

## Appendix B

### Operations on the Columbia River - Relationship between Columbia River Treaty, Non Treaty Storage Agreement, and Water Use Plans

The actual physical operations on the Columbia River are a result of a combination, or layering, of different agreements that fall within the Columbia River Treaty framework, plus some limited unilateral flexibility that Canada has to meet system and non-power needs. The Columbia River Treaty itself is highly prescriptive to meet detailed requirements for flood control and power generation. Other agreements are used by the Canadian and US Entities to achieve a more advantageous operation and address other fisheries or recreation interests.

These other agreements fall into two categories:

- Those that change the operation of the 15.5 million acre feet of Treaty Storage
- Those that change the operation of the additional storage built in Canada, referred to as Non-Treaty Storage

When Mica dam was constructed, it was built with an additional 5 million acre-feet of live storage capacity beyond that required under the terms of the Columbia River Treaty. It was economic to build this extra storage due to the increased power generation at Mica from the higher dam and the improved ability to regulate reservoir discharges. This additional reservoir storage cannot be fully utilized without agreement from the US Entity as doing so could conflict with reservoir discharge requirements under the Columbia River Treaty. This additional storage is managed under the Non Treaty Storage Agreement (NTSA). Similarly, an additional 0.25 MAF of storage was built at Arrow (El. 1444 – 1446 ft), however, this storage is only available when required for flood control.

The combination of operations of the Treaty Storage and Non-Treaty Storage managed under the different agreements determines the total flow released from Canadian reservoirs. However, BC Hydro has flexibility to operate the individual dams for Canadian benefits provided i) the flood control draft requirements at each reservoir are maintained, and, ii) the total discharge from Canadian reservoirs remains unchanged. This *Canadian Flexibility* allows BC Hydro to move water between Mica, Revelstoke<sup>1</sup>, Arrow, and Duncan (within project operating constraints) in response to various power, social and environmental interests.

It was primarily through use of this Canadian Flexibility and use of BC Hydro's portion of the Non-Treaty storage that beneficial changes to operations on the Columbia were investigated in the Columbia Water Use Plan. The WUP consultative planning process was conducted from 2000 to 2004 and resulted in a consensus agreement on a preferred operating regime and package of monitoring and physical works projects.

The Water Use Plan and BC Hydro's water licences, which are consistent with the Columbia River Treaty requirements, provide the overall framework for system operations. Any operational changes considered by BC Hydro with respect to Non-Treaty storage utilization or agreements for mutual benefit on the use of Treaty storage must adhere to these overall operational conditions.

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<sup>1</sup> Revelstoke dam is not a Treaty dam.

This appendix describes the different agreements that are used to manage the Treaty and Non-Treaty storage and also provides further detail on the Columbia Water Use Plan.

## 1.0 Columbia River Treaty Operations

The Columbia River Treaty dictates the flows to be released from Canadian Treaty storage, given current conditions and forecasted flows, and what flood control space should be available in Canadian Treaty reservoirs at certain times during the year. The default operation is determined through the **Assured Operating Plan** which is developed 5 years in advance. The Assured Operating Plan includes Operating Rule Curves that guide the Treaty storage operations to ensure flood control, optimum power, and refill for the coordinated system in average and better water years. During low flow conditions, Critical Rule Curves guide reservoir operations<sup>2</sup> for firm power needs. This default Treaty storage operation can then be updated/modified through a number of different methods<sup>3</sup>.

A **Detailed Operating Plan** is prepared each year for the following year based on the Assured Operating Plan. Operating rules developed in the Assured Operating Plan may be changed by mutual agreement to achieve results more advantageous to both countries<sup>4</sup>. If no agreement is reached, then the rules developed in the Assured Operating Plan are applied. The Detailed Operating Plan contains detailed information on project specific constraints and special operating rules, and, once completed, is the guiding document for Treaty storage operation for the year. Typically, there are only minor changes from the Assured Operating Plan to the Detailed Operating Plan.

