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# Glen Canyon Monthly Operations Call

## Basin Hydrology and Operations

March 23, 2022

# 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.”

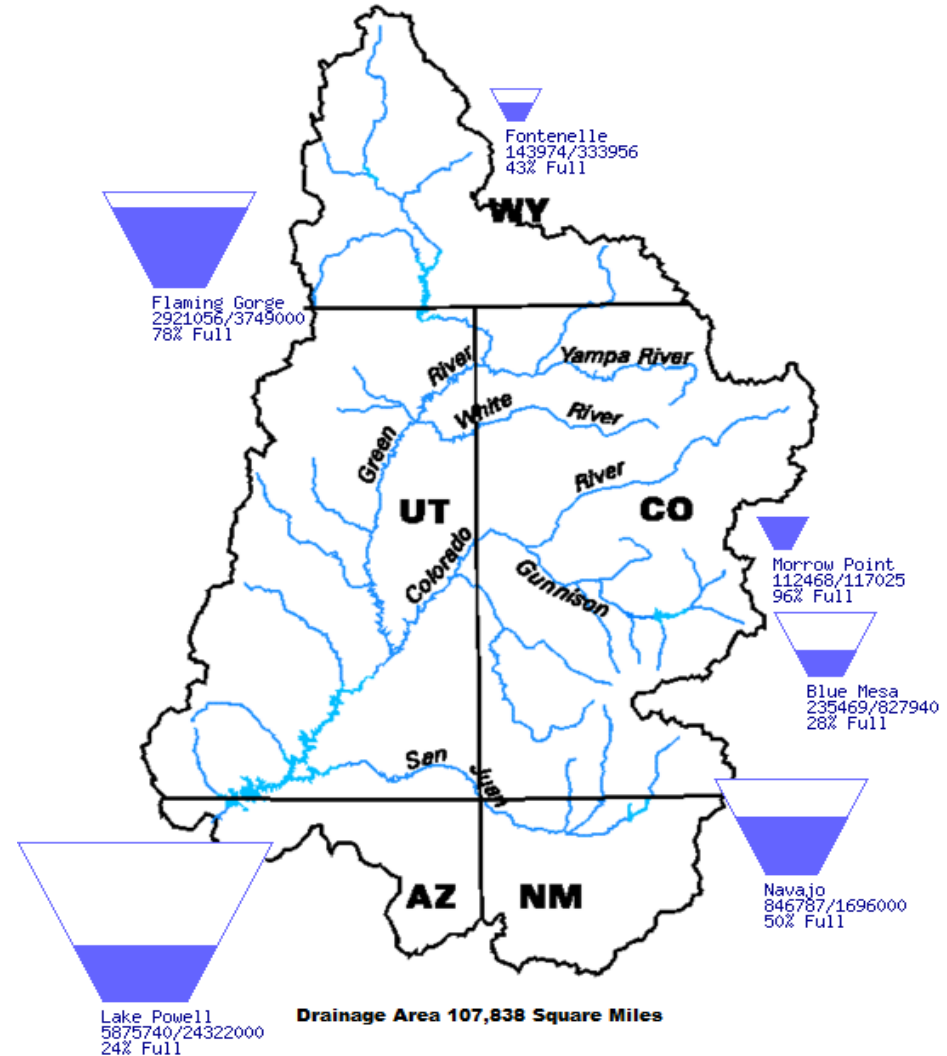


# Upper Basin Storage (as of March 22, 2022)

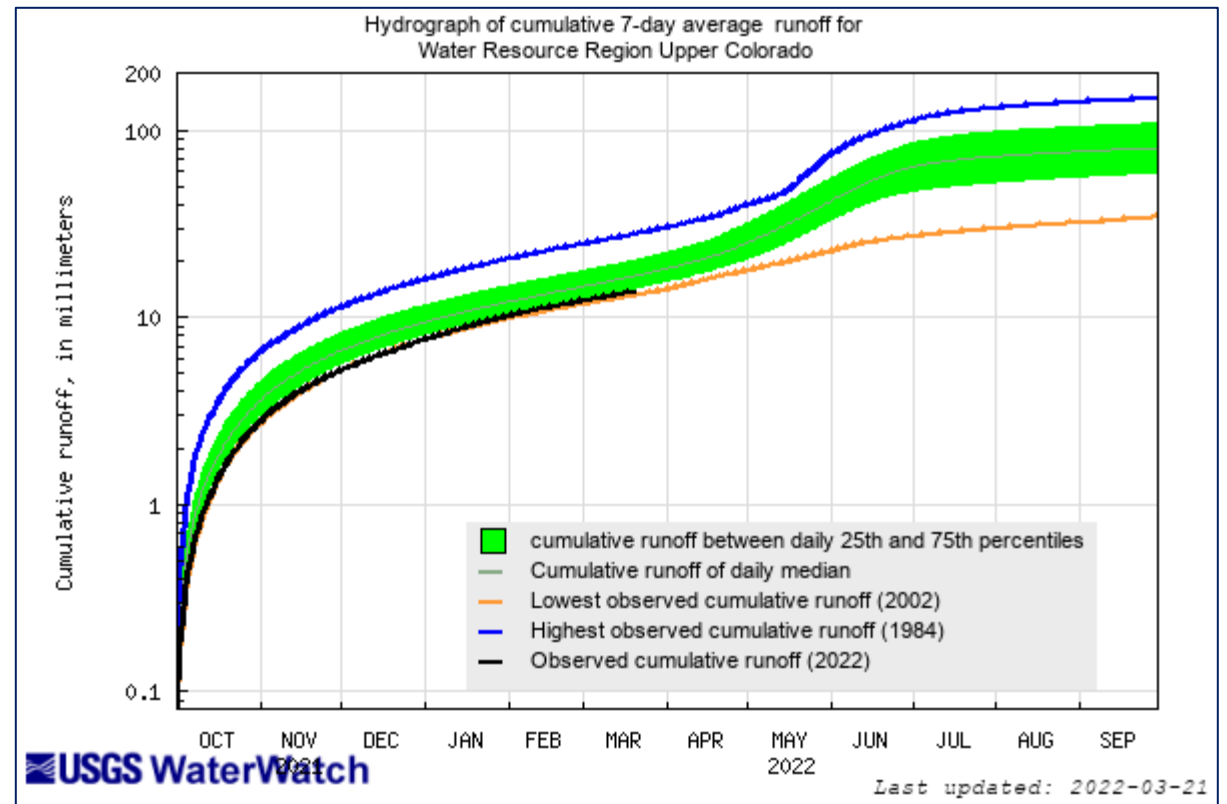
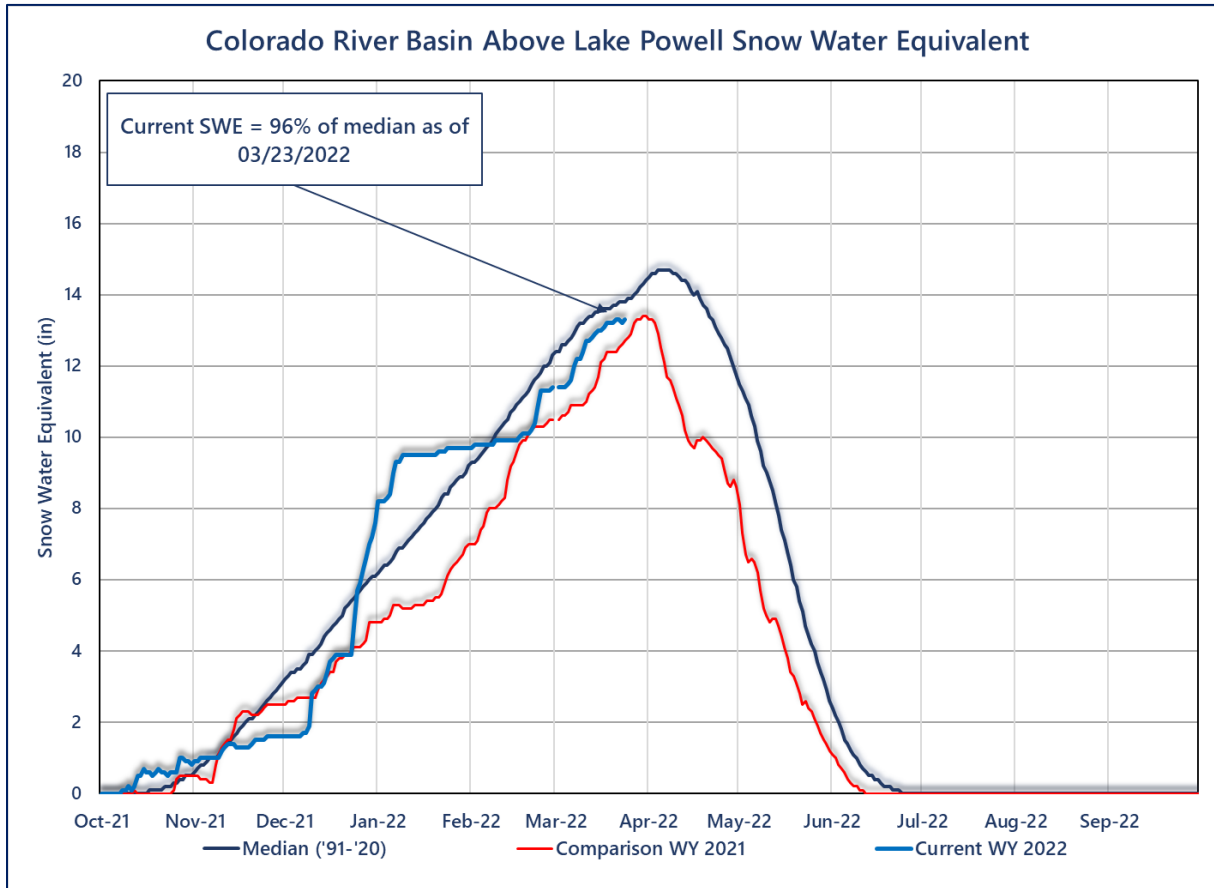
Data Current as of:  
03/21/2022

## Upper Colorado River Drainage Basin

| Reservoir         | Percent Current Live Storage | Current Live Storage (maf) | Live Storage Capacity (maf) | Elevation (feet) |
|-------------------|------------------------------|----------------------------|-----------------------------|------------------|
| Fontenelle        | 43                           | 0.14                       | 0.33                        | 6,477.10         |
| Flaming Gorge     | 78                           | 2.92                       | 3.75                        | 6,018.31         |
| Blue Mesa         | 28                           | 0.24                       | 0.83                        | 7,435.58         |
| Navajo            | 50                           | 0.85                       | 1.70                        | 6,017.80         |
| Lake Powell       | 24                           | 5.87                       | 24.32                       | 3,524.06         |
| UC System Storage | 33                           | 10.16                      | 30.93                       |                  |



