RECLAMATION
Managing Water in the West

Flaming Gorge Technical Working Group

April 2018 Hydrology Summary

Jed Parker, P.E.

For the purposes of discussions related to implementing the ROD in 2018, an evaluation has been made of the current hydrologic conditions in the Upper Green River (*i.e*. above Flaming Gorge Dam) and Yampa River Basins. The evaluation centered on the historical unregulated inflow statistics for Flaming Gorge Dam during the period from 1963 through 2017. The April 1, 2018 final forecast is 1,000,000 acre-feet for Flaming Gorge, which falls in the average (below median) hydrologic classification. Information regarding Yampa River hydrology indicates that the hydrologic classification will likely be moderately dry (<70% and >90% exceedance) for spring 2018.

The combined April through July forecast of the Yampa River at Maybell and Little Snake at Lily is 755,000 acre-feet. This forecast would fall into the moderately dry hydrologic classification of the ROD.

Snow water equivalent (SWE) as April 9, 2018, for the Upper Green River and Yampa/White River Basins are 115 and 87 percent of median, respectively. Flaming Gorge SWE is similar to 1987 and 1968, while Deerlodge SWE is similar to 1987 and 2001. The Tower snotel site, used as a reference point for Yampa snowpack and runoff, currently has 40.7 inches of SWE (88 percent of median). On April 8, Tower SNOTEL measured SWE inches of:

- 1987 = 35.5 in; Yampa 746 kaf obs spring (74%)
- 2001 = 36.9 in; Yampa 790 kaf obs spring (78%)

The difference between the Tower SNOTEL figures and Yampa River observed spring volume differs significantly and needs to be considered when comparing any values this early in the snow accumulation season.

Basin Hydrology

Green River Basin Hydrology

The April 8, 2018, ESP forecast of April through July unregulated inflow (current forecast) for Flaming Gorge Reservoir is 1,090,000 acre-feet (AF) (111% of 30-year average). This forecast falls at 48 percent exceedance based on the historic unregulated inflow record (1963-2017).

Figure 1 illustrates the Upper Green River SWE as of April 8, 2018 and compares it against the nearest April-July water years 2016 and 2005. Figures 2 and 3 show the spatial extent of significant areas of modeled snow accumulation for the Upper Green River Basin and how this is incorporated into the water supply forecasts. Figure 3 indicates that the forecast for Flaming Gorge Reservoir has remained fairly stable. The April 1, 2018 final forecast (1,000 kaf) features an increase in the April–July projection of 60,000 acre-feet when compared to the March 1, 2018 final forecast.

Historic year unregulated inflow volumes that compare with current snowpack (based off of April 8, 2018 ESP) are 2016 with total inflow into Flaming Gorge of 1,047 kaf (107 percent of average) and 2005 with total inflow into Flaming Gorge of 1,111 kaf (113 percent of average).

Figure 4 illustrates the current forecast in relation to the historic unregulated inflow volumes. Figure 5 illustrates Flaming Gorge Reservoir April final forecast probability (percent exceedance).

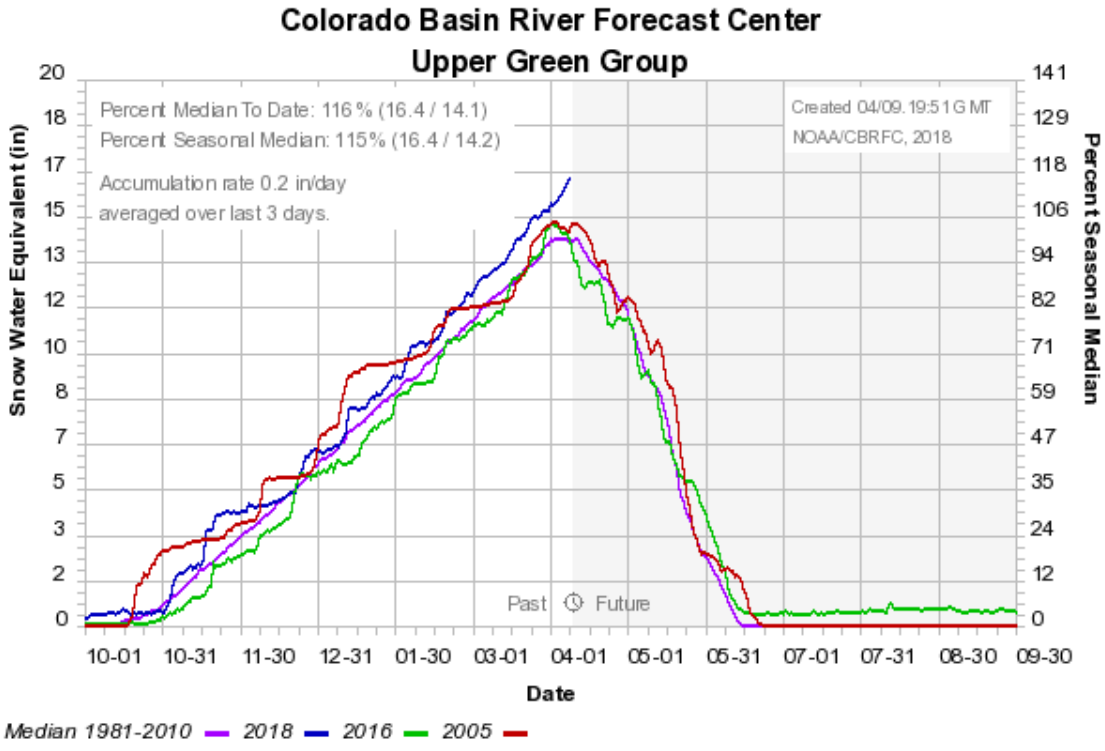

FIGURE 1. Upper Green River Basin Snotel Tracking. 1981-2010 percent of median compared against 2018 YTD Snow Water Equivalent (SWE), 2016, and 2005 percent of average SWE.

