CALIFORNIA DEPARTMENT OF WATER RESOURCES

California's Groundwater Conditions Semi-Annual Update: October 2022

Executive Summary

California is in the midst of the third statewide drought declared in the last two decades (2007-2009, 2012-2016, 2020 – present). The state's communities, environment, and agricultural sector are facing exceptional challenges under extreme dry conditions. A growing body of evidence suggests that the current three-year drought is an extension of the 2012-2016 drought interrupted by just a few wet years. Hot and dry conditions are expected to continue into water year 2023. Also, historical data show that 2001-2022 is the driest 22-year period on record in at least 1,200 years and has surpassed the severity of the megadrought in the late 1500s that witnessed the second-driest 22-year period (1571-1592) in the Western United States.

Droughts in California are more commonplace because climate change has fundamentally altered the state's hydrologic cycle. As described in the recently released California's Water Supply Strategy, Adapting to a Hotter, Drier Future, 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. Over the last three years, state leaders have earmarked $8 billion to modernize water infrastructure and management, which enabled emergency drought response as well as projects by local and state agencies to address current and future droughts impacts and become more resilient. The Department of Water Resources (DWR) has awarded more than $480 million to date in drought relief assistance to small and urban communities to address water supply challenges and over $350 million in sustainable groundwater funding to help build long-term resilience at both local and regional levels.

Every drought in California increases reliance and use of groundwater, which provides up to 58 percent of the state's total water supply in dry years with over 80-percent of Californians depending on groundwater for some portion of their water supply. Over the last several decades, groundwater basins have been utilized both as a drought buffer and a climate adaptation strategy resulting in overdraft, land subsidence, stream depletion, and groundwater quality degradation in various parts of the state. During the current drought, Governor Newsom has issued several drought emergency proclamations that direct DWR and other agencies to actively respond to the current drought and continue preparing for future droughts by implementing actions including accelerating subsidence and groundwater data collection, improved dry well reporting and drinking water assistance, local well permitting coordination, and regulatory relief of groundwater recharge projects under specified circumstances to mitigate drought impacts.

Key Findings

General

- Californians continue to rely on groundwater to compensate for dwindling snowpack and surface water supplies during the current drought.

Groundwater Levels

- Statewide groundwater levels have been in general decline for the past 20 years with 46 percent of monitoring wells showing a declining trend (**Table 2 and Figure 8**) and is associated with the declining trend in snowpack and precipitation (**Figure 1**).
- Increased reliance on groundwater during drought periods has resulted in continued lowering of groundwater levels in several parts of the state (**Table 1 and Figures 5-7**), exceeding five feet of decline in 30-50% of monitoring wells statewide.
- Groundwater level changes from Spring 2021 to Spring 2022 show groundwater levels declined greater than five feet in 32 percent of wells (**Figure 5**).
- In the Tulare Lake Hydrologic Region, over 40 percent of monitoring wells show declines of more than 25 feet in the last three years.

Land Subsidence

- The frequency of statewide land subsidence monitoring and reporting increased in 2022 and shows that land subsidence continued to occur during July 2021 to July 2022 period (**Figure 9**).

Well Infrastructure

- In the first 11 months of WY 2022, the number of new domestic and irrigation wells installed statewide, as reported to DWR, is on pace with the rate of new wells installed in WY 2021 (**Table 5**).
- A total of 1,021 dry well reports were received in the first 11 months of WY 2022, which is similar to the total number of dry wells (1,046) reported in WY 2021 (**Table 5**).
- DWR awarded more than $480 million to date in drought relief assistance to small and urban communities to address water supply challenges.

Against the backdrop of a new climate reality, the State is entrusted with a historic responsibility to uphold the human right to water as well as assist, guide, and support local agencies and interested parties in implementing the provisions of the Sustainable Groundwater Management Act (SGMA) and the actions identified in the Governor's Water Resilience Portfolio and California's Water Supply Strategy. In addition, it is important to increase public awareness and understanding about the critical role of groundwater in meeting the current and future water needs of California for the success of state and local plans.

In recognition of the increased long-term reliance on groundwater and even greater reliance during dry periods, it is imperative that local and state groundwater management decisions, both near-term drought actions and long-term implementation of SGMA, be made with the best available data and information in a transparent and collaborative environment. 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 Groundwater Conditions Update is part of a family of groundwater data, tools, and publications under the umbrella of DWR's California's Groundwater (Bulletin 118) and are being provided to local and state agencies to fulfill this imperative.

Introduction

This report is a semi-annual update of the annual Groundwater Conditions Report published in March 2022 and part of DWR's California's Groundwater (Bulletin 118). Water Year 2022 groundwater data used in this report includes data received electronically by DWR as of August 31, 2022. For a statewide summary of Water Year 2022 conditions, see DWR's Water Year 2022 Brochure. The most recent groundwater data is available in the California's Groundwater Live website, which is updated on a daily basis as data is received by DWR. Additional data and information are available in the CNRA Open Data and Water Data Library websites.

The disparity in reporting periods for various groundwater data sets in this semi-annual report stems from the fact that there is generally 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. DWR maintains the California Groundwater Live (CalGW Live) website which is updated daily and presents the most up-to-date data received by DWR.

Since the enactment of SGMA in 2014, significant progress has been made by the local agencies and the state to collect, report, and disseminate groundwater data and manage groundwater resources. Today, groundwater sustainability plans (GSP) are fully developed and in the implementation phase for basins providing 98% of the total groundwater pumped in the state. In addition to maintaining the CalGW Live website for the most recent data, DWR is working towards making annual groundwater use data reported by GSAs available to the public as well as improving timely reporting of groundwater data. Additional relevant groundwater data resources are discussed towards the end of this report.

Drought and Groundwater in California

California's climate is highly variable and can produce extreme swings. California is currently in its third year of a drought, which was preceded by one of the wettest years on record (2017) on the heels of a prior statewide drought (2012 – 2016). California's climate varies seasonally, annually, and over longer multi-year and decadal cycles. **Figure 1** shows the annual variability of statewide precipitation for the past 50 years. Since 2000, more than half of California's Water Years have been dry or drought years, contributing to over-all moisture deficit conditions in our hydrologic system. During dryer periods, groundwater extraction is increased to balance out the seasonal and annual variations in the state's surface water supply.

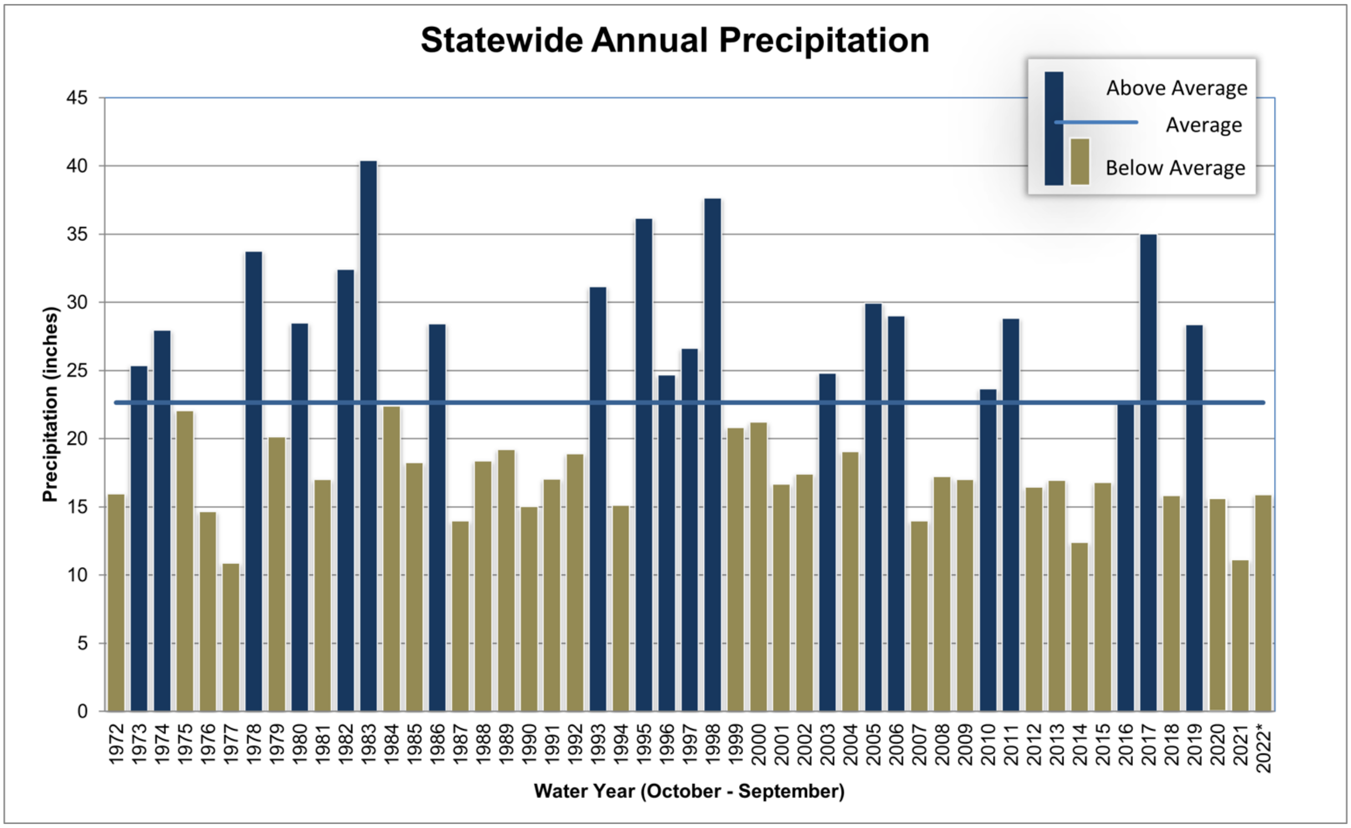


Figure 1: Statewide Annual Precipitation, NOAA National Centers for Environmental Information, (Climate at a Glance: U.S. Time Series, Precipitation). *2022 Water Year Data uses projected totals based off mean precipitation levels from September 1896 to 2021.

Seasonal variations in statewide precipitation can also be substantial, as shown in **Figure 2** for the Northern Sierra 8-Station Precipitation Index. The State had an exceptionally wet season from the beginning of WY 2022 from October through the end of December 2021; it was on track to match the wettest year on record (2017) in the Northern Sierra, where most of the state's precipitation falls. However, January, February, and March 2022 were the driest on record dating back over 100 years, ultimately leading to a water year with well below average annual precipitation.

