Hydrologic Analysis of the Refill Probabilities Associated with Increasing the Storage Capacities of Anderson Ranch and Arrowrock Reservoirs

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Overview

The Boise River system includes three major storage dams, a diversion dam, and one major and one minor off-stream storage reservoir. Arrowrock Dam, Anderson Ranch Dam, Boise River Diversion Dam, Lake Lowell, and Hubbard Reservoir were constructed as part of Reclamation's Boise Project. Boise River Diversion Dam diverts water from the Boise River to the New York Canal which conveys water to Lake Lowell and a large percentage of the acreage in the Boise Project.

The three major storage dams are in series, i.e., water from Anderson Ranch Reservoir passes through Arrowrock Reservoir and then through Lucky Peak Reservoir, Figure 1 shows the relative location of Anderson Ranch, Arrowrock, and Lucky Peak in the Boise River System. Lucky Peak Dam was constructed by the U.S. Army Corps of Engineers and is maintained and operated by them. Anderson Ranch Dam and Arrowrock Dam are reserved works, facilities maintained and operated by Reclamation. Anderson Ranch, Arrowrock, and Lucky Peak are operated together as a system for flood control and irrigation water supply.

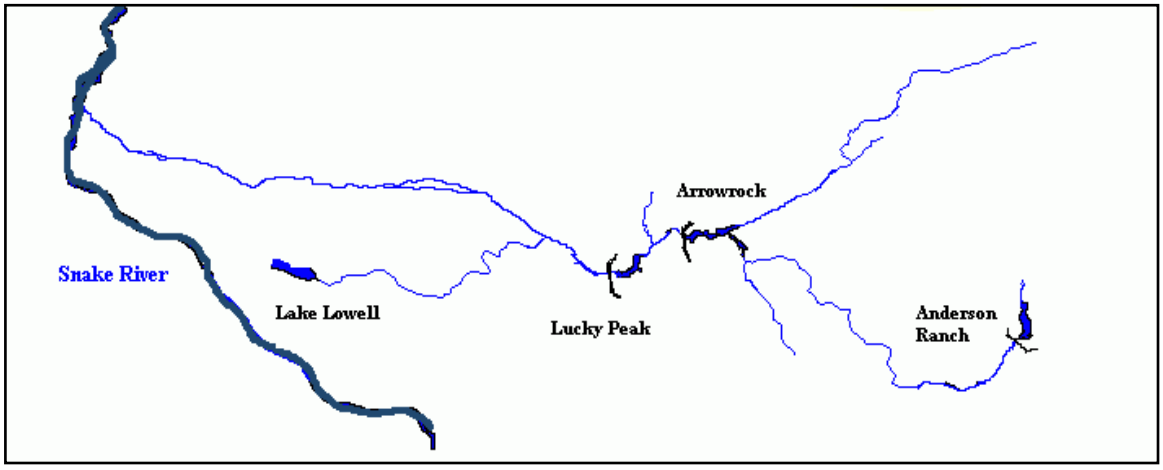

Figure 1: Location of the main storage dams on the Boise River.

Purpose and Need

As the demand for water increases in the Boise River Valley, options for additional water supply need to be explored. One proposal is to raise the dams at Anderson Ranch and Arrowrock Reservoirs, hence increasing their storage capacities. This proposal raises several questions including the cost/benefits of such a project. The first question that should be answered is, "Is there enough water in the Boise River System to fill the additional storage capacities of Anderson Ranch and Arrowrock Reservoirs if the dams were raised?" To answer this question, a hydrologic analysis was conducted to model various different dam raise scenarios.

Modeled Scenarios

Eleven different dam raise scenarios were modeled at Anderson Ranch and at Arrowrock Dams. Table 1 shows the scenarios that were modeled and the additional available storage capacities that the different dam raises would create.

