Glen Canyon Dam Technical Work Group
Agenda Item Information
October 29, 2014

Agenda Item

Update – Colorado River Annual Operating Plan and Drought Contingency Planning

Presenter

Katrina Grantz, Hydraulic Engineer, Bureau of Reclamation, Upper Colorado Region

Previous Action Taken

N/A

Relevant Science

N/A

Background Information

The presentation is intended to provide information to TWG members on the Colorado River 2015 Annual Operating Plan (AOP) and Reclamation's drought contingency planning activities in the Upper Colorado River Basin.

The Annual Operation Plan (AOP) for the Colorado River reports on both the past operations of the Colorado River Reservoir for the completed year as well as projected operations and releases from these reservoirs for the current (i.e., upcoming year). The purpose of the AOP is to illustrate the potential range of reservoir operations that might be expected in the upcoming water year and reflects operational rules, guidelines and decisions that have been put into place for the Colorado River reservoirs, including the 2007 Interim Guidelines. The AOP document is prepared by Reclamation, in consultation with representatives of the Governors of the seven Colorado River Basin States, Indian Tribes, Upper Colorado River Commission, appropriate Federal agencies, and others interested in Colorado River operations. Further Information and a draft version of the 2015 AOP can be found at: http://www.usbr.gov/uc/water/rsvrs/ops/aop/index.html.

Entities that rely on the Colorado River are concerned with the ongoing drought, declining reservoirs, the potential for loss of hydroelectric generation at Lake Powell, and the potential for the first ever shortages in the Lower Basin. In the Colorado River Basin (Basin), 2000 to 2014 was the driest 15–year period in over 100 years of record keeping. During that time, water storage in the major reservoirs in the Basin declined from nearly full to about half of capacity. Within the Upper Basin, if current drought conditions persist, recent analyses show a small chance that Lake Powell water elevations could be low enough within the next decade that Glen Canyon Dam could lose the ability to generate power, which could result in the loss of funding operations for Colorado River Storage Project (CRSP) reservoirs and significant environmental programs in the Upper Basin and in the Grand Canyon and could upset the stability and reliability of power supplies on the Western Grid. Confronted with these possibilities, Reclamation has been working with Basin stakeholders to establish potential contingency options that are consistent with the Law of the River and other existing laws. Elements of these contingency options include: (1) expanding weather modification to increase supplies for the Colorado River system; (2) coordination of CRSP reservoir operations to better maintain power pool at Glen Canyon Dam; and (3) Upper Basin demand management to allow more water to reach Lake Powell.

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Managing Water in the West

2015 Colorado River Annual Operating Plan Drought Contingency Planning

Technical Work Group Meeting
October 29, 2014

U.S. Department of the Interior
Bureau of Reclamation

Update: Colorado River Annual Operating Plan

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Colorado River Annual Operating Plan

- Report of Colorado River hydrology and reservoir operations for past year and projections for the upcoming year.
- Purpose: Illustrate range of reservoir operations that might be expected in the upcoming water year
- Reflects operational rules, guidelines and decisions that have been put into place for the Colorado River reservoirs.
- AOP document is prepared by Reclamation, in consultation with representatives of the Basin States, Indian Tribes, Upper Colorado River Commission, appropriate Federal agencies, and other Basin stakeholders. Typically three consultation meetings.
- 2015 AOP currently in final stages of development. Expect transmittal to Secretary of Interior in upcoming weeks. http://www.usbr.gov/uc/water/rsvrs/ops/aop/index.html.

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Reservoir Operations
Water Years 2014 and 2015

