8 CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

§ 354.16. Groundwater Conditions
Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:

☑ **23 CCR § 354.16**

This section presents information on current and historical groundwater conditions within the Delta-Mendota Subbasin (Basin) based on available data for the following parameters: groundwater elevations, groundwater storage, groundwater quality, land subsidence, interconnected surface waters (ISW), and groundwater dependent ecosystems (GDEs). For the purposes of this assessment, "current conditions" refers to Basin conditions documented in Water Year (WY) 2023, as described in the *WY 2023 Annual Report* (Delta-Mendota GSAs, 2024)

For "historical conditions", two periods are relevant. The first considers available data through December 2014, which is considered the historical, pre-Sustainable Groundwater Management Act ("pre-SGMA") period. This period includes data collected prior to the implementation of the Sustainable Groundwater Management Act (SGMA) on January 1, 2015[30], and constitutes a baseline condition for the Basin. The second period of interest is from January 2015 through WY 2023, which represents recent or "post-SGMA" conditions. In some cases, certain other historical periods are also discussed in this section when the discussion is constrained by the time periods of available datasets or when the groundwater conditions characterization is improved by the incorporation of data from other time periods.

The Hydrogeologic Conceptual Model (HCM; **Section 7**) identifies two principal aquifers in the Basin: an "Upper" semi-confined aquifer located above the Corcoran Clay, and a "Lower" confined aquifer situated below the Corcoran Clay. Consistent with the HCM, this section presents data and information to characterize conditions in both the Upper Aquifer and the Lower Aquifer.

8.1 Data Sources and Compilation

§ 352.6. Data Management System
Each Agency shall develop and maintain a data management system that is capable of
storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.

☑ **23 CCR § 352.6**

In accordance with Title 23 of the California Code of Regulations (23 CCR) § 352.6, the Basin has developed a Data Management System (DMS) to serve as a central repository for monitoring data across the Basin.

[30] Groundwater elevations (**Section 8.2**) are typically reported to the California Department of Water Resources (DWR) as seasonal highs and lows for each WY, and the change in storage (**Section 8.3**) is estimated by WY using Central Valley Hydrologic Model 2 (CVHM2); therefore WY 2015 was used as the beginning of the post-SGMA period to characterize groundwater elevations and trends and change in storage. Additionally, DWR began collecting Interferometric Synthetic Aperture Radar (InSAR) data in June 2015 as part of SGMA technical assistance; therefore, June 2015 is used as the beginning of the post-SGMA period in **Section 8.6**. In **Section 8.8**, the assessment of changes in GDE coverage relies on data from The Nature Conservancy's (TNC's) GDE Pulse raster dataset, which spans from 2013 to 2022. This duration is identified as the "post-SGMA" era for evaluating alterations in GDE coverage.

The DMS contains data from each monitoring site in tabular and graphical formats collected by the Groundwater Sustainability Agencies (GSA) within the Basin. Data stored in the DMS include groundwater elevations, surface water elevations, land surface elevations, and groundwater quality results. Information pertaining to each SGMA representative monitoring site (RMS), including the site identifier, location, and well completion information (if applicable), is stored with the DMS and can be displayed through a Geographic Information System (GIS). The DMS will continue to be updated as new data are collected.

Additionally, publicly available datasets reviewed and assessed as part of the development and implementation of this Groundwater Sustainability Plan (GSP) include the following and are further described in **Section 5.2.1**:

- Land use and cropping information from the California Department of Water Resources' (DWR) Provisional 2021 Statewide Crop Mapping GIS shapefile (DWR, 2023f);
- Land categorization information from the California Conservation Easement and Protected Areas databases (GreenInfo Network, 2023a, 2023b);
- Point source locations from the State Water Resources Control Board (SWRCB) GeoTracker dataset (SWRCB, 2023b);
- Raw groundwater quality information from the SWRCB Safe Drinking Water Information System (SWRCB, 2023a);
- Groundwater quality data from the SWRCB and United States Geologic Survey (USGS) Groundwater Ambient Monitoring and Assessment (GAMA) Groundwater Information System (SWRCB & USGS, 2023);
- Groundwater level data from the DWR's California Statewide Groundwater Elevation Monitoring program (CASGEM) (DWR, 2023d);
- Water quality data from the Comprehensive Groundwater Quality Management Plan (CGQMP), as part of the Central Valley Regional Water Quality Control Board (CVRWQCB) long-term Irrigated Lands Regulatory Program (ILRP);
- Water quality information from Central Valley-Salinity Alternatives for Long-term Sustainability (CV-SALTS);
- Well information from the DWR Online System for Well Completion Reports (DWR, 2023e);
- Subsidence data from TRE ALTAMIRA Interferometric Synthetic Aperture Radar (InSAR) (DWR, 2023g);
- Subsidence data from USGS Central Valley Extensometer Data (USGS, 2023a);
- Subsidence data from the University Navstar Consortium (UNAVCO) Continuous Global Positioning System (CGPS) (EarthScope Consortium, 2023);
- InSAR data from the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) (NASA JPL; DWR & NASA JPL, 2021);
- Subsidence data from extensometers collected by the DWR;

- Subsidence data from the United States Bureau of Reclamation (USBR) subsidence benchmarks along the San Joaquin River;
- Subsidence and surface water flow data from the San Joaquin River Restoration Program (SJRRP);
- Light detection and ranging (LIDAR) data from the DWR and USGS;
- Subsidence data from the DWR's California Aqueduct Subsidence Program (CASP);
- Surface water monitoring data from the USGS National Water Information System (NWIS);
- Surface water and precipitation monitoring data from the DWR California Data Exchange Center (CDEC);
- Surface water diversion data from the SWRCB Electronic Water Rights Information Management System (eWRIMS);
- Precipitation data from the DWR's California Irrigation Management Information System (CIMIS); and
- The Nature Conservancy's (TNC's) GDE Pulse Interactive Map.

8.2 Groundwater Elevations and Flow Direction

§ 354.16. Groundwater Conditions
(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:
(1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

☑ **23 CCR § 354.16(a)**

This section describes groundwater elevation conditions in the Basin, including gradients, flow directions, and trends. The discussion covers historical (1950-2014), post-SGMA (2015-2023), and current (WY 2023) conditions, the role of imported surface water in the Basin, and how conjunctive use has impacted groundwater trends temporally and spatially. Groundwater elevation contour maps associated with seasonal high and seasonal low groundwater elevations for each principal aquifer, as well as hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients, are included and discussed.

8.2.1 Groundwater Elevation Contour Maps

☑ **23 CCR § 354.16(a)(1)**

8.2.1.1 Pre-SGMA Groundwater Elevations (Early 1900s – WY 2014)

In its natural, pre-development state, groundwater flow directions in the Upper and Lower Aquifer systems of the western San Joaquin Valley were primarily to the northeast, running from the Coast Range towards the San Joaquin River and the Sacramento-San Joaquin Delta. This pre-development groundwater flow direction is supported by various sources (Hotchkiss & Balding, 1971; LSCE et al., 2015; SLDMWA, 2015).

Around the turn of the 20^{th} century, the Lower Aquifer exhibited artesian conditions, with numerous flowing artesian wells across the Basin (Mendenhall et al., 1916). The pressure differences driving these artesian conditions created an upwards gradient from the Lower Aquifer to the Upper Aquifer. However, with the advent and widespread adoption of turbine pumps in the early 1900s, groundwater pumping in the Central Valley, and particularly from the Tulare Formation, increased substantially, causing the lowering of groundwater levels and reduction in the occurrence of artesian conditions (Hotchkiss & Balding, 1971). By the latter half of the century, the Basin had undergone periods of significant groundwater level declines resulting in substantial decreases in hydraulic heads within the Lower Aquifer in some regions, primarily due to intensive pumping (Bertoldi et al., 1991).

Despite the localized pumping depressions within certain parts of the Basin, the predominant northeastward groundwater flow direction within the Upper Aquifer has persisted (AECOM, 2011; DWR, 2010). In general, groundwater flows outward from the Basin towards groundwater elevation lows in the neighboring Madera and Chowchilla Subbasins, except along the southern and western boundaries where there is some recharge from local streams and canal seepage (SLDMWA, 2015) and as well as northward Basin boundary inflows. Groundwater in the Upper Aquifer generally flows to the northeast towards the San Joaquin River during wet and normal periods. One notable exception is in the Orestimba Creek area, west of Newman, where groundwater flows west during drought conditions and east during wet periods (CCID, 1997; SJREC, 1997). Calculations based on aquifer transmissivity indicate that the net groundwater outflow in the Upper Aquifer has been approximately three times greater during drought periods compared to normal periods (CCID, 1997; SJREC, 1997).

8.2.1.2 Post-SGMA Groundwater Elevations (WY 2015 – WY 2023)

This section presents groundwater elevation contours for seasonal high and seasonal low conditions in each principal aquifer in WY 2015 and WY 2023, representing conditions at the inception of the SGMA and current conditions, respectively. Consistent with the Basin's Annual Reports (Delta-Mendota GSAs, 2023, 2022b, 2021, 2020), the seasonal high is defined by groundwater level measurement recorded between February and April, and the seasonal low is defined by groundwater level measurement recorded in September or October.

WY 2015 Groundwater Elevations

Figure GWC-2 and **Figure GWC-3** present contour maps of groundwater elevations for the 2015 seasonal high and seasonal low, respectively, for the Upper Aquifer. During 2015 seasonal high conditions, groundwater elevations ranged from approximately 30 feet above mean sea level (ft msl) to 220 ft msl throughout the Basin (**Figure GWC-2**). Groundwater flow in the Upper Aquifer during the 2015 seasonal high was primarily towards the San Joaquin River with a moderate northeastern gradient in areas north of the City of Firebaugh and a slightly steeper, predominately eastern gradient south of Firebaugh towards groundwater elevation lows in the neighboring Madera Subbasin. During 2015 seasonal low conditions, groundwater elevations ranged from about -30 ft msl to 240 ft msl throughout the Basin (**Figure GWC-3**). Several cones of depression were evident northwest of the City of Patterson, north of the City of Los Banos, south of the City of Dos Palos, and northeast of the City of Mendota. Groundwater highs were primarily on the western edge of the Basin and between the Cities of Firebaugh and Mendota.

Figure GWC-4 and **Figure GWC-5** present contour maps of groundwater elevations for the 2015 seasonal high and seasonal low, respectively, for the Lower Aquifer. Fewer data are available for the Lower Aquifer than for the Upper Aquifer; thus, detailed contouring is not possible in all parts of the Basin. During 2015 seasonal high conditions, groundwater elevations in the Lower Aquifer ranged from about -80 ft msl to 70 ft msl (**Figure GWC-4**). During 2015 seasonal low conditions, groundwater elevations ranged from about -160 ft msl to 50 ft msl in most of the Basin (**Figure GWC-5**). Groundwater elevations in the Lower Aquifer tend to be higher in the north than the south and highest in the central portion of the Basin, with an apparent groundwater divide (a change in groundwater flow direction) near the central portions of the SJREC GSA Group, where groundwater levels were above 40 ft msl in both seasons. In 2015, the gradients to the south of the divide dipped steeply to the southwest towards the Westside Subbasin, while the gradients on the north side of the divide were shallower and in a northerly direction. However, sparse groundwater level data from the Lower Aquifer in the northern Grassland and SJREC GSA Group areas makes determination of exact gradients uncertain.

WY 2023 Groundwater Elevations

Figure GWC-6 and **Figure GWC-7** present contour maps of groundwater elevations for WY2023 seasonal high (February to April 2023) and seasonal low (September to October 2022), respectively, for the Upper Aquifer, as presented in the *WY 2023 Annual Report*. During WY2023 seasonal high conditions, groundwater elevations ranged from about 10 ft msl to 130 ft msl throughout the Subbasin (**Figure GWC-6**). Groundwater generally flowed in the north to northeast direction throughout the Subbasin; however, groundwater flowed in the southeast direction along the southern boundary towards the Kings Subbasin. During WY2023 seasonal low conditions, groundwater elevations again ranged from about -10 ft msl to 130 ft msl with similar flow direction patterns as observed during seasonal high conditions in the Subbasin (**Figure GWC-7**). Differences in groundwater elevations in the Upper Aquifer between seasonal high and seasonal low conditions during WY2023 can likely be attributed to consecutive Dry (WY2020) and Shasta Critical (WY2021 and WY2022) water years prior to and during the seasonal low period of September and October 2022, resulting in increased groundwater pumping. Initial groundwater level recovery during the seasonal high period of February through April 2023 occurred following precipitation and recharge after wet conditions in the winter of 2023 (Delta-Mendota GSAs, 2024).

Figure GWC-8 and **Figure GWC-9** present contour maps for groundwater elevations for WY2023 seasonal high (February to April 2023) and seasonal low (September to October 2022), respectively, for the Lower Aquifer, as presented in the *WY 2023 Annual Report*. A great majority of wells perforated in the Lower Aquifer with groundwater level measurements during WY2023 seasonal high and seasonal low conditions are located within the Northern & Central Delta-Mendota Region and in the southern portion of the Subbasin around the Fresno County Management Areas A and B GSP region and Tranquillity Irrigation District area.

During WY2023 seasonal high conditions, groundwater elevations in the Lower Aquifer ranged from about -80 ft msl to 100 ft msl (**Figure GWC-8**). During WY2023 seasonal low conditions, groundwater elevations ranged from -150 ft msl to 100 ft msl (**Figure GWC-9**). The large range in groundwater elevations are due to a combination of Lower Aquifer elevations (high in the west along the Coastal Range and lower to the east near the Valley floor) and pumping. Groundwater flow patterns Subbasin-wide in the Lower Aquifer are generally to the north and northeastern direction in the northern portion of the Subbasin, and generally to the south direction towards the Westside and Kings Subbasins in the southern portion of the

Subbasin. Similar to the Upper Aquifer, differences in groundwater elevations between seasonal high and seasonal low conditions during WY2023 can likely be attributed to consecutive Dry (WY2020) and Shasta Critical (WY2021 and WY2022) water years prior to and during the seasonal low period of September and October 2022, resulting in increased groundwater pumping. Initial groundwater level recovery occurred during the seasonal high period of February through April 2023 following precipitation and recharge after the wet conditions in the winter of 2023 (Delta-Mendota GSAs, 2024).

8.2.2 Efforts to Address Impacts to Beneficial Users

Declining groundwater elevations can lead to dewatering in shallow wells. DWR, in coordination with the SWRCB, has developed the California's Groundwater Live dashboard that contains information about reported dry domestic well within groundwater basins in California. Since 2015, 21 of the 2,177 drinking water wells (**Section 5.1.5**) within the Basin have been reported as dry to DWR, or less than 1 percent any given year. Based on data from the counties, only 37 well permits have been requested for well replacement since 2015, not all of which were for drinking water wells. This generally corroborates the reported dry well values. Based on the number of reported dry wells by water year over time, the years with the most dewatered wells occur in the year immediately following extreme droughts, such as 2015. Impacts to individual wells that may occur due to declining groundwater conditions will be addressed through the Basin-wide Well Mitigation Policy (see **Section 16.1**).

8.2.3 Gradients

☑ **23 CCR § 354.16(a)**

8.2.3.1 Lateral Gradients

Lateral gradients are discussed above in the context of the groundwater elevation contour maps (see **Section 8.2.1**). The groundwater gradient in the Upper Aquifer was generally from south or southwest to north or northeast and ranged from 10 to 30 feet per mile. Groundwater flow in the Lower Aquifer was generally similar to the flow in the Upper Aquifer, generally to the north and northeastern direction, with a gradient ranging from 6 to 20 feet per mile.

8.2.3.2 Vertical Gradients

In the majority of the Basin, groundwater levels are higher in the Upper Aquifer than in the Lower Aquifer, and the vertical gradient between the two aquifers is generally downwards (SJREC GSA, 2022). Downwards gradients are greatest in areas where the Lower Aquifer is actively used as a water supply (lowering the potentiometric head in that zone). The vertical gradients are subject to fluctuations due to varying pumping rates and irrigation practices over time (Bertoldi et al., 1991).

Throughout most of the Basin, the Corcoran Clay layer acts as a regional aquitard, limiting the vertical migration of groundwater between the Upper and Lower Aquifers. Periods of substantial declines in groundwater levels have also led to the inelastic compaction of fine-grained materials in certain areas, especially between the Cities of Los Banos and Mendota. This compaction has potentially caused significant reductions (ranging from 1.5 to 6 times) in the permeability of clay layers within the Tulare Formation, including the Corcoran Clay (Bertoldi et al., 1991). In areas outside the Corcoran Clay layer (along the western margin of the Basin), localized interfingered clays minimize the downward migration of groundwater, although in areas where the clay layers do not exist or are not competent, groundwater migrates from shallower to deeper groundwater zones. Similarly, in areas where the Corcoran Clay's natural barrier effect has been compromised (i.e., due to many wells constructed across the clay), the wells may be facilitating vertical hydraulic connection across the Corcoran Clay aquitard and other clay layers, allowing groundwater to flow from the Upper Aquifer to the Lower Aquifer under the prevailing downwards gradients.

Vertical gradients were evaluated by comparing measurements taken in the same season for pairs of wells located within one mile of each other where one well is screened in the Upper Aquifer and one well is screened in the Lower Aquifer. **Figure GWC-1** shows the vertical gradients of 7 pairs of wells distributed across the Basin, one pair in the northern Basin, four pairs in the central Basin and two pairs in the southern Basin. The magnitude of vertical gradients between the two aquifers within the Basin ranges from approximately 0.2 to 0.8 (feet [ft]/ft) in the downward direction and displays a strong seasonality. The seasonality is controlled by the aquifer that locally exhibits a larger annual range in groundwater elevations. Larger gradients tend to correspond with seasonal high-water levels in the Upper Aquifer, although in two well pairs (DMS 6-001/6-002 and DMS 14-025/14-026), the largest gradients correspond with seasonal low water levels in the Lower Aquifer. Several well pairs display a shift in gradients around 2017, with three well pairs exhibiting generally larger downward gradients after 2017 (largely due to increased water levels in the Upper Aquifer), and two well pairs exhibiting generally smaller downward gradients.

8.2.4 Long-Term Groundwater Elevation Trends

☑ **23 CCR § 354.16(a)(2)**

Long-term trends in groundwater elevations were evaluated based on examination of historical groundwater level data for the Basin's 108 Representative Monitoring Wells for Chronic Lowering of Groundwater Levels (RMW-WLs; 60 in the Upper Aquifer and 48 in the Lower Aquifer) (**Table GWC-1**). Trends in groundwater levels were characterized using linear regression (recognizing that this method can be slightly biased by the data's temporal frequency and distribution) for all RMW-WLs with available data to determine whether the data exhibit significant upward (increasing) or downward (decreasing) trends with time. For the purpose of this analysis, a trend identified from the linear regression was considered significant when its p-value was less than or equal to 0.05 and the slope was greater than +/- 0.1 feet per year (ft/yr).

Groundwater level trends and hydrographs for ten RMW-WLs (five in the Upper Aquifer and five in the Lower Aquifer) are shown on **Figure GWC-10** through **Figure GWC-13**. The hydrographs shown on these figures were selected based on their length of record, their distribution throughout the Basin, and their representativeness of conditions in their area. Hydrographs were developed for the historical time period 1950 through 2023, which captures the earliest available data and the completion of the Delta-Mendota Canal in 1951 as illustrated in **Figure GWC-10** and **Figure GWC-11**, and the more recent period from 2015 through 2023, which captures recent groundwater level trends during the SGMA implementation period as illustrated in **Figure GWC-12** and **Figure GWC-13**.

8.2.4.1 Pre-SGMA Groundwater Elevation Trends (Early 1800s - WY 2014)

Figure GWC-10 and **Figure GWC-11** show five RMW-WLs hydrographs across the Basin in the Upper and Lower Aquifer respectively and the groundwater elevation trend over the pre-SGMA period for each

RMW-WL in the Basin. Over the pre-SGMA period, groundwater levels generally declined in the southern and central portions of the Basin, while more long-term stability or increasing groundwater levels occurred in the northern portion of the Basin. Of the 36 RMW-WLs in the Upper Aquifer with groundwater elevation records during the pre-SGMA period, 23 (63.9 percent) showed statistically significant decreasing trends, one (2.8 percent) showed a statistically significant increasing trend, and 12 (33.3 percent) showed stable groundwater levels (i.e., no significant trend) (**Figure GWC-10**).

Of the 20 RMW-WLs in the Lower Aquifer with groundwater elevation records during the pre-SGMA period, nine (45.0 percent) showed statistically significant decreasing trends, three (15.0 percent) showed statistically significant increasing trends, and eight (40.0 percent) showed stable groundwater levels (i.e., no significant trend) (**Figure GWC-11**).

Prior to Imported Water Deliveries (1850-1950s)

Prior to 1850, the majority of agriculture and development in the San Joaquin Valley consisted of rain-fed grain and cattle production, with irrigated agricultural development beginning sporadically during this time via river (primarily San Joaquin River) and perennial stream diversions (SWRCB, 2011). Construction of the railroad through the San Joaquin Valley from 1869 through 1875 made markets in larger coastal cities more accessible to valley farmers, increasing demand for more extensive agriculture. Significant irrigation sourced from surface water and resulting agricultural production began in the western side of the San Joaquin Valley in 1872 when the San Joaquin River was diverted through the Miller and Lux canal system west of Fresno (DWR, 1965). By the 1890s and early 1900s, sizable areas of the southern San Joaquin Valley had to be taken out of production due to salt accumulation and shallow water tables. Much of this land lay idle until the 1920s when development of reliable electric pumps and the energy to power them accelerated the expansion of irrigated agriculture with the availability of vast groundwater resources. The resultant groundwater pumping lowered the water table in many areas (San Joaquin Valley Drainage Program, 1988; SWRCB, 1977) and allowed for the leaching of salts that had accumulated in the soil, particularly near the valley trough and western side of the valley. Groundwater pumping for irrigation from around 1920 to 1950 drew the water table down as much as 200 feet in areas along the westside of the San Joaquin River (K. R. Belitz & Heimes, 1990). Declining water tables were causing higher pumping costs and land subsidence, and farmers were finding poorer quality water as water tables continued to decline. These issues sparked interest in the development of new imported surface water supplies, leading to the construction of the Central Valley Project (CVP) (Delta-Mendota GSAs, 2022a).

Post-Imported Water Deliveries (1950s-2012)

Surface water deliveries from the CVP via the Delta-Mendota Canal (DMC) began in the early 1950s, and from the State Water Project (SWP) via the California Aqueduct in the early 1970s (Sneed et al., 2013). The CVP is the primary source of imported surface water in the Basin, with CVP supplies used directly by nine Basin GSAs and additionally as part of recharge and exchange programs, as described in **Section 5.1**. By contrast, only Oak Flat Water District receives deliveries from SWP. The introduction of imported water supplies to the Basin resulted in a decrease in groundwater pumping in some parts of the Basin and the greater Central Valley, which led to a steady recovery of groundwater levels. During the droughts of 1976-1977 and 1987-1992, diminished deliveries of imported surface water prompted increased pumping of groundwater to meet irrigation demands, bringing groundwater levels to near-historic lows. In general, following periods of drought, recovery of pre-drought water levels has been rapid, especially in the Upper

Aquifer. This trend has been observed in hydrographs for wells across the Basin (**Figure GWC-10** and **Figure GWC-11**) (Delta-Mendota GSAs, 2022a).

Recent Pre-SGMA Drought Period (Beginning 2012)

During the 2012-2016 drought, groundwater level trends similar to those reported during the 1976-1977 and 1987-1992 droughts were observed. With diminished imported surface water deliveries, groundwater pumping increased throughout the Basin to meet irrigation demands. This resulted in historic or near-historic low groundwater levels during the height of the drought in 2014, when CVP and SWP allocations for agricultural water service contractors were 0 percent, Exchange Contractors and refuge deliveries were less than 75 percent, and post-1914 surface water rights in the San Joaquin River watershed were curtailed (Delta-Mendota GSAs, 2022a; USBR, 2023).

8.2.4.2 Post-SGMA Groundwater Elevation Trends (WY 2015 - WY 2023)

Figure GWC-12 and **Figure GWC-13** show five RMW-WLs hydrographs across the Basin in the Upper and Lower Aquifer respectively and the groundwater elevation trend over the post-SGMA period for each RMW-WL in the Basin. During the post-SGMA period, Upper Aquifer groundwater levels throughout the Basin have become more stable, and in many cases increased, with some areas of localized groundwater declines (**Table GWC-1**). Of the 48 RMW-WLs in the Upper Aquifer with groundwater elevation records during the post-SGMA period, eight (16.7 percent) showed statistically significant decreasing trends, 14 (29.2 percent) showed a statistically significant increasing trend, and 26 (54.2 percent) showed stable groundwater levels (i.e., no significant trend) (**Figure GWC-12**).

Of the 33 RMW-WLs in the Lower Aquifer with groundwater elevation records during the post-SGMA period, 11 (33.3 percent) showed statistically significant decreasing trends, six (18.2 percent) showed statistically significant increasing trends, and 16 (48.5 percent) showed stable groundwater levels (i.e., no significant trend) (**Figure GWC-13**).

In 2015, reduced CVP and SWP deliveries and historic low groundwater levels continued. In June 2015, senior water rights holders with a priority date of 1903 or later in the San Joaquin and Sacramento River watersheds and the Delta were ordered by the SWRCB to curtail diversions (SWRCB, 2015). This marked the first time in recent history that pre-1914 water rights holders were curtailed. During 2017 through 2019, wetter conditions prevailed, allowing groundwater levels to recover until the most recent dry period beginning in 2020. This recovery was largely a result of reduced pumping due to increased surface water availability, with CVP allocations reaching 100 percent and robust San Joaquin River flows. During the dry and critically dry years of 2020 – 2022, groundwater levels again fell throughout most of the Basin, before recovering during the wet year of 2023. This pattern of increased drought-driven groundwater pumping, accompanied by declining groundwater elevations, followed by recovery is a predominant factor to be considered in the sustainable management of the Basin (Delta-Mendota GSAs, 2022a).

8.3 Change in Groundwater Storage

§ 354.16. Groundwater Conditions

(b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.

☑ **23 CCR § 354.16(b)**

The Central Valley Hydrologic Model Version 2 (CVHM2; Model) (Traum et al., 2024) was used herein to estimate changes in groundwater storage for the two principal aquifers over two sequential time periods.

The first period evaluated is the historical pre-SGMA period that covers the WY 1970 through WY 2014 time frame. The WY 1970-2014 pre-SGMA period differs from the WY 1950-2014 pre-SGMA period (WY 1950 through WY 2014) used to characterize groundwater conditions for the groundwater level sustainability indicator, as it is based on and limited by the temporal extent of CVHM2. Further, these time periods differ to some degree from the time periods used to assess the Basin water budget as detailed in **Section 9.1** and **Appendix H**.

The second period evaluated is the post-SGMA period from WY 2015 through WY 2023. It is noted that the change in storage reported for this post-SGMA period is not always consistent with the change in storage previously reported in the Basin's WY 2019 through WY 2023 Annual Reports (Delta-Mendota GSAs, 2020, 2021, 2022b, 2023), due in part to differences in methodology. **Table GWC-2** compares the change in storage calculated by CVHM2 to the volumes reported in the Basin's Annual Reports which were based on analytical estimates using groundwater elevations. The change in storage calculated from CVHM2 is the summation of change is storage for stress periods within a water year, while the change in storage for annual reports is calculated from consecutive seasonal high groundwater levels. The change in storage calculated by CVHM2 and presented in **Table GWC-2** includes the volume of water release caused by subsidence as permanent loss of storage in aquitards (**Section 9.2**).

As detailed in **Appendix H**, the Model was refined based on local surface water delivery and pumping data for the period of WY 2003-2019, with reliable data primarily available after WY 2010 in most areas of the Basin. Therefore, the assumptions made for the development of the Model during other periods were not validated, and the results of the pre-SGMA period include major sources of uncertainty. The adjustments to surface water delivery and groundwater pumping primarily focused on improving average periodical representation of these components in the Model. While storage results are presented herein for informational purposes and to maintain consistency with other sections of this chapter, Model results for periods different than those defined for the Basin water budget are deemed significantly uncertain and are not relied upon for planning and development in this GSP. It is also worth noting that the Model incorporated subsidence simulation, and a significant portion of the change in groundwater storage in the Lower Aquifer is caused by subsidence and changes in aquitard storage. This component is not entirely caused by the management and operation of the Basin and is significantly impacted by actions outside of it. Sensitivity analyses conducted during the Model application suggest that up to 50 percent of the subsidence (and subsequent loss of storage) within the Basin is caused by pumping in adjacent basins.

Furthermore, as discussed in **Section 9.2**, subsidence is generally overestimated by the Model in the Basin, leading to overestimation of water release caused by subsidence and consequently the change in groundwater storage. Potential calibration of the Model to local subsidence and groundwater level targets as additional data becomes available will improve and likely reduce the estimations of water release caused by subsidence and the change in groundwater storage for pre-SGMA and post-SGMA periods. Therefore, the changes in groundwater storage presented here and in the water budget chapter should be considered conservative estimates.

Table GWC-2. Change in Storage in CVHM2, Including Volume of Water Release Caused by Subsidence, Compared to Prior Annual Reports

Water Year	Annual Change in Storage, CVHM2 (AF)		Annual Change in Storage, Annual Report (AF)	
	Upper Aquifer	Lower Aquifer	Upper Aquifer	Lower Aquifer
2019	61,000	-121,000	53,600	-32,500
2020	-128,000	-201,000	16,100	-29,800
2021	-113,000	-223,000	-220,600	-69,100
2022	-28,000	-191,000	-387,300	-71,700
2023	196,000	-142,000	21,500	-74,700

Abbreviations:
AF = acre-feet
CVHM2 = Central Valley Hydrologic Model version 2

8.3.1 Pre-SGMA Change in Groundwater Storage (WY 1970 – WY 2014)

Table GWC-3 shows the CVHM2-estimated cumulative change in groundwater storage and annual rate of changes in storage for the Upper and Lower Aquifers. It also shows the cumulative and annual rates of water release caused by subsidence as defined in **Section 9.2**. During the pre-SGMA period, the Upper Aquifer experienced a cumulative groundwater storage decline of -2,198,000 AF. This equates to an average annual decline of about -49,000 acre-feet per year (AFY) in the Upper Aquifer's groundwater storage. This annual rate of change in groundwater storage is approximately 20 percent of the average annual pumping from the Upper Aquifer in the same period, which totaled to 245,000 AFY. **Figure GWC-14** shows annual and cumulative groundwater storage change and water release caused by subsidence in the Upper Aquifer and the associated water year types. The annual change in groundwater storage for the Upper Aquifer generally follows water year types, showing increases in storage in most wet and above normal water years and decreases in storage during most below-normal, dry, critical, and Shasta-critical water years.

The cumulative groundwater storage change for the pre-SGMA period in the Lower Aquifer was -209,000 AF (**Table GWC-3**). The cumulative volume of water release caused by subsidence in the Lower Aquifer for the same period is 3,136,000 AF. The average total annual rate of decline during the same period, including both change in storage and water release caused by subsidence, was about -75,000 AFY, equivalent to 54 percent of the annual average pumping from the Lower Aquifer (137,150 AFY). **Figure GWC-15** shows annual and cumulative groundwater storage change and water release caused by subsidence in the Lower Aquifer and the associated water year types. The change in the Lower Aquifer's groundwater storage generally correlates with water year types, showing increases in storage in most wet years and declines in storage in others. However, the magnitude of changes in storage does not consistently align with water year types. Overall, both aquifers showed an overall declining trend in groundwater storage during the pre-SGMA period.

8.3.2 Post-SGMA Change in Groundwater Storage (WY 2015 – WY 2023)

During the post-SGMA period, the Upper Aquifer experienced a cumulative groundwater storage increase of 62,000 AF (**Table GWC-3**). This equates to an average annual increase of about 7,000 AFY in the Upper Aquifer's groundwater storage. The increase in storage is primarily due to increased recharge during the period and wetter water year types, considering that the average pumping from the Upper Aquifer during the post-SGMA period (308,000 AFY) did not decrease compared to the pre-SGMA period. As shown in **Figure GWC-14**, the annual change in groundwater storage for the Upper Aquifer follows water year types, showing increase in storage in wet water years and decreases in storage during most below-normal, dry, critical, and Shasta-critical water years.

The cumulative groundwater storage change for the post-SGMA period in the Lower Aquifer was approximately -77,000 AF (**Table GWC-3**). The cumulative volume of water release caused by subsidence during the same period was -1,367,000 AF. As shown in **Figure GWC-15**, the change in Lower Aquifer groundwater storage does not correlate with water year types, decreasing throughout the entire post-SGMA period. The consistent decline in groundwater storage is likely due to consistent subsidence in some portions of the Basin and the comparably lower magnitude of recharge from boundary inflows and surficial recharge than the total pumping from the aquifer. As discussed in **Section 9.3.3**, conditions in neighboring groundwater basins are the primary cause of subsidence in the Basin and significantly impact the change in the Lower Aquifer's groundwater storage. Consequently, the consistent decline in the Lower Aquifer's groundwater storage in the Basin is not solely attributable to local groundwater management, nor can be mitigated solely by actions in the Basin. It is primarily a result of regional groundwater conditions adversely impacting the Basin.

Table GWC-3. Change in Storage and Water Release Caused by Subsidence in the Upper and Lower Aquifers

Period	Change in Storage		Water Release Caused by Subsidence	
	Annual Rate (AFY)	Cumulative Volume (AF)	Annual Rate (AFY)	Cumulative Volume (AF)
Upper Aquifer				
Pre-SGMA (Oct 1970 – Sep 2014)	-49,000	-2,198,000	-5,000	-210,000
Post-SGMA (Oct 2014 – Sep 2023)	7,000	62,000	-5,000	-42,000
Lower Aquifer				
Pre-SGMA (Oct 1970 – Sep 2014)	-5,000	-209,000	-70,000	-3,136,000
Post-SGMA (Oct 2014 – Sep 2023)	-9,000	-77,000	-152,000	-1,367,000

Abbreviations:
AF = acre-feet
AFY = acre-feet per year
SGMA = Sustainable Groundwater Management Act
WY = Water Year

8.4 Seawater Intrusion

§ 354.16. Groundwater Conditions
(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

☑ **23 CCR § 354.16(c)**

The Basin is physically separated from the Pacific Ocean by the Coast Ranges; therefore, the phenomenon of seawater intrusion does not occur in the Basin, does not pose a risk to the beneficial uses or users of groundwater in the Basin, and is therefore not a relevant Sustainability Indicator in the Basin.

8.5 Groundwater Quality

§ 354.16. Groundwater Conditions
(d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.

☑ **23 CCR § 354.16(d)**

This section describes groundwater quality issues that may affect the supply and beneficial uses of groundwater in the Basin, including non-point source constituents of concern (COCs) and point-source contamination sites and discharges. The primary constituents discussed include arsenic, nitrate, 1,2,3-trichloropropane (1,2,3-TCP), gross alpha radioactivity, total dissolved solids (TDS), and hexavalent chromium, with additional discussion of nitrite, boron, and selenium.

8.5.1 Water Quality Data Sources, Aquifer Assignment, Screening Levels, and Analysis Methods

Concentration data for potential COCs were compiled from wells in the Basin's Representative Monitoring Network and the GAMA Groundwater Information System (SWRCB & USGS, 2023).

8.5.1.1 Aquifer Assignment

The following rules were used to assign the groundwater quality data to the two principal aquifers in the Basin based on the available construction information for the wells from which the sampling occurred:

- Wells were assigned to the Upper Aquifer if the total well depth[31] or bottom of the screened interval (if provided) was shallower than the bottom of the Corcoran Clay in that location, as interpolated from the USGS depth and thickness of Corcoran Clay contours (Faunt, 2012a, 2012b).
- Wells were assigned to the Lower Aquifer if the top of well's screened interval was deeper than the bottom of the Corcoran Clay.
- Wells located outside of the mapped extent of the Corcoran Clay extent were assigned to the Upper Aquifer.
- Wells with no total depth or bottom of screen depth included in the available construction information in areas where the Corcoran Clay exists could not be conclusively assigned to the Upper or Lower Aquifer. Similarly, for wells with a total depth below the base of the Corcoran Clay but without available screen interval depth information, it was not possible to determine whether the wells were screened entirely in the Lower Aquifer or whether they were screened in both the

[31] Total well depth was used to assign aquifer units to wells providing water quality data, as opposed to 80 percent of total depth as was used in the water level well impacts analysis, due to differing objectives of the analyses. Water quality analyses are concerned with what aquifer units the wells could draw from, while the water level well impacts analysis is concerned with whether pumps are able to function when groundwater is at a particular elevation.

Upper and Lower Aquifers. These wells were not used for characterizing the principal aquifers individually, but data from them was used for Basin-wide statistics.

8.5.1.2 Screening Levels

Potential COCs were initially identified by comparing the highest measured concentrations detected at individual wells to applicable regulatory standards. For the purpose of this analysis, the screening levels for drinking water are used. This is because drinking water uses are the most sensitive beneficial use identified in the *Water Quality Control Plan for the California Regional Water Quality Control Board Central Valley Region* (Basin Plan) for most constituents, and potable use is the only beneficial use for which numeric regulatory standards or water quality objectives are assigned (CVRWQCB, 2019). in the Basin, and thus a conservative standard by which to assess groundwater quality concerns. Per California Water Code (CWC) §106.3(a), all drinking water users of groundwater are considered beneficial users with a human "right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." Screening levels used in this analysis include the following:

- Primary Maximum Contaminant Levels (MCLs): Primary MCLs are drinking water standards set by the United States Environmental Protection Agency (USEPA), the California Environmental Protection Agency (CalEPA), and the SWRCB based on human health considerations. The Basin Plan establishes the Primary MCLs outlined in Title 22 of the California Code of Regulations (22 CCR) as groundwater quality objectives for groundwaters designated as domestic or municipal supply (CVRWQCB, 2019, 2020).
- Secondary MCLs: Secondary MCLs are non-health related standards set by the USEPA and SWRCB based on aesthetic characteristics of drinking water such as taste, odor, and color. The Basin Plan establishes the Secondary MCLs outlined in 22 CCR as groundwater quality objectives for groundwaters designated as domestic or municipal supply (CVRWQCB, 2019, 2020).
- Health Based Screening Levels (HBSLs): HBSLs are non-enforceable standards set by the USGS National Water-Quality Assessment (NAWQA) Project to evaluate whether a constituent may pose a risk to human health.

8.5.1.3 Analysis Methods

Temporal Analysis – Trends

Concentration data were analyzed to identify exceedances of applicable screening levels. For wells with at least four measurements taken in the period between calendar years 1950 and 2014, historical trends were characterized using a Mann-Kendall test that determines whether the concentrations exhibit significant upward (increasing) or downward (decreasing) trends with time. For the purpose of this analysis, trends identified from the Mann-Kendall test were considered significant if their p-value was less than or equal to 0.05. The same test was applied to wells with at least four measurements from January 2015 to present to calculate short-term, post-SGMA trends. Results from these trend analyses are discussed in further detail for each COC in **Section 8.5.2**.

Spatial Analysis

To give a comparison of general water quality conditions just before SGMA's implementation and in the years since, average concentrations of COCs over the decades immediately preceding and following the start of SGMA implementation (calendar years 2005 – 2014 and 2015 – 2023, respectively) were mapped across the Basin. For TDS and nitrate, constituents which have the greatest spatial data coverage, concentration contours for the pre-SGMA and post-SGMA periods were developed based on the methodology applied by the Central Valley Salt and Nitrate Management Plan (San Joaquin Valley Drainage Authority, 2016). The COC concentrations were averaged by well over the period of interest. Declustering of the data was then accomplished by averaging concentrations by Public Land Survey System (PLSS) sections to achieve a more even spatial distribution of data. Contours were then generated using natural neighbors interpolation, which calculates a weighted average of nearby data to estimate values for the locations without data. In order to achieve sufficient spatial coverage that is consistent in both time periods (pre- and post-SGMA implementation), only PLSS sections containing data from both before and after January 2015 were used in the interpolation. In sections where no data were available during the time period of interest, the average concentration from the most recent decade with data was used. As some portions of the Basin contain few or no wells with both construction and water quality data, wells with unknown depths were combined with Upper Aquifer wells for the contour generation. Because the Lower Aquifer typically contains lower TDS and nitrate concentrations than the Upper Aquifer, and the wells of unknown depth may draw water from the Lower Aquifer instead of or in addition to the Upper Aquifer, the inclusion of the wells of unknown depth in the Upper Aquifer contours represents a best-case scenario for Upper Aquifer water quality utilizing available data.

8.5.2 Groundwater Quality Constituents of Concern

This section describes the identification and occurrence of potential COCs in the Basin during pre-SGMA (calendar years 1950 – 2014) and post-SGMA (calendar years 2015 – 2023) time periods. Potential groundwater quality COCs were identified based on input from interested parties in the Basin and were also informed by the recommendations made by the SWRCB during their 2022 review of GAMA data (SWRCB, 2022). In their 2022 letter to DWR, the SWRCB identified potential COCs for the Basin as those constituents having an MCL or HBSL exceedance in three or more wells categorized as domestic, irrigation/industrial, municipal, or water supply since 1 January 2015. With this approach, the SWRCB identified seven potential COCs in the Basin for consideration, including: arsenic, hexavalent chromium (chromium VI), nitrate (as nitrogen), nitrate plus nitrite, TDS, 1,2,3-TCP, and gross alpha radioactivity.

It should be noted that while the SWRCB letter identified these potential COCs as deserving of review by the GSA(s) in their respective basins, it also acknowledged that it may not be appropriate to set Sustainable Management Criteria (SMC) for all of the COCs identified.

> *"While it may not be appropriate for a GSP to set minimum thresholds and measurable objectives for all constituents identified for the basin, most or all of the constituents should be discussed in the basin setting, since these constituents are present in the basin at concentrations that can impact beneficial users of groundwater"* (SWRCB, 2022).

Interested parties in the Basin similarly identified TDS and nitrate as potential COCs due to agricultural and drinking water concerns, respectively. Boron and selenium, which are present in groundwater in parts of the Basin, are also discussed in this GSP.

Table GWC-4 and **Table GWC-5** summarize these seven COCs in terms of their respective screening level, number of wells and samples, detections above screening levels, and numbers of impacted wells during the pre-SGMA (1950 – 2014) and post-SGMA (2015 – 2023) periods, respectively.

Table GWC-4. COC Detections Above Screening Level Pre-SGMA (1950-2014)

Constituent of Concern	Screening Level (Screening Level Type)	Wells Sampled (a)		Impacted Wells (b)	Percentage of Wells Impacted	Impacted Upper Aquifer Wells	Percentage of Upper Aquifer Wells Impacted	Impacted Lower Aquifer Wells	Percentage of Lower Aquifer Wells Impacted
Arsenic	10 ug/L (Primary MCL)	All types	690	122	18 percent	66	18 percent	6	27 percent
		Excluding monitoring	342	40	12 percent	12	7 percent	4	24 percent
Nitrate as Nitrogen	10 mg/L (Primary MCL)	All types	1845	456	25 percent	284	37 percent	3	11 percent
		Excluding monitoring	1411	261	18 percent	177	34 percent	2	8 percent
Nitrate and Nitrite as Nitrogen	10 mg/L (Primary MCL)	All types	79	37	47 percent	15	38 percent	1	13 percent
		Excluding monitoring	33	4	12 percent	4	19 percent	0	0 percent
1,2,3-TCP	0.005 ug/L (Primary MCL)	All types	465	32	7 percent	7	4 percent	0	0 percent
		Excluding monitoring	193	2	1 percent	0	0 percent	0	0 percent
Gross Alpha Radioactivity	15 pCi/L (Primary MCL)	All types	129	19	15 percent	8	22 percent	0	0 percent
		Excluding monitoring	129	19	15 percent	8	22 percent	0	0 percent
TDS	1,000 mg/L (Upper Secondary MCL)	All types	1609	863	54 percent	388	57 percent	16	52 percent
		Excluding monitoring	1158	548	47 percent	163	42 percent	14	56 percent
Chromium VI	10 ug/L (Primary MCL)	All types	319	136	43 percent	76	37 percent	1	6 percent
		Excluding monitoring	129	48	37 percent	99	48 percent	3	19 percent

Abbreviations:

1,2,3-TCP = 1,2,3-Trichloropropane
mg/L = Milligrams per Liter
TDS = Total Dissolved Solids
USGS = United States Geological Survey
ug/L = Micrograms per Liter

Notes:

(a) Data are presented both from all wells sampled and from all wells except for monitoring wells. The exclusion of monitoring wells is consistent with the methodology used by the SWRCB in their analysis of Groundwater Quality Considerations for High and Medium Priority Groundwater Basins (3).
(b) "Impacted wells" refers to wells in which a constituent of concern is detected above its screening level.

Sources:

1. Water quality monitoring data, provided by the GSAs
2. SWRCB and USGS's GAMA Groundwater Information System, dated December 2023 (https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/)

3. SWRCB (2022) Groundwater Quality Considerations for High and Medium Priority Groundwater Basins. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/DrinkingWater/Files/20221122_Groundwater-Quality-Comments-to-DWR.pdf

Table GWC-5. COC Detections Above Screening Level Post-SGMA (2015-2023)

Constituent of Concern	Screening Level (Screening Level Type)	Wells Sampled (a)		Impacted Wells (b)	Percentage of Wells Impacted	Impacted Upper Aquifer Wells	Percentage of Upper Aquifer Wells Impacted	Impacted Lower Aquifer Wells	Percentage of Lower Aquifer Wells Impacted
Arsenic	10 ug/L (Primary MCL)	All types	177	34	19 percent	22	22 percent	1	10 percent
		Excluding monitoring	111	15	14 percent	4	11 percent	1	10 percent
Nitrate as Nitrogen	10 mg/L (Primary MCL)	All types	445	144	32 percent	92	50 percent	5	24 percent
		Excluding monitoring	335	61	18 percent	14	17 percent	5	25 percent
Nitrate and Nitrite as Nitrogen	10 mg/L (Primary MCL)	All types	414	119	29 percent	26	44 percent	0	0 percent
		Excluding monitoring	372	83	22 percent	13	30 percent	0	0 percent
1,2,3-TCP	0.005 ug/L (Primary MCL)	All types	311	41	13 percent	13	9 percent	1	9 percent
		Excluding monitoring	109	6	6 percent	1	3 percent	1	9 percent
Gross Alpha Radioactivity	15 pCi/L (Primary MCL)	All types	90	4	4 percent	2	8 percent	0	0 percent
		Excluding monitoring	90	4	4 percent	2	8 percent	0	0 percent
TDS	1,000 mg/L (Upper Secondary MCL)	All types	338	189	56 percent	138	62 percent	21	50 percent
		Excluding monitoring	173	71	41 percent	37	43 percent	17	55 percent
Chromium VI	10 ug/L (Primary MCL)	All types	127	98	77 percent	65	86 percent	3	50 percent
		Excluding monitoring	73	47	64 percent	14	64 percent	3	50 percent

Abbreviations:
1,2,3-TCP = 1,2,3-Trichloropropane
mg/L = Milligrams per Liter
TDS = Total Dissolved Solids
USGS = United States Geological Survey
ug/L = Micrograms per Liter
GAMA = Groundwater Ambient Monitoring and Assessment
MCL = Maximum Contaminant Level
pCi/L = Picocuries per Liter
SGMA = Sustainable Groundwater Management Act
SWRCB = State Water Resources Control Board

Notes:
(a) Data are presented both from all wells sampled and from all wells except for monitoring wells. The exclusion of monitoring wells is consistent with the methodology used by the SWRCB in their analysis of Groundwater Quality Considerations for High and Medium Priority Groundwater Basins (3).
(b) "Impacted wells" refers to wells in which a constituent of concern is detected above its screening level.

Sources:
1. Water quality monitoring data, provided by the GSAs
2. SWRCB and USGS's GAMA Groundwater Information System, dated December 2023 (https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/)
3. SWRCB (2022) Groundwater Quality Considerations for High and Medium Priority Groundwater Basins. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/DrinkingWater/Files/20221122_Groundwater-Quality-Comments-to-DWR.pdf

Table GWC-6 and **Table GWC-7** show the concentration trends in COCs within the Basin during the pre-SGMA (1950 – 2014) and post-SGMA (2015 – 2023) periods for the wells that had sufficient data to calculate a trend.

Table GWC-6. Trends in COCs Pre-SGMA (1950-2014)

Constituent of Concern	Upper Aquifer				Lower Aquifer			
	Wells analyzed (a)	Increasing	Decreasing	No Trend (b)	Wells analyzed	Increasing	Decreasing	No Trend
Arsenic	95	1	4	90	8	0	0	8
Nitrate as Nitrogen	236	29	26	181	15	5	0	10
Nitrate and Nitrite as Nitrogen	6	1	0	5	0	0	0	0
1,2,3-Trichloropropane	99	1	2	96	5	0	0	5
Gross Alpha Radioactivity	29	3	1	25	8	0	0	8
Total Dissolved Solids	190	28	12	150	11	1	1	9
Chromium VI	90	8	3	79	2	1	1	0

Notes:
(a) Wells were analyzed for trends if at least four measurements of the constituent of concern were taken within the 1950 - 2014 time period.
(b) Trends were identified with Mann-Kendall analysis at the 95 percent confidence level. Only significant trends with $p < 0.05$ are counted as increasing or decreasing.

