CALIFORNIA DEPARTMENT OF WATER RESOURCES

California's Groundwater Conditions: Semi-Annual Update

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CALIFORNIA DEPARTMENT OF WATER RESOURCES

California's Groundwater Conditions Semi-Annual Update: May 2024

Message from DWR Deputy Director of Sustainable Water Management

Paul Gosselin, DWR Director of Sustainable Water Management

Groundwater is a vital component of California's water supply, sustaining communities, households, agriculture, businesses, and the natural environment. Demand on California's groundwater system is increasing as our State continues to experience climate impacts, including extremes of drought and flood, and more precipitation coming as rain and less as snow.

Groundwater plays a key role in a reliable and resilient water supply future for California, as recognized in Governor Newsom's Water Supply Strategy which calls on the State and local agencies to expand groundwater storage as a key strategy to address the water supply challenges of our warming climate.

This fall marks the 10th anniversary of the signing of the Sustainable Groundwater Management Act (SGMA), California's landmark groundwater legislation that established a statewide framework to protect groundwater resources over time and empowered local agencies to manage their groundwater basins for long-term sustainably. Looking back over this first decade of SGMA, the state and local agencies have made incredible progress in understanding the State's groundwater resources and infrastructure through investments in new technologies, data, tools, and expanded monitoring efforts. State-local partnerships have been critical in achieving so much in such a short period of time under SGMA and improving the management of California's groundwater basins for a sustainable and resilient water supply future.

DWR releases a Semi-Annual Groundwater Conditions Update every spring and fall to provide the most up-to-date data and information on current groundwater conditions in California. These reports are part of the informational resources associated with DWR's comprehensive California's Groundwater (Bulletin 118) publication which is updated every five years. Together, these resources help state and local water managers better understand the groundwater system below our feet to help inform science-backed management decisions.

I am pleased to share the Spring 2024 edition of DWR’s Semi-annual Groundwater Conditions Update, which provides an overview of groundwater conditions after Water Year 2023, a year marked by historic precipitation and flooding, and one of the largest snowpacks in 70 years.

For the first time, this update contains data from Annual Reports submitted to DWR by local groundwater sustainability agencies (GSAs), providing a more comprehensive compilation of groundwater data than in past updates. This data, reported by GSAs across the 99 basins that submitted Annual Reports, shows that a remarkable 4.1 million acre-feet of managed groundwater recharge occurred in 2023, and for the first time since 2019, there was an increase in groundwater storage during Water Year 2023, with a reported increase of 8.7 million acre-feet.

While this is impressive and encouraging, long-term groundwater storage remains in a deficit from years of pumping more than what has been replenished. We need to continue streamlining processes and investing in water management strategies and infrastructure, like stormwater capture and groundwater recharge, and enhanced water conveyance facilities like the Delta Conveyance Project. As California works to address current and future water supply challenges, DWR will continue to guide and support local GSAs and water managers to ensure that our water supply remains resilient and reliable for all Californians into the future.

Deputy Director, Sustainable Water Management, California Department of Water Resources

Executive Summary

In September 2024, California will celebrate the 10-year anniversary of the Sustainable Groundwater Management Act (SGMA), a groundbreaking piece of legislation that established a statewide framework to safeguard the state's groundwater resources. SGMA granted local agencies the authority to manage their groundwater basins sustainably and directed the California Department of Water Resources (DWR) to provide technical and financial assistance while assessing statewide progress toward sustainability. Through the enormous efforts of local agencies and the uninterrupted support of DWR, California's water management landscape has undergone a transformation of unprecedented proportions in the last decade and is now better prepared than ever in managing state's precious water resources, particularly during flood and drought.

As the implementation of SGMA began, Groundwater Sustainability Agencies (GSAs) were established in June 2017, and the first-ever Groundwater Sustainability Plans (GSPs) were submitted by Critically Overdrafted (COD) basins in January 2020. By January 2022, GSPs had been submitted by all high- and medium- priority basins, indicating widespread commitment to SGMA implementation. In January 2024, DWR concluded its comprehensive review of all GSPs, marking another significant milestone. Beginning in 2020, GSAs submitted Annual Reports in April of each year. These reports not only provide a suite of groundwater data to DWR but also offer valuable insights into local water management operations and statewide progress toward sustainable water management goals. The current semi-annual report summarizes the most recent groundwater data received by DWR with a focus on Water Year 2023 (WY 2023).

During WY 2023, California experienced a rapid shift from extreme dry to extreme wet resulting in notable changes in precipitation, recharge, groundwater extraction, groundwater levels, and land subsidence compared to the preceding year. These shifts underscore the complexities of water resource management in the face of climate variability, presenting both challenges and opportunities for adaptation. In WY 2023, a three-year long drought from 2020 to 2022 gave way to extreme flooding in parts of the state and one of the largest snowpacks in decades.

Although WY 2023 ranked as the 8th wettest year in the last 50 years, with nearly 100 percent recovery of surface water reservoir levels, long-term groundwater storage in aquifers remains in a deficit due to decades of pumping that often exceeded the replenishment. Nevertheless, through cooperative efforts between the State and local agencies, available floodwaters in WY 2023 were effectively utilized to achieve remarkable levels of floodwater recharge, totaling approximately 453,000 acre-feet. This success was made possible by proactive water management strategies that included swift regulatory streamlining measures and financial support from the state for infrastructure enhancements. Additional locally driven recharge programs and projects in operation during WY 2023 allowed the State to achieve an annual total of approximately 4.1 million acre-feet of managed aquifer recharge, 3.8 million acre-feet of that recharge occurred in the San Joaquin Valley accounting for 93 percent of the total managed aquifer recharge in the state.

In WY 2023, increased surface water supply led to a significant reduction in statewide groundwater extraction, amounting to a total annual extraction of 9.5 million acre-feet, a stark contrast to the 17 million acre-feet extracted in WY 2022. The San Joaquin Valley accounted for more than half of the statewide reduction in groundwater extraction. This reduction, coupled with increased managed aquifer recharge, led to a positive change in groundwater storage of about 8.7 million acre-feet, in stark contrast to the negative change in storage of about 6.4 million acre-feet in WY 2022. Consequently, the groundwater levels rose by more than five feet in 52 percent of monitored wells, declined by more than five feet in 4 percent of wells, and remained steady (less than 5 feet change) in 44 percent of wells. However, long-term trends in groundwater levels indicate decreasing groundwater levels in 48% of monitored wells over the last 20 years due to a significant decrease in precipitation as compared to the previous 100 years and groundwater extraction that routinely exceeded the replenishment of groundwater aquifers. It underscores the fact that a single year, or even a few years, of heavy precipitation is not enough to refill the state's depleted groundwater basins. As anticipated, there was a decline in the number of reported dry wells during WY 2023 compared to previous years.

While active land subsidence was noted in the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions during WY 2023, it was over a much smaller area as compared to WY 2022. In contrast, an uplift exceeding 0.1 feet is observed over an area spanning about 800 square miles, which is almost 40 times more than the 23 square miles of area reported to have observed an uplift exceeding 0.1 ft during the five-year period from WY 2018 to WY 2022.

A very wet WY 2023 underscored the critical importance of proactive water management strategies, including groundwater recharge and infrastructure enhancements, to mitigate the impacts of climate-driven extremes. The state is actively investing in groundwater basin characterization programs and infrastructure upgrades to optimize groundwater storage and recharge capabilities.

While wet years offer temporary relief, achieving sustainable water management necessitates long-term planning and adaptation strategies, particularly in the context of a projected hotter, drier climate in California. Despite the positive trends in groundwater conditions observed in WY 2023, long-term groundwater storage deficits persist today owing to decades of pumping in excess of replenishment. To address this, the State will continue to invest in water management strategies like stormwater capture and groundwater recharge, while also proactively preparing for leveraging wet years to fortify long-term water supply resilience.

This semi-annual report presents data received by DWR as of April 2024, and reflects the impacts of wet WY 2023. However, it should be noted that groundwater response is a slow process and takes months to years to fully respond to changes in surface water conditions. This report is the latest in a series of Semi-annual Groundwater Conditions Updates, last published in October 2023. These updates are part of the informational resources associated with DWR's California's Groundwater (Bulletin 118). The most recent groundwater data is available on the California's Groundwater Live website, which is updated daily as data is received by DWR. Additional data and information are available in the CNRA Open Data and Water Data Library websites.

Since the enactment of SGMA in 2014, great strides have been made by local agencies and the state to collect, report, and disseminate groundwater data and improve management of groundwater resources. This semi-annual update compiles the best available data to illustrate the current conditions of California's groundwater resources. The disparity in reporting periods for various groundwater data sets in this semi-annual report is due to an inherent lag between local groundwater data collection in the field and reporting to DWR. Furthermore, the frequency of groundwater data collection is not the same for all data types. As a result, it is possible that all data collected locally for the period of analysis may not have been included in the summary and analysis presented in this semi-annual report.

Key Findings

Water Year 2023

- Statewide precipitation in Water Year (WY) 2023 ranks as the 8th wettest WY in the last 50 years and resulted in nearly 100 percent recovery of surface water reservoir levels.
- Despite record precipitation in some parts of the state in WY 2023, the cumulative departure from the average annual statewide precipitation (**Figure 1**) for the 2000-2023 period shows that there is declining precipitation trend during this period. Groundwater storage and level data similarly reflect decreasing long-term trends (**Figure 1** and **Figure 14**).
- New data from SGMA Annual Reports for WY 2023 show that for most basins there were decreases in groundwater extraction (**Figure 8**) and groundwater reliance (**Figure 9**), and an increase in groundwater storage (**Figure 10**).

Groundwater Management: Recharge, Extraction, and Change in Storage

- September 2024 will mark the 10-year anniversary of the Sustainable Groundwater Management Act (SGMA) in California. Over these past 10 years, GSAs and the State are more prepared to manage the state's water needs through floods and drought conditions.
- DWR has awarded over $121 million to 69 groundwater recharge projects.
- Governor Newsom's Executive Orders N-4-23, N-6-2023 and N-7-23 facilitated, by streamlining permitting requirements, the use of over 401,000 acre-feet of floodwaters to contribute recharge into California's groundwater basins (**Figure 5**).
- The large volumes of water that were recharged in WY 2023 compared to the previous five years reflect not only the high precipitation received across the state, but also the collaborative efforts of federal, state, and local agencies and landowners far surpassed the Water Supply Strategy goal to expand annual recharge by 500,000 acre-feet.
- In WY 2023, 21 of the 99 basins submitting Annual Report data reported a combined total of 4.1 million acre-feet of managed recharge. Of the total managed aquifer recharge, the San Joaquin Valley accounted for approximately 3.8 million acre-feet of managed recharge in WY 2023, about 93 percent of the States total managed groundwater recharge (**Figure 6).**
- During WY 2023, approximately 9.7 million acre-feet of groundwater was pumped from the 99 basins that submitted Annual Reports; this is a substantial reduction from the 17.5 million acre-feet reported by 96 basins in WY 2022.
- The San Joaquin Valley accounted for over 5.4 million acre-feet of groundwater extraction reported in Annual Reports, more than half of the State's total extraction in WY 2023 (**Figure 7**), which was a 52 percent decrease compared to the 11 million acre-feet extracted in WY 2022.
- The majority of groundwater basins across the state showed significant reductions in groundwater extraction in WY 2023 compared to WY 2022 (**Figure 8**). Groundwater use by basin as a percentage of total water use also decreased in the majority of basins between WY 2023 and WY 2022 (**Figure 9**).
- While the 8.7 million acre-feet increase in groundwater in storage represents significant progress towards replenishing aquifers, a single wet year is still not

enough to recover from several consecutive dry years. (**Figure 10**). In contrast, the previous two dry water years (WY 2022 and WY 2021), had a combined decrease in groundwater storage of 14.3 million acre-feet.

- The change in groundwater storage reflects the combination of recharge (managed and natural) and extraction. Data from 93 of the 99 basins submitting Annual Report data reported a positive annual change (increase) in groundwater storage, reflecting the cumulative effect of increased recharge and decreased extraction (pumping) brought about by a reduced reliance on groundwater during the wet WY 2023.

Groundwater Levels

- The one-year change data (**Table 10** and **Figure 11**) shows groundwater levels rose in 52 percent of monitored wells, declined in 4 percent of wells, and remained relatively stable in 45 percent of wells.
- In the Tulare Lake Hydrologic Region, groundwater levels rose in over 68 percent of the monitoring wells in WY 2023 (**Figure 11),** although 60 percent of wells had water levels that were still below normal at the end of WY 2023 (**Figure 12**).
- Long-term trends in groundwater levels (**Table 14, Figure 14**) indicate decreasing levels in 48 percent of monitored wells over the last 20 years statewide. Decreasing groundwater level trends are most pronounced in the Tulare Lake Hydrologic Region, while all other hydrologic regions had more wells with decreasing long-term groundwater level trends than increasing trends.

Land Subsidence

- Active land subsidence is observed in the Sacramento River, San Joaquin River, and Tulare Lake Hydrologic Regions (**Figure 15**).
- Between October 2022 and October 2023, an area of approximately 800 square miles experienced an uplift of greater than 0.1 feet, while an area of about 2,400 square miles subsided by greater than 0.1 feet. There are no areas that subsided by more than 0.6 feet (**Figure 15**).

Well Infrastructure and Data Reporting

- There were fewer domestic and irrigation well installations in 2023 compared to both 2022 and 2021 (**Table 14**).
- 669 dry wells were reported in WY 2023, fewer than those in WY 2021 (814) and WY 2022 (1,494). Even with a wet WY 2023, dry wells are still being reported in the beginning of WY 2024 (**Table 14**).
- Of the over 9,000 groundwater wells monitored in WY 2023, 13 percent had measurements for 10 or more months of the year and one percent were telemetered, providing near-real time continuous data (**Figure 20**)
- Real-time groundwater level data reporting is very limited with 23 percent of groundwater level measurement data being submitted within 60 days of collection and only about 10 percent submitted within 30 days (**Figures 21**).
- The state continues to work with local agencies and the public by increasing telemetered sites from 100 to over 150 between WY 2022 and 2023 to expand the collection and availability of real-time, publicly available data through telemetered sites.

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Introduction

After three consecutive years of extreme drought, California experienced extreme flooding and accumulation of one of the largest snowpacks in 70 years in 2023. A fourth consecutive year of drought was averted by the arrival of 31 atmospheric rivers to the west coast, 19 of which made landfall in California.

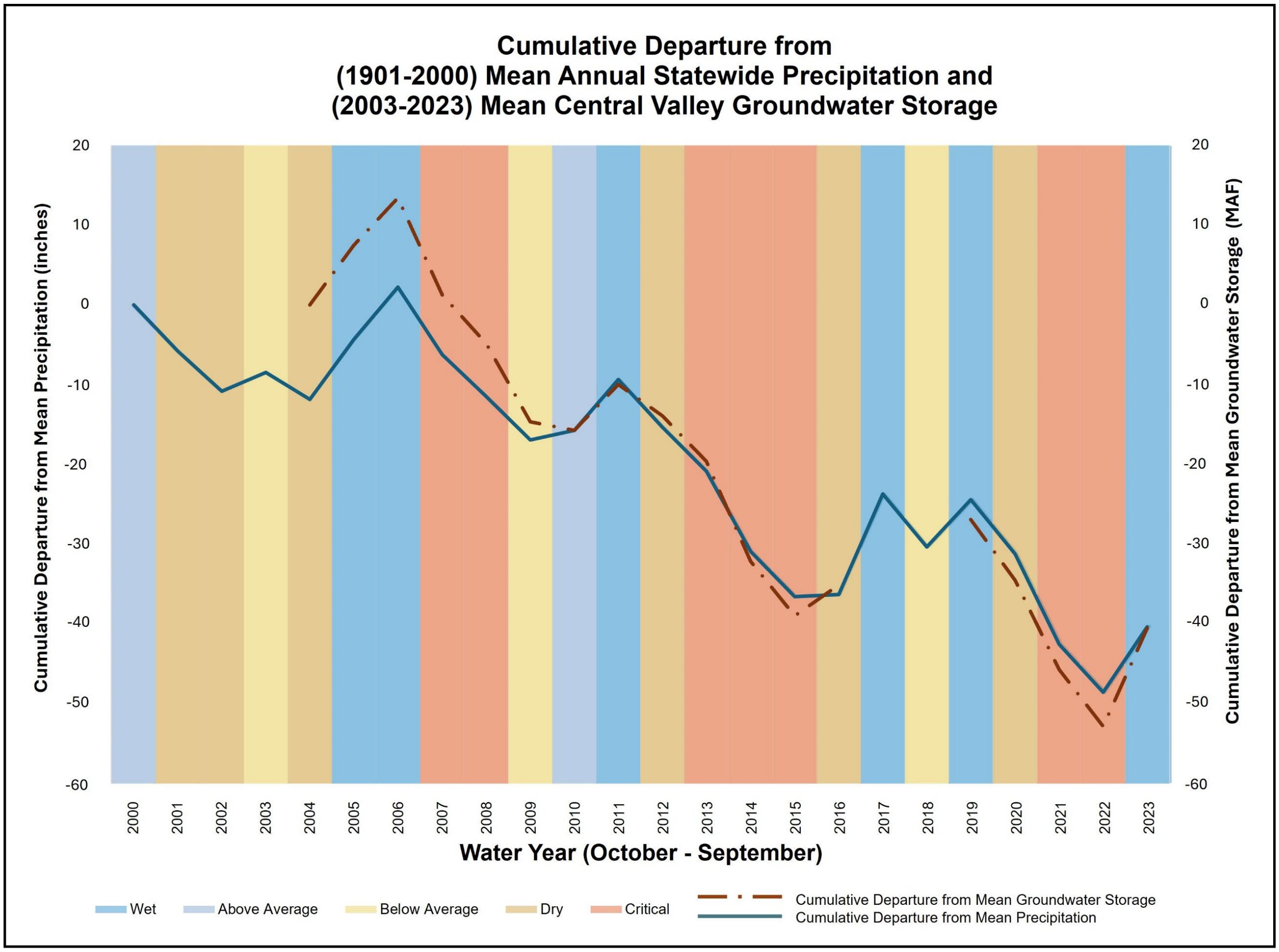
Local, state, and federal agencies across California have been working proactively and preparing for years to take advantage of wet years like Water Year (WY) 2023 which resulted in an unprecedented level of managed aquifer recharge. Additionally, the Governor's executive orders (N-4-23, N-6-23, and N-7-23) relaxed certain permitting requirements and the state took swift action to support local agencies to expedite diversions of extraordinary amounts of flood water away from vulnerable communities for groundwater recharge. Federal, state, and local agencies coordinated to prioritize the diversion of flood flows away from the reemerging Tulare Lake to protect vulnerable communities while bolstering groundwater recharge.

The heavy precipitation during WY 2023 greatly benefited surface water resources and contributed to a reduction in groundwater pumping and increased groundwater recharge, allowing for limited recovery of groundwater levels after many years of chronic decline. However, it is important to recognize that one year of heavy precipitation will not refill depleted groundwater basins. As California grapples with a hotter, drier climate, future forecasts indicate even more extreme variations between wet and dry seasons, changes in seasonal timing, and a warming climate that means less water will be available to meet our needs (California's Water Supply Strategy: Adapting to a Hotter, Drier Future).

