Columbia River Treaty

2014/2024 Review

United States Entity Supplemental Report

Appendix A

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United States Entity

APPENDIX A
U.S. ENTITY SUPPLEMENTAL STUDIES METHODOLOGY

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A.1 INTRODUCTION

In general, the planning and operation of the Canadian Treaty projects does not consider operations not defined in the actual Treaty or Treaty Protocol. Since the Phase 1 studies were primarily focused on looking at the two fundamental river purposes defined under the Treaty, power and flood control, the studies did not include additional operations not considered under the Treaty. By approaching the Phase 1 studies from this Treaty standpoint, both the U.S. and Canadian Entities believed they created a baseline of information for comparison to build from for future studies and for engagement with the sovereigns and stakeholders within their respective countries. However, the U.S. Entity is fully aware that a number of other river uses and needs significantly influence the U.S. operations. In particular, the U.S.'s obligations to carry out its Endangered Species Act (ESA) responsibilities for listed fish species affected by the Federal Columbia River Power System (FCRPS) have resulted in a profound and substantial change in the way the FCRPS is operated. The U.S. Entity felt it was important to look at the Phase 1 study results with the Biological Opinion (BiOp) operations included to provide a more realistic view of the operation of U.S. projects. The purpose of this appendix is to describe the modeling, methodology and criteria used in the U.S. Entity Phase 1 Supplemental studies that were utilized to assess the impacts to the U.S. system and fish operations when BiOp requirements were applied to the Phase 1 studies.

The Phase 1 studies referred to in this appendix are:

1. Treaty Continues post-2024 and Called Upon flood control is implemented (Study A);
2. Treaty is Terminated in 2024 and Called Upon flood control is implemented (Study B); and
3. Treaty Continues post-2024 with largely the same Treaty operations as today (Study C).

A.2 BASE CASE BIOLOGICAL OPINION STUDY

A.2.1 Phase 1 Long Term Studies

The Phase 1 process developed long-term studies for 1 August 2024 through 31 July 2025 based on various assumptions about the post-2024 future of the Columbia River Treaty. All AOP25 studies ran from 1 August 1928 through 31 July 1998, used historic streamflows and runoff volumes, and were based on an estimate of the loads and resources for 2024-2025.

The long-term studies developed for Phase 1 were re-run to make them suitable for use in the studies which would include U.S. BiOp requirements. Generally these revised studies used the same study data (e.g., rule curves, loads, project requirements) as the respective AOP studies except as noted here. Changes include re-running the studies for a different operating year (October-September), use of forecast flood control data (provided by the Corps) when the original study flood control was in observed mode, and computing operating power curves based on forecast volumes and forecast flood control. The operations for Mica, Arrow, and Duncan were extracted from these modified long-term studies for use in the Supplemental studies.

A.2.2 Short-Term Studies with Fish Operations

To investigate possible impacts to U.S. operations due to the changes in flood control and Canadian operations developed in the Phase 1 studies, additional studies were run using the Phase 1 studies results. The various scenarios are named Phase 1+BiOp to distinguish them from their respective Phase 1 studies.

A recent BPA Rate Case study was the basis for the Supplemental studies. The Rate Case study was prepared using non-power requirements submitted for use in preparation of the 2008 PNCA critical period studies and was developed for the 2010 Rate Case. This Rate Case study includes system operations under the May 5, 2008 final BiOp RPA[1]. Some of the operations included in the Rate Case study are the operations of Mica, Arrow, and Duncan extracted from the respective Phase 1 study; loads, unit outage, and hydro-independent data from the 2010 rate case study; and U.S. projects' operating requirements from the 2010 Rate Case study.

A.3 BIOLOGICAL OPINION CRITERIA AND OPERATIONS

The base case Biological Opinion study was a recent BPA rate case study. It was prepared using the 2008 PNCA data submittal project operating requirements and Biological Opinion objectives and was prepared for the 2010 rate case. This study is the most recent and highly developed scenario of Biological Opinion operations in the region. A comprehensive list of the project and operating criteria for the Biological Opinion that were used as input to the rate case is shown below.