Sources:
1. Water quality monitoring data, provided by the GSAs
2. SWRCB and USGS's GAMA Groundwater Information System, dated December 2023 (https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/)

Table GWC-7. Trends in COCs Post-SGMA (2015-2023)

Constituent of Concern	Upper Aquifer				Lower Aquifer			
	Wells analyzed (a)	Increasing	Decreasing	No Trend (b)	Wells analyzed	Increasing	Decreasing	No Trend
Arsenic	26	0	0	26	1	0	0	1
Nitrate as Nitrogen	132	28	14	90	12	2	2	8
Nitrate and Nitrite as Nitrogen	24	3	2	19	0	0	0	0
1,2,3-Trichloropropane	115	3	4	108	9	0	1	8
Gross Alpha Radioactivity	4	0	0	4	2	0	0	2
Total Dissolved Solids	125	16	30	79	8	1	0	7
Chromium VI	59	15	3	41	4	1	1	2

Notes:
(a) Wells were analyzed for trends if at least four measurements of the constituent of concern were taken within the 2015 - 2023 time period.
(b) Trends were identified with Mann-Kendall analysis at the 95 percent confidence level. Only significant trends with $p < 0.05$ are counted as increasing or decreasing.

Sources:
1. Water quality monitoring data, provided by the GSAs
2. SWRCB and USGS's GAMA Groundwater Information System, dated December 2023 (https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/)

8.5.2.1 Arsenic

Background Information

Arsenic is a semi-metallic trace element which can occur naturally in groundwater. It is acutely toxic when ingested in concentrations of hundreds of micrograms per liter (ug/L) or higher, and exposure to lower concentrations is associated with increased risk of multiple types of cancer. The SWRCB and the USEPA have set the state and federal primary MCLs for arsenic at 10 ug/L (SWRCB, 2017b). Arsenic in the Basin's groundwater is primarily derived from reductive dissolution of iron or manganese oxyhydroxides, particularly in sands originating from the Sierra Nevada, or from desorption from aquifer sediments in oxic groundwater with a high pH (Dubrovsky et al., 1991; Fram, 2017). Arsenic distribution and mobility in the Basin, particularly within the Upper Aquifer, has been shown to be strongly influenced by the geologic sources of aquifer sediments (Dubrovsky et al., 1991). More recent analysis has confirmed that pesticides, which are sometimes a source of arsenic in other locations, are not a significant source of arsenic within the Basin (Fram, 2017). This conclusion was based on a lack of correlation with agricultural land and a negative correlation with nitrate, further supporting the natural (i.e., geologic) origin of arsenic in the Basin.

Occurrence and Trends during Pre-SGMA Period (1950 – 2014)

Arsenic was detected above the Primary MCL of 10 ug/L in 122 of 690 wells (18 percent) sampled during the pre-SGMA time period (1950-2014) (**Table GWC-4**). **Figure GWC-16** shows the spatial distribution of average arsenic concentration between 2005 and 2014 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. Arsenic was detected in groundwater above its MCL near the Cities of Firebaugh, Los Banos, Patterson, and Mendota (**Figure GWC-16**). One public supply well in the City of Los Banos was put on standby due to arsenic from 2010 to 2012 (Northern and Central Delta-Mendota GSAs, 2022). Arsenic has been more frequently detected in the Upper Aquifer than in the Lower Aquifer, although the Lower Aquifer has fewer available data. Arsenic in both aquifers has generally been detected in higher levels in the southern half of the Basin.

Although elevated arsenic concentrations have been linked in some instances to groundwater development (Haugen et al., 2021), the vast majority of wells in the Basin do not exhibit any trend in arsenic concentrations as indicated in **Figure GWC-17**. **Figure GWC-17** shows the spatial distribution of the arsenic concentration trends between 1950 and 2014 by well, and presents the well counts with increasing, decreasing and no trend. Further, while few contemporaneous water level and arsenic measurements are available in the same locations, where data do exist, no clear relationship with groundwater levels has been observed (**Table GWC-6**, **Appendix I**) over the pre-SGMA time period (1950-2014). For example, an increasing trend in arsenic concentrations was noted in one City of Los Banos well, with two more Los Banos wells and two wells in Firebaugh exhibiting decreasing trends. All of the wells with observed historical arsenic trends were screened in the Upper Aquifer.

Occurrence and Trends during Post-SGMA Period (2015 – 2023)

Since January 2015, arsenic was detected above the Primary MCL of 10 ug/L μg/L in 34 of 177 wells (19 percent) sampled, suggesting no significant change from pre-SGMA conditions (**Table GWC-5**). **Figure GWC-18** shows the spatial distribution of average arsenic concentration between 2015 and 2023 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. Arsenic has continued to be detected above its MCL in wells near the Cities of Firebaugh, Los Banos, and Patterson, and MCL exceedances have been observed in wells near the Fink Road Landfill, west of Crows Landing as shown in **Figure GWC-18**. Concentrations have generally remained lower in the northern half of the Basin, with northern arsenic concentrations lower in the Lower Aquifer than in the Upper Aquifer. Several wells with elevated arsenic in the southern half of the Basin could not conclusively be assigned to either aquifer. **Figure GWC-19** shows the spatial distribution of the arsenic concentration trends between 2015 and 2023 by well, and presents the well counts with increasing, decreasing and no trend. Recent increasing trends in arsenic concentration have been noted near the City of Firebaugh and in one rural well in the southwestern portion of the Basin; however as shown in **Figure GWC-19** and **Table GWC-7,** most wells have exhibited no recent trends.

8.5.2.2 Nitrate and Nitrite

Background Information

Nitrate is a common natural and human-influenced chemical. It is produced in small amounts by biologic nitrogen fixation; however, the majority of nitrate in groundwater is derived from synthetic and organic fertilizers and animal or human wastes. Exposure to nitrate can cause the serious and potentially fatal condition in infants, methemoglobinemia (“blue baby syndrome”). Nitrite, a more reduced form of nitrogen, may also be found in groundwater and can exhibit greater toxicity than nitrate. State and federal primary MCLs for nitrate are set to 10 milligrams per liter (mg/L) (nitrate as nitrogen). The primary MCL for nitrite is 1 mg/L (nitrite as nitrogen) or a combined primary MCL of 10 mg/L of total nitrogen from both nitrate and nitrite (SWRCB, 2017c; USEPA, 2006). This discussion focuses on nitrate because it is the dominant component of nitrate plus nitrite, and Primary MCL exceedances of nitrate plus nitrite usually occur in areas that also have Primary MCL exceedances for nitrate alone (see **Appendix I**). Nitrite individually exceeds its Primary MCL of 1 mg/L in fewer than 2 percent of Basin wells sampled since 2015 (SWRCB & USGS, 2023). Additionally, nitrate is more frequently reported than the combined value.

Discharges of nitrate in the Basin from irrigated agricultural operations is regulated by the CVRWQCB through waste discharge requirements. The General Waste Discharge Requirements Orders that apply to irrigated agricultural operations are commonly referred to as the Irrigated Lands Regulatory Program (ILRP). Other sources of nitrate discharges in the Basin are also regulated by the CVRWQCB under individual or general waste discharge requirements. For example, most dairies in the Basin are subject to the CVRWQCB's Reissued General Order for Existing Milk Cow Dairies. Most other facilities fall under the CVRWQCB's land discharge program, which is referred to as Waste Discharges to Land (Non-Chapter 15) Program. The Nitrate Control Program, an initiative of CV-SALTS, was adopted into Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) in 2018. It applies to all dischargers of nitrate and includes critical goals for ensuring that those that rely on groundwater have access to safe drinking water that that is not contaminated by nitrate and requires development of an implementation plan to no longer cause or contribute to exceedances from those that discharge nitrate in the Basin. These programs are overseen by the CVRWQCB, pursuant to its authority under the Porter-Cologne Water Quality Control Act (CWC Division 7), as described in **Section 5.2.1.1**.

Occurrence and Trends during Pre-SGMA Period (1950 – 2014)

Nitrate and nitrite were detected above the Primary MCL of 10 mg/L in 37 of 79 wells (47 percent) sampled during the pre-SGMA time period (1950-2014) (**Table GWC-4**). Over the period of 2000 through 2016, ambient nitrate concentrations in the Basin's groundwater were determined to fall in the 73rd percentile among the Central Valley subbasins (CV-SALTS, 2016). Localized groundwater with elevated nitrate concentrations has been noted in the Basin as far back as the 1960's, particularly in the Upper Aquifer (Hotchkiss & Balding, 1971). Nitrate occurrence in the Basin is influenced by land use and is typically associated with agricultural areas, although elevated nitrate concentrations were also discovered in 2012 in soil of the Spreckels Sugar Company cleanup site, located just outside the City of Mendota, (see **Section 8.5.3**) due to the disposal of high-nutrient process wastewater (CVRWQCB, 2018; Delta-Mendota GSAs, 2022a).

Figure GWC-20 shows the spatial distribution of average nitrate concentration between 2005 and 2014 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. Elevated nitrate concentrations have been observed primarily in the central portions of the Basin, in the Upper Aquifer as indicated in **Figure GWC-20**. Both increasing and decreasing trends in nitrate concentrations can be observed in the Basin, primarily in the northern half, with fewer significant trends in the south. No consistent relationship between groundwater levels and nitrate concentrations is apparent. Based on the spatial interpolation of the available data and consideration of aquifer thicknesses, approximately 12.8 percent of the Upper Aquifer's volume has nitrate concentrations greater than 10 mg/L. In many locations, nitrate concentrations remain steady as groundwater levels fluctuate. In a few locations nitrate increases with water levels, which could suggest soil leaching during infiltration, while other nearby locations exhibit the opposite relationship. A recent study of San Joaquin Valley wells with water level and nitrate data from 2000 to 2022 categorized several wells in the northern and middle portions of the Basin as belonging to a group in which nitrate levels tended to increase with droughts and decrease during recovery, while other northern wells fell into a group showing the opposite relationship (Levy et al., 2024). **Figure GWC-21** shows the spatial distribution of the nitrate concentration trends between 1950 and 2014 by well, and presents the well counts with increasing, decreasing and no trend. **Figure GWC-21** further suggests that the vast majority of wells in the Basin do not exhibit any trend in nitrate concentrations. This suggests that the occurrence of nitrate is highly dependent on local conditions (**Table GWC-6, Appendix I**).

Occurrence and Trends during Post-SGMA Period (2015 – 2023)

Since January 2015, nitrate and nitrite have been detected above the Primary MCL of 10 mg/L in 119 of 414 wells (29 percent) sampled (**Table GWC-5**). **Figure GWC-22** shows the spatial distribution of average nitrate concentration between 2015 and 2023 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. **Figure GWC-23** shows the spatial distribution of the nitrate concentration trends between 2015 and 2023 by well, and presents the well counts with increasing, decreasing and no trend. Elevated concentrations of nitrate (or nitrate plus nitrite) and increasing trends have continued in many of the areas of the Upper Aquifer where they have historically occurred as indicated in **Figure GWC-22**, **Figure GWC-23** and **Table GWC-7**. A few wells towards the northern and southern ends of the Basin, which had not been sampled in the previous decade, were determined to have MCL exceedances based on recently collected data, though nearby wells in the northern portion of the Basin had historically exhibited increasing trends. Few recent decreasing trends in concentration have been observed in the Upper Aquifer. Conditions in the Lower Aquifer have remained approximately the same as in the preceding decade, and concentration trends largely mirror those from the historical time period. The nitrate contours suggest a slight (2.4 percent) increase in areas of the Upper Aquifer that exceed the primary MCL.

In 2018, the CVRWQCB designated the Basin as a Priority 2 under the Nitrate Control Program based on ambient nitrate concentrations in groundwater measured between 2000 and 2016. Notices to Comply with the Nitrate Control Program were sent to dischargers of nitrate by the CVRWQCB in December 2023. Per the Notice to Comply, dischargers have a year plus 60 days to determine if they will form and participate in a Management Zone to comply with the Nitrate Control Program or if they will comply through a more conservative, traditional permitting approach. Regardless, those subject to the Nitrate Control Program must ensure that those that rely on groundwater have access to reliable, safe drinking water that does not exceed nitrate water quality standards. This first step towards compliance is submittal of a Preliminary Management Zone Plan by December 28, 2024, along with an Early Action Plan that provides for testing domestic groundwater wells for nitrate and provision of alternative drinking water supplies to households where well water is found to contain concentrations of nitrate that exceed the primary MCL of 10 mg/L (CV-SALTS, 2023a, 2023b).

8.5.2.3 1,2,3-Trichloropropane (TCP)

Background Information

1,2,3-TCP is a human-influenced organic solvent used in industrial processes and is associated with historical pesticide products. It is slightly water soluble and denser than water, is not readily captured by soil, and does not easily degrade, which enables it to be transported both laterally and vertically downwards in groundwater and accumulate in deeper parts of aquifers. 1,2,3-TCP exposure has acute and chronic health effects, and the chemical is recognized as a human carcinogen by the State of California (SWRCB, 2017a).

Occurrence and Trends during Pre-SGMA Period (1950 – 2014)

1,2,3-TCP was detected above the Primary MCL of 0.005 ug/L in 32 of 465 wells (7 percent) sampled from the pre-SGMA time period (1950-2014), two of which were in dedicated monitoring wells installed at Cleanup Program Sites (**Table GWC-4**). **Figure GWC-24** shows the spatial distribution of average 1,2,3-TCP concentration between 2005 and 2014 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. **Figure GWC-25** shows the spatial distribution of the 1,2,3-TCP concentration trends between 1950 and 2014 by well, and presents the well counts with increasing, decreasing and no trend. As shown in **Figure GWC-24** and **Figure GWC-25,** the most significant source of 1,2,3-TCP in the Basin, and the only location with an increasing trend, is the Crop Production Services Oxalis Cleanup Program Site, an agricultural chemical production and distribution facility, which has been the subject of groundwater investigation and monitoring since the late 1990's (**Table GWC-6**) (SWRCB, 2014). No 1,2,3-TCP has been detected in the Lower Aquifer.

Occurrence and Trends during Post-SGMA Period (2015 – 2023)

Figure GWC-26 shows the spatial distribution of average 1,2,3-TCP concentration between 2015 and 2023 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. **Figure GWC-27** shows the spatial distribution of the 1,2,3-TCP concentration trends between 2015 and 2023 by well, and presents the well counts with increasing, decreasing and no trend. In the 2015 - 2023 time period, 1,2,3-TCP was detected above the Primary MCL of 0.005 ug/L in 41 of 311 wells (13 percent) sampled as shown in **Figure GWC-26**. However, no locations, except for the aforementioned Oxalis site, exhibited an overall increasing trend during that period, and two exhibited overall declines as shown in **Figure GWC-27** and **Table GWC-7**. Virtually all detections of 1,2,3-TCP have been confined to isolated locations within the Upper Aquifer, along with a single well in the Lower Aquifer.

8.5.2.4 Gross Alpha Radioactivity

Background Information

Alpha particles are a low energy form of radiation emitted by some radioactive elements. Gross alpha radioactivity in groundwater is most commonly associated with decay of naturally occurring uranium or thorium and has been observed infrequently in the Basin (Fram, 2017). Alpha radiation can increase the risk of cancer when alpha-emitters, such as radon, radium, or uranium, are ingested or inhaled. Gross alpha radioactivity has a state and federal primary MCL of 15 picocuries per liter (pCi/L) (SWRCB, 2017d).

Occurrence and Trends during Pre-SGMA Period (1950 – 2014)

Gross alpha was detected above the Primary MCL of 15 pCi/L in 19 of 129 wells (15 percent) sampled from the pre-SGMA time period (1950-2014) (**Table GWC-4**). The SGMA Groundwater Quality Visualization Tool indicates that MCL exceedance rates for uranium, the most common alpha emitter, were similarly low (8 percent of all measurements) during this period (SWRCB, 2023d). **Figure GWC-28** shows the spatial distribution of average gross alpha radioactivity between 2005 and 2014 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. MCL exceedances occurred in various parts of the Basin but tended to be spatially isolated, with nearby wells exhibiting substantially lower levels of alpha radiation as shown in **Figure GWC-28**. **Figure GWC-29** shows the spatial distribution of the gross alpha radioactivity trends between 1950 and 2014 by well, and presents the well counts with increasing, decreasing and no trend. All exceedances were recorded in the Upper Aquifer or in wells of uncertain depths. Gross alpha radioactivity levels were generally stable over the historic period as indicated in **Figure GWC-29** and **Table GWC-6**.

Occurrence and Trends during Post-SGMA Period (2015 – 2023)

Figure GWC-30 shows the spatial distribution of average gross alpha radioactivity between 2015 and 2023 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. **Figure GWC-31** shows the spatial distribution of the gross alpha radioactivity trends between 2015 and 2023 by well, and presents the well counts with increasing, decreasing and no trend. Gross alpha radioactivity measurements conducted since January 2015 have shown few MCL exceedances, with only four impacted wells Basin-wide as shown in **Figure GWC-30** and **Table GWC-5**. Most wells in the Basin showed no significant trends in gross alpha radioactivity as indicated in **Figure GWC-31**; however, many areas with previous MCL exceedances have shown gross alpha radioactivity levels below the MCL in the post-SGMA time period, suggesting a moderate decline.

8.5.2.5 Total Dissolved Solids (TDS)

Background Information

TDS is a measure of all the dissolved ionic constituents in water and is a common measure of salinity. At lower concentrations, TDS primarily affects the taste of drinking water; however, high concentrations of salt can damage crops, affect plant growth, damage home and industrial equipment, and pose health risks. The SWRCB has established a "Recommended" Secondary MCL of 500 mg/L, an "Upper" Secondary MCL of 1,000 mg/L, and a Short-term Maximum Secondary MCL of 1,500 mg/L (SWRCB, 2017e). These standards are included as water quality objectives in the Basin Plan for groundwater designated for domestic and municipal use (CVRWQCB, 2019). Under the Basin Plan, all groundwaters within the Basin are considered potentially suitable for domestic and municipal supply unless otherwise designated; however, water with TDS concentrations over 3,000 mg/L is generally considered unsuitable for use as a source of municipal or domestic water under the SWRCB *Sources of Drinking Water Policy* (CVRWQCB, 2019; SWRCB, 1988). The Basin Plan also identifies Basin groundwater as potentially suitable for agricultural supply, which has historically been considered a more sensitive beneficial use than domestic and municipal supply with respect to TDS, however, no numeric water quality objectives are established for TDS in water for agricultural use (CVRWQCB, 2019). The *Central Valley Region Salt and Nitrate Management Plan* recommends that groundwater for agricultural use be assigned to one of four classes based on a volume-weighted average of salinity in the production zone. Under this classification scheme, most of the Basin's groundwater would fall into the second and third classes, suitable for stock watering and irrigation of salt-tolerant crops, or for stock watering only, respectively (CV-SALTS, 2017).

The main sources of salinity in the Basin's groundwater are Coast Ranges sediments of marine origin through which rainwater percolates before entering the Basin's groundwater system, concentration due to evapotranspiration where water tables are shallow, and deep percolation of irrigation water or agricultural drainage (Davis et al., 1959; Fram, 2017; Mendenhall et al., 1916; US Dept. of the Interior & CNRA 1990; Westlands Water District et al., 2018).

Discharges of TDS in the Basin from irrigated agricultural operations is regulated by the CVRWQCB through waste discharge requirements. The General Waste Discharge Requirements Orders that apply to irrigated agricultural operations are commonly referred to as the Irrigated Lands Regulatory Program (ILRP). Other sources of TDS discharges in the Basin are also regulated by the CVRWQCB under individual or general waste discharge requirements. For example, most dairies in the Basin are subject to the CVRWQCB's Reissued General Order for Existing Milk Cow Dairies. Most other facilities fall under the CVRWQCB's land discharge program, which is referred to as Waste Discharges to Land (Non-Chapter 15) Program. The Salt Control Program, an initiative of CV-SALTS, was adopted into Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) in 2018. It applies to all dischargers of salinity and includes critical goals for ensuring that those that rely on groundwater have access to safe drinking water and requires development of an implementation plan to no longer cause or contribute to exceedances from those that discharge salt in the Basin. These programs are overseen by the CVRWQCB, pursuant to its authority under the Porter-Cologne Water Quality Control Act (CWC Division 7), as described in **Section 5.2.1.1**.

Occurrence and Trends during Pre-SGMA Period (1950 – 2014)

Water with elevated TDS concentrations is common in the Upper Aquifer, especially in the southern portion of the Basin, and in areas with shallow groundwater above the A-clay, as described in **Section 7.1.4**. High TDS is common in the San Joaquin Valley, where some farmland has been rendered unusable due to salt accumulation since the 1880s (US Dept. of the Interior & CNRA, 1990). As early as 1936, the City of Dos Palos began receiving surface water deliveries to support all of its water needs, because the local groundwater in both the Upper and Lower Aquifers was (and is) too saline to be used for drinking or for irrigation in that portion of the Basin (SJREC GSA, 2022).

TDS was detected above the Upper Secondary MCL of 1,000 mg/L in 863 of 1609 wells (54 percent) sampled during the pre-SGMA time period (1950-2014) (**Table GWC-4**). **Figure GWC-32** shows the spatial distribution of average TDS concentration between 2005 and 2014 by well and presents the well counts above and below the MCL. Based on spatial interpolation of the available data and considering the thicknesses of the aquifer units, approximately 53.5 percent of the Upper Aquifer's volume has TDS concentrations greater than 1,000 mg/L and 8.8 percent has TDS concentrations over 3,000 mg/L as shown in **Figure GWC-32**. The Lower Aquifer tends to have lower TDS concentrations, though localized areas with elevated concentrations of TDS exist.

Significant migration of salinity derived from Coast Ranges sediments has occurred within the Basin due to regional groundwater gradients. Natural recharge in the mountains and foothills followed by flow towards the San Joaquin River resulted in a prevailing movement of groundwater northeastwards across the Basin under pre-development conditions (prior to around 1920) (K. R. Belitz & Heimes, 1990; Westlands Water District et al., 2018). These gradients have been intensified by pumping in adjacent basins generating cones of depression in the adjoining Madera and Chowchilla Subbasins (K. R. Belitz & Heimes, 1990; Phillips et al., 1991; Westlands Water District et al., 2018). Since TDS concentrations have historically been higher just south of the Basin than within its boundaries, these regional flow patterns have resulted in a volume of high TDS water, sometimes referred to as the "Western Saline Front", propagating eastward across the southern portion of the Basin, a phenomenon that has been noted since the early 1900s (Davis et al., 1959; Mendenhall et al., 1916; SWRCB & USGS, 2023; Westlands Water District et al., 2018). **Figure GWC-33** shows the spatial distribution of the TDS concentration trends between 1950 and 2014 by well, and presents the well counts with increasing, decreasing and no trend. Groundwater with TDS concentrations in excess of 3,000 mg/L has been observed in the southern and central parts of the Basin, and as shown in **Figure GWC-33**, increasing trends have been observed in groundwater near the Cities of Mendota, Firebaugh, Los Banos, Gustine, and Patterson (**Table GWC-6**). The migration of saline water has been identified through the northeastern migration of electrical conductivity contours in the 1990s and early 2000s, and during the same period, the Cities of Mendota and Firebaugh were obligated to install supply wells east of the San Joaquin River to ensure continued access to water of an acceptable quality (SJREC GSA, 2022).

Decreasing TDS trends were also observed in a few wells in the northern and central portions of the SJREC area as shown in **Figure GWC-33**. **Figure GWC-34** shows the locations with increasing TDS concentrations and locations with groundwater elevation trends across the Basin. Though regional groundwater level gradients are considered a significant driver of saline water migration, TDS concentrations in individual wells across the Basin appear largely independent of local groundwater levels, and increasing trends have been observed where groundwater levels are stable as shown in **Figure GWC-34**. TDS concentrations in most of the Lower Aquifer have historically been lower than in the Upper Aquifer, although concentrations have still exceeded 1,000 mg/L in many portions of the Basin. Few trends in Lower Aquifer TDS concentrations have historically been observed.

Areas in the Basin where Upper Aquifer TDS concentrations have historically been below 1,000 mg/L include the southeastern portion of the Basin near Aliso Water District, where surface water infiltrates from the Mendota Pool, the Eastside Bypass, and losing reaches of the San Joaquin River and its tributaries. The banking of CVP water at the nearby Meyers Water Bank beginning in 2002 appears to also have helped protect water quality in this region. Lower TDS concentrations can also be found near the Basin’s northwestern boundary, where ephemeral streams from the Coast Ranges recharge the groundwater. The effect of the streams is most notable in upslope locations, closest to the Basin boundary, as the water dissolves increasing amounts of salt from the underlying marine sediments as it travels downgradient (Hotchkiss & Balding, 1971). Similarly, zones of lower TDS groundwater can be found near Los Banos Creek and another zone of lower TDS groundwater can be found on the eastern side of the Basin, near the San Joaquin River, in areas not affected by shallow saline water tables.

Occurrence and Trends during Post-SGMA Period (2015 – 2023)

Figure GWC-35 shows the spatial distribution of average TDS concentration between 2015 and 2023 by well and presents the well counts above and below the MCL. Since January 2015, TDS concentrations above 1,000 mg/L have persisted in the Upper Aquifer across the Basin, with zones of very high-salinity water (with TDS concentrations in excess of 3,000 mg/L) in the central and southern portions of the Basin as shown in **Figure GWC-35**. TDS was detected above the Upper Secondary MCL of 1,000 mg/L in 189 of 338 wells (56 percent) sampled during the post-SGMA time period (2015-2023) (**Table GWC-5**). The TDS contours suggest a slight (2.6 percent) increase in volume of the Upper Aquifer exceeding the Upper Secondary MCL.

Figure GWC-36 shows the spatial distribution of the TDS concentration trends between 2015 and 2023 by well, and presents the well counts with increasing, decreasing and no trend. Increasing TDS trends have continued in many of the locations where they were historically observed, including near the City of Mendota and north of Los Banos; however, short-term decreasing trends have also been observed, particularly in parts of the southeast portion of the basin that may be exhibiting water quality benefits from water banking activities, as shown in **Figure GWC-36** and **Table GWC-7**. TDS concentrations remain lower in the Lower Aquifer with few significant trends, though groundwater with TDS above 1,000 mg/L continues to be present in many locations.

8.5.2.6 Hexavalent Chromium

Background Information

Hexavalent chromium (i.e., chromium VI or chrome 6) is the more mobile of chromium's two naturally occurring oxidation states (chromium III and chromium VI). Hexavalent chromium is a human carcinogen with a HBSL of ug/L (USGS, 2024). The SWRCB has approved a primary MCL for hexavalent chromium of 10 ug/L in April 2024 (SWRCB, 2024b). Within the Basin, it is most commonly found in oxic waters of the Upper Aquifer, particularly within sediments originated in the Coast Range, but can also be found in the Lower Aquifer (Dubrovsky et al., 1991; Fram, 2017; SWRCB & USGS, 2023). Chromium VI concentrations in well water throughout most of the Basin have been shown to be significantly correlated with outcrops of serpentinite rocks, further suggesting that geology exerts significant control on chromium VI's occurrence (Hausladen et al., 2018; Morrison et al., 2009). It has also been suggested that agricultural activities in the Central Valley could contribute to chromium VI concentrations in groundwater via oxidation of naturally occurring chromium III during irrigation cycles (Hausladen et al., 2018; Mills et al., 2011). Correlations between nitrate and chromium VI are sometimes cited as evidence of this phenomenon; however, this correlation has been found to be weaker in most of the Basin than in other parts of the state (Hausladen et al., 2018).

Occurrence and Trends during Pre-SGMA Period (1950 – 2014)

Chromium VI was detected above the Primary MCL of 10 ug/L in 136 of 319 wells (43 percent) sampled during the pre-SGMA time period (1950-2014) (**Table GWC-4**). Chromium VI has been noted as a potential concern for the City of Patterson's drinking water supplies, with concentrations between the new MCL of 10 ug/L and the preexisting HBSL of 20 ug/L regularly detected in the City's municipal well water for over a decade (Northern and Central Delta-Mendota GSAs, 2022; SWRCB, 2023c).

Figure GWC-37 shows the spatial distribution of average chromium VI concentration between 2005 and 2014 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. **Figure GWC-38** shows the spatial distribution of the chromium VI concentration trends between 1950 and 2014 by well, and presents the well counts with increasing, decreasing and no trend. Elevated chromium VI has been historically detected throughout the northern and central portions of the Basin, primarily in the Upper Aquifer. Increasing trends have been observed near the City of Los Banos. Few MCL exceedances or trends have been observed in the Lower Aquifer, though data for the Lower Aquifer are less available as shown in **Figure GWC-37, Figure GWC-38** and **Table GWC-6**. While few sites in the Basin have chromium VI and groundwater level data collected at the same time, those with data do not suggest any relationship between groundwater levels and chromium VI concentrations (**Appendix I**). This finding supports the relative importance of geology over irrigation-induced oxidation as a major control on chromium VI occurrence.

Occurrence and Trends during Post-SGMA Period (2015 – 2023)

Since January 2015, chromium VI was detected above the Primary MCL of 10 ug/L in 98 of 127 wells (77 percent) (**Table GWC-5**). **Figure GWC-39** shows the spatial distribution of average chromium VI concentration between 2015 and 2023 by well, and presents the well counts exceeding the MCL, below the MCL and with no detection. Few measurements have been recorded from the Lower Aquifer, though available data show only three exceedances in that aquifer as illustrated in **Figure GWC-39**. Concentrations above the State primary MCL of 10 ug/L continue to be detected in Patterson's municipal well water.

Figure GWC-40 shows the spatial distribution of the chromium VI concentration trends between 2015 and 2023 by well, and presents the well counts with increasing, decreasing and no trend. Elevated chromium VI continues to be detected in the Upper Aquifer in the northern and central regions of the Basin, including near the Cities of Los Banos, Patterson, and Newman since January 2015. Increasing concentration trends have continued near the City of Los Banos and in one well near Crows Landing, while decreasing trends have been observed near Newman and in one well near Patterson as indicated in **Figure GWC-40** and **Table GWC-7**.

8.5.2.7 Other Constituents of Interest

Elevated boron and selenium, primarily from natural sources, have also been observed in parts of the Basin. Boron and selenium may be concentrated in shallow groundwater in agricultural areas due to evaporation and, in some instances, the introduction of boron-containing agricultural or industrial chemicals (S. J. Deverel & Fujii, 1987; S. Deverel & Millard, 1988; Hotchkiss & Balding, 1971; SWRCB, 2017b). Boron is not considered a primary COC, because it is has no enforceable regulatory threshold for groundwater and is not a health concern. Selenium has a State and Federal primary MCL of 50 ug/L, which has only been exceeded in one Basin well since 2015 (SWRCB, 2017c; SWRCB & USGS, 2023).

Boron and selenium can damage crops at high concentrations and have also been of concern within and to the south of the Grassland GSA area, where high-selenium agricultural drainage water being used to manage wetlands was discovered in 1986 to be causing wildlife deformities (Grassland GSA and Merced County, 2022). The Grassland Bypass Project was subsequently initiated to prevent the introduction of low-quality water to the wetlands in the Grassland area (SLDMWA, 2019). The use of groundwater from the southern portion of the Grassland GSA Group is minimal due to its salinity and, in some cases, elevated boron and selenium concentrations.

8.5.3 Point-Source Contamination Sites

In addition to the widespread non-point source groundwater quality COCs, there are 505 potential point-source contamination sites located within the Basin that historically or currently have the potential to influence shallow groundwater quality, as depicted in **Figure GWC-41**. These sites are mostly associated with military, industrial, or commercial land uses (e.g., gas stations), and are comprised of 201 closed Leaking Underground Storage Tank (LUST) Cleanup sites, 17 open LUST Cleanup sites, 67 closed Site Cleanup Program locations, 18 open Site Cleanup Program locations, 11 closed Military Cleanup Program locations, one open Military Cleanup Program location, 94 permitted Underground Storage Tank (UST) sites, 18 Land Disposal sites, five Waste Discharge Requirement (WDR) sites, 60 Department of Toxic Substances Control (DTSC) Cleanup sites, and two DTSC Hazardous Waste sites The 36 active cleanup sites (LUST Cleanup, Site Cleanup Program, and Military Cleanup Program) are listed in **Table GWC-8.**

Included in the open Site Cleanup Program locations is the site of the former Spreckels Sugar Company, located in Fresno County Management Area A (MAA). From 1961 to 2008, the company used the Steffens Process to refine sugar, which produces a non-toxic filtrate with a very high concentration of salt. Until 1990, this filtrate was disposed to onsite ponds (125 acres) and had significant impacts on soil and groundwater quality in portions of the Farmers Water District and Fresno County MAA (County of Fresno GSA, 2022; Farmers Water District, 2022). Groundwater monitoring initiated in the 1980's has indicated that high salinity groundwater, referred to as the "Steffens Plume", has migrated northeastward from the site due to groundwater pumping onsite and near Mendota Pool (CVRWQCB, 2018).

In 2018, the CVRWQCB designated the former Spreckels Facility as a Site Cleanup Program location and issued a Cleanup and Abatement Order (CAO). (CVRWQCB, 2018). The CAO mandates that the parties responsible for the contaminated groundwater develop a plan that will prevent the further spread of the contaminated groundwater and meet the outlined groundwater quality objectives based on the upper tolerance bounds for background TDS concentration (Farmers Water District, 2022). Groundwater at the site is monitored semiannually and an evapotranspirative cover was constructed to close the former ponds in accordance with the site's Closure and Post-Closure Maintenance Plan (Spreckels Sugar Company, Inc., 2021). In 2022, a site assessment was conducted to delineate the horizontal and vertical extent of groundwater impacted by the Steffens Plume below the A-clay north of the Site and to identify factors that may affect the quality of domestic water supplies south of Whitesbridge Avenue. The assessment concluded that the plume extended approximately one mile northeast of the ponds in the Upper Aquifer and recommended that a feasibility study be conducted to evaluate remediation options (Spreckels Sugar Company, 2022). The Mendota Pool Group submitted a letter in response to the assessment contending that the plume extended into the Farmers Water District and requesting that additional monitoring wells be installed near the bottom of the Upper Aquifer (Mendota Pool Group, 2023). In March 2023, CVRWQCB agreed that additional monitoring was needed to delineate the extent of the plume and particularly to determine whether it is the cause of increasing TDS observed in one of the Farmers Water District's wells. The CVRWQCB instructed Spreckels Sugar Company to submit plans for additional monitoring and to conduct a Feasibility Study and Remedial Options Evaluation (CVRWQCB, 2024a, 2024b). The GSAs will continue to closely follow the status of the future monitoring and remediation activities under the CAO to protect nearby beneficial users.

Table GWC-8. Summary of Active Point-Source Contamination Sites

Site Name	City	Regulating Program	Status
Chevron TAOC OHM Pump Station	Vernalis	Site Cleanup Program	Open - Site Assessment
Crows Landing Naval Auxiliary Landing Field-Administration Area Plume	Crows Landing	Military Cleanup Program	Open - Remediation
Former Tidewater Associated Oil Company (TAOC) Right of Way, Gustine	Gustine	Site Cleanup Program	Open - Site Assessment
Gustine High School	Gustine	LUST Cleanup Program	Open - Eligible for Closure
Gustine Maintenance Yard	Gustine	LUST Cleanup Program	Open - Site Assessment
Nutrien Ag Solutions (Crop Production Services), Vernalis	Vernalis	Site Cleanup Program	Open - Site Assessment
PRC Patterson	Patterson	Site Cleanup Program	Open - Verification Monitoring
Q Plus	Crows Landing	LUST Cleanup Program	Open - Eligible for Closure
Sun Dry Products	Vernalis	Site Cleanup Program	Open - Remediation
WH Breshears, Newman Facility	Newman	Site Cleanup Program	Open - Remediation

Site Name	City	Regulating Program	Status
Ag & Industrial Supply Inc. (Former)	Firebaugh	LUST Cleanup Program	Open - Site Assessment
Alliance Petroleum	Firebaugh	Site Cleanup Program	Open - Assessment & Interim Remedial Action
Big G's Automotive Center	Firebaugh	LUST Cleanup Program	Open - Site Assessment
Camacho Property	Firebaugh	LUST Cleanup Program	Open - Site Assessment
Central Valley Fertilizer	Dos Palos	Site Cleanup Program	Open - Assessment & Interim Remedial Action
Choperena Tire Disposal Site (Panoche Burn Site)	Firebaugh	Site Cleanup Program	Open - Site Assessment
Crop Production Services (CPS) Oxalis	Oxalis	Site Cleanup Program	Open - Remediation
Dan's Exxon	Dos Palos	LUST Cleanup Program	Open - Remediation
Dos Palos Y BP Station	Dos Palos	LUST Cleanup Program	Open - Site Assessment
Forebay Chevron	Santa Nella	LUST Cleanup Program	Open - Assessment & Interim Remedial Action
Former Trent Pump Station	Los Banos	Site Cleanup Program	Open - Site Assessment
Hamburg Ranch - Flores Parcel	Firebaugh	Site Cleanup Program	Open - Site Assessment
Italo's Mini Mart	Firebaugh	LUST Cleanup Program	Open - Remediation
Las Deltas Grocery	Firebaugh	LUST Cleanup Program	Open - Site Assessment
Los Banos Gateway Center, LLC - 1159 G Street Site	Los Banos	Site Cleanup Program	Open - Site Assessment
Meza Brothers, Inc.	Los Banos	Site Cleanup Program	Open - Site Assessment
Nicoletti Oil, Inc.	Dos Palos	Site Cleanup Program	Open - Remediation
Ramirez Property	Firebaugh	LUST Cleanup Program	Open - Site Assessment
San Luis Reservoir S.R.A.	Gustine	LUST Cleanup Program	Open - Site Assessment
Santos Texaco #2	Los Banos	LUST Cleanup Program	Open - Site Assessment
Shaibi Market	Dos Palos	LUST Cleanup Program	Open - Eligible for Closure
Simplot - Firebaugh	Firebaugh	Site Cleanup Program	Open - Site Assessment
Spreckels Sugar Co.	Mendota	Site Cleanup Program	Open - Assessment & Interim Remedial Action
Tri-Air, Inc.	Firebaugh	Site Cleanup Program	Open - Site Assessment
Vacant Building	Mendota	LUST Cleanup Program	Open - Site Assessment
Westside Ford Lincoln Mercury	Firebaugh	LUST Cleanup Program	Open - Remediation

Abbreviations:
LUST = Leaking Underground Storage Tank

8.5.4 Efforts to Address Impacts to Beneficial Users

Perched water in agricultural areas, including the Firebaugh Canal Water District, CCID's Camp 13 area, and other locations upgradient, has proved problematic due to salinity and waterlogging of soils. These areas are part of the Grassland Basin Drainage Area, a 97,000-acre region overlapping the southern Basin and the northern Westside Subbasin. Perched water below the Firebaugh Canal Water District has been classified as a saline sink, and perched water throughout the region is highly detrimental to agriculture unless managed (SJREC GSA, 2022; USBR, 2015). The perched water table of the Grassland Basin Drainage Area have historically been managed through the use of tile drains which discharged via the San Luis Drain to the Kesterson Reservoir, from which the water was intended to be transported to the Delta for disposal and to the Grassland Water District for use in managed wetlands. Plans to export the drainage water to the Delta were abandoned in the 1970s due to environmental concerns, and application of the water to wetlands and the Kesterson Reservoir was discontinued in 1986 due to accumulation of naturally occurring salts and selenium. Beginning in 1986, the Grassland Bypass Project conveyed the drainage water to tributaries of the San Joaquin River. Through source control to reduce agricultural drainage and reuse of drainage water for irrigation, the farmers and water managers were able to reduce the discharge of drainage water to the river. This was facilitated by the San Joaquin River Improvement Project (SJRIP), which was initiated in 2001 with funding from the State of California Proposition 13 to cultivate salt-tolerant forage crops on dedicated farmland. By 2014, drainage discharge to the San Joaquin River had been eliminated in summer months, reducing salt loading by over 100,000 tons per year (Grassland Basin Authority, n.d.; Grassland GSA and Merced County, 2022; Panoche Water District, 2001; SJREC GSA, 2022; US Dept. of the Interior & CNRA, 1990).

In 2019, the Grassland Basin Authority was formed to manage drainage in the Grassland Basin Drainage Area. The Grassland Basin Authority is now responsible for the SJRIP, which utilizes strategic pumping and subsurface drains to capture agricultural drainage water. The water collected by the SJRIP is used to irrigate approximately 5,500 acres of forage crops such as Jose Tall Wheat Grass, along with pistachios used for saline irrigation strategy research by the University of California Agriculture and Natural Resources program. The SJRIP actively monitors local groundwater quality for any potential problems with selenium or salts (Grassland Basin Authority, n.d.; Grassland GSA and Merced County, 2022; SJREC GSA, 2022). Facilities associated with the Grassland Bypass Project have been repurposed for stormwater management. The Grassland Bypass Project Long–Term Storm Water Management Plan is intended to route storm-induced discharges to Mud Slough, which runs through the San Luis National Wildlife Refuge and the California Fish and Wildlife Service's China Island to the San Joaquin River,, and will facilitate better management of salt and selenium-bearing water (SLDMWA, 2019).

8.6 Land Subsidence

§ 354.16. Groundwater Conditions
(e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

☑ **23 CCR § 354.16(e)**

Declining groundwater levels can cause a release of "water of compaction" from compacting silt and clay layers (aquitards) resulting in land subsidence (Galloway & Riley, 1999). Such subsidence may be elastic (reversible) or inelastic (permanent) depending on the geotechnical properties of the soil and the changes in effective pressure caused by groundwater extraction. The effects of inelastic subsidence accumulate over time and frequently exhibit delayed responses due to the slow compaction of less permeable units (GSI Environmental Inc., 2022). While subsidence in the San Joaquin Valley has been attributed to a number of sources, including the hydrocompaction of moisture-deficient deposits above the water table, fluid withdrawal from oil and gas fields, deep-seated tectonic movements, and oxidation of peaty soils, the largest magnitude and areal extent of land subsidence in the San Joaquin Valley is due to aquifer-system compaction caused by groundwater pumping (Bertoldi et al., 1991; Farrar & Bertoldi, 1988;

Galloway & Riley, 1999; Ireland et al., 1984; Poland et al., 1975; Sneed et al., 2013). The majority of the San Joaquin Valley's inelastic subsidence can be attributed to pumping groundwater from below the Corcoran Clay, which causes compaction and reduces storage in the fine-grained materials in the lower confined aquifer (Delta-Mendota GSAs, 2022a).

Land subsidence is a prevalent issue in the Basin which has impacted prominent infrastructure of statewide importance, namely the DMC and the California Aqueduct, in addition to other facilities including the San Joaquin River Bifurcation, Sack Dam, Mendota Dam, the Chowchilla Bypass, and the Mendota Pool/ San Joaquin River Levee Systems (GSI Environmental Inc., 2022). Several of these pieces of infrastructure are underlain by large amounts of fine-grained sediments, increasing their susceptibility to subsidence (GSI Environmental Inc., 2022). Subsidence along the DMC and California Aqueduct can lead to reduced freeboard and flow capacity, with rippling effects on imported water availability throughout the State. Even modest amounts of subsidence in critical locations, especially where canal gradients are small, can impact canal operations (Sneed & Brandt, 2015). Subsidence within the Basin has reduced flow capacity on the DMC by as much as 1,000 cubic feet per second, and USBR anticipates that without correction, flows would need to be reduced by 37 percent of its original design capacity by 2035 and by 44 percent by 2070 to meet USBR requirements for minimum freeboard and clearance under bridges (USBR, 2014; USBR & SLDMWA, 2023)[32]. The USBR and SLDMWA have initiated an environmental assessment and feasibility study for a subsidence correction project to return the DMC to its design capacity and maintain it for at least 50 years following completion. The restoration plans assume a maximum of two feet of additional inelastic subsidence by 2040 and elastic subsidence throughout the canal's lifetime (USBR & SLDMWA, 2023). Additional subsidence impacts have been noted at Mendota Dam and Sack Dam, both of which have been considered for repair or replacement, and throughout the SJREC surface water distribution network, which by 2017 had experienced a 30 percent loss of capacity (SJREC GSA, 2022).

The GSAs within the Basin have conducted subsidence monitoring at key sites near critical infrastructure and across Basin, as shown in **Figure GWC-42**. Publicly available data collected from multiple sources, including the SJRRP, USBR surveying along the DMC, USGS extensometer data, and the EarthScope Consortium's (formerly UNAVCO) CGPS network, have been evaluated for seamless Basin-wide coverage. The extent, cumulative total, and annual rate of historical and recent land subsidence are discussed below with respect to two sequential time periods representing pre-SGMA (prior to WY 2015) and post-SGMA conditions (WY 2015 – WY 2023). Subbasin GSAs have also coordinated closely with key entities in the development of this GSP, including staff from USBR, SLDMWA and GSAs that are responsible for this critical infrastructure.

8.6.1 Pre-SGMA Subsidence (WY 1926 – WY 2014)

Subsidence in the San Joaquin Valley and the Basin tends to correspond with lack of surface water availability, with the most severe subsidence occurring in times of drought or reduced deliveries (Northern and Central Delta-Mendota GSAs, 2022). While subsidence has occurred within the Basin, the most significant hotspots have historically been located outside of the Basin, to the south and east in areas associated with cones of groundwater depression.

[32] See Figure 2-1 in the main body of USBR & SLDMWA, 2023 and Figure 1 in Appendix D of USBR & SLDMWA, 2023 for observed and anticipated reductions in flow capacity.

Prior to Imported Water Deliveries

Land subsidence from groundwater pumping began in the San Joaquin Valley in the mid-1920s (Bertoldi et al., 1991; Galloway & Riley, 1999; Poland et al., 1975) and by 1970, about half of the San Joaquin Valley had experienced land subsidence of more than a foot (Poland et al., 1975). Along the DMC, in the northern portion of the San Joaquin Valley, extensive groundwater extraction from unconsolidated deposits caused subsidence of approximately 28 feet between 1926 and 1970 (Poland et al., 1975), reaching 30 feet in 1980 (Ireland, 1986).

Post-Imported Water Deliveries

When groundwater pumping decreased in the Basin following the start of imported water deliveries from the CVP via the DMC in the early 1950s, compaction rates were reduced in certain areas and groundwater levels recovered to near predevelopment levels. After 1974, land subsidence was demonstrated to have slowed or largely stopped (DWR, 2017b); however, land subsidence remained poised to resume under certain conditions. Such examples include the severe droughts that occurred between 1976 and 1977 and between 1987 and 1992. Those droughts, along with other corroborating factors, led to diminished deliveries of imported water which prompted some water agencies and farmers (especially in the western Central Valley) to refurbish old pumps, drill new water wells, and begin pumping groundwater to make up for cutbacks in the imported water supply (Delta-Mendota GSAs, 2022a). However, following these droughts, compaction virtually ceased and groundwater levels rose to near pre-drought levels quite rapidly as a result of reduced groundwater pumping and the resurgence of imported water supplies (Galloway et al., 1999; Swanson, 1998).

Subsidence observed in the northern San Joaquin Valley in 1926-1970 was centered southwest of the City of Mendota, outside of the Basin (Poland et al., 1975). DWR's compilation of historical subsidence maps from 1945-2005 show the same pattern, as indicated in **Figure GWC-43** (DWR, 2019). Historical subsidence rates in the Mendota area exceeded 1.6 feet/year) during the mid-1950s and early 1960s (Ireland et al., 1984). The area southwest of Mendota has experienced some of the highest levels of subsidence in California, where from 1925 to 1977, this area sustained over 29 feet of subsidence (USGS & California Water Science Center, 2017). Historical subsidence rates along Highway 152 calculated from leveling-survey data from 1972, 1988, and 2004 show that for the two 16-year periods (1972-1988 and 1988-2004), maximum subsidence rates of about 50 millimeters/year (approximately 0.16 feet/year) were found just south of the El Nido-Red Top area, to the east of the Basin boundary (Sneed et al., 2013). **Figure GWC-44** shows the geodetic surveys completed along the southern half of DMC in 1935, 1953, 1957, 1984, and annually from 1996-2001. The survey results indicated that subsidence rates were greatest between the 1953 and 1957 surveys, and that the maximum subsidence along the DMC (about 3.0 meters, or about 10 feet) was just east of DMC Check Structure Number 18 (Delta-Mendota GSAs, 2022a; Sneed et al., 2013).