The hydrologic cycle links surface and groundwater resources, and a reduction in precipitation over the last 20 years coincides with a reduction in groundwater storage. The cumulative departure from mean for both precipitation and storage are plotted in **Figure 1** for 2000 to 2023. **Figure 1** shows how recent precipitation within the state has fallen short of the long-term (1901-2000) mean and correlates with a reduction in groundwater storage. The necessity of pumping more groundwater during periods of decreased precipitation and reduced surface water availability, combined with diminished natural recharge rates, leads to an overall decline in water availability within the system and the observed reductions in groundwater in storage.

Despite experiencing the second most rainfall of the 2000-2023 period, WY 2023 was a wet year amidst a declining precipitation trend. While groundwater recovery can be observed following wet years, the overall storage remains lower than it was two decades ago. These trends underscore the urgent need for sustainable groundwater management practices to ensure water resiliency amidst ongoing climate challenges.

Figure 1: Cumulative Departure from Long Term (1901-2000) Mean Annual Statewide Precipitation based on data from NOAA National Centers for Environmental Information and NASA GRACE-FO* ([Climate at a Glance: U.S. Time Series, Precipitation]()).



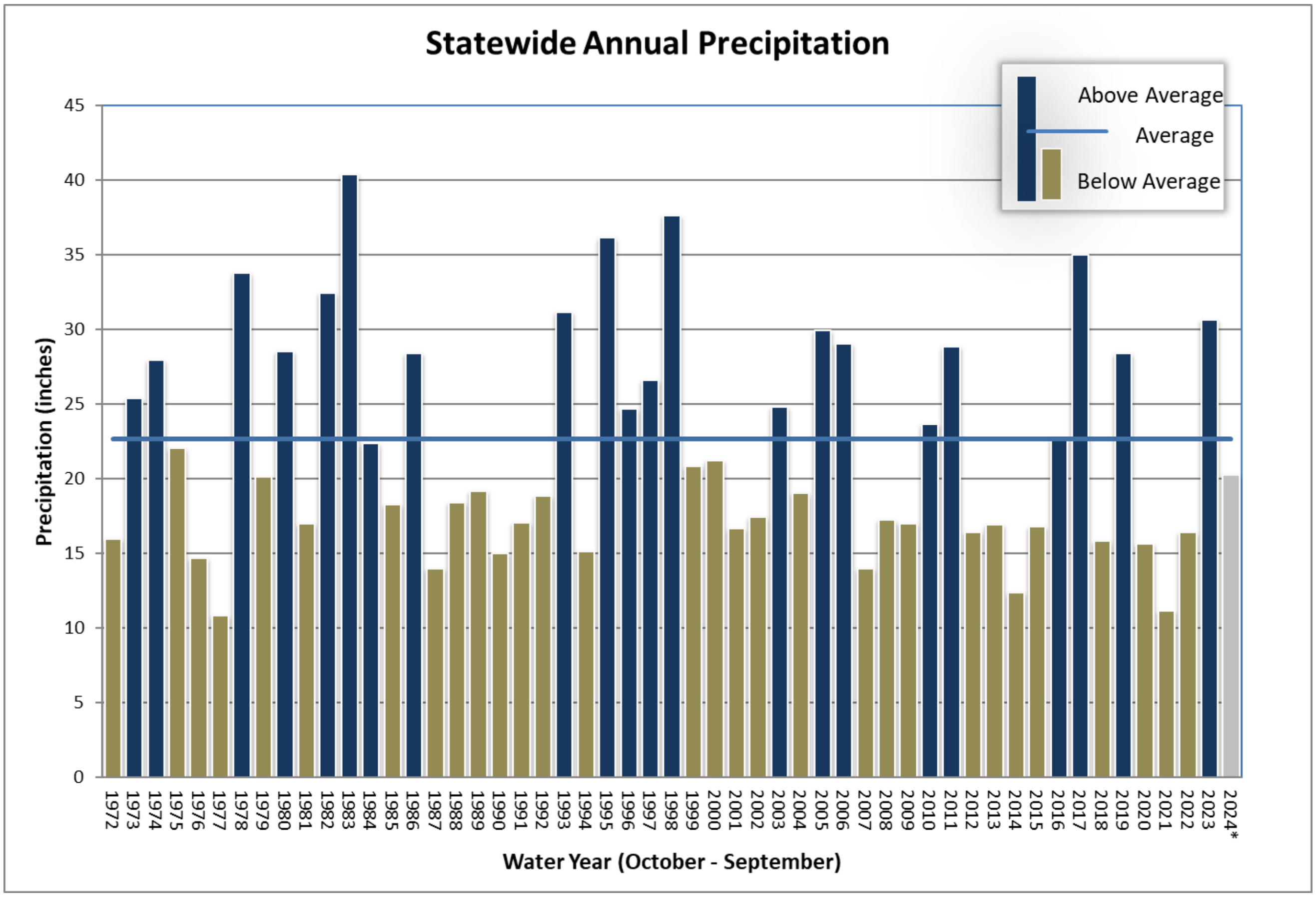
**NASA GRACE/GRACE-FO data provided by personal communication from J.T. Reager at NASA Jet Propulsion Laboratory)*

Water Year 2023 Precipitation, Recharge, and Water Management

Historic Precipitation and Snowpack

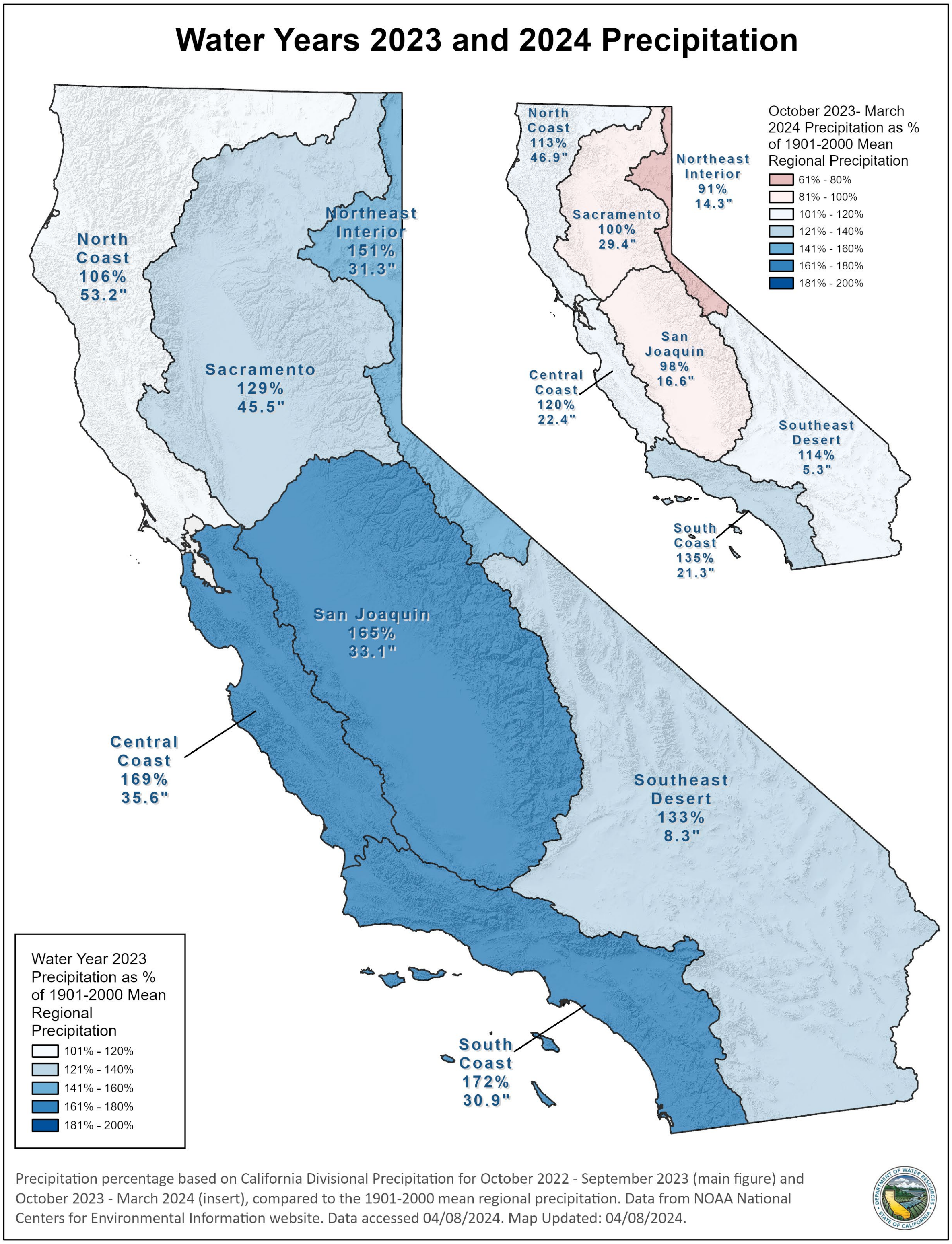
The extreme precipitation and flooding in California in WY 2023 made headlines but these conditions were not uniformly observed across the state and are not representative of the prolonged dry weather conditions that have characterized the state's climate over the past two decades. Despite WY 2023's wet conditions, long term trends show extended dry periods intermixed with infrequent wet periods (**Figure 2**). Over the last 23 years, there have been 16 years of dry weather conditions. Of those dry years, three (19%) have been below average; six (37%) have been dry; and seven (44%) have been critically dry (**Figure 1**).

Figure 2: Statewide Annual Precipitation, NOAA National Centers for Environmental Information, (Climate at a Glance: U.S. Time Series, Precipitation). *WY 2024 Precipitation (grey) through March 2024.



In WY 2023, precipitation exceeded the long-term (1901-2000) mean in all hydrologic regions of the state. **Figure 3** shows the amount of precipitation as a percent of the long-term mean for each hydrologic region. As discussed in more detail in the California Groundwater Conditions Update – October 2023 report, extreme amounts of precipitation, with much occurring as snowfall, was experienced in the San Joaquin, Central Coast and South Coast Hydrologic Regions. For comparison, **Figure 3 inset** provides the precipitation information for WY 2024 year-to-date. As of April 2024, statewide precipitation is closer to mean with the coastal and southern desert regions slightly above mean, and the Central Valley regions at mean values. The combination of a wet year followed by an average year allows for generally favorable groundwater conditions for the remainder of WY 2024.

Figure 3: 2023/2024 Water Year Precipitation NOAA National Centers for Environmental Information (Climate at a Glance: Precipitation), CDEC (Snow Pack Conditions Snow Water Content).



Groundwater Recharge and Surface Water Diversions

Historic wet years like WY 2023 underscore the importance of California's natural and built groundwater infrastructure and its ability to capture, convey, and store high flows from precipitation events. Although wet years can refill reservoirs and restore natural surface water systems, recent history indicates they are typically infrequent and isolated occurrences that serve as brief interruptions within longer periods of dry and drought years. For example, since 2000, there have been 13 dry/critical years and only six wet years, with 2005-2006 being the only consecutive wet years. During wet years, groundwater accounts for approximately 40 percent of the state's total water supply and during dry years it accounts for up to 58 percent of total water supply. Groundwater plays an important role in a reliable and resilient water supply for California. A key strategy to managing California's water resources through climate-driven weather extremes is to be able to utilize California's natural and built water infrastructure to divert the abundance of surface water available during wet years like WY 2023 for infiltration or application to the aquifers, known as groundwater recharge. The Newsom Administration's California's Water Supply Strategy: Adapting to a Hotter, Drier Future identified groundwater recharge as a key strategy and set the goal of expanding average annual groundwater recharge by 500,000 acre-feet.

Groundwater recharge occurs when water moves down (infiltrates) from the ground surface, or from the bottom of a waterway, through the subsurface into an underlying aquifer (**Figure 4**). This movement of water from the surface to the subsurface helps to restore and replenish groundwater aquifers throughout the state, which have been over-pumped during prolonged drought conditions. Groundwater recharge occurs both naturally across the landscape as well as when facilitated by human actions, known as managed aquifer recharge. Managed aquifer recharge is an important water resiliency strategy, helping to bolster California's ability to respond to future drought conditions and meet water needs. The systems and pathways throughout the state that facilitate and expedite all forms of groundwater recharge and storage are referred to as the natural and built groundwater infrastructure.

Natural groundwater infrastructure includes rivers, springs, floodplains, wetlands, aquifers (in both alluvial groundwater basins and hard rock [non-basin] areas), permeable outcrops, mountain meadows, natural wetlands, and other pathways that naturally exist in the environment that have facilitated groundwater recharge, discharge, and storage for millions of years.

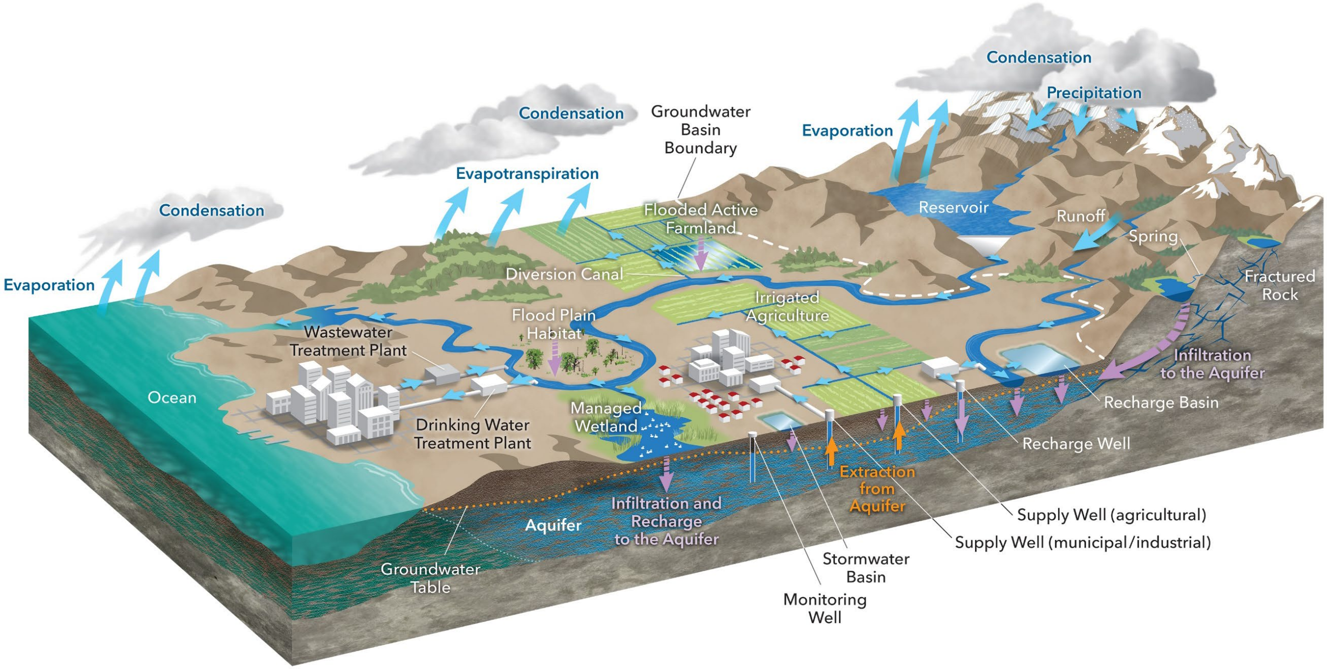
Built groundwater infrastructure includes the facilities, conveyance, and strategies that humans have developed and used to extract, replenish, and convey groundwater. Extraction from the aquifers and hard rock (non-basin) areas occurs via wells that pump groundwater to the surface for use. Infrastructure and strategies that help to replenish groundwater, managed aquifer recharge, include recharge basins, intentional flooding of agricultural fields, aquifer storage and recovery wells (injecting water directly into the aquifer), unlined canals, stormwater capture, conveyance infrastructure, recycled water recharge, multi-benefit areas such as engineered wetlands, recreational areas with recharge ponds, fluvial floodplain restoration, etc. These facilities and strategies are designed to divert surface water from local waterways for the purpose of recharge, rather than allowing the surface water to flow out of the basin.

The practice of using surface water instead of groundwater, when conditions allow, is called "in-lieu" recharge, and is a conjunctive use management strategy that helps to offset groundwater withdrawals, leaving groundwater in the aquifer. This is especially important when pumping reductions occur in areas where it is difficult to recharge the aquifer due to lack of natural or built infrastructure, or within a confined, and in many cases deep, aquifer. When in-lieu recharge is used in areas that rely on groundwater from deep, confined aquifers, the pumping reductions can also help to halt or prevent land surface collapse, called land subsidence, that has been experienced in some areas of the state due to over-pumping (**Figure 16**).

Quantifying recharge is important for groundwater management and understanding impacts to groundwater storage. However, quantification is difficult due to variability in precipitation and recharge across the hydrologic regions of California. DWR is coordinating with multiple entities to gather the best available information to estimate natural recharge in California. One such entity is the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory's (JPL) Gravity Recovery and Climate Experiment (GRACE) program, which measures gravity field fluctuations to calculate changes in the mass of Earth's hydrologic, cryospheric, and oceanographic components through time. NASA JPL has used GRACE data to estimate the change in total groundwater storage in the Central Valley and nearby areas (**Figure 1**). DWR is also enhancing its existing California Central Valley Simulation Fine Grid (C2VSimFG) model that will allow for more comprehensive estimates for Central Valley-wide changes in groundwater storage. Improved understanding of broad-scale hydrologic changes through time will provide context and insight for the regional changes in groundwater in storage and components of the hydrologic cycle, such as recharge.

In contrast, the amount of managed aquifer recharge occurring within the built groundwater infrastructure is more readily quantified; however, systematic and regular statewide reporting is not established, resulting in numerous data gaps. To date, calculating the volume of managed aquifer recharge has relied on a variety of data sources and assumptions, making it challenging to capture the complete picture of recharge across the state.