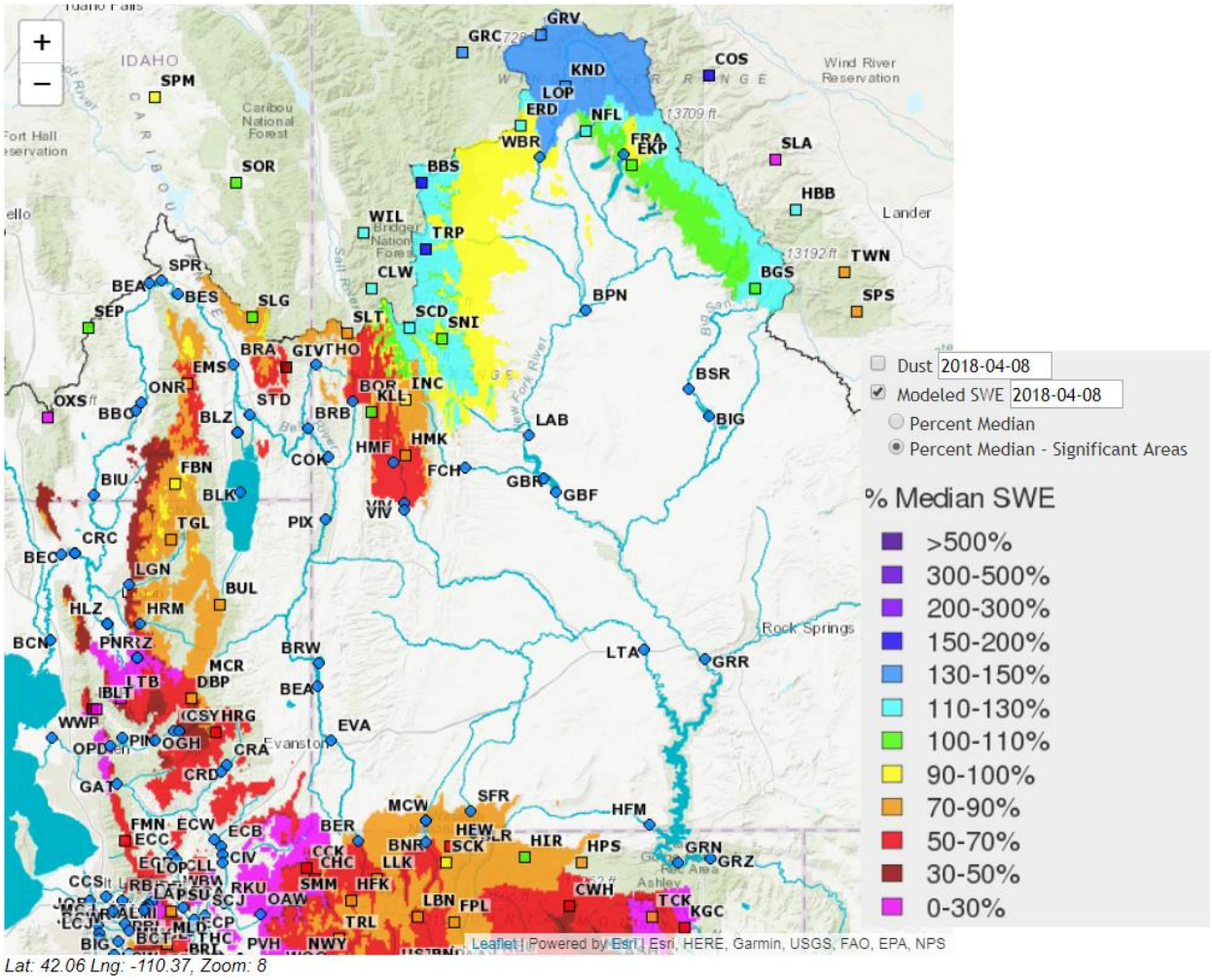

FIGURE 2. Upper Green River Basin modeled SWE significant areas as of April 8, 2018.

