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MEMORANDUM

TO: Charles Morrill, WDFW

FROM: David A. Benner

DATE: February 27, 2013

RE: Re-Evaluation of winter 2012/2013 operations at Grand Coulee and Bonneville

At the February 20, 2013 Technical Management Team Meeting (TMT) discussions centered around reducing chum protection flows at Bonneville Dam as a result of decreasing water supply and the priority to meet the April 10th Upper Rule Curve elevation at Grand Coulee. The result of this meeting was a plan to reduce the Bonneville Tailwater elevation by 0.5 ft every two days starting on February 20, 2013, with a daily one-hour rewetting to elevation 13.5 feet below Bonneville Dam.

At your request, this memorandum will re-evaluate November 1, 2012 through February 19, 2013 operations at Grand Coulee Dam and Bonneville Dam to determine if Grand Coulee could have been operated in a more conservative manner where the 13.5 ft TW target at Bonneville Dam could have been maintained beyond current operations.

- ***Based on this exercise, it appears that 800-900 Kaf of additional water could have been stored in Grand Coulee between November 1, 2012 and February 19, 2013. Utilizing the 2-20-2013 STP inflows to Bonneville Dam, 800 Kaf of additional water from Grand Coulee could have extended the 13.5 ft tailwater operation to approximately March 16th, 2013, and 900 Kaf would have extended the operation an additional 2-3 days, to March 18-19.***

The following data and other information were used from November 1, 2012 to February 19, 2013:

Grand Coulee Daily Average Inflow
Grand Coulee Daily Average Outflow

Grand Coulee Reservoir Elevation
Grand Coulee Reservoir Storage Table
Bonneville Dam Daily Average Outflow

The following are assumptions used in this modeling exercise.

1. At Bonneville Dam:
 - A 11.5 ft TW corresponds to a Project Total Discharge of 125 Kcfs
 - A 12.5 ft TW corresponds to a Project Total Discharge of 135 Kcfs
 - A 13.5 ft TW corresponds to a Project Total Discharge of 145 Kcfs
 - A 17.5 ft TW corresponds to a Project Total Discharge of 185 Kcfs
2. The Bonneville TW target was 11.5 ft from November 1-19, 12.5 ft from November 20-26, from November 27, 2012 to February 19, 2013 the Bonneville TW target was 13.5 ft.
3. A change in outflow at Grand Coulee could be seen immediately at Bonneville Dam.

Beginning November 1, 2012 the difference between the actual outflow at Bonneville Dam and the target outflow (based on TW target) was calculated, and converted to a volume in (Kaf). For each day, the actual storage change at Grand Coulee was calculated based on actual inflows and outflows. Next, the storage needed to just meet the Bonneville Dam target outflow was calculated. Finally, a modified Grand Coulee storage change was then estimated by accounting for both the actual inflows and outflows from Grand Coulee and that needed to meet target flows at Bonneville. This storage change was then added to the previous day's useable storage to get a modeled useable storage. Using the Grand Coulee storage tables a modified Grand Coulee elevation was estimated using the modeled useable storage. Because the Grand Coulee storage tables contain useable storage in increments of 10 Kaf, modeled useable storage values had to rounded to the nearest ten (Kaf) to match up with an actual elevation in the tables. This modeling operation continued throughout the period of interest, November 1, 2012 through February 19, 2013. It should be pointed out that for many portions of the modeled period, Bonneville Dam target flows to just meet the 13.5 ft tailwater could not be maintained without refilling Grand Coulee Dam above full (1290 feet). During these periods, the Bonneville Target flow was increased to a level where Grand Coulee would not exceed full.

Figure 1 displays actual Bonneville Dam outflows and Grand Coulee reservoir elevations as well as modeled Bonneville target outflows and resulting Grand Coulee reservoir elevations between November 1, 2012 and February 19, 2013. Based on the results of this modeling effort, had Grand Coulee been operated in a manner where releases were only to meet chum target flows or to avoid refilling above a full reservoir, the elevation of Grand Coulee at midnight of February 19, 2013 would have been 11.6 feet higher than the actual elevation on the same date. The actual elevation of Grand Coulee on February 19, 2013 was 1277.2 feet, whereas the modeled elevation was 1288.8 feet, the volume difference between these elevations is 900 Kaf. As mentioned previously, daily

differences between the actual and modeled flows at Bonneville had to be rounded to the nearest 10 Kaf to utilize the Grand Coulee storage tables. Because this rounding may have limited the accuracy of the modeled Grand Coulee elevations, Bonneville Dam actual and modeled outflows were summed over the model period and converted to a volume. The volume of the actual Bonneville outflows was determined to be 800 Kaf greater than that of the modeled Bonneville outflows. Therefore, it could be assumed that this volume could have been stored in Grand Coulee. In summary, based on this exercise, it appears that 800-900 Kaf of additional water could have been stored in Grand Coulee between November 1, 2012 and February 19, 2013.