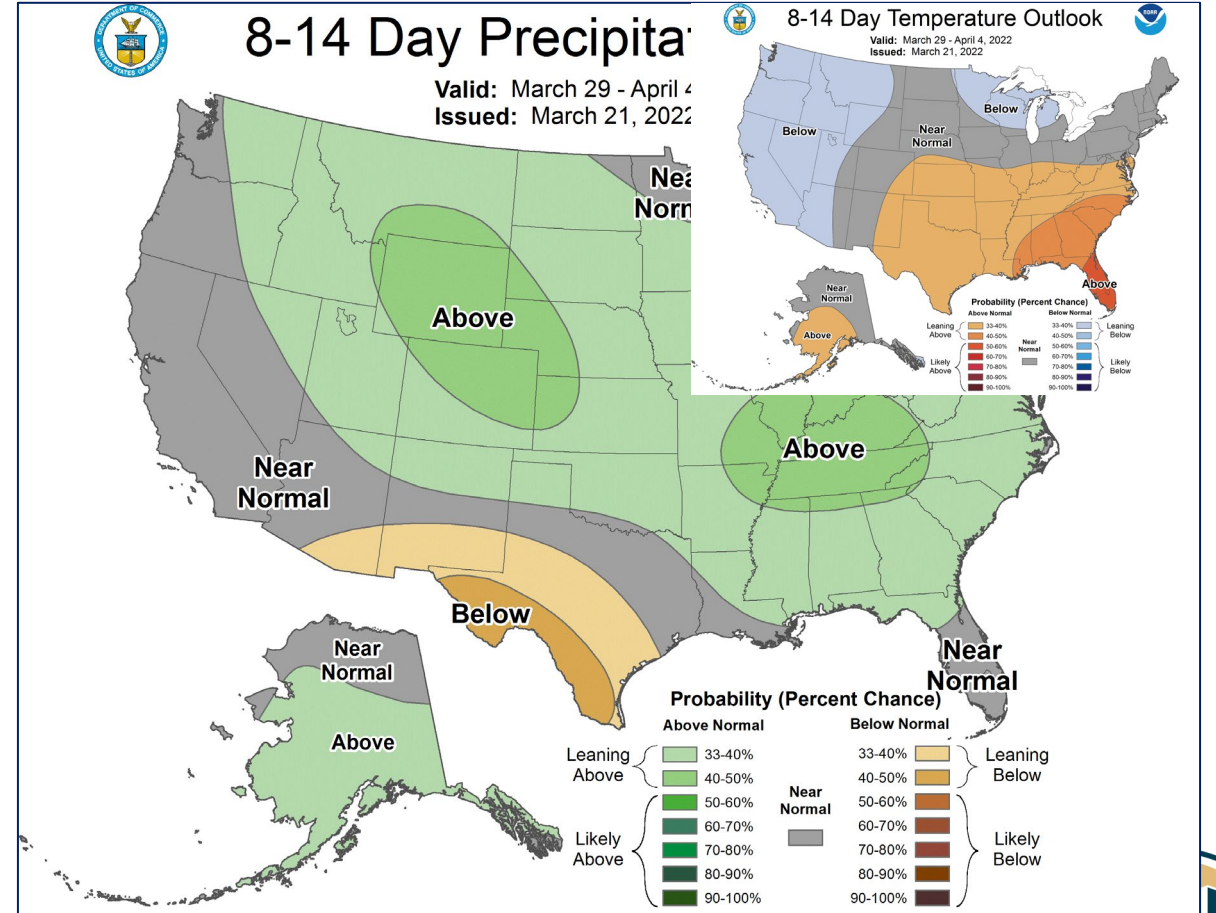
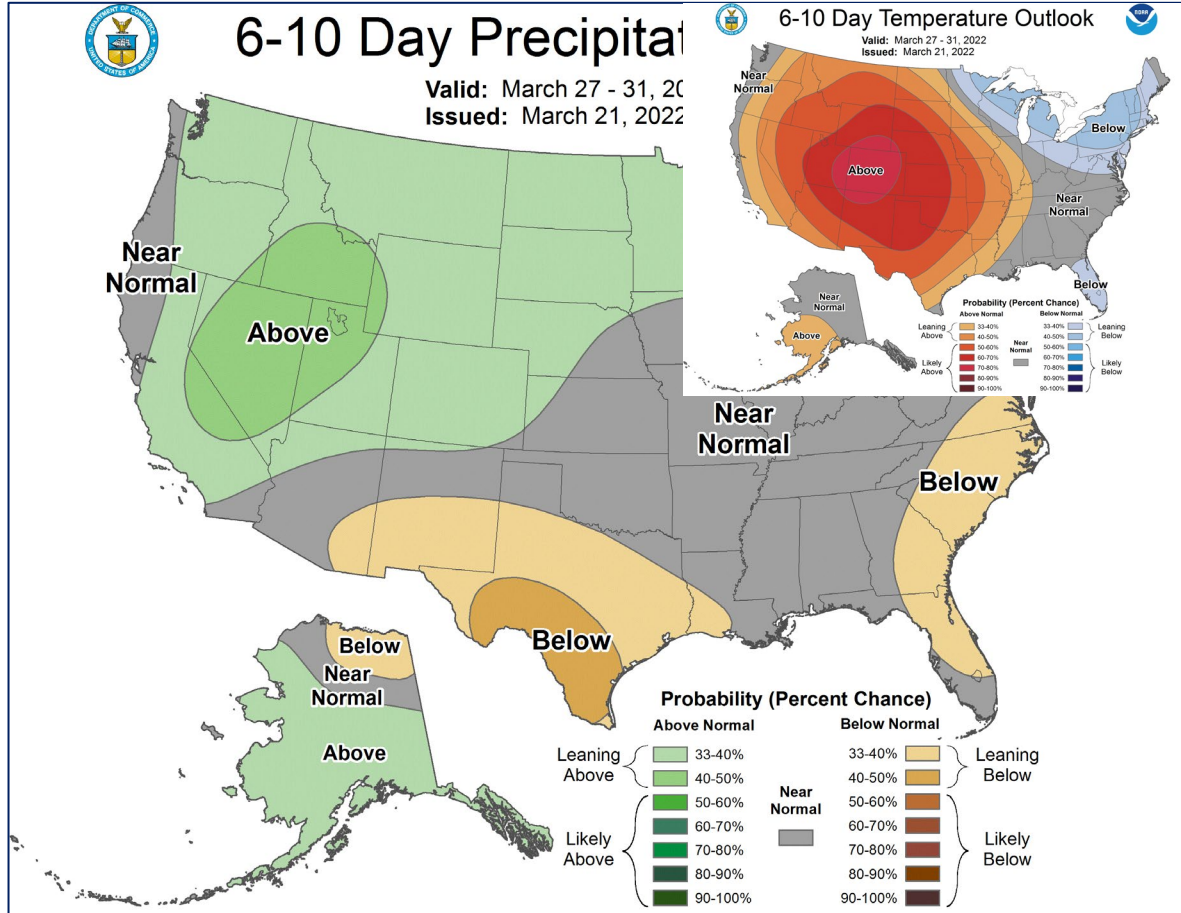
# Upper Colorado SWE and Observed Inflows



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



# Climate Prediction Center Precipitation

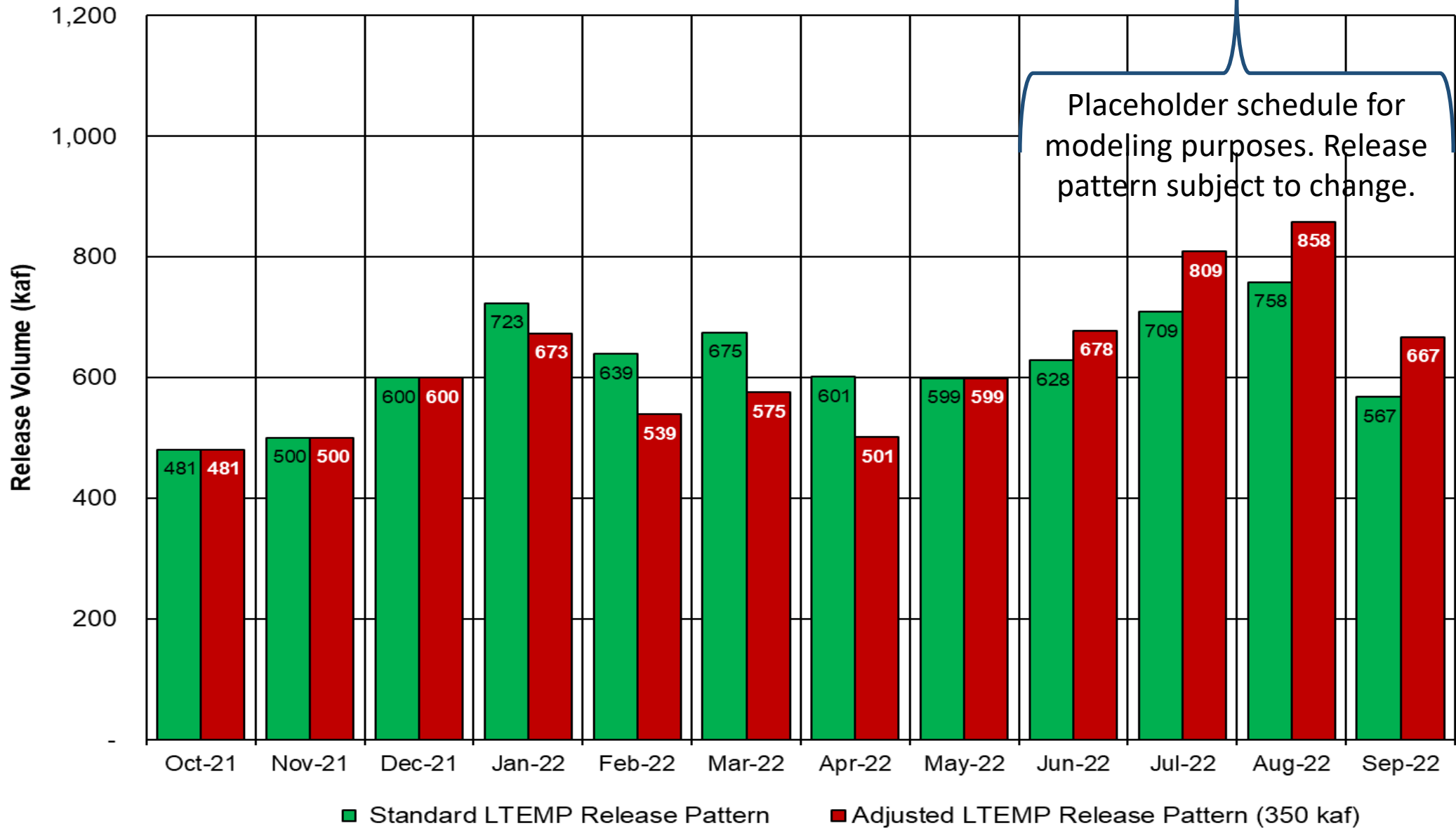


**Water Year 2022  
Potential 7.48 maf  
Pattern  
Adjustments**



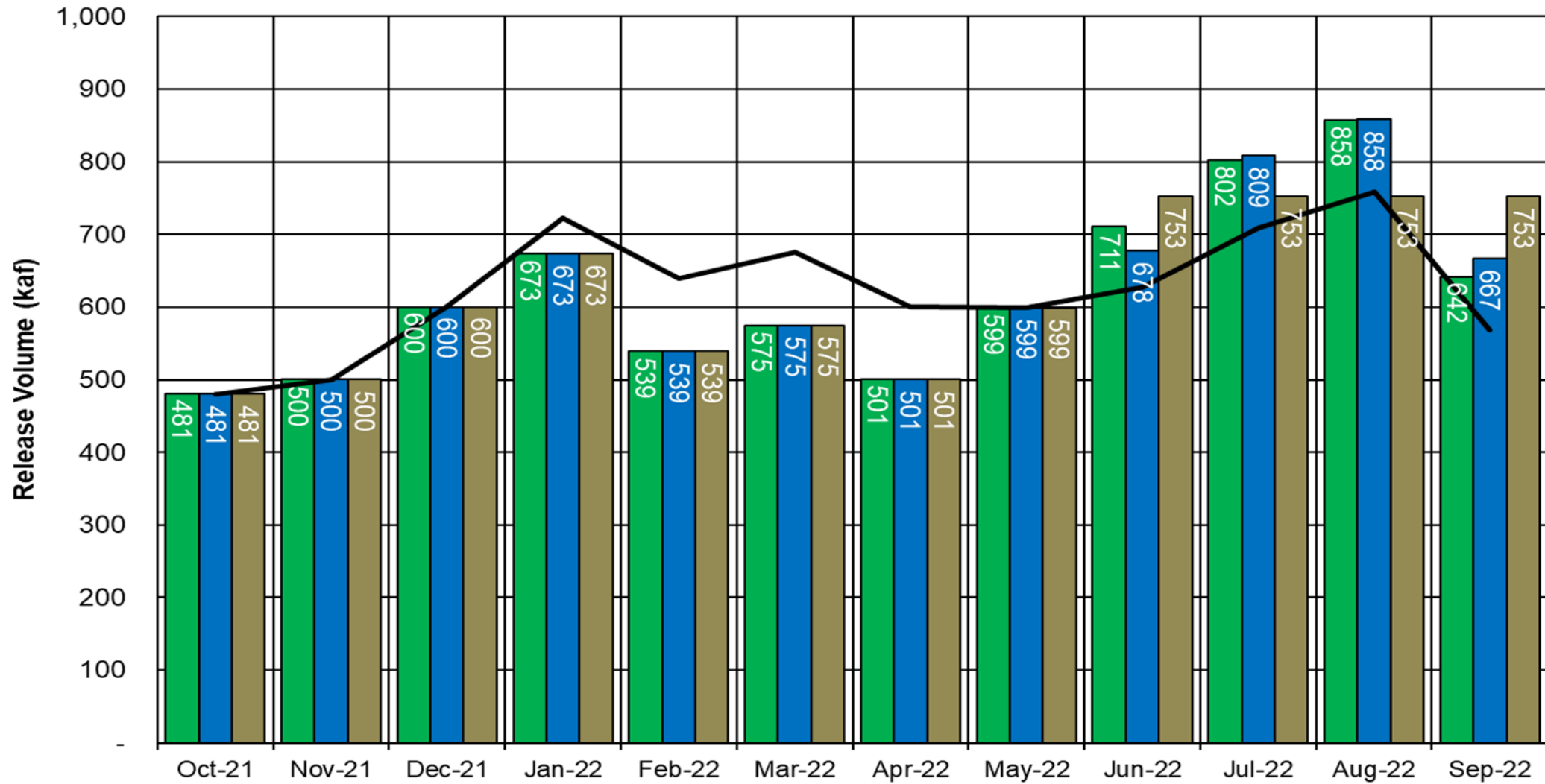
# Potential Lake Powell Monthly Release Volume Distribution

