ANNUAL REPORT

to the

GOVERNMENTS

of

THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

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

30 September 2011

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COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

C A N A D A • U N I T E D S T A T E S

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

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

8 February 2012

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

The Honourable Joe Oliver
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Clinton and Minister Oliver:

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-seventh Annual Report of the Permanent Engineering Board, dated 30 September 2011. The report documents the results achieved under the Treaty for the period from 1 October 2010 to 30 September 2011.

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

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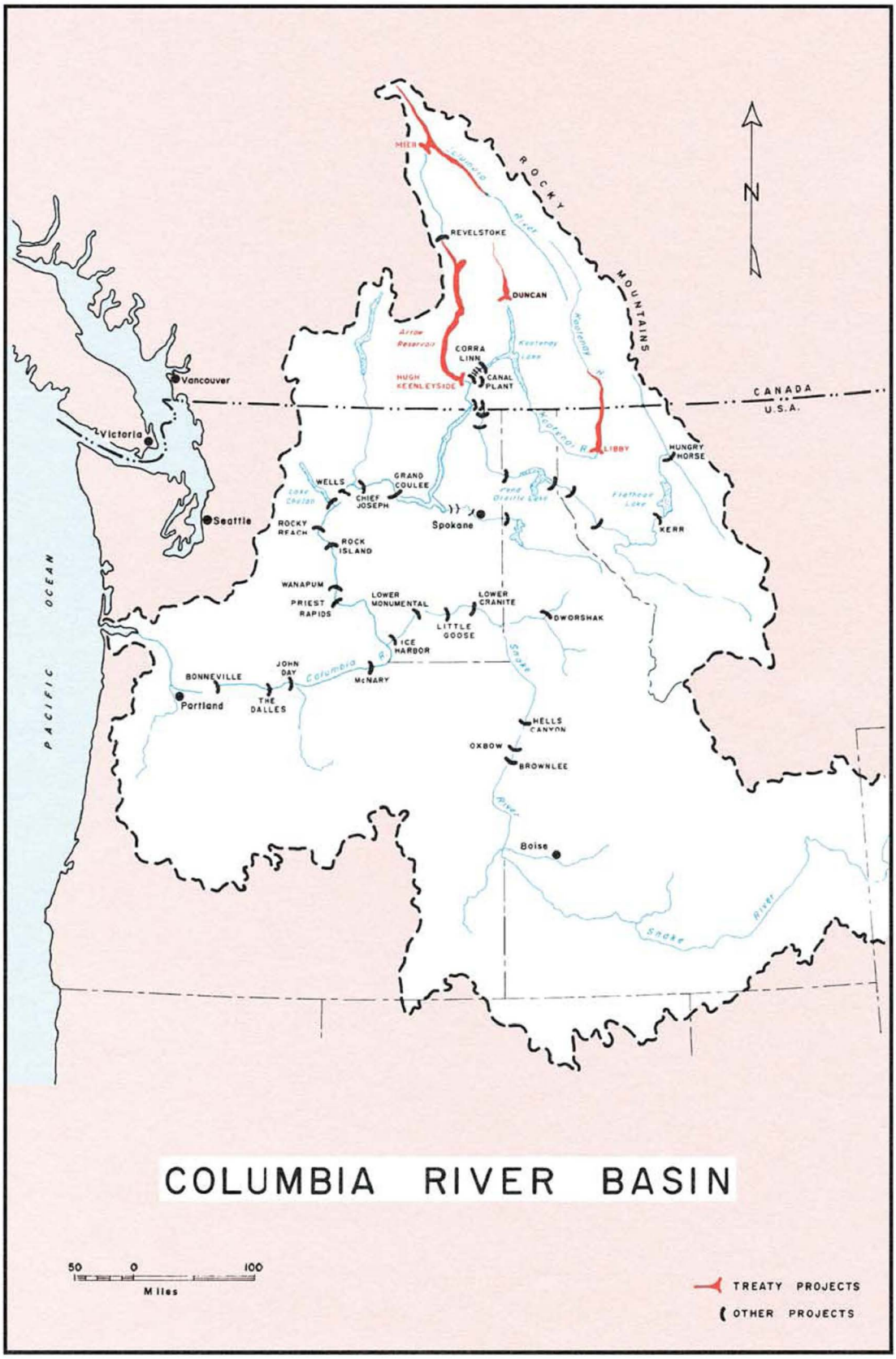
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ROCKY
MOUNTAINS
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REVELSTOKE
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COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

Washington, D.C. Ottawa, Ontario

30 September 2011

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EXECUTIVE SUMMARY

The forty-seventh 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 2010 to 30 September 2011.

During the reporting period, the Canadian Treaty projects – Mica, Duncan, and Arrow – were operated according to the 2010-2011 and 2011-2012 Detailed Operating Plans (DOPs), 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 Libby Coordination Agreement (LCA) dated February 2000, including the 13 January 2010 and 12 October 2010 updates to the Libby Operating Plan (LOP), U.S. requirements for power and guidelines set forth in the U.S. Fish and Wildlife Service (USFWS) 2006 Biological Opinion, and the U.S. National Marine Fisheries Service (NMFS) Biological opinions and Action Agency Plans, as approved by Court order. 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 2010 through 31 July 2011, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits, before deducting transmission losses, was 535.7 megawatts of average energy at rates up to 1,316 megawatts. From 1 August 2011 to 30 September 2011, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits before deducting transmission losses was 525.9 megawatts of average energy at rates up to 1,314 megawatts. The Canadian Entitlement obligation was determined by the 2010-2011 and 2011-2012 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 DOPs, Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024, dated 29 March 1999 and supplemental Entitlement-related agreements. During the course of the Operating Year, there were two curtailment periods to Canadian Entitlement deliveries, primarily due to a combination of planned maintenance and unexpected weather/load-resource conditions. These included a total of 1,793 MWh over two days in September 2010 and 6 MWh in one hour in November 2010. All of the curtailed power was delivered later within the same month of curtailment as agreed.

Canadian Treaty storage began the operating year on 1 August 2010 at 82.9 percent full, and ended the year on 31 July 2011 at 99.2 percent full. The actual runoff for the overall Columbia basin (U.S. and Canada combined) measured at The Dalles for January through July 2011 was 132% of normal. The operating year 2010-2011 was unique in that, after a relatively uneventful winter, near record precipitation and cold temperatures resulted in very high runoff and a very active flood control season.

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. A hydrometeorological station network status report was completed in February 2011. For real time operations, CRTHMC revised an objective decision-support procedure developed in 2007 to predict the start of spring freshet. The procedure has assisted the Kootenay Lake Board of Control in its determination over the past few years. The Committee also reviewed a statistical forecast model for Libby basin water supply and the new procedure was used starting December 2010. The CRTHC is working with the National Weather Service River Forecast Center (NWRFC) to update forecast procedures for use in Treaty operations planning. CRTHMC is coordinating proposed improvements to the snow monitoring network involving conversion of existing snow courses to automated snow pillow sites to enhance the real-time monitoring of snow accumulations in the region.

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 U.S. Entity continued work on the CRT 2014/2024 Review studies. The U.S. CRT 2014/2024 Review Team (Review Team) completed and published the U.S. Entity Supplemental Report in September 2010, a companion report to the CRT 2014/2024 Phase 1 Report. The Supplemental Report summarizes the additional studies conducted by the U.S. Entity in which Endangered Species Act (ESA) BiOps and other fish operations were added to the Phase 1 studies to represent how actual system operations may be affected by the various Phase 1 scenarios. As part of the second phase of the CRT 2014/2024 Review, USACE conducted the Flood Risk Assessment required for the Phase 2 modeling, which included floodplain mapping and surveying, levee assessment, and economic surveying. In addition, USACE continued to work on developing the modeling tools and capabilities to evaluate future Phase 2 studies using a risk-based probabilistic approach. These studies, together with other work and public consultation, will help inform decision makers on matters affecting the future of the Treaty.

Litigation continued in 2011 with respect to salmonids in the Columbia River system (and not directly associated with the Treaty). NOAA's National Marine Fisheries Service concluded in their 2008/2010 Biological Opinion (BiOp) that the operation of the Federal Columbia River Power System (FCRPS) is not likely to jeopardize the continued existence of salmon and steelhead in the Columbia River basin. In October 2010, several environmental groups, the State of Oregon, and the Nez Perce Tribe challenged the 2008/2010 FCRPS BiOp. In August 2011, Judge Redden sent the 2008/2010 BiOp back to NOAA Fisheries after concluding that the BiOp needed further work on the non-specific mitigation actions (mostly related to fish habitat). The Judge further concluded that the existing 2008/2010 FCRPS BiOp was adequate under the Endangered Species Act and directed that the BiOp remain in place through 2013. He also ordered that the government continue to fund and implement all of the mitigation measures in the BiOp through December 31, 2013. The court ordered a new biological opinion be issued by January 1, 2014. Annual progress reports must be filed with the Court. Finally, the Corps of Engineers shall conduct spring and summer spill operations in a manner consistent with the court's annual spill orders, and provide monthly implementation reports.

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 41

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 42
B: Columbia River Treaty Entities 47
C: Record of Flows at the International Boundary 51
D: Project Information 54

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 2010 through 30 September 2011, 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.

Hugh Keenleyside Dam (Arrow Lakes) – Columbia River, British Columbia
Concrete spillway and discharge works with navigation locks and earthfill dam.
The new 185-MW power plant is on the north abutment (right-hand side).

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 78th meeting on 9 February 2011 in Vancouver, BC. In conjunction with this meeting, the Board also held its 59th joint meeting with the Entities.

The following topics were discussed at the meeting: the 2010 and 2011 DOP and supplemental operating agreements; Libby VarQ and 2010 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 for AOP16 and AOP17; prospects for a non-treaty storage agreement; Kootenay Lake IJC Board of Control activities; update on Hydrometeorological Committee activities; release of 2010 Supplemental 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 Operating Committee Agreement on Operation of Treaty Storage for Non-power Uses from 11 December 2010 through 31 July 2011, signed 30 November 2010.

  This agreement is similar to previous agreements implemented to utilize Treaty storage for non-power uses. These uses include the following: (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; (4) providing a minimum discharge objective at Arrow during January through March 2011 for the purpose of protecting eggs deposited on the streambed by Mountain Whitefish during December 2010 through January 2011; (5) improving the U.S. capability to meet flow objectives for salmon at Vernita Bar below Priest Rapids Dam during the period of December 2010 through early May 2011. This agreement supplements the 2010–2011 Detailed Operating Plan (DOP).

- Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2015-2016, dated 20, September 2011

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2015 through 31 July 2016.

- Detailed Operating Plan for Columbia River Storage for 1 August 2011 through 31 July 2012, dated 21 June 2011

  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 2011 through 31 July 2012.

- Annual Report of the Columbia River Treaty, Canadian and United States Entities, for the period 1 August 2010 through 30 September 2011.

  This report summarizes the operation of Treaty projects and other activities of the Entities for the period 1 August 2010 through 30 September 2011.

Report to the Governments

The forty-sixth Annual Report of the Board, dated 30 September 2010, was submitted to the governments of Canada and the United States.

Duncan Dam – Duncan River, British Columbia
The earthfill dam with discharge tunnels to the left and spillway to the right.

TREATY IMPLEMENTATION

General

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

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 four turbines at Mica Dam by 1977, and completion of the Revelstoke dam in 1984 (and a fifth turbine in December 2010), and installation of two turbines adjacent to the Keenleyside Dam in Arrow Lakes in 2002, have resulted in 5053 MW of generation capacity in British Columbia that might not have been installed without the Treaty. Two additional generating units are being installed at Mica Dam. An addition unit at Revelstoke dam is also planned.

The Treaty provides Canada with an option to divert the Kootenay River at Canal Flats into the headwater of the Columbia River starting 1984. BC Hydro undertook engineering feasibility and environmental studies but no further work has been done recently.

Further to the expiration of the Sales Agreements 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 to begin operation by 1 April 1968. It was the first of the Treaty projects to be completed and became fully operational on 31 July 1967, well in advance of Treaty requirement. The Sales Agreement for Duncan expired 31 March 1998.

The earthfill dam is situated 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.

The project is shown on page 13, 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 the starting date of 1 April 1969 for the 30-year Sales Agreement.

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 (owned by Columbia Basin Trust and Columbia Power Corporation, which are Crown Corporations in British Columbia), 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 Lakes 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 the total gas pressure in the releases 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 dam is located on the Columbia River 137 km (85 mi) north of the town of Revelstoke in 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 was designed for six generating units. Four generators have been installed with a total capacity of 1805 MW. Installations of the two remaining generating units, each with a capacity of 500 MW, are scheduled for completion by 2015.

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 planning 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.

The Committee's 2010 Annual Report was completed in January 2011 and its 2011 Annual Report is scheduled for completion in early 2012. A hydrometeorological station network status report was completed in February 2011. The Committee continues to review the adequacy of the existing hydro-met network capabilities to support Treaty operations.

Two of the monitoring stations are currently not staffed and, in the interim, data used in forecast is based on NOAA National Weather Service estimates until new observers are appointed. BPA identified five locations in the Mica/Revelstoke area for automated snow pillow stations to enhance the real-time monitoring of snow accumulation. BPA and BC Hydro are working to install the stations as early as summer 2012.

Data management systems have been changed at BC Hydro (to WISKI) and at USACE (to a new Regional Water Control Data System). The Committee is also working to resolve a Treaty accounting issue caused by changes from daylight savings time.

For real time operations, CRTHMC revised an objective decision-support procedure developed in 2007 to predict the start of spring rise. The procedure has assisted the Kootenay Lake Board of Control in its determination over the past few years. The Committee also reviewed a statistical forecast model for Libby basin water supply and the new procedure is used starting December 2010.
The Northwest River Forecast Center changed its official forecast procedures in the 2012 water year to use ensemble stream flow prediction, replacing previous statistical and single-trace procedures. Forecasts are now made more frequently. CRTHMC will identify which ones of the forecasts are to be used for Treaty operation planning.

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) for the three Treaty projects in Canada is prepared. This plan accounts for projected resources and demands to determine operations that are more advantageous to both countries than those in accordance with the AOP. To supplement the DOP, the Entities may enter into agreements throughout the year regarding the operation 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 since then. Details on Libby operations are discussed further below.

During the reporting year, operation of Treaty storage in Canada was regulated under the rule curves set out in the Entities' *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2010 through 31 July 2011*, signed on 29 June 2010, and the *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2011 through 31 July 2012*, signed on June 21, 2011, 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 in the 2000-2001 operating year. Information on Libby operations is provided separately in the Libby Operating Plan prepared by the U.S. Entity. Operation at Libby takes 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 99.94 percent of the time. Three curtailments occurred in September and November 2010 totaling 5 hours and 1799 MWh.

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 September of 2010. The line is currently 60 percent complete and under further regulatory review - with the commercial operation date uncertain. Involvement of the U.S. government is primarily through the Western Area Power Administration (WAPA), which committed $161 million in stimulus loan funds to encourage the project.

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.

TransCanada started work on Northern Lights in 2000. Initially, Northern Lights 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 Northern Lights on hold pending clarity on the provincial intertie strategy and market condition improvements (generation development, wind load balancing and load requirements).

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.

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 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 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, and both the BC Hydro and BPA NTSA accounts were completely refilled in January 2011. Negotiations between respective US and Canadian stakeholders on a new long-term NTSA is near completion and could be in place by spring 2012.

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.

Mica Dam and Lake Kinbasket – Columbia River, British Columbia
The spillway is on the right of the earthfill dam, and the underground powerhouse on the left.

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 2010 to 30 September 2011, Treaty operations are based on the Treaty operating year of 1 August 2010 to 31 July 2011. Additional information for 1 August 2011 to 30 September 2011 is based on the Treaty operating year 1 August 2011 to 31 July 2012.

Treaty storage in Canada was operated by the Canadian Entity in accordance with the documents listed below. The Libby project was operated by the U.S. Entity according to the 2003 FCOP, the 2000 LCA, including the 13 January 2010 and 12 October 2010 updates to the Libby Operating Plan (LOP), U.S. requirements for power, guidelines set forth in the U.S. Fish and Wildlife Service (USFWS) 2008 Biological Opinion, and the U.S. National Marine Fisheries Service (NMFS) Biological Opinions and Action Agency Plans, as approved by Court order, 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 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.

- *Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2011–2012*, dated March 2007

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2011 through 31 July 2012.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2011 through 31 July 2012*, dated June 2011

  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 2011 through 31 July 2012.

- *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 Entity Agreement on the 2010-11 Storage Agreement (Not Treaty)*, signed 12 November 2010.

  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 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.

System Storage

The 2010–2011 operating year began on 1 August 2010 with the Canadian Treaty storage at 15.9 km3 (12.9 Maf) or 82.9 percent full. Canadian Treaty storage drafted to a minimum of 2.1 km3 (1.7 Maf) on 15 April 2011 and refilled to 18.9 km3 (15.3 Maf) or 99.2 percent full on 31 July 2011. Throughout the operating year, composite Canadian Treaty storage was very close to the TSR study composite storage plus any operations implemented under the Supplement Operating Agreements (DOAs) or the LCA, except for some amounts of inadvertent draft or storage in all periods. Inadvertent draft or storage occurs routinely due to updated forecasts or differences between forecast and actual inflows. Canadian storage began the operating year on the DOP levels determined in the TSR study. It remained near the forecasted TSR levels through August. There were some departures from TSR levels due to additional drafts in September and November 2010. Canadian storage was inadvertently drafted below the DOP TSR in September 2010 due to an increase in rainfall late in the month, resulting in record high inflows into Canadian storage. This rain event caused a substantial increase in the TSR-specified storage content after the final TSR study was run with actual updated inflows, and after the actual operation had been completed. The inadvertent draft below TSR in November was mainly due to changes in the TSR composite Treaty storage content target throughout the month, as driven by changing inflow forecasts.

During November and December 2010, the Canadian Entity exercised the option to provisionally draft Arrow under the LCA. This 137 cubic hectometer (hm3 (111 kaf)) provisional draft was returned (stored back) by early February. There was only one LCA cycle implemented this year, as compared to the two cycles provided for, due primarily to unfavorable market conditions.

For January until the end of June 2011, Canadian storage remained above the TSR-specified levels. This was primarily due to the Non-Power Uses operating agreement that was implemented to achieve mutual benefits for the U.S. and Canada. Under provisions of that agreement, the U.S. Entity stored 1233 hm3 (1 Maf) of flow augmentation water. At the time this was stored, the water supply forecast was slightly less than average. This operation helped to reduce flows downstream of Hugh Keenleyside Dam for Canadian whitefish operation. The flow augmentation water was subsequently released across 15 April through July 2011 to remain below the flood control maximum levels in May through June, meet U.S. salmon flow objectives and manage rapidly increasing stream flow forecasts.

The spring water supply forecasts at The Dalles increased as the water year developed, from 109 Maf (January-July) in March to 141 Maf in June. For July through 15 August 2011, Canadian storage was drafted below TSR levels primarily due to differences between forecast and actual inflows, and also due to the operation of the non-power agreement to smooth Arrow Treaty flows through August.

The 1 January 2011 water supply forecast for the Columbia River above The Dalles for January through July was 128.3 km3 (104.0 Maf), or 96.9 percent of the 1971–2000 average. The spring water supply forecasts at the Dalles increased as the water year developed. By the 1 June 2011 forecast, the runoff prediction increased to 173.9 km3 (141.0 Maf), and the actual January through July runoff for the Columbia River above The Dalles was 169.0 km3 (137.0 Maf), or 127.7 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 2010 to 30 September 2011. 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 753.50 m (2472.1 ft), 0.88 m (2.9 ft) below full pool on 13 October 2010 due to a rainfall event in late September resulting in a record high inflow. The reservoir was drawn down during the fall and winter to meet electrical demands and to prepare for above normal spring runoff. It reached a minimum this year of 725.0 m (2378.6 ft) on 6 May 2011, comparable to the 2010 minimum level.

From early May through early July, Mica generation was reduced to near minimum required for fish flush and as is normal in response to lower electrical demands in the summer and must-run generation elsewhere in the system. Due to above normal snowpack in the Columbia basin, generation was increased across July/August to meet market opportunities as well as for reservoir control to minimize spill risks. Due to high freshet inflows, B.C. Hydro sought and received permission from the Comptroller of Water Rights in August to surcharge the reservoir by 0.3 m (1 ft) up to 2476 ft on an interim basis for power and flood control purposes. The option to surcharge the reservoir will help minimize spill probabilities and amounts. In response to a rain event in late September/early October, the reservoir continued to fill to reach a peak level of 754.17 m (2474.3 ft) on 3 October 2011. The last time the reservoir filled to near full was in 2007.

