BUREAU OF RECLAMATION

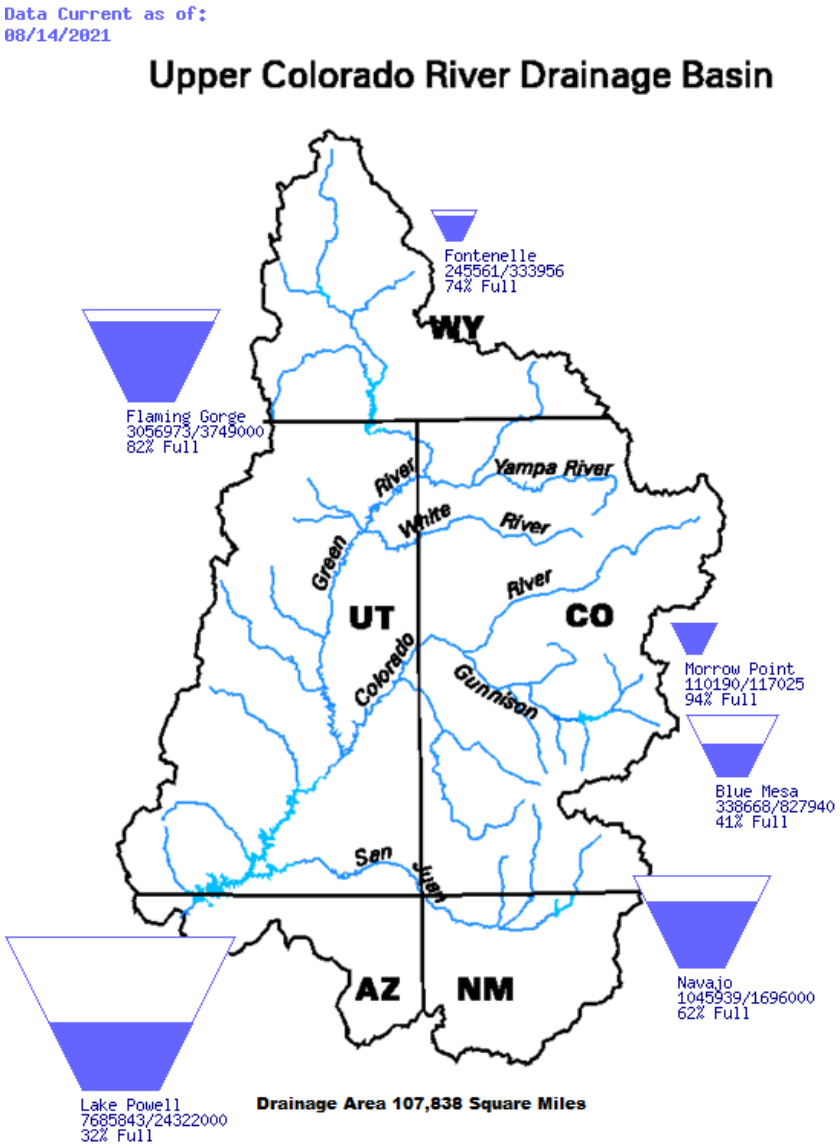
Basin Hydrology, Water Quality, and Operations

GCDAMP AMWG

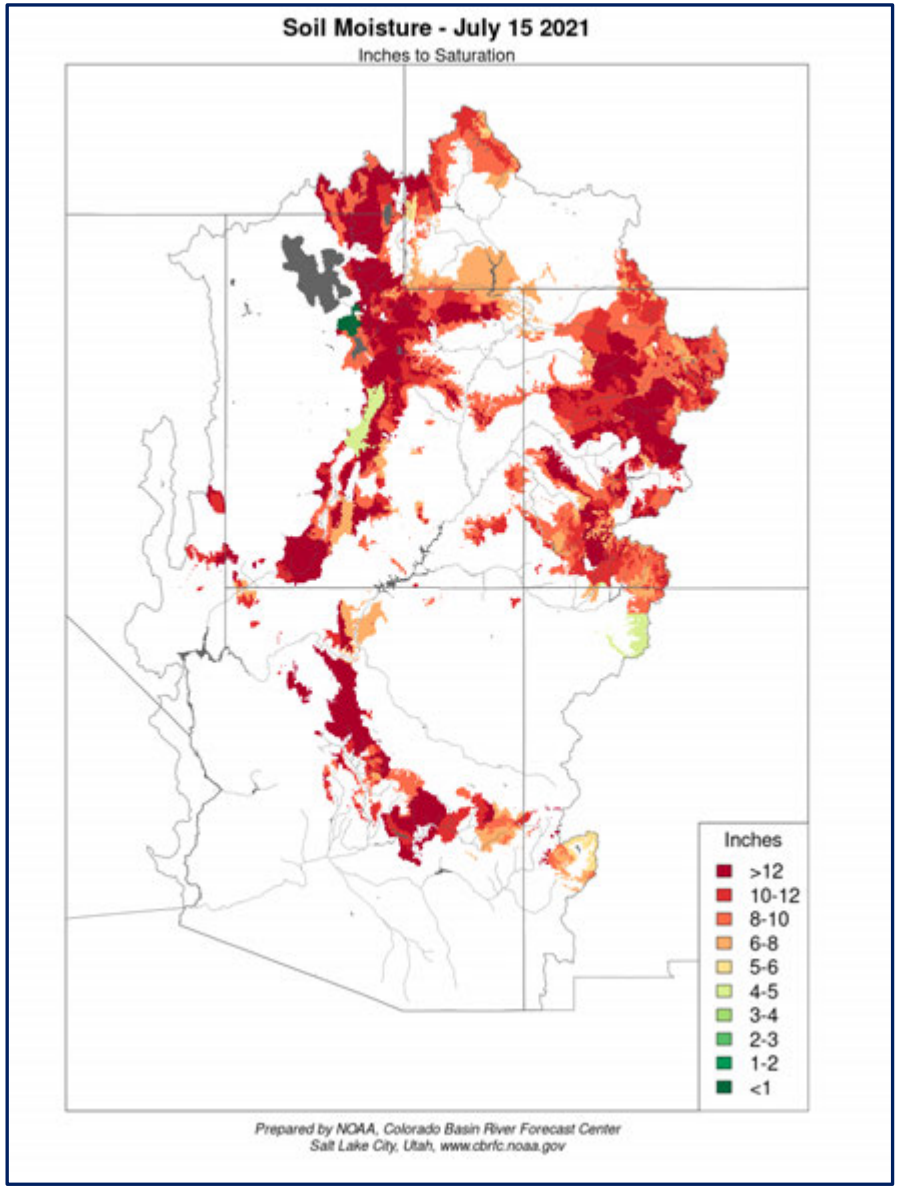
August 18, 2021

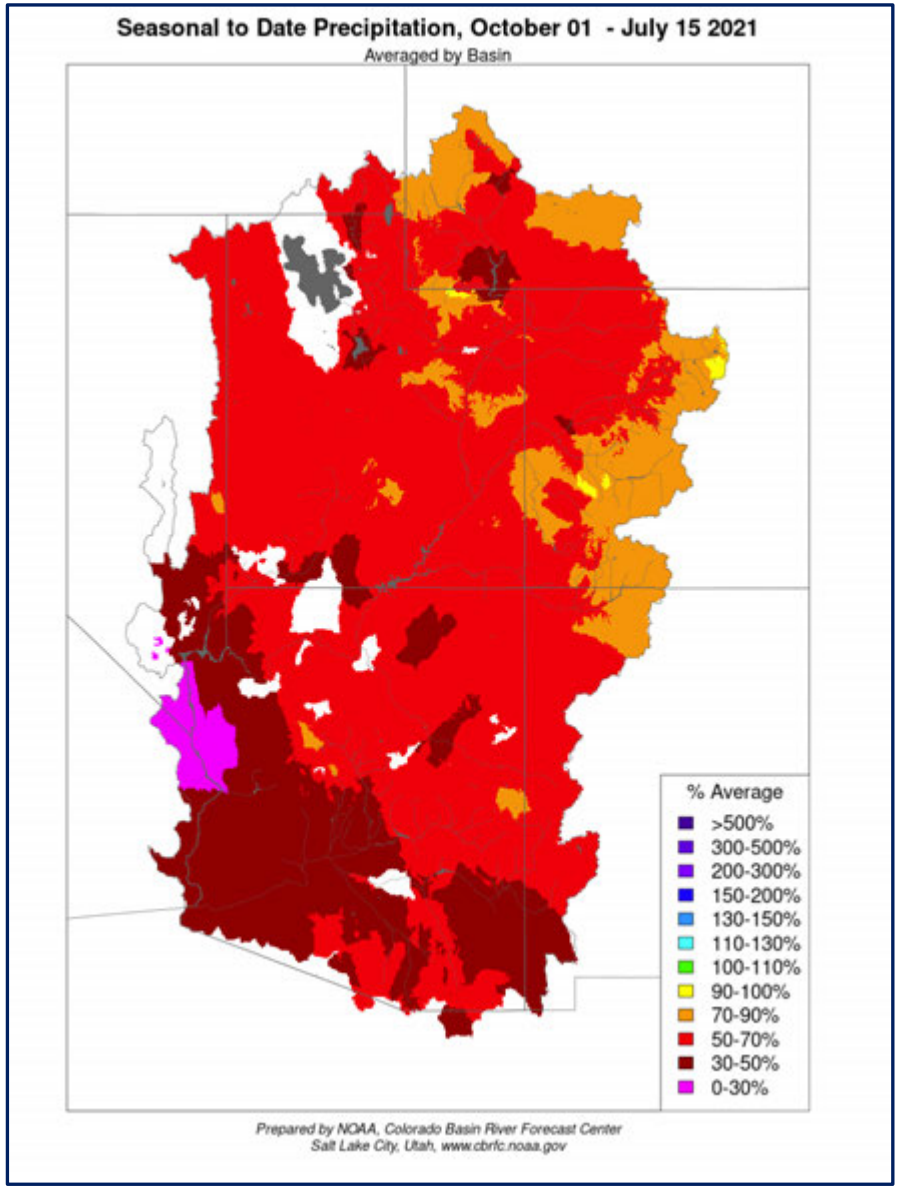
Upper Basin Storage (as of August 15, 2021)

Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	74	0.25	0.33	6,493.97
Flaming Gorge	82	3.06	3.75	6,022.15
Blue Mesa	41	0.34	0.83	7,454.96
Navajo	62	1.04	1.70	6,033.40
Lake Powell	32	7.67	24.32	3,551.22
UC System Storage	40	12.48	31.09	