A.3.1 RPA 4 Storage Project Operations and Flow Targets from the 2008 BiOp

Table A-1 Seasonal Flow Objectives and Planning Dates

	Spring	Summer
Lower Snake River at Lower Granite	Apr 3 - Jun 20: 85-100 kcfs Based on Lower Granite forecast April-1 Apr-Jul: 16-20 Maf	Jun 21 - Aug 31: 50-55 kcfs Based on Lower Granite forecast April-1 Apr-Jul: 16-28 Maf
Columbia River at McNary	Apr 10 - Jun 30: 220-260 kcfs Based on The Dalles forecast April-1 Apr-Aug: 80-92 Maf	Jul 1 - Aug 31: 200 kcfs
Columbia River at Priest Rapids	Apr 10 - Jun 30 135 kcfs	n/a
Columbia River at Bonneville	Nov 1 - emergence: 125-160 kcfs More specifically based on RPA 17 tailwater elevations Nov 1 - March: 11.5 foot tailwater elevation Apr 1 - Apr 30: 16.5 foot tailwater elevation	n/a

[1] Reasonable and Prudent Action

A.3.1.1 Dworshak

- Operate to standard flood control criteria; shift system flood control to Grand Coulee *(flood control shift in C+BiOp study only)*
- When not operating to minimum flows, operate to reach the flood control rule curve on or about April 10 to increase flows for spring flow management.
- Provide minimum flows while not exceeding Idaho State Total Dissolved Gas (TDG) water quality standard of 110%.
- Refill by about June 30.
- Draft to elevation 1535 feet by the end of August and elevation 1520 feet (80 feet from full) by the end of September. To minimize occurrences of a second peak flow in the summer, draft along the straight line computed between the June 30 and August 31 contents. Do not exceed a maximum flow of 14,000 cfs, which represents 10,000 cfs through the turbines, and 4,000 cfs spill. This is assumed not to exceed Idaho State TDG standard.
- Maximum project discharge for salmon flow augmentation to be within state of Idaho TDG water quality standards of 110%.

A.3.1.2 Libby

- Operate consistent with the Columbia River Treaty, and the International Joint Commission and the 1938 Order on Kootenay Lake.
- VARQ (variable outflow) flood control procedures.
- Variable December 31 flood control draft based on early season water supply forecast.
- Operate to a maximum flow of 4,800 cfs in October, and no higher than elevation 2436 feet in November, and be at December 31 flood control elevation.
- January – April 30, when not operating to minimum flows, operate to reach the flood control rule curve on or about April 10 to increase flows for spring flow management.
- Operate to provide tiered white sturgeon augmentation volumes to achieve habitat attributes for sturgeon spawning/recruitment consistent with the 2006 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BiOp) in May, June and July
- Refill by June 30 to provide for summer flow augmentation.
- Draft to 2449.0 feet (10 feet from full) by the end of September except in lowest 20^{th} percentile water years, as measured at The Dalles, when draft will increase to 2439.0 feet (20 feet) from full by end of September. To minimize occurrences of a second peak flow in the summer, draft along the straight line computed between the June 30 and September 30 contents.

- Meet minimum flow requirements for bull trout from May 15 to September 30 as described in the USFWS 2006 Libby Biological Opinion and 4,000 cfs in October through May 14 for resident fish.
- Limit spill to avoid exceeding Montana State TDG standard of 110%, when possible, and in a manner consistent with the Action Agencies' responsibilities for ESA-listed resident fish.
- Limit outflow fluctuations by operating to ramping rates set in the 2006 USFWS Biological Opinion to avoid stranding bull trout.

