



— BUREAU OF —  
RECLAMATION

# Glen Canyon Monthly Operations Call

## Basin Hydrology and Operations

August 24, 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.”

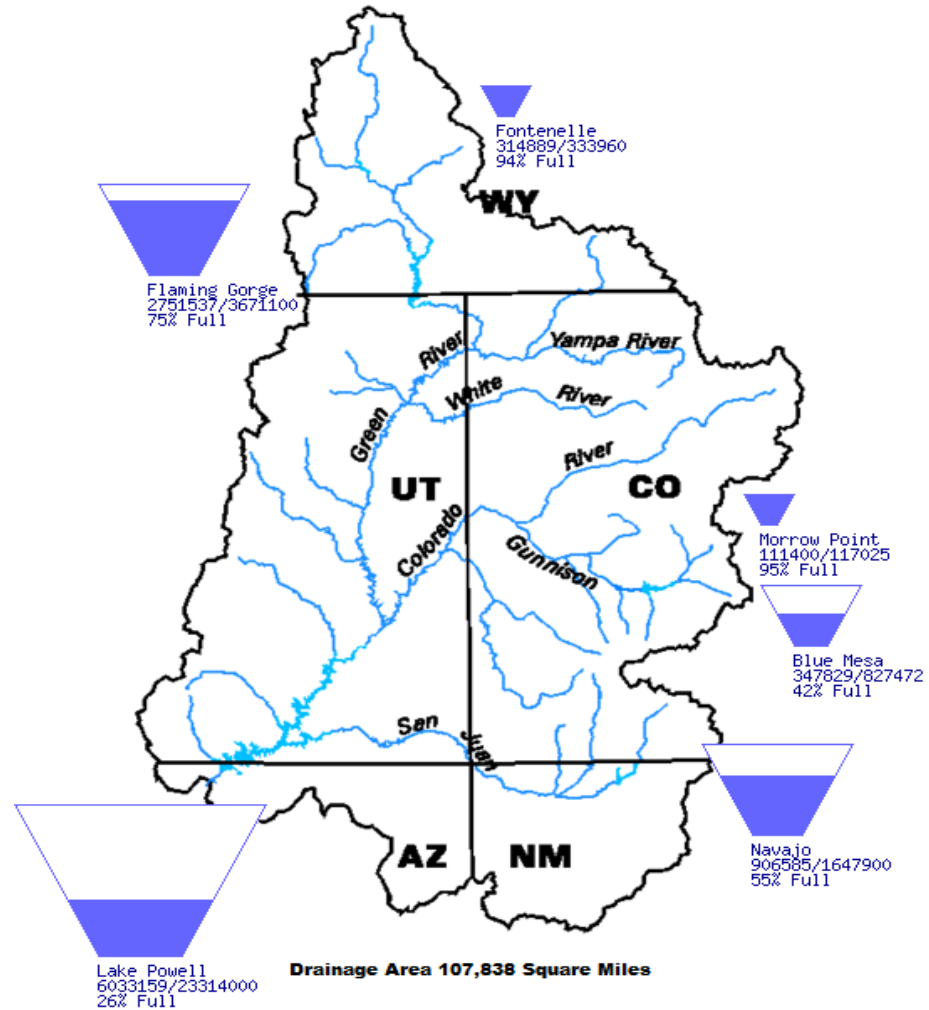


# Upper Basin Storage (as of August 22, 2022)

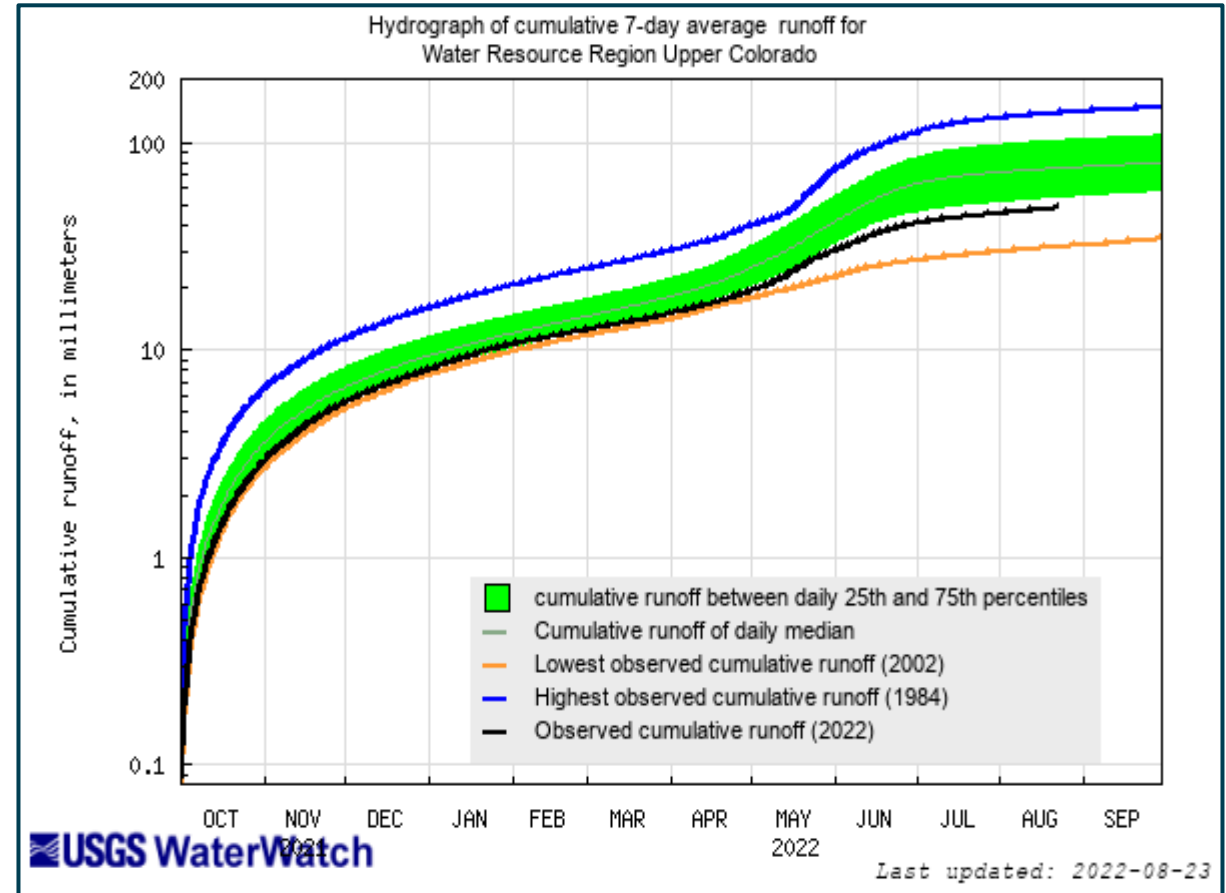
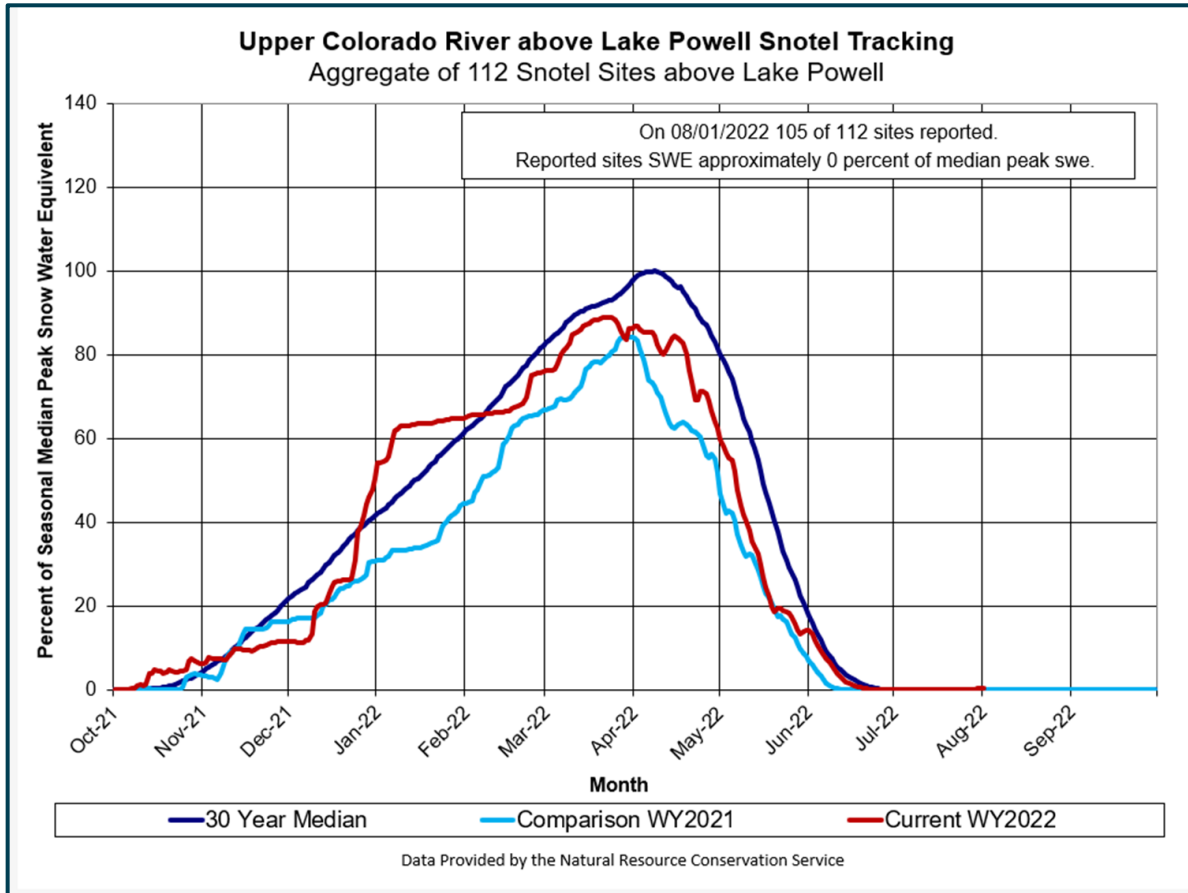
Data Current as of:  
08/22/2022

## Upper Colorado River Drainage Basin

| Reservoir            | Percent Current Live Storage | Current Live Storage (maf) | Live Storage Capacity (maf) | Elevation (feet) |
|----------------------|------------------------------|----------------------------|-----------------------------|------------------|
| Fontenelle           | 94                           | 0.32                       | 0.33                        | 6,503.54         |
| Flaming Gorge        | 75                           | 2.75                       | 3.67                        | 6,015.23         |
| Blue Mesa            | 42                           | 0.35                       | 0.83                        | 7,456.78         |
| Navajo               | 91                           | 0.91                       | 1.65                        | 6,024.43         |
| Lake Powell          | 26                           | 6.03                       | 23.31                       | 3533.27          |
| UC System Storage    | 35                           | 10.48                      | 29.79                       |                  |
| Total System Storage | 34                           | 19.98                      | 58.48                       |                  |



# Upper Colorado SWE and Observed Inflows



Available online at: [https://waterwatch.usgs.gov/index.php?id=wwdur\\_cumrunoff](https://waterwatch.usgs.gov/index.php?id=wwdur_cumrunoff)



