

RECLAMATION

Managing Water in the West

Lower Colorado River Basin Coordinated Operations

**Review of WY 2012 Operations
Projected Operations for WY 2013**

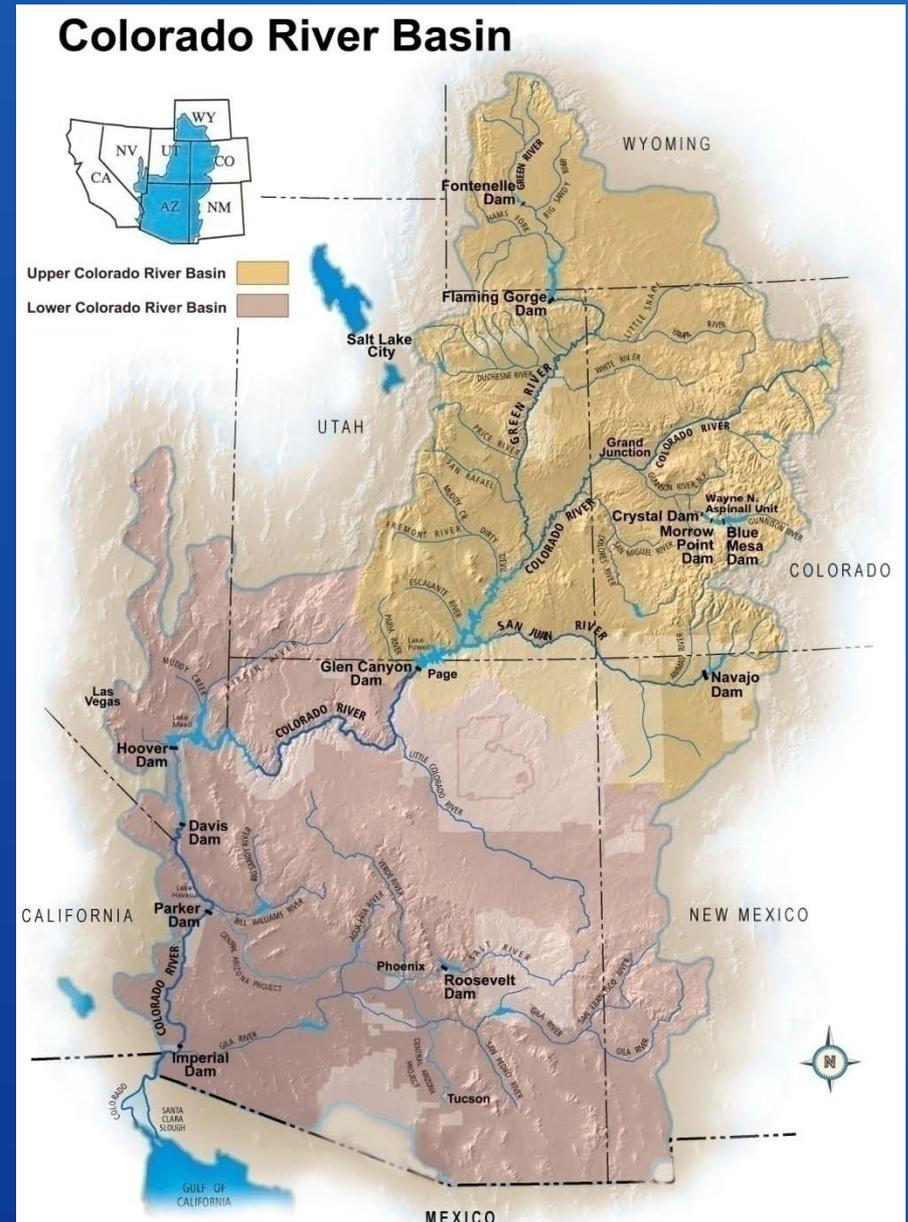
Reclamation Drought Workshop
November 6, 2012



U.S. Department of the Interior
Bureau of Reclamation

Colorado River Basin Hydrology

- 16.5 million acre-feet (maf) allocated annually
- 13 to 14.5 maf of consumptive use annually
- 60 maf of storage
- 15.0 maf average annual “natural” inflow into Lake Powell over past 100 years
- Inflows are highly variable year-to-year



RECLAMATION

Lower Basin Colorado River Management Objectives

Lake Mead



Lake Mohave



Hoover Dam

Davis Dam

Lake Havasu



Parker Dam

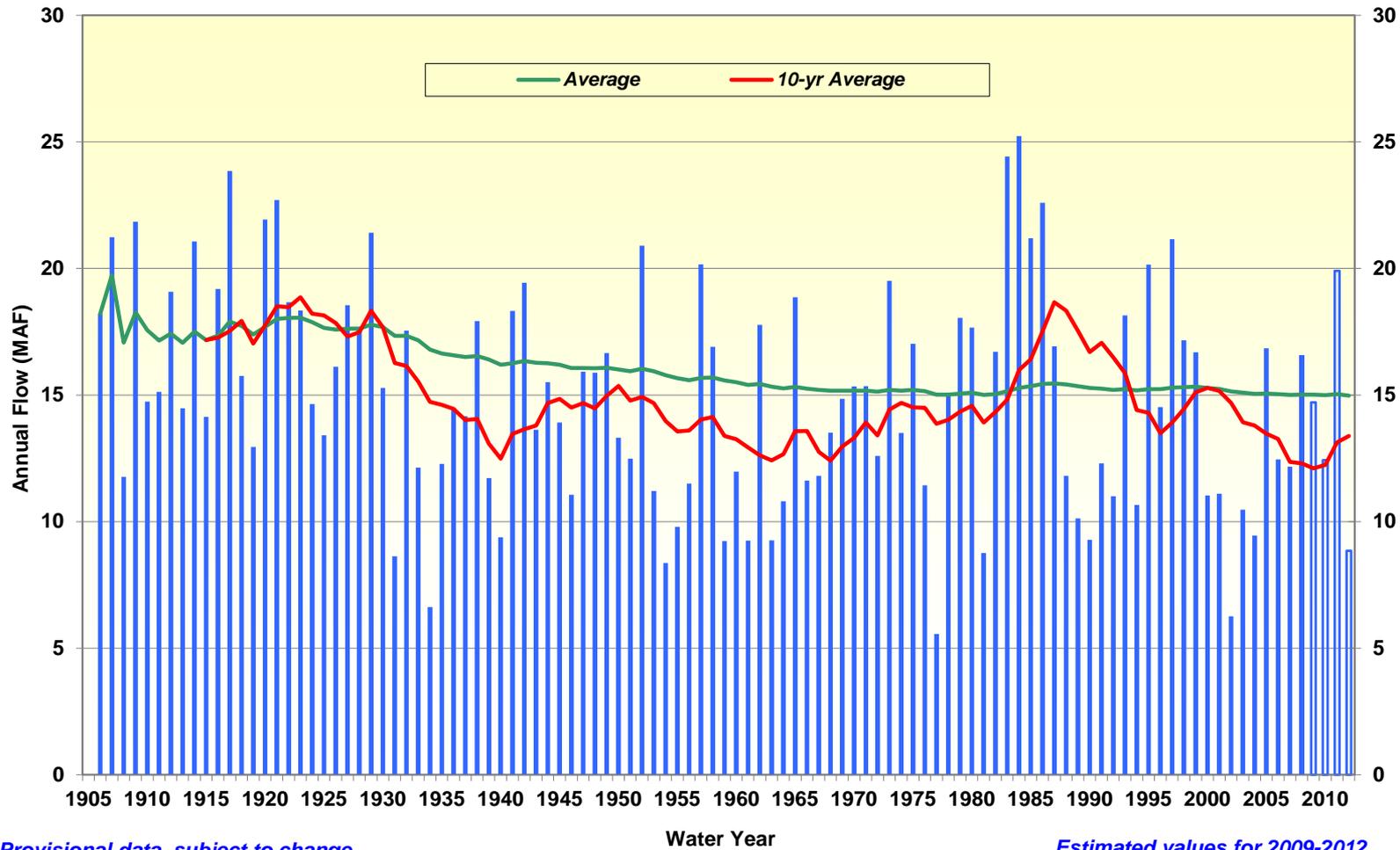
- Provide flood control and river regulation
- Meet water demands
- Generate hydropower
- Enhance and maintain ecosystem habitat
- Recover and protect endangered species
- Provide recreation