A.3.1.3 Grand Coulee

- Use standard flood control criteria including adjustments for flood control shifts from Dworshak in the C+BiOp Study only. There was no flood control shift from Brownlee to Grand Coulee in any study.
- Operate to achieve 85% probability of reaching flood control elevation by about April 10.
- Refill by June 30 each year
- Ensure that the project is drafted enough to meet drum gate maintenance criteria. The maintenance requires 60 days at or below elevation 1255 feet. The maintenance is required at least 1 of every 3 years, 2 of every 5 years, and 3 of every 7 years. Most years draft deep enough because of other operating requirements, such as flow targets for fish and flood control, to allow for drum gate maintenance. However, occasionally, the modeling forces the draft to elevation 1255 feet to allow for this drum gate maintenance and stay within the 1-of-3, 2-of-5, and 3-of-7-years requirement.
- Draft to support salmon flow objectives during July-August with variable draft limit of 1278 to 1280 feet by August 31 based on the water supply forecast. Future evaluation of this element may be accomplished as discussed in the Federal Columbia River Power System (FCRPS) Biological Assessment (BA).
- Reduce pumping into Banks Lake and allow Banks Lake to operate up to 5 feet from full pool (elevation 1565) during August to help meet salmon flow objectives when needed.
- If the Lake Roosevelt drawdown component of Washington's Columbia River Water Management Program (CRWMP) is implemented, it will not reduce flows during the salmon flow objective period (April to August). The metric for this is that Lake Roosevelt will be drafted by an additional 1.0 foot in non-drought years and by about 1.8 feet in drought years by the end of August. A third of this water will go to in-stream flows. A more detailed description of this element is provided in this section of the FCRPS BA.
- Outflow from Grand Coulee may be used to help meet tailwater elevations below Bonneville Dam to support chum spawning and incubation during the fall and winter months.
- Operate to help meet Priest Rapids flow objective to support fall chinook salmon spawning and incubation April through June.
- Operate to minimize TDG production at site and downstream.

A.3.1.4 Hungry Horse

- VARQ (variable outflow) flood control procedures.
- Maintain minimum flows all year for bull trout with a sliding scale based on the forecast. Operate to meet minimum flows of 3200-3500 cfs at Columbia Falls on the mainstem Flathead River and 400-900 cfs in the South Fork Flathead River.
- When not operating to minimum flows, operate to achieve 75% probability of reaching flood control elevation by about April 10.
- Refill by June 30 each year.
- Draft during July through September to a draft limit of 3550 feet (10 feet from full) by September 30, except in the driest 20th percentile of water conditions limit the draft to 3540 feet (20 feet from full). If the project fails to refill 20 feet from full, release inflows or operate to meet minimum flows through the summer months. To minimize occurrences of a second peak flow in the summer, draft along the straight line computed between the June 30 and September 30 contents.
- Limit spill to maximum of 15% of outflow to avoid exceeding Montana State TDG standards of 110% to the extent possible.
- Limit outflow fluctuations by operating to ramping rates set in 2000 USFWS Biological Opinion to avoid stranding bull trout.

A.3.1.5 Albeni Falls

- Operate to standard flood control criteria.
- Operate to provide Lake Pend Oreille shoreline spawning conditions for kokanee (winter pool levels of 2053 feet elevation) per USFWS Biological Opinion of 2000.

A.3.2 RPA 17 Chum Spawning Flows from 2008 BiOp

Provide adequate conditions for chum spawning in the mainstem Columbia River in the area of the Ives Island complex and/or access to the Hamilton and Hardy Creeks for this spawning population.

- Provide a tail water elevation below Bonneville Dam of approximately 11.5 feet beginning the first week of November (or when chum arrive) and ending by December 31, if reservoir elevations and climate forecasts indicate this operation can be maintained through incubation and emergence. The model uses a flow-vs.-tailwater elevation rating curve, which also factors in tributary flows, and maintains this tailwater elevation through March to reflect likely in-season management decisions.
- Make adjustments to the tailwater elevation consistent with the water supply forecasts.

