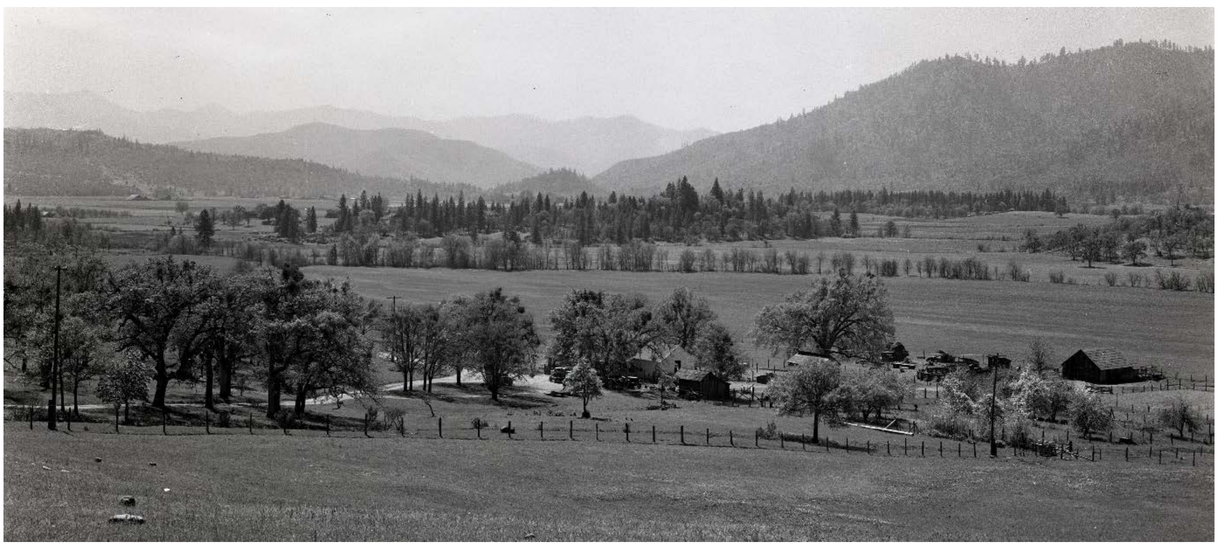
RECLAMATION

Managing Water in the West

Hydrologic Evaluation of Reeder Reservoir to Increase January and February Flows to Ashland Creek

Technical Memorandum



U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Regional Office
Boise, Idaho

July 2016

Mission of the Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Mission of the U.S. Department of the Interior

Protecting America's Great Outdoors and Powering Our Future

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

Photograph on front cover: View of farmland near Ashland, Oregon. Contact Reclamation Photographer Dave Walsh for information. April 23, 1946.

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1.0 PROJECT OVERVIEW

The objective of this work is to evaluate the refill probability of Reeder Reservoir under a range of potential increased releases to Ashland Creek in January and February. Potential increased releases would augment Ashland Creek flows and improve the ability of the Bureau of Reclamation (Reclamation) to meet 2012 Rogue River Biological Opinion (BiOp) habitat uplift obligations (National Marine Fisheries Service, 2012). The evaluation was conducted with hydrologic and reservoir historical data from water years 2005-2015.

2.0 REEDER RESERVOIR BACKGROUND

The City of Ashland (City) owns and operates Reeder Reservoir on Ashland Creek. Impounded by the Hosler Dam, Reeder Reservoir is fed by the West and East Forks of Ashland Creek. Reeder Reservoir is the primary source of drinking water for Ashland residents and also provides irrigation water (Carollo Engineers, 2012). Reeder Reservoir has a capacity of 850 acre-feet (AF) and a surface area of 20 acres when full (Bear Creek Watershed Council, 2001). Measured historical hydrologic data for Reeder Reservoir and Ashland Creek is limited.