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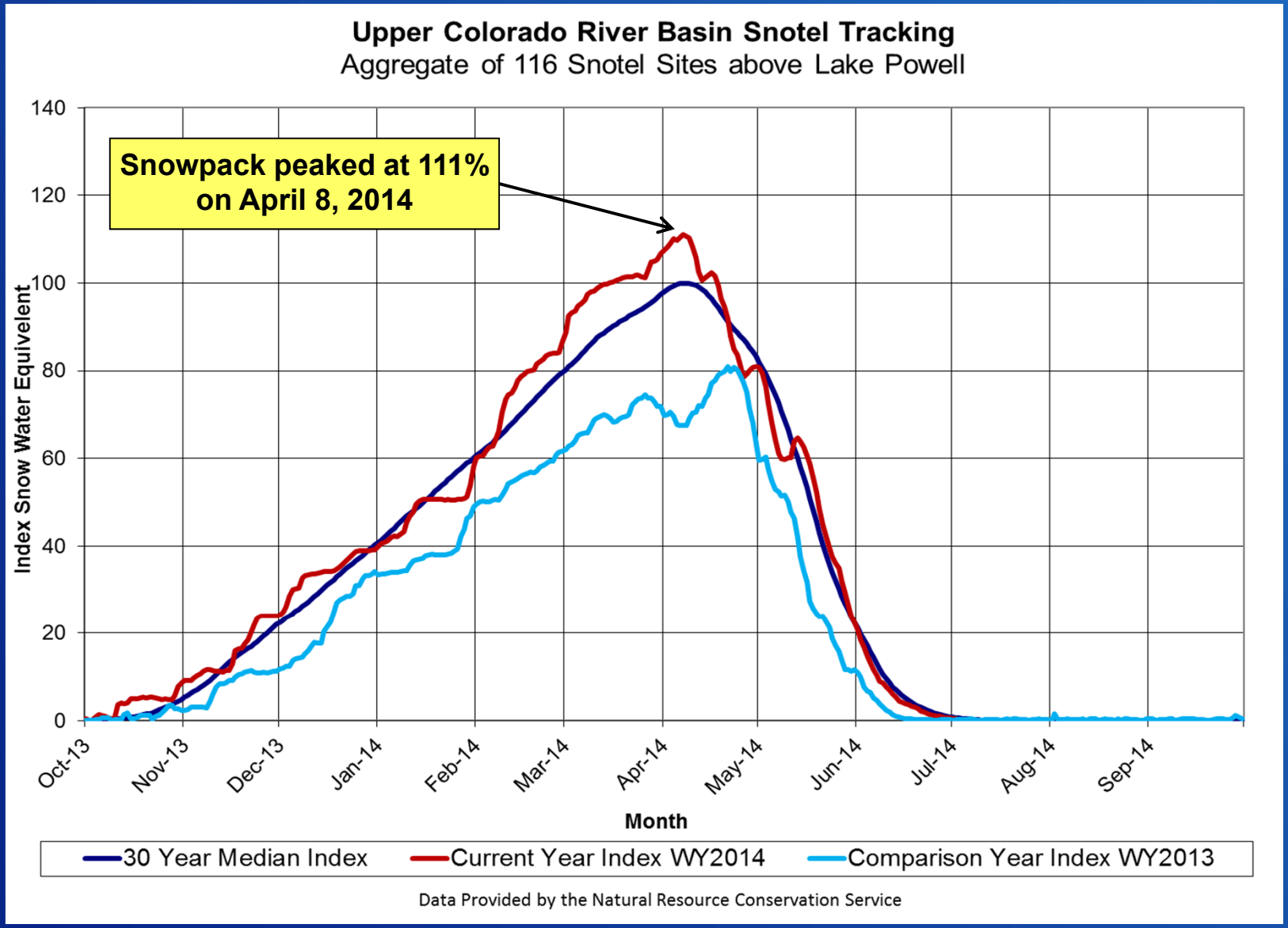
Upper Basin Hydrology



