BUREAU OF RECLAMATION

Glen Canyon Monthly Operations Call

Basin Hydrology and Operations

March 21, 2023

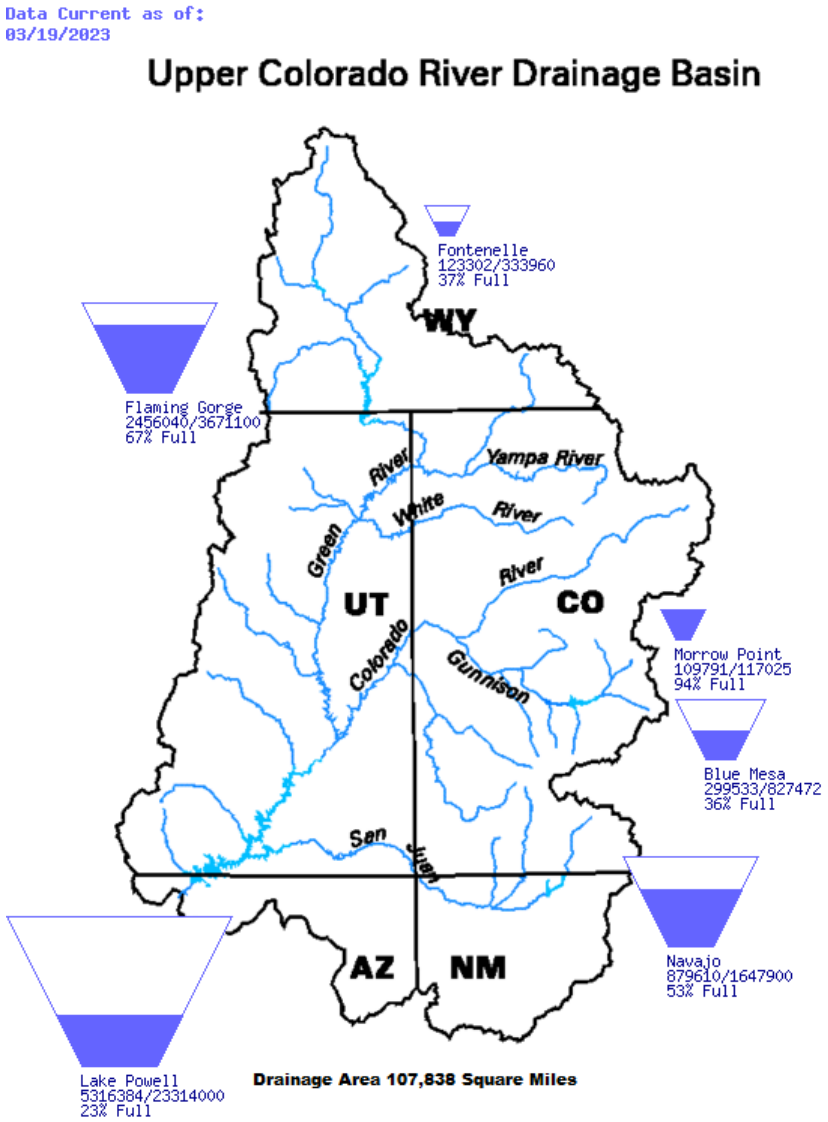
Background

This briefing is being provided consistent with the provision in Attachment B - Section 1.1 of the LTEMP ROD which states:

"Annually, Reclamation will develop a hydrograph based on the characteristics above. Reclamation will seek consensus on the annual hydrograph through monthly operational coordination calls with governmental entities, and regular meetings of the GCDAMP Technical Working Group (TWG) and AMWG. Reclamation will conduct monthly Glen Canyon Dam operational coordination meetings or calls with the DOI bureaus (USGS, NPS, FWS, and BIA), WAPA, and representatives from the Basin States and UCRC. The purpose of these meetings or calls is for the participants to share and seek information on Glen Canyon Dam operations. One liaison from each Basin State and from the UCRC may participate in the monthly operational coordination meetings or calls."

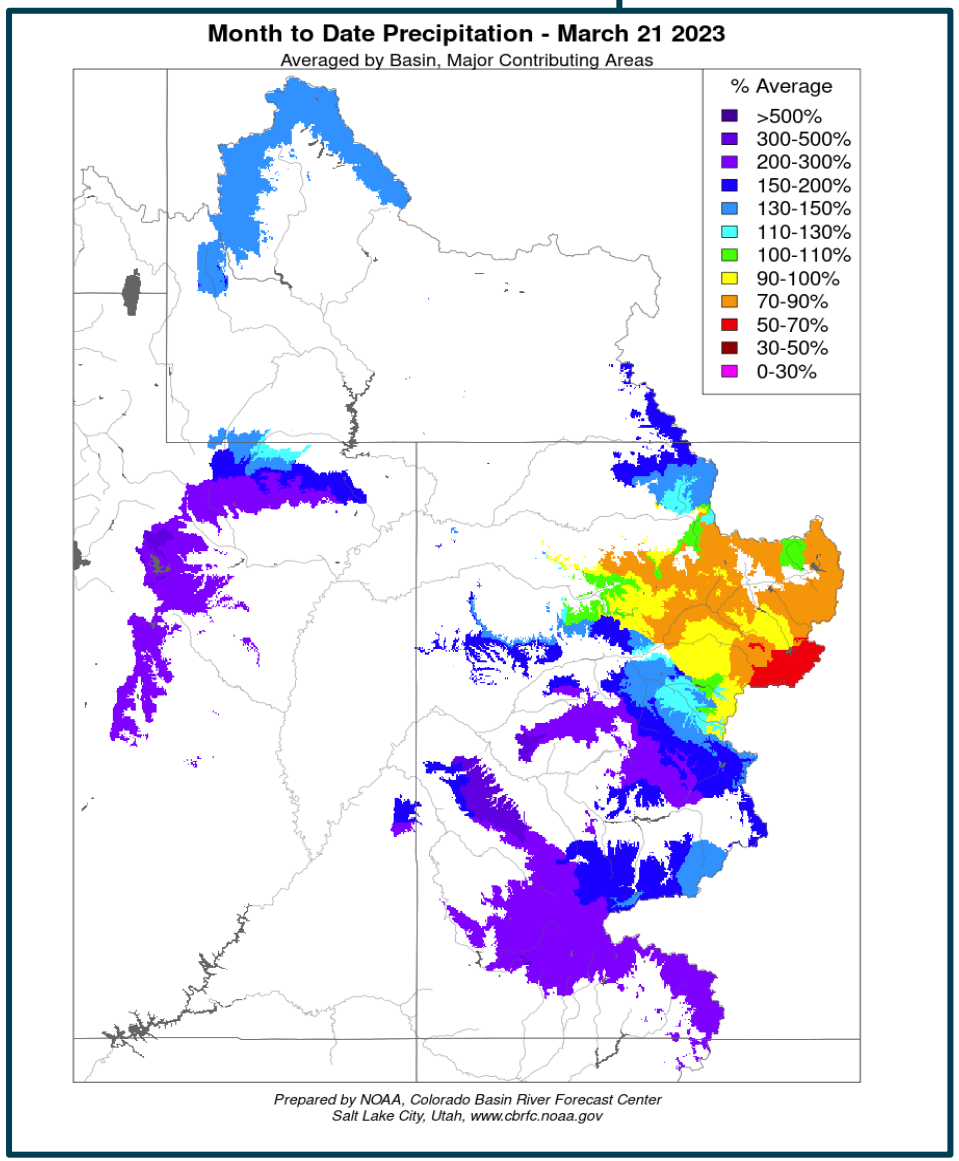
Upper Basin Storage (as of March 20, 2023)

Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	37	0.12	0.33	6,472.38
Flaming Gorge	67	2.46	3.67	6,005.89
Blue Mesa	36	0.30	0.83	7,448.29
Navajo	54	0.88	1.65	6,021.76
Lake Powell	23	5.32	23.31	3,520.98
UC System Storage	31	9.20	29.79	
Total System Storage	32	18.88	58.48	

