BUREAU OF RECLAMATION

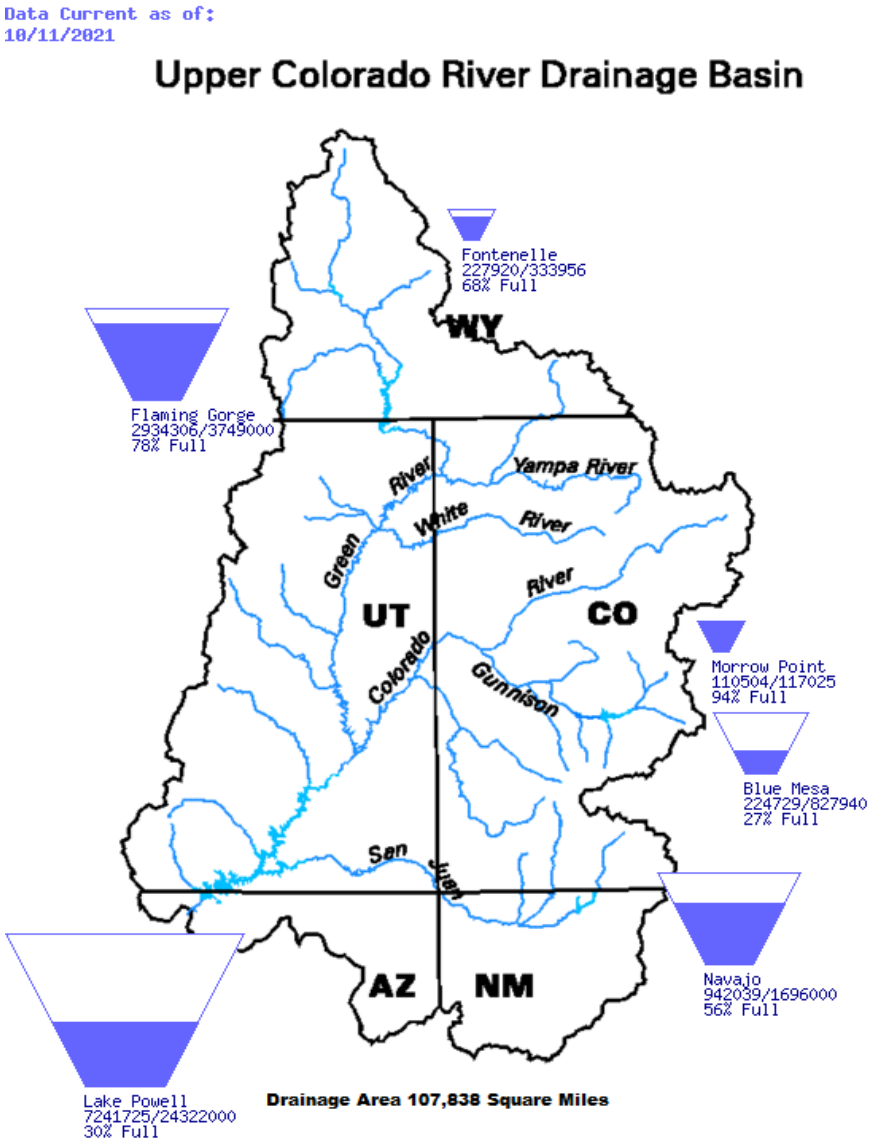
Update on Hydrology, Glen Canyon Operations and Water Quality

GCDAMP Technical Working Group

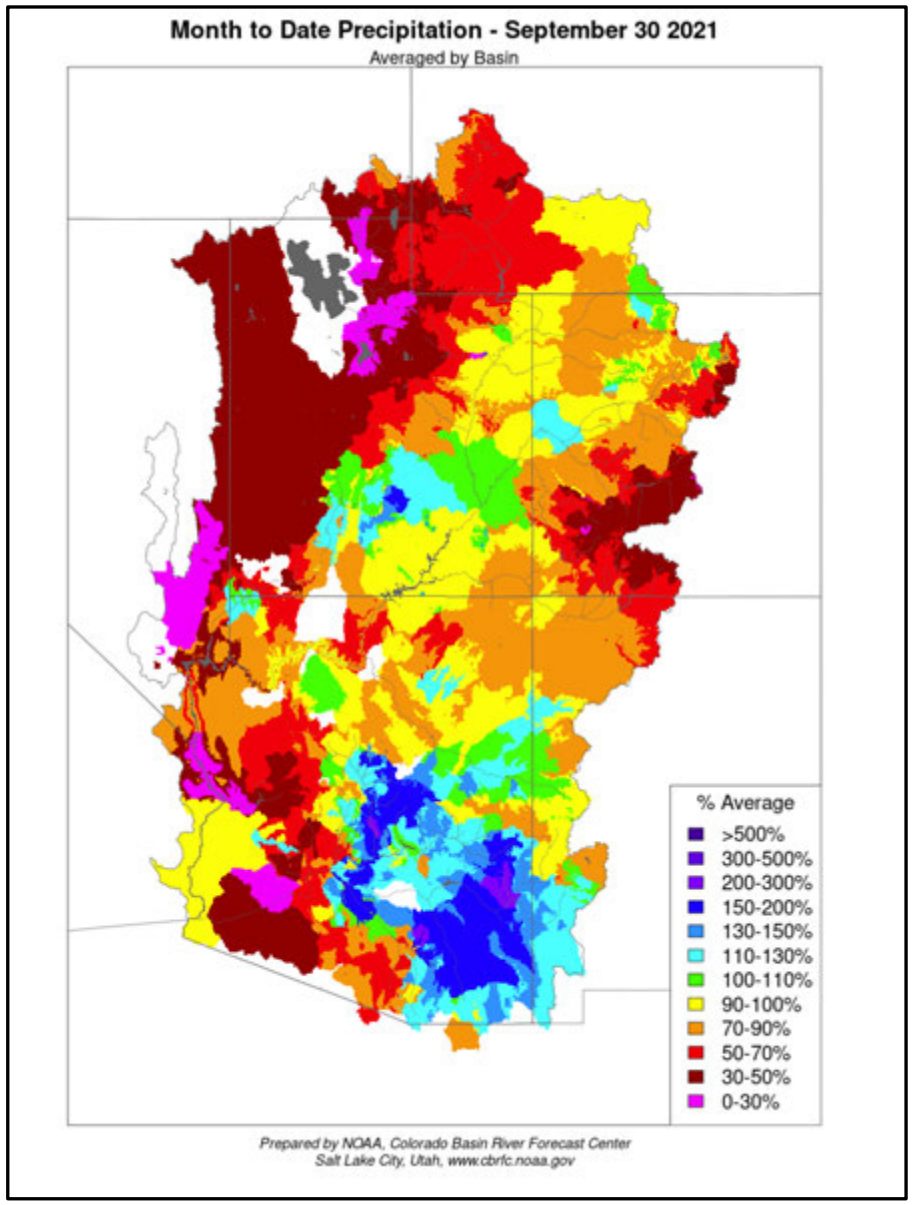
October 13, 2021

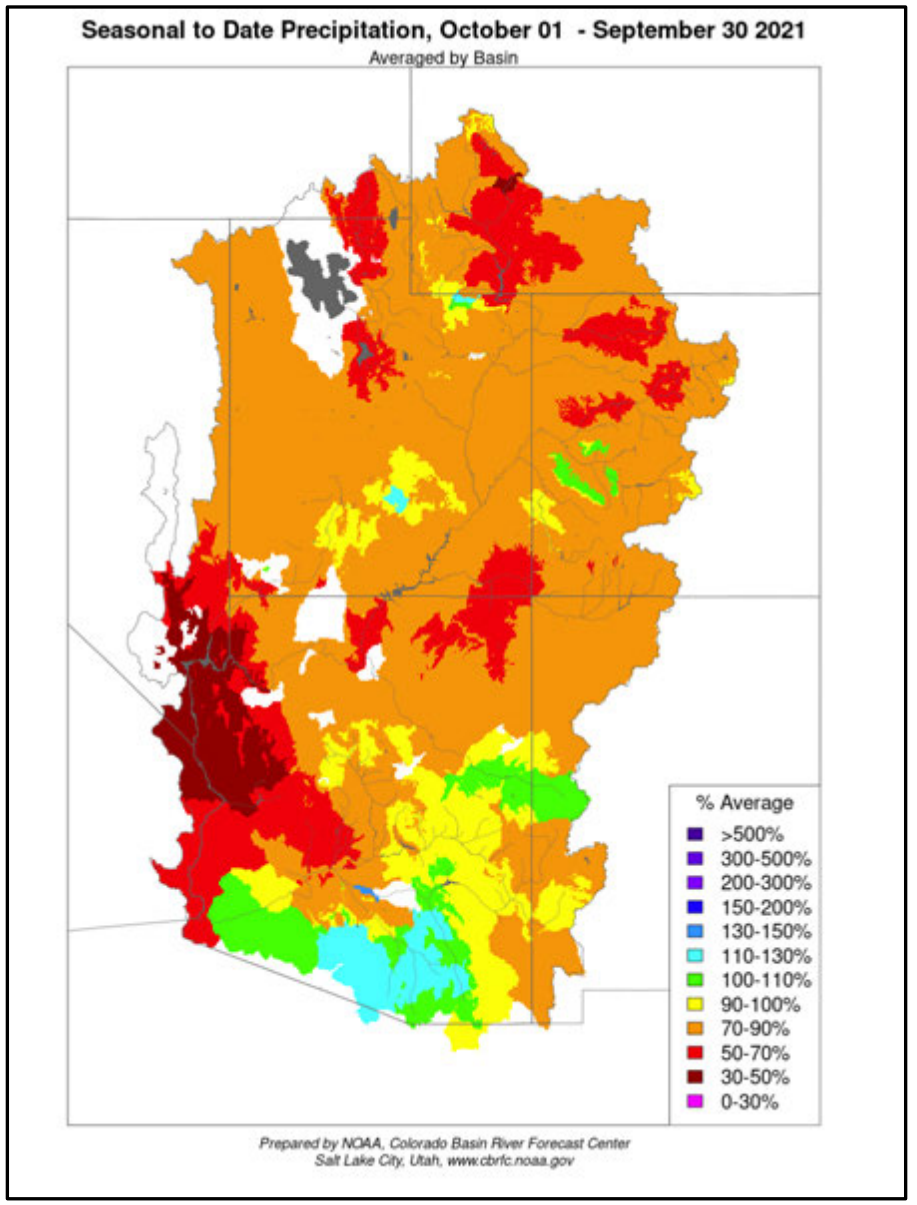
Upper Basin Storage (as of October 11, 2021)

Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	64	0.23	0.33	6,491.45
Flaming Gorge	78	2.93	3.75	6,018.71
Blue Mesa	27	0.22	0.83	7,433.06
Navajo	57	0.94	1.70	6,023.21
Lake Powell	30	7.24	24.32	3,545.13
UC System Storage	31	11.70	31.09	

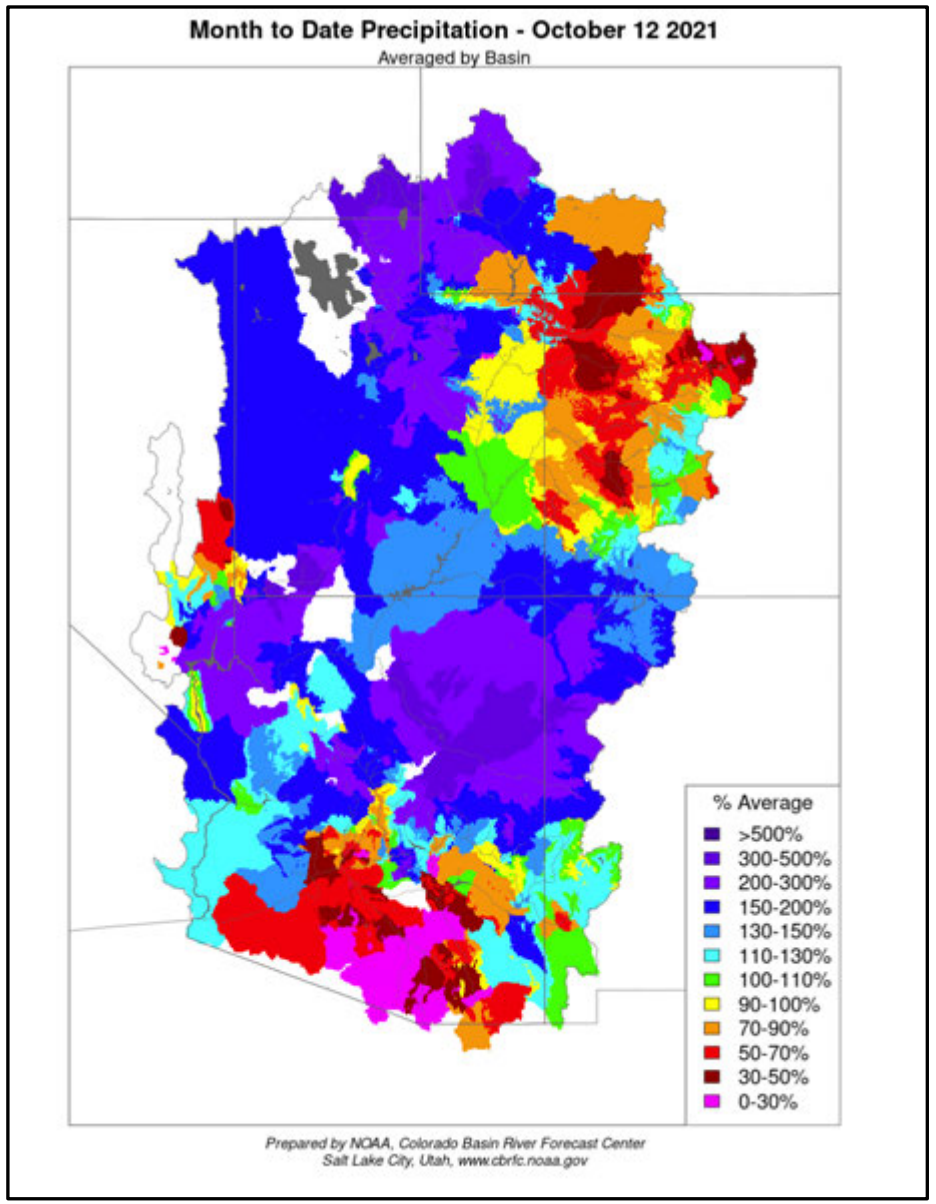


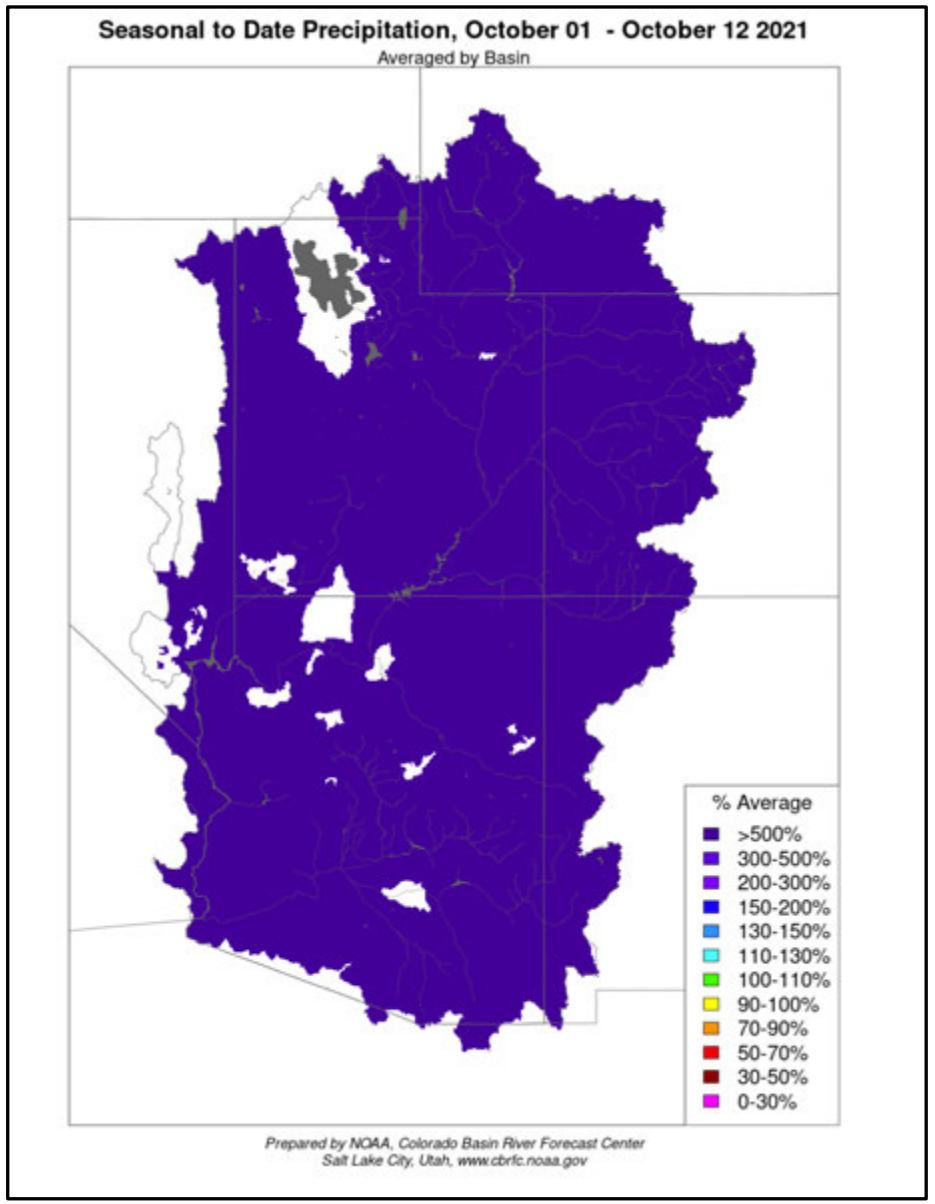
2021 Precipitation: September and Seasonal



