

ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
Washington, D.C. Ottawa, Ontario
30 SEPTEMBER 1973



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
V. RAUDSEPP, Member

UNITED STATES SECTION

H.B. WILLIS, Chairman
C.K. MALLORY, Member

31 December 1973

The Honorable Henry Kissinger
The Secretary of State
Washington, D.C.

The Honourable D.S. Macdonald
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 ninth Annual Report, dated 30 September 1973, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1972 to 30 September 1973.

Respectfully submitted:

For the United States

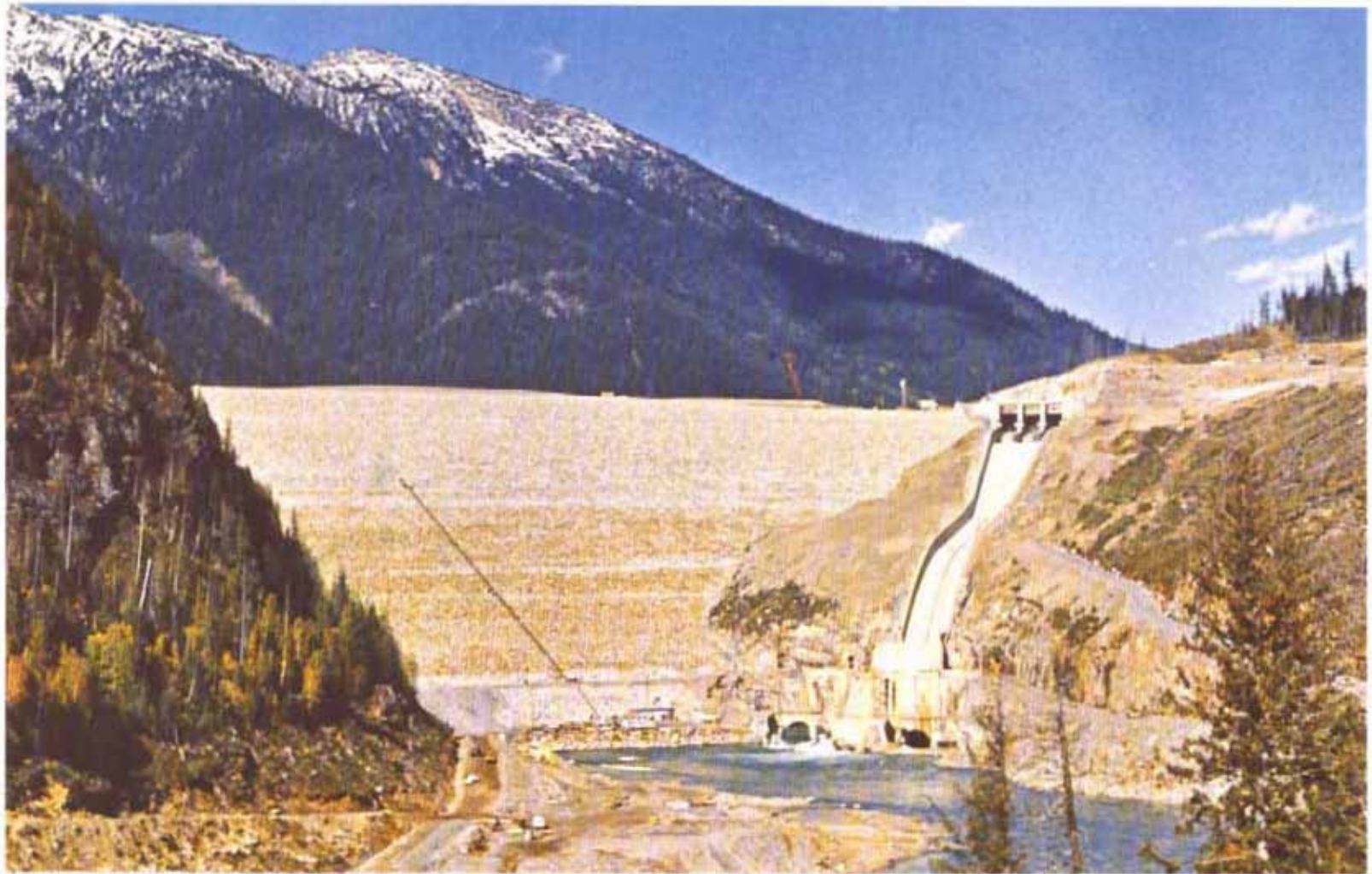
Homer B. Willis, Chairman

For Canada

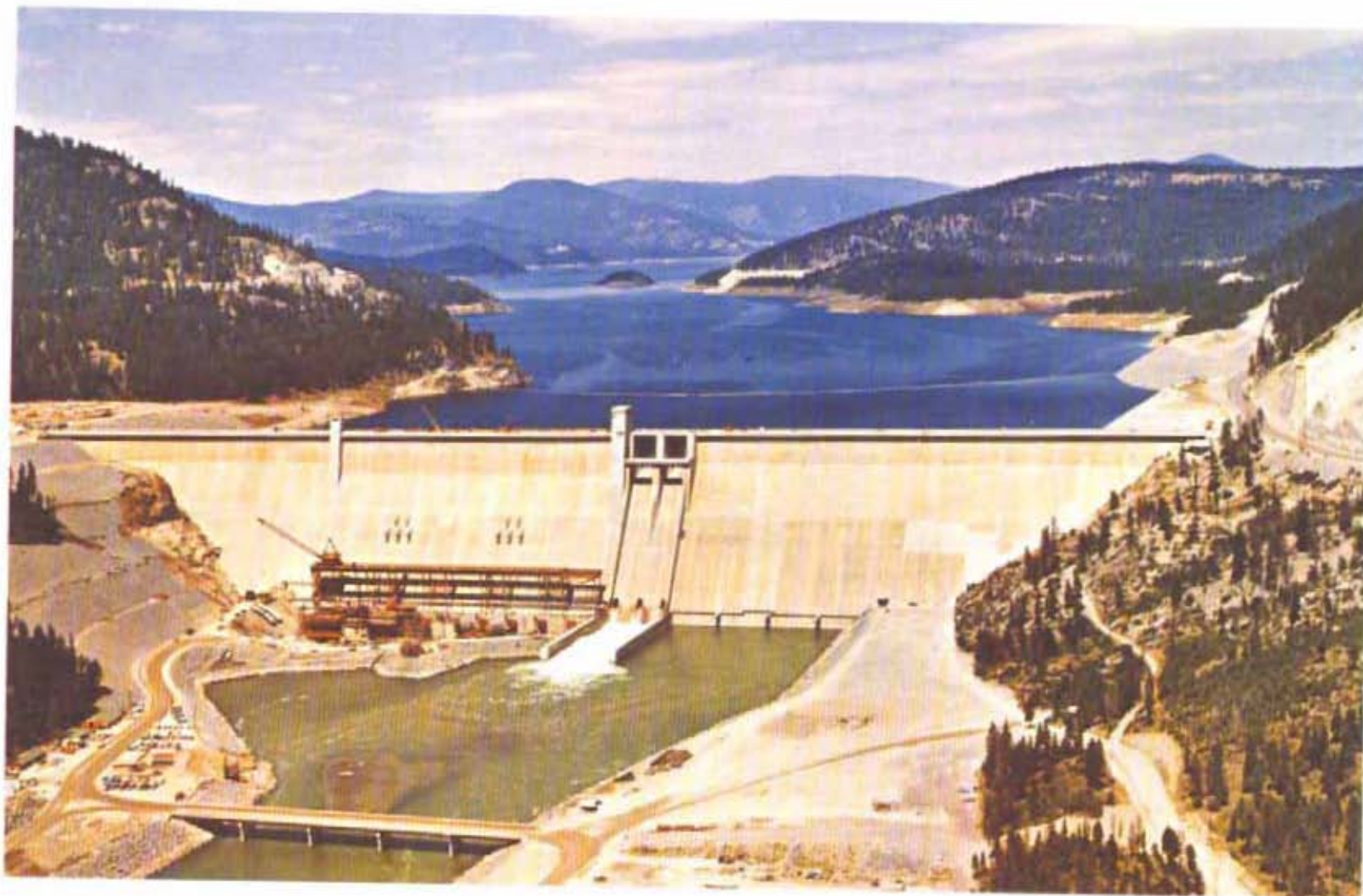
G.M. MacNabb, Chairman

Charles K. Mallory

V. Raudsepp



MICA DAM — completes the Canadian storage commitment under the Treaty.



LIBBY DAM—the only United States project constructed under the Treaty.

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**COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD**

Washington, D.C.

Ottawa, Canada

30 September 1973

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

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SUMMARY

The ninth 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. Project construction, progress of Entity studies, operation of the Arrow, Duncan, Mica and Libby reservoirs, and the resulting benefits are described.

Two Board meetings and one meeting of the Board with the Entities were held during the reporting period. The Board also inspected the Mica, Arrow, and Libby projects during the month of August 1973. The Duncan, Arrow, Mica and Libby storage projects are now complete and in full operation.

The Duncan, Arrow, Mica and Libby reservoirs have been operated in accordance with the objectives of the Treaty and the terms of the operating plans developed by the Entities. Although reservoir operations reduced peak freshet flows the unregulated peaks would not have reached damaging levels in either country.

Studies pertaining to development of the hydrometeorological network and power and flood control operating plans are being continued by the Entities to ensure operation of the projects in accordance with the terms of the Treaty. Downstream power benefits are being calculated by the Entities as required by 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 1972 to 30 September 1973, 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 also 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.

