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TWG

Basin Hydrology and Operations

October 14, 2020

Upper Colorado Basin

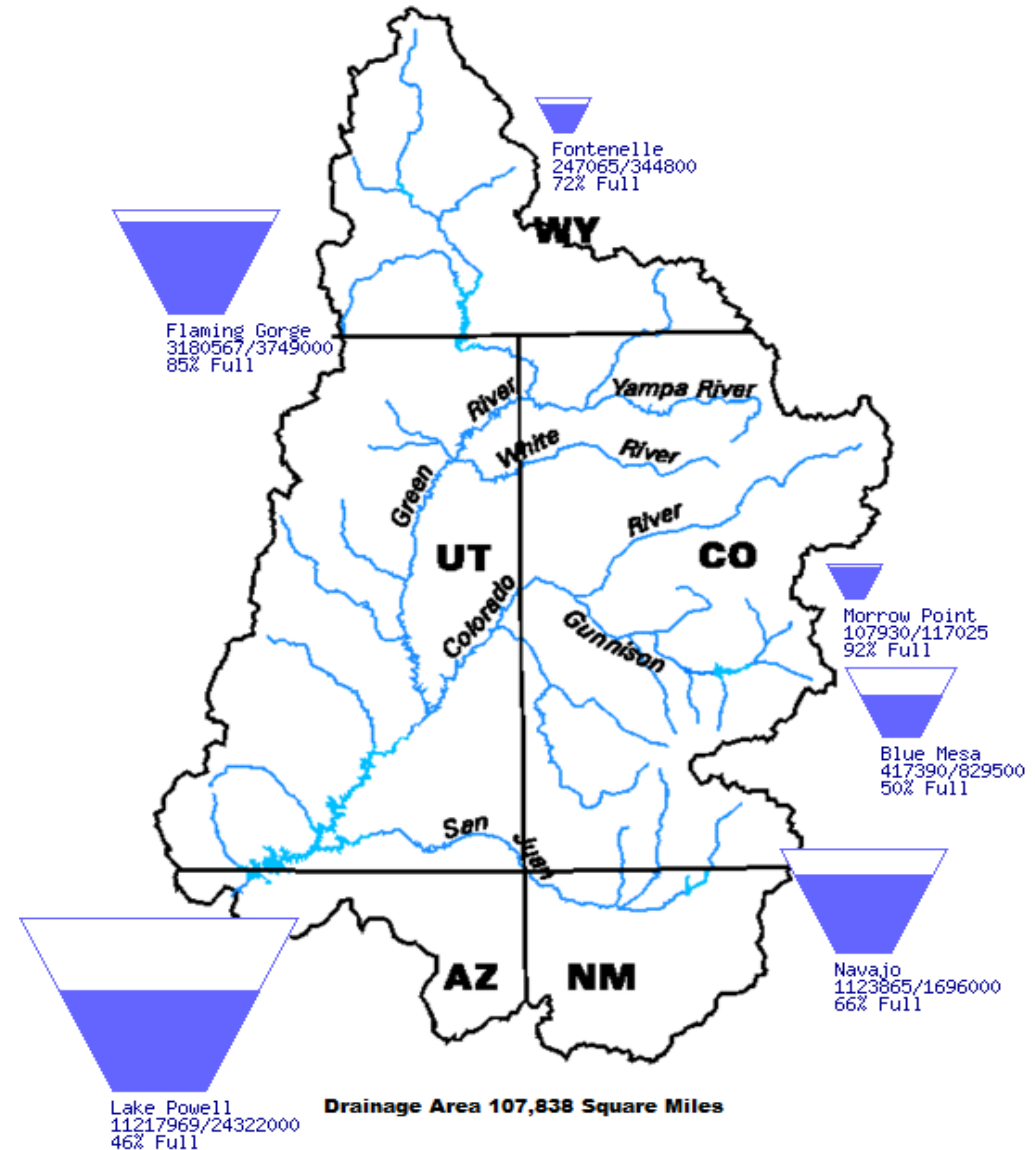
Water Year 2020 Observed Hydrology and Projected October Hydrology



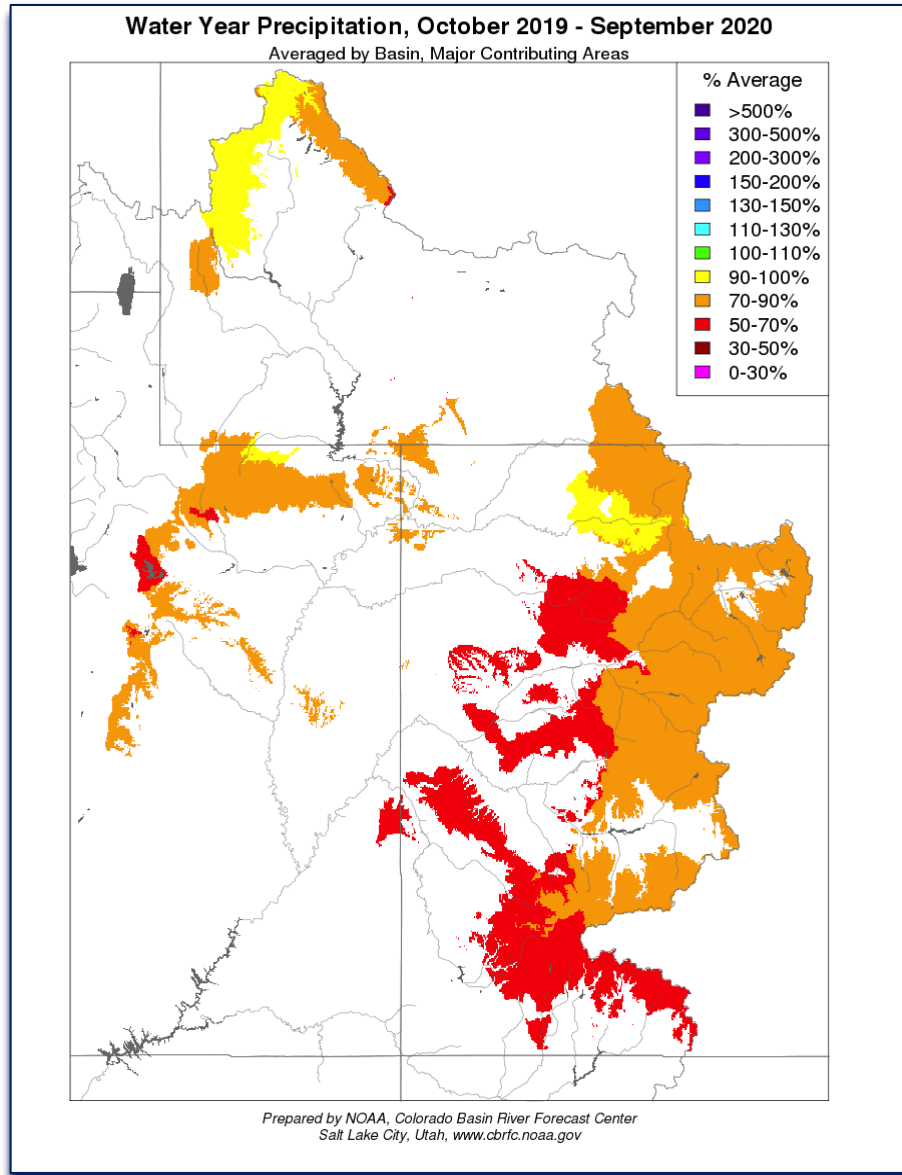
Upper Basin Storage (as of October 12, 2020)

Upper Colorado River Drainage Basin

Reservoir	Percent Full	Storage (maf)	Elevation (feet)
Fontenelle	72	0.247	6,492.93
Flaming Gorge	85	3.18	6,025.55
Blue Mesa	50	0.417	7,467.24
Navajo	66	1.12	6,041.02
Lake Powell	46	11.22	3,594.34



