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# California Groundwater Conditions Update – Spring 2019

## Groundwater Levels Continue to Rebound from Last Drought

California's climate is the most variable of any state, historically swinging from dry to flood conditions with climate change intensifying these swings. Although three of the last four water years have been above normal with 2017 and 2019 standing out as some of the wettest on record, the last decade has had a majority of the years below normal precipitation and include the timeframe of the state's most recent drought.

The Department of Water Resource's (DWR) assessment of the state's water conditions is comprehensive and dynamic. Many factors are considered during the assessment including reservoir and groundwater levels. Reservoirs account for approximately 30 percent of California's water supply and groundwater provides an average of 40 percent, but in dry years groundwater can provide up to 60 percent. The remaining water sources are a combination of rainfall, snow pack, desalination, and water reuse.

It is easy to see high reservoir and river levels resulting from a season of heavy rain and snow fall, but groundwater levels can reflect a different hydrologic response throughout the state's 515 groundwater basins (Bulletin 118). Data on groundwater levels provides valuable information on seasonal fluctuations as well as long-term changes and trends in groundwater storage. Although water levels in shallow basins may respond quickly after a single season of heavy precipitation, deeper and more severely depleted groundwater basins may take years to recharge and recover.

The changes in groundwater levels in this report illustrate how groundwater storage changes over time based on hydrologic conditions. A one-year comparison of groundwater levels provides information about the short-term effects of a single wet or dry year, while a multi-year comparison of groundwater levels provides information about trends in groundwater storage. Groundwater is an important component of water budgets throughout the state because the snow pack varies from year-to-year and reservoir levels can also vary because they are used for both water storage and flood control.

However, these changes in groundwater levels are not only influenced by precipitation. There are many factors that ultimately influence groundwater conditions and groundwater levels. The water level data presented here does not distinguish the specific causes of changing groundwater levels, as this would require a more detailed analysis.

## Data Coverage

DWR has completed an evaluation of statewide groundwater level data reported in spring 2019 for California groundwater basins. Spring data corresponds to the time period immediately before the typical irrigation season begins in a region. This helps show groundwater levels before summer crop irrigation and other uses. In Central and Northern California, the pre-irrigation season is in March, while in Southern California, that season is typically earlier.

The Spring 2019 Groundwater Level Data Coverage map (**Figure 1**) shows a comparison between total spring 2019 reporting and typical reporting in previous years. Typical reporting includes wells with water level data submitted to DWR over the past five spring seasons (2015-2019) by CASGEM Monitoring Entities, other local agencies, and well owners. Although the reporting percentage is high and coverage is good, there are still gaps in spring 2019 coverage throughout the state, including portions of Tulare, Kern, San Bernardino, Riverside, and Imperial counties.

## By the Numbers

The Statewide Annual Precipitation chart (**Figure 2**) shows precipitation measured in inches, from 1970 to 2019 (NOAA, Climate at a Glance). Since 2009, there have been five below average water years, three average water years, and three above average water years. Following the 2012 to 2015 drought period, 2017 and 2019 were above average water years.

Groundwater Elevation Level Change Maps (**Figures 3-6**) show changes in groundwater levels over time. Groundwater level change data is shown only where a well has a measurement in both spring seasons from the selected time period. Points are represented by color and shape and depict a net increase, decrease, or relatively small change (-/+ 5 ft). **Table 1** summarizes the statistical review of these groundwater level changes.

The Spring 2018 to Spring 2019 Groundwater Level Change map and charts (**Figure 3**) and Spring 2016 to Spring 2019 Groundwater Level Change map and charts (**Figure 4**) show the one-year change and three-year change in statewide groundwater levels. These figures cover or follow a relatively wetter time period, with 2016, 2017, and 2019 at or above average precipitation years (**Figure 2).**

The one-year change map (**Figure 3**) shows that approximately 50 percent of the well measurements indicate net water level changes of +/- 5 feet. Twenty-five percent of the remaining statewide well measurements show an increase in water levels. Most of the groundwater level declines greater than 25 feet occurred in the Tulare Lake Hydrologic Region specifically in the San Joaquin Valley Subbasin.

The three- year change map (**Figure 4)** shows that approximately 65 percent of the well measurements indicate sustainable groundwater levels with net water level changes of +/- 5 feet. A cluster of well measurements show a decrease in groundwater levels greater than 25 feet along the eastern side of the San Joaquin groundwater basin within the San Joaquin River and Tulare Lake Hydrologic Regions. This group of decreased groundwater level measurements accounts for approximately six percent of the well measurements obtained within these Hydrologic Regions. The Sacramento Hydrologic region has notable groundwater level increases with 49 percent of the wells showing higher than five feet increases and with even higher increases in Yolo and Sutter counties.

The Spring 2014 to Spring 2019 Groundwater Level Change map and charts (**Figures 5**) and Spring 2009 to Spring 2019 Groundwater Level Change map and charts (**Figure 6**) depict a very different story for the five-year and 10-year changes in groundwater levels.

