

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

**COLUMBIA RIVER TREATY**  
**PERMANENT ENGINEERING BOARD**

**Washington, D.C.**

**Ottawa (Ontario)**

**30 SEPTEMBER 2000**



# 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**  
D.R. WHELAN, Chairman  
C. Kang, Member

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

28 February 2001

The Honorable Colin Powell  
Secretary of State  
Washington, D.C.

The Honourable Ralph Goodale  
Minister of Natural Resources Canada  
Ottawa, Ontario

Dear Secretary Powell and Minister Goodale:

We refer you to the Treaty between the United States of America and Canada relating to cooperative development of the water resources of the Columbia River basin, signed in Washington, D.C., on 17 January 1961.

In accordance with the provisions of Article XV paragraph 2(e), we are submitting the thirty-sixth Annual Report of the Permanent Engineering Board, dated 30 September 2000. The report documents the results achieved under the Treaty for the period from 1 October 1999 to 30 September 2000.

At the beginning of this reporting period, the Entities were not in full compliance with the requirements of the Treaty. The Assured Operating Plans (AOPs) and Determinations of Downstream Power Benefits (DDPBs) for operating years 2000-2001 through 2004-2005 had not been prepared and signed six years in advance. However, as noted in the transmittal letter with the 1998-1999 Annual Report, the Entities signed an agreement on 16 February 2000 concerning the disputed Libby operation. This agreement enabled the outstanding AOPs/DDPBs to be implemented.

The Board is pleased to report that as of 16 February 2000, the requirements of the Treaty have been satisfied.

Respectfully submitted:

For the United States

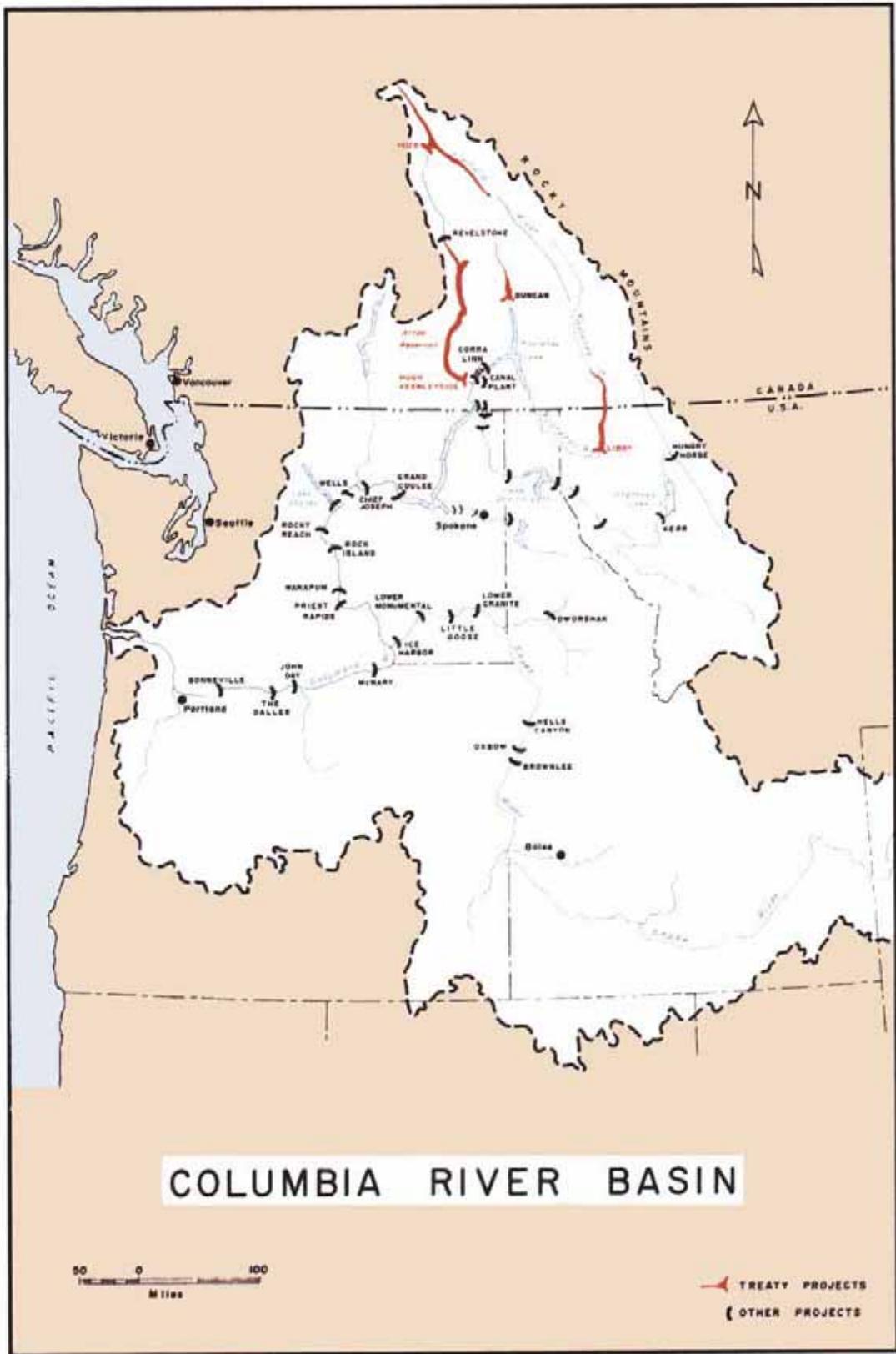
Steven Stockton, Chair

Ronald Wilkerson

For Canada

Dan Whelan, Chair

for Charles Kang



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Ottawa, Ontario

30 September 2000

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## **DEDICATION**

The Permanent Engineering Board dedicates this Annual Report to the Columbia River Treaty staff of the Bonneville Power Administration, the U.S. Army Corps of Engineers, and the British Columbia Hydro and Power Authority (BC Hydro) for their efforts to achieve full compliance with the Treaty for the first time since operating year 1993–1994.

In addition, the Board praises the Operating Committee for keeping the efficient and effective operation of the Treaty projects as their paramount objective throughout the resolution process. Despite their differences over operations affecting the Treaty, the Entities managed to continue the day-to-day Treaty operation. The Board recognizes that this was achieved largely through the dedicated efforts of the members of the Entities' Operating Committee, who put aside their differences and worked together to implement the Treaty.

## SUMMARY

The thirty-sixth 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.

As reported in this document, the requirements of the Treaty have been satisfied.

At the beginning of this reporting period, the Entities were not in full compliance with the requirements of the Treaty. The Assured Operating Plans (AOPs) / Determinations of Downstream Power Benefits (DDPBs) for operating years 2000–2001 through 2004–2005 had not been prepared and signed six years in advance. As noted in the transmittal letter with the 1998–1999 Annual Report, the Entities signed an agreement on 16 February 2000 concerning the disputed Libby operation. This agreement enabled the outstanding AOPs and DDPBs to be implemented.

**During the operating year, 1 August 1999 through 31 July 2000, the entitlement to the downstream power benefits accruing to each country from the Treaty storage was determined, according to the procedures set out in the Treaty and Protocol, to be 559.5 megawatts (MW) of average annual energy and 1461.9 MW of capacity.**

From 1 August 1999 through 31 March 2000, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 306.8 average megawatts of energy at rates up to 801.7 MW of capacity. The delivery from 1 April 2000 to 31 July 2000 was 277.4 average megawatts of energy at rates up to 794.0 MW of capacity.

In accordance with the Entity agreements on the DDPBs for operating years 1999–2000 and 2000–2001, the Canadian Entity delivered to the U.S. Entity 0.4 average megawatts of annual energy and no dependable capacity during the period 1 August 1999 through 31 March 2000, and no energy nor capacity afterward.

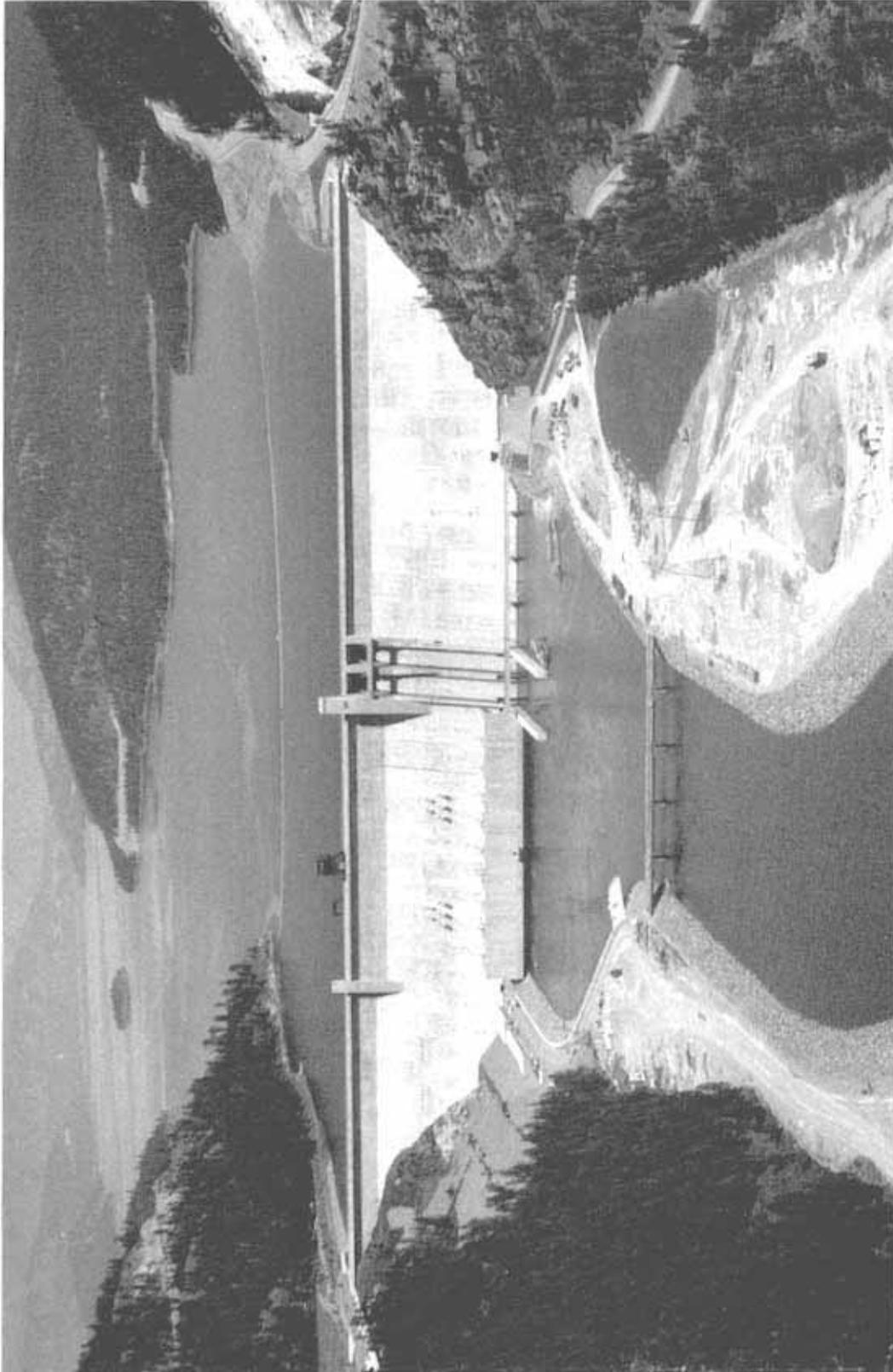
The Duncan, Arrow and Mica projects were operated in conformity with the Treaty during the 1999–2000 operating year. The operation reflected detailed operating plans developed by the Entities, the flood control operating plan for Treaty reservoirs and other agreements between the Entities. The Columbia River Treaty projects were not operated for flood control during this reporting year.

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

## **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 1999 through 30 September 2000, 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 and Lake Koocanusa – Kootenai River, Montana  
The dam and reservoir, Lake Koocanusa, with the powerhouse 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 Parliament of Canada 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 30 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 US\$253.9 million 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 totalling US \$64.4 million 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.