WY2020 Precipitation and Observed Inflow



Water Year 2020 Observed Unregulated Inflow as of October 1, 2020

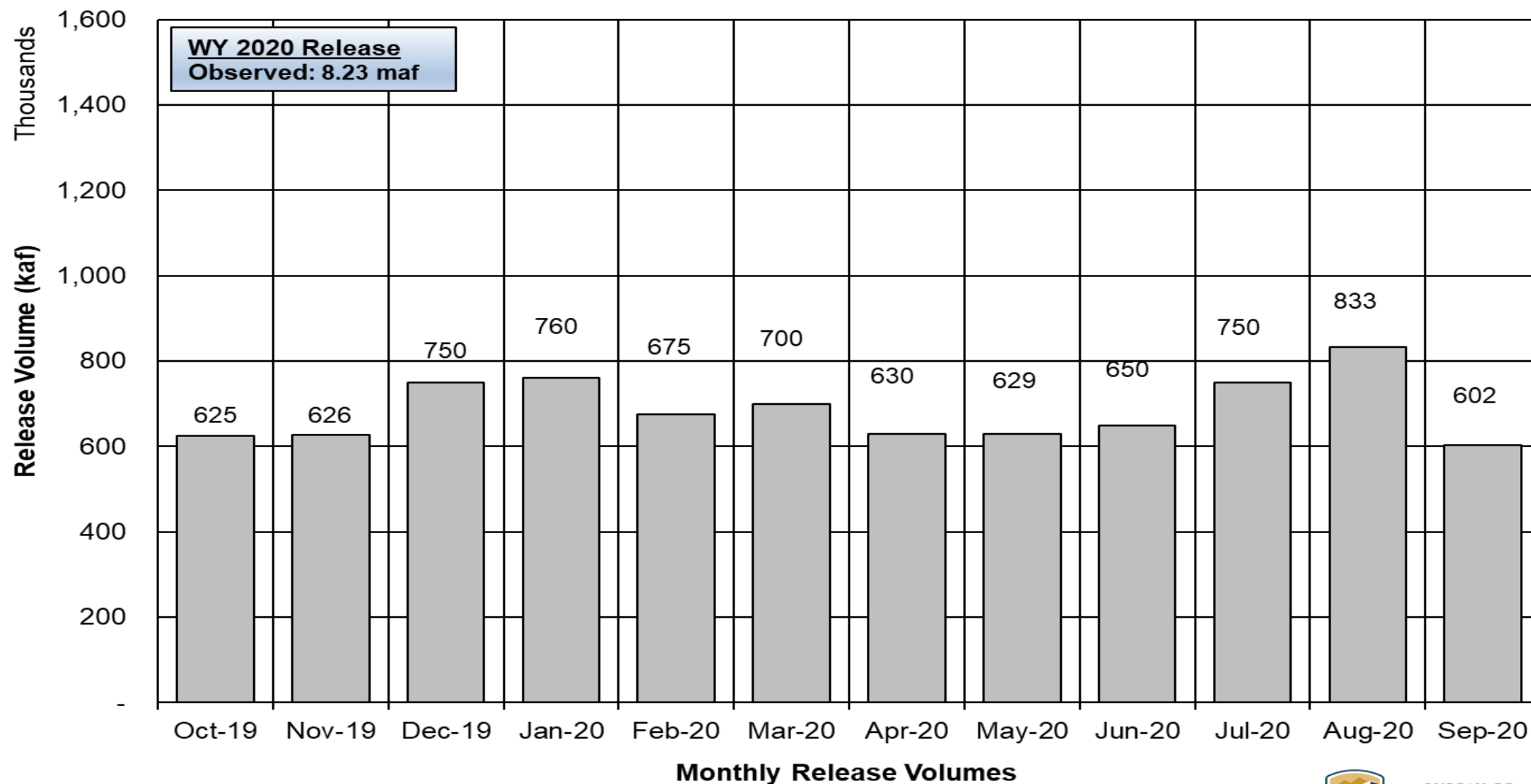
Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	997	92
Flaming Gorge	1,250	81
Blue Mesa	608	64
Navajo	430	40
Powell	5,847	54

¹ Percent of average based on the period of record from 1981-2010.

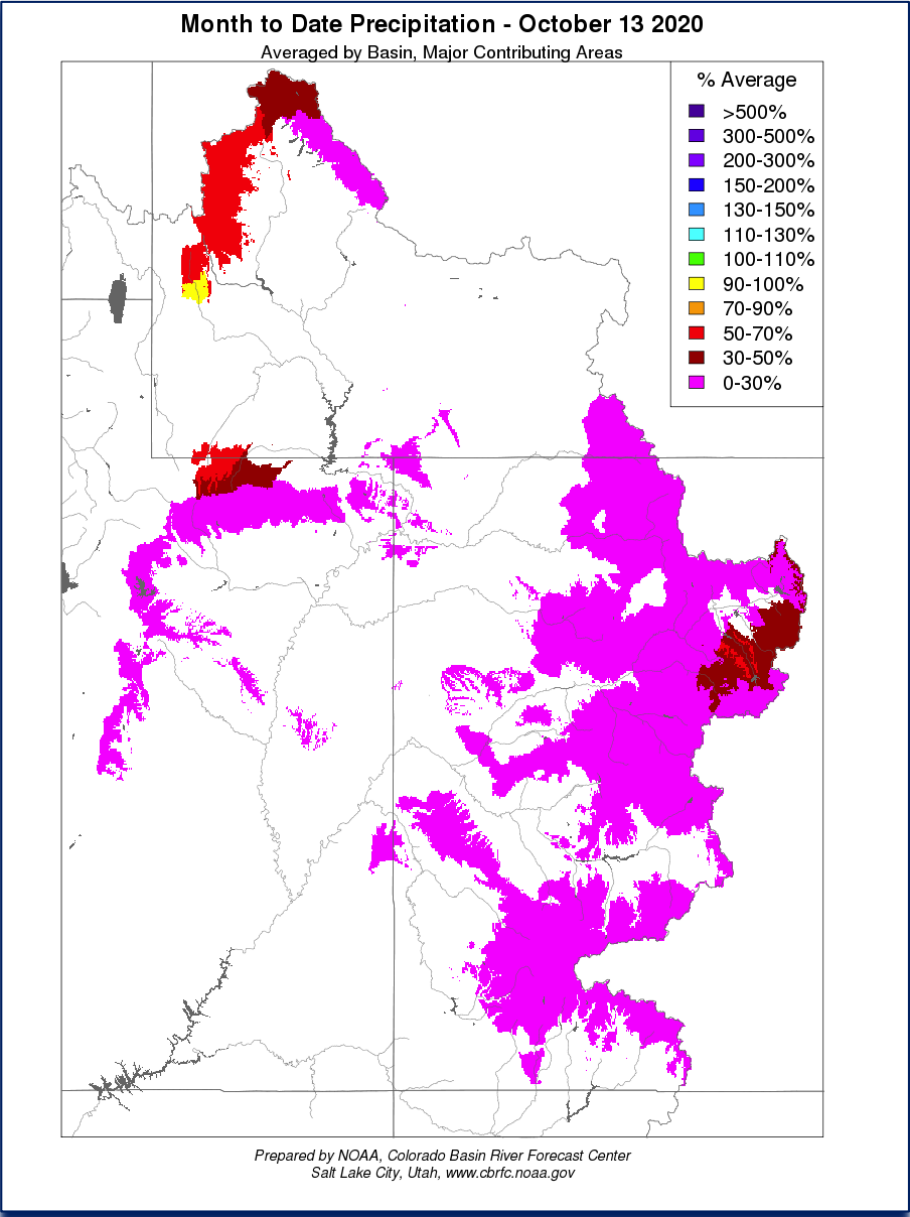


Lake Powell Monthly Release Volume Distribution

Based on Observed WY2020 Releases



Seasonal Precipitation and WY2021 Forecast



Water Year 2021 Forecasted Unregulated Inflow as of October 1, 2020

Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	890	82
Flaming Gorge	1,115	77
Blue Mesa	755	84
Navajo	705	66
Powell	7,900	73

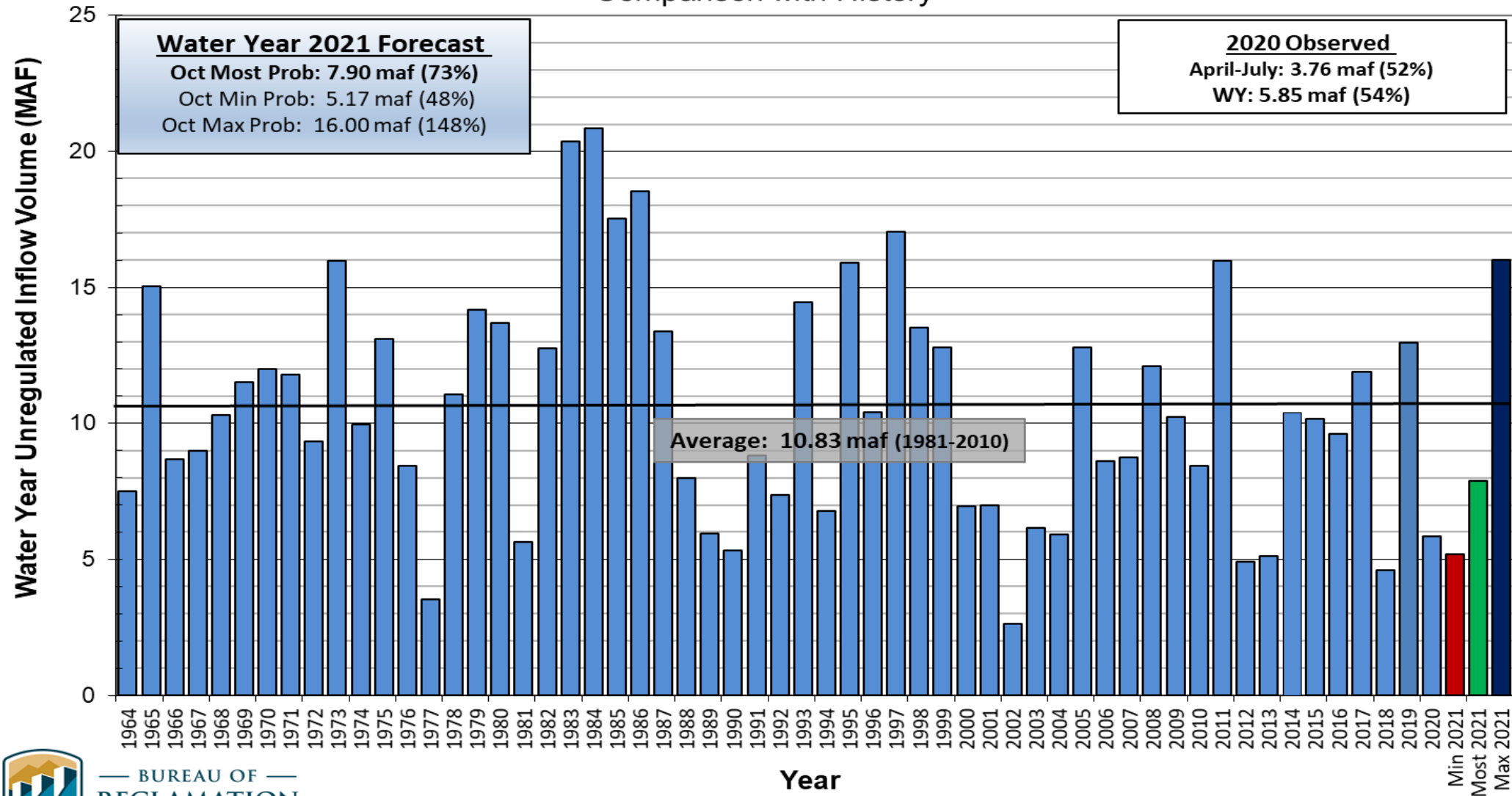
¹ Percent of average based on the period of record from 1981-2010.