Recent Pre-SGMA Subsidence

The CGPS data collected between 2007 to 2014 show seasonally variable subsidence and compaction rates, including uplift from elastic rebound occurring during the fall and winter (Sneed & Brandt, 2015). Vertical displacement data at Station P303, near the City of Los Banos, indicate subsidence at fairly consistent rates during and between drought periods (Sneed & Brandt, 2015). Vertical displacement data at Station P304, near the City of Mendota, indicate that most subsidence occurred during drought periods with very little occurring between drought periods. Data from extensometers 12S/12E-16H2, located on the DMC west of Los Banos, and 14S/13E-11D6, located between the DMC and California Aqueduct west of Mendota, showed subsidence rate increases during 2014, the third year of the most recent pre-SGMA drought (Sneed & Brandt, 2015). Meanwhile, the El Nido–Red Top area experienced a yearly subsidence rate of 0.95 feet per year between December 2014 and December 2015, as recorded by the SJRRP Global Positioning System (GPS) network (SJRRP, 2023).

The California Aqueduct, which runs parallel and in close proximity to the DMC across the Basin, is infrastructure of statewide importance. During construction of the California Aqueduct, it was thought that subsidence within the San Joaquin Valley would cease with the delivery of water from the CVP, though additional freeboard was incorporated into the design and construction of the California Aqueduct in an attempt to mitigate for future subsidence (DWR, 2017b). After water deliveries from the California Aqueduct began in the late 1960's, subsidence rates along the Aqueduct just south of the Basin decreased to an average of 0.025 feet per year during normal to wet hydrologic years. During dry to critical hydrologic years, however, subsidence rates averaged approximately 0.042 feet per year. During the drought years of 2013 to 2015, the same reach of the California Aqueduct experienced a subsidence rate of 0.033 feet per year, in line with other dry periods; however, more southern reaches saw subsidence rates similar to those seen before the Aqueduct began delivering water, with some areas experiencing nearly 0.10 feet of subsidence per month (based on NASA Uninhabited Aerial Vehicle Synthetic Aperture Radar [UAVSAR] flight measurements). Since California Aqueduct deliveries began, dry and critically dry water years (with lower deliveries) have resulted in extensive groundwater withdrawals, resulting in over a foot of subsidence near the Aqueduct at the Basin's southern end and nearly six feet in the subsidence hotspot located south of the Basin (DWR, 2017b).

8.6.2 Post-SGMA Subsidence (WY 2015 – WY 2023)

Based on subsidence rates observed over the last decade, it is anticipated that without mitigation within and outside of the Basin, subsidence will continue to impact operations of the DMC and California Aqueduct, particularly in areas dependent on groundwater from the Lower Aquifer and in periods of drought. The Basin has continued to experience a combination of elastic and inelastic subsidence, with predominately inelastic subsidence documented in the 2012 - 2016 drought, while later dry periods have been followed by moderate rebounds (GSI Environmental Inc., 2022). **Figure GWC-45** shows the surveyed subsidence rates in 2014, 2016, 2018 and 2021 along the DMC. For instance, the City of Patterson is located directly east of Pool 7 of the DMC and relies entirely on the Lower Aquifer for its potable water. During the 2014-2016 drought, the area experienced 0.22 ft/yr of subsidence, which decreased to 0.06 ft/yr immediately after the drought ended (2016-2018) as indicated in **Figure GWC-45** (Northern and Central Delta-Mendota GSAs, 2022). Furthermore, Reach 4A of the San Joaquin River near Dos Palos experienced between 0.38 and 0.42 ft/yr in subsidence between 2008 and 2016. As a result of subsidence, freeboard in Reach 4A is projected to be reduced by 0.5 feet by 2026 as compared to 2016, resulting in a 50 percent reduction in designed flow capacity (DWR, 2018a).

More recent subsidence measurements indicate subsidence hot spots within the Basin include the area east of Los Banos and the Tranquillity Irrigation District (TRID) area. The USGS began periodic measurements of the land surface in the San Joaquin Valley over the last decade. Between December 2011 and December 2014, total subsidence in the El Nido-Red Top area (located to the east of Los Banos within the Merced Subbasin) ranged from 0.15 to 0.75 feet (SLDMWA, 2015). Though centered outside of the Basin, subsidence has extended from this hotspot into the Basin. The Jet Propulsion Laboratory (JPL) at the California Institute of Technology has also monitored subsidence in California using InSAR. This monitoring has been continued by DWR through its contract with TRE ALTAMIRA Inc. (DWR, 2023g).

A recent report from NASA documenting data for the period from May 2015 to September 2016 indicates that the two previously-identified primary subsidence areas originating outside the Basin near the community of Corcoran (approximately 46 miles southeast of the Basin) and centered on the El Nido-Red Top area were joined by a third area of significant subsidence within the Basin near TRID (NASA JPL, 2020). **Figure GWC-46** shows the subsidence rate in the vicinity of San Joaquin River from the report. **Figure GWC-47** shows the subsidence rate in TRID area. For the study period, total subsidence near the City of Corcoran, El Nido-Red Top area, and TRID area was 1.8 feet, 1.25 feet and 1.7 feet, respectively. In response to the increased subsidence, TRID has initiated semiannual surveying and is working to reduce Lower Aquifer pumping and optimize the timing and spatial distribution of pumping to limit subsidence. Local survey data show as much as 4.14 feet of subsidence in TRID since monitoring began in 2013, with the majority occurring prior to 2017 as indicated in **Figure GWC-47**. Similar trends have been noted in many locations throughout the Basin, as Lower Aquifer pumping declined in 2017 in response to the renewed availability of surface water deliveries (Delta-Mendota GSAs, 2022a).

In the years following the NASA JPL study, InSAR data have indicated that the hotspot formerly situated in the El Nido-Red Top area has shifted southeast and is now centered in the Chowchilla and Madera Subbasins, where it has become a significant maintenance concern for Sack Dam, located on the San Joaquin River east of Dos Palos. **Figure GWC-48** shows the total subsidence measured by InSAR from June 2015 to June 2023 around the Basin compared with the total subsidence measured by the SJRRP's GPS network for the overlapping period of July 2012 to July 2023. Between 2015 and 2023, total vertical displacement within the Basin ranged from minor uplift on the western margin of the Basin to approximately 2.2 feet of subsidence in the southeast, showing the influence of the abovementioned out-of-Basin hotspots (DWR, 2023g; SJREC GSA, 2022). The SJRRP monitoring shows good agreement with the InSAR dataset, with maximum subsidence between 2.5 and 3.0 feet on the Basin's easternmost edge between 2012 and 2023, associated with the out-of-Basin Chowchilla/Madera hotspot (SJRRP & USBR, 2023).

Figure GWC-49 shows the vertical displacements at six UNAVCO monitoring sites across the Basin, and **Figure GWC-50** and **Figure GWC-51** show the vertical displacements relative to April 2004 at UNAVCO Stations P303 and P304 respectively. High-frequency data from two CGPS stations near the El Nido-Red Top area show interesting trends. At Station P303, between 2007 and 2014, 50 mm (or approximately 0.16 feet) of subsidence occurred at this location. Vertical displacement (subsidence) at Station P303 as shown in **Figure GWC-49** and **Figure GWC-50** occurred at fairly consistent rates during and between drought periods, indicating that these areas continued to pump groundwater despite climatic variations (possibly due to a lack of surface water availability) (Sneed & Brandt, 2015). Residual compaction may also be a factor. By contrast, data from Station P304 show that most subsidence in this area occurred during drought periods and very little occurred between drought periods as shown in **Figure GWC-49** and **Figure GWC-51**. This suggests that the area received other sources of water (most likely surface water available between drought periods) and that residual compaction was not very important in this area. These two areas suggest a close link between the availability of surface water, groundwater pumping, and inelastic land subsidence (Delta-Mendota GSAs, 2022a).

This linkage has been further demonstrated by the success of the Red Top Subsidence Mitigation Project and the Subsidence Control Measures Agreement, through which CCID began providing surface water to Triangle T Water District and other water users in the Red Top area in exchange for reductions in pumping from the Lower Aquifer (Chowchilla Subbasin, 2023; SJREC GSA, 2022). These programs are helping solve a regional problem that has impacted the SJREC due to groundwater extractions outside the SJREC service area and outside of the Basin. In 2017, almost 50,000 AF of surface water was recharged directly and provided to irrigators in the adjacent basin in-lieu of them pumping groundwater. In 2018, an additional 10,000 AF of surface water was put to beneficial use in that area. Since initiation of the project, the subsidence rate at Sack Dam (San Luis Canal Company headworks) has reduced from 0.042 feet/ year to 0.012 feet/year, or by 70 percent. **Figure GWC-52** shows the subsidence rates at Sack Dam from 2012 to 2021. Subsidence rates in the following years have remained substantially lower than pre-project implementation rates as indicated in **Figure GWC-52**. As deliveries continue, the subsidence is expected to reduce to background levels (SJREC GSA, 2022). This demonstrates that collaboration across subbasin boundaries to reduce Lower Aquifer pumping can have a significant positive impact on subsidence occurring outside the Basin with benefits that also extend into the Basin.

8.6.3 Master Plan for Subsidence Monitoring and Management

In 2022, the GSAs conducted a subsidence characterization and analysis study of the Basin and used the findings to develop a *Conceptual Master Plan for Subsidence Monitoring and Management* (Subsidence Master Plan; SLDMWA, 2022)(See **Appendix J**). The Subsidence Master Plan categorized land within the Basin into six risk categories based on proximity to critical infrastructure and subsidence rates observed in the previous 10 years as shown in **Figure GWC-53**. Subsidence and groundwater monitoring and management guidelines were then established for lands in each of the risk categories (**Table GWC-9**). In response to the identified risks, the Basin's Representative Monitoring Network tracks land subsidence and Lower Aquifer water levels throughout the Basin, with emphasis on high-risk areas (**Sections 14.2.5** and **14.2.1**). Furthermore, the GSAs are enacting projects and management actions (P/MAs) to address subsidence through reductions in Lower Aquifer pumping within and adjacent to the Basin (**Section 15**). The Subsidence Master Plan also guided the development of the Pumping Reduction Plan (**Section 16.1.1**) to address subsidence in the Basin that is caused by pumping within the Basin.

DELTA-MENDOTA SGMA

Table GWC-9. Subsidence Risk Categories from the Conceptual Master Plan for Subsidence Monitoring and Management for the Delta-Mendota Subbasin

Risk Category	Criteria	Recommended Monitoring and Management Practices	GSA Group(s)	Area (acres)
1	1. Within 1 mile of DMC or critical infrastructure. 2. Subsidence rates of 0.05 ft/year or more in last decade.	• Regularly re-evaluate water level MTs to determine if they are protective of subsidence. • Cross-validate GPS stations with InSAR every 6 years. • Install pressure transducers in wells near subsidence monitoring sites. • Inventory and track major groundwater extraction wells on an ongoing basis. • Establish tiered groundwater extraction management triggers based on level of subsidence tolerated by infrastructure. • Collect yearly mid-Summer groundwater elevation measurements at all monitoring wells, in addition to Spring and Fall levels.	• Central GSA Group • SJREC GSA Group • Farmers Water District GSA Group • Aliso Water District GSA Group	44,700
2	1. More than 1 mile from DMC or critical infrastructure. 2. Subsidence rates of 0.05 ft/year or more in last decade.	• Regularly re-evaluate water level MTs to determine if they are protective of subsidence. • Cross-validate GPS stations with InSAR every 6 years. • Install pressure transducers in wells near subsidence monitoring sites. • Estimate GSA-level total pumping relative to projections. Evaluate for management if excessive extractions or subsidence observed.	• All GSA Groups	193,000

Risk Category	Criteria	Recommended Monitoring and Management Practices	GSA Group(s)	Area (acres)
3	1. Within 1 mile of DMC or critical infrastructure. 2. Subsidence rates of 0.02-0.05 ft/year in last decade.	• Regularly re-evaluate water level MTs to determine if they are protective of subsidence. • Cross-validate GPS stations with InSAR every 6 years. • Install pressure transducers in wells near subsidence monitoring sites. • Inventory and track major groundwater extraction wells on an ongoing basis. • Establish tiered groundwater extraction management triggers based on level of subsidence tolerated by infrastructure. • Collect yearly mid-Summer groundwater elevation measurements at all monitoring wells, in addition to Spring and Fall levels.	• Central GSA Group • SJREC GSA Group • Grassland GSA Group	21,200
4	1. More than 1 mile from DMC or critical infrastructure. 2. Subsidence rates of 0.02-0.05 ft/year in last decade.	• Estimate GSA-level total pumping relative to projections. Evaluate for management if excessive extractions or subsidence observed. • Regularly re-evaluate water level MTs to determine if they are protective of subsidence. • Cross-validate GPS stations with InSAR every 6 years.	• All GSA Groups	221,000
5	1. Within 1 mile of DMC or critical infrastructure. 2. Subsidence rates of less than 0.02 ft/year in last decade.	• Inventory wells if subsidence rates increase.	• Northern GSA Group • Central GSA Group • SJREC GSA Group	61,800

Risk Category	Criteria	Recommended Monitoring and Management Practices	GSA Group(s)	Area (acres)
6	1. More than 1 mile from DMC or critical infrastructure. 2. Subsidence rates of less than 0.02 ft/year in last decade.	• Estimate extractions if subsidence rates increase.	• Northern GSA Group • Central GSA Group • SJREC GSA Group • Grassland GSA Group	218,000

Abbreviations:
DMC = Delta-Mendota Canal
ft/yr = feet per year
GSA = Groundwater Sustainability Agency
InSAR = Interferometric Synthetic Aperture Radar
MT = Minimum Threshold

8.7 Interconnected Surface Water Systems

§ 354.16. Groundwater Conditions
(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

☑ 23 CCR § 354.16(f)

This section presents the identification of ISW and an estimate of the quantity and timing of depletions of those systems. ISW is defined in the GSP regulations (23 CCR § 354(o)) as "*surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.*" GDEs, including wetlands, are discussed in **Section 8.8**, and therefore not included for discussion in this section.

Measured groundwater levels and streamflow are fundamental data required to characterize the nature and occurrence of ISW. Specifically, maps showing depth to groundwater can identify areas where saturated and unsaturated conditions might exist beneath a surface water body, and streamflow gains (seepage from groundwater) or losses (leakage to groundwater) can be identified from measured changes in flow between two points along a creek, stream, or river, or estimated through the Basin's numerical model (further described in **Section 9**).

ISW can be affected by changes in groundwater levels and aquifer storage. ISW "depletions" occur where groundwater pumping results in reductions in flow or water levels of ISW (DWR, 2024b). In areas of declining groundwater levels, the depletion rate increases until the water table falls beneath the bottom of the river/stream channel and surface water becomes "disconnected" from the underlying groundwater. Under these disconnected conditions, the potential for surface water leakage is greatest and maximum depletion rates occur. Hence, once a surface water body has become disconnected from the underlying groundwater system, the surface water depletion rate is independent of future changes (i.e., reductions) in groundwater levels and aquifer storage. Available groundwater level and stream data compiled for the Basin and simulated historical conditions by the numerical model (further described in **Section 9**) were considered in the evaluation of the potential for ISW and surface water depletions.

8.7.1 Measured Relationship Between Groundwater Levels and Streamflow

The ISW analysis in the Basin relies on natural surface water bodies delineated in the USGS National Hydrography Dataset (NHD). Perennial and intermittent surface water bodies are most likely to be ISW, while ephemeral surface water bodies are generally not ISW, as their channel bottoms remain above the water table (DWR, 2024b). To construct a representative stream network for the Basin, data from the NHD dataset and local maps were utilized. This process involved excluding delivery and diversion structures, irrigation canals, and ephemeral surface water bodies, as illustrated in **Figure GWC-54**.

The resulting stream network includes the San Joaquin River, Del Puerto Creek, Orestimba Creek, Los Banos Creek, and Fresno Slough. Comparisons of the groundwater table and the elevation of the bottom of the surface water body (streambed) and the stream discharges were used to determine if a surface water body is an ISW. The groundwater table was characterized by Spring 2014 (pre-SGMA) groundwater elevations in shallow Upper Aquifer wells located in a two-mile radius from surface water features.[33] Per SGMA regulations, "The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015." (CWC § 10727.2(b)(4)). Elevation of the streambed was characterized using ground elevation from LIDAR data.

Methodologies used to identify ISW within the Basin is consistent with the DWR Guidance (DWR, 2024b). A surface water body with nearby groundwater elevations above or similar to the adjacent streambed elevation was identified as ISW. A surface water body with nearby groundwater elevations less than 30 feet below the streambed elevation was identified as potential ISW. A surface water body with nearby groundwater elevation more than 30 feet below the streambed elevation was identified as likely disconnected and not an ISW.

Additionally, streams which had no measured flows for extended period of the year based on historical stream gage data were identified as ephemeral and considered to be likely disconnected. The data for this analysis were obtained from the stream gage networks of USGS, United States Army Corps of Engineers (USACE), and SJRRP. As shown on **Figure GWC-55**, where shallow wells with historical data were available, their measured groundwater elevations were compared to the closest two-mile section of the streambed. Due to the limited number of shallow wells along surface water bodies with groundwater elevations, this analysis could only be performed for selected sections of the San Joaquin River, Orestimba Creek, Fresno Slough and Los Banos Creek.

Figure GWC-56 shows the elevation profile of the San Joaquin River indicating potential interconnected conditions from mile 16 through 106 (mileposts are shown in **Figure GWC-55**). Similar elevation profile analyses in **Figure GWC-57**, **Figure GWC-58** and **Figure GWC-59** for Orestimba Creek, Los Banos Creek and Fresno Slough, respectively, indicate that the differences in elevation between the estimated streambeds

[33] Fall 2014 groundwater conditions were used to characterize pre-SGMA conditions in other sections of this GSP, but Spring 2014 was used herein to characterize pre-SGMA ISW conditions more conservatively.

and the available groundwater measurements are more than 30 feet. Furthermore, analysis of the measured streamflows at stream gages upstream of Orestimba Creek and Los Banos Creek indicates extended dry periods, including no flows during WY 2014, as shown in **Figure GWC-60** and **Figure GWC-61**. **Figure GWC-62** shows the depth to water profiles of shallow monitoring wells in the vicinity of the Orestimba Creek. It can be inferred that the well runs dry and does not show any response to flows in the creek. Therefore, Los Banos Creek, Fresno Slough, and Orestimba Creek are identified as likely disconnected and not ISW.

Due to lack of shallow groundwater measurements in the vicinity of the Del Puerto Creek, this tributary has been identified as a data gap and has been classified as Uncertain/Likely Disconnected since the available streamflow measurements represented in **Figure GWC-63** indicate that the creek runs dry for extended periods of the historical record.

To examine whether the portions of the streams that were identified as potential ISW have a quantifiable relationship to the principal aquifer, the potential correlation between Upper Aquifer groundwater elevation and stream stage measured from stream gauges over a common timeframe (between 2007 and 2020) were evaluated. A linear correlation between the stream stage and the local groundwater elevation was then evaluated for each station, as shown on **Figure GWC-55**. A positive correlation would mean that, when the stream stage increases, the groundwater elevation also increases, indicating that there is potential interconnectivity between the stream and groundwater, and vice versa.

Among the stream gauging stations, stations along the San Joaquin River exhibited statistically significant positive correlations between stream stage and groundwater elevation data.[34] Groundwater elevation measurements from the wells and streamflow data from stream gauging stations are generally limited for other tributaries, and thus there is insufficient data to support statistically significant correlation between groundwater levels and monthly average stream stage data. **Figure GWC-64** summarizes the results of the ISW analysis and classification of the streams in the Basin. Using the best available data, science, and tools, miles 16 to 106 of the San Joaquin River is identified as potential ISW (likely connected) and will be subject to definition of depletion of ISW sustainable management criteria. Historically, most of the San Joaquin River, which forms the majority of the Basin's eastern border, was a gaining reach (Delta-Mendota GSAs, 2022a). Snowmelt runoff during the Spring and early Summer resulted in these conditions through a good portion of the year. However, significant decreases in groundwater elevations due to a myriad of factors, including pumping in adjacent basins, tile drains, the channelizing of flood flows, and upstream diversions on the river, have reversed this condition so most reaches are now losing reaches (Delta-Mendota GSAs, 2022a). Some localized gaining reaches still remain on the lower river, such as between the Stanislaus and Merced Rivers; however, many reaches along these rivers (and along localized streams) may transition from gaining to losing depending on hydrology (Delta-Mendota GSAs, 2022a).

8.7.2 Model-Calculated Streamflow Depletions

Depletions of ISW are measured as a rate or volume of water removed from the stream. However, it is noted that only depletions of ISW caused by groundwater use are considered Undesirable Results; other causes of depletion are outside of the purview of the GSAs to manage under SGMA. Available data are

[34] For the purpose of this analysis, correlation with a p-value that is less or equal to 0.05 is considered to be significant.

insufficient to directly calculate surface water depletions due to groundwater use from streamflow measurements or to estimate depletions from a surface water budget. Estimates of depletions due to groundwater pumping (use) therefore rely on application of the numerical model (Model) described in **Section 9**. The representation of ISWs in the Model grid, shown in **Figure GWC-65**, is used to calculate total depletion rate and depletion rate caused by groundwater pumping (use).

Surface water depletions occur when surface water leakage out of the river channel is greater than groundwater seepage into the river, resulting in a net depletion (loss) of surface water from the river. **Table GWC-10** shows model-calculated depletions for the potential ISW for WY 2014 (pre-SGMA conditions), the historical water budget period WY 2003-2018, and current water budget period WY 2019-2023. The depletion rate is determined by river flow and stage, hydraulic conductivity of the streambed, hydraulic conductivity of the underlying aquifer materials, and the difference between river stage and adjacent groundwater levels. The long-term Historical (WY 2003-2018) average annual depletion within potential interconnected reaches (San Joaquin River) in the Basin is approximately 94,832 AFY and was 118,888 AFY in WY 2014 (pre-SGMA). The Current (WY 2019-2023) average annual depletion within these interconnected reaches is approximately 132,558 AFY. Depletions of ISW are smallest during low flow conditions because of low surface-water flow and stage. The greatest volume of depletions of ISW happen during high flow conditions, specifically during periods of runoff following the dry Summer and Fall when groundwater levels are lowest.

Table GWC-10. Calculated Depletions for the Potential ISW

Water Year	ISW	Winter (AFY)	Spring (AFY)	Summer (AFY)	Fall (AFY)	Total (AFY)
WY 2014 (Pre-SGMA)	San Joaquin River	-18,095 (-25)	-2,539 (-3.5)	-76,105 (-105)	-22,149 (-31)	-118,888 (-164)
Average WY 2003 - WY2018 (Historical Period)	San Joaquin River	-29,647 (-41)	-33,534 (-46)	-18,520 (-26)	-13,132 (-18)	-94,832 (-131)
Average WY 2019 - WY2023 (Current Period)	San Joaquin River	-51,950 (-72)	-35,455 (-49)	-25,934 (-36)	-19,218 (-27)	-132,558 (-183)

Abbreviations:
AFY = acre-feet per year
ISW = Interconnected Surface Water
WY = water year

Notes:
(1) Depletion rates are calculated for the interconnected section of ISW.
(2) For the purpose of this analysis, Spring is defined to be March to May, Summer is defined to be June to August, Fall is defined to be September to November, and Winter is defined to be December to February each year.
(3) Values in parentheses are in cubic feet per second.

Pumping lowers groundwater levels, which can result in a reduction in streamflow or volume of water in a surface water body in two ways: (1) a reduction of inflow to an ISW from groundwater, or (2) an increase in outflow from an ISW to groundwater (DWR, 2024b). Additionally, the relationships between groundwater levels and depletions can be influenced by the hydraulic gradient between groundwater systems on either side of a river.

Depletion of ISWs caused by groundwater management (pumping) within the Basin is estimated by comparing Model's baseline scenario with a "no pumping" scenario (**Section 9**). The no pumping scenario simulates Basin conditions when zero groundwater pumping is occurring within the Basin, while holding all other factors the same (i.e., pumping in adjacent basins). Differentiating the baseline scenario from the no pumping scenario isolates the impacts of Basin pumping on different aspects of the Basin groundwater conditions, including depletion of ISW. As shown in **Table GWC-11**, the WY 2014 (pre-SGMA) depletion rate caused by pumping within the Basin is estimated to be 11,948 AFY within the potential ISW reaches, while the long-term historical average annual depletion rate caused by Basin pumping is approximately 6,686 AFY. The Current (WY 2019-2023) average annual depletion within these ISW reaches caused by pumping within the Basin is estimated to be approximately 12,584 AFY.

Table GWC-11. Average Historical (WY 2003-2018) Depletion of ISW Caused by Groundwater Pumping

Water Year	ISW	Winter (AFY)	Spring (AFY)	Summer (AFY)	Fall (AFY)	Total (AFY)
WY 2014 (Pre-SGMA)	San Joaquin River	306 (0.4)	730 (1)	-9,709 (-13)	-3,275 (-4.5)	-11,948 (-16.5)
Average WY 2003 - WY2018 (Historical Period)	San Joaquin River	-1,617 (-2)	-2,507 (-3.5)	-2,173 (-3)	-389 (-0.5)	-6,686 (-9)
Average WY 2019 - WY2023 (Current Period)	San Joaquin River	-4,003 (-5.5)	-3,708 (-5)	-4,606 (-6)	-266 (-0.4)	-12,584 (-17)

Abbreviations:
AFY = acre-feet per year
ISW = Interconnected Surface Water
WY = water year

Notes:
(1) Depletion rates are calculated for the interconnected section of ISW.
(2) For the purpose of this analysis, Spring is defined to be March to May, Summer is defined to be June to August, Fall is defined to be September to November, and Winter is defined to be December to February each year.
(3) Values in parentheses are in cubic feet per second.

8.8 Groundwater Dependent Ecosystems

§ 354.16. Groundwater Conditions
(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

☑ **23 CCR § 354.16(g)**

This section presents the identification of GDEs and an assessment of long-term temporal trends of vegetation metrics in the Basin. GDEs are defined as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)).

Long-term trends were evaluated for a historical period from calendar year 2013 through calendar year 2022, which is based on the temporal range of TNC's GDE Pulse Interactive Map (TNC, 2024) and therefore differs from the post-SGMA period used to characterize groundwater conditions for other Sustainability Indicators (WY 2015 – WY 2023). For the purposes of this analysis, 2013 through 2022 is considered a "post-SGMA" period, although it is recognized that data collected from January 2013 through December 2014 predates the enactment of SGMA. The TNC GDE Pulse raster datasets do not evaluate trends for a pre-SGMA (prior to 2015) or current (WY 2023) period; therefore, only post-SGMA trends are described in **Section 8.8.2** below.

8.8.1 Identification of Groundwater Dependent Ecosystems

To determine the presence of GDEs within the Basin, the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset was used as the primary reference (DWR et al., 2023). This dataset mainly includes riparian communities situated alongside existing stream channels and combines information from 48 publicly available State and Federal datasets, including two habitat classes: (1) wetland features associated with the surface expression of groundwater under natural conditions, and (2) vegetation types linked to the subsurface presence of groundwater (phreatophytes). Wetland GDE classification was derived from both the NCCAG and Ducks Unlimited datasets (Ducks Unlimited, n.d.). Wetland areas that were not continuously saturated and those dependent on seasonal management and surface water were excluded. **Figure GWC-66** shows the spatial extent of the identified wetlands.

The TNC guidelines developed for the identification of GDEs state that groundwater depths less than 30 feet below ground surface (ft bgs) are generally accepted as being an indicator of potential GDEs supported by groundwater (The Nature Conservancy, 2019). Vegetative GDEs from the NCCAG dataset were excluded in locations where the Spring 2015 depth to groundwater exceeded 30 ft bgs, since they are likely not dependent on groundwater from the Upper Aquifer system. The distribution of the identified vegetative GDEs in the Basin is shown in **Figure GWC-67**. **Table GWC-12** lists the different vegetative GDEs within the Basin mapped in **Figure GWC-67**.

Table GWC-12. Potential Vegetative GDEs in the Basin

Scientific Name / NCCAG Category	Common Name
Acer negundo	Box-elder
Allenrolfea occidentalis	Iodine Bush
Artemisia douglasiana - provisional	Douglas' Wormwood
Arundo donax	Giant Reed
Atriplex lentiformis	Quailbush
Baccharis salicifolia	Mule fat
California Warm Temperate Marsh/Seep	Not applicable
Elymus (Leymus) triticoides	Creeping Wildrye
Freshwater Emergent Marsh	N/A
Juglans hindsii and hybrids	Northern California Black Walnut
Lepidospartum squamatum	Scalebroom
Populus fremontii	Fremont Cottonwood
Quercus lobata	Valley Oak
Rosa californica	California Rose
Rubus armeniacus	Himalayan blackberry
Salix exigua	Narrowleaf Willow
Salix gooddingii	Goodding's Willow
Salix laevigata	Red Willow
Salix lasiolepis	Arroyo Willow
Schoenoplectus (acutus, californicus)	Hardstem Bulrush

Scientific Name / NCCAG Category	Common Name
Southwestern North American Salt Basin and High Marsh	N/A
Sporobolus airoides	Alkali Sacaton

Abbreviations:
GDEs = Groundwater Dependent Ecosystems
N/A = not applicable
NCCAG = Natural Communities Commonly Associated with Groundwater

8.8.2 Post-SGMA Change in GDE Coverage (2013–2022)

The TNC GDE Pulse Interactive Map, which uses remote sensing data from satellites to monitor the health of vegetation, can be used to assess long-term temporal trends of vegetation metrics in the Basin (TNC, 2024). The Normalized Derived Vegetation Index (NDVI) metric, which is a reliable measure of the photosynthetic chlorophyll content in vegetation cover, was used for that analysis. The TNC GDE Pulse tool calculates the annual NDVI from surface reflectance-corrected multispectral Landsat imagery and applies a linear fit to the NDVI time series data to estimate the NDVI trends over a specific timespan of interest.

Since NDVI is used to estimate vegetation greenness and provides a proxy for vegetation growth, change in the GDE area can be estimated using the TNC GDE Pulse raster data that shows the NDVI trends between 2013 and 2022. The timespan selected is based on the availability of data from TNC GDE Pulse. Moderate to large increases in NDVI trends represent an increase in the GDE area, and moderate to large decreases in NDVI trends represent a decrease in the GDE area. Therefore, the change in the GDE area can be estimated by subtracting the GDE area with decreasing NDVI trends from the GDE area with increasing NDVI trends.

For this analysis, raster change values that range from -628 to 628 were assumed to represent little or no change in NDVI trends.[35] For each potential GDE area within the Basin, the total number of raster pixels that fall within the GDE polygon boundary, the number of pixels that show increasing NDVI trends, and the number of pixels that show decreasing NDVI trends were summarized, as shown in **Table GWC-13**. The change in area for each likely GDE was then calculated by dividing the difference between the increasing and decreasing NDVI trends' pixel counts by the total pixel count. Results from **Table GWC-13** indicate a general increase in GDE areas by 16 percent in the Basin over the 2013-2022 time period. shows the extent and location of the NDVI trend changes, correlating to the increase or decrease in identified GDEs.

[35] The NDVI range of -628 to 628 is approximately two percent of the raster values' total range. It was selected by visually comparing the raster pixels that fall within this range with the "little or no change" NDVI trend category from the TNC GDE Pulse website. Therefore, raster values larger than 628 represent a moderate or large increase in NDVI trends, and raster values smaller than -628 represent a moderate or large decrease in NDVI trends.

Table GWC-13. Change in GDE Area (2013-2022) Based on NDVI

Possible GDEs	Total Pixel Count	Pixel Count of Decreasing NDVI Trends	Pixel Count of Increasing NDVI Trends	Change in GDE Area (2013 – 2022)
Delta-Mendota	372,192	41,160 (11 percent)	102,278 (27 percent)	16 percent

Abbreviations:
GDEs = Groundwater Dependent Ecosystems
NDVI = Normalized Derived Vegetation Index

8.8.3 Other Environmental Users of Groundwater

In addition to vegetation and wetland communities, other environmental users of groundwater include species reliant on ISW. TNC compiled a list of freshwater species located within each groundwater basin for use by GSAs to evaluate species reliant on surface water. **Appendix K** contains the TNC freshwater species list for the Basin and their respective Federal and State Protection status. The list includes 269 unique species grouped into three taxonomic groups: birds, herps (i.e., reptiles), and plants. The species on this list, including their statuses, are provided as of April 2015.

8.9 Data Gaps and Uncertainty Regarding Groundwater Conditions

Data gaps and sources of uncertainty are presented below with respect to each Sustainability Indicator.

8.9.1 Groundwater Levels

As stated previously in **Section 7.1.5**, there is relatively greater uncertainty in the characterization of the Lower Aquifer, as compared to the Upper Aquifer, in terms of its hydraulic head, water storage properties, and water quality. This uncertainty is a natural consequence of the fact that fewer wells have been drilled to the deepest depth zones, resulting in a lower spatial density of data. Furthermore, screen depth information is missing for many wells from which groundwater levels have historically been recorded. Without screen depth information, wells with a total depth below the bottom of the Corcoran cannot be assigned to an aquifer, meaning that the associated water level data cannot be used to characterize either aquifer. During the development of this GSP, the GSAs have significantly expanded the Lower Aquifer Representative Monitoring Network (**Section 14**); however, significant data gaps remain in the eastern portion of the Basin, particularly in the Grassland GSA Group area.

8.9.2 Groundwater Storage

Given that the modeled estimates of groundwater storage are derived in part from groundwater level measurements, similar uncertainty exists in the Lower Aquifer as described above for groundwater levels. Additionally, uncertainty in the estimated aquifer storage properties and their spatial variability affects model calculations of change in storage. The distribution of pumping from the Upper and Lower Aquifers is generally determined using available well construction information and can be improved through measured pumping data, incorporation of the GSA's well census data, and better characterization of aquifer properties. Changes to the assumed distribution of pumping can significantly impact modeled estimates of groundwater storage change.

Furthermore, existing uncertainties in model input data, including western boundary subsurface flows, boundary conditions, and the implementation of surface water diversions and deliveries within the modeled stream network, influence the simulation of groundwater levels, calculations of streamflow, surface water deliveries, and seepage, and ultimately the estimation of change in groundwater storage for each aquifer. As more data become available, these inherent uncertainties will be proportionally improved to better reflect the actual conditions in the Basin.

Lastly, as discussed in **Section 9**, the Model overestimates rates and extent of subsidence causing a correspondent overestimation of water release caused by subsidence and total loss of storage. While simulation results were considered as conservative assumptions for planning in this GSP, the loss in storage shown in this Section is likely overestimated and should be improved upon further refinement of the Model and availability of additional data.

8.9.3 Water Quality

Limited water quality data are available for the Lower Aquifer, and in some portions of the Basin, in both principal aquifers. During the development of this GSP, the GSAs have significantly expanded the Representative Monitoring Network for groundwater quality (**Section 14**); however, data gaps remain, especially with respect to the relationship between groundwater quality impacts and trends and groundwater management (i.e., water levels). Collection of monitoring data from the expanded Representative Monitoring Network will help address these data gaps.

Extensive water quality testing of groundwater served to municipal customers by public water systems is required under CCR Title 22, resulting in significant amounts of water quality data in urban areas within the Basin. In contrast, relatively fewer data are available in non-urban areas and for constituents that have not historically been a concern or whose appearance is highly localized, such as 1,2,3-TCP or gross alpha radioactivity. Geographically, water quality data tend to be sparser in areas and at depths where there is less use of groundwater, either due to small populations or easier access to better quality water from other sources. In some locations, it is considered common knowledge that groundwater quality is poor, and therefore groundwater is neither extracted nor monitored. This is the case in substantial portions of the Grassland GSA Group area.

Finally, much of the available water quality data comes from wells whose total depths and/or screen depths are unknown, making it impossible to determine which aquifer or aquifers the wells sample. This particularly limits the amount of data that can be definitively associated with the Lower Aquifer, because wells drilled to depths below the Corcoran Clay may also be screened above the Corcoran Clay. In response to these data gaps and uncertainties, the GSAs have substantially expanded the Basin's Representative Monitoring Network and are taking other measures to fill data gaps, as described in **Sections 14.2.4**, **14.3.2**, and **14.5**.

8.9.4 Land Subsidence

As shown in **Figure GWC-48**, InSAR data collected by DWR do not fully cover the Basin, and significant gaps in coverage exist in the central portion of the Basin. These areas are partially covered by survey data collected by USBR and DWR along the DMC and California Aqueduct, respectively, as well as subsidence information retrieved from the SJRRP GPS stations and collected by individual GSAs. Therefore, this GSP has sufficient data to characterize subsidence conditions in the vicinity of critical infrastructure, but there is greater uncertainty in characterizing subsidence conditions in areas of the Basin further away from critical infrastructure, particularly south of Los Banos and west of Dos Palos.

8.9.5 Interconnected Surface Water Systems

Insufficient groundwater elevation data exist in the shallow Upper Aquifer zone near ISW bodies, and insufficient streamflow data (stage and flow rate) exist along the ISW, particularly around Del Puerto Creek. In response to these data gaps and uncertainties, the GSAs have substantially expanded the Basin's Representative Monitoring Network and are taking other measures to fill data gaps, as described in **Section 14.2.6**. As more data become available, these inherent uncertainties will be proportionally improved to better reflect the actual conditions in the Basin.

Table GWC-1. Groundwater Elevation Trends in Representative Monitoring Wells

DMS ID	Local ID	State Well ID	Aquifer	Latitude	Longitude	Pre-SGMA (1950-2014)			Post-SGMA (2015-2023)		
						Trend (ft/yr)	R Squared	Significance of Trend[1]	Trend (ft/yr)	R Squared	Significance of Trend[1]
01-001	MP030.43R	04S06E36C001M	Lower	37.550862	-121.260919	-0.39	0.033	Not Significant	2.20	0.053	Not Significant
01-002	MP033.71L	05S07E05F001M	Lower	37.53138	-121.22431	1.30	0.182	Significant, Increasing	3.20	0.161	Significant, Increasing
01-003	MP045.78R	06S08E20D002M	Lower	37.406198	-121.121273	-1.40	0.419	Significant, Decreasing	-12.00	0.435	Significant, Decreasing
01-004	MC10-2	07S08E28R002M	Upper	37.2907	-121.0875	-1.50	0.884	Significant, Decreasing	-0.17	0.241	Significant, Decreasing
01-005	MP058.28L	08S08E15G001M	Upper	37.240656	-121.075193	-1.40	0.562	Significant, Decreasing	-1.80	0.065	Significant, Decreasing
01-006	91		Lower	37.26042	-121.0611	N/A	N/A	Insufficient Data	-0.10	0.001	Not Significant
01-007	MP021.12L		Lower	37.642858	-121.365121	-1.90	0.460	Significant, Decreasing	-1.40	0.018	Not Significant
01-008	MP051.66L		Lower	37.332953	-121.085714	-0.48	0.030	Not Significant	-4.50	0.146	Significant, Decreasing
01-128	Merc_9		Upper	37.220131	-121.055797	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
01-129	Merc_11		Upper	37.234383	-121.043439	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
02-002	WELL 02 - NORTH 5TH ST		Lower	37.471196	-121.132831	-1.40	0.249	Significant, Decreasing	2.10	0.121	Significant, Increasing
02-009	Keystone well		Upper	37.477183	-121.167222	-5.30	0.775	Significant, Decreasing	3.40	0.360	Significant, Increasing
02-109	Floragold Well		Upper	37.469795	-121.150375	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
03-001	MW-2		Upper	37.501461	-121.101125	-0.53	0.166	Not Significant	0.22	0.011	Not Significant
03-002	MW-3		Upper	37.48156	-121.135034	-1.80	0.073	Not Significant	0.81	0.024	Not Significant
03-003	WSJ003		Upper	37.494	-121.0862	N/A	N/A	Insufficient Data	1.10	0.130	Significant, Increasing
03-008	ISW-2 Planned		Upper	37.497103	-121.08325	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
03-009	ISW-2 Planned		Lower	37.497103	-121.08325	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
04-001	121		Lower	37.6129	-121.2942	N/A	N/A	Insufficient Data	1.20	0.089	Not Significant
04-006	Grayson Well 274		Upper	37.562343	-121.176757	N/A	N/A	Insufficient Data	-1.40	0.408	Significant, Decreasing
04-007	Grayson Well 274A		Lower	37.55	-121.17644	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
04-008	ARRA 28		Lower	37.579962	-121.277101	N/A	N/A	Insufficient Data	27.00	0.600	Significant, Increasing
04-210	WSID Planned #1		Upper	37.6527306	-121.3110194	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
04-211	WSID Planned #1		Lower	37.6527306	-121.3110194	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
05-124			Upper	37.362568	-121.069589	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
05-127			Upper	37.596234	-121.220976	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
05-128			Lower	37.359006	-121.058253	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
06-001	P259-1	06S08E09E001M	Lower	37.43139	-121.0994	-7.00	0.082	Not Significant	-0.30	0.002	Not Significant
06-002	P259-3	06S08E09E003M	Upper	37.43139	-121.0994	-2.30	0.209	Significant, Decreasing	-0.63	0.147	Significant, Decreasing
07-002	MC15-1	10S10E32L001M	Lower	37.0173	-120.8999	-13.00	0.956	Significant, Decreasing	0.34	0.008	Not Significant
07-003	MC15-2	10S10E32L002M	Upper	37.0173	-120.8999	-7.40	0.493	Significant, Decreasing	-0.45	0.006	Not Significant
07-005	MP091.68R	12S11E03Q001M	Lower	36.9097	-120.7554	-3.80	0.430	Significant, Decreasing	-5.10	0.139	Significant, Decreasing
07-007	MC18-1	12S12E16E003M	Lower	36.8896	-120.6702	-22.00	0.749	Significant, Decreasing	1.60	0.052	Significant, Increasing
07-009	KRCDTID03		Upper	36.60276	-120.23201	0.54	0.014	Not Significant	1.30	0.085	Significant, Increasing
07-010	KRCDTID02		Upper	36.65	-120.25	1.80	0.069	Significant, Increasing	2.10	0.178	Significant, Increasing
07-014	TW-4		Lower	36.64294444	-120.2405	N/A	N/A	Insufficient Data	9.30	0.189	Significant, Increasing
07-015	TW-5		Lower	36.675786	-120.267836	N/A	N/A	Insufficient Data	15.00	0.255	Significant, Increasing
07-016	Well 01		Lower	37.100426	-121.007245	7.20	0.733	Not Significant	-0.78	0.018	Significant, Decreasing
07-017	Well 1		Upper	37.092944	-120.925805	N/A	N/A	Insufficient Data	-2.80	0.218	Significant, Decreasing
07-018	WSJ001		Upper	36.6098	-120.262639	N/A	N/A	Insufficient Data	7.30	0.269	Not Significant
07-028	MP093.27L (Well 500)		Lower	36.906406	-120.727637	-2.10	0.138	Significant, Decreasing	-7.50	0.177	Significant, Decreasing
07-031	CDMGSA-01C		Upper	36.817599	-120.73073	N/A	N/A	Insufficient Data	-3.90	0.975	Significant, Decreasing
07-032	CDMGSA-01D		Lower	36.817599	-120.73073	N/A	N/A	Insufficient Data	-3.80	0.884	Significant, Decreasing
07-033	TW-4 Upper		Upper	36.64294444	-120.2405	N/A	N/A	Insufficient Data	-0.55	0.009	Not Significant
07-035	MP098.74L		Upper	36.887097	-120.635452	0.38	0.008	Not Significant	3.00	0.023	Not Significant
07-036	PWD Well 20		Lower	36.7707	-120.648282	-38.00	0.780	Significant, Decreasing	5.20	0.080	Not Significant
07-170	AGC100012335-GDACX00005		Upper	36.848851	-120.671707	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
07-189	Well 18		Lower	36.807618	-120.61143	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
07-212	Well 31		Lower	36.822135	-120.653637	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
07-425	MC18-2	12S12E16E02AM	Upper	36.8896	-120.6702	-19.00	0.383	Significant, Decreasing	11.00	0.425	Significant, Increasing
08-002	MP102.04L		Upper	36.879012	-120.578351	-0.64	0.003	Not Significant	1.60	0.040	Not Significant
09-001	2480-72	12S15E32B002M	Upper	36.847966	-120.35053	-0.73	0.190	Significant, Decreasing	-2.70	0.132	Not Significant

Table GWC-1. Groundwater Elevation Trends in Representative Monitoring Wells

DMS ID	Local ID	State Well ID	Aquifer	Latitude	Longitude	Pre-SGMA (1950-2014)			Post-SGMA (2015-2023)		
						Trend (ft/yr)	R Squared	Significance of Trend[1]	Trend (ft/yr)	R Squared	Significance of Trend[1]
09-002	12S16E31G001M	12S16E31G001M	Upper	36.8439	-120.2611	-1.70	0.580	Significant, Decreasing	2.50	0.232	Not Significant
09-003	13S15E14M001M	13S15E14M001M	Upper	36.7986	-120.3092	-0.76	0.217	Significant, Decreasing	1.90	0.101	Not Significant
09-004	13S16E30A001M	13S16E30A001M	Upper	36.776138	-120.259304	-0.39	0.031	Not Significant	1.80	0.043	Not Significant
09-011	Aliso-South Planned		Lower	36.782626	-120.262676	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
09-012	Aliso-North Planned		Lower	36.9012	-120.28235	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
10-009	TSS-MW-325		Upper	36.76386	-120.32586	N/A	N/A	Insufficient Data	32.00	0.368	Significant, Increasing
10-010	TSS-MW-485		Lower	36.76386	-120.32606	N/A	N/A	Insufficient Data	3.40	0.034	Not Significant
11-005	1ML-5		Lower	37.106152	-120.936111	N/A	N/A	Insufficient Data	-1.60	0.181	Not Significant
11-006	1ML-6		Lower	37.107496	-120.93136	-22.00	0.224	Not Significant	-3.30	0.437	Significant, Decreasing
11-010	1PL-1		Lower	37.1820231	-120.9065	N/A	N/A	Insufficient Data	-1.80	0.133	Not Significant
11-013	1PU-1		Upper	37.14347	-120.87239	N/A	N/A	Insufficient Data	-0.07	0.002	Not Significant
11-019	3PL-2		Lower	37.216619	-120.889508	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
11-020	1PL-6		Lower	37.1635	-120.81814	N/A	N/A	Insufficient Data	1.30	0.027	Not Significant
11-021	1PL-5		Lower	37.253719	-120.94015	3.60	0.331	Not Significant	-2.80	0.373	Significant, Decreasing
11-022	1PL-4		Lower	37.105651	-120.835283	N/A	N/A	Insufficient Data	33.00	0.502	Not Significant
11-023	1PU-2		Upper	37.046361	-120.811	N/A	N/A	Insufficient Data	-0.65	0.699	Significant, Decreasing
11-024	1PL-7		Lower	37.11378	-120.78279	N/A	N/A	Insufficient Data	-0.29	0.002	Not Significant
12-001	SPRECK-MW-7	T13S/R15E-34	Upper	36.74963	-120.31976	-0.43	0.203	Significant, Decreasing	1.90	0.259	Not Significant
13-001	HANS-7C1	T14S/R15E-7C1	Upper	36.734	-120.37915	-0.36	0.098	Significant, Decreasing	1.40	0.199	Significant, Increasing
13-003	TL-HS-3	T13S/R15E-29F2	Upper	36.77304	-120.36233	0.52	0.013	Not Significant	1.50	0.019	Not Significant
13-004	USGS-31J6	13S15E31J006M	Lower	36.75517	-120.3732	-1.80	0.284	Significant, Decreasing	1.00	0.012	Not Significant
13-011	MW1LA Planned		Lower	36.71124	-120.25874	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
13-012	MW1UA Planned		Upper	36.71124	-120.25874	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
14-001	CCID Well #2		Upper	37.307	-121.054	-0.48	0.475	Significant, Decreasing	0.80	0.052	Not Significant
14-002	1005		Upper	36.786891	-120.377036	-0.61	0.540	Significant, Decreasing	-1.60	0.054	Not Significant
14-003	1006		Upper	37.0157	-120.667	-0.02	0.011	Not Significant	0.04	0.001	Not Significant
14-004	1008	10S10E28A001M	Upper	37.0409	-120.891	-0.51	0.569	Significant, Decreasing	0.29	0.003	Not Significant
14-005	1011	11S13E17E001M	Upper	36.9783	-120.58	-0.09	0.135	Not Significant	1.00	0.181	Significant, Increasing
14-006	1014	09S09E05R001M	Upper	37.173597	-120.995531	-0.16	0.239	Significant, Decreasing	0.12	0.001	Not Significant
14-007	1043	11S13E34E001M	Upper	36.932003	-120.541998	-0.26	0.311	Significant, Decreasing	2.50	0.491	Significant, Increasing
14-008	2410	10S12E13L001M	Upper	37.06	-120.612	-0.15	0.044	Not Significant	0.38	0.113	Significant, Increasing
14-019	1050		Lower	37.373654	-121.057238	N/A	N/A	Insufficient Data	15.00	0.613	Not Significant
14-020	1027		Lower	37.173458	-121.018397	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
14-021	1056		Lower	37.031767	-120.833558	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
14-022	Elrod #4 Well #21		Upper	36.85206	-120.3996	N/A	N/A	Insufficient Data	-1.30	0.532	Significant, Decreasing
14-023	26B		Lower	36.860673	-120.510729	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
14-024	CCID 2723		Lower	36.86125	-120.51044	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
14-025	SDMW West - Lower Aquifer		Lower	36.98352	-120.50053	35.00	0.335	Significant, Increasing	-2.20	0.300	Significant, Decreasing
14-026	SDMW West - Upper Aquifer		Upper	36.98352	-120.50053	-0.43	0.003	Not Significant	1.40	0.171	Significant, Increasing
14-027	CLB Well #10		Upper	37.05317	-120.826	-1.40	0.657	Significant, Decreasing	1.00	0.099	Significant, Increasing
15-001	Firebaugh Well #17		Upper	36.85422	-120.4418	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
16-001	CLB Well #12		Upper	37.05231	-120.8684	-1.00	0.463	Significant, Decreasing	0.98	0.139	Significant, Increasing
16-002	CLB Well #8		Upper	37.08072152	-120.8308364	-1.80	0.868	Not Significant	N/A	N/A	Insufficient Data
17-001	Mendota City #7		Upper	36.78405	-120.34527	-17.00	0.336	Significant, Decreasing	1.90	0.002	Not Significant
18-001	Newman City #6		Lower	37.31809	-121.03062	0.64	0.086	Not Significant	-20.00	0.128	Not Significant
18-002	Newman City #8		Lower	37.32212	-121.01333	3.90	0.003	Not Significant	-35.00	0.894	Significant, Decreasing
19-002	2PU-1		Upper	37.307928	-120.98812	N/A	N/A	Insufficient Data	0.80	0.033	Not Significant
19-005	2MU-1		Upper	37.310139	-120.948833	-0.55	0.781	Significant, Decreasing	0.05	0.012	Not Significant
19-008	2MU-4		Upper	37.299139	-120.944667	-0.59	0.806	Significant, Decreasing	-0.17	0.154	Not Significant
19-009	2MU-5		Upper	37.308333	-120.932639	-0.37	0.644	Significant, Decreasing	-0.13	0.218	Not Significant
19-010	1PU-3		Upper	37.31892	-120.9841	N/A	N/A	Insufficient Data	0.33	0.006	Not Significant
20-001	TIWD #17		Upper	37.15494	-120.75037	N/A	N/A	Insufficient Data	-1.60	0.031	Not Significant

Table GWC-1. Groundwater Elevation Trends in Representative Monitoring Wells

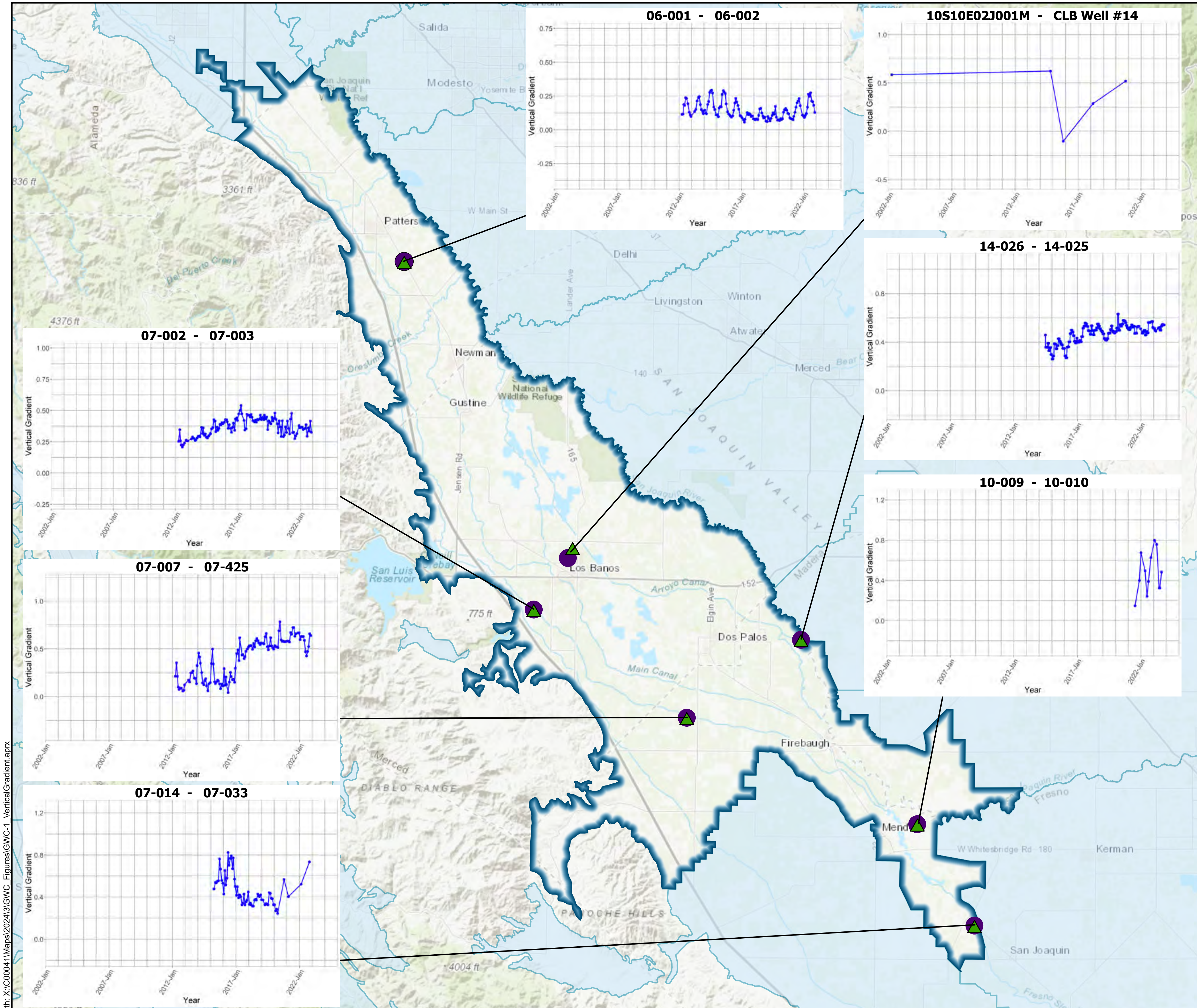
DMS ID	Local ID	State Well ID	Aquifer	Latitude	Longitude	Pre-SGMA (1950-2014)			Post-SGMA (2015-2023)		
						Trend (ft/yr)	R Squared	Significance of Trend[1]	Trend (ft/yr)	R Squared	Significance of Trend[1]
22-001	Gustine City #5		Lower	37.25248	-120.99326	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
22-002	Gustine City #6		Upper	37.25735	-120.99682	N/A	N/A	Insufficient Data	N/A	N/A	Insufficient Data
23-003	SDMW East - Lower Aquifer		Lower	36.98381	-120.49899	45.00	0.561	Significant, Increasing	-1.60	0.153	Significant, Decreasing
23-004	SDMW East - Upper Aquifer		Upper	36.98381	-120.49899	-2.10	0.069	Significant, Decreasing	1.10	0.140	Significant, Increasing

Abbreviations:

ft/yr = feet per year
N/A = not applicable
RMWs = Representative Monitoring Wells
SGMA = Sustainable Groundwater Management Act

Notes:

1. For the purpose of this analysis, a trend identified from the linear regression was considered significant when its p-value was less than or equal to 0.05 and the slope was greater than +/- 0.1 ft/yr.
2. Trends were only calculated for RMWs that had at least four groundwater elevation measurement recorded during the specified time period.



