ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

Washington, D.C. Ottawa (Ontario)

30 September 1998

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

CANADA • UNITED STATES

CANADIAN SECTION
D. R. WHELAN, Chairman
J. Allan, Member

UNITED STATES SECTION
S. L. STOCKTON, Chairman
R. H. Wilkerson, Member

28 February 1999

The Honorable Madeleine Albright
Secretary of State
Washington, DC

The Honourable Ralph Goodale
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Albright and Minister Goodale:

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 thirty-fourth Annual Report, dated 30 September 1998 of the Permanent Engineering Board (Board). The report sets forth results achieved under the Treaty for the period from 1 October 1997 to 30 September 1998.

Regrettably, the disagreement over the operation of Libby Dam has prevented the Entities from agreeing on the Assured Operating Plans (AOP) and Determinations of Downstream Power Benefits (DDPB) for operating years 2000–2001, 2001-2002, 2002–2003, and 2003-2004. Paragraph 9 of Annex A of the Treaty requires the Entities to prepare an AOP and the associated DDPB for the sixth succeeding year of operation. For this reason, the Board concludes that the requirements of the Treaty are not being fully met.

The Board remains very concerned that the dispute between the United States and Canadian Entities over the Libby Dam fisheries operations has not been resolved by the Governments. The Board wishes the Governments to understand that if the issue is not resolved by the operating year beginning 1 August 2000, the Entities will be entering that operating year without an agreement on the operation of the Canadian Treaty projects. As a consequence, the United States will have no assurance of the quantity and timing of Columbia River flows at the Canada/U.S.

border on which to base coordination of power system and Columbia River fisheries operations. Similarly, Canada will lose the assurance of the amount and timing of its entitlement to one-half of the downstream power benefits resulting from the operation of the Canadian Treaty storage projects. The longer this condition exists, the more uncertain U.S. and Canadian Treaty benefits become. **Thus, the *raison d'être* of the Treaty is brought into question.**

The Entities also are concerned about the lack of resolution of the Libby Dam issue by the Governments. They informed the Board at the 2 February 1999 Board-Entities meeting that because of this situation they are exploring possible interim measures for developing operating plans and determining downstream power benefits. The Board asked the Entities to report their interim plans by August 1999. The Board will review these interim plans and will report its findings to the Governments.

Respectfully submitted:

For the United States

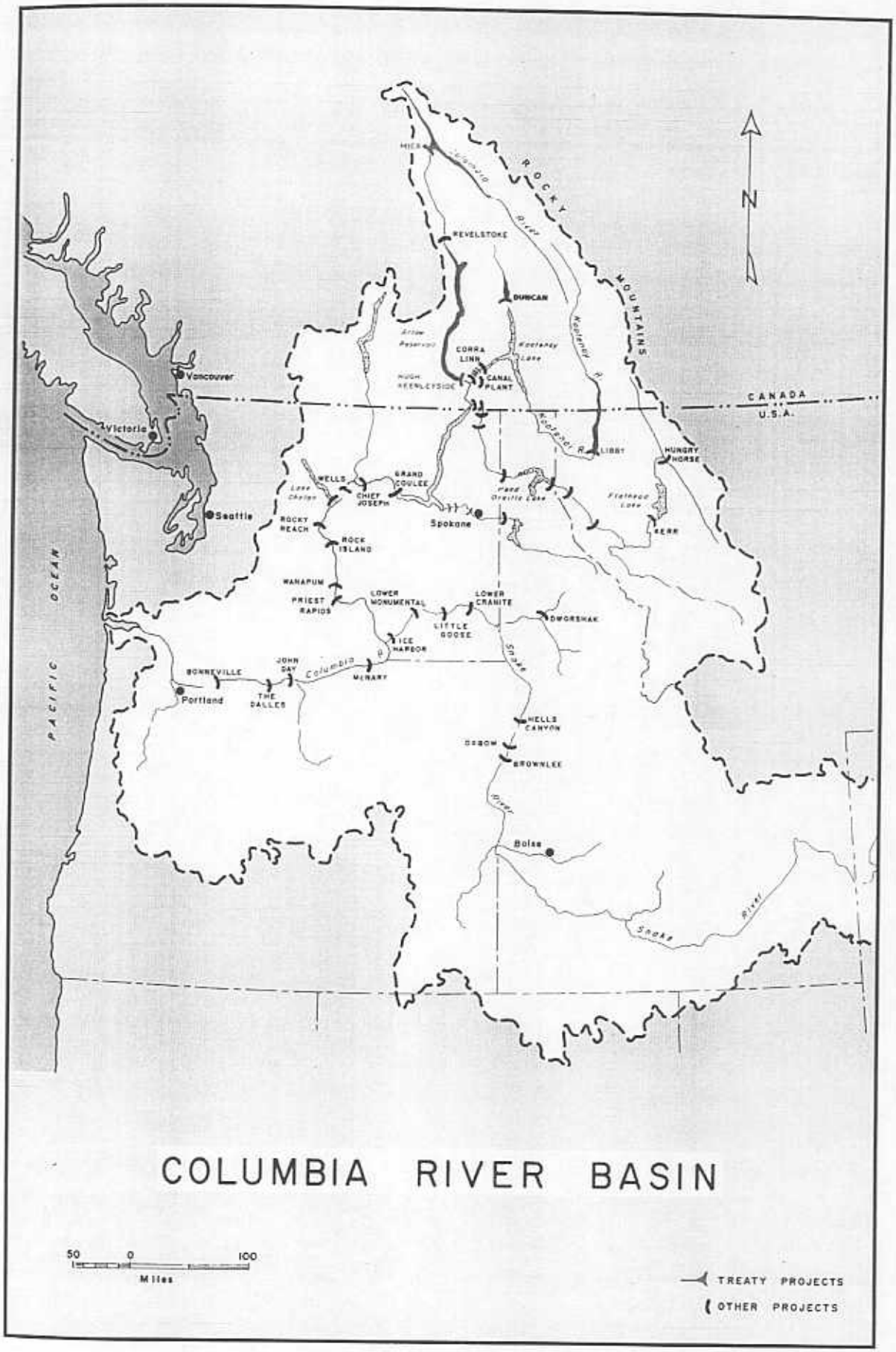
Steven Stockton, Chair

Ronald Wilkerson

For Canada

Dan Whelan, Chair

John Allan



COLUMBIA RIVER BASIN

ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

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30 September 1998

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SUMMARY

The thirty-fourth 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. This report describes the status of projects, progress of Entity studies, operation of the Duncan, Arrow, Mica and Libby reservoirs, and the resulting benefits.

The Duncan, Arrow and Mica 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. During the spring and summer of 1998, reservoir operations were controlled not only by power and flood control requirements, but also by environmental considerations to ensure adequate flows to meet fishery needs in both Canada and the United States.

The downstream power benefits to each country, resulting from the AOP and DDPB determinations, were 553.3 megawatts annual energy and 1229.6 megawatts of capacity for the August 1997 through July 1998 period. At Libby Dam, operations for the white sturgeon and salmon mandated by the requirements of the U.S. Endangered Species Act were implemented by the U.S. Army Corps of Engineers. The Canadian Entity disputes the U.S. Entity's authority under the treaty to unilaterally decide on these operations at Libby Dam.

Normal operations at other Treaty reservoirs, as formulated in the 1997–1998 Detailed Operating Plan (DOP), were modified through Entity agreements. The use of non-Treaty storage was modified by corporate agreements to minimize interference between fishery requirements and power operations.

Operations under the 1990 and subsequent agreements between the Entities relating to the use of non-Treaty storage, refill enhancement for the Mica and Arrow reservoirs, and initial filling of non-Treaty reservoirs did not conflict with Treaty operations. The Columbia River Basin reservoir system was operated for flood control during the spring of 1998 and resulted in reducing the peak flows at The Dalles by 174,800 cfs. Libby Dam was the only Treaty storage utilized during the flood. Flood damage reduction benefits attributable to that Treaty storage amounted to $(US) 2,900,000.

The disagreement over the operation of Libby has prevented the Entities from agreeing on the Assured Operating Plans (AOP) and Determinations of Downstream Power Benefits (DDPB) for operating years 2000–2001, 2001-2002, 2002–2003, and 2003-2004. Paragraph 9 of Annex A of the Treaty requires the Entities to prepare an AOP and the associated DDPB for the sixth succeeding year of operation. For this reason, the Board concludes that the requirements of the Treaty are not being fully met.

The Permanent Engineering Board remains very concerned that the dispute between the United States and Canadian Entities over the Libby Dam fisheries operations issue has not been resolved by the Governments.

The Board wishes the Governments to understand that if the issue is not resolved by the operating year beginning 1 August 2000, the Entities will be entering that operating year without an

agreement on the operation of the Canadian Treaty projects. As a consequence, the United States will have no assurance of Columbia River flows at the Canada/U.S. border on which to base the coordination of its power system and fisheries operations. Similarly, Canada will lose the assurance of both the amount and timing of its entitlement to one-half of the downstream power benefits resulting from operation of the Canadian Treaty storage projects. The longer this condition exists, the more uncertain U.S. and Canadian Treaty benefits become. **Thus, the *raison d'être* of the Treaty is brought into question.**

INTRODUCTION

The Columbia River Treaty provides for the cooperative development of the water resources of the Columbia River basin. Article XV of the Treaty established a Permanent Engineering Board and specified that one of its duties is 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 1997 through 30 September 1998, 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.

Libby Dam - Kootenai River, Montana
The dam and reservoir, Lake Koocanusa. The powerhouse is at the left of the spillway.

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 a 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 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 benefit available 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 totaling $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 that cannot be resolved by the two countries may be referred by either country 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 Exchange of Notes and Attachment Relating to Terms of Sale of January 1964 and the Canadian Entitlement Purchase Agreement of 13 August 1964 (the Sales Agreement) provided that the Treaty storage would be operative for power purposes on the following dates: Duncan storage on 1 April 1968; Arrow storage on 1 April 1969; and, Mica storage on 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, each appointed a member and an alternate member 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 Canadian 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. 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 that 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; and

(g) consulting with the Entities in the establishment and operation of a hydrometeorological system as required by Annex A of the Treaty.

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Hugh Keenleyside Dam (Arrow Lakes) - 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 of America 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, the 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 Chair. 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 Entities are shown in Appendix B. Ms. Judith Johansen succeeded Mr. John S. Robertson effective 8 June 1998 who earlier had succeeded Mr. Randall Hardy as Chair of the U.S. 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 the following:

(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) assistance to and cooperation 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 of 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; and

(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 held its 64th meeting on 3 February 1998 in Portland, Oregon. In conjunction with this meeting the Board also met with the Entities, the 45th joint meeting.

The 45th meeting of the Board with the Entities focused on two issues of importance to the implementation of the Treaty: 1) Return and disposition of the Canadian entitlement to one-half the downstream power benefits; and 2) the lack of agreement between the Entities on Assured Operating Plans for the operating years 2000-01 and beyond because of the disagreement between the Entities over the operation of Libby Dam in compliance with the U.S. Endangered Species Act. The Entities reported that they had reached agreement on the disposal of the Canadian Entitlement and the point of delivery of the power to the border. Agreements have been drafted by cannot be signed in final form pending a formal exchange of notes between the governments on both the disposal and the point of delivery matters.

Reports Received

Throughout the report year, the Entities maintained contact with the Board and the Board's Engineering Committee. Information pertinent to the operation of Treaty storage projects was made available to the Board.

The following documents involving the operation of Columbia River Treaty Storage have been received by the Board from the Entities since the last annual report:

- Agreement Among the Columbia Treaty Operating Committee, and the Bonneville Power Administration, and the British Columbia Hydro and Power Authority on Implementation of the Arrow Local Method for Treaty Storage for Operating Year 1997-1998, signed 2 February 1998.

  This agreement defines arrangements for the sharing of approximately 7 MW of annual average downstream U.S. power benefits that arise from implementing the Arrow Local Method of computing the variable refill curve for Arrow rather than the Arrow Total Method in the 1998-1999 Detailed Operating Plan (DOP). The primary difference between the Arrow Local and Total Methods is that the Arrow Local Method excludes the forecast volume of inflow above the Mica project in computing the inflow into Arrow, whereas the Arrow Total Method includes the forecast volume of inflow above the Mica project.

- Columbia River Treaty Entity Agreement on Adjustment of Transmission Losses to Reflect Step-Up Transformer Losses on U.S. Columbia River Federal Projects, signed 9 March 1998.