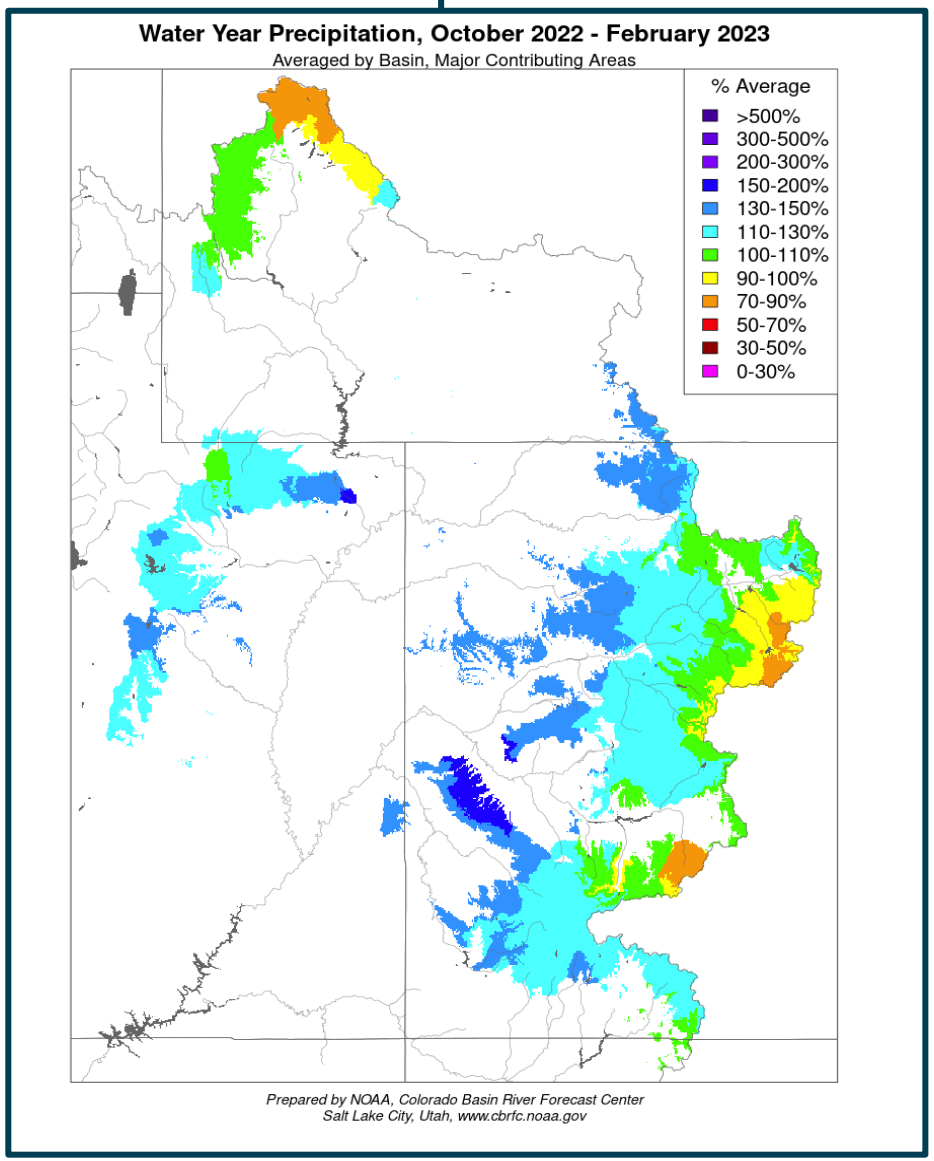


February Month and January WY Precipitation

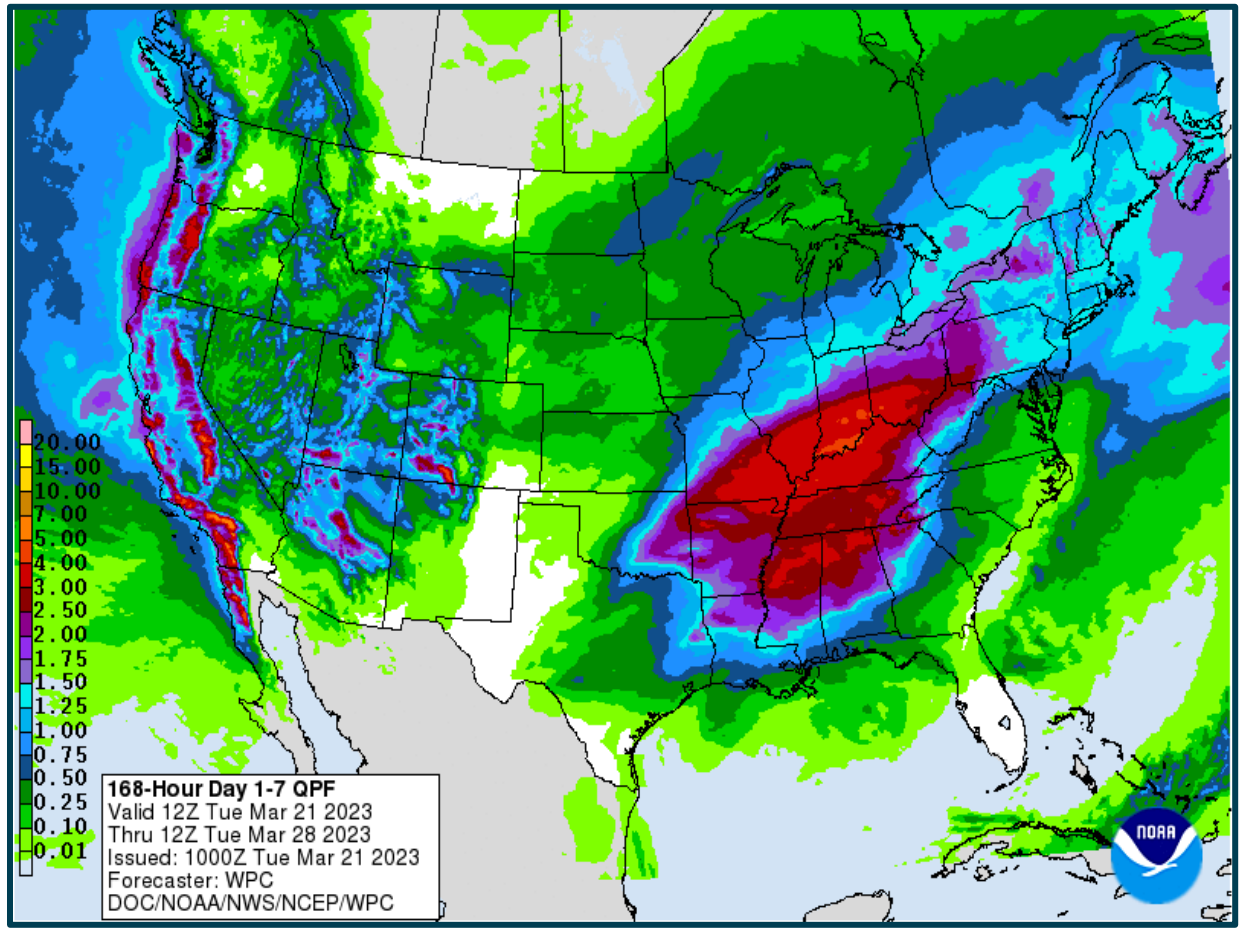
Month to Date Precipitation

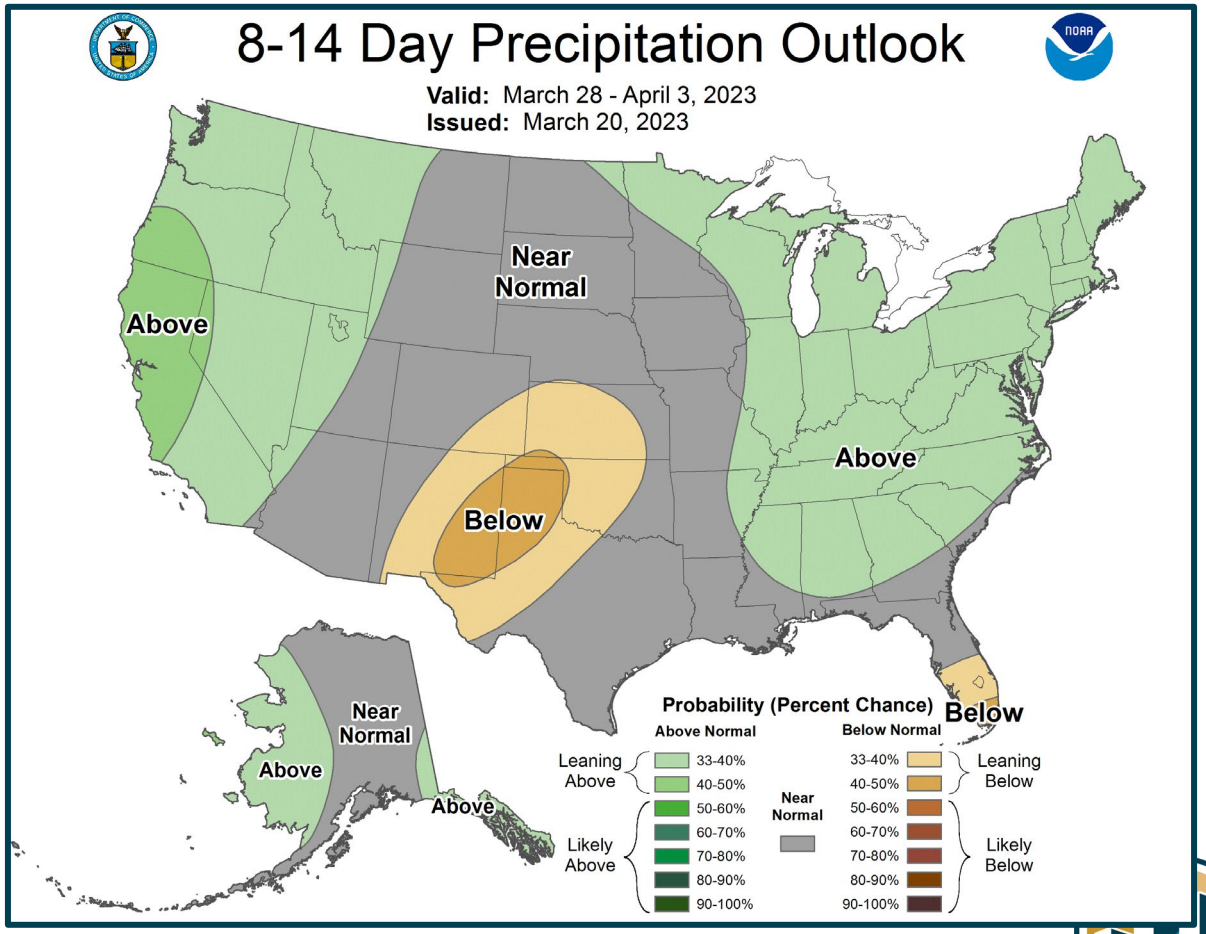


WY Precipitation

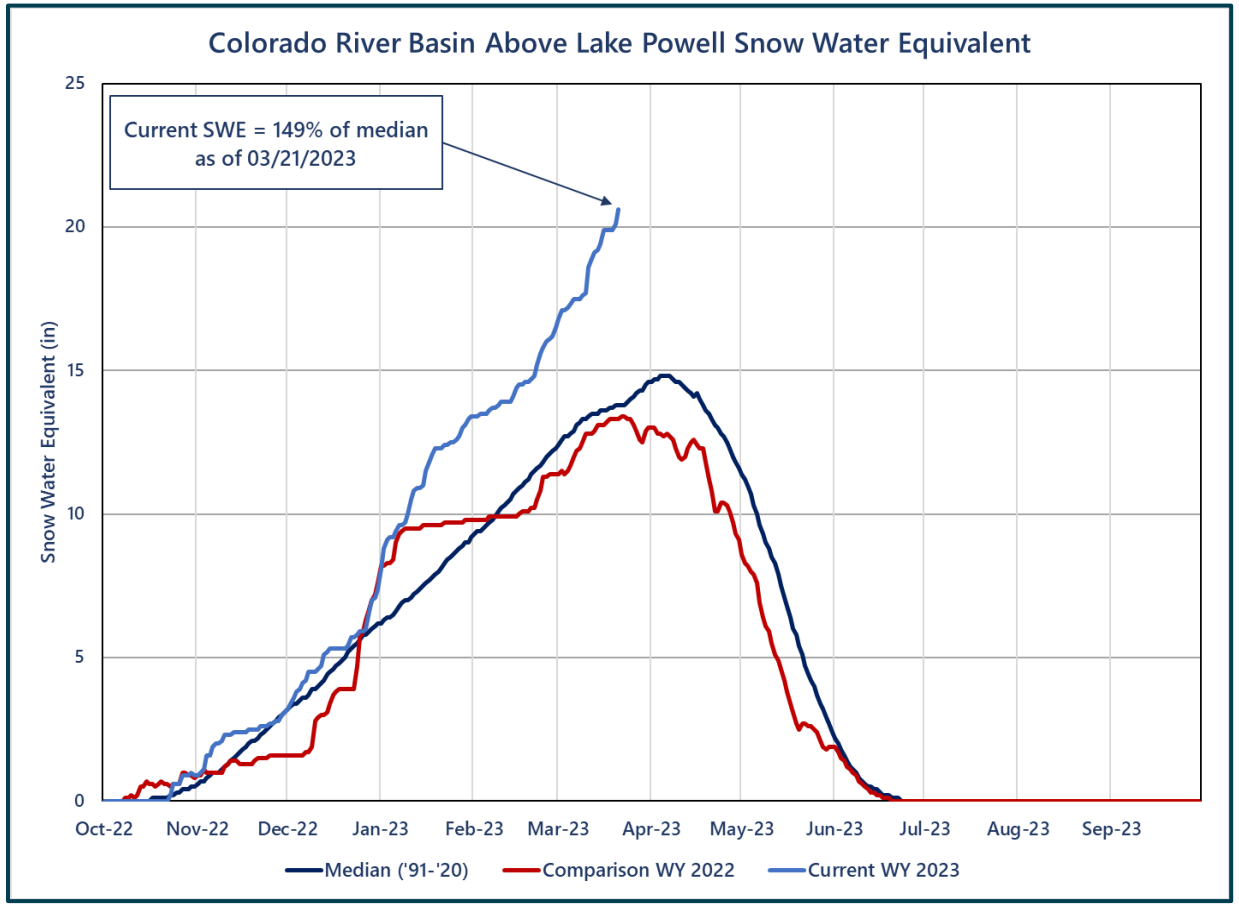


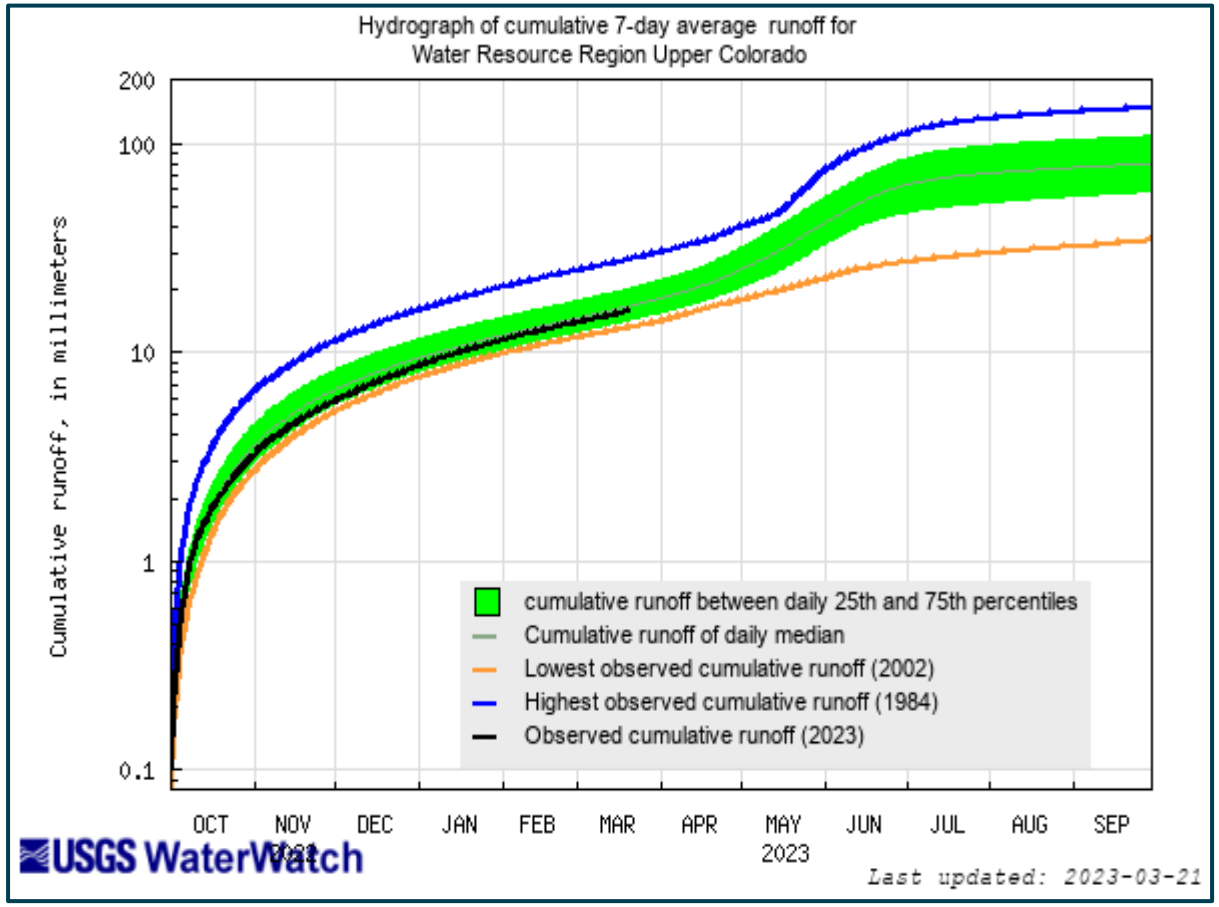
Climate Prediction Center Short-Term Precipitation Forecast





Upper Colorado SWE and Observed Inflows





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

Most Probable March Forecast
Water Year 2023

April – July 2023
Forecasted Unregulated Inflow

as of March 3, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	620	84
Flaming Gorge	880	91
Blue Mesa	665	105
Navajo	735	117
Powell	8,000	125

Water Year 2023
Unregulated Inflow Forecast

as of March 3, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	916	85
Flaming Gorge	1,264	90
Blue Mesa	904	100
Navajo	953	105
Powell	10,869	113

[1]Averages are based on the 1991 through 2020 period of record.