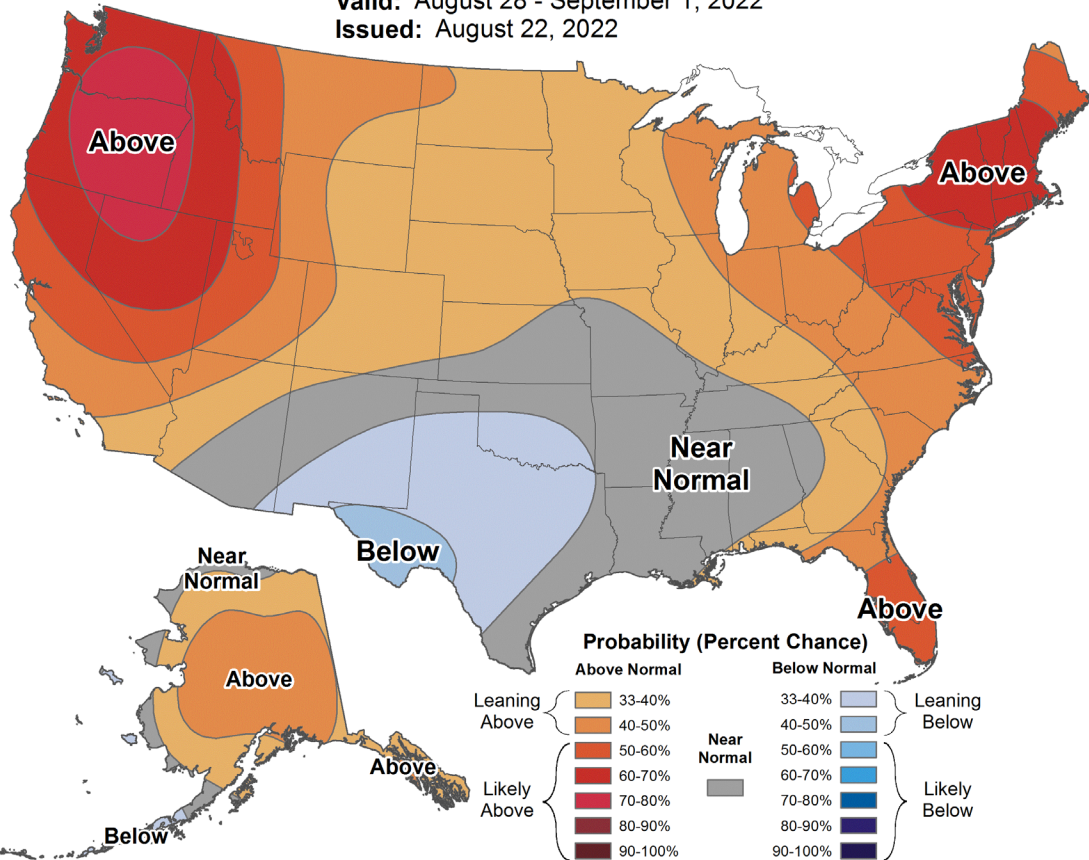
# Precipitation and Temperature Outlook



## 6-10 Day Temperature Outlook



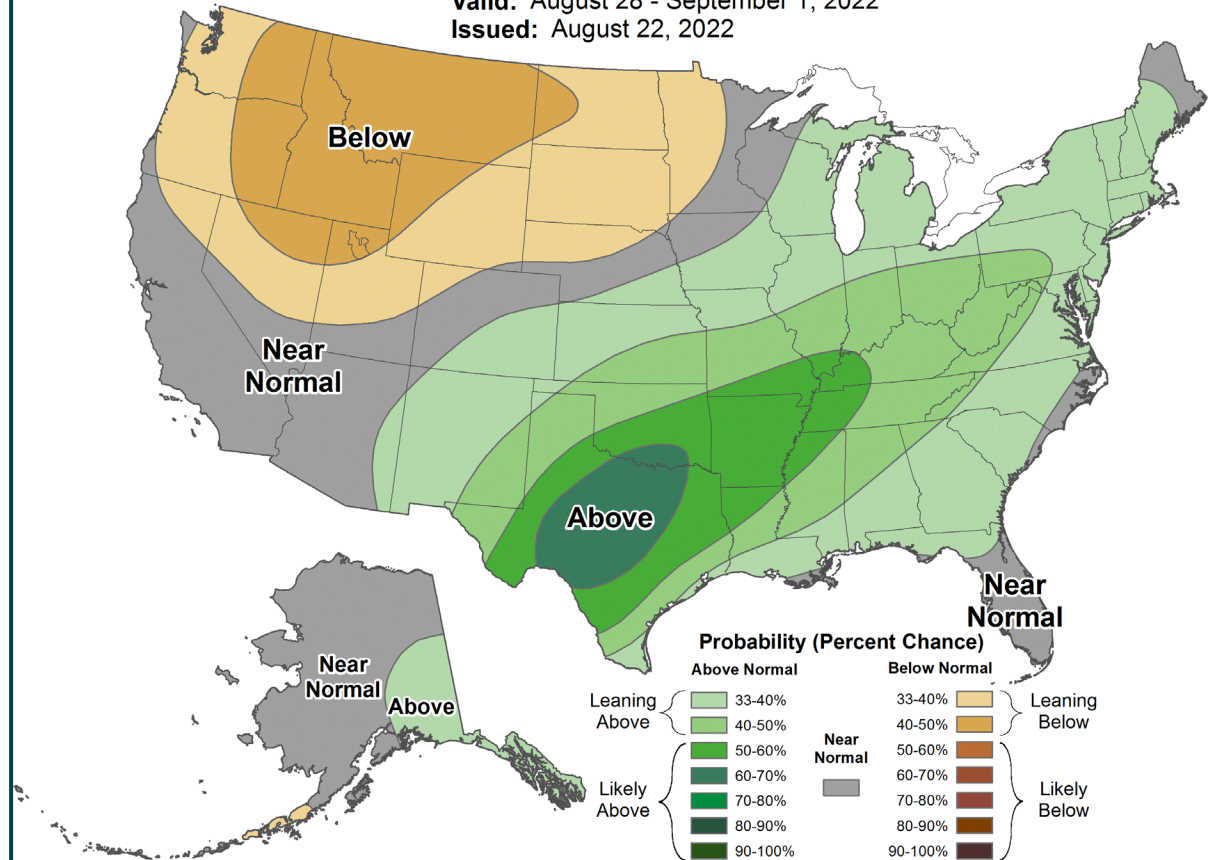
Valid: August 28 - September 1, 2022  
 Issued: August 22, 2022



## 6-10 Day Precipitation Outlook



Valid: August 28 - September 1, 2022  
 Issued: August 22, 2022



# Most Probable Forecast – August Final

## Water Years 2022 and 2023

April – July 2022  
Preliminary Observed  
Unregulated Inflow

| Reservoir     | Inflow (kaf) | Percent of Avg <sup>1</sup> |
|---------------|--------------|-----------------------------|
| Fontenelle    | 456          | 62                          |
| Flaming Gorge | 552          | 57                          |
| Blue Mesa     | 431          | 68                          |
| Navajo        | 381          | 60                          |
| Powell        | 3,750        | 59                          |

Water Year 2022  
Unregulated Inflow Forecast  
as of August 2, 2022

| Reservoir     | Inflow (kaf) | Percent of Avg <sup>1</sup> |
|---------------|--------------|-----------------------------|
| Fontenelle    | 736          | 69                          |
| Flaming Gorge | 890          | 63                          |
| Blue Mesa     | 573          | 71                          |
| Navajo        | 561          | 62                          |
| Powell        | 5,961        | 62                          |

Water Year 2023  
Unregulated Inflow Forecast  
as of August 2, 2022

| Reservoir     | Inflow (kaf) | Percent of Avg <sup>1</sup> |
|---------------|--------------|-----------------------------|
| Fontenelle    | 925          | 86                          |
| Flaming Gorge | 1,210        | 86                          |
| Blue Mesa     | 820          | 91                          |
| Navajo        | 810          | 89                          |
| Powell        | 8,300        | 86                          |

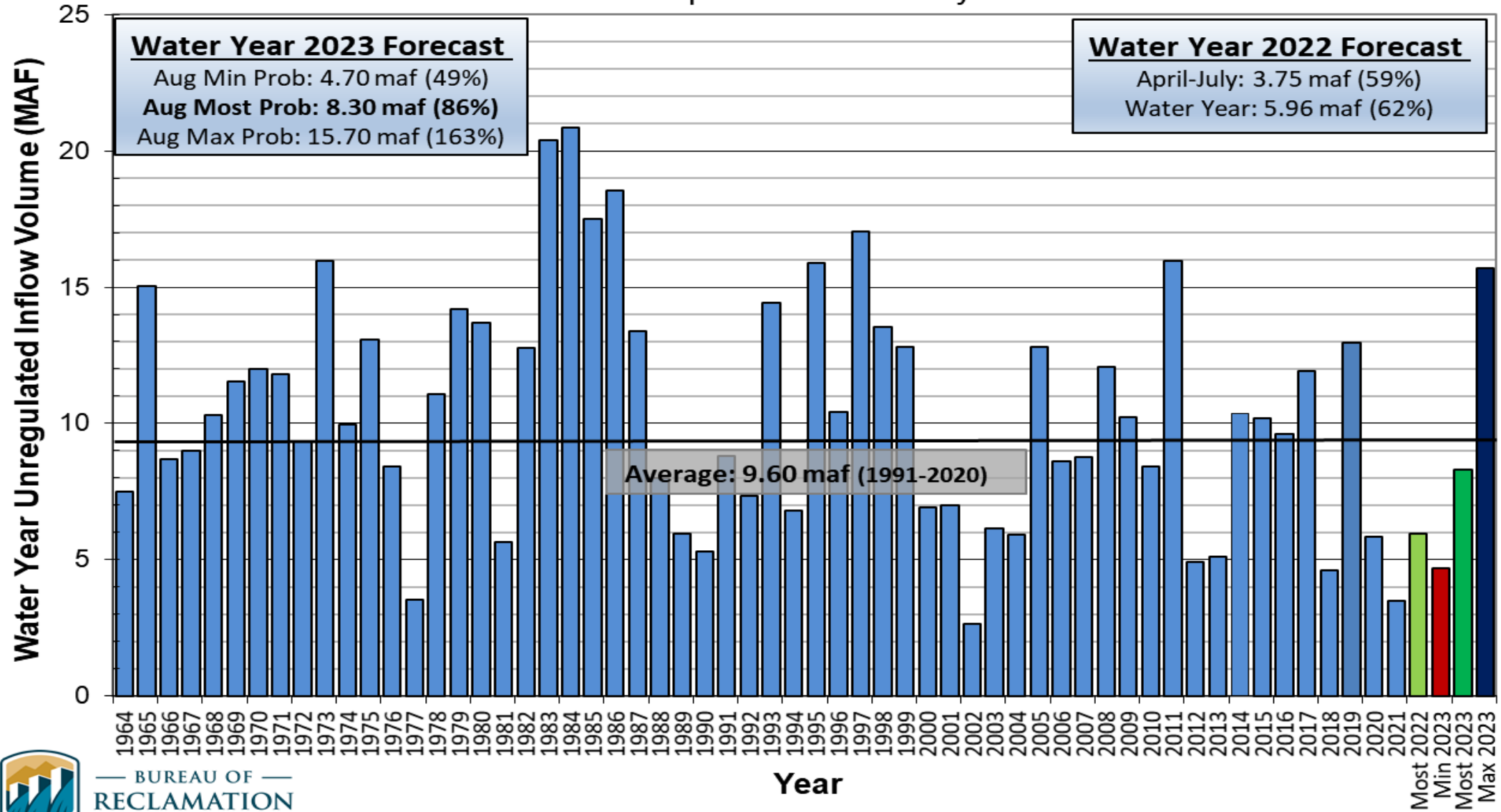
<sup>1</sup>Averages are based on the 1991 through 2020 period of record.



