

## HYDROLOGIC CONDITIONS

These drought conditions have significantly depleted Lake Mead's storage.



COLLEGE OF AGRICULTURE & LIFE SCIENCES  
COOPERATIVE EXTENSION

**WATER RESOURCES  
RESEARCH CENTER**

Elevations in Lake Mead over time.

Source: Municipal Leader Magazine, April 2022

# Identifying Pathways to Solutions: Focus on the Lower Colorado River Basin

CSG-WEST Colorado River Forum

Sharon B. Megdal, Ph.D., Director

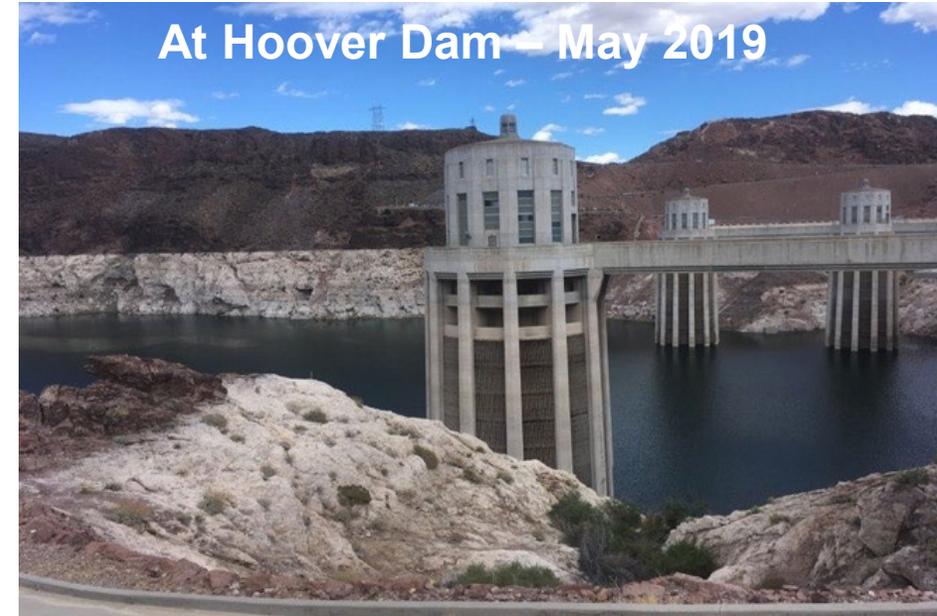
October 18, 2022

smegdal@arizona.edu @SBMWater

wrrc.arizona.edu

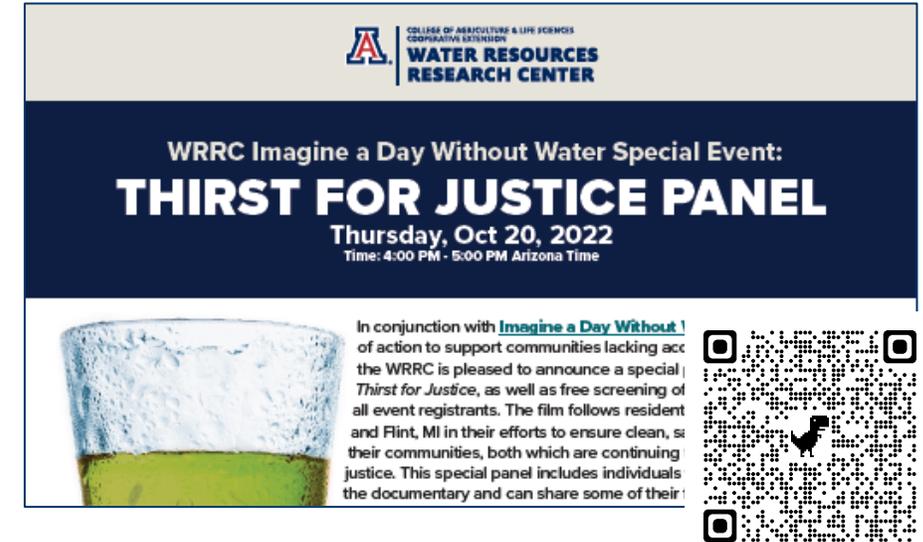
# Outline

- About the University of Arizona Water Resources Research Center (WRRC)
- Focus on Lower Basin
- What shortages mean to AZ
- What was done to prepare
  - Water Banking
  - Drought Contingency Plan agreements
- Pathways to solutions and process



# Bridging academia and the real-world of water management

- Water Resources Research Center (WRRC) is a federally authorized center.
- Mission: We tackle key water policy and management issues, empower informed decision-making, and enrich understanding through engagement, education, and applied research.
- Webinars, annual conference, publications, etc
- Partnerships and respectful dialogues are essential to our work.
- My work focuses on water policy and management.



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**WATER RESOURCES RESEARCH CENTER**

WRRC Imagine a Day Without Water Special Event:  
**THIRST FOR JUSTICE PANEL**  
Thursday, Oct 20, 2022  
Time: 4:00 PM - 5:00 PM Arizona Time

In conjunction with [Imagine a Day Without Water](#) of action to support communities lacking access to clean water, the WRRC is pleased to announce a special screening of the documentary *Thirst for Justice*, as well as free screening of all event registrants. The film follows residents of Flint, MI in their efforts to ensure clean water for their communities, both which are continuing to fight for justice. This special panel includes individuals from the documentary and can share some of their



## Stay Informed

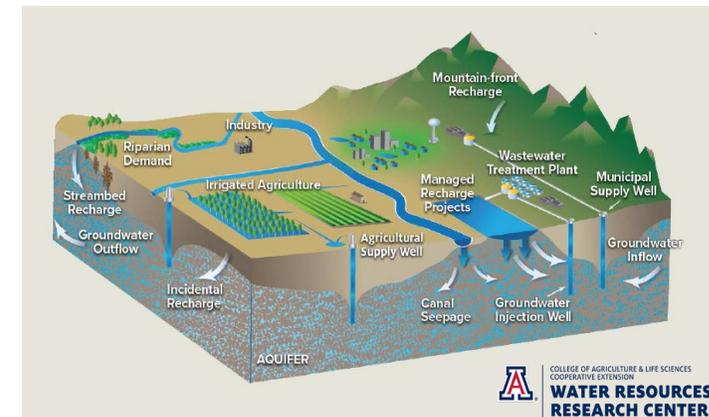
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[wrrc.arizona.edu/subscribe](https://wrrc.arizona.edu/subscribe)



