CALIFORNIA DEPARTMENT OF WATER RESOURCES

California's Groundwater Conditions: Semi-Annual Update

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FALL BULLETIN 118
INFORMATION UPDATE

CALIFORNIA DEPARTMENT OF WATER RESOURCES

California's Groundwater Conditions Semi-Annual Update: October 2023

Executive Summary

California experienced an unprecedented wet winter in Water Year (WY) 2023 with a deluge from 19 atmospherics rivers which made landfall in California. Statewide annual precipitation in WY 2023 totaled 33.56 inches, which is about 141 percent of the long-term (1901-2000) annual average precipitation statewide. According to the April 1 snow survey, the statewide snowpack was at 237 percent of normal for the date – the deepest on record since the state's network of snow sensors was established in the mid-1980s. The snowpack was so deep that it contained roughly 30 million acre-feet of water, or more water than 1.7 times the annual average groundwater use (about 18 million acre-feet) in California. The subsequent snowmelt runoff filled surface water reservoirs and caused historic flooding, and thereby interrupted the ongoing three-year drought (2020-2022) with a wet winter. However, the state's groundwater basins, which supply more than 40 percent of the state's total water supply, in an average year, remain seriously depleted despite the wet winter because the groundwater basins require a much longer timeframe to recover. If next year reverts back to dry conditions, we could see an extension of that drought. As California transitions to a warmer and drier climate, such a scenario becomes increasingly likely. This further emphasizes the importance of embracing water conservation as a way of life, rain or shine.

The wet season of 2023 demonstrated how quickly California's weather can move from one extreme to another as severe drought conditions gave way to flooding and one of the largest snowpacks in 70 years. We went from planning for a 4th year of extreme drought to dealing with historic flooding and then back to hot conditions in the summer.

DWR worked together with reservoir operators and local agencies to coordinate reservoir operations and ensure the massive snowmelt volumes could pass safely through the reservoir system while minimizing impacts to communities. State and local water managers also recognized an opportunity to recharge the floodwaters into groundwater aquifers, which have been chronically depleted over repeated droughts during the past two decades.

The Governor's executive orders (N-4-23, N-6-23, and N-7-23) and recent changes to the water code (1242.1) relaxed certain permitting requirements for flood diversions and allowed the state and local agencies to quickly manage snowmelt runoff and leverage flood water for groundwater recharge. In addition, the state's continued financial assistance to local agencies for recharge projects and actions helped the state reach an unprecedented level of managed aquifer recharge. Just how much recharge occurred this year will become

clearer after April 1, 2024, when Annual Reports are due from the local groundwater sustainability agencies (GSAs) and other groundwater managers across the state. These facts underscore the urgency and importance of enhanced monitoring of groundwater recharge opportunities and operations.

This semi-annual report presents data received by DWR as of August 31, 2023, and partially reflects the impacts of recent storms, flooding, and natural and managed aquifer recharge. 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.

California continues to invest in ensuring the resiliency of groundwater resources. The Sustainable Groundwater Management Act (SGMA) of 2014 set forth a vision that all the state's groundwater basins be sustainably managed by 2042. The state has invested in planning, implementation, and technical assistance to help reach that goal. Further, the state has been proactive in addressing the effects of climate change on our groundwater resources. In 2022, the Governor released California's Water Supply Strategy, Adapting to a Hotter, Drier Future, which describes how recurrent and longer periods of extreme dry weather is the new climate reality of California and could diminish our existing water supply by up to 10% by 2040. Replenishing the state's groundwater basins is a key element of this strategy. The state continues to make investments to modernize water infrastructure and management, and has facilitated emergency drought response efforts, as well as projects by local and state agencies, to address current and future drought impacts and become more resilient. The Department of Water Resources (DWR) also continues to award funding for drought relief assistance to small and urban communities to address water supply challenges and sustainable groundwater management funding to help build long-term resilience at both local and regional levels.

Groundwater provides up to 58 percent of the state's total water supply in dry years, and over 80-percent of Californians depend on groundwater for some portion of their water supply. Groundwater also serves as a drought buffer and a critical component to the state's climate adaptation strategy, but without sustainable groundwater management, negative effects such as overdraft, dry wells, land subsidence, stream depletion, and groundwater quality degradation can occur and have historically been observed in various parts of the state. Governor Newsom's drought emergency proclamations have improved drought response by accelerating data collection, improving dry well reporting and drinking water assistance, requiring heightened coordination for local well permitting, and providing regulatory relief for groundwater recharge projects under specified circumstances to mitigate drought impacts.

This report is the latest in a series of Semi-annual Groundwater Conditions Updates, last published in March 2023. These updates are part of the informational resources associated with DWR's California's Groundwater (Bulletin 118). This report uses groundwater data received electronically by DWR as of August 31, 2023. 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

Flood, Drought, and Groundwater

- Statewide precipitation in Water Year (WY) 2023 ranks as the 8th wettest year in the last 50 years, resulting in nearly 100 percent recovery of surface water reservoir levels.
- Groundwater storage has been slower to recover than surface storage, as expected; but, has trended positively in most of the state in WY 2023.
- Governor Newsom's Executive Orders N-4-23, N-6-2023 and N-7-23 facilitated the use of over 390,000 acre-feet of floodwaters to recharge California's groundwater basins by relaxing permitting requirements. Senate Bill 122 (2023) added California Water Code Section 1242.1 to codify some of the Executive Order language. The State Board streamlined the permitting process for temporary groundwater storage permits to fast-track floodwater capture for recharge.
- Despite record precipitation in some parts of the state in WY 2023, the cumulative departure from the average annual statewide precipitation (**Figure 2**) for the 2000-2023 period shows that there is an accumulated precipitation deficit during this period. Groundwater level and storage data similarly reflect decreasing long-term trends.

Groundwater Levels

- In WY 2023, groundwater levels began to recover from the prior drought years, but only partially. It will likely require several more wet years and more focused efforts to increase recharge and reduce pumping to recover from the most recent drought and the cumulative depletion of groundwater aquifers that has occurred over decades.
- The one-year change data (**Table 1 and Figure 7**) show more well locations with increases in measured groundwater levels, as expected after a wet winter. However, over the last 20 years, more than 46 percent of monitoring wells in the state had a decreasing trend in groundwater levels.
- In the Tulare Lake Hydrologic Region, groundwater levels declined in over 30 percent of the monitoring wells in WY 2023 (**Figure 7)** and over 70 percent of wells in this region exhibited groundwater level declines during the 2018-2023 period (**Figure 10**). In contrast, more than 50 percent of the monitoring wells in the South Coast Hydrologic Region exhibited groundwater levels increase during the same 5-year period.

Groundwater Extraction and Change in Storage

- During WY 2022, over 17 million acre-feet of groundwater extraction was reported within 96 basins that submitted GSP/Alternative Annual Reports (**Figure 12**). This is approximately 1 million acre-feet (six percent) less extraction than that in WY 2021 in 94 basins with GSP/Alternative data. The Central Valley as a whole accounted for over 15 million acre-feet of pumping in WY 2022, approximately 90 percent of groundwater extractions in California.
- During WY 2022, about 6.4 million acre-feet of decline in groundwater storage was reported across 96 basins (**Figure 13**), which is about 1.5 million acre-feet (19 percent) less than that reported during WY 2021 for 94 basins. The Central Valley accounted for over 5.8 million acre-feet of storage decline in WY 2022, approximately 91 percent of groundwater storage declines in California.
- Similar to WY 2021, the largest decline of groundwater in storage in WY 2022 occurred in the Tulare Lake Hydrologic Region. Specifically, Kern County and Kings basins saw the greatest decreases of groundwater in storage, about 1.7 million AF and 680 thousand AF, respectively.

Land Subsidence

- From July 2022 to July 2023, an area of approximately 4,000 square miles experienced subsidence of greater than 0.1 feet, about 46 square miles were greater than 0.6 feet of subsidence, and no areas subsided more than 0.8 feet (**Figure 14**). These measurements indicate a decrease in subsidence from the prior year.
- The Tulare Lake Hydrologic Region has the most areas of land subsidence, with about 2,400 square miles experiencing greater than 0.1 feet of subsidence from July 2022 to July 2023.

Well Infrastructure

- Fewer domestic and irrigation wells were installed in 2023 than any year in the past 9 years since the Sustainable Groundwater Management Act was passed (**Table 9**).
- Fewer dry wells were reported in 2023 compared to 2021 and 2022.
- The time delay between the collection and the reporting of groundwater monitoring data and limited spatial coverage makes it difficult to draw conclusions about the groundwater level response to the storms and flooding during WY 2023 (**Figures 19 and 20**).

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Introduction

The wet season of 2023 demonstrated how quickly California's weather can move from one extreme to another as severe drought conditions gave way to flooding and accumulation of one of the largest snowpacks in 70 years. A fourth consecutive year of drought was averted by an unprecedented 31 atmospheric rivers off the west coast, 19 of which made landfall in California. This precipitation greatly benefited surface water resources and marked the beginning of groundwater levels recovering after many years of chronic decline. This sudden deluge led to news reports that the drought in California is all but over without realizing that one year of heavy precipitation will not refill depleted groundwater basins that require a much longer timeframe to recover.

California agencies proactively worked to take advantage of this year's heavy precipitation. The Governor's executive orders (N-4-23, N-6-23, and N-7-23) relaxed certain permitting requirements and allowed the state to quickly manage snowmelt runoff and leverage it for groundwater recharge, water transfers, and increased storage. In addition, the state's continued financial assistance to local agencies for recharge projects and actions helped the state reach an unprecedented level of managed aquifer recharge in Water Year (WY) 2023.

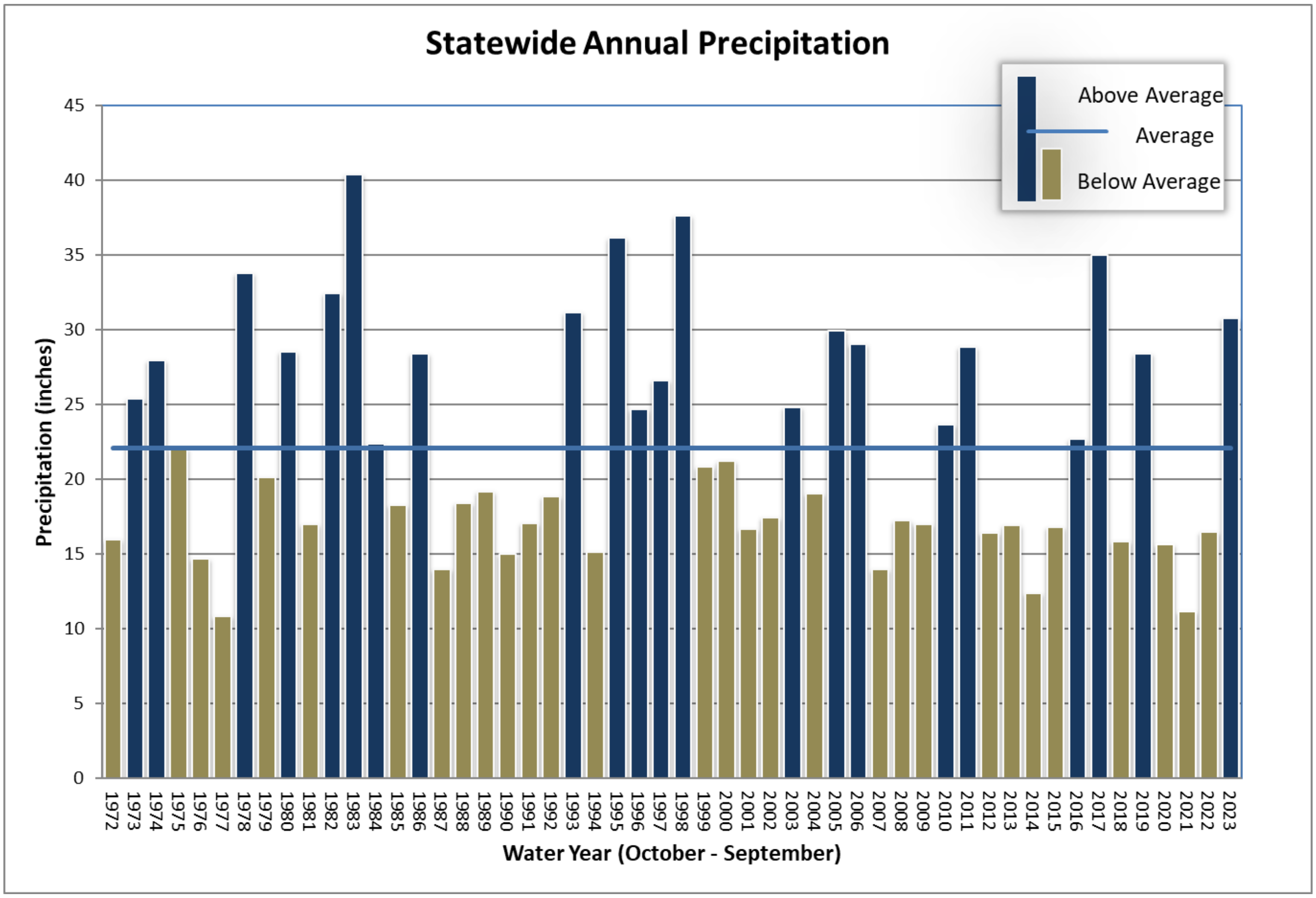
> ***What is a water year?***
>
> *A water year is a 12-month period that extends from October 1 to September 30. The water year is designated by the calendar year in which it ends.*

Local agencies and the state continue to make significant progress toward collecting, reporting, and disseminating groundwater data as well as improving management of groundwater resources in support of the implementation of the Sustainable Groundwater Management Act (SGMA). Groundwater Sustainability Plans (GSPs) have been developed and most are in the implementation phase. Basins with GSPs, along with alternatives to GSPs and adjudicated areas, provide 98% of the total groundwater supply in the state. DWR continues to work toward making periodic groundwater monitoring data, annual groundwater use data, and change in groundwater storage data, reported by Groundwater Sustainability Agencies (GSAs), publicly available. DWR also maintains the California's Groundwater Live website and provides datasets available for download from the CNRA Open Data website, for access to the most recent groundwater data.

