



— BUREAU OF —
RECLAMATION

Colorado River Basin April 2021 5-year Projected Future Conditions

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Glen Canyon Dam Adaptive Management Program Technical Work Group Meeting
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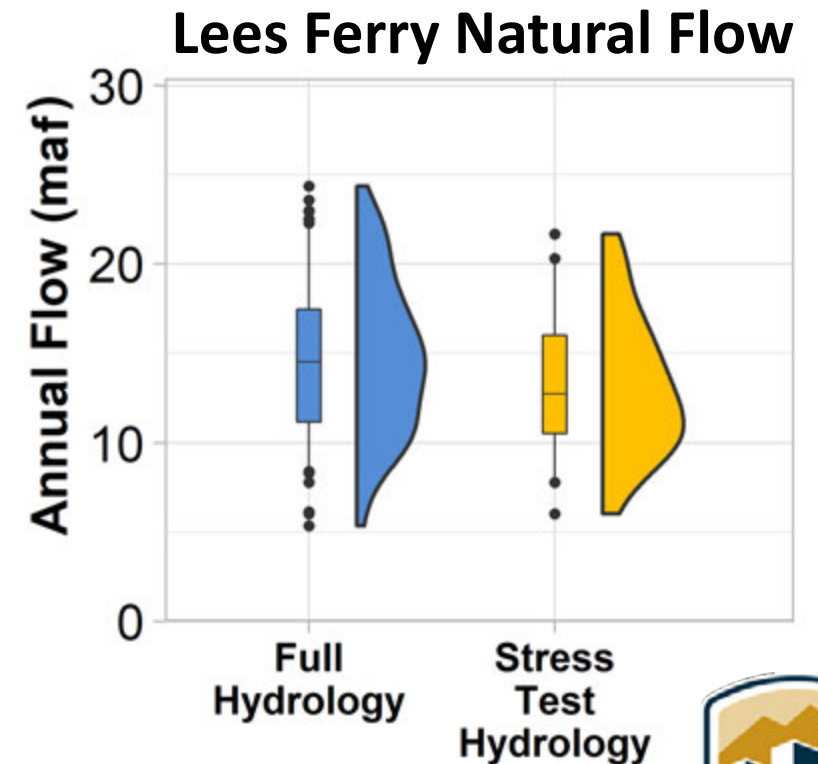
Reclamation Operational Modeling Model Comparison

	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 35 (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



Approach for Official April 2021 Probabilistic Modeling

1. Use the April Colorado River Mid-term Modeling System (CRMMS)
 - Ensemble mode using 35 future inflow sequences to project 2021 operations
 - 2021 hydrology per the Colorado Basin River Forecast Center's April official forecast consisting of 35 future inflow sequences
2. Initialize CRSS with all 35 CRMMS MTOM mode projections of December 2021 reservoir conditions, 2022 Lake Powell operating tier, and 2022 Lake Mead operating condition
3. Use CRSS to project 2022-2026 conditions using 114 hydrologic inflow sequences from the observed natural flow record (1906-2019), i.e., "Full Hydrology", and 32 hydrologic inflow sequences from the observed natural flow record (1988-2019), i.e., "Stress Test Hydrology"
 - Full Hydrology: 35 initial conditions x 114 hydrologic inflow sequences = 3,990 total simulations in CRSS
 - Stress Test Hydrology: 35 initial conditions x 32 hydrologic inflow sequences = 1,120 total simulations in CRSS
4. Compute probabilities across all future traces



