

TECHNICAL REPORT TO THE
PPWB COMMITTEE ON HYDROLOGY

NATURAL FLOW

OVERFLOWING RIVER

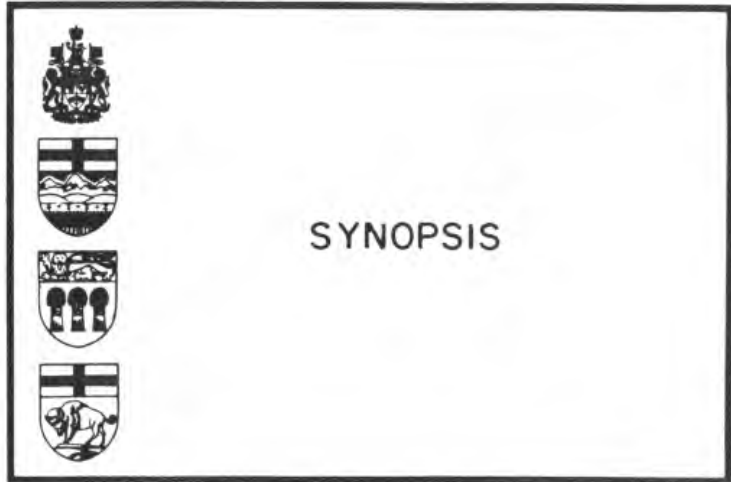
AT SASKATCHEWAN - MANITOBA BOUNDARY

JULY 1988

PPWB REPORT # 103

PREPARED BY:

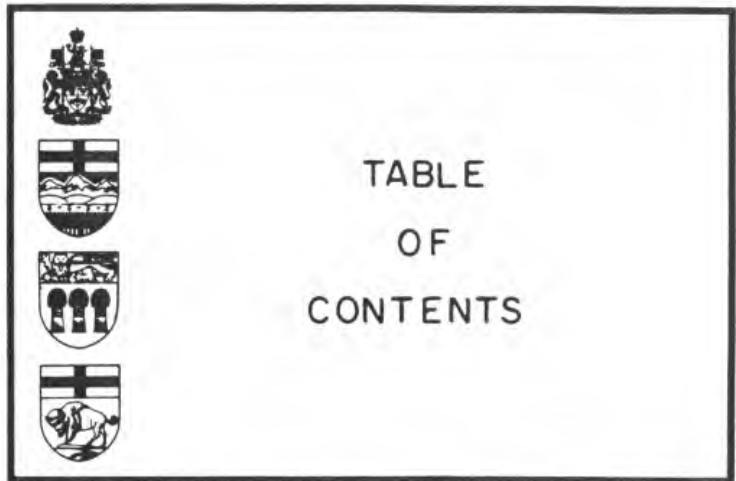
HYDROLOGY DIVISION
PRAIRIE FARM REHABILITATION ADMINISTRATION
AGRICULTURE CANADA



The average annual natural flow of Overflowing River at the Saskatchewan-Manitoba boundary is 169 000 dam³ on a water year basis or 168 000 dam³ on a calendar year basis. Average annual consumptive water use in the Saskatchewan portion of the basin now amounts to approximately 3330 dam³, 2.0% of the average annual natural flow. A drainage project within the Saskatchewan portion of the basin currently decreases the natural effective and gross drainage areas by 17.2 km², or 1.1%, at the interprovincial boundary. It is estimated that this decreased drainage area reduced the average annual natural flow at the interprovincial boundary by 1810 dam³. The cumulative net effect of consumptive water use and man-made drainage is to decrease the average annual natural flow at the interprovincial boundary by approximately 5140 dam³, or 3.1%.

The present (1986) level of consumptive use (including drainage) in the Saskatchewan portion of the Overflowing River basin would not, on an annual basis, have exceeded Saskatchewan's 50% share of the natural flow at the Saskatchewan-Manitoba boundary at any time during the 74-year period 1912-13 to 1985-86. In fact, Saskatchewan would have used an annual maximum of only 21.9% of the natural flow (corresponds to the water balance period 1980-81). The average annual quantity of water which would have been delivered to Manitoba in excess of 50% of natural flow would have amounted to approximately 79 600 dam³.

The existing hydrometric gauging station Overflowing River at Overflowing River (05LD001) does not provide adequate hydrometric data for calculating the natural flow of Overflowing River at the Saskatchewan-Manitoba boundary. However, an accurate estimate of natural flow at the boundary is not required until water uses in the Saskatchewan portion of the basin become significant. Monitoring of apportionment is not required at the present time because the uses in the Saskatchewan portion of the basin are not substantial.



| | <u>Page Number</u> |
|--|------------------------|
| INTRODUCTION | 1 |
| BASIN GEOGRAPHY | 3 |
| BASIN WATER USE | 5 |
| NATURAL FLOW CALCULATIONS | 7 |
| PRESENT USE FLOW CALCULATIONS | 11 |
| PROCEDURE FOR FUTURE CALCULATION OF NATURAL FLOW | 13 |
| CONCLUSIONS AND RECOMMENDATIONS | 17 |
| ACKNOWLEDGEMENTS | 19 |
| BIBLIOGRAPHY | 21 |

APPENDICES:

| | |
|--|----|
| Appendix A - Water Use - Overflowing River Basin at the Saskatchewan-Manitoba Boundary | 23 |
| Appendix B - Recorded and Natural Streamflow Arrays | 27 |

TABLES:

| | | |
|---|---|----|
| 1 | Water Use Projects within the Natural Effective Drainage Area of the Overflowing River Basin | 6 |
| 2 | Natural Flow Calculations for 1985-86 - Overflowing River at the Saskatchewan-Manitoba Boundary | 15 |

APPENDIX A

| | | |
|-----|---|----|
| A-1 | Overflowing River Basin at the Saskatchewan-Manitoba Boundary - Total Historic Water Use (Including Drainage) | 25 |
| A-2 | Overflowing River Basin at the Saskatchewan-Manitoba Boundary - Total Water Use at the Present (1986) Level of Use (Including Drainage) | 26 |

APPENDIX B

| | | |
|-----|--|----|
| B-1 | Overflowing River at Overflowing River - 05LD001 Recorded Flow | 29 |
| B-2 | Overflowing River at Overflowing River - 05LD001 Regression Equations Used to Estimate Natural Monthly Mean Flow | 30 |
| B-3 | Overflowing River at Overflowing River - 05LD001 Natural Flow | 31 |
| B-4 | Overflowing River at the Saskatchewan-Manitoba Boundary - Natural Flow | 32 |
| B-5 | Overflowing River at the Saskatchewan-Manitoba Boundary - Flows at the Present (1986) Level of Upstream Use | 33 |
| B-6 | Overflowing River Basin Balance of Flow Table for Apportionment at the Present (1986) Level of Use | 34 |

FIGURE:

| | | |
|---|---|----|
| I | Location Map of the Overflowing River Basin | 35 |
|---|---|----|



The Overflowing River natural flow study is one of a series of natural flow studies conducted for the Prairie Provinces Water Board. Following completion of the Prairie Provinces Water Board's study on determination of natural flow of the North Saskatchewan, South Saskatchewan, Saskatchewan, Churchill, and Qu'Appelle River basins in 1977, the Board agreed to have other interprovincial basins studied to determine if monitoring of flow for apportionment might be required. Eighteen interprovincial basins were initially identified and assigned a priority. Two additional basins, Beaver River and Overflowing River, were subsequently added to the list. The Board agreed that the basins would be studied in order of priority as funds and time became available.

This report entitled, 'Natural Flow, Overflowing River at Saskatchewan-Manitoba Boundary' describes the basin geography, water use within the basin, and the derivation of historic natural flows at the Saskatchewan-Manitoba boundary. The present (1986) level of use is analyzed in conjunction with natural flows to determine the potential for apportionment deficits now and in the foreseeable future. The procedure to be used for the future calculation of natural flow is also provided, and the adequacy of the existing hydrometric network for the determination of natural flow at the interprovincial boundary is assessed.



The Overflowing River originates in eastern Saskatchewan, along the southeastern edge of the Pasquia Hills, encompassing the region immediately north of the Town of Hudson Bay, Saskatchewan (see Figure 1). From the headwaters in the Pasquia Hills, the river flows in a southeasterly direction until entering Leaf Lake, approximately 15 km northeast of the Town of Erwood, Saskatchewan. From Leaf Lake, the river takes a northeasterly course for approximately 33 km before passing into Manitoba. After entering Manitoba, the river flows in an easterly direction and eventually discharges into Dawson Bay of Lake Winnipegosis approximately 50 km from the interprovincial boundary.

The topography of the area provides very well-drained conditions in the headwaters (Pasquia Hills) and somewhat poorer-drained conditions below Leaf Lake. The area below Leaf Lake (comprising approximately 75% of the total drainage area of the Overflowing River basin) is quite flat and predominantly comprised of wetlands or marsh. Consequently, the unit runoff in the lower reaches of the basin is lower than for the rest of the basin.

The natural (i.e. before any man-made drainage works) gross and effective drainage areas of the Overflowing River basin at the Saskatchewan-Manitoba boundary are equal at 1 580 km². A minor portion of the runoff at the boundary originates in Manitoba from an area

having a gross and effective drainage area of 13.5 km². A table of gross and effective drainage areas⁽¹⁾ for key points in the basin is provided in Figure 1.

Overflowing River is classified as a perennial stream. Snowmelt in the spring contributes to high flows which rapidly give way to a generally diminishing base flow, resulting from marsh drainage and groundwater contribution, which persists through the remainder of the year. The median and mean annual natural runoff volumes of Overflowing River at the Saskatchewan-Manitoba boundary are 143 200 dam³ and 169 200 dam³, respectively. These values were determined from the array of natural flows at the interprovincial boundary as presented in Appendix B, Table B-4.



Two major consumptive water use projects are located within the effective drainage area in the Saskatchewan portion of the Overflowing River basin:

1. Bay Meadows - NW19-46-01-W2
Storage Capacity at FSL = 2 760 dam³
2. Leaf Lake - SE20-47-01-W2
Storage Capacity at FSL = 19 120 dam³

Bay Meadows (Water Rights #13048) is licensed for an annual diversion of 407 dam³. Constructed in 1978 by Ducks Unlimited, the 3 350 m long, one-metre high dyke creates a water body with a storage of 2 760 dam³ at FSL. The dyke and control structure are located immediately above Leaf Lake and all outflow from the Bay Meadows project enters Leaf Lake.

Leaf Lake (Water Rights #13049) is licensed for an annual diversion of 1 357 dam³. An outlet control structure consisting of a steel radial gate and four stop-log bays was constructed in 1978 by Ducks Unlimited. Soon after construction, the lake was drained to enhance vegetation growth for waterfowl production. Throughout 1980 and 1981, Leaf Lake was maintained 0.5 m below the natural FSL. From 1982 to the spring of 1986, Leaf Lake was maintained at the natural FSL. Throughout the summer of 1986, Leaf Lake was kept at 1.0 m below

the natural FSL until being raised, in the fall of 1986, to the present operating FSL of 1 038.0 m (0.5 m above the natural FSL) with a storage of 19 120 dam³. During the years 1978-81 and 1986, the operation of this project increased the flow in the river considerably, particularly when the project was drained in 1978, and resulted in most of the negative values as shown in Table A-1 during these years.

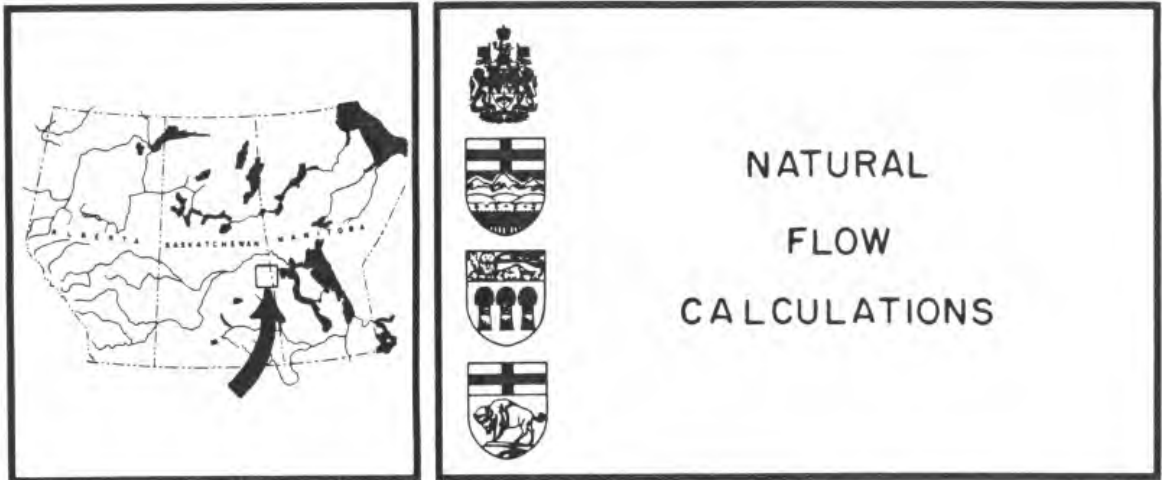
Information on licensed water use projects was obtained from the Saskatchewan Water Corporation. No unauthorized consumptive water use projects were identified on aerial photographs or noticed during a June 1987 field trip. However, an unauthorized drainage project which is believed to have been constructed in 1982 drains 17.2 km² of the natural effective and gross drainage area of the Overflowing River basin into the Red Deer River basin. All water use and drainage projects within the effective drainage area of the Overflowing River basin at the Saskatchewan-Manitoba boundary are provided in Table 1. Most of the negative values in Table A-1 prior to 1978, particularly in the month of March, resulted from the assumption regarding the accumulation of net evaporation during winter months for the Pasquia Lake Project. However, the Bay Meadows Project also had an impact on the negative values in the years since 1978.

Table 1
Water Use Projects within the Natural Effective Drainage Area
of the Overflowing River Basin

| Project Number | Land Location | Province | Project Status | Water Rights File Number | First Year Of Operation | Purpose | Capacity (dam ³) | Estimated Annual Depletion* (dam ³) | Comments |
|----------------|---------------|----------|----------------|--------------------------|-------------------------|----------|------------------------------|---|---------------------------------|
| 1 | NW18-46-03-W2 | Sask. | Licensed | 4113 | 1942 | Domestic | 278 | 185 | Pasquia Lake |
| 2 | NW18-46-03-W2 | Sask. | Licensed | 6248 | 1975 | Domestic | - | 358 | Teepee Creek Diversion |
| 3 | NW19-46-01-W2 | Sask. | Licensed | 13048 | 1978 | Wildlife | 2 760 | 3 033 | Bay Meadows |
| 4 | SE20-47-01-W2 | Sask. | Licensed | 13049 | 1979 | Wildlife | 19 120 | -56 | Leaf Lake |
| 5 | NW05-45-02-W2 | Sask. | Unauthorized | - | 1982 | Drainage | - | 1 505 | 17.2 km ² affected** |

* Estimated average annual net depletion to streamflow, including evaporation, based on the period of operation

** 17.2 km² was removed from the natural effective and gross drainage area of the Overflowing River basin and transferred to the Red Deer River basin



Natural flow, the quantity of water which would have been recorded under natural conditions (i.e. prior to the effect of human interference or intervention), was derived by using the Project Depletion Method⁽²⁾ to adjust recorded flow. Natural flows for the gauging station Overflowing River at Overflowing River (05LD001) were extended to cover the 75-year historic period 1912 to 1986. The natural flows were then transferred to the Saskatchewan-Manitoba boundary using drainage area and unit runoff ratios.

The only long-term hydrometric gauging station in the basin, Overflowing River at Overflowing River (05LD001), was established in 1954 and is still in operation. The array of recorded monthly mean flows for this station is shown in Appendix B, Table B-1. In 1964, a second hydrometric gauging station, Overflowing River near Hudson Bay (05LD003), was established. However, records prior to 1975 are only seasonal or miscellaneous. Furthermore, this shorter-term station is located above the Ducks Unlimited Bay Meadows and Leaf Lake projects and therefore does not adequately reflect streamflow at the interprovincial boundary.

Historic upstream water uses within the effective drainage area of the Overflowing River basin, as shown in Table 1, were determined on an annual basis as a function of estimated water use (including evaporation and drainage diversion) and available inflow. The estimated

annual water uses (excluding the use by Water Rights #6248) varied from year to year because of the variable net evaporation. The Teepee Creek Diversion losses were assumed constant from year to year and were distributed uniformly over the months April to October. All of the water use projects (including the drainage project) presented in Table 1 lie within the natural effective drainage area of the Overflowing River basin above the hydrometric gauging station Overflowing River at Overflowing River (05LD001), and thus were used in the natural flow calculations.

The variable estimated monthly water uses (including water diverted out of the basin) for all projects located above the hydrometric gauging station 05LD001 were added to the recorded monthly mean flows of the gauging station. The result was the natural monthly mean flows for the station 05LD001 for the years 1954 to 1986. Natural monthly mean flows for periods of missing record in the period 1912 to 1986 were estimated from recorded and natural flows in adjacent drainage basins.

For the months March to October inclusive, missing natural monthly mean flows of Overflowing River at Overflowing River (05LD001) were estimated using the regression equations presented in Appendix B, Table B-2. Priorities were assigned to the regression equations on the basis of the adjusted (to account for degrees of freedom) coefficient of correlation, the adjusted standard error of estimate, the magnitude of the intercept, and the overall hydrologic validity of each equation. The regression equation assigned priority No. 1 was used to estimate as many missing values as possible, then the regression equations assigned priorities No. 2, 3, 4 and 5 were used to estimate values which had not been estimated from higher priority regression equations. The variables used in these regression equations were selected on the basis of hydrologic similarity and their potential for providing estimates of flow for periods of missing data.

For the winter months of November to February inclusive, missing natural flows of Overflowing River at Overflowing River (05LD001) were estimated from a general monthly recession curve. The general recession curve was derived from natural monthly data⁽³⁾ of Swan River near Minitonas (05LE006) for the periods 1913 to 1928 and 1950 to 1986 plotted on semi-logarithmic paper (flows plotted on the logarithmic axis). The appropriate monthly relationships expressed as a function of calculated and estimated October natural flows are presented in Appendix B, Table B-2. The complete array of natural flows for Overflowing River at Overflowing River (05LD001) is presented in Appendix B, Table B-3.

