ANNUAL REPORT

to the

GOVERNMENTS

of

THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

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

30 September 2013

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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
T. Newton, Member

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

5 February 2014

The Honorable John Kerry
Secretary of State
Washington, D.C.

The Honourable Joe Oliver
Minister of Natural Resources
Ottawa, Ontario

Dear Secretary Kerry 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-ninth Annual Report of the Permanent Engineering Board, dated 30 September 2013. The report documents the results achieved under the Treaty for the period from 1 October 2012 to 30 September 2013.

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

for Tim Newton

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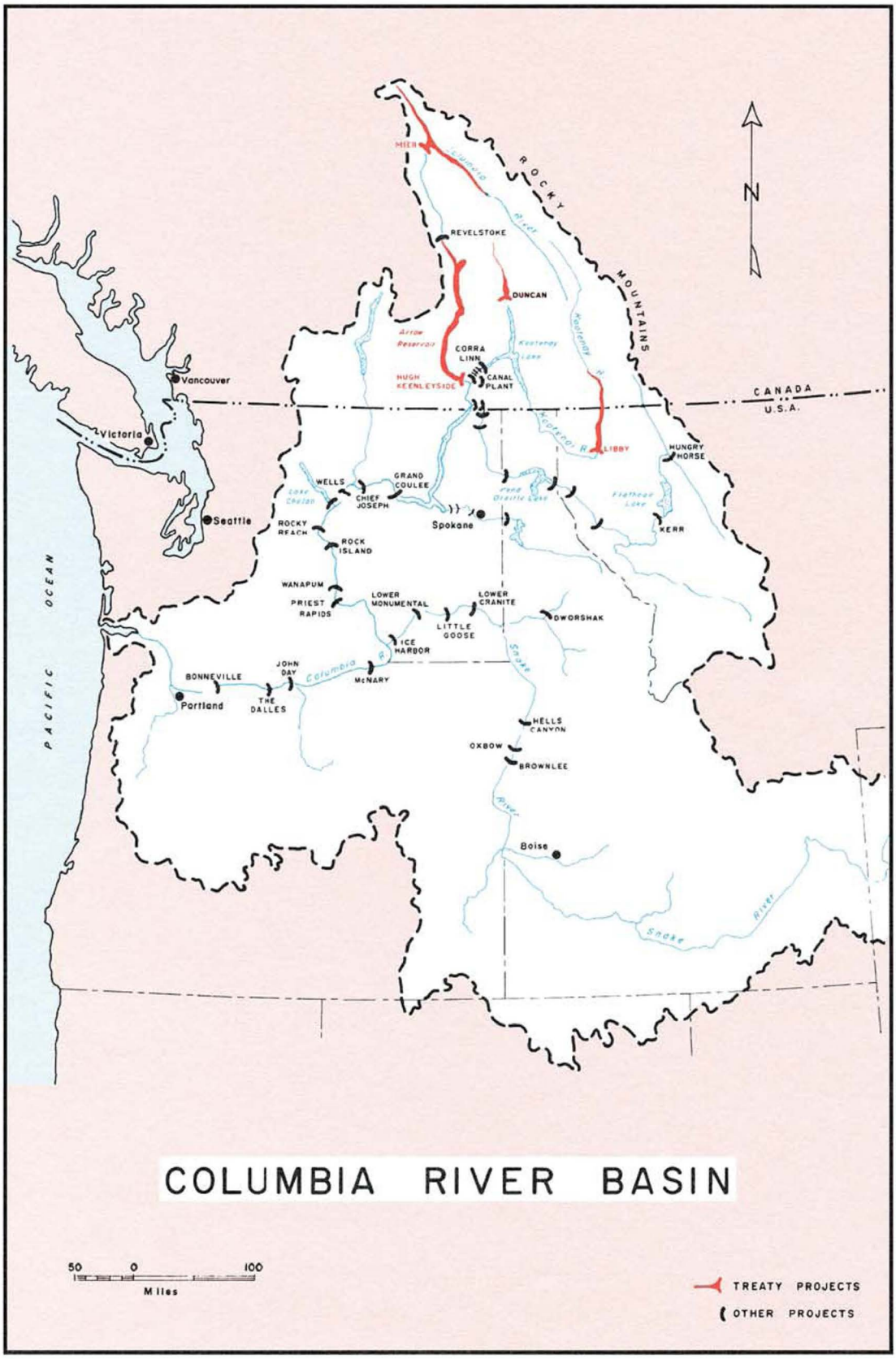
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ANNUAL REPORT

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COLUMBIA RIVER TREATY

PERMANENT ENGINEERING BOARD

Washington, D.C. Ottawa, Ontario

30 September 2013

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EXECUTIVE SUMMARY

The forty-ninth 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 (CRT) 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 2012 to 30 September 2013.

During the reporting period, the Canadian Treaty projects – Mica, Duncan, and Arrow – were operated according to the 2012-2013 and 2013-2014 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), including 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, as clarified, and the National Oceanic and Atmospheric Administration (NOAA) Fisheries' 2010 Biological Opinion (BiOp) for operation and maintenance of the Federal Columbia River Power System (FCRPS).

Canadian Treaty storage began the Operating Year on 1 August 2012 at 99.7 percent full, and ended the year on 31 July 2013 at 99.1 percent full. The actual runoff for the overall Columbia Basin (U.S. and Canada combined) measured at The Dalles for January through July 2013 was 96% of normal. The 2013 water year was relatively average, ranking 31st wettest out of 54 years of record in total April-August runoff as measured at The Dalles.

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 2012 through 31 July 2013, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits, before deducting transmission losses, was 504.5 megawatts of average energy at rates up to 1,321 megawatts of capacity. From 1 August 2013 to 30 September 2013, the U.S. Entity delivery of the Canadian Entitlement to downstream power benefits before deducting transmission losses was 505.5 megawatts of average energy at rates up to 1,336 megawatts of capacity. The Canadian Entitlement obligation was determined by the 2012-2013 and 2013-2014 Assured Operating Plans (AOP) and Determination of Downstream Power Benefits.

During the course of the 2012-2013 Operating year, there were four curtailment events for Canadian Entitlement deliveries, primarily due to a forest fire near Grand Coulee, transmission congestion within the BPA system, transmission maintenance work, and transmission congestion in the Puget Sound area of Washington State. All of the curtailed power was delivered later within the same month of curtailment, as per agreements between the Entities, with the exception of the 28 September 2013 curtailment, which was delivered on 1 October 2013.

The CRT Entities signed a short-term agreement (27 Sept 2013 to 31 Aug 2015) in consideration of Canadian concerns over Libby variable discharge flood control (VarQ) operations. The short-term agreement is supplemental to the 2000 LCA, and most of the LCA provisions remain in place. Under the short-term agreement, BC Hydro receives further flexibility for its Arrow provisional draft account as well as a more efficient benefit-delivery mechanism.

The Columbia River Treaty Hydrometeorological Committee (CRTHMC) continues to work on evaluating the sufficiency and adequacy of the existing hydrometeorological network capabilities to support Treaty operations. The CRTHMC adopted a new seasonal volume forecast procedure for the Dworshak project for use in water year 2014 and laid out a schedule of dates for official seasonal volume forecasts using the ensemble streamflow prediction (ESP) produced by the Northwest River Forecast Center. Snow pillow installation occurred at Keystone Creek during August 2013. The site has already begun accumulating snow and transmitting data. Potential locations for three additional sites for snow pillow installation were identified by BPA and B.C. Hydro.

The Long-term Non-Treaty Storage Agreement (NTSA), executed in April 2012, was utilized by the Bonneville Power Administration (BPA) and B.C. Hydro to store water in high runoff periods in the summer of 2012. Water stored during the spring and summer was released from early August through mid-September 2012. An agreement between BPA and B.C. Hydro to utilize additional non-Treaty space available at Arrow allowed shaping of Arrow outflows during high flows in July and August 2012 for the mutual benefit of both B.C. Hydro and downstream U.S. systems. The NTSA was also used to shape high Arrow outflows in early July 2013 into August and early September 2013. The CRT Operating Committee (CRTOC) monitored the storage operations made under the Agreement throughout the Operating Year to ensure they did not adversely impact operation of CRT storage required by the DOP.

The 2008/2010 FCRPS Biological Opinion contained a “Reasonable and Prudent Alternative” (RPA) which identified specific actions to ensure the survival of Endangered Species Act (ESA) listed salmon and steelhead in the United States. The actions required BPA and the Corps to pursue negotiations with Canada for annual agreements to provide 1 Maf of Treaty storage and negotiate a new long-term agreement on use of non-Treaty space in Canada so long as such an agreement provides both power and non-power benefits for B.C. Hydro, BPA, and other Canadian and U.S. interests. The Entities did provide 1 Maf of Treaty storage for fish needs in 2013 through the Non-Power Uses Agreement (1 December 2012 through 31 July 2013). The NTSA also reserves an additional 0.5 Maf for fish in the spring for qualifying dry years.

During the period of this Annual Report, the U.S. Entity hosted numerous public and other meetings as part of the development of a recommendation regarding future Treaty actions. Monthly Sovereign Review Team (SRT) meetings continued throughout the year. Technical studies were completed during summer 2013. The final regional recommendation to the State Department is expected by the end of the calendar year.

In Canada, the CRT Review is being led by the BC provincial government. Regional public consultation sessions were held over the course of the year BC Hydro has continued to do technical studies to support these consultation activities. A decision by the BC provincial Cabinet is expected by the end of the calendar year with a public announcement to follow in the new year.

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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
CRTOC ……Columbia River Treaty Operating Committee
cfs ……Cubic feet per second
DDPB ……Determination of Downstream Power Benefits
DOP ……Detailed Operating Plan (from 1 August to 31 July)
ESA ……Endangered Species Act
ESP ……Ensemble Streamflow Prediction
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
SRT ……Sovereign Review Team
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 2012 through 30 September 2013, 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.

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 80th meeting on 6 February 2013 in Vancouver, BC. In conjunction with this meeting, the Board also held its 61st joint meeting with the Entities.

The following topics were discussed at the meeting: the 2012 and 2013 DOP and supplemental operating agreements; Libby VarQ and 2012 Operations; Canadian entitlement delivery; production of the 2017-2018 Assured Operating Plan and Determination of Downstream Power Benefits (AOP/DDPB) which was nearing completion and development of future plans for AOP19; status of implementation of the 2012 long-term non-treaty storage agreement; Kootenay Lake IJC Board of Control activities; update on Hydrometeorological Committee activities; status of Treaty websites; and status of 2014/2024 planning studies.

Reports Received

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

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

- Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2017-2018, dated January 2013

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2017 through 31 July 2018.

- Columbia River Treaty Entity Agreement on the Assured Operating Plan and Determination of Downstream Power Benefits for the 2017-2018 Operating Year, signed 12 April 2013.

  This document is the agreement to implement the AOP and DDPB that provide information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2017 through 31 July 2018.

- Detailed Operating Plan for Columbia River Storage for 1 August 2013 through 31 July 2014, dated May 2013

  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 2013 through 31 July 2014.

- Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Columbia River Storage for 1 August 2013 through 31 July 2014, signed 31 May 2013.

  This document is the agreement between the Entities to implement the DOP for Columbia River storage during the period 1 August 2013 through 31 July 2014.

- Annual Report of the Columbia River Treaty, Canadian and United States Entities, for the period 1 October 2012 through 30 September 2013.

  This report summarizes the operation of Treaty projects and other activities of the Entities for the period 1 October 2012 through 30 September 2013.

Report to the Governments

In accordance with Article XV, paragraph 2(e) of the Treaty, the forty-eighth Annual Report of the Board, dated 30 September 2012, 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 have been operated accordingly to 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 turbines with a capacity of 520 MW each are being installed in the Mica Dam. The first one is targeted for completion by 2015 and the other by 2016. An additional generation unit at Revelstoke is also being 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 12, and project data are provided in Appendix D, Table 1.

Arrow Project

Hugh Keenleyside Dam, at the outlet of the Arrow Lakes, was the second Treaty project to be completed. It became operational on 10 October 1968, well ahead of 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 licensed to 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, which could be 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 Francis turbines and generators have been installed with a total capacity of 1805 MW. Installations of the two remaining generating units, each with a capacity of 520 MW, are scheduled for completion by 2016.

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 reservoir level 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 2012 Annual Report was completed in January 2013 and its 2013 Annual Report is scheduled for completion in early 2014.

A lack of real time and late season snowpack data had been identified as a deficiency of the network. To address this deficiency, a new snow pillow station was installed in August 2013 in the Keystone Creek Basin in the Revelstoke area. Three additional high elevation snow pillow stations are scheduled to be installed during the summer of 2014 in BC, but their locations have not been finalized.

Data accessibility for both Treaty and non-Treaty project operators was improved through regular stakeholder meetings initiated by USACE and a 24-hour helpdesk maintained by BC Hydro. BC Hydro has also initiated efforts to ensure data recovery in the event of a major system interruption.

Under current methodologies, exceptionally high precipitation or runoff in some months could lead to unreasonably high water supply forecast or bias in flow data used in operation studies. The Hydrometeorological Committee met and agreed to adjust model output in two such occurrences, in October 2012 and in May 2013.

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 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 thereafter. 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 2012 through 31 July 2013*, signed on 8 June 2012, and the *Detailed Operating Plan for Columbia River Treaty Storage, 1 August 2013 through 31 July 2014*, signed on 31 May, 2013, as well as in accordance with additional agreements between the Entities signed during the year. These documents were based on the operating criteria and 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 since signing.

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 99.97 percent of the time. Three curtailments occurred in March, April and September 2013 totaling 3 hours and 98 MWh. BPA Transmission Services owns and operates more than 15,000 circuit miles of high-voltage transmission lines in the Pacific Northwest. To ensure continued transmission system reliability and to respond to growing requests for transmission service, BPA continues to expand and reinforce the aging transmission system. In 2013 flowgates were added for the Puget Sound Area North of Echo Lake (S>N) and South of Custer (N>S); they are operating as intended.

BPA's Network Open Season (NOS) process, conducted across 2008-2010, identified additional transmission projects to be built to reinforce the transmission system to avoid overloaded lines, provide additional capacity, and maintain the overall integrity and reliability of the system. Some of these projects include: (1) Big Eddy-Knight which is a 28 mile 500kV transmission line between The Dalles, OR and Goldendale, WA that will add capacity needed to move the power west of the Cascades. This project is scheduled to be energized in December 2014; (2) The Central Ferry Lower Monumental transmission project which is 40 miles of a new 500kV transmission line that is scheduled to be energized in December 2015; (3) The Montana to Washington transmission project which is an upgrade to the existing BPA Transmission system West of Garrison substation. This project includes upgrades at five existing substations, the addition of a new compensation substation, and an upgrade of 12-mile section of Transmission line between Taft and Dworshak subs. This project is scheduled to be energized in Fall 2018; and (4) the I-5 Corridor which is 79 miles of new 500kV transmission line between 2 new substations near Castle Rock, WA (Casey substation) and Troutdale, OR (Sundial substation). This project is scheduled to be energized in spring 2018.

BPA is also moving ahead with shorter term transmission initiatives including a project to manage hourly firm transmission sales by February 2014 and implementation of fifteen minute scheduling by September 2014. These shorter term transmission initiatives along with several other initiatives discussed at BPA's Transmission Customer Forum collectively act to maintain, improve, and enhance the federal transmission system.

The 357 km (214 mile) privately-owned 230-kV Alberta –Montana Ltd ("MATL") line between Lethbridge, Alberta and Great Falls, Montana went into service in 2013. Involvement of the U.S. government was primarily through the Western Area Power Administration (WAPA), which committed $161 million in stimulus loan funds to encourage the project.

Legislation was proposed in the U.S. in 2008, and reintroduced in 2010, to amend the Federal Power Act to give the Federal Energy Regulatory Commission the authority to address known cyber security threats to the reliability of the bulk power system, and to provide emergency authority to address future cyber security threats. The legislation is still being debated. In September 2012 the Commission announced the creation of a new Office of Energy Infrastructure Security that will help it to focus on potential cyber and physical security risks to energy facilities under its jurisdiction. Canadian governments have continued in discussion with the U.S. regarding cyber security 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

The Long Term Non-Treaty Storage Agreement (NTSA), executed in April 2012, was utilized by BPA and B.C. Hydro to store water in high runoff periods in the summer of 2012. Water stored during the spring/summer was released from early August through mid-September 2012. An agreement between BPA and B.C. Hydro to utilize additional non-Treaty space available at Arrow allowed shaping of Arrow outflows during the high flows in July and August 2012, for the mutual benefit of both B.C. Hydro and downstream U.S. systems. The NTSA was also used to shape high Arrow outflows in early July 2013, into August and early September 2013. The CRTOC monitored the storage operations made under the Agreement throughout the Operating Year to ensure they did not adversely impact operation of CRT storage required by the DOP.

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.

Biological Opinion on the Federal Columbia River Power System (FCRPS)

The 2008/2010 FCRPS Biological Opinion contained a "reasonable and prudent alternative" which identified specific actions to ensure the survival of ESA listed salmon and steelhead in the United States. The actions required BPA and the Corps pursue negotiations with Canada for annual agreements to provide 1 Maf of Treaty storage and negotiate a new long-term agreement on use of non-Treaty space in Canada so long as such an agreement provides both power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests. The Entities did provide 1 Maf of Treaty storage for fish needs in 2013 through the Non-Power Uses Agreement (1 December 2012 through 31 July 2013). A new NTSA was signed by BPA and the BC Hydro on 12 April 2012 which reserves an additional 0.5 Maf for fish in the spring of qualifying dry years.

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 2012 to 30 September 2013, Treaty operations there under are based on the Treaty Operating Year of 1 August 2012 to 31 July 2013. Additional information for 1 August 2013 to 30 September 2013 is based on the Treaty Operating Year 1 August 2013 to 31 July 2014.

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 2012–2013*, dated January 2008

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2012 through 31 July 2013.

- *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.

- *Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 2013–2014*, dated December 2008

  This document provides information on the operating plan for Columbia River Treaty storage and the resulting downstream power benefits for the period 1 August 2013 through 31 July 2014.

- *Detailed Operating Plan for Columbia River Storage for 1 August 2012 through 31 July 2013*, dated June 2012

  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 2012 through 31 July 2013.

- *Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-power Uses from 1 December 2012 through 31 July 2013*, signed 4 December 2012

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

- *Detailed Operating Plan for Columbia River Storage for 1 August 2013 through 31 July 2014*, dated May 2013

  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 2012 through 31 July 2013.

In addition to the agreements listed above, the Bonneville Power Administration and B.C Hydro and Power Authority developed the following bilateral agreements:

- *Agreement for use of Non-Treaty Storage Agreement Recallable Accounts for the period 2 March 2013 through 29 March 2014*, agreed upon 5 March 2013

- *Agreement on use of Non-Treaty Storage for July and August 2013 for the period 1 July 2013 through 30 August 3013*, agreed upon 3 July 2013

The CRTOC monitored the storage operations made under the Agreement throughout the Operating Year to ensure they did not adversely impact operation of CRT storage required by the DOP.

System Storage

Precipitation and temperatures took a turn away from the previous two wet and cool Operating Years toward the warmer and drier side of normal. Water Year (WY) 2013 was a relatively average year, marked by neutral El Nino Southern Oscillation (ENSO) conditions, with the April-August runoff across the basin, measured at The Dalles, being 107.4 km3, (kilometers cubed) (87.05 Maf), or 99% of the 30 year average (1981 – 2010). Conditions in the Upper Columbia (105% of normal measured at Arrow) and Kootenai Basins (121% measured at Libby) were wet while the Snake Basin was relatively dry (70% of normal measured at Lower Granite) resulting in the overall relatively average runoff. Similar to 2012, the upper Columbia and Kootenai River basins were again hit in mid- to late June with a significant rainfall event, 2- 4 inches in the Libby basin and similar totals in the upper Columbia.

Only minor modifications in actual hydro operations occurred during the year, which were due to significant powerhouse outages at Mica, where the project was drafted much deeper than required by the Flood Control Operating Plans (FCOP) and then surcharged to reduce spill during the latter part of the freshet. After a very wet October, and relatively average November and December, basin-wide precipitation was drier than normal during January through March.

Conditions in the upper Columbia were somewhat wetter during the spring, but this was offset by drier than normal conditions on the Snake, which resulted in the average April-August runoff and an unregulated peak flow at The Dalles of only 14,200 m3/s (cubic meters per second) (503 kcfs (thousand cubic feet per second)). Since 1960, 2013 ranks 31st out of 54 years of record in total April-August runoff as measured at The Dalles.

For the 1 August 2012 through 30 September 2013 reporting period, the Canadian Treaty Projects were operated according to the 2011-2012 and the 2012-2013 Detailed Operating Plans (DOPs), the 2003 Flood Control Operating Plan (FCOP), and several supplemental operating agreements described below. The Libby project was operated consistently with the Libby Coordination Agreement (LCA) including the Libby Operating Plan, United States (U.S.) requirements for power, and U.S. Fish and Wildlife Service's 2006 Biological Opinion (BiOp), as clarified, and NOAA Fisheries' 2010 Supplemental Biological Opinion (BiOp) for operation and maintenance of the Federal Columbia River Power System.

Under the 2012-2013 and 2013-2014 DOPs, Canadian storage was operated according to criteria from the 2012-2013 and 2013-2014 AOPs. During the 2012-2013 Operating Year, composite Canadian Treaty storage (Canadian storage) was operated close to the Treaty Storage Regulation (TSR) study composite storage, plus any operations implemented under the Supplemental Operating Agreements (SOAs) or the Libby Coordination Agreement (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 (1 August 2012) slightly below the DOP levels as determined in the TSR study. Canadian storage was drafted below TSR levels through September primarily due to differences in forecast and actual inflows. The Canadian Entity exercised their option to provisionally draft Arrow for only one of the two cycles under the LCA this year. The one and only cycle drafted Arrow by 68.5 cubic hectometer (hm3 (55.5 kaf)) in October 2012. The LCA draft was not returned by the end of March 2013, and, by mutual agreement, the return was delayed until the week of 28 September through 4 October 2013.