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Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Groundwater Level Measurement Locations

- Upper Aquifer
- Lower Aquifer

Notes

1. Positive gradient indicates downward flow from Upper Aquifer to Lower Aquifer; negative gradient indicates upward flow from Lower Aquifer to Upper Aquifer.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
2. Basemap is ESRI's topographic map, downloaded March 2024

N

0 12 24
Miles

Vertical Gradients Between Upper and Lower Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

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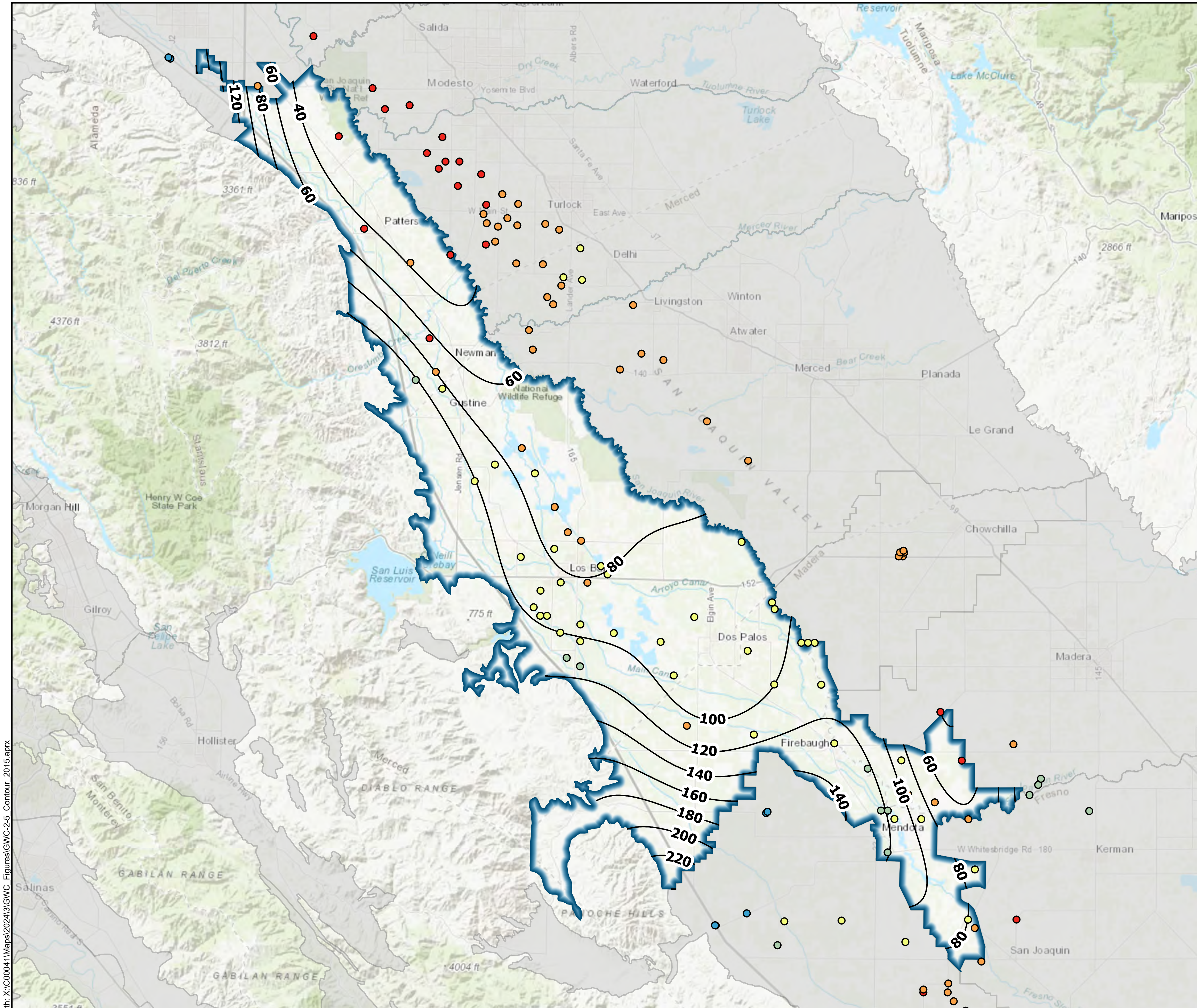
Figure GWC-1



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Groundwater Elevation (ft msl)

- < 40
- 40 - 80
- 80 - 120
- 120 - 180
- > 180

Groundwater Elevation Contour (20 ft interval)

Abbreviations

ft = feet
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
ft msl = feet above mean sea level
SGMA = Sustainable Groundwater Management Act

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
2. Groundwater elevations measured by GSAs or provided by DWR via the SGMA Data Viewer.

Notes

1. All locations are approximate.
2. Seasonal high and low groundwater elevations for each well were identified by picking the highest and lowest elevations reported in the time period of interest (February - April 2015 for seasonal high, September - October 2015 for seasonal low).
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N 0 12 24 Miles

2015 Seasonal High Groundwater Elevation Contours, Upper Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

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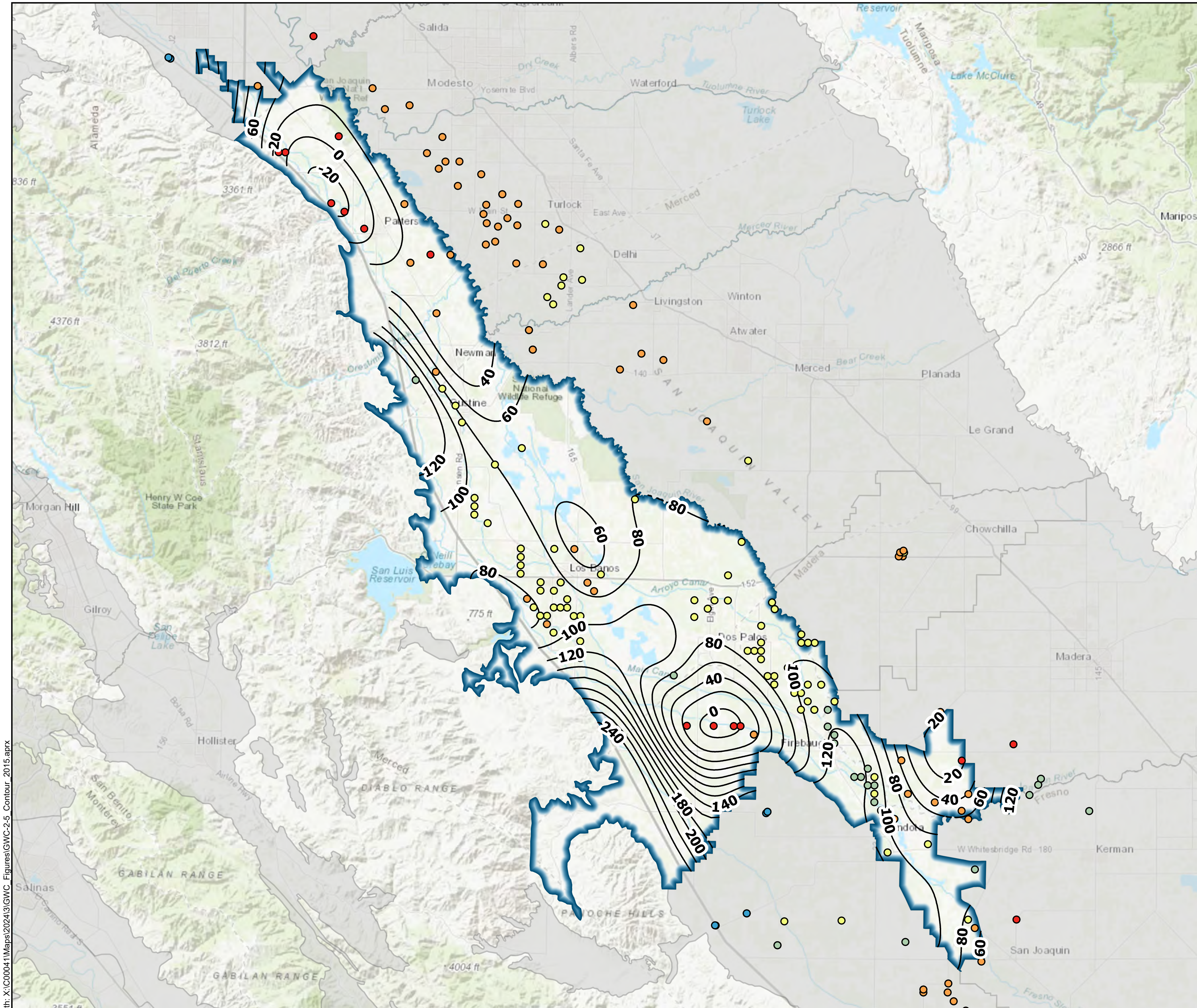
Figure GWC-2

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-2-5_Contour_2015.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Groundwater Elevation (ft msl)

- < 20
- 20 - 70
- 70 - 110
- 110 - 180
- > 180

Groundwater Elevation Contour (20 ft interval)

Abbreviations

ft = feet
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
ft msl = feet above mean sea level
SGMA = Sustainable Groundwater Management Act

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
2. Groundwater elevations measured by GSAs or provided by DWR via the SGMA Data Viewer.

Notes

1. All locations are approximate.
2. Seasonal high and low groundwater elevations for each well were identified by picking the highest and lowest elevations reported in the time period of interest (February - April 2015 for seasonal high, September - October 2015 for seasonal low).
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N 0 12 24 Miles

2015 Seasonal Low Groundwater Elevation Contours, Upper Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

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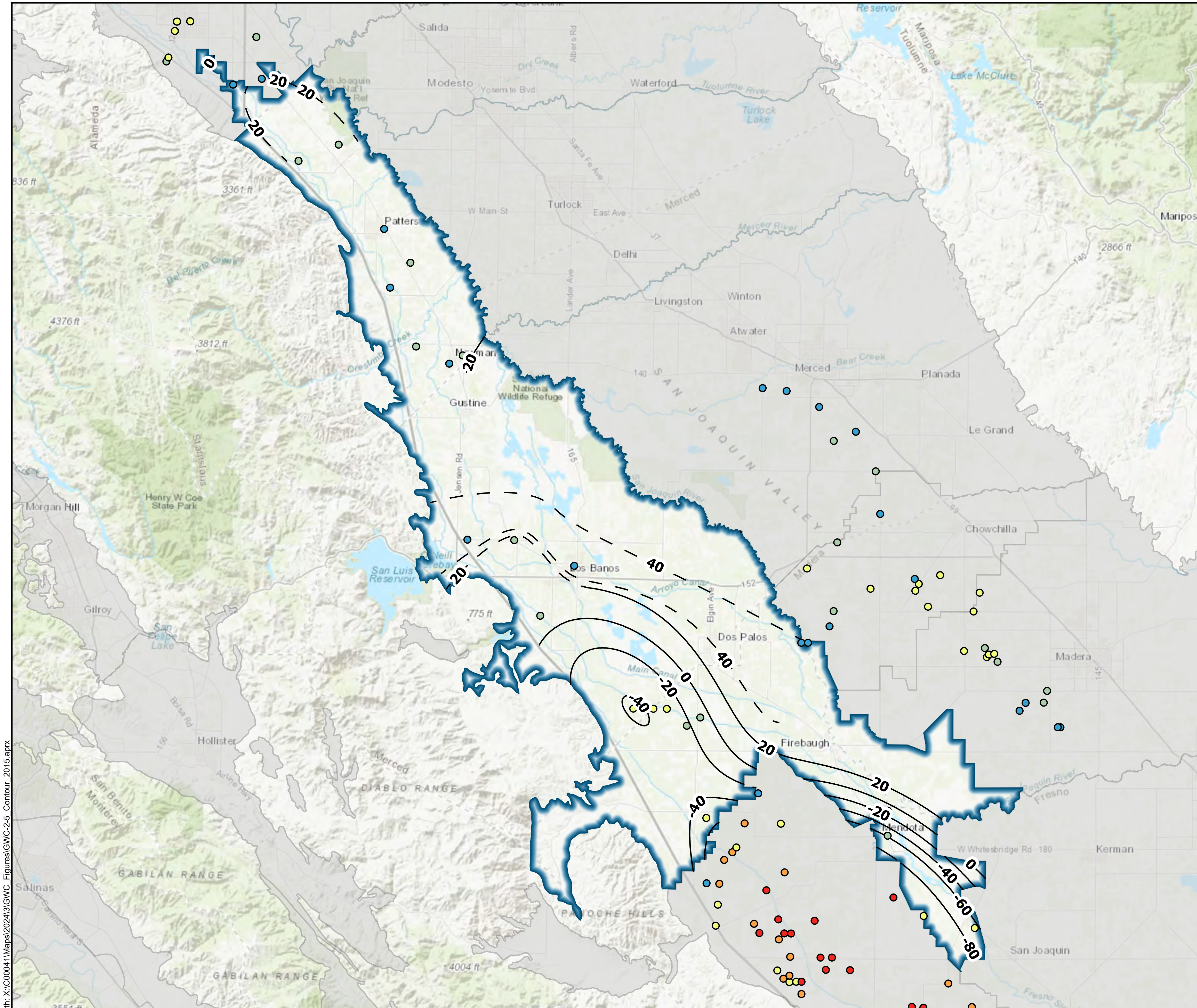
Figure GWC-3

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-2-5_Contour_2015.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Groundwater Elevation (ft msl)

- < -180
- -180 to -90
- -90 to -30
- -30 to 30
- > 30

Calculated Groundwater Elevation Contour (20 ft inerval)

Inferred Groundwater Elevation Contour (20 ft interval)

Abbreviations

ft = feet
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
ft msl = feet above mean sea level
SGMA = Sustainable Groundwater Management Act

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
2. Groundwater elevations measured by GSAs or provided by DWR via the SGMA Data Viewer.

Notes

1. All locations are approximate.
2. Seasonal high and low groundwater elevations for each well were identified by picking the highest and lowest elevations reported in the time period of interest (February - April 2015 for seasonal high, September - October 2015 for seasonal low).
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N

0 12 24
Miles

2015 Seasonal High Groundwater Elevation Contours, Lower Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

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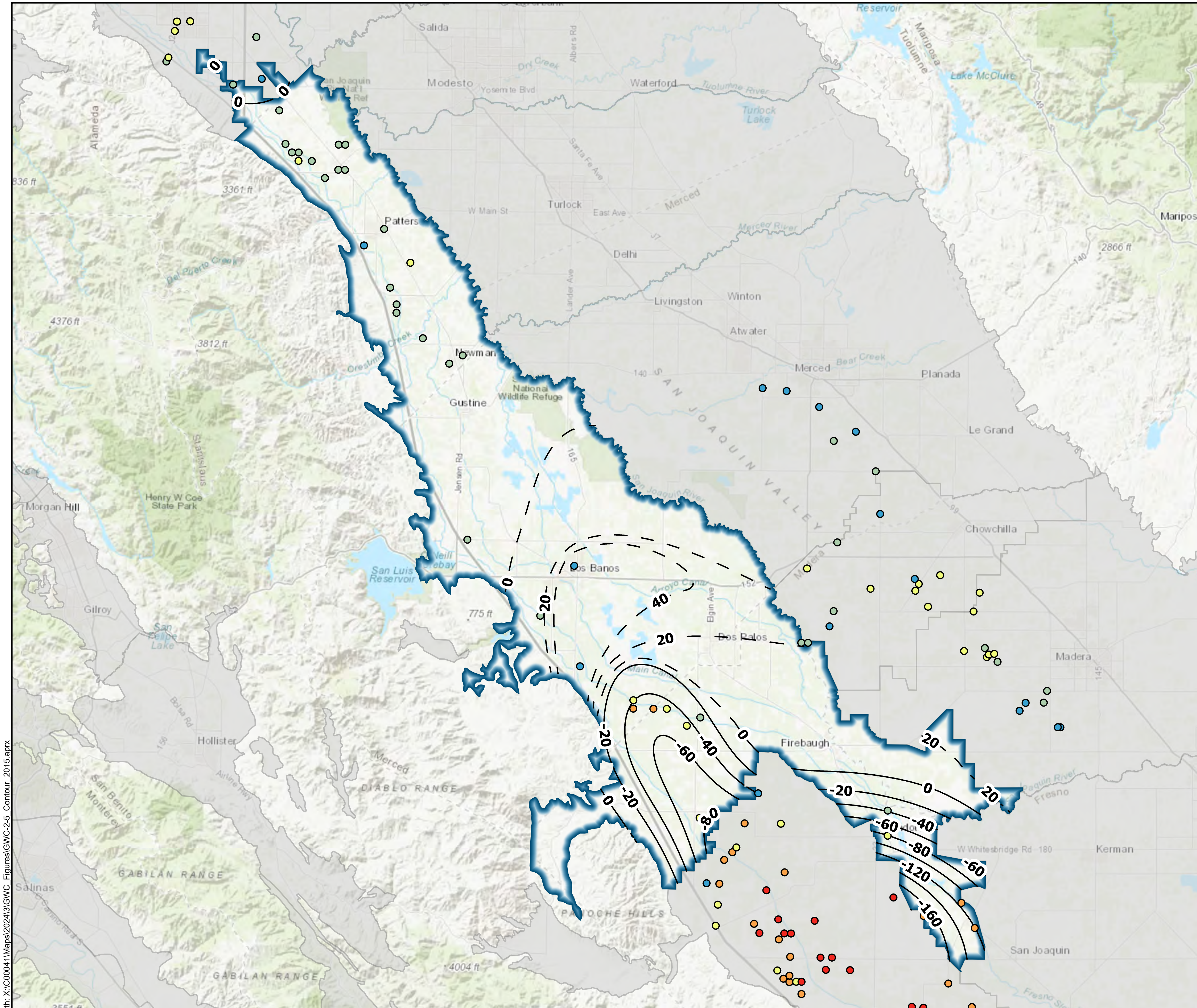
Figure GWC-4

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-2-5_Contour_2015.aprx



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Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Groundwater Elevation (ft msl)

- < -170
- -170 to -80
- -80 to -30
- -30 to 30
- > 30
- Calculated Groundwater Elevation Contour (20 ft interval)
- Inferred Groundwater Elevation Contour (20 ft interval)

Abbreviations

ft = feet
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
ft msl = feet above mean sea level
SGMA = Sustainable Groundwater Management Act

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
2. Groundwater elevations measured by GSAs or provided by DWR via the SGMA Data Viewer.

Notes

1. All locations are approximate.
2. Seasonal high and low groundwater elevations for each well were identified by picking the highest and lowest elevations reported in the time period of interest (February - April 2015 for seasonal high, September - October 2015 for seasonal low).
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N 0 12 24 Miles

2015 Seasonal Low Groundwater Elevation Contours, Lower Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

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Figure GWC-5

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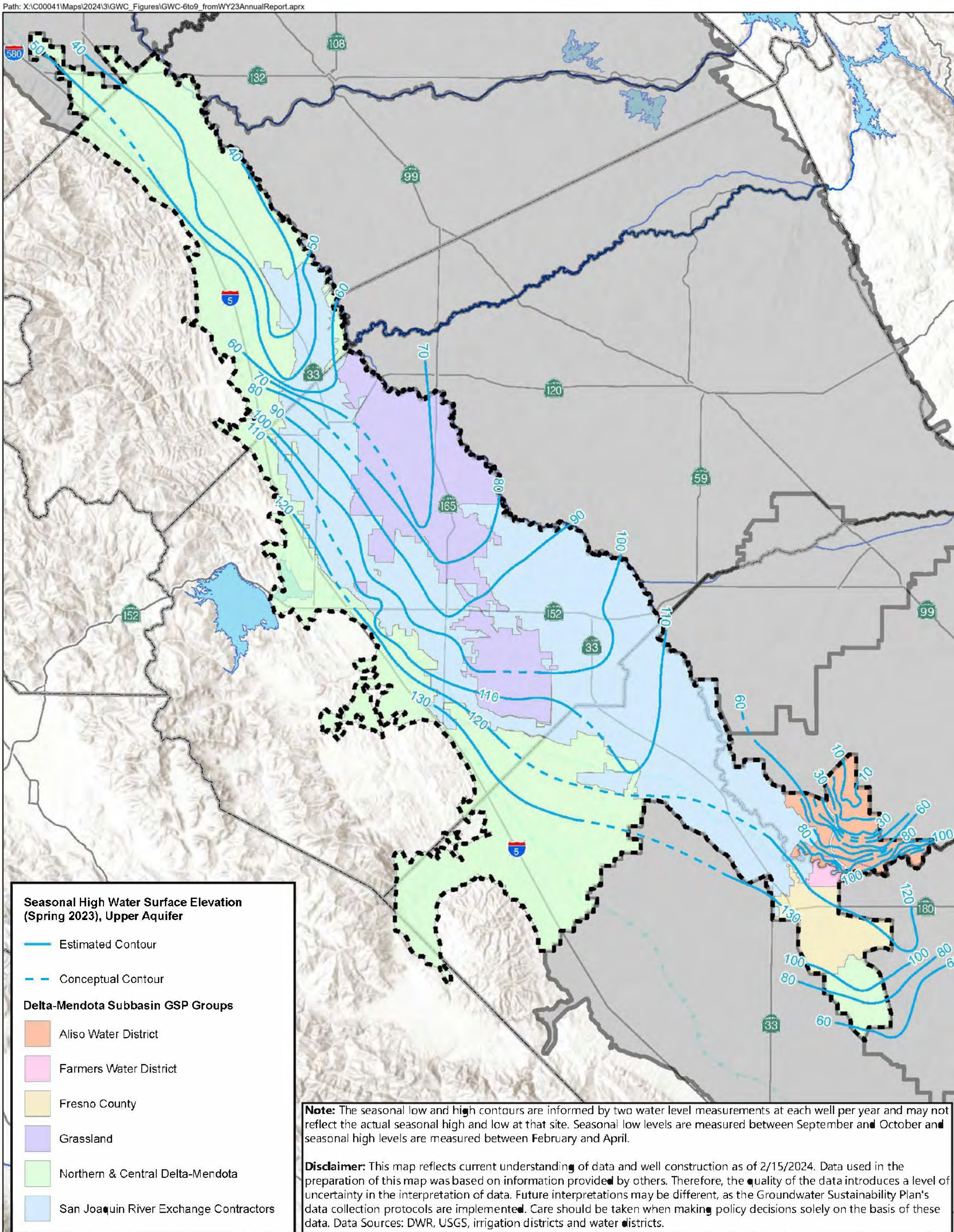

Note: The seasonal low and high contours are informed by two water level measurements at each well per year and may not reflect the actual seasonal high and low at that site. Seasonal low levels are measured between September and October and seasonal high levels are measured between February and April.

Disclaimer: This map reflects current understanding of data and well construction as of 2/15/2024. Data used in the preparation of this map was based on information provided by others. Therefore, the quality of the data introduces a level of uncertainty in the interpretation of data. Future interpretations may be different, as the Groundwater Sustainability Plan's data collection protocols are implemented. Care should be taken when making policy decisions solely on the basis of these data. Data Sources: DWR, USGS, irrigation districts and water districts.

Delta-Mendota Subbasin

Seasonal High Upper Aquifer Water Surface Elevation

Water Year 2023 Annual Report

Delta-Mendota Subbasin Boundary | Highway | California Aqueduct | Neighboring Subbasin | Major Lake or Reservoir | Delta-Mendota Canal | County Boundary | Major River

0 2.5 5 10 Miles

DELTA-MENDOTA SGMA

Project #: 0012462.00
Map Created: February 2024

Current Seasonal High Groundwater Elevation Contours, Upper Aquifer

Sources
1. Figure is sourced from the Delta-Mendota Subbasin Water Year 2023 Annual Report, Figure 2.

Notes
1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

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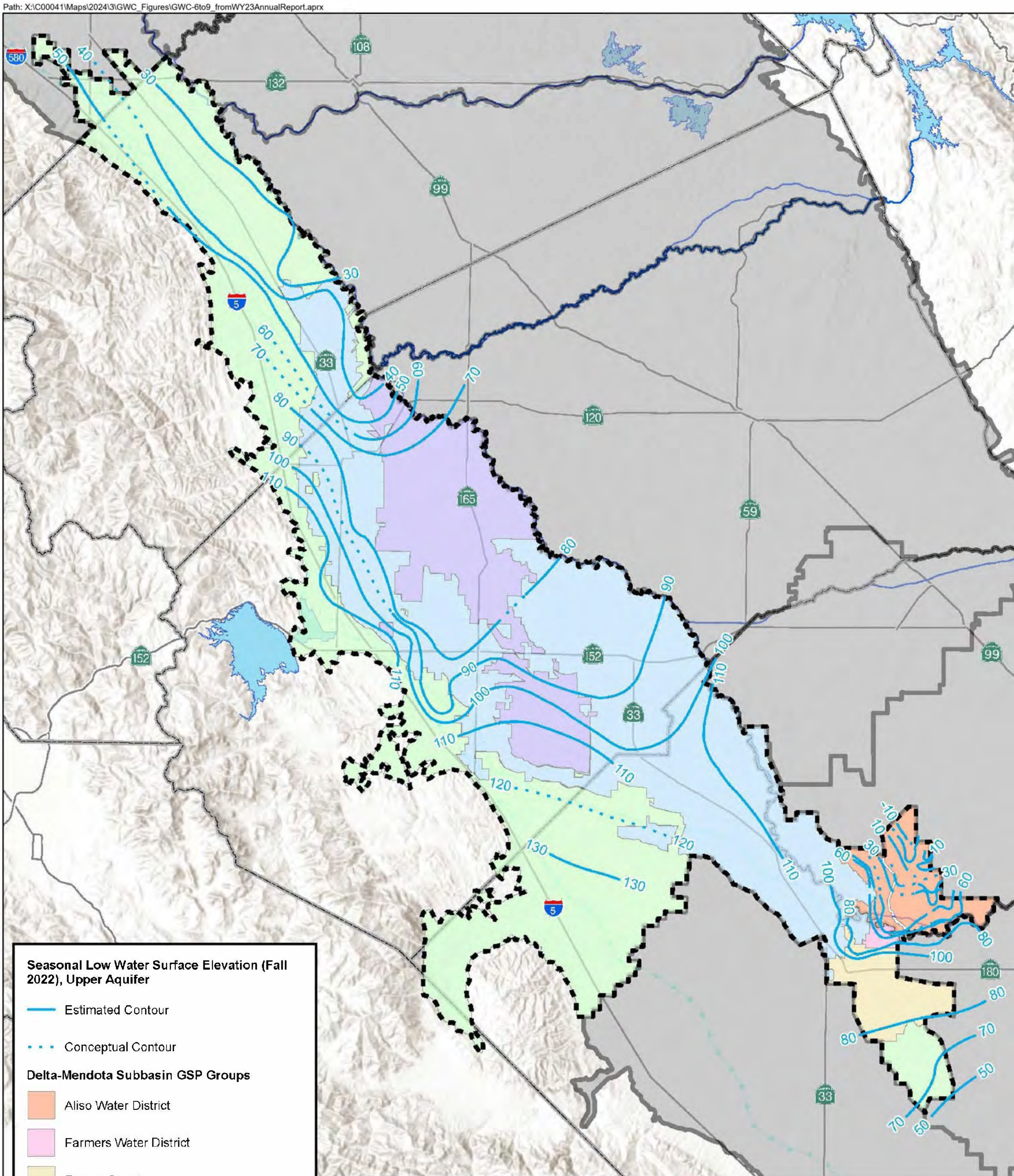
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-6

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-6to9_fromWY23AnnualReport.aprx



Note: The seasonal low and high contours are informed by two water level measurements at each well per year and may not reflect the actual seasonal high and low at that site. Seasonal low levels are measured between September and October and seasonal high levels are measured between February and April.

Disclaimer: This map reflects current understanding of data and well construction as of 2/15/2024. Data used in the preparation of this map was based on information provided by others. Therefore, the quality of the data introduces a level of uncertainty in the interpretation of data. Future interpretations may be different, as the Groundwater Sustainability Plan's data collection protocols are implemented. Care should be taken when making policy decisions solely on the basis of these data. Data Sources: DWR, USGS, irrigation districts and water districts.

Delta-Mendota Subbasin

Seasonal Low Upper Aquifer Water Surface Elevation

Water Year 2023 Annual Report

Delta-Mendota Subbasin Boundary — Highway — California Aqueduct

Neighboring Subbasin — Major Lake or Reservoir — Delta-Mendota Canal

County Boundary — Major River

N

0 2.5 5 10 Miles

DELTA-MENDOTA SGMA

Project #: 0012462.00

Map Created: February 2024

Current Seasonal Low Groundwater Elevation Contours, Upper Aquifer

Sources

1. Figure is sourced from the Delta-Mendota Subbasin Water Year 2023 Annual Report, Figure 3.

Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

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Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-7

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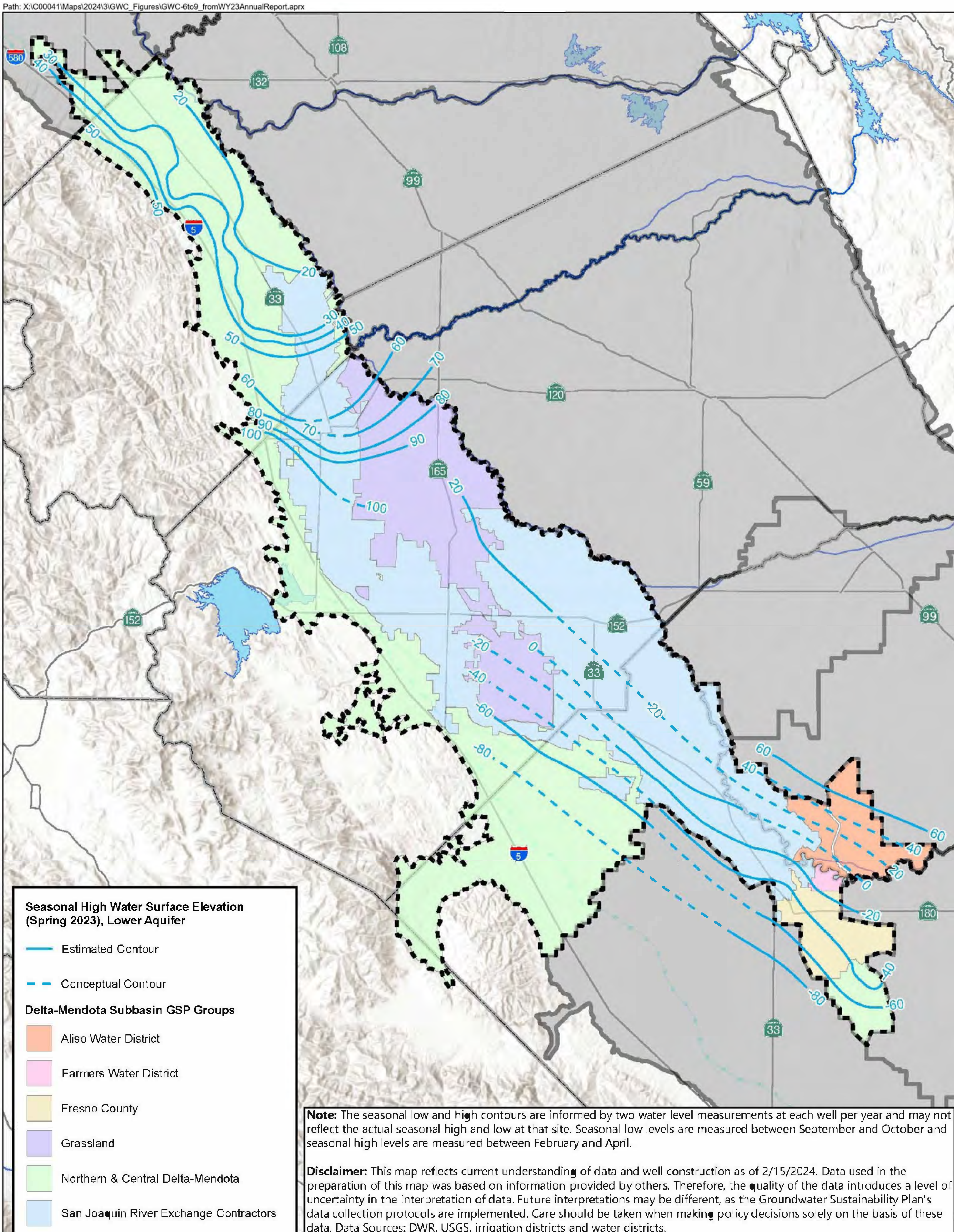

Delta-Mendota Subbasin

Seasonal High Lower Aquifer Water Surface Elevation

Water Year 2023 Annual Report

Delta-Mendota Subbasin Boundary
Neighboring Subbasin
County Boundary
Highway
Major Lake or Reservoir
Major River
California Aqueduct
Delta-Mendota Canal

0 2.5 5 10 Miles

DELTA-MENDOTA SGMA

Project #: 0012642.00
Map Created: February 2024

Current Seasonal High Groundwater Elevation Contours, Lower Aquifer

Sources
1. Figure is sourced from the Delta-Mendota Subbasin Water Year 2023 Annual Report, Figure 4.

Notes
1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Delta-Mendota Subbasin
July 2024
C00041.09

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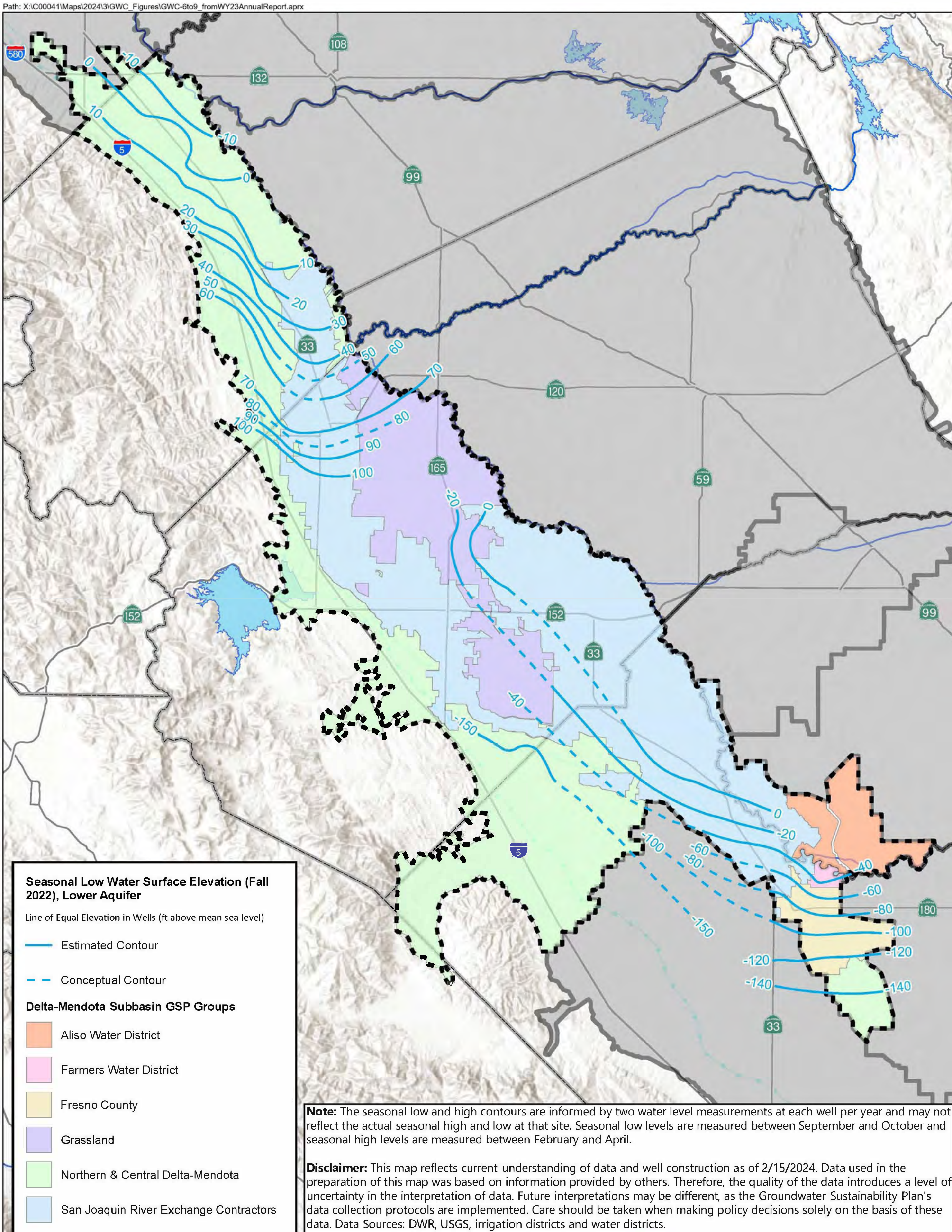
Figure GWC-8

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-6to9_fromWY23AnnualReport.aprx



Note: The seasonal low and high contours are informed by two water level measurements at each well per year and may not reflect the actual seasonal high and low at that site. Seasonal low levels are measured between September and October and seasonal high levels are measured between February and April.

Disclaimer: This map reflects current understanding of data and well construction as of 2/15/2024. Data used in the preparation of this map was based on information provided by others. Therefore, the quality of the data introduces a level of uncertainty in the interpretation of data. Future interpretations may be different, as the Groundwater Sustainability Plan's data collection protocols are implemented. Care should be taken when making policy decisions solely on the basis of these data. Data Sources: DWR, USGS, irrigation districts and water districts.

Delta-Mendota Subbasin

Seasonal Low Lower Aquifer Water Surface Elevation

Water Year 2023 Annual Report

Delta-Mendota Subbasin Boundary
Neighboring Subbasin
County Boundary
Highway
Major Lake or Reservoir
Major River
California Aqueduct
Delta-Mendota Canal

N

0 2.5 5 10 Miles

DELTA-MENDOTA SGMA

Project #: 0012462.00
Map Created: February 2024

Current Seasonal Low Groundwater Elevation Contours, Lower Aquifer

Sources
1. Figure is sourced from the Delta-Mendota Subbasin Water Year 2023 Annual Report, Figure 5.