Lake Powell Unregulated Inflow

Water Year 2021 Forecast (issued October 1)

Comparison with History



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Upper Colorado Basin

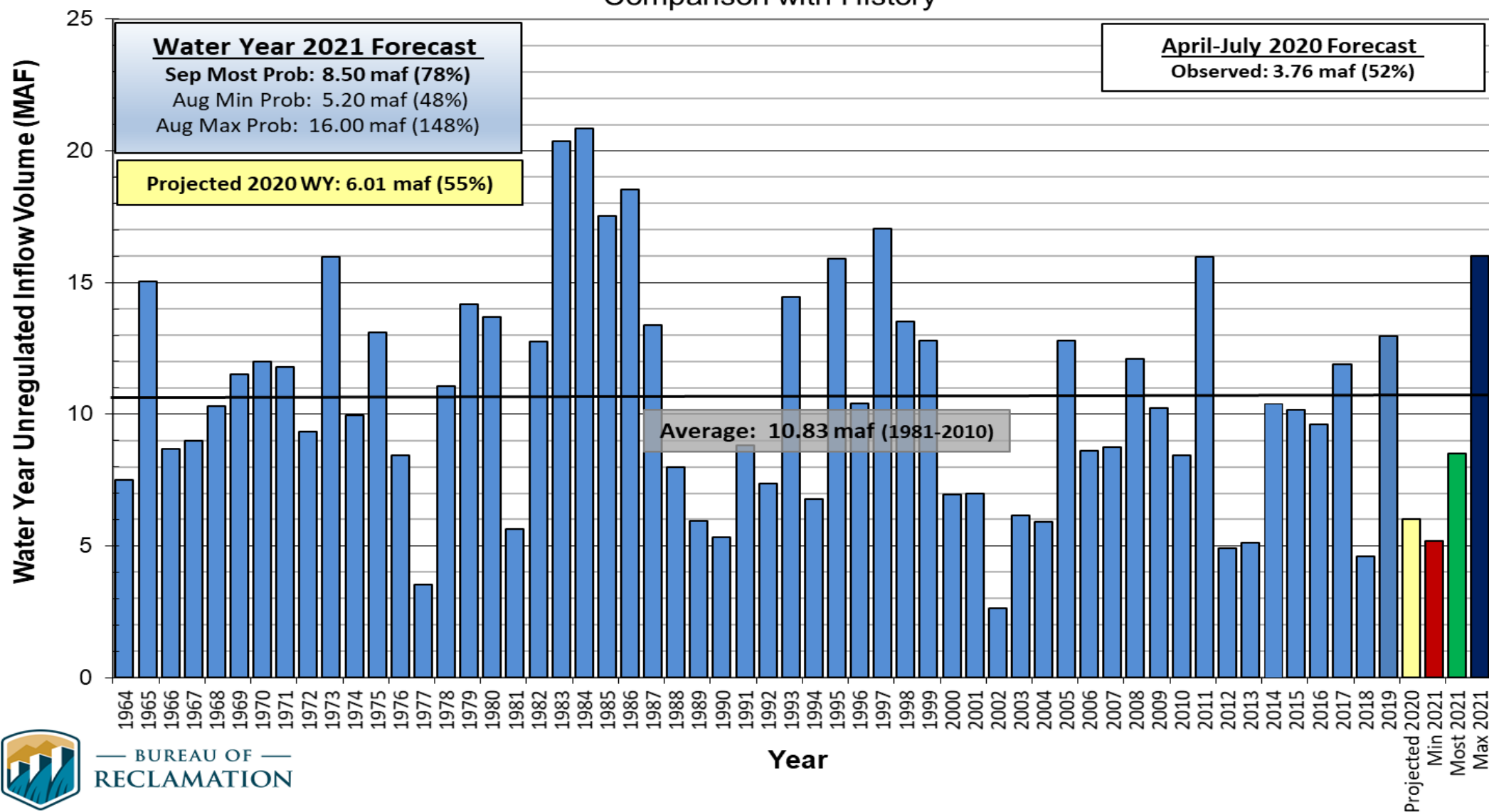
Projected Operations for Water Year 2021 Based on September 2020 Modeling



Lake Powell Unregulated Inflow

Water Year 2021 Forecast (issued September 1)

Comparison with History

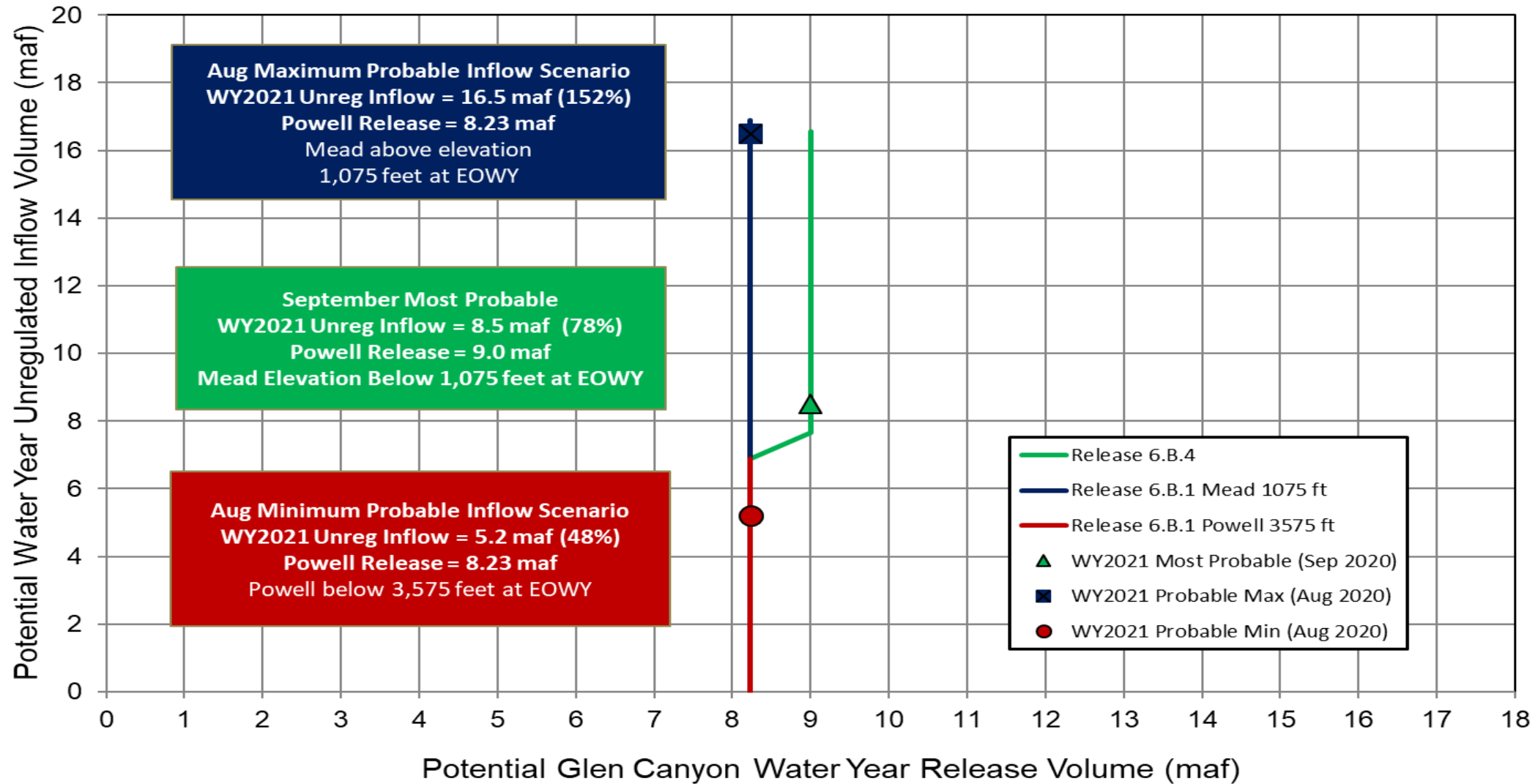


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Lake Powell Release Scenarios under Section 6.B