# Lake Powell Unregulated Inflow

## Water Year 2022 and 2023 Forecast *(issued August 2)*

### Comparison with History



# Upper Basin Drought Response Actions

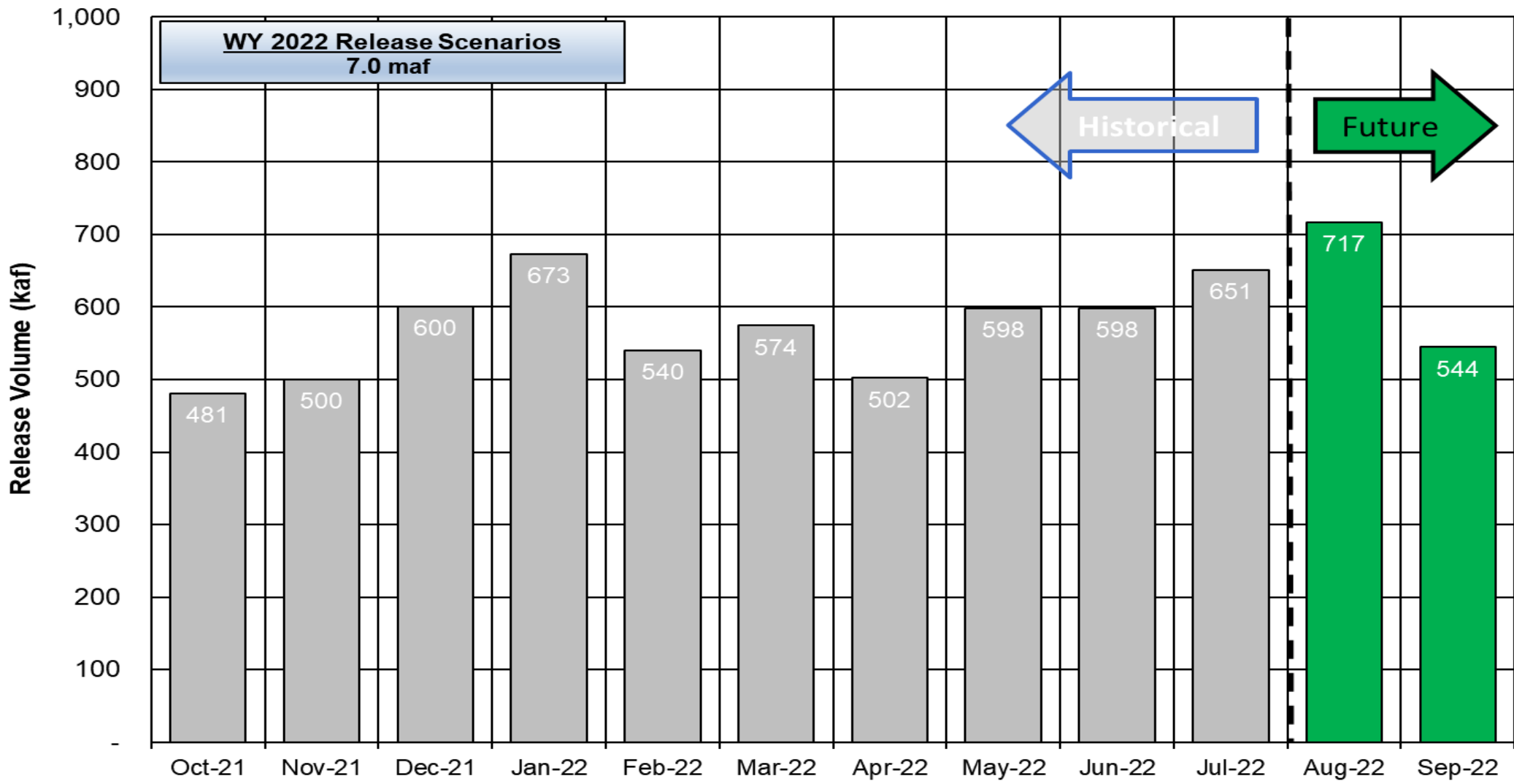
- The Bureau of Reclamation announced on May 3, 2022, two separate urgent drought response actions that will help prop up Lake Powell by nearly 1 million acre-feet (maf) of water over the next 12 months (May 2022 through April 2023). To protect Lake Powell, more water will flow into the lake from upstream 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/20220429-2022DroughtResponseOperationsPlan-ApprovalMemo-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 7.00 maf (GC Operational Adjustment), in accordance with Sections 6 and 7.D of the 2007 Interim Guidelines.
    - For more information: <https://www.usbr.gov/uc/DocLibrary/Plans/20220503-2022DROA-GlenCanyonDamOperationsDecisionLetter-508-DOI.pdf>





# Potential Lake Powell Monthly Release Volume Distribution

## Release Scenarios for Water Year 2022



WY 2022 Release Scenarios  
7.0 maf

Historical

Future



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



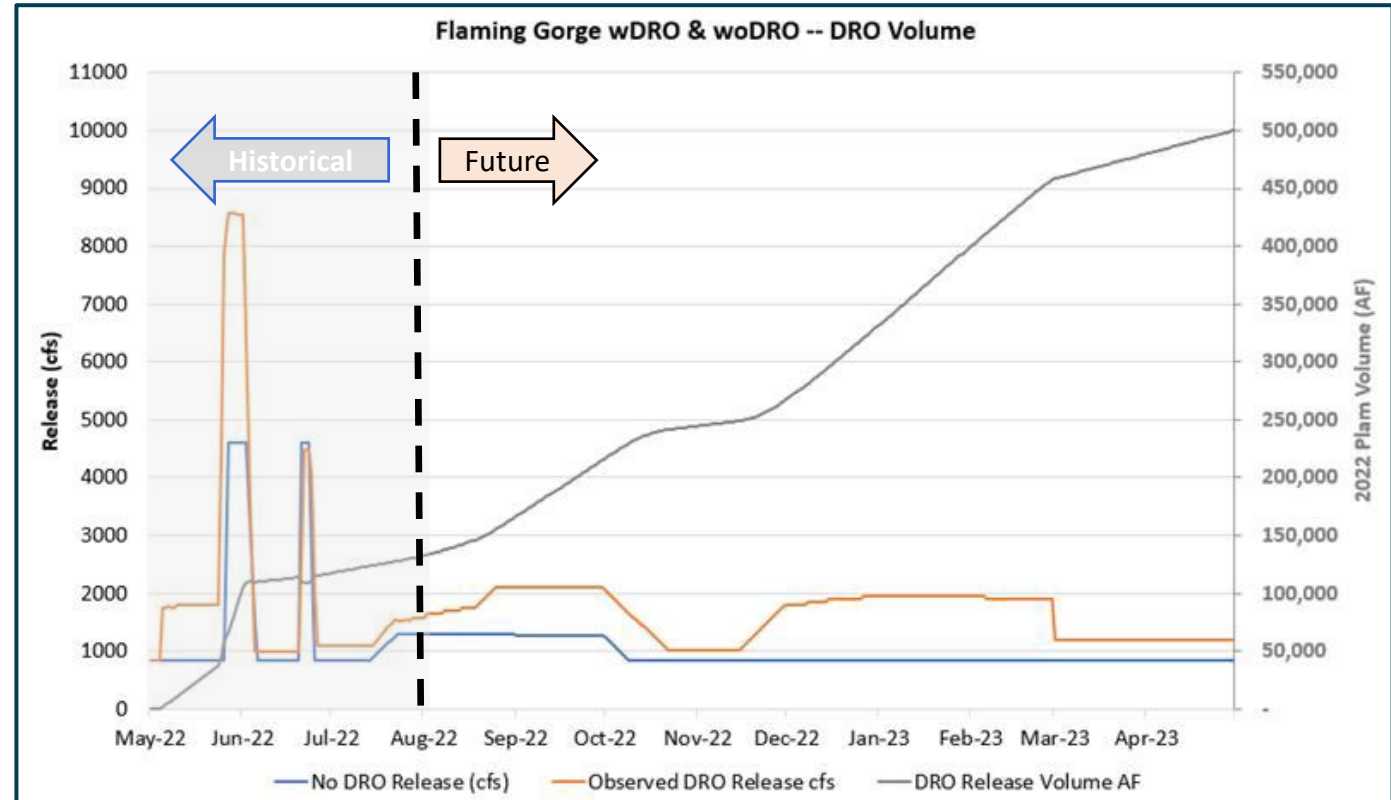
# Drought Response Operations Agreement (DROA)

## DROA Volumes Released<sup>1</sup>

| Reservoir     | 2021 DROA Volume (kaf) | 2022 DROA Volume (kaf) | Total DROA Volume (kaf) |
|---------------|------------------------|------------------------|-------------------------|
| Flaming Gorge | 125                    | 500                    | 625                     |
| Blue Mesa     | 36                     | 0                      | 36                      |
| Navajo        | 0                      | 0                      | 0                       |
| Powell        | 161                    | 500                    | 661                     |

<sup>1</sup>DROA operational year is from May through April.

## Flaming Gorge 2022 Plan





# August 24-Month Study Projections

## Upper Colorado Basin Region Operations



# Timing of Operational Decisions

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



# 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.

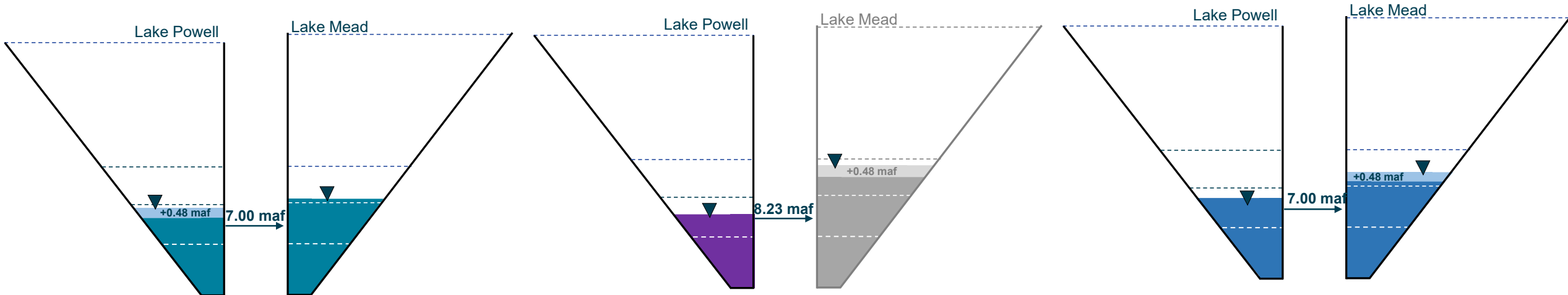


# End of Calendar Year 2022 Lake Powell and Lake Mead Elevations Based on August 2022 24-Month Study<sup>1,2,3</sup>

**Physical Elevations:** Real-time or projected elevations based on a 7.00 maf release from Lake Powell in WY 2022 and 7.00 maf in WY 2023.

**Powell Tier Determination:** Projected elevation “as if” the additional 0.48 maf were released from Powell in WY 2022 and with an 8.23 maf WY 2023 Powell release.

**Effective Elevation & Mead Operating Condition Determination:** Projected elevation “as if” the additional 0.48 maf were released from Powell in WY 2022, with an adjusted WY 2023 Powell release of 7.00 maf.



| Reservoir   | End of Calendar Year 2022 Physical Elevation |
|-------------|--|
| Lake Powell | 3,521.84                                     |
| Lake Mead   | 1,040.47                                     |

| Reservoir   | End of Calendar Year 2022 Powell Tier Determination Elevation |
|-------------|---|
| Lake Powell | 3,505.66  |
| Lake Mead   | NA  |

| Reservoir   | End of Calendar Year 2022 Effective Elevation |
|-------------|---|
| Lake Powell | 3,513.10                                      |
| Lake Mead   | 1,047.61                                      |

<sup>1</sup> For more information: <https://www.usbr.gov/uc/DocLibrary/Plans/20220503-2022DROA-GlenCanyonDamOperationsDecisionLetter-508-DOI.pdf>.

<sup>2</sup> Both the Powell Tier Determination and Effective Elevations are “as if” the additional 0.48 maf were delivered to Mead in WY 2022. Powell’s Tier Determination elevation is used to set the WY 2023 operating tier. For Mead, the Effective Elevation is used to set the CY 2023 operating condition. The Department of Interior and Reclamation will work to determine the manner in

14 which to operate Glen Canyon Dam to ensure the benefits of these actions are preserved.

<sup>3</sup> Images are **not** to scale.