These figures illustrate how some groundwater basins may not have fully recovered to pre-drought conditions, specifically the San Joaquin, Tulare Lake, and South Coast Hydrologic Regions where 30 to 70 percent, respectively, of well measurements show a decrease in groundwater levels for both time periods. However, the five-year change map (**Figure 5**) does show groundwater increases in the Sacramento Hydrologic Region in Tehama, Yolo, and Sutter counties, as well as a net groundwater level increase throughout the San Francisco Bay Hydrologic Region.

## In Conclusion

Although Spring 2019 groundwater levels have mostly recovered from the past one to three years, they have not fully recovered to pre-drought conditions throughout the state as shown in the five- and 10-year time periods. At this time, there is insufficient data coverage to determine the long-term effects of the drought in some subbasins throughout the state; however, since CASGEM reporting requirements began in 2011, statewide data coverage has improved in most areas except for data gaps in Tulare, Kern, San Bernardino, Riverside, and Imperial counties.

Additional information and groundwater level change maps for the past time periods including one-, three-, five-, and 10-year groundwater level change maps, can be found on the DWR Groundwater Management Data Tools Website under the Mapping Tab. Geospatial datasets of this groundwater level data can be viewed and downloaded from the SGMA Data Viewer.

**Table 1:** Statistical Summary of Groundwater Level Change Maps (**Figures 3-6**)

| Period | Total Wells Compared | Decrease >25 ft | Decrease 5-25 ft | Change +/- 5 ft | Increase 5-25 ft | Increase >25 ft |
|---|---|---|---|---|---|---|
| **1 Year Change:** 2019 levels compared to 2018 levels | 5,576 | 1% | 8% | 65% | 22% | 3% |
| **3 Year Change:** 2019 levels compared to 2016 levels | 5,241 | 1% | 7% | 49% | 34% | 9% |
| **5 Year Change:** 2019 levels compared to 2014 levels | 4,946 | 5% | 17% | 41% | 31% | 6% |
| **10 Year Change:** 2019 levels compared to 2009 levels | 2,417 | 11% | 22% | 44% | 19% | 5% |

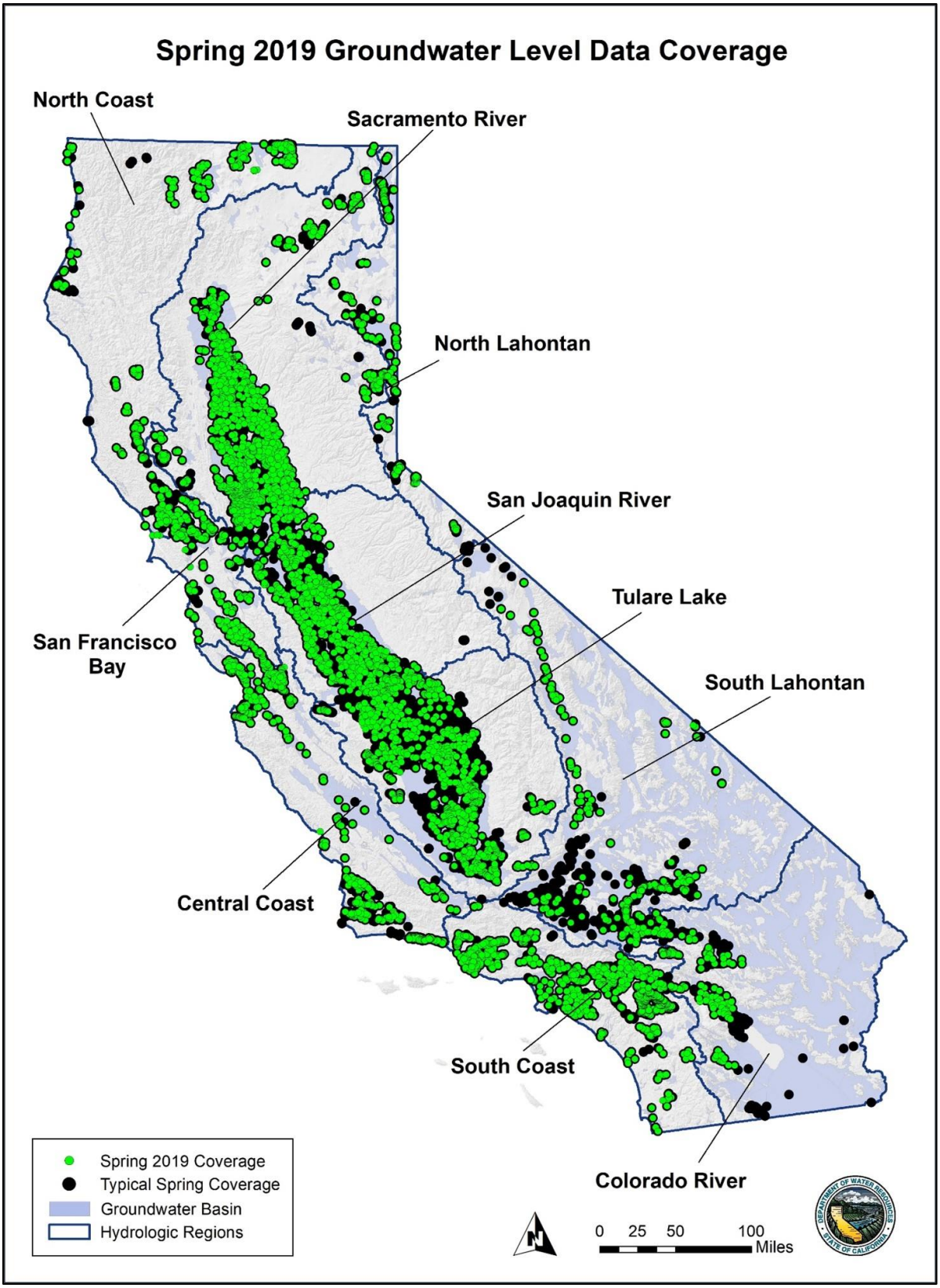


**Figure 1:** Well elevation data coverage for 2019 (green) compared to the past five years (black) throughout the different hydrologic regions of California. Map based on available data from DWR Water Data Library as of 8/15/2019.