7.48 MAF Release Pattern for Water Year 2022



# Potential Lake Powell Monthly Release Volume Distribution

## DROA Release Scenarios for Water Year 2022



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

■ 350 kaf LTEMP Adjusted    
 ■ Alternative A    
 ■ Alternative B    
 — Standard LTEMP







# Upper Colorado Basin

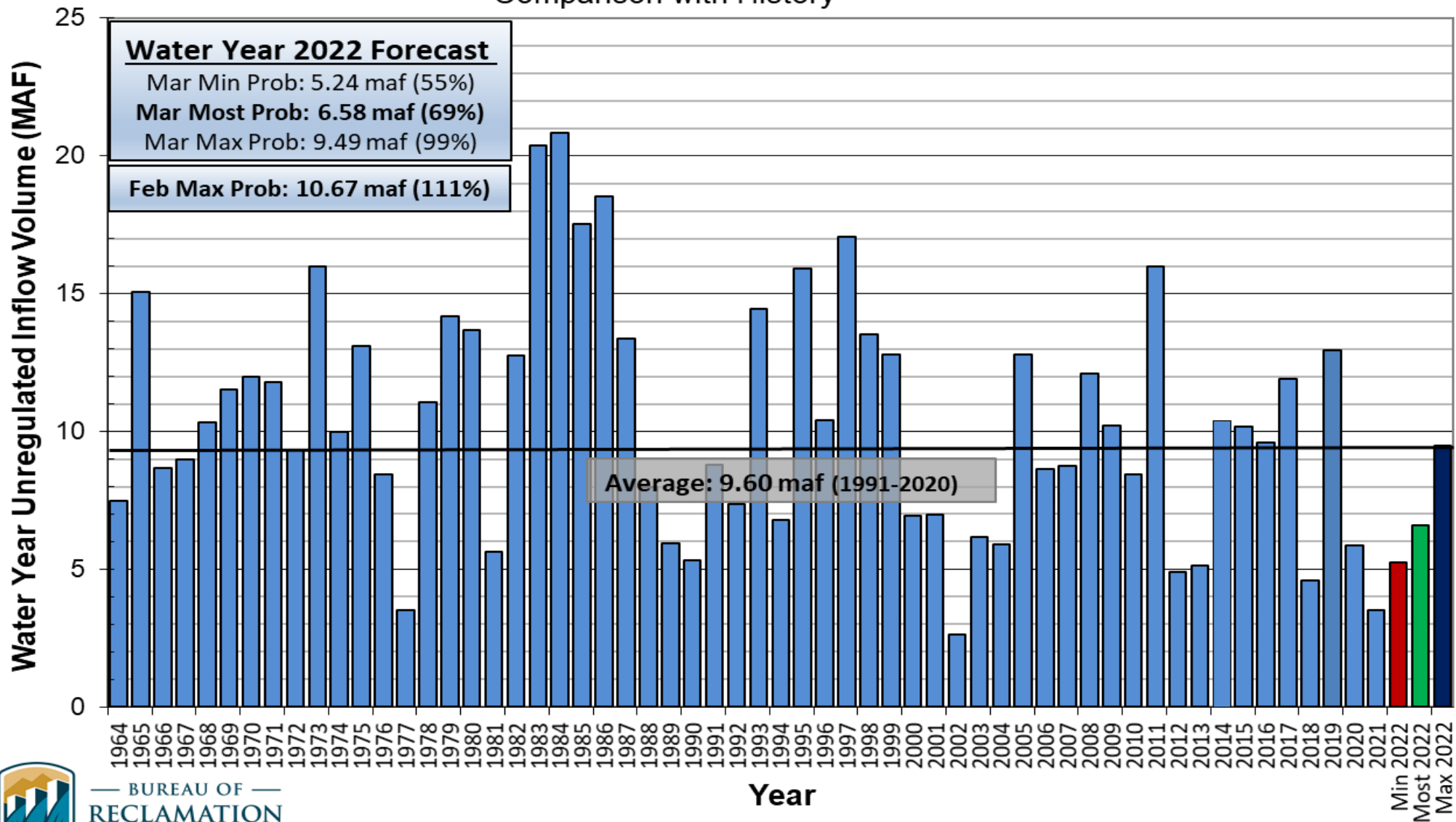
**Projected Operations  
for Water Year 2022  
Based on March 2022  
Modeling**



# Lake Powell Unregulated Inflow

## Water Year 2022 Forecast (issued March 3)

### Comparison with History



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# Most Probable March Forecast Water Year 2022

April – July 2022  
Forecasted Unregulated Inflow  
as of March 3, 2022

| Reservoir     | Unregulated Inflow (kaf) | 1991-2020 Percent of Avg |
|---------------|--------------------------|--------------------------|
| Fontenelle    | 450                      | 61                       |
| Flaming Gorge | 540                      | 56                       |
| Blue Mesa     | 560                      | 88                       |
| Navajo        | 455                      | 72                       |
| Powell        | 4,400                    | 69                       |

April-July Midmonth = 4,600 (72%)

Water Year 2022  
Forecasted Unregulated Inflow  
as of March 3, 2022

| Reservoir     | Unregulated Inflow (kaf) | 1991-2020 Percent of Avg |
|---------------|--------------------------|--------------------------|
| Fontenelle    | 726                      | 68                       |
| Flaming Gorge | 884                      | 63                       |
| Blue Mesa     | 783                      | 87                       |
| Navajo        | 614                      | 67                       |
| Powell        | 6,583                    | 69                       |

Water Year Midmonth = 6,783 (71%)



# 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) <sup>1</sup> | Elevation (feet)                | Operation According to the Interim Guidelines   | Live Storage (maf) <sup>1</sup> |
| 3,700                        | Equalization Tier<br>Equalize, avoid spills or release 8.23 maf   | 24.3                            | 1,220                           | Flood Control Surplus or Quantified Surplus Condition<br>Deliver > 7.5 maf                            | 25.9                            |
| 3,636 - 3,666<br>(2008-2026) | Upper Elevation Balancing Tier <sup>3</sup><br>Release 8.23 maf;<br>if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf | 15.5 - 19.3<br>(2008-2026)      | 1,200<br>(approx.) <sup>2</sup> | Domestic Surplus or ICS Surplus Condition<br>Deliver > 7.5 maf  | 22.9<br>(approx.) <sup>2</sup>  |
| 3,575                        |   |                                 | 1,145                           |   |                                 |
|                              | Mid-Elevation Release Tier<br>Release 7.48 maf;<br>if Lake Mead < 1,025 feet, release 8.23 maf  | 9.5                             | 1,105                           | Normal or ICS Surplus Condition<br>Deliver ≥ 7.5 maf  | 11.9                            |
|                              |   |                                 | 1,075                           |   |                                 |
|                              | <b>3,535.40 ft</b>  |                                 |                                 | <b>1,065.85 ft</b>  | 9.4                             |
| 3,525                        | <b>Jan 1, 2022 Projection</b>   | 5.9                             | 1,050                           | Shortage Condition<br>Deliver 7.167 <sup>4</sup> maf  | 7.5                             |
|                              | Lower Elevation Balancing Tier<br>Balance contents with a min/max release of 7.0 and 9.5 maf  | 4.0                             | 1,025                           | Shortage Condition<br>Deliver 7.083 <sup>5</sup> maf  | 5.8                             |
| 3,490                        |   |                                 | 1,000                           |   |                                 |
| 3,370                        |   | 0                               | 895                             | Shortage Condition<br>Deliver 7.0 <sup>6</sup> maf<br>Further measures may be undertaken <sup>7</sup> | 4.3                             |
|                              |   |                                 |                                 |   | 0                               |

Diagram not to scale

<sup>1</sup> Acronym for million acre-feet

<sup>2</sup> 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.

<sup>3</sup> Subject to April adjustments which may result in a release according to the Equalization Tier

<sup>4</sup> Of which 2.48 maf is apportioned to Arizona, 4.4 maf to California, and 0.287 maf to Nevada

<sup>5</sup> Of which 2.40 maf is apportioned to Arizona, 4.4 maf to California, and 0.283 maf to Nevada

<sup>6</sup> Of which 2.32 maf is apportioned to Arizona, 4.4 maf to California, and 0.280 maf to Nevada

<sup>7</sup> 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.

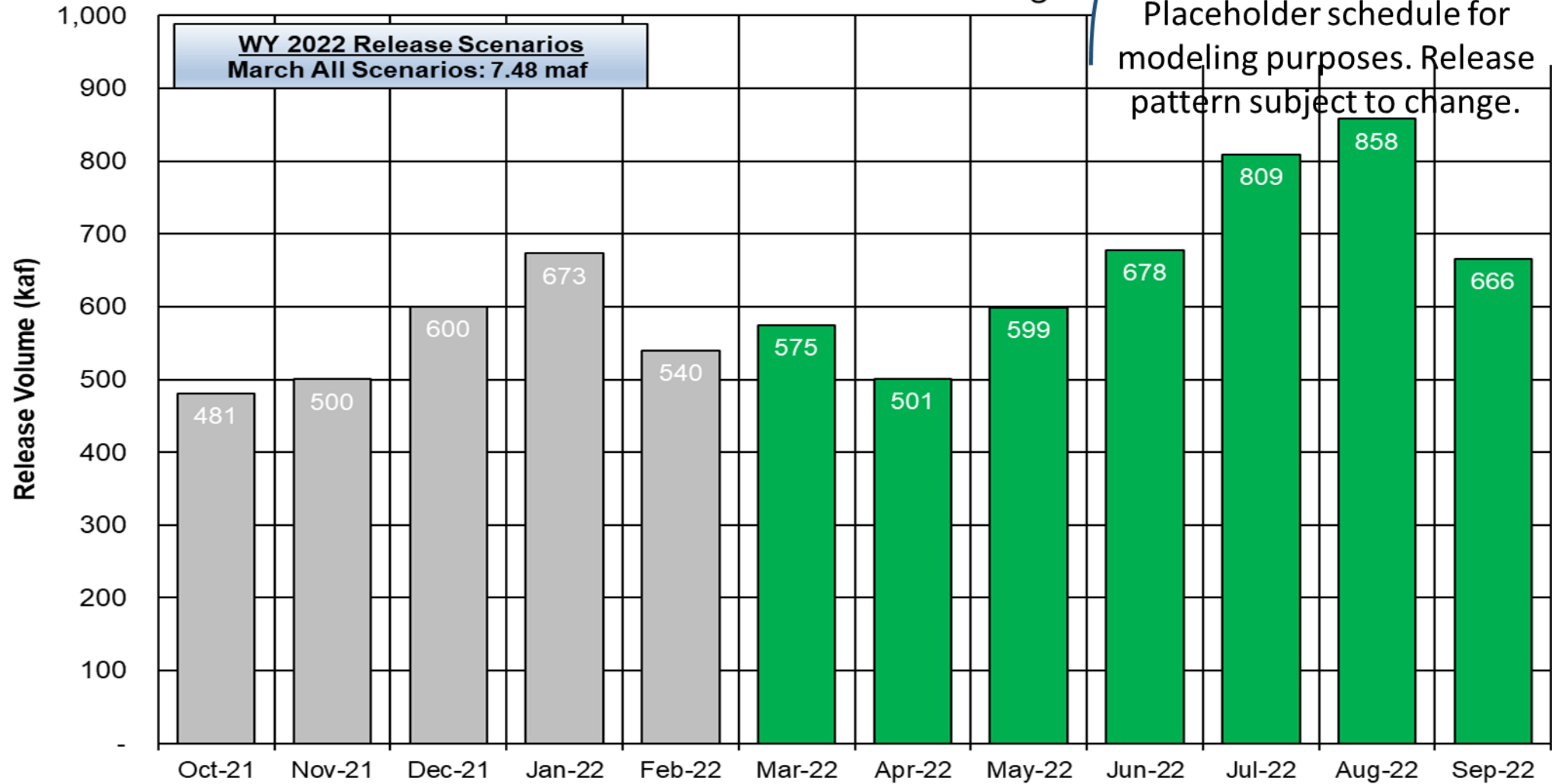
<sup>1</sup> Lake Powell and Lake Mead operating determinations are based on August 2021 24-Month Study projections consistent with the 2007 Interim Guidelines and 2019 Drought Contingency Plans. These determinations will be documented in the 2022 Annual Operating Plan for Colorado River Reservoirs.



# Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2022

Based on March 2022 Modeling



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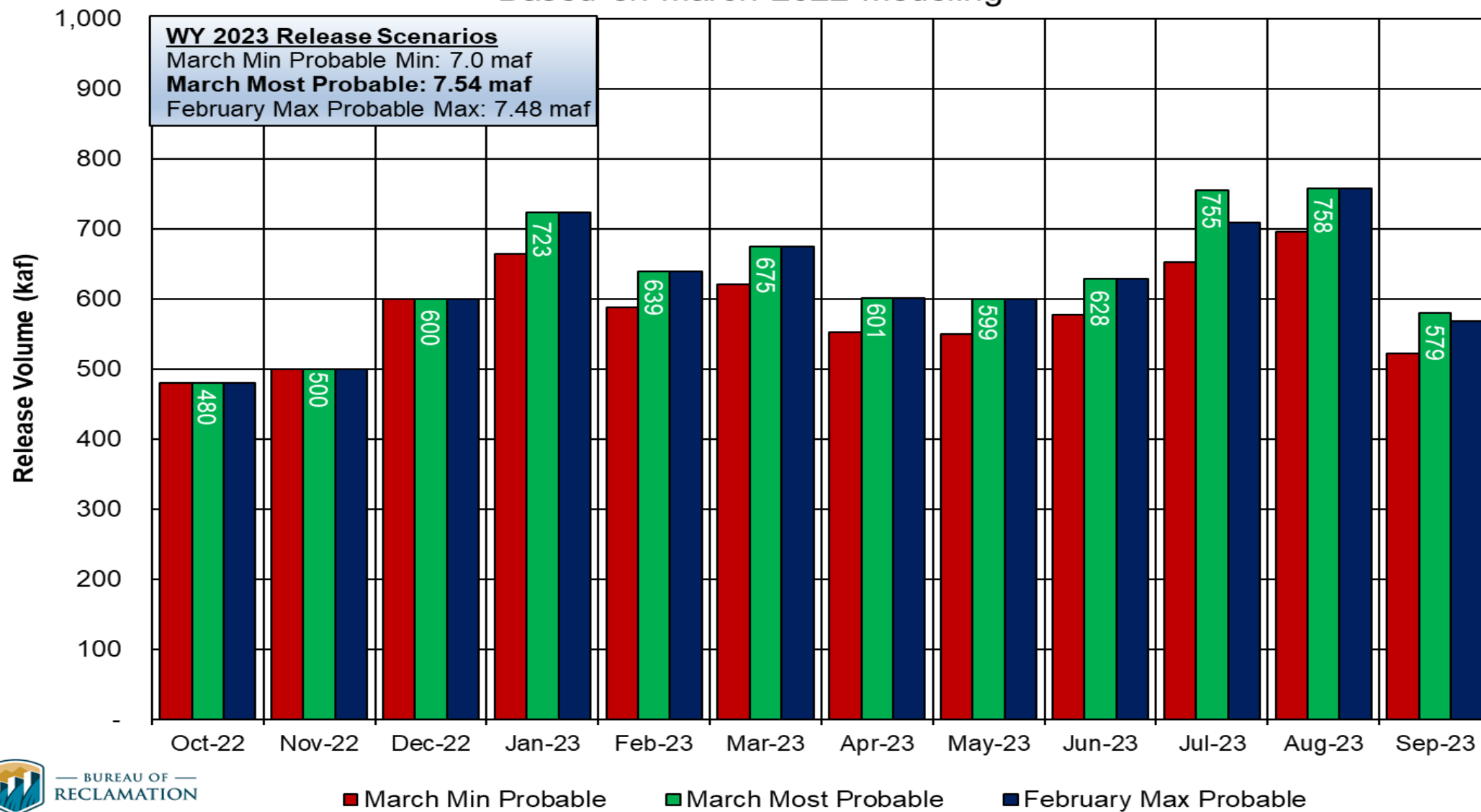
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# Potential Lake Powell Monthly Release Volume Distribution

Release Scenarios for Water Year 2023

Based on March 2022 Modeling



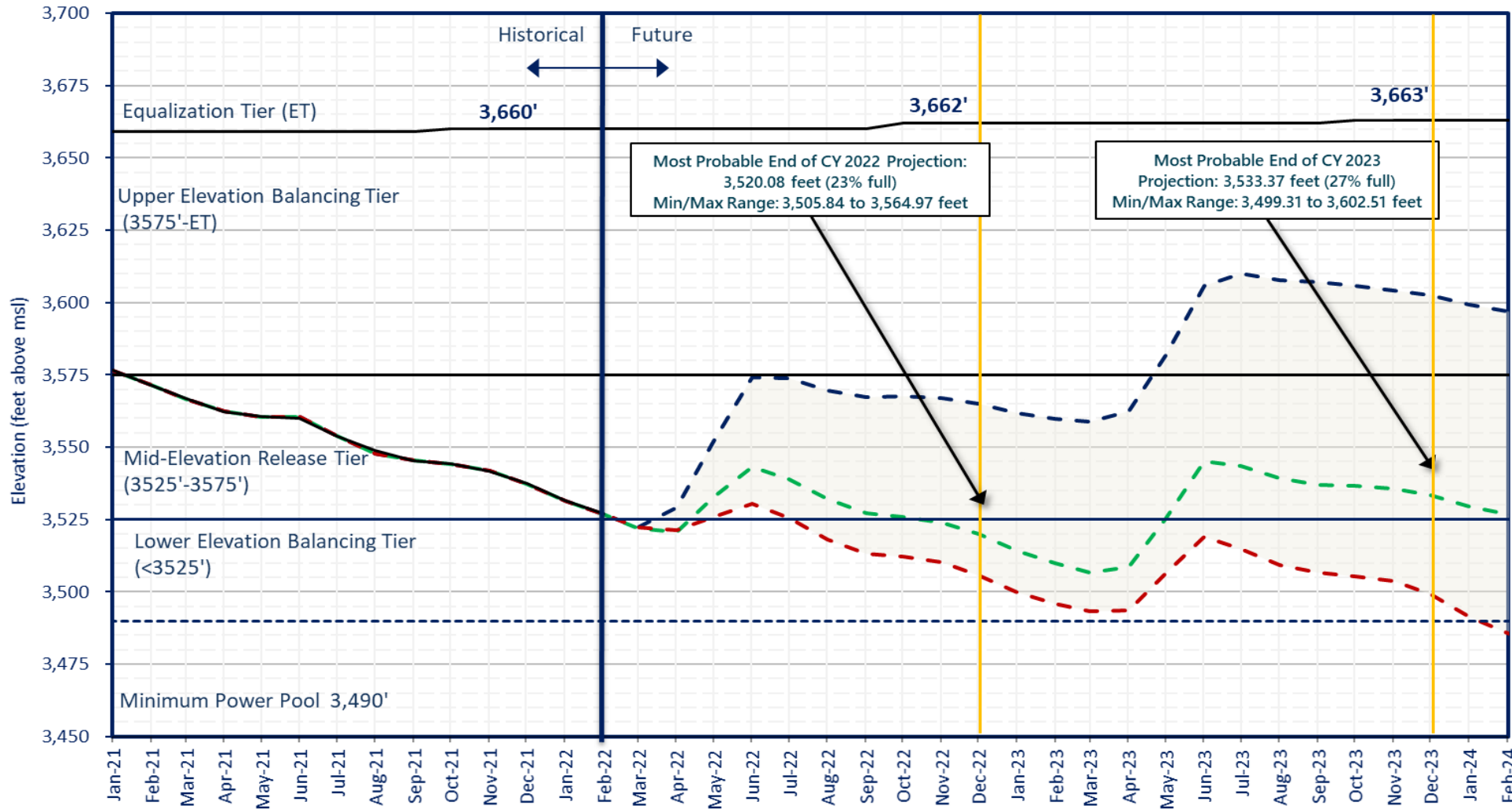
# Reclamation Operational Modeling Model Comparison

|                                | 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, 35 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

Projections from the March 2022 24-Month Study Inflow Scenarios



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- February 2022 Maximum Probable Inflow - Lake Powell release of 7.48 maf in WY2022 and 7.48 maf in WY2023
- March 2022 Most Probable Inflow - Lake Powell release of 7.48 maf in WY2022 and 7.54 maf in WY2023
- March 2022 Minimum Probable Inflow - Lake Powell release of 7.48 maf in WY2022 and 7.0 maf in WY2023
- Historical Elevations

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





# March 2022 24-MS Trigger Elevation Differences

- **Most probable**

- March 2022 - 3,521.97 feet (185 kaf below 3,525 ft)
- April 2022 – 3,520.68 feet (262 kaf below 3,525 ft)
- November 2022 elevation decrease below 3,525 ft through May 2023
- December 2022 (24MS) – 3,520.08 feet (298 kaf below 3,525 ft)
- March 2023 – 3,506.71 feet (1.06 maf below 3,525 ft)
- Elevations fall below 3,525 in March 2024
- Elevations remain above 3,490 feet entire most probable run



# March 2022 24-MS Trigger Elevation Differences

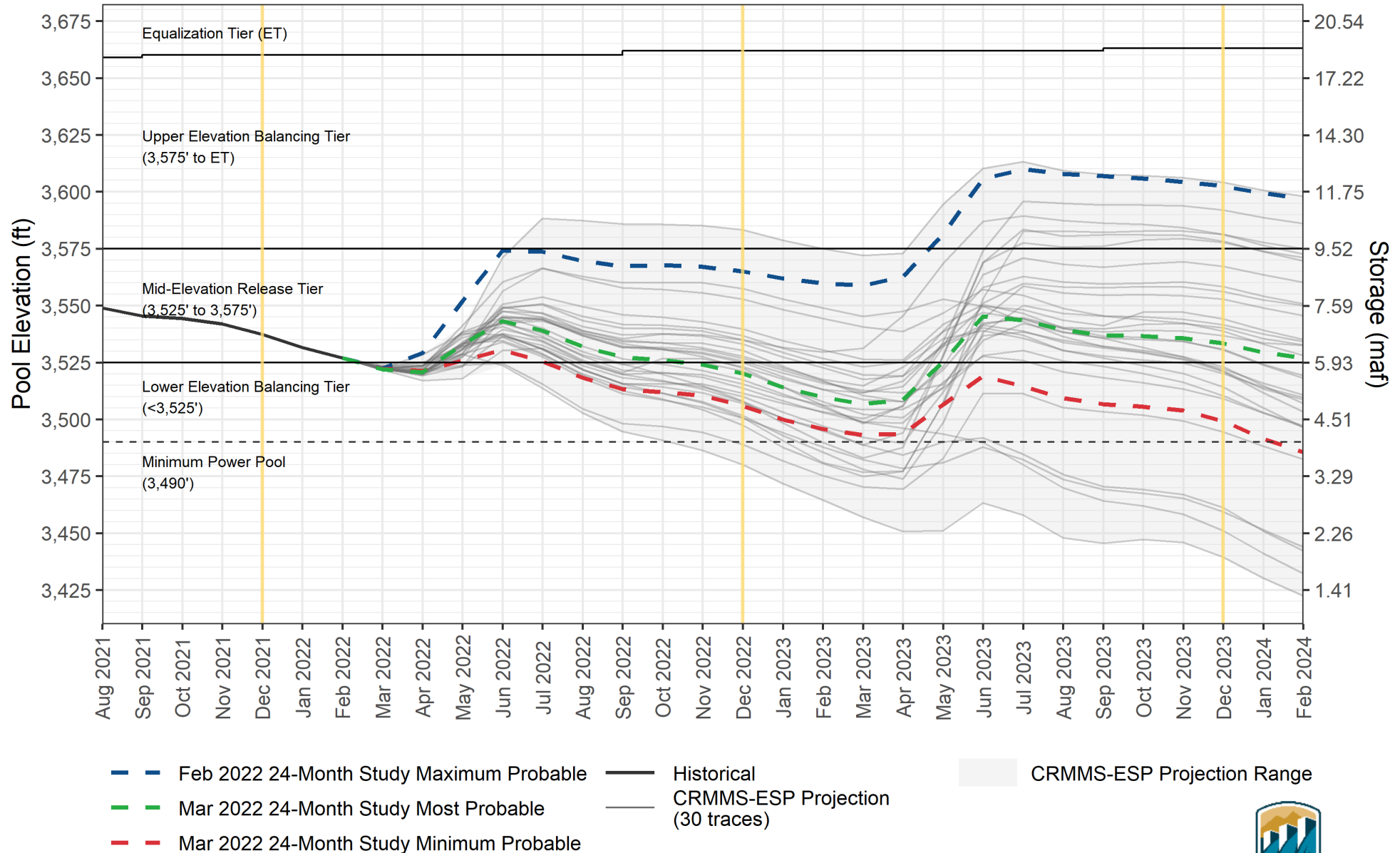
- **Min probable**

- March 2022 - 3,522.17 feet (173 kaf below 3,525 ft)
- April 2022 – 3,521.29 feet (226 kaf below 3,525 ft)
  