# Lake Powell & Lake Mead Operational Table

Lake Powell Operational Tier Determination Run (aka "Exhibit Run") with an 8.23 maf Release<sup>1,2</sup>

| 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,<br>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                           | Normal or ICS Surplus Condition<br>Deliver ≥ 7.5 maf  | 15.9   |
|                              | Mid-Elevation Release Tier<br>Release 7.48 maf;<br>if Lake Mead < 1,025 feet,<br>release 8.23 maf  | 9.5                             | 1,105                           |   | Shortage Condition<br>Deliver 7.167 <sup>4</sup> maf |
|                              |  |                                 | 1,075                           | 9.4   |  |
|                              | Lower Elevation Balancing Tier<br>Balance contents with a min/max release of 7.0 and 9.5 maf   | 5.9                             | 1,050                           | Shortage Condition<br>Deliver 7.083 <sup>5</sup> maf  | 7.5  |
| 3,525                        |  |                                 | 1,025                           |   | 5.8  |
| 3,490                        |  | 4.0                             | 1,000                           | Shortage Condition<br>Deliver 7.0 <sup>6</sup> maf<br>Further measures may be undertaken <sup>7</sup> | 4.3  |
| 3,370                        |  | 0                               | 895                             |   | 0  |

**3,505.66 ft  
Jan 1, 2023  
Projection**

**1,047.61 ft  
Jan 1, 2023  
Projection**

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

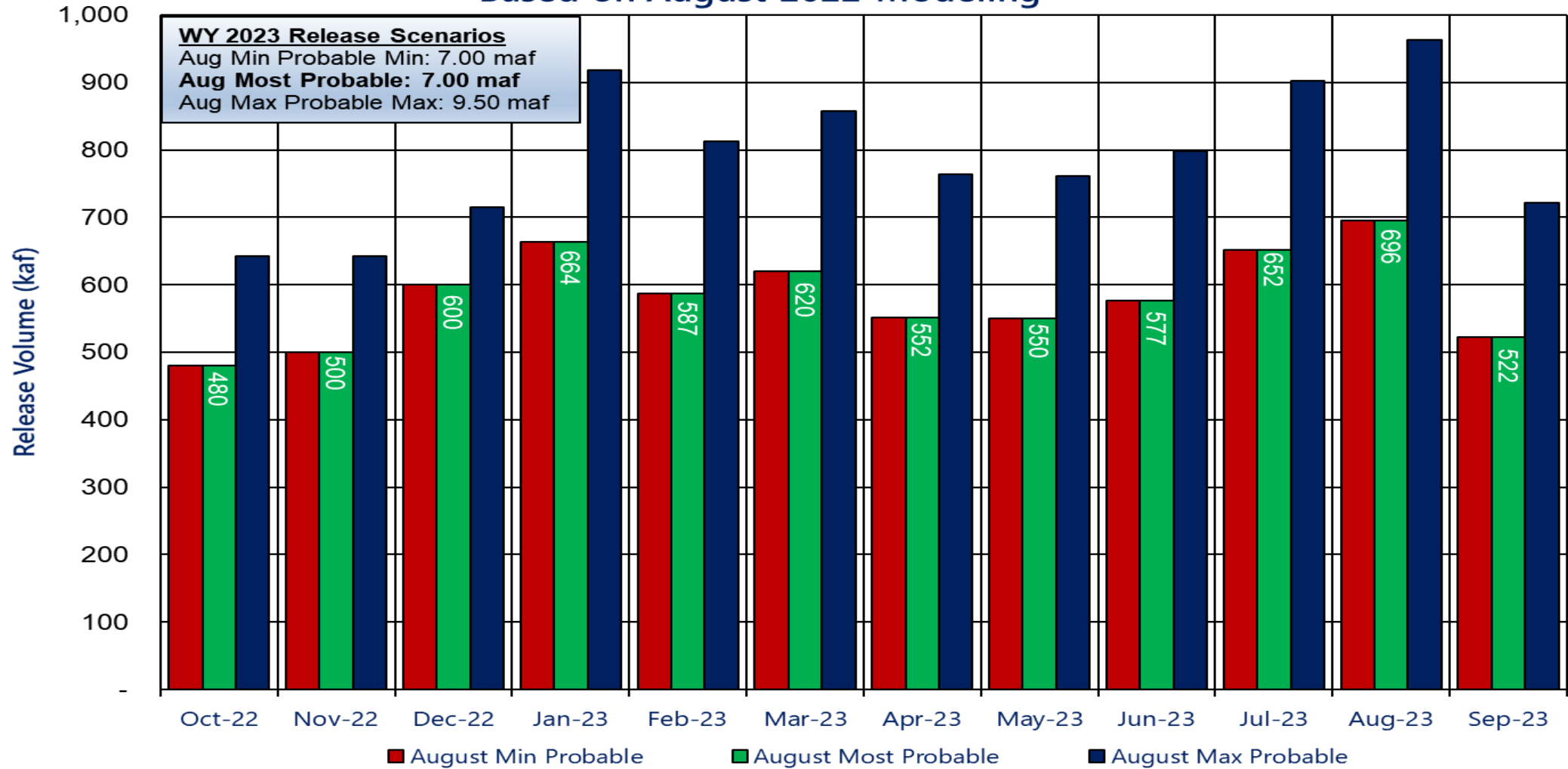
<sup>7</sup> Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Division States and Mexico is likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation 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 operational tier determinations are based on August 2021 24-Month Study projections will be documented in the draft 2023 AOP.

<sup>2</sup> The operating determination for WY 2023 is based on a projected elevation "as if" the 0.48 maf were delivered to Lake Mead with a Glen Canyon Dam release pattern of 8.23 maf.



## Potential Lake Powell Monthly Release Volume Distribution Release Scenarios for Water Year 2023 Based on August 2022 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.

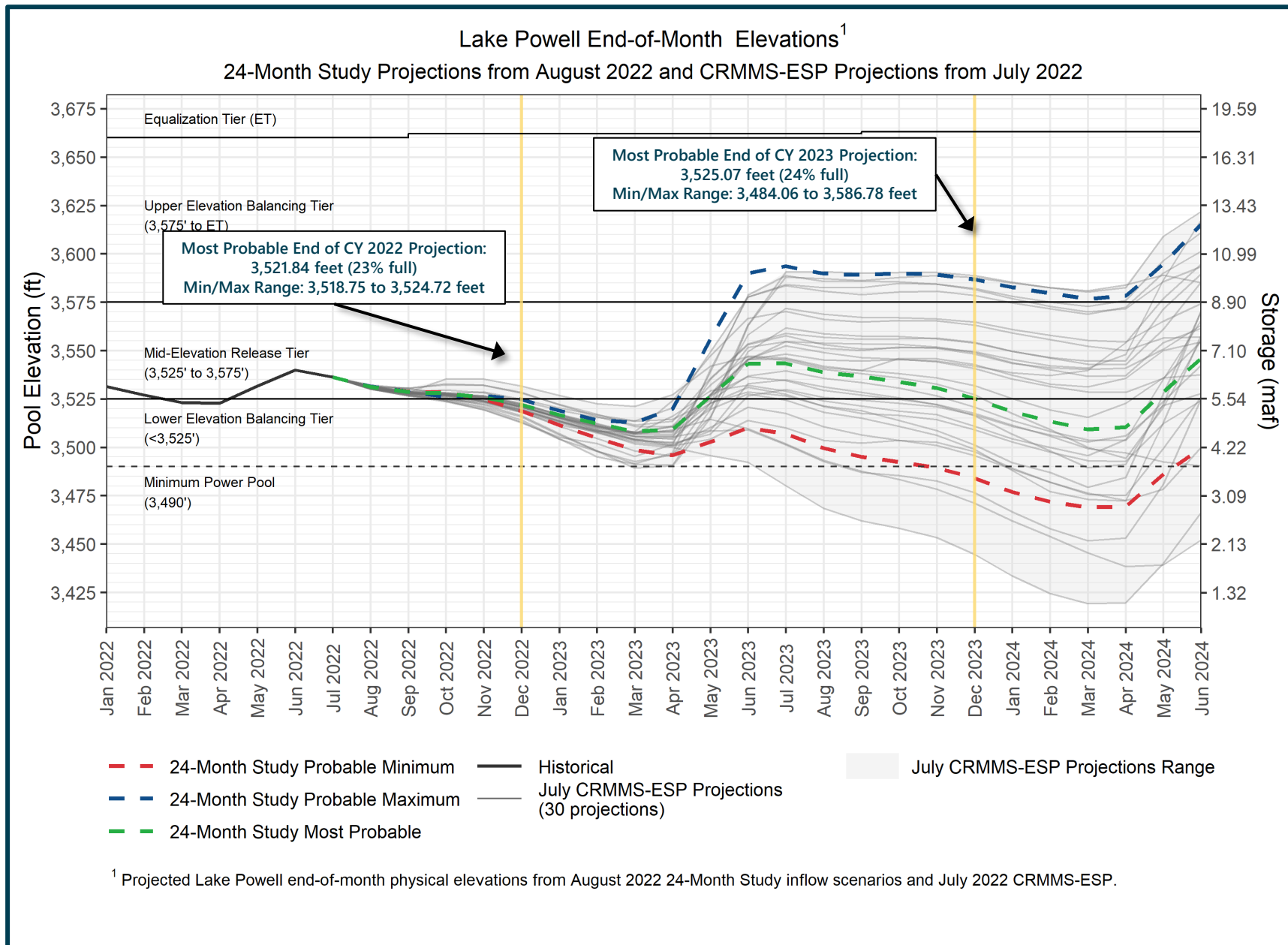




# Reclamation Operational Modeling Model Comparison

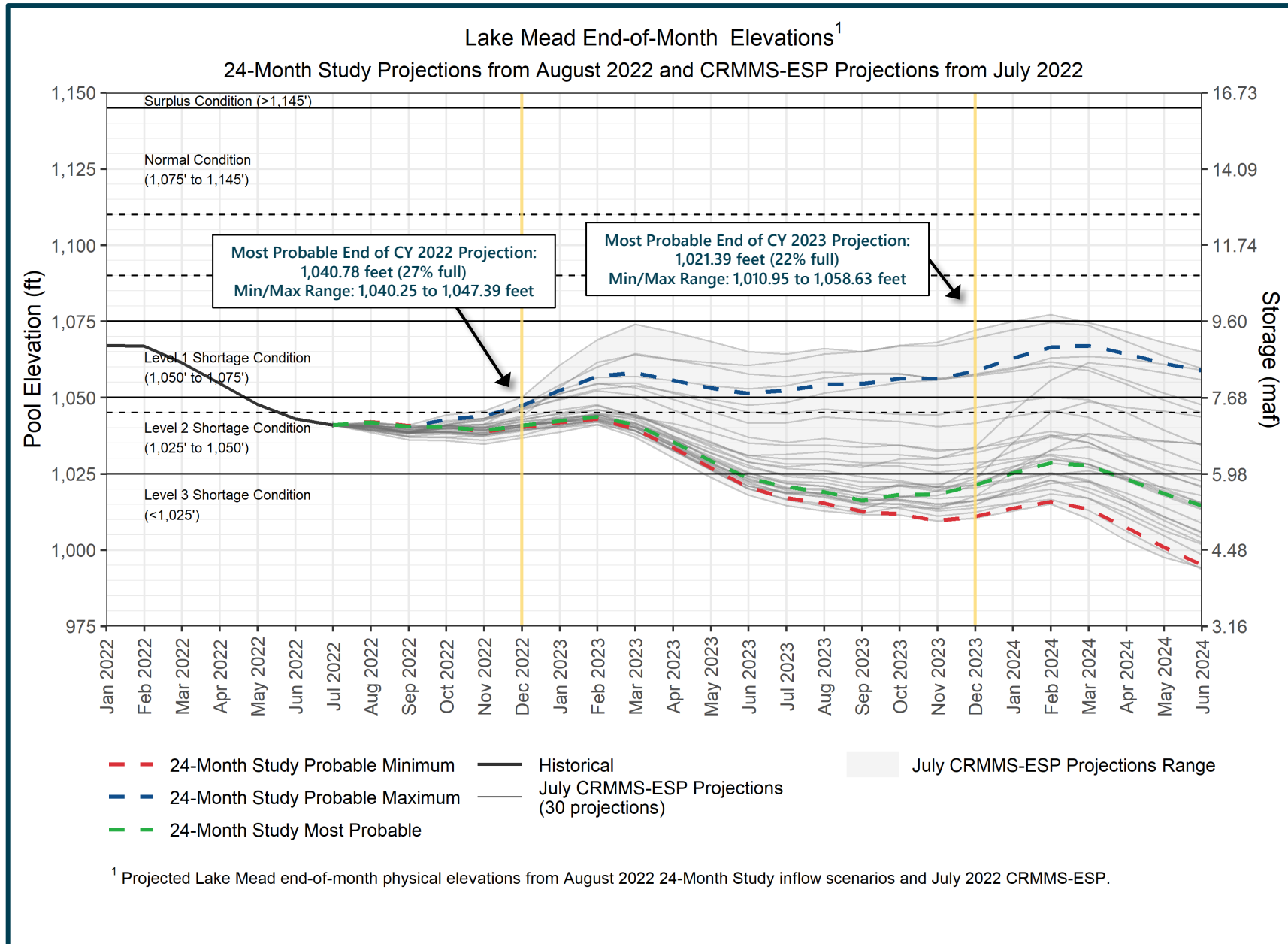
|                                | Colorado River Mid-term Modeling System (CRMMS)               |   | CRSS   |
|--------------------------------|---|---|--|
|                                | 24-Month Study Mode (Manual Mode)                             | Ensemble Mode (Rule-based Mode)                               |  |
| 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                                      |





The chart above displays projected “physical” elevations for Lake Powell. Based on August 2022 24-Month Study modeling, Lake Powell’s elevation is projected to be less than 3,525 feet and the operating tier for water year 2023 is the Lower Elevation Balancing Tier.





