BAY AREA WATER SUPPLY AND CONSERVATION AGENCY
BOARD OF DIRECTORS MEETING

May 7, 2025

Correspondence and media coverage of interest between April 23, 2025 and May 5, 2025

Correspondence

From:	Dave Warner
To:	Tom Smegal, BAWSCA CEO/General Manager
Date:	April 18, 2025
Subject:	Design Drought and an 8.5 year alternative 2025-04, and 8 year drought opinion by Alex Dufour

From:	Spreck Rosekrans
To:	Kate Stacy, SFPUC Commission President Dennis Herrera, SFPUC General Manager
cc:	Tom Smegal, BAWSCA CEO/General Manager
Date:	April 4, 2025
Subject:	Groundwater banking in the Central Valley

Press Release/Statement

From:	California Department of Water Resources
Date:	April 29, 2025
Subject:	State Water Project Allocation Increases As Winter Runoff Flows into California's Reservoirs

From:	Sites Project Authority
Date:	April 26, 2025
Subject:	Updated operations analysis finds water for more than 3 million people could have been captured if Sites Reservoir were operational today

From:	Tom Smegal, BAWSCA CEO/General Manager
Date:	April 10, 2025
Subject:	Statement Supporting the Timely and Continued Evaluation of the Tuolumne Healthy Rivers and Landscapes (HRL) Proposal by the State Water Board

Water Supply Conditions:

Date:	May 1, 2025
Source:	Courthouse News Service
Article:	California marks third year of decent Sierra snowpack

Date:	April 27, 2025
Source:	California Water Blog
Article:	Wet Season's end for Water Year 2025

Water Management:

Date: May 2, 2025
Source: Grist News
Article: How California's farmers can recharge the aquifers they've drained

Date: April 29, 2025
Source: Inside Climate News
Article: USGS Water data centers may soon close, threatening states' water Management

Date: April 23, 2025
Source: UCLA Anderson Review
Article: The New Math of Reservoir Management Amid Climate Change

Date: April 25, 2025
Source: Water Blueprint for the San Joaquin Valley
Article: The Critical Role of Airborne Snow Observatory Flights in Managing California's Water Future

Date: April 24, 2025
Source: Water and the West
Article: 'We need to plan for a more water-resilient future:' Q&A with Richard G. Luthy, urban water expert

Date: April 23, 2025
Source: Department of Water Resources
Article: DWR Teacher Workshops Increase Access to Water Education

Water Policy:

Date: May 5, 2025
Source: Public Policy Institute of California
Article: How California Partners with the Federal Government on Water Infrastructure

Date: April 30, 2025
Source: Lake County News Reports
Article: Environmental panel approves bill calling for tribal input on water projects

Date: April 29, 2025
Source: Public Policy Institute of California
Article: How California Partners with the Federal Government on Water and Weather Forecasts

Lourdes Enriquez

From: Dave Warner <dwar11@gmail.com>
Sent: Friday, April 18, 2025 9:59 AM
To: Tom Smegal
Cc: Peter Drekmeier
Subject: The design drought and an 8.5 year alternative
Attachments: The design drought and an 8.5 year alternative 2025-04-18.pdf; Alex Dufour 8 year drought opinion 2019.pdf

Hi Tom,

Wishing you a happy Easter! I included you as a cc on the attached letter to the SFPUC Commissioners. It's similar to the letter I wrote for your March 19th Board meeting, but goes in a little more depth, including mentioning that switching to the alternative 8.5 year drought model would equate to more than twice the amount of water needed to make Santa Clara and San Jose permanent customers.

Please forgive me if I am out of place with this, but if the BAWSCA Board becomes interested in wanting the SFPUC to do a risk analysis on various drought models and if you haven't already done so, it might be worth either you or Tom Francis reading section 2.2.3 of the LTVA where it reviews the climate workshop held with 9 climate scientists. My read is that as a group they agree on warming but are not sure about precipitation changes particularly as they move further in the future, from 2040 to 2070. For me 2.2.3 is better context for climate change risk rather than snippets I or others say.

The LTVA can be found here:
https://www.sfpuc.gov/sites/default/files/about-us/policies-reports/LTVA_AdaptationPlanSFPUC_Phase1.pdf

One other data point: Alexis Dufour who was the project manager for the LTVA (and is no longer with the SFPUC), presented the attached slide at a San Francisco Mayor's Bay Delta Plan stakeholder group meeting in 2019. While section 2.2.3 of the LTVA mentions that climate scientists were asked about their confidence level in their predictions, the report doesn't provide that data. This slide gets at the confidence level aspect. No scientist had high confidence in their predictions at least for this question for 2070.

Best regards,

Dave

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Please note that the data here should not be relied upon, but instead considered as a framework for staff to investigate. It was prepared using information publicly available, along with estimates and assumptions. Staff will have a much greater depth of expertise and access to data.

April 18, 2025

Re: The Design Drought and an 8.5 year Alternative Model

Dear Commissioners,

There's a simple 8.5 year alternative to the design drought that would increase firm yield (available annual supply) by 25 mgd. To put 25 mgd in context, this is more than twice the amount needed to make Santa Clara and San Jose permanent wholesale customers. If demand continues to decline or stay flat then the SFPUC, like the San Diego County Water Authority, will want to sell more water to try to hold down the per acre foot price. Or if demand increases, 25 mgd would reduce needed alternative water supplies (AWS) by the same amount, where the currently unplanned capital cost for 25 mgd ranges from $1.25 billion to $5.0 billion[1]

The Alternative 8.5 year drought model compared to the design drought

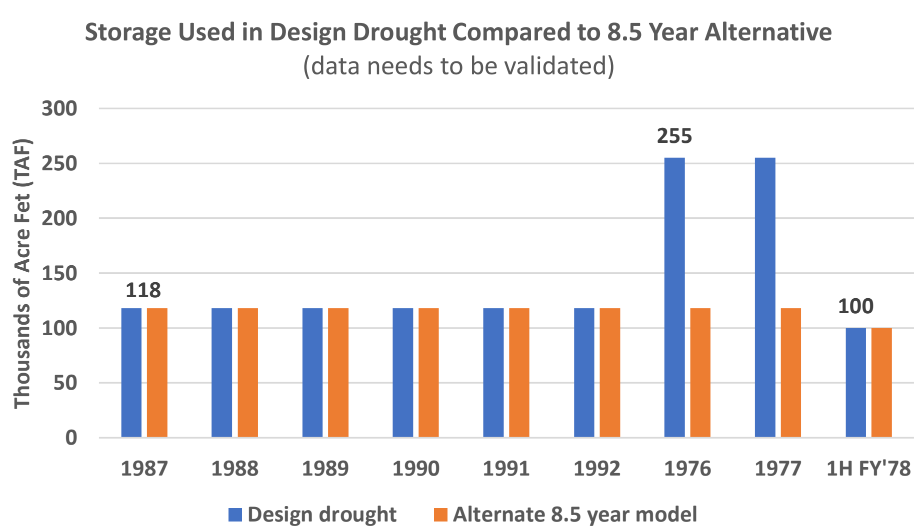

Figure 1: Comparison of the design drought model to the alternative 8.5 year model. Note the only difference between the two models is the amount of storage used in the last full two years.

[1] The most recent AWS Plan estimated average capital cost per mgd of supply in the $200 million range for a total capital cost for 25 mgd coming to $5 billion.. Other larger scale recycled water projects in California have a capital cost closer to $50 million per mgd for a total capital cost for 25 mgd coming to $1.25 billion.

The alternative 8.5 year drought model has just one difference with the design drought model.

The Design Drought

As you know, the 8.5 year design drought is composed of two droughts, the 1987-92 drought plus the 1976-77 drought plus a half year to account for precipitation not arriving until the winter[2].

Using an annual supply of 240 mgd, the 1987-92 drought would have required 707 thousand acre feet (TAF) of water from storage[3] for an average annual storage needed of 118 TAF.[4] The 1976-77 drought would have required 510 TAF of storage[5] for an annual average storage used of 255 TAF.[6] When adding in the last half year of storage used, total storage needed comes to ~1,350 TAF.

The Alternative 8.5 year model

The alternate 8.5 year model uses the same amount of storage as the design drought for the first 6 years. But for the last two full years of the design drought, instead of using the much more severe 1976-77 drought, it continues for two more years of the average annual storage used for the 1987-92 drought. Total storage needed drops to ~1,100 TAF, about 250 TAF less than the design drought.

This difference can be seen graphically in figure 1.

The Benefit: The RWS would support demand of 198 mgd

Reducing storage needed from 1,350 TAF to 1,100 TAF to survive an 8.5-year drought increases available supply or firm yield from 152 mgd to 177 mgd, under the assumption the Bay Delta Plan is implemented as is. Factoring in the impact of the SFPUC's rationing methodology, firm yield of 177 mgd supports demand at 198 mgd.[7]

The Alternative 8.5 year model is low risk

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[2] The drought years are measured from July 1 to June 30th, rather than on a calendar year or water year basis.
[3] Per table 3-9 on page 70 of the SFPUC's Long Term Vulnerability Assessment (LTVA).
[4] 118 = 707 ÷ 6
[5] Ibid.
[6] 255 = 510 ÷ 2
[7] The rationing methodology contemplates that as storage levels decrease, 10% rationing is implemented and later increased to 20% rationing. At a demand level of 170 mgd, the rationing policy would save 18 mgd of supply and at a demand level of 198 mgd the rationing policy would save 21 mgd.

The SFPUC's Long Term Vulnerability Assessment (LTVA) provided extensive analyses regarding drought risk, although it did not specifically discuss risk associated with the design drought. However, estimates could be derived.

Climate change impact to the RWS

Precipitation: **The LTVA found "no clear direction of change in mean annual precipitation over the planning horizon [2050 & 2070]** ."[8] For the 9 climate scientists engaged in the associated workshop, the median response for the "most likely" estimates for 2070 was no change in mean annual precipitation, although the estimates ranged from 10% decline in precipitation to 5% increase.[9]

Temperature: The LTVA found, "there is a central tendency of warming of +2°C and +4°C by 2040 and 2070."[10] Curiously the LTVA found droughts to become rarer with warming temperatures.

Using data from the LTVA or engaging the research teams that produced the LTVA, the SFPUC should be able to estimate return periods for both the design drought and the alternative 8.5 year model suggested here. My own analysis suggest that the alternative 8.5 year model has an estimated return period of 1,000 years or more even with planning for a 10% reduction in precipitation by 2070.

How 250 TAF less storage increases firm yield by 25 mgd

Reducing needed storage by 250 TAF means that an additional 250 TAF is available either for consumption or could be applied to towards meeting Bay Delta Plan required flows. Spreading out 250 TAF evenly over the 8.5 years equates to additional water available of 29 TAF per year or 25 mgd. The latest AWS Plan states that available supply or firm yield of the RWS is 152 mgd with the Bay Delta Plan in effect. An additional 25 mgd means that firm yield increases to 177 mgd which translates into to supporting 198 mgd of demand when considering the impact of the SFPUC's rationing methodology.

The importance of understanding design drought risk

The idea of the 8.5 year alternative drought model highlights the importance of understanding design drought risk. If another reasonable 8.5 year drought model

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[8] LTVA page xxii in first bullet under ES.4 Results, assumes Representative Concentration Pathway (RCP) 8.5, the highest baseline climate change scenario.

[9] Table 2-2 of the LTVA under the 2070 RCP8.5 climate change scenario.

[10] LTVA page xxii in first bullet under ES.4 Results, assumes RCP 8.5.

can increase supply and reduce costs through either reducing the need for AWS or adding permanent customers, it's worth understanding the risk tradeoff between the models.

Please ask staff for a risk analysis/drought probability for both the design drought and the alternative 8.5 year model.

Please also ask for an update to the climate science workshop that was a foundational part of the LTVA. The last one was done in 2019. Climate science continues to advance.

A combination of a risk-based drought planning model and regular updates to RWS climate change risk as done in the LTVA, is our best way of ensuring water supply reliability while preventing unnecessary costs and taking only what we need from the river.