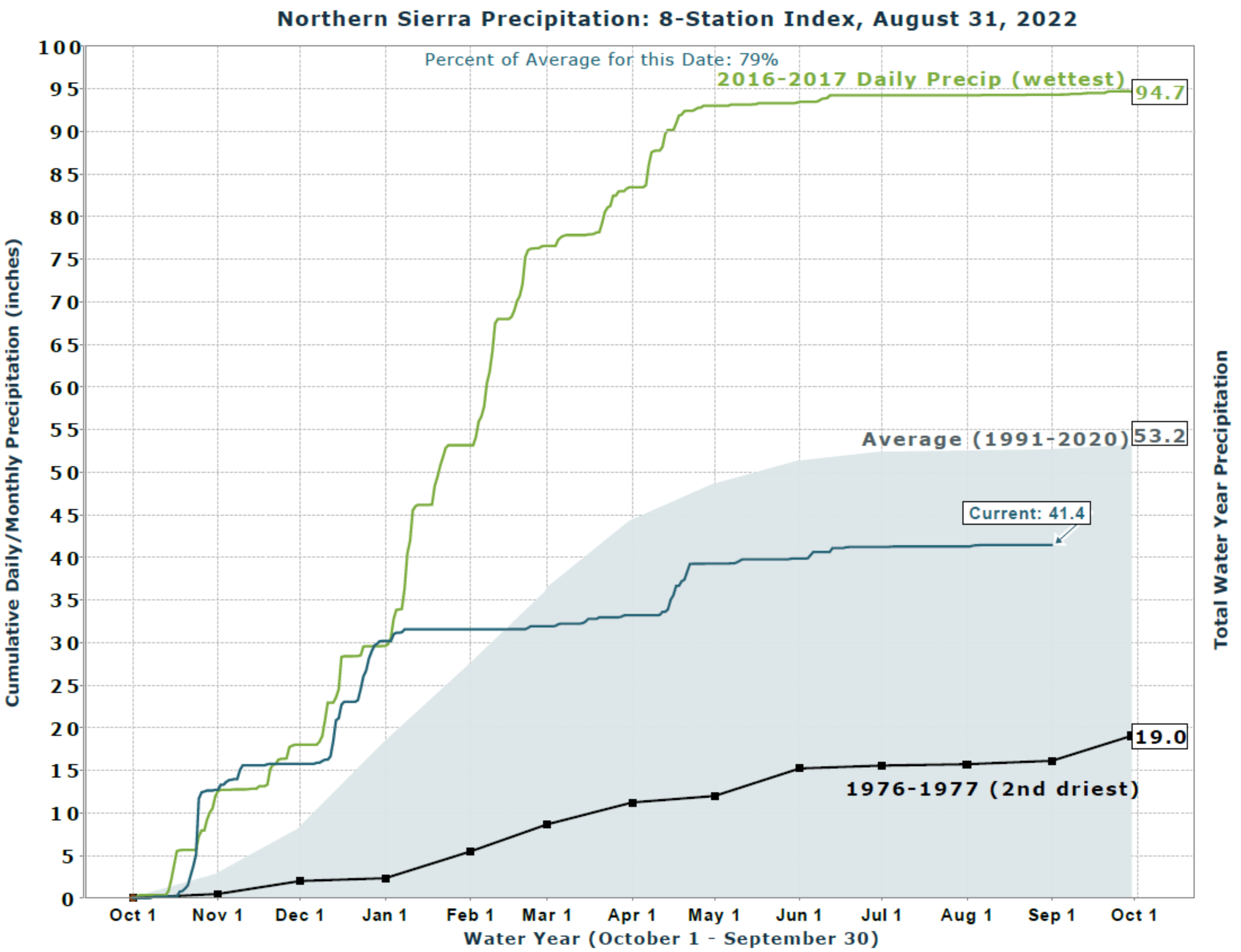


Figure 2: Northern Sierra Precipitation: Average precipitation (53.2 inches) with highest in 2016-2017 WY (94.7inches) and current 2021-2022 WY (up to August 31) precipitation (41.4 inches) based on CDEC Sierra Precipitation 8-Station Index.

California is also experiencing dryer than average conditions over a longer term. It is reported in a recent study published in the Nature Climate Change journal that 2000-2022 is the driest 22-year stretch on record in at least 1,200 years in California. Historical data shows that 15 of the 22 years during the 2000-2022 period had below average annual statewide precipitation (**Figure 1**). The cumulative departure from the average annual statewide precipitation (**Figure 3**) for the 2000-2022 period shows the accumulated precipitation deficit during this period.

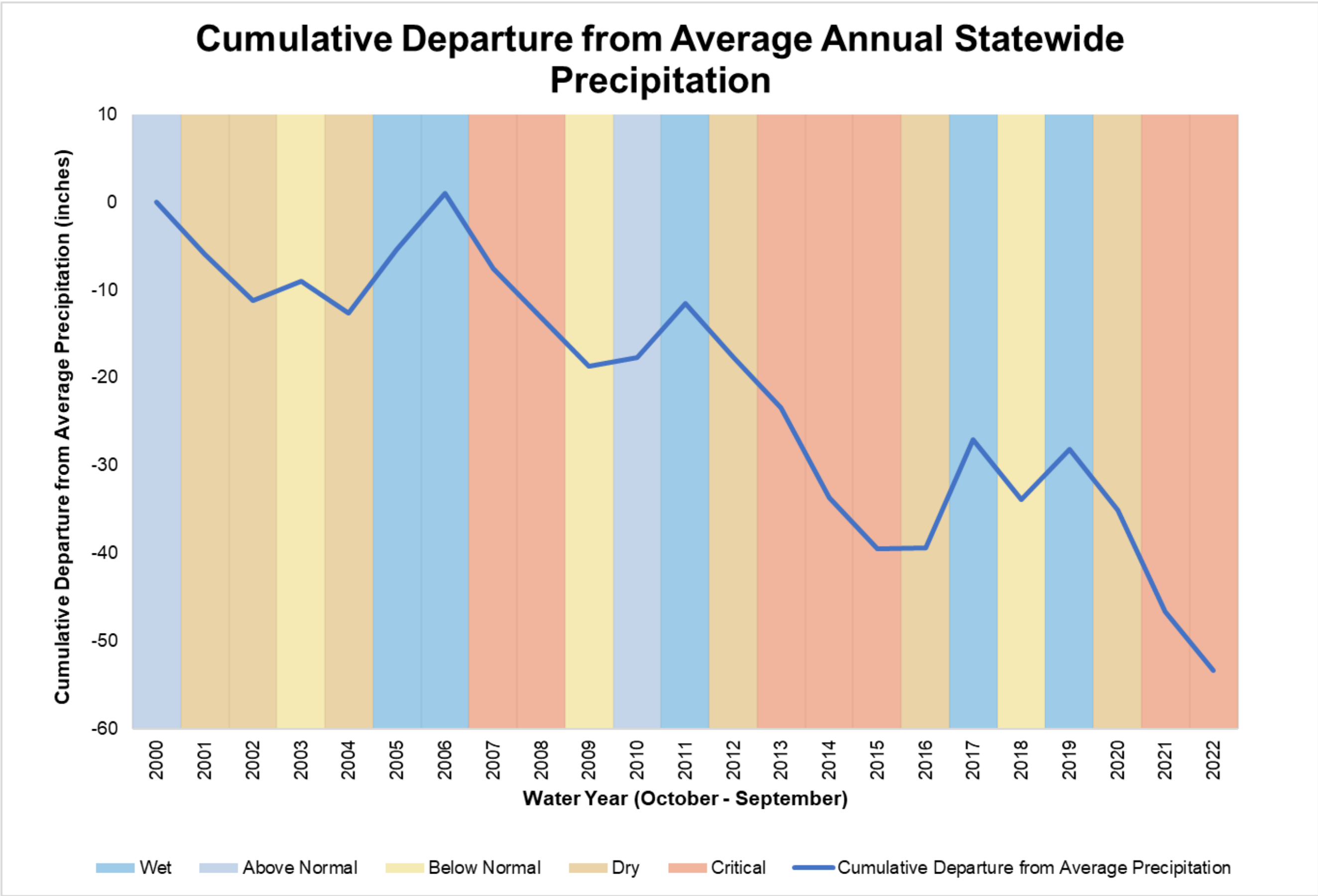


Figure 3: Cumulative Departure from Average Annual Statewide Precipitation based on data from NOAA National Centers for Environmental Information, (Climate at a Glance: U.S. Time Series, Precipitation). *2022 Water Year Data uses projected totals based off mean precipitation levels from September 1896 to 2021 means.

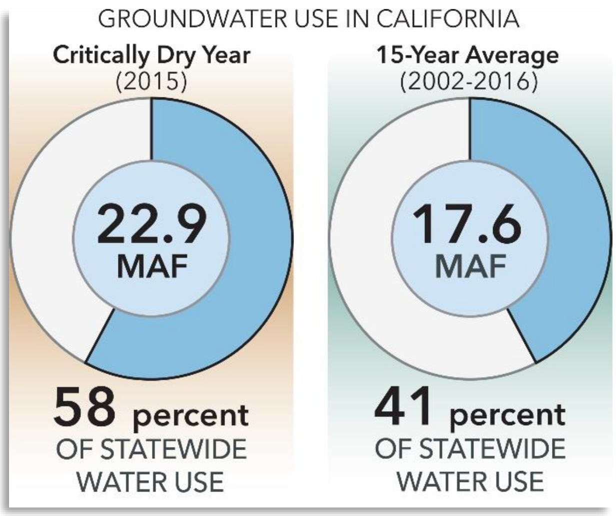


Figure 4: Total Groundwater Use and Percentage of Statewide Water Supply in a Critically Dry Year versus 15-Year Average.

While precipitation drives the hydrologic system in California, groundwater basins have been utilized over past decades both as a drought buffer and a climate adaptation strategy. On average, groundwater provides 41 percent of the state's total annual water use, and up to 58 percent of the total annual water use in drought years, while the rest of the annual water use is provided by surface water and water reuse. As shown in **Figure 4**, groundwater use during the 2002–2016 period averaged approximately 17.6 million acre-feet (maf), which represents 41 percent of the average annual total water use (42.9 maf) in the state during that period. During the critically dry year of 2015, total water use in the state declined slightly from the average but groundwater use increased and amounted to approximately 22.9

maf, representing 58 percent of total annual water use (39.4 maf) in 2015 (California's Groundwater Update 2020).

Long-term reliance on groundwater as a drought buffer is not sustainable. Historical data shows that overuse of groundwater combined with a decreased recharge caused by lower precipitation over the last 20 years has prevented groundwater level recovery in many areas of the state (**Figure 8**).

Groundwater Levels

Changes in groundwater levels, especially groundwater level declines during drought, can indicate potential vulnerabilities to groundwater wells, the environment, and areas susceptible to land subsidence and water quality degradation. Groundwater level data provide valuable information on seasonal fluctuations, long-term changes, and trends in groundwater storage. Groundwater levels are measured on a regular schedule in 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 Groundwater Sustainability Agencies implementing SGMA and by Monitoring Entities participating in the California Statewide Groundwater Elevation Monitoring (CASGEM) Program.

The maps shown in **figures 5, 6, 7, and 8** depict how groundwater levels have changed over time. **Figures 5, 6, and 7** show respectively one-year, three-year, and five-year change in groundwater levels during the spring season. **Figure 8** uses trend analysis of groundwater levels for wells having measurements in at least 10 water years over a 20-year period to illustrate the long-term trend (a well's water level increasing or decreasing trend over a 20-year period).

The groundwater level change maps also display, in accompanying bar charts, the percentage of wells with various ranges of increases and decreases in groundwater levels by the entire state and hydrologic regions. **Table 1** summarizes the statewide information for one-year, three-year, and five-year changes shown in the groundwater level change maps.