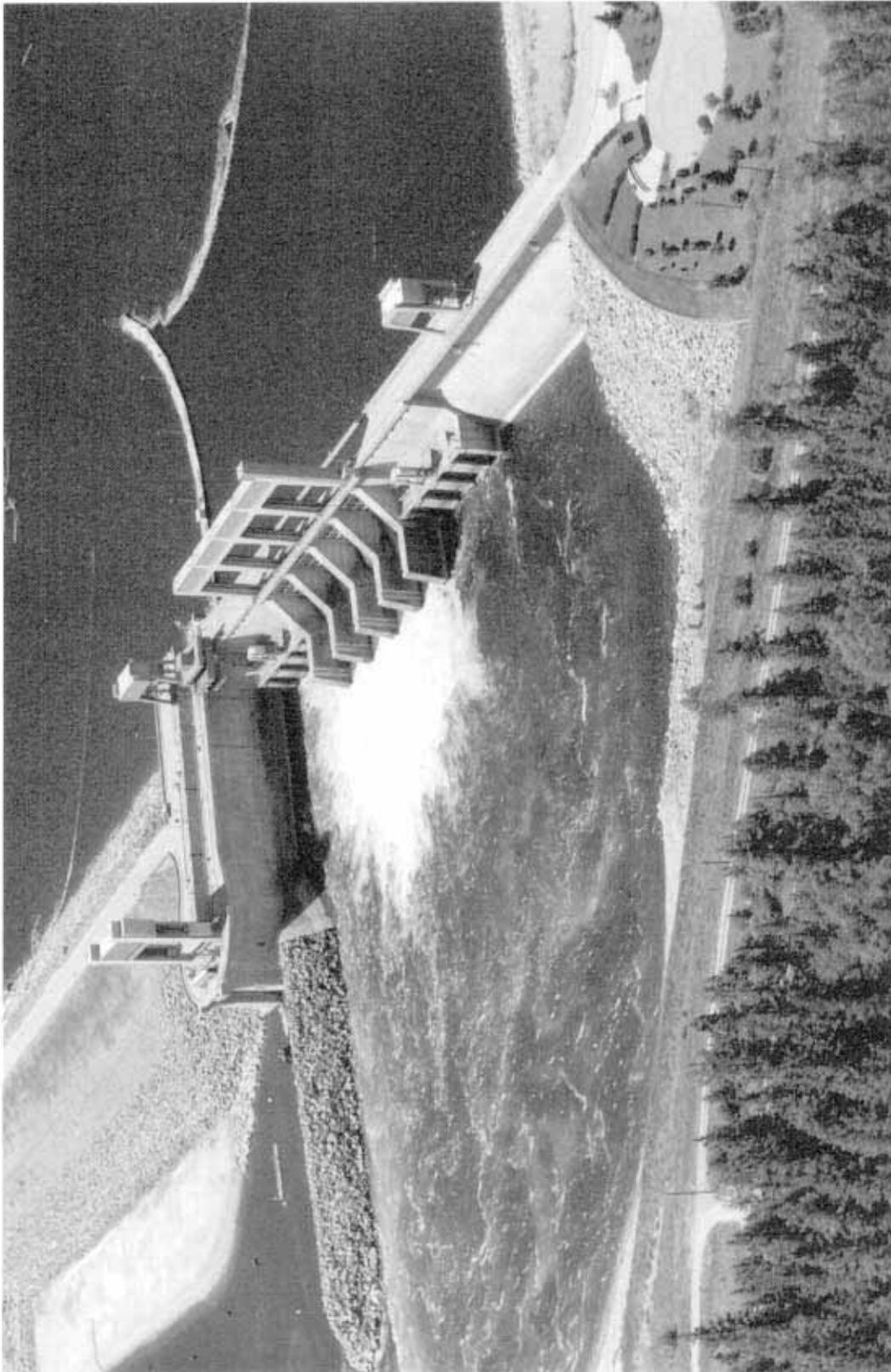
The names of Board members, alternate members and secretaries are shown in Appendix A. Mr. James S. Mattison succeeded Mr. Prad Kharé as an alternate member for Canada on 19 October 1999. Mr. Robert A. Bank succeeded Mr. Richard J. DiBuono as Secretary for the United States on 15 May 2000. The names 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 Article XV(2) of the Treaty and related documents, include:

- (a) assembling records of the flows of the Columbia River and the Kootenay River at the Canada–United States of America boundary;
- (b) reporting to Canada and the United States of America whenever there is substantial deviation from the hydroelectric and flood control operating plans and, if appropriate, including in the report recommendations for remedial action and compensatory adjustments;
- (c) assisting in reconciling differences concerning technical or operational matters that may arise between the Entities;

- (d) making periodic inspections and requiring reports as necessary from the Entities, with a view to ensuring that the objectives of the Treaty are being met;
- (e) making reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty and making special reports concerning any matter 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.



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 U.S. 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 (BC Hydro) as the Canadian Entity.

The names of the members of the Entities are shown in Appendix B.

### 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 the 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 66th meeting on 16 February 2000 in Portland, Oregon. In conjunction with this meeting, the Board also held its 47th joint meeting with the Entities, during which the Entities signed the Libby Coordination Agreement (LCA) and the agreements implementing the outstanding Assured Operating Plans (AOPs) and Determinations of Downstream Power Benefits (DDPBs).

In addition to the Libby and AOP/DDPB issues, the Board and Entities also discussed (1) status of the return and disposition of the Canadian entitlement to the downstream power benefits and (2) other issues related to Treaty operations during the year.

In accordance with Treaty Article XV(2)(d), from 22 through 25 August 2000, the Board made an inspection tour of Treaty projects at the Libby, Hugh Keenleyside and Mica dams. The Board also visited the Bureau of Reclamation's Grand Coulee Dam and BC Hydro's Revelstoke Dam and Canal Plant and the Corra Linn Dam. The previous inspection of the Treaty projects by the Board was undertaken in August 1996.

### 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 on Implementation of the Arrow Local Method for Treaty Storage for Operating Year 1999–2000, Among the Columbia Treaty Operating Committee (OC), BPA and the British Columbia Hydro and Power Authority (BC Hydro), signed 23 December 1999.*

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 Energy Content Curve (VECC) for Arrow in the *1999–2000 Detailed Operating Plan (DOP)* rather than the Arrow Total Method. The Arrow Local VECC Method had been the only method used in the DOP from the late 1970s through the 1995–1996 operating year, and the Canadian Entity had requested compensation for its continued use because of the increased power benefits that typically result from the use of this method. These increased power benefits result from the additional draft of Arrow that typically occurs with the Arrow Local Method during the January–March period, and a corresponding

reduction in the draft during the April–July period. This occurs because the Arrow Local Method does not adjust Arrow to compensate for Mica being re-operated to its Project Operating Criteria as in the DOP, while in the Arrow Total Method, the operation of Arrow is adjusted in response to the re-operation of Mica.

- *Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Nonpower Uses for 1 January through 31 July 2000*, signed 22 December 1999.

This agreement is similar to previous agreements implemented to utilize *Treaty Storage for nonpower uses*. These uses include (1) providing flows for Canadian trout spawning for the April through June period, (2) enhancing the capability in the United States of providing spring and summer flow augmentation for salmon and steelhead by storing 1 million acre-feet of water in Arrow by late April, (3) enhancing the lake levels at Arrow and (4) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam.

- *Assured Operating Plans and Determination of Downstream Power Benefits for Operating Years 2000–2005*, dated January 2000.

These five documents are the AOPs and DDPBs for the Operating Years 1 August 2000 through 31 July 2005.

- *Columbia River Treaty Entity Agreement Coordinating the Operation of the Libby Project with the Operation of Hydroelectric Plants on the Kootenay River and Elsewhere in Canada*, signed 16 February 2000.

This agreement, also referred to as the *Libby Coordination Agreement (LCA)*, resolved the issues concerning the operations of the Libby project, which enabled the outstanding AOPs and DDPBs to be implemented. The LCA sets forth the implementing procedures of the Entities for coordinating on a continuing basis the operation of the Libby project with the operation of hydroelectric plants on the Kootenay River and elsewhere in Canada. In order to accomplish this, it (1) establishes the Arrow provisional draft operational practice related to the operation of Libby for updated nonpower requirements, (2) sets forth procedures for storage exchanges between Libby and Canadian Storage, (3) specifies Libby nonpower requirements in the Assured Operating Plan studies, (4) states that DOP studies apply only to Canadian Storage and (5) addresses alleged past and any future power losses and differences regarding the operation of the Libby project and impacts upon the hydroelectric plants on the Kootenay River and elsewhere in Canada. The Agreement was effective 16 February 2000 and will remain in effect until 15 September 2024, unless either Entity elects to terminate the agreement with a minimum 30-day notice.

- *Columbia River Treaty Entity Agreements on the Assured Operating Plans and Determination of Downstream Power Benefits for Operating Years 2000–2005*, signed 16 February 2000.

These five agreements implement the AOPs and DDPBs for the Operating Years 1 August 2000 through 31 July 2005. These agreements were made possible by the LCA.

- *Columbia River Treaty Entity Agreement to Study Various Alternatives for Shifting Columbia River Flows to Make Available Increased Amounts of Water in July and August*, signed 31 May 2000.

The U.S. Fish and Wildlife Service and National Marine Fisheries Service have developed Biological Opinions (BiOps) on the operation of the Federal Columbia River Power System in response to the *U.S. Endangered Species Act*. The U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration are responsible for implementing the measures of the BiOps. Under this agreement, the U.S. and Canadian Entities have agreed to study and evaluate the feasibility of additional water releases from Canada in July and August by shifting flow from other periods in the operational year to assist in meeting the BiOps flow objectives at the McNary project on the Columbia River. The Columbia Treaty Operating Committee will carry out the studies and present them to the Entities. It is currently projected that these studies will be accomplished in January 2001. If both Entities agree on an alternative and decide to proceed, the Operating Committee will begin negotiations of a proposed Entity Agreement for releasing water in July and August 2001.

- *Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2000 through 31 July 2001*, signed 11 July 2000.

This agreement implements the DOP for Columbia River Storage for 1 August 2000 through 31 July 2001.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2000 through 31 July 2001*, dated July 2000.

This document provides the general guidelines, operating criteria and reservoir rule curves for the operation of the three Treaty reservoirs (Mica, Arrow and Duncan) in Canada and the Libby Project in the United States for the operating year from August 2000 through July 2001.

- *Columbia River Treaty Operating Committee Agreement on the Operation of Treaty Storage for Enhancement of Mountain Whitefish Spawning for the Period 1 September 2000 through 30 April 2001, signed 23 August 2000.*

This agreement supplements the 2000–2001 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 a provisional draft from Arrow Reservoir from 4 September 2000 to the beginning of whitefish spawning, which normally occurs around 22 December 2000. Storage will occur from 1 January 2000 through 20 January 2001, unless otherwise agreed. All provisional draft will be returned by 30 April 2001, but shall not detrimentally impact whitefish during the March 2001 incubation period. 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 1999 through 30 September 2000, dated October 2000.*

This report summarizes the operation of Treaty projects for the period 1 October 1999 through 30 September 2000.

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

- Letter of Agreement of 3 March 2000, between BC Hydro and BPA, regarding Non-Treaty Storage for Enhancement of U.S. Flow Augmentation.

The term of this agreement is 1 May through 31 August 2000. The objective of the agreement is to store spring river flows during the period 1 May through 4 July 2000 in non-Treaty storage space. This stored water is then released from 5 July through 31 August 2000 to enhance flow augmentation in the Columbia River downstream in the United States. Release rights during the period July–August are permitted as long as no physical spill occurs at Mica and Revelstoke in the process.

## **Report to the Governments**

The thirty-fifth Annual Report of the Board was submitted to the governments of Canada and the United States of America on 29 February 2000.



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 completion of the Revelstoke project in 1984 have caused power benefits to increase substantially. This amounts to some 4000 MW of generation capacity in Canada that may not have been installed without the Treaty. In addition, the installation of two units for a total generating capacity of 170 MW at Hugh Keenleyside Dam is currently underway, 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. BC Hydro 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 in 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 ft high and extends 2600 ft 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 14, 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, construction is currently underway to install two generating units, totalling approximately 170 MW of generating capacity.

The dam consists of two main components: a concrete gravity structure that extends 1200 ft from the north bank of the river and includes the spillway, low-level outlets, and navigation lock; and an earthfill section that rises 170 ft above the river bed and extends 1650 ft 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 new powerplant will be located on the north abutment (left bank); an intake approach channel of about 4900 ft long around the north end of the concrete dam would divert waters of the Arrow Reservoir through a powerhouse located in a rock outcrop 1300 ft downstream. The generating facility would be powered by two Kaplan turbines, 85 MW each. The power generated would be transmitted by a new 230 kilovolt (kV) transmission line to the Selkirk substation, for integration into BC Hydro's existing power grid. The expected completion date is spring of 2002, and the power production at the new generating facilities will be incidental to releases made for Treaty purposes. There are also environmental benefits associated with reduced entrained gases, which are known to be harmful to fish.

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 ft above its foundation and extends 2600 ft across the Columbia River valley. It creates a reservoir 135 miles long, Kinbasket Lake, with a total storage capacity of 20 million acre-feet. The project utilizes 12 million acre-feet of live storage, of which 7 million acre-feet are committed under the Treaty.

Although not required by the Treaty, a powerhouse was added to the project by BC Hydro. The underground powerhouse has space for a total of six 434-MW units, with

a total capacity of 2604 MW. At present, four generators are in operation, for a total of 1736 MW.

The project is shown in the picture on page 22, 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 3055 ft long, rises 370 ft 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, when completed in 1976, had four units with a total installed capacity of 420 MW.

Construction of four additional generating units was initiated during fiscal year 1978, but Congressional restrictions imposed in the *1982 Appropriations Act* provided 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 MW. Recent U.S. legislation (Public Law 104-303, 12 October 1996) authorizes the Corps of Engineers to complete 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. BC Hydro 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 1980, 1983, 1987, 1989, 1990 and 1992.

