U.S. Benefits from the Columbia River Treaty – Past, Present and Future: A Province of British Columbia Perspective

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EXECUTIVE SUMMARY

In 1964, Canada and the Unites States (U.S.) ratified the Columbia River Treaty (Treaty). The impetus for the Treaty was the disastrous flood of 1948 which devastated the City of Vanport and cost many lives, along with growing power demand in the Pacific Northwest. In exchange for an equal share of the U.S. downstream power and flood control benefits, Canada agreed to build three dams in British Columbia and allowed one U.S. dam to flood into Canada. The Canadian facilities vastly reduced flood risk in the U.S. while enabling the production of significantly more electricity at U.S. hydropower facilities.

The U.S. prepaid Canada $64 million to rent 8.45 million acre feet of storage space in the new Canadian reservoirs for 60 years to support assured flood control which resulted in reduced flood damage and increased safety for U.S. citizens. At the same time 110,000 hectares (270,000 acres) of Canadian ecosystems were inundated; residents, First Nations, communities and infrastructure were displaced; farms and forestry activities were impacted. The U.S. also committed in the Treaty to paying Canada half of the incremental power potential that could be produced because of the new flow regimes that the Treaty dams made possible. The Treaty has no end date but either country can unilaterally terminate the Treaty from September 2024 onwards provided that at least 10 years notice is given. This ability to terminate the Treaty, and changing flood control provisions whether the Treaty is terminated or not, have prompted both countries to undertake a review of the Treaty to determine its future.

The Treaty has worked well in optimizing flood control and power objectives. However, as society's values change, so have the benefits of the Treaty. The coordinated management of river flows and storage reservoirs has since produced a wide range of additional benefits to interests such as ecosystems, navigation, water supply and recreation. Yet, the existing and future benefits under the Treaty, and the risks and losses that could occur if the Treaty is terminated are not well understood.

Treaty Benefits in the U.S.

Flood Control: Half of the available flood storage in the Columbia basin is located in British Columbia. Since the Treaty storage became operational, there has never been a flood causing major damage along the Columbia River, avoiding $2 billion in potential damage in one year alone.[1] In 2024, regardless of whether the Treaty continues or is terminated, planned assured flood control operations change to a more ad hoc "called upon" flood control. This means that all U.S. reservoirs that are able to reduce damaging flood flows at The Dalles will need to be drafted deeper than is current practice before Canada can be "called upon" to provide additional assistance. At this time, the Canadian and U.S. Entities disagree on how called upon flood control would be implemented. Regardless of this disagreement, modelling has shown that this will increase the flood risk on the system while altering current reservoir operations and increase the risk of reservoirs not being able to refill, with likely negative consequences for a number of interests, such as fisheries, ecosystems, power production and water supply. British Columbia is open to discussing alternative flood risk management arrangements that would make better use of existing facilities, increasing certainty of operations and avoiding negative impacts to U.S. interests.

[1] February 2013. Permanent Engineering Board Meeting.

Hydro power: The Treaty has significantly enhanced hydropower production in the U.S. and continues to provide predictable and reliable flows that translate into firm energy so that utilities can meet their customer load. During the Treaty review, Bonneville Power Administration's analyses have focused on average energy benefits based on assumed Canadian operations, and presented the information in a way that could lead people to believe that the power benefit of continuing the Treaty is only 10% of the Canadian Entitlement. British Columbia believes that the value is much higher than the current return of the Canadian Entitlement when power benefits along with other values and interests that benefit from coordinated operations are factored in.

Coordination under the Treaty allows the hydro system to respond to seasonal challenges during cold winter conditions when inflows are reduced, as well as dry hot summers when irrigation, fisheries and recreation are competing for the same low flows. In both instances, Canada releases flows first to maximize U.S. power production. Without the Treaty, BC Hydro would operate solely for British Columbia domestic energy and other needs in a manner quite different than today, with system coordination greatly diminished. This would create significant uncertainty for the U.S. that would affect system planning and reliability across the U.S. portion of the Columbia River Basin.

Ecosystems: Flexibility within the Treaty has allowed changes in coordinated operations to benefit ecosystem values. Supplementary agreements have contributed to enhancing ecosystem values, particularly U.S. salmon recovery, by augmenting flows in the spring to better imitate the natural hydrograph, and augmenting flows during late summer and during dry years which are particularly critical to fish survival. As climate change predictions foresee hotter and drier conditions for the lower Columbia Basin, this coordination will become only more valuable. Without the Treaty, these beneficial ecosystem operations would cease to exist and water in the Canadian portion of the basin would be managed solely for Canadian environmental and other interests. Past and ongoing litigation has prompted U.S. agencies, Tribes and other stakeholders to invest to heavily in ecosystem recovery over the last decades. Decisions on the future of the Treaty should ensure that these investments are not lost.

Water supply: Additional Canadian flows for power production and ecosystems during low water conditions also benefit to some degree consumptive use as U.S. water managers re-regulate flows using Grand Coulee Dam for a host of interests competing for a limited resource. The changing flood control regime in 2024, requires greater emptying of U.S. reservoirs and risks upsetting the sensitive water allocation balance that is becoming increasingly strained. Climate change predictions will likely exacerbate the current tension between water users.

Navigation: Commercial navigation on the Columbia River is a key contributor to the economic sustainability of the U.S. Pacific Northwest. Changes to Treaty flood control provisions will likely result in more frequent higher flows that could worsen navigation conditions by increasing shipping times and affecting docking operations. High flows may also increase sedimentation thereby reducing channel depth and increasing dredging costs. During low flow conditions and without Treaty flow augmentation from Canada, navigation interests will also likely be impacted by reduced channel draft, disrupting navigation and raising the risk of grounding.

Treaty Benefits in Canada

The only benefit to Canada from the Treaty is the sharing of downstream benefits from additional power production potential made possible by the coordination of flows. Half of the potential additional power that could be realised due only to Treaty operations, which is called the Canadian Entitlement, is returned to Canada in electricity at the border. The U.S. has chosen to use these Treaty power flows for other, equally important, purposes besides power production. This should not be used as a reason to reduce equitable benefits to Canada. As dictated by the Treaty, the amount of Canadian Entitlement is forecast to decrease over time while British Columbia continues to be impacted, through reservoir operations and ongoing costs to maintain the Treaty dams, and our flexibility to manage for the needs of BC basin residents is constrained in order to meet Treaty requirements for U.S. interests. This has caused some residents to question whether the fundamental Treaty principle of creating and sharing benefits equitably is still valid. Simply put, without the Canadian Entitlement, British Columbia would see no reason for the Treaty to continue.

The Future of the Treaty

The Columbia River Treaty between Canada and the United States is known throughout the world as one of the most successful examples of a transboundary water treaty. Other countries see the agreement as setting a benchmark on cooperation and benefit sharing.

The Treaty is founded on the principle, set out in the Treaty's preamble, that the greatest benefits to each country can be secured through cooperative measures. The alternatives to cooperation in each country require careful examination.

As climate change will increasingly alter the environment of the Columbia basin in the broadest sense, reservoir management and coordination are seen as important tools in adapting to climate change challenges that threaten salmon recovery, water supply and energy reliability. This would suggest a need for more collaboration, not less. As both Canada and the U.S. continue to review options regarding the future of the Treaty, it is important that citizens on both sides of the border understand how the Treaty is beneficial, who benefits, how further cooperation can enhance or create new benefits, and what is at risk of being lost if the Treaty is terminated.

DISCLAIMER: The content of this paper represents the views and perspectives of the Province of British Columbia and is not to be interpreted necessarily as the views of the Government of Canada.

1. INTRODUCTION

The Columbia River Treaty (Treaty) between Canada and the United States (U.S.) is known throughout the world as one of the most successful examples of a transboundary water treaty. Other countries see the agreement as setting a benchmark for cooperation and equitable sharing of benefits on an international river system.

The Treaty, signed in 1961 and ratified in 1964, has proven to be durable over time. The flexibility within the Treaty has allowed operations to adapt to evolving societal values. The construction and operation of Treaty dams are designed to provide flood control and hydropower benefits in both countries, and these benefits were to be shared fairly and equitably. As a result of the Treaty, development has taken place in the flood plain and costly flood damage including loss of life has been greatly reduced, while hydropower generation that has supported billions of dollars in economic development has increased.