Table 1: Statistical Summary of Groundwater Level (GWL) Changes from spring 2022 (As Shown in **Figures 5-7**). Water Year Type as defined by the Sacramento River 8-Station Index, Department of Water Resources, California Data Exchange Center, [WSIhist (ca.gov).](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 (Critical vs Dry): 2022 compared to 2021	5,823	4.7%	27.1%	61.4%	5.6%	1.2%
3-Year GWL Change (Critical vs Below Normal): 2022 compared to 2019	5,126	12.5%	39.2%	40.2%	6.7%	1.3%
5-Year GWL Change (Pre-Current Drought): 2022 compared to 2017	4,868	11.1%	36.7%	39.2%	10.1%	3.0%

The one-year change map (**Figure 5**) shows that approximately 61 percent of the statewide well measurements indicate no significant changes (less than +/- 5 feet) in net water level. From Spring 2021 to Spring 2022, approximately 32 percent of measured wells show more than five feet of decline in groundwater levels, and only seven percent show more than five feet of increase in water levels. The Tulare Lake Hydrologic Region outpaces all other hydrologic regions in the state with 71 percent of wells showing one-year declines in water levels, which is about 10 percent more than the one-year declines reported last year (California Groundwater Conditions Update – Spring 2021). The San Francisco Bay Hydrologic Region showed 17 percent of wells with increasing water levels, the most among all hydrologic regions.

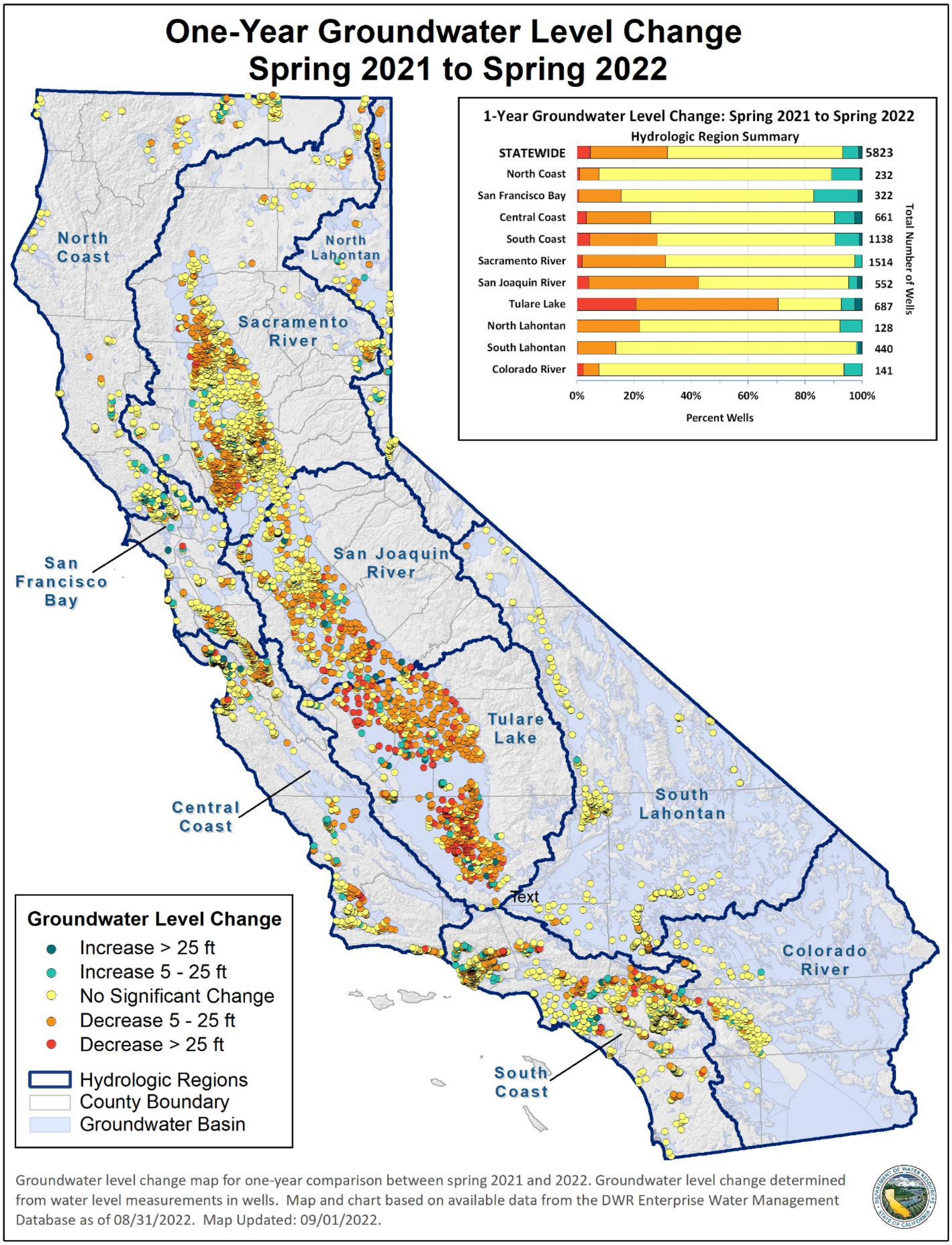


Figure 5: Statewide and hydrologic region groundwater level change map for one-year period between spring 2021 and 2022. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 08/31/2022.

The three-year change map (**Figure 6)** spans the current drought period and shows more declines than increases in groundwater levels. Statewide, more than 50 percent of measured wells show more than five feet of decline in groundwater levels. The Tulare Lake Hydrologic Region has the highest percentage (80 percent) of wells with declining groundwater levels, with over 40 percent of wells showing declines of more than 25 feet in the 3-year period. The Sacramento and San Joaquin River hydrologic regions show that nearly 70 percent of wells have some declines in water levels. Groundwater level changes are more balanced in the South Coast and Colorado River hydrologic regions which show similar levels of increases and decreases: greater than five feet increases in 20 percent of wells and decreases in 28 percent of wells in the South Coast; and greater than five feet increases in 28 percent of wells and decreases in 17 percent of wells in the Colorado River hydrologic region.

The previous drought in California lasted from 2012 through 2016, which ended with one of the wettest years on record in 2017. For several years after the last drought, groundwater levels increased in some areas. However, the five-year (2017-2022) change map (**Figure 7**) shows that in most areas of the state groundwater levels have dropped below the 2017 levels, even though two (2017 and 2019) of the five years experienced above average statewide precipitation (**Figure 1**). The South Coast and Colorado River hydrologic regions had more wells with increasing groundwater levels. Statewide, 48 percent of wells experienced more than five feet of decline in groundwater levels while 13 percent of wells had increasing water levels, illustrating the variable nature of groundwater level depletion and recovery across the state.

Figure 8 shows the trend of groundwater level change over time. Rather than a direct comparison of groundwater levels from two different time periods (as in **figures 5, 6, and 7**), **Figure 8** shows the magnitude of decreasing or increasing groundwater level trends in wells over the 20-year period from WY 2002 to WY 2022, which includes droughts from 2007 to 2009, 2012 to 2016, and the current drought (2020 to present). Groundwater levels measured at wells during this 20-year period were analyzed using the Mann-Kendall non-parametric test to determine whether a statistically significant trend (declining trend, no trend, or increasing trend) was present. The data used for this analysis came from wells that have at least 10 years of data within the 2002-2022 period. If a statistically significant trend was observed, the Theil-Sen method was used to calculate the estimated slope of the trend line to quantify the decline or increase as explained in California's Groundwater Update 2020 Appendix C - Methods and Assumptions. 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 2002 to WY 2022 are summarized in **Table 2**.

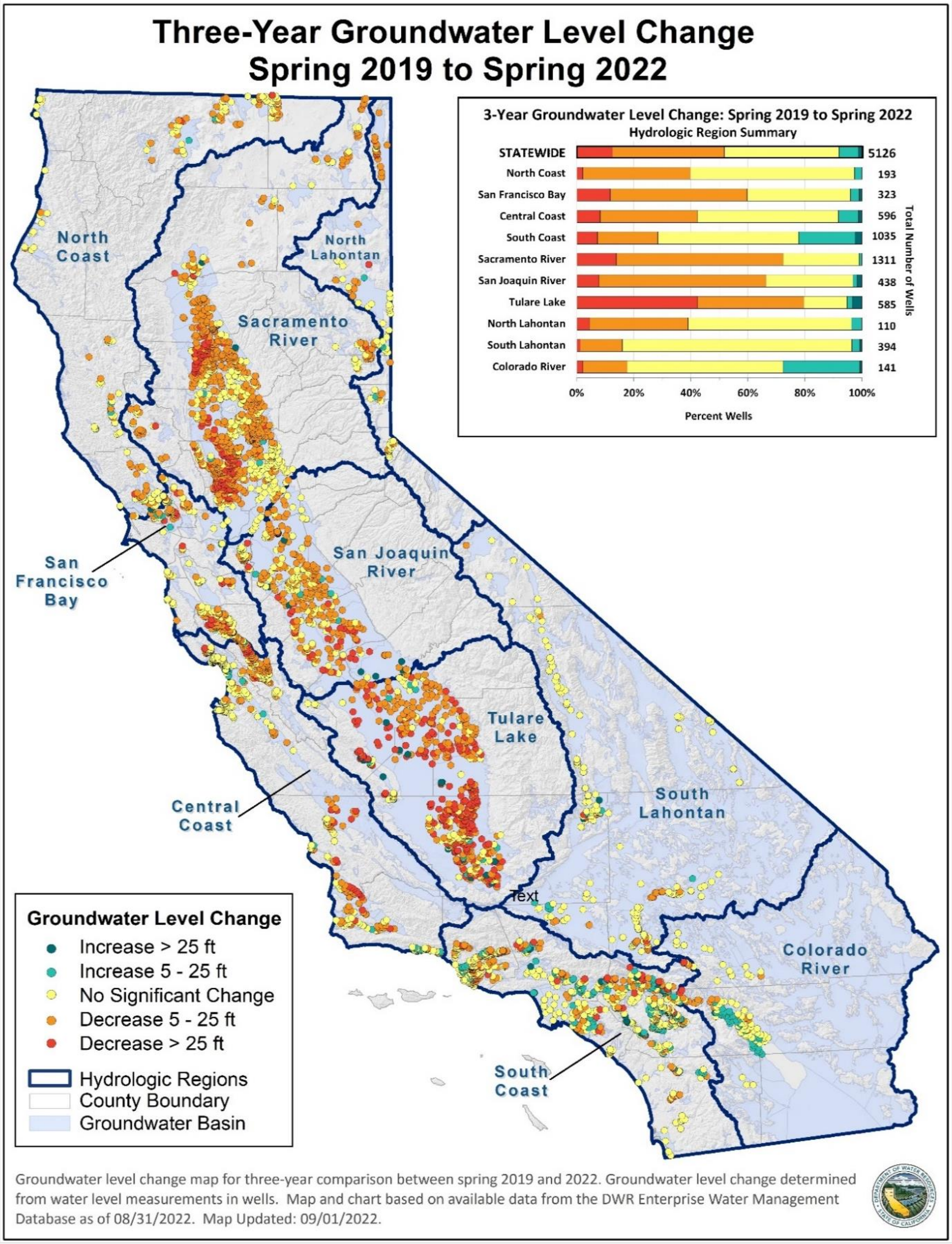


Figure 6: Statewide and hydrologic region groundwater level change map for three-year period between Spring 2019 and 2022. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 08/31/2022.

