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2023 Colorado River Annual Operating Plan

Colorado River Management Work Group

First Consultation

June 1, 2022

Upper Colorado Basin

Water Year 2022 Hydrology

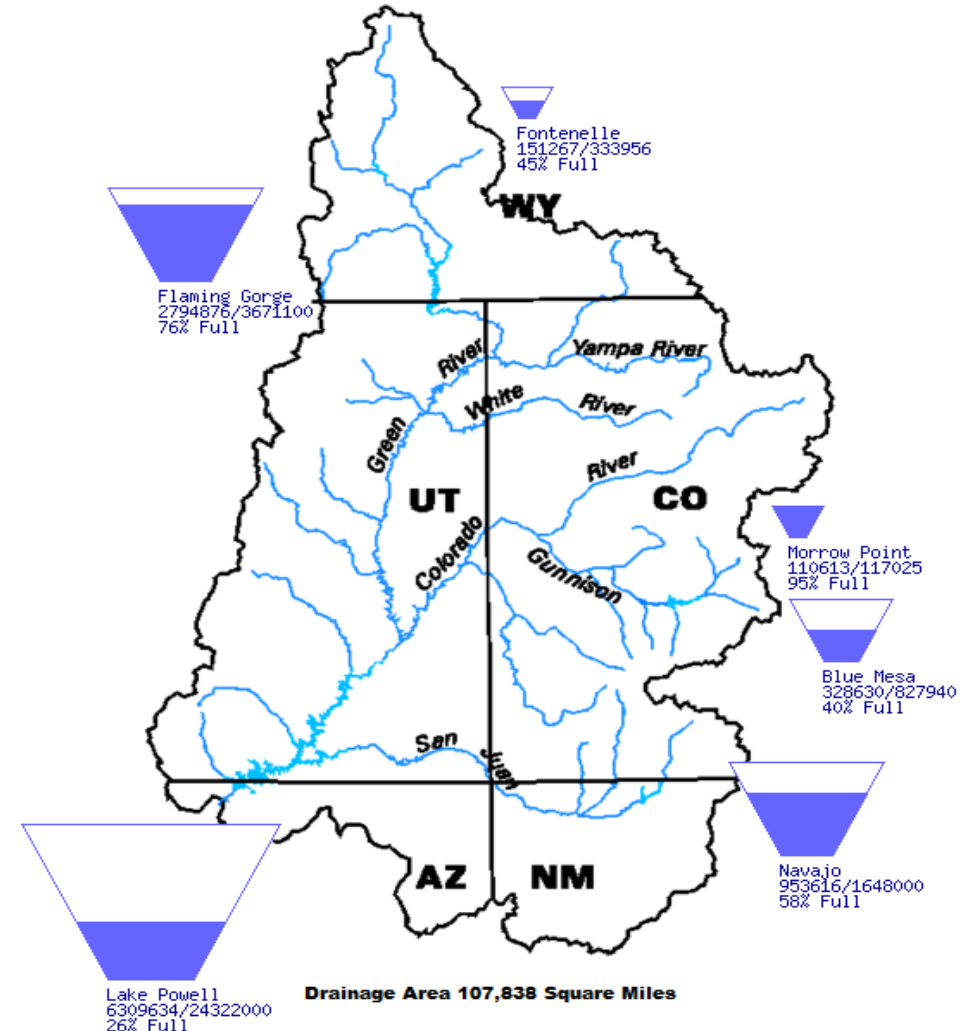


Upper Basin Storage (as of May 30, 2022)

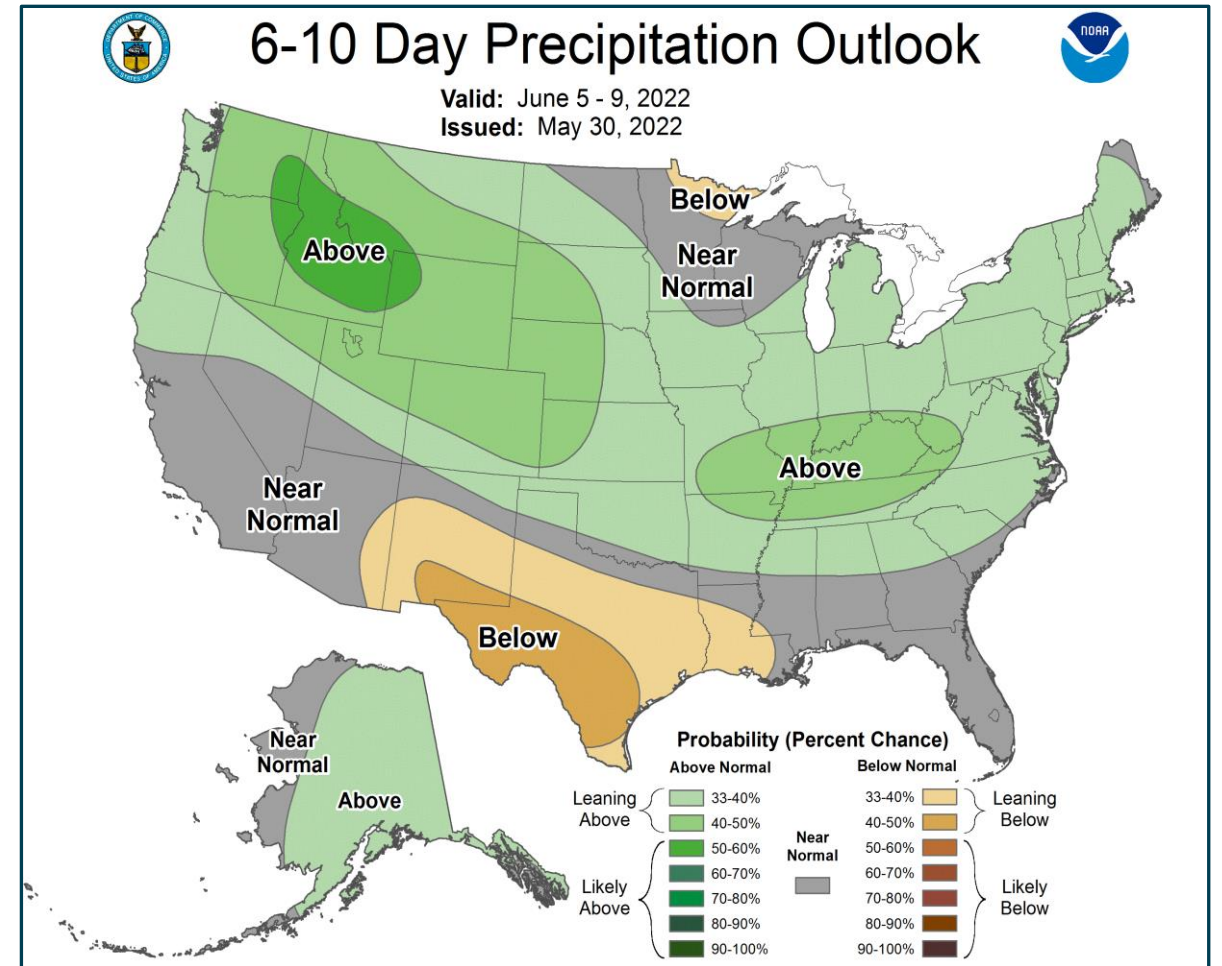
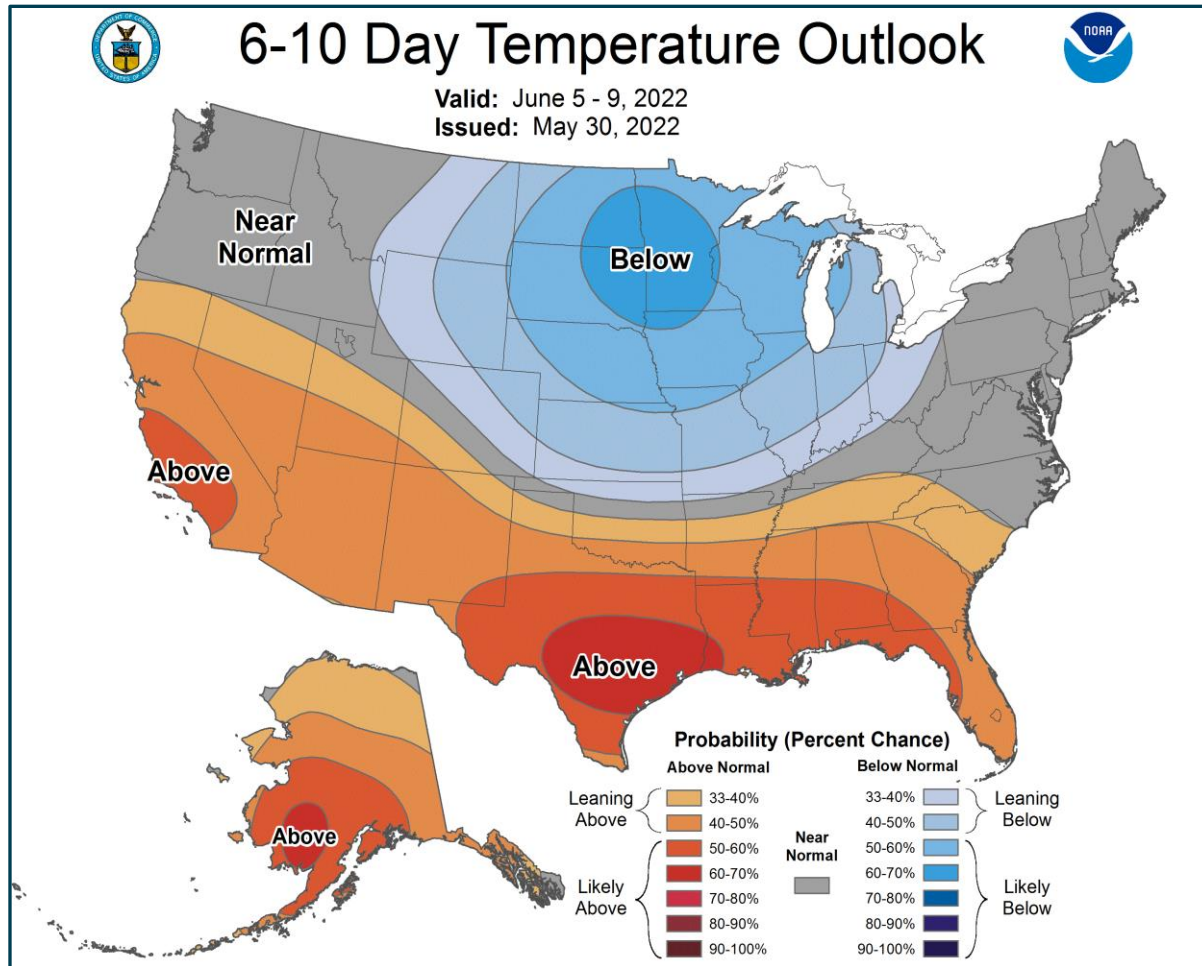
Data Current as of:
05/29/2022

