ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

Washington, D.C. Ottawa, Ontario

30 SEPTEMBER 1992

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
J. D. OULTON, Chairman
J. Allan, Member

UNITED STATES SECTION
H. H. KENNON, Chairman
R. H. Wilkerson, Member

31 December, 1992

The Honorable James Baker
The Secretary of State
Washington, DC

The Honourable Jake Epp
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, DC, on 17 January 1961.

In accordance with the provisions of Article XV paragraph 2(e), there is submitted herewith the twenty-eighth Annual Report, dated 30 September 1992, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1991 to 30 September 1992.

Respectfully submitted:

For the United States

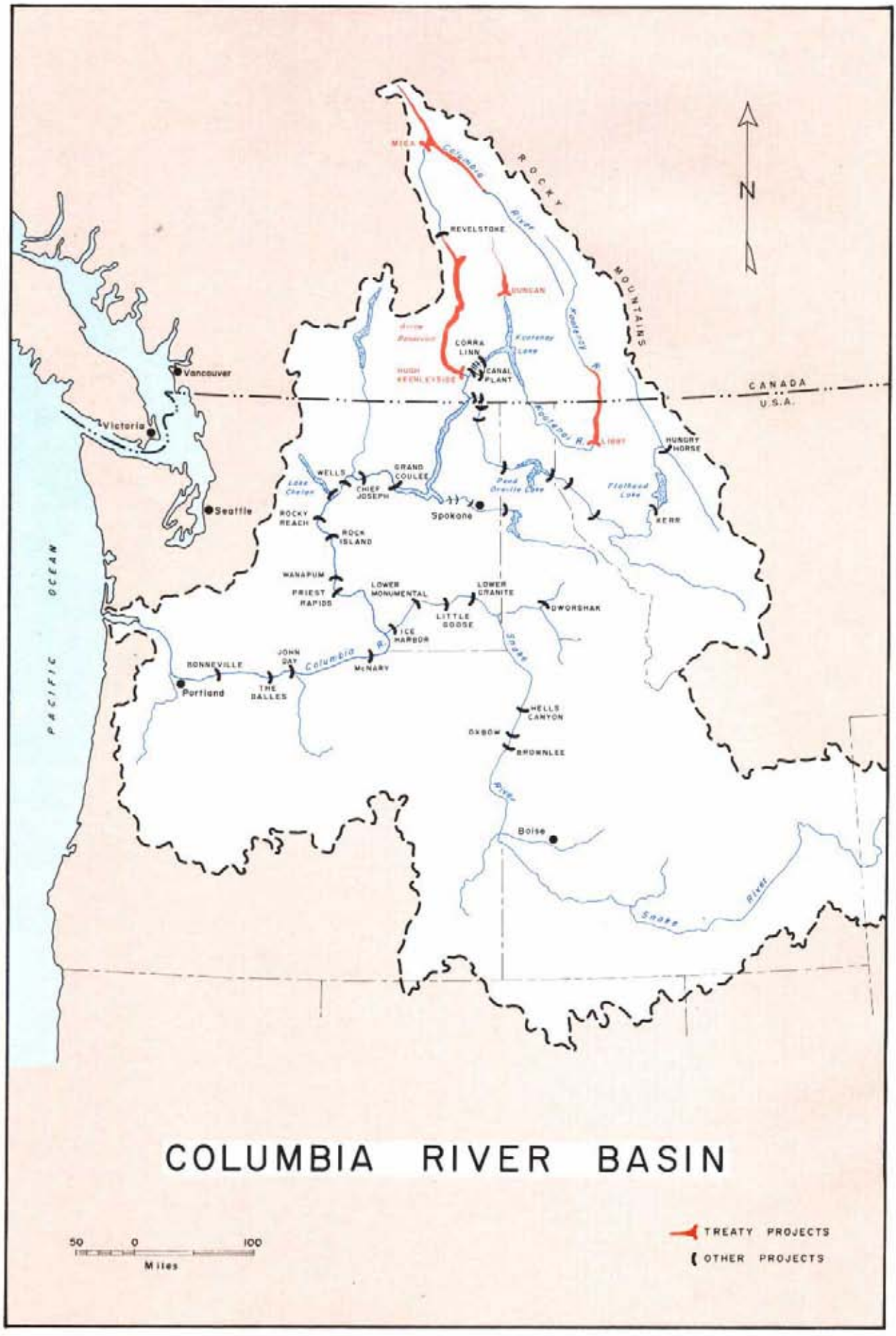
Herbert H. Kennon, Chairman

Ronald H. Wilkerson

For Canada

J. D. Oulton, Chairman

J. Allan



COLUMBIA RIVER BASIN

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COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

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CONTENTS

LIST OF PHOTOGRAPHS

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

HYDROGRAPHS

APPENDICES

SUMMARY

The twenty-eighth 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. Operations under the 1990 non-Treaty storage agreement between the Entities relating to the use of non-Treaty storage, refill enhancement for Mica and Arrow reservoirs, and initial filling of non-Treaty reservoirs did not conflict with Treaty operations. Flood control operations on a daily basis were not required this year. (pages 27-35)

Studies pertaining to development of the hydrometeorological network, power operating plans and calculations of downstream power benefits are being continued by the Entities to ensure compliance with the terms of the Treaty. With respect to the calculation of downstream power benefits, the Entities have agreed that there is no independent capacity credit end point calculation. (pages 20-25)

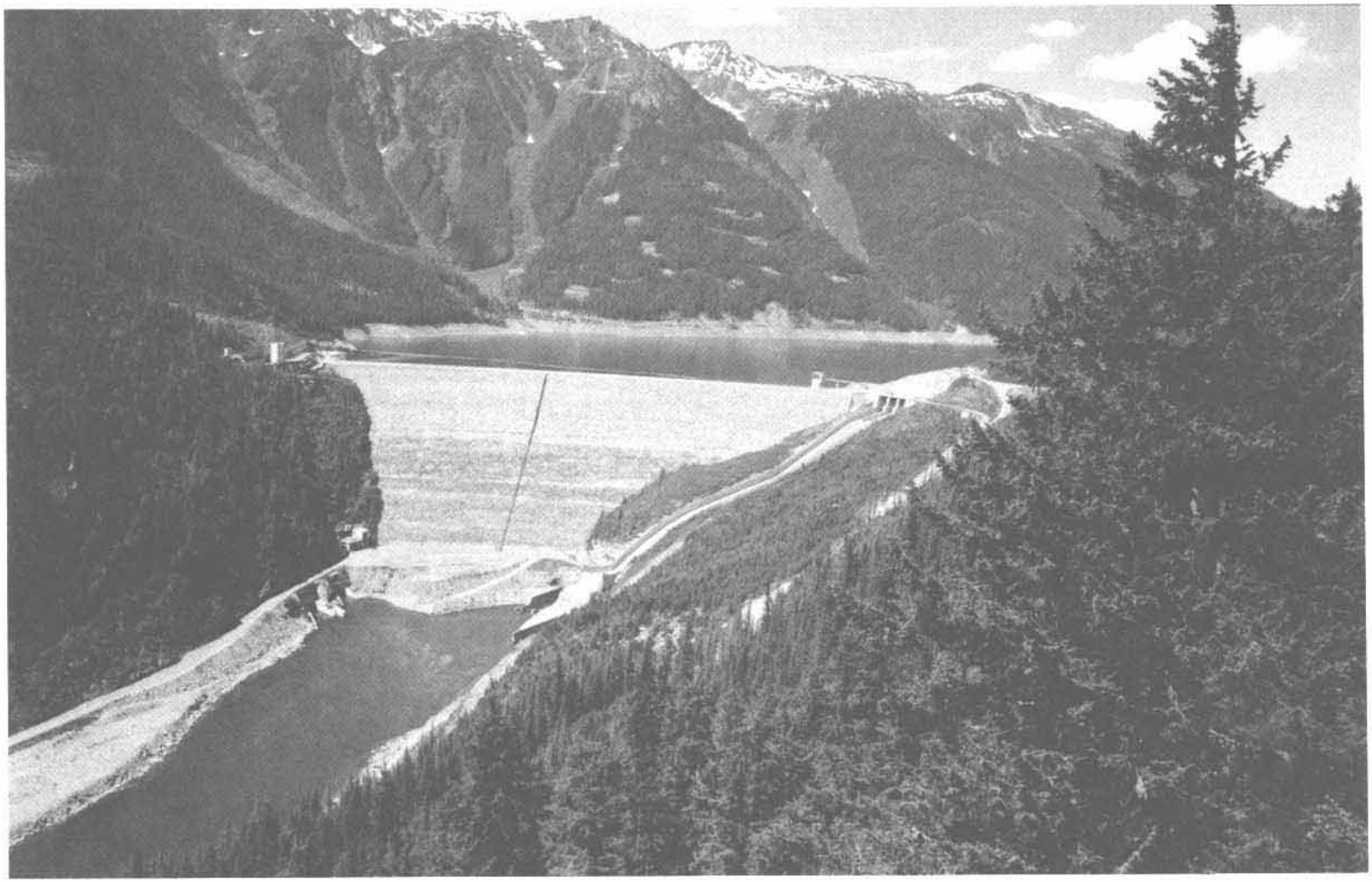
During the year, the Entities entered into an agreement which specifies methods of delivery of downstream benefits to Canada during the period 1 April 1998 through 31 March 2003. The Assured Operating Plan and Determination of Downstream Power Benefits for 1997-98 specifies that 50.0 megawatts of average annual energy and 111.1 megawatts of capacity are returnable to Canada for the period 1 April 1998 through 31 July 1998 from operation of Duncan reservoir storage. (page 22)

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

INTRODUCTION

The Columbia River Treaty, which provides for cooperative 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 1991 through 30 September 1992, 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. Summaries of the essential features of the Treaty and of the responsibilities of the Board and of the Entities are included. The report refers to items currently under review by the Entities, provides discussion regarding the operations of the Treaty reservoirs and of the resulting power and flood control benefits, and presents the conclusions of the Board.



MICA DAM Columbia River, British Columbia
The earth dam showing the spillway at the right. The underground powerhouse is at the left.

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 of the United States, Prime Minister Pearson of Canada, 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 streamflow 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 benefit available 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. 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. It is noted that on 14 September 1992, Mr. Vic Niemela succeeded Mr. Mac Clark as an alternate member for Canada.