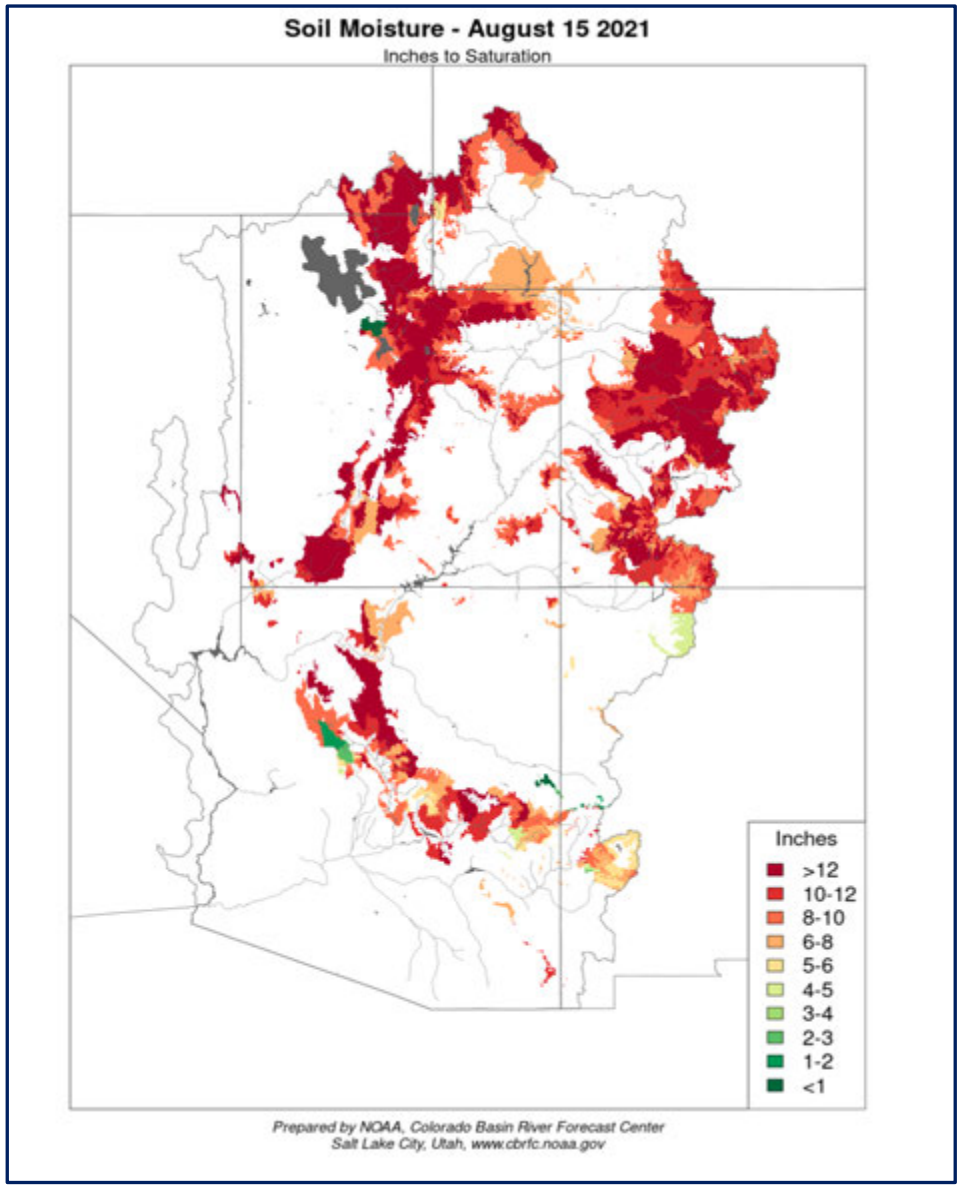
Soil Moisture and Precipitation – July 2021

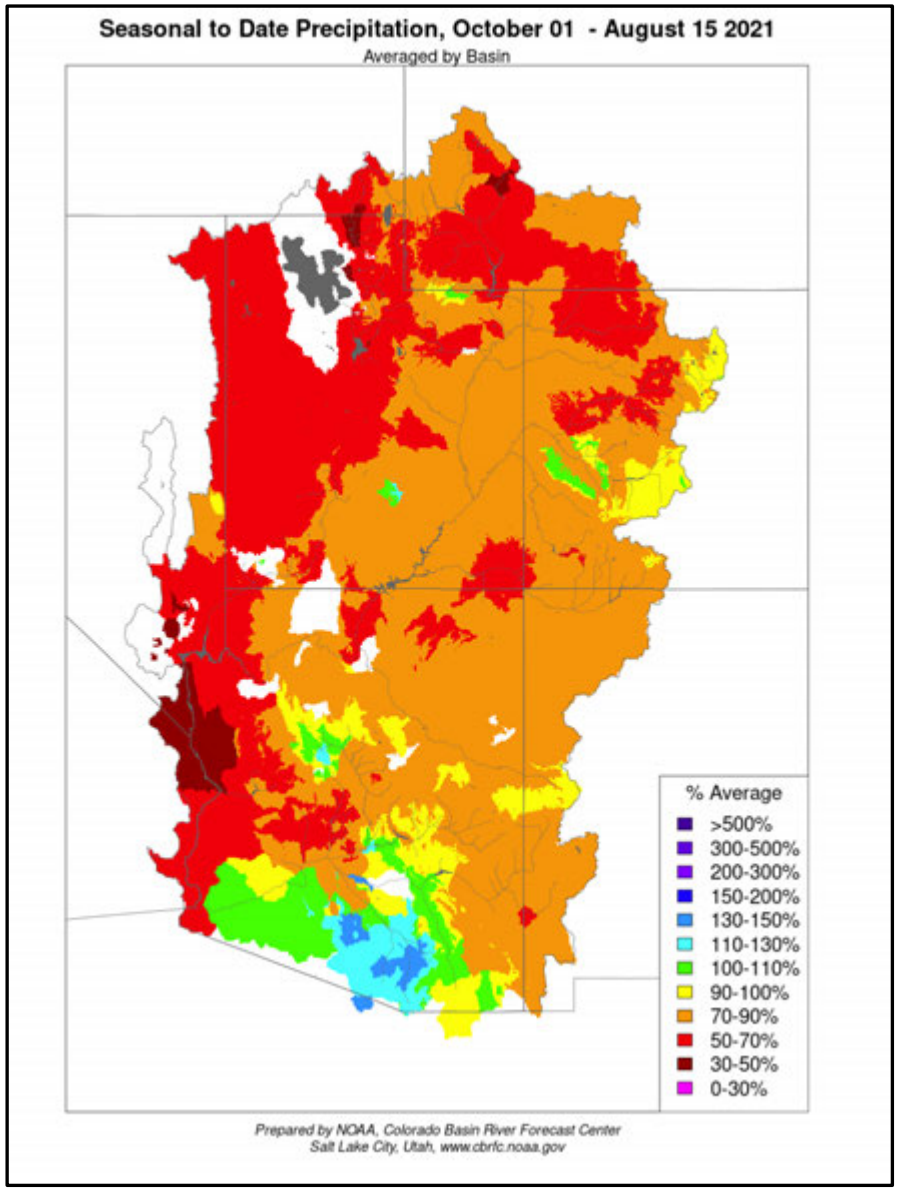




https://www.cbrfc.noaa.gov/rmap/grid800/index.php?type=todate

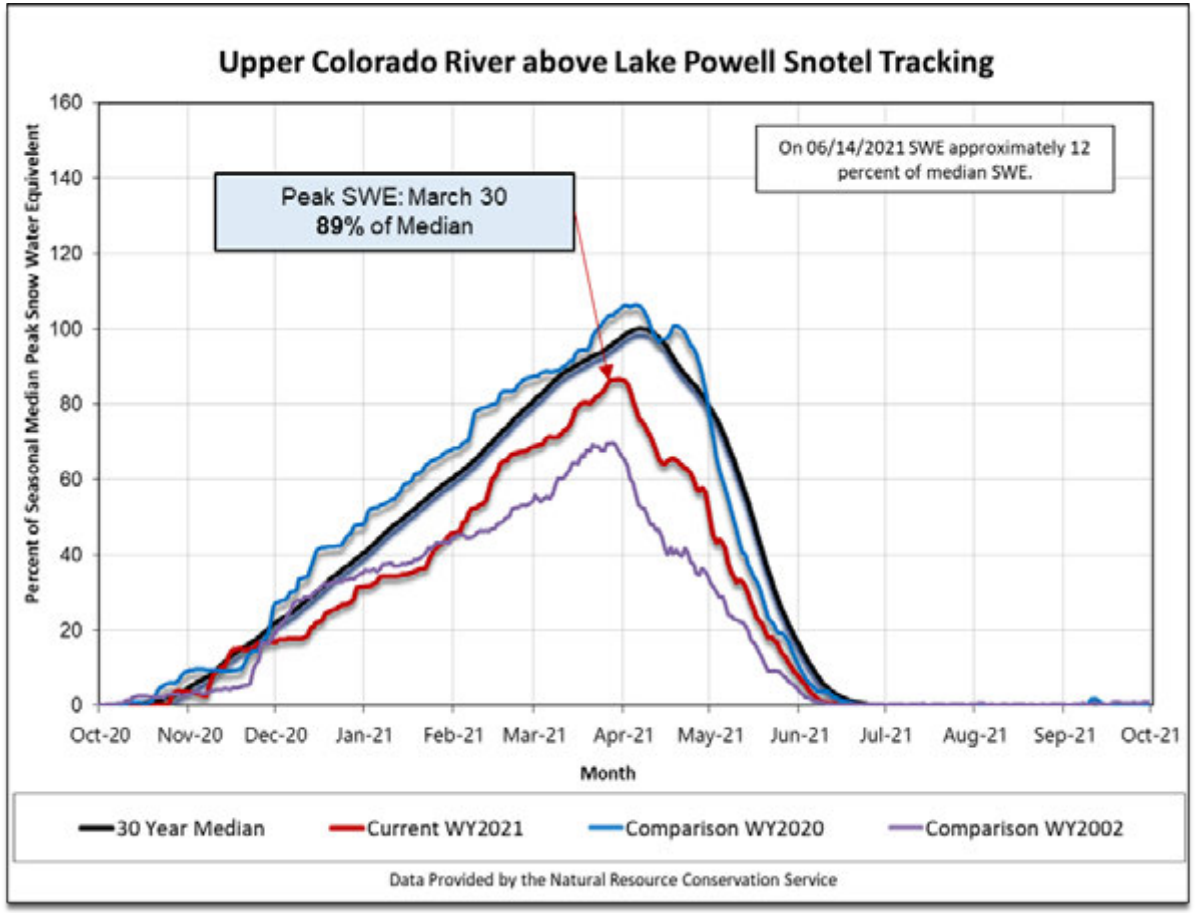
Soil Moisture and Precipitation – August 2021