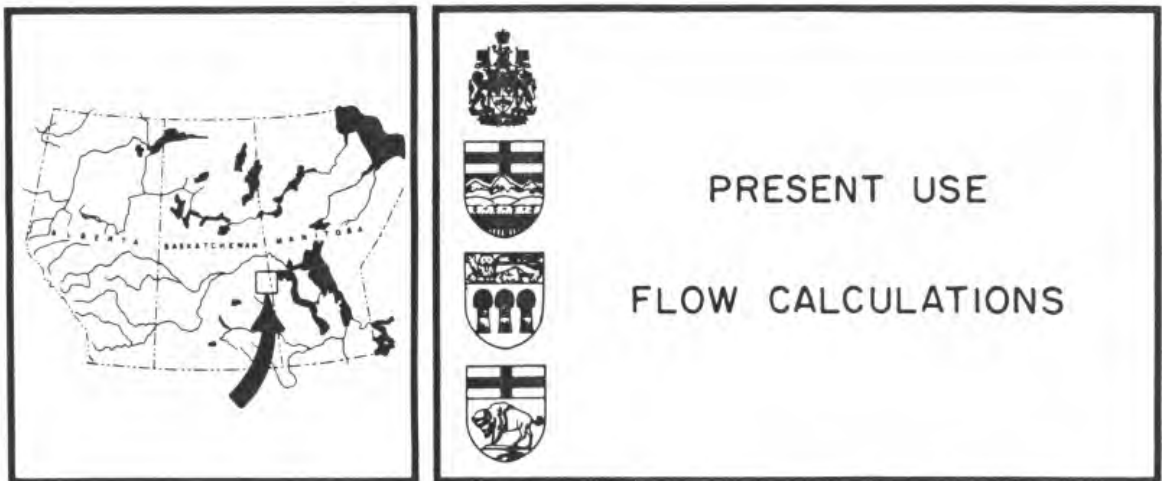
Natural flows of Overflowing River at the Saskatchewan-Manitoba boundary are based entirely on natural flows derived for the hydro-metric gauging station Overflowing River at Overflowing River (05LD001). The natural flows developed for 05LD001 were transferred to the interprovincial boundary by multiplying these natural flows by a drainage area ratio of 0.469 and a unit runoff ratio of 1.09, which reflects the approximate difference in unit runoff (9%) of the basin above and below the interprovincial boundary. The monthly natural flows derived for Overflowing River at the Saskatchewan-Manitoba boundary for the 74-year period 1912-13 to 1985-86 are shown in Appendix B, Table B-4.

As the base station Overflowing River at Overflowing River (05LD001) is not operated on a year-round basis, the accuracy of the annual natural flow estimates at the interprovincial boundary is even more questionable. The first (and easiest) step in improving the accuracy of the annual natural flow estimates would be to obtain flow records during the winter months. Without such data, the general monthly recession curve developed for the Swan River basin would continue to be used to estimate natural flow for the winter months. Although the Swan River basin is in proximity to the Overflowing River basin, the recession curve may not be entirely appropriate because of the somewhat different basin geography. Consequently, it would be desirable to obtain a continuous record of flows at the current

hydrometric gauging station to confirm the recession curve or to develop a more appropriate recession curve.

As water use develops in the basin, the procedure for estimating natural flows at the boundary would come under closer scrutiny and may eventually become inadequate. Furthermore, estimates of natural flow at the interprovincial boundary are subject to the inaccuracies and potential error inherent in estimating flow at a location that controls only 47% of the total drainage area of the base station.

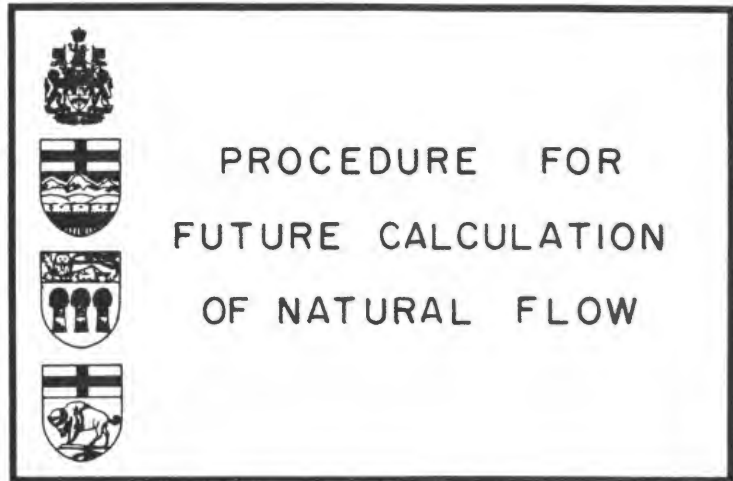
Caution should be exercised by users who may wish to utilize this data base in conducting other studies. Such data users should recognize the limitations of the estimates which were made. The estimates have been published because these estimates, rough as they are, provide an adequate basis for evaluating the effect of potential water uses in Saskatchewan on natural flows of Overflowing River at the Saskatchewan-Manitoba boundary over the 74-year historic period 1912-13 to 1985-86. More refined estimates may be obtained either by conducting an analysis which better accounts for changes in topography (i.e. unit runoff) or by collecting more pertinent hydrometric data (e.g. measuring winter flows or establishing a station at the interprovincial boundary) within the basin. However, such efforts were considered to be beyond the scope of this study.



An analysis was made to determine whether present (1986) use flow of Overflowing River at the Saskatchewan-Manitoba boundary would have been less than 50% of the natural flow, under the terms of the 1969 Master Agreement on Apportionment, in the period 1912-13 to 1985-86. A monthly array of uses was created, assuming that all current uses (including the drainage project) upstream of the Saskatchewan-Manitoba boundary were in existence for the entire study period. (All licensed and unauthorized projects in the basin are located in Saskatchewan.) The existing water uses were determined for the study period on an annual basis as a function of estimated water use (including evaporation) and available inflow. The estimated annual water uses consequently varied from year to year because of the variable net evaporation. Current water uses upstream of the Saskatchewan-Manitoba boundary were combined to form an array of monthly uses (Appendix A, Table A-2). This array of monthly uses was subtracted from the natural flows at the interprovincial boundary to produce an estimate of monthly flows (Appendix B, Table B-5) which would have been recorded at the Saskatchewan-Manitoba boundary during the period 1912-13 to 1985-86 had the present (1986) level of use (including drainage) been in effect for the entire period.

An array of one-half the natural flow at the interprovincial boundary was then subtracted from the array of natural flows adjusted for present use (Appendix B, Table B-5). The residual monthly flows

(Appendix B, Table B-6) provide a picture of the balance-of-flow situation for Overflowing River over the 74-year historic period 1912-13 to 1985-86. Table B-6 indicates that Saskatchewan would have always passed at least 50% of the natural flow of Overflowing River at the interprovincial boundary on an annual basis during the 74-year period. However, there were 24 months where the present (1986) level of upstream use (including the effect of the drainage project) would have been greater than half the monthly natural flow at the interprovincial boundary. The largest monthly 'deficit' ($0.344 \text{ m}^3/\text{s}$) would have occurred in August, 1984 but represents only 1.0% of the 1984-85 annual volume passed to Manitoba in excess of Saskatchewan's 50% share. In fact, Saskatchewan would have used an annual maximum of only 21.9% of the natural flow (corresponds to the water balance period 1980-81) under the present (1986) level of development. Manitoba would have received an average annual volume of $79\,600 \text{ dam}^3$ in excess of its 50% share.



If it becomes necessary to formally monitor the apportionment of streamflow in the Overflowing River basin, natural flow calculations would have to be performed on a regular basis to ensure that Manitoba receives its share of the flow. Natural flows of Overflowing River would be computed using the Project Depletion Method, based on the generalized equation:

$$Q_{\text{Nat}} = (Q_{\text{Rec}} + \text{ND}) / (\text{NCD})$$

where:

Q_{Nat} is the natural flow at the hydrometric station,

Q_{Rec} is the recorded flow at the hydrometric station,

ND is the net depletion of streamflow at upstream water use projects, and

NCD is a factor to account for the net contribution to streamflow due to upstream drainage projects.

The net depletion of streamflow at upstream water use projects (ND) may be computed as the sum of:

1. water withdrawal for human or livestock use, less the portion of this withdrawal which is returned to the stream or reservoir,
2. net evaporation (gross evaporation minus precipitation) from the reservoir, and

3. change in reservoir storage over the specified time interval; an increase in storage is considered a positive (+) net depletion while a decrease in storage is considered a negative (-) net depletion.

The factor (NCD) which accounts for the net contribution to streamflow at the hydrometric gauging station due to upstream drainage projects is computed as the ratio of the current effective drainage area of the gauging station (as influenced by drainage projects) to the natural effective drainage area of the hydrometric gauging station.

For purposes of the Overflowing River natural flow study, monthly recorded flows of Overflowing River at Overflowing River (05LD001) were adjusted for storage and evaporation by major projects, diversions to Ruby Lake through the Teepee Creek Diversion, and upstream drainage works. The estimation of streamflow depletion from major projects required monthly simulations of Pasquia Lake and the Ducks Unlimited Bay Meadows and Leaf Lake projects. Historic monthly water uses were lagged to account for the time of travel from the point of use to the hydrometric gauging station. The present (1986) level of consumptive water use in Saskatchewan was determined to be only 2.0% of the average annual natural flow of Overflowing River at the Saskatchewan-Manitoba boundary.

Future calculations of natural flow for monitoring apportionment need not be conducted in such detail until monitoring for apportionment is required. Simplifications can be made to the calculation procedure without unduly affecting the accuracy of the resulting natural flows. Major projects can be combined for purposes of estimating streamflow depletion, and the lag time of monthly water uses can be ignored.

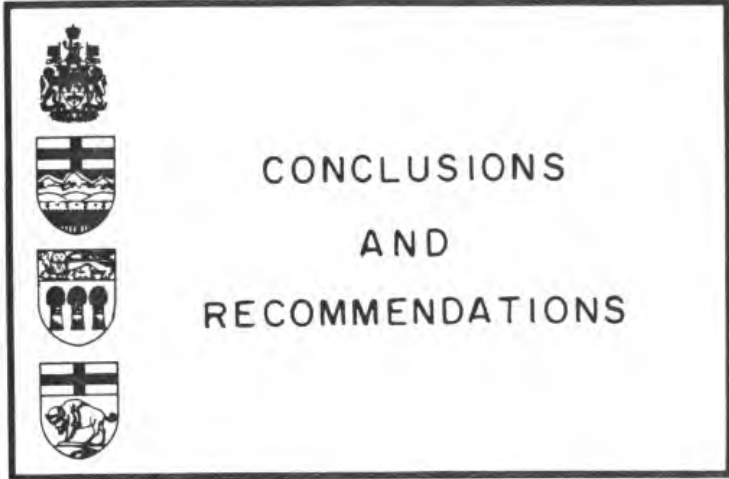
Table 2 illustrates the recommended procedure for calculating natural flows of Overflowing River at the Saskatchewan-Manitoba boundary for the 1985-86 water balance period. The calculated annual natural flow at the interprovincial boundary of 131 075 dam³ is within 0.5% of the 130 467 dam³ annual natural flow determined using the detailed calculation procedure.

Table 2

**Natural Flow Calculations for 1985-86
Overflowing River at the Saskatchewan-Manitoba Boundary**

| Month | Recorded Flow at 05LD001 | | Net Evaporation ⁽¹⁾ (mm) | Combined Project Area at FSL ⁽²⁾ (ha) | Net Depletion to Streamflow (dam ³) | | Natural Flow ⁽⁵⁾ at 05LD001 | | Natural Flow ⁽⁷⁾ at Sask-Man Boundary (m ³ /s) |
|---------------------------|--------------------------|---------------------|--|---|---|---------------------------------------|--|----------------------|--|
| | (m ³ /s) | (dam ³) | | | Project Evap. Loss ⁽³⁾ | Teepee Creek Diversion ⁽⁴⁾ | (dam ³) | (m ³ /s) | |
| April | 19.9 | 51 580.8 | 41.4 | 1 100 | 455.4 | 51.1 | 52 349.0 | 20.196 | 10.324 |
| May | 22.8 | 61 067.5 | 58.5 | 1 100 | 643.5 | 51.1 | 62 072.5 | 23.175 | 11.847 |
| June | 12.5 | 32 400.0 | 31.3 | 1 100 | 344.3 | 51.1 | 32 960.2 | 12.716 | 6.501 |
| July | 7.37 | 19 739.8 | 149.0 | 1 100 | 1 639.0 | 51.1 | 21 537.6 | 8.041 | 4.111 |
| August | 10.5 | 28 123.2 | 80.9 | 1 100 | 889.9 | 51.1 | 29 210.3 | 10.906 | 5.575 |
| September | 7.50 | 19 440.0 | 31.1 | 1 100 | 342.1 | 51.1 | 19 932.9 | 7.690 | 3.931 |
| October | 7.10 | 19 016.6 | 50.6 | 1 100 | 556.6 | 51.1 | 19 722.9 | 7.364 | 3.765 |
| November | - | - | -26.9 | 1 100 | 0 | 0 | - | 3.691 ⁽⁶⁾ | 1.887 |
| December | - | - | -15.0 | 1 100 | 0 | 0 | - | 1.850 ⁽⁶⁾ | 0.946 |
| January | - | - | -23.2 | 1 100 | 0 | 0 | - | 0.933 ⁽⁶⁾ | 0.477 |
| February | - | - | -14.5 | 1 100 | 0 | 0 | - | 0.466 ⁽⁶⁾ | 0.238 |
| March | 0.175 | 468.7 | -24.1 | 1 100 | 0 | 0 | 468.7 | 0.175 | 0.089 |
| Total (dam ³) | - | - | N/A | N/A | 4 870.8 | 357.7 | - | 256 400.8 | 131 074.7 |

- (1) Monthly net evaporation is calculated as the difference between gross evaporation at The Pas and 1,012 * precipitation at Yorkton.
- (2) The combined incremental flooded area for Bay Meadows (886 ha), Leaf Lake (154 ha) and Pasquia Lake (60 ha) is 1100 ha. (The runoff is generally sufficient to maintain all three projects at FSL throughout the year.)
- (3) Calculated as the product of Net Evaporation⁽¹⁾ and Combined Project Area⁽²⁾. Negative values during the winter months November to March were arbitrarily set to zero.
- (4) 358 dam³ annual Teepee Creek Diversion is distributed uniformly over the open water months April to October.
- (5) Summation of recorded flow and net depletion to streamflow from project evaporation losses and Teepee Creek Diversions divided by a drainage factor (0.995), which is calculated as the ratio of the present (1986) effective drainage area (3353 km²) to the natural effective drainage area (3370 km²).
- (6) Natural flows for the winter months November to February are graphically estimated from the general semi-logarithmic recession curve, expressed mathematically as:
- log(Nov.) = log(Oct.) - 0.3000
log(Dec.) = log(Oct.) - 0.6000
log(Jan.) = log(Oct.) - 0.8973
log(Feb.) = log(Oct.) - 1.1984
- (7) Calculated as the combined product of the natural flow at 05LD001⁽⁵⁾, the ratio (0.469) of the natural drainage area at the interprovincial boundary (1580 km²) to the natural drainage area at 05LD001 (3370 km²) and the unit runoff ratio (1.09) of the basin above and below the interprovincial boundary.

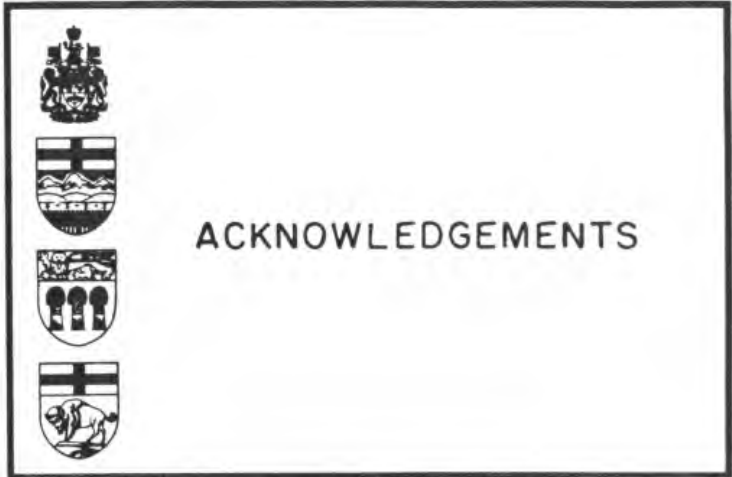


CONCLUSIONS

1. The average annual consumptive water use (including drainage) in the Saskatchewan portion of the Overflowing River basin now represents 3.1% of the average annual natural flow of Overflowing River at the Saskatchewan-Manitoba boundary.
2. Under present (1986) conditions, at least 50% of the annual natural flow of Overflowing River at the Saskatchewan-Manitoba boundary would have been passed to Manitoba in all years of the 74-year period 1912-13 to 1985-86. In fact, Saskatchewan would have used an annual maximum of only 21.9% of the natural flow (corresponds to the water balance period 1980-81). The average annual quantity of water which would have been delivered to Manitoba in excess of 50% of natural flow during the 74-year period would have been 79 600 dam³.
3. The existing hydrometric network is not adequate for calculating the natural flow of Overflowing River at the Saskatchewan-Manitoba boundary. However, an accurate estimate of natural flow at the boundary is not required until water uses in the Saskatchewan portion of the basin become significant.

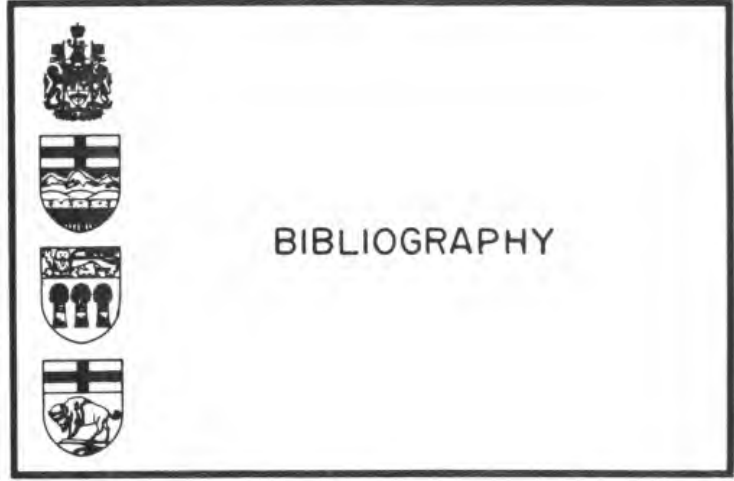
RECOMMENDATIONS

1. Based on the present (1986) level of development in the Saskatchewan portion of the Overflowing River basin, monitoring of apportionment should not be implemented at this time.
2. If monitoring of apportionment becomes necessary, a hydrometric gauging station should be established at the Saskatchewan-Manitoba boundary to provide a continuous record of the flows.