Most Probable March Midmonth Forecast
Water Year 2023

April – July 2023
Forecasted Unregulated Inflow

as of March 20, 2023

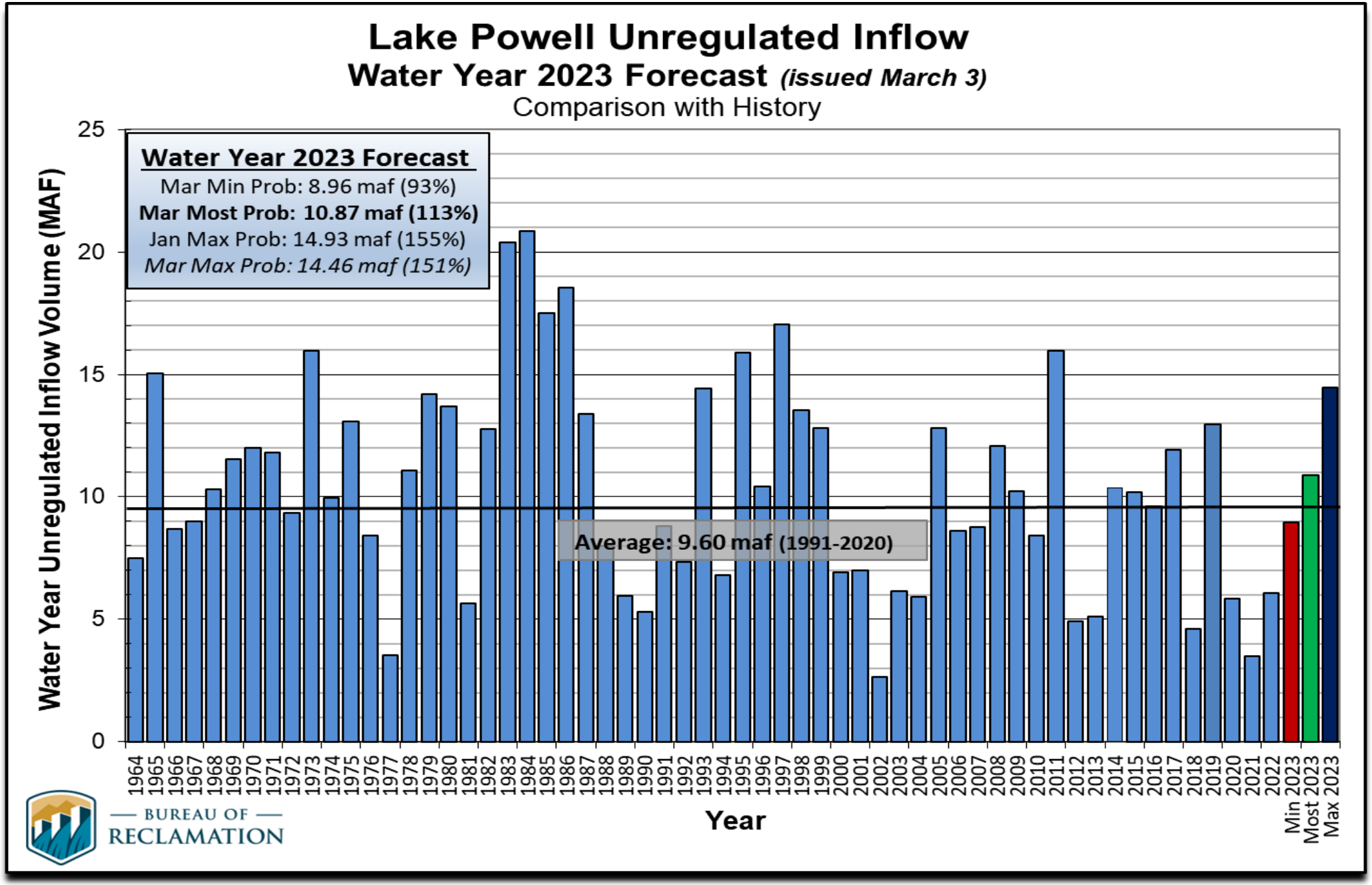
Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	710	97
Flaming Gorge	1,100	114
Blue Mesa	830	131
Navajo	960	152
Powell	10,000	156

Water Year 2023
Unregulated Inflow Forecast

as of March 20, 2023

Reservoir	Inflow (kaf)	Percent of Avg[1]
Fontenelle	1,006	93
Flaming Gorge	1,484	105
Blue Mesa	1,086	120
Navajo	1,078	129
Powell	12,869	134

[1]Averages are based on the 1991 through 2020 period of record.


Lake Powell Unregulated Inflow
Water Year 2023 Forecast (issued March 3)
Comparison with History
Water Year 2023 Forecast
Mar Min Prob: 8.96 maf (93%)
Mar Most Prob: 10.87 maf (113%)
Jan Max Prob: 14.93 maf (155%)
Mar Max Prob: 14.46 maf (151%)
Average: 9.60 maf (1991-2020)
Water Year Unregulated Inflow Volume (MAF)
0
5
10
15
20
25
1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Min 2023 Most 2023 Max 2023
Year
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Upper Colorado Basin

Hydrology and Operations Projections Based on January and March 2023 24-Month Study

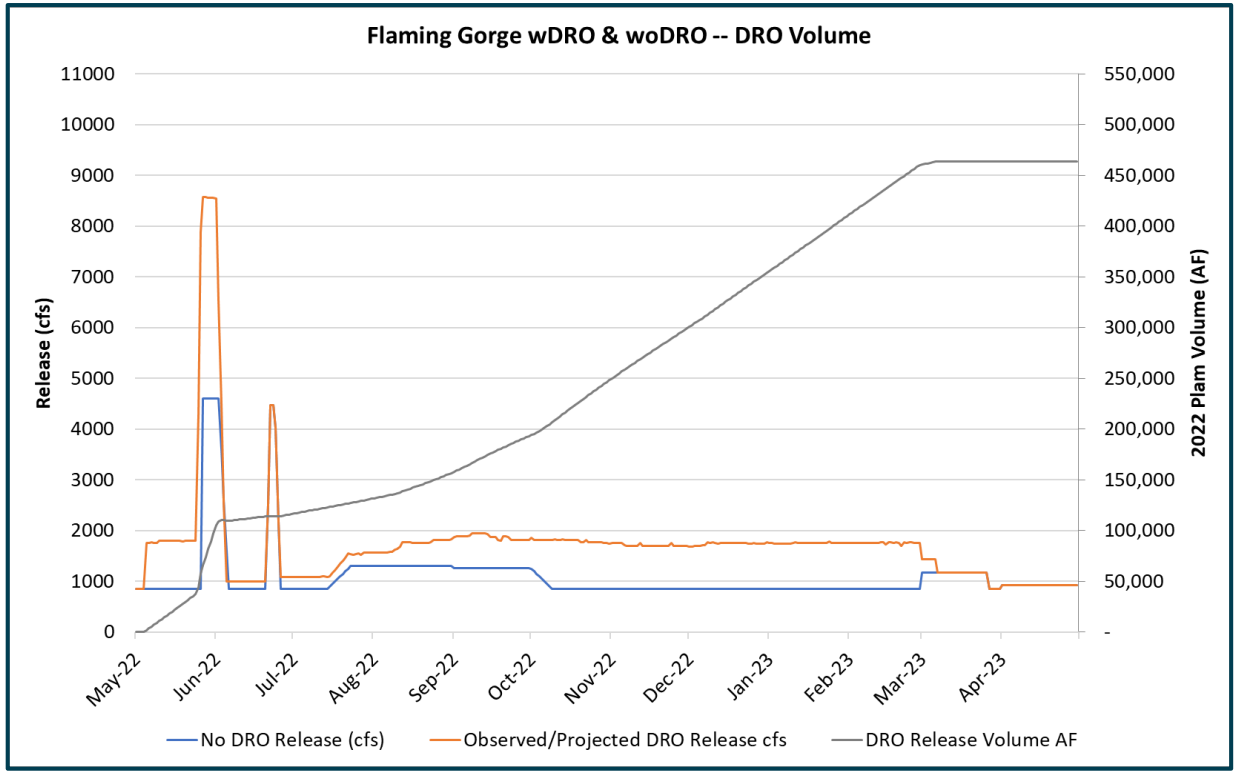
Drought Response Operations Agreement (DROA)

DROA Volumes Released[1]

Reservoir	2021 DROA Volume (kaf)	2022 DROA Volume (kaf)	Total DROA Volume (kaf)
Flaming Gorge	125	463	588
Blue Mesa	36	0	36
Navajo	0	0	0
Volume in Powell	161	463	624

[1]DROA operational year is from May through April.

Flaming Gorge 2022 Plan Daily Releases



Flaming Gorge DROA final volume = 463 kaf

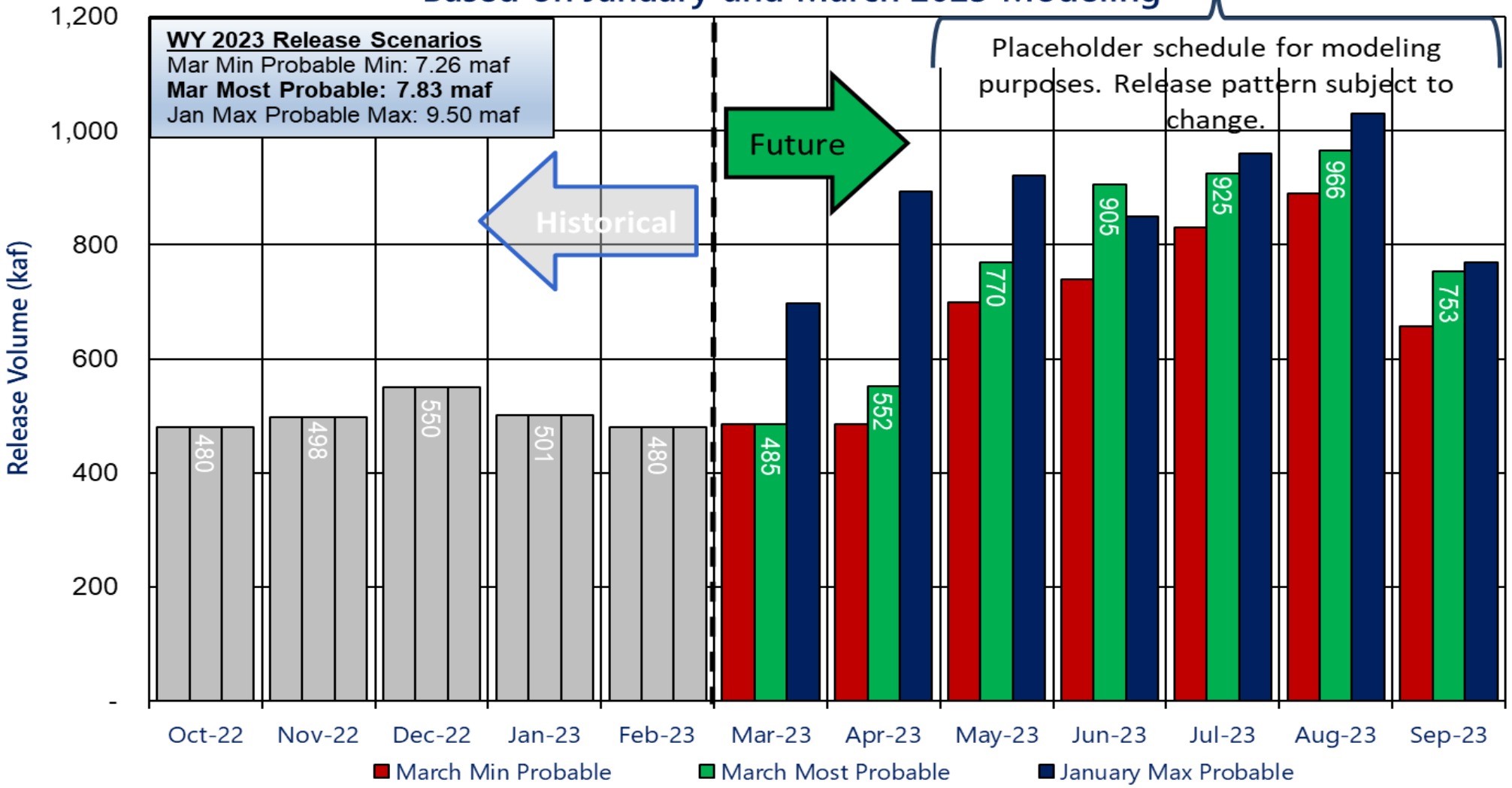
Upper Basin Reservoir Operations in Water Year 2023