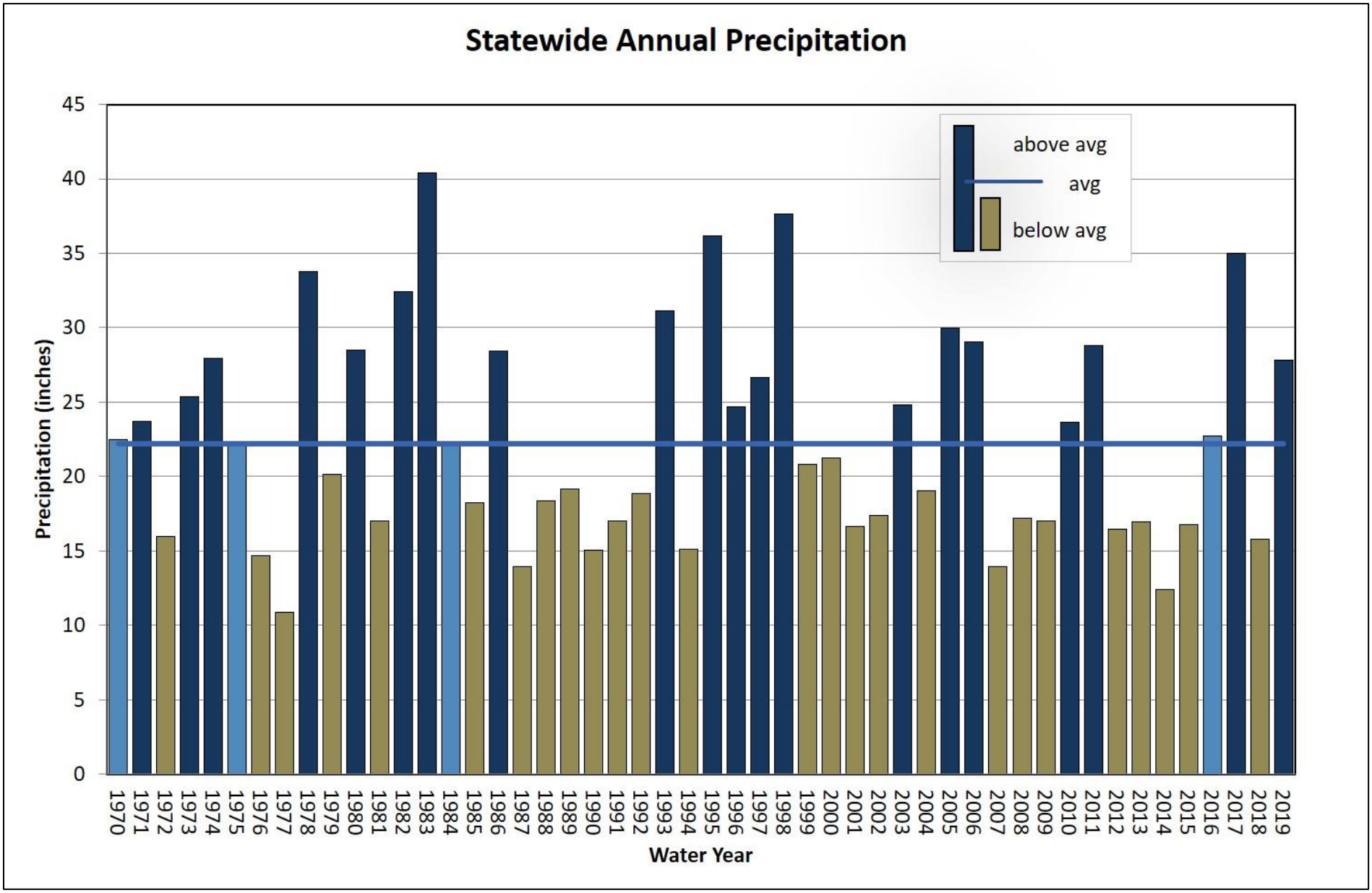


**Figure 2:** Statewide Annual Precipitation, tabular data of the chart can be found in Appendix A, Table 2 (Data Source: NOAA National Centers for Environmental Information, Climate at Glance: U.S. Time Series, Precipitation)

