APPENDIX 4.1-IV

Recreational Sites and Trails in the Generation and Transmission Components LSA

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1 SIMULATED SYSTEM OPERATIONS UNDER AN ALTERNATIVE RESOURCE PLAN

As described in Section 1, the environmental assessment is based on the Contingency Resource Plan (CRP) and the potential need for the Rev6 project with an in-service date of 2021. All of the results presented in Section 4.1.1 are therefore based on GOM assumptions that include the resource portfolio, load forecasts, and price forecasts for the year October 1, 2022 to September 30, 2023 as described in Section 3.

This appendix provides a comparison of GOM results under the Base Resource Plan (BRP), which moves out the potential need for the Rev6 project until 2030. The GOM assumptions for the BRP are summarized below as described in the Technical Memo *REV6 Operations Modelling Studies with Site C in resource mix* (BC Hydro, Reliability and Planning; 2015).

The simulations involved the same two model steps, HYSIM and GOM models, explained in Section 1.1.

1.1 GOM Assumptions

Study period

- The study year used for the resource portfolio, load forecasts, and price forecasts is October 1, 2031 through September 30, 2032.

Load and resources

- Resources are based on the BRP portfolio that was released by Resource Planning in August 2013.
- Monthly average load energy and monthly peak power demand forecasts come from the 2012 mid-gap load forecast with no liquefied natural gas load. These are consistent with the BRP above.

Prices

- Electricity prices are based on the 2013 BC Hydro corporate forecast price Scenario 1 (mid electricity, mid green-house-gas, mid natural-gas), in 2012 $CDN, and on average, are about $40. The electricity prices are adjusted for each month, based on the water year.
- For more information on the modelling methods, see the Technical Memo *REV6 Operations Modelling Studies with Site C in resource mix* (BC Hydro, Reliability and Planning; 2015).

1.2 Simulated Revelstoke Reservoir Elevations – BRP and CRP

To determine if the incremental differences in simulated Revelstoke Reservoir elevations between the Base and Rev6+WL scenarios varied by resource plan, the differences between the duration curves of the Rev6+WL and Base scenarios are shown for the BRP and CRP (Figure 1). The difference in time spent at or above elevation level, E, between the Base and Rev6+WL scenarios was calculated as the percent of time at or above elevation level, E, under the Rev6+WL scenario minus the percent of time at or above elevation level, E, under the Base scenario, such that;

$$\Delta x_E = x_{ERev6+WL} - x_{EBase}$$

These differences were calculated at each elevation level for the simulations under both the BRP and CRP to determine if the incremental differences between the Rev6+WL and Base scenarios varied by resource plan (Figure 1). Duration curves are shown for the Base and Rev6+WL scenarios under the BRP and CRP in Figure 1 (a) and (b), while differences between duration curves are shown in Figure 1 (c). The incremental differences in Revelstoke Reservoir elevation durations Δx_E between the Base and Rev6+WL scenarios are very similar under the BRP and CRP (Figure 1 (c)).