However, demands on the Columbia River have increased significantly since the Treaty was signed. New and emerging issues, not foreseen in the 1960s, now pose significant challenges to resource managers on the Columbia River and its tributaries. Some of these challenges include: operational changes to support salmon recovery efforts and to enhance other ecosystem values; the rapid growth of renewable resources and implications for reliability of the power grid; increasing stress on water supply for urban growth, industry, irrigation and agricultural development; the continued development into the historic flood plain and implications for flood risk management; the importance of navigation and recreation in supporting the regional economy; and growing awareness and knowledge of the impacts of climate change and need for adaptation. All of these challenges have implications on current and future coordination on the Columbia River between the U.S. and Canada.

There are two important elements of the Treaty that have led both countries to launch separate reviews of the Treaty. The first is the option for either country to unilaterally terminate most provisions of the Treaty at its earliest termination date of September 16, 2024 (60 years after ratification) by giving the required minimum ten years notice. The second is the expiry of the pre-paid assured flood control operation in Canada of 8.45 million acre feet (MAF) that the U.S. purchased for sixty years in 1964 and the resulting shift to an ad hoc "Called Upon" flood control operation. Both of these changes could significantly alter the coordination benefits that have accrued to both countries through the Treaty.

There is a view in the U.S. that Canada receives a disproportionally high share of power benefits from the treaty and that those benefits should be reduced. The Province of British Columbia refutes that premise. The value of coordination to the U.S. is much broader than the value to Canada. The only benefit to Canada of continued coordination under the Treaty beyond 2024 is the return of the Canadian Entitlement, which is one half of the incremental downstream power potential resulting from Treaty operations. In order to understand the value of this coordination, U.S. stakeholders need to ask themselves: How important is knowledge of planned operations in Canada to U.S. planning for its entire coordinated system in the U.S. Pacific Northwest? How important are good communication and coordination during extreme weather events which can have significant consequences for property and safety? How important is the coordination of flows in managing and reducing ecosystem impacts and in helping U.S. salmon recovery efforts? How critical to economic

development are Canadian flow releases during summer low flow periods and droughts for water supply, recreation, navigation and fisheries? And is the value of all of these interests worth risking by terminating the Columba River Treaty? The purpose of this paper is to examine some of these questions and to provide a Province of British Columbia perspective on the U.S. benefits from continued coordination under the Treaty beyond 2024, and the risks to U.S. interests if the Treaty is terminated.

2. THE COLUMBIA RIVER TREATY TODAY

2.1 Current Operations

Hydroelectric systems in British Columbia and the U.S. Pacific Northwest are managed to both meet electricity demand and also manage the water for multiple purposes. This is a complex system, made all the more complicated by a series of dams and reservoirs where operations at one affect the others. The Treaty is implemented by the U.S. Entity, represented by the U.S. Army Corps of Engineers (USACE) and Bonneville Power Administration (BPA), and the Canadian Entity, BC Hydro. BC Hydro is a Crown Corporation owned by the Province of British Columbia (BC).[2] The Province of British Columbia is the Canadian Entity for the purpose of the disposal of the Canadian Entitlement.

Canadian Columbia River facilities

The Canadian portion of the Columbia River basin comprises only about 15% of the physical area, but contributes approximately 38% of the basin runoff on average and up to 50% of the peak flood volume at The Dalles, Oregon in high flow years. This proportion is expected to increase in the future as climate change scenarios predict the Canadian portion of the basin will get wetter and the lower U.S. portion of the basin to get dryer. The effective storage volume in Canada is 20.5 million acre-feet[3] (MAF) which is close to 50% of the active storage currently available in the entire Columbia River basin.

The Columbia River in Canada has three dams in series – Mica, Revelstoke, and Hugh Keenleyside. The upstream most project – Mica – is the largest storage on the whole Columbia system with 12 MAF of active storage. It should be noted that Revelstoke Dam is not a Treaty dam and is operated for daily/weekly shaping. Mica and Revelstoke will have a combined generating capacity of approximately 5,700 megawatts (MW) by 2024, or 50% of BC Hydro's generating capacity, and are critical in reliably meeting British Columbia domestic load. Hugh Keenleyside Dam is the third project in the series. It is a low head dam and despite being the third largest reservoir in British Columbia with 7 MAF of active storage, it has relatively little power generation. The primary purpose of this dam was to provide flood control and power benefits to the U.S. under the Treaty. In 2002, the 185 MW Arrow Lakes Generating Station was installed adjacent to the dam.

Duncan Dam (1.4 MAF) on the Kootenay River is the third Canadian Treaty dam and does not currently have any power generating capability.

[2] All proprietary rights, title, interests and obligations under the Treaty, including the Canadian Entitlement, were transferred to British Columbia under the 1963 Canada – British Columbia Agreement.

[3] Although the Columbia River Treaty called for 15.5 MAF of storage to be built at Mica, Arrow and Duncan, Mica was built with an additional 5.0 MAF of storage (referred to as Non-Treaty Storage), which is managed under the Non-Treaty Storage Agreement. The Treaty provides the foundation for the Non-Treaty Storage Agreement, without a Treaty this Agreement would not exist.

U.S. Columbia River facilities

The U.S. portion of the Columbia Basin represents approximately 85% of the physical area and contributes approximately 62% of basin runoff on average. There are eleven hydroelectric facilities on the U.S. Columbia River main stem with a combined generation capacity of 20,347 MW. Six of these projects are owned by the U.S. Federal government (U.S. Bureau of Reclamation/USACE) and five of these projects are owned by Public Utility Districts (Mid-Columbia PUDs).

Operations of these and other non-mainstem U.S facilities are coordinated by the Pacific Northwest Coordination Agreement[4] which coordinates power production while taking into account non-power uses for water resources. This agreement enables the region's major generating utilities to gain many of the coordination benefits they would realize if the system were a single utility managed by a single owner.

The largest generating facility in the Columbia River system is the Grand Coulee Dam. It is the largest hydropower facility in the United States with a total generating capacity of 6,809 MW. The reservoir has approximately 5 MAF of active storage and plays a key role as part of the Columbia Basin Project, irrigating more than 600,000 acres of farm land that produces almost $630 million per year in irrigated crops. Grand Coulee is deemed to be the cornerstone for water control on the Columbia River in the U.S.[5].

BPA describes how some aspects of the interconnected multi-use system[6] are managed in the U.S. as paraphrased below:

> The Federal Columbia River Power System is a complex system of 31 interconnected dams on the Columbia, Snake, and Willamette rivers. The dams are authorized for many purposes including navigation, fish mitigation, irrigation, and flood control. The multi purposes of the dams mean that Bonneville cannot simply produce power whenever needed. Water released at one dam for power or other purposes will affect the water and power production at all the downstream dams. *This is why international cooperation is essential* [*B.C. emphasis*]. Grand Coulee is the only significant storage dam in the U.S. on the mainstream of the Columbia River. All of the downstream dams are essentially managed as run-of-river. Bonneville has very limited control over when power is produced. Nevertheless, Bonneville must produce power to meet its load obligations and adjust generation for energy imbalance to maintain the stability of the electrical grid. The federal agencies cannot choreograph this complex operation unless they plan operations months in advance. Bonneville creates the operating plan of how water will be deployed for power and all the other system purposes 18 months in advance. This plan is then constantly adjusted for changing water

[4] PNCA is an Agreement for Coordination of Operations among U.S Power Systems of the Pacific Northwest signed on September 15, 1964 by the USACE, BPA, the Bureau of Reclamation, and the major generating utilities in the Pacific Northwest. The Agreement stipulates that the parties agree to coordinate the operation of their respective systems to provide optimum Firm Load Carrying Capability and useable secondary energy for the Coordinated Systems. It also outlines water storage and power transfer rights and obligations to all the participants to the Agreement. The current PNCA terminates on September 15, 2024, one day before the earliest termination date of the Columbia River Treaty.