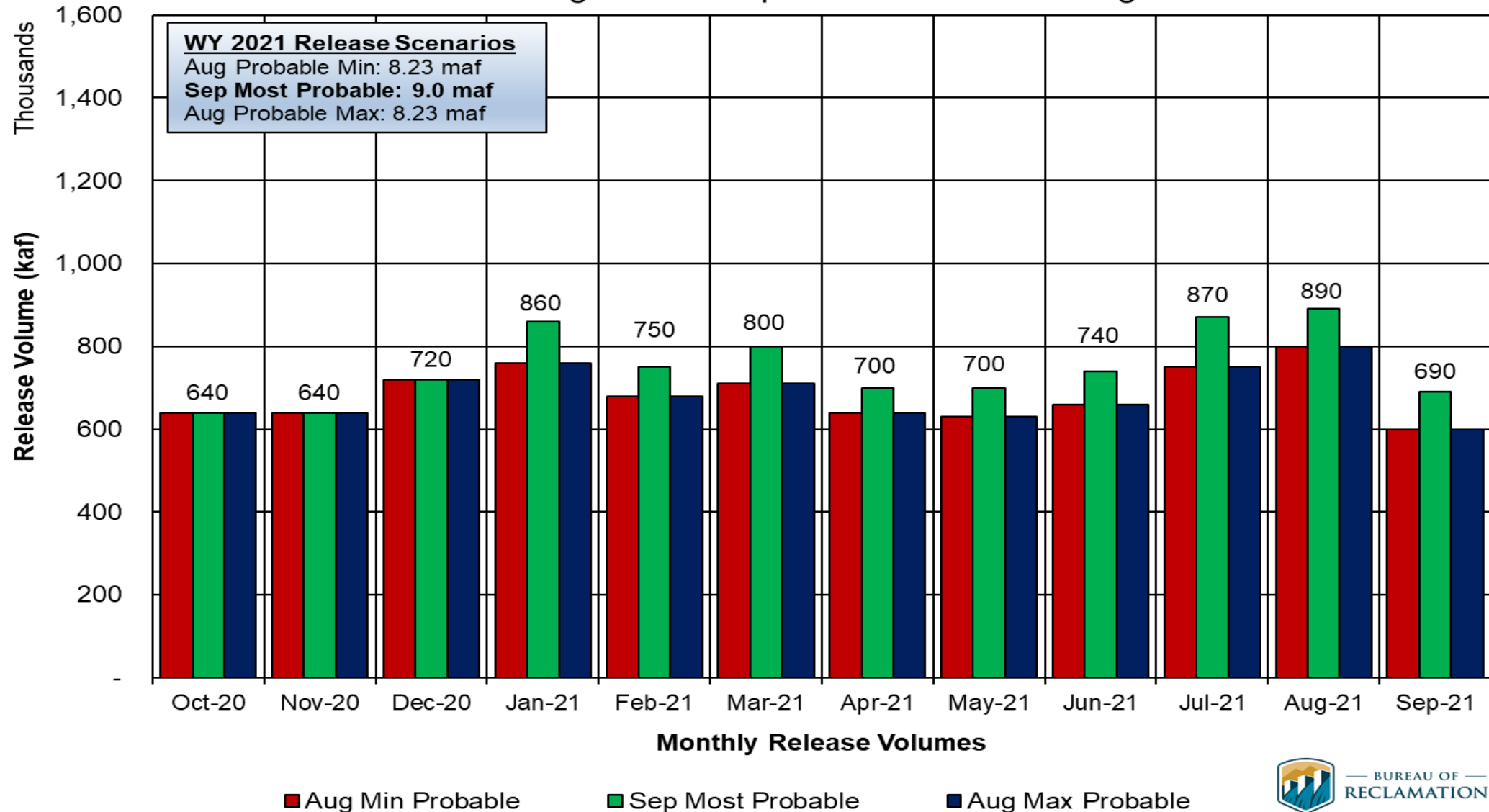
Water Year 2021 Release Volume as a Function of Upper Elevation Balancing Tier
based on August and September 2020 24-Month Study Conditions



Potential Lake Powell Monthly Release Volume Distribution

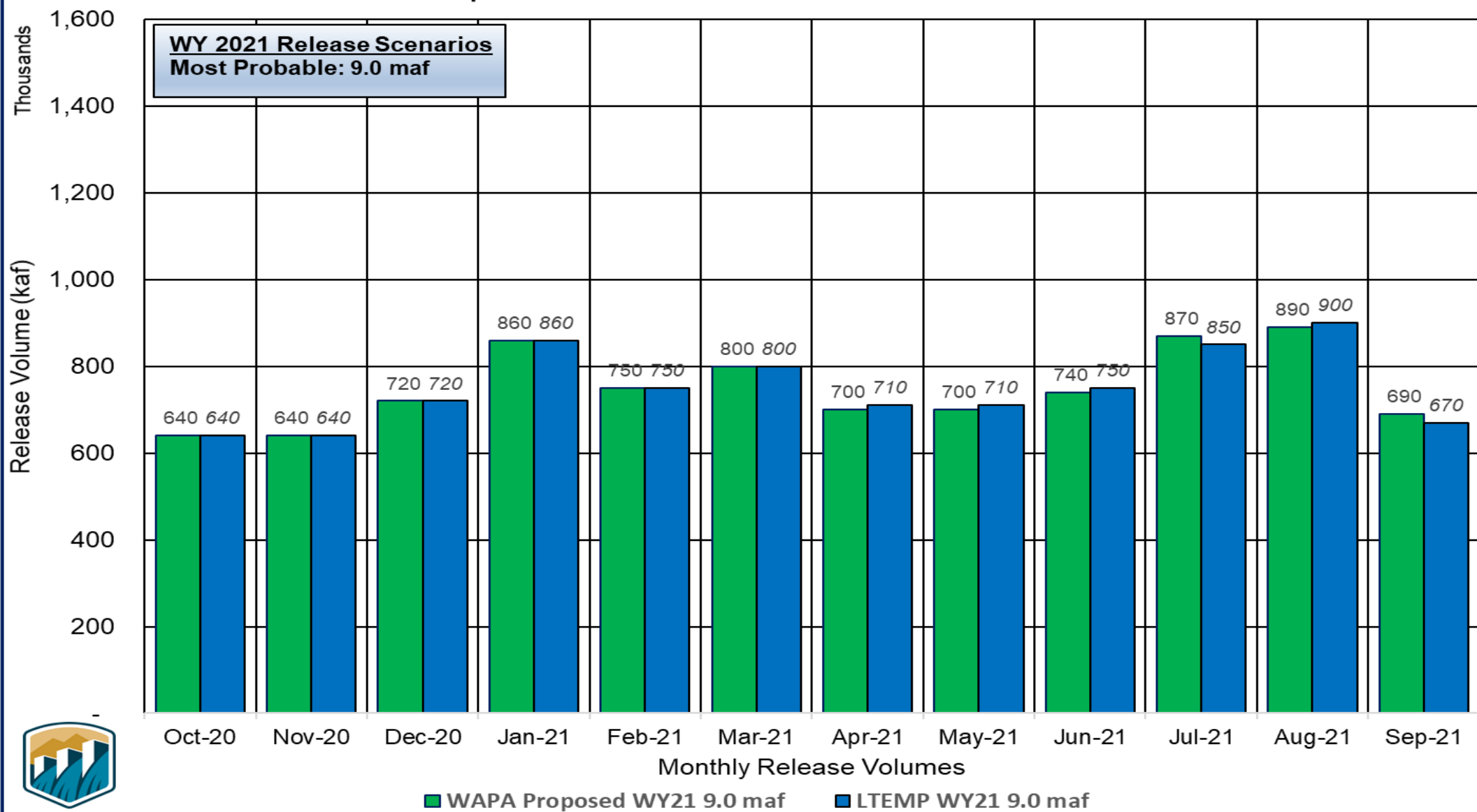
Release Scenarios for Water Year 2021

Based on August and September 2020 Modeling



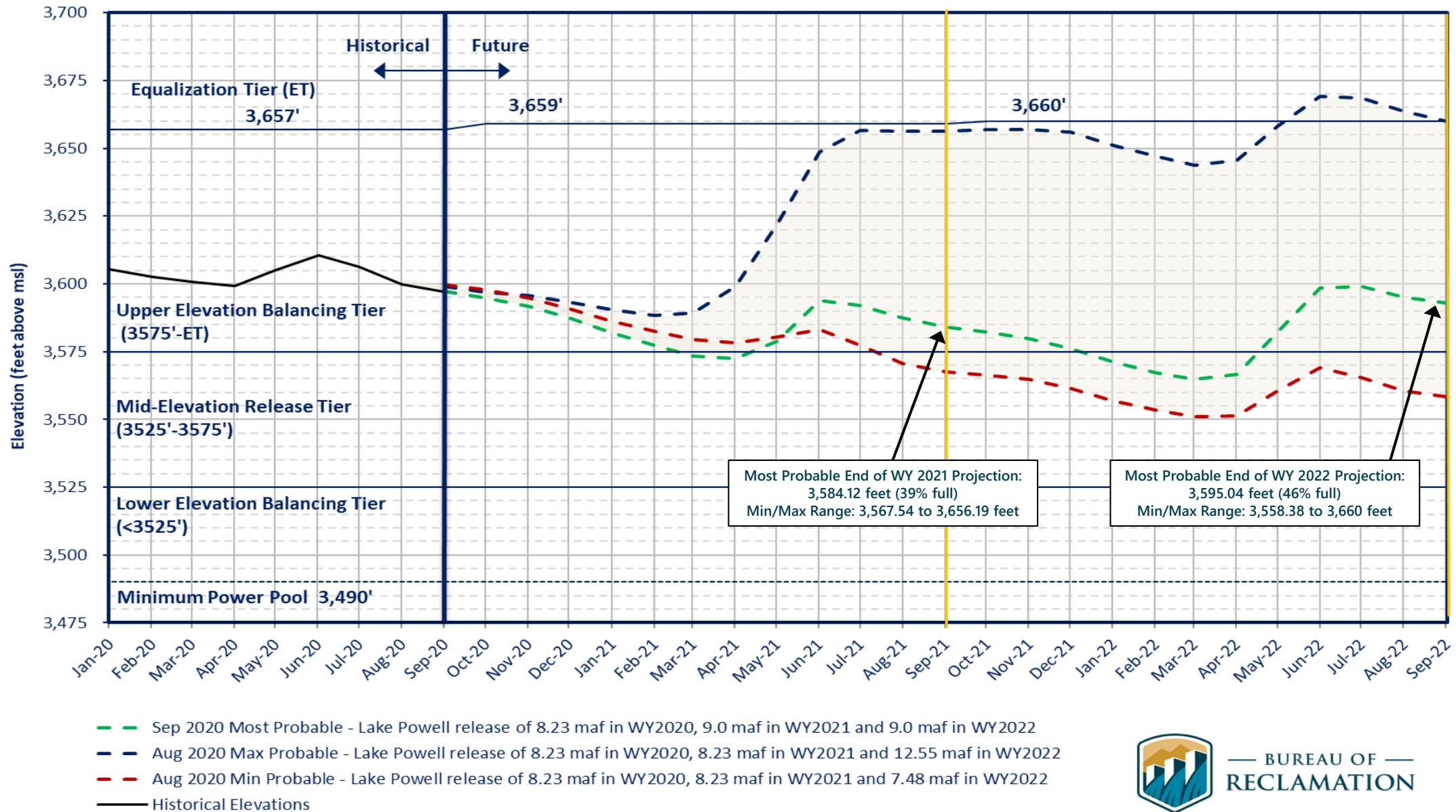
Lake Powell Monthly Release Volume Distribution