Flood, Drought, and Groundwater in California

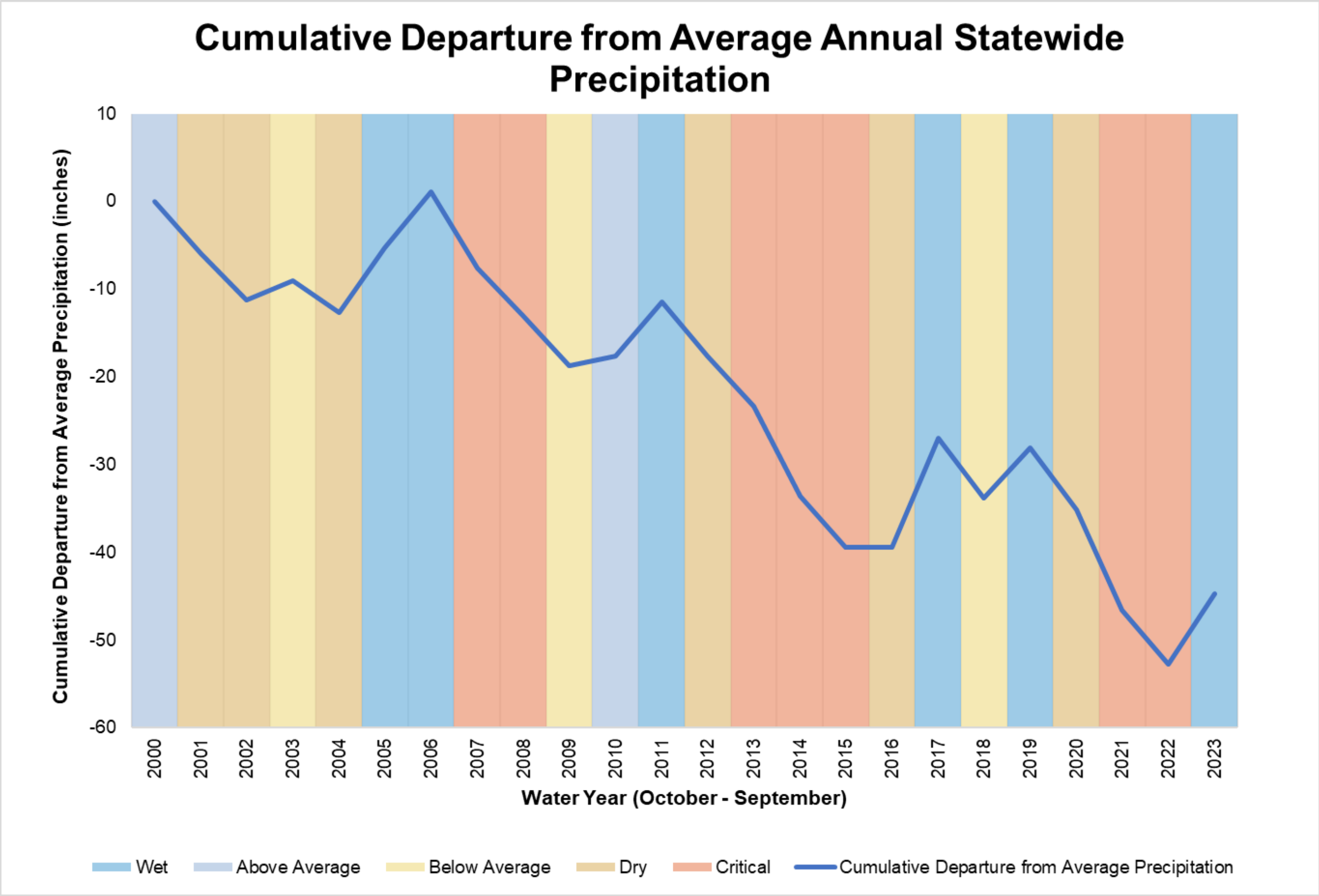
The recent extreme precipitation and flooding in California made headlines but these conditions were not experienced across the entire state and are not representative of the long-term dry weather the state has been experiencing during the past two decades. Despite this year's wet conditions, California is experiencing drier than average conditions over the longer term. In other words, California experienced flooding while in the midst of a drought. It was reported in a recent study that 2000-2022 was the driest 22-year stretch on record in at least 1,200 years in California. Historical data shows that 16 of the 23 years during the 2000-2023 period had below average annual statewide precipitation (**Figure 1**). The cumulative departure from the average annual statewide precipitation (**Figure 2**) for the 2000-2023 period shows the accumulated precipitation deficit during this period has reached a low of -55 inches in 2022.

Figure 1: Statewide Annual Precipitation, NOAA National Centers for Environmental Information, (Climate at a Glance: U.S. Time Series, Precipitation).



Very wet years, such as this year, can refill reservoirs and restore natural surface water systems, but groundwater basins depleted by decades of imbalance from pumping that exceeds recharge require more than one or two wet years to recover. As California transitions to a warmer and drier climate, this scenario of persistent groundwater depletion becomes increasingly likely, further emphasizing the importance of sustainable groundwater management and embracing water conservation as a way of life, rain or shine.

Figure 2: Cumulative Departure from Average Annual Statewide Precipitation based on data from NOAA National Centers for Environmental Information, (Climate at a Glance: U.S. Time Series, Precipitation).



Historic Precipitation and Snowpack

In WY 2023, precipitation exceeded the long-term (1901-2000) mean in all regions of the state. The spatial distribution of WY 2023 precipitation across the state, expressed as a percentage of each hydrologic region's long-term mean precipitation, is shown in **Figure 3**. On April 1, 2023 the California Cooperative Snow Surveys reported statewide snowpack was 237 percent of normal for the date – the deepest on record since the state's network of snow sensors was established in the mid-1980s. According to a news report published in April 3, 2023 in Los Angeles Times, the snowpack was so deep that it contained roughly 30 million acre-feet of water, or more water than 1.7 times the annual average groundwater use (about 18 million acre-feet) in California. The spatial distribution of snow water contents in Northern, Central, and Southern Sierra is shown in **Figure 4** as percentage of the historical average. Snowpack in the Central and Southern Sierras reached historic highs, with snow water content exceeding the 1982-83 maximum to-date in these regions. In the Northern Sierra, although the snow water content was above average, it was below the 1982-83 maximum to date for that region.

The wet weather refilled reservoirs and bolstered California's surface water supplies. In April, a 100 percent State Water Project (SWP) allocation was announced for the first time since 2006. The federal Central Valley Project also announced 100 percent allocations for the first time since 2017. The SWP captured a total of 3.5 million acre-feet in SWP reservoirs from December 1, 2022 to August 31, 2023 and delivered 856 thousand acre-feet of water to SWP contractors.

Flood Response and Surface Water Diversions

Record breaking precipitation and historic levels of snowpack in the Sierra Nevada elevated the risk for flooding across the state. DWR activated the Flood Operations Center (FOC) from January 3 through January 20 and from March 9 through June 16. Between January and July, DWR deployed staff to support communities, such as those in the vicinity of the Tulare Basin, Pajaro, San Joaquin, and Merced Rivers, and provided over 1.9 million sandbags and other materials to 32 counties across California.

As this year's emergency shifted from drought to rain-driven flooding and then to snowmelt-driven high flows, DWR worked together with reservoir operators and local emergency response agencies to coordinate reservoir operations and ensure that the massive snowmelt volumes could pass safely through the reservoir system while minimizing impacts to communities. The State took swift action to support local agencies to expedite diversions of an unprecedented amount 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. Through state assistance, about 60,000 acre-feet of water was diverted, including about 24,700 acre-feet of flood flows, from the Kern River to the California Aqueduct via the Kern Intertie, simultaneously reducing flood conditions in the lakebed and recharging depleted groundwater basins. With the extreme precipitation and runoff and the need to manage flood waters, water managers recognized an opportunity to recharge the depleted groundwater aquifers. DWR's emergency flood diversion and recharge enhancement efforts provided 30 temporary pumps to local agencies who were able to divert an estimated 16,000 acre-feet of floodwater for recharge in the Tulare Lake region from late April to early July.

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

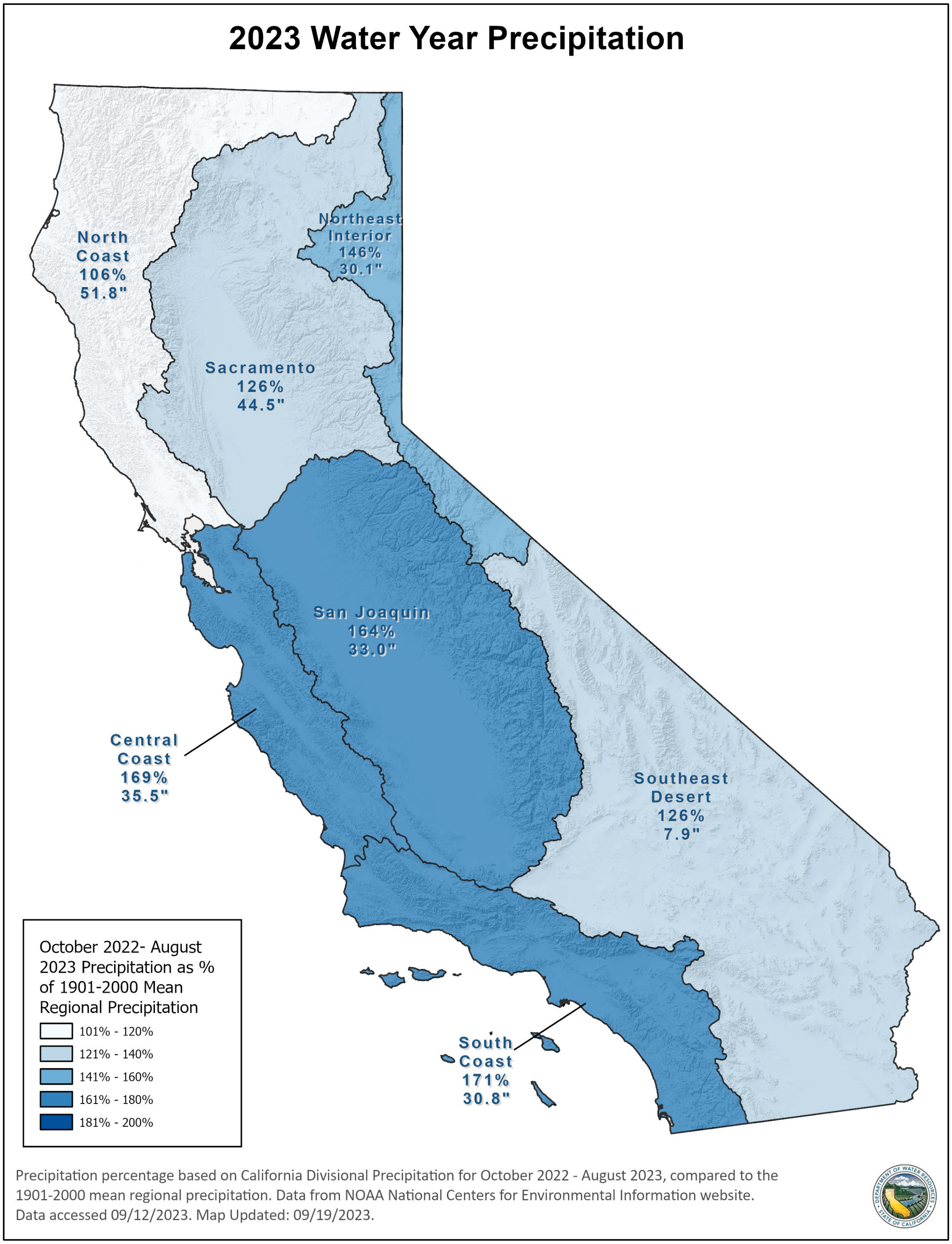
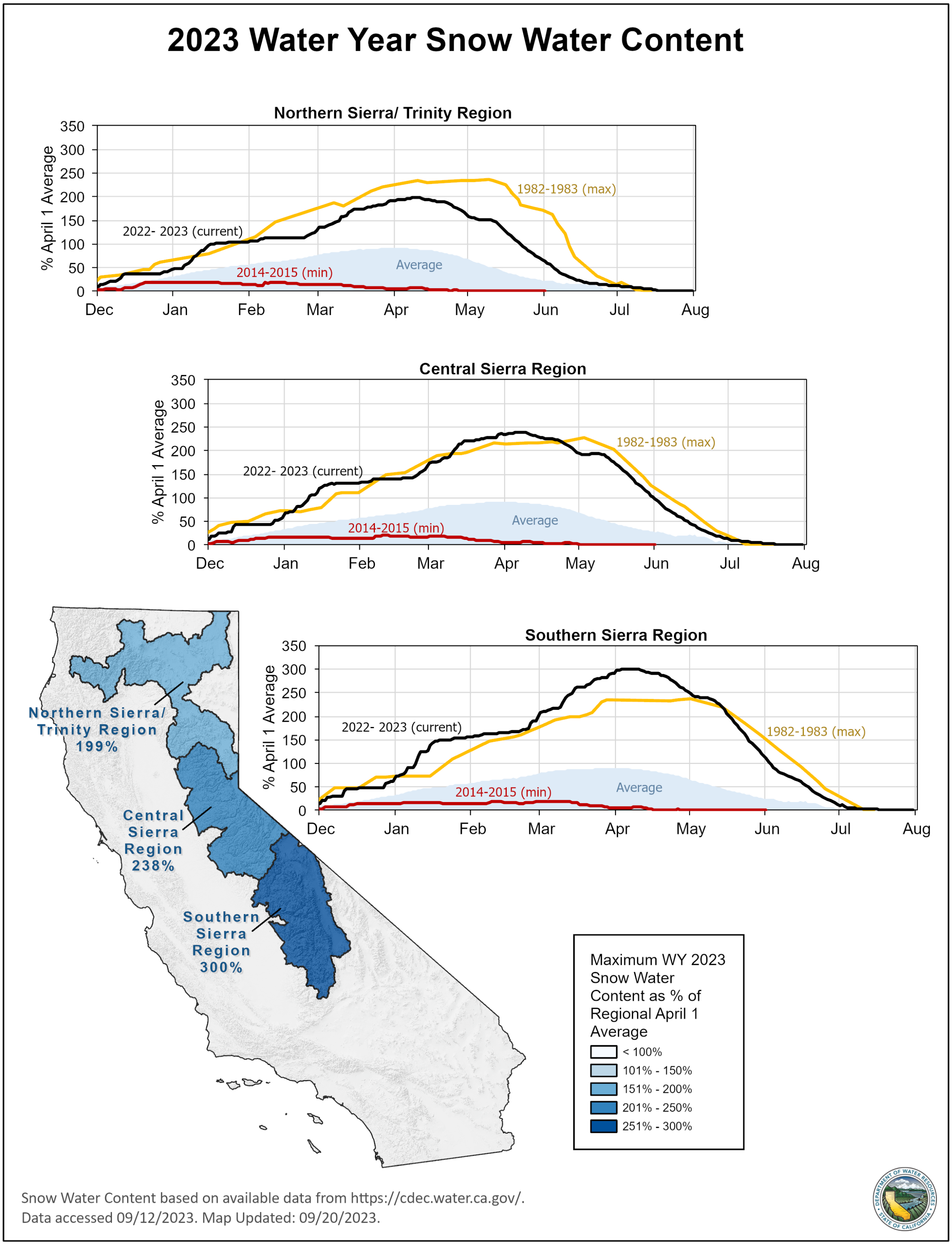