Natural Flow

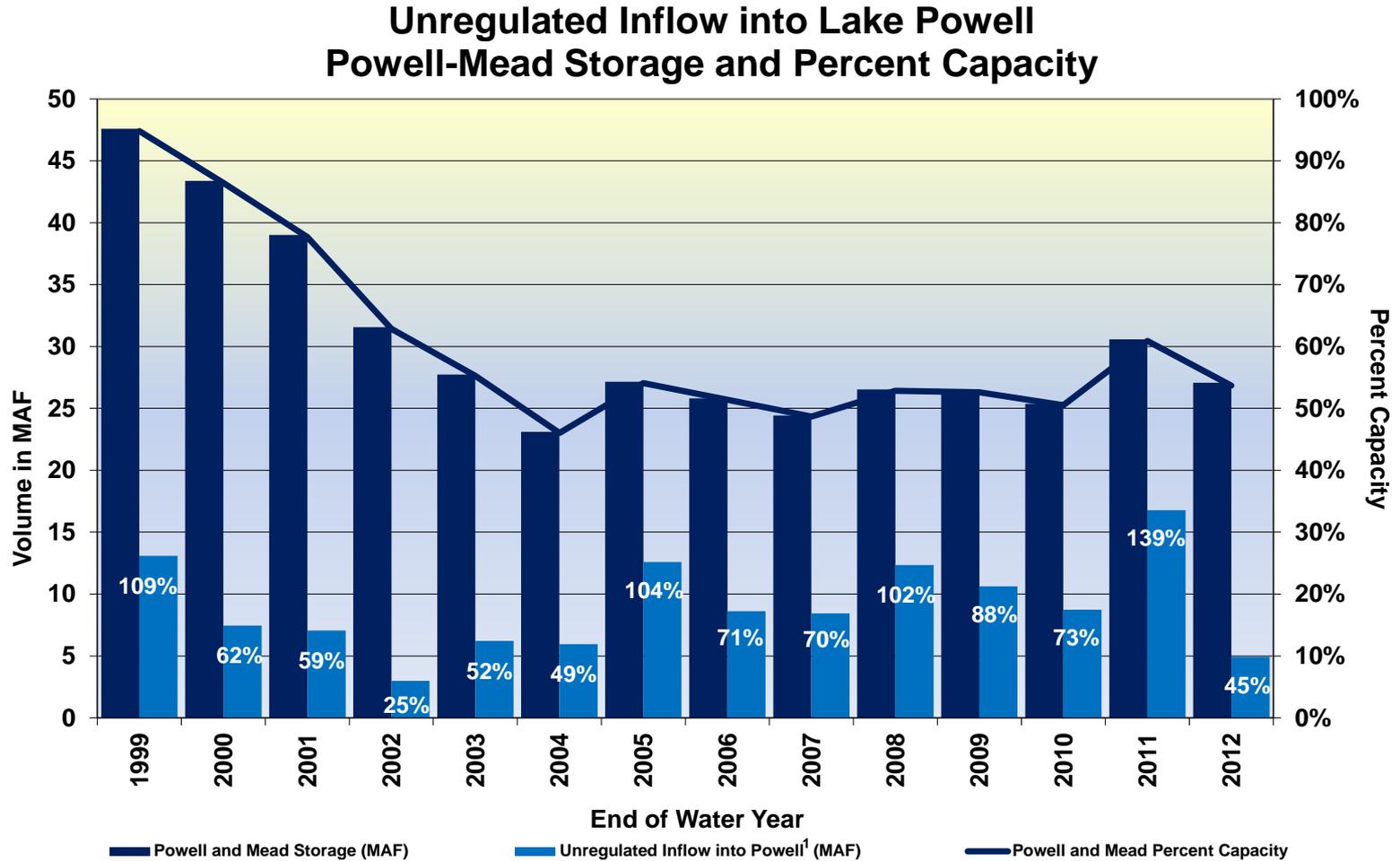
Colorado River at Lees Ferry Gaging Station, Arizona

Water Year 1906 to 2012

Colorado River at Lees Ferry, AZ - Natural Flow



State of the System (Water Years 1999-2012)¹



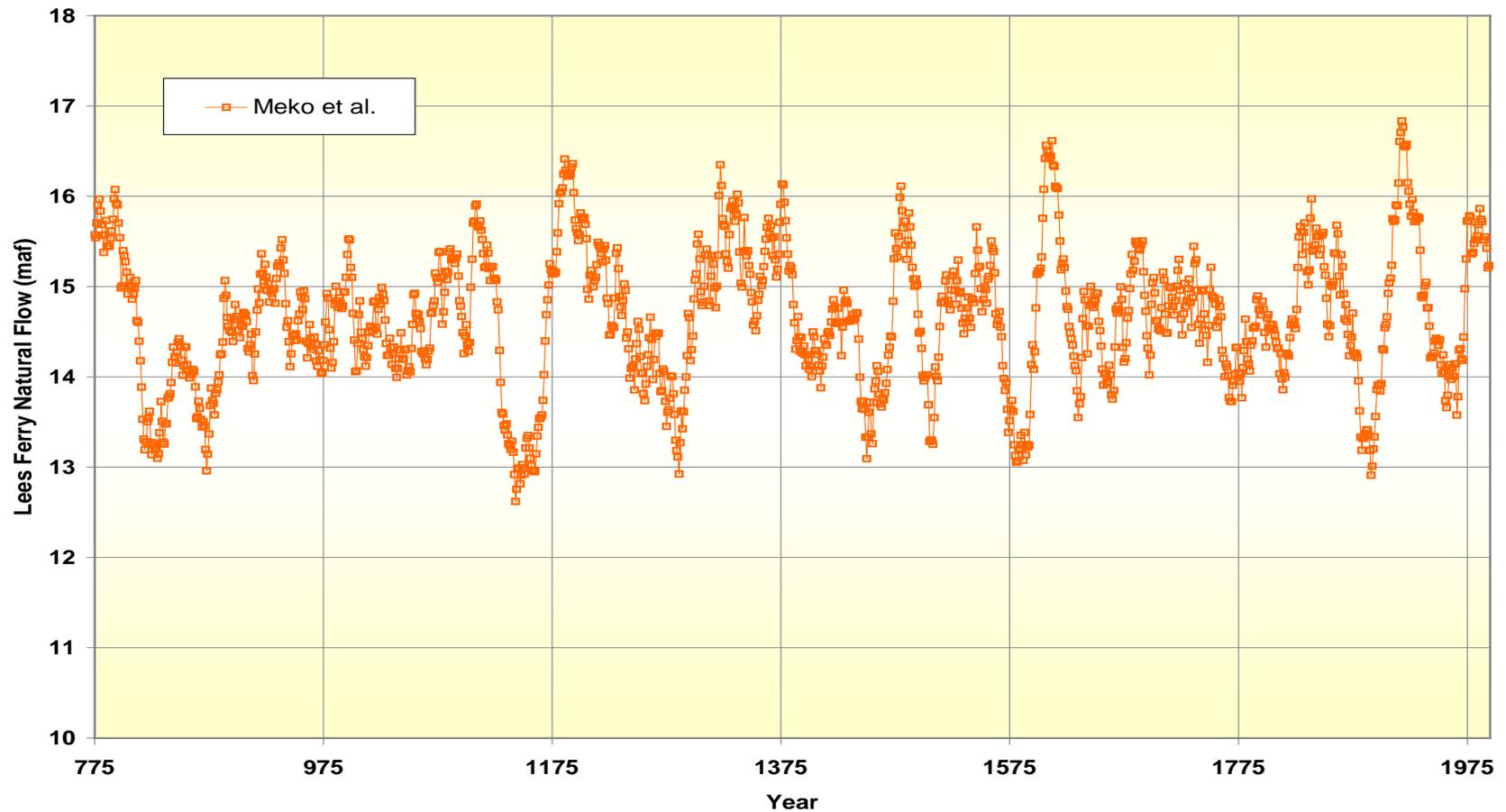
¹ Percentages at the top of the light blue bars represent percent of average unregulated inflow into Lake Powell for a given water year. Water years 1999-2011 are based on the 30-year average from 1971 to 2000. Water year 2012 is based on the 30-year average from 1981-2010.