Notes
1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

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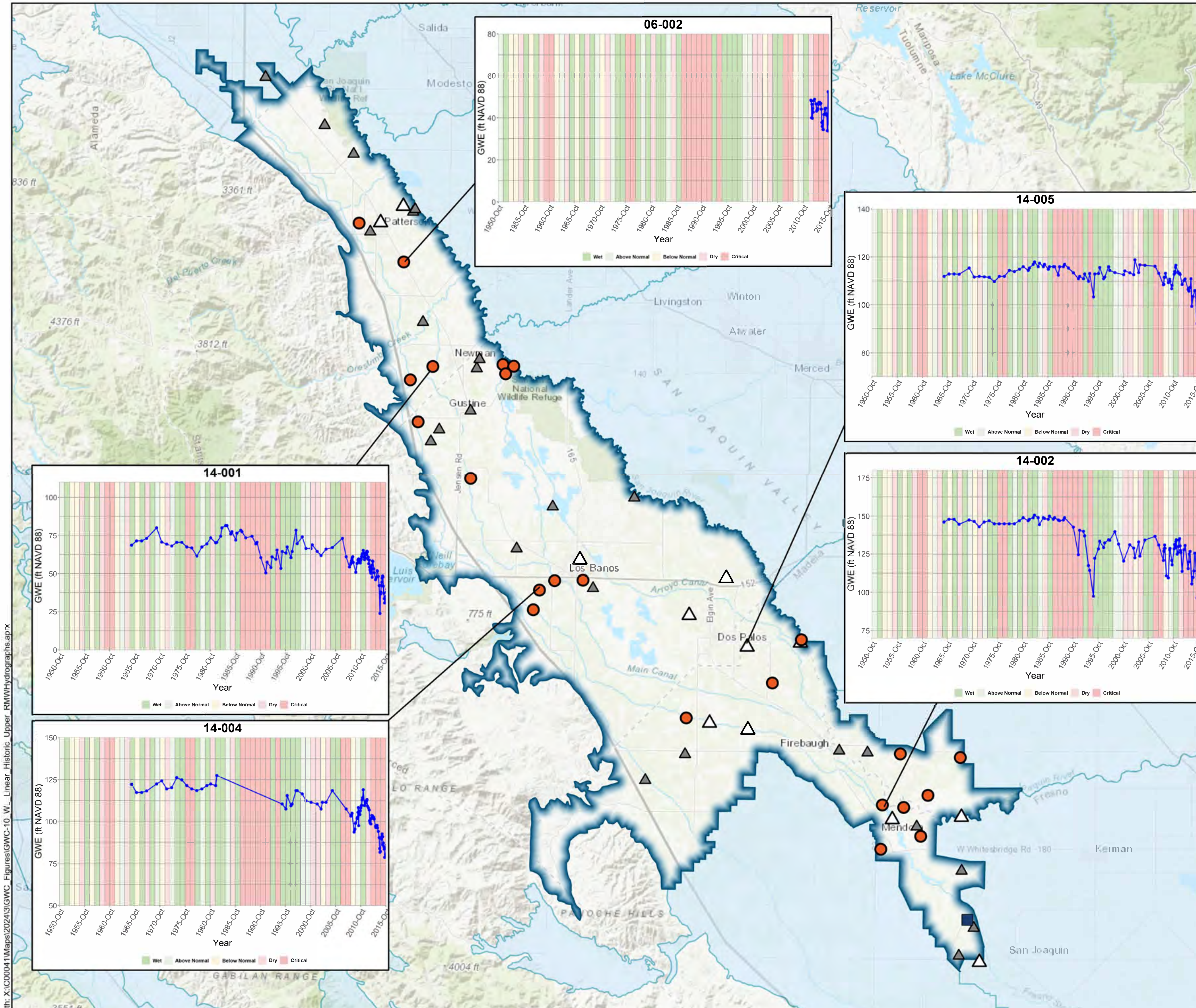
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-9



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Groundwater Elevation Trend (see Notes 1 & 2)

- Decreasing
- No Significant Trend
- Increasing
- Insufficient Data to Calculate a Trend

Abbreviations

DWR = California Department of Water Resources
ft/yr = feet per year
GSA = Groundwater Sustainability Agency

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

Notes

1. A linear regression was conducted on water level data from the historic time period (i.e., 1950-2014).
2. A trend identified from the linear regression was considered significant when its p-value was less than or equal to 0.05 and the slope was greater than +/- 0.1 ft/yr.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N

0 12 24
Miles

Historical (1950-2014) Groundwater Elevation Hydrographs, Upper Aquifer

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Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-10

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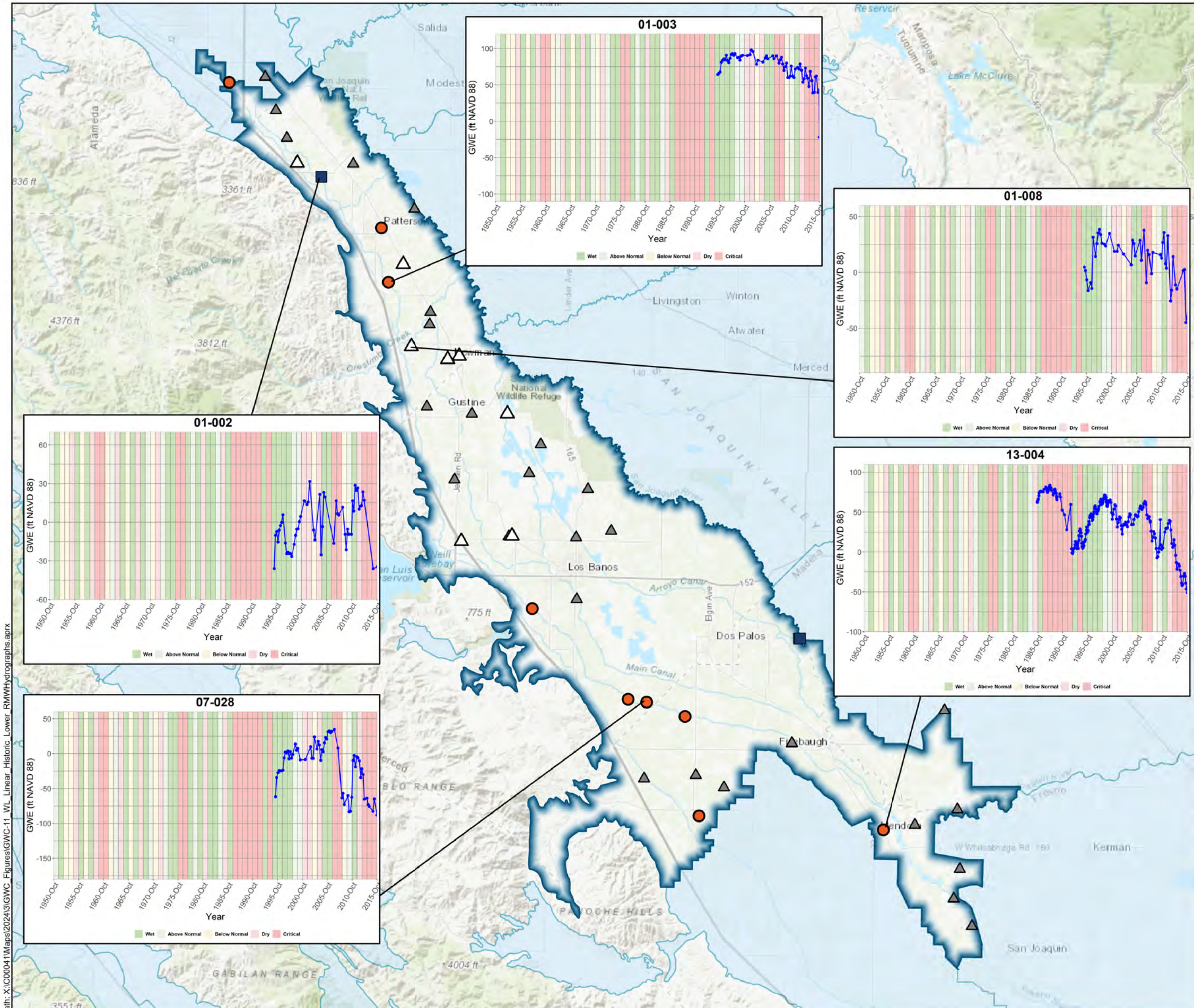

Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Groundwater Elevation Trend (see Notes 1 & 2)

- Decreasing
- No Significant Trend
- Increasing
- Insufficient Data to Calculate a Trend

Abbreviations

DWR = California Department of Water Resources
ft/yr = feet per year
GSA = Groundwater Sustainability Agency

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

Notes

1. A linear regression was conducted on water level data from the historic time period (i.e., 1950-2014).
2. A trend identified from the linear regression was considered significant when its p-value was less than or equal to 0.05 and the slope was greater than +/- 0.1 ft/yr.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N

0 12 24
Miles

Historical (1950-2014) Groundwater Elevation Hydrographs, Lower Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

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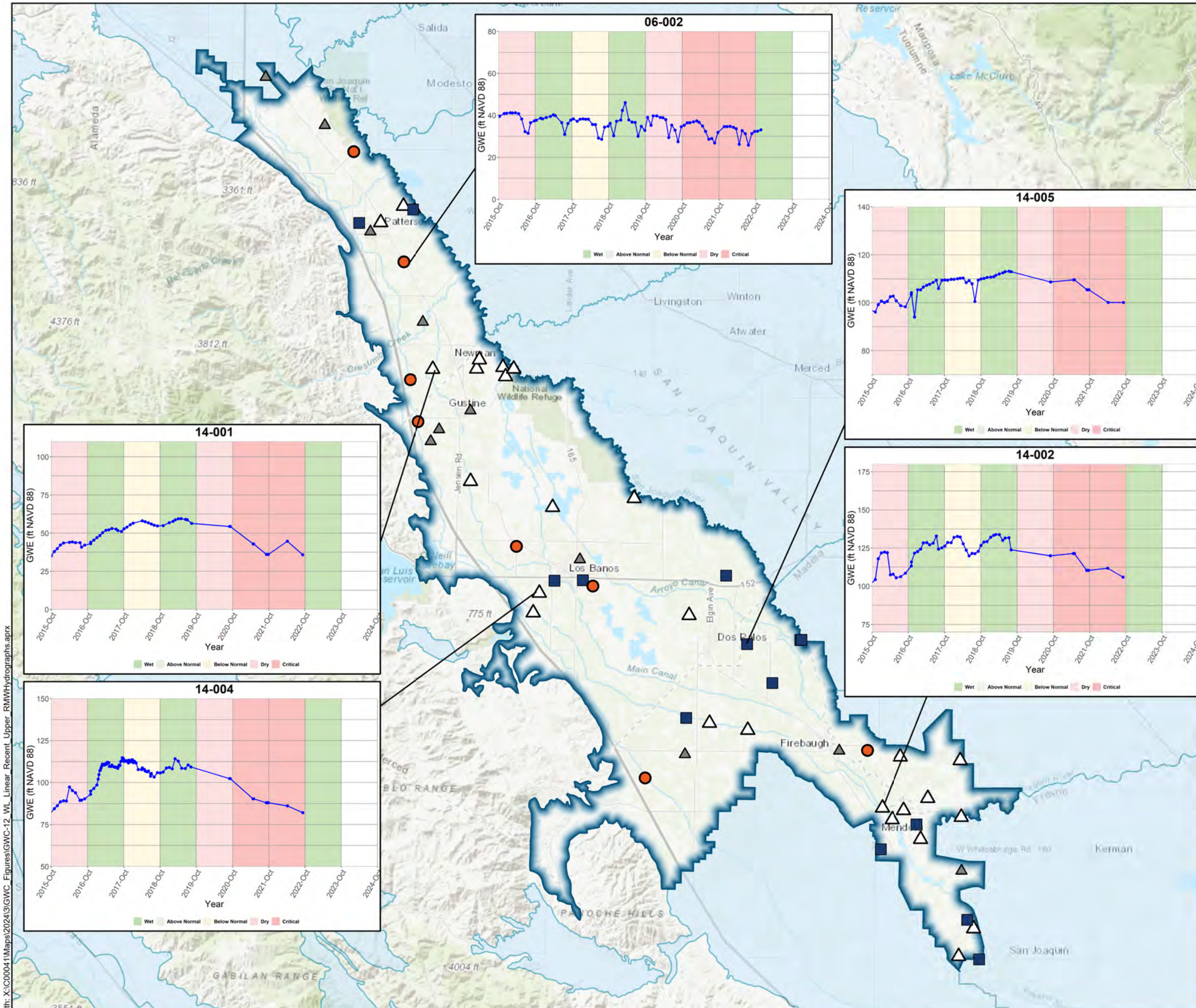
Figure GWC-11



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Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Groundwater Elevation Trend (see Notes 1 & 2)

- Decreasing
- Increasing
- Insufficient Data to Calculate a Trend
- No Significant Trend

Abbreviations

DWR = California Department of Water Resources
ft/yr = feet per year
GSA = Groundwater Sustainability Agency

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

Notes

1. A linear regression was conducted on water level data from the recent time period (i.e., 2015-2023).
2. A trend identified from the linear regression was considered significant when its p-value was less than or equal to 0.05 and slope was greater than +/- 0.1 ft/yr.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

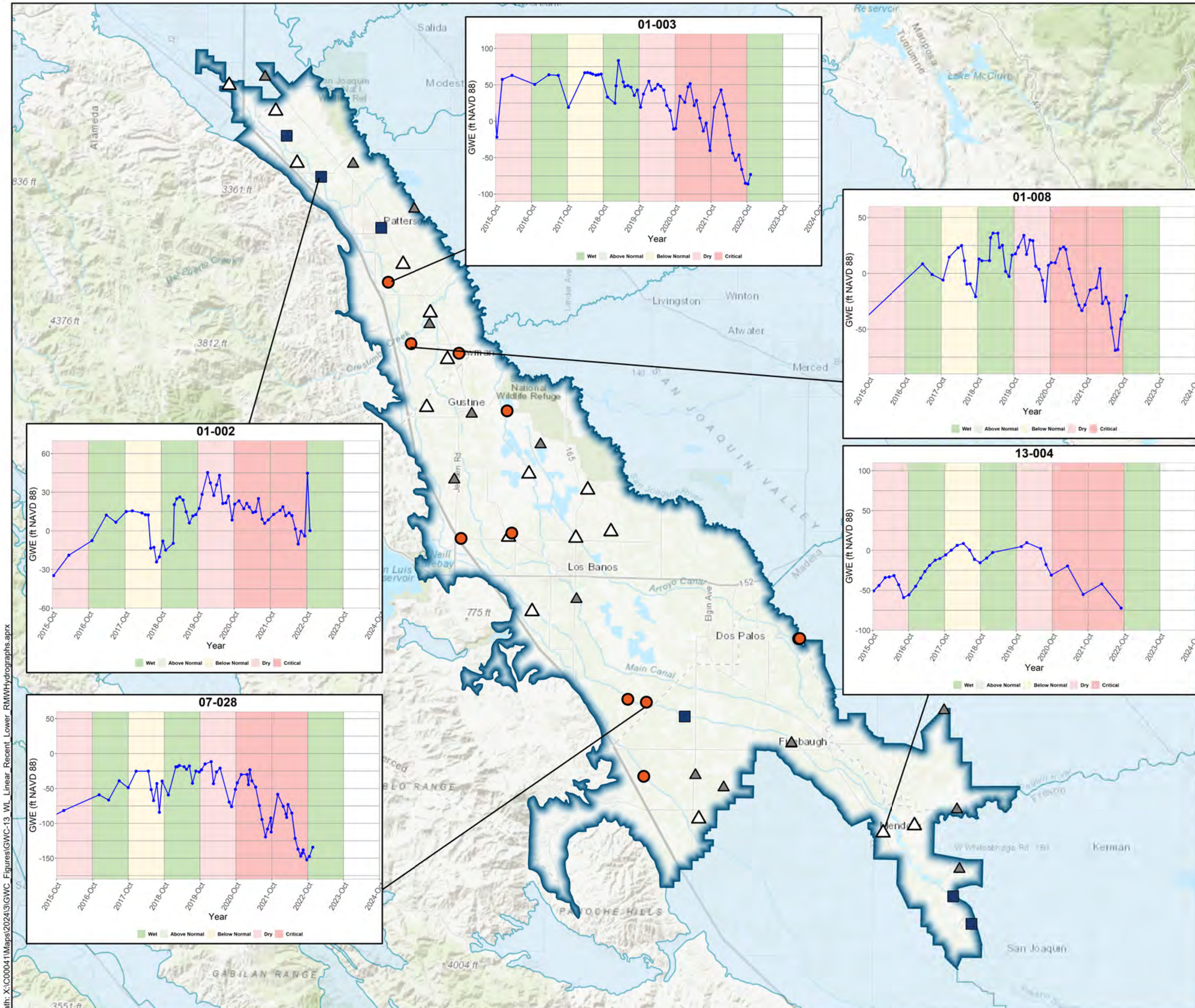
N 0 12 24 Miles

Recent (2015-2023) Groundwater Elevation Hydrographs, Upper Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-12



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Groundwater Elevation Trend (see Notes 1 & 2)

- Decreasing
- Increasing
- Insufficient Data to Calculate a Trend
- No Significant Trend

Abbreviations

DWR = California Department of Water Resources
ft/yr = feet per year
GSA = Groundwater Sustainability Agency

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

Notes

1. A linear regression was conducted on water level data from the recent time period (i.e., 2015-2023).
2. A trend identified from the linear regression was considered significant when its p-value was less than or equal to 0.05 and slope was greater than +/- 0.1 ft/yr.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N 0 12 24 Miles

Recent (2015-2023) Groundwater Elevation Hydrographs, Lower Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

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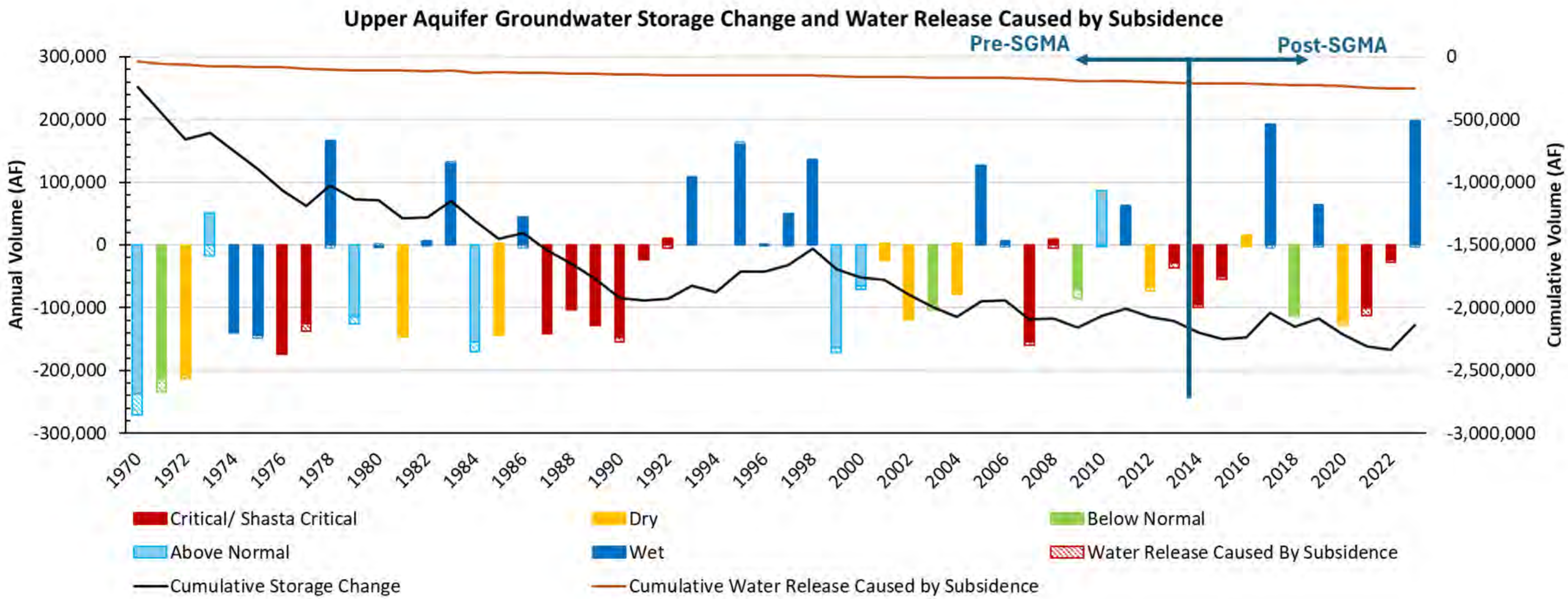
Figure GWC-13



Notes:

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Abbreviations

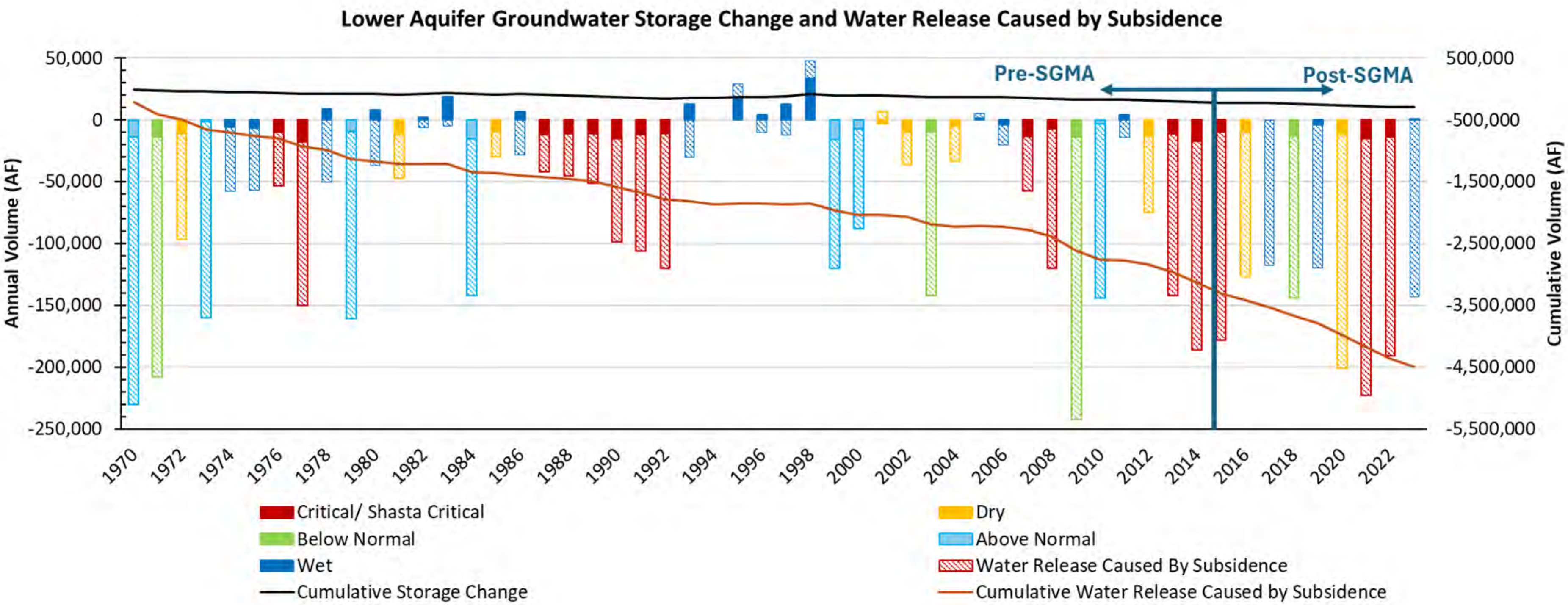
AF = acre-feet

SGMA = Sustainable Groundwater Management Act

Annual Groundwater Storage Change, Upper Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-14



Notes:

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Abbreviations

AF = acre-feet

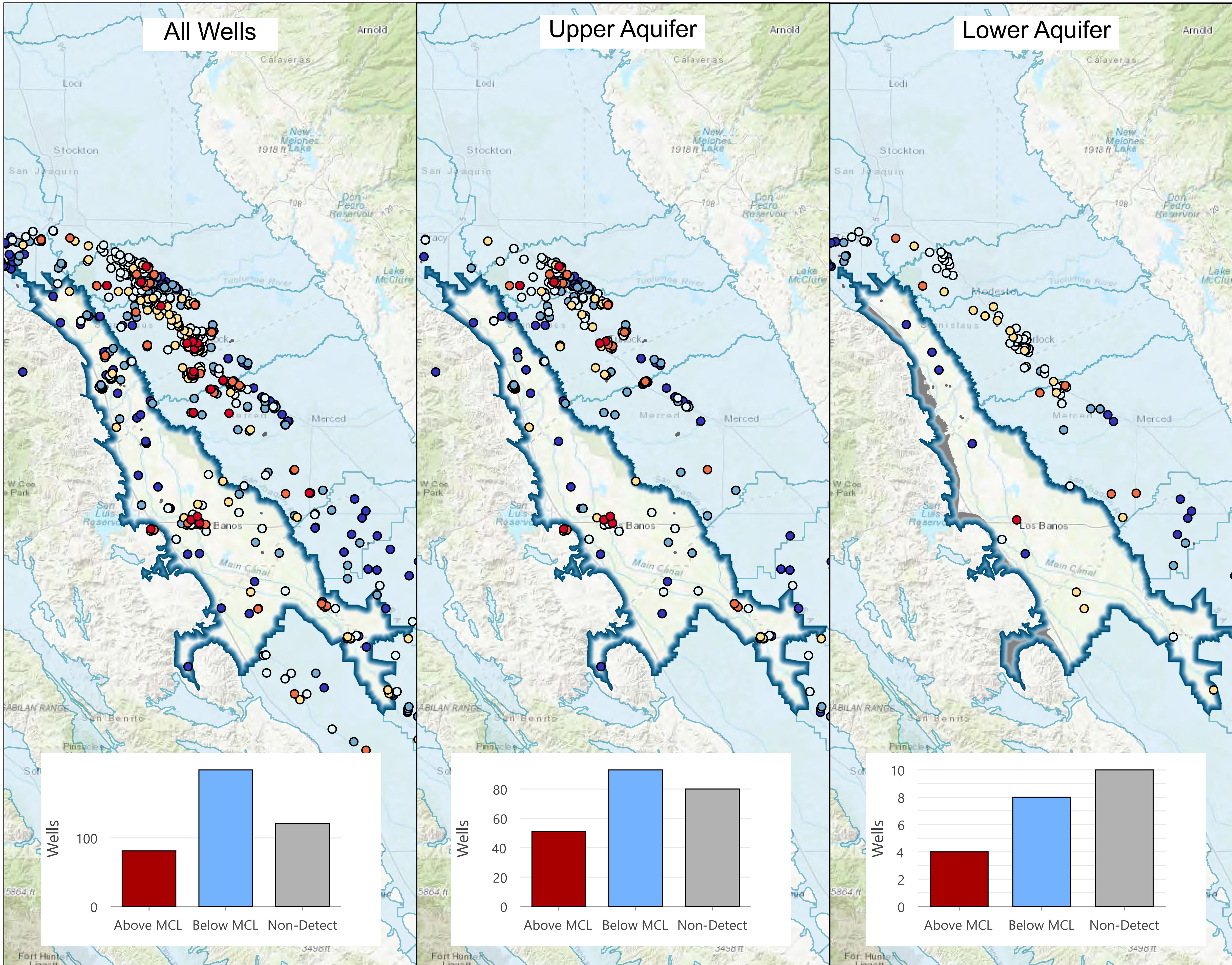
SGMA = Sustainable Groundwater Management Act

Annual Groundwater Storage Change, Lower Aquifer

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-15



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Average concentration by well (ug/L)
(MCL = 10 ug/L)

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50
- Not detected

Abbreviations

1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. ug/L = Micrograms per Liter

Notes

1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Area shaded in grey indicates that the Lower Aquifer is not present.
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Arsenic Concentrations (2005 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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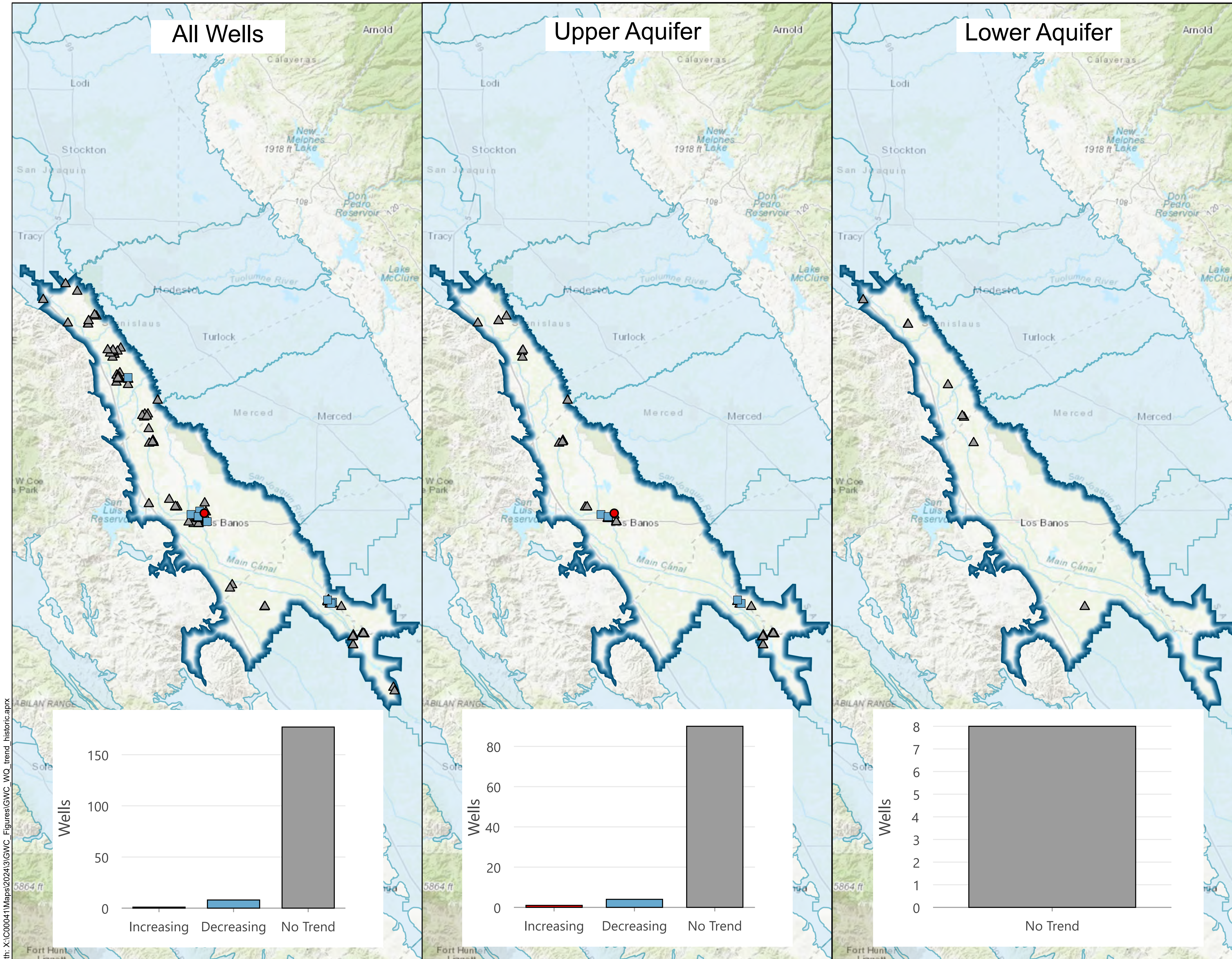
Figure GWC-16



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Arsenic Concentration Trends (1950 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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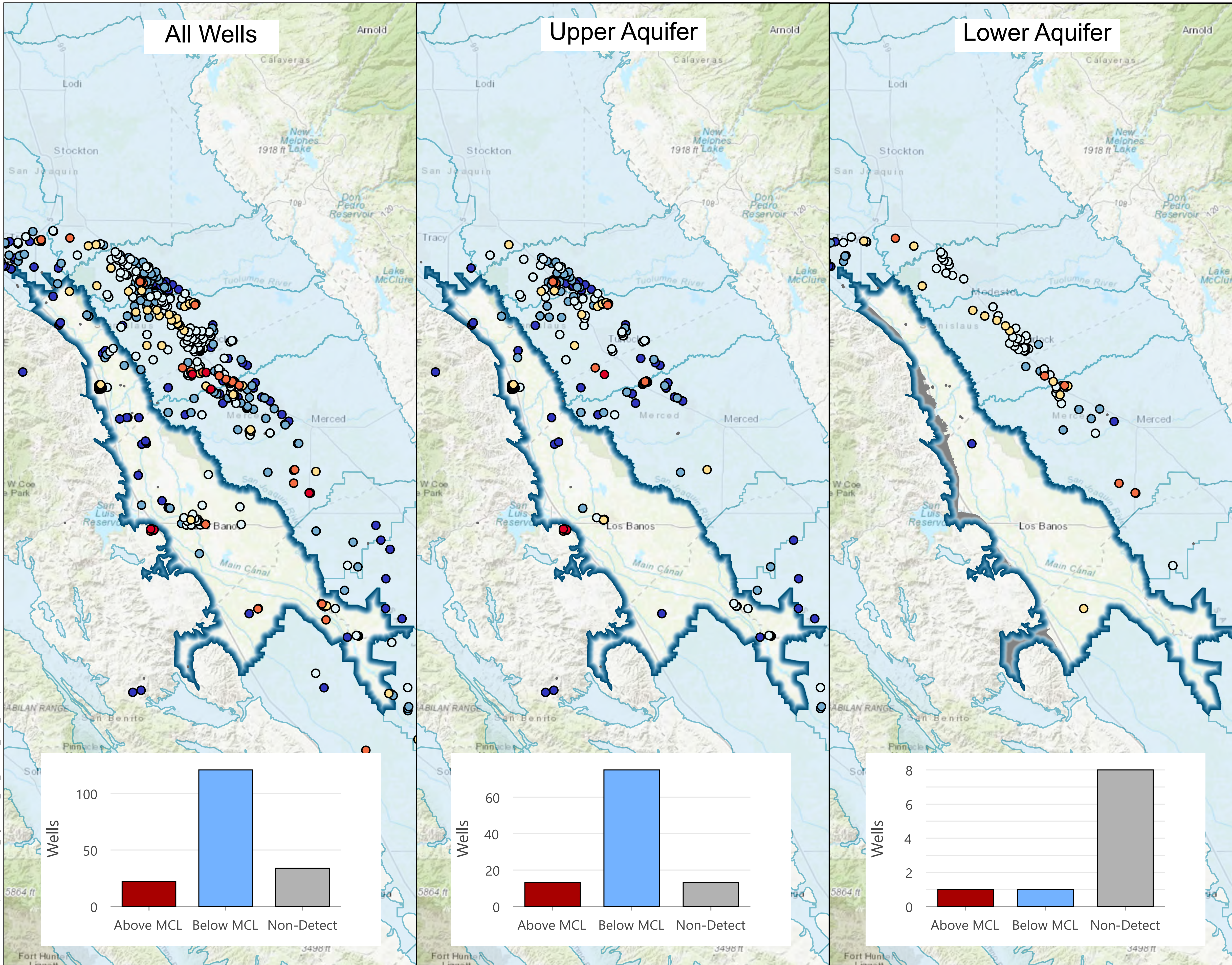
Figure GWC-17

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_historic.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Average concentration by well (ug/L)
(MCL = 10 ug/L)

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50
- Not detected

Abbreviations

1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. ug/L = Micrograms per Liter

Notes

1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Exceedances in bar graphs may not equal number of impacted wells in table GWC-5, as wells are mapped by average, not maximum concentration.
4. Area shaded grey indicates that the Lower Aquifer is not present.
5. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Arsenic Concentrations (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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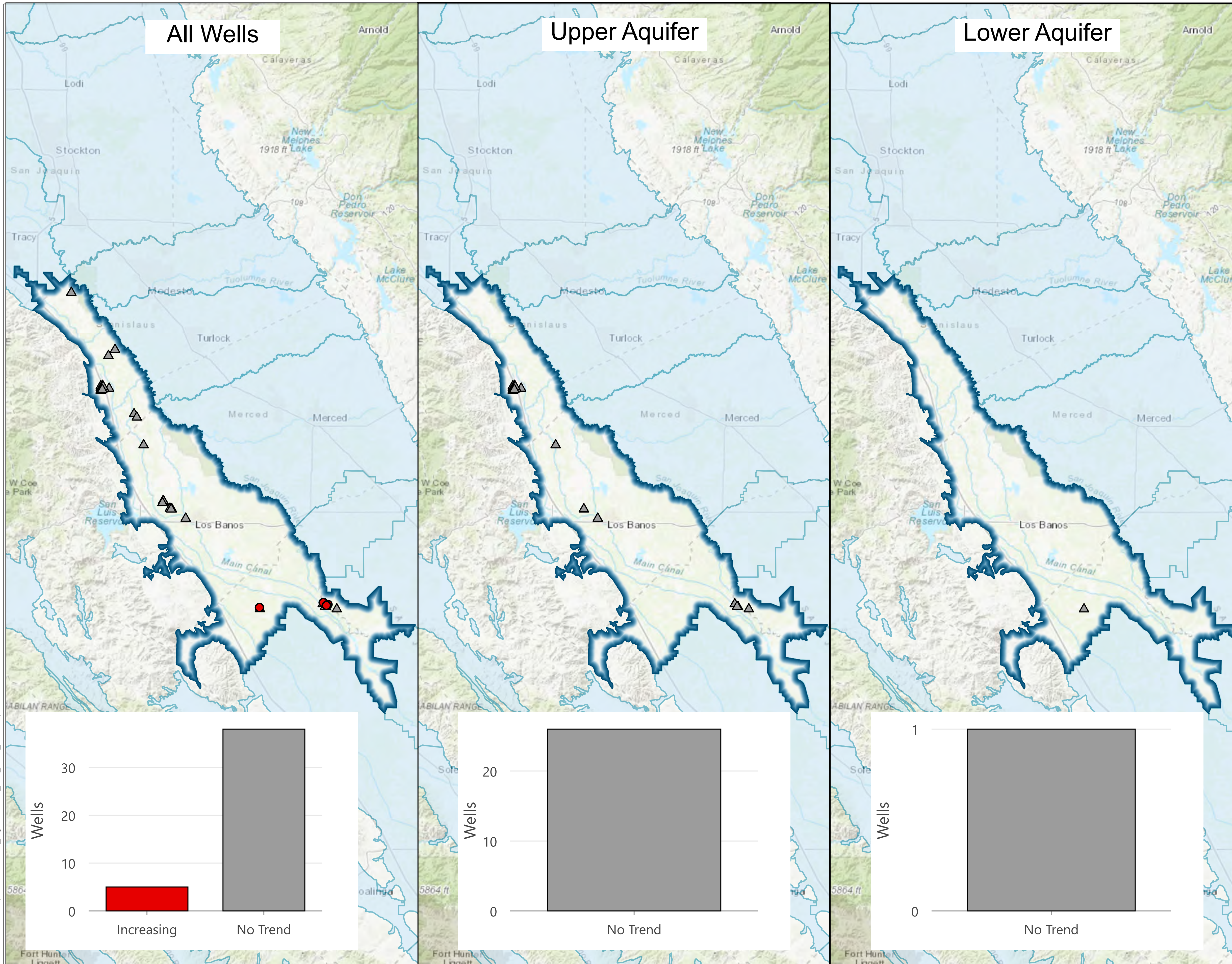
Figure GWC-18

Path: X:\C00041\Maps\2024\3\GWC_Figures\DM_WQ_contours_2015_2023.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Arsenic Concentration Trends (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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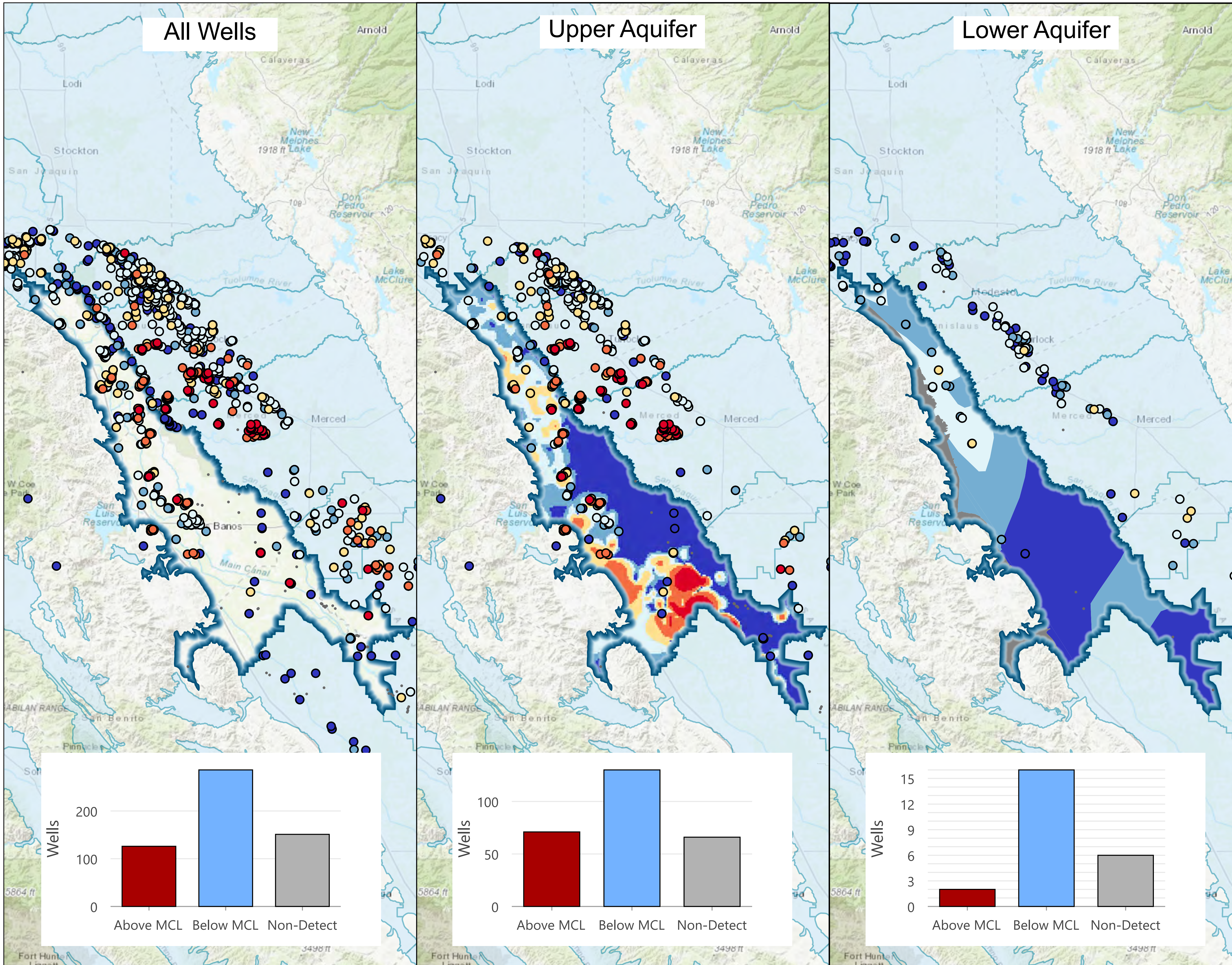
Figure GWC-19

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_recent.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Average concentration by well (mg/L)
(MCL = 10 mg/L)

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50
- Not detected

Approximate Concentration Contours (mg/L)
Value

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50

Abbreviations

1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. mg/L = Milligrams per Liter

Notes

1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Area shaded in grey indicates that the Lower Aquifer is not present.
4. Wells of uncertain depth were also considered in the development of Upper Aquifer concentration contours. See text for details.
5. Data from previous time periods may be used to fill spatial gaps in development of contours.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Nitrate as Nitrogen Concentrations (2005 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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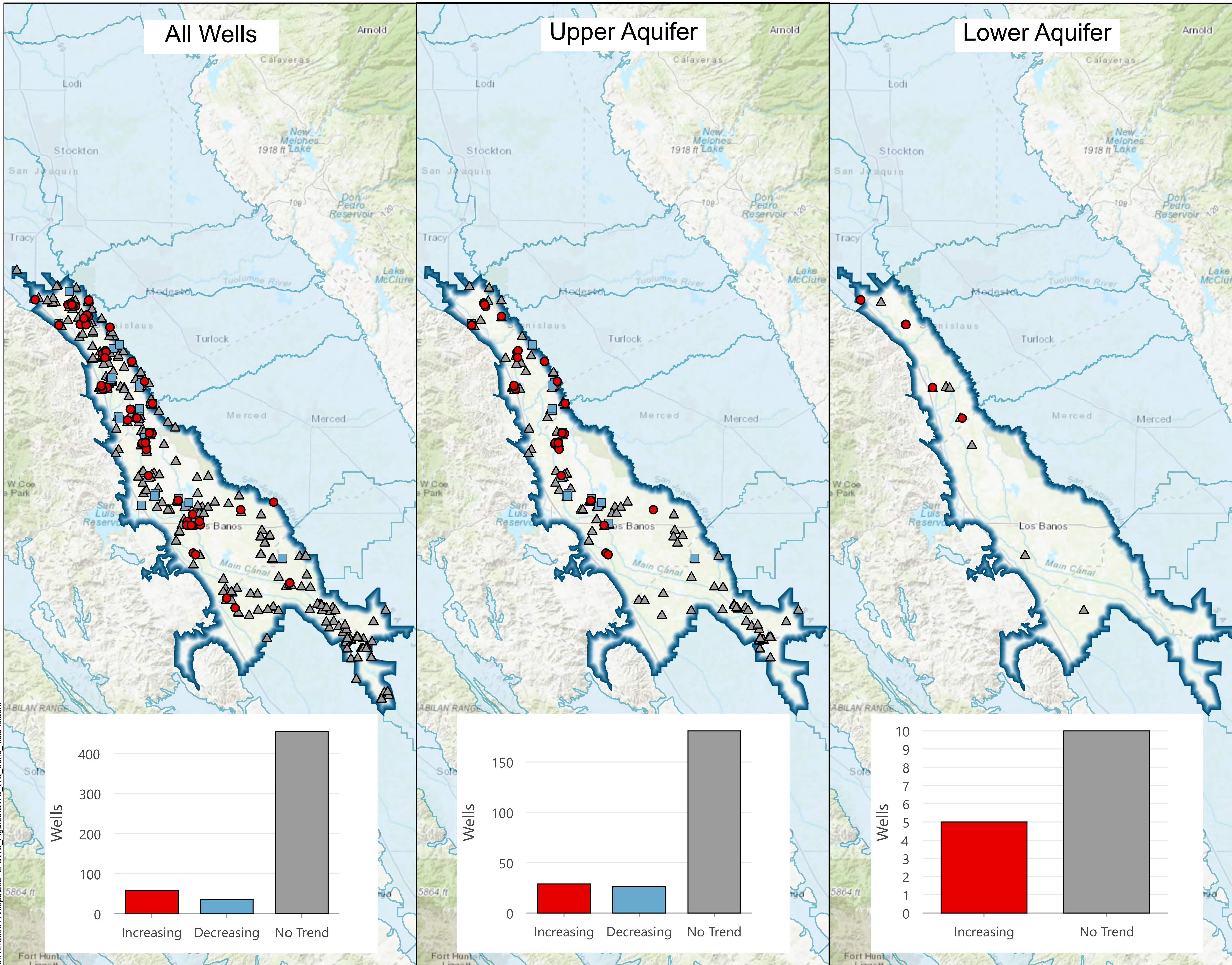
Figure GWC-20



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Nitrate as Nitrogen Concentration Trends (1950 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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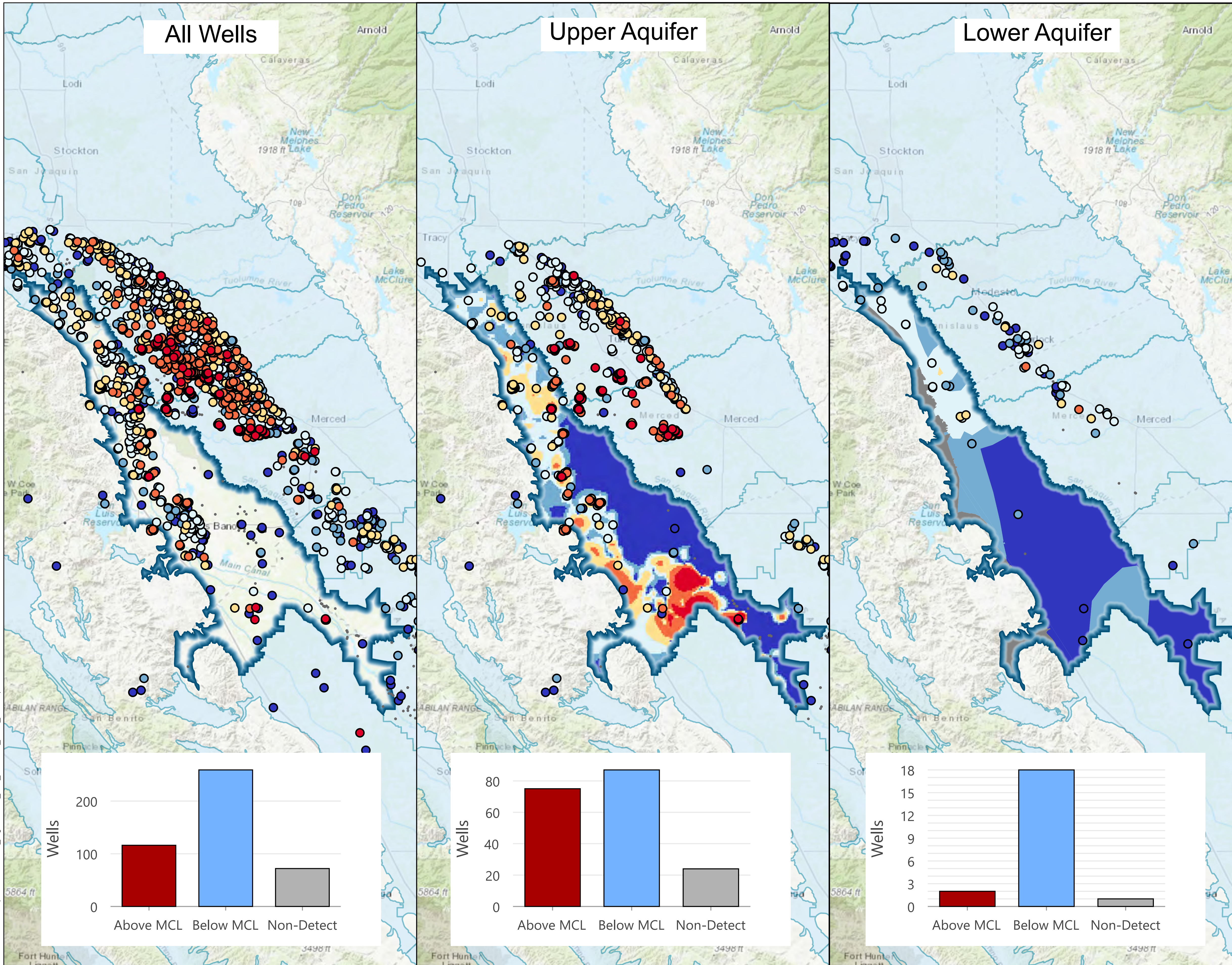
Figure GWC-21



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Average concentration by well (mg/L)
(MCL = 10 mg/L)

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50
- Not detected

Approximate Concentration Contours (mg/L)
Value

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50

Abbreviations
1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. mg/L = Milligrams per Liter

Notes
1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Exceedances in bar graphs may not equal number of impacted wells in Table GWC-5, as wells are mapped by average, not maximum concentration.
4. Area shaded grey indicates that the Lower Aquifer is not present.
5. Wells of uncertain depth were also considered in the development of Upper Aquifer concentration contours. See text for details.
6. Data from previous time periods may be used to fill spatial gaps in development of contours.
7. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N
0 12 24
Miles