The chart above displays projected “physical” elevations for Lake Mead. Based on August 2022 24-Month Study modeling, Lake Mead’s operating condition for calendar year 2023 is the Level 2 Shortage Condition within the 1,045 – 1,050 elevation band.





# 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                       |          |          |          |          |          |          |          |          |          |                      |          |          |
| 3                       |          |          |          |          |          |          |          |          |          |                      |          |          |
| 4                       |          |          |          |          |          |          |          |          |          |                      |          |          |
| 5                       |          |          |          |          |          |          | [Outage] |          |          |                      |          |          |
| 6                       |          |          |          |          |          |          | [Outage] |          |          |                      |          |          |
| 7                       | [Outage] |          |          |          |          |          |          |          |          |                      |          |          |
| 8                       | [Outage] |          |          |          |          |          |          |          |          |                      |          |          |
| Units Available         | 6        | 6        | 6        | 6        | 5        | 4        | 6        | 6        | 6        | 6                    | 6        | 6        |
| Capacity (cfs)          | 18,700   | 18,600   | 11,700   | 18,700   | 14,800   | 11,300   | 17,900   | 14,900   | 18,500   | 18,400               | 18,250   | 18,200   |
| Capacity (kaf/month)    | 1,150    | 1,110    | 1,110    | 1,160    | 810      | 980      | 1,000    | 1,050    | 1,110    | 1,130                | 1,120    | 1,080    |
| Max (kaf) <sup>1</sup>  | 481      | 500      | 600      | 673      | 540      | 575      | 502      | 598      | 598      | 673                  | 717      | 543      |
| Most (kaf) <sup>1</sup> | 481      | 500      | 600      | 673      | 540      | 575      | 502      | 598      | 598      | 673                  | 717      | 543      |
| Min (kaf) <sup>1</sup>  | 481      | 500      | 600      | 673      | 540      | 575      | 502      | 598      | 598      | 673                  | 717      | 542      |
|                         |          |          |          |          |          |          |          |          |          | (updated 08-17-2022) |          |          |

AUG MOST<sup>2</sup>

AUG MOST

7.0 maf

7.0 maf

7.0 maf

1 Projected release, based on August 2022 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 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                       |          |                   |          | [Outage] |          |          |          |          |          |          |          |          |
| 3                       |          |                   |          | [Outage] |          |          |          |          |          |          |          |          |
| 4                       |          |                   |          |          |          |          |          |          |          |          |          |          |
| 5                       | [Outage] |                   |          |          |          |          |          |          |          |          |          |          |
| 6                       | [Outage] |                   |          |          |          |          |          |          |          |          |          |          |
| 7                       |          |                   |          |          |          | [Outage] |          |          |          |          |          |          |
| 8                       |          |                   |          |          |          | [Outage] |          |          |          |          |          |          |
| Units Available         | 8        | 8/6               | 8        | 6        | 6        | 4        | 6        | 6        | 6        | 8        | 8        | 6        |
| Capacity (cfs)          | 18,100   | 24,750/<br>18,100 | 24,600   | 17,800   | 17,800   | 11,000   | 17,500   | 18,100   | 18,650   | 25,500   | 25,300   | 18,400   |
| Capacity (kaf/month)    | 1,120    | 1,190             | 1,510    | 1,200    | 950      | 740      | 1,040    | 1,110    | 1,110    | 1,430    | 1,560    | 1,130    |
| Max (kaf) <sup>1</sup>  | 643      | 642               | 715      | 919      | 813      | 858      | 764      | 761      | 798      | 902      | 963      | 722      |
| Most (kaf) <sup>1</sup> | 480      | 500               | 600      | 664      | 587      | 620      | 552      | 550      | 577      | 652      | 698      | 522      |
| Min (kaf) <sup>1</sup>  | 480      | 500               | 600      | 664      | 587      | 620      | 552      | 550      | 577      | 652      | 698      | 522      |
|                         |          |                   |          |          |          |          |          |          |          |          |          |          |

AUG MOST<sup>2</sup>

AUG MOST

9.5 maf

7.0 maf

7.0 maf

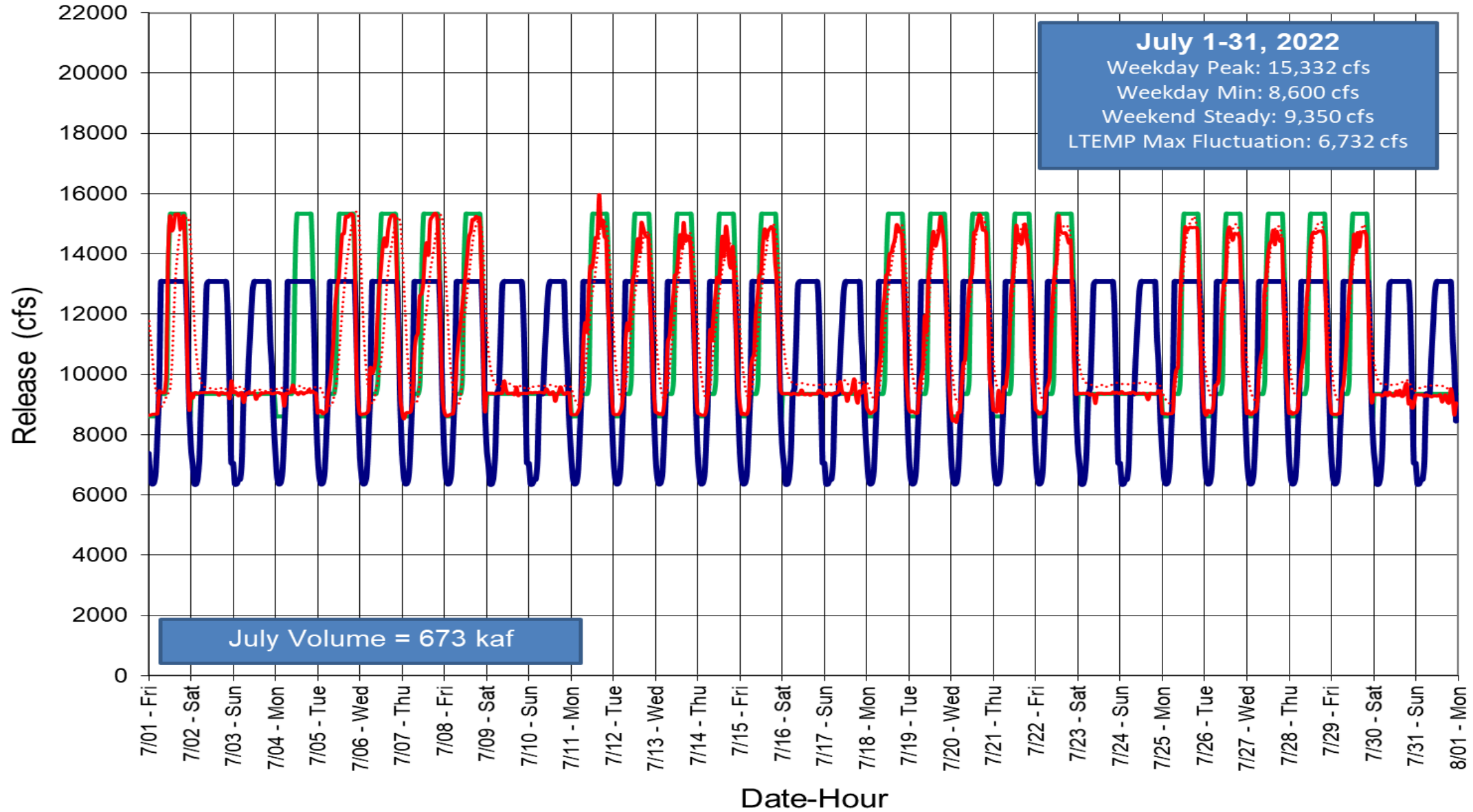
(updated 08-17-2022)

1 Projected release, based on August 2022 minimum, most and maximum probable Inflow Projections and 24-Month Study model runs.

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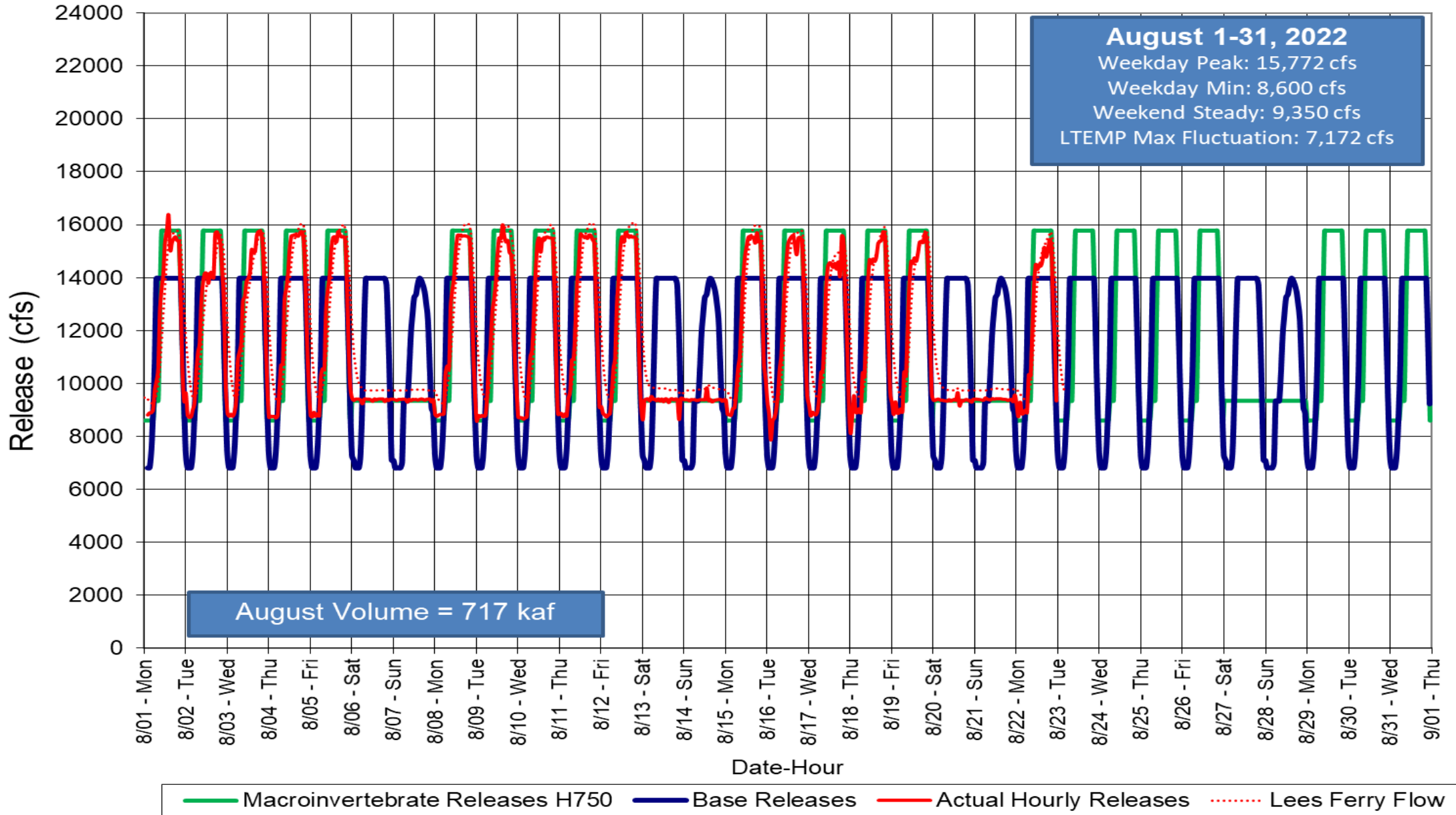
# Glen Canyon Dam Hourly Release Pattern July 2022