The Detailed Operating Plan is implemented via **Treaty Storage Regulation** studies that determine the monthly storage rights and obligations for Duncan, Mica and Arrow. Studies are conducted twice monthly to determine the end of month targets for Canadian Treaty reservoir storage. The Treaty Storage Regulation uses actual inflows to date plus the forecast stream flows, along with current reservoir conditions.

The Treaty Storage Regulation specified operation can, and is often, modified by mutual agreement between the Entities. This may be done only with prior agreement from both Entities. **Supplemental Operating Agreements** have been signed and implemented each year since 1993 to allow such operations to benefit power, fish, wildlife, recreation, and other interests on both sides of the border. A prime example of an essential annual supplemental operating agreement is the:

*Non-power Uses Agreement, which includes the following provisions:*

- Flow management for rainbow trout spawning in the Canadian Columbia River to maintain non-decreasing river levels at Norns Creek Fan below Keenleyside between 1 April and 30 June.
- Flow management for whitefish protection during the January through March period.
- Storage of flow augmentation water in Canadian Treaty reservoirs during January through March for later release to assist salmon out-migration in the U.S. system.

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<sup>2</sup> Under the Columbia River Treaty, all storage reservoirs in the combined United States and Canadian system are to be drafted “proportionately” between the critical rule curves when needed to meet the firm load. Since the objective is maximizing power production, Arrow tends to be drafted deeper earlier than Grand Coulee.

<sup>3</sup> Further detail of Operating Rule Curves, the Flood Control Operating Plan and general operations under the Columbia River Treaty can be found in section 2.2 of the Water Use Plan Consultative Committee Report (BC Hydro 2005) and section 1.2 and Appendix A of the Columbia River Treaty 2014/2024 Phase 1 Report (Canadian and US Entity, 2010)

<sup>4</sup> This is explicit under Article XIV (2-K) of the Columbia River Treaty.

Another agreement that modifies the Treaty Storage Regulation is the **Libby Coordination Agreement**, which was signed to set aside a dispute over Libby operations. The Libby Coordination Agreement allows the U.S. Entity to operate Libby dam to meet U.S. fisheries laws and provides options for Canada to self-compensate for the resulting loss of power production. This is accomplished by Canada releasing water from the Arrow Lakes Reservoir (above normal Treaty requirements) and receiving the resulting power generated at U.S. federal plants during periods of high power value. Later, Canada re-stores the water (reducing the Arrow discharge below that required by the Treaty) and returns the power to the U.S. during times of lower power value, with the value difference being the net compensation to Canada. The Libby Coordination Agreement also provides Canada an option to exercise an Arrow-Libby “storage swap” when beneficial to Canada. Such a “storage swap” has been implemented in several years to improve recreational conditions for the communities on Koochanusa Reservoir.

The actual operation of the Canadian Treaty Storage is finalized through a weekly Treaty Flow Agreement where the Entities agree on the total Arrow + Duncan outflow for the following week. These outflows are based on drafting or filling Canadian reservoirs to end-of-month storage levels determined by the Treaty Storage Regulation study, and modified by any Supplementary Operating Agreements. Small alterations to releases may also be requested based on unforeseen circumstances throughout the week. Flood control requests during the refill season can be on a daily basis as conditions are constantly changing.