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 features 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

PERMANENT ENGINEERING BOARD

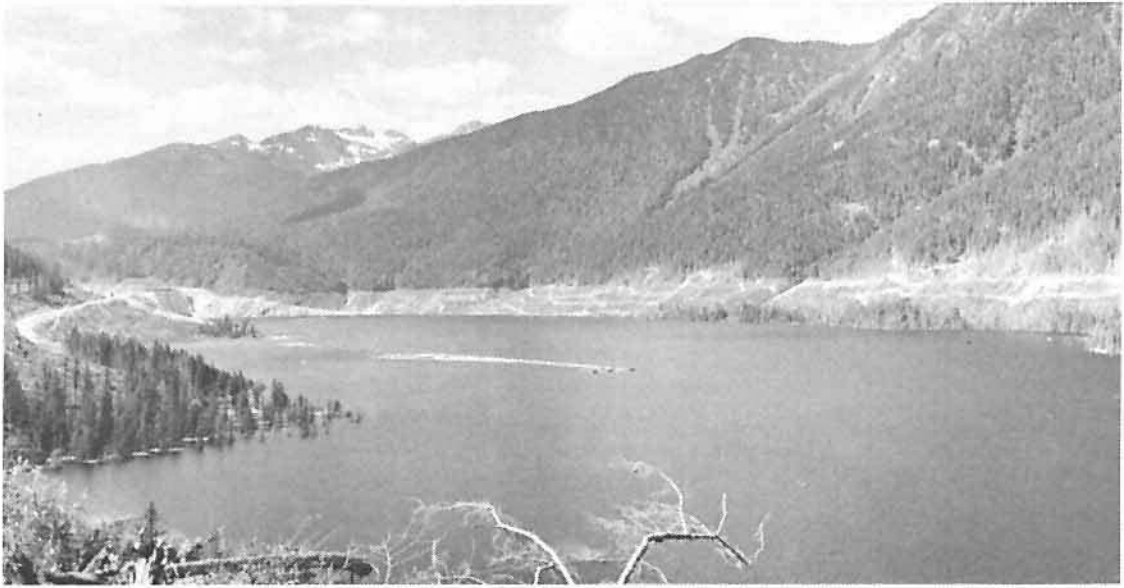
General

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. 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 the Board members, alternate members and secretaries are shown in Appendix A. It is noted that on the United States Section of the Board Mr. Homer B. Willis has replaced Mr. Joseph M. Caldwell as Chairman and Mr. Charles K. Mallory has replaced Mr. John W. Neuberger as member. It is also noted that Mr. V. Raudsepp has replaced Mr. A. F. Paget as a member of the Canadian Section of the Board.



MICA RESERVOIR near the dam.

July 1973.

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 hydro-meteorological system as required by Annex A of the Treaty.

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.

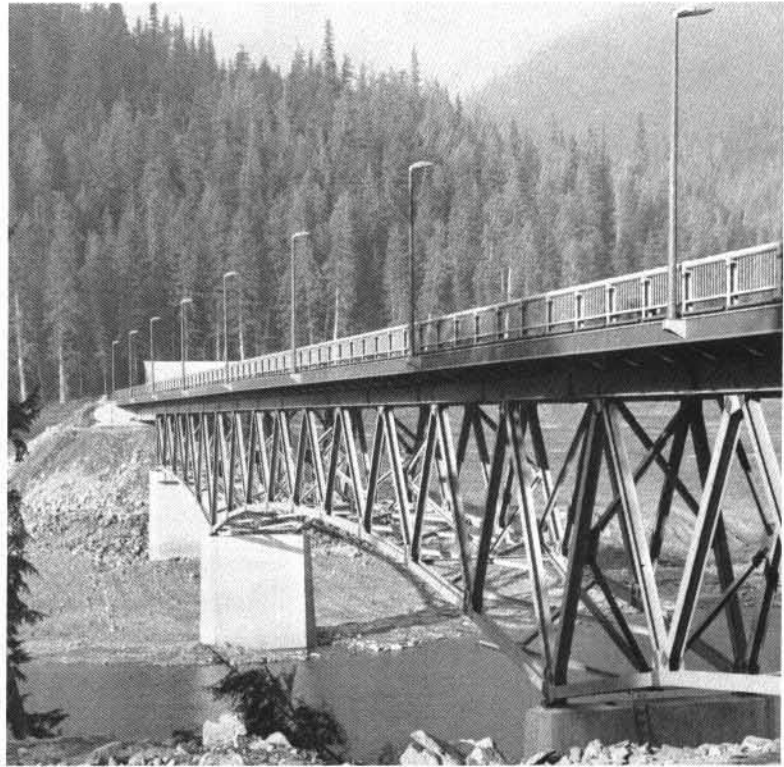
Establishment of the Entities

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. 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. Donald P. Hodel has replaced Mr. H. R. Richmond as Chairman of the United States Entity and that Major General Richard E. McConnell has replaced Major General K. T. Sawyer as member. It is also noted that Mr. W. D. Kennedy has replaced the Honourable R. G. Williston as Chairman of the Canadian Entity.

COLUMBIA RIVER BRIDGE

on the road to
Mica powerhouse.
November 1972.



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.

ACTIVITIES OF THE BOARD

Meetings and Field Inspections

The first meeting of the Board during the report year was held in Victoria, B.C. on 20 November 1972 to review progress under the Treaty and preparation of the Board's Annual Report. The Board met with the Entities on the same day to discuss Entity studies and general progress. The second meeting of the Board was held in Castlegar, B.C. on 29 August 1973. The Board visited the Mica, Hugh Keenleyside and Libby dams on 29 and 30 August 1973.

Reports Received

The Board received semi-annual progress reports from the Entities. These reports included a record of documents approved by the Entities, a general outline of reservoir operations and Entity studies, and reports on construction progress of the Mica and Libby projects to the end of March 1973 and September 1973 respectively.

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. The Entities also provided copies of computer printouts of studies for the Assured Operating Plan and downstream power benefit calculation, new storage elevation tables for the Arrow Lakes and Duncan reservoir, and the following documents and reports:

- Report of Columbia River Treaty Canadian and United States Entities for the period 1 October 1971 to 30 September 1972
- Report on Operation of Columbia River Treaty Projects 1 August 1971 through 31 July 1972
- Columbia River Treaty Flood Control Operating Plan
- Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1977-78, plus a copy of the Entities' agreement on this document
- Detailed Operating Plan for Columbia River Treaty Storage 1 July 1972 through 31 July 1973, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1977-78, and Downstream Power Benefit Computations for 1977-78 Operating Year, plus a copy of the Entities' agreement on these documents
- Initial Filling of Mica Reservoir
- Program for Initial Filling of Mica Reservoir, Amendment, plus a copy of the Entities' agreement on this document.

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 July 1973 through 31 July 1974, plus a copy of the Entities' agreement on this document

- Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1978-79, plus a copy of the Entities' agreement on this document
- Determination of Downstream Power Benefits Resulting from Canadian Storage for Operating Year 1978-79, 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 1972 to 30 September 1973
- Report on Operation of Columbia River Treaty Projects 1 August 1972 through July 1973.

Report to Governments

The eighth Annual Report of the Board was submitted to the two governments on 31 December 1972.

MICA OUTLET WORKS

intake tower at
upper end of tunnel.
July 1973.



PROGRESS

General

The results achieved under the terms of the Treaty include progress on construction of the Treaty projects and on studies regarding development of the hydrometeorological network, power and flood control operating plans, and the annual calculation of downstream power benefits. Duncan Dam was placed in operation on 31 July 1967. The Arrow project was declared operational on 10 October 1968 and the dam was named the Hugh Keenleyside Dam on 9 June 1969. Both projects were completed well in advance of Treaty requirements and continued to produce power and flood control benefits during this report year. The Mica project commenced storage operation on 29 March 1973, and on 17 April 1973 the Libby storage project was declared fully operational. All the Treaty storage projects are now in operation.

The Mica dam and the Libby dam are shown in the pictures at the front of this report and the locations of the Treaty projects are shown on Plate 1.

Construction Progress of the Treaty Projects

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 upstream face, outlet works tower and power intakes.

July 1973.

The general arrangement of structures for the Mica project is shown on Plate 2. The main dam has a nearly vertical impervious core supported between zones of coarser material. Two 45-foot diameter tunnels were constructed in the left abutment for river diversion. Spillway facilities and control works to provide regulated discharges from storage are located in the left abutment and power facilities are being constructed underground in the right abutment.

At the end of the previous report year the main dam fill had reached the final crest elevation of 2500 feet and was essentially complete, the spillway was complete except for minor finishing, concrete work on the power intakes was nearly

complete, and construction of the reservoir outlet works was well advanced. By the end of this report year all essential components of the storage project were complete.

The dam rises about 800 feet above the bedrock foundation and contains some 42,700,000 cubic yards of material. The crest was constructed to a width of 110 feet as a precautionary measure to ensure safety of the structure against overtopping which might result if a major landslide were to occur in the reservoir area. The completed fill is shown on Plate 3.

The two tunnels constructed for river diversion have been modified to provide for release of water from the lower portion of the reservoir without passing flows through the powerhouse. Tunnel number 2 was closed and smaller water conduits

MICA OUTLET WORKS

completing
the sloping portion of
the permanent tunnel.
March 1973.



and energy dissipating facilities were installed for use as low level outlets during the initial filling period. The permanent outlet works discharge into tunnel number 1.

Early in 1972 the British Columbia Hydro and Power Authority awarded a contract for constructing access tunnels and roads for the underground powerhouse. Contracts have also been awarded for the supply of four turbines and generators and for the powerhouse and associated works. There will be space for six units with a total capacity of 2,610,000 kw; the first two 435,000 kw generators are scheduled for service in 1976.

The project area is shown on Plate 4. The clearing program in the reservoir is virtually complete.



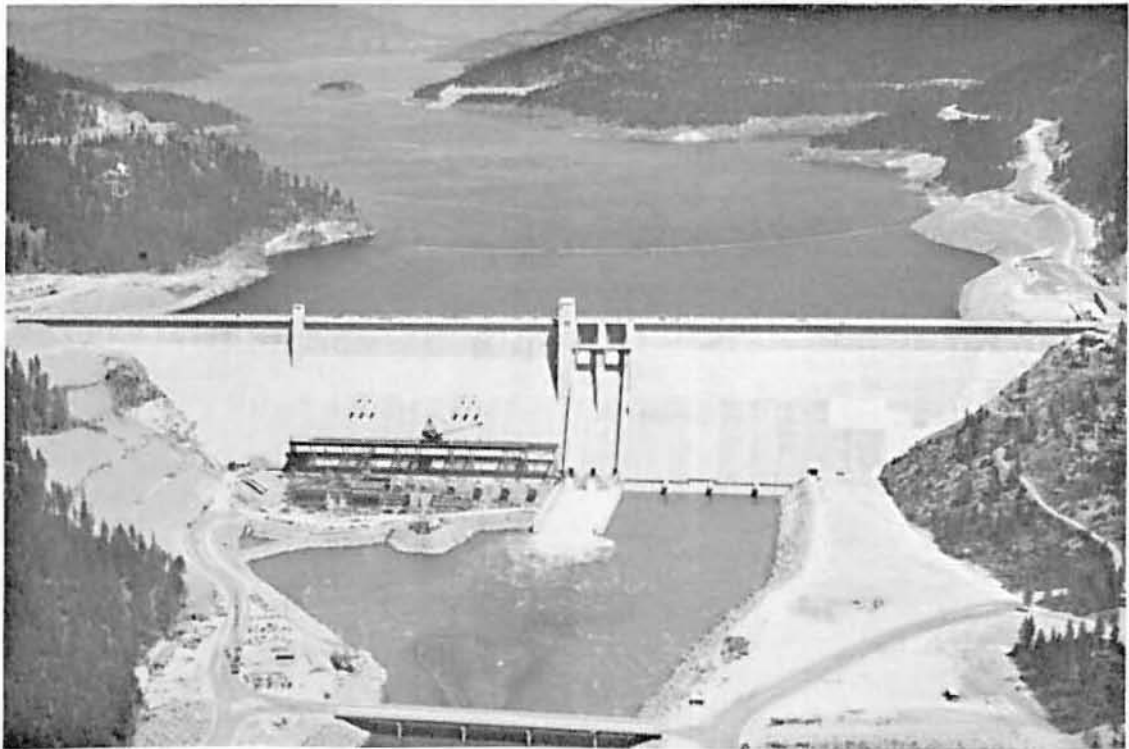
MICA POWERHOUSE excavation.

