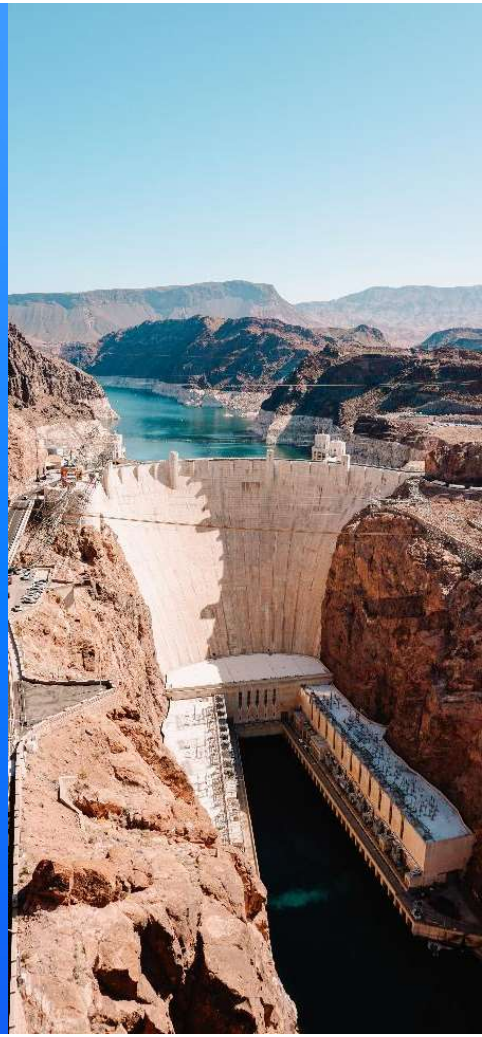
Jacobs Challenging today. Reinventing tomorrow.

Life Support: Drought Resilience Lessons from the Western U.S., Past and Present

July 28, 2022



Team

Moderator:

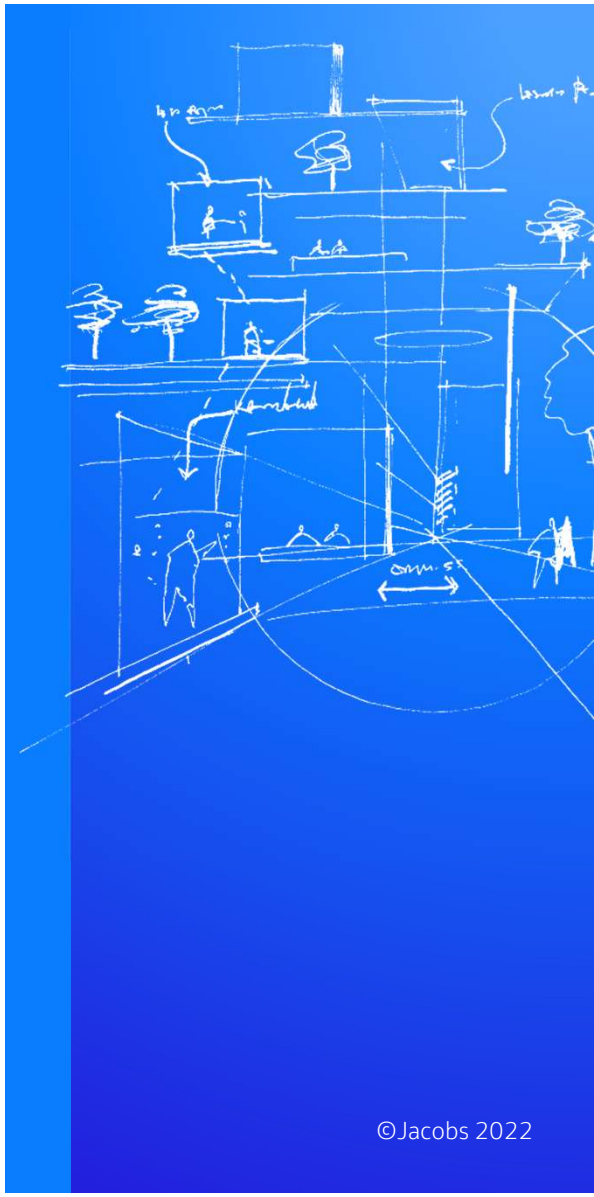
Adam Murdock
Global Solutions Director – Conveyance and Storage, Jacobs

Speakers:

Bob Harding
Senior Water Resources Engineer, Jacobs

Aaron Mead
Engineer, Metropolitan Water District of Southern California (MWD)

Jeff Den Bleyker
Senior Water Resources Planner, Jacobs



Drought and Aridification: Impacts to our Water Supply

- We are all facing the effects of drought – but this is not just a typical drought cycle – we are coming to terms with aridification – a climate change induced, long term reduction in water supply – that, of course, on top of considering increasing growth and increasing water demands
- Unfortunately, there is no silver bullet. Overcoming this challenge requires creative approaches, collaboration and a long view – we are all in this together and there is a lot that we can learn from each other.
- That is why I am excited to introduce Bob, Aaron and Jeff. Bob and Aaron will sketch the history of programmatic efforts to adapt to diminishing water supplies on the Colorado River, and Jeff will describe a project in which a specific water utility, NDSD, took an innovative approach to creating a resilient water supply for Great Salt Lake.

Colorado River and Its Past

Bob Harding, Jacobs

Introduction to the Law of the Colorado River

- Historical Highlights
- Federal, Interstate, and California Interaction
- Metropolitan's Programs


Colorado River Basin
WY
UT
NV
CO
NM
AZ
CA
MEXICO
UPPER BASIN
LAKE POWELL
LEE FERRY
LAKE MEAD
LAKE MOHAVE
LOWER BASIN
LAKE HAVASU
California Aqueduct
Los Angeles Aqueduct
Colorado River Aqueduct
MWD
CVWD
PVID
IID
Yuma Project
All-American Canal
COLORADO RIVER DELTA
GULF OF CALIFORNIA

