

COLUMBIA RIVER DEVELOPMENT

**Determination
of
Canadian
Downstream Power
Entitlement**

GOVERNMENT USE ONLY

Work Group No. 1
November 1963



Carl Blake

UNITED STATES
DEPARTMENT OF THE INTERIOR
BONNEVILLE POWER ADMINISTRATION
PORTLAND 8, OREGON

November 20, 1963

Dear Sir:

Enclosed are copies of two reports prepared by Work Group No. 1 on the Determination of Canadian Downstream Power Entitlement of development for 15,500,000 acre-feet storage at Arrow Lakes, Duncan Lake, and Mica. The smaller report is a summary report prepared for the negotiators. The larger report is a technical report and includes considerable details, tables, charts, and explanatory material on the calculations.

You will note that we have stamped the reports for "Government Use Only." This is to emphasize the importance of limiting this information to our joint efforts of completing an arrangement whereby these projects can be constructed. Premature release of these results to the press or general public could be very harmful to the ultimate conclusion of a workable Treaty between the United States and Canada on this matter. Your cooperation in this restriction for your own use and for discussions with the Pacific Northwest utilities and Federal agencies working on this problem is vital to a successful conclusion.

The results of these studies are somewhat different from those developed earlier because of the different basic assumptions agreed upon by the Work Group members.

If it is important to your examination of these results, additional copies can be made available to you through Mr. Gordon Culp, Corps of Engineers, or the Bonneville Power Administration offices.