— Macroinvertebrate Releases H750    — Base Releases    — Actual Hourly Releases    ····· Lees Ferry Flow

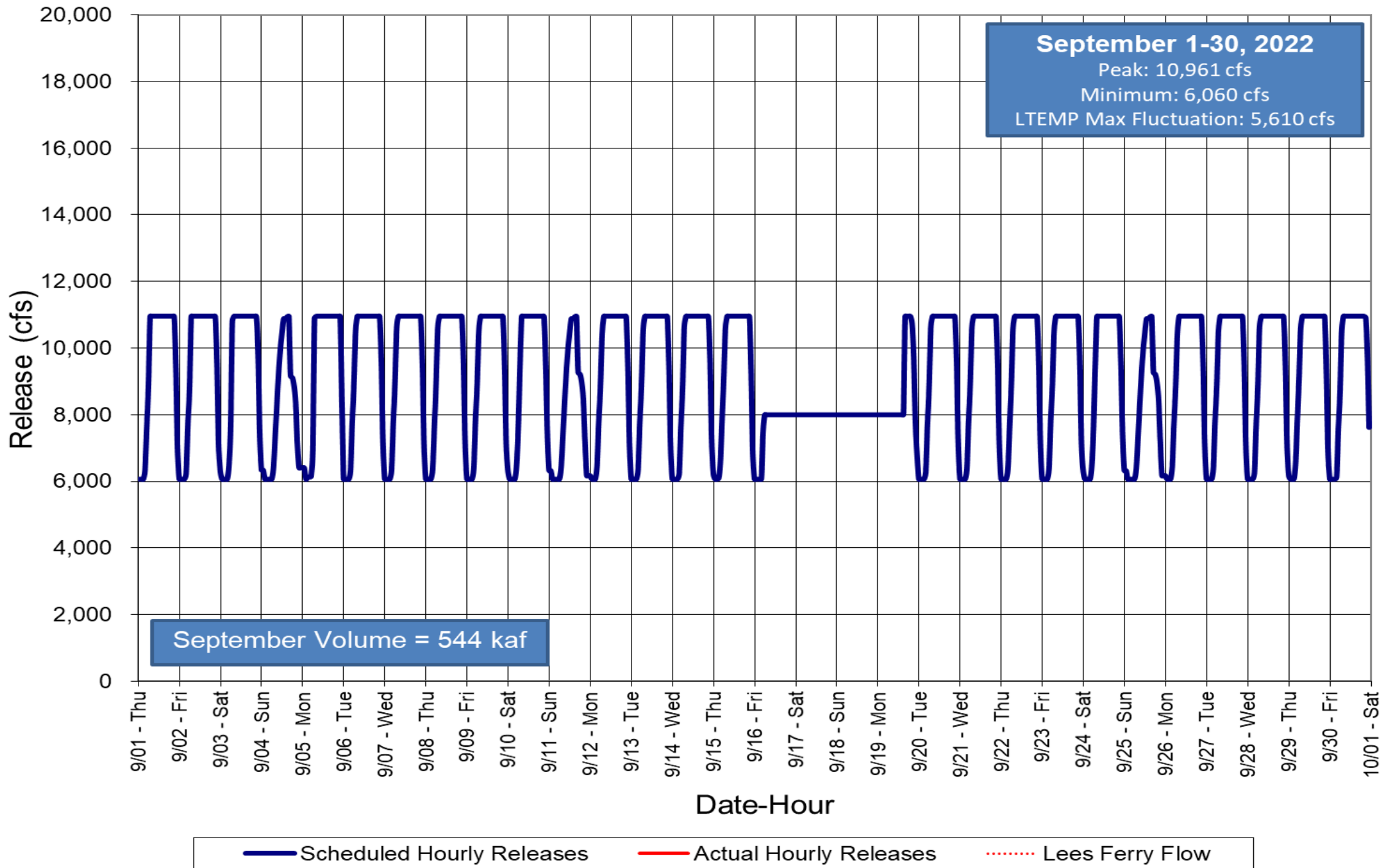


# Glen Canyon Dam Hourly Release Pattern August 2022





# Glen Canyon Dam Hourly Release Pattern September 2022

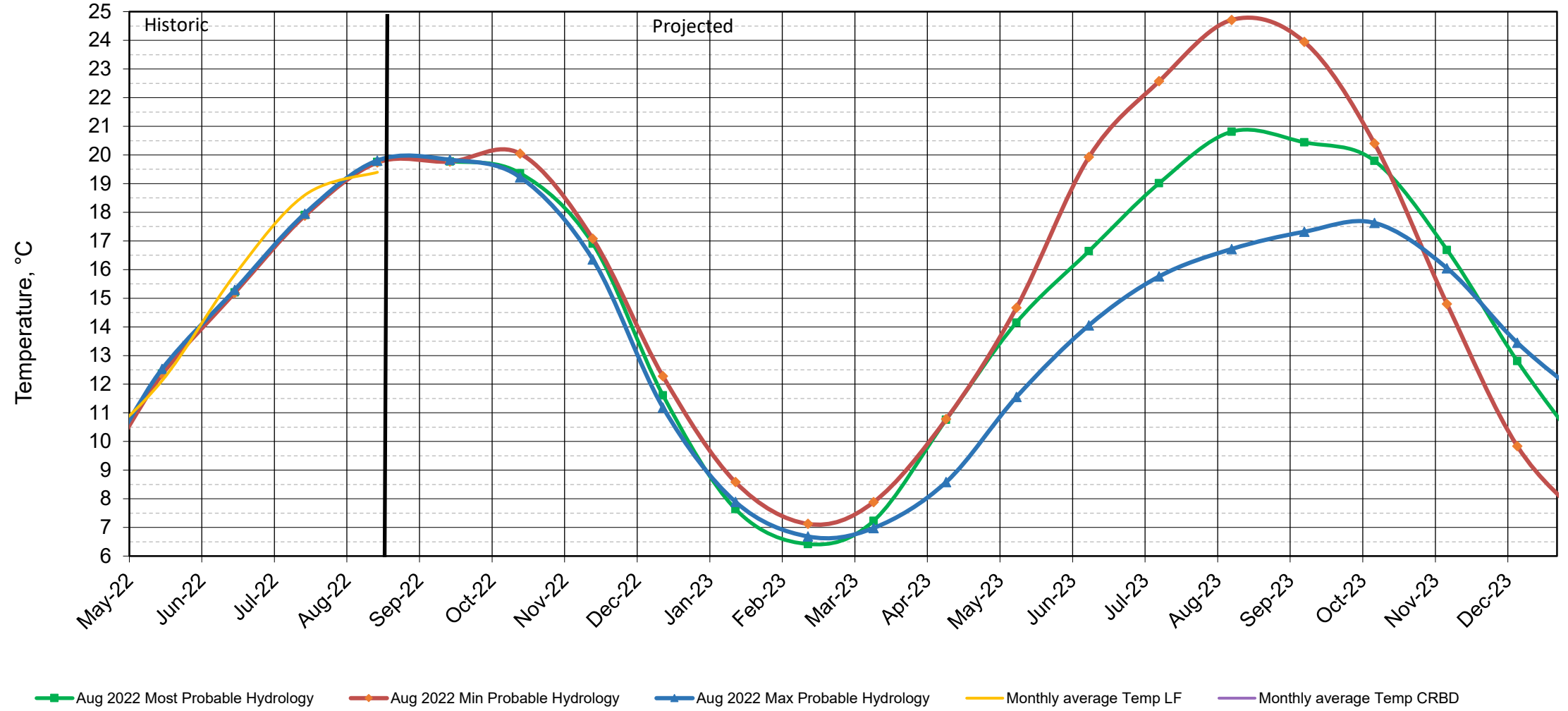


# Water Quality



# Lake Powell Release Temperature

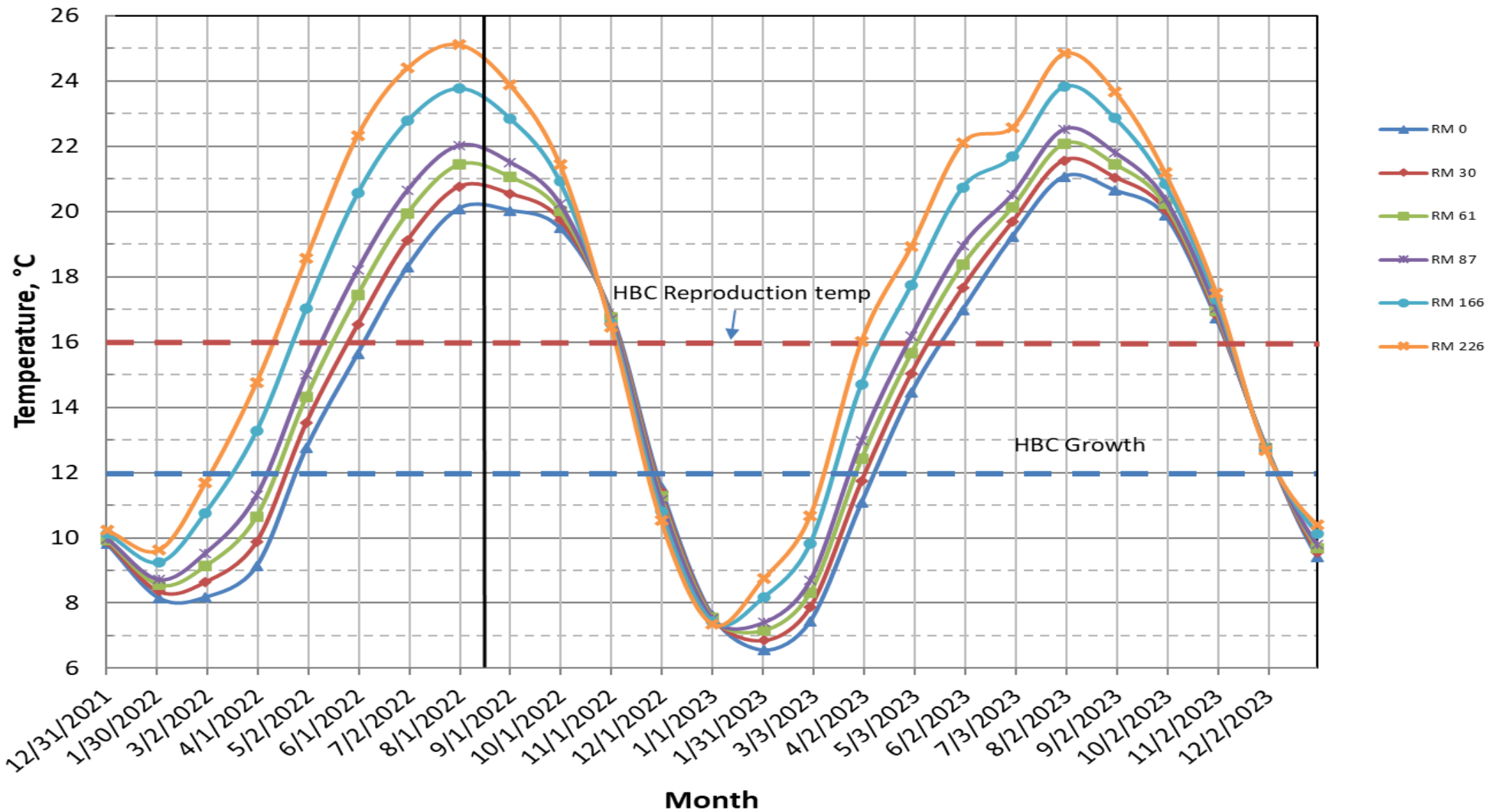
## Projected Temperature based on August 2022 Forecast