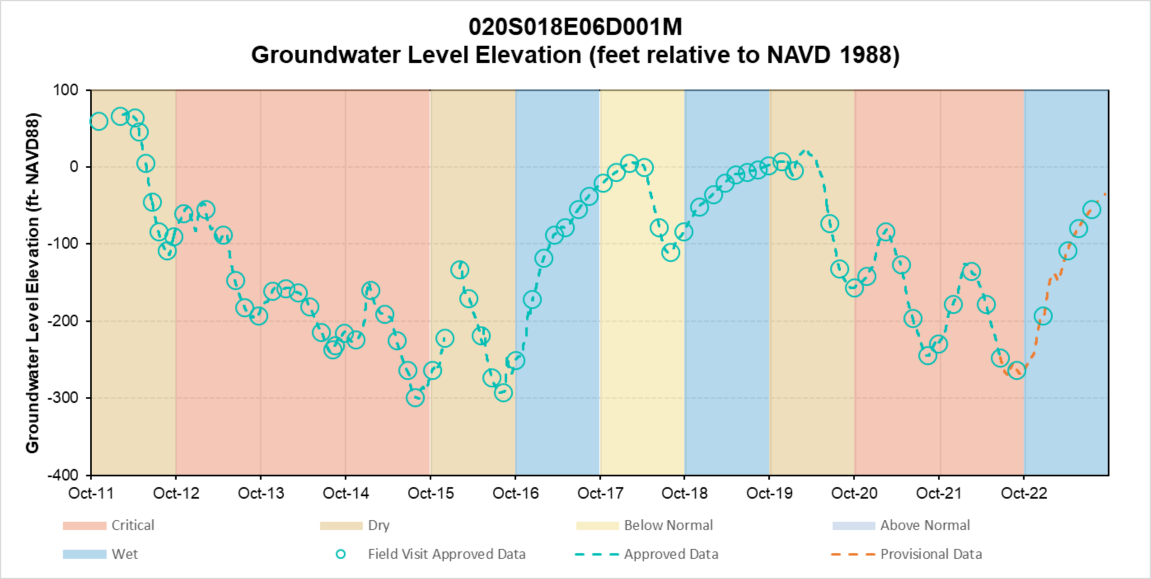
Figure 4: 2023 Snow Water Content, CDEC (Snowpack Conditions Snow Water Content)



Groundwater Recharge

The managed and natural recharge made available from the storms of 2023 has proven highly beneficial. The abundance of surface water also reduced the need to pump groundwater, allowing for additional groundwater recovery. This year, groundwater levels began to recover from the prior drought years, but only partially. It will likely require several more wet years, in addition to more focused efforts to increase recharge and reduce pumping, to recover from the most recent drought and the cumulative depletion of groundwater aquifers that occurred over the years. For example, a hydrograph from a 1,007 foot deep well located in the Tulare Subbasin (**Figure 5**), where WY 2023 precipitation exceeded 160 percent of 1901-2000 average, showed a groundwater level increase of almost 200 feet since the seasonal low in August 2022, but is still about 120 feet below the February 2012 recorded high groundwater level and approximately 50 feet below the March 2018 and March 2020 recorded high groundwater levels which followed wet years in the San Joaquin Valley.

Figure 5: Hydrograph Showing Groundwater Elevation Changes in a Monitoring Well in Tulare Subbasin USGS Site 020SA8E06D001M.

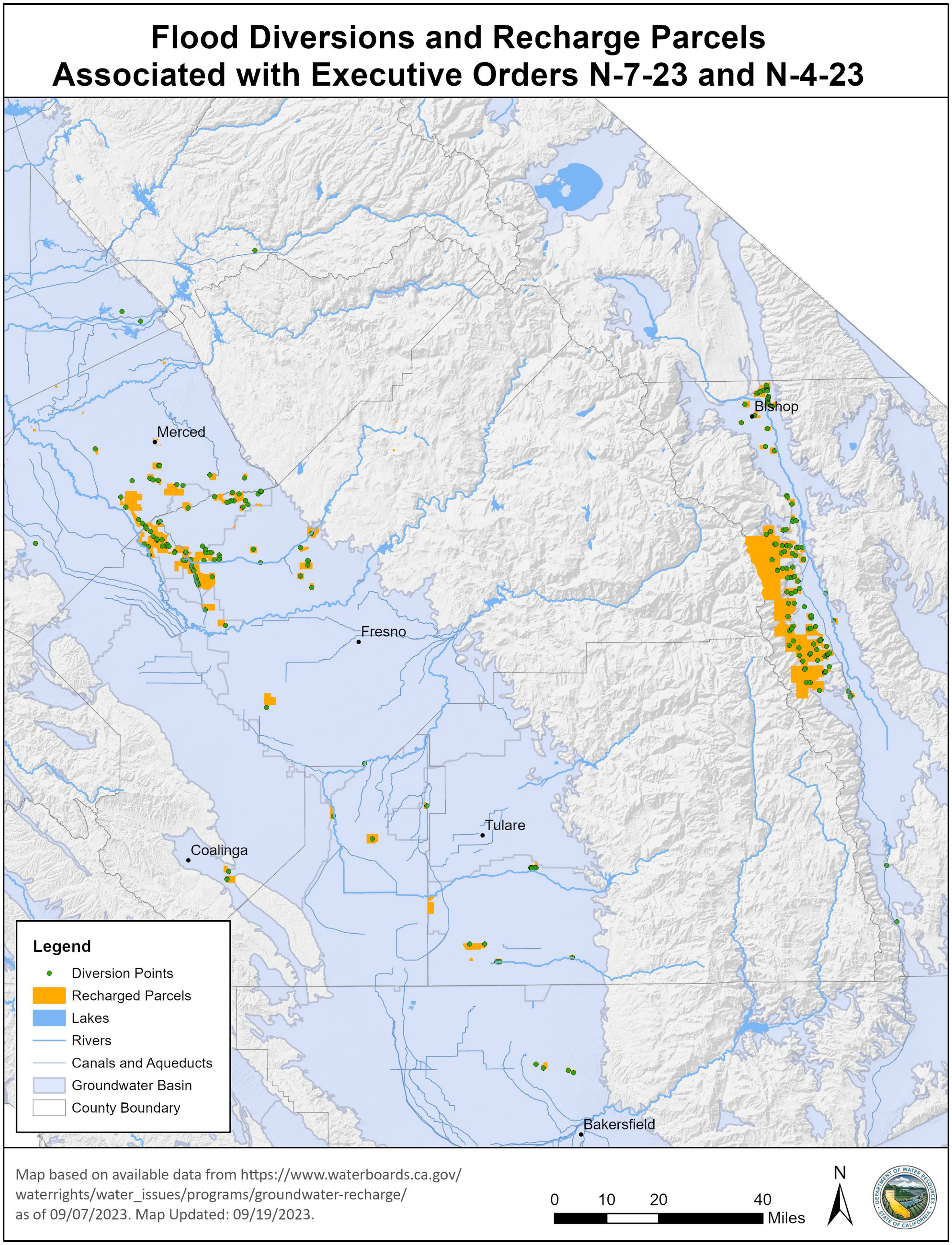


[Governor Newsom's Water Supply Strategy](#) identified expediting groundwater recharge as a key water resilience strategy. As a result, the state has prioritized groundwater recharge as a critical long-term strategy for sustainable groundwater management and drought mitigation. Under Executive Orders N-4-23, N-6-23, and N-7-23 a reported 390,817 acre-feet of floodwater was diverted for groundwater recharge on 95,575 acres of land. **Figure 6** shows the points of diversion and parcels reported to the State Board where floodwater was diverted and recharged.

In 2023, the State Water Board also streamlined the permitting process for temporary groundwater storage permits to fast-track efforts to capture floodwater to recharge groundwater basins. DWR supported local agencies in navigating the State Water Board's Streamlined Temporary Permit process, resulting in a total of 670,000 acre-feet of permitted diversions for recharge. The State Water Board also approved a Temporary Urgency Change Petition (TUCP) to the Bureau of Reclamation for 600,000 acre-feet for recharge.

Based on initial estimates, over three million acre-feet of managed aquifer recharge occurred statewide in WY 2023. The total amount of recharge that occurred this year will be calculated after April 1, 2024, when Annual Reports are submitted by the local groundwater sustainability agencies (GSAs) and other groundwater managers across the state. However, that total will not include all the groundwater recharge that has occurred statewide this year because other than SGMA annual reports, there is no central repository for statewide groundwater recharge data and all groundwater basins in the state are not required to submit annual reports. The winter storms, high snowpack, spring runoff this year, and longer-term sustainable groundwater management requirements underscore the urgency and importance of enhanced monitoring of statewide groundwater recharge opportunities and operations. Statewide recharge opportunities and facilities are ever expanding under various programs and activities. In WY 2023, an additional 1.5 million acre-feet of potential recharge capacity was added through state and local agency actions.

Figure 6: Recharge and diversion locations associated with Executive Orders N-7-23 and N-4-23.



DWR's Locals Assistance on Groundwater Projects

In addition to expediting the permitting process for diversions and recharge, the State is making substantial financial investments in groundwater recharge initiatives. DWR provides financial and technical support to groundwater sustainability agencies (GSAs) responsible for groundwater recharge projects designed to achieve long-term groundwater sustainability and reliability through implementation of SGMA. DWR supports GSAs by providing grant funding, particularly through the Sustainable Groundwater Management Grant Program and other Technical Services. Between 2021 and the end of 2023, DWR has awarded over $360 million in grants to bolster local groundwater management, including recharge initiatives. There is no centralized database of statewide recharge infrastructures and their capacities, which is necessary for effective management of groundwater. California Groundwater Projects Tool catalogued 343 groundwater recharge projects in the State that have received some form of financial assistance from DWR. The cumulative annual recharge capacity of these 343 projects, which received DWR funding, can be as much as 2.2 million acre-feet. There are other existing recharge projects that are being operated by local agencies and additional recharge projects are planned statewide that will increase the state's overall recharge capacity.

To enhance the understanding of suitable recharge locations across the State, DWR is investing over $15 million to conduct airborne electromagnetic (AEM), ground-based geophysical surveys, and groundwater basin characterization activities. The AEM surveys are akin to MRI scans of the subsurface, providing insights into the composition of groundwater basins and recharge pathways. The AEM data, when combined with other subsurface information, such as groundwater levels, lithology, existing geophysical data, and data measured from the construction of new groundwater monitoring wells, will advance the identification of permeable deposits and buried paleo-valleys that support high-rate and high-volume recharge projects. AEM data and information is already accessible for many parts of the State and is facilitating more informed decision-making in groundwater recharge activities.

Status of California's Groundwater Conditions

The heavy precipitation in WY 2023 has raised questions about how the rain and snow have affected groundwater conditions. Based on available data, the high rainfall helped but did not fully alleviate impacts from the recent drought and past dry years. The short-term (one-year) changes in groundwater conditions that reflect the impacts of recent wet year and the long-term (5 years and 20 years) conditions that show the trends in changes in groundwater levels are discussed below.

Short-Term Groundwater Conditions

Groundwater level change maps show the net change, or difference, between two measurements collected at different times from the same well. The spring 2022 to spring

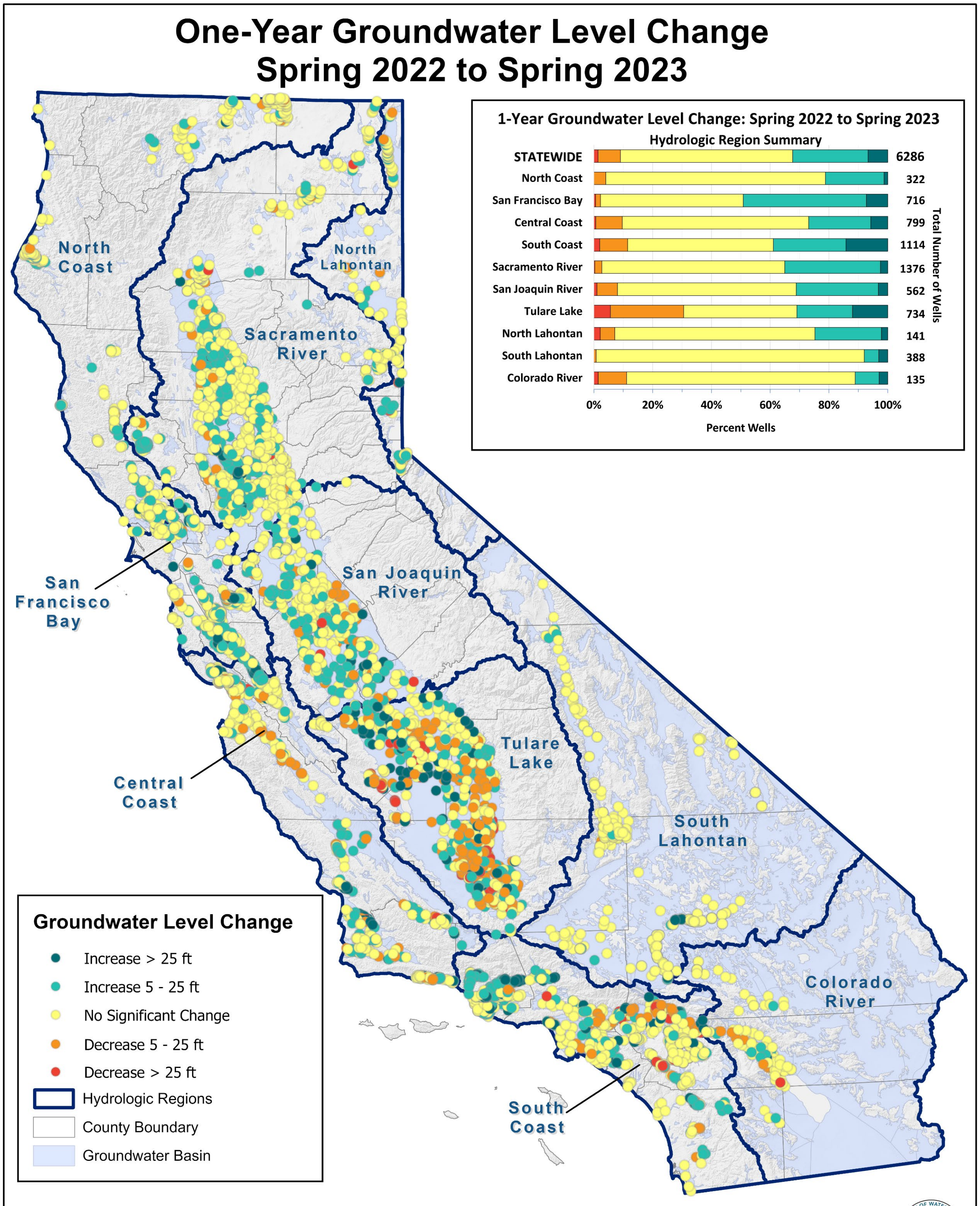
2023 one-year change data (**Table 1** and **Figure 7**) show more increases than declines in groundwater levels statewide, as expected after a wet winter. From spring 2022 to spring 2023, approximately 30 percent of measured wells show more than five feet of increase, and only nine percent show more than five feet of decrease from the previous spring season. This is a significant difference from the 2021 to 2022 one-year spring change report where 26 percent of wells showed a net decrease in groundwater levels (California Groundwater Conditions Update – October 2022).