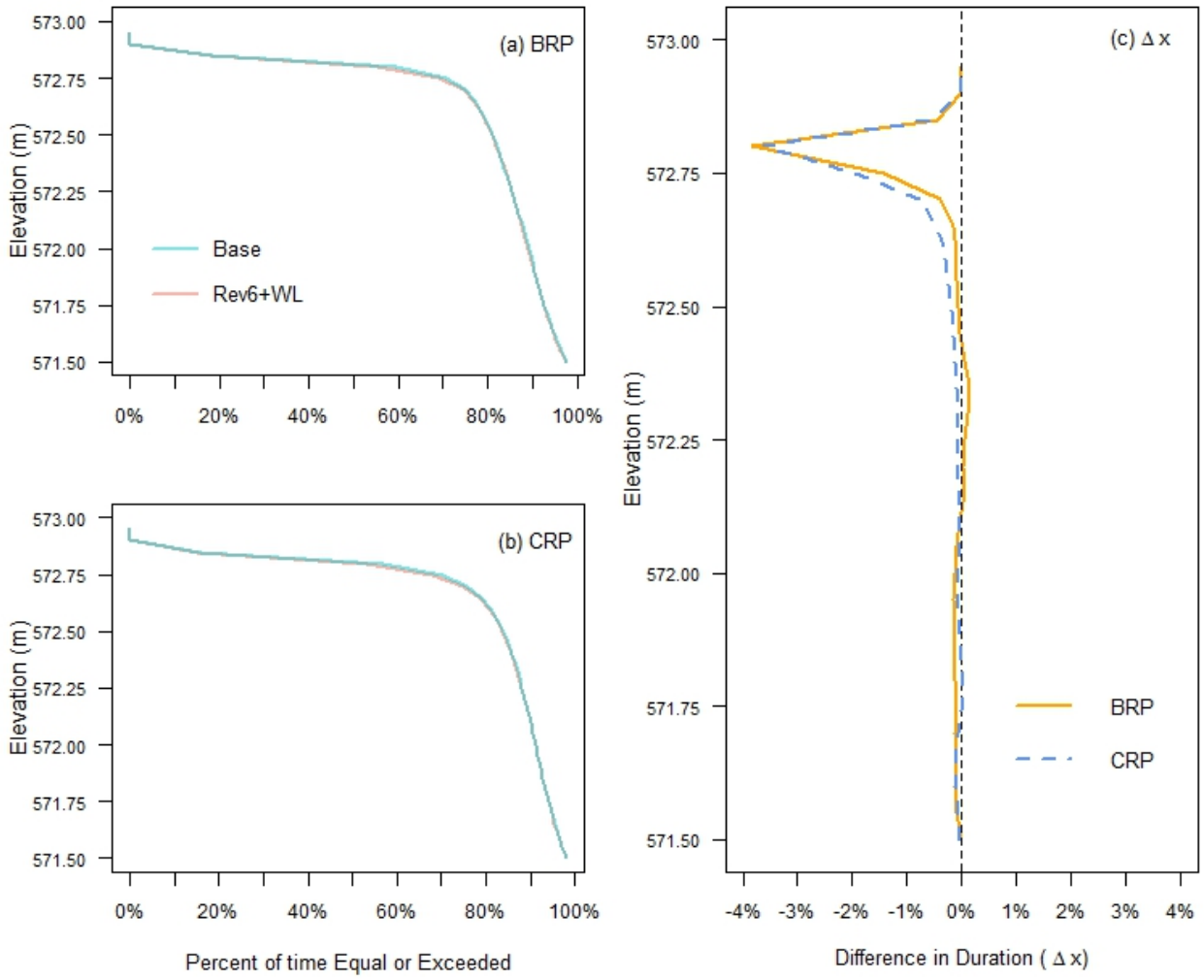

Figure 1: (a) Simulated elevation duration curves across all 60 years of data for the Base and Rev6+WL scenarios under the BRP. (b) Simulated elevation duration curves across all 60 years of data for the Base and Rev6+WL scenarios under the CRP. (c) Differences between the duration curves of the Rev6+WL and Base scenarios are shown for the BRP and CRP. Δx_E is the difference in the percent of time at or above elevation, E, under the Rev6+WL scenario minus the percent of time at or above elevation, E, under the Base scenario. The yellow line plots Δx for each elevation level under the BRP, while the blue dashed line plots Δx for each elevation level under the CRP. Note that the "difference in duration" are differences in the percentages shown on the x-axis of panels (a) and (b), but are not percentage differences.

1.3 Simulated Revelstoke Dam Discharges – BRP and CRP

To determine if the incremental differences in simulated Revelstoke Dam discharges between the Rev6+WL and Base scenarios varied by resource plan, the differences between the duration curves of the Rev6+WL and Base scenarios across the full 60 years of simulation data are shown for the BRP and CRP (Figure 2) (See Appendix 4.1-II for a comparison of duration curves on a monthly time step.). The difference in time spent at or above discharge level, D, between the Base and Rev6+WL scenarios was calculated as the percent of time at or above discharge, D, under the Rev6+WL scenario minus the percent of time at or above discharge, D, under the Base scenario, such that;

$$\Delta x_D = x_{DRev6+WL} - x_{DBase}$$

These differences were calculated at each discharge level for the simulations under both the BRP and CRP to determine if the incremental differences between the Rev6+WL and Base scenarios varied by resource plan (Figure 2). Duration curves are shown for the Base and Rev6+WL scenarios under the BRP and CRP in Figure 2 (a) and (b), while differences between duration curves are shown in Figure 2 (c). The incremental differences in Revelstoke Dam discharge durations Δx_D between the Base and Rev6+WL scenarios are very similar under the BRP and CRP (Figure 24 (c)).