For January until the end of June 2013, Canadian storage remained above the TSR-specified levels. This was due to operation under the Non-Power Uses Agreement that was implemented to achieve mutual fish benefits for the U.S. and Canada. Under provisions of this agreement, the U.S. Entity stored 1233 hm3 (1 Maf) of flow augmentation water in January. The January forecast for the April – August water supply volume as measured at The Dalles was slightly above average 113.5 km3 (92.03 Maf). This operation helped to modify and manage flows downstream of Hugh Keenleyside Dam for Canadian whitefish operation in January through March, and for Canadian trout spawning protection in April through June 2013. The flow augmentation water was subsequently released starting the second week through the end of July 2013 to help meet U.S. salmon flow objectives. The water supply forecasts at The Dalles increased as the water year developed, from a January-July forecast of 110.6 km3 (89.7 Maf) in March to 120.8. km3 (97.9 Maf) in July.

During the spring freshet, B.C. Hydro sought and received approvals from the B.C. Comptroller of Water Rights (CWR) to surcharge by up to 0.3 m (1 ft) at Mica for power related reasons. Additionally, B.C. Hydro and BPA exercised storage operation under the Summer Shaping Agreement utilizing the maximum available Non-Treaty Storage (NTS). This Non-Treaty Storage was made available due to earlier releases across winter 2012/2013 under the Long Term Non-Treaty Storage Agreement. Refer to Section III, Long Term Non-Treaty Storage, for more information on Non-Treaty operations. A total of approximately 0.70 km3 (0.57 Maf) was stored in early July and released in August. With this operation, the Columbia River flows at Birchbank (downstream of the Kootenai and Columbia confluence) peaked at 4,460 m3/s (158 kcfs) on 5 July 2013, substantially below 2012 peak flow and below the flood damage threshold of 5,100 m3/s (180 kcfs) .

For August through September 2013, Canadian storage targeted the Treaty Storage Regulation content. Due to differences in forecasted and actual inflows, there were minor inadvertent end of month storage across this time period.

At the beginning of the 2012-2013 Operating Year (1 August 2012), actual Canadian storage was at 19.06 km3 (15.45 Maf) or 99.7 percent full. Canadian Treaty storage drafted to a minimum of 5.0 km3 (4.1 Maf) on 26 April 2013 and refilled to 18.9 km3 (15.4 Maf) or 99.1 percent full at the end of the Operating Year, 31 July 2013.

The 1 January 2013 water supply forecast for the Columbia River above The Dalles for January through July was 126.4 km3 (102.5 Maf), or 101.1 percent of the 1981–2010 average. The spring water supply forecasts at the Dalles dropped as the water year developed. By the 1 June 2013 forecast, the runoff prediction dropped to 115.8 km3 (93.9 Maf), and with higher than normal June precipitation, the actual January through July runoff for the Columbia River above The Dalles rose to 120.5 km3 (97.7 Maf), or 96.4 percent of the 1981-2010 average.

Operations of the three Canadian reservoirs — Mica, Arrow, and Duncan — and the Libby Reservoir in the United States, are illustrated on pages 29 to 32 for the 13-month period from 31 August 2012 to 30 September 2013. 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 (Kinbasket Reservoir)

The Kinbasket Reservoir reached its maximum 2012 elevation of 754.72 m (2476.1 ft) on 29 August 2012. This record high level was due primarily to very high rainfall in June-July that contributed to high basin inflows in combination with an extended outage for two Mica generators that lasted several months. During the fall and into the winter, the reservoir was drawn down to meet electrical demands, to prepare for the 2013 spring runoff and to manage extensive planned generating unit outages during the spring/summer 2013.

In preparation for the extensive Mica outage, B.C. Hydro released all of its Non-Treaty water by the end of the winter to enable additional draft from Kinbasket Reservoir prior to the outage, thereby minimizing spill risk at Mica during the extensive outage. Kinbasket Reservoir reached a minimum level for the year of 722.8 m (2371.4 ft) on 24 April 2013, about 0.8 m (2.7 ft) higher than the 2012 minimum level. Mica generation was limited to 2 units during the extended outage, which began in April and will continue until early November. The Mica powerplant output was reduced to below normal in April, and, except for brief periods, remained below normal during the entire outage. For five weeks from early June to mid-July, the Mica powerplant was completely isolated from the grid and discharged very little water.

The basin runoff forecast hovered around normal from 1 January through 1 April. The actual January-July inflows at Mica were about 108 percent of normal. In July 2013, B.C. Hydro received permission from the B.C. Comptroller of Water Rights (CWR) to surcharge Kinbasket Reservoir by up to 0.3 m (1 ft) for power related reasons. Since mid-July, when the power plant was reconnected to the grid, the refill of Kinbasket Reservoir was managed by running the two available generators at virtually maximum possible output. The Kinbasket Reservoir was in surcharge and spilled water during much of September.

Keenleyside (Arrow Lakes Reservoir)

The minimum reservoir level during 2013 was 427.9 m (1404.0 ft) on 13 February. This was 0.4m (1.4 ft) higher than the previous year's minimum level. The maximum level reached by Arrow Lakes Reservoir in 2013 was on 3 July, at 440.0 m (1443.5 ft), 0.15 m (0.5 ft) below normal full pool.

The Arrow local runoff forecasts for 2013 hovered around normal for the 1 February to 1 May forecasts. The actual January-July 2013 local inflow volume to Arrow was about 103 percent of normal. Canadian Treaty Storage was in proportional draft from September 2012 to October 2012, but was otherwise on Operating Rule Curve at other times during the 2012-2013 Operating Year.

To manage Arrow releases during the high inflow period of 2013, a Summer Shaping Agreement utilizing Non-Treaty storage was developed and signed by B.C. Hydro and BPA. The agreement was used by both parties to store Non-Treaty water in early July, with the stored water then released by the end of August. The Non-Treaty storage allowed the parties to limit flows to minimize flood risk downstream of Keenleyside Dam in Canada and to improve fish flows in the U.S. At about the same time, Arrow reservoir was refilled to near full, fully utilizing its storage to minimize downstream flood risks.

These combined efforts resulted in a substantial reduction in the peak Columbia River flows. The Columbia River at Birchbank reached at maximum flow of 4,460 m^3/s (158 kcfs) on 5 July 2013, below the threshold flow for minor flooding impacts of 5,100 m^3/s (180 kcfs).

Duncan (Duncan Reservoir)

From September 2012 through April 2013, Duncan Reservoir was operated to supplement inflow into Kootenay Lake, to provide spawning and incubation flows for fish, and to meet Treaty flood control requirements. Duncan Reservoir was drafted to its minimum licensed level of 546.85 m (1794.2 ft) on 28 April 2013 -- a fairly typical operation for Duncan. The reservoir discharge was reduced to a minimum of 3 m^3/s (0.1 kcfs) beginning 24 May 2013 to initiate reservoir refill and to reduce the rate of rise for Kootenay Lake. Releases from Duncan Reservoir were then held at minimum until early July to manage the level of Kootenay Lake and maximize the value of the downstream energy generation. After the Kootenay Lake level began to recede, the Duncan Reservoir discharge was increased to manage the rate of refill for Duncan Reservoir. By 31 July 2013, the Duncan Reservoir level had reached 576.4 m (1891 ft), and the level peaked a week later, on 7 August, at 576.64 m (1891.9 ft), or 0.04 m (0.1 ft) below the normal full pool level.

The flows in the Duncan River downstream of the Lardeau River (DRL) peaked this year at 386 m^3/s (13.6 kcfs) on 7 July 2013. Duncan Dam discharges were adjusted in August to target a reservoir level of 575.5 m (1888.0 ft +/- 1 ft) on Labour Day (2 September 2013).

Libby (Koocanusa Reservoir)

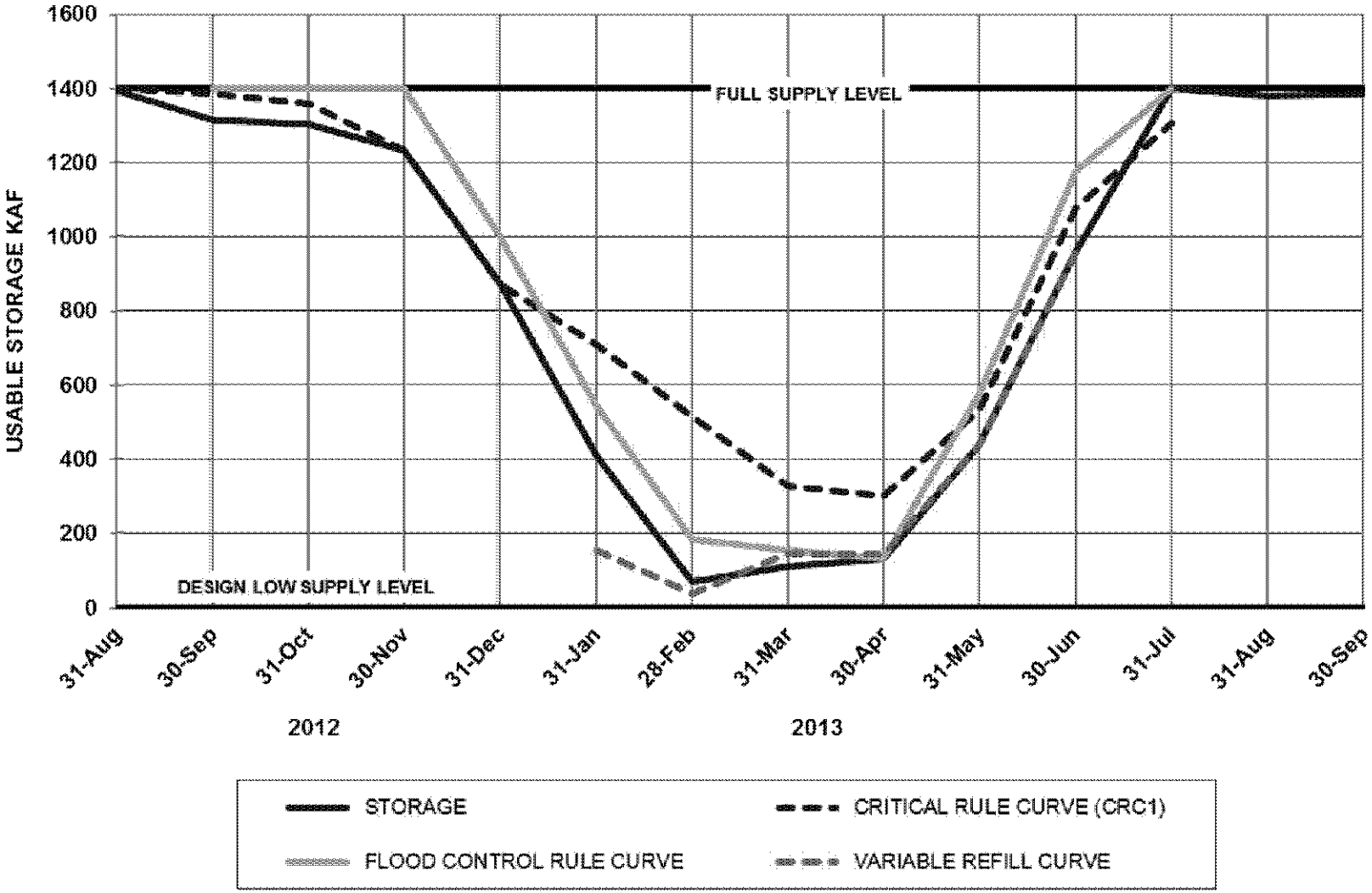
The December 2012 water supply forecast for April-August 2013 runoff came in at 7.6 km^3 (6.2 Maf) or 106 percent of average which set the end of December Flood Risk Management (FRM) elevation to 734.87 m (2411 ft). Subsequent forecasts ranged from 7.6 to 8.5 km^3 (6.2 to 6.9 Maf), with a May 1 forecast of 8.0 km^3 (6.5 Maf), or 111 percent of average. The start of refill was set for 1 May in 2013 and VarQ releases were set at 510 m^3/s (18 kcfs) when inflows increased above the VarQ outflow. VarQ was held until May 11 when flows were increased to powerhouse capacity for the first of two sturgeon pulses, one of 7 days (11 May to 18 May) and one for 12 days (24 May to 5 June). June river flows were adjusted to approximately 453 m^3/s (16 kcfs) to target refill of the reservoir. From 18 June to 20 June, the Kootenai Basin was hit by a wraparound storm from the Gulf of Mexico which produced rain totals throughout the basin of 2 to 4 inches in a 3-day span. As a result of this event, releases were increased above power plant capacity from 22 June through 10 July – spilling a total of 203 kaf. Inflows increased from 850 m^3/s (30 kcfs) to 2,520 m^3/s (89 kcfs) on 22 June and the reservoir ended June at elevation 748.62 m (2456.1 ft). The reservoir reached its peak elevation of 749.14 m (2457.8 ft) on 5 July 2013.