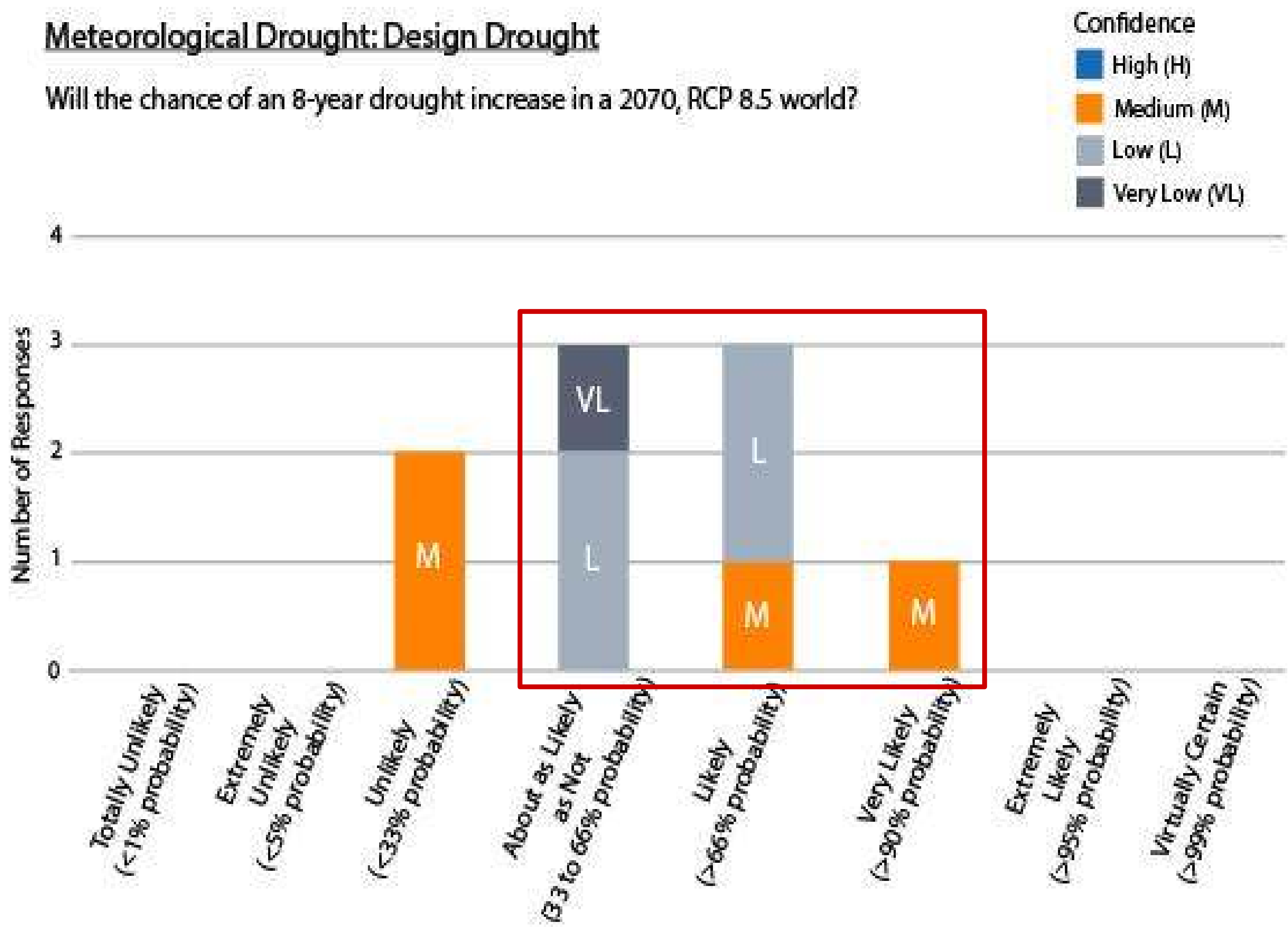
Kind regards,

Dave Warner

cc: Dennis Herrera, SFPUC General Manager
Steven Ritchie, SFPUC Assistant General Manager, Water Enterprise
SFPUC Citizens' Advisory Committee
Tom Smegal, BAWSCA CEO

Hetch Hetchy Regional Water System

Will the chance of an 8-year drought increase in 2070?



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RESTORE HETCH HETCHY
Yosemite National Park

3286 Adeline St. Suite 8
Berkeley, California 94703
510.893.3400
Tax ID # 77-0551533

April 4, 2025

Kate H. Stacy, President
Dennis Herrera, General Manager
San Francisco Public Utilities Commission

Subject: Groundwater banking in the Central Valley

Dear President Stacy and General Manager Herrera:

I am writing again to encourage the San Francisco Public Utilities Commission to pursue opportunities to bank groundwater in the Central Valley.[1] Groundwater banking has the potential, at relatively low cost, to improve SFPUC water supplies while simultaneously helping agricultural communities to address critical aquifer overdraft. Improved supplies could then be used in a number of ways, including as a hedge against drought, to accommodate growth or for environmental enhancement.

Groundwater banking has been the most popular and successful approach for water supply investments in California for the last three decades, even before our landmark Sustainable Groundwater Management Act was passed in 2014. Farmers have invested in groundwater banking for their own use, and cities have invested in groundwater banking in rural areas (see attachment 1).

The SFPUC's Regional Groundwater Storage and Recovery Project (RGSR) is an excellent groundwater banking program, but it only provides a maximum of 61,000 acre-feet in additional storage. There is far greater opportunity in the much depleted "cone of depression" within the Eastside Water District – not far from the Tuolumne River and the SFPUC's San Joaquin Pipelines (see attachment 2).

In a 1993 study the SFPUC's own consultants described groundwater banking in the Eastside Water District as "ideal", but ranked the opportunity only as "fair" because of "institutional complexity".[2] While institutional complexity no doubt continues to be a challenge, California's Sustainable Groundwater Management Act has provided strong incentives for farmers in the Central Valley to find ways to recharge their aquifers.

Excess water in the Tuolumne watershed is often available for groundwater recharge. For example, the river's annual flow, measured at Modesto, exceeded 1,000,000 acre-feet in 6 of the last 20 years (see Attachment 3). While some of those flows certainly provided important environmental benefits to the lower Tuolumne River and to the Sacramento-San Joaquin Delta, there could have been significant diversions for groundwater recharge that would have benefited both farming communities and SFPUC customers.

It is time to realize the substantial opportunity to improve water supply at low cost, and to address institutional address challenges directly and in good faith. The San Francisco Public Utilities Commission should engage Stanislaus County interests, including the Eastside Water District, the Turlock and Modesto Irrigation Districts, and the East Turlock Groundwater Sustainability Agency to develop and implement a groundwater recharge plan that would benefit all parties.

It is in everyone's interest to pursue this low hanging fruit as so many other California water agencies have done successfully.

Sincerely,

Spreck Rosekrans
Executive Director

CC:

Alicia John-Baptiste, Mayor's Chief of Infrastructure, Climate, and Mobility
Tom Smegal, Chief Executive Officer/General Manager, BAWSCA
Tom Chambers, Chair, BAWSCA
Peter Drekmeier, Tuolumne River Trust
Sarah Woolf, General Manager, Eastside Water District
Karla Nemeth, Director, California Department of Water Agencies

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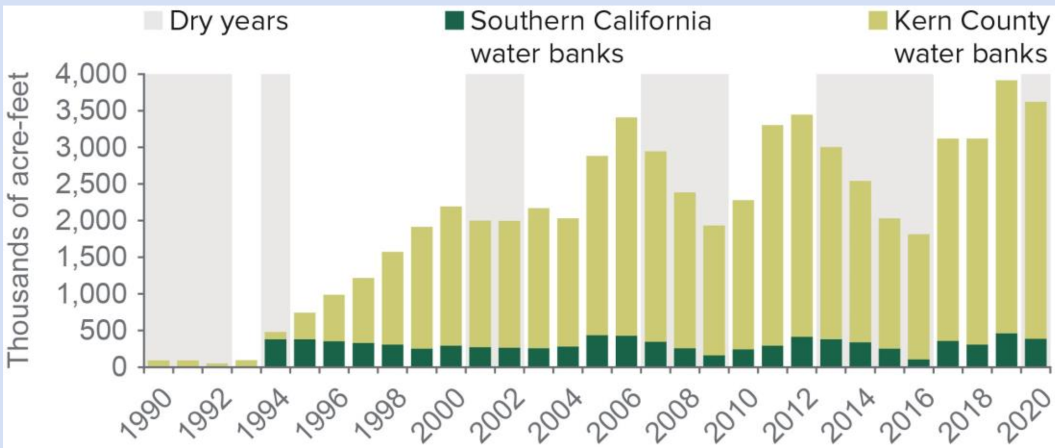
[1] Previous communications include Restore Hetch Hetchy Comments on SFPUC Alternative Water Supply Plan (2023-8-25), RHH Groundwater Banking Presentation for Bay Area Water Stewards (2023-9-15), Group Flood-MAR letter re Tuolumne watershed (2024-7-16), in person meetings with staff and commissioners as well as public comments during Commission meetings.

[2] City and County of San Francisco Hetch Hetchy Water and Power, Reconnaissance Evaluation of Alternative Sites for Groundwater Banking, Bookman-Edmonston Engineering Inc, and Luhdorff and Scalmanini Consulting Engineers, unpublished work July 1993

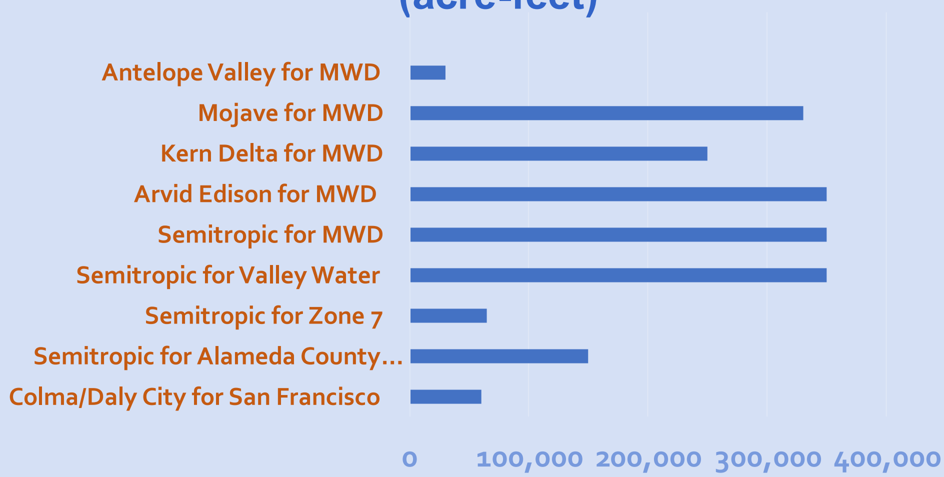
Kate H. Stacy, President & Dennis Herrera, General Manager
San Francisco Public Utilities Commission
April 4, 2025
Groundwater banking in the Central Valley
Attachment 1

RESTORE HETCH HETCHY
Yosemite National Park

PPIC groundwater "banking" data: ag and urban



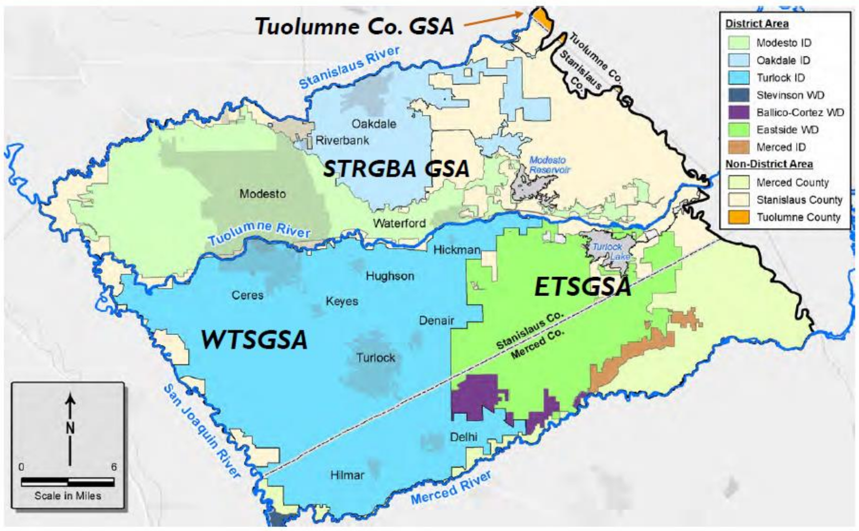
Selected Groundwater Banking Projects for Urban Water Agencies in California (acre-feet)



Kate H. Stacy, President & Dennis Herrera, General Manager
San Francisco Public Utilities Commission
April 4, 2025
Groundwater banking in the Central Valley
Attachment 2

RESTORE HETCH HETCHY
Yosemite National Park

GROUNDWATER SUSTAINABILITY AGENCIES (GSAs) AND LOCAL AGENCIES / URBAN AREAS

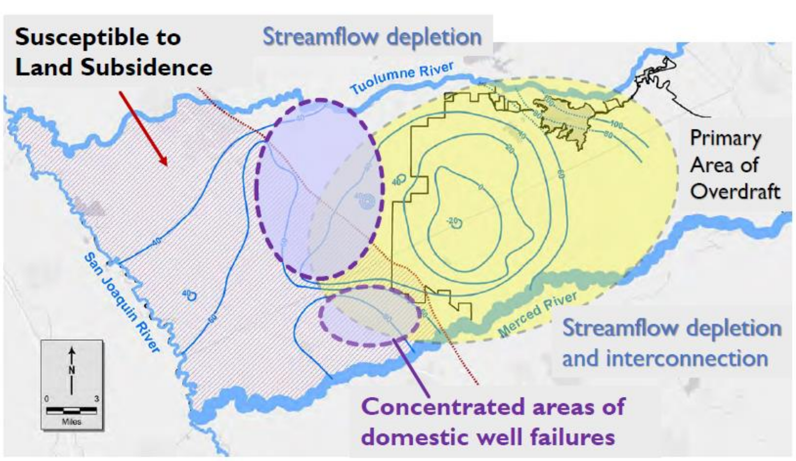


- Two GSAs in each Subbasin
- Tuolumne Co. GSA participates through agreement with Stanislaus County
- Many agencies overlap both subbasins:
  - Stanislaus County
  - City of Modesto
  - Waterford/Hickman
- Shared water resources from the Tuolumne River