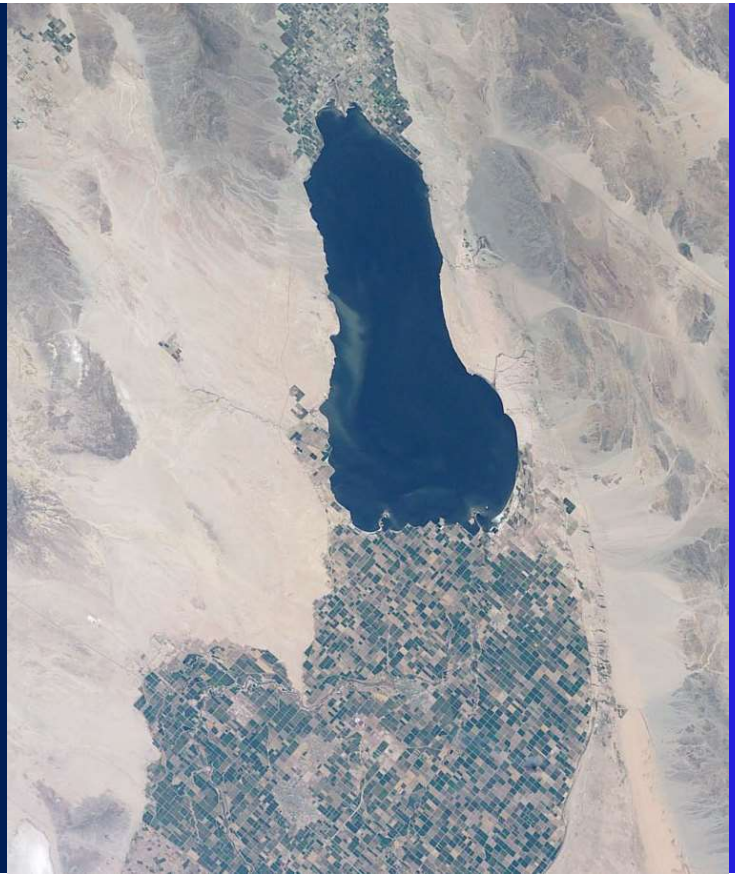
Early Colorado River

Boulder Canyon dam site

Alamo Canal - Imperial Valley

- Floods and Droughts
- Federal Government Help

Salton Sea



- Formed in 1905
- Natural trend toward hyper-salinity
- IID agreed to provide 800,000 AF by fallowing through 2017
- Provide time for State to develop a long-term solution

Wyoming v. Colorado

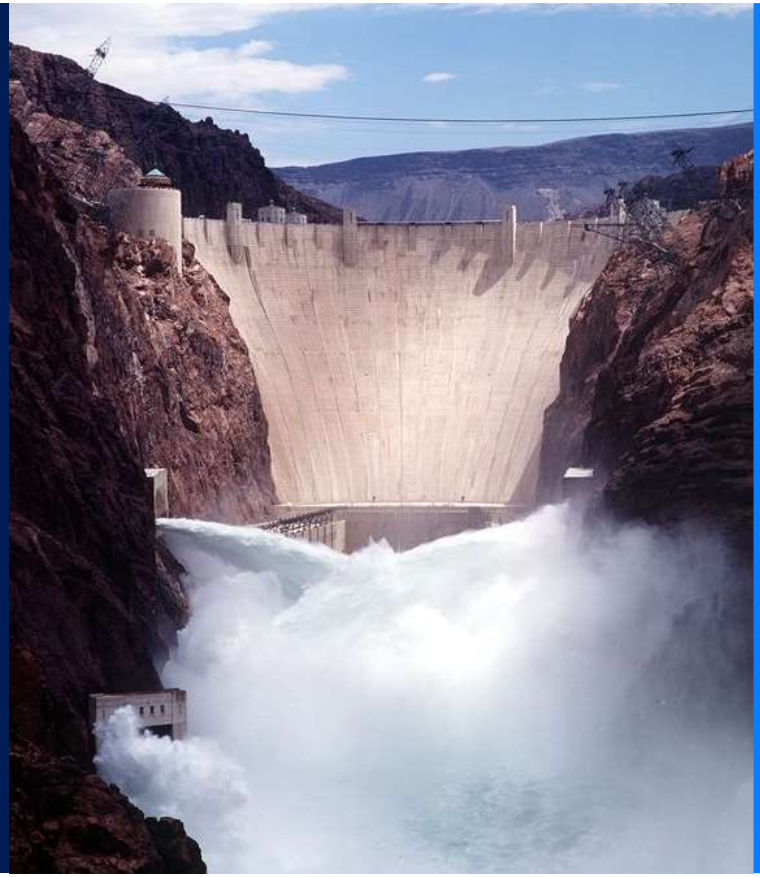
- 1922 Supreme Court Decision

Laramie River

Salton Sea

- Defined System
- Divided Basin
- Apportioned System
- Mexico Allocation
- Required Congressional Approval