The Entities began an effort in the fall of 1999 to reconsider the definition of hydrometeorological facilities required as part of the Treaty System and of those with value as Supporting Facilities. Depending on the outcome of this effort, the list of hydrometeorological facilities constituting the Columbia River Treaty Hydrometeorological System Network may be revised. The committee expects to provide the Permanent Engineering Board with a letter in 2001 describing its current interpretation of the hydrometeorological facility definitions.

## **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 (AOPs). They represent the basic commitment of the Canadian Entity to operate the Treaty storage in Canada (at Duncan, Arrow and Mica) and provide the Entities with a basis for system planning. Canada's commitment to operate under an AOP is tied directly to the benefits produced by that plan. At the beginning of each operating year, a Detailed Operating Plan (DOP), 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 that would be obtained by operating in accordance with the AOP.

In 1995, the Entities submitted to the Board its report entitled *Assured Operating Plan (AOP) and Determination of Downstream Power Benefits (DDPB) for Operating Year 1999–2000*. 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 1999–2000 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 called *Detailed Operating Plan (DOP) for Columbia River Treaty Storage, 1 August 1999 through 31 July 2000*, and in associated Entities' agreements. As was the case for 1996–1997, 1997–1998 and 1998–1999, the DOP uses the load, resources and nonpower requirements from the 1999–2000 AOP rather than the Pacific Northwest Coordination Agreement (PNCA) operating data, as has been done in DOPs for years prior to 1996–1997. This was done because actual PNCA operations in the U.S. system are based on the U.S. Fish and Wildlife Service and the National Marine Fishery Service BiOps and associated nonpower requirements, and the Entities could not agree to use these updates in the DOP. One of the main measures defined in the BiOps 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 Entity Agreement implementing the DOP for the operating year 1999–2000 describes the divergence of opinions between the Entities on the Libby fishery operation. It was reported in previous annual reports that the Entities could not sign agreements to implement the AOP and DDPB reports for 2000–2001 and subsequent years until there was 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 Board also expressed its concern that the Entities were not in full compliance with Treaty requirements due to their inability to agree on an AOP and the DDPB for 2000–2001 and subsequent operating years. The Board also noted that the differing Entity positions on Libby, if not resolved by the start of operating year 2000–2001 on 1 August 2000, could adversely impact the operation of the Canadian Treaty reservoirs and would prevent the determination of the downstream benefits those reservoirs produce. This issue was also brought to the attention of the national governments by a letter dated 19 November 1999 from the Board. In the 1999 Annual Report, the Board reported details of initiatives undertaken by the Entities for resolving the Libby dispute. The Board remained hopeful that the Entities would be successful in their efforts to resolve the Libby dispute.

As reported in the 29 February 2000 cover letter for the 1999 Annual Report, the Entities signed a Libby Coordination Agreement (LCA) on 16 February 2000 to address the issues concerning the operations of the Libby Project. The Board is pleased that the Entities have signed this agreement, as it has enabled them to sign agreements to implement the outstanding AOPs and DDPBs for operating years 2000–2001 through 2004–2005. The LCA allows the Entities to coordinate reservoir operations and agree to AOPs and DDPBs without the need for them to alter their respective positions regarding

the validity of the Libby fisheries operation under the Treaty. The LCA essentially freezes the dispute, potentially until 2024, unless either Entity chooses to terminate early, on 30 days' notice. Details of the LCA are presented in the Operation section of this report.

It was reported in the 1996, 1997 and 1998 Board Annual Reports that the *Entity Agreement on Resolving the Dispute on Critical Period Determination*, the *Capacity Entitlement for the 1998–1999, 1999–2000, and 2000–2001 AOP/DDPBs*, and *Operating Procedures for the 2001–2002 and Future AOPs* resolved a lengthy dispute regarding the calculation of the downstream power benefits. 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 arrangements for returning the Canadian Entitlement to British Columbia across existing transmission lines are based on the agreement entitled *Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for April 1, 1998 through September 15, 2024*, which was signed 29 March 1999. 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.

In addition to the delivery agreement referred to above, the terms and conditions for the disposal of portions of the Canadian Entitlement within the United States are based on the agreement entitled *Agreement on Disposals of the Canadian Entitlement Within the United States for April 1, 1998 through September 15, 2024 Between Bonneville Power Administration, Acting on Behalf of the U.S. Entity and the Province of British Columbia*, signed 29 March 1999.

Both the delivery agreement and the disposal agreement became effective on 31 March 1999 through a diplomatic exchange of notes between the United States and Canada.

## **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, and the revised plan, dated October 1999, defined the flood control operation of the Duncan, Arrow, Mica and Libby reservoirs during the period covered in this report. The 1972 plan was received from the Entities and reviewed by the Board in the 1972–1973 report year, and was in effect until October 1999. This 1972 plan has been replaced by the new plan completed in October 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 Kootenai 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 BC Hydro 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 BC Hydro and the Bonneville Power Administration.

## **Operations for Fish**

Many U.S. reservoirs are presently operated in accordance with BiOps 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 Fisheries and Oceans Canada. These efforts continue to evolve. In this regard, the Board notes that the AOPs and the DDPBs 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 DOPs 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, with the underground powerhouse 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 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 AOPs and DDPBs. 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 the 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 the 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 AOPs and DOPs used to plan the operation of Columbia River Treaty Storage.

- *Assured Operating Plan for Columbia River Treaty Storage, 1 August 1999 through 31 July 2000*, dated November 1994.

This document provides information on the operation plan for Columbia River Treaty storage and resulting downstream power benefits for the period 1 August 1999 through 31 July 2000.

- *Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998, through 15 September 2024*, signed 29 March 1999.

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. The agreement became effective on 31 March 1999 through a diplomatic exchange of notes between the United States and Canada. Execution of this agreement supersedes and terminates the *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 U.S. Entity, dated 20 November 1996, and the *Entity Agreement* of the same name, dated 26 March 1998, but which never reached its effective date.

- *Agreement on Disposals of the Canadian Entitlement Within the United States for 1 April 1998, Through 15 September 2024 Between the Bonneville Power Administration, Acting on Behalf of the U.S. Entity, and the Province of British Columbia*, signed 29 March 1999.

This agreement describes the arrangements by which the Canadian Entitlement shall be disposed of in the United States by British Columbia.

- *Columbia River Treaty Flood Control Operating Plan*, dated October 1999.

This plan prescribes the criteria and procedures by which the Canadian Entity will operate the Mica, Duncan and Arrow reservoirs to achieve desired flood control objectives in the United States and Canada. Criteria for Libby Reservoir were included in the plan to meet the Treaty requirement to coordinate its operation for flood control protection in Canada. The plan was originally prepared in October 1972. This 1999 plan updates information, incorporates new storage reservation diagrams and clarifies procedures.

- *Agreement on Implementation of the Arrow Local Method for Treaty Storage for Operating Year 1999–2000, Among the Columbia Treaty Operating Committee, the Bonneville Power Administration and the British Columbia Hydro and Power Authority, signed 23 December 1999.*

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 VECC for Arrow in the 1999–2000 DOP rather than the Arrow Total Method. The Arrow Local VECC Method had been the only method used in the DOP from the late 1970s through the 1995–1996 operating year, and the Canadian Entity had requested compensation for its continued use because of the increased power benefits that typically result from the use of this method. These increased power benefits result from the additional draft of Arrow that typically occurs with the Arrow Local Method during the January–March period and a corresponding reduction in the draft during the April–July period. This occurs because the Arrow Local Method does not adjust Arrow to compensate for Mica being re-operated to its Project Operating Criteria as in the DOP, while in the Arrow Total Method, the operation of Arrow is adjusted in response to the re-operation of Mica.

- *Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Nonpower Uses for 1 January through 31 July 2000, signed 22 December 1999.*

This agreement is similar to previous agreements implemented to utilize Treaty Storage for nonpower uses. These uses include (1) providing flows for Canadian trout spawning for the April through June period, (2) enhancing the capability in the United States of providing spring and summer flow augmentation for salmon and steelhead by storing 1 million acre-feet of water in Arrow by late April, (3) enhancing the lake levels at Arrow and (4) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam.

- *Columbia River Treaty Entity Agreement Coordinating the Operation of the Libby Project with the Operation of Hydroelectric Plants on the Kootenay River and Elsewhere in Canada, signed 16 February 2000.*

This agreement sets forth the implementing procedures of the Entities for cooperating on a continuing basis on the operation of the Libby project with the operation of hydroelectric plants on the Kootenay River and elsewhere in Canada. In order to accomplish this, it (1) establishes the Arrow provisional draft provisions related to the operation of Libby for updated nonpower requirements, (2) sets forth procedures for storage exchanges between Libby and Canadian storage, (3) specifies Libby nonpower requirements in the AOP studies, (4) states

that DOP studies apply only to Canadian storage and (5) addresses alleged past and any future power losses and differences regarding the operation of the Libby project and impacts upon the hydroelectric plants on the Kootenay River and elsewhere in Canada. The Agreement is effective 16 February 2000 and will remain in effect until 15 September 2024 unless either Entity elects to terminate the agreement.

- *Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2000 through 31 July 2001*, signed 11 July 2000.

This agreement implements the DOP for Columbia River storage for 1 August 2000 through 31 July 2001.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2000 through 31 July 2001*, dated July 2000.

This document provides the general guidelines, operating criteria and reservoir rule curves for the operation of the three Treaty reservoirs (Mica, Arrow and Duncan) in Canada and the Libby Project in the United States for the operating year from August 2000 through July 2001.

- *Columbia River Treaty Operating Committee Agreement on the Operation of Treaty Storage for Enhancement of Mountain Whitefish Spawning for the Period 1 September 2000 through 30 April 2001*, signed 23 August 2000.

This agreement supplements the 2000–2001 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 a provisional draft from Arrow Reservoir from 4 September 2000 through 22 December 2000, or the beginning of whitefish spawning. Storage will occur from 1 January 2000 through 20 January 2001, unless otherwise agreed. All provisional draft will be returned by 30 April 2001 but shall not detrimentally impact whitefish during the March 2001 incubation period. 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 1999 through 30 September 2000*, dated October 2000.

This report summarizes the operation of Treaty projects for the period 1 October 1999 through 30 September 2000.

## **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 1999, preceding the beginning of the report year, saw the coordinated Columbia River reservoir system filled to 99.87 percent of capacity. As a result, first-year firm load carrying capability (FLCC) was adopted for the 1999–2000 operating year. Due to above-average streamflows throughout the year, the system generally operated to the Operating Rule Curve or flood control for the entire period, producing large amounts of surplus energy.

During the spring and summer of 2000, 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, the U.S. Army Corps of Engineers conducted operations for the white sturgeon and salmon, mandated by the requirements of the U.S. Endangered Species Act. For several years, the operation of Libby Dam for these fishery purposes in the United States and the associated downstream power impacts to Canada were the causes for dispute. By signing the LCA on 16 February 2000, the Entities resolved this dispute and were able to successfully address both fishery and power concerns while not impacting the Treaty. Normal operations at other Treaty reservoirs, as formulated in the 1999–2000 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.

The coordinated Columbia River reservoir system reached 97.07 percent of its maximum storage capacity by the end of July 2000. This storage condition triggered the use of the first-year FLCC for the 2000–2001 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 1999. Mica Treaty storage continued to fill during August, reaching full storage of 7.0 Maf on 10 August 1999. The reservoir reached a maximum elevation of 2474.6 (0.4 ft below full pool elevation) on 31 August 1999 and started to draft in early September as power plant releases exceeded inflows. Kinbasket Lake began the report year (1 October 1999 to 30 September 2000) at an elevation of 2465.2 ft, or 9.8 ft below its full level.

Throughout the fall of 1999, Treaty storage in Mica was generally drafted for power purposes. The reservoir was drafted to an elevation of 2434.2 ft by 31 December 1999.

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, an elevation of 2384.5 ft on 27 April 2000. This level was 11.0 ft higher than the lowest level reached in the previous year. Mica Treaty storage was completely drafted by 30 April 2000. With the start of the spring freshet in May, Mica discharges remained low until July, and the reservoir refilled by 35 ft to an elevation of 2419.9 ft at the end of June. On 31 July 2000, the elevation of the reservoir was 2451.3 feet and Treaty storage was 6.6 Maf (94 percent of full). The reservoir reached the peak level for the year of 2457.8 ft, or 17.0 ft below full pool, on 15 August 2000. The Mica reservoir elevation on 31 August 2000 was 2455.2 ft (about 20 ft from full pool).

### **Arrow Project**

Arrow reservoir began the report year on 1 October 1999 at an elevation of 1432.4 ft, or 11.6 ft below full, after a summer in which the reservoir filled to capacity at an elevation of 1444.0 feet on 1 August. Reservoir releases decreased over the fall months, from an average of 62 000 cubic feet per second (cfs) in September to 46 000 cfs in October and 44 000 cfs in November. Arrow reservoir drafted to an elevation of 1423.3 ft by 31 December 1999, with the Treaty storage at 5.8 Maf, or 81 percent of full.

