

# COLUMBIA RIVER TREATY HYDROELECTRIC OPERATING PLAN

**ASSURED  
OPERATING PLAN FOR  
OPERATING YEAR 1978-79**



# C O L U M B I A   R I V E R   T R E A T Y

## AGREEMENT

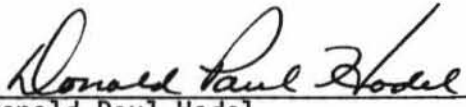
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### HYDROELECTRIC OPERATING PLAN FOR TREATY STORAGES

#### OPERATING YEAR 1978-79

The Columbia River Treaty between the United States and Canada requires that hydroelectric operating plans be agreed in advance by the Entities for the operation of the storages provided in the Treaty. The Canadian Entity and the United States Entity herewith agree that the Treaty storages will be operated in accordance with the attached "Columbia River Treaty Operating Plan, Assured Operating Plan for Operating Year 1978-79," dated September 1973.

  
W. D. Kennedy  
Chairman  
Canadian Entity

  
Donald Paul Hodel  
Chairman  
United States Entity

September 28, 1973  
Date of Agreement

COLUMBIA RIVER TREATY  
HYDROELECTRIC OPERATING PLAN

Assured Operating Plan for  
Operating Year 1978-79

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COLUMBIA RIVER TREATY  
HYDROELECTRIC OPERATING PLAN

Assured Operating Plan for  
Operating Year 1978-79

INTRODUCTION

The Treaty between Canada and the United States of America relating to the cooperative development of the water resources of the Columbia River Basin requires that each year an Assured Operating Plan be agreed by the Entities for the operation of the Columbia River Treaty Storage in Canada during the sixth succeeding year. This plan will provide to the Entities information for the sixth succeeding year for planning the power systems in their respective countries which are dependent on or coordinated with the operation of the Canadian storage projects. The data assumed for this Assured Operating Plan will undergo review by the Entities immediately prior to the 1978-79 operating year and such data may be revised to reflect data and criteria current at that time. Should the Entities fail to agree on such revisions, then this Assured Operating Plan will form the basis for the Detailed Operating Plan for 1978-79.

This Assured Operating Plan was prepared in accordance with the Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage<sup>1/</sup>. It is based on criteria contained in Annex A and Annex B of the Columbia River Treaty<sup>2/</sup>, Article VII of the Protocol<sup>3/</sup>, and Section B.1. of the Terms of Sale<sup>4/</sup>. The other operating criteria reflected in this plan is the Columbia River Treaty Flood Control Operating Plan<sup>5/</sup>.

The Assured Operating Plan consists of:

(a) The Operating Rule Curve for the whole of the Canadian Treaty Storage, including the Critical Rule Curve, Assured Refill Curve, Variable Refill Curves, and the individual project Flood Control Storage Reservation Curves.

(b) Operating Rules which specifically designate criteria for operation of the Canadian Treaty Projects in accordance with the principles contained in the above references.

A 30-year System Regulation Study<sup>6/</sup> was utilized to develop and test the operating rules and rule curves. It contains the agreed-upon operating constraints such as maximum and minimum project elevations and discharges.

#### SYSTEM REGULATION STUDIES

In accordance with Annex A, Paragraph 7, of the Treaty, the Columbia River Operating Committee conducted system regulation studies reflecting Canadian storage operation for optimum generation in both Canada and the United States. Downstream power benefits were computed with the Canadian storage operation based on the operating rules specified herein. There is no reduction of the Canadian Entitlement of downstream power benefits.

System Regulation Studies for the Assured Operating Plan were based on 1978-79 estimated loads and resources in British Columbia and in the United States Pacific Northwest System. Historical flows for the period July 1928 through June 1958, modified to estimated 1978-79 conditions<sup>7/</sup>, were used.

The Critical Rule Curve for these studies was determined from Bonneville Power Administration Study 79-41. The study indicated a 42-1/2 month

critical period for the United States system resulting from the low flows during the period from 16 August 1928 through February 1932. It was assumed that all reservoirs, both in the United States and Canada, were full at the beginning of the critical period.

In the studies, individual project flood control criteria were followed. Although only 7.0 million acre-feet of storage content at Mica is committed for power operation purposes under the Treaty, the studies are based on a full storage content of 20 million acre-feet to test compatibility with flood control parameters. Flood Control and Variable Refill Criteria are based on historical inflow volumes.

#### OPERATING RULE CURVES

The operation of Canadian storage during the 1978-79 Operating Year shall be guided by an Operating Rule Curve for the whole of Canadian storage, and by Flood Control Storage Reservation Curves for the individual dual projects. The Operating Rule Curve is derived from the various curves described below. These curves are first determined for the individual Canadian storages and then summed to obtain the values for the whole of usable Canadian storage given by the composite tables included in this Plan. This is in accordance with the provision of Article VII(2) of the Protocol.

(a) Critical Rule Curve. The Critical Rule Curve indicates the end-of-month storage content of Canadian storage during the critical period. It is designed to protect the ability of the United States system to serve firm load and to protect the firm level of Mica generation with the occurrence of flows no worse than those during the most adverse

historical streamflow period. A tabulation of the Composite Critical Rule Curve for the whole of Canadian storage is included as Table 1.

(b) Refill Curve. The Refill Curve is a guide to operation of Canadian storage which defines the normal limit of storage draft for secondary energy in order to provide a high probability of refilling the storage. In general, the Operating Plan does not permit serving secondary loads at the risk of failing to refill storages and thereby jeopardizing the firm load carrying capability of the system or the Mica generating plant during subsequent years. The end of the refill period is considered to be 31 July.

The Refill Curve is, in turn, defined by two curves as discussed below. In each case, adjustment should be made for water required for refill of upstream reservoirs when applicable.

(1) Assured Refill Curve. The Assured Refill Curve indicates the end-of-month storage content required to assure refill of Canadian storage based on the 1930-31 water year, the system's second lowest historical volume of inflow for the period January through July as measured at The Dalles, Oregon. The tabulation of the composite Assured Refill Curve for the whole of Canadian storage is included as Table 2.

The curve was based on higher flows than the minimum discharge requirements for the period April through July. The schedule of outflows is the same as the Power Discharge Requirements used in computing the Variable Refill Curve discussed in (2) below when The Dalles volume runoff is less than 90 million acre-feet.

(2) Variable Refill Curve. The Variable Refill Curve gives end-of-month storage contents for the period January through July

required to refill Canadian storage based on historical inflow volume and specified Power Discharge Requirements during the refill period. In the system regulation studies the Power Discharge Requirement was made a function of the natural January - July runoff volume at The Dalles, Oregon. In those years when this volume was lower than 90 million acre-feet, the discharge used was that required to meet firm loads while refilling. In years when the runoff volume at The Dalles equaled or exceeded 90 million acre-feet the Power Discharge Requirement was the project minimum outflow. The following are the April through July Power Discharge Requirements used in computing the Variable Refill Curves:

| <u>Project</u> | <u>Power Discharge Requirements in c.f.s.<br/>For January through July Volume at The Dalles</u> |                                               |
|----------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------|
|                | <u>Less Than 90 m.a.f.</u>                                                                      | <u>Equal to or Greater<br/>Than 90 m.a.f.</u> |
| Arrow          | 28,200                                                                                          | 5,000                                         |
| Duncan         | 2,300                                                                                           | 100                                           |
| Mica           | 18,300                                                                                          | 3,000                                         |

Composite Variable Refill Curves for the whole of Canadian storage for the 30 years of historical record are recorded as Table 3. These illustrate the probable range of these curves based on historical conditions. In the actual operation in 1978-79, the Power Discharge Requirements will be based on the forecast of unregulated runoff at The Dalles.

(c) Flood Control Storage Reservation Curve. The Flood Control Storage Reservation Curves<sup>8/</sup> give end-of-month storage content to which each individual Canadian storage project shall be evacuated for flood control and other requirements during the Storage Evacuation Period. During the Flood Control Refill Period the flood control curves used in

in the studies were developed from daily system regulation studies. They reflect the use of historical inflow volumes. Flood control curves for the thirty-year study period are shown on Tables 4, 5, and 6. Tables 5 and 6 reflect an assumed transfer of 2 million acre-feet of storage space from Arrow to Mica. In actual operation, the Flood Control Storage Reservation Curves will be based on the Flood Control Operating Plan, using the latest forecast of runoff available at that time.