Anderson Ranch Dam		Arrowrock Dam		
Dam Raise, (full pool elevation)	**Additional storage capacity (acre-ft)**	**Dam Raise, (full pool elevation)**	**Additional storage capacity (acre-ft)**	**Total Additional Storage (acre-ft)**
No raise, (4196 feet)	0	1-foot, (3217 feet)	3155	3155
No raise, (4196 feet)	0	2-foot, (3218 feet)	6336	6336
1-foot, (4197 feet)	4757	No raise, (3216 feet)	0	4757
1-foot, (4197 feet)	4757	1-foot, (3217 feet)	3155	7912
1-foot, (4197 feet)	4757	2-foot, (3218 feet)	6336	11093
3-foot, (4199 feet)	14354	No raise, (3216 feet)	0	14354
3-foot, (4199 feet)	14354	1-foot, (3217 feet)	3155	17509
3-foot, (4199 feet)	14354	2-foot, (3218 feet)	6336	20690
6-foot, (4202 feet)	28954	No raise, (3216 feet)	0	28954
6-foot, (4202 feet)	28954	1-foot, (3217 feet)	3155	32109
6-foot, (4202 feet)	28954	2-foot, (3218 feet)	6336	35290

Table 1: Modeled Scenarios

Model Methodology

The Boise/Payette River MODSIM model (MODSIM version 7.2.18a) was used to simulate Boise River operations under the various dam raise scenarios. This particular model is a subset of the Upper Snake River model which was used most recently in the "*Biological Assessment for the Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir*", November 2004. MODSIM is a general purpose river and reservoir operations computer simulation model developed jointly by Colorado State University and Reclamation. The model used for this study simulates at a monthly timestep with a period of record from 1928-2000. Natural flow rights and storage rights for the Boise system were simulated in the model. The following is a list of assumptions and methods that were used to simulate the dam raise scenarios.

- Reservoir fill rights and storage rights for the new space were junior to all other rights. In other words, the new space was last to fill.
- Demands for any storage accrued in the new space were simulated at three different downstream locations (above the Broadway Bridge, between the Broadway and Glenwood bridges, and around the Eagle area).
- The new simulated demands were large enough to use up any accrued storage every year.

- Junior natural flow rights were created for the new demands to simulate realistic situations and to defer the new storage releases until mid-summer.

Results

The desired goal of this hydrologic analysis was to determine the additional volume of water that could be stored and delivered if the storage capacities of these reservoirs were increased. Figures 2-4 shows the probabilities of the additional storage water delivered (Anderson Ranch, Arrowrock, and Anderson Ranch and Arrowrock combined) for the different scenarios. Please note that one of the modeling assumptions was to use all of the additional accrued storage every year, therefore these probabilities also reflect how well the new additional storage space refilled every year.