- December 2022 (24MS) – 3,505.84 feet (1.11 maf below 3,525 ft)
  
- March 2023 – 3,493.14 feet (1.77 maf below 3,525 ft)
- February 2024 MPP – 3,485.67 feet (212 kaf below 3,490 ft)



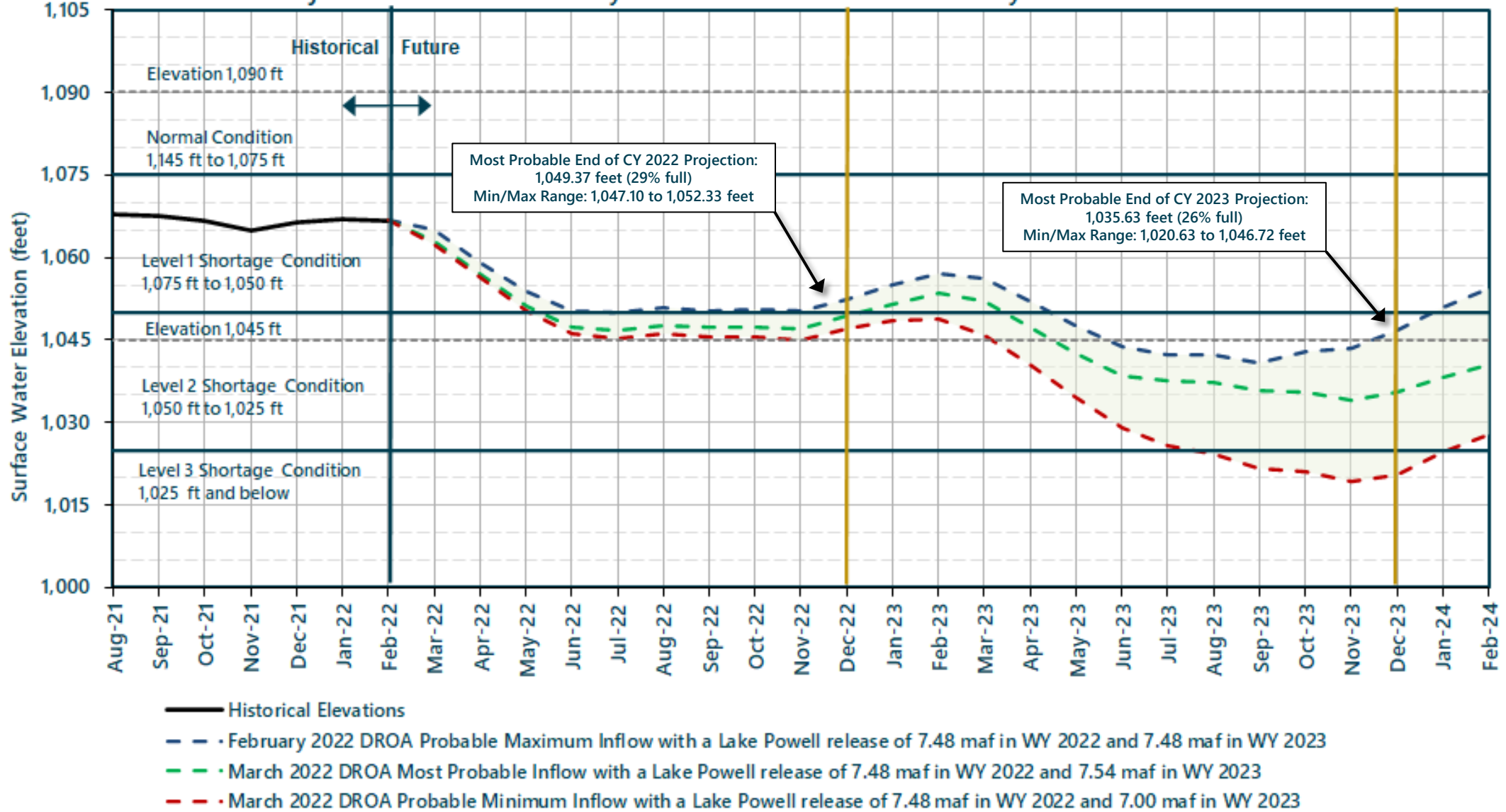
# Lake Powell End-of-Month Elevations

## CRMMS Projections from March 2022



# Lake Mead End of Month Elevations

Projections from the February and March 2022 24-Month Study Inflow Scenarios

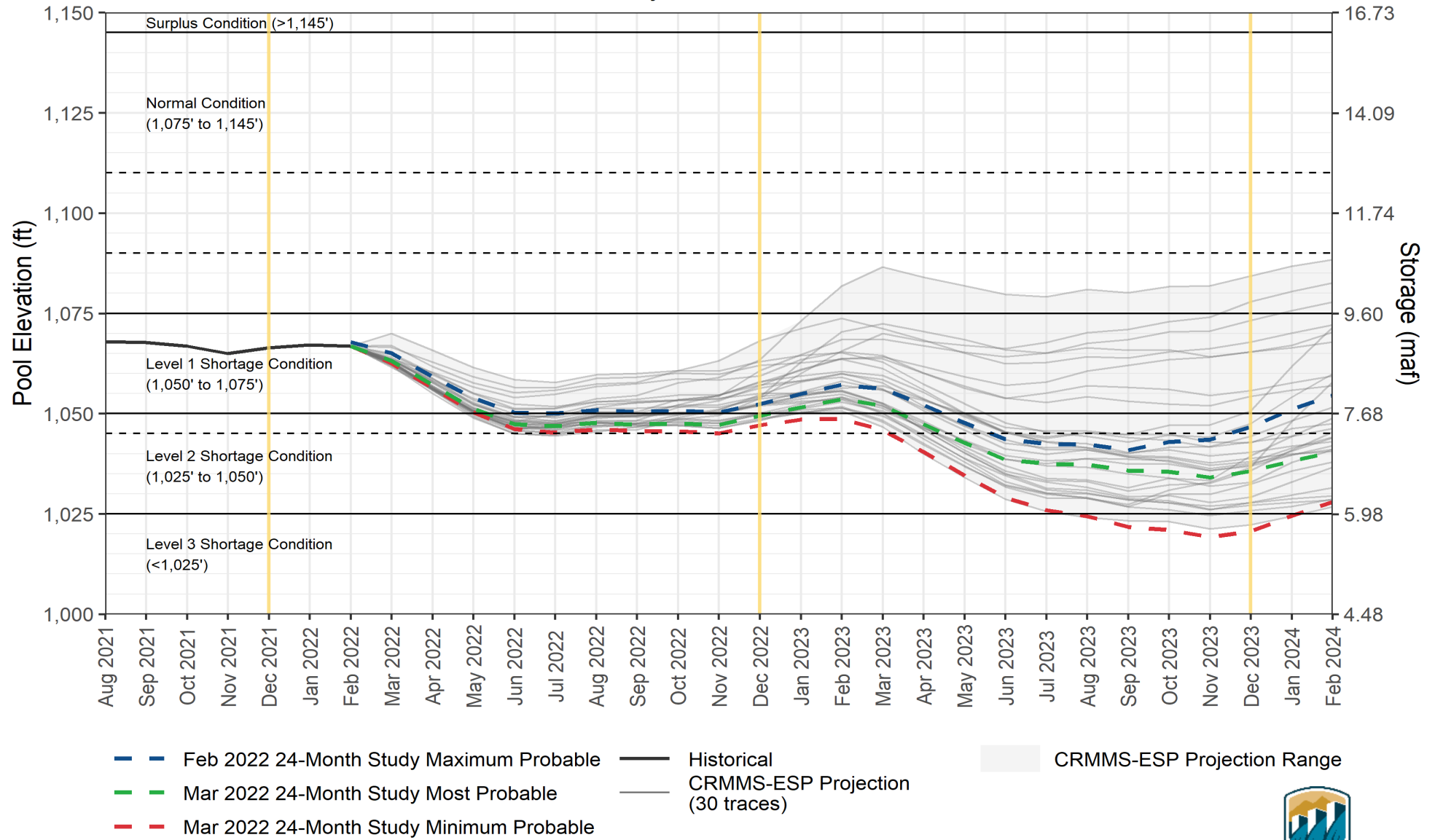


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# Lake Mead End-of-Month Elevations

CRMMS Projections from March 2022





# Upper Colorado Basin

## Hydropower Maintenance



# 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                       |          |          |          |          | [Outage] |          |          |          |          |          |          |          |                       |
| 2                       |          |          |          |          |          | [Outage] |          |          |          |          |          |          |                       |
| 3                       |          |          |          |          |          |          |          |          |          |          |          |          |                       |
| 4                       |          |          |          |          |          |          |          |          |          |          |          |          |                       |
| 5                       |          |          |          |          |          |          | [Outage] |          |          |          |          |          |                       |
| 6                       |          |          |          |          |          |          | [Outage] |          |          |          |          |          |                       |
| 7                       | [Outage] |          |          |          |          |          |          | [Outage] |          |          |          |          |                       |
| 8                       | [Outage] |          |          |          |          |          |          |          |          |          |          |          |                       |
| 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   | 18,000   | 14,900   | 18,600   | 18,500   | 18,300   | 18,100   | MAR MOST <sup>2</sup> |
| Capacity (kaf/month)    | 1,150    | 1,110    | 1,110    | 1,160    | 810      | 980      | 1,100    | 970      | 1,090    | 1,140    | 1,120    | 1,080    | MAR MOST              |
| Max (kaf) <sup>1</sup>  | 481      | 500      | 600      | 673      | 540      | 575      | 501      | 599      | 678      | 809      | 858      | 666      | 7.48 maf              |
| Most (kaf) <sup>1</sup> | 481      | 500      | 600      | 673      | 540      | 575      | 501      | 599      | 678      | 809      | 858      | 666      | 7.48 maf              |
| Min (kaf) <sup>1</sup>  | 481      | 500      | 600      | 673      | 540      | 575      | 501      | 599      | 678      | 809      | 858      | 666      | 7.48 maf              |
|                         |          |          |          |          |          |          |          |          |          |          |          |          | (updated 03-22-2022)  |