A.3.3 VERNITA BAR FLOWS

- Minimum flows for December through May are established as the lower of the following:
  - 68% of the highest October or November flow at Wanapum, or
  - 70,000 cfs
- Flows less than 70,000 cfs are rounded to the nearest 5,000 cfs.
- 50,000 is the lowest minimum Vernita Bar flow from December through May. 36,000 cfs is the lowest minimum Vernita Bar flow allowed June through November.

A.3.4 JUVENILE BYPASS SPILL AND GAS CAPS

The following table shows how much each dam should spill for fish passage. On the lower Snake River, April through June water supply forecasts of less than 12.8 Maf at Lower Granite imply that seasonal average flow at Lower Granite may be less than 65 kcfs. Water supply forecasts of 14.6 Maf for the April through June period at Lower Granite imply that flow on the lower Snake River may be expected to be greater than 80 kcfs.

Table A-2 Spill Criteria for a 2008 Study

	Spill	Minimum Turbine Flow	Days	Hour Ending	Notes
LWG	20 kcfs 20 kcfs 18 kcfs	11.5 kcfs	Apr 3 - May 6 May 21 - Jun 4 Jun 5 - Aug 8	All hours	See spring transport criteria
LGS	30% flow	11.5 kcfs	Apr 5 - May 6 May 21 - Aug 11	All hours	
LMN	Gas cap Gas cap 17 kcfs	11.5 kcfs	Apr 7 - May 6 May 21 - Jun 4 Jun 5 - Aug 13	All hours	
IHR	35% flow	9.5 kcfs	Apr 7 - Jun 15	All hours	
	35% flow		Jun 16 - Aug 15	All hours	
MCN	40% flow	50 kcfs	April 10 - Jun 15	All hours	
	50% flow		Jun 16 - Aug 31	All hours	
JDA	30% flow	50 kcfs	Apr 10 – 19	All hours	
	30% vs. 40% flow		Apr 20 - Jul 20	All hours	
	30% flow		Jul 21 - Aug 31	All hours	

	Spill	Minimum Turbine Flow	Days	Hour Ending	Notes
TDA	40% flow	50 kcfs	Apr 10 - Aug 31	All hours	
BON	0	30 kcfs	March: 0 days	All hours	No March spill for Spring Creek Hatchery release
	100 kcfs		Apr 10 - Jun 15	All hours	5 kcfs corner collector operation Apr -Aug 31
	85 kcfs day / Gas cap night		Jun 16 - Jul 31	All hours. Day/night spill hours vary.	Jun 1-30 day hrs are 0430-2130; Jul l-31 day hrs are 0430-2200; Aug 1-15 day hrs are 0500-2145; Aug 16-31 day hrs are 0500-2030.
	75 kcfs day / gas cap night		Aug 1 - Aug 31		

The following table shows whether to spill at the three lower Snake River dams based on the expected seasonal average flow.

Table A-3 Summary of Spring Spill Decisions from the Final 2008 BiOp

Lower Granite Dam	**Apr 1-15**	**Apr 16-30**	**May**	**June[2]**
Seasonal Average Flows < 65 kcfs	No spill	No spill	No spill	Spill Jun 5-30
Seasonal Average Flows > 65 kcfs	Spill Apr 3-15	Spill Apr 16-30	Spill May 1-31	Spill Jun 5-30
Little Goose Dam	**Apr 1-15**	**Apr 16-30**	**May**	**June2**
Seasonal Average Flows < 65 kcfs	No spill	No spill	No spill	Spill Jun 5-30
Seasonal Average Flows > 65 kcfs	Spill Apr 5-15	Spill Apr 16-30	Spill May 1-31	Spill Jun 5-30
Lower Monumental Dam	**Apr 1-15**	**Apr 16-30**	**May**	**June2**
Seasonal Average Flows < 65 kcfs	No spill	No spill	No spill	Spill Jun 5-30
Seasonal Average Flows > 65 kcfs	Spill Apr 7-15	Spill Apr 16-30	Spill May l -31	Spill Jun 5-30

[2] Summer spill starts June 5th on average based on fish passage criteria.