Nitrate as Nitrogen Concentrations (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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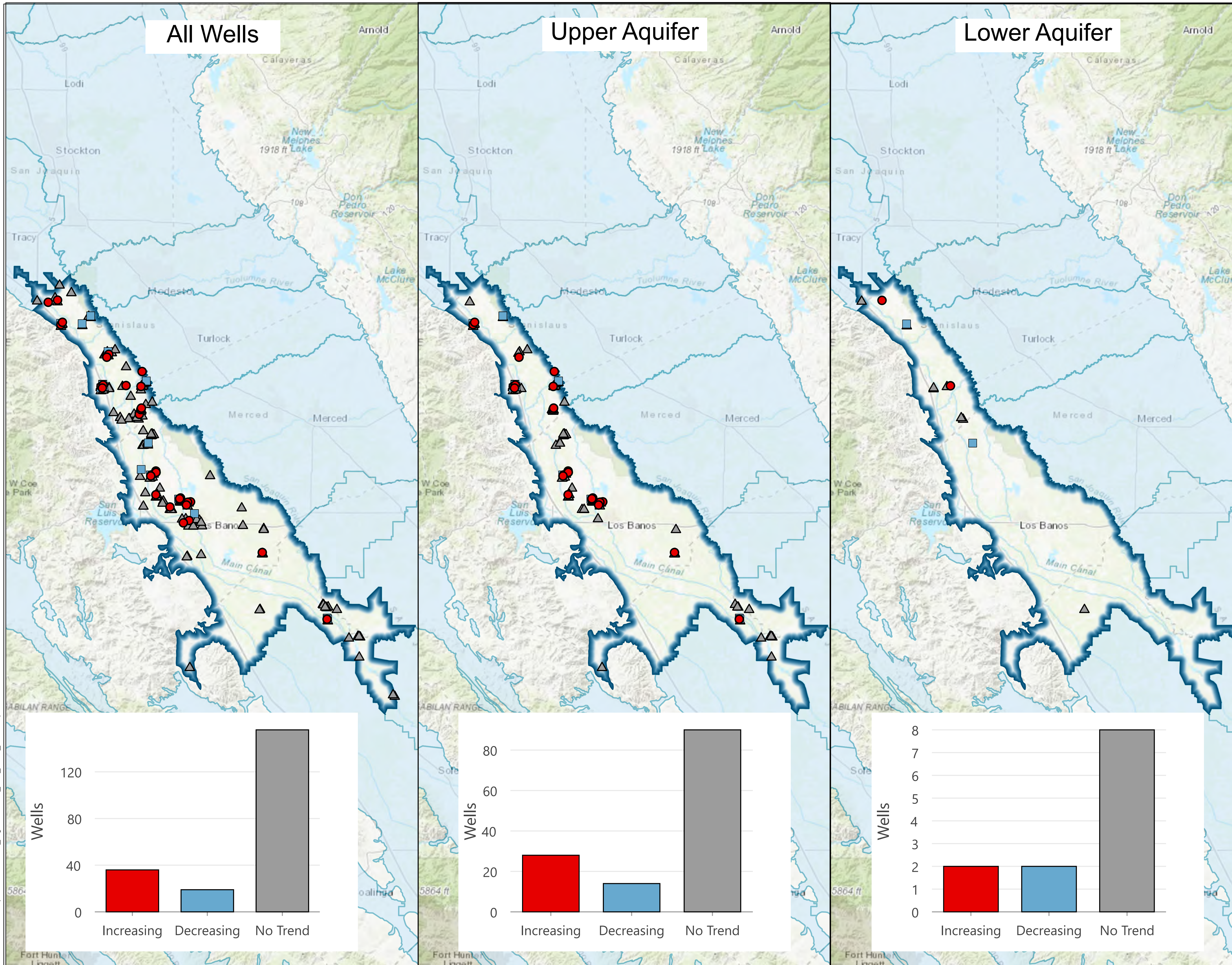
Figure GWC-22

Path: X:\C00041\Maps\2024\3\GWC_Figures\DM_WQ_contours_2015_2023.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend
- Increasing
- Decreasing
- No Trend

Abbreviations
GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes
1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
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3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Nitrate as Nitrogen Concentration Trends (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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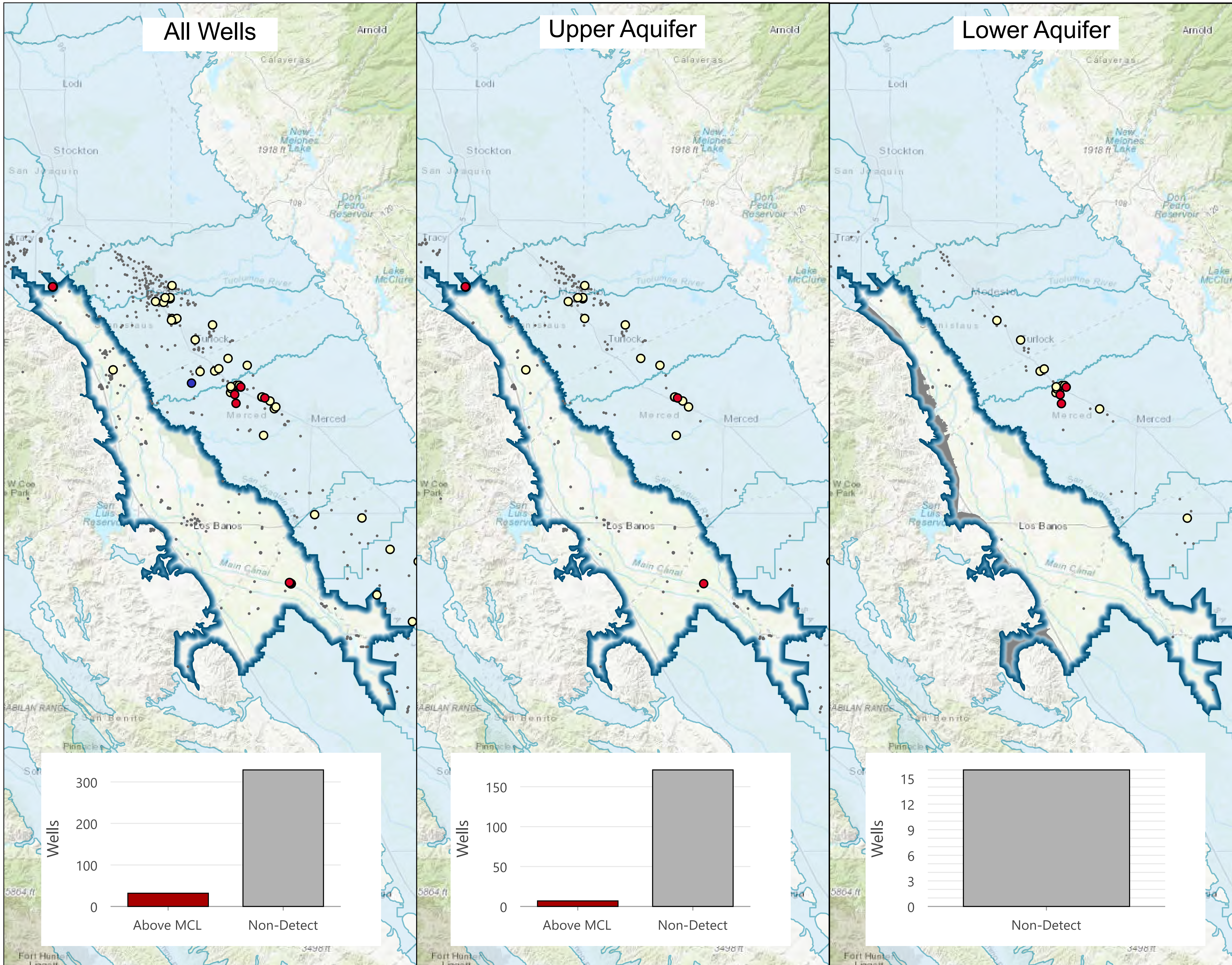
Figure GWC-23

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_recent.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Average concentration by well (ug/L)
(MCL = 0.005 ug/L)

- < 0.005
- 0.005 - 0.5
- > 0.5
- Not detected

Abbreviations
1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. ug/L = Micrograms per Liter

Notes
1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Area shaded in grey indicates that the Lower Aquifer is not present.
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

1,2,3-Trichloropropane Concentrations (2005 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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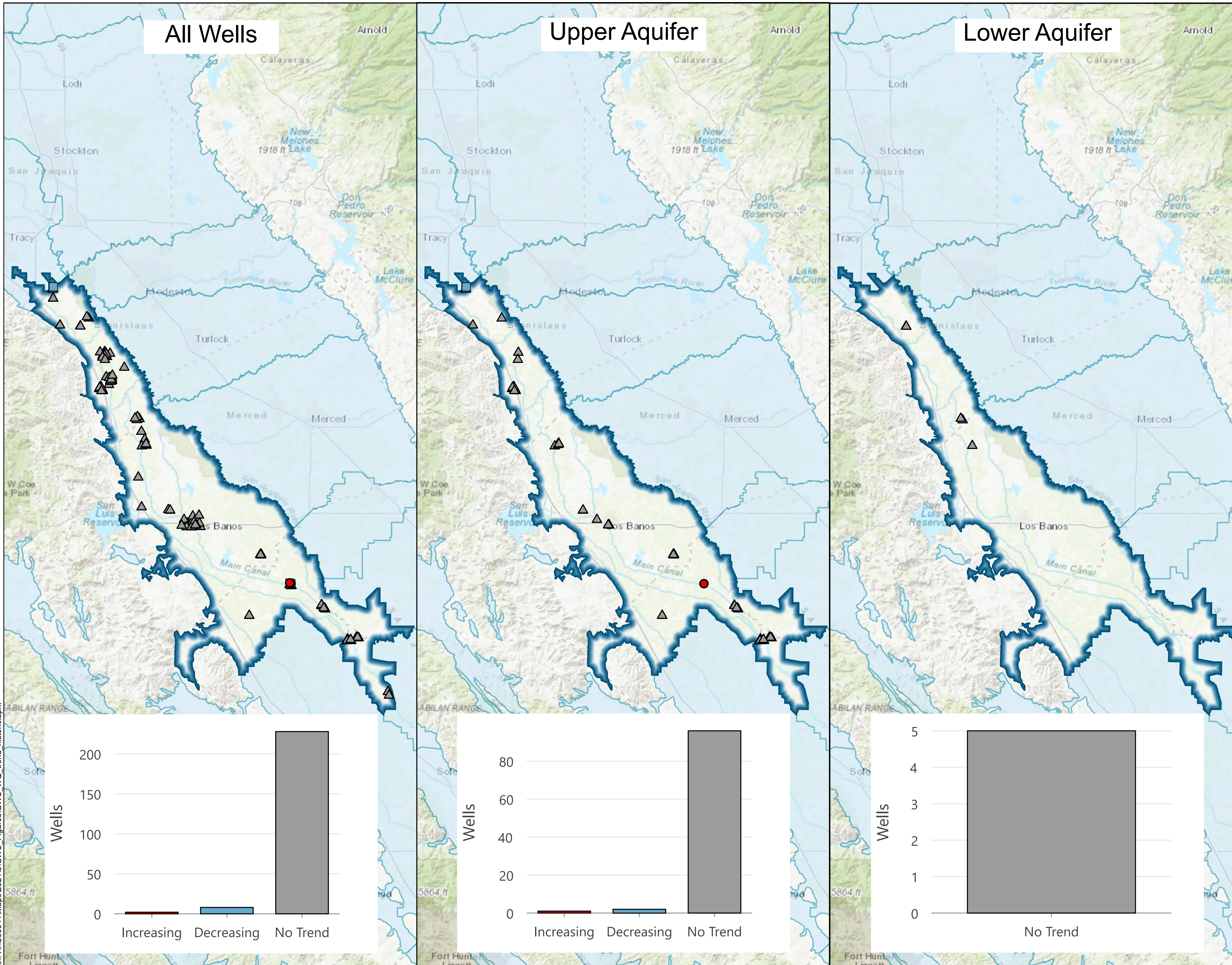
Figure GWC-24



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend
- Increasing
- Decreasing
- No Trend

Abbreviations
GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes
1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

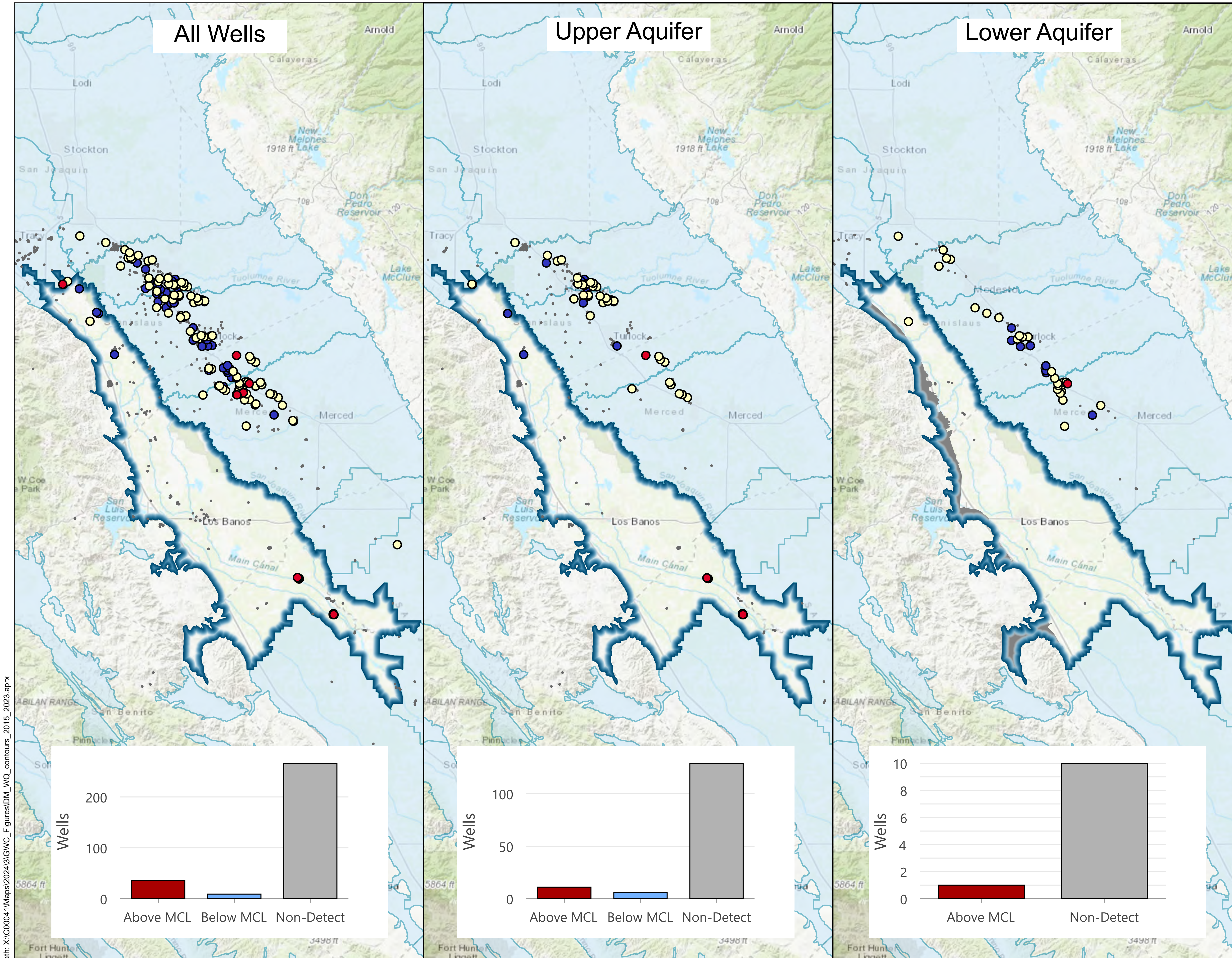
1,2,3 - Trichloropropane Concentration Trends (1950 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-25

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_historic.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Average concentration by well (ug/L)
(MCL = 0.005 ug/L)

- < 0.005
- 0.005 - 0.5
- > 0.5
- Not detected

Abbreviations

1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. ug/L = Micrograms per Liter

Notes

1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Exceedances in bar graphs may not equal number of impacted wells in table GWC-5, as wells are mapped by average, not maximum concentration.
4. Area shaded grey indicates that the Lower Aquifer is not present.
5. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

1,2,3 - Trichloropropane Concentrations (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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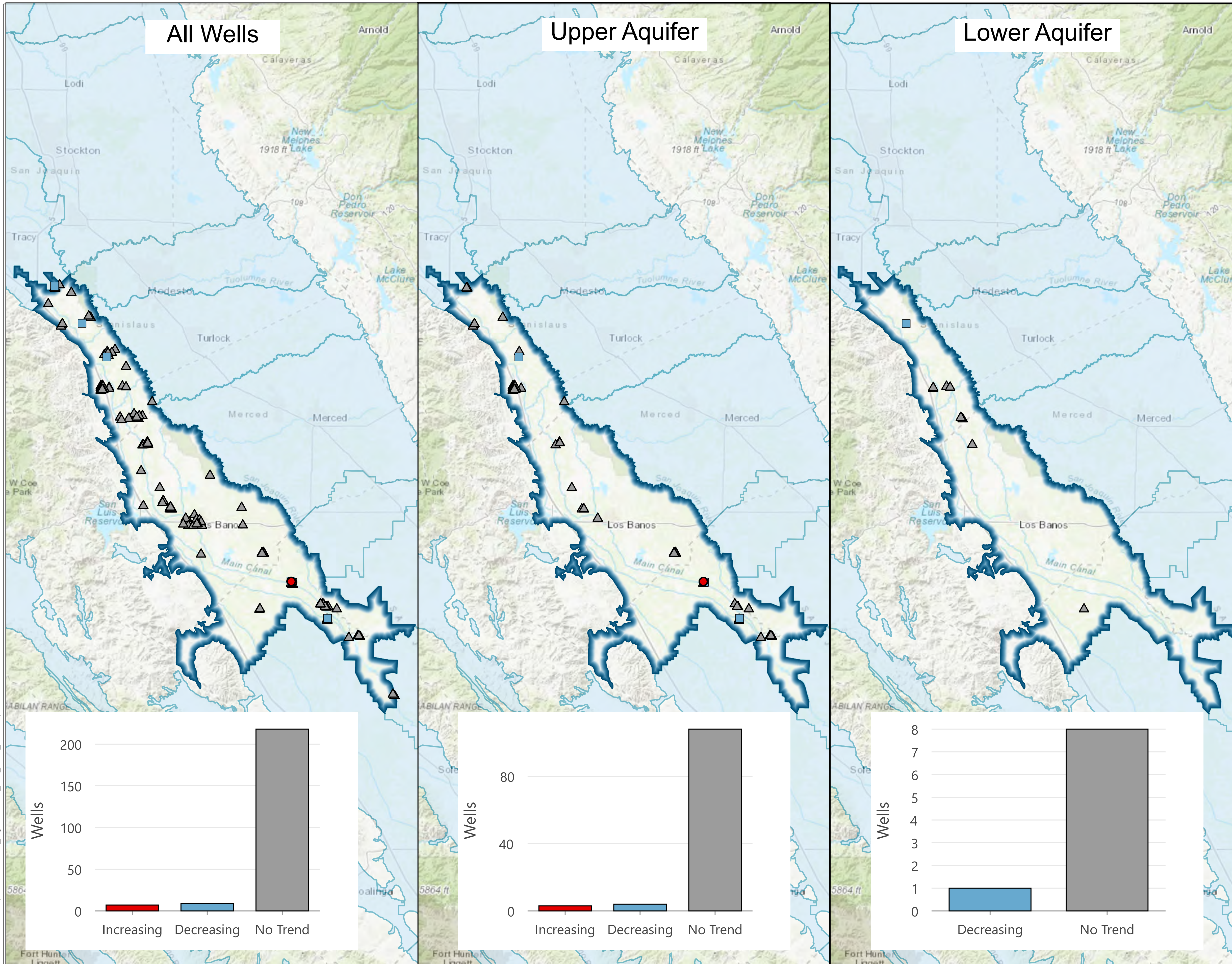
Figure GWC-26



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

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3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

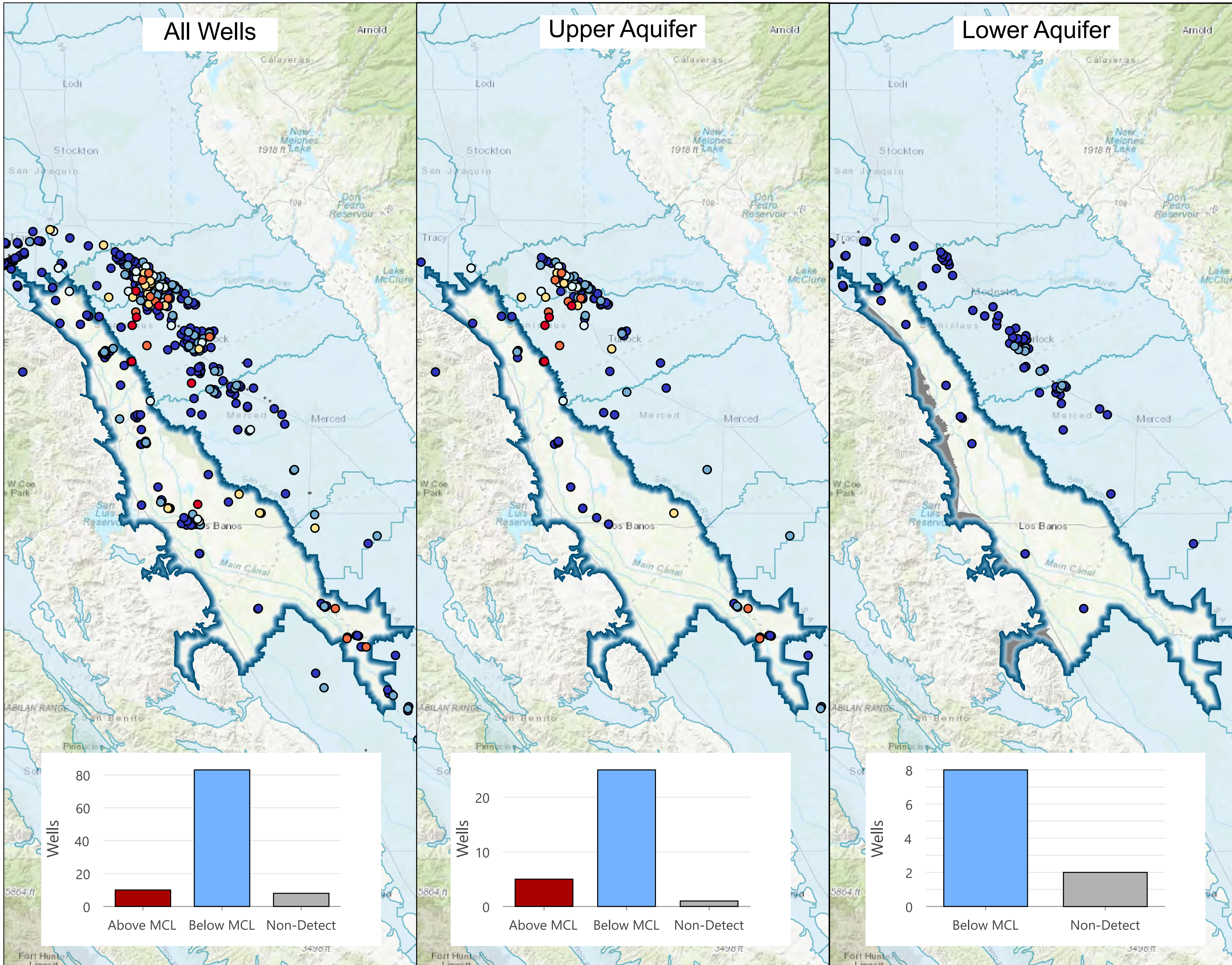
1,2,3 - Trichloropropane Concentration Trends (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-27

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_recent.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Average activity by well (pCi/L)
(MCL = 15 pCi/L)

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 30
- > 30
- Not detected

Abbreviations
1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. pCi/L = Picocuries per Liter

Notes
1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells
3. Area shaded in grey indicates that the Lower Aquifer is not present..
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

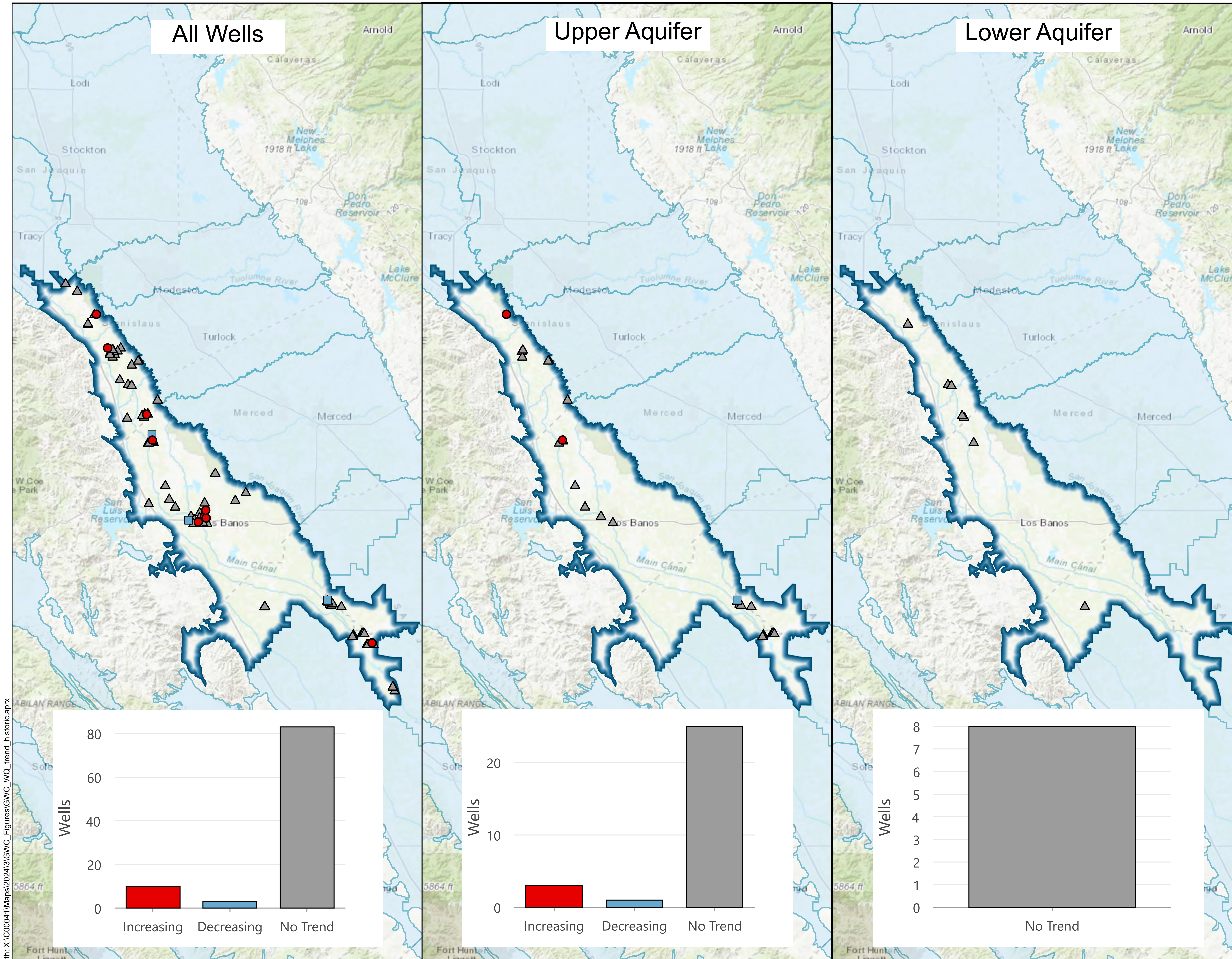
0 12 24
Miles

Gross Alpha Radioactivity (2005 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-28



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend
- Increasing
- Decreasing
- No Trend

Abbreviations
GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes
1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Gross Alpha Radioactivity Trends (1950 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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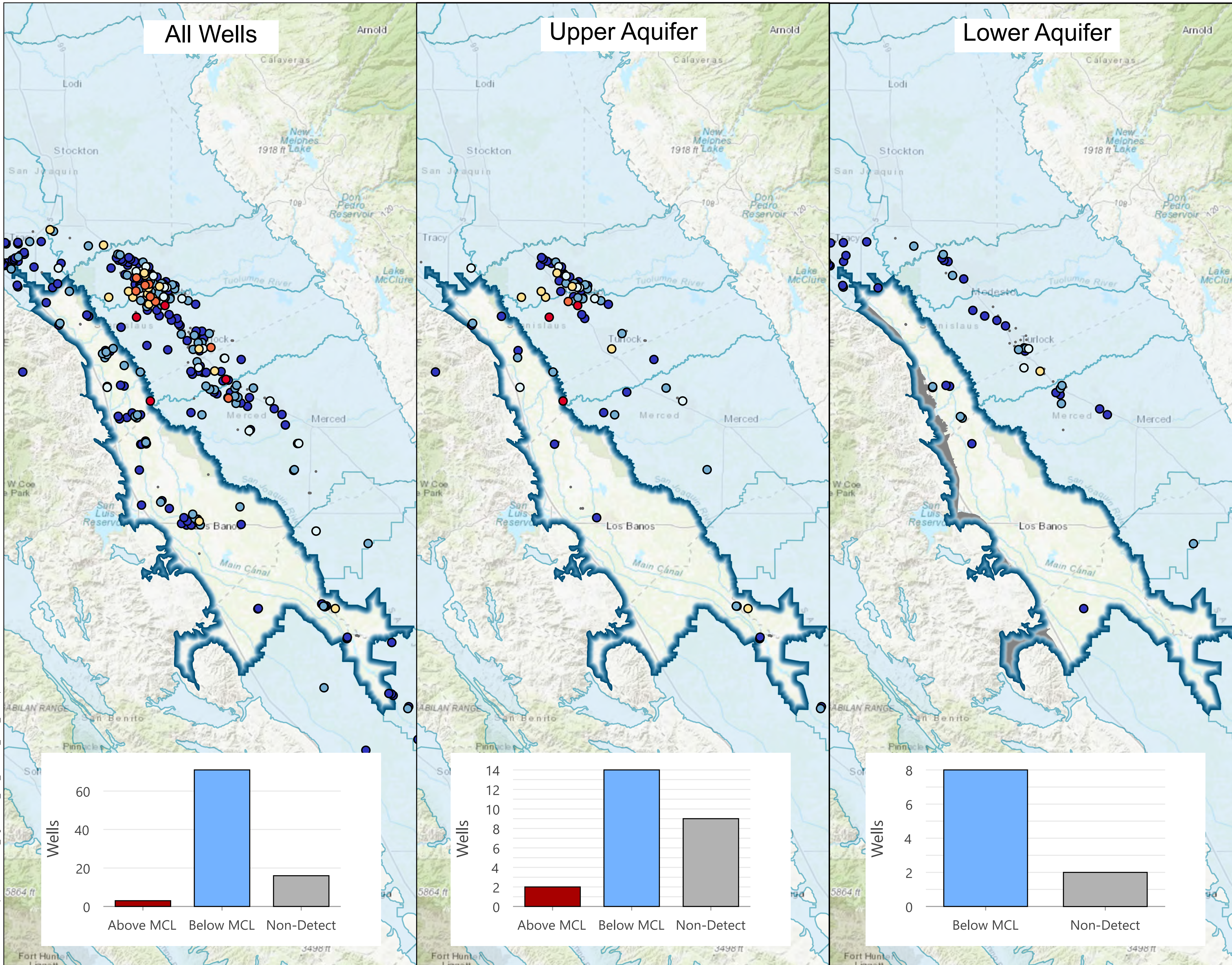
Figure GWC-29

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_historic.aprx



Path: X:\C00041\Maps\2024\3\GWC_Figures\DM_WQ_contours_2015_2023.aprx

Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Average activity by well (pCi/L)
(MCL = 15 pCi/L)

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 30
- > 30
- Not detected

Abbreviations

1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. pCi/L = Picocuries per Liter

Notes

1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Exceedances In bar graphs may not equal number of Impacted wells in Table GWC-5, as wells are mapped by average, not maximum concentration.
4. Area shaded grey indicates that the Lower Aquifer is not present.
5. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

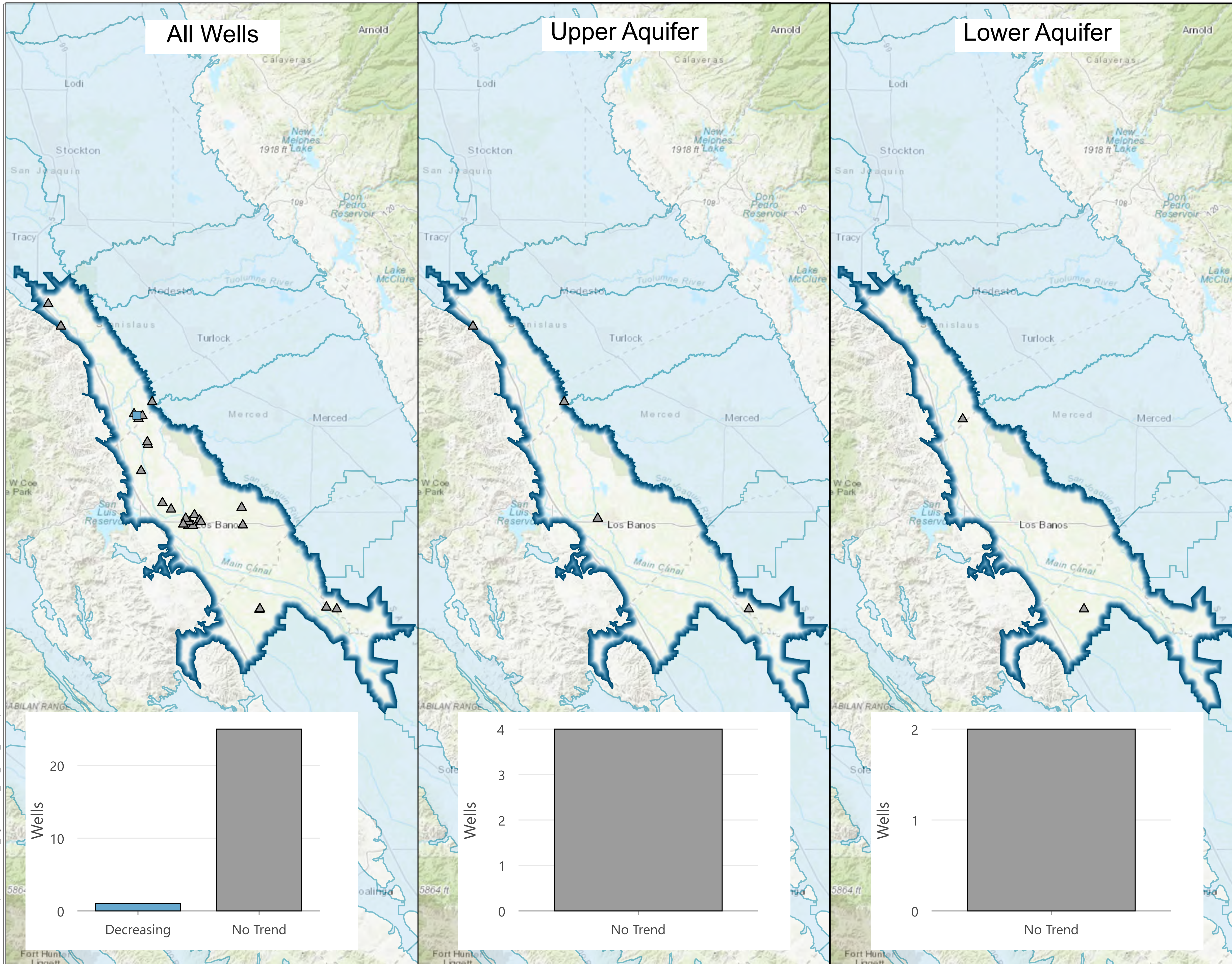
0 12 24
Miles

Gross Alpha Radioactivity (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-30



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Gross Alpha Radioactivity Trends (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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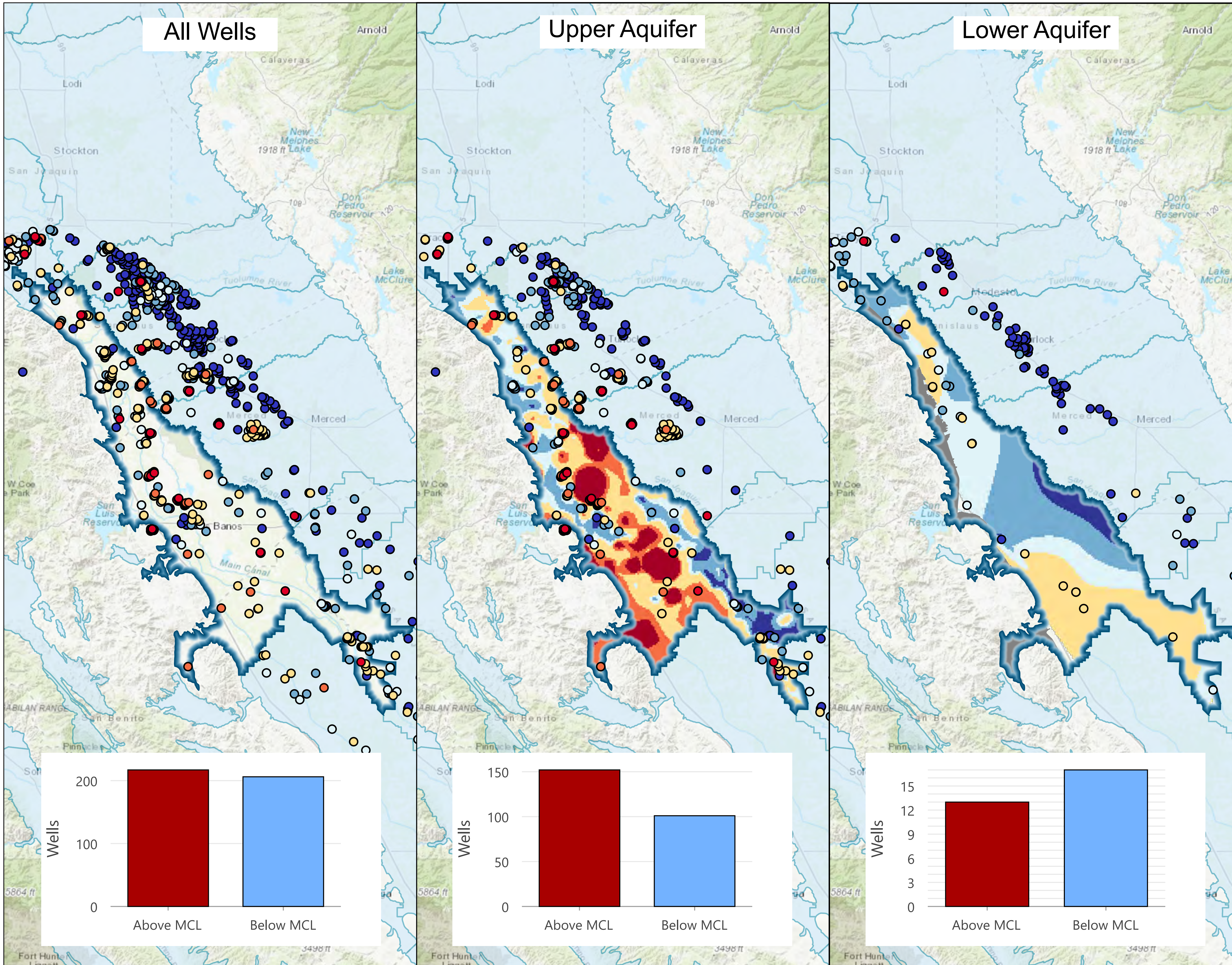
Figure GWC-31

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_recent.aprx



Legend
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Average concentration by well (mg/L)
(MCL = 1,000 mg/L)
- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- 2000 - 3000
- > 3000

Approximate Concentration Contours (mg/L)
Value
- < 500
- 500 - 750
- 750 - 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- > 3,000

Abbreviations
1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. mg/L = Milligrams per Liter

Notes
1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Area shaded in grey indicates that the Lower Aquifer is not present.
4. Wells of uncertain depth were also considered in the development of Upper Aquifer concentration contours. See text for details.
5. Data from previous time periods may be used to fill spatial gaps in development of contours.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Total Dissolved Solids Concentrations (2005 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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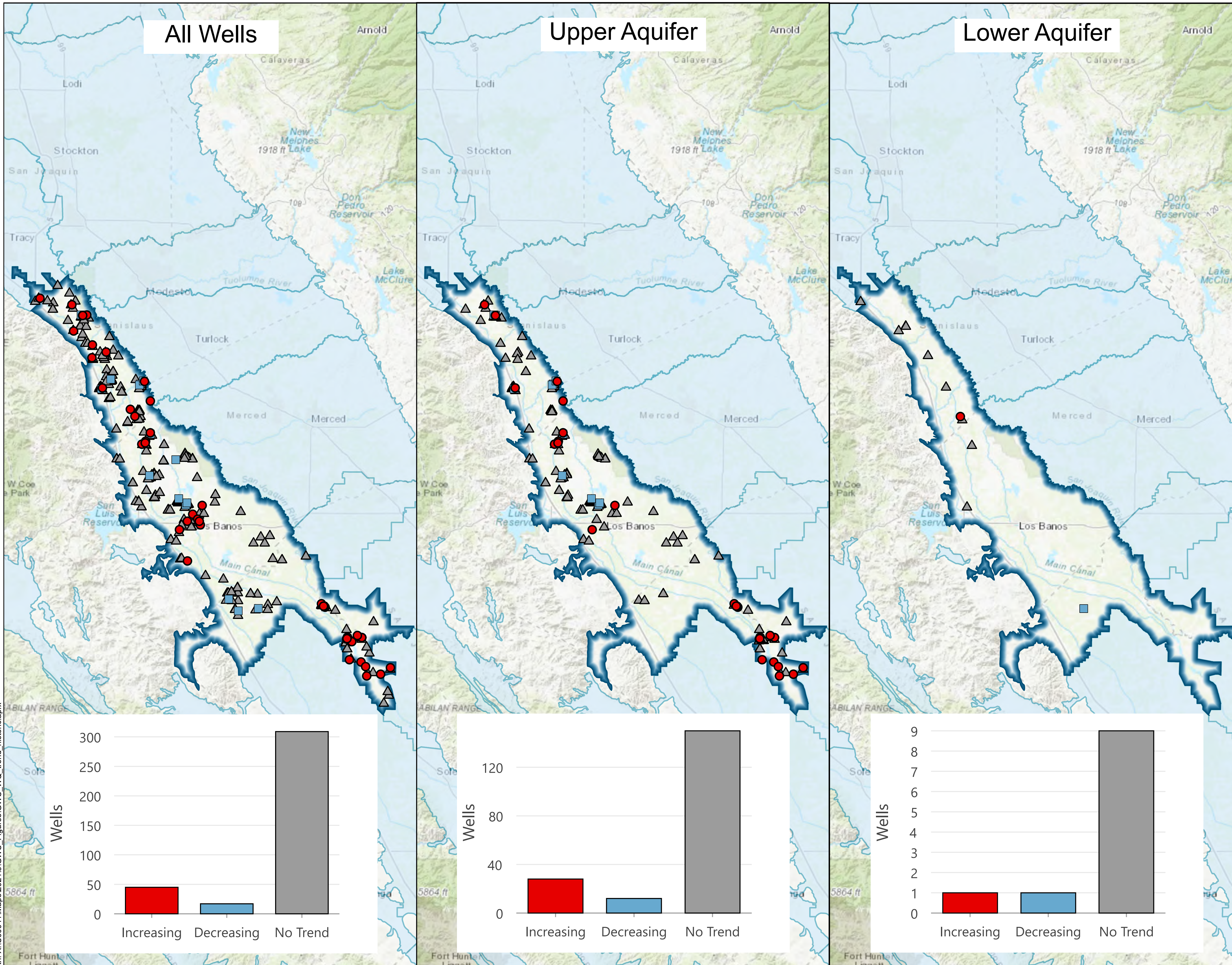
Figure GWC-32



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Total Dissolved Solids Concentration Trends (1950 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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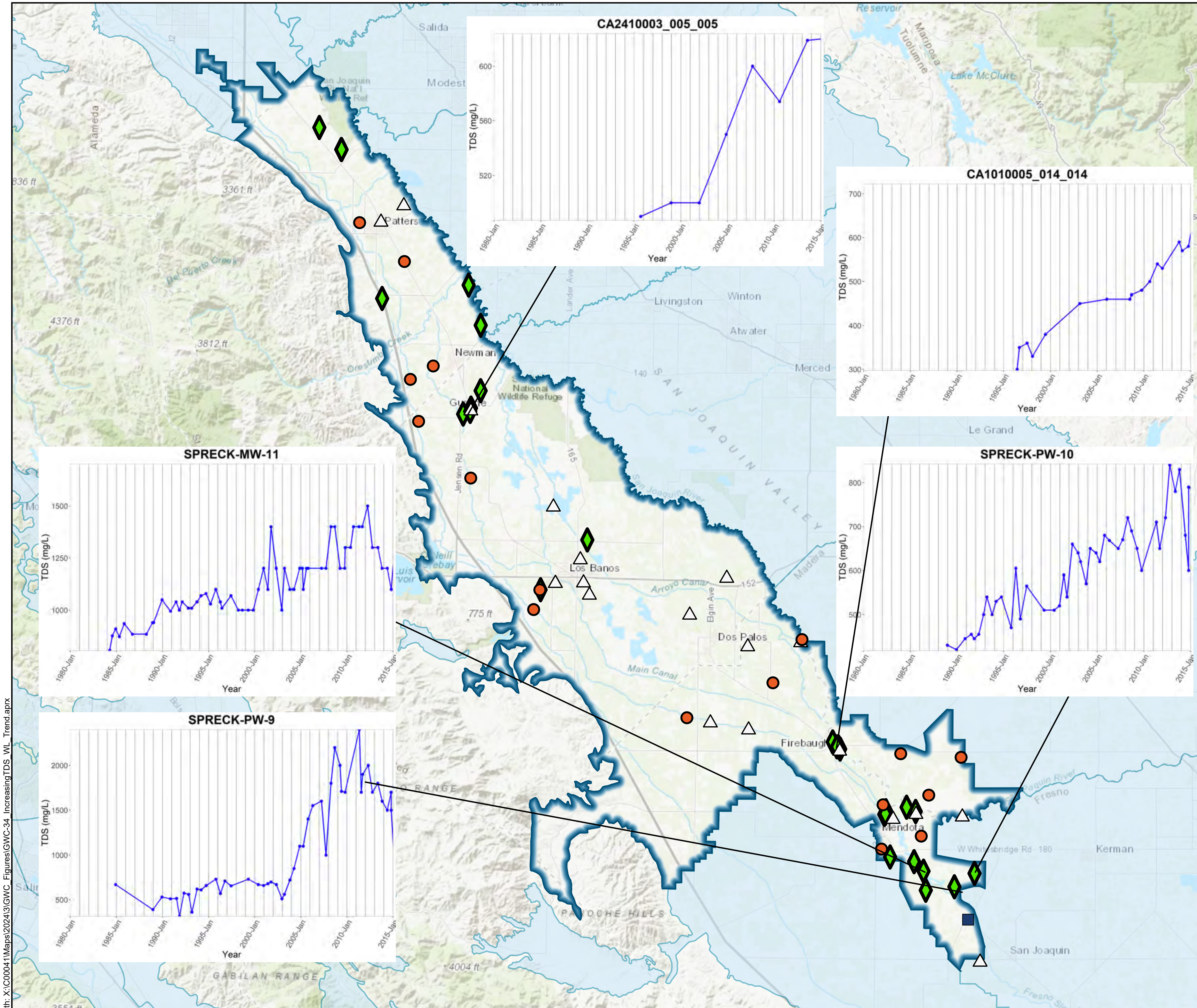
Figure GWC-33

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_historic.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Increasing Total Dissolved Solids

Groundwater Elevation Trend (see Notes 1 & 2)

- Decreasing
- Increasing
- No Significant Trend

Abbreviations

CASGEM = California Statewide Groundwater Elevation Monitoring
DWR = California Department of Water Resources
ft/yr = feet per year
GAMA = Groundwater Ambient Monitoring and Assessment Program
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
2. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.
3. Water level data collected by the GSAs and from DWR and CASGEM. 2023.