Upper Colorado River Drainage Basin

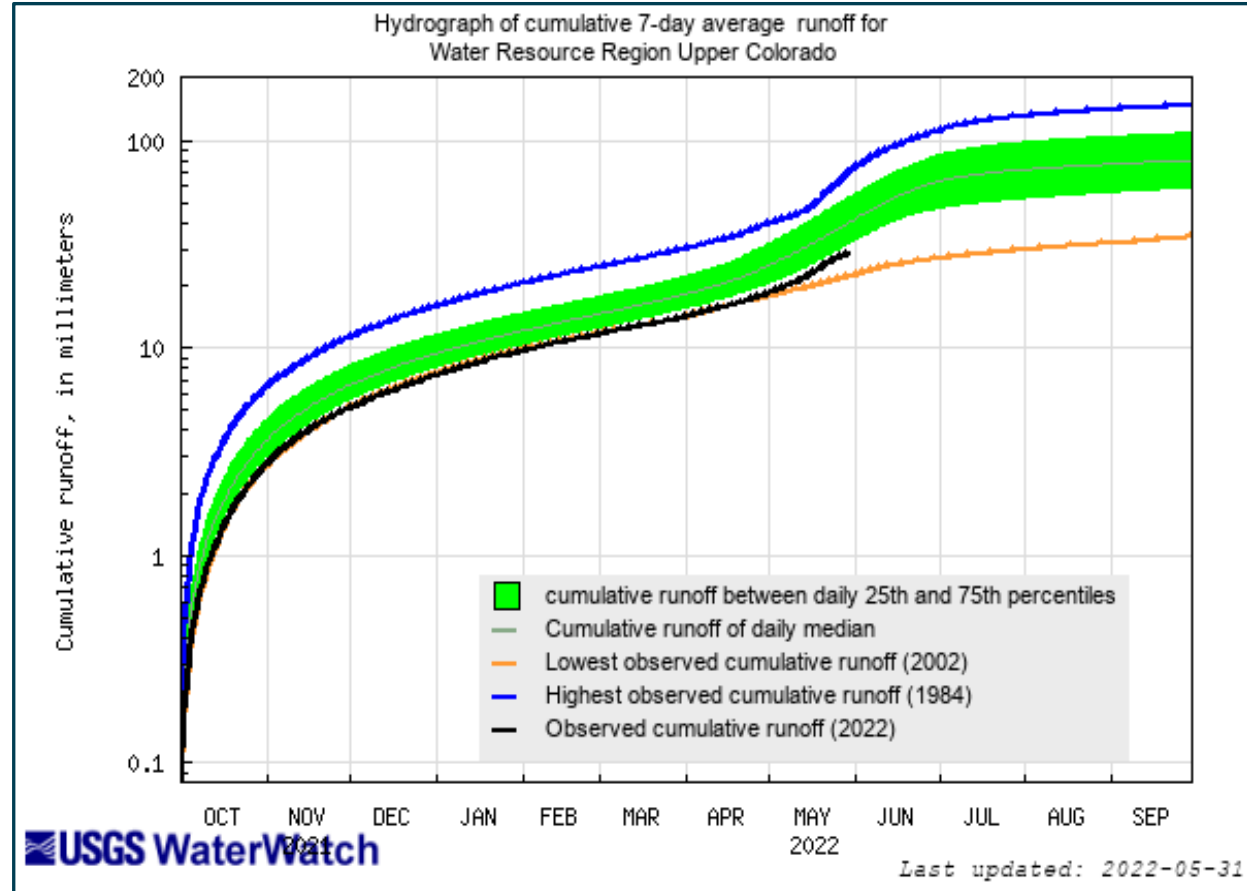
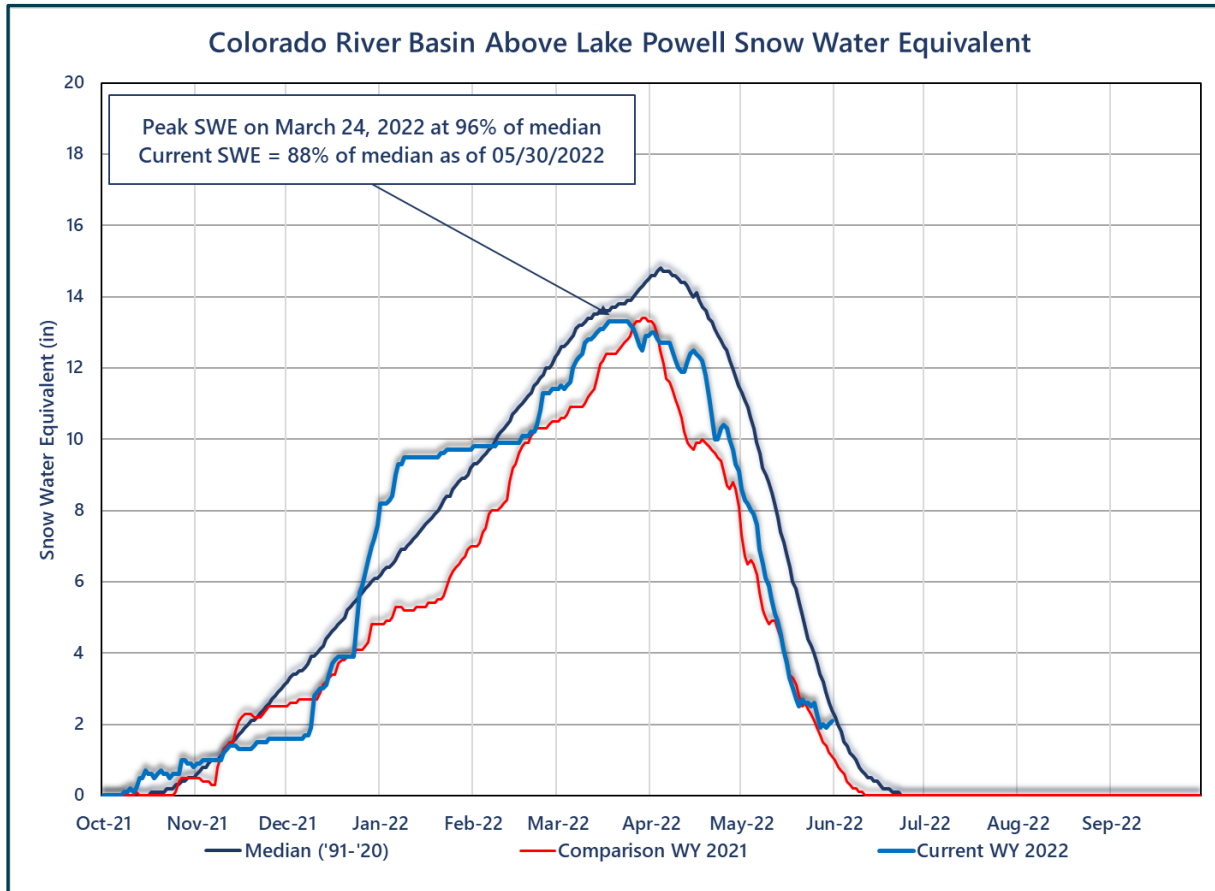
Reservoir	Percent Current Live Storage	Current Live Storage (maf)	Live Storage Capacity (maf)	Elevation (feet)
Fontenelle	46	0.15	0.33	6,479.24
Flaming Gorge	76	2.78	3.67	6,016.13
Blue Mesa	40	0.33	0.83	7,454.13
Navajo	58	0.95	1.65	6,029.40
Lake Powell	26	6.32	24.32	3,531.34
UC System Storage	35	10.67	30.8	



Precipitation and Temperature Outlook



Upper Colorado SWE and Observed Inflows



<https://waterwatch.usgs.gov/index.php>



Most Probable May Final Forecast April-July and WY

April – July 2022
Forecasted Unregulated Inflow
as of May 4, 2022

Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	475	65
Flaming Gorge	550	57
Blue Mesa	490	77
Navajo	380	60
Powell	3,800	59

Water Year 2022
Forecasted Unregulated Inflow
as of May 4, 2022

Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	758	62
Flaming Gorge	890	63
Blue Mesa	708	78
Navajo	544	60
Powell	5,980	62



Most Probable May Mid-Month Forecast April-July and WY

April – July 2022
Forecasted Unregulated Inflow
as of May 18, 2022

Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	450	61
Flaming Gorge	520	54
Blue Mesa	445	70
Navajo	340	54
Powell	3,500	55

Water Year 2022
Forecasted Unregulated Inflow
as of May 18, 2022

Reservoir	Unregulated Inflow (kaf)	Percent of Average ¹
Fontenelle	732	60
Flaming Gorge	860	61
Blue Mesa	664	73
Navajo	503	55
Powell	5,680	59