WAPA Proposed 9.0 maf Pattern for Water Year 2021



Lake Powell End of Month Elevations

Historic and Projected based on August and September 2020 24-Month Study Inflow Scenarios

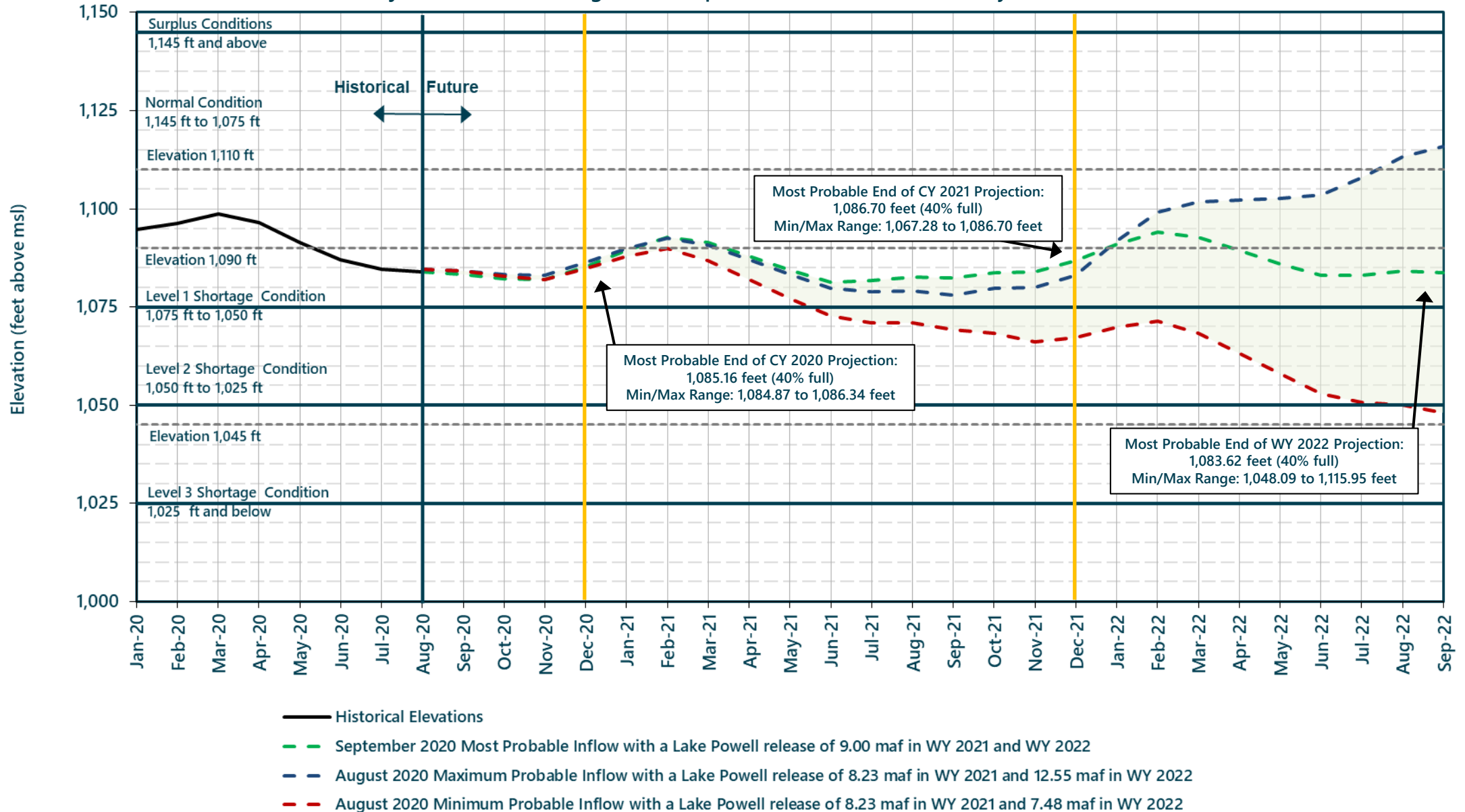


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Lake Mead End of Month Elevations

Projections from the August and September 2020 24-Month Study Inflow Scenarios



Glen Canyon Power Plant Planned Unit Outage Schedule for Water Year 2021

Unit Number	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021
1												
2												
3												
4												
5												
6												
7												
8												
Units Available	5	6/5	6	6	6	6	6	6	6	6	6	6/4
Capacity (cfs)	16,500	20,100 / 16,400	20,000	19,900	19,800	19,600	19,500	19,500	19,700	20,100	20,000	19,900 / 12,600
Capacity (kaf/month)	1,110	1,200	1,260	1,230	1,110	1,230	1,230	1,270	1,270	1,320	1,350	1,110
Max (kaf) ²	640	640	720	760	680	710	640	630	660	750	800	600
Most (kaf) ¹	640	640	720	860	750	800	710	710	740	870	890	690
Min (kaf) ²	640	640	720	760	680	710	640	630	660	750	800	600
										(updated 09-21-2020)		

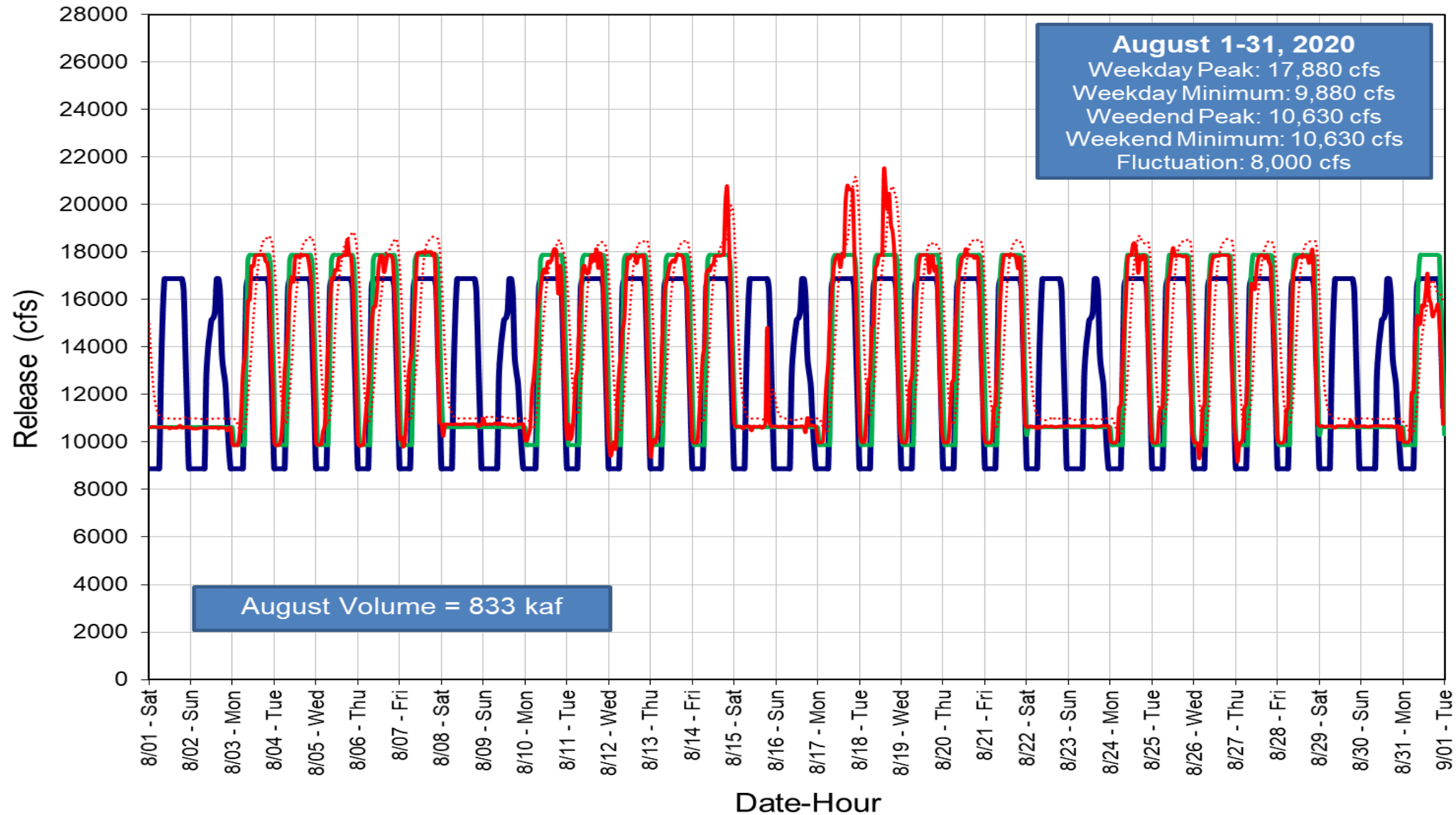
1 Projected release, based on August 2020 Most Probable Inflow Projections and 24-Month Study model runs