Sincerely yours,

H. M. McIntyre
H. M. McIntyre
Chairman, Work Group No. 1

Enclosures 2

COLUMBIA RIVER DEVELOPMENT

Determination of Canadian Downstream Power Entitlement

November 1963

REPORT ON COLUMBIA RIVER TREATY TO THE NEGOTIATORS
FROM WORK GROUP NO. 1

Work Group No. 1

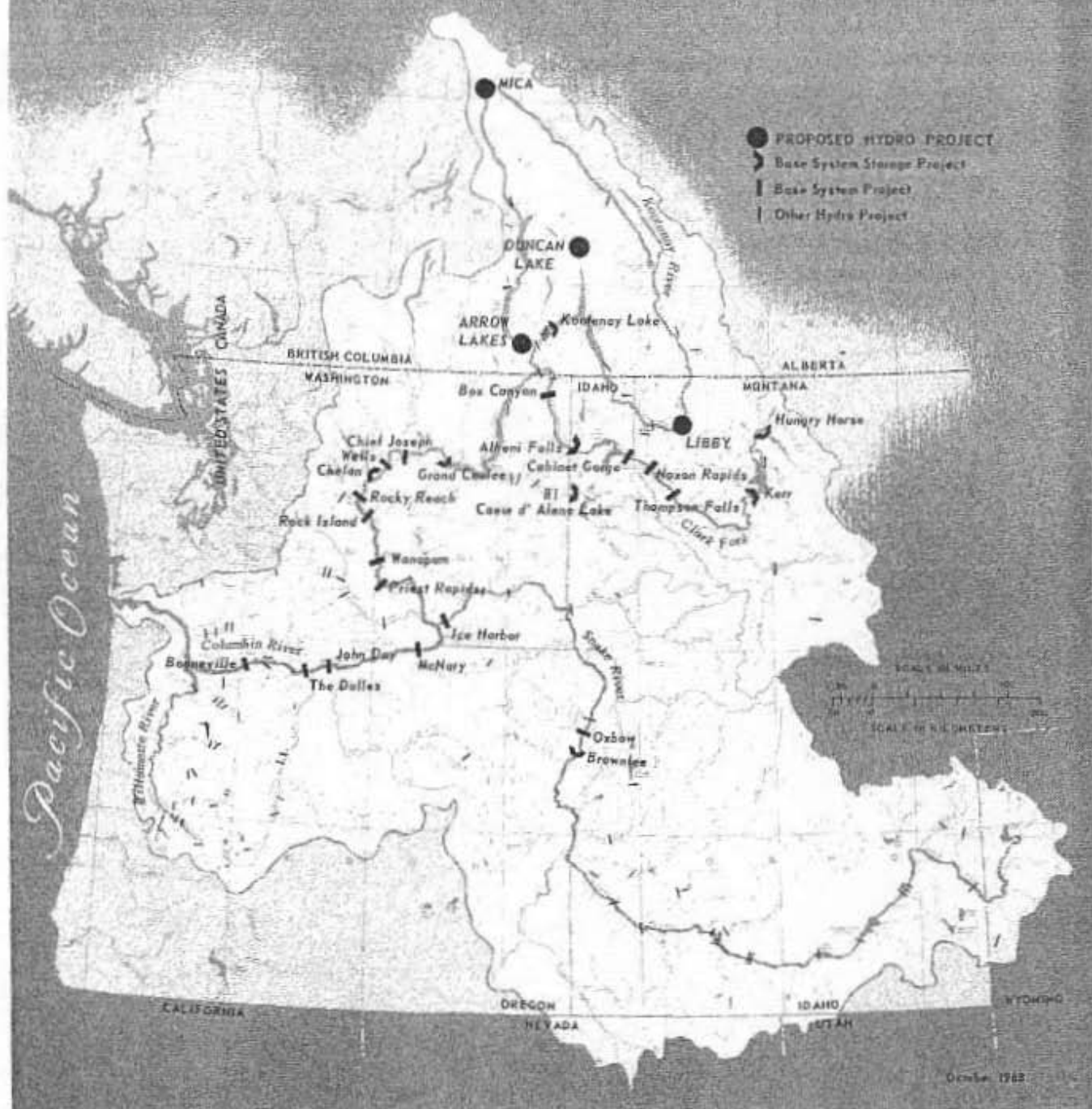
For Canada

W. D. Kennedy, Chairman
G. J. A. Kidd
G. MacNabb
J. F. Parkinson

For the United States

H. M. McIntyre, Chairman
D. J. Lewis, Alternate Chairman
D. H. Knight
A. J. Porter
Howard C. Elmore

Columbia River Basin



COLUMBIA RIVER DEVELOPMENT

CANADIAN DOWNSTREAM POWER ENTITLEMENT

1. At a meeting of negotiators held in Washington, D. C., on 6 September 1963, it was decided to establish two Work Groups. This is a report on the activities of Work Group No. 1 whose terms of reference were:

"Quantity and duration of sales of benefits and problems resulting from the changes in the amount of downstream benefits over the period.

"Problems of differing rates of change in capacity and energy benefits."

2. The purpose of this report is to provide a current estimate of the Canadian downstream power entitlement as determined in accordance with the Treaty with particular reference to the period of the first 30 years. During September, October, and November studies were made in Portland with the participation of United States (Federal and non-Federal representatives) and Canadian engineers, and meetings of Work Group No. 1 were held on 7 September, 17 and 18 September, 7 and 8 October, and 7 and 8 November 1963.

3. Before the studies could be undertaken, assumptions had to be made on the possible varying conditions which would prevail during the life of the Treaty. A list of the assumptions used in these particular studies is attached as Appendix No. 1. Some have a large effect on the Canadian entitlement, particularly Items (I) "Load Estimates," (II) "The Decline of Capacity Entitlement," and (III) "Grand Coulee Pumping." The Work Group was not able to reach common agreement on the validity of some of the assumptions used because these involve interpretation of the Treaty, or items on which the Treaty is silent, and it was anticipated that the negotiators would wish to consider these points before any final decisions are made. For this reason it was decided that the studies would show the results for alternative assumptions.

4. The results of the studies are shown in the accompanying Table for different levels of load estimated to occur in the period of about 30 years.

The points in time which are shown by the table are those for which detailed computation of entitlement was made. These points were selected to make the best portrayal of entitlement with time and most have some particular significance in this regard. Some mark the point

ESTIMATED CANADIAN ENERGY AND CAPACITY ENTITLEMENTS

<u>Load Forecast</u>		<u>Level of Development</u>	<u>Energy Entitlement-MW</u>	<u>Capacity Entitlement-MW</u>		
<u>Range</u>	<u>Average-MW 1/</u>			<u>United States Method 2/</u>	<u>Canadian Method 2/</u>	<u>Increment from Grand Coulee Pumping 3/</u>
High	10,400	1968-69	106	191	191	0
	11,100	1969-70	536	956	956	16
	15,200	1974-75	714 775	1,331 1370	1,331	59 972
	19,600	1978-79	516 618	1,279 1341	1,279	62 1390
	23,300	1981-82	378	1,196	1,196	64 1341
	33,900	1988-89	216	742 812	742	70
	37,600	1990-91	173	822	822	72
	49,800	1996-97	146	0	1,177	0
Low	10,100	1968-69	105	191	191	0
	10,700	1969-70	540	956	956	16
	15,400	1976-77	700	1,322	1,322	61
	20,000	1983-84	507	1,235	1,235	66
	23,600	1988-89	374	1,140	1,140	70
	36,800	2001-02	167	743	743	81
	49,700	2010-11	134	0	1,079	0