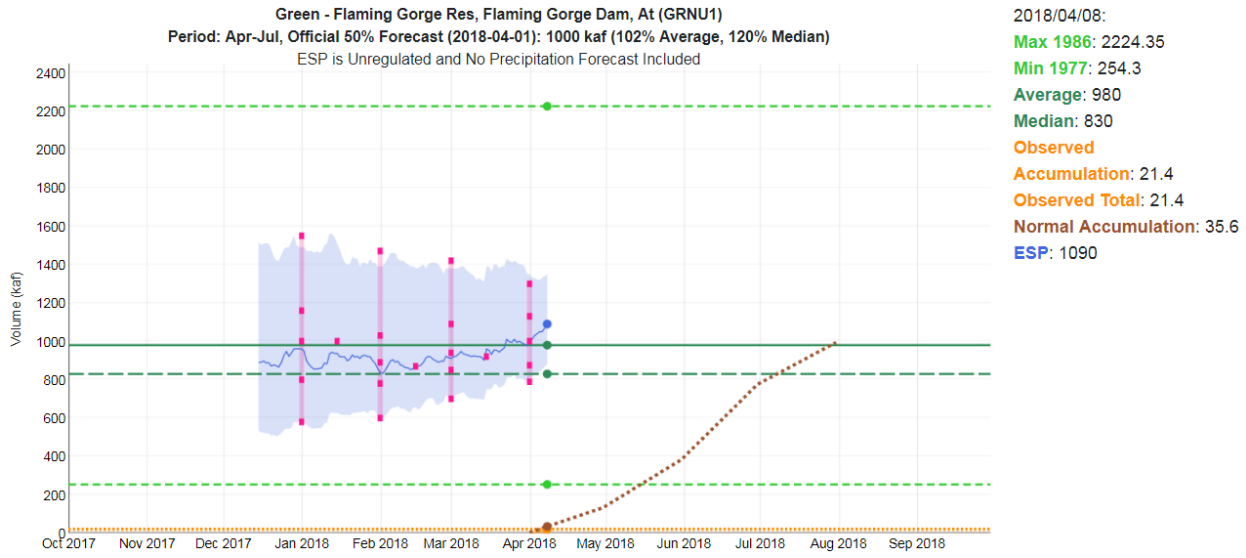

FIGURE 3. Upper Green River Basin Water Supply Forecast as of April 8, 2018.

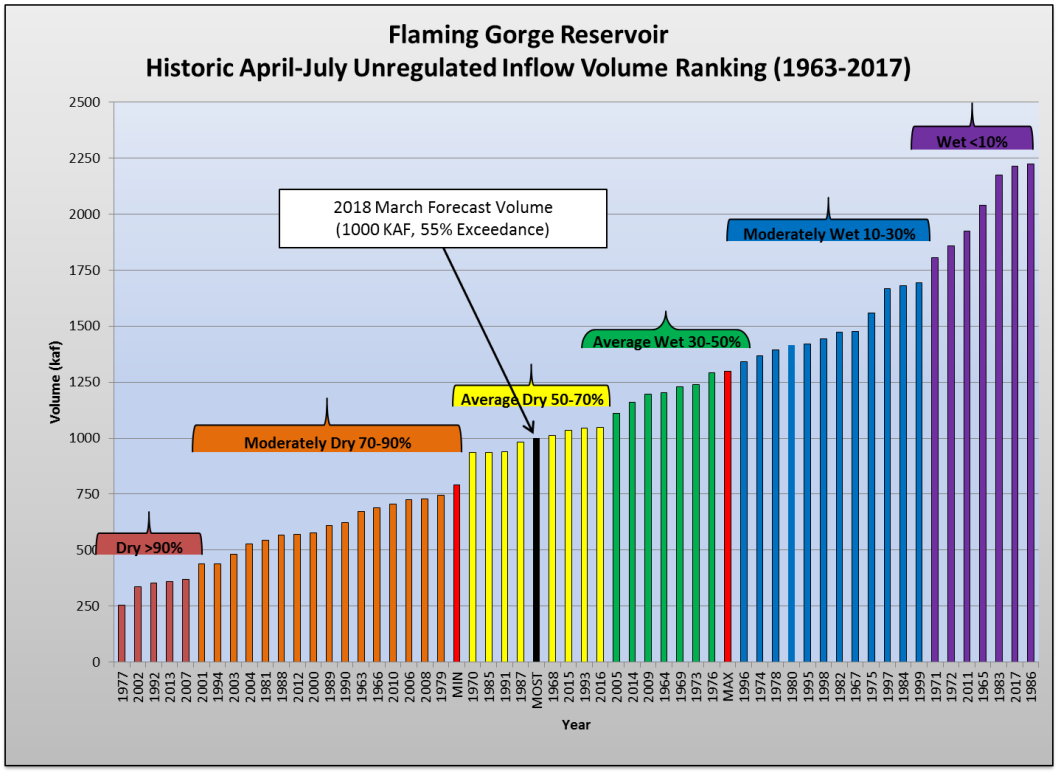

FIGURE 4. Flaming Gorge Reservoir February 1, 2018 forecast and ranked historic April-July unregulated inflow volume for years 1963-2017.

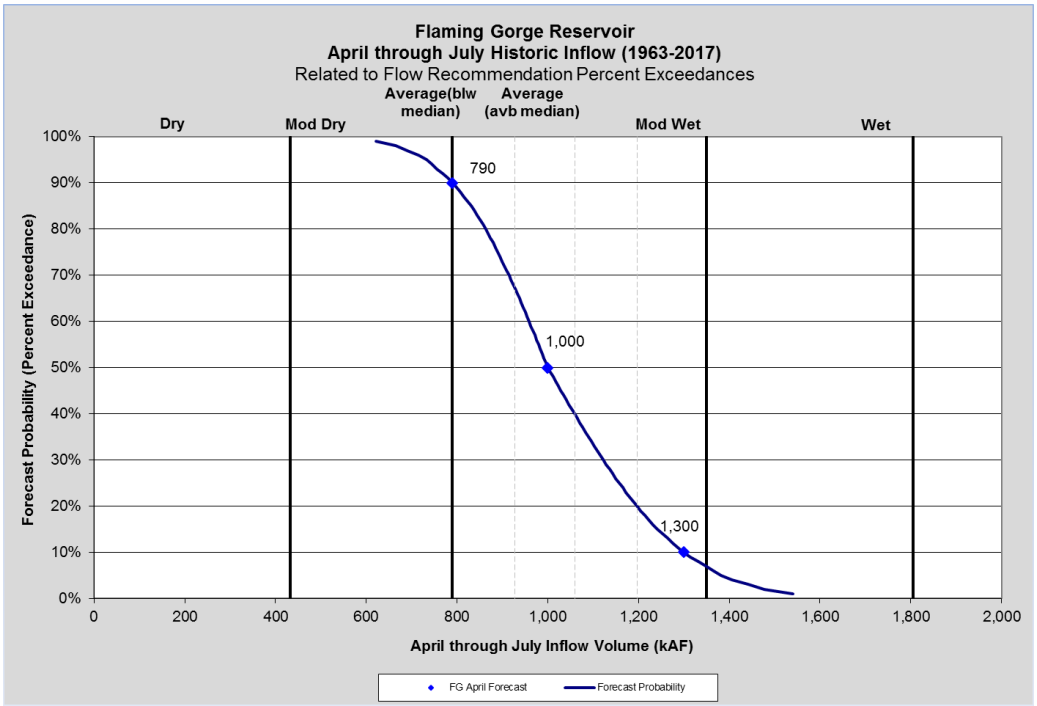

FIGURE 5. Flaming Gorge Reservoir April final forecast probability (percent exceedance) and historic April-July unregulated inflow volume for years 1963-2017