Notes

1. All locations are approximate
2. A linear regression was conducted on water level data from the historic time period (i.e., 1950-2014).
3. A trend identified from the linear regression was considered significant when its p-value was less than or equal to 0.05 and slope was greater than +/- 0.1 ft/yr.
4. Increasing TDS trends were identified from wells with at least 4 concentration measurements in the historic period using a Mann-Kendall test at the 95% certainty level.
5. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N

0 12 24
Miles

Locations of Increasing Total Dissolved Solids Concentrations

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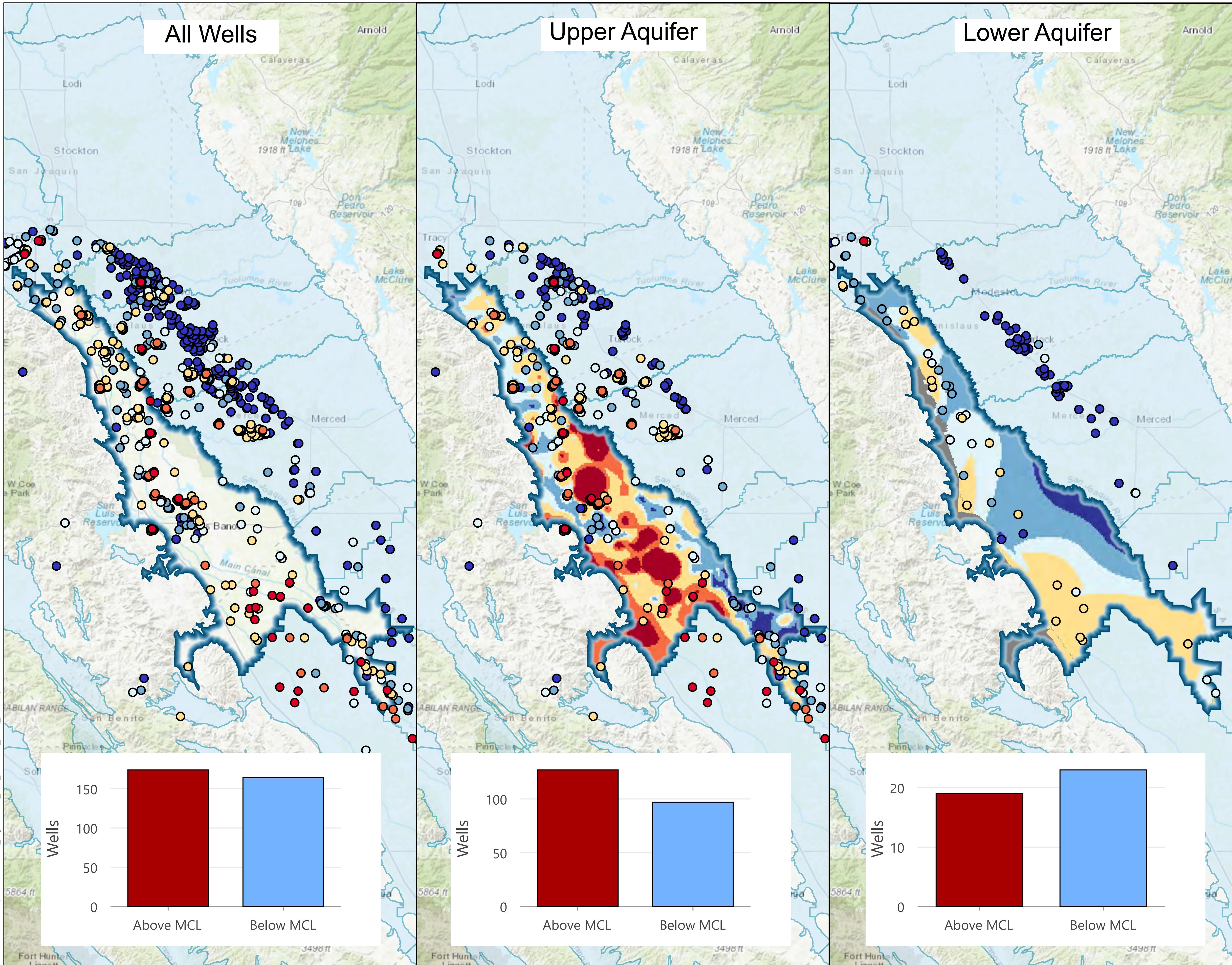
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-34

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-34_IncreasingTDS_WL_Trend.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Average concentration by well (mg/L)
(MCL = 1,000 mg/L)

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- 2000 - 3000
- > 3000

Approximate Concentration Contours (mg/L)
Value

- < 500
- 500 - 750
- 75 - 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- > 3,000

Abbreviations
1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. mg/L = Milligrams per Liter

Notes
1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Exceedances in bar graphs may not equal number of impacted wells in Table GWC-5, as wells are mapped by average, not maximum concentration.
4. Area shaded grey indicates that the Lower Aquifer is not present.
5. Wells of uncertain depth were also considered in the development of Upper Aquifer concentration contours. See text for details.
6. Data from previous time periods may be used to fill spatial gaps in development of contours.
7. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Total Dissolved Solids Concentrations (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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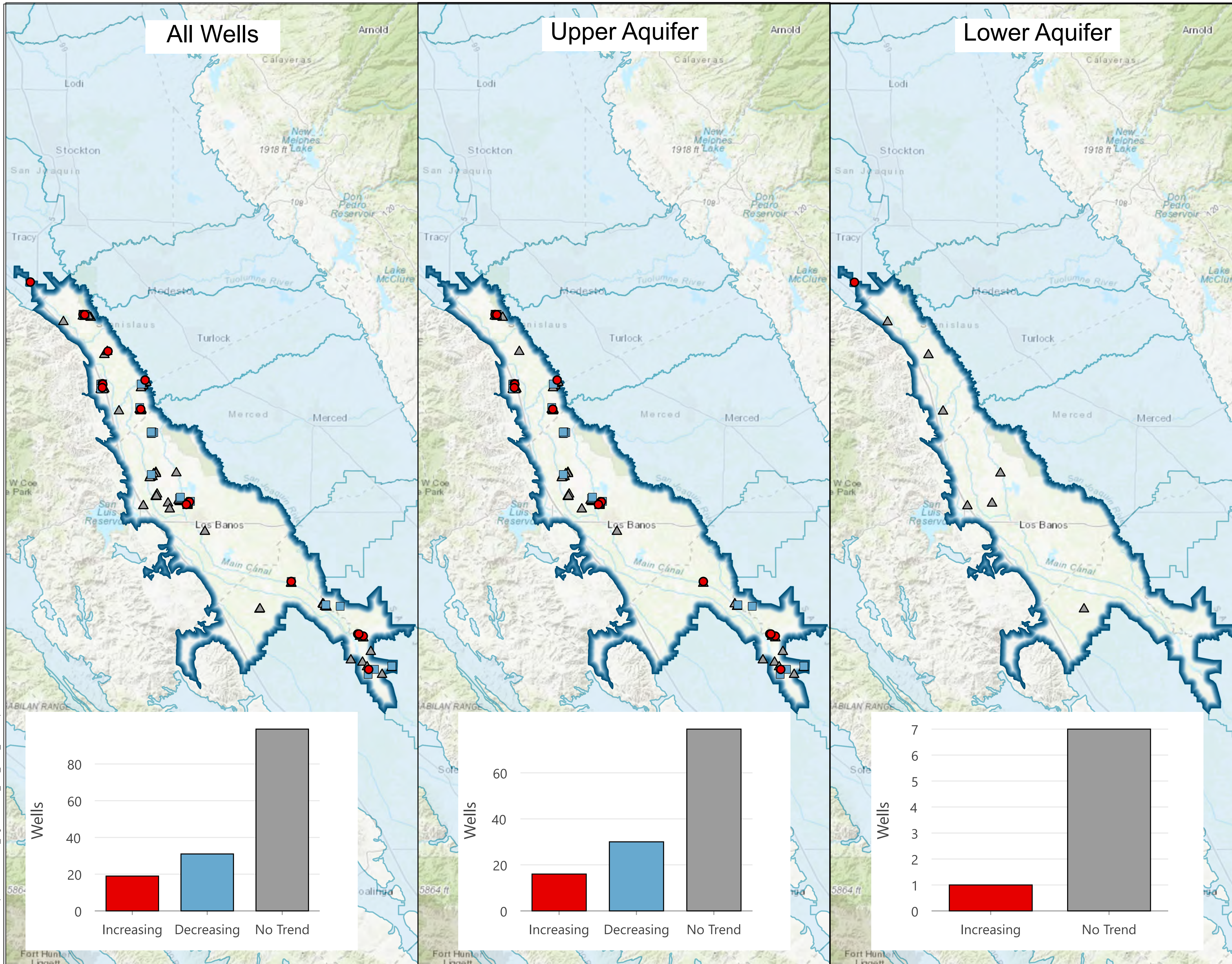
Figure GWC-35

Path: X:\C00041\Maps\2024\3\GWC_Figures\DM_WQ_contours_2015_2023.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend
- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Total Dissolved Solids Concentration Trends (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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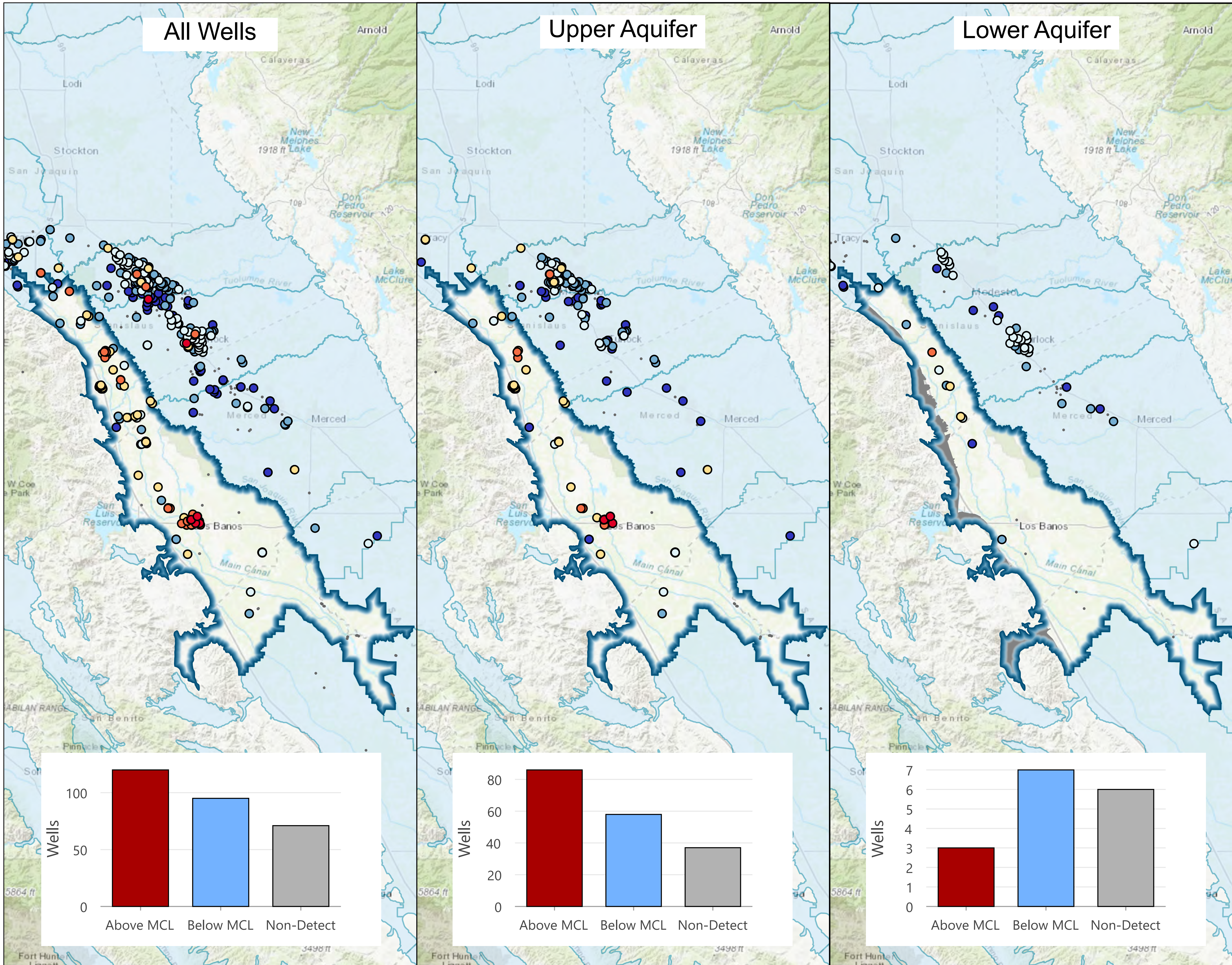
Figure GWC-36

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_recent.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Average concentration by well (ug/L)
(MCL = 10 ug/L)

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50
- Not detected

Abbreviations

1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. ug/L = Micrograms per Liter

Notes

1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Area shaded in grey indicates that the Lower Aquifer is not present.
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded June 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Hexavalent Chromium Concentrations (2005 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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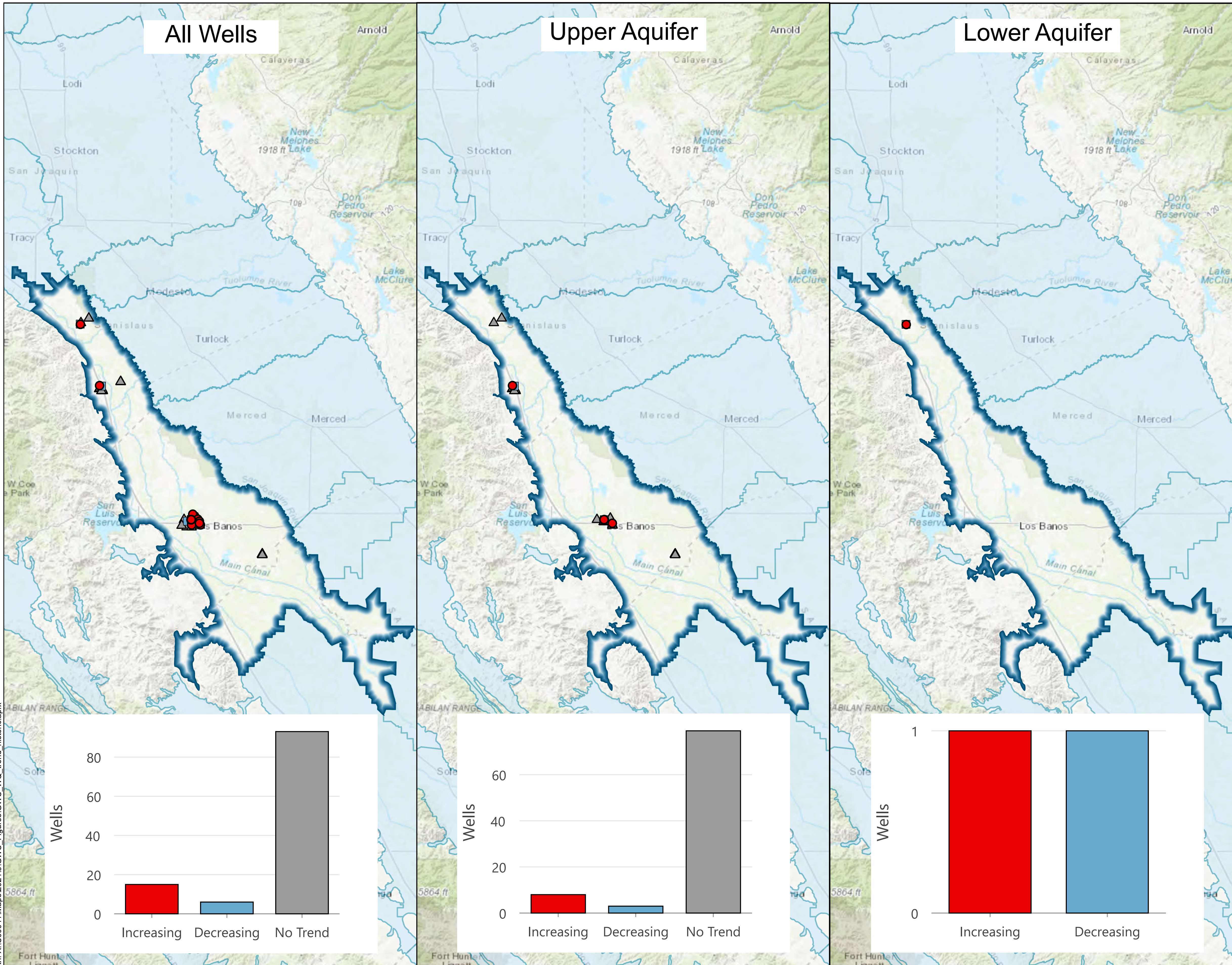
Figure GWC-37



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Hexavalent Chromium Concentration Trends (1950 - 2014)

Delta-Mendota Subbasin
July 2024
C00041.09

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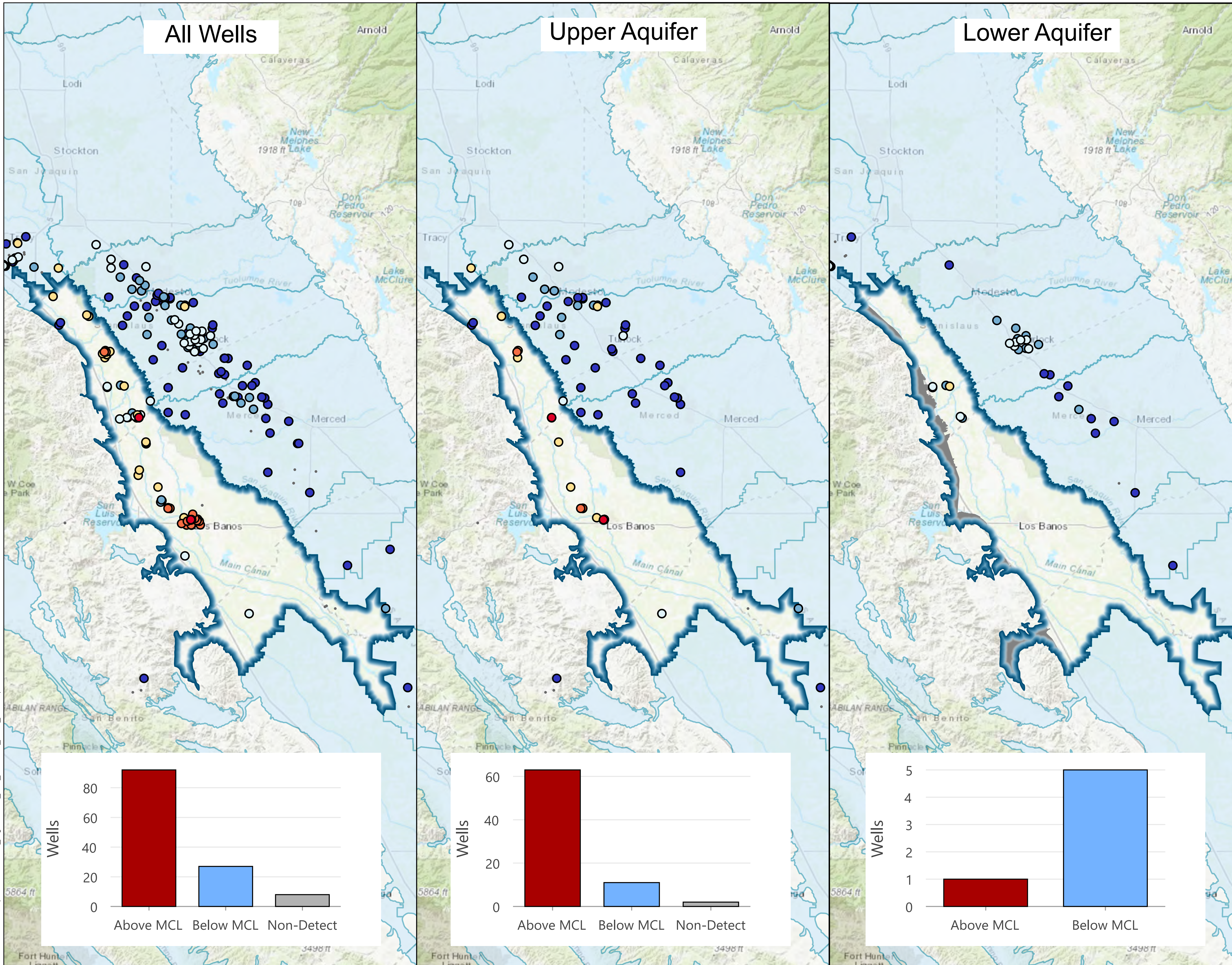
Figure GWC-38

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_historic.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Average concentration by well (ug/L)

Average

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- > 50
- Not detected

Abbreviations

1. GSA = Groundwater Sustainability Agency
2. GAMA = Groundwater Ambient Monitoring and Assessment Program
3. SWRCB = State Water Resources Control Board
4. USGS = United States Geological Survey
5. MCL = Maximum Contaminant Level
6. ug/L = Micrograms per Liter

Notes

1. All locations are approximate.
2. "All Wells" includes wells composite wells and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Exceedances In bar graphs may not equal number of Impacted wells in Table GWC-5, as wells are mapped by average, not maximum concentration.
4. Area shaded grey indicates that the Lower Aquifer is not present.
5. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded June 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24

Miles

Hexavalent Chromium Concentrations (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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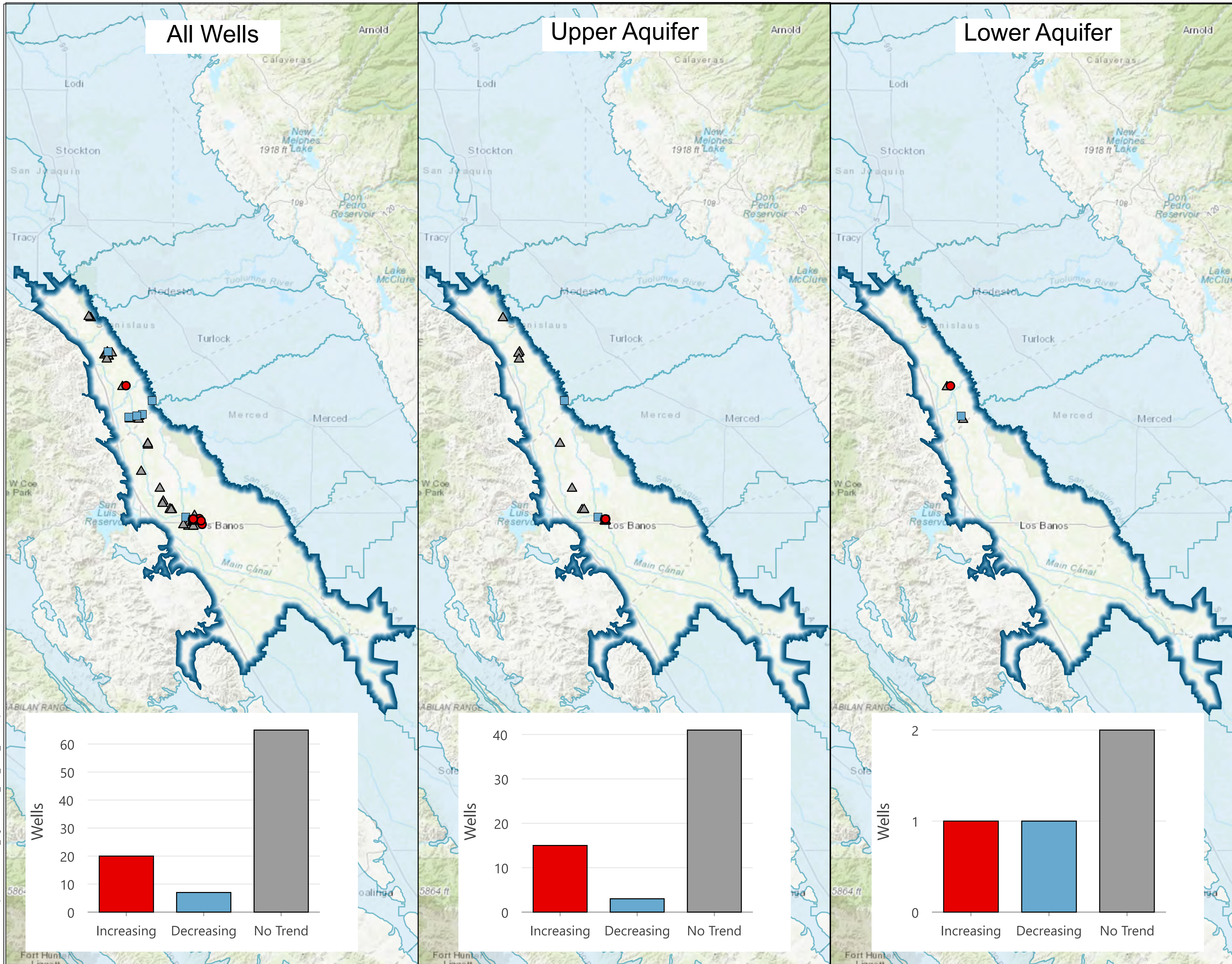
Figure GWC-39

Path: X:\C00041\Maps\2024\3\GWC_Figures\DM_WQ_contours_2015_2023.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Concentration Trend

- Increasing
- Decreasing
- No Trend

Abbreviations

GAMA = Groundwater Ambient Monitoring and Assessment Program
GSA = Groundwater Sustainability Agency
SWRCB = State Water Resources Control Board
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. "All Wells" includes wells screened in multiple aquifers and wells of unknown screen depth, in addition to Upper and Lower Aquifer wells.
3. Wells are mapped if at least four measurements of the constituent of concern are available in the time period of interest.
4. Trends were identified with Mann-Kendall analysis and are considered significant when $p < 0.05$.
5. Charts at the bottom show the total well count for each trend category in each frame.
6. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

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2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Basemap is ESRI's topographic map, downloaded April 2024.
4. Concentration data collected by the GSAs and from the GAMA Groundwater Information System. SWRCB and USGS. 2023.

N

0 12 24
Miles

Hexavalent Chromium Concentration Trends (2015 - 2023)

Delta-Mendota Subbasin
July 2024
C00041.09

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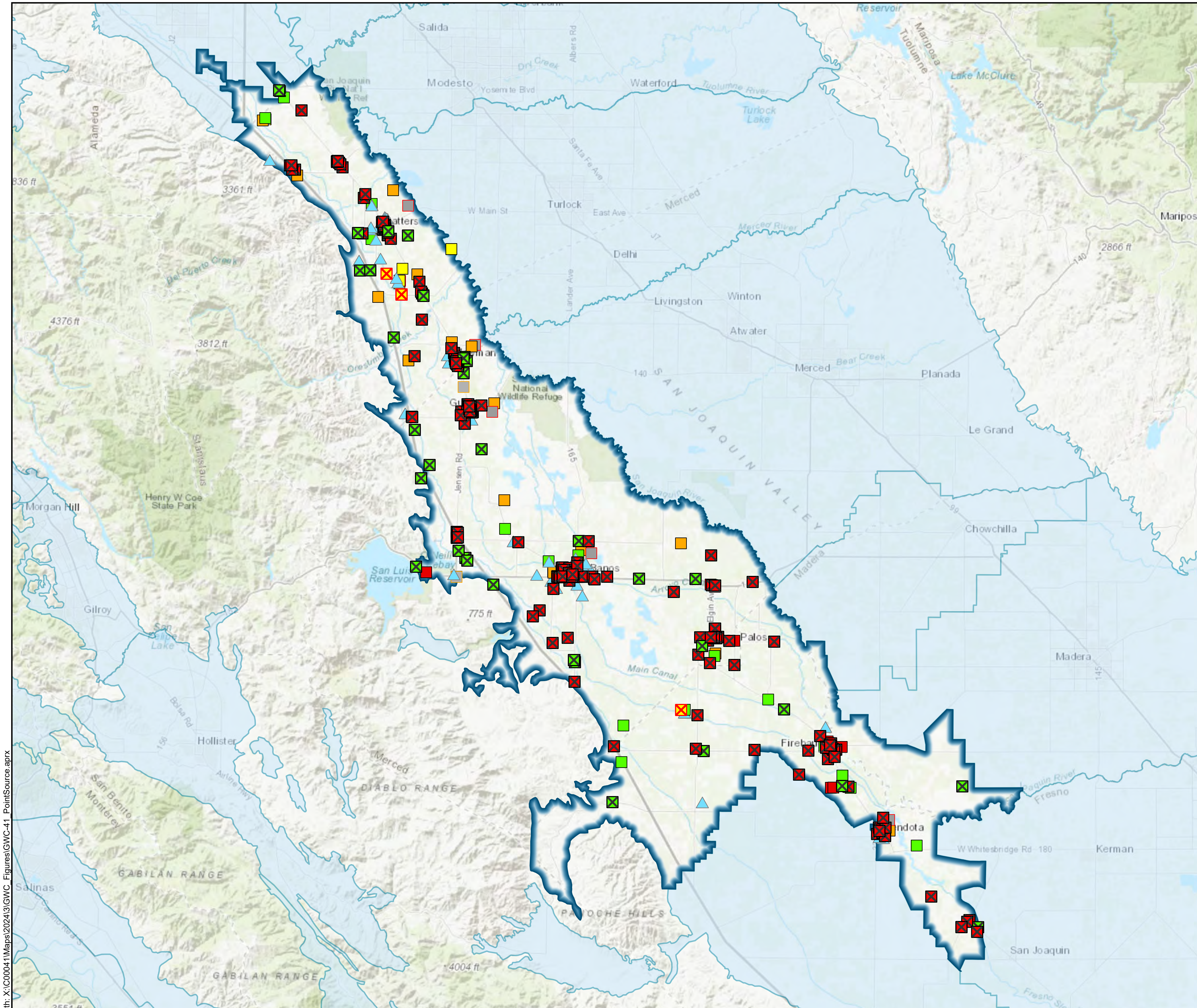
Figure GWC-40

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC_WQ_trend_recent.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Site Type

- Cleanup Program Site - Closed
- LUST Cleanup Site - Closed
- Military Cleanup Site - Closed
- Cleanup Program Site - Open
- LUST Cleanup Site - Open
- Military Cleanup Site - Open
- Military UST Site
- Single-Walled UST
- Permitted UST
- WDR Site
- Land Disposal Site
- DTSC Cleanup Site
- DTSC Hazardous Waste Site

Abbreviations

DTSC = California Department of Toxic Substances Control
DWR = California Department of Water Resources
LUST = Leaking Underground Storage Tank
SWRCB = State Water Resources Control Board
UST = Underground Storage Tank
WDR = Waste Discharge Requirement

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
2. Locations of contamination sites from SWRCB GeoTracker website (http://geotracker.waterboards.ca.gov/datadownload), accessed 30 November 2023.

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

N

0 12 24

Miles

Point Source Contamination Sites

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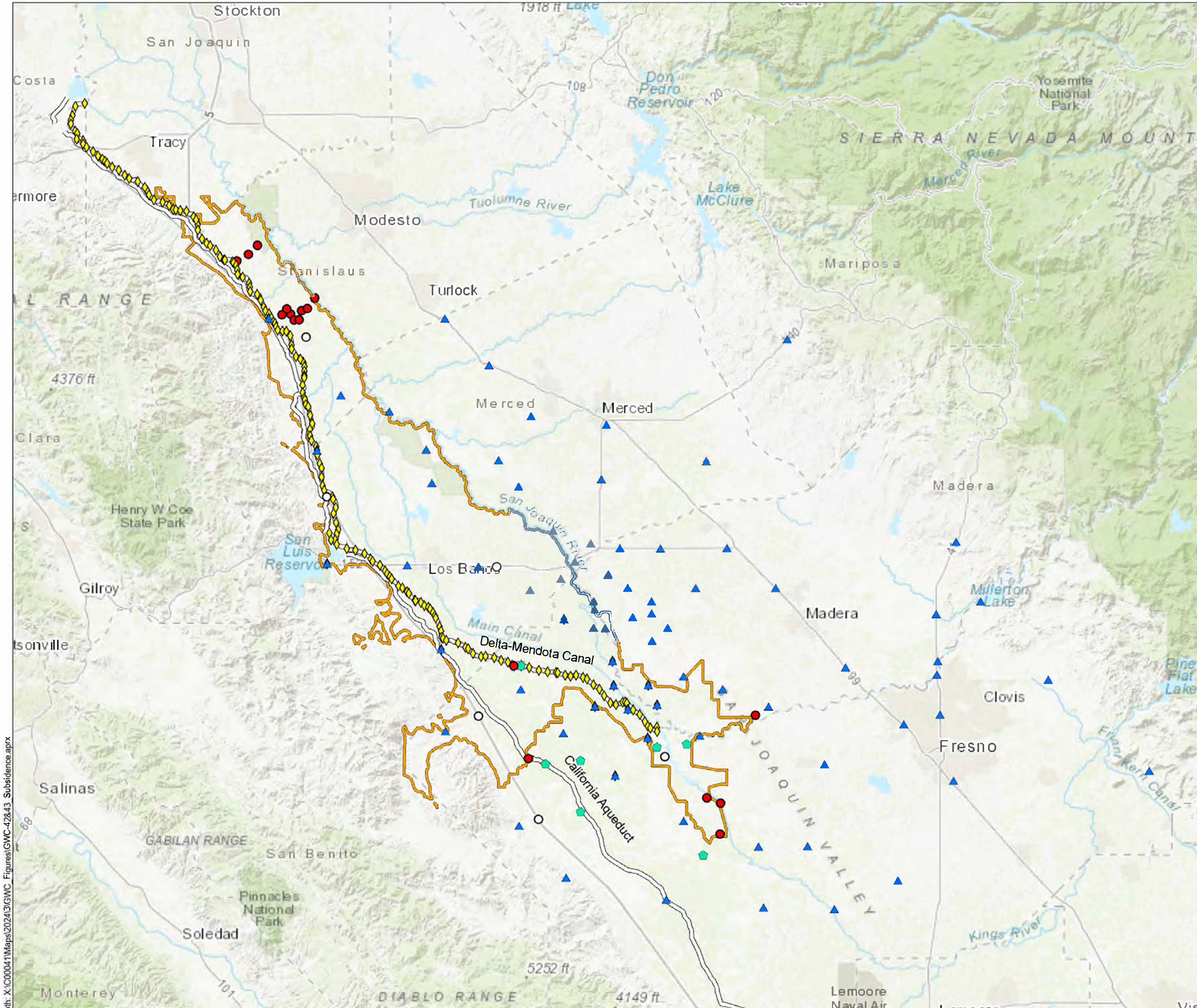
Delta-Mendota Subbasin
December 2023
C00041.09

Figure GWC-41

Path: X:\C00041\Maps\2024\3\GWC\GWC_Figures\GWC-41_PointSource.aprx



Legend

- UNAVCO CGPS Sites
- Caltrans Central Valley Spatial Network
- Bureau of Reclamation DMC monitoring
- Extensometer
- San Joaquin River Restoration Project
- Survey Point
- Other monitoring point

Abbreviations

CGPS = Continuous Global Positioning System
DMC = Delta-Mendota Canal
UNAVCO = University Navstar Consortium

Notes

1. All locations are approximate.
2. Map includes sites managed by Basin GSAs and sites managed by other entities with public data.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained March 2024.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

N

0 12 24
Miles

Subsidence Monitoring Locations

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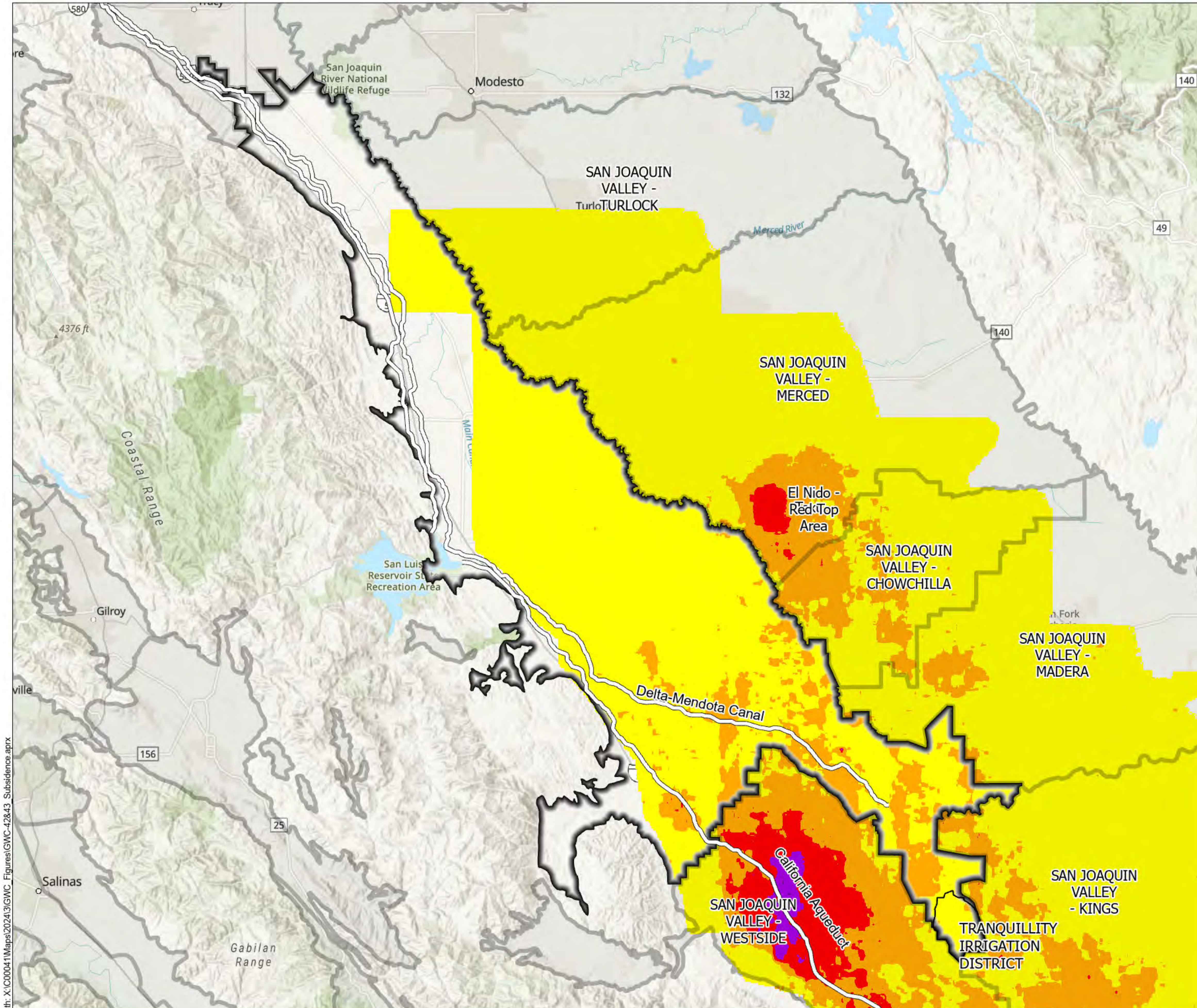
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-42

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-42843_Subsidence.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Canals and Aqueducts

Vertical Displacement SJV DWR 1949 to 2005 (feet)

- -30 to -25 (feet)
- -25 to -20 (feet)
- -20 to -15 (feet)
- -15 to -10 (feet)
- -10 to -5 (feet)
- -5 to 0 (feet)

Abbreviations
DWR = California Department of Water Resources
SJV = San Joaquin Valley

Notes
1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained December 2023.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. DWR. (2023). TRE ALTAMIRA InSAR Dataset [Raster]. (https://sgma.water.ca.gov/webgis/config/custom/html/SGMADataViewer/doc/#tre-altamira-insar-dataset)

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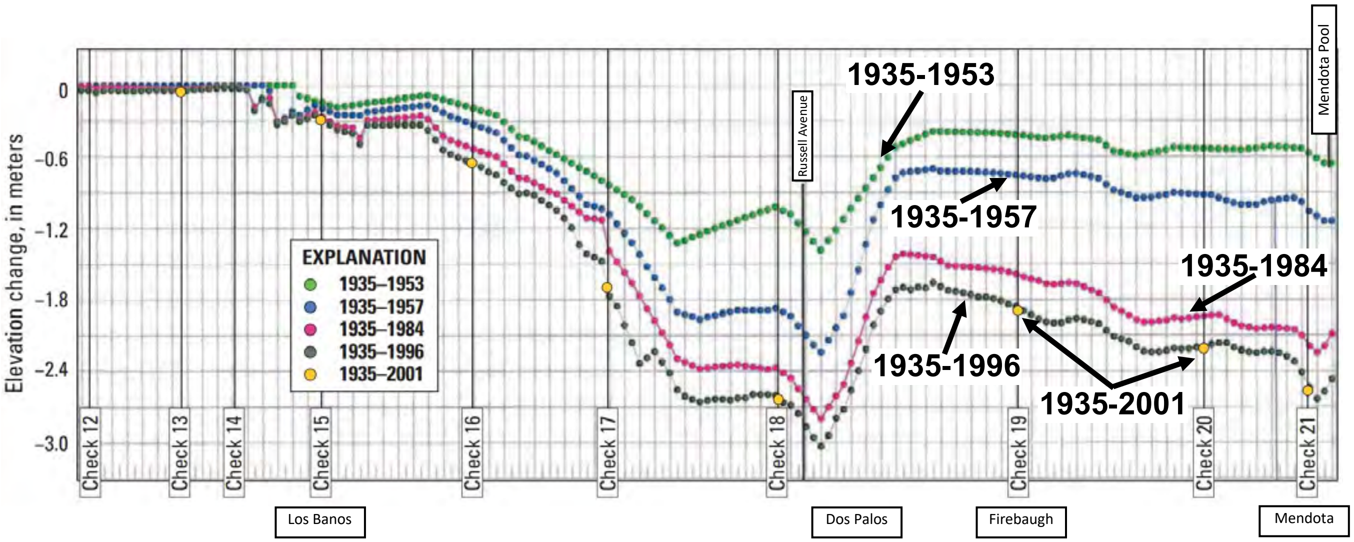
Total Subsidence, 1949 - 2005

eki environment & water

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-43

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-42&43_Subsidence.aprx



Abbreviations

DMC = Delta–Mendota Canal

USGS = United States Geological Survey

Notes

1. Communities are named at the approximate location where the Delta-Mendota Canal passes closest to them; however, not all communities are directly adjacent to the DMC.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

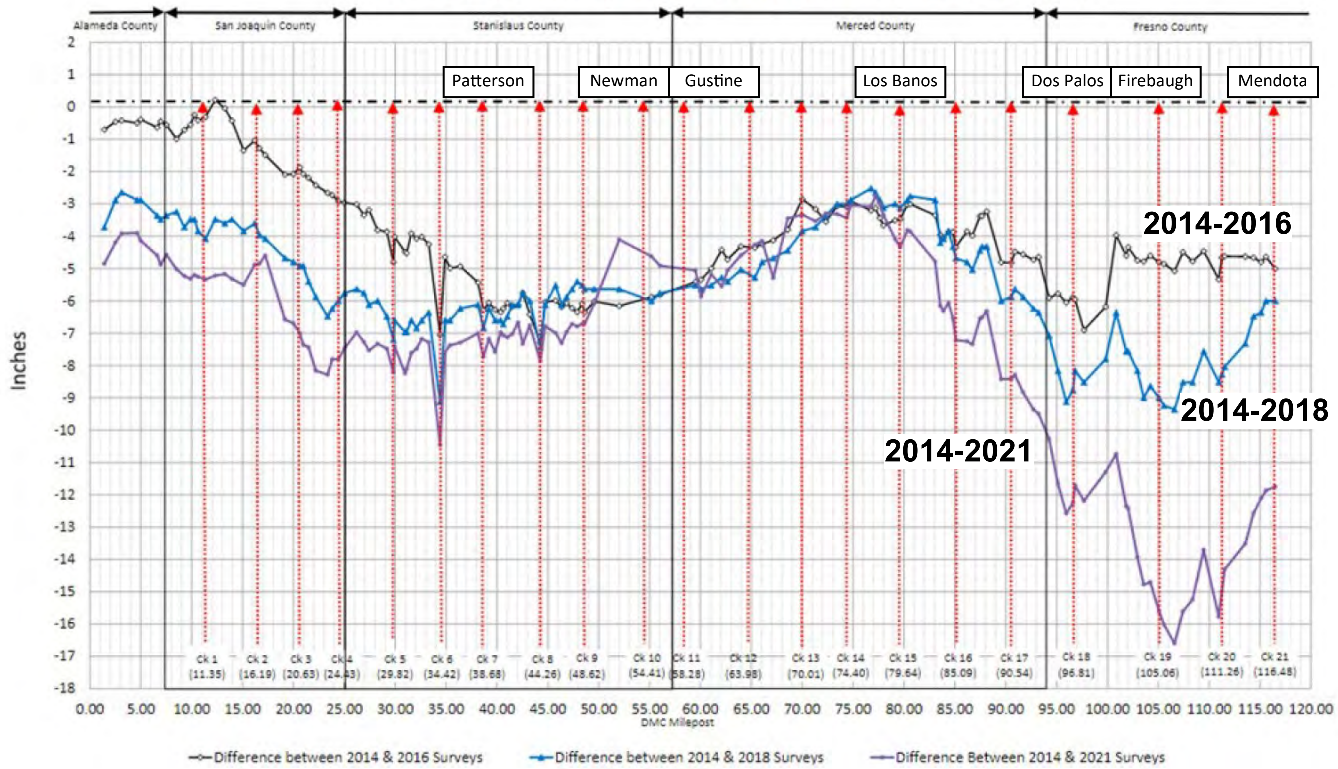
1. Line graph is obtained from: Sneed, M., Brandt, J. T., & Solt, M. (2013). *Land subsidence along the Delta-Mendota Canal in the northern part of the San Joaquin Valley, California, 2003-10* (Scientific Investigations Report 2013–5142; figure 17C). USGS Publications Warehouse. https://doi.org/10.3133/sir20135142.
2. Inset basemap is ESRI's World Topographic Map. Obtained 26 June 2024.
3. Basin boundary is based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

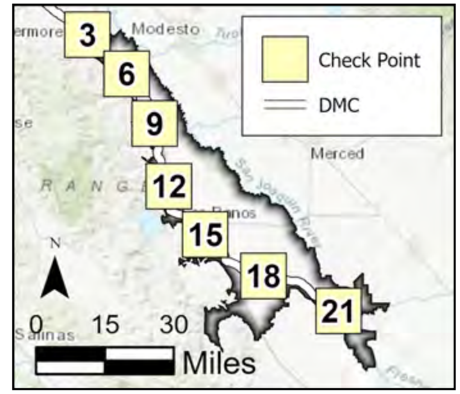
Elevation Change Along the Southern Half of the Delta-Mendota Canal, 1935 - 2001

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-44





Abbreviations

DMC = Delta-Mendota Canal

USBR= United States Bureau of Reclamation

Notes

1. Communities are named at the approximate location where the Delta-Mendota Canal passes closest to them; however, not all communities are directly adjacent to the DMC.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

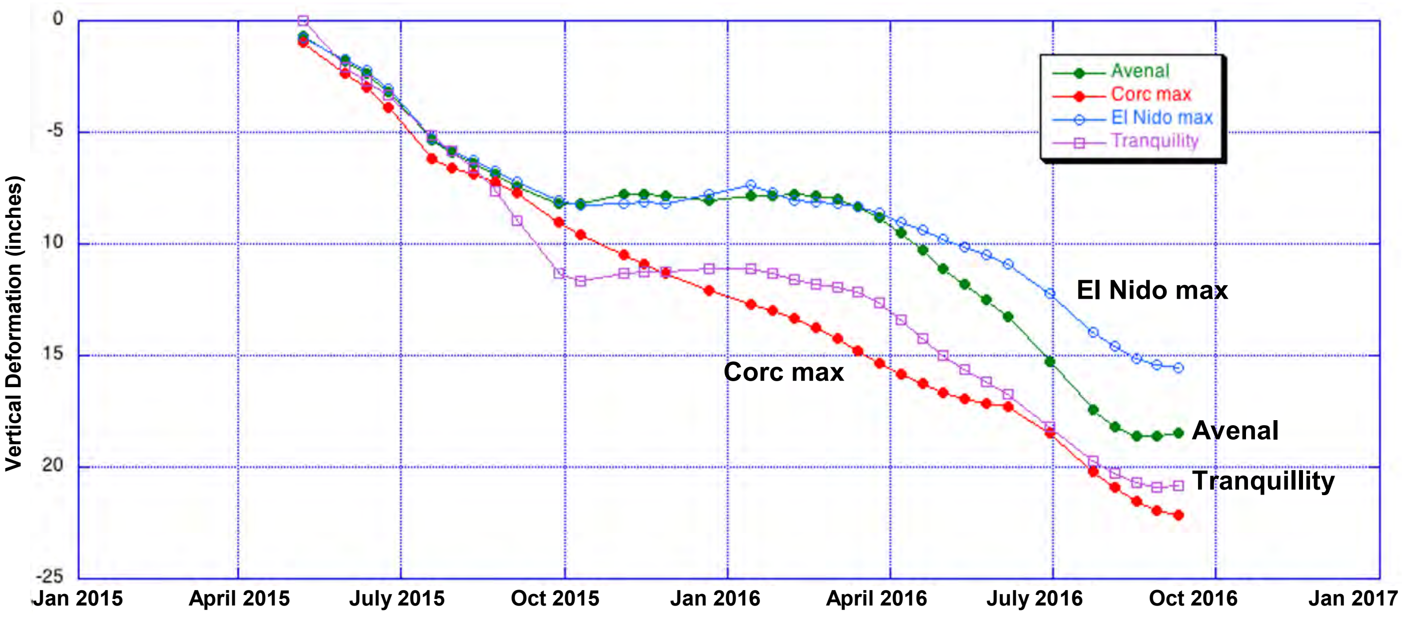
1. Line graph is obtained from: SLDMWA. (2022). *Conceptual Master Plan for Subsidence Monitoring and Management for the Delta-Mendota Subbasin*. Prepared by GSI Environmental Inc. Figure 4-52.
2. Inset basemap is ESRI's World Topographic Map. Obtained 26 June 2024.
3. Basin boundary is based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