2 Projected release, based on August 2020 Min and Max Probable Inflow Projections and 24-Month Study model runs

3 Dependent upon availability to shift reserves, which will increase capacity by 40MW at current efficiency.



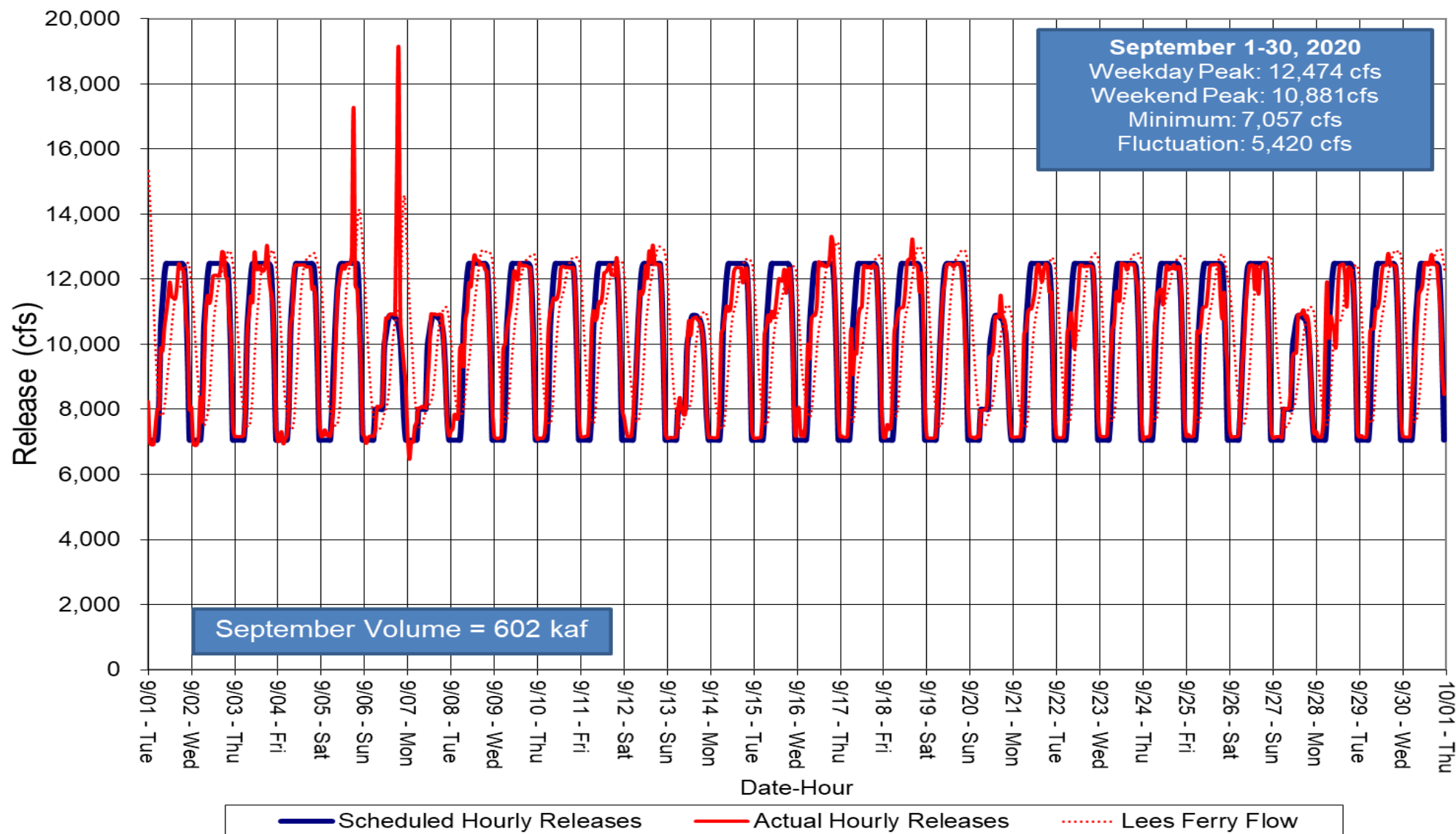
Glen Canyon Dam Hourly Release Pattern August 2020



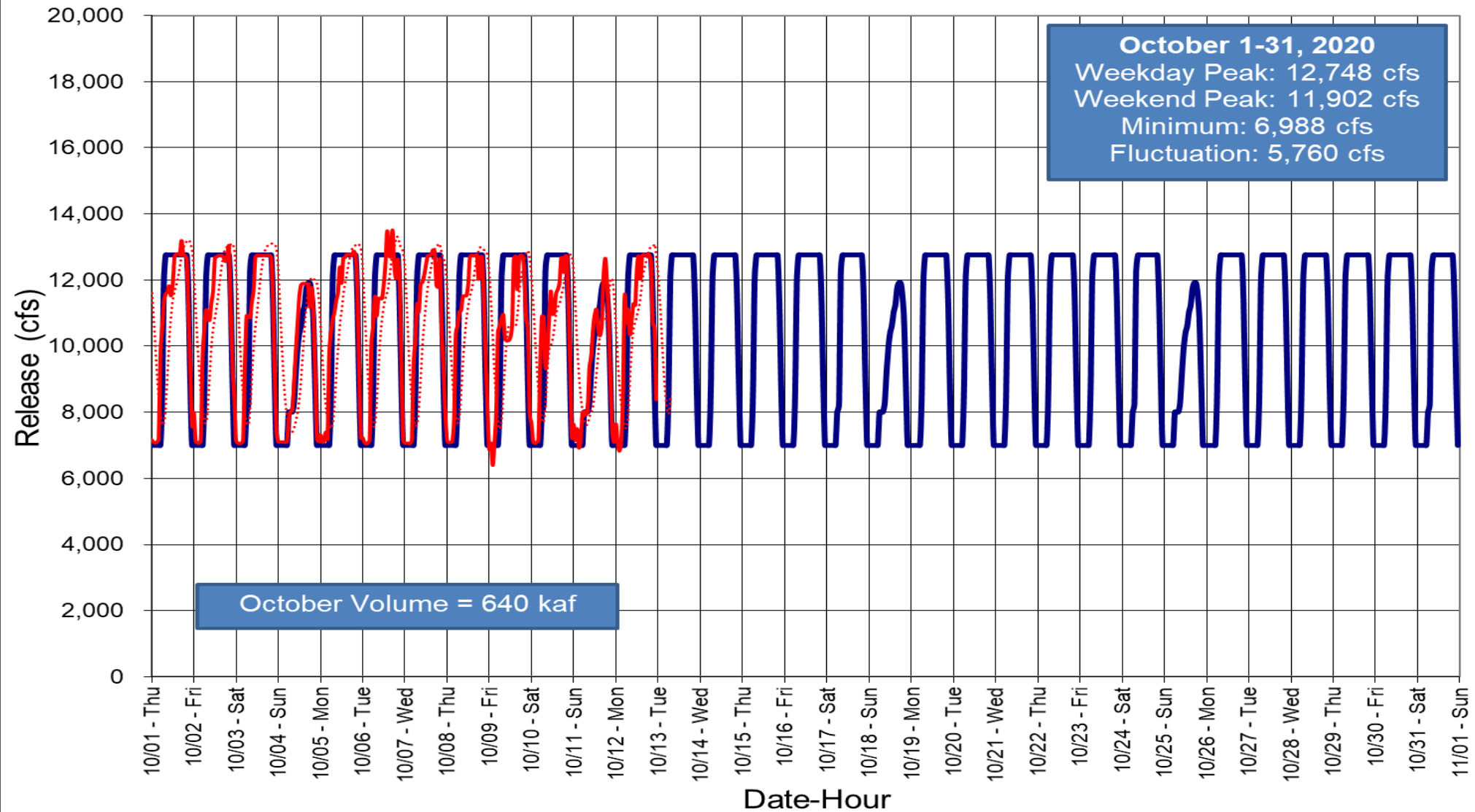
— Scheduled Hourly Releases — Macroinvertebrate Releases — Actual Hourly Releases Lees Ferry Flow



Glen Canyon Dam Hourly Release Pattern September 2020



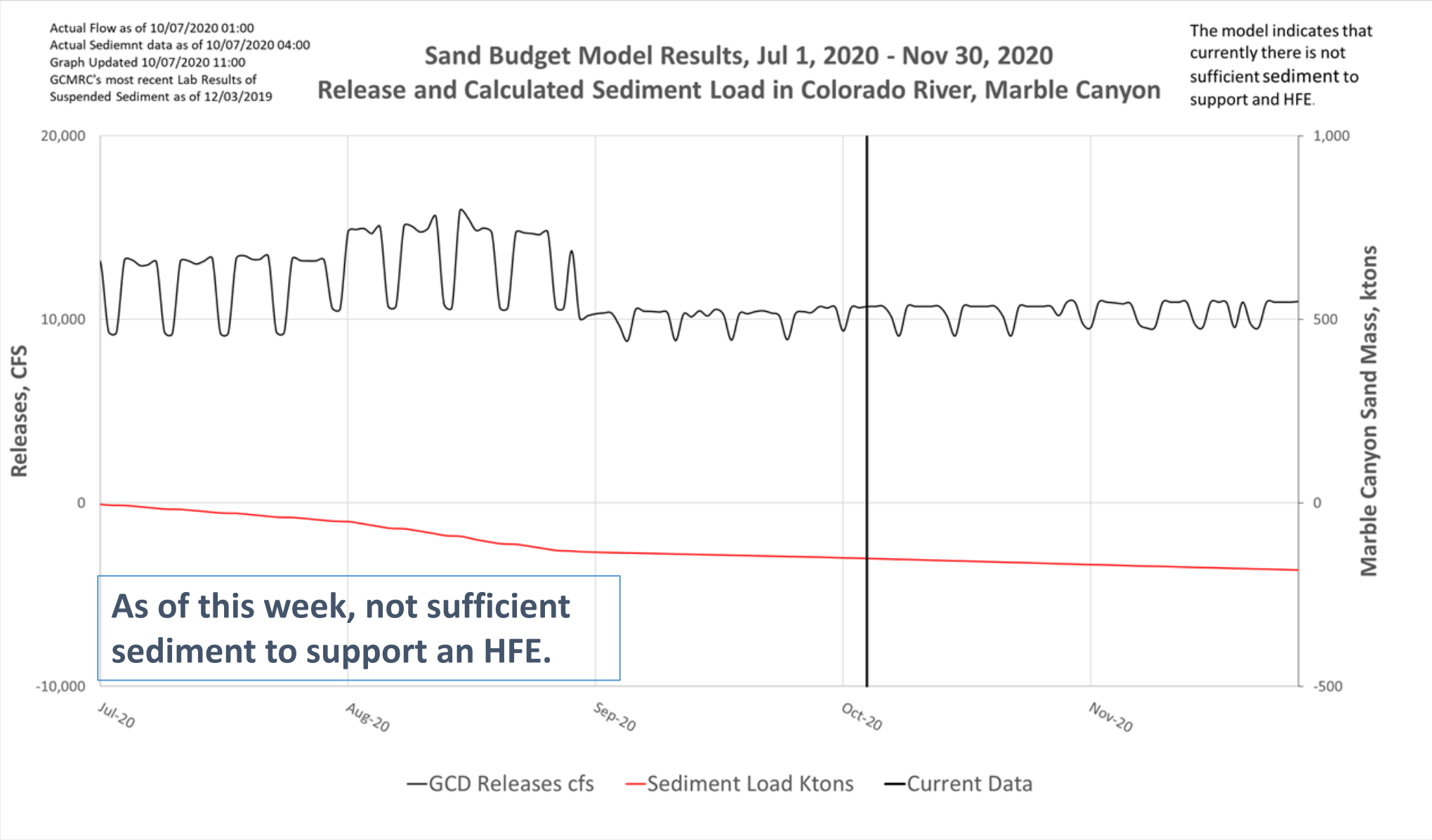
Glen Canyon Dam Hourly Release Pattern October 2020