Important Caveats

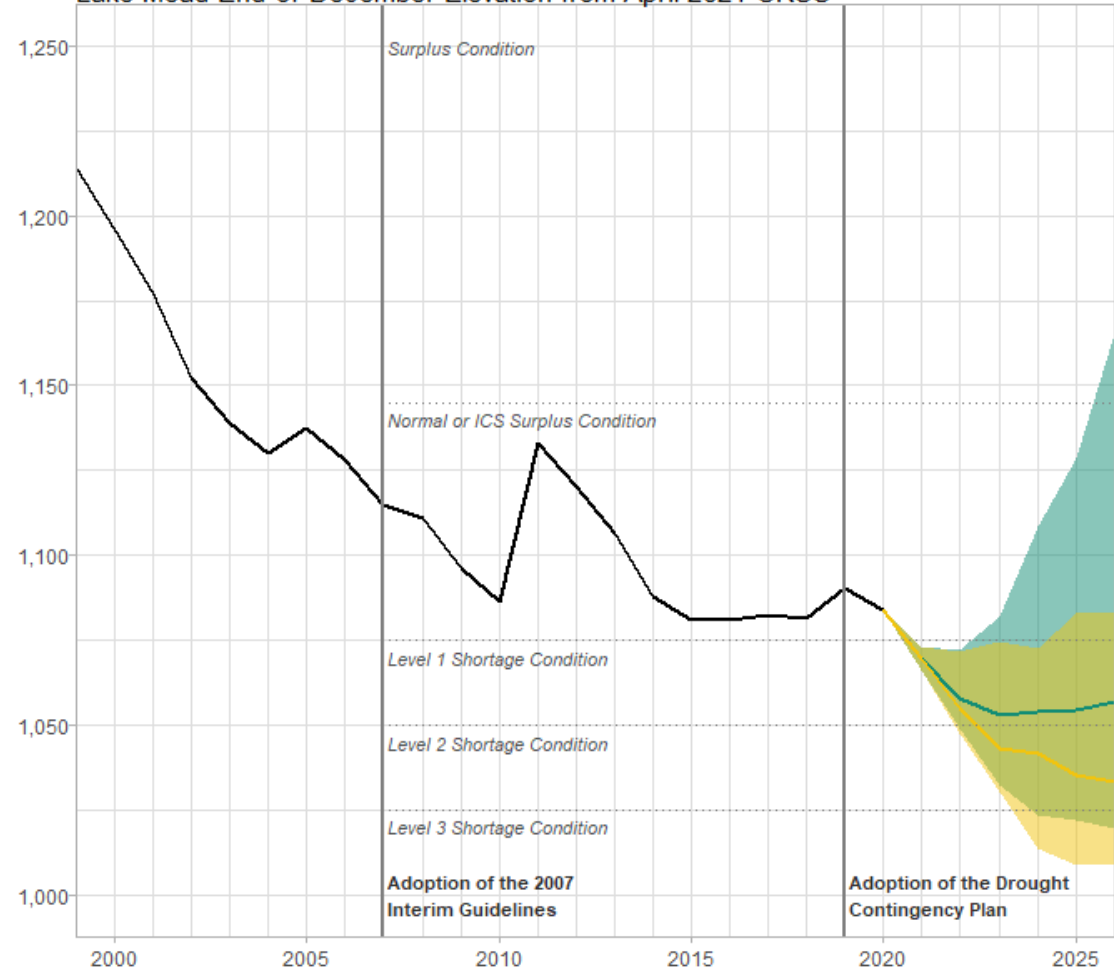
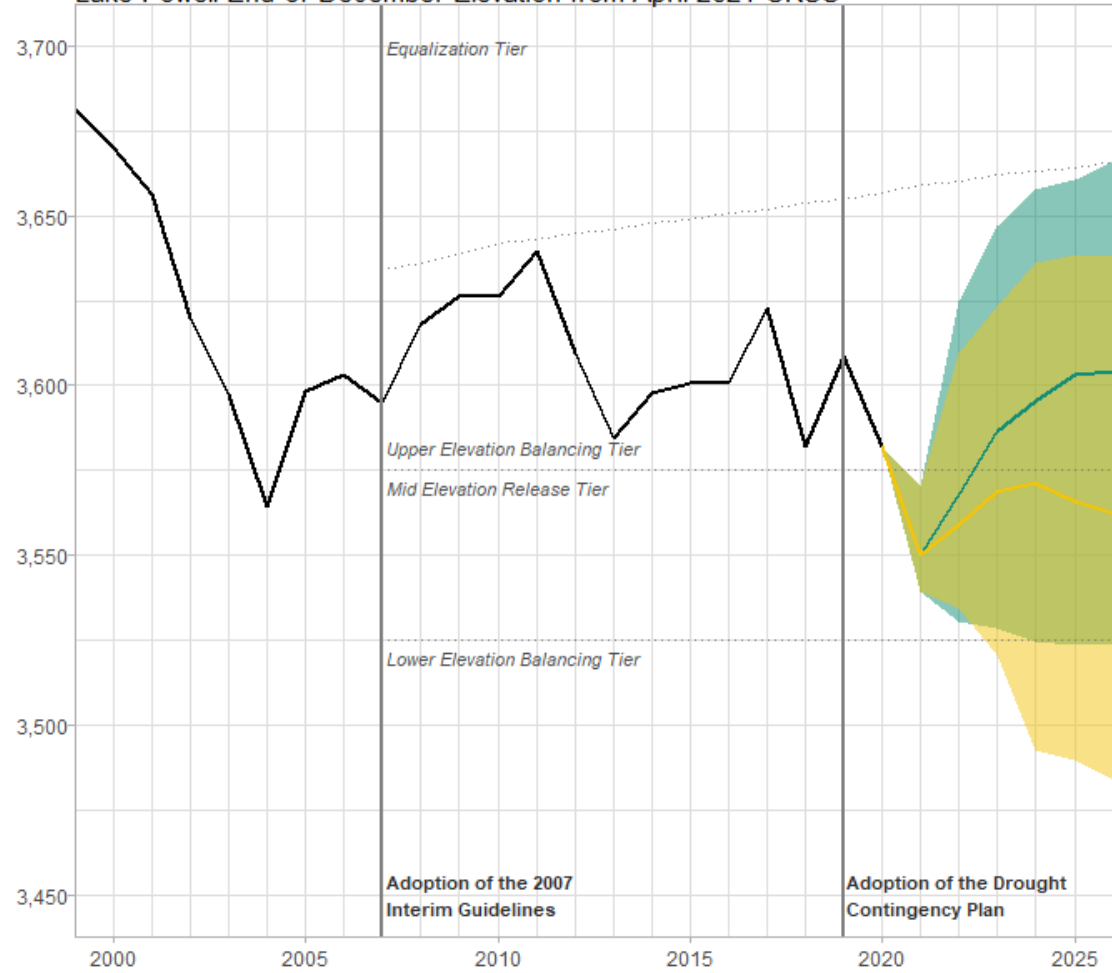
- April 2021 projections use the April 2 forecast from the Colorado River Basin Forecast Center
- 2021 forecast has declined since the April forecast
 - Most probable April – July inflow declined by 1.4 maf between April 2 and June 3.
- Projections are sensitive to initial conditions that are based on the 2021 forecast