Colorado River Drought

- 1999-2010 was the second driest 12-year period in the 100-year historical record (WYs 2009-2010 data are estimated)
- Tree-ring reconstructions show more severe droughts have occurred over the past 1200 years (e.g., drought in the mid 1100s)
- Observed 2012 April through July runoff was 29% of average¹
- Not unusual to have a few years of above average inflow during longer-term droughts (e.g., the 1950s)

¹ Percent of average is based on the period of record from 1981-2010.

Annual Natural Flow at Lees Ferry Tree-ring Reconstruction (Meko et al., 2007) 25-Year Running Mean



Impetus for the Interim Guidelines



- Seven years of unprecedented drought
- Increased water use
- To date, there has never been a shortage in the Lower Basin and there were no shortage guidelines
- Operations between Lake Powell and Lake Mead were coordinated only at the higher reservoir levels “equalization”

Interim Guidelines¹ - A Robust Solution

- Operations specified through the full range of operation for Lake Powell and Lake Mead
- Encourage efficient and flexible use and management of Colorado River water through the ICS mechanism
- Strategy for shortages in the Lower Basin, including a provision for additional shortages if warranted²
- In place for an interim period (through 2026) to gain valuable operational experience
- Basin States agree to consult before resorting to litigation

1. Issued in Record of Decision, dated December 13, 2007; available at <http://www.usbr.gov/lc/region/programs/strategies.html>

2. Mexico water deliveries are not directly affected by these guidelines

Lake Powell & Lake Mead

Operational Diagrams and Current Conditions

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
3,620		13.73	1,200 (approx.) ²		22.9 (approx.) ²
10/28/12	Upper Elevation Balancing Tier³ Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	10/28/12	1,145	Domestic Surplus or ICS Surplus Condition Deliver > 7.5 maf	15.9
3,575		9.5	1,116		13.23
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf		10/28/12	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	10/28/12
3,525		5.9	1,075	Shortage Condition Deliver 7.167 ⁴ maf	9.4
3,490	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf	4.0	1,050	Shortage Condition Deliver 7.083 ⁵ maf	7.5
3,370		0	1,025	Shortage Condition Deliver 7.0 ⁶ maf	5.8
			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.

WY 2012
Review of Lower Basin Operations

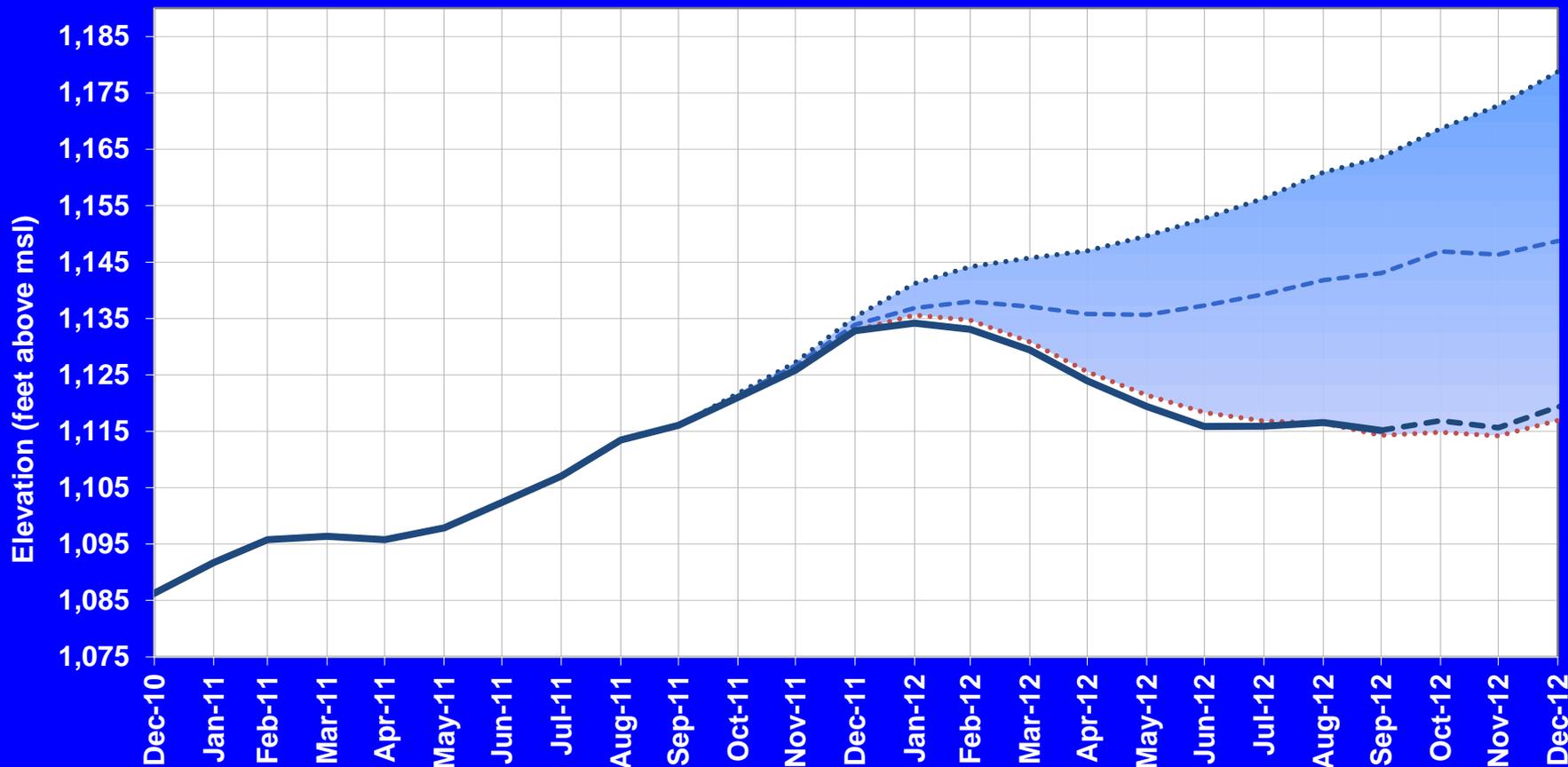
Summary of Lake Powell and Lake Mead Projections