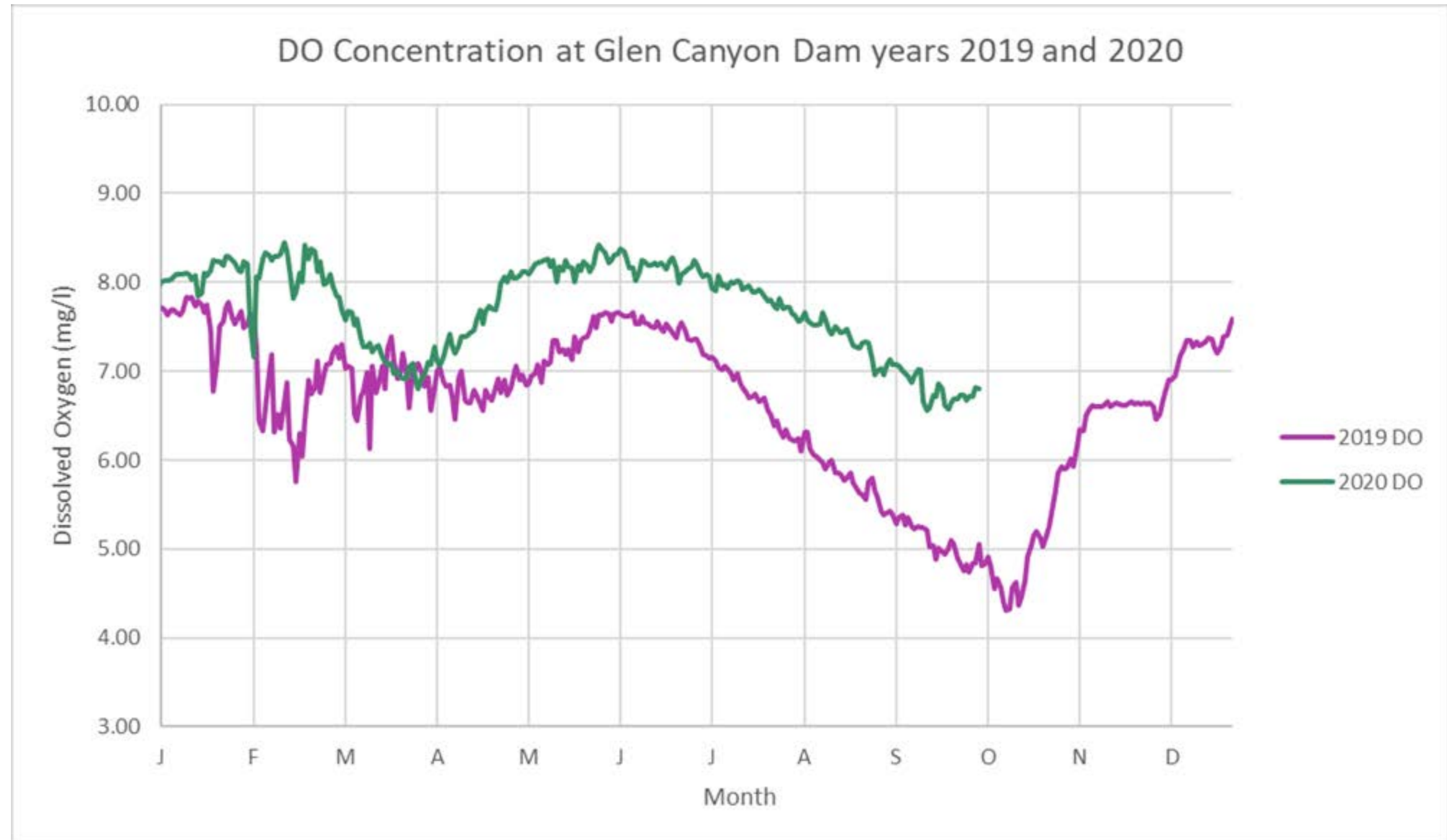


Water Quality



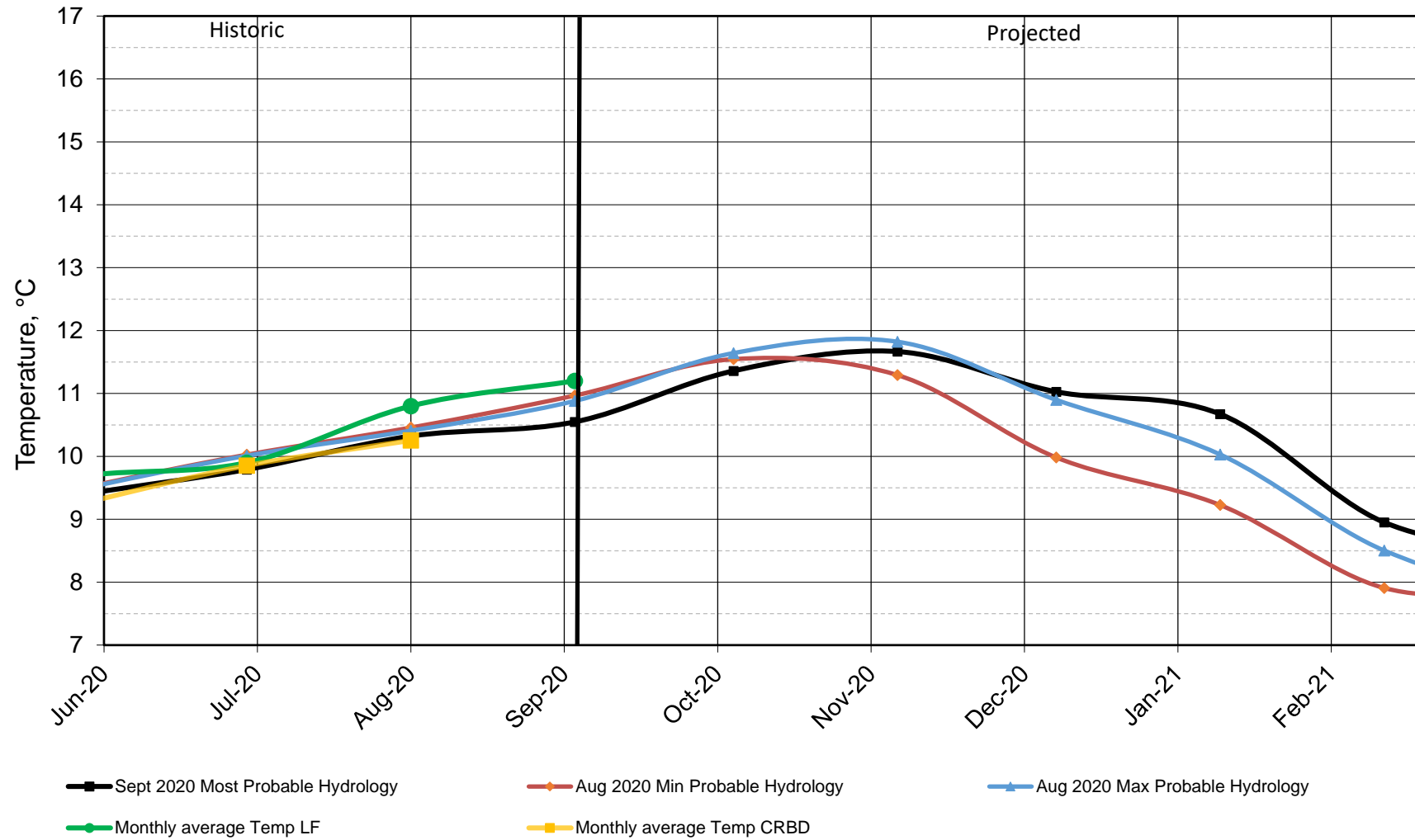
Sand Budget Model Results – October 7, 2020