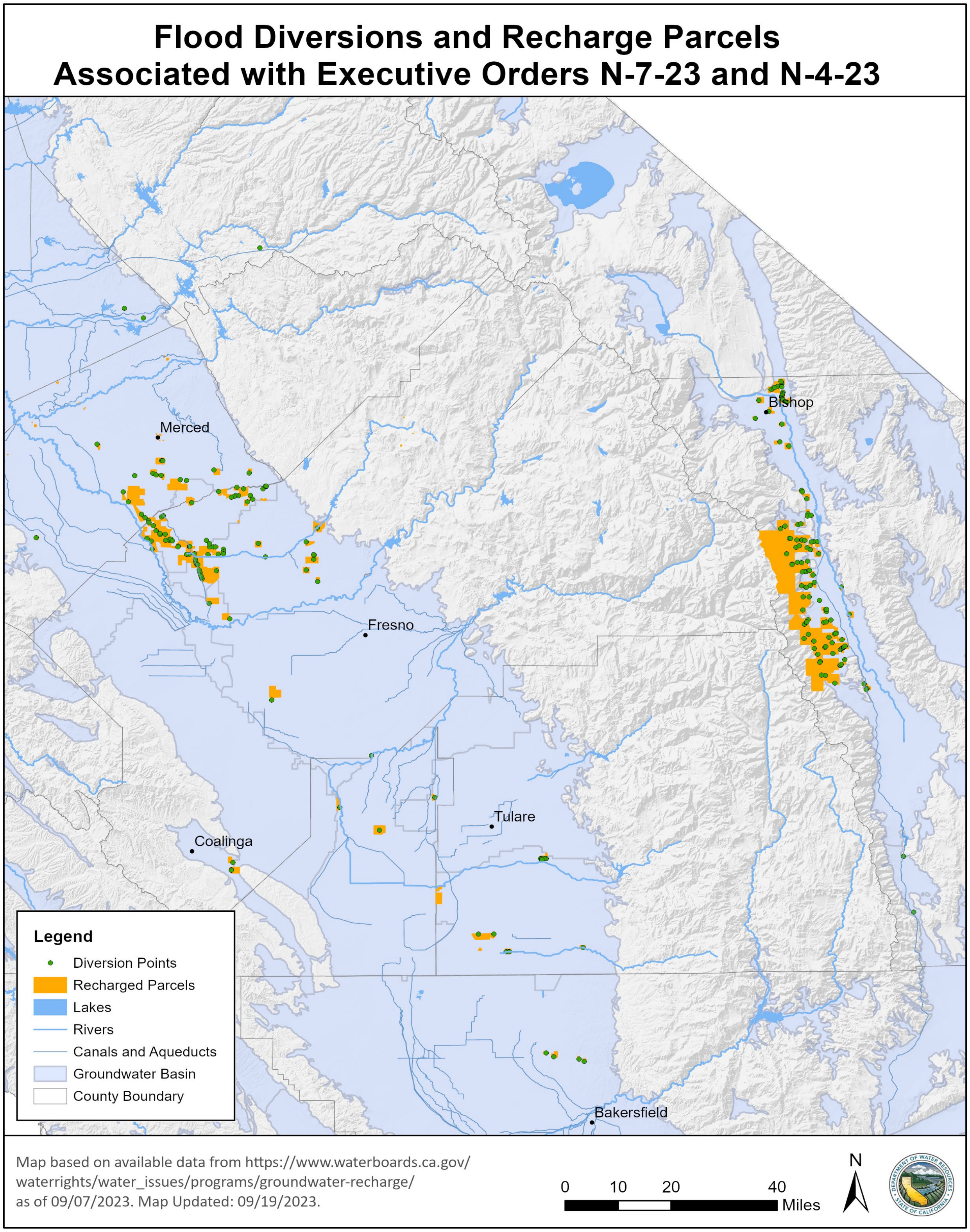
Figure 4: Schematic of the Hydrologic Cycle emphasizing the recharge mechanisms for natural and managed recharge.



Water Year 2023 Diversions and Recharge

The importance of California's built water infrastructure is demonstrated by the implementation of both water supply and resiliency strategies, as well as flood risk reduction strategies in a wet year, like WY 2023. The intense flooding and flood risk in several areas of the state resulted in the activation of emergency response by federal, state, and local agencies to protect communities. Governor Newsom's Executive Orders N-4-23, N-6-23, and N-7-23 expedited diversions from waterways for flood risk reduction and groundwater recharge by clarifying that diversions of flood flows for flood management can be used to recharge aquifers. DWR and local agencies worked together to leverage existing capacity and resources to divert as much excess water as possible from the local river systems and away from vulnerable communities at risk of flooding or experiencing active flooding. A reported 401,403 acre-feet of floodwater was diverted under the Executive Orders for flood risk reduction and groundwater recharge onto 95,575 acres of land. **Figure 5** shows the points of diversion and parcels reported to the State Water Resources Control Board (SWRCB) where floodwater was diverted and recharged. The Executive Orders also called for collaboration between state agencies to expedite recharge project permitting and coordination with local agencies. The SWRCB issued ten (10) temporary permits for underground storage in WY 2023 for a total of 669,353 acre-feet of permitted recharge capacity, as well as a Temporary Use Change Permit to the Bureau of Reclamation which allowed for up to 602,182 acre-feet in additional diversions for recharge in the San Joaquin Valley.

Figure 5: Recharge and diversion locations associated with Executive Orders N-7-23 and N-4-23.



Based on extensive outreach and listening to the challenges of local agencies during the flood emergency, DWR launched the Temporary Flood Diversion and Recharge Enhancement initiative which provided 30 temporary pumps to six local agencies in the San Joaquin Valley to divert more flood water from local waterways to areas for recharge. A volume of 10,837 acre-feet of diversions for recharge were reported under this initiative. DWR also assisted local agencies in land clearing by removing 291 acres of orchards and vineyards, which prepared the land to receive future floodwater, reducing the local district's flood risk and increasing recharge capacity. A summary of the diversions resulting from these state-enhanced recharge diversion efforts during WY 2023 is shown in **Table 1**.

In July 2023, Senate Bill 122 codified many of the provisions of the aforementioned flood diversion Executive Orders into the California Water Code (CWC) Section 1242.1, which allows parties to divert flood waters for groundwater recharge without a water right under certain conditions. Like the Executive Orders, CWC Section 1242.1 places requirements on the location and timing of diversions and requires reporting of any diversions to the SWRCB and the appropriate GSA.

Table 1: Water Year 2023 Diversions for Flood Risk Reduction and Recharge.

Diversion Source	Reported Diversions (acre-feet)	Permitted Capacity (acre-feet)	Data Source
Executive Orders	401,403	Not applicable	Governor's Executive Orders N-7-23 & N-4-23 For Flood Diversion
Water Code § 1242.1	0	Not applicable	Flood Recharge Diversions (Water Code §1242.1)
SWRCB Temporary Permits – Underground Storage	20,031	669,353	Pending Temporary Permits for Underground Storage
SWRCB Temporary Use Change Petition – United States Bureau of Reclamation	20,677	602,182	Temporary Urgency Change Petitions
DWR's Temporary Flood Diversion and Recharge Enhancement Initiative	10,837	Not applicable	Participating Local Agency Reporting
Total	**452,948**	**1,271,535**	

GSP Annual Reports Managed Aquifer Recharge - WY 2019 to WY 2023

As part of SGMA implementation, Groundwater Sustainability Agencies (GSAs) and other local agencies are required to report managed aquifer recharge within their groundwater basins or subbasins on an annual basis. SGMA Annual Reports have been submitted in phases:

- Alternative Plan Annual Reports submitted in 2017 for WY 2016
- Critically Overdrafted basin Annual Reports first submitted in 2020 for WY 2019
- Remaining SGMA basin Annual Reports first submitted in 2022 for WY 2021

In this section, Annual Report data submittals of managed aquifer recharge since WY 2019 are discussed. WY 2023 Annual Report details for recharge, extraction, and change in storage are provided in subsequent sections of this report.

The reported annual managed aquifer recharge volumes, as summarized in **Table 2**, capture nearly all the diverted volumes and represent the most comprehensive current information available. The WY 2023 annual report recharge data were received from 99 high and medium priority basins, accounting for about 90% of pumping in all groundwater basins. Adding the adjudicated areas, totaling about 130 basins, accounts for about 98% of groundwater pumping in all 515 basins in California. Receiving this information on an annual basis is a significant step in DWR's efforts to better understand and track recharge efforts in California. **Table 2** shows the GSP Annual Report managed aquifer recharge volumes from WY 2019 to WY 2023.

Table 2: GSP Annual Report Managed Aquifer Recharge Volumes, 2019-2023. Table based on available data from CNRA Open Data as of 4/18/2024.

Water Year	Water Year Type	Number of Basins Submitting Annual Reports	Number of Basins Reporting Managed Recharge	Managed Aquifer Recharge Volume (AF)
WY 2019	Wet	23	9	2,144,61
WY 2020	Dry	26	8	525,059
WY 2021	Critical	94	12	205,428
WY 2022	Critical	98	15	315,089
WY 2023	Wet	99	21	4,136,259

The abundance of surface water in WY 2023 is clearly apparent when comparing reported managed recharge volumes over the last 5 years. When comparing WY 2022 and WY 2023, the following observations are made:

- An additional 3,821,170 acre-feet of water were recharged to the aquifers in WY 2023, which is over 13 times the volume recharged in WY 2022.
- All basins with reported recharge volumes in WY 2022 reported increased recharge volumes in 2023. Individual basin recharge volumes in WY 2023 ranged from 1.05 times to over 188 times that of WY 2022.
- 6 additional basins reported recharge for WY 2023 that did not report recharge in WY 2022. Four of those basins reported recharge for the first time and 2 basins reported recharge for the first time since WY 2020.

The most recent wet year prior to WY 2023 occurred in WY 2019. GSP Annual Report data for WY 2019 were received from 23 basins, nine of which reported volumes for managed aquifer recharge. When comparing managed aquifer recharge volumes between WY 2019 and WY 2023 for those nine basins, the following observations are made:

- An additional 1,618,448 acre-feet of water were recharged in WY 2023, which is about 1.9 times the volume recharged in WY 2019.
- All but one basin reported increased recharge volumes in WY 2023 compared to WY 2019, with individual basin recharge volumes in WY 2023 ranging from 0.9 times to over 7.3 times that of WY 2019.
- These nine basins, primarily COD basins located in the San Joaquin Valley, account for 91 percent of the total managed aquifer recharge volume in WY 2023.

The large volumes of water that were recharged in WY 2023 compared to the previous five years reflect not only the high precipitation received across the state, but also the collaborative efforts of federal, state, and local agencies and landowners to expedite high flow diversions, facilitate and implement recharge projects, and maximize use of the current natural and built groundwater infrastructure. Those efforts far surpassed the Water Supply Strategy goal to expand annual recharge by 500,000 acre-feet. For more detailed information about the GSP managed aquifer recharge volumes, see the section GSP Data: Groundwater Recharge, Extraction, Change in Storage.

In-Lieu Recharge

In-lieu recharge is equally as important as groundwater recharge by infiltration or injection. It relies on the intentional delivery and use of surface water as an alternative to pumping groundwater. In-lieu recharge capacity depends on surface water availability and the existing infrastructure to store and convey that water to where it is needed. In some areas, in-lieu recharge is the most effective type of recharge because it leaves groundwater in the aquifer by reducing pumping. This can provide replenishment to both deep confined aquifers and shallow unconfined aquifers, depending on the vertical zone of the underlying aquifer where pumping is reduced. Reduction of pumping in the deeper confined aquifers can have significant benefits toward subsidence mitigation by reducing or slowing the dewatering and compaction of the fine-grained materials in deep aquifers.

Enhanced Recharge Capacity Through Local and State Actions

In addition to the reported volumes of diversions and recharge, assessing recharge capacity is important for a comprehensive understanding of the recharge infrastructure and for tracking progress toward recharge goals. Recharge capacity refers to the total recharge capability of the current natural and built infrastructure.

Efforts to continue or expand recharge are identified in many GSPs as projects and management actions for achieving sustainability. DWR has been assisting the advancement of these local projects through financial and technical assistance. Some of the recharge projects described in the GSPs were at least partially, if not fully, funded by DWR grants or other state financial assistance programs. Since 2018, DWR has awarded over $121 million to 69 groundwater recharge projects. Estimated recharge benefits for these projects are currently being compiled; however best available information indicates almost 115,000 acre-feet per year of potential recharge capacity. Additionally, Governor Newsom's flood and drought Executive Orders allowed for suspension of CEQA requirements for water conservation, flood management, and recharge projects that met certain criteria, expediting construction of these projects. **Table 3** shows the best available information gathered in 2023 from all GSPs, Executive Orders, and Financial Assistance records regarding existing and planned recharge projects. The GSP recharge capacity information presented here is taken from GSPs submitted in 2020 and 2022, and some of which did not contain recharge capacity information. Therefore, the information presented in **Table 3** does not represent the complete recharge capacity picture; however, it represents the current best available information. DWR is working toward refining this information.

Table 3: Existing and Planned Additional Recharge Capacity.

	Total Number of Projects	Existing Capacity (AF)[b]	Estimated Planned Additional Capacity (AF)[b]
GSP Recharge Projects	357	2,251,572	854,962
Executive Order CEQA Exemptions for Recharge Projects[a]	24	Not applicable	144,795
DWR Financial Assistance for Recharge Projects	69	Not applicable	114,860

[a] Includes projects approved under Executive Order N-7-22, Actions 5 and 13 and Executive Order N-7-23, Action 6. Many projects that received CEQA suspensions under the Executive Orders also received financial assistance from DWR.

[b] These numbers are based on the information provided in the initial GSP submittals. Recharge capacity is often reported as potential or estimated annual recharge benefits.

Water Year 2023 was significant for many reasons, with recharge often being in the spotlight. The State is working to better understand the natural and managed recharge occurring across the state as well as identifying ways to facilitate and expedite more recharge via the natural and existing groundwater infrastructure, especially during extreme weather events. California's natural groundwater infrastructure is immense, with groundwater basins providing between 850 million to 1.3 billion acre-feet of storage, which is about 32 to 50 times more than the combined storage of about 26 million acre-feet in the state's surface reservoirs. DWR has launched the Basin Characterization Program that is collecting, analyzing, and archiving datasets that enhance the understanding of aquifer systems to support State and local agencies in managing California's natural infrastructure. Key goals of this program related to recharge are: (1) provide information regarding the recharge suitability of an area for enhanced recharge; (2) identify and delineate pathways for groundwater to recharge into different aquifer systems; and (3) conduct pilot studies. DWR is also working to better understand the built groundwater infrastructure in the state, which is crucial for identifying ways to optimize, enhance, or incentivize actions that utilize the built infrastructure for water resiliency and California's ability to respond to climate-driven weather extremes.

GSP Annual Report Data: Recharge, Extraction, Change in Storage - WY 2023

As part of SGMA implementation, DWR receives Groundwater Sustainability Plan (GSP) and Alternative Plan Annual Report datasets from GSAs every year in April for the previous water year. These reports are publicly available on the SGMA Portal GSP Status Summary Page. The information provided in these Annual Reports includes groundwater recharge, extraction, water use, and change in groundwater storage. This information provides insights into the balance between groundwater withdrawals and replenishment, helping to gauge the sustainability of a GSA's groundwater practices and resources.

Groundwater Recharge Reported from WY 2023 GSP Annual Reports

In WY 2023, 21 of the 99 basins submitting Annual Report data reported a combined total of 4.1 million acre-feet of managed recharge. For WY 2023, groundwater basins with the highest groundwater recharge per area (total groundwater recharge normalized by basin area, reported as AF/Acre) are listed in **Table 4**, and the basins with the highest total groundwater recharge (AF) are listed in **Table 5**.

Figure 6 depicts groundwater recharge (per area and total) for basins subject to SGMA for WY 2023.The Central Valley accounted for approximately 3.9 million acre-feet of the state's 4.1 million acre-feet of recharge, with the highest recharge amounts reported in the San Joaquin Valley, accounting for approximately 3.8 million acre-feet of recharge in WY 2023, or about 93 percent of the state's groundwater recharge. The highest reported managed recharge per area occurred in the Oxnard, Tule, and Kern County subbasins, with recharge of 1.92, 1.46, and 1.02 acre-feet per acre, respectively. The greatest volumes of recharged groundwater occurred in the Kern County, Tule, and Kings subbasins, accounting for 1,824,171; 698,330; and 651,277 acre-feet, respectively.

Table 4: WY 2023 Groundwater Recharge per Area by Basin. Top 10 basins as volume and normalized by basin area. Recharge values based on data reported through 2023 GSP/Alternative annual reports.

Basin Name (Top 10 ranked by groundwater recharge per area)	Basin Number	**Groundwater Recharge per Area (AF/Acre)***	Groundwater Recharge (AF)	Basin Area (Acres)
Santa Clara River Valley - Oxnard	4-004.02	**1.92**	111,254	57,888
San Joaquin Valley - Tule	5-022.13	**1.46**	698,330	477,590
San Joaquin Valley - Kern County	5-022.14	**1.02**	1,824,171	1,782,318
San Joaquin Valley - Kaweah	5-022.11	**0.72**	316,800	441,048
San Joaquin Valley - Kings	5-022.08	**0.66**	651,277	981,323
Santa Clara Valley - Santa Clara	2-009.02	**0.49**	93,600	189,581
Gilroy-Hollister Valley - Llagas Area	3-003.01	**0.42**	19,800	47,371
San Joaquin Valley - Chowchilla	5-022.05	**0.42**	60,440	145,574
Santa Clara Valley - Niles Cone	2-009.01	**0.35**	22,728	65,214
San Joaquin Valley - Westside	5-022.09	**0.26**	161,930	622,208

**Groundwater recharge per area is not indicative of local recharge rates or infiltration properties.*

Table 5: WY 2023 Groundwater Recharge by Basin. Top 10 basins as total volume. Recharge values based on data reported through 2023 GSP/Alternative annual reports.

Basin Name (Top 10 ranked by groundwater recharge)	Basin Number	**Groundwater Recharge (AF)**	Groundwater Recharge per Area (AF/Acre)	Basin Area (Acres)
San Joaquin Valley - Kern County	5-022.14	**1,824,171**	1.02	1,782,318
San Joaquin Valley - Tule	5-022.13	**698,330**	1.46	477,590
San Joaquin Valley - Kings	5-022.08	**651,277**	0.66	981,323
San Joaquin Valley - Kaweah	5-022.11	**316,800**	0.72	441,048
San Joaquin Valley - Westside	5-022.09	**161,930**	0.26	622,208
Santa Clara River Valley - Oxnard	4-004.02	**111,254**	1.92	57,888
Santa Clara Valley - Santa Clara	2-009.02	**93,600**	0.49	189,581
San Joaquin Valley - Chowchilla	5-022.05	**60,440**	0.42	145,574
San Joaquin Valley - Delta-Mendota	5-022.07	**53,600**	0.07	764,964
San Joaquin Valley - Madera	5-022.06	**42,632**	0.12	347,667

Groundwater Extraction Reported from WY 2023 GSP Annual Reports

During WY 2023, approximately 9.7 million acre-feet of groundwater extraction, or groundwater pumping, was reported across the 99 basins that submitted Annual Reports, down from the 17.5 million acre-feet reported in WY 2022 (California Groundwater Conditions Update – October 2023). For WY 2023, groundwater basins with the highest groundwater extraction per area (total groundwater pumped normalized by basin area, reported as AF/Acre) are listed in **Table 6**, and the basins with the highest total groundwater extraction (AF) are listed in **Table 7**.