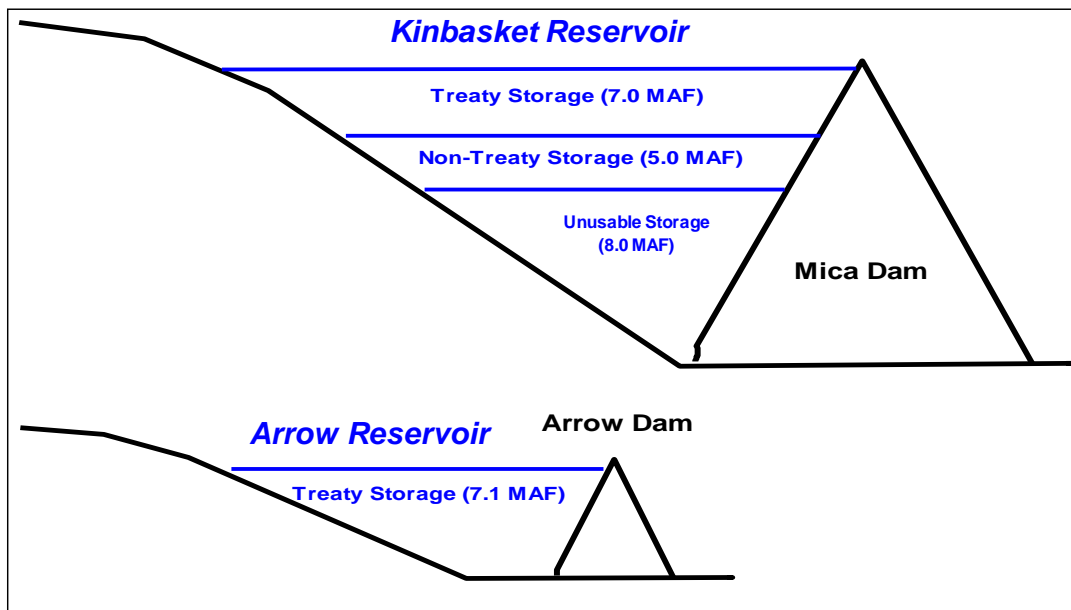
## 2.0 Non-Treaty Storage Agreement

The Non-Treaty Storage Agreement (NTSA) is separate and distinct from the Columbia River Treaty. While the Columbia River Treaty is an international agreement between the United States and Canada for the primary purpose of flood control and power production, the Non-Treaty Storage Agreement is a commercial agreement<sup>5</sup> between BC Hydro and Bonneville Power Administration.

The prescriptive formulas that operate the 15.5 MAF of storage under the Treaty are based on the assumption that there is up to 7.0 MAF of water stored at Kinbasket, up to 7.1 MAF of water stored at Arrow, and up to 1.4 MAF stored at Duncan. The available 5.0 MAF of Non-Treaty storage volume notionally exists at Mica dam (Figure 1). Non-Treaty Storage Agreement operations directly impact discharges from the Arrow Reservoir and have an indirect impact on discharges from the Kinbasket and Revelstoke reservoirs.

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<sup>5</sup> While the NTSA is distinct from the Treaty, prior to BC Hydro and BPA signing the NTSA, the Canadian and U.S. Treaty entities were required to, and did, affirm that operations under the NTSA do not diminish the benefits to either country from the Treaty.



**Figure 1: Notional storage volumes in Kinbasket and Arrow Lakes Reservoirs**

### History of Non-Treaty Agreements

The Non-Treaty storage cannot be fully utilized without agreement from the US Entity as doing so could conflict with reservoir discharge requirements under the Columbia River Treaty. In 1983, BC Hydro and Bonneville Power Administration reached a short-term agreement covering operations of some of the additional 5.0 MAF of Kinbasket storage. When the short-term agreement expired, the first longer-term Non-Treaty Storage Agreement was signed in 1984. This also resolved a dispute over the filling of Revelstoke reservoir. As part of the initial 1984 NTSA conditions all of the storage except for the 0.5 MAF began full and the two parties agreed to share the operations of 2 MAF.

The NTSA was then expanded in 1990 such that both parties agreed to share the operations of all 4.5 MAF of the initially-full Non-Treaty storage. The release provisions of the 1990 agreement expired in June 2004, while storage refill provisions remained in effect for an additional seven years until February 2011 when the 4.5 MAF of NTSA storage was completely filled.

The most recent Non-Treaty Storage Agreement also governs the full 5 million acre-feet, was signed in April 2012 and will expire in September 2024.