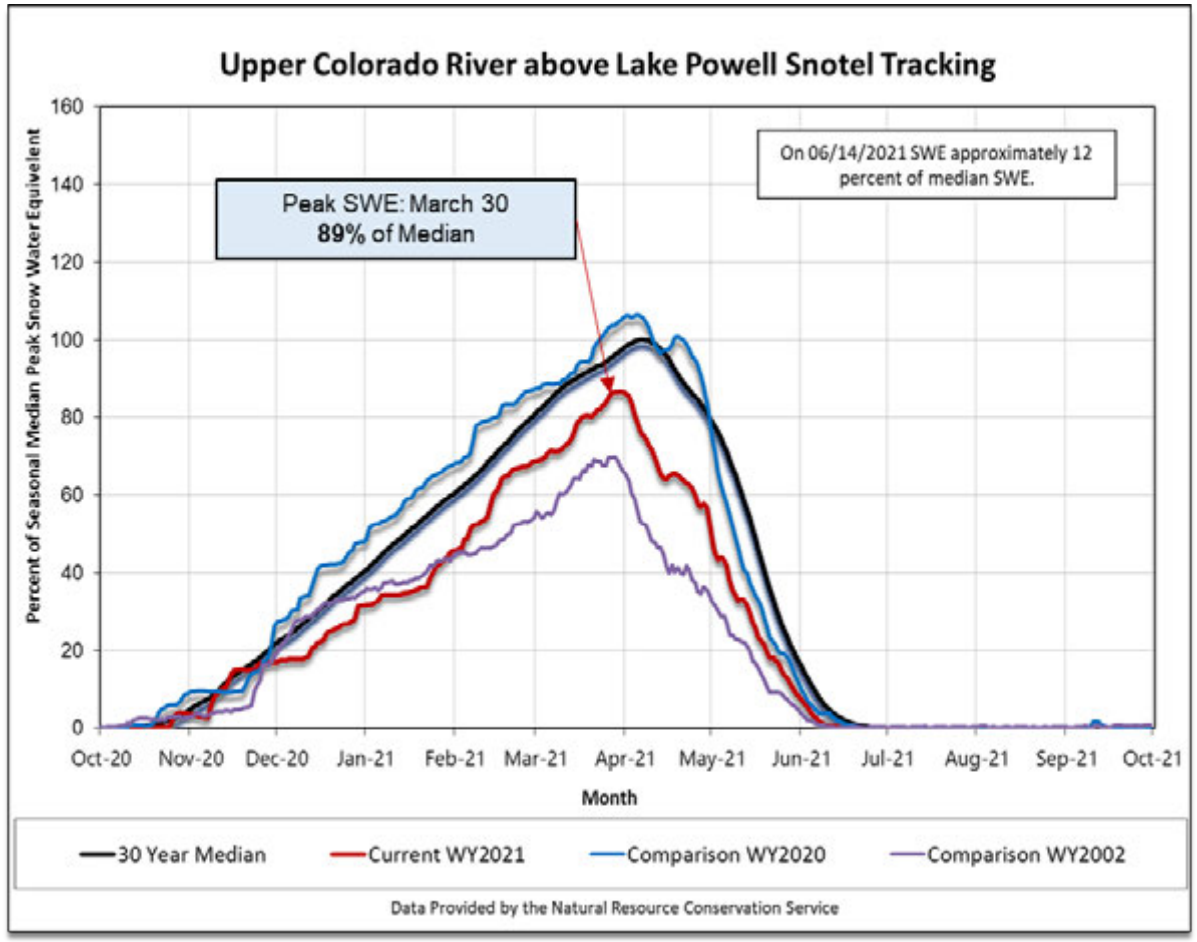


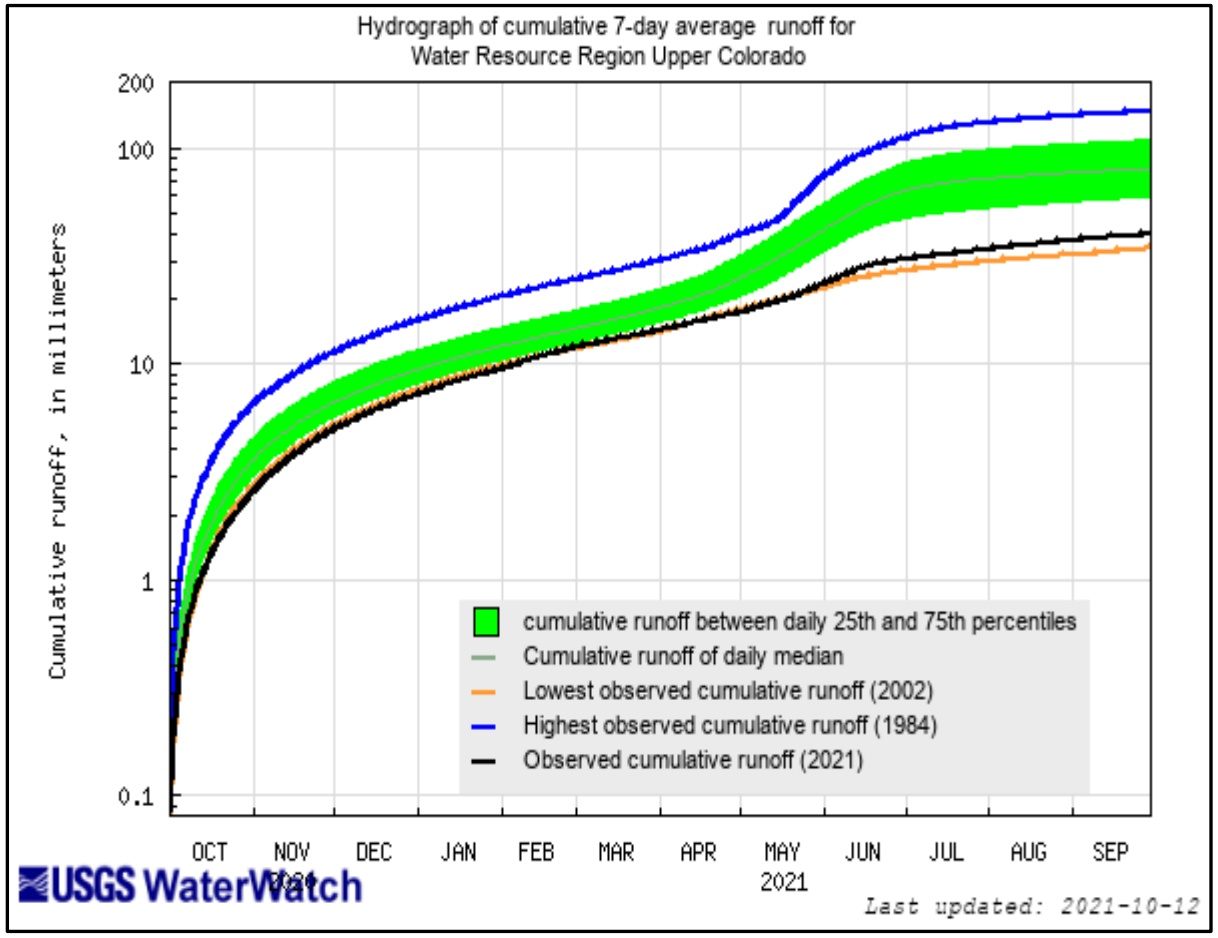
2022 Precipitation: October and Seasonal





Current SWE and Observed UC Runoff





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

October 2021 30-Year Average Shift 1991-2020

- CRSP Initial Unit facilities will continue to operate according to their Records of Decision
- Moving to the 1991-2020 statistics will provide forecasted reservoir operations that are more reflective of the dry conditions we are currently experiencing
  - The significant wet hydrology observed in the 1980s will be removed from the forecast probabilities and no longer influencing and overestimating forecasted water volumes.
  - Incorporating the last decade of record dry hydrology from 2011-2020 includes the observed higher temperatures and drier conditions that have occurred with climate change.
- Upper Green Basin least amount of change because of 2011 and 2017 wet hydrology
- San Juan has greatest shift with continued dry hydrology over last decade

	April-July Volumes				Water Year Volumes			
Reservoirs	1981-2010 April-July Avg Volume (kaf)	1991-2020 April-July Avg Volume (kaf)	April-July Volume Difference (kaf)	April-July Percent Difference	1981-2010 WY Avg Volume (kaf)	1991-2020 WY Avg Volume (kaf)	WY Volume Difference (kaf)	WY Percent Difference
Fontenelle	726	735	9	1%	1,082	1,074	(7)	-1%
Flaming Gorge	979	966	(12)	-1%	1,455	1,411	(43)	-3%
Blue Mesa	676	636	(40)	-6%	955	904	(51)	-5%
Navajo	737	628	(109)	-15%	1,075	911	(165)	-15%
Powell	7,155	6,392	(763)	-11%	10,831	9,603	(1,228)	-11%

Most Probable August Forecast
Water Year 2021

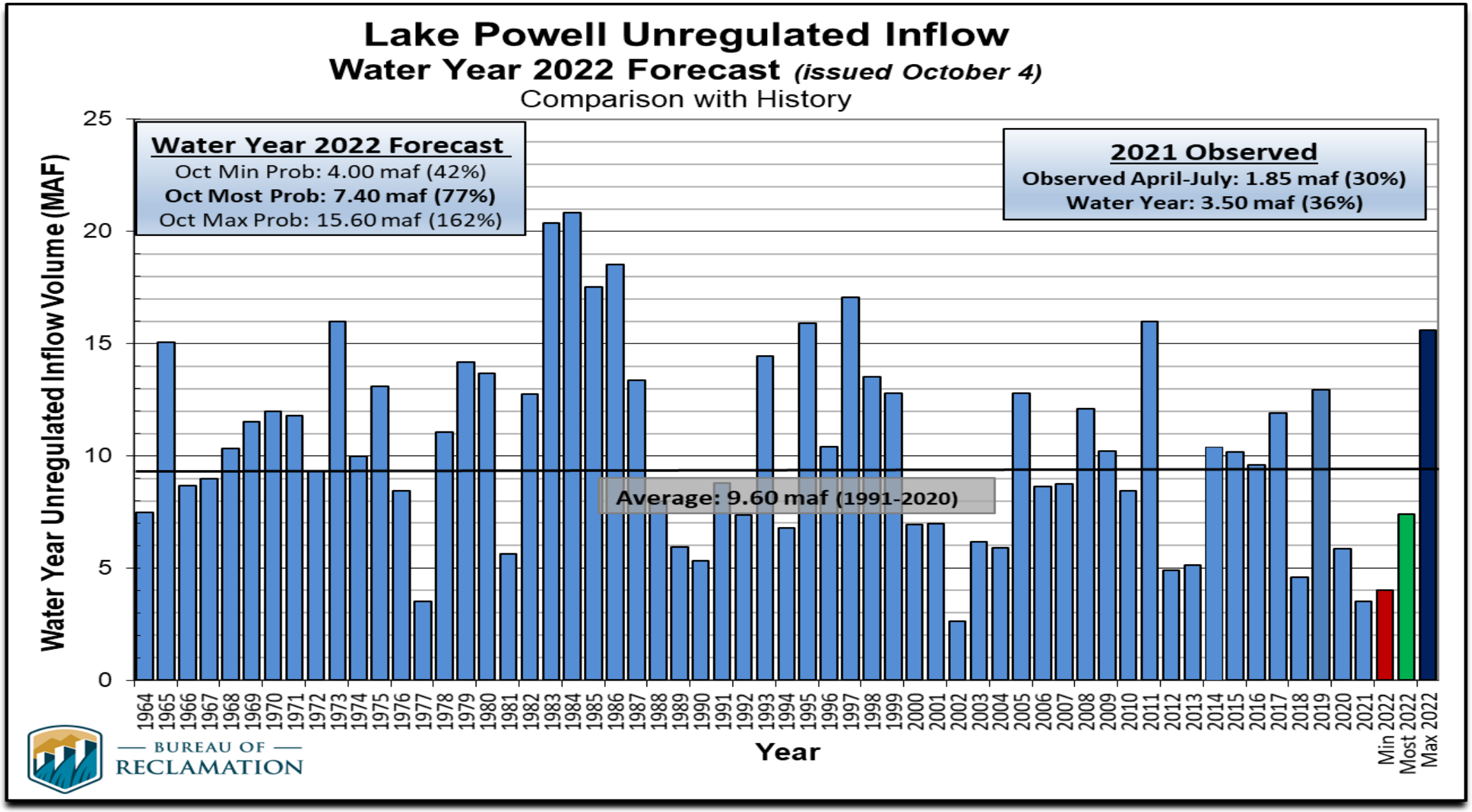
April – July 2021
Observed Unregulated Inflow
as of October 11, 2021

Reservoir	Unregulated Inflow (kaf)	1981-2010 Percent of Avg	1991-2020 Percent of Avg
Fontenelle	318	44	43
Flaming Gorge	380	39	39
Blue Mesa	317	47	50
Navajo	378	51	60
Powell	1,850	26	30

Water Year 2021
Preliminary Observed Unregulated Inflow
as of October 11, 2021

Reservoir	Unregulated Inflow (kaf)	1981-2010 Percent of Avg	1991-2020 Percent of Avg
Fontenelle	561	52	52
Flaming Gorge	650	45	46
Blue Mesa	518	54	57
Navajo	403	37	44
Powell	3,502	32	36

Lake Powell Unregulated Inflow Chart



Most Probable August Forecast Water Year 2022

April – July 2022 Forecasted Unregulated Inflow as of October 4, 2021

Reservoir	Unregulated Inflow (kaf)	1981-2010 Percent of Avg	1991-2020 Percent of Avg
Fontenelle	575	79	78
Flaming Gorge	732	75	76
Blue Mesa	550	81	86
Navajo	518	70	82
Powell	5,170	72	81