Arrow Reservoir

The Arrow Lakes Reservoir reached a maximum elevation of 439.3 m (1441.3 ft), or 0.82 m (2.7 ft) below full pool on 5 July 2010. Canadian projects operated in proportional draft mode from late summer to early December to meet Treaty firm loads while balancing the need to refill Mica, Arrow Lakes and Duncan Reservoirs by July/August. Even in proportional draft, Arrow Lakes Reservoir remained relatively high primarily due to Treaty flex operations (Mica releases) and the complete refilling of the storage space managed under the July 1990 Non-Treaty Storage Agreement (NTSA). Arrow Lakes Reservoir reached a minimum level of 430.59 m (1412.7 feet) on 10 April 2011. By comparison, the Arrow Lakes Reservoir reached a minimum level of 429.00 m (1407.5 ft) on 14 January 2010. As basin inflows increased from snowmelt runoff during May through early July, the reservoir filled quite rapidly up to its Treaty flood control level (upper rule curve) to reach a maximum level of 439.6 m (1442.1 ft), or 0.58 m (1.9 ft) below full pool on 28 July 2011. The last time the reservoir filled to within 1 ft of full was on 6 July 2008. Arrow Reservoir then drafted across the summer months reaching 438.09 m, 436.84 m (1437.3 ft, 1433.2 ft) by 31 August and 30 September 2011, respectively.

Duncan Reservoir

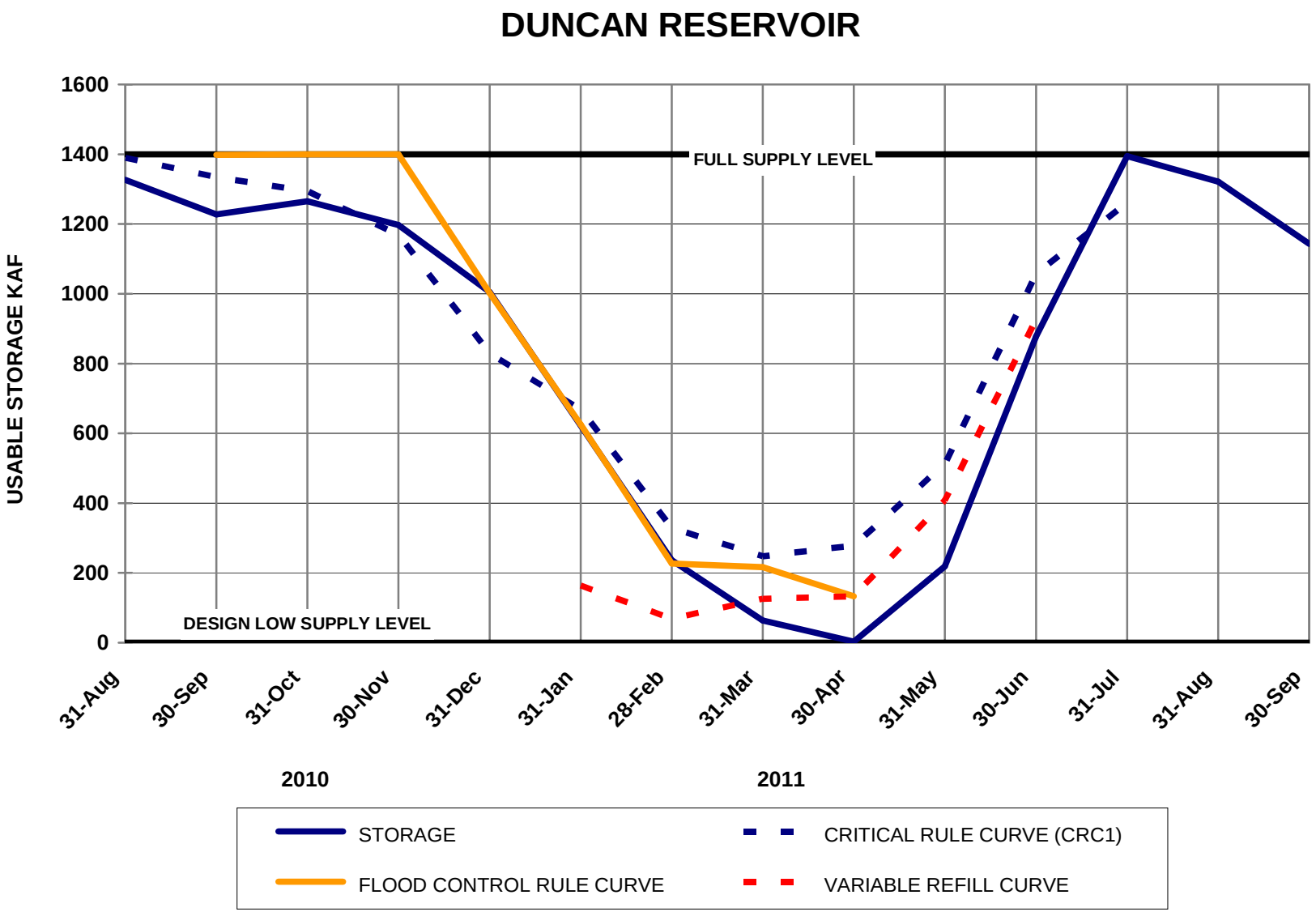
Duncan Reservoir refilled to 576.04 m (1889.9 ft) or 0.64 m (2.1 ft) below full on 12 August 2010. From September 2010 through April 2011, Duncan was operated to supplement inflow into Kootenay Lake to provide spawning and incubation flows for fish and to meet Treaty flood control requirements. As in most years, the reservoir was drafted to near empty in late April or early May. Duncan Reservoir reached its licensed minimum level for the year of 546.9 m (1794.2 ft) on 1 May 2011. By comparison, in 2010, the reservoir reached a minimum elevation of 547.1 m (1797.31 ft) on 18 April 2010. Reservoir discharge was reduced to a minimum of 3.0 m^3/s (0.1 kcfs) in early June to initiate reservoir refill. In response to a significant local rainstorm in late July/early August, B.C. Hydro applied and received permission from the Comptroller of Water Rights to store 0.30 m (1 ft) above the maximum elevation in August up to 576.99 m (1893 ft). Duncan Reservoir reached a maximum level of 576.71 m (1892.2 ft) or 0.03 m (0.1 ft) above full on 1 August 2011 and Duncan discharges peaked at 16.8 kcfs (475 m^3/s) measured at Duncan River below the Lardeau confluence (DRL) gauging station on 5 August 2011. As inflows subsided, Duncan discharges were adjusted as needed across August through to 5 September (Labor Day) to target a reservoir elevation of ~574.9 ± 0.3 m (~1886 ± 1 ft) for the Spillway Operating Gate (SPOG) rehabilitation work starting mid October. For the balance of September, project flows were increased to facilitate drafting of the reservoir to reach an elevation of 572.14 m (1877.1 ft) on 30 September 2011.

Libby Reservoir

The Libby (Koocanusa) Reservoir filled to a maximum elevation of 744.6 m (2442.9 ft) on 17 August 2010, 4.9 m (16.1ft) from full pool. The reservoir drafted through the fall and winter period. By 31 December 2010, the reservoir was at elevation 735.2 m (2412.0 ft) and operated during the winter to the VARQ storage reservation diagram. The winter period was characterized by above average snow build-up and a continuously rising water supply forecast (WSF). Lake Koocanusa was drafted to an end of April elevation of 716.3 m (2349.9 ft.), 2.8 m (9.3 ft.) below the flood control target. The reservoir drafted to its lowest elevation of 712.5 m (2337.7 ft) on 12 May 2011. Outflow was adjusted pursuant to VARQ rules well above the minimum VARQ flow of 343 m^3/s (12.1 kcfs), due to the high seasonal runoff volume forecast. Libby Dam provided 1.48 km^3 (1.2 Maf) of storage for sturgeon releases and released the storage accumulated by 11 July 2011. The reservoir filled to a maximum elevation of 747.8 m (2453.4 ft) on 04 August 2011, 1.7 m (5.6 ft) from full pool and drafted to elevation 746.1 m (2447.7 ft) by 31 August 2011, and to elevation 745.8 m (2446.8 ft) by 30 September 2011.

Flood Control Operations

Columbia River Basin projects were operated according to the May 2003 Flood Control Operating Plans. The 2010 water supply forecasts averaged above normal across the Columbia River Basin, Upper Columbia Basin, and the Snake River Basin. The regulated peak flow at The Dalles, Oregon, was 14 113 m^3/s (498.4 kcfs) on 4 June 2011, and the unregulated flow was estimated at 21 767 m^3/s (768.7 kcfs) on 15 June 2011. The peak stage observed at Vancouver, Washington, was 5.30 m (17.37 ft.) on 1 June 2011, and the estimated unregulated stage was 7.77 m (25.5 ft.) on 16 June 2011.