12

1/ See Appendix Section I

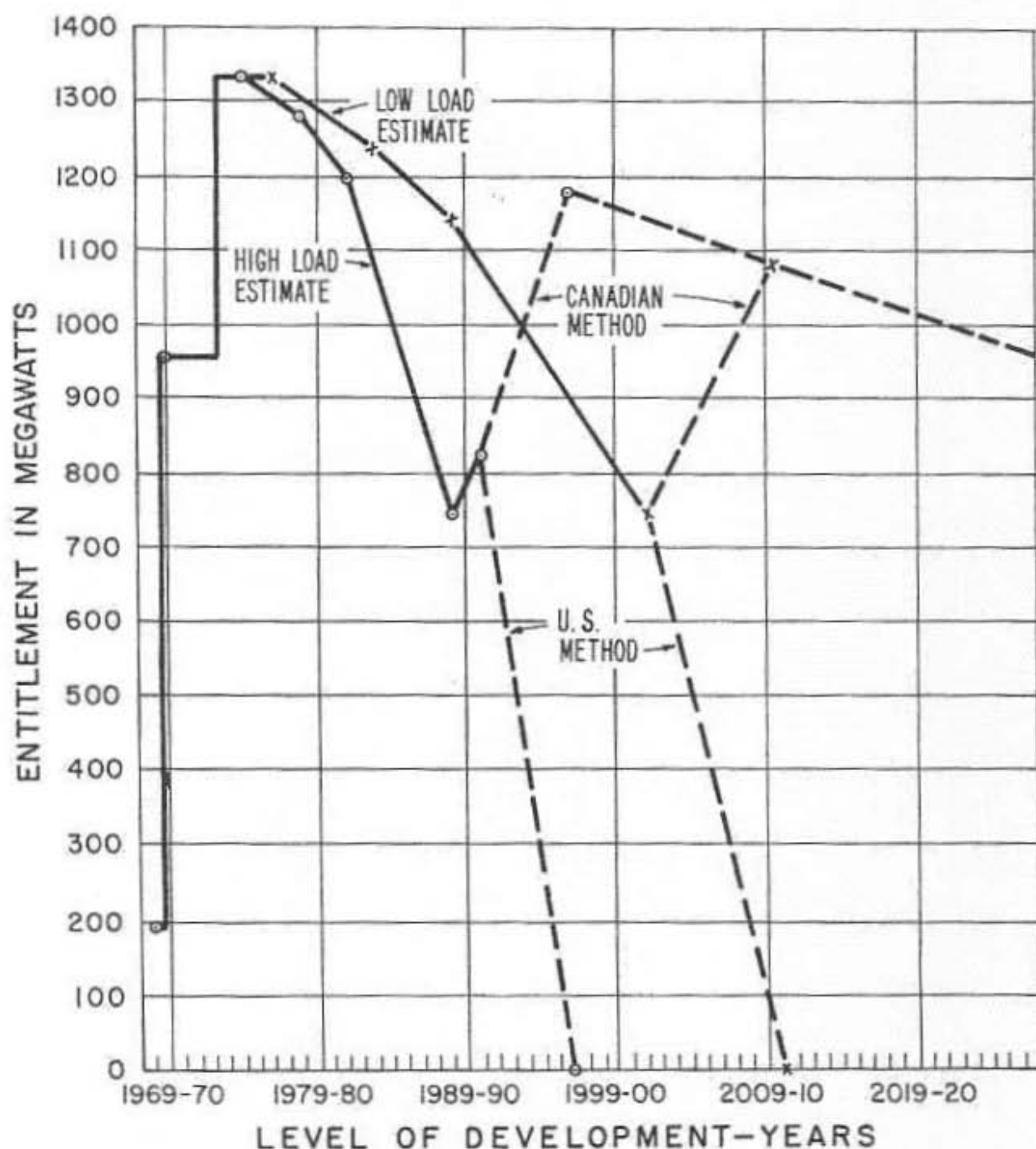
2/ See Appendix Section II

3/ See Appendix Section III

November 16, 1963

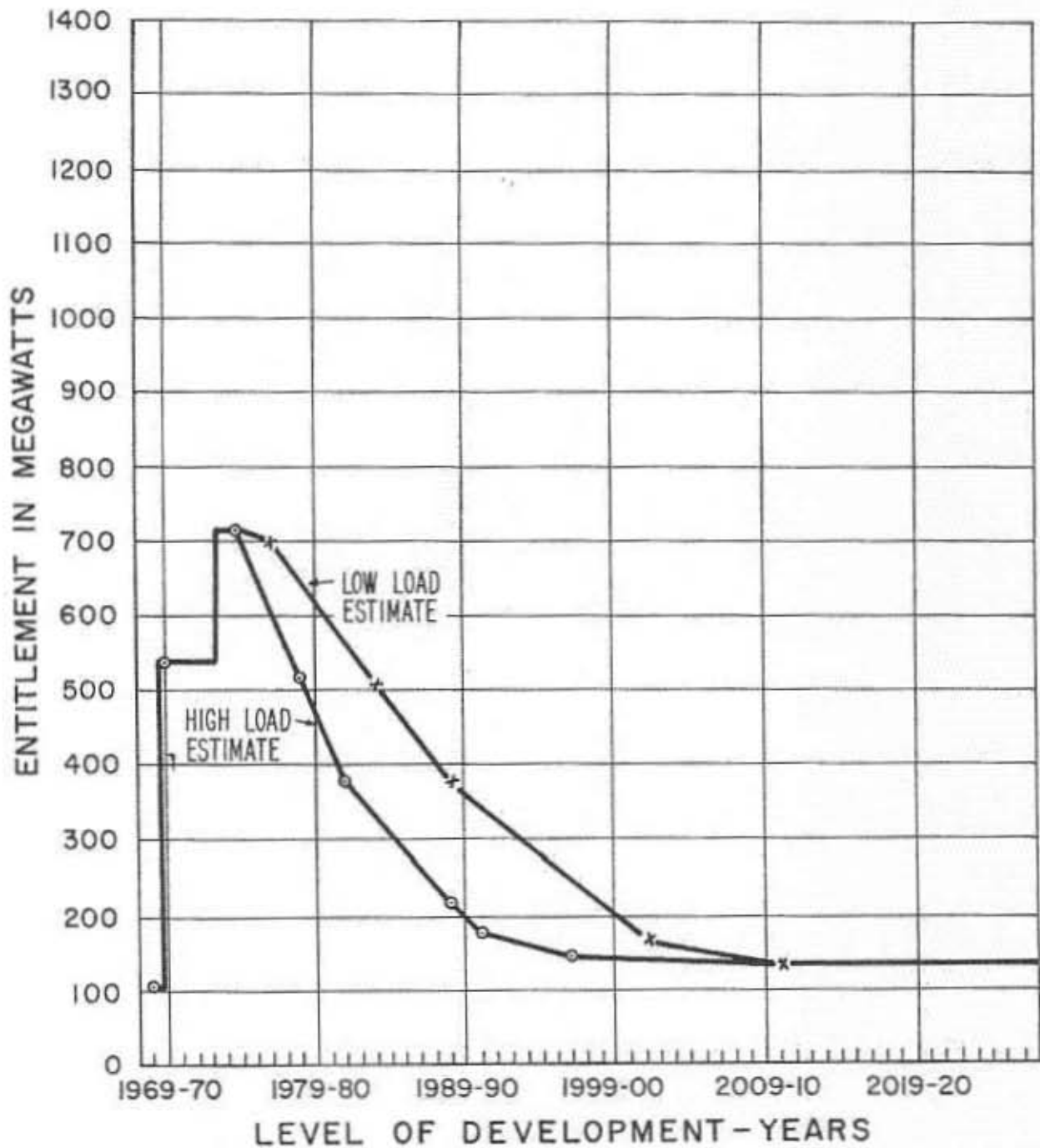
ESTIMATED CANADIAN CAPACITY ENTITLEMENTS

Downstream benefits include net generation at Grand Coulee which excludes capability used for at-site irrigation pumping.