# Groundwater Level Change* - Spring 2018 to Spring 2019

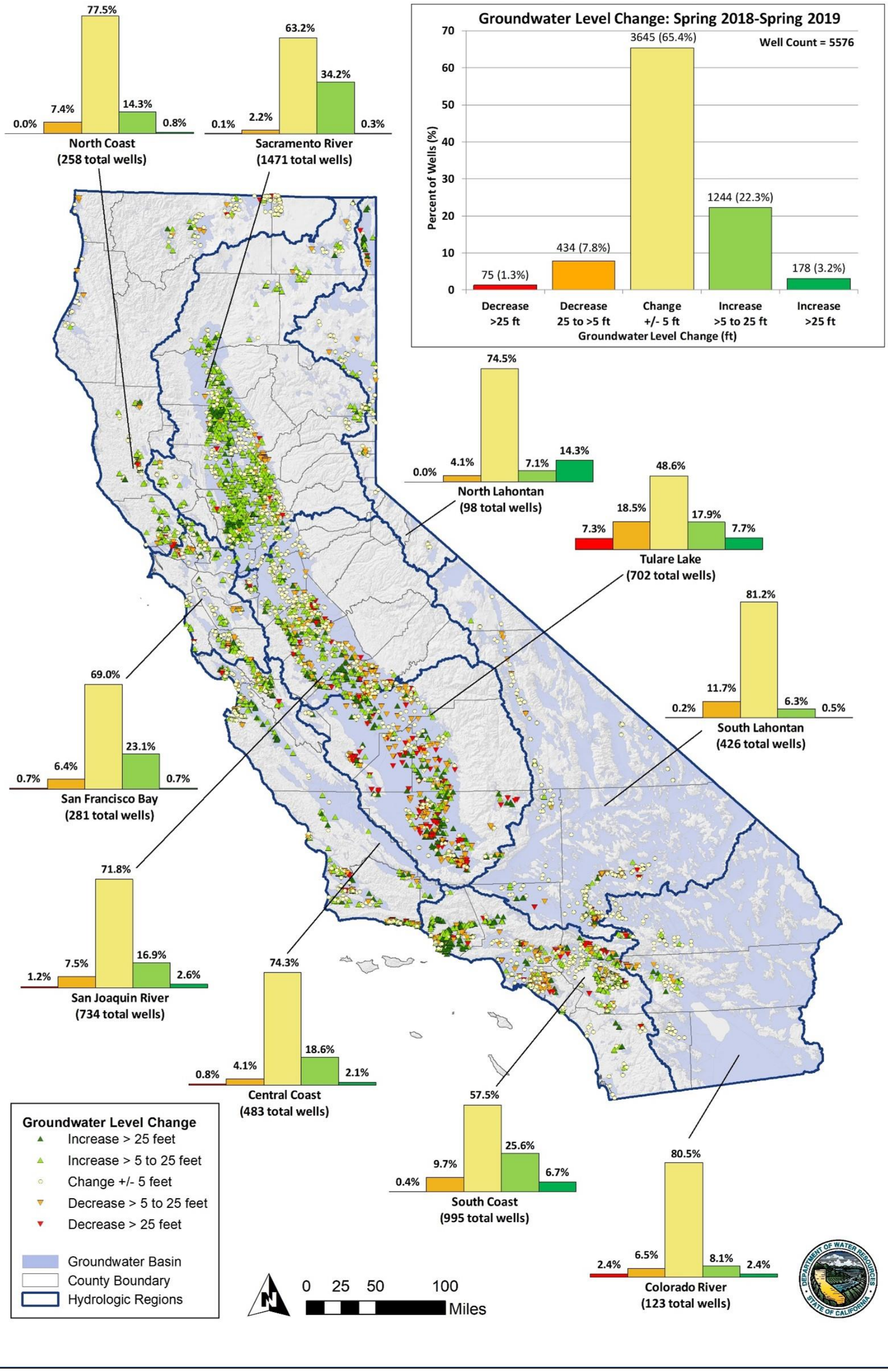


**Figure 3**: Groundwater level change map for 1-year period between 2018 and 2019. Tabular data of the chart can be found in Appendix B, Table 3. *Map and charts based on available data for the DWR Water Data Library as of 08/15/2019.