  This agreement adjusts transmission loss rates calculated for the delivery of the downstream power benefits in a previous document entitled "Columbia River Treaty Entity Agreement on

Aspects of the Delivery of the Canadian Entitlement for April 1, 1998 through September 15, 2024 between the Canadian Entity and the United States Entity", signed on 20 November 1996. This previous document established a total transmission loss rate of 3.4%, which was calculated based upon the assumption that all step-up transformer losses for the U.S. Federal Projects and U.S. non-Federal Projects were included in the Assured Operating Plan (AOP) and downstream power benefit studies. The transmission loss rate used in this document, while accounting for the step-up loss rate for U.S. non-Federal Projects, did not account for the step-up transformer losses for U.S. Federal Projects. To account for these additional step-up transformer losses, and until a different calculation of transmission loss is made by the Entities in accordance with Article XIV 2.(j) of the Columbia River Treaty, this agreement increases the transmission loss percentage for the 1997-1998 and subsequent operating years by 0.2%, for a total transmission loss factor of 3.6%.

- Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024, signed 26 March 1998.

  This agreement provides arrangements for the delivery of the Canadian Entitlement, including the point of delivery, method of accounting for transmission losses, and guidelines for scheduling. This agreement becomes effective upon an exchange of diplomatic notes between the United States and Canada, which has not occurred as of the publishing of this report.

- Columbia River Treaty Operating Committee Agreement on Modification of Scheduling Procedures for Aspects of Delivery of the Canadian Entitlement, April 1998 through February 1999, signed 30 March 1998.

  This agreement modifies scheduling procedures agreed upon in a previous document entitled "Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024 between the Canadian Entity and the United States Entity", signed on 20 November 1996. The scheduling procedures described in Attachment B of this document require the Canadian Entity to provide the U.S. Entity with both an Initial Weekly Estimate and a Mid-Week Estimate of energy to be scheduled for the following week. The Operating Committee determined that during the period from April 1998 through February 1999, changes between the initial and mid-week estimate of Entitlement energy delivery were very unlikely. Therefore, they agreed that a monthly time interval provides sufficient notification prior to 1 April 1999, and therefore have decided to suspend the weekly estimation procedure during the period 1 April 1998 through 28 February 1999, and resume the weekly interval after 28 February 1999.

- Columbia River Treaty Operating Committee Agreement on Treatment of Transmission Losses Relative to the Canadian Entitlement, signed 1 April 1998.

This agreement supplements the agreement listed above under Item c, entitled "Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024", signed 26 March 1998. It provides procedures to be followed for handling and accounting for transmission losses attributable to deliveries of the Entitlement. These procedures are a modification of procedures previously provided in Section 10 of Attachment B to the Entity Agreement, which was entitled "Canadian Entitlement Scheduling Procedures."

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 1998 through 31 July 1999, signed 30 July 1998.

  This agreement implements the DOP for Columbia River Storage for 1 August 1998 through 31 July 1999.

- Agreement among the Columbia River Treaty Operating Committee, and the Bonneville Power Administration, and the British Columbia Hydro and Power Authority on the Operation of Canadian Treaty and Libby Storage Reservoirs and Exchanges of Power for the Period 1 August 1998 through 17 January 1999, signed 31 July 1998.
  This agreement supplements the 1998-1999 DOP. The objective of this agreement is to provide for the optimal balancing of water in Libby and Arrow reservoirs and the storage and return of power between the parties. It considers mutually beneficial power and non-power objectives, including enhanced summer recreation at Libby reservoir, and reduced spill at Canadian plants downstream of Libby on the Kootenay River.

- Detailed Operating Plan for Columbia River Storage for 1 August 1998 through 31 July 1999, dated August 1998.

  This document serves as a guide and provides criteria for operation of the Columbia River Treaty storage during the operating year from August 1998 through July 1999. Further details on the DOP are provided in this report in the section pertaining specifically to the DOP.

- Columbia River Treaty Operating Committee Agreement on the Operation of Canadian Treaty and Libby Storage Reservoirs for the Period 1 August 1998 through 30 April 1999, signed 19 August 1998.

  This agreement supplements the 1998-1999 DOP. The objective of this agreement is to modify the terms of the 31 July 1998 agreement listed above under Item g to provide the U.S. with provisional draft rights during the fall instead of the exchanges of power.

- Columbia River Treaty Operating Committee Agreement on the Operation of Treaty Storage for Enhancement of Mountain Whitefish Spawning for the Period 8 September 1998, through 31 July 1999, signed 8 September 1998.

  This agreement supplements the 1998-1999 DOP. The objective of this agreement is to enhance mountain whitefish spawning conditions in the Columbia River downstream from the Arrow project through the use of Treaty storage. This is accomplished by adjusting outflows from Arrow and is made possible by changes in the plan for storage and release of water at the Mica and Arrow projects from what would have been done under the DOP.

- Annual Report of the Columbia River Treaty Canadian and United States Entities, for the period 1 October 1997 through 30 September 1998, dated November 1998.

  This report summarizes the operation of Treaty projects for the period 1 October 1997 through 30 September 1998. Further details on the Entity Annual Report are provided later in this report.

The following document involving the operation of Columbia River Non-Treaty Storage has been received by the Board from the Entities:

- Letter Agreement of 29 May 1998, between B.C. Hydro and Power Authority and Bonneville Power Administration, regarding Non-Treaty Storage for Enhancement of U.S. Flow Augmentation.

  The term of this agreement is 2 May through 31 August 1998. The objective of the agreement is to store spring river flows during the period May-June into non-Treaty storage space. This stored water is then released in July-August to enhance flow augmentation in the Columbia River downstream in the U.S. Release rights during the period July-August are permitted as long as no physical spill occurs at Mica and Revelstoke in the process.

Under the reporting schedule that has been agreed upon by the Board and the Entities, four additional documents, those listed below, would normally have been received at this time. However, due to a lack of agreement between the Entities over differences in energy and power benefits resulting from operation of Libby Dam with and without releases for endangered fish species, the Entities have not submitted them.

- "Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for the Operating Year 2000-2001."

- "Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for the Operating Year 2001-2002."

- "Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for the Operating Year 2002-2003."

- "Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for the Operating Year 2003-2004."

The Entities have however, briefed the PEB and PEBCOM on these issues. Further details on these documents are provided in the next section of this report.

Report to Government

The thirty-third Annual Report of the Board was submitted to the governments of Canada and the United States of America on 28 February 1998.

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 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 1976–1977, 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 capacity in Canada that may not have been installed without the Treaty. In addition, the installation of 170 MW generating capacity at Hugh Keenleyside Dam and additional generating units at Revelstoke Dam in Canada are 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 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 in 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 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 Lake, 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, a proposal to install two generating units, totaling approximately 170 megawatts of generating capacity is currently being reviewed by the province of British Columbia and the Canadian government.

The dam consists of two main components: a concrete gravity structure that 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 that rises 170 feet above the river bed and 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 7, 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 23, 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. Commercial generation of power began on 24 August 1975, which coincided with the formal dedication of the project. The concrete gravity dam is 3,055 feet long, rises 370 feet above the river bed 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, when completed in 1976, had 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. Recent U.S. legislation (Public Law 104-303, 12 Oct. 1996) authorized the Corps of Engineers to construct and install generating units 6 through 8. No action to do so has been taken during this report period.

The Libby project is shown in the picture on page 2, 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 debris clean-up.

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 stream flow 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 that 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 1976–1977 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 1985–1986 report year, the Entities provided the Board with the 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 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 in Canada (Duncan, Arrow and Mica) 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 the three Treaty storage projects in Canada and the Treaty project in the United States (Libby), 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 1987-1988 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. The Entities' report: *Columbia River Treaty Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans*, dated December 1991, provides guidelines for the preparation of the operating plans and incorporates the Entities' agreements.

In 1994, the Entities submitted to the Board its report entitled: *Assured Operating Plan (AOP) and Determination of Downstream Power Benefits (DDPB) for Operating Year 1997-1998.* The report established operating rule curves for the three Treaty storage reservoirs in Canada and calculated the downstream power benefits resulting from the operation of the reservoirs for the 1997-1998 operating year.

During the report year, actual operations of the Treaty storage in Canada were regulated under the rule curves set out in the Entities' report: *Detailed Operating Plan (DOP) for Columbia River Treaty Storage, 1 August 1997 through 31 July 1998*, and in associated Entities' agreements. This year's DOP uses the load, resources and non-power requirements from the 1997-1998 AOP rather than using the Pacific Northwest Coordination Agreement (PNCA) operating data, as has been done in previous DOPs. This was done because actual PNCA operations in the U.S. system are based on the U.S. Fish and Wildlife Service (FWS) and the National Marine Fishery Service (NMFS) Biological Opinions and associated non-power requirements and the Entities could not agree to use these updates in the DOP. One of the main measures defined in the Biological Opinions includes changing the customary seasonal release rates from Libby Dam such that spring and summer flows would be higher, and fall and winter flows lower, than in the past.

The Canadian Entity believes that these fishery operations are not consistent with the Treaty. The DOP for the operating year 1997-1998 shows the divergence of opinions between the Entities on the Libby fishery operation by displaying two sets of operating rule curves for the project. While the rule curves defined by the U.S. Entity include the flow regime specified in the FWS and NMFS' Biological Opinions, the Canadian Entity's rule curves reflect the earlier agreements between the

Entities. Given that the Entities have been unable to reach an agreement on the operation of the Libby project since early 1995, the two governments have initiated discussions to resolve the question.

As reported in the 1996 and 1997 Board Annual Reports, the *Entity Agreement on Resolving the Dispute on Critical Period Determination, the Capacity Entitlement for the 1998-1999, 1999-2000, and 2000-2001 AOP/DDPB's, and Operating Procedures for the 2001-2002 and Future AOPs has resolved.* If this issue is raised in the future, the Board will re-examine the matter by using its earlier recommendations as guidelines on the appropriate Treaty interpretation and application of the critical streamflow period definition and the established operating procedures. A more detailed discussion of this issue is contained in the 1996 and 1997 Annual Reports of the Board.

The Entities have also come to agreement on the arrangements for returning the Canadian Entitlement to British Columbia across existing transmission lines. The initial agreement on the delivery arrangements was signed on 20 November 1996. This agreement has now been superseded by an agreement signed on 26 March 1998. This latter agreement provides arrangements for the delivery of the Canadian Entitlement, including the point of delivery, method of accounting for transmission losses, and guidelines for scheduling. This agreement becomes effective upon an exchange of diplomatic notes between the United States and Canada, which has not occurred as of the publishing of this report.

While the substantive issues relating to the calculation of the downstream power benefits and the appropriate arrangements for their return to Canada have now been resolved, the Libby fishery operation issue remains outstanding, and needs to be resolved. The Entities indicate they will not sign agreements to implement the AOP and DDPB reports for the years 2000-2001, 2001-2002, 2002-2003, and 2003-2004, which are now overdue, without resolution of the issue of whether or not the Libby Dam water control operations for endangered species (salmon and sturgeon) should be included in the AOP.

The Canadian Entity's main concern with the fisheries operations is that they reduce the extent to which Libby can be coordinated with downstream projects in Canada. Depending on water conditions, this reduced coordination reduces the benefit of Libby storage releases on the Canal Plant Project in B.C. The U.S. has taken the position that in order to comply with the Biological Opinions pursuant to the U.S. Endangered Species Act, special water control operations must be carried out at Libby. This matter is currently being reviewed by the governments. Until the issue is resolved, the Entities will not agree on the AOP/DDPB reports noted above.

As reported in the 1997 Annual Report, the PEB is very concerned that the Entities are not in full compliance with Treaty requirements due to their inability to agree on an AOP and the DDPB for operating years 2000-2001, 2001-2002, 2002-2003, and 2003-2004 because of the Libby Dam fishery operation issue. The differing Entity positions on Libby, if not resolved by the start of operating year 2000-01 on 1 August 2000, may adversely impact the operation of the Canadian Treaty reservoirs and will prohibit the determination of the downstream benefits those reservoirs produce. As a consequence, there will be no assured plan of operation for the Canadian Treaty reservoirs and thus no basis for the

development of a Detailed Operating Plan for operating year 2000-2001. The United States will have no assurance of Columbia River flows at the Canada/U.S. border on which to base the coordination of its power system and fisheries operations. Similarly, Canada will lose the assurance of both the amount and timing of its entitlement to one-half of the downstream power benefits resulting from operation of the Treaty storage projects in Canada.

Both the AOP and DDPB are required to be completed six years in advance by paragraph 9, Annex A of the Treaty. The completion of the AOP and DDPB six years in advance were important considerations during the original Treaty negotiations. The inability of the Entities to meet these provisions of the Treaty most assuredly will create potential for a loss of Treaty benefits to both nations. **Thus, the *raison d'être* of the Treaty is brought into question.**

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,* dated October 1972, 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 1972–1973 report year and is still in effect. The plan is currently being revised and should be completed by the summer of 1999.