Yampa River Basin Hydrology

The combined current forecast for the Little Snake at Lily plus Yampa River at Maybell is 755,000 AF (61% of 30-year average). This forecast falls at approximately 86% exceedance based on a ranking of the historic record (1922-2017).

Figure 6 illustrates the Yampa River at Deerlodge Park SWE as of April 8, 2018 and compares it against water years 1987 and 2001.

Figures 7 and 8 show the spatial extent of significant areas of modeled snow accumulation for the Yampa River Basin and how this is incorporated into the water supply forecasts. Figure 8 indicates that the forecast for the Yampa River at Deerlodge is stable and the April 1, 2018, final forecast equals 750 kaf.[1]

Figure 9 below shows the current forecast in relation to historic flow volumes. Figure 10 illustrates the Yampa River at Maybell plus Lily April final forecast probability (percent exceedance).

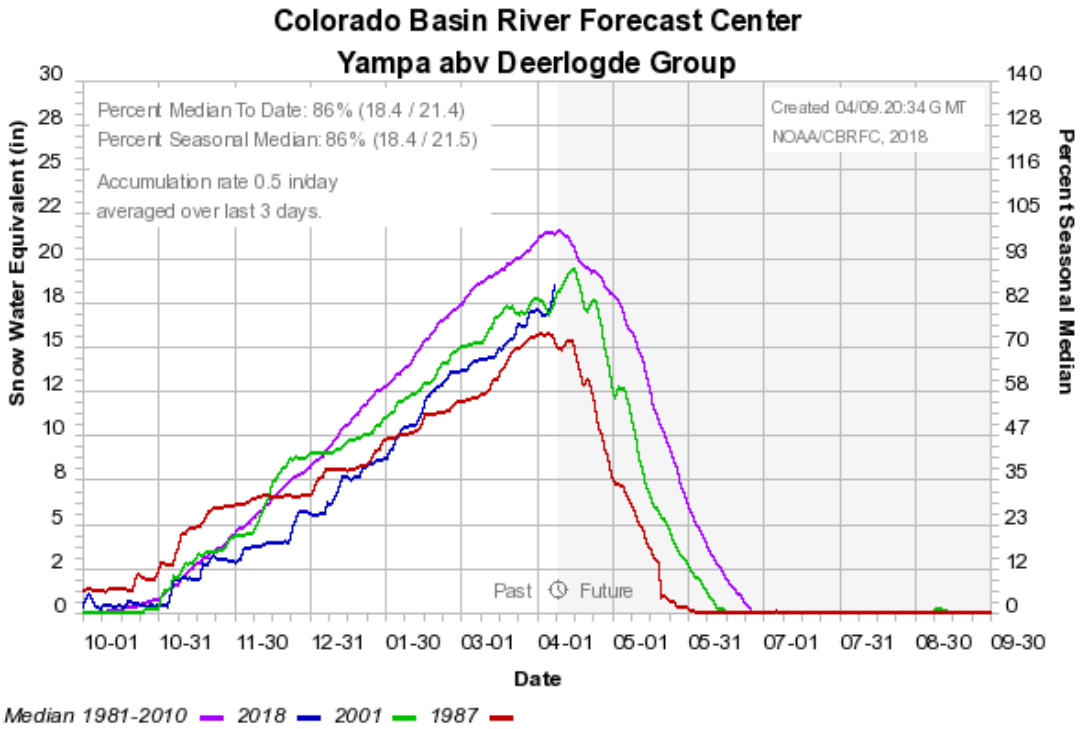

FIGURE 6. Yampa River above Deerlodge SNOTEL Group. 1981-2010 percent of average SWE compared against 2018 YTD, and analog years 1987 and 2001.

[1] The Yampa River at Deerlodge forecast volume differs from the Yampa River – Maybell Plus Lily volume. The historic gage record to calculate the Maybell plus Lily forecast volume is significantly longer than the Deerlodge dataset. The forecast volumes will be close, but the actual volume may differ due to routing in the CBRFC forecast model.