2.1 Physical Description and Limitations

Inflows. Gaged daily flow data for the West and East Forks of Ashland Creek (14353000 and 14353500, respectively) are available from the United State Geological Survey (USGS) for the following time periods: 10/1/1924-1/31/1933, 12/1/1974-9/30/1982, and 10/1/2002-present (United States Geological Survey, 2016). The West and East Fork USGS gages are located roughly 1,000 feet upstream from Reeder Reservoir. In addition, the City maintains and gages a Cipoletti weir on each fork roughly 300 feet upstream of the reservoir. Due to weir and instrumentation capacities, the Cipoletti data is only valid up to 18.6 cubic feet per second (cfs). Since the weirs are downstream of the gages and there are no diversions between them, it would be expected that the flow in the weirs would be greater than or equal to the flows measured at the gages. However, inspection of the measured data revealed that this was not always the case, so the assumption was made to use the maximum value reported by each gage/weir pair. Since there is still distance between the measurement points and the reservoir, there is likely additional inflow that is not accounted for in this data.

Storage. There is a gage at the reservoir for the water surface elevation which is converted into a storage volume.

Outflows. There is no gage on Ashland Creek downstream of Reeder Reservoir to measure total outflows from the reservoir.

Water leaves Reeder Reservoir via either the spillway or the outlet works; only a portion of the outlet works outflow is measured. The spillway weir is not currently used as a measurement device nor is it calibrated to be used as such. When the spill gates are closed, maximum storage in Reeder Reservoir is 850 AF (Reeder's full capacity). If the spill gates are lowered into a down position, Reeder can only store roughly 93% (790 AF) of its total capacity before spilling.

After being released through the outlet works, outflow can follow many possible paths (Figure 2.1). The City maintains a generator with measured inflow data. The City's water treatment plant is downstream of the generator. There is a generator bypass link to Ashland Creek. An energy dissipation vault between the reservoir and the generator can also bypass the outlet works to Ashland Creek. Water that flows through the generator is the only measured outflow from Reeder Reservoir.

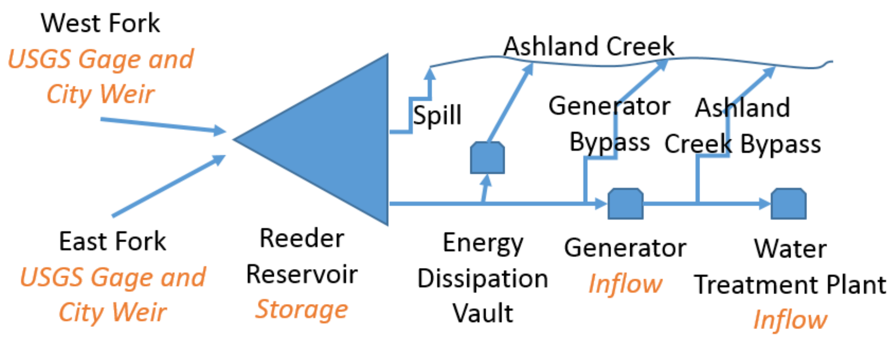

Figure 2.1. Diagram (not to scale) of Reeder Reservoir. Orange text indicates that data is available.

The four potential paths for flow through the outlet works are 1) all water goes through the City's generators and then is released in combination to the City's water treatment plant for drinking water or to the Ashland Creek Bypass, 2) water is divided between an energy dissipation vault which flows to Ashland Creek and the generator, 3) all water is sent through the energy dissipation vault, and 4) all water is sent through the generator bypass. Release options 2, 3, and 4 have outflow from the reservoir that is not measured. Those options are used during time of generator maintenance, big storm events, or when the reservoir is filling very quickly.

There are many factors contributing to uncertainty in the reservoir mass balance equation for Reeder Reservoir. These include unmeasured outflow paths from Reeder Reservoir, lack of information on spillway gate position over the study period, potential for unaccounted for inflows over the ¼-mile distance between the inflow measurements and the reservoir, undefined groundwater influences (contributing or reducing), and gage errors. Evaporation from the 20-acre reservoir is also ignored.