# Water policy and management reflect many determining factors

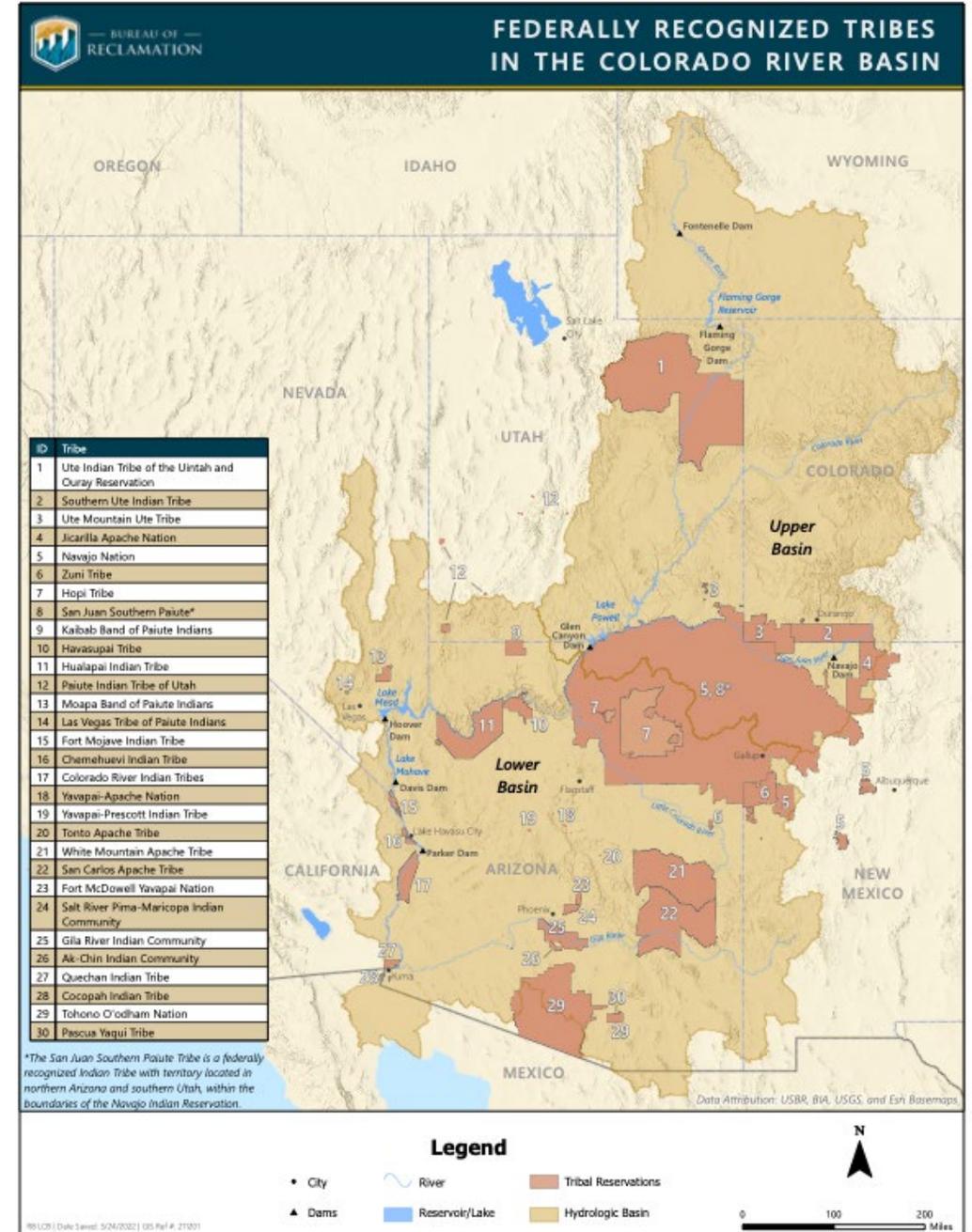
- Resource Availability
- Location of water demands and supplies
- Economics
- Historic and Current Legal/Institutional Framework
- The nature of involvement of multiple governmental and non-governmental entities, including the extent of centralized versus decentralized decision making
- Politics of Area
- Public values and socio-cultural factors
- Historical context
- Information
- Etc...



# Geographic context



W:\480790 CRBS P2\GIS\MapFigs\Chapter\_Figs\March2015\_edits\Figure\_1-1\_v3.mxd Itheyerda 3/20/2015



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# Wicked Water Problems Context