The Overflowing River natural flow study was conducted by B. J. Bell of the Hydrology Division of the Prairie Farm Rehabilitation Administration. The study was carried out under the direction of F. R. J. Martin, Manager of the Hydrology Division. The final text was reviewed by R. L. Kellow, Executive Director of the Prairie Provinces Water Board, and other members of the Committee on Hydrology.

A special note of thanks must be given to R. J. Woodvine for his helpful advice on various aspects of the study and assistance in preparing this report, to both J. C. Rakochy and the Resource Unit for typing the text, to W. B. Gilmer for his drafting assistance, and to K. E. Dowie for his help in assembling the final report.



1. Mowchenko, M. and Meid, P.O., May, 1983: The Determination of Gross and Effective Drainage Areas in the Prairie Provinces, Agriculture Canada, Prairie Farm Rehabilitation Administration, Hydrology Report #104, Addendum No. 3 (dated January, 1988).
2. Prairie Provinces Water Board, May, 1976: Determination of Natural Flow for Apportionment Purposes, Report No. 48.
3. Agriculture Canada, Prairie Farm Rehabilitation Administration, Hydrology Division, September, 1985: Natural Flow, Swan River at Saskatchewan-Manitoba Boundary, Technical Report to the PPWB Committee on Hydrology.
4. Department of Regional Economic Expansion, Prairie Farm Rehabilitation Administration, Hydrology Division, November, 1980: Natural Flow, Assiniboine River at Saskatchewan-Manitoba Boundary, Technical Report to the PPWB Committee on Hydrology.
5. Agriculture Canada, Prairie Farm Rehabilitation Administration, Hydrology Division, July, 1988: Natural Flow, Red Deer River at Saskatchewan-Manitoba Boundary, Technical Report to the PPWB Committee on Hydrology.




APPENDIX A
WATER USE
OVERFLOWING RIVER BASIN
AT THE
SASKATCHEWAN - MANITOBA
BOUNDARY

LIST OF TABLES

| <u>Table Number</u> | | <u>Page Number</u> |
|-------------------------|---|------------------------|
| A-1 | Overflowing River Basin at the Saskatchewan-Manitoba Boundary - Total Historic Water Use (Including Drainage) | 25 |
| A-2 | Overflowing River Basin at the Saskatchewan-Manitoba Boundary - Total Water Use at the Present (1986) Level of Use (Including Drainage) | 26 |

Table A-1

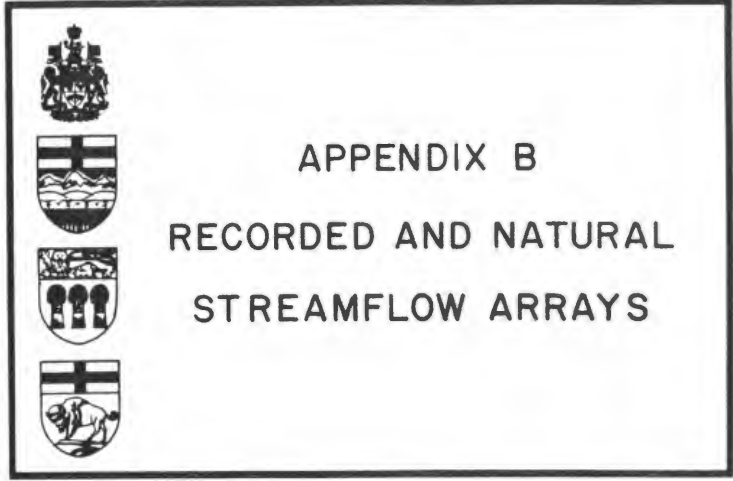
OVERFLOWING RIVER BASIN AT THE SASKATCHEWAN-MANITOBA BOUNDARY
 TOTAL HISTORIC WATER USE (INCLUDING DRAINAGE) - m³/s

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | CU.DAMS |
|------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| 1912 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1913 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1914 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1915 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1916 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1917 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1918 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1919 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1920 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1921 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1922 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1923 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1924 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1925 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1926 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1927 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1928 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1929 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1930 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1931 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1932 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1933 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1934 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1935 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1936 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1937 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1938 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1939 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1940 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1941 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0 |
| 1942 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.100 | 0.009 | 0.000 | 290 |
| 1943 | 0.000 | 0.000 | -0.028 | 0.005 | 0.018 | 0.019 | 0.022 | 0.020 | 0.016 | 0.006 | 0.000 | 0.000 | 208 |
| 1944 | 0.000 | 0.000 | -0.010 | 0.007 | 0.018 | 0.021 | 0.016 | 0.021 | 0.008 | 0.007 | 0.001 | 0.000 | 233 |
| 1945 | 0.000 | 0.000 | -0.012 | -0.009 | 0.021 | 0.018 | 0.027 | 0.029 | -0.004 | 0.007 | 0.001 | 0.000 | 202 |
| 1946 | 0.000 | 0.000 | -0.013 | 0.005 | 0.015 | 0.016 | 0.017 | 0.018 | 0.008 | 0.003 | 0.000 | 0.000 | 187 |
| 1947 | 0.000 | 0.000 | -0.023 | 0.002 | 0.017 | 0.002 | 0.025 | 0.009 | 0.010 | 0.005 | 0.000 | 0.000 | 126 |
| 1948 | 0.000 | 0.000 | -0.030 | -0.017 | 0.014 | 0.024 | 0.021 | 0.026 | 0.017 | 0.009 | 0.001 | 0.000 | 173 |
| 1949 | 0.000 | 0.000 | -0.030 | 0.005 | 0.009 | 0.011 | 0.021 | 0.019 | 0.014 | 0.007 | 0.001 | 0.000 | 149 |
| 1950 | 0.000 | 0.000 | -0.017 | 0.002 | 0.016 | 0.020 | 0.010 | 0.014 | 0.016 | -0.001 | 0.000 | 0.000 | 158 |
| 1951 | 0.000 | 0.000 | -0.030 | 0.000 | 0.015 | 0.009 | 0.018 | 0.015 | -0.037 | -0.010 | -0.001 | 0.000 | -53 |
| 1952 | 0.000 | 0.000 | -0.014 | 0.010 | 0.011 | 0.017 | 0.024 | 0.017 | 0.011 | 0.008 | 0.001 | 0.000 | 226 |
| 1953 | 0.000 | 0.000 | -0.022 | 0.005 | 0.006 | 0.013 | 0.000 | 0.013 | -0.001 | 0.007 | 0.001 | 0.000 | 54 |
| 1954 | 0.000 | 0.000 | -0.021 | -0.009 | 0.010 | 0.006 | 0.008 | -0.002 | 0.001 | 0.003 | 0.000 | 0.000 | -5 |
| 1955 | 0.000 | 0.000 | -0.020 | -0.011 | 0.007 | 0.020 | 0.025 | 0.030 | 0.014 | 0.007 | 0.001 | 0.000 | 191 |
| 1956 | 0.000 | 0.000 | -0.041 | 0.006 | 0.013 | 0.027 | 0.021 | 0.030 | 0.022 | 0.000 | 0.000 | 0.000 | 200 |
| 1957 | 0.000 | 0.000 | -0.022 | -0.002 | 0.021 | 0.018 | 0.025 | 0.015 | 0.017 | 0.008 | 0.001 | 0.000 | 215 |
| 1958 | 0.000 | 0.000 | -0.012 | -0.001 | 0.021 | 0.023 | 0.013 | 0.022 | 0.006 | 0.003 | 0.000 | 0.000 | 196 |
| 1959 | 0.000 | 0.000 | -0.016 | 0.004 | 0.020 | 0.012 | 0.027 | 0.012 | 0.004 | -0.001 | 0.000 | 0.000 | 163 |
| 1960 | 0.000 | 0.000 | -0.015 | 0.002 | 0.016 | 0.022 | 0.034 | 0.025 | 0.023 | 0.009 | 0.001 | 0.000 | 308 |
| 1961 | 0.000 | 0.000 | -0.018 | 0.006 | 0.018 | 0.033 | 0.038 | 0.037 | 0.023 | 0.002 | 0.000 | 0.000 | 367 |
| 1962 | 0.000 | 0.000 | -0.026 | 0.004 | 0.025 | 0.030 | 0.030 | 0.017 | 0.017 | -0.002 | 0.000 | 0.000 | 245 |
| 1963 | 0.000 | 0.000 | -0.016 | 0.005 | 0.014 | 0.006 | 0.022 | 0.016 | 0.014 | 0.006 | 0.000 | 0.000 | 180 |
| 1964 | 0.000 | 0.000 | -0.024 | 0.004 | 0.021 | 0.032 | 0.027 | 0.008 | 0.011 | 0.006 | 0.000 | 0.000 | 226 |
| 1965 | 0.000 | 0.000 | -0.026 | 0.005 | 0.008 | 0.003 | 0.018 | 0.024 | 0.008 | 0.012 | 0.001 | 0.000 | 140 |
| 1966 | 0.000 | 0.000 | -0.029 | 0.002 | 0.018 | 0.005 | 0.013 | 0.012 | 0.014 | 0.011 | 0.001 | 0.000 | 123 |
| 1967 | 0.000 | 0.000 | -0.026 | -0.004 | 0.023 | 0.034 | 0.040 | 0.034 | 0.012 | -0.001 | 0.000 | 0.000 | 296 |
| 1968 | 0.000 | 0.000 | -0.018 | 0.006 | 0.014 | 0.024 | 0.015 | 0.015 | 0.006 | 0.001 | 0.000 | 0.000 | 168 |
| 1969 | 0.000 | 0.000 | -0.022 | 0.008 | 0.020 | 0.031 | 0.009 | 0.025 | 0.009 | -0.010 | -0.001 | 0.000 | 185 |
| 1970 | 0.000 | 0.000 | -0.019 | -0.002 | 0.018 | 0.015 | 0.020 | 0.029 | 0.018 | 0.007 | 0.000 | 0.000 | 227 |
| 1971 | 0.000 | 0.000 | -0.023 | 0.005 | 0.022 | 0.006 | -0.007 | 0.026 | 0.018 | 0.006 | 0.000 | 0.000 | 140 |
| 1972 | 0.000 | 0.000 | -0.023 | 0.005 | 0.016 | 0.024 | 0.015 | 0.026 | 0.014 | 0.012 | 0.001 | 0.000 | 240 |
| 1973 | 0.000 | 0.000 | -0.009 | -0.008 | 0.016 | -0.008 | 0.009 | 0.021 | 0.014 | 0.002 | 0.000 | 0.000 | 102 |
| 1974 | 0.000 | 0.000 | -0.032 | 0.005 | 0.007 | 0.022 | 0.027 | 0.000 | 0.012 | 0.013 | 0.001 | 0.000 | 146 |
| 1975 | 0.000 | 0.000 | -0.013 | 0.013 | 0.031 | 0.038 | 0.050 | 0.034 | 0.032 | 0.024 | 0.002 | 0.000 | 556 |
| 1976 | 0.000 | 0.000 | -0.022 | 0.028 | 0.045 | 0.022 | 0.034 | 0.044 | 0.045 | 0.031 | 0.002 | 0.000 | 600 |
| 1977 | 0.000 | 0.000 | -0.015 | 0.025 | 0.026 | 0.046 | 0.041 | 0.042 | 0.021 | 0.027 | 0.002 | 0.984 | 3203 |
| 1978 | 0.047 | 0.000 | -0.316 | 0.088 | 0.310 | 0.160 | 0.398 | 0.198 | 0.114 | 0.036 | -3.512 | -0.892 | -8754 |
| 1979 | -0.034 | 0.000 | -0.010 | 0.018 | 0.024 | 0.029 | 0.028 | 1.991 | 0.231 | 0.064 | 0.004 | 0.000 | 6257 |
| 1980 | 0.000 | 0.000 | 0.829 | 0.261 | 0.360 | 0.252 | 0.337 | 0.155 | 0.221 | 0.078 | 0.004 | 0.000 | 6624 |
| 1981 | 0.000 | 0.000 | -0.210 | 0.037 | 0.263 | 0.154 | 0.232 | 0.177 | 0.146 | -0.036 | -0.002 | 1.210 | 5248 |
| 1982 | 0.067 | 0.005 | -0.329 | 0.223 | 0.179 | 0.512 | 0.383 | 0.399 | 0.282 | 0.170 | 0.028 | 0.011 | 5078 |
| 1983 | 0.005 | 0.003 | -0.619 | -1.833 | -1.680 | 0.914 | 3.665 | 0.622 | 0.293 | 0.121 | 0.023 | 0.009 | 4134 |
| 1984 | 0.005 | 0.002 | -0.261 | 0.231 | 0.475 | 0.441 | 0.581 | 0.620 | 0.026 | 0.037 | 0.011 | 0.005 | 5758 |
| 1985 | 0.002 | 0.001 | -0.395 | 0.243 | 0.340 | 0.203 | 0.566 | 0.371 | 0.180 | 0.232 | 0.029 | 0.009 | 4719 |
| 1986 | 0.005 | 0.002 | -1.734 | -0.733 | 0.247 | 1.408 | 1.405 | 0.524 | 1.455 | 0.290 | 0.023 | 0.006 | 7574 |
| MIN | -0.034 | 0.000 | -1.734 | -1.833 | -1.680 | -0.008 | -0.007 | -0.002 | -0.037 | -0.036 | -3.512 | -0.892 | -8754 |
| MAX | 0.067 | 0.005 | 0.829 | 0.261 | 0.475 | 1.408 | 3.665 | 1.991 | 1.455 | 0.290 | 0.029 | 1.210 | 7574 |
| MEAN | 0.001 | 0.000 | -0.050 | -0.018 | 0.015 | 0.063 | 0.111 | 0.077 | 0.045 | 0.018 | -0.045 | 0.018 | 627 |

Table A-2

OVERFLOWING RIVER BASIN AT THE SASKATCHEWAN-MANITOBA BOUNDARY
 TOTAL WATER USE AT THE PRESENT (1986) LEVEL OF USE (INCLUDING DRAINAGE) - m³/s