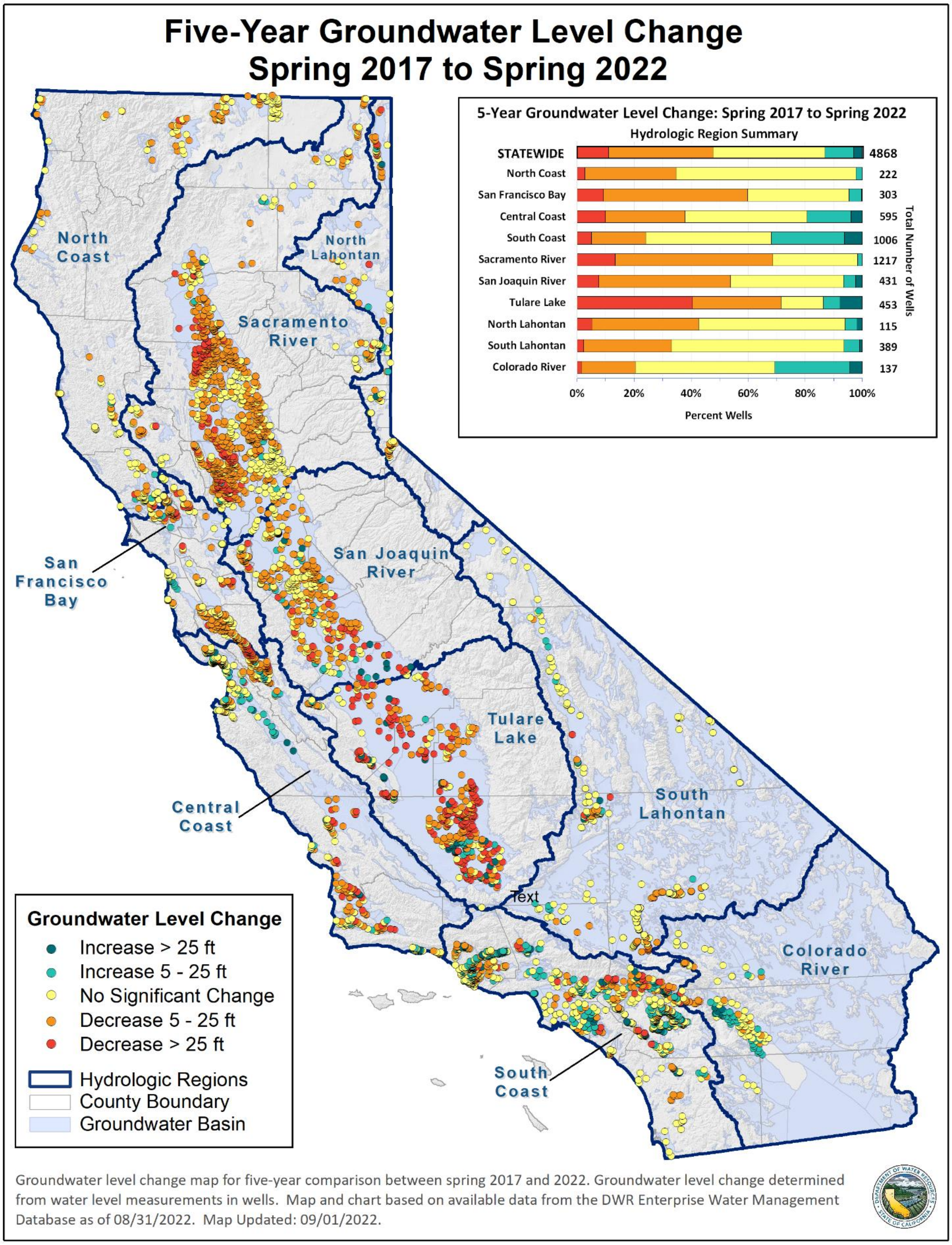


Figure 7: Statewide and hydrologic region groundwater level change map for five-year period between spring 2017 and 2022. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the [DWR Water Data Library](#) as of 08/31/2022.

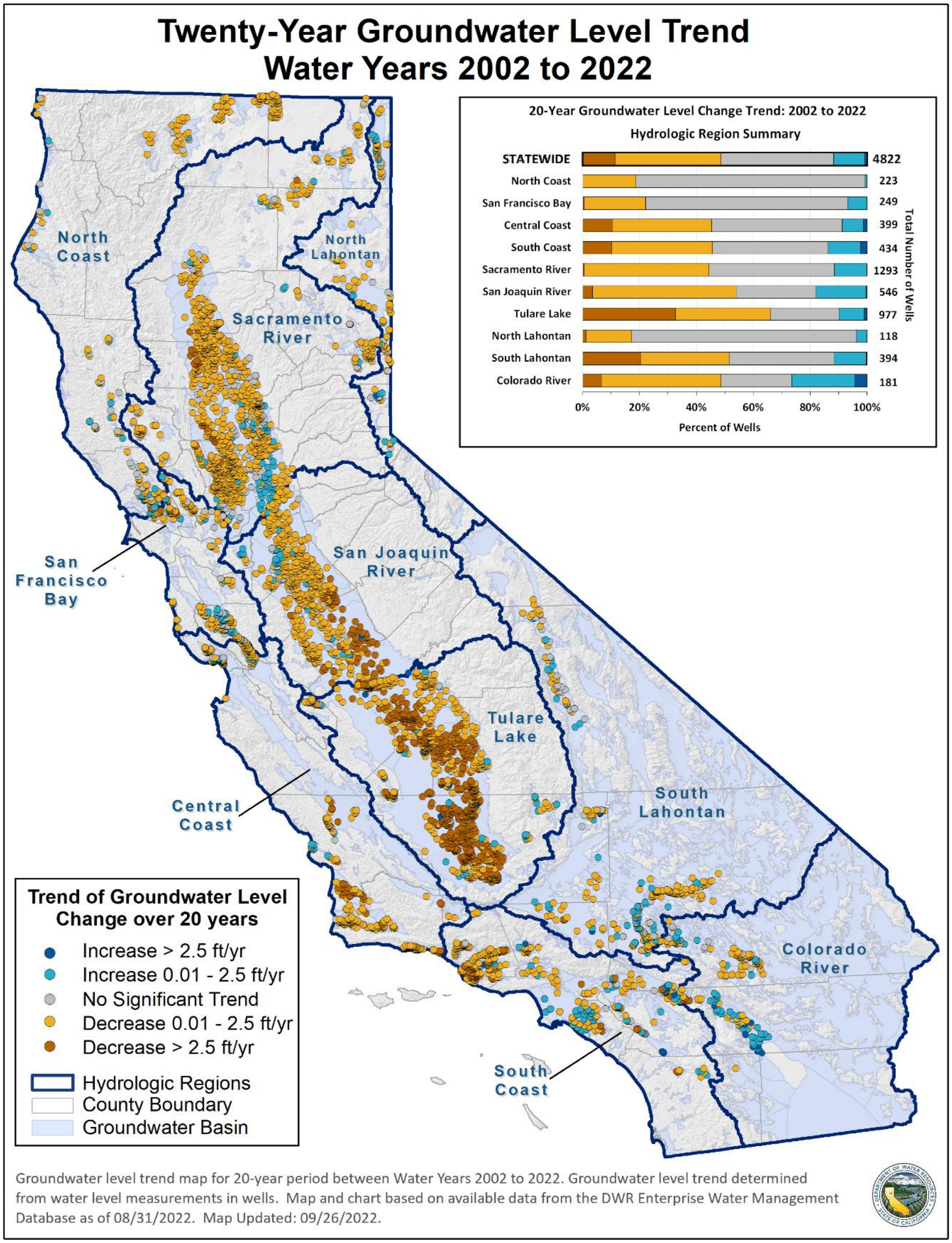


Figure 8: Statewide and hydrologic region groundwater level trend analysis map for Water Years 2002-2022. See **Table 2** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 08/31/2022.

Table 2: Statistical Summary of Groundwater Level Trend Map (**Figure 8**)

Period	Total Well Count	Decrease > 2.5 ft	Decrease 0.01 - 2.5 ft	No Significant Trend (Less than +/- 0.01 ft)	Increase 0.01 - 2.5 ft	Increase > 2.5 ft
20-Year Trend: 2002 to 2022	4822	10.9%	35.4%	37.6%	10.4%	0.8%

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. In response to a recent drought executive order to accelerate subsidence data collection and reporting, DWR has increased the reporting frequency of monthly InSAR data from annually to quarterly to provide more real-time information. Vertical ground surface displacement estimates are derived from the InSAR data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE ALTAMIRA, under contract with DWR. This report includes figures, tables, and discussion of land subsidence data for both WY 2022 and the entire InSAR dataset which is referenced as "Since 2015" (a period from June, 2015 to July, 2022). **Tables 3** provides a summary of vertical displacement observed in the InSAR dataset in WY 2022 and **Table 4** provides a summary of cumulative vertical displacement since 2015.

Table 3: Total Area of Subsidence Corresponding to Subsidence Amount for July 2021 to July 2022 (**Figure 9**)

Period	Subsidence >0.1 ft	0.1 to 0.2 ft	0.2 to 0.4 ft	0.4 to 0.6 ft	0.6 to- 0.8 ft	0.8 to 1 ft	>1 ft
July 2021 - July 2022	4,518 sq miles	1,534 sq miles	1,580 sq miles	635 sq miles	417 sq miles	292 sq miles	60 sq miles

Table 4: Total Area of Subsidence Corresponding to Subsidence Amount since 2015 (**Figure 10**)

Period	Subsidence >0.5 ft	0.5 to 1 ft	1 to 2 ft	2 to 3 ft	3 to 4 ft	4 to 5 ft	> 5 ft
June 2015 - July 2022	3,231 sq miles	1,226 sq miles	879 sq miles	458 sq miles	310 sq miles	277 sq miles	82 sq miles

Two maps are provided in this report to display the location and magnitude of statewide land subsidence for the one-year period from July 2021 to July 2022 (**Figure 9**) and for the 7-year period from June 2015 to July 2022 (**Figure 10**). The total area in square miles for 7-year cumulative subsidence is less than the reported total for annual subsidence because the minimum value reported in **Table 4** is a higher value (0.5 feet) than that for the annual summary (0.1 feet) and data coverage for annual maps is higher than that of cumulative subsidence due to improvements in the InSAR processing techniques.

Figure 9 shows the total annual rate of subsidence in feet/year for July 2021 to July 2022. Annual subsidence is shown in six categories: 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 1foot/year.

Figure 10 shows total subsidence, in feet, from June 2015 to July 2022. Subsidence of less than 0.5 feet is shown in grey color on the map to show the geographic coverage of the InSAR dataset. The hydrologic region summary chart only represents areas of subsidence with 0.5 feet or more.

