THE STATE OF WYOMING

Water Development Office

6920 YELLOWTAIL ROAD TELEPHONE: (307) 777-7626 CHEYENNE, WY 82002
FAX: (307) 777-6819

TECHNICAL MEMORANDUM

TO: Water Development Commission **DATE:** November 22, 2011

FROM: Chace Tavelli, P.E. **REFERENCE:** Bear River Basin Plan Update, 2011

SUBJECT: Reservoir Evaporation– *Tab XI (2011)*

Contents

1.0 Introduction

Reservoir evaporation is the second largest consumptive use of water in the Bear River Basin. There are five main reservoirs in the basin that are either larger than 1,000 acre-feet, or are considered significant for the purposes of this study. A technical memorandum has been written for each of these five reservoirs. There are other reservoirs in the basin that may not be considered significant but, because evaporation is the second largest use of water, these have been included in the evaporation calculations presented herein. For this update, a different approach was taken to calculate evaporation compared to the 2001 Plan (for methodology used in the 2001 plan see http://waterplan.state.wy.us/plan/bear/finalrept/chapter_3.html). The focus of this technical memorandum is to detail the approach used for calculating reservoir evaporation in this update.

2.0 Approach to Evaporation Calculations

Evaporation calculations require three variables; evaporation, precipitation, and water body surface acreage. WRDS staff gathered the evaporation and precipitation data, while the surface acreage for each reservoir was found in the State Engineer's Office (SEO) water right permits.

The nearest station having daily pan evaporation data is the National Weather Service COOP station at Green River, which is located in the Green River Basin. Data for this station were gathered from the High Plains Regional Climate Center's (http://www.hprcc.unl.edu) CLIMOD program. The data collection period was from 1971 to 2010. A monthly and annual average over the period was calculated by summing the daily values for each month and dividing by 40, the number of years in the period of record. Pan evaporation values were multiplied by a factor of 0.7 to convert the pan evaporation to reservoir evaporation. The 0.7 value is a commonly used factor for this conversion.

Reservoirs in the basin were identified and precipitation data were retrieved for each. The precipitation data were taken from WRDS's Water and Climate Map Server. This web mapping application allows a user to obtain monthly and annual precipitation values for any point in the state using spatially gridded data from the PRISM Climate Group, Oregon State University (http://www.prismclimate.org). Precipitation values were taken from an approximately 4km x 4km grid cell that best represented the precipitation at each reservoir. The monthly values for the period of record were averaged to obtain representative monthly precipitation. Because gridded PRISM data were used, a precipitation value could be obtained for the actual location of the reservoir.

Surface acreage was handled two different ways depending on the size of the reservoir. In an effort to estimate an average surface acreage for a year, reservoirs with a capacity greater than 1,000 acre-ft were assumed to have a surface water elevation ten feet lower than their operating elevation. The remaining reservoirs were assumed to be full and were modeled accordingly. Because there are limited operation data for the reservoirs it is difficult to develop an average yearly surface water elevation. Ten feet was chosen because it seemed reasonable and conservative without being overly conservative. Smaller reservoirs were assumed to be full because little information and data are available from SEO for most of these reservoirs.

3.0 Reservoirs

Five reservoirs are described in this technical memorandum: Sulphur Creek, Woodruff Narrows, Ben, Broadbent, and Whitney Reservoirs. In the 2001 Plan, Sulphur Creek and Woodruff Narrows Reservoirs' evaporation were calculated in the model as was also done for this update. Other reservoirs identified in various river basin planning databases were also evaluated and included in the final evaporation estimates. These reservoirs are Martin, Crompton, Painter, Quealy, and Larson.

4.0 Evaporation Calculations

Monthly averages for reservoir evaporation and precipitation data were calculated. The precipitation was then subtracted from the reservoir evaporation data to get the average net evaporation for each month. This monthly value was then converted to feet and multiplied by the reservoir's surface area to obtain total evaporation for the year. In addition to the existing evaporation being calculated, the low and high projections for evaporation were calculated. To develop the low and high projections, the existing climatic conditions are assumed to remain consistent for the planning horizon. This assumption simplified the calculations for the projections because only the surface acreage of the reservoirs was manipulated to develop the final estimates. The low projection assumes that all reservoirs with a capacity less than 100 acre-feet are empty and the remaining reservoirs are at 50% of active capacity. For the high projection, all reservoirs were considered full. Table 1 shows the final evaporation estimates for existing conditions and the low and high projected conditions.

Table 1: Reservoir Evaporation

Main Reservoirs	Low Projection Evaporation (acre-feet)	Existing Conditions Evaporation (acre-feet)	High Projection Evaporation (acre-feet)
Sulphur Creek Reservoir	846	1,013	1,210
Woodruff Narrows Reservoir	3,654	3,986	5,244
Ben Reservoir	-	41	41
Broadbent Reservoir	-	35	34
Whitney Reservoir	39	49	59
Evaporation (Main reservoirs)	4,540	5,125	6,589
Other Reservoirs	**Low Projection Evaporation (acre-feet)**	**Existing Conditions Evaporation (acre-feet)**	**High Projection Evaporation (acre-feet)**
Martin	-	21	21
Crompton	-	151	151
Painter	-	42	42
Quealy	-	19	19
Larson	-	3	3
Evaporation (Other reservoirs)	-	236	236
TOTAL EVAPORATION	**4,540**	**5,361**	**6,825**

5.0 Summary

The evaporation estimate from the 2001 Plan was 5,280 acre-feet, compared to the 5,361 acre-feet calculated in this update. There were some differences in the approaches taken; however, the methods used to derive evaporation estimates for this update's estimate are acceptable and reproducible.

It is recommended that the State establish (or reestablish) the collection of water-level and evaporation data for the main reservoirs in this system. The State should also consider the development of a better reservoir model for evaluating the effects of reservoirs on the hydrology of the system and to better estimate evaporation. The StateMod model, proposed in other technical memoranda for this update, has the capability to model actual, and proposed, reservoir operations, which adds another benefit to developing a complete StateMod model for the Bear River Basin.