FISH PASSAGE CENTER

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MEMORANDUM

TO: Dave Statler, Nez Perce Tribe
Erick VanDyke, ODFW

FROM: Fish Passage Center Staff

DATE: June 24, 2016

SUBJECT: Data Request Regarding Drawing Down Lower Granite Reservoir to Better Meet Water Quality Standards for Temperature

Recently there have been discussions related to management alternatives for maintaining cooler water temperatures throughout the FCRPS. The US Army Corps of Engineers (COE) has expressed extreme concern regarding the ability to maintain temperatures below 68°F at Lower Granite Dam tailrace to address the survival of endangered sockeye salmon. The COE has proposed targeting a temperature of 65°F at Lower Granite Dam. They have recommended the reshaping of summer augmentation water from Dworshak Reservoir as a means of accomplishing this goal. Some salmon managers did not agree with this proposal, as it has the likely potential to decrease the existing flow and spill mitigation protection available for juvenile fall Chinook during August, as well as affecting the ability to continue moderating temperatures in August. The COE proposal essentially provides mitigation for one species at the expense of another species.

You asked us to specifically review existing data and information to determine if the drawing down of Lower Granite Reservoir to a lower elevation could provide an alternate mechanism for achieving the goal of reducing water temperature at Lower Granite Dam.

We have concluded, based on our review, that the drawdown of the Lower Granite Reservoir offers significant potential for reducing the water temperature at Lower Granite Dam and possibly contribute to overall lower temperatures at the other downstream Snake River sites.

In order to respond to your request we have reviewed several documents, including:

- Lower Granite and Little Goose Projects, 1992 Reservoir Drawdown Test Report, US Army Corps of Engineers, October 1992.
- Experimental Drawdown Study, Lower Granite Reservoir, North-Central Idaho, March 1992, U.S. Geological Survey Open-File Report 94-109, 1994
- Lower Snake River Drawdown Test, Draft Environmental Impact Statement, April 1994.
- Columbia River System Operational Review, Final Environmental Impact Statement, November 1995.
- CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 4.0 User Manual, June 2016.
- Haeseker, S.L., J.M. McCann, J.E. Tuomikoski, and B. Chockley. 2012. Assessing freshwater and marine environmental influences on life-stage-specific survival rates of Snake River spring/summer Chinook salmon and steelhead. Transactions of the American Fisheries Society, 141:1, 121–138.

Reservoir Elevations:

Presently the Lower Granite project has a full pool elevation of 738 feet and a five foot operating range to the minimum operating pool (MOP) at 733 feet. The juvenile fish facilities become inoperable below MOP. The elevation of the floor of the adult fish ladder exit into the forebay at Lower Granite Dam is 727 feet. However, the Lower Granite Dam is unique in that is was built with an emergency fish ladder exit and water supply system. The emergency exit is an overflow weir with an 18 inch discharge pipe and chute set at a 15 degree angle leading from the ladder to the lowered pool. The pipe is closed from elevation 735 feet to 719 feet, with a half pipe/chute from elevation 710 to 719 feet. The half pipe allows the emergency system to operate over a pool range from elevation 710 to 719 feet. The emergency system was used in the 1992 Drawdown test with adult passage success. It was determined in the Columbia River System Operational Review that the adult emergency fish ladder exit could be easily modified to operate at elevation 690 feet without major construction by extending the discharge pipe and chute and by using larger pumps to supply forebay water to the ladder. Both the powerhouse and spillway are operational to 690 feet. Consequently, the drawdown of the Lower Granite reservoir is possible from elevation 738 feet to 690 feet.

Fish Passage:

As stated above, there are no major concerns with adult fish passage. Minor modifications to the emergency adult fish exit would be necessary to draw the reservoir down to 690 feet. The juvenile fish facilities would not be operational below the minimum operating pool. A minimum powerhouse operation of 5 Kcfs for station service may be necessary to provide attraction water for the adult fish facility.