[5] Information from Bureau of Reclamation's website http://www.usbr.gov/pn/grandcoulee/

[6] United States Department of Energy – Bonneville Power Administration. Docket No. NJ12-7-000, Request for Leave to Answer and Answer to Protests and Comments. Section IIB(2i) page 13-18.

conditions and plans are updated for the next day, the next week, the next month, and outward for the 18 month period. Only if the system is carefully planned can Bonneville ensure that the system will be managed to satisfy all federal obligations (which include flood control, power, ecosystems, recreation and navigation among others).

Other Agreements Stemming from the Treaty

The Treaty permits the Entities to develop agreements that allow for mutually beneficial changes to baseline Treaty operations to adjust for changing values and needs, including fisheries interests. This has led the development of a number of related agreements over the years, including the Non-Treaty Storage Agreement, Supplemental Operating Agreements, and the Libby Coordination Agreement.

When Mica Dam was constructed, it was built with an additional 5 MAF (6.2 km^3) of live storage capacity beyond what was required under the terms of the Treaty. So long as the Treaty continues, Canada cannot fully utilize this additional reservoir storage without agreement from the U.S. Entity as doing so could conflict with reservoir discharge requirements under the Treaty. As a result, this additional storage is coordinated under a commercial agreement between BC Hydro and BPA called the Non-Treaty Storage Agreement (NTSA). The NTSA provides both fisheries and power benefits as described in later sections.

2.2 A Coordinated System

2.2.1 Flood Control

Currently, Canadian Treaty dams are drawn down (or drafted) to, or below their prescribed flood control rule curves, also called storage reservation diagrams. These are derived from provisions within the Treaty and the USACE Flood Control Operating Plan. These storage reservation diagrams dictate the minimum amount of vacated space required for a given April to August inflow forecast volume so that in larger snow-pack years the reservoirs can store flood flows and reduce major downstream flood damage and risk to the public. The power draft of up to 15.5 MAF required under the Treaty operations usually causes the reservoirs to be operated lower than the flood control storage reservation diagrams, and this additional draft provides space for additional flood peak reductions. Reservoir levels can be below, but cannot be above the flood control rule curve. In other words, flood control operation for the protection of life and property has priority over operations for power or other uses.

Treaty operations have significantly reduced flood damage on the Columbia River system. Since the Treaty dams were constructed, there has never been a peak flow over 600,000 cubic feet per second (cfs) at The Dalles, Oregon, the flow considered to be the beginning of major flood damage in the lower Columbia River. Historically, prior to the Treaty, one-third of the years had peak flows over 600,000 cfs. There are four years of record where the peak unregulated Columbia River stream flows at The Dalles did or would have exceeded 1,000,000 cfs without Treaty storage: 1894, 1948, 1972, and 1974. The first two of these pre-Treaty floods caused catastrophic damage and loss of life. Moreover, the continued provision of assured flood control has enabled further development of the lower Columbia flood plain and port facilities. The USACE has estimated damages prevented by Columbia storage regulation during 1972, 1974, 1996 and 1997 at about $260, $306,

$227 and $379 million, respectively.[7] In 2012 alone, USACE estimates of flood damage prevented (by Treaty and non-Treaty facilities) was approximately $2 billion.[8] These values are not overstated as they are not inflated to today's dollars, and are based on outdated estimates of development in the flood plain. More recent estimates by USACE estimate that, on average, annual flood damages avoided on the U.S. Columbia system are approximately $100-200 million. Given that Canadian storage accounts for approximately 50% of total active storage on the system it can be estimated that the operation of Treaty projects provides approximately $75 million per year in avoided flood damages. Cumulative flood damages prevented by projects (Treaty and non-Treaty) in the Pacific Northwest have totalled almost $32 billion.[9]

The assured annual flood control operation that was purchased by the U.S. for 60 years for $64.4 million expires on September 16, 2024, regardless of whether the Treaty continues or is terminated. Thereafter, flood control will switch to an ad hoc "Called Upon" operation, described later in this paper.

2.2.2 Power Production

The coordinated power operations under the Treaty are specified in Assured Operating Plans (AOPs) and Detailed Operating Plans (DOPs) which provide assured operation of Canadian storage and more certainty with respect to the monthly volume of flows that will be crossing the border. The AOPs, prepared five years in advance under procedures set out in the Treaty, are designed to achieve a joint optimum power operation in Canada and the U.S. by regulating the flows on the Columbia River. The AOP is used to determine the downstream power benefits, which are the increased generation capability at downstream U.S. projects based on the coordinated Canadian Treaty storage operation to improve and optimize generation at downstream U.S. projects. These downstream benefits are shared between the U.S. and Canada and the resulting Canadian share is called the Canadian Entitlement.

Prior to the commencement of each August to July operating year, the Entities prepare the DOP, which allows changes in operations where the Entities agree there are mutual benefits. The changes in recent years have been primarily to address ecosystem values in Canada and the U.S. The changes included in the DOP do not affect the determination of downstream power benefits.

Within each year the Treaty Storage Regulation (TSR) studies and the weekly (or when required daily) coordination phone calls provide the U.S. Entity certainty of flows on any given day/week. Other agreements provide the ability to modify flows due to water conditions or other unusual conditions when possible for mutual benefit. The operating restriction that the AOPs, DOPs, and TSRs place on Canadian storage do not apply to or constrain management of U.S. storage. This allows the U.S. to use the improved stream flows that Canada provides in any manner that it sees fit to meet its domestic needs and allows the U.S. to manage its own system to meet multiple objectives.

The Treaty enabled additional hydropower related benefits such as installation of additional generators at downstream dams, the electrical intertie between the Pacific Northwest and California, the Pacific Northwest Coordination Agreement[4], and regional preference legislation in the U.S. for federal hydropower.

[7] U.S. Army Corps of Engineers. *Effect of Reservoir Regulation on Flood Peaks and Damages: Columbia River Basin*. http://www.nwd-wc.usace.army.mil/crwmg/reports/

[8] February 2013. Permanent Engineering Board Meeting.

[9] http://www.nwd-wc.usace.army.mil/PB/MRC/pdf/WMBRIEF_MRC_Physical.pdf

Coordinated operation of the U.S. power system in the Pacific Northwest with the Canadian Storage under the Columbia River Treaty has provided a reliable system to serve customers electric load. Implications for reliability post-2024 are discussed in section 3.3.

One of the purposes of the Treaty is to optimize the power production of the entire coordinated system across the Basin. In low water years, or when seasonal flows are less than expected, the whole system, including the Canadian dams, enters into "proportional draft" operations. Proportional draft means that Canada provides extra water in dry years, an assured winter flow, and summer draft in long dry summers. The low generation value dams like Hugh Keenleyside are drafted before the high generation value dams like Grand Coulee. Essentially, proportional drafting means Canadian reservoirs have to release more water than inflow in dry conditions to benefit the U.S.

For example, while Arrow Lakes and Grand Coulee reservoirs have similar amounts of active storage (approximately 7 MAF and 5 MAF respectively), Arrow Lakes Reservoir has a low head dam with only 185 MW of generating capacity, while Grand Coulee is a higher head dam with 6,809 MW of generating capacity. Under the terms of the Treaty, the reservoirs are drafted in order of priority to maximize power production. What this means is that Arrow Lakes is drafted before Grand Coulee, and the very head-sensitive Grand Coulee project is able to stay at a higher elevation in order to maximize power production. This operation also provides additional benefits to recreation, navigation and other interests in the U.S. while potentially impacting similar interests in Canada.

Another example of how the Treaty helps maintain reliability is how reservoir operations respond to energy needs during the winter. In the Pacific Northwest cold arctic outbreaks typically occur once or twice a winter for periods as long as a few weeks. Cold arctic outbreaks:

- significantly increase the regional electrical load, as more heating equipment is in service more frequently and for longer cycles;
- significantly reduce inflows available for hydro-electric generation as the runoff freezes into ice and snow and melting of snow and ice is reduced; and
- virtually eliminate wind generation within the region due to the large stable air mass associated with arctic outbreaks.

In these instances, Canadian reservoirs are operated to respond to the increased power needs during low flows in the U.S. by providing assured winter flows through proportional drafting.