http://www.usbr.gov/uc/water/notice/Graphs/Upper_Colorado.html

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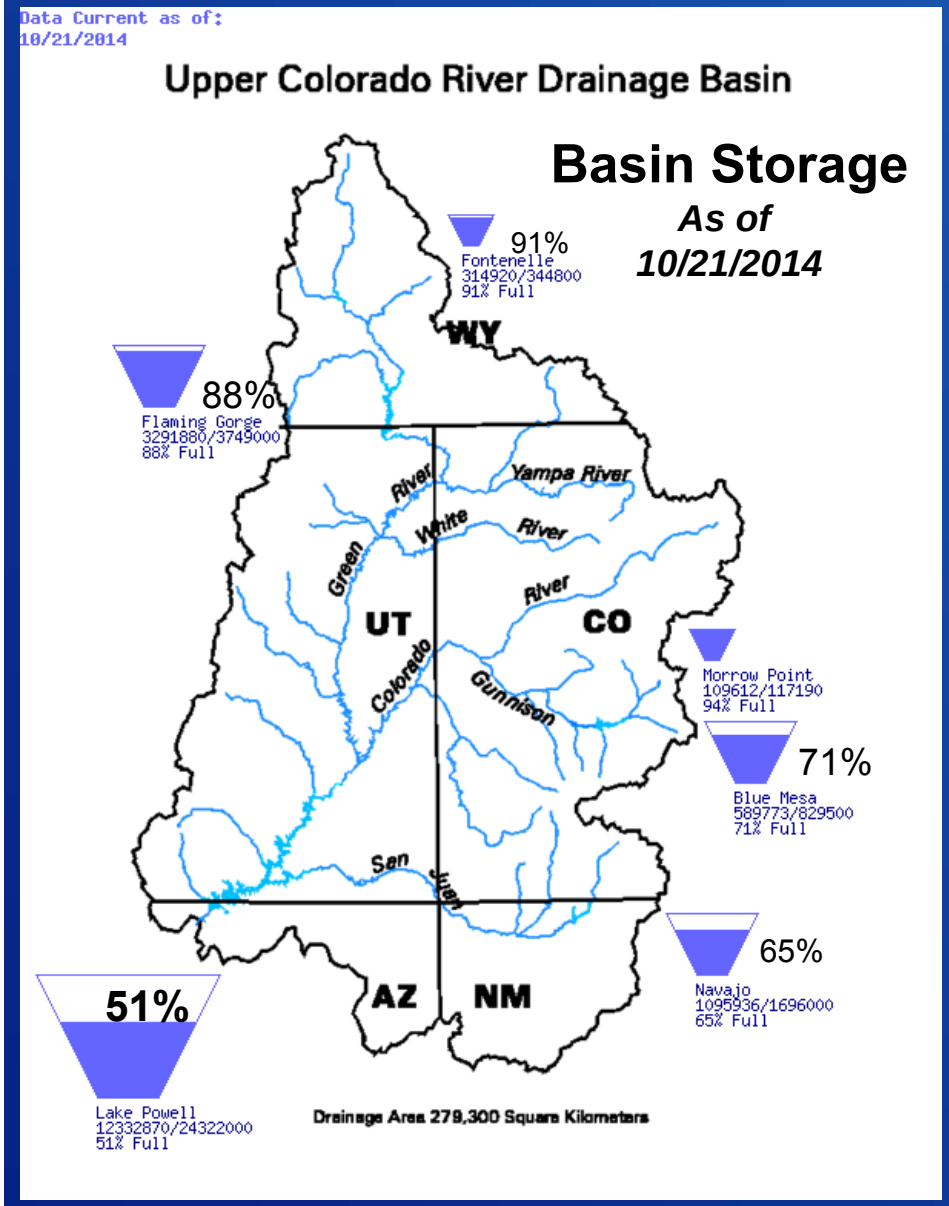
Upper Basin Storage



http://www.usbr.gov/uc/water/basin/tc_cr.html

Water Year 2014
Observed Unregulated Inflow

Reservoir	WY 2015 Inflow (KAF)	Percent of Average[1]
Fontenelle	1,424	132%
Flaming Gorge	1,689	116%
Blue Mesa	1,145	120%
Navajo	696	65%
Powell	10,381	96%