Boulder Canyon Project Act 1928



Colorado River Storage Project 1956

- Glen Canyon Dam
- Flaming Gorge Dam
- Others

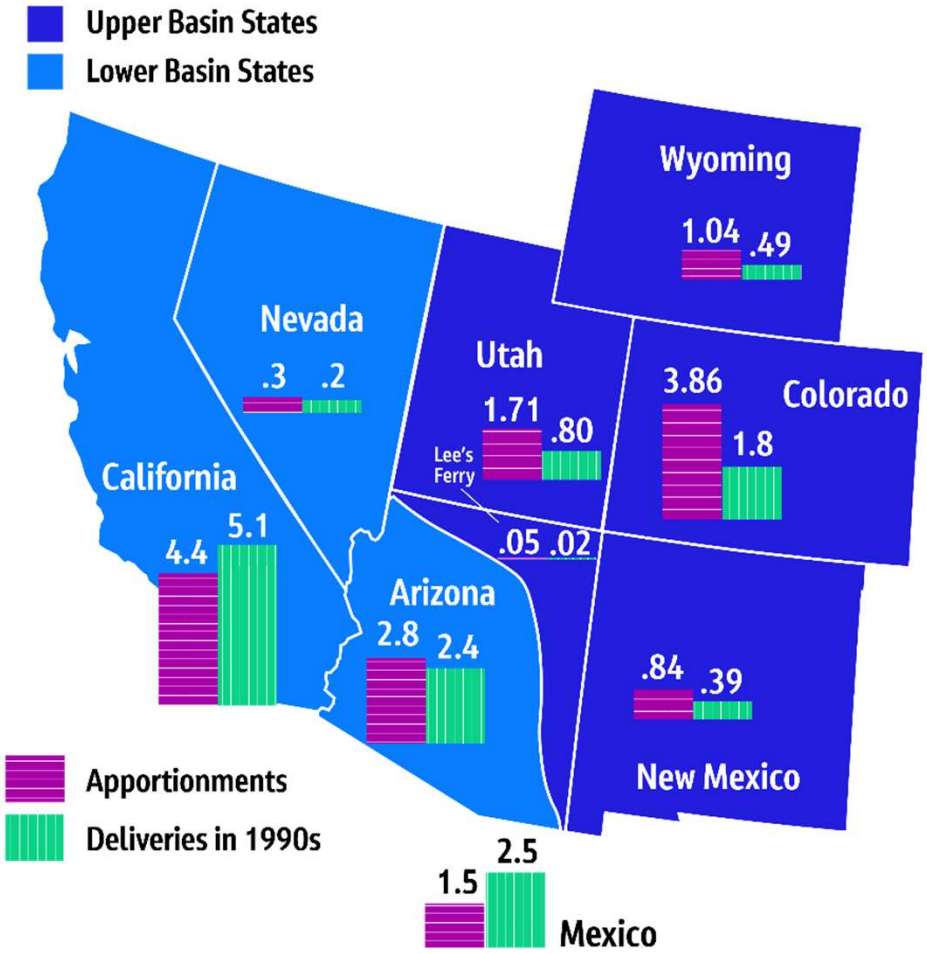
Arizona v. California 1963

- Congressional apportionment
- Mainstem only; tributaries excluded
- Secretarial discretion during shortage
- Apportionments
  - California 4.4 MAF/year
  - Arizona 2.8 MAF/year plus tributaries
  - Nevada 300 TAF/year

Colorado River Basin Project Act 1968

- Authorized Central Arizona Project (CAP)
- Maintained California priority

Colorado River Deliveries in the 1990sts



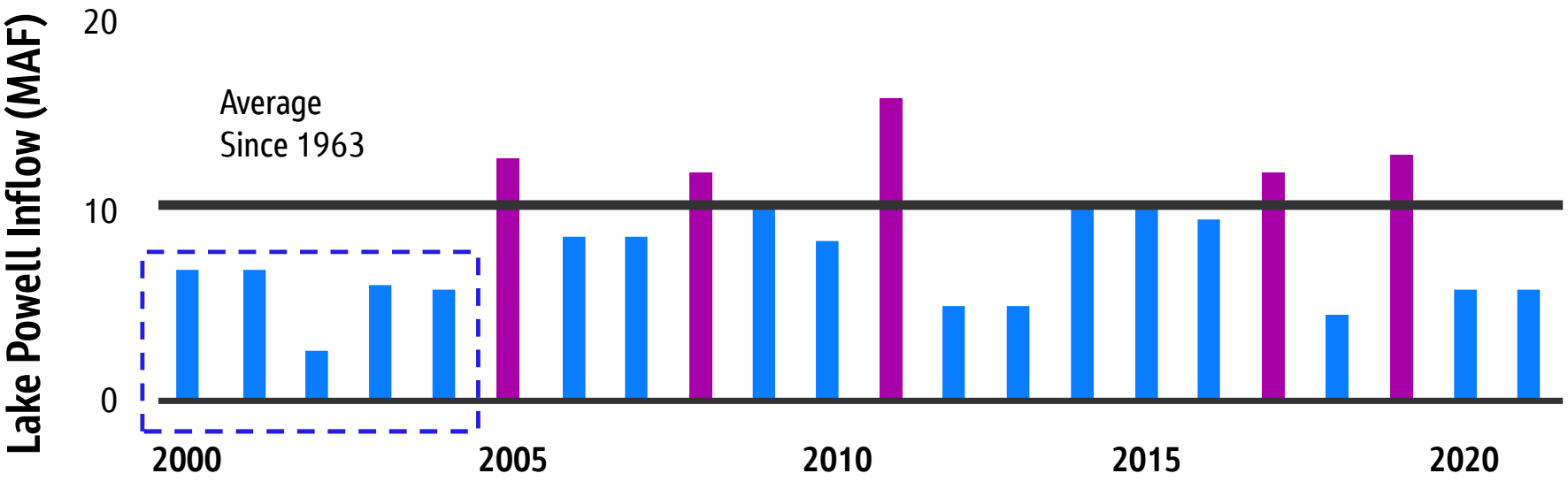
California 4.4 Plan Actions

- Increase offstream storage
- Increase conservation and re-use
- Reduce over-deliveries
- Implement ag to urban water transfers

Recent Efforts to Manage Water Supply on the Colorado River

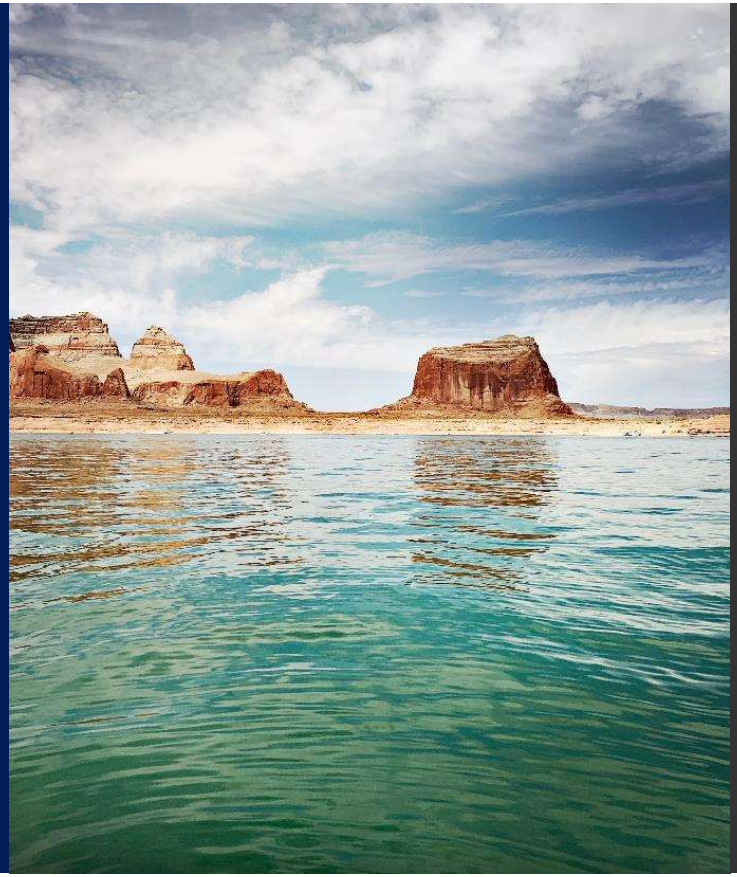
Aaron Mead, Metropolitan Water District of Southern California