# Groundwater Level Change* - Spring 2016 to Spring 2019

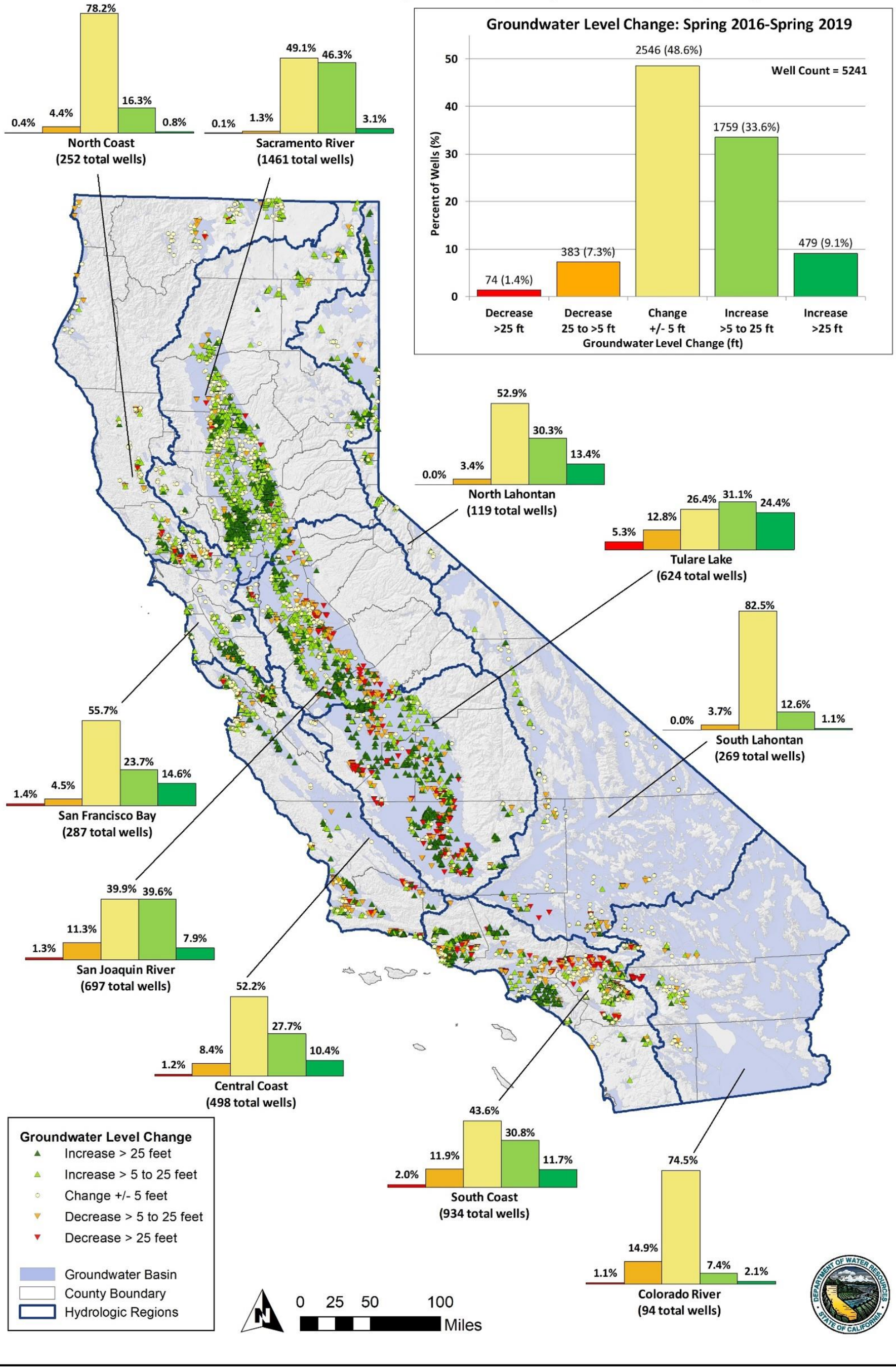


**Figure 4**: Groundwater level change map for 3-year period between 2016 and 2019. Tabular data of the chart can be found in Appendix B, Table 4. *Map and charts based on available data for the DWR Water Data Library as of 08/15/2019.

