

ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

Washington, D.C.

Ottawa, Ontario

30 SEPTEMBER 1961



COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

C A N A D A · U N I T E D S T A T E S

CANADIAN SECTION

G.M. MacNABB, Chairman
B.D. Marr, Member

UNITED STATES SECTION

L.A. DUSCHA, Chairman
J.E. Harper, Member

31 December 1981

The Honorable Alexander M. Haig, Jr.
The Secretary of State
Washington, D.C.

The Honourable M. Lalonde
Minister of Energy, Mines and
Resources
Ottawa, Ontario

Gentlemen:

Reference is made to the Treaty between the United States of America and Canada, relating to co-operative development of the water resources of the Columbia River basin, signed at Washington, D.C., on 17 January 1961.

In accordance with the provisions of Article XV paragraph 2(e), there is submitted herewith the seventeenth Annual Report, dated 30 September 1981, of the Permanent Engineering Board.

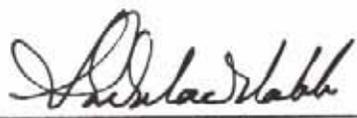
The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1980 to 30 September 1981.

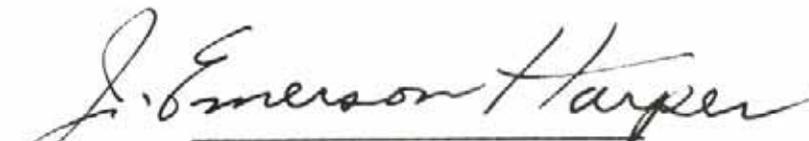
Respectfully submitted:

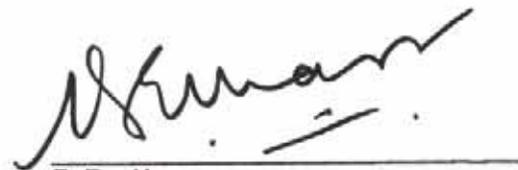
For the United States

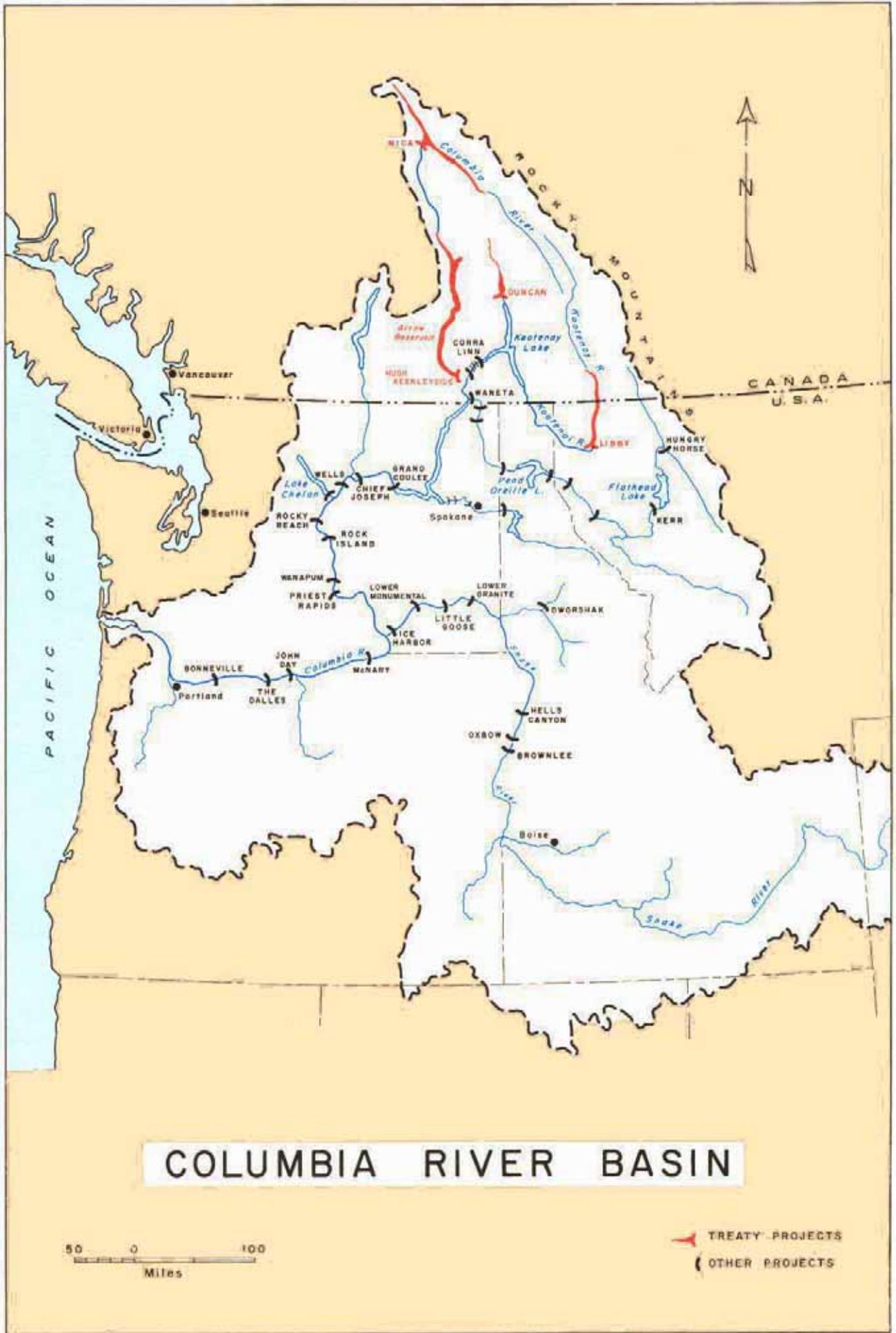
For Canada


Lloyd A. Duscha, Chairman


G.M. MacNabb, Chairman


J. Emerson Harper


B.E. Marr



COLUMBIA RIVER BASIN

**ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA**

**COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD**

Washington, D.C.

Ottawa, Ontario

30 September 1981

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Photographs supplied by the British Columbia Hydro and Power Authority and the Corps of Engineers, U.S. Army.

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SUMMARY

The seventeenth Annual Report of the Permanent Engineering Board is submitted to the Governments of the United States and Canada in compliance with Article XV of the Columbia River Treaty of 17 January 1961. The status of projects, progress of Entity studies, operation of the Duncan, Arrow, Mica and Libby reservoirs, and the resulting benefits are described.

The Duncan, Arrow, Mica and Libby storage projects were operated throughout the year in accordance with the objectives of the Treaty and the terms of operating plans developed by the Entities. Although reservoir operations reduced peak freshet flows the unregulated peaks would not have caused any significant flood damages in either country.

Studies pertaining to development of the hydrometeorological network and power operating plans are being continued by the Entities to ensure operation of the projects in accordance with the terms of the Treaty. The use of a 40-year period of streamflow record for the development of Assured Operating Plans, as noted in the last Annual Report, has not affected operating commitments. However, the Entities have now reverted to the use of the 30-year record of streamflow stipulated by paragraph 8 of the Protocol to the Treaty.

The Board concludes that the objectives of the Treaty are being met.

INTRODUCTION

The Columbia River Treaty, which provides for co-operative development of the water resources of the Columbia River basin, was signed in Washington, D.C. on 17 January 1961 by representatives of the United States and Canada. Article XV of the Treaty established a Permanent Engineering Board and specified that one of its duties would be to "make reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty..."

This Annual Report, which covers the period 1 October 1980 to 30 September 1981, describes activities of the Board, progress being achieved by both countries under the terms of the Treaty, operation of the Treaty projects, and the resulting benefits. The report states that, in the opinion of the Board, the objectives of the Treaty are being met. Summaries of the essential features of the Treaty and of the responsibilities of the Board and of the Entities are included.



MICA DAM
The earth dam with spillway in operation during 1981.

Columbia River, British Columbia

THE COLUMBIA RIVER TREATY

General

The Columbia River Treaty was signed in Washington, D.C. on 17 January 1961 and was ratified by the United States Senate in March of that year. In Canada ratification was delayed. Further negotiations between the two countries resulted in formal agreement by an exchange of notes on 22 January 1964 to a Protocol to the Treaty and to an Attachment Relating to Terms of Sale. The Treaty and related documents were approved by the Canadian Parliament in June 1964.

The Canadian Entitlement Purchase Agreement was signed on 13 August 1964. Under the terms of this agreement Canada's share of downstream power benefits resulting from the first thirty years of scheduled operation of each of the storage projects was sold to a group of electric utilities in the United States known as the Columbia Storage Power Exchange.

On 16 September 1964 the Treaty and Protocol were formally ratified by an exchange of notes between the two governments. The sum of \$253.9 million (U.S. funds) was delivered to the Canadian representatives as payment in advance for the Canadian entitlement to downstream power benefits during the period of the Purchase Agreement. On the same date at a ceremony at the Peace Arch Park on the International Boundary the Treaty and its Protocol were proclaimed by President Johnson, Prime Minister Pearson, and Premier Bennett of British Columbia.

Features of the Treaty and Related Documents

The essential undertakings of the Treaty are as follows:

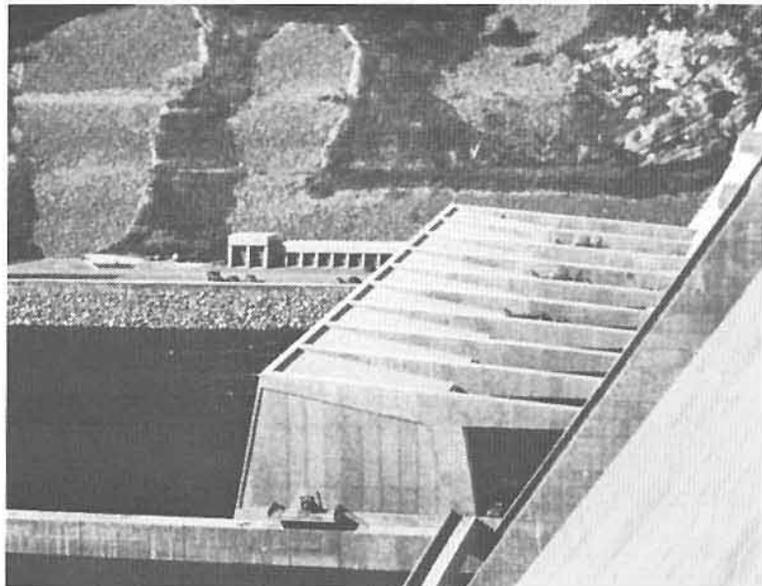
- (a) Canada will provide 15.5 million acre-feet of usable storage by constructing dams near Mica Creek, the outlet of Arrow Lakes and Duncan Lake, in British Columbia.
- (b) The United States will maintain and operate hydroelectric power facilities included in the base system and any new main-stem projects to make the most effective use of improved stream flow resulting from operation of the Canadian storage. Canada will operate the storage in accordance with procedures and operating plans specified in the Treaty.
- (c) The United States and Canada will share equally the additional power generated in the United States as a result of river regulation by upstream storage in Canada.
- (d) On commencement of the respective storage operations the United States will make payments to Canada totalling \$64.4 million (U.S. funds) for flood control provided by Canada.
- (e) The United States has the option of constructing a dam on the Kootenai River near Libby, Montana. The Libby reservoir would extend some 42 miles into Canada and Canada would make the necessary Canadian land available for flooding.
- (f) Both Canada and the United States have the right to make diversions of water for consumptive uses and, in addition, after September 1984 Canada has the option of making for power purposes specific diversions of the Kootenay River into the headwaters of the Columbia River.