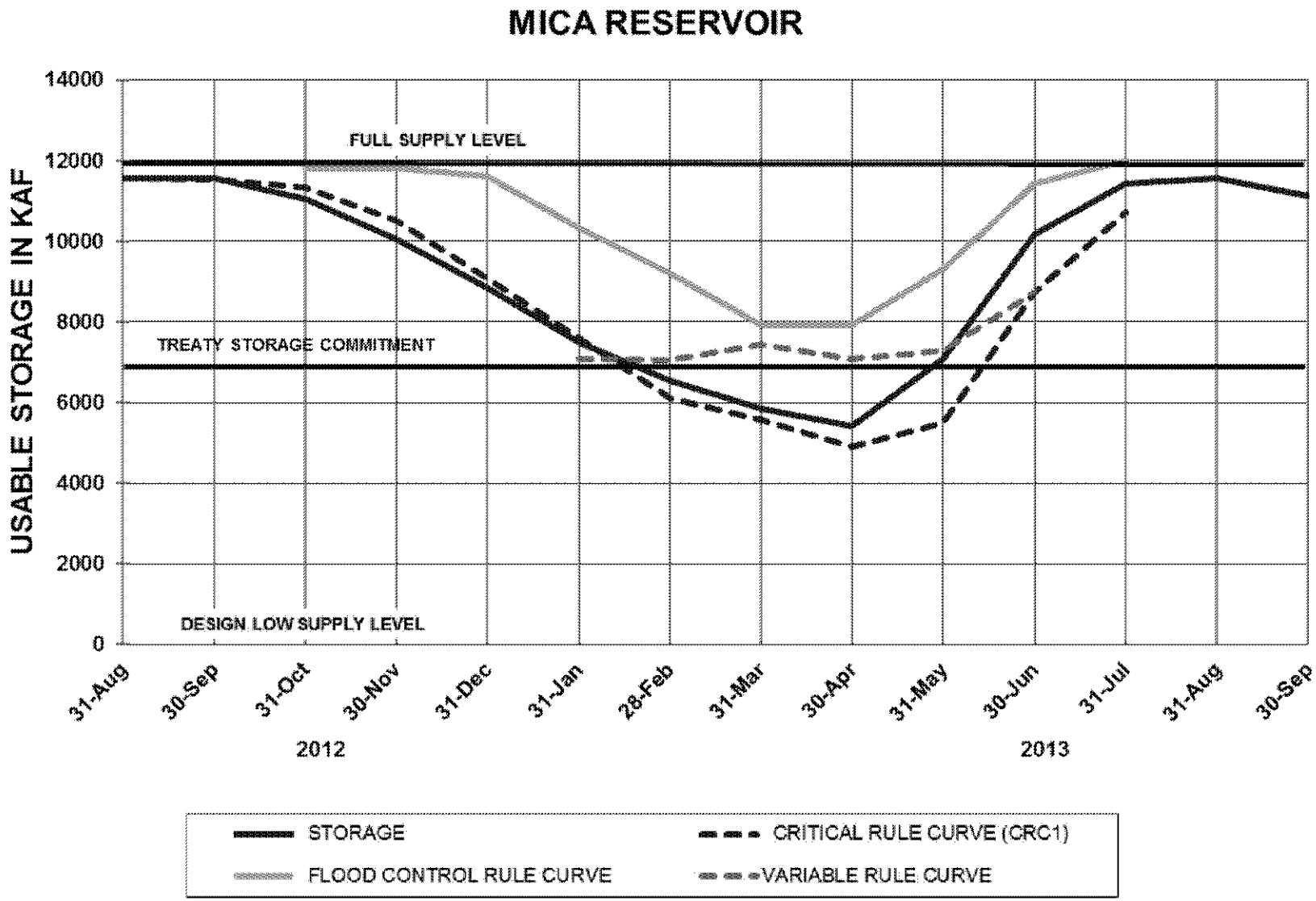
In order to accommodate a 2 unit outage beginning the third week of July and to try and get the reservoir to an elevation below 747.25 m (2451.6 ft) on 31 August, releases were held at powerhouse capacity until 21 July and then were ramped down to 396 m^3/s (14 kcfs). The 396 m^3/s (14 kcfs) represented powerhouse capacity with only three units available and was held until the end of the month. The Lake Koocanusa was at an elevation of 748.74 m (2456.5 ft) at the end of July 2013 and 746.46 m (2449.0 ft) at the end of August 2013. The final April-August runoff totaled 8.9 km^3 (7.2 Maf) (121% of normal).