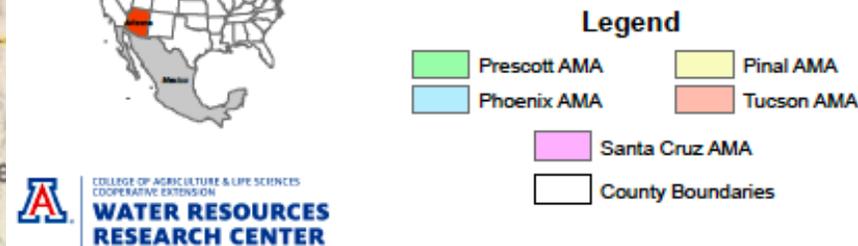
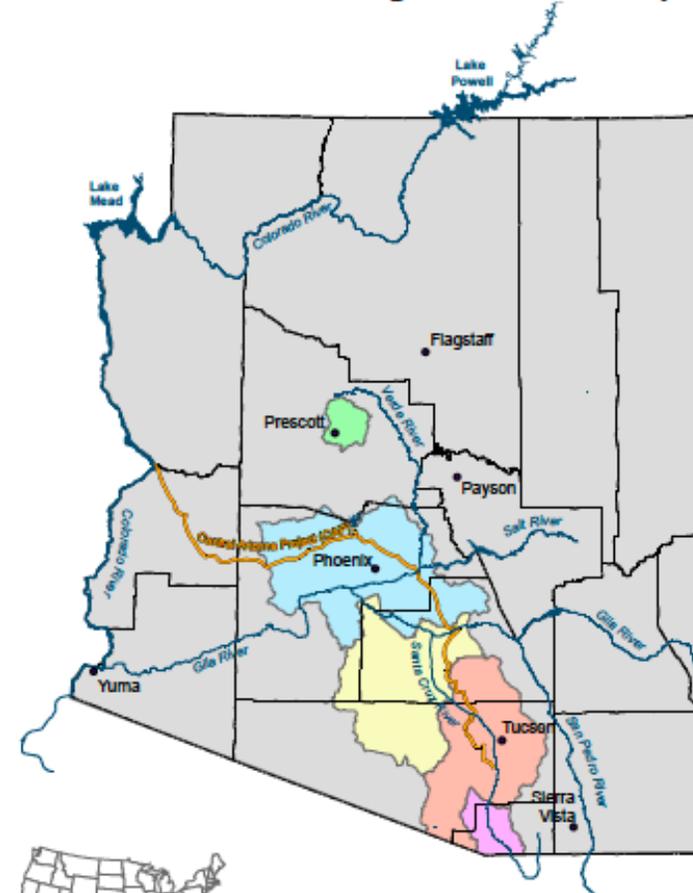
- “Wicked Water Problems” are big problems that do not have a simple pathway to resolving them.
- Some reasons
  - incomplete or contradictory knowledge
  - the number of people and opinions involved
  - the large economic burden
  - the interconnected nature of these problems with other problems [e.g., geopolitics, poverty]
- Collaboration and interdisciplinary work are necessary for addressing Wicked Water Problems.
- Process is important to identifying pathways to solutions.



# Lower Basin and Arizona

## Arizona Active Management Areas (AMA's)

## The Central Arizona Project



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Figure 1. Map of Arizona showing the Active Management Areas and county boundaries.

# Central Arizona Project is vulnerable to shortage

## Colorado River Water Supply Report

System Contents\*: 19.60 MAF

As of September 26, 2022

Last Year System Contents: 23.03 MAF

Reservoir Capacities (MAF)			
Reservoir	Current	Change**	Maximum
Lake Mead	7.32	+ 0.11	25.90
Lake Powell	5.82	- 0.21	23.31
Flaming Gorge Reservoir	2.69	- 0.06	3.75
Fontenelle Reservoir	0.28	- 0.04	0.34
Navajo Reservoir	0.87	- 0.04	1.70
Blue Mesa Reservoir	0.30	- 0.05	0.83
Morrow Point Reservoir	0.12	0.00	0.12
Crystal Reservoir	0.02	0.00	0.03

\*System contents now include Lake Mohave and Havasu

\*\*With respect to previous month's report

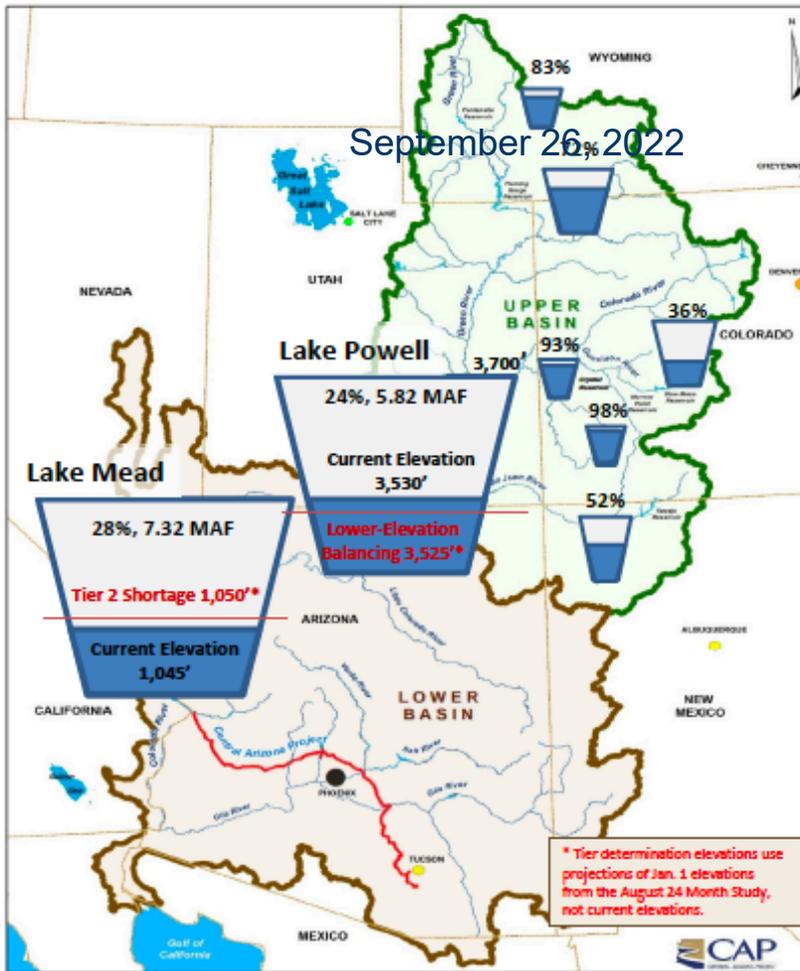


YOUR WATER. YOUR FUTURE.



Elevations in Lake Mead over time.

Source: Municipal Leader Magazine, April 2022



\* Tier determination elevations use projections of Jan. 1 elevations from the August 24 Month Study, not current elevations.