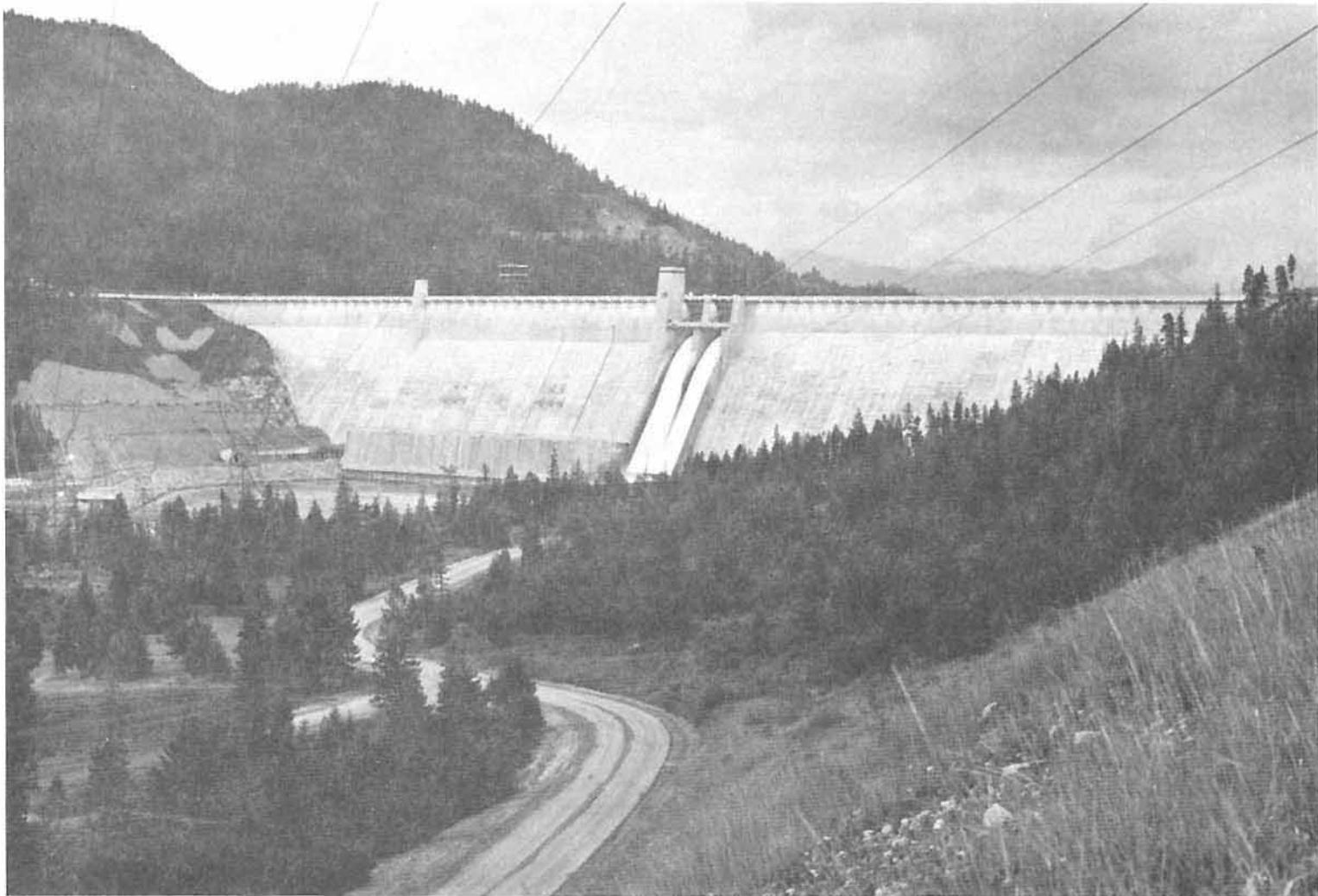
- (g) Differences arising under the Treaty which cannot be resolved by the two countries may be referred by either to the International Joint Commission or to arbitration by an appropriate tribunal as specified by the Treaty.
- (h) The Treaty shall remain in force for at least 60 years from its date of ratification, 16 September 1964.

The Protocol of January 1964 amplified and clarified certain terms of the Columbia River Treaty. The Attachment Relating to Terms of Sale signed on the same date established agreement that under certain terms Canada would sell in the United States its entitlement to downstream power benefits for a 30-year period. The Canadian Entitlement Purchase Agreement of 13 August 1964 provided that the Treaty storages would be operative for power purposes on the following dates:

Duncan storage	1 April 1968
Arrow storage	1 April 1969
Mica storage	1 April 1973

POWERHOUSE and embankment protection at Libby Dam.





9

LIBBY DAM
The powerhouse is at the toe of the concrete dam to the left of the spillway.

Kootenai River, Montana

PERMANENT ENGINEERING BOARD

General

Article XV of the Columbia River Treaty established a Permanent Engineering Board consisting of two members to be appointed by Canada and two members by the United States. Appointments to the Board were to be made within three months of the date of ratification. The duties and responsibilities of the Board were also stipulated in the Treaty and related documents.

Establishment of the Board

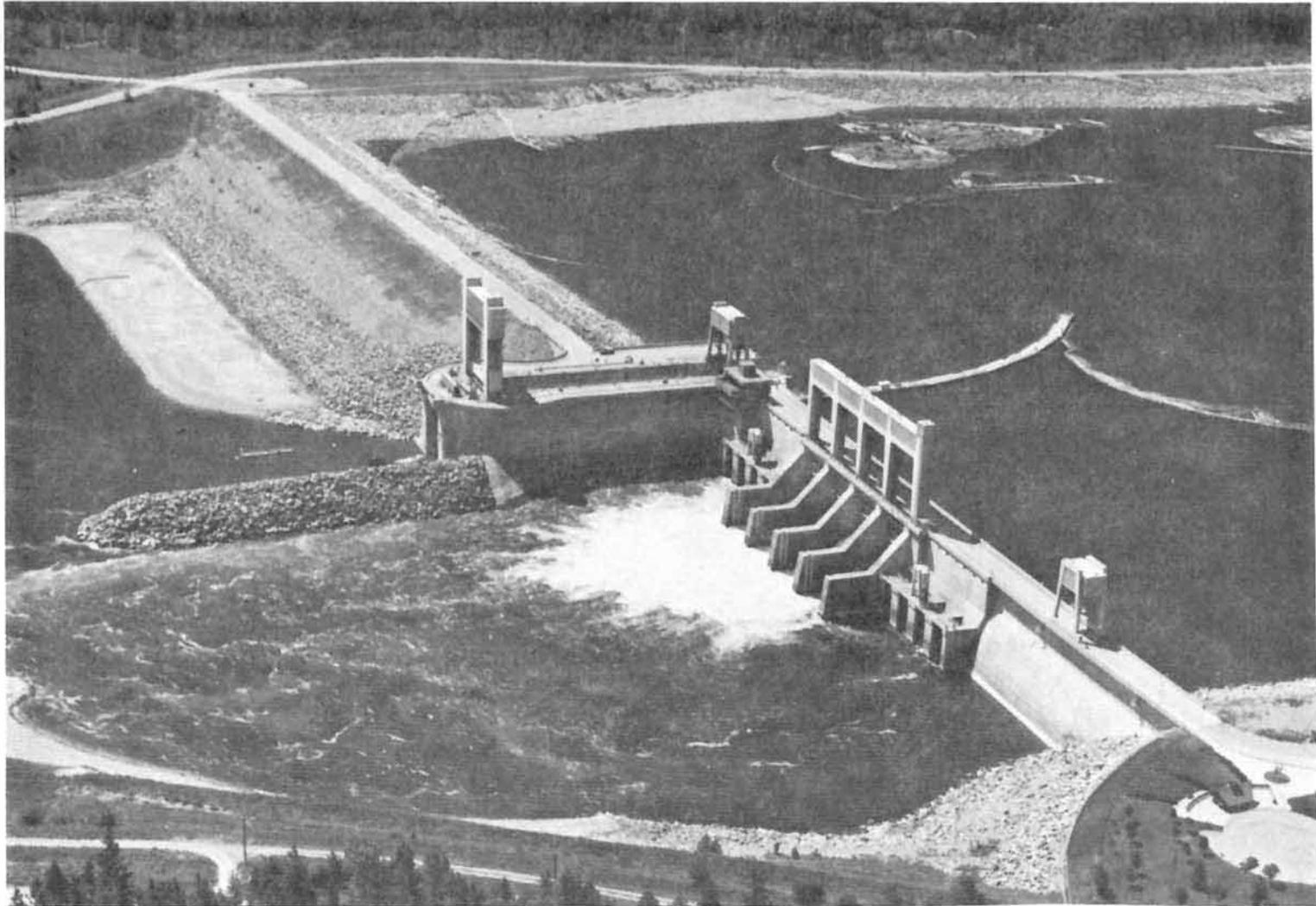
Pursuant to Executive Order No. 11177 dated 16 September 1964 the Secretary of the Army and the Secretary of the Interior on 7 December 1964 appointed two members and two alternate members to form the United States Section of the Permanent Engineering Board. Pursuant to the Department of Energy Organization Act of 4 August 1977 the appointments to the United States Section of the Board are now made by the Secretary of the Army and the Secretary of Energy. The members of the Canadian Section of the Board were appointed by Order in Council P.C. 1964-1671 dated 29 October 1964. Each member was authorized to appoint an alternate member. On 11 December 1964 the two governments announced the composition of the Board.

The names of Board members, alternate members and secretaries are shown in Appendix A.

Duties and Responsibilities of the Board

The general duties and responsibilities of the Board to the governments, as set forth in the Treaty and related documents, include:

- (a) assembling records of the flows of the Columbia River and the Kootenay River at the Canada-United States of America boundary;
- (b) reporting to Canada and the United States of America whenever there is substantial deviation from the hydroelectric and flood control operating plans and if appropriate including in the report recommendations for remedial action and compensatory adjustments;
- (c) assisting in reconciling differences concerning technical or operational matters that may arise between the entities;
- (d) making periodic inspections and requiring reports as necessary from the entities with a view to ensuring that the objectives of the Treaty are being met;
- (e) making reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty and making special reports concerning any matter which it considers should be brought to their attention;
- (f) investigating and reporting with respect to any other matter coming within the scope of the Treaty at the request of either Canada or the United States of America;
- (g) consulting with the entities in the establishment and operation of a hydrometeorological system as required by Annex A of the Treaty.