The spring 2022 to spring 2023 change data also shows that approximately 59 percent of the statewide well measurements indicate no significant changes (less than +/- 5 feet) in net groundwater level. San Francisco Bay, South Coast, and Sacramento River Hydrologic Regions had the three greatest increases in groundwater levels. Tulare Lake and San Joaquin River Hydrologic Regions showed approximately 30 percent net groundwater level increases in measured wells, however, Tulare Lake Hydrologic Region also had over 30 percent of measured wells showing groundwater level declines (**Figure 7)** despite the high precipitation in the region (**Figure 4**).

Table 1: Statistical Summary of Groundwater Level (GWL) Changes from spring 2023 (As shown in **Figure 7** and **Figure 10**). 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): Spring 2023 compared to Spring 2022	6,286	1%	8%	59%	26%	8%
5-Year GWL Change (Post-last Drought): Spring 2023 compared to Spring 2018	4,882	7%	24%	49%	16%	5%

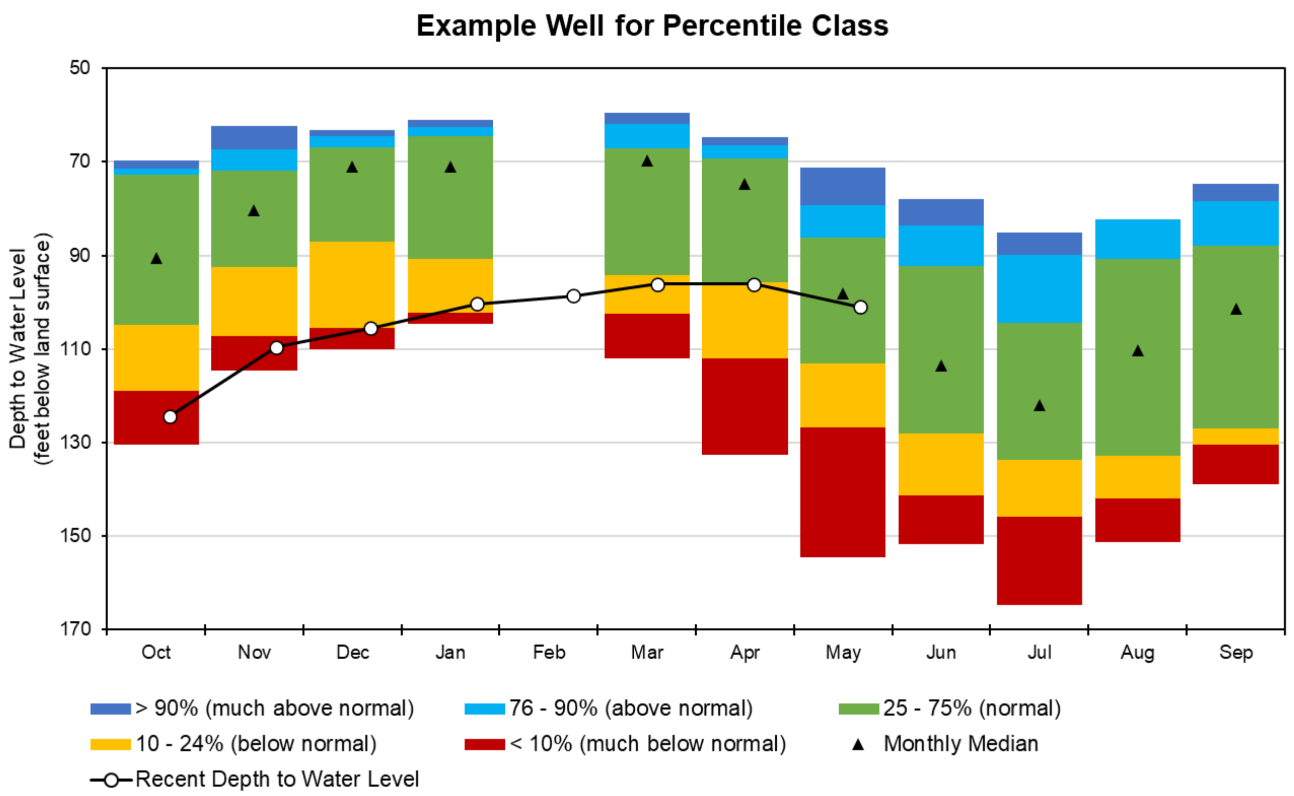
Figure 7: Statewide and hydrologic region groundwater level change map for one-year period between spring 2022 and 2023. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 08/31/23.



Groundwater level change map for one-year comparison between spring 2022 and 2023. Groundwater level change determined from water level measurements in wells. Map and chart based on available data from the DWR Enterprise Water Management Database as of 08/31/2023. Map update: 09/01/2023

Comparing a current groundwater level measurement to that well's past measurements provides context for current groundwater conditions at that site. Groundwater level percentile class information is determined by comparing a single measurement to all other measurements collected in the same month at a well. The "percentile class" is a statistical determination that describes the percentage of all measurements that are below a specific measurement. If 90 percent of measurements are below (deeper) than a given measurement, then it is in the 90th percentile and if only 10 percent of measurements are below, then that measurement is in the 10th percentile. An average measurement is the 50th percentile. Groundwater levels organized into monthly percentiles help describe seasonal fluctuations in groundwater levels in that well. **Figure 8** shows the monthly percentile class distribution for a 430 foot deep well located in the San Joaquin Valley. Recent water level measurements collected over the past water year are shown by the white circles. These can be compared against the monthly percentiles, shown by the colored bars, and the monthly median, shown by the black triangles, to see how a recent measurement compares to the well's period of record.

Figure 8: Graph showing recent water level measurements from an example well collected over the past water year (October 2022 to September 2023) compared to the monthly percentiles and monthly median.



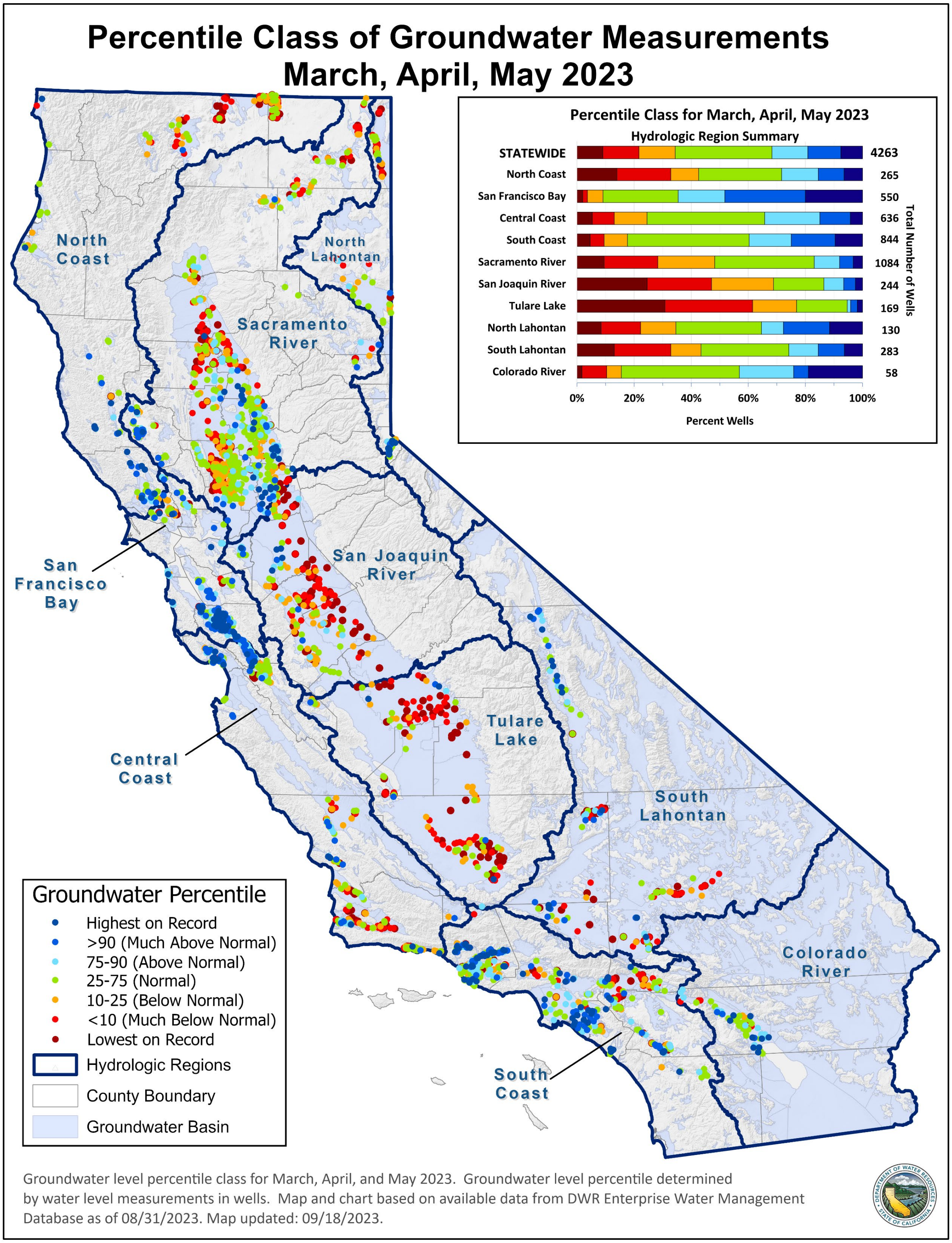
In the example graph from a single well, percentile class data based on all monthly measurements (colored bars) shows the seasonal fluctuation of groundwater levels. Recent groundwater levels collected from October 2022 through May 2023 (white circles) shows how groundwater levels increase, reach the seasonal high, and then begin to decrease slightly in May. Notably, groundwater elevations at this well exhibit a significant increase of 30 feet, transitioning from 130 feet below land surface in October to 100 feet below land surface in April. During this period, the groundwater elevations progressively move from the 10th percentile (much below the normal range) to the 25th to 75th percentile range (within the normal range). Between April and May, despite a 5-foot drop in groundwater elevation, the percentile distribution demonstrates that this decline is typical for that time of year. Additionally, the groundwater elevations show improvement by converging closer to the monthly median, even as they decrease. By evaluating recent groundwater elevation measurements relative to historical ranges, seasonal fluctuations of groundwater conditions can be better evaluated. For this well, there were insufficient historical measurements in February to develop a percentile class distribution. As of the writing of this report, no data was available beyond May.

Figure 9 uses percentile class statistics to show groundwater levels for March, April, and May 2023, compared to previous years' groundwater levels collected during the same months, and indicates where groundwater is comparatively high or low to what has been observed in the past. Percentile class data in the Figure 9 map and chart require that in each well at least 10 years of measurements are available in the period of record for a given month. The figure shows that groundwater levels have improved from last year, and that there is wide variability. The percentiles observed statewide from for March, April, and May 2023 are summarized in **Table 2**. This table shows a statewide balance of groundwater levels above and below average, there is much more variability when looking at the data from individual hydrologic regions as shown in the chart in **Figure 9**. About 22 percent of wells are at or near historic lows, while about 20 percent are at or near historic highs. This is a significant improvement over last year, when about 55 percent of wells were at or near historic lows and only about 5% were at or near historic highs (California Groundwater Conditions Update – March 2023).

Table 2: Statistical Summary of percentile classes for March, April, and May (As Shown in **Figure 9**).

Percentile Class	Total Well Count	Lowest on Record	Less 10%	10-25%	25-75%	75-90%	Greater 90%	Highest on Record
Statewide Percentile Class for March, April, and May 2023	4263	9%	13%	13%	34%	13%	12%	8%

Figure 9: Statewide and hydrologic region groundwater level percentile map for Groundwater wells in the months of March, April, and May. See **Table 2** for specific groundwater level statistics. Map and chart are based on available data from the DWR Water Data Library as of 08/31/2023.



Long-Term Groundwater Conditions

It is important to consider groundwater recovery over the long-term. While short-term trends provide insight into the immediate fluctuations in groundwater elevations and allow for more timely responses to water supply needs, long term trends offer a broader perspective on the sustainable use of the resource over many years. When comparing spring 2023 groundwater levels to spring 2018 groundwater levels through the five-year change data (**Table 1** and **Figure 10**), conditions show that groundwater levels have not recovered to pre-2020 levels. Statewide, between spring 2018 and fall 2023 approximately 30 percent of wells experienced more than five feet of decline in groundwater levels while approximately 21percent of wells had experienced more than five feet of increase in groundwater levels, illustrating the variable nature of groundwater level depletion and recovery across the state. The Central Valley outpaced state averages of measured groundwater declines with over 75 percent of measured wells showing declines greater than five feet. Conversely, in the South Coast Region greater than 50 percent of measured wells have groundwater levels increases of five feet or more.

Analysis of the spring 2018 to 2023 change data show that groundwater levels have not fully recovered from recent drought years, despite a wet 2019 and 2023. Additional wet years are needed to refill groundwater aquifers. For comparison, 2017's wet conditions did not significantly improve long-term groundwater levels that declined during the preceding droughts. This highlights a longer-term pattern where several years of drought followed by one or two wet years doesn't allow the groundwater systems to fully recover. The cumulative effect of this pattern of wet years followed by longer dry periods ultimately results in a decrease in groundwater storage and highlights the need for continued effort to sustainably manage groundwater basins.

Figure 11 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 WY 2003 to WY 2023. This period includes droughts from 2007 to 2009, 2012 to 2016, and the most current drought (2020 to present). During this 20-year period of stressed water resources and increased groundwater use, more than 46 percent of statewide wells had a decreasing trend in groundwater levels while just over 10 percent of wells demonstrate an increasing trend. The percent changes observed from WY 2003 to WY 2023 are summarized in **Table 3**.

Figure 11 also shows several clusters of wells with steep groundwater level declines across the state during the most recent 20-year period. These trends were more pronounced in the southern Central Valley, although the north end of the valley shows a continued decrease of groundwater levels of up to 2.5 feet per year. Areas of steep groundwater decline occur in the Sacramento Valley in the Sacramento River Hydrologic Region, the southeastern part of the San Joaquin Valley in the San Joaquin River Hydrologic Region, and most groundwater basins within the Tulare Lake Hydrologic Region. Moderate groundwater level declines occur in the North Coast, North Lahontan, South Coast, and South Lahontan Hydrologic Regions. There are notable increases in groundwater levels in the basins in the Colorado River Hydrologic Region.

Table 3: Statistical Summary of Groundwater Level Trend Map (**Figure 11**).

Period	Total Well Count	Decrease > 2.5 ft	Decrease 0.01 - 2.5 ft	No Significant Trend	Increase 0.01 - 2.5 ft	Increase > 2.5 ft
20-Year Trend: 2003 to 2023	4771	11.0%	34.2%	39.0%	10.4%	0.9%

Figure 10: Statewide and hydrologic region groundwater level change map for five-year period between spring 2018 and 2023. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 08/31/2023.