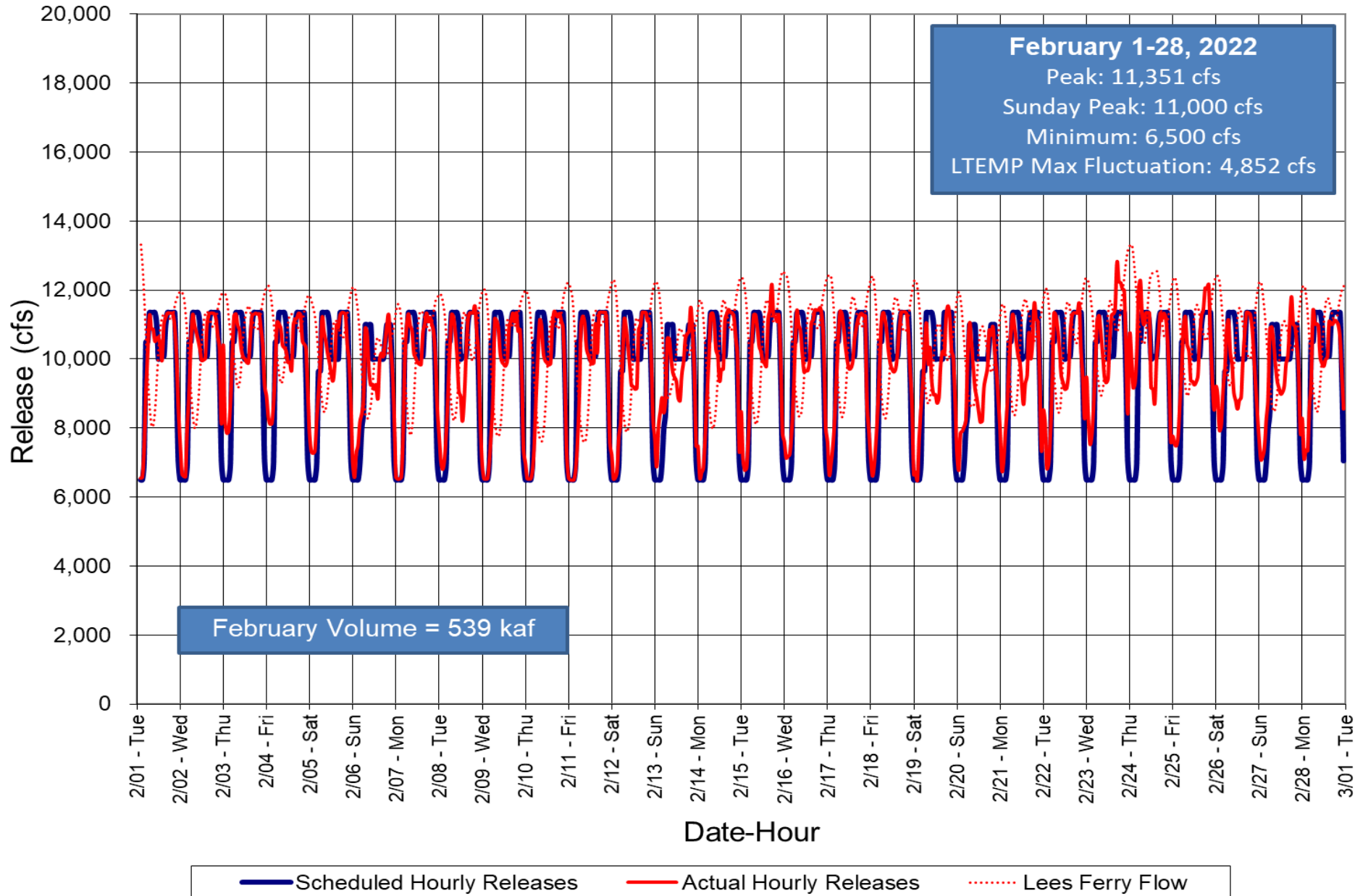
1 Projected release, based on March 2022 minimum and most and February 2022 maximum probable inflow projections and 24-Month Study model runs.  
 2 Dependent upon availability to shift contingency reserves, which will increase capacity by 30-40MW (3%) at current efficiency.



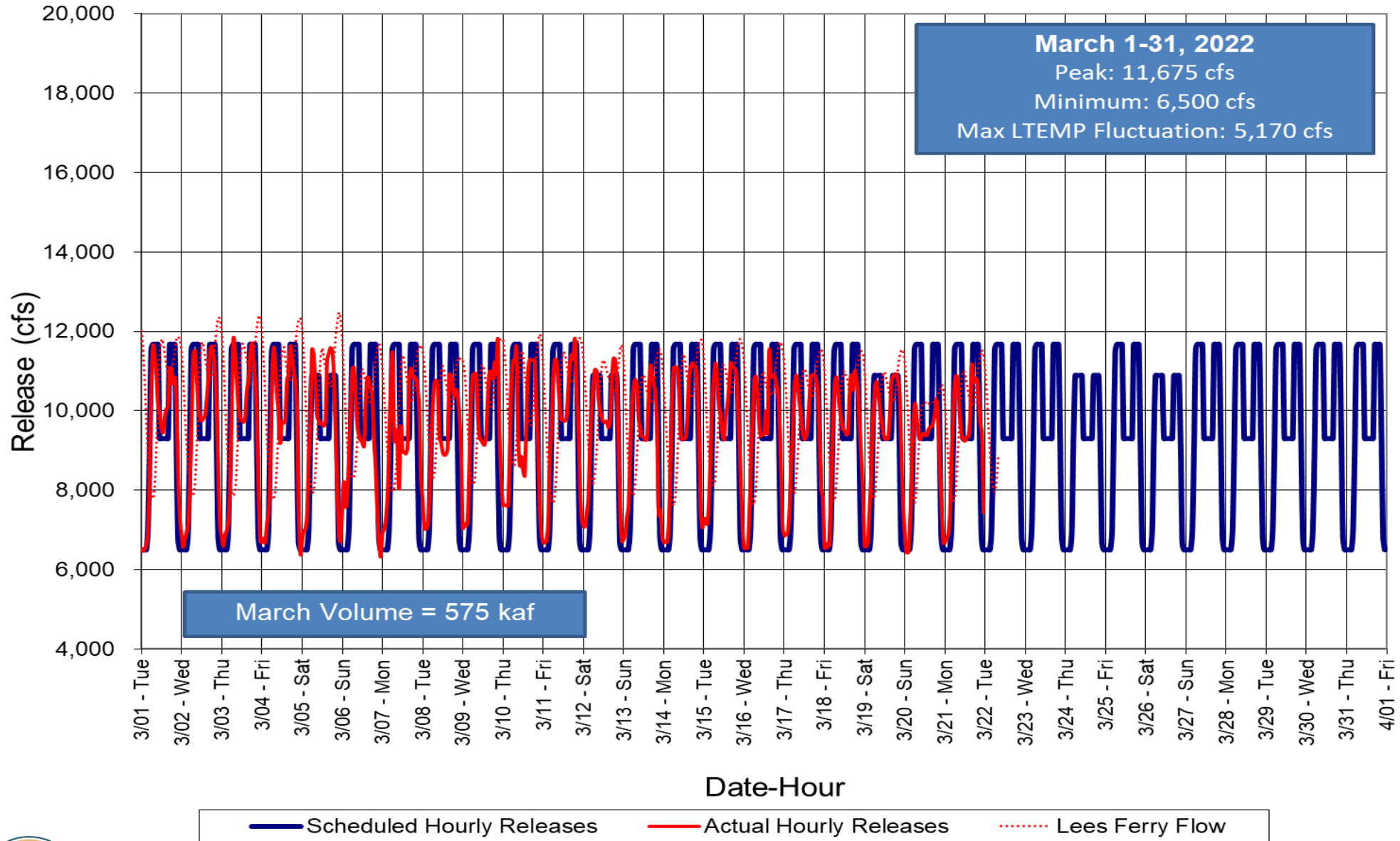




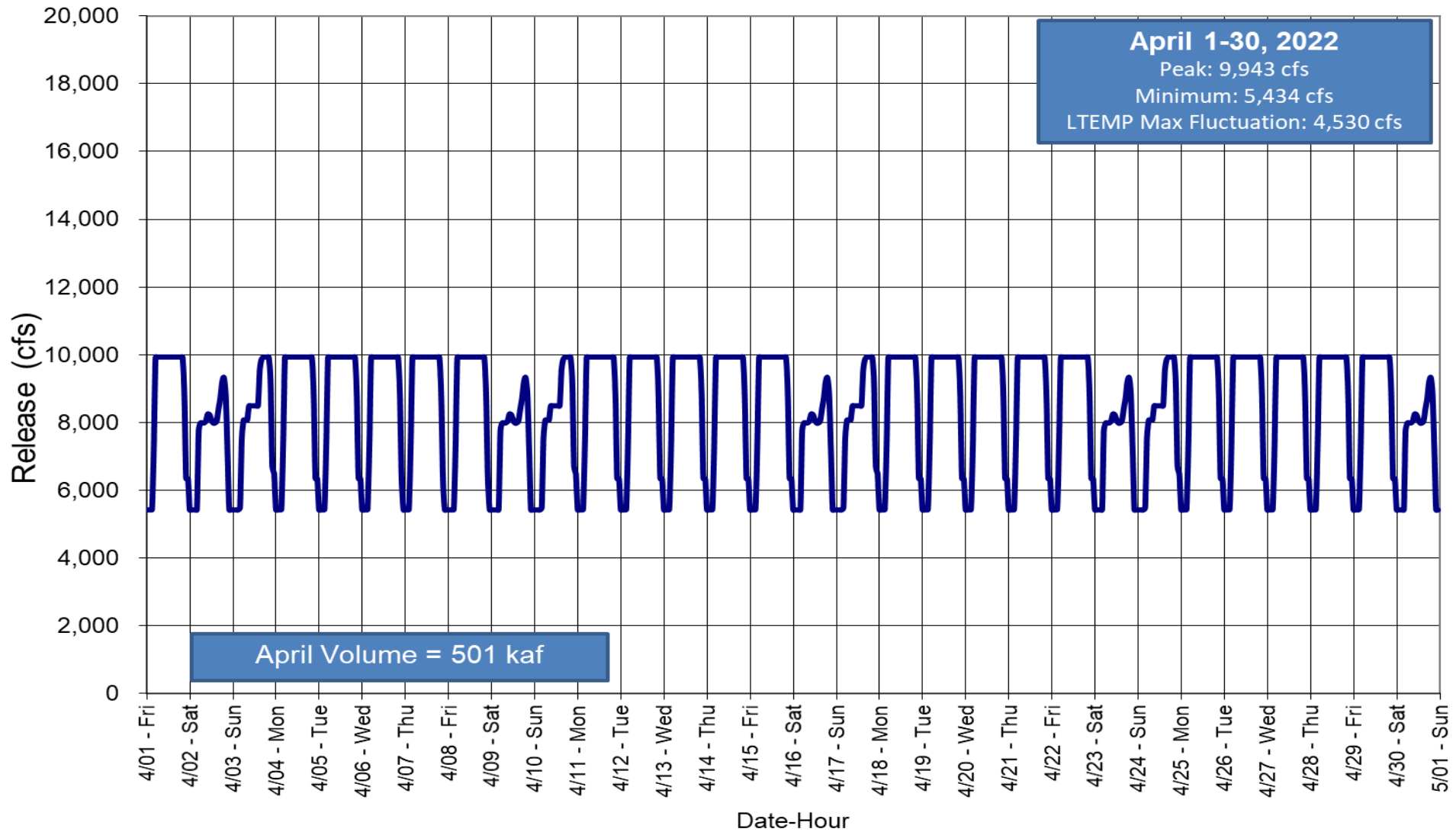
# Glen Canyon Dam Hourly Release Pattern February 2022