October 1973.

Libby Project in the United States

Libby dam, the fourth and last of the Treaty projects to be placed under construction, is on the Kootenai River 17 miles northeast of the town of Libby in northwest Montana. Construction began in the spring of 1966 and the project became fully operational, except for at-site power facilities, on 17 April 1973, thus fulfilling the requirements of paragraphs 1 and 8 of Article XII of the Treaty.

A photograph of Libby dam is shown on page 18. The general arrangement of the structures is shown on Plate 5, and the reservoir area and the highway and railroad relocations are depicted on Plate 6. At full pool, elevation 2459 feet, gross



LIBBY DAM and Lake Kootenai in operation; powerhouse is under construction. July 1973.

storage of the reservoir, Lake Koocanusa, is 5,809,000 acre-feet, of which 4,934,000 acre-feet is usable for flood control and power. Nearly half of the 90-mile length of Lake Koocanusa, when full, is in Canada. Procurement and preparation of the land required for the portion of the reservoir in Canada is, in accordance with the terms of the Treaty, the obligation of the Canadian Government. By subsequent agreement between Canada and the Province of British Columbia on 8 July 1963, British Columbia undertook responsibility for these flowage costs in Canada.

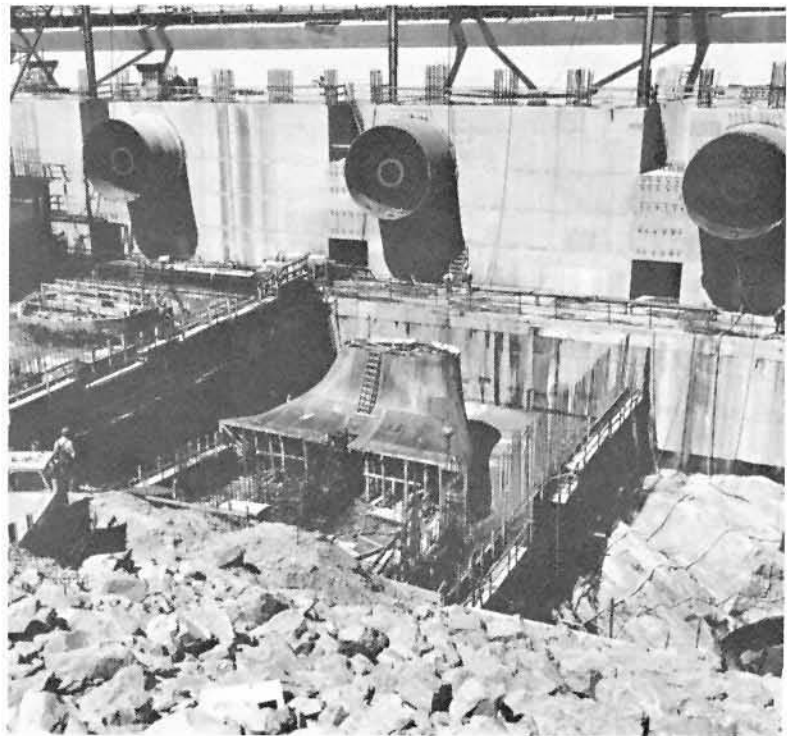
Construction of the dam is essentially complete. Work continues on visitors' facilities and historical exhibits, which are scheduled for completion prior to an anticipated dedication ceremony in August 1975. Construction of the lower two sections of the selective withdrawal structure is nearly complete and the total structure is scheduled for completion in 1975. This withdrawal structure will make it possible to regulate the quality of the water released from the dam by drawing water from various levels of the reservoir.

Powerhouse construction started in May 1972 and concrete placement continues in the erection and generator bays. Unit No. 1 is scheduled for power on line by June 1975 and unit No. 4 by March 1976. Turbine and generator contracts have been awarded and many of the turbine parts have been delivered for assembly at the powerhouse staging area.

In November 1972, work was started on the placement of a rock buttress to stabilize the left bank rock ribs upstream of the left abutment. This construction, which required a total of 2,300,000 cubic yards of rock fill, was completed in July 1973. The buttress was recommended by a Board of consultants after a rock slide occurred near the left abutment on 31 July 1971. An extensive instrumentation system was installed to monitor movement of the rock in this area.

Relocation of the Burlington Northern Railroad track was completed in 1970. Construction of forest development roads was completed in September 1972. Work

LIBBY POWERHOUSE
with three turbine bays
at different stages
of construction.
July 1973.



on the relocation of Montana State Highway 37 along the east bank of Lake Koocanusa is approximately 93 percent complete and is scheduled for completion in 1975.

LIBBY RESERVOIR

area cleared
near Wardner,
British Columbia.
April 1973.



Libby Project in Canada

Due to an unusually poor winter snowfall, full pool elevation of 2459 was not reached in 1973. The pool reached a maximum elevation of 2415 by mid-August and has since been continuously drafted for downstream power generation.

In view of the delayed filling schedule, expropriation proceedings which had been planned to ensure acquisition and clearing of all land prior to flooding, have been relaxed in favour of negotiated agreements. Negotiations with owners of the nine remaining properties generally require agreement on only minor details.

The British Columbia Forest Service has cleared all but 10 acres of the total 9,240 acres of forested land. As soon as property acquisition has been concluded clearing will be completed.

All new roads made necessary by the project were completed in 1972 and the two major highway bridges over the reservoir at Wardner and Kikomun Creek have been used by the public for well over a year. Modifications to the Canadian Pacific Railway track between Fort Steele and Wardner were completed during the current year.

TREATY TOWER

on Libby Dam beside spillway
with observation deck
and recess
for commemorative sculpture.
July 1973.



The Provincial Department of Recreation and Conservation is proceeding with development of waterfront parks and recreational facilities at Wardner and Kikomun Creek. The Kikomun Creek park encompasses an area of 1,390 acres and will have extensive day use amenities and a 50-unit campground.

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.

In developing the hydrometeorological network the Entities, with the concurrence of the Board, adopted a document 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. The Columbia River Treaty Hydrometeorological Committee, formed by the Entities, makes recommendations on establishing the Treaty Hydrometeorological System.

During this report year the Entities developed new storage elevation tables for the Arrow Lakes and the Duncan reservoir. Copies were provided to the Board. The Entities also developed revised discharge tables for Hugh Keenleyside Dam and discharge tables for the low level outlet works at the Mica dam.

Power Operating Plans

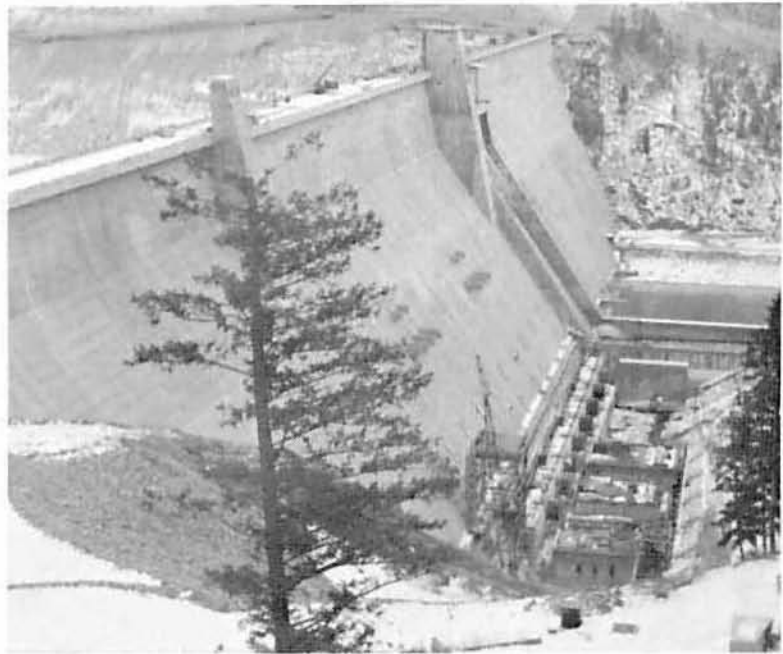
The Treaty and related documents provide that before any of the Canadian storage becomes operative the Entities will agree on operating plans and downstream power benefits for each ensuing year until the total of 15,500,000 acre-feet of storage in Canada becomes operative. In addition, based on the terms of the Treaty, the Entities are to agree annually on operating plans and on the resulting downstream power benefits for the sixth succeeding year of operation.

The operating plan for operating year 1976-77, which included for the first time generation at the Mica project, was completed during the previous report year and reviewed by the Board. It did not depart substantially from the plan for 1975-76. The operating plan for 1977-78, received during this report year, had been delayed because of the complexities in planning the operation of the four generating units at Mica and the requirement to produce optimum generation in both Canada and the United States. The Board has reviewed this plan and concludes that it is consistent with the terms of the Treaty and does not depart substantially from previous plans. The operating plan for 1978-79 was provided to the Board after the end of the report year.

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 1973. A detailed operating plan for the operating year ending 31 July 1974 was forwarded to the Board after the end of this report year.

LIBBY DAM

with powerhouse construction
in foreground.
January 1973.



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 1977-78. 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. This material facilitated review of the

documents by the Board. A report on determination of downstream power benefits for the operating year 1978-79 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" which replaced the interim plan and which provides for flood control operation of the Duncan, Arrow, Mica and Libby reservoirs was received from the Entities early in the 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.