HUGH KEENLEYSIDE DAM
Concrete spillway and discharge works with navigation lock and earth dam.

Columbia River, British Columbia

ENTITIES

General

Article XIV(1) of the Treaty provides for the designation by Canada and the United States of entities which are empowered and charged with the duty of formulating and executing the operating arrangements necessary to implement the Treaty. Provision is made for either government to designate one or more entities. The powers and duties of the entities are specified in the Treaty and related documents.

Establishment of the Entities

Executive Order No. 11177, previously referred to, designated the Administrator of the Bonneville Power Administration, Department of the Interior, and the Division Engineer, North Pacific Division, Corps of Engineers, Department of the Army, as the United States Entity with the Administrator to serve as Chairman. Pursuant to the Department of Energy Organization Act of 4 August 1977 these appointments are now made by the Secretary of the Army and the Secretary of Energy. Order in Council P.C. 1964-1407 dated 4 September 1964 designated the British Columbia Hydro and Power Authority as the Canadian Entity for the purposes of the Treaty.

The names of the members of the two entities are shown in Appendix B. It is noted that Mr. Peter T. Johnson has succeeded Mr. S. Sterling Munro as Chairman of the United States Entity and that Brigadier General James W. van Loben Sels has succeeded Brigadier General Richard M. Wells as member of the United States Entity.

Powers and Duties of the Entities

In addition to the powers and duties specified elsewhere in the Treaty and related documents the Treaty requires that the entities be responsible for:

- (a) co-ordination of plans and exchange of information relating to facilities to be used in producing and obtaining the benefits contemplated by the Treaty,
- (b) calculation of and arrangements for delivery of hydroelectric power to which Canada is entitled for providing flood control,
- (c) calculation of the amounts payable to the United States of America for standby transmission services,
- (d) consultation on requests for variations made pursuant to Articles XII(5) and XIII(6).
- (e) the establishment and operation of a hydrometeorological system as required by Annex A,
- (f) assisting and co-operating with the Permanent Engineering Board in the discharge of its functions,
- (g) periodic calculation of accounts,
- (h) preparation of the hydroelectric operating plans and the flood control operating plans for the Canadian storage together with determination of the downstream power benefits to which Canada is entitled,
- (i) preparation of proposals to implement Article VIII and carrying out any disposal authorized or exchange provided for therein,

- (j) making appropriate arrangements for delivery to Canada of the downstream power benefits to which Canada is entitled including such matters as load factors for delivery, times and points of delivery, and calculation of transmission loss,
- (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.

Article XIV(4) of the Treaty provides that the two governments may, by an exchange of notes, empower or charge the entities with any other matter coming within the scope of the Treaty.

CONTROL ROOM
for the powerhouse
at Libby Dam.



ACTIVITIES OF THE BOARD

Meetings

The Board met in Vancouver, British Columbia on 24 November 1980 to review progress under the Treaty, and to discuss preparation of the Board's Annual Report. The Board met with the Entities on the same day to discuss Entity studies and general progress.

Reports Received

Throughout the report year the Canadian Entity provided the Board with weekly reports on operation of the Canadian storage reservoirs and with daily flow forecasts during the freshet season for the northern part of the Columbia River basin. The United States Entity provided monthly reports on the operation of the Libby storage reservoir. The Entities also provided copies of computer printouts of studies for the Assured Operating Plan and downstream power benefit calculations, and the following documents and reports:

- Report of Columbia River Treaty Canadian and United States Entities for the period 1 October 1979 to 30 September 1980
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1985-86, plus a copy of the Entities' agreement on this document
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1980 through 31 July 1981, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1985-86, plus a copy of the Entities' agreement on this document

- Arrow Lakes Storage Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration dated 24 June 1981
- Revisions to Assured Operating Plans for Operating Years 1980-81 through 1985-86, 4 December 1980.

Subsequent to the end of this report year the Board received the following documents and reports from the Entities:

- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1981 through 31 July 1982, plus a copy of the Entities' agreement on this document
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1986-87, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1986-87, plus a copy of the Entities' agreement on this document
- Report of Columbia River Treaty Canadian and United States Entities for the period 1 October 1980 to 30 September 1981.

Report to Governments

The sixteenth Annual Report of the Board was submitted to the two governments on 31 December 1980.



DUNCAN DAM
The earth dam with discharge tunnels on the left and spillway on the right.

Duncan River, British Columbia

PROGRESS

General

The results achieved under the terms of the Treaty include construction of the Treaty projects, progress in developing the hydrometeorological network, power and flood control operating plans, and the annual calculation of downstream power benefits. The three Treaty storage projects in British Columbia, the Duncan, Arrow and Mica projects, are now in operation and supply power benefits and flood control benefits in both Canada and the United States. The Libby storage project in Montana is in operation and provides power and flood control benefits in both countries. Completion of the Canal Plant on the Kootenay River in 1976 and installation of generators at Mica Dam during 1976 and 1977 have caused the power benefits in Canada to increase substantially. Completion of the Revelstoke project, now under construction, will result in a further substantial increase in power benefits in Canada. By 1985 some 4,000 megawatts of generation in Canada that would otherwise not have been installed will be benefiting from the operation of Treaty storage. This will be the installed capacity at Mica and Revelstoke on the Columbia River and at the Canal Plant on the Kootenay River. In addition, the installation of generating capacity at Hugh Keenleyside Dam and at the Murphy Creek Site near Trail, British Columbia is now being considered.

The Treaty provides Canada with the option of diverting the Kootenay River into the headwaters of the Columbia River commencing in 1984. British Columbia Hydro and Power Authority is currently studying both the engineering and environmental aspects of the potential diversion at Canal Flats.

The locations of the above projects are shown on Plate 1 in Appendix D.

Status of the Treaty Projects

Duncan Project

Duncan Dam, the smallest Treaty project, was scheduled by the Sales Agreement for operation by 1 April 1968 and was the first of the Treaty projects to be completed. It became fully operational on 31 July 1967, well in advance of Treaty requirements.

The earthfill dam, about 130 feet high, is located on the Duncan River a few miles north of Kootenay Lake. The reservoir behind the dam extends for about 27 miles and provides 1,400,000 acre-feet of usable storage which is all committed under the Treaty. There are no power facilities included in this project which is shown in the picture on page 15.

Characteristics of the project are shown in Table 1 of Appendix D.

Arrow Project

The Hugh Keenleyside Dam, at the outlet of the Arrow Lakes, was the second Treaty project to be completed. It became operational on 10 October 1968 well ahead of the date of 1 April 1969 scheduled by the Sales Agreement. The project has no associated power facilities, however, installation of generators is now being considered.

The dam consists of two main components: a concrete gravity structure which includes the spillway, low-level outlets and navigation lock and an earthfill section which rises 170 feet above the riverbed. The reservoir, about 145 miles long, includes both the Upper and Lower Arrow Lakes, and provides 7,100,000 acre-feet of Treaty storage.

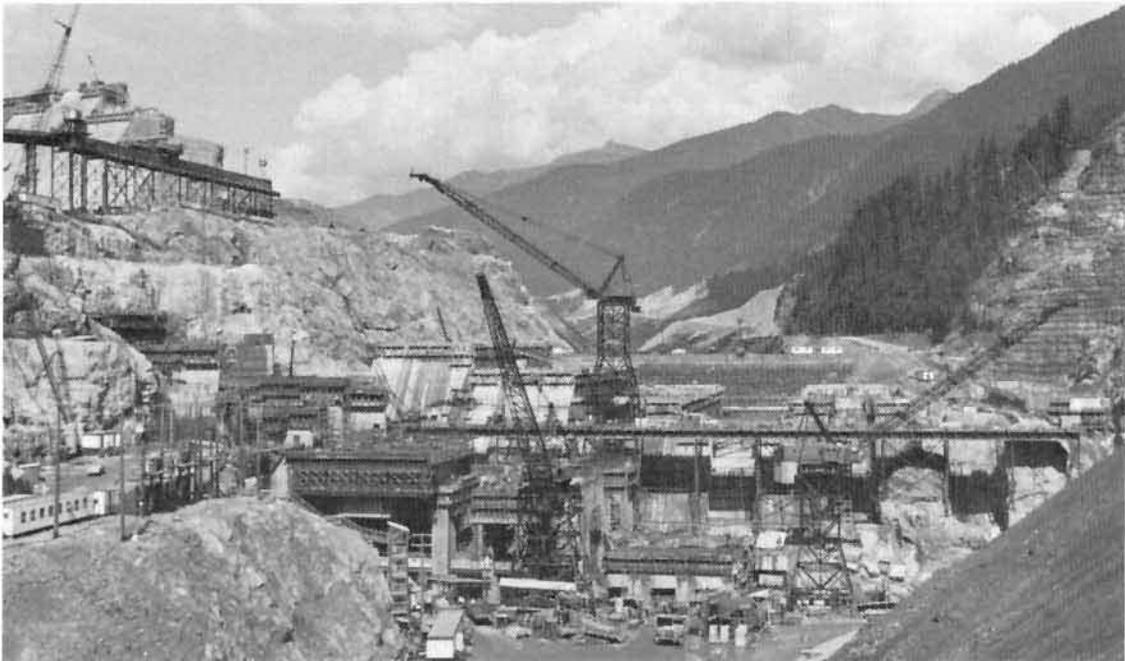
The project is shown in the picture on page 9 and project data are shown in Table 2 of Appendix D.

Mica Project

Mica Dam, the largest of the Treaty projects, was scheduled by the Sales Agreement for initial operation on 1 April 1973. The project was declared operational and commenced storing on 29 March 1973.

Mica Dam is located on the Columbia River about 85 miles north of Revelstoke, British Columbia. The earthfill dam rises more than 800 feet above its foundation and creates a reservoir 135 miles long, Kinbasket Lake, with a storage capacity of 20,000,000 acre-feet. The project utilizes 12,000,000 acre-feet of live storage of which 7,000,000 acre-feet are committed under the Treaty.

The underground powerhouse has space for a total of six 434 megawatt units with a total capacity of 2,604 megawatts. The first two generators were



REVELSTOKE DAM under construction downstream from Mica Dam.

placed in service late in 1976 and the last of the initial four units commenced operation in October 1977.

The project is shown in the picture on page 2 and project data are shown in Table 3 of Appendix D.