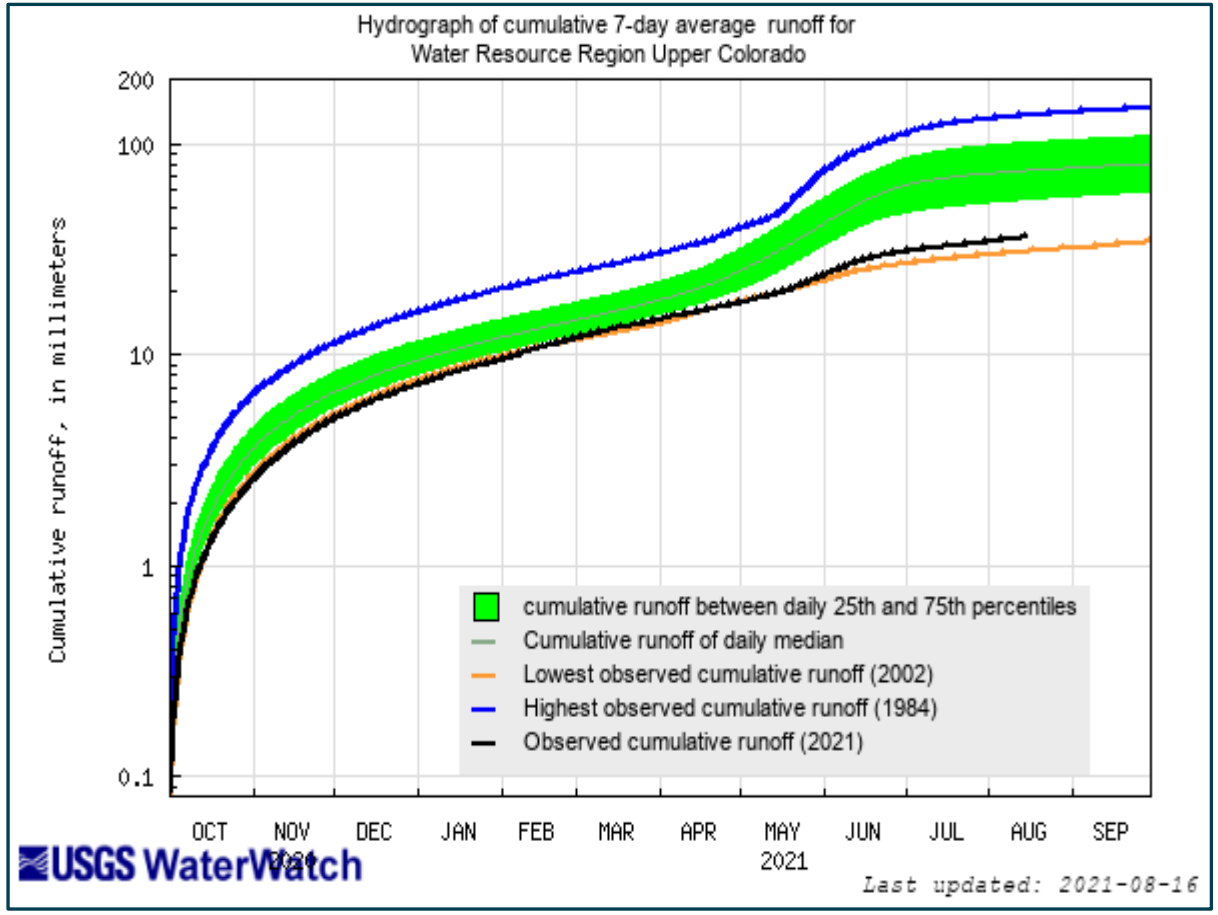




https://www.cbrfc.noaa.gov/rmap/grid800/index.php?type=todate

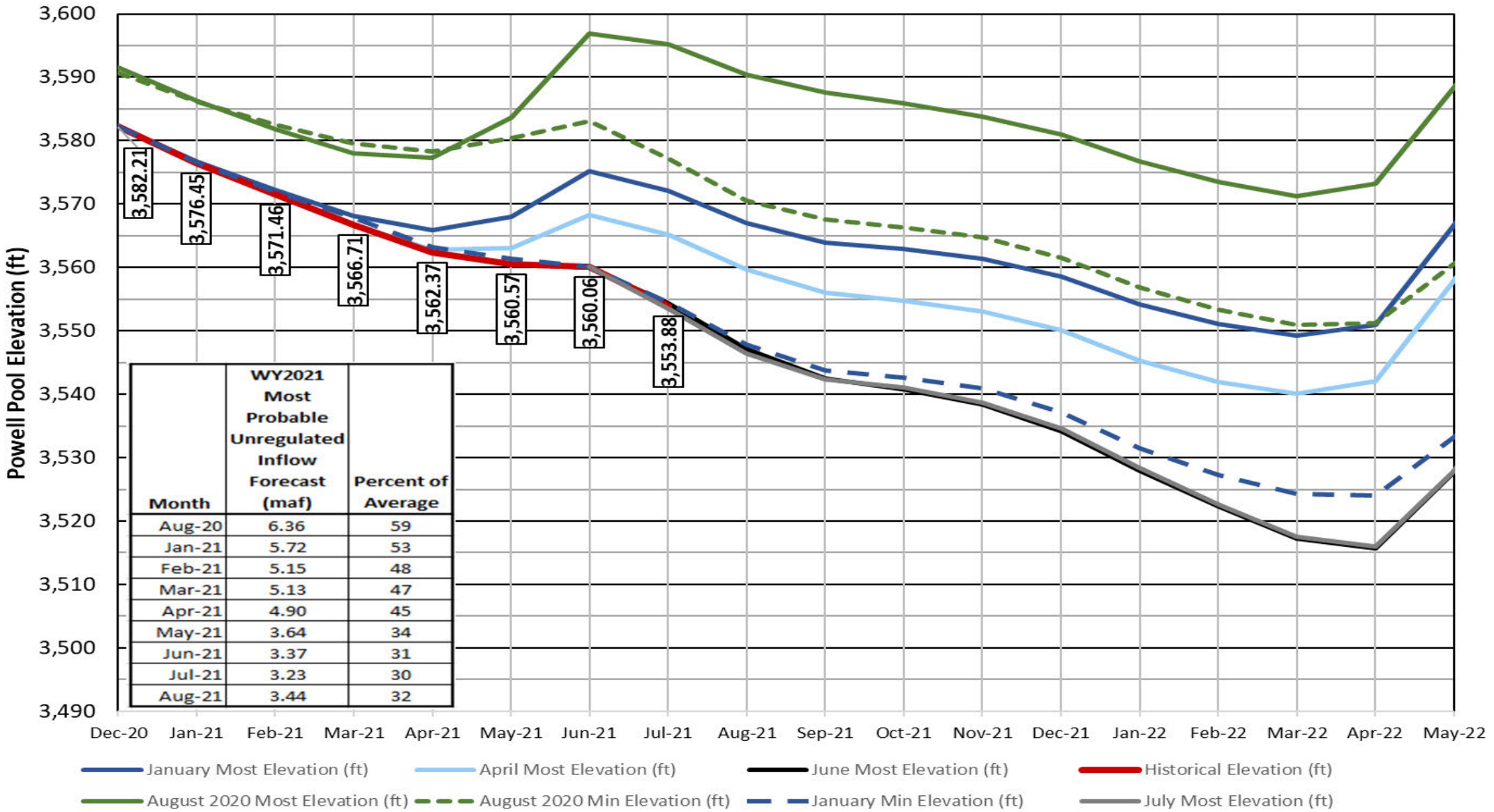
Current SWE and Observed UC Runoff





Available online at: https://waterwatch.usgs.gov/index.php?id=wwdur_cumrunoff

Lake Powell 24-Month Study Most Probable Elevation Projections
August 2020 through July 2021



Month	WY2021 Most Probable Unregulated Inflow Forecast (maf)	Percent of Average
Aug-20	6.36	59
Jan-21	5.72	53
Feb-21	5.15	48
Mar-21	5.13	47
Apr-21	4.90	45
May-21	3.64	34
Jun-21	3.37	31
Jul-21	3.23	30
Aug-21	3.44	32

Most Probable August Forecast Water Year 2021

April – July 2021 Observed Unregulated Inflow

as of August 2, 2021

Reservoir	Unregulated Inflow (kaf)	Percent of Average[1]
Fontenelle	318	44
Flaming Gorge	380	39
Blue Mesa	317	47
Navajo	378	51
Powell	1,850	26

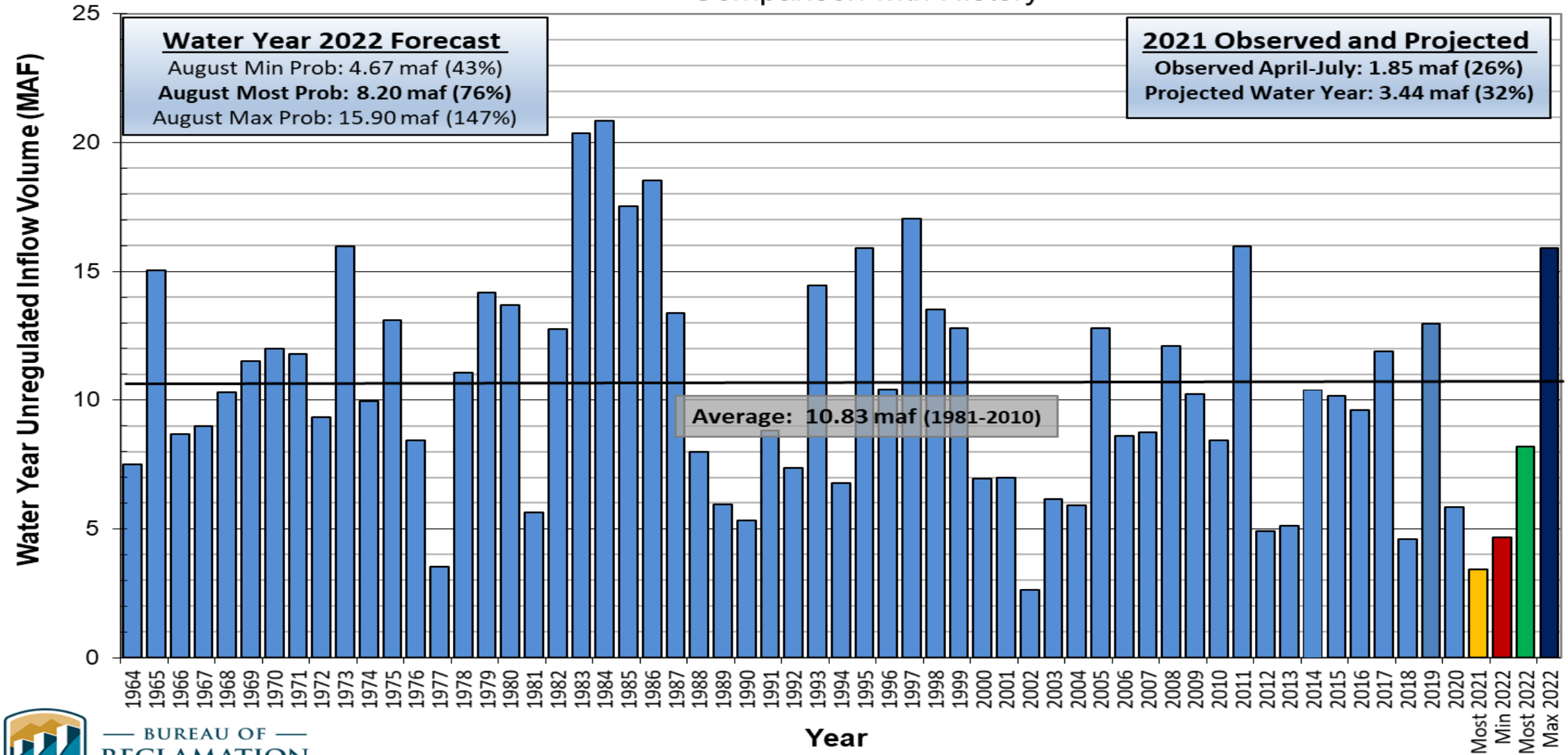
Water Year 2021 Forecasted Unregulated Inflow

as of August 2, 2021

Reservoir	Unregulated Inflow (kaf)	Percent of Average[1]
Fontenelle	552	51
Flaming Gorge	649	45
Blue Mesa	519	54
Navajo	504	47
Powell	3,437	32