The names of the current members of the Board's Engineering Committee are also shown in Appendix A.

Duties and Responsibilities

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;

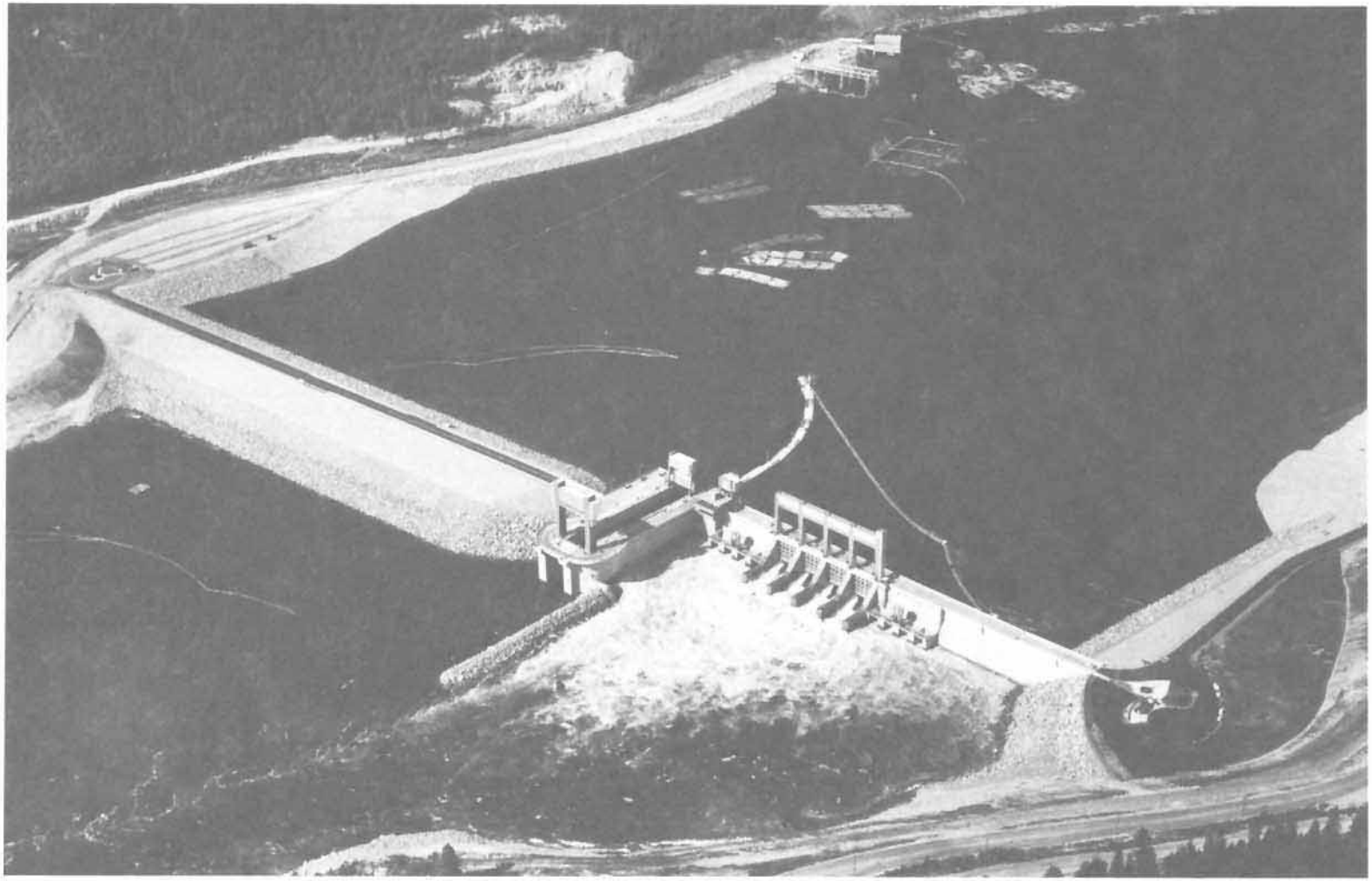
(c) assisting in reconciling differences concerning technical or operational matters that may arise between the entities;

(d) making periodic inspections and requiring reports as necessary from the entities and 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.



HUGH KEENLEYSIDE DAM Columbia River, British Columbia
Concrete spillway and discharge works with navigation lock and earth dam.

ENTITIES

General

Article XIV(1) of the Treaty provides that Canada and the United States shall each designate one or more entities to formulate and execute the operating arrangements necessary to implement the Treaty. The powers and duties of the entities are specified in the Treaty and its 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 the Bonneville Power Administration was transferred to the Department 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.

The names of the members of the two Entities are shown in Appendix B. It is noted that on 22 November 1991, Mr. Randall W. Hardy became Chairman of the United States Entity replacing Mr. Jack Robertson, the Acting Chairman. Also, on 25 June 1992, Mr. Norman Olsen succeeded Mr. Robert Wyman as Chairman of the Canadian Entity.

Powers and Duties of the Entities

In addition to the powers and duties specified elsewhere in the Treaty and related documents, Article XIV(2) of the Treaty requires that the entities be responsible for:

(a) coordination 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 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 cooperating 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

The Board met in Portland, Oregon on 3 December 1991 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. The Board also met in Vancouver, British Columbia on 14 September 1992 to review progress under the Treaty. On the same day the Board met with the Entities to receive a briefing on the status of Entity discussions regarding capacity credit limitation under the Treaty.

On 15, 16 and 17 September the Board made an inspection of Treaty projects and visited three related power projects. Inspection tours were conducted at the Mica, Hugh Keenleyside and Libby projects, and the Duncan project was viewed from the air. The Board also visited the B.C. Hydro Revelstoke Dam and Kootenay Canal Project, both made feasible by the Treaty, and the Bureau of Reclamation's Grand Coulee Dam.

Reports Received

Throughout the report year the Canadian Entity provided the Board with reports on operation of the Canadian storage reservoirs and with flow forecasts during the freshet season for the northern part of the Columbia River basin. The United States Entity provided reports on the operation of the Libby storage reservoir. The Entities made copies of computer printouts of studies for the Assured Operating Plan and Determination of Downstream Power Benefits available for review and provided the following documents and reports to the Board:

— Annual Report of the Columbia River Treaty Canadian and United States Entities for the period 1 October 1990 through 30 September 1991

— Detailed Operating Plan for Columbia River Treaty Storage 1 August 1991 through 31 July 1992, November 1991, plus a copy of the Entities' agreement on this document

— Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1996-97, February 1992, plus a copy of the Entities' agreement on this document

— Analysis of the Columbia River Treaty Capacity Credit Dispute, June 5, 1992, B.C. Hydro and Power Authority

— Attachments and Documents for Analysis of the Columbia River Treaty Capacity Credit Dispute

— Columbia River Treaty Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans, December 1991, plus a copy of the Entities' agreement on this document

— Letter agreement, dated 22 June 1992, between Bonneville Power Administration and B.C. Hydro and Power Authority to provide for the exchange of storage between Duncan and Libby reservoirs

— Columbia River Treaty Entity Agreement on Aspects of the Canadian Entitlement Return for April 1, 1998 through March 31, 2003, dated 28 July 1992.

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

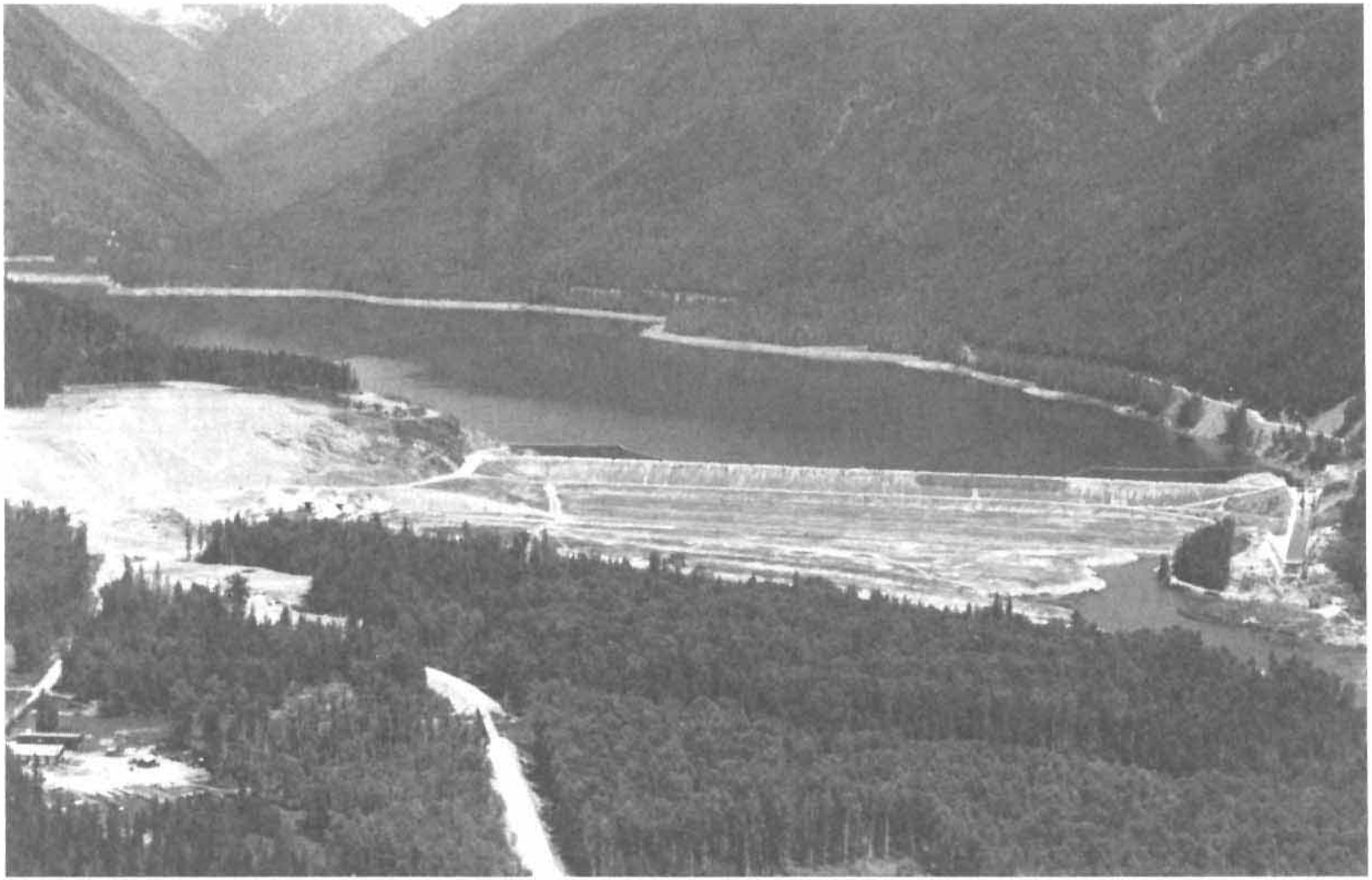
— Annual Report of the Columbia River Treaty Canadian and United States Entities for the period 1 October 1991 - 30 September 1992

— Detailed Operating Plan for Columbia River Treaty Storage 1 August 1992 through 31 July 1993, plus a copy of the Entities agreement

— Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1997-98, October 1992, plus a copy of the Entities agreement

Report to Governments

The twenty-seventh Annual Report of the Board was submitted to the two governments on 31 December 1991.