Figure 7 depicts groundwater extractions (per area and total) for basins subject to SGMA for WY 2023. The Central Valley accounted for over 7.7 million acre-feet of pumping in WY 2023, about 79 percent of groundwater extractions in California in that year. Although the highest extraction volumes of over 5.4 million acre-feet occurred within the San Joaquin Valley, 54 percent of the state's extraction, the highest extraction rates were found in smaller basins outside the valley. The greatest extraction per area occurred in the Fillmore, 180/411 Foot Aquifer, and East Side Aquifer basins, with extraction rates of 1.48, 1.45, and 1.44 acre-feet per acre, respectively. The greatest extraction volumes were in the Kings, Eastern San Joaquin, and Kern County subbasins, accounting for 864, 806, and 751 thousand acre-feet, respectively. The extraction volumes closely correlate to reported change in storage for each respective subbasin.

Table 6: WY 2023 Groundwater Extraction per Area by Basin. Top 10 basins as volume and normalized by basin area. Extraction values based on data reported through 2023 GSP/Alternative annual reports.

Basin Name (Top 10 ranked by groundwater extraction per area)	Basin Number	**Groundwater Extraction per Area (AF/Acre)**	Groundwater Extraction (AF)	Basin Area (Acres)
Santa Clara River Valley - Fillmore	4-004.05	**1.48**	33,469	22,586
Salinas Valley - 180/400 Foot Aquifer	3-004.01	**1.45**	129,800	89,706
Salinas Valley - East Side Aquifer	3-004.02	**1.44**	82,700	57,474
San Pasqual Valley	9-010	**1.41**	4,928	3,498
San Joaquin Valley - Merced	5-022.04	**1.38**	706,717	512,606
Sacramento Valley - Vina	5-021.57	**1.31**	242,000	184,917
San Joaquin Valley - Modesto	5-022.02	**1.22**	300,300	245,252
Coastal Plain of Orange County	8-001	**1.14**	255,123	224,226
San Joaquin Valley - Eastern San Joaquin	5-022.01	**1.05**	805,994	764,802
Big Valley	5-015	**1.05**	25,500	24,231

Table 7: WY 2023 Groundwater Extraction by Basin. Top 10 basins as total volume. Extraction values based on data reported through 2023 GSP/Alternative annual reports.

Basin Name (Top 10 ranked by groundwater extraction)	Basin Number	**Groundwater Extraction (AF)**	Groundwater Extraction Rates (AF/Acre)	Basin Area (Acres)
San Joaquin Valley - Kings	5-022.08	**863,611**	0.88	981,323
San Joaquin Valley - Eastern San Joaquin	5-022.01	**805,994**	1.05	764,802
San Joaquin Valley - Kern County	5-022.14	**750,959**	0.42	1,782,318
San Joaquin Valley - Merced	5-022.04	**706,717**	1.38	512,606
Sacramento Valley - Colusa	5-021.52	**577,400**	0.80	722,785
San Joaquin Valley - Tule	5-022.13	**400,810**	0.84	477,590
San Joaquin Valley - Turlock	5-022.03	**363,900**	1.05	348,187
San Joaquin Valley - Kaweah	5-022.11	**308,000**	0.70	441,048
San Joaquin Valley - Modesto	5-022.02	**300,300**	1.22	245,252
San Joaquin Valley - Madera	5-022.06	**272,226**	0.78	347,667

GSP Annual Reports include information on surface water supply and total water use, both by source type as well as water use sector. Surface water supply and groundwater use vary significantly depending on the water year type. In wetter years where there is typically abundant precipitation, higher snowpack levels, and increased streamflow, users may rely more on surface water sources and reduce groundwater pumping. During a dry year, groundwater becomes a more critical water source as surface water supplies diminish, leading to an increase in groundwater pumping to meet water demands.

The impact of water year variability on groundwater extraction is illustrated in **Figure 8** which shows the difference between groundwater extraction in WY 2023 and WY 2022 across groundwater basins with reported extraction volumes. During the dry year of 2022, many basins experienced higher levels of groundwater extraction. In contrast, the wet year of 2023 saw a notable increase in surface water supplies that resulted in reduced groundwater extraction in most basins.

Figure 9 depicts the groundwater use by basin as a percentage of total water use, based on numbers reported in 2023 GSP Annual Reports. In WY 2023, 50 of the 99 basins that submitted Annual Reports reported less than 50% dependency on groundwater supplies; statewide groundwater use accounted for 34% of the total water use within 99 basins submitting annual reports, down from 64% in WY 2021 and 65% in WY 2022. Similarly, surface water supplies increased to 63% of total water supplies in WY 2023, up from 33% and 31% in WY 2021 and WY 2022, respectively.

Change in Groundwater Storage Reported from WY 2023 GSP Annual Reports

The change in groundwater storage for a basin reflects the difference between recharge (managed and natural inflows) and groundwater discharge (extraction and natural outflows). In WY 2023, 93 of the 99 basins submitting Annual Report data reported a positive annual change in groundwater in storage, reflecting the cumulative effect of increased recharge and decreased extraction (pumping) brought about by a surge in surface water supplies due to wet conditions. Conversely, in WY 2022, 76 of the 97 basins submitting Annual Report data reported a negative annual change in groundwater in storage (California Groundwater Conditions Update – March 2022). Reported changes in storage data are presented in **Table 8**, **Table 9**, and **Figure 10**. **Table 8** lists basins with the greatest change in groundwater in storage per area (change in groundwater in storage normalized by basin area, reported as AF/Acre) and **Table 9** provides a list of the basins with the greatest change in groundwater in storage volume (AF).

Figure 10 shows the reported change in storage for each of these basins for the same period. During WY 2023, groundwater in storage increased by 8.7 million acre-feet reported across the 99 basins. Conversely, in WY 2022, a 6.4 million acre-feet of decrease in groundwater in storage was reported across 97 basins (California Groundwater Conditions Update – October 2023).

While the 8.7 million acre-feet increase in groundwater in storage represents significant progress towards replenishing the aquifers, it still highlights that a single wet year is not enough to recover from several consecutive dry years. In WY 2023, the Central Valley accounted for nearly 6 million acre-feet of groundwater storage recovery, which amounts to approximately 69 percent of total groundwater storage recovery in California. Notably, 56 percent of the state's groundwater storage recovery occurred in the San Joaquin Valley—the Kern County, Kings, and Kaweah subbasins saw the greatest increase of groundwater in storage, with approximately 2.2 million, 1.3 million, and 996 thousand acre-feet, respectively. Data for these and all other basins reporting extraction and storage data can be found on the CNRA Open Data portal.

Table 8: WY 2023 Change in Storage per Area by Basin. Top 10 basins based on volume and normalized by basin area. Change in storage values based on data reported through 2023 GSP/Alternative annual reports.

Basin (Top 10 ranked by change in storage per area)	Basin Number	**Change in Storage per Area (AF/Acre)**	Change in Storage (AF)	Basin Area (Acres)
Santa Clara River Valley - Piru	4-004.06	**4.65**	50,703	10,897
San Joaquin Valley - Kaweah	5-022.11	**2.26**	996,000	441,048
Ventura River Valley - Upper Ventura River	4-003.01	**2.25**	11,898	5,278
Salinas Valley - Forebay Aquifer	3-004.04	**1.74**	163,500	94,052
Carpinteria	3-018	**1.51**	12,071	7,978
Santa Clara River Valley - Fillmore	4-004.05	**1.51**	34,149	22,586
San Luis Rey Valley - Upper San Luis Rey Valley	9-007.01	**1.44**	27,727	19,254
Santa Clara River Valley - Santa Clara River Valley East	4-004.07	**1.39**	94,203	67,687
San Joaquin Valley - Kings	5-022.08	**1.30**	1,280,000	981,323
Gilroy-Hollister Valley - North San Benito	3-003.05	**1.27**	166,115	131,030

Table 9: WY 2023 Change in Storage by Basin. Top 10 basins as a volume. Change in storage values based on data reported through 2023 GSP/Alternative annual reports.

Basin (Top 10 ranked by total change in storage)	Basin Number	**Total Change in Storage (AF)**	Change in Storage Rates (AF/Acre)	Basin Area (Acres)
San Joaquin Valley - Kern County	5-022.14	**2,239,354**	1.26	1,782,318
San Joaquin Valley - Kings	5-022.08	**1,280,000**	1.30	981,323
San Joaquin Valley - Kaweah	5-022.11	**996,000**	2.26	441,048
San Joaquin Valley - Tule	5-022.13	**535,750**	1.12	477,590
Sacramento Valley - Yolo	5-021.67	**279,200**	0.52	540,693
San Joaquin Valley - Delta-Mendota	5-022.07	**264,800**	0.35	764,964
San Joaquin Valley - Turlock	5-022.03	**251,100**	0.72	348,187
Gilroy-Hollister Valley - North San Benito	3-003.05	**166,115**	1.27	131,030
San Joaquin Valley - Merced	5-022.04	**166,067**	0.32	512,606
Salinas Valley - Forebay Aquifer	3-004.04	**163,500**	1.74	94,052

Figure 6: Managed Groundwater Recharge Reported by Basin for Water Year 2023. See **Table 4** and **Table 5** for specific groundwater extraction statistics. Map and charts based on available data from GSP/Alternative annual reports as of 04/19/2024.

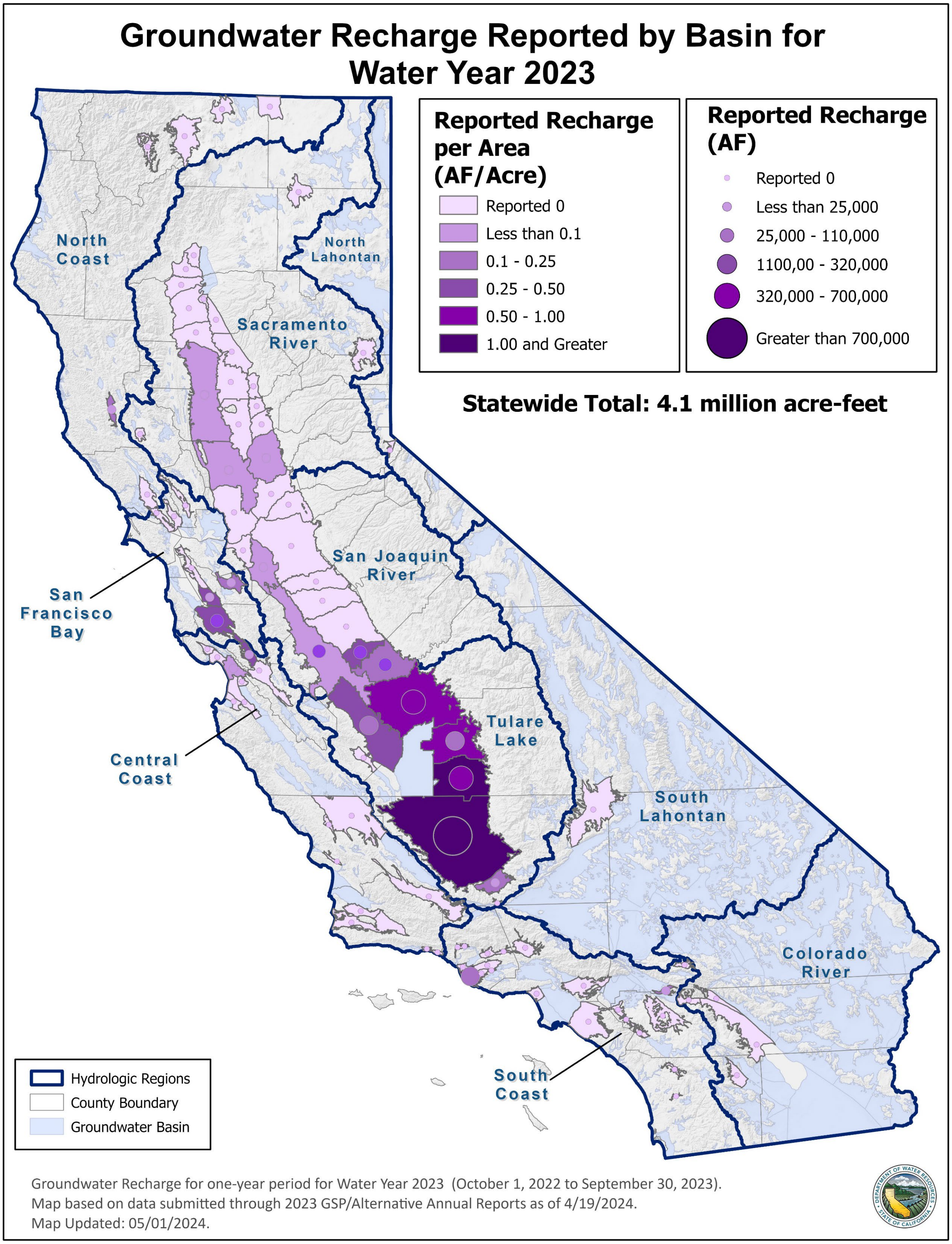


Figure 7: Groundwater Extraction Reported by Basin for Water Year 2023. See **Table 6** and **Table 7** for specific groundwater extraction statistics. Map and charts based on available data from GSP/Alternative annual reports as of 04/19/2024.

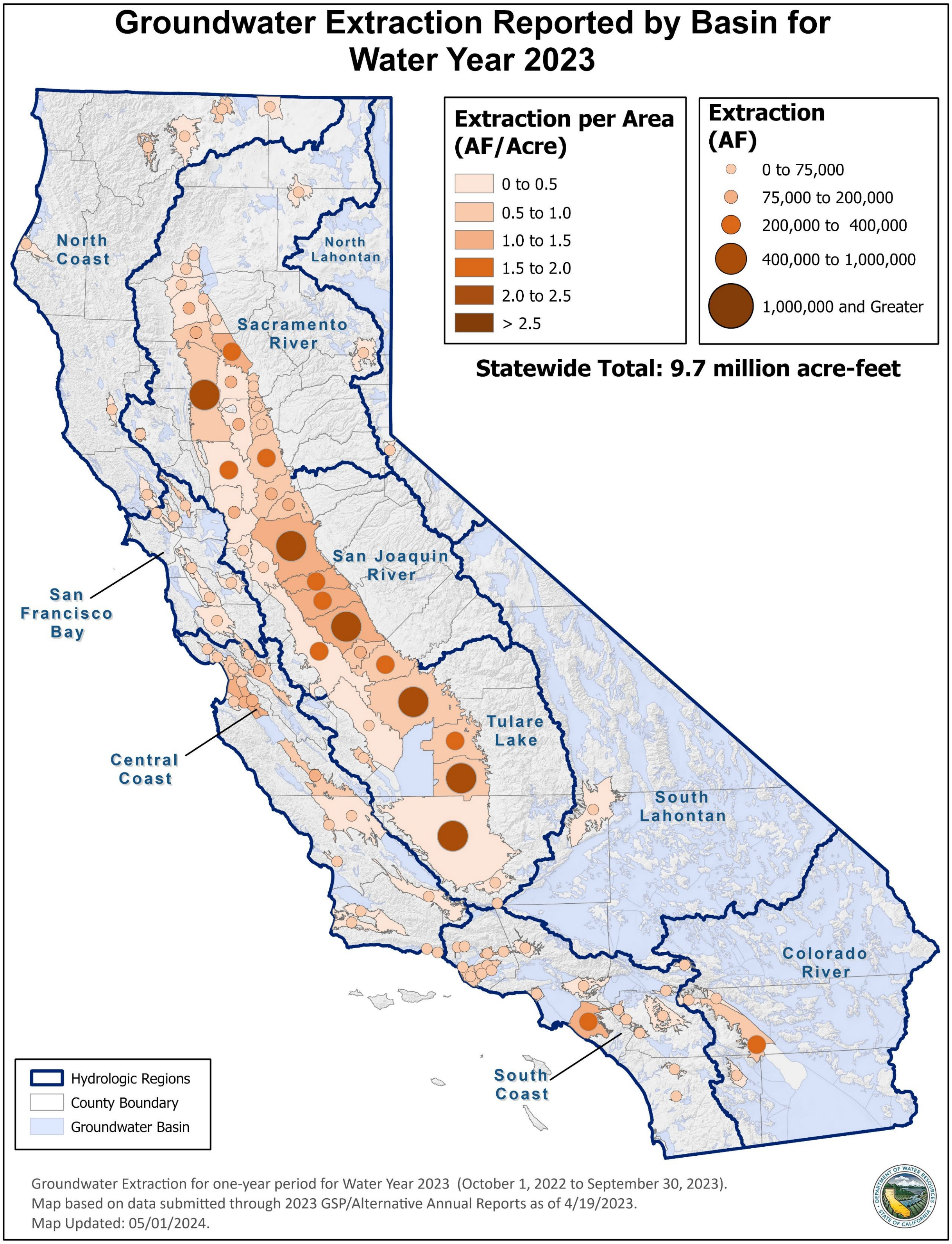


Figure 8: Groundwater Extraction differences between WY 2023 (wet year) and WY 2022 (dry year) as Reported by Basin. Map and charts based on available data from GSP/Alternative annual reports as of 04/19/2024.

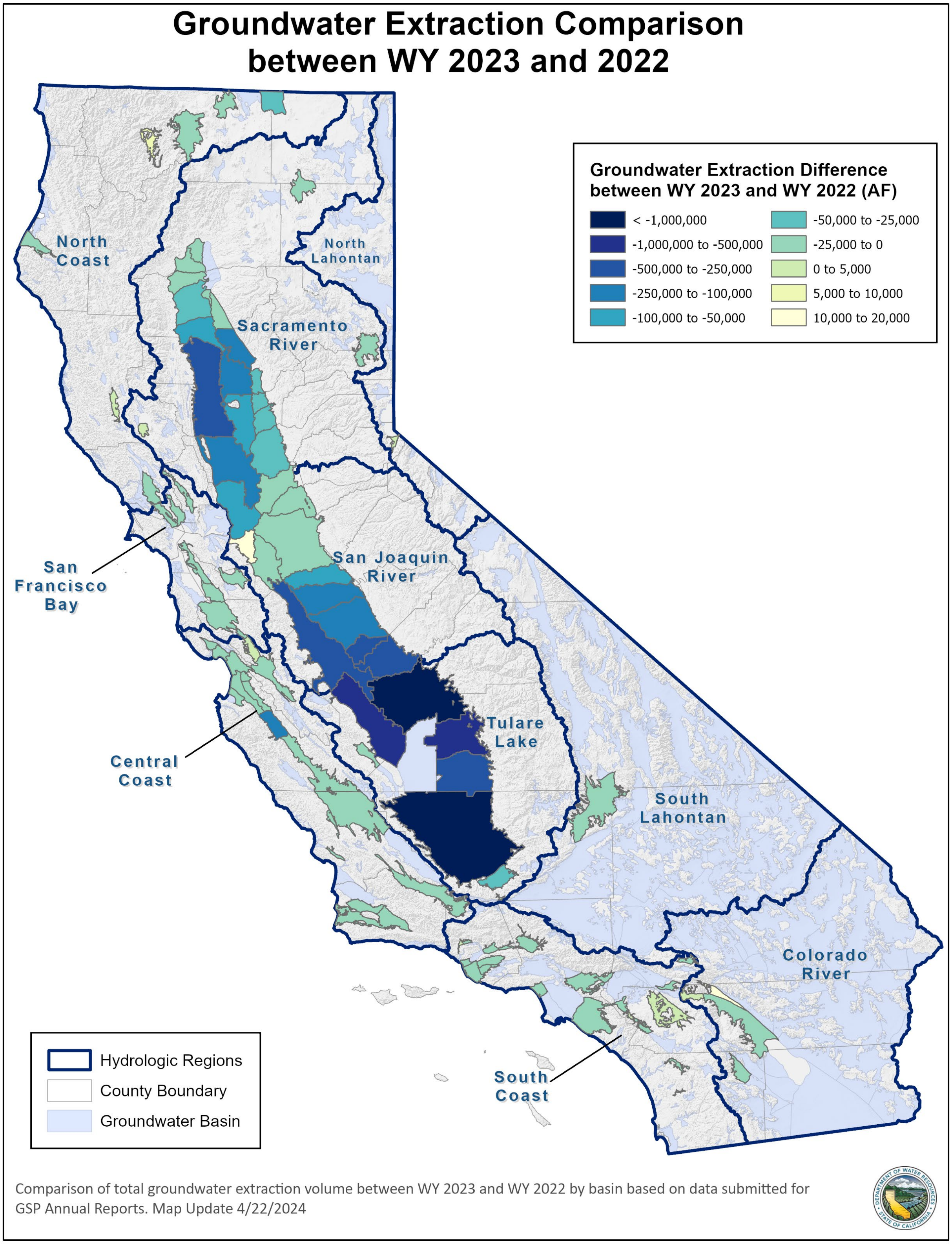


Figure 9: Groundwater Use as a Percentage of Total Water Use as Reported by Basin for Water Year 2023 compared to Water Year 2022. Map and charts based on available data from GSP/Alternative annual reports as of 04/19/2024.