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | CU.DAMS |
|------|-------|-------|--------|--------|-------|--------|--------|--------|--------|--------|-------|-------|---------|
| 1912 | 0.006 | 0.003 | -0.199 | 0.139 | 0.195 | 0.545 | 0.317 | 0.170 | 0.241 | 0.348 | 0.122 | 0.058 | 5115 |
| 1913 | 0.029 | 0.015 | -0.326 | 0.198 | 0.571 | 0.468 | 0.397 | 0.438 | 0.341 | 0.171 | 0.039 | 0.017 | 6217 |
| 1914 | 0.008 | 0.004 | -0.254 | 0.143 | 0.468 | 0.578 | 0.590 | 0.477 | 0.360 | -0.001 | 0.011 | 0.006 | 6306 |
| 1915 | 0.003 | 0.002 | -0.132 | 0.134 | 0.396 | 0.033 | 0.174 | 0.567 | 0.069 | 0.111 | 0.019 | 0.007 | 3681 |
| 1916 | 0.004 | 0.002 | -0.326 | 0.198 | 0.207 | 0.814 | 0.603 | 0.603 | -0.033 | 0.154 | 0.032 | 0.013 | 5998 |
| 1917 | 0.007 | 0.003 | -0.345 | 0.095 | 0.742 | 0.481 | 0.915 | 0.348 | 0.306 | 0.230 | 0.022 | 0.006 | 7450 |
| 1918 | 0.003 | 0.002 | -0.290 | 0.188 | 0.353 | 0.475 | 0.672 | 0.284 | 0.347 | 0.158 | 0.030 | 0.012 | 5890 |
| 1919 | 0.006 | 0.003 | -0.151 | 0.125 | 0.400 | 0.211 | 0.347 | 0.214 | 0.188 | 0.192 | 0.052 | 0.023 | 4265 |
| 1920 | 0.012 | 0.006 | -0.328 | 0.075 | 0.670 | 0.498 | 0.526 | 0.334 | 0.359 | 0.006 | 0.019 | 0.010 | 5778 |
| 1921 | 0.005 | 0.003 | -0.201 | 0.120 | 0.462 | 0.150 | 0.345 | 0.496 | 0.146 | 0.103 | 0.092 | 0.048 | 4694 |
| 1922 | 0.024 | 0.012 | -0.363 | 0.130 | 0.882 | 0.550 | 0.387 | 0.140 | 0.100 | 0.088 | 0.035 | 0.016 | 5289 |
| 1923 | 0.008 | 0.004 | -0.387 | 0.087 | 0.768 | 0.444 | 0.601 | 0.574 | 0.387 | 0.199 | 0.030 | 0.011 | 7218 |
| 1924 | 0.006 | 0.003 | -0.343 | -0.044 | 0.551 | 0.531 | 0.335 | 0.467 | 0.286 | 0.008 | 0.020 | 0.011 | 4833 |
| 1925 | 0.005 | 0.003 | -0.611 | 0.120 | 0.546 | 0.311 | 0.660 | 0.432 | 0.210 | 0.041 | 0.022 | 0.011 | 4628 |
| 1926 | 0.005 | 0.003 | -0.218 | 0.125 | 0.501 | 0.556 | 0.404 | 0.421 | 0.232 | -0.095 | 0.016 | 0.012 | 5175 |
| 1927 | 0.006 | 0.003 | -0.305 | 0.114 | 0.419 | 0.451 | 0.245 | 0.387 | 0.019 | 0.056 | 0.059 | 0.031 | 3920 |
| 1928 | 0.016 | 0.008 | -0.283 | 0.217 | 0.493 | 0.309 | 0.359 | 0.494 | 0.397 | 0.199 | 0.021 | 0.006 | 5904 |
| 1929 | 0.003 | 0.002 | -0.320 | 0.094 | 0.154 | 0.466 | 0.506 | 0.476 | 0.184 | 0.014 | 0.008 | 0.004 | 4194 |
| 1930 | 0.002 | 0.001 | -0.595 | 0.107 | 0.263 | 0.169 | 0.263 | 0.364 | 0.299 | 0.126 | 0.016 | 0.005 | 2678 |
| 1931 | 0.003 | 0.001 | -0.332 | 0.173 | 0.463 | 0.415 | 0.396 | 0.192 | 0.193 | 0.139 | 0.027 | 0.011 | 4431 |
| 1932 | 0.006 | 0.003 | -0.484 | -0.122 | 0.468 | -0.048 | 0.448 | 0.083 | 0.311 | 0.114 | 0.016 | 0.006 | 2131 |
| 1933 | 0.003 | 0.002 | -0.496 | 0.084 | 0.067 | 0.332 | 0.524 | 0.321 | 0.313 | 0.095 | 0.023 | 0.010 | 3356 |
| 1934 | 0.005 | 0.003 | -0.542 | 0.221 | 0.635 | 0.416 | 0.652 | 0.614 | 0.207 | 0.149 | 0.019 | 0.006 | 6313 |
| 1935 | 0.003 | 0.002 | -0.573 | 0.126 | 0.407 | 0.106 | 0.471 | 0.347 | 0.252 | 0.118 | 0.019 | 0.007 | 3395 |
| 1936 | 0.004 | 0.002 | -0.379 | 0.220 | 0.578 | 0.299 | 0.410 | 0.430 | 0.168 | 0.177 | 0.014 | 0.003 | 5093 |
| 1937 | 0.001 | 0.001 | -0.341 | 0.062 | 0.488 | 0.580 | 0.437 | 0.426 | 0.123 | 0.102 | 0.009 | 0.002 | 4996 |
| 1938 | 0.001 | 0.001 | -0.420 | 0.127 | 0.347 | 0.022 | 0.066 | 0.257 | 0.151 | 0.157 | 0.012 | 0.002 | 1908 |
| 1939 | 0.001 | 0.001 | -0.411 | 0.157 | 0.391 | 0.195 | 0.489 | 0.459 | 0.245 | 0.175 | 0.013 | 0.002 | 4545 |
| 1940 | 0.001 | 0.001 | -0.438 | 0.090 | 0.532 | 0.249 | -0.011 | 0.473 | 0.167 | 0.051 | 0.006 | 0.002 | 2960 |
| 1941 | 0.001 | 0.000 | -0.526 | 0.060 | 0.401 | 0.392 | 0.500 | 0.448 | 0.353 | 0.127 | 0.010 | 0.002 | 4666 |
| 1942 | 0.001 | 0.001 | -0.708 | 0.017 | 0.501 | 0.354 | 0.289 | -0.138 | 0.268 | 0.201 | 0.024 | 0.008 | 2133 |
| 1943 | 0.004 | 0.002 | -0.533 | 0.230 | 0.513 | 0.483 | 0.491 | 0.420 | 0.346 | 0.167 | 0.026 | 0.010 | 5687 |
| 1944 | 0.005 | 0.002 | -0.196 | 0.179 | 0.444 | 0.464 | 0.336 | 0.426 | 0.201 | 0.164 | 0.017 | 0.005 | 5412 |
| 1945 | 0.002 | 0.001 | -0.227 | -0.100 | 0.537 | 0.412 | 0.577 | 0.568 | -0.042 | 0.194 | 0.028 | 0.009 | 5223 |
| 1946 | 0.005 | 0.002 | -0.246 | 0.200 | 0.412 | 0.371 | 0.387 | 0.372 | 0.190 | 0.107 | 0.019 | 0.008 | 4827 |
| 1947 | 0.004 | 0.002 | -0.435 | 0.165 | 0.585 | 0.206 | 0.592 | 0.195 | 0.291 | 0.168 | 0.033 | 0.014 | 4817 |
| 1948 | 0.007 | 0.003 | -0.566 | -0.162 | 0.706 | 0.578 | 0.460 | 0.535 | 0.428 | 0.213 | 0.025 | 0.008 | 5906 |
| 1949 | 0.004 | 0.002 | -0.582 | 0.190 | 0.277 | 0.322 | 0.476 | 0.397 | 0.314 | 0.171 | 0.017 | 0.005 | 4197 |
| 1950 | 0.002 | 0.001 | -0.319 | 0.145 | 0.489 | 0.477 | 0.245 | 0.435 | 0.343 | 0.027 | 0.015 | 0.007 | 4917 |
| 1951 | 0.004 | 0.002 | -0.569 | 0.137 | 0.599 | 0.327 | 0.470 | 0.370 | -0.445 | 0.072 | 0.107 | 0.056 | 3020 |
| 1952 | 0.028 | 0.014 | -0.262 | 0.283 | 0.373 | 0.446 | 0.556 | 0.388 | 0.260 | 0.200 | 0.024 | 0.008 | 6123 |
| 1953 | 0.004 | 0.002 | -0.423 | 0.209 | 0.297 | 0.550 | 0.585 | 0.590 | 0.308 | 0.233 | 0.049 | 0.020 | 6396 |
| 1954 | 0.010 | 0.005 | -0.395 | -0.057 | 0.508 | 0.526 | 0.372 | 0.119 | 0.260 | 0.171 | 0.052 | 0.024 | 4205 |
| 1955 | 0.012 | 0.006 | -0.383 | -0.007 | 0.558 | 0.522 | 0.541 | 0.619 | 0.277 | 0.166 | 0.015 | 0.004 | 6172 |
| 1956 | 0.002 | 0.001 | -0.782 | 0.226 | 0.664 | 0.836 | 0.577 | 0.671 | 0.464 | 0.034 | 0.018 | 0.009 | 7156 |
| 1957 | 0.005 | 0.002 | -0.430 | 0.082 | 0.665 | 0.450 | 0.519 | 0.292 | 0.350 | 0.172 | 0.012 | 0.002 | 5602 |
| 1958 | 0.001 | 0.000 | -0.234 | 0.122 | 0.491 | 0.464 | 0.291 | 0.440 | 0.132 | 0.129 | 0.032 | 0.014 | 4974 |
| 1959 | 0.007 | 0.003 | -0.300 | 0.181 | 0.496 | 0.297 | 0.627 | 0.277 | 0.226 | 0.092 | 0.049 | 0.025 | 5241 |
| 1960 | 0.012 | 0.006 | -0.294 | 0.264 | 0.616 | 0.602 | 0.713 | 0.489 | 0.457 | 0.182 | 0.011 | 0.001 | 8079 |
| 1961 | 0.001 | 0.000 | -0.345 | 0.229 | 0.422 | 0.665 | 0.717 | 0.713 | 0.428 | 0.042 | 0.002 | 0.000 | 7584 |
| 1962 | 0.000 | 0.000 | -0.506 | 0.134 | 0.558 | 0.609 | 0.573 | 0.318 | 0.342 | -0.026 | 0.001 | 0.001 | 5275 |
| 1963 | 0.001 | 0.000 | -0.302 | 0.157 | 0.307 | 0.157 | 0.476 | 0.321 | 0.302 | 0.134 | 0.011 | 0.003 | 4139 |
| 1964 | 0.001 | 0.001 | -0.453 | 0.158 | 0.563 | 0.648 | 0.559 | 0.203 | 0.324 | 0.205 | 0.043 | 0.018 | 5982 |
| 1965 | 0.009 | 0.005 | -0.496 | 0.221 | 0.376 | 0.384 | 0.512 | 0.514 | 0.223 | 0.349 | 0.062 | 0.024 | 5774 |
| 1966 | 0.012 | 0.006 | -0.563 | 0.154 | 0.456 | 0.233 | 0.465 | 0.341 | 0.316 | 0.250 | 0.030 | 0.010 | 4517 |
| 1967 | 0.005 | 0.002 | -0.495 | -0.040 | 0.749 | 0.799 | 0.802 | 0.652 | 0.237 | 0.010 | 0.008 | 0.004 | 7236 |
| 1968 | 0.002 | 0.001 | -0.342 | 0.188 | 0.335 | 0.676 | 0.537 | 0.382 | 0.183 | 0.081 | 0.024 | 0.011 | 5476 |
| 1969 | 0.005 | 0.003 | -0.413 | 0.332 | 0.498 | 0.637 | 0.177 | 0.491 | 0.175 | -0.108 | 0.022 | 0.015 | 4810 |
| 1970 | 0.008 | 0.004 | -0.371 | 0.013 | 0.558 | 0.428 | 0.755 | 0.673 | 0.385 | 0.195 | 0.038 | 0.016 | 7161 |
| 1971 | 0.008 | 0.004 | -0.448 | 0.307 | 0.567 | 0.158 | -0.100 | 0.539 | 0.344 | 0.140 | 0.018 | 0.006 | 4059 |
| 1972 | 0.003 | 0.002 | -0.446 | 0.209 | 0.588 | 0.551 | 0.318 | 0.526 | 0.271 | 0.244 | 0.015 | 0.001 | 6023 |
| 1973 | 0.001 | 0.000 | -0.175 | -0.084 | 0.429 | 0.061 | 0.320 | 0.447 | 0.293 | 0.079 | 0.019 | 0.008 | 3723 |
| 1974 | 0.004 | 0.002 | -0.612 | -0.263 | 0.537 | 0.663 | 0.567 | 0.022 | 0.275 | 0.320 | 0.041 | 0.014 | 5507 |
| 1975 | 0.007 | 0.004 | -0.251 | -0.022 | 0.484 | 0.596 | 0.660 | 0.323 | 0.299 | 0.180 | 0.040 | 0.017 | 6177 |
| 1976 | 0.009 | 0.004 | -0.429 | 0.267 | 0.533 | 0.155 | 0.437 | 0.530 | 0.512 | 0.228 | 0.014 | 0.002 | 5973 |
| 1977 | 0.001 | 0.000 | -0.288 | 0.188 | 0.184 | 0.537 | 0.449 | 0.524 | 0.142 | 0.238 | 0.047 | 0.019 | 5391 |
| 1978 | 0.010 | 0.005 | -0.374 | 0.185 | 0.580 | 0.262 | 0.506 | 0.279 | 0.191 | 0.122 | 0.044 | 0.021 | 4844 |
| 1979 | 0.011 | 0.005 | -0.576 | 0.207 | 0.629 | 0.783 | 0.542 | 0.431 | 0.287 | 0.124 | 0.012 | 0.003 | 6471 |
| 1980 | 0.002 | 0.001 | -0.398 | 0.323 | 0.533 | 0.363 | 0.489 | 0.224 | 0.323 | 0.121 | 0.014 | 0.004 | 5267 |
| 1981 | 0.002 | 0.001 | -0.306 | 0.083 | 0.428 | 0.231 | 0.344 | 0.261 | 0.209 | 0.024 | 0.040 | 0.022 | 3541 |
| 1982 | 0.011 | 0.005 | -0.391 | 0.257 | 0.203 | 0.595 | 0.445 | 0.468 | 0.330 | 0.194 | 0.031 | 0.012 | 5679 |
| 1983 | 0.006 | 0.003 | -0.454 | 0.223 | 0.375 | 0.406 | 0.243 | 0.538 | 0.341 | 0.137 | 0.025 | 0.010 | 4877 |
| 1984 | 0.005 | 0.003 | -0.310 | 0.256 | 0.533 | 0.499 | 0.682 | 0.732 | 0.027 | 0.038 | 0.012 | 0.005 | 6581 |
| 1985 | 0.003 | 0.001 | -0.469 | 0.276 | 0.389 | 0.231 | 0.665 | 0.432 | 0.207 | 0.268 | 0.032 | 0.010 | 5411 |
| 1986 | 0.005 | 0.003 | -0.415 | 0.153 | 0.442 | 0.480 | 0.179 | 0.549 | 0.225 | 0.234 | 0.024 | 0.006 | 4971 |
| MIN | 0.000 | 0.000 | -0.782 | -0.162 | 0.067 | -0.048 | -0.100 | -0.138 | -0.445 | -0.108 | 0.001 | 0.000 | 1908 |
| MAX | 0.029 | 0.015 | -0.132 | 0.332 | 0.882 | 0.836 | 0.915 | 0.732 | 0.512 | 0.349 | 0.122 | 0.058 | 8079 |
| MEAN | 0.006 | 0.003 | -0.392 | 0.140 | 0.477 | 0.420 | 0.459 | 0.408 | 0.250 | 0.136 | 0.028 | 0.011 | 5141 |



LIST OF TABLES

| <u>Table Number</u> | | <u>Page Number</u> |
|-------------------------|--|------------------------|
| B-1 | Overflowing River at Overflowing River - 05LD001 Recorded Flow | 29 |
| B-2 | Overflowing River at Overflowing River - 05LD001 Regression Equations Used to Estimate Natural Monthly Mean Flow | 30 |
| B-3 | Overflowing River at Overflowing River - 05LD001 Natural Flow | 31 |
| B-4 | Overflowing River at the Saskatchewan-Manitoba Boundary Natural Flow | 32 |
| B-5 | Overflowing River at the Saskatchewan-Manitoba Boundary Flows at the Present (1986) Level of Upstream Use . . . | 33 |
| B-6 | Overflowing River Basin Balance of Flow Table for Apportionment at the Present (1986) Level of Use . . . | 34 |

Table B-1

OVERFLOWING RIVER AT OVERFLOWING RIVER - 05LD001
 RECORDED FLOW - m³/s

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | CU.DAMS |
|------|-----|-----|-------|--------|--------|--------|--------|--------|--------|--------|-----|-----|---------|
| 1912 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1913 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1914 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1915 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1916 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1917 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1918 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1919 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1920 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1921 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1922 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1923 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1924 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1925 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1926 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1927 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1928 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1929 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1930 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1931 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1932 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1933 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1934 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1935 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1936 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1937 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1938 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1939 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1940 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1941 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1942 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1943 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1944 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1945 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1946 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1947 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1948 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1949 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1950 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1951 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1952 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1953 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1954 | - | - | - | - | 52.900 | 72.100 | 36.500 | 24.500 | 38.400 | - | - | - | - |
| 1955 | - | - | - | - | 71.000 | 22.200 | 12.000 | 8.040 | 2.890 | 2.770 | - | - | - |
| 1956 | - | - | 0.054 | 11.100 | 74.000 | 57.100 | 30.900 | 17.900 | 9.110 | 6.860 | - | - | - |
| 1957 | - | - | 0.000 | 13.700 | 45.200 | 16.700 | 4.750 | 0.813 | 1.700 | 1.190 | - | - | - |
| 1958 | - | - | 0.005 | 21.300 | 13.500 | 4.400 | 6.920 | 1.710 | 3.040 | 9.970 | - | - | - |
| 1959 | - | - | 0.576 | 14.700 | 19.200 | 10.700 | 16.900 | 9.210 | 24.500 | 17.900 | - | - | - |
| 1960 | - | - | 0.007 | 34.600 | 52.000 | 30.900 | 11.600 | 3.780 | 1.330 | 0.733 | - | - | - |
| 1961 | - | - | 0.062 | 14.500 | 11.900 | 3.200 | 0.107 | 0.020 | 0.015 | 0.014 | - | - | - |
| 1962 | - | - | 0.000 | 3.960 | 13.100 | 5.660 | 0.673 | 0.125 | 0.719 | 0.922 | - | - | - |
| 1963 | - | - | 0.000 | 7.040 | 4.500 | 4.530 | 6.510 | 1.530 | 2.670 | 1.850 | - | - | - |
| 1964 | - | - | 0.094 | 7.990 | 27.400 | 4.210 | 8.010 | 9.400 | 17.600 | 13.200 | - | - | - |
| 1965 | - | - | 0.076 | 17.400 | 39.300 | 55.600 | 25.900 | 9.520 | 13.100 | 17.600 | - | - | - |
| 1966 | - | - | 0.318 | 14.500 | 16.300 | 23.200 | 34.500 | 17.000 | 8.220 | 6.870 | - | - | - |
| 1967 | - | - | 0.577 | 0.881 | 52.500 | 27.300 | 5.250 | 1.960 | 1.080 | 3.120 | - | - | - |
| 1968 | - | - | 0.697 | 8.290 | 10.100 | 36.200 | 43.500 | 14.500 | 10.500 | 7.790 | - | - | - |
| 1969 | - | - | 0.323 | 25.300 | 17.500 | 6.000 | 0.651 | 0.287 | 0.273 | 11.100 | - | - | - |
| 1970 | - | - | 0.128 | 4.860 | 35.700 | 22.600 | 66.900 | 20.100 | 6.010 | 11.300 | - | - | - |
| 1971 | - | - | 0.232 | 30.700 | 24.500 | 6.600 | 2.080 | 2.120 | 0.517 | 4.410 | - | - | - |
| 1972 | - | - | 0.093 | 13.000 | 47.800 | 14.000 | 4.220 | 1.500 | 0.544 | 0.917 | - | - | - |
| 1973 | - | - | 0.000 | 6.600 | 18.500 | 37.300 | 21.100 | 4.560 | 3.980 | 5.820 | - | - | - |
| 1974 | - | - | 0.500 | 21.400 | 70.300 | 42.600 | 7.400 | 2.630 | 5.010 | 10.100 | - | - | - |
| 1975 | - | - | 0.713 | 9.750 | 41.800 | 43.400 | 12.300 | 7.460 | 9.150 | 12.300 | - | - | - |
| 1976 | - | - | 0.554 | 8.650 | 5.530 | 21.300 | 25.200 | 9.180 | 3.250 | 1.350 | - | - | - |
| 1977 | - | - | 0.000 | 4.940 | 7.410 | 3.740 | 3.790 | 15.000 | 19.400 | 13.800 | - | - | - |
| 1978 | - | - | 0.716 | 15.300 | 38.900 | 13.700 | 6.400 | 8.350 | 10.700 | 15.000 | - | - | - |
| 1979 | - | - | 0.000 | 17.700 | 62.300 | 51.900 | 9.150 | 2.150 | 1.640 | 2.310 | - | - | - |
| 1980 | - | - | 0.005 | 4.850 | 2.500 | 0.410 | 0.770 | 1.140 | 1.360 | 2.910 | - | - | - |
| 1981 | - | - | 0.349 | 6.830 | 9.120 | 2.790 | 2.430 | 2.030 | 0.679 | 15.600 | - | - | - |
| 1982 | - | - | 0.024 | 7.850 | 11.600 | 18.800 | 12.600 | 4.460 | 3.080 | 8.080 | - | - | - |
| 1983 | - | - | 0.108 | 16.100 | 43.700 | 41.700 | 38.600 | 11.000 | 6.970 | 7.220 | - | - | - |
| 1984 | - | - | 0.241 | 30.500 | 53.400 | 43.200 | 7.480 | 0.731 | 0.491 | 3.740 | - | - | - |
| 1985 | - | - | 0.070 | 19.900 | 22.800 | 12.500 | 7.370 | 10.500 | 7.500 | 7.100 | - | - | - |
| 1986 | - | - | 0.175 | 9.940 | 24.600 | 11.400 | 5.600 | 3.880 | 1.140 | 4.250 | - | - | - |
| MIN | - | - | 0.000 | 0.881 | 2.500 | 0.410 | 0.107 | 0.020 | 0.015 | 0.014 | - | - | - |
| MAX | - | - | 0.716 | 34.600 | 74.000 | 72.100 | 66.900 | 24.500 | 38.400 | 17.900 | - | - | - |
| MEAN | - | - | 0.216 | 13.682 | 31.541 | 23.271 | 14.487 | 6.881 | 6.563 | 7.128 | - | - | - |