TODD GROUNDWATER

SUSTAINABILITY CONSIDERATIONS

TURLOCK GROUNDWATER

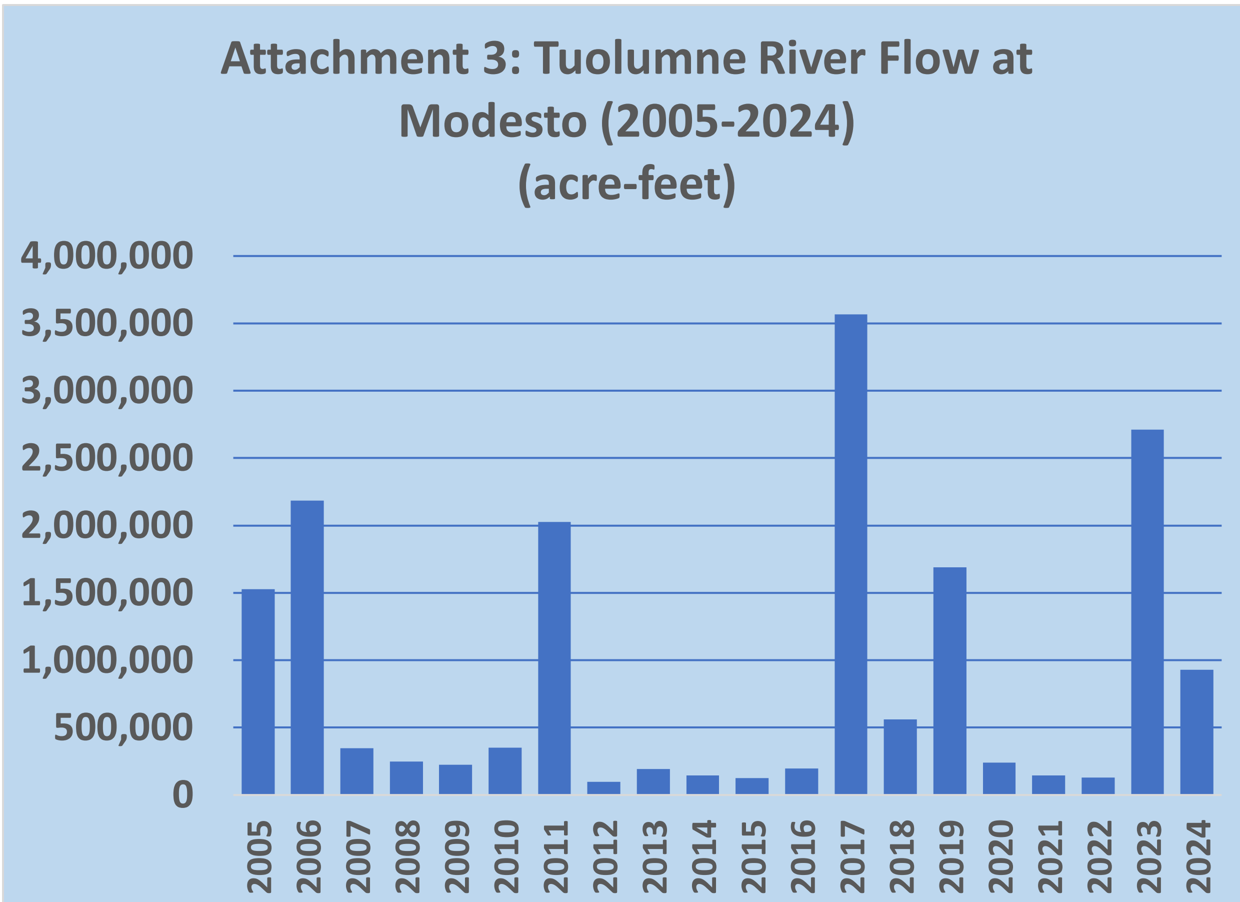


- Declining groundwater levels and overdraft
- Water supply well impacts
- Streamflow depletion and possible disconnection along the Merced River
- Streamflow depletion on Tuolumne River
- Corcoran Clay and associated compressible clay layers susceptible to land subsidence

DRAFT

TODD GROUNDWATER

Kate H. Stacy, President & Dennis Herrera, General Manager
San Francisco Public Utilities Commission
April 4, 2025
Groundwater banking in the Central Valley
Attachment 3



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News Releases
April 29, 2025

Contact:
Ryan Endean, Public Affairs Office, Department of Water Resources
media@water.ca.gov

State Water Project Allocation Increases as Winter Runoff Flows into California's Reservoirs

San Luis Reservoir is seen from B.F. Sisk Dam in Merced County, California. Photo taken April 15, 2025.

SACRAMENTO, Calif. – As snow begins to melt in the mountains and make its way to California reservoirs, the Department of Water Resources (DWR) today announced an increase to the State Water Project allocation forecast for 2025. The allocation has increased to 50 percent of requested water supplies, up from 40 percent last month. The State Water Project provides water to 27 million Californians and 750,000 acres of farmland.

California's snowpack peaked on April 4 at 100 percent for the season. With the weather warming up, that snowpack is now starting to melt and flow into California's watersheds and further filling up reservoirs. Lake Oroville, the State Water Project's largest reservoir, is 120 percent of average for this date and 95 percent full. DWR anticipates that Lake Oroville could reach capacity this spring, which would mark the third straight year the reservoir has filled. San Luis Reservoir in Merced County, a critical storage space for Southern California water, is 101 percent of average for this date and 83 percent full.

"This winter, water managers were able to navigate extreme swings between wet and dry conditions thanks in part to new operating permits that allow increased flexibility in operations to move water into storage while protecting endangered species," said DWR Director Karla Nemeth. "Our full reservoirs will allow us to help meet the needs of the State Water Project contractors and their customers this year as well as provide some water supply next year in the event that dry conditions return."

California's water system is complex and requires real-time adjustments to balance the needs of our state's cities and farms and the natural environment. Earlier this month, the State Water

Project reduced pumping in the Sacramento-San Joaquin Delta to minimum levels to protect endangered fish species. These reductions are required as part of the operating permit for the State Water Project. Operators will likely maintain that lower rate through the end of May unless San Joaquin or Sacramento River flows increase beyond certain high-flow thresholds.

These constraints reinforce the need for California to invest in additional water supply infrastructure to provide operational flexibility. The proposed Sites Reservoir and Delta Conveyance Project would have been hugely beneficial to water supply had they been in place this season. The Delta Conveyance Project could have captured more than 867,000 acre-feet of additional water supply this winter, which would have translated to a 20 percent increase in the current State Water Project allocation, on top of the increase announced today.

Each year, DWR provides allocation forecasts based on available water storage, projected water supply, and water demands. Learn more about how the State Water Project allocation process works at https://water.ca.gov/News/Blog/2025/Jan-25/Get-the-Facts-About-the-State-Water-Project-Allocation.

The allocation forecast notice to State Water Contractors and historical data on SWP allocations are available at https://water.ca.gov/programs/state-water-project/management/swp-water-contractors.

# # #

PRESS RELEASE:
Sites Project Authority
April 26, 2025

Updated operations analysis finds water for more than 3 million people could have been captured if Sites Reservoir were operational today

The Sites Project Authority (Authority) announced that during this wet weather season, Sites Reservoir could have captured more than 550,000 acre-feet of water from late November 2024 through early April 2025. These results continue to show that there is water available in the Sacramento River that could be diverted in a safe and protective manner, providing new water supplies for dry years. Also, these operations simulations build confidence that the performance of the project can meet funding expectations.

“Once again, we’re seeing how well Sites Reservoir would perform during wet periods if it were operational today, by capturing and storing water for drier periods,” said Fritz Durst, Chair of the Sites Project Authority Board of Directors. “We know California will continue to experience more intense and wetter storms and there will be longer and drier periods that follow, so we need to have additional storage in place to capture water when it comes so it’s there when we need it.”

Sites Reservoir is specifically designed to capture and store water during wet periods to increase water flexibility, reliability, and resiliency in drier periods. The analysis, based on actual river flows, found Sites Reservoir could have diverted more than 500,000 acre-feet of water in about five months. During a nineteen-day period in February 2025, Sites could have diverted at continuous maximum rates accumulating more than 150,000 acre-feet of water in storage.

This year’s diversions would have been in addition to the approximately 850,000 acre-feet captured during the last diversion season, which runs from early September to mid-June, for a total of 1.4 million acre-feet or about 95% of Sites Reservoir’s useable full capacity.

“While rainfall may vary from year to year, our analyses continue to demonstrate that every drop counts,” added Durst. “Sites Reservoir will help us capitalize on rain when it does come, providing a water savings account for when California’s communities, farms, and environment need it most.”

The past three years have been a wetter period and illustrate why it is important for Sites to be part of portfolio of water management tools. For example, to make space for this year’s diversions, a portion of the water captured in 2023 and 2024 would have had to been moved out to other storage or use facilities. Water use across the state varies; however, a single acre-foot of water is enough to exceed the average annual indoor and outdoor water use of two to three California households, according to the Water Education Foundation.

# # #

Sites is an off-stream reservoir proposed north of the Sacramento-San Joaquin Delta, where it would provide unique water supply and environmental benefits during dry periods, especially during extended drought. Additional information can be found at www.sitesproject.org or on Facebook and Twitter at @SitesProject.

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Bay Area Water Supply & Conservation Agency

Statement from Tom Smegal, Chief Executive Officer for the Bay Area Water Supply and Conservation Agency (BAWSCA), Supporting the Timely and Continued Evaluation of the Tuolumne Healthy Rivers and Landscapes (HRL) Proposal by the State Water Board

April 10, 2025

Last month, the Tuolumne River Partners (TRP) comprising the San Francisco Public Utilities Commission (SFPUC) and Modesto and Turlock Irrigation Districts sent a letter to Governor Newsom reiterating that the Tuolumne HRL proposal is integral to the State Water Board's overall evaluation of a Bay Delta Plan. BAWSCA supports that position.

BAWSCA appreciates the administration's commitment to getting a comprehensive HRL agreement ready for the State Water Board's consideration this summer. However, BAWSCA shares the TRPs' concern that action on the Tuolumne HRL Proposal is delayed and might not be included in this summer's action.

In 2018, the State Water Board adopted Phase 1 of the Bay-Delta Plan, which if implemented severely restricts flows that can be used for water supply purposes during droughts from the Tuolumne River, which is the source of 85% of the water for the San Francisco Regional (Hetch Hetchy) Water System (System), which in turn provides two-thirds of the water used by BAWSCA's agencies.

Soon thereafter, as encouraged by the State Board in its adoption of Phase 1, the SFPUC and its Tuolumne River partners came forward with the Tuolumne River Voluntary Agreement (TRVA) which proposed that a combination of river flows, river operations, and habitat enhancements could provide equal or better results for species protection with less impact to water supplies.

In January 2021, then BAWSCA Chair Barbara Pierce stated BAWSCA's clear and sensible request: that the TRVA be evaluated by the State Water Board to determine whether it was indeed equal to or better than the adopted Bay-Delta Plan in terms of the State's environmental objectives while maintaining a reliable supply of water at a fair price for the water customers that BAWSCA represents. That evaluation of the TRVA, now called the Tuolumne HRL Proposal, has been taking place since 2023.

BAWSCA's support for the State Board's evaluation of the Tuolumne HRL Proposal is consistent with BAWSCA's mandate from the California Legislature to protect the water-supply needs of BAWSCA's 26 members and the 1.8 million people, and over 40,000 businesses and community organizations in Alameda, Santa Clara, and San Mateo Counties that they serve. A reliable supply of high-quality water at a fair price is BAWSCA's goal, as it has been for more than 20 years.

# # #

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California marks third year of decent Sierra snowpack

A rare straight three years of average snowfall or better in the mountains means it's statistically more likely that a dry year isn't far off.

Courthouse News Service | May 1, 2025 | Edvard Pettersson

Snow at the Phillips Station in the Sierra Nevada mountains (California Department of Water Resources via Courthouse News)

(CN) — For the third time in as many years, snowfall in California's Sierra Nevada mountains stood at or above average as the rainy season comes to a close, giving the state a further reprieve from the severe drought conditions that have plagued the West Coast in recent decades.

"Overall we have made it to above median in terms of our snowfall this season," Andrew Schwartz, the director of UC Berkeley's Central Sierra Snow Lab, said at a presentation Thursday. "Which is fantastic news."

A recent storm not only added another 9 inches of snowfall at the research laboratory located at the Donner Pass in the Sierra Nevada this week, Schwartz said, but also slowed the snowmelt that has started already as the temperatures have begun to rise.

California depends on the snowpack for a big chunk of its fresh water supply, and average snowfall this past winter will ensure that there will plenty of water from the melting snows to keep the state's reservoirs well supplied.

The California Department of Water Resources on Tuesday announced an increase to the State Water Project allocation forecast for 2025 after the state's snowpack peaked on April 4 at 100% for the season.

The State Water Project, a collection of canals, pipelines, reservoirs and hydroelectric power facilities, provides water to 27 million Californians and 750,000 acres of farmland.

Lake Oroville, the largest reservoir in the project, stands at 120% of average for this date and 95% full. The massive reservoir in Northern California could reach capacity this spring for the third straight year.

Farther south, the San Luis Reservoir in Merced County — a critical storage space for water destined for Southern California — is 101% of average for this date and 83% full.

"Things are looking quite good around the state with our snow and water resources," Schwartz said at Thursday's presentation.

It's exceedingly rare for snowfall in California to be at or above average for three years in a row, he added, occurring once every 25 years. The last time it happened was in the late 1990s.

"The caveat to that being that we never really have seen four years in a row, at least here at the snow lab," Schwartz said. "And even if we were to see a fourth year in a row, drought will be returning sooner than later."

The three wet years, however, will give the state a good basis and storage for drier years to come, he concluded.

# # #

Wet Season's end for Water Year 2025
California Water Blog | April 27, 2025 | Jay Lund

California's Water Year runs from October 1 of the previous calendar year through September 30. California's "wet" season is traditionally October 1 – April 1. The rest of the year (and often parts of the "wet" season) is usually dry. We can get major storms into April, but often not.

So almost all of this Water Year's precipitation has fallen already.

Precipitation
Statewide precipitation this wet season has been unusually average overall (104%), but a bit weird otherwise. The north was unusually wet (and without major floods), but the south was unusually dry – so extremely dry for months that the south had extensive wildfires in January!

Like many years, this wet season had some wild swings between months, as well as across regions. Northern California was unusually dry until mid-November (25% of average), until some good storms began arriving (254% of average November), but January was dry again (12% of average), and February very wet (187% of average), before settling into an average (102%) March. No wonder we are often confused about how we the water year will be until the end of March. (In most years California gets some form of monthly whiplash, separately from the recently-famed interannual weather whiplash (Swain et al 2025).