Water Year 2022 Forecasted Unregulated Inflow as of October 4, 2021

Reservoir	Unregulated Inflow (kaf)	1981-2010 Percent of Avg	1991-2020 Percent of Avg
Fontenelle	830	77	77
Flaming Gorge	1,070	74	76
Blue Mesa	760	80	84
Navajo	705	66	77
Powell	7,400	68	77

Upper Colorado Basin

Projected Operations for Water Year 2022 Based on October 2021 Modeling

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%)
- 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

Lake Powell & Lake Mead Operational Table

Operating Determinations for Water Year/Calendar Year 2022

Lake Powell

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
3,636 - 3,666 (2008-2026)		15.5 - 19.3 (2008-2026)
	Upper Elevation Balancing Tier[3] Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	
3,575		9.5
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	
	3,535.40 ft Jan 1, 2022 Projection	
3,525		5.9
	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf	
3,490		4.0
3,370		0

Lake Mead

Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf)[1]
1,220	**Flood Control Surplus or Quantified Surplus Condition** Deliver > 7.5 maf	25.9
1,200 (approx.)[2]		22.9 (approx.)[2]
	Domestic Surplus or ICS Surplus Condition Deliver > 7.5 maf	
1,145		15.9
	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	
1,105		11.9
1,075	***1,065.85 ft Jan 1, 2022 Projection***	9.4
	Shortage Condition Deliver 7.167[4] maf	
1,050		7.5
	Shortage Condition Deliver 7.083[5] maf	
1,025		5.8
	Shortage Condition Deliver 7.0[6] maf Further measures may be undertaken[7]	
1,000		4.3
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

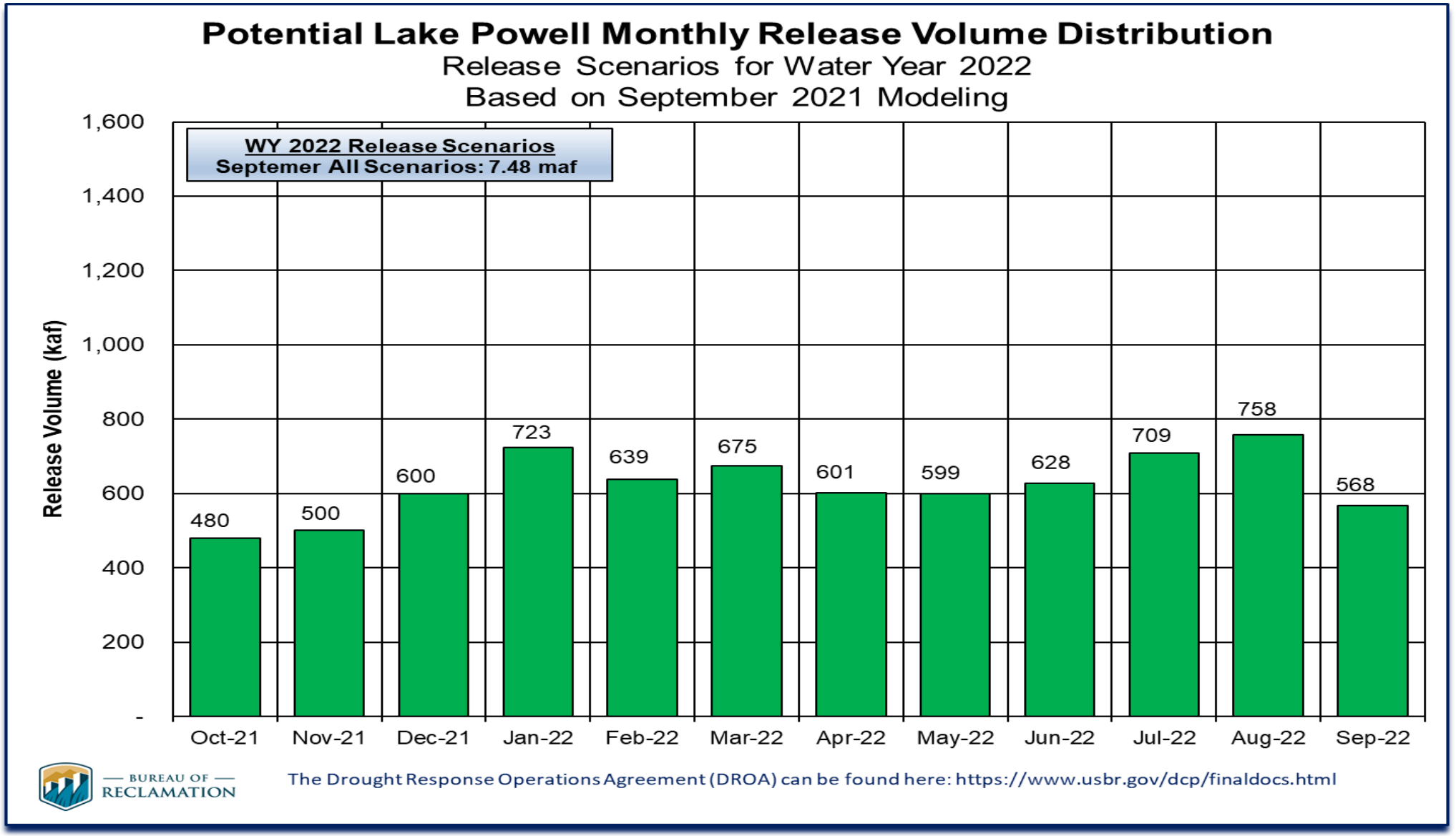
[5] Of which 2.40 maf is apportioned to Arizona, 4.4 maf to California, and 0.283 maf to Nevada

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

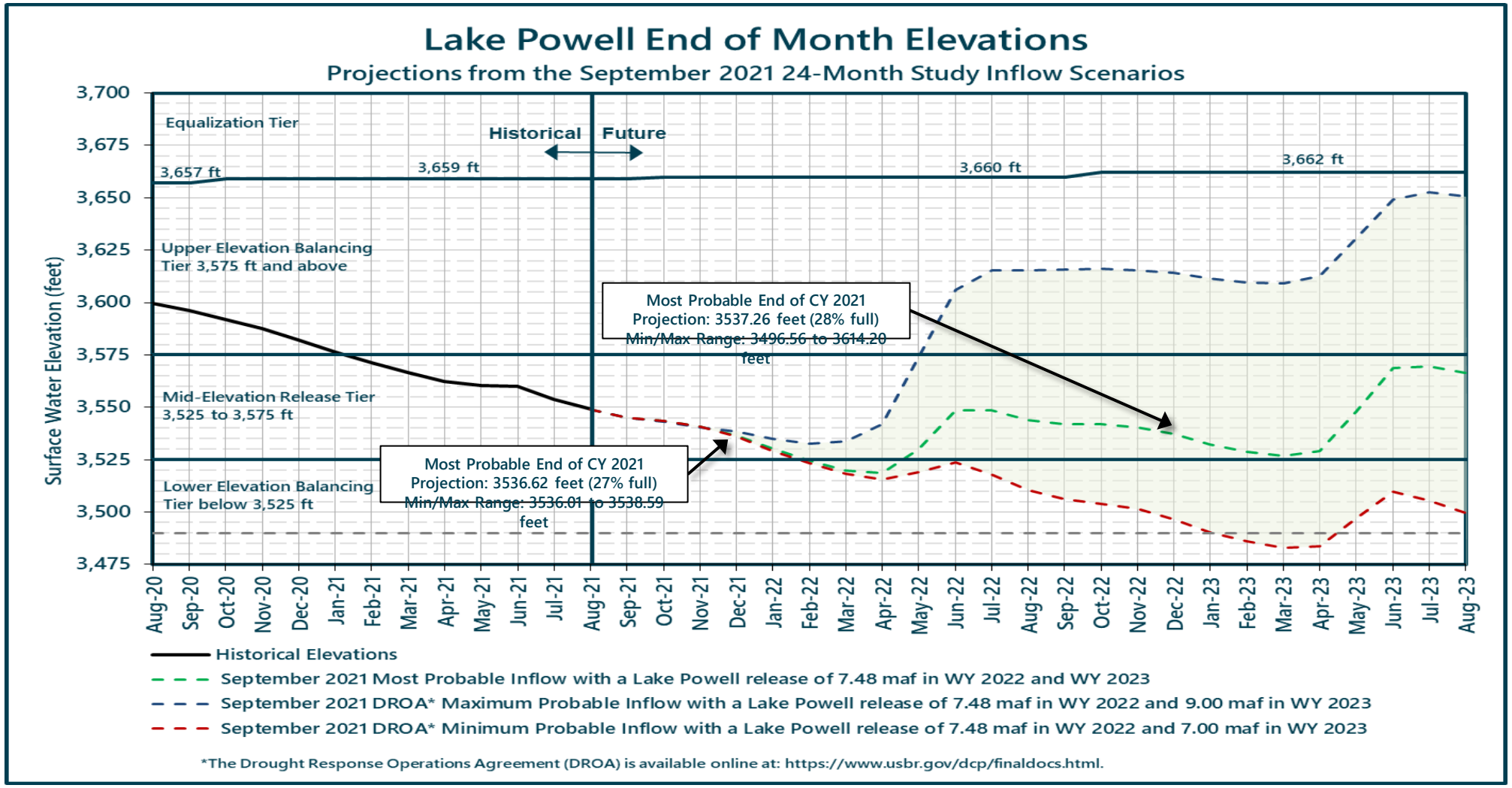
[7] Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Division States and Mexico is likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation with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

[1] Lake Powell and Lake Mead operating determinations are based on August 2021 24-Month Study projections consistent with the 2007 Interim Guidelines and 2019 Drought Contingency Plans. These determinations will be documented in the 2022 Annual Operating Plan for Colorado River Reservoirs.

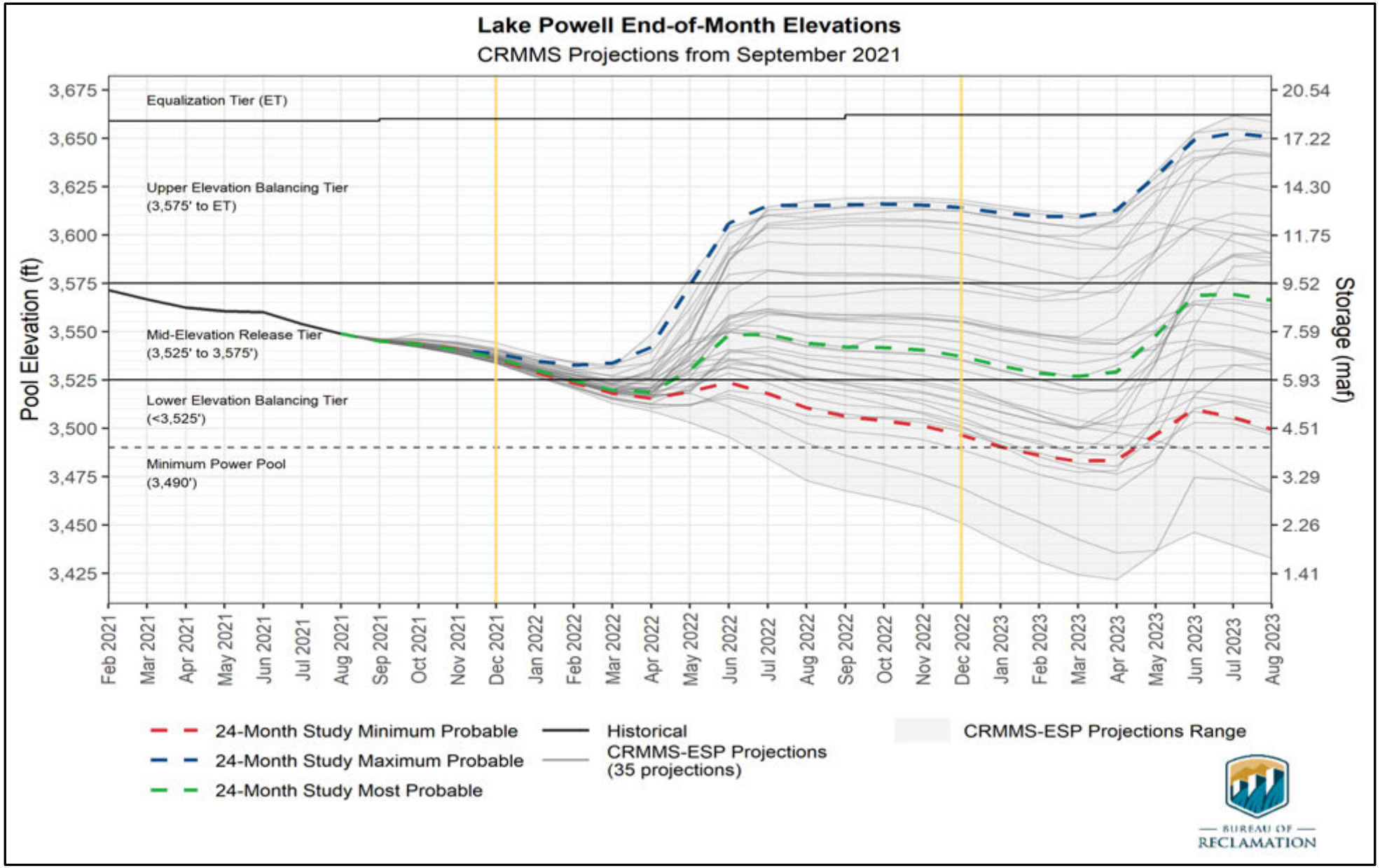
Potential Lake Powell Monthly Release Distribution for Water Year 2022



Lake Powell End of Month Elevations Chart



Lake Powell Probabilistic End of Month Elevations Chart



Lake Mead water shortages

2007 Interim Guidelines, Minute 323, Lower Basin Drought Contingency Plan, and Binational Water Scarcity Contingency Plan
Total Volumes (kaf)