[1] *Percent of average is based on the period of record from 1981-2010.*

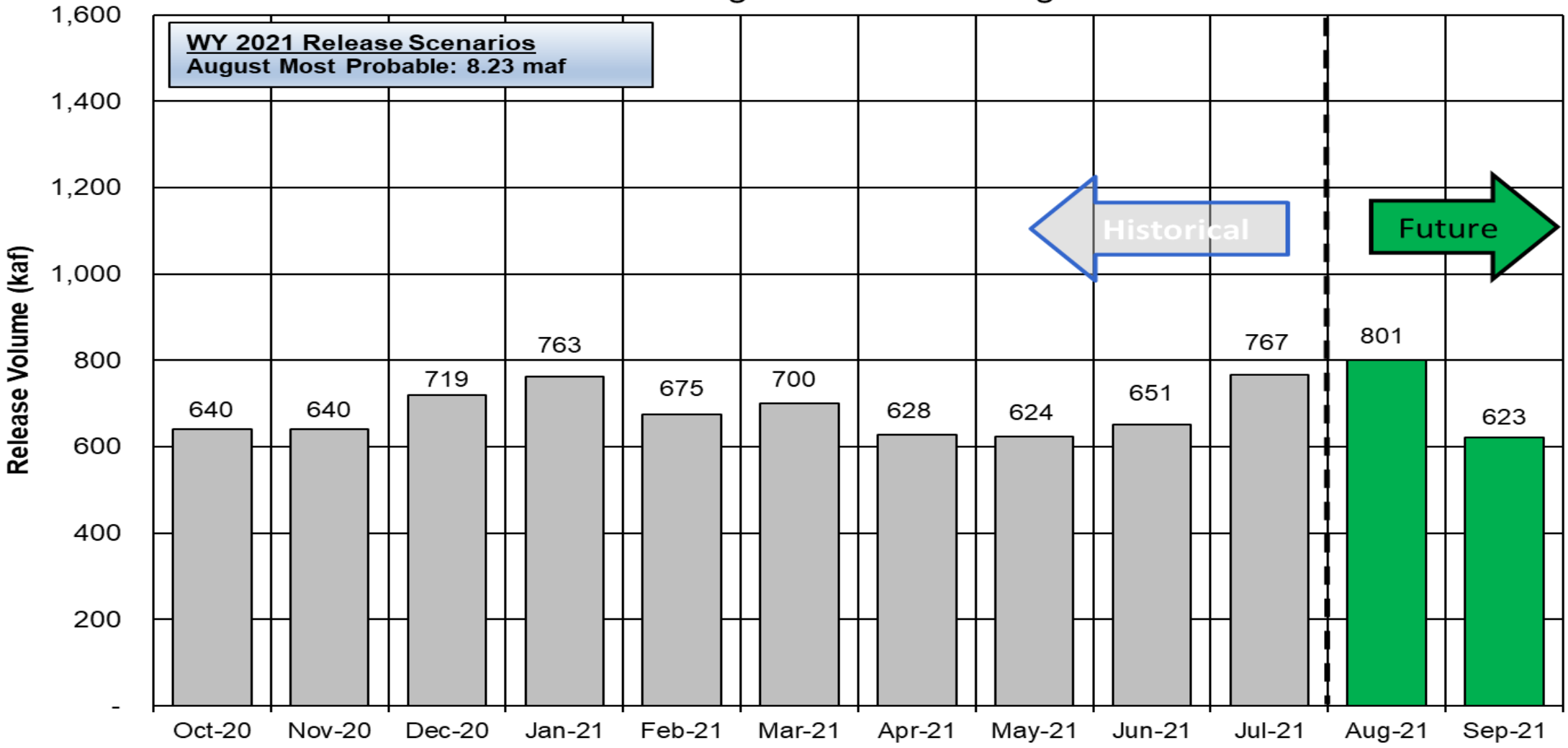
Lake Powell Unregulated Inflow
Water Year 2021 and 2022 Forecast *(issued August 2)*
Comparison with History



BUREAU OF RECLAMATION

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2021
Based on August 2021 Modeling



BUREAU OF RECLAMATION

The Drought Response Operations Agreement (DROA) can be found here: https://www.usbr.gov/dcp/finaldocs.html

2021 DROA Timeline of Events

- January 2021: Minimum Probable 24 Month Study run projected Powell below 3,525’
  - Formal notification to parties
  - Enhanced monitoring and coordination
  - Monthly analysis of min/most/max
- May 2021: Most Probable 24 Month Study run projected Powell within inches of 3,525’
  - DROA planning formally initiated
- July 2021: Continued declining hydrology and declining Powell
  - Consultation and initiation of DROA releases under emergency provision of agreement

Upper Basin DROA Initial Unit Drought Response Releases that started in July 2021

- July WY2021 forecast decreased 140 kaf from the June forecast
- Continued drought conditions exacerbated already parched soil moisture conditions
- WY2022 most probable forecast decreased 1.84 maf (17%)
  - May forecast 9.97 maf (92% avg)
  - July forecast 8.13 maf (75% avg)
- Prospects of future monsoon events unknown

DROA Releases for the July 24MS Model Run

	Jul	Aug	Sep	Oct	Nov	Dec	
	(kaf)	(kaf)	(kaf)	(kaf)	(kaf)	(kaf)	Sum
Flaming Gorge	13	42	43	27	0	0	125
Blue Mesa	0	14	18	4	0	0	36
Navajo	0	0	0	0	10	10	20
Sum:	13	56	61	31	10	10	181

August 24-Month Study Projections

Upper Colorado Basin Region Operations

Lake Powell & Lake Mead Operational Table

Lake Powell Operational Tier Determination Run[1]

Lake Powell			Lake Mead		
Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf)[1]	Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf)[1]
3,700	**Equalization Tier** Equalize, avoid spills or release 8.23 maf	24.3	1,220	**Flood Control Surplus or Quantified Surplus Condition** Deliver > 7.5 maf	25.9
3,636 - 3,666 (2008-2026)	**Upper Elevation Balancing Tier**[2] Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.5 - 19.3 (2008-2026)	1,200 (approx.)[2]	**Domestic Surplus or ICS Surplus Condition** Deliver > 7.5 maf	22.9 (approx.)[2]
			1,145		15.9
			1,105	**Normal or ICS Surplus Condition** Deliver ≥ 7.5 maf	11.9
3,575		9.5	1,075		9.4
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf			**Shortage Condition** Deliver 7.167[4] maf	
3,535.40 ft Jan 1, 2022 Projection			1,050		7.5
3,525		5.9		**Shortage Condition** Deliver 7.083[5] maf	
			1,025		5.8
3,490	**Lower Elevation Balancing Tier** Balance contents with a min/max release of 7.0 and 9.5 maf	4.0	1,000	**Shortage Condition** Deliver 7.0[6] maf Further measures may be undertaken[7]	4.3
3,370		0	895		0

Diagram not to scale

[1] Acronym for million acre-feet

[2] This elevation is shown as approximate as it is determined each year by considering several factors including Lake Powell and Lake Mead storage, projected Upper Basin and Lower Basin demands, and an assumed inflow.

[3] Subject to April adjustments which may result in a release according to the Equalization Tier

[4] Of which 2.48 maf is apportioned to Arizona, 4.4 maf to California, and 0.287 maf to Nevada

[5] Of which 2.40 maf is apportioned to Arizona, 4.4 maf to California, and 0.283 maf to Nevada

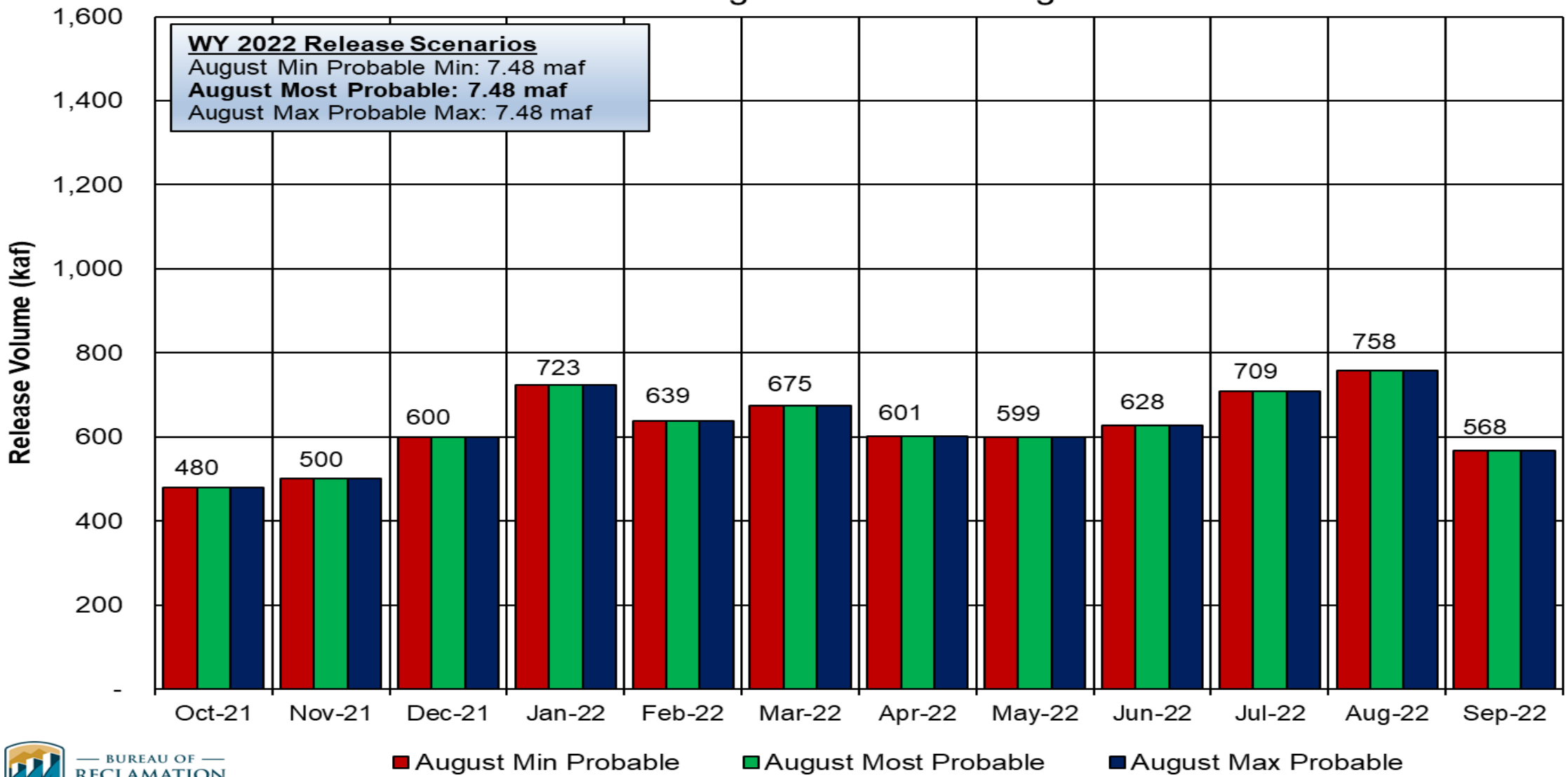
[6] Of which 2.32 maf is apportioned to Arizona, 4.4 maf to California, and 0.280 maf to Nevada

[7] Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Division States and Mexico is likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation with the Basin States, may result in the undertaking of further measures, consistent with applicable Federal law.

[1] Lake Powell and Lake Mead operational tier determinations are based on August 2021 24-Month Study projections will be documented in the draft 2022 AOP.