(d) Definition of Operating Rule Curve. Prior to 1 January, the Operating Rule Curve is defined by the Critical Rule Curve or the Assured Refill Curve, whichever is higher. The Critical Rule Curve for the first year of the critical period is used in the foregoing determination. Beginning 1 January, the Operating Rule Curve is defined by first determining the higher of the Critical Rule Curve and the Assured Refill Curve; the Operating Rule Curve is the lower of the above-determined value or the Variable Refill Curve. Also, in all periods the Operating Rule Curve meets all requirements for flood control operation (except as noted in paragraph (d) of the Operating Rules). Composite Operating Rule Curves for the whole of Canadian storage for all 30 years of historical record are included as Table 7 to illustrate the probable future range of these curves based on historical conditions.

#### OPERATING RULES

The following rules, used in the System Regulation Study, will apply to the operation of Canadian storage in the 1978-79 Operating Year.

(a) The whole of the Canadian storage may be drafted to its Operating Rule Curve as required to produce optimum generation in Canada and

the United States in accordance with Annex A, Paragraph 7, of the Treaty, subject to project physical characteristics, operating constraints, and the criteria for the Mica project listed in (e) below.

(b) The whole of the Canadian storage will not be drafted below its Operating Rule Curve unless:

(1) Reservoir storage in the United States system has been drafted to its refill curve.

(2) Deliveries of secondary energy in the United States are discontinued.

(3) Committed firm thermal and miscellaneous resources not displaced by surplus firm hydro resources are in operation or other replacement energy has been secured from sources other than those committed.

(c) When the conditions of (b) above are met, and it is necessary to draft additional storage to produce optimum generation as determined by the Critical Period System Regulation study, the whole of the Canadian storage and reservoir storage in the United States system will be drafted proportionately between its Operating Rule Curve or Energy Content Curve, respectively, and its Critical Rule Curve. The proportionate draft will be made, if necessary, first to the first year Critical Rule Curve, then between the first and second year Critical Year Rule Curve, the second and third year Critical Rule Curve, etc. When it is necessary to operate the whole of the Canadian storage and the United States reservoir storage below their lowest Critical Rule Curves, each shall be operated proportionately between its lowest Critical Rule Curve and its normal minimum content, except that Mica Reservoir will continue to be operated in accordance with (e) below, so as to optimize generation at site as well as downstream in the United States.

(d) Each project will be operated on or below the storage content defined by its Flood Control Storage Reservation Curve, unless such content is below that indicated by the Variable Refill Curve.

(e) Mica project will be operated to the following monthly criteria as qualified in (1) to (4) below:

Mica Project Operating Criteria

| <u>Month</u> | <u>Target End-of-Period<br/>Storage Content (KSFD)</u> | <u>Target Average<br/>Outflow<br/>(CFS)</u> | <u>Minimum<br/>Outflow<br/>(CFS)</u> | <u>Maximum<br/>Outflow<br/>(CFS)</u> |
|--------------|--------------------------------------------------------|---------------------------------------------|--------------------------------------|--------------------------------------|
| July         | 9990.2                                                 | -                                           | 10,000                               | -                                    |
| August 1-15  | 9990.2                                                 | -                                           | 10,000                               | -                                    |
| August 16-31 | 9990.2                                                 | -                                           | 10,000                               | -                                    |
| September    | 9990.2                                                 | -                                           | 10,000                               | 34,000                               |
| October      | -                                                      | 15,000                                      | 10,000                               | 34,000                               |
| November     | -                                                      | 18,000                                      | 10,000                               | 34,000                               |
| December     | -                                                      | 28,000                                      | 15,000                               | 34,000                               |
| January      | -                                                      | 29,000                                      | 15,000                               | 34,000                               |
| February     | -                                                      | 29,000                                      | 10,000                               | 34,000                               |
| March        | -                                                      | 15,000                                      | 10,000                               | 34,000                               |
| April 1-15   | -                                                      | 15,000                                      | 10,000                               | -                                    |
| April 16-30  | -                                                      | 15,000                                      | 10,000                               | -                                    |
| May          | -                                                      | 10,000                                      | 10,000                               | -                                    |
| June         | -                                                      | 10,000                                      | 10,000                               | 34,000                               |

(1) Mica monthly outflows will be increased in the months from October to June if required to avoid violation of the Flood Control Storage Reservation Curve.

(2) Mica monthly average outflows will be increased in the months from July to March and the month of June if the Arrow reservoir storage in the previous month is within the following limits:

| <u>Month</u> | <u>Arrow Reservoir<br/>End-of-Month<br/>Storage Content (KSPD)</u> | <u>Mica Outflow<br/>in Next Month (CFS)</u> |
|--------------|--------------------------------------------------------------------|---------------------------------------------|
| July         | 0 - 1000                                                           | 34,000                                      |
|              | 1001 - 2100                                                        | 20,000                                      |
| August       | 0 - 1000                                                           | 30,000                                      |
|              | 1001 - 2100                                                        | 20,000                                      |
| September    | 0 - 2000                                                           | 20,000                                      |
| October      | 0 - 1700                                                           | 23,000                                      |
| November     | 0 - 1500                                                           | 31,000                                      |
| December     | 0 - 1000                                                           | 32,000                                      |
| January      | 0 - 1000                                                           | 32,000                                      |
| February     | 0 - 1000                                                           | 17,000                                      |
| March        | -                                                                  | -                                           |
| April        | -                                                                  | -                                           |
| May          | 0 - 500                                                            | 24,000                                      |
| June         | 0 - 1000                                                           | 34,000                                      |
|              | 1001 - 2100                                                        | 20,000                                      |

If the above table indicates the Mica outflow in August should be increased, the higher outflow applies in the first half only, and the second half of August will be examined using the August 15 Arrow content and the same criteria as for the first half.

(3) Unless an adjustment to the Mica target outflows during January, February, March, or June is required as specified in (2) above, Mica outflow will be reduced to minimum values to maintain the reservoir above the following storage content:

|          |             |
|----------|-------------|
| January  | 7900.0 KSFD |
| February | 7560.6 KSFD |
| March    | 6994.6 KSFD |
| April    | 6779.0 KSFD |
| May      | 7298.2 KSFD |
| June     | 8656.9 KSFD |

In this situation, the water remaining in Arrow will be sufficient to meet power draft requirements in the United States.

(4) Storage releases from Mica in excess of 7 million acre-feet may be made at the discretion of the Canadian Section of the Operating Committee, and these additional storage releases will be retained in the Arrow reservoir, subject to flood control criteria at Arrow. The total combined storage draft from Mica and Arrow will not exceed 14.1 million acre-feet.

The operating rules set forth above are designed to produce optimum generation in Canada and in the United States, as required by Annex A of the Treaty in the situation where Mica dead storage has been filled. If this does not occur some modification of the rules may be necessary to ensure adequate and complete drafting of Canadian Treaty storage in Mica reservoir to meet United States power requirements. In that event, such modified rules will be included in the 1978-79 Detailed Operating Plan.

#### IMPLEMENTATION

The Entities have agreed that each year a Detailed Operating Plan will be prepared for the immediately succeeding operating year. Such

Detailed Operating Plans are made under authority of Article XIV 2.(k) of the Columbia River Treaty which states:

". . . the powers and the duties of the entities include:

(k) preparation and implementation of detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under the plans referred to in Annexes A and B."

The Detailed Operating Plan for 1978-79 will reflect the latest available load, resource, and other pertinent data to the extent the Entities agreed these data should be included in the plan. Beginning on 1 January 1978 the Assured Operating Plan contained herein will be reviewed and the data and criteria updated, as agreed by the Entities, to form the basis for a Detailed Operating Plan for the 1978-79 Operating Year. Failing agreement on updating the Assured Operating Plan, the Detailed Operating Plan will include all data and criteria given in this Assured Operating Plan. Actual operation during the 1978-79 Operating Year shall be guided by the Detailed Operating Plan.