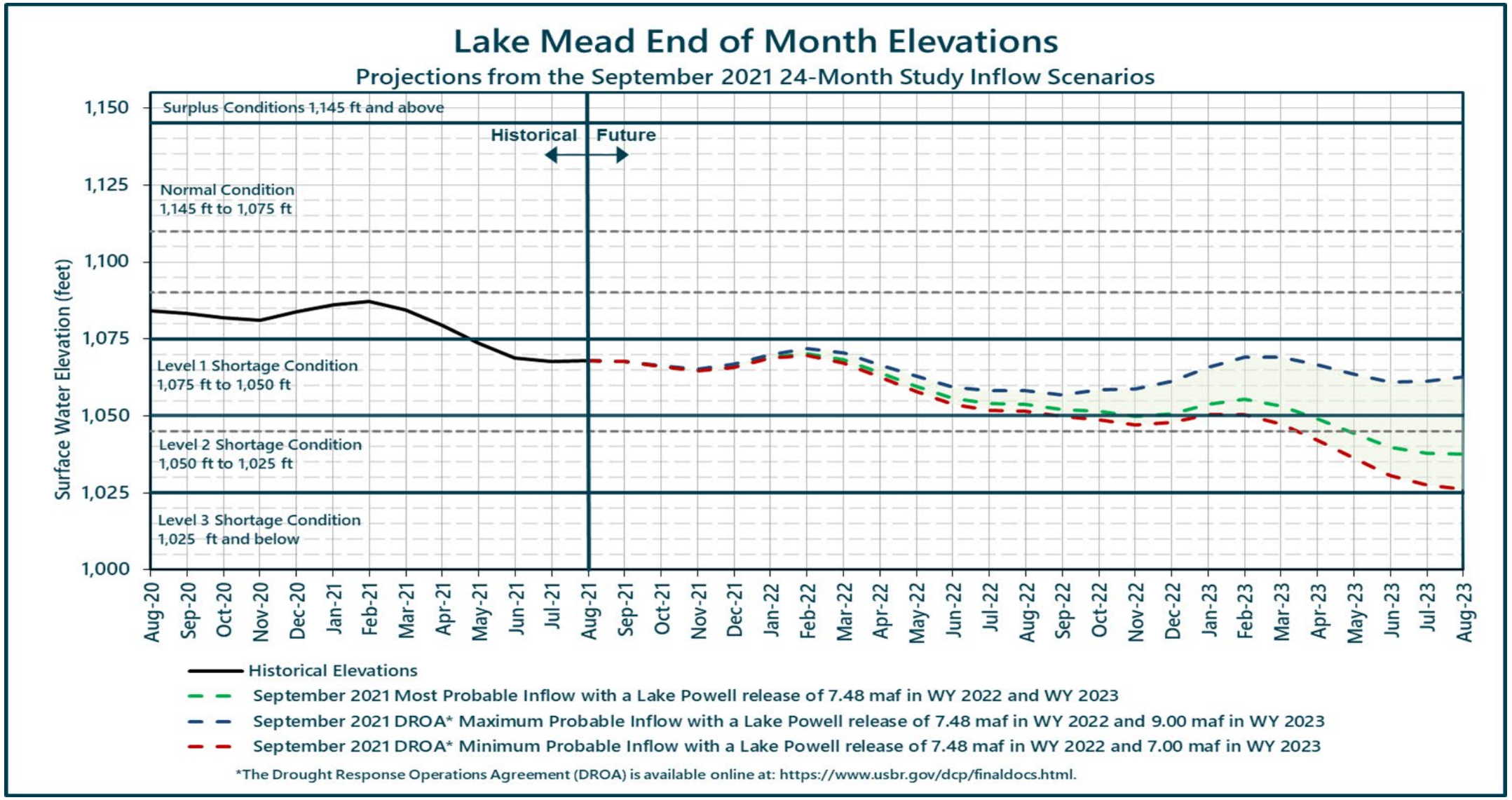
Lake Mead Elevation (feet msl)	2007 Interim Guidelines Shortages		Minute 323 Delivery Reductions	Total Combined Reductions	DCP Water Savings Contributions			Binational Water Scarcity Contingency Plan Savings	Combined Volumes by Country *US: (2007 Interim Guidelines Shortages + DCP Contributions)* *Mexico: (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

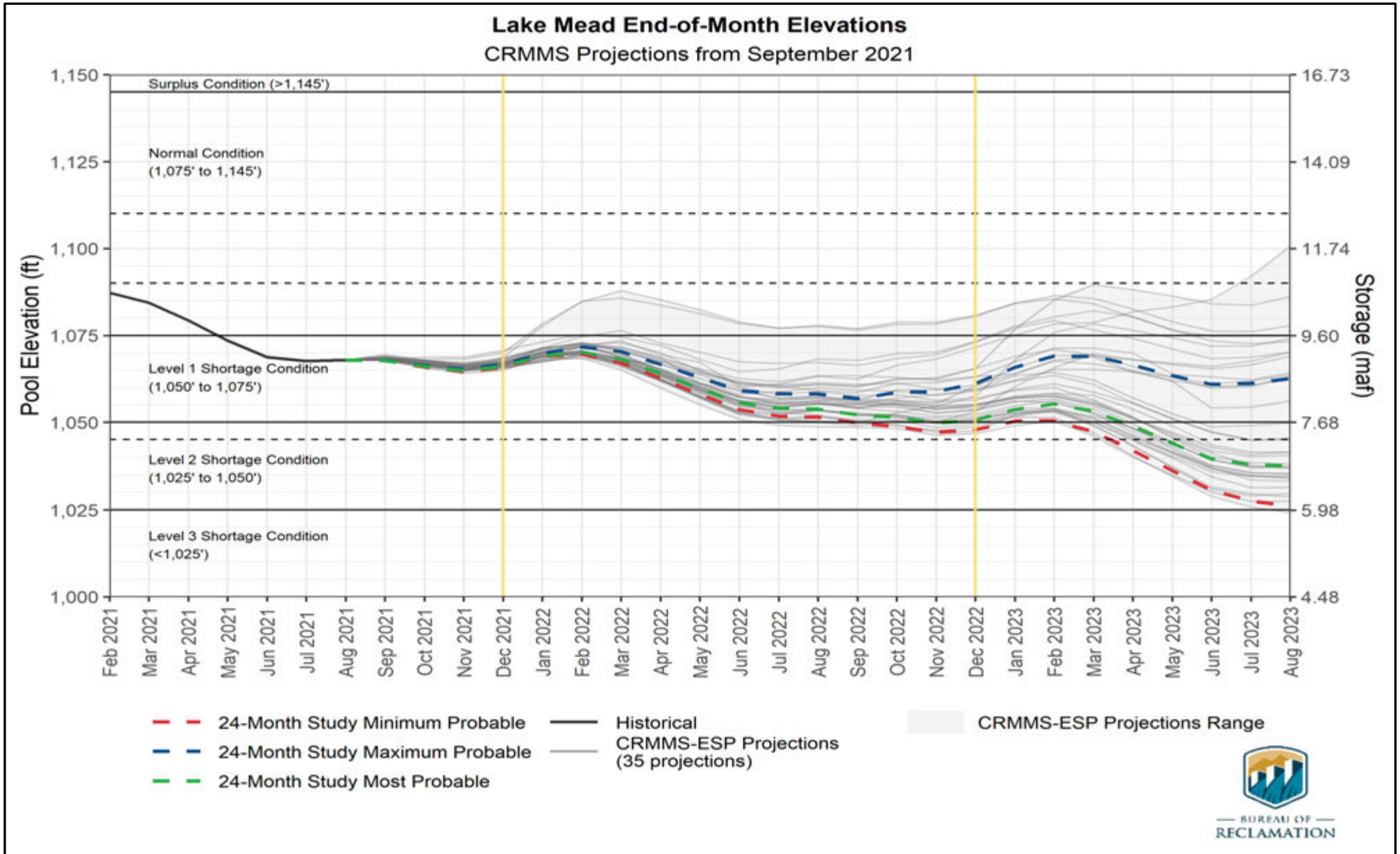
2022 Reductions + Contributions

The Secretary of the Interior will take affirmative actions to implement programs designed to create or conserve 100,000 acre-ft per annum or 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



Lake Mead Probabilistic End of Month Elevations Chart



Upper Colorado Basin

Hydropower Maintenance

Glen Canyon Dam Power Plant Unit Outage Schedule for 2021

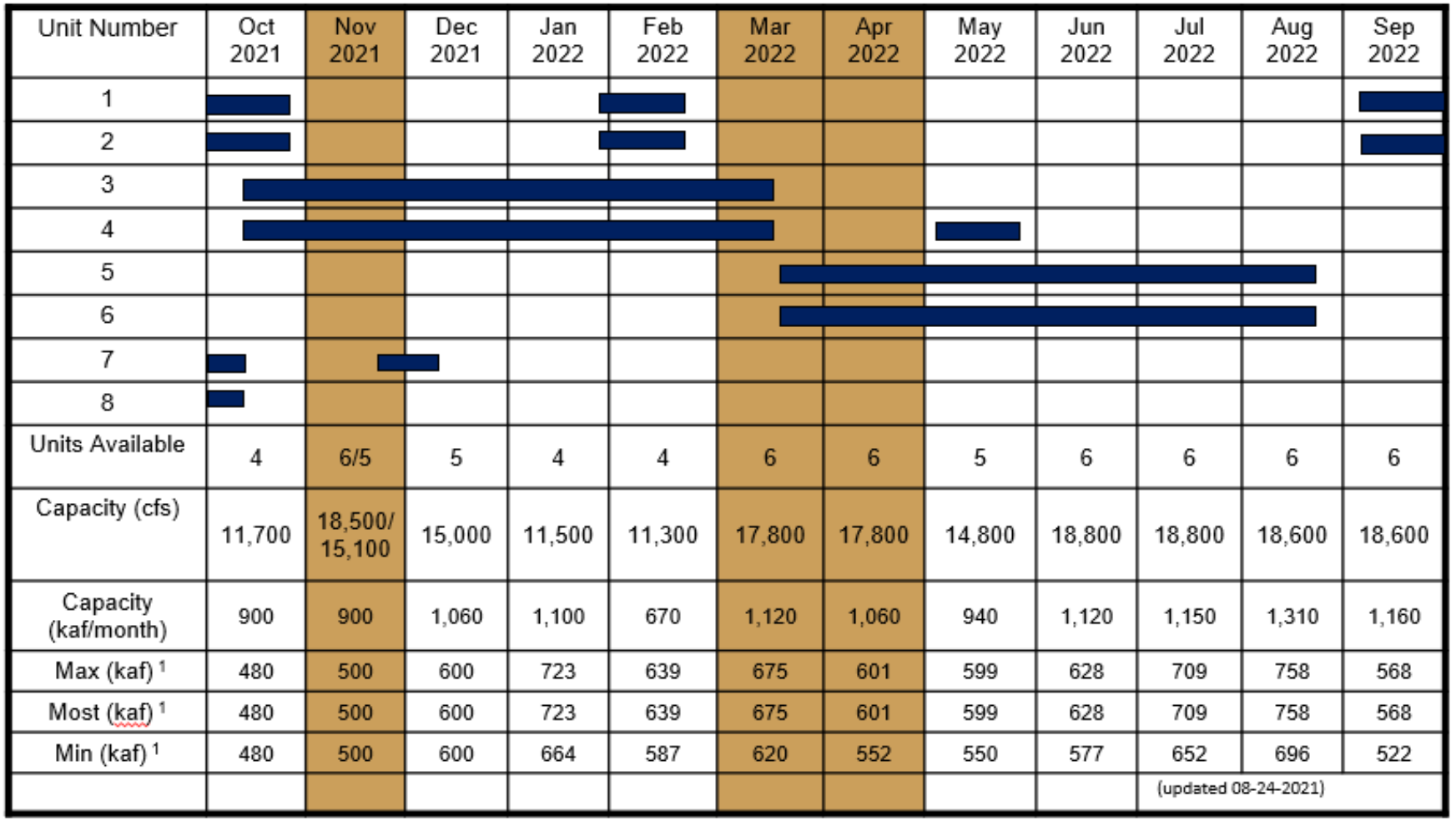
Unit Number	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	5	5/4	6	6	6	6/4	4	5	6	6	6	4	
Capacity (cfs)	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

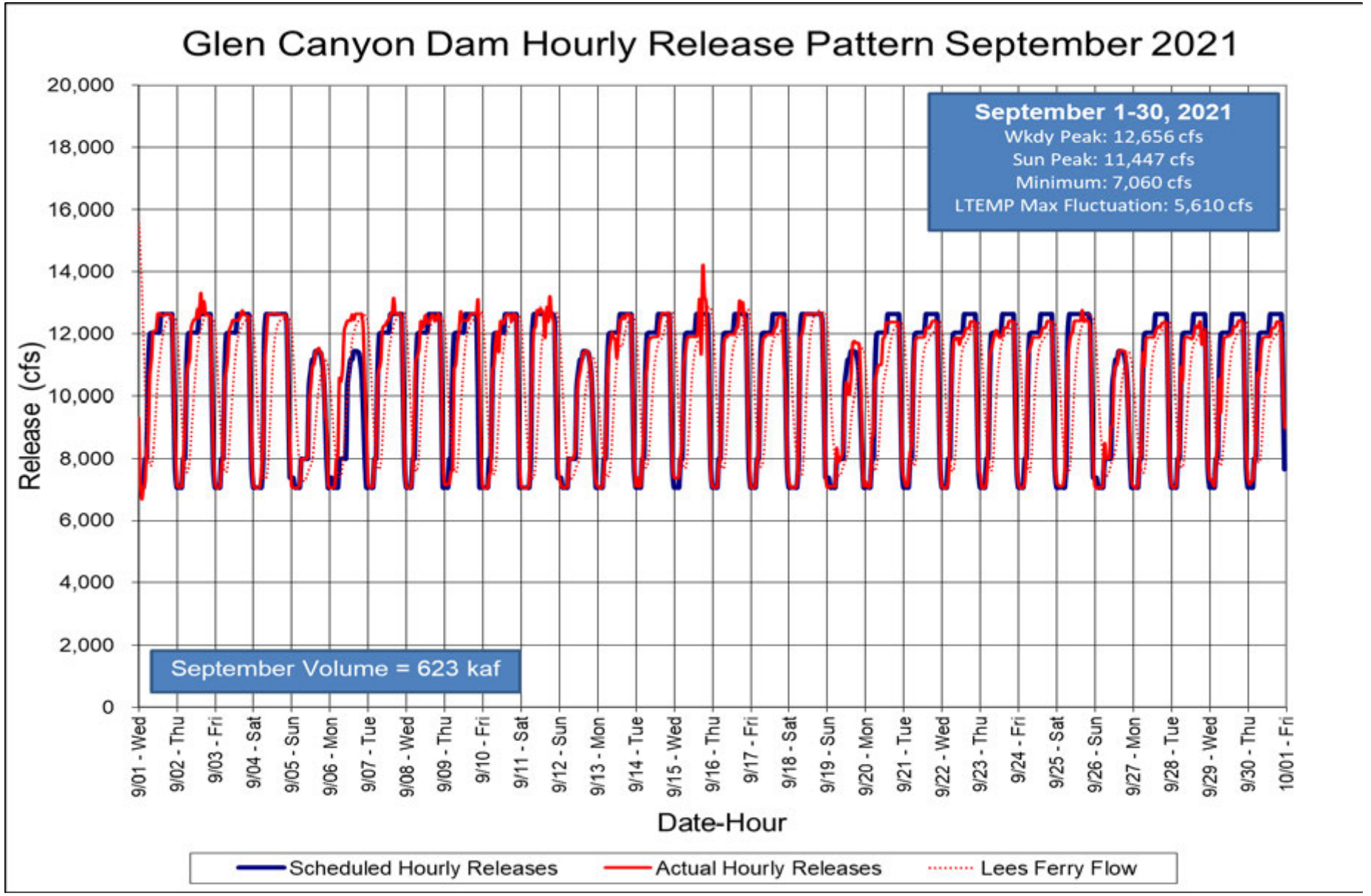


Unit Number	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022	Jul 2022	Aug 2022	Sep 2022	
Units Available	4	6/5	5	4	4	6	6	5	6	6	6	6	
Capacity (cfs)	11,700	18,500/ 15,100	15,000	11,500	11,300	17,800	17,800	14,800	18,800	18,800	18,600	18,600	AUG MOST[2]
Capacity (kaf/month)	900	900	1,060	1,100	670	1,120	1,060	940	1,120	1,150	1,310	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 08-24-2021)			