### Provisions under the Current Non-Treaty Storage Agreement

The NTSA is an enabling agreement that provides for up to 5.0 MAF of storage operated by mutual agreement. As an enabling agreement, neither party is obligated to manage to a strict set of rules, but rather maintains the flexibility to utilize the additional storage to meet their power and non-power management objectives.

Unlike Treaty storage, there is no “default operation” for the Non-Treaty storage. On a weekly basis, both parties propose a release or storage transaction for their NTSA account, and these transactions must be agreed to by both parties before implementation occurs.

The 5 MAF of non-treaty storage is divided into different storage accounts, with only 3 MAF routinely operated as active storage (Figure 2). Highlights of the agreement include:

- The Active Storage Account of 3 MAF (1.5 MAF each for BC Hydro and BPA), to be operated by mutual agreement, is smaller than the active storage account in the 1990 agreement (4.5 MAF).
- The Recallable Storage Account of 0.5 MAF is similar to the 1990 agreement, while the Recallable Release Account of 1.5 MAF is new. Neither of these accounts can be operated unless BC Hydro, at its sole discretion, makes them available for operation.
- A 0.5 MAF release right to BPA is included for use in May/June to support salmon migration in the lower Columbia River during low flow years defined as the driest 20% of runoff years.
- A 2 kcfs release right to BC Hydro is included for use in the October – April period during low flow years to support firm energy resource planning requirements (thus deferring the need to procure other provincial energy sources).
- Improved termination and re-fill clauses that significantly reduce the extent and duration of potential storage use at the end of the contract term.

These terms met BC Hydro’s objectives of achieving greater control of Canadian reservoir operations, supporting BC Hydro’s ability to meet existing Columbia WUP objectives, and creating additional power and non-power benefits.