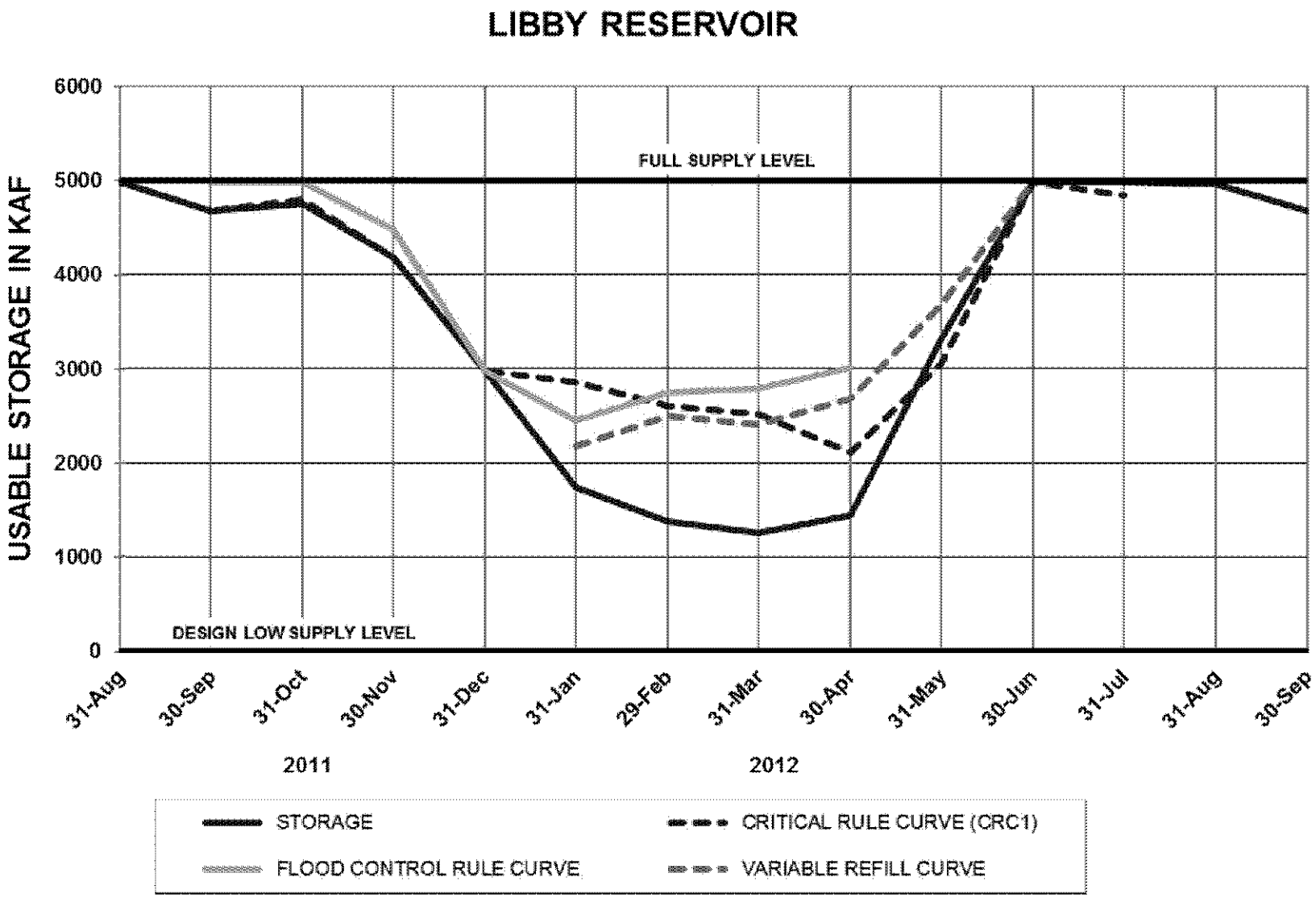
Flood Control Operations

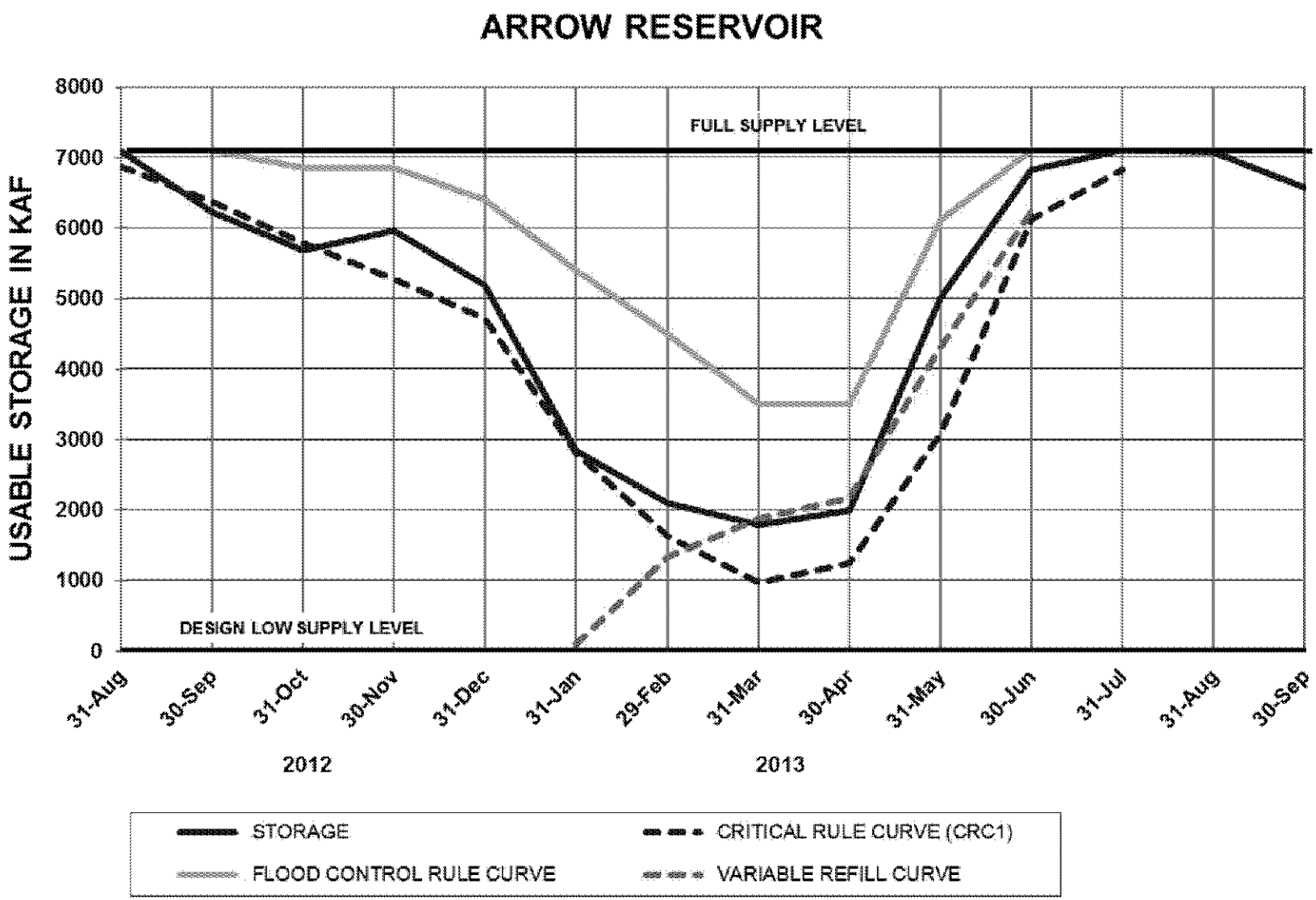
Columbia River Basin projects were operated according to the May 2003 Flood Control Operating Plans. Peak regulated and unregulated flows are discussed in the next section on Treaty Benefits.

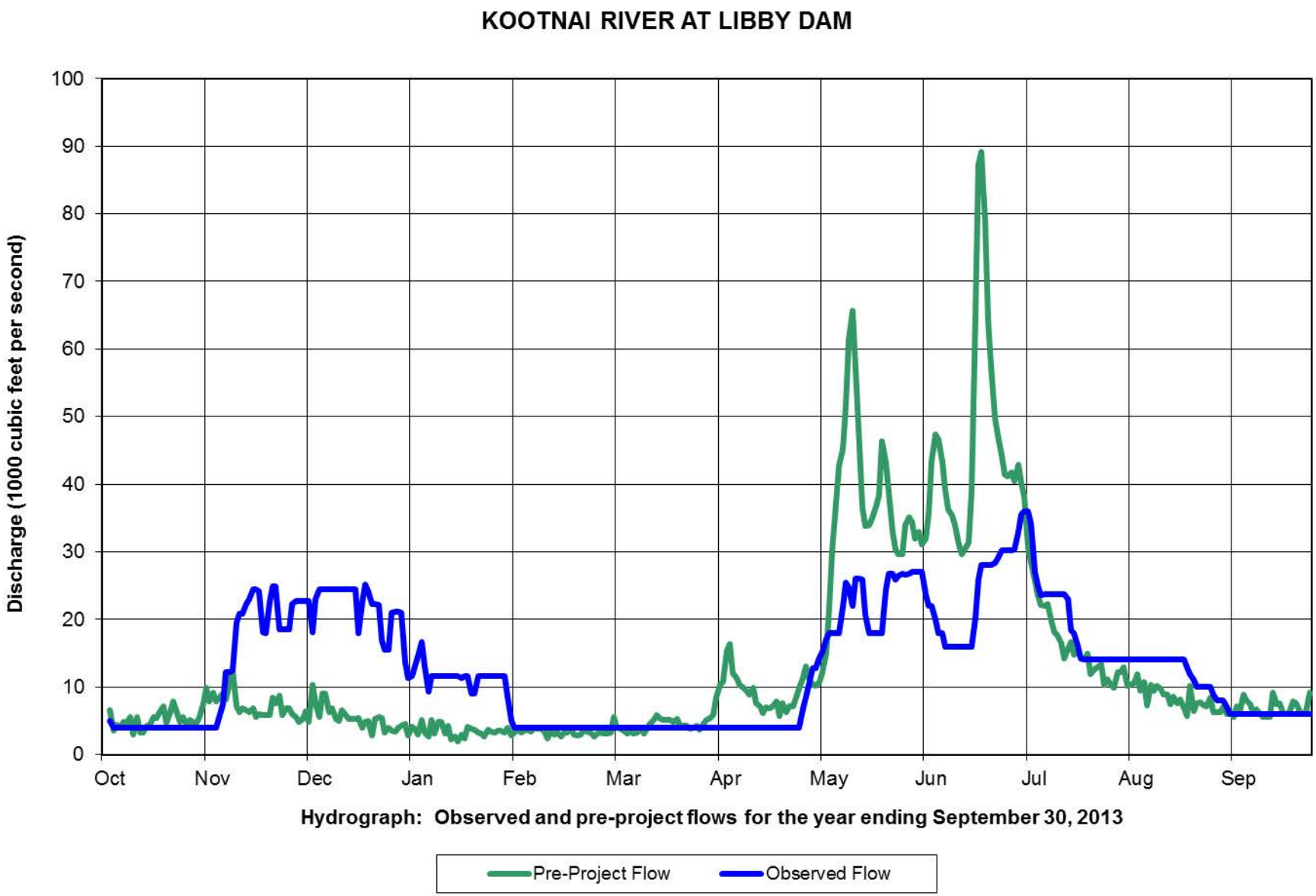
DUNCAN RESERVOIR

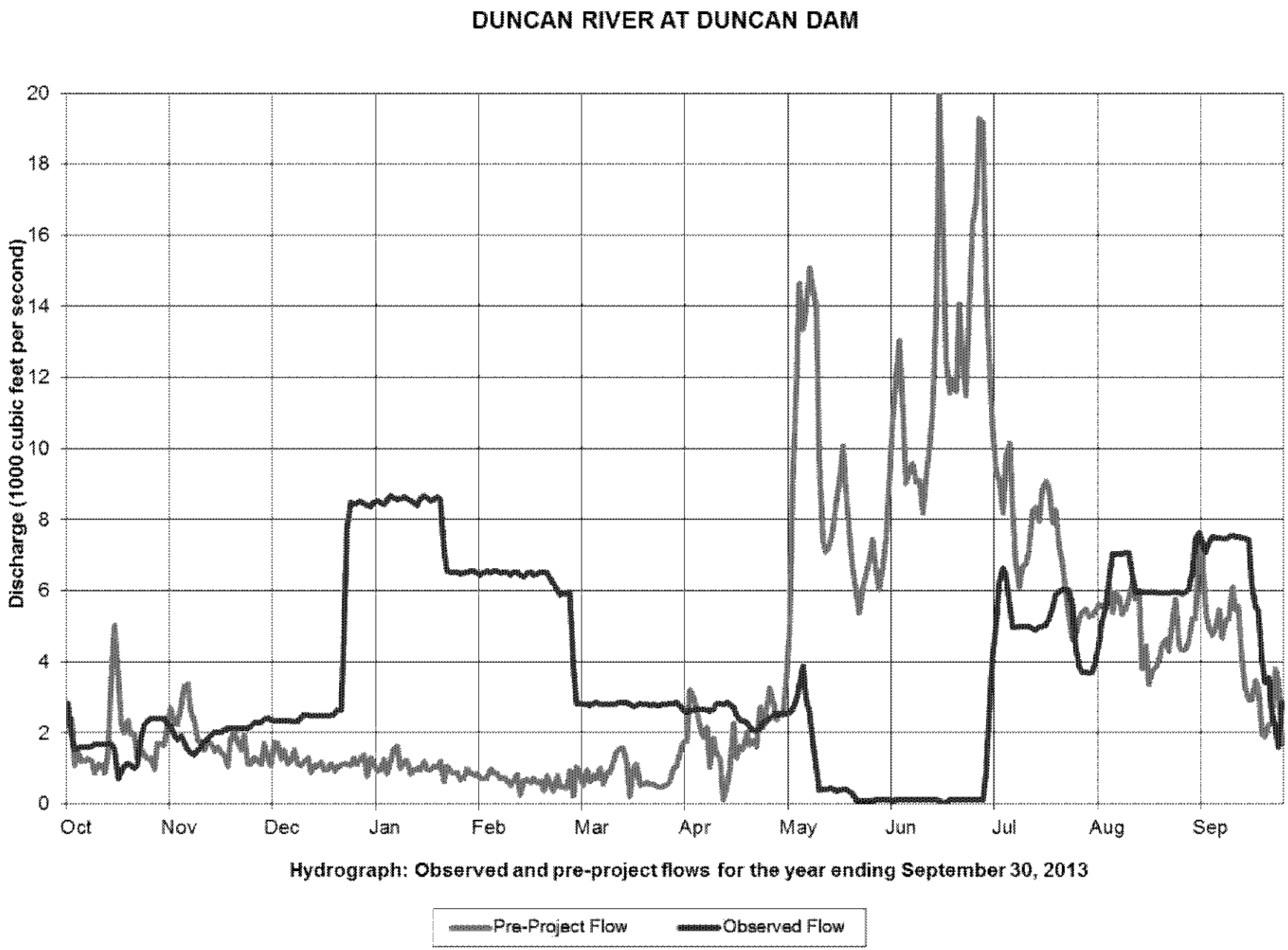



MICA RESERVOIR
USABLE STORAGE IN KAF
14000
12000
10000
8000
6000
4000
2000
0
FULL SUPPLY LEVEL
TREATY STORAGE COMMITMENT
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
28-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2012
2013
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE RULE CURVE