Lake Powell Release Temperature

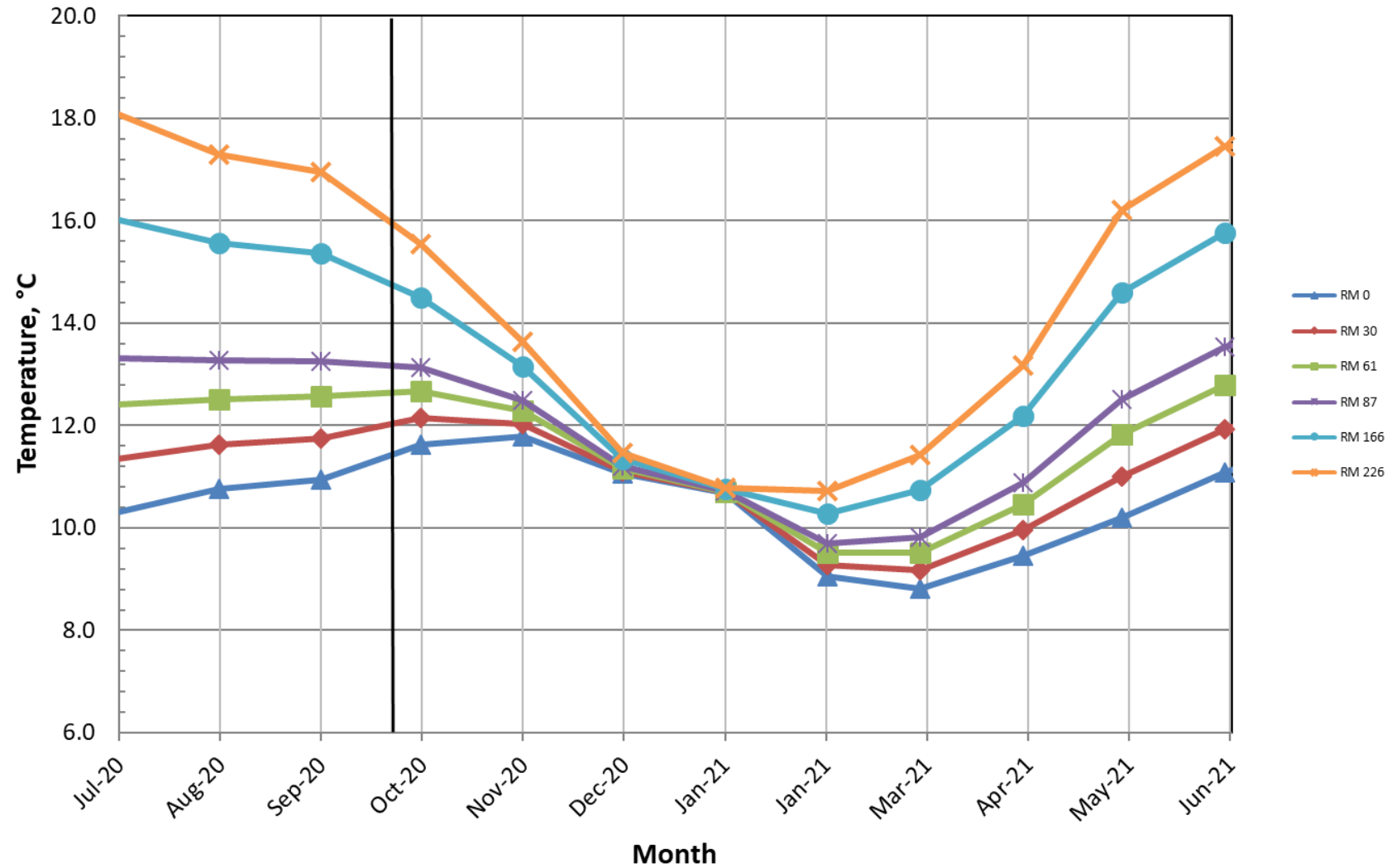
Projected Temperature based on September 2020 Forecast



#Projection start date is based on initial conditions (Dec 2019)

Colorado River, Grand Canyon Water Temperatures

Projections based on September 2020, Most Probable Hydrology






Upper Colorado Basin

Statistical Out-Year Update to 24-Month Study



Integrated Mid-term Modeling System

	24-Month Study Mode	MTOM Mode
Primary Use	AOP tier determinations and projections of current conditions	Risk-based operational planning and analysis
Probabilistic or Deterministic	Deterministic – single hydrologic trace	Probabilistic 35 (or more) hydrologic traces
Simulated Reservoir Operations	Operations input manually	Rule-driven operations
Time Horizon (years)		
Frequency of Publication	Monthly	Monthly

	WY 2021 Source of Monthly Unregulated Inflow for Upper Colorado Reservoirs in the 24 Month Study																																						
	Most Probable																																						
				April-July Unregulated Inflow																																			
Month Issued	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov				
Jan	RFC	RFC	RFC	Official A-J	Official A-J	Official A-J	Official A-J	ESP Jan	ESP Jan	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med																
Feb		RFC	RFC	RFC	Official A-J	Official A-J	Official A-J	ESP Feb	ESP Feb	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med						
Mar			RFC	RFC	RFC	Official A-J	Official A-J	ESP Mar	ESP Mar	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med					
Apr				RFC	RFC	RFC	Official A-J	ESP Apr	ESP Apr	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med					
May					RFC	RFC	RFC	ESP May	ESP May	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med					
Jun						RFC	RFC	RFC	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	ESP Jun	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med					
Jul							RFC	RFC	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	ESP Jul	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med					
Aug								RFC	RFC	RFC	ESP Aug	ESP Aug	ESP Aug	ESP Aug	ESP Aug	ESP Aug	ESP Aug	ESP Aug	ESP Aug	ESP Aug	ESP Aug	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med				
Sep									RFC	RFC	RFC	ESP Sep	ESP Sep	ESP Sep	ESP Sep	ESP Sep	ESP Sep	ESP Sep	ESP Sep	ESP Sep	ESP Sep	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med				
Oct										RFC	RFC	RFC	ESP Oct	ESP Oct	ESP Oct	ESP Oct	ESP Oct	ESP Oct	ESP Oct	ESP Oct	ESP Oct	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med				
Nov											RFC	RFC	RFC	ESP Nov	ESP Nov	ESP Nov	ESP Nov	ESP Nov	ESP Nov	ESP Nov	ESP Nov	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med			
Dec												RFC	RFC	RFC	ESP Dec	ESP Dec	ESP Dec	ESP Dec	ESP Dec	ESP Dec	ESP Dec	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med		
RFC values are issued by the Colorado Basin River Forecast Center (RFC) as the official forecast values for the next three-month period of time. The values are calculated using Ensemble Streamflow Predictions (ESP) modeling. This official forecast has the least amount of error associated with it.																																							
Official A-J values are official forecast values issued by the RFC for the April-July runoff period using ESP. Apr-Jul water supply forecast volume is disaggregated by the RFC.																																							
81-15 Med values are the monthly median inflow values generated from water years 1981-2015 calculated using the database maintained by the Bureau of Reclamation Upper Colorado Region (UCBOR). A water year begins October 1 and ends September 30.																																							
Interpolated values are calculated by UCBOR and are based on percent of the 81-15 median. The method takes the precent of median of the previous month's forecast value and interpolates over two months to the percent of median for the month following the interpolation period. This is done to smoothly transition between the end of the current water year and the next water year.																																							
ESP monthly values are generated using the RFC ESP forecasted volume for the water year using the current month's initial hydrological conditions. The RFC provides monthly volumes consistent with the 3-month forecast and the water year ESP volume.																																							
* Light grey text indicates that the model is run in this month, however, only results for the first 24 months of the model run (black text) are published in the 24 Month Study report																																							

	WY 2021 Source of Monthly Unregulated Inflow for Upper Colorado Reservoirs in the 24 Month Study																																			
	Minimum Probable																																			
				April-July Unregulated Inflow																																
Month Issued	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Jan	RFC	RFC	RFC	Coord A-J 10th %ile	Coord A-J 10th %ile	Coord A-J 10th %ile	Coord A-J 10th %ile	inter- polate	inter- polate	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	inter- polate	inter- polate	81-15 Med												
Feb Mar																																				
Apr				Coord A-J 10th %ile	Coord A-J 10th %ile	Coord A-J 10th %ile	Coord A-J 10th %ile	inter- polate	inter- polate	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med			
May Jun Jul																																				
Aug								RFC	RFC	RFC	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	10th %ile Aug ESP	inter- polate	inter- polate	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15		
Sep																																				
Oct										RFC	RFC	RFC	10th %ile Oct ESP	10th %ile Oct ESP	10th %ile Oct ESP	10th %ile Oct ESP	10th %ile Oct ESP	10th %ile Oct ESP	10th %ile Oct ESP	10th %ile Oct ESP	10th %ile Oct ESP	inter- polate	inter- polate	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15	25th %ile of 81-15			
Nov Dec																																				
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Coord A-J 10th %ile values are the official forecast of the total April-July volume issued by the RFC for the April-July runoff period using SWS and ESP. Monthly values are disaggregated using the 81-15 average monthly distribution.																																				
25th %ile of 81-15 values are the monthly 25th percentile (75% exceedance) inflow values generated from water years 1981-2015 calculated using the database maintained by the Bureau of Reclamation Upper Colorado Region (UCBOR). A water year begins October 1 and ends September 30.																																				
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10th %ile Jan/Apr/Aug/Oct ESP values are generated using the RFC ESP forecasted volume for the water year using the monthly initial hydrological conditions. Monthly values are disaggregated from the total water year ESP volume using the median 81-15 statistical monthly distribution, consistent with the 3-month forecast. ESP forecasts are issued for each month of the base flow period to the end of the current water year for the 24-month study.																																				
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Month Issued	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Jan	RFC	RFC	RFC	A-J Coord 90th %ile	A-J Coord 90th %ile	A-J Coord 90th %ile	A-J Coord 90th %ile	inter- polate	inter- polate	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	inter- polate	inter- polate	81-15 Med											
Feb																																			
Mar																																			
Apr				A-J Coord 90th %ile	A-J Coord 90th %ile	A-J Coord 90th %ile	A-J Coord 90th %ile	inter- polate	inter- polate	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	inter- polate	inter- polate	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med	81-15 Med		
May																																			
Jun																																			
Jul																																			
Aug								RFC	RFC	RFC	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	90th %ile Aug ESP	inter- polate	inter- polate	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15		
Sep																																			
Oct										RFC	RFC	RFC	90th %ile Oct ESP	90th %ile Oct ESP	90th %ile Oct ESP	90th %ile Oct ESP	90th %ile Oct ESP	90th %ile Oct ESP	90th %ile Oct ESP	90th %ile Oct ESP	90th %ile Oct ESP	inter- polate	inter- polate	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15	75th %ile of 81-15		
Nov																																			
Dec																																			
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Questions/Discussion



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