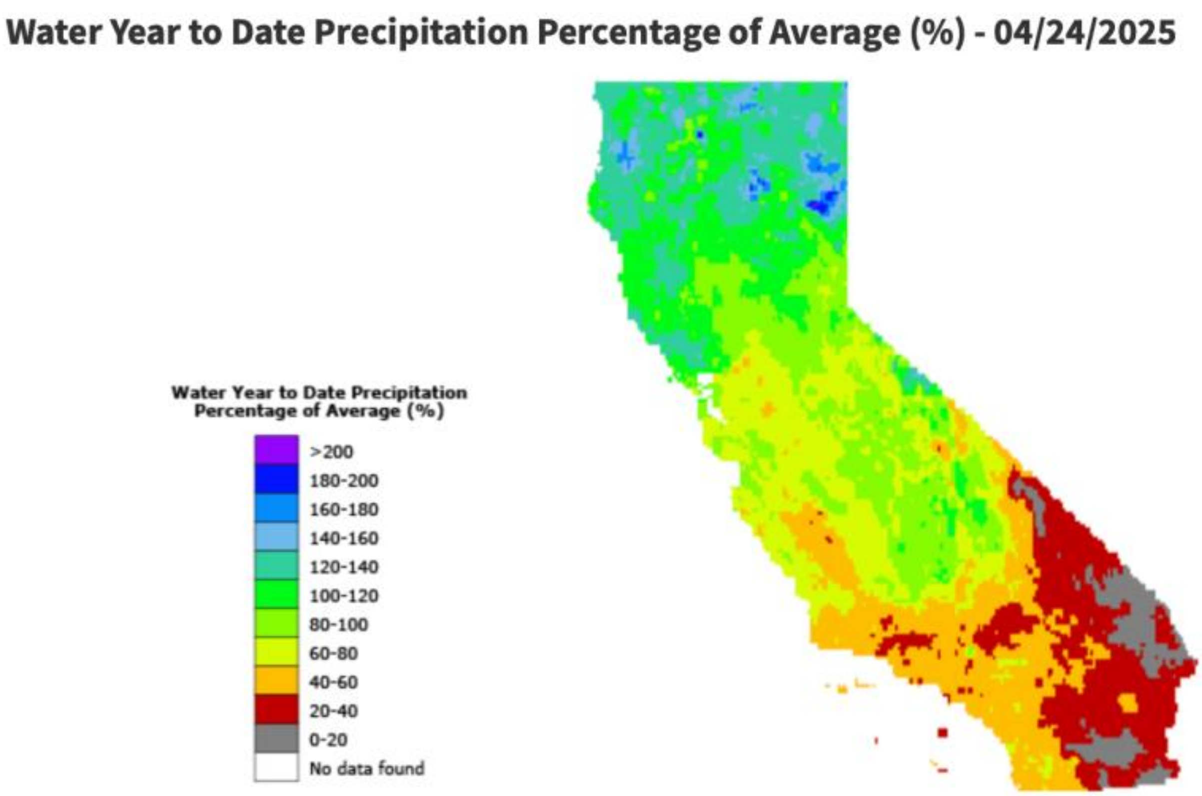

Figure 1. Statewide precipitation by April 8, 2025, roughly the nominal end of California's wet season. https://cww.water.ca.gov/

Snowpack

Snowpack is doing well with about 99% for this date, 120% for the north, 91% for the central Sierra and 85% for the southern Sierra. Not a bad year for snow.

The figure below shows we can have a wide range of snow accumulations and melting patterns. These are changing with a warming climate.

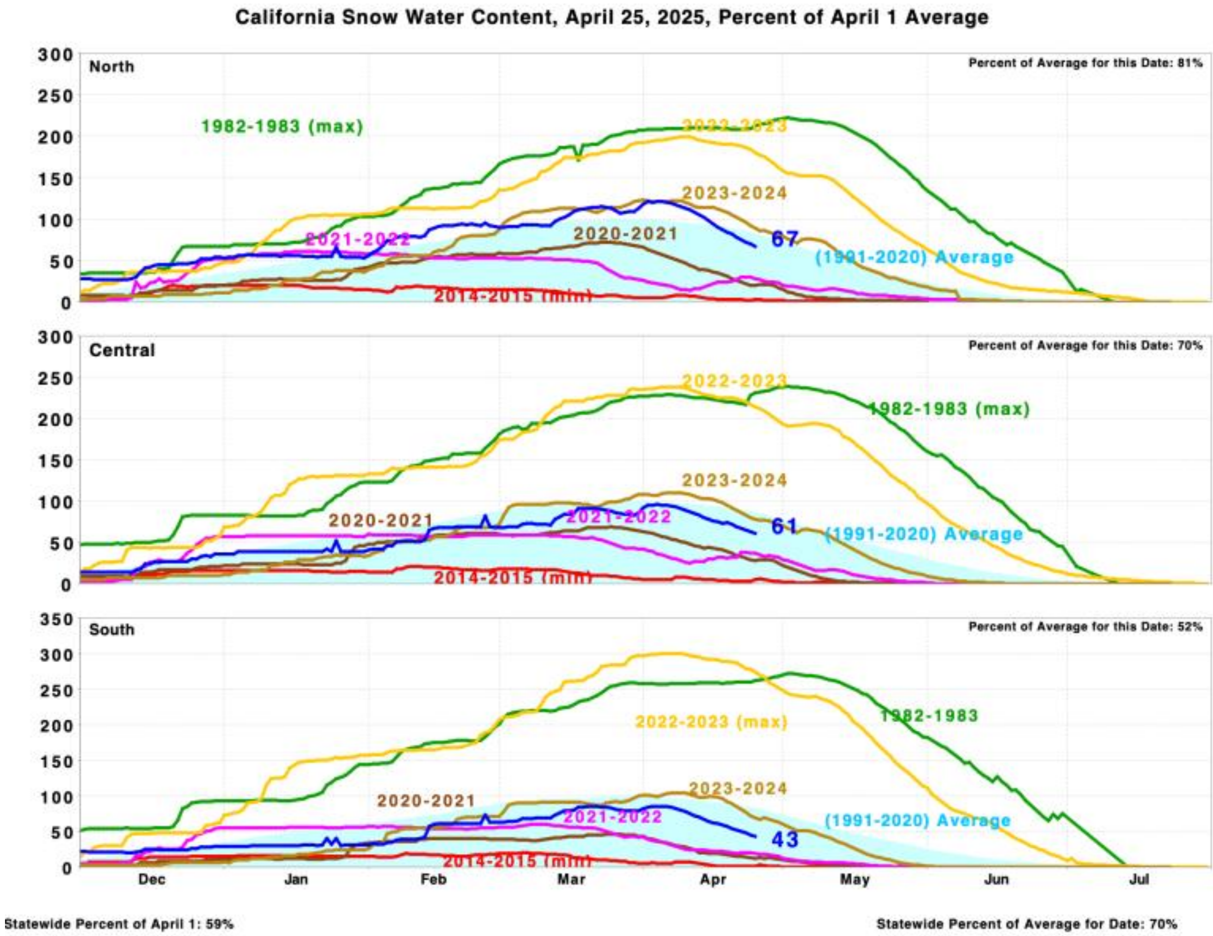

Figure 2. 2025 California Snowpack. https://cdec.water.ca.gov/reportapp/javareports?name=PLOT_SWC.pdf

Reservoir Storage

Because the last two years have not been dry, California has an unusual amount of water in its reservoirs. Much unfilled storage in the table below is remaining empty flood storage, which will be partially or entirely filled by melting snow in the coming month or so. Alas, this is not true for the Colorado River reservoirs, which continue to be overdrafted since 1983, when they filled for the first and perhaps last time.

Area	Capacity 1000 AF	Hist Ave 1000 AF	2024 1000 AF	2025 1000 AF	% Ave
INTRASTATE					
North Coast	3,096	2,229	2,429	2,592	116
San Francisco Bay	711	525	519	492	94
Central Coast	982	637	880	734	115
South Coast	2,107	1,433	1,583	1,396	97
Sacramento	16,038	12,012	13,922	13,996	117
San Joaquin	11,483	7,639	8,596	8,900	117
Tulare Lake	2,088	884	1,266	1,110	126
North Lahontan	1,073	505	887	811	161
South Lahontan	412	264	349	297	112
Subtotal	**37,989**	**26,129**	**30,430**	**30,328**	**116**
INTERSTATE					
North Coast	1,137	686	669	791	115
Colorado River (1)	52,939	32,802	19,600	18,908	58
Subtotal	**54,076**	**33,487**	**20,269**	**19,699**	**59**
TOTAL	**92,065**	**59,616**	**50,699**	**50,028**	**84**
1 - INCLUDES LAKE POWELL AND LAKE MEAD					

Table 1. California reservoir storage on April 8, 2025 from:
https://cdec.water.ca.gov/reportapp/javareports?name=STORAGE

Groundwater

California's systematic groundwater data is still maturing for statewide and regional assessments but seems to be improving rapidly.

Over the last 20 years, of several thousand wells monitored semi-annually, few had increasing groundwater levels, and more had decreased levels than no change. Areas with the greatest overdraft are concentrated in the southern Central Valley's Tulare Basin. This pattern of overdraft is about a century old.

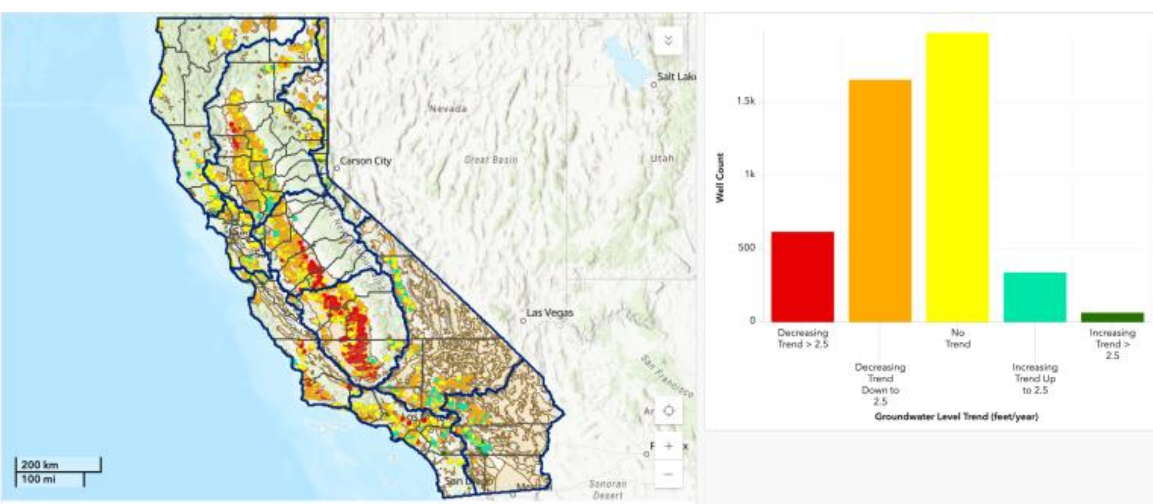

Figure 3. Central Valley groundwater trends over 20 years until 2025.
https://sgma.water.ca.gov/CalGWLive/#groundwater

The last three wetter years have partially reversed trend, with more well levels rising than falling. However, areas with the greatest historical overdraft also seem to have more wells where water levels continue to decrease.

Is SGMA working, or did we just have three wetter years? Maybe a bit of both. What Is certain is that the last three years have been unusually wet. As we move closer to 2040, the state will need a reasoned approach for considering how much of non-compliance is hydrologic luck as opposed to inadequate management (Escriva-Bou et al. 2020).

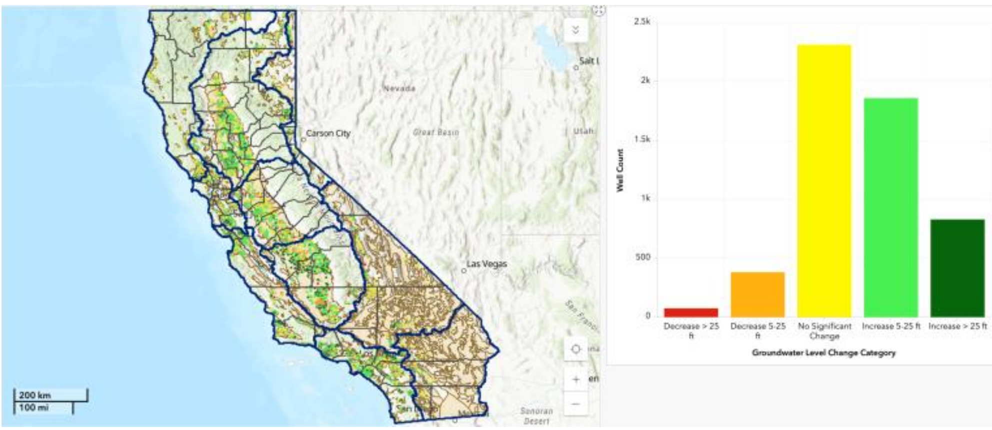

Figure 4. Central Valley groundwater trends over 3 years until 2025
https://storymaps.arcgis.com/stories/b3886b33b49c4fa8adf2ae8bdd8f16c3

SWP and CVP Water Deliveries

State Water Project (SWP) allocations are now 40% for this year (the 30-year average allocation is 60%). The Central Valley Project allocations are 100% for the most senior water contractors (Settlement and Exchange contractors) and for Friant contractors' Class 1 water, 75% of historical use for urban contractors, and 40% for other south-of-Delta contractors (12-year average is 30%). There is a possibility that some allocations might increase further.