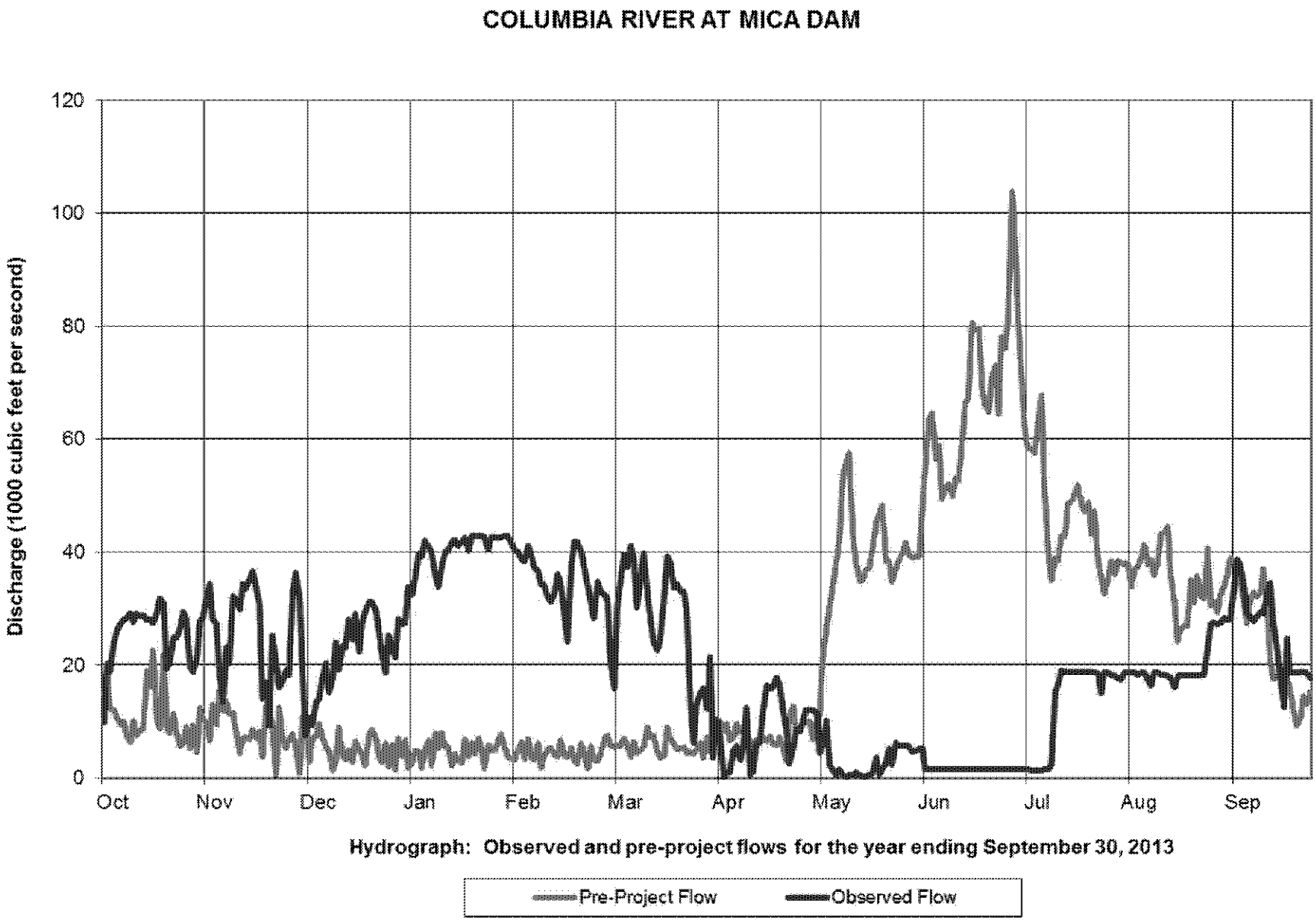

LIBBY RESERVOIR
USABLE STORAGE IN KAF
6000
5000
4000
3000
2000
1000
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
29-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2011
2012
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE

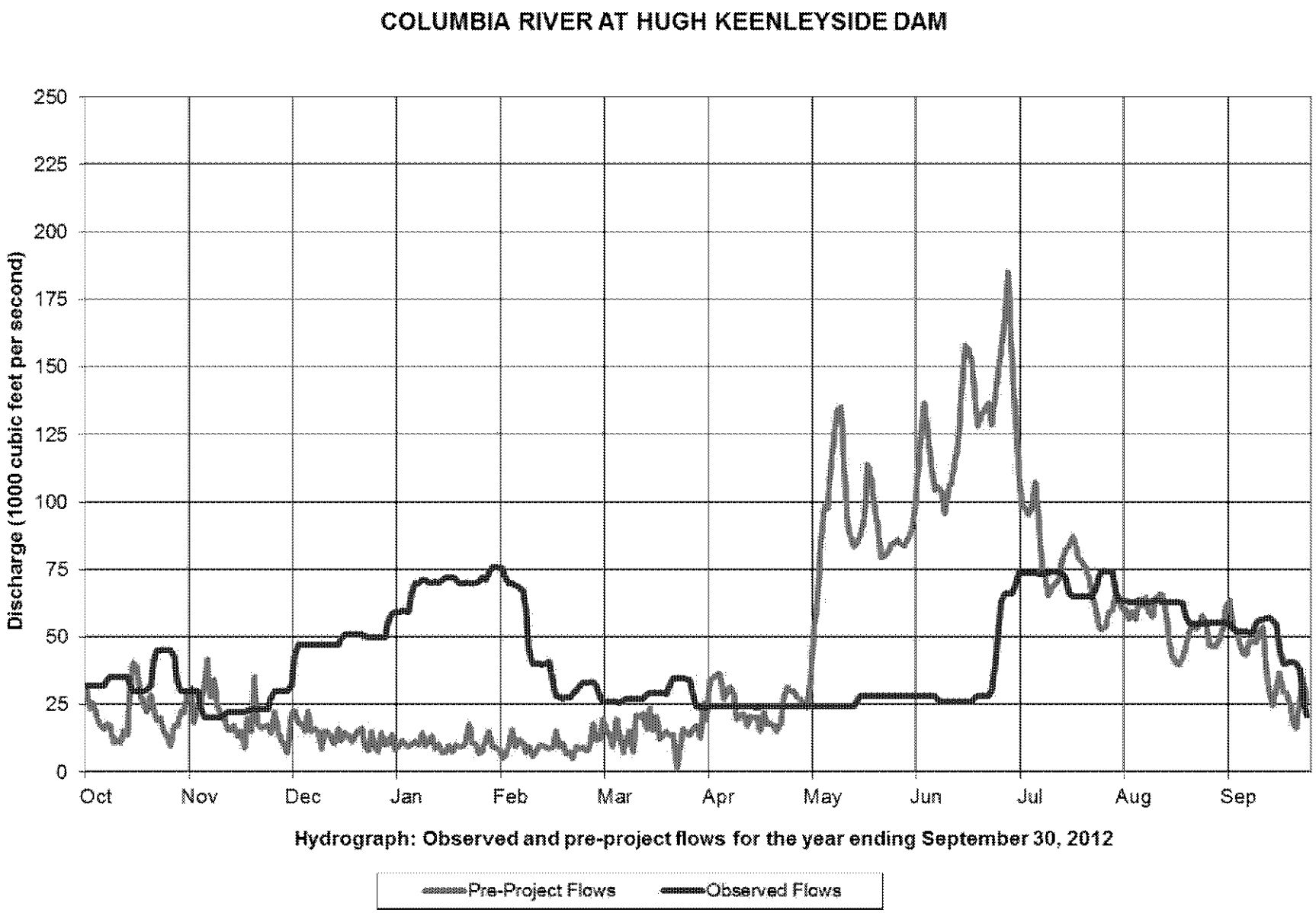

ARROW RESERVOIR
USABLE STORAGE IN KAF
8000
7000
6000
5000
4000
3000
2000
1000
0
FULL SUPPLY LEVEL
DESIGN LOW SUPPLY LEVEL
31-Aug
30-Sep
31-Oct
30-Nov
31-Dec
31-Jan
29-Feb
31-Mar
30-Apr
31-May
30-Jun
31-Jul
31-Aug
30-Sep
2012
2013
STORAGE
CRITICAL RULE CURVE (CRC1)
FLOOD CONTROL RULE CURVE
VARIABLE REFILL CURVE

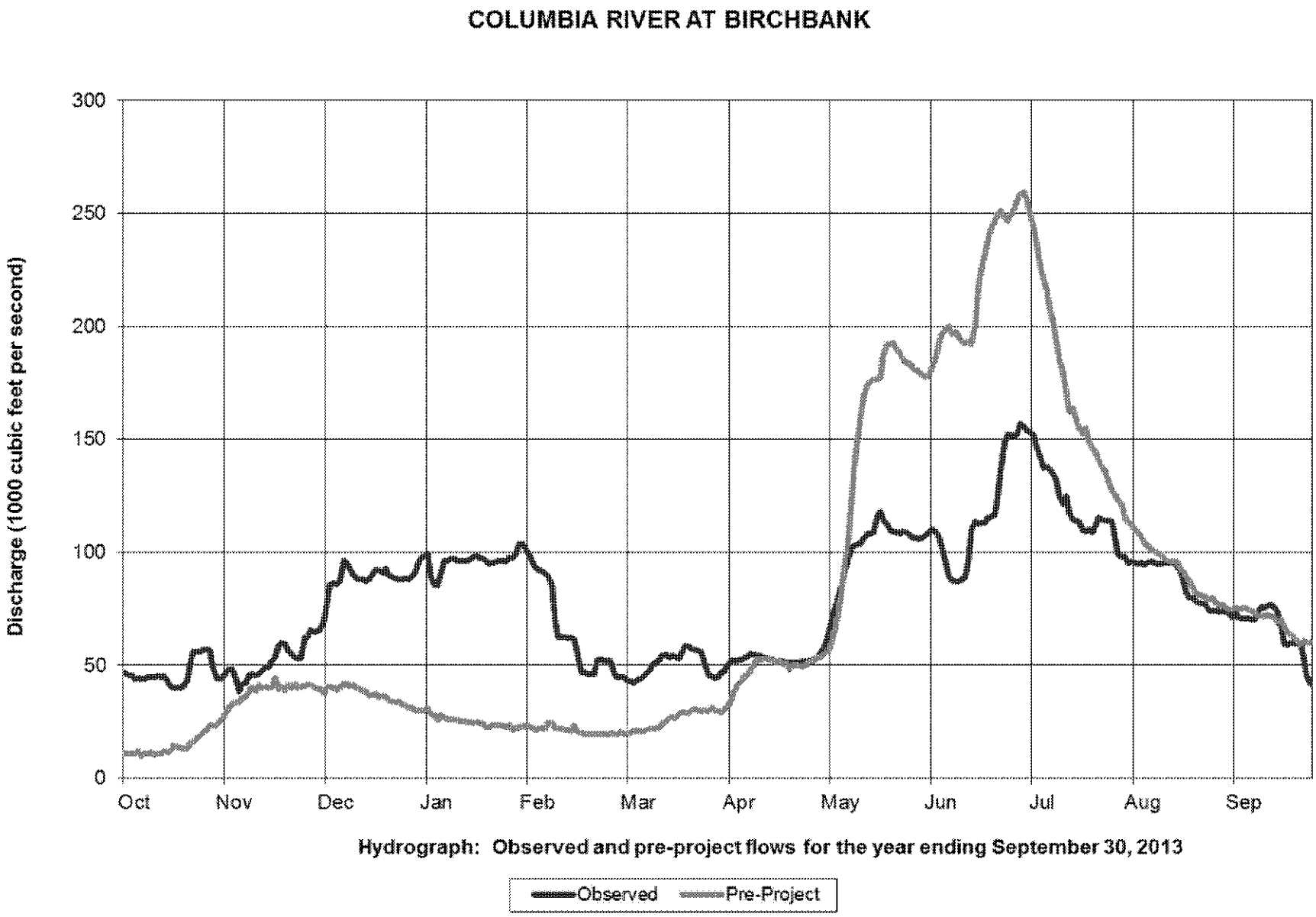

KOOTNAI RIVER AT LIBBY DAM
Discharge (1000 cubic feet per second)
100
90
80
70
60
50
40
30
20
10
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Hydrograph: Observed and pre-project flows for the year ending September 30, 2013
Pre-Project Flow
Observed Flow