2.2.3 Ecosystem

Since the Treaty was ratified, society's values have changed, and environmental interests have become increasingly important in both countries. More specifically in the U.S., operations for salmon recovery have been designed so that they partially restore spring freshet flows which are needed to move migrating salmon smolts past the dams and downstream to the ocean as rapidly as practical. The Biological Opinion by National Oceanic and Atmospheric Administration (NOAA) sets passage objectives and spill (water overflow) targets for all of the Federal Columbia River Power System Dams. Recent Biological Opinions for Columbia salmon require holding as much water as possible in U.S. reservoirs through the early spring by maintaining the

reservoir levels near their flood control elevations. This provides the maximum amount of water available for discharges in late spring and summer to help fish travel downstream more rapidly. Surety of flows from Canada enables fisheries managers in the United States to better plan these operations. The Technical Management Team (TMT), comprised of federal agencies, tribes, and states, makes recommendations on U.S. dam and reservoir operations for fisheries based on the forecast runoff and the knowledge of assured Canadian operations.

Flexibility under the Treaty has resulted in operational changes (via Supplemental Operating Agreements, NTSA, and the Libby Coordination Agreement) that benefit U.S. and Canadian fish including:

- Vernita Bar protection flows for salmon;
- Draft of projects during the summer to help meet fish flow objectives at the McNary Dam;
- Chum salmon operation in fall and winter below Bonneville Dam;
- White fish and trout spawning flows below Arrow; and
- Libby white sturgeon and bull trout releases.

The Supplemental Operating Agreements, developed by the Canadian and U.S. Entities for within-year operations, generally provide for 1 MAF of flow augmentation that the U.S. can release in June/July. There have been numerous such agreements entered into over the years, beginning in the 1990s.

Treaty power and flood control operations provide ancillary benefits to ecosystems. Proportional drafting for power generation during the dry season or low flow years also enhance fisheries flows. In addition, NTSA provides additional benefits for U.S. fish interests by allowing for the use of an additional 5 MAF of Canadian storage that is not coordinated under the Treaty. The dry year release provision that is available in the NTSA is particularly valuable for U.S. fisheries interests because it guarantees the U.S. a 0.5 MAF unilateral release right for use in May/June to support salmon migration in the lower Columbia River during the driest 20% of runoff years. If the Treaty is terminated, it is unlikely that the Canadian Entity would continue to pursue these and other mutually beneficial agreements for fisheries because there would be no baseline from which to negotiate changes. The Canadian Entity would already have the flexibility to balance the interests in Canada.

3 THE COLUMBIA RIVER TREATY POST-2024

The previous chapter described how coordination under the Treaty has been successful in meeting its primary objectives while shifting operations to address values, such as fisheries, that were not contemplated in the original agreement. The following section looks forward to 2024 and beyond, and describes what will and may change, depending on the choices of both countries regarding the future of the Treaty. The first section outlines how climate change is predicted to affect the hydrology of the Columbia Basin. Climate change was not a factor when the Treaty was developed fifty years ago. However, the outlook on climate change provides the necessary context within which to examine the implications on U.S. interests into the future.

3.1 Climate Change

Climate change in the Columbia Basin continues to be researched on both sides of the border.[10] Data indicates that over the past century the U.S. Pacific Northwest and British Columbia have been getting warmer. The general trend in projected climate change scenarios is for more precipitation in winter, spring and fall, and less precipitation in summer. The snowmelt will start earlier, and spring and early-summer flows will peak earlier and be substantially higher. As well, late-summer and early-fall flows will be substantially lower and the low flows will last longer. However, because of BC's colder, higher elevation topography, snowpack in this region will be less impacted than U.S. areas further to the south.

The late summer low flows will also be exacerbated by a reduction in glacier melt as the glaciers continue to retreat. Although the impact of glacier melt on annual flow volumes is relatively minor, even glacier cover of 5%, such as in the Mica basin can contribute significant flow in the late summer. During the warm and dry summer of 1998, for example, glacier melt contributed 35% to the Mica basin's September stream flow. The impact of receding glaciers should be included in any climate change studies because of glaciers' significant effect during late summer, low flow periods.

In Canada, the Columbia and Kootenay watersheds are projected to see an overall annual increase in water supply and are expected to remain snowmelt dominated. The hydrology in these northern sub-basins will not be impacted to the same degree by climatic changes as will the lower U.S. sub-basins.

In the U.S., a number of studies indicate the changes to the annual runoff can be expected to be more significant. Many of the U.S. sub-basins will transition from snowmelt dominated to hybrid rainfall-snowmelt watersheds, and the current hybrid sub-basins will turn into rainfall-dominated watersheds. Some studies suggest that certain sub-basins could also potentially be drier with a corresponding decrease in water supply.

In general, the longer periods of low flows will coincide with periods when out-of-stream demands, such as for domestic water supply and irrigation are highest and in-stream demands, such as for hydroelectricity generation, fish habitat and recreation are critical. Higher temperatures and longer low flow periods could also pose a risk to fish stocks that are already under stress, potentially causing higher mortality rates during that period. The seasonal shift in flows throughout the entire Columbia system, and the shift from snowmelt dominated to a mixed snowmelt/ rainfall or rainfall dominated system for some of the southern sub-basins, could have other implications for U.S. flood risk management and ecosystem function on the river.

Climate change in general could result in a need to prepare for increased frequency and unpredictability of extremes in weather at both ends of the spectrum for flooding and drought. Reservoirs provide a mechanism that can assist in adapting to climate change challenges by increasing storage during times of relative water abundance and releasing stored water during times of relative water scarcity. The coordination and flexibility contained within the Treaty provide important mechanisms to help address some of the challenges climate change will bring.

[10] BC Hydro, *Potential Impacts of Climate Change on BC Hydro's Water Resources*, 2012
River Management Joint Operating Committee (Bonneville Power Administration, U.S. Army Corp of Entingeers, Bureau of Reclaimation), *Climate and Hydrology Datasets for use in the RMJOC Agencies' Longer-Term Planning Studies, 2011*

3.2 Flood Control

3.2.1 Called Upon Flood Control

As of September 2024, Canadian flood control commitments to the U.S. will be limited to an ad hoc "Called Upon"[11] approach, as set out in the Treaty. The U.S will also have to pay the Canadian operating costs and economic losses for each Called Upon request. These Treaty provisions are not well defined and there is substantial disagreement between the two Entities on their interpretation. After 2024, the U.S. will have to first make effective use of its reservoirs before 'calling upon' Canada to provide flood control space; this obligation exists whether the Treaty continues or is terminated.

Flood damage risks continue well into June as even average water years have the potential to develop into large peak flow years due to precipitation and high temperatures that may come late in the spring. The USACE's own extensive modeling[12] to quantify flood risk shows that the risk of flooding is greater post-2024 than pre-2024, even with the advantageous assumptions of Called Upon made by the USACE (which British Columbia disagrees with). Maintaining the same level of risk essentially requires having a similar amount of flood control space available in Canadian reservoirs pre- and post-2024, and the ability to direct refill of Canadian storage when required. The U.S. view of Called Upon Flood Control won't ensure the same level of risk as compared to pre-2024 and yet would still require significant changes to operations at U.S. reservoirs that would likely impact multiple water uses in the U.S. British Columbia's view is that Called Upon Flood Control may be able to provide the same level of flood risk to the U.S. by using all the smaller U.S. reservoirs on the Columbia, Snake and other tributaries. Such operation would likely impact multiple water uses on these smaller reservoirs.

The Province of British Columbia believes that there are more efficient ways to manage flood risk than the default and that Called Upon Flood Control is a step backwards. Under this flood control regime, the U.S. must make effective use of "all related storage in the United States"[13] before seeking additional help from Canada. This means that U.S. reservoirs will have to draft deeper and more frequently than they currently do. This requirement will likely have significant impacts on U.S. interests such as fisheries, recreation, irrigation and potentially navigation. Effective use at Libby dam, which is located in Montana and resulted in the creation of the Koocanusa Reservoir which extends approximately 70 kilometers back into Canada, will also have impacts on Canadian interests, although it will also increase flood protection downstream in Canada.

The following sections describe the potential impacts of Called Upon Flood Control and the differing views between the Canadian and U.S. Entities.