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2022
Based on August 2021 Modeling

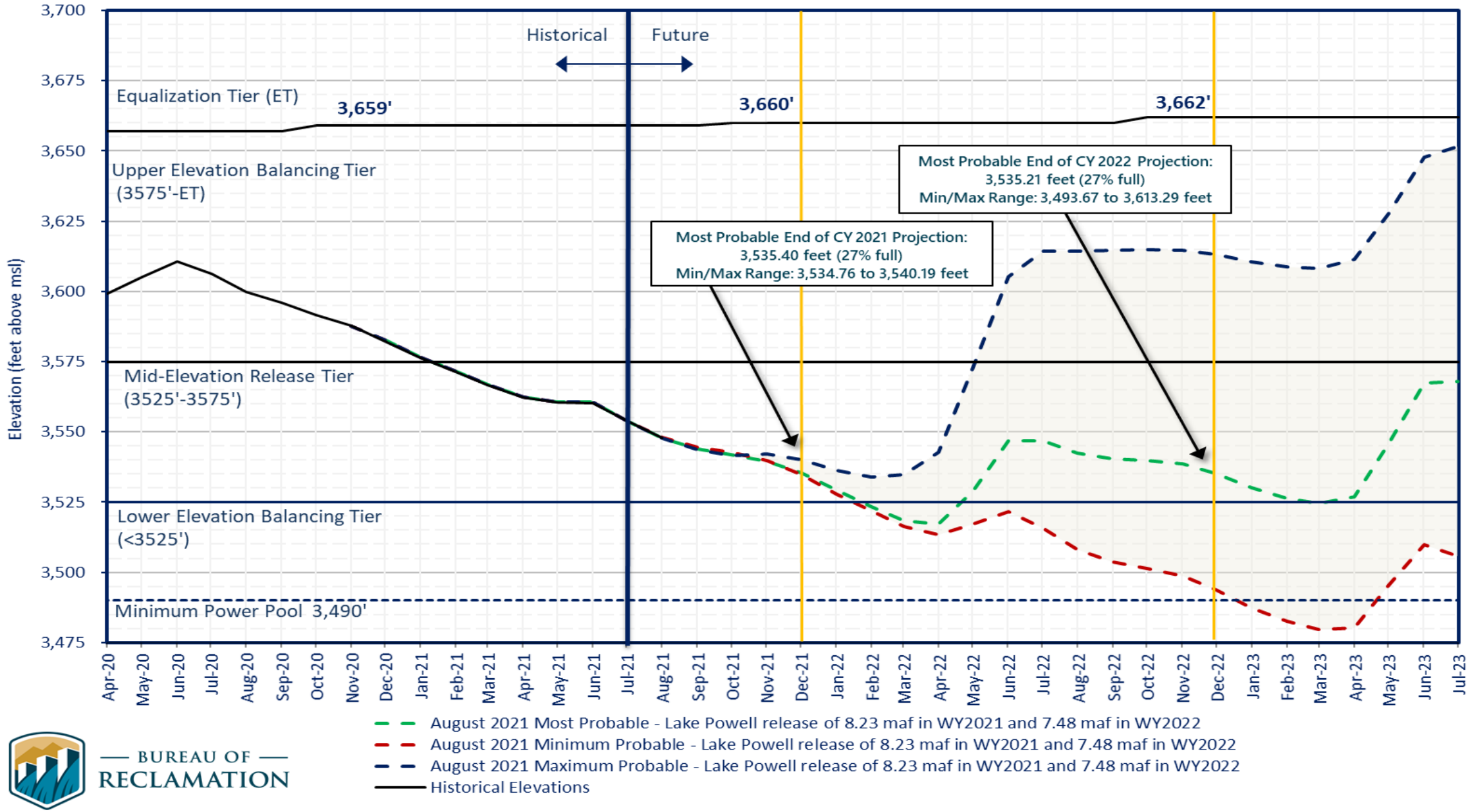


BUREAU OF RECLAMATION

The Drought Response Operations Agreement (DROA) can be found here: https://www.usbr.gov/dcp/finaldocs.html

Lake Powell End of Month Elevations

Projections from the August 2021 24-Month Study Inflow Scenarios



BUREAU OF RECLAMATION

Lake Powell & Lake Mead Operational Table

Lake Mead Operating Condition Determination for CY 2022[1]

Lake Powell			Lake Mead		
Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf)[1]	Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf)[1]
3,700	**Equalization Tier** Equalize, avoid spills or release 8.23 maf	24.3	1,220	**Flood Control Surplus or Quantified Surplus Condition** Deliver > 7.5 maf	25.9
3,636 - 3,666 (2008-2026)	**Upper Elevation Balancing Tier**[2] Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.5 - 19.3 (2008-2026)	1,200 (approx.)[2]	**Domestic Surplus or ICS Surplus Condition** Deliver > 7.5 maf	22.9 (approx.)[2]
			1,145		15.9
			1,105	**Normal or ICS Surplus Condition** Deliver ≥ 7.5 maf	11.9
3,575		9.5	1,075		9.4
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf			Shortage Condition Deliver 7.167[4] maf ***1,065.85 ft*** ***Jan 1, 2022*** ***Projection***	
			1,050		7.5
3,525		5.9		**Shortage Condition** Deliver 7.083[5] maf	
			1,025		5.8
3,490	**Lower Elevation Balancing Tier** Balance contents with a min/max release of 7.0 and 9.5 maf	4.0	1,000	**Shortage Condition** Deliver 7.0[6] maf Further measures may be undertaken[7]	4.3
3,370		0	895		0

Diagram not to scale

[1] Acronym for million acre-feet

[2] This elevation is shown as approximate as it is determined each year by considering several factors including Lake Powell and Lake Mead storage, projected Upper Basin and Lower Basin demands, and an assumed inflow.

[3] Subject to April adjustments which may result in a release according to the Equalization Tier

[4] Of which 2.48 maf is apportioned to Arizona, 4.4 maf to California, and 0.287 maf to Nevada

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[1] Lake Powell and Lake Mead operational tier determinations are based on August 2021 24-Month Study projections will be documented in the draft 2022 AOP.

2007 Interim Guidelines, Minute 323, Lower Basin Drought Contingency Plan, and Binational Water Scarcity Contingency Plan

Total Volumes (kaf)

Lake Mead Elevation (feet msl)	2007 Interim Guidelines Shortages		Minute 323 Delivery Reductions	Total Combined Reductions	DCP Water Savings Contributions			Binational Water Scarcity Contingency Plan Savings	Combined Volumes by Country *US: (2007 Interim Guidelines Shortages + DCP Contributions)* *Mexico: (Minute 323 Delivery Reductions + Binational Water Scarcity Contingency Plan Savings)*					Total Combined Volumes
	AZ	NV	Mexico	***Lower Basin States + Mexico***	AZ	NV	CA	Mexico	*AZ Total*	*NV Total*	*CA Total*	*Lower Basin States Total*	*Mexico Total*	***Lower Basin States + Mexico***
1,090 - 1,075	0	0	0	***0***	192	8	0	41	192	8	0	*200*	*41*	***241***
1,075 - 1050	320	13	50	***383***	192	8	0	30	512	21	0	*533*	*80*	***613***
1,050 - 1,045	400	17	70	***487***	192	8	0	34	592	25	0	*617*	*104*	***721***
1,045 - 1,040	400	17	70	***487***	240	10	200	76	640	27	200	*867*	*146*	***1,013***
1,040 - 1,035	400	17	70	***487***	240	10	250	84	640	27	250	*917*	*154*	***1,071***
1,035 - 1,030	400	17	70	***487***	240	10	300	92	640	27	300	*967*	*162*	***1,129***
1,030 - 1,025	400	17	70	***487***	240	10	350	101	640	27	350	*1,017*	*171*	***1,188***
<1,025	480	20	125	***625***	240	10	350	150	720	30	350	*1,100*	*275*	***1,375***

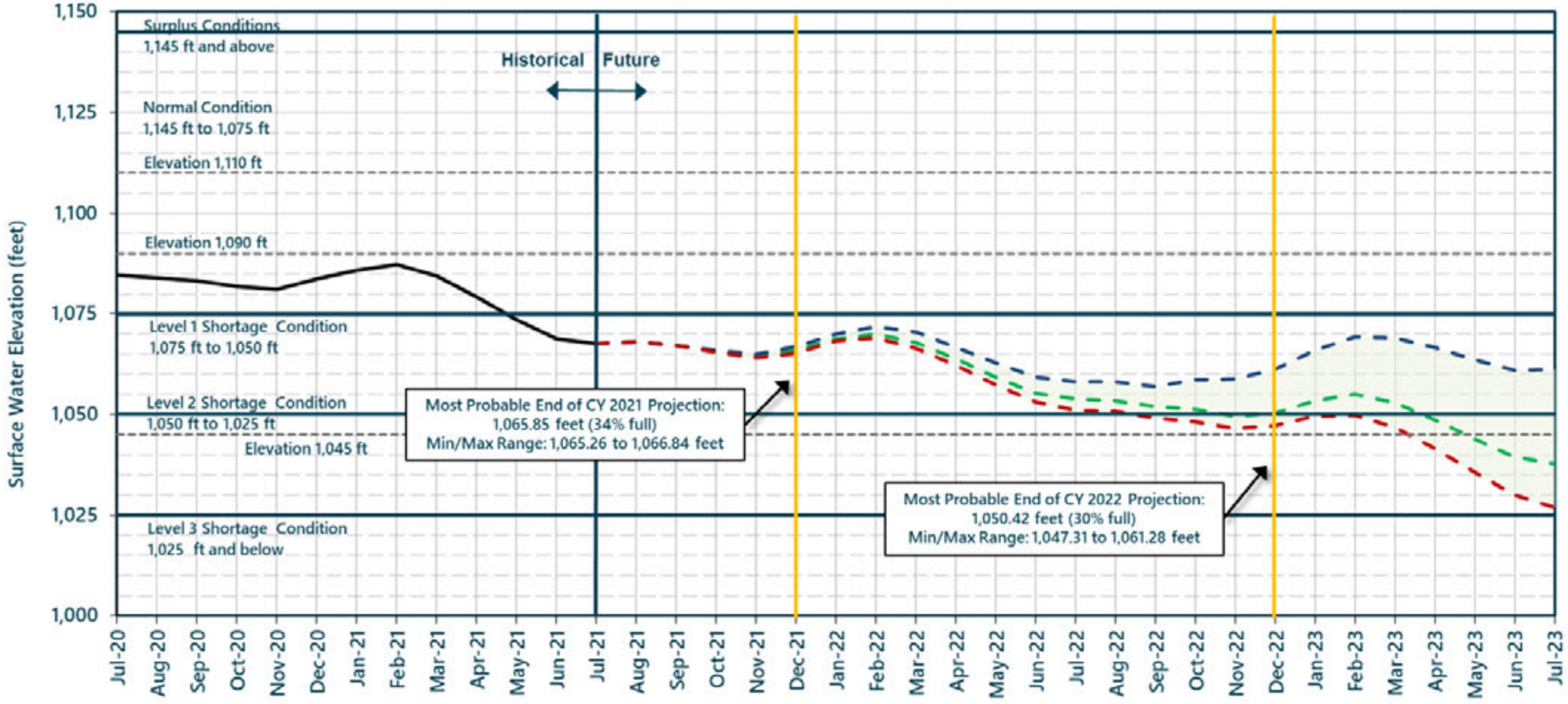
2022 Reductions + Contributions

2022 Reductions + Contributions

The Secretary of the Interior will take affirmative actions to implement programs designed to create or conserve 100,000 acre-ft per annum of more of Colorado River System water to contribute to conservation of water supplies in Lake Mead and other Colorado River reservoirs in the lower basin. All actions taken by the United States shall be subject to applicable law, including availability of appropriations.

Lake Mead End of Month Elevations

Projections from the August 2021 24-Month Study Inflow Scenarios



Historical Elevations

August 2021 Most Probable Inflow with a Lake Powell release of 7.48 maf in WY 2022 and WY 2023

August 2021 Maximum Probable Inflow with a Lake Powell release of 7.48 maf in WY 2022 and 9.00 maf in WY 2023

August 2021 Minimum Probable Inflow with a Lake Powell release of 7.48 maf in WY 2022 and 7.00 maf in WY 2023

The Drought Response Operations Agreement (DROA) is available online at: https://www.usbr.gov/dcp/finaldocs.html.