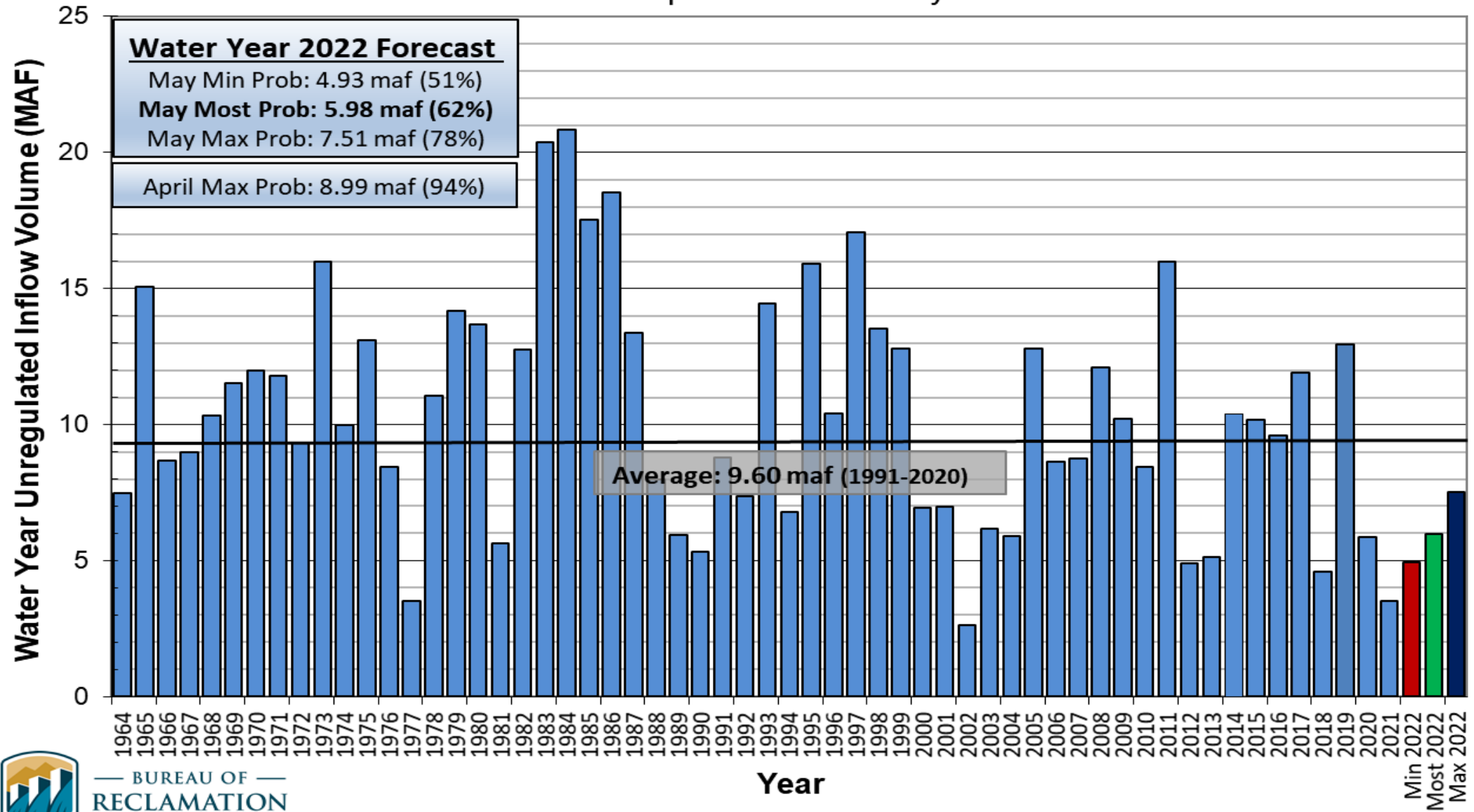
Powell April Forecast 6,310 kaf (65%) - a decrease of 630 kaf



Lake Powell Unregulated Inflow

Water Year 2022 Forecast *(issued May 4)*

Comparison with History



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Upper Colorado Basin

Projected Operations for
Water Year 2022 Based on
April and May 2022
Modeling



Lake Powell & Lake Mead Operational Table

Operating Determinations for Water Year/Calendar Year 2022

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 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	15.5 - 19.3 (2008-2026)	1,200 (approx.) ²	Domestic Surplus or ICS Surplus Condition Deliver > 7.5 maf	22.9 (approx.) ²
3,575	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.5	1,145	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	15.9
	3,535.40 ft		1,105		11.9
			1,075	1,065.85 ft	9.4
3,525	Jan 1, 2022 Projection	5.9	1,050	Shortage Condition Deliver 7.167 ⁴ maf	7.5
3,490	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf	4.0	1,025	Shortage Condition Deliver 7.083 ⁵ maf	5.8
3,370		0	1,000	Shortage Condition Deliver 7.0 ⁶ maf Further measures may be undertaken ⁷	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.

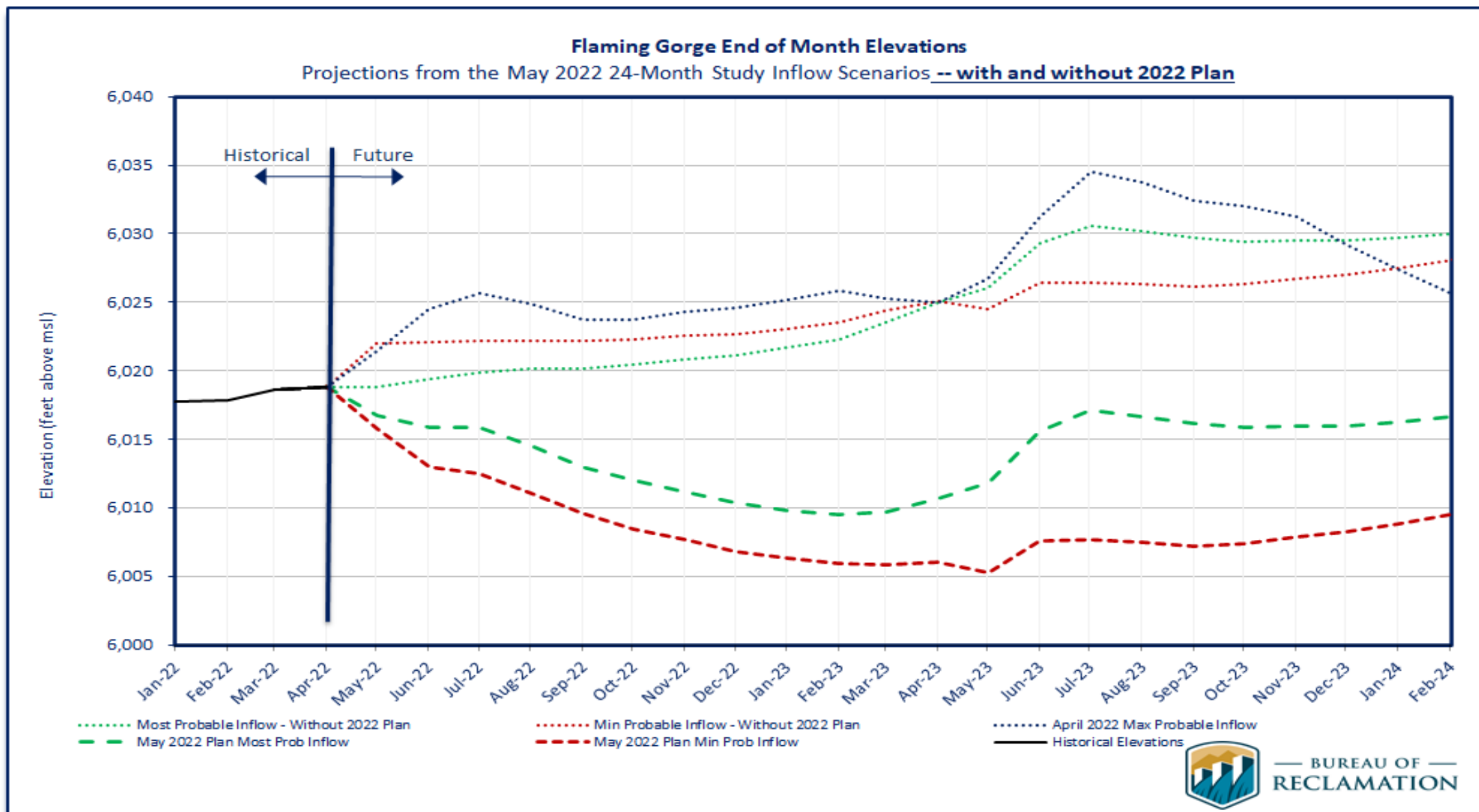
¹ Lake Powell and Lake Mead operating determinations are based on August 2021 24-Month Study projections consistent with the 2007 Interim Guidelines and 2019 Drought Contingency Plans. These determinations will be documented in the 2022 Annual Operating Plan for Colorado River Reservoirs.