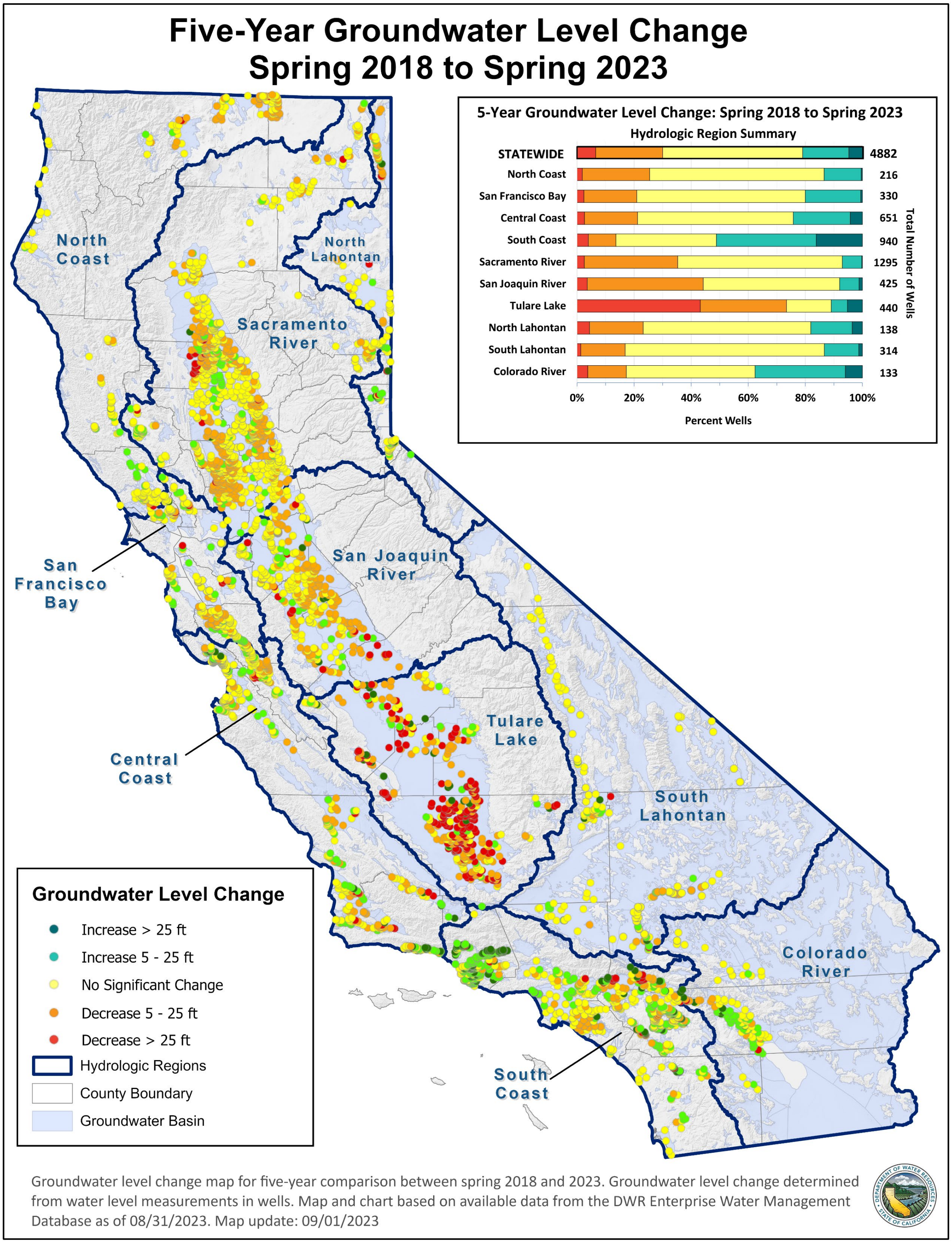
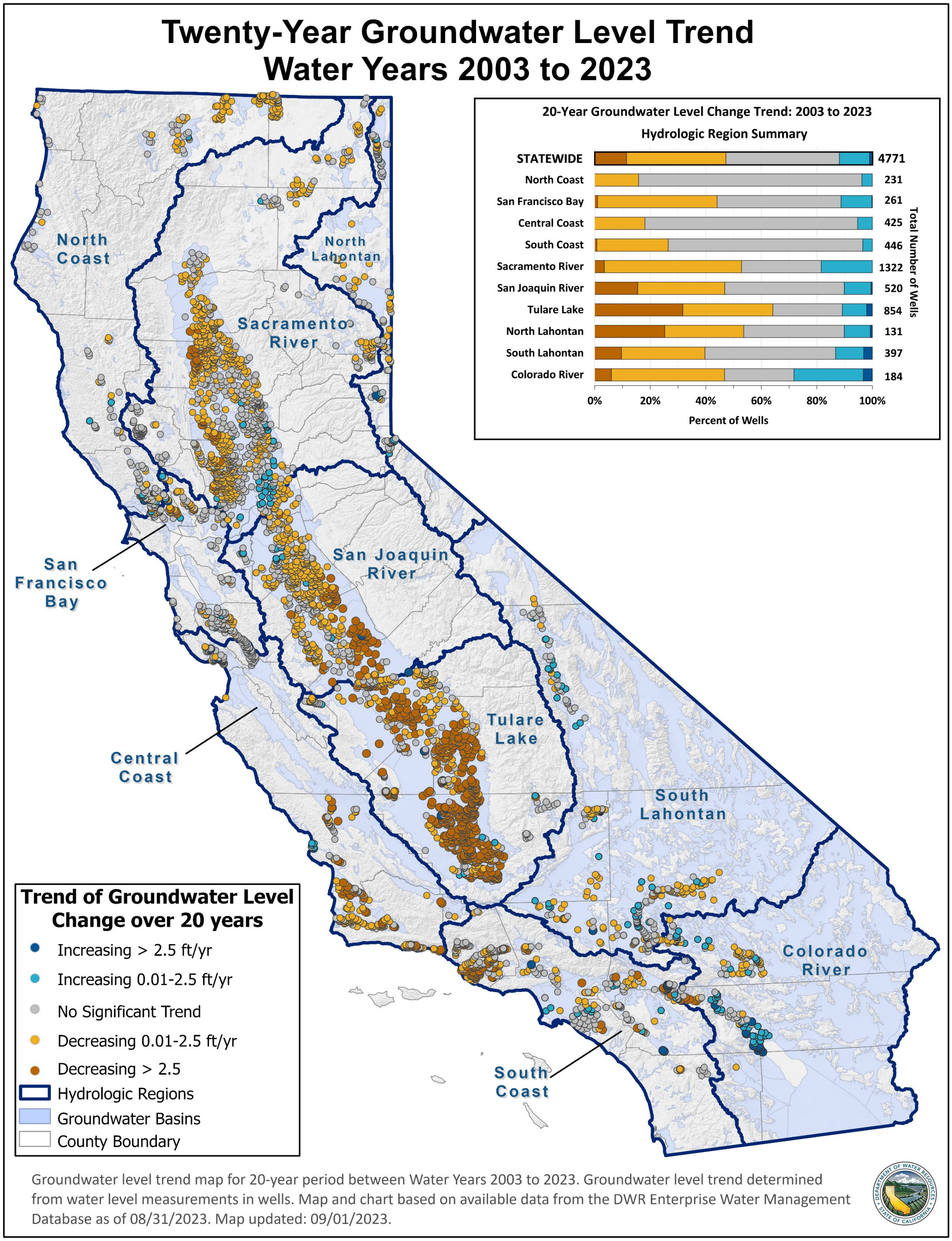


Figure 11: Statewide and hydrologic region groundwater level trend analysis map for WYs 2003-2023. See **Table 3** for specific groundwater level statistics. Map and charts based on available data from the [DWR Water Data Library](#) as of 08/31/2023.



Groundwater Extraction and Change in Storage Data from GSPs

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 groundwater extraction and change in storage data presented in this groundwater conditions update provides information for WY 2022. DWR will have data for groundwater extraction and change in storage conditions for WY 2023 after April 1, 2024 when Annual Reports are submitted by the GSAs. These data will provide a better understanding of the amount of managed and natural recharge that took place in WY 2023. During WY 2022, which marked the third year of a drought that began in 2020, over 17 million acre-feet of groundwater extraction was reported across the state within the 96 basins that submitted Annual Reports. This is approximately one million acre-feet less groundwater extraction than was reported during WY 2021 (California Groundwater Conditions Update – March 2023). For WY 2022, groundwater basins with the highest groundwater extraction per area (total groundwater pumped normalized by basin area, reported as AF/Acre) are listed in **Table 4**, and the basins with the highest total groundwater extraction (AF) are listed in **Table 5**.

Figure 12 depicts groundwater extractions (per area and total) for basins subject to SGMA for WY 2022. The Central Valley accounted for over 15 million acre-feet of pumping in WY 2022, about 90 percent of groundwater extractions in California. The majority of the highest extraction rates and volumes were within the San Joaquin Valley. The greatest extraction per area occurred in the Chowchilla, Kaweah, and Fillmore basins, with extraction rates of 2.81, 2.10, and 1.99 acre-feet per acre respectively. The greatest volumes extracted were in the Kern County, Kings, and Kaweah basins, accounting for 2.3, 1.9, and 0.9 million acre-feet respectively. The extraction volumes closely correlate to reported change in storage.

Table 4: WY 2022 Groundwater Extraction per Area by Basin. Top 10 basins as volume and normalized by basin area. Extraction values based on data reported through 2022 GSP/Alternative annual reports.

Basin (Top 10 ranked by groundwater extraction per area)	**Groundwater Extraction per Area (AF/Acre)**	Groundwater Extraction (AF)	Basin Area (Acres)
San Joaquin Valley – Chowchilla	**2.81**	409,060	145,574
San Joaquin Valley – Kaweah	**2.10**	925,400	441,048
Santa Clara River Valley – Fillmore	**1.99**	44,895	22,586
San Joaquin Valley – Kings	**1.98**	1,943,168	981,323
San Joaquin Valley – Madera	**1.95**	676,498	347,667
San Joaquin Valley – Vina	**1.92**	354,700	184,917
San Pasqual Valley	**1.82**	6,359	3,498
San Joaquin Valley – Merced	**1.80**	920,588	512,606
San Joaquin Valley – Turlock	**1.59**	554,400	348,187
San Joaquin Valley – Tule	**1.51**	719,338	477,590

Table 5: WY 2022 Groundwater Extraction by Basin. Top 10 basins as total volume. Extraction values based on data reported through 2022 GSP/Alternative annual reports.

Basin (Top 10 ranked by groundwater extraction)	**Groundwater Extraction (AF)**	Groundwater Extraction Rates (AF/Acre)	Basin Area (Acres)
San Joaquin Valley– Kern County	**2,343,630**	1.31	1,782,318
San Joaquin Valley– Kings	**1,943,168**	1.98	981,323
San Joaquin Valley– Kaweah	**925,400**	2.10	441,048
San Joaquin Valley– Merced	**920,588**	1.80	512,606
Sacramento Valley – Colusa	**899,000**	1.24	722,785
San Joaquin Valley - Eastern San Joaquin	**818,507**	1.07	764,802
San Joaquin Valley – Tule	**719,338**	1.51	477,590
San Joaquin Valley - Madera	**676,498**	1.95	347,667
San Joaquin Valley – Westside	**608,000**	0.98	622,208
San Joaquin Valley - Delta-Mendota	**563,900**	0.74	764,964

Table 6 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 7** provides a list of the basins with the greatest change in groundwater in storage volume (AF). **Figure 13** shows the reported change in storage for each of these basins for the same time period. During WY 2022, a 6.4 million acre-feet decrease of groundwater in storage was reported across the 97 basins. This is approximately 1.5 million acre-feet less change in storage than reported during WY 2021, a volume of overdraft documenting a drought year, following several consecutive drought and dry years where surface water availability was extremely low resulting in significant increased dependence on groundwater pumping (California Groundwater Conditions Update – March 2023). The Central Valley accounted for over 5.8 million acre-feet of storage decline in WY 2022, approximately 90 percent of groundwater storage declines in California. The Kern County, Kings, and Delta Mendota basins saw the greatest decrease of groundwater in storage, approximately 1.7 MAF, 680 TAF, and 460 TAF respectively.

Figure 13 also shows several basins that reported an increase in groundwater storage. Data for these and all other basins reporting extraction and storage data can be found on the CNRA Open Data portal.

Table 6: WY 2022 Change in Storage per Area by Basin. Top 10 basins as a volume and normalized by basin area. Change in storage values based on data reported through 2022 GSP/Alternative annual reports.

Basin (Top 10 ranked by change in storage by area)	**Change in Storage per Area (AF/Acre)**	Change in Storage (AF)	Basin Area (Acres)
San Joaquin Valley – Chowchilla	**-1.03**	-149,624	145,574
San Joaquin Valley - Kern County	**-0.98**	-1,740,468	1,782,318
San Joaquin Valley – Kaweah	**-0.81**	-359,000	441,048
San Joaquin Valley – Turlock	**-0.79**	-274,600	348,187
Salinas Valley – Forebay	**-0.74**	-69,400	94,052
Santa Clara River Valley – Piru	**-0.71**	-7,758	10,897
San Joaquin Valley - Modesto	**-0.70**	-172,300	245,252
San Joaquin Valley – Kings	**-0.69**	-680,000	981,323
San Joaquin Valley - Delta-Mendota	**-0.60**	-459,000	764,964
San Joaquin Valley - Madera	**-0.56**	-193,905	347,667

Table 7: WY 2022 Change in Storage by Basin. Top 10 basins as a volume. Change in storage values based on data reported through 2022 GSP/Alternative annual reports.

Basin (Top 10 ranked by total change in storage)	**Total Change in Storage (AF)**	Change in Storage Rates (AF/Acre)	Basin Area (Acres)
San Joaquin Valley - Kern County	**-1,740,468**	-0.98	1,782,318
San Joaquin Valley – Kings	**-680,000**	-0.69	981,323
San Joaquin Valley - Delta-Mendota	**-459,000**	-0.60	764,964
Sacramento Valley – Colusa	**-377,170**	-0.52	722,785
San Joaquin Valley – Kaweah	**-359,000**	-0.81	441,048
San Joaquin Valley – Turlock	**-274,600**	-0.79	348,187
San Joaquin Valley – Merced	**-261,986**	-0.51	512,606
San Joaquin Valley – Madera	**-193,905**	-0.56	347,667
Sacramento Valley – Yolo	**-192,260**	-0.36	540,693
San Joaquin Valley - Modesto	**-172,300**	-0.70	245,252

Figure 12: Groundwater Extraction Reported by Basin map for Water Year 2022. See **Table 4** and **Table 5** for specific groundwater extraction statistics. Map and charts based on available data from GSP/Alternative annual reports of 08/24/2023.