ESTIMATED CANADIAN ENERGY ENTITLEMENTS

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at which a particular block of storage becomes available. Some are the year in which a substantial dependence upon thermal energy begins. Others mark the year in which the decline in capacity entitlement is accelerated. In this way a better definition of entitlement is obtained than would result from a constant interval between points. The results are shown for two different rates of load growth.

The Canadian capacity and energy entitlements are shown graphically on the accompanying charts.

Two levels of capacity entitlement are indicated in the later years reflecting both the United States and Canadian methods of applying the limitation clause shown in Annex B of the Treaty.

The table also shows the additional Canadian capacity entitlement if the gross generation of Grand Coulee were to be used rather than the net generation.

5. In the time available it was not possible to consider the effect of all the alternative assumptions for each of the different level of loads considered in the studies. The effects of some of these alternatives have been considered as examples for individual years and comments on the assumptions listed in Appendix I are discussed as follows.

As described in Appendix - Item IV, a question has been raised regarding the forecast level of irrigation streamflow depletions. The studies showed that at or near ultimate development of the Base System, a change of one year in the assumption of irrigation depletions would cause a change of about 7 megawatts in capacity and 0.5 megawatts in energy entitlement. For instance, if the irrigation depletions assumed for 1977 did not occur until 1982, the capacity entitlement would be increased from 1,196 megawatts to 1,231 megawatts and the energy from 378 megawatts to about 380 megawatts.

The Treaty states in Sec. 6 of Annex B that "Unless otherwise agreed upon by the entities, the determination of the downstream power benefits shall be based upon stream flows for the twenty year period beginning with July 1928." Use of the thirty-year period 1928-58 would result in no change in capacity entitlement. Energy entitlement for the thirty years of streamflow as compared to twenty years would be as follows for two selected load levels.

Level of Development (High Load Estimate)	Streamflow Period		
	20-Years	30-Years	Increase
1978-79	516	594	78
1990-91	173	246	73

As described in Item IX of Appendix 1, studies were to be made of the effect on energy entitlement of inability to discontinue operation of all thermal plants during periods of abundant secondary hydro energy. Such inability would decrease the usability of secondary energy. As an example, the 1978-79 system capability studies were examined for various degrees of thermal energy replacement as follows:

Percent Replaceable	<u>100</u>	<u>80</u>	<u>60</u>	<u>40</u>	<u>20</u>	<u>0</u>
Energy Entitlement-megawatts	516	560	600	650	720	810

If hydro projects additional to those included in the ultimate hydro system were to be added, the effect would be to decrease the amount of thermal plant and Base System hydro peaking installation thus delaying the decline of entitlement. For example, the addition of 2,000 megawatts of capacity in excess of prime would delay the ultimate installation of Base System capacity by about two years, prolonging entitlements by about the same interval. The energy entitlement would also be prolonged.

ASSUMPTIONS USED IN THE STUDIES OF THE CANADIAN
DOWNSTREAM POWER ENTITLEMENT

I LOAD ESTIMATES

Because of the difficulty of forecasting loads over a period of 30 years, it was agreed for these particular studies two load estimates would be used;

- (i) the probable load estimate prepared by BPA on 17 September, - High Load Forecast
- (ii) the "average" estimate of the Federal Power Commission forecast made in 1956 adjusted in the earlier years to provide a transition between the actual and forecasted loads - Low Load Forecast.

In both cases it was agreed that the same load shapes would be applicable to the same levels of load and that the shapes would be those used in the BPA estimates, dated 17 September 1963.

II DECLINE IN CAPACITY ENTITLEMENT

The last sentence of Paragraph 2 of Annex B of the Treaty states:

"The capacity credit shall not exceed the difference between the capability of the base system without Canadian storage and the maximum feasible capability of the base system with Canadian storage, to supply firm load during the critical streamflow periods."

There was no agreement between the United States and Canadian representatives on the meaning or application of this sentence in determining the Canadian capacity entitlement in the later years, consequently the results would be presented with two alternative solutions.

The interpretation of this sentence has a material effect on the Canadian capacity entitlement.

III GRAND COULEE PUMPING

The United States representatives considered that the net output of Grand Coulee i.e. excluding the pumping load, should be used as the generation of this resource. The Canadian representatives considered that Grand Coulee pumping should be regarded as a load. It was agreed that in these studies the results would be shown for the difference between Grand Coulee net generation and gross generation.

