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MEMORANDUM

TO: Ed Bowles, ODFW

FROM: Michele DeHart, FPC

DATE: February 6, 2007

RE: Water Travel Time through JDA Pool at Minimum Irrigation Pool and at Minimum Operating Pool at Various Flows and the Impact of the Montana Plan

In response to your request, the FPC staff has estimated water travel times at various flow rates through JDA Pool at Minimum Irrigation Pool (MIP) and at Minimum Operating Pool (MOP) and the impact the Montana (MT) Plan would have on these water travel times. The Reservoir Replacement Method was used for calculating water travel times through a reservoir.

This formula is:

$$WTT\ (s) = \text{Reservoir Volume } (ft^3) / \text{Flow } (ft^3/s)$$

This method was suggested by personnel from the US Army Corps of Engineers. In particular, Lester Cunningham from the COE in Walla Walla, Washington suggested using the storage replacement method for calculating water particle transit time between respective pools based on the fact that the average water transit time is the same as the time that it takes to completely replace the volume of water contained in a reservoir. An "average" particle of water starting at

the upstream end of the pool will "theoretically" exit at the downstream end when the volume of water that was in the pool has exited from the downstream end of the pool.

The use of the storage replacement method was validated by computer program HEC-2 developed by the U.S. Army Corps of Engineers Hydrological Engineering Center for the Lower Snake River.

The storage replacement method is relatively simple if the following are known: flow rate exiting the pool, pool elevation, and pool storage/elevation rating curve.

Reservoir volumes for this analysis were taken form Reservoir Storage Tables developed by the Corps of Engineers. For this analysis, the elevation at John Day under MIP was assumed to be 262 feet with a gross storage volume of 2217.8 Kaf. The elevation at John Day under MOP was assumed to be 257 feet with a gross storage volume of 1989.9 Kaf.

Calculations were performed under three flow scenarios for the summer season (see Table 1), 100 Kcfs, 150 Kcfs, and 200 Kcfs.

For this analysis, it was assumed that the impact of the MT Plan would be a reduction in summer flows of 7 Kcfs in the lower Columbia River. This flow value was taken directly from Montana's System Operation Request dated July 6, 2005. This SOR can be found at on the COE's website at http://www.nwd-wc.usace.army.mil/tmt/sor/2005/2005-MT-1_final_v2.pdf. The flow value used in this analysis was taken from the first paragraph on page 6, this paragraph reads,

> "Council staff estimated the 50-year-average change in flow at McNary dam to be diminished by 8.3 Kcfs in July and 5.6 Kcfs in August, but increased by 0.9 Kcfs in September…"

Based on this statement, the average impact of the MT Plan over the entire summer (July and August) was assumed to be the average of the July and August impacts, 7 Kcfs.

Calculations of water travel times through John Day Pool under MOP and MIP conditions were calculated under two scenarios for all three flow levels:

1. The Base Case: This was the "normal scenario," was simple calculation of the water travel time (in days) through John Day Pool under MIP and MOP at summer flow levels of 100 Kcfs, 150 Kcfs, and 200 Kcfs.

2. The Base case with the MT Plan: This scenario was similar to the Base Case, however reduced each base flow by 7 Kcfs, the estimated flow impact of the MT Plan. Essentially, this scenario was a calculation of the water travel time (in days) through the John Day Pool under MIP and MOP at summer flow levels of 93 Kcfs, 143 Kcfs, and 193 Kcfs.

Table 1 displays the results of this analysis.

Table 1. Water travel times at various flow rates through JDA Pool at Minimum Irrigation Pool (MIP) and at Minimum Operating Pool (MOP) and the impact the Montana (MT) Plan would have on these water travel times.

Summer Flows						
	JDA at MIP			**JDA at MOP**		
	WTT through JDA at MIP at 100,000 cfs	WTT through JDA at MIP at 150,000 cfs	WTT through JDA at MIP at 200,000 cfs	WTT through JDA at MOP at 100,000 cfs	WTT through JDA at MOP at 150,000 cfs	WTT through JDA at MOP at 200,000 cfs
Base	11.2	7.5	5.6	10.0	6.7	5.0
Base w/ MT Plan	12.0	7.8	5.8	10.8	7.0	5.2

In Summary:

1. Under a flow scenario of 100 Kcfs, the water travel time through John Day Pool at MIP was 11.2 days and at MOP was 10.0 days, a decrease in water travel time of 1.2 days. When the base flow was reduced by 7 Kcfs (MT Plan), the water travel time through John Day Pool under MOP conditions was 10.8 days. Therefore, the decrease in flow resulting under the MT Plan would negate 67% of the water travel benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.
2. Under a flow scenario of 150 Kcfs, the water travel time through John Day Pool at MIP was 7.5 days and at MOP was 6.7 days, a decrease in water travel time of 0.8 days. When the base flow was reduced by 7 Kcfs (MT Plan), the water travel time through John Day Pool under MOP conditions was 7.0 days. Therefore, the decrease

in flow resulting under the MT Plan would negate 38% of the water travel benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.

3. Under a flow scenario of 200 Kcfs, the water travel time through John Day Pool at MIP was 5.6 days and at MOP was 5.0 days, a decrease in water travel time of 0.6 days. When the base flow was reduced by 7 Kcfs (MT Plan), the water travel time through John Day Pool under MOP conditions was 5.2 days. Therefore, the decrease in flow resulting under the MT Plan would negate 33% of the water travel benefit seen when JDA was operated under MOP instead of MIP under normal base conditions.

In summary, this simple analysis indicates that implementing the Montana Plan after the John Day Reservoir has been drawn down from MIP to MOP negates 67% of the benefit in water travel time at flows of 100 Kcfs, 38% of the benefit in water travel time at flows of 150 Kcfs, and 33% of the benefit in water travel time at flows of 200 Kcfs. It is also important to note that the implementation of the Montana Plan with the John Day reservoir at MIP would increase water travel times through the reservoir by 7% at flows of 100 Kcfs, and 4% at flows of 150 Kcfs and 200 Kcfs.