The operating rules to be used in implementation of the Detailed Operating Plan are generally the same as the operating rules described in this document.

The values used in the study to define the various rule curves were month-end values only. In actual day-to-day operation it is necessary to operate in such a manner during the course of each month that these month-end values can be observed in accordance with the operating rules. Because of the normal variation of power load and streamflow during any

month, straight line interpolation between the month-end points should not be assumed.

During the storage drawdown season, Canadian storage should not be drafted below its month-end point at any time during the month unless it can be conservatively demonstrated that sufficient inflow is available, in excess of the minimum outflow required to serve power demand, to refill the reservoir to its end-of-month value as required. During the storage evacuation and refill season, operation will be consistent with the Flood Control Operating Plan. When refill of Canadian storage is being guided by Flood Control Refill Curves<sup>5/</sup>, such curves will be computed on a day-by-day basis using the residual volume-of-inflow forecasts depleted by the volume required for minimum outflow from each day through the end of the refill season.

#### REFERENCES

- 1/ Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage dated 25 July 1967.
- 2/ Treaty between Canada and the United States of America relating to Cooperative Development of the Water Resources of the Columbia River Basin dated 17 January 1961.
- 3/ Protocol — Annex to Exchange of Notes dated 22 January 1964.
- 4/ Terms of Sale — Attachment to Exchange of Notes dated 22 January 1964.
- 5/ Columbia River Treaty Flood Control Operating Plan, dated October 1972.
- 6/ BPA Hydroelectric Power Planning Program, Assured Operating Plan 30-Year System Regulation Study 79-41, dated 20 September 1973.
- 7/ Extension of Modified Flows through 1958, Water Management Subcommittee of CBIAC, dated June 1960.
- 8/ Summary of End-of-Month Reservoir Storage Requirement from Columbia River Flood Regulation Studies dated April 1973.

TABLE 1  
COLUMBIA RIVER TREATY  
COMPOSITE CRITICAL RULE CURVES  
FOR THE WHOLE OF CANADIAN STORAGE  
END OF MONTH CONTENTS IN KSF  
1978-79 OPERATING YEAR

|        | JUL    | AUG    | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR   | MAY    | JUN    |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|--------|
| 1ST YR | 7814.6 | 7802.8 | 7592.3 | 7276.9 | 6901.1 | 5566.6 | 3462.3 | 1877.8 | 1350.1 | 797.8 | 2181.4 | 5611.0 |
| 2ND YR | 6942.7 | 6842.3 | 6364.3 | 5615.8 | 4698.0 | 3421.4 | 1500.6 | 902.6  | 199.5  | 437.9 | 1579.6 | 3825.1 |
| 3RD YR | 5654.7 | 5889.3 | 5763.3 | 5073.5 | 4395.7 | 2679.1 | 1183.4 | 332.7  | 96.1   | 0.0   | 777.7  | 2401.9 |
| 4TH YR | 2983.7 | 2769.9 | 2620.5 | 2220.0 | 1668.5 | 470.7  | 95.0   | 0.0    | 0.0    | 0.0   | 0.0    | 0.0    |

TABLE 2  
COLUMBIA RIVER TREATY  
COMPOSITE ASSURED REFILL CURVE  
FOR THE WHOLE OF CANADIAN STORAGE  
END OF MONTH CONTENTS IN KSFD  
1978-79 OPERATING YEAR

| JUL<br>7.9 | AUG<br>841.5 | SEP<br>1533.6 | OCT<br>1807.2 | NOV<br>1964.0 | DEC<br>2030.2 | JAN<br>2087.7 | FEB<br>2119.7 | MAR<br>2218.5 | APR<br>1795.3 | MAY<br>3100.7 | JUN<br>5924.7 | JUL<br>7814.6 |
|------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
|------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|

TABLE 3  
COLUMBIA RIVER TREATY  
COMPOSITE VARIABLE REFILL CURVES  
FOR THE WHOLE OF CANADIAN STORAGE  
END OF MONTH CONTENTS IN KSFO  
1978-79 OPERATING YEAR

| FLOW<br>YEAR | JUL | AUG | SEP | OCT | NOV | DEC | JAN    | FEB    | MAR    | APR    | MAY    | JUN    | JUL    |
|--------------|-----|-----|-----|-----|-----|-----|--------|--------|--------|--------|--------|--------|--------|
| 1928-29      |     |     |     |     |     |     | 5885.3 | 6328.5 | 6250.6 | 5473.8 | 5753.0 | 7664.2 | 7314.6 |
| 1929-30      |     |     |     |     |     |     | 4085.5 | 3595.2 | 3593.4 | 3863.2 | 4657.6 | 6943.3 | ??     |
| 1930-31      |     |     |     |     |     |     | 4876.1 | 4320.1 | 4277.9 | 3729.8 | 4932.1 | 7249.1 | ??     |
| 1931-32      |     |     |     |     |     |     | 0.0    | 0.0    | 0.0    | 0.0    | 1485.8 | 5924.3 | ??     |
| 1932-33      |     |     |     |     |     |     | ??     | ??     | ??     | ??     | 906.3  | 4814.3 | ??     |
| 1933-34      |     |     |     |     |     |     | ??     | ??     | ??     | 15.9   | 2724.4 | 6190.0 | ??     |
| 1934-35      |     |     |     |     |     |     | 3235.4 | 2897.7 | 2937.4 | 2333.5 | 3071.7 | 5879.7 | ??     |
| 1935-36      |     |     |     |     |     |     | 2850.0 | 2305.3 | 2234.8 | 2260.1 | 4861.5 | 7318.2 | ??     |
| 1936-37      |     |     |     |     |     |     | 6968.8 | 6393.2 | 6313.0 | 5622.5 | 5916.3 | 7284.5 | ??     |
| 1937-38      |     |     |     |     |     |     | 267.6  | 74.8   | 46.0   | 238.0  | 2323.2 | 6076.6 | ??     |
| 1938-39      |     |     |     |     |     |     | 4313.1 | 3789.9 | 3786.6 | 3696.7 | 6037.7 | 7147.1 | ??     |
| 1939-40      |     |     |     |     |     |     | 3517.1 | 3081.6 | 3191.7 | 3110.8 | 4894.4 | 7045.8 | ??     |
| 1940-41      |     |     |     |     |     |     | 5593.5 | 5114.3 | 5222.3 | 5467.5 | 6349.7 | 7312.4 | ??     |
| 1941-42      |     |     |     |     |     |     | 1528.2 | 1183.6 | 1141.0 | 1474.9 | 3235.2 | 5895.3 | ??     |
| 1942-43      |     |     |     |     |     |     | 1956.9 | 1581.1 | 1515.1 | 2168.9 | 3395.4 | 5682.3 | ??     |
| 1943-44      |     |     |     |     |     |     | 7317.2 | 7107.9 | 7044.4 | 6573.4 | 6775.6 | 7739.2 | ??     |
| 1944-45      |     |     |     |     |     |     | 7167.7 | 6709.3 | 6665.9 | 5867.5 | 6518.4 | 7458.4 | ??     |
| 1945-46      |     |     |     |     |     |     | 0.0    | 0.0    | 0.0    | 0.0    | 1954.7 | 5837.0 | ??     |
| 1946-47      |     |     |     |     |     |     | ??     | ??     | ??     | ??     | 2336.5 | 5861.8 | ??     |
| 1947-48      |     |     |     |     |     |     | ??     | ??     | ??     | ??     | 1918.2 | 6936.3 | ??     |
| 1948-49      |     |     |     |     |     |     | 1769.8 | 1414.8 | 1379.4 | 1941.5 | 5175.3 | 7268.0 | ??     |
| 1949-50      |     |     |     |     |     |     | 0.0    | 0.0    | 0.0    | 0.0    | 687.7  | 4867.0 | ??     |
| 1950-51      |     |     |     |     |     |     | ??     | ??     | ??     | ??     | 2424.7 | 5266.9 | ??     |
| 1951-52      |     |     |     |     |     |     | 313.9  | 116.2  | 76.1   | 453.7  | 2841.5 | 5162.4 | ??     |
| 1952-53      |     |     |     |     |     |     | 996.6  | 655.9  | 645.1  | 806.9  | 2676.3 | 5941.4 | ??     |
| 1953-54      |     |     |     |     |     |     | 0.0    | 0.0    | 0.0    | 0.0    | 583.3  | 4144.7 | ??     |
| 1954-55      |     |     |     |     |     |     | 255.5  | 107.2  | 93.2   | 99.8   | 970.3  | 4885.6 | ??     |
| 1955-56      |     |     |     |     |     |     | 0.0    | 0.0    | 0.0    | 0.0    | 2119.6 | 5944.5 | ??     |
| 1956-57      |     |     |     |     |     |     | ??     | ??     | ??     | ??     | 3132.7 | 6970.3 | ??     |
| 1957-58      |     |     |     |     |     |     | 1524.5 | 1237.5 | 1318.8 | 1763.9 | 5837.1 | 7814.6 | ??     |

