# ANNUAL REPORT

# to the

# GOVERNMENTS

# of

# THE UNITED STATES and CANADA

**COLUMBIA RIVER TREATY**

**PERMANENT ENGINEERING BOARD**

**Washington, D.C.** **Ottawa, Ontario**

**30 September 2010**

*This page intentionally left blank*

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

CANADA • UNITED STATES

**CANADIAN SECTION**
**J. WILL, Chair Nominee**
**T. Newton, Member**

**UNITED STATES SECTION**
**S.L. STOCKTON, Chair**
**E. Sienkiewicz, Member**

9 February 2011

The Honorable Hillary Clinton
Secretary of State
Washington, D.C.

The Honourable Christian Paradis
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Clinton and Minister Paradis:

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 at Washington, D.C., on 17 January 1961.

In accordance with the provisions of Article XV, paragraph 2(e), we are submitting the forty-sixth Annual Report of the Permanent Engineering Board, dated 30 September 2010. The report documents the results achieved under the Treaty for the period from 1 October 2009 to 30 September 2010.

The Board is pleased to report that, for this reporting period, the objectives of the Treaty were met.

Respectfully submitted:

For the United States

Steven Stockton, Chair

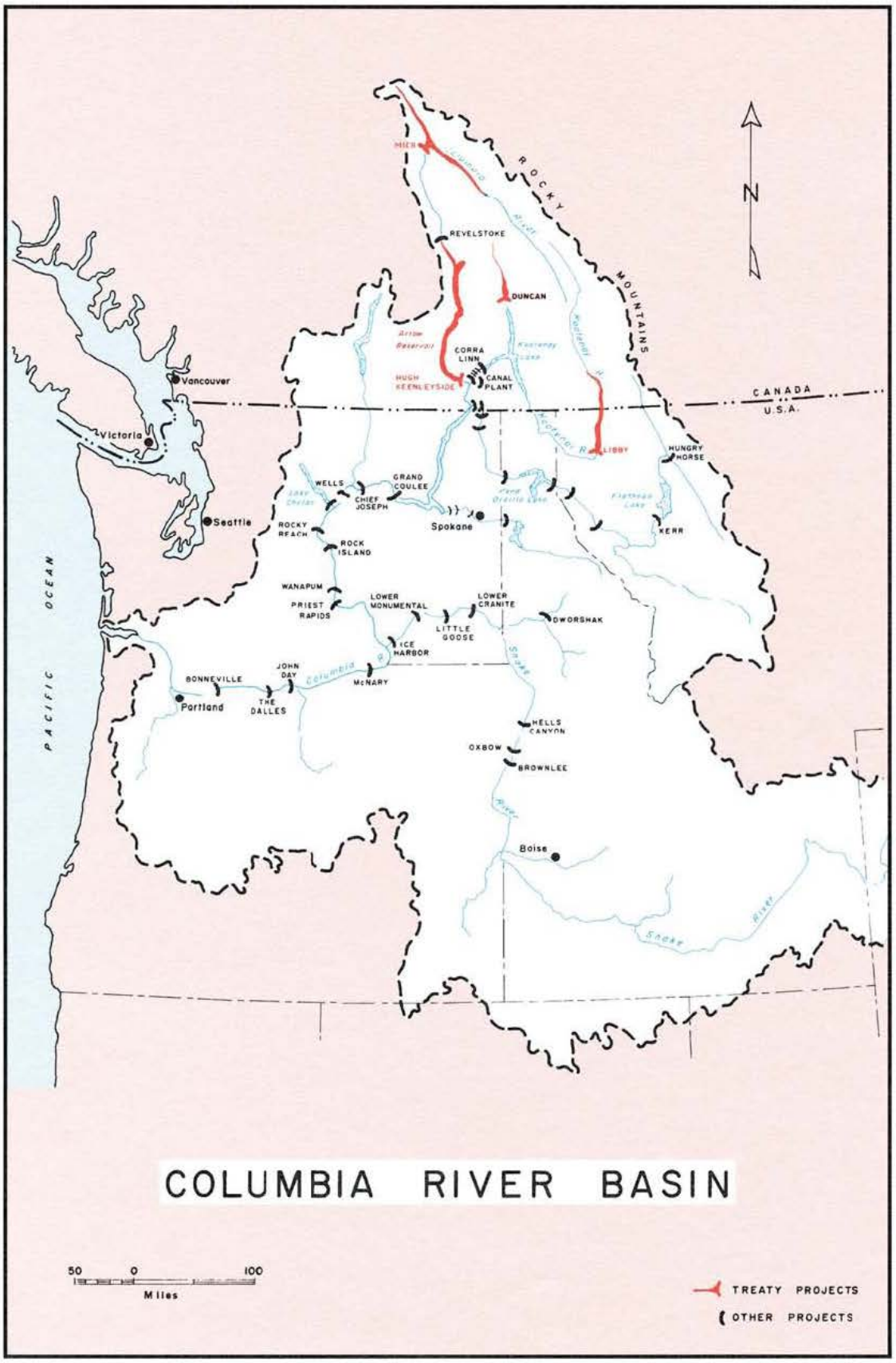
Ed Sienkiewicz

For Canada

Jonathan Will, Chair Nominee

Tim Newton

*This page intentionally left blank*


ROCKY MOUNTAINS
N
MICA
REVELSTOKE
DUNCAN
Arrow Reservoir
CORRA LINN
CANAL PLANT
HUGH KEENLEYSIDE
Kootenay Lake
Kootenay R.
Kootenai R.
LIBBY
HUNGRY HORSE
CANADA
U.S.A.
Vancouver
Victoria
Seattle
WELLS
GRAND COULEE
CHIEF JOSEPH
Lake Chelan
Spokane
Pend Oreille Lake
Flathead Lake
KERR
ROCKY REACH
ROCK ISLAND
WANAPUM
PRIEST RAPIDS
LOWER MONUMENTAL
LOWER GRANITE
LITTLE GOOSE
DWORSHAK
ICE HARBOR
Columbia R.
Snake
JOHN DAY
McNARY
BONNEVILLE
THE DALLES
Portland
HELLS CANYON
OXBOW
BROWNLEE
River
Boise
Snake
River
PACIFIC OCEAN
COLUMBIA RIVER BASIN
50 0 100
Miles
TREATY PROJECTS
OTHER PROJECTS

*This page intentionally left blank*

# ANNUAL REPORT

# to the

# GOVERNMENTS

# of

# THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

Washington, D.C. Ottawa, Ontario

30 September 2010

*This page intentionally left blank*

# EXECUTIVE SUMMARY

The forty-sixth Annual Report of the Permanent Engineering Board is submitted to the governments of Canada and the United States in compliance with Article XV of the Columbia River Treaty of 17 January 1961. This report describes Treaty projects, storage operations, and the resulting benefits achieved by each country for the period from 1 October 2009 to 30 September 2010.

During the reporting period, the Canadian Treaty projects – Mica, Duncan, and Arrow – were operated according to the 2009–2010 and 2010–2011 Detailed Operating Plans, the 2003 Flood Control Operating Plan (FCOP), and several supplemental operating agreements. Treaty storage in the United States at the Libby project was operated by the U.S. Entity according to the 2003 FCOP, the 2000 Libby Coordination Agreement (LCA), U.S. requirements for power, and the guidelines set forth in the 2000 Biological Opinion (BiOp) by the United States Fish and Wildlife Service (USFWS), the 2004 BiOp by the National Marine Fisheries Service (NMFS), and strict application of the eight-step variable discharge flood control (VarQ) operating procedures. As reported in this document, the objectives of the Treaty have been met for the reporting period.

The Canadian entitlement to the downstream power benefits for the reporting period was determined, according to the procedures set out in the Treaty and Protocol. From 1 August 2009 through 31 July 2010, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 567.1 megawatts of average energy at rates up to 1,352 megawatts. From 1 August 2010 to 30 September 2010, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 535.7 megawatts of average energy at rates up to 1,316 megawatts. The Canadian Entitlement obligation was determined by the 2009-2010 and 2010-2011 Assured Operating Plan and Determination of Downstream Power Benefits.

The U.S. Entity delivered the Canadian entitlement to the Canadian Entity at existing points of interconnection on the Canada-U.S. border according to the DOP's, *Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024*, dated 29 March 1999. During the course of the 2009-2010 operating year there were several curtailments of Canadian Entitlement deliveries, but all of the curtailed power was delivered later in the month of curtailment.

Canadian Treaty storage began the operating year on 1 August 2009 at 82.0 percent full, and ended the year on 31 July 2010 at 82.5 percent full. Seasonal flow volume above The Dalles was 79.0 percent of average for January through July 2010. The operating year 2009-2010 was characterized by below average precipitation in most parts of the Columbia River Basin.

The 2008 BiOp concluded that the continued operation of the FCRPS is not likely to jeopardize the continued existence of endangered salmon and steelhead in the Columbia River basin. Numerous parties immediately challenged the BiOp upon release. In February 2010, Judge Redden ordered a voluntary three month remand of the 2008 BiOp for the purpose of incorporating the Adaptive Management Implementation Plan (AMIP) and its administrative record. This was accomplished with completion of the 2010 Supplemental BiOp in May. In September 2010, Judge Redden permitted plaintiffs to file supplemental complaints to the 2010 Supplemental BiOp. Plaintiffs filed a motion for summary judgment in October and the defendants filed their reply briefs in December. A hearing will likely occur in early 2011.

The Columbia River Treaty Hydrometeorological Committee (CRTHMC) continues to work on evaluating the sufficiency and adequacy of the existing hydrometeorological network capabilities to support Treaty operations. The committee has drafted a Station Network Status Report identifying stations that have undergone changes between 2005 and 2010 (inclusive). However, this report does not address the overarching question about the sufficiency of the network. The committee is continuing to address the question of adequacy of the network.

The Entities are currently engaged in technical studies aimed at establishing baseline conditions for power and flood control operations post-2024 with and without the Treaty. During the period of this annual report, the Entities completed the joint “Phase 1” power and flood control studies for the 2014/2024 CRT Review process and released the report to the public on 30 July 2010, following months of extensive reviews, discussions, Entity and Coordinator meetings, and outreach meetings with stakeholders and State Department personnel. These studies, together with other work and public consultation, will help inform decision makers on matters affecting the future of the Treaty.

# TABLE OF CONTENTS

Letter of Transmittal

**EXECUTIVE SUMMARY** ..... iii

**ABBREVIATIONS AND ACRONYMS** ..... viii

**INTRODUCTION** ..... 1

**THE COLUMBIA RIVER TREATY** ..... 3
General ..... 3
Features of the Treaty and Related Documents ..... 3
Termination Provisions ..... 4

**PERMANENT ENGINEERING BOARD** ..... 5
General ..... 5
Establishment of the Board ..... 5
Duties and Responsibilities ..... 5

**ENTITIES** ..... 8
General ..... 8
Establishment of the Entities ..... 8
Powers and Duties of the Entities ..... 8

**ACTIVITIES OF THE BOARD** ..... 10
Meetings ..... 10
Reports Received ..... 10
Report to the Governments ..... 11

**TREATY IMPLEMENTATION** ..... 13
General ..... 13
Treaty Projects ..... 13
Duncan Project ..... 13
Arrow Project ..... 14
Mica Project ..... 14
Libby Project in the United States ..... 15
Libby Project in Canada ..... 15
Hydrometeorological Network ..... 15
Power Operating Plans and Calculation of Downstream Power Benefits ..... 16
Transmission Developments ..... 18
Flood Control Operating Plan ..... 19
Flow Records ..... 19
Non-Treaty Storage ..... 19
Fisheries Operations ..... 19

**OPERATIONS UNDER THE TREATY** ..... 21
General ..... 21
System Storage ..... 24
Mica Reservoir ..... 25
Arrow Reservoir ..... 25
Duncan Reservoir ..... 26
Libby Reservoir ..... 26
Flood Control Operations ..... 26
Duncan Reservoir Levels ..... 27
Mica Reservoir Levels ..... 28
Libby Reservoir Levels ..... 29
Arrow Reservoir Level ..... 30
Kootenai River at Libby Dam ..... 31
Duncan River at Duncan Dam ..... 32
Columbia River at Mica Dam ..... 33
Columbia River at Hugh Keenleyside Dam ..... 34
Columbia River at Birchbank ..... 35

**TREATY BENEFITS** ..... 36
Flood Control Benefits ..... 36
Power Benefits ..... 37
Other Benefits ..... 37

**CONCLUSIONS** ..... 39

## LIST OF PHOTOGRAPHS

Libby Dam ..... 2
Hugh Keenleyside Dam ..... 7
Duncan Dam ..... 12
Mica Dam ..... 20
Columbia River, Revelstoke Dam and Cora Linn Dam ..... 38
Treaty Tower, Mica Spillway and 2010 Treaty Inspection Tour ..... 40

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

## LIST OF HYDROGRAPHS

Duncan Reservoir Levels ....27
Mica Reservoir Levels ....28
Libby Reservoir Levels ....29
Arrow Reservoir Levels ....30
Kootenai River at Libby Dam ....31
Duncan River at Duncan Dam ....32
Columbia River at Mica Dam ....33
Columbia River at Hugh Keenleyside Dam ....34
Columbia River at Birchbank ....35

## APPENDICES

A: Columbia River Treaty Permanent Engineering Board ....41
B: Columbia River Treaty Entities ....46
C: Record of Flows at the International Boundary ....50
D: Project Information ....53

# ABBREVIATIONS AND ACRONYMS

AER ……Actual Energy Regulation
aMW ……Average Megawatts
AOP ……Assured Operating Plan (from 1 August to 31 July)
BC Hydro ……British Columbia Hydro and Power Authority
BiOp ……Biological Opinion
BPA ……Bonneville Power Administration
CEPA ……Canadian Entitlement Purchase Agreement
CRTHMC ……Columbia River Treaty Hydrometeorological Committee
cfs ……Cubic feet per second
DDPB ……Determination of Downstream Power Benefits
DOP ……Detailed Operating Plan (from 1 August to 31 July)
FCOP ……Flood Control Operating Plan
FCRPS ……Federal Columbia River Power System
ft ……Feet
$hm^3$ ……Cubic hectometres
IJC ……International Joint Commission
kaf ……Thousand acre-feet
kcfs ……Thousand cubic feet per second
km ……Kilometres
$km^3$ ……Cubic kilometres
kV ……Kilovolts
LCA ……Libby Coordination Agreement
m ……Meters
$m^3/s$ ……Cubic meters per second
Maf ……Million acre-feet
mi ……Miles
MW ……Megawatts
MWh ……Megawatt hour
NMFS ……National Marine Fisheries Service
NOAA ……National Oceanic and Atmospheric Administration
NTSA ……Non-Treaty Storage Agreement
PEBCOM ……Permanent Engineering Board Engineering Committee
PNCA ……Pacific Northwest Coordination Agreement
PSANI ……Puget Sound Area / Northern Intertie
TSR ……Treaty Storage Regulation
USACE ……U.S. Army Corps of Engineers
USFWS ……U.S. Fish and Wildlife Service
VarQ ……Variable discharge flood control

# 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 from 1 October 2008 through 30 September 2009, describes the activities of the Board, Treaty projects, storage operations, and the resulting benefits achieved by each country. It also presents summaries of the essential features of the Treaty and of the responsibilities of the Board and the Entities.

The report refers to items currently under review by the Entities; provides details on calculating flood control and power benefits and on operation of Treaty reservoirs and flow discharges at the border; and presents the conclusions of the Board.