[1] 1981-2010 period

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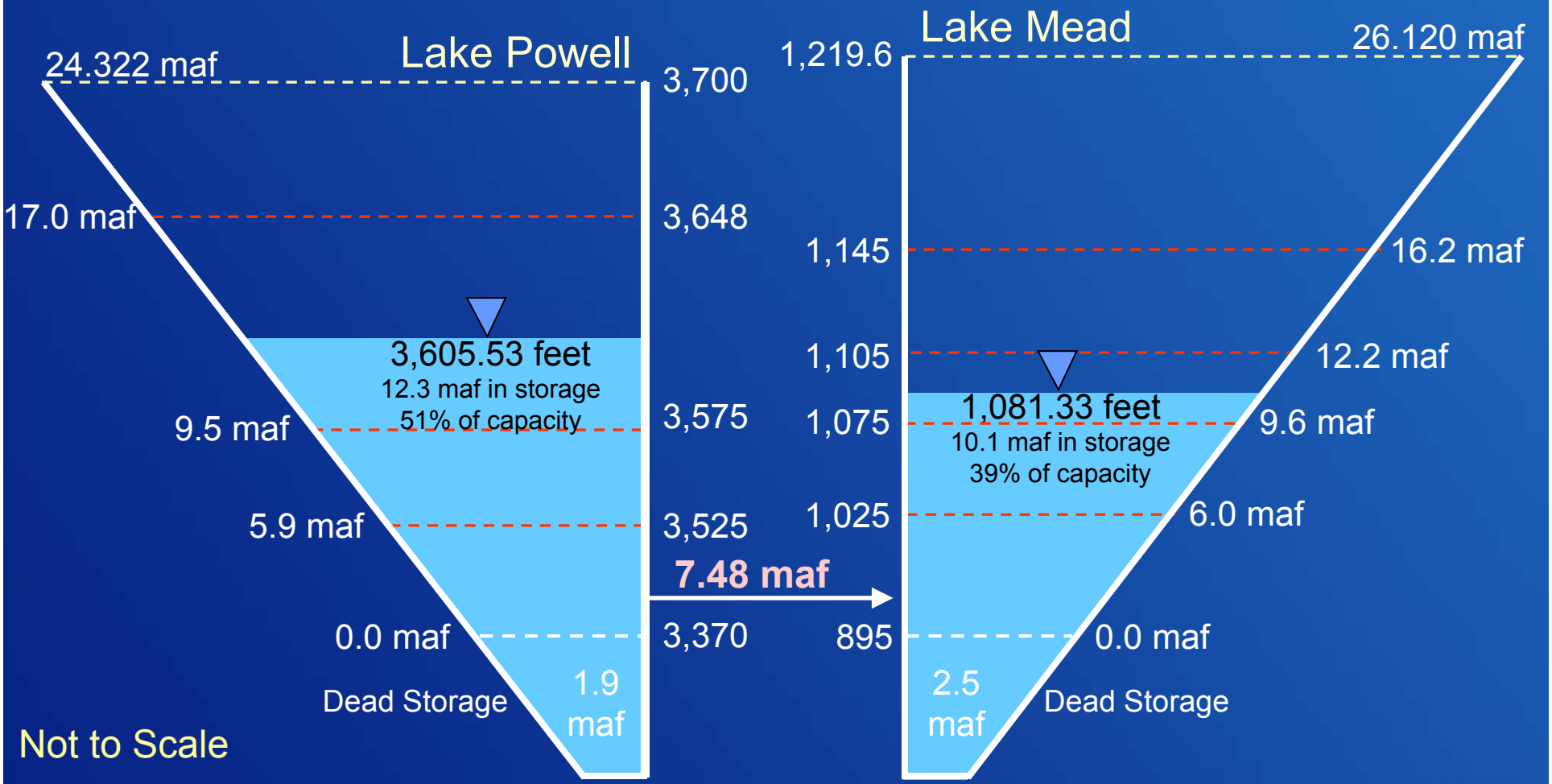
End of Water Year 2014 Conditions

Observed Unregulated Inflow into Powell[1] = 10.38 maf (96% of average)



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

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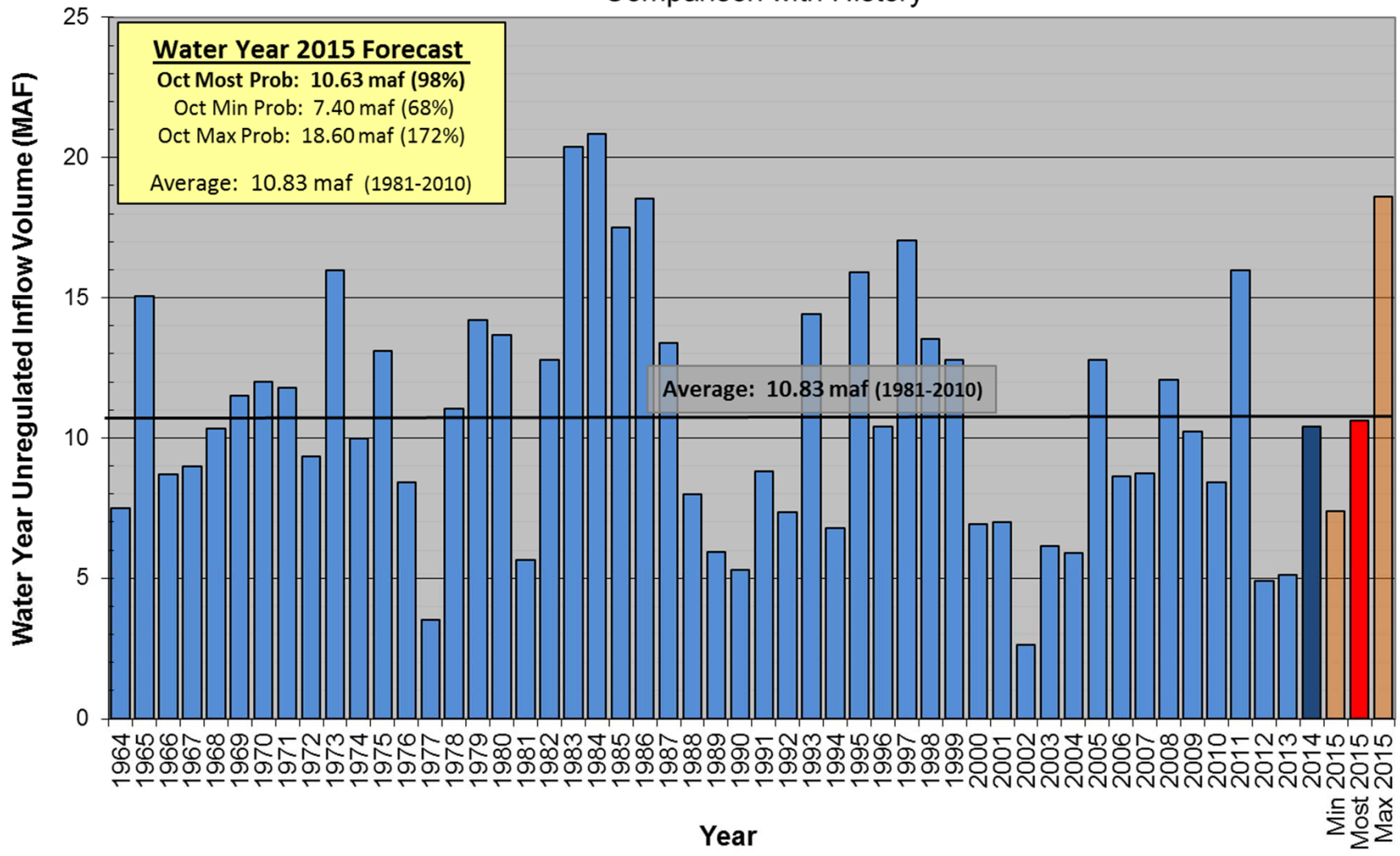
Lake Powell Unregulated Inflow
Water Year 2015 Forecast *(issued Oct 1)*
Comparison with History