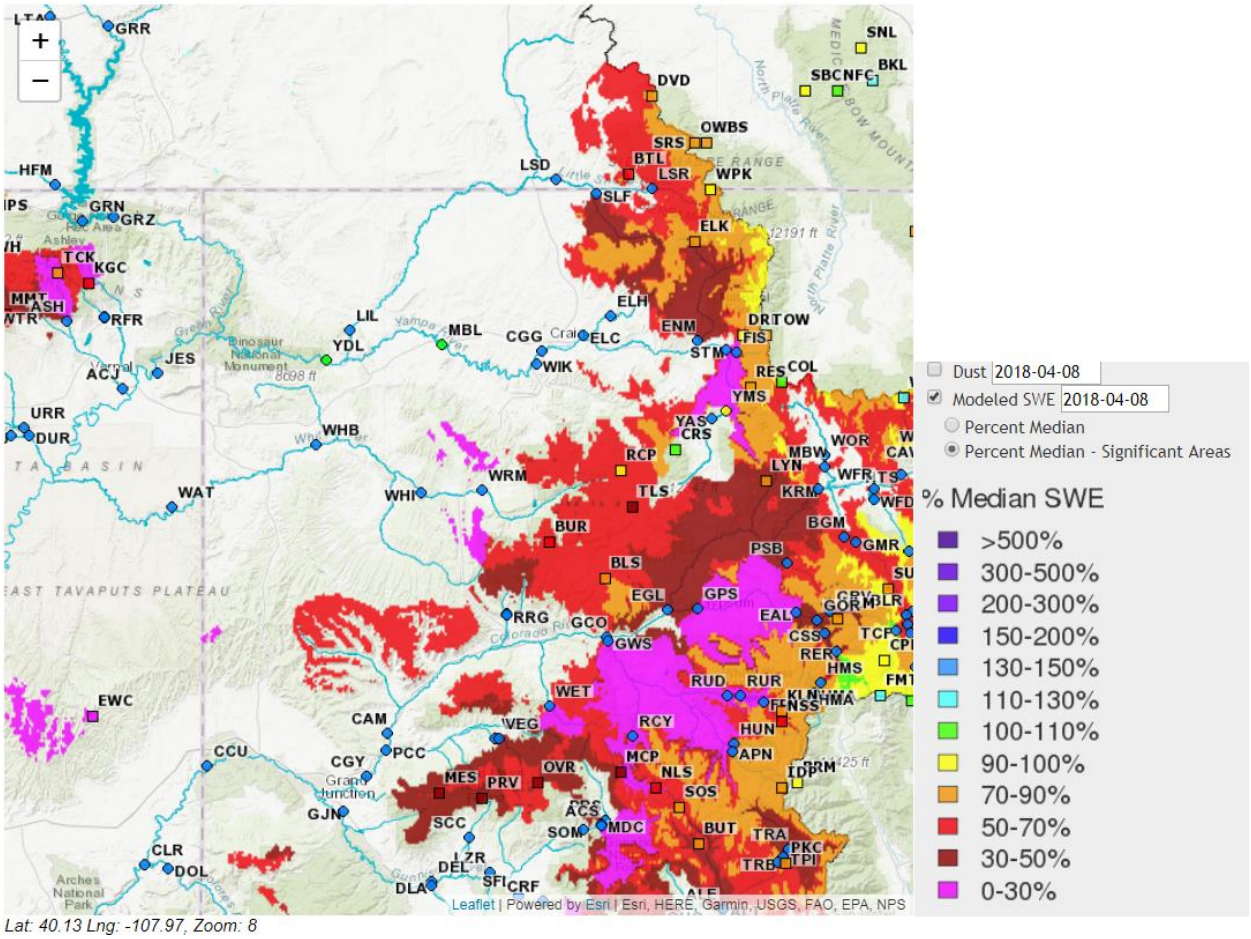

FIGURE 7. Yampa River Basin modeled SWE significant areas as of April 8, 2018.

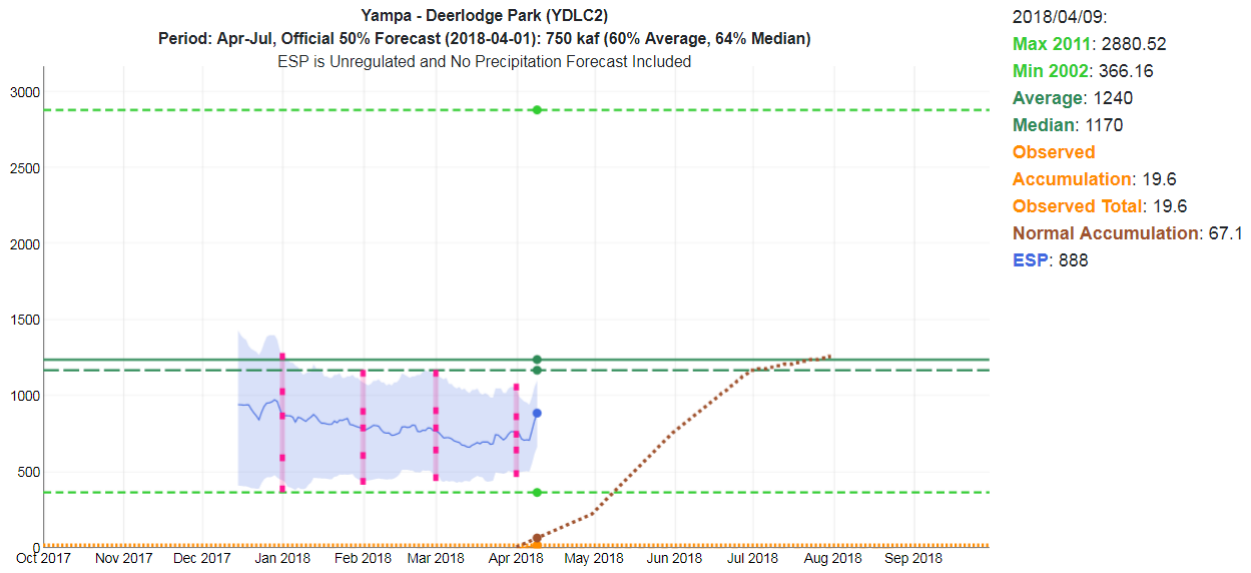

FIGURE 8. Yampa – Deerlodge Park Water Supply Forecast as of April 9, 2018.