3.0 DATA DEVELOPMENT

A spreadsheet was developed to determine the impact on Reeder Reservoir storage of releasing additional flows in January and February to help satisfy BiOp requirements. As explained in Section 2, the available total outflow data is incomplete. Therefore, the total outflow was calculated using the measured storage and estimated inflow (described in section 2.1) using Equation 1, where the subscripts t and t-1 denote the current and previous time steps, respectively.

$$\boldsymbol{Inflow_t} - (\boldsymbol{Storage_t} - \boldsymbol{Storage_{t-1}}) = \boldsymbol{Total\ Outflow} \qquad (1)$$

Using the estimated inflows described in section 2.1 directly in this calculation resulted in some negative outflow values, suggesting that there may be additional inflow to the reservoir that is not measured by the gages used in this study. To account for this, the estimated inflows were adjusted so that the calculated total outflows were no longer negative.

An estimate of unmeasured outflow (referred to as spill) was calculated by subtracting the known component of outflow (inflow to the generator) from the calculated total outflow. Figure 3.1 shows the calculated total outflows, measured outflow through the generator, and unmeasured spill.

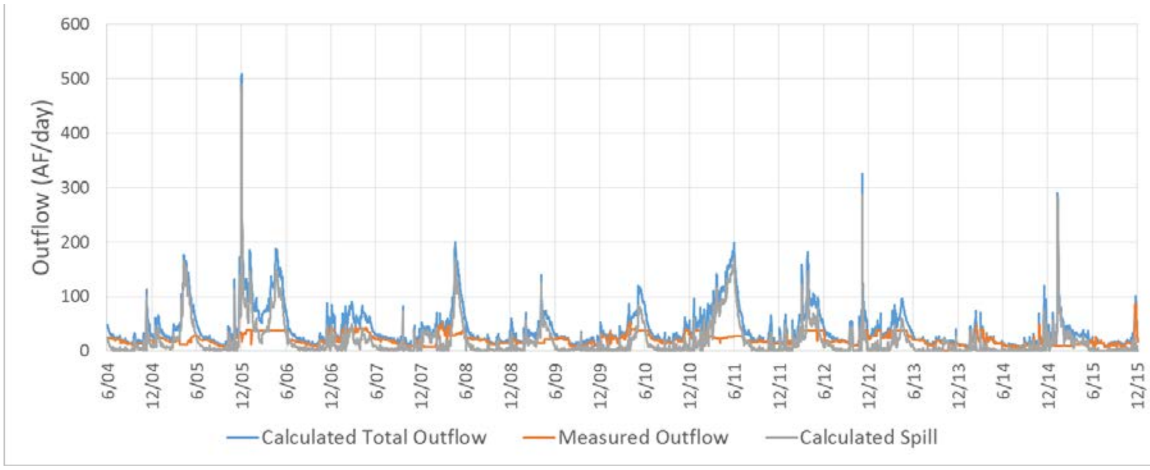

Figure 3.1. Outflows for Reeder Reservoir: calculated total outflow (blue), measured outflow through the generator (orange), and calculated spill (gray).

This study assumed that BiOp releases would be defined as additional releases above and beyond what has historically been released from the reservoir during the months of January and February. Based on this, a "baseline" or minimum outflow time series was developed for the study period where the baseline outflow equals the measured outflow through the generator plus the calculated spill during January and February and equals the generator flow during the remainder of the year.

BiOp release scenarios were then simulated as follows, for each timestep:

1) Calculate the amount of water available (supply) to satisfy downstream demands as inflow plus current storage (starting storage for the timestep).
2) Subtract the "baseline outflow" from the available supply to determine the supply remaining for BiOp release.
3) Subtract the BiOp release from the remaining supply and calculate the resulting storage.
4) If the resulting storage is greater than the reservoir storage capacity, calculate the additional spill required.
5) Recalculate the resulting storage (ending storage for the timestep). This becomes the starting storage for the next timestep.

Historical gaged and calculated storage values are not the same (Figure 3.2); the calculated storage values are always larger than the measured values. This is due to the limited available information on the operational activities that occur at the reservoir. For example, in periods where the gaged storage hovers around 800 AF (e.g., January to July 2006), the spillway gates were in the lower position so the reservoir capacity was reduced to roughly 93%. There was no information that could be used in the calculation to determine when the spillway gates were in the lower position, so it was assumed that they were always in the higher position, allowing the reservoir to fill to maximum capacity when it may not have historically. Another example is the limited information regarding when releases were made through the energy dissipation vault. Since it could not be determined when these releases would be made at any given time, the resulting calculated storage was larger than measured. The calculation method presented did not consider any operations to reduce the rate of refill other than operations that may have been accounted for in the minimum flow series for January and February.