Hydrograph: Observed and pre-project flows for the year ending September 30, 2013


COLUMBIA RIVER AT MICA DAM
Discharge (1000 cubic feet per second)
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, 2013
Pre-Project Flow
Observed Flow


COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM
Discharge (1000 cubic feet per second)
250
225
200
175
150
125
100
75
50
25
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, 2012
Pre-Project Flows
Observed Flows


COLUMBIA RIVER AT BIRCHBANK
Discharge (1000 cubic feet per second)
300
250
200
150
100
50
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, 2013
Observed
Pre-Project

TREATY BENEFITS

Flood Control Benefits

The annual volume of runoff at The Dalles was near average in 2013, but it was unevenly distributed upstream. The Upper Columbia, including the Kootenai/y sub-basin, experienced higher than average runoff in contrast to the Upper Snake sub-basin which had extremely dry conditions and near record low runoff. Most of the other sub-basins were near average. There was one spring flooding event in 2013. The Kootenai/y was hit by a large storm from 18-20 June which produced rain totals of 2 to 4 inches in the 3-day period. Inflows to Lake Koocanusa increased from 850 m3/s (30 kcfs) on 18 June to 2,520 m3/s (89 kcfs) on 22 June. Libby Dam was successfully operated to minimize flood damages in the both the U.S. and Canada. Damaging flows were not experienced in the lower Columbia River in 2013. 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 May 2013	14, 200 (503,000)	11 May 2013	9,580 (338,000)

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 May 2013	5.6 m (18.4 ft)	12 May 2013	3.1 m (10.3 ft)

Duncan and Libby projects limited the peak stage of Kootenay Lake to elevation 533.2 m (1749.3 ft) on 25 June 2013. Without regulation from these Treaty dams, the peak would have been about 1.7 meters higher (approximately elevation 534.9 m or 1,754.9 ft). For reference, flood stage at Kootenay Lake is 534.92 m (1,755.0 ft). Duncan, Arrow, Mica and Libby projects limited the peak flow of the Columbia River at Trail, just upstream of Birchbank, British Columbia, to 4,417 m^3/s (156 kcfs) on 5 July 2013, below the threshold flow for minor flooding impacts of 5,100 m^3/s (180 kcfs). Absent the dams, the flow would have been approximately 7,334 m^3/s (259 kcfs). For reference, the bankfull flow at Birchbank is estimated to be 6,370 m^3/s (225 kcfs).

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 2012 through 31 July 2013, the Canadian Entitlement amount, before deducting transmission losses, was 504.5 aMW of energy, scheduled at rates up to 1321 MW capacity. From 1 August 2013 through 30 September 2013, the amount, before deducting transmission losses, was 505.5 aMW of energy, scheduled at rates up to 1336 MW capacity.

During the course of the 2012-2013 Operating Year, there were four curtailment events for Canadian Entitlement deliveries. These included a 43 megawatt hour (MWh) cut on 9 September 2012 due to a forest fire near Grand Coulee, a 48 MWh cut on 19 March 2013 due to transmission congestion within the BPA system, a 22 MWh cut on 25 April 2013 due to transmission line maintenance work and a 28 MWh cut on 28 September 2013 due to transmission congestion in the Puget Sound area of Washington State. The curtailed power was delivered later within the same month of curtailment, as per agreements between the Entities, with the exception of the 28 September 2013 cut, which was delivered on 1 October 2013.

Actual U.S. power benefits from the operation of Canadian storage are unknown and can only be roughly estimated. Canadian 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 increase in average annual U.S. power generation in 2013 due to the operation of Canadian storage, as measured by the PNCA AER, is 552 aMW. In addition, the Treaty regulation shifted the timing of generation from the low value freshet period, into higher value winter months. No quantification of this benefit is provided in this report.

Other Benefits

The CRTOC completed one supplemental storage agreement that provided non-power benefits in 2013, the Non-Power Uses Agreement (1 December 2012 through 31 July 2013). Non-power benefits included changes in storage at Canadian reservoirs and changes in flows below Arrow Dam that enhanced trout and whitefish spawning in Canada, and provided 1 Maf of flow augmentation to benefit downstream migration of salmon and steelhead in the U.S.

Revelstoke Dam, Columbia River, BC

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

CONCLUSIONS

This report described Treaty projects, storage operations, and the resulting benefits achieved by each country for the period from 1 October 2012 to 30 September 2013. Canadian Treaty storage began the Operating Year on 1 August 2012 at 99.7 percent full, and ended the year on 31 July 2013 at 99.1 percent full. The actual runoff for the overall Columbia Basin (U.S. and Canada combined) for the 2013 water year was relatively average, ranking 31st wettest out of 54 years of record in total April-August runoff as measured at The Dalles.

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. During the course of the 2012-2013 Operating Year, there were four curtailment events for Canadian Entitlement deliveries with all of the curtailed power delivered later within the same month of curtailment, as per agreements between the Entities, with the exception of the 28 September 2013 curtailment, which was delivered on 1 October 2013.

The CRT Entities continue to seek resolution to Canadian concerns over Libby VarQ operations and have approved a short-term agreement where BC Hydro receives further flexibility for its Arrow provisional draft account as well as a more efficient benefit-delivery mechanism.

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.

No significant operational issues were observed during this reporting period.

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

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

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Institute for Water Resources
U.S. Army Corps of Engineers
Alexandria, Virginia

Mr. George Bell
Consultant
Lake Oswego, Oregon

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Principal Hydrologic & Hydraulic Engineer
Engineering & Construction CoP
Directorate of Civil Works
U.S. Army Corps of Engineers
Washington, DC

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Director General
Electricity Resources Branch
Natural Resources Canada
Ottawa, Ontario

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

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

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

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

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

RECORD OF MEMBERSHIP

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Mr. Wendell Johnson* 1964–1970
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Mr. Homer Willis* 1973–1979
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Mr. John Elmore* 1994–1996
Mr. Steven Stockton* 1996–
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Mr. Paul Barber 1994–1995
Mr. Daniel Burns 1995–1997
Mr. George Bell 1997–
Mr. Earl Eiker 2000–2004
Mr. Robert Pietrowsky 2004–

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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. John Allan 1991–1999
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Mr. Daniel Whelan* 1996–2002
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Mr. Jack Ebbels 2001–2003
Mr. Tim Newton 2003–
Mr. Tom Wallace* 2004–2012
Mr. Jonathan Will* 2012–

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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
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Members

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Principal Hydrologic & Hydraulic Engineer
Engineering & Construction CoP
Directorate of Civil Works
U.S. Army Corps of Engineers
Washington, DC

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

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

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

Canada

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

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

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

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
ENGINEERING COMMITTEE

RECORD OF MEMBERSHIP

United States

Members

Mr. Shapur Zanganeh* 1990-1995
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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-
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Canada

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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. Elliot E. Mainzer, Acting Chair
Acting Administrator and CEO
Bonneville Power Administration
Department of Energy
Portland, Oregon

Colonel John S. Kem, 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

Mr. Scott R. Simms, Secretary
Policy Strategist
Regional Coordination
Bonneville Power Administration
Department of Energy
Portland, Oregon

Canada

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Executive Vice President
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
Principal 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

Ms. Pamela A. Kingsbury, 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
Specialist 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

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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
Manager
Hydrologic and Technical Services
Generation Resource Management
British Columbia Hydro and Power Authority
Burnaby, British Columbia

Mr. Adam Gobena, Member
Senior Engineer
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 2013

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	9.15	9.38	28.60	15.10	7.83	6.23	10.30	18.60	38.10	36.00	15.70	10.20
2	7.05	8.49	29.30	15.00	6.57	6.50	11.60	20.30	37.50	35.90	16.00	9.69
3	7.27	7.84	26.00	15.90	6.38	6.96	13.20	21.40	37.70	35.30	16.20	9.38
4	5.46	7.88	29.90	17.00	6.49	7.56	15.10	22.00	38.30	38.30	16.10	8.96
5	5.58	8.08	33.70	18.90	6.57	7.36	17.10	24.40	38.50	39.80	16.30	8.44
6	5.38	11.30	36.90	15.90	6.38	7.25	21.70	26.50	35.00	40.30	16.00	7.90
7	5.30	14.90	34.70	12.50	6.36	7.25	24.10	31.30	34.30	39.80	16.00	7.48
8	5.24	15.20	32.70	14.30	6.38	7.17	22.80	36.20	33.60	36.00	15.90	7.54
9	5.26	16.30	31.30	14.70	6.46	7.21	20.00	40.00	31.10	30.40	16.00	7.57
10	5.23	22.20	30.60	14.90	6.32	7.03	17.60	42.90	28.90	28.70	15.60	7.59
11	5.37	23.50	30.20	14.90	6.33	6.74	16.40	43.80	27.60	27.50	15.80	7.35
12	5.46	23.60	29.80	14.80	6.44	6.96	15.70	50.50	25.50	26.60	15.80	7.22
13	5.62	24.70	29.70	14.60	6.19	7.28	14.80	56.30	24.30	26.80	15.70	7.34
14	5.79	26.10	29.50	14.30	6.45	8.07	14.40	57.00	23.90	26.70	15.70	7.49
15	6.02	26.90	29.20	14.40	6.27	8.94	13.50	49.90	23.20	26.20	15.60	7.56
16	5.88	27.20	27.60	14.50	6.25	10.40	12.80	46.80	22.80	26.20	15.70	7.58
17	6.03	25.70	23.60	14.30	6.24	11.30	12.10	43.80	22.70	25.80	15.60	7.12
18	5.99	21.60	27.40	14.40	6.27	11.40	11.50	42.10	22.80	25.50	15.80	7.41
19	5.66	21.10	29.60	14.30	6.28	10.70	11.20	36.60	24.00	24.20	15.70	7.82
20	5.77	27.90	28.00	11.80	6.30	10.60	11.10	33.80	28.10	20.60	15.50	7.63
21	5.77	32.20	26.50	11.80	6.28	10.40	11.80	33.90	36.20	20.10	15.60	7.26
22	5.57	30.60	26.40	14.10	6.34	10.40	12.20	38.10	37.90	18.20	15.60	7.46
23	5.42	24.90	25.00	14.20	6.27	10.10	11.90	38.40	37.20	16.60	15.40	7.46
24	5.43	23.60	21.20	14.40	6.40	9.62	11.40	36.50	36.00	16.40	14.40	7.34
25	5.51	23.40	19.80	14.40	6.19	9.25	11.30	40.30	36.10	16.30	13.60	7.71
26	5.42	23.00	20.00	14.50	6.30	9.05	11.40	39.90	36.30	15.90	12.70	8.08
27	5.44	25.60	23.70	14.70	6.19	8.90	12.60	39.10	36.00	15.90	11.30	7.75
28	5.50	26.00	24.50	14.50	6.15	8.76	14.00	38.50	36.70	15.80	11.40	8.20
29	5.86	26.10	24.40	14.60		8.83	14.90	39.00	37.20	16.00	11.20	10.20
30	6.96	26.60	23.40	14.10		9.03	17.80	39.70	36.90	15.90	11.00	11.40
31	9.45		17.30	11.10		9.47		38.90		15.80	10.90	
Mean	**5.96**	**21.06**	**27.44**	**14.48**	**6.39**	**8.60**	**14.54**	**37.63**	**32.15**	**25.79**	**14.83**	**8.07**