Libby Dam – Kootenai River, Montana

# THE COLUMBIA RIVER TREATY

## General

The Columbia River Treaty was signed at 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, on 22 January 1964, in a formal agreement by an exchange of notes to a Protocol to the Treaty, and to an Attachment Relating to Terms of Sale. The Treaty and related documents were approved by the Canadian Parliament in June 1964.

The Canadian Entitlement Purchase Agreement (CEPA) 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 Canadian 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 countries. 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 19.1 $km^3$ (15.5 Maf) 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 the hydroelectric power facilities included in the base system and any new main-stem projects to make the most effective use of improved streamflow resulting from operation of the Canadian storage. Canada will operate the storage in accordance with the 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 67.6 km (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 use and, in addition, after September 1984, Canada has the option of making specific diversions of the Kootenay River into the headwaters of the Columbia River for power purposes.

(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 CEPA 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. All sales under the Sales Agreement have now expired.

## Termination Provisions

Article XIX describes the period of the Treaty and provisions for its termination. While the Treaty has no official termination date, Canada or the United States may issue notice to terminate most of the provisions of the Treaty 60 years (at the earliest) from its date of ratification (that is, on September 16, 2024), provided they have given at least ten years' written notice. Certain provisions of Treaty change automatically in 2024, while others continue for the useful life of the Treaty facilities.

The Entities are currently engaged in technical studies aimed at establishing baseline conditions for power and flood control operations post-2024 with and without the Treaty. These studies, together with other work and public consultation, will help inform decision makers on matters affecting the future of the Treaty.

# PERMANENT ENGINEERING BOARD

## General

Article XV of the Columbia River Treaty establishes a Permanent Engineering Board consisting of two members to be appointed by Canada and two members to be appointed 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 are also stipulated in the Treaty and related documents.

## Establishment of the Board

On 7 December 1964, pursuant to Executive Order No. 11177 dated 16 September 1964, the Secretary of the Army and the Secretary of the Interior 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, as are the names of the current members of the Board's Engineering Committee (PEBCOM).

## 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 on the establishment and operation of a hydrometeorological system as required by Annex A of the Treaty.

# ENTITIES

## General

Article XIV(1) of the Columbia River 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 (BPA), the Department of the Interior (moved by a later Executive Order to the Department of Energy), and the Division Engineer, North Pacific (now Northwestern) Division, Corps of Engineers, Department of the Army, as the United States Entity, with the Administrator to serve as Chair. Pursuant to the Department of Energy Organization Act of 4 August 1977, the BPA 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 of America for standby transmission services;

(d) consultation on requests for variations made pursuant to articles XII(5) and XIII(6);

(e) establishment and operation of a hydrometeorological system as required by Annex A;

(f) assisting and cooperating with the Permanent Engineering Board in the discharge of its functions;

(g) periodic calculation of accounts;

(h) preparation of the hydroelectric operating plans and flood control operating plans for the Canadian storage together with determination of the downstream power benefits to which Canada is entitled;

(i) preparation of proposals to implement Article VIII, and carrying out of any disposal authorized or exchange provided for therein;

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

(k) preparation and implementation of detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under the plans referred to in annexes A and B. Article XIV(4) of the Treaty provides that the two governments may, by an exchange of notes, empower or charge the Entities with any other matter coming within the scope of the Treaty.

# ACTIVITIES OF THE BOARD

## Meetings

The Board held its 77th meeting on 10 February 2010 in Portland, OR. In conjunction with this meeting, the Board also held its 58th joint meeting with the Entities.

The following topics were discussed at the meeting: the 2009 and 2010 DOP and supplemental operating agreements; Libby VarQ and 2009 Operations; Canadian entitlement delivery; production of the 2014-2015 Assured Operating Plan and Determination of Downstream Power Benefits (AOP/DDPB) and development of future plans; prospects for a non-treaty storage agreement; Kootenay Lake IJC Board of Control activities; update on Hydrometeorological Committee activities; release of 2008 FCRPS BiOp and associated litigation issues; status of Treaty websites; status of 2014/2024 planning initiatives; Canadian Water Use Plans and the Canadian Columbia River Forum.

## Reports Received

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

Since the last Annual Report, the Board has received the following documents involving the operation of Columbia River Treaty storage:

- Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2014-2015, dated September 2010

  *This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2014 through 31 July 2015.*

- Columbia River Treaty Entity Agreement on the Assured Operating Plan and Determination of Downstream Power Benefits for the 2014-2015 Operating Year, signed 27 September 2010

  *This document is the agreement to implement the AOP and DDPB that provide information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2014 through 31 July 2015.*

- Detailed Operating Plan for Columbia River Storage for 1 August 2010 through 31 July 2011, dated June 2010

  *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 for the operating year from 1 August 2010 through 31 July 2011.*

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2010 through 31 July 2011, signed 29 June 2010

  *This document is the agreement between the Entities to implement the DOP for Columbia River storage during the period 1 August 2010 through 31 July 2011.*

- Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Nonpower Use for 11 December 2009 through 31 July 2010

  *This agreement is for the purpose of obtaining additional mutual benefits for non-power use by shaping the discharge from the Arrow reservoir.*

- Annual Report of the Columbia River Treaty, Canadian and United States Entities, for the period 1 October 2009 through 30 September 2010

  *This report summarizes the operation of Treaty projects and other activities of the Entities for the period 1 October 2009 through 30 September 2010.*

## Report to the Governments

The forty-fifth Annual Report of the Board, dated 30 September 2009, was submitted to the governments of Canada and the United States.

# TREATY IMPLEMENTATION

## General

Implementation of the Treaty resulted in the construction of the Treaty projects, development of the hydrometeorological network, annual preparation of power plans and flood control operating plans, and annual calculation of downstream power benefits. The three Treaty storage projects in British Columbia — the Duncan, Arrow, and Mica projects — produce flood control and power benefits in both Canada and the United States. The Libby storage project in the United States also provides flood control and power benefits in both countries. The locations of the Treaty projects are shown in Appendix D, Plate No. 1.

In the United States, the 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, all owned by BC Hydro, have resulted in additional power benefits. These benefits amount to some 4400 MW of generation capacity in British Columbia that might not have been installed without the Treaty. In addition, the construction of a 185-MW hydropower plant adjacent to the Hugh Keenleyside Dam was completed in 2002. A fifth generating unit at Revelstoke has been installed and became operational on 22 December 2010. Additional generating units at Revelstoke and Mica dams in Canada are being planned and could become operational within the next decade.

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 undertook engineering feasibility and environmental studies but no activities have occurred recently.

Further to the expiration of the Sales Agreement in 1998, 1999 and 2003, the Board has monitored issues relating to the transmission and return of the Canadian entitlement, and the restructuring of electricity markets. It has also reviewed the impacts of U.S. resource agencies' biological opinions (BiOps) on Treaty operations.

## Treaty Projects

Duncan Project

Duncan Dam, the smallest Treaty project, was scheduled in the 30-year Sales Agreement to begin 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 Sales Agreement for Duncan expired 31 March 1998.

The earthfill dam is 39.6 m high (130 ft) and extends 792.5 m (2600 ft) across the Duncan River valley, 9.7 km (6 mi) north of Kootenay Lake. The reservoir behind the dam extends for as much as 43.5 km (27 mi) and provides 1.73 $km^3$ (1.4 Maf) of usable storage, which is all committed under the Treaty. No power generation facilities have been installed in this project.

The project is shown on page 12, and project data are provided in Appendix D, Table 1.

Arrow Project

Hugh Keenleyside Dam, at the outlet of the Arrow Lakes, was the second Treaty project to be completed. It became operational on 10 October 1968, well ahead of 1 April 1969, the date scheduled in the 30-year Sales Agreement. The Sales Agreement for Arrow expired 31 March 1999.

The dam consists of two main components: a concrete gravity structure that extends 366 m (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 52 m (170 ft) above the riverbed and extends 503 m (1650 ft) from the navigation lock to the south bank of the river. The reservoir, up to 233 km (145 mi) long when full, includes both the Upper and Lower Arrow lakes and provides 8.8 $km^3$ (7.1 Maf) of Treaty storage.

The new 185-MW power plant at the Arrow Project, completed in 2002 and owned by Arrow Lakes Power Corporation, is located on the north abutment (left bank). A 1493 m (4900 ft) intake approach channel runs along the north end of the concrete dam and diverts the water of the Arrow Reservoir through a powerhouse located in a rock outcrop 396 m (1300 ft) downstream. The generating facility contains two 92.5 MW Kaplan turbines. The facility is connected by a new 230 kV transmission line to the Selkirk substation integrate into BC Hydro's existing power grid. The power production at the new generating facility is incidental to releases for Treaty purposes. This new power plant reduces spill at Keenleyside Dam and provides environmental benefits by reducing entrained gases that are harmful to fish.

The project is shown on page 7, and project data are provided in Appendix D, Table 2.

Mica Project

Mica Dam, the largest of the Treaty projects, was scheduled under the 30-year Sales Agreement to begin operation on 1 April 1973. The project was declared operational and commenced to store water on 29 March 1973. The Sales Agreement for Mica expired on 31 March 2003. The dam is located on the Columbia River 137 km (85 mi) north of Revelstoke, British Columbia. The earthfill dam rises more than 244 m (800 ft) above its foundation and extends 793 m (2600 ft) across the Columbia River valley. It is one of the tallest dams in North America. It creates a reservoir, the Kinbasket Lake, that is up to 217 km (135 mi) long with a storage capacity of 24.7 $km^3$ (20 Maf). The project is operated within 14.8 $km^3$ (12 Maf) of live storage, of which 8.6 $km^3$ (7 Maf) are committed under the Treaty.

Although not required by the Treaty, BC Hydro added a powerhouse to the project. The underground powerhouse has space for six generating units. Four generators have been installed with a total capacity of 1805 MW. Installations of the two remaining generating units are scheduled for completion in 2014 and 2015. Each has a capacity of 500 MW.

The project is shown on page 20, and project data are provided in Appendix D, Table 3.

Libby Project in the United States

Libby Dam is located on the Kootenai River, 27.4 km (17 mi) northeast of the town of Libby, Montana. Construction began in the spring of 1966, and 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 931 m (3055 ft) long, rises 113 m (370 ft) above the riverbed, and creates Lake Koocanusa, which is up to 145 km (90 mi) long and extends 67.6 km (42 mi) into Canada. Lake Koocanusa has a gross storage of 7.2 $km^3$ (5. 9 Maf), of which 6.1 $km^3$ (5.0 Maf) is usable for flood control and power purposes. When completed in 1976, the Libby powerhouse 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 600 MW. Recent U.S. legislation (*Public Law 104-303*, 12 Oct. 1996) authorizes the U.S. Army Corps of Engineers (USACE) to complete generating units six through eight. No action was taken in this regard during this reporting period.

The Libby project is shown on page 2, and project data are provided in Appendix D, Table 4.

Libby Project in Canada

Canada has fulfilled its obligation to prepare the land required for the 68 km (42 mi) portion of Lake Koocanusa in Canada. British Columbia is responsible for reservoir debris clean-up on the Canadian side of the border.

## 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 the detailed programming of flood control and power operation. This system includes snow courses, meteorological stations, and streamflow gauges. The Columbia River Treaty Hydrometeorological Committee (CRTHMC), formed by the Entities in 1968, makes recommendations on further development of the Treaty Hydrometeorological System. An Annual Report is submitted to the CRT Operating Committee, which will include water supply forecast verification starting in 2009.

The CRTHMC continued to work with agencies to maintain climate and hydrometeorological data monitoring stations, and has prepared a draft report on the status of those stations within the province of British Columbia. CRTHMC has also prepared a draft proposal for additional snow pillows in British Columbia to replace existing snow courses to provide daily snow information. Daily data could lead to better correlations of records at different stations, which in turn could generate pseudo-historical records over a broader geographic area from a more limited number of historical records. This proposal is now under CRTOC review.

The CRTHMC continues to revise a forecasting procedure for the onset of spring rise (formerly referred to as freshet) in the Kootenay Lake. The Committee is also reviewing a revised Libby basin water supply forecast procedure developed by the Seattle District of USACE.

The CRTHMC continues to work on evaluating the sufficiency and adequacy of the existing hydrometeorological network capabilities to support Treaty operations. The committee has drafted a Station Network Status Report identifying stations that have undergone changes between 2005 and 2010 (inclusive). However, this report does not address the overarching question about the sufficiency of the network.

## Power Operating Plans and Calculation of Downstream Power Benefits

The Treaty and related documents require the Entities to develop and agree on an Assured Operating Plan (AOP) annually for the sixth succeeding year from the current year. This AOP, prepared five years in advance, represents the basic commitment of the Canadian Entity to operate the Treaty storage in Canada (Duncan, Arrow, and Mica) and provides the Entities with a basis for system planning. The calculation of downstream power benefits accrued to each country under the Treaty is also prepared five years in advance based on the Treaty operation criteria in the AOP. At the beginning of each operating year, a detailed operating plan (DOP) which includes the three Treaty projects in Canada, is prepared in consideration of projected resources and demands to obtain results that may be more advantageous to both countries than those obtained by operating in accordance with the AOP. To supplement the DOP, the Entities may enter into agreements throughout the year regarding the operations of Treaty storage that provide mutual benefits to both Entities. The operating plan for the Libby project in the United States has been prepared separately since 2000 and has not been included in the DOP thereafter. Details on Libby operations are discussed further below.

During the reporting year, the actual operations of the Treaty storage in Canada were regulated under the rule curves set out in the Entities' *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2009 through 31 July 2010*, signed on 1 July 2009, and the *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2010 through 31 July 2011*, signed on 29 June 2010, as well as in accordance with additional agreements between the Entities signed during the year. These documents were based on the operating criteria and hydro-regulation studies contained in the corresponding AOPs, together with any changes agreed to by the Entities.

The Libby operating criteria and expected operation of the Libby project are no longer included in the annual DOP beginning 2000-2001. Information on Libby operations is provided separately in the Libby Operating Plan prepared by the U.S. Entity. Operations at Libby take non-power considerations into account as required in the BiOps of the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic & Atmospheric Administration (NOAA) Fisheries Service. Compared to operations prior to 2000–2001, the BiOps requires higher releases from Libby Dam in the spring and summer and lower releases in the fall and winter.

In January 2003, USACE adopted, on an interim basis, a new approach to determine operations at Libby. This approach, referred to as VarQ, applies only when dry-to-moderate hydrologic runoff conditions are forecasted. It uses (encroaches) flood control storage space to store water to increase flows for fisheries during the spring period. In June 2008, USACE issued a Record of Decision for Libby Dam Flood Control and Fish Operations and incorporated the VarQ Flood Control Procedures into the Libby Dam Water Control Manual. USACE will continue to coordinate with Canada on the operation of Libby Dam pursuant to the provisions of the Columbia River Treaty.

The Libby Coordination Agreement (LCA), signed on 16 February 2000, addressed some of the issues concerning salmon and white sturgeon fisheries operations of the Libby Project, and allowed the Entities to coordinate reservoir releases and agree to AOPs and DDPBs without having to fully resolve outstanding issues of disagreement. The LCA could be terminated by either Entity on 30 days' notice. Details of the LCA are presented later in this report under "Operations under the Treaty." The Entities have successfully implemented the LCA in the past nine years.

A lengthy dispute between the Entities during the early 1990s regarding the calculation of downstream power benefits was resolved by signing 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*. If circumstances so require in the future, the Board will re-examine the matter by using its earlier recommendations as guidelines for the appropriate Treaty interpretation, and for the 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 *Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for April 1, 1998 through September 15, 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.

In addition to the delivery agreement referenced above, the terms and conditions for the disposal of portions of the Canadian entitlement within the United States are based on the *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 an exchange of diplomatic notes between Canada and the United States.