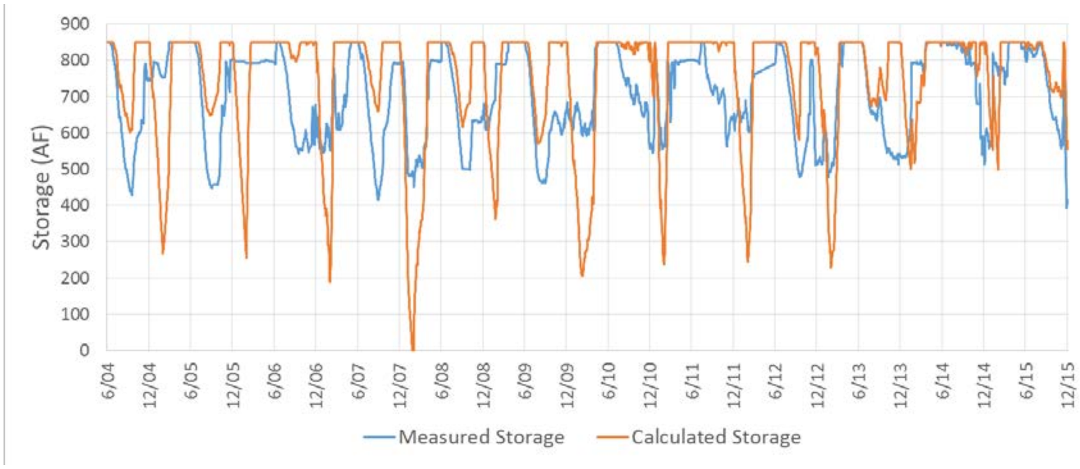

Figure 3.2. Comparison of the measured (blue) and calculated (orange) storage for Reeder Reservoir.

4.0 ANALYSIS OF ADDITIONAL FLOWS

The datasets and methods described in Section 3.0 were used to analyze the potential impact of additional flows to the existing outflows during January and February. Flow rates ranging from 0 to 10 cfs were added to the baseline outflow in January and February.

Figure 4.1 shows the storage volume that results for a range of additional outflows in January and February. The reservoir reaches its maximum capacity at some point each year with each flow alternative. Under the 10 cfs alternative (and occasionally under the 5 cfs alternative), storage in the reservoir declines to the point that water is not available to sustain the additional flows throughout January and February.

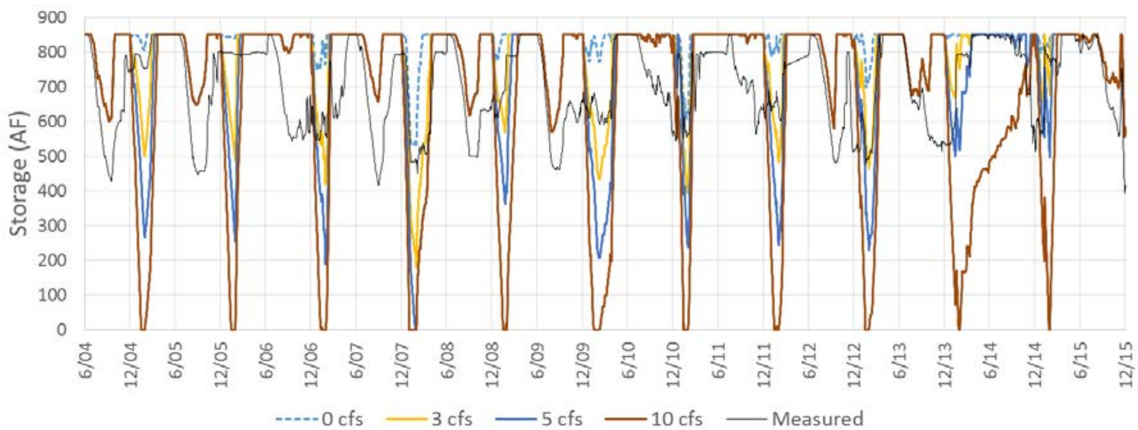

Figure 4.1. Comparison of the historical gaged storage (black) and the calculated storage for a range of potential additional releases in January and February to help meet BiOp requirements.