DUNCAN DAM Duncan River, British Columbia
The earth dam with discharge tunnels to the left and spillway to the right.

PROGRESS

General

The results achieved under the terms of the Treaty include construction of the Treaty projects, development of the hydrometeorological network, annual preparation of 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 – produce power and flood control benefits in Canada and the United States. The Libby storage project also provides power and flood control benefits in both countries. In the United States increased flow regulation provided by Treaty projects has facilitated the installation of additional generating capacity at existing plants on the Columbia River. In Canada completion of the Canal Plant on the Kootenay River in 1976, installation of generators at Mica Dam in 1976-77 and the completion of the Revelstoke project in 1984 have caused power benefits to increase substantially. This amounts to some 4,000 megawatts of generation in Canada that may not have been installed without the Treaty. In addition, the installation of generating capacity at Hugh Keenleyside Dam and at the Murphy Creek Site near Trail, British Columbia is planned for the future.

The Treaty provides Canada with an option, which commenced in 1984, of diverting the Kootenay River at Canal Flats into the headwaters of the Columbia River. The British Columbia Hydro and Power Authority has completed engineering feasibility and detailed environmental studies of the potential diversion. No further activities are planned at this time.

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 is about 130 feet high and extends 2,600 feet across the Duncan River valley, approximately six 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.

The project is shown in the picture on page 15 and project data are provided 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 at present has no associated power facilities, however, installation of generators is planned for the future.

The dam consists of two main components: a concrete gravity structure which extends 1,200 feet from the north bank of the river and includes the spillway, low-level outlets and navigation lock; and an earthfill section which rises 170 feet above the riverbed and which extends 1,650 feet from the navigation lock to the south bank of the river. 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 8 and project data are provided 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 extends 2,600 feet across the Columbia River valley. It creates a reservoir 135 miles long, Kinbasket Lake, with a total 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.

Although not required by the Treaty, a powerhouse was added to the project by B.C. Hydro and Power Authority. The underground powerhouse has space for a total of six 434 megawatt units with a total capacity of 2,604 megawatts. At present four generators are in operation for a total of 1,736 megawatts.

The project is shown in the picture on page 2 and project data are provided 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 is 3,055 feet long, rises 370 feet above the riverbed and creates Lake Koocanusa which is 90 miles long and extends 42 miles into Canada. Lake Koocanusa has a gross storage of 5,869,000 acre-feet, of which 4,980,000 acre-feet are usable for flood control and power purposes. The Libby powerhouse, completed in 1976, has four units with a total installed capacity of 420 megawatts.

Construction of four additional units was initiated during fiscal year 1978 and the turbines have been installed. However, Congressional restrictions imposed in the 1982 Appropriations Act provide for completion of only one of these units. That unit became available for service late in 1987. The total installed capacity for the five units is 525 megawatts.

The Libby project is shown in the picture on page 23 and project data are provided 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 Koocanusa in Canada. British Columbia Hydro and Power Authority is now responsible for reservoir maintenance, debris clean-up and shoreline activities.

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.

In the 1985-86 report year the Entities provided the Board with a report "Revised Hydrometeorological Committee Documents", dated November 1985. The list of hydrometeorological facilities included in this document, which constitute the network, was updated by the Entities in 1987, 1989 and 1990.

Power Operating Plans and Annual Calculation of Downstream Benefits

The Treaty and related documents require the Entities 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 commitment of the Canadian Entity to operate the Treaty storage and provide the Entities with a basis for system planning. Canada's commitment to operate under an Assured Operating Plan is tied directly to the benefits produced by that plan. At the beginning of each operating year, a Detailed Operating Plan which includes Libby reservoir 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.

Near the end of the 1987-88 report year the Entities signed two agreements relating to changes in the principles and procedures used in preparing the assured operating plans and in calculating downstream power benefits. These agreements were based on Entity studies of the impact of several proposed changes to Treaty reservoir operating procedures and to the determination of downstream power benefits. Specific changes resulting from the agreements include the use of updated streamflows in all steps of the calculations, updated estimates of irrigation withdrawals and return flows, a revised definition of power loads and generating resources, the use of updated power system operating technology, and consistent application of operating procedures through all steps of the calculations. The Board agrees with the Entities' view that these studies represent the most thorough and complex examination of the technical aspects of the Columbia River Treaty since the ratification in 1964.

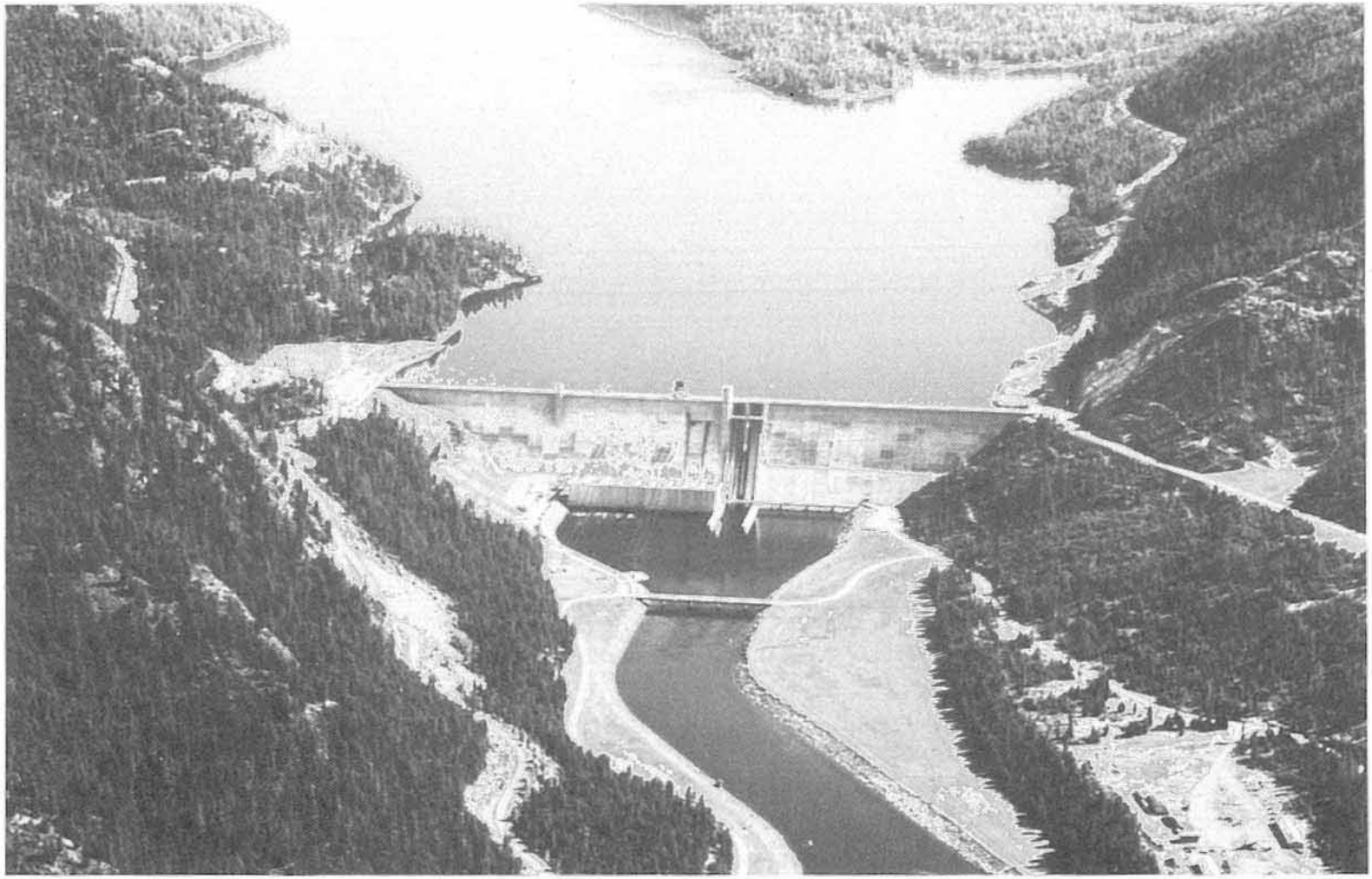
The Board also agrees that the changes provided in the two Entity agreements resolved the concerns which the Board had expressed in annual reports prior to 1988.

The document "Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1996-97" was provided to the Board during this operating year, and the document "Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1997-98" was provided following the end of the report year. These documents follow the same basic approach used in previous years, providing for optimum generation in both countries. They are the fifth and sixth assured operating plans based on the 1988 principles and procedures. Neither of these plans include firm energy shifting as part of the United States optimum operation.

The use of half-months in the critical period of the Step III studies used to determine downstream benefits was brought to the attention of the Entities during the 1989-90 report year. The Board has reserved judgment on this practice of using half-months pending the Entities' review and further Board consideration.

Streamflows used in these Assured Operating Plans were derived from the 1980 level Modified Streamflows with irrigation depletion estimates interpolated between the 1980 and 2030 values. The Entities are updating actual and projected irrigation depletion data.