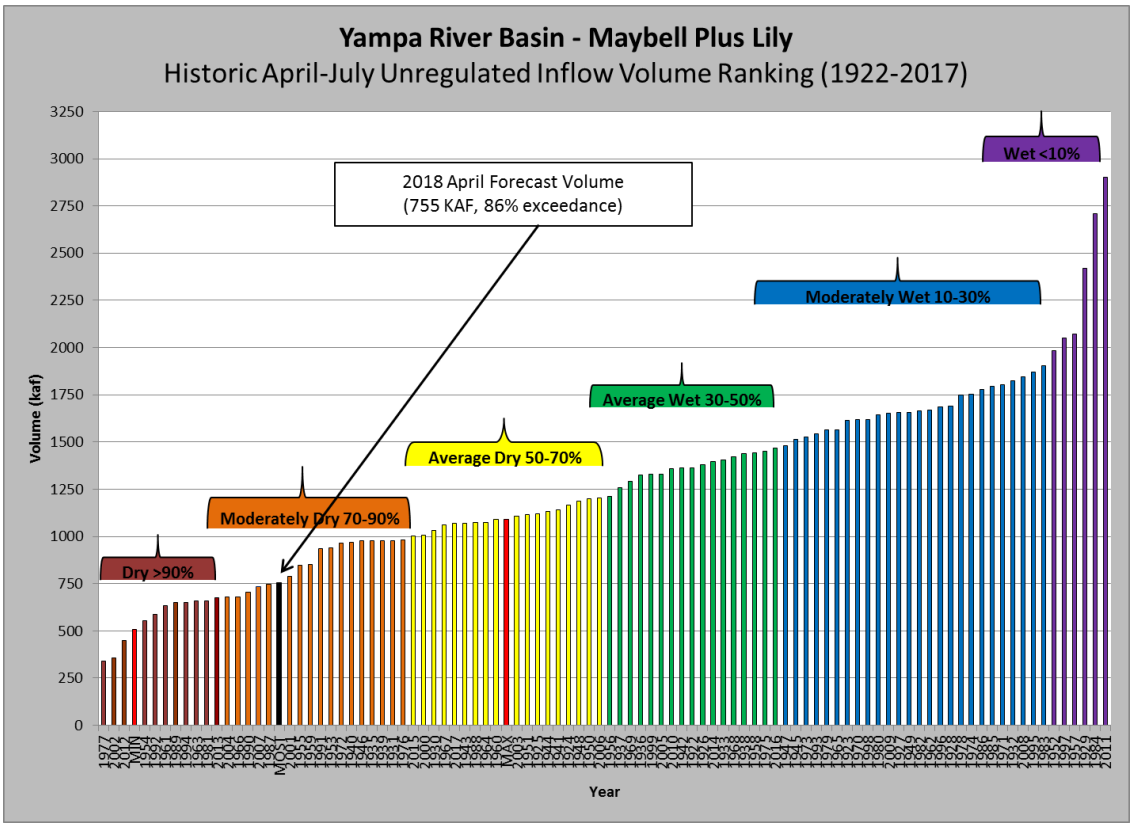

FIGURE 9. Yampa River Basin (Maybell plus Lily) April forecast and ranked April-July unregulated inflow volume for years 1922-2017.

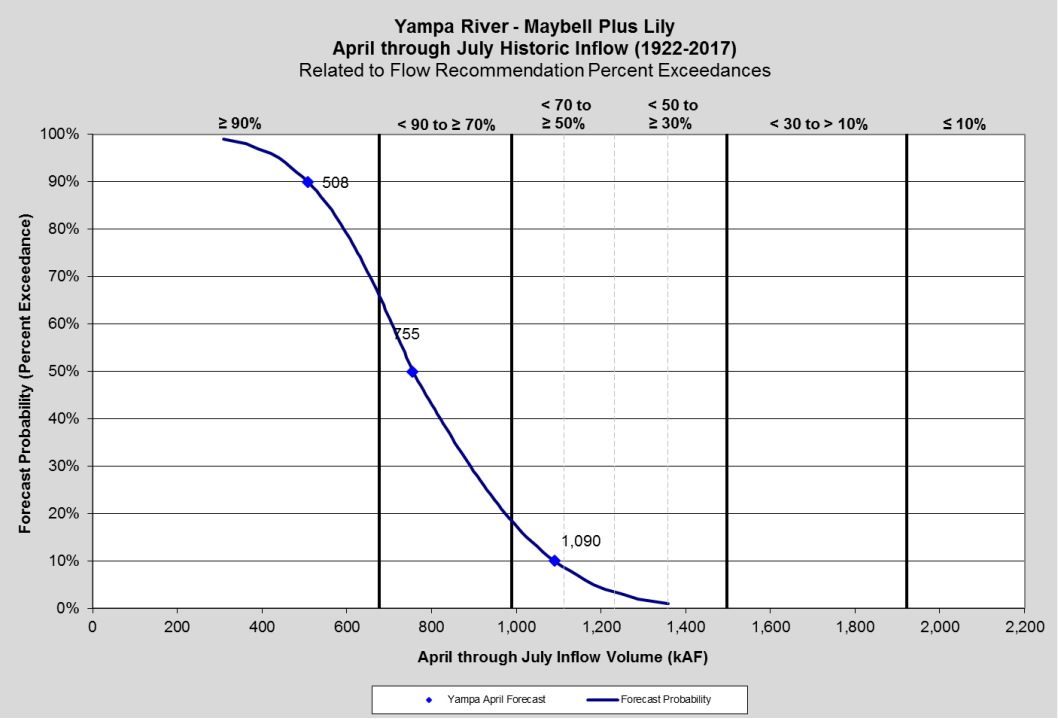

FIGURE 10. Yampa River – Maybell Plus Lily April final forecast probability (percent exceedance) and historic April-July unregulated inflow volume for years 1963-2017.