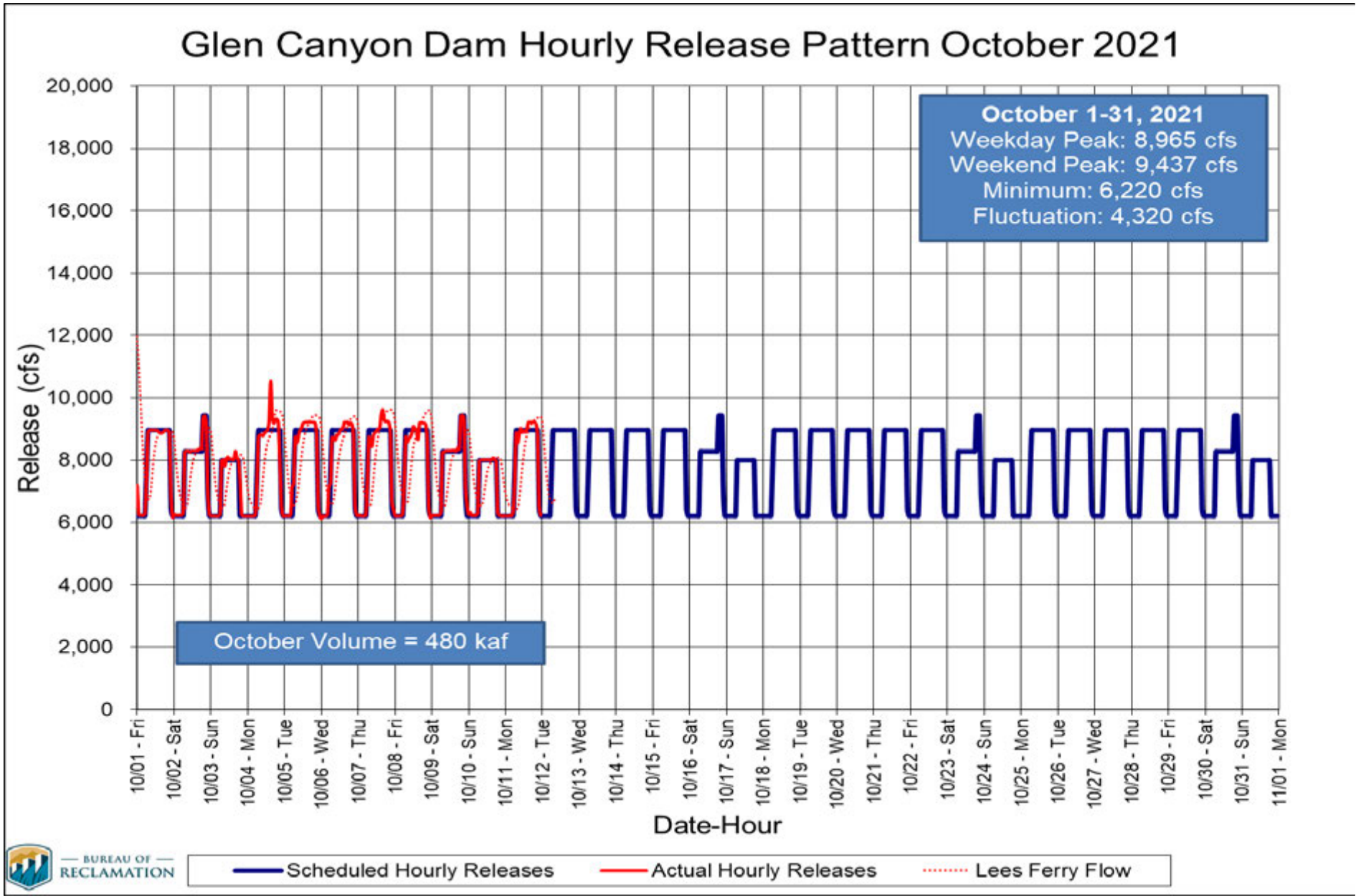
1 Projected release, based on August 2021 minimum, most and maximum probable inflow projections and 24-Month Study model runs.

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

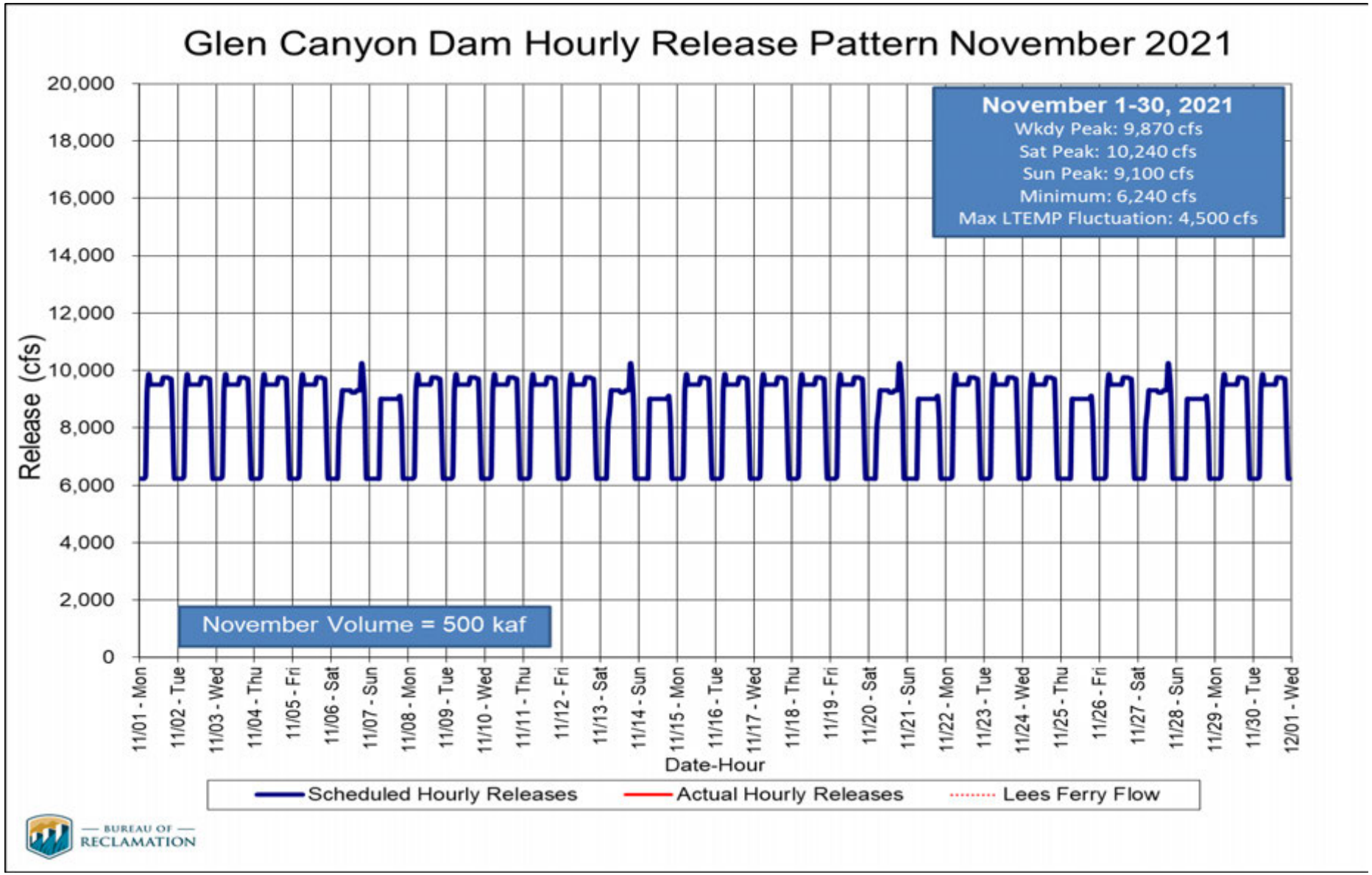
Glen Canyon Dam Hourly Release Pattern September 2021



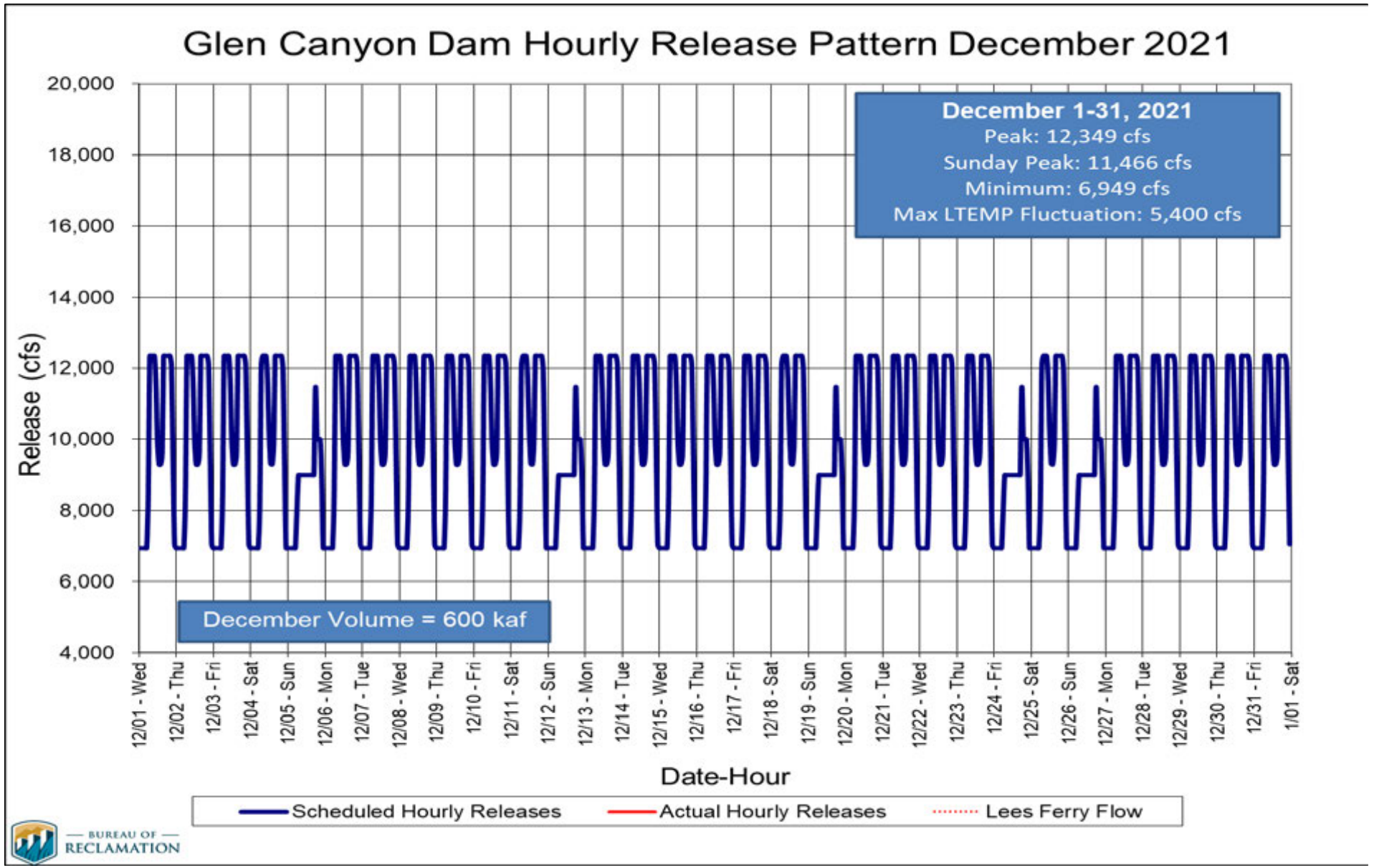
Glen Canyon Dam Hourly Release Pattern October 2021



Glen Canyon Dam Hourly Release Pattern November 2021

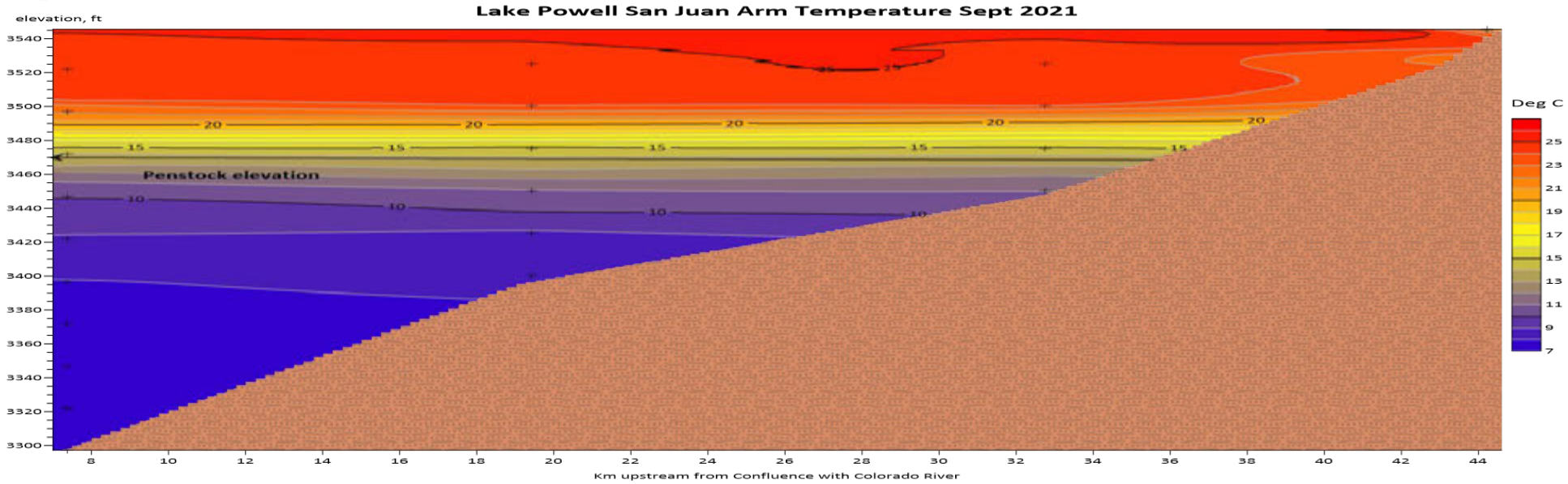


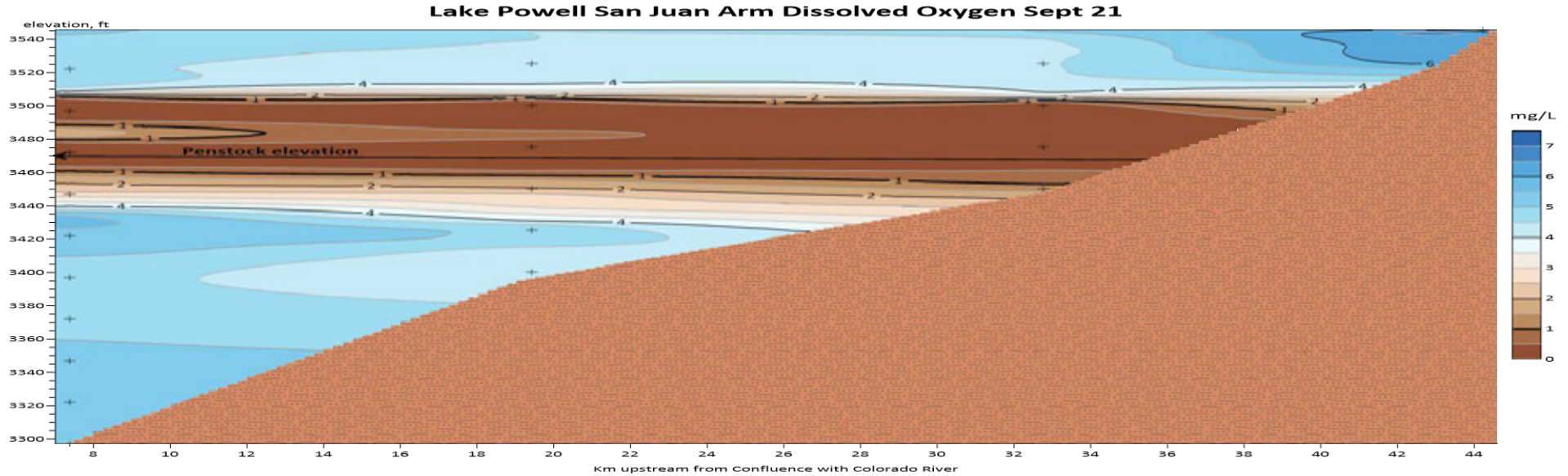
Glen Canyon Dam Hourly Release Pattern December 2021