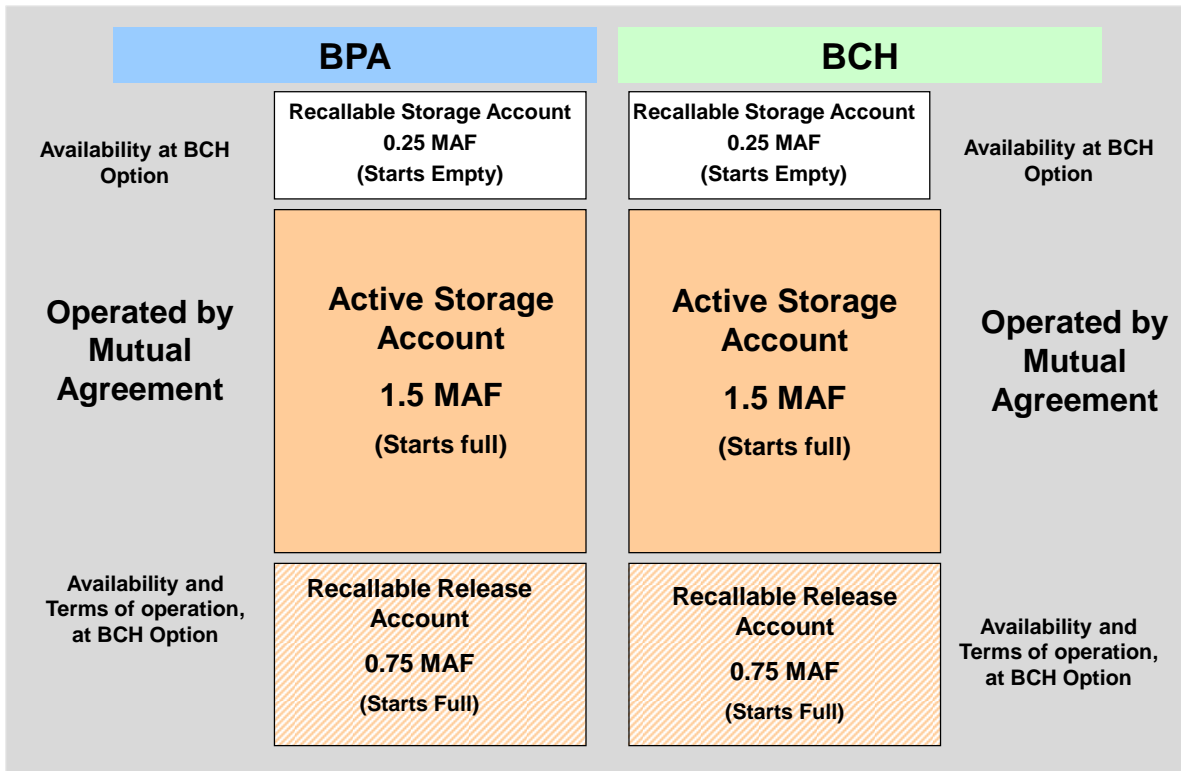


Figure 2: Summary of the 2011 NTSA Accounts

### 3.0 Water Use Plan / Water License Requirement Programs

BC Hydro has water licenses to store and divert water for hydropower production. As part of license requirements, BC Hydro undertook extensive consultation to develop Water Use Plans for the Columbia (Mica, Revelstoke, Hugh Keenleyside) and Duncan between 2000 and 2004. The consultative planning process involved government agencies, First Nations, local residents and other interest groups, and the goal was to find a better balance between competing uses of water, such as domestic water supply, fish and wildlife, recreation, heritage and electrical power needs. The

process developed recommendations on how incremental changes to operations of the facilities might have positive impacts on a variety of different interests. In many circumstances benefits were achieved through physical works in lieu of changes to operations. Recommendations also included monitoring programs and information gathering for future decision making.

In January 2007, the provincial Comptroller of Water Rights approved the Columbia River WUP and issued BC Hydro with the Implementation Order<sup>6</sup> which directs and mandates:

- all current operations within the system, and
- delivery of 62 monitoring programs & feasibility studies and 25 physical works at a cost of approximately \$120M over 12 years.

These operational changes, programs and projects are expected to benefit heritage and culture, fish and aquatic resources, erosion control, recreation, and wildlife and vegetation interests.

A review of Arrow Lake reservoir operations is slated for 5 years after implementation to evaluate the effectiveness of operations and physical works. A full review of the Columbia Water Use Plan is scheduled for 2020.

During the consultative process for the Columbia WUP, operational changes contemplated could not violate the Columbia River Treaty. This limited the scope to operational changes that could be achieved unilaterally by BC Hydro such as Canadian flexibility operations (e.g. moving water between Kinbasket and Arrow Lake reservoir), constraints on reservoir maximum/minimum levels that could be accommodated within the Treaty operations, ramping rates, and the incremental use of the BC Hydro portion of the Non-Treaty storage. Operating alternatives that affect the Detailed Operating Plans, Supplemental Operating Agreements or operations under the NTSA could also be considered; however, BC Hydro's ability to secure such operations through successful negotiations with the US Entity had to also be assessed.

### **Operating Constraints Agreed to in the WUP**

The following constraints were placed on Columbia operations to implement the WUP:

- *Kinbasket Reservoir and Mica dam*: no operational constraints;
- *Revelstoke Reservoir*: no operational constraints;
- *Revelstoke dam/Middle Columbia River*: A year round minimum flow of 5 kcfs<sup>7</sup> (142 m<sup>3</sup>/s) at Revelstoke dam was implemented with an estimated cost of \$3 million/year. Also, an experimental flow release program (1 July and 31 August) was agreed to for the Middle Columbia (Revelstoke Reach) to benefit juvenile recruitment of sturgeon up to a cap of \$5 million over a ten year period. A conservation aquaculture program is in place for White Sturgeon in the Middle Columbia and Arrow Lakes and involves assessing the effectiveness of the flow releases.
- *Arrow Lakes Reservoir / Middle Columbia River*: There were no operational changes for the Arrow Lakes Reservoir; however, 'soft constraints' are in place to balance vegetation, wildlife, , fisheries, recreation culture and heritage, shore erosion, and power generation as described in Table 2.