For most state and federal water contractors, this water year is good or ok, certainly not a drought year. But there will always be demands for more water from the projects, especially with SGMA bringing groundwater overdraft to an end in some of the driest parts of California.

Biological Water Year Data

As we intensely struggle with slow progress in improving water operations for ecological purposes, we will need more organized and real-time information on biological conditions. We collect considerable data on salmon returns and juveniles statewide, Delta smelt (alas, mostly zeros), and other fishes, as well as various waterbirds.

But these data are not yet organized for policy, water management, or public discourse. Today they are fragmented and tend to be mostly available annually. There are some efforts to improve this situation, such as https://www.cbr.washington.edu/sacramento/.

We need better organized and available real time data to support broader and more integrated discussions on ecosystem policy and water management. Otherwise California's struggles will be longer, more expensive, more controversial, and less productive.

(As is often the case, the organization of data on a problem reflects the organization and effectiveness of our institutions. This is borne out by recent improvements in groundwater data.)

Overall

California's 2025 water year has had a good "wet" season overall. Neither floods nor droughts overall, except for great dryness in southern California creating landscape conditions for horrible wildfires. Even in statistically average years, California water will usually be weird in places and at times.

As we work to improve water management, we need to improve our data management, and water accounting. The pace of innovation is often limited by our ability to organize effective data development.

# # #

About the Author

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How California's farmers can recharge the aquifers they've drained
Grist News | May 2, 2025 | Frida Garza

In parts of California's Central Valley, so much groundwater has been pumped out of the ground to deal with the region's persistent drought that the land is starting to sink in. Underground aquifers — layers of sand, gravel, clay, and water — are vital resources that communities can turn to when surface water is scarce. But when more water is pumped out of aquifers than is put back in — as is happening in the southern part of the valley — it can cause the ground to slowly contract, like a drying sponge.

After studying this phenomenon, Rosemary Knight, a professor of geophysics at the Stanford Doerr School of Sustainability, became interested in identifying the fastest ways to replenish California's groundwater using managed aquifer recharge. This technique involves flooding a piece of land with excess surface water and allowing that water to seep through the ground and into aquifers, where it can be stored for later use. Armed with a massive electromagnetic dataset, Knight and a team of researchers set out to analyze sediment types below the surface in the California Central Valley and map out the quickest routes to refilling aquifers.

Their research, published last month in the journal Earth and Space Science, found that between 2 million and 7 million acres of land in the Central Valley are suitable for recharge — or between 19 and 56 percent of the valley's total area. Most of the rechargeable land is currently used to grow crops. Many farmers are enthused about the data, according to Knight — and keen to implement it. As climate change continues to exacerbate water challenges in California, her team's research points to how agricultural producers can help to ensure sustainable water access for all. "They want to be part of the solution," said Knight.

Since 2000, the U.S. Southwest has been in the driest 25-year period the region has seen in over a millennium, according to researchers at the University of California, Los Angeles, who found that climate change has supercharged these dry conditions. Part of the way rising global temperatures exacerbate water challenges is by increasing the evaporation of surface water, or water in rivers, lakes, and reservoirs. Scientists are also eyeing how climate change could impact snowpack in the Sierra Nevada mountain range, which forms a critical part of California's annual water supply every spring as it melts and moves into rivers and streams. In 2015, a multiyear drought in California led to an unprecedented decline in snowpack in the Sierra Nevada; researchers have also predicted that global warming could cause snowlines on the Sierra Nevada to rise towards the end of the century, meaning snow would only form at higher elevations, reducing the overall amount of snow on the mountain range.

Water is critical for the region because the Central Valley is an agricultural powerhouse, producing one-fourth of the nation's food, according to the U.S. Geological Survey. It's home to more than 250 different crops — from hay and cotton to rice and corn to tomatoes and olives. But the state's agricultural industry has also been blamed for depleting groundwater while wells run dry in nearby rural communities. Over the past two decades, groundwater levels in California have been steadily falling, despite aquifers being periodically recharged naturally by snowmelt and rainfall, according to a 2022 study in Nature Communications.

"Natural recharge was not keeping pace with the rate of extraction," said Knight.

In order to determine how water would flow through sediments below the ground, Knight and her colleagues used a large set of electromagnetic data acquired by the California Department of Water Resources. The data was collected by helicopters flying over the Central Valley in a grid formation, with flightlines spaced a few miles apart. Using special equipment that sends an electromagnetic signal into the ground, the choppers were able to determine how the current is conducted through layers of soil at a depth of up to 300 meters. Areas full of coarse materials like sand and gravel — where water flows seamlessly — can't conduct electricity easily.

By interpreting these results, the researchers were able to construct a 3D model of the subsurface and pinpoint "fastpaths" for water to travel down into aquifers.

This kind of information could be vital for regional California agencies, which have been instructed to develop plans for using groundwater more efficiently under the state's Sustainable Groundwater Management Act. The data that Knight and her colleagues produced — which they've made available online — can also help agricultural producers decide whether or not to implement groundwater recharge on their lands. Their analysis reveals which specific croplands are best suited for recharging aquifers (like the ones used to grow fruits, nuts, and field crops, as well as vineyards) and which aren't (those used for rice and citrus).

This level of soil data can help farmers make decisions about whether managed recharge is right for their land. "Growers really want to have confidence that if their land is being flooded for recharge, that water is going to very rapidly move below the ground surface," said Knight. Better guidance for agricultural producers has already been circulating; the Almond Board of California has been recommending groundwater recharge for a few years now and published an introductory guide for growers.

Christine Gemperle, a longtime almond grower who sits on the Almond Board of California, has flooded one of her orchards twice for groundwater recharge — and said she has seen numerous benefits beyond raising groundwater levels in her area. They include flushing gophers out of her fields (they love her cover crops, Gemperle said) and pushing salts that accumulate from irrigation further down into the soil. Although she wasn't able to do it this winter, due to dry conditions lowering the amount of surface water available, she feels optimistic that this kind of data can empower other farmers to explore recharge. "There's so much opportunity," she said.

Like many farmers in the state, Gemperle already had access to canals that transport water from a reservoir to her fields for irrigation. This made recharge fairly straightforward: When she saw the canals were full of water during a particularly wet year, she got permission from her local irrigation district to open the canal gates and flood her land. The prevalence of this kind of infrastructure is an advantage for California farmers interested in recharge, according to Shimon Anisfeld, a professor at the Yale School of the Environment focused on water management who was not involved in Knight's study.

Managed recharge can provide some "environmental win-wins," said Anisfeld. When farmers face wet winters and dry summers, recharge can help store excess surface water, making it accessible during the growing season. In certain instances, like when farmlands are restored into floodplains, aquifer recharge can also double as habitat restoration for wildlife.

Farmers are likely to be motivated to dedicate some of their land to aquifer recharge, said Anisfeld, especially if they can reap the benefits later.

Still, he suggested, Californians will likely need to tackle its water challenges by decreasing demand as much as boosting supply. "I'm not convinced that recharge is going to be a substitute for reducing water use," he said. "I don't think it can, on its own, solve the whole problem." Managed aquifer recharge may be a more attractive option for farmers than the alternative of changing their agricultural practices. "If you can recharge groundwater, that gives you more to work with," Anisfeld said. "It means you can keep on farming and keep on growing water-intensive crops."

Knight agreed that growers don't "want to stop pumping" groundwater or have to fallow their fields. She hopes that by publishing a version of their data online and making it accessible to the public, her team will help empower individual stakeholders to explore the options that are best for their soil.

"I care about actionable data presented in a way that is helpful to end users, such as growers, managers of water districts," she said. That way, "the user can make their own decisions about how best to use the results."

As for Gemperle, she sees flooding her farmland as a way to ensure that her community continues to have access to water. "I see it as something that really points to how connected we are in this agricultural landscape," she said. "We are more connected than disconnected."

# # #

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USGS Water data centers may soon close, threatening states' water management
Inside Climate News | April 29, 2025 | Wyatt Myskow

The Trump administration has terminated the leases of 25 U.S. Geological Survey Water Science Centers, which inform the water decisions of local and state governments across the country.

USGS scientists take streamflow measurements along the Mississippi River in St. Louis. This information is critical in making flood predictions and response plans. Credit: Jennifer LaVista/USGS

Across the country, the data collected at stream gauges managed by the U.S. Geological Survey are used to implement drought measures when streamflows are low, alert local authorities of floods, help administer water to users on rivers and issue pollution discharge permits required by the Clean Water Act for communities across the country.

But more than two dozen USGS Water Science Centers that house the employees and equipment to manage those gauges and equipment will soon have their leases terminated after being targeted by the Department of Government Efficiency, headed by billionaire Elon Musk. Data collected by the centers inform studies of the condition of the country's water resources and shape local and state water management plans.

It's the latest in the Trump administration's assault on science and federal agencies, and means that centers from Alaska to Massachusetts will close once their leases are up, according to Public Employees for Environmental Responsibility, a nonprofit that supports government employees. The leases of 16 out of the 25 centers end Aug. 31, 2025. Staffers at targeted centers, speaking anonymously because they are not authorized to speak to the media, said they are in the dark as to what happens when the leases end and how their operations, vital to water management across the country, will be able to continue, though talks continue about renewing some of the affected leases.

“These [centers] are just super, super important, and there’s no rhyme or reason, no thought at all given to canceling these leases,” said Kyla Bennett, a scientist and attorney formerly with the U.S. Environmental Protection Agency, now working as PEER’s science policy director. “They’re doing it because it’s convenient, because these particular centers happen to be up for renewal.”

Most centers have no plans to vacate facilities, which would require relocating employees, vehicle fleets and equipment. A staffer, whose identity is being withheld because they are not authorized to speak to the press, said they only learned of the termination of the lease for the center where they work when the landlord asked them where they were going after the General Services Administration canceled it at the direction of DOGE.

The equipment requires regular monitoring to maintain the quality of the data and provide repairs as needed. In a worst case scenario, workers said, the termination of the leases would result in employees being unable to get out in the field to make the necessary checkups and repairs, making the agency unable to produce the data. In the best case, maintenance will take longer, and data quality will decrease, potentially affecting some operations.

“We are actively working with GSA to ensure that every facility and asset is utilized effectively, and where necessary, identifying alternative solutions that strengthen our mission,” a USGS spokesperson said in a statement. “These efforts reflect our broader commitment to streamlining government operations while ensuring that scientific endeavors remain strong, effective, and impactful. This process is ongoing, and we will provide updates as more information becomes available.”

One of the Water Science Centers whose lease will expire this year is the USGS field office in Moab, Utah, the town famed for its proximity to Arches and four other national parks in the region.

David O’Leary, the center director at the USGS’ Utah Water Science Center, couldn’t comment on the termination of the site’s lease or its future, but said the Moab field office services sites across 24,000 square miles in southern Utah—a landscape bigger than many states.

The Moab office operates and monitors more than 30 stream gauges, eight water quality sites, five meteorological sites, two groundwater monitoring sites and one sediment monitoring site. Many of those, he said, send information in real time to federal, tribal, state and local partners about floods and the flows of streams and rivers in the Colorado River Basin and even provide data for the administering of state water rights during drought conditions.

“They cover a lot of territory, and I think they provide a lot of value to Utah and water users in the Upper Colorado River Basin, and we’re really proud of what they can accomplish out of that office,” O’Leary said, adding he’s hopeful operations will continue for the field office.

“You can’t manage what you can’t measure.”
— Blake Bingham, Utah Division of Water Rights

The USGS is vital to how Utah manages the “precious and limited resource” that is water across the state, said Blake Bingham, the deputy state engineer at the Utah Division of Water Rights, which administers water to users across the state.

Utah, like much of the West, uses the prior appropriation system in which users who are first in time to use water have their rights to it prioritized. The stream gauges managed by the USGS inform those decisions, he said. When they measure drought conditions, the state can then cut water deliveries to junior users to protect those with earlier, prioritized rights. It’s something they do every day, and it is not possible without the help of USGS, he said. The big concern for the Division of Water Rights is that without a field office, USGS staff would not be able to monitor and fix the gauges.

“You can’t manage what you can’t measure,” Bingham said. “So it’s just a fundamental part of what we do.”

The state of Utah also funds roughly two-thirds of the stream gauges operated by the USGS, said Candice Hasenyager, the director of the Utah Division of Water Resources, and has contracts with the agency for those services. The work the USGS Water Science Centers do across the country is largely funded by states, not the federal government.

The data is “absolutely foundational to our understanding of the current and past hydrology,” of the state, Hasenyager said, and shapes Utah’s long-term water planning, noting that 99 percent of its water supply starts as snowpack that then melts into runoff found in streams and rivers that are tracked by the USGS.

“We don’t really know how they would manage it if that office was closed,” she said, and the potential loss of its lease has put the state’s planning in an uncertain place.

Some leases may be restored, staffers told Inside Climate News, at the urging of the USGS, though it is uncertain how many may stay open.

“We’re very concerned about being able to manage our water resources within the state of Utah” without the assistance of USGS and other targeted federal programs, said Hasenyager, and the state will continue to communicate the importance those programs to the federal government.

# # #

Correction: A previous version of this story misstated the amount of Utah’s water supply that starts in the snowpack. The state gets 95 percent of its water from snowpack, not 99 percent.

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The New Math for Reservoir Management Amid Climate Change
UCLA Anderson Review - Research Brief | April 23, 2025 | Monika Brown

Sacramento River Basin serves as a test case for conserving water over unpredictable weather cycles

The summer of 2022 brought worrying news for California's water supply.

Shasta Lake (seen above in 2024, having filled back up), the state's largest reservoir and a critical source of water for millions, saw its levels drop to 38% of capacity in July — a historic low for that time of year. That drought laid bare a growing challenge: how to balance immediate water demand with long-term supply in an era of increasing climate uncertainty.