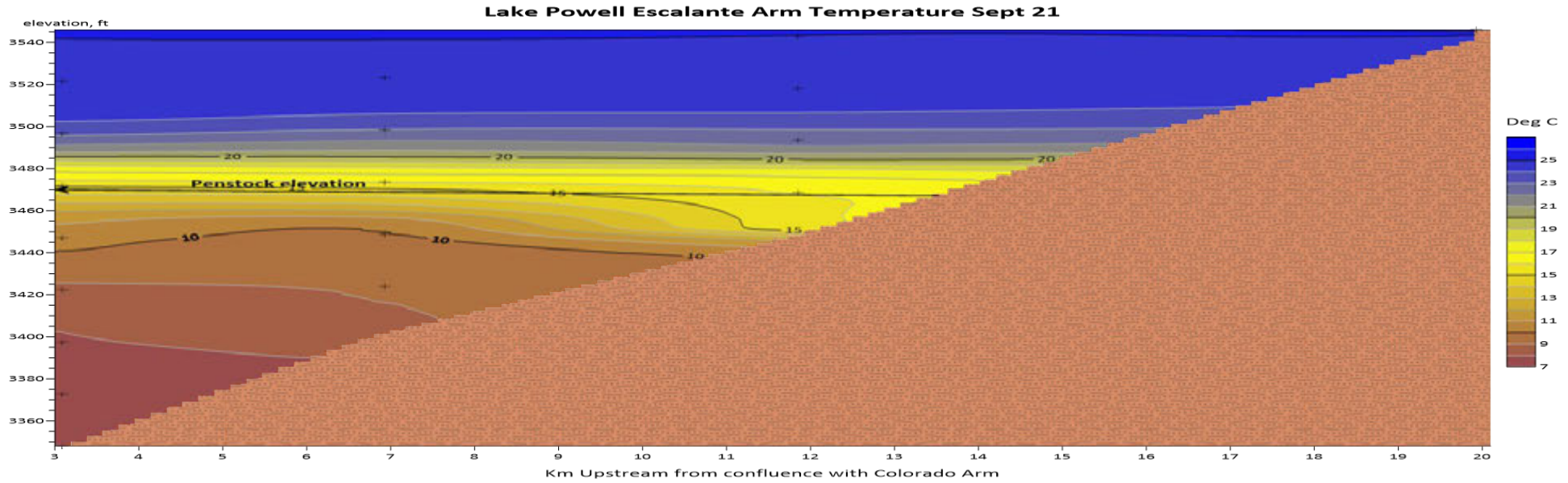
Water Quality

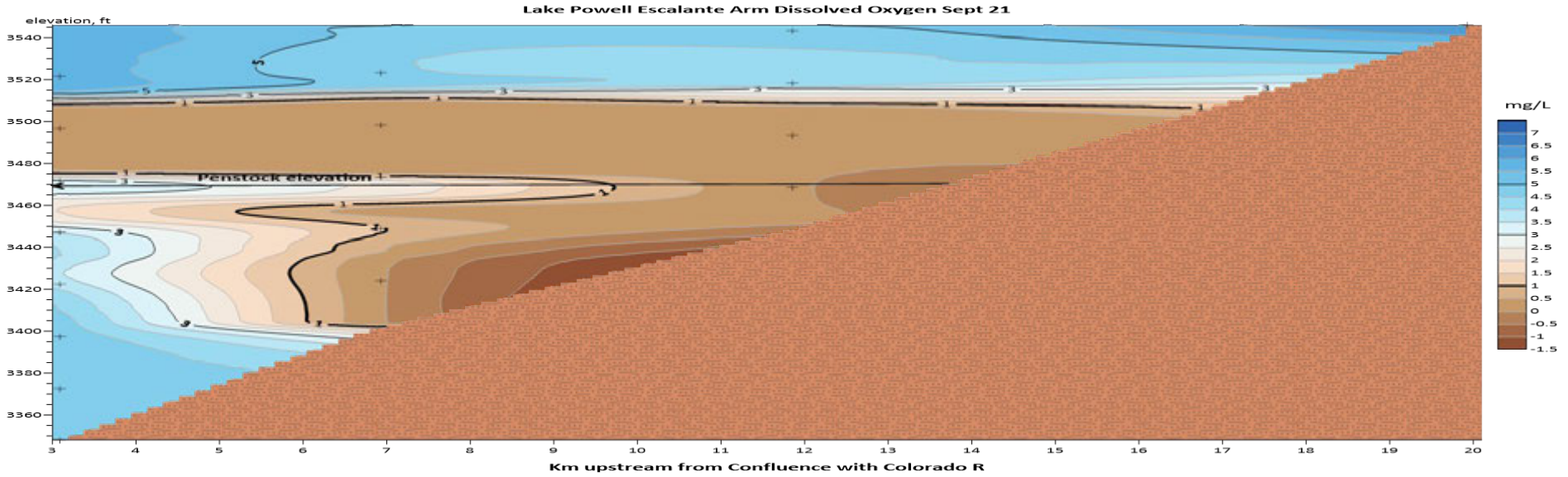
Water quality profiles of the San Juan Arm, temperature and DO Sept. 2021



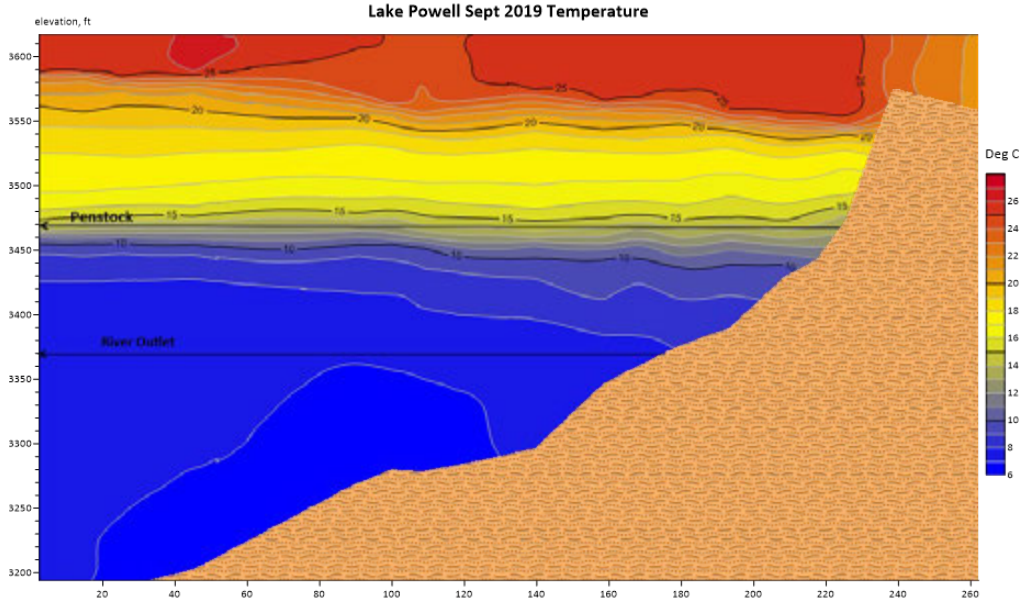


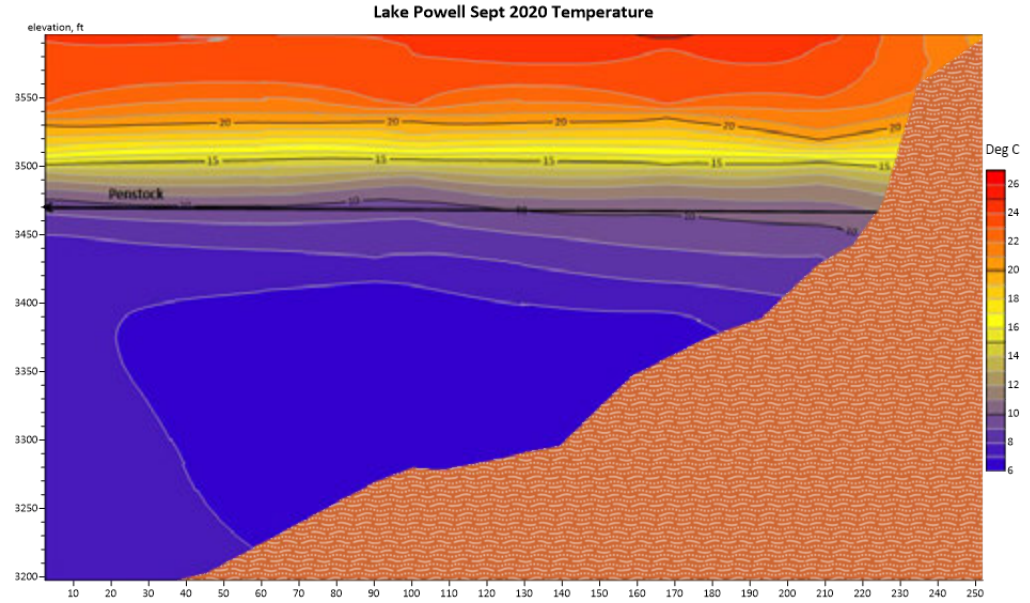
Water quality profiles of the Escalante Arm temperature and DO Sept. 2021

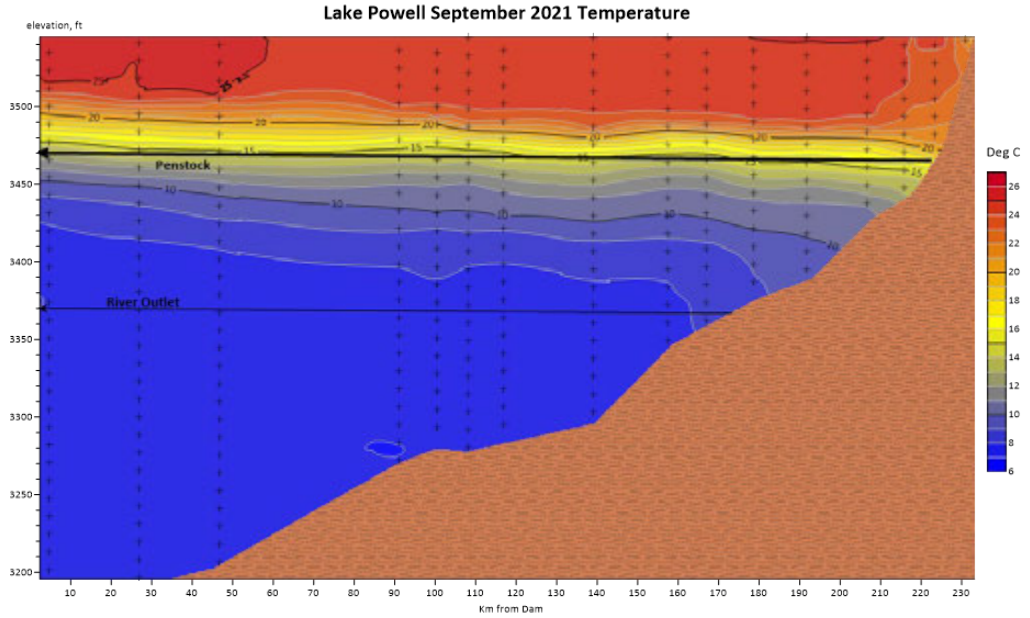




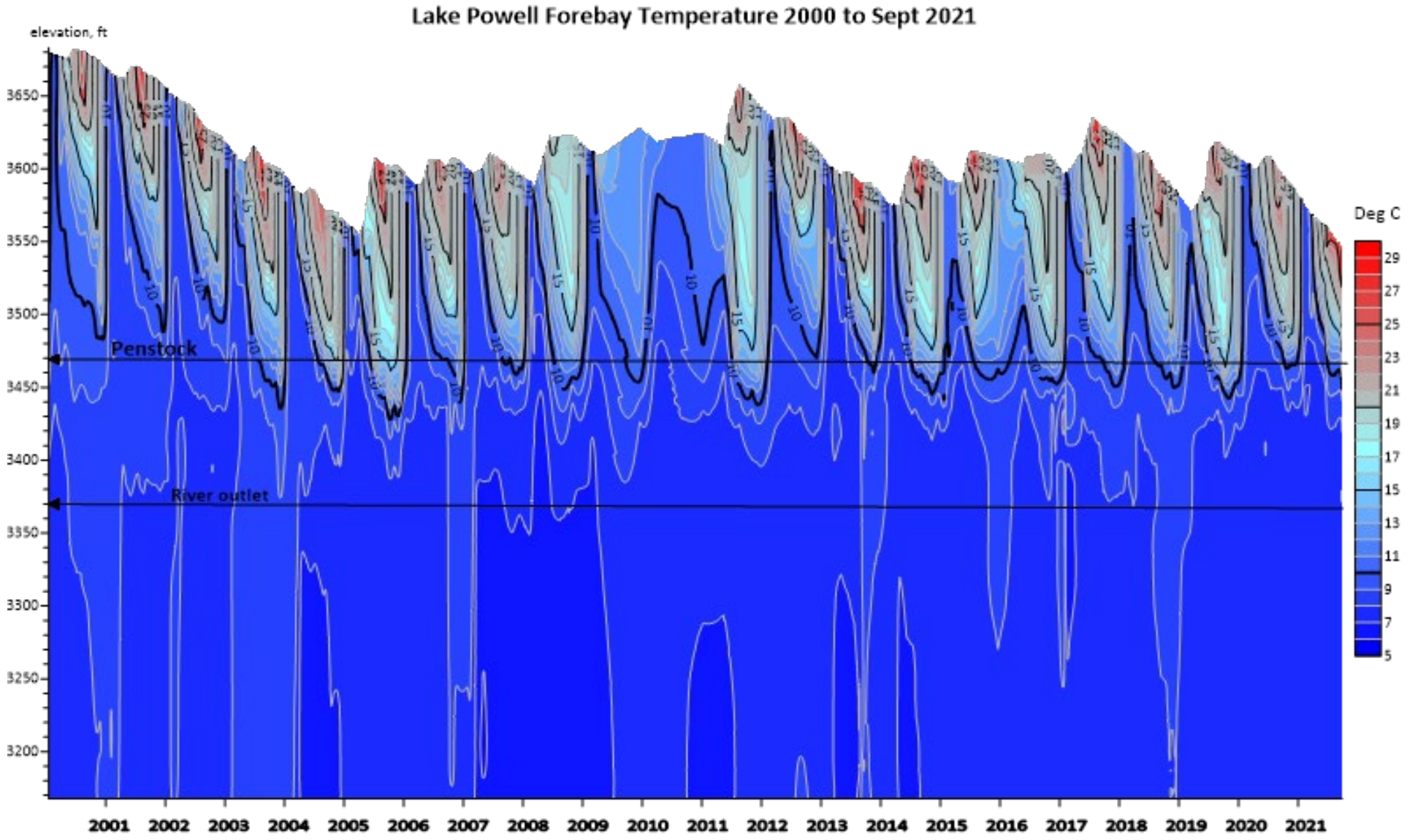
Lake Powell temperature profiles by year in Sept. 2019-2021