Libby Project in the United States

Libby Dam is located on the Kootenai River 17 miles northeast of the town of Libby, Montana. Construction began in the spring of 1966, storage has been fully operational since 17 April 1973, and commercial generation of power began on 24 August 1975, coincident with formal dedication of the project. The concrete gravity dam rises 370 feet above the riverbed and creates Lake Kootenai which is 90 miles long and extends 42 miles into Canada. Lake Kootenai has a gross storage of 5,809,000 acre-feet, of which 4,934,000 acre-feet are usable for flood control and power purposes. The present installed capacity at the Libby powerhouse is 420 megawatts.

LAKE KOOCANUSA
and boat ramp at
McGillivray Campground
in Montana.



Construction of the Libby Additional Units and Reregulating Dam project was initiated in 1978. A contract for the manufacture and installation of the turbines for the four additional units in the main dam was 99% complete by September 1981. The first generator is scheduled for delivery in May 1982. Installation and start-up of the first of these four generating units is expected to be completed by November 1983. There has been no construction activity on the reregulating dam since that project was halted by Court Order late in 1978. Further construction on the reregulating dam must wait legal and legislative resolution of the matter.

The Libby project is shown in the picture on page 6 and project data are shown in Table 4 of Appendix D.

Libby Project in Canada

Canada has fulfilled its obligation to prepare the land required for the 42-mile portion of Lake Koochanusa in Canada. Coordinated by the Province of British Columbia's Ministry of Environment, parks facilities are being enhanced and potential park sites studied for future development; fishery and wildlife studies are being continued. A program of property fencing is underway to maintain control of livestock because of continuing reservoir bank sloughing.

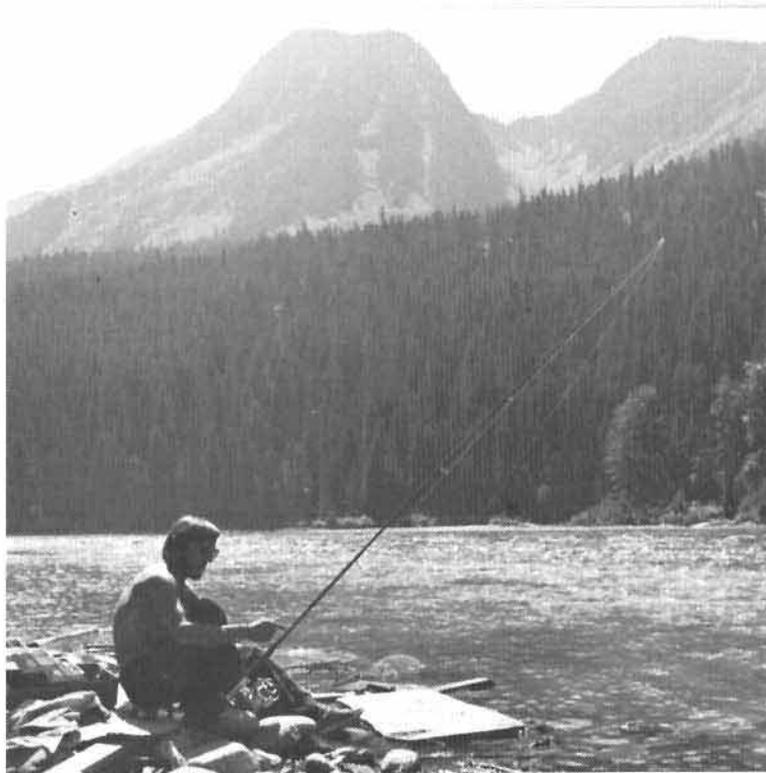
Hydrometeorological Network

One of the responsibilities assigned to the Entities by the Treaty is the establishment and operation, in consultation with the Permanent Engineering Board, of a hydrometeorological system to obtain data for detailed programming of flood control and power operation. This system includes snow courses, meteorological stations and streamflow gauges. The Columbia River Treaty Hydrometeorological Committee, formed by the Entities, makes recommendations on further development of the Treaty Hydrometeorological System.

In developing the hydrometeorological network the Entities, with the concurrence of the Board, adopted a document in 1976 which defines the Columbia River Treaty Hydrometeorological System Network and sets forth a method of classifying facilities into those required as part of the Treaty System and those of value as Supporting Facilities.

During the 1976-77 report year the Entities, with the concurrence of the Board, adopted a plan for exchange of operational hydrometeorological data. That plan is still in force. A revised plan for exchange of operational data and a new listing of Treaty hydrometeorological facilities have been drafted by the Entities. Changes in these documents continue to be required as a result of the increasing use of satellite telemetry for network automation, and the implementation of computerized data exchange and processing facilities. These documents therefore are still in draft form.

SPORT FISHING
on the Columbia River
below Mica Dam.



Progress is being made in automating the collection and processing of hydrometeorological data in the Columbia River system. The "Columbia River Operational Hydromet System", a computer system that has capability for direct input of data from other computer terminals and for the retrieval of data reports, is in operation in Portland, Oregon. A data processing computer being installed at British Columbia Hydro and Power Authority's Burnaby Mountain System Control Centre will facilitate data exchange between the Entities. Telemetry from hydrometeorological stations in the Canadian drainages is gradually being converted from conventional VHF/UHF to satellite telemetry, using the GOES weather satellite system. Data from converted stations will then be relayed to a National Weather Service communication network.

Power Operating Plans

The Treaty and related documents provide that the Entities are to agree annually on operating plans and on the resulting downstream power benefits for the sixth succeeding year of operation. These operating plans, prepared five years in advance, are called Assured Operating Plans. They represent the basic operating commitment of the Canadian Entity, and provide the Entities with a basis for system planning. At the beginning of each operating year, a Detailed Operating Plan is prepared on the basis of current resources and loads to obtain results that may be more advantageous to both countries than those which would be obtained by operating in accordance with the Assured Operating Plan.

As noted in the Board's annual report to 30 September 1980, the Entities, starting with the Assured Operating Plan for 1980-81, had used a 40-year period of streamflow record for their analysis rather than the 30-year period specified by the Protocol to the Treaty. The Entities had taken this action in an effort to keep the Assured Operating Plans as current and realistic

as possible and considered that little difference, if any, resulted from the change of the streamflow record. While the Protocol reference is to streamflow records employed to calculate downstream power benefits, the Board's view is that Canada's commitment to operate under an assured plan is tied directly to the benefits produced by that plan; therefore the streamflow records used must be identical. As a result, studies have been carried out by the Entities which show that for the operating years 1980-81 through 1985-86 the adoption of the longer period of streamflow has no impact on the Canadian Entity's commitment to operate under the Treaty.

The Board has reviewed results of these studies and considers that a detailed recalculation of the existing Assured Operating Plans is not required. However, future development of Assured Operating Plans must revert to the use of the 30-year record of streamflow unless the two governments agree on a change to paragraph 8 of the Protocol to the Treaty. The Entities have reverted to the 30-year period starting with the Assured Operating Plans for 1986-87.

The Assured Operating Plan for operating year 1985-86, received by the Board early in the report year, includes generation at the Mica and Revelstoke projects in Canada and is based on the operation of the system for optimum generation in both countries.

Early in this report year the Entities provided the Board with a Detailed Operating Plan for Canadian storage for the operating year ending 31 July 1981. A Detailed Operating Plan for the operating year ending 31 July 1982 was forwarded to the Board after the end of the report year. These plans contain criteria for operating the Arrow, Duncan, Mica and Libby reservoirs.

As noted in the Board's Annual Report to 30 September 1980, references to the use of different periods of streamflow for developing operating plans and for calculating downstream power benefits in the Entities' document "Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans", 1 May 1979, should be modified.

Annual Calculation of Downstream Benefits

The general requirements for determination of assured operating plans and downstream power benefits are summarized in the first paragraph of the preceding section.

In this report year the Entities provided the Board with a copy of their agreed document outlining downstream power benefits resulting from Canadian storage for the operating year 1985-86. The Board has completed its review of this document and concludes that it meets the requirements of the Treaty. Copies of the three computer studies used in the final calculations for the determination of downstream benefits, and which also provide the basis of the hydroelectric operating plan, were forwarded to the Board by the Entities. A report on determination of downstream power benefits for the operating year 1986-87 was received from the Entities after the end of the report year.

Flood Control Operating Plans

The Treaty provides that Canadian storage reservoirs will be operated by the Canadian Entity in accordance with operating plans designed to minimize flood damage in the United States and Canada.

The "Columbia River Treaty Flood Control Operating Plan" defines flood control operation of the Duncan, Arrow, Mica and Libby reservoirs. This plan was received from the Entities and reviewed by the Board in the 1972-73 report year.

Flow Records

Article XV(2)(a) of the Treaty specified that the Permanent Engineering Board shall assemble records of flows of the Columbia and Kootenay Rivers at the Canada-United States of America boundary. Actual recorded flows for the Kootenai River at Porthill, Idaho, and for the Columbia River at Birchbank, British Columbia, Plate 1, are tabulated in Appendix C for this report year.

KINBASKET LAKE
and Mica Dam
in British Columbia.



OPERATION

General

The Columbia River Treaty Operating Committee was established by the Entities to develop operating plans for the Treaty storages and to direct operation of these storages in accordance with the terms of the Entity agreements.

During the report year the Treaty storage in Canada was operated by the Canadian Entity in accordance with:

- Columbia River Treaty Flood Control Operating Plan
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1980 through 31 July 1981
- Detailed Operating Plan for Columbia River Treaty Storage 1 August 1981 through 31 July 1982
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1980-81
- Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1981-82.

In addition, two special agreements were in effect during this period:

- Arrow Lakes Storage Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration dated 24 June 1981

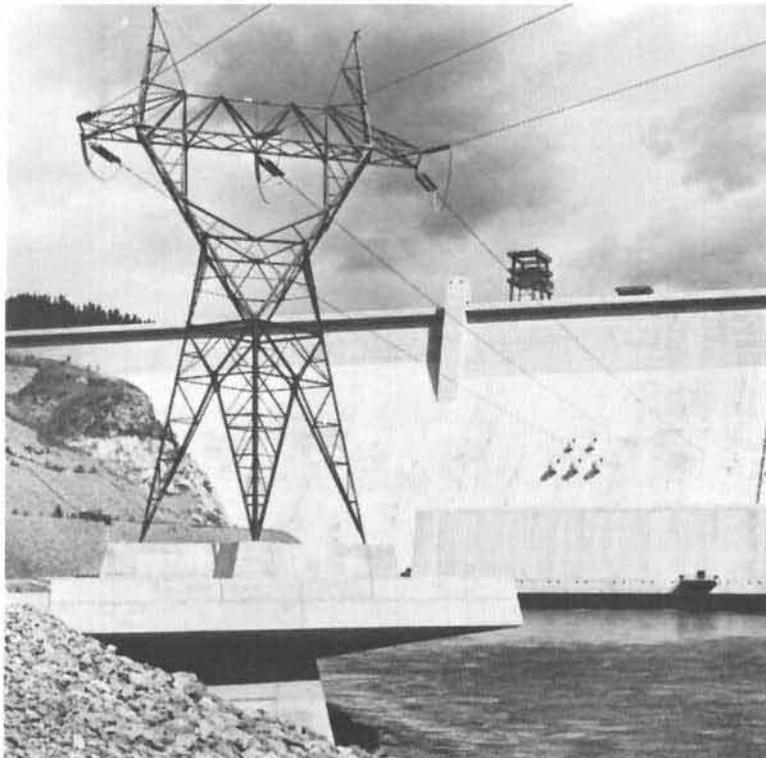
- Mica Storage Arrangement between British Columbia Hydro and Power Authority and Bonneville Power Administration, plus a copy of the Entities' Agreement to Enhance Filling of Mica Reservoir dated 3 July 1980.