Probabilities of Flow Events for Spring 2018

The Flaming Gorge unregulated inflow and Yampa River forecasts are average (below median) and moderately dry, respectively. An analysis was completed to assist in the determination of appropriate flow objectives for spring and summer 2018. The ten most similar historic years for the Yampa River Basin (Maybell plus Lily) compared to the current forecast (Table 1) were analyzed assuming a normal distribution.

Table 2 presents the percent exceedance of cumulative days greater than or equal to various flow levels at Yampa River (Maybell plus Lily). The current analysis indicates that it is likely Yampa River flows above 10,000 cfs will not be achieved this year.

Table 1
Yampa River (Maybell plus Lily) – April through July Unregulated Volume
Ten Similar Years to the April 1, 2018 Forecast
Thousand Acre-Feet (KAF)

Year	April-July Unreg Inflow Volume (KAF)
MIN	508
2004	678
1966	679
1990	703
2007	736
1987	746
MOST	755
2001	790
1955	845
1959	852
1991	934
1953	938
MAX	1,090

Table 2
Spring 2018 – Days above Specific Flow Thresholds in the Yampa River
(Maybell plus Lily)
Based on the April 1, 2018 Forecast
Percent Exceedance (%)

April 1, 2018 Forecast	% Exceed	Days above 8000 cfs	Days above 9000 cfs	Days above 10000 cfs	Days above 11000 cfs	Days above 12000 cfs	Days above 13000 cfs	Days above 14000 cfs
YAMPA	25%	8	5	2	0	0	0	0
	50%	3	0	0	0	0	0	0
	75%	1	0	0	0	0	0	0
	90%	0	0	0	0	0	0	0

Colorado Basin River Forecast Center Yampa River Analysis

The Colorado Basin River Forecast Center (RFC) calculates exceedance probabilities based on thirty-five years of historic temperature and precipitation data (1981-2015) and current hydrologic conditions to provide projections of flow. The RFC provides projections based upon (1) strict observance to the historic dataset and (2) current hydrologic conditions including SWE, flow, and soil moisture and (3) incorporation of the five-day quantitative precipitation forecast (QPF). QPF is the expected amount of forecasted precipitation.

The RFC provides a synopsis of the current seasonal outlook for the Yampa River at Deerlodge. This synopsis is provided below:

> This outlook is based on flows from ESP with model states as of April 4. Precipitation for the month of March was below average at 85 percent. As a result, the current water year precipitation in the Yampa River Basin is at 77 percent of normal. Precipitation has been below average for all months of the water year with the exception of February. The snow water equivalent on April 1 had little change from early March and remained near 75 percent of median. The temperatures in March were near normal which helped to limit any significant snowmelt and keep the below normal snowpack intact.
>
> The Yampa River basin will be impacted by a series of storm systems for first part of April. The first system arrives late this week followed by a more significant system this weekend. The weekend system has the potential to bring widespread heavy precipitation and snow accumulation to the basin. The current precipitation forecast for April 4th-11th is for 1.0-2.0+ inches of precipitation. Snow levels may be quite high with these events and as a result the 10-day streamflow forecasts indicate the flow at Yampa-Deerlodge reaching around 3500-4000 cfs early next week. Additional precipitation may occur during the second weekend of the month as another storm system approaches the area.

The RFC provides updated Yampa River April through July seasonal exceedance probabilities for both the river flows and daily maximum peak flow. Table 3 presents the RFC projections of maximum peak flow based on current information. Figures 11 and 12 illustrate the probabilities

of the Yampa River at Deerlodge river flows exceeding certain thresholds and exceedance probabilities over the April through July spring period.

Table 3
Maximum Peak Daily Flow on the Yampa River at Deerlodge
Based on the April 8, 2018, RFC Analysis
Percent Exceedance (%)

CBRFC April 8, 2018 Projections	% Exceed	Maximum Daily Peak (cfs)	Number of Days to Peak from 04/01/18	Number of Days Above 4,000 cfs	Number of Days above 5,000 cfs	Number of Days above 6,000 cfs	Number of Days above 8,000 cfs	Number of Days above 10,000 cfs	Number of Days above 12,000 cfs
YAMPA	10%	12,764	70	50	40	34	20	9	2
	25%	10,003	62	43	35	24	12	1	0
	50%	8,550	56	35	25	15	1	0	0
	75%	7,200	48	29	15	8	0	0	0
	90%	6,067	45	19	6	0	0	0	0