For the period 21 December 1999 to 17 January 2000, Arrow outflows were reduced to between 50 000 cfs and 55 000 cfs to maintain lower river levels during the whitefish spawning period. This amount could be sustained through the period of emergence in February and March. To achieve the January level of flows, BC Hydro exercised an option to store up to 400 thousand second foot days (Ksfd) under the Whitefish Provisional Draft Agreement over the first 16 days of January. During the latter part of January, outflows from Arrow averaged about 73 000 cfs, decreasing in February to 51 000 cfs and then reducing to about 40 000 cfs in March. Between 21 March and 29 March 2000, the outflows from Arrow were progressively reduced for rainbow trout spawning. In exchange for the rainbow trout protection flows in the spring, the United States exercised an option, under the Nonpower Uses agreement signed in December 1999, to store up to 1 Maf in Arrow by late April 2000 for flow augmentation objectives. The flow augmentation storage was subsequently released during May.

The Columbia River Treaty Operating Committee agreed to use the Arrow Local Method for determining the Mica and Arrow Variable Refill Curves (VRCs) between January and June 2000. Compared to the Total Method, the Arrow Local Method recognizes Mica outflows in excess of those from operating Mica to the VRC when computing Arrow's VRC and, on average, results in lower VRCs at Arrow during January through April. In both cases, the Arrow reservoir is targeted to be full on 31 July. The agreement for implementing the Arrow Local Method was signed in December 1999, with the expectation that power benefits realized in excess of those expected by the Total

Method would be shared equally between the Bonneville Power Administration and BC Hydro. However, because of the unusually high energy prices during the summer compared with those in the fall of 2000, there were no power benefits realized.

Arrow Reservoir reached its lowest level for the year at 1393.9 ft on 4 April 2000. Arrow Treaty storage account reached its minimum at 0.99 Maf, or 14 percent of full, on 28 March 2000. During April and May, the Arrow discharge was maintained at about 20 000 cfs to prevent rainbow trout spawning at higher river levels. Arrow discharge was maintained above 20 000 cfs until 20 June 2000. During the last 10 days of June, flows were reduced to 14 000 cfs when the backwater effects of higher Kootenay River flows provided adequate river levels for rainbow trout protection at Norns Creek Fan, a prime spawning location for rainbow trout.

The Arrow fisheries operations were conducted under the terms of two Operating Committee agreements: "Operation of Treaty Storage for Enhancement of Mountain Whitefish Spawning for the Period of 1 September 1999 through 30 April 2000" and "Operation of Treaty Storage for Nonpower Uses for 1 January through 31 July 2000." These agreements enabled the Arrow project flows to be adjusted to reduce impacts to whitefish and rainbow trout redds. With the low discharge in April and May and the start of the spring freshet with high inflows in May, the Arrow Reservoir rose to an elevation of 1398.4 ft by 30 April, 1414.6 ft by 31 May, and 1435.8 ft by 30 June 2000. Arrow reservoir levels remained below the Treaty flood control curve levels throughout the operating year.

The Arrow discharge was increased substantially in July as Arrow Treaty storage neared full, and the reservoir reached its highest elevation during the operating year at an elevation of 1443.9 ft on 25 July 2000. The Arrow Treaty storage content reached full (7.1 Maf) on 2 August 2000. The Coordinated Columbia System was on proportional draft during August 2000. As a result, by the end of the reporting period, 30 September 2000, Arrow Treaty storage was drafted to an elevation of 1430.3 ft with a Treaty storage content of 5.36 Maf, or 75 percent of full.

The Arrow Lakes Power Company project at Keenlyside Dam began full construction of a powerhouse on 15 March 1999. The powerhouse will contain two generating units, each capable of generating 85 MW of capacity. Construction of the powerhouse may be complete as early as November 2001.

### **Duncan Project**

Duncan reservoir reached full pool at an elevation of 1892.0 ft on 15 August 1999 and fluctuated up to 0.1 ft higher due to high inflows. The reservoir essentially passed inflows during August 1999. In September 1999, Duncan reservoir releases averaged 5300 cfs to maintain Kootenay Lake levels and Kootenay River flows. This resulted in

a reservoir elevation of 1884.2 ft at the start of the report year on 1 October 1999. The project discharge averaged 6400 cfs in October, 2000 cfs in November and about 2100 cfs in December. The Duncan Reservoir level was at an elevation of 1866.8 ft (69 percent of full) on 31 December 1999. The reservoir remained at or below the flood control curve throughout the operating year.

During January 2000, the Duncan discharge was increased to about 8300 cfs. The reservoir was drafted throughout February and March and reached its lowest level for the year at an elevation of 1794.3 ft (0.3 ft above empty) on 30 March 2000.

The Duncan discharge was reduced to a minimum (100 cfs) on 9 May 2000 and remained at that level during most of June to allow refill of the reservoir. The reservoir reached an elevation of 1825.7 ft by 31 May and an elevation of 1861.4 ft by 30 June. Duncan remained on minimum discharge until 21 July and increased thereafter to slow the rate of reservoir refill. The reservoir reached full pool elevation of 1892.0 ft on 31 July 2000 and started to draft gradually in the later part of August.

Duncan passed inflows during early August 2000, but the discharge was increased later in the month to manage the Kootenay Lake elevations at close to the maximum levels permitted under the International Joint Commission Order. The Duncan reservoir was drafted to an elevation of 1867.9 ft by 30 September 2000.

### **Libby Project**

Lake Koocanusa (Libby Reservoir) started the operating year on 1 August 1999 at an elevation of 2456.9 ft, or 2.1 ft from full. Libby inflow in August 1999 was 151 percent of normal, the third highest for the period 1928–1988. A peak reservoir elevation of 2459.0 ft was reached on 9 August, essentially a full pool. A 1999 Libby/Arrow storage exchange agreement was consequently not required to maintain reservoir levels. Due to the abundance of water in the Columbia Basin system, the resulting end-of-month Libby Reservoir elevation in August was 2455.6 ft, 3.4 ft from full and 16.6 ft above the 1995 BiOp interim draft limit of an elevation of 2439 ft.

For most of September 1999, outflows were held steady at 12 000 cfs as the project began a slow draft to the 31 December 1999 flood control elevation of 2411.0 ft. Outflows were reduced to 10 000 cfs on 16 September for transmission line testing, and releases were brought back to 12 000 for the remainder of the month. At the start of the report year on 1 October 1999, the reservoir was at an elevation of 2 448.5 ft. Outflows were reduced again on 26 October for transmission line work. Outflow was maintained at 12 000 cfs through 4 November, when the decision was made to reduce outflow to 8000 cfs. At that time, inflow was near 125 percent of average, with inflow running at about 5800 cfs and the reservoir drafted to an elevation of 2437.6 ft. The operational strategy was to slow the rate of draw down to the target elevation of 2411 ft on

31 December 1999 to meet the recommendations of the National Marine Fisheries Service 1995 BiOp. The Kootenay River basin above Libby Dam experienced a significant storm on 13 and 14 November. This event caused the reservoir inflow to reach as high as 40 000 cfs on 14 November. The storm also caused the November month average inflow to be 12 300 cfs, or 265 percent of average. The November 1999 runoff was the largest in the 60-year period of record. Consequently, releases from Libby had to be increased to powerhouse capacity (25 000 cfs) to evacuate reservoir storage to the flood control target elevation of 2411 feet by 31 December. Outflow near full powerhouse capacity continued through December, except for a few periods of reduction for power, or to capture and tag burbot in the Kootenai River downstream of Libby. With concurrence of the National Marine Fisheries Service, the elevation of Libby reservoir was 2408.1 ft on 31 December 1999. This was 2.9 ft below the flood control elevation of 2411 ft.

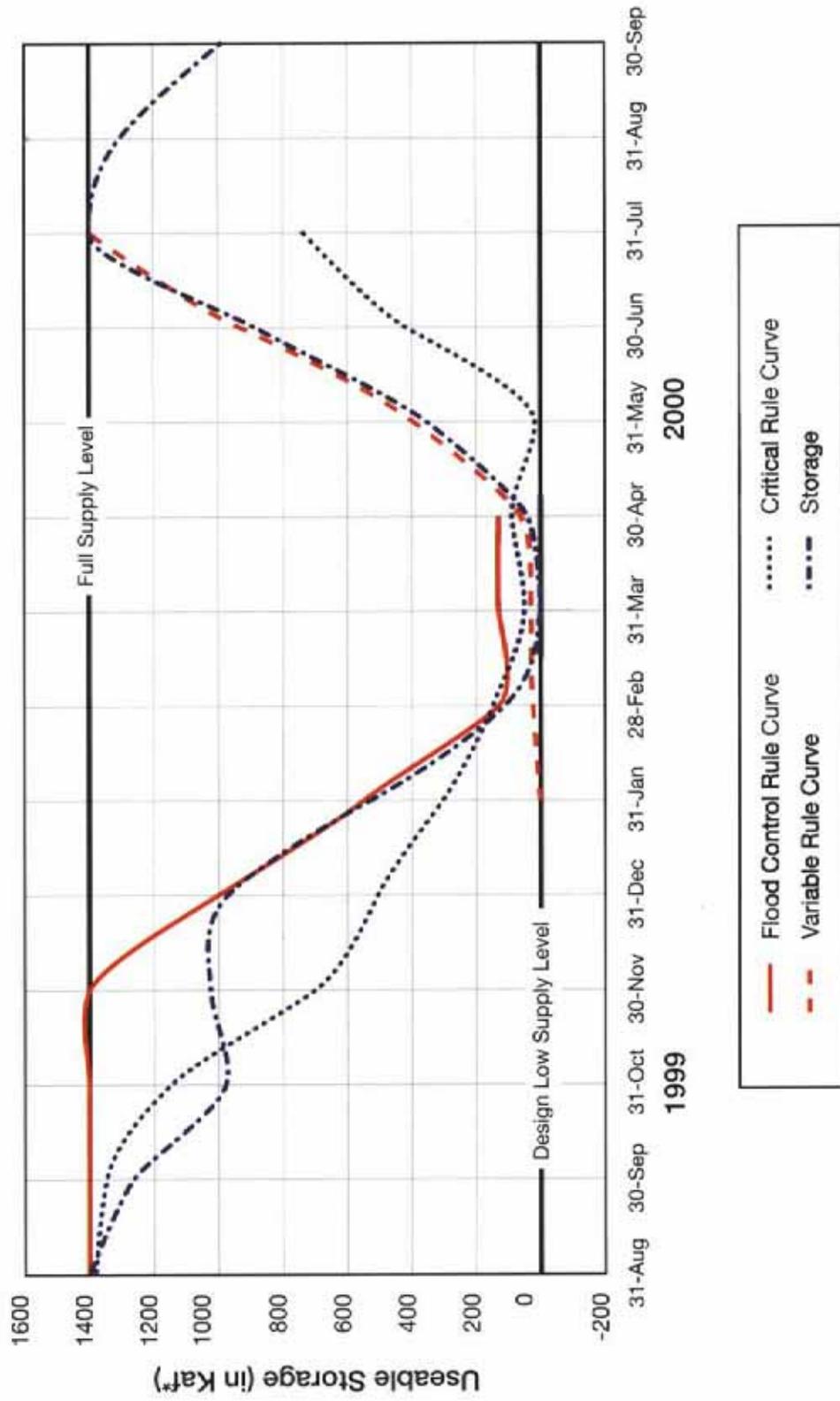
The January 2000 water supply forecast was 6.87 Maf (108 percent of normal) for the April through August period. The end-of-January flood control evacuation requirement was an elevation of 2370.9 ft. A release of near powerhouse capacity was needed for most of January to reach this elevation. The water supply forecast in February was 107 percent of normal. To achieve the end-of-February flood control elevation target, outflow averaged 16 700 cfs during February. In March, the water supply forecast dropped slightly again to 105 percent of normal. By early March, the 95-percent confidence of refill curve at Libby on 15 April was near an elevation of 2339 ft. Since inflow to the project was near the minimum of 4000 cfs, the U.S. Army Corps of Engineers decided to operate to the 15 April, 95-percent confidence of refill curve. On 14 March, Lake Koocanusa was at an elevation of 2337.1 ft, and on 15 April the lake was at an elevation of 2342.6 ft.

Libby continued to release 4000 cfs until 6 June 2000, when outflow was increased to full powerhouse discharge capacity (25 000 cfs) for 17 days, followed by a slow ramp down to 8 000 cfs. This operation was performed to satisfy the request of the U.S. Fish and Wildlife Service for sturgeon. The Fish and Wildlife Service initially requested 19 days of full powerhouse release from Libby. In ongoing discussions with the Fish and Wildlife Service, it was agreed to release full powerhouse discharge capacity for 17 days, followed by a slow ramp down to a flow that would not harm listed bull trout in the Kootenai River. Although 9000 cfs was the preferred bull trout minimum flow, the Fish and Wildlife Service agreed to 8000 cfs in year 2000 as the June precipitation did not materialize, and the lake was not refilling as expected. By 3 July 2000, the sturgeon operation was complete, and Libby was releasing 8000 cfs for bull trout. Lake Koocanusa was at an elevation of 2421.3 ft on 3 July, about 20 feet below expectations. Because of much drier than forecast runoff, Lake Koocanusa reached its maximum elevation of 2436.3 ft on 15 August 2000, 22.7 ft below full. An outflow of 8000 cfs for bull trout continued through 21 September, when the reservoir reached an elevation of 2332.9 ft. Outflow was slowly reduced to 6,000 cfs, and the reservoir ended up at an elevation of 2432.3 ft on 31 September 2000.