DUNCAN RESERVOIR
USABLE STORAGE KAF
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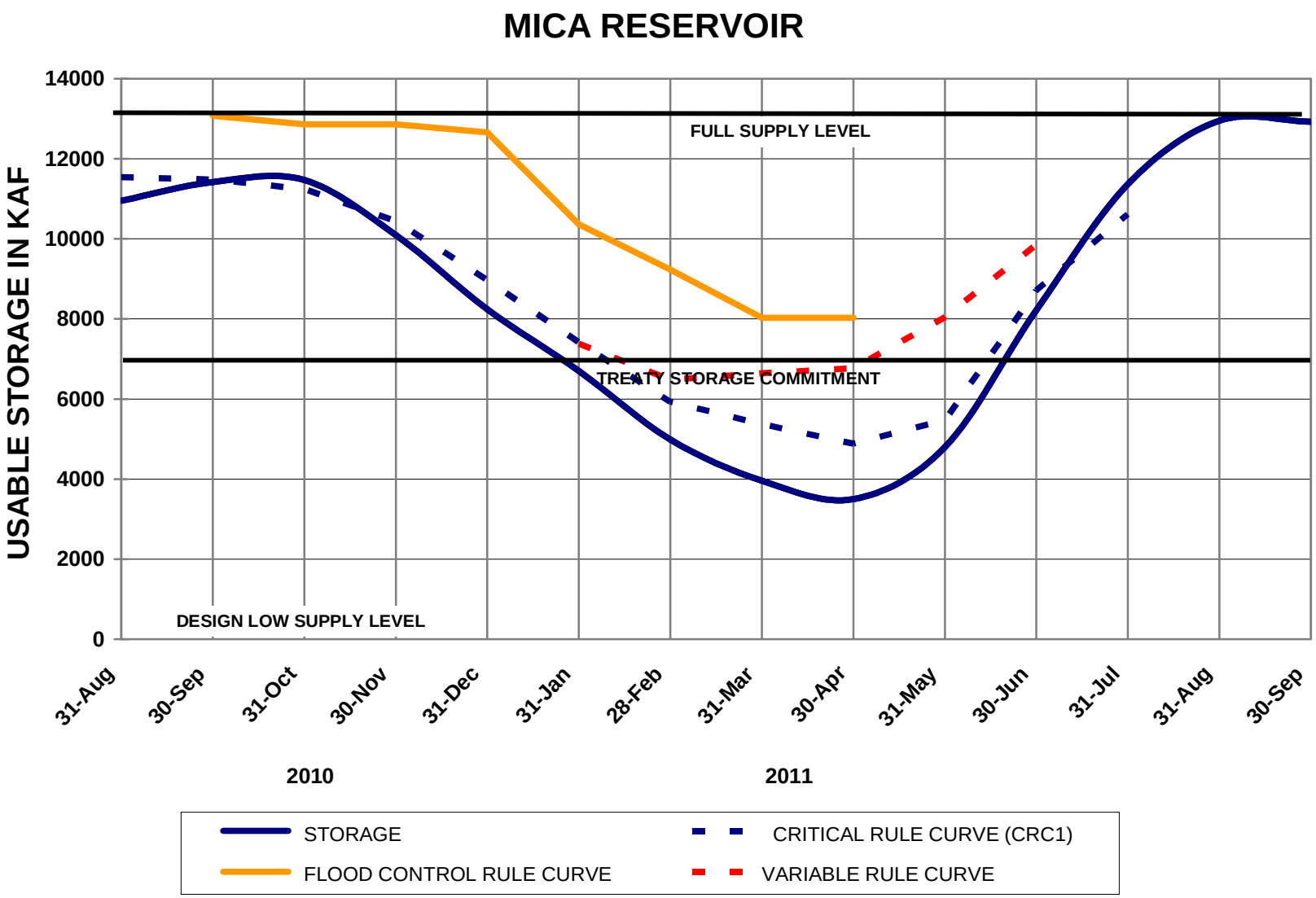
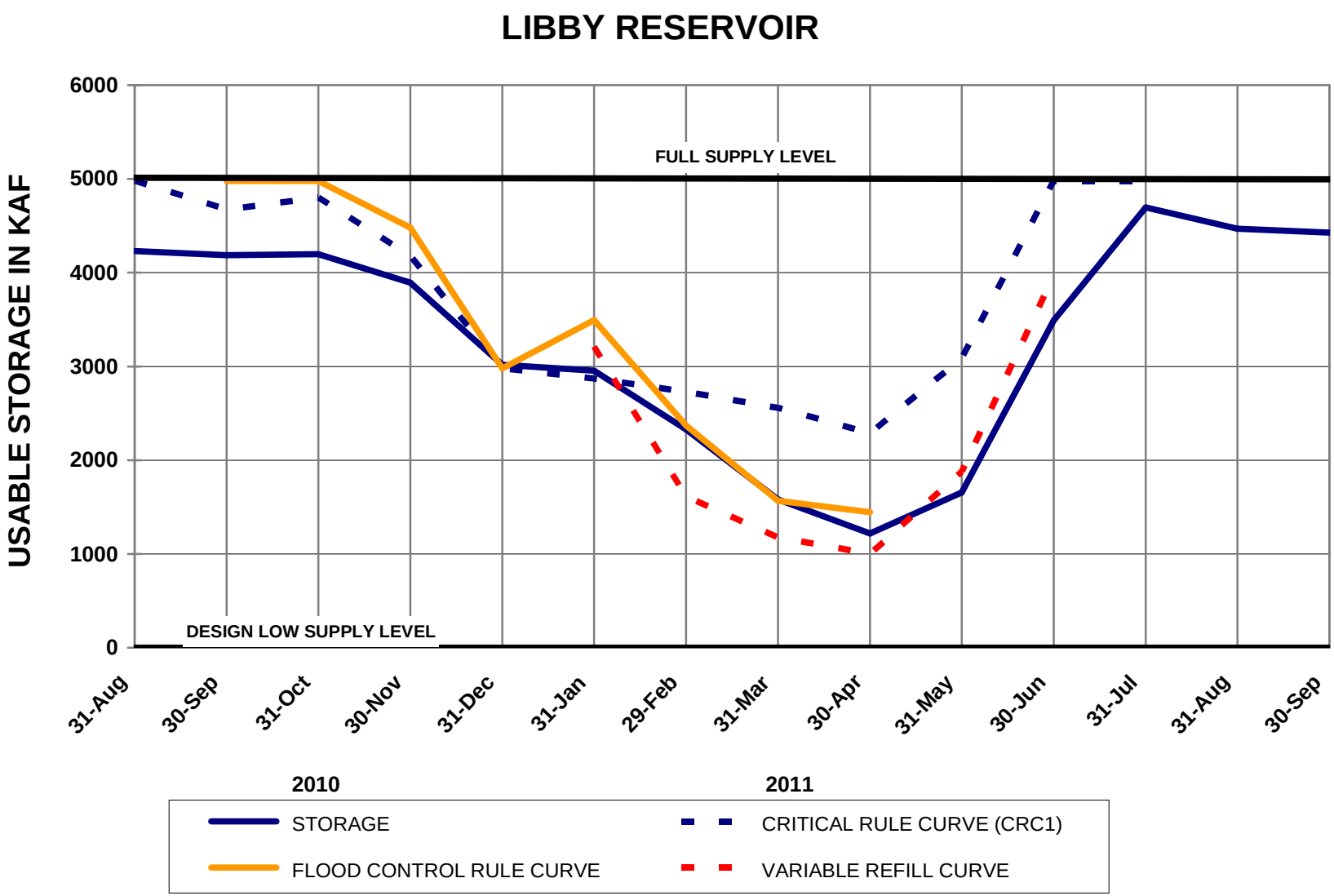
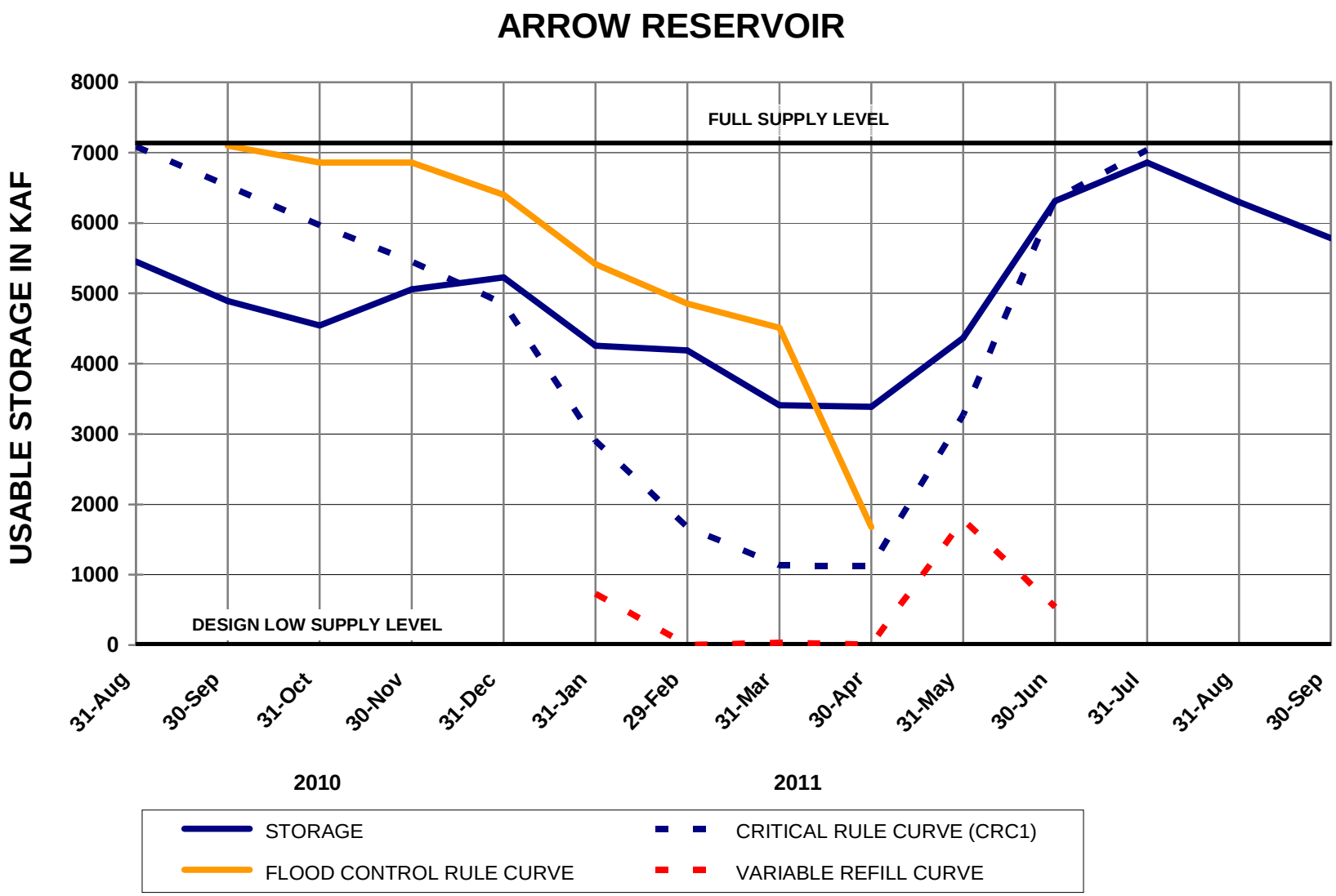
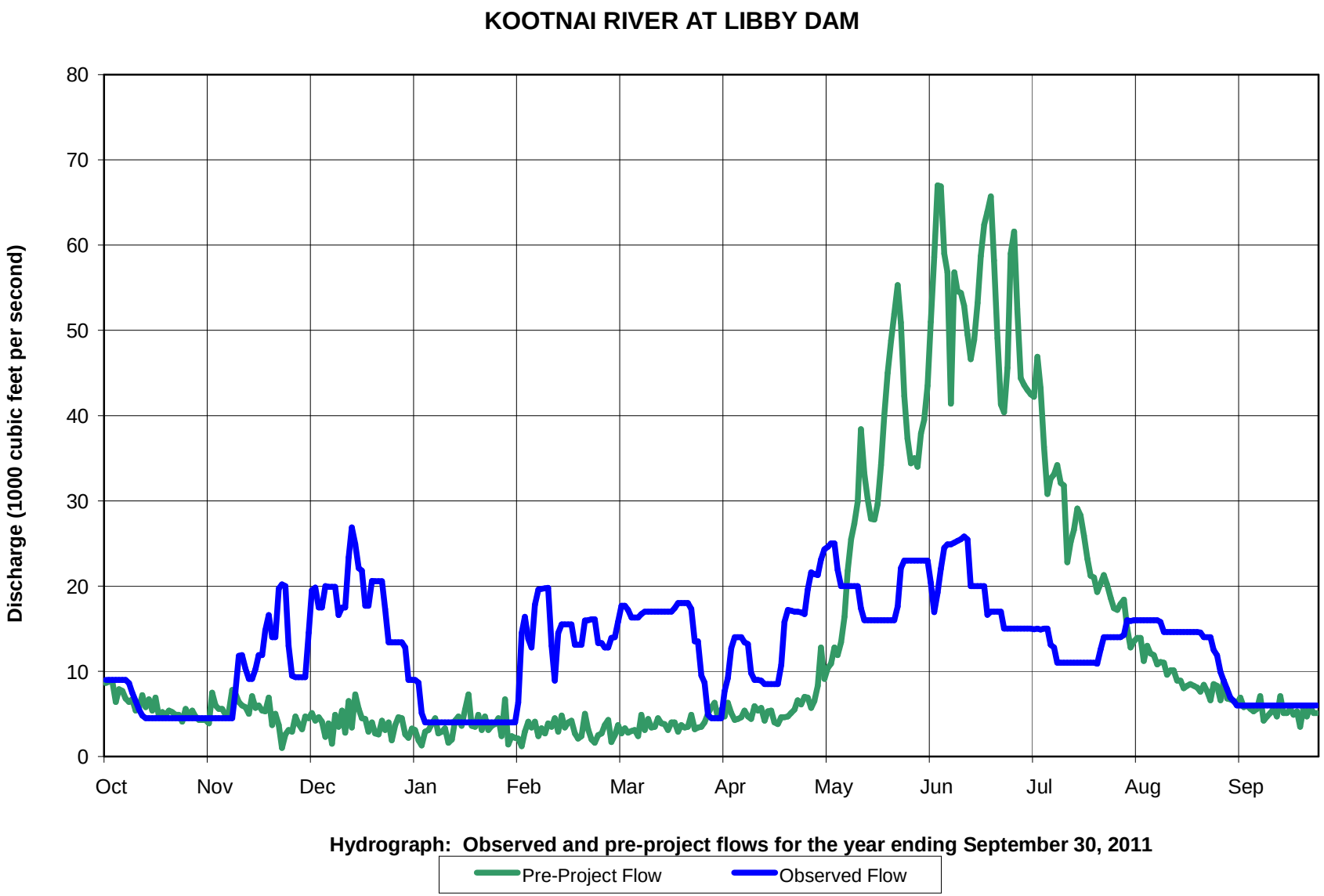
1400
1200
1000
800
600
400
200
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
28-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2010
2011
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE

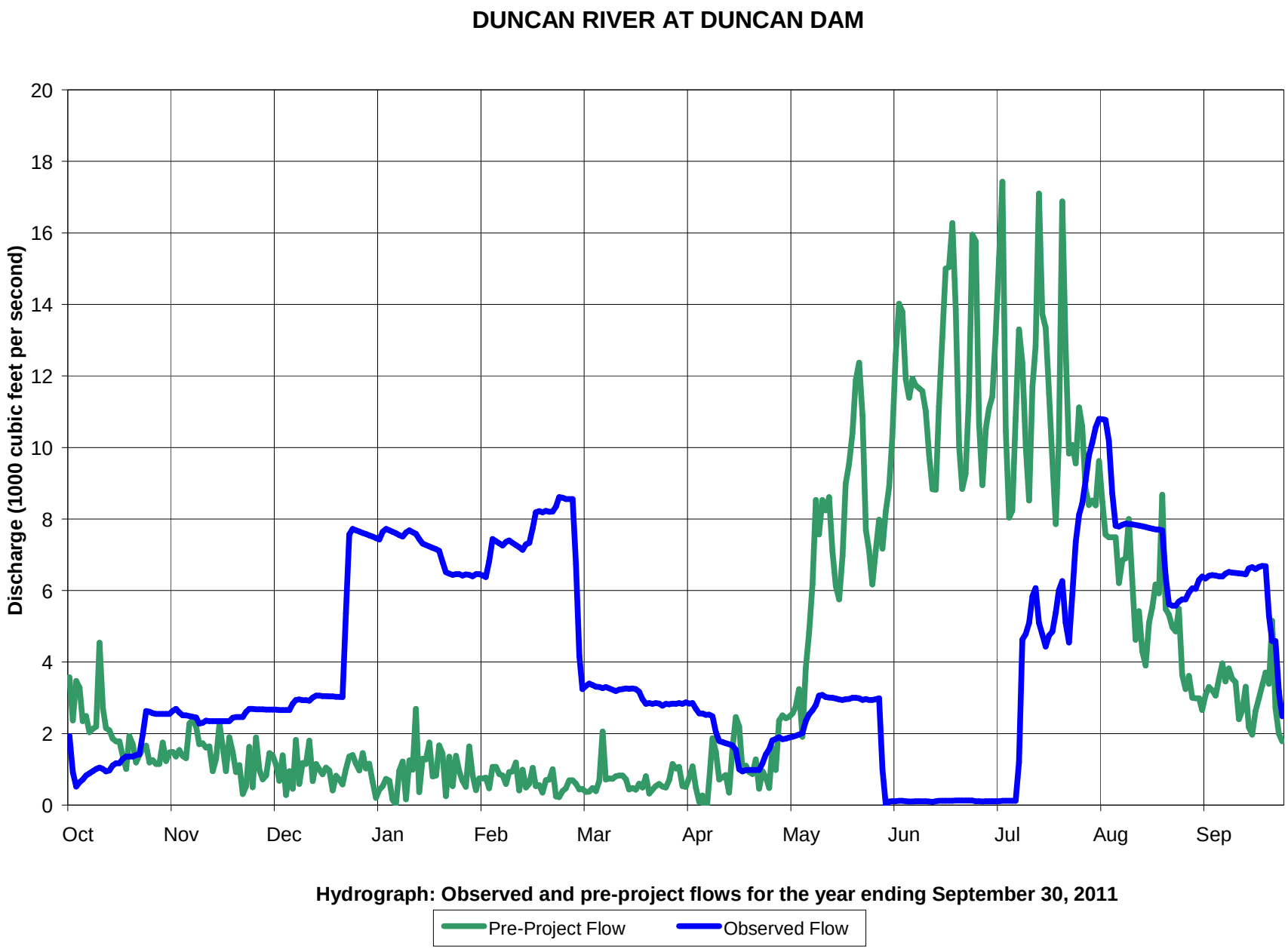

MICA RESERVOIR
USABLE STORAGE IN KAF
14000
12000
10000
8000
6000
4000
2000
0
FULL SUPPLY LEVEL
TREATY STORAGE COMMITMENT
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
28-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2010
2011
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE RULE CURVE

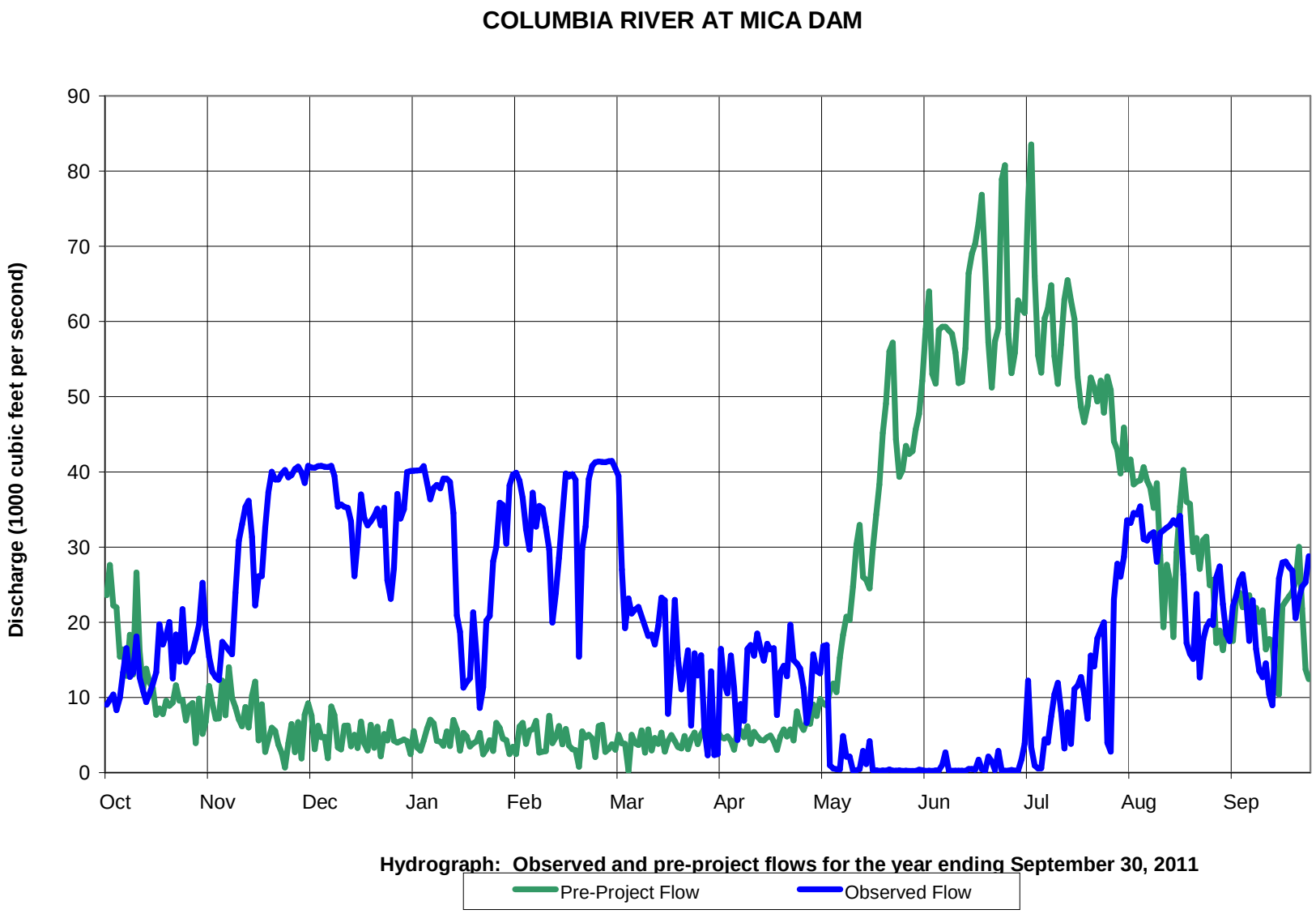

LIBBY RESERVOIR
USABLE STORAGE IN KAF
6000
5000
4000
3000
2000
1000
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
29-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2010
2011
STORAGE
FLOOD CONTROL RULE CURVE
CRITICAL RULE CURVE (CRC1)
VARIABLE REFILL CURVE