TABLE 4  
FLOOD CONTROL STORAGE RESERVATION CURVES  
DUNCAN  
KSFD  
1978-79 OPERATING YEAR

|         | JUL   | AUG   | SEP   | OCT   | NOV   | DEC   | JAN   | FEB   | MAR   | APR   | MAY   | JUN   | JUL   |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1928-29 | 679.1 | 679.1 | 679.1 | 679.1 | 679.1 | 477.4 | 370.5 | 276.3 | 276.3 | 297.9 | 389.7 | 533.9 | 679.1 |
| 1929-30 | "     | "     | "     | "     | "     | "     | 359.0 | 254.6 | 254.6 | 277.3 | 374.1 | 526.3 | "     |
| 1930-31 | "     | "     | "     | "     | "     | "     | 341.8 | 221.3 | 221.3 | 246.0 | 350.4 | 514.2 | "     |
| 1931-32 | "     | "     | "     | "     | "     | "     | 245.5 | 38.8  | 38.8  | 82.2  | 254.6 | 582.8 | "     |
| 1932-33 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 67.5  | 164.8 | 546.5 | "     |
| 1933-34 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 100.3 | 313.1 | 578.8 | "     |
| 1934-35 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 57.0  | 160.3 | 461.3 | "     |
| 1935-36 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 92.8  | 325.2 | 679.1 | "     |
| 1936-37 | "     | "     | "     | "     | "     | "     | 327.2 | 193.1 | 193.1 | 219.3 | 330.2 | 504.2 | "     |
| 1937-38 | "     | "     | "     | "     | "     | "     | 245.5 | 38.8  | 38.8  | 57.0  | 190.6 | 515.7 | "     |
| 1938-39 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 80.7  | 359.0 | 679.1 | "     |
| 1939-40 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 77.1  | "     | "     | "     |
| 1940-41 | "     | "     | "     | "     | "     | "     | 294.4 | 129.6 | 129.6 | 159.3 | 284.3 | 481.5 | "     |
| 1941-42 | "     | "     | "     | "     | "     | "     | 275.3 | 94.3  | 94.3  | 128.5 | 265.2 | 456.3 | "     |
| 1942-43 | "     | "     | "     | "     | "     | "     | 278.3 | 99.3  | 99.3  | 146.2 | 221.3 | 621.1 | "     |
| 1943-44 | "     | "     | "     | "     | "     | "     | 366.0 | 267.7 | 267.7 | 289.9 | 383.7 | 530.9 | "     |
| 1944-45 | "     | "     | "     | "     | "     | "     | 334.8 | 207.7 | 207.7 | 210.2 | 323.2 | 541.0 | "     |
| 1945-46 | "     | "     | "     | "     | "     | "     | 245.5 | 38.8  | 38.8  | 69.1  | 295.4 | 620.6 | "     |
| 1946-47 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 75.1  | 287.4 | 603.0 | "     |
| 1947-48 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 38.8  | 273.7 | 679.1 | "     |
| 1948-49 | "     | "     | "     | "     | "     | "     | 321.6 | 182.0 | 182.0 | 210.2 | 382.1 | "     | "     |
| 1949-50 | "     | "     | "     | "     | "     | "     | 245.5 | 38.8  | 38.8  | 58.0  | 157.3 | 498.6 | "     |
| 1950-51 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 76.6  | 258.6 | 507.7 | "     |
| 1951-52 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 40.8  | 65.5  | 228.4 | "     |
| 1952-53 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 58.0  | 207.7 | 495.1 | "     |
| 1953-54 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 57.5  | 210.2 | 520.8 | "     |
| 1954-55 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 53.9  | 128.0 | 461.8 | "     |
| 1955-56 | "     | "     | "     | "     | "     | "     | "     | 0.0   | 0.0   | 0.0   | 213.2 | 551.5 | "     |
| 1956-57 | "     | "     | "     | "     | "     | "     | "     | 38.8  | 38.8  | 63.0  | 349.4 | 629.2 | "     |
| 1957-58 | "     | "     | "     | "     | "     | "     | "     | "     | "     | 69.6  | 332.7 | 679.1 | "     |

TABLE 5  
FLOOD CONTROL STORAGE RESERVATION CURVES  
ARROW  
KSFO  
1978-79 OPERATING YEAR

|         | JUL    | AUG    | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR    | MAY    | JUN    | JUL    |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1928-29 | 3602.3 | 3602.3 | 3602.3 | 3476.3 | 3476.3 | 3098.1 | 3098.1 | 3098.1 | 3098.1 | 3133.9 | 3258.5 | 3602.3 | 3602.3 |
| 1929-30 | "      | "      | "      | "      | "      | "      | 3083.5 | 3070.4 | 3055.8 | 3094.6 | 3229.7 | "      | "      |
| 1930-31 | "      | "      | "      | "      | "      | "      | 3098.1 | 3098.1 | 3098.1 | 3133.9 | 3258.5 | "      | "      |
| 1931-32 | "      | "      | "      | "      | "      | "      | 2387.3 | 1741.9 | 1031.0 | 1149.5 | 2247.1 | "      | "      |
| 1932-33 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1059.3 | 1784.3 | 3057.3 | "      |
| 1933-34 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1807.5 | 2349.9 | 3602.3 | "      |
| 1934-35 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1031.0 | 1748.5 | 3057.3 | "      |
| 1935-36 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1396.1 | 2157.4 | 3602.3 | "      |
| 1936-37 | "      | "      | "      | "      | "      | "      | 3021.0 | 2950.4 | 2873.3 | 2925.2 | 3105.2 | "      | "      |
| 1937-38 | "      | "      | "      | "      | "      | "      | 2387.3 | 1741.9 | 1031.0 | 1300.8 | 1853.8 | 3170.2 | "      |
| 1938-39 | "      | "      | "      | "      | "      | "      | 2660.5 | 2266.3 | 1828.5 | 2006.1 | 2757.8 | 3602.3 | "      |
| 1939-40 | "      | "      | "      | "      | "      | "      | 2872.3 | 2668.1 | 2442.7 | 2558.7 | 3022.5 | "      | "      |
| 1940-41 | "      | "      | "      | "      | "      | "      | 3098.1 | 3098.1 | 3098.1 | 3133.9 | 3258.5 | "      | "      |
| 1941-42 | "      | "      | "      | "      | "      | "      | 2387.3 | 1741.9 | 1031.0 | 1172.2 | 1956.7 | "      | "      |
| 1942-43 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1344.6 | 1463.1 | 2412.0 | "      |
| 1943-44 | "      | "      | "      | "      | "      | "      | 3098.1 | 3098.1 | 3098.1 | 3133.9 | 3258.5 | 3602.3 | "      |
| 1944-45 | "      | "      | "      | "      | "      | "      | 2664.5 | 2274.3 | 1840.7 | 1931.0 | 2499.7 | 3391.1 | "      |
| 1945-46 | "      | "      | "      | "      | "      | "      | 2387.3 | 1741.9 | 1031.0 | 1265.0 | 2223.9 | 3602.3 | "      |
| 1946-47 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1383.5 | 2170.0 | "      | "      |
| 1947-48 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1206.0 | 2239.5 | "      | "      |
| 1948-49 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1398.6 | 2517.3 | "      | "      |
| 1949-50 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1136.4 | 1136.4 | 2255.2 | "      |
| 1950-51 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1123.8 | 1377.9 | 3360.8 | "      |
| 1951-52 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1367.8 | 1815.0 | 3036.6 | "      |
| 1952-53 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1195.4 | 1498.9 | "      | "      |
| 1953-54 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1157.1 | 1650.7 | 1920.9 | "      |
| 1954-55 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1113.2 | 1676.4 | 3247.4 | "      |
| 1955-56 | "      | "      | "      | "      | "      | "      | "      | 879.8  | 22.7   | 312.6  | 1390.0 | 2736.1 | "      |
| 1956-57 | "      | "      | "      | "      | "      | "      | "      | 1741.9 | 1031.0 | 1246.8 | 2674.1 | 3602.3 | "      |
| 1957-58 | "      | "      | "      | "      | "      | "      | "      | "      | "      | 1213.5 | 2265.2 | "      | "      |