## **Flood Control Operation**

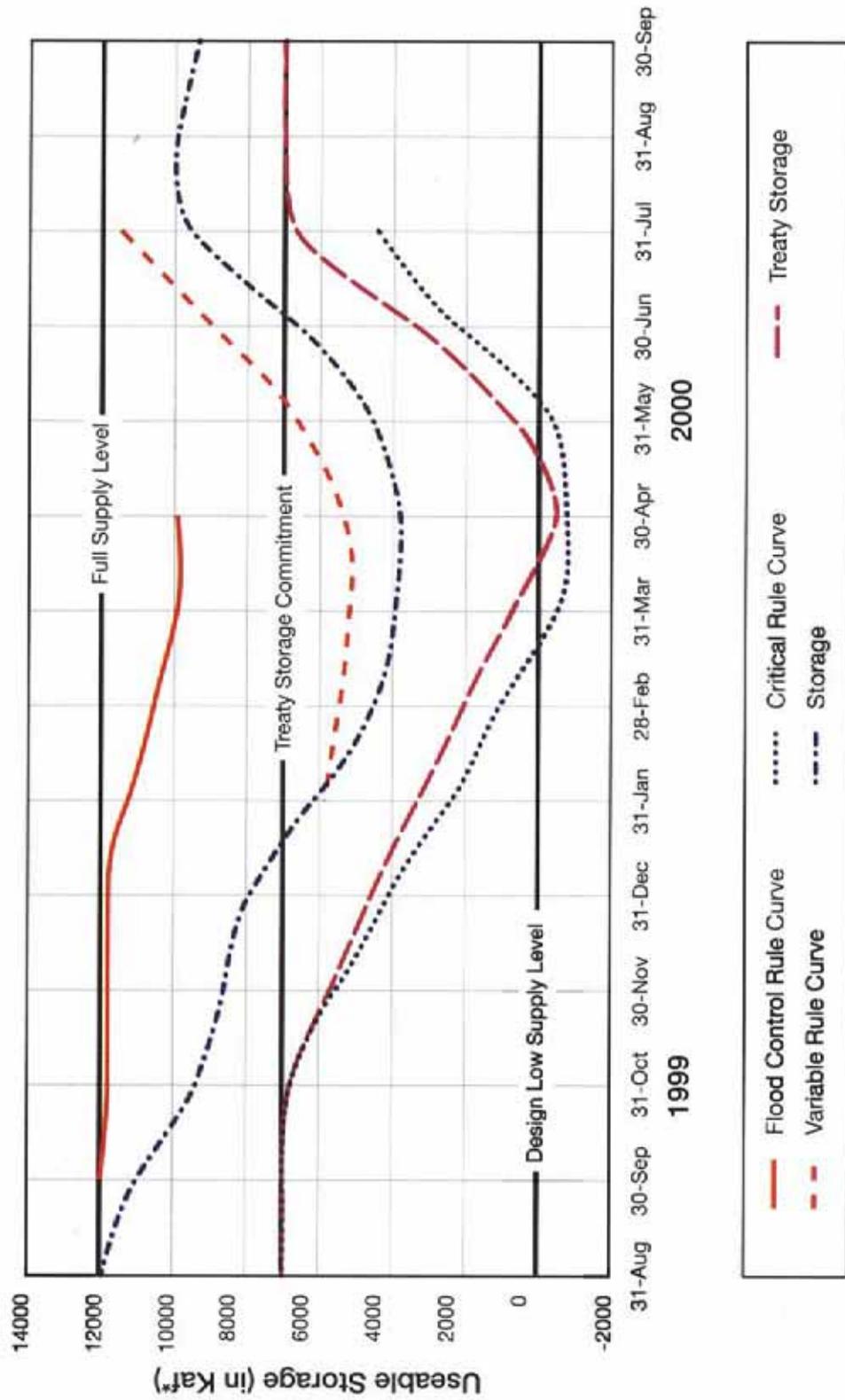
The Columbia River Basin reservoir system was not operated for flood control during the period covered in this report, since the weekly operations agreed upon were adequate to accomplish spring flood evacuation goals. The peak regulated flow at The Dalles, Oregon, was 375 100 cfs on 23 April 2000, and the peak unregulated flow was 449 600 cfs on 27 May 2000. The observed peak stage at Vancouver, Washington, was 11.5 ft, 2.1 ft below flood stage, on 24 April 2000. The peak unregulated stage would have been 16.5 ft on 27 May 2000.

## Duncan Reservoir Levels



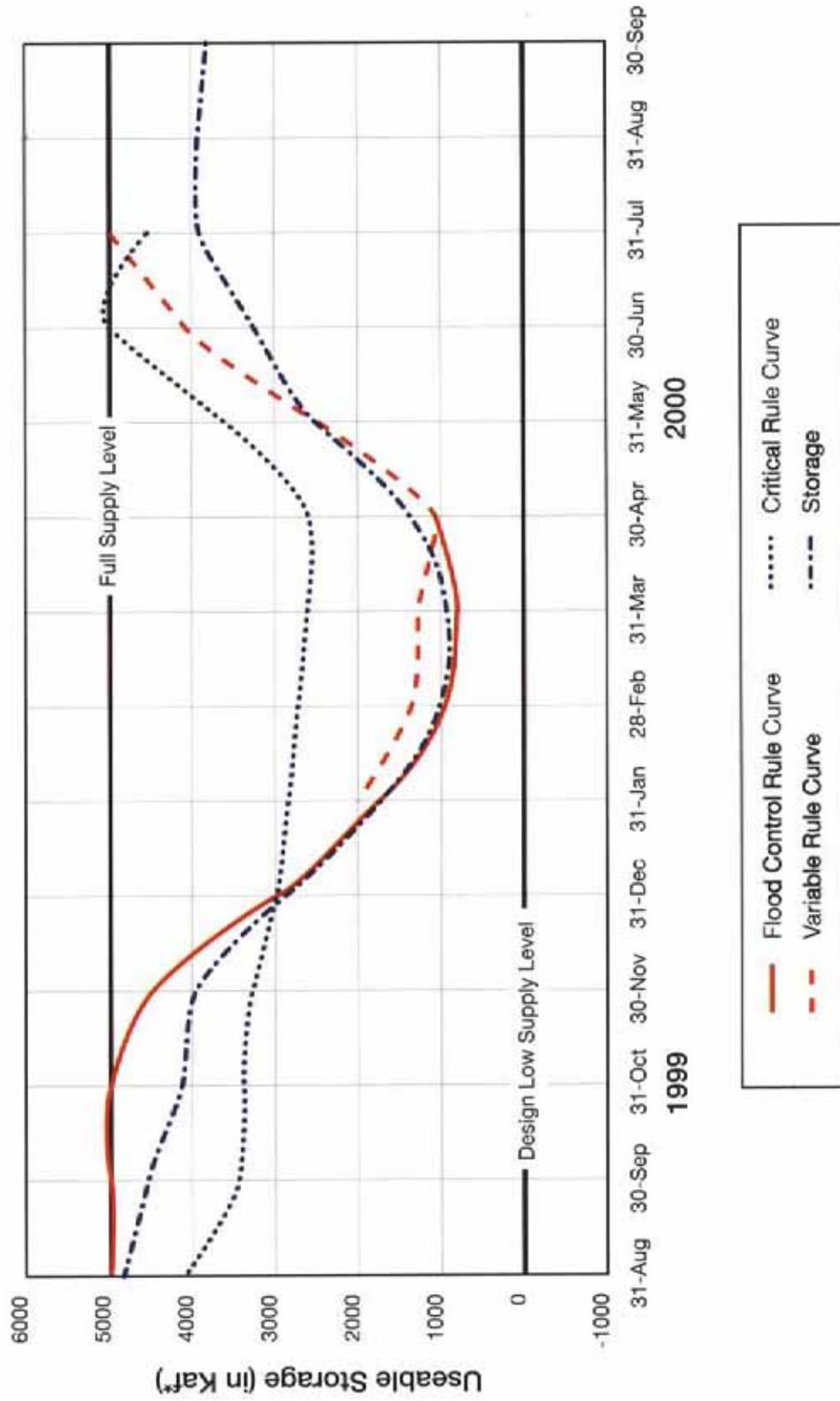
\* Kaf = thousand acre-feet

# Mica Reservoir Levels



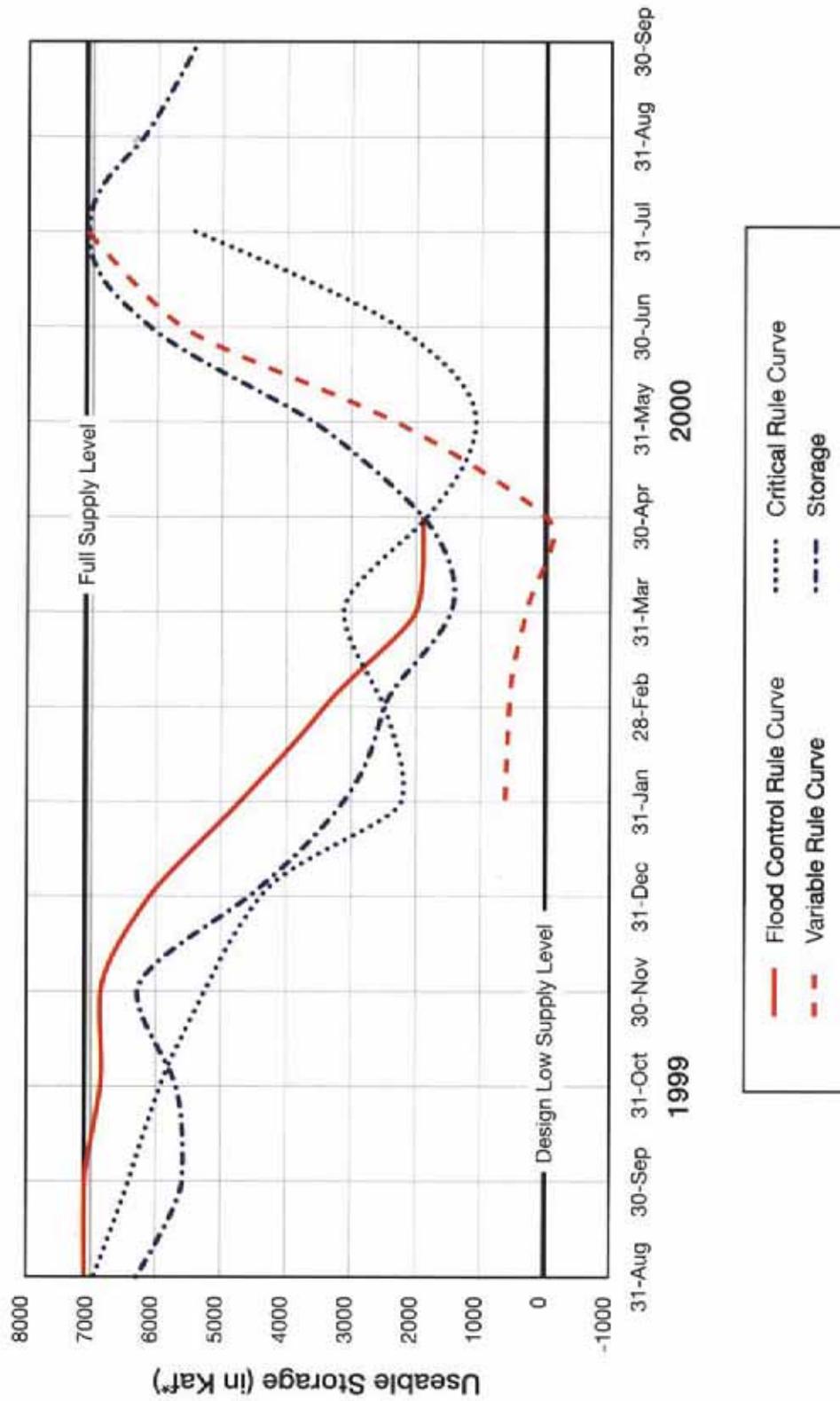
\* Kaf = thousand acre-feet.