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.

Non-treaty Storage

Since 1984 agreements have also been reached between the B.C. Hydro and Power Authority and the Bonneville Power Administration concerning the use of non-Treaty storage. These agreements do not interfere with operations under the Treaty; rather, they extend the concepts of the Treaty and benefit both the B.C. Hydro and Power Authority and the Bonneville Power Administration.

Operations for Fish

Many U.S. reservoirs are presently operated in accordance with biological opinions issued by the U.S. Fish and Wildlife and the National Marine Fishery Service under the Endangered Species Act. Treaty reservoirs, in Canada, are operated in accordance with the requirements of the Canadian Department of Fishery and Oceans. These efforts continue to evolve. In this regard, the Board notes

that the assured operating plans and the determination of downstream power benefits are to be based on optimal operation for power and flood control in accordance with the requirements of the Treaty. The Board continues to maintain its long standing position that the Entities may develop detailed operating plans to address fishery needs providing those actions do not conflict with Treaty requirements.

Mica Dam and Lake Kinbasket - Columbia River, British Columbia
The earth dam showing the spillway at the right. The underground powerhouse is at the left.

OPERATION

General

The Columbia River Treaty Operating Committee was established by the Entities to develop operating plans for the Treaty storage and to direct operation of this storage 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 the following documents:

- Columbia River Treaty Flood Control Operating Plan, dated October 1972, as amended by the Review of Flood Control, Columbia River Basin, Columbia River and Tributaries Study, CRT-63, dated June 1981.

  This agreement prescribes the criteria and procedures by which the Canadian Entity will operate Mica, Duncan, and Arrow Projects, and the United States will operate Libby Project to achieve the desired flood control objectives in the United States and Canada;

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

  This agreement states principles for changes in the preparation of the AOP's and DDPB's. These changes involve revisions of information to be used in studies such as the definition of the power loads and generating resources in the Pacific Northwest area, stream flows to be used, estimates of irrigation withdrawals and return flows, and other related information;

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

  This agreement states the specific procedures to be used in implementing the previous agreement on Principles for Preparation of the Assured Operating Plan and Determination of Downstream Power Benefits;

- 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: (a) Use of Columbia River non-Treaty Storage, (b) Mica and Arrow Refill Enhancement, and (c) Initial Filling of non-Treaty Reservoirs, signed 9 July 1990.

  This agreement provides information relating to the initial filling of Revelstoke Reservoir, the coordinated use of some of the Columbia River non-Treaty storage, and actions taken to enhance the refill of the reservoirs impounded by Mica and Arrow Dams;

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

  This document serves as a guide for the preparation and use of hydroelectric operating plans such as the Assured Operating Plans and Detailed Operating Plans used to plan the operation of Columbia River Treaty Storage;

- Assured Operating Plan for Columbia River Treaty Storage, 1 August 1997 through 31 July 1998, dated October 1994.

  This document provides information on the operation plan for Columbia River Treaty storage and resulting downstream power benefits for the period 1 August 1997 through 31 July 1998;

- Agreement Among the Columbia Treaty Operating Committee, and the Bonneville Power Administration, and the British Columbia Hydro and Power Authority on Implementation of the Arrow Local Method for Treaty Storage for Operating Year 1997-1998, signed 2 February 1998.

  This agreement defines arrangements for the sharing of approximately 7 MW of annual average downstream U.S. power benefits that arise from implementing the Arrow Local Method of computing the variable refill curve for Arrow rather than the Arrow Total Method in the 1998-1999 Detailed Operating Plan (DOP). The primary difference between the Arrow Local and Total Methods is that the Arrow Local Method excludes the forecast volume of inflow above the Mica project in computing the inflow into Arrow, whereas the Arrow Total Method includes the forecast volume of inflow above the Mica project.

- Columbia River Treaty Entity Agreement on Adjustment of Transmission Losses to Reflect Step-Up Transformer Losses on U.S. Columbia River Federal Projects, signed 9 March 1998.

  This agreement adjusts transmission loss rates calculated for the delivery of the downstream power benefits in a previous document entitled "Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for April 1, 1998 through September 15, 2024 between the Canadian Entity and the United States Entity", signed on 20 November 1996.

This previous document established a total transmission loss rate of 3.4%, which was calculated based upon the assumption that all step-up transformer losses for the U.S. Federal Projects and U.S. non-Federal Projects were included in the Assured Operating Plan (AOP) and downstream power benefit studies. The transmission loss rate used in this document, while accounting for the step-up loss rate for U.S. non-Federal Projects, did not account for the step-up transformer losses for U.S. Federal Projects. To account for these additional step-up transformer losses, and until a different calculation of transmission loss is made by the Entities in accordance with Article XIV 2.(j) of the Columbia River Treaty, this agreement increases the transmission loss percentage for the 1997-1998 and subsequent operating years by 0.2%, for a total transmission loss factor of 3.6%.

- Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024, signed 26 March 1998.

  This agreement provides arrangements for the delivery of the Canadian Entitlement, including the point of delivery, method of accounting for transmission losses, and guidelines for scheduling. This agreement becomes effective upon an exchange of diplomatic notes between the United States and Canada, which has not occurred as of the publishing of this report.

- Columbia River Treaty Operating Committee Agreement on Modification of Scheduling Procedures for Aspects of Delivery of the Canadian Entitlement, April 1998 through February 1999, signed 30 March 1998.

  This agreement modifies scheduling procedures agreed upon in a previous document entitled "Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024 between the Canadian Entity and the United States Entity", signed on 20 November 1996. The scheduling procedures described in Attachment B of this document require the Canadian Entity to provide the U.S. Entity with both an Initial Weekly Estimate and a Mid-Week Estimate of energy to be scheduled for the following week. The Operating Committee determined that during the period from April 1998 through February 1999, changes between the initial and mid-week estimate of Entitlement energy delivery were very unlikely. Therefore, they agreed that a monthly time interval provides sufficient notification prior to 1 April 1999, and therefore have decided to suspend the weekly estimation procedure during the period 1 April 1998 through 28 February 1999, and resume the weekly interval after 28 February 1999.

- Columbia River Treaty Operating Committee Agreement on Treatment of Transmission Losses Relative to the Canadian Entitlement, signed 1 April 1998.

  This agreement supplements the agreement listed above under Item c, entitled "Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024", signed 26 March 1998. It provides procedures to be

followed for handling and accounting for transmission losses attributable to deliveries of the Entitlement. These procedures are a modification of procedures previously provided in Section 10 of Attachment B to the Entity Agreement, which was entitled "Canadian Entitlement Scheduling Procedures."

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 1998 through 31 July 1999, signed 30 July 1998.

  This agreement implements the DOP for Columbia River Storage for 1 August 1998 through 31 July 1999.

- Agreement among the Columbia River Treaty Operating Committee, and the Bonneville Power Administration, and the British Columbia Hydro and Power Authority on the Operation of Canadian Treaty and Libby Storage Reservoirs and Exchanges of Power for the Period 1 August 1998 through 17 January 1999, signed 31 July 1998.

  This agreement supplements the 1998-1999 DOP. The objective of this agreement is to provide for the optimal balancing of water in Libby and Arrow reservoirs and the storage and return of power between the parties. It considers mutually beneficial power and non-power objectives, including enhanced summer recreation at Libby reservoir, and reduced spill at Canadian plants downstream of Libby on the Kootenay River.

- Detailed Operating Plan for Columbia River Storage for 1 August 1998 through 31 July 1999, dated August 1998.

  This document serves as a guide and provides criteria for operation of the Columbia River Treaty storage during the operating year from August 1998 through July 1999. Further details on the DOP are provided in this report in the section pertaining specifically to the DOP.

- Columbia River Treaty Operating Committee Agreement on the Operation of Canadian Treaty and Libby Storage Reservoirs for the Period 1 August 1998 through 30 April 1999, signed 19 August 1998.

  This agreement supplements the 1998-1999 DOP. The objective of this agreement is to modify the terms of the 31 July 1998 agreement listed above under Item g to provide the U.S. with provisional draft rights during the fall instead of the exchanges of power.

- Columbia River Treaty Operating Committee Agreement on the Operation of Treaty Storage for Enhancement of Mountain Whitefish Spawning for the Period 8 September 1998, through 31 July 1999, signed 8 September 1998.

  This agreement supplements the 1998-1999 DOP. The objective of this agreement is to enhance mountain whitefish spawning conditions in the Columbia River downstream from the Arrow project through the use of Treaty storage. This is accomplished by adjusting outflows from Arrow and is made possible by changes in the plan for storage and release of water at the Mica and Arrow projects from what would have been done under the DOP.

Power Operation

The three Canadian Treaty storage projects, Duncan, Arrow and Mica, and the one U.S. Treaty storage project, Libby Dam, were in operation throughout the report year.

The summer of 1997, preceding the beginning of the report year, saw the coordinated Columbia River reservoir system filled to 99.09 percent of capacity. As a result, first-year firm load carrying capability (FLCC) was adopted for the 1997-98 operating year. Due to greater than average stream flows throughout the year, the system generally operated to the Operating Rule Curve or Flood Control Rule Curve for the entire period.

During the spring and summer of 1998, reservoir operations were controlled not only by power and flood control requirements, but also by environmental considerations to ensure adequate flows to meet fishery needs in both Canada and the United States. At Libby Dam, operations for the white sturgeon and salmon mandated by the requirements of the U.S. Endangered Species Act were implemented by the U.S. Army Corps of Engineers. The Canadian Entity disputes the U.S. Entity's authority under the treaty to unilaterally decide on this operation. Discussions between the Canadian and U.S. governments continued in an effort to resolve this issue. Normal operations at other Treaty reservoirs, as formulated in the 1997–1998 Detailed Operating Plan, were modified through Entity agreements. The use of non-Treaty storage was modified by corporate agreements to minimize interference between fishery requirements and power operations.

The coordinated Columbia River reservoir system reached 99.39 percent of its maximum storage energy by the end of July 1998. This value was used to determine the FLCC, with the result that first-year FLCC was adopted for the 1998–1999 operating year.

Mica Project

The Mica Treaty storage volume reached 6.7 million acre-feet (maf) which was 95 percent of full content on 31 July 1997. Mica Treaty storage continued to fill during August reaching full Treaty Storage of 7.0 maf on 12 August, 1997. The reservoir reached full pool elevation on 2 October 1997. Kinbasket Lake began the report year (1 October 1997 to 30 September 1998) at elevation 2474.5 feet, 0.5 feet below its full level.

Throughout the fall of 1997, Treaty storage in Mica was generally drafted for power purposes. The reservoir was drafted to elevation 2439.8 feet by 31 December 1997.

During the period beginning in January and continuing through April, the reservoir was drafted for power purposes and reached its lowest level of the year, elevation 2386.4 feet on 23 April 1998. This level was 3 feet higher than the previous year's lowest level. Mica Treaty storage reached a minimum of 0.03 million acre-feet on 30 April 1998. With the start of the spring freshet in early May, Mica discharges were reduced and the reservoir quickly refilled. On 31 July 1998, the elevation of the reservoir was 2463.5 feet and Treaty storage was 6.5 maf. -The Mica Treaty storage reached full on 13 August 1998. The reservoir reached the peak level for the year of 2466.6 feet (8.4 feet below full) on 10 August 1998.

Arrow Project

Arrow Lake began the report year on 1 October 1997 at elevation 1,432.2 feet, 11.8 feet below full, after a summer in which the reservoir reached a peak elevation of 1,444.1 feet on 31 July 1997. Reservoir releases decreased over the fall months from an average of 59 thousand cubic feet per second (kcfs) in September to an average of 38 kcfs in November and increased to an average of 60 kcfs in December. Arrow reservoir was drafted to elevation 1,427.7 feet by 31 December 1997, and Arrow Treaty storage on that date was 6.0 maf, or 84 percent of full.

In late December, the Canadian Entity requested that Arrow outflows be selectively reduced below Treaty requests to keep river levels at acceptable and maintainable levels during whitefish spawning and later emergence. The U.S. Entity agreed to this request under terms of the Non-Power Uses Agreement. During the period from January through March, the reservoir continued to be drafted. The reservoir reached its lowest level of the period, elevation 1,386.2 feet, on 1 April 1998. The Arrow fisheries operations were conducted under the terms of the two Operating Committee agreements, "Operation of Treaty Storage for Enhancement of Whitefish Spawning for 20 September, 1997, through 30 April, 1998, and "Operation of Treaty Storage for Nonpower Uses for 1 January through 31 July, 1998".