TABLE 6  
FLOOD CONTROL STORAGE RESERVATION CURVES  
MICA  
KSFD  
1978-79 OPERATING YEAR

[illegible]

TABLE 7  
COLUMBIA RIVER TREATY  
COMPOSITE OPERATING RULE CURVES  
FOR THE WHOLE OF CANADIAN STORAGE  
END OF MONTH CONTENTS IN KSFO  
1978-79 OPERATING YEAR

FLOW  
YEAR

|         | JUL    | AUG    | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR    | MAY    | JUN    | JUL    |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1928-29 | 7814.6 | 7802.8 | 7592.3 | 7276.6 | 6901.1 | 5566.6 | 3606.9 | 2429.3 | 2852.8 | 1795.3 | 3158.7 | 6257.5 | 7814.6 |
| 1929-30 | ??     | ??     | ??     | ??     | ??     | ??     | 3411.7 | ??     | ??     | ??     | ??     | ??     | ??     |
| 1930-31 | ??     | ??     | ??     | ??     | ??     | ??     | 3606.9 | ??     | ??     | ??     | ??     | ??     | ??     |
| 1931-32 | ??     | ??     | ??     | ??     | ??     | ??     | 0.0    | 0.0    | 0.0    | 0.0    | 1485.8 | 5854.0 | ??     |
| 1932-33 | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | 906.3  | 4814.3 | ??     |
| 1933-34 | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | 15.9   | 2579.9 | 6132.1 | ??     |
| 1934-35 | ??     | ??     | ??     | ??     | ??     | ??     | 2832.0 | 2399.6 | 2656.7 | 1733.5 | 3042.0 | 5868.3 | ??     |
| 1935-36 | ??     | ??     | ??     | ??     | ??     | ??     | 2532.0 | 2125.9 | 2085.6 | 1697.9 | 3145.4 | 6257.5 | ??     |
| 1936-37 | ??     | ??     | ??     | ??     | ??     | ??     | 3606.9 | 2429.3 | 2852.8 | 1795.3 | 3158.7 | ??     | ??     |
| 1937-38 | ??     | ??     | ??     | ??     | ??     | ??     | 267.6  | 74.8   | 46.1   | 238.0  | 2323.2 | 6043.5 | ??     |
| 1938-39 | ??     | ??     | ??     | ??     | ??     | ??     | 3606.9 | 2429.3 | 2838.2 | 1795.3 | 3158.7 | 6257.5 | ??     |
| 1939-40 | ??     | ??     | ??     | ??     | ??     | ??     | 3149.5 | ??     | 2844.1 | ??     | ??     | ??     | ??     |
| 1940-41 | ??     | ??     | ??     | ??     | ??     | ??     | 3606.9 | ??     | 2852.8 | ??     | ??     | ??     | ??     |
| 1941-42 | ??     | ??     | ??     | ??     | ??     | ??     | 1528.2 | 1183.6 | 1141.0 | 1031.5 | 2885.5 | 5895.3 | ??     |
| 1942-43 | ??     | ??     | ??     | ??     | ??     | ??     | 1956.9 | 1317.2 | 1515.1 | 1410.1 | 3005.2 | 5682.3 | ??     |
| 1943-44 | ??     | ??     | ??     | ??     | ??     | ??     | 3606.9 | 2429.3 | 2852.8 | 1795.3 | 3158.7 | 6257.5 | ??     |
| 1944-45 | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     |
| 1945-46 | ??     | ??     | ??     | ??     | ??     | ??     | 0.0    | 0.0    | 0.0    | 0.0    | 1954.7 | 5837.0 | ??     |
| 1946-47 | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | 2324.0 | 5861.8 | ??     |
| 1947-48 | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | 1918.2 | 6257.5 | ??     |
| 1948-49 | ??     | ??     | ??     | ??     | ??     | ??     | 1769.8 | 1414.8 | 1379.4 | 1702.6 | 3158.7 | ??     | ??     |
| 1949-50 | ??     | ??     | ??     | ??     | ??     | ??     | 0.0    | 0.0    | 0.0    | 0.0    | 687.7  | 4867.0 | ??     |
| 1950-51 | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | 2292.5 | 5266.9 | ??     |
| 1951-52 | ??     | ??     | ??     | ??     | ??     | ??     | 313.9  | 116.2  | 76.1   | 463.7  | 2806.2 | 6051.8 | ??     |
| 1952-53 | ??     | ??     | ??     | ??     | ??     | ??     | 996.6  | 665.9  | 645.1  | 806.9  | 2666.2 | 5886.6 | ??     |
| 1953-54 | ??     | ??     | ??     | ??     | ??     | ??     | 0.0    | 0.0    | 0.0    | 0.0    | 583.3  | 4144.7 | ??     |
| 1954-55 | ??     | ??     | ??     | ??     | ??     | ??     | 255.5  | 107.2  | 93.2   | 99.8   | 970.3  | 4885.6 | ??     |
| 1955-56 | ??     | ??     | ??     | ??     | ??     | ??     | 0.0    | 0.0    | 0.0    | 0.0    | 2119.6 | 5925.9 | ??     |
| 1956-57 | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | ??     | 3041.1 | 6257.5 | ??     |
| 1957-58 | ??     | ??     | ??     | ??     | ??     | ??     | 1524.5 | 1237.5 | 1318.8 | 1659.1 | 3158.7 | ??     | ??     |

C O L U M B I A   R I V E R   T R E A T Y

AGREEMENT

on

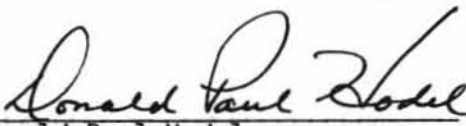
DETERMINATION OF DOWNSTREAM POWER BENEFITS

RESULTING FROM CANADIAN STORAGE

FOR OPERATING YEAR 1978-79

The Columbia River Treaty between Canada and the United States requires that the downstream power benefits resulting from operating plans agreed to by the Entities will be determined in advance by the Entities. The determination of downstream power benefits for the operating year 1978-79 is covered in the attached report, dated September 1973, and is agreed to by the United States Entity and the Canadian Entity.

  
W. D. Kennedy  
Chairman  
Canadian Entity

  
Donald Paul Hodel  
Chairman  
United States Entity

September 28, 1973  
Date of Agreement

DETERMINATION OF DOWNSTREAM POWER BENEFITS RESULTING FROM CANADIAN STORAGE  
FOR OPERATING YEAR 1978-79  
September 1973

I. Introduction.

The Treaty between Canada and the United States of America and related documents relating to the cooperative development of the water resources of the Columbia River Basin requires that downstream power benefits from Canadian storage be determined in advance by the two entities. The purpose of this report is to set out the results of downstream power benefit computations for the sixth succeeding year, 1978-79, and for the storages for which the Assured Operating Plan was developed.

The procedures followed in the benefit studies are those provided in Annex A, Paragraph 7, in Annex B of the Treaty; in Articles VIII, IX, and X of the Protocol; and in the document, "Procedures for the Determination of Downstream Power Benefits Resulting from Canadian Storage," dated September 9, 1968.