Upper Colorado Basin

Hydropower Maintenance

Glen Canyon Dam Power Plant Unit Outage Schedule for 2021

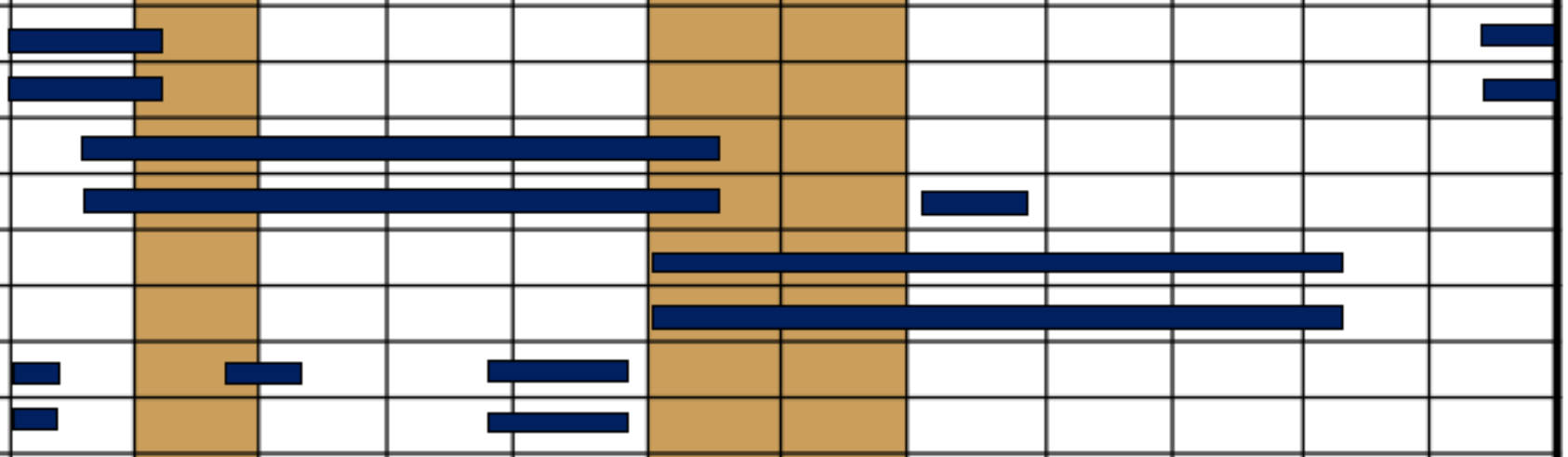
Unit Number	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	5	5/4	6	6	6	6/4	4	5	6	6	6	4	
Capacity (cfs)	16,400	16,400/ 12,200	19,800	19,600	19,500	19,400 (20,150)[3]	19,200	15,700	19,200	19,000	18,800	11,800	AUG MOST[2]
Capacity (kaf/month)	1,040	1,140	1,250	1,220	1,080	1,540	1,140	1,050	1,140	1,170	1,150	990	AUG MOST
Max (kaf) [1]	640	640	720	763	675	700	628	624	652	766	801	623	8.23 maf
Most (kaf) [1]	640	640	720	763	675	700	628	624	652	766	801	623	8.23 maf
Min (kaf) [1]	640	640	720	760	680	700	628	624	652	766	801	623	8.23 maf
										(updated 08-17-2021)			

1 Projected release, based on August 2021 minimum, most and maximum probable Inflow Projections and 24-Month Study model runs.

2 Dependent upon availability to shift contingency reserves, which will increase capacity by 30-40MW (3%) at current efficiency.

3 Increased capacity available from shifting contingency reserves for Spring Disturbance Flow.

Glen Canyon Dam Power Plant Unit Outage Schedule for 2022

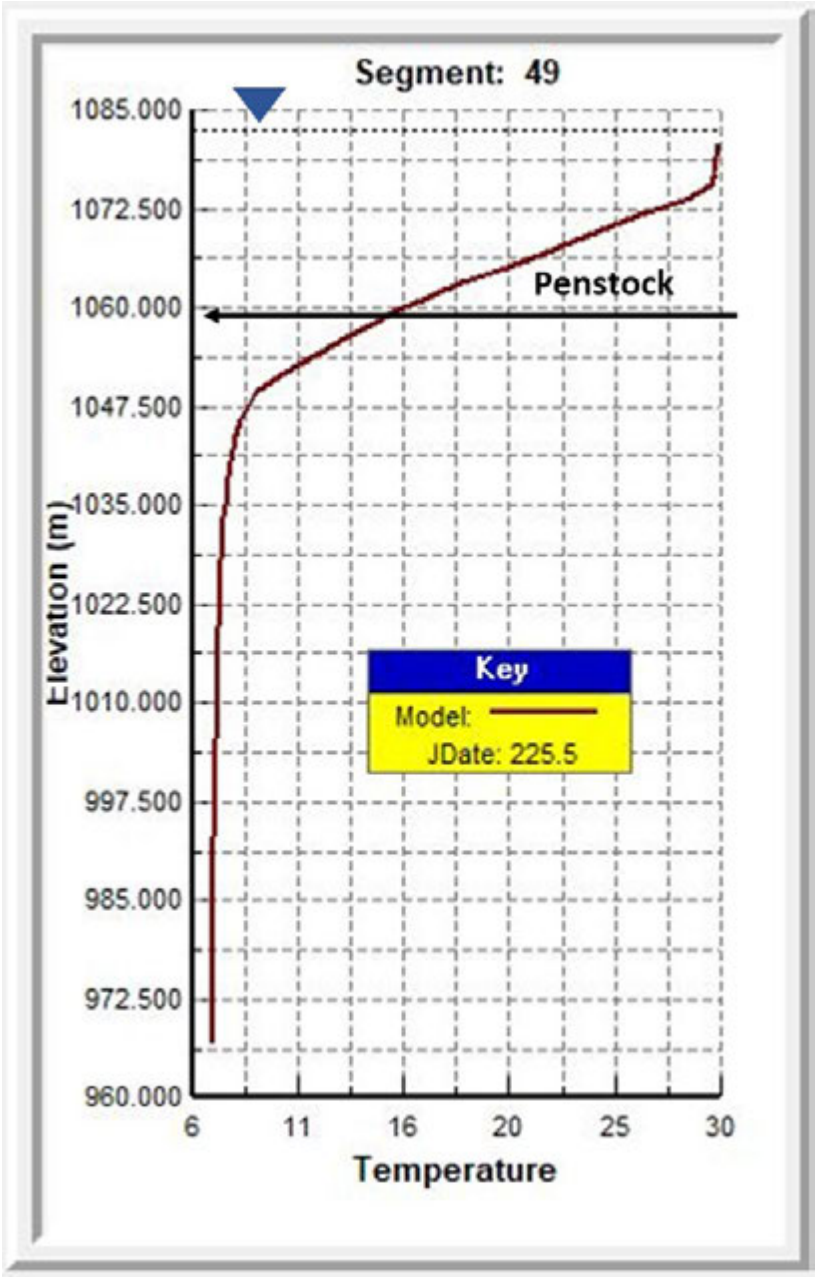


Unit Number	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022	Jul 2022	Aug 2022	Sep 2022	
Units Available	4	4	5	4	4	6	6	5	6	6	8	6	
Capacity (cfs)	11,700	11,700	15,000	11,500	11,300	11,200	17,800	14,800	18,800	18,800	25,500	18,600	AUG MOST[2]
Capacity (kaf/month)	780	730	1,060	1,100	690	860	1,060	940	1,120	1,180	1,570	1,160	AUG MOST
Max (kaf) [1]	480	500	600	723	639	675	601	599	628	709	758	568	7.48 maf
Most (kaf) [1]	480	500	600	723	639	675	601	599	628	709	758	568	7.48 maf
Min (kaf) [1]	480	500	600	664	587	620	552	550	577	652	696	522	7.48 maf
										(updated 08-17-2021)			

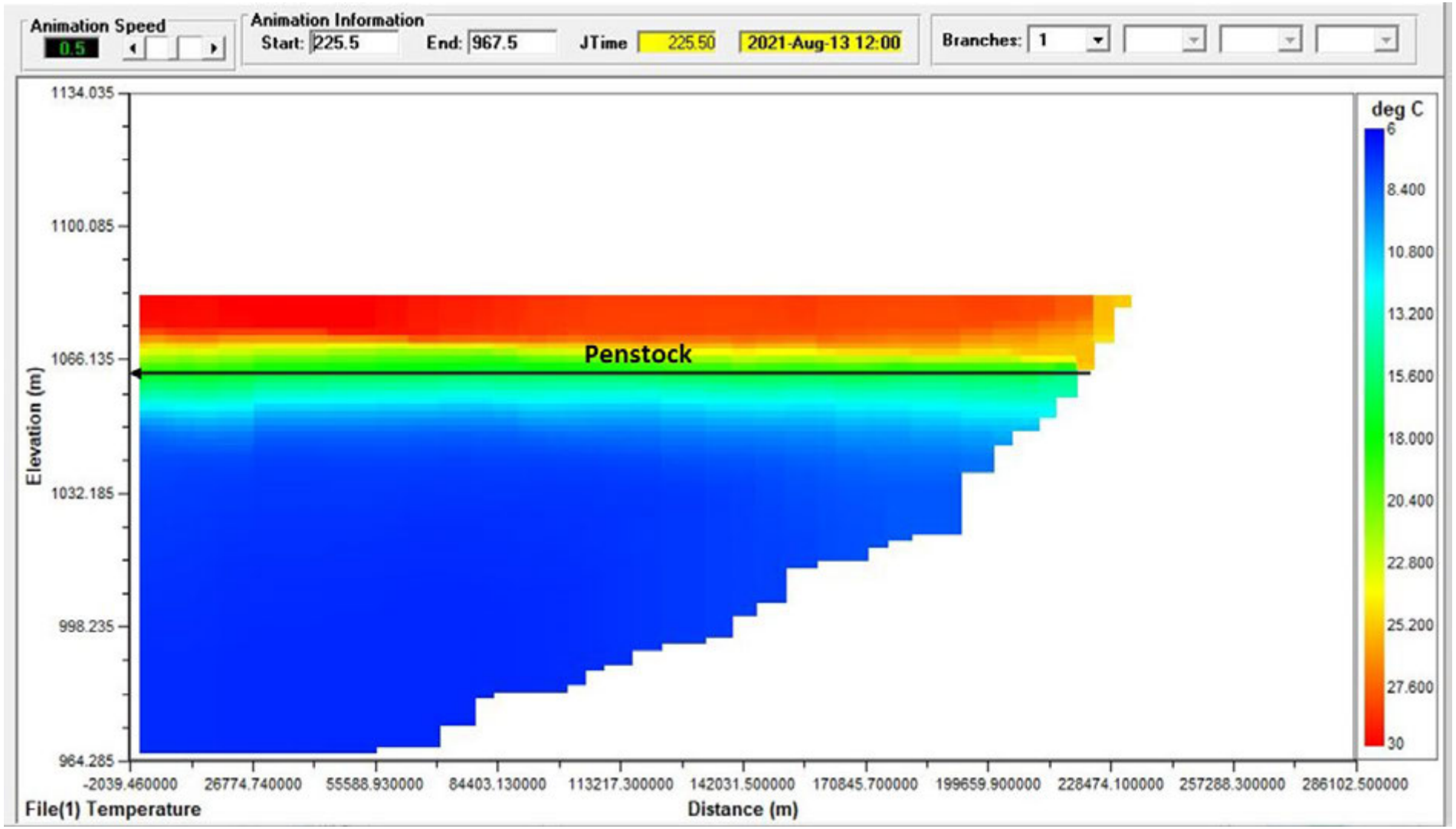
1 Projected release, based on August 2021 minimum, most and maximum probable inflow projections and 24-Month Study model runs.
2 Dependent upon availability to shift contingency reserves, which will increase capacity by 30-40MW (3%) at current efficiency.