Review of 24-Month Study 2012 Water Year Operations Projections

24-Month Study	Projected Powell WY Unreg Inflow	Projected Lake Powell EOWY Elevation	Projected Glen Canyon WY Release	Projected Lake Mead EOWY Elevation
Aug 2011	116% 12.60 maf	3646.40 ft	13.57 maf	1152.61 ft
Oct 2011	107% 11.60 maf	3645.00 ft	12.26 maf	1143.02 ft
Jan 2012	79% 8.55 maf	3643.92 ft	9.46 maf	1116.43 ft
Apr 2012	63% 6.79 maf	3632.55 ft	9.46 maf	1114.30 ft
Oct-1 2012	45% 4.91 maf	3621.56 ft	9.46 maf	1115.16 ft

Lake Mead End of Month Elevation

Projections from October 2011 and October 2012 24-Month Study Inflow Scenarios

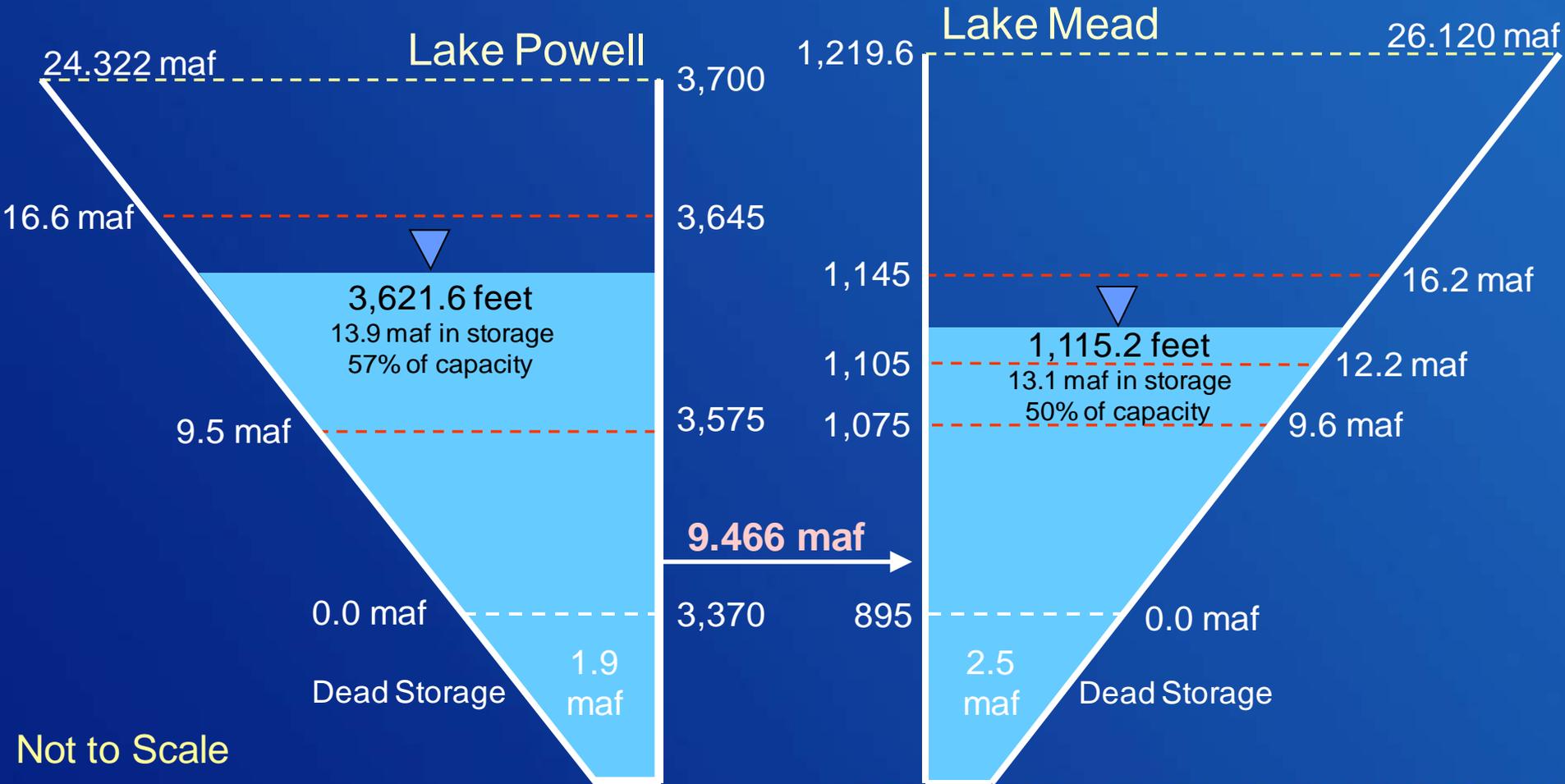


- October 2011 Probable Maximum (14.40 maf release from Lake Powell in WY 2012)
- - - - October 2011 Most Probable (12.26 maf release from Lake Powell in WY 2012)
- October 2011 Probable Minimum (9.46 maf release from Lake Powell in WY 2012)
- Historical Elevations
- - - - October 2012 Most Probable (9.47 maf release from Lake Powell in WY 2012)

Water Year 2012

End of Water Year Conditions

Preliminary Observed Unregulated Inflow into Powell¹ = 4.91 maf (45% of average)



Not to Scale

¹ Percent of average inflow is based on the 30-year period of record from 1981-2010.

Lower Basin Side Inflows

Glen Canyon to Hoover in WY/CY 2012^{1,2}

Month in WY/CY 2012		Intervening Flow Glen Canyon to Hoover (KAF)	Intervening Flow Glen Canyon to Hoover (% of Average)	Difference From 5-Year Average (KAF)
H I S T O R Y	October 2011	66	135%	+17
	November 2011	36	78%	-10
	December 2011	84	78%	-24
	January 2012	55	71%	-23
	February 2012	44	45%	-54
	March 2012	43	55%	-35
	April 2012	46	61%	-30
	May 2012	16	25%	-48
	June 2012	7	21%	-26
	July 2012	69	128%	+15
	August 2012	170	165%	+67
September 2012	96	130%	+22	
F U T U R E	October 2012	49		
	November 2012	46		
	December 2012	108		
WY 2012 Totals		732	85%	-129
CY 2012 Totals		749	87%	-112

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 2007-2011.

Water Year 2013 Projected Lower Basin Operations

*Operational Tier based on 2012 August 24-Month Study

Lake Powell & Lake Mead Operational Table

Operational Tiers for 2013 based on August 2012 Projections¹

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) 3,614.89		15.5 - 19.3 (2008-2026) 13.23	1,200 (approx.) ²	Domestic Surplus or ICS Surplus Condition Deliver > 7.5 maf	22.9 (approx.) ²
1/1/13 Projection	Upper Elevation Balancing Tier³ Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	1/1/13 Projection	1,145 1,119.14	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	15.9 13.52
3,575		9.5	1/1/13 Projection	Shortage Condition Deliver 7.167 ⁴ maf	1/1/13 Projection
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf		1,075		9.4
3,525		5.9	1,050	Shortage Condition Deliver 7.083 ⁵ maf	7.5
	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf		1,025		5.8
3,490		4.0	1,000	Shortage Condition Deliver 7.0 ⁶ maf Further measures may be undertaken ⁷	4.3
3,370		0	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