The Canadian Entitlement Benefits were computed as follows:

- Step I - based on the total U.S. planned hydro and thermal system with  $15\frac{1}{2}$  maf of Canadian storage operated for optimum generation in both countries (79-41 study).
- Step II - based on the U.S. base hydro and thermal system with  $15\frac{1}{2}$  maf of Canadian storage operated for optimum generation in both countries (79-42 study).
- Step III - based on the U.S. base hydro and thermal system operated for optimum generation in U.S. (79-13 study).

In addition to the determination of downstream power benefits for the operating year 1978-79, separate determinations were carried out in accordance with the document, "Operating Plans with Mica Generation," dated 15 November 1971, which was agreed by the Entities to implement the provisions of Annex A, paragraph 7, relating to the limit of year-to-year change in the operation of Canadian storage in operating plans designed to achieve optimum generation at-site in Canada and downstream in Canada and the United States of America.

II. Results of Study.

- (a) The Canadian Entitlement, which is one-half the total computed downstream power benefits, was computed to be:

Dependable Capacity = 1,454.5 mw

Average Annual Energy = 683.5 mw

- (b) One-half of the minimum permitted downstream power benefits computed in accordance with paragraph 4 of the document dated 15 November 1971 determined for 15 maf of Canadian storage operated for optimum generation in the United States:

Dependable Capacity = 1,430.5 mw

Average Annual Energy = 661.5 mw

Whenever one-half the downstream power benefits equal or exceed the above established minimum, they are within permitted range. Therefore, since one-half the established 1978-79 downstream power benefits exceed this, they fall within the specified range.

### III. Effect on Canadian Entitlement

The Canadian Entitlement to downstream power benefits was sold in the United States of America under the Canadian Entitlement Purchase Agreement dated 13 August 1964. By definition, the Canadian Entitlement for 1978-79 which was sold was that which would have been computed if the 1978-79 Assured Operating Plan had been designed to achieve optimum generation downstream in the United States alone. The Canadian Entitlement determined for the conditions above would have been:

Dependable Capacity =  $\frac{1}{2}$  of 2,909 mw or 1,454.5 mw

Average Annual Energy =  $\frac{1}{2}$  of 1,366 mw or 683.0 mw

Since the 1978-79 Assured Operating Plan was in fact designed to achieve optimum generation at-site in Canada and downstream in the United States of America, Section 7 of the Agreement requires that "any reduction in the Canadian Entitlement resulting from action taken pursuant to paragraph 7 of Annex A of the Treaty shall be determined in accordance with subsection (3) of Section 6 of this Agreement." The Canadian Entitlement of downstream power benefits under the 1978-79 Assured Operating Plan was determined as:

Dependable Capacity =  $\frac{1}{2}$  of 2,909 mw or 1,454.5 mw

Average Annual Energy =  $\frac{1}{2}$  of 1,367 mw or 683.5 mw

The comparison indicates no significant differences between the two measurements and therefore there is no reduction of the Canadian Entitlement.

### IV. Computation of Entitlement.

The following Tables and Charts are attached and summarize the study:

Table 1. Computation of Canadian Entitlement

The essential elements used in the computation of the Canadian Entitlement as provided in Paragraph 2 and 3 of Annex B are shown in this table.

Table 2. Summary of Power Regulations for the Computation of Canadian Entitlement to Downstream Benefits

This table summarizes the Step I, II, and III regulations by projects.

Table 3. Determination of Load Shape for Steps II and III, Canadian Entitlement Computation

The load shape for Steps II and III carry the same ratio between each month and the annual average as does the Pacific Northwest area load. The Northwest area firm loads on this table were based on the current forecast data. The Grand Coulee pumping load is also included in this estimate.

The firm load for Steps II and III is computed as follows:

- (1) Estimate the hydro nominal prime power for the critical period;
- (2) Add the thermal from Step I less reserve and minimum thermal generation;
- (3) Multiply (2) by the ratio of the area annual average firm load to the area critical period firm load to obtain the annual average firm load for Steps II and III (the ratios used in this study were 0.98674 and 0.95652, respectively);
- (4) Pro rate the average annual Step II or III load determined in (3) by months in the ratio that each monthly area load bears to the annual average area load; and
- (5) Subtract the thermal in each month to obtain the monthly firm hydro load. The average annual hydro load for Steps II and III also becomes the firm energy considered usable according to Annex B, Paragraph 3(a).

Chart 1 & 2. Secondary Energy Duration Curve, Steps II and III

These charts are duration curves of the secondary energy for Steps II and III. The secondary energy is the capability each month which exceeds the firm hydro loads shown in Table 3. The usable secondary energy shown in average megawatts for each step is computed in accordance with Annex B, Paragraphs 3(b) and 3(c). The "other usable secondary" was computed on the basis of 40% of the remainder after thermal replacement. The thermal replacement was limited to the existing

and scheduled thermal energy capability after allowance for reserve and minimum thermal generation, except when an energy surplus condition occurs; then the thermal replacement must not exceed the total of the thermal energy capability and the estimated secondary load.

|                                 |              |
|---------------------------------|--------------|
| Thermal Energy Capability - mw  | 5,549        |
| Less 5% Reserve - mw            | 277          |
| Less Minimum Thermal Generation | <u>1,335</u> |
| Thermal Replacement - mw        | 3,937        |

The following tabulation shows the ordinate values for usable secondary energy:

|                     | <u>Step II</u> | <u>Step III</u> |
|---------------------|----------------|-----------------|
| Thermal Replacement | 3,937          | 3,937           |
| Other               | <u>1,488</u>   | <u>2,487</u>    |
| Total - mw          | 5,425          | 6,424           |

TABLE 1

## COMPUTATION OF CANADIAN ENTITLEMENT

Generation Figures are in Average Megawatts; Load Factors, in Percent

Determination of Dependable Capacity Credited to Canadian Storage

|                                                                                |              |
|--------------------------------------------------------------------------------|--------------|
| Critical Period Average Rate of Generation with Canadian Storage, Step II . .  | 9,041        |
| Critical Period Average Rate of Generation without Canadian Storage, Step III. | <u>7,036</u> |
| Gain Due to Canadian Storage . . . . .                                         | 2,005        |
| Estimated Average Critical Period Load Factor — Percent . . . . .              | 68.916       |
| Dependable Capacity Gain <sup>1/</sup> . . . . .                               | 2,909        |
| Canadian Share of Dependable Capacity . . . . .                                | 1,454.5      |

Determination of Increase in Average Annual Usable EnergyStep II (with Canadian Storage)

|                                               |            |
|-----------------------------------------------|------------|
| Annual Firm Hydro Energy . . . . .            | 8,869      |
| Thermal Replacement Energy . . . . .          | 1,803      |
| Other Usable Secondary Energy . . . . .       | <u>305</u> |
| System Annual Average Usable Energy . . . . . | 10,977     |

Step III (without Canadian Storage)

|                                               |            |
|-----------------------------------------------|------------|
| Annual Firm Hydro Energy . . . . .            | 6,559      |
| Thermal Replacement Energy . . . . .          | 2,321      |
| Other Usable Secondary Energy . . . . .       | <u>730</u> |
| System Annual Average Usable Energy . . . . . | 9,610      |

|                                                        |       |
|--------------------------------------------------------|-------|
| Average Annual Usable Energy Gain . . . . .            | 1,367 |
| Canadian Share of Average Annual Energy Gain . . . . . | 683.5 |

<sup>1/</sup> Dependable capacity gain credited to Canadian storage equals gain in critical period average rate of generation divided by the estimated average critical period load factor.