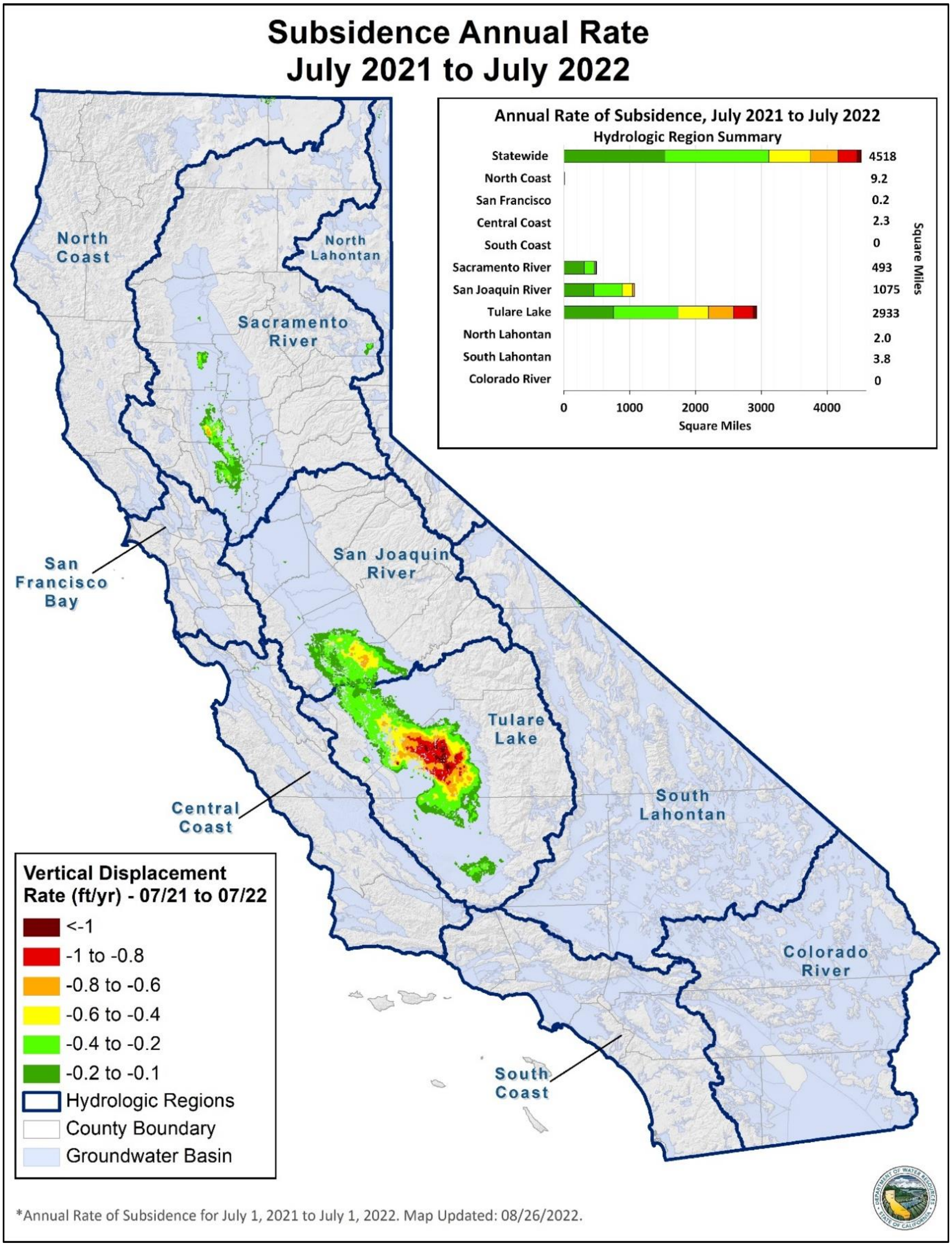


Figure 9: Statewide annual subsidence map for July 2021 to July 2022. See **Table 3** for specific subsidence level statistics. Map and charts based on available data from the CNRA Open Data as of 08/25/2022.

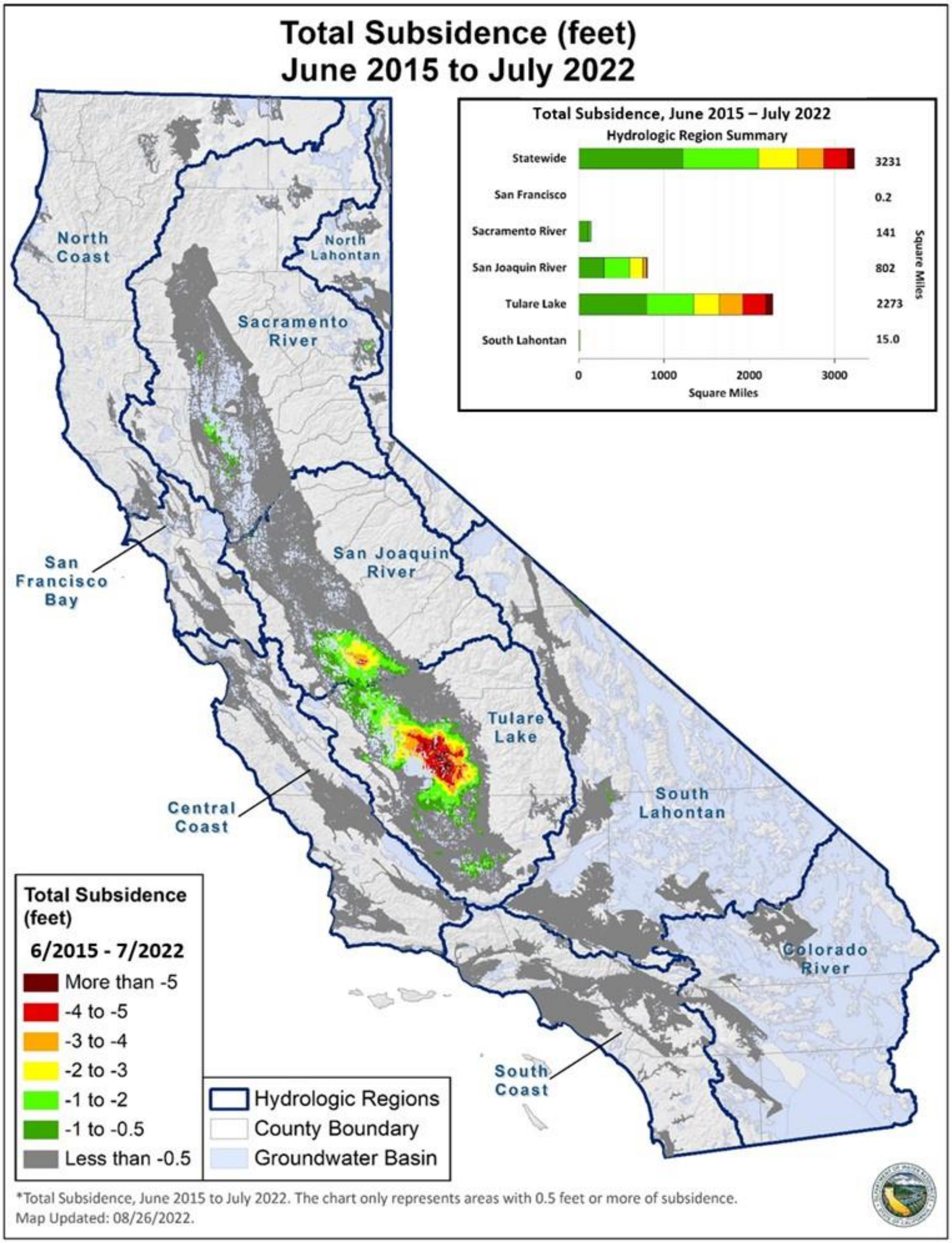


Figure 10: Statewide total subsidence map between June 2015 to July 2022. See **Table 4** for specific subsidence level statistics. Map and charts based on available data from the CNRA Open Data as of 08/25/2022.

For the July 2021 to July 2022 period, statewide data shows a total area of 4,518 square miles with recorded subsidence greater than 0.1 feet, and 60 square miles recording greater than 1foot of subsidence. The Tulare Lake Hydrologic Region has the most areas of subsidence with about 3000 square miles of area experiencing greater than 0.1 feet of subsidence during the July 2021 to July 2022 period. During the same one-year period, South Coast and Colorado River hydrologic regions recorded no subsidence over 0.1 feet whereas San Francisco, North Lahontan and South Lahontan hydrologic regions recorded greater than 0.1 feet of subsidence in less than 4 square miles area.

Groundwater Levels and Land Subsidence

Groundwater levels and land subsidence are two of the six sustainability indicators under SGMA and are intricately connected. **Figure 11** shows groundwater levels in conjunction with ground surface elevations measured with an extensometer well and plotted over time since 1991 at a site in Yolo County. The time-series graphs demonstrate how groundwater levels affect elastic (reversible) and inelastic (irreversible) land subsidence. The groundwater level data shows how the depth to groundwater fluctuates seasonally, with corresponding seasonal changes, or vertical displacement, in land surface elevations. The chart shows that prior to 2013, the seasonal depth to groundwater was generally consistent and did not exceed approximately 80 ft. During this time the ground vertical displacement was minimal (plus or minus approximately one inch) and mostly inelastic. However, during the 2012 –2016 drought, pumping increased causing the seasonal water levels to decline beyond 110 ft, establishing a new historical low groundwater level for this site. This resulted in considerable inelastic subsidence with the ground vertical displacement of approximately 10 inches in two years, permanently decreasing groundwater storage capacity.

Although the dramatic vertical displacement has abated since 2015 at this site, seasonal groundwater levels at this site frequently drop below 90 ft and some inelastic land subsidence each year can be seen as the current drought continues.