The Board notes that the Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1997-98 determines a power entitlement of 50.0 megawatts of average annual energy and 111.1 megawatts of capacity resulting from operation of Duncan reservoir. These entitlements are not covered by the existing sales agreement and are the first downstream benefits due to be returned to Canada that have not been previously sold to the United States. During the year the Entities entered into an agreement which specifies methods of delivery of downstream benefits to Canada during the period 1 April 1998 through 31 March 2003. The Board has been briefed by the Entities on the status of planning for the return of downstream benefits to Canada, beginning in the 1997-98 operating year.



LIBBY DAM Kootenai River, Montana
The dam and reservoir, Lake Koocanusa. The powerhouse is at the left of the spillway.

Early in this report year the Entities provided the Board with the Detailed Operating Plan for Canadian Treaty storage and Libby reservoir for the operating year ending 31 July 1992. The Detailed Operating Plan for the operating year ending 31 July 1993 was forwarded to the Board after the end of the report year and is under review. These plans contain criteria for operating the Arrow, Duncan, Mica and Libby reservoirs.

In April 1984 the Entities reached a long term storage agreement relating to the initial filling of non-Treaty reservoirs, the use of non-Treaty storage and Mica and Arrow reservoirs refill enhancement. In July 1990 the Entities signed a new non-Treaty Storage Agreement which extends the previous agreement by ten years, expands the amount of coordinated non-Treaty storage to be operated under the agreement and shares the responsibility to fill any new Columbia River reservoir built in British Columbia. This expanded storage agreement went into effect during the 1990-91 report year. The Board notes that this agreement will not interfere with operations under the Treaty, extends the concepts of the Treaty, and is expected to benefit both Entities.

The Northwest Power Planning Council was established by Act of Congress in 1980 to prepare a program for improvement of fish and wildlife in the Columbia River basin and to develop a conservation and electric power plan for the Pacific Northwest. The Council, on 15 November 1982, adopted the Columbia River Basin Fish and Wildlife Program which establishes a water budget. This budget reserves 3.45 million acre-feet of storage upstream from Priest Rapids Dam on the Columbia River and 1.19 million acre-feet upstream from Lower Granite Dam on the Snake River. This storage is used by United States' project operators when it is required to improve low flows in the main rivers during the downstream migration of anadromous fish. Fisheries and native Indian interests control use of the storage for this purpose. The use of storage from Treaty reservoirs in Canada is advocated by the United States Northwest Power Planning Council in its Fish and Wildlife Program.

With regard to the use of Treaty storage to meet water budget purposes, the Board has stated in previous reports that the assured operating plans are to provide for optimum operation for power and flood control. The Board has also noted, however, that the Entities may agree to provide water for fish migration under detailed operating arrangements providing this does not conflict with Treaty requirements.

The Treaty specifies both the method for calculating dependable hydroelectric capacity to be credited to Canadian storage and a means for determining a limit which the capacity credit must not exceed. The Entities agree on the method for calculating the capacity credit; i.e. the benefit which accrues from Treaty storage in Canada in meeting peak loads in the system. However, the appropriate approach for calculating limitations to the capacity credit is still being evaluated by the Entities.

For the past several years the Entities were unable to agree on whether, during the negotiation of the Treaty and associated documents, there had been agreement among the negotiators for a separate capacity credit end point calculation not specifically defined in the Treaty documents. However, near the end of this report year the Entities agreed that there is no independent end point calculation. The Board has reviewed this matter and agrees with the Entities' conclusion. Several other aspects of preparing assured operating plans and determining downstream power benefits are still under evaluation by the Entities. The Board looks forward to the complete resolution of these matters within the coming 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 and is still in effect.

Flow Records

Article XV(2)(a) of the Treaty specifies that the Permanent Engineering Board shall assemble records of flows of the Columbia and Kootenay Rivers at the Canada-United States of America boundary. Flows for this report year are tabulated in Appendix C for the Kootenai River at Porthill, Idaho and for the Columbia River at Birchbank, 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 Treaty and subsequent 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 1991 through 31 July 1992

— Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1991-92

— Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1992-93

— Columbia River Treaty Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans, December 1991

In addition, the following agreements were in effect during this period:

— An agreement between the Entities dated 9 April 1984 relating to:

  — Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration Relating to: (1) Initial Filling of non-Treaty Reservoirs, (2) The Use of Columbia River non-Treaty Storage and (3) Mica and Arrow Reservoir Refill Enhancement

— Contract between Bonneville Power Administration and Mid-Columbia Purchasers Relating to Federal and Canadian Columbia River Storage

— Agreement executed by the United States of America Department of Energy acting by and through the Bonneville Power Administration and British Columbia Hydro and Power Authority relating to: (1) Use of Columbia River non-Treaty Storage, (2) Mica and Arrow Refill Enhancement and (3) Initial Filling of non-Treaty Reservoirs, signed 9 July 1990

— Columbia River Treaty Entity Agreement on Principles for the Preparation of the Assured Operating Plan and Determination of Downstream Power Benefits, July 1988

— Columbia River Treaty Entity Agreement on Changes to Procedures for the Preparation of the Assured Operating Plan and Determination of Downstream Power Benefit Studies, August 1988

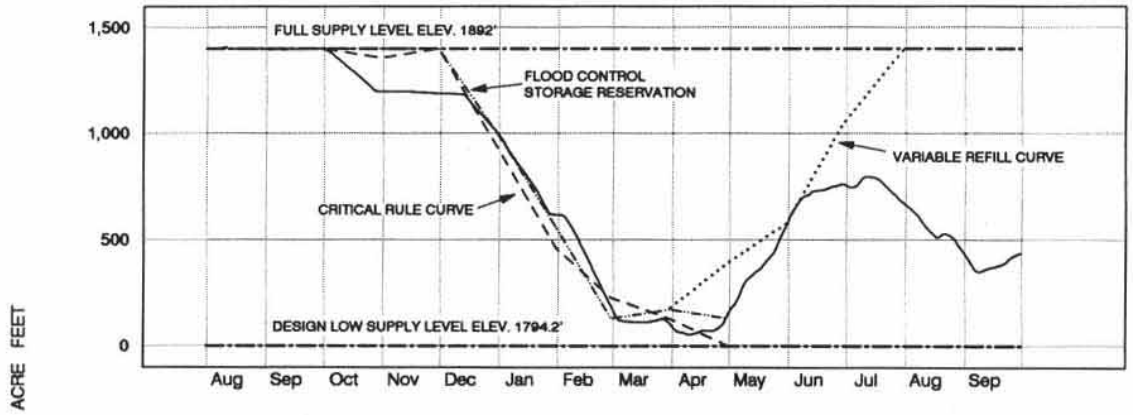
— Letter agreement, dated 22 June 1992, between Bonneville Power Administration and B.C. Hydro and Power Authority to provide for the exchange of storage between Duncan and Libby reservoirs

— Columbia River Treaty Entity Agreement on Aspects of the Canadian Entitlement Return for April 1, 1998 through March 31, 2003, dated 28 July 1992.

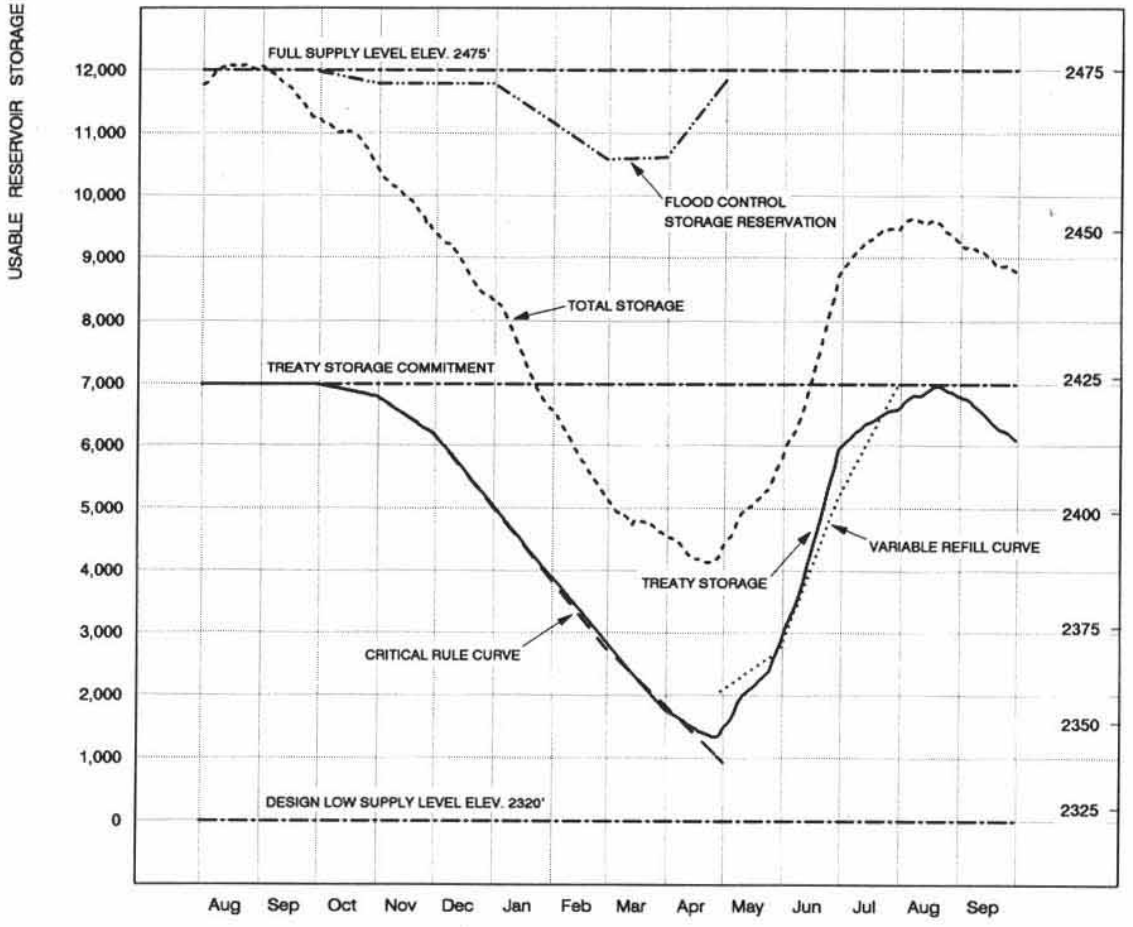
Power Operation

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

All Treaty storage and the Libby reservoir filled during the summer of 1991 and the coordinated system was operated at the start of the operating year in accordance with the first year critical rule curves. However, by the start of the report year very dry weather had set in over the basin and the system began operating under proportional draft, with reservoirs drafted between the first and second year rule curves through December. Proportional draft was not required in January, February and March but was again instituted in April, continuing through the rest of the report year.