SUMMARY OF POWER REGULATIONS FOR 1978-79  
FOR THE  
COMPUTATION OF CANADIAN ENTITLEMENT  
TO DOWNSTREAM BENEFITS

TABLE 2

| PROJECTS                            | BASE DATA       |                                       | STEP I                 |                               |                                       | STEP II                |                               |                                       |                              | STEP III               |                               |                                       |                              |
|-------------------------------------|-----------------|---------------------------------------|------------------------|-------------------------------|---------------------------------------|------------------------|-------------------------------|---------------------------------------|------------------------------|------------------------|-------------------------------|---------------------------------------|------------------------------|
|                                     | Number of Units | Wominal Installed Peaking Capacity MW | Usable Storage 1000 AF | January Peaking Capability MW | Critical Period Average Generation MW | Usable Storage 1000 AF | January Peaking Capability MW | Critical Period Average Generation MW | Average Annual Generation MW | Usable Storage 1000 AF | January Peaking Capability MW | Critical Period Average Generation MW | Average Annual Generation MW |
| <b>CANADIAN</b>                     |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Mica                                |                 |                                       | 7,008                  |                               |                                       | 7,008                  |                               |                                       |                              |                        |                               |                                       |                              |
| Arrow                               |                 |                                       | 7,145                  |                               |                                       | 7,145                  |                               |                                       |                              |                        |                               |                                       |                              |
| Duncan                              |                 |                                       | 1,347                  |                               |                                       | 1,347                  |                               |                                       |                              |                        |                               |                                       |                              |
| Subtotal                            |                 |                                       | 15,500                 |                               |                                       | 15,500                 |                               |                                       |                              |                        |                               |                                       |                              |
| <b>BASE FEDERAL SYSTEM</b>          |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Hungry Horse                        | 4               | 328                                   | 3,161                  | 162                           | 101                                   | 3,008                  | 250                           | 116                                   | 104                          | 3,008                  | 278                           | 213                                   | 102                          |
| Albion Falls                        | 3               | 49                                    | 1,155                  | 22                            | 24                                    | 1,155                  | 21                            | 22                                    | 22                           | 1,155                  | 23                            | 25                                    | 25                           |
| Grand Coulee                        | 22-23+2         | 5,538                                 | 5,232                  | 5,162                         | 2,003                                 | 5,072                  | 5,503                         | 1,772                                 | 2,335                        | 5,072                  | 5,201                         | 1,226                                 | 2,215                        |
| Chief Joseph                        | 23-27           | 2,309                                 |                        | 2,309                         | 1,091                                 |                        | 2,309                         | 1,003                                 | 1,327                        |                        | 2,309                         | 708                                   | 1,239                        |
| Ice Harbor                          | 6               | 693                                   |                        | 693                           | 219                                   |                        | 693                           | 224                                   | 304                          |                        | 693                           | 171                                   | 304                          |
| McWary                              | 14              | 1,127                                 |                        | 1,127                         | 648                                   |                        | 1,127                         | 594                                   | 766                          |                        | 1,127                         | 430                                   | 715                          |
| John Day                            | 16              | 2,484                                 | 535                    | 2,484                         | 918                                   |                        | 2,484                         | 927                                   | 1,273                        |                        | 2,484                         | 680                                   | 1,233                        |
| The Dalles                          | 22              | 2,018                                 |                        | 2,018                         | 817                                   |                        | 2,018                         | 795                                   | 1,044                        |                        | 2,018                         | 618                                   | 1,019                        |
| Bonneville                          | 10              | 574                                   |                        | 574                           | 553                                   |                        | 574                           | 547                                   | 552                          |                        | 574                           | 457                                   | 533                          |
| Subtotal                            |                 | 15,120                                | 10,083                 | 14,551                        | 6,374                                 | 9,235                  | 14,979                        | 6,000                                 | 7,727                        | 9,235                  | 14,707                        | 4,528                                 | 7,385                        |
| <b>BASE SYSTEM NON-FEDERAL</b>      |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Kootenay Lake (Canadian)            |                 |                                       | 787                    |                               |                                       | 427                    |                               |                                       |                              | 427                    |                               |                                       |                              |
| Kerr                                | 3               | 185                                   | 1,219                  | 173                           | 114                                   | 1,219                  | 173                           | 103                                   | 122                          | 1,219                  | 179                           | 151                                   | 122                          |
| Thompson Falls                      | 6               | 40                                    |                        | 40                            | 36                                    |                        | 38                            | 37                                    | 32                           |                        | 38                            | 36                                    | 31                           |
| Noxon Rapids                        | 4               | 430                                   | 231                    | 394                           | 173                                   |                        | 430                           | 160                                   | 218                          |                        | 430                           | 179                                   | 219                          |
| Cabinet Gorge                       | 4               | 230                                   |                        | 230                           | 112                                   |                        | 230                           | 99                                    | 129                          |                        | 230                           | 111                                   | 129                          |
| Box Canyon                          | 4               | 71                                    |                        | 70                            | 46                                    |                        | 70                            | 44                                    | 48                           |                        | 71                            | 51                                    | 48                           |
| Coeur d'Alene & Long Lake           |                 |                                       | 327                    |                               |                                       | 223                    |                               |                                       |                              | 223                    |                               |                                       |                              |
| Wells                               | 10              | 842                                   |                        | 842                           | 438                                   |                        | 842                           | 410                                   | 518                          |                        | 842                           | 288                                   | 476                          |
| Chelan                              | 2               | 54                                    | 677                    | 50                            | 38                                    | 676                    | 51                            | 38                                    | 46                           | 676                    | 52                            | 49                                    | 45                           |
| Rocky Reach                         | 11              | 1,291                                 |                        | 1,291                         | 645                                   |                        | 1,291                         | 606                                   | 772                          |                        | 1,291                         | 427                                   | 718                          |
| Rock Island                         | 10              | 159                                   |                        | 155                           | 155                                   |                        | 156                           | 155                                   | 149                          |                        | 158                           | 124                                   | 140                          |
| Wanapum                             | 10              | 986                                   |                        | 986                           | 560                                   |                        | 986                           | 525                                   | 665                          |                        | 986                           | 366                                   | 600                          |
| Priest Rapids                       | 10              | 912                                   |                        | 912                           | 528                                   |                        | 912                           | 497                                   | 625                          |                        | 912                           | 357                                   | 566                          |
| Brownlee                            | 4               | 450                                   | 980                    | 450                           | 225                                   | 974                    | 450                           | 256                                   | 268                          | 974                    | 450                           | 254                                   | 261                          |
| Oxbow                               | 4               | 220                                   |                        | 220                           | 94                                    |                        | 220                           | 111                                   | 118                          |                        | 220                           | 115                                   | 118                          |
| Subtotal                            |                 | 5,870                                 | 4,221                  | 5,813                         | 3,164                                 | 3,519                  | 5,849                         | 3,041                                 | 3,710                        | 3,519                  | 5,859                         | 2,508                                 | 3,473                        |
| TOTAL BASE SYSTEM HYDRO             |                 | 20,990                                | 29,804                 | 20,364                        | 9,538                                 | 28,254                 | 20,828                        | 9,041                                 | 11,437                       | 12,754                 | 20,566                        | 7,036                                 | 10,858                       |
| <b>ADDITIONAL STEP I PROJECTS</b>   |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Libby                               | 4               | 483                                   | 4,934                  | 211                           | 191                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Boundary                            | 4               | 650                                   |                        | 650                           | 361                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Spokane River Plants                | 4               | 153                                   |                        | 147                           | 89                                    |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Hells Canyon                        | 3               | 450                                   |                        | 450                           | 178                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Dworshak                            | 3               | 460                                   | 2,015                  | 417                           | 161                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Lower Granite                       | 3-6             | 466                                   |                        | 466                           | 220                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Little Goose                        | 3-6             | 466                                   |                        | 466                           | 216                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Lower Monumental                    | 3               | 466                                   |                        | 466                           | 217                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Pelton and Round Butte              |                 | 454                                   | 274                    | 423                           | 132                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Subtotal                            |                 | 4,048                                 | 7,223                  | 3,696                         | 1,765                                 |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Independent Resources               |                 | 4,650                                 | 8,489                  | 3,720                         | 1,714                                 |                        |                               |                                       |                              |                        |                               |                                       |                              |
| TOTAL HYDRO RESOURCES               |                 | 29,688                                | 45,516                 | 27,780                        | 13,017                                |                        |                               |                                       |                              |                        |                               |                                       |                              |
| <b>MISCELLANEOUS CONTRACTS</b>      |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
|                                     |                 |                                       |                        | 38                            | 11                                    |                        |                               |                                       |                              |                        |                               |                                       |                              |
| <b>THERMAL RESOURCES</b>            |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Existing Thermal Plants             |                 |                                       |                        | 1,397                         | 218                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Centralia #1 & #2                   |                 |                                       |                        | 1,400                         | 1,260                                 |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Trojan                              |                 |                                       |                        | 1,130                         | 1,017                                 |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Jim Bridger #1, #2, & #3            |                 |                                       |                        | 1,500                         | 1,350                                 |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Colstrip #1 & #2                    |                 |                                       |                        | 350                           | 315                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Hanford #2                          |                 |                                       |                        | 1,100                         | 990                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Colstrip #3 & #4                    |                 |                                       |                        | 525                           | 392                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| TOTAL THERMAL RESOURCES             |                 |                                       |                        | 7,402                         | 5,549                                 |                        |                               |                                       |                              |                        |                               |                                       |                              |
| TOTAL IMPORTS                       |                 |                                       |                        | -                             | 457                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| TOTAL RESOURCES (HYDRO AND THERMAL) |                 |                                       |                        | 35,220                        | 19,034                                |                        |                               |                                       |                              |                        |                               |                                       |                              |
| RESERVES 1/                         |                 |                                       |                        | -2,369                        | -277                                  |                        |                               |                                       |                              |                        |                               |                                       |                              |
| RESOURCES AVAILABLE FOR LOAD        |                 |                                       |                        | 32,851                        | 18,757                                |                        |                               |                                       |                              |                        |                               |                                       |                              |
| <b>ESTIMATED LOAD</b>               |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Pacific Northwest Area              |                 |                                       |                        | 29,607                        | 18,158                                |                        |                               |                                       |                              |                        |                               |                                       |                              |
| SURPLUS OR (DEFICIT)                |                 |                                       |                        | 3,244                         | 599                                   |                        |                               |                                       |                              |                        |                               |                                       |                              |
| <b>CRITICAL PERIOD</b>              |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
| Starts:                             |                 |                                       | August 16, 1928        |                               |                                       | September 1943         |                               |                                       |                              | September 16, 1936     |                               |                                       |                              |
| Ends:                               |                 |                                       | February 1932          |                               |                                       | April 1945             |                               |                                       |                              | April 15, 1937         |                               |                                       |                              |
| Length (Months)                     |                 |                                       | 42-1/2 Months          |                               |                                       | 20 Months              |                               |                                       |                              | 7 Months               |                               |                                       |                              |
| <b>STUDY IDENTIFICATION</b>         |                 |                                       |                        |                               |                                       |                        |                               |                                       |                              |                        |                               |                                       |                              |
|                                     |                 |                                       | 79-41                  |                               |                                       | 79-42                  |                               |                                       |                              | 79-13                  |                               |                                       |                              |