There are two options possible for juvenile fish passage. The project could remove the juvenile fish screens and spill the maximum amount of water (approximately 45 Kcfs) achievable under the 120% gas cap. Alternately, the screens could remain in place and the COE could pursue the development of the Lift Tank System proposed in the Biological Drawdown Test Environmental Impact Statement. The Lift Tank System is designed to lift fish from the

gatewell and allow juvenile migrants to exit an orifice from the tank to the existing collection channel.

Overall survival of juvenile salmonids migrating across the Lower Granite Reservoir will likely improve due to the increase in water velocity and decrease in water transit time at the lower elevation (Haeseker et al., 2012).

Concrete Structures/Dam Embankments:

During the 1992 Drawdown Test changes/movements were not detected from concrete structures and dam embankments/railroad and road embankments/ levees did not suffer any major structural damage. It is known that some cracking of roadways and railroad embankments did occur in 1992 and some areas will need adjustments in terms of rip-rap, additional yearly road repair, etc. if a seasonal drawdown were to occur.

Turbine Units:

During the 1992 drawdown test, short-term analysis showed the turbines to have operated in a mechanically safe manner. The performance of the turbines did drop at lower head levels. The COE did note in their report that the test in 1992 was for a relatively short period and some turbine modifications may be needed if the drawdown were to be extended for longer periods of time. In 1992, one of the largest concerns was potential cavitation due to operating turbines at low tailwater (as Little Goose was also drawn down).

Water Temperature:

The water temperature at Lower Granite Dam is a function of several parameters. Based on our review of the water quality sections of the aforementioned reports and CE-QUAL-W2 documentation, we explored how three parameters would be affected by the drawdown of the reservoir. These parameters include the: surface area of the reservoir exposed to solar radiation; the water travel time through the reservoir and the ratio of Dworshak cool water releases to the total volume of water in the reservoir.

The surface area exposed to solar radiation will decrease as the reservoir is drawn down. Table 1 approximates the changes in channel width at full pool and under a drawdown to elevation 700-710 feet at two locations: near Lower Granite Dam (River mile 108.31) and at the upstream end of Lower Granite Reservoir (River mile 139.4). These estimates were based on diagrams that were presented in the COEs 1992 Reservoir Drawdown Test Report, which can be found at the end of this memo (Appendix A). The average reduction in width when drawn down to 700-710 feet could be roughly estimated to be 30% (10% near dam, 50% upstream end of reservoir). With the length between cross-sections remaining constant, one can assume the surface area of the water surface to be reduced by an approximate average of 30%.

Table 1. Approximate Reductions in Channel Width at Full Pool and Under a Drawdown to elevation 700-710 feet at two locations: near Lower Granite Dam (River mile 108.31) and at the upstream end of Lower Granite Reservoir (RM 139.4).

Location	Percent Reduction in Width of Channel between a Full LGR Reservoir and a Reservoir Drawn Down to 700-710 feet
Near Dam (RM 108.31)	10%
Upstream End of Reservoir (RM 139.43)	50%

The decrease in the Lower Granite Reservoir volume will result in an increase in water velocity and a reduction in the water transit time (WTT) through the Reservoir (i.e., faster WTT). The water transit time decreases from 8.2 days at full pool (738 feet) to 3.0 days at elevation 690 feet at a flow rate of 30 Kcfs. At a flow rate of 60 Kcfs, water transit time decreases from 4.1 days at full pool to 1.5 days at elevation 690 feet. When the flow rate is increased to 90 Kcfs, water transit time decreases from 2.7 days at full pool to 1.0 day at elevation 690 feet (Table 2).

Table 2. Reductions in Water Travel Time/Increased Velocities at constant flows of 30 Kcfs, 60 Kcfs and 90 Kcfs.