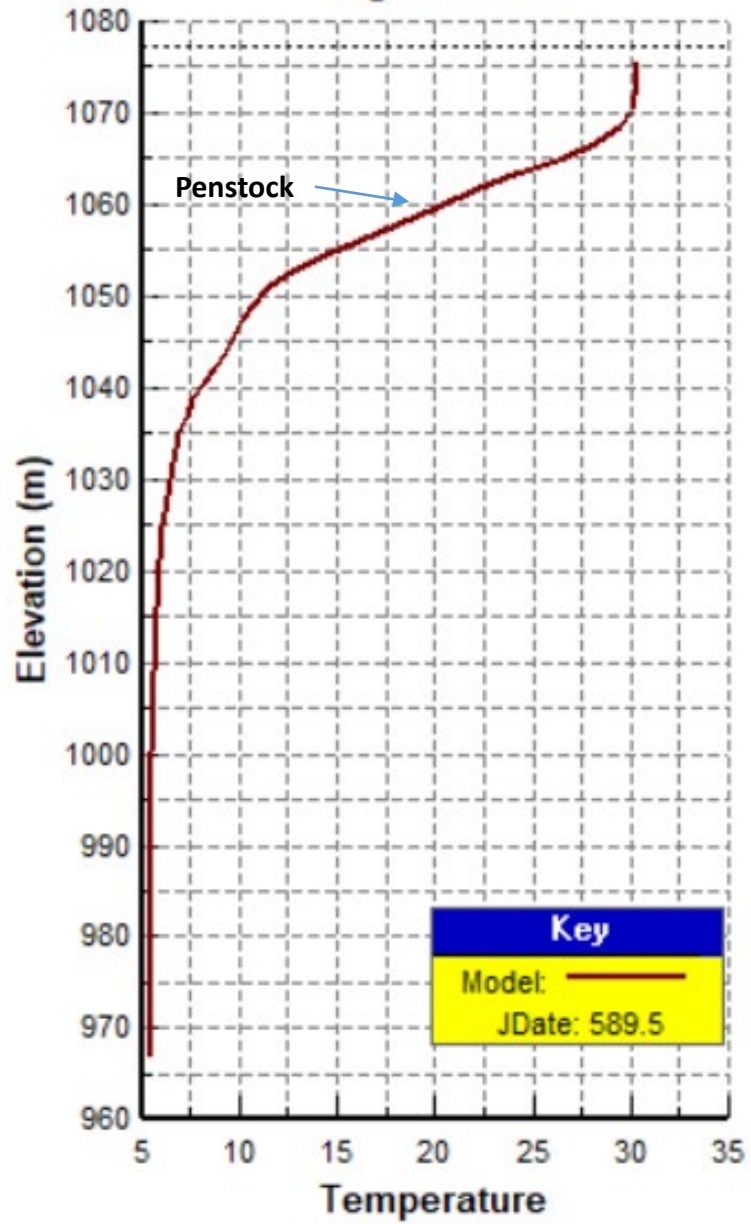
#Projection start date is based on initial conditions (March 2021)

# Colorado River, Grand Canyon Water Temperatures

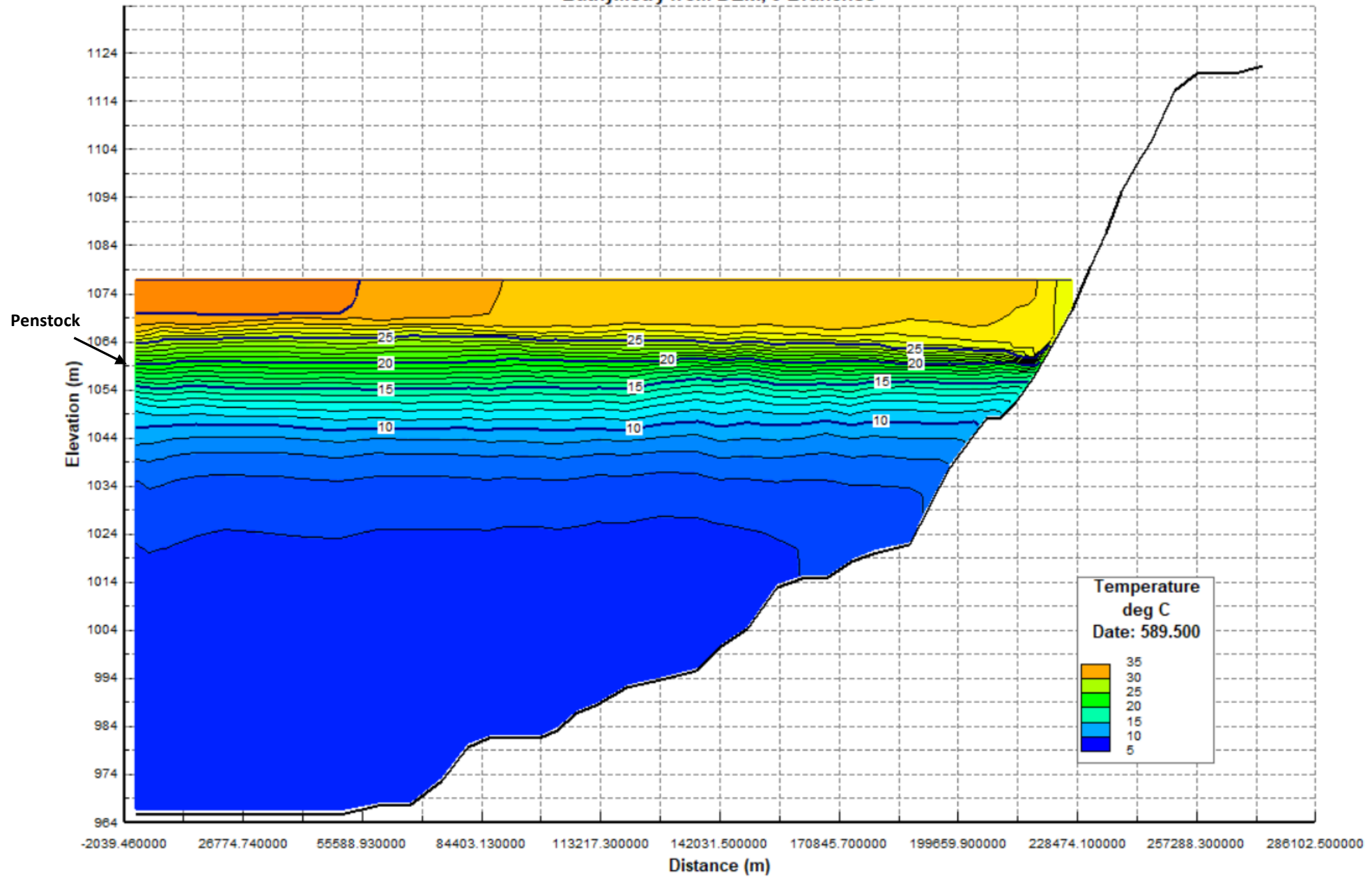
Projections based on August 2022, Most Probable Hydrology



Segment: 49



Lake Powell  
Bathymetry from DEM; 9 Branches

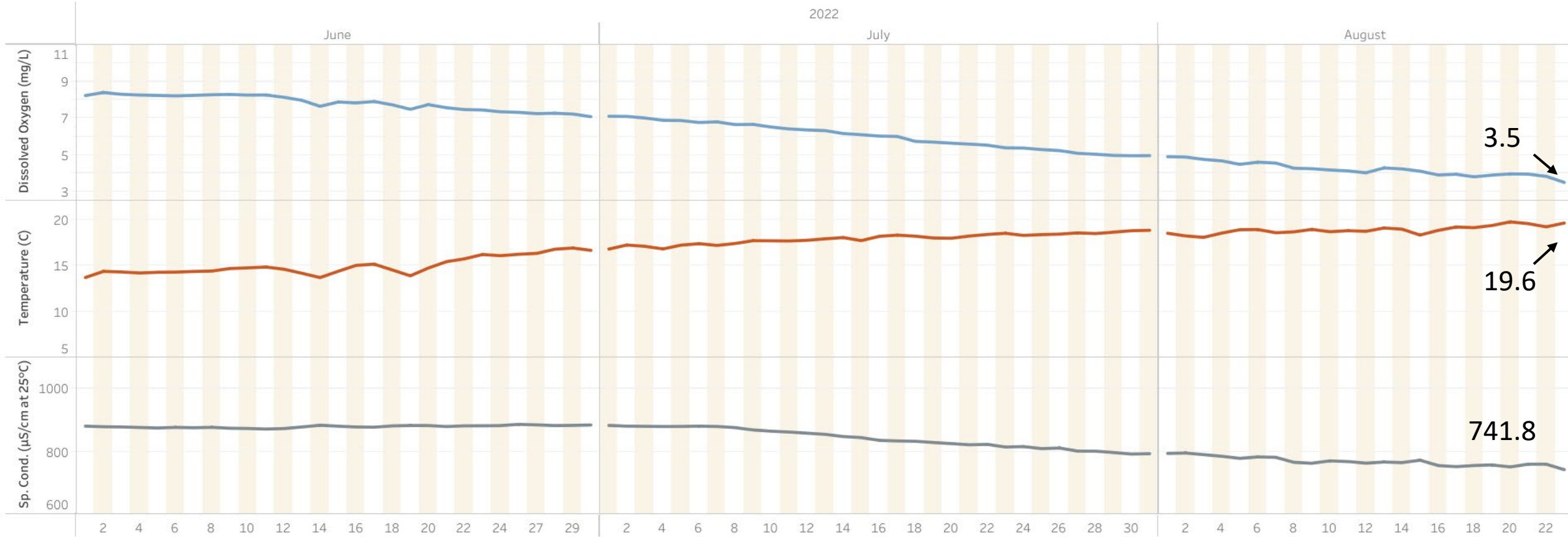




# Daily Water Quality Data at Glen Canyon Dam

[Download PDF](#)

## Daily Dissolved Oxygen & Temperature Values



The trends of daily average Dissolved Oxygen, Temperature and Specific Conductance shown for the past 30 days.

Select Date Extent  
6/1/2022 to 8/31/2022

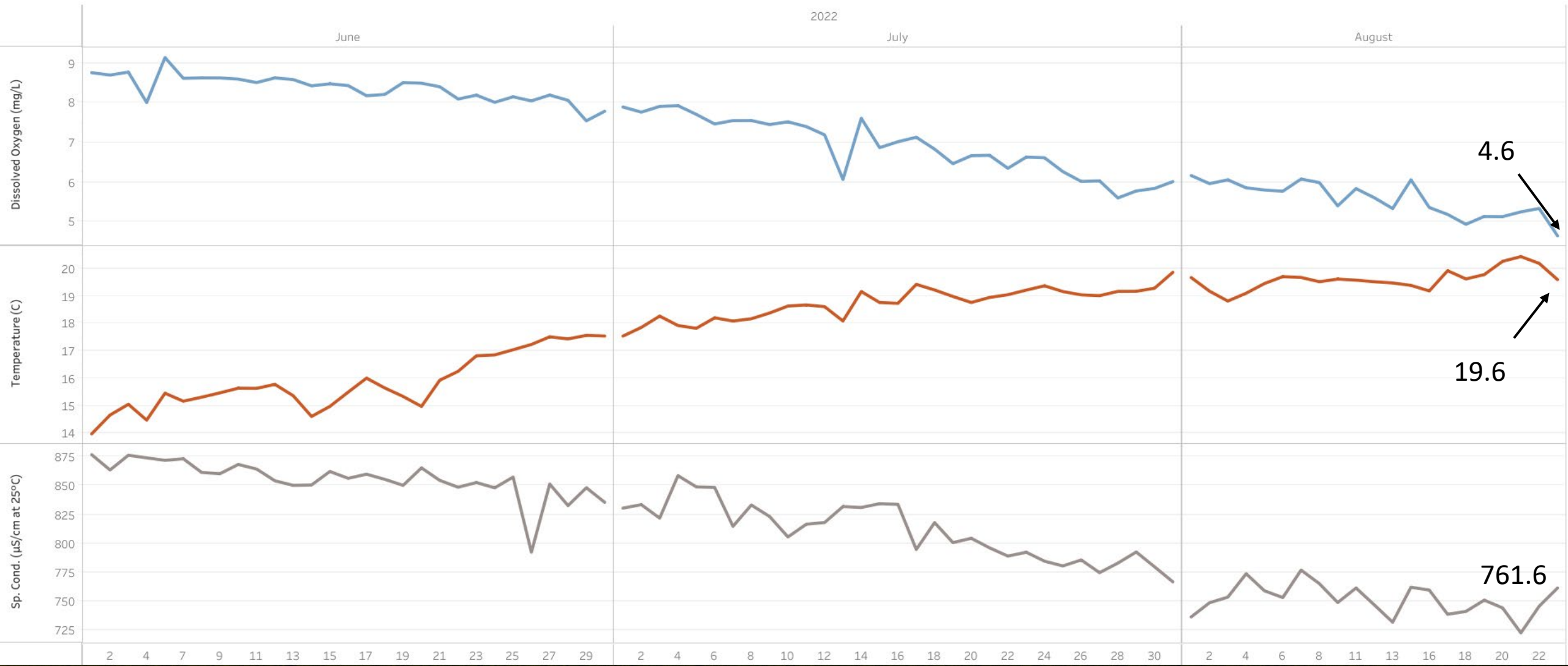
These data are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data have not received final approval by the U.S. Geological Survey (USGS) and are provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data. Please visit GCMRC's Discharge, Sediment and Water Quality web site for a QA/QC version of these data: [https://www.qcmrc.gov/discharge\\_qw\\_sediment/station/GCDAMP/09379901](https://www.qcmrc.gov/discharge_qw_sediment/station/GCDAMP/09379901)