Drought Response Actions

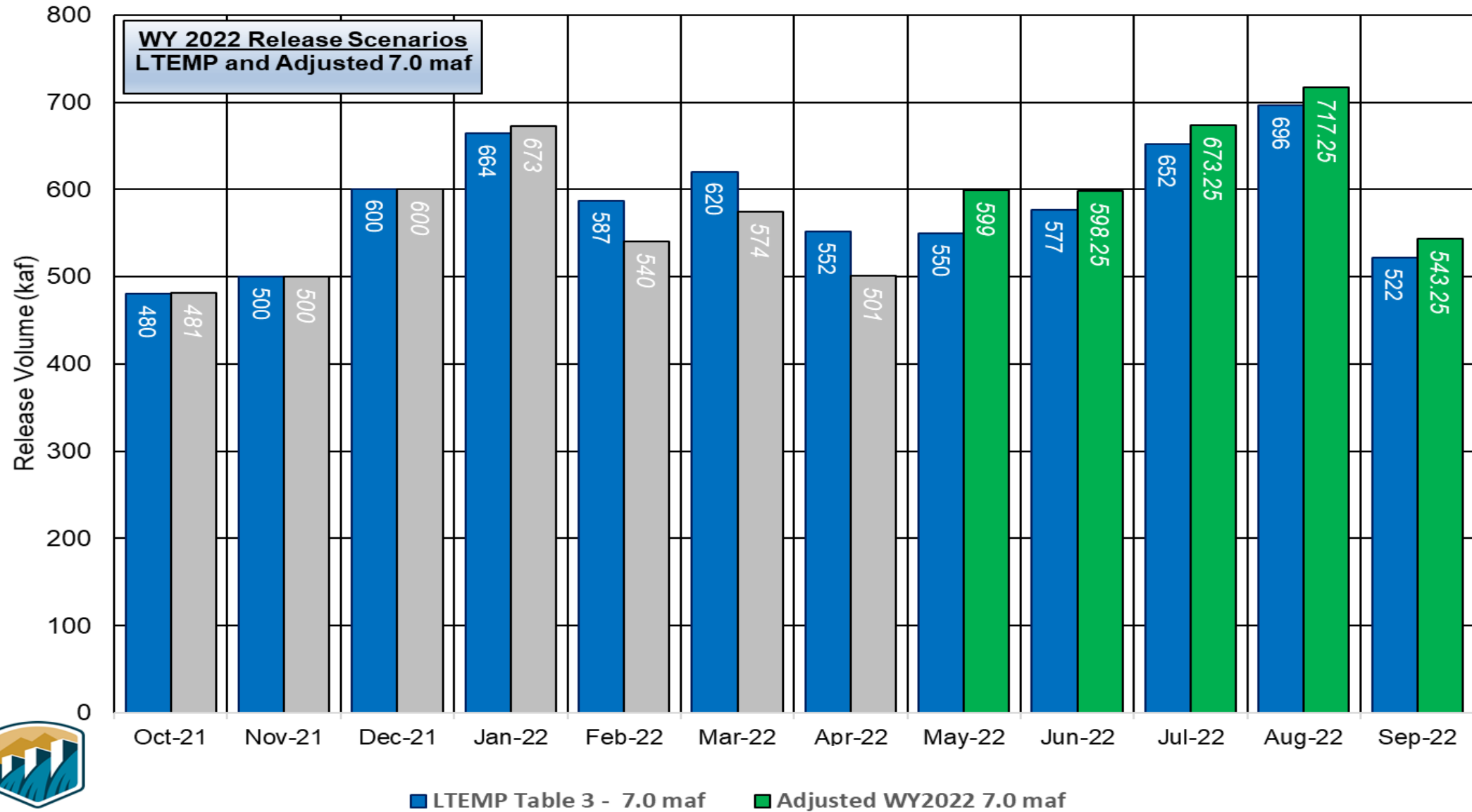
- The Bureau of Reclamation announced on May 3, 2022, two separate urgent drought response actions that will help prop up Lake Powell by nearly 1 million acre-feet (maf) of water over the next 12 months (May 2022 through April 2023). To protect Lake Powell, more water will flow into the lake from upstream reservoirs and less water will be released downstream:
 - Under a Drought Contingency Plan adopted in 2022, approximately 500 thousand acre-feet (kaf) of water will come from Flaming Gorge Reservoir, located approximately 455 river miles upstream of Lake Powell (2022 Plan).
 - For more information: <https://www.usbr.gov/uc/DocLibrary/Plans/20220503-2022DROA-GlenCanyonDamOperationsDecisionLetter-508-DOI.pdf>
 - Another 480 kaf will be left in Lake Powell by reducing Glen Canyon Dam's annual release volume from 7.48 maf to 7.0 maf (GC Operational Adjustment), as outlined in the 2007 Interim Guidelines that control operations of Glen Canyon Dam and Hoover Dam.
 - For more information: <https://www.usbr.gov/uc/DocLibrary/Plans/20220429-2022DroughtResponseOperationsPlan-ApprovalMemo-508-DOI.pdf>





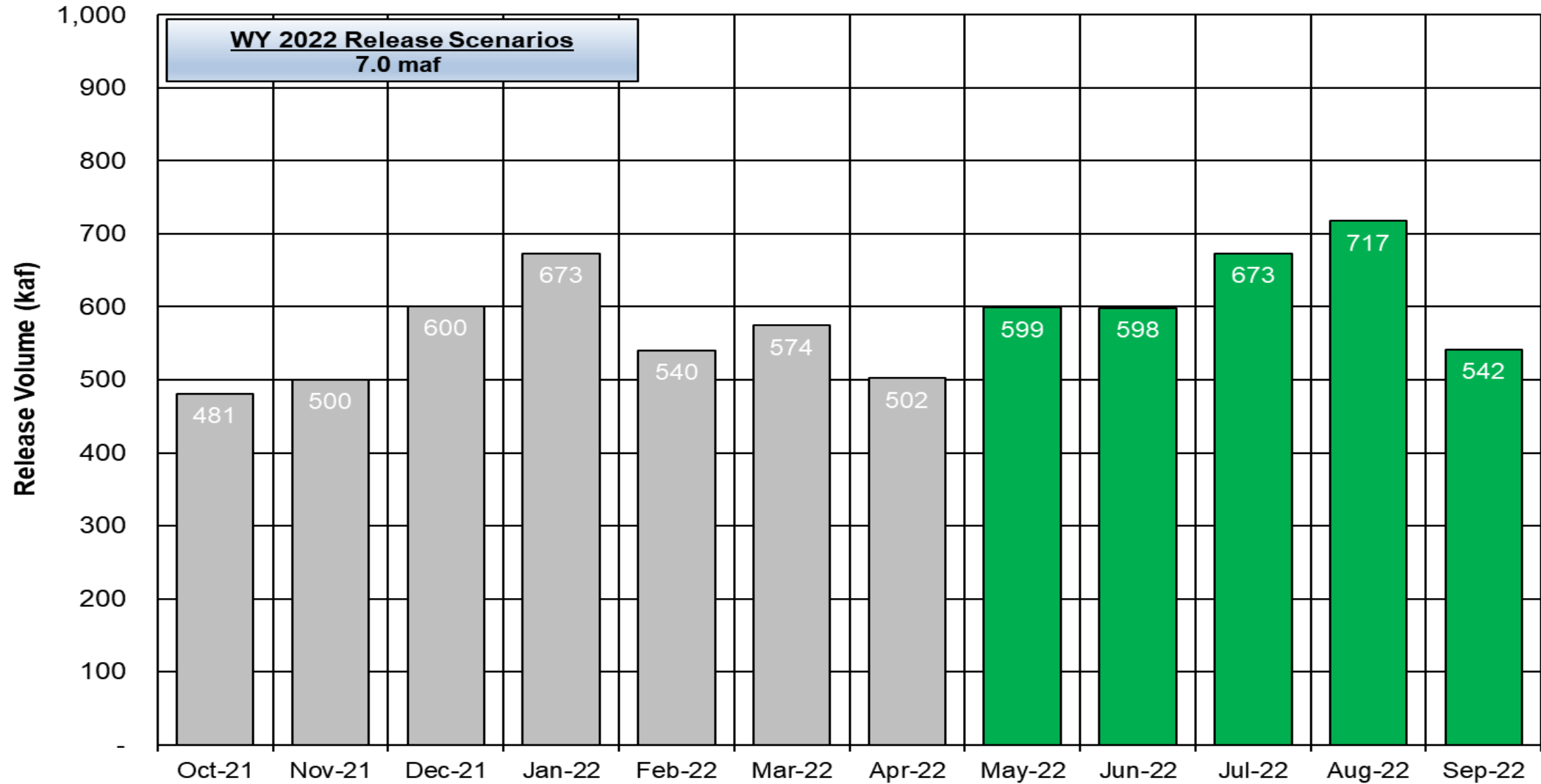
Lake Powell Monthly Release Volume Distribution

7.0 maf Pattern for Water Year 2022



Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2022



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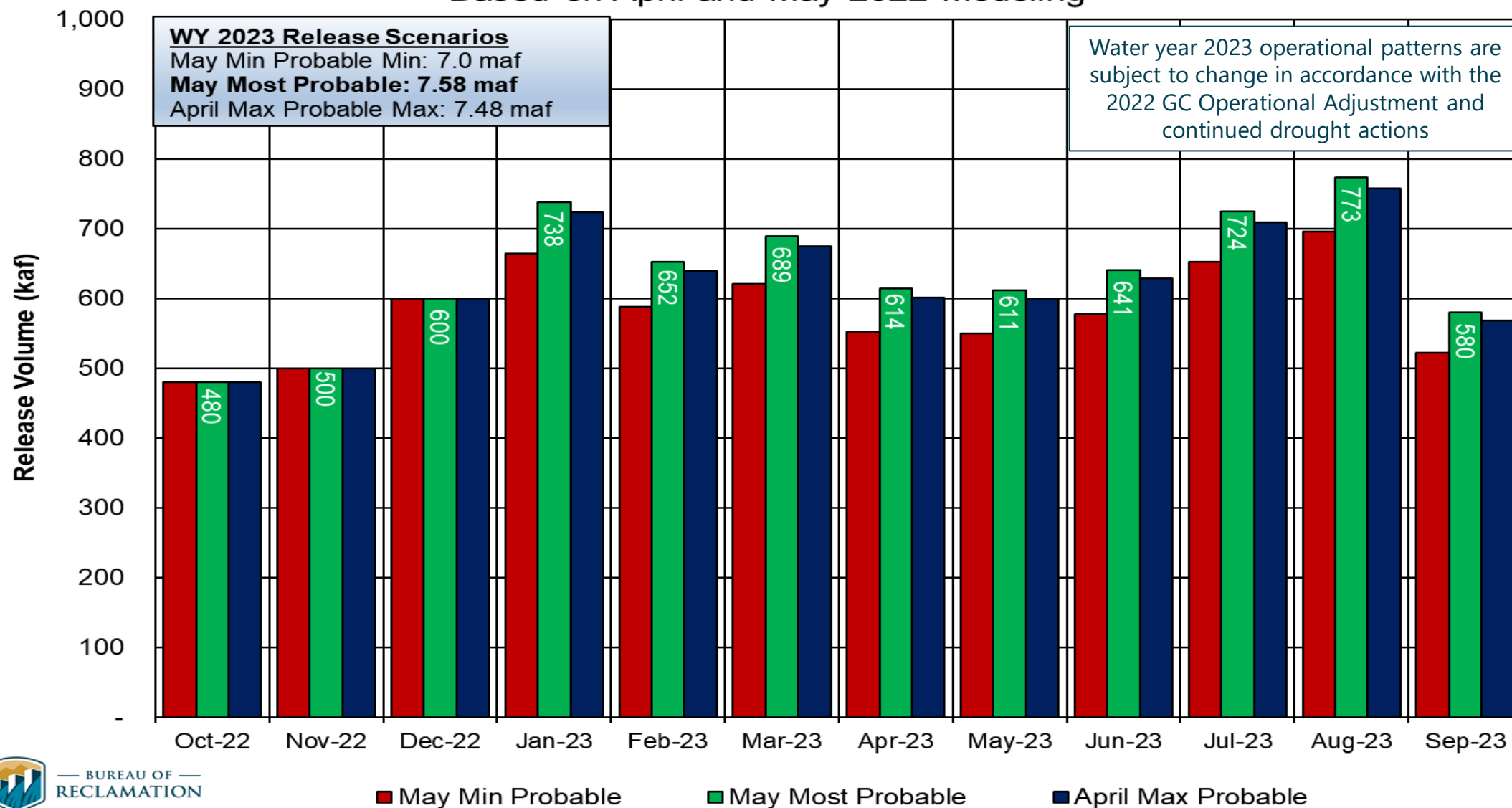
The Drought Response Operations Agreement (DROA) can be found here: <https://www.usbr.gov/dcp/finaldocs.html>



Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2023

Based on April and May 2022 Modeling



Timing of Operational Decisions

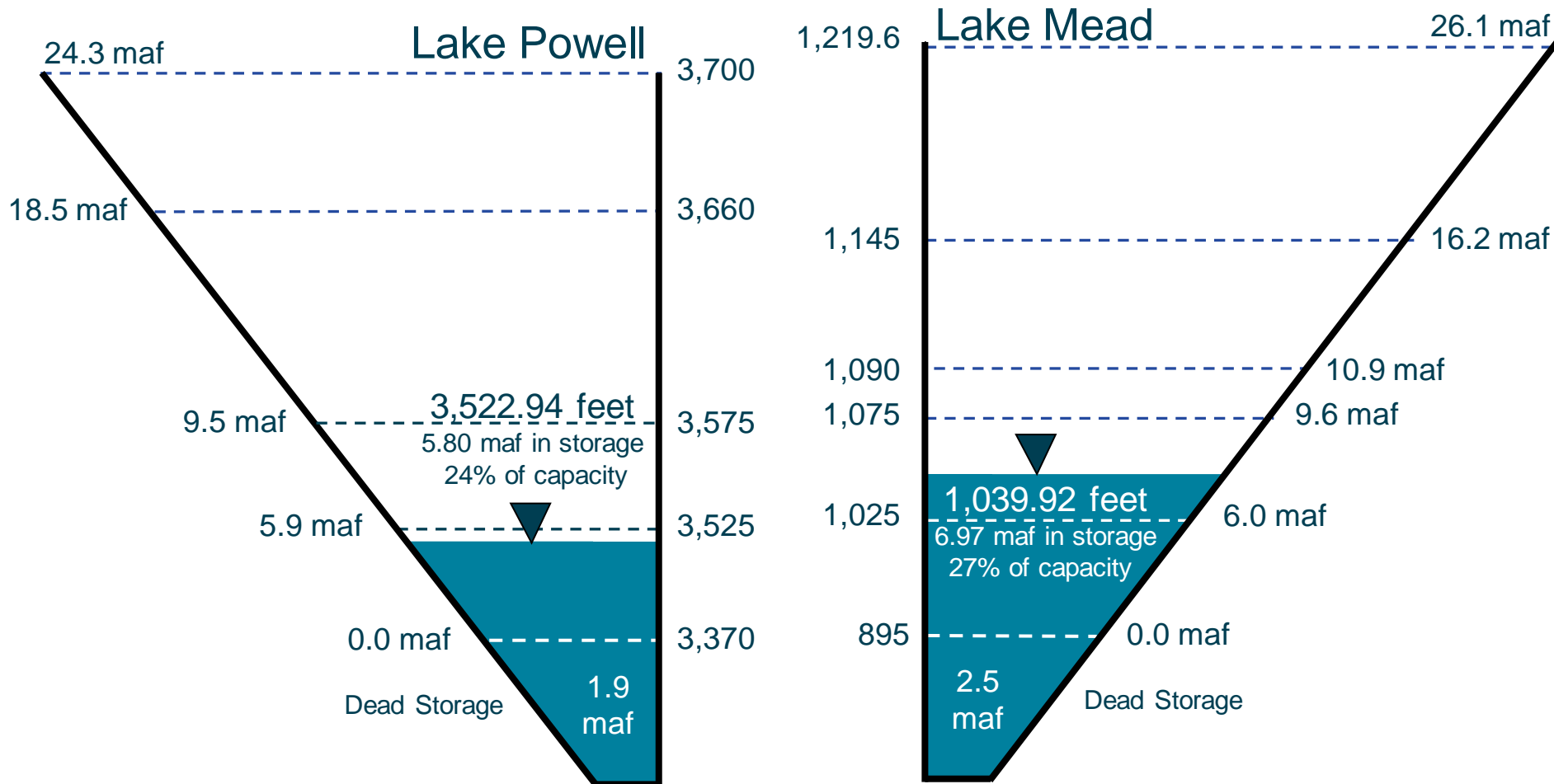
- August 24-Month Study projections of January 1 elevations sets the operating tiers for Lake Powell and Lake Mead



End of Calendar Year 2022 Projections

May 2022 24-Month Study Most Probable Inflow Scenario^{1, 2}

Based on a Lake Powell release of 7.00 maf in WY 2022 and 7.58 maf in WY 2023



Not to Scale

¹ WY 2022 unregulated inflow into Lake Powell is based on the CBRFC forecast dated 5/4/22.

² Projected Physical elevations and storages are shown in the teacup diagram. The projected effective elevation will be used to set the following year's operating tier/operating condition. This elevation includes the 8.23 maf release pattern traditionally used to determine the following year's operating tier, as well as the 480 kaf that would have been released from Lake Powell in WY 2022, absent the 2022 Drought Response Operations Plan. The projected effective End of Calendar Year 2022 Elevation from the May 2022 24-Month Study is 3,507.95 feet at Lake Powell and 1,046.78 feet at Lake Mead.



End of Calendar Year 2022 Projections: Effective and Tier Determination Elevations

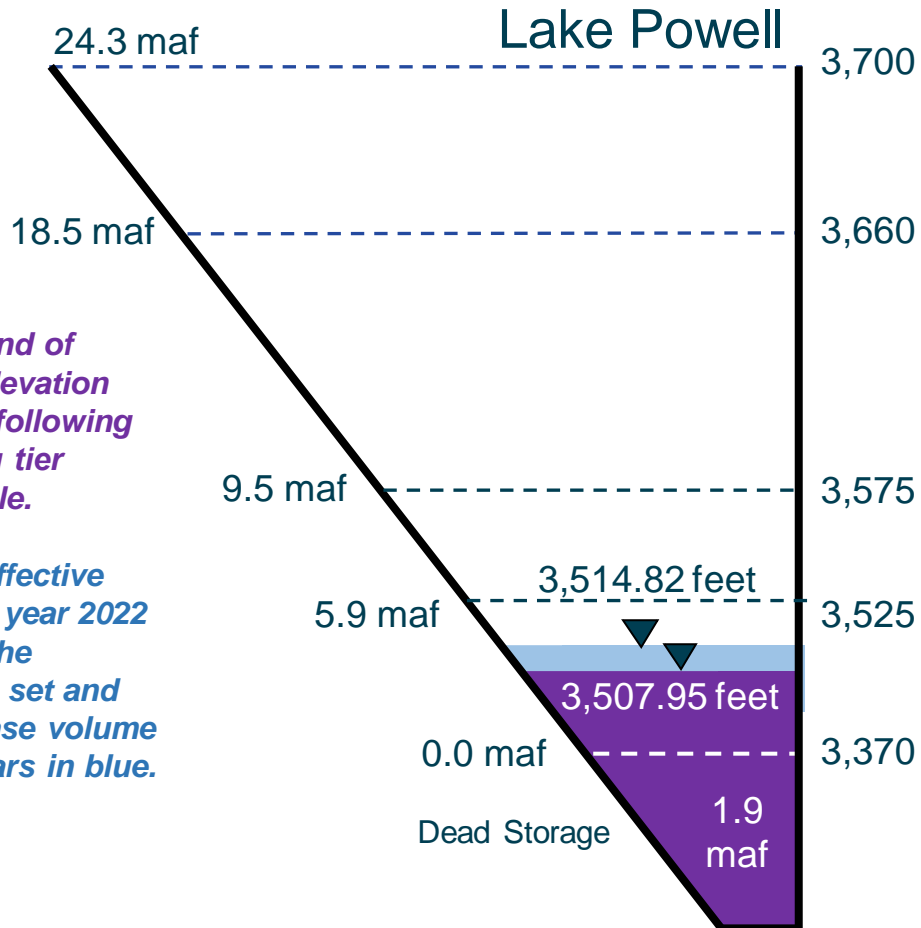
May 2022 24-Month Study Most Probable Inflow Scenario¹

Based on a Lake Powell release of 7.00 maf in WY 2022 and 7.58 maf in WY 2023

Lake Powell

The projected end of calendar year elevation used to set the following year's operating tier appears in purple.

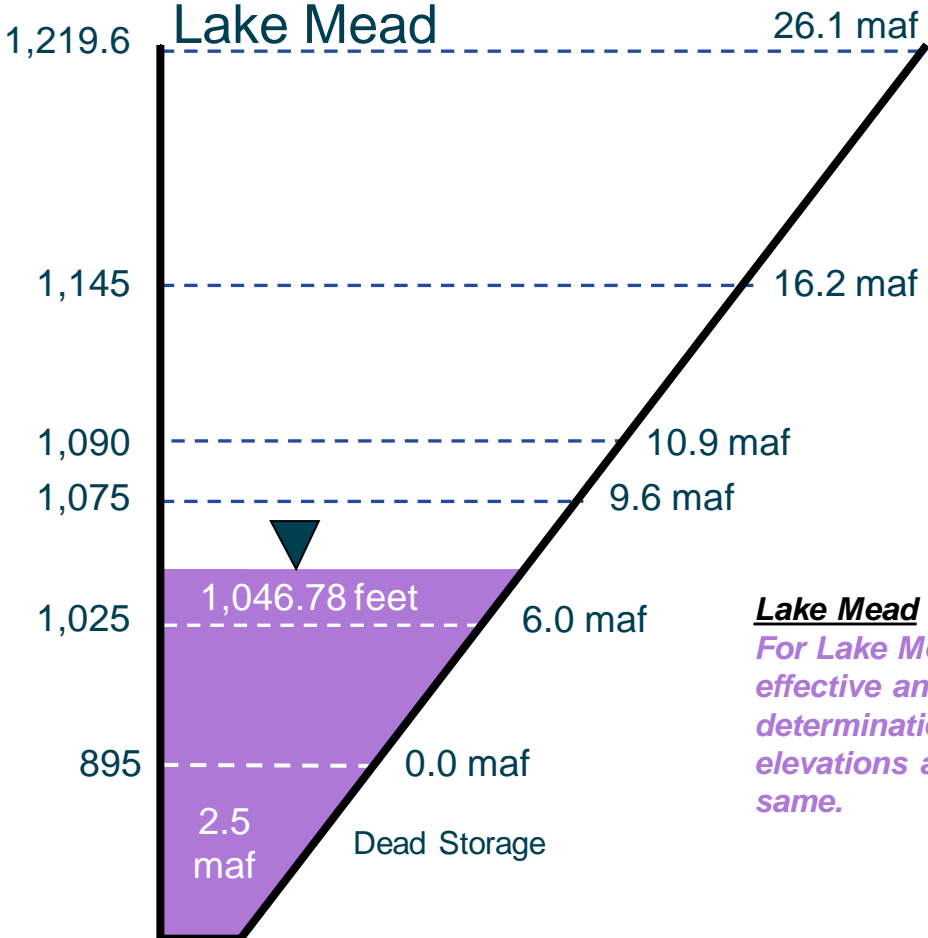
The projected effective end of calendar year 2022 elevation after the operating tier is set and the annual release volume is revised appears in blue.