## Libby Reservoir Levels



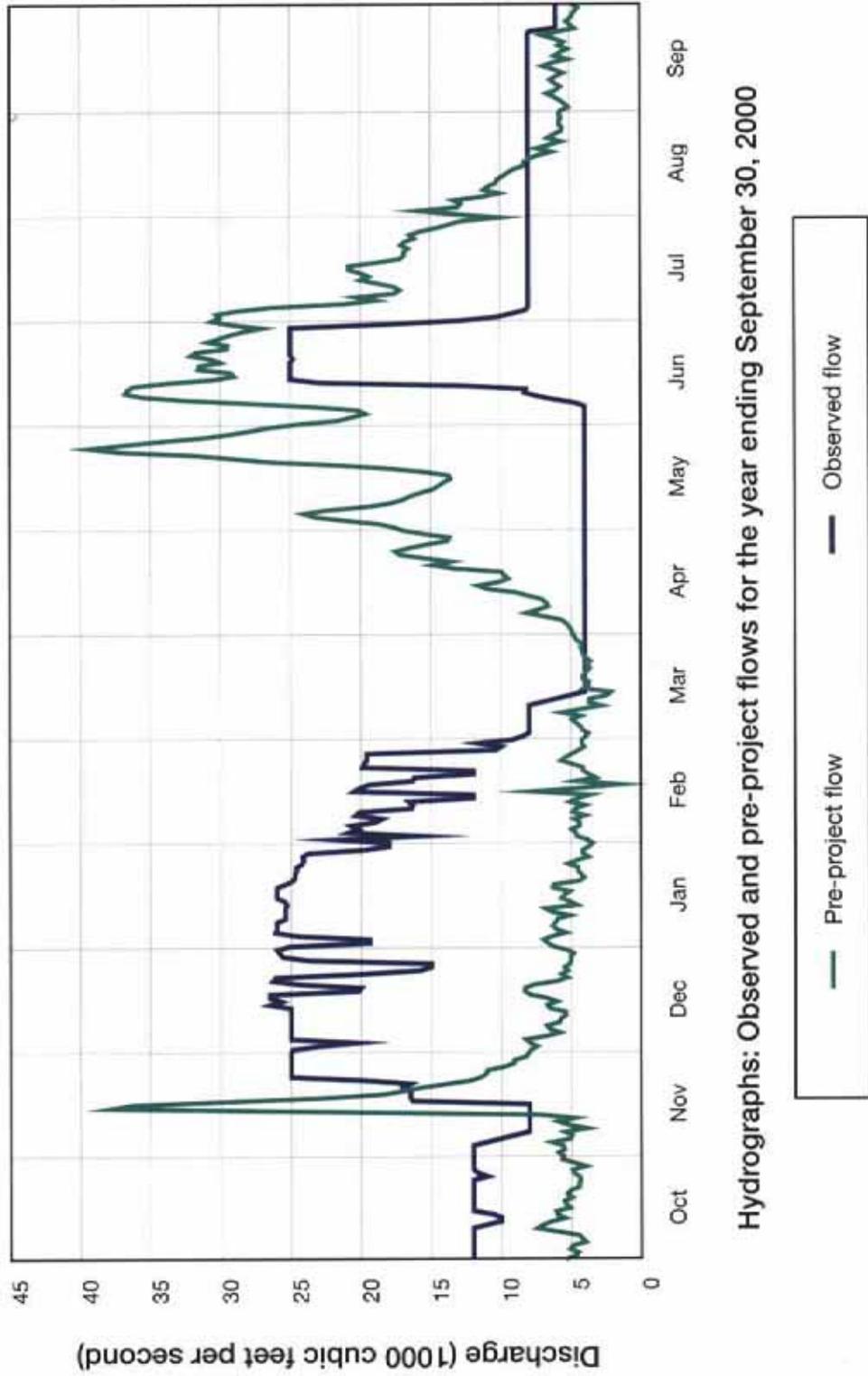
\* Kaf = thousand acre-feet

## Arrow Reservoir Levels

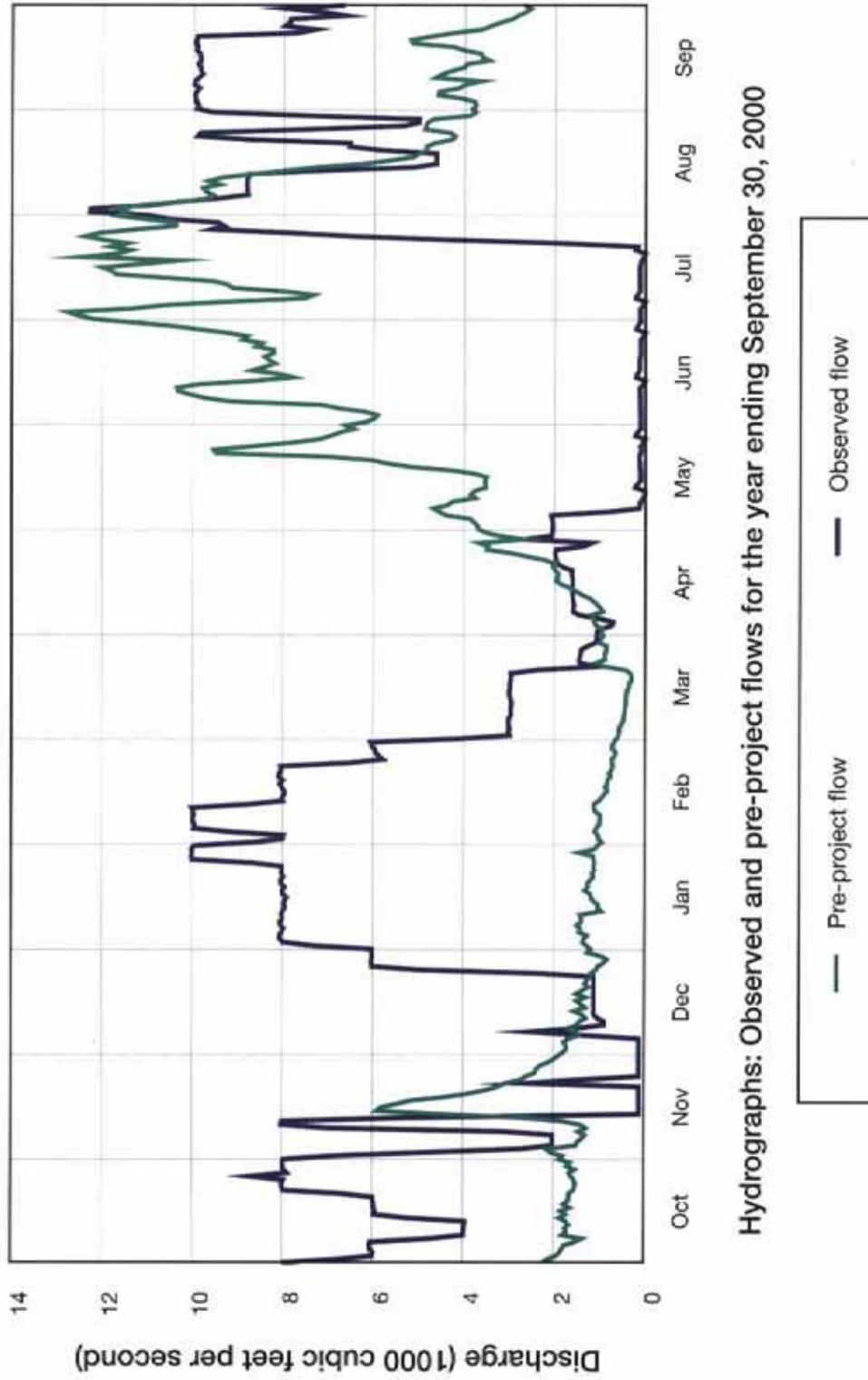


\* Kaf = thousand acre-feet

## Kootenai River at Libby Dam

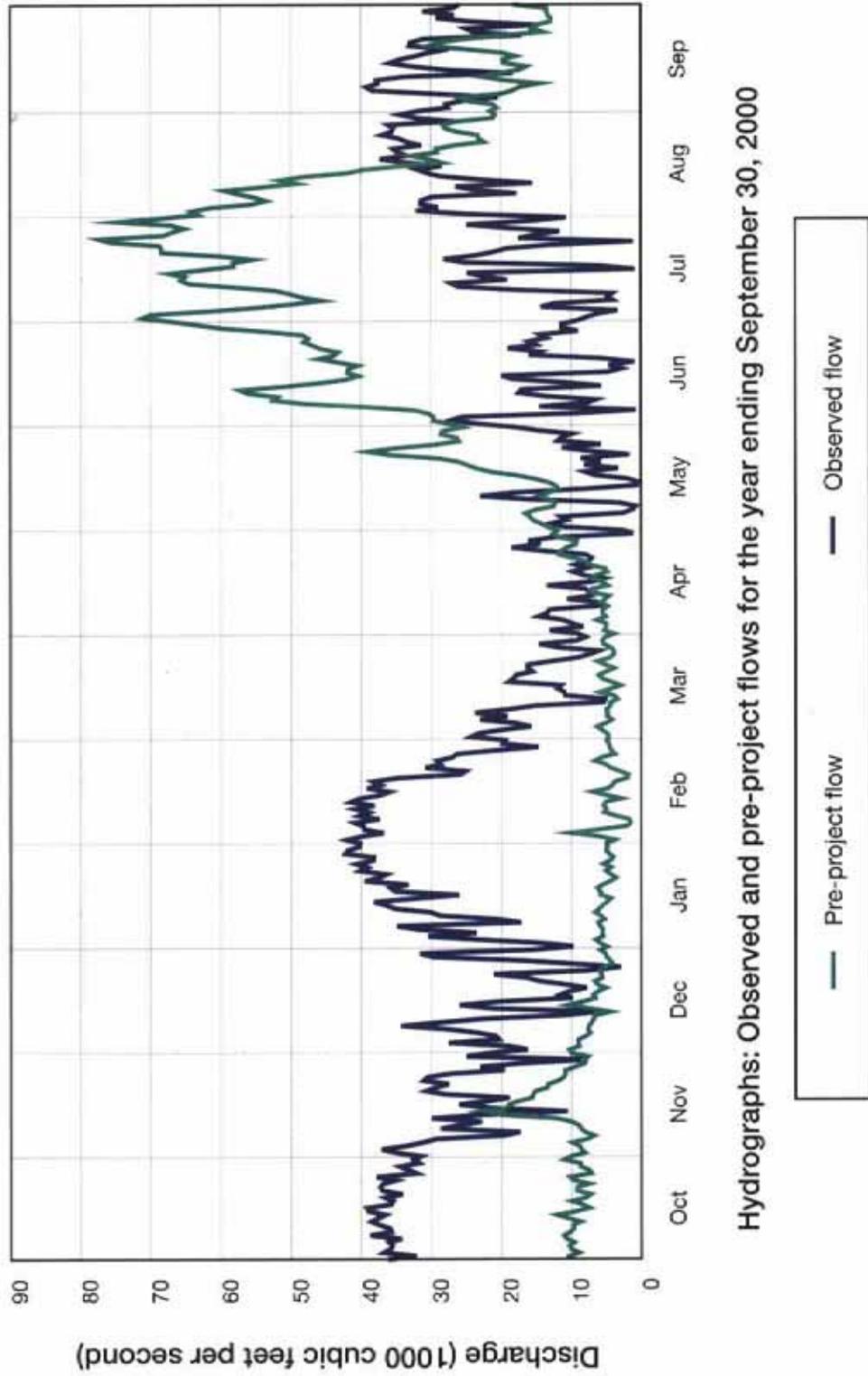


## Duncan River at Duncan Dam



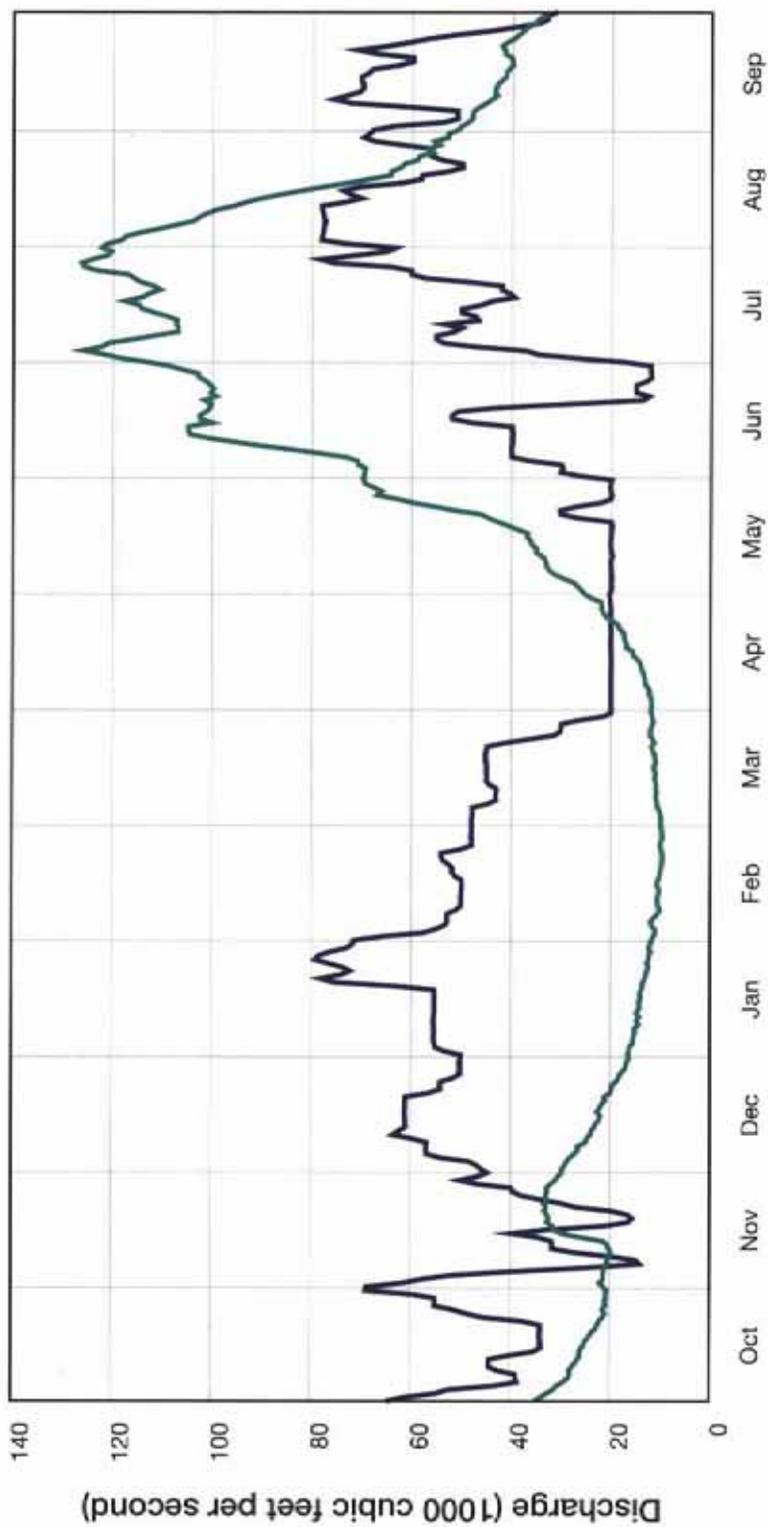
Hydrographs: Observed and pre-project flows for the year ending September 30, 2000