## Transmission Developments

During the reporting period the Canadian Entitlement was delivered as scheduled 99.79 percent of the time. The last curtailment of the Canadian Entitlement was in July, 2010 (three instances totaling 15 hours and 3,074 MWh, as a result of another utility's maintenance outages impacting the Northern Intertie transfer capability). In the run-up to the 2010 Winter Olympics in B.C., the Entities and Pacific Northwest regional utilities cooperated to minimize maintenance and forced outages – there were none in the six months between November 2009 and May 2010, with the Olympics in February and the Para-Olympics in March.

Several transmission and generation projects have been proposed in the northwest. Of these, the 357 km (214 mile) privately-owned 230-kV Alberta –Montana Ltd ("MATL") line between Lethbridge, Alberta and Great Falls, Montana began construction in October of 2010. Commercial operation is expected by September of 2011.

In May of 2009, the corporation Sea Breeze Pacific Juan de Fuca Cable, LP received the British Columbia Transmission Company's final Combined Interconnected Impact and Facility Study. The company, proposing an undersea 50 km, 550 MW high voltage direct current line between Vancouver Island B.C. and Washington's Olympic peninsula, sought funding of $480 million from the U.S. Department of Energy in 2009 under the American Recovery Reinvestment Act.

On July 1, 2010, the British Columbia Transmission Company was reintegrated with BC Hydro, once again making BC Hydro a vertically integrated utility encompassing all aspects of electricity production, transmission, and distribution.

Work continues on the implementation of the North American Electric Reliability Corporation's mandatory reliability standards, which are enforceable in the U.S. and most Canadian provinces. Reliability oversight in British Columbia and Alberta is coordinated with the North American Electric Reliability Corporation and the Western Electricity Coordinating Council.

TransCanada started work on NorthernLights in 2000. Initially, NorthernLights was a proposed U.S. $2.2 billion, 500 kilovolt, 1550 kilometre (963 mile) high voltage direct current electric transmission line from central Alberta to a terminal in southern Alberta and interconnecting with the Pacific Northwest. It was envisioned as a direct line that would support the cogeneration potential of Alberta's oil sands, exporting surplus power and creating an opportunity for bi-directional trade between Alberta and Oregon. TransCanada has put NorthernLights on hold pending clarity on the provincial intertie strategy and market condition improvements (generation development, wind load balancing and load requirements).

Legislation was proposed in the U.S. in 2008, and reintroduced in March of 2010, to amend the Federal Power Act to give the Federal Energy Regulatory Commission the authority to address known cybersecurity threats to the reliability of the bulk power system, and to provide emergency authority to address future cybersecurity threats. The legislation is still being debated. Canadian governments have continued in discussion with the U.S. regarding cybersecurity threats to reliability.

The Board will continue to keep governments informed of transmission developments that may impact Treaty implementation.

## Flood Control Operating Plan

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, was received from the Entities and reviewed by the Board in the 1973 reporting year, and was in effect until October 1999. The revised plan, dated October 1999 and updated in May 2003, defines the flood control operations of the Duncan, Arrow, Mica, and Libby reservoirs during the period covered in this report.

## 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-U.S. boundary. Flows for this reporting 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 BPA concerning the use of non-Treaty storage. These agreements do not interfere with operations under the Treaty. They do extend the concepts of the Treaty and benefit both BC Hydro and the BPA. As per contract terms, release rights under the Non-Treaty Storage Agreement (NTSA) terminated effective 30 June 2004. The extended provision of the agreement requires that active non-Treaty storage space in Mica be refilled within seven years (the deadline is 30 June 2011). As of September 2010, the BC Hydro and BPA NTSA accounts were over 90 percent full and are expected to refill completely this fall/winter prior to the 30 June 2011 deadline. Negotiations between respective US and Canadian stakeholders began in the spring of 2010 on a new long-term NTSA. If successful negotiations proceed on schedule, it is expected that a new NTSA could be in place by late summer of 2011.

## Fisheries Operations

Many U.S. reservoirs are presently operated in accordance with BiOps issued by the USFWS and the NMFS 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 AOP and DDPB are to be based on optimal operations for power and flood control in accordance with the requirements of the Treaty. The Board continues to maintain its long-standing position that the Treaty permits the Entities to develop DOPs to address fisheries' needs, to the extent that these actions do not conflict with Treaty objectives.

# OPERATIONS UNDER THE TREATY

## General

The Columbia River Treaty Operating Committee was established by the Entities to develop operating plans for the Treaty storage, and to direct the operation of this storage in accordance with the terms of the Treaty and subsequent Entity agreements. These plans follow the operating year from August to July of the following year. Although the Permanent Engineering Board reporting period is 1 October 2009 to 30 September 2010, Treaty operations there under are based on the Treaty operating year of 1 August 2009 to 31 July 2010. Additional information for 1 August 2010 to 30 September 2010 is based on the Treaty operating year 1 August 2010 to 31 July 2011.

Treaty storage in Canada was operated by the Canadian Entity in accordance with the documents listed below. Treaty storage in the United States at the Libby project was operated by the U.S. Entity according to the 2003 FCOP, the 2000 LCA, U.S. requirements for power, and the guidelines set forth in the 2000 BiOp by the USFWS, the 2004 BiOp by the NMFS, and strict application of the eight-step VarQ operating procedures.

- *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 the principles for changes to the preparation of the AOP and DDPB. These changes involve revisions to the 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 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 an exchange of diplomatic 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 United States Entity, dated 20 November 1996, and the Entity Agreement of the same name, dated 26 March 1998, 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 Province of British Columbia may dispose of the Canadian entitlement in the United States.

- *Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2009–2010*, dated November 2004

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2009 through 31 July 2010.

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

  The LCA addresses issues concerning the operation of the Libby project and allows the Entities to coordinate reservoir operations and agree to AOPs and DDPBs without having to alter their respective positions on the validity of the Libby fisheries operations under the Treaty.

- *Columbia River Treaty Flood Control Operating Plan*, updated May 2003

  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 the 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. The 1999 plan provides current information, incorporates new storage reservation diagrams, and clarifies procedures. The plan was updated in May 2003.

- *U.S. Entity Approval Relating to Amendatory Agreement No. 1 to the 1997 Pacific Northwest Coordination Agreement*, signed 13 June 2003

  This agreement amends the 1997 Pacific Northwest Coordination Agreement to include definitions; adds text related to previously received interchange energy; and replaces text related to interchange pricing, accounting, and review of charges.

- *Columbia River Treaty Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans for Operation of Canadian Treaty Storage*, dated 16 December 2003

  This document serves as a guide for the preparation and use of hydroelectric operating plans, such as the AOP and DOP, for operation of the Columbia River Treaty storage.

- *Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2010–2011*, dated January 2006

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2010 through 31 July 2011.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2009 through 31 July 2010*, dated July 2009

  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 for the operating year from 1 August 2009 through 31 July 2010.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2010 through 31 July 2011, dated June 2010*

  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 for the operating year from 1 August 2010 through 31 July 2011.

- *Columbia River Treaty Entity Agreement on the 2010 Summer Storage Agreement (Not Treaty) for 5 June 2010 through 10 September 2010*, signed 7 July 2010

  This agreement is for the purpose of reducing inflow to Grand Coulee during the peak freshet period, providing late-summer flow support for U.S. fisheries, enhancing Arrow Lakes summer reservoir levels, and providing energy benefits for both countries.

- *Columbia River Treaty Operating Committee Agreement on Provisional Storage for the Period 26 September 2009 through 3 April 2010*, signed 28 September 2009.

  This agreement is for the purpose of obtaining additional mutual benefits, both for power and non-power, by shaping the discharge from the Arrow reservoir.

- *Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-power Uses from 11 December 2009 through 31 July 2010*, signed 3 December 2009

  This agreement is similar to previous agreements implemented to utilize Treaty storage for non-power uses. These uses include: (1) providing flows for Canadian trout spawning for the April through June period; (2) enhancing the capability in the U.S. of providing spring and summer flow augmentation for salmon and steelhead by storing 1 Maf of water in Arrow by late April; (3) enhancing Arrow Lakes levels by ensuring progressive refill; and, (4) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam.

- *Columbia River Treaty Operating Committee Agreement on Changes to Attachment B to 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 United States Entity, dated 29 March 1999*, signed 19 December 2007

  This agreement amends the scheduling guidelines for delivery of the Canadian Entitlement contained in Attachment B in the Aspects of Delivery Agreement.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2010 through 31 July 2011*, dated 29 June 2010

  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 for the operating year from 1 August 2009 through 31 July 2010.

## System Storage

The 2009–2010 operating year began on 1 August 2009 with the Canadian Treaty storage at 15.7 $km^3$ (12.7 Maf) or 82.0 percent full. Canadian Treaty storage drafted to a minimum of 3.9 $km^3$ (3.0 Maf) on 15 April 2010 and refilled to 15.9 $km^3$ (12.9 Maf) or 82.5 percent full on 31 July 2010. Throughout the operating year, composite Canadian Treaty storage was very close to the TSR composite storage except for small deviations caused by inadvertent draft or storage. Inadvertent draft or storage occurs routinely due to updated forecasts or differences between forecast and actual inflows. Canadian storage began the operating year near the DOP levels determined in the TSR study. It remained near the forecasted TSR levels through September. From October 2009 through June 2010, Canadian storage remained above the TSR, and returned to near TSR levels in July. This was primarily due to supplemental operating agreements that were implemented and resulted in mutual benefits for both the U.S. and Canada.

The 1 January 2010 water supply forecast for the Columbia River above The Dalles for January through July was 109.2 $km^3$ (88.5 Maf), or 82.5 percent of the 1971–2000 average. By the 1 April 2010 forecast, the runoff prediction dropped to 86.0 $km^3$ (84.7 Maf), and the actual January through July runoff for the Columbia River above The Dalles was 104.5 $km^3$ (84.7 Maf), or 78.9 percent of the 1971-2000 average.

Operations of the three Canadian reservoirs — Mica, Arrow, and Duncan — and the Libby Reservoir in the United States, are illustrated on pages 27 to 30 for the 13-month period from 31 August 2009 to 30 September 2010. The hydrographs show actual reservoir levels (Storage Curve) and key rule curves that govern the operations of the Treaty storage. The Flood Control Rule Curve specifies maximum month-end reservoir levels which will permit evacuation of the reservoir to control precipitation and snowmelt events. The Critical Rule Curve shows minimum month-end reservoir levels, which should be maintained to enable the anticipated power demands to be met under the most adverse water supply conditions. The Variable Refill Curve shows the reservoir elevations necessary to ensure refilling of the reservoir by the end of July with a reasonable degree of confidence.

Mica Reservoir

The Mica (Kinbasket) reservoir reached a maximum elevation of 751.97 m (2467.1 ft), 2.41 m (7.9 ft) below full pool on 24 September 2009. The reservoir was drawn down during the fall and winter to meet electrical demands and to prepare for the spring runoff. It reached a minimum this year at 724.7 m (2377.6 ft) on 10 May 2010, lower than the 2009 minimum level. By comparison, in 2009, the minimum level was 730.4 m (2396.2 ft) on 9 May. The lower spring levels were due to a combination of higher winter loads and consecutive months of drier fall/winter weather conditions. From late May through early July, Mica generation was reduced to near minimum flows as is normal in response to lower electrical demands and system constraints, and to achieve a high probability of refill on the reservoir. This operation, however, continued through early August due to generation restrictions at the Revelstoke generating station. By mid-August, the project resumed normal operations with the return of Revelstoke units such that generation from the Upper Columbia projects was increased to better support the Arrow Lakes reservoir levels for summer recreation. Near record high inflow event in September resulted in continued filling of Kinbasket reservoir across September through early October reaching an elevation of 753.04 m (2470.6 ft), 1.34 m (4.4 ft) below full pool on 30 September 2010. The reservoir was projected to continue to gain storage in October, and reach a maximum of 753.5 m (2472 ft), 0.9 m (3 ft) below full pool by mid October 2010, higher than the 2009 peak level.

Arrow Reservoir

The Arrow Lakes reservoir reached a maximum elevation of 437.8 m (1435.6 ft) on 30 June 2009, 2.5 m (8.4 ft) below full. The reservoir drafted across fall and winter as is normal to meet Treaty firm loads. It reached a minimum level this year at 429.0 m (1407.5 ft) on 14 January 2010. By comparison, the Arrow Lakes Reservoir reached a minimum level of 429.3 m (1408.6 ft) on 30 March 2009. The higher winter/spring levels were primarily due to a combination of low Arrow Treaty discharges, refill of the July 1990 Non-Treaty Storage Agreement (NTSA) and Treaty Flex operations. As basin inflows increased from snowmelt runoff during May through early July, the reservoir filled quite rapidly up to its Treaty flood control level (maximum possible level) in June to reach a maximum level of 439.3 m (1441.3 ft), or 0.82 m (2.7 ft) below full pool on 5 July 2010. Due to a combination of generation restrictions in the upstream reservoirs in July through early August and Treaty proportional draft operation since August 2010, Arrow reservoir drafted across the summer months reaching 437.54 m, 436.11 m, 434.64 m (1435.5 ft, 1430.8 ft, 1426.0 ft) by 31 July, 31 August 31 and 30 September 2010, respectively.