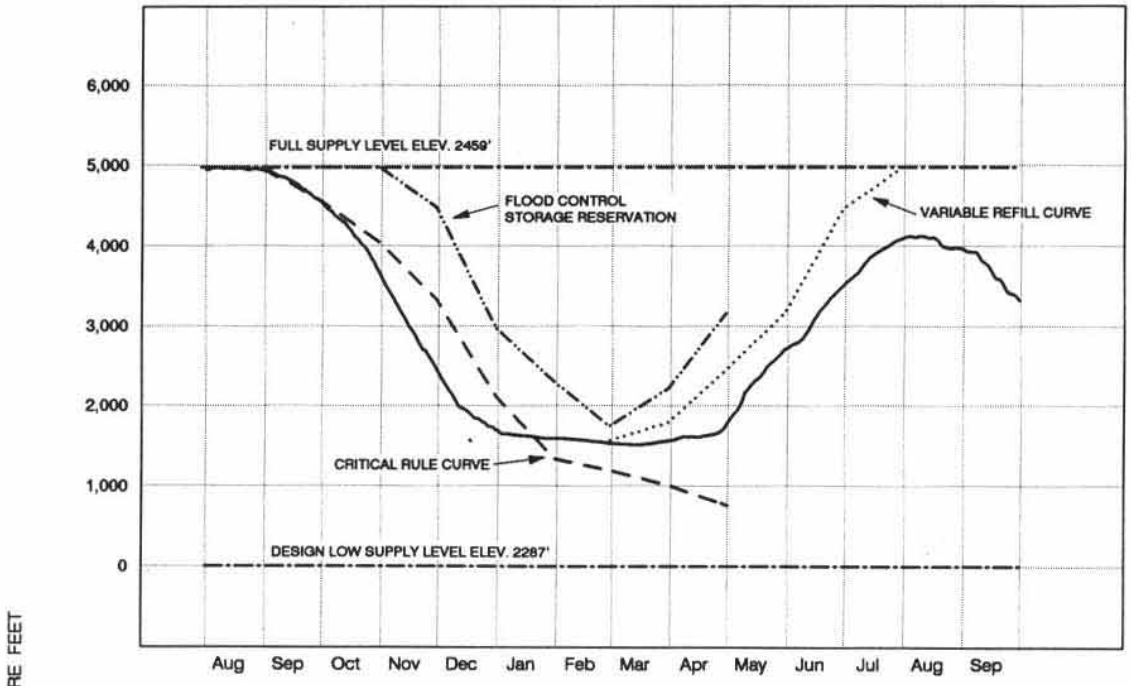


DUNCAN RESERVOIR

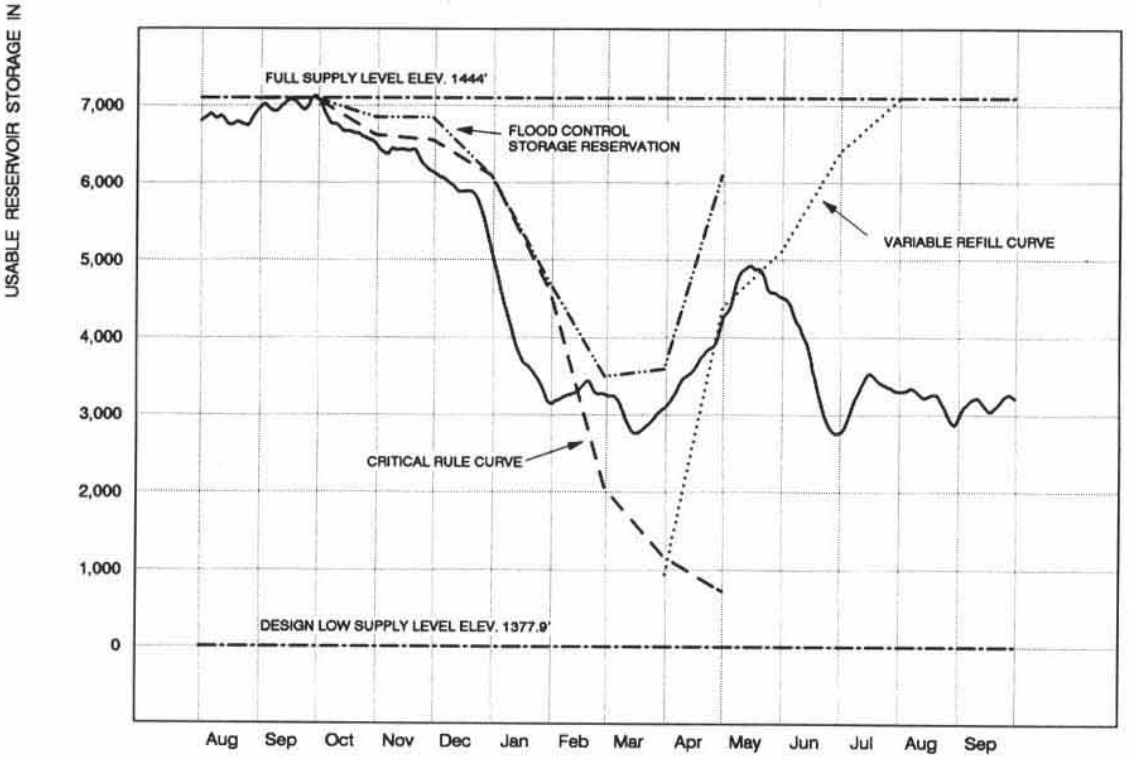


MICA RESERVOIR

HYDROGRAPHS - Duncan and Mica reservoir levels for the 14-month period ending 30 September 1992.



LIBBY RESERVOIR



ARROW RESERVOIR

USABLE RESERVOIR STORAGE IN 1,000 ACRE FEET

HYDROGRAPHS - Libby and Arrow reservoir levels for the 14-month period ending 30 September 1992.

The weather during the report year was drier and warmer than normal. Low snow packs through the winter resulted in a much reduced freshet during the spring and summer of 1992. Greater than average precipitation in June and July was not sufficient to make up for the very dry winter, and reservoirs did not fill over the summer period.

During the summer months storage was transferred from Duncan to Libby reservoir under a storage transfer agreement between the B.C. Hydro and Bonneville Power Administration. This was undertaken to help mitigate the effects of low inflows and very low water levels on Lake Koocanusa. These storage transfers were accomplished without disrupting Treaty operations.

Commencing in the 1984 report year, operation in the United States incorporated requirements of the Northwest Power Planning Council's Fish and Wildlife Program. This program specifies a water budget for use in meeting minimum flow requirements for the downstream migration of anadromous fish. In this report year, water budget flows were released during May and June.

Operation of the reservoirs is illustrated on pages 30 and 31 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 forecast 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 Treaty storages have also been provided to the Board.

Mica reservoir began the report year at elevation 2,467.9 feet, about seven feet below full supply level, after having been completely full in August 1991. Drafting of Treaty storage began 1 October, and both Treaty and non-Treaty storage was drafted at a high rate through the end of February. Drafting continued through March and April, though at a much reduced rate. The reservoir reached its lowest level, 2,389.7 feet, on 23 April with 1.4 million acre-feet of Treaty storage remaining.

In late April, a heavy rainstorm started the refill process which continued at a slow but steady rate through May and June. The reservoir continued to fill at a reduced rate through July and the first part of August, on 7 August reaching its peak elevation, 2,451.8 feet, twenty-three feet below full pool. Although the reservoir began drafting due to release of non-Treaty storage, Treaty storage continued to fill and reached 99.6% capacity on 21 August. At the end of September 1992, Mica reservoir was at elevation 2,443.0 feet.

Arrow reservoir began the report year full at elevation 1,444.1 feet, then immediately began drafting in October. Drafting continued until February when reduced outflows allowed the reservoir to refill slightly. Drafting resumed in March and the reservoir reached its lowest level prior to the spring freshet at 1,407.4 feet on 17 March.

During the last half of March, outflows were kept low to facilitate fisheries studies at Norns Creek downstream of the dam and to ensure that trout spawning in the Norns Creek fan occurred at low river levels. Low Arrow discharges during this period supported the United States Entity's plan to store additional water in Arrow reservoir for later release to assist in fish flows. The reservoir rose until 14 May when it reached its peak elevation of the summer at 1,426.3 feet, substantially higher than normal for that time of year, but 17.7 feet below full supply level.

A very low runoff volume forecast for the Columbia River basin caused power discharge requirements to increase, and reservoir outflows were increased several times during the mid-May to mid-June period. Reservoir levels again fell and reached the minimum level for the year at 1,407.2 feet on 28 June. Discharges were then reduced and the reservoir refilled by about seven feet before drafting continued again in mid-July. Reservoir levels fell gradually throughout August and September and Arrow reservoir was at elevation 1,411.6 feet at the end of September.

At the start of the report year, Duncan reservoir was at its full supply level of 1,892 feet. Drafting occurred throughout October, then stopped until mid-December. Drafting resumed in December and continued until 5 March. A further draft, beginning 28 March, brought the reservoir to its lowest level of the year, 1,800.2 feet, by 10 April.

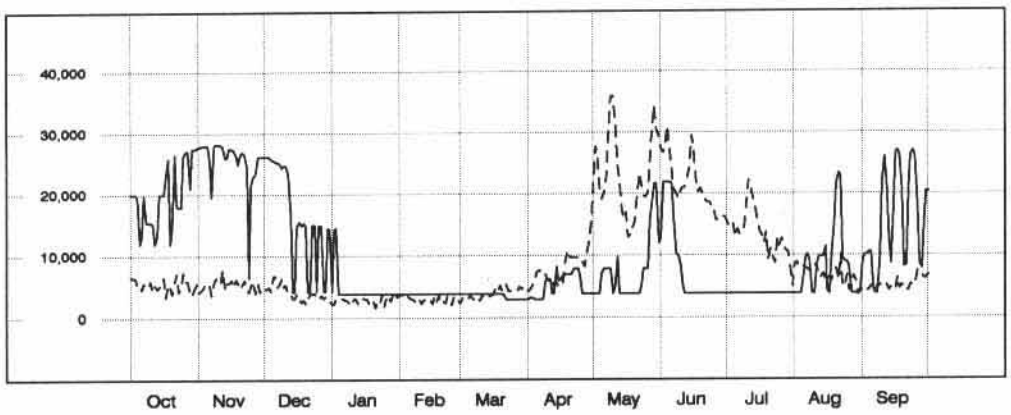
Refill began 24 April and Duncan reservoir reached elevation 1,850.1 feet by 9 June. At that time, an agreement between Bonneville Power Administration and B.C. Hydro was undertaken to transfer storage from Duncan reservoir to Libby reservoir, to enhance summer levels in Lake Koocanusa. The reservoir continued to rise slowly until its peak of 1,856.1 feet on 11 July. This peak was 36 feet below full pool elevation and was the lowest recorded peak for Duncan reservoir. Drafting then continued through the end of September. Duncan reservoir ended the report year at elevation 1,831.9 feet.