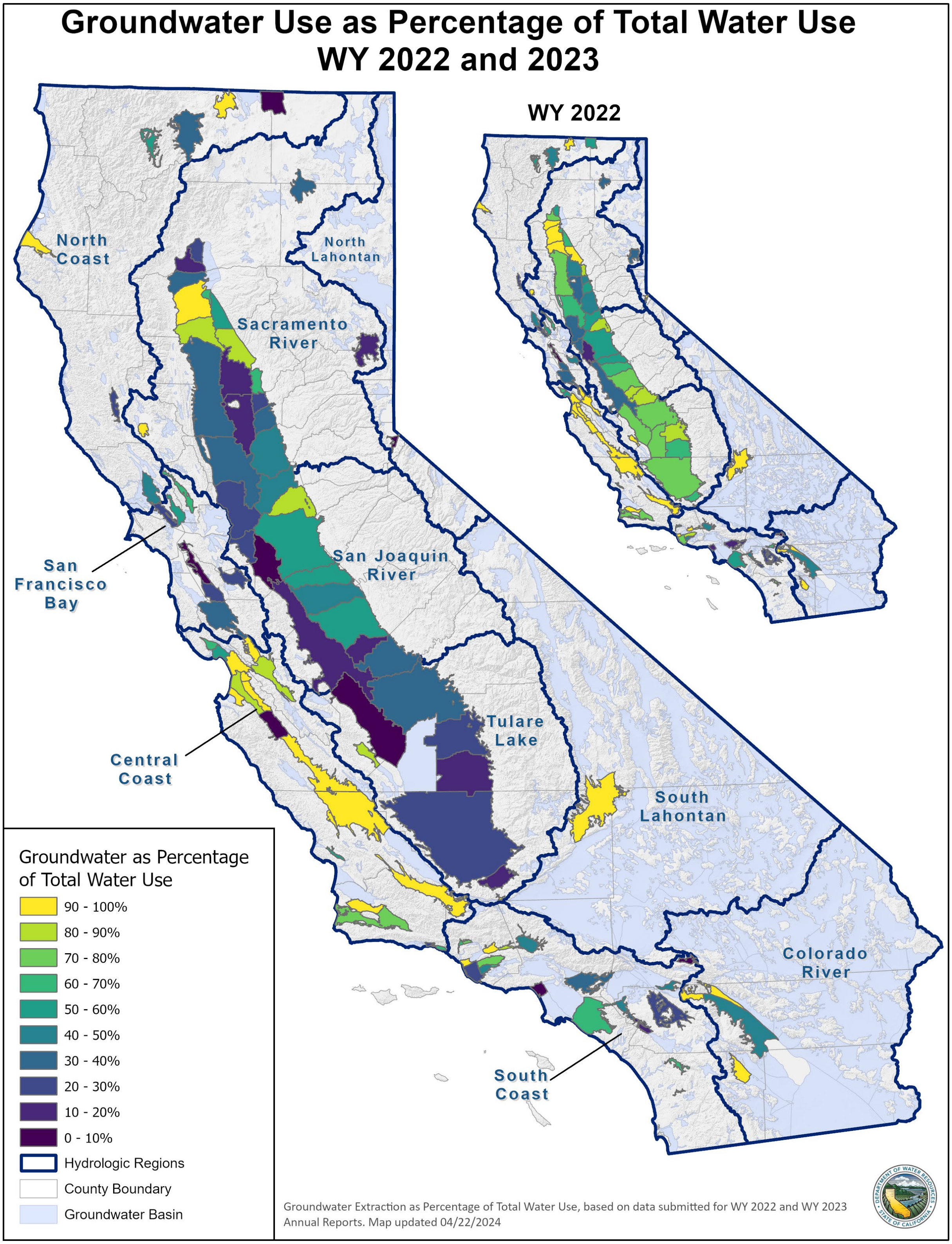
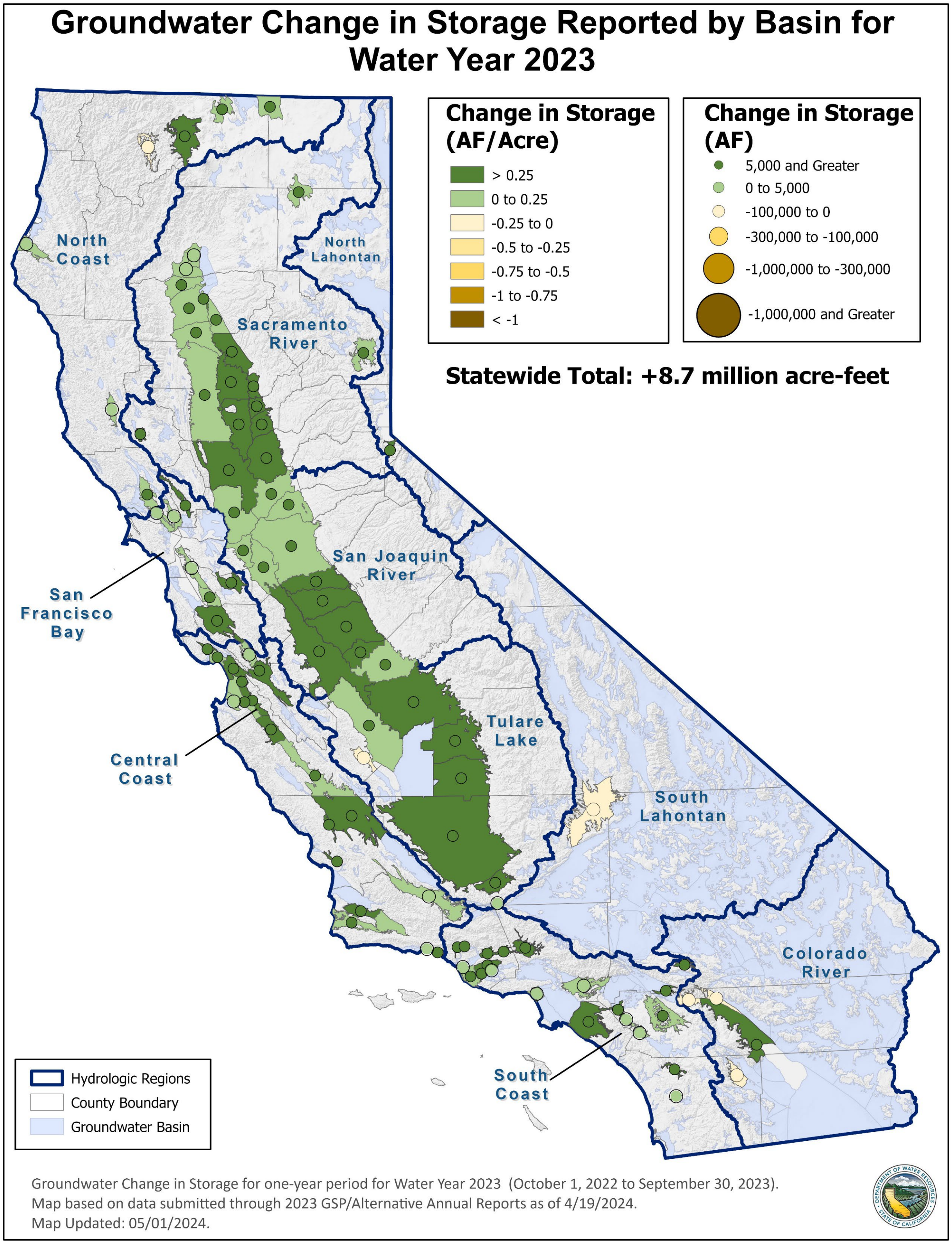


Figure 10: Groundwater Change in Storage Reported by Basin for Water Year 2023. See **Table 8** and **Table 9** for specific groundwater storage statistics. Map and charts based on available data from GSP/Alternative annual reports as of 04/19/2024.



Status of California's Groundwater Conditions

The heavy precipitation in WY 2023 prompted inquiries into the effects of rain and snow melt on groundwater conditions. Based on available data, it can be inferred that the high precipitation did not completely alleviate impacts of the recent drought and preceding dry years. Water levels measured in wells at the end of WY 2023 were higher than those in the previous water year, and there was some notable improvement when compared with historical average water levels. Longer term comparisons, however, show that water levels have not recovered from the impacts of past drought periods and long-term overdraft.

Short-Term Groundwater Conditions

The one-year change in groundwater levels between fall 2022 and fall 2023, presented in **Table 10** and **Figure 11**, shows more increases than declines in groundwater levels in wells across the state. From fall 2022 to fall 2023, 52 percent of measured wells showed groundwater level increases of more than five feet, whereas only four percent showed declines greater than five feet, 45 percent showed no significant changes (less than +/- 5 feet). This is a stark contract from the 2021 to 2022 one-year comparison of fall water levels, where only 11 percent of wells showed an increase in groundwater levels and 51 percent of wells showed a decrease in groundwater levels (California Groundwater Conditions Update – March 2022). The hydrologic regions with the greatest percentage of wells with increases in water levels from fall 2022 to fall 2023 (**Figure 11**) were Tulare Lake (68 percent), San Francisco Bay (62 percent), and South Coast (60 percent), and Sacramento River (55 percent).

Table 10: Summary of Groundwater Level (GWL) Changes Compared to fall 2023 (shown in **Figure 11** and **Figure 13**). Water Year Type as defined by the Sacramento River 8-Station Index, Department of Water Resources, California Data Exchange Center, WSIhist (ca.gov).

Period (Water Year Types)	Total Well Count	Decrease > 25 ft	Decrease 5 to 25 ft	No Significant Change (Less than +/- 5 ft)	Increase 5 to 25 ft	Increase >25 ft
1-Year GWL Change (Wet): Fall 2023 compared to Fall 2022	5,581	1%	3%	45%	36%	15%
5-Year GWL Change (Post-last Drought): Fall 2023 compared to Fall 2018	4,470	4%	17%	50%	20%	9%

To understand how much a single water level measurement in a well is above or below an average measurement, it is necessary to have a long record of measurements. **Figure 12** uses percentile statistics to describe how a measurement collected in fall 2023 (September, October, November) compares to other fall measurements collected in wells with a long period of fall measurements. The fall 2023 measurement is classified into one of five percentile categories, or statistical bins, based on all fall measurements for that well. These categories are: lowest 10% (Much Below Normal), 10-25% (Below Normal), 25-75% (Normal), 75-90% (Above Normal), and highest 90% (Much Above Normal). A more detailed description of percentile class analysis is provided in the Semi-Annual Groundwater Conditions Update: October 2023 report.

The percentiles observed across the state for fall 2023 (September, October, and November) are summarized in **Table 11**. This table shows that 30 percent of the wells in the analysis are in the normal percentile class, 40 percent higher than normal, and 30 percent lower than normal water levels. The data further indicates that measurements from 5 percent of wells have the lowest groundwater levels on record for that well and 11 percent have the highest groundwater levels on record. Percentages vary within each hydrologic region (see **Figure 12** inset). For example, San Francisco Bay, Central Coast, South Coast, Colorado River, South Lahontan Hydrologic Regions all show that more than 50 percent of groundwater level measurements are higher than normal, while the North Coast, San Joaquin River, and Tulare Lake Hydrologic Regions have more than 50 percent of groundwater levels that are lower than normal.

Table 11: Statistical Summary of percentile classes for September, October, November 2023 (as shown in **Figure 12**).

Percentile Class	**Total Well Count**	**Lowest on Record**	**Less 10%**	**10-25%**	**25-75%** (Normal)	**75-90%**	**Greater 90%**	**Highest on Record**
Statewide Percentile Class for September, October, November 2023	5,030	5%	12%	13%	30%	15%	14%	11%

Figure 11: Statewide and hydrologic region groundwater level change map for one-year period between fall 2022 and 2023. See **Table 10** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 03/15/2024.

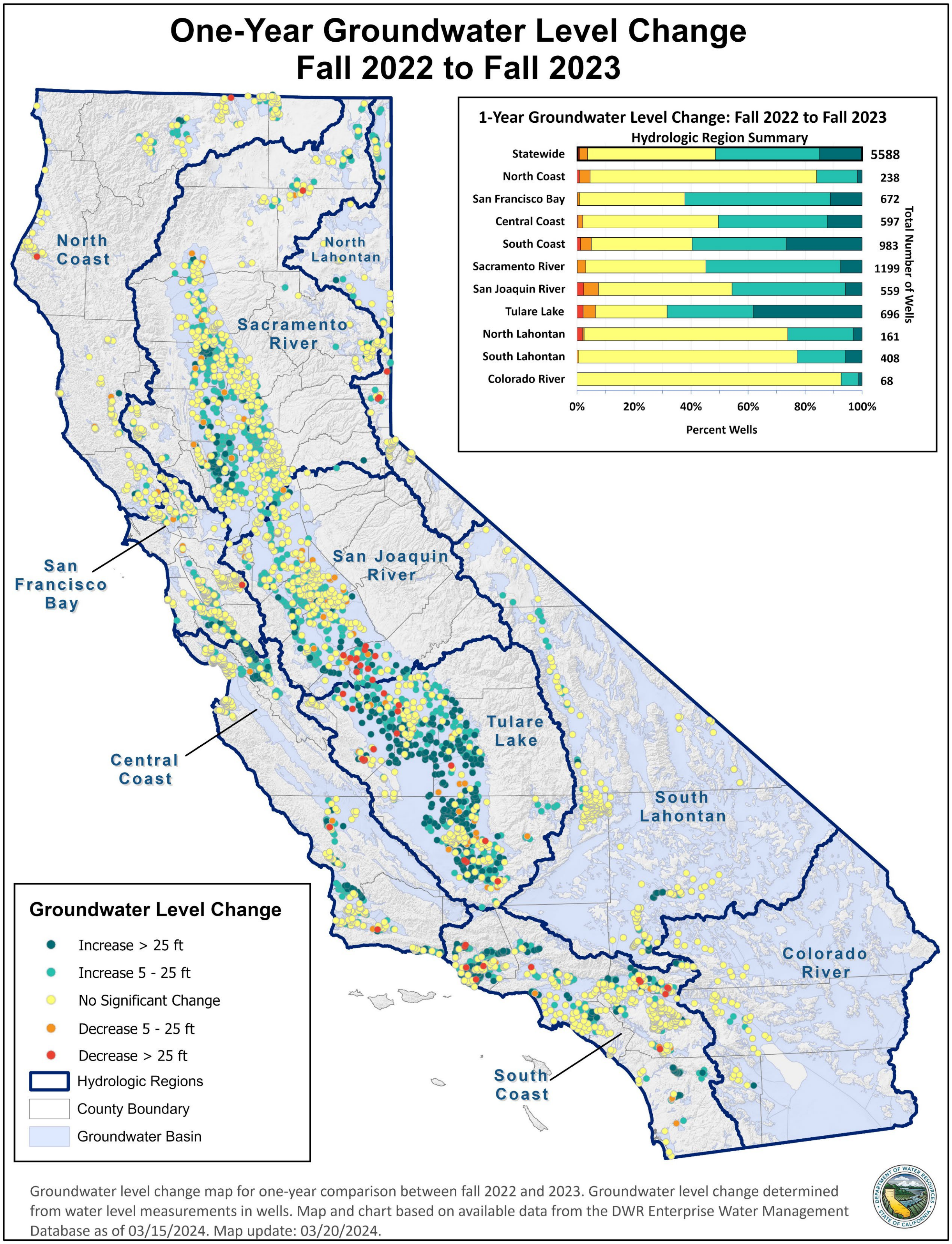
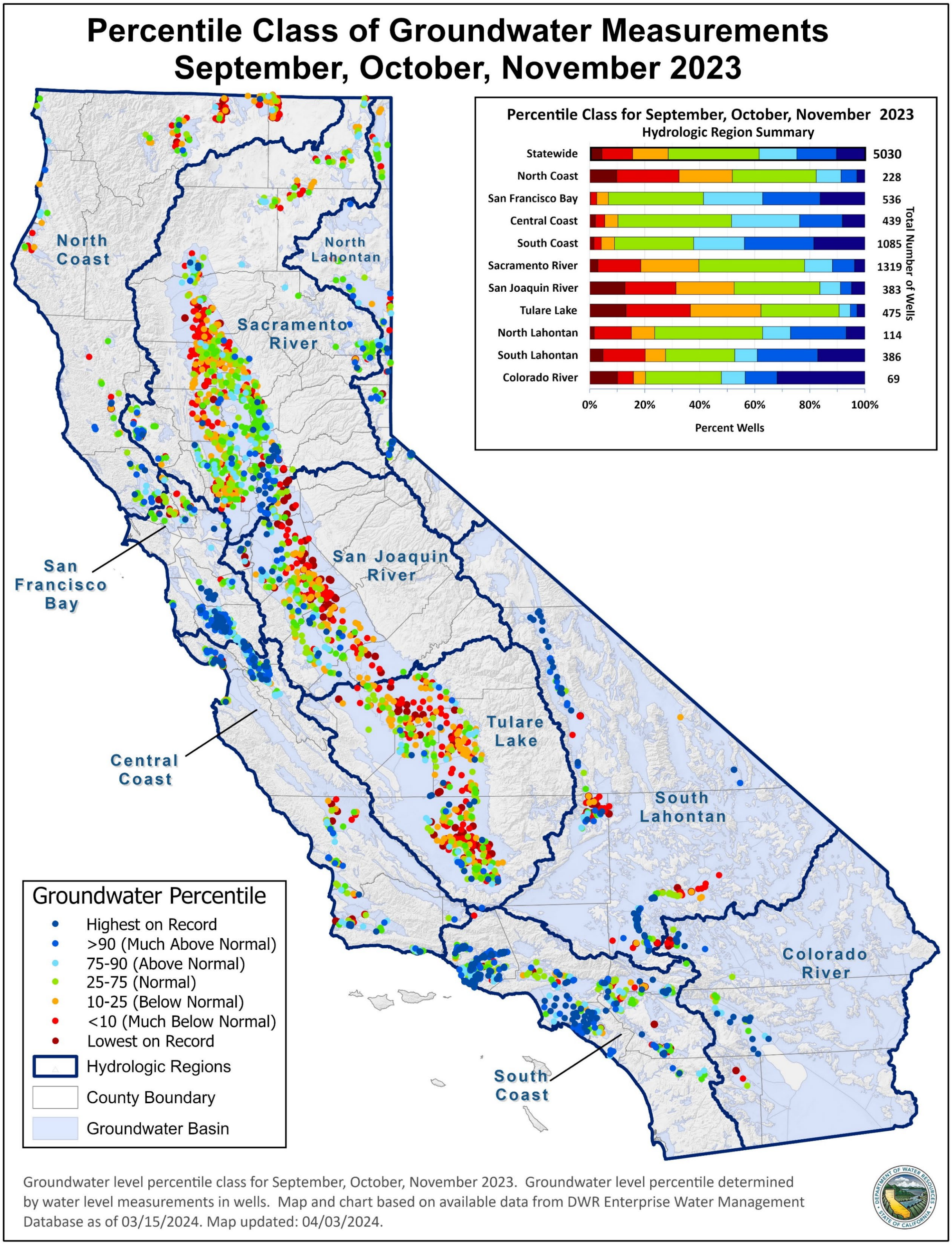


Figure 12: Statewide and hydrologic region groundwater level percentile map for groundwater wells in the months of September, October, and November. See **Table 11** for specific groundwater level statistics. Map and chart are based on available data from the DWR Water Data Library as of 03/15/2024.