- Lake Powell will be operated consistent with the 2007 Interim Guidelines, the Upper Basin Drought Response Operations Agreement and Upper Basin Records of Decision
- Lake Powell's projected end of calendar year (CY) 2022 "tier determination" elevation in the August 2022 24-Month Study determines Lake Powell's operating tier in CY 2023
  - Lake Powell will operate in the Lower Elevation Balancing Tier where Lake Powell and Lake Mead will balance contents with Glen Canyon Dam release volumes no less than 7.0 maf and no more than 9.5 maf
- Consistent with the provisions of the 2007 Interim Guidelines, and to preserve the benefits to Glen Canyon Dam facilities from 2022 Operations into 2023 and 2024, Reclamation will consult with the Basin States on monthly and annual operations. Reclamation will also ensure all appropriate consultation with Basin Tribes, the Republic of Mexico, other federal agencies, water users and non-governmental organizations with respect to implementation of these monthly and annual operations.
  - The Glen Canyon Dam annual release has initially been set to 7.00 maf, and in April 2023 Reclamation will evaluate hydrologic conditions to determine if balancing releases may be appropriate under the conditions established in the 2007 Interim Guidelines;
  - Balancing releases will be limited (with a minimum of 7.00 maf) to protect Lake Powell from declining below elevation 3,525 feet at the end of December 2023;
  - Balancing releases will take into account operational neutrality of the 0.480 maf that was retained in Lake Powell under the May 2022 action1. Any Lake Powell balancing release volume will be calculated as if the 0.480 maf had been delivered to Lake Mead in WY 2022; and
  - The modeling approach for WY 2023 will apply to 2024.

Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2023

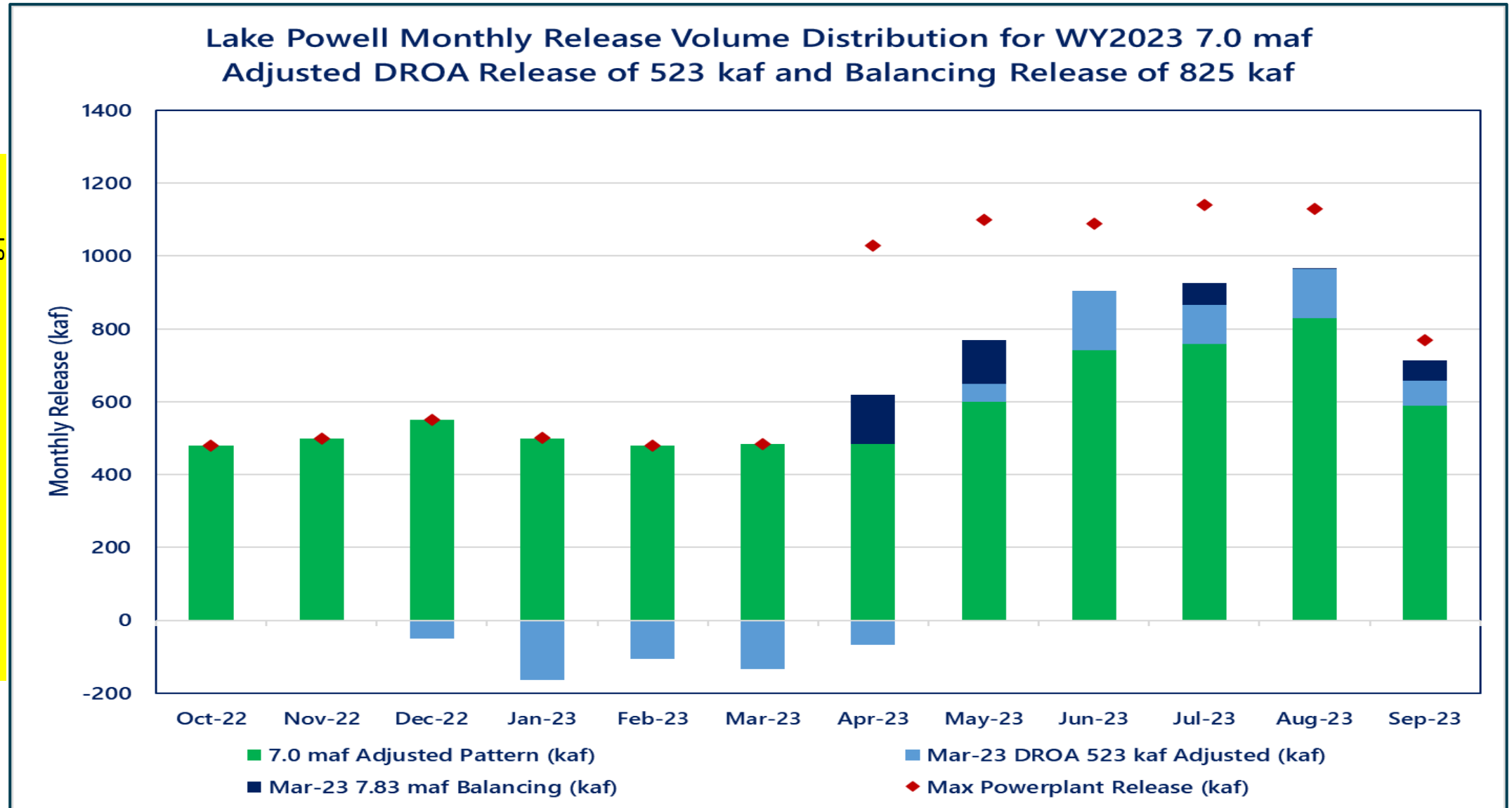
Based on January and March 2023 Modeling



Consistent with the provisions of the 2007 Interim Guidelines, and to preserve the benefits to Glen Canyon Dam facilities from 2022 Operations into 2023 and 2024, Reclamation will consult with the Basin States on monthly and annual operations. Reclamation will also ensure all appropriate consultation with Basin Tribes, the Republic of Mexico, other federal agencies, water users and non-governmental organizations with respect to implementation of these monthly and annual operations.

WY2023 March 24MS Official

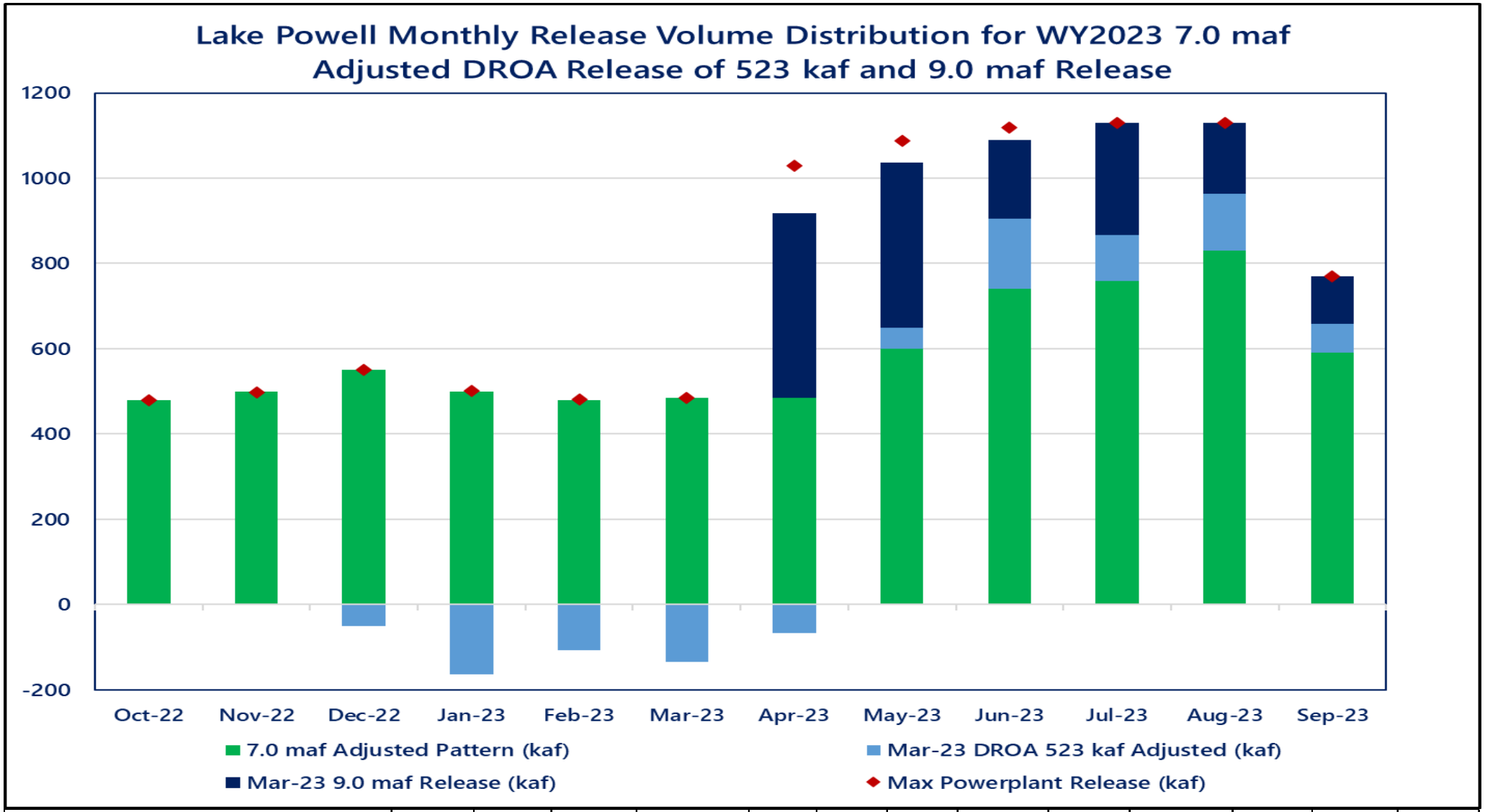
All scenarios are for discussion purposes to assist Reclamation in the GCD decision-making process.