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
2010
2011
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE

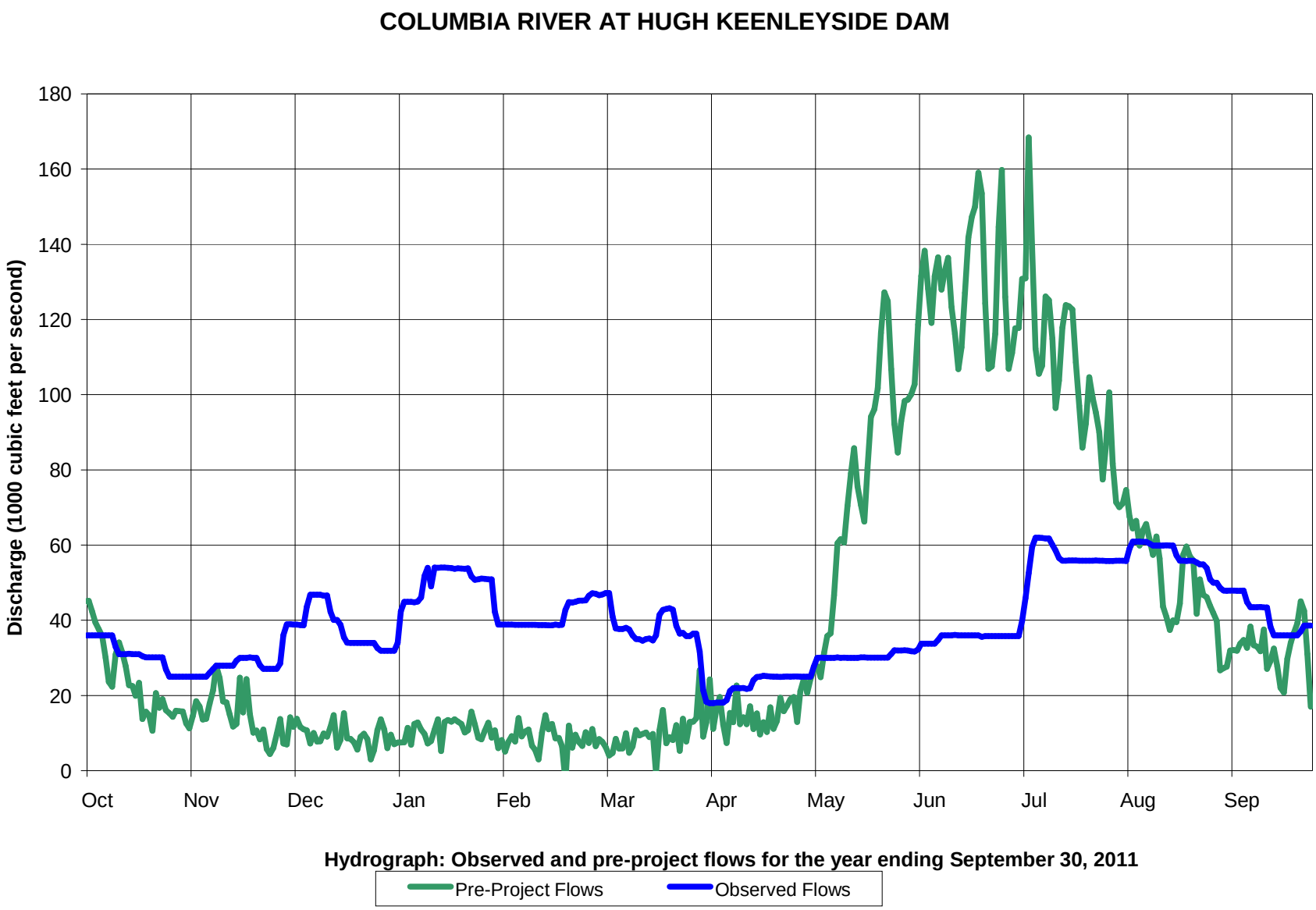


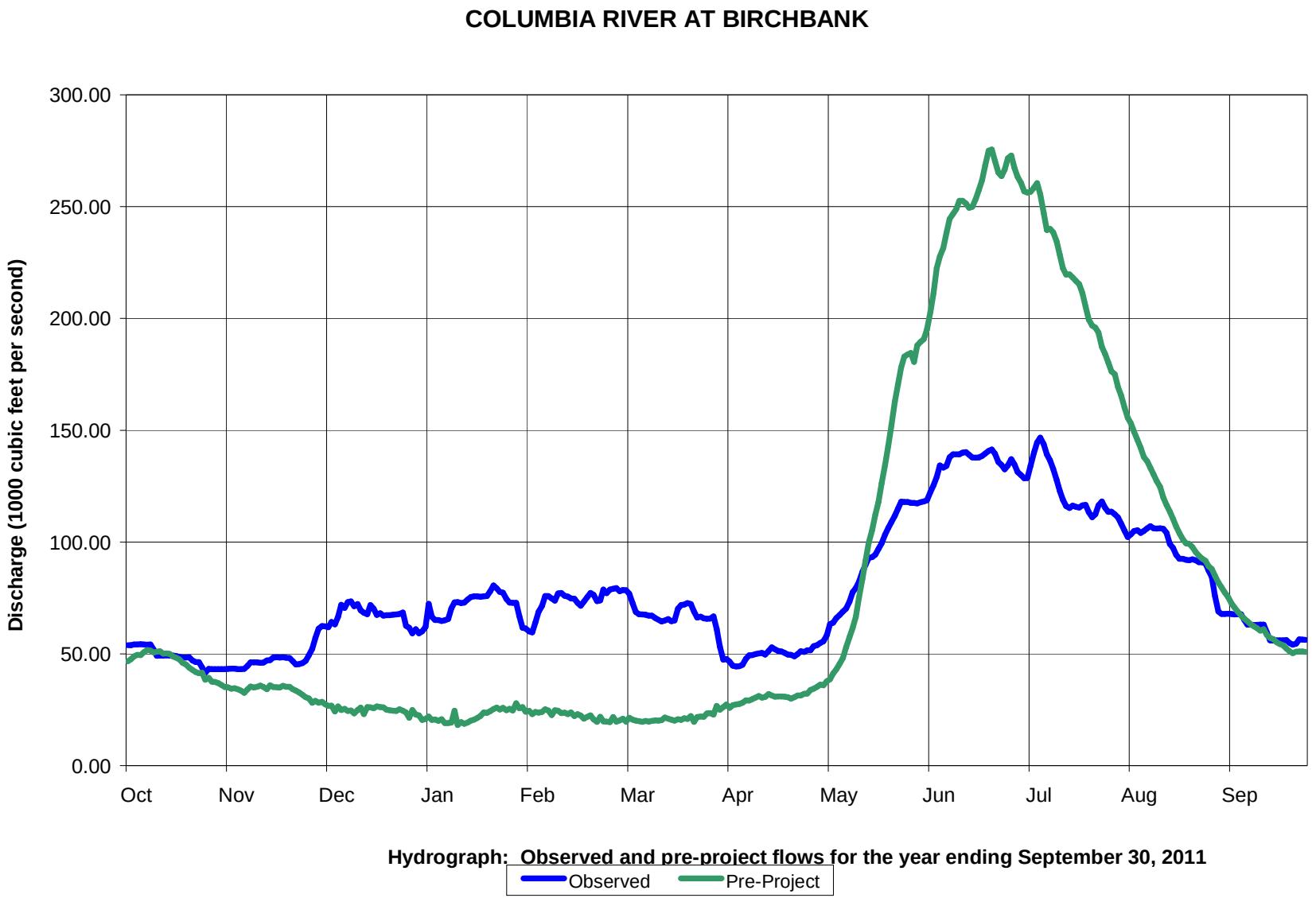
Hydrograph: Observed and pre-project flows for the year ending September 30, 2011


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, 2011
Pre-Project Flow
Observed Flow



Hydrograph: Observed and pre-project flows for the year ending September 30, 2011


COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM
Discharge (1000 cubic feet per second)
180
160
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, 2011
Pre-Project Flows
Observed Flows



Hydrograph: Observed and pre-project flows for the year ending September 30, 2011

TREATY BENEFITS

Flood Control Benefits

Water Year 2011 was unique in that, after a relatively uneventful winter, near record precipitation in spring resulted in very high runoff and a very active flood control season. Reservoirs throughout the Columbia River basin, including the Treaty projects, were drafted during the winter and spring in preparation for flood season. Despite best efforts, minor flooding occurred at many locations during 2011. The actual runoff for the overall Columbia basin (U.S. and Canada combined) measured at The Dalles for January through July 2011 was 132% of normal. 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 Unregulated Flow m^3/s (cfs)	Date	Peak Regulated Flow m^3/s (cfs)
15 June 2011	21,767 (768,700)	4 June 2011	14,113 (498,400)

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

Date	Peak Unregulated Stage meters (feet)	Date	Peak Regulated Stage meters (feet)
16 June 2011	7.77 m (25.5)	1 June 2011	5.3 m (17.37)

Duncan and Libby projects limited the peak elevation of Kootenay Lake to elevation 533.92 m (1751.7 ft) on 15 June 2011. Without regulation from those Treaty dams, the peak would have been about elevation 536.78 m (1761.1 ft). For reference, flood stage at Kootenay Lake is 534.92 m (1755.0 ft). Duncan, Arrow, Mica and Libby projects limited the peak flow of the Columbia River at Trail, just upstream of Birchbank, British Columbia, to 4110 m^3/s (~145,200 cfs) on 9 July 2011. Absent the dams, the flow would have been ~8,700 m^3/s (~307,100 cfs). For reference, the bankfull flow at Birchbank is estimated to be 6,372 m^3/s (225,000 cfs).