Duncan Reservoir

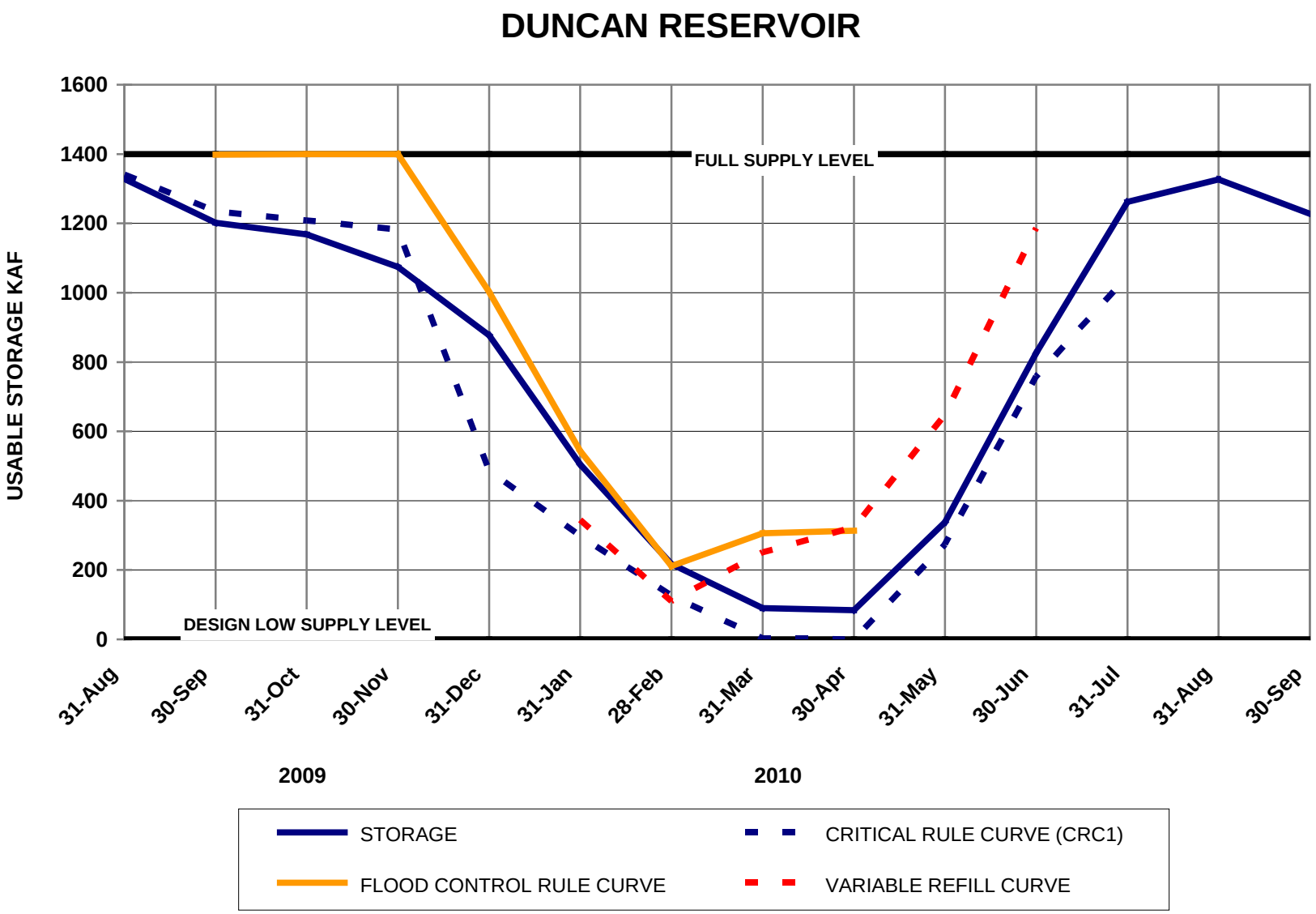
Duncan reservoir refilled to 575.86 m (1,889.3 ft), 0.82 m (2.7 ft) below full pool on 21 August 2009. From September 2009 through April 2010, Duncan discharge was used to supplement inflow into Kootenay Lake and to provide spawning and incubation flows for fish. B.C. Hydro requested a permanent variance to the Duncan Flood Control Curve for 28 February 2010 and beyond from 551.0 m (1,807.7 ft) to 552.4 m (1,812.5 ft), which was subsequently approved by the U.S. Army Corps of Engineers (USACE). The additional storage on 28 February increased the ability to maintain a minimum river flow at the Duncan River below the Lardeau confluence of 73 $m^3/s$ (2.6 kcfs), for incubation of fish eggs during the March-April period as agreed to under the Duncan Water User Plan (WUP). As in most years, the reservoir was drafted to near empty in late April or early May. In 2010, however, reservoir storage draft was limited due to high inflows in April and WUP requirements preventing further increases in outflows. For this reason, the Duncan Reservoir reached its minimum level for the year of 547.1 m (1797.31 ft) on 18 April, about 1.0 m (3 ft) above the minimum licensed level. By comparison, in 2009, the reservoir reached a minimum elevation of 547.1 m (1794.9 ft) on 23 April. Reservoir discharge was reduced to a minimum of 3.0 $m^3/s$ (0.1 kcfs) on 19 May 2010 to initiate reservoir refill. This operation continued through to early August when Duncan reservoir reached a maximum level of 576.04 m (1889.9 ft) or 0.64 m (2.1 ft) below full on 12 August 2010. The project was operated to pass inflows through the balance of August and until Labor Day (6 September) in order to reach a target of 575.5 +/- 0.3 m (1888 ft +/- 1 ft) as per WUP requirements. For the balance of September, project flows were increased to facilitate drafting of the reservoir to reach an elevation of 573.72 m (1882.3 ft) on 30 September 2010.

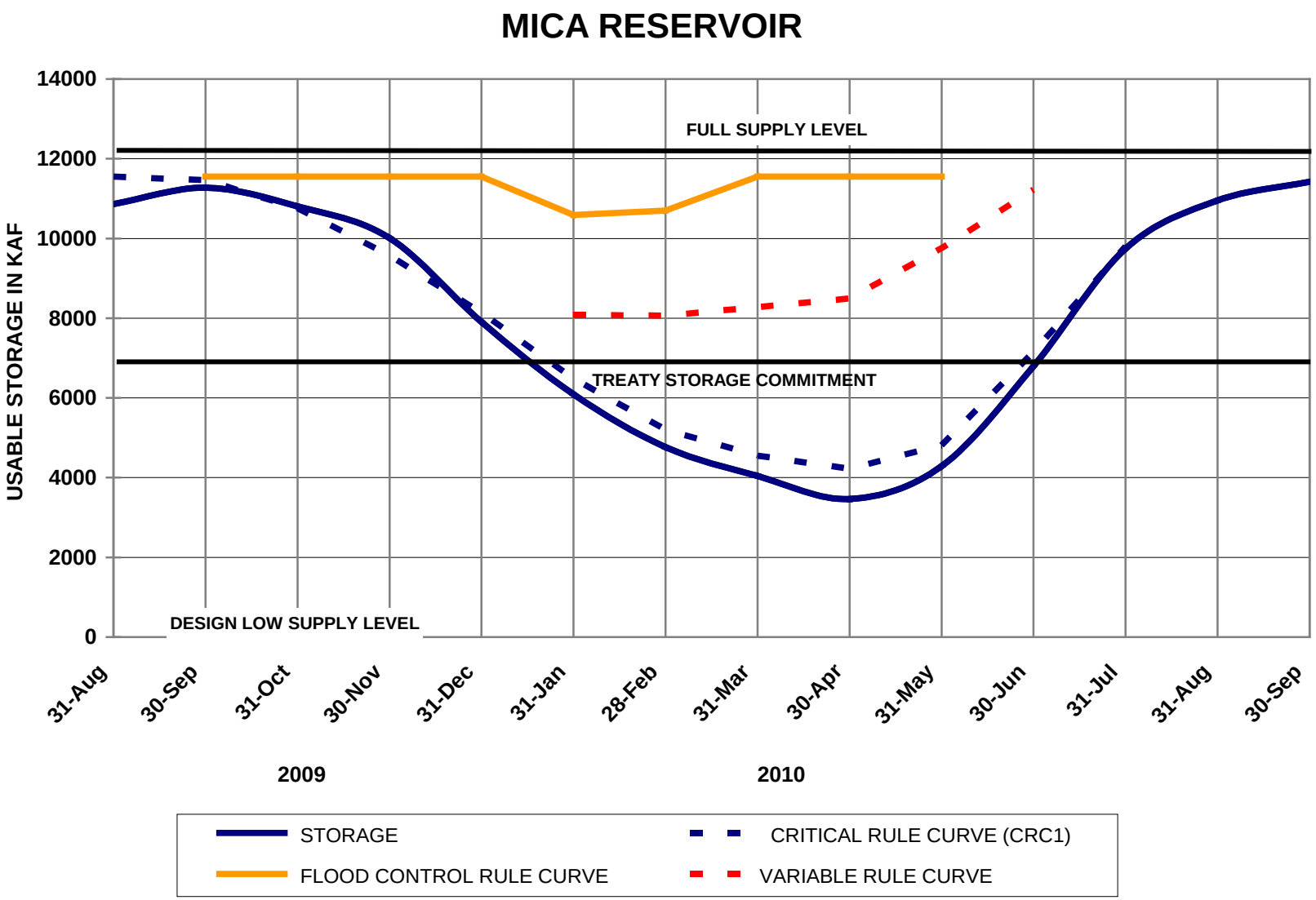
Libby Reservoir

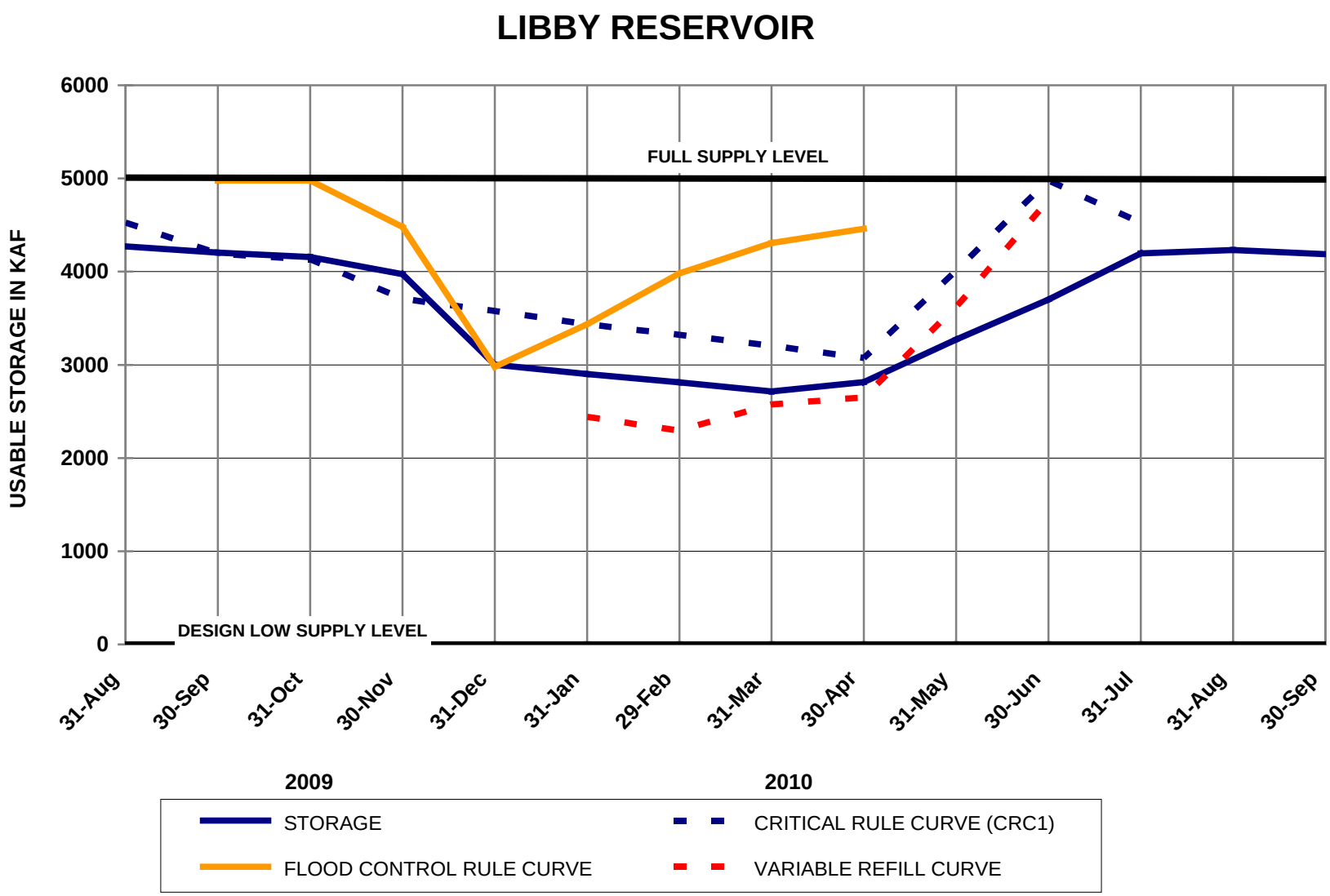
The Libby (Koocanusa) Reservoir filled to its maximum elevation of 744.7 m (2,443.3 ft) on 25 August 2009, 4.8 m (15.7 ft) from full pool. The reservoir drafted through the fall and winter period. By 31 December 2009, the reservoir was at elevation 734.84 m (2,410.9 ft) and operated during the winter to the VARQ storage reservation diagram. The reservoir drafted to its lowest elevation of 732.25 m (2,402.4 ft) on 17 April 2010. During the refill period, Libby Dam operated in accordance to the VARQ operating procedures with an approved deviation to remain at a minimum discharge, storing 0.32 $km^3$ (0.26 Maf) to increase the likelihood of meeting the minimum spillway crest elevation to provide spill as part of the sturgeon releases. Libby Dam provided 0.98 $km^3$ (0.8 Maf) of storage for sturgeon releases and released the storage accumulated under the deviation by 15 July. The reservoir filled to its maximum elevation of 744.6 m (2442.9 ft) on 17 August 2010, 4.9 m (16.1 ft) from full pool and drafted to elevation 744.4 m (2442.1 ft) by 31 August.