Megadrought in the Western US – Part 1




California Service Areas
Los Angeles Aqueduct
California Aqueduct
CALIFORNIA
Colorado River
Hoover Dam
Lake Mohave
Davis Dam
ARIZONA
Lake Havasu
Parker Dam
Coachella Valley W.D.
Colorado River Aqueduct
Palo Verde I.D.
MWD
Coachella Canal
SALTON SEA
Senator Wash Reservoir
Imperial Dam
IID
All American Canal
Yuma Project
PACIFIC OCEAN
UNITED STATES
MEXICO

California Priority System



1. Palo Verde
2. Yuma Project
3. (a) Imperial & Coachella
   (b) Palo Verde

3.85 MAF

4. Metropolitan — **550 TAF**

Total Basic Apportionment 4.4 MAF

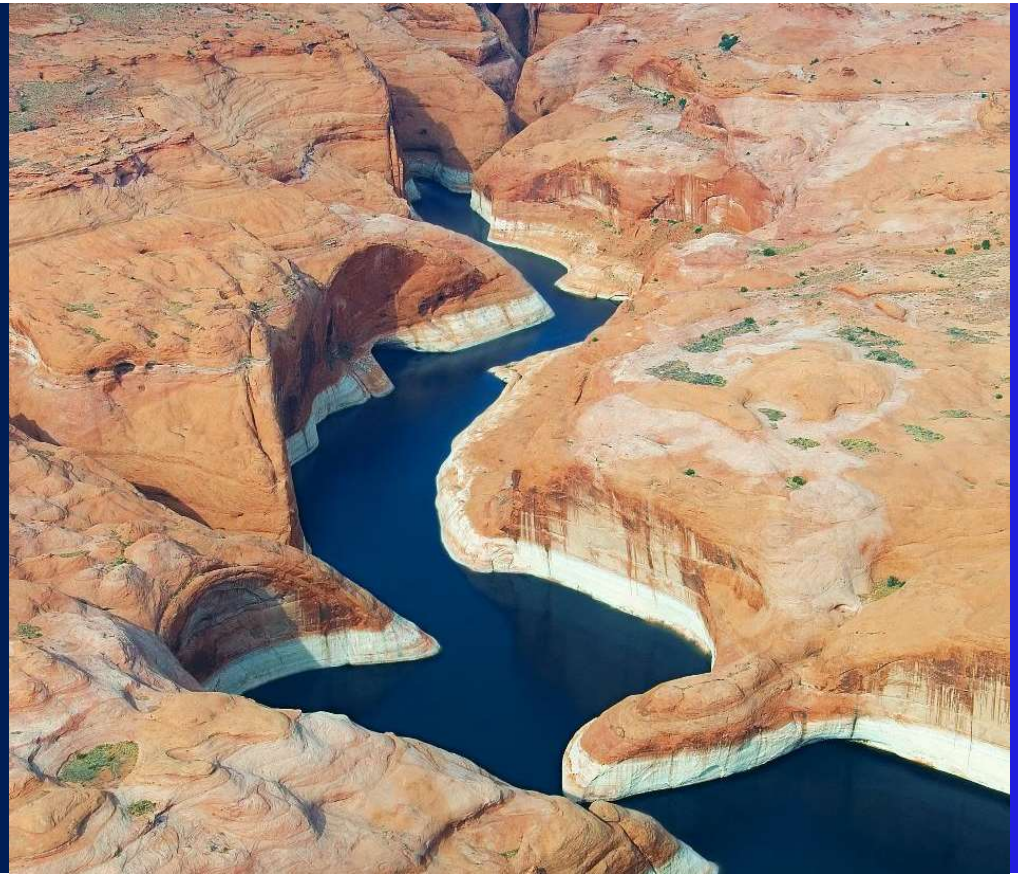
5. Metropolitan — **662 TAF**
6. Imperial, Coachella, Palo Verde — **300 TAF**

Elements of the Quantitative Settlement Agreement (2003)

Salton Sea: avian sanctuary

- Quantification of Priority 3a apportionments
  - Imperial capped at 3.1 MAF
  - Coachella capped at 330 KAF
- Agricultural conservation
  - E.g., All American Canal and Coachella Canal lining
- Transfers to urban areas
  - E.g., San Diego County Water Authority
- Salton Sea mitigation