April 2021 Full Hydrology vs. Stress Test Hydrology

Lake Powell End-of-December Elevation from April 2021 CRSS

Lake Mead End-of-December Elevation from April 2021 CRSS



Upper Basin – Lake Powell

Percent of Traces with Event or System Condition

Results from April 2021 CRMMS MTOM Mode/CRSS using the Full Hydrology and Stress Test Hydrology (values in percent)

Event or System Condition	2021	2022	2023	2024	2025	2021	2022	2023	2024	2025
Equalization Tier (Powell ≥ Equalization [EQ] Elevation)	0	0	6	12	17	0	0	0	3	7
<i>Equalization – annual release > 8.23 maf</i>	0	0	6	12	17	0	0	0	3	7
<i>Equalization – annual release = 8.23 maf</i>	0	0	0	0	0	0	0	0	0	0
Upper Elevation Balancing Tier (Powell < EQ Elevation and ≥ 3,575 ft)	100	3	36	49	50	100	3	31	41	39
<i>Upper Elevation Balancing – annual release > 8.23 maf</i>	0	2	35	45	44	0	2	30	39	36
<i>Upper Elevation Balancing – annual release = 8.23 maf</i>	100	<1	1	4	5	100	<1	<1	2	3
<i>Upper Elevation Balancing – annual release < 8.23 maf</i>	0	0	0	<1	0	0	0	0	<1	0
Mid-Elevation Release Tier (Powell < 3,575 and ≥ 3,525 ft)	0	91	51	31	23	0	91	65	45	35
<i>Mid-Elevation Release – annual release = 8.23 maf</i>	0	0	0	<1	2	0	0	0	0	5
<i>Mid-Elevation Release – annual release = 7.48 maf</i>	0	91	51	30	21	0	91	65	45	30
Lower Elevation Balancing Tier (Powell < 3,525 ft)	0	6	7	8	10	0	6	4	11	18
<i>Below Minimum Power Pool (Powell < 3,490 ft)</i>	0	0	1	4	6	0	0	<1	9	12

Notes:

¹ Modeled operations include the 2007 Interim Guidelines, Upper Basin Drought Response Operations, Lower Basin Drought Contingency Plan, and Minute 323, including the Binational Water Scarcity Contingency Plan.