Power Operation

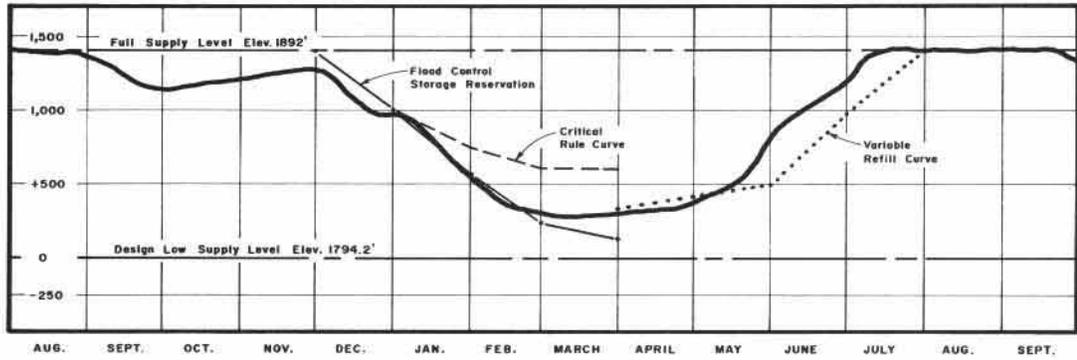
The three Canadian Treaty reservoirs, Duncan, Arrow and Mica, and the Libby reservoir in the United States were in full operation throughout this report year.

Although most reservoirs in the Columbia River System filled during the 1980 freshet, below average streamflows after the freshet period contributed to a storage energy deficit of 1.4 billion kilowatt hours by 30 September 1980. By the end of November 1980 above average precipitation had resulted in the elimination of this deficit.

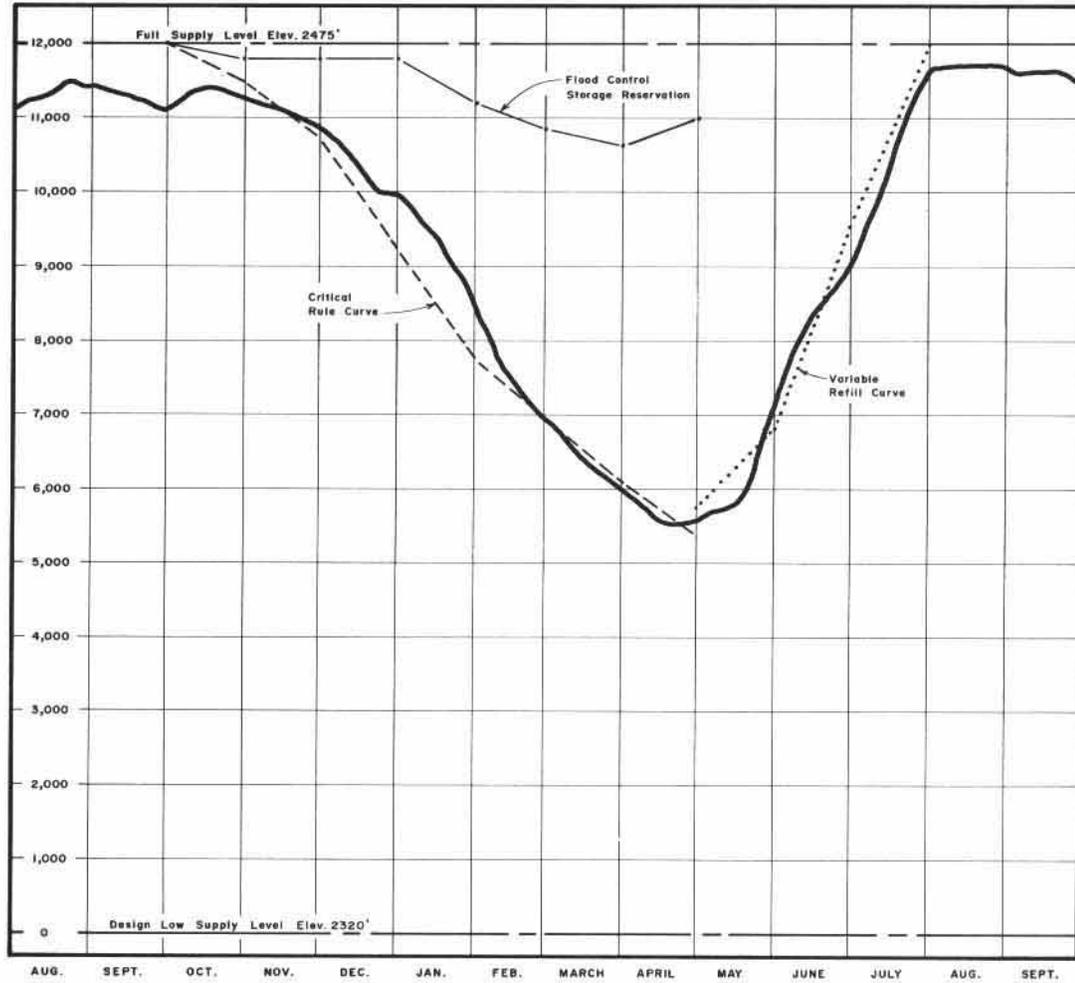
TRANSMISSION TOWER
near the powerhouse
at Libby Dam.



FEET
ACRE
STORAGE IN 1,000

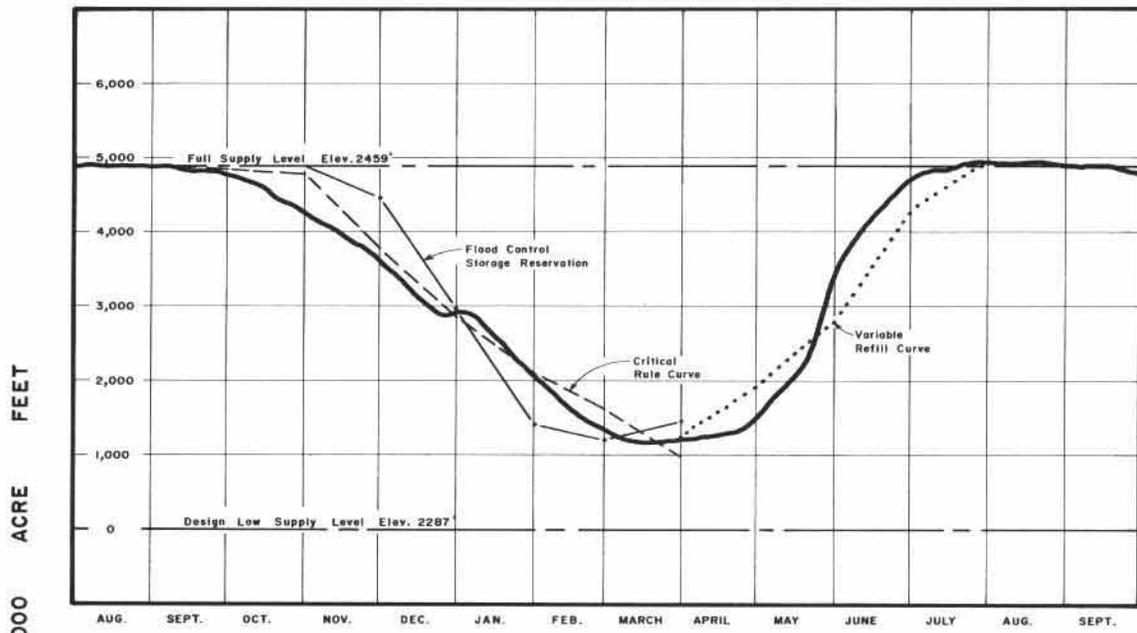


DUNCAN RESERVOIR

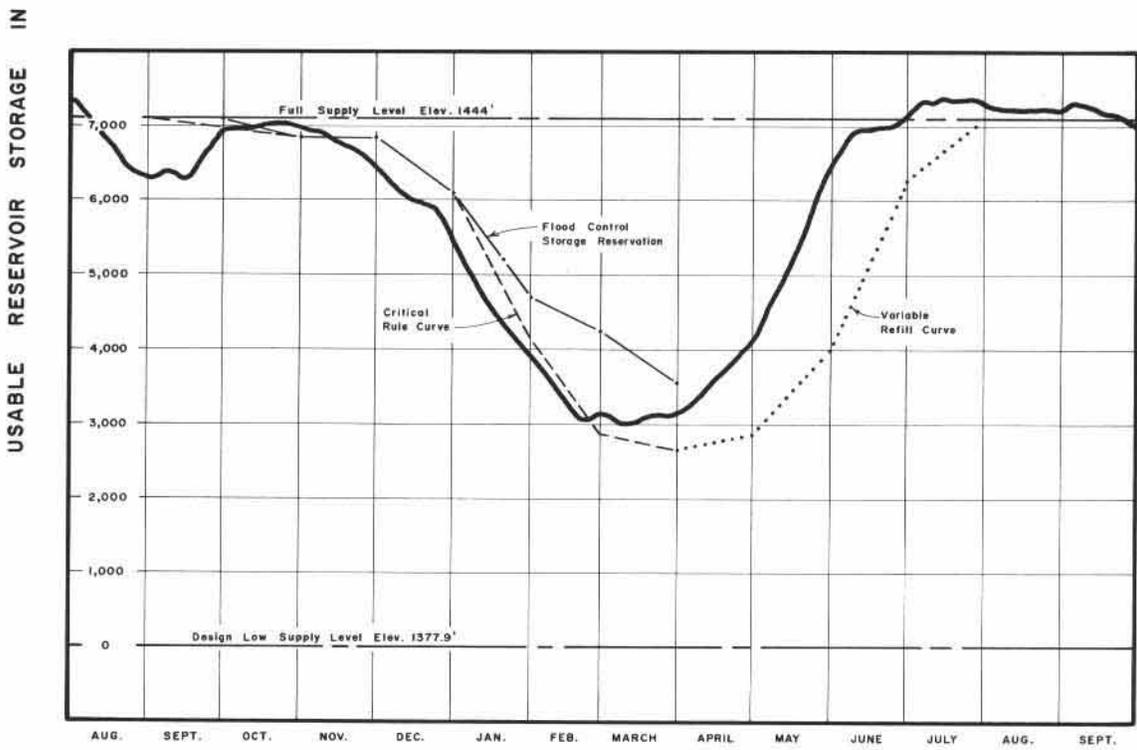


MICA RESERVOIR

HYDROGRAPHS – Duncan and Mica reservoir levels for the 14-month period ending 30 September 1981.