Table B-2

OVERFLOWING RIVER AT OVERFLOWING RIVER - 05LD001
REGRESSION EQUATIONS USED TO ESTIMATE
NATURAL MONTHLY MEAN FLOW

| Month ¹ | Years | Regression Equation | Correlation Coefficient | Standard Error of Estimate ⁵ | Priority Number |
|--------------------|------------------|---|-------------------------|---|-----------------|
| March | 1912-55 | $Q_E^2 = .03 \text{ BMH1}$ | - | - | 1 |
| April | 1912-55 | $Q_E^{3,4} = .30 (19.176 + .1403 \text{ BMH1})$ | .784 | 32.1 | 1 |
| May | 1912, 1937-50 | $Q_E = 14.036 + .1694 \text{ BMH1}$ | .863 | 33.4 | 2 |
| | 1913-36, 1951-53 | $Q_E^4 = 9.640 + .9805 \text{ BLE6}$ | .920 | 27.0 | 1 |
| June | 1912, 1937-42 | $\log Q_E = .4347 + .4779 \log \text{ BMH1}$ | .547 | 57.2/133 | 4 |
| | 1913, 1920-36 | $\log Q_E = .5020 + .8227 \log \text{ BLE6}$ | .867 | 43.1/75.8 | 2 |
| | 1914-19, 1951-53 | $\log Q_E = .3168 + .4578 \log \text{ CLC1} + .3575 \log \text{ BLE6}$ | .902 | 39.2/64.4 | 1 |
| | 1943-50 | $\log Q_E = .4270 + .6980 \log \text{ BME1}$ | .814 | 44.6/80.4 | 3 |
| July | 1912, 1937-41 | $\log Q_E = -1.5023 + 1.0969 \log \text{ PGK1} + .3680 \log \text{ BMH1}$ | .601 | 74.1/286 | 5 |
| | 1913, 1920-36 | $\log Q_E = .3277 + 1.0102 \log \text{ BLE6}$ | .846 | 52.1/109 | 2 |
| | 1914-19, 1951-53 | $\log Q_E = .1439 + .5488 \log \text{ CLC1} + .4464 \log \text{ BLE6}$ | .888 | 47.5/90.6 | 1 |
| | 1942-43 | $\log Q_E = .1435 + .9353 \log \text{ BME1}$ | .653 | 68.3/215 | 4 |
| | 1944-50 | $\log Q_E = 1.0997 + .4123 \log \text{ AMC1}$ | .770 | 59.1/144 | 3 |
| August | 1912, 1937-43 | $Q_E^4 = 3.438 + .2134 \text{ BMH1}$ | .652 | 79.5 | 3 |
| | 1913-36, 1950-53 | $Q_E = -.571 + 2.4971 \text{ BLE6} + .1516 \text{ BMH1}$ | .881 | 51.0 | 1 |
| | 1944-49 | $\log Q_E = .7552 + .4620 \log \text{ BMD4}$ | .715 | 65.2/187 | 2 |
| September | 1912, 1937-41 | $\log Q_E = -.3707 + .9323 \log \text{ BMH1}$ | .527 | 76.6/328 | 5 |
| | 1913-19, 1950-53 | $Q_E = .362 + 2.3318 \text{ BLE6} + .2058 \text{ CLC1}$ | .912 | 52.8 | 1 |
| | 1920-36 | $Q_E = -.232 + 3.1799 \text{ BLE6}$ | .897 | 55.9 | 2 |
| | 1942-47 | $Q_E = 2.021 + 1.7658 \text{ BME1}$ | .750 | 82.4 | 4 |
| | 1948-49 | $Q_E = -.499 + 6.0870 \text{ AMD5}$ | .748 | 84.0 | 3 |
| October | 1912, 1936-42 | $\log Q_E = -.3598 + .9883 \log \text{ BMH1}$ | .472 | 76.0/316 | 4 |
| | 1913-35, 1950-54 | $Q_E = 1.256 + 2.1510 \text{ BLE6}$ | .832 | 42.0 | 1 |
| | 1943 | $Q_E = 1.465 + 1.9065 \text{ BME1}$ | .573 | 66.8 | 3 |
| | 1944-49 | $\log Q_E = .9711 + .5657 \log \text{ BMD4}$ | .812 | 56.9/132 | 2 |

¹ Natural flows for the winter months November to February were graphically estimated from a semi-logarithmic general recession curve, which can be expressed mathematically by the following equations:

$$\begin{aligned} \log(\text{Nov.}) &= \log(\text{Oct.}) - 0.3000 \\ \log(\text{Dec.}) &= \log(\text{Oct.}) - 0.6000 \\ \log(\text{Jan.}) &= \log(\text{Oct.}) - 0.8973 \\ \log(\text{Feb.}) &= \log(\text{Oct.}) - 1.1984 \end{aligned}$$

The general recession curve was developed from naturalized monthly winter flows for Swan River near Minnetonka (05LE006) as presented in Table B-5 of the September, 1985 PPWB Swan River natural flow report⁽³⁾.

January to March monthly flows for 1912 were estimated as the average monthly volumes for the period 1913-86.

² Missing natural monthly mean flows for March were estimated by multiplying March flows at BMH1 by a factor of 0.03. This factor was derived so that the mean of the values for the estimated period (1912-55) equalled the mean for the recorded period (1956-86).

³ Grouped April-May regression; the multiplier .30 is the average April proportion (30%) of the sum of April and May natural monthly mean flows of 05LD001.

⁴ The lower end of the regression line was manually adjusted to intersect the origin.

⁵ Standard error of estimate expressed as a percentage of the mean of the dependent variable for the regressed period. For logarithmic relationships, both the lower/upper bounds are given.

LIST OF SYMBOLS

- BLE6 Natural flow of Swan River near Minnetonka (05LE006), in m³/s, as presented in Table B-5 of the September, 1985 PPWB Swan River natural flow report⁽³⁾.
- BME1 Natural flow of Assiniboine River near Russell (05ME001), in m³/s, as presented in Table B-5 of the November, 1980 PPWB Assiniboine River natural flow report⁽⁴⁾.
- BMH1 Natural flow of Assiniboine River at Brandon (05MH001), in m³/s, as developed for the November, 1980 PPWB Assiniboine River natural flow report⁽⁴⁾.
- BMD4 Natural flow of Assiniboine River near Kamsack (05MD004), in m³/s, as presented in Table B-4 of the November, 1980 PPWB Assiniboine River natural flow report⁽⁴⁾.
- AMC1 Recorded flow of Assiniboine River at Sturgis (05MC001), in m³/s.
- CLC1 Natural flow of Red Deer River near Erwood (05LC001), in m³/s, as presented in Table B-4 of the July, 1988 PPWB Red Deer River natural flow report⁽⁵⁾.
- PGK1 Total monthly precipitation at The Pas during specified month, in mm.
- AMD5 Recorded flow of Shell River near Inglis (05MD005), in m³/s.

Table B-3

OVERFLOWING RIVER AT OVERFLOWING RIVER - 05LD001
 NATURAL FLOW - m³/s

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | CU.DAMS |
|------|-------|-------|-------|--------|---------|--------|---------|--------|--------|--------|--------|--------|---------|
| 1912 | 1.057 | 0.529 | 0.208 | 17.585 | 44.859 | 27.861 | 25.065 | 13.724 | 27.595 | 41.783 | 20.941 | 10.495 | 612378 |
| 1913 | 5.293 | 2.646 | 0.344 | 25.368 | 39.969 | 28.206 | 119.920 | 54.818 | 23.338 | 12.000 | 6.014 | 3.014 | 851727 |
| 1914 | 1.520 | 0.760 | 0.335 | 14.748 | 55.237 | 19.541 | 5.112 | 2.288 | 3.073 | 4.403 | 2.207 | 1.106 | 291892 |
| 1915 | 0.558 | 0.279 | 0.103 | 6.540 | 8.747 | 5.894 | 16.146 | 6.466 | 3.566 | 5.076 | 2.544 | 1.275 | 151514 |
| 1916 | 0.643 | 0.321 | 0.078 | 13.797 | 24.703 | 91.536 | 45.713 | 12.762 | 8.588 | 9.505 | 4.764 | 2.388 | 565004 |
| 1917 | 1.204 | 0.602 | 0.133 | 15.236 | 51.753 | 32.928 | 43.242 | 8.869 | 5.919 | 4.313 | 2.162 | 1.083 | 443465 |
| 1918 | 0.546 | 0.273 | 0.195 | 9.133 | 18.032 | 32.736 | 44.266 | 18.938 | 10.071 | 8.787 | 4.404 | 2.207 | 395717 |
| 1919 | 1.113 | 0.556 | 0.076 | 10.707 | 21.936 | 15.322 | 16.404 | 8.401 | 15.953 | 16.969 | 8.505 | 4.262 | 317448 |
| 1920 | 2.150 | 1.075 | 0.183 | 16.373 | 77.266 | 32.074 | 10.366 | 5.287 | 4.220 | 7.595 | 3.807 | 1.908 | 429648 |
| 1921 | 0.962 | 0.481 | 0.131 | 15.350 | 37.510 | 41.583 | 25.755 | 47.792 | 45.626 | 34.749 | 17.416 | 8.729 | 728972 |
| 1922 | 4.402 | 2.201 | 0.314 | 29.409 | 114.150 | 29.225 | 13.267 | 25.663 | 17.512 | 11.910 | 5.969 | 2.992 | 680720 |
| 1923 | 1.509 | 0.754 | 0.183 | 28.399 | 65.482 | 77.824 | 68.597 | 32.520 | 9.404 | 8.268 | 4.144 | 2.077 | 790728 |
| 1924 | 1.047 | 0.524 | 0.270 | 12.395 | 22.755 | 14.129 | 5.451 | 29.197 | 7.244 | 7.707 | 3.863 | 1.936 | 281956 |
| 1925 | 0.976 | 0.488 | 0.664 | 21.243 | 24.703 | 55.554 | 44.231 | 12.647 | 11.731 | 7.887 | 3.953 | 1.981 | 490220 |
| 1926 | 0.999 | 0.499 | 0.183 | 9.794 | 20.706 | 23.511 | 5.746 | 1.882 | 2.427 | 8.561 | 4.291 | 2.150 | 121691 |
| 1927 | 1.084 | 0.542 | 0.213 | 27.178 | 68.351 | 59.795 | 40.063 | 25.442 | 39.644 | 22.295 | 11.174 | 5.600 | 795172 |
| 1928 | 2.824 | 1.412 | 0.598 | 16.234 | 21.731 | 12.951 | 29.210 | 11.142 | 5.085 | 4.336 | 2.173 | 1.089 | 287977 |
| 1929 | 0.549 | 0.275 | 0.193 | 9.242 | 15.983 | 9.407 | 7.086 | 2.115 | 1.740 | 2.706 | 1.356 | 0.680 | 135537 |
| 1930 | 0.343 | 0.171 | 0.126 | 9.764 | 17.867 | 20.724 | 19.592 | 3.297 | 4.255 | 3.773 | 1.891 | 0.948 | 218431 |
| 1931 | 0.478 | 0.239 | 0.153 | 4.515 | 10.461 | 3.958 | 2.987 | 1.534 | 4.818 | 7.999 | 4.009 | 2.009 | 114043 |
| 1932 | 1.013 | 0.507 | 0.069 | 8.384 | 14.886 | 7.594 | 14.616 | 3.577 | 3.724 | 4.336 | 2.173 | 1.089 | 163997 |
| 1933 | 0.549 | 0.275 | 0.096 | 10.674 | 27.571 | 37.938 | 25.064 | 4.620 | 7.346 | 7.190 | 3.604 | 1.806 | 334224 |
| 1934 | 0.911 | 0.455 | 0.513 | 11.027 | 50.318 | 24.042 | 14.548 | 3.335 | 3.324 | 4.650 | 2.331 | 1.168 | 308724 |
| 1935 | 0.589 | 0.294 | 0.121 | 8.940 | 18.647 | 43.612 | 21.982 | 6.781 | 3.292 | 5.100 | 2.556 | 1.281 | 298059 |
| 1936 | 0.646 | 0.323 | 0.073 | 17.202 | 32.182 | 23.511 | 11.209 | 2.484 | 1.273 | 1.986 | 0.995 | 0.499 | 243669 |
| 1937 | 0.252 | 0.126 | 0.073 | 6.240 | 17.559 | 10.627 | 1.088 | 1.229 | 0.598 | 1.549 | 0.776 | 0.389 | 106882 |
| 1938 | 0.196 | 0.098 | 0.630 | 9.280 | 18.694 | 9.270 | 4.329 | 3.175 | 1.260 | 1.489 | 0.746 | 0.374 | 130889 |
| 1939 | 0.189 | 0.094 | 0.263 | 7.470 | 17.153 | 8.143 | 4.905 | 3.041 | 1.219 | 1.493 | 0.748 | 0.375 | 119234 |
| 1940 | 0.189 | 0.095 | 0.032 | 2.831 | 15.899 | 6.290 | 4.007 | 1.718 | 0.862 | 1.110 | 0.556 | 0.279 | 89785 |
| 1941 | 0.141 | 0.070 | 0.064 | 8.434 | 17.779 | 8.559 | 2.719 | 1.184 | 1.500 | 1.557 | 0.780 | 0.391 | 113965 |
| 1942 | 0.197 | 0.099 | 0.348 | 12.016 | 20.269 | 14.532 | 8.554 | 7.386 | 12.919 | 5.676 | 2.845 | 1.426 | 227376 |
| 1943 | 0.719 | 0.359 | 0.108 | 15.548 | 29.566 | 19.641 | 10.149 | 6.575 | 6.744 | 6.915 | 3.466 | 1.737 | 267914 |
| 1944 | 0.876 | 0.438 | 0.057 | 5.115 | 16.949 | 8.176 | 4.509 | 2.112 | 6.222 | 3.399 | 1.704 | 0.854 | 133112 |
| 1945 | 0.431 | 0.215 | 0.307 | 9.689 | 21.217 | 12.388 | 10.898 | 3.118 | 7.714 | 6.788 | 3.402 | 1.705 | 205649 |
| 1946 | 0.860 | 0.430 | 0.573 | 12.281 | 20.150 | 8.784 | 8.274 | 3.102 | 5.572 | 5.437 | 2.725 | 1.366 | 183645 |
| 1947 | 0.689 | 0.344 | 0.085 | 17.623 | 43.843 | 27.666 | 17.637 | 5.590 | 15.029 | 9.976 | 5.000 | 2.506 | 385281 |
| 1948 | 1.264 | 0.632 | 0.162 | 23.680 | 73.141 | 21.047 | 9.630 | 5.691 | 16.606 | 5.642 | 2.828 | 1.417 | 427551 |
| 1949 | 0.715 | 0.357 | 0.048 | 9.992 | 18.084 | 16.879 | 11.509 | 4.023 | 7.110 | 3.502 | 1.755 | 0.880 | 197309 |
| 1950 | 0.444 | 0.222 | 0.167 | 12.698 | 31.141 | 15.269 | 9.311 | 27.370 | 5.672 | 5.369 | 2.691 | 1.349 | 295989 |
| 1951 | 0.680 | 0.340 | 0.146 | 16.487 | 54.621 | 25.495 | 20.454 | 14.903 | 46.364 | 40.816 | 20.456 | 10.253 | 662829 |
| 1952 | 5.170 | 2.585 | 0.130 | 11.494 | 29.108 | 18.795 | 15.268 | 9.678 | 7.324 | 5.571 | 2.792 | 1.399 | 288849 |
| 1953 | 0.706 | 0.353 | 0.114 | 13.616 | 31.464 | 52.716 | 104.750 | 59.004 | 58.315 | 14.517 | 7.276 | 3.647 | 916516 |
| 1954 | 1.839 | 0.919 | 0.291 | 14.239 | 52.909 | 72.107 | 36.508 | 24.499 | 38.401 | 17.279 | 8.660 | 4.340 | 716734 |
| 1955 | 2.189 | 1.094 | 0.414 | 31.303 | 71.006 | 22.219 | 12.024 | 8.069 | 2.905 | 2.778 | 1.395 | 0.699 | 412807 |
| 1956 | 0.353 | 0.176 | 0.016 | 11.103 | 74.013 | 57.126 | 30.922 | 17.929 | 9.132 | 6.861 | 3.441 | 1.725 | 562938 |
| 1957 | 0.870 | 0.435 | 0.000 | 13.697 | 45.219 | 16.719 | 4.775 | 0.829 | 1.717 | 1.199 | 0.604 | 0.303 | 228382 |
| 1958 | 0.153 | 0.076 | 0.000 | 21.298 | 13.519 | 4.423 | 6.934 | 1.731 | 3.047 | 9.973 | 5.002 | 2.507 | 180969 |
| 1959 | 1.264 | 0.632 | 0.561 | 14.702 | 19.219 | 10.713 | 16.926 | 9.223 | 24.505 | 17.899 | 8.975 | 4.498 | 340573 |
| 1960 | 2.268 | 1.134 | 0.000 | 34.601 | 52.016 | 30.922 | 11.633 | 3.805 | 1.353 | 0.743 | 0.377 | 0.189 | 366399 |
| 1961 | 0.095 | 0.048 | 0.045 | 14.504 | 11.917 | 3.232 | 0.144 | 0.057 | 0.039 | 0.017 | 0.013 | 0.006 | 79121 |
| 1962 | 0.003 | 0.002 | 0.000 | 3.962 | 13.123 | 5.690 | 0.703 | 0.142 | 0.736 | 0.921 | 0.467 | 0.234 | 68655 |
| 1963 | 0.118 | 0.059 | 0.000 | 7.043 | 4.513 | 4.537 | 6.531 | 1.547 | 2.685 | 1.856 | 0.936 | 0.469 | 79811 |
| 1964 | 0.237 | 0.118 | 0.072 | 7.992 | 27.420 | 4.242 | 8.037 | 9.409 | 17.611 | 13.207 | 6.623 | 3.319 | 260078 |
| 1965 | 1.674 | 0.837 | 0.052 | 17.402 | 39.308 | 55.604 | 25.917 | 9.543 | 13.109 | 17.612 | 8.831 | 4.426 | 512032 |
| 1966 | 2.232 | 1.116 | 0.290 | 14.500 | 16.317 | 23.206 | 34.513 | 17.012 | 8.233 | 6.881 | 3.453 | 1.731 | 342256 |
| 1967 | 0.873 | 0.436 | 0.553 | 0.875 | 52.521 | 27.333 | 5.290 | 1.994 | 1.094 | 3.120 | 1.569 | 0.786 | 255535 |
| 1968 | 0.397 | 0.198 | 0.680 | 8.294 | 10.113 | 36.224 | 43.516 | 14.515 | 10.507 | 7.791 | 3.909 | 1.959 | 364770 |
| 1969 | 0.988 | 0.494 | 0.303 | 25.306 | 17.520 | 6.030 | 0.662 | 0.311 | 0.283 | 11.092 | 5.564 | 2.789 | 187739 |
| 1970 | 1.406 | 0.703 | 0.110 | 4.856 | 35.717 | 22.616 | 66.919 | 20.128 | 6.029 | 11.307 | 5.671 | 2.842 | 474004 |
| 1971 | 1.433 | 0.717 | 0.210 | 30.703 | 24.521 | 6.607 | 2.074 | 2.144 | 0.536 | 4.416 | 2.218 | 1.112 | 201763 |
| 1972 | 0.561 | 0.280 | 0.071 | 13.003 | 47.816 | 14.024 | 4.236 | 1.526 | 0.559 | 0.929 | 0.470 | 0.235 | 221735 |
| 1973 | 0.119 | 0.059 | 0.000 | 6.592 | 18.514 | 37.294 | 21.108 | 4.581 | 3.994 | 5.823 | 2.922 | 1.465 | 270054 |
| 1974 | 0.739 | 0.369 | 0.470 | 21.403 | 70.307 | 42.621 | 7.427 | 2.632 | 5.021 | 10.113 | 5.073 | 2.542 | 445390 |
| 1975 | 1.282 | 0.641 | 0.701 | 9.761 | 41.830 | 43.437 | 12.349 | 7.495 | 9.182 | 12.325 | 6.172 | 3.093 | 391031 |
| 1976 | 1.560 | 0.780 | 0.533 | 8.674 | 5.574 | 21.323 | 25.233 | 9.223 | 3.295 | 1.381 | 0.687 | 0.344 | 207472 |
| 1977 | 0.174 | 0.087 | 0.000 | 4.962 | 7.436 | 3.784 | 3.832 | 15.042 | 19.423 | 13.826 | 6.923 | 3.470 | 208430 |
| 1978 | 1.750 | 0.875 | 0.419 | 15.361 | 39.198 | 13.870 | 6.783 | 8.561 | 10.819 | 15.040 | 7.585 | 3.801 | 327944 |
| 1979 | 1.917 | 0.958 | 0.000 | 17.716 | 62.324 | 51.928 | 9.178 | 4.022 | 1.988 | 2.378 | 1.223 | 0.613 | 406589 |
| 1980 | 0.309 | 0.155 | 0.784 | 5.149 | 2.852 | 0.669 | 1.101 | 1.306 | 1.576 | 2.997 | 1.548 | 0.776 | 50687 |
| 1981 | 0.391 | 0.196 | 0.152 | 6.850 | 9.370 | 2.951 | 2.657 | 2.210 | 0.827 | 15.575 | 7.858 | 3.938 | 140242 |
| 1982 | 1.986 | 0.993 | 0.000 | 8.039 | 11.784 | 19.293 | 12.990 | 4.855 | 3.369 | 8.258 | 4.197 | 2.103 | 205290 |
| 1983 | 1.061 | 0.530 | 0.000 | 14.346 | 42.015 | 42.451 | 42.105 | 11.805 | 7.274 | 7.351 | 3.749 | 1.879 | 461560 |
| 1984 | 0.948 | 0.474 | 0.000 | 30.709 | 53.868 | 43.640 | 8.041 | 1.347 | 0.554 | 3.775 | 1.955 | 0.980 | 385105 |
| 1985 | 0.494 | 0.247 | 0.000 | 20.108 | 23.137 | 12.708 | 7.912 | 10.885 | 7.691 | 7.328 | 3.734 | 1.871 | 253548 |
| 1986 | 0.944 | 0.472 | 0.000 | 9.141 | 24.795 | 12.733 | 7.007 | 4.457 | 2.533 | 4.615 | 2.313 | 1.159 | 185511 |
| MIN | 0.003 | 0.002 | 0.000 | 0.875 | 2.852 | 0.669 | 0.144 | 0.057 | 0.039 | 0.017 | 0.013 | 0.006 | 50687 |
| MAX | 5.293 | 2.646 | 0.784 | 34.601 | 114.150 | 91.536 | 119.920 | 59.004 | 58.315 | 41.783 | 20.941 | 10.495 | 916516 |
| MEAN | 1.057 | 0.529 | 0.208 | 13.759 | 32.322 | 24.373 | 18.795 | 9.831 | 9.224 | 8.285 | 4.159 | 2.084 | 329221 |