### Columbia River at Mica Dam



Hydrographs: Observed and pre-project flows for the year ending September 30, 2000

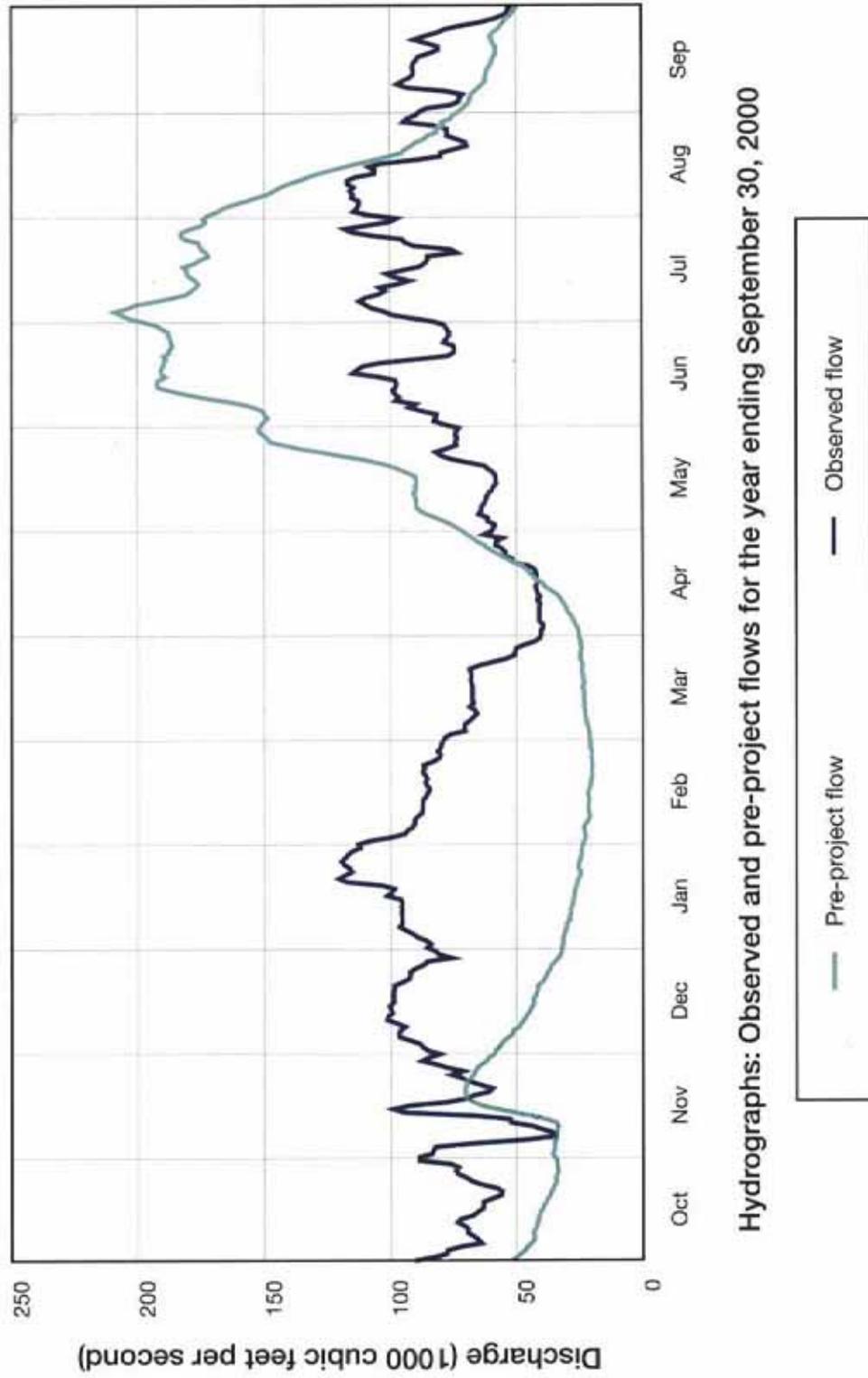
## Columbia River at Hugh Keenleyside Dam



Hydrographs: Observed and pre-project flows for the year ending September 30, 2000



## Columbia River at Birchbank



## BENEFITS

### Flood Control Provided

There was no major Columbia River flooding during the 1999–2000 operating year. Although modest potential for flooding existed during the winter and spring, favourable weather conditions and weekly operation requests were adequate to meet Treaty flood control goals. There were substantial accomplishments in peak flow reduction. The peak regulated flow and river stages are shown in the following tables:

#### Columbia River Streamflow at The Dalles, Oregon

Date	Peak Regulated Flow (cfs)	Date	Peak Unregulated Flow (cfs)
23 April 2000	375 100	27 May 2000	449 600

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

Date	Peak Regulated Stage (ft)	Date	Peak Unregulated Stage (ft)
24 April 2000	11.5	27 May 2000	16.5

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about 2.20 ft, and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia, by about 3.76 ft. 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 by the hydrographs on pages 37 to 41, which show the actual discharges and the flows that would have occurred if the dams had not been built. 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.

### Power Benefits

Downstream power benefits in the United States, which arise from operation of the Canadian Treaty storage, were pre-determined for the first 30 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. Canada retains 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. The benefits from Libby regulation, which occur downstream in the United States, are not shared under the Treaty.

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 Canadian Treaty storage. The table below summarizes Canada's share of the downstream power benefits from each project:

<b>Treaty Storage</b>	<b>Date Returnable</b>	<b>Share of Canadian Entitlement (%)</b>
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.

During the operating year 1 August 1999 through 31 July 2000, 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 559.5 MW of average annual energy and 1461.9 MW of capacity.

From 1 August 1999 through 31 March 2000, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 306.8 average megawatts of energy at rates up to 801.7 MW of capacity. The delivery from 1 April 2000 to 31 July 2000 was 277.4 average megawatts of energy at rates up to 794.0 MW of capacity.

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 and ending on 1 April 2003. Further, on 31 March 1999, a diplomatic exchange of notes adopted an agreement permitting disposal of the Canadian Entitlement directly in the United States. The exchange also designated the Province of British Columbia as a Canadian Entity.

In accordance with the Entity Agreements on the DDPBs for operating years 1999–2000 and 2000–2001, the Canadian Entity delivered to the U.S. Entity 0.4 average megawatts of annual energy and no dependable capacity during the period 1 August 1999 through 31 March 2000, and no energy nor capacity afterward.

## **Other Benefits**

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

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## CONCLUSIONS

1. The Duncan, Arrow and Mica projects were operated in conformity with the Treaty during the 1999–2000 operating year. The operation reflected DOPs developed by the Entities, the flood control operating plan for Treaty reservoirs and other agreements between the Entities.
2. During the operating year 1 August 1999 through 31 July 2000, the entitlement to 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 559.5 MW of average annual energy and 1461.9 MW of capacity.
3. From 1 August 1999 through 31 March 2000, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 306.8 average megawatts of energy at rates up to 801.7 MW of capacity. The delivery from 1 April 2000 to 31 July 2000 was 277.4 average megawatts of energy at rates up to 794.0 MW of capacity.
4. In accordance with the Entity Agreements on the DDPBs for operating years 1999–2000 and 2000–2001, the Canadian Entity delivered to the U.S. Entity 0.4 average megawatts of annual energy and no dependable capacity during the period 1 August 1999 through 31 March 2000, and no energy nor capacity afterward.
5. The Columbia River Treaty Projects were not operated for flood control during this reporting year.
6. The Entities continued to operate the hydrometeorological network as required by the Treaty.
7. At the beginning of this reporting period, the Entities were not in full compliance with the requirements of the Treaty. The AOPs and DDPBs for operating years 2000–2001 through 2004–2005 had not been prepared and signed six years in advance. As noted in the transmittal letter with the 1998–1999 Annual Report, the Entities signed an agreement on 16 February 2000 concerning the disputed Libby operation. This agreement enabled the outstanding AOPs and DDPBs to be implemented.
8. As reported in these documents, the requirements of the Treaty have been satisfied.

**APPENDIX A**

**COLUMBIA RIVER TREATY  
PERMANENT ENGINEERING BOARD**

## COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

### United States

### Canada

#### Members

Mr. Steven Stockton, Chair  
Director of Engineering and Technical  
Services  
South Pacific Division, U.S. Army  
Corps of Engineers  
San Francisco, California

Mr. Ronald Wilkerson  
Missoula, Montana

Mr. Daniel Whelan, Chair  
Director General  
Energy Resources Branch  
Natural Resources Canada  
Ottawa, Ontario

Mr. Charles Kang  
Deputy Minister  
Ministry of Employment and Investment  
Victoria, British Columbia

#### Alternates

Mr. Earl Eiker (Nominee)  
Directorate of Civil Works  
HQ, U.S. Army Corps of Engineers  
Washington, D.C.

Mr. George Bell  
Lake Oswego, Oregon

Mr. David Burpee  
Director, Renewable and Electrical Energy  
Division  
Energy Resources Branch  
Natural Resources Canada  
Ottawa, Ontario

Mr. James Mattison  
Director, Water Planning and  
Allocation Branch  
Ministry of Sustainable Resource  
Management  
Victoria, British Columbia

#### Secretaries

Mr. Robert Bank  
Engineering and Construction Division  
HQ, U.S. Army Corps of Engineers  
Washington, D.C.

Mr. David Burpee  
Director, Renewable and Electrical Energy  
Division  
Energy Resources Branch  
Natural Resources Canada  
Ottawa, Ontario

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**COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD**
**Record of Membership**

United States	Members		Canada
Mr. Wendell Johnson <sup>1</sup>	1964–1970	Mr. Gordon McNabb <sup>1</sup>	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 <sup>1</sup>	1971–1973	Mr. Ben Marr	1974–1987
Mr. Homer Willis <sup>1</sup>	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	1991–1999
Mr. Emerson Harper	1978–1988	Mr. David Oulton <sup>1</sup>	1991–1996
Mr. Lloyd Duscha <sup>1</sup>	1979–1990	Mr. Daniel Whelan <sup>1</sup>	1996–
Mr. Ronald Wilkerson	1988–	Mr. Charles Kang	1999–
Mr. Herbert Kennon <sup>1</sup>	1990–1994		
Mr. John Elmore <sup>1</sup>	1994–1996		
Mr. Steven Stockton <sup>1</sup>	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	1997–1999
Mr. George Bell	1997–	Mr. James Mattison	1999–

**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	1995–2000		
Mr. Robert Bank	2000–		

<sup>1</sup> Chair

**COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD**

**ENGINEERING COMMITTEE**

**Current Membership**

**United States**

Mr. Robert Bank, P.E., Chair  
Engineering and Construction Division  
HQ, 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 Cowan, P.E.  
Office of Technical Services  
Western Area Power Administration  
Lakewood, Colorado

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

**Canada**

Mr. Roger McLaughlin, P.Eng., Chair  
Electricity Development Branch  
Ministry of Energy and Mines  
Victoria, British Columbia

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

Dr. Bala Balachandran, P.Eng.  
Water Planning and Allocation Branch  
Ministry of Energy and Mines  
Victoria, British Columbia

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

## **APPENDIX B**

### **COLUMBIA RIVER TREATY ENTITIES**

## COLUMBIA RIVER TREATY ENTITIES

### United States

### Canada

#### Members

Ms. Judith Johansen, Chair  
Administrator and Chief Executive  
Officer

Bonneville Power Administration  
Department of Energy  
Portland, Oregon

BG Carl Strock  
Division Engineer  
U.S. Army Engineer Division  
North Pacific  
Portland, Oregon

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

**APPENDIX C**

**RECORD OF FLOWS  
AT THE  
INTERNATIONAL BOUNDARY**

## Kootenai River at Porthill, Idaho

Daily discharges (in thousands of cubic feet per second) for the year ending 30 September 2000