Libby reservoir began the report year at elevation 2,449.6 feet, 9.4 feet below full supply level, after having filled in July 1991. The reservoir drafted rapidly from 1 October through 12 December. In January low water supply forecasts resulted in a hold on further drafting in order to improve refill probabilities. The reservoir was lightly drafted through January to March, reaching its lowest level of 2,362.2 feet on 14 March.

The snowmelt runoff, which began in late April, was relatively small and earlier than normal. Near the end of May, Bonneville Power Administration requested an increase in Libby outflow, which combined with low inflows kept the reservoir low and brought many complaints from recreational users of Lake Koocanusa in Canada and the United States. To alleviate these concerns, B.C. Hydro and Power Authority and Bonneville Power Administration reached an agreement that permitted B.C. Hydro to store water in Libby reservoir by replacing the Libby outflows with releases from Duncan reservoir. This storage transfer arrangement began 10 June and continued until 4 August when B.C. Hydro ceased storing into Libby reservoir. The reservoir was then drafted through September, ending the report year at elevation 2,420.3 feet.

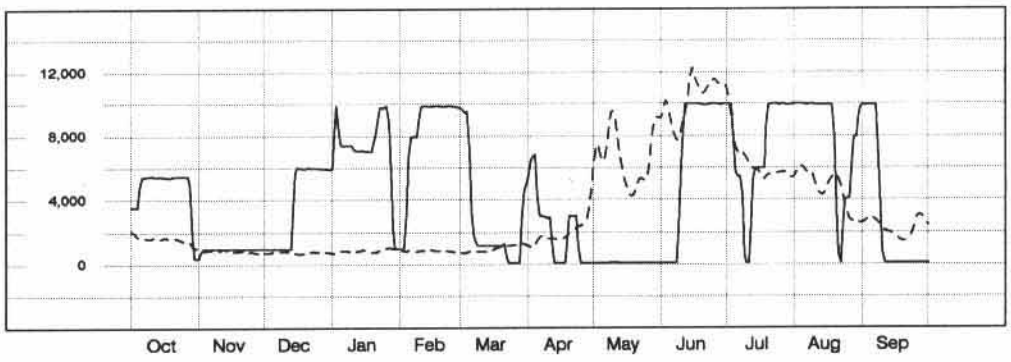
Flood Control Operation

During the 1992 freshet, flood control was provided by normal refill of Treaty projects and other storage reservoirs in the Columbia River basin. Daily operation of reservoirs for flood control was not required. The freshet was controlled to well below damaging levels.

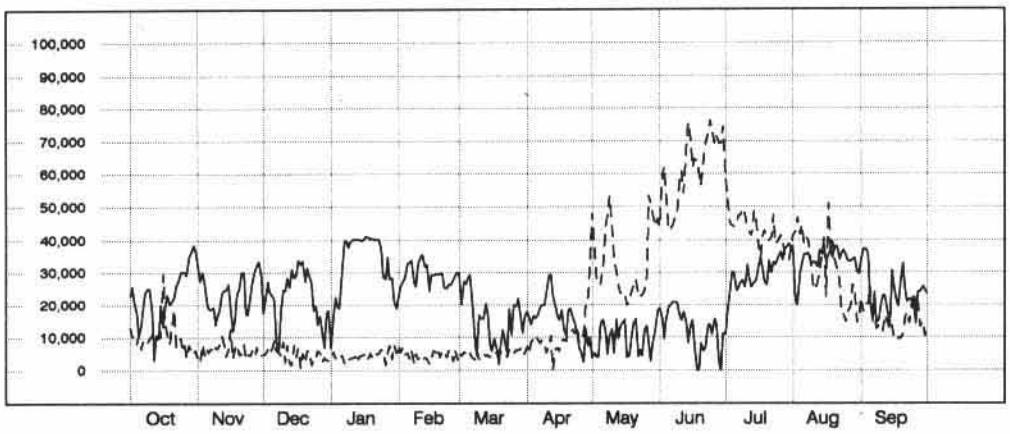


KOOTENAI RIVER AT LIBBY DAM

DISCHARGE IN CUBIC FEET PER SECOND



DUNCAN RIVER AT DUNCAN DAM

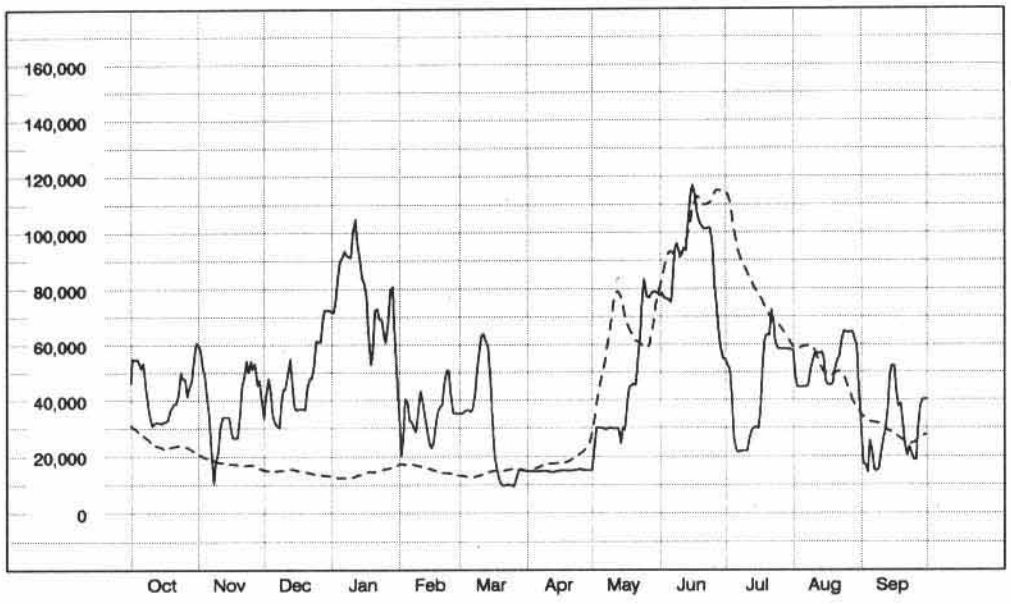


COLUMBIA RIVER AT MICA DAM

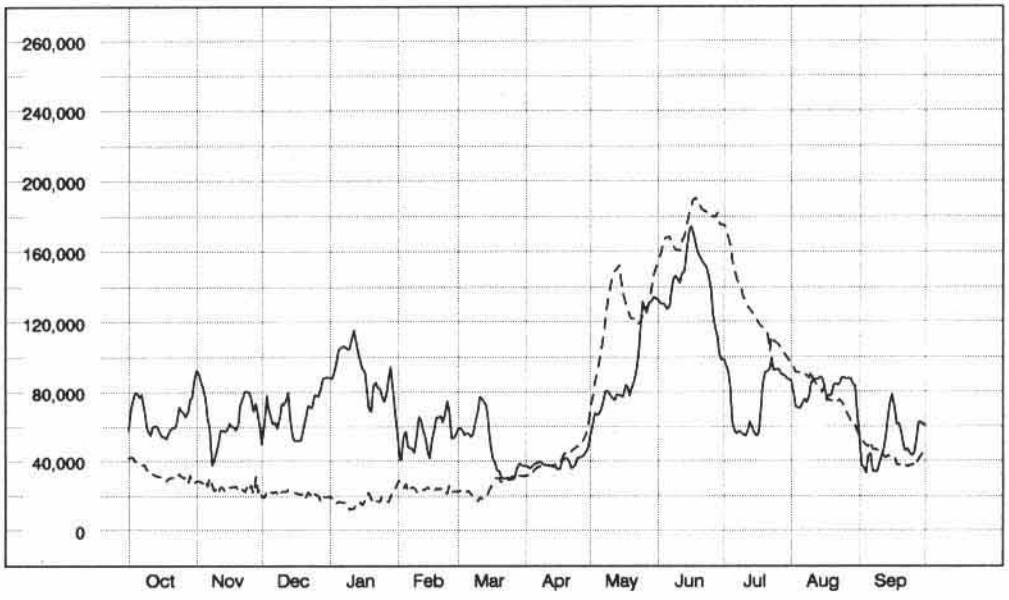
——— Observed Flows
– – – Pre-Project Flows

HYDROGRAPHS - Observed and pre-project flows
for year ending 30 September 1992

DISCHARGE IN CUBIC FEET PER SECOND



COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM



COLUMBIA RIVER AT BIRCHBANK

——— Observed Flows
– – – Pre-Project Flows

HYDROGRAPHS - Observed and pre-project flows
for year ending 30 September 1992

BENEFITS

Flood Control Provided

Without regulation by upstream reservoirs, the 1992 freshet would have produced low freshet levels at Trail, British Columbia and at The Dalles, Oregon and would not have caused flood damage in the United States.

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about 1.4 feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by about 2.7 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 pages 36 and 37 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 328,000 cfs to 232,000 cfs.

All payments required by Article VI(1) as compensation for flood control provided by the Canadian Treaty storage 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.

Power Benefits

Downstream power benefits in the United States which arise from operation of the Canadian Treaty storage were pre-determined for the first thirty years of operation of each project 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 delivers capacity and energy to Columbia Storage Power Exchange participants as purchasers of the Canadian Entitlement. The benefits of additional generation made possible on the Kootenay River in Canada as a result of regulation provided by Libby, and generation at the Mica and Revelstoke projects, are retained wholly within Canada. The benefits from Libby regulation which occur downstream in the United States are not shareable under the Treaty.