COLUMBIA RIVER AT BIRCHBANK, BRITISH COLUMBIA

Daily discharges in thousands of cubic feet per second for the year ending 30 September 2013

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1.0	46.7	47.0	69.8	98.6	101.6	52.3	45.7	51.5	108.7	148.2	114.2	76.9
2.0	45.6	48.2	78.6	99.2	99.4	51.7	45.1	51.7	107.3	151.9	113.8	74.2
3.0	45.6	48.2	85.8	89.0	95.6	47.5	44.2	52.4	106.7	152.2	113.3	74.0
4.0	44.1	43.5	86.5	85.5	93.0	44.6	44.8	52.7	106.3	151.6	106.2	74.0
5.0	44.4	38.1	85.8	85.5	92.3	45.0	46.5	54.1	105.8	152.5	98.8	73.8
6.0	43.8	41.5	87.1	90.3	91.4	44.9	47.2	56.0	106.4	156.6	98.2	73.6
7.0	43.9	42.0	96.1	96.2	90.5	43.6	50.0	58.7	108.0	155.5	98.1	73.8
8.0	44.8	45.0	95.3	96.2	89.4	43.0	52.0	63.7	109.0	153.9	95.2	73.2
9.0	44.9	45.9	93.0	97.2	85.4	42.1	52.3	69.7	110.2	153.1	95.7	71.0
10.0	45.0	45.8	89.9	97.3	70.3	43.0	52.3	74.6	108.7	151.3	95.5	70.8
11.0	45.0	45.9	88.6	96.1	62.4	43.9	52.4	80.0	106.8	146.4	94.8	70.9
12.0	44.9	47.3	87.9	96.2	62.3	44.6	52.9	84.9	101.9	142.6	95.2	70.6
13.0	45.0	49.2	87.9	96.3	62.3	46.0	53.6	91.0	94.8	137.4	94.7	70.3
14.0	42.8	49.3	87.3	96.2	62.0	47.9	55.1	96.5	89.1	137.8	95.2	70.3
15.0	40.2	51.5	88.1	96.5	62.3	50.3	54.5	101.7	87.4	136.9	95.8	73.2
16.0	40.2	53.7	90.6	97.9	61.2	50.6	54.5	102.8	87.3	134.1	95.3	75.7
17.0	40.2	58.2	92.4	98.2	55.3	52.4	54.3	103.5	87.2	131.5	95.1	75.6
18.0	40.2	60.0	91.7	97.7	47.1	54.4	53.6	104.0	87.6	124.7	94.9	76.5
19.0	40.9	59.6	91.2	97.2	46.7	54.7	52.9	106.1	89.1	121.4	95.2	76.6
20.0	43.1	56.3	92.6	95.6	45.9	53.2	52.7	108.5	96.6	124.7	95.5	75.3
21.0	50.8	55.2	89.7	95.1	46.0	54.1	52.8	108.3	109.8	117.3	95.4	73.8
22.0	55.9	53.2	89.0	95.2	46.1	53.9	51.2	108.9	113.3	114.4	95.6	66.8
23.0	55.9	52.8	88.5	95.8	62.9	52.8	52.0	116.5	112.8	114.1	93.5	59.6
24.0	56.2	52.8	87.8	96.0	62.9	55.7	51.6	117.8	113.2	113.4	92.7	59.1
25.0	56.7	62.0	88.1	96.4	59.7	58.8	51.2	114.1	113.1	109.8	86.8	60.1
26.0	56.9	62.6	88.3	95.9	52.2	58.2	51.1	112.1	115.4	109.1	82.0	59.8
27.0	56.3	65.6	88.1	97.5	52.4	57.2	51.1	109.8	115.6	109.9	79.8	59.3
28.0	49.1	64.5	88.7	97.7	52.1	56.8	51.2	109.1	116.5	108.8	79.8	59.6
29.0	44.2	65.0	90.8	99.3		56.4	51.4	108.6	124.9	111.6	77.9	53.1
30.0	44.0	66.1	94.7	103.5		55.7	51.7	108.5	136.1	115.2	77.6	45.3
31.0	44.8		97.5	103.4		50.9		109.0		114.2	77.2	
Mean	**46.5**	**52.5**	**88.9**	**96.1**	**68.2**	**50.5**	**51.0**	**89.9**	**105.8**	**132.3**	**94.2**	**68.9**

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

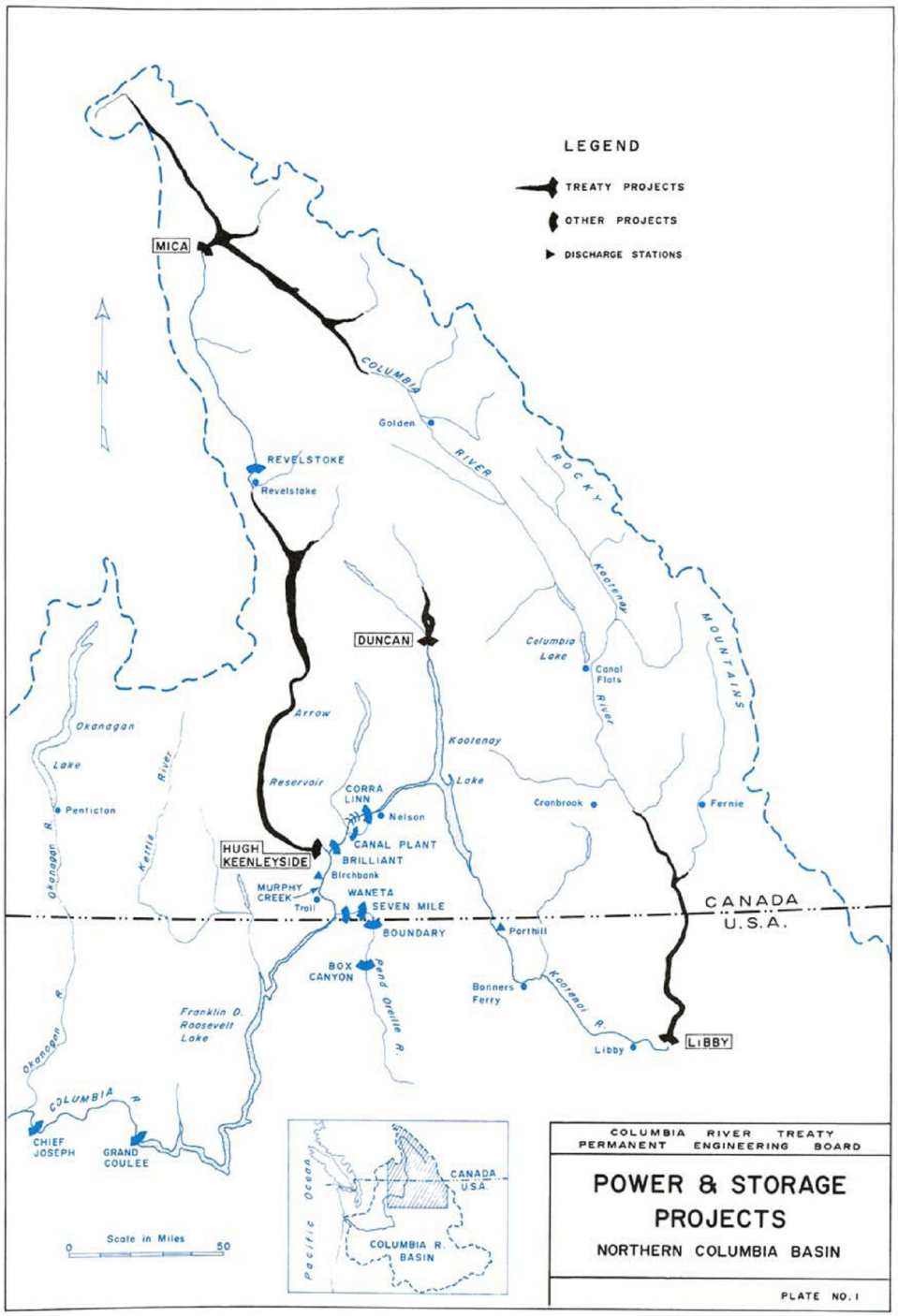
LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
N
COLUMBIA
RIVER
ROCKY
MOUNTAINS
Golden
REVELSTOKE
Revelstoke
DUNCAN
Columbia Lake
Canal Flats
Kootenay
River
Arrow
Reservoir
Okanagan
Lake
Penticton
Okanagan R.
Kettle
River
Kootenay
Lake
CORRA LINN
Nelson
CANAL PLANT
BRILLIANT
HUGH KEENLEYSIDE
Birchbank
MURPHY CREEK
Trail
WANETA
SEVEN MILE
BOUNDARY
Cranbrook
Fernie
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 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 m (2600 ft)
Approximate height above riverbed	39.6 m (130 ft)
Spillway – Maximum capacity	1350 m^3/sec (47.7 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 (1378 ft)
Surface area at full pool	52,610 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	6800 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)	23.5 m (77 ft)
Maximum turbine discharge	1200 m^3/sec (42.4 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	42,900 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	4250 m^3/sec (150 kcfs)
Outlet works – Maximum capacity	1060 m^3/sec (37.4 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 (38.2 kcfs)

Currently under-construction (expected completion by 2016):

2 units at 520 MW	1040 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	697.1 m (2287 ft)
Surface area at full pool	18,820 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	931.2 m (3055 ft)
Approximate height above riverbed	112.8 m (370 ft.)
Spillway – Maximum capacity	4110 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 m (352 ft)
Maximum turbine discharge of 5 units at full pool	750 m^3/sec (26.5 kcfs)