# Groundwater Level Change* - Spring 2014 to Spring 2019

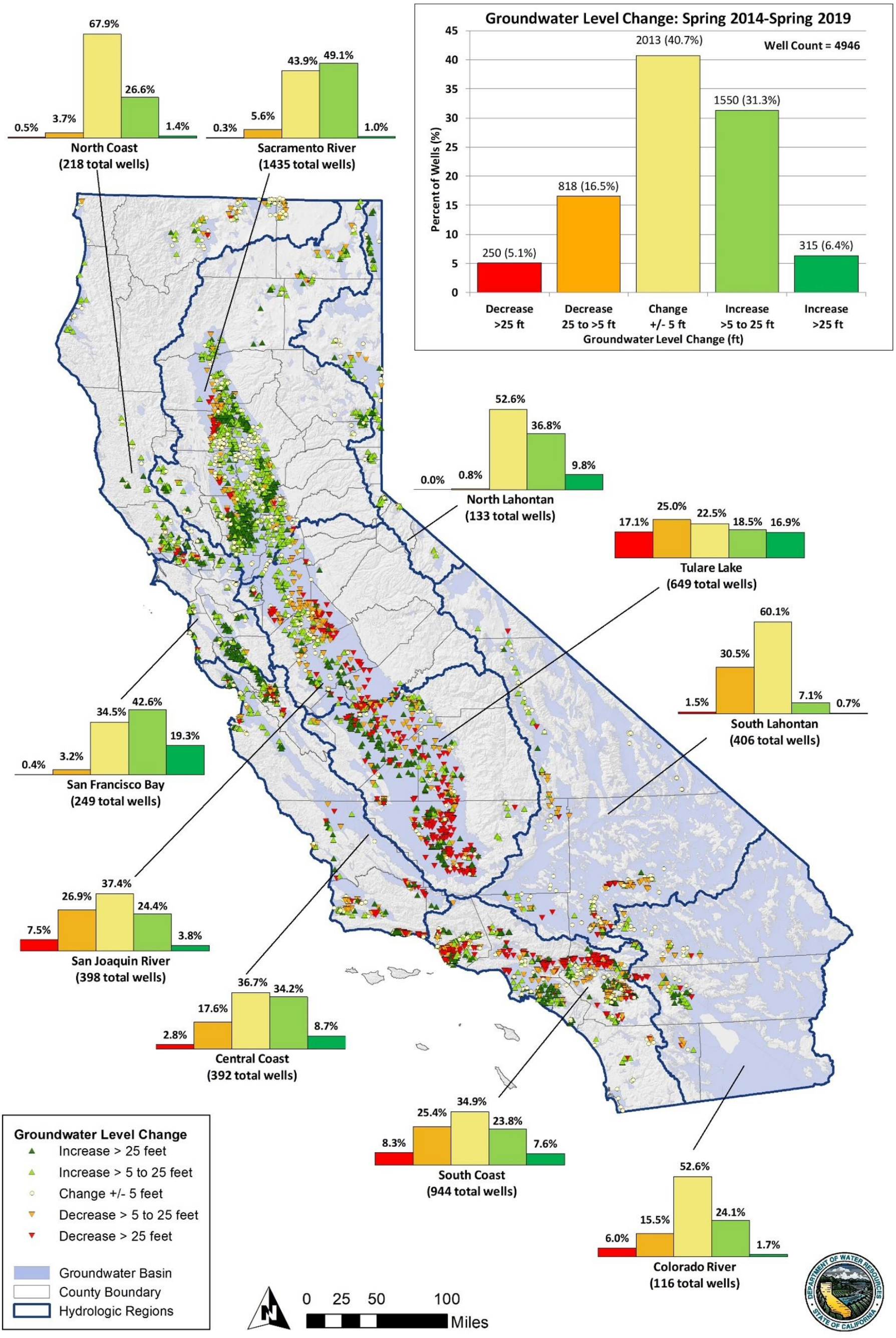


**Figure 5**: Groundwater level change map for 5-year period between 2014 and 2019. Tabular data of the chart can be found in Appendix B, Table 5. *Map and charts based on available data for the DWR Water Data Library as of 08/15/2019.