Note that the “difference in duration” are differences in the percentages shown on the x-axis of panels (a) and (b), but are not percentage differences. For example, for the BRP and CRP, the percent of time at or above 50 kcfs was 20% for the Rev6+WL scenario and 22% for the Base scenario (Figure 2 (a) and (b)), a difference in duration of about -2% (Figure 2 (c)) or a percentage difference of -9% (because [20-22]/22 = 0.09). At most discharge levels, the differences in duration (Δx) between the Rev6+WL and Base scenarios are similar under the BRP and CRP.

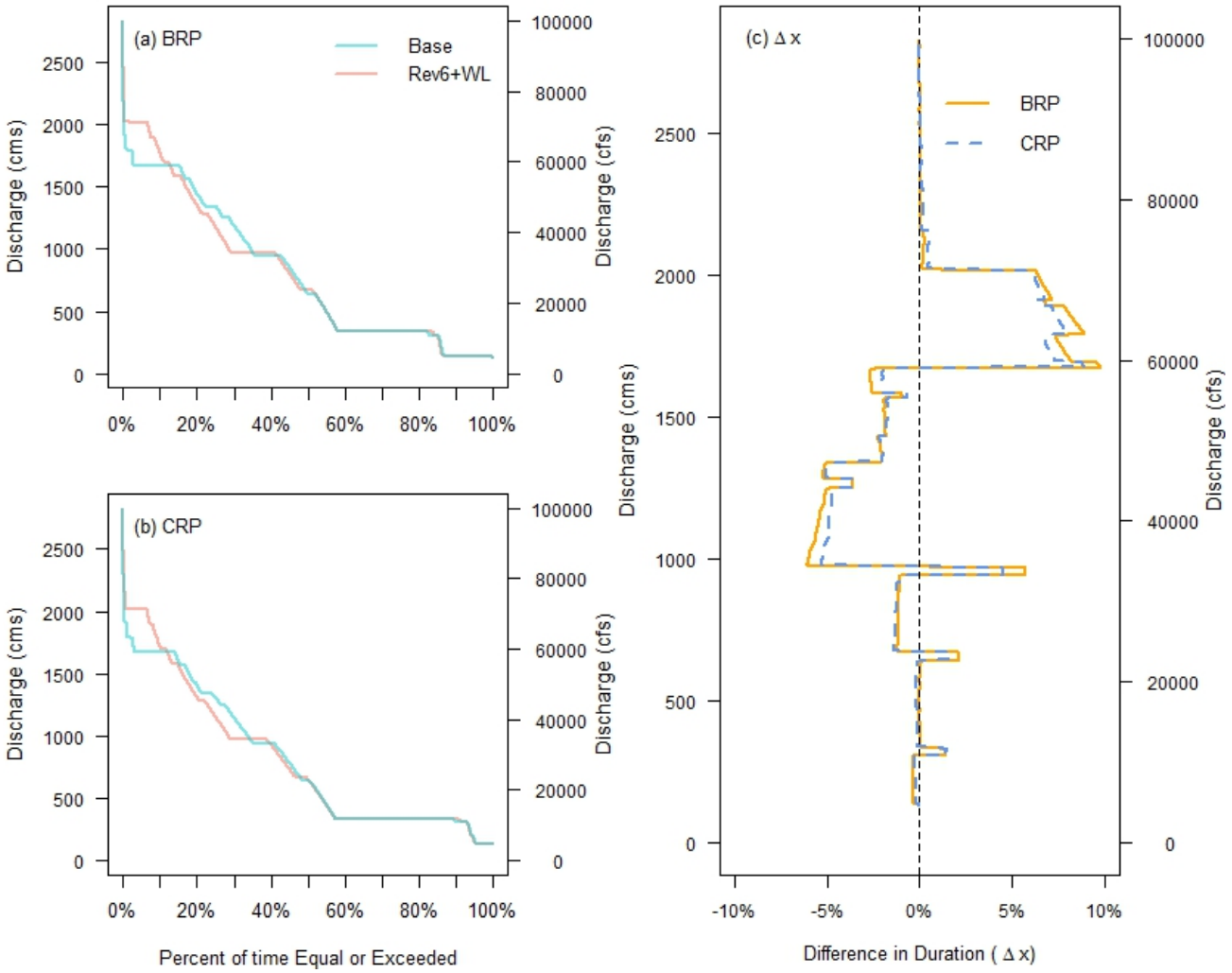

Figure 2: (a) Simulated discharge duration curves across all 60 years of data for the Base and Rev6+WL scenarios under the BRP. (b) Simulated discharge duration curves across all 60 years of data for the Base and Rev6+WL scenarios under the CRP. (c) Differences between the duration curves of the Rev6+WL and Base scenarios are shown for the BRP and CRP. ΔxD is the difference in the percent of time at or above discharge, D, under the Rev6+WL scenario minus the percent of time at or above discharge, D, under the Base scenario. The yellow line plots Δx for each discharge level under the BRP, while the blue dashed line plots Δx for each discharge level under the CRP. Note that the "difference in duration" are differences in the percentages shown on the x-axis of panels (a) and (b), but are not percentage differences.

1.4 Peaking – BRP and CRP

Using simulated dam discharges, daily peaking was determined as the difference between the maximum and minimum discharge within each day (midnight to midnight).

Figure 3 shows boxplots of peaking under each resource plan for the BRP and the CRP. Peaking appears to be very similar under both resource plans for the Base scenarios. It also appears to be very similar under both resource plans for the Rev6+WL scenarios.