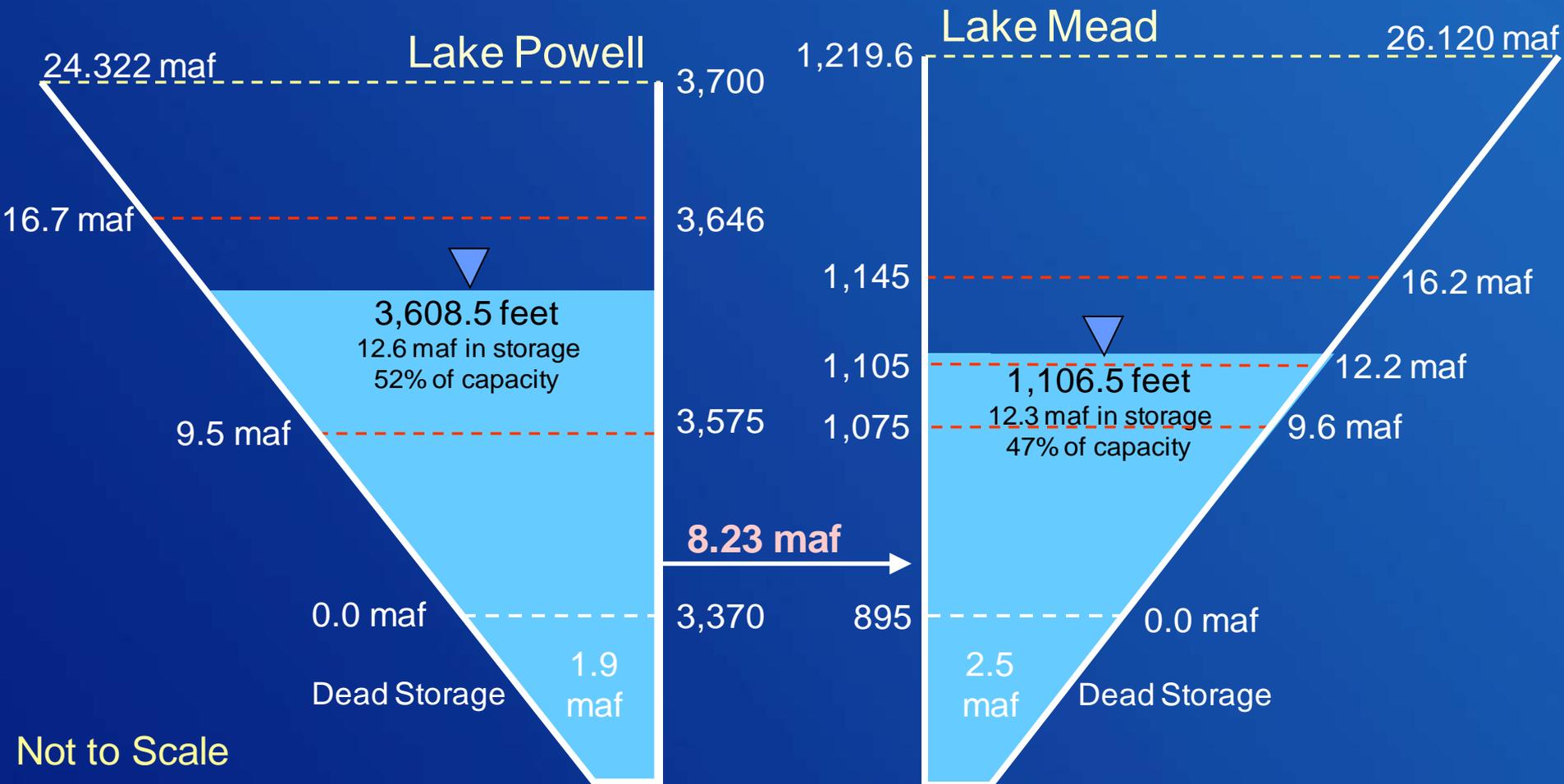
⁷ Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Division States and Mexico is likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation with the Basin States, may result in the undertaking of further measures, consistent with applicable Federal law.

¹ January 1, 2013, projections are based on the August 2012 24-Month Study.

Water Year 2013 Projections

October 2012 24-Month Study Most Probable Inflow Scenario

Projected Unregulated Inflow into Powell¹ = 7.60 maf (70% of average)



Not to Scale

¹ WY 2013 unregulated inflow volume is based on the CBRFC outlook dated 10/1/12. Percent of average inflow is based on the 30-year period of record from 1981-2010.

RECLAMATION

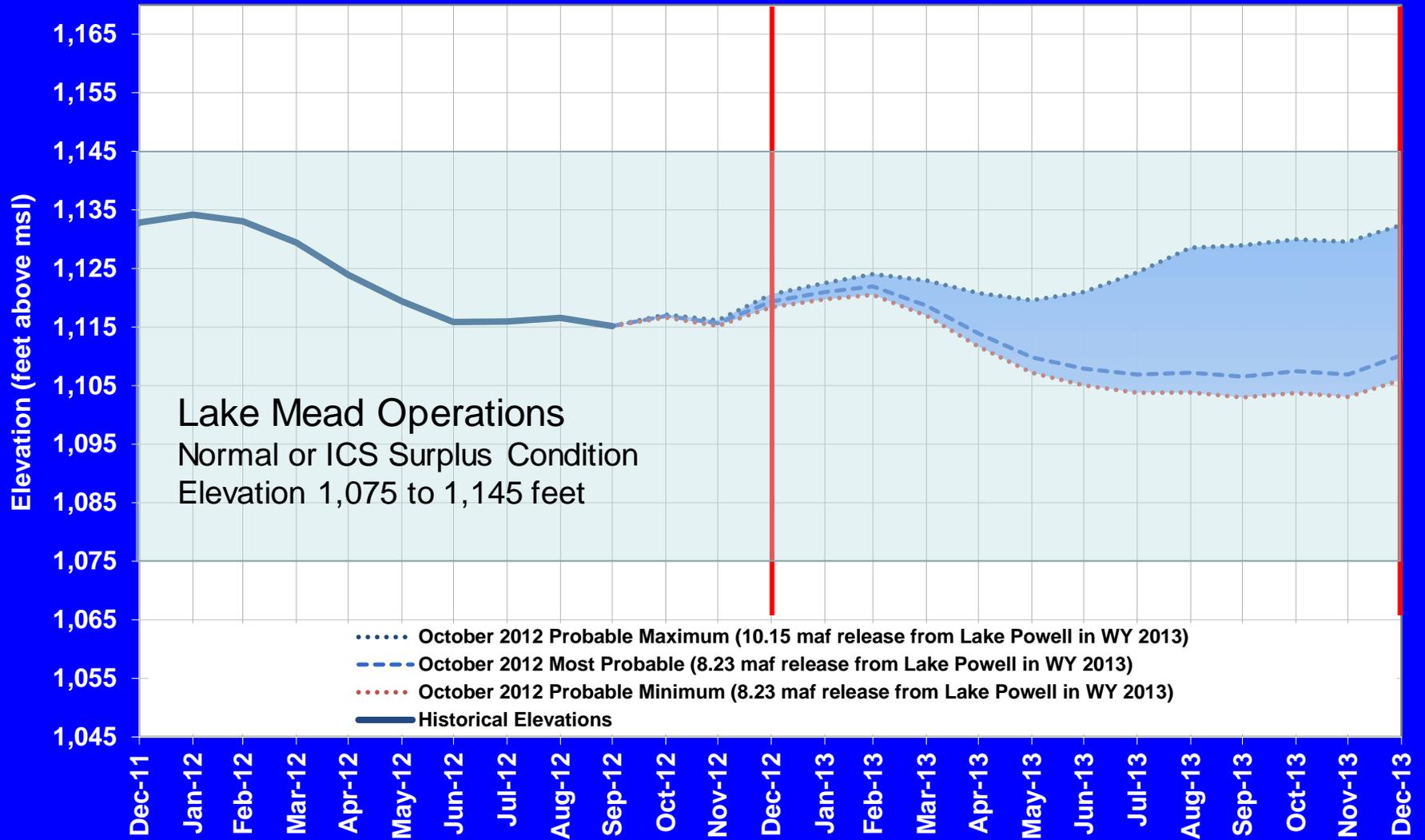
Projected Lake Mead Elevations

Based on October 2012 24-Month Study Inflow Scenarios

Powell Inflow Scenario	CY 2013 (on January 1, 2013)	CY 2014 (on January 1, 2014)
Probable Minimum	1,118.4 feet	1,106.0 feet
Most Probable	1,119.3 feet	1,110.2 feet
Probable Maximum	1,120.6 feet	1,132.4 feet