Not to Scale

¹ WY 2022 unregulated inflow into Lake Powell is based on the CBRFC forecast dated 5/4/22.

Lake Mead



Lake Mead

For Lake Mead, the effective and tier determination elevations are the same.



Lake Powell WY 2023 Operating Tier Scenarios


Based on May 2022 24-Month Study Inflow Scenarios

Inflow Scenario	Operating Tier/ Release Volume
May DROA* Minimum Probable	Lower Elevation Balancing 7.00 maf
May Most Probable	Lower Elevation Balancing 7.58 maf
April DROA* Maximum Probable	Mid-Elevation Release 7.48 maf

*The Drought Response Operations Agreement (DROA) can be found online at:
<https://www.usbr.gov/dcp/finaldocs.html>.



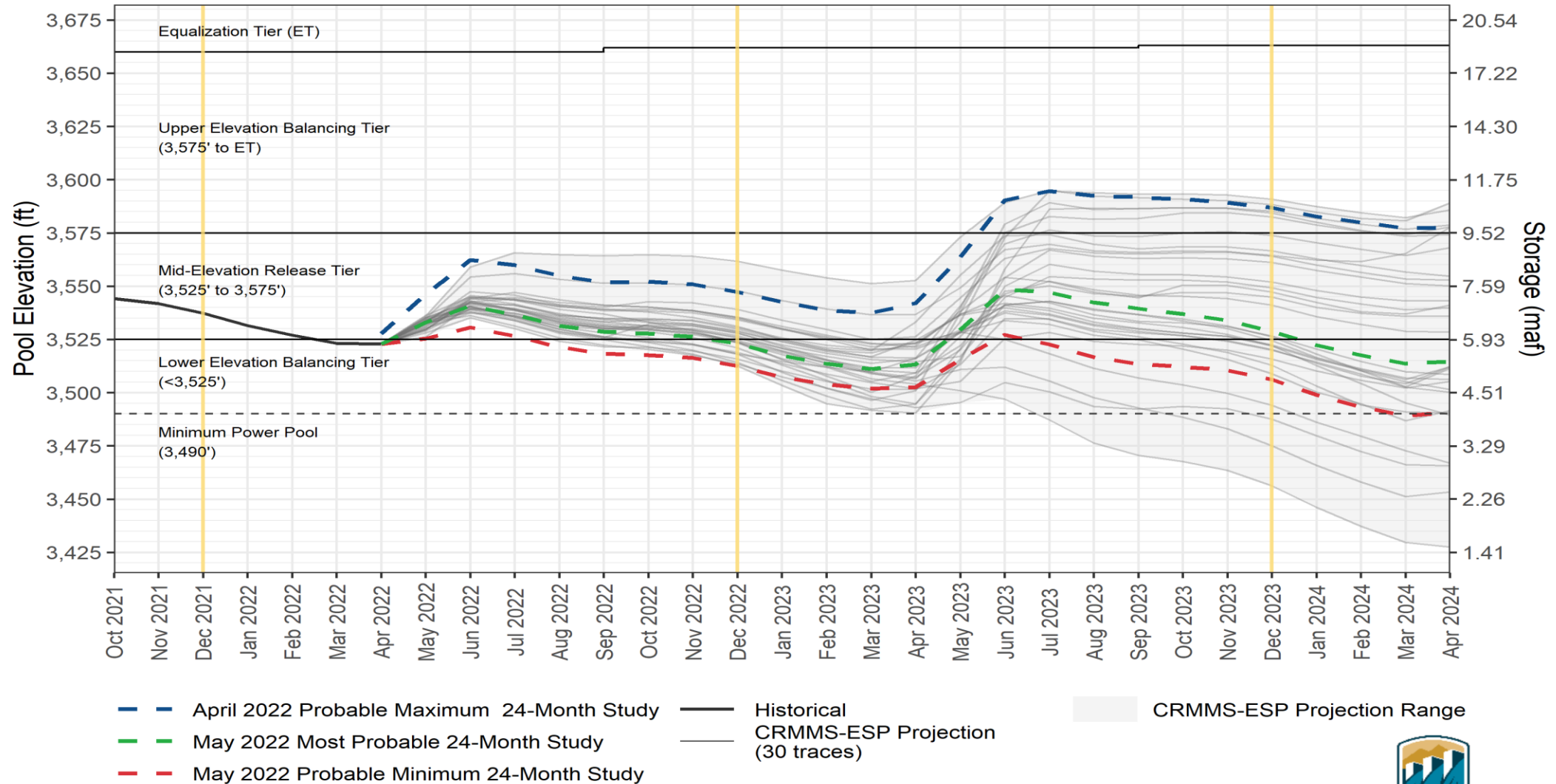
Reclamation Operational Modeling Model Comparison

	<i>Colorado River Mid-term Modeling System (CRMMS)</i>		<i>CRSS</i>
	<i>24-Month Study Mode (Manual Mode)</i>	<i>Ensemble Mode (Rule-based Mode)</i>	
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)			
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

CRMMS Projections from April and May 2022



Projected Lake Powell end-of-month physical elevations from the latest CRMMS-ESP and 24-Month Study inflow scenarios. Note: The April 2022 Probable Maximum 24-Month Study projection does not reflect the action taken in May to reduce the water year 2022 release from Glen Canyon dam by 480 kaf. The probable maximum scenario will be adjusted for this action the next time it is run. CRMMS 2-Year Probabilistic Projections are available online at: <https://www.usbr.gov/lc/region/q4000/riverops/crmms-2year-projections.html>



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	
1													
2													
3													
4													
5													
6													
7													
8													
Units Available	6	6	6	6	5	4	6	5	6	6	6	6	
Capacity (cfs)	18,700	18,600	11,700	18,700	14,800	11,300	17,900	14,900	18,570	18,440	18,270	18,170	MAY MOST ²
Capacity (kaf/month)	1,150	1,110	1,110	1,160	810	980	1,000	1,050	1,090	1,130	1,120	1,080	MAY MOST
Max (kaf) ¹	481	500	600	673	540	575	502	599	598	673	717	542	7.0 maf
Most (kaf) ¹	481	500	600	673	540	575	502	599	598	673	717	542	7.0 maf
Min (kaf) ¹	481	500	600	673	540	575	502	599	598	673	717	542	7.0 maf
										(updated 05-17-2022)			

1 Projected release, based on May 2022 minimum and most and April 2022 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 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													
4													
5													
6													
7													
8													
Units Available	5	6	6	6	4	6	6	6	6	6	6	4	
Capacity (cfs)	14,790	18,100	17,980	17,750	13,050	17,470	17,500	18,100	18,700	18,630	18,440	11,500	MAY MOST ²
Capacity (kaf/month)	950	1,080	1,110	1,060	670	1,035	1,040	1,110	1,110	1,140	1,130	750	MAY 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	738	652	639	614	611	641	724	773	580	7.58 maf
Min (kaf) ¹	480	500	600	664	587	620	552	550	577	652	696	522	7.0 maf
										(updated 05-17-2022)			

1 Projected release, based on May 2022 minimum and most and April 2022 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.



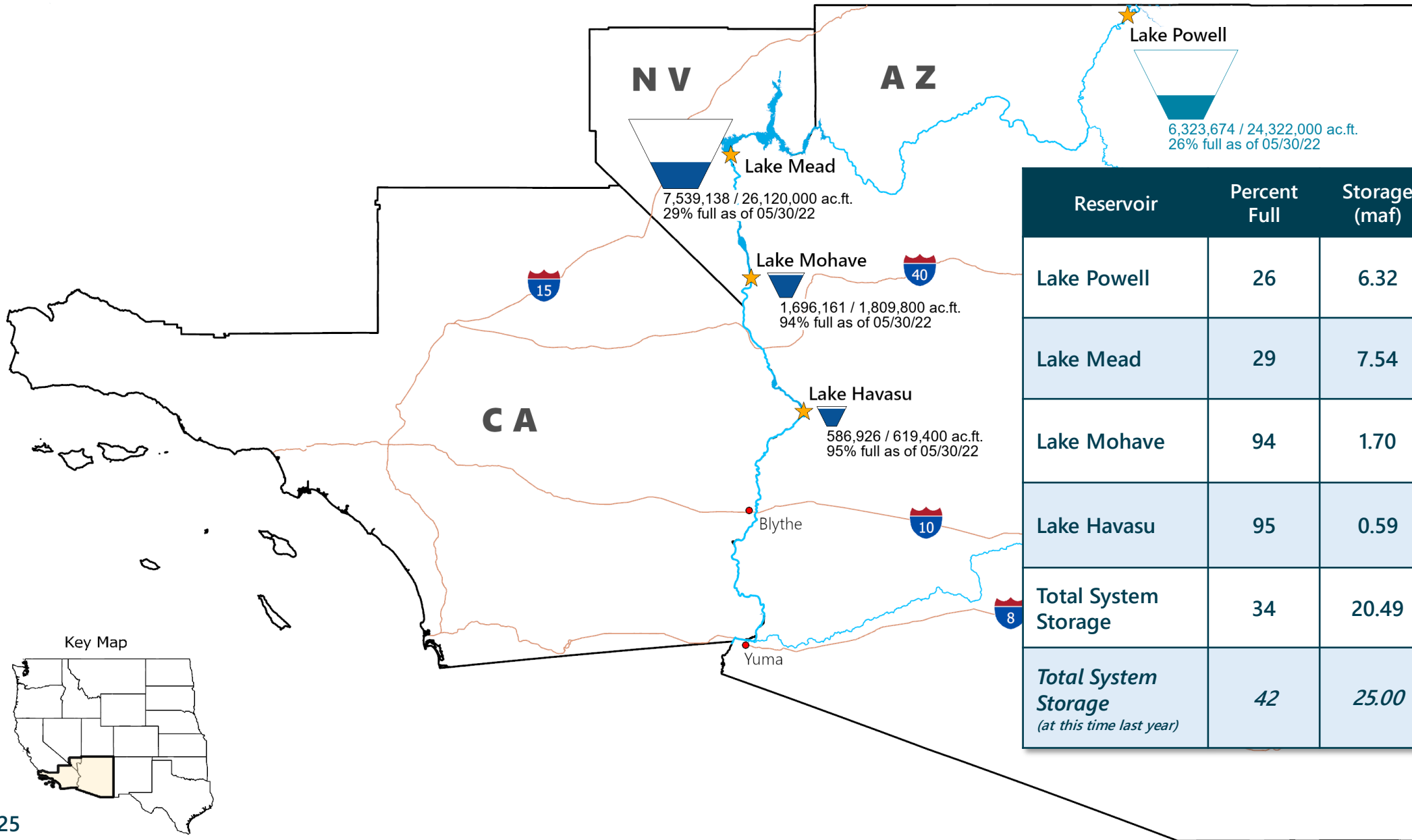


Lower Colorado Basin

Calendar Year 2022 Operations Update



Lower Colorado Basin System Conditions (as of May 30, 2022)