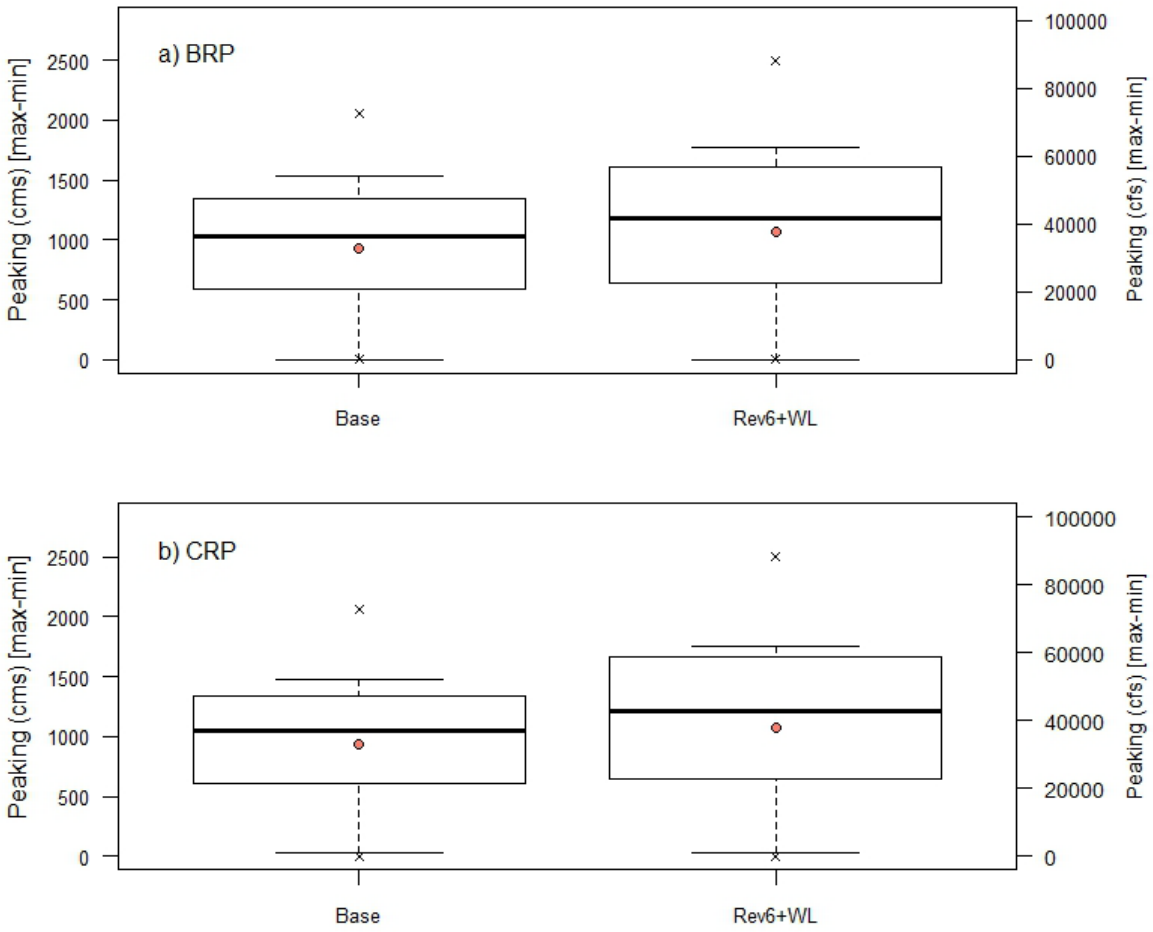

Figure 3: Boxplots show variability in daily peaking for the Base and Rev6+WL scenarios across all water years (1940-1999) under a) the BRP and b) the CRP. The top line of the box is the 75th percentile, the dark line inside the box is the median, and the bottom line of the box is the 25th percentile. The red point is the mean. The dotted lines or whiskers above and below the boxes encompass the 5th and 95th percentile. The maximum and minimum of the data are shown with an x.

1.5 Spills – BRP and CRP

Table 1 shows boxplots of spills under each resource plan for the BRP and the CRP. In general, spills occur very rarely – most of the time the spills are at 0 cms (i.e., no spills). Spills appears to be very similar under both resource plans for the Base scenarios. It also appears to be very similar under both resource plans for the Rev6+WL scenarios, however the maximum spill size is smaller under the BRP than under the CRP.

Table 1: The amount of time that different sized spills were simulated under the BRP and CRP for the Base and Rev6+WL scenarios. The amount of time is shown in 1 hour increments across all 60 years and as a percentage of the 60 year time frame.

Spill size		BRP				CRP			
cms	cfs	Base		Rev6+WL		Base		Rev6+WL	
		Hours	% Total	Hours	% Total	Hours	% Total	Hours	% Total
0 (i.e., no spill)	**0 (i.e., no spill)**	523671	99.633%	523708	99.640%	523318	99.566%	523421	99.585%
>0-141.6	**>0-5000**	0	0.000%	0	0.000%	0	0.000%	0	0.000%
>141.6-283.2	**>5000-10000**	1497	0.285%	1796	0.342%	1848	0.352%	2059	0.392%