LIBBY RESERVOIR



ARROW RESERVOIR

HYDROGRAPHS – Libby and Arrow reservoir levels for the 14-month period ending 30 September 1981.

Warm, dry weather during the winter maintained high rates of inflow and created power surpluses. It also depleted the snowpack. However, above average precipitation during May, June and July resulted in a runoff volume 20 percent higher than the forecasts. All major reservoirs in the system filled by 31 July and some spill occurred. By the end of this report year flows were receding and Coordinated System reservoirs were 0.3 billion kilowatt hours below rule curve levels.

As noted, the 1981 freshet, although less than average, exceeded the volume forecast. This permitted the use of extra storage in the Arrow Lakes reservoir under a special agreement. The Agreement to Enhance Mica Filling terminated 30 April 1981 and therefore was not pertinent to this year's operation.

Operation of the reservoirs is illustrated on pages 28 and 29 by hydrographs which show actual reservoir levels and some of the more important rule curves which govern operation of the Treaty storages. The Flood Control Storage Reservation curve specifies maximum month-end reservoir levels which will permit evacuation of the reservoir to control the forecasted freshet. The Critical Rule Curve shows minimum month-end reservoir levels which should be maintained to enable the anticipated power demands to be met under adverse water supply conditions. The Variable Refill Curve shows reservoir elevations necessary to ensure refilling the reservoir by the end of July with a reasonable degree of confidence. Similar rule curves which apply to operation of the combined Canadian Treaty storages have also been provided to the Board.

At the beginning of the report year the Duncan reservoir was at elevation 1876.2 feet, 16 feet below full pool. Throughout the draft season releases were scheduled in conjunction with Libby discharges to minimize spill at Kootenay River hydroelectric plants. The minimum reservoir elevation for the year was 1819.5 feet on 12 March 1981. In mid-March outflows were reduced to

minimum. On 1 June outflows were increased to 1,000 cfs and the reservoir filled on 14 July. Drafting began on 21 September and at the end of the report year the reservoir elevation was 1886.9 feet.

The Arrow reservoir was at elevation 1442.4 feet, 1.6 feet below full pool, at the beginning of this report year and it remained about the same elevation throughout October. Beginning 1 November the reservoir was drafted to meet Flood Control Rule Curve requirements and on 12 March 1981 the reservoir reached elevation 1409.4 feet, its minimum for the year. Filling began in April and Treaty storage space was filled in early June. The extra two feet of storage authorized by the Arrow Lakes Storage Agreement filled with water surplus to United States' requirements by 10 June. The reservoir reached its peak elevation of 1446.3 feet on 15 July. Storage was drafted slowly in late summer and the reservoir elevation was 1442.8 feet on 30 September. The United States' share, half of the extra storage, was still held in the reservoir at that date.

Treaty storage space in the Mica reservoir was full at the beginning of the report year. The reservoir elevation was 2466.6 feet, about eight feet below normal full pool elevation. From October through December discharges to meet British Columbia Hydro and Power Authority's generating needs and downstream United States' requirements were less than Detailed Operating Plan target releases. Following curtailment of generation at Mica during the last week of December, drafting began again in January and continued until late April. The reservoir reached elevation 2406.1 feet on 22 April 1981, its minimum for the report year.

Mica reservoir began to refill in late April when inflow increased due to snowmelt. Treaty storage space was filled by 29 July when the reservoir elevation reached 2470.4 feet. At this time the reservoir also held some 68,000 acre-feet of storage in a special account.

During the first half of August spilling occurred as a result of high inflows. The peak elevation, 2472.4 feet, occurred 28 August. Treaty storage space remained full through the summer, and on 30 September the Mica reservoir was at elevation 2469.6 feet.

At the beginning of this report year Libby reservoir was at elevation 2456.0 feet, three feet below normal full pool elevation. High discharges were needed to meet power requirements up to the end of December and drafting continued until the reservoir reached its lowest elevation for the year, 2349.7 feet on 14 March 1981. The reservoir filled rapidly and some spilling was required in July to adhere to the flood control rule curve. On 27 July the reservoir reached full pool elevation. It remained near that level until mid-September and at year end was at elevation 2455.9 feet.

SPAWNING CHANNEL
for Kokanee and
Rainbow trout serves
Arrow reservoir.



Flood Control Operation

Flood control during the 1981 spring runoff was provided by a faster than normal refill operation of the Treaty projects and other storage reservoirs in the Columbia Basin. Peak flows, resulting from snowmelt and above normal rainfall, occurred in June. Operation for flood control during the 1981 freshet was in accordance with the Entities' document "Columbia River Treaty Flood Control Operating Plan" and the freshet was controlled to well below damaging levels.

BOAT RAMP
at Peck Gulch,
Lake Kocanusa.



BENEFITS

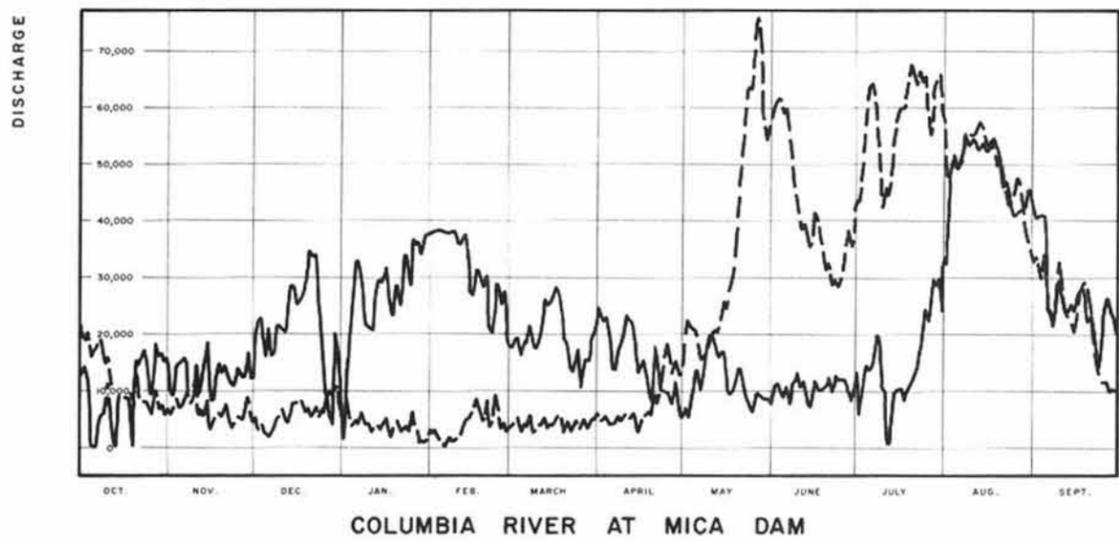
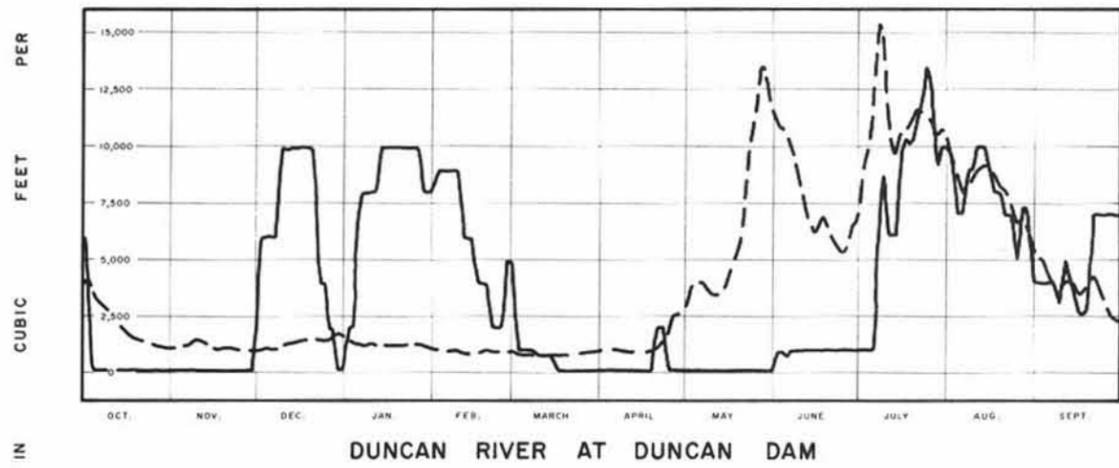
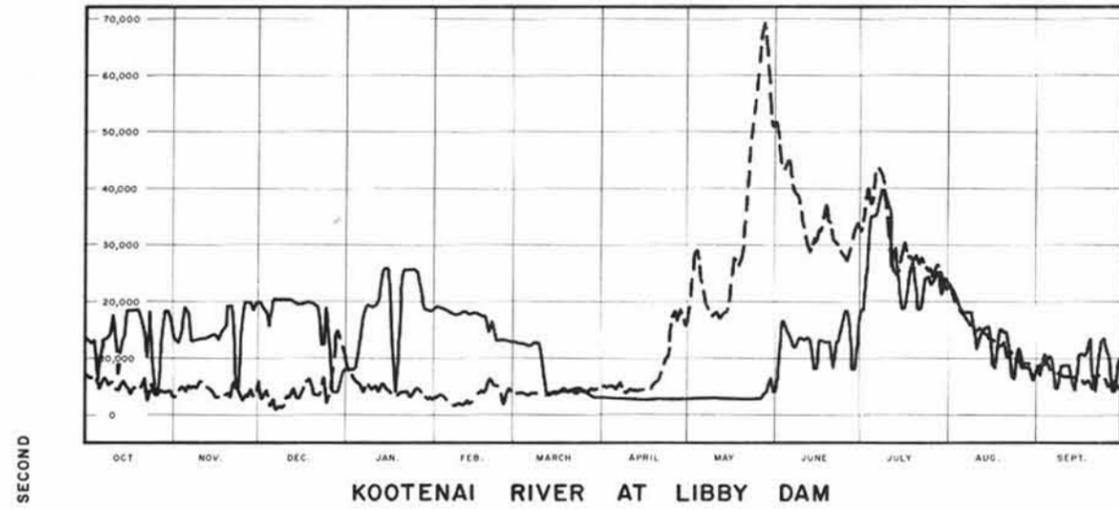
Flood Control Provided

Without regulation by upstream reservoirs the 1981 freshet would have produced a less than average peak discharge at The Dalles, Oregon, and would have caused little flood damage. In Canada, even without the four storage projects constructed as a result of the Treaty, the peak discharge of the Columbia River at Trail would not have reached damaging levels.