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<sup>6</sup> The order included an addendum with additional recommendations to address the incremental impacts of operations due to Revelstoke Unit 5. In August 2010 the CWR approved amendments to the Columbia Water Use Plan to include monitoring programs associated with Mica Generating Unit 5 and 6 (BC Hydro, 2012b).

<sup>7</sup> kcfs indicates *thousand cubic feet per second*. m<sup>3</sup>/s indicates *cubic meters per second*. 1 kcfs = 28 m<sup>3</sup>/s.

**Table 2 Soft Constraints on Arrow Lake Reservoir<sup>8</sup>**

Interest	Summary of soft constraint
Vegetation	If vegetation showing signs of stress (May-June) target lower reservoir levels in the fall. Preserve vegetation at/above 434 m (1424 ft).
Wildlife	Make sure reservoir levels inundating bird habitat in the early summer is no worse than 1984-1999 statistics. Bird habitat for the fall should be as good or better than 1984-1999 statistics. Draft reservoir quickly after full pool reached - target 438m (1437 ft) (or lower) by 7 Aug.
Fish	Keep levels high enough in fall for tributary access for kokanee spawning (August-November). Levels below 434 m (1424 ft) could cause problems for tributary access.
Recreation	Target reservoir levels between 437.4-438.9 m (1435-1440 ft) from 24 May to 30 Sep.
Culture & Heritage	Maintain reservoir levels below 436 m (1430 ft) for all but 2.5 months.
Shoreline Erosion	Minimize duration of full pool events - water levels of 439 m (1440 ft) are ideal. Avoid sudden draw down after full pool.

- *Hugh Keenleyside Dam /Lower Columbia:* BC Hydro is to continue to pursue Mountain Whitefish flows (reducing outflows from Arrow Reservoir during whitefish spawning, 1-21 January, and then managing excessive flow reductions after that until 31 March); and Rainbow Trout flows (avoid decreasing river levels from 1 April to 30 June) within various agreements with the US Entity.

## 4.0 Physical Operations of Mica, Arrow Duncan

The Columbia River Treaty provides the overall operating framework for operations at Mica, Arrow and Duncan reservoirs, and is highly prescriptive to meet detailed requirements for flood control and power generation. These default operations can only be changed by mutual agreement between the Canadian and US Entities.

BC Hydro has some flexibility (limited by flood control draft requirements) to operate the individual dams for Canadian power, social and environmental benefits. This *Canadian Flexibility* allows BC Hydro to move water between Mica, Revelstoke, Arrow, and Duncan provided the total discharge from Arrow and Duncan remains unchanged.

Modifications to the default operations that are advantageous to both countries can be made by mutual agreement and are used to address other ecosystem or social interests. Any operational changes considered by BC Hydro must adhere to the overall operational constraints within BC Hydro's water licenses and Water Use Plan Implementation Order.

Several different mechanisms are available to alter the default operations. The Entities can use annual Detailed Operating Plans or Supplemental Agreements to modify the operation of Treaty storage, or the Entities can use the Non-Treaty Storage Agreement to modify operation of the Non-

<sup>8</sup> Adapted from Columbia Water Use Plan (2005)

Treaty storage. Non-Treaty Storage Agreement operations cannot diminish benefits to either country under the Columbia River Treaty.

The actual physical operations on the Columbia River are a result of a combination of operations of the Treaty Storage and Non-Treaty Storage made through these various agreements, and Canadian flexibility operations under the Treaty. The general seasonal shape of operations is prescribed by the Columbia River Treaty Assured Operating Plan, and the Non-Treaty Storage Agreement and Supplemental Agreements typically provide smaller adjustments to these base operations.