Long-Term Groundwater Conditions

Unlike the positive one-year gains delivered by WY 2023, long-term trends show that groundwater conditions are still impacted by a series of dry and drought periods that have reoccurred over the last 20-plus years. Based on groundwater level measurement data, water levels in 21 percent of wells are still lower than they were in 2018 **(Table 10)** and 48 percent of wells with available data show a 20-year declining groundwater level trend **(Table 12)**.

The 5-year comparison of groundwater level data provided in **Table 10** and **Figure 13** show groundwater level changes between fall 2018 and fall 2023 which includes impacts from the most recent drought as well as recovery from the wet WY 2023. Statewide, fall 2023 groundwater levels were higher than 2018 levels by five feet or more in approximately 30 percent of wells, while 20 percent of wells had groundwater levels that were lower by five feet or more, demonstrating the variable nature of groundwater level depletion and recovery across the state over time. The Sacramento River, San Joaquin River, and Tulare Lake Hydrologic Regions experienced declines greater than five feet in 28%, 26%, and 41% of measured wells, respectively. Markedly, Tulare Lake Hydrologic Region exhibited a 35 percent increase in groundwater levels above five feet, likely caused by the significant flooding that occurred in the area and abundant surface water availability in WY 2023.

Figure 14 shows the 20-year trend of groundwater level change over time by depicting the magnitude of decreasing or increasing groundwater level trends in wells over the period from WY 2003 to WY 2023. This period includes droughts from 2007 to 2009, 2012 to 2016, and the most recent drought (2020 to 2022). During this 20-year period of stressed water resources and increased groundwater use, 48 percent of statewide wells had a decreasing trend in groundwater levels while just over 10 percent of wells demonstrated an increasing trend. The percentage changes observed from WY 2003 to WY 2023 are summarized in **Table 12**. **Figure 14** also shows several clusters of wells with steeply declining groundwater level trends across the state during the most recent 20-year period. These trends were most pronounced in the Tulare Lake Hydrologic Region (38 percent), North Lahontan Hydrologic Region (22 percent), and San Joaquin River Hydrologic Region (14 percent). The Colorado River Hydrologic Region showed the greatest percentage of wells (5 percent) with an upward trend of more than 2.5 feet per year.

Table 12: Statistical Summary of 20-Year Groundwater Level Trend Map **(Figure 14)**.

Period	Total Well Count	Decrease > 2.5 ft/yr	Decrease 0.01 - 2.5 ft/yr	No Significant Trend	Increase 0.01 - 2.5 ft/yr	Increase > 2.5 ft/yr
20-Year Trend: 2003 to 2023	4,547	12%	36%	40%	11%	1%

Figure 13: Statewide and hydrologic region groundwater level change map for five-year period between fall 2018 and fall 2023. See **Table 10** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 03/15/2024.

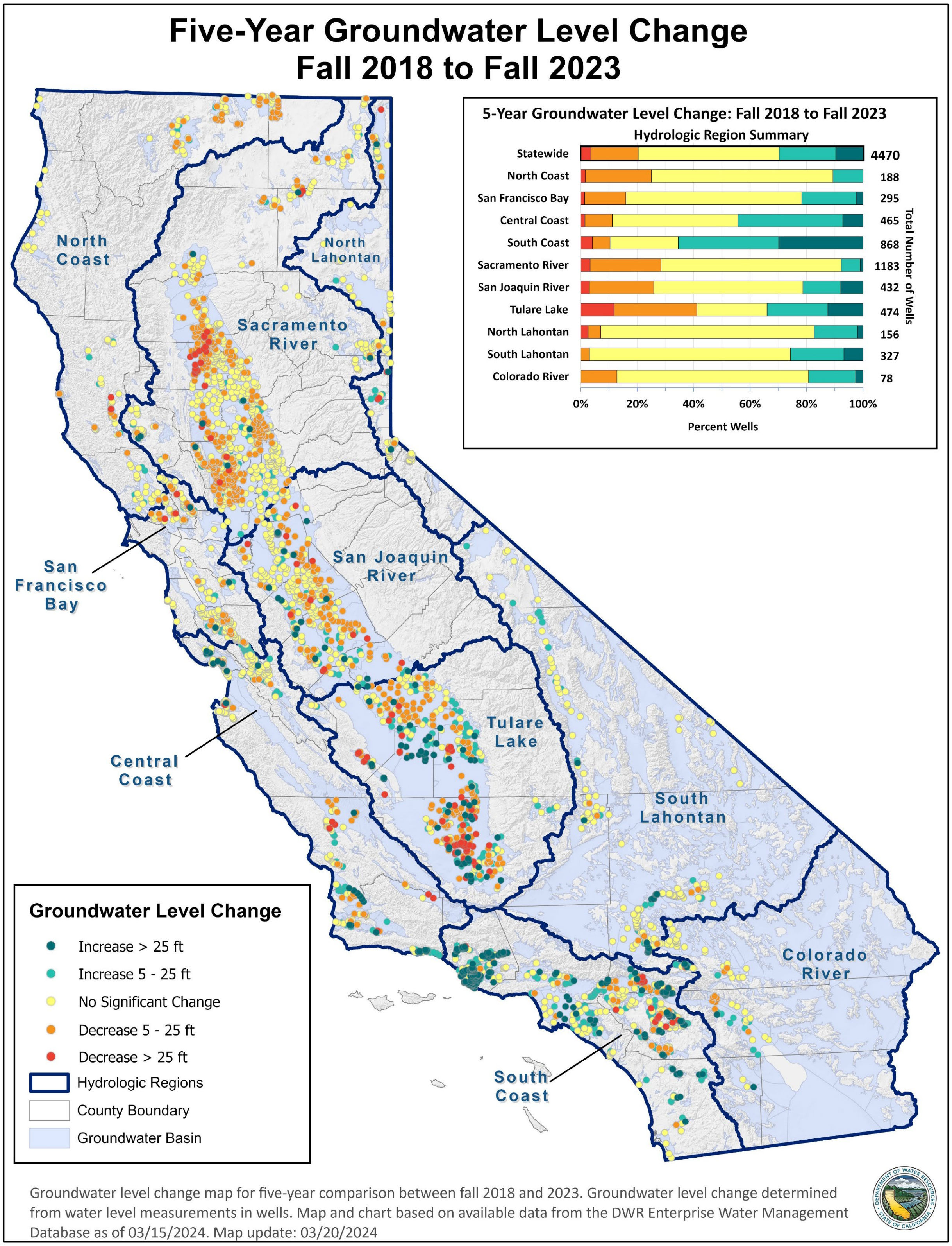
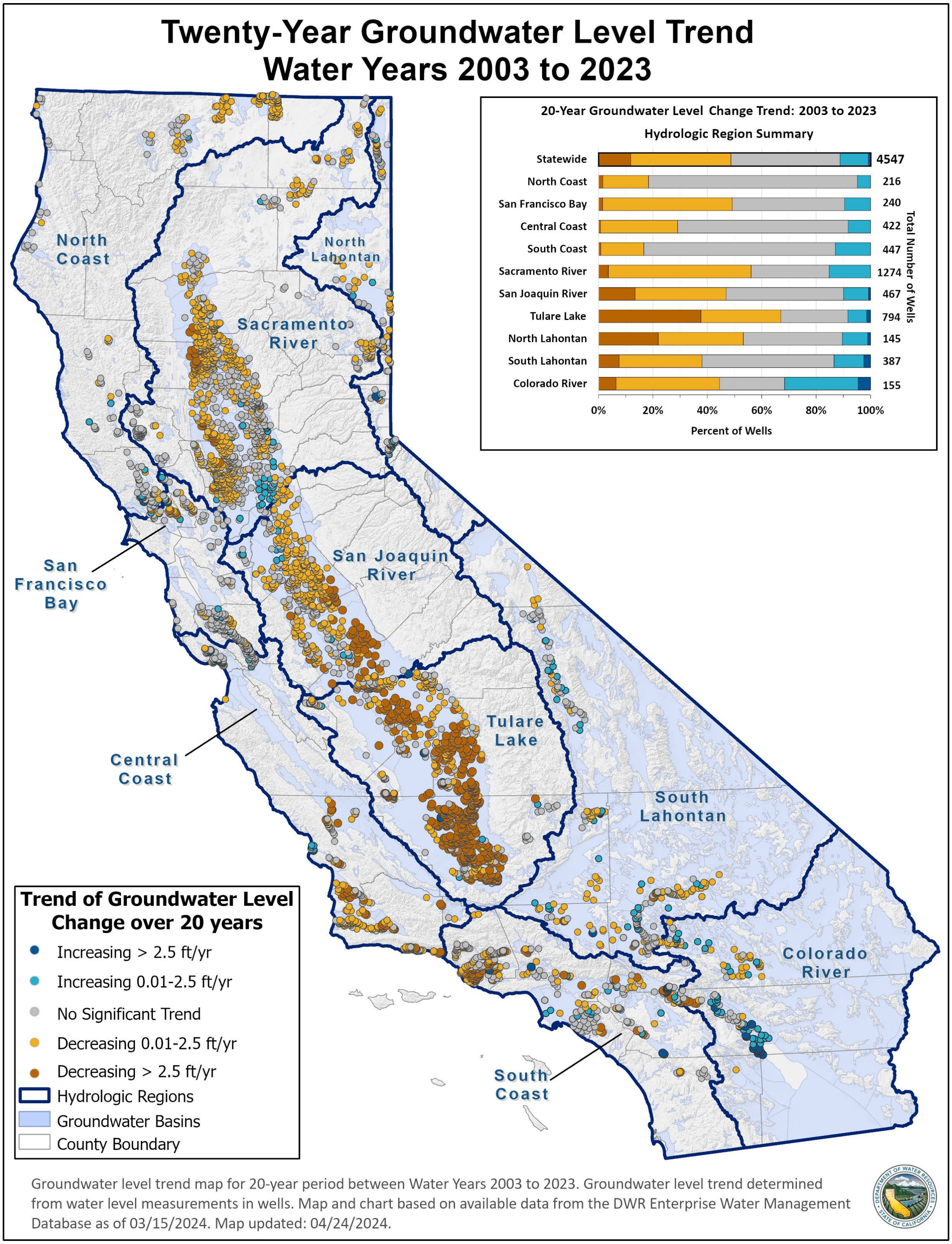


Figure 14: Statewide and hydrologic region groundwater level trend analysis map for WYs 2003-2023. See **Table 12** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 03/15/2024.



Land Subsidence

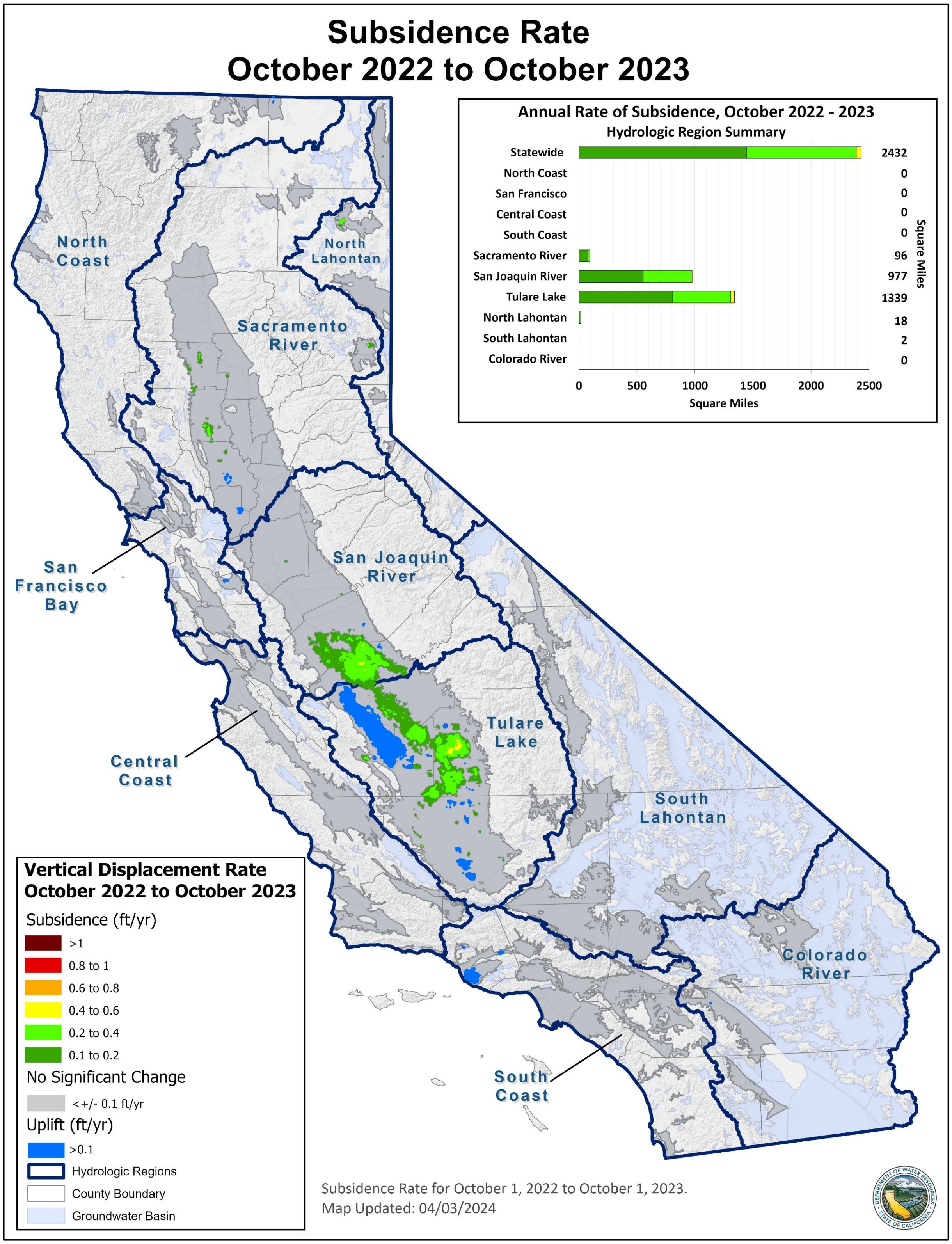
Land subsidence has been documented throughout the last century in many areas of the state, with over 30 feet of vertical displacement or "sinking" of the land surface in some areas. Subsidence has damaged and reduced capacity to water conveyance infrastructure, reduced groundwater storage availability for future use, and caused damage to other critical infrastructure. Since 2015, there have been significant improvements to the state's subsidence monitoring network, most notably the processing and reporting of satellite-based Interferometric Synthetic Aperture Radar (InSAR) data, which provides monthly subsidence data for more than 150 groundwater basins with a geographical coverage of about 40,000 square miles. In 2022, DWR increased the reporting frequency of InSAR data from annually to quarterly to provide more up-to-date information. **Figure 15** shows land subsidence data over WY 2023, and **Figure 16** shows a comparison of the most recent 5 years (October 1, 2018, through October 1, 2023). **Table 13** provides a summary of vertical displacement rates observed in the InSAR dataset between October 1, 2022, and October 1, 2023, and for the period from October 1, 2018 through October 1, 2023.

Table 13: Total Area (in square miles) of Subsidence (Subs.) and Uplift Corresponding to Displacement Rate (ft/yr) for one- year (**Figure 15**) and five-year (**Figure 16**).

	Uplift >0.1 ft/yr	**Subs. >0.1 ft/yr**	**Subs. >0.2 ft/yr**	**Subs. >0.4 ft/yr**	**Subs. >0.6 ft/yr**	**Subs. >0.8 ft/yr**	**Subs. >1 ft/yr**
One Year October 2022 – October 2023	826	2432	985	41	0	0	0
Five Year October 2018 – October 2023	29	3,961	2,149	800	113	0	0

Figure 15 shows the annual rate of vertical displacement in feet per year from October 2022 to October 2023, and **Figure 16** shows the annual rate of vertical displacement from October 2018 to October 2023. Annual displacement rates shown in these figures are divided into seven categories: subsidence of 0.1-0.2 feet/year, 0.2-0.4 feet/year, 0.4-0.6 feet/year, 0.6-0.8 feet/year, 0.8-1 feet/year, greater than 1 foot/year, and uplift of greater than 0.1 feet/year.

