19	22	26	48
New Snow Courses	0	-	0	0	-	0	0	-	0	0	0	0	0	-	0	0	0	0
Existing Recording Rain Gauges	-	6	6	-	2	2	-	0	0	-	0	0	-	0	0	0	7	7
New Recording Rain Gauges	-	5	5	-	2	2	-	0	0	-	0	0	-	0	0	0	7	7
Existing Standard MSC Gauges	-	39	39	-	16	16	-	0	0	-	0	0	-	0	0	0	52	52
New Standard MSC Gauges	-	0	0	-	7	7	-	0	0	-	0	0	-	0	0	0	7	7
Meteorologic Gauges Requiring Data Transmission Upgrading	9	13	22	7	0	7	7	0	7	10	10	16	11	0	11	41	23	60
Soil and Snowpack Temperatures	-	-	0	-	-	0	-	-	0	-	1	1	-	-	0	0	1	1
Wind Observations	-	-	0	-	-	0	-	1	1	-	-	0	-	-	0	0	1	1

The total number of gauges for each basin (under the basin subheading 'BOTH') and for all basins (under the main heading 'TOTALS') represent the number of different gauges required. The values noted, take into account gauges used for more than one forecast type or in more than one basin, therefore the totals may not be the arithmetic sum of the gauges required for individual forecast types or individual basins.

APPENDIX III

TERMS OF REFERENCE FOR CURRENT

PPWB COMMITTEES

APPENDIX III

The Terms of Reference for the four current Board Committees, as published in the 1978-79 Annual Report, are repeated here for reference purposes.

COMMITTEE ON HYDROLOGY

Terms of Reference

At the request of, and under the direction of the PPWB, the Committee on Hydrology shall investigate, oversee, review, report and recommend on matters pertaining to hydrology of interprovincial or interjurisdictional basins.

The Committee may consider such things as natural flow; forecasting; network design; collection, processing and transmission of data; basin studies and other items of interprovincial interest involving hydrology.

COMMITTEE ON WATER QUALITY

Terms of Reference

At the request of, and under the direction of the Prairie Provinces Water Board, the Committee on Water Quality shall investigate, oversee, review, report and recommend on matters pertaining to water quality of interprovincial and interjurisdictional basins.

Carrying out the above responsibilities may include such things as natural quality assessment; quality forecasting; network design; processing and dissemination of data; determination of implications or proposed projects that may significantly alter the water quality of interprovincial streams; consideration of special problems; establishment of procedures for emergency situations; and other items of interprovincial interest involving water quality.

COMMITTEE ON WATER DEMAND

Terms of Reference

The Committee on Water Demand shall be composed of one member representing each of the Provinces of Alberta, Saskatchewan and Manitoba, two members representing Canada, and the Executive Director of the Prairie Provinces Water Board shall be Chairman. The Committee shall function during the life of the Water Demand Study in the Saskatchewan-Nelson Basin and shall have the responsibility of providing technical guidance and financial management for the Water Demand Study on behalf of the Board.

The Water Demand Study shall be divided into two parts. Part One shall be done under the auspices of the Prairie Provinces Water Board and consist of a study of a later date and would provide estimates of future water demands. Throughout Part One of the study the Committee shall: monitor and oversee the technical and financial aspects of the study as directed by the Board; ensure that there is no duplication of studies, and report regularly to the Board on the progress of the study.

COMMITTEE ON INTERJURISDICTIONAL AGREEMENTS ADMINISTRATION

Terms of Reference

It was agreed that a committee consisting of the Executive Director, one member from Saskatchewan, one member from Alberta, and the Inland Waters Directorate of Environment Canada be struck to handle the problem of developing a methodology for the efficient adminstration of interjurisdictional agreements, particularly as regards Battle and Lodge Creek Basins.