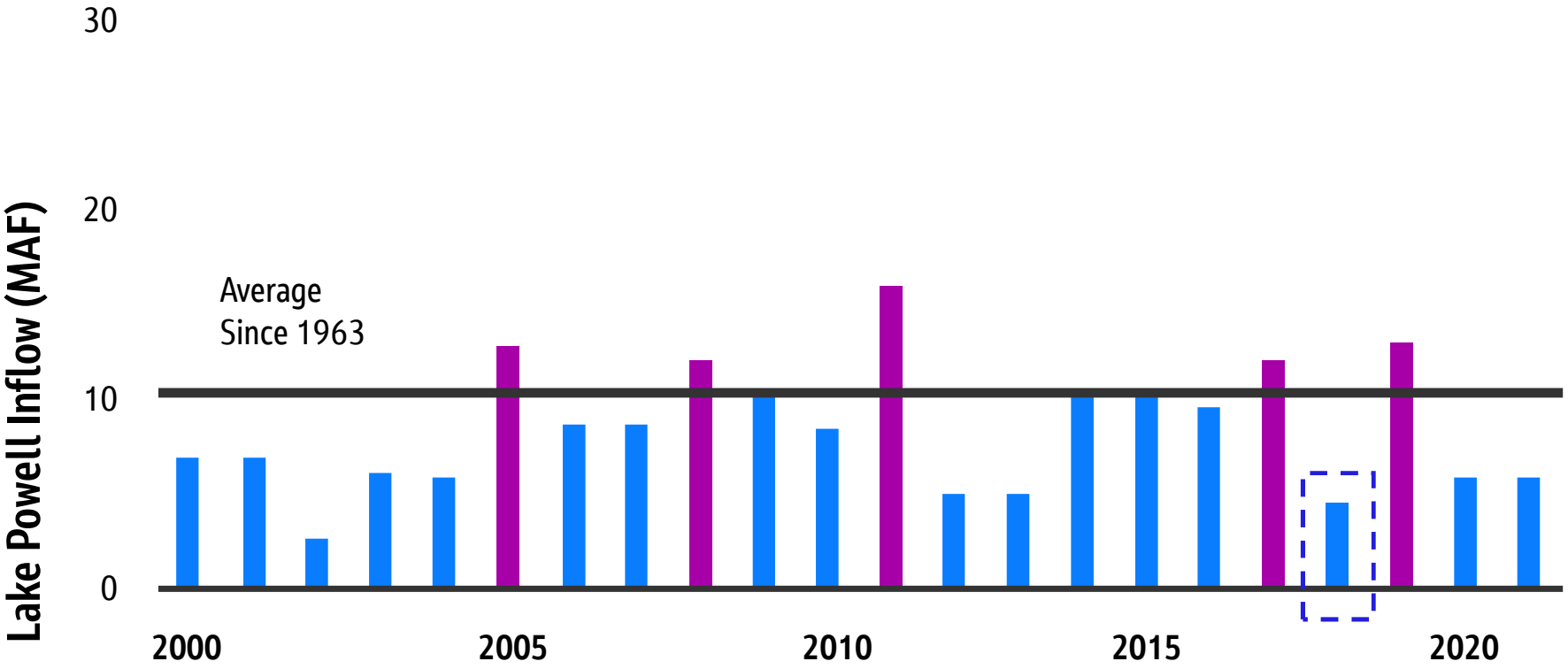
Interim Guidelines (2007)



Lake Powell

- Intentionally Created Surplus (ICS)
  - Water "banking" in Lake Mead
- Reservoir operating condition set by levels of Lakes Powell and Mead
  - Shortages for AZ and NV (not CA)
- Lake Powell release volumes set by reservoir levels
- In effect through December 31, 2025

Megadrought in the Western US – Part 2

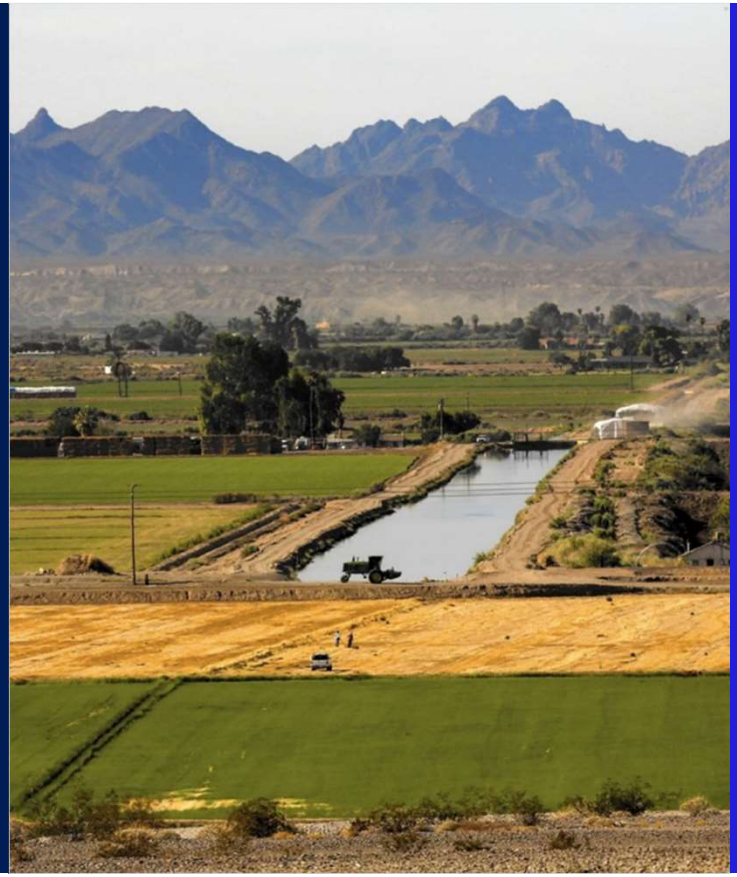


Drought Contingency Plan (2019)

- Additional constraints on water use:
  - "DCP Contributions"
- Additional incentives to create ICS

Projected January 1 lake Mead Elevation (feet msi)	2007 Interim Guidelines Shortages		DCP Contributions			Combined Volumes (2007 Interim Guidelines Shortages & DCP Contributions)			
	Arizona	Nevada	Arizona	Nevada	California	Arizona	Nevada	California	Lower Division States total
At or below 1,090 and above 1,075	0	0	192	8	0	192	8	0	200
At or below 1,075 and at or above 1,050	320	13	192	8	0	512	21	0	533
Below 1,050 and above 1,045	400	17	192	8	0	592	25	0	617
At or below 1,045 and above 1,040	400	17	240	10	200	640	27	200	867
At or below 1,040 and above 1,035	400	17	240	10	250	640	27	250	917
At or below 1,035 and above 1,030	400	17	240	10	300	640	27	300	967
At or below 1,030 and at or above 1,025	400	17	240	10	350	640	27	350	1,017
Below 1,025	400	20	240	10	350	720	30	350	1,100