Implications of Called Upon

Post-2024, even if the Treaty continues, the Canadian Treaty dams will no longer have to conform to the flood control rule curves under the Flood Control Operating Plan described in section 2.2.1 because of the shift to Called Upon Flood Control. This would allow the Canadian Entity to operate Canadian reservoirs very differently than they are currently even though the Treaty power draft would continue. The Treaty allows

[11] The Treaty does not explicitly use the terms "Called Upon" and "On-Call" for the ad hoc flood control provided under the Treaty for post-2024 and pre-2024, respectively. Instead this has become established terminology used by the Canadian and U.S. Entities.
[12] Flood Risk Analysis – Iteration 2 Results (http://www.crt2014-2024review.gov/PowerPoint.aspx)
[13] Columbia River Treaty Protocol section 1.(2)

Canada the flexibility to move water between the different Canadian Treaty dams as long as the total power draft remains the same. This flexibility increases without the current flood control rule curves which expire in 2024.

In particular, to maximize domestic power production, Arrow Lakes Reservoir could be kept at a high, more stable elevation; consequently the storage space in Arrow Lakes Reservoir for flood control that the USACE currently relies upon would not be immediately available. Arrow Lakes Reservoir is particularly important for U.S. flood control because it takes only four days for flow releases from Arrow to reach the lower Columbia. Four days is within the forecasting timeframe so Arrow, along with Grand Coulee, can be used to manage flows during flood events. Water from headwater reservoirs such as Mica Dam and Hungry Horse have longer travel times.

In the longer term, all dams require significant capital investment and maintenance which can be significantly higher than the initial capital cost of the project. An evaluation of the small amount of power generation and the potential cost of major upgrades to Hugh Keenleyside Dam might lead to different operations or physical configurations than are currently modelled if the Treaty is terminated. This along with potential water licensing changes (i.e. changes in allowable minimum and maximum elevations) should the Treaty be terminated, could affect the storage available under post-2024 Called Upon Flood Control. Although Called Upon Flood Control continues regardless of whether the Treaty continues or is terminated, this obligation only extends for the life of the Treaty dams and there is no requirement for Canada to maintain the same amount of storage.

Called Upon Rights and Obligations

The Canadian[14] and U.S.[15] Entities have differing views on the rights and obligations related to Called Upon Flood Control. Each Entity has published a paper describing their positions. The respective views differ primarily over:

1) the forecasted peak flow at The Dalles that may trigger a Called Upon Flood Control request; and
2) which U.S. reservoirs must be used to provide effective use flood control.

British Columbia's view is that Called Upon Flood Control could only be used when forecasts of potential floods indicate there is a reasonable risk of exceeding 600,000 cfs at The Dalles. Based on this flow target, Called Upon Flood Control is expected to be used infrequently and only in very large snow pack years when effective use of all U.S. storage will be unable to maintain flows at The Dalles below 600,000 cfs. Called Upon Flood Control is not a mechanism to transfer the responsibility of managing the risk of changing or inaccurate forecasts from U.S. storage to Canadian storage.

For the U.S. to be eligible to call upon Canada for flood control assistance after 2024, the U.S. must first plan for, and use, to the extent necessary all available U.S. storage that can contribute to providing U.S. flood protection ('effective use'). This effective use requirement will result in changes to the current operations of

[14] Canadian Entity, *Canadian Entity View of Columbia River Post-2024 Called Upon Procedure.* February 14, 2013 http://blog.gov.bc.ca/columbiarivertreaty/files/2012/07/130214-CanadianEntity_View_CRT_Post-2024_CU-FINAL4.pdf
[15] U.S. Army Corp of Engineers, *White Paper on Columbia River Post-2024 Flood Risk Management Procedure.* September 2011.

U.S. reservoirs. The U.S. reservoirs will be drawn deeper more frequently and will result in risk and occurrences of not being able to meet refill targets. U.S. studies have demonstrated that this may create impacts primarily to fisheries; however other interests are also being examined, such as water supply and irrigation, recreation and navigation. The U.S. Entity's view that flows of 450,000 cfs at the Dalles are the trigger for Called Upon Flood Control means that the impacts of effective use would be more frequent.

This effective use requirement leads to the second area of disagreement between the Entities with regards to the implementation of Called Upon Flood Control. Effective use requires that the "...U.S. will call upon Canada to operate [Canadian storage] only to control potential floods in the U.S. that could not be adequately controlled by *all the related storage facilities in the U.S."* British Columbia interprets this provision to mean that if a facility can be effective in reducing flows at The Dalles it should be part of the effective use requirement before calling upon Canada.

To date, U.S. studies have been limited to a small number of headwater projects (Libby, Dworshak, Hungry Horse, Brownlee) and Grand Coulee. BC Hydro has conducted a preliminary analysis to determine the ability of smaller U.S. reservoirs on the Columbia main stem and tributaries to reduce flows at The Dalles. The results show that drafting other U.S. projects can be effective in reducing peak flood volumes as required by the Protocol. U.S. flood control operations, therefore, would need to include many additional projects such as Chief Joseph, Wells, the five mid-Columbia facilities (as was provided pre-1970), McNary, John Day, The Dalles, and Lower and Upper Snake dams. BC Hydro analysis estimated U.S. energy losses due to effective use at these facilities (in a Called Upon year) to be approximately 1,300-3,000 gigawatt hours with an estimated value of $40 to $150 million. Other potential adverse impacts on fisheries, recreation, irrigation and navigation interests have not yet been evaluated.

Winter Flood Events

Called Upon Flood Control is impractical for dealing with winter flood events. Unlike spring flood events, which are mainly snowmelt driven and can be planned months in advance based on inflow forecasts, winter flood events tend occur due to intense rain events which are less predictable and more immediate. It is unclear how the U.S. could operate to show effective use of their facilities in these instances. The U.S. Entity has not yet put forward a plausible approach for addressing these issues.

3.2.2 Coordinated Flood Risk Management

Canadian storage is valuable in mitigating risk of flooding in the U.S., and it is British Columbia's view that to maintain the same level of flood risk post-2024, the U.S. should be interested in more coordination with Canada, not less.

Continuing the Treaty would provide the U.S. with a greater ability to manage flood risk even under a Called Upon flood control regime, as the U.S. will be able to rely on information on the coordinated and assured Canadian power draft and a forecast of the planned Canadian reservoir operations throughout the year. However, the U.S. view of Called Upon may not protect U.S. locations to the same level of flood risk pre- and post-2024 as previously discussed. Potential climate change scenarios may also increase the flood risk, especially with respect to more frequent extreme weather events.

British Columbia believes that working collaboratively within the Treaty framework, the U.S. and Canadian Entities can find a solution to the problems brought about by the change in flood control regime post-2024, and seek an agreement to supplement Called Upon Flood Control that will not have undue adverse impacts on other interests. Mechanisms for addressing winter storms are also possible. Outside of the Treaty framework, such agreement would be much harder and more costly to achieve, if not impossible.

3.3 Power Production and Reliability

During the Treaty review, BPA's power analyses have focused on average energy benefits (over a 70 year period) based on assumed Canadian operations, and the resulting information is presented in a way that could lead people to believe that the power benefit of continuing the Treaty is only 10% of the Canadian Entitlement. British Columbia believes that the value is much higher, and even exceeds what is currently returned to Canada. Framing the value question around the average cost of energy is missing a larger issue of fulfilling the core responsibility of utilities to provide reliable power at all times (for example, during periods of low flows). Reliability of the electrical system is important to BPA, and to the Public Utility Districts that share in the benefits of the coordination as well as share in the cost of the return of the Canadian Entitlement to Canada.

The importance of coordination to planning the whole Pacific Northwest system was already discussed in Section 2.2.2, which outlined how planning of up to 18 months in advance is required for reliable power supply and the ability to manage for other values. As mentioned in BPA's own documents, '*international cooperation is essential'*. Currently, certainty around Columbia River regulation from Canada for a given water condition is the backbone around which additional inflows and operations are coordinated throughout the downstream system. Terminating the Treaty would create significant uncertainty in downstream operations as Canadian operations would be unknown and could not be relied upon.