During the operating year, 1 August 1991 through 31 July 1992, the downstream power benefits accruing to each country from the Treaty storage were 587.3 megawatts of average annual energy and 1,428.9 megawatts capacity.

The Canadian Entitlement Purchase Agreement terminates in stages beginning in 1998.

The portion of Canada's share of downstream power benefits attributable to each of the Treaty projects is the ratio of each project's storage to the whole of the Canadian Treaty storage. Accordingly, Canada's share of the downstream power benefits returnable from each project is:

Duncan storage	beginning 1 April 1998	9.0%
Arrow storage	beginning 1 April 1999	45.8%
Mica storage	beginning 1 April 2003	45.2%

After 1 April 2003, Canada's share of downstream benefits is fully returnable.

Other Benefits

By agreement between the Entities, streamflows are 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 implemented under the Detailed Operating Plan and provide mutual benefits.

CONCLUSIONS

1. The Duncan, Arrow, Mica and Libby projects have been operated in conformity with the Treaty. Operation reflected detailed operating plans developed by the Entities, the flood control operating plan for Treaty reservoirs, and the 1990 non-Treaty storage agreement between the Entities relating to the use of non-Treaty storage, refill enhancement of Mica and Arrow reservoirs, and initial filling of non-Treaty reservoirs. Operation under this agreement did not conflict with normal Treaty operations.

2. The Entities have reached agreement on the Detailed Operating Plan for Columbia River Treaty Storage for 1992-93.

3. The Entities are continuing to develop the hydrometeorological network and power operating plans and to calculate power benefits as required by the Treaty.

4. The Assured Operating Plan and Determination of Downstream Power Benefits for 1997-98, the first document to contain benefits not covered by the Sales Agreement, was received following the end of the report year. This document specifies that 50.0 megawatts of average annual energy and 111.1 megawatts of capacity are returnable to Canada for the period 1 April 1998 through 31 July 1998 from operation of Duncan reservoir storage.

5. The Entities are continuing to develop plans for the return of downstream benefits to Canada commencing in operating year 1997-98. The Entities have reached an interim agreement covering the period 1 April 1998 through 31 March 2003, which specifies methods and points of delivery of downstream benefits to Canada.

6. Near the end of this report year the Entities agreed that there is no independent capacity credit end point calculation. The Entities are continuing to review other processes used in the preparation of assured operating plans and determination of downstream power benefits.

7. Storage transfers during the year between Duncan and Libby reservoirs under an agreement between B.C. Hydro and Power Authority and Bonneville Power Administration did not interfere with Treaty operations.

8. The objectives of the Treaty are being met.

APPENDIX A

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

Members

United States	Canada
Mr. Herbert Kennon, Chairman Deputy Director Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, DC	Mr. David Oulton, Chairman Assistant Deputy Minister Energy Sector Energy, Mines and Resources Canada Ottawa, Ontario
Mr. Ronald Wilkerson 4655 Highway 200 East Missoula, Montana	Mr. John Allan Deputy Minister Ministry of Energy, Mines and Petroleum Resources Victoria, BC

Alternates

Mr. John Elmore Chief, Operations, Construction and Readiness Division Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, DC	Mr. Vic Niemela 1) Regional Director Environmental Conservation Directorate Environment Canada Vancouver, BC
Mr. Thomas Weaver Assistant Administrator for Engineering Western Area Power Administration Department of Energy Golden, Colorado	Dr. Donald Kasianchuk Comptroller of Water Rights Ministry of Environment, Lands & Parks Victoria, BC

Secretaries

Mr. Shapur Zanganeh Hydraulics and Hydrology Branch Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, DC	Mr. Mac Clark 4376 Starlight Way North Vancouver, BC

1) Vice Mr. Mac Clark as of 14 September 1992.

APPENDIX A

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

Record of Membership

Members

United States		Canada	
Mr. Wendell Johnson 1)	1964-1970	Mr. Gordon MacNabb 1)	1964-1991
Mr. Morgan Dubrow	1964-1970	Mr. Arthur Paget	1964-1973
Mr. John Neuberger	1970-1973	Mr. Valter Raudsepp	1973-1974
Mr. Joseph Caldwell 1)	1971-1973	Mr. Ben Marr	1974-1987
Mr. Homer Willis 1)	1973-1979	Mr. Tom Johnson	1987-1988
Mr. King Mallory	1973-1975	Mr. Douglas Horswill	1989-1991
Mr. Raymond Peck, Jr.	1976-1977	Mr. John Allan	1991-
Mr. Emerson Harper	1978-1988	Mr. David Oulton 1)	1991-
Mr. Lloyd Duscha 1)	1979-1990		
Mr. Ronald Wilkerson	1988-		
Mr. Herbert Kennon 1)	1990-		

Alternates

Mr. Fred Thrall	1964-1974	Mr. Mac Clark	1964-1992
Mr. Emerson Harper	1964-1978	Mr. Jim Rothwell	1964-1965
Mr. Alex Shwaiko	1974-1987	Mr. Hugh Hunt	1966-1988
Mr. Thomas Weaver	1979-	Dr. Donald Kasianchuk	1988-
Mr. Herbert Kennon	1987-1990	Mr. Vic Niemela 2)	1992-
Mr. John Elmore	1990-		

Secretaries

Mr. John Roche	1965-1969	Mr. Mac Clark	1964-
Mr. Verle Farrow	1969-1972		
Mr. Walter Duncan	1972-1978		
Mr. Shapur Zanganeh	1978-		

1) Chairman.
2) Vice Mr. Mac Clark as of 14 September 1992.

APPENDIX A

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

ENGINEERING COMMITTEE

Current Membership

United States	Canada
Members	
Mr. Shapur Zanganeh, Chairman Hydraulics and Hydrology Branch Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, DC	Mr. Neill Lyons, Chairman Environmental Conservation Directorate Environment Canada North Vancouver, BC
Mr. Gary Fuqua Office of Energy Resources Bonneville Power Administration Portland, Oregon	Mr. David Burpee Electricity Branch Energy, Mines and Resources Canada Ottawa, Ontario
Mr. Larry Eilts Western Area Power Administration Department of Energy Golden, Colorado	Mr. Roger McLaughlin Energy Resources Division Ministry of Energy, Mines and Petroleum Resources Victoria, BC
Mr. Earl Eiker Hydraulics and Hydrology Branch Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, DC	Mr. Robin Round Water Management Division Ministry of Environment, Lands & Parks Victoria, BC
Alternates	
Mr. Richard Mittelstadt Water Management Division U.S. Army Corps of Engineers North Pacific Division Portland, Oregon	
Mr. Steve Wright Bonneville Power Administration Department of Energy Washington, DC	

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

United States	Canada
Members	
Mr. Randall Hardy, Chairman 1) Administrator, Bonneville Power Administration Department of Energy Portland, Oregon	Mr. Norman Olsen, Chairman 2) Chairman, British Columbia Hydro and Power Authority Vancouver, BC
Major General Ernest Harrell Division Engineer U.S. Army Engineer Division, North Pacific Portland, Oregon	

1) Vice Mr. Jack Robertson as of 22 November 1991.
2) Vice Mr. Robert Wyman as of 25 June 1992.

APPENDIX C

RECORD OF FLOWS

AT THE

INTERNATIONAL BOUNDARY

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
1	15,900	29,300	27,000	14,600	6,220	5,890	6,450	17,500	18,200	6,530	5,180	9,430
2	19,800	29,300	27,100	6,190	6,090	5,950	6,950	15,300	24,600	6,590	4,930	10,600
3	20,200	29,400	27,300	14,200	6,050	5,730	7,540	13,600	25,500	6,610	5,270	10,800
4	20,200	29,700	27,400	14,400	5,970	6,300	8,280	13,600	25,300	6,580	5,310	11,200
5	18,500	30,000	26,900	5,640	5,890	6,500	8,360	16,900	25,100	6,250	7,940	11,000
6	13,000	29,600	27,100	5,330	5,800	6,520	8,140	18,600	23,300	6,170	10,200	6,140
7	15,000	24,400	27,400	5,440	5,690	6,620	7,710	20,000	17,700	6,070	10,600	5,600
8	18,600	23,900	27,000	5,390	5,580	6,790	7,370	20,300	13,000	6,090	8,580	5,670
9	16,000	29,100	26,400	5,340	5,550	6,680	9,390	18,500	12,200	6,060	5,390	12,600
10	15,800	29,700	26,000	5,310	5,620	6,720	9,520	14,100	10,100	6,150	5,350	23,300
11	15,700	29,800	26,200	5,170	5,490	6,630	9,520	15,100	7,670	6,150	9,560	26,300
12	15,200	29,700	26,200	5,260	5,500	6,650	7,590	15,400	6,940	5,920	10,900	22,200
13	12,800	29,400	22,000	5,250	5,490	6,730	7,410	11,200	7,170	5,800	11,100	12,100
14	15,100	27,600	16,800	5,300	5,510	6,920	11,100	10,400	8,420	6,020	10,500	11,000
15	20,000	27,600	6,600	5,140	5,510	7,160	10,200	10,300	7,750	5,890	10,600	18,500
16	20,200	28,800	6,020	5,290	5,380	7,400	10,500	10,200	7,130	5,670	5,250	26,800
17	20,400	28,900	14,600	5,280	5,520	7,610	12,900	9,950	6,890	5,710	5,030	28,000
18	24,500	28,500	15,700	5,180	5,410	7,850	15,600	9,860	6,890	5,730	12,500	26,400
19	23,700	27,700	15,200	5,120	5,700	7,920	15,300	10,300	6,670	5,650	16,100	19,800
20	13,700	26,600	15,600	5,070	5,830	7,990	14,400	10,600	6,520	5,560	23,100	10,200
21	17,300	28,300	15,200	4,950	5,710	7,490	14,400	10,900	6,540	5,590	24,500	12,000
22	24,700	28,300	6,440	5,060	5,590	6,730	14,600	10,100	6,340	5,680	21,700	22,300
23	19,100	27,900	6,220	5,120	5,770	6,590	14,000	11,000	6,220	5,480	11,600	26,900
24	18,400	22,600	14,800	5,050	5,880	6,500	13,600	13,000	6,170	5,610	9,630	28,000
25	19,900	10,300	15,200	5,290	5,950	6,480	11,800	13,000	6,090	5,450	10,100	25,000
26	27,100	22,700	6,420	5,300	5,760	6,490	9,890	14,200	6,160	5,370	9,330	19,400
27	28,300	23,500	14,700	5,250	5,690	6,490	10,600	20,700	6,080	5,550	5,840	10,800
28	26,700	24,800	15,100	5,360	5,760	6,920	12,200	24,200	6,260	5,560	5,660	9,770
29	24,000	27,000	6,500	6,140	5,810	6,750	13,800	26,500	6,270	5,590	5,720	16,600
30	28,300	27,200	6,170	6,460		6,470	15,900	24,400	6,600	5,230	5,440	20,700
31	28,900		14,200	6,260		6,330		17,000		5,200	5,640	
Mean	19,900	27,050	17,920	6,263	5,714	6,768	10,830	15,060	10,990	5,855	9,631	16,640