IV MODIFIED FLOWS

In Paragraph 6 of Annex B to the Treaty, it is specified that the flows to be used in the studies will be those in the report entitled, "Modified Flows at Selected Power Sites - Columbia Basin," dated June 1957. Because of necessary revisions to this document, both the United States and Canadian representatives agreed to accept the revision of this report dated June 1958. Both reports include estimates of irrigation depletion in the years 1960 and 2010 and two matters of principle in this regard had to be considered:

- (i) Should the figure for intermediate years be determined by straight line interpolation,
- and (ii) Should the figure for 1968 be adjusted because the recent experience shows the irrigation depletions have not been as large as was first forecast.

It was agreed that for these studies a straight line interpolation between the 1960 and 2010 figures would be assumed. The studies would show the effect of possible alterations in the irrigation depletions by assuming, for example, that the irrigation depletions forecast for 1981-82 did not occur until 1990-91.

V RESERVE REQUIREMENT

The Treaty does not specify what allowances should be included for reserve requirements but it was agreed that for these studies allowances for reserve generation would be 8 percent on peak capacity and 5 percent of the thermal energy.

VI USE OF CANADIAN ENTITLEMENT

It was agreed to assume for these studies that the Canadian entitlement would be sold in California up to 1979-80 and thereafter it would be sold in the Pacific Northwest.

VII USE OF CANADIAN STORAGE

It was agreed for the later years in these studies that storage would be used as necessary to avoid spill and that Arrow Lakes, Duncan Lake, and about 4 million acre-feet of storage at Mica would be operated to suit the United States requirements but giving some regard to Mica generation.

VIII 20-YEAR AND 30-YEAR FLOWS

It was agreed that the present studies would be made on the basis of 20-year flows as specified in the Treaty but the effect of using 30-year flows would be mentioned in the report.

IX THERMAL PLANT SHUT-DOWN

Originally 100 percent thermal plant shut-down was assumed but later discussions indicated that this might not be practicable. It was agreed that in these present studies for the year 1978-79 the effect on Canadian entitlement with thermal plant shut-down ranging between 0 percent and 100 percent would be shown.

X INDEPENDENT RESOURCES

Because the Treaty is not specific on how independent resources are to be treated, it was agreed that in the present studies these resources would be considered in Step I of the studies but not in Steps II or III.

XI KOOTENAY DIVERSION

The date when it will be economic to make the diversion of the Kootenay in Canada is unknown but it was agreed for these studies to use a maximum diversion at Canal Flats of 1,500,000 acre-feet commencing in 1984-85, to include the diversion in Steps I and II but not in Step III, and to limit the rate of diversion to a maximum of 5,000 second-feet.

XII KOOTENAY LAKE REGULATION

The rules of the International Joint Commission would be followed in all cases. The filling of Kootenay Lake after August in Steps II and III would not be permitted in these studies. During the drawdown period Kootenay storage would be withdrawn as necessary as long as the maximum end-of-month elevations stipulated in the rules were not violated.

XIII PULL-BACK OF MICA STORAGE

It was agreed in the present studies there would be no pull-back of Mica storage as permitted in Paragraph 7 of Annex A of the Treaty.

XIV ADDITIONAL HYDRO TO BE INSTALLED IN THE UNITED STATES

For the present studies it would be assumed that the potential hydro projects shown in Table I for the 1984-85 study outlined in the report entitled, "Review of Canadian Entitlement - December 1962," would be added to the United States system before any new thermal would be developed.

It was agreed that if possible, the effect of adding or subtracting additional hydro resources in the United States would be illustrated in the report as it would affect the timing of the decline of Canadian entitlement.

XV EVAPORATION

At the present time different assumptions have been adopted by Bonneville Power Administration and the Corps of Engineers with regard to evaporation from storage projects included in Step I but excluded from Steps II or III. These differing assumptions had been adopted because of computer program limitations. It was agreed to proceed with the studies with this difference of assumptions. It was agreed that the proper treatment of evaporation losses would be to remove a project's evaporation loss whenever that project is deleted from a study.

XVI IN-SERVICE DATES FOR CANADIAN STORAGE

It was agreed for these studies that the in-service dates for the Canadian storage would be:

- (i) Duncan - April 1968
- (ii) Arrow - April 1969
- (iii) Mica Storage - April 1973

XVII HANFORD REACTOR

It was agreed that for these studies the Hanford Reactor should be considered as operating for dual purposes up to 1972-73 and after this date should be considered as operating for single purpose.