LGR Elevation* (ft)	Storage at Elevation (Acre Feet)	WTT Through LGR Pool @ 30 Kcfs, (days)	Ave. Velocity (ft/s)
738	485001	8.2	0.88
733	442940	7.4	0.97
719	338395	5.7	1.27
710	280995	4.7	1.53
690	177070	3.0	2.42

LGR Elevation* (ft)	Storage at Elevation (Acre Feet)	WTT Through LGR Pool @ 60 Kcfs, (days)	Ave. Velocity (ft/s)
738	485001	4.1	1.77
733	442940	3.7	1.94
719	338395	2.8	2.54
710	280995	2.4	3.05
690	177070	1.5	4.85

LGR Elevation* (ft)	Storage at Elevation (Acre Feet)	WTT Through LGR Pool @ 90 Kcfs, (days)	Ave. Velocity (ft/s)
738	485001	2.7	2.65
733	442940	2.5	2.91
719	338395	1.9	3.80
710	280995	1.6	4.58
690	177070	1.0	7.27

* Pool elevations: 738 feet equals full pool; 733 feet equals Minimum Operating Pool; 719 feet equals top elevation of emergency adult ladder exit and near navigation lock sill; 710 feet equals present maximum depth of emergency adult ladder exit; 690 feet represents turbine and spillway operation maximum depth operating with modified emergency adult ladder exit.

The input of cool water from Dworshak/Clearwater will comprise a larger percentage of volume in Lower Granite Reservoir and will have a greater impact on temperature as the Reservoir is drawn down. At Dworshak powerhouse maximum discharge and spill to the 110% gas cap (14 Kcfs), the percent volume will increase from 5.7 percent to 15.7 percent, almost a threefold increase, as the Reservoir is drawn down from full to elevation 690 feet (Table 3).

Table 3. Dworshak Daily Flow Volume as a percentage of the LGR Reservoir Volume.

LGR Elevation* (ft)	Storage at Elevation (Acre Feet)	At 7.5 Kcfs	At 10 Kcfs	At 14 Kcfs
738	485001	3.1	4.1	5.7
733	442940	3.4	4.5	6.3
719	338395	4.4	5.9	8.2
710	280995	5.3	7.1	9.9
690	177070	8.4	11.2	15.7

* Pool elevations: 738 feet equals full pool; 733 feet equals Minimum Operating Pool; 719 feet equals top elevation of emergency adult ladder exit and near navigation lock sill; 710 feet equals present maximum depth of emergency adult ladder exit; 690 feet represents turbine and spillway operation maximum depth operating with modified emergency adult ladder exit.

Model Results:

There is no recent modeling available to evaluate the impact of drawdown on temperature at Lower Granite using CE-QUAL-W2, however, there were several model runs conducted as part of the Columbia River System Operational Review (SOR) in 1995. The SOR evaluated several alternate scenarios for the effect on water quality parameters using the COLTEMP model. The model runs were conducted for five flow years (ranging from low to high flow years) under three different weather patterns applied to each year (below average, average and above average). The model results were presented as the average number of days in any year where the temperatures were estimated to exceed 17.2°C (63°F) (this was considered to represent a "resistance temperature for fish"). The base case was a model run implementing the provisions of the 1994 to 1998 Biological Opinion. In this case, an average of 79 days exceeded the 17.2°C (63°F) criteria, with a high of 87 days exceeding and a low of 67 days exceeding across all the model runs. The preferred alternative case in the SOR was for LGR to be drawn down to near spillway crest for a four and a half month period beginning April 16 and ending August 31. Under this scenario the average number of days where the temperature exceeded 17.2°C (63°F) was reduced to 68, with a high of 83 days and a low of 62 days across all scenarios.

It is apparent from both the modeling conducted for the SOR and the calculations that we made for the specific parameters related to temperature, that a reduction in the temperature and improvement in river temperature conditions at Lower Granite Dam (and possibly further downstream) can be expected with a drawdown of the Lower Granite reservoir. The extent of river improvement will be dependent on the magnitude and duration of the drawdown.