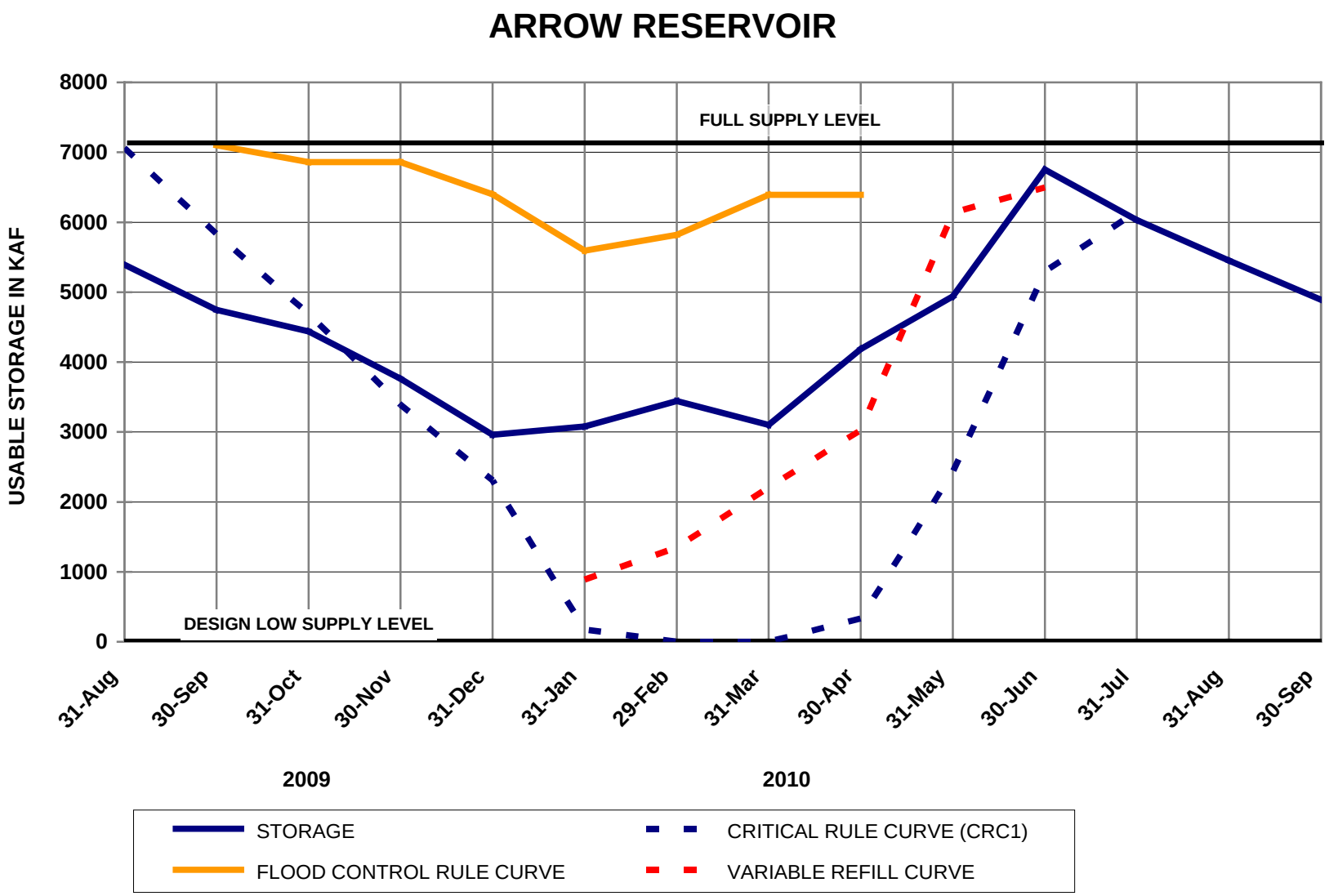
## Flood Control Operations

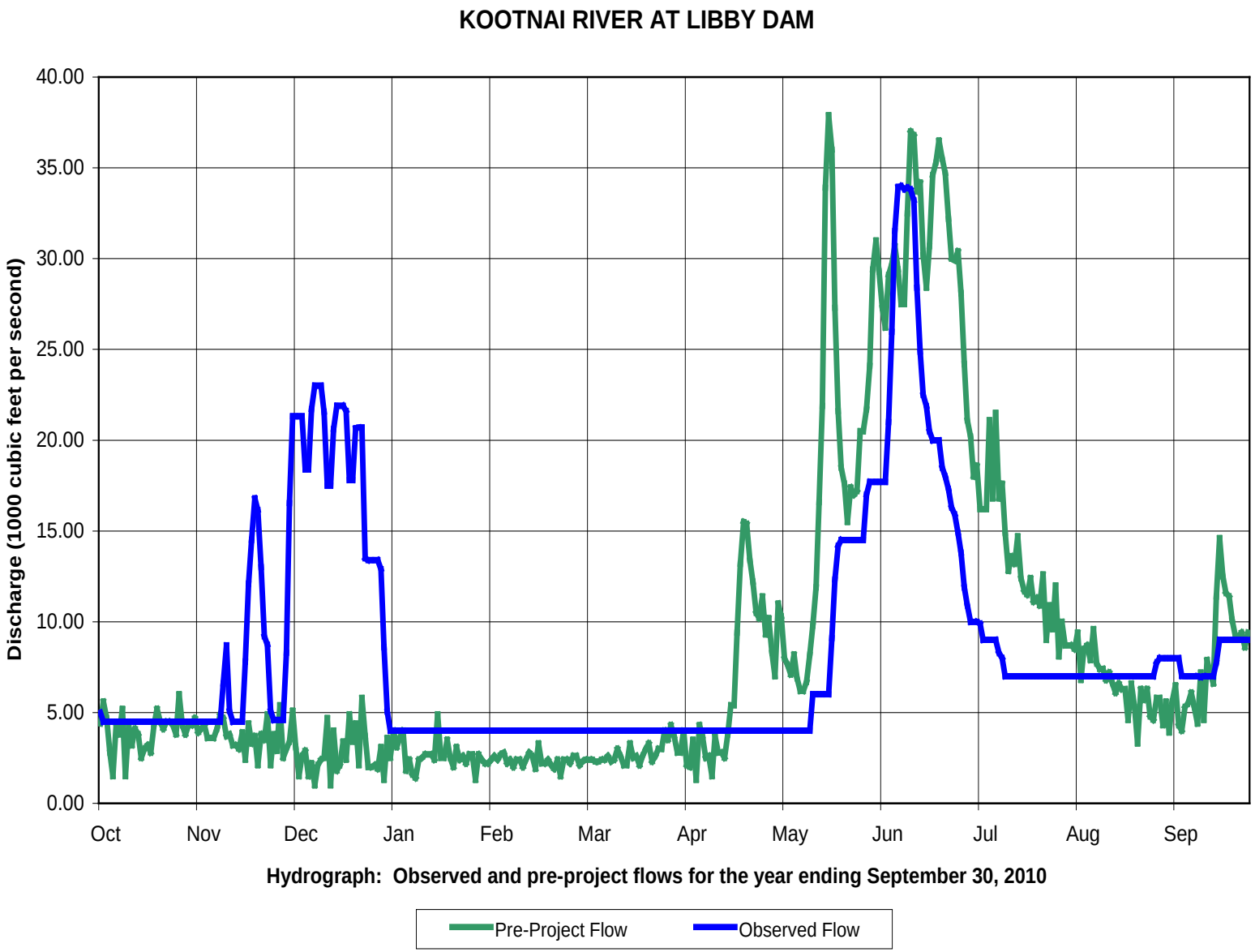
Columbia River Basin projects were operated according to the May 2003 Flood Control Operating Plans. The 2010 water supply forecasts averaged below normal across the Columbia River Basin, Upper Columbia Basin, and the Snake River Basin. The regulated peak flow at The Dalles, Oregon, was 11 066 $m^3/s$ (390.8 kcfs) on 11 June 2010, and the unregulated flow was estimated at 15 576 $m^3/s$ (550.1 kcfs) on 7 June 2010. The peak stage observed at Vancouver, Washington, was 4.45 m (14.6 ft.) on 12 June 2010, and the estimated unregulated stage was 5.85 m (19.2 ft.) on 9 June 2010.


DUNCAN RESERVOIR
USABLE STORAGE KAF
1600
1400
1200
1000
800
600
400
200
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
28-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2009
2010
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE

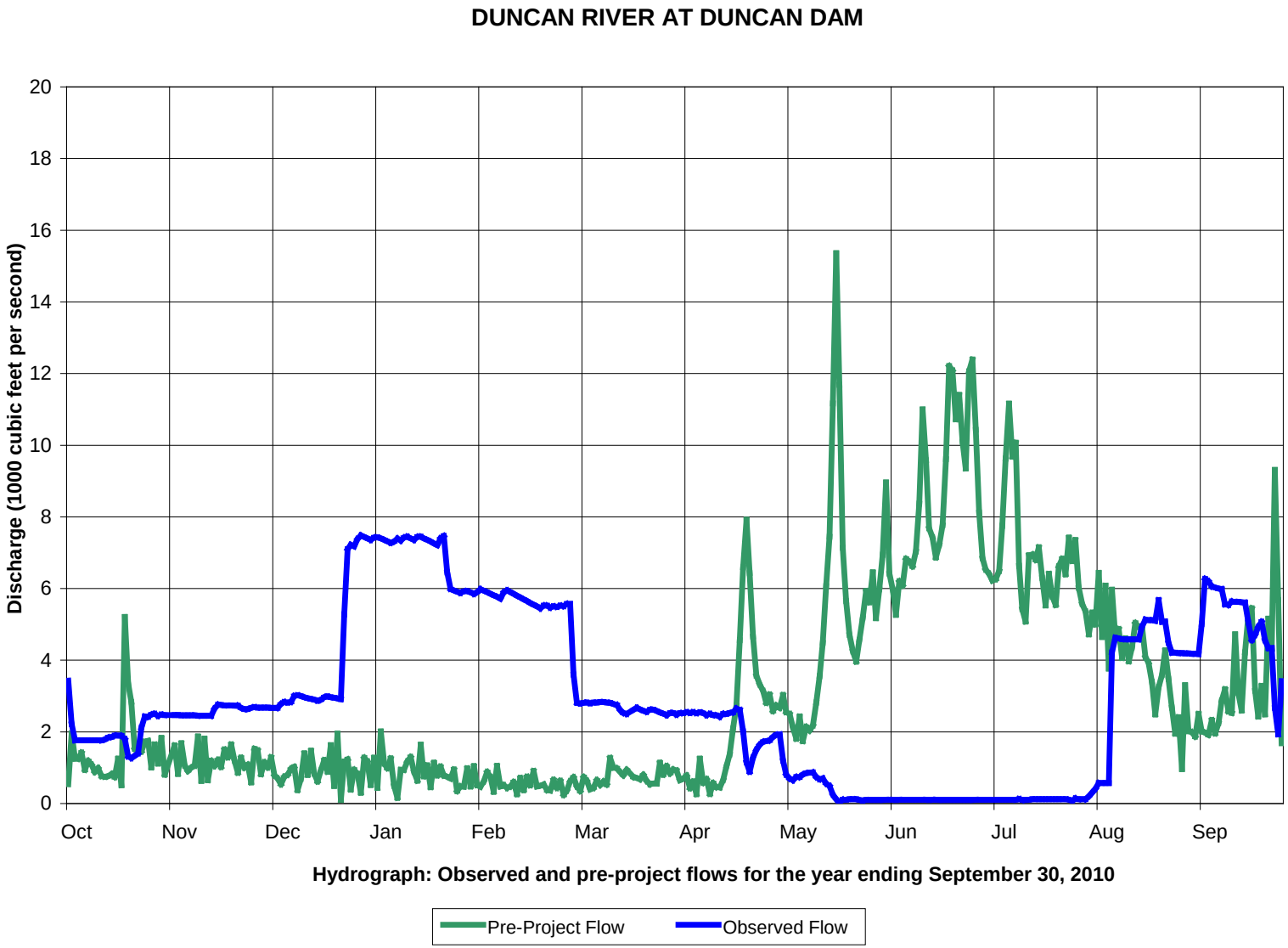

MICA RESERVOIR
USABLE STORAGE IN KAF
14000
12000
10000
8000
6000
4000
2000
0
FULL SUPPLY LEVEL
TREATY STORAGE COMMITMENT
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
28-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2009
2010
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE RULE CURVE

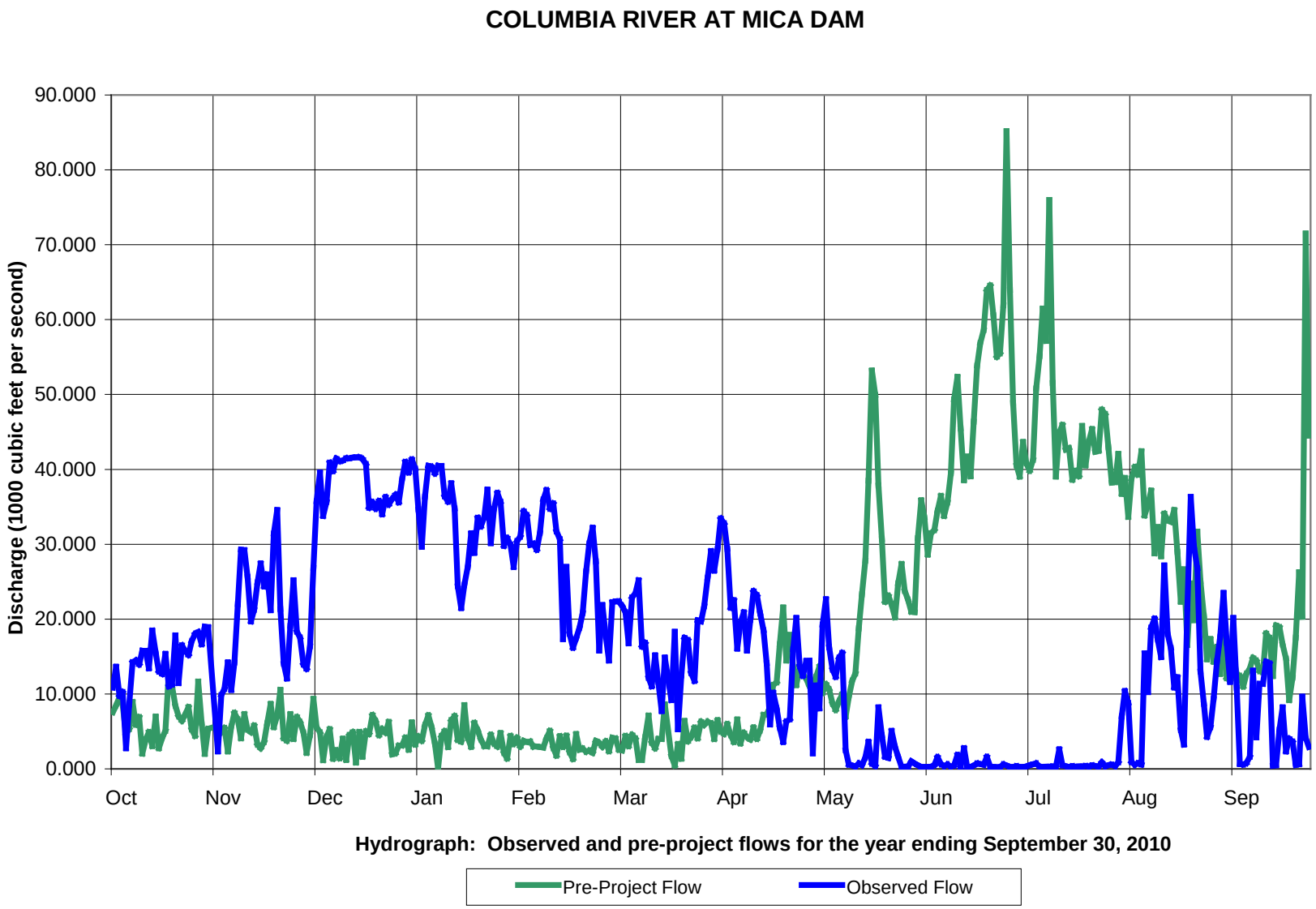

LIBBY RESERVOIR
USABLE STORAGE IN KAF
6000
5000
4000
3000
2000
1000
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
29-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2009
2010
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE

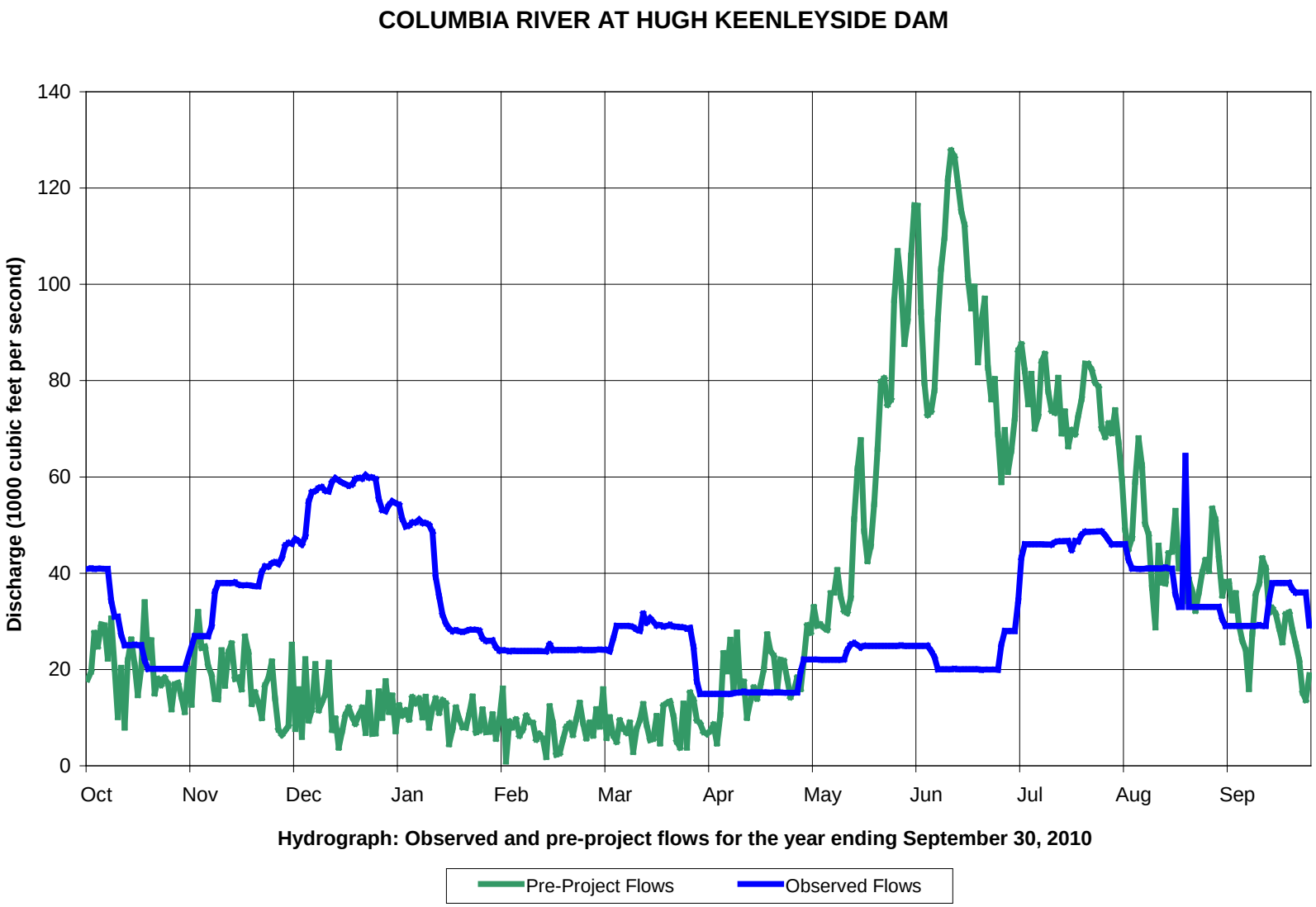

ARROW RESERVOIR
USABLE STORAGE IN KAF
8000
7000
6000
5000
4000
3000
2000
1000
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
29-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2009
2010
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE

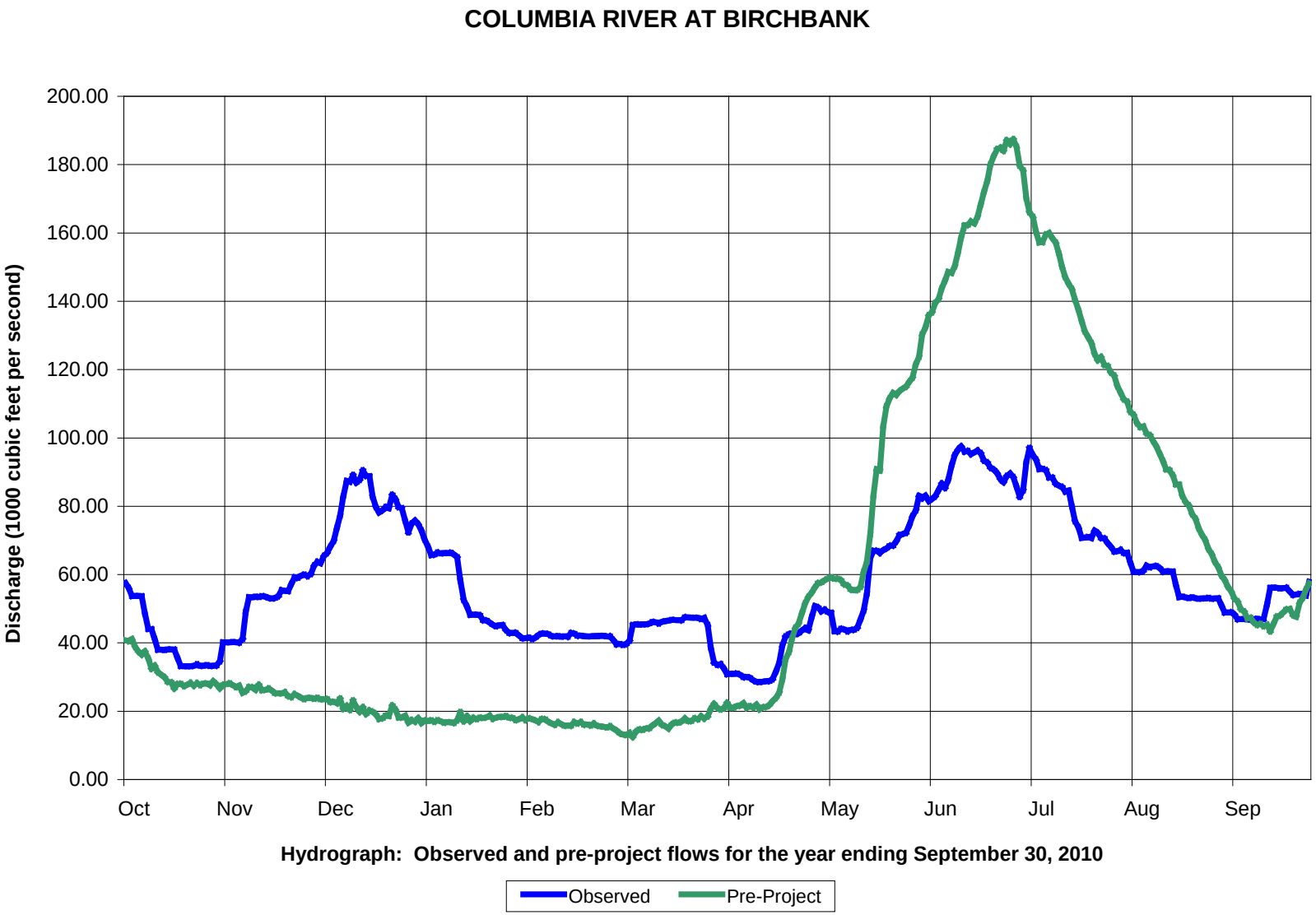



**Hydrograph: Observed and pre-project flows for the year ending September 30, 2010**


DUNCAN RIVER AT DUNCAN DAM
Discharge (1000 cubic feet per second)
0
2
4
6
8
10
12
14
16
18
20
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Hydrograph: Observed and pre-project flows for the year ending September 30, 2010
Pre-Project Flow
Observed Flow


COLUMBIA RIVER AT MICA DAM
Discharge (1000 cubic feet per second)
90.000
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.000
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Hydrograph: Observed and pre-project flows for the year ending September 30, 2010
Pre-Project Flow
Observed Flow


COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM
Discharge (1000 cubic feet per second)
140
120
100
80
60
40
20
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Hydrograph: Observed and pre-project flows for the year ending September 30, 2010
Pre-Project Flows
Observed Flows


COLUMBIA RIVER AT BIRCHBANK
Discharge (1000 cubic feet per second)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Hydrograph: Observed and pre-project flows for the year ending September 30, 2010
Observed
Pre-Project

# TREATY BENEFITS

## Flood Control Benefits

The Columbia River basin reservoir system, including the Columbia River Treaty projects, was drafted in the winter in preparation for the spring freshet. No major flooding occurred during the 2009-2010 operating year. Unregulated Columbia River runoff volume as measured at The Dalles was 79% of the 1971-2000 average (August-July). The peak regulated and unregulated flows, and river stages are shown in the following tables:

## Columbia River Steam flow at The Dalles, Oregon

| Date | Peak Regulated Flow $m^3/s$ (cfs) | Date | Peak Unregulated Flow $m^3/s$ (cfs) |
|---|---|---|---|
| 11 June 2010 | 11,066 (390,800) | 7 June 2010 | 15,576 (550,060) |

## Columbia River Stage at Vancouver, Washington
## Flood Stage is 4.9 meters (16.0 feet)

| Date | Peak Regulated Stage meters (feet) | Date | Peak Unregulated Stage meters (feet) |
|---|---|---|---|
| 12 June 2010 | 4.45 (14.6) | 9 June 2010 | 5.85 (19.2) |

Duncan and Libby projects limited the peak elevation of Kootenay Lake to elevation 522.97 m (1748.6 ft) on 18 June 2010. It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about 0.8 m (2.5 ft). Duncan, Arrow, Mica and Libby projects limited the peak flow of the Columbia River at Trail, just upstream of Birchbank, British Columbia, to 2760 $m^3/s$ (97,000 cfs) on 16 June 2010. Absent the dams the flow would have been 6,110 $m^3/s$ (216,000 cfs). This reflects a reduction in the peak river flow of approximately 3,350 $m^3/s$ (119,000 cfs). Flood stage at Kootenay Lake is 534.92 m (1755.0 ft) and the bankfull flow at Birchbank is estimated to be 6,372 $m^3/s$ (225,000 cfs).

## Power Benefits

From 1 August 2009 through 31 July 2010, the U.S. Entity delivered the Canadian Entitlement to downstream power benefits of 567.1 average megawatts (aMW), not including the reduction for transmission losses, at rates up to 1,352 MW during 1 August 2009 through 31 July 2009, and 535.7 aMW at rates up to 1,316 MW during 1 August 2010 through 30 September 2010.

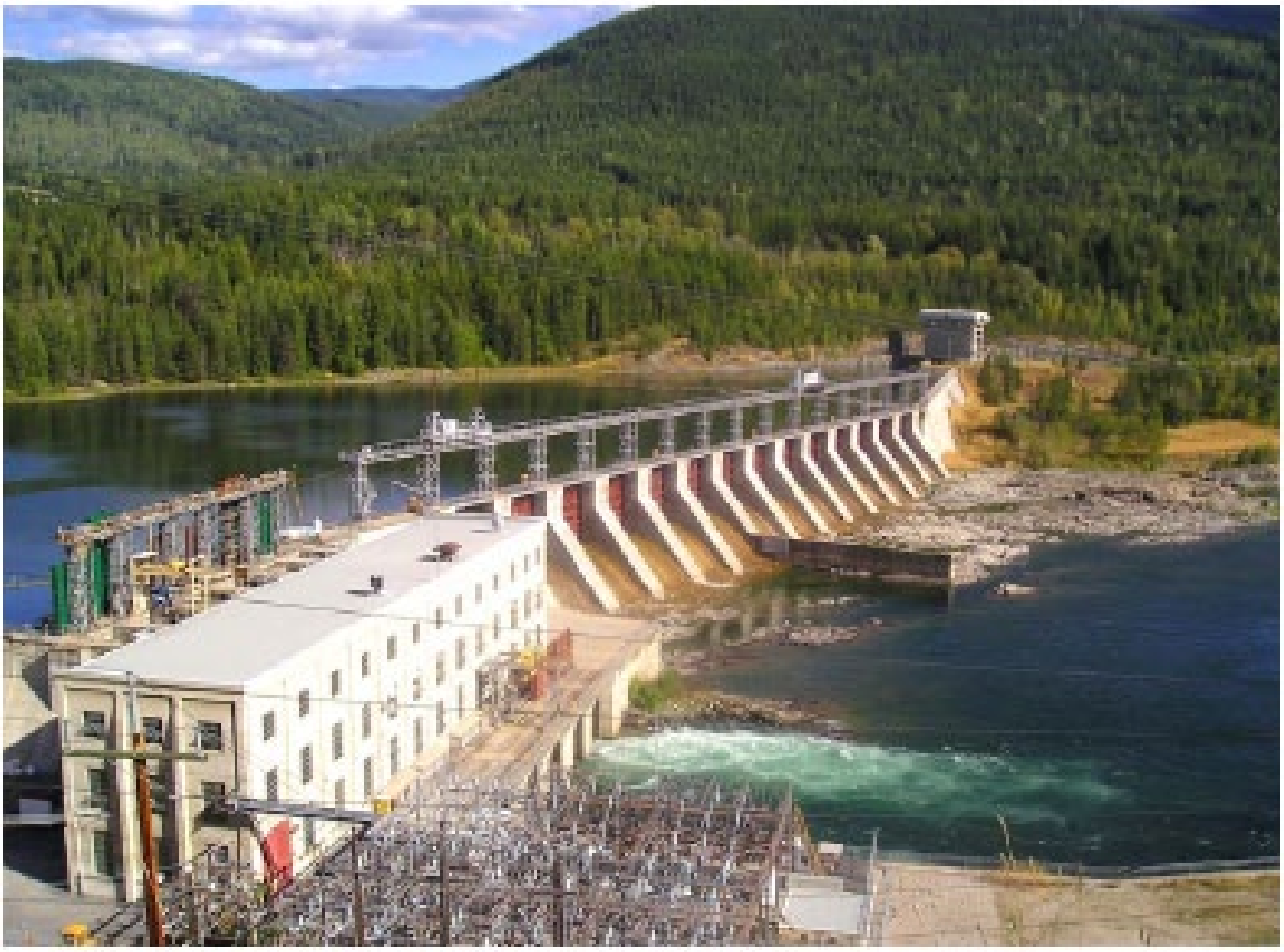
During the course of the operating year, several curtailments of Canadian Entitlement occurred. To ensure continuity of service, transmission maintenance was postponed until after the 2010 Winter Olympics and 2010 Para-Olympics held in British Columbia were completed. Curtailments included: 2 hours in November 2009 for 1,210 MWh; 1 hour in May 2010 for 17 MWh; 1 hour in June 2010 for 10 MWh, and; 15 hours in July 2010 for 3,074 MWh. All of the curtailed power was delivered later in the month of curtailment.

## Other Benefits

Reservoirs were regulated for seasonal non-power purposes by agreement between the Entities in the 2010 operating year. A Libby-Arrow Swap agreement was done in August 2009 to improve late summer recreation levels at Lake Koocanusa. A Fall Storage Agreement was implemented in October 2009 to store water into Arrow for winter releases to enhance power production and shape releases to benefit resident fish. The Non-power Uses Agreement was signed in December 2009 to protect mountain whitefish spawning in winter and enhance rainbow trout spawning protection below Arrow Dam in spring. The Non-power Uses Agreement also enabled the US to store 1 MAF of water in Mica to augment flows in the United States to aid salmon migration. A Summer Storage Agreement (not Treaty) was implemented in June 2010 providing late summer flow support for U.S. fisheries and enhancing Arrow Lake summer reservoir levels.

Columbia River, British Columbia

Revelstoke Dam, Columbia River, BC



Cora Linn Dam (FortisBC) at the outflow of Kootenay Lake, British Columbia

# CONCLUSIONS

1. The Duncan, Arrow, and Mica projects were operated in compliance with the Treaty during the period covered by this report. Operations reflected the DOPs developed by the Entities, the FCOP for Treaty reservoirs, and other agreements between the Entities. Treaty storage in the United States at the Libby project was operated by the U.S. Entity according to the 2003 FCOP, the 2000 LCA, U.S. requirements for power, and the guidelines set forth in the 2000 BiOp by the USFWS, the 2004 BiOp by the NMFS, and strict application of the eight-step VarQ operating procedures.

2. The Canadian entitlement to the downstream power benefits for the reporting period was determined, according to the procedures set out in the Treaty and Protocol. From 1 August 2009 through 31 July 2010, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 567.1 megawatts of average energy at rates up to 1,352 megawatts. From 1 August 2010 to 30 September 2010, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits was 535.7 megawatts of average energy at rates up to 1,316 megawatts. There were 19 hours of curtailments to Canadian Entitlement deliveries during the 2009-2010 operating year, but all of the curtailed power was delivered later within the same month.

3. The 2009–2010 operating year began on 1 August 2009 with the Canadian Treaty storage at 15.7 $km^3$ (12.7 Maf) or 82.0 percent full. Canadian Treaty storage drafted to a minimum of 3.9 $km^3$ (3.0 Maf) on 15 April 2010 and refilled to 15.9 $km^3$ (12.9 Maf) or 82.5 percent full on 31 July 2010. The 1 April 2010 water supply forecast for the Columbia River above The Dalles for January through July was 86.0 $km^3$ (69.7 Maf), or 65.0 percent of the 1971–2000 average. The actual January through July runoff at The Dalles was 104.5 $km^3$ (84.7 Maf), or 79.0 percent of average.

4. The 2008 BiOp concluded that the continued operation of the FCRPS is not likely to jeopardize the continued existence of endangered salmon and steelhead in the Columbia River basin. Numerous parties immediately challenged the BiOp upon release. In February 2010, Judge Redden ordered a voluntary three month remand of the 2008 BiOp for the purpose of incorporating the Adaptive Management Implementation Plan (AMIP) and its administrative record. This was accomplished with completion of the 2010 Supplemental BiOp in May. In September 2010, Judge Redden permitted plaintiffs to file supplemental complaints to the 2010 Supplemental BiOp. Plaintiffs filed a motion for summary judgment in October and the defendants filed their reply briefs in December. A hearing will likely occur in early 2011.