Lake Mead End of Month Elevations

Projections from October 2012 24-Month Study Inflow Scenarios



CRSS Probabilities of System Conditions through 2017

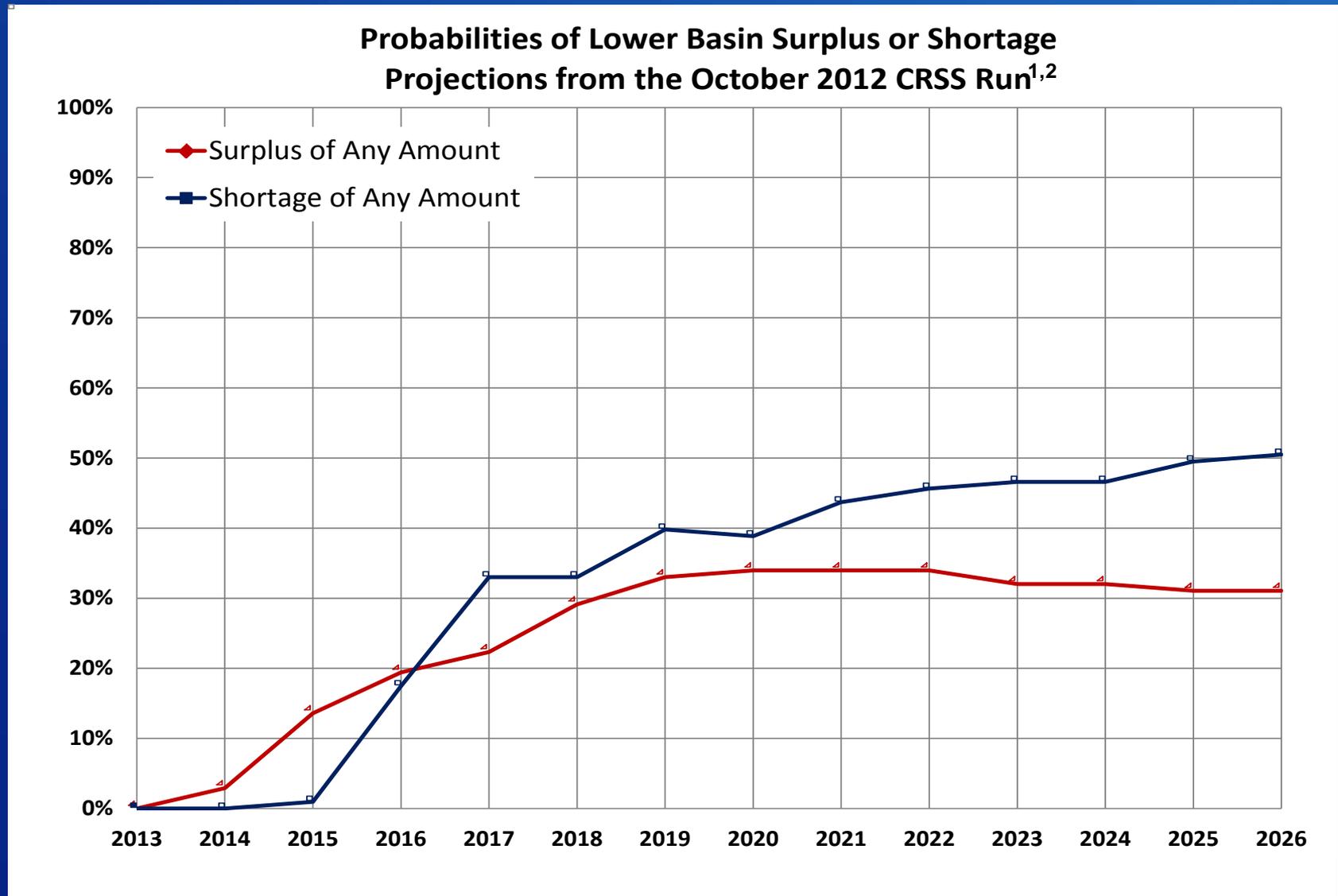
Probabilities of Occurrence of Event or System Condition Results from October 2012 CRSS Run^{1,2} (values in percent)

	Event or System Condition	2013	2014	2015	2016	2017
Upper Basin – Lake Powell	Equalization Tier	12	31	33	39	43
	<i>Equalization – annual release > 8.23 maf</i>	10	31	33	38	40
	<i>Equalization – annual release = 8.23 maf</i>	2	0	0	1	3
	Upper Elevation Balancing Tier	88	61	48	44	39
	<i>Upper Elevation Balancing – annual release > 8.23 maf</i>	0	0	2	15	22
	<i>Upper Elevation Balancing – annual release = 8.23 maf</i>	88	61	46	29	17
	Mid-Elevation Release Tier (annual release = 7.48 maf)	0	8	18	9	13
Lower Elevation Balancing Tier	0	0	1	8	5	
Lower Basin – Lake Mead	Shortage Condition – any amount (Mead ≤ 1,075 ft)	0	0	1	17	33
	<i>Shortage – 1st level (Mead ≤ 1,075 and ≥ 1,050)</i>	0	0	1	16	28
	<i>Shortage – 2nd level (Mead < 1,050 and ≥ 1,025)</i>	0	0	0	1	5
	<i>Shortage – 3rd level (Mead < 1,025)</i>	0	0	0	0	0
	Surplus Condition – any amount (Mead ≥ 1,145 ft)	0	3	14	19	22
	<i>Surplus – Flood Control</i>	0	0	2	4	5
	Normal or ICS Surplus Condition	100	97	85	64	45

¹ Reservoir initial conditions based on December 31, 2012, projected conditions from the October 2012 24-Month Study

² Hydrologic inflow traces based on resampling of the observed natural flow record from 1906-2008