OPERATION

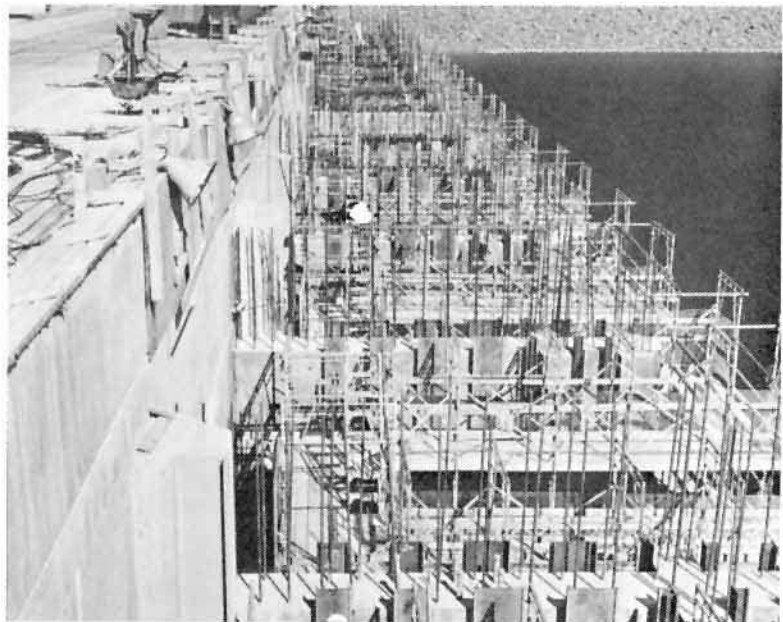
General

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 the "Interim Flood Control Operating Plan for Duncan and Arrow Reservoirs", the "Columbia River Treaty Flood Control Operating Plan", the "Detailed Operating Plan for Columbia River Treaty Storage 1 July 1972 through 31 July 1973", the "Detailed Operating Plan for Columbia River Treaty Storage 1 July 1973 through 31 July 1974", and the "Hydroelectric Operating Plans for Canadian Storage during the Operating Years 1969-70 through 1974-75".

SELECTIVE WITHDRAWAL

structure
under construction
at Libby Dam.
July 1973.

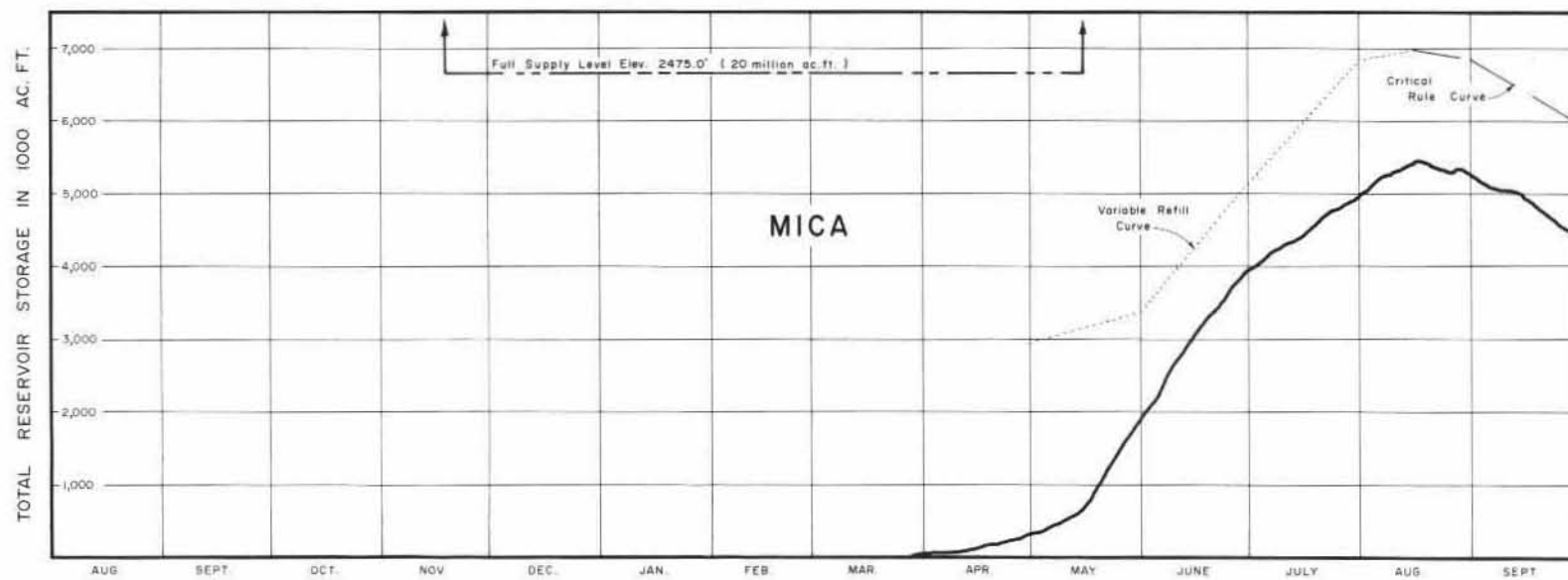
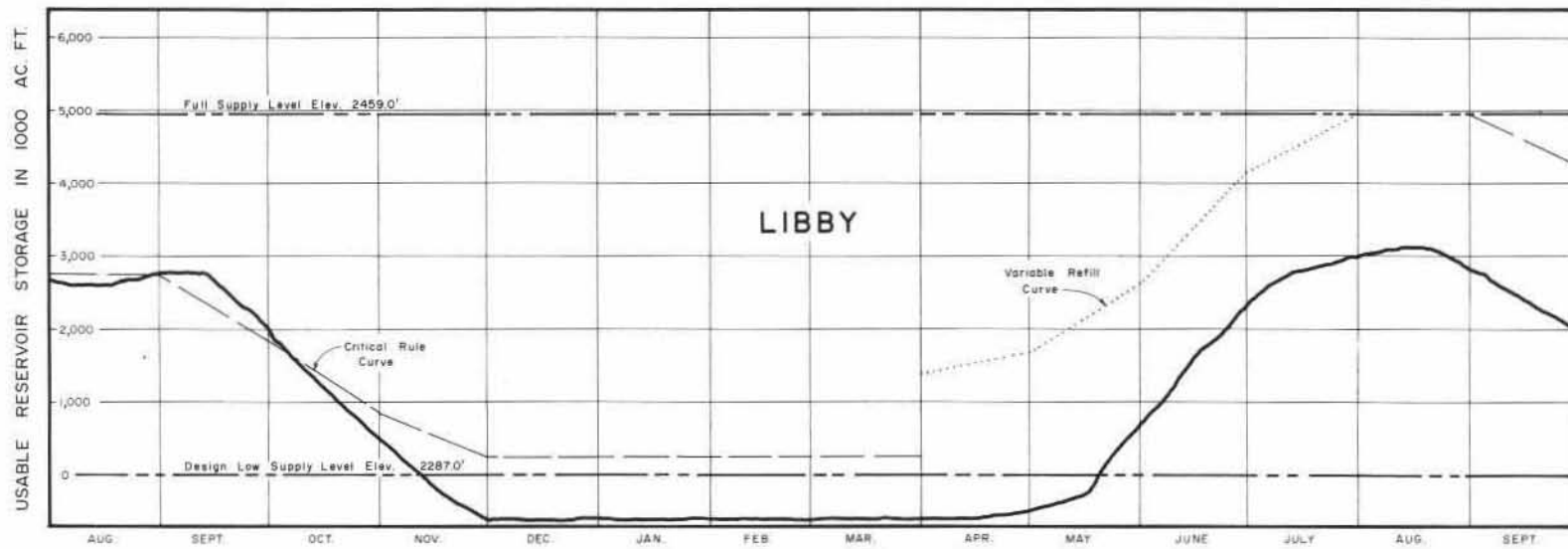


Power Operation

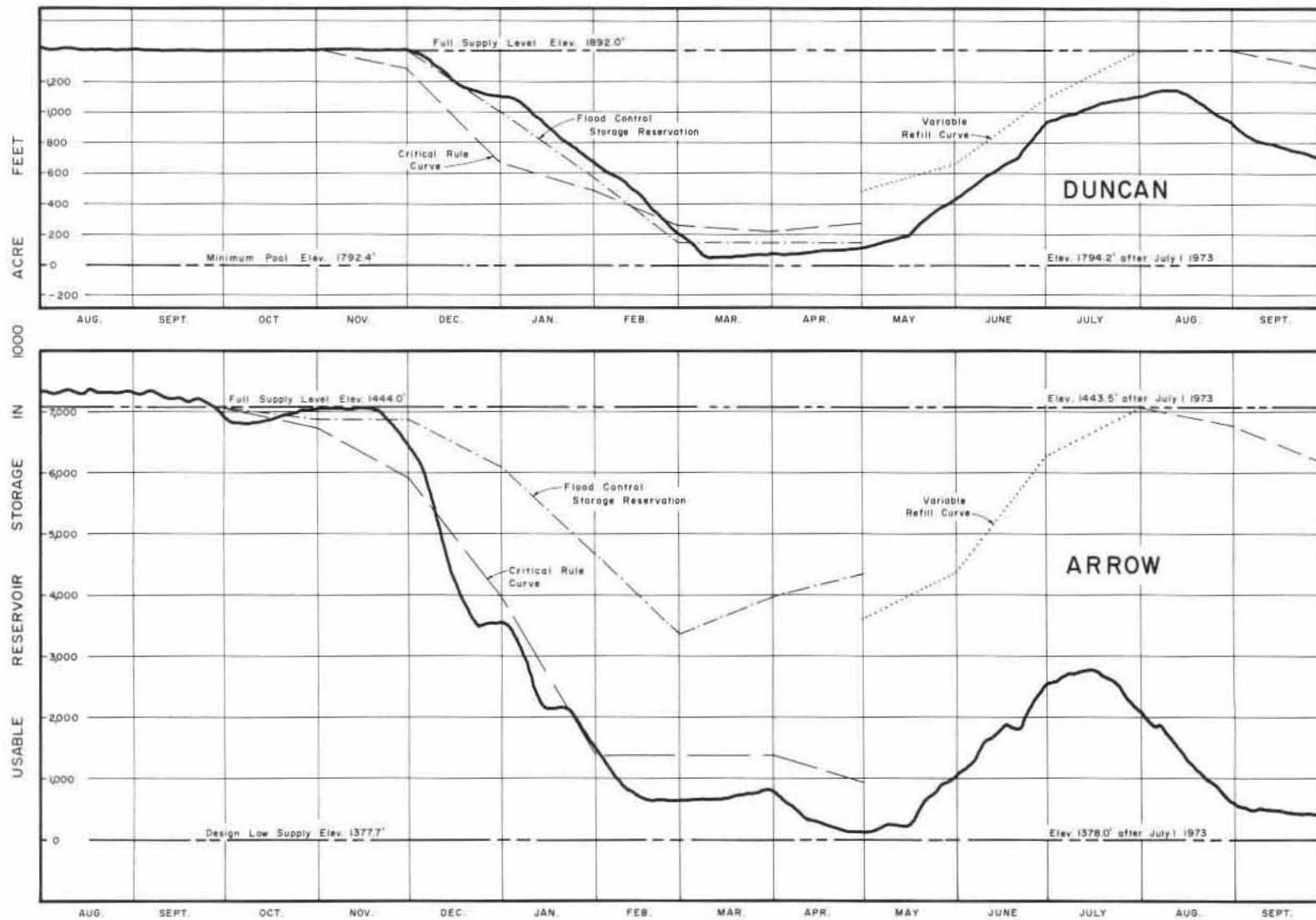
Both the Duncan and Arrow reservoirs were fully operational during the report year and provided reservoir storage to supplement natural streamflow during the storage draft season. The Libby reservoir was partly operational at the beginning of the report year and became fully operational on 17 April 1973. The reservoir provided some storage to supplement natural flows late in 1972. The Mica reservoir did not become operational until 29 March 1973 just prior to the freshet. Due to the abnormally small freshet in 1973 none of the reservoirs filled and drafting of storage began in July.