Observed Water Year 2014: 10.38 maf (96%)

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Lake Powell Operational Tier Determinations (2007 Interim Guidelines)

- August 24-Month Study projection of January 1 elevations establishes the Lake Powell operating Tiers for the upcoming year
- If in Upper Elevation Balancing, April 24-Month Study projection of Sept 30th elevation / storage could shift to Powell operations to balancing or equalization for remainder of water year
- Reservoir operating plans are continually updated throughout the water year as hydrologic and operational conditions change.

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Lake Powell & Lake Mead Operational Table

Operational Tiers for Water/Calendar Year 2015 determined with the August 2014 24-Month Study

Lake Powell

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
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)
3,596.62 ft Jan 1,2015 projection		
3,575	**Mid-Elevation Release Tier** Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.5
3,525	**Lower Elevation Balancing Tier** Balance contents with a min/max release of 7.0 and 9.5 maf	5.9
3,490		4.0
3,370		0

Lake Mead

Elevation (feet)	Operation According to the Interim Guidelines	Live Storage (maf)[1]
1,220	**Flood Control Surplus or Quantified Surplus Condition** Deliver > 7.5 maf	25.9
1,200 (approx.)[2]	**Domestic Surplus or ICS Surplus Condition** Deliver > 7.5 maf	22.9 (approx.)[2]
1,145		15.9
1,105	**Normal or ICS Surplus Condition** Deliver ≥ 7.5 maf	11.9
1,083.37 ft Jan 1, 2015 projection		
1,075	**Shortage Condition** Deliver 7.167[4] maf	9.4
1,050	**Shortage Condition** Deliver 7.083[5] maf	7.5
1,025	**Shortage Condition** Deliver 7.0[6] maf Further measures may be undertaken[7]	5.8
1,000		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.

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Lake Powell Operational Scenarios

Based on October 2014 24-Month Study Inflow Scenarios

Powell Inflow Scenario	WY 2015 Release Projection
Probable Minimum	Upper Elevation Balancing Tier w/ Projected April shift to Balancing 9.0 maf release
Most Probable	Upper Elevation Balancing Tier w/ Projected April shift to Balancing 9.0 maf release
Probable Maximum	Upper Elevation Balancing Tier w/ Projected April shift to Equalization 12.1 maf release