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about five feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by about seven feet. The effect of storage in the Duncan, Arrow, Mica and Libby reservoirs on flows at the sites and on flows of the Columbia River at Birchbank is illustrated on page 35 by hydrographs which show both the actual discharges and the flows that would have occurred if the dams had not been built. It is noted that the hydrograph showing pre-project conditions for Birchbank has been computed on the assumption that the effects of Duncan, Arrow, Mica and Libby regulation and of the regulation provided by the Corra Linn development on Kootenay Lake have been removed.

The operation of Columbia Basin reservoirs for the system as a whole reduced the natural annual peak discharge of the Columbia River near The Dalles, Oregon from about 579,000 cfs to 436,000 cfs. Regulation by the Treaty storage projects during the 1981 freshet period contributed only minor flood control benefits in Canada and the United States.

All payments required by Article VI(1) as compensation for flood control provided by the Canadian Treaty storage projects have been made by the United States to Canada; the final payment was made on 29 March 1973 when the Mica project was declared operational.



LEGEND
 ———— Observed Flows
 - - - - - Pre-Project Flows

HYDROGRAPHS - Observed and pre-project flows for year ending 30 September 1981.

Power Benefits

Downstream power benefits in the United States which arise from operation of the Canadian Treaty Storage were pre-determined and the Canadian one-half share was sold in the United States under the terms of the Canadian Entitlement Purchase Agreement. The United States Entity delivered capacity and energy to Columbia Storage Power Exchange participants as purchasers of the Canadian Entitlement. No additional downstream power benefits were realized during the year from the operation of Treaty storage other than the added generation made possible on the Kootenay River in Canada and additional generation in the United States system resulting from regulation provided by Libby. The Kootenay River benefits in Canada, under Article XII of the Treaty, and generation at the Mica project are retained wholly within Canada while the benefits from Libby in the United States are not shareable under the Treaty.

Some additional power benefits were realized in 1981 through the use of non-Treaty storage under the Arrow Lakes Storage Agreement. These were shared by British Columbia Hydro and Power Authority and Bonneville Power Administration. These operations were outside the Treaty and did not conflict with Treaty operations. The effects benefited both countries.

Other Benefits

Streamflows have been regulated for non-power purposes such as accommodating construction in river channels and providing water to assist the downstream migration of juvenile fish in the United States. These arrangements are supplemental to Treaty operating plans and have not created conflicts with operations under those plans.

CONCLUSIONS

1. The Duncan, Arrow, Mica and Libby projects have been operated in conformity with the provisions of the Treaty, the detailed operating plans developed by the Entities, and the flood control operating plan for Treaty reservoirs. Special operating arrangements have accommodated other interests without harming system operation and were consistent with the intent of the Treaty.
2. Entity evaluations pertaining to development of the hydrometeorological network, power operating plans, and the annual calculation of downstream power benefits are proceeding satisfactorily.
3. Regulation by the Treaty storage projects during the 1981 freshet period contributed only minor flood control benefits in Canada and the United States because of below average runoff conditions.
4. The use of a 40-year period of streamflow record for development of Assured Operating Plans for 1980-81 through 1985-86 has not affected operating commitments. The 30-year streamflow record specified by the Protocol to the Treaty is being used in subsequent calculations.
5. The objectives of the Treaty are being met.

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

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Chief, Engineering Division,
Civil Works Directorate,
Office, Chief of Engineers,
U.S. Army,
Washington, D.C.

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Office of Power Marketing
Coordination,
Department of Energy,
Washington, D.C.

Mr. Alex Shwaiko
Chief, Office of Policy,
Civil Works Directorate,
Office, Chief of Engineers,
U.S. Army,
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Mr. Thomas L. Weaver
Assistant Administrator,
Power Management and Operation
and Maintenance,
Western Area Power Administration,
Department of Energy,
Golden, Colorado

Mr. S.A. Zanganeh
Hydrologic Engineering Section,
Engineering Division,
Civil Works Directorate,
Office, Chief of Engineers,
U.S. Army,
Washington, D.C.

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President,
Natural Sciences & Engineering
Research Council Canada,
Ottawa, Ontario

Mr. B.E. Marr
Deputy Minister,
Ministry of Environment,
Victoria, B.C.

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Pacific and Yukon Region,
Inland Waters Directorate,
Department of the Environment,
Vancouver, B.C.

Mr. H.M. Hunt
Head, Power and Special
Projects Section,
Ministry of Environment,
Victoria, B.C.

Secretaries

Mr. E.M. Clark
Regional Director,
Pacific and Yukon Region,
Inland Waters Directorate,
Department of the Environment,
Vancouver, B.C.

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United States

Canada

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Mr. John W. Neuberger	1970-1973	Mr. V. Raudsepp	1973-1974
Mr. Joseph B. Caldwell 1)	1971-1973	Mr. B.E. Marr	1974-
Mr. Homer B. Willis 1)	1973-1979		
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Mr. Raymond A. Peck, Jr.	1976-1977		
Mr. J. Emerson Harper	1978-		
Mr. Lloyd A. Duscha 1)	1979-		

Alternates

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Mr. J. Emerson Harper	1964-1978	Mr. J.T. Rothwell	1964-1965
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Mr. Thomas L. Weaver	1979-		

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Mr. John W. Roche	1965-1969	Mr. E.M. Clark	1964-
Mr. Verle Farrow	1969-1972		
Mr. Walter W. Duncan	1972-1978		
Mr. S.A. Zanganah	1978-		

1) Chairman

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Administrator, Bonneville
Power Administration,
Department of Energy,
Portland, Oregon

Brigadier General James W. van Loben Sels 2)

Division Engineer,
North Pacific Division,
Corps of Engineers,
U.S. Army,
Portland, Oregon

Canada

Mr. R.W. Bonner, Chairman

Chairman, British Columbia
Hydro and Power Authority,
Vancouver, B.C.

1) Vice Mr. S. Sterling Munro as of 11 August 1981.

2) Vice Brigadier General Richard M. Wells as of 11 August 1981.

RECORD OF FLOWS
AT THE
INTERNATIONAL BOUNDARY

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	35,700	47,000	74,500	97,900	105,000	58,400	44,000	49,100	123,000	116,000	145,000	65,400
2	36,400	47,000	81,200	96,400	108,000	66,100	43,900	52,000	121,000	116,000	148,000	62,800
3	43,400	47,000	81,600	95,200	110,000	69,600	43,800	47,600	121,000	115,000	152,000	69,800
4	48,700	47,300	82,300	94,600	109,000	69,200	43,700	42,600	123,000	116,000	147,000	69,200
5	44,800	47,000	85,800	96,000	103,000	68,400	37,700	42,700	123,000	126,000	140,000	67,700
6	41,700	47,700	86,200	98,100	111,000	67,300	29,800	42,500	124,000	146,000	137,000	67,400
7	39,600	49,800	85,800	98,900	109,000	65,300	29,700	41,500	123,000	169,000	138,000	67,300
8	39,200	52,600	84,800	102,000	109,000	61,500	29,700	41,700	120,000	164,000	143,000	67,300
9	36,700	53,300	83,300	106,000	109,000	55,900	29,700	42,000	118,000	151,000	141,000	67,600
10	36,000	56,900	84,000	108,000	104,000	56,400	29,000	44,600	118,000	137,000	141,000	71,200
11	36,000	62,900	83,700	104,000	110,000	56,000	28,800	55,200	118,000	120,000	138,000	72,700
12	32,600	63,600	82,300	101,000	105,000	52,500	25,900	55,300	119,000	112,000	137,000	70,000
13	29,600	56,500	83,300	102,000	109,000	47,700	23,100	55,300	115,000	106,000	135,000	63,700
14	28,700	47,700	84,000	101,000	110,000	47,700	23,600	55,300	115,000	129,000	131,000	62,200
15	28,900	47,300	83,000	101,000	101,000	45,700	21,600	57,800	115,000	144,000	125,000	64,900
16	28,800	47,700	78,800	101,000	94,000	41,400	22,000	59,100	116,000	146,000	126,000	64,800
17	28,600	50,500	79,800	101,000	91,100	38,600	19,700	66,900	116,000	145,000	124,000	64,800
18	28,500	51,200	79,500	101,000	95,900	38,400	19,600	76,600	116,000	141,000	126,000	65,200
19	37,100	51,600	77,000	99,700	94,900	39,800	23,300	77,900	115,000	134,000	125,000	65,700
20	48,000	53,300	74,900	99,000	94,900	42,200	29,200	80,200	116,000	133,000	117,000	62,600
21	50,100	54,000	77,700	99,300	89,300	41,900	30,400	82,700	116,000	131,000	114,000	60,000
22	50,500	56,900	75,600	99,400	75,200	43,300	33,600	89,600	115,000	132,000	110,000	60,300
23	49,400	59,700	75,200	100,000	64,200	45,300	33,300	90,200	115,000	128,000	108,000	60,400
24	46,300	63,200	80,500	101,000	60,300	45,200	35,700	95,400	114,000	125,000	109,000	60,100
25	51,200	59,300	81,900	102,000	60,700	45,400	36,300	103,000	111,000	131,000	106,000	57,800
26	43,800	59,000	83,000	105,000	56,000	45,900	38,500	106,000	112,000	130,000	101,000	55,300
27	41,700	62,500	86,200	106,000	55,700	46,400	42,800	104,000	113,000	126,000	107,000	61,900
28	41,300	63,200	101,000	105,000	54,900	46,700	42,300	105,000	113,000	140,000	107,000	69,300
29	41,300	63,900	109,000	101,000		46,000	43,500	113,000	111,000	151,000	101,000	69,400
30	41,300	68,500	109,000	106,000		44,500	44,400	116,000	111,000	155,000	99,100	69,500
31	42,700		105,000	104,000		44,000		121,000		158,000	84,100	
Mean	39,600	54,700	84,400	101,000	92,800	51,100	32,600	71,300	117,000	135,000	125,000	65,200