In a working paper, UCLA Anderson's Felipe Caro, University of Mannheim's Martin Glanzer and UCLA Anderson's Kumar Rajaram develop a model for the management of reservoir systems over the long term. It's designed to minimize societal costs of a water shortage. In a case study of California's Sacramento River Basin, the authors' management policy reduced average shortage costs — the cost of getting water from other, last-resort, sources — by 40% compared with the current policy, potentially remarkable savings.

Source: California Department of Water Resources
Drought left Shasta Lake at 28% of its total capacity in September 1976.

Thinking in Cycles, Not Years

Instead of the fixed or infinite timelines used by most traditional models, the authors' approach uses cycles. A cycle begins when all reservoirs in a system like the Sacramento River Basin are simultaneously full and ends when they reach that state again — regardless of how many years it takes. Sacramento River Basin's last complete cycle stretched from 2006 to 2019.

California's reservoirs can be thought of like a network of interconnected buckets — each varying in size and refilled by unpredictable amounts of rainfall and snowmelt. Humans can determine when to empty the buckets, but only

Mother Nature determines the timing to refill them. When trying to make the best decisions to manage these water resources, traditional models face three key problems:

- Short-term planning risks depleting reservoirs too quickly during dry years.
- Fixed-time horizons force artificial deadlines, leading to short-sighted decisions — one cycle may be considerably longer than the last.
- Long-term models struggle to accurately value future water needs, often favoring short-term use and risking long-term shortages.

The study focuses on three major reservoirs in the Sacramento River Basin, each with unique characteristics: Shasta Lake (slow to fill, large capacity), Trinity Lake (moderate filling rate) and Folsom Lake (the smallest of the three, quick to fill). The researchers used publicly available data from the California Data Exchange Center covering the period from May 1, 2000, to April 30, 2024. The data included daily inflow measurements, evaporation rates and reservoir capacities. May marks the beginning of the dry season, so the data enables the researchers to analyze 24 complete seasonal changes.

Rather than treating each of the three reservoirs separately, the researchers' model first combines them into one "virtual reservoir" to determine optimal total water releases. This aggregation allows the researchers to overcome the "curse of dimensionality" — the exponential increase in computational complexity when managing multiple factors (reservoirs in this case).

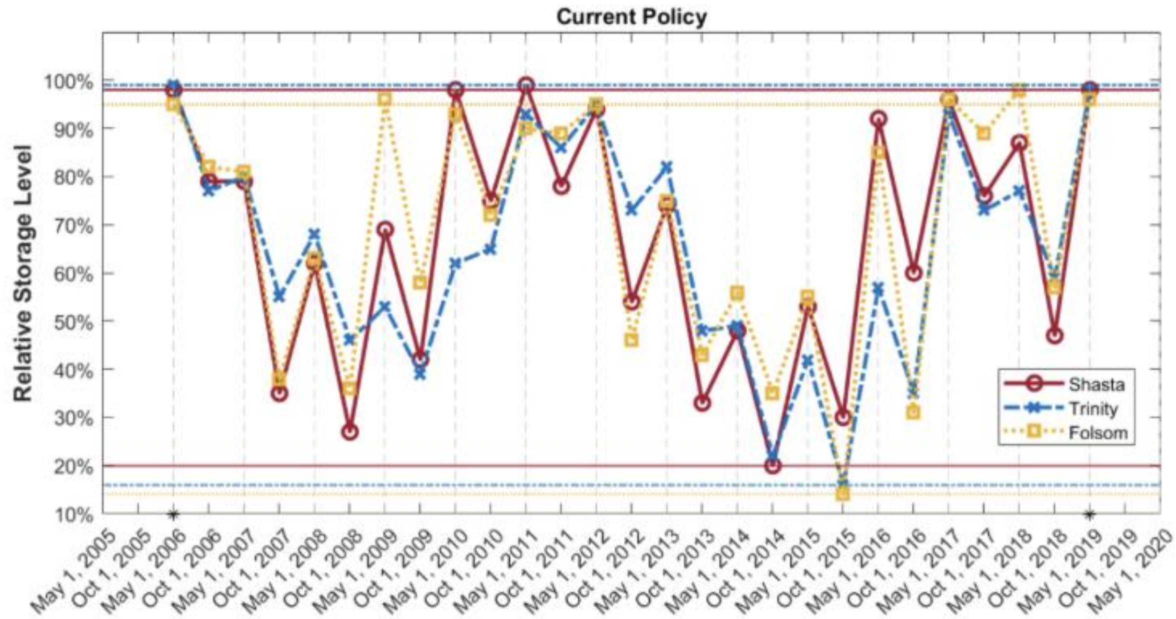
To handle climate uncertainty, the researchers developed a framework that prepares for the unexpected. Instead of relying solely on historical weather patterns, which may become less reliable due to climate change, the model assumes nature acts as an adversary, always choosing the worst-case scenario for water inflow. However, the model prevents overreaction with a system that quantifies how much a predicted weather scenario deviates from expected patterns.

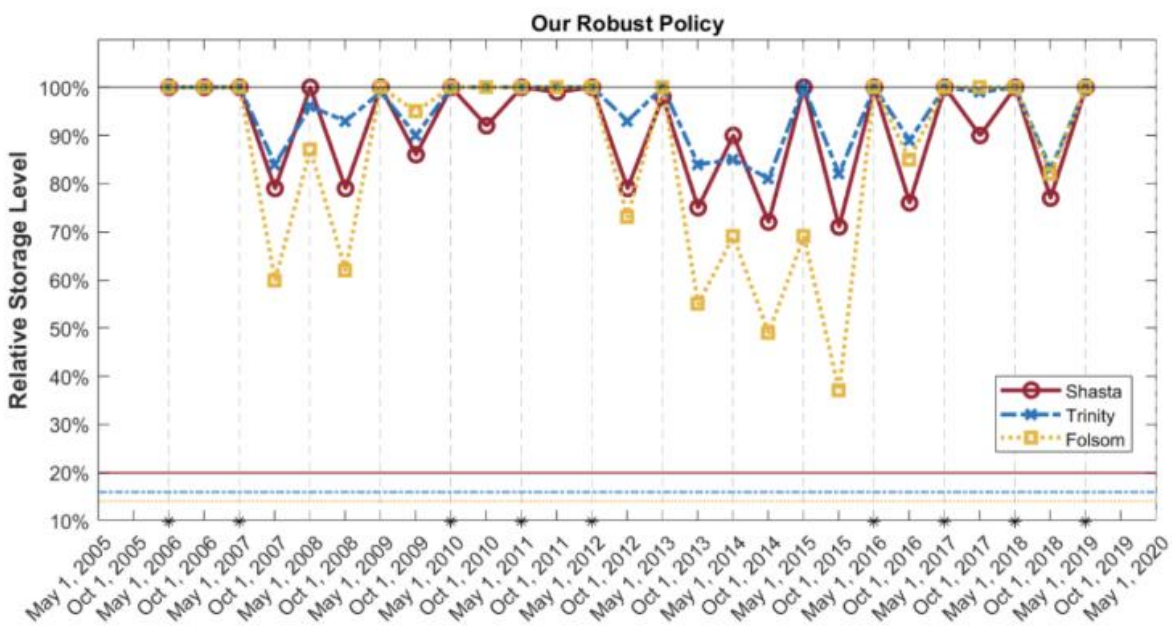
Caro, Glanzer and Rajaram's approach seeks to keep the model cautious without becoming overly conservative. When extreme scenarios are predicted, the system forces the model to weigh them against more typical patterns, avoiding under- and overreacting. The model then allocates water releases based on each reservoir's unique characteristics. For example, Folsom Lake might release a larger portion of its water compared with Shasta Lake because Folsom can refill more quickly.

Testing with real data revealed the following observations:

- A 40% reduction in average water shortage costs compared with current practices.
- Performance within 3% to 15% of the mathematically best possible solution.
- Higher overall storage rates across all reservoirs.
- Better performance during critical drought periods.

As can be seen in the charts below, the current management policy led Trinity and Folsom lakes to reach their minimum levels during the 2015 drought. The researchers' model maintained higher water levels, by better anticipating and preparing for the drought conditions.





The model is more than simply hoarding water. It finds a strategic balance — when it withholds water, it's in ways that avoid causing harm. In wet years, traditional models tend to release too much, missing a chance to rebalance storage across reservoirs. This model uses those opportunities to prepare for future dry periods by doing such rebalancing. It also prioritizes essential uses like drinking water, while delaying nonessential uses — like irrigation for certain crops — when future supply looks uncertain.

The implications of the researchers' work extend beyond California. As climate change increases weather volatility worldwide, this cycle-based approach could help water managers make decisions about when to store and when to release water. The model's optimization framework could make it particularly valuable in regions facing increasing climate uncertainty.

Caro, Glanzer and Rajaram's work suggests that by working with nature's cycles rather than against them, we can dramatically improve how we manage our water resources.

# # #

The Critical Role of Airborne Snow Observatory Flights in Managing California's Water Future
Water Blueprint for the San Joaquin Valley | April 25, 2025

California's water supply hinges heavily on its snowpack—often called the state's natural reservoir. Snow that accumulates in the Sierra Nevada during winter slowly melts in spring and summer, feeding rivers and reservoirs across the state. This snowmelt supports the natural environment, agriculture, powers hydroelectric generation, and provides drinking water to millions. But to manage this precious resource, accurate data on how much snow is in the mountains—and how much water it represents—is essential. That's where the Airborne Snow Observatory (ASO) flights come in.

Operated by the Department of Water Resources (DWR) in partnership with state and local water agencies, ASO flights use advanced LiDAR and spectrometer technology to measure snow depth and to calculate snow water equivalent (the amount of water stored in the snowpack) with unprecedented accuracy.

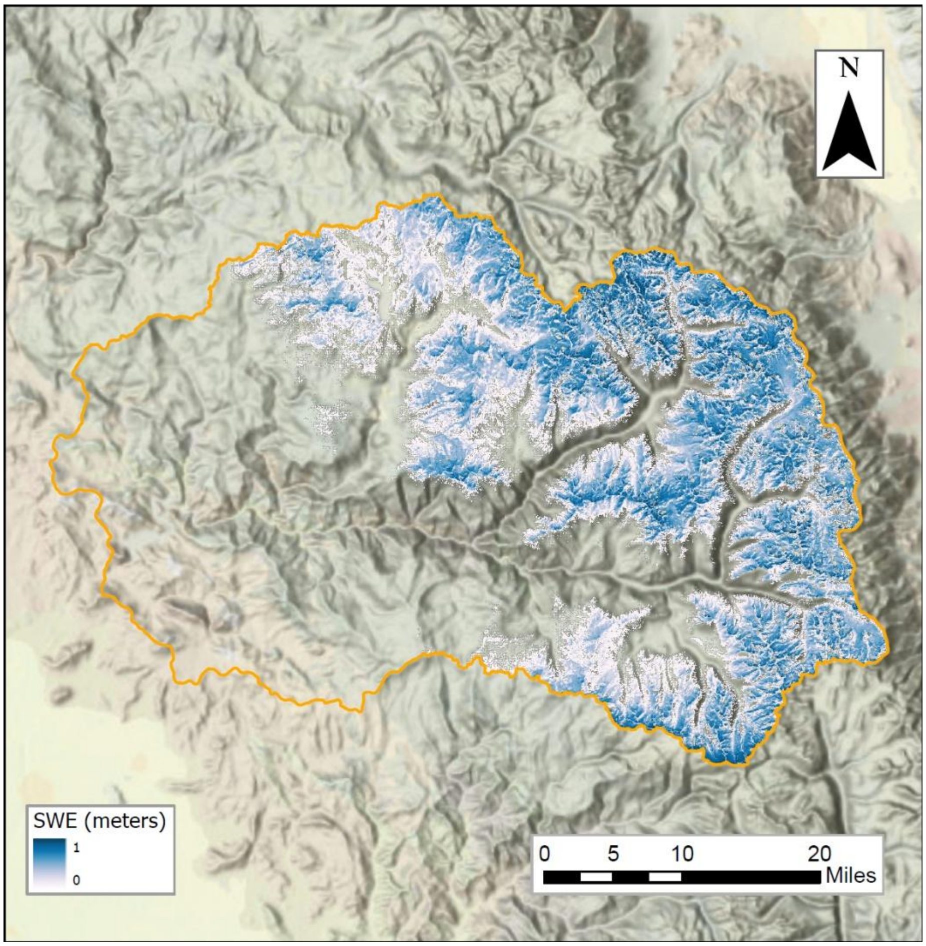
The value of this data can't be overstated. For water managers, precise snowpack measurements are the foundation for predicting how much snowmelt runoff will occur—and when. This directly informs decisions about reservoir releases, flood control, irrigation scheduling, and drought preparedness. For example, releasing too much water early in the season based on an overestimate of snowpack can leave reservoirs empty when the melt runs dry. While in wet years, knowledge of large snowpack allows water users time to make early releases of flood flows at lower, and safer, levels to reduce flood risk.

In recent years, as climate change accelerates the volatility of snow accumulation and melt timing, ASO data has become even more critical. Snowpack levels can fluctuate drastically due to warmer winters and earlier thaws, making past trends unreliable for future planning. ASO's detailed measurements allow for dynamic, responsive water management in an increasingly unpredictable environment. Because of this forecasting advancement, ASO has been identified as a solution in California's Water Resilience Portfolio, which provides a roadmap to building the State's water resilience.

Moreover, ASO supports broader environmental goals by improving habitat management for endangered fish species and maintaining instream flows. It enables a fine-tuned balancing act between human and ecological needs.