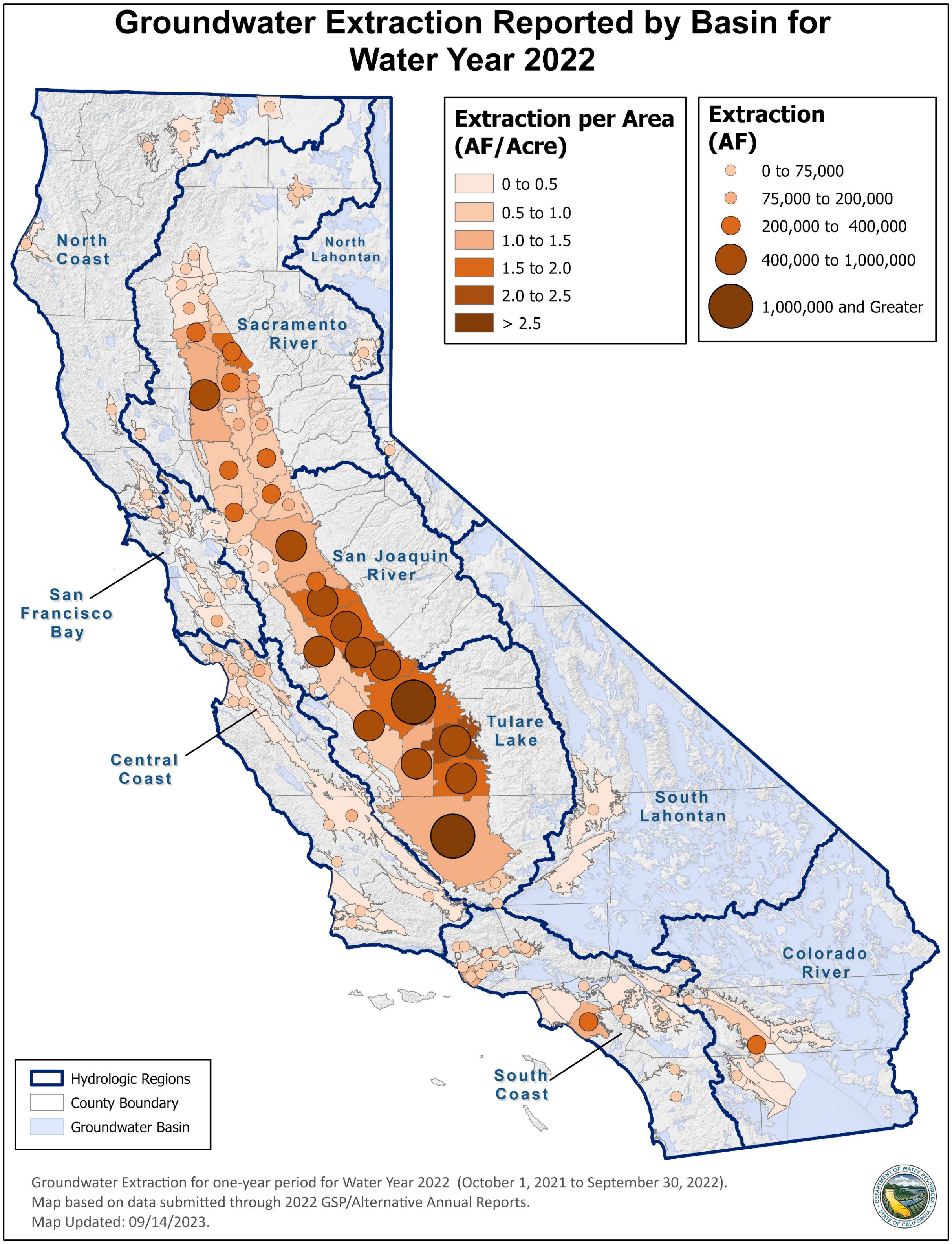
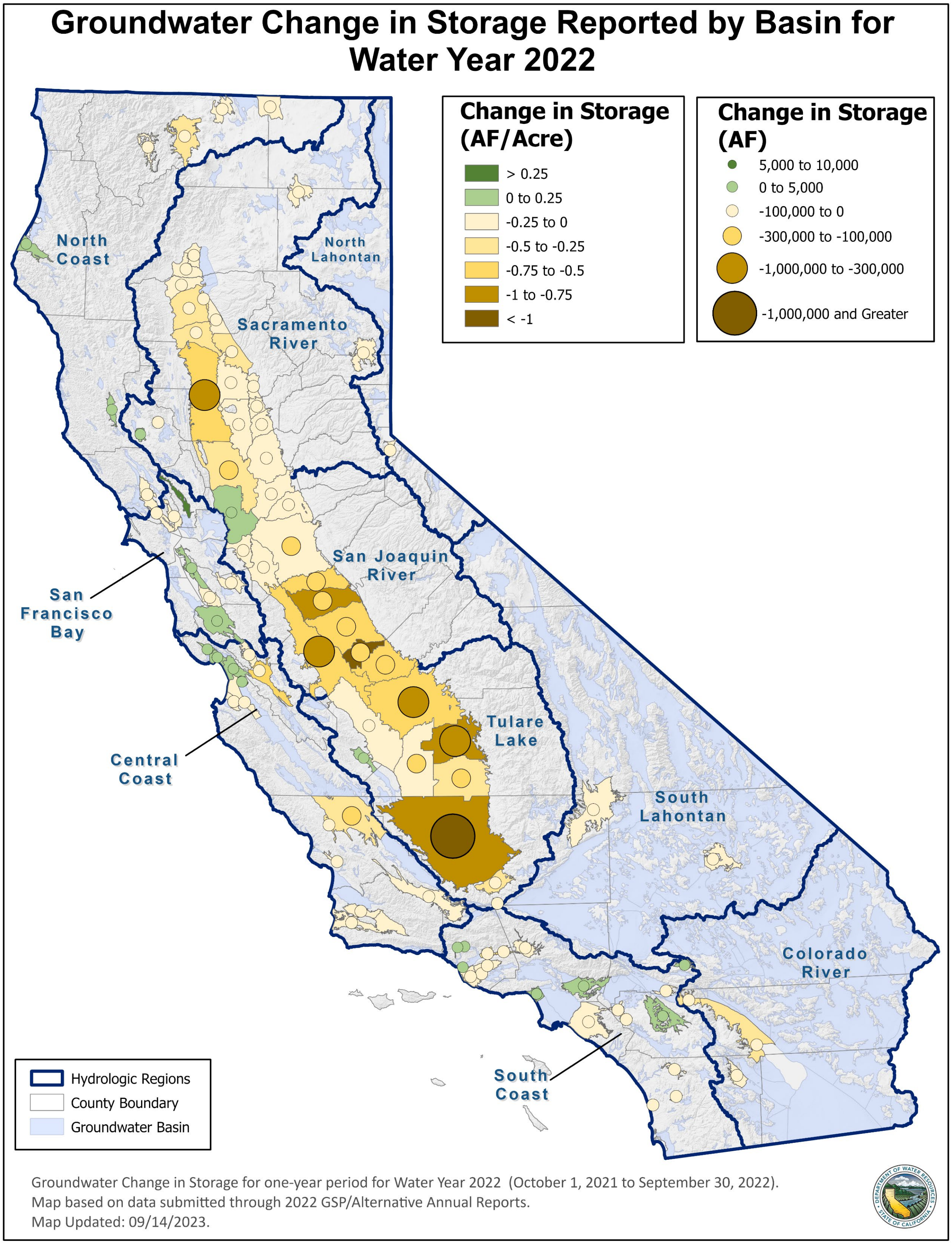


Figure 13: Groundwater Change in Storage Reported by Basin map for Water Year 2022. See **Table 6** and **Table 7** for specific groundwater storage statistics. Map and charts based on available data from GSP/Alternative annual reports of 08/24/2023.



Land Subsidence

Land subsidence has been documented throughout the last century in certain areas of the state resulting in over 30 feet of vertical displacement or "sinking" of the land surface in some areas. This has caused damage 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 and covers about 40,000 mi^2. In 2022, DWR has increased the reporting frequency of monthly InSAR data from annually to quarterly to provide more up-to-date information. This report includes figures, tables, and discussion of land subsidence data through July 1, 2023 in comparison to the most recent 5 years (July 1, 2018 through July 1, 2023). **Table 8** provides a summary of vertical displacement rates observed in the InSAR dataset between July 1, 2022 and July 1, 2023 and for the period from July 1, 2018 through July 1, 2023.

Table 8: Total Area (in square miles) of Subsidence (Subs.) and Uplift Corresponding to Displacement Rate (ft/yr)

	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
July 18 - July 23 (5 year)	0	4,321	2,332	911	236	1	0
July 22 - July 23 (One year)	224	1,665	1,472	594	46	0	0

Figure 14 shows the annual rate of vertical displacement in feet/year for July 2022 to July 2023. Annual displacement rates are shown in 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, and greater than 1 foot/year, and uplift of greater than 0.1 feet/year.

Figure 14: Statewide annual subsidence map for July 2022 to July 2023. See **Table 8** for specific subsidence level statistics. Map and charts based on available data from the [CNRA Open Data](#) as of 9/1/2023.

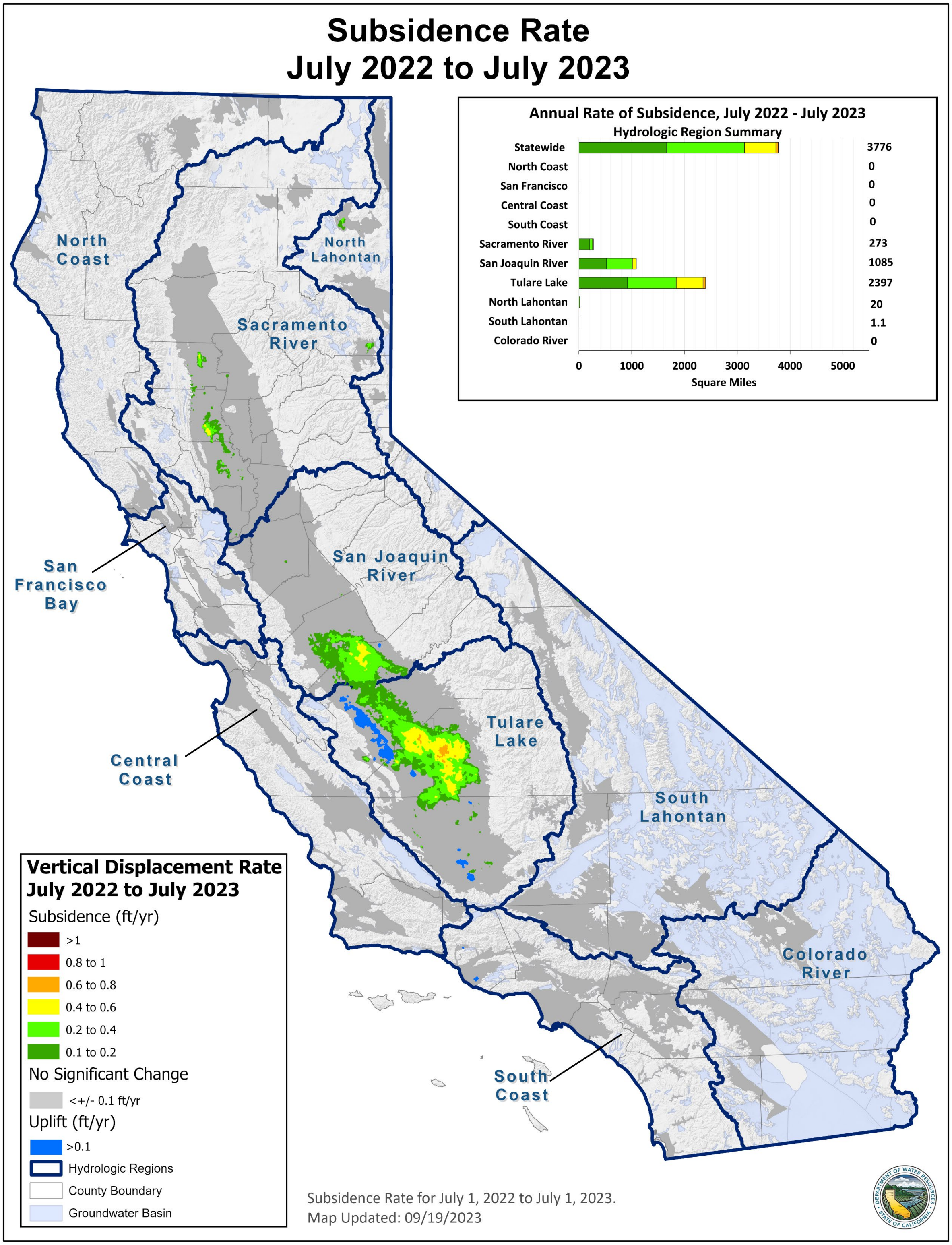
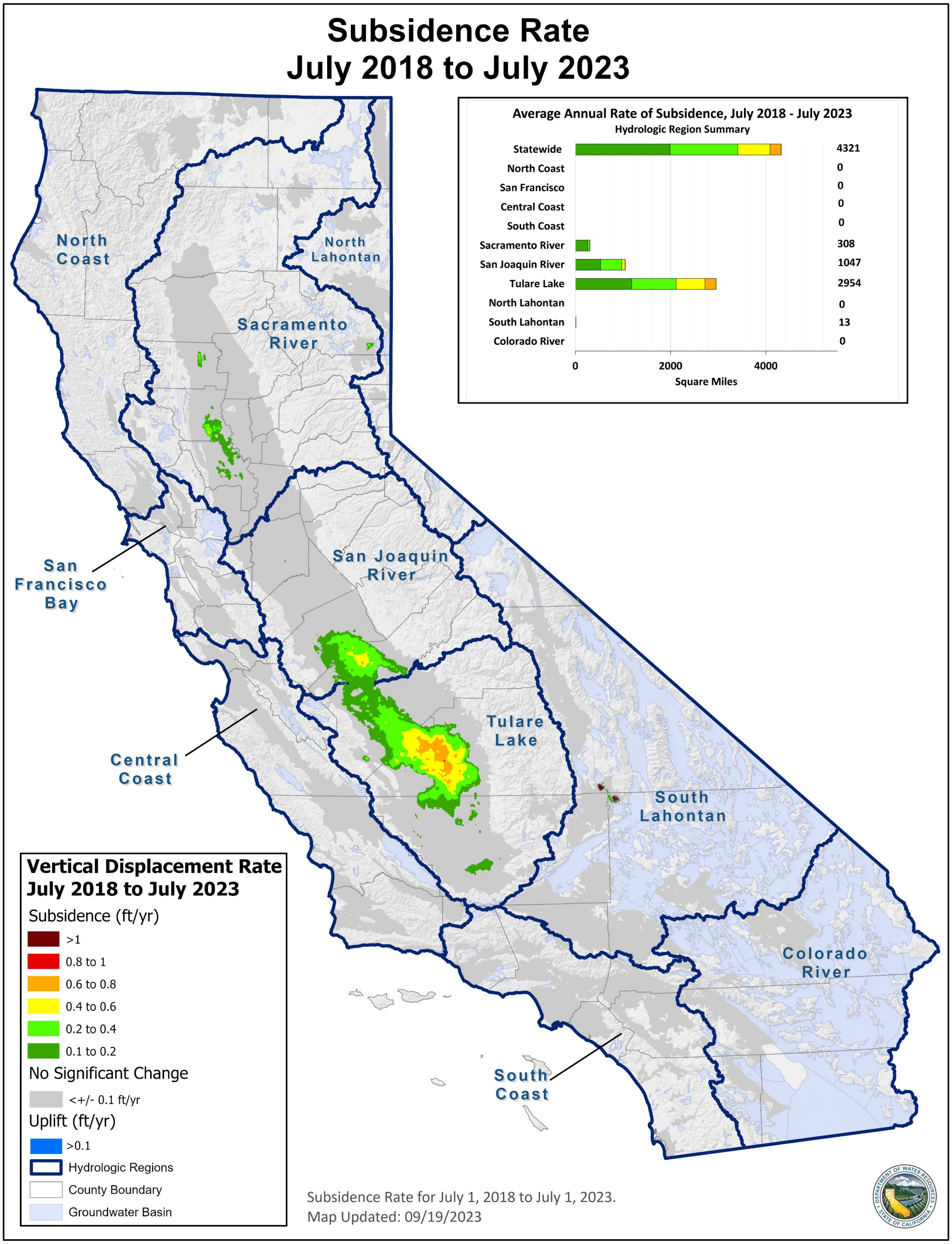


Figure 15 shows the average annual rate of vertical displacement in feet/year for July 2018 to July 2023. Annual displacement rates are shown in seven categories: subsidence of 0.1-0.2 feet/year, 0.2-0.4 feet/year, 0.4-0.6 feet/year, 0.6-0.8 feet/year, 0.8-1 feet/year, and greater than 1 foot/year, and uplift of greater than 0.1 feet/year.