Within the 0 to 10 cfs range, there are two flow rates of particular interest (Figure 4.2). First, a flow rate of 4.6 cfs is the highest flow rate that can be maintained throughout the BiOp flow period. The calculations assumed that historical operations would be adjusted so that spill is reduced and the reservoir is allowed to fill every year. If operations are not adjusted, the highest allowable release would be less than 4.6 cfs. Second, a flow rate of 1.2 cfs is the highest flow at which the storage does not go below the historical measured minimum storage value of 393 AF at any time. There is no established minimum storage level for Reeder Reservoir. In reality, the reservoir does have water quality issues when storage levels get too low.

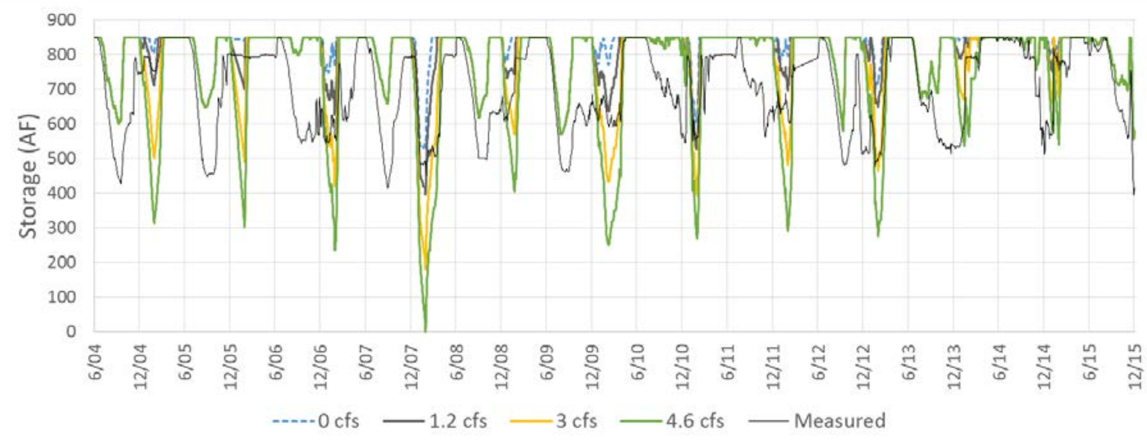

Figure 4.2. Comparison of the historical gaged storage (black) and the calculated storage for a range of potential additional releases in January and February to help meet BiOp requirements.

The City begins releases out of Reeder Reservoir in June to mitigate temperature impacts for operations at the waste water treatment plant. Due to these operations, May 31st reservoir refill was evaluated for each year of the period of record (2005-2015). The measured storage had five years where 850 acre-feet was not reached by May 31st but was reached at a later date; three of those years (2006, 2008, and 2011) are due to the spillway gate position and one year (2007) due to releases though energy dissipation vault to prepare for large inflows. Figure 4.3 shows the exceedance plot of the storage on May 31st for the measured storage as well as the simulated storage for a range of potential BiOp flows. Flow rates of 5 cfs or less resulted in the reservoir being full by May 31st, so the exceedance are represented by the blue 5-cfs line. In 2014, the 10 cfs alternative storage was 461 AF on May 31st and storage did not return to full until the 2015 water year.