A.3.5 JUVENILE PASSAGE SPILLS AT NON-FEDERAL PROJECTS

Juvenile Passage spills at non-Federal projects are shown in the following table, as submitted for Operating Year 2008 PNCA planning. Wells spills the percentage described below if Chief Joseph's outflow is less than 140,000 cfs; otherwise, Wells spills 10,200 cfs between April 12 and August 26.

Table A-4 Project Spill for Fish in Percent of Regulated Flow (%)

PROJECTS	Apr 1-15	Apr 16-30	May	Jun	Jul	Aug 1-15	Aug 16-31
Wells	1.7	6.5	6.5	6.5	6.5	6.5	4.5
Rocky Reach	0.0	0.0	20.1	12.5	9.0	9.0	0.0
Rock Island	10	10.0	10.0	17.0	20.0	20.0	0.0
Wanapum	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Priest Rapids	0.0	61.0	61.0	50.0	39.0	39.0	19.5

Overgeneration Spill: Spill up to the cap on total dissolved gas in the order listed in the table below to avoid generation levels that exceed the secondary market limit.

Table A-5 Spill Levels to Avoid Generation over Secondary Market Limit

Project	120%	125%	130%	135%
MCN	138 kcfs	230 kcfs	310 kcfs	450 kcfs
TDA	128 kcfs	250 kcfs	360 kcfs	600 kcfs
JDA	94 kcfs	240 kcfs	450 kcfs	600 kcfs
BON	96/114/138 kcfs[3]	150 kcfs	225 kcfs	270 kcfs
LWG	40 kcfs	70 kcfs	90 kcfs	150 kcfs
LGS	27 kcfs	80 kcfs	150 kcfs	250 kcfs
LMN	23 kcfs	95 kcfs	180 kcfs	250 kcfs
IHR	97 kcfs	125 kcfs	180 kcfs	240 kcfs
CHJ	150 kcfs	200 kcfs	300 kcfs	450 kcfs
GCL[4]	30 kcfs	75 kcfs	120 kcfs	170 kcfs
GCL[5]	10 kcfs	20 kcfs	35 kcfs	55 kcfs

[3] 96 kcfs in all months except 114 kcfs in July and 138 kcfs in August and September
[4] During all periods except May
[5] During May, when GCL is more likely below elevation 1260, the spillway crest elevation, and the regulating outlets must be used to spill

A.4 PHASE 1 STUDY EFFECTIVE USE OPERATIONS AT U.S. PROJECTS INPUT TO SUPPLEMENTAL STUDIES

The primary Called Upon operating strategies for all studies except the C study included as input to the Biological Opinion studies were the Called Upon flood control upper limit draft levels developed from the Phase 1 study for the Canadian storage project operations, and effective use flood control curves as upper reservoir limits for U.S. projects. The rate case study included the flood control upper limit elevations developed for the BPA rate case studies and used current flood control operations.

The Phase 1 C Studies, where the Treaty continues, were prepared using current strategies employed in development of Assured Operating Plans and Detailed Operating Plans under the Treaty. In the A and C Studies where the Treaty continues, Libby reservoir operated to Standard Flood Control in the Phase 1 studies, but operated to VarQ flood control in the Supplemental studies, because VarQ is a recommended action in the BiOp. In the B Studies, Libby operated to the VarQ flood control in both Phase 1 and the Supplemental studies. When Called Upon triggered an effective use operation at Libby in the Phase 1 studies, Libby operated no higher than the effective use flood control curves in the same years in the Supplemental studies.

It should be noted that the Supplemental studies do not make any assumptions or decisions about how project operational requirements might change due to Called Upon flood control or flow changes from Canada. Data, requirements, and procedures were not modified from those used for the rate case study.