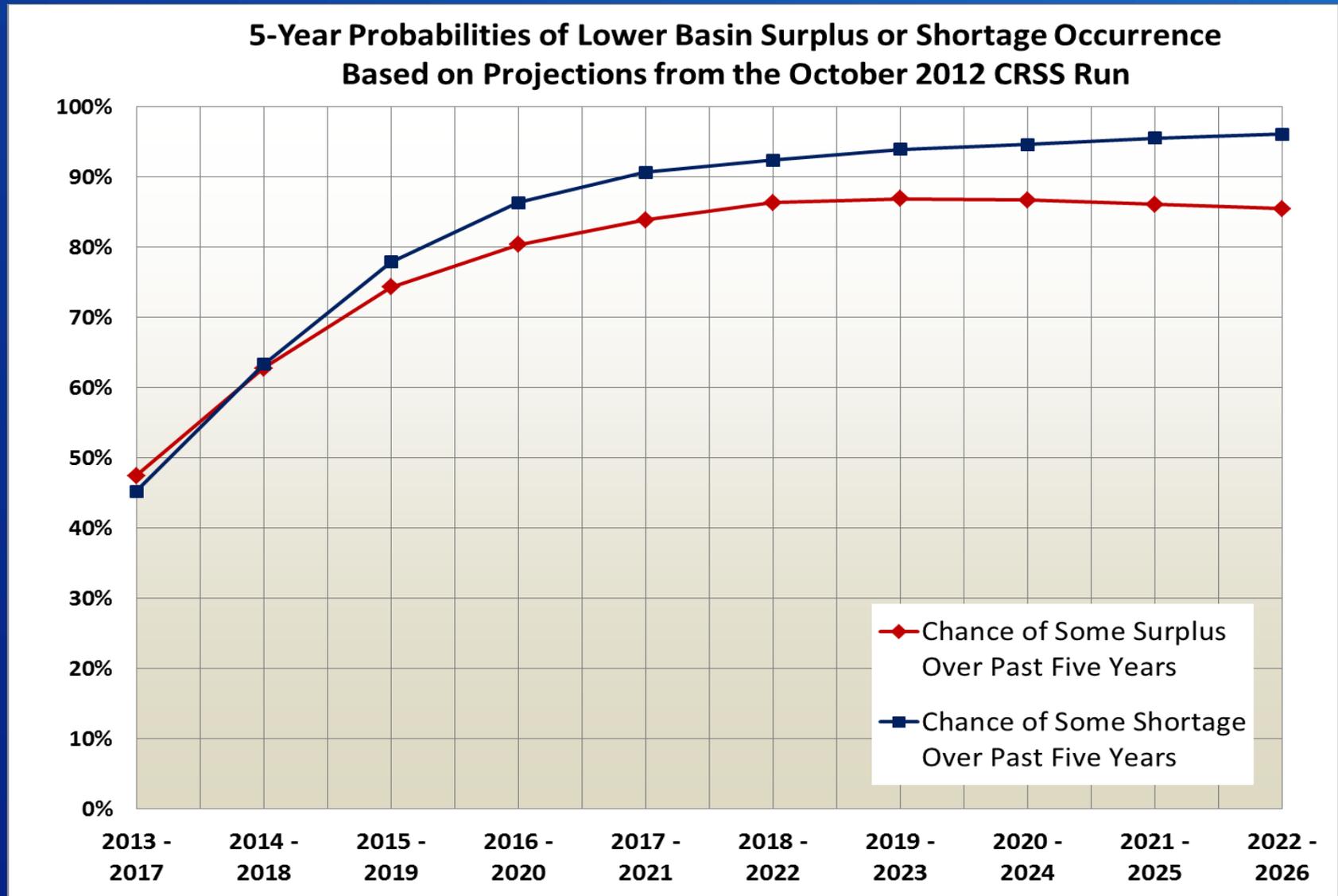
Lower Basin Surplus & Shortage through 2026



¹ Reservoir initial conditions based on December 31, 2012, projected conditions from the October 2012 24-Month Study

² Hydrologic inflow traces based on resampling of the observed natural flow record from 1906-2008

Lower Basin Surplus & Shortage through 2026



¹ Reservoir initial conditions based on December 31, 2012, projected conditions from the October 2012 24-Month Study

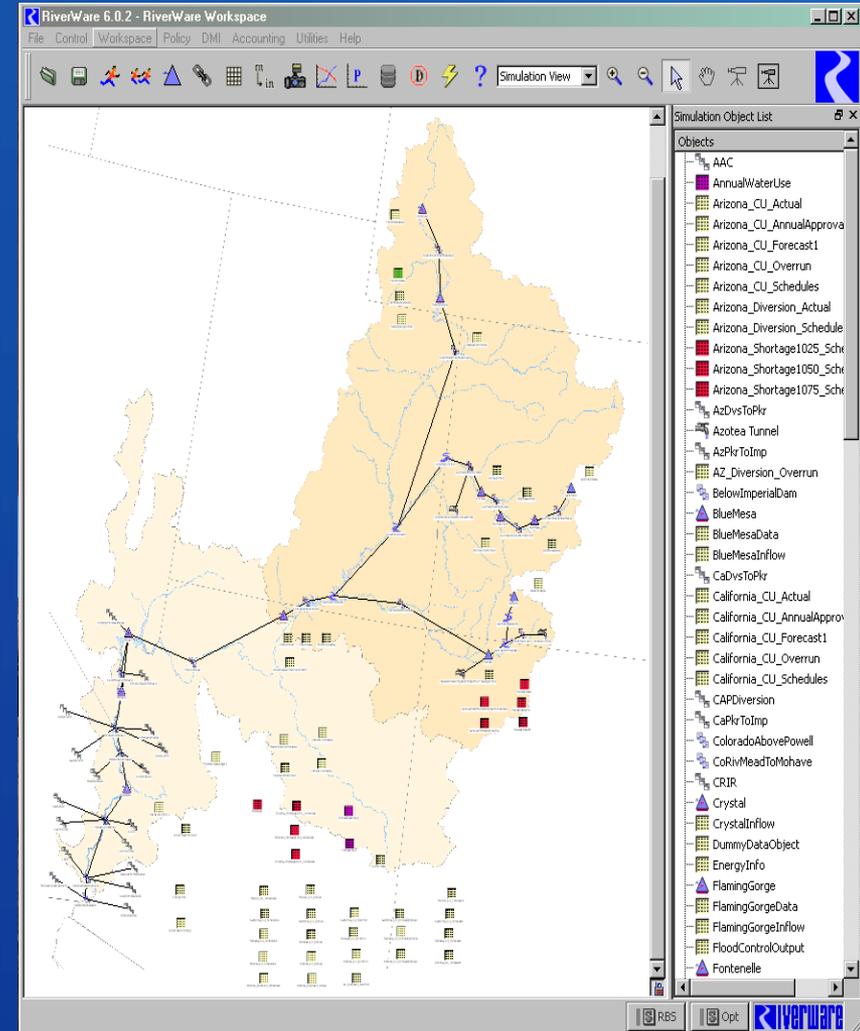
² Hydrologic inflow traces based on resampling of the observed natural flow record from 1906-2008

Next Steps

RECLAMATION

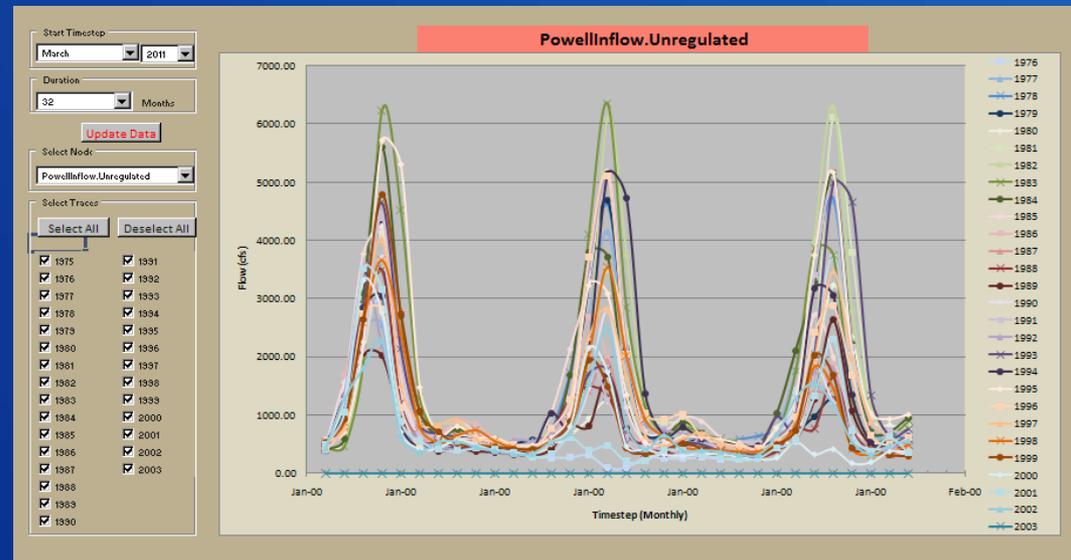
MTOM- Overview

- Based on 24-Month Study, but able to simulate multiple traces for a probabilistic output and analysis
- MTOM is additional tool to evaluate risk and uncertainty in Colorado River Basin
- 24-Month Study is still official model for operational tier determinations



MTOM Updates - Inflows

- Bias corrected inflows
 - Previously used raw ESP output
 - Did not match official forecasts used in 24MS for some months (base flow months)
 - Improved consistency of inflow assumptions



MTOM: Next Steps

- Continue to test and validate operations
- Development will continue on enhancements in 2013
 - Extend model to 5 year outlook
 - Lower Basin demand variability
 - Upper Basin tributary forecasts (i.e. Animas, North Fork)
 - Improve flexibility for alternative/additional inflows

An aerial photograph of a large dam and reservoir in a desert landscape. The reservoir is a deep blue color, contrasting with the brown, rocky terrain. The dam is a large, white concrete structure. In the background, there are mountains and a clear blue sky. The text "Questions/Discussion" is overlaid in white on the image.