Operation of the reservoirs is illustrated on pages 29 and 30 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 and Arrow reservoirs were at or close to normal full supply levels and drafting of the partial Libby storage had commenced. Use of the Canadian Treaty storage began in November 1972. Below



HYDROGRAPHS - Libby and Mica reservoir levels for the 14th-month period ending 30 September 1973.



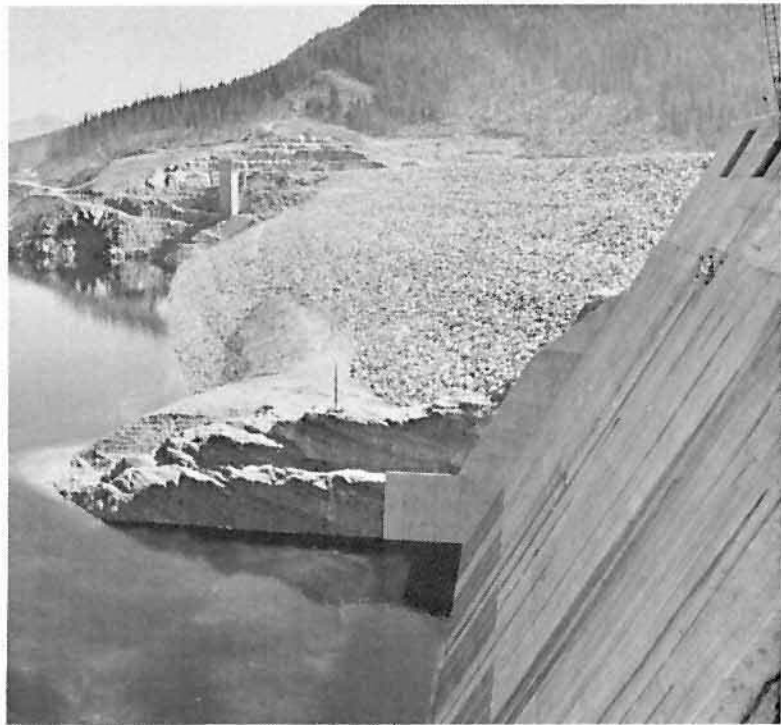
HYDROGRAPHS - Duncan and Arrow reservoir levels for the 14-month period ending 30 September 1973.

average water conditions during the report year resulted in the storages being operated essentially for firm power requirements throughout the report year. Operation for flood control was not required during the 1973 freshet because the runoff was extremely low.

The Duncan reservoir provided about 1.4 million acre-feet of reservoir storage. This storage was drafted between the end of November 1972 and early March 1973. Reservoir discharges were reduced and storing commenced on 12 March 1973. The reservoir reached a maximum elevation of about 1876.5 feet on 12 August 1973, 15.5 feet below full pool elevation. Drafting of storage began later in the month and by the end of the report year the reservoir was at elevation 1848.3 feet.

Release of storage from the Arrow reservoir began in the middle of November 1972 and continued until the reservoir reached an elevation of about 1386 feet late in February 1973. Additional storage was released during April and the reservoir reached a minimum elevation of about 1381 feet during this month. A total of about 7 million acre-feet of stored water had been provided. The reservoir was maintained at about elevation 1381 feet until the middle of May when involuntary storage commenced due to rising inflows. The need for water in the United States to generate power and to fill Grand Coulee reservoir reduced the available supply and the Arrow reservoir filled only to an elevation of about 1407 feet, 37 feet below normal full pool elevation, in the middle of July. Drafting of storage commenced immediately and the reservoir reached an elevation of 1382.5 feet by the end of August. At the end of the report year the reservoir was at an elevation of 1380.7 feet.

MICA RESERVOIR
at upstream face
of dam.
July 1973.



The Mica reservoir became operational and commenced storing on 29 March 1973. Reservoir discharges were maintained at practical minimum flows until 19 June 1973 when the low level outlets were opened to provide maximum discharges to meet downstream requirements. These outlets remained fully open until the end of the report year and only involuntary storage occurred after 19 June 1973. The reservoir reached a maximum elevation of 2268.6 feet on 16 August 1973 and by the end of the report year had been lowered to elevation 2242.2 feet.

The initial filling program for Mica, agreed to by the Entities, provides for the accumulation of dead storage in exchange for equivalent amounts of electrical energy supplied to the United States by the Canadian Entity. A total of 1,010,000 acre-feet of dead storage had been accumulated by this method at the end of the report year.

The Libby reservoir, which was partially operational in the previous report year was at an elevation of about 2404 feet in September 1972. On 12 September 1972 drafting of the reservoir commenced to facilitate the construction program and by 2 December 1972 the reservoir had been lowered to elevation 2230 feet. A total of 2.5 million acre-feet of storage had been provided during the report year. The reservoir was maintained at this level until filling commenced on about 12 April 1973. Reservoir discharges were generally maintained at minimum rates except for the last part of the months of June and July when outflows were increased to assist in filling Grand Coulee reservoir. The reservoir reached a maximum elevation of about 2415.3 feet on 16 August 1973. Drafting of storage commenced immediately and by the end of the report year the reservoir was at elevation 2382.0 feet.

In order to assess the requirements of Article XII(1) of the Treaty a water level gauge has been installed on Lake Koocanusa at the International Boundary to record the upper range of the reservoir levels. As the reservoir did not reach this range during the report year no data are reported.

MICA DAM
in winter.
January 1973.

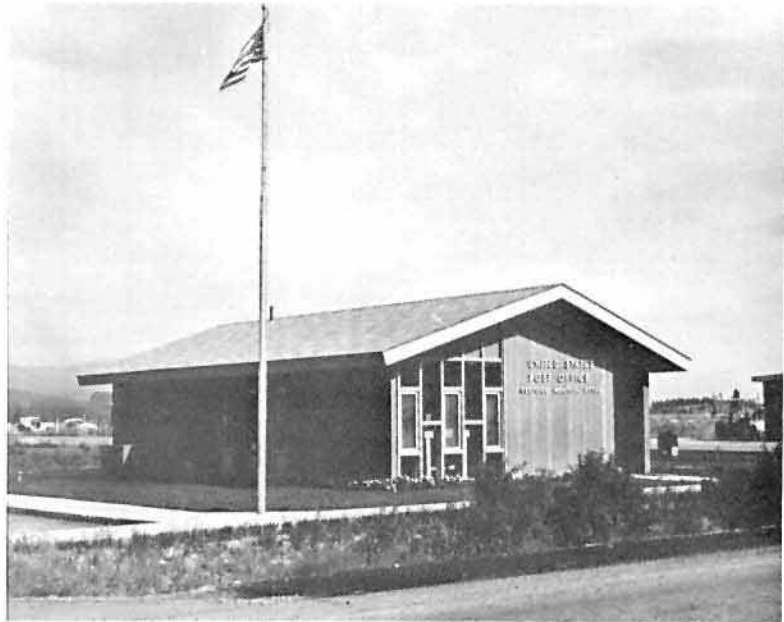


Flood Control Operation

During the drawdown period operation of the Duncan, Arrow and Libby reservoirs produced sufficient storage space, in accordance with the Columbia River Treaty Flood Control Operating Plan, to control the maximum flood indicated by runoff volume forecasts. Because of the extremely low runoff during the 1973 freshet operation for flood control was not required.

REXFORD POST OFFICE

rebuilt outside
Libby reservoir area.
July 1973.



BENEFITS

Flood Control Payment

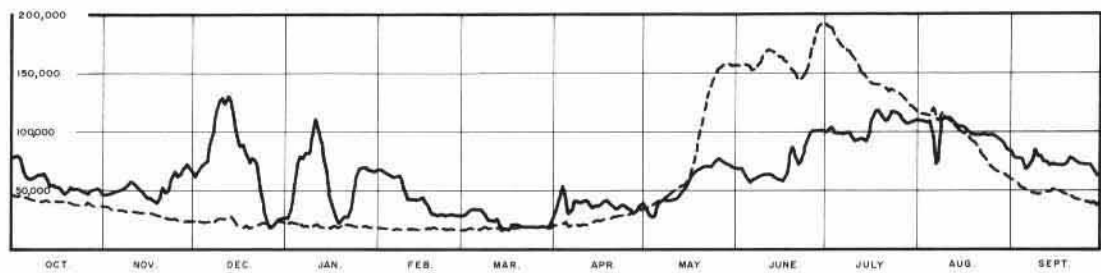
Article VI(1)(a) of the Treaty provides that the United States shall pay Canada \$1,200,000 in United States funds upon commencement of operation of the storage at Mica dam. The Mica project was declared operational on 29 March 1973 and the flood control payment was received by Canada on the same day.

Flood Control Provided

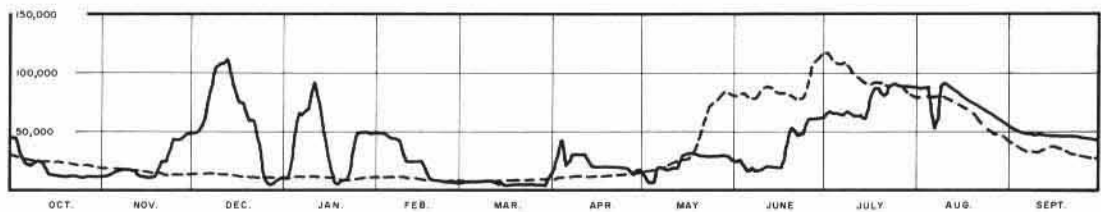
The unregulated 1973 freshet at The Dalles would have been below river bank full stage, therefore reservoir operation did not provide flood control protection. In Canada, although the freshet was comparatively larger, the unregulated freshet would not have reached damaging levels.