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	13.0	14.2	29.4	25.5	21.5	12.0	9.1	17.5	15.7	16.6	9.4	8.8
2	13.0	14.1	29.4	21.4	18.6	11.1	9.8	19.6	15.1	14.2	9.3	8.9
3	13.0	13.8	25.7	21.6	21.8	10.6	10.5	23.6	15.2	13.2	9.3	8.8
4	13.0	13.7	26.1	26.8	22.0	10.7	11.1	25.3	15.2	12.2	9.3	9.0
5	13.0	12.9	28.8	27.7	22.2	11.6	12.8	23.7	15.6	12.1	9.4	8.8
6	13.0	11.5	29.3	27.7	20.0	12.3	13.9	21.2	15.9	11.8	9.3	8.9
7	13.0	10.7	29.4	27.8	19.6	12.2	13.1	19.0	16.7	11.7	9.3	9.0
8	13.1	10.0	29.3	27.6	21.5	12.1	12.1	17.4	17.7	11.4	9.3	8.8
9	14.1	9.8	29.2	27.6	21.4	11.8	11.6	16.6	18.7	11.5	9.3	9.0
10	14.1	10.3	29.0	27.7	18.5	11.8	12.1	17.1	18.9	11.5	9.1	9.0
11	13.5	11.3	29.4	27.6	18.3	11.6	13.3	16.7	17.7	11.1	9.2	9.2
12	12.5	13.4	29.6	27.5	18.1	11.0	15.0	15.5	22.5	10.8	9.1	9.0
13	11.6	19.9	30.3	27.4	14.4	10.1	17.2	14.9	35.0	10.7	9.0	9.0
14	11.3	22.8	30.2	27.6	14.8	9.1	19.2	14.5	36.0	10.6	9.0	8.9
15	12.5	19.0	30.2	27.5	21.0	8.1	18.5	14.4	36.4	10.4	9.1	8.8
16	13.5	17.1	29.7	27.5	21.2	8.0	17.4	15.0	36.0	10.5	9.2	8.9
17	13.5	22.0	30.4	27.2	20.4	7.7	17.0	16.8	34.4	10.4	9.0	8.8
18	13.4	22.1	28.8	27.2	18.3	7.6	17.6	19.3	33.6	10.3	9.0	8.6
19	13.4	21.5	24.6	26.8	17.5	7.6	18.4	21.1	33.4	10.1	8.7	8.8
20	13.3	21.4	24.1	26.5	14.0	7.8	19.8	21.6	32.7	9.9	9.0	8.7
21	13.2	20.9	28.7	26.5	14.2	7.6	21.3	22.7	32.2	9.6	8.9	8.9
22	13.2	20.7	29.3	26.6	20.3	7.6	22.7	25.4	32.2	9.9	8.9	8.8
23	13.0	26.7	27.7	26.4	21.0	7.8	24.0	26.6	31.7	9.6	8.9	8.7
24	13.0	28.7	22.5	26.2	21.2	8.4	22.4	24.4	31.1	9.7	9.0	7.9
25	12.7	29.0	18.6	26.3	21.4	8.5	19.8	22.2	30.7	9.7	8.9	7.3
26	12.4	29.3	17.8	26.3	20.4	8.4	17.6	20.6	30.4	9.7	8.8	7.1
27	13.2	29.5	19.2	26.2	13.4	8.4	16.2	19.1	30.1	9.5	9.0	7.2
28	13.4	29.3	27.1	24.8	12.8	8.6	16.8	19.0	29.9	9.5	9.0	7.1
29	14.2	29.2	27.9	22.4	13.3	9.2	18.3	18.4	29.2	9.3	8.9	7.1
30	14.3	29.2	28.1	21.0	-	9.2	17.7	17.3	21.1	9.3	9.0	7.0
31	14.1	-	28.1	20.9	-	9.1	-	16.6	-	9.2	8.8	-
<b>Mean</b>	<b>13.1</b>	<b>19.5</b>	<b>27.4</b>	<b>26.1</b>	<b>18.7</b>	<b>9.6</b>	<b>16.2</b>	<b>19.5</b>	<b>26.0</b>	<b>10.8</b>	<b>9.1</b>	<b>8.5</b>

## Columbia River at Birchbank, British Columbia

Daily discharges (in thousands of cubic feet per second) for the year ending 30 September 2000

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	90.4	83.7	85.1	84.1	99.6	78.4	40.3	59.0	82.6	91.1	114.4	75.6
2	82.6	83.0	87.2	85.8	94.3	76.3	39.6	58.6	81.9	99.2	113.0	72.4
3	77.7	82.3	88.3	89.3	93.2	70.3	39.6	61.4	81.6	102.4	112.3	72.4
4	77.3	67.1	92.2	91.1	91.1	70.6	41.0	61.4	87.6	107.4	112.3	71.0
5	72.4	47.0	96.4	93.9	90.4	70.3	41.0	65.0	92.5	109.8	115.1	77.7
6	63.9	34.6	96.8	96.4	90.4	68.5	41.0	63.9	90.1	112.3	114.8	93.2
7	65.3	34.8	96.1	95.4	89.3	67.1	41.0	63.9	97.8	109.8	115.8	97.1
8	67.1	39.9	94.3	95.4	87.6	65.7	41.0	62.9	96.4	104.5	114.4	94.6
9	69.6	43.8	97.5	95.4	87.2	66.4	40.6	62.2	98.2	102.1	116.9	91.8
10	69.2	52.3	101.4	95.7	87.2	68.5	41.7	61.8	98.9	104.2	116.9	90.8
11	70.6	52.6	101.0	95.4	87.2	67.1	40.6	61.1	97.8	96.8	113.7	90.8
12	73.5	66.0	99.2	95.7	86.9	67.5	41.7	59.7	97.5	92.2	106.3	91.1
13	72.4	94.6	99.9	95.4	85.8	67.5	42.0	59.0	98.2	98.2	105.9	90.8
14	67.5	98.9	100.3	96.1	85.1	67.5	42.4	57.9	105.2	101.4	108.4	89.7
15	65.7	92.9	98.9	101.4	84.4	67.5	41.7	58.3	114.8	95.0	103.1	88.6
16	63.6	77.7	98.9	99.6	85.5	67.5	41.7	58.3	113.0	88.3	89.3	84.4
17	63.2	70.3	98.9	98.5	86.2	67.8	42.0	59.0	110.9	86.2	79.8	80.9
18	63.2	67.1	98.9	103.1	85.5	68.2	42.4	61.1	103.8	85.1	79.8	80.9
19	59.7	61.1	98.5	116.9	86.2	67.8	42.7	62.5	90.1	85.1	74.5	85.5
20	56.2	59.7	98.5	120.4	87.2	68.2	45.2	69.2	77.0	73.5	69.6	90.4
21	55.8	64.3	95.4	118.0	86.5	68.5	51.2	75.9	74.9	75.9	69.9	86.2
22	57.9	68.5	92.5	115.1	86.9	65.0	51.6	79.8	74.5	90.4	73.5	81.2
23	63.9	71.7	92.2	116.2	83.3	59.7	55.1	81.9	74.9	93.9	77.3	78.0
24	67.8	75.9	92.2	118.3	80.9	54.0	54.4	77.7	78.8	95.4	77.3	71.7
25	69.9	71.3	90.1	119.4	80.2	50.9	55.8	73.8	77.7	107.0	77.3	63.9
26	73.1	77.3	86.9	118.0	81.2	50.5	58.3	74.2	76.6	115.1	82.6	58.6
27	74.2	81.9	85.5	116.9	80.2	50.1	57.9	73.5	76.6	118.0	94.6	55.1
28	73.1	87.6	75.9	115.1	79.8	47.0	55.4	74.2	77.7	109.1	93.2	53.0
29	76.3	84.8	80.9	112.0	79.1	42.7	62.9	73.8	78.4	100.3	89.7	53.0
30	88.6	80.5	82.3	112.7	-	40.6	60.0	72.8	82.6	97.5	88.3	51.6
31	88.6	-	85.5	108.1	-	40.3	-	78.4	-	108.4	85.5	-
<b>Mean</b>	<b>70.3</b>	<b>69.1</b>	<b>93.1</b>	<b>103.7</b>	<b>86.5</b>	<b>62.8</b>	<b>46.4</b>	<b>66.5</b>	<b>89.6</b>	<b>98.6</b>	<b>96.3</b>	<b>78.7</b>

## APPENDIX D

### PROJECT INFORMATION

Power and Storage Projects, Northern Columbia Basin

Plate No. 1

Project Data:

Duncan Project

Table 1

Arrow Project

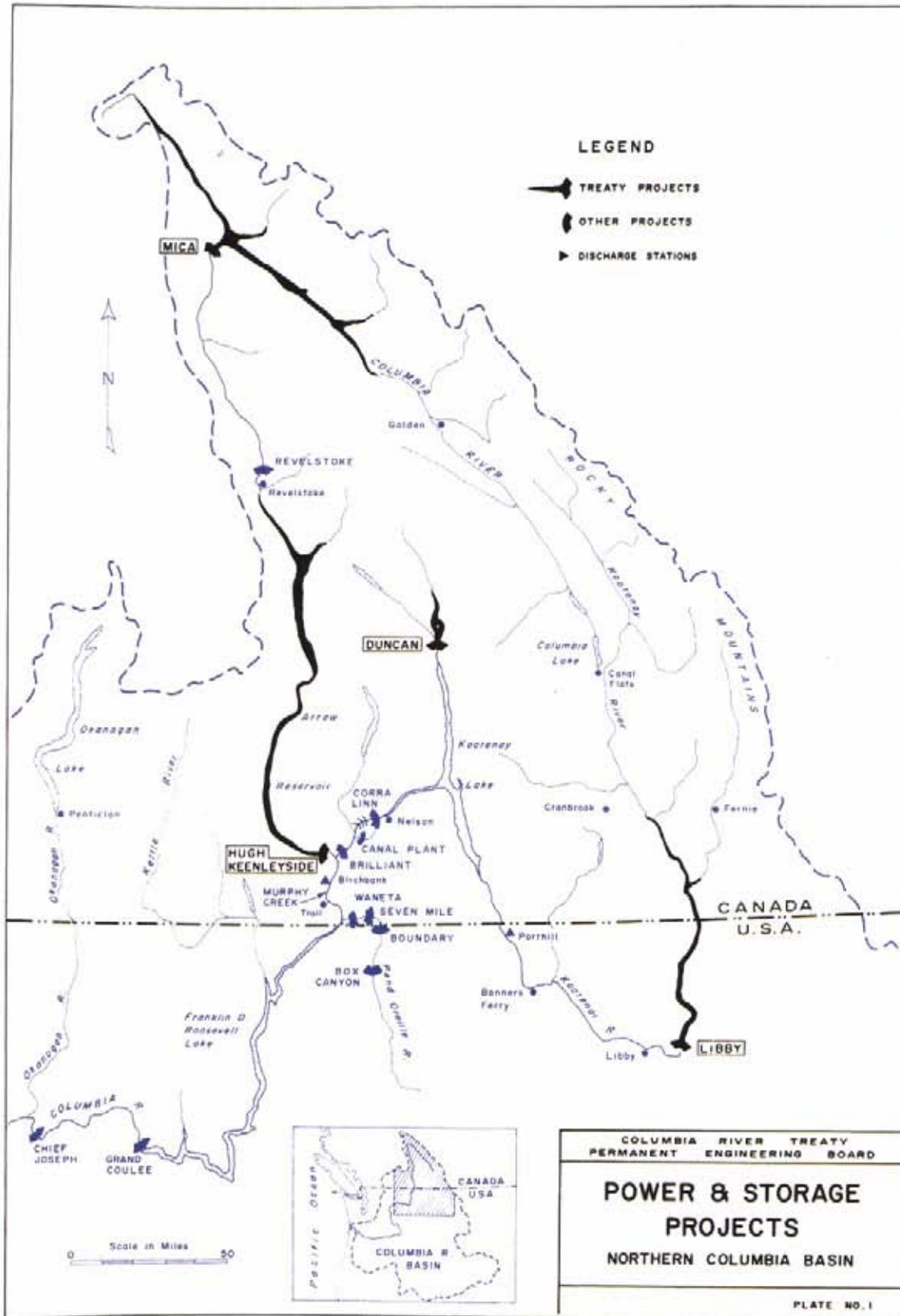
Table 2

Mica Project

Table 3

Libby Project

Table 4



# POWER AND 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	1892.0 ft
Normal minimum pool elevation	1794.2 ft
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	1907 ft
Length	2600 ft
Approximate height above riverbed	130 ft
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	1444.0 ft
Normal minimum pool elevation	1377.9 ft
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	1459 ft
Length	2850 ft
Approximate height above riverbed	170 ft
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	2475 ft
Normal minimum pool elevation	2320 ft
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	2500 ft
Length	2600 ft
Approximate height above foundation	800 ft
Spillway – Maximum capacity	150 000 cfs
Outlet works – Maximum capacity	37 400 cfs

**Power Facilities**

Designed ultimate installation – 6 units at 434 MW	2604 MW
Power commercially available	December 1976
Currently installed – 4 units at 434 MW	1736 MW
Head at full pool	600 ft
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	2459 ft
Normal minimum pool elevation	2287 ft
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	2472 ft
Length	3055 ft
Approximate height above riverbed	370 ft
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 ft
Maximum turbine discharge – of 5 units at full pool	26 500 cfs