REPORT ON

WRIA 46 STEP B SURFACE WATER STORAGE ASSESSMENT

Submitted to:

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EXECUTIVE SUMMARY

This Water Storage Assessment identifies and reviews a number of potential surface water impoundments to improve streamflow and water supply conditions. It is the third assessment of storage in WRIA 46, following a Step A Assessment that identified various types of storage opportunities, and a Step B Assessment that investigated the feasibility of using a 17-acre portion of the Entiat River floodplain for overbank and shallow groundwater storage. In early 2008, the Water Quantity Subcommittee requested that Golder Associates evaluate and collect hydrologic data related to specific surface water reservoir opportunities on Preston Creek, Lake Creek, Pyramid Creek, and Myrtle Lake. This assessment included hydrologic monitoring, geologic reconnaissance, storage volume and run-off analysis, a cost/benefit evaluation, and a review of project permitting considerations.

The range of flows that could be produced by each reservoir were based on site-specific field data collected during 2008 and HEC/HMS runoff models that incorporated over 20 years of hydrologic data. The water quantities available for storage were evaluated in the context of the storage allocation period defined in Washington Administrative Code (WAC) 173-546, between May 1 and July 15.

The estimated volumes available for storage and the resulting flow releases for each site are summarized below:

Site	Average Annual Storage Volume (acre-feet)	30-Day Flow Release (cfs)		
		Average	Minimum	Maximum
Preston Creek	700	9	n/a	n/a
Lake Creek	4,700	74	41	118
Myrtle Lake	810	13	6	23
Pyramid Creek	6,300	94	50	137

Note: Minimum and maximum values are not available at Preston Creek because no hydrologic model was developed at this site.

In general, between about 20 to 60 feet of annual water level fluctuation would be expected in the reservoirs, with higher water level fluctuations during wet years and lower fluctuations in dry years. More complex operational rules could be developed to reduce annual fluctuations and increase releases during dry years using carry-over storage. By assuming that the storage captured during the early summer would be held for a fixed 30 to 60-day release during late summer, the reservoirs are "oversized" to some extent in order to hold the maximum amount of wet-year inflow. The reservoirs could be downsized to some degree by managing to the average-year inflow and releasing water earlier in the year, coincident with periods of higher inflows. These are complexities that have not been incorporated into the simulations at this time.

The constraint placed on storage by the storage allocation (WAC 173-546) reduces the potential volume of storage to some degree. The storage volumes could be increased if the reservoirs were able to capture water under different regulatory constraints set in the water storage allocation. This could be done while maintaining baseflows.

The benefits to Entiat River streamflows produced by these storage volumes were described in terms of percent improvement to the instream flow recommendations at the USGS stream gauges at Ardenvoir and Entiat. Benefits were also expressed in terms of improved habitat area, using the results of previous IFIM modeling conducted during the Watershed Assessment (Entrix, 2003).

Outflows from storage impoundments could be expected to flow into downstream reaches to provide habitat and instream flow benefits, and the benefits to streamflow and associated habitat can be significant. Flow increases of 5 to 50 cfs do not appreciably change the number of days that instream flows are met compared to current conditions. For example, an increase of 50 cfs would lead to no more than a 10% improvement in the number days that instream flows are met compared to current conditions. However, flow increases of 100 cfs or more can result in significant improvements in the number of days that instream flows are met compared to current conditions. Flow increases of 100 cfs or more can be achieved from an impoundment at Pyramid Creek.

In relation to "fish flows", flow increases of less than 25 cfs lead to only small improvements over the current condition. However, increasing daily flows by 50 cfs would result in 70% to 80% of the days meeting the fish flows. Increasing daily flows by 100 cfs results in almost 100% of the days meeting the recommended fish flows. Flows of 50 cfs could be achieved by the impoundment at Pyramid Creek.

Improvements to spawning habitat were also evaluated using the results of the WRIA 46 Flow Study Report (Entrix, 2003). In general the largest percent improvements to spawning habitat occur when flows in the Entiat River are less than 100 cfs. Flow releases of 50 cfs would likely increase the number of measurements meeting spawning criteria by 15% to 20%. Flows of 50 cfs could be achieved by the impoundment at Pyramid Creek.

The flows produced by the impoundments at Myrtle Lake and Preston Creek are less than 15 cfs during average years and would provide a relatively low benefit to instream flows.

Attaining permits for the water storage sites appear to be relatively equal, except for the Lake Creek site. This site has been identified by the U.S. Forest Service as a Botanical Special Interest Area, is a proposed as a Research Natural Area (RNA), and contains the very best wetland complex in the area. As such, it is highly unlikely that a project in the Lake Creek basin would be permitted. Aside from the Lake Creek project, there are no specific hurdles that make any of the three remaining projects categorically unfeasible. At the same time, these are major construction projects that would have a significant footprint on otherwise undeveloped land. The Myrtle Lake and Pyramid Creek sites would require road construction in areas that are currently used for hiking and recreation.