# 2007 Interim Guidelines, Minute 323, Lower Basin Drought Contingency Plan, and Binational Water Scarcity Contingency Plan Total Volumes (kaf)

	Lake Mead Elevation (feet msl)	2007 Interim Guidelines Shortages		Minute 323 Delivery Reductions	Total Combined Reductions	DCP Water Savings Contributions			Binational Water Scarcity Contingency Plan Savings	Combined Volumes by Country <i>US: (2007 Interim Guidelines Shortages + DCP Contributions)</i> <i>Mexico: (Minute 323 Delivery Reductions + Binational Water Scarcity Contingency Plan Savings)</i>					Total Combined Volumes
		AZ	NV	Mexico	<b>Lower Basin States + Mexico</b>	AZ	NV	CA	Mexico	AZ Total	NV Total	CA Total	Lower Basin States Total	Mexico Total	<b>Lower Basin States + Mexico</b>
Tier Zero	1,090 - 1,075	0	0	0	<b>0</b>	192	8	0	41	192	8	0	200	41	<b>241</b>
Tier 1	1,075 - 1050	320	13	50	<b>383</b>	192	8	0	30	512	21	0	533	80	<b>613</b>
Tier 2A	1,050 - 1,045	400	17	70	<b>487</b>	192	8	0	34	592	25	0	617	104	<b>721</b>
Tier 2B	1,045 - 1,040	400	17	70	<b>487</b>	240	10	200	76	640	27	200	867	146	<b>1,013</b>
Tier 2C	1,040 - 1,035	400	17	70	<b>487</b>	240	10	250	84	640	27	250	917	154	<b>1,071</b>
Tier 2D	1,035 - 1,030	400	17	70	<b>487</b>	240	10	300	92	640	27	300	967	162	<b>1,129</b>
Tier 2E	1,030 - 1,025	400	17	70	<b>487</b>	240	10	350	101	640	27	350	1,017	171	<b>1,188</b>
Tier 3	<1,025	480	20	125	<b>625</b>	240	10	350	150	720	30	350	1,100	275	<b>1,375</b>

← 2023 Reductions + Contributions

Ted Cooke slide  
September 16, 2022



The Secretary of the Interior will take affirmative actions to implement programs designed to create or conserve 100,000 acre-ft per annum or more of Colorado River System water to contribute to conservation of water supplies in Lake Mead and other Colorado River reservoirs in the lower basin. All actions taken by the United States shall be subject to applicable law, including availability of appropriations.

# Wicked Water Problem: Water supply-demand imbalances in the Colorado River Basin

## No exaggeration: Record lows at Lake Powell and Lake Mead call for drastic action

Lake Powell's elevation requires immediate protective actions. Everyone will be asked to conserve to delay or reduce further mandatory reductions.

**OP ED** Tom Buschatzke and Ted Cooke 6:00 a.m. MT May 8 Arizona Republic



Interior Secretary Deb Haaland said in a statement that the West's drought is "one of the most significant challenges facing our country" and that the department "is committed to using every resource available to conserve water and ensure that irrigators, Tribes and adjoining communities receive adequate assistance and support to build resilient communities and protect our water supplies."

The question now is whether states and stakeholders will use that money to make the kind of drastic cuts needed to save the river and avoid a full-blown water crisis in the West.

≡ CNN politics

AudioLive TV

### Biden administration outlines plan to pay for Colorado River water cuts as crisis looms

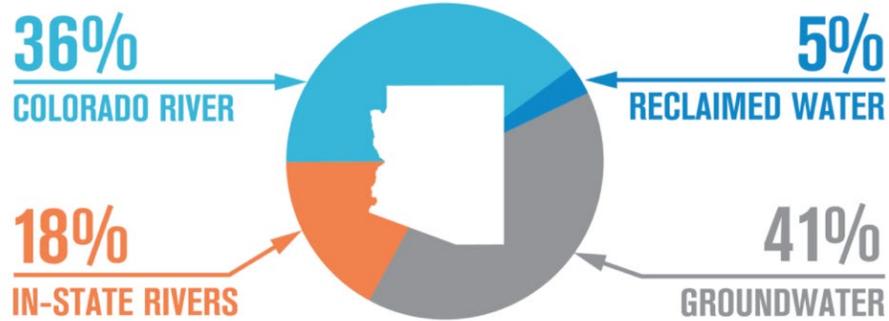
By Ella Nilsen, CNN  
Published 2:23 PM EDT, Wed October 12, 2022

Arizona Department of Water Resources director Tom Buschatzke, one of the main state negotiators, said he is worried too much priority will be given to compensating stakeholders for short-term cuts, instead of demanding long-term water conservation and systemic change.

"I am a proponent of not being in a place where the \$4 billion of IRA money is gone and we haven't created any long-term benefit," Buschatzke said. "That would be the worst outcome of all. The money will be gone."

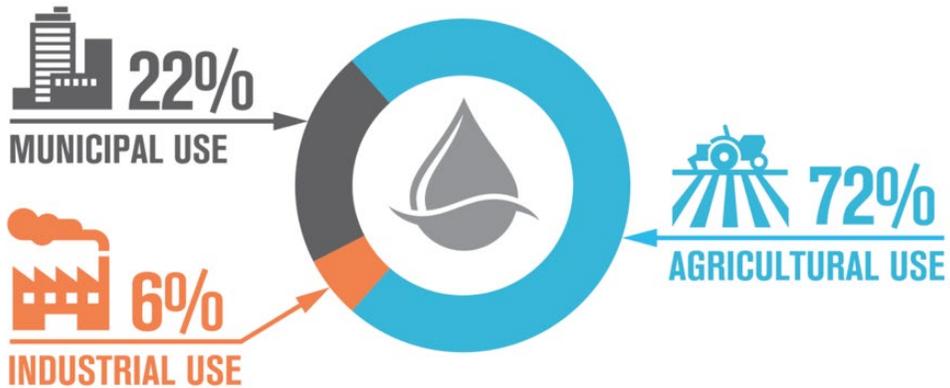
# Related Wicked Water Problem - Groundwater Overdraft