As observed during the 2012–2016 drought, increased groundwater extraction during the most recent drought resulted in accelerated land subsidence in parts of the Central Valley. The wet Spring in 2023 has decreased land subsidence rates for now. For the July 2022 to July 2023 period, statewide data show an area of approximately 4,000 square miles with recorded subsidence of greater than 0.1 feet, about 46 square miles with greater than 0.6 feet of subsidence, and no areas subsiding more than 0.8 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 recording greater than 1 foot of subsidence (California Groundwater Conditions, Semi-Annual Update: March 2023).

During the July 2022 to July 2023 period, the Tulare Lake Hydrologic Region has the most areas of subsidence with about 2,400 square miles of area experiencing greater than 0.1 feet of subsidence, followed by the San Joaquin River Region with about 1,100 square miles, and the Sacramento River Region with about 270 square miles. As during previous dry-wet-dry cycles, 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 15: Statewide average annual subsidence map for July 2018 to July 2023. See **Table 8** or specific subsidence level statistics. Map and charts based on available data from the CNRA Open Data as of 9/1/2023.



Well Infrastructure

Many factors influence the type and number of groundwater extraction wells (well infrastructure) drilled 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. This report includes a summary of data submitted to OSWCR over the last nine water years (2015 – 2023) for groundwater extraction wells classified as domestic or irrigation wells. Data for WY 2023 reported here includes data available through OSWCR on August 31, 2023.

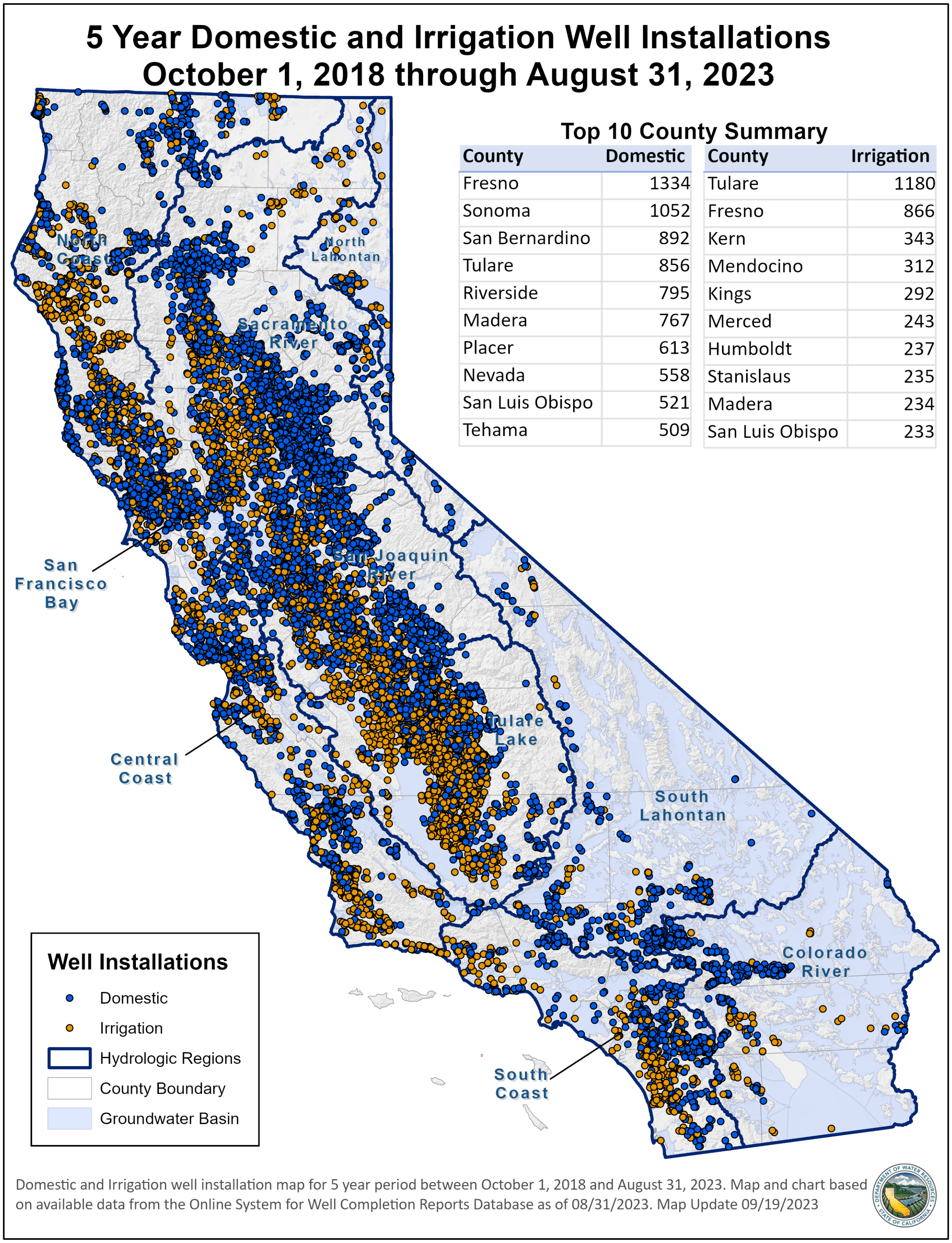
This report also provides a nine-year summary of dry water wells reported by members of the public to DWR's Dry Well Reporting System. Reporting is voluntary, so the actual numbers of dry wells and/or the number of resolved dry wells may be higher than what is reported in the database.

The year-to-year statistics of domestic, irrigation, and dry wells are provided in **Table 9**. The data go back to WY 2015, which captures the end of the previous drought (2012 – 2016). The total number of domestic and irrigation wells installed since 1977 are also provided for context. The water year type designations shown here are based on the San Joaquin Valley Water Year Hydrologic Classification Index, because no statewide water-year type index currently exists. **Figure 16** shows the domestic and irrigation wells installed during the past 5 water years (2019 – 2023).

Table 9: Statewide Summary of Newly Installed Domestic and Irrigation Wells and Number of Dry Well Reporting. *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	3,528	3,048	1,442
WY 2016	Dry	4,412	2,870	546
WY 2017	Wet	3,136	1,488	166
WY 2018	Below Average	2,641	1,120	86
WY 2019	Wet	2,740	1,343	46
WY 2020	Dry	3,012	1,342	75
WY 2021	Critical	3,630	1,795	814
WY 2022	Critical	3,921	1,655	1,494
WY 2023 through August 31, 2023	Wet	2,464	1,000	650
5 Year Total	-	15,867	7,136	3,068
9 Year Total	-	29,584	15,662	5,319
Total since 1977*	-	280,814	61,912	5,711

Figure 16: Statewide newly installed domestic and irrigation wells map for 5-year period from WY 2019 through 2023. See **Table 9** for specific well data. Map and charts based on available data from the CNRA Open Data as of 08/31/2023.



Domestic Wells

Domestic (household) wells provide water to millions of people throughout California. During the WY 2023 through August, a total of 2,464 new domestic wells were reported to be installed in the state (**Table 9**). During the last nine water years (since October 2014), a total of 29,584 domestic wells have been installed, accounting for approximately 10 percent of the total 280,814 domestic wells installed since 1977. The 2,464 new domestic wells installed in WY 2023 through August is the lowest in the last nine water years. The highest number of domestic wells (4,412) were installed in WY 2016.

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 16**. The counties with the highest number of new domestic wells were Fresno (1,344), Sonoma (1,052), and San Bernadino (892). The spatial distribution shows numerous domestic wells being installed outside of the 515 groundwater basins, in volcanic and fractured rock aquifers across the state, highlighting the dependence on groundwater in these areas.

Irrigation Wells

Irrigation wells typically have higher capacity and pump more groundwater than domestic wells and provide water to farms that feed millions of people throughout California and the world. During WY 2023 through August, a total of 1,000 new irrigation wells were reported to be installed in the state (**Table 9**). The 1,000 irrigation wells installed during WY 2023 through August is the lowest in the last nine full water years. Over the last nine water years since October 2014, a total of 15,662 irrigation wells have been installed across the state, accounting for approximately 25 percent of the 61,912 irrigation wells installed statewide since 1977. The year-to-year number of new irrigation wells has fluctuated from a low of 949 in WY 2018 to a high of 3,041 in WY 2015.

The location of new domestic and irrigation wells installed over the past five years (WY 2019 through WY 2023) is shown in **Figure 16**. Irrigation wells are much less geographically spread throughout the state when compared with the geographic spread of domestic wells. Over the past five water years, Tulare County had more new irrigation wells (1,180) installed than any other county in the state, accounting for approximately one out of every seven new irrigation wells (17 percent). Neighboring Fresno County (866) and Kern County (343) ranked 2nd and 3rd respectively for most 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 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 naturally increase during extended dry periods as groundwater use increases and groundwater levels decline.

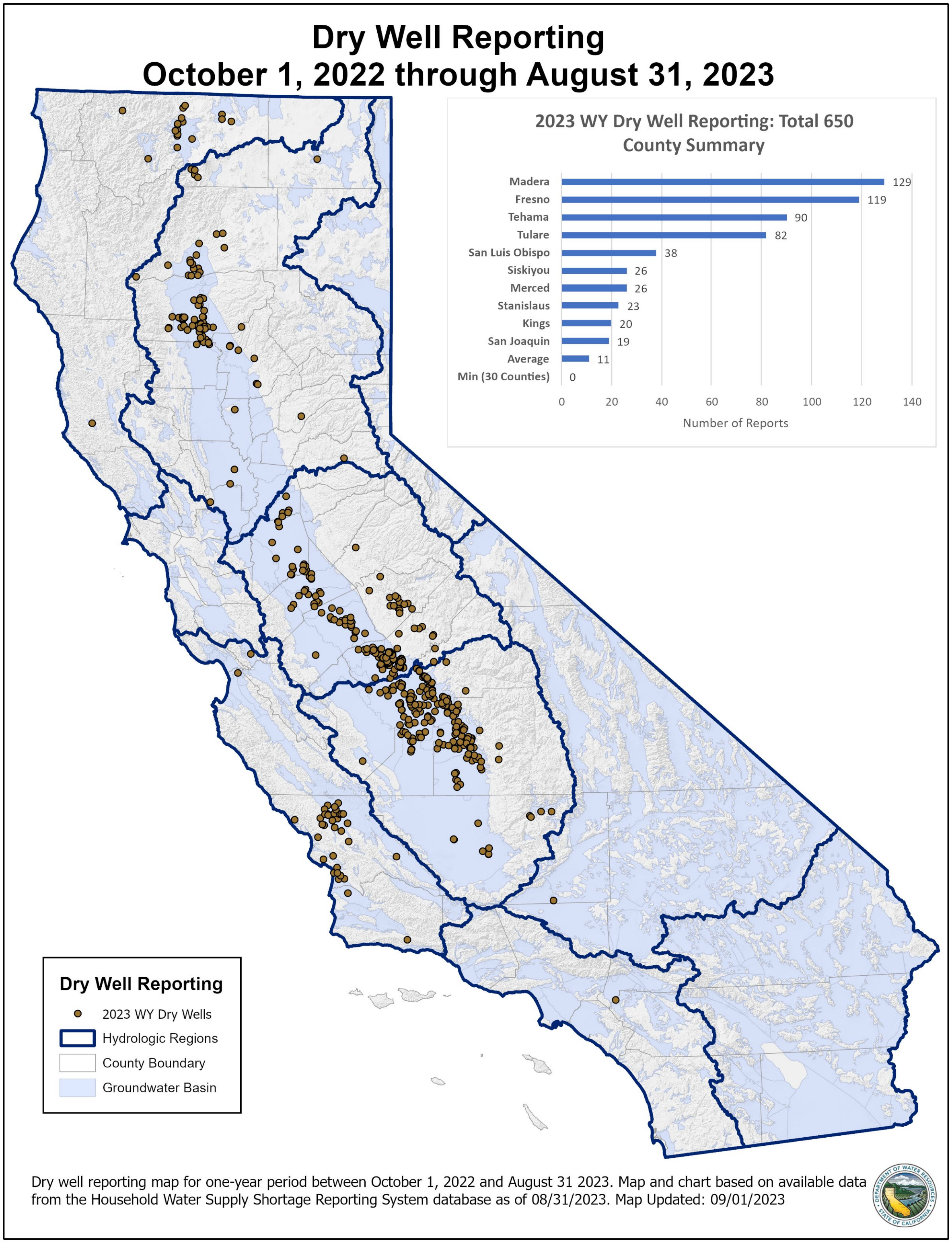
DWR manages the Dry Well Reporting System where Californians experiencing problems with their private, self-managed wells that are not served by a public water system can voluntarily report dry wells and be connected with entities providing local drought assistance. DWR's Dry Well Reporting System was originally developed during the 2012-2016 drought. 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. The system helps centralize and disseminate information statewide when well outages are reported. 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. 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 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. This report includes a summary of data submitted to the Dry Well Reporting System over the last nine water years (2015 – 2023). Dry well reporting for WY 2023 includes data reported through August 31, 2023.

In WY 2023 (up to August 31, 2023), a total of 650 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 in wells 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 are not resolved after a single wet year. A

total of 5,319 new dry well reports were received over the last nine water years (2015-2023), and a total of 5,711 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 9**). The locations of reported dry wells in WY 2023 are shown in **Figure 17**.