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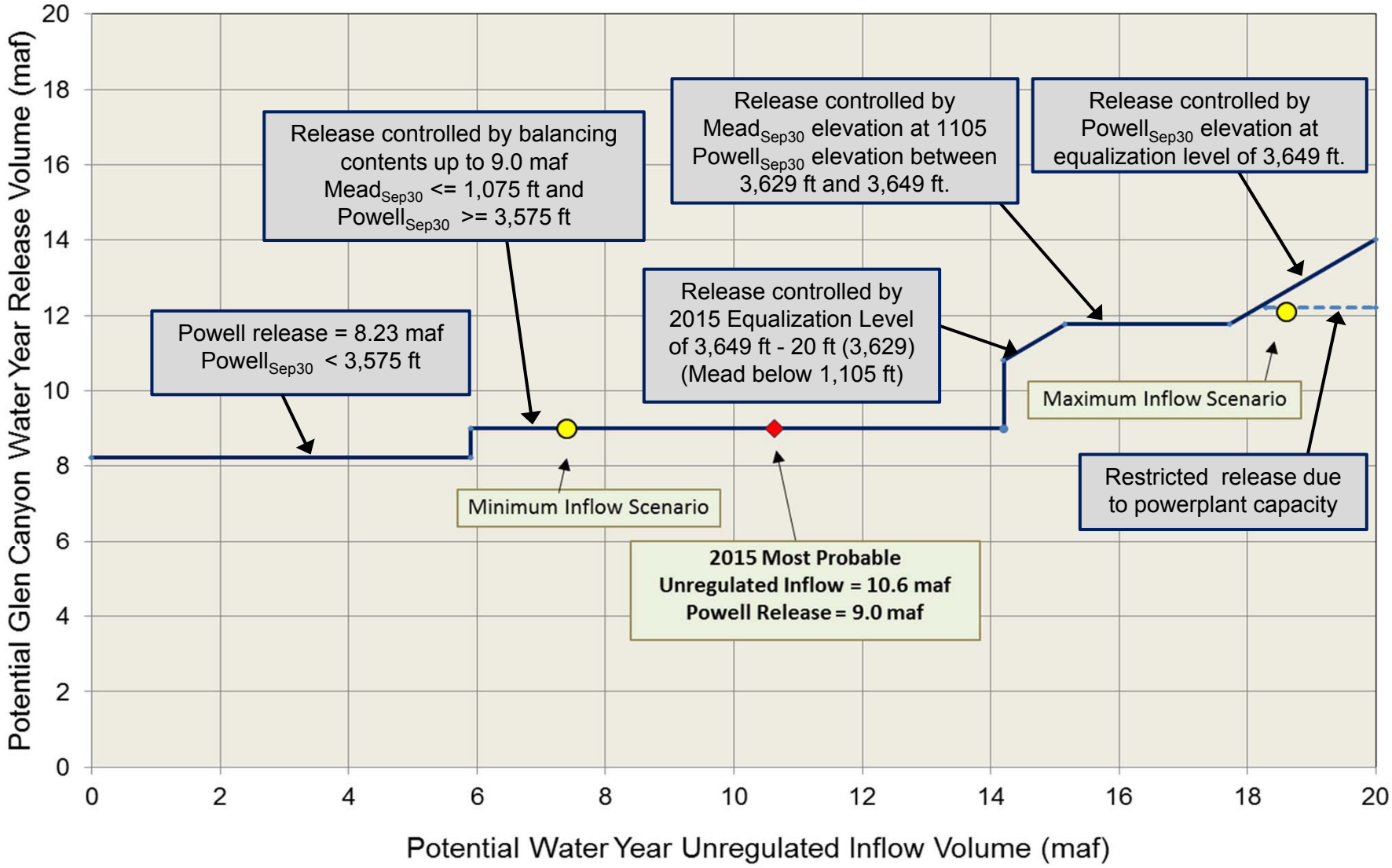
Potential Lake Powell Release Scenarios

Water Year 2015 Release Volume as a Function of Unregulated Inflow Volume
based on October 2014 24-Month Study Conditions



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Reclamation Upper Basin Drought Contingency Planning

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Colorado River Drought

- Inflow into Lake Powell has been below average 12 of the past 15 years (2000-2014)
- The period from 2000-2014 was the driest 15-year period in over 100 years of historical record
- Tree-ring reconstructions show more severe droughts have occurred over the past 1200 years (e.g., drought in the mid 1100s)
- However, based on the paleo-record, less than five 15-year periods were drier than the period from 2000-2014
- Not unusual to have a few years of above average inflow during longer-term droughts (e.g., 1950s)