5. The Columbia River Treaty Hydrometeorological Committee (CRTHMC) continues to work on evaluating the sufficiency and adequacy of the existing hydro-met network capabilities to support Treaty operations. The committee has developed a Station Network Status Report identifying stations that have undergone changes between 2005 and 2010 (inclusive). However, this report does not address the overarching question about the sufficiency of the network. The committee is continuing to address the question of adequacy of the network.

6. The Board concludes that the objectives of the Treaty have been met for the reporting period.

Treaty Tower, Libby Dam, Libby Montana

Spillway, Mica Dam, Columbia River, BC

2010 Treaty Inspection Tour, Revelstoke Airport, BC (Mount Revelstoke is in the background)

# APPENDIX A

# COLUMBIA RIVER TREATY
# PERMANENT ENGINEERING BOARD

# COLUMBIA RIVER TREATY
# PERMANENT ENGINEERING BOARD

## United States

Members

Mr. Steven Stockton, P.E., Chair
Director
Civil Works
U.S. Army Corps of Engineers
Washington, DC

Mr. Ed Sienkiewicz
Consultant
Newberg, Oregon

Alternates

Mr. Robert A. Pietrowsky
Director
Institute for Water Resources
U.S. Army Corps of Engineers
Alexandria, Virginia

Mr. George Bell
Consultant
Lake Oswego, Oregon

Secretaries

Mr. Jerry W. Webb, P.E., D.WRE
Principal Hydrologic & Hydraulic Engineer
Engineering & Construction CoP
Directorate of Civil Works
U.S. Army Corps of Engineers
Washington, DC

## Canada

Mr. Jonathan Will, Chair Nominee
Director General
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

Mr. Tim Newton, P.Eng.
Consultant
Vancouver, British Columbia

Mr. Glen Davidson, P.Eng.
Comptroller of Water Rights
Water Management Division
B.C. Ministry of Natural Resource Operations
Victoria, British Columbia

Mr. Ivan Harvie, P.Eng.
Senior Engineer
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
Calgary, Alberta

Mr. Darcy Blais
Senior Policy Advisor
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

# COLUMBIA RIVER TREATY
# PERMANENT ENGINEERING BOARD

## RECORD OF MEMBERSHIP

### United States

Members

Mr. Wendell Johnson* 1964–1970
Mr. Morgan Dubrow 1964–1970
Mr. John Neuberger 1970–1973
Mr. Joseph Caldwell* 1971–1973
Mr. Homer Willis* 1973–1979
Mr. King Mallory 1973–1975
Mr. Raymond Peck, Jr. 1976–1977
Mr. Emerson Harper 1978–1988
Mr. Lloyd Duscha* 1979–1990
Mr. Ronald Wilkerson 1988–2005
Mr. Herbert Kennon* 1990–1994
Mr. John Elmore* 1994–1996
Mr. Steven Stockton* 1996–
Mr. Ed Sienkiewicz 2005–

Alternates

Mr. Fred Thrall 1964–1974
Mr. Emerson Harper 1964–1978
Mr. Alex Shwaiko 1974–1987
Mr. Herbert Kennon 1987–1990
Mr. Thomas Weaver 1979–1997
Mr. John Elmore 1990–1994
Mr. Paul Barber 1994–1995
Mr. Daniel Burns 1995–1997
Mr. George Bell 1997–
Mr. Earl Eiker 2000–2004
Mr. Robert Pietrowsky 2004–

Secretaries

Mr. John Roche 1965–1969
Mr. Verle Farrow 1969–1972
Mr. Walter Duncan 1972–1978
Mr. Shapur Zanganeh 1978–1995
Mr. Richard DiBuono 1995–2000
Mr. Robert Bank 2000–2004
Mr. Jerry Webb 2004–

### Canada

Mr. Gordon McNabb* 1964–1991
Mr. Arthur Paget 1964–1973
Mr. Valter Raudsepp 1973–1974
Mr. Ben Marr 1974–1987
Mr. Tom Johnson 1987–1988
Mr. Douglas Horswill 1989–1991
Mr. John Allan 1991–1999
Mr. David Oulton* 1991–1996
Mr. Daniel Whelan* 1996–2002
Mr. Charles Kang 1999–2001
Mr. Jack Ebbels 2001–2003
Mr. Tim Newton 2003–
Mr. Tom Wallace* 2004–

Mr. Mac Clark 1964–1992
Mr. Jim Rothwell 1964–1965
Mr. Hugh Hunt 1966–1988
Dr. Donald Kasianchuk 1988–1996
Mr. Vic Niemela 1992–1994
Mr. David Burpee 1994–2007
Mr. Jack Farrell 1996–1997
Mr. Prad Kharé 1997–1999
Mr. James Mattison 1999–2009
Mr. Ivan Harvie 2007–
Mr. Glen Davidson 2009–

Mr. Mac Clark 1964–1992
Mr. David Burpee 1992–2003
Ms. Eve Jasmin 2003–2007
Mr. Darcy Blais 2007–

*Chair

# COLUMBIA RIVER TREATY
# PERMANENT ENGINEERING BOARD
# ENGINEERING COMMITTEE

## CURRENT MEMBERSHIP

### United States

Members

Mr. Jerry W. Webb, P.E., D.WRE, Chair
Principal Hydrologic & Hydraulic Engineer
Engineering & Construction CoP
Directorate of Civil Works
U.S. Army Corps of Engineers
Washington, DC

Mr. Kamau Sadiki
Manager
National Hydropower Program Business Line
Operations Community of Practice
U.S. Army Corps of Engineers
Washington, DC

Mr. Michael Cowan, P.E.
Technical Services Manager
Corporate Services Office
Western Area Power Administration
Lakewood, Colorado

Mr. Patrick McGrane, P.E.
Manager
River and Reservoir Operations Group
Pacific Northwest Regional Office
Bureau of Reclamation
Boise, Idaho

### Canada

Mr. Ivan Harvie, P.Eng., Chair
Senior Engineer
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
Calgary, Alberta

Mr. Darcy Blais
Senior Policy Advisor
Renewable and Electrical Energy Division
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

Mr. KT Shum
Head, Licensing & Allocation
Water Management Division
B.C. Ministry of Natural Resource Operations
Victoria, British Columbia

# COLUMBIA RIVER TREATY
# PERMANENT ENGINEERING BOARD
# ENGINEERING COMMITTEE

## RECORD OF MEMBERSHIP

### United States

Members

Mr. Shapur Zanganeh* 1990-1995
Mr. Gary Fuqua 1990-1996
Mr. Earl Eiker 1990-2000
Mr. Steve Wright 1990-1996
Mr. Larry Eilts 1991-1995
Mr. Richard Mittelstadt 1991-1996
Mr. Richard DiBuono* 1995-2000
Mr. James Barton 1996-2001
Mr. Robert Johnson 1996-1998
Mr. James Fodrea 1997-2009
Mr. Michael Cowan 1998-
Mr. Robert Bank* 2000-2004
Mr. Kamau Sadiki 2001-
Mr. Jerry Webb* 2003-
Mr. Patrick McGrane 2009-

### Canada

Mr. Neill Lyons* 1990-1996
Mr. Dave McCauley 1990-1992
Mr. B. Stipdonk 1990-1991
Mr. Roger McLaughlin* 1991-2009
Mr. Robin Round 1991-1993
Mr. David Burpee* 1992-2000
Dr. Bala Balachandran 1993-2008
Mr. Bruno Gobeil 1995-1997
Mr. Larry Adamache 1996-2001
Ms. Myriam Boudreault 1997-2001
Ms. Donna Clarke 2001-2003
Mr. Ivan Harvie* 2002-
Ms. Eve Jasmin 2003-2007
Mr. Darcy Blais 2007-
Mr. KT Shum 2008-

*Chair

# APPENDIX B

# COLUMBIA RIVER TREATY ENTITIES

# COLUMBIA RIVER TREATY ENTITIES

## United States

Members

Mr. Steven J. Wright, Chair
Administrator and Chief Executive Officer
Bonneville Power Administration
Department of Energy
Portland, Oregon

BG John R. McMahon, Member
Division Engineer
U.S. Army Engineer Division
Northwestern
Portland, Oregon

Coordinators

Mr. Stephen R. Oliver, BPA Coordinator
Vice President
Generation Supply
Bonneville Power Administration
Department of Energy
Portland, Oregon

Mr. G. Witt Anderson, USACE Coordinator
Regional Director
Programs Directorate
U.S. Army Engineer Division
Northwestern
Portland, Oregon

Secretaries

Dr. Anthony G. White, Secretary
Public Utility Specialist
Regional Coordination
Bonneville Power Administration
Department of Energy
Portland, Oregon

## Canada

Mr. David Cobb, Chair
President and CEO
British Columbia Hydro and Power Authority
Vancouver, British Columbia

Mr. Christopher K. O'Riley, Deputy Chair
Executive Vice President
Engineering, Aboriginal Relations and Generation
British Columbia Hydro and Power Authority
Vancouver, British Columbia

Ms. Renata Kurschner, Coordinator
Director
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Mr. Douglas A. Robinson, Secretary
Specialist Engineer
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

# COLUMBIA RIVER TREATY ENTITIES OPERATING COMMITTEE

## CURRENT MEMBERSHIP

### United States

Members

Mr. Richard M. Pendergrass, Alternating Chair
Manager
Power and Operations Planning
Bonneville Power Administration
Department of Energy
Portland, Oregon

Mr. John M. Hyde, Member
Treaty Team Coordinator
Regional Coordination
Bonneville Power Administration
Department of Energy
Portland, Oregon

Mr. James D. Barton, Alternating Chair
Chief
Columbia Basin Water Management Division
U.S. Army Engineer Division
Northwestern
Portland, Oregon

Mr. Steven Barton, Member
Hydraulic Engineer
U.S. Army Engineer Division
Northwestern
Portland, Oregon

### Canada

Mr. Kelvin J. Ketchum, Chair
Manager
System Optimization
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Mr. Alaa Abdalla, Member
Manager, Reliability and Planning
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Ms. Gillian Kong, Member
Senior Engineer
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Mr. Herbert Louie, Member
Specialist Engineer
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

# COLUMBIA RIVER TREATY ENTITIES HYDROMETEOROLOGICAL COMMITTEE

## CURRENT MEMBERSHIP

### United States

Members

Ms. Ann McManamon, Co-chair
Hydrologist
Bonneville Power Administration
Department of Energy
Portland, Oregon

Mr. Peter F. Brooks, Co-chair
Chief
Hydrologic Engineering Branch
U.S. Army Engineer Division
Northwestern
Portland, Oregon

### Canada

Ms. Stephanie Smith, Chair
Senior Hydrologist
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Mr. Frank Weber, Member
Runoff Forecasting Team Lead
Hydrology and Technical Services
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, 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 2010

| Day | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.31 | 6.20 | 19.00 | 6.54 | 5.38 | 5.21 | 8.20 | 12.20 | 29.80 | 21.10 | 8.55 | 8.25 |
| 2 | 5.58 | 6.20 | 22.90 | 5.66 | 5.38 | 5.29 | 7.77 | 11.80 | 33.60 | 20.00 | 8.55 | 9.25 |
| 3 | 5.45 | 5.73 | 22.80 | 5.76 | 5.43 | 5.29 | 7.57 | 11.60 | 37.60 | 18.20 | 8.45 | 9.44 |
| 4 | 5.41 | 5.56 | 22.60 | 5.75 | 5.43 | 5.38 | 7.16 | 11.90 | 37.60 | 16.60 | 8.45 | 9.23 |
| 5 | 5.30 | 5.52 | 22.70 | 5.68 | 5.38 | 5.45 | 7.15 | 11.50 | 35.40 | 15.60 | 8.44 | 9.23 |
| 6 | 5.17 | 5.74 | 20.30 | 5.68 | 5.33 | 5.47 | 6.94 | 10.90 | 33.40 | 15.30 | 8.35 | 9.23 |
| 7 | 5.27 | 6.20 | 20.50 | 5.46 | 5.33 | 5.46 | 6.75 | 10.50 | 32.70 | 15.00 | 8.46 | 9.23 |
| 8 | 5.24 | 6.00 | 23.30 | 5.30 | 5.33 | 5.46 | 6.62 | 10.10 | 33.00 | 14.50 | 8.46 | 9.24 |
| 9 | 5.39 | 5.82 | 24.30 | 5.30 | 5.33 | 5.57 | 6.94 | 9.92 | 35.80 | 13.60 | 8.36 | 8.84 |
| 10 | 5.10 | 8.29 | 24.80 | 5.43 | 5.23 | 5.52 | 6.72 | 9.71 | 40.90 | 13.30 | 8.35 | 8.23 |
| 11 | 5.14 | 9.61 | 24.60 | 5.37 | 5.28 | 5.56 | 6.69 | 9.75 | 46.90 | 13.20 | 8.34 | 8.03 |
| 12 | 5.09 | 6.27 | 22.80 | 5.38 | 5.28 | 5.51 | 6.52 | 9.79 | 47.80 | 12.80 | 8.25 | 8.03 |
| 13 | 5.18 | 5.69 | 20.10 | 5.58 | 5.33 | 5.60 | 6.58 | 10.10 | 47.30 | 12.50 | 8.34 | 8.03 |
| 14 | 5.38 | 5.52 | 19.60 | 5.62 | 5.38 | 5.69 | 6.43 | 10.70 | 46.60 | 12.10 | 8.34 | 8.03 |
| 15 | 5.45 | 5.50 | 23.30 | 5.74 | 5.38 | 5.64 | 6.47 | 11.90 | 45.50 | 11.50 | 8.24 | 8.03 |
| 16 | 5.39 | 5.57 | 24.00 | 5.91 | 5.38 | 5.67 | 6.67 | 15.10 | 44.10 | 10.60 | 8.24 | 8.03 |
| 17 | 5.28 | 9.18 | 24.10 | 5.92 | 5.33 | 5.63 | 6.95 | 17.60 | 44.80 | 10.20 | 8.24 | 8.04 |
| 18 | 5.36 | 12.40 | 23.90 | 5.84 | 5.33 | 5.74 | 7.68 | 21.00 | 42.60 | 10.20 | 8.13 | 8.03 |
| 19 | 5.46 | 15.60 | 22.90 | 5.86 | 5.34 | 5.89 | 8.70 | 23.60 | 39.10 | 9.94 | 8.13 | 8.25 |
| 20 | 5.43 | 17.30 | 20.10 | 5.77 | 5.30 | 5.79 | 9.71 | 24.40 | 35.70 | 9.89 | 8.13 | 8.50 |
| 21 | 5.40 | 17.70 | 20.00 | 5.80 | 5.25 | 5.88 | 11.60 | 22.00 | 34.80 | 9.57 | 8.13 | 10.20 |
| 22 | 5.48 | 14.10 | 22.20 | 5.96 | 5.20 | 5.90 | 14.50 | 22.00 | 34.30 | 9.46 | 8.13 | 11.10 |
| 23 | 5.49 | 10.70 | 23.20 | 5.66 | 5.18 | 6.04 | 15.90 | 23.30 | 32.60 | 9.59 | 8.13 | 10.70 |
| 24 | 5.56 | 9.51 | 22.20 | 5.56 | 5.16 | 6.03 | 14.70 | 23.60 | 31.20 | 9.56 | 8.13 | 10.50 |
| 25 | 5.56 | 6.28 | 16.00 | 5.54 | 5.17 | 6.18 | 13.40 | 23.10 | 30.40 | 9.43 | 8.13 | 10.30 |
| 26 | 5.56 | 5.82 | 15.00 | 5.43 | 5.17 | 6.09 | 12.20 | 22.60 | 28.20 | 8.92 | 8.13 | 10.20 |
| 27 | 6.49 | 5.92 | 14.90 | 5.43 | 5.18 | 6.06 | 11.80 | 23.90 | 27.20 | 9.29 | 8.03 | 10.20 |
| 28 | 6.28 | 5.88 | 14.90 | 5.38 | 5.19 | 6.20 | 12.40 | 25.40 | 25.30 | 9.00 | 8.13 | 10.20 |
| 29 | 5.77 | 6.10 | 14.80 | 5.38 | | 6.78 | 12.50 | 25.70 | 24.00 | 8.86 | 8.13 | 10.20 |
| 30 | 5.67 | 10.20 | 13.80 | 5.38 | | 8.51 | 12.20 | 26.70 | 23.00 | 9.07 | 8.04 | 10.00 |
| 31 | 5.75 | | 9.49 | 5.43 | | 8.70 | | 28.40 | | 8.66 | 8.03 | |
| **Mean** | **5.50** | **7.94** | **20.49** | **5.63** | **4.79** | **5.91** | **8.88** | **17.12** | **34.88** | **12.18** | **8.26** | **8.86** |