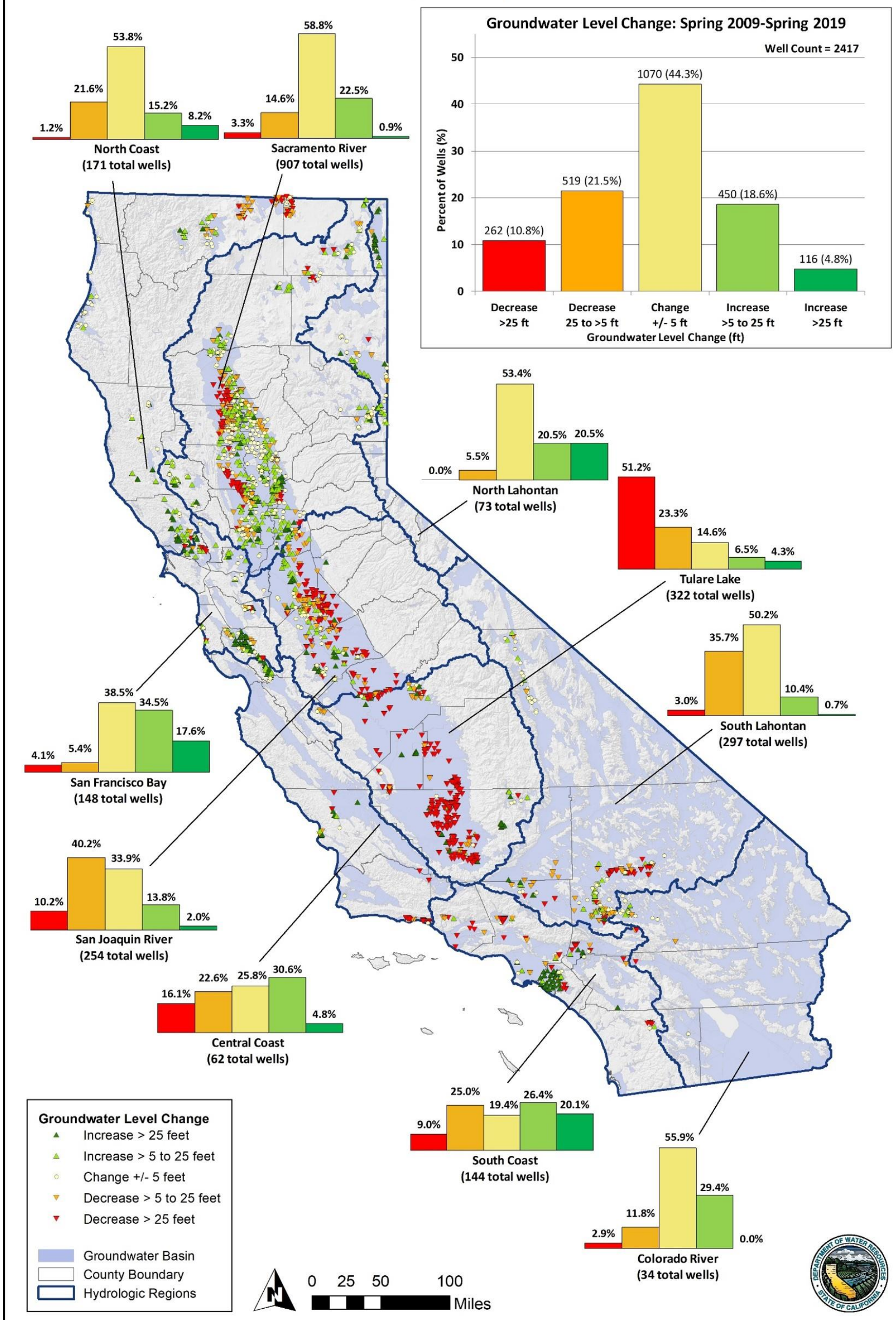


**Figure 6**: Groundwater level change map for 10-year period between 2009 and 2019. Tabular data of the chart can be found in Appendix B, Table 6. *Map and charts based on available data for the DWR Water Data Library as of 08/15/2019.

# Appendix A

## Tabular Data for Statewide Annual Precipitation

**Table 2:** Data Source: NOAA National Centers for Environmental Information, Climate at Glance: U.S. Time Series, Precipitation.

| Water Year | Precipitation (in) | Average (in) | Departure from the Mean |
|---|---|---|---|
| 1970 | 22.46 | 22.18 | 0.01 |
| 1971 | 23.72 | 22.18 | 1.27 |
| 1972 | 15.94 | 22.18 | -6.51 |
| 1973 | 25.37 | 22.18 | 2.92 |
| 1974 | 27.95 | 22.18 | 5.5 |
| 1975 | 22.06 | 22.18 | -0.39 |
| 1976 | 14.66 | 22.18 | -7.79 |
| 1977 | 10.86 | 22.18 | -11.59 |
| 1978 | 33.76 | 22.18 | 11.31 |
| 1979 | 20.12 | 22.18 | -2.33 |
| 1980 | 28.5 | 22.18 | 6.05 |
| 1981 | 17.01 | 22.18 | -5.44 |
| 1982 | 32.41 | 22.18 | 9.96 |
| 1983 | 40.41 | 22.18 | 17.96 |
| 1984 | 22.38 | 22.18 | -0.07 |
| 1985 | 18.24 | 22.18 | -4.21 |
| 1986 | 28.43 | 22.18 | 5.98 |
| 1987 | 13.97 | 22.18 | -8.48 |
| 1988 | 18.37 | 22.18 | -4.08 |
| 1989 | 19.19 | 22.18 | -3.26 |
| 1990 | 15.02 | 22.18 | -7.43 |
| 1991 | 17.03 | 22.18 | -5.42 |
| 1992 | 18.88 | 22.18 | -3.57 |
| 1993 | 31.14 | 22.18 | 8.69 |
| 1994 | 15.13 | 22.18 | -7.32 |
| 1995 | 36.18 | 22.18 | 13.73 |
| 1996 | 24.69 | 22.18 | 2.24 |
| 1997 | 26.62 | 22.18 | 4.17 |
| 1998 | 37.65 | 22.18 | 15.2 |
| 1999 | 20.82 | 22.18 | -1.63 |
| 2000 | 21.23 | 22.18 | -1.22 |
| 2001 | 16.67 | 22.18 | -5.78 |
| 2002 | 17.41 | 22.18 | -5.04 |
| 2003 | 24.8 | 22.18 | 2.35 |
| 2004 | 19.06 | 22.18 | -3.39 |

| Water Year | Precipitation (in) | Average (in) | Departure from the Mean |
|---|---|---|---|
| 2005 | 29.94 | 22.18 | 7.49 |
| 2006 | 29.02 | 22.18 | 6.57 |
| 2007 | 13.96 | 22.18 | -8.49 |
| 2008 | 17.22 | 22.18 | -5.23 |
| 2009 | 17 | 22.18 | -5.45 |
| 2010 | 23.66 | 22.18 | 1.21 |
| 2011 | 28.82 | 22.18 | 6.37 |
| 2012 | 16.44 | 22.18 | -6.01 |
| 2013 | 16.95 | 22.18 | -5.5 |
| 2014 | 12.39 | 22.18 | -10.06 |
| 2015 | 16.78 | 22.18 | -5.67 |
| 2016 | 22.72 | 22.18 | 0.27 |
| 2017 | 35.02 | 22.18 | 12.57 |
| 2018 | 15.81 | 22.18 | -6.64 |
| 2019 | 27.81 | 22.18 | 5.63 |

# Appendix B

## Tabular Data and detailed description for Groundwater Level Change Map

**Table 3:** Groundwater Level Change Data for Spring 2018-2019 for Figure 3

| Hydrologic Region | Total Well Count | Decrease > 25 feet | Decrease 5 to 25 feet | Change +/- 5 feet | Increase 5 to 25 feet | Increase >25 feet |
|---|---|---|---|---|---|---|
| North Coast | 258 | 0.0% | 7.4% | 77.5% | 14.3% | 0.8% |
| San Francisco Bay | 281 | 0.7% | 6.4% | 69.0% | 23.1% | 0.7% |
| Central Coast | 483 | 0.8% | 4.1% | 74.3% | 18.6% | 2.1% |
| South Coast | 995 | 0.4% | 9.7% | 57.5% | 25.6% | 6.7% |
| Sacramento River | 1471 | 0.1% | 2.2% | 63.2% | 34.2% | 0.3% |
| San Joaquin River | 734 | 1.2% | 7.5% | 71.8% | 16.9% | 2.6% |
| Tulare Lake | 702 | 7.3% | 18.5% | 48.6% | 17.9% | 7.7% |
| North Lahontan | 98 | 0.0% | 4.1% | 74.5% | 7.1% | 14.3% |
| South Lahontan | 426 | 0.2% | 11.7% | 81.2% | 6.3% | 0.5% |
| Colorado River | 123 | 2.4% | 6.5% | 80.5% | 8.1% | 2.4% |
| Statewide | 5576 | 1.3% | 7.8% | 65.4% | 22.3% | 3.2% |