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about 4.5 feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by about 7 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 36 by hydrographs which show actual discharges and pre-project flows that would have occurred if the dams had not been built. It is noted that the pre-project hydrograph 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.

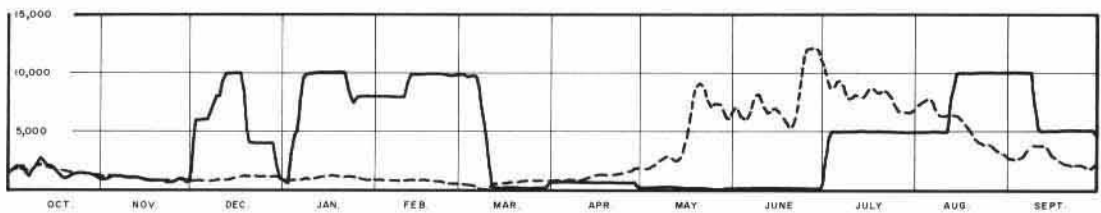
DISCHARGE IN CUBIC FEET PER SECOND



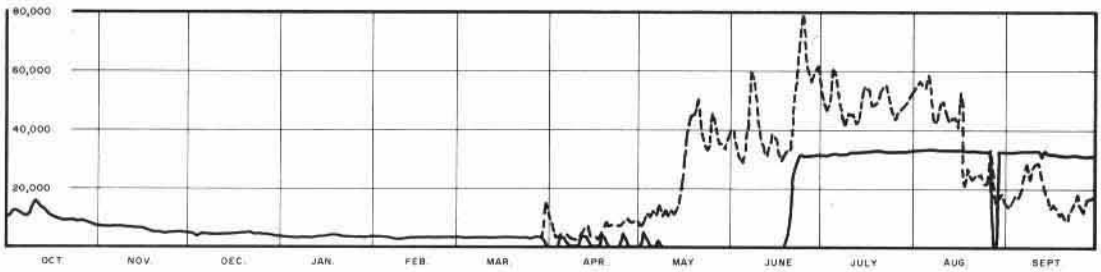
Columbia River at Birchbank



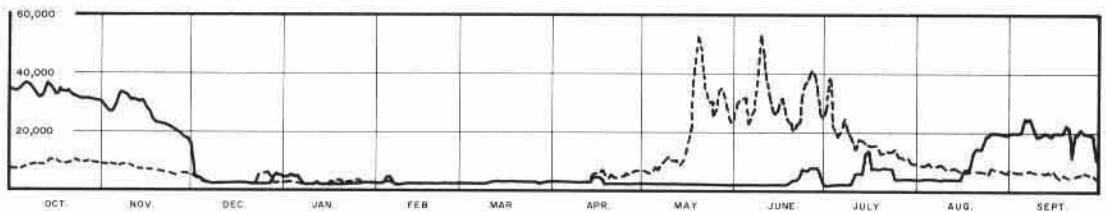
Columbia River at Hugh Keenleyside Dam



Duncan River at Duncan Dam



Columbia River at Mica Dam



Kootenai River at Libby Dam

LEGEND
— Observed Flows
--- Pre-Project Flows

HYDROGRAPHS - Observed and pre-project flows for the year ending 30 September 1973.

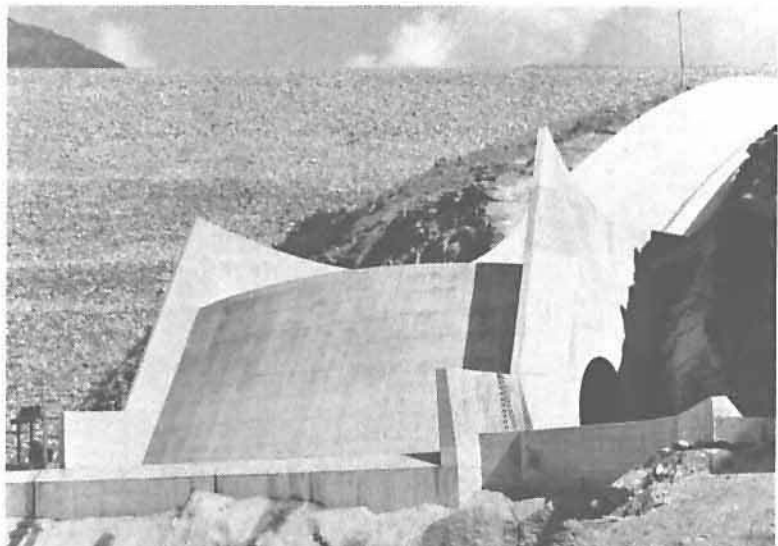
The operation of Columbia Basin reservoirs for the system as a whole reduced the natural annual peak discharge of the Columbia River near The Dalles, Oregon by approximately 194,000 cfs to a flow of 208,000 cfs, the lowest annual peak daily flow recorded at that point.

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 for a 30-year period. No additional downstream power benefits were realized during the year from the operation of Treaty dams other than the added generation made possible on the Kootenay River in Canada. The Kootenay River benefits in Canada, under Article XII of the Treaty, are retained wholly within Canada.

MICA SPILLWAY

flip bucket at
bottom of chute.
July 1973.



CONCLUSIONS

1. The Duncan, Hugh Keenleyside, Mica and Libby dams are complete.
2. Entity studies pertaining to development of the hydrometeorological network, power and flood control operating plans, and the annual calculation of downstream power benefits are proceeding satisfactorily.
3. 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, the interim flood control operating plan for Duncan and Arrow reservoirs, and the flood control operating plan for Treaty reservoirs.
4. Finally, the Board concludes that the objectives of the Treaty are being met.

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

United States

Canada

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

Mr. G. M. MacNabb, Chairman
Senior Assistant Deputy Minister,
Department of Energy, Mines
and Resources,
Ottawa, Ontario

Mr. Charles King Mallory (2)
Deputy Assistant Secretary for
Energy and Minerals,
(Power Resources and Regulations)
U.S. Department of the Interior,
Washington, D.C.

Mr. V. Raudsepp (3)
Deputy Minister of Water Resources,
Department of Lands, Forests and
Water Resources,
Victoria, B.C.

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U.S. Army,
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Inland Waters Directorate,
Department of the Environment,
Vancouver, B.C.

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Assistant and Power Engineering
Advisor,
Office of the Assistant Secretary
for Water and Power Development,
Department of the Interior,
Washington, D.C.

Mr. H. M. Hunt
Chief, Power and Major Licences
Division,
Water Resources Service,
Department of Lands, Forests and
Water Resources,
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Assistant Chief,
Hydrologic Engineering Branch,
Civil Works Directorate,
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U.S. Army,
Washington, D.C.

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

- (1) Vice Mr. Joseph M. Caldwell as of 26 September 1973.
- (2) Vice Mr. John W. Neuberger as of 6 September 1973.
- (3) Vice Mr. A. F. Paget as of 29 June 1973.

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

United States

Mr. Donald P. Hodel, Chairman (1)

Administrator, Bonneville
Power Administration,
Department of the Interior,
Portland, Oregon

Major General Richard E. McConnell (2)

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

Canada

Mr. W. D. Kennedy, Chairman (3)

B.C. Hydro and Power
Authority,
Vancouver, B.C.

- (1) Vice Mr. H. R. Richmond as of 1 December 1972.
- (2) Vice Major General K. T. Sawyer as of 15 December 1972.
- (3) Vice The Honourable R. G. Williston as of October 1972.

RECORD OF FLOWS

AT THE

INTERNATIONAL BOUNDARY

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
1	78,900	45,900	61,400	26,200	67,100	29,000	33,900	34,500	68,700	101,000	109,000	78,700
2	79,700	45,900	66,900	33,000	65,900	30,500	42,600	28,900	68,700	104,000	108,000	77,700
3	76,300	47,100	70,200	52,700	64,800	33,500	54,800	26,800	63,900	99,800	107,000	77,000
4	66,100	48,900	72,700	71,500	62,700	33,800	46,800	27,400	58,500	98,900	108,000	77,000
5	61,200	49,400	74,000	79,400	60,500	33,700	30,000	38,000	55,800	99,300	95,100	67,500
6	59,800	50,000	88,000	77,900	61,800	33,600	34,100	41,700	59,500	97,900	71,400	69,100
7	60,000	51,200	99,400	81,800	62,400	33,600	40,600	42,100	59,700	99,300	75,600	74,400
8	61,900	54,500	118,000	81,800	59,500	28,700	40,300	41,000	61,400	99,300	110,000	84,300
9	63,900	57,900	127,000	95,700	51,100	24,700	39,600	41,100	62,000	95,000	111,000	78,900
10	63,900	57,400	129,000	111,000	43,100	24,300	40,100	41,500	62,800	92,000	112,000	78,800
11	64,600	54,600	123,000	104,000	42,500	24,800	40,700	42,700	63,300	92,700	110,000	74,700
12	60,800	51,200	131,000	91,800	42,900	26,100	39,200	43,000	62,100	93,900	107,000	73,400
13	53,400	50,000	125,000	79,500	42,200	21,300	35,000	47,400	61,100	92,600	105,000	70,700
14	53,800	46,500	112,000	68,700	42,800	17,200	35,700	51,500	58,800	90,900	104,000	72,600
15	52,700	43,800	93,600	49,400	44,000	17,700	35,500	54,000	58,400	97,100	104,000	71,900
16	52,300	43,800	87,300	36,900	41,800	17,200	38,600	59,400	57,700	111,000	102,000	71,600
17	48,900	40,600	88,700	27,300	35,200	20,900	40,800	64,200	62,600	118,000	99,600	71,400
18	46,200	38,100	81,000	22,500	30,000	20,300	40,700	66,100	77,600	118,000	98,500	71,200
19	48,100	43,500	73,900	25,300	30,000	20,400	38,000	67,500	86,200	113,000	97,100	72,700
20	52,100	51,000	77,200	27,800	29,000	19,800	36,000	69,300	79,100	109,000	96,400	77,200
21	51,300	47,800	76,300	27,700	29,700	19,700	34,800	70,200	71,000	110,000	97,800	76,700
22	51,300	49,100	70,800	34,400	29,900	19,300	36,000	69,900	74,000	117,000	98,000	73,900
23	50,300	60,000	54,100	48,200	29,000	19,400	36,300	70,000	80,100	117,000	96,300	72,700
24	48,500	66,400	35,800	61,700	29,500	19,500	35,700	72,600	91,000	116,000	96,600	72,400
25	47,900	61,300	24,200	68,500	29,700	19,500	34,200	77,000	100,000	114,000	96,700	72,300
26	46,300	62,900	18,800	68,900	29,500	19,300	33,800	75,500	101,000	109,000	95,400	72,400
27	50,000	68,900	19,900	69,000	29,500	19,600	30,600	74,700	101,000	107,000	93,600	72,100
28	50,200	73,000	22,800	67,300	29,000	19,700	34,700	72,600	101,000	107,000	91,200	67,400
29	50,400	69,700	25,200	66,600		19,400	37,600	71,600	101,000	108,000	88,600	62,900
30	48,600	65,500	26,000	66,300		23,100	39,200	70,100	99,500	109,000	84,400	63,900
31	46,200		25,800	67,000		29,300		68,700		110,000	84,400	
Mean	56,300	53,200	74,200	61,000	43,400	23,800	37,900	55,500	73,600	105,000	98,500	73,300