WY2023	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Total
Max Powerplant Release (kaf)	480	498	550	501	480	485	1,030	1,100	1,090	1,140	1,130	770	
7.0 maf LTEMP Pattern (kaf)	480	500	600	664	587	620	552	550	577	652	696	522	7,000
Mar23 24MS Official 7.83 maf Pattern (kaf)	480	498	550	501	480	485	552	770	905	925	966	713	7,825

WY2023 Potential GCD Release of 9.0 maf

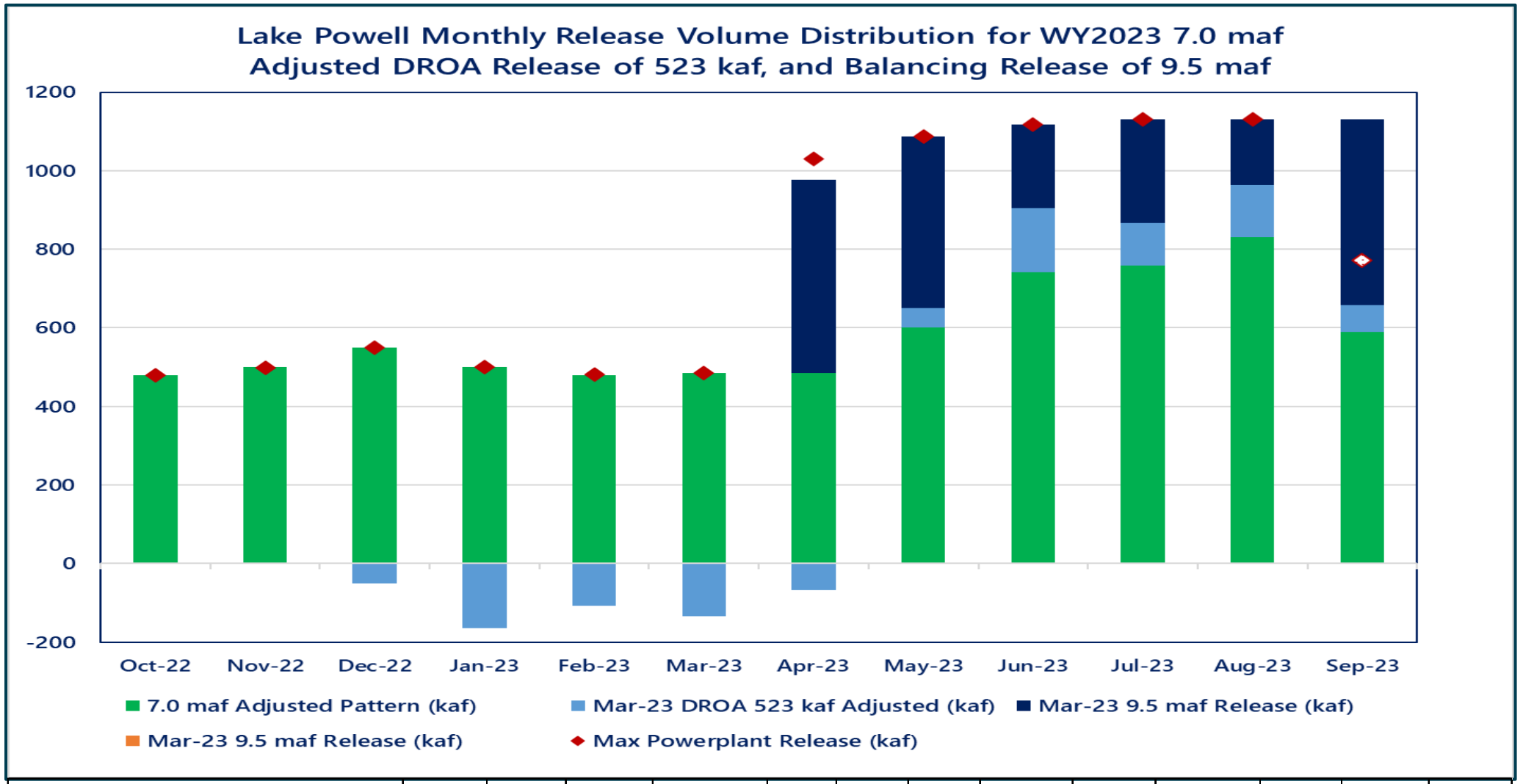
All scenarios are for discussion purposes to assist Reclamation in the GCD decision-making process.



WY2023	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Total
Max Powerplant Release (kaf)	480	498	550	501	480	485	1,030	1,100	1,090	1,140	1,130	770	
7.0 maf LTEMP Pattern (kaf)	480	500	600	664	587	620	552	550	577	652	696	522	7,000
Mar23 24MS Official 7.83 maf Pattern (kaf)	480	498	550	501	480	485	552	770	905	925	966	713	7,825
Mar-23 9.0 maf Release (kaf)	480	498	550	501	480	485	850	1,036	1,090	1,130	1,130	770	9,000

WY2023 Potential GCD Release of 9.5 maf

All scenarios are for discussion purposes to assist Reclamation in the GCD decision-making process.



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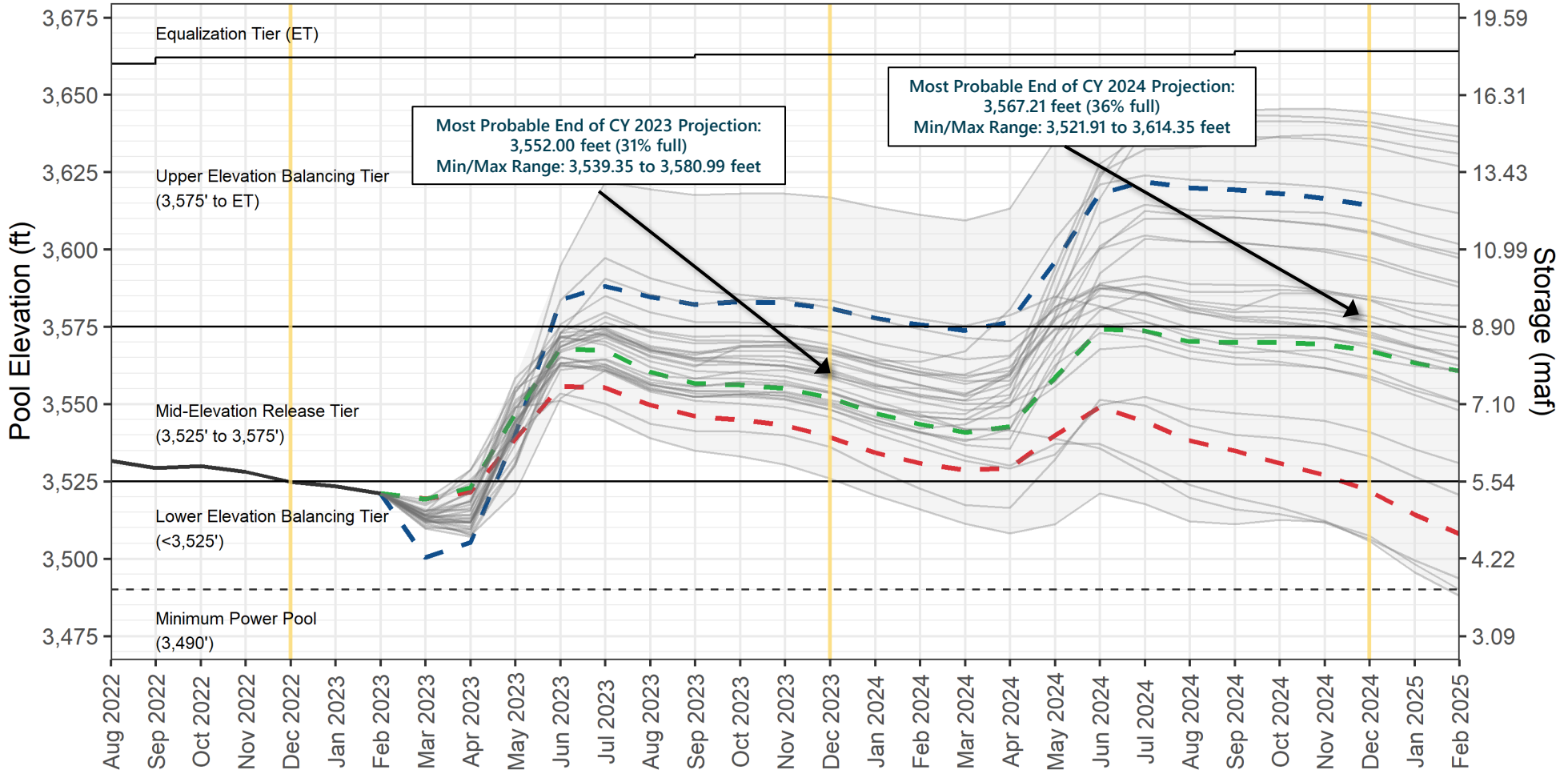
Max Powerplant Release (kaf)	480	498	550	501	480	485	1,030	1,100	1,090	1,140	1,130	770	
7.0 maf LTEMP Pattern (kaf)	480	500	600	664	587	620	552	550	577	652	696	522	7,000
Mar23 24MS Official 7.83 maf Pattern (kaf)	480	498	550	501	480	485	552	770	905	925	966	713	7,825
Mar-23 9.0 maf Release (kaf)	480	498	550	501	480	485	850	1,036	1,090	1,130	1,130	770	9,000
Mar-23 9.5 maf Release (kaf)	480	498	550	501	480	485	910	1,088	1,118	1,130	1,130	1,130	9,500

Reclamation Operational Modeling
Model Comparison

	Colorado River Mid-term Modeling System (CRMMS)		CRSS
	24-Month Study Mode (Manual Mode)	Ensemble Mode (Rule-based Mode)	
Primary Use	AOP tier determinations and projections of current conditions	Risk-based operational planning and analysis	Long-term planning, comparison of alternatives
Simulated Reservoir Operations	Operations input manually	Rule-driven operations	
Probabilistic or Deterministic	Deterministic – single hydrologic trace	Deterministic OR Probabilistic 30 (or more) hydrologic traces	Probabilistic – 100+ traces
Time Horizon (years)	1 - 2	1 - 5	1 - 50
Upper Basin Inflow	Unregulated forecast, 1 trace	Unregulated ESP forecast, 30 traces	Natural flow; historical, paleo, or climate change hydrology
Upper Basin Demands	Implicit, in unregulated inflow forecast		Explicit, 2016 UCRC assumptions
Lower Basin Demands	Official approved or operational		Developed with LB users

Lake Powell End-of-Month Elevations[1]

CRMMS Projections from January and March 2023



[1] Projected Lake Powell end-of-month physical elevations from the latest CRMMS-ESP and 24-Month Study inflow scenarios.

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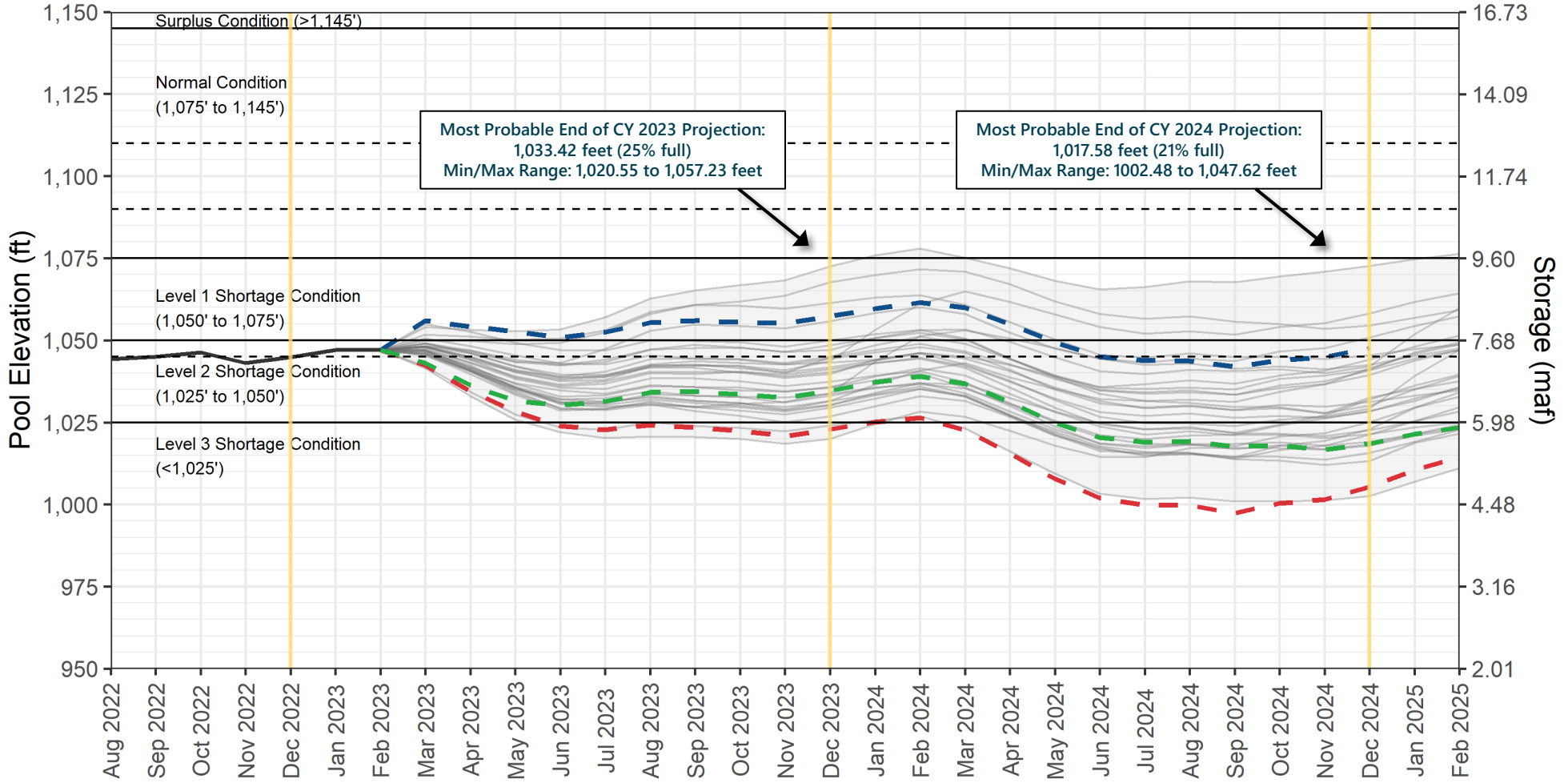
Lake Mead End-of-Month Elevations[1]

CRMMS Projections from January and March 2023



[1] Projected Lake Mead end-of-month physical elevations from the latest CRMMS-ESP and 24-Month Study inflow scenarios.