Questions/Discussion

RECLAMATION

Annual Operating Plan

Lake Powell Unregulated Inflow Scenarios

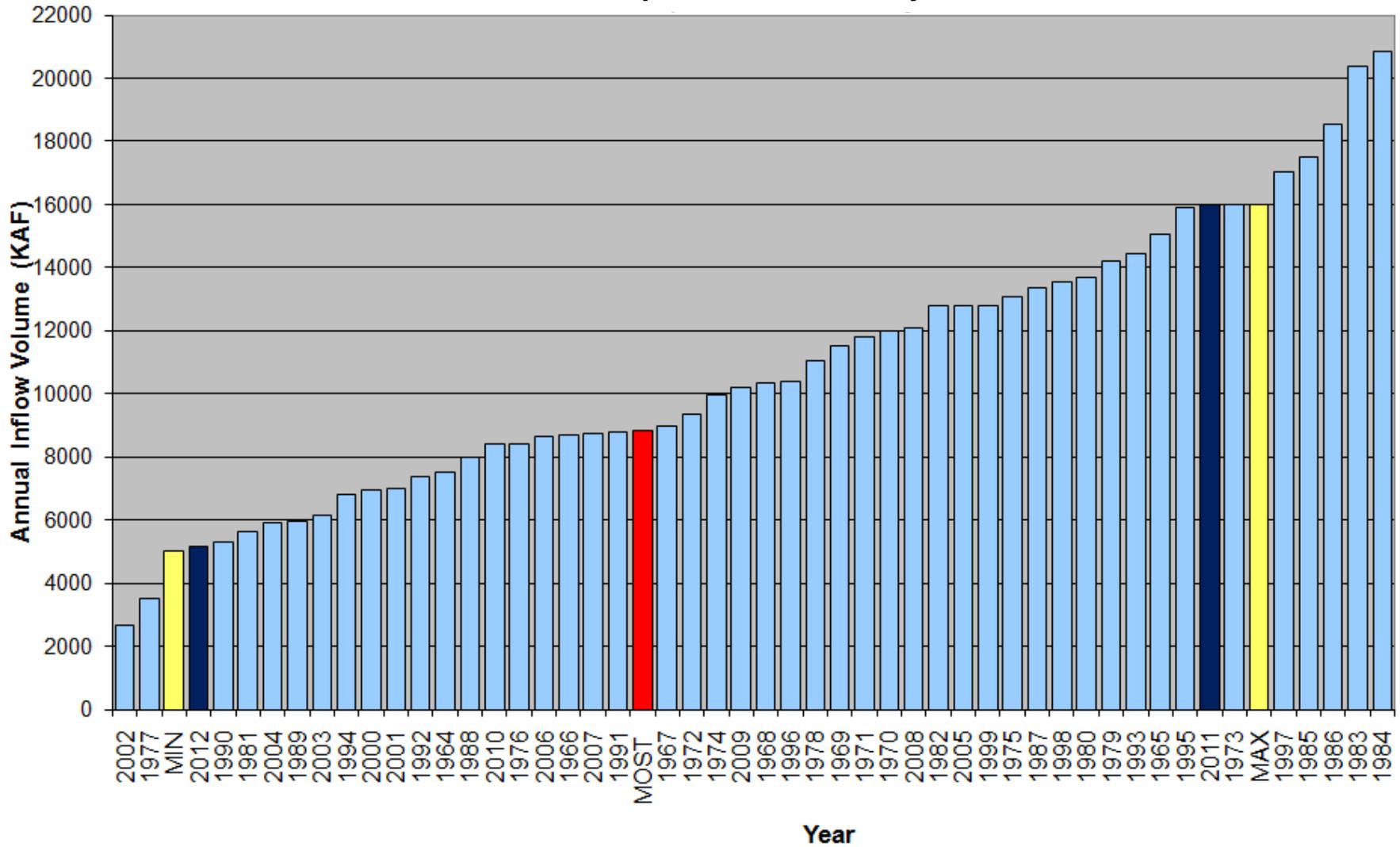
Scenario	2012 AOP WY 2012	2013 AOP WY 2013 Developed August 2012
Minimum Probable	7.00 maf (65 %*)	5.00 maf (46 %)
Most Probable	12.60 maf (116 %)	8.85 maf (82 %)
Maximum Probable	19.50 maf (180 %)	16.00 maf (148 %)

* Percent of average water year unregulated inflow 1981-2012 (10.83 MAF)

Lake Powell Unregulated Inflow

August Water Year 2013 Forecast

Comparison with History



Lake Powell & Lake Mead Operational Table

Operational Tiers for 2013 based on August 2012 Projections¹

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) 3,614.89		15.5 - 19.3 (2008-2026) 13.23	1,200 (approx.) ²	Domestic Surplus or ICS Surplus Condition Deliver > 7.5 maf	22.9 (approx.) ²
1/1/13 Projection	Upper Elevation Balancing Tier³ Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	1/1/13 Projection	1,145 1,119.14	Normal or ICS Surplus Condition Deliver ≥ 7.5 maf	15.9 13.52
3,575		9.5	1/1/13 Projection	ICS Surplus Condition Deliver ≥ 7.5 maf	1/1/13 Projection
	Mid-Elevation Release Tier Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf		1,075	Shortage Condition Deliver 7.167 ⁴ maf	9.4
3,525		5.9	1,050	Shortage Condition Deliver 7.083 ⁵ maf	7.5
	Lower Elevation Balancing Tier Balance contents with a min/max release of 7.0 and 9.5 maf		1,025	Shortage Condition Deliver 7.0 ⁶ maf	5.8
3,490		4.0	1,000	Shortage Condition Deliver 7.0 ⁶ maf Further measures may be undertaken ⁷	4.3
3,370		0	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 January 1, 2013, projections are based on the August 2012 24-Month Study.

Water Year	Powell Elevation (feet)
2008	3,636
2009	3,639
2010	3,642
2011	3,643
2012	3,645
2013	3,646
2014	3,648
2015	3,649
2016	3,651
2017	3,652
2018	3,654
2019	3,655
2020	3,657
2021	3,659
2022	3,660
2023	3,662
2024	3,663
2025	3,664
2026	3,666

Lake Powell Equalization Elevation Table

2013 Level – 3,646 feet

WY2013 Operations under Interim Guidelines as projected in August 2012 24-Month Study

Scenario	Initial Operational Tier	Projected Annual Release Volume
Minimum Probable	Upper Elevation Balancing	8.23 maf
Most Probable	Upper Elevation Balancing	8.23 maf
Maximum Probable	Upper Elevation Balancing*	11.21 maf

* Upper Elevation Balancing with a projected April adjustment to equalization with Lake Powell September 30, 2013 elevation governing.