Note: Shaded area denotes natural flow data derived by regression analysis as indicated in Table B-2. Caution should be exercised in using these flows.

Table B-4

OVERFLOWING RIVER AT THE SASKATCHEWAN-MANITOBA BOUNDARY
NATURAL FLOW - m³/s

| | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | CU.DAMS |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|---------|
| 1912-13 | 8.987 | 22.925 | 14.238 | 12.809 | 7.013 | 14.102 | 21.353 | 10.702 | 5.363 | 2.705 | 1.352 | 0.176 | 321527 |
| 1913-14 | 12.964 | 20.426 | 14.414 | 61.284 | 28.014 | 11.927 | 6.132 | 3.073 | 1.540 | 0.777 | 0.388 | 0.171 | 427756 |
| 1914-15 | 7.537 | 28.228 | 9.986 | 2.612 | 1.169 | 1.570 | 2.250 | 1.128 | 0.565 | 0.285 | 0.143 | 0.053 | 146939 |
| 1915-16 | 3.342 | 4.470 | 3.012 | 8.251 | 3.304 | 1.822 | 2.594 | 1.300 | 0.652 | 0.329 | 0.164 | 0.040 | 77578 |
| 1916-17 | 7.051 | 12.624 | 46.778 | 23.361 | 6.522 | 4.389 | 4.857 | 2.435 | 1.220 | 0.615 | 0.308 | 0.068 | 289916 |
| 1917-18 | 7.786 | 26.448 | 16.827 | 22.098 | 4.532 | 3.025 | 2.204 | 1.105 | 0.553 | 0.279 | 0.140 | 0.100 | 225406 |
| 1918-19 | 4.667 | 9.215 | 16.729 | 22.622 | 9.678 | 5.147 | 4.490 | 2.251 | 1.128 | 0.569 | 0.284 | 0.039 | 203190 |
| 1919-20 | 5.472 | 11.210 | 7.830 | 8.383 | 4.293 | 8.153 | 8.672 | 4.346 | 2.178 | 1.099 | 0.549 | 0.094 | 164483 |
| 1920-21 | 8.367 | 39.486 | 16.391 | 5.297 | 2.702 | 2.157 | 3.881 | 1.946 | 0.975 | 0.492 | 0.246 | 0.067 | 217088 |
| 1921-22 | 7.844 | 19.169 | 21.251 | 13.162 | 24.424 | 23.317 | 17.758 | 8.900 | 4.461 | 2.250 | 1.125 | 0.160 | 379618 |
| 1922-23 | 15.029 | 58.335 | 14.935 | 6.780 | 13.115 | 8.949 | 6.086 | 3.050 | 1.529 | 0.771 | 0.385 | 0.094 | 341946 |
| 1923-24 | 14.513 | 33.464 | 39.771 | 35.056 | 16.619 | 4.806 | 4.225 | 2.118 | 1.061 | 0.535 | 0.268 | 0.138 | 403318 |
| 1924-25 | 6.334 | 11.629 | 7.220 | 2.786 | 14.921 | 3.702 | 3.939 | 1.974 | 0.989 | 0.499 | 0.249 | 0.339 | 144465 |
| 1925-26 | 10.856 | 12.624 | 28.390 | 22.604 | 6.463 | 5.995 | 4.031 | 2.020 | 1.012 | 0.511 | 0.255 | 0.094 | 249908 |
| 1926-27 | 5.005 | 10.582 | 12.015 | 2.936 | 0.962 | 1.240 | 4.375 | 2.193 | 1.099 | 0.554 | 0.277 | 0.109 | 108904 |
| 1927-28 | 13.889 | 34.930 | 30.558 | 20.474 | 13.002 | 20.260 | 11.394 | 5.710 | 2.862 | 1.443 | 0.722 | 0.306 | 410410 |
| 1928-29 | 8.296 | 11.105 | 6.618 | 14.927 | 5.694 | 2.599 | 2.216 | 1.110 | 0.557 | 0.281 | 0.141 | 0.099 | 142031 |
| 1929-30 | 4.723 | 8.168 | 4.807 | 3.621 | 1.081 | 0.889 | 1.383 | 0.693 | 0.348 | 0.175 | 0.087 | 0.064 | 68763 |
| 1930-31 | 4.990 | 9.131 | 10.591 | 10.012 | 1.685 | 2.174 | 1.928 | 0.966 | 0.484 | 0.244 | 0.122 | 0.078 | 111932 |
| 1931-32 | 2.307 | 5.346 | 2.023 | 1.526 | 0.784 | 2.462 | 4.088 | 2.049 | 1.027 | 0.518 | 0.259 | 0.035 | 59251 |
| 1932-33 | 4.285 | 7.607 | 3.881 | 7.469 | 1.828 | 1.903 | 2.216 | 1.110 | 0.557 | 0.281 | 0.141 | 0.049 | 82902 |
| 1933-34 | 5.455 | 14.090 | 19.388 | 12.809 | 2.361 | 3.754 | 3.674 | 1.842 | 0.923 | 0.466 | 0.233 | 0.262 | 172090 |
| 1934-35 | 5.635 | 25.714 | 12.286 | 7.435 | 1.704 | 1.699 | 2.376 | 1.191 | 0.597 | 0.301 | 0.150 | 0.062 | 156593 |
| 1935-36 | 4.569 | 9.529 | 22.287 | 11.234 | 3.465 | 1.682 | 2.606 | 1.306 | 0.655 | 0.330 | 0.165 | 0.037 | 152382 |
| 1936-37 | 8.791 | 16.446 | 12.015 | 5.728 | 1.269 | 0.651 | 1.015 | 0.508 | 0.255 | 0.129 | 0.064 | 0.037 | 123272 |
| 1937-38 | 3.189 | 8.973 | 5.431 | 0.556 | 0.628 | 0.306 | 0.792 | 0.397 | 0.199 | 0.100 | 0.050 | 0.322 | 55272 |
| 1938-39 | 4.742 | 9.553 | 4.737 | 2.212 | 1.623 | 0.644 | 0.761 | 0.381 | 0.191 | 0.097 | 0.048 | 0.134 | 66372 |
| 1939-40 | 3.817 | 8.766 | 4.161 | 2.507 | 1.554 | 0.623 | 0.763 | 0.382 | 0.192 | 0.097 | 0.049 | 0.016 | 60622 |
| 1940-41 | 1.447 | 8.125 | 3.214 | 2.048 | 0.878 | 0.441 | 0.567 | 0.284 | 0.143 | 0.072 | 0.036 | 0.033 | 45826 |
| 1941-42 | 4.310 | 9.086 | 4.374 | 1.390 | 0.605 | 0.767 | 0.796 | 0.399 | 0.200 | 0.101 | 0.051 | 0.178 | 58741 |
| 1942-43 | 6.141 | 10.358 | 7.426 | 4.371 | 3.775 | 6.602 | 2.901 | 1.454 | 0.729 | 0.367 | 0.183 | 0.055 | 116905 |
| 1943-44 | 7.946 | 15.109 | 10.037 | 5.187 | 3.360 | 3.446 | 3.534 | 1.771 | 0.888 | 0.448 | 0.224 | 0.029 | 137177 |
| 1944-45 | 2.614 | 8.662 | 4.178 | 2.304 | 1.079 | 3.180 | 1.737 | 0.871 | 0.436 | 0.220 | 0.110 | 0.157 | 67463 |
| 1945-46 | 4.951 | 10.843 | 6.331 | 5.569 | 1.593 | 3.942 | 3.469 | 1.739 | 0.871 | 0.439 | 0.220 | 0.293 | 106311 |
| 1946-47 | 6.276 | 10.297 | 4.489 | 4.228 | 1.585 | 2.848 | 2.779 | 1.393 | 0.698 | 0.352 | 0.176 | 0.043 | 92841 |
| 1947-48 | 9.006 | 22.405 | 14.138 | 9.013 | 2.857 | 7.680 | 5.098 | 2.555 | 1.281 | 0.646 | 0.323 | 0.083 | 198170 |
| 1948-49 | 12.101 | 37.378 | 10.756 | 4.921 | 2.908 | 8.486 | 2.883 | 1.445 | 0.724 | 0.365 | 0.182 | 0.025 | 217220 |
| 1949-50 | 5.106 | 9.242 | 8.626 | 5.882 | 2.056 | 3.633 | 1.790 | 0.897 | 0.450 | 0.227 | 0.113 | 0.085 | 100457 |
| 1950-51 | 6.489 | 15.914 | 7.803 | 4.758 | 13.987 | 2.899 | 2.744 | 1.375 | 0.689 | 0.348 | 0.174 | 0.075 | 151702 |
| 1951-52 | 8.425 | 27.913 | 13.029 | 10.453 | 7.616 | 23.694 | 20.859 | 10.454 | 5.240 | 2.642 | 1.321 | 0.066 | 347745 |
| 1952-53 | 5.874 | 14.875 | 9.605 | 7.803 | 4.946 | 3.743 | 2.847 | 1.427 | 0.715 | 0.361 | 0.180 | 0.058 | 138607 |
| 1953-54 | 6.958 | 16.079 | 26.940 | 53.531 | 30.153 | 29.801 | 7.419 | 3.718 | 1.864 | 0.940 | 0.470 | 0.149 | 470867 |
| 1954-55 | 7.277 | 27.038 | 36.849 | 18.657 | 12.520 | 19.624 | 8.830 | 4.426 | 2.218 | 1.119 | 0.559 | 0.212 | 367142 |
| 1955-56 | 15.997 | 36.287 | 11.355 | 6.145 | 4.124 | 1.484 | 1.419 | 0.713 | 0.357 | 0.180 | 0.090 | 0.008 | 206775 |
| 1956-57 | 5.674 | 37.823 | 29.193 | 15.802 | 9.162 | 4.667 | 3.506 | 1.758 | 0.882 | 0.445 | 0.222 | 0.000 | 288682 |
| 1957-58 | 7.000 | 23.109 | 8.544 | 2.440 | 0.423 | 0.877 | 0.613 | 0.309 | 0.155 | 0.078 | 0.039 | 0.000 | 115287 |
| 1958-59 | 10.884 | 6.909 | 2.260 | 3.543 | 0.885 | 1.557 | 5.097 | 2.556 | 1.281 | 0.646 | 0.323 | 0.287 | 95458 |
| 1959-60 | 7.513 | 9.821 | 5.475 | 8.650 | 4.713 | 12.523 | 9.147 | 4.587 | 2.299 | 1.159 | 0.580 | 0.000 | 175323 |
| 1960-61 | 17.682 | 26.582 | 15.802 | 5.945 | 1.945 | 0.692 | 0.380 | 0.193 | 0.097 | 0.049 | 0.025 | 0.023 | 182939 |
| 1961-62 | 7.412 | 6.090 | 1.652 | 0.074 | 0.029 | 0.020 | 0.009 | 0.007 | 0.003 | 0.002 | 0.001 | 0.000 | 40189 |
| 1962-63 | 2.025 | 6.707 | 2.908 | 0.359 | 0.073 | 0.376 | 0.471 | 0.239 | 0.120 | 0.060 | 0.030 | 0.000 | 35313 |
| 1963-64 | 3.599 | 2.307 | 2.319 | 3.338 | 0.790 | 1.372 | 0.949 | 0.478 | 0.240 | 0.121 | 0.060 | 0.037 | 41126 |
| 1964-65 | 4.084 | 14.013 | 2.168 | 4.107 | 4.808 | 9.000 | 6.749 | 3.385 | 1.696 | 0.855 | 0.428 | 0.026 | 135733 |
| 1965-66 | 8.893 | 20.088 | 28.416 | 13.245 | 4.877 | 6.699 | 9.000 | 4.513 | 2.262 | 1.141 | 0.570 | 0.148 | 263104 |
| 1966-67 | 7.410 | 8.339 | 11.859 | 17.637 | 8.694 | 4.208 | 3.516 | 1.765 | 0.885 | 0.446 | 0.223 | 0.282 | 172564 |
| 1967-68 | 0.447 | 26.840 | 13.968 | 2.703 | 1.019 | 0.559 | 1.594 | 0.802 | 0.402 | 0.203 | 0.101 | 0.348 | 129826 |
| 1968-69 | 4.239 | 5.168 | 18.512 | 22.238 | 7.418 | 5.369 | 3.982 | 1.998 | 1.001 | 0.505 | 0.252 | 0.155 | 187061 |
| 1969-70 | 12.932 | 8.953 | 3.082 | 0.338 | 0.159 | 0.145 | 5.668 | 2.843 | 1.425 | 0.719 | 0.359 | 0.056 | 96508 |
| 1970-71 | 2.482 | 18.253 | 11.558 | 34.198 | 10.286 | 3.081 | 5.778 | 2.898 | 1.452 | 0.732 | 0.366 | 0.107 | 242426 |
| 1971-72 | 15.691 | 12.531 | 3.377 | 1.060 | 1.096 | 0.274 | 2.257 | 1.133 | 0.568 | 0.287 | 0.143 | 0.036 | 101197 |
| 1972-73 | 6.645 | 24.436 | 7.167 | 2.165 | 0.780 | 0.286 | 0.475 | 0.240 | 0.120 | 0.061 | 0.030 | 0.000 | 112327 |
| 1973-74 | 3.369 | 9.462 | 19.059 | 10.787 | 2.341 | 2.041 | 2.976 | 1.493 | 0.749 | 0.378 | 0.189 | 0.240 | 139883 |
| 1974-75 | 10.938 | 35.930 | 21.781 | 3.795 | 1.345 | 2.566 | 5.168 | 2.592 | 1.299 | 0.655 | 0.328 | 0.358 | 229007 |
| 1975-76 | 4.988 | 21.377 | 22.198 | 6.311 | 3.830 | 4.692 | 6.298 | 3.154 | 1.581 | 0.797 | 0.399 | 0.272 | 200189 |
| 1976-77 | 4.433 | 2.849 | 10.897 | 12.895 | 4.713 | 1.684 | 0.706 | 0.351 | 0.176 | 0.089 | 0.044 | 0.000 | 102509 |
| 1977-78 | 2.536 | 3.800 | 1.934 | 1.958 | 7.687 | 9.926 | 7.066 | 3.538 | 1.773 | 0.894 | 0.447 | 0.214 | 110220 |
| 1978-79 | 7.850 | 20.031 | 7.088 | 3.466 | 4.375 | 5.529 | 7.686 | 3.876 | 1.942 | 0.980 | 0.490 | 0.000 | 167350 |
| 1979-80 | 9.054 | 31.850 | 26.537 | 4.691 | 2.055 | 1.016 | 1.215 | 0.625 | 0.313 | 0.158 | 0.079 | 0.400 | 205669 |
| 1980-81 | 2.631 | 1.458 | 0.342 | 0.563 | 0.668 | 0.806 | 1.532 | 0.791 | 0.397 | 0.200 | 0.100 | 0.078 | 25195 |
| 1981-82 | 3.501 | 4.789 | 1.508 | 1.358 | 1.130 | 0.423 | 7.959 | 4.016 | 2.012 | 1.015 | 0.507 | 0.000 | 74629 |
| 1982-83 | 4.108 | 6.022 | 9.860 | 6.638 | 2.481 | 1.722 | 4.220 | 2.145 | 1.075 | 0.542 | 0.271 | 0.000 | 103072 |
| 1983-84 | 7.331 | 21.471 | 21.694 | 21.517 | 6.033 | 3.717 | 3.757 | 1.916 | 0.960 | 0.484 | 0.242 | 0.000 | 235672 |
| 1984-85 | 15.693 | 27.528 | 22.302 | 4.109 | 0.689 | 0.283 | 1.929 | 0.999 | 0.501 | 0.252 | 0.126 | 0.000 | 195881 |
| 1985-86 | 10.276 | 11.824 | 6.494 | 4.043 | 5.563 | 3.930 | 3.745 | 1.908 | 0.956 | 0.482 | 0.241 | 0.000 | 130467 |
| MIN | 0.447 | 1.458 | 0.342 | 0.074 | 0.029 | 0.020 | 0.009 | 0.007 | 0.003 | 0.002 | 0.001 | 0.000 | 25195 |
| MAX | 17.682 | 58.335 | 46.778 | 61.284 | 30.153 | 29.801 | 21.353 | 10.702 | 5.363 | 2.705 | 1.352 | 0.400 | 470867 |
| MEAN | 7.063 | 16.570 | 12.536 | 9.686 | 5.061 | 4.760 | 4.259 | 2.138 | 1.072 | 0.540 | 0.271 | 0.106 | 169231 |