# Glen Canyon Dam Hourly Release Pattern March 2022



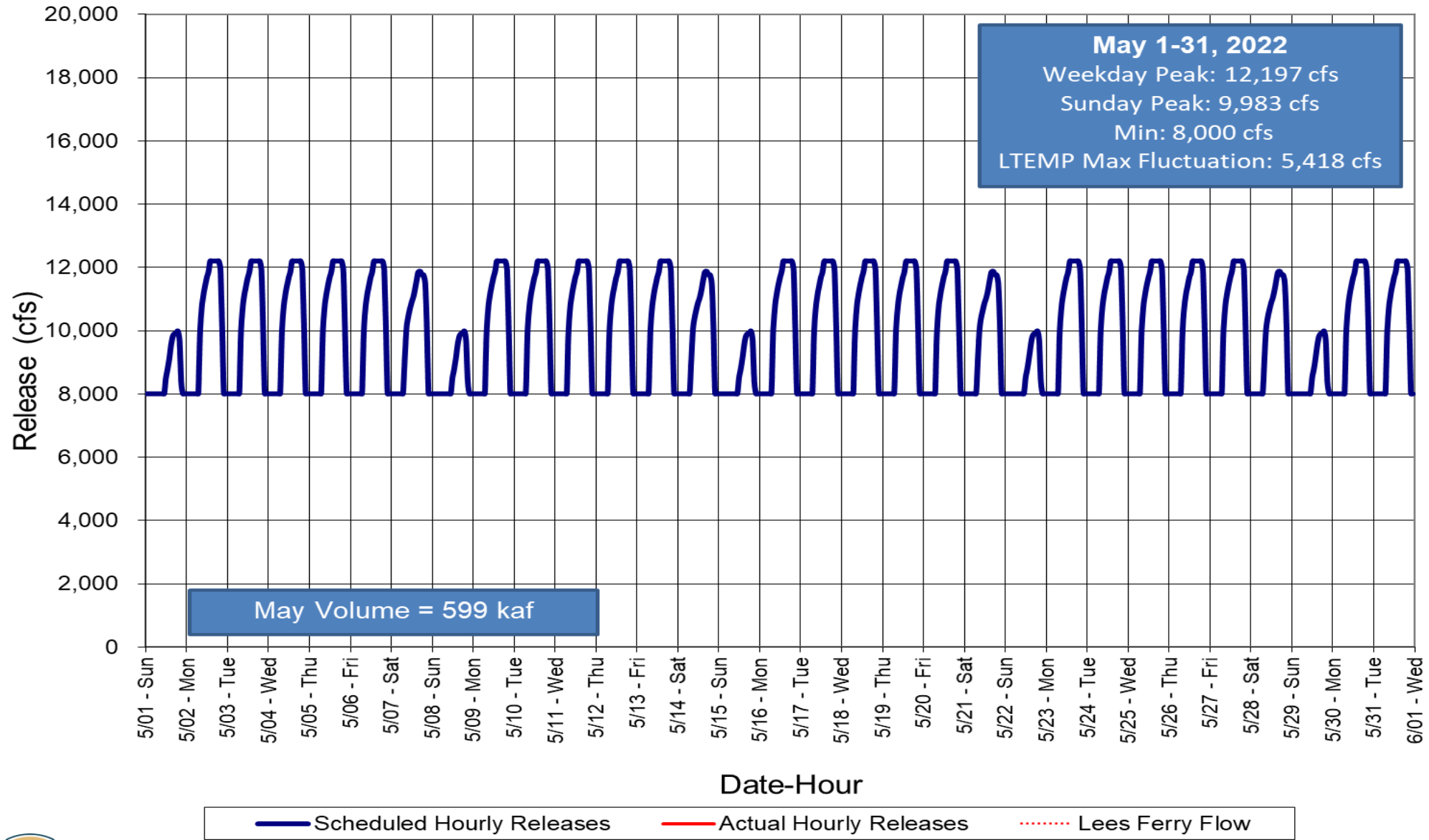
# Glen Canyon Dam Hourly Release Pattern April 2022



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



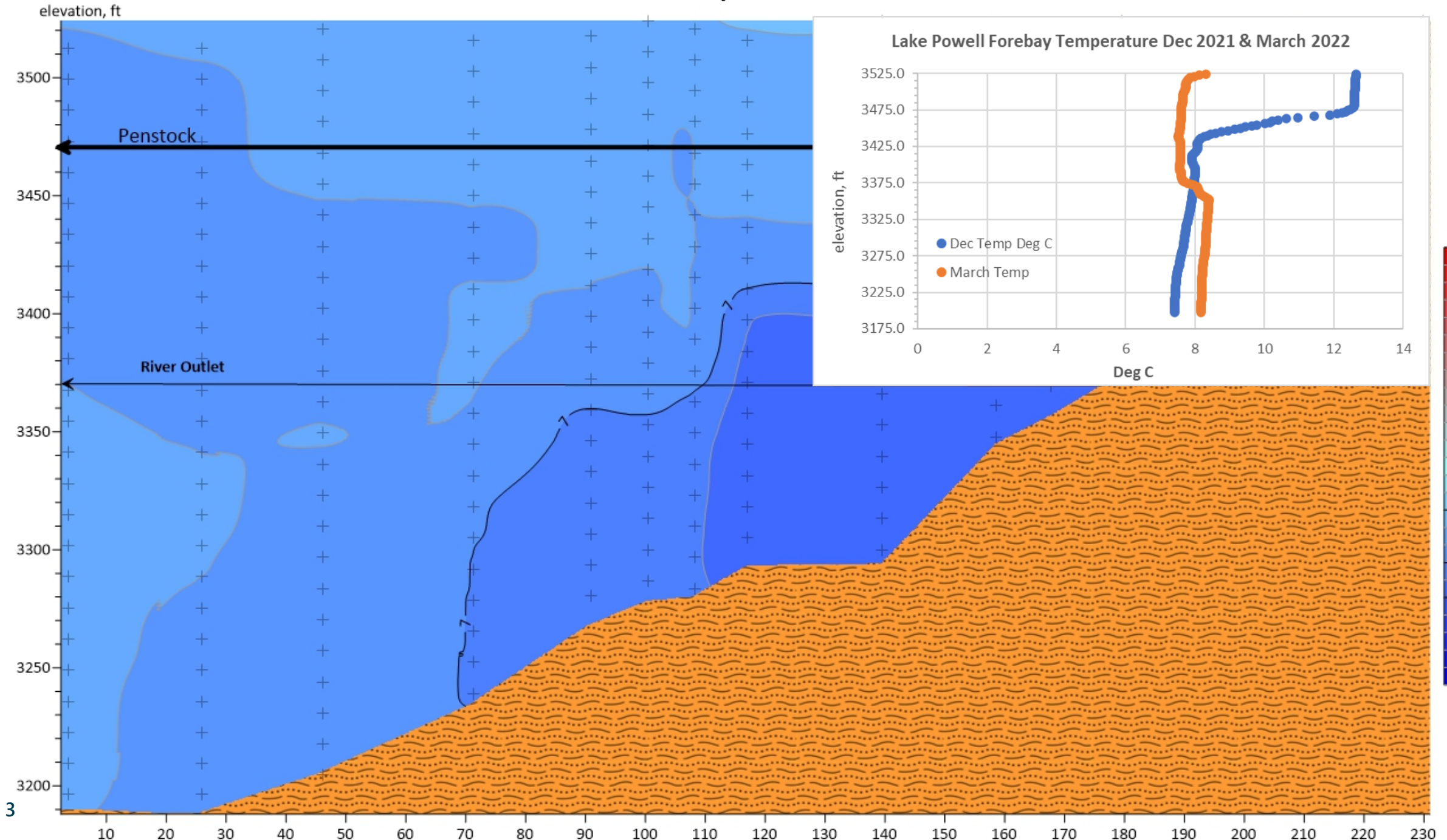
# Glen Canyon Dam Hourly Release Pattern May 2022