Potential Considerations:

Based on the 1992 Drawdown Study the primary negative consequences of the drawdown were the interruption of navigation and the potential impact to roads along the reservoir.

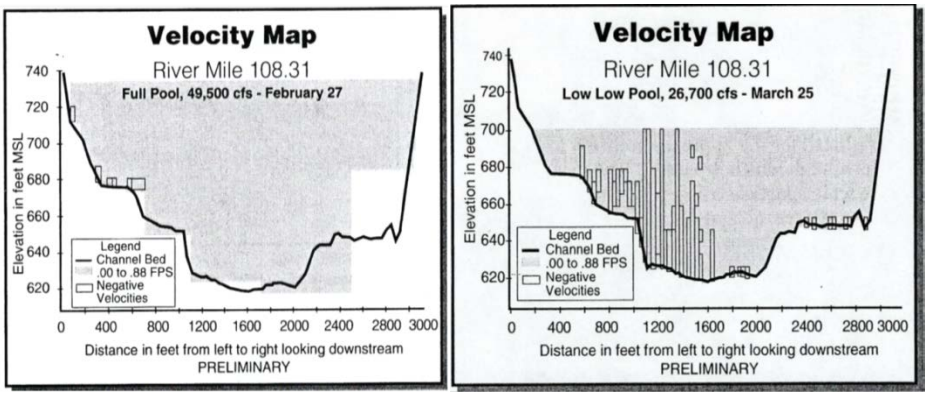
Dependent on the timing, duration and depth of the reservoir drawdown, there are potential impacts to navigation. Barge transportation of commodities would have to be rerouted to rail or truck transport and pool marinas may be affected. The extent of the negative consequences would need to be assessed within the context of alternatives for barge transport and the importance of meeting water quality standards.

Conclusion:

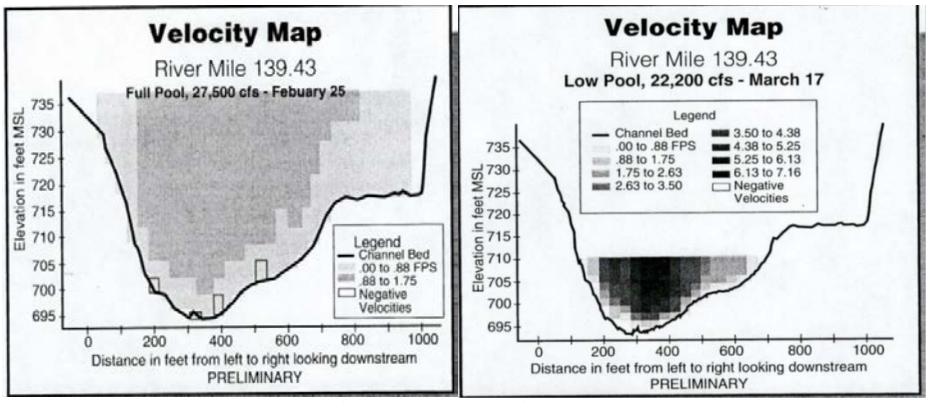
In conclusion, after reviewing the available information, it is our opinion that the drawdown of Lower Granite Reservoir represents a plausible opportunity for improving temperatures at Lower Granite Dam and possibly downstream. Considering the ongoing issues regarding the inability to achieve water quality standards in the present hydrosystem, coupled with concern regarding climate change, this drawdown should not be overlooked as a way to address the high temperatures in the Snake River and improve the survival of listed species.

Appendix A

Figures from Lower Granite and Little Goose Projects
(1992 Reservoir Drawdown Test Report, Pages 79-83).



At River mile (RM) 108.31 of Snake (Lower Granite at RM 107.5)



At River mile 139.43. Upstream end of Reservoir (near confluence of Snake and Clearwater).