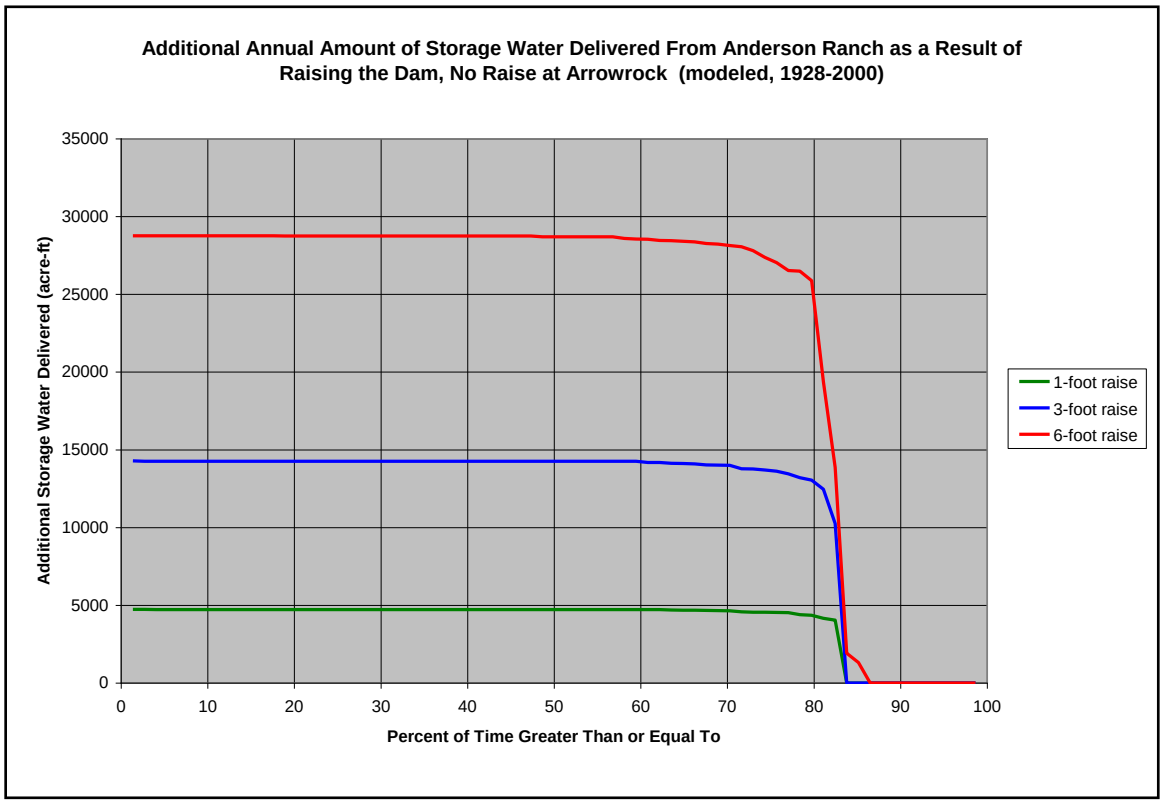

Figure 2: Probabilities of additional storage water delivered from Anderson Ranch