The last step in this evaluation was to predict how many days beyond February 20, 2013 (date when chum protection was reduced from 13.5 ft) the extra 800-900 Kaf of water in Grand Coulee could have maintained the 13.5 ft tailwater at Bonneville Dam. For this portion of the analysis, the 2-20-2013 STP for Bonneville Dam Inflows were obtained at <http://www.nwrhc.noaa.gov/stp/station/stpplot/stpplot.cgi?BONO3>. Using these flows, determinations concerning the volume of water needed to extend the 13.5 ft tailwater at Bonneville (assumed Bonneville target flow of 145 Kcfs) could be made. Based on 2-20-2013 STP inflows to Bonneville Dam, 800 Kaf of additional water from Grand Coulee could have extended the 13.5 ft tailwater operation to approximately March 16th, 2013, and 900 Kaf would have extended the operation an additional 2-3 days, to March 18-19.

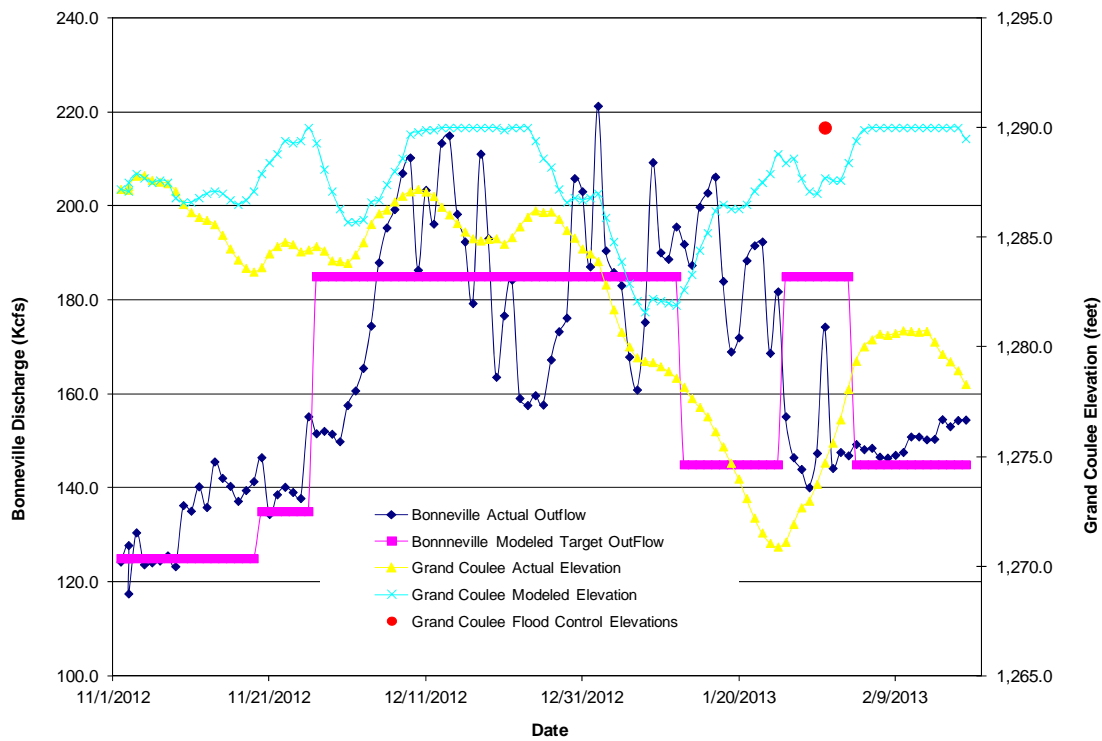


Figure 1. Actual Bonneville Dam outflows and Grand Coulee reservoir elevations as well as modeled Bonneville target outflows and resulting Grand Coulee reservoir elevations between November 1, 2012 and February 19, 2013.

Figure 1 shows that the most significant draft from Grand Coulee occurred during the month of January. Grand Coulee began January at an elevation of 1284.3 feet and drafted continuously through January 25th, reaching a minimum of 1270.9 feet. As Bonneville flows were well above that needed to maintain the 13.5 foot tailwater, operators cannot attribute this draft to that needed for chum. Additionally, the end of January flood control elevation was full (1290 feet) at Grand Coulee, so heavy drafts were also not for flood control. It is likely that the January drafts from Grand Coulee were primarily for power generation.