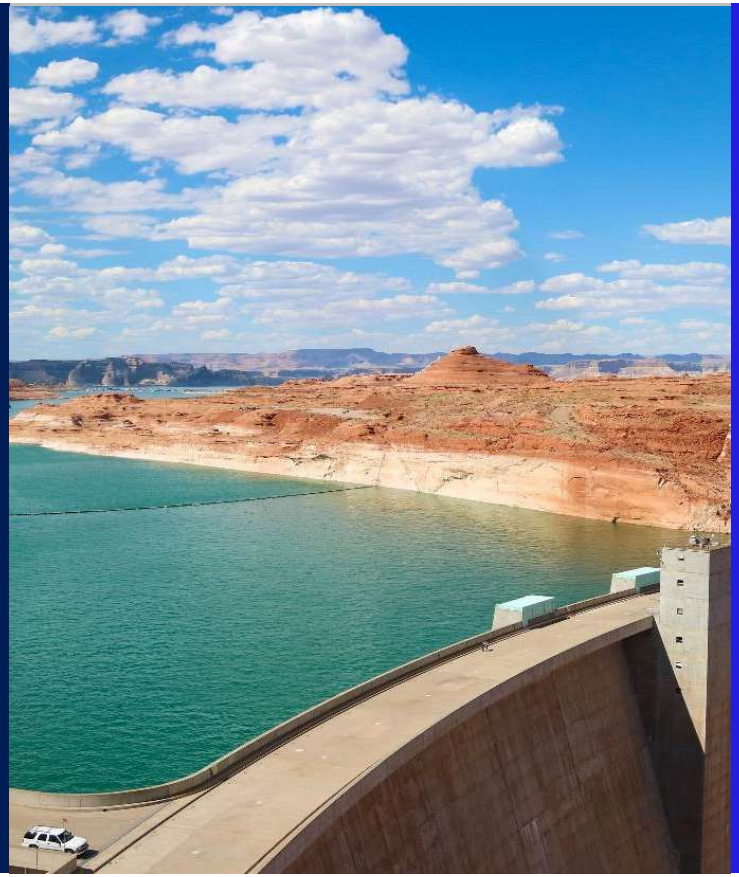
"500+ Plan"



- MOU signed in December 2021
- Goal: 500+ KAF/year additional conservation in Lower Basin for 2022 & 2023
- $200M funding
  - AZ, CA, NV: $100M
  - Federal: $100M
- Projected total conservation to date: 223 KAF
  - Efforts are ongoing

Palo Verde Irrigation District: System conservation fallowing

Cut to Lake Powell Release, Upstream Reservoir Releases



Lake Powell

- April 2022, USBR concerned about Lake Powell elevations
  - Dipped below 3525'
  - Min. power pool = 3490'
  - Infrastructure concerns
- Reduced release from 7.48 MAF to 7.0 MAF
- Released 500 KAF from upstream reservoir (Flaming Gorge)

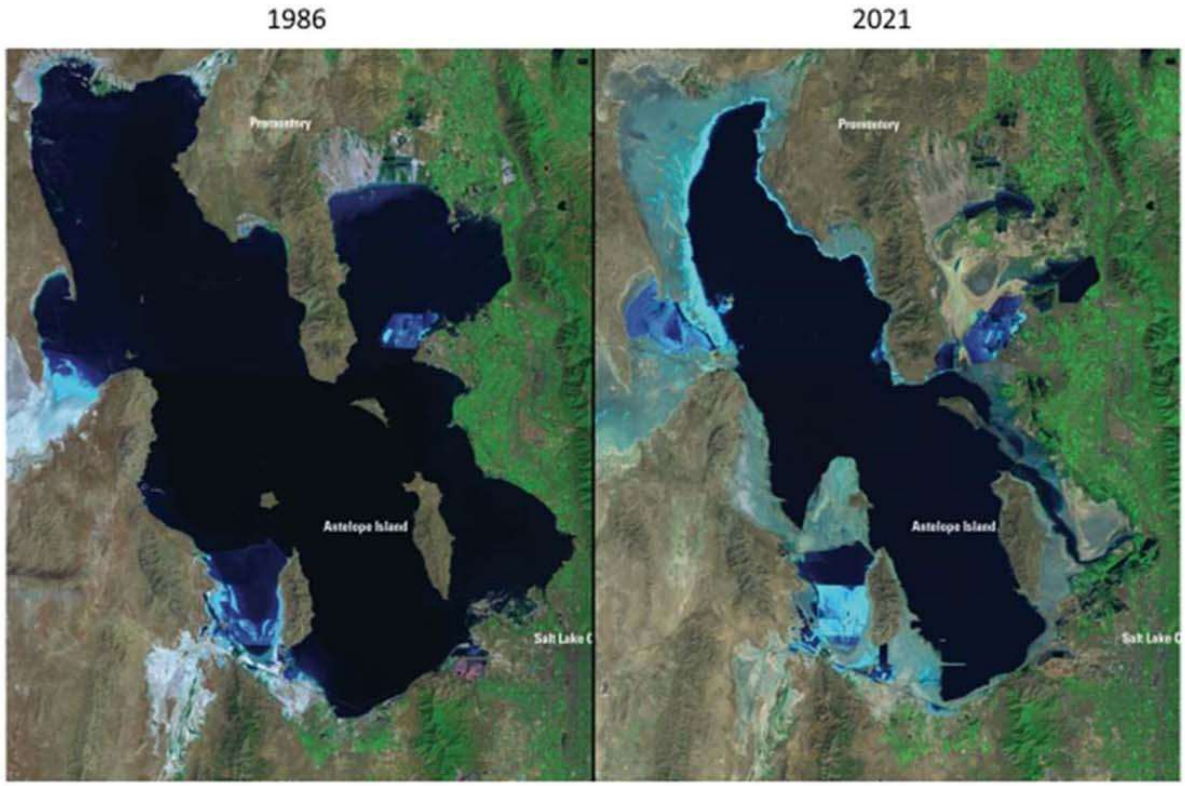
June 14, Senate Hearing, Committee on Energy and Natural Resources

- Continuing concern over reservoir levels
  - Esp. power generation and infrastructure at Lake Powell
- USBR Commissioner:
  - Basin States need to conserve 2-4 MAF in 2023
  - 60 days to develop a plan
  - If no plan, USBR will impose one

Keeping Water in Great Salt Lake: An Innovative Approach to Meet Discharge Limits