A.5 CANADIAN PROJECTS

In the Phase 1 A1F studies the Treaty continues but flood control changes to Called Upon. Canada provided a possible flex operation of Mica, Arrow, and Duncan for A1F studies. This flex operation is not assured and represents only one potential operational scenario. Phase 1 B1 studies draft Mica, Arrow, and Duncan only for local flood control in Canada. Phase 1 B2 studies operate Mica, Arrow, and Duncan to a possible power operation provided by BC Hydro. The power operation is also not assured and only represents one potential outcome. All of these studies deviate from the Canadian operation as required for Called Upon flood control. The Phase 1 Report contains more complete information about these operations in Canada.

For studies where the Treaty continues (A and C Studies) Mica, Arrow, and Duncan were initially fixed to their operations from their respective Phase 1 study. As the studies developed, Mica's operation continued to be from the Phase 1 study, but Duncan and Arrow's operations were modified. First Duncan's operation was modified to meet specific flow and elevation targets during the course of each year. Arrow balanced these changes at Duncan so the composite storage effect was unchanged from the composite storage in the Phase 1 study.

It is assumed that the Entities would agree to a Supplemental Operating Agreement (SOA) to improve fish flows in the U.S. and Canada. The SOA operations are modeled in the A and C Studies where the Treaty continues. Through this SOA, Arrow's operation included the storage

and release of 1 Maf of water for Flow Augmentation downstream in the U.S. The SOA for 1 Maf of storage is characterized by storage at Arrow of up to 1 Maf for flow augmentation in January in all years, and release the 1 Maf at a rate of 15 percent in May, 15 percent in June, and 70 percent in July. However in years where the February 1 water supply forecast at The Dalles for the January through July period is greater than 110.4 Maf, the flow augmentation storage is released in February. The storage during January enhanced whitefish spawning conditions downstream of Arrow.

The trout spawning operation is included in the SOA. At Arrow it occurs in the April through June period. It is characterized by flows of at least 15 kcfs April 16 through 30 followed by May and June flows equal to or greater than the preceding month whenever possible with no more than a 10 kcfs decrease allowed. This operation is also contingent upon having a Treaty in place, so it is only shown in the A and C studies.

The B studies, where the Treaty terminates, Mica, Arrow, and Duncan were fixed to their Phase 1 operations. No agreements (SOAs) are assumed between the U.S. and Canada for either Flow Augmentation or whitefish and trout spawning flows.

A.6 OPERATION OF BROWNLEE RESERVOIR FOR THE SUPPLEMENTAL STUDIES

In the rate case study that was used as the basis for the Supplemental studies with the Biological Opinion, Brownlee operated to the fixed operation submitted for the 2008 PNCA operating year. Idaho Power Company provides this fixed operation for the 70-year period of record that was studied.

Brownlee reservoir is not a federal reservoir, so it does not have operations specified under the Biological Opinions for endangered fish species. Idaho Power Company does provide some operations that enhance flow augmentation in the lower Snake River. These operations are done in conjunction with the federal agencies.

Brownlee reservoir may shift flood control to Grand Coulee in the spring. In the Supplemental Studies Brownlee reservoir did not shift flood control to Grand Coulee.

Brownlee reservoir passes a quantity of flow augmentation through the reservoir in the late summer and fall to enhance flow in the lower Snake River. Idaho Power Company is not to keep the upper Snake flow augmentation water in storage but pass it though the reservoir. The Bureau of Reclamation will attempt to provide 487 KAF annually of flow augmentation from the Reclamation projects in the Upper Snake River basin consistent with its Proposed Action as described in the November 2007 Biological Assessment for operations and maintenance of its projects in the Snake River basin above Brownlee Reservoir. Reclamation’s flow augmentation program is dependent on willing sellers and must be consistent with Idaho State law.