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Upper Colorado Basin

Hydropower Maintenance

Glen Canyon Dam Power Plant Unit Outage Schedule for 2023

Unit Number	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023	
1													
2													
3								START TIME TBD					
4								START TIME TBD					
5													
6													
7													
8													
Units Available	6	6	6	6	6	6	6	6	6	6	6	4	
Capacity (cfs)	18,200	18,150	18,050	18,000	17,919	17,900	17,950	18,700	19,000	19,300	19,100	12,000	MAR MOST[2]
Capacity (kaf/month)	1,120	1,080	1,110	1,110	970	1,090	1,030	1,100	1,190	1,140	1,130	770	MAR MOST
Max (kaf) [1]	480	498	549	980	870	698	893	921	850	960	1,030	770	9.50 maf
Most (kaf) [1]	480	498	549	501	480	485	552	770	905	925	966	711	7.87 maf
Min (kaf) [1]	480	498	549	501	480	485	485	700	741	815	875	653	7.26 maf
										(updated 02-14-2023)			

1 Projected release, based on March 2023 24MS for the minimum and most probable and January 2023 24MS for the 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.

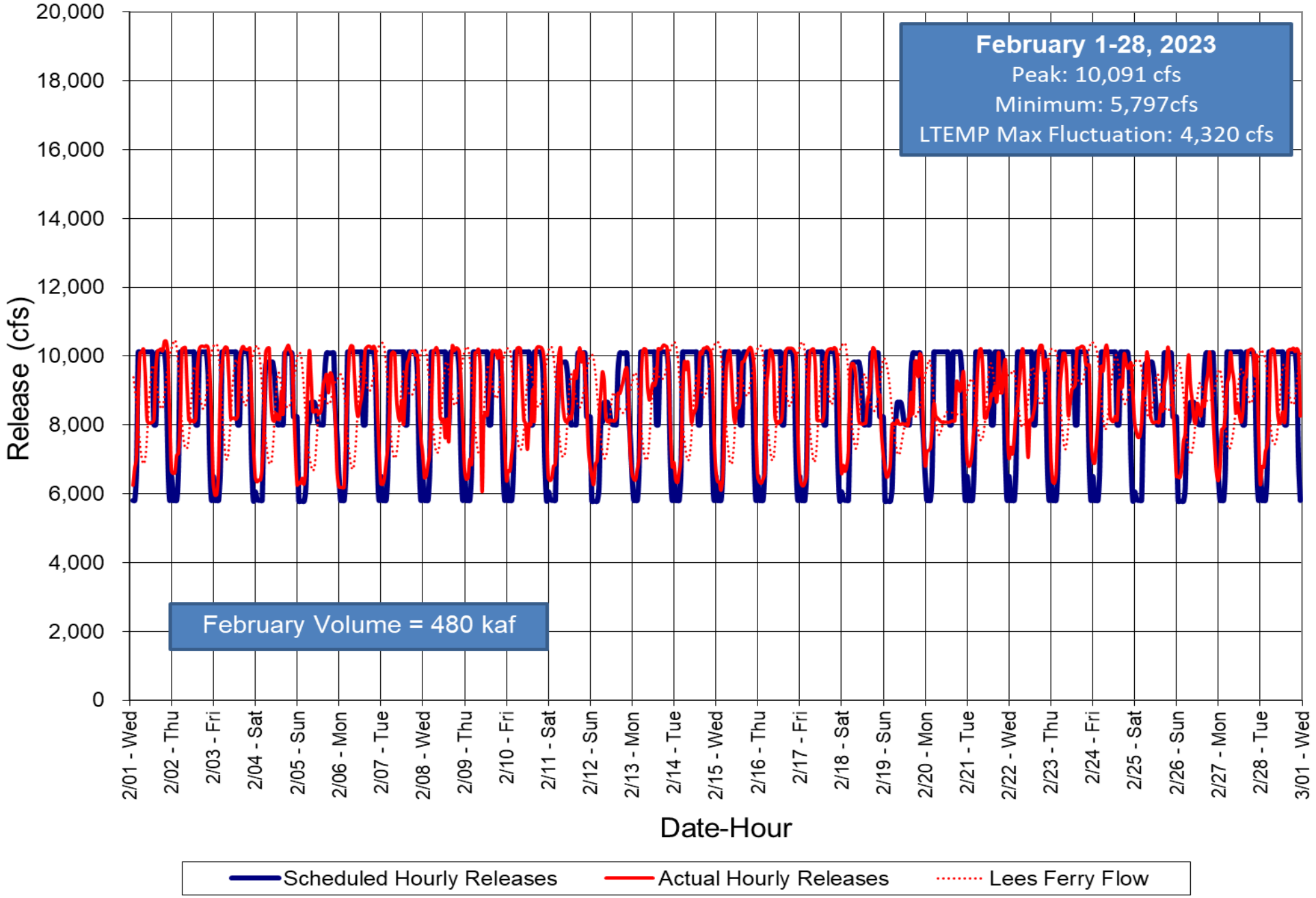
Glen Canyon Dam Power Plant Unit Outage Schedule for WY2024

Unit Number	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jun 2024	Jul 2024	Aug 2024	Sep 2024	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	5	4	6	8	6	7	5	6	8	8	8	6	
Capacity (cfs)	15,500	12,000	18,900	25,600	18,620	21,950	15,150	19,000	26,700	26,670	26,540	19,350	FEB MOST[2]
Capacity (kaf/month)	1,060	830	1,160	1,470	1,120	1,510	1,050	1,270	1,590	1,640	1,630	1,220	FEB 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	520	552	550	577	652	696	522	7.00 maf
										(updated 02-14-2023)			

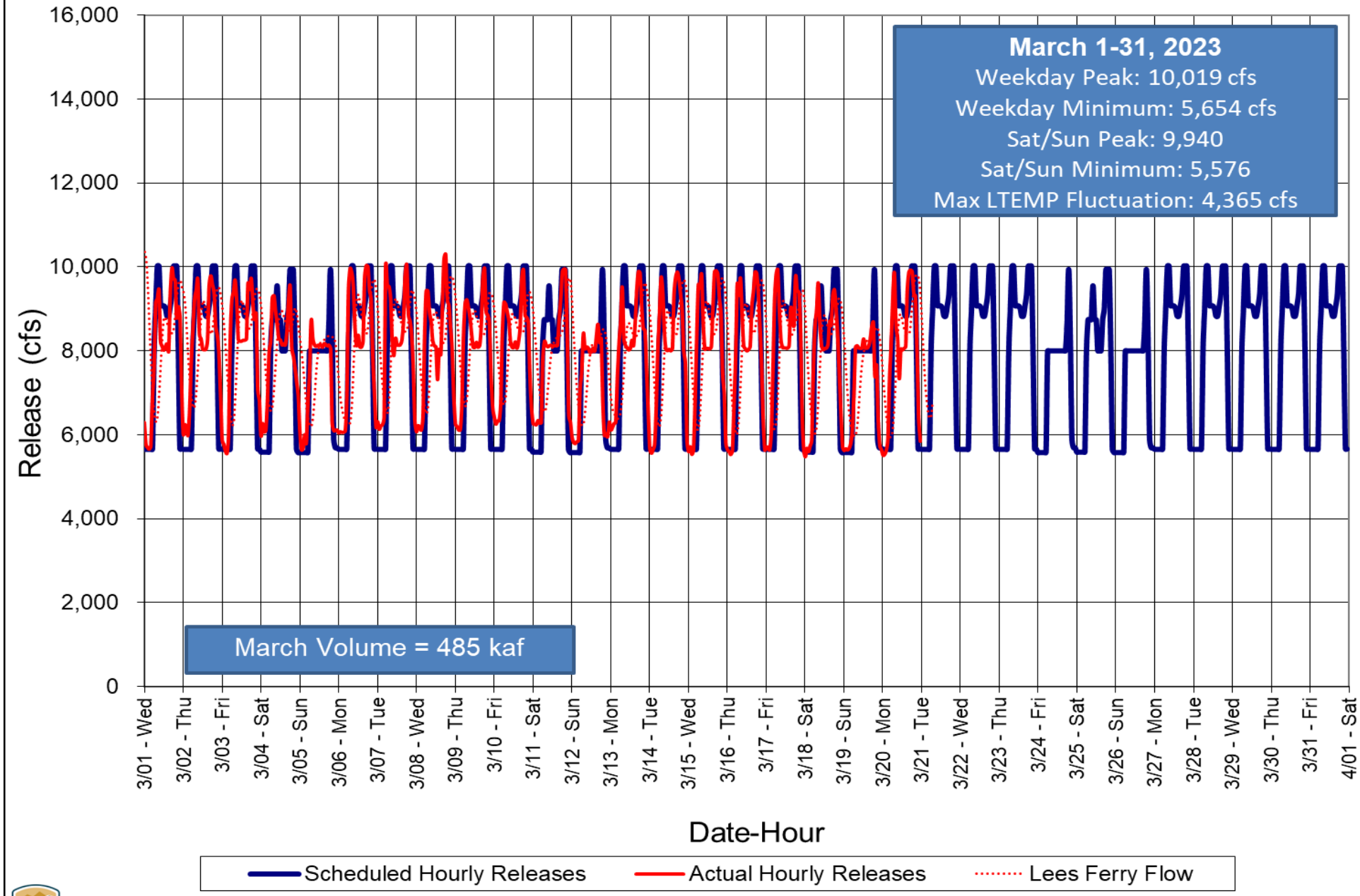
1 Projected release, based on February 2023 24MS for the minimum and most probable and January 2023 24MS for the maximum probable inflow projections and 24-Month Study model runs.