Public participation and feedback is part of the EIS process and public support is critical. The projects are infeasible without public support and backing. The purpose and need statement, the first step in the permitting, is critical to the permitting process and describing the project to the public. This statement must detail the necessity of the project and should be consistent with the goals of the Forest Plan. The project applicant, in this case assumed to be the Conservation District, is responsible for preparing the purpose and need statement.

Construction costs were based on the estimated cost of the proposed Wymer Dam in the Yakima River basin. The Wymer Dam is a proposed off-channel reservoir with a concrete dam that is similar in size to what would be necessary for dams in the Entiat. The total estimated cost of that project is $780 million (USBR, 2007), and includes detailed cost items such as borrow material, concrete,

transportation, labor and other costs. A portion of the cost is tied to pumping and piping from the Yakima River. These costs are not anticipated for the proposed projects in the Entiat. Without the pumping and piping the estimate cost of Wymer Dam is approximately $450 million. As a rough guide, we estimated that 1 foot of impoundment height translates to $1 million. These construction costs are only rough estimates. The estimates assume similar design and materials as the Wymer Dam. The estimates are based on dollar values in 2007 and are subject to inflation and changes in material costs. Transportation costs in the Entiat could be higher because of the remote nature of the sites, difficult terrain, and need for new roads. However, the construction costs could be lower since the structures are somewhat smaller and there could be innovative designs that might minimize construction costs. The construction costs estimates are: $320 million for the Pyramid Creek; $280 million for Preston Creek; and $60 million for Myrtle Lake

It is difficult to explicitly evaluate the dollar value or benefit of improved ecological habitat. We therefore looked at the "market" for environmental flows. We reviewed the various storage projects that were awarded grant funding by the Department of Ecology in 2008 and considered the level of grant funding to represent the "value" of storage water. This value was obtained by dividing the estimated cost of the projects that received funding by the storage capacities of the projects. The value of storage water is approximately $5,000 per acre foot of annual storage using this methodology. Based on the $5,000 per acre foot dollar value, the "desired" costs for the Entiat storage projects would be: $4 million for 700 acre feet of storage at Preston Creek, $32 million for 6,300 acre feet of storage at Pyramid Creek, and $4 million for 810 acre feet of storage Myrtle Lake.

Comparing the target costs to the estimated actual construction costs indicates that the costs far outweigh the ability to fund the projects using grant funding. For all three sites, the estimated costs are at least an order of magnitude higher than the current market value for storage water. It is not likely that these Entiat storage projects (large surface impoundments) would receive consideration for funding at this time without significant matching funding from outside sources. It is possible that the future dollar value for stored water could increase to the point where the estimated construction costs approach the market value for the water. However, at this time, the proposed storage reservoirs do not appear economically feasible.

Site-specific conclusions and recommendations follow:

- A reservoir on Lake Creek would be infeasible primarily because of permitting difficulties associated with flooding the existing wetland complex in the upper Lake Creek Basin.

- A reservoir on Preston Creek may be feasible from geotechnical and permitting perspectives, but not recommended given the size of the impoundment relative to the basin water yield, and potential land ownership issues in the bottom of the basin may complicate the permitting process.

- A reservoir on Myrtle Lake is feasible from geotechnical and permitting perspectives and, despite the relatively low water yield, the project is more feasible than Preston Creek and Lake Creek because the size of the impoundment is smaller. However, a 60-foot tall impoundment is still necessary to store between 400 and 1,410 acre-feet per year. During a normal year there is approximately 810 acre-feet available for storage and this translates to about 13 cfs over a 30-day release schedule. This amount would improve August or

September flows in the Entiat River by 5 to 12%. A rough construction cost estimate of $60 million dollars translates to approximately $74,000 per acre-foot of storage.

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- A reservoir on Pyramid Creek is feasible from geotechnical and permitting perspectives and, relative to all the other sites, the basin water yields are high. A 320-foot tall impoundment is necessary to store between 3,690 and 8,700 acre-feet per year. During a normal year, there is 6,310 acre-feet available for storage and this translates to 47 cfs over a 60-day release schedule. This amount would improve August and September flows in the Entiat River by 22 to 48%. A rough construction cost estimate of $320 million dollars translates to $51,000 per acre-foot of storage.

- All of the sites have unit costs that are much higher than the $5,000 per acre foot figure that currently approximates the value of storage water funded by grants from Ecology.

- Of the two most feasible sites, Pyramid Creek has the highest total cost ($320 M) but the lowest unit cost ($51,000 per AF). Further consideration of this site may be warranted if a source for matching funds could be identified and a compelling purpose and needs statement could be developed for permitting.

- A final storage option that has not been investigated is groundwater storage. A "white paper" describing concepts and potential storage volumes is being developed and will be completed by the middle of February 2009.