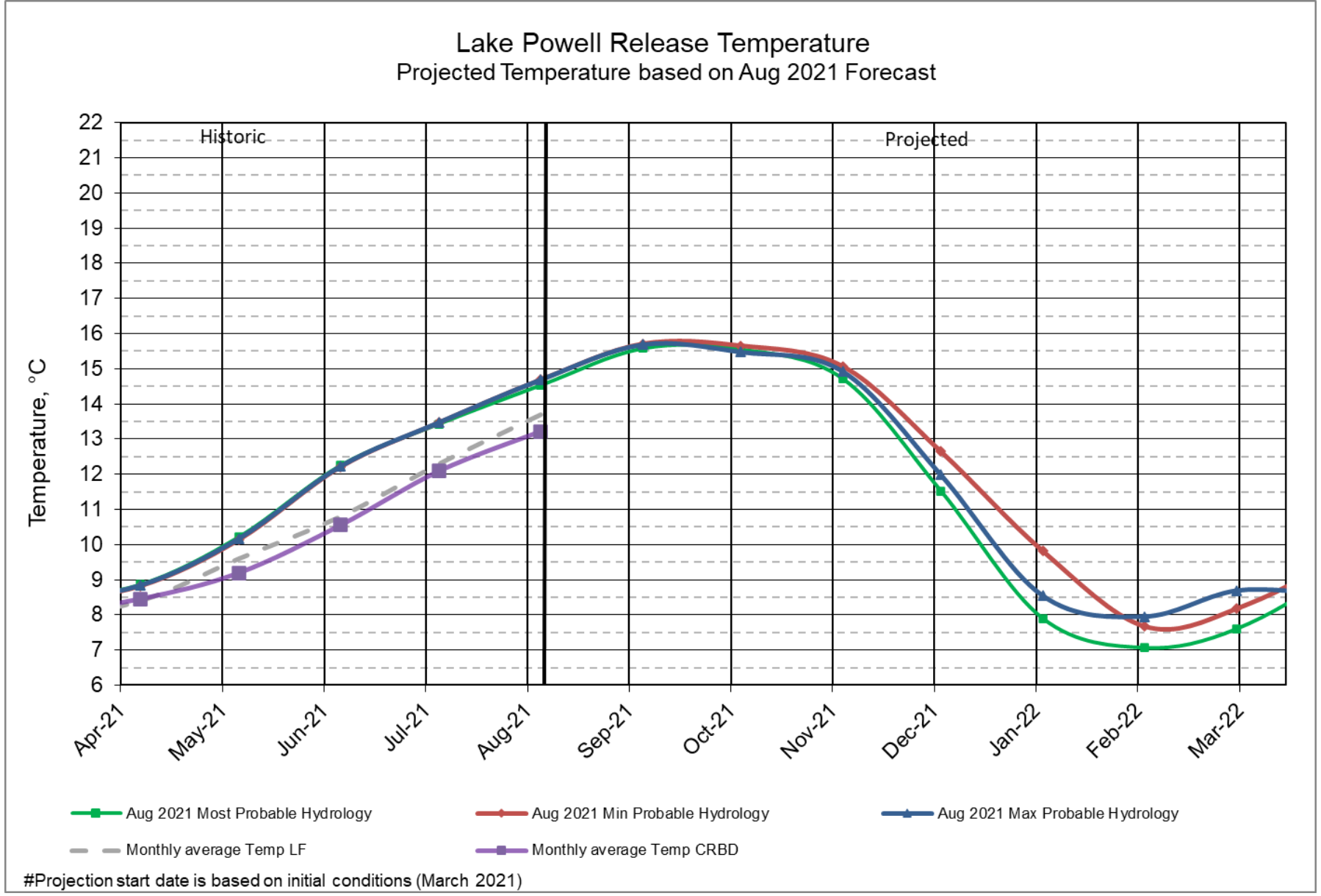
Water Quality

Temperature Profile of Lake Powell near Glen Canyon Dam
8/13/2021



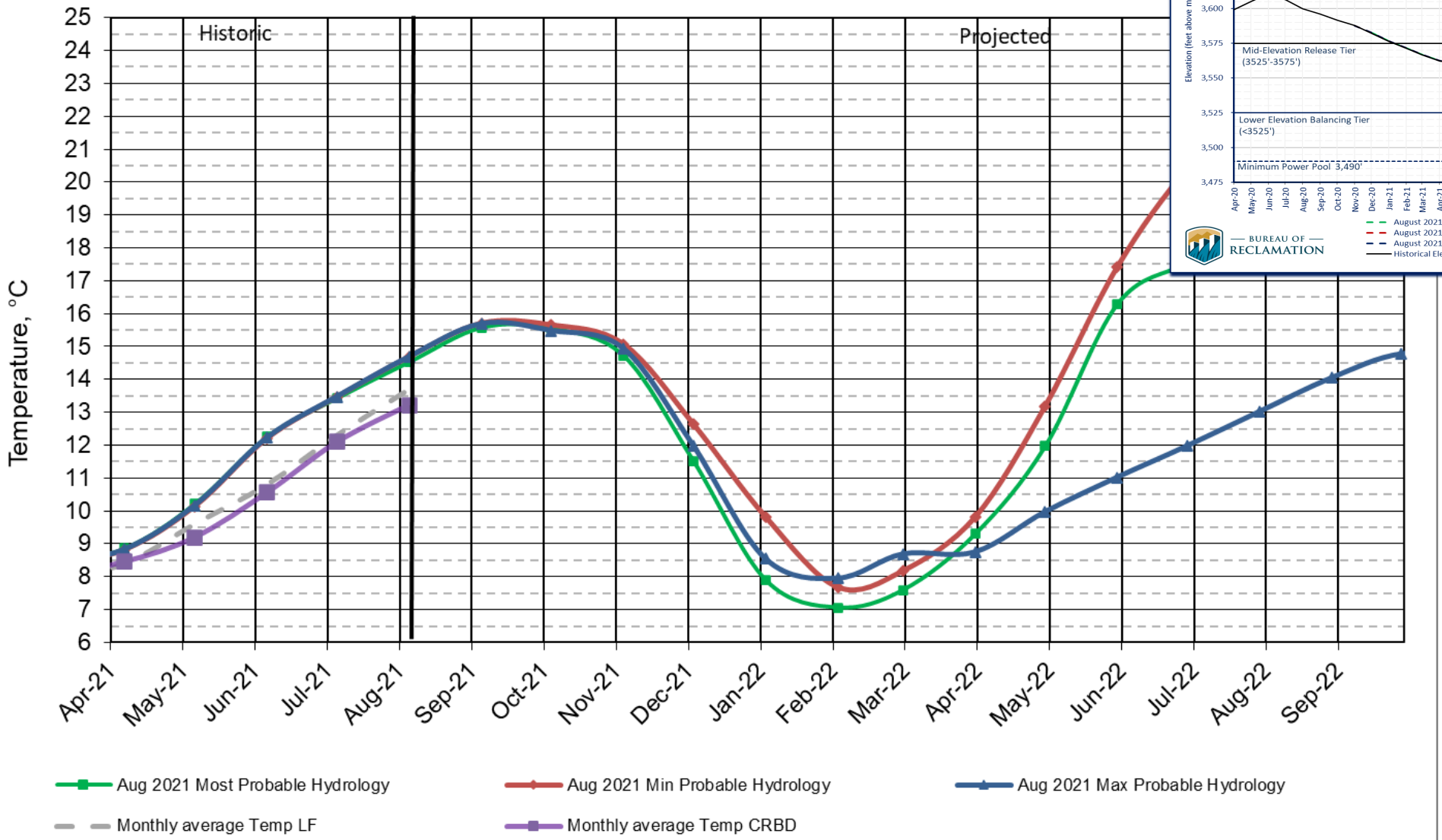
Cross Sectional Temperature Profile of Lake Powell
8/13/2021



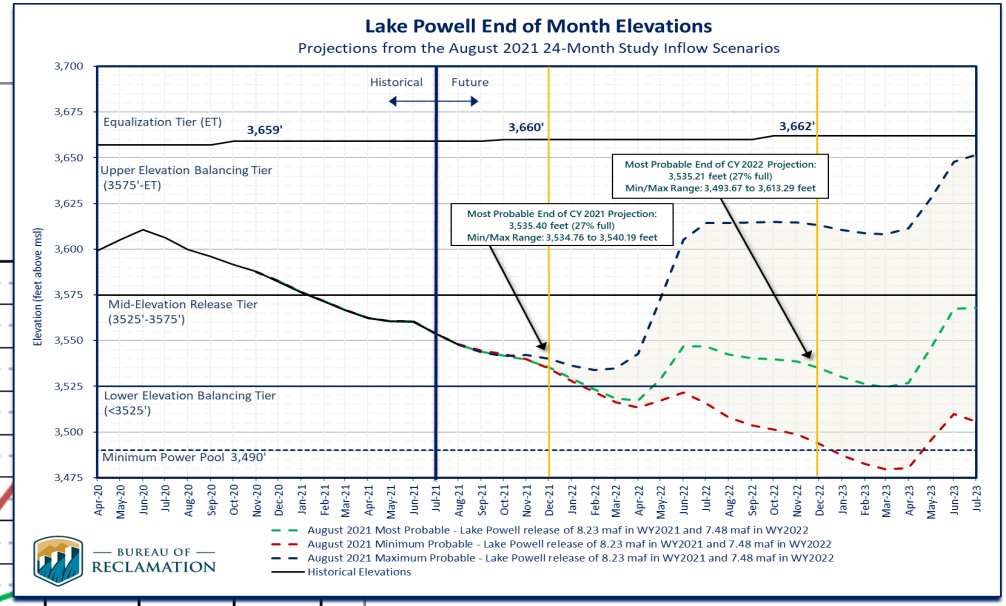

Lake Powell Release Temperature
Projected Temperature based on Aug 2021 Forecast
Historic
Projected
Temperature, °C
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Aug 2021 Most Probable Hydrology
Aug 2021 Min Probable Hydrology
Aug 2021 Max Probable Hydrology
Monthly average Temp LF
Monthly average Temp CRBD
#Projection start date is based on initial conditions (March 2021)