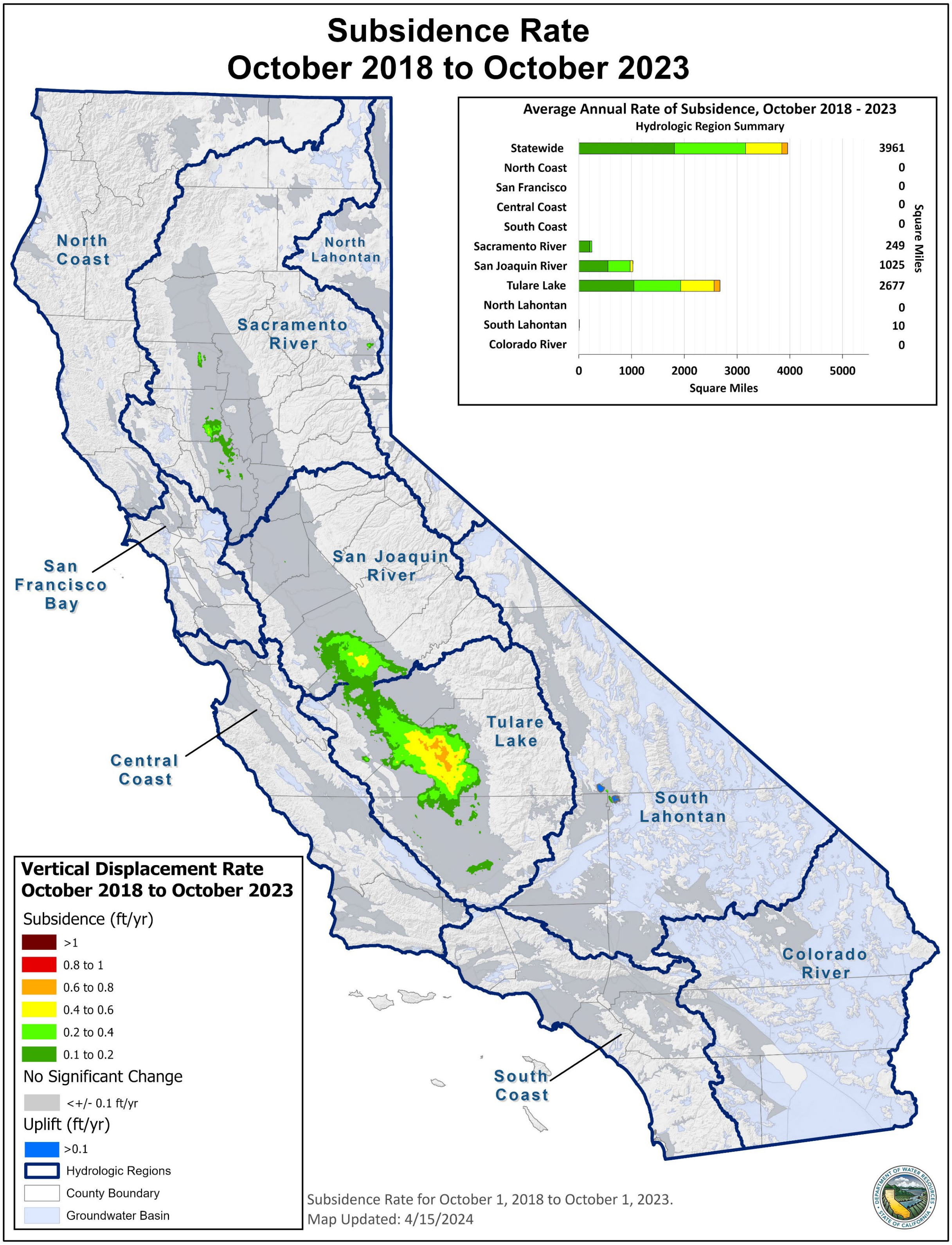
Figure 15: Statewide annual subsidence map for October 2022 to October 2023. See **Table 13** for specific subsidence level statistics. Map and charts based on available data from the CNRA Open Data as of 3/1/2024.



Similar to what was observed during the 2012–2016 drought, increased groundwater extraction during the most recent drought (2020-2022) resulted in accelerated land subsidence in parts of the Central Valley. The wet spring in 2023 has decreased land subsidence rates for now. For WY 2023, statewide data show an area of approximately 2,400 square miles with recorded subsidence of greater than 0.1 feet and about 41 square miles with subsidence greater than 0.4 feet, and no areas of subsidence exceeding 0.6 feet. In contrast, statewide data for WY 2022 showed a total area of about 5,400 square miles with recorded subsidence greater than 0.1 feet and about 80 square miles with subsidence greater than 1 foot (California Groundwater Conditions, Semi-Annual Update: March 2023).

Land subsidence can be elastic, where, under some conditions, the ground surface can rebound and show uplift. During the October 2022 to October 2023 period, the Tulare Lake Hydrologic Region had the most areas of uplift, with about 730 square miles experiencing an uplift of greater than 0.1 feet. Coincidentally, this region also had the most areas of subsidence, with about 1,300 square miles of area experiencing more than 0.1 feet of subsidence. Like previous dry-wet-dry climate cycles, land subsidence rates are likely to increase again during future dry periods unless long term groundwater extraction is reduced as part of ongoing sustainable groundwater management.

Figure 16: Statewide average annual subsidence map for October 2018 to October 2023. See **Table 13** or specific subsidence level statistics. Map and charts based on available data from the [CNRA Open Data](#) as of 3/1/2024.



Well Infrastructure

Many factors influence the type and number of groundwater extraction wells (well infrastructure) constructed in California, such as climate conditions, surface water supplies, groundwater level changes, legislative actions, age of the well, and other local conditions. Well completion reports (WCR) are submitted to DWR through the Online System for Well Completion Reports (OSWCR) when a well is installed, replaced, or destroyed. California Water Code Section 13751 requires that WCRs be submitted to DWR within 60 days of the completion of the work. As such, there is up to a 2-month delay in the reporting of well construction information. A summary of data submitted to OSWCR over the last several years for groundwater extraction wells classified as domestic or irrigation wells is presented here.

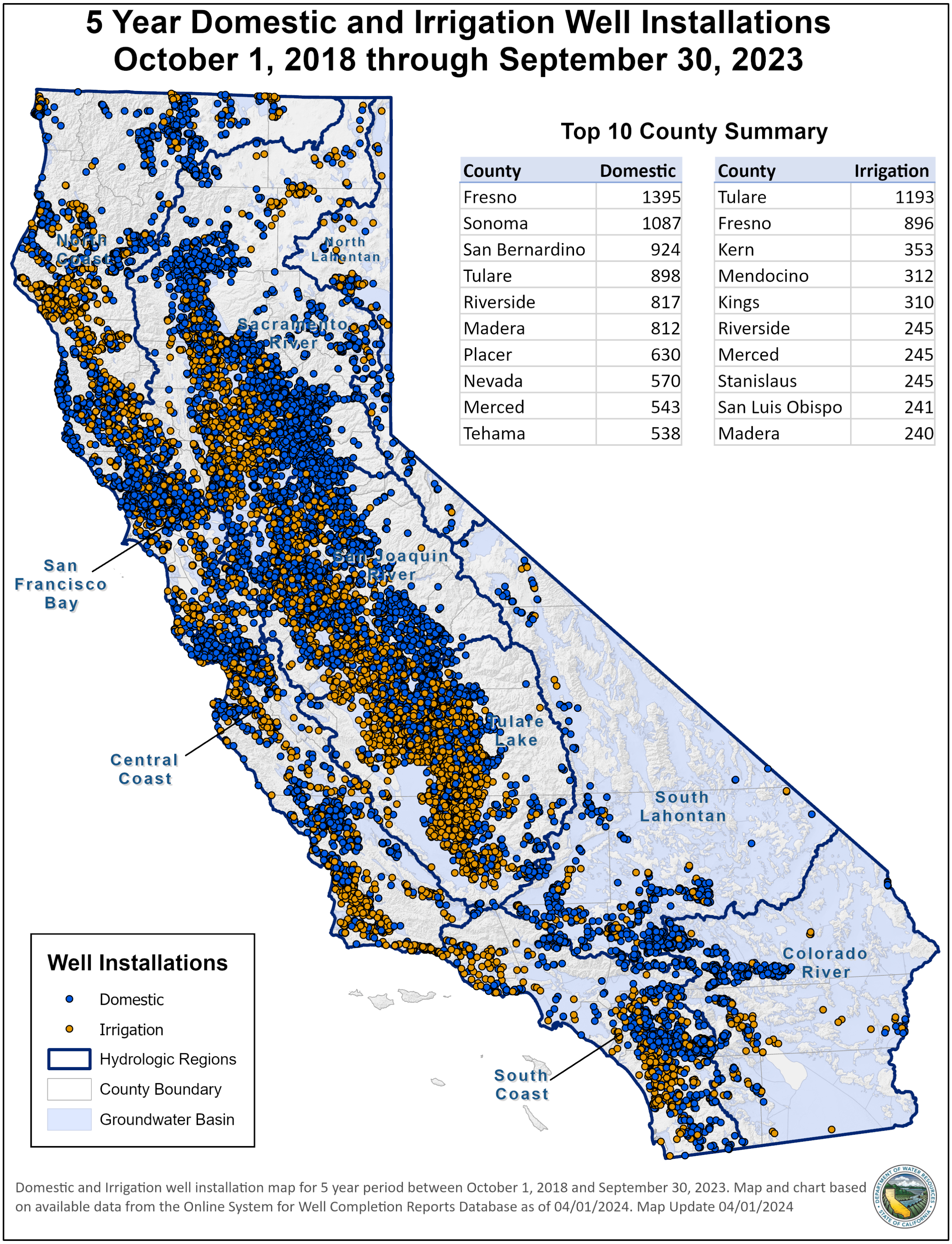
A summary of dry water wells reported by members of the public to DWR's Dry Well Reporting System for the past nine years is also presented here. Dry Well Reporting is voluntary, so the actual numbers of dry wells and/or the number of resolved dry wells may be higher than what is reported to DWR.

The year-to-year statistics of domestic, irrigation, and dry wells are provided in **Table 14**. The data goes back to WY 2015, which captures the end of the 2012-2016 drought. The total number of domestic and irrigation wells installed since 1977 are also provided in **Table 14**. The water year type designations shown in Table 14 are based on the San Joaquin Valley Water Year Hydrologic Classification Index, because no statewide water-year type index currently exists. **Figure 17** shows the domestic and irrigation wells installed during the past 5 water years (2019 – 2023).

Table 14: Statewide Summary of Newly Installed Domestic and Irrigation Wells and Number of Reported Dry Wells. *Dry Well Reporting started in 2013, whereas the database of WCRs for domestic and irrigation wells are considered complete since 1977.

Water Year	Water Year Type	Number of New Domestic Wells	Number of New Irrigation Wells	Dry Wells Reported
WY 2015	Critical	3,530	3,048	1,442
WY 2016	Dry	4,413	2,870	546
WY 2017	Wet	3,137	1,488	166
WY 2018	Below Average	2,644	1,120	86
WY 2019	Wet	2,742	1,342	46
WY 2020	Dry	3,017	1,344	75
WY 2021	Critical	3,645	1,802	814
WY 2022	Critical	3,999	1,691	1,494
WY 2023	Wet	3,237	1,231	669
WY 2024 through February 28, 2024	TBD	826	289	107
5 Year Total (WY 2019 - 2023)	-	16,640	7,392	3,098
9 Year Total (WY 2015 - 2023)	-	30,364	15,918	5,338
Total since 1977*	-	282,422	62,459	5,837

Figure 17: Statewide newly installed domestic and irrigation wells map for 5-year period from WY 2019 through 2023. See **Table 14** for specific well data. Map and charts based on available data from the [CNRA Open Data]() as of 04/01/2024.



Top 10 County Summary

County	Domestic
Fresno	1395
Sonoma	1087
San Bernardino	924
Tulare	898
Riverside	817
Madera	812
Placer	630
Nevada	570
Merced	543
Tehama	538

County	Irrigation
Tulare	1193
Fresno	896
Kern	353
Mendocino	312
Kings	310
Riverside	245
Merced	245
Stanislaus	245
San Luis Obispo	241
Madera	240

Domestic and Irrigation well installation map for 5 year period between October 1, 2018 and September 30, 2023. Map and chart based on available data from the Online System for Well Completion Reports Database as of 04/01/2024. Map Update 04/01/2024

Domestic Wells

Domestic (household) wells provide critical water supply to millions of people throughout California and are often the sole source of water supply for many households. During WY 2023, a total of 3,237 new domestic wells were reported to be installed in the state (**Table 14**). During the last nine water years (October 2014 through September 2023), a total of 30,364 domestic wells have been installed, accounting for approximately 11 percent of the total 282,422 domestic wells installed since 1977. Although the number of new domestic wells installed in the wet WY 2023 is fewer than the number of wells installed during the critical years of 2021 and 2022, the 3,237 new wells installed in WY 2023 is more than any other year since 2016. The relatively high number of domestic well installations could be attributed to the aquifers not fully recovering from the droughts that have dominated most of the past 20 years and replacement wells having to be drilled deeper.

The location of new domestic and irrigation wells installed in California over the past five years (WY 2019 through WY 2023) is shown in **Figure 17**. The counties with the highest number of new domestic wells installed in the past five years were Fresno (1,395), Sonoma (1,087), and San Bernardino (924). Figure 17 shows that numerous domestic wells were installed outside of the 515 groundwater basins, particularly in volcanic and fractured-rock aquifers across the state, which underscores the importance of groundwater and the reliance on groundwater in these non-basin areas.

Irrigation Wells

Irrigation wells typically are constructed deeper than domestic wells, have higher pumping capacity, and pump more groundwater than domestic wells. They play a crucial role in supplying water to farms that feed millions of people in California and around the world.

During WY 2023, a total of 1,231 new irrigation wells were reported to be installed in the state, which is the lowest since WY 2018 when 1,120 irrigation wells were installed (**Table 14**). Over the last nine water years, the annual installation of irrigation wells has ranged from a low of 1,120 in WY 2018 to a high of 3,048 in WY 2015. A total of 15,918 irrigation wells have been installed in the last nine water years, accounting for approximately 25 percent of the total 62,549 irrigation wells installed statewide since 1977.

The location of new domestic and irrigation wells installed over the past five years (WY 2019 through WY 2023) are shown in **Figure 17**. Irrigation wells are much less geographically spread throughout the state when compared with domestic wells. In the past five water years, Tulare County installed more irrigation wells (1,193) than any other county in the state, accounting for approximately one out of every seven new irrigation wells (17 percent) statewide. Neighboring Fresno County (896) and Kern County (353) ranked 2nd and 3rd, respectively, for the highest number of new irrigation well installations.

Dry Well Reporting

Dry well reporting is an important tool to track areas where changes in local groundwater conditions may be impacting beneficial uses and users of groundwater in California for household water uses. It is also a key indicator of areas where drought assistance is most needed. As California continues to experience periods of climate-driven severe drought conditions, leading to less available precipitation and snowmelt and extreme heat, Californians rely heavily on groundwater to meet their water supply needs. Reports of dry wells increase during extended dry periods as groundwater reliance increases and groundwater levels decline.

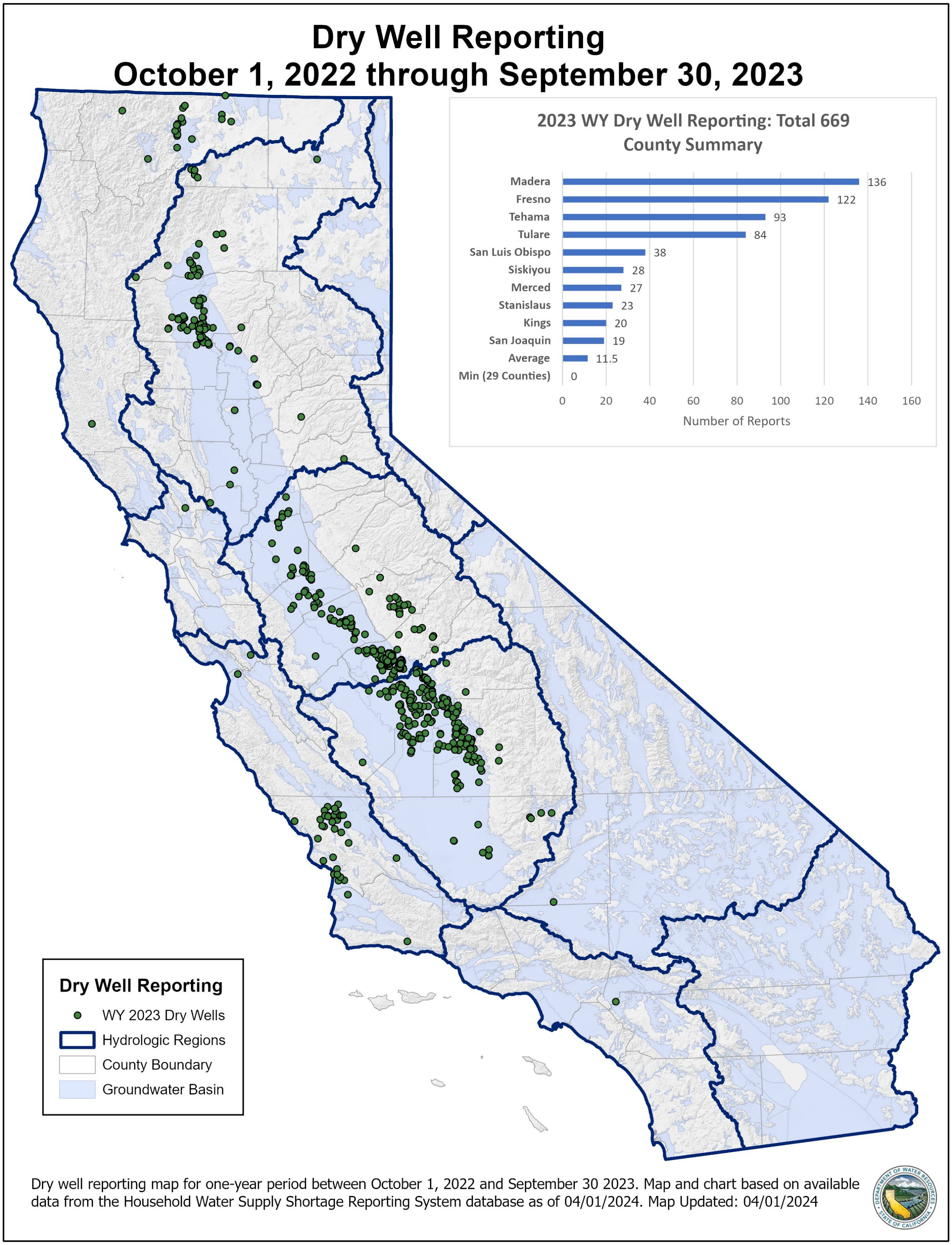
DWR manages the Dry Well Reporting System where Californians experiencing problems with their private, self-managed wells that are not served by a public water system can voluntarily report dry wells and be connected with entities providing local drought assistance. DWR's Dry Well Reporting System was originally developed during the 2012-2016 drought to help centralize and disseminate information statewide when well outages are reported. Based on feedback from counties, the system has been updated to directly and immediately notify local agencies, including county officials, water agencies, and GSAs, when household water supply well outages are reported in their region. This centralized reporting system helps ensure that local and State agencies are quickly notified and can respond to provide available resources such as interim water supplies or appropriate funding sources to help address the issues.

The Dry Well Reporting database is designed to receive reports when a domestic well goes dry or when a dry well problem is resolved. DWR provides a statewide statistical summary of locally reported dry wells on the Dry Well Reporting System website over the last nine full water years (2015-2023) and includes data for WY 2024 reported through April 1, 2024 (**Table 14**). The summary includes a cumulative report of dry wells by county, a map showing the statewide distribution of dry wells, and an accounting of dry wells reported to the state by quarter from 2013 to present.