Jeff Den Bleyker, Jacobs

Great Salt Lake: A Lake in Decline

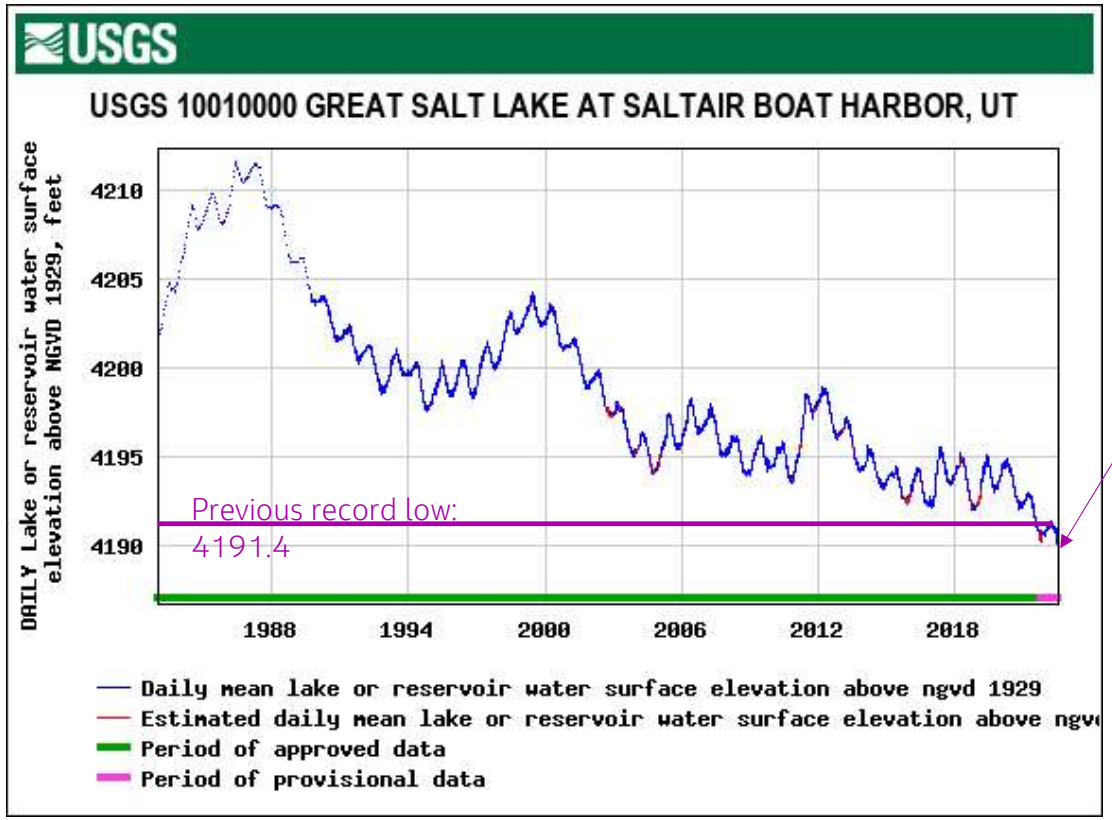


2,300 Square Miles

950 Square Miles

Great Salt Lake: A Lake in Decline

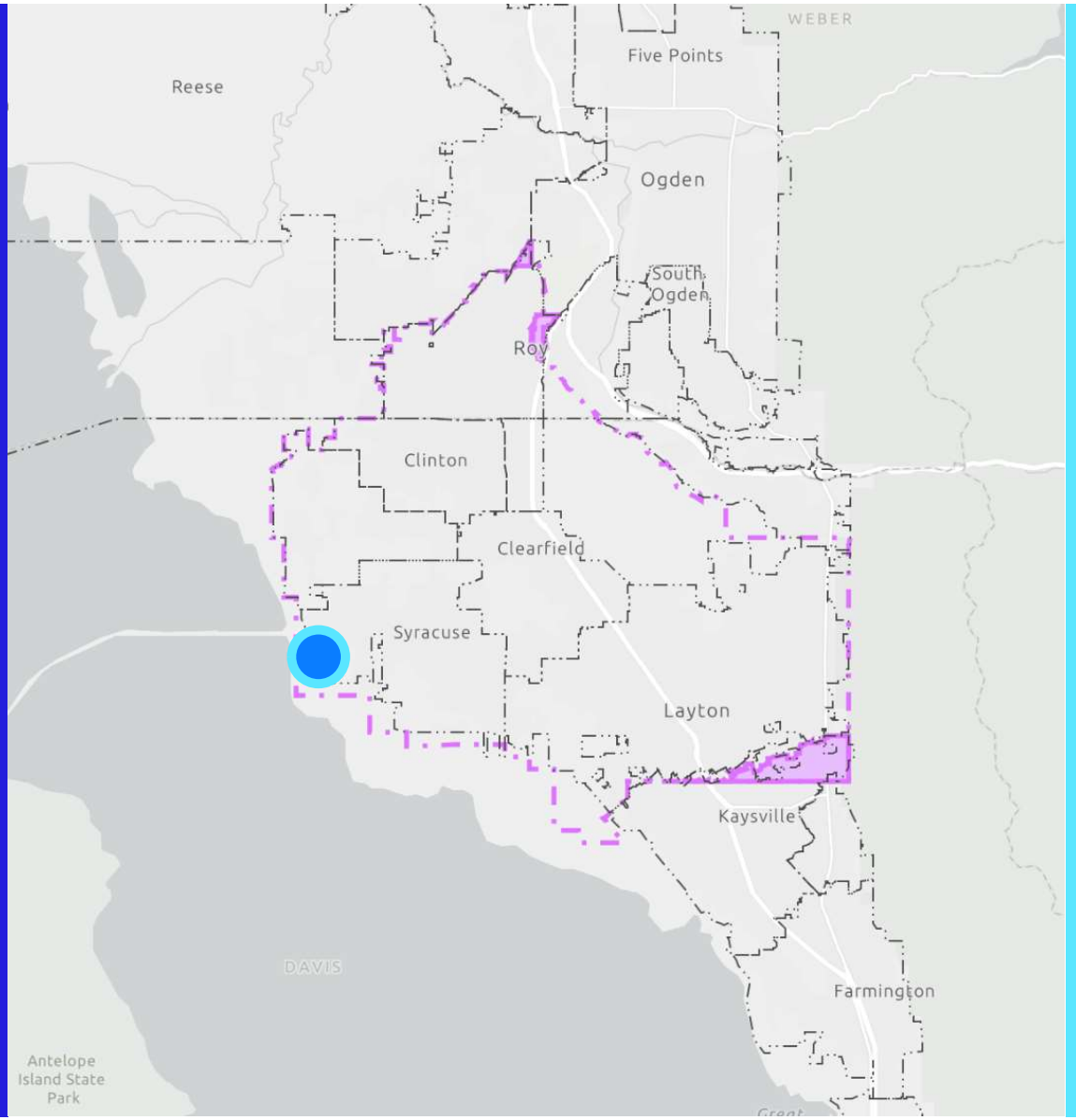
How does this reshape our decisions?