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 February 2023



Glen Canyon Dam Hourly Release Pattern March 2023



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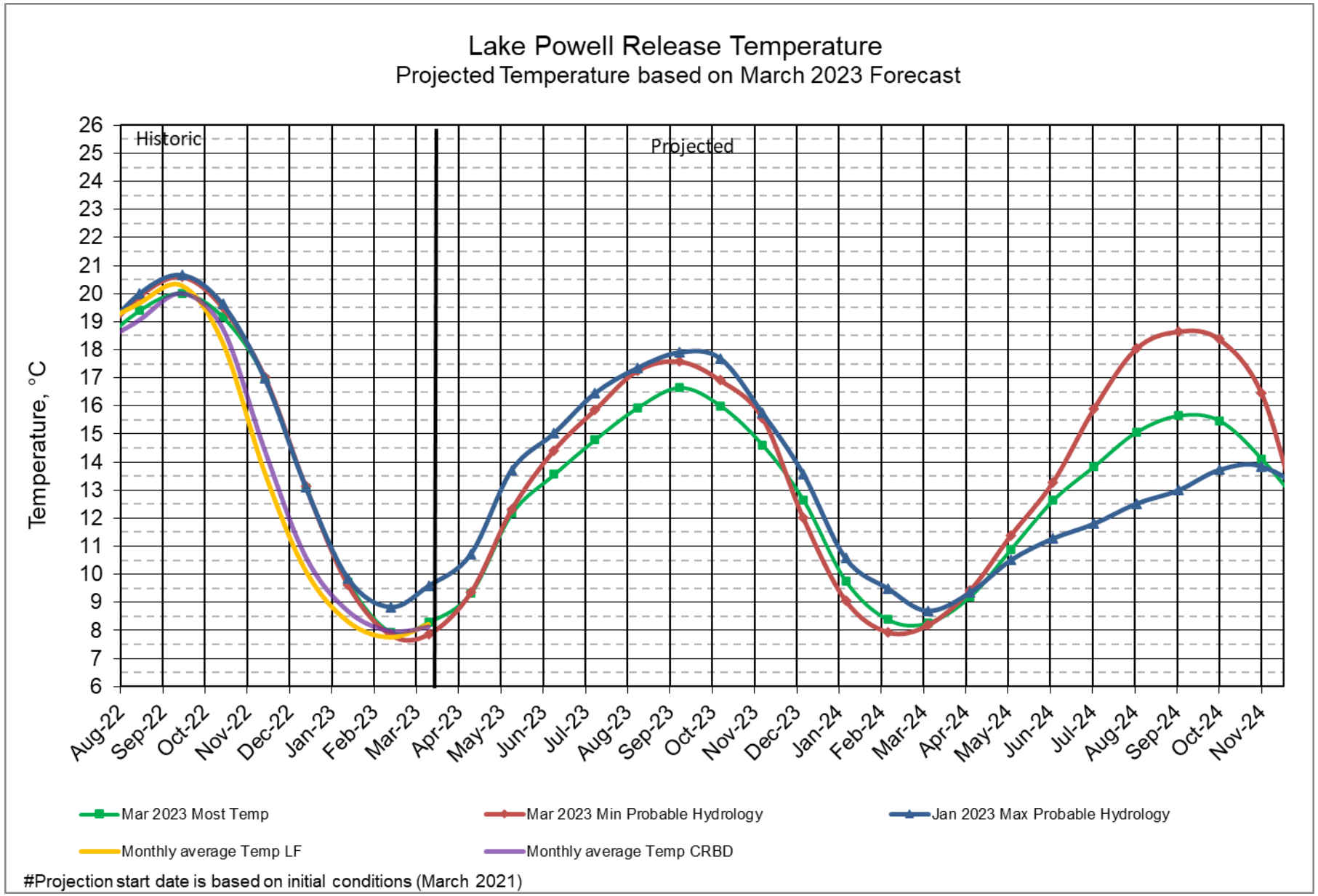
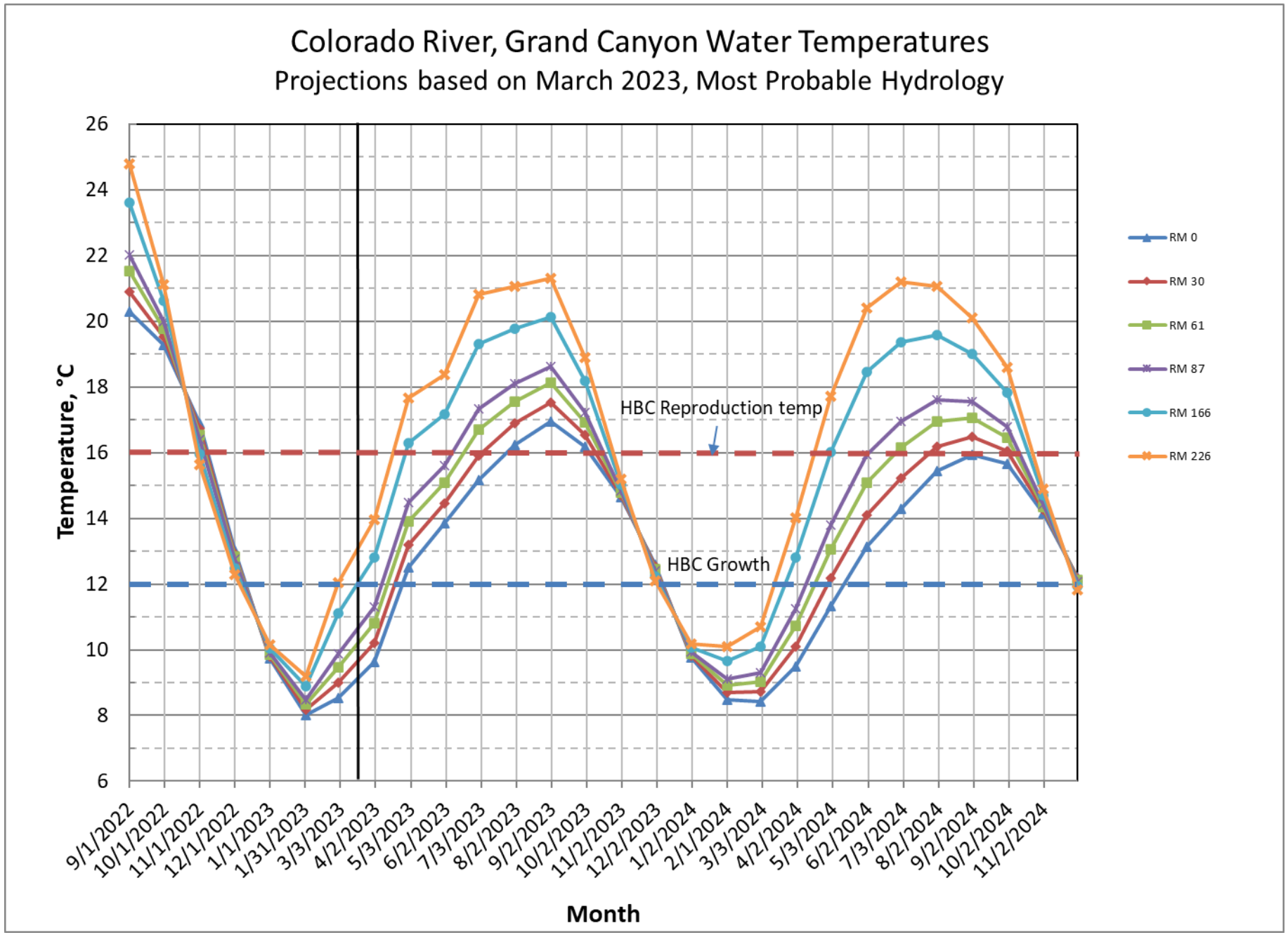
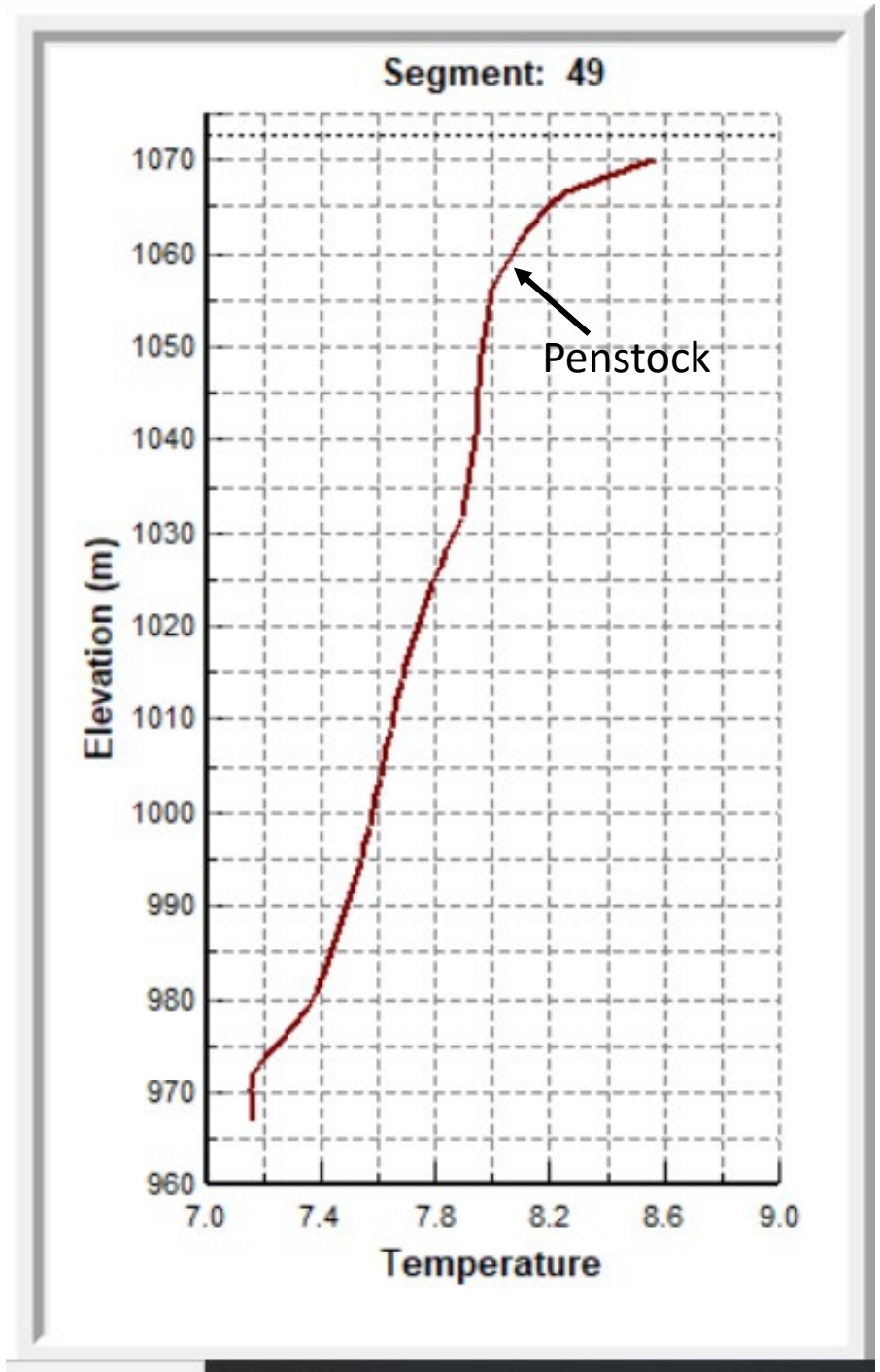
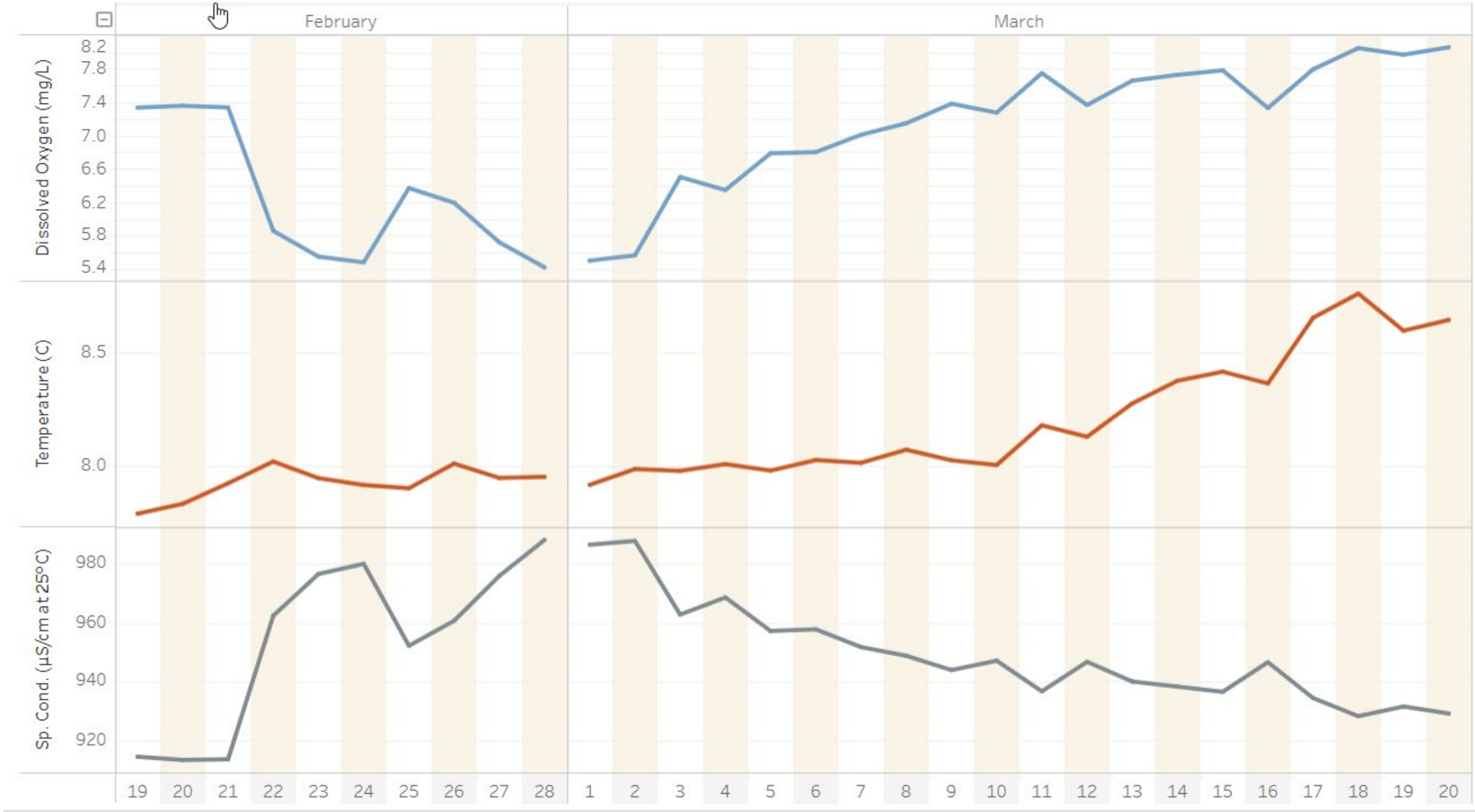
Water Quality