The submission of dry well reports is voluntary so the data may not represent the total number of dry wells occurring across the state, only those submitted to the Dry Well Reporting System. Community outreach by DWR, the State Board, GSAs, and non-governmental organizations over the years since the development of the dry well reporting system has resulted in more awareness and greater usage of the system over time, and more dry well reports are likely being submitted to the Dry Well Reporting database than were submitted in the past.

In WY 2023, a total of 669 new dry well reports were received by DWR compared to 1,494 in WY 2022. As highlighted in the groundwater conditions section of this report, although groundwater elevations show an increasing trend over the past water year, the 5-year trend is still decreasing in most areas. This underscores the fact that impacts of the last several critically dry years have not been resolved after a single wet year. A total of 5,338 new dry well reports were received over the last nine water years (2015-2023), and a total of 5,837 dry well reports have been received since 2013. The year-to-year number of dry well reports has fluctuated from a low of just 46 in WY 2019 to a high of 1,494 in WY 2022 (**Table 14**). The locations of reported dry wells in WY 2023 are shown in **Figure 18**.

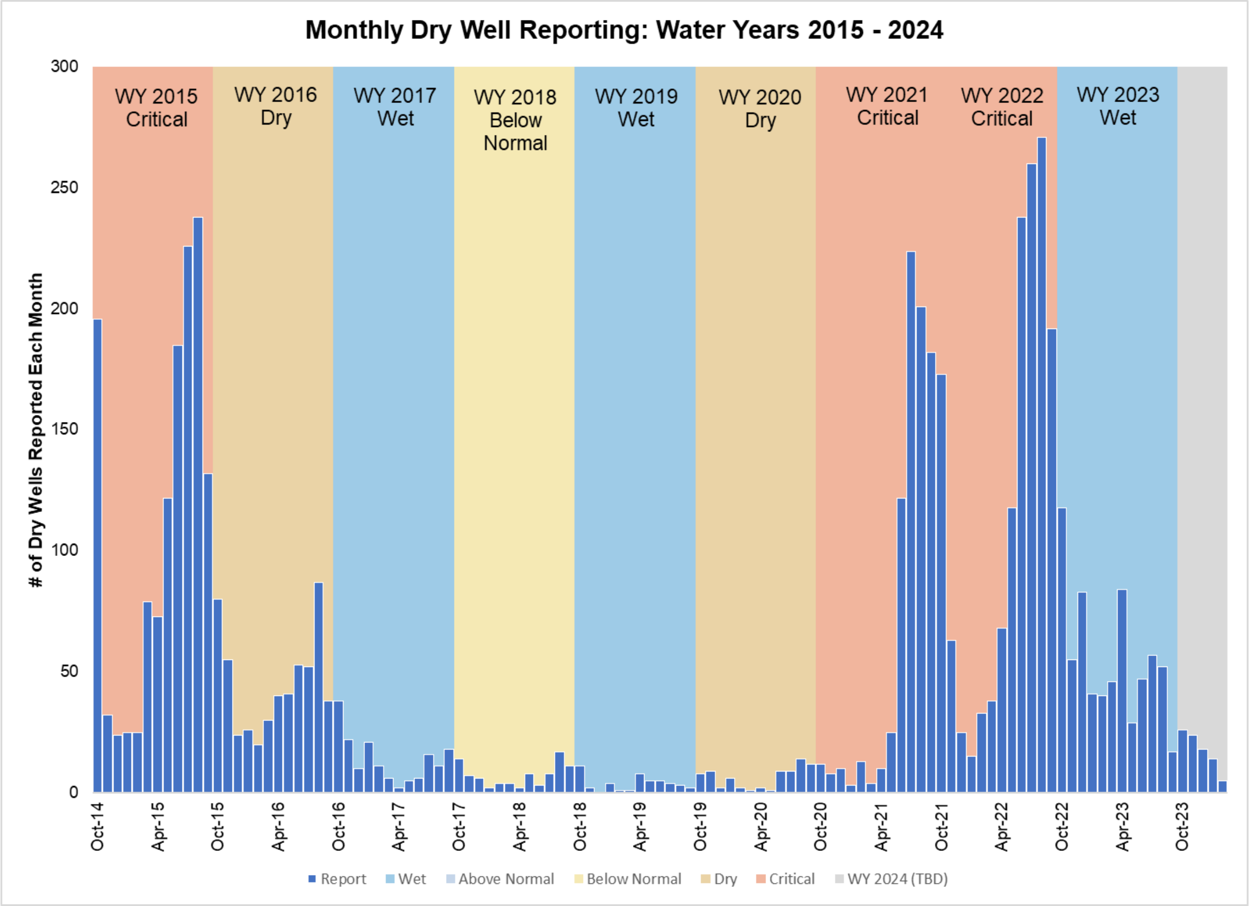
Figure 18: Statewide one-year reported dry wells map for WY 2023. Map and charts based on available data from the CNRA Open Data as of 04/01/2024.



In WY 2023, the highest number of dry well reports were received in Madera County (136), Fresno County (122), and Tehama County (93). These three counties account for approximately half the dry well reports (52 percent) received statewide in WY 2023 to date. Sixteen counties reported between 1 and 10 dry wells and 29 counties reported zero dry wells.

The statewide trend for dry well reporting over the past nine water years (2015-2023) shows a correlation between extended dry periods and the number of dry well reports. More dry wells were reported during the critical years of 2015, 2021, and 2022 than any other period. The wet winter of 2022-2023 resulted in an apparent decline in dry wells reported during WY 2023. **Figure 19** shows a monthly time series of dry well reports from October 2014 to March 2024.

Figure 19: Monthly Dry Well Reporting (October 2014 through March 2024).



Groundwater Reporting Assessment

Groundwater level data is used to analyze short-term, seasonal, and long-term groundwater level changes, trends in groundwater storage, as well as susceptibility to land subsidence, seawater intrusion and dry wells. Groundwater levels are typically measured on a regular schedule from a variety of groundwater wells located throughout the state. Some measurements are collected by DWR, although much of the data are collected and reported to DWR by hundreds of local GSAs implementing SGMA, by entities participating in the California Statewide Groundwater Elevation Monitoring (CASGEM) Program, and other parties. While local entities submit a significant amount of groundwater data to DWR, there are local monitoring networks and high-frequency data that remain at the local level and are never submitted to DWR. As a result, these data do not appear in the statistics and figures presented in this section.

The assessment of data in this report evaluates the frequency of groundwater level data collection from individual monitoring wells (measurement frequency) and the timeliness of submitting the measurement after it was collected (reporting delay). Wells having a measurement frequency of about a month or less allow for the evaluation of seasonal groundwater fluctuations and an accurate determination of the annual groundwater level highs and lows within a given well. Wells with a short reporting delay (30 days or less) provide important operational information about the effects of recent hydrologic conditions (e.g. rain or drought) on the groundwater system and can help with groundwater management in the relatively near term.

In general, late winter to early spring measurements capture the pre-irrigation annual high groundwater levels while late summer to early fall measurements capture the post-irrigation annual lows. Groundwater level highs and lows, however, vary in time based on the year, location of the well, and surrounding land uses. These temporal and geographic variations in annual highs and lows can only be evaluated with data collected monthly or more frequently. Wells with monthly data collection for WY 2023 are shown in **Figure 20.**

Figure 20 is a map showing the location of 9,205 wells with reported groundwater level measurements collected throughout WY 2023. Of these wells, 1,344 (13 percent) had groundwater measurements collected in at least 10 months in WY 2023 and are labeled as wells with monthly groundwater level data. Wells with equipment to automatically measure and transmit data are shown as telemetered wells. **Figure 21** shows the data reporting delays for measurements collected from wells throughout the state in WY 2023. Groundwater levels that are measured and promptly reported provide real-time insights into current groundwater levels and are essential for understanding how events, such as drought or extreme precipitation and runoff affect groundwater conditions. Knowing groundwater conditions in near-real time is beneficial for more effective groundwater management and drought and flood planning and response. In **Figure 21** the reporting delay time is divided into groups of <1 day, < 30 days, 30 to 59 days, 60 to 89 days, 90 to

180 days, and > 180 days. The average time to submit groundwater level data to DWR for WY 2023 was over 250 days after data collection. For WY 2023, about 23 percent of groundwater level measurement data were submitted in fewer than 60 days from the collection date and only about 10 percent were submitted in fewer than 30 days. About 31 percent of groundwater level measurements were submitted more than 180 days after collection.

Telemetry plays a crucial role in managing groundwater resources effectively by enabling the collection of measurements at a high frequency with a very short submittal delay. DWR, with support from United States Geological Survey, operates about 150 telemetered sites that monitor groundwater elevation and subsidence data (**Figure 20**) on a real-time basis and is made available to the public on the Water Data Library. Expanding the utilization of telemetry in DWR's statewide groundwater monitoring network enhances data-informed water management decisions at both local and regional levels across California. This empowers communities to effectively plan for and proactively address the increasing demands on water resources and potential for water shortage. Telemetered data is highly regarded for its superior quality, offering near-real time and continuous updates on groundwater conditions.

Figure 20: Statewide groundwater level data reported for data collected between January 1 and April 30, 2023. Map based on available data from the CNRA Open Data as of 8/31/2023.

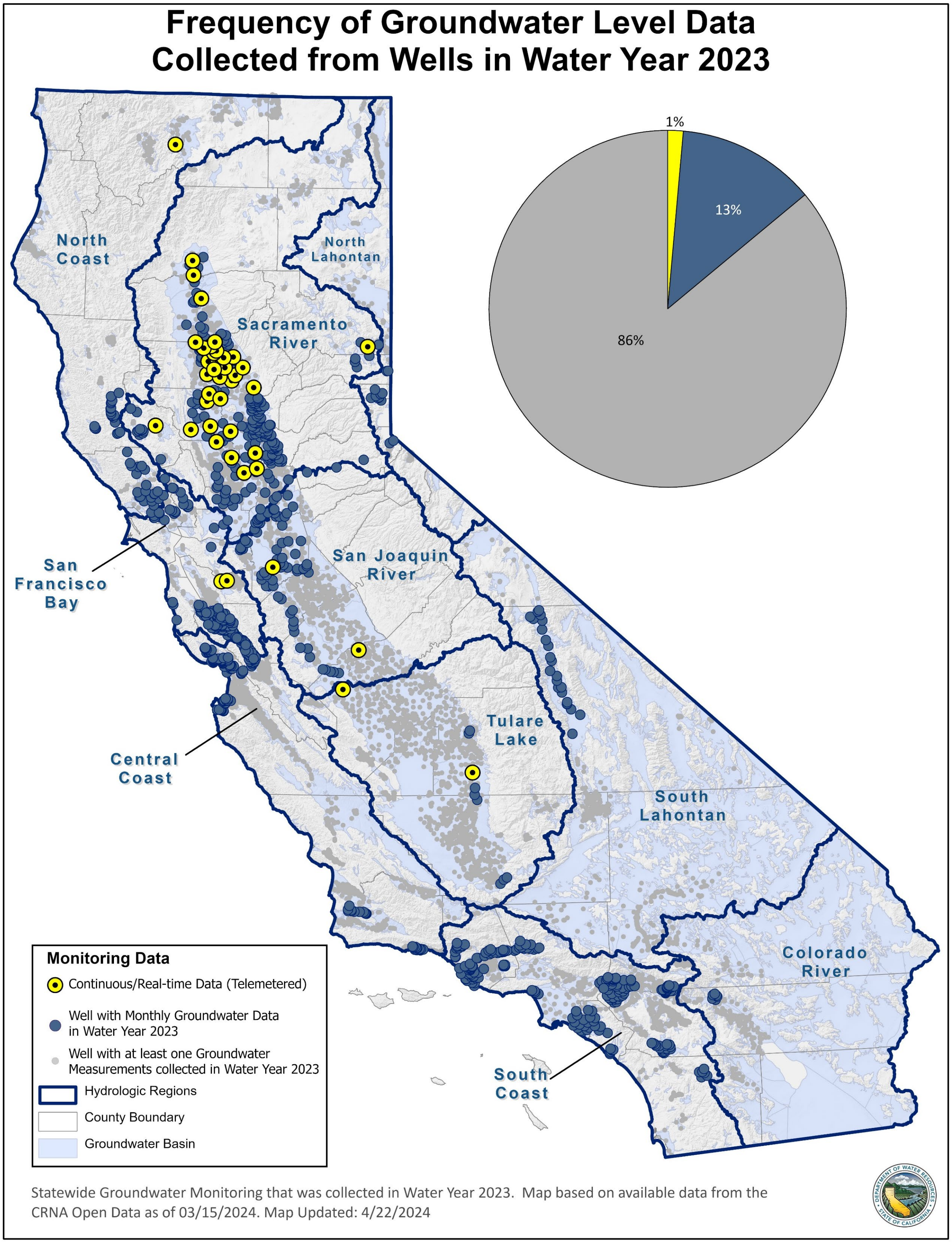
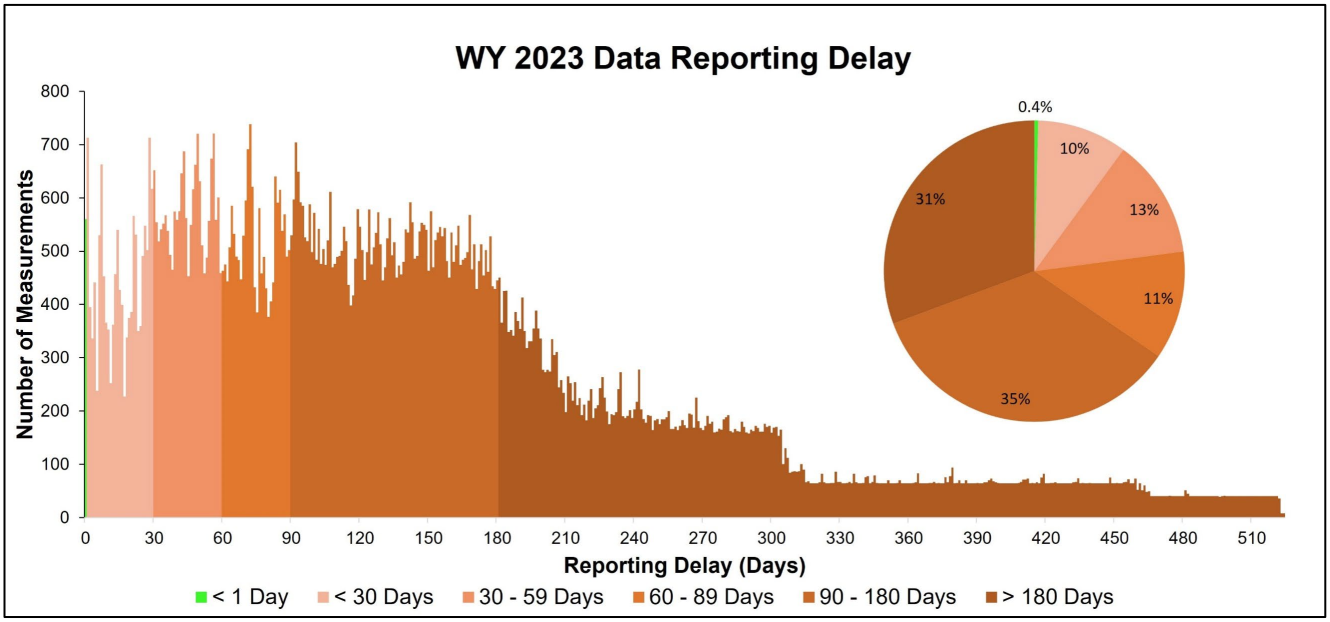


Figure 21: Statewide Groundwater Level Measurement Reporting Delay for WY 2023. Charts based on available data from the CNRA Open Data as of 03/15/2024.



Closing Thoughts

California's climate is in a state of constant flux, characterized by increasing variability and extremes. These changes have far-reaching implications for the management of water resources within the state. The historical patterns and strategies that have long shaped water management are now being upended, prompting a search for innovative approaches to secure the future of California's water supply. Local water managers are now faced with unprecedented decision-making challenges due to the changing climate. The state has long been accustomed to seasonal variations in rainfall, with wet winters and dry summers. However, climate change has intensified these variations, making it increasingly difficult to anticipate when and how much precipitation will occur. Although the recent extreme drought was interrupted by one wet winter, it would be unwise to assume that this marks the end of water scarcity concerns. In wetter years where there is typically abundant precipitation, higher snowpack levels, and increased streamflow, users may rely more on surface water sources and reduce groundwater pumping. During a dry year, groundwater becomes a more critical water source as surface water supplies diminish, leading to an increase in groundwater pumping to meet water demands, thereby reducing groundwater in storage.

As data from the past water year has shown, one year of above-average precipitation across the state cannot undo the effects from years of drought and overdraft. Groundwater levels, while somewhat recovered after WY 2023, are generally still lower than those recorded after the 2012-2016 drought. Although uplift is recorded in specific regions in WY 2023, land subsidence remains prevalent across large areas when considering a five-year period. While both domestic and irrigation well installations in WY 2023 are lower than any of the past nine years, dry wells are still being reported across the state.

Groundwater, a precious resource, is fundamental to the well-being of numerous communities, industries, and environments across the state. It serves as a crucial source of drinking water, sustains agricultural activities, and is vital for ecosystem health. With California facing the impacts of a shifting climate, effective groundwater management is increasingly essential as a safeguard against droughts and water shortages. During WY 2023, 4.1 million acre-feet of managed recharge, 9.7 million acre-feet of groundwater extraction, or groundwater pumping, and 8.7 million acre-feet increase of groundwater in storage was reported by GSPs. These data point toward a positive annual change in groundwater storage, reflecting the cumulative effect of increased recharge and decreased extraction (pumping) brought about by a reduced reliance on groundwater during the wet WY 2023.

As the state navigates the complex landscape of water management in the face of a changing climate, the infrequent collection and delayed reporting of groundwater data in many areas create roadblocks to informed decision-making and sustainable resource management. Investment in enhanced monitoring infrastructure is crucial to enable more frequent and accurate data collection. Streamlining reporting processes and leveraging technology can reduce delays, ensuring that data are readily available to decision-makers. While the first ten years of SGMA implementation has led to improvements in data collection and reporting, there is still much work to be done to continue filling data gaps and making groundwater data more accessible and actionable.

The reliance on occasional wet winters to replenish water reservoirs and groundwater aquifers cannot be sustained in the face of a changing climate. Embracing water conservation as a long-term practice is imperative. This cultural shift is not just an option but a necessity to ensure that we can effectively and conjunctively manage water resources in an environment marked by increasing climatic uncertainties. As the state grapples with the challenges of a hotter drier future, the ongoing efforts to enhance groundwater recharge become increasingly vital as a safeguard against droughts and water shortages. California's evolving climate poses profound challenges to water management at the local level and calls for continued discussions about the state's role in climate adaptation.