Simply put, ASO flights give California water managers the tools to make better informed, more sustainable decisions. As the state grapples with a future of water scarcity and climate extremes, expanding the use of ASO technology may be one of the smartest investments the government can make to ensure resilience and equity in water distribution. The snow may fall in the mountains, but the impact of measuring it reaches all of California.

Despite the benefits of ASO, the State of California has shifted from building the program up, to slashing funding in the current budget. The California state plan was to invest $40 million per year into these crucial measurements, which would cover all snow-dominated watersheds in California. The State has been operating a portion of those watersheds on a budget of $15 million. Current planning for FY 2026 shrinks the program budget to just $4 million. This budget cut will limit the State's own runoff forecast resilience and will have trickle down impacts on federal runoff forecasts, both of which are essential for water managers and flood control operations, putting life and property at risk.



This picture shows the Kings River Basin's estimated Snow Water Equivalent (SWE). A survey done by ASO on April 9, 2022, estimated that 358 +/- 18 thousands of acre feet of SWE existed in the Kings River Basin. This type of flight survey and traditional snow survey methods can help water managers better plan for the runoff season in both wet and dry times. Typically, most of the runoff in the Kings River Basin is from snowmelt occurring between April and July. In Water Year 2022, the Kings River water users observed just 38% of average runoff for the April to July period.

# # #

‘We need to plan for a more water-resilient future:’ Q&A with Richard G. Luthy, urban water expert

Professor Luthy’s work focuses on ways to ensure that water overflows in both urban and rural California can be captured and stored underground. He spoke with & the West about the measures the state needs to consider to protect its water supplies into an uncertain future.

Water & the West | April 24, 2025

Above: Prof. Richard Luthy and Stanford graduate students discuss an experiment to neutralize pollution at the former site of the Hunters Point Naval Shipyard in San Francisco in 2004. Linda A. Cicero / Stanford News Service

Richard G. Luthy is the Silas H. Palmer Professor of Civil and Environmental Engineering at Stanford University, and the former director of the National Science Foundation’s Engineering Research Center for Re-inventing the Nation’s Urban Water Infrastructure (ReNUWIt), a four-university consortium. His work focuses on ways to ensure that water overflows in both urban and rural California can be captured and stored underground — a requirement now as the ability to construct new dams for overground storage has almost vanished.

Felicity Barringer, the editor and lead writer for “& the West,” conducted this interview.

Felicity Barringer: **Water supplies in California have always been whipsawed as periods of floods alternate with periods of drought. For all the billions of dollars of investment in California’s water infrastructure and its dams and canals, water reliability still eludes the state. There have been three debilitating droughts in the last 15 years. Water agencies are now devoting significant resources to enhancing supplies, both reusing water and finding new places to store it. But there’s a difference between urban and agricultural areas when it comes to storage capability. Can you describe the difference?**

Richard Luthy: When we think of storage, what comes to mind are reservoirs. In California essentially all the good reservoir sites have already been taken. One of the last reasonable locations is the proposed Sites Reservoir in northern California's Colusa County for off-stream storage of water from the Sacramento River. That will be able to hold 1.5 million acre-feet of water when it is completed. [An acre-foot is the equivalent of 325,851 gallons, or enough water to last two to three average homes for a year.]

Floodwater from winter runoff covered agricultural land in Tulare County in the spring of 2023. Tulare Lake had been the largest freshwater lake west of the Mississippi River, but was largely drained in the late 19th and early 20th centuries for agriculture.

Meanwhile, further south in the San Joaquin Valley, over-pumping of groundwater has resulted in substantial subsurface storage capacity in agricultural areas. The groundwater is gone, but the aquifers that held it remain, and could provide considerable storage space.

Groundwater recharge and storage is different between urban and rural areas. Mainly it's a matter of geology and available land. Los Angeles and Orange Counties have the right geology in some places where recharge is possible. Los Angeles, for example, has a number of recharge basins at the base of the San Gabriel Mountains. In the Bay Area there are recharge basins near Los Gatos and in the Quarry Lakes recreational area between between Fremont and Union City. But aside from that there aren't many good places in our urban environment for recharge because of the clayey soil on the flatlands around the Bay.

"In the San Joaquin Valley, groundwater over-pumping since 1960 has created about 80-100 million acre-feet of potential storage capacity."

The situation is different in agricultural areas where there's land and where groundwater has been over-pumped, which creates space for recharge. In the San Joaquin Valley, groundwater over-pumping since 1960 has created about 80-100 million acre-feet of potential storage capacity. Whether or not all that can be realized, it's still many times the volume of the major reservoirs in the Sacramento and San Joaquin regions.

There are several water banking facilities in Kern County that can store water for both rural irrigation districts and cities. Because of the 440-mile California Aqueduct, it's possible for Valley Water, the water wholesaler for Santa Clara County , for example, to store water near Bakersfield. Like many water agencies, it is entitled to take a set amount of water from California's State Water Project. But by not using its full entitlement to State Water Project (SWP) water, that entitlement can be stored in an underground holding area near Bakersfield, called a water bank.

This exchange allows Valley Water to forgo taking water directly from the aqueduct and let that water be taken out near Bakersfield and stored underground. When Valley Water wants to withdraw water from the water bank, it takes more than its entitlement of water from the SWP aqueduct up north and then makes that up by pumping water back to the SWP from storage in the south. Valley Water pays the Semitropic Water Storage District to handle the recharge and pump-back. The water bank capacity for VW is 350,000 acre feet. By comparison, the Anderson Reservoir (VW's largest) holds about one-fourth of that amount — 89,000 acre-feet.

A recharge basin undergoing maintenance, right, in Madera Irrigation District in the San Joaquin Valley. Richard Luthy

FB: Your earlier work was focused on stormwater recapture, particularly in the Los Angeles area. Why have southern California cities made many more efforts to set up systems to capture stormwater, compared to northern California cities? What urban areas have been most successful at both capturing and cleaning stormwater? Where have efforts to recapture stormwater been wanting?

"The City and County of Los Angeles imposed a parcel tax to fund stormwater initiatives that was approved by the voters in 2018. This is funding stormwater capture and recharge."

RL: One important issue when it comes to capturing stormwater is ground permeability and available space in the subsurface unsaturated zone. In the Bay Area, the flat lands adjacent to the bay have lots of clay and water doesn't naturally infiltrate well. (Just try digging a hole to plant a tree, it's hard!) Palo Alto, Menlo Park, and other cities on "the flats" have clayey soil. The best place for recharge is in the hills or the base of the hills (for example Los Gatos Spreading basins near the intersection of 85 and 280).

The San Fernando Valley in Los Angeles comprises the outwash from the Los Angeles River and other streams. That ground is quite permeable. The San Fernando Valley has the right geology for percolation. The City and County of Los Angeles imposed a parcel tax to fund stormwater initiatives that was approved by the voters in 2018. This is funding stormwater capture and recharge, which will play a big role in securing the city's future water supply, along with water reuse.

In the Bay Area, one option to avoid the obstacles posed by the pervasive clay soils would be to have a centralized collection point, then treat the water and pump it to percolation ponds in areas where percolation is possible. But the pipeline for that is expensive. We've looked at that for capture and recharge of Coyote Creek water being pumped to the Los Gatos spreading basins. These basins were constructed in the 1920s and infiltrate water from Los Gatos Creek, downstream from the Lexington Reservoir. They were constructed to help address land subsidence due to over-pumping for irrigating the orchards that were once a dominant part of the local economy. Today those basins contribute to water supply and provide co-benefits of a park and hiking trails.

So the idea would be to capture runoff in Coyote Creek, which flows along the east side of San Jose, and take that water just before it enters the Bay. That's a lot of water, and building a pipe and pumping to Los Gatos is expensive. But it's still less than what we pay San Francisco Public Utility Commission for Hetch Hetchy water.

Stanford University, on the peninsula south of San Francisco, collects runoff on both the east and west sides of campus. It doesn't percolate because of the clay. Instead the university takes advantage of the campus lake water irrigation system and reverse pumps to Felt Lake. Felt Lake is Stanford's 'rain barrel.'

Another place in the peninsula area where stormwater is recharged is at Orange Memorial Park in San Mateo County.

FB: Your focus more recently has turned to groundwater storage. Can you describe how the planning, the infrastructure and the regulations differ between stormwater recapture and recharging groundwater? What are the similarities, if any, between the requirements of finding good basins in urban areas to store captured stormwater and finding the best places to develop recharge basins in the agricultural areas of the Central Valley? In which agricultural areas has groundwater been most successfully recharged?

RL: Because of the concern for groundwater protection in California, there are state regulations on injection of water into the subsurface. But they don't apply to capturing and percolating stormwater. Stormwater isn't injected; the regulations affecting it are passed by localities and typically address operational issues like holding time in a pond (a few days at most) to avoid allowing mosquitoes to breed. I think things are changing with increasing use of runoff. In Los Angeles the issue is urban contaminants like insecticides, herbicides, automotive chemicals and such. Lately, however, perfluorochemicals are receiving attention.

Los Angeles plans widespread deployment of dry wells and if this were done at a basin scale, some treatment would be needed. Dry wells are deep holes in the ground with gravel that receive street runoff with minimal treatment, like trash removal and sand removal.

FB: The Public Policy Institute of California reported recently that in the 2023 water year, the total volume recharged in California's Central Valley was 7.6 million acre feet, an increase of 17 percent over 2017. What changed? Can you describe what you have seen local water agencies doing to enhance their ability to develop the infrastructure needed to create recharge basins and direct excess water into them? How much does it cost, and where can that money come from?

RL: One change made in 2023, and continued in 2024 and 2025, is that the governor relaxed permitting rules for recharge. The rules were established years ago to ensure the downstream water rights holders didn't lose their water to upstream diversions. But with the overabundance of rain in 2023 and the potential for flooding in the San Joaquin Valley, it was clear that diversions to groundwater basins would not impact the downstream holders of water rights. So the diversions happened roughly from February to June, using mobile pumps and making sure the diverted water had no contact with dairy farms or land recently treated with fertilizer or pesticides.

“Another change is a movement towards irrigation districts building dedicated recharge basins.”

Another change is a movement towards irrigation districts building dedicated recharge basins. Dedicated basins can be engineered by scraping a compacted surface layer and clay and agricultural chemicals and building berms. Also, they can be repeatedly filled, and maybe six feet deep with periodic refilling. These might be 40 to 60 acres each.

Land in the San Joaquin Valley for a recharge basin might cost $20,000 per acre. There would be construction costs on top of that. The irrigation district charges fees for the delivery of water (and farmers comprise the district’s board’s membership.) This is happening in Madera and Fresno Irrigation Districts for example.


Don Cameron, left, general manager of Terranova Ranch, oversaw the construction of five miles of canals and the purchase of diesel booster pumps for recharge. Recharge water, right, flows through a pipe into an orchard at Terranova as part of a system designed to divert floodwater from the Kings River.
Andrew Innerarity/California Department of Water Resources

Farmers can do this too. Don Cameron, General Manager of Terranova Ranch, oversaw the construction of five miles of canals and purchase of diesel booster pumps for recharge. But this is expensive and took ten years with permitting and construction. Nonetheless, the ranch recharged over 18,000 acre feet in 2023. Terranova Ranch is a 9000-acre farm and has the resources to undertake an operation of this scale.

FB: What are the legal, practical, and political obstacles facing a water district that wants to enhance its ability to recharge floodwaters? How can they be overcome?

RL: This is something that requires more investigation. However, irrigation districts don’t condemn land. An irrigation district will advertise a purchase price for land and then see who comes forward with an offer. The irrigation district will decide based on various factors like adjacency to canals and what co-benefits may come with the purchase. I think one legal/political issue is to have a regular process for capturing high flows without the governor making a proclamation on a year-by-year basis. This could make temporary pumping permits predictable and less expensive.

FB: Some sites have much better geology for recharge than others. But the land that becomes available on Central Valley farms is priced based on its growing capacity, not its underground geology. How hard is it to locate recharge basins in the best spots?

This is a good question. What I've seen is that the irrigation districts have been in business for 100 years, and they know what areas are good for percolation. What they don't know is whether naturally occurring subsurface contaminants are a threat and how best to deal with that.

As a practical matter, which new sites are established for recharge depends on who wants to sell at an offered price. Then decisions are made as to whether this is a good deal or not. Therefore, the priority for irrigation districts shifts from site selection for optimal infiltration to implementing best management practices for water quality from the outset of recharge planning.

FB: You are working to accelerate the implementation of dedicated recharge basins. For every new recharge basin, there will be more acre-feet of water stored for future use. What metrics do you follow to determine the acceleration of dedicated recharge basins and the amount of water they can store?

In May 2024, water being diverted for the first time onto land that was converted to a groundwater recharge basin near Caruthers in Fresno County. Xavier Mascareñas / California Department of Water Resources

RL: Recharge basins percolate water, and a good recharge basin will look empty because the water has drained (i.e. it only looks like a lake for a short while.)

"For water quality, we need to ensure that the surface layer of the basin and the recharge water will not mobilize naturally occurring arsenic, chromium, and uranium."

Our approach considers a) water quality, b) recharge delivery, and c) co-benefits. These are three aspects needed to accelerate implementation of dedicated recharge basins. For water quality we need to ensure that the surface layer of the basin and the recharge water will not mobilize naturally occurring arsenic, chromium, and uranium. Our preliminary work shows that uncaptured, high flows offer a significant opportunity to help meet the needs of both irrigation districts and downstream users.

What’s missing is better understanding of the magnitude of such flows and what infrastructure investments would have the biggest payoff for capturing and recharging these flows while also reducing flooding risks. Irrigation districts recognize the importance of serving small communities in their districts but have not incorporated that recognition into their current operations. Simply stated, there is a need for insights on how to achieve co-benefits for all communities.