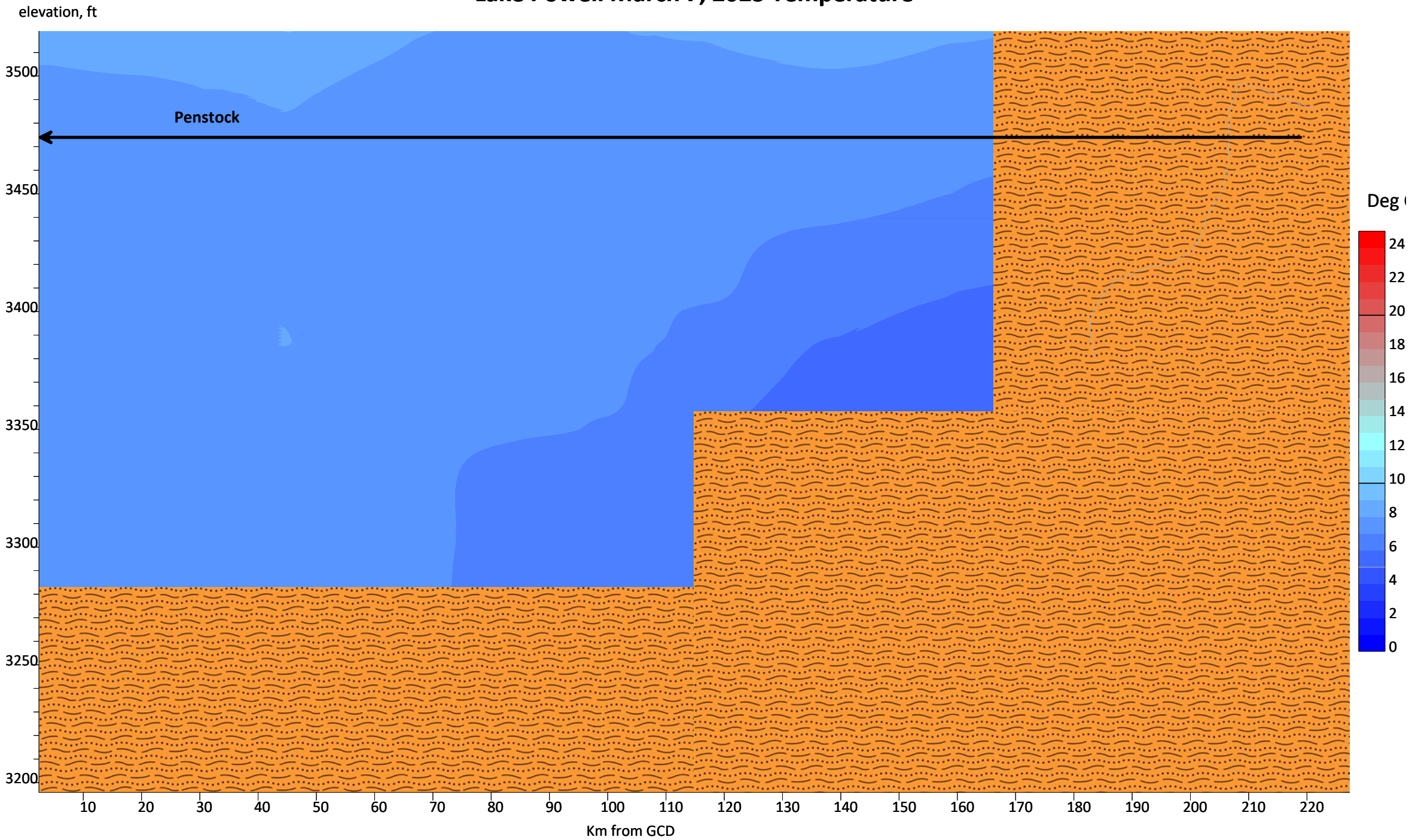

Lake Powell Release Temperature
Projected Temperature based on March 2023 Forecast
Historic
Projected
Temperature, °C
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22
Jan-23
Feb-23
Mar-23
Apr-23
May-23
Jun-23
Jul-23
Aug-23
Sep-23
Oct-23
Nov-23
Dec-23
Jan-24
Feb-24
Mar-24
Apr-24
May-24
Jun-24
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Mar 2023 Most Temp
Mar 2023 Min Probable Hydrology
Jan 2023 Max Probable Hydrology
Monthly average Temp LF
Monthly average Temp CRBD
#Projection start date is based on initial conditions (March 2021)


Colorado River, Grand Canyon Water Temperatures
Projections based on March 2023, Most Probable Hydrology
Temperature, °C
26
24
22
20
18
16
14
12
10
8
6
HBC Reproduction temp
HBC Growth
9/1/2022
10/1/2022
11/1/2022
12/1/2022
1/1/2023
1/31/2023
3/3/2023
4/2/2023
5/3/2023
6/2/2023
7/3/2023
8/2/2023
9/2/2023
10/2/2023
11/2/2023
12/2/2023
1/2/2024
2/1/2024
3/3/2024
4/2/2024
5/3/2024
6/2/2024
7/3/2024
8/2/2024
9/2/2024
10/2/2024
11/2/2024
Month
RM 0
RM 30
RM 61
RM 87
RM 166
RM 226

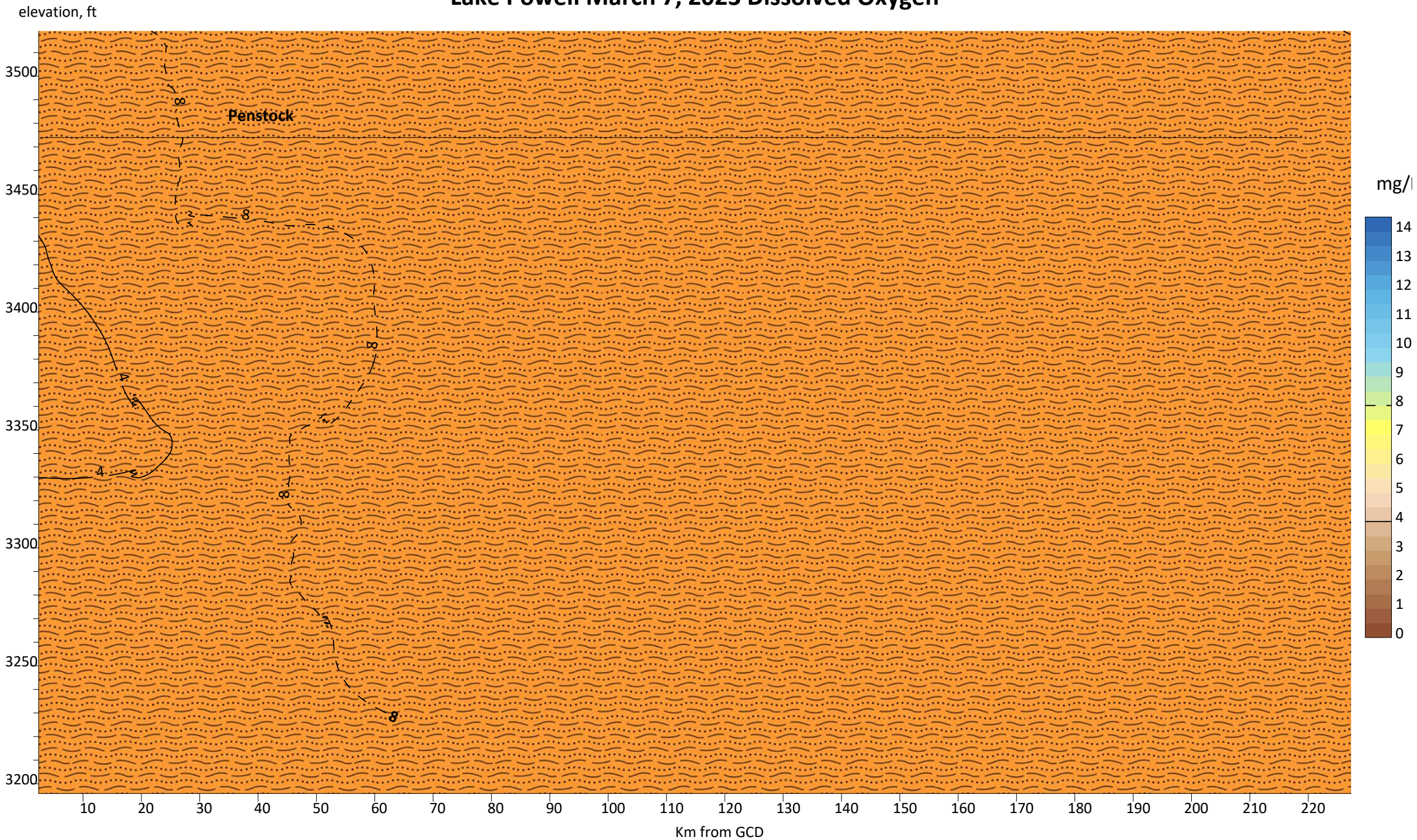

Segment: 49
1070
1060
1050
1040
1030
1020
1010
1000
990
980
970
960
Elevation (m)
7.0
7.4
7.8
8.2
8.6
9.0
Temperature
Penstock


February
March
Dissolved Oxygen (mg/L)
8.2
7.8
7.4
7.0
6.6
6.2
5.8
5.4
Temperature (C)
8.5
8.0
Sp. Cond. (µS/cm at 25°C)
980
960
940
920
19 20 21 22 23 24 25 26 27 28 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

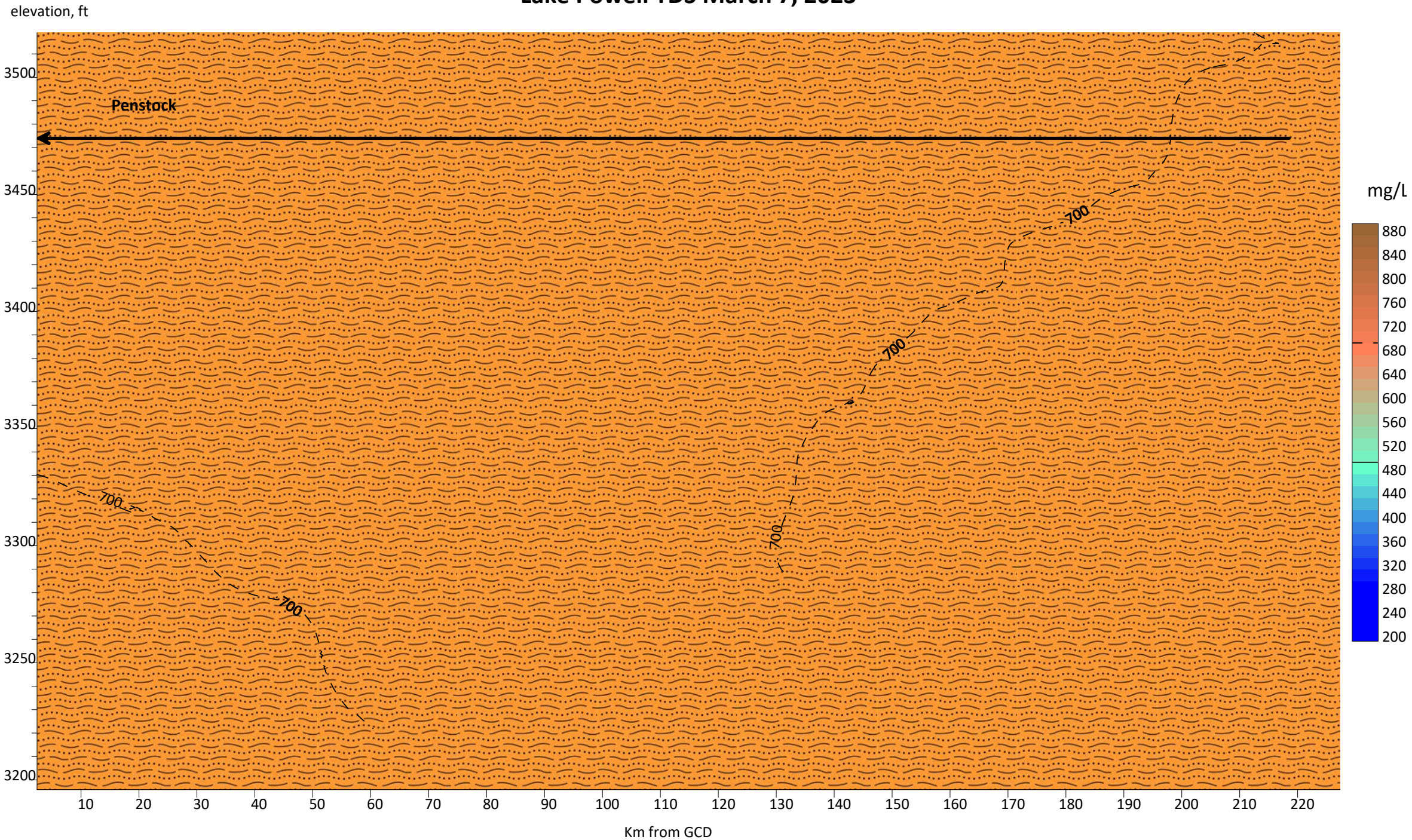
Lake Powell March 7, 2023 Temperature



Lake Powell March 7, 2023 Dissolved Oxygen



Lake Powell TDS March 7, 2023




Questions?
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