# COLUMBIA RIVER AT BIRCHBANK, BRITISH COLUMBIA

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2010

| Day | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 57.53 | 40.18 | 65.42 | 70.32 | 41.43 | 39.58 | 33.61 | 50.77 | 78.85 | 88.49 | 66.82 | 53.02 |
| 2 | 56.01 | 40.17 | 66.38 | 68.15 | 41.52 | 39.64 | 33.77 | 50.31 | 83.03 | 85.73 | 66.87 | 53.01 |
| 3 | 53.70 | 40.27 | 68.19 | 65.69 | 41.21 | 39.48 | 32.51 | 49.27 | 82.36 | 82.77 | 67.19 | 50.99 |
| 4 | 53.75 | 40.15 | 69.92 | 65.87 | 41.55 | 39.73 | 30.90 | 49.69 | 83.06 | 84.68 | 66.38 | 48.89 |
| 5 | 53.73 | 40.09 | 73.61 | 66.46 | 42.28 | 40.70 | 30.97 | 49.07 | 81.52 | 92.85 | 66.34 | 48.93 |
| 6 | 53.69 | 41.20 | 77.22 | 66.23 | 42.68 | 45.24 | 30.93 | 48.80 | 82.15 | 96.99 | 63.49 | 48.88 |
| 7 | 48.61 | 49.15 | 82.83 | 66.26 | 42.71 | 45.46 | 31.01 | 43.41 | 82.92 | 95.01 | 60.83 | 48.22 |
| 8 | 44.04 | 53.35 | 87.40 | 66.29 | 42.54 | 45.39 | 30.63 | 43.35 | 84.72 | 93.62 | 60.76 | 46.96 |
| 9 | 44.02 | 53.38 | 87.19 | 66.38 | 42.07 | 45.47 | 30.03 | 44.05 | 86.65 | 90.85 | 60.71 | 46.92 |
| 10 | 41.10 | 53.49 | 89.10 | 65.84 | 41.93 | 45.47 | 30.00 | 43.89 | 85.38 | 90.92 | 61.14 | 46.99 |
| 11 | 38.01 | 53.43 | 86.90 | 65.08 | 42.00 | 45.65 | 29.80 | 43.42 | 87.70 | 90.52 | 62.63 | 46.88 |
| 12 | 38.01 | 53.66 | 87.81 | 58.25 | 41.85 | 46.06 | 29.10 | 43.80 | 91.92 | 88.39 | 62.19 | 46.90 |
| 13 | 37.91 | 53.51 | 90.45 | 52.58 | 41.87 | 46.01 | 28.67 | 43.88 | 95.02 | 88.32 | 62.40 | 46.94 |
| 14 | 38.08 | 53.18 | 88.92 | 50.65 | 41.81 | 45.72 | 28.57 | 44.49 | 96.50 | 86.63 | 62.46 | 47.03 |
| 15 | 38.07 | 53.02 | 88.79 | 48.26 | 42.86 | 46.16 | 28.63 | 46.87 | 97.49 | 86.01 | 61.92 | 46.80 |
| 16 | 38.03 | 53.13 | 82.79 | 48.22 | 42.67 | 46.37 | 28.77 | 49.49 | 96.02 | 85.62 | 60.84 | 47.01 |
| 17 | 35.66 | 53.70 | 79.84 | 48.22 | 42.14 | 46.50 | 28.87 | 54.49 | 96.17 | 84.28 | 60.92 | 51.27 |
| 18 | 33.23 | 55.40 | 78.15 | 48.00 | 42.13 | 46.72 | 29.45 | 64.81 | 95.26 | 84.57 | 60.91 | 56.10 |
| 19 | 33.16 | 55.23 | 78.84 | 46.65 | 41.95 | 46.70 | 31.66 | 66.94 | 95.79 | 80.02 | 60.87 | 56.20 |
| 20 | 33.18 | 55.18 | 79.73 | 46.51 | 41.93 | 46.69 | 34.19 | 66.91 | 96.27 | 75.64 | 56.89 | 56.15 |
| 21 | 33.14 | 57.29 | 79.44 | 45.97 | 41.93 | 46.66 | 39.23 | 66.35 | 95.49 | 73.80 | 53.38 | 55.95 |
| 22 | 33.29 | 59.14 | 83.32 | 45.29 | 42.01 | 47.47 | 41.82 | 67.12 | 93.41 | 70.72 | 53.51 | 56.04 |
| 23 | 33.66 | 59.05 | 82.08 | 44.92 | 41.94 | 47.46 | 42.55 | 67.64 | 92.73 | 70.83 | 53.28 | 56.08 |
| 24 | 33.35 | 59.65 | 79.76 | 45.13 | 42.07 | 47.42 | 42.69 | 68.39 | 91.33 | 70.99 | 53.15 | 55.05 |
| 25 | 33.29 | 59.95 | 79.37 | 45.16 | 42.02 | 47.37 | 42.59 | 68.50 | 90.74 | 70.67 | 53.29 | 54.09 |
| 26 | 33.46 | 59.57 | 75.74 | 43.76 | 41.91 | 47.32 | 42.84 | 69.73 | 89.67 | 72.83 | 53.07 | 54.19 |
| 27 | 33.28 | 60.23 | 72.43 | 42.94 | 41.90 | 47.03 | 43.60 | 71.53 | 88.01 | 72.10 | 52.97 | 54.31 |
| 28 | 33.34 | 62.61 | 74.85 | 42.94 | 40.84 | 47.34 | 44.30 | 71.81 | 87.03 | 70.77 | 53.01 | 54.01 |
| 29 | 33.39 | 63.68 | 75.80 | 42.95 | | 45.19 | 43.68 | 72.27 | 88.76 | 70.53 | 52.99 | 53.91 |
| 30 | 34.63 | 63.33 | 74.75 | 42.20 | | 38.50 | 47.61 | 74.38 | 89.56 | 69.24 | 53.17 | 57.91 |
| 31 | 40.21 | | 72.94 | 41.39 | | 34.28 | | 77.02 | | 68.19 | 52.96 | |
| **Mean** | **40.15** | **53.18** | **79.35** | **53.63** | **41.99** | **44.67** | **34.77** | **57.17** | **89.52** | **81.70** | **59.27** | **51.52** |

# APPENDIX D

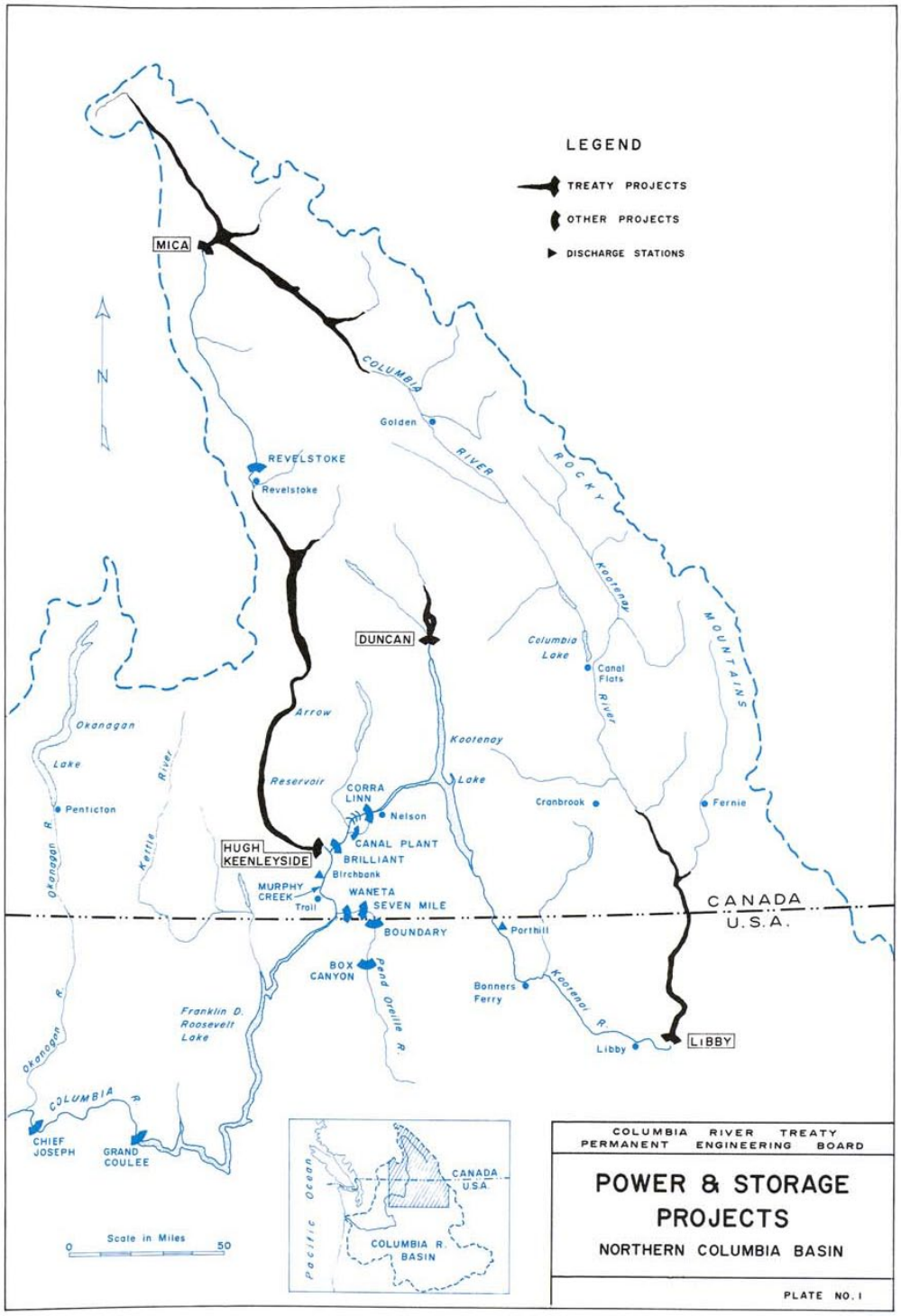
# PROJECT INFORMATION

## Power and Storage Projects

| | |
|---|---|
| Northern Columbia Basin | Plate No. 1 |

## Project Data

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




# 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 | 577 m (1892 ft.) |
| Normal minimum pool elevation | 547 m (1794.2 ft.) |
| Surface area at full pool | 7290 hectares (18 000 acres) |
| Total storage capacity | 1.77 $km^3$ (1.43 Maf) |
| Usable storage capacity | 1.73 $km^3$ (1.40 Maf) |
| Treaty storage commitment | 1.73 $km^3$ (1.40 Maf) |

## Dam, Earthfill

| | |
|---|---|
| Crest elevation | 581 m (1907 ft.) |
| Length | 792.5 m (2600 ft.) |
| Approximate height above riverbed | 39.6 m (130 ft.) |
| Spillway – Maximum capacity | 1350 $m^3$/sec (47.70 kcfs) |
| Discharge tunnels – Maximum capacity | 570 $m^3$/sec (20.0 kcfs) |

## 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 | 440 m (1444 ft.) |
| Normal minimum pool elevation | 420 m (1377.9 ft.) |
| Surface area at full pool | 52 650 hectares (130 000 acres) |
| Total storage capacity | 10.3 $km^3$ (8.34 Maf) |
| Usable storage capacity | 8.8 $km^3$ (7.10 Maf) |
| Treaty storage commitment | 8.8 $km^3$ (7.10 Maf) |

### Dam, Concrete Gravity and Earthfill

| | |
|---|---|
| Crest elevation | 445 m (1459 ft.) |
| Length | 869 m (2850 ft.) |
| Approximate height above riverbed | 52 m (170 ft.) |
| Spillway – Maximum capacity | 6700 $m^3$/sec (240 kcfs) |
| Low-level outlets – Maximum capacity | 3740 $m^3$/sec (132 kcfs) |

### Power Facilities

Currently installed:

| | |
|---|---|
| 2 units at 92.5 MW | 185 MW |
| Power commercially available | 2002 |
| Head at full pool (Gross maximum head) | 23.6 m (77 ft.) |
| Maximum turbine discharge | 1200 $m^3$/sec (42.40 kcfs) |

# 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 | 754.4 m (2475 ft.) |
| Normal minimum pool elevation | 707.1 m (2320 ft.) |
| Surface area at full pool | 42 930 hectares (106 000 acres) |
| Total storage capacity | 24.7 $km^3$ (20 Maf) |
| Usable storage capacity | 14.8 $km^3$ (12 Maf) |
| Treaty storage commitment | 8.6 $km^3$ (7 Maf) |

### Dam, Earthfill

| | |
|---|---|
| Crest elevation | 762.0 m (2500 ft.) |
| Length | 792.5 m (2600 ft.) |
| Approximate height above foundation | 244 m (800 ft.) |
| Spillway – Maximum capacity | 2250 $m^3$/sec (150 kcfs) |
| Outlet works – Maximum capacity | 1060 $m^3$/sec (37.40 kcfs) |

### Power Facilities

| | |
|---|---|
| Designed ultimate installation: | |
| 6 units at 450 MW | 2700 MW |
| Currently installed: | |
| 4 units at 451 MW | 1805 MW |
| Power commercially available | 1976 |
| Head at full pool | 183 m (600 ft.) |
| Maximum turbine discharge of 4 units at full pool | 1080 $m^3$/sec (38.14 kcfs) |
| Currently planned: | |
| 2 units at 500 MW | 1000 MW |

# 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 | 749.5 m (2459 ft.) |
| Normal minimum pool elevation | 697.0 m (2287 ft.) |
| Surface area at full pool | 18 830 hectares (46 500 acres) |
| Total storage capacity | 7.2 $km^3$ (5.87 Maf) |
| Usable storage capacity | 6.1 $km^3$ (4.98 Maf) |

### Dam, Concrete Gravity

| | |
|---|---|
| Deck elevation | 753.5 m (2472 ft.) |
| Length | 916.0 m (3055 ft.) |
| Approximate height above riverbed | 112.8 m (370 ft.) |
| Spillway – Maximum capacity | 4106 $m^3$/sec (145 kcfs) |
| Low-level outlets – Maximum capacity | 1730 $m^3$/sec (61 kcfs) |

### Power Facilities

| | |
|---|---|
| Designed ultimate installation: | |
| 8 units at 105 MW | 840 MW |
| Currently installed: | |
| 5 units at 120 MW | 600 MW |
| Power commercially available | 1975 |
| Head at full pool | 107.0 m (352 ft.) |
| Maximum turbine discharge of 5 units at full pool | 745.6 $m^3$/sec (26.50 kcfs) |