KOOTENAI RIVER AT PORTHILL, IDAHO — Daily discharges for the year ending 30 September 1992 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
1	58,200	92,500	49,700	88,400	55,000	59,700	36,700	61,200	131,000	96,000	78,900	37,500
2	70,100	91,100	62,100	88,100	41,800	58,400	36,200	67,400	130,000	91,600	71,300	36,400
3	76,300	85,800	78,100	90,700	41,400	55,200	36,700	66,800	130,000	83,100	70,700	32,900
4	79,900	82,700	71,800	97,500	54,800	56,000	38,100	67,500	127,000	62,400	70,600	43,300
5	78,900	76,100	65,300	104,000	57,400	56,000	39,000	70,100	129,000	57,300	73,400	44,200
6	77,000	64,200	61,900	105,000	48,300	54,100	39,100	76,400	136,000	55,800	76,000	34,300
7	78,700	60,300	62,500	106,000	48,200	56,600	39,500	80,500	145,000	57,500	73,900	33,700
8	70,400	37,800	59,500	106,000	47,000	62,800	38,300	80,600	147,000	56,300	77,300	34,300
9	60,000	40,400	65,000	105,000	45,200	68,900	37,900	78,200	144,000	54,900	85,700	38,000
10	57,200	45,700	73,500	105,000	55,900	77,200	37,800	76,600	142,000	54,400	85,900	43,500
11	55,000	51,000	72,800	110,000	65,800	76,400	37,300	75,300	148,000	57,500	87,600	46,700
12	60,200	58,100	75,700	115,000	64,300	74,100	37,000	78,400	149,000	62,700	87,200	53,700
13	60,700	58,400	80,000	109,000	57,900	72,200	36,800	78,300	160,000	60,000	88,500	66,900
14	60,700	57,300	64,800	102,000	54,400	63,200	36,800	77,200	172,000	56,100	87,800	74,400
15	57,900	58,300	54,300	97,400	45,200	50,800	35,500	77,200	175,000	54,600	84,300	78,400
16	54,600	62,300	52,100	93,500	41,900	42,100	35,800	83,900	171,000	55,800	76,400	71,000
17	54,300	60,300	51,800	91,700	51,500	38,400	40,100	82,900	165,000	72,500	77,900	61,400
18	53,000	60,100	52,000	81,700	58,200	34,600	42,200	77,800	160,000	84,200	77,900	61,700
19	55,800	58,300	52,200	70,200	64,900	34,600	42,100	81,500	158,000	91,000	83,000	57,300
20	58,800	61,800	59,600	68,400	65,500	31,200	40,400	86,100	155,000	91,800	84,800	48,800
21	59,700	72,100	64,600	83,200	65,900	29,800	36,200	93,100	153,000	93,100	83,600	46,200
22	59,600	76,200	72,500	85,900	62,400	30,200	36,300	102,000	152,000	99,500	84,700	47,300
23	62,300	80,500	71,200	82,300	67,700	30,500	38,100	118,000	147,000	92,000	88,100	44,000
24	71,800	80,300	71,000	81,500	74,800	29,600	42,100	132,000	139,000	92,900	88,200	43,300
25	69,700	80,100	78,500	78,000	70,300	29,600	42,500	127,000	125,000	93,000	87,600	44,300
26	68,200	77,300	78,000	74,500	53,800	30,200	42,900	129,000	118,000	90,300	87,900	50,700
27	65,800	69,300	77,800	79,000	53,200	35,300	43,900	131,000	112,000	89,800	87,800	62,500
28	68,400	73,800	82,200	88,900	55,300	38,700	45,800	132,000	102,000	89,300	83,600	62,400
29	76,300	66,800	88,100	94,400	59,100	38,300	48,200	134,000	98,000	87,600	83,400	60,900
30	77,100	59,700	88,400	83,400		37,100	55,000	134,000	98,400	86,800	67,500	61,300
31	88,500		88,600	68,300		37,400		132,000		86,900	51,900	
Mean	66,000	66,600	68,600	91,400	56,100	48,000	39,800	93,200	141,000	76,000	80,400	50,700

COLUMBIA RIVER AT BIRCHBANK, B.C. — Daily discharges for the year ending 30 September 1992 in cubic feet per second.

APPENDIX D

PROJECT INFORMATION

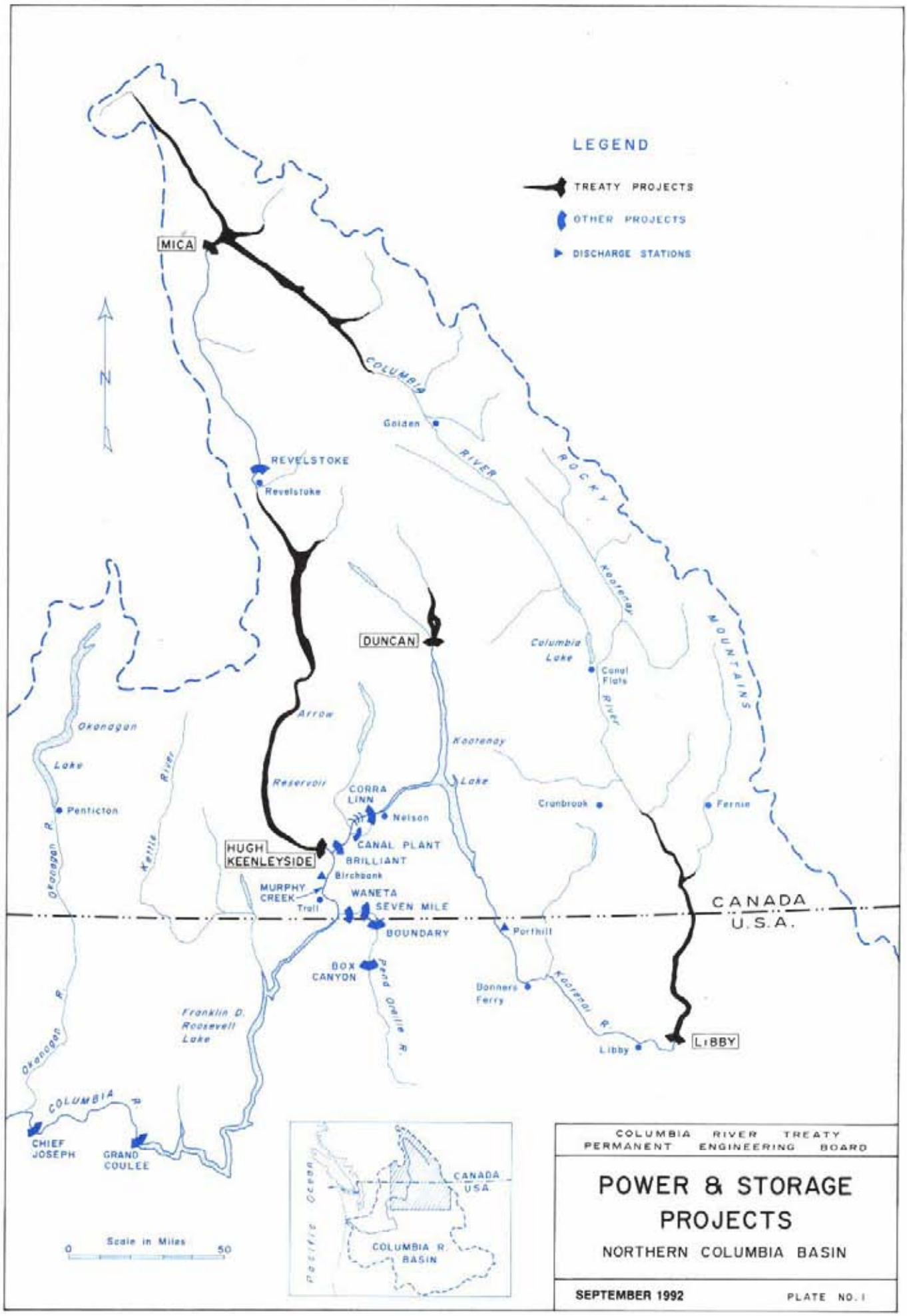

LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
COLUMBIA
Golden
RIVER
ROCKY
MOUNTAINS
Kootenay
REVELSTOKE
Revelstoke
DUNCAN
Columbia Lake
Canal Flats
Arrow
Reservoir
Okanagan
Lake
Penticton
Okanagan R.
Kettle River
Kootenay
Lake
CORRA LINN
Nelson
CANAL PLANT
BRILLIANT
Birchbank
HUGH KEENLEYSIDE
MURPHY CREEK
Trail
WANETA
SEVEN MILE
BOUNDARY
CANADA
U.S.A.
Cranbrook
Fernie
Porthill
BOX CANYON
Pend Oreille R.
Bonners Ferry
Kootenai R.
Libby
LIBBY
Franklin D. Roosevelt Lake
Okanogan R.
COLUMBIA
CHIEF JOSEPH
GRAND COULEE
Scale in Miles
0
50
Pacific Ocean
CANADA
USA
COLUMBIA R. BASIN
COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
POWER & STORAGE PROJECTS
NORTHERN COLUMBIA BASIN
SEPTEMBER 1992
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	1,432,400 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 Project	
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	
Construction began	June 1966
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	5,869,000 ac-ft
Usable Storage Capacity	4,980,000 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	
5 units at 105 mw	525 mw
Head at full pool	352 feet
Maximum Turbine Discharge	
of 5 units at full pool	26,500 cfs