FB: As you reckon with the hydrological, economic and political realities of finding new ways to store water in California, do you think that the state’s water resiliency will get better or stay about the same over the next decade? Is there a different answer for urban water districts and rural irrigation districts?

RL: I am optimistic. Of course we need the political will, but recurring droughts are a reminder that we need to plan for a more water-resilient future.

There isn’t a single activity that will solve our water problems, but conservation, recycling, desalination, stormwater capture, recharge, and water banking will go a long way. Desalination can mean brackish surface water or groundwater, not just seawater. Locally, Alameda County Water District treats brackish groundwater, and Anitoch treats brackish surface water.

“There isn’t a single activity that will solve our water problems, but conservation, recycling, desalination, stormwater capture, recharge, and water banking will go a long way. ”

The coastal urban areas in California can reuse treated wastewater that otherwise would go to the ocean. We have some excellent examples in Orange County and Monterey. Increasingly, we see a move towards potable water reuse.

An agency like the San Francisco Public Utilities Commission can partner with irrigation districts like those in Modesto and Turlock to recharge water to help meet water demands and environmental flow requirements during droughts. Irrigation districts in the San Joaquin Valley can achieve the goals of the Sustainable Groundwater Management Act, the 2014 law designed to ensure future groundwater supplies, by capturing surge or flood flows with dedicated recharge basins.

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DWR Teacher Workshops Increase Access to Water Education
Department of Water Resources | April 23, 2025


DWR employee Emily Alejandrino teaching at the Project WET workshop.

DWR recently celebrated 10 years of educator workshops focused on climate change and the state's water resources. These workshops are a key part of DWR's commitment to supporting education about water and climate resiliency for California's schoolchildren.

DWR offers these workshops to teachers and environmental education professionals in partnership with the Water Education Foundation, who coordinates training for Project Water Education Today (Project WET) curriculum for California. Educator workshops include presentations by DWR environmental scientists about water and climate change, and Project WET curriculum training. After the training, participants receive Project WET guides and access to lesson plans for over 60 water-focused activities for all grade levels. By participating in these workshops, educators increase their knowledge of California's water resources as well as local and statewide mitigation and adaptation efforts to build climate resiliency. They go home prepared to share these science-based lessons with their students through hands-on, engaging activities.

In 10 years of these workshops, DWR has trained nearly 1,000 teachers, reaching over 250,000 students. "This investment in teacher education is an opportunity for DWR to help educators gain a better understanding of California's water resources and climate change impacts and solutions," said Karen Swan, water education specialist at DWR. "When teachers have confidence in their own knowledge, they are more prepared and excited to share with their students."

The most recent workshop was held in February in Stockton, in partnership with San Joaquin County Office of Education (SJCOE). "We strive to ensure our region's teachers have the resources and knowledge they need to teach about science and environmental literacy topics that impact our communities," said Tamara Basepayne, SJCOE director of STEM programs & outdoor education. "Teachers appreciate getting to interact with scientists who are on the ground doing this work every day. It helps them bring a passion for science and local resources to their community."

Educators who work with students in grades 3-12 are invited to participate in the next workshop on May 3 in Imperial County, hosted in partnership with the Imperial Irrigation District. To register or find information about this or other Project WET workshops as they are scheduled, visit the California Project WET website at https://www.watereducation.org/project-wet-workshops.

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How California Partners with the Federal Government on Water Infrastructure
Public Policy Institute of California | May 5, 2025 | Letitia Grenier and Jeffrey Mount

This is the second in a multi-part series examining the state-federal partnership in managing California's water.

When it comes to water, California tends to view itself as a self-contained system—and this perception is not without merit. Except for water diverted from the Colorado River along the state's southeastern border, water supplies in the state are derived solely from precipitation that falls on California's many watersheds.

But as in the other 49 states, California does not manage this water alone. As climate expert Daniel Swain explained in an interview with us last week, the federal government is a critical partner in water and weather forecasting, and declining federal involvement in these areas will have consequences for the state.

The federal government is also a key partner in California's overall water management, and here too, the current administration looks likely to shrink the role of the federal government. As these policies continue to unfold, we take stock of just how involved the federal government is in the day-to-day management of California's water.

Headwater forests

Headwater forests in California are the source of two-thirds of the state's water. Strong land management in these areas is crucial to maintaining water quality and protecting water infrastructure. Multiple federal agencies own and manage around half the land in the headwater regions, with the US Forest Service managing the largest tracts of land. In the Sierra Nevada and southern Cascade Mountains, which are home to the most critical water sources, that ownership rate rises to 70%. Although the state contributes a significant amount to managing these forests—thanks to recent passage of bond initiatives—most expenditures for fuel reduction to reduce wildfire severity are federal. And the federal government is a key partner during wildfire emergencies.

Water supply

The federal government is equally important to water supply management. At the top of list is the federally owned and operated Central Valley Project, a sprawling water supply project that supports farms and cities in the Central Valley along with some San Francisco Bay Area communities. It includes Shasta Reservoir, the largest reservoir in California, and hundreds of miles of aqueducts. The Central Valley Project also works closely with the State Water Project to supply water to nearly 30 million Californians. In addition, the federal government serves as the de facto watermaster for the Colorado River, where tensions are high between the seven states that rely on the river as supplies have dwindled since 2000 due to persistent drought.

The federal government invests heavily in water management, particularly on farms. Both the US Department of Agriculture (USDA) and the Bureau of Reclamation support efforts to improve water supply reliability and on-farm conservation. USDA's Natural Resource Conservation

Service (NRCS) coordinates with the Bureau on WaterSMART program investments that prioritize water conservation and drought resilience. (Federal investment in WaterSMART projects totaled over $4.3 billion in 2024 alone for both municipal and agriculture projects.) And NRCS houses the Environmental Quality Incentives Program, or EQIP, which pays farmers for implementing improved water management systems. Between 2017 and 2022, EQIP payments in California totaled nearly half a billion dollars.

Flood management

The federal government plays a crucial yet underappreciated role in river and coastal flood management. Here the federal government is involved in all phases of reducing flood risk. The US Army Corps of Engineers usually takes on the role of planning, designing, and estimating the costs and benefits of flood projects. Congress is the largest funder of large flood control infrastructure projects, typically providing 50–75% of the funding, and the Army Corps of Engineers often leads construction efforts. The Corps also prescribes how to manage the state's many reservoirs during floods.

Communities throughout the state rely on Federal Emergency Management Agency (FEMA) flood hazard maps to develop land use zoning and establish construction standards. The National Flood Insurance Program provides most flood insurance policies for businesses and homes on the floodplains. And during flood emergencies, the Army Corps of Engineers and FEMA support state and local governments in flood fighting and recovery.

Protecting native biodiversity and endangered species

Finally, two agencies—the US Fish and Wildlife Service and the National Marine Fisheries Service—play a large role in protecting native biodiversity and setting regulatory standards to protect endangered species. And the Environmental Protection Agency oversees the state's administration of the Clean Water Act, which protects water quality for all uses. These three agencies, along with the Army Corps of Engineers, the Bureau of Reclamation, the Forest Service, and others also invest in habitat restoration projects throughout the state.

This is just a short list of how the federal government is involved in California water. But it is intended to highlight a policy question: how should the state respond if the federal government reduces its involvement and investments in California water management? With many of these federal agencies already experiencing reductions in their labor force and more reductions planned, a diminished federal partner may be in California's future.

# # #

Environmental panel approves bill calling for tribal input on water projects
Lake County News Reports | April 30, 2025

A bill requiring the State Water Quality Control Board or regional water quality control board to describe and consider the impact on tribes of proposed water projects subject to their approval was approved today by the Assembly Committee on Environmental Safety and Toxic Materials.

Assemblymember James C. Ramos (D-San Bernardino) introduced the bill, AB 362, that also requires the state and local boards to adopt, when applicable, water quality standards to protect reasonable protections of tribal water uses.

“Under current law State and Regional Water Boards are not required to work with tribal communities even though the state’s First People have managed the land and its resources for centuries,” Ramos said. “Tribes are committed to the health and safety of delicate eco systems and a tradition of responsibility and stewardship. This long history and deep knowledge by our tribes deserves to be respected, and put to good use as we work to wisely manage our natural resources.

“We appreciate and applaud Committee Chair Damon Connolly and the committee members’ leadership today in voting to expedite the equitable protection of tribal uses of water,” said bill sponsor Shingle Springs Band of Miwok Indians’ Vice Chairperson Malissa Tayaba said. “By moving this critical issue forward, it shows a recognition of the need to finally elevate tribal beneficial uses to the same level as other beneficial uses that were codified decades ago. Designation and implementation of tribal uses statewide is long overdue. It’s time that California finally acts to put tribal uses of water on equal footing with other beneficial uses.”

In managing water quality and access, the State Water Board designates certain uses such as recreation, navigation, and preservation and protection of aquatic resources and wildlife as beneficial uses of water that are defined in the California Code of Regulations.

Also supporting AB 362 are Audubon California, Blue Lake Rancheria Tribe of California, Buena Vista Rancheria of Me-Wuk Indians, California Environmental Voters, California Indian Environmental Alliance, California Nations Indian Gaming Association, Clean Water Action, Colfax Todds Valley Consolidated Tribe of the Colfax Rancheria, Defenders of Wildlife, Friends of the River, Hopland Band of Pomo Indians, La Jolla Band of Luiseño Indians, Restore the Delta, San Francisco Baykeeper, Santa Rosa Rancheria Tachi Yokut Tribe, Santa Ynez Band of Chumash Indians, Save California Salmon, Sierra Club, Sierra Consortium Suscol Intertribal Council, The Climate Reality Project, California State Coalition, The Sierra Fund, Water Climate Trust and Wilton Rancheria.

AB 362 will head next to the Assembly Appropriations Committee.

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How California Partners with the Federal Government on Water and Weather Forecasts
Public Policy Institute of California | April 29, 2025 | Sarah Bardeen

This is the first in a multi-part series examining the state-federal partnership in managing California's water.

There's a lot in the news about changes underway at federal agencies, including agencies California relies on for water and weather forecasts. The reductions in funding and workforce will have implications for the state. As these changes continue to unfold, it's worth taking a step back to examine exactly how the state partners with the federal government on forecasts. We asked climate scientist Daniel Swain to explain.

How is the National Oceanic and Atmospheric Administration (NOAA) involved in weather forecasting in California?

NOAA operates a vast array of instruments that measure weather, including satellites, radar, wind sensors, weather balloons, and thermometers. NOAA also brings the data together and makes it available for free to the public, including easy-to-use visualizations, such as the NOAA Climate at a Glance portal. It's a fundamental public service used by researchers, businesses, local governments, and others.

Researchers from NOAA and the National Weather Service (NWS, which is housed within NOAA) also provide the backbone of all runoff predictions in California, which is very important for the state's water management, including water supply and flooding. They do this with help from federal partners including the US Department of Agriculture, US Army Corps of Engineers, US Geological Survey, and the National Science Foundation's National Center for Atmospheric Research. Together, these agencies provide highly reliable, real-time measures of flow and water quality on many rivers.

What role does local knowledge play in weather forecasts?

Local knowledge is still critically important. NWS operates field offices around the country—including 10 serving California—and the folks who work there have detailed local geographic and meteorological knowledge, relevant not only to weather but also to fire and water-related hazards, that predictive models often can't fully replicate. Human forecasters know a model's weak spots and biases, and they're good at adjusting predictions accordingly—as well as closely coordinating with local and state government agencies during emergencies. Human knowledge makes for better, more accurate, more timely, and better communicated predictions and warnings.

How does the private sector fit in with weather forecasting?

The private weather and water sector, including the companies behind websites and apps many of us consult regularly, all use freely available data from NOAA and the NWS as the basis for most of the informational products they offer. There's wide agreement that greater collaboration between public and private sectors on weather and climate would be desirable. Ironically, the federal government was on the cusp of taking a big step in this direction this year before staff reductions began.

It would be essentially impossible for the private sector to completely replace what NOAA and the National Weather Service provide, because it would be difficult to make a profit while still meeting the NWS's mission of providing critical and life-saving services to the entire American public on a 24/7/365 basis. Folks in the private weather sector understand that their industry relies, in large part, on critical services that NOAA makes freely available.

How does longer-term research relate to weather forecasting?

We know with certainty that the climate is warming, but a lot of important details remain fuzzy. The point of ongoing climate research is to bring those details into focus, including what the future may hold for droughts, wildfires, and floods. Having those answers sooner and with more clarity allows us to prepare with appropriate infrastructure, like levees and floodplain restoration, and management, like prescribed fire and sustainable vegetation treatments. The federal government is the primary funder of research to answer these questions, through internal studies at research labs and external research at universities.

Final thoughts?

Weather forecasting relies on information collected throughout the country and the world, including oceans, land surfaces, and the atmosphere. The federal government's size enables efficiencies of scale that are hard to replicate on state-by-state basis. It's not easy to launch and maintain a fleet of Earth-orbiting satellites and ground-based radars, and there's no way any entity could spin this up in a matter of weeks or months.

Forecast data from federal agencies benefit California and the rest of the US. For instance, this past January, we saw shockingly destructive wildfires in Los Angeles. As terrible as the outcome was, it could have been even worse. The National Weather Service's excellent advance predictions allowed LA and the state to stage firefighting resources in advance and take other preemptive measures. Had we not known that extreme winds following record-dry conditions were coming, the fires likely would have been even more numerous and destructive.

This is just one illustration of how California relies on robust federal involvement in weather forecasting and climate data collection and management. Given the recent and proposed reductions in NOAA's budget and workforce, it may be prudent for the state to consider how weather and water forecasting could work in California with a greatly reduced federal partner.

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