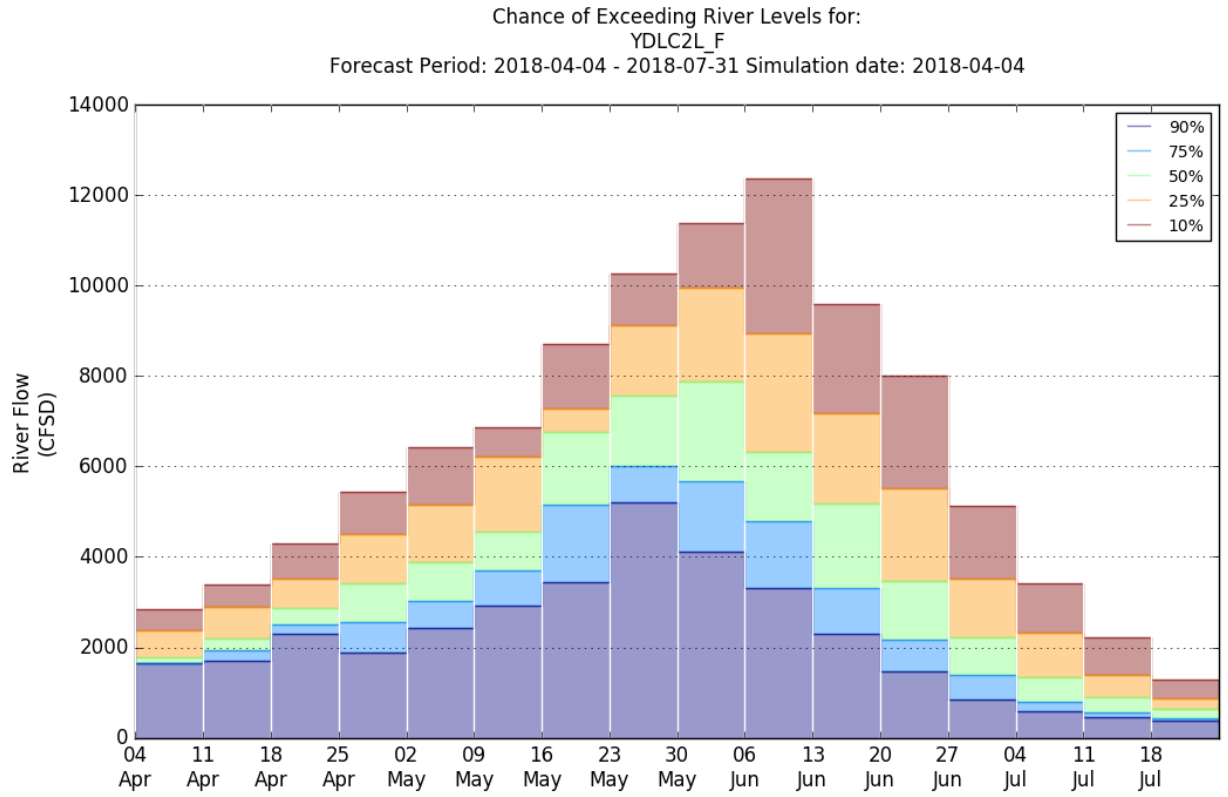

FIGURE 11. RFC April 4, 2018 projection of Yampa River at Deerlodge flows exceeding thresholds for various percent exceedance at a weekly time step for the 2018 April through July period.

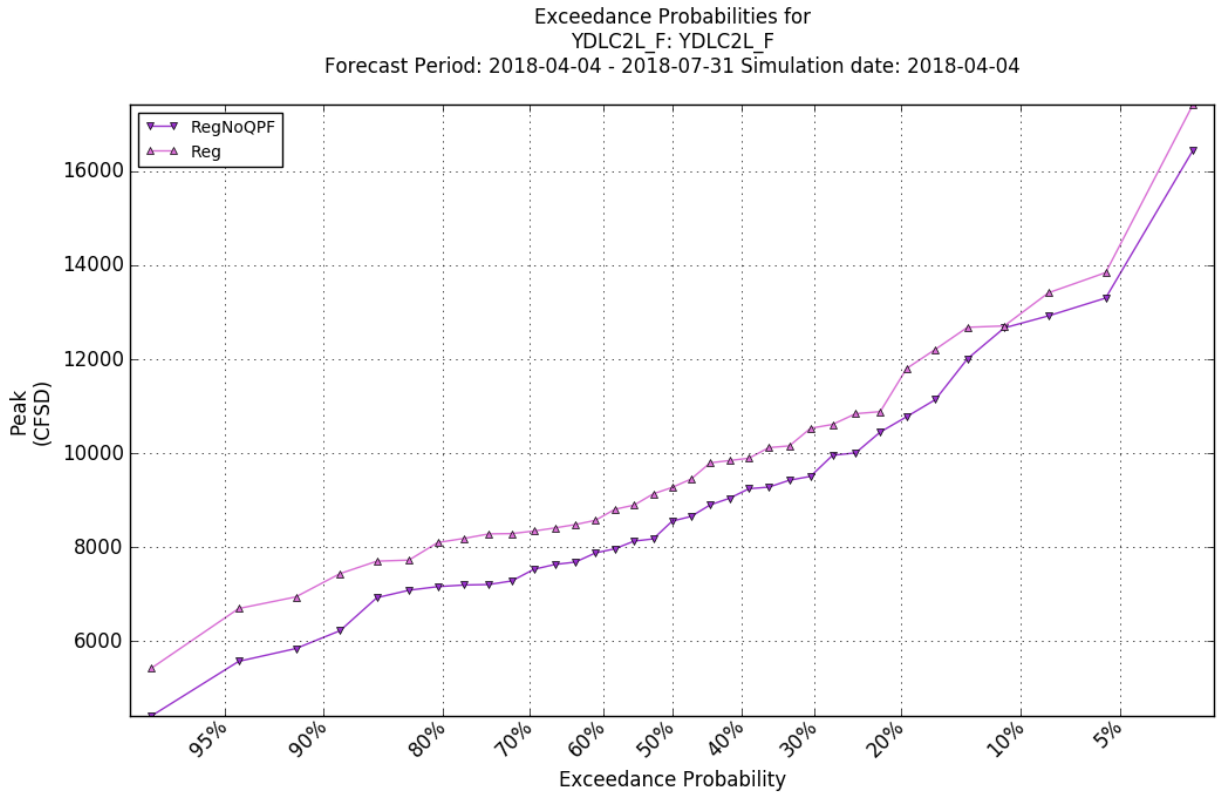

FIGURE 12. RFC April 4, 2018 projection of Yampa River at Deerlodge maximum peak daily flow exceedance probabilities based on current hydrologic conditions and historical precipitation and temperature.