Note: Caution should be exercised in using this data base for other studies.

Table B-5

OVERFLOWING RIVER AT THE SASKATCHEWAN-MANITOBA BOUNDARY
 FLOWS AT THE PRESENT (1986) LEVEL OF UPSTREAM USE - m³/s

| | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | CU. DAMS |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|----------|
| 1912-13 | 8.848 | 22.730 | 13.693 | 12.493 | 6.843 | 13.861 | 21.005 | 10.580 | 5.306 | 2.676 | 1.338 | 0.502 | 316661 |
| 1913-14 | 12.766 | 19.855 | 13.946 | 60.887 | 27.576 | 11.586 | 5.961 | 3.035 | 1.524 | 0.768 | 0.384 | 0.425 | 421428 |
| 1914-15 | 7.394 | 27.760 | 9.409 | 2.022 | 0.692 | 1.210 | 2.251 | 1.117 | 0.559 | 0.282 | 0.141 | 0.185 | 140326 |
| 1915-16 | 3.209 | 4.074 | 2.979 | 8.077 | 2.737 | 1.754 | 2.483 | 1.281 | 0.645 | 0.325 | 0.162 | 0.365 | 74413 |
| 1916-17 | 6.853 | 12.417 | 45.964 | 22.758 | 5.919 | 4.421 | 4.703 | 2.402 | 1.207 | 0.609 | 0.304 | 0.413 | 283957 |
| 1917-18 | 7.691 | 25.706 | 16.346 | 21.184 | 4.184 | 2.719 | 1.974 | 1.082 | 0.547 | 0.276 | 0.138 | 0.390 | 217823 |
| 1918-19 | 4.479 | 8.862 | 16.254 | 21.950 | 9.394 | 4.800 | 4.332 | 2.221 | 1.116 | 0.563 | 0.281 | 0.190 | 196914 |
| 1919-20 | 5.346 | 10.810 | 7.619 | 8.036 | 4.080 | 7.965 | 8.480 | 4.294 | 2.155 | 1.087 | 0.543 | 0.422 | 160670 |
| 1920-21 | 8.292 | 38.815 | 15.893 | 4.772 | 2.368 | 1.798 | 3.875 | 1.927 | 0.965 | 0.486 | 0.243 | 0.268 | 210995 |
| 1921-22 | 7.724 | 18.707 | 21.100 | 12.817 | 23.928 | 23.170 | 17.655 | 8.808 | 4.413 | 2.225 | 1.113 | 0.524 | 375285 |
| 1922-23 | 14.899 | 57.453 | 14.385 | 6.393 | 12.975 | 8.849 | 5.998 | 3.016 | 1.513 | 0.763 | 0.381 | 0.480 | 336782 |
| 1923-24 | 14.426 | 32.696 | 39.328 | 34.455 | 16.045 | 4.419 | 4.027 | 2.087 | 1.050 | 0.529 | 0.265 | 0.481 | 395992 |
| 1924-25 | 6.378 | 11.078 | 6.689 | 2.451 | 14.454 | 3.416 | 3.930 | 1.955 | 0.979 | 0.493 | 0.247 | 0.951 | 140352 |
| 1925-26 | 10.736 | 12.078 | 28.079 | 21.944 | 6.031 | 5.785 | 3.990 | 1.998 | 1.001 | 0.505 | 0.252 | 0.312 | 244227 |
| 1926-27 | 4.880 | 10.080 | 11.459 | 2.532 | 0.541 | 1.008 | 4.470 | 2.176 | 1.087 | 0.548 | 0.274 | 0.414 | 103960 |
| 1927-28 | 13.775 | 34.511 | 30.106 | 20.229 | 12.615 | 20.241 | 11.338 | 5.651 | 2.831 | 1.428 | 0.714 | 0.588 | 406390 |
| 1928-29 | 8.079 | 10.613 | 6.309 | 14.569 | 5.200 | 2.202 | 2.017 | 1.090 | 0.551 | 0.278 | 0.139 | 0.418 | 136276 |
| 1929-30 | 4.629 | 8.014 | 4.341 | 3.115 | 0.605 | 0.705 | 1.368 | 0.685 | 0.344 | 0.173 | 0.086 | 0.659 | 65309 |
| 1930-31 | 4.882 | 8.868 | 10.422 | 9.750 | 1.321 | 1.876 | 1.803 | 0.951 | 0.479 | 0.242 | 0.121 | 0.411 | 108549 |
| 1931-32 | 2.134 | 4.883 | 1.608 | 1.131 | 0.592 | 2.270 | 3.948 | 2.022 | 1.016 | 0.512 | 0.256 | 0.519 | 55215 |
| 1932-33 | 4.407 | 7.139 | 3.929 | 7.021 | 1.745 | 1.592 | 2.102 | 1.094 | 0.551 | 0.278 | 0.139 | 0.545 | 80813 |
| 1933-34 | 5.371 | 14.023 | 19.055 | 12.285 | 2.040 | 3.441 | 3.579 | 1.819 | 0.913 | 0.461 | 0.230 | 0.804 | 168850 |
| 1934-35 | 5.414 | 25.080 | 11.870 | 6.783 | 1.090 | 1.491 | 2.228 | 1.172 | 0.590 | 0.298 | 0.149 | 0.635 | 150370 |
| 1935-36 | 4.443 | 9.123 | 22.182 | 10.763 | 3.118 | 1.430 | 2.488 | 1.287 | 0.648 | 0.327 | 0.163 | 0.416 | 148466 |
| 1936-37 | 8.571 | 15.869 | 11.716 | 5.318 | 0.840 | 0.482 | 0.838 | 0.494 | 0.252 | 0.127 | 0.064 | 0.378 | 118541 |
| 1937-38 | 3.127 | 8.485 | 4.850 | 0.119 | 0.202 | 0.183 | 0.690 | 0.387 | 0.197 | 0.099 | 0.050 | 0.742 | 50489 |
| 1938-39 | 4.616 | 9.206 | 4.715 | 2.147 | 1.365 | 0.492 | 0.604 | 0.369 | 0.189 | 0.096 | 0.048 | 0.545 | 64440 |
| 1939-40 | 3.661 | 8.375 | 3.966 | 2.017 | 1.095 | 0.378 | 0.588 | 0.370 | 0.190 | 0.096 | 0.048 | 0.454 | 56149 |
| 1940-41 | 1.357 | 7.593 | 2.965 | 2.058 | 0.405 | 0.274 | 0.516 | 0.278 | 0.141 | 0.071 | 0.035 | 0.559 | 43104 |
| 1941-42 | 4.250 | 8.685 | 3.982 | 0.889 | 0.157 | 0.414 | 0.669 | 0.388 | 0.198 | 0.100 | 0.050 | 0.885 | 54560 |
| 1942-43 | 6.123 | 9.857 | 7.073 | 4.083 | 3.913 | 6.334 | 2.700 | 1.429 | 0.721 | 0.363 | 0.181 | 0.588 | 114294 |
| 1943-44 | 7.715 | 14.596 | 9.554 | 4.696 | 2.940 | 3.100 | 3.367 | 1.746 | 0.878 | 0.443 | 0.221 | 0.225 | 130582 |
| 1944-45 | 2.435 | 8.218 | 3.715 | 1.968 | 0.653 | 2.978 | 1.573 | 0.854 | 0.432 | 0.218 | 0.109 | 0.384 | 62145 |
| 1945-46 | 5.051 | 10.305 | 5.919 | 4.992 | 1.026 | 3.984 | 3.275 | 1.711 | 0.862 | 0.435 | 0.217 | 0.538 | 101129 |
| 1946-47 | 6.076 | 9.885 | 4.118 | 3.841 | 1.213 | 2.658 | 2.671 | 1.373 | 0.691 | 0.348 | 0.174 | 0.478 | 88524 |
| 1947-48 | 8.841 | 21.820 | 13.933 | 8.421 | 2.661 | 7.389 | 4.931 | 2.522 | 1.267 | 0.639 | 0.320 | 0.649 | 193693 |
| 1948-49 | 12.264 | 36.672 | 10.178 | 4.461 | 2.373 | 8.058 | 2.671 | 1.421 | 0.716 | 0.361 | 0.180 | 0.606 | 211367 |
| 1949-50 | 4.916 | 8.964 | 8.304 | 5.406 | 1.659 | 3.319 | 1.618 | 0.879 | 0.445 | 0.224 | 0.112 | 0.404 | 95562 |
| 1950-51 | 6.344 | 15.425 | 7.326 | 4.513 | 13.552 | 2.556 | 2.717 | 1.361 | 0.682 | 0.344 | 0.172 | 0.644 | 147450 |
| 1951-52 | 8.288 | 27.314 | 12.702 | 9.983 | 7.246 | 24.138 | 20.786 | 10.347 | 5.183 | 2.614 | 1.307 | 0.328 | 343804 |
| 1952-53 | 5.591 | 14.502 | 9.159 | 7.247 | 4.558 | 3.482 | 2.647 | 1.403 | 0.707 | 0.357 | 0.178 | 0.481 | 133012 |
| 1953-54 | 6.750 | 15.782 | 26.390 | 52.946 | 29.563 | 29.493 | 7.186 | 3.670 | 1.844 | 0.930 | 0.465 | 0.543 | 464372 |
| 1954-55 | 7.334 | 26.530 | 36.323 | 18.285 | 12.401 | 19.365 | 8.659 | 4.374 | 2.194 | 1.107 | 0.593 | 0.594 | 362898 |
| 1955-56 | 16.004 | 35.729 | 10.833 | 5.604 | 3.505 | 1.208 | 1.253 | 0.697 | 0.353 | 0.178 | 0.089 | 0.790 | 201711 |
| 1956-57 | 5.448 | 37.159 | 28.358 | 15.225 | 8.491 | 4.203 | 3.472 | 1.740 | 0.872 | 0.440 | 0.220 | 0.430 | 280572 |
| 1957-58 | 6.918 | 22.444 | 8.094 | 1.922 | 0.132 | 0.527 | 0.440 | 0.297 | 0.153 | 0.077 | 0.038 | 0.234 | 109175 |
| 1958-59 | 10.762 | 6.418 | 1.797 | 3.252 | 0.445 | 1.425 | 4.967 | 2.524 | 1.267 | 0.639 | 0.320 | 0.586 | 90637 |
| 1959-60 | 7.332 | 9.326 | 5.178 | 8.023 | 4.436 | 12.296 | 9.055 | 4.537 | 2.274 | 1.147 | 0.573 | 0.294 | 170046 |
| 1960-61 | 17.418 | 25.966 | 15.200 | 5.232 | 1.456 | 0.234 | 0.198 | 0.182 | 0.096 | 0.048 | 0.024 | 0.368 | 175044 |
| 1961-62 | 7.183 | 5.668 | 0.987 | 0.000 | 0.000 | 0.000 | 0.000 | 0.005 | 0.003 | 0.002 | 0.001 | 0.506 | 37739 |
| 1962-63 | 1.891 | 6.148 | 2.299 | 0.000 | 0.000 | 0.034 | 0.497 | 0.238 | 0.118 | 0.060 | 0.030 | 0.302 | 30721 |
| 1963-64 | 3.443 | 1.999 | 2.162 | 2.862 | 0.470 | 1.070 | 0.815 | 0.467 | 0.237 | 0.120 | 0.060 | 0.489 | 37387 |
| 1964-65 | 3.926 | 13.449 | 1.520 | 3.548 | 4.605 | 6.676 | 6.544 | 3.341 | 1.678 | 0.846 | 0.423 | 0.522 | 129836 |
| 1965-66 | 8.672 | 19.711 | 28.031 | 12.733 | 4.363 | 6.476 | 8.651 | 4.451 | 2.238 | 1.128 | 0.564 | 0.711 | 257497 |
| 1966-67 | 7.255 | 7.883 | 11.627 | 17.172 | 8.353 | 3.891 | 3.266 | 1.735 | 0.875 | 0.441 | 0.220 | 0.777 | 167894 |
| 1967-68 | 0.487 | 26.091 | 13.169 | 1.901 | 0.367 | 0.322 | 1.584 | 0.793 | 0.397 | 0.201 | 0.100 | 0.689 | 122189 |
| 1968-69 | 4.050 | 4.833 | 17.835 | 21.701 | 7.036 | 5.186 | 3.900 | 1.974 | 0.990 | 0.499 | 0.250 | 0.568 | 181763 |
| 1969-70 | 12.600 | 8.456 | 2.445 | 0.161 | 0.000 | 0.000 | 5.777 | 2.821 | 1.410 | 0.711 | 0.355 | 0.427 | 92544 |
| 1970-71 | 2.469 | 17.695 | 11.129 | 33.443 | 9.613 | 2.696 | 5.583 | 2.860 | 1.437 | 0.724 | 0.362 | 0.555 | 235471 |
| 1971-72 | 15.383 | 11.965 | 3.218 | 1.160 | 0.557 | 0.000 | 2.117 | 1.116 | 0.562 | 0.284 | 0.142 | 0.482 | 97332 |
| 1972-73 | 6.436 | 23.847 | 6.616 | 1.847 | 0.254 | 0.014 | 0.231 | 0.225 | 0.119 | 0.060 | 0.030 | 0.175 | 105587 |
| 1973-74 | 3.453 | 9.032 | 18.997 | 10.467 | 1.894 | 1.748 | 2.896 | 1.475 | 0.741 | 0.374 | 0.187 | 0.852 | 137318 |
| 1974-75 | 10.675 | 35.393 | 21.118 | 3.228 | 1.323 | 2.290 | 4.849 | 2.551 | 1.285 | 0.648 | 0.324 | 0.609 | 222522 |
| 1975-76 | 5.010 | 20.893 | 21.602 | 5.651 | 3.507 | 4.394 | 6.119 | 3.114 | 1.564 | 0.789 | 0.394 | 0.701 | 194483 |
| 1976-77 | 4.166 | 2.315 | 10.742 | 12.458 | 4.184 | 1.172 | 0.478 | 0.337 | 0.174 | 0.088 | 0.044 | 0.288 | 96188 |
| 1977-78 | 2.348 | 3.616 | 1.397 | 1.509 | 7.163 | 9.784 | 6.828 | 3.491 | 1.754 | 0.885 | 0.442 | 0.588 | 105025 |
| 1978-79 | 7.665 | 19.452 | 6.826 | 2.960 | 4.096 | 5.338 | 7.565 | 3.832 | 1.922 | 0.969 | 0.484 | 0.576 | 163045 |
| 1979-80 | 8.847 | 31.221 | 25.754 | 4.148 | 1.624 | 0.729 | 1.092 | 0.613 | 0.310 | 0.156 | 0.078 | 0.798 | 198754 |
| 1980-81 | 2.308 | 0.925 | 0.000 | 0.073 | 0.443 | 0.483 | 1.410 | 0.777 | 0.392 | 0.198 | 0.099 | 0.383 | 19732 |
| 1981-82 | 3.418 | 4.361 | 1.277 | 1.013 | 0.868 | 0.214 | 7.936 | 3.976 | 1.991 | 1.004 | 0.502 | 0.391 | 71282 |
| 1982-83 | 3.851 | 5.819 | 9.264 | 6.194 | 2.013 | 1.392 | 4.026 | 2.114 | 1.063 | 0.536 | 0.268 | 0.454 | 97583 |
| 1983-84 | 7.108 | 21.096 | 21.288 | 21.275 | 5.495 | 3.376 | 3.620 | 1.890 | 0.950 | 0.479 | 0.240 | 0.310 | 230412 |
| 1984-85 | 15.437 | 26.995 | 21.803 | 3.427 | 0.000 | 0.257 | 1.891 | 0.987 | 0.495 | 0.250 | 0.125 | 0.469 | 189852 |
| 1985-86 | 10.000 | 11.435 | 6.264 | 3.379 | 5.131 | 3.724 | 3.477 | 1.876 | 0.946 | 0.477 | 0.239 | 0.415 | 124899 |
| MIN | 0.487 | 0.925 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.005 | 0.003 | 0.002 | 0.001 | 0.175 | 19732 |
| MAX | 17.418 | 57.453 | 45.964 | 60.887 | 29.563 | 29.493 | 21.005 | 10.580 | 5.306 | 2.676 | 1.338 | 0.951 | 464372 |
| MEAN | 6.923 | 16.092 | 12.117 | 9.235 | 4.672 | 4.517 | 4.125 | 2.110 | 1.060 | 0.535 | 0.268 | 0.501 | 164194 |

Note: Caution should be exercised in using this data base for other studies.