Elevation Change Along the Delta-Mendota Canal, From USBR Survey Data, 2014 - 2021

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-45



Abbreviations
Corc = Corcoran

Notes:
If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

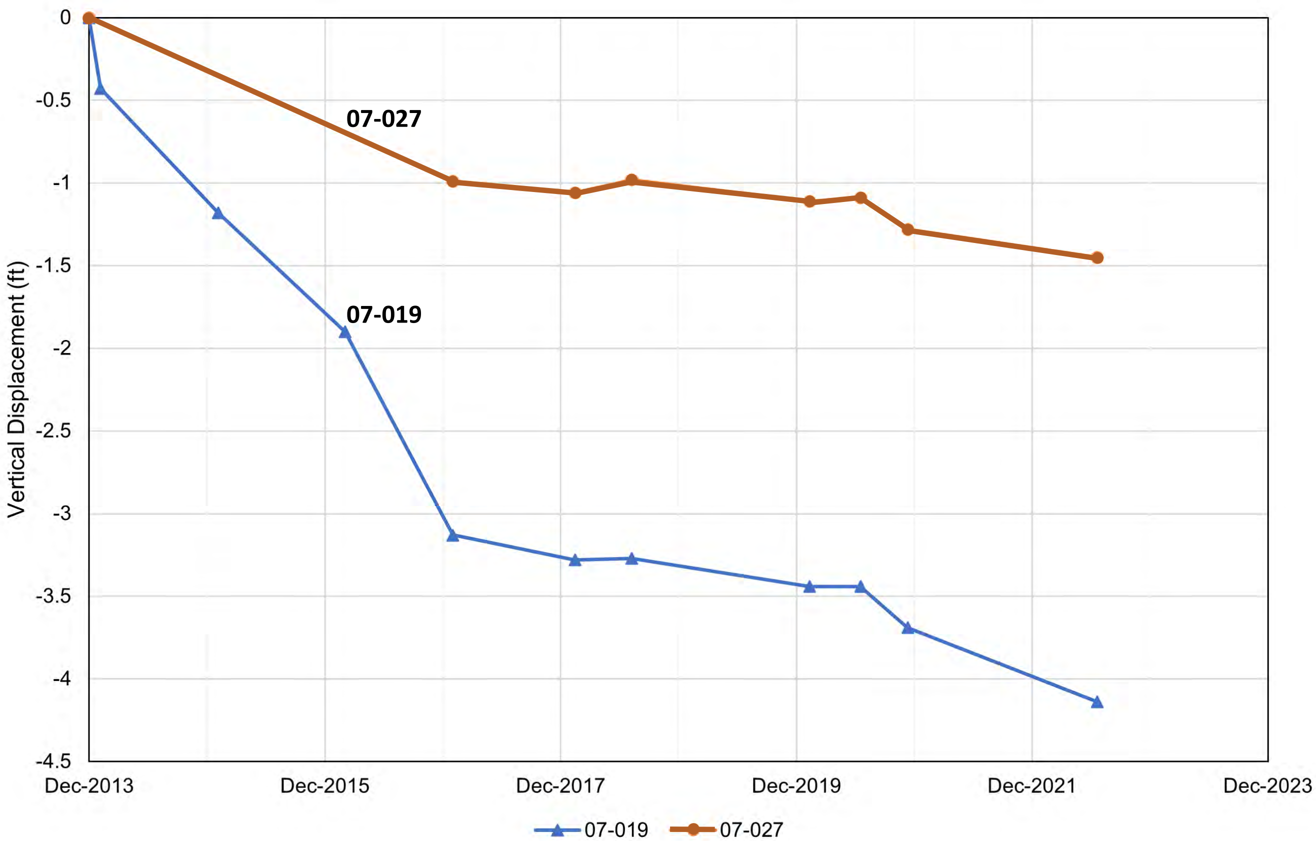
Sources
1. Line graph from NASA 2020 "Progress Report: Subsidence in California, March 2015 – September 2016"
2. Inset basemap is ESRI's World Topographic Map. Obtained 26 June 2024.
3. Basin boundary is based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

Subsidence in San Joaquin Valley Locations in 2015 and 2016

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-46



Abbreviations

ft = feet

TRID = Tranquillity Irrigation District

Notes:

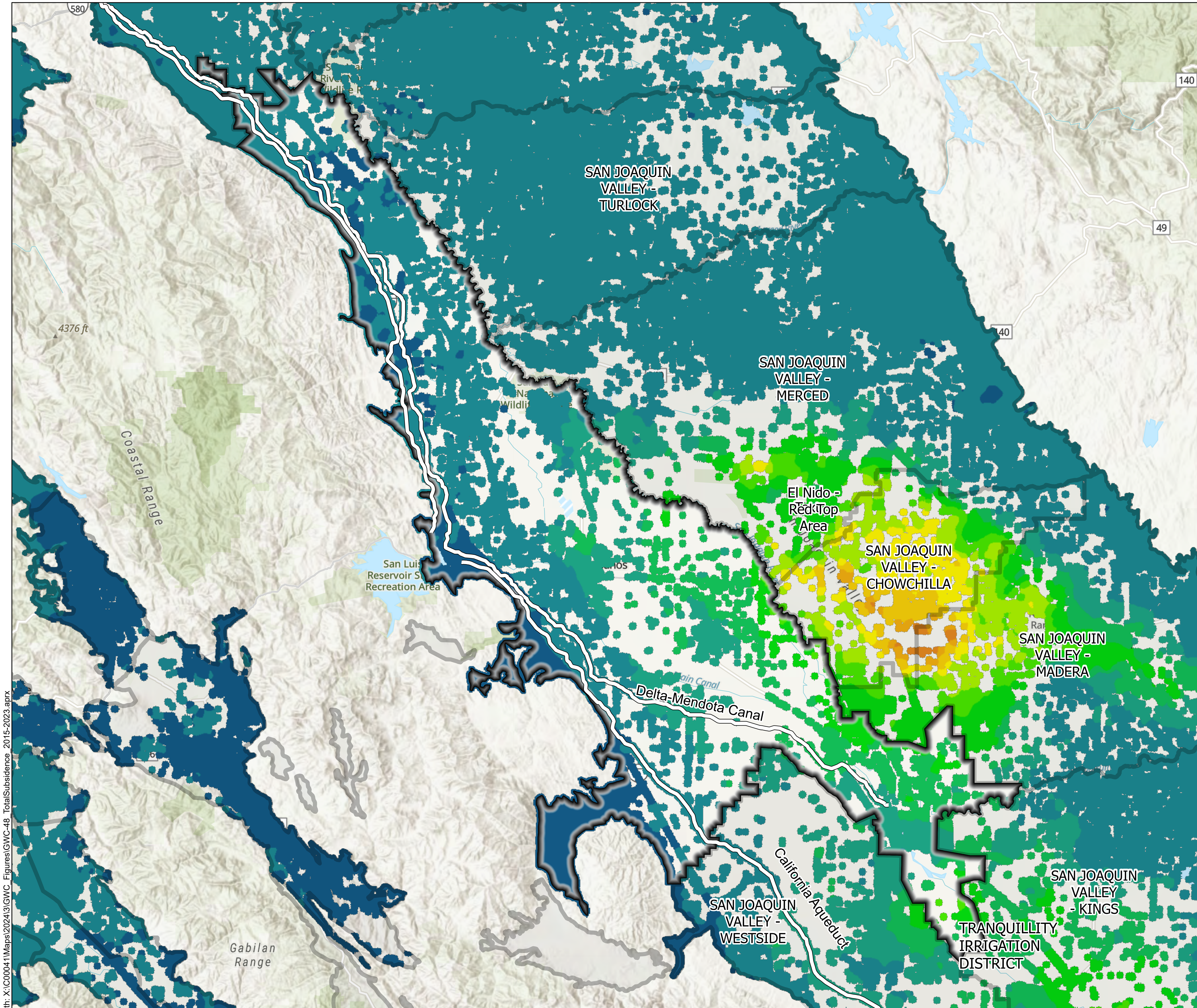
1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Total Vertical Displacement at TRID Monitoring Sites 07-019 and 07-027 Relative to December 2013

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-47



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Canals and Aqueducts

Vertical Displacement

- -5 to -4.5 (feet)
- -4.5 to -4 (feet)
- -4 to -3.5 (feet)
- -3.5 to -3 (feet)
- -3 to -2.5 (feet)
- -2.5 to -2 (feet)
- -2 to -1.5 (feet)
- -1.5 to -1 (feet)
- -1 to -0.5 (feet)
- -0.5 to 0 (feet)
- 0 - 0.5 (feet)

Abbreviations

DWR = California Department of Water Resources
InSAR = Interferometric Synthetic Aperture Radar

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. DWR. (2023). TRE ALTAMIRA InSAR Dataset [Raster]. (https://sgma.water.ca.gov/webgis/config/custom/html/SGMADataViewer/doc/#tre-altamira-insar-dataset)

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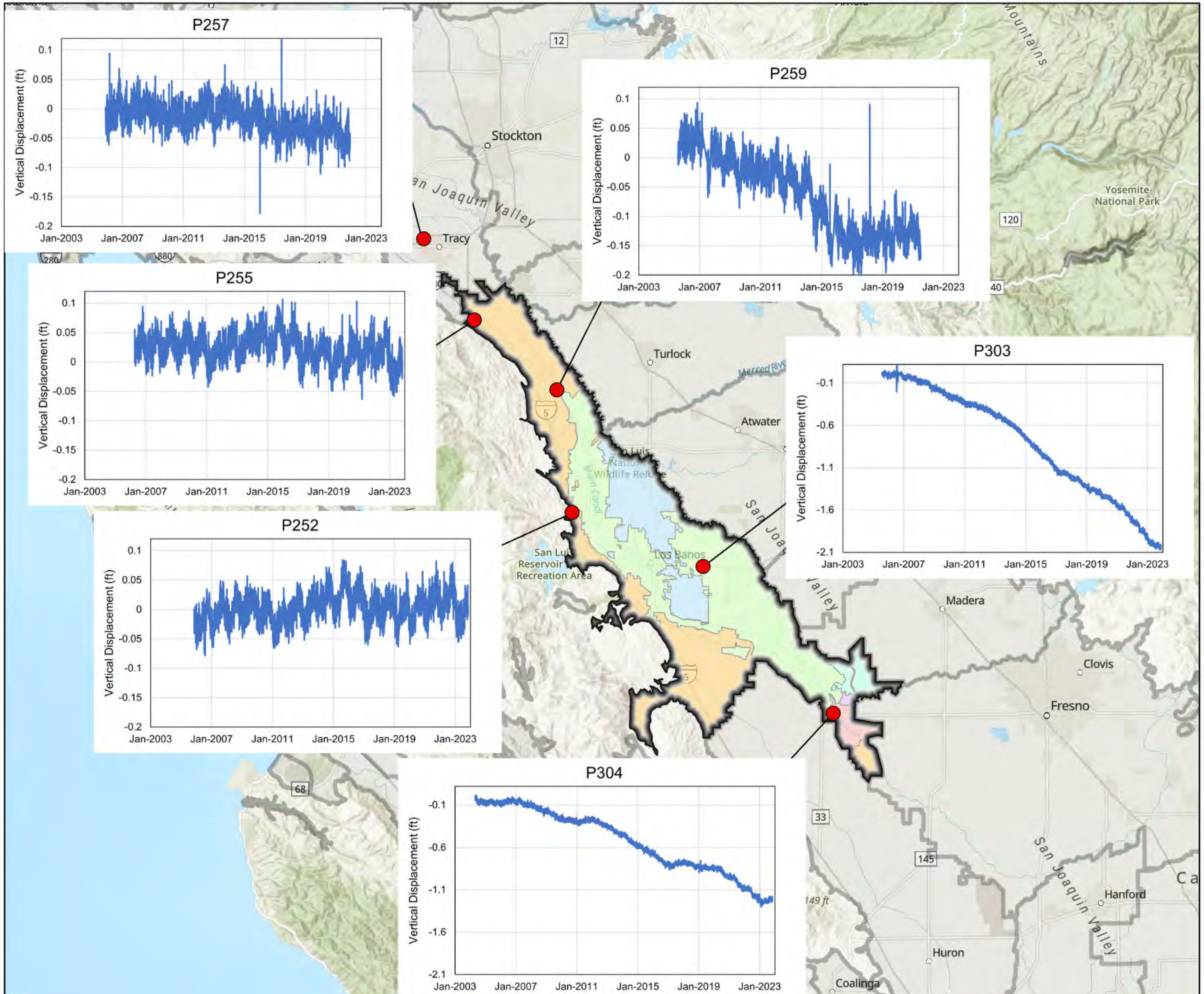
Total subsidence June 2015 - June 2023

Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-48

eki environment & water

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-48_TotalSubsidence_2015-2023.aprx



Legend
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Aliso Water District
- Farmers Water District
- Fresno County
- Grassland Water District
- Northern and Central Delta-Mendota
- San Joaquin River Exchange Contractors
- UNAVCO CGPS Sites

Abbreviations
CGPS = Continuous Global Positioning System
ft = Feet

Notes
1. All locations are approximate.
2. Timeseries for P303 and P304 are shown with a different vertical scale the other timeseries.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained March 2024.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Subsidence data from EarthScope Consortium. (2023). UNAVCO NOTA GPS dataset.

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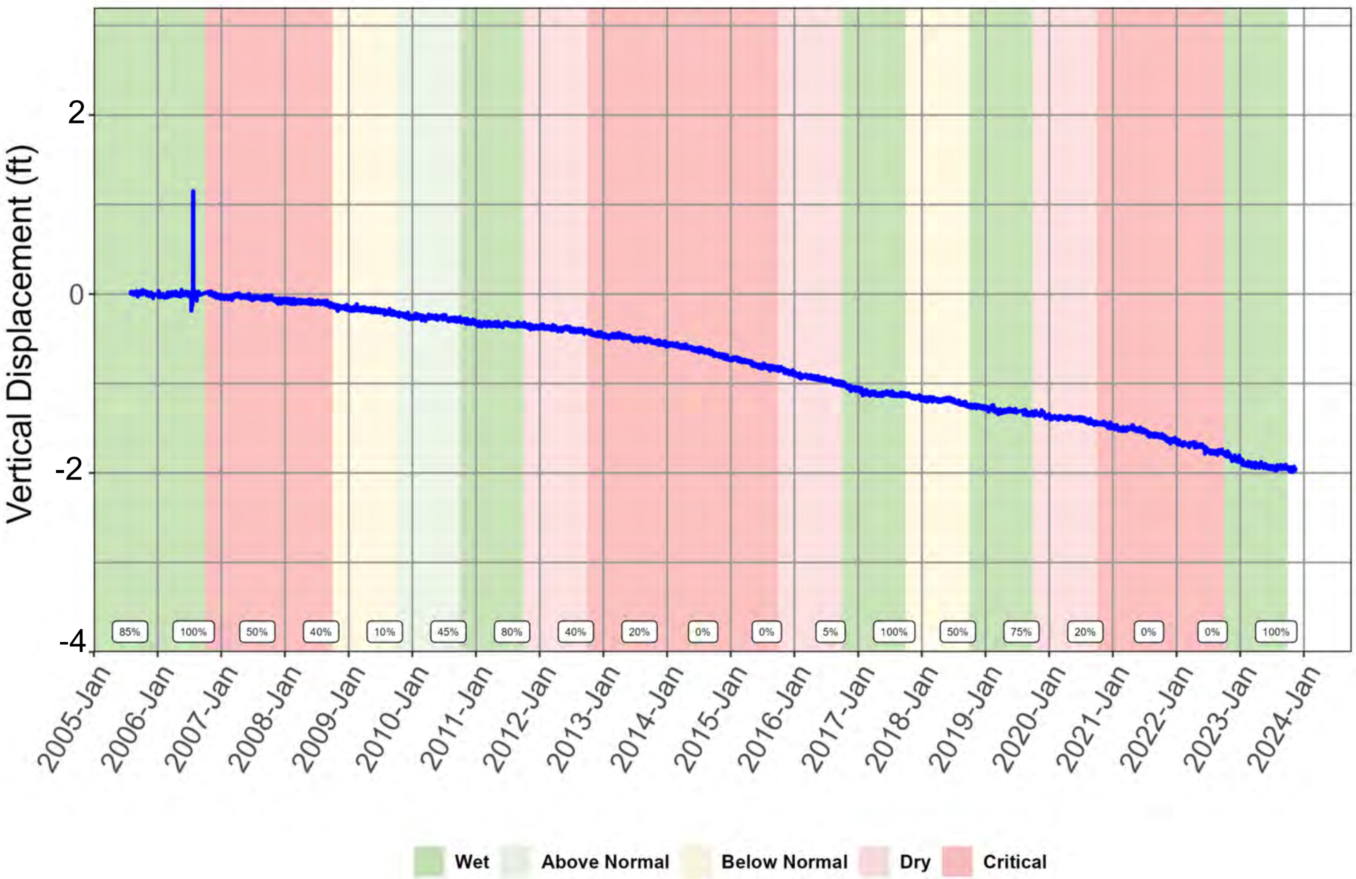
Basin-Wide Vertical Displacement Recorded at UNAVCO Monitoring Sites

eki environment & water

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-49

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-42&43_Subsidence.aprx



Abbreviations

ft = feet
CVP = Central Valley Project
UNAVCO = University Navstar Consortium
CGPS = Continuous Global Positioning System
USBR = United States Bureau of Reclamation

Notes

1. CVP allocations for south of Delta agricultural contractors shown in white boxes.
2. Background colors indicate water year type.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. EarthScope Consortium. (2023). UNAVCO NOTA GPS
2. USBR. (2023). Summary of Water Supply Allocations.

Vertical Displacement Relative to April 2004 at UNAVCO CGPS Station P303

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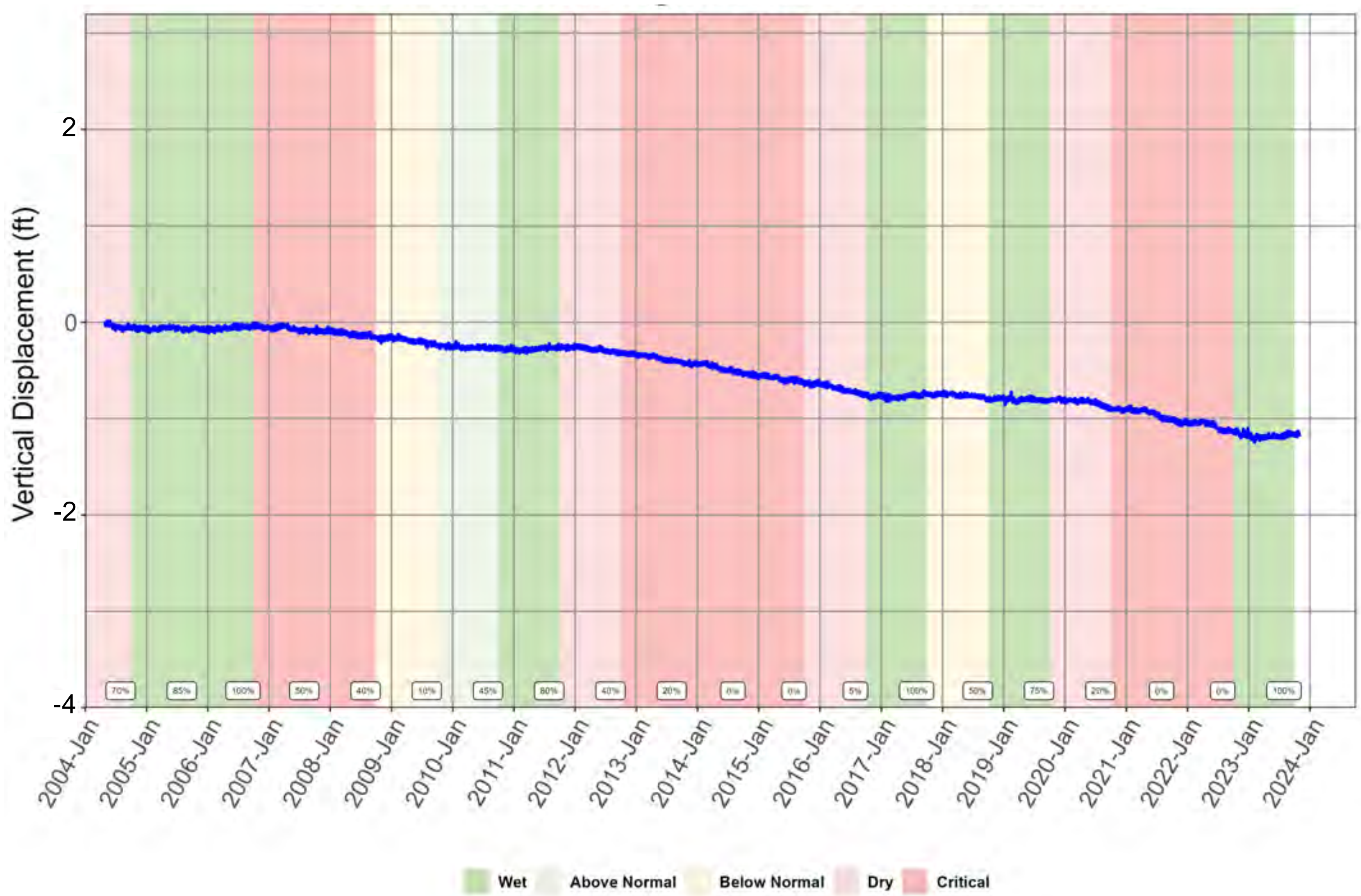
Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-50



Abbreviations

ft = feet
CVP = Central Valley Project
UNAVCO = University Navstar Consortium
CGPS = Continuous Global Positioning System
USBR = United States Bureau of Reclamation

Notes

1. CVP allocations for south of Delta agricultural contractors shown in white boxes.
2. Background colors indicate water year type.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. EarthScope Consortium. (2023). UNAVCO NOTA GPS
2. USBR. (2023). Summary of Water Supply Allocations.

Vertical Displacement Relative to April 2004 at UNAVCO CGPS Station P304

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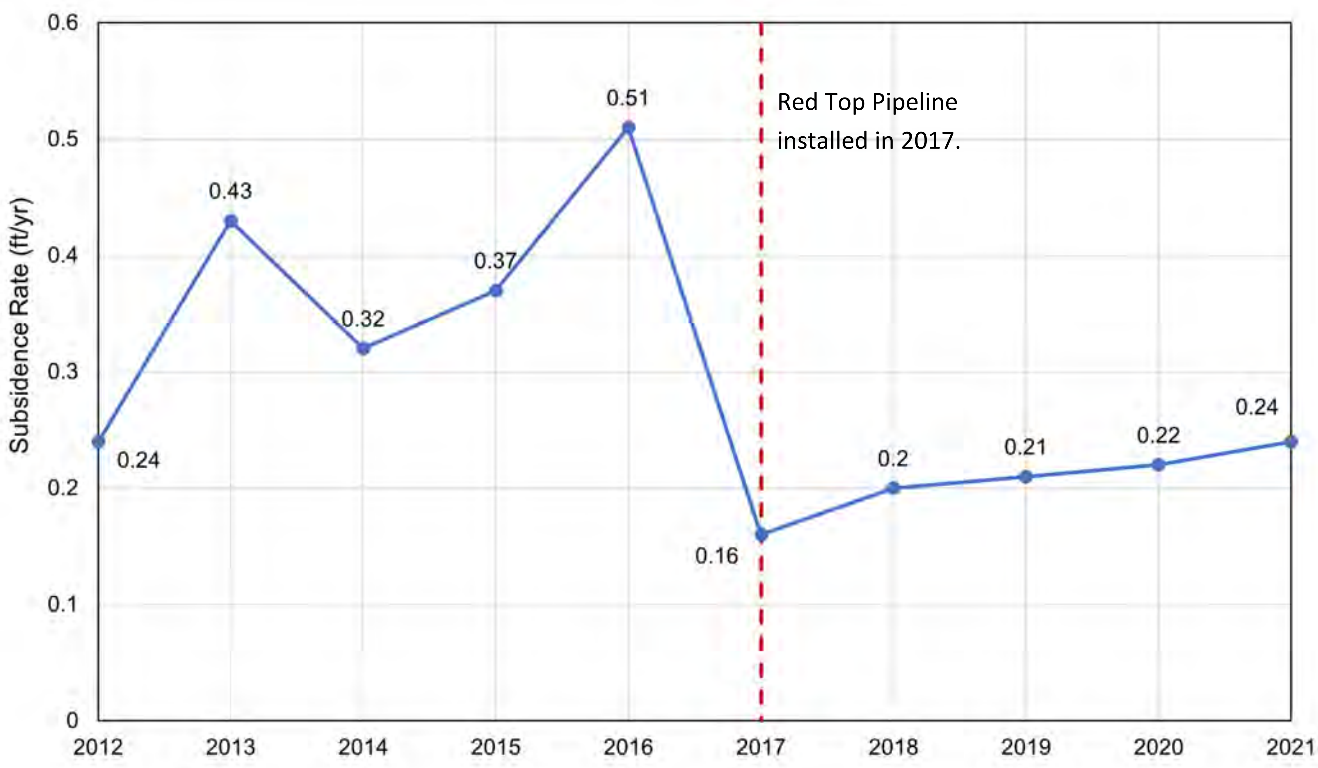
Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-51



Abbreviations

ft/yr = Feet per Year

Notes:

If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

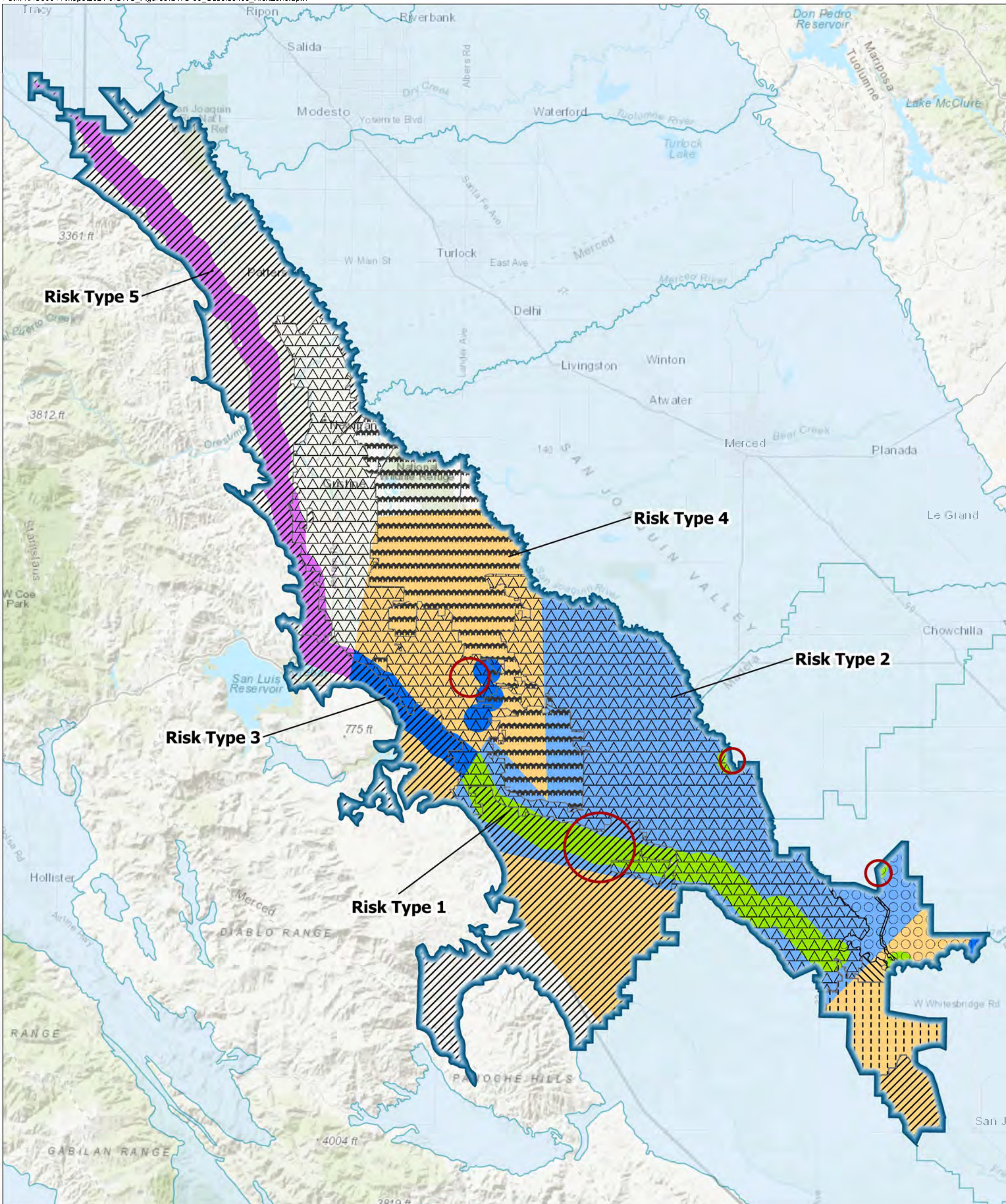
Sack Dam Subsidence Rate, 2012 — 2021

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-52

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-53_Subsidence_RiskZone.aprx



Legend

GSA Group
- Aliso Water District
- Central Delta-Mendota
- Farmers Water District
- Fresno County
- Grassland Water District
- Northern Delta-Mendota
- San Joaquin River Exchange Contractors
- Proposed Land Subsidence Monitoring Location

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Land Subsidence Risk Category
- Risk Type1
- Risk Type2
- Risk Type3
- Risk Type4
- Risk Type5

Notes
1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. GSA boundaries. California Department of Water Resources. August 25, 2023.
2. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.
3. Risk zones from Conceptual Master Plan for Subsidence Monitoring and Management for the Delta-Mendota Subbasin, SLDMWA 2022.

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Abbreviations

GDE = Groundwater Dependent Ecosystem
GSA = Groundwater Sustainability Agencies
RMW-WQs = Representative Monitoring Wells for Water Quality
ISW = Interconnected surface water

Land Subsidence Risk Zones and Proposed Additional Monitoring Locations from Conceptual Master Plan for Subsidence Monitoring and Management for the Delta-Mendota Subbasin

Delta-Mendota Subbasin
September 2023
C00041.09

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Figure 53

Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Streams Included in the ISW Analysis
- Streams Excluded from the ISW Analysis

Abbreviations
DWR = Department of Water Resources
ISW = Interconnected Surface Water

Notes
1. Streams in gray are ephemeral or lined/artificial flow paths and are therefore excluded in the ISW analysis.
2. Surface water features in the analysis is based on NHD flow line database .
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

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Streams in the Interconnected Surface Water Analysis

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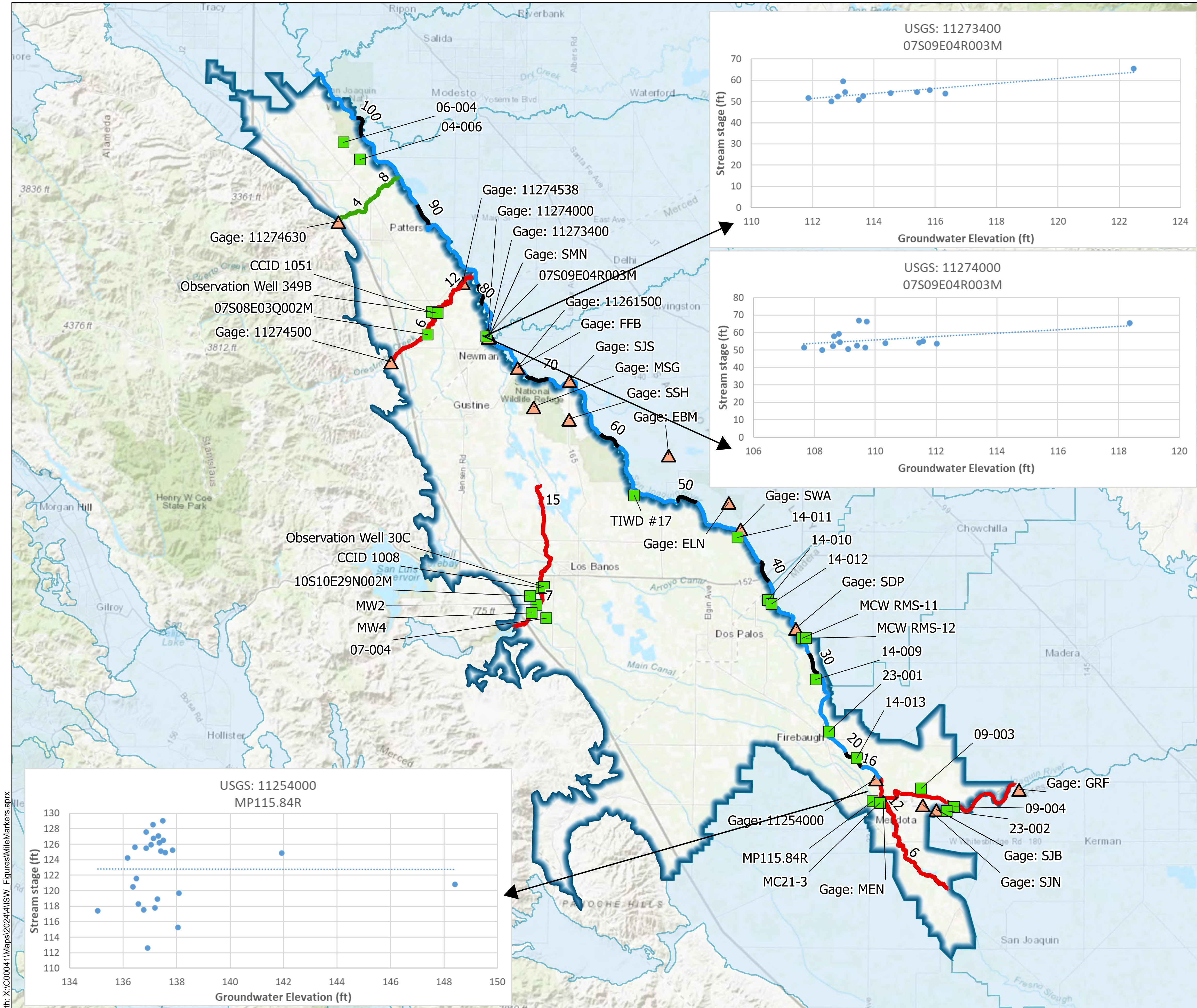
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-54

Path: X:\C00041\Maps\2024\4\ISW_Figures\ISW_Streams.aprx



Path: X:\C00041\Maps\2024\4\ISW_Figures\MileMarkers.aprx

Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Stream Classification

- Likely Disconnected
- Potential ISW (Likely Connected)
- Uncertain/Likely Disconnected
- Upper Aquifer Well with Water Level Records Available for ISW Screening
- Stream Gages

Abbreviations

DWR = Department of Water Resources
ISW = Interconnected Surface Water

Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

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Mile Markers of the Interconnected Surface Water

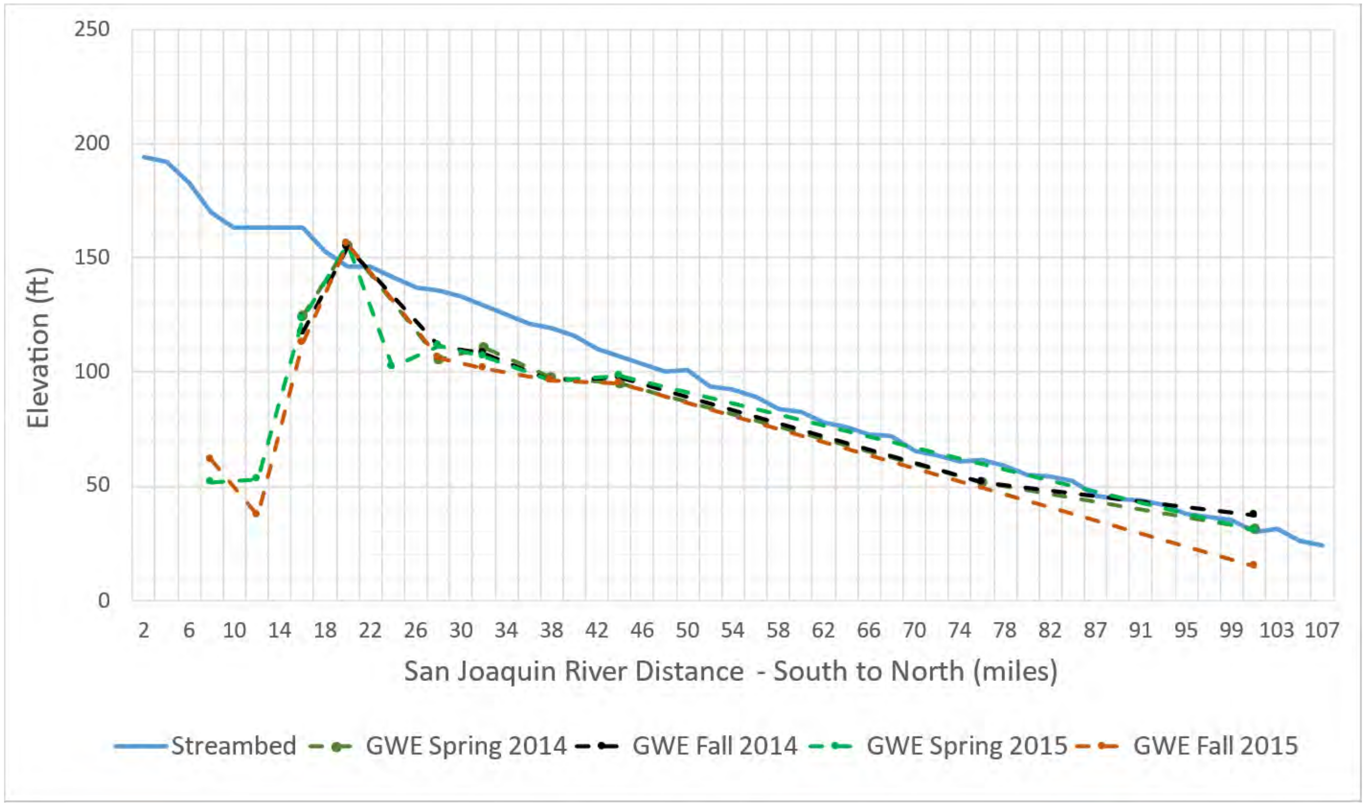
eki environment & water

Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-55

Abbreviations

ft = Feet
GWE = Groundwater Elevation
SJR = San Joaquin River

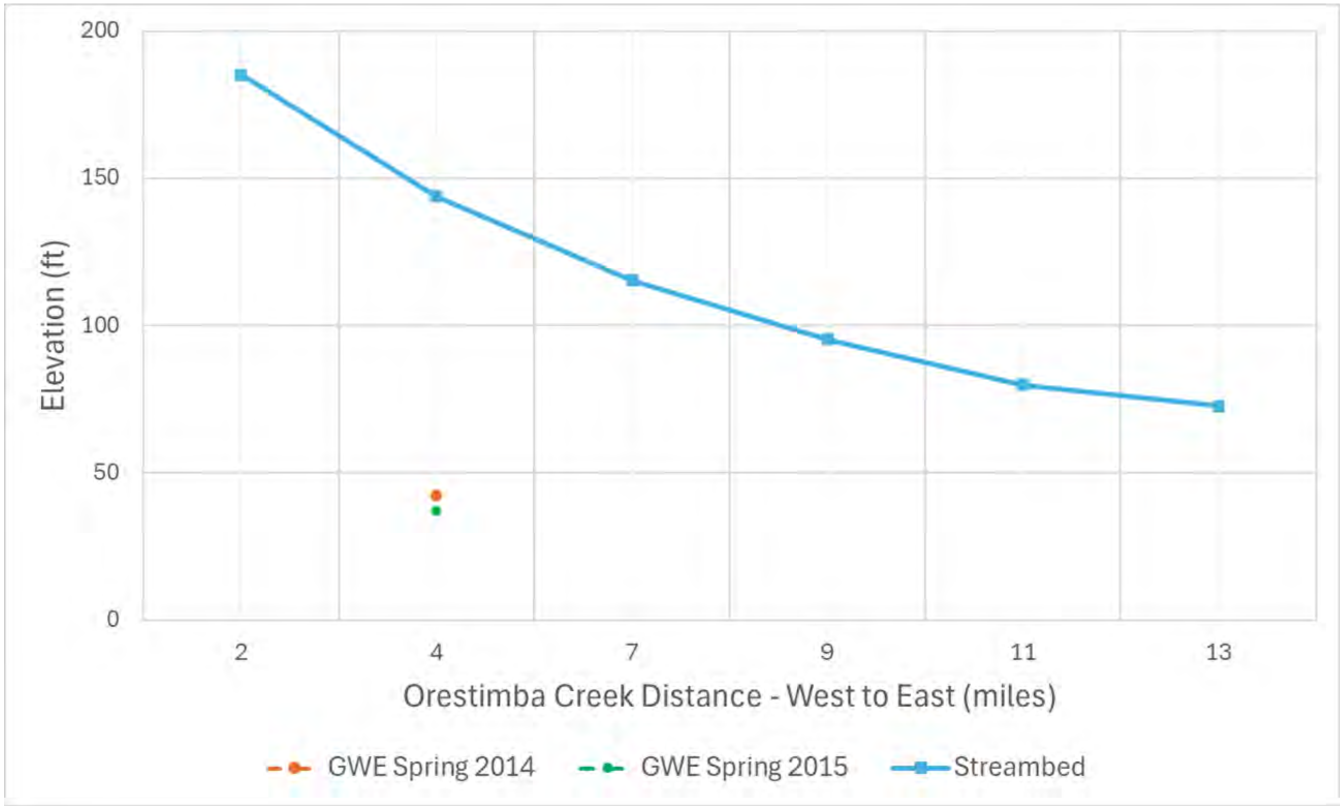


Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

SJR Streambed and Groundwater Elevation along SJR

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-56



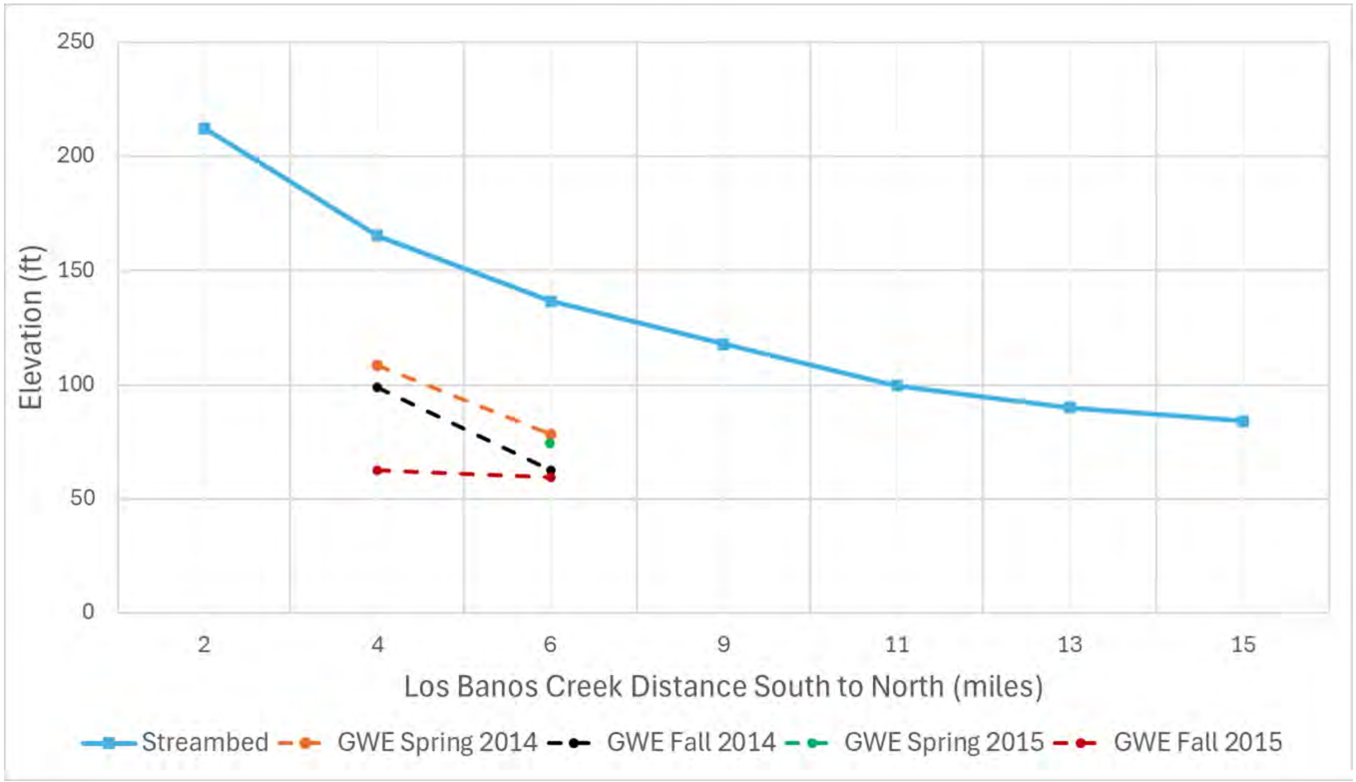
Abbreviations

ft = Feet
GWE = Groundwater Elevation

Notes
1. Fall 2014 and Fall 2015 GWE measurements are not available for Orestimba Creek.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Orestimba Creek Streambed and Groundwater Elevation along Orestimba Creek

Delta-Mendota Subbasin
July 2024
C00041.09
eki environment & water
Figure GWC-57



Abbreviations

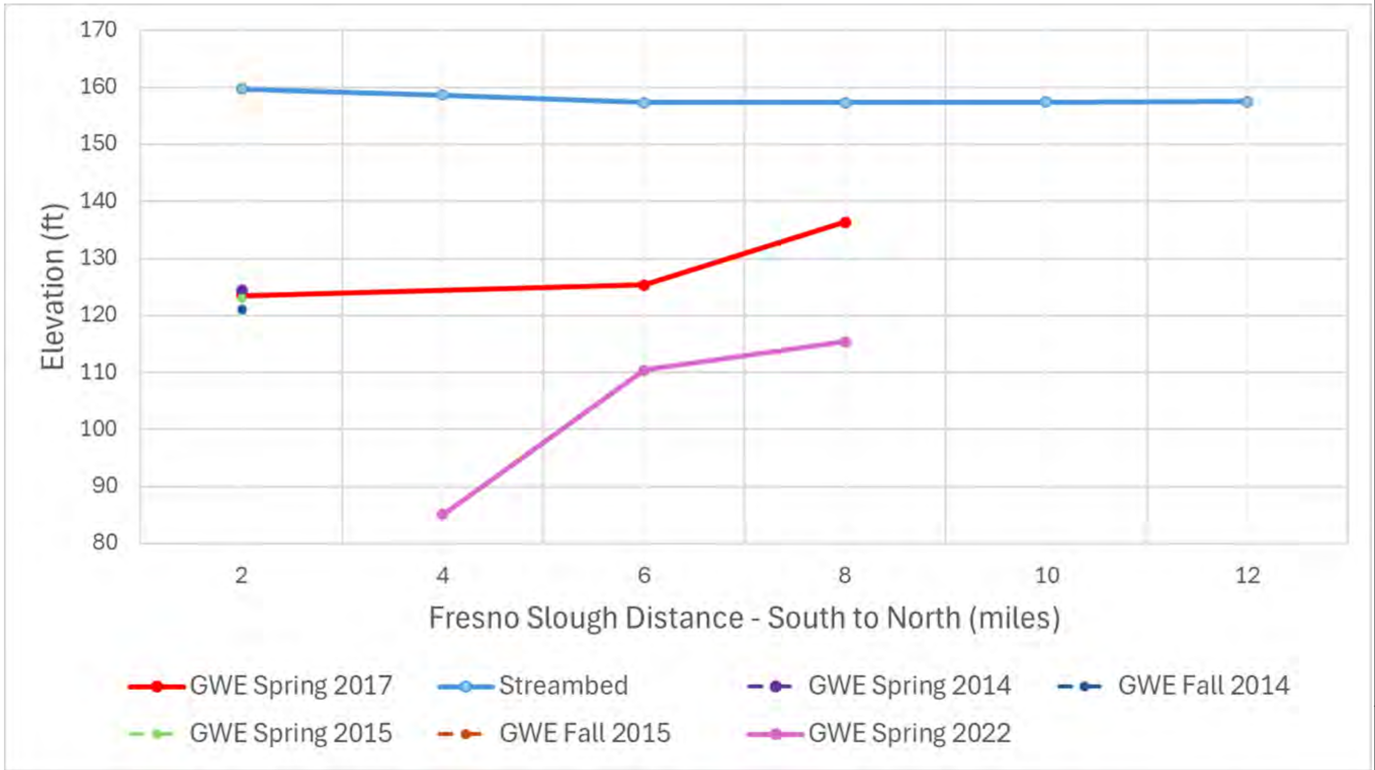
ft = Feet
GWE = Groundwater Elevation

Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Los Banos Creek Streambed and Groundwater Elevation along Los Banos Creek

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-58



Abbreviations