**Table 4:** Groundwater Level Change Data for Spring 2016-2019 for Figure 4

| Hydrologic Region | Total Well Count | Decrease > 25 feet | Decrease 5 to 25 feet | Change +/- 5 feet | Increase 5 to 25 feet | Increase >25 feet |
|---|---|---|---|---|---|---|
| North Coast | 252 | 0.4% | 4.4% | 78.2% | 16.3% | 0.8% |
| San Francisco Bay | 287 | 1.4% | 4.5% | 55.7% | 23.7% | 14.6% |
| Central Coast | 498 | 1.2% | 8.4% | 52.2% | 27.7% | 10.4% |
| South Coast | 934 | 2.0% | 11.9% | 43.6% | 30.8% | 11.7% |
| Sacramento River | 1461 | 0.1% | 1.3% | 49.1% | 46.3% | 3.1% |
| San Joaquin River | 697 | 1.3% | 11.3% | 39.9% | 39.6% | 7.9% |
| Tulare Lake | 624 | 5.3% | 12.8% | 26.4% | 31.1% | 24.4% |
| North Lahontan | 119 | 0.0% | 3.4% | 52.9% | 30.3% | 13.4% |
| South Lahontan | 269 | 0.0% | 3.7% | 82.5% | 12.6% | 1.1% |
| Colorado River | 94 | 1.1% | 14.9% | 74.5% | 7.4% | 2.1% |
| Statewide | 5241 | 1.4% | 7.3% | 48.6% | 33.6% | 9.1% |

**Table 5:** Groundwater Level Change Data for Spring 2014-2019 for Figure 5

| Hydrologic Region | Total Well Count | Decrease > 25 feet | Decrease 5 to 25 feet | Change +/- 5 feet | Increase 5 to 25 feet | Increase >25 feet |
|---|---|---|---|---|---|---|
| North Coast | 218 | 0.5% | 3.7% | 67.9% | 26.6% | 1.4% |
| San Francisco Bay | 249 | 0.4% | 3.2% | 34.5% | 42.6% | 19.3% |
| Central Coast | 392 | 2.8% | 17.6% | 36.7% | 34.2% | 8.7% |
| South Coast | 944 | 8.3% | 25.4% | 34.9% | 23.8% | 7.6% |
| Sacramento River | 1435 | 0.3% | 5.6% | 43.9% | 49.1% | 1.0% |
| San Joaquin River | 398 | 7.5% | 26.9% | 37.4% | 24.4% | 3.8% |
| Tulare Lake | 649 | 17.1% | 25.0% | 22.5% | 18.5% | 16.9% |
| North Lahontan | 133 | 0.0% | 0.8% | 52.6% | 36.8% | 9.8% |
| South Lahontan | 406 | 1.5% | 30.5% | 60.1% | 7.1% | 0.7% |
| Colorado River | 116 | 6.0% | 15.5% | 52.6% | 24.1% | 1.7% |
| Statewide | 4946 | 5.1% | 16.5% | 40.7% | 31.3% | 6.4% |

**Table 6:** Groundwater Level Change Data for Spring 2009-2019 for Figure 6

| Hydrologic Region | Total Well Count | Decrease > 25 feet | Decrease 5 to 25 feet | Change +/- 5 feet | Increase 5 to 25 feet | Increase >25 feet |
|---|---|---|---|---|---|---|
| North Coast | 171 | 1.2% | 21.6% | 53.8% | 15.2% | 8.2% |
| San Francisco Bay | 148 | 4.1% | 5.4% | 38.5% | 34.5% | 17.6% |
| Central Coast | 62 | 16.1% | 22.6% | 25.8% | 30.6% | 4.8% |
| South Coast | 144 | 9.0% | 25.0% | 19.4% | 26.4% | 20.1% |
| Sacramento River | 907 | 3.3% | 14.6% | 58.8% | 22.5% | 0.9% |
| San Joaquin River | 254 | 10.2% | 40.2% | 33.9% | 13.8% | 2.0% |
| Tulare Lake | 322 | 51.2% | 23.3% | 14.6% | 6.5% | 4.3% |
| North Lahontan | 73 | 0.0% | 5.5% | 53.4% | 20.5% | 20.5% |
| South Lahontan | 297 | 3.0% | 35.7% | 50.2% | 10.4% | 0.7% |
| Colorado River | 34 | 2.9% | 11.8% | 55.9% | 29.4% | 0.0% |
| Statewide | 2417 | 10.8% | 21.5% | 44.3% | 18.6% | 4.8% |