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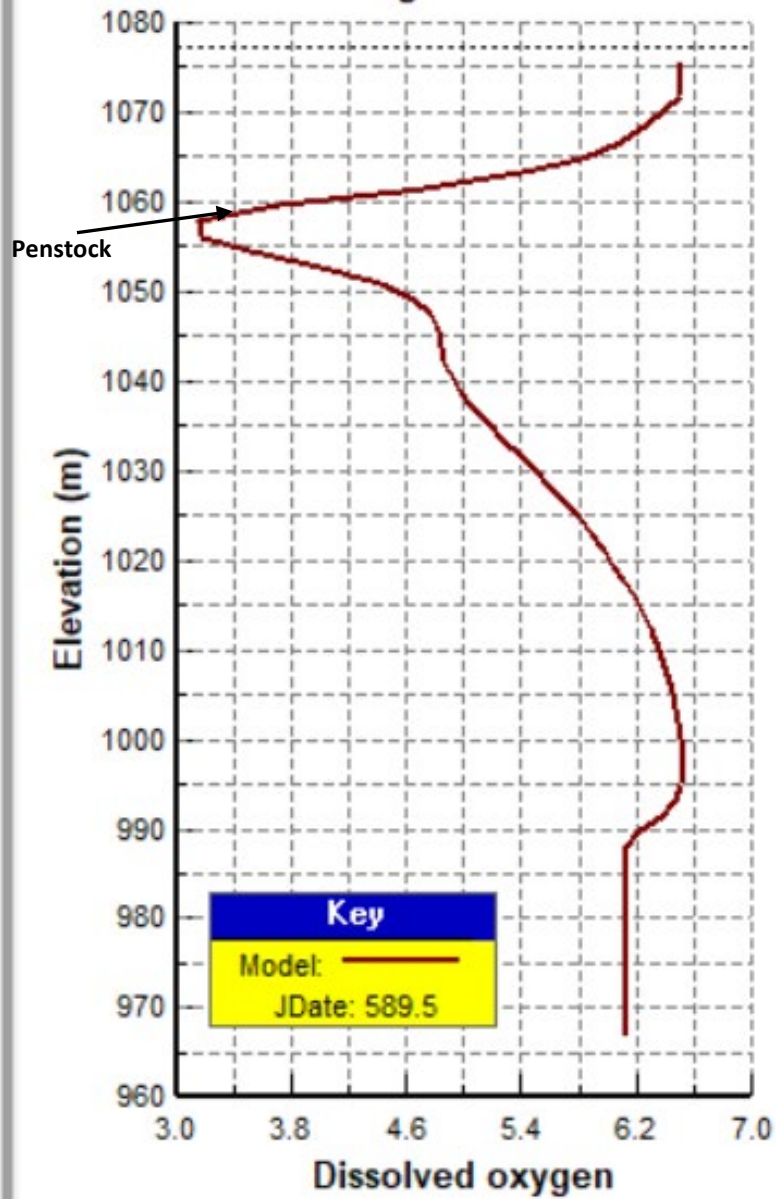
# Lees Ferry Daily Average

## Temperature and Dissolved Oxygen Daily Averages

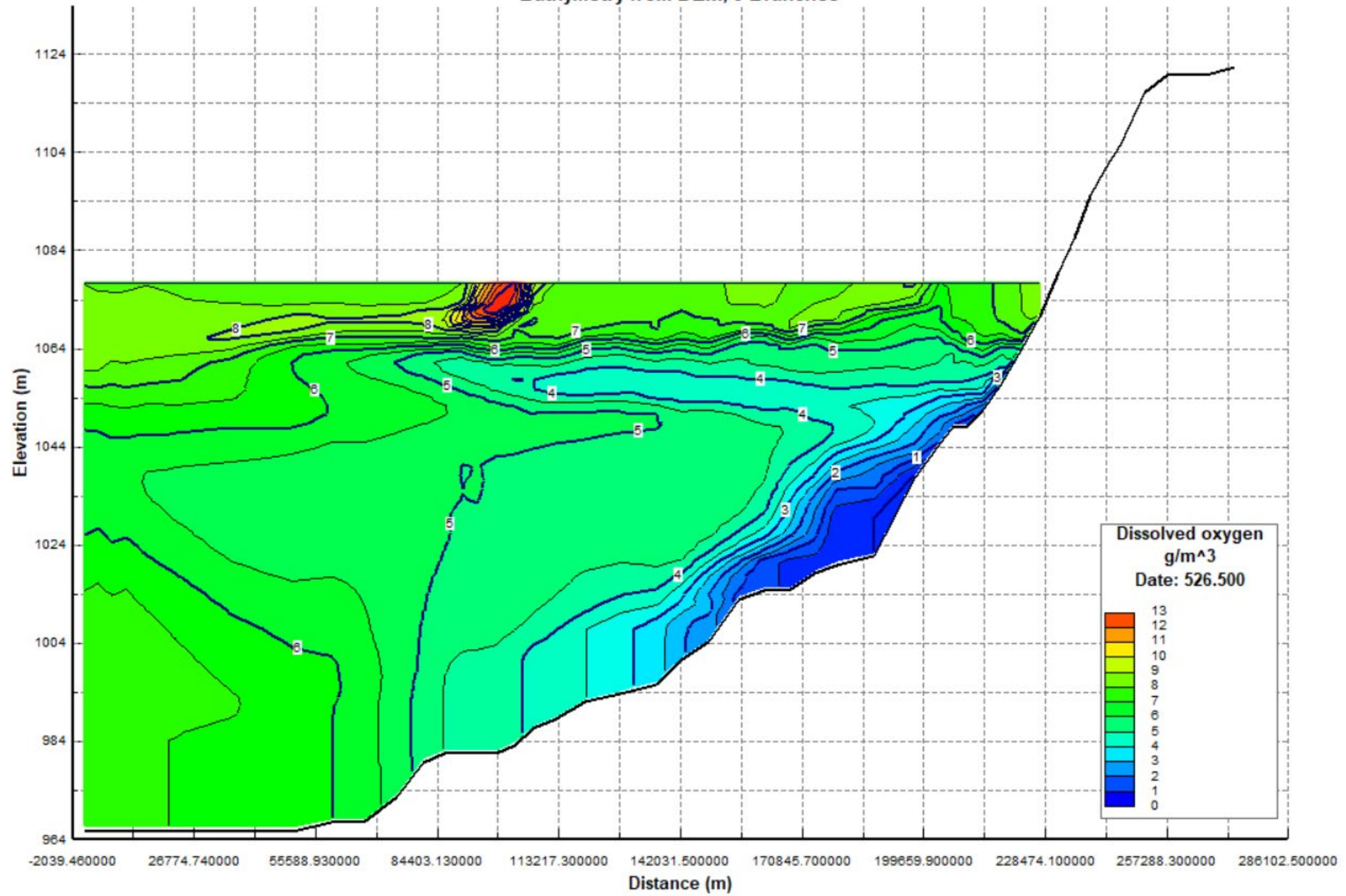




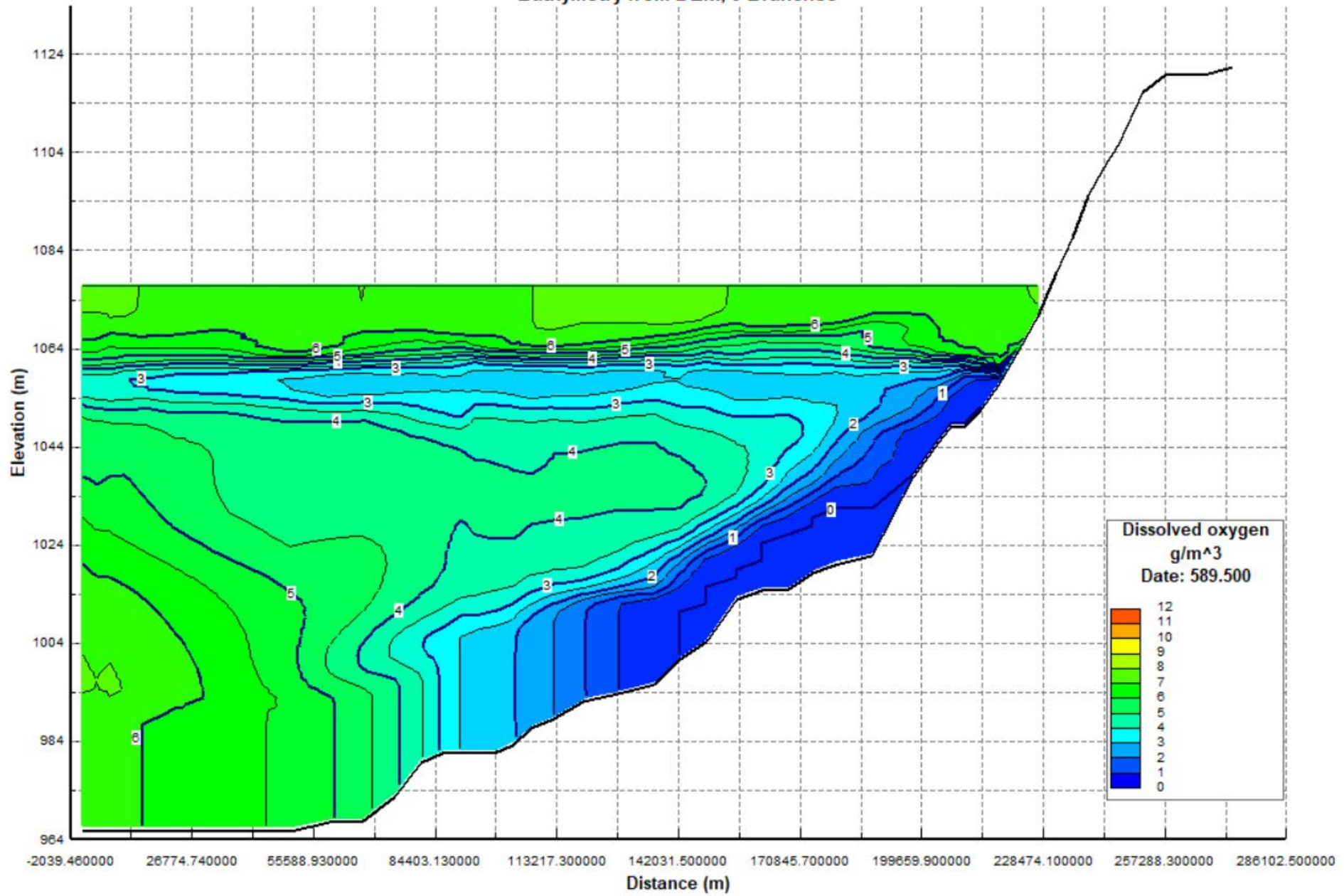
### Segment: 49



Lake Powell  
Bathymetry from DEM; 9 Branches



Lake Powell  
Bathymetry from DEM; 9 Branches



# Questions?



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RECLAMATION