## ARIZONA'S WATER SUPPLY

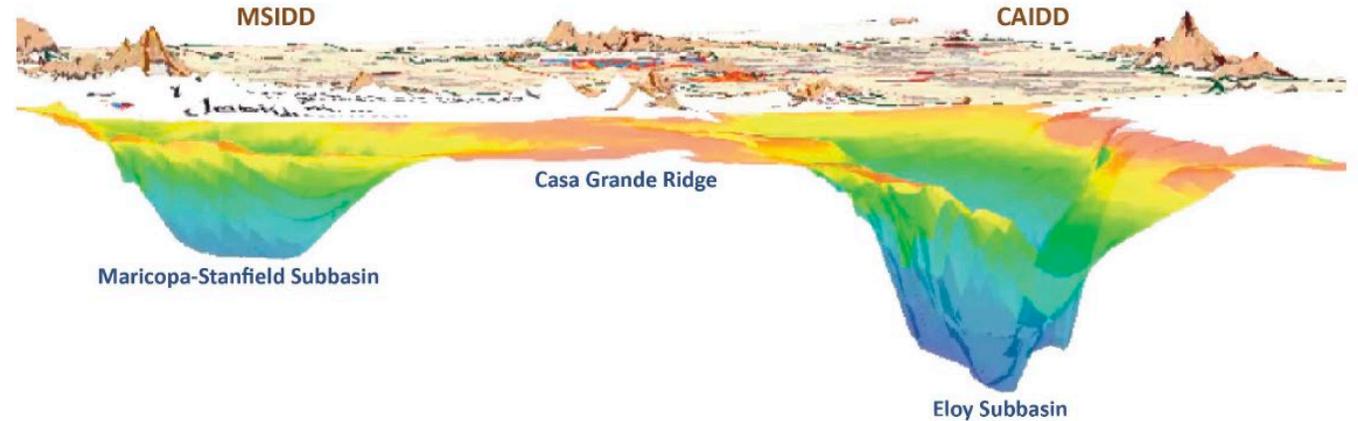


SOURCE: ADWR, 2020

## ARIZONA'S WATER USE BY SECTOR (2019)



SOURCE: ADWR, 2020



5x vertical exaggaration of aquifer extending below land surface  
(vertical scale of aquifer is exaggerated 5x greater than the horizontal scale)

Figure 8. 3-D Representation of the Pinal AMA Aquifer from 2019 ADWR model, extended to 3000 feet below land surface, based on ADWR's 2014 geology update (Seasholes 2020) - Note: the aquifer bottom is modeled to 3000 feet and is deeper in certain areas

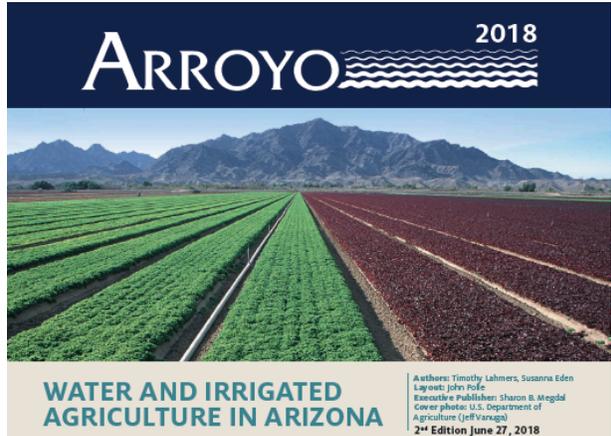
### NEWS

## Ogallala Aquifer on track to 70% depletion in 40-45 years

by: [Hannah Adamson](#)  
Posted: Oct 6, 2022 / 10:42 PM CDT  
Updated: Oct 6, 2022 / 10:42 PM CDT



# About irrigated agriculture



**Introduction**

Why is so much of Arizona's water used to irrigate crops in the desert? A partial answer to this question is that Arizona provides at least two of the three prerequisites for producing crops: ample sunshine, high-quality soils, and adequate water. Although the desert lacks sufficient rainfall to grow most crops, Arizona's rivers have supported agriculture for thousands of years, and aquifers in Arizona's desert valleys hold vast quantities of groundwater. Ongoing drought, coupled with the water demands of a growing population, however, threaten those rivers and aquifers. In this context, it is useful to reexamine irrigated agriculture: its benefits, water using practices, constraints, and trends.

This *Arroyo* seeks to provide a comprehensive picture of Arizona's irrigated agriculture, presenting first a brief history of the state's desert agriculture, followed by profiles of agricultural regions in Arizona, their water sources, uses, and crops. Following sections offer background and discussion on the two major sources of water for irrigated agriculture in Arizona: groundwater and the Colorado River. A description of agricultural water use efficiency and conservation, including new crops that may reduce water application follows. Voluntary fallowing of farmland for water conservation and transfer to other uses is discussed. Collaboration opportunities with university and government agencies on conservation and water efficiency improvements are outlined. The reader will come away with a deeper understanding of how Arizona achieves sustainable food and fiber production in a desert climate.

**What is Irrigated Agriculture?**

Irrigated agriculture involves the controlled application of water to a crop. In semi-arid environments, such as Arizona, irrigation is essential because there