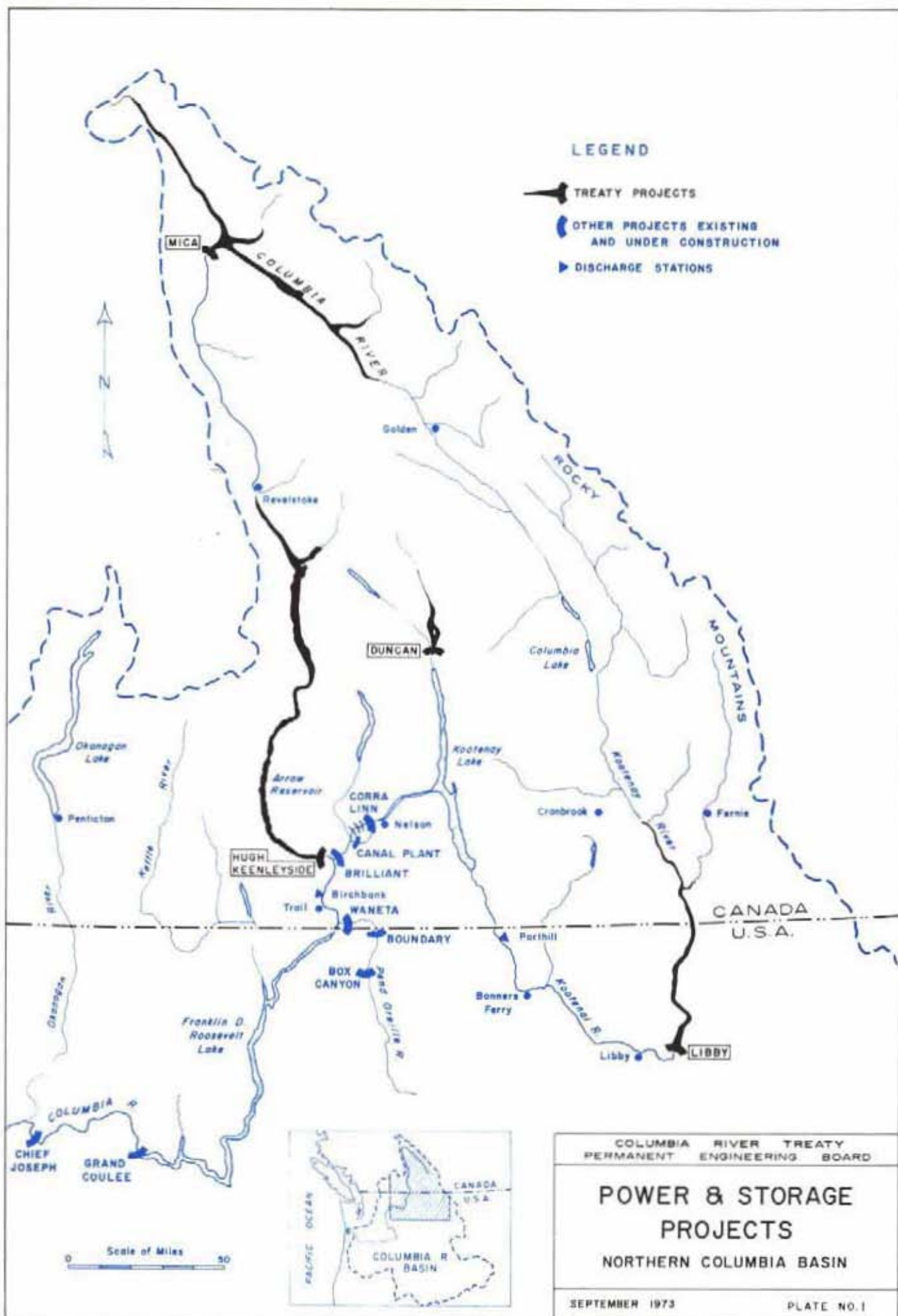
COLUMBIA RIVER AT BIRCHBANK, B.C. — Daily discharges for the year ending 30 September 1973 in cubic feet per second.

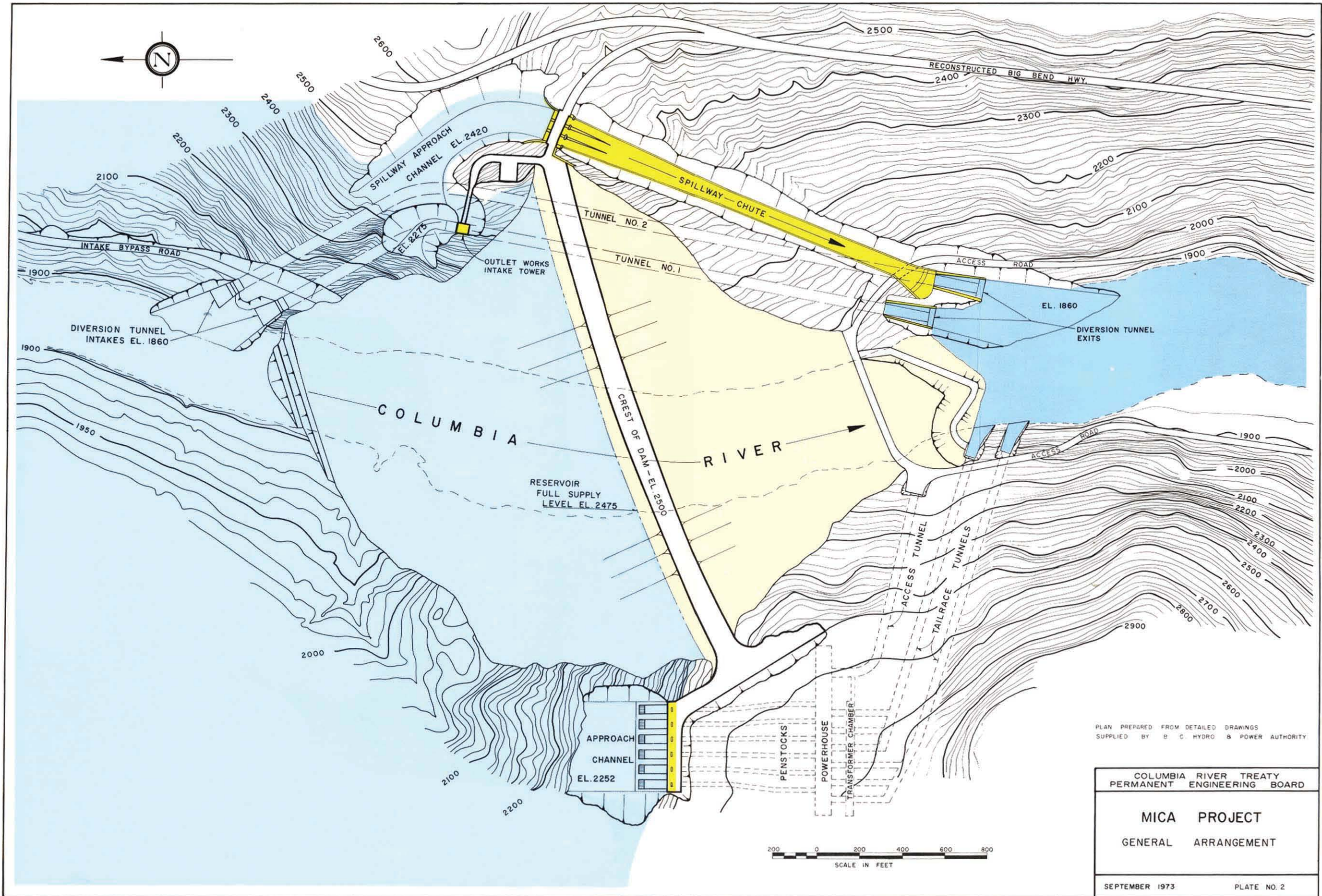
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
1	32,900	28,300	12,600	6,940	4,760	4,600	5,590	9,570	13,200	5,450	4,490	20,000
2	33,200	27,000	8,340	6,690	4,660	4,670	5,640	9,370	12,400	4,980	4,550	19,900
3	33,700	26,100	5,520	6,310	4,800	4,700	5,620	9,630	11,300	4,730	4,530	19,900
4	34,200	25,800	5,330	5,840	5,810	4,640	5,620	10,300	10,500	4,490	4,440	20,000
5	34,700	28,100	4,540	5,450	6,260	4,500	5,510	11,100	10,500	4,400	4,550	25,000
6	35,300	31,000	3,850	3,610	5,440	4,510	5,900	11,900	11,000	4,620	4,770	25,100
7	34,800	33,300	3,570	2,720	4,090	4,450	6,190	13,200	12,300	4,520	4,680	25,100
8	33,300	33,200	3,430	2,620	3,930	4,450	6,110	13,700	12,700	4,380	4,560	21,100
9	31,300	32,200	3,500	2,610	3,860	4,290	6,070	13,300	13,700	4,200	4,460	19,900
10	30,600	30,600	3,600	2,690	4,090	4,480	6,130	12,500	11,900	5,140	4,440	19,700
11	31,300	30,100	3,760	2,730	4,160	5,020	6,260	11,600	10,500	7,640	4,570	19,700
12	33,200	30,400	3,920	2,840	3,910	5,300	6,780	11,000	9,820	7,980	4,550	20,200
13	35,800	29,700	4,050	3,090	3,900	5,020	7,420	11,300	9,590	8,090	4,440	20,100
14	35,800	28,900	3,950	3,390	3,810	4,860	8,520	13,000	9,080	13,700	4,390	20,100
15	33,700	28,200	4,010	3,710	3,840	4,720	8,960	16,200	8,770	15,600	4,380	20,300
16	32,000	26,600	4,020	4,480	3,880	4,820	8,830	21,200	8,370	10,400	6,720	20,700
17	33,500	25,600	4,120	4,860	3,910	4,780	8,760	26,200	8,060	9,540	7,200	20,600
18	32,700	24,000	4,310	5,080	3,930	5,090	8,640	28,600	7,590	9,230	7,910	20,700
19	31,800	22,900	4,370	5,040	4,020	5,040	7,630	27,900	8,280	9,280	12,800	23,300
20	32,300	22,100	4,390	4,910	3,940	5,000	7,140	25,500	8,910	9,350	14,300	22,800
21	31,800	21,700	4,420	4,780	4,020	5,010	7,150	21,200	8,870	9,280	14,300	13,500
22	31,100	21,500	4,500	4,690	4,120	5,080	7,050	17,800	9,500	9,240	14,200	19,700
23	30,600	21,200	4,730	4,620	4,040	5,260	7,480	16,400	11,400	9,200	18,300	20,900
24	30,600	20,900	4,710	4,610	4,140	5,310	7,960	16,300	12,400	6,170	19,200	22,800
25	30,700	19,500	4,720	4,590	4,160	5,390	8,410	17,800	12,400	5,200	19,300	21,000
26	30,800	19,800	4,600	4,650	4,260	5,440	8,650	16,600	12,700	5,380	19,800	20,600
27	30,700	20,300	4,810	4,760	4,520	5,620	8,950	14,400	12,700	5,250	19,800	20,700
28	30,600	18,800	5,780	4,770	4,560	5,570	9,830	13,000	12,300	5,020	19,600	20,800
29	30,400	17,200	6,610	4,820		5,700	10,200	12,400	10,200	4,880	19,900	12,400
30	30,000	17,100	7,110	4,870		5,740	9,980	12,400	6,980	4,790	19,800	10,800
31	29,300		7,000	4,880		5,580		12,900		4,550	19,600	
Mean	32,400	25,400	4,970	4,440	4,320	4,990	7,430	15,400	10,600	6,990	10,300	20,300