July 25, 2022: ~4189.8ft

North Davis Sewer District

- Serves seven cities in two counties
- 80 square miles
- Population served is approx. 225,000
- 100 miles of sewer collection lines
- 34 MGD treatment plant
- Average annual volume: 22,400 af
- Discharges to Farmington Bay of GSL



Downstream Waterbody

- Water quality in Farmington Bay has been a significant challenge
  - Threats of litigation
  - Algae, odors, dissolved oxygen, harmful algal blooms (HABs)
- Lots of research but questions remained:
  - What are the controlling processes?
    - What roles do external and internal nutrient loading play?
- How to best protect beneficial uses?
  - Loading reductions? Hydrologic controls?

Lots of uncertainty!

- Uncertain discharge limits
  - New 1.0 mg/L phosphorus discharge limit
  - Indication that might be dropped to 0.1 mg/L and new TIN limit
- Will discharge limits help water quality?
- Will improvements need to be torn out and upgraded again?
- What about Great Salt Lake?

A Perfect Storm


Photo credit: Kevin Cowan

1. Continuing water quality concerns in Farmington Bay
   - Algae, odors, dissolved oxygen, harmful algal blooms (HABs)
2. Regulatory uncertainty – how stringent will discharge limits be?
3. A need for water – reuse of effluent
   - NDSD had been considering reuse for more than twelve years
   - Timing is a function of water demand, cost to treat for reuse, and price of water
4. A declining Great Salt Lake

A Nutrient Management Master Plan

"Hedge your Bets" Strategy

- $16M in temporary chemical treatment
- $180M new treatment plant
  - **Reuse of effluent**

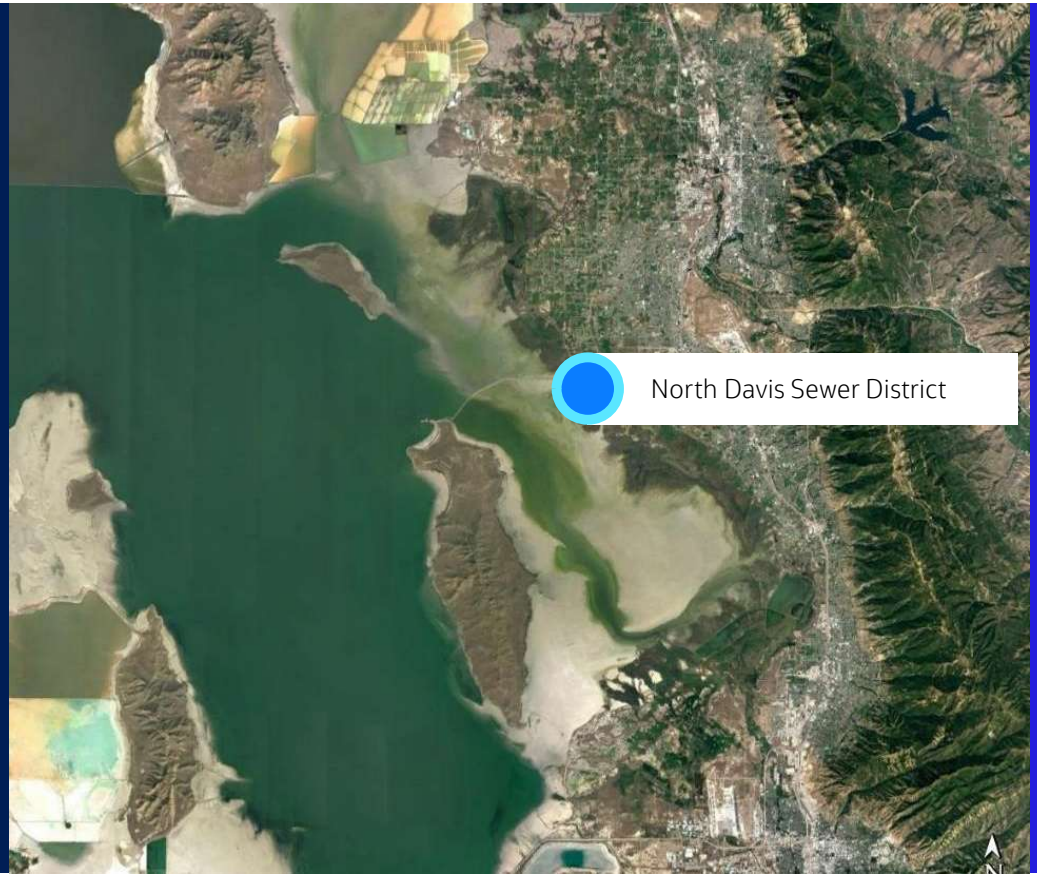
"All in" Strategy

- $180M new treatment plan
  - **Reuse of effluent**

But what about Great Salt Lake?

- "Adaptive" Strategy

What about Great Salt Lake?



- A new WRF likely leads to reuse
- Reduction or loss of flow to Great Salt Lake
- What if we step back and rethink what we are trying accomplish?
- Can we address WQ/HAB risks without the risk of loss of flow?

Poll Question

Has implementation of wastewater reuse in your location had to consider the impact of reduced discharges on the downstream water balance?

A. Yes
B. No

What is the best solution for the system?

- Lots of Tradeoffs:
  - Reduce nutrient loading?
  - Preserve shoreline habitat?
  - Preserving flow into GSL and thus its water levels?
- Engaged all stakeholders
- Developed the science
- Considered all options

An Innovative Approach to Meeting Discharge Limits

Relocating NDSD's Outfall

- Completely eliminates NDSD's nutrient load from Farmington Bay
- Moves NDSD's current nutrient load to Gilbert Bay
  - Less sensitive to nutrients
  - Hypersaline conditions naturally control cyanobacteria
  - Brine shrimp control phytoplankton

Conclusion

- Consensus achieved!
- Outfall 003 was approved by DWQ
- Water will stay in GSL
  - 22,000AF/year
- No enhanced treatment
  - $50M vs $180M
- Pumpstation/pipeline construction is underway, slated for completion in 2024

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