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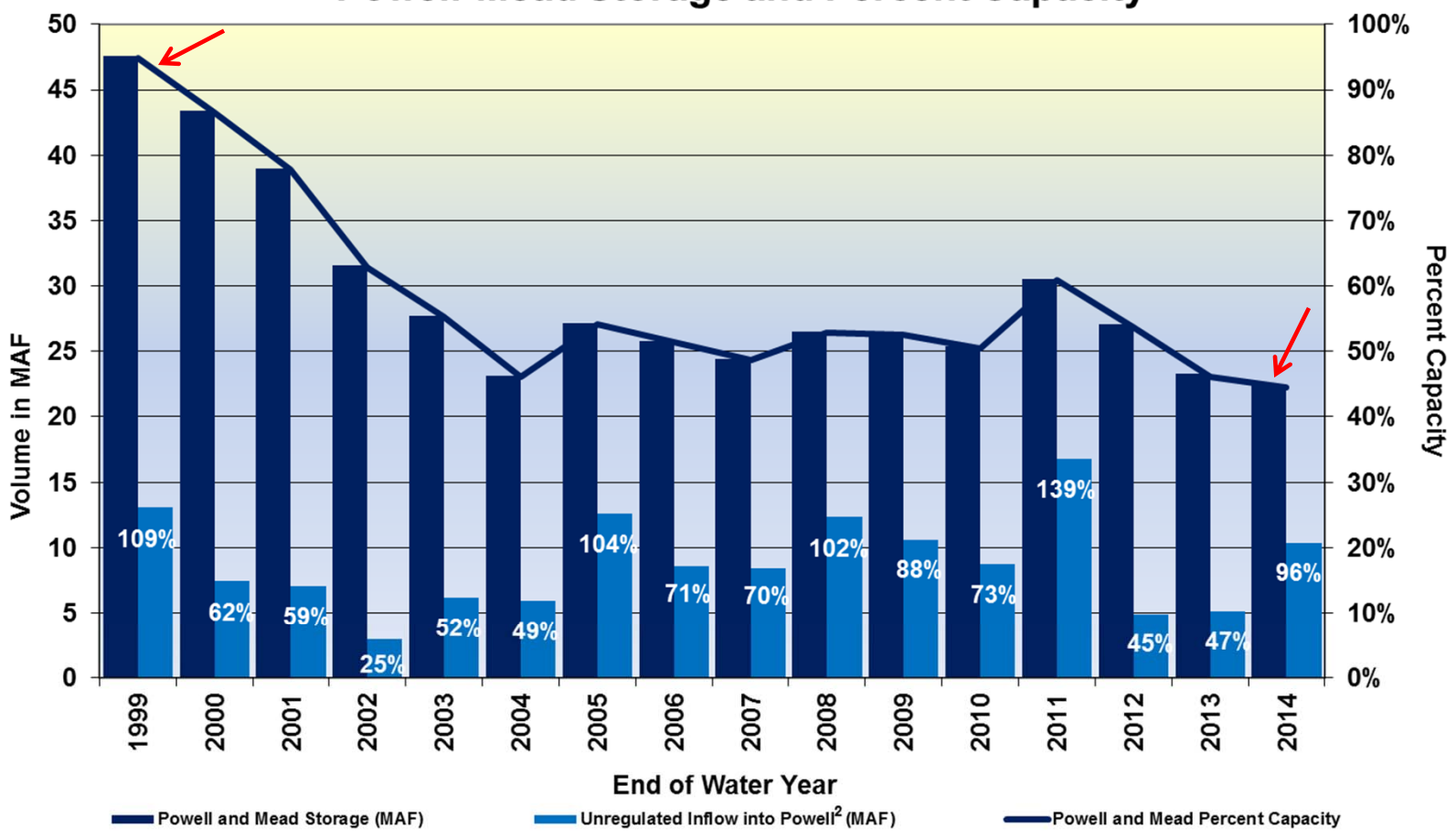
State of the System (Water Years 1999-2014)[1]



[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 years 2012-2014 are based on the 30-year average from 1981-2010.

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Percent of Traces with Event or System Condition

Results from October 2014 CRSS[1,2,3] (values in percent)