Reservoir	Percent Full	Storage (maf)	Elevation (feet)
Lake Powell	26	6.32	3,531.34
Lake Mead	29	7.54	1,048.00
Lake Mohave	94	1.70	642.91
Lake Havasu	95	0.59	448.36
Total System Storage	34	20.49	-
<i>Total System Storage (at this time last year)</i>	<i>42</i>	<i>25.00</i>	-



Lower Basin Side Inflows – WY/CY 2022^{1,2,3}

Intervening Flow from Glen Canyon to Hoover Dam

Month in WY/CY 2022		5-Year Average Intervening Flow (kaf)	Observed Intervening Flow (kaf)	Observed Intervening Flow (% of Average)	Difference From 5-Year Average (kaf)
Observed	October 2021	69	80	116%	11
	November 2021	68	42	62%	-26
	December 2021	69	64	94%	-4
	January 2022	87	60	69%	-27
	February 2022	88	58	65%	-31
	March 2022	107	42	40%	-65
	April 2022	72	32	44%	-40
Projected	May 2022	43			
	June 2022	22			
	July 2022	56			
	August 2022	66			
	September 2022	62			
	October 2022	69			
	November 2022	68			
	December 2022	69			
	WY 2022 Totals	810	628	78%	-182
	CY 2022 Totals	810	647	80%	-163

¹ Values were computed with the LC's gain-loss model for the most recent 24-month study.

² Percents of average are based on the 5-year mean from 2017-2021.

³ Lake Mead's evaporation in the intervening flow mass balance incorporates evaporation coefficients developed by the USGS between 2010-2019. The study report can be found online at: <https://pubs.usgs.gov/of/2021/1022/ofr20211022.pdf>



Lake Powell & Lake Mead Operational Table

Operational Tiers for Water/Calendar Year 2022¹

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 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	15.5 - 19.3 (2008-2026)	1,200 (approx.) ²	Domestic Surplus or ICS Surplus Condition Deliver > 7.5 maf	22.9 (approx.) ²
3,575			1,145	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	15.9
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.5	1,105		11.9
			1,075		9.4
				Shortage Condition Deliver 7.167 ⁴ maf	
			1,050	Shortage Condition Deliver 7.083 ⁵ maf	7.5
3,525		5.9	1,025		5.8
	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
3,490					
3,370		0	895		0

3,535.40 ft
Jan 1, 2022
Projection

1,065.85 ft
Jan 1, 2022
Projection

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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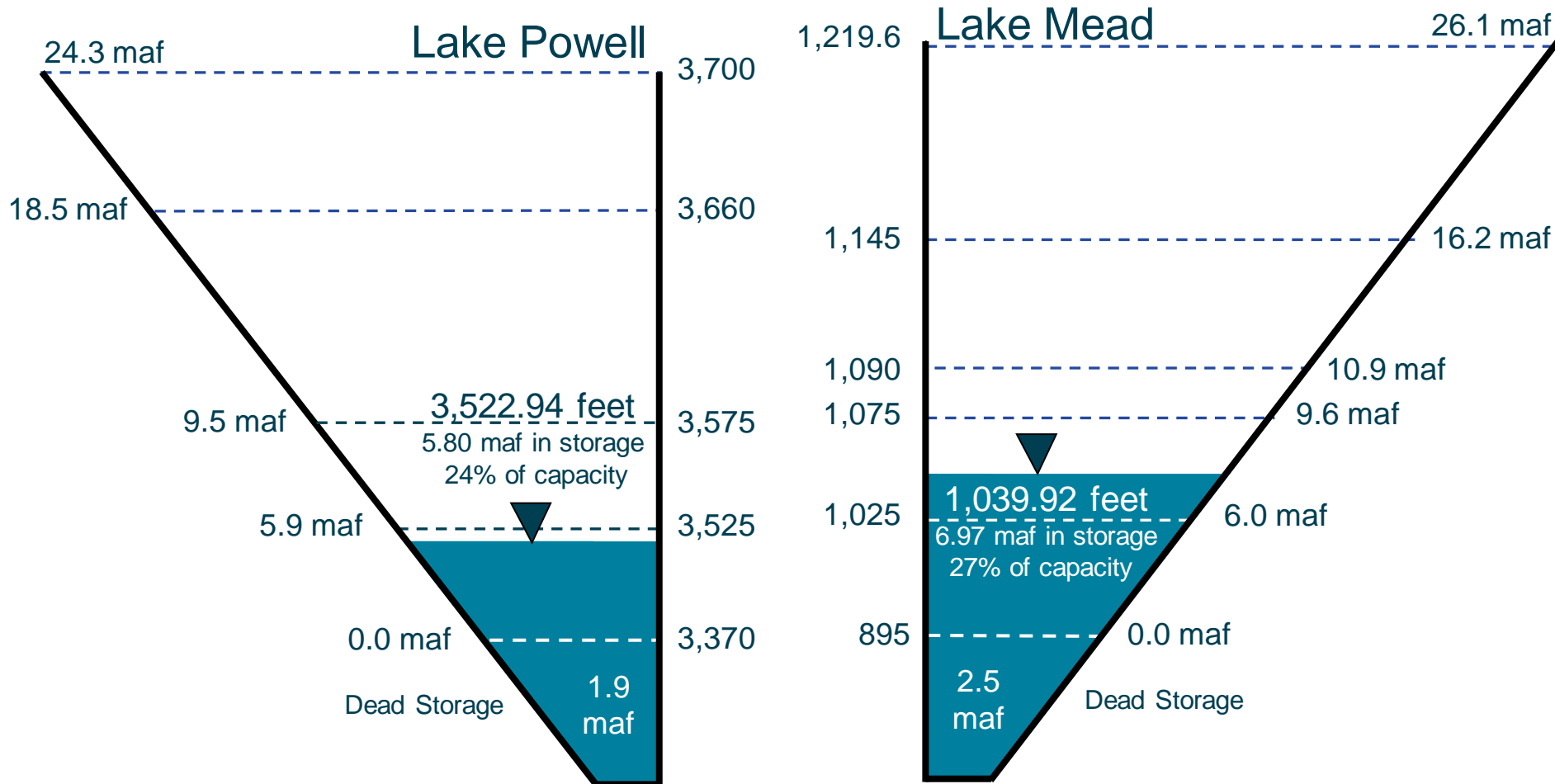
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End of Calendar Year 2022 Projections

May 2022 24-Month Study Most Probable Inflow Scenario^{1, 2}

Based on a Lake Powell release of 7.00 maf in WY 2022 and 7.58 maf in WY 2023



Not to Scale

¹ WY 2022 unregulated inflow into Lake Powell is based on the CBRFC forecast dated 5/4/22.

² Projected Physical elevations and storages are shown in the teacup diagram. The projected effective elevation will be used to set the following year's operating tier/operating condition. This elevation includes the 8.23 maf release pattern traditionally used to determine the following year's operating tier, as well as the 480 kaf that would have been released from Lake Powell in WY 2022, absent the 2022 Drought Response Operations Plan. The projected effective End of Calendar Year 2022 Elevation from the May 2022 24-Month Study is 3,507.95 feet at Lake Powell and 1,046.78 feet at Lake Mead.



End of Calendar Year 2022 Projections: Effective and Tier Determination Elevations