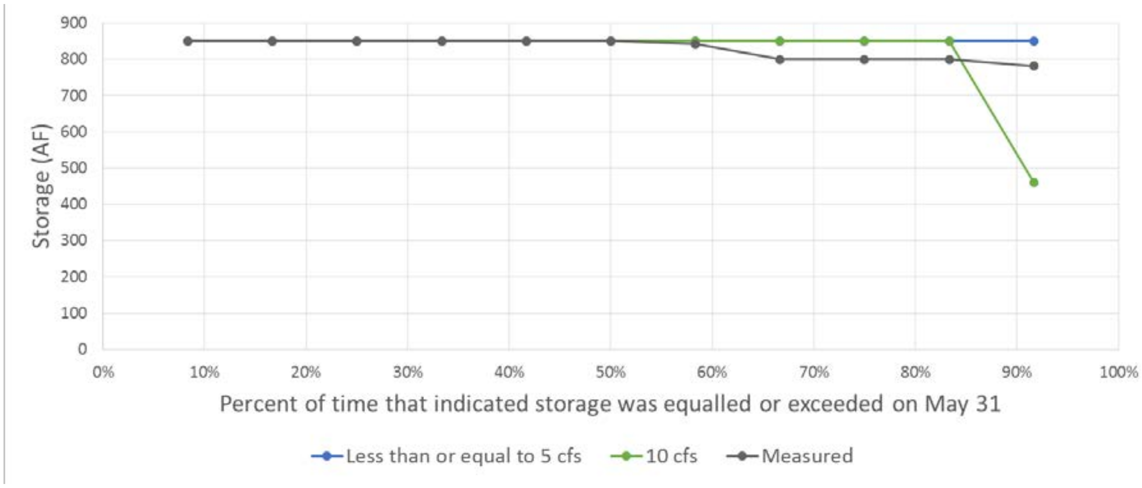

Figure 4.3. Exceedance plot of the historical measured storage (black) and the calculated storage on May 31st for a range of potential additional releases. The calculated storages for flow less than 5 cfs are not shown because their exceedance is identical to the 5 cfs line.

5.0 CONCLUSIONS

This study evaluated the refill probability under a range of potential increased releases from Reeder Reservoir to Ashland Creek to help Reclamation meet BiOp Requirements. Release scenarios evaluated ranged from 0 cfs to an additional 10 cfs. The results of this study suggest that Reeder Reservoir could refill 100% of the time by May 31st and support a BiOp release of a constant flow rate of 4.6 cfs in January and February.

5.1 Limitations and Considerations

Data limitations such as incomplete measurement of outflow and lack of a flood control curve restricted the evaluation process. Real-time operations of the energy dissipation vault for flood control releases and drawdown of the reservoir will be a large factor on the refill timing and the spring/summer spill regime. This analysis evaluated the hydrologic conditions to support the release of BiOp flows; it did not investigate how the spill and storage will need to be managed differently in other times of the year.

Any release to help Reclamation meet BiOp requirements will change the operations of Reeder Reservoir. Releasing water in January and February will reduce spill later in the year and affect the operation of the energy dissipation vault. The reduced Reeder total outflow in spring as it refills from additional winter releases needs to be acknowledged by operators and interests downstream as historical flows in Ashland Creek after the BiOp flow period will change with these additional release.

Figure 4.1 shows how low the storage in Reeder Reservoir may get with additional outflows but that issue is not discussed in depth in the analysis. Water quality in the reservoir as influenced by low storage values may affect how the additional flow rates are chosen. A BiOp flow of 4.6 cfs does draw the reservoir to empty one year and below 300 AF six years. A simplistic analysis found that a flow rate of 1.2 cfs is the largest flow which would allow the reservoir to keep a storage value of at least the lowest value in the historic measured record.

6.0 LITERATURE CITED

Parenthetical Reference	Bibliographic Citation
Bear Creek Watershed Council, 2001	Bear Creek Watershed Council. (2001). Bear Creek watershed assessment: Phase II – Bear Creek tributary assessment. Available at: http://www.rvcog.org/pdf/WR_BCWA_PART2_Mt_Ashland.pdf
Carollo Engineers, 2012	Carollo Engineers. (2012). *Comprehensive water master plan for the City of Ashland.* April 2012. Available at http://www.ashland.or.us/SIB/files/2012%20CWMP-Carollo(1).pdf
National Marine Fisheries Service, 2012	National Marine Fisheries Service. (2012). *Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Future Operation and Maintenance of the Rogue River Basin Project*. April 2012. Available at http://www.usbr.gov/pn/programs/esa/oregon/rogue/biop.pdf
United States Geological Survey, 2016	U.S. Geological Survey. (2016). *National water information system data available on the World Wide Web (USGS Water Data for the Nation)*. Available at waterdata.usgs.gov/nwis