**ARIZONA WATER MAP POSTER**

THE UNIVERSITY OF ARIZONA  
WATER RESOURCES RESEARCH CENTER

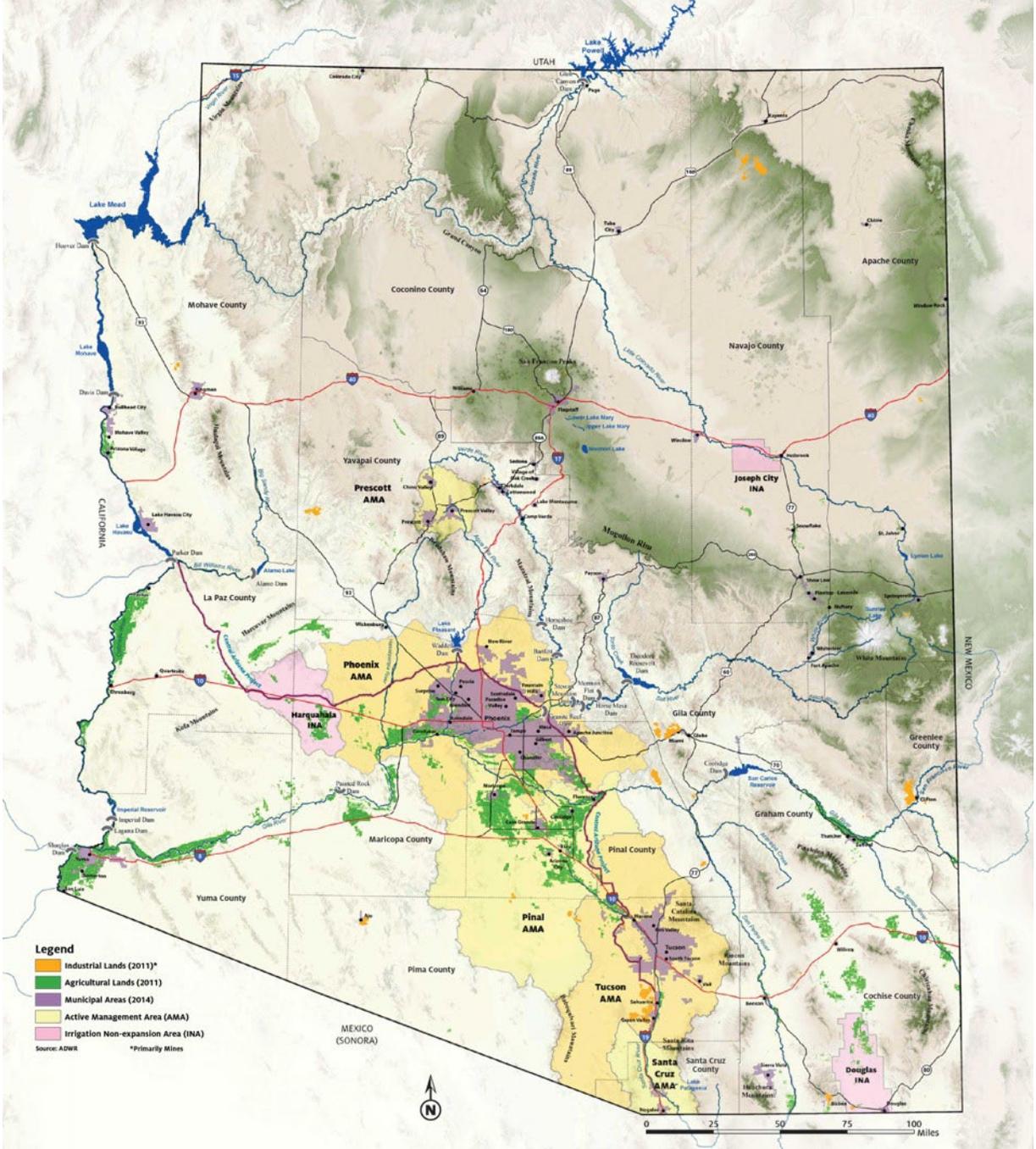
**ARIZONA WATER**

**LAND OWNERSHIP**

**WATER USE BY GROUNDWATER BASIN**

**CO-COARDO RIVER APPROPRIATIONS**

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**OR EMAIL: wrrc@email.arizona.edu**



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<https://wrrc.arizona.edu/publications/arroyo>

# Arizona is a leader in artificial recharge

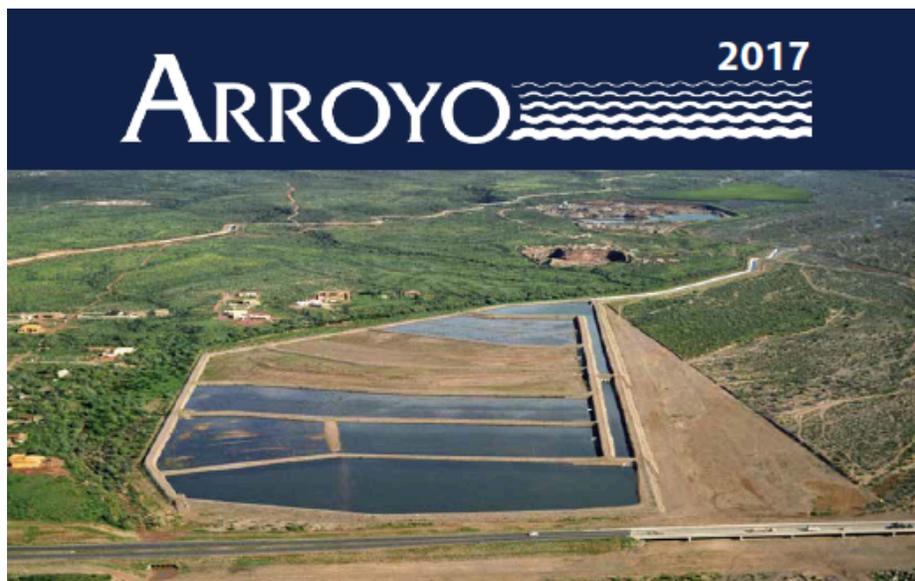
- The process of adding water to an aquifer
  - Natural Recharge results from natural process such as precipitation and streamflow
  - Incidental recharge is water entering the aquifer after various human uses, such as irrigation uses or leaks in water lines
  - Artificial recharge facilities or projects that are developed for the purpose of adding water to an aquifer
  - Artificial recharge used over the years to:
    - Manage groundwater supply
    - Assure full use of Colorado River water allocation
    - ➔ • Protect against shortages during drought - Arizona Water Banking Authority
    - Enable affordable use of Central Arizona Project water
    - For replenishment by the Central Arizona Groundwater Replenishment District (CAGRDR)



<https://wrrc.arizona.edu/publications/arroyo/arroyo-2017-arizona-water-banking-recharge-and-recovery>



Pima Mine Road Recharge Project. South of Tucson <sup>13</sup>



## ARIZONA WATER BANKING, RECHARGE, AND RECOVERY

Authors: Noah Silber-Coats, Susanna Eden  
 Layout: John Polle  
 Executive Publisher: Sharon B. Megdal  
 Cover Photo: Agua Fria Recharge Basins,  
 Central Arizona Project

Throughout this Arroyo, water banking refers to the storage of water underground in natural aquifers for future use. In Arizona, this underground storage is achieved through recharge projects permitted by the Arizona Department of Water Resources (ADWR) through the Underground Storage, Savings and Replenishment Program. When there is a need to use stored water, it is recovered through wells permitted for recovery also by ADWR. While simple in concept, the actual functioning of water banking, recharge, and recovery in Arizona can be very complicated. The purpose of this Arroyo is to describe, in a clear and straight forward way, how water banking, recharge, and recovery actually work.