	Event or System Condition	2015	2016	2017	2018	2019
Upper Basin – Lake Powell	**Equalization Tier**	**8**	**23**	**25**	**26**	**30**
	Equalization – annual release > 8.23 maf	*8*	*23*	*25*	*26*	*29*
	Equalization – annual release = 8.23 maf	*0*	*0*	*0*	*0*	*1*
	Upper Elevation Balancing Tier *(Powell < Eq level and ≥ 3,575 ft)*	**92**	**59**	**55**	**54**	**45**
	Upper Elevation Balancing – annual release > 8.23 maf	*49*	*47*	*43*	*41*	*33*
	Upper Elevation Balancing – annual release = 8.23 maf	*43*	*10*	*11*	*10*	*12*
	Upper Elevation Balancing – annual release < 8.23 maf	*0*	*2*	*1*	*3*	*0*
	Mid-Elevation Release Tier *(Powell < 3,575 and ≥ 3,525 ft)*	**0**	**18**	**18**	**11**	**17**
	Mid-Elevation Release – annual release = 8.23 maf	*0*	*0*	*0*	*1*	*3*
	Mid-Elevation Release – annual release = 7.48 maf	*0*	*18*	*18*	*10*	*14*
	Lower Elevation Balancing Tier (Powell ≤ 3,525 ft)	**0**	**0**	**2**	**9**	**8**
	Powell below Minimum Power Pool (Powell ≤ 3,490 ft)	**0**	**0**	**0**	**4**	**6**
Lower Basin – Lake Mead	**Shortage Condition – any amount (Mead ≤ 1,075 ft)**	**0**	**25**	**53**	**62**	**61**
	Shortage – 1st level (Mead ≤ 1,075 and ≥ 1,050)	*0*	*25*	*40*	*44*	*37*
	Shortage – 2nd level (Mead < 1,050 and ≥ 1,025)	*0*	*0*	*13*	*14*	*14*
	Shortage – 3rd level (Mead < 1,025)	*0*	*0*	*0*	*4*	*10*
	Surplus Condition – any amount (Mead ≥ 1,145 ft)	**0**	**0**	**6**	**9**	**15**
	Surplus – Flood Control	*0*	*0*	*0*	*1*	*2*
	Normal or ICS Surplus Condition	**100**	**75**	**41**	**29**	**24**

[1] Reservoir initial conditions based on the most probable October 24-month Study projected levels for December 31, 2014.
[2] Hydrologic inflow traces based on resampling of the observed natural flow record from 1906-2010.
[3] Percentages shown may not be representative of the full range of future possibilities that could occur with different modeling assumptions.

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Upper Basin Drought Planning

- Concern regarding ongoing drought, declining reservoirs and the possibility of loss of hydroelectric generation at Lake Powell
- Reclamation working with Upper Basin States and other stakeholders to develop an Upper Basin Contingency Plan
- A primary objective in the Upper Basin is to preserve power production at Glen Canyon Dam.

UB Drought Contingency Planning

- Ongoing coordination with Colorado River Basin stakeholders

- Upper Basin planning considerations
  1. Weather modification (cloud seeding)
  2. Upper Basin voluntary demand management
  3. Upper Basin Reservoirs extended operations

Extended Reservoir Operations

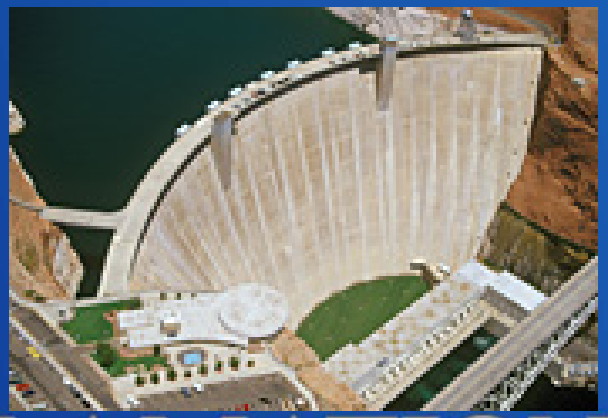
- An extension of the operation of the CRSP reservoirs above Lake Powell to release water into Lake Powell during critically low periods
- Stay within existing RODs and BOs
- Evaluating taking “action” (moving water from UB reservoirs) when Powell is forecasted to be below critical elevation thresholds

Reclamation Drought Contingency Modeling Approach

- Evaluating CRSP Extended Operations when Powell forecasted to be below 3,525’
  - Also evaluated 3,490’ in previous model runs; initial results indicate that could be too late for action.
- Evaluating demand management scenarios in Upper and Lower Basins
- Testing operational implementation strategies

Reclamation modeling preliminary results

- Reclamation modeling to date has produced very similar results to Basin States' previous modeling results
- Extended Operations of CRSP reservoirs can significantly reduce risk of Powell dropping below minimum power pool
- Additional efforts (demand management in Upper and Lower basin) may further improve ability to improve conditions at Lake Powell
- Additional modeling is necessary



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Summary

- Fortunate to start the drought in 2000 with nearly full system conditions
- A wide range of future outcomes is possible through 2020, including an “extended drought”
- Putting water back into the system, through a range of options, improves system resiliency and helps to avoid critical reservoir elevations
- It is important to develop a Upper Basin Contingency Plan for the small, but real, possibility of reaching critical elevations at Lake Powell

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