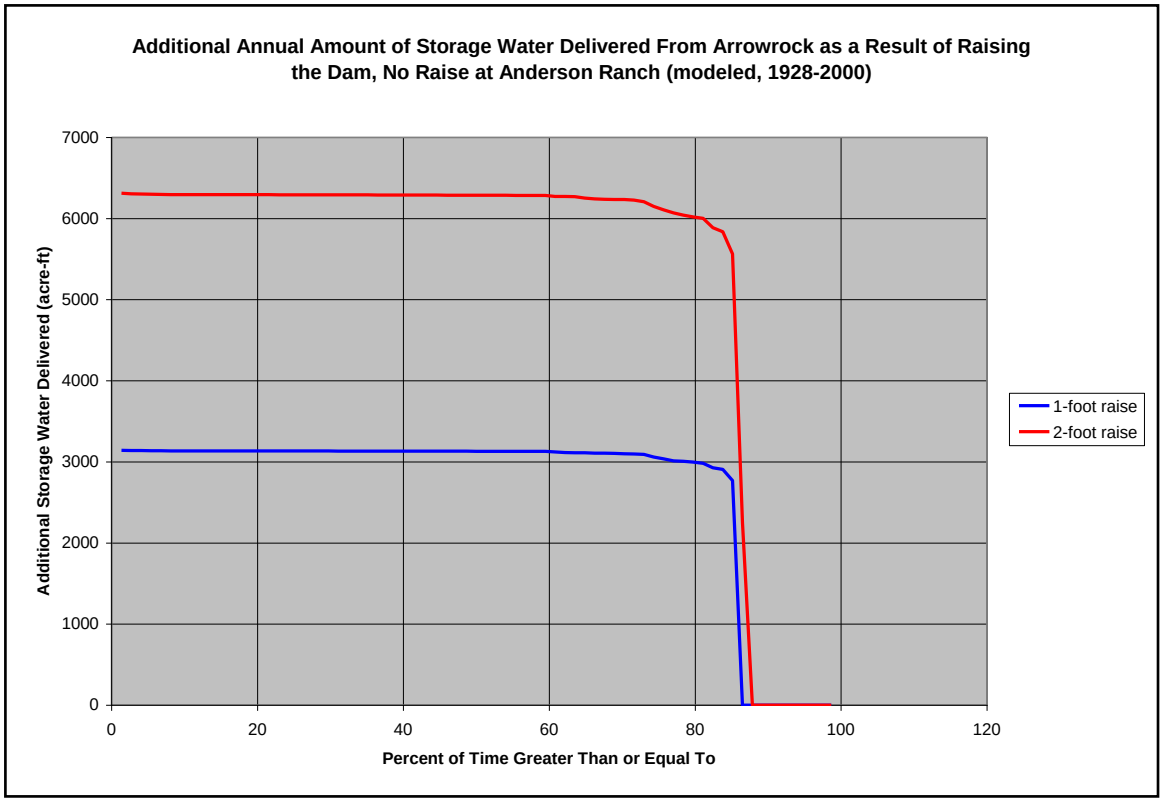

Figure 3: Probabilities of additional storage water delivered from Arrowrock

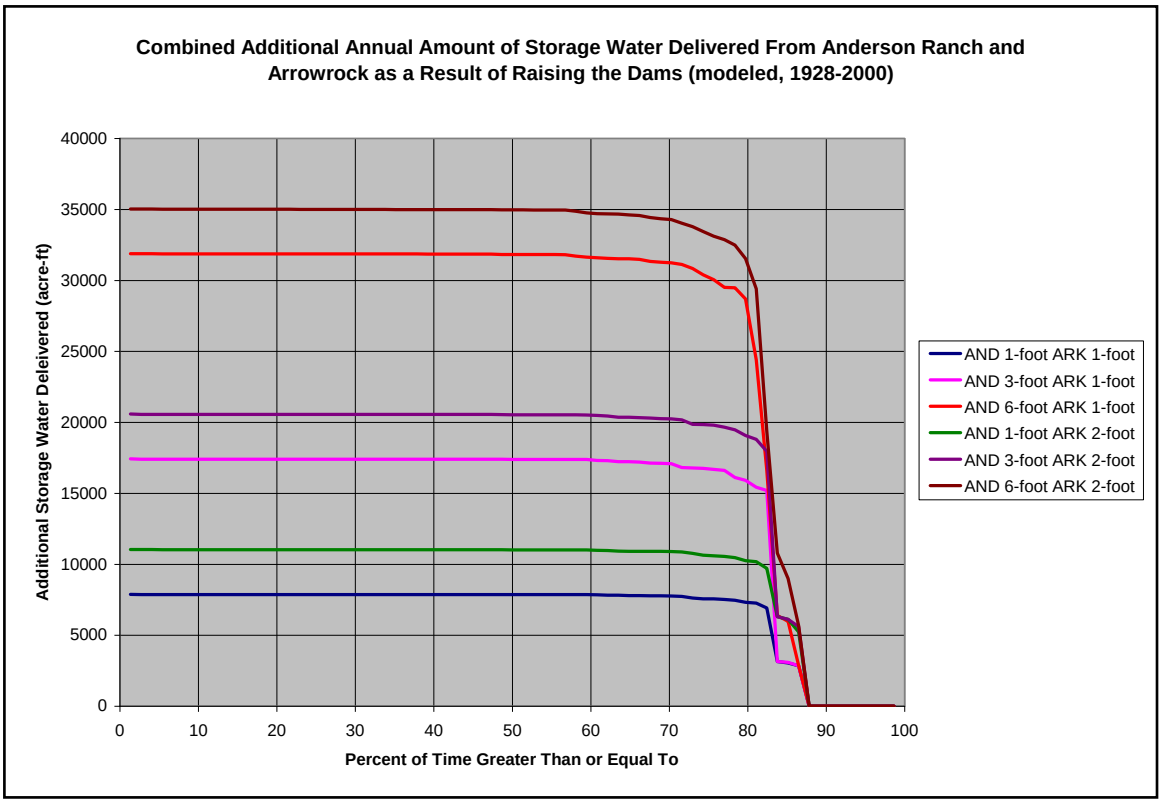

Figure 4: Probabilities of additional storage water delivered from Anderson Ranch and Arrowrock combined.

For comparison purposes, Figure 5 shows the peak annual physical active contents of Anderson Ranch and Arrowrock Reservoirs for the current configuration (no-raise at either dam) and the maximum raise scenario (6-ft raise at Anderson Ranch and 2-ft raise at Arrowrock). Note that Anderson Ranch would fill in either case between 60% and 70% of the time and Arrowrock would fill in either scenario between 80% and 90% of the Time.