² Reservoir initial conditions on March 31, 2021 were simulated using the April 2021 MTOM based on the CBRFC unregulated inflow forecast ensemble dated April 2, 2021.

³ Each of the 35 initial conditions from MTOM were coupled with 114 hydrologic inflow sequences from the Full Hydrology that resamples the observed natural flow record from 1906-2019 for a total of 3,990 traces analyzed and with 32 hydrologic inflow sequences from the Stress Test Hydrology that resamples the observed natural flow record from 1988-2019 for a total of 1,120 traces analyzed.

⁴ Percentages shown in this table may not be representative of the full range of future possibilities that could occur with different modeling assumptions.

⁵ Percentages shown may not sum to 100% due to rounding to the nearest percent.



Lower Basin – Lake Mead

Percent of Traces with Event or System Condition

Results from April 2021 CRMMS MTOM Mode/CRSS using the **Full Hydrology** and **Stress Test Hydrology** (values in percent)

Event or System Condition	2021	2022	2023	2024	2025	2021	2022	2023	2024	2025
Surplus Condition – any amount (Mead ≥ 1,145 ft)	0	0	0	1	4	0	0	0	0	0
Surplus – Flood Control	0	0	0	0	<1	0	0	0	0	0
Normal or ICS Surplus Condition (Mead < 1,145 and > 1,075 ft)	100	3	6	17	19	100	3	8	9	6
Recovery of DCP ICS / Mexico’s Water Savings (Mead >/≥ 1,110 ft)	0	0	0	4	9	0	0	0	0	<1
DCP Contribution / Mexico’s Water Savings (Mead ≤ 1,090 and > 1,075 ft)	100	3	5	11	10	100	3	7	9	3
Shortage Condition – any amount (Mead ≤ 1,075 ft)	0	97	94	82	77	0	97	92	91	94
<i>Shortage / Reduction – 1st level (Mead ≤ 1,075 and ≥ 1,050)</i>	0	97	81	37	34	0	97	71	31	33
DCP Contribution / Mexico’s Water Savings (Mead ≤ 1,075 and > 1,050 ft)	0	97	81	37	34	0	97	71	31	33
<i>Shortage / Reduction – 2nd level (Mead < 1,050 and ≥ 1,025)</i>	0	0	13	44	32	0	0	21	60	36
DCP Contribution / Mexico’s Water Savings (Mead ≤ 1,050 and > 1,045 ft)	0	0	11	9	6	0	0	17	6	7
DCP Contribution / Mexico’s Water Savings (Mead ≤ 1,045 and > 1,040 ft)	0	0	2	9	6	0	0	4	11	6
DCP Contribution / Mexico’s Water Savings (Mead ≤ 1,040 and > 1,035 ft)	0	0	<1	11	8	0	0	0	16	6
DCP Contribution / Mexico’s Water Savings (Mead ≤ 1,035 and > 1,030 ft)	0	0	0	10	7	0	0	0	17	6
DCP Contribution / Mexico’s Water Savings (Mead ≤ 1,030 and ≥/ > 1,025 ft)	0	0	0	5	6	0	0	0	9	10
<i>Shortage / Reduction – 3rd level (Mead < 1,025)</i>	0	0	0	1	11	0	0	0	<1	25
DCP Contribution / Mexico’s Water Savings (Mead </≤ 1,025 ft)	0	0	0	1	11	0	0	0	<1	25

Notes:

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Questions

5-year projections available at:

<https://www.usbr.gov/lc/region/g4000/riverops/crss-5year-projections.html>

<https://www.usbr.gov/lc/region/g4000/riverops/crss-alt-hydrology.html>

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