Arrow reservoir reached its highest level of the year, elevation 1,438.6 feet, on 31 July 1998 slightly above the full pool elevation of 1444.0 feet. The Arrow Treaty storage content reached 7.1 maf, or 100 percent full on 29 July 1998. By the end of the reporting period, 30 September 1998, Arrow reservoir had been drafted to elevation 1433.2 feet with a Treaty storage content of 6.27 maf, or 88 percent of full content.

To minimize spill at the downstream Kootenay River plants in Canada and maintain water levels in Lake Koocanusa in Canada and the United States, the Canadian and U.S. Entities agreed to a Libby-Arrow water transfer for the late summer of 1998. Under this agreement, Libby release volumes were reduced by about a total of 107 thousand second foot-days (ksfd) through August, and an equal amount of water was released from Arrow reservoir. This Arrow water that was effectively stored in Libby during August was to be returned to Arrow reservoir in the October 1998 to 16 January 1999 period.

Duncan Project

Duncan reservoir refilled to elevation 1892.1 feet on 31 July 1997, which is 0.1 feet above the full pool elevation of 1892.0 feet. During the month of September 1997, an average of 5.0 kcfs was discharged to maintain the Kootenay Lake flows and lake levels. This resulted in a reservoir elevation of 1889.8 feet at the start of the report year on 1 October 1997. The project discharge averaged 4.2 kcfs in October, 4.9 kcfs in November and 6.0 kcfs in December 1997. Higher discharges were necessary again between mid-December to February to again support Kootenay Lake levels and flows. The reservoir elevation was 1,859.4 feet (61 percent of full) on 31 December 1997.

During January 1998, the Duncan discharge was increased to about 8.2 kcfs. The reservoir was drafted throughout February to mid-March and reached its lowest level for the year at elevation 1795.9 feet (1.7 feet above empty) on 24 March 1998. Beginning in May, the reservoir was returned to its minimum outflow of 100 cfs to start the refill process. It remained on minimum discharge until 5 July, when the outflow was increased to slow the rate of reservoir refill. The Duncan reservoir reached full pool at elevation 1892.0 feet on 12 August 1998. During the month of August, inflow maintained the reservoir near full pool, and on 1 September, the discharge was increased to start drafting the reservoir and fill Kootenay Lake. The reservoir was drafted to elevation 1878.0 feet by 30 September 1998.

Libby Project

Lake Koocanusa started the operating year on 1 August 1997 at elevation 2453.6 feet, 5.4 feet below full pool. Lake Koocanusa reached its maximum summer elevation of 2454.8, 4.2 feet from full on 12 August, 1997. The Arrow Libby swap agreement was initiated by the Canadian Entity on 13 August. Libby outflow was increased to 14,500 cfs, 10,000 cfs less than full Powerhouse capacity. The additional 10,000 cfs was released from Arrow Lakes for the remaining 19 days of August, for a total exchange amount of 190 ksfd. Because of the 190 ksfd exchange, Lake Koocanusa ended the month of August at elevation 2450.1 feet, 8.9 feet from full. At the start of the report year on 1 October 1997, the reservoir was at elevation 2447.4 feet. From September to December 1997 Libby was used for weekly load shaping. Two periods (28 November through 30 November, and 25 December through 28 December) of minimum outflow of 4000 cfs were provided to complete a study of burbot movement downstream of Libby.

The reservoir was drafted to elevation 2411.7 by the end of December 1997 which is within one foot of the flood control rule curve of 2411.0 feet.

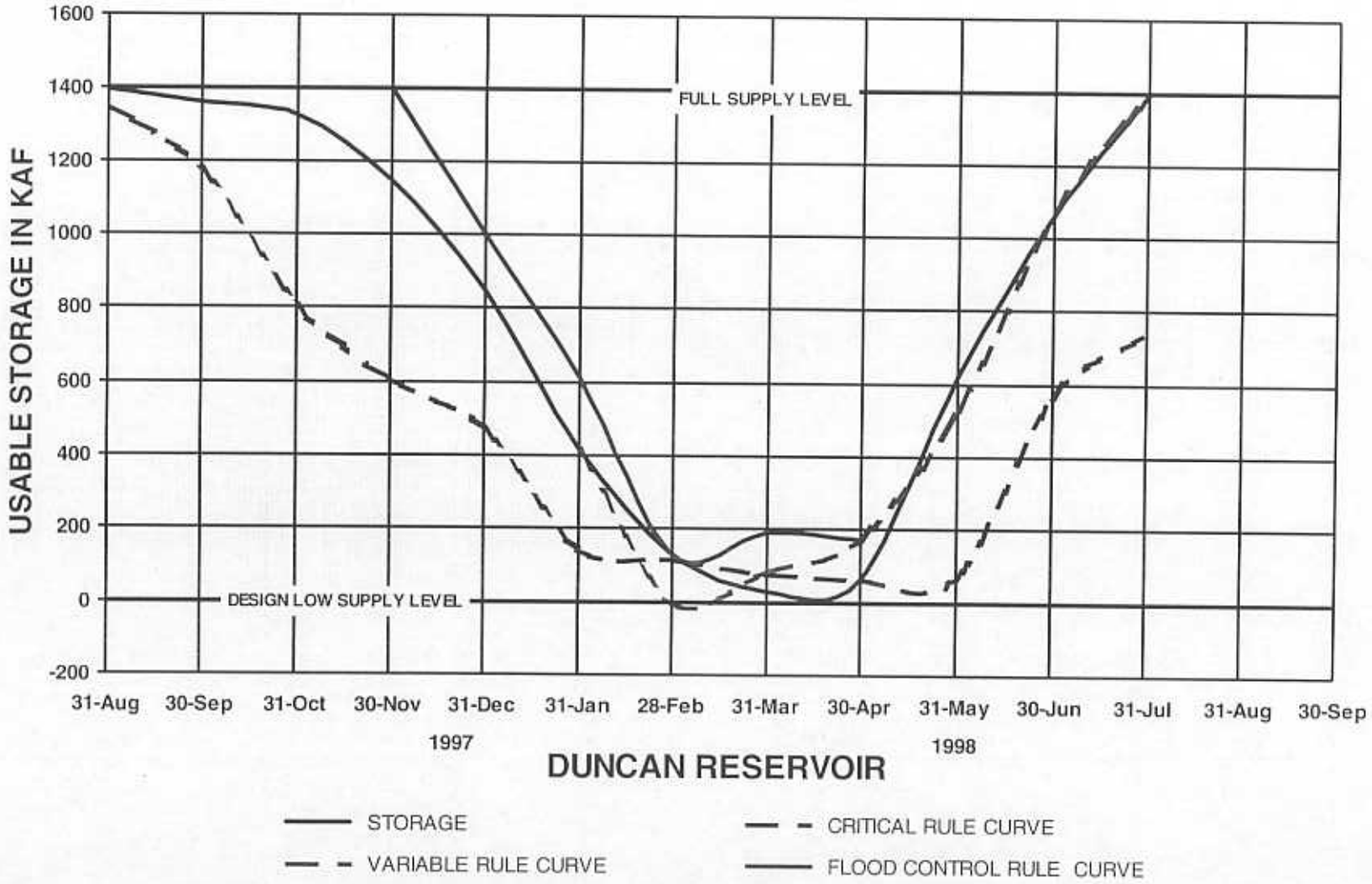
Libby was operated from January to April, 1998 to stay within the end of month flood control target elevations. Since the May final water supply forecast was less than 80 percent of average, the U.S. Fish and Wildlife Service requested only one sturgeon pulsing operation. By the end of May, Lake Koocanusa refilled to elevation 2440.2 feet. During the first 25 days of June, the outflow from Libby was held near 20,000 cfs, at the request of the U.S. Fish and Wildlife, to maintain a level wetted perimeter after sturgeon spawning occurred during the late may rain event. Lake Koocanusa filled to elevation 2454.2 feet, only 4.8 feet from full by 30 June 1998.

During the first half of July 1998 Libby outflow was managed to supply downstream fishery needs while evacuating Lake Koocanusa to a proposed target elevation of 2439 by 31 August 1998. Because of a two day reduced outflow to assist recovery of drowning victims, on 17 July Lake Koocanusa filled to its highest 1998 elevation of 2458.3 feet, only 0.7 feet from full. Because of changing hydrologic conditions, the U.S. and Canadian Entities agreed to a Libby Arrow exchange of only 107 ksfd (down from an earlier proposed exchange of 200 ksfd) of storage so the end of August target elevation would be near 2444 feet. At the end of August 1998 the reservoir elevation was 2443.9 feet, 15.1 feet from full.

Libby was operated to meet power demands during September. The observed reservoir level, at the end of the reporting year, on 30 September, 1998 was 2437.9 feet, 21.3 feet from full.