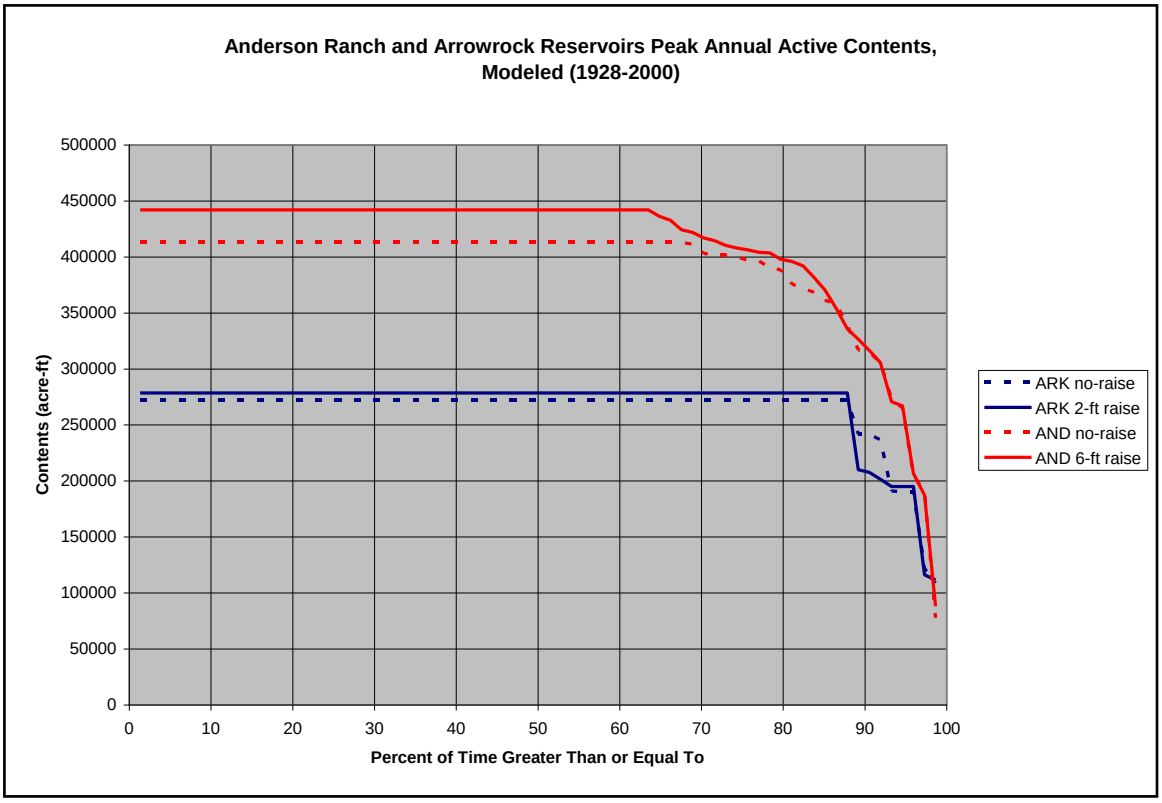

Figure 5: Probability of annual maximum active contents for Anderson Ranch and Arrowrock Reservoirs

Conclusion

This hydrologic analysis has shown there is a fairly high probability of filling the additional space and delivering the additional storage water created by raising the dams at Anderson Ranch and Arrowrock dams in any given year. For example, there is around a 60% probability of delivering about 35,000 acre-feet and around an 80% probability of delivering over 30,000 acre-feet of additional storage if Anderson Ranch was raised 6 feet and Arrowrock was raised 2-feet. This probability reflects historic hydrology and may seem high at first glance, but this perception is probably the result of the drought conditions that have existed in the Boise Basin over the last few years (2000-2005). Assuming that the climate of the next 75 years will be similar to the climate of the last 75 years, the probability estimates presented in this report are deemed reasonable.