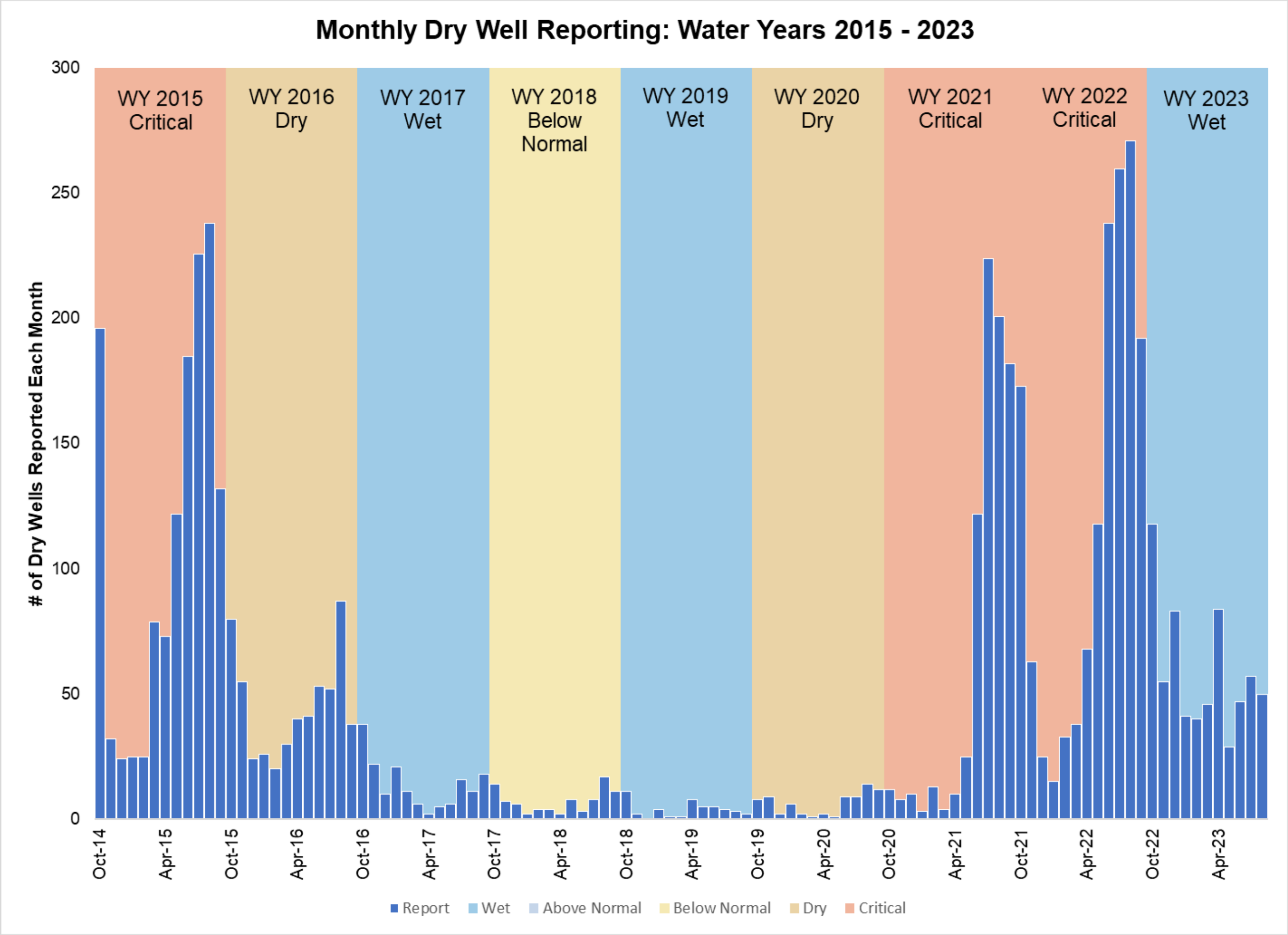
Figure 17: Statewide one-year reported dry wells map for WY 2023 through August 31. Map and charts based on available data from the CNRA Open Data as of 08/31/2023.



In WY 2023 up to August 31, 2023, the highest number of dry well reports were received in Madera County (129), Fresno County (119), and Tehama County (90). These three counties account for approximately half the dry well reports (52 percent) received statewide in WY 2023 to date. Fifteen counties reported between 1 and 10 dry wells and 30 counties reported zero dry wells.

The statewide trend for dry well reporting over the past eight water years (2015-2022) 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 18** shows a monthly time series of dry well reports from October 2014 to August 2023.

Figure 18: Monthly Dry Well Reporting (October 2014 through August 2023)



Groundwater Reporting Assessment

Groundwater level data provides valuable information on seasonal and long-term groundwater changes, trends in groundwater storage, and susceptibility to land subsidence and dry wells. Groundwater levels are typically measured on a regular schedule from a variety of groundwater wells located throughout the state. Late winter and early spring measurements capture the pre-irrigation seasonal high groundwater levels. Groundwater level data are collected by DWR and also collected and reported to DWR by hundreds of local Groundwater Sustainability Agencies implementing SGMA, by entities participating in the California Statewide Groundwater Elevation Monitoring (CASGEM) Program, and other parties.

Groundwater levels 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 planning.

Reporting the effects of recent storms and recharge on current groundwater conditions is difficult due to limitations in data collection and reporting. **Figure 19** shows the data reporting delay for measurements collected from wells throughout the state in the WY 2022. The reporting delay time is divided into groups of 0 to 30 days, 30 to 60 days, 60 to 90 days, 90 to 180 days, and over 180 days. The average time to submit groundwater level data to DWR for WY 2022 was about 85 days after data collection. Eight percent of well measurements reported monitoring data within 30 days of the measurement date. Nearly 17 percent of well measurements take between 30 and 90 days to report recorded data and 28 percent of well measurements take over 90 days. Nearly half of the groundwater level data was reported after 180 days. These delays in data reporting limit the ability to draw conclusions on recent events.

For most wells monitored across the state, measurements are collected 2 to 4 times a year. While this is sufficient for capturing long term trends, more frequent monitoring is required to understand how groundwater levels change seasonally or within a season. A single groundwater level measurement provides data about the water level at a specific time and can be helpful for comparison with prior seasons or years. For example, to record how groundwater levels were changing during the wet winter and spring of WY 2023, monthly or more frequent data are needed.

Figure 19: Statewide Groundwater Level Measurement Reporting Delay for WY 2022. Charts based on available data from the CNRA Open Data as of 08/31/2023.

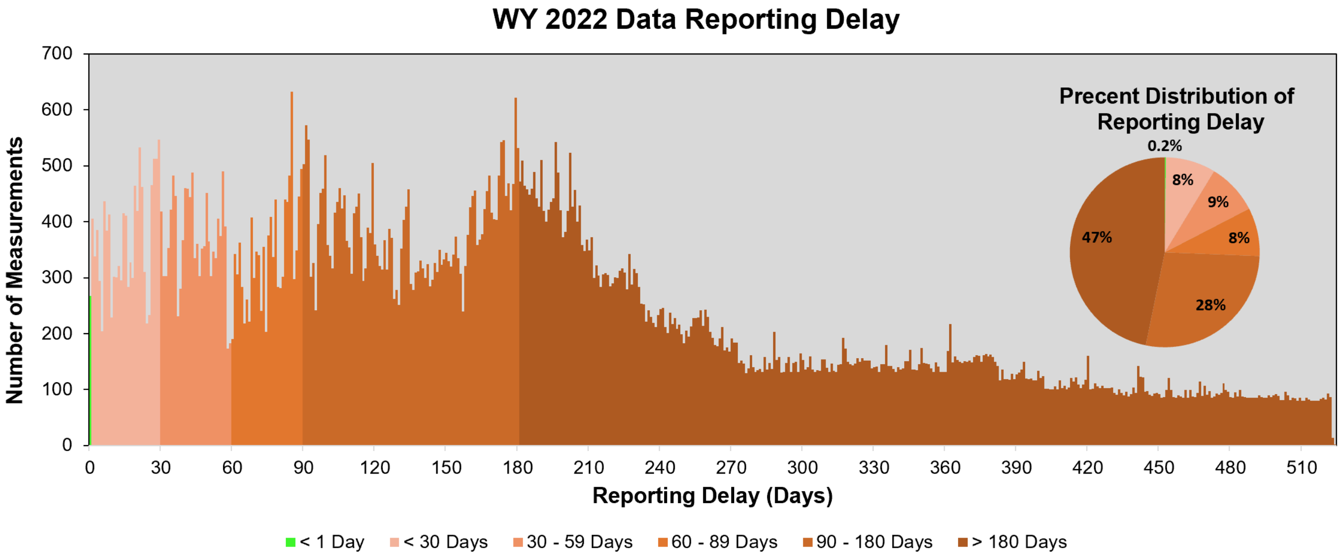
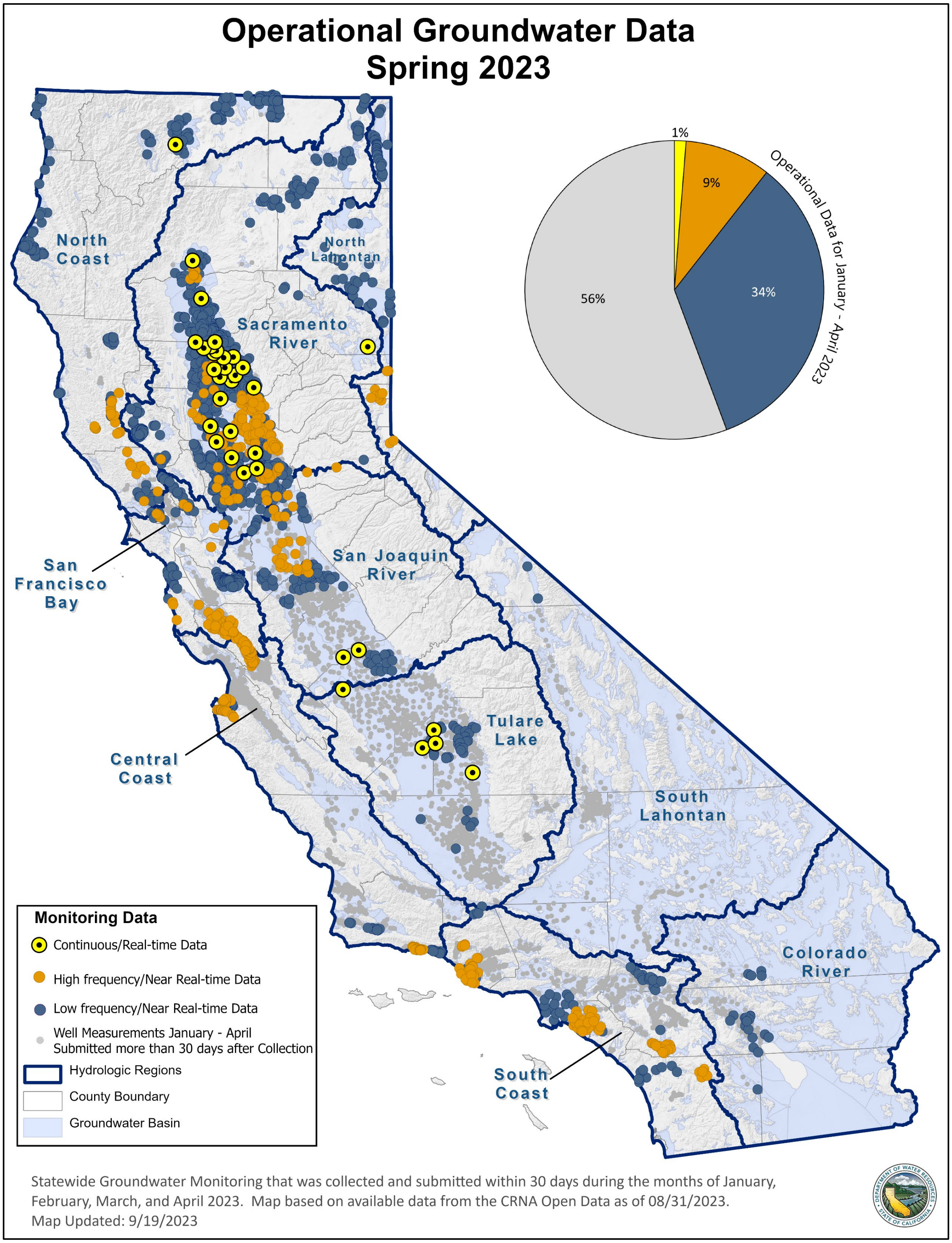


Figure 20 is a map of wells reporting groundwater level measurements collected between January 1 and April 30, 2023. Within this period, groundwater level measurements were submitted for 7,925 wells. Of these wells, data collected in 3,551 wells (44 percent) was submitted within 30 days and illustrates operational data, or the data that was available to DWR during and immediately after winter and spring 2023. Within the January to April period, wells with operational data include 2,690 wells (34 percent) with a single measurement labeled as low-frequency/near real-time data, 744 wells (9 percent) with multiple measurements labeled as high-frequency/near real-time data, and 117 wells (<1 percent) with telemetered data labeled as continuous/real-time data.

Telemetry is a valuable tool for effective management of groundwater resources, as it provides a means to collect accurate and timely data that can be used to make informed groundwater management decisions, help monitor the effectiveness of water management practices, and identify areas in need of improvement. DWR, with support from USGS, operates 43 telemetered monitoring sites, with most sites having multiple wells to record groundwater elevation and subsidence data on a real-time basis. In total, over 100 wells transmit measurements through telemetry and DWR is in the process of deploying more than 25 more telemetry sites statewide in 2023 and 2024. Expanding the use of telemetry in developing DWR's statewide, representative groundwater monitoring network improves data-driven water management decision-making at a local and regional scale throughout California enabling communities to plan for and meet the growing demands placed on water resources.

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.



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. 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. If the following year reverts back to dry conditions, there is a real possibility of an extension of the drought. In fact, as California transitions to a warmer and drier climate overall, such scenarios become increasingly likely.

As data from the past water year has shown, even above average precipitation across the state alone can't undo the damage from years of drought. Groundwater levels, while recovering, are still lower than the period after the 2012-2016 drought. While both domestic and irrigation well installations in WY 2023 are projected to be lower than any of the past nine years, dry wells are still being reported across the state. The 650 dry wells reported thus far in WY 2023 were lower than WY 2021 and 2022 but were still more than any year between 2016 and 2020.

The historical patterns and strategies that have guided water management for decades are being disrupted, requiring exploration of innovative approaches to ensure the sustainability of California's water supply. Groundwater is an invaluable resource that underpins the livelihoods of countless communities and industries in California. It serves as a vital source of drinking water, supports agricultural production, and plays a crucial role in sustaining ecosystems. As the state grapples with the challenges posed by a changing climate, groundwater management becomes even more critical as a buffer against droughts and water scarcity.

One of the key achievements of SGMA is the emphasis on collecting data to better understand and manage groundwater resources. Accurate, high-frequency, and comprehensive data is the foundation upon which effective groundwater management is built. Data allows for the monitoring of aquifer levels, assessment of the impacts of pumping, and development of strategies to mitigate overdraft and other issues. While SGMA has led to improvements in data collection and reporting, there is still much work to be done to make this data more operational. 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 create roadblocks to informed decision-making and sustainable resource management. Investment in monitoring infrastructure is crucial to enable more frequent and accurate data collection. Streamlining reporting processes and leveraging technology can reduce delays, ensuring that data is readily available to decision-makers.

The reliance on occasional wet winters to replenish water reservoirs can no longer be sustainable 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 manage water resources effectively in an environment marked by increasing climatic uncertainties. 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.