Power Benefits

A Determination of Downstream Power Benefits (DDPB) is computed in conjunction with the AOP. This computation represents the optimized generation from downstream U.S. projects that could have been produced by an optimized Canadian/U.S. system. The DDPB is prepared in accordance with the Treaty, the Protocol, and other Entity Agreements. The Canadian Entitlement represents one-half of the DDPB. For the period 1 August 2010 through 31 July 2011, the Canadian Entitlement amount, before deducting transmission losses, was 535.7 aMW of energy, scheduled at rates up to 1316 MW. From 1 August 2011 through 30 September 2011, the amount, before deducting transmission losses, was 525.9 aMW of energy, scheduled at rates up to 1314 MW.

During the course of the Operating Year, there were two curtailment periods to Canadian Entitlement deliveries, primarily due to a combination of planned maintenance and unexpected weather/load-resource conditions. These included a total of 1793 MWh over two days in September 2010 and 6 MWh in one hour in November 2010. All of the curtailed power was delivered later within the month of curtailment as agreed.

Actual U.S. power benefits from the operation of CRT storage are unknown and can only be roughly estimated. Treaty storage has such a large impact on the U.S. system operation that its absence would significantly affect operating procedures, non-power requirements, loads and resources, and market conditions, thus making any benefit analysis highly speculative. A rough estimate of the impact on downstream U.S. power generation during the 2010-2011 operating year, with and without the regulation of Canadian storage, based on the PNCA AER that includes minimum flow and spill requirements for U.S. fishery objectives is 787 aMW. In addition to the increase in average annual U.S. power generation, the Treaty regulation also shifted the timing of generation from the low value freshet period, into higher value winter months. No quantification of this benefit was reported by the Entities.

Other Benefits

The CRTOC completed one supplemental operating agreement for non-power benefits both in Canada and the U.S. in 2011. Non-power benefits include changes to stream flows below Arrow Dam that enhanced trout and mountain whitefish spawning in Canada and the downstream migration of salmon in the U.S.

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 2010-2011 and 2011-2012 Detailed Operating Plans (DOPs), 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 Libby Coordination Agreement (LCA) dated February 2000, including the 13 January 2010 and 12 October 2010 updates to the Libby Operating Plan (LOP), and U.S. requirements for power and guidelines set forth in the U.S. Fish and Wildlife Service (USFWS) 2006 Biological Opinion, and the U.S. National Marine Fisheries Service (NMFS) Biological opinions and Action Agency Plans, as approved by Court order.

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 2010 through 31 July 2011, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits, before deducting transmission losses, was 535.7 megawatts of average energy at rates up to 1,316 megawatts. From 1 August 2011 to 30 September 2011, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits before deducting transmission losses was 525.9 megawatts of average energy at rates up to 1,314 megawatts. The Canadian Entitlement obligation was determined by the 2010-2011 and 2011-2012 Assured Operating Plan and Determination of Downstream Power Benefits.

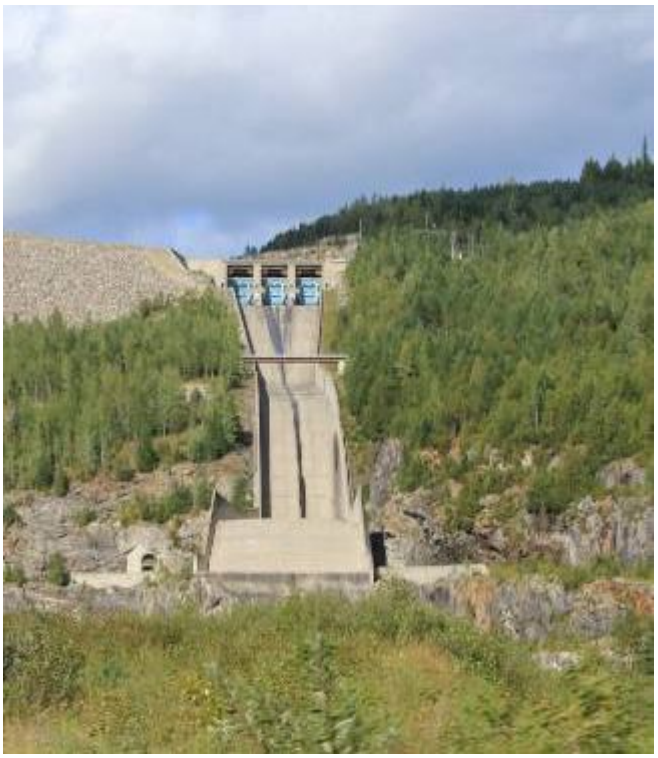
3. At the beginning of the 2010-2011 operating year on 1 August 2010, actual Canadian storage was at 15.9 km^3 (12.9 Maf) or 82.9 percent full on 31 July 2010. It drafted to a minimum of 2.1 km^3 (1.7 Maf) on 15 April 2011. Canadian composite storage refilled to 18.9 km^3 (15.3 Maf) or 99.2 percent full on 31 July 2011. The water supply during the 2010-2011 operating year was above average in the Columbia Basin above Grand Coulee and the Snake River above Lower Granite. The actual runoff in the Canadian portion of the Columbia basin measured at Birchbank was 115% of normal for January through July 2011. The actual runoff for the overall Columbia basin (U.S. and Canada combined) measured at The Dalles for January through July 2011 was 132% of normal.

4. NOAA's National Marine Fisheries Service concluded in their 2008/2010 Biological Opinion (BiOp) that the operation of the Federal Columbia River Power System (FCRPS) is not likely to jeopardize the continued existence of salmon and steelhead in the Columbia River basin. In October 2010, several environmental groups, the State of Oregon, and the Nez Perce Tribe challenged the 2008/2010 FCRPS BiOp. In August 2011, Judge Redden sent the 2008/2010 BiOp back to NOAA Fisheries after concluding that the BiOp needed further work on the non-specific mitigation actions (mostly related to fish habitat). He further concluded that the existing 2008/2010 FCRPS BiOp was adequate under the Endangered Species Act and directed that the BiOp remain in place through 2013. The Judge also ordered that the government continue to fund and implement all of the mitigation measures in the BiOp through December 31, 2013. The court ordered a new biological opinion be issued by January 1, 2014. Annual progress reports must be filed with the Court. Finally, the Corps of Engineers shall conduct spring and summer spill operations in a manner consistent with the court's annual spill orders, and provide monthly implementation reports.

5. The Columbia River Treaty Hydrometeorological Committee (CRTHMC) continues to work on evaluating the adequacy of the existing hydro-met network capabilities to support Treaty operations. The CRTHC is working with the National Weather Service River Forecast Center (NWRFC) to update forecast procedures for use in Treaty operations planning and the committee is coordinating proposed improvements to the snow monitoring 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 Forests, Lands and 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–

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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–

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Mr. Gordon McNabb* 1964–1991
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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 Forests, Land, and 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. David Ponganis, USACE Coordinator
Regional Director of Programs
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. Charles Reid, 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. William Proctor, 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. Adam Gobena, 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 2011

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	10.30	6.22	11.10	11.00	6.98	15.20	13.40	28.10	40.50	29.50	17.30	13.30
2	10.30	7.10	16.90	10.80	6.84	15.50	15.30	29.70	43.10	28.10	17.20	11.00
3	10.30	7.74	20.60	11.00	9.46	16.60	16.40	30.10	44.50	27.50	17.10	10.50
4	10.30	7.14	21.10	9.55	17.60	16.80	16.20	31.00	44.30	27.60	17.50	9.65
5	10.40	6.68	19.40	6.81	19.80	18.80	15.10	33.60	44.40	27.00	18.60	8.56
6	10.30	6.69	19.30	5.98	17.50	20.30	17.40	35.30	46.20	26.50	18.60	8.34
7	10.10	7.57	21.20	6.30	16.40	20.40	18.30	37.00	45.80	26.30	18.30	7.67
8	10.10	8.91	21.50	6.31	21.00	19.70	20.90	38.70	45.60	25.60	18.30	7.48
9	9.70	7.96	21.60	6.48	22.10	19.00	21.40	39.10	48.00	24.40	18.20	7.53
10	8.51	10.60	21.40	5.97	22.30	19.30	21.20	36.60	49.20	23.60	18.20	7.53
11	7.79	14.00	19.10	5.69	22.60	20.30	20.90	37.10	49.20	23.00	18.00	7.53
12	6.65	14.20	19.50	5.72	22.00	20.70	21.20	41.50	48.40	22.30	18.10	7.53
13	5.98	12.70	20.90	5.96	16.30	20.60	21.10	44.50	47.50	21.40	18.10	7.56
14	5.79	11.10	29.60	6.42	12.70	21.10	17.90	44.70	48.00	20.30	18.20	7.56
15	5.76	11.00	32.70	7.65	17.50	21.50	16.70	47.50	46.80	18.30	17.30	7.50
16	5.61	12.40	29.70	8.52	18.70	21.90	16.50	52.90	45.70	17.60	16.70	7.52
17	5.63	14.20	26.80	12.10	18.70	22.40	17.00	49.90	44.80	17.30	16.50	7.52
18	5.58	14.40	25.00	16.50	18.50	22.00	17.30	42.70	42.50	17.10	16.30	7.52
19	5.59	17.40	21.40	14.80	18.40	22.00	16.90	38.50	38.90	16.90	16.20	7.53
20	5.56	18.60	21.30	12.10	16.50	21.80	16.40	37.40	38.30	16.80	16.20	7.83
21	5.52	16.20	23.40	10.90	16.10	21.70	16.10	39.10	38.30	16.40	16.40	7.62
22	5.49	15.70	23.50	10.10	16.10	22.30	15.80	42.40	38.40	15.90	16.30	7.55
23	5.56	20.90	23.30	9.42	18.30	22.50	17.80	44.00	38.70	16.00	16.30	7.56
24	5.60	21.10	23.10	8.90	18.50	22.50	22.40	43.80	37.00	15.60	16.30	7.52
25	6.02	20.00	19.50	8.48	18.40	22.70	24.00	44.20	34.80	15.20	16.20	7.52
26	5.98	14.90	16.20	8.07	18.20	22.50	25.00	45.80	32.70	15.30	16.30	7.52
27	5.89	11.50	15.70	7.94	15.90	21.40	25.50	45.50	31.40	15.40	16.20	7.53
28	5.80	11.20	15.60	7.77	15.80	18.30	25.80	44.90	31.10	17.20	15.70	7.54
29	5.70	11.10	15.70	7.40		17.60	25.80	43.90	30.90	17.70	15.70	7.63
30	5.87	11.10	15.60	7.93		14.30	25.10	43.70	30.80	17.70	15.50	7.52
31	5.93		14.00	7.51		13.50		41.60		17.70	14.10	
Mean	**7.21**	**12.34**	**20.83**	**8.71**	**17.11**	**19.85**	**19.36**	**40.48**	**41.53**	**20.55**	**16.96**	**8.09**