Utilities have a fundamental obligation to reliably meet their firm electrical load obligations. Reliability incorporates different components, including:

- Firm Energy: The fuel for the Federal Columbia River Power System (FCRPS) is water. The amount of available water depends upon the weather and varies greatly throughout the year and from year to year. Utilities must be able to meet their load obligation in prolonged dry periods that could extend over multiple years.
- Seasonality of loads: The system must be able to meet the load as it changes seasonally even during winter cold snaps when inflows are significantly reduced, and during dry hot summers when irrigation, fisheries, and recreation are all competing with power for water.
- Dependable Capacity: Sufficient capacity is required to reliably generate electricity at the instant it is required. As the balancing authority, BPA must provide sufficient reserve capacity to back up the high amount of wind and other intermittent energy sources connected to its system.
- Over supply and wind integration: Utilities must be able to shed generation when there is more generation than load. This is an increasing issue for the Pacific Northwest.

The Treaty provides assured winter flows, drafts in dry years to maintain the U.S. ability to meet its firm load during high demand and drafts in dry summers when U.S. inflows are reduced. As such, the Treaty plays a critical role in providing reliable power to the entire U.S. Pacific Northwest, even in drought conditions. The reliability and planning value of coordination is difficult to quantify as it provides benefits to purposes beyond power production. However British Columbia believes coordination is worth much more to the U.S. than the Canadian Entitlement, especially when all the risks to water supply, ecosystem, recreation, and navigation are also considered.

The following sections describe the value of the Treaty to the reliability of the power system. The first section, however, highlights the risk of assuming a Canadian operation will stay the same if the Treaty is terminated by describing different possible Canadian operations.

Potential operational changes

Under the terms of the Treaty, reservoirs are drafted in order to maximize power production. For example, Arrow Lakes Reservoir is drafted before Grand Coulee, and as a result, the very head-sensitive Grand Coulee hydro project is able to maintain a higher elevation in order to maximize power production.

Arrow Lakes Reservoir has the most potential of any of the Canadian reservoirs to change operations post 2024. Although it is a large storage facility (7.1 MAF), it has a relatively low head dam; the associated power plant (Arrow Lakes Generating Station) has only 185 megawatts of installed capacity. If the Treaty is terminated, an optimal power operation for Canada would keep this reservoir near full to maximize energy production. Essentially Arrow Lakes Reservoir could operate as a near run-of river facility with only a small draft for local Canadian flood control. This operation could release more water in spring but less in summer.

However, there are a number of domestic environmental and social interests around the Arrow Lakes Reservoir and the downstream river reach that could cause the reservoir to be operated much differently than an optimal Canadian power operation. For example, Arrow Lakes Reservoir could be operated at a much lower level to benefit vegetation and wildlife interests in the Revelstoke reach. Or, flow releases from Arrow Lakes Reservoir during the spawning period January to March could be minimized to reduce potential stranding of whitefish and trout eggs. Essentially, Arrow Lakes Reservoir could re-regulate the flows from Mica for environmental and social benefits in Canada. The U.S. would have to access their reliability needs without the assured winter flows under the Treaty.

If the Treaty is terminated, the Arrow Lakes Reservoir and other Canadian reservoirs would be operated solely for Canadian interests and would not be operated to provide downstream regulation for U.S. projects. Under these conditions, Grand Coulee would likely have to take on most of the responsibility for regulating the flows in the Columbia River in the U.S, especially for flood control. Deeper and more frequent drafts of Grand Coulee reservoir would be expected, with associated risks to refill and impacts on capacity and energy outputs as well as recreation, irrigation, and fisheries interests.

Furthermore, the information on Canadian operations that the U.S. could rely on for structuring its planned operations would be minimal as committing in advance to any set of operations would reduce Canadian flexibility without providing any Canadian gains. Except for emergency situations, little advance information on planned operations would likely be made available and communication would be similar to that between

Seattle City Light's Boundary Dam in the U.S. and BC Hydro's Seven Mile Dam immediately downstream in Canada on the Pend d'Oreille River.

Seasonal cold snaps

As discussed in section 2.2.2, seasonal cold snaps typically occur once or twice a winter, sometimes for extended periods. These cold snaps increase electrical demand and at the same time reduce the generation resources available to meet the load.

As long as the Treaty continues, the reduction in U.S. inflows (and generation) is countered by a corresponding increase in Treaty storage releases needed to maintain the U.S. Pacific Northwest firm energy load carrying capability. The assured release of water under the Treaty in the winter provides reliability in the Pacific Northwest. For example, in comparing the Treaty operations to the BC Hydro reference case in the Treaty Terminate scenario[16], the Treaty provides a 1.5 to 3.0 MAF draft of water during January/February of the lowest water years. This would provide approximately 1,500 to 3,000 GWh of additional U.S. generation during those months.

In addition, the Non-Treaty Storage Agreement can and has been utilized to release more water from Canadian storage and increase U.S. generation during a cold snap. In the absence of the Treaty, both of these reliable water augmentation mechanisms would be lost. Power utilities in the region would need to purchase generation at a time when other regions may also be experiencing increased demand. Alternatively, U.S. utilities may need to build additional winter peaking capacity to ensure reliability.

Seasonal and extended dry periods

As described previously, the Treaty provides for proportional summer draft in long dry summers to maintain reliability for customers by drafting Canadian storage before Grand Coulee, whereby Grand Coulee Reservoir is able to stay at a higher elevation than it would if Canada operated in its own self-interest to maximize power production and provide additional benefits to recreation, navigation and other Canadian interests. These conditions may become more prevalent as climate change predictions indicate that the southern Columbia Basin is expected to become hotter and dryer over time with prolonged dry water sequences.

In the U.S. Entity Iteration 1 studies for the Columbia River Treaty Review, U.S. generation was analyzed with continued Treaty coordination post-2024, and compared to U.S. generation that would result from flows derived from an assumed Canadian operation with "optimal" Canadian power generation.

In 20% of the years with the lowest water conditions, the U.S. losses in generation from uncoordinated operations was more than 1,000 aMW or 1,460 GWh over the months of August and September. This would be greater in an extreme dry year. Such a loss may result in the need to build new generation or force purchase of electricity from the wholesale market at the prevailing rate. Market prices for power in the Pacific Northwest tend to be higher in dry periods due to greatly-reduced hydro power generation.

Dry periods can extend over multiple years. When there are a number of low water years in a row, the Canadian Treaty storage does not refill each year. Even under these conditions, the Treaty requires additional water to be released from Canadian storage to supplement the low flows in the U.S. in order to maintain the

[16] BC Hydro, Columbia River Treaty Review Technical Studies [Draft], March 11, 2013

system's ability to meet the firm load. In these drought years, Canadian out-flow is greater than the in-flow and up to 15.5 MAF of the Treaty storage and up to 5 MAF of the Non-Treaty storage[17] can be used as long as the Treaty continues. If the Treaty was terminated, the contrary might occur in that Canadian outflow may not be greater than Canadian inflow in dry years as water may be retained in Canada to enhance Canadian refill and other Canadian interests.

The U.S. relies on these water augmentation mechanisms built into the Treaty to supplement flows in dry years. The load–resource balance that BPA publishes[18], which is used by the entire U.S. Pacific Northwest region for planning, assumes this supplemental flow from Canada in dry years.

In addition, due to fisheries constraints, the U.S. power system is now operated to a one year critical period based on 1937, which was the driest historical year. U.S. reservoirs have to refill in order to have enough water to be used for spring and summer fisheries flows. As a result, U.S. reservoirs are no longer used to shift water from a wetter year to a drier year.

Canadian storage under the Treaty and NTSA are the only mechanisms the U.S. has to supplement flows in multi-year droughts. Without these assured mechanisms, the U.S. utilities would likely re-examine their reliability planning criteria and the Pacific Northwest system firm energy load carrying capability. Additional resources may be required to meet the Pacific Northwest utilities firm load commitments.

Climate change predictions may exacerbate seasonal and extended dry climatic conditions as the downstream half of the Columbia Basin is anticipated to become drier and hotter over time and prolonged dry water conditions could increase in frequency.