>283.2-424.7	**>10000-15000**	384	0.073%	96	0.018%	314	0.060%	96	0.018%
>424.7-566.3	**>15000-20000**	0	0.000%	0	0.000%	24	0.005%	24	0.005%
>566.3-707.9	**>20000-25000**	48	0.009%	0	0.000%	96	0.018%	0	0.000%

1.6 Summary of Incremental Differences Between the BRP and CRP

In general, the GOM simulation results under the BRP and CRP show that:

- The incremental differences in duration between the Base and Rev6+WL scenarios are very similar for both Revelstoke Reservoir elevation and Revelstoke Dam discharge under the BRP and CRP (Figure 1 and Figure 2);
- The Base and Rev6+WL scenarios differ between the two resource plans, which can be seen most prominently with the discharge data. Minimum discharges of 141.6 cms (5000 cfs) occur about 11% of the time under the BRP, compared to 4% of the time under the CRP, which is more than twice as often under the BRP than under the CRP. Most of this difference occurs in the freshet period (see Appendix 4.1-II for monthly discharge duration curves). This difference is due to the difference in loads and resources between the two resource plans. Under the BRP, both the load forecast is lower and other resources in

the system are running higher. With less net load served by these other resources, the amount of time Revelstoke runs at minimum flows is greater. This effect is most prevalent in freshet, when inflows to Revelstoke Reservoir are high and electricity trade is primarily imports;

- The peaking datasets are similar for both the Base and Rev6+WL scenarios under the BRP and CRP (Figure 3);
- There are very few spills in general (Table 1).