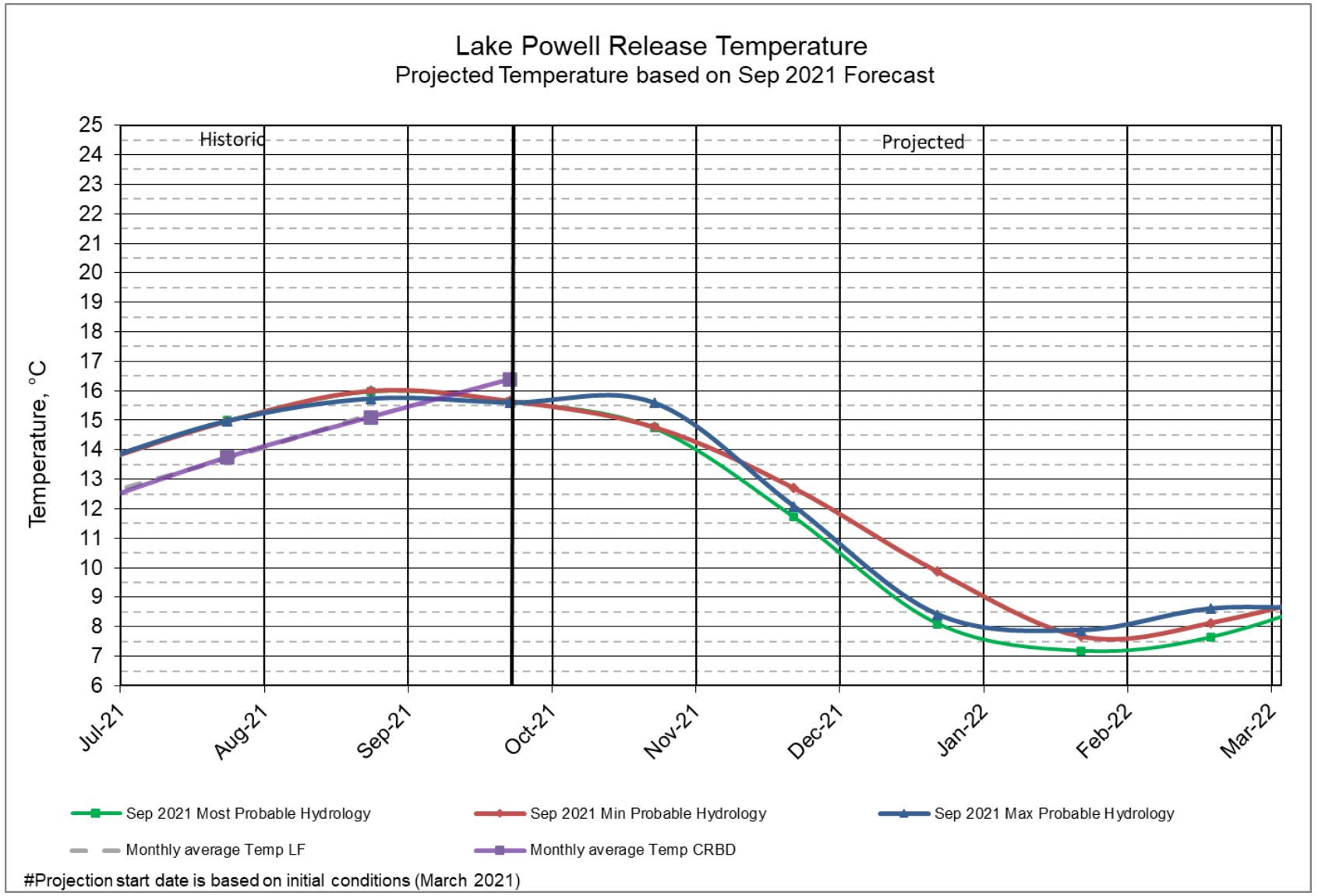




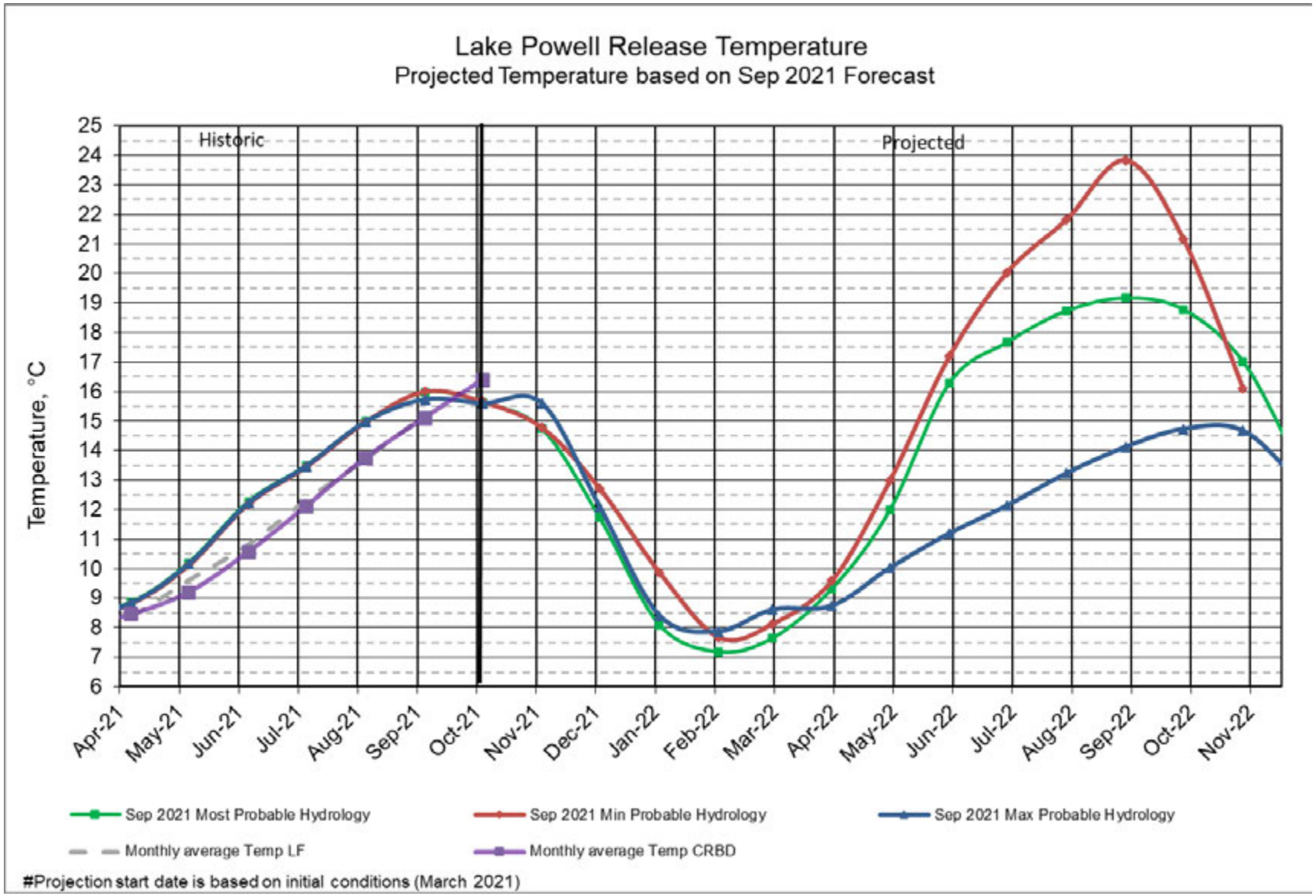
Lake Powell forebay temperature profiles and elevations from 2000 to 2021.



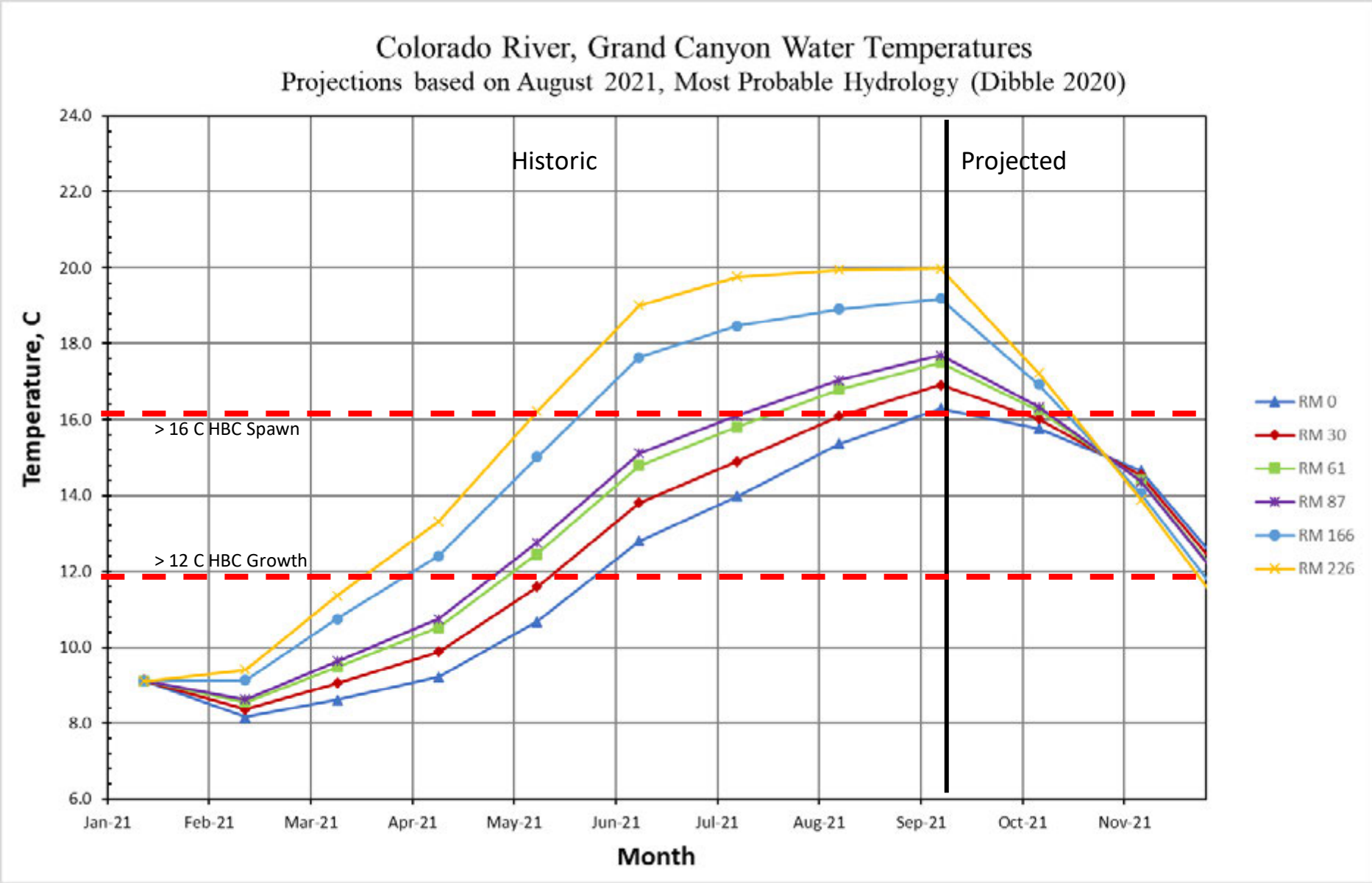
Lake Powell projected temperature releases @ 6 months



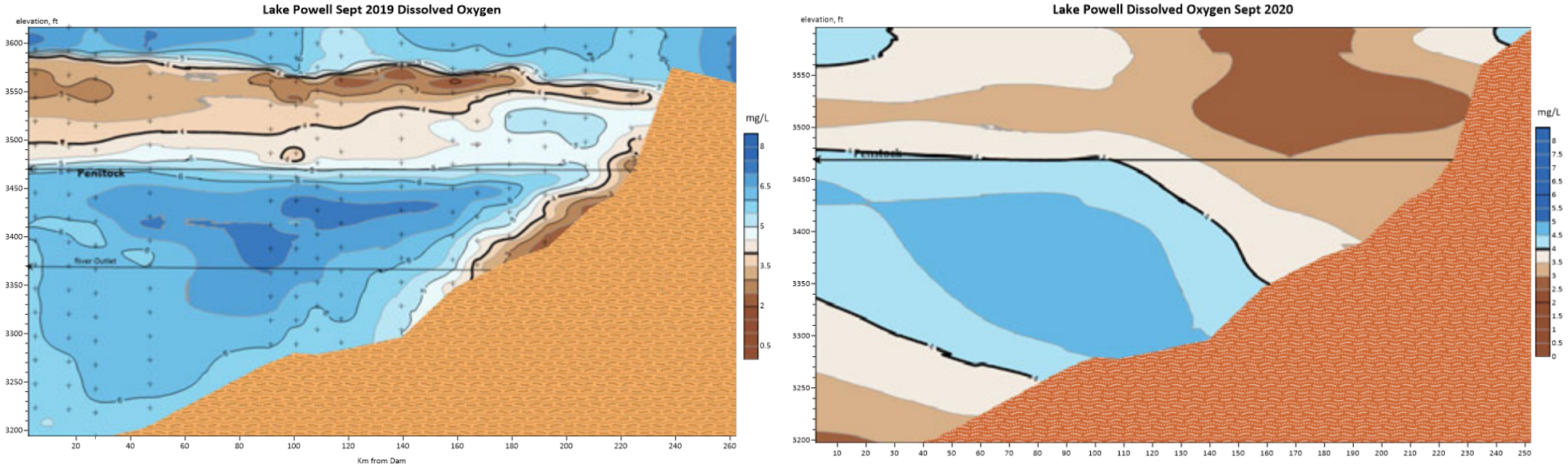
Lake Powell projected temperature releases @12 months



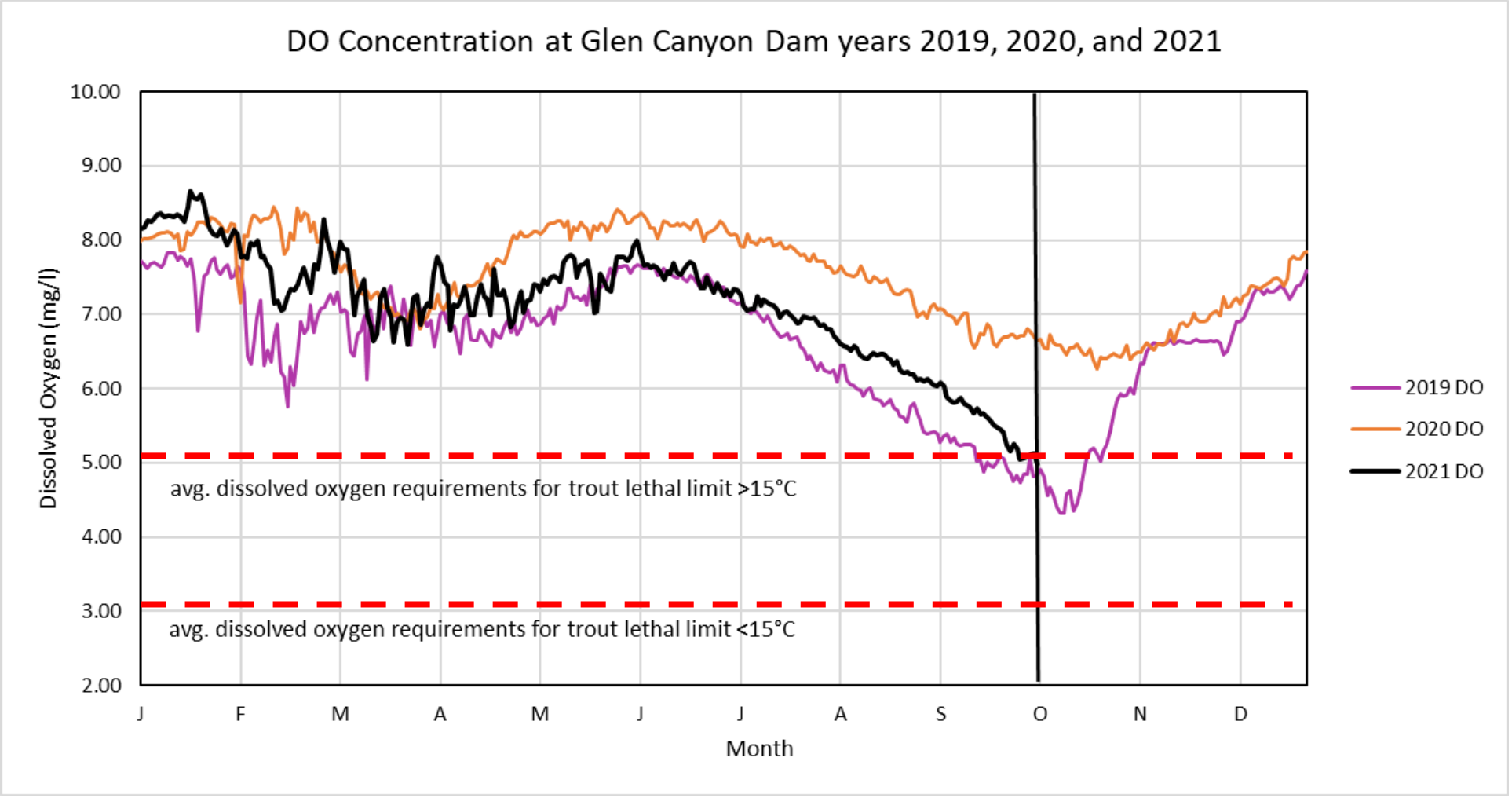
Projected Water Temperatures in Grand Canyon 2021