Wind integration and over supply in the U.S. Pacific Northwest

Over the last five years, installed wind generation capacity has increased to over 4,000 MW causing over supply to become a chronic problem during the freshet period (April through July). Over supply occurs when the minimum hydroelectric generation combined with wind generation exceeds the demand. In this situation generation must be curtailed (water spilled or wind turbines idled) to maintain the stability of the power grid. There are, however, limits to how much water can be spilled past the generators at U.S. dams on the Columbia because spilling water raises the total dissolved gas in the water to levels that can be damaging to fish. BPA has an Overgeneration Management Protocol to turn down wind generation in over supply situations. The costs are currently shared 50/50 between BPA and the wind power producers. For 2013, if water conditions are average, the oversupply is estimated to be 283 MW-months with displacement costs of $10 million[19].

When there is an oversupply of electricity the market prices can become negative, and producers actually pay buyers to absorb the excess energy. In 2012 the light load hour prices were negative for 60% of the time April through July. The NTSA is being used to reduce the amount of surplus generation. In 2012, 2.8 MAF of water was stored under the NTSA from April through July. If this water had not been stored during the spring months, another 4,000 MW-months (approximately $40-60 million) would have been generated (or spilled) at

[17] The current expected use of non-Treaty Storage is not to support Firm Energy Load Carrying Capability in the U.S. as the US Entity uses the agreement to support fisheries operations and shape energy into higher value periods. However, under extreme conditions it is possible that the U.S. priorities change, and the Non-Treaty storage provides some backup or insurance.
[18] Bonneville Power Administration, Pacific Northwest Loads and Resources Study (2012 White Book) https://www.bpa.gov/power/pgp/planning.shtml
[19] www.nwcouncil.org/media/5729978/3.pdf

the U.S. dams, causing additional wind displacement and/or additional fisheries issues related to total dissolved gas. The NTSA and the Treaty both provide mechanisms for reducing the amount of wind displacement required.

3.4 Ecosystem

As noted in section 2.2.3, coordination of reservoir operations and subsequent flows under the Treaty have expanded coordinated operations beyond power production and flood control to include ecosystem objectives. This is accomplished through a number of actions, including proportional drafting during annual low flow periods to provide extra flows during late summer, Supplementary Operating Agreements that provide higher flows during the freshet to assist with fish recovery, and dry year strategies as part of the NTSA.

During the dry summer period, coastal and interior rivers that are either rainfall driven or have little snow accumulation tend to dry up and may reach their annual low flows in August or September. Flows on the Columbia River main stem are primarily maintained from the snow and glacier melt at high elevations in Canada and parts of the U.S. basin. In low snow pack years, the natural inflow in late summer is considerably less. For example, at McNary dam, where the summer flow objective for fisheries is 200,000 cfs, the unregulated flow drops below this level on average by the end of July and reaches 100,000 cfs by the third week in August.

If the Treaty is terminated, Canadian reservoirs would be managed for Canadian interests: domestic fish operations could have priority in some months; recreation interests could take priority in summer; bird and wildlife or cultural heritage could take priority in other times of the year. Different combinations of priorities in Canada could change under different water conditions and also change over time to adapt to changing climate conditions. A degree of balance between different domestic values and interests was achieved during the Columbia River Water Use Planning process in B.C. However, during that process the existence of the Treaty constrained the flexibility of operations to meet some important domestic objectives. It is not possible at this time to predict what may result from a future Water Use Plan that would not be constrained by Treaty requirements. If notice of Treaty termination is given, changes to the current operating regime would be explored in the next Water Use Plan review scheduled for 2021.

Treaty termination would likely have a significant impact to U.S. fisheries operations under low flow conditions which could be exacerbated by climate change in the Basin. There are a number of significant benefits to U.S. fisheries that would be lost by Treaty termination. These include:

- Proportional Drafting: Due to power provisions of the Treaty the coordinated system moves into proportional draft in low water conditions. The Canadian reservoirs draft to maximize electrical generation in the system, which in turn provides water for U.S. fisheries operations, especially in dry years and dry summers. Cold water flows from Canada in late summer support fish survival and spawning, especially during low flow years. While the Canadian reservoirs need to comply with proportional draft requirements under the Treaty, U.S. operations have the flexibility to manage flows for a variety of competing interests once the water crosses the border.

- Non-Power Uses Agreement: The U.S. relies on this water augmentation mechanism to supplement flows for fisheries purposes. Currently, 1 MAF of flow augmentation under the agreement moves water from January/February to June/July to more closely replicate portions of the natural hydrograph. US Entity studies have modelled ecosystem components that would require further coordination with Canada. Both present and potential future ecosystem enhancements would require similar or greater coordination that could only occur under the Treaty.
- Non-Treaty Storage Agreement: The NTSA is particularly valuable for U.S. salmon interests as the dry year release provision guarantees a right to the U.S. to release 0.5 MAF for use in May/June to support salmon migration in the lower Columbia River during the driest 20% of runoff years. It should be noted that the U.S. Entity analysis to date has not included the impacts from the loss of coordination under the NTSA, provisions of which would not continue under Treaty termination.

In addition, U.S. fisheries may be significantly impacted by the current default post-2024 flood control operation, which will change the operation of all U.S. reservoirs. As explained in section 3.1.1, Called Upon Flood Control will require U.S. reservoirs to be drafted deeper more frequently, which would likely affect a range of ecosystem and other values. Currently, in the spring, the U.S. operates many of its reservoirs to the upper flood control level to provide more water in spring and summer for fisheries. With the requirement starting in 2024 for the U.S. to first make effective use of its reservoirs for flood control, more water would be discharged in winter to draft the reservoirs deeper than is current practice and therefore having less water to release in the spring. This would increase the risk of reservoirs not being able to refill, and subsequently result in less water available for fisheries in the summer. If the Treaty continues British Columbia is open to discussing incremental flood risk management arrangements that could avoid these impacts.

It is useful to note that BPA's investments in fisheries recovery are many times higher than the value of the Canadian Entitlement under the Treaty. On average, BPA alone spends approximately $700 million per year on fish and wildlife enhancements in the Basin. Of those total expenditures, an annual average of $180 million was as a result of power losses by reregulating of power flows for fish. These are only some of the investments being made in ecosystem mitigation and restoration as other U.S. agencies, Tribes, power utilities, and non-profits are also dedicating significant resources to enhance environmental values. It may not be cost effective for the U.S. to pursue the reduction or elimination of the Canadian Entitlement payments if the resulting uncertain river flows and lack of coordination during low flow periods undermine the more costly investments in fish survival.

3.5 Water Supply

During the dry summer period, coastal and interior rivers that are either rainfall driven or have little snow accumulation tend to dry up and may reach their annual low flows in July to September. Throughout these months there is heightened competition in the U.S. for limited water resources. Future decisions regarding the Treaty may significantly affect water supply to a range of stakeholders in downstream states. The most significant potential causes of change are the effective use of U.S. reservoirs for flood control and the loss of flow augmentation and proportional draft.

As explained in section 3.1.1 the change in the flood control regime in 2024 to Called Upon Flood Control will require the U.S. to make effective use of U.S. reservoirs to minimize flood risk prior to calling upon Canada for assistance by providing additional storage. This means that U.S. reservoirs will need to be drawn down deeper and more frequently than they are currently because reliance on planned Canadian reservoir space will no longer be possible. Furthermore, as risks of changing or inaccurate inflow predictions transfer from Canadian reservoirs to U.S. reservoirs, corresponding risk of reservoirs not achieving refill is increased. Consequently, predictability in the availability of storage water for water users would be decreased, and for irrigators, pumping costs may increase with lower reservoir levels. B.C. maintains that the Called Upon Flood Control regime is a step backwards that does not serve either country well and is open to discussing mutually beneficial arrangements.

Treaty termination would produce negative consequences to U.S. water supply during low flow periods and years. Previous sections on post-2024 power production and ecosystems describe mechanisms under the Treaty and the NTSA that augment flows during seasonal low flow periods and during the 20% lowest flow years. These supplemental flows would no longer be available if coordination under the Treaty is discontinued. In short, without the cooperation set out in the Treaty between the two countries, reservoir levels and flows will likely be significantly changed from their current conditions. Climate change predictions of lower U.S. Columbia inflows and hotter, drier summers will only increase the need for collaboration. The impacts on water supply in the U.S. may be significant.