1/ Peak reserves are 8% of peak load; energy reserves are 5% of thermal plant energy capability.

DETERMINATION OF LOAD SHAPE FOR STEP II AND III  
1978-79 CANADIAN ENTITLEMENT COMPUTATIONS

| Pacific Northwest Area Load                                           |          |        |               | Step II                                             |                   |                 | Step III                                                   |                   |                 |
|-----------------------------------------------------------------------|----------|--------|---------------|-----------------------------------------------------|-------------------|-----------------|------------------------------------------------------------|-------------------|-----------------|
|                                                                       | Peak     | Avg.   | Load Factor % | Total Firm Load 1/                                  | Thermal Firm Load | Hydro Firm Load | Total Firm Load 1/                                         | Thermal Firm Load | Hydro Firm Load |
| July                                                                  | 23,799 * | 16,490 | 69.29         | 11,684                                              | 3,937             | 7,747           | 9,577                                                      | 3,937             | 5,640           |
| Aug. 1-15                                                             | 24,286 * | 16,642 | 68.53         | 11,792                                              | 3,937             | 7,855           | 9,665                                                      | 3,937             | 5,728           |
| Aug. 16-31                                                            | 24,209 * | 16,545 | 68.34         | 11,723                                              | 3,937             | 7,786           | 9,609                                                      | 3,937             | 5,672           |
| Sept. 1-15                                                            | 24,401 * | 16,401 | 67.21         | 11,621                                              | 3,937             | 7,684           | 9,525                                                      | 3,937             | 5,588           |
| Sept. 16-30                                                           | 24,355 * | 16,365 | 67.19         | 11,596                                              | 3,937             | 7,659           | 9,504                                                      | 3,937             | 5,567           |
| October                                                               | 26,047 * | 17,246 | 66.21         | 12,220                                              | 3,937             | 8,283           | 10,016                                                     | 3,937             | 6,079           |
| November                                                              | 26,787 * | 18,600 | 69.44         | 13,180                                              | 3,937             | 9,243           | 10,802                                                     | 3,937             | 6,865           |
| December                                                              | 29,430 * | 20,085 | 68.25         | 14,232                                              | 3,937             | 10,295          | 11,664                                                     | 3,937             | 7,727           |
| January                                                               | 29,607 * | 20,771 | 70.16         | 14,718                                              | 3,937             | 10,781          | 12,063                                                     | 3,937             | 8,126           |
| February                                                              | 27,613 * | 19,760 | 71.56         | 14,001                                              | 3,937             | 10,064          | 11,476                                                     | 3,937             | 7,539           |
| March                                                                 | 26,490 * | 18,728 | 70.70         | 13,270                                              | 3,937             | 9,333           | 10,876                                                     | 3,937             | 6,939           |
| Apr. 1-15                                                             | 25,182 * | 17,803 | 70.70         | 12,615                                              | 3,937             | 8,678           | 10,339                                                     | 3,937             | 6,402           |
| Apr. 16-30                                                            | 25,191 * | 17,863 | 70.91         | 12,657                                              | 3,937             | 8,720           | 10,374                                                     | 3,937             | 6,437           |
| May                                                                   | 25,533 * | 17,294 | 67.73         | 12,254                                              | 3,937             | 8,317           | 10,044                                                     | 3,937             | 6,107           |
| June                                                                  | 25,327 * | 17,178 | 67.83         | 12,172                                              | 3,937             | 8,235           | 9,976                                                      | 3,937             | 6,039           |
| Critical Period Avg.                                                  |          | 18,158 | 68.916        | 12,978                                              | 3,937             | 9,041           | 10,973                                                     | 3,937             | 7,036           |
| Annual Average                                                        |          | 18,073 |               | 12,806                                              | 3,937             | 8,869           | 10,496                                                     | 3,937             | 6,559           |
| January Peak                                                          | 29,607 * |        |               |                                                     |                   |                 |                                                            |                   |                 |
| Step I Critical Period Aug. 16, 1928 - Feb. 29, 1932<br>42-1/2 Months |          |        |               | Critical Period Sept. 1943 - Apr. 1945<br>20 Months |                   |                 | Critical Period Sept. 16, 1936 - Apr. 15, 1937<br>7 Months |                   |                 |

1/ Total firm load of Step II and Step III systems, computed for each system to have an average energy load equivalent to the average energy capability within the critical period and to bear a constant ratio, month by month, to the Pacific Northwest Area Load.

\* Figures so marked are peak megawatts. All other figures are monthly or semi-monthly energy in average megawatts.

MEGAWATTS

12000

11804.0

10000

8000

6000

4000

2000

1844.0

0

5,425  
OTHER  
USABLE  
SECONDARY  
305 AVG. MW  
3,937

THERMAL REPLACEMENT  
1,803 AVERAGE MW

# DURATION CURVE OF SECONDARY ENERGY

1978-79 30YR CAN. ENT. STEP II

STUDY 79 CHART 1

TOTAL=2,567 AVERAGE MW

PERCENT OF TIME

0

20

40

60

80

100

MEGAWATTS

14000  
13766.0

12000

10000

8000

6000

4000

2000  
2482.0

0  
0

6,424

OTHER USABLE  
SECONDARY  
730 AVERAGE MW

3,937

THERMAL REPLACEMENT  
2,321 AVERAGE MW

# DURATION CURVE OF SECONDARY ENERGY

1978-79 30YR CAN. ENT. STEP III

STUDY 79 CHART 2

TOTAL = 4,146 AVERAGE MW

PERCENT OF TIME

20

40

60

80

100