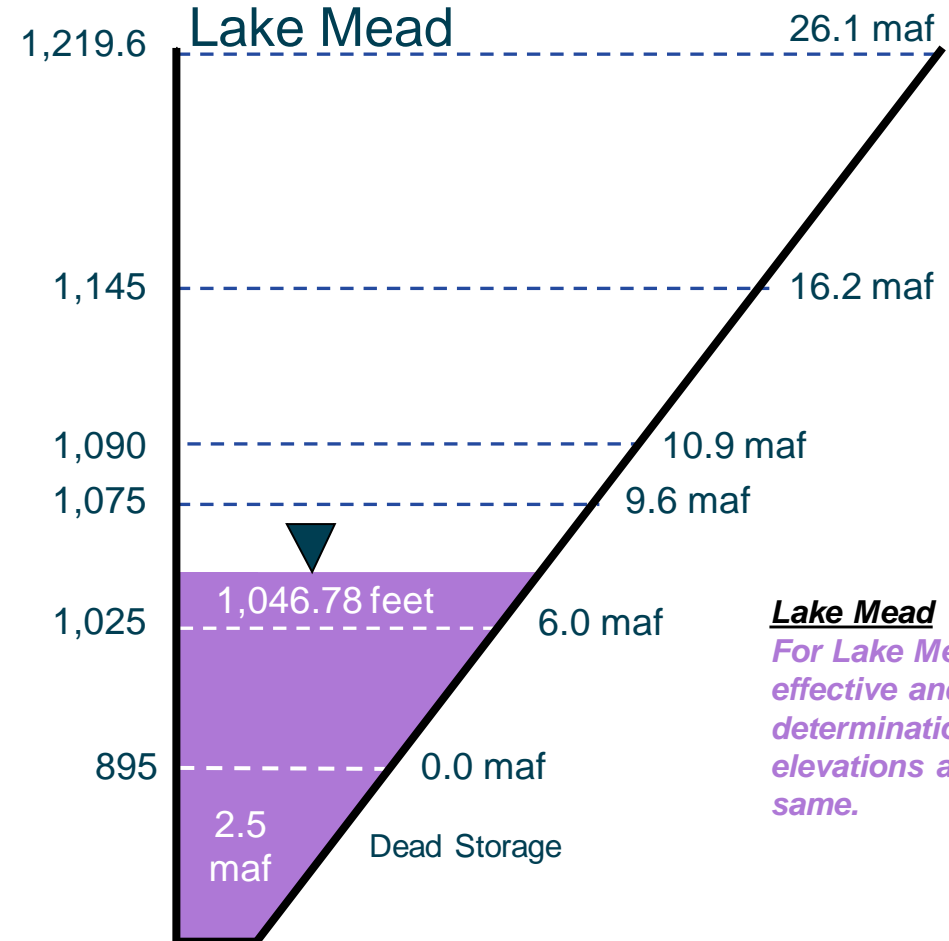
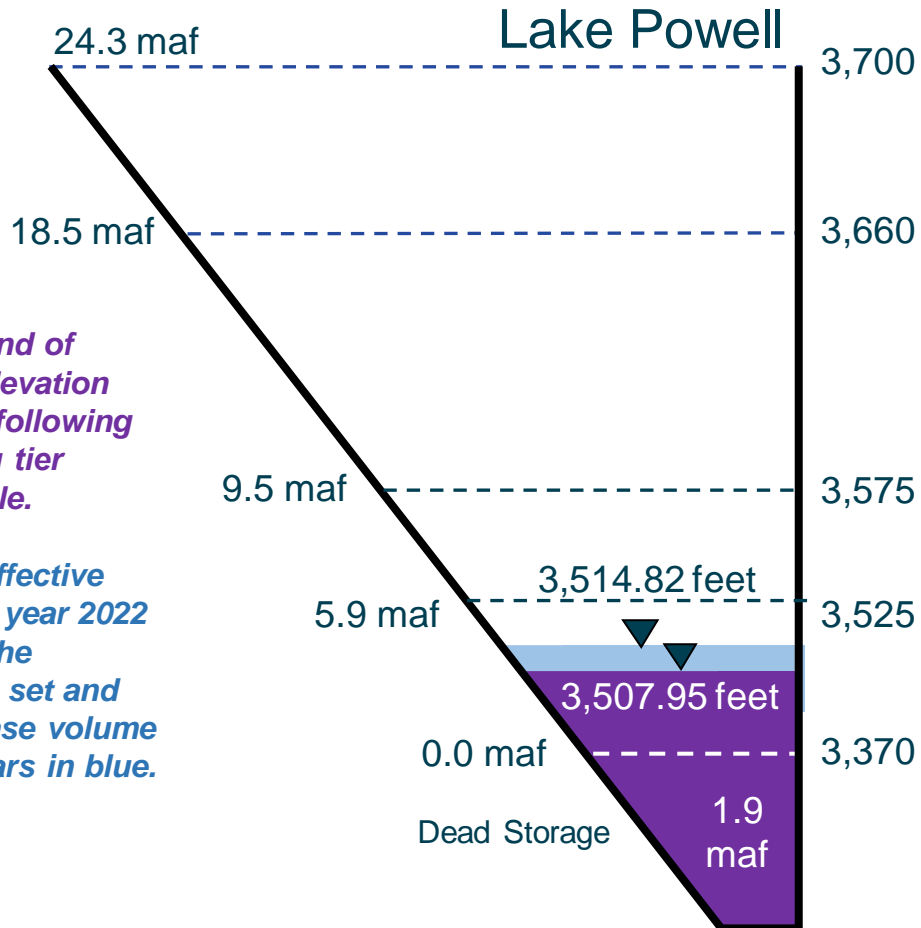
May 2022 24-Month Study Most Probable Inflow Scenario¹

Based on a Lake Powell release of 7.00 maf in WY 2022 and 7.58 maf in WY 2023

Lake Powell

The projected end of calendar year elevation used to set the following year's operating tier appears in purple.

The projected effective end of calendar year 2022 elevation after the operating tier is set and the annual release volume is revised appears in blue.



Lake Mead

For Lake Mead, the effective and tier determination elevations are the same.

Not to Scale



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

Total Volumes (kaf)

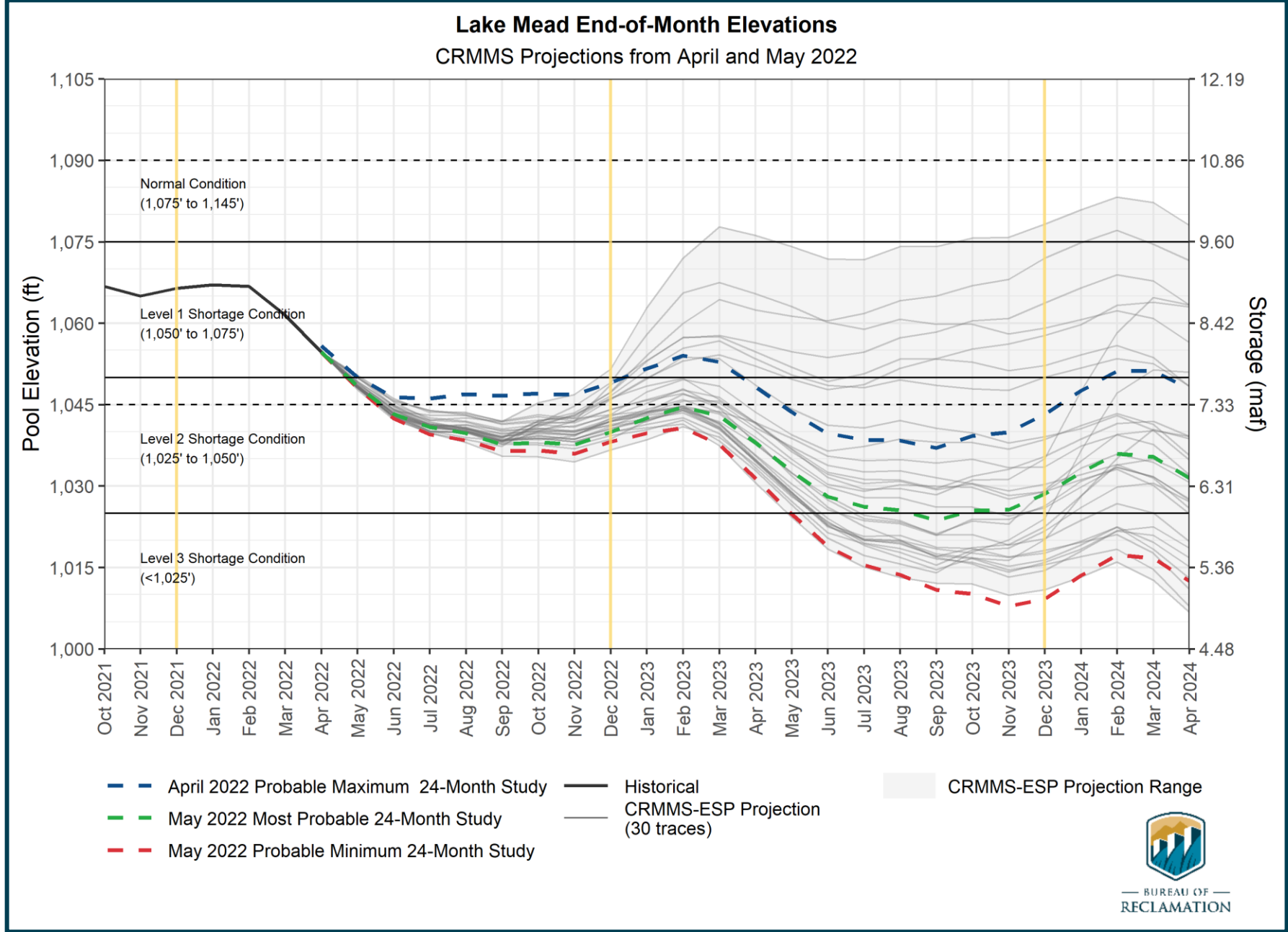
Lake Mead Elevation (feet msl)	2007 Interim Guidelines Shortages		Minute 323 Delivery Reductions	Total Combined Reductions	DCP Water Savings Contributions			Binational Water Scarcity Contingency Plan Savings	Combined Volumes by Country <i>US: (2007 Interim Guidelines Shortages + DCP Contributions)</i> <i>Mexico: (Minute 323 Delivery Reductions + Binational Water Scarcity Contingency Plan Savings)</i>					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 - 1,050	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

➔
**Projected 2023
Reductions +
Contributions**

←
**Projected 2023
Reductions +
Contributions**

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





Projected Lake Mead end-of-month physical elevations from the latest CRMMS-ESP and 24-Month Study inflow scenarios. Note: The April 2022 Probable Maximum 24-Month Study projection does not reflect the action taken in May to reduce the water year 2022 release from Glen Canyon dam by 480 kaf. The probable maximum scenario will be adjusted for this action the next time it is run. CRMMS 2-Year Probabilistic Projections are available online at: <https://www.usbr.gov/lc/region/g4000/riverops/crmms-2year-projections.html>



Additional Operational Data

Provisional 2022 Year-to-Date Totals

- Mexico Excess Flows
 - 1,403 af (through 5/30)
- Brock Reservoir Total Storage
 - 45,083 af (through 5/27)
- Senator Wash Total Storage
 - 37,529 af (through 5/27)



YAO Operations Update

- Pumped drainage return flows from the Wellton-Mohawk Irrigation and Drainage District
 - Flow at station 0+00 on the Main Outlet Drain from January through April 2022 was 32,686 ac-ft at 2,564 ppm
- Provisional drainage flows to the Colorado River
 - From the South Gila Drainage Wells January through April 2022 was 396 ac-ft at 1,739 ppm
 - From the Yuma Mesa Conduit January through April 2022 was 12,201 ac-ft at 1,270 ppm



2023 Colorado River Annual Operating Plan
Colorado River Management Work Group
First Consultation
June 1, 2022



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