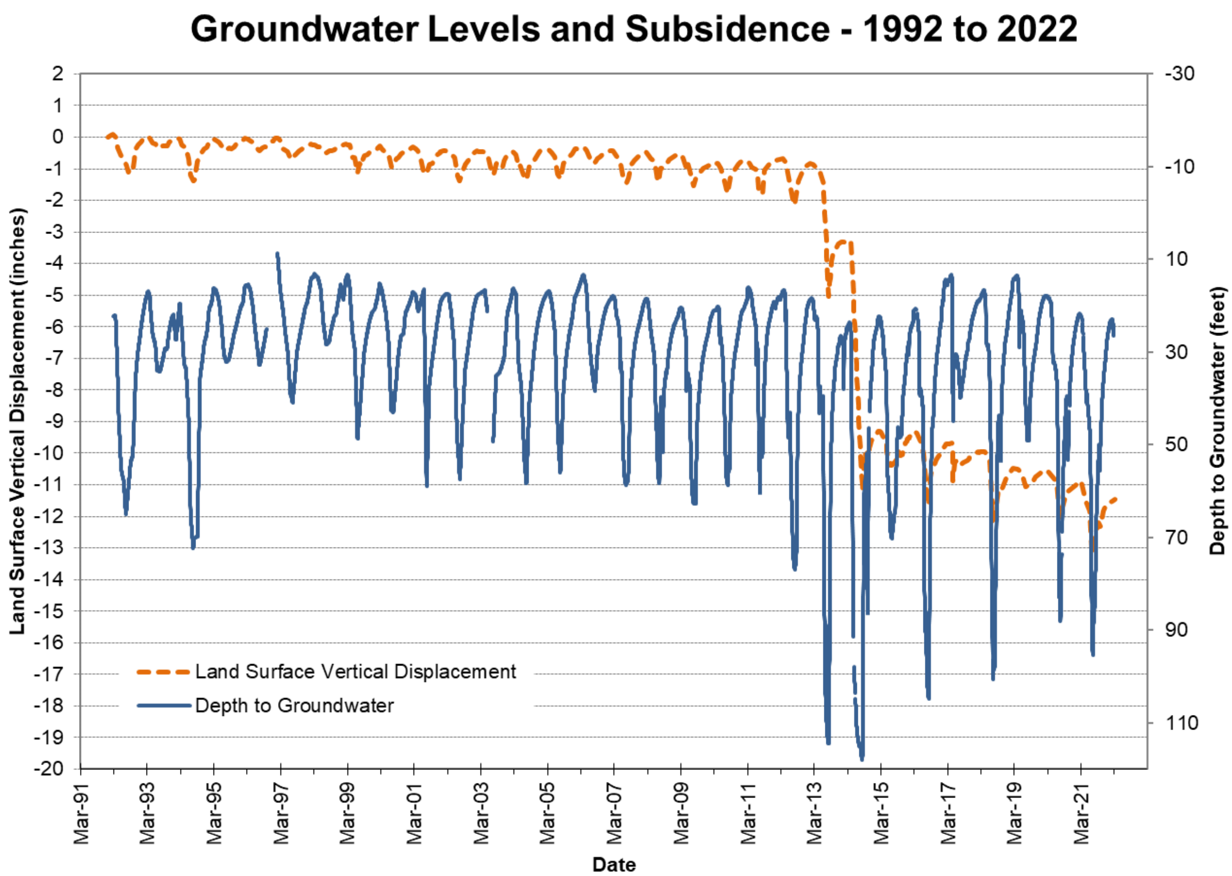


Figure 11: Hydrograph Showing Groundwater Level Changes in a Monitoring Well in conjunction with Land Subsidence in Yolo County, California.

Well Infrastructure

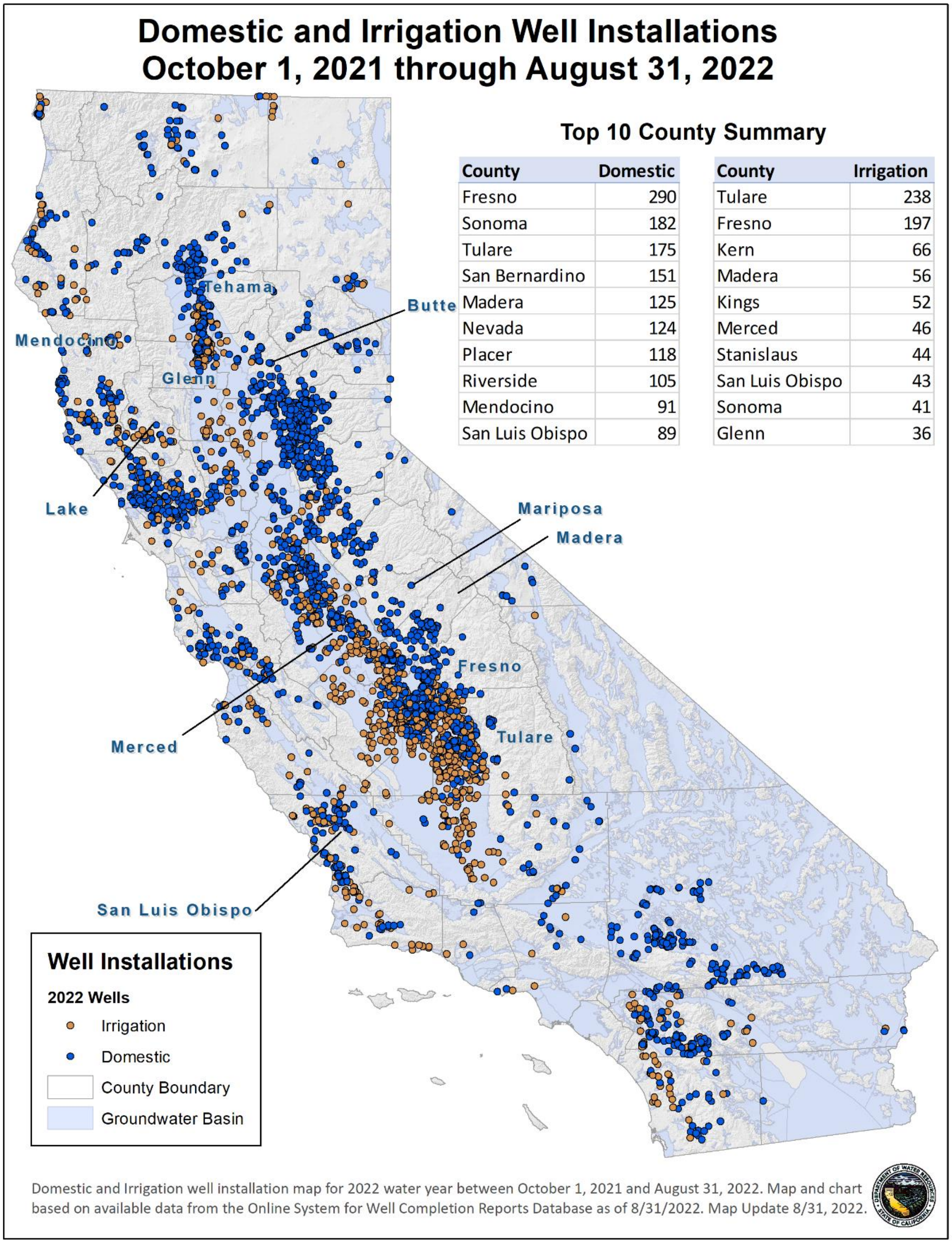
Many factors influence the type and number of groundwater extraction wells (well infrastructure) drilled in California, such as climate conditions, surface water supplies, groundwater level changes, legislative actions, age of the well and other local conditions. Well completion reports (WCR) are submitted to DWR through the Online System for Well Completion Reports (OSWCR) when a well is installed, replaced, or destroyed. This report includes a summary of data submitted to OSWCR over the last eight water years (2015 – 2022) for groundwater extraction wells classified as domestic or irrigation wells.

This report also provides an eight-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.

An 8-year summary and year-to-year statistics of domestic, irrigation, and dry wells are provided in **Table 5**. The data go back to the 2015 water year, 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. As stated in the Introduction, Water Year 2022 groundwater data used in this semi-annual report includes data received electronically by DWR as of August 31, 2022.

Table 5: Statewide Summary of Newly Installed Domestic and Irrigation Wells and Number of Dry Well Reporting Over Last 8-Years and Total. *Dry Well Reporting started in 2013, whereas the database of WCRs for domestic and irrigation wells are considered to be complete since 1977

Type of Wells	Total since 1977*	8 Year Total (WY 2015 to WY 2022)	WY 2015	WY 2016	WY 2017	WY 2018	WY 2019	WY 2020	WY 2021	WY 2022 (Oct 2021 to Aug 2022)
			Critical	Dry	Wet	Below Normal	Wet	Dry	Critical	Critical
Domestic Wells	276,875	25,651	3,527	4,407	3,124	2,600	2,739	2,990	3,481	2,783
Irrigation Wells	60,339	14,092	3,041	2,866	1,487	1,113	1,332	1,325	1,713	1,215
Dry Wells Reported	4,851	4,373	1,357	546	123	72	52	86	1,046	1,021



County	Domestic
Fresno	290
Sonoma	182
Tulare	175
San Bernardino	151
Madera	125
Nevada	124
Placer	118
Riverside	105
Mendocino	91
San Luis Obispo	89

County	Irrigation
Tulare	238
Fresno	197
Kern	66
Madera	56
Kings	52
Merced	46
Stanislaus	44
San Luis Obispo	43
Sonoma	41
Glenn	36

Figure 12: Statewide newly installed domestic and irrigation wells map for Water Year 2022 through August 2022. See **Table 5** for specific well data. Map and charts based on available data from the CNRA Open Data as of 08/31/2022.

Domestic Wells

Domestic (household) wells provide water to millions of people throughout California. During the 2022 water year (up to August 31), a total of 2,783 new domestic wells were reported to be installed in the state. During the last eight water years (since October 2014), a total of 25,651 domestic wells have been installed, accounting for approximately 9% of the total 276,875 domestic wells installed since 1977. The year-to-year number of new domestic wells has fluctuated from a low of 2,600 in WY 2018 to a high of 4,407 in WY 2016.

The location of new domestic and irrigation wells installed in California during the 2022 water year is shown in **Figure 12**. The counties with the highest number of new domestic wells were Fresno (290), Sonoma (182), and Tulare (175). 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.

A monthly timeseries of new domestic well installations since October 2014 is presented in **Figure 13**, along with a cumulative graph. The number of new domestic wells is typically influenced by changes in populations and new home construction, which is strongly influenced by economic cycles. New domestic wells could also be replacement wells for wells that went dry during a drought.