COLUMBIA RIVER AT BIRCHBANK, BRITISH COLUMBIA

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2011

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	53.91	43.25	62.32	62.03	61.34	79.43	61.08	53.46	117.54	137.03	113.59	84.42
2	53.92	43.34	61.85	72.33	60.00	78.05	53.25	53.93	117.26	134.71	112.36	75.82
3	54.19	43.34	64.28	66.51	59.65	78.53	47.33	54.81	117.78	131.38	111.00	68.96
4	54.21	43.17	63.19	65.08	64.10	78.43	47.68	55.59	118.18	129.89	108.14	67.86
5	54.29	43.21	66.58	65.12	68.80	76.92	46.47	58.31	118.73	128.51	105.09	67.83
6	54.15	43.27	71.94	64.73	71.41	72.64	44.70	63.33	122.31	128.63	102.19	67.92
7	54.13	44.62	70.59	65.03	75.88	68.70	44.31	63.92	125.40	134.00	103.40	67.79
8	54.21	46.15	73.08	65.58	75.79	67.78	44.42	65.95	129.11	139.91	104.96	67.65
9	51.89	46.17	73.46	70.37	74.74	67.57	45.12	67.38	134.26	144.58	105.24	67.77
10	49.10	46.23	71.26	73.01	73.74	67.56	47.82	68.93	133.27	146.65	104.03	67.73
11	49.20	45.96	72.28	73.09	77.05	67.07	49.34	70.23	134.00	143.76	104.89	65.26
12	49.24	46.12	69.48	72.74	77.23	67.12	49.47	73.31	137.94	139.24	106.09	63.10
13	49.30	47.01	68.42	72.92	75.92	66.03	49.89	77.56	139.23	136.52	107.13	63.05
14	49.21	47.14	67.75	74.22	75.61	65.00	50.20	79.45	139.21	132.72	106.17	62.91
15	49.21	48.34	71.85	75.43	74.78	64.45	50.39	82.25	139.20	127.90	106.02	62.99
16	48.98	48.50	70.23	75.77	74.64	64.89	49.66	86.65	139.97	122.85	106.12	63.11
17	48.73	48.38	67.44	75.69	72.84	65.51	51.33	89.85	140.17	118.89	105.92	63.10
18	48.31	48.49	68.16	75.51	71.49	64.54	52.94	92.89	139.07	116.07	104.13	59.58
19	48.39	48.28	67.06	75.69	73.35	64.93	51.99	93.26	137.79	115.22	99.06	56.09
20	48.41	48.10	67.29	75.87	75.37	70.16	51.28	94.39	137.70	116.29	97.38	55.94
21	47.06	46.74	67.29	77.93	77.29	71.80	51.02	96.91	137.85	115.81	94.21	56.04
22	46.26	45.19	67.50	80.55	76.41	72.09	50.41	99.47	138.53	115.46	92.50	56.00
23	46.28	45.49	67.66	79.34	73.52	72.69	49.70	103.30	139.54	116.36	92.50	56.01
24	43.93	45.89	67.82	77.68	73.90	72.23	49.53	106.23	140.78	116.62	92.10	56.11
25	41.57	46.85	68.48	77.33	78.77	68.91	48.94	108.96	141.43	113.43	91.84	54.88
26	43.26	49.34	62.52	74.56	77.15	66.22	49.82	111.74	139.58	111.06	92.31	54.06
27	43.21	52.26	61.63	72.88	78.71	66.66	51.23	114.87	135.77	112.45	91.90	54.58
28	43.20	57.14	59.17	72.83	79.08	65.84	50.86	117.98	134.47	116.39	91.03	56.42
29	43.18	61.29	60.98	72.83		65.66	51.56	117.97	132.48	118.09	91.03	56.37
30	43.13	62.45	59.21	66.88		65.80	51.59	117.88	134.28	115.28	90.44	56.30
31	43.12		60.02	61.63		66.72		117.54		113.44	87.23	
Mean	**48.62**	**47.72**	**66.80**	**71.97**	**73.16**	**69.35**	**49.78**	**85.75**	**133.09**	**125.46**	**100.65**	**62.52**

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

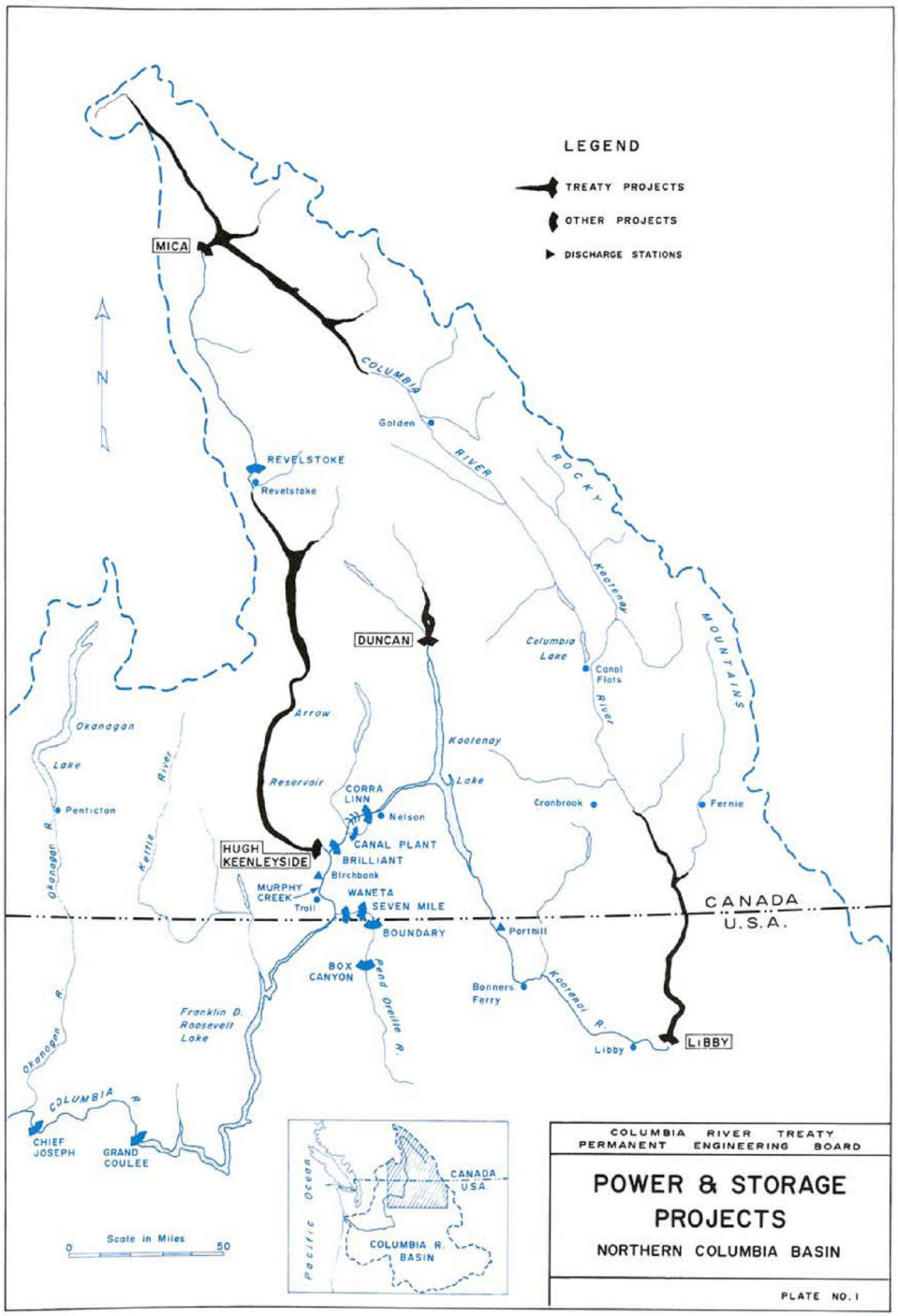
LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
N
COLUMBIA
RIVER
ROCKY
MOUNTAINS
Golden
REVELSTOKE
Revelstoke
DUNCAN
Columbia Lake
Canal Flats
Kootenay
River
Arrow
Reservoir
Okanagan
Lake
Penticton
Okanagan R.
Kettle
River
Kootenay
Lake
CORRA LINN
Nelson
Cranbrook
Fernie
HUGH KEENLEYSIDE
CANAL PLANT
BRILLIANT
Birchbank
MURPHY CREEK
Trail
WANETA
SEVEN MILE
BOUNDARY
CANADA
U.S.A.
Porthill
BOX CANYON
Pend Oreille R.
Bonners Ferry
Kootenai R.
Franklin D. Roosevelt Lake
Libby
LIBBY
COLUMBIA R.
CHIEF JOSEPH
GRAND COULEE
Scale in Miles
0
50
Pacific Ocean
CANADA
USA
COLUMBIA R. BASIN
COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
POWER & STORAGE PROJECTS
NORTHERN COLUMBIA BASIN
PLATE NO. 1

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)