Table B-6

OVERFLOWING RIVER BASIN BALANCE OF FLOW TABLE FOR APPORTIONMENT
AT THE PRESENT (1986) LEVEL OF USE - m³/s

| | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | JAN | FEB | MAR | CU.DAMS |
|---------|-------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|---------|
| 1912-13 | 4.354 | 11.267 | 6.574 | 6.088 | 3.336 | 6.810 | 10.329 | 5.229 | 2.624 | 1.323 | 0.662 | 0.414 | 155898 |
| 1913-14 | 6.284 | 9.642 | 6.739 | 30.245 | 13.569 | 5.622 | 2.895 | 1.498 | 0.754 | 0.380 | 0.190 | 0.340 | 207550 |
| 1914-15 | 3.626 | 13.646 | 4.415 | 0.716 | 0.107 | 0.425 | 1.126 | 0.553 | 0.277 | 0.140 | 0.070 | 0.158 | 66857 |
| 1915-16 | 1.537 | 1.839 | 1.473 | 3.951 | 1.085 | 0.843 | 1.186 | 0.631 | 0.319 | 0.161 | 0.080 | 0.345 | 35624 |
| 1916-17 | 3.327 | 6.105 | 22.575 | 11.077 | 2.658 | 2.227 | 2.274 | 1.185 | 0.597 | 0.301 | 0.151 | 0.379 | 138999 |
| 1917-18 | 3.798 | 12.482 | 7.932 | 10.134 | 1.918 | 1.207 | 0.872 | 0.530 | 0.271 | 0.137 | 0.068 | 0.340 | 105120 |
| 1918-19 | 2.145 | 4.255 | 7.890 | 10.639 | 4.555 | 2.226 | 2.087 | 1.096 | 0.552 | 0.278 | 0.139 | 0.170 | 95319 |
| 1919-20 | 2.611 | 5.205 | 3.704 | 3.844 | 1.933 | 3.888 | 4.144 | 2.121 | 1.066 | 0.538 | 0.269 | 0.375 | 78429 |
| 1920-21 | 4.108 | 19.072 | 7.697 | 2.123 | 1.017 | 0.719 | 1.934 | 0.954 | 0.477 | 0.241 | 0.120 | 0.234 | 102451 |
| 1921-22 | 3.802 | 9.123 | 10.475 | 6.236 | 11.716 | 11.512 | 8.776 | 4.358 | 2.182 | 1.101 | 0.550 | 0.444 | 185477 |
| 1922-23 | 7.385 | 28.285 | 6.917 | 3.003 | 6.417 | 4.374 | 2.955 | 1.491 | 0.748 | 0.377 | 0.189 | 0.433 | 165809 |
| 1923-24 | 7.170 | 15.964 | 19.442 | 16.927 | 7.736 | 2.016 | 1.914 | 1.028 | 0.519 | 0.262 | 0.131 | 0.412 | 194334 |
| 1924-25 | 3.211 | 5.263 | 3.079 | 1.058 | 6.994 | 1.565 | 1.961 | 0.967 | 0.484 | 0.244 | 0.122 | 0.781 | 68120 |
| 1925-26 | 5.308 | 5.766 | 13.884 | 10.642 | 2.800 | 2.787 | 1.975 | 0.988 | 0.495 | 0.250 | 0.125 | 0.265 | 119272 |
| 1926-27 | 2.378 | 4.789 | 5.451 | 1.064 | 0.060 | 0.388 | 2.283 | 1.080 | 0.538 | 0.271 | 0.136 | 0.360 | 49508 |
| 1927-28 | 6.831 | 17.046 | 14.827 | 9.992 | 6.114 | 10.111 | 5.641 | 2.796 | 1.400 | 0.706 | 0.353 | 0.435 | 201186 |
| 1928-29 | 3.931 | 5.060 | 3.000 | 7.105 | 2.353 | 0.903 | 0.909 | 0.535 | 0.272 | 0.137 | 0.069 | 0.369 | 65260 |
| 1929-30 | 2.267 | 3.930 | 1.938 | 1.304 | 0.065 | 0.261 | 0.677 | 0.339 | 0.170 | 0.086 | 0.043 | 0.627 | 30928 |
| 1930-31 | 2.388 | 4.303 | 5.126 | 4.743 | 0.479 | 0.789 | 0.838 | 0.467 | 0.237 | 0.120 | 0.060 | 0.371 | 52583 |
| 1931-32 | 0.981 | 2.210 | 0.596 | 0.367 | 0.200 | 1.039 | 1.905 | 0.997 | 0.502 | 0.253 | 0.127 | 0.502 | 25589 |
| 1932-33 | 2.265 | 3.336 | 1.989 | 3.286 | 0.831 | 0.640 | 0.994 | 0.539 | 0.272 | 0.137 | 0.069 | 0.521 | 39362 |
| 1933-34 | 2.644 | 6.978 | 9.361 | 5.880 | 0.860 | 1.564 | 1.742 | 0.898 | 0.452 | 0.228 | 0.114 | 0.673 | 82804 |
| 1934-35 | 2.597 | 12.222 | 5.727 | 3.066 | 0.238 | 0.642 | 1.039 | 0.576 | 0.292 | 0.147 | 0.074 | 0.604 | 72074 |
| 1935-36 | 2.158 | 4.358 | 11.038 | 5.146 | 1.385 | 0.589 | 1.185 | 0.634 | 0.320 | 0.162 | 0.081 | 0.398 | 72275 |
| 1936-37 | 4.175 | 7.645 | 5.709 | 2.454 | 0.205 | 0.157 | 0.331 | 0.240 | 0.125 | 0.063 | 0.032 | 0.360 | 56677 |
| 1937-38 | 1.533 | 3.998 | 2.135 | -0.159 | -0.112 | 0.030 | 0.294 | 0.189 | 0.097 | 0.049 | 0.025 | 0.581 | 22853 |
| 1938-39 | 2.245 | 4.429 | 2.347 | 1.041 | 0.554 | 0.170 | 0.224 | 0.179 | 0.094 | 0.047 | 0.024 | 0.478 | 31253 |
| 1939-40 | 1.752 | 3.992 | 1.885 | 0.764 | 0.318 | 0.066 | 0.207 | 0.178 | 0.094 | 0.047 | 0.024 | 0.446 | 25838 |
| 1940-41 | 0.633 | 3.531 | 1.358 | 1.034 | -0.034 | 0.054 | 0.232 | 0.136 | 0.070 | 0.035 | 0.018 | 0.542 | 20191 |
| 1941-42 | 2.095 | 4.142 | 1.795 | 0.195 | -0.145 | 0.031 | 0.271 | 0.189 | 0.098 | 0.049 | 0.025 | 0.797 | 25190 |
| 1942-43 | 3.053 | 4.678 | 3.359 | 1.897 | 2.025 | 3.033 | 1.250 | 0.703 | 0.357 | 0.180 | 0.090 | 0.561 | 55841 |
| 1943-44 | 3.743 | 7.041 | 4.535 | 2.103 | 1.260 | 1.377 | 1.600 | 0.860 | 0.434 | 0.219 | 0.110 | 0.210 | 61994 |
| 1944-45 | 1.128 | 3.887 | 1.625 | 0.816 | 0.113 | 1.388 | 0.704 | 0.418 | 0.214 | 0.108 | 0.054 | 0.305 | 28414 |
| 1945-46 | 2.575 | 4.884 | 2.753 | 2.208 | 0.229 | 2.013 | 1.541 | 0.842 | 0.426 | 0.215 | 0.108 | 0.392 | 47973 |
| 1946-47 | 2.938 | 4.736 | 1.874 | 1.727 | 0.420 | 1.234 | 1.282 | 0.677 | 0.342 | 0.172 | 0.086 | 0.456 | 42104 |
| 1947-48 | 4.338 | 10.617 | 6.864 | 3.914 | 1.233 | 3.549 | 2.381 | 1.244 | 0.627 | 0.316 | 0.158 | 0.608 | 94608 |
| 1948-49 | 6.213 | 17.983 | 4.800 | 2.001 | 0.919 | 3.815 | 1.229 | 0.698 | 0.354 | 0.179 | 0.089 | 0.594 | 102757 |
| 1949-50 | 2.363 | 4.343 | 3.991 | 2.465 | 0.631 | 1.502 | 0.724 | 0.431 | 0.220 | 0.111 | 0.056 | 0.361 | 45333 |
| 1950-51 | 3.100 | 7.468 | 3.424 | 2.134 | 6.558 | 1.107 | 1.345 | 0.673 | 0.337 | 0.170 | 0.085 | 0.606 | 71600 |
| 1951-52 | 4.075 | 13.357 | 6.187 | 4.757 | 3.438 | 12.291 | 10.357 | 5.120 | 2.563 | 1.293 | 0.646 | 0.295 | 169932 |
| 1952-53 | 2.654 | 7.064 | 4.356 | 3.346 | 2.085 | 1.611 | 1.224 | 0.689 | 0.350 | 0.177 | 0.088 | 0.452 | 63709 |
| 1953-54 | 3.270 | 7.742 | 12.920 | 26.181 | 14.487 | 14.592 | 3.477 | 1.811 | 0.912 | 0.460 | 0.230 | 0.469 | 228938 |
| 1954-55 | 3.695 | 13.011 | 17.898 | 8.956 | 6.141 | 9.553 | 4.244 | 2.161 | 1.085 | 0.547 | 0.274 | 0.489 | 179327 |
| 1955-56 | 8.006 | 17.585 | 5.156 | 2.531 | 1.443 | 0.445 | 0.544 | 0.341 | 0.175 | 0.088 | 0.044 | 0.786 | 98324 |
| 1956-57 | 2.611 | 18.247 | 13.761 | 7.324 | 3.910 | 1.870 | 1.719 | 0.861 | 0.431 | 0.218 | 0.109 | 0.430 | 136231 |
| 1957-58 | 3.418 | 10.889 | 3.822 | 0.701 | -0.080 | 0.088 | 0.134 | 0.143 | 0.076 | 0.038 | 0.019 | 0.234 | 51532 |
| 1958-59 | 5.320 | 2.963 | 0.667 | 1.481 | 0.003 | 0.647 | 2.419 | 1.246 | 0.627 | 0.316 | 0.158 | 0.443 | 42908 |
| 1959-60 | 3.575 | 4.415 | 2.441 | 3.698 | 2.080 | 6.035 | 4.482 | 2.244 | 1.125 | 0.567 | 0.284 | 0.294 | 82384 |
| 1960-61 | 8.577 | 12.675 | 7.299 | 2.260 | 0.483 | -0.112 | 0.008 | 0.086 | 0.047 | 0.024 | 0.012 | 0.357 | 83574 |
| 1961-62 | 3.477 | 2.623 | 0.161 | -0.037 | -0.015 | -0.010 | -0.004 | 0.001 | 0.002 | 0.001 | 0.001 | 0.506 | 17644 |
| 1962-63 | 0.879 | 2.795 | 0.845 | -0.180 | -0.036 | -0.154 | 0.261 | 0.119 | 0.059 | 0.030 | 0.015 | 0.302 | 13064 |
| 1963-64 | 1.643 | 0.846 | 1.003 | 1.193 | 0.074 | 0.384 | 0.340 | 0.228 | 0.117 | 0.059 | 0.030 | 0.471 | 16824 |
| 1964-65 | 1.884 | 6.443 | 0.436 | 1.495 | 2.201 | 4.176 | 3.169 | 1.649 | 0.830 | 0.419 | 0.209 | 0.509 | 61969 |
| 1965-66 | 4.226 | 9.667 | 13.824 | 6.110 | 1.924 | 3.126 | 4.151 | 2.195 | 1.107 | 0.558 | 0.279 | 0.637 | 125945 |
| 1966-67 | 3.550 | 3.713 | 5.697 | 8.353 | 4.006 | 1.787 | 1.508 | 0.852 | 0.433 | 0.218 | 0.109 | 0.636 | 81612 |
| 1967-68 | 0.264 | 12.671 | 6.185 | 0.550 | -0.142 | 0.043 | 0.787 | 0.392 | 0.197 | 0.099 | 0.050 | 0.516 | 57277 |
| 1968-69 | 1.931 | 2.249 | 8.580 | 10.582 | 3.327 | 2.502 | 1.910 | 0.975 | 0.490 | 0.247 | 0.124 | 0.490 | 88233 |
| 1969-70 | 6.134 | 3.979 | 0.904 | -0.008 | -0.079 | -0.072 | 2.942 | 1.399 | 0.697 | 0.352 | 0.176 | 0.399 | 44289 |
| 1970-71 | 1.228 | 8.568 | 5.351 | 16.344 | 4.470 | 1.155 | 2.694 | 1.411 | 0.711 | 0.358 | 0.179 | 0.502 | 114258 |
| 1971-72 | 7.538 | 5.699 | 1.530 | 0.630 | 0.009 | -0.137 | 0.988 | 0.549 | 0.278 | 0.140 | 0.070 | 0.464 | 46734 |
| 1972-73 | 3.113 | 11.630 | 3.032 | 0.764 | -0.136 | -0.129 | -0.007 | 0.105 | 0.059 | 0.030 | 0.015 | 0.175 | 49423 |
| 1973-74 | 1.769 | 4.301 | 9.468 | 5.073 | 0.723 | 0.727 | 1.408 | 0.728 | 0.366 | 0.185 | 0.092 | 0.732 | 67377 |
| 1974-75 | 5.206 | 17.428 | 10.227 | 1.331 | 0.651 | 1.007 | 2.264 | 1.255 | 0.636 | 0.321 | 0.160 | 0.430 | 108018 |
| 1975-76 | 2.516 | 10.205 | 10.503 | 2.496 | 1.592 | 2.048 | 2.969 | 1.537 | 0.773 | 0.390 | 0.195 | 0.565 | 94389 |
| 1976-77 | 1.950 | 0.891 | 5.294 | 6.010 | 1.827 | 0.330 | 0.125 | 0.161 | 0.086 | 0.044 | 0.022 | 0.288 | 44934 |
| 1977-78 | 1.080 | 1.716 | 0.430 | 0.530 | 3.319 | 4.821 | 3.295 | 1.722 | 0.868 | 0.438 | 0.219 | 0.481 | 49914 |
| 1978-79 | 3.740 | 9.436 | 3.282 | 1.227 | 1.909 | 2.573 | 3.721 | 1.894 | 0.950 | 0.479 | 0.240 | 0.576 | 79370 |
| 1979-80 | 4.320 | 15.296 | 12.486 | 1.803 | 0.597 | 0.221 | 0.484 | 0.300 | 0.153 | 0.077 | 0.039 | 0.598 | 95920 |
| 1980-81 | 0.992 | 0.196 | -0.171 | -0.208 | 0.109 | 0.080 | 0.644 | 0.382 | 0.194 | 0.098 | 0.049 | 0.345 | 7135 |
| 1981-82 | 1.667 | 1.967 | 0.523 | 0.334 | 0.303 | 0.002 | 3.956 | 1.968 | 0.985 | 0.497 | 0.248 | 0.391 | 33967 |
| 1982-83 | 1.797 | 2.808 | 4.335 | 2.874 | 0.773 | 0.531 | 1.916 | 1.042 | 0.526 | 0.265 | 0.133 | 0.454 | 46046 |
| 1983-84 | 3.442 | 10.361 | 10.441 | 10.516 | 2.479 | 1.518 | 1.742 | 0.932 | 0.470 | 0.237 | 0.119 | 0.310 | 112576 |
| 1984-85 | 7.591 | 13.231 | 10.652 | 1.373 | -0.344 | 0.115 | 0.926 | 0.487 | 0.245 | 0.124 | 0.062 | 0.469 | 91912 |
| 1985-86 | 4.862 | 5.523 | 3.017 | 1.357 | 2.350 | 1.758 | 1.604 | 0.922 | 0.468 | 0.236 | 0.118 | 0.415 | 59666 |
| MIN | 0.264 | 0.196 | -0.171 | -0.208 | -0.344 | -0.154 | -0.007 | 0.001 | 0.002 | 0.001 | 0.001 | 0.158 | 7135 |
| MAX | 8.577 | 28.285 | 22.575 | 30.245 | 14.487 | 14.592 | 10.357 | 5.229 | 2.624 | 1.323 | 0.662 | 0.797 | 228938 |
| MEAN | 3.392 | 7.807 | 5.849 | 4.392 | 2.142 | 2.137 | 1.995 | 1.041 | 0.524 | 0.264 | 0.132 | 0.448 | 79578 |

Note: See report section entitled "Present Use Flow Calculations" for information on the derivation of this table. Positive values indicate the quantity of water passed on to Manitoba in excess of 50% of natural flow. Negative values indicate a monthly 'deficit' in supplying 50% of natural flow.