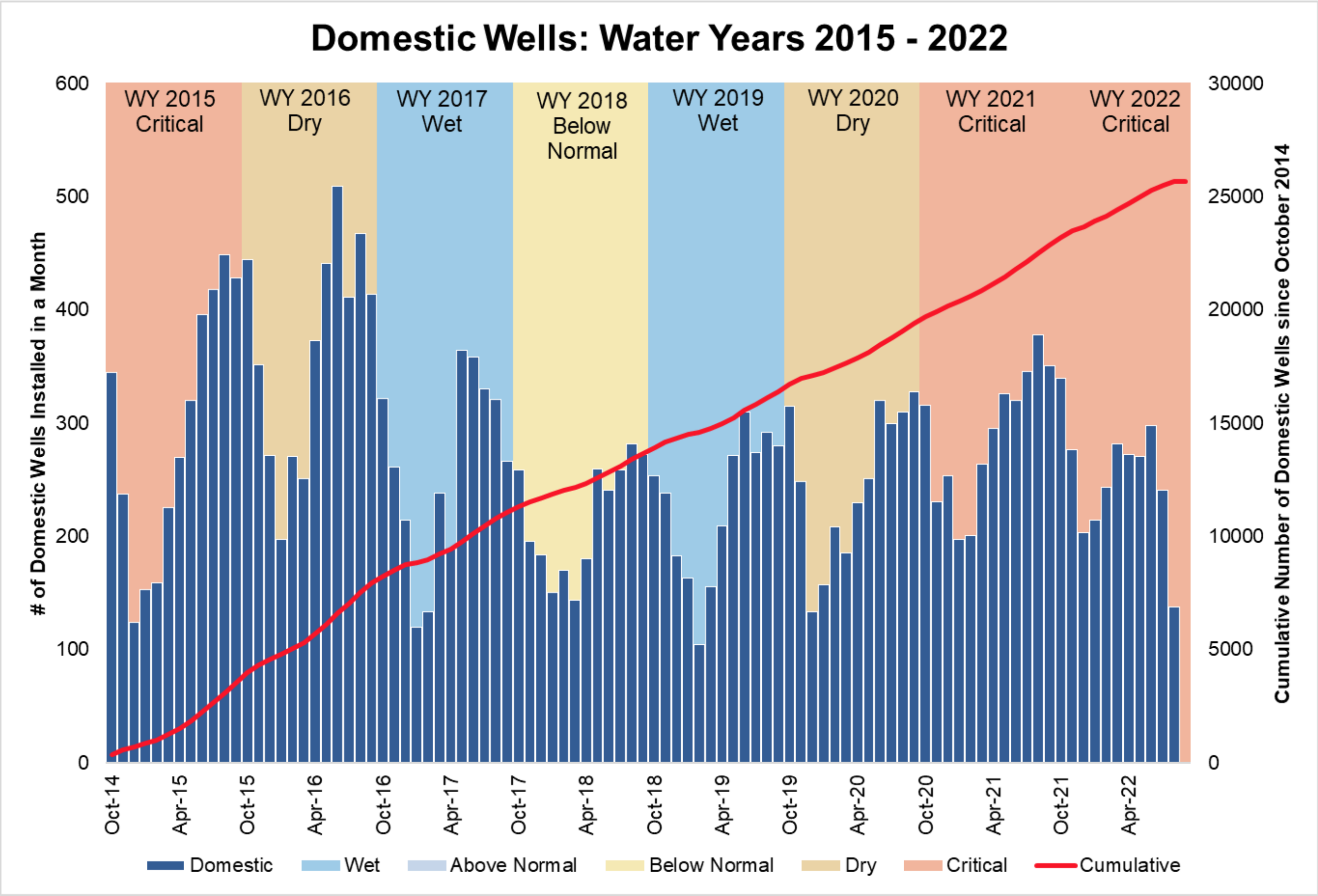


Figure 13: Monthly Domestic Well Installations with Cumulative Curve (WY 2015-2022)

Irrigation Wells

Irrigation wells typically have higher capacity and pump more groundwater than do domestic wells to provide water to farms that feed millions of people throughout California and the world. During the 2022 water year (up to August 31), a total of 1,215 new irrigation wells were reported to be installed in the state. Over the last eight years since October 2014, a total of 14,092 irrigation wells have been installed across the state, accounting for approximately 23 percent of the 60,339 irrigation wells installed statewide since 1977. The year-to-year number of new irrigation wells has fluctuated from a low of 1,113 in WY 2018 to a high of 3,041 in WY 2015.

Figure 12 shows the location of newly installed irrigation wells in WY 2022 through August. New irrigation wells that have been installed in California are much less geographically spread throughout the state when compared with the geographic spread of domestic wells. In the 2022 water year, Tulare County had more new irrigation wells (238) installed than any other county in the state, accounting for approximately one out of every five new irrigation wells (20 percent). Neighboring Fresno County (197) and Kern County (66) ranked 2nd and 3rd respectively for most new irrigation well installations. These three counties combined account for 41 percent of all new irrigation wells installed in WY 2022. In contrast, 35 California counties had less than 10 new irrigation wells installed, and eight counties had no new irrigation wells installed in WY 2022.

A monthly timeseries of new installations of irrigation wells since October 2014 is presented in **Figure 14,** along with a cumulative graph. Installation trends for new irrigation wells reflect changes in annual precipitation and drought conditions but may also be influenced by other factors such as local and state ordinances, laws, or executive orders, cropping trends, irrigation methods, or the availability of alternative agricultural water supplies. A combined total of 5,907 new irrigation wells were installed during 2015 and 2016 water years towards the end of the 2012 – 2016 drought. This also coincides with the enactment of SGMA in 2014 and the most severe drought conditions during that time period.

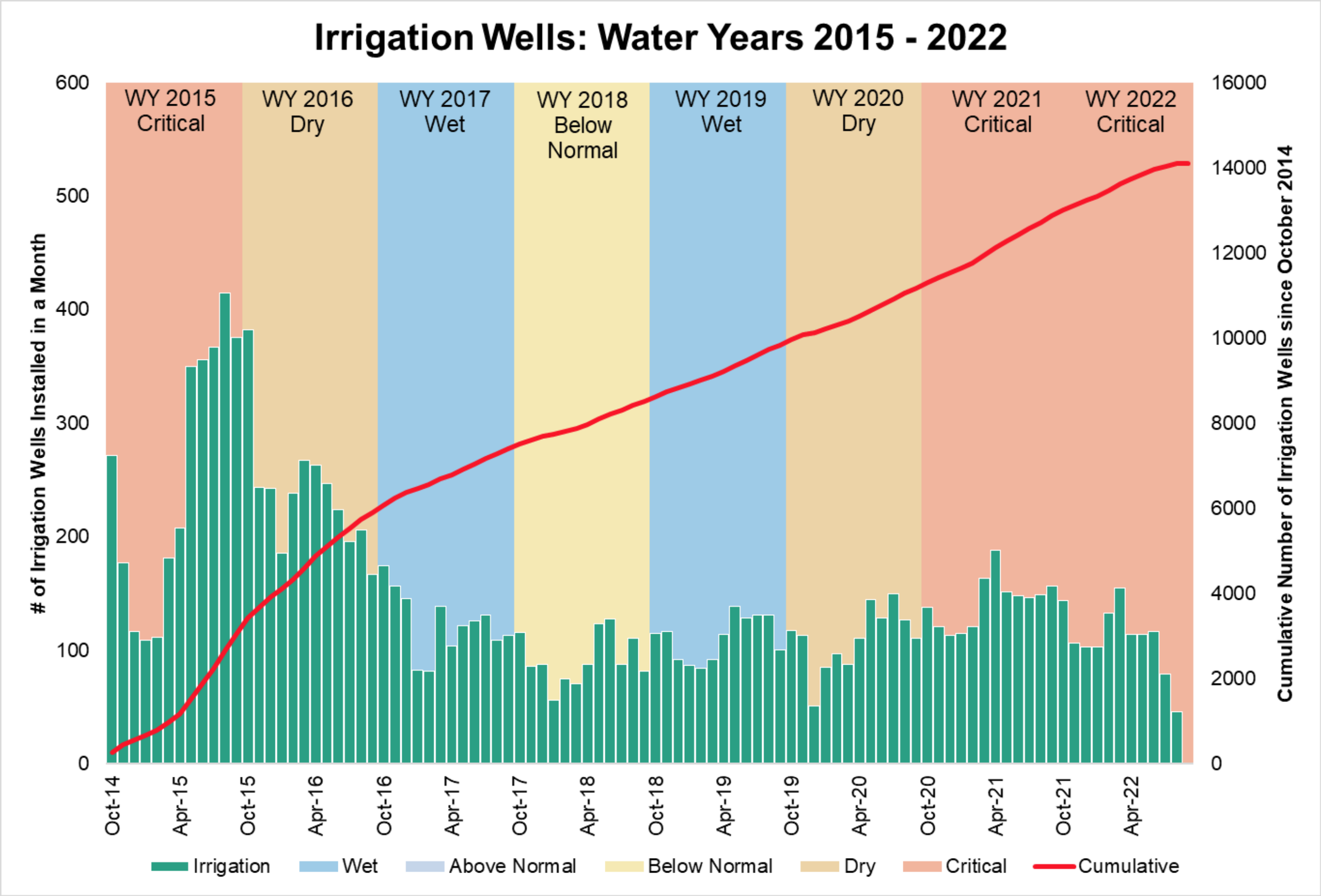


Figure 14: Monthly Irrigation Well Installations with Cumulative Curve (2015-2022)

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'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. Dry well reports submitted to the Dry Well Reporting database can document a new domestic well that went dry or a resolution to a previously reported dry well. The submission of these dry well reports is voluntary so the data may not represent the actual number of dry wells occurring across the state. Since the system has been updated, more dry well reports are likely being submitted to the Dry Well Reporting database than were submitted in the past.

In WY 2022, a total of 1,021 new dry well reports were received by DWR compared to 1,046 in WY 2021. A total of 4,373 new dry well reports were received over the last eight years (2015-2022), and a total of 4,851 dry well reports have been received since 2013. The year-to-year number of dry well reports has fluctuated from a low of just 52 in WY 2019 to a high of 1,357 in WY 2015. For full year-to-year statistics of dry well reporting over the last eight-years see **Table 5**. The locations of dry wells reports in WY 2022 are shown in **Figure 15**.

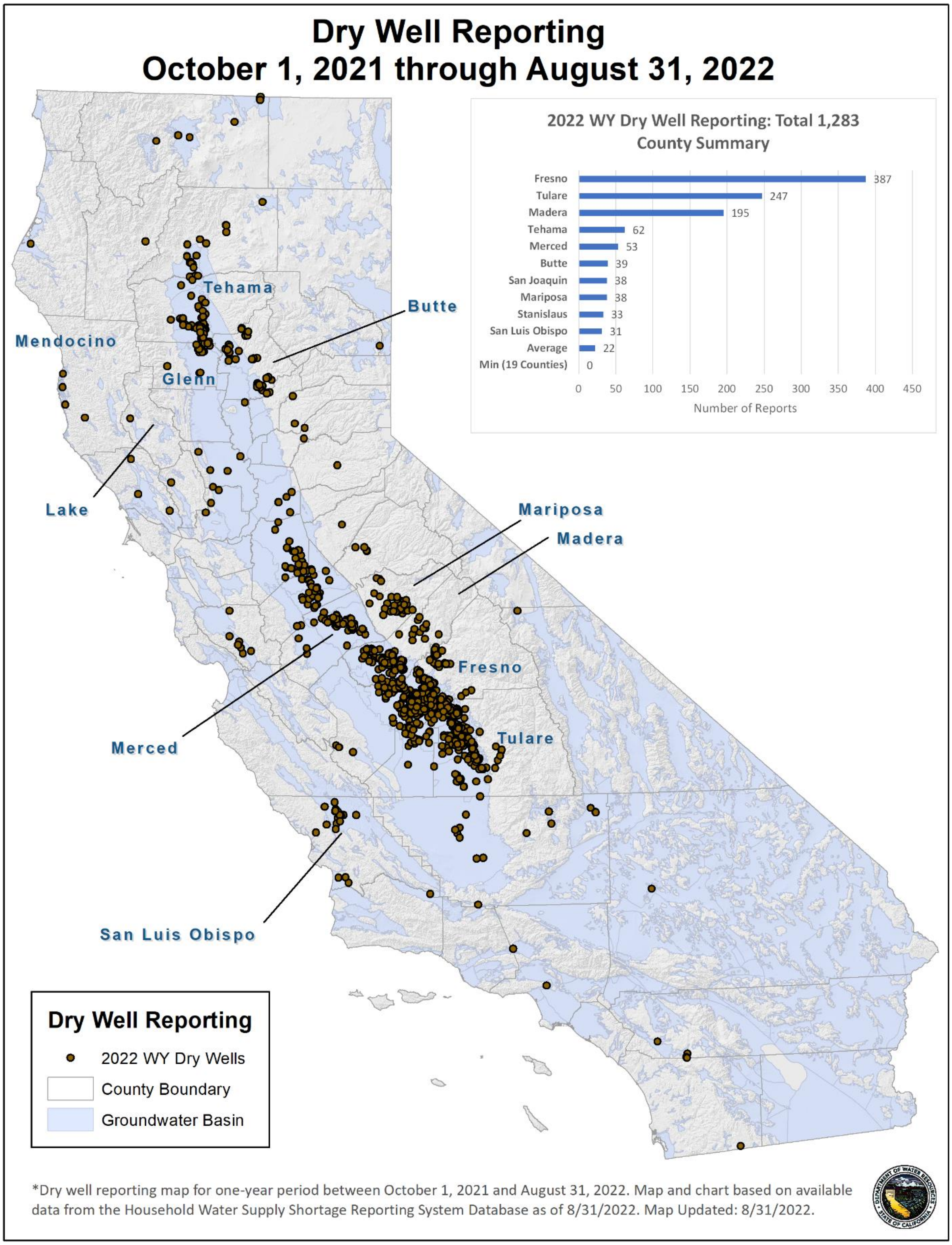


Figure 15: Statewide one-year reported dry wells map for Water Year 2022 (October 2021 through August 2022). Map and charts based on available data from the CNRA Open Data as of 08/31/2022.