3.6 Navigation

The Columbia River is an important commercial waterway for the transportation of all types of goods and commodities from the region to domestic and international markets. Four main stem dams and four lower Snake River dams also contain navigation locks to allow ship and barge passage from the ocean as far as Lewiston, Idaho. The Columbia River has over 790 kilometers (485 miles) of navigable river and serves 36 ports and carries approximately 40% of all U.S. wheat. Over 35 million tons of cargo each year worth approximately $12 billion annually are exported and imported along the River.

Suppliers, traders and exporters all rely on low cost and dependable shipping conditions to be competitive on the world market. While Columbia River elevations experience seasonal adjustments which are anticipated, prolonged low or high water conditions may impact the safety and cost of navigation and port operations. In recent years, $50 million to $200 million has been spent annually on maintaining sufficient navigation channel depth, facilitating further port expansion, and supporting economic development.[20]

Changes that will be occurring because of the Treaty may significantly affect navigation and related interests. After 2024, the flood control operational regime will change from a predictable assured Flood Control operation to the ad-hoc Called Upon Flood Control that will increase the frequency of higher flows at The Dalles. Currently, Columbia Basin flood risk is managed collaboratively between both countries to reduce flood flows.

[20] Port of Vancouver letter to U.S. Entity February 12, 2013

Under the ad-hoc Called Upon Flood Control, forecasted Columbia River flows at The Dalles of 600 kcfs are needed before Canadian reservoirs can be called on to provide additional storage. This will increase the frequency of higher flows and could affect navigation and port operations, increasing shipping times and/or affecting docking operations. Higher flows may also increase the rate of erosion and sedimentation, affecting channel depths.

There are unresolved differences between the Canadian and U.S. Entities on the interpretation of Treaty requirements after 2024; however it is clear that a change to Called Upon Flood Control is a significant step back from the current Assured Flood Control regime. B.C. is open to discussing more effective flood risk management arrangements that could benefit both countries and prevent these adverse impacts.

Treaty coordination of water flows is especially beneficial to navigation in dry seasons and years. Under the Treaty, during low water conditions in the summer, water is released from Canadian reservoirs in order to optimize power on the entire system. If the Treaty is terminated, Canadian reservoirs would be managed purely for Canadian domestic interests and the proportional drafting, where water is released from Canadian reservoirs first, would no longer occur, meaning lower flows crossing the border.

Similarly, the NTSA augments flows to the U.S. in the driest 20% of years. This agreement is linked to the Treaty and would expire if the Treaty is terminated. In both low flow season and dry years, ceasing Canadian flow augmentation could impact available channel draft, disrupt transport and raise the risk of grounding.

4 BENEFITS OF THE TREATY AND COORDINATED FLOOD CONTROL

4.1 Benefits to the U.S.

The preceding chapters have outlined the Province of British Columbia's perspective on the benefits and risks to the U.S. if the Treaty is terminated as compared to continued coordination. Coordination with Canada has been shown to provide certainty for power planning for BPA, the Mid-C public utility districts and other power generators that provide the reliability required in meeting the electricity needs of power customers. During cold, dark winter periods when energy for heating and lighting is critical, or during the dry summer months when power production drops due to low river flows, supplementary water releases from Canada under the Treaty reduce the risk of curtailing load. In 1 in 5 years when the Basin is driest, the NTSA dry year strategy provides incremental flows to meet summer demand.

Other interests and stakeholders benefit from the Treaty as well. U.S. fisheries programs, including legal requirements to meet salmon recovery objectives, have made billions of dollars in investments to support these goals. Treaty coordination is contributing to ecosystem recovery and enhancement plans through proportional drafts and flow augmentations from Canada during the spring freshets and low flow summer period and throughout dry years as well. At this stage no one can predict how terminating the Treaty may impact the sustainability of these fisheries values and protect previous and ongoing investments. However, collaboration between the two countries under the Treaty can only benefit ongoing efforts to address ecosystem needs in both countries.

Water supply managers in several states are under pressure to meet a variety of stakeholder demands. Trade-offs between interests, such as agriculture, recreation, domestic and industrial consumption, have become the

norm and conflict around these choices will only increase as a result of expected climatic change. If the Treaty is terminated, flows in Canada during critical dry periods will be managed for Canadian domestic interests. However, if the Treaty continues the two countries can continue an ongoing dialogue, in the spirit of the Treaty's founding principles of creating and sharing benefits equally, to address new challenges that were not contemplated in the 1960as when the Treaty was signed.

The Treaty has benefited U.S. communities by minimizing significant floods through planned coordinated operations, saving billions of dollars in flood damage in the U.S. The default change in flood control regime in 2024 prescribed by the Treaty whether it is terminated or not will likely impact all of the interests considered in this paper. Navigation, and the domestic and international commerce it supports, would be affected by higher flood flows that could disrupt marine traffic throughout the system, and would need to respond to infilling and shoaling at significant additional costs. The use of U.S. storage that would see reservoirs drafted deeper and more frequently with more refill failures could affect all the interests discussed earlier: fisheries, agriculture, navigation, recreation water supply, and power production. The Province believes the current level of flood control can best be re-negotiated from within the structure of the current Treaty.

While quantifying all of the benefits of the Treaty and the risks and losses if the Treaty is terminated is beyond the scope of this paper, it is clear that current social and environmental expectations extend far beyond just flood protection and power production.

4.2 Benefits to Canada

British Columbia does not face the same water resource pressures as the U.S. BC has sufficient available reservoir storage to manage flows to protect communities from significant floods and there is ample water supply for agriculture, domestic consumption and industrial uses. B.C.'s ability to balance recreation, ecosystem and power production interests are only limited by the Treaty.

Treaty constraints and requirements on Canadian reservoirs continue to impact environmental, social and economic values in British Columbia. While the U.S. Entity has the freedom and flexibility to manage Treaty flows south of the border for a variety of domestic interests, the Canadian Entity does not have that flexibility due to operations required under the Treaty. Citizens in the Canadian Columbia Basin continue to raise the issue of imbalance between historic and ongoing impacts of the Treaty facilities and their operations and the share of benefits to the Province of British Columbia.

The only benefit to Canada from the Treaty is through the return of the Canadian Entitlement. The Canadian Entitlement is an estimated calculation of half of the potential increase in power production in the U.S. as a result of coordination under the Treaty. The Canadian Entitlement is returned to B.C. in the form of energy at the border. The revenue from the sale of the energy on the market becomes part of the general revenue to the Province. While historically annual revenues from the sale of the Canadian Entitlement have been approximately $200 million on average, current market prices have been depressed in recent years meaning that the Canadian Entitlement has been worth $100-150 million per year. The size of the Canadian Entitlement is forecasted to decrease over time.

While the U.S. has chosen to trade-off some of its potential downstream power benefits from the Treaty for more valuable benefits, it is British Columbia's view that, given the benefits and the avoidance of losses and risks described throughout this paper, the U.S. benefits more from the Treaty than does Canada. The Province of British Columbia is of the view that Canada should not bear the financial burden of the choices that the U.S. has made to regulate water for other purposes beyond what was initially intended under the Treaty.

5 CONCLUSION

There appears to be a misconception by residents on both sides of the border that the Treaty can be terminated and easily renegotiated for more benefits to Canada, or more benefits to the U. S., depending on which side of the border one lives. The original Treaty took twenty years to negotiate during a simpler time when fewer values were considered and with no consultation. Today's world is much more complex than it was in the 1960's, government processes are more daunting, and it is unlikely that an entirely new Treaty could be developed. B.C. does not believe that a series of transboundary commercial agreements to replace the Treaty would be workable or desirable on such a large scale. The Treaty, however, provides for considerable flexibility and changes can be made at any time if both countries agree. Given this, British Columbia's position is that if the two countries cannot agree on changes within the Treaty framework, there is almost no hope that an entirely new Treaty could be negotiated.

The Columbia River Treaty has worked well for both Canada and the U. S. and has adapted to changing values over time. Citizens and stakeholders in both countries need to be fully informed on all the future costs, risks and benefits of alternatives in each country when seriously considering the future of the Treaty.