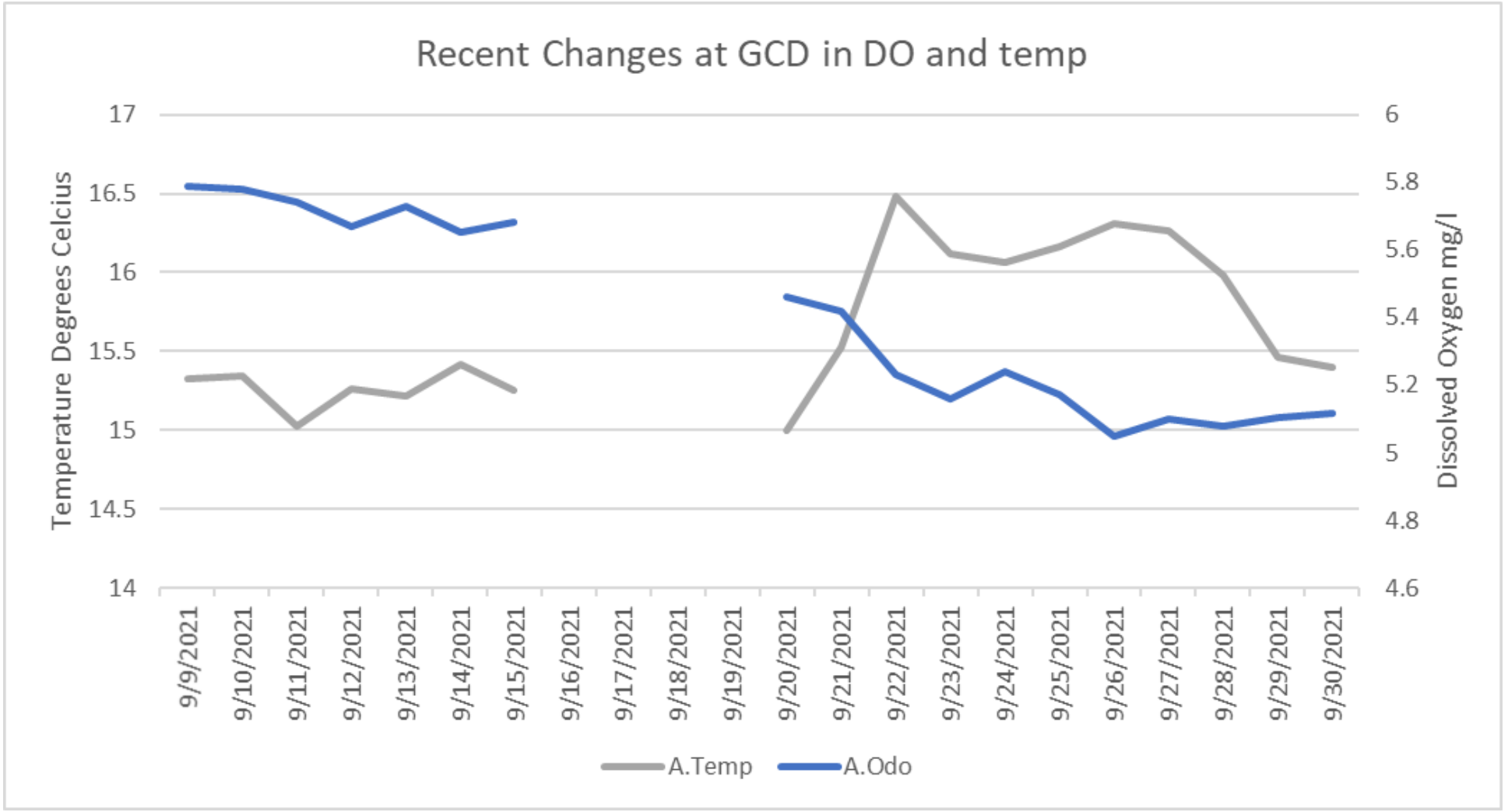
Lake Powell September DO profiles for 2019-2021



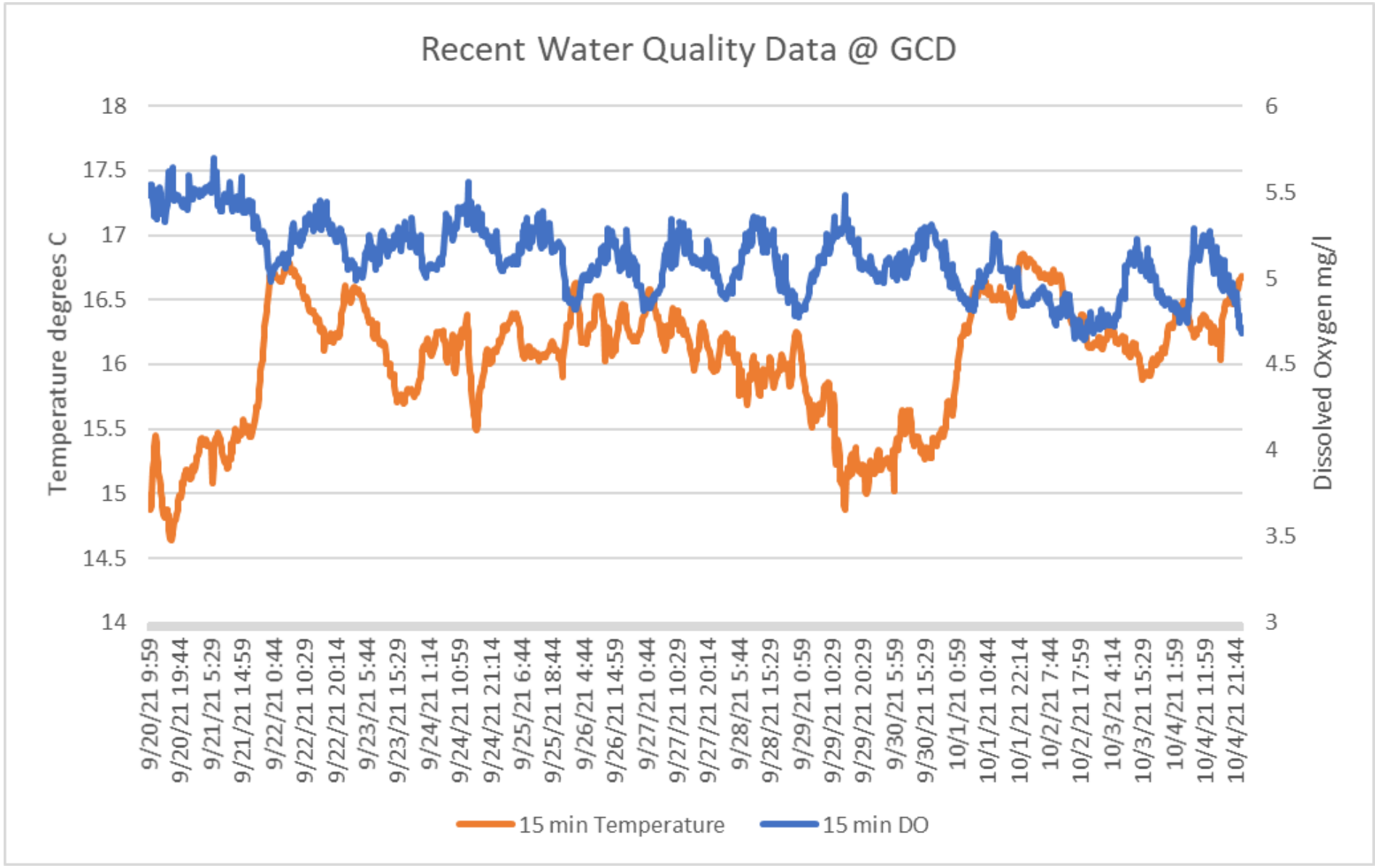
Lake Powell release DO levels for 2019-2021



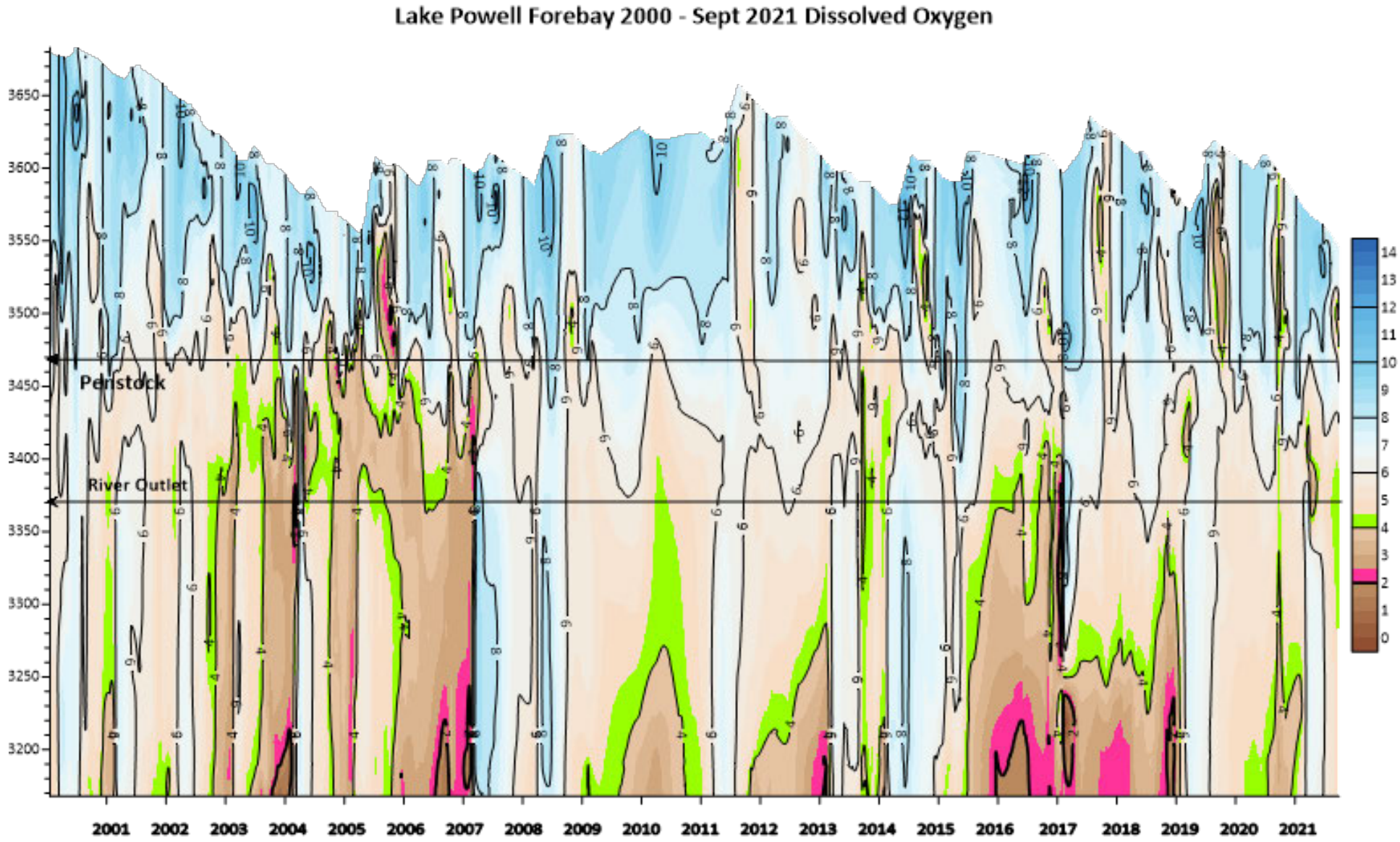
Daily temperature and DO values for September releases at GCD



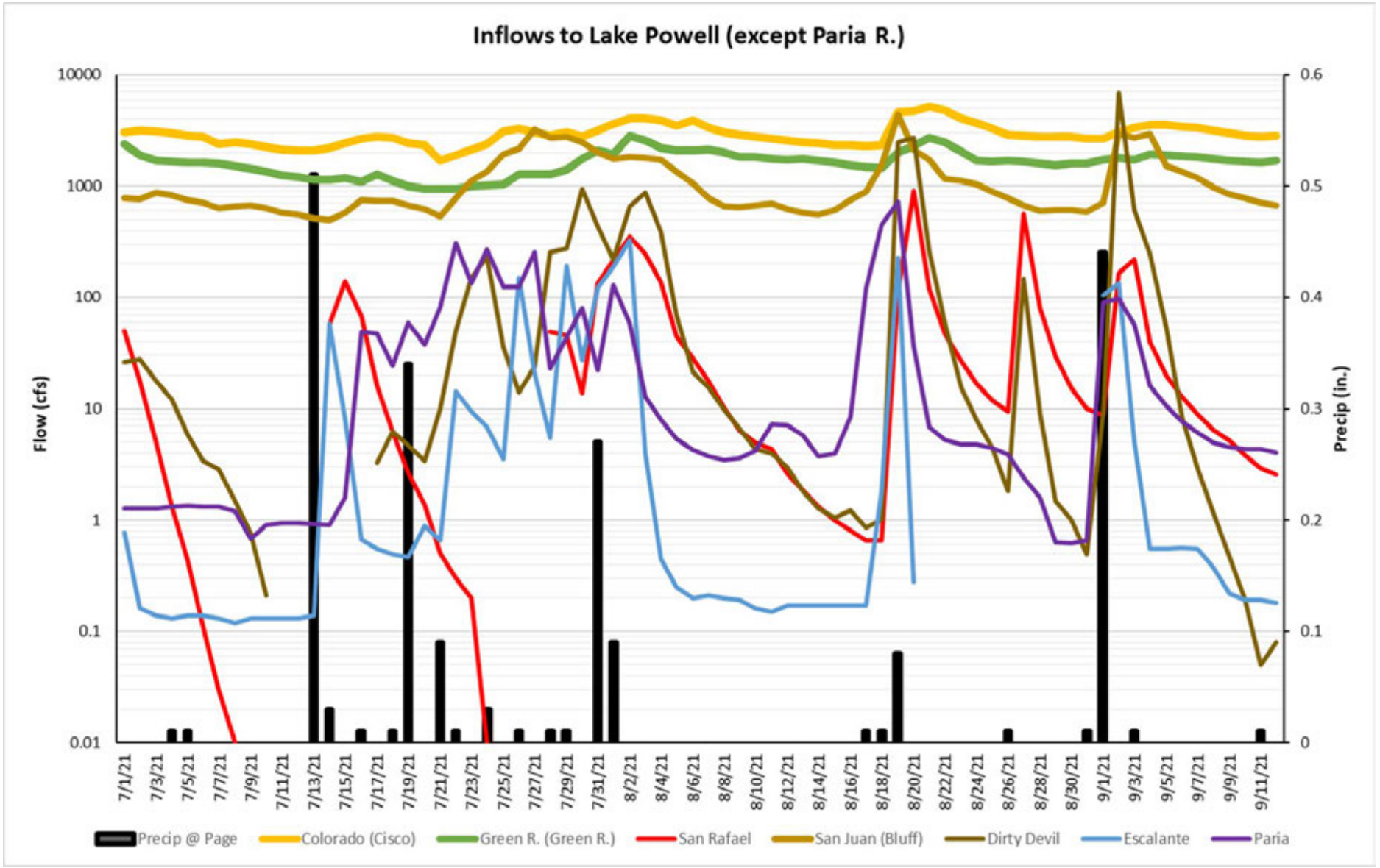
15-min Temperature and DO data for 9/20-10/4 releases at GCD



Lake Powell forebay DO profiles and elevations from 2000 to 2021



Tributary flow data and precip data showing monsoonal events



Photograph looking towards Lake Powell showing a cut through the delta at Cha.

Photograph looking up the delta at Cha showing the channel cut.


Questions?
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