A decade ago, the Arroyo examined the issue of artificial recharge, reviewing the status of legislation, regulation, and recharge projects in Arizona. While covering some of the same background information, this issue has a broader goal—to describe how all the

elements of water banking, recharge, and recovery operate to provide future water security to Arizona's water users. This Arroyo is organized into seven major sections, beginning with this introduction. The second section discusses groundwater management in Arizona and the Groundwater Management Act of 1980, subsequent amendments and legislation. In the third section, the laws related to water banking, recharge, and recovery are examined. The fourth section provides an overview of the ways in which the laws are translated in practice, drawing on both aggregate statistics and specific examples. The fifth section looks at two important entities in water banking, recharge, and recovery efforts—the Central Arizona Groundwater Replenishment District (CAGR) and the Arizona Water Banking Authority (AWBA). As explained in that section, these two entities serve different purposes and operate according to very different models. The sixth section



The Arroyo is published by the Water Resources Research Center  
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 Email: wrrc@email.arizona.edu; Web Site: wrrc.arizona.edu



Photos (L to R) MAR 5 ceremonial opening, March 2019, and October 2021. Sharon B. Megdal

## Reflections: Water, Recharge, and Life

by Sharon B. Megdal  
 11/12/2021

Managed aquifer recharge (MAR), the term commonly used for the practice of storing water underground, often for later recovery or use, is a widely deployed water management tool. Through legislative action and regulatory programs, Arizona has established a robust program of MAR project permitting and stored water accounting, which facilitates the utilization of MAR. Notably, the Arizona Water Banking Authority has stored millions of acre-feet of Colorado River water in aquifers for recovery during times of shortage. Tucson Water has positioned itself well to deal with cutbacks in Central Arizona Project (CAP) deliveries by relying on recharge and recovery of CAP water to supply its customers and store the water it receives in excess of customer demand. And there are many other examples of how Arizona's storage and recovery framework has enabled cost-effective approaches to meeting water management objectives.



Photo: Gila River MAR 5 interpretive trail, Sharon B. Megdal

On October 22, 2021, approximately 60 people who had attended the WRRRC 2021 Annual Conference, *Tribal Water Resilience in a Changing Environment*, visited the Gila River Indian Community (GRIC)'s MAR 5 recharge project and Gila River Interpretive Trail. Field trip participants learned from GRIC Governor Stephen Roe Lewis how MAR 5 represents the legacy of his late father, Rodney "Rod" Blaine Lewis. Rod Lew is fought for the water that supports the environment, culture, education, and economy of the Community. His vision of reconnecting the Akimel O'odham - River People - to water led to their innovative water projects, of which MAR 5 is just one, though perhaps the most prominent.

# Recent publications



Link [here](#).

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**Watershed  
Restoration**

**Watershed Projects  
Prioritizing**

**& More!**

## MANAGED AQUIFER RECHARGE

MAR AS A MECHANISM TO ADVANCE WATER POLICY GOALS: A PERSPECTIVE

by Sharon B. Megdal, Ph.D.

Director, University of Arizona Water Resources Research Center (Tucson, AZ)

### Introduction

The imbalance between water supply and demand is of growing concern globally. Rarely a day goes by without news about the dwindling surface water supplies, with the Colorado River as the poster child. Coverage of approaches to addressing the supply/demand imbalance is broad, with strategies including augmentation, reuse, market mechanisms, and conservation. The dialogue involves not only diminishing surface water supplies but also the increasing role of, and threats to, groundwater — which accounts for 99% of Earth’s liquid freshwater (UNESCO World Water Assessment Programme 2022, *see* References, below). Not coincidentally, heightened dialogue on groundwater has coincided with World Water Day’s 2022 theme: “Groundwater — Making the Invisible Visible” and the annual *United Nations World Water Development Report* with the same moniker. Next August, the annual Stockholm World Water Week has the theme of “Seeing the Unseen: The Value of Water.” Next December, the 2022 UN-Water Summit on Groundwater will continue 2022’s global focus on groundwater.

A key component of discussions regarding groundwater, including conjunctive management of groundwater and surface water, is managed aquifer recharge (“MAR” — sometimes referred to as artificial recharge). MAR is increasingly being recognized as an important mechanism for addressing water quantity and/or water quality concerns. The 2021 compendium *Managing Aquifer Recharge - A Showcase for Resilience and Sustainability* (2021 Compendium) defines MAR as “intentionally replenishing aquifers to stabilize water storage and improve water quality” (Zheng, Ross et al. 2021, 16). Alternatively, Australia’s National Guidelines for Managed Aquifer Recharge define MAR as “the purposeful recharge of water to aquifers for subsequent recovery or environmental benefit. It is not a method for waste disposal” (Natural Resources Management Ministerial Council, et al. 2009, 1). MAR “... can be done in a myriad of ways that respect other uses of water or harness otherwise wasted water. The enthusiasm for MAR schemes and their popularity and success are enhanced by significant auxiliary benefits such as in protecting against seawater intrusion, improving environmental flows, banking water for drought relief and purifying water through natural processes” (Zheng, Ross et al. 2021, 16). As noted by Dillon et al. in the editorial paper for the volume, *Managed Aquifer Recharge for Water Resilience*: “Managed aquifer recharge... is part of the palette of solutions to water shortage, water security, water quality decline, falling water tables, and endangered groundwater-dependent ecosystems. It can be the most economic, most benign, most resilient, and most socially acceptable solution, but frequently has not been implemented due to lack of awareness, inadequate knowledge of aquifers, immature perception of risk, and incomplete policies for integrated water management, including linking MAR with demand management. MAR can achieve much towards solving the myriad local water problems that have collectively been termed ‘the global water crisis’” (Dillon, Fernández Escalante et al. 2020, 12).

Link [here](#).