In WY 2022, the highest number of dry well reports were received in Fresno County (359), Tulare County (230), and Madera County (163). These three counties account for approximately two out of every three dry well reports (65 percent) received statewide in WY 2022. Twenty-three counties reported between 1 and 10 dry wells and 20 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. Figure 16 shows a monthly timeseries of dry well reports from October 2014 to August 2022.

The state distributed $92 million to communities in 26 counties for drought-related projects in 2021, which aided 353,000 Californians.

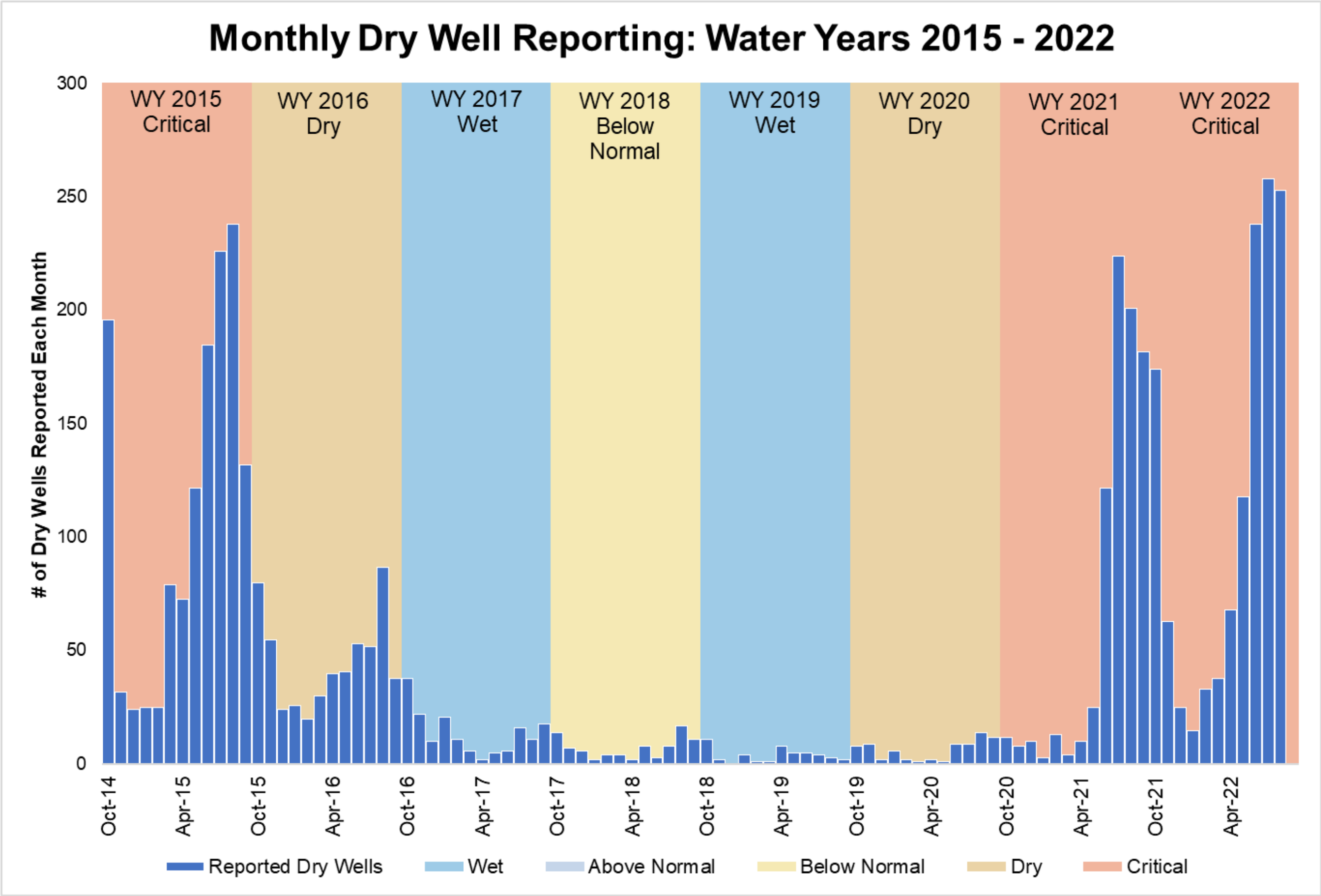


Figure 16: Monthly Dry Well Reporting (WY 2015 – WY 2022)

Data Used in This Report and Other Relevant Data Resources

As previously stated, the disparity in reporting periods for various groundwater data sets in this semi-annual update stem from the fact that there is an inherent lag between local data collection in the field and reporting to DWR. The frequency of groundwater data collection is not the same for all data types which results in submission of data in different timeframes. For example, groundwater level data are often collected only in fall and spring; as a result, groundwater conditions maps cannot be reliably developed for the summer months until the fall measurements are received.

In addition, it takes time to process and quality control the data received by DWR. As a result, this semi-annual report contains data that are received, quality controlled, and processed as of writing this report and are indicated accordingly for various data types. It is recognized that all data collected locally for the period of analysis may not have been included in the summary and analysis presented in this report. DWR is actively working toward expanding groundwater data collection and streamlining data processing, quality control, and synthesis to ensure more timely reporting and access to groundwater data.

DWR maintains the California Groundwater Live website which is updated daily and presents the most up-to-date groundwater data received by DWR. It is an interactive application that allows users to explore, analyze, and visualize the latest groundwater data and information for California. Groundwater data is also available to the public on the CNRA Open Data, Water Data Library, and SGMA Data Viewer web applications.

The California Groundwater Projects Tool is an interactive mapping tool that allows users to explore a database of nearly 3,000 projects funded by DWR and planned or implemented by local agencies in California over the last decade to manage and monitor groundwater resources.

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 assistance for drought.

DWR has also developed an interactive mapping tool, called the Dry Domestic Well Susceptibility Tool, that identifies areas within groundwater basins throughout the state that may be prone to water supply shortages in drinking water wells. Susceptibility is identified based on recent groundwater level measurements and potential 5-year water level decline. The Dry Well Susceptibility Tool is housed on the California's Groundwater Live web-based platform which contains the most recently available information and data on groundwater conditions across the state. The State, local agencies, and well owners can use this tool to anticipate where wells may go dry based on historical conditions to inform drought preparedness decision-making. The Dry Domestic Well Susceptibility tool can be used by navigating to California's Groundwater Live website.

The Dry Well Reporting and Dry Domestic Well Susceptibility tools provide important information and resources for counties, local water agencies, groundwater sustainability agencies, and well owners to use for drought-related planning and decision-making.

Closing Thoughts

Groundwater is a vital resource in California. It sustains our ecosystems, supports our agriculture, fuels our economy, quenches our thirst, and reduces the impacts of droughts and changing climate. Groundwater accounts for about 40 percent of the state's average annual water supply and nearly 60 percent in drought years. More than 80 percent of Californians depend on groundwater for some portion of their water supply. Many communities, particularly in rural areas of California's Central Valley, are 100 percent reliant on groundwater for all their water needs. Groundwater takes on even more importance in the face of California's new climate reality characterized by recurrent and prolonged droughts with the possibility of a reduction of up to 10% in the State's existing water supply by 2040.

During the current 2020-2022 drought, with no end yet in sight, more than 2,000 wells went dry leaving households and communities without water. Even during the 5-year period (2017-2022) that included two wet years (2017 and 2019), the data show that groundwater levels continue to decline. The practice of resorting to pumping groundwater to offset the shortage of surface water supplies is still prevalent as we have recorded about 26,000 new domestic wells and about 14,000 irrigation wells installed in the past 8 years.

Increasing reliance and overuse of groundwater in past decades, especially during recurrent and prolonged dry periods, have resulted in critical overdraft conditions in 21 basins that cover about one-fifth of the total groundwater basin area of the state and accounts for close to two-thirds of the state's average annual groundwater use. California's $50 billion agricultural economy is at risk. Recurrent droughts have stressed the environment of California with increasing losses and destruction of fish and wildlife habitat and lack of food and drinking water for wild animals. Groundwater quality degradation in many parts of California has put some of the state's most vulnerable populations at risk. The lowering of groundwater levels over the past decades has caused land subsidence, which has damaged and continues to impair critical infrastructure in several parts of the state. Some coastal aquifers have built safeguards, and will need more, against increased sea water intrusion from groundwater level declines and sea level rise. Stream depletions due to excessive groundwater pumping pose a serious threat to the state's goal of protection and enhancement of natural ecosystems.

Significant progress has been made by local agencies and the state towards ending these undesirable trends in groundwater after the passage of SGMA and subsequent development and implementation of the GSPs accompanied by data collection, reporting, and dissemination. Financial assistance provided by the state has accelerated our progress towards sustainability and resiliency. The technical assistance including data and tools provided by DWR and other state agencies has provided local agencies a new level of understanding, analyses, and decision making. Yet, we must acknowledge that data gaps exist, in terms of geographic coverage, frequency, and reporting lag, all of which hinder our ability to fully understand and report the current conditions of groundwater in a timely manner. There are areas in the state where little groundwater data is available. California's Groundwater Update 2020 Highlights documented 17 recommendations to advance data-driven decision making, which will fill many of these gaps when implemented.

Governor Newsom's Water Resilience Portfolio and California's Water Supply Strategy include multiple actions and recommendations aimed at sustainable and resilient management of groundwater resources. The onus is on both the State and local agencies to collaboratively work towards implementing the provisions of SGMA and the actions and recommendations identified in California's Groundwater Update 2020 Highlights, the Governor's Water Resilience Portfolio, and California's Water Supply Strategy. It should also be noted that increasing public awareness and understanding of the critical role of groundwater in meeting the total water needs of California, as well as the current statewide groundwater conditions, are essential for the success of all state and local regulations and plans. The publication of annual and semi-annual groundwater conditions reports and the 5-year updates of the California's Groundwater (Bulletin 118) is a major step towards achieving that end.