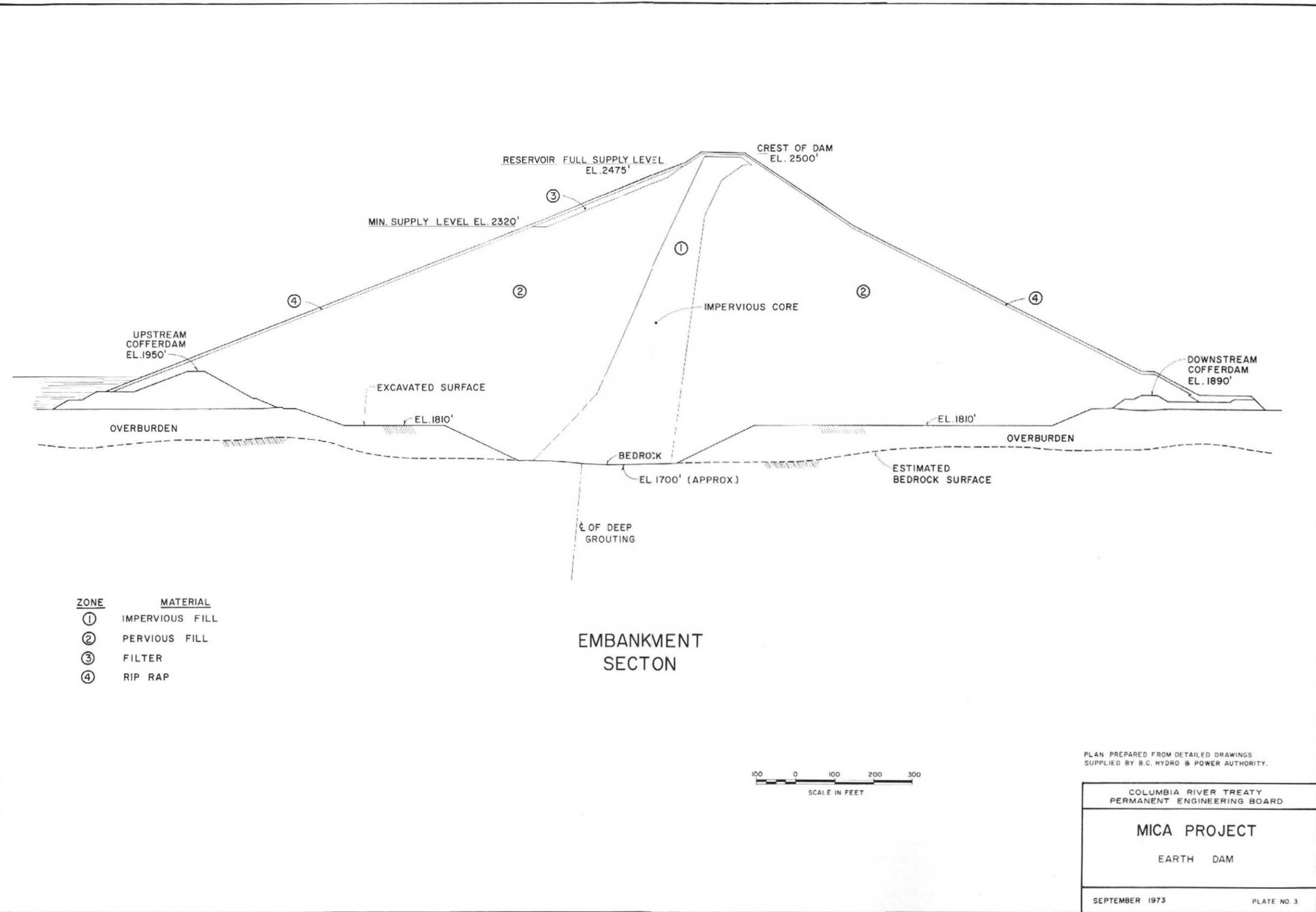
KOOTENAI RIVER AT PORTHILL, IDAHO — Daily discharges for the year ending 30 September 1973 in cubic feet per second.

LIST OF PLATES

	<u>Plate No.</u>
Power and Storage Projects Northern Columbia Basin	1
Mica Project General Arrangement	2
Mica Project Progress Chart of Dam	3
Mica Project General Project Area	4
Libby Project General Arrangement	5
Libby Project Reservoir Area	6

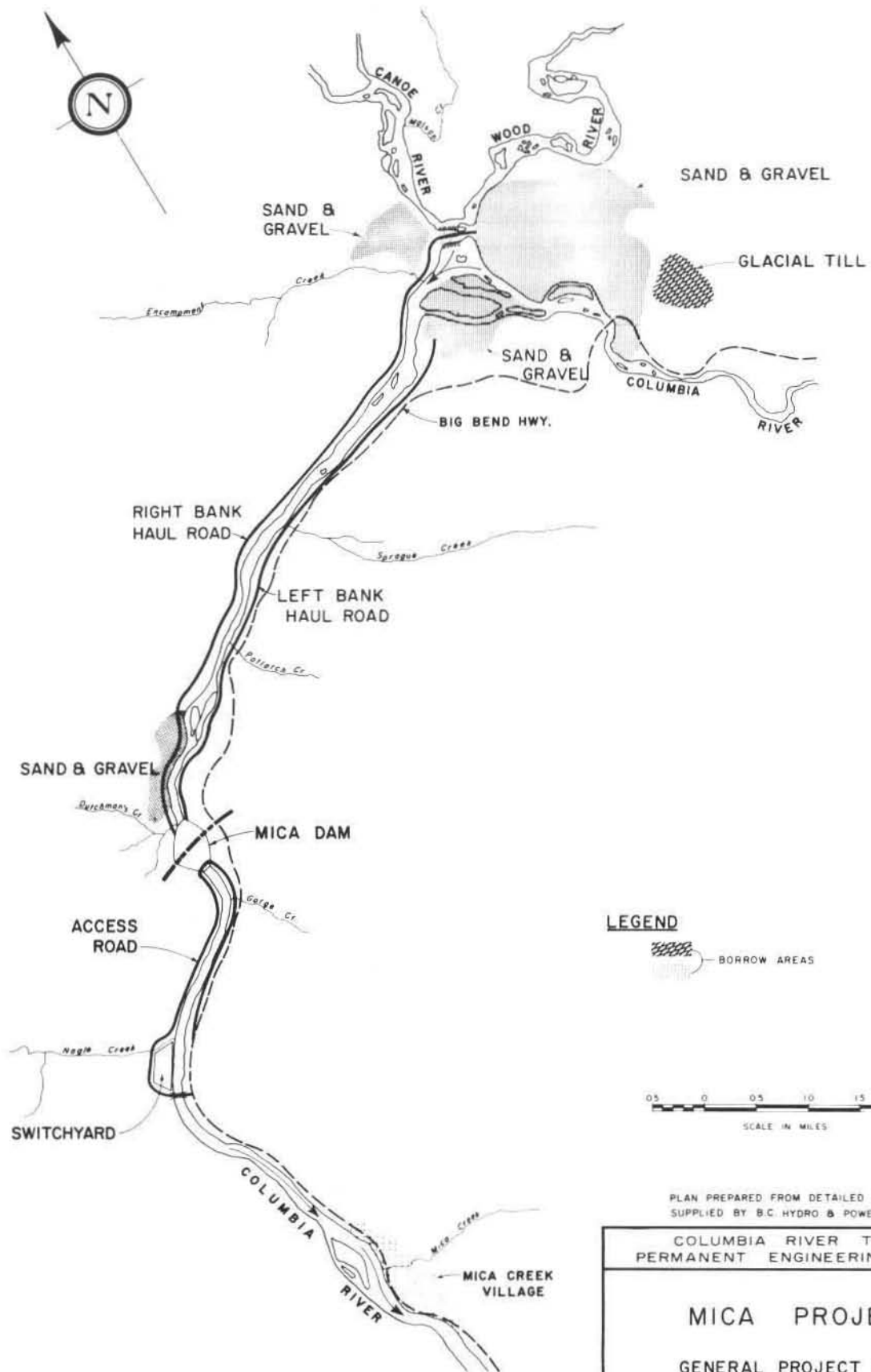






PLAN PREPARED FROM DETAILED DRAWINGS
SUPPLIED BY B.C. HYDRO & POWER AUTHORITY.

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD	
MICA PROJECT	
EARTH DAM	
SEPTEMBER 1973	PLATE NO. 3



PLAN PREPARED FROM DETAILED DRAWINGS
SUPPLIED BY B.C. HYDRO & POWER AUTHORITY

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

MICA PROJECT GENERAL PROJECT AREA

SEPTEMBER 1973

PLATE NO. 4