# RENEWABLE RESOURCES JOURNAL



VOLUME 37 NUMBER 3

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Congressional Research Service

# Categories of options/solutions/actions

- Conservation
- Greater efficiency
- Water reuse
- Water storage/banking/managed aquifer recharge
- Desalination (augmentation example)
- Moving water
- Marketing and other mutually agreed-upon transactions
- Rainwater and stormwater capture
- Gray water systems
- Designing the built environment

# Process is important to identifying pathways to solutions

- Functioning cooperative mechanism(s)
- Trust and mutual respect
- Involvement of key stakeholders
- Good communication
- Persistence
- Patience
- Sharing experiences and lessons learned
- Eating with your partners
  - This was said before COVID (November 2019), when we stopped meeting with our partners!



# AZ Drought Contingency Plan process established the foundation for current discussions

- Information sharing
- Inclusive approaches
- Everyone is a water stakeholder and a decision-maker influencer
- Education and engagement efforts are key components
- Identifying and implementing pathways to solutions to wicked water problems require broad-based approaches and innovation
- Respectful relationships are key to working through these challenging times.
- But 2019 actions were not enough



# The modified Arizona Water Infrastructure Finance Authority (WIFA)

## Senate Bill 1740

<https://azgovernor.gov/print/5911>

- The legislation appropriates more than \$1 billion to the Water Infrastructure Finance Authority (WIFA) and expands it with new responsibilities to provide loans and grants to water providers and entities for the purposes of importing water into Arizona, conservation, efficiency and reuses, and new technologies.
- “Challenges bring opportunity,” said Arizona Department of Water Resources Director Tom Buschatzke. “This expansion of WIFA creates an opportunity for the state to secure its water future.

### Gov. Ducey Appoints Four WIFA Board Members

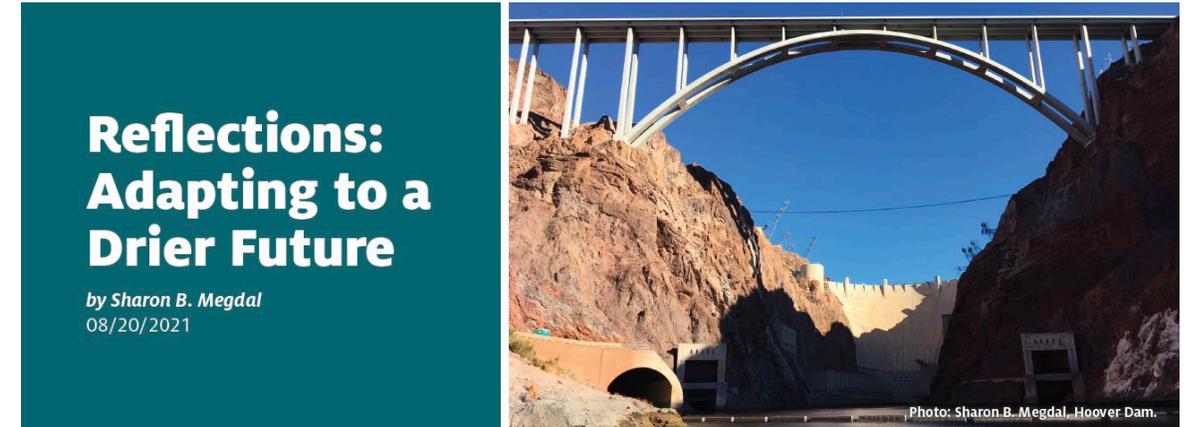
On October 3, Arizona Governor Doug Ducey announced the appointment of four members to the new Water Infrastructure Finance Authority (WIFA) Board. The board, which will have nine members appointed by the Governor and State Legislature, will be responsible for awarding loans and grants to Arizona water providers and other water entities for the purpose of bringing new water into the state, developing water-saving technologies, or improving water use efficiency. The Governor stated, “Now, with the right team, we’re positioned with \$1.4 billion to secure our state’s water future for the next 100 years.” Ducey’s appointees include David Beckham, Buchanan Davis, Jonathan Lines, and Andy Tobin. The President of the Arizona Senate and the Senate Minority Leader have also selected their respective appointees. The WIFA board has three vacancies yet to be filled; the Speaker of the House and House Minority Leader will each choose an appointee, and the Governor will make one additional selection from a list of nominees provided by the House Speaker and Senate President. The President of the Arizona Senate and the Senate Minority Leader have already selected their respective appointees.



WRRC Weekly Wave, October 14, 2022

# Colorado River Basin

- Big cutbacks in Colorado River water deliveries => impacts to all states and all water using sectors
- Impacts other water supplies as well (e.g. groundwater)
- Short, intermediate, and long-term actions are needed
- An informed public, who knows where their water comes from, is essential
- What can I/we do?
- Process matters



## Reflections: Adapting to a Drier Future

by Sharon B. Megdal  
08/20/2021

Photo: Sharon B. Megdal, Hoover Dam.

**O**n August 16, 2021, the United States Bureau of Reclamation announced a Tier 1 Shortage to go into effect on January 1, 2022. This



Aerial view of the Colorado River, near Parshall, Colorado in September 2020. (Photo: Mitch Tobin, The Water Desk)

## Reflections: The Colorado River Is Not Waiting

by Sharon B. Megdal  
08/26/2022

**T**he week of August 15 was full of news about the Colorado River. As announced by US Bureau of Reclamation Commissioner Camille Calimlim Touton in mid-June, Monday, August 15, was the deadline for the seven

# About optimism



[Link](#)

- Optimistic that we will get where we need to be
- Failure is not an option.
- We must adapt

# Words quoted not long ago by Dr. Tom Meixner about hope and optimism

A Celebration of Life and Love

**Thomas Meixner**

July 29, 1970 – October 5, 2022



**St. Cyril of Alexandria Catholic Church**  
Friday, October 14, 2022

“Hope is not optimism,  
which expects things to  
turn out well, but  
something rooted in the  
conviction that there is  
good worth working for.”

Attributed to Seamus Heaney, paraphrasing  
Vaclav Havel

Thank you  
[smegdal@arizona.edu](mailto:smegdal@arizona.edu)