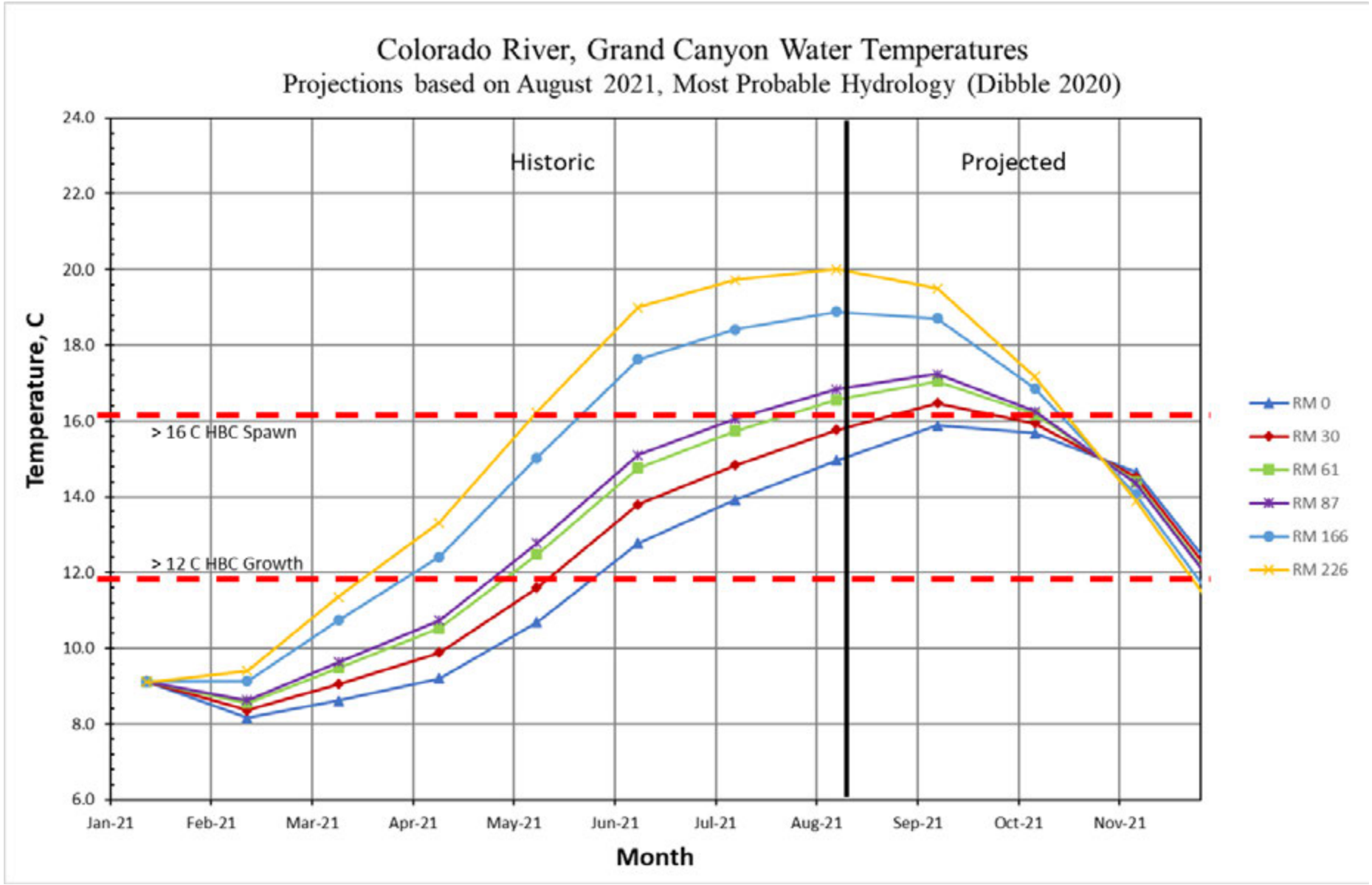
Lake Powell Release Temperature

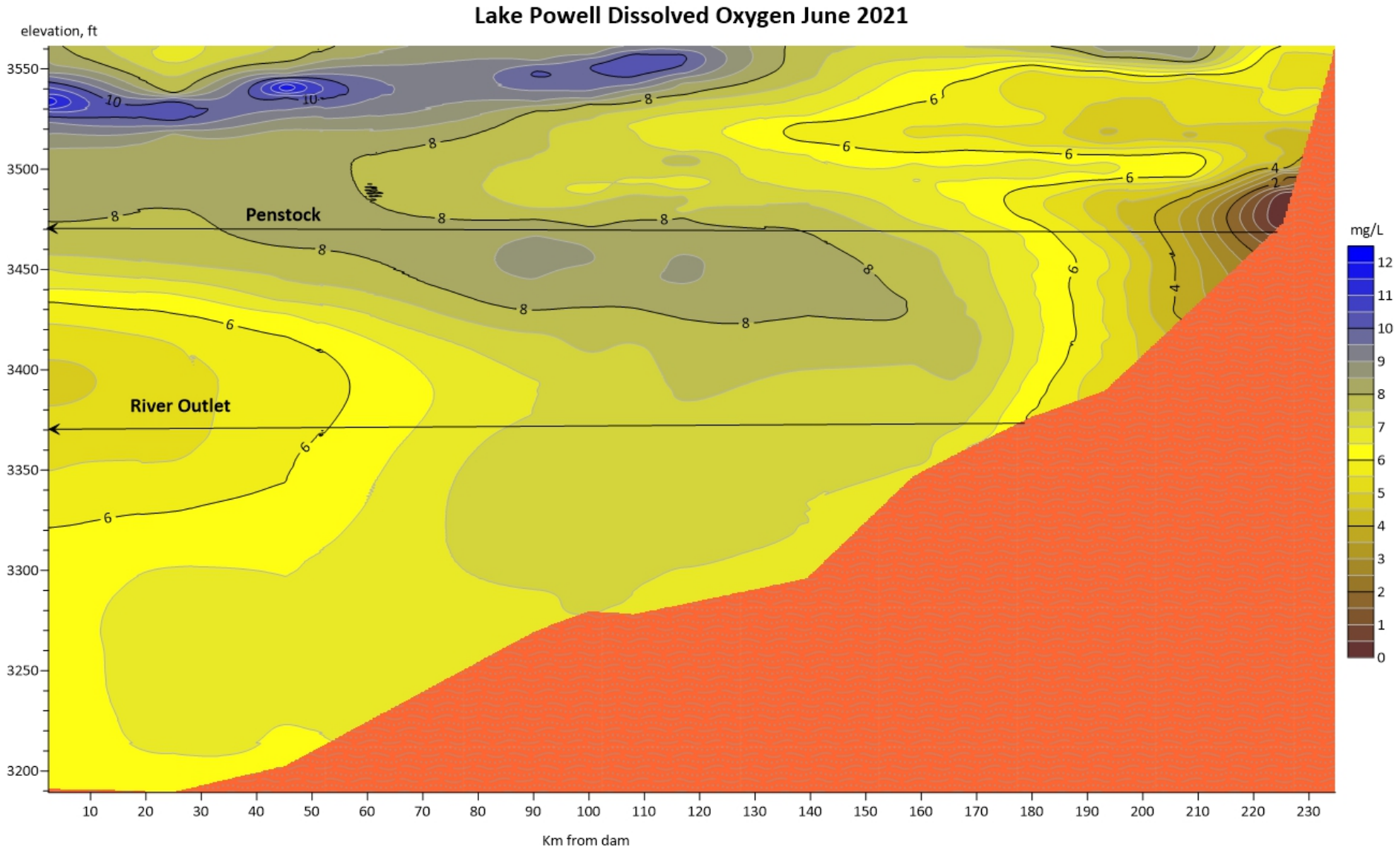
Projected Temperature based on Aug 2021 Forecast

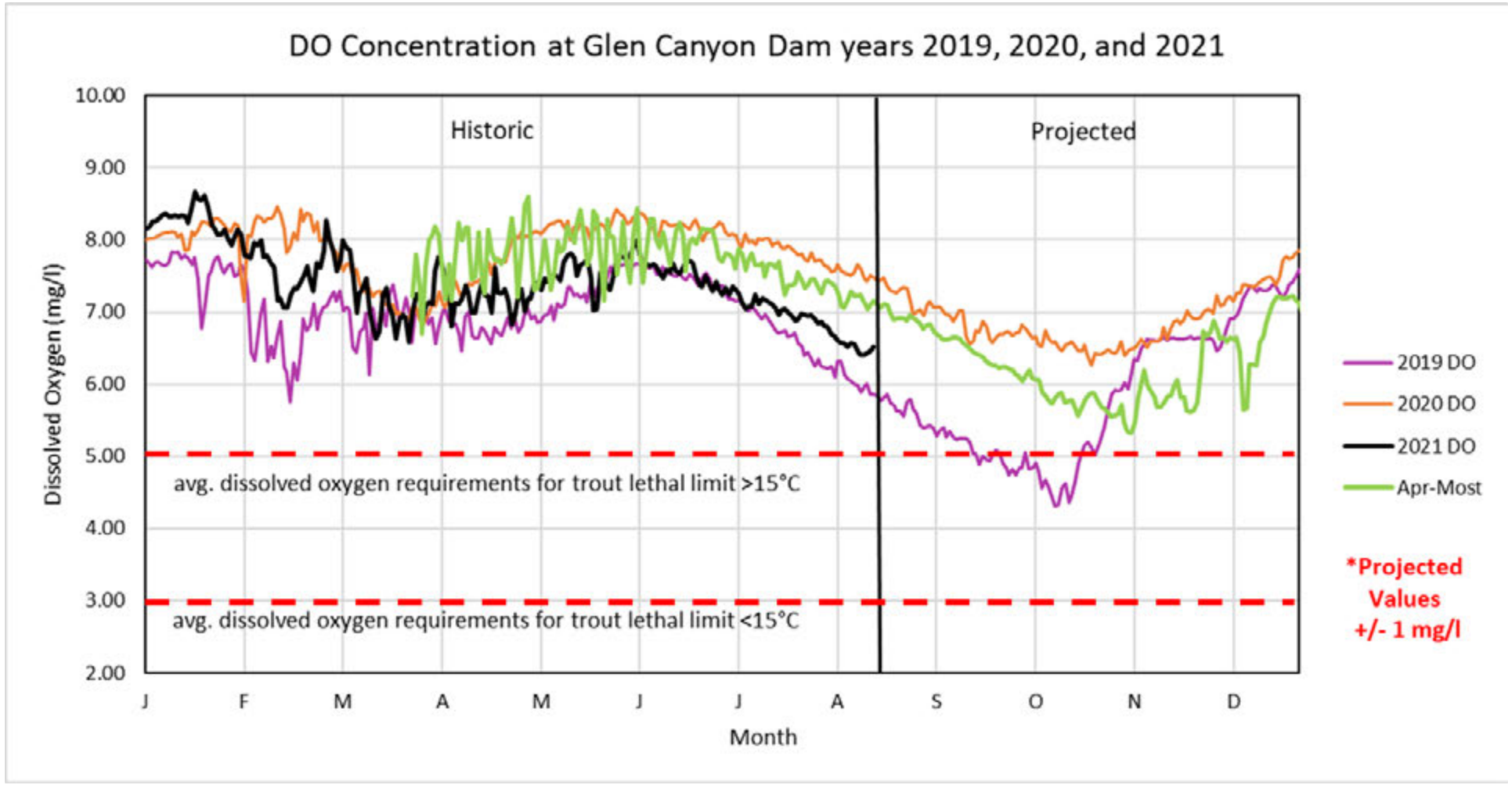


#Projection start date is based on initial conditions (March 2021)




Colorado River, Grand Canyon Water Temperatures
Projections based on August 2021, Most Probable Hydrology (Dibble 2020)
Historic
Projected
> 16 C HBC Spawn
> 12 C HBC Growth
Temperature, C
Month
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
RM 0
RM 30
RM 61
RM 87
RM 166
RM 226


Lake Powell Dissolved Oxygen June 2021
elevation, ft
3550
3500
3450
3400
3350
3300
3250
3200
Penstock
River Outlet
10
8
6
4
2
mg/L
12
11
10
9
8
7
6
5
4
3
2
1
0
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230
Km from dam


DO Concentration at Glen Canyon Dam years 2019, 2020, and 2021
Historic
Projected
Dissolved Oxygen (mg/l)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
avg. dissolved oxygen requirements for trout lethal limit >15°C
avg. dissolved oxygen requirements for trout lethal limit <15°C
J
F
M
A
M
J
J
A
S
O
N
D
Month
2019 DO
2020 DO
2021 DO
Apr-Most
*Projected Values +/- 1 mg/l

Activities / Next Steps

- Updated 5-Year Outlook of Colorado River System Conditions will be available in late August or early September
  - A website with a new visualization tool is being developed

Questions / Discussion

For more information:

https://www.usbr.gov/uc/water/

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RECLAMATION