COLUMBIA RIVER AT BIRCHBANK, B.C. – Daily discharges for the year ending 30 September 1981 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	13,400	15,100	22,600	18,100	22,600	18,100	7,020	28,000	18,600	27,000	25,000	9,800
2	14,000	14,500	22,400	16,700	22,400	17,800	7,100	29,600	23,800	26,700	24,900	10,200
3	14,000	14,300	21,200	15,800	22,100	17,500	6,960	25,700	27,400	34,100	23,800	10,300
4	14,200	18,700	21,400	15,100	21,900	17,200	6,850	21,600	27,200	38,900	21,600	10,100
5	13,600	20,800	20,400	17,300	21,800	17,200	6,690	18,400	25,700	39,700	21,100	10,800
6	6,560	17,200	23,600	21,100	21,600	17,200	6,690	16,400	25,500	39,400	20,900	11,100
7	13,500	15,600	23,400	24,300	21,400	17,100	6,740	15,000	24,600	42,800	20,600	6,490
8	14,200	17,200	23,100	25,200	21,400	17,100	6,610	14,100	24,200	44,500	20,600	6,670
9	14,300	17,900	23,000	24,900	21,500	17,000	6,580	13,500	25,400	44,400	20,300	9,470
10	17,300	20,200	23,300	24,700	21,000	16,600	6,590	14,000	26,100	42,000	11,800	9,700
11	15,600	15,000	23,400	24,800	20,600	10,300	6,390	15,400	26,300	38,200	15,700	9,770
12	13,600	16,400	23,100	24,900	21,100	7,790	6,220	16,000	26,000	31,800	16,500	9,750
13	8,670	19,400	22,800	27,800	21,300	7,420	6,340	15,300	25,700	33,600	17,100	6,680
14	13,400	14,300	22,700	29,400	21,700	7,410	6,160	15,000	25,900	25,900	17,300	5,670
15	17,700	16,400	22,600	29,500	22,200	7,500	6,070	18,300	25,900	23,700	17,300	11,200
16	19,400	16,200	22,800	28,200	22,800	7,600	6,140	22,800	27,900	23,100	10,900	11,500
17	19,600	15,700	22,900	12,300	23,600	7,820	6,450	22,900	28,100	26,700	10,700	11,300
18	19,700	16,800	22,600	7,980	24,000	7,850	6,820	21,400	28,400	30,300	16,500	11,900
19	19,800	20,000	22,500	15,900	24,100	7,690	7,350	21,600	28,400	29,000	16,500	14,100
20	19,300	21,700	22,200	26,400	24,500	7,650	7,830	22,500	28,100	24,000	16,300	7,300
21	16,400	22,100	22,400	28,600	23,900	7,650	8,740	23,900	26,400	22,400	16,400	5,530
22	14,800	18,600	22,300	29,000	21,000	7,420	9,810	25,300	29,200	22,500	13,800	11,100
23	15,600	8,330	12,800	29,000	19,800	7,530	11,500	25,000	29,600	28,700	9,130	14,100
24	18,500	7,670	20,500	29,400	19,200	7,480	16,900	24,300	33,400	26,700	8,320	14,800
25	7,990	19,500	23,700	29,400	19,300	7,500	21,500	24,400	33,000	26,300	12,900	11,900
26	5,910	21,600	18,900	29,200	19,100	7,720	19,900	26,000	31,600	26,700	11,700	10,600
27	6,040	22,200	32,600	24,900	18,800	7,740	17,800	24,700	26,000	27,800	10,100	5,840
28	17,300	21,700	30,800	23,400	18,300	7,400	17,000	22,900	20,100	28,200	10,200	5,690
29	19,800	21,100	23,100	22,700		6,810	20,100	21,400	19,400	27,800	10,200	10,200
30	19,200	22,400	20,200	22,800		6,860	23,400	21,900	26,100	26,200	7,640	11,200
31	16,700		19,400	22,700		7,030		19,300		25,000	8,430	
Mean	14,800	17,600	22,500	23,300	21,500	10,700	10,000	20,900	26,500	30,800	15,600	9,820

PROJECT INFORMATION

Power and Storage Projects,
Northern Columbia Basin

Plate No. 1

Project Characteristic Data

Duncan Project

Table No. 1

Arrow Project

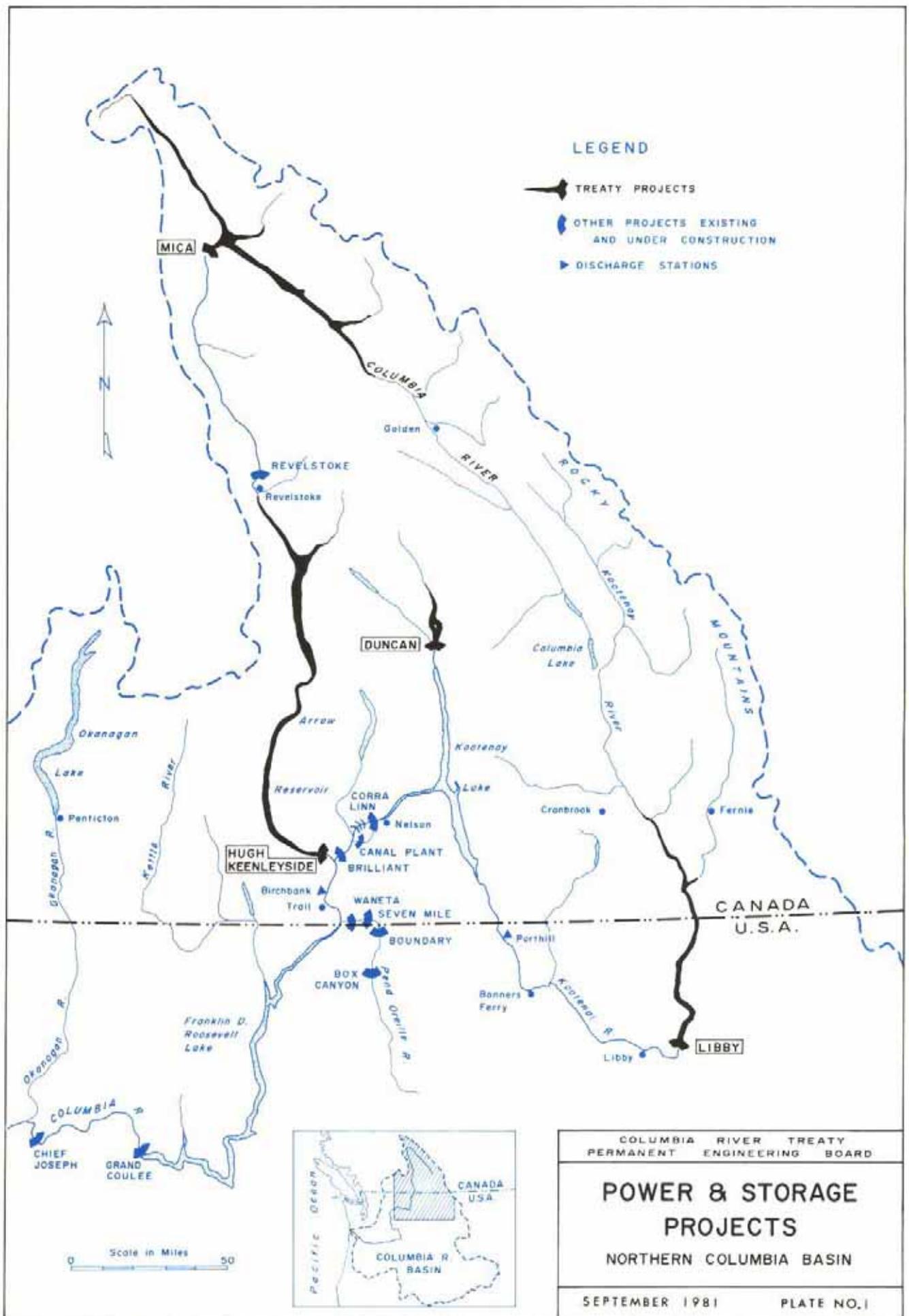
Table No. 2

Mica Project

Table No. 3

Libby Project

Table No. 4



COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

POWER & STORAGE PROJECTS

NORTHERN COLUMBIA BASIN

SEPTEMBER 1981 PLATE NO. 1

TABLE 1

DUNCAN PROJECT

Duncan Dam and Duncan Lake

Storage Project

Construction began	17 September 1964
Storage became fully operational	31 July 1967

Reservoir

Normal Full Pool Elevation	1,892 feet
Normal Minimum Pool Elevation	1,794.2 feet
Surface Area at Full Pool	18,000 acres
Total Storage Capacity	1,432,500 ac-ft
Usable Storage Capacity	1,400,000 ac-ft
Treaty Storage Commitment	1,400,000 ac-ft

Dam, Earthfill

Crest Elevation	1,907 feet
Length	2,600 feet
Approximate height above riverbed	130 feet
Spillway – Maximum Capacity	47,700 cfs
Discharge Tunnels – Maximum Capacity	20,000 cfs

Power Facilities

None

TABLE 2

ARROW PROJECT

Hugh Keenleyside Dam and Arrow Lakes

Storage Project

Construction began	March 1965
Storage became fully operational	10 October 1968

Reservoir

Normal Full Pool Elevation	1,444 feet
Normal Minimum Pool Elevation	1,377.9 feet
Surface Area at Full Pool	130,000 acres
Total Storage Capacity	8,337,000 ac-ft
Usable Storage Capacity	7,100,000 ac-ft
Treaty Storage Commitment	7,100,000 ac-ft

Dam, Concrete Gravity and Earthfill

Crest Elevation	1,459 feet
Length	2,850 feet
Approximate height above riverbed	170 feet
Spillway – Maximum Capacity	240,000 cfs
Low Level Outlets – Maximum Capacity	132,000 cfs

Power Facilities

None

TABLE 3

MICA PROJECT

Mica Dam and Kinbasket Lake

Storage	
Construction began	September 1965
Storage became fully operational	29 March 1973
Reservoir	
Normal Full Pool Elevation	2,475 feet
Normal Minimum Pool Elevation	2,320 feet
Surface Area at Full Pool	106,000 acres
Total Storage Capacity	20,000,000 ac-ft
Usable Storage Capacity	
Total	12,000,000 ac-ft
Commitment to Treaty	7,000,000 ac-ft
Dam, Earthfill	
Crest Elevation	2,500 feet
Length	2,600 feet
Approximate height above foundation	800 feet
Spillway – Maximum Capacity	150,000 cfs
Outlet Works – Maximum Capacity	37,400 cfs
Power Facilities	
Designed ultimate installation	
6 units at 434 mw	2,604 mw
Power commercially available	December 1976
Presently installed	
4 units at 434 mw	1,736 mw
Head at full pool	600 feet
Maximum Turbine Discharge	
of 4 units at full pool	38,140 cfs

TABLE 4

LIBBY PROJECT

Libby Dam and Lake Koocanusa

Storage Project	1966
Construction began	
Storage became fully operational	17 April 1973
Reservoir	
Normal Full Pool Elevation	2,459 feet
Normal Minimum Pool Elevation	2,287 feet
Surface Area at Full Pool	46,500 acres
Total Storage Capacity	5,809,000 ac-ft
Usable Storage Capacity	4,934,000 ac-ft
Dam, Concrete Gravity	
Deck Elevation	2,472 feet
Length	3,055 feet
Approximate height above riverbed	370 feet
Spillway – Maximum Capacity	145,000 cfs
Low Level Outlets – Maximum Capacity	61,000 cfs
Power Facilities	
Designed ultimate installation	
8 units at 105 mw	840 mw
Power commercially available	24 August 1975
Presently installed	
4 units at 105 mw	420 mw
Head at full pool	352 feet
Maximum Turbine Discharge of 4 units at full pool	19,625 cfs