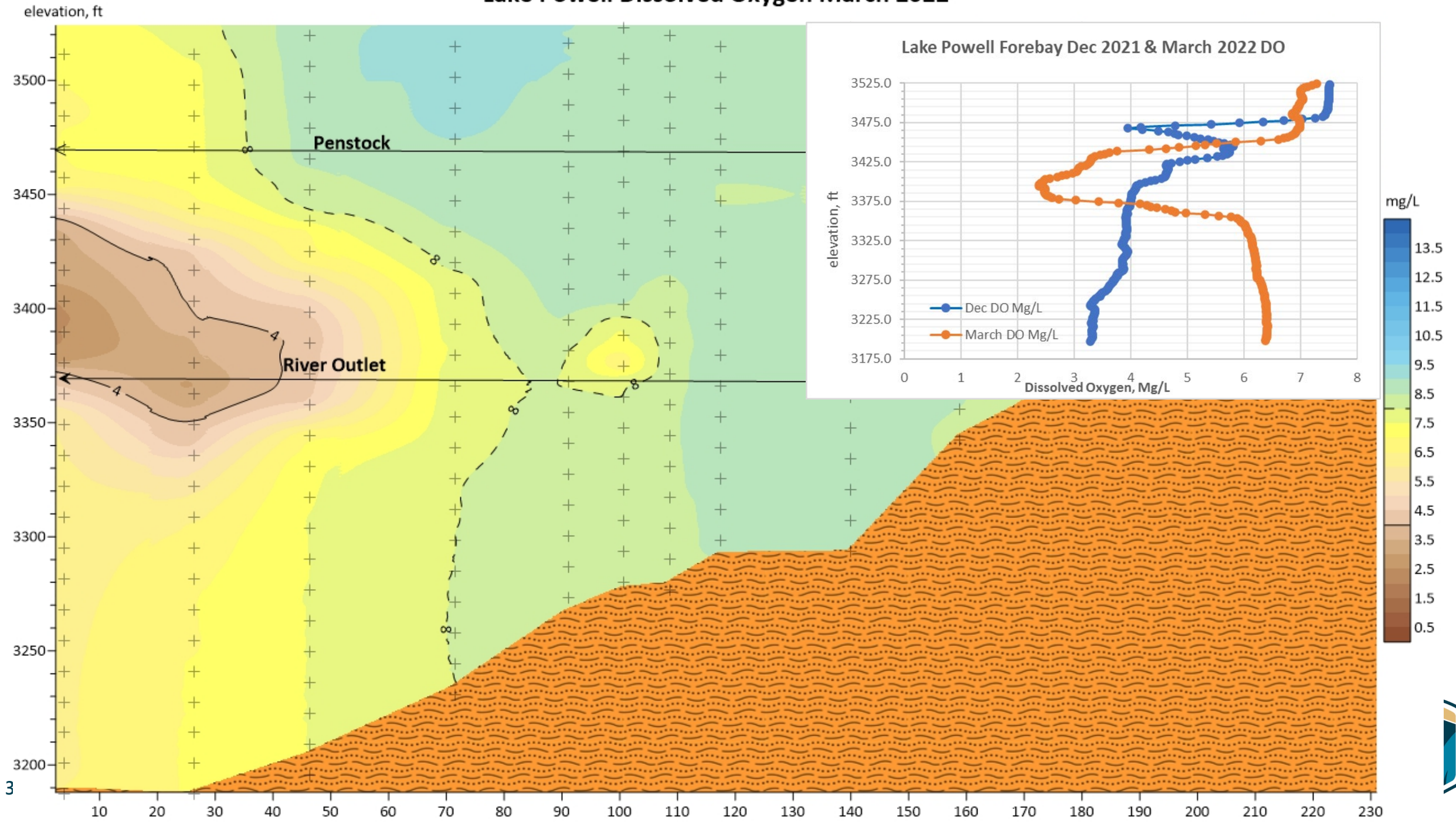
# Water Quality



# Lake Powell Temperature March 2022

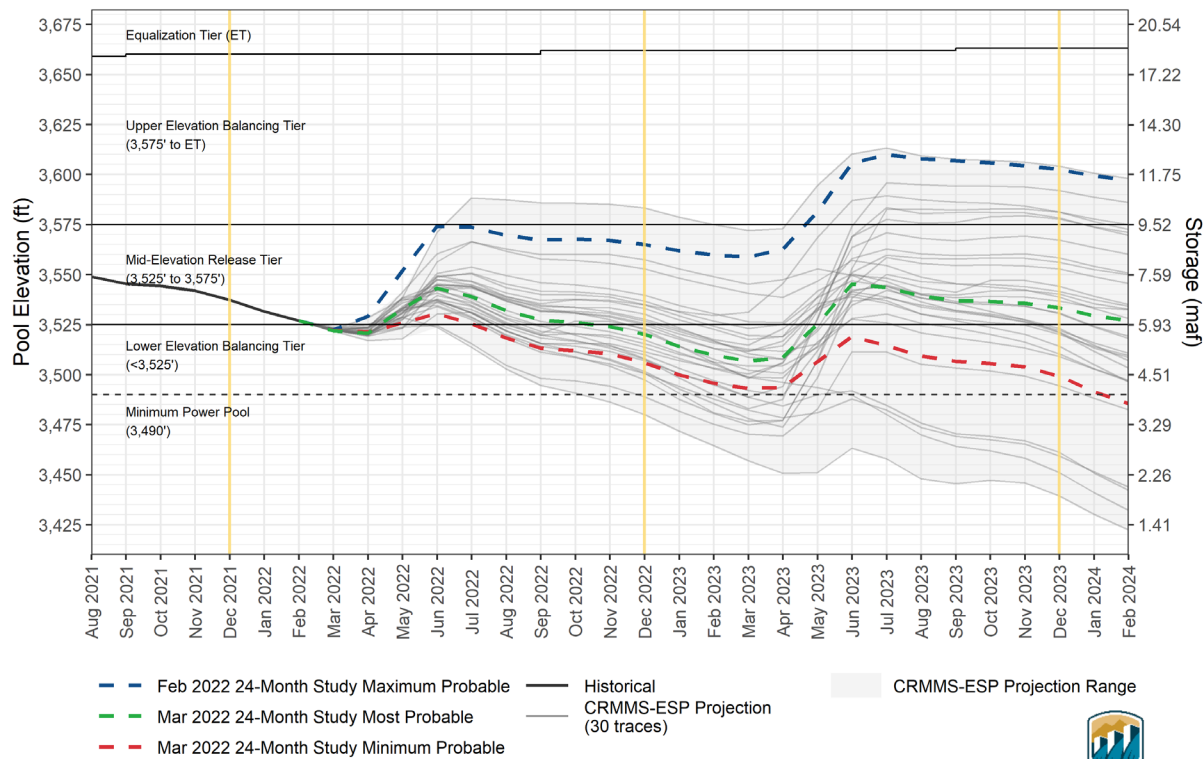


# Lake Powell Dissolved Oxygen March 2022



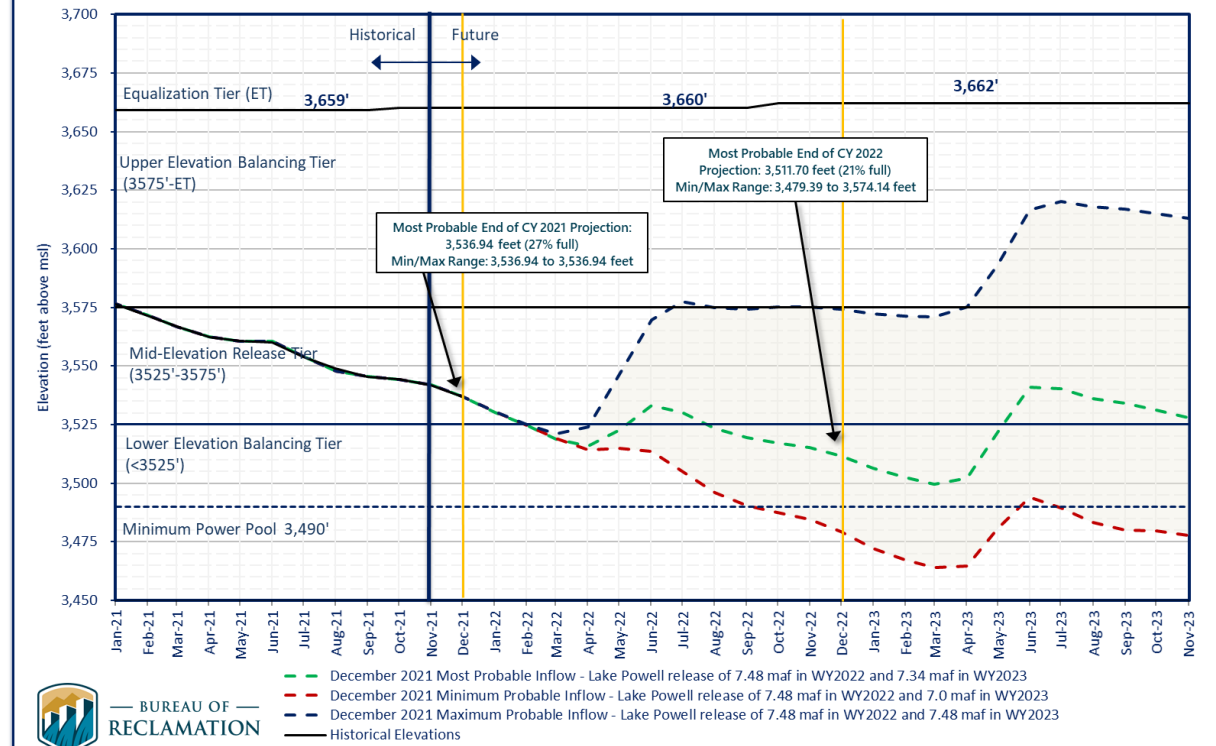
# March 2022 and December 2021 Projected Elevation Comparison

**Lake Powell End-of-Month Elevations**  
CRMMS Projections from March 2022



**Lake Powell End of Month Elevations**

Projections from the December 2021 24-Month Study Inflow Scenarios



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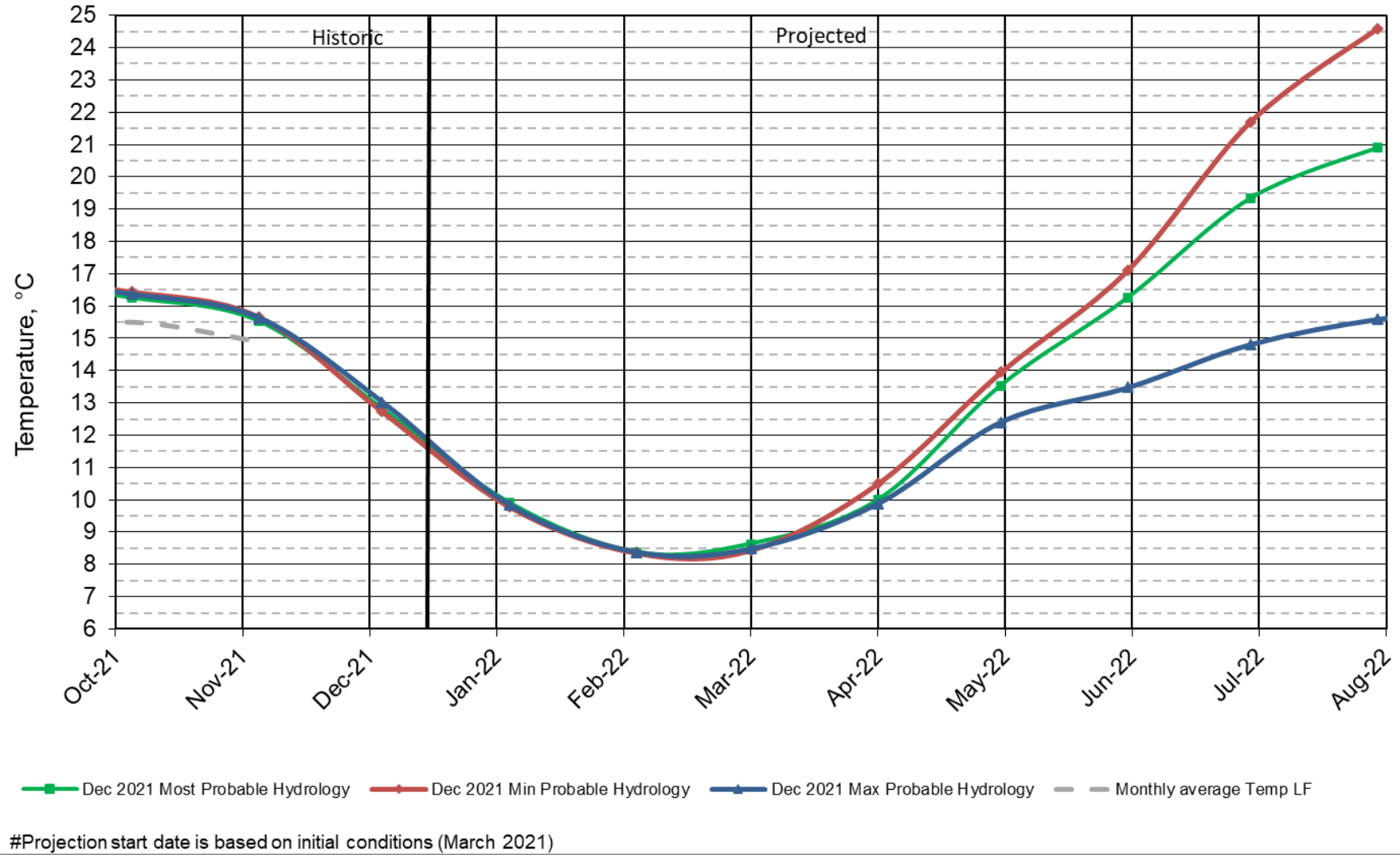
- December 2021 Most Probable Inflow - Lake Powell release of 7.48 maf in WY2022 and 7.34 maf in WY2023
- December 2021 Minimum Probable Inflow - Lake Powell release of 7.48 maf in WY2022 and 7.0 maf in WY2023
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- Historical Elevations

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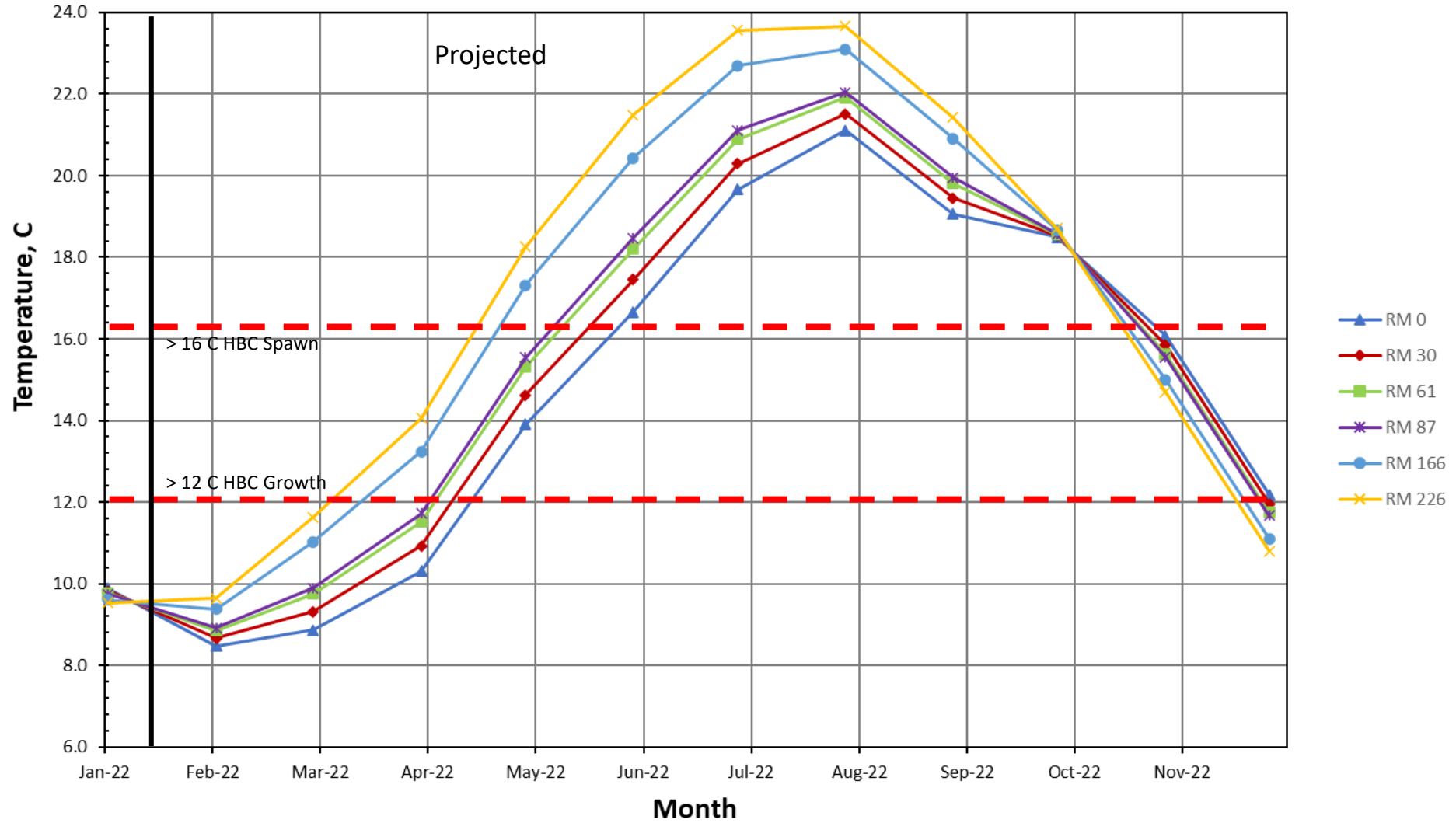




## Lake Powell Release Temperature Projected Temperature based on Dec 2021 Forecast



Colorado River, Grand Canyon Water Temperatures  
 Projections based on December 2021 24MS, Most Probable Hydrology (Dibble 2020)



# Questions?



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