Flood Control Operation

The Columbia River Basin reservoir system was operated on a daily basis for flood control for only a short time in the spring of 1998 when heavy precipitation caused a sharp rise in runoff in late May Reductions in outflows from the Canadian Treaty storage projects were not required to alleviate flooding conditions in the Portland, Oregon-Vancouver, Washington area during this high water event because there was sufficient storage available in U.S. reservoirs, including Lake Koocanusa behind Libby, to achieve flood control objectives. Flood runoffs stored in Lake Koocanusa during the May event contributed to the overall flow reduction of approximately 175,000 cfs measured at The Dalles. The monetary value of the damages prevented by operation of the U.S. Treaty storage for flood control was approximately $(US)2,900,000.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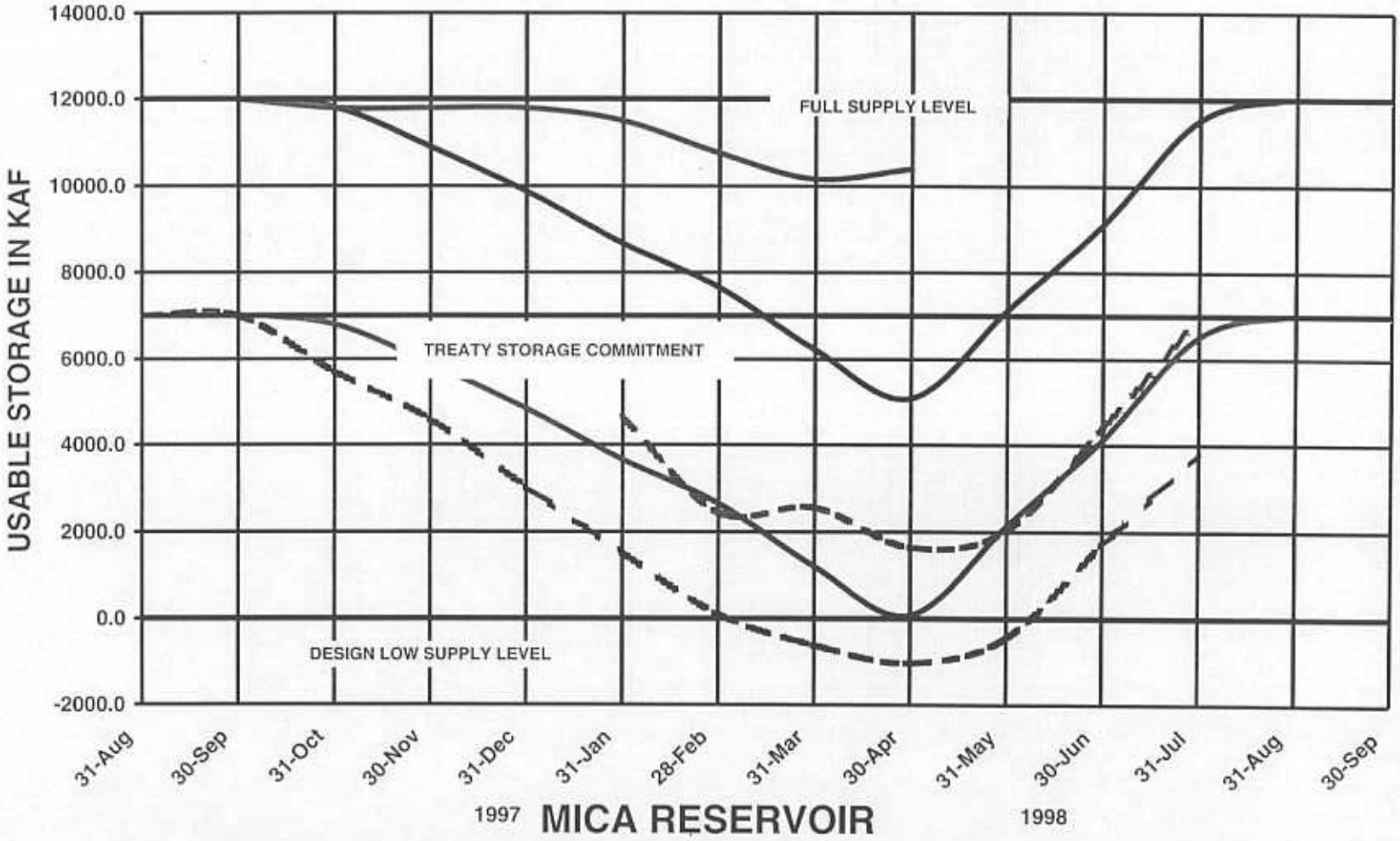
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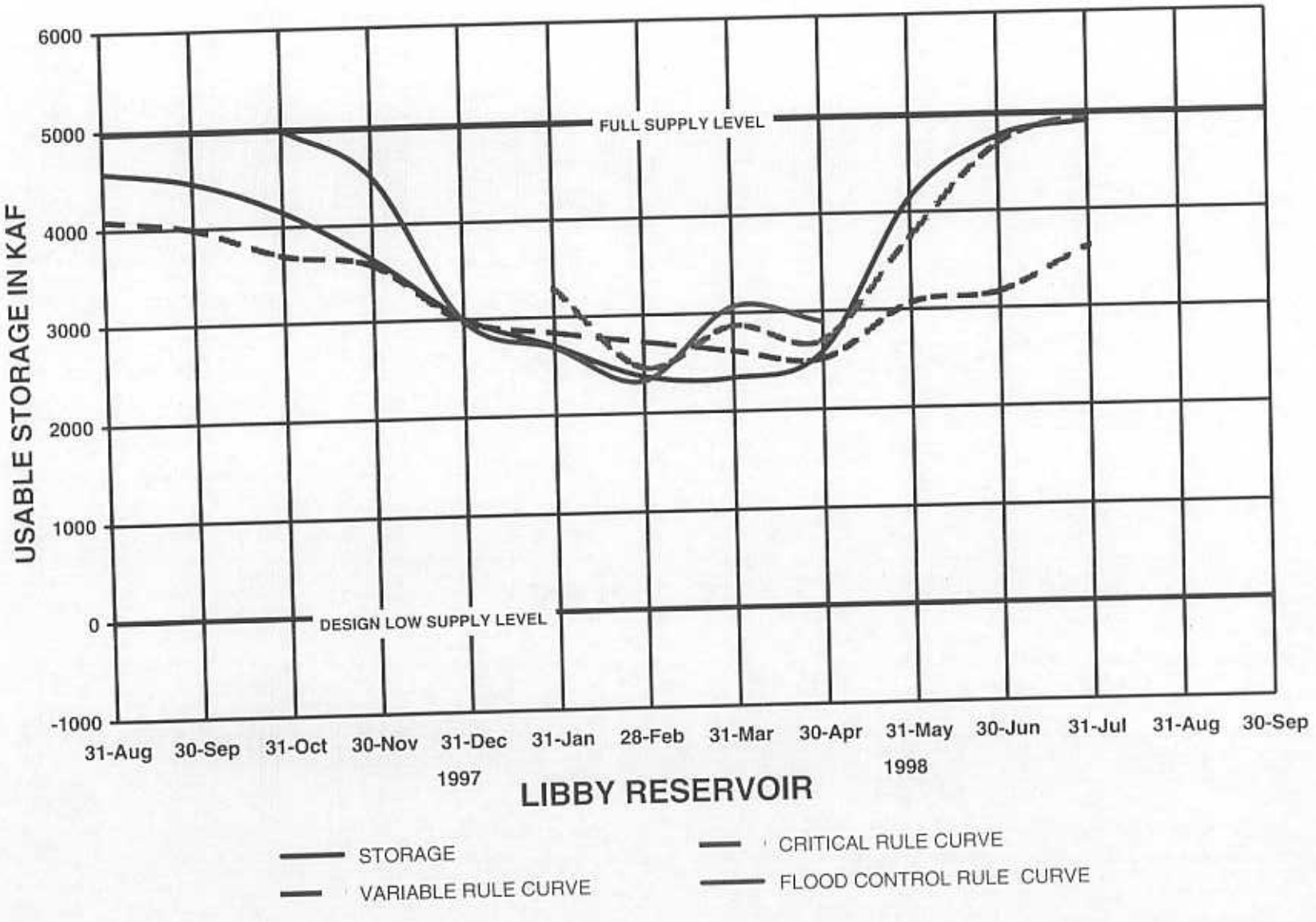
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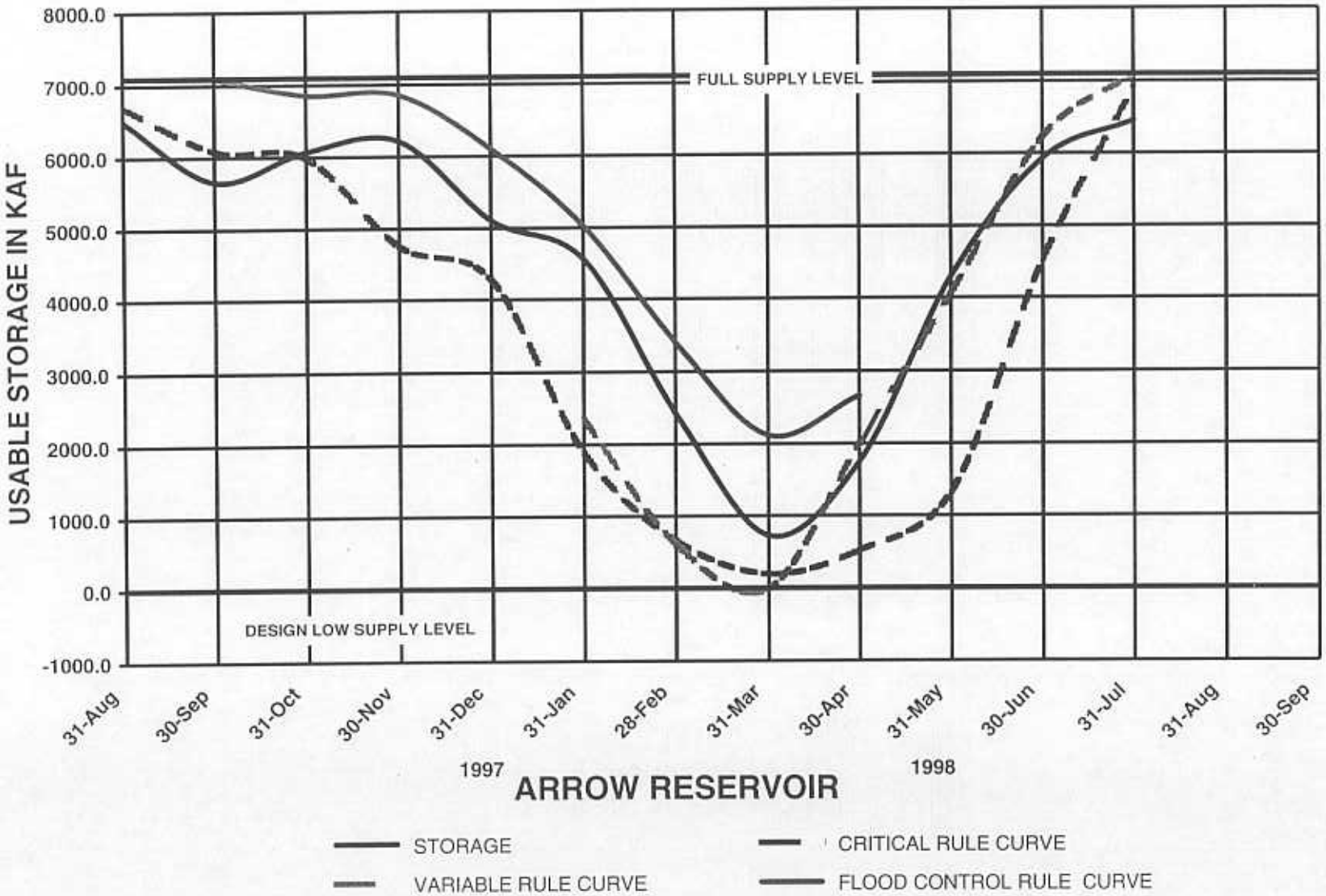
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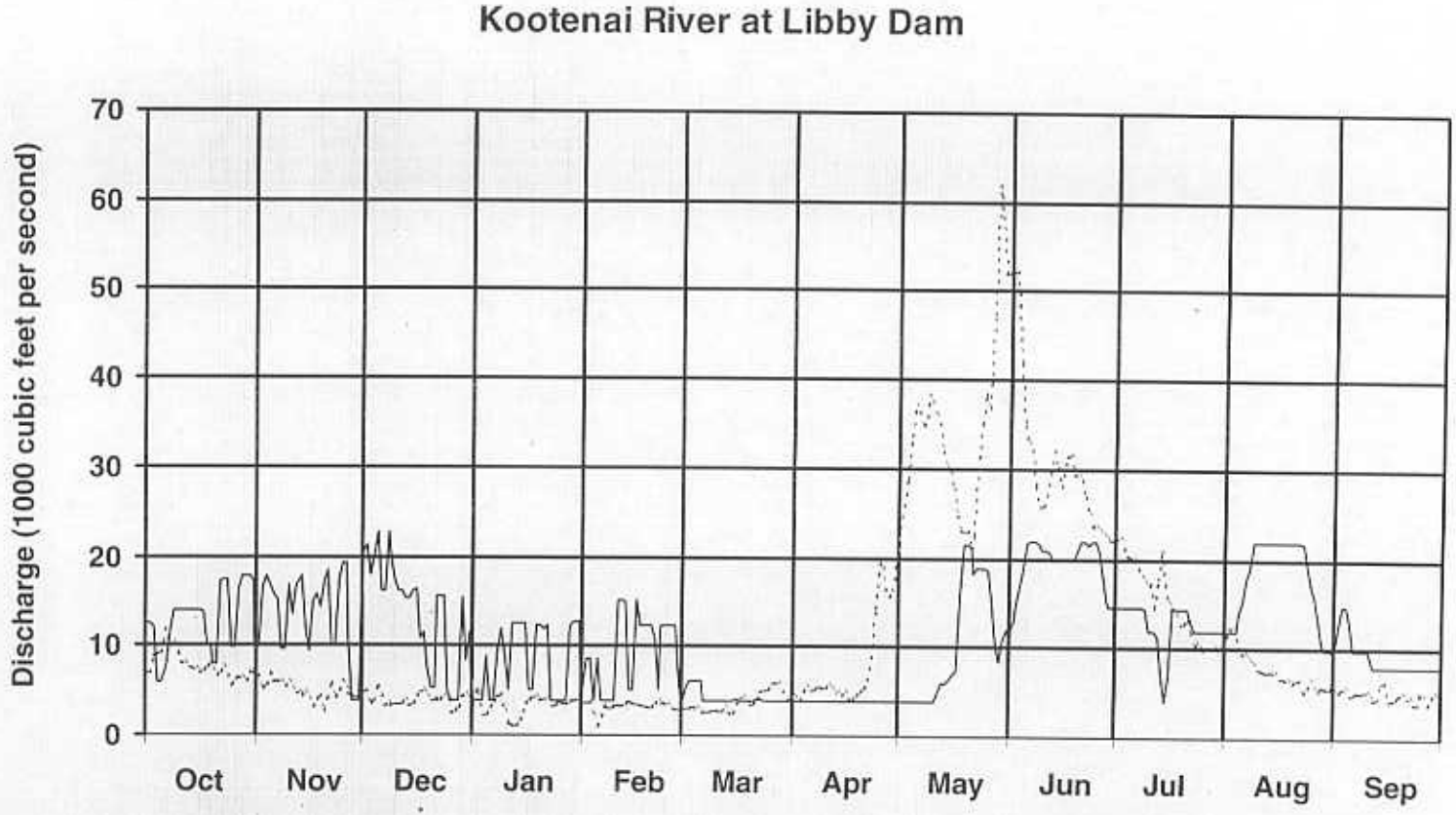
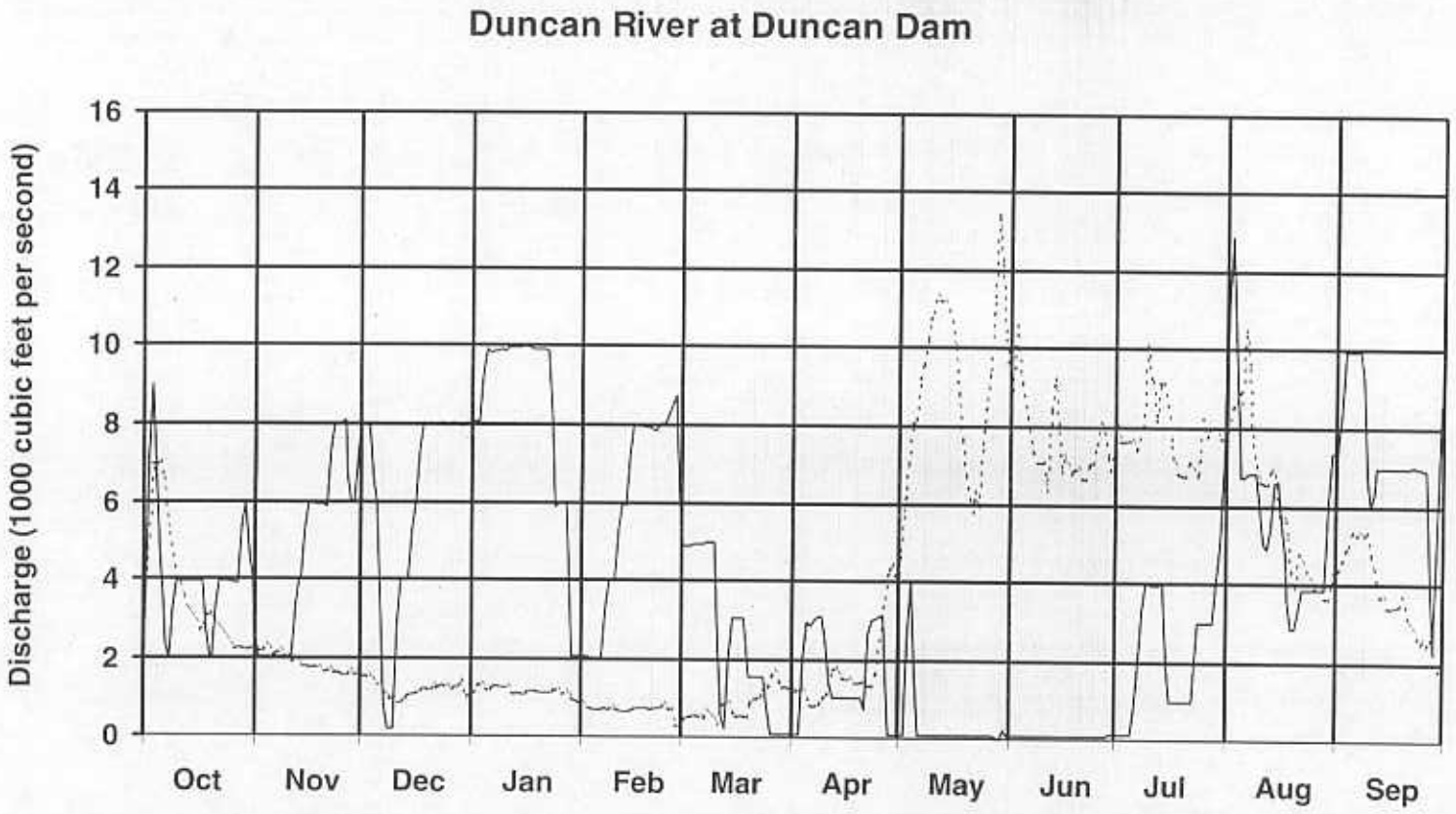
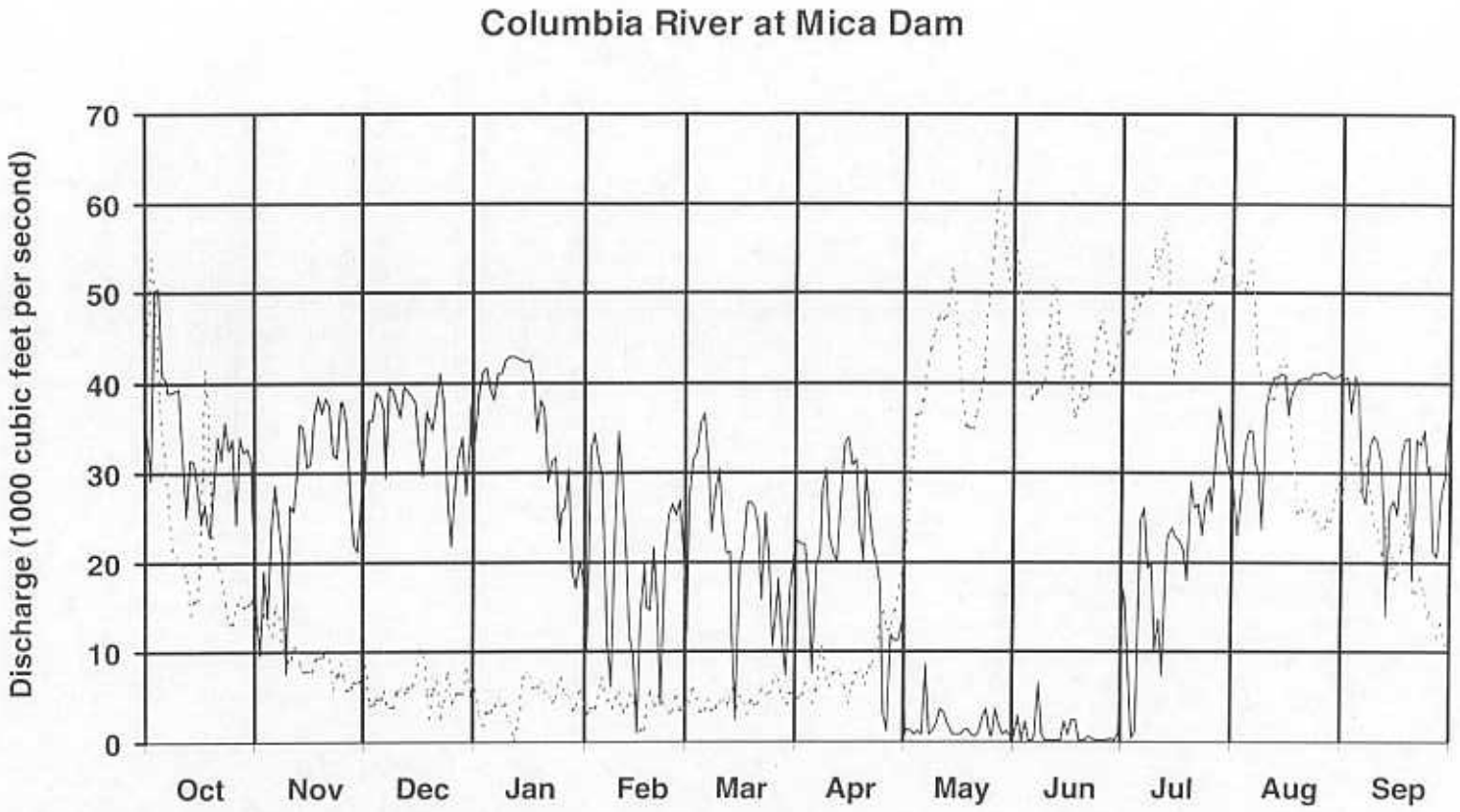
FLOOD CONTROL RULE CURVE



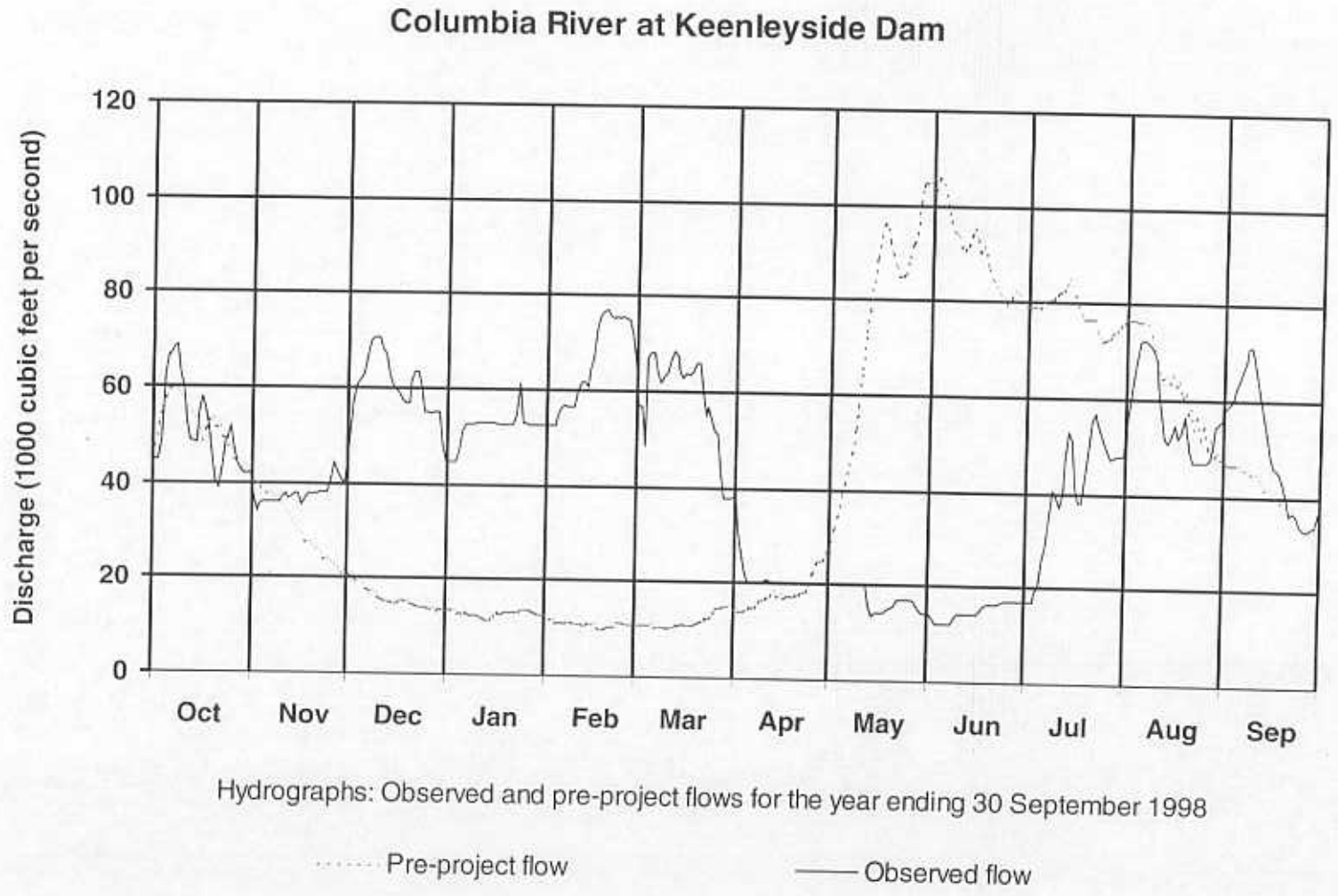
Hydrographs: Observed and pre-project flows for the year ending 30 September 1998



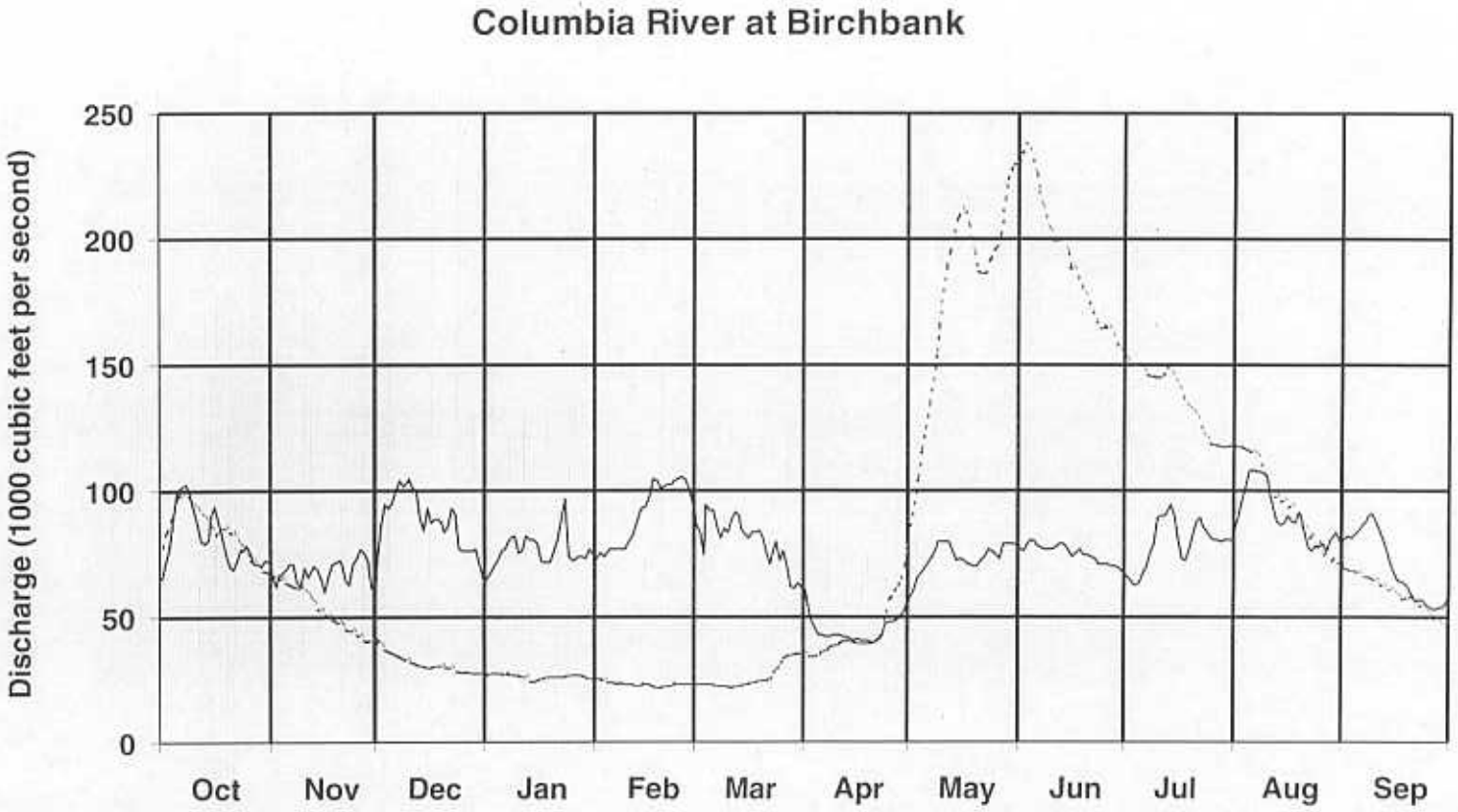
Hydrographs: Observed and pre-project flows for the year ending 30 September 1998



Hydrographs: Observed and pre-project flows for the year ending 30 September 1998



Hydrographs: Observed and pre-project flows for the year ending 30 September 1998



Hydrographs: Observed and pre-project flows for the year ending 30 September 1998

BENEFITS

Flood Control Benefits

In contrast to the previous year, when a major flood occurred in the Columbia River basin and all Four Treaty projects were utilized to store flood runoff, only Libby Dam was called upon to help control the less significant flood of May 1998. The peak regulated and river stage for that event is shown in the tables below:

Columbia River Streamflow at The Dalles, Oregon

Date	Peak Regulated Flow-cfs	Date	Peak Unregulated Flow-cfs
30 May 1998	442200	29 May 1998	617000

Columbia River Stage at Vancouver, Washington
(Flood Stage is 16.0 ft.)

Date	Peak Regulated Stage-ft.	Date	Peak Unregulated Stage-ft.
1 June 1998	14.8	31 May 1998	22.4

In the spring of 1998, the operation of Columbia Basin reservoir system as a whole reduced the natural peak discharge of the Columbia River near The Dalles, Oregon from about 617,000 cfs to 442,200 which resulted in a stage reduction at Vancouver, Washington of 7.6 feet.

The damage prevented by the operation of the Treaty storage at Libby Dam for the period from 1 October 1997 to 30 September 1998 is estimated to be $(US)2,900,000.

All payments required by Article VI(1) of the Treaty 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 share was sold in the United States under the terms of the Canadian Entitlement Purchase Agreement. The U.S. Entity delivers capacity and energy to Columbia Storage Power Exchange participants, the 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, as well as generation at the Mica and Revelstoke projects, are retained by Canada. The benefits from Libby regulation, which occur downstream in the United States, are not shared under the Treaty.

During the operating year, 1 August 1997 through 31 July 1998, the downstream power benefits accruing to each country from the Treaty storage were determined, according to the procedures set out in the Treaty and Protocol, to be 553.3 megawatts of average annual energy and 1229.6 megawatts of capacity.

The Canadian Entitlement Purchase Agreement expires in stages over the period 1998 to 2003. 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. The table below summarizes Canada's share of the downstream power benefits returnable from each project:

Treaty Storage	Date Returnable	Share of Canadian Entitlement %
Duncan	1 April 1998	9.0
Arrow	1 April 1999	45.8
Mica	1 April 2003	45.2

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

The agreement between the Entities, signed on 20 November 1996, sets out the details of delivery points and reliability of delivery for the downstream power benefits returnable to Canada beginning 1 April 1998. This agreement is also reported in the Reports Received Section on page 11 of this document.

Other Benefits

By agreement between the Entities, stream flows are regulated for non-power purposes, such as accommodating construction in river channels and providing water to meet fish needs in both countries. These arrangements are implemented under the Detailed Operating Plan and other agreements to provide mutual benefits.

CONCLUSIONS

1. During the operating year, 1 August 1997 through 31 July 1998, the downstream power benefits accruing to each country from the Treaty storage were determined, according to the procedures set out in the Treaty and Protocol, to be 553.3 megawatts of average annual energy and 1229.6 megawatts of capacity.

2. The damage prevented by the operations of the Treaty storage at Libby Dam for the period from 1 October 1997 to 30 September 1998 is estimated to be $(US)2,900,000.

3. The Entities continued to operate the hydrometeorological network as required by the Treaty.

4. On 1 April 1998, Entitlement power began being returned to Canada at the U.S.-Canada border, over existing power lines, as established by the 20 November 1996 Entity Agreement. For the period 1 April 1998 through 31 July 1998, the amount returned for Ducan was 50 average megawatts of energy at a peak of 111 megawatts of capacity. For the period beginning 1 August 1998 and ending 31 March 1999, the amount returned will be 50.8 megawatts of energy at a peak of 136.8 megawatts of capacity.

5. The Duncan, Arrow and Mica projects were operated in conformity with the Treaty during the 1997–1998 operating year. The operation reflected detailed operating plans developed by the Entities, the flood control operating plan for Treaty reservoirs, and other agreements between the Entities.

6. From October through December 1997, the Libby Dam project was operated for power requirements according to the Entities' report: Detailed Operating Plan (DOP) for Columbia River Treaty Storage for Operating Year 1997–1998. For the remainder of the operating year, the U.S. Entity operated Libby in accordance with the flood control operating plan and the U.S. fishery requirements to protect and enhance the white sturgeon and salmon population. The Canadian Entity believes that the fishery operations are inconsistent with the Treaty. The two governments are engaged in discussions to resolve the issue.

7. In August 1998, the Entities agreed on a DOP for the operating year 1998-1999 in conformance with the requirements of the Treaty. As in the previous DOP, the Libby project has two sets of operating rule curves, thus reflecting the Entities' disagreement over operation of the project.

8. The Board concludes that the disagreement between the Entities over Libby Dam fisheries operations has prevented the Entities from agreeing on the Assured Operating Plans (AOP) and Determinations of Downstream Power Benefits (DDPB) for upcoming operating years 2000-2001, 2001-2002, 2002-2003, and 2003-2004. The Treaty requires the Entities to prepare an AOP and the associated DDPB for each operating year six years in advance. If the Libby disagreement is not resolved by the start of operating year 2000-2001, the Entities will enter that year without a plan for operation of the Canadian Treaty projects and without a basis for determining downstream power benefits.

9. Based on the preceding conclusion, the Treaty requirements are not fully met.

APPENDIX A

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

United States	*Canada*
	Members
Mr. Steven Stockton, Chair Chief, Engineering Division Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, D.C.	Mr. Daniel Whelan, Chair Director General Energy Resources Branch Department of Natural Resources Ottawa, Ontario
Mr. Ronald Wilkerson Missoula, Montana	Mr. John Allan Deputy Minister Ministry of Forests Victoria, British Columbia
	Alternates
Mr. Earl E. Eiker (Nominee) Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, D.C.	Mr. David Burpee Director, Renewable and Electrical Energy Division Energy Resources Branch Department of Natural Resources Ottawa, Ontario
Mr. George E. Bell Lake Oswego, Oregon	Mr. Prad Kharé Deputy Comptroller of Water Rights Ministry of Environment, Lands and Parks Victoria, British Columbia
	Secretaries
Mr. Richard DiBuono Senior Hydraulic Engineer Directorate of Civil Works H.Q., U.S. Army Corps of Engineers Washington, D.C.	Mr. David Burpee Director, Renewable and Electrical Energy Division Energy Resources Branch Department of Natural Resources Ottawa, Ontario

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

Record of Membership

Members

United States		*Canada*	
Mr. Wendell Johnson[1]	1964–1970	Mr. Gordon McNabb[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]	1991–1996
Mr. Lloyd Duscha[1]	1979–1990	Mr. Daniel Whelan[1]	1996–
Mr. Ronald Wilkerson	1988–		
Mr. Herbert Kennon[1]	1990–1994		
Mr. John Elmore[1]	1994–1996		
Mr. Steven Stockton[1]	1996–		

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. Herbert Kennon	1987–1990	Dr. Donald Kasianchuk	1988–1996
Mr. Thomas Weaver	1979–1997	Mr. Vic Niemela	1992–1994
Mr. John Elmore	1990–1994	Mr. David Burpee	1994–
Mr. Paul Barber	1994–1995	Mr. Jack Farrell	1996–1997
Mr. Daniel Burns	1995–1997	Mr. Prad Kharé	1997–
Mr. George E. Bell	1997–		

Secretaries

Mr. John Roche	1965–1969	Mr. Mac Clark	1964–1992
Mr. Verle Farrow	1969–1972	Mr. David Burpee	1992–
Mr. Walter Duncan	1972–1978		
Mr. Shapur Zanganeh	1978–1995		
Mr. Richard DiBuono	1995–		

[1] Chair

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

ENGINEERING COMMITTEE

Current Membership

United States

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Directorate of Civil Works
H.Q., U.S. Army Corps of Engineers
Washington, D.C.

Mr. Earl Eiker, P.E.
Directorate of Civil Works
H.Q., U.S. Army Corps of Engineers
Washington, D.C.

Mr. James Barton, P.E.
Water Management Division
U.S. Army Corps of Engineers
Northwestern Division
Portland, Oregon

Mr. Michael S. Cowan, P.E.
Chief, Program Office
Western Area Power Administration
Golden, Colorado

Mr. James Fodrea, P.E.
U.S. Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

Canada

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Electricity Development Branch
Ministry of Employment and Investment
Victoria, British Columbia

Mr. David Burpee
Renewable and Electrical Energy Division
Department of Natural Resources
Ottawa, Ontario

Ms. Myriam Boudreault
Renewable and Electrical Energy Division
Department of Natural Resources
Ottawa, Ontario

Dr. Bala Balachandran, P.Eng.
Water Management Branch
Ministry of Environment, Lands and Parks
Victoria, British Columbia

Mr. Larry Adamache, P. Eng.
Aquatic and Atmospheric Sciences Division
Environment Canada
Vancouver, British Columbia

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

United States | *Canada*

Members

Mr. Randall Hardy, Chair
Administrator and Chief Executive Officer
Bonneville Power Administration
Department of Energy
Portland, Oregon

Mr. Brian Smith, Chair
British Columbia Hydro and
Power Authority
Vancouver, British Columbia

BG Robert H. Griffin
Division Engineer
U.S. Army Engineer Division,
North Pacific
Portland, Oregon

APPENDIX C

RECORD OF FLOWS

AT THE

INTERNATIONAL BOUNDARY

Kootenay River at Porthill, Idaho

Daily discharges in thousands of cubic feet per second for the year ending 30 September 1998

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	13.5	20.0	6.8	11.9	13.2	8.3	9.5	21.0	32.9	18.5	13.8	10.7
2	13.7	13.9	20.3	6.3	7.4	6.5	9.3	22.4	30.1	18.2	13.8	10.6
3	13.9	13.1	22.0	6.7	9.7	7.5	9.3	23.4	28.8	18.2	13.9	13.5
4	13.2	19.3	20.7	6.4	9.8	8.1	9.6	25.7	28.6	18.1	13.9	15.2
5	11.2	20.4	20.7	6.2	9.8	8.2	10.0	26.0	29.3	18.0	14.0	15.2
6	11.7	18.8	22.3	9.9	9.6	8.0	10.3	25.0	30.7	17.8	15.4	13.2
7	12.3	18.7	17.2	6.2	6.2	7.9	10.5	24.6	31.8	17.4	16.9	10.8
8	12.2	18.4	17.0	6.6	5.9	6.2	10.5	24.5	31.2	17.2	19.2	10.7
9	15.3	13.2	22.3	10.3	5.9	6.0	10.4	23.8	30.2	17.2	20.7	10.7
10	16.5	12.8	20.7	12.7	6.0	6.1	10.2	22.5	29.3	16.4	22.6	10.7
11	16.3	18.0	18.3	10.1	6.3	6.1	10.1	20.5	28.7	15.1	23.0	10.7
12	16.2	16.0	17.1	6.7	14.9	6.3	10.1	18.7	29.0	15.0	23.1	9.7
13	16.1	19.0	16.7	12.3	15.9	6.3	9.9	18.9	28.3	14.8	23.1	9.1
14	16.1	19.3	16.1	13.6	15.9	6.3	9.7	19.1	28.1	13.6	23.1	9.1
15	16.1	19.3	16.3	13.4	8.0	6.5	9.4	18.2	27.7	9.7	23.2	9.0
16	16.1	12.9	17.0	13.4	7.2	6.9	9.2	16.9	28.0	7.3	23.2	9.0
17	15.9	12.0	15.5	13.1	15.2	7.8	9.0	16.6	28.2	10.4	23.1	9.1
18	15.1	16.4	12.2	7.1	13.7	7.9	8.9	17.5	27.7	15.8	23.4	9.1
19	12.3	17.8	12.6	6.9	13.4	7.7	8.9	26.2	27.1	16.0	23.4	9.2
20	11.6	18.0	8.9	12.6	13.4	7.5	9.1	29.7	26.6	16.0	23.5	9.3
21	10.1	19.8	6.9	13.1	14.0	7.4	9.5	31.4	27.3	16.0	23.2	9.1
22	10.7	18.8	7.2	13.1	11.5	7.6	10.5	31.1	28.0	16.0	23.2	9.0
23	17.5	12.4	15.3	13.2	7.8	9.0	12.4	31.0	27.9	14.6	23.1	9.0
24	18.5	12.2	15.9	6.5	13.3	11.8	17.3	30.9	27.5	13.8	22.5	8.8
25	17.9	18.8	15.5	6.1	13.6	13.2	20.0	29.8	27.5	13.7	20.2	9.0
26	12.0	20.0	6.8	6.0	13.5	13.1	18.1	29.9	27.0	13.7	17.9	9.2
27	11.6	19.1	5.8	6.1	13.5	12.6	16.3	41.7	24.8	13.7	16.7	9.1
28	17.8	11.8	5.7	6.2	13.4	11.9	16.1	46.8	21.7	13.7	14.1	9.1
29	19.2	6.7	5.9	12.7		11.2	17.2	37.0	19.7	13.6	11.7	9.0
30	20.4	6.1	15.1	13.4		10.4	19.0	33.6	18.8	13.7	11.0	9.0
31	22.0		9.8	13.4		9.9		35.5		13.8	10.9	
Mean	14.9	16.1	14.5	9.7	11.0	8.4	11.7	26.4	27.8	15.1	19.1	10.2

Columbia River at Birchbank, British Columbia

Daily discharges in thousands of cubic feet per second for the year ending 30 September 1998

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	65.0	65.7	72.4	64.6	73.1	86.2	60.4	57.6	76.3	66.4	83.0	79.8
2	71.0	61.4	85.1	66.7	74.9	83.3	55.1	60.4	75.9	65.0	88.3	81.6
3	76.3	65.7	93.9	69.9	73.8	74.5	48.7	65.3	78.4	62.2	95.0	81.2
4	88.3	67.1	92.9	72.0	74.2	94.3	45.9	67.1	79.8	62.5	101.0	82.3
5	99.6	68.2	94.6	75.6	76.3	91.8	42.4	68.9	79.5	63.6	107.7	83.7
6	99.9	70.6	99.9	76.3	76.6	92.2	42.4	71.3	78.0	66.7	108.1	85.8
7	101.4	70.6	103.5	78.8	76.6	85.5	42.0	73.8	77.0	69.6	107.7	87.6
8	102.1	63.2	101.4	80.5	76.6	81.2	42.0	76.6	76.6	75.2	107.7	89.3
9	97.5	61.8	103.1	81.6	76.6	84.8	42.4	79.1	76.6	78.4	106.7	90.4
10	92.2	68.9	104.2	74.9	79.1	83.0	42.4	79.5	76.6	88.6	104.9	87.6
11	85.8	65.3	101.0	75.9	81.6	88.3	42.7	79.1	77.3	89.7	99.2	83.7
12	79.1	66.7	99.2	81.9	85.8	91.1	42.0	79.1	78.8	90.1	93.2	80.2
13	78.8	69.9	88.3	80.2	91.1	89.3	41.7	75.6	78.4	91.1	87.6	75.6
14	79.8	68.2	84.1	80.2	92.5	84.8	41.0	72.0	77.0	93.9	86.2	70.6
15	88.6	64.6	92.5	78.8	93.6	82.6	40.6	72.8	75.9	90.1	86.5	66.7
16	93.6	59.3	86.5	72.4	96.8	80.5	41.0	71.7	73.8	80.2	89.3	64.3
17	87.6	66.0	88.3	71.3	104.5	83.3	40.6	70.6	74.9	73.1	87.2	63.9
18	81.9	70.6	88.3	71.0	103.8	83.3	40.6	70.6	76.3	72.0	86.9	63.2
19	74.9	71.0	86.2	71.0	100.7	83.7	40.6	69.9	74.5	76.6	91.1	61.4
20	69.9	71.7	83.0	75.9	101.4	80.5	39.6	69.9	74.5	82.3	89.3	59.0
21	68.5	70.3	85.1	80.2	102.4	75.2	39.9	72.0	73.8	87.2	83.3	55.8
22	72.0	63.9	92.5	87.9	102.4	70.6	40.3	73.8	72.8	89.0	77.0	56.9
23	76.6	62.5	90.8	96.4	103.8	74.5	42.0	76.3	70.3	86.2	75.9	56.5
24	75.9	70.3	76.6	73.8	104.5	79.1	47.3	75.6	70.3	83.7	77.7	54.4
25	77.7	73.1	75.9	72.4	104.9	72.0	47.7	74.2	70.6	81.9	77.0	53.3
26	75.2	76.3	75.6	72.4	104.5	75.9	48.0	73.1	70.3	80.2	78.8	52.6
27	70.3	75.2	75.9	73.5	101.0	69.9	48.4	78.8	69.9	80.2	75.9	52.6
28	70.6	72.0	75.9	73.5	94.6	61.8	49.8	78.4	69.9	79.5	80.2	54.0
29	69.6	61.1	76.3	73.1		61.1	51.9	78.4	69.2	79.8	81.2	53.7
30	72.0	63.6	70.6	76.3		63.2	54.7	78.4	67.5	80.2	83.0	56.5
31	71.3		64.6	74.2		61.1		77.7		80.2	79.5	
Mean	81.1	67.5	87.4	75.9	90.3	79.6	44.8	73.1	74.7	78.9	89.6	69.5

APPENDIX D

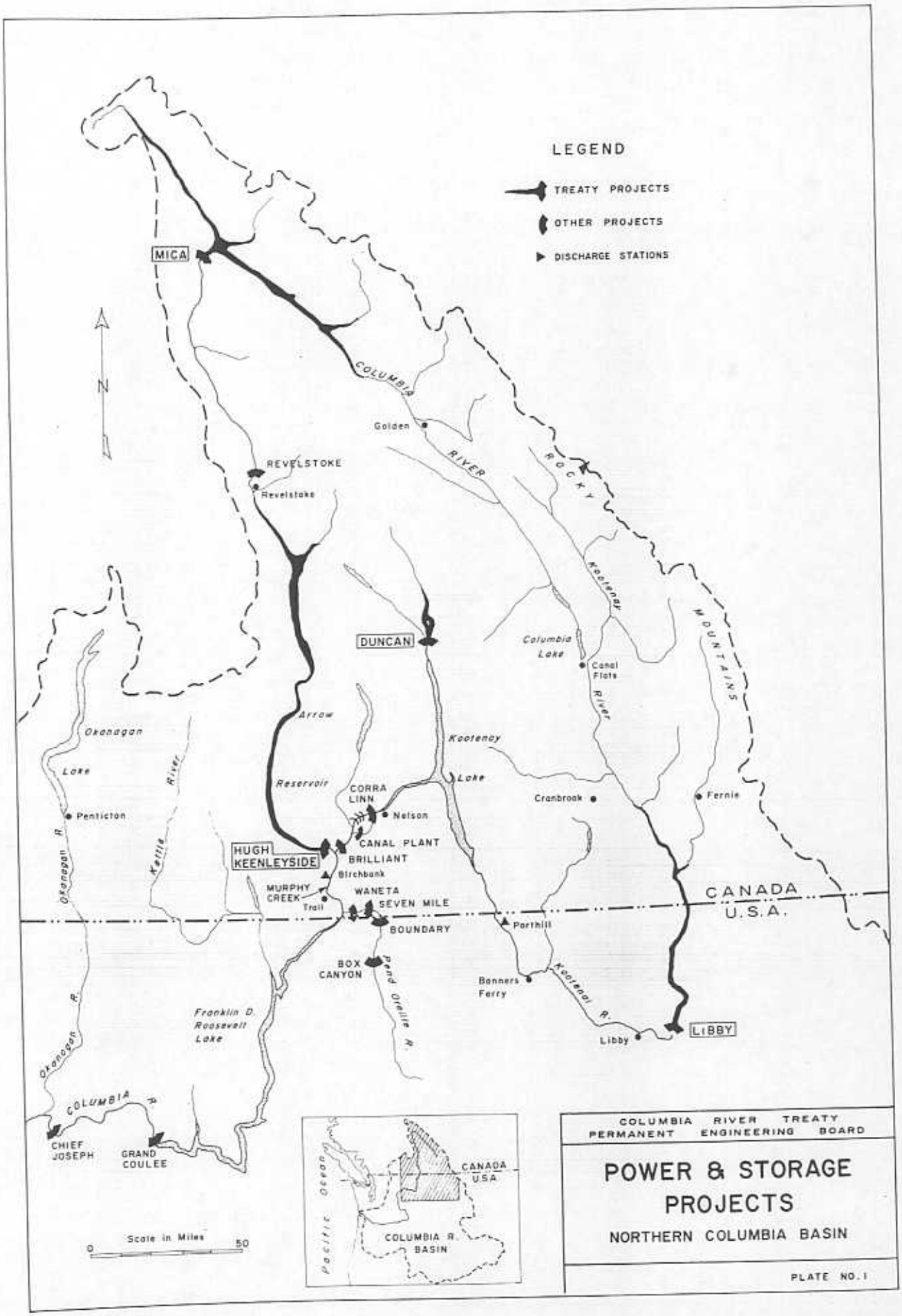
PROJECT INFORMATION

Power and Storage Projects,

Northern Columbia Basin	Plate No. 1

Project Data

Duncan Project	Table No. 1
Arrow Project	Table No. 2
Mica Project	Table No. 3
Libby Project	Table No. 4


LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
N
COLUMBIA
Golden
RIVER
ROCKY
REVELSTOKE
Revelstoke
Kootenay
MOUNTAINS
DUNCAN
Columbia
Lake
Canal
Flats
River
Okanagan
Lake
Arrow
Reservoir
Kootenay
Lake
Cranbrook
Fernie
Penticton
Okanagan R.
Kettle River
CORRA
LINN
Nelson
HUGH
KEENLEYSIDE
CANAL PLANT
BRILLIANT
Birchbank
MURPHY
CREEK
Trail
WANETA
SEVEN MILE
BOUNDARY
CANADA
U.S.A.
Porthill
BOX
CANYON
Pend Oreille R.
Kootenai R.
Bonners
Ferry
LIBBY
Libby
Franklin D.
Roosevelt
Lake
Okanogan R.
COLUMBIA R.
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
PLATE NO. 1

POWER & STORAGE PROJECTS

Northern Columbia Basin

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 acre-feet
Usable storage capacity	1,400,000 acre-feet
Treaty storage commitment	1,400,000 acre-feet

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 acre-feet
Usable storage capacity	7,100,000 acre-feet
Treaty storage commitment	7,100,000 acre-feet

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 acre-feet
Usable storage capacity	12,000,000 acre-feet
Treaty storage commitment	7,000,000 acre-feet

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
Currently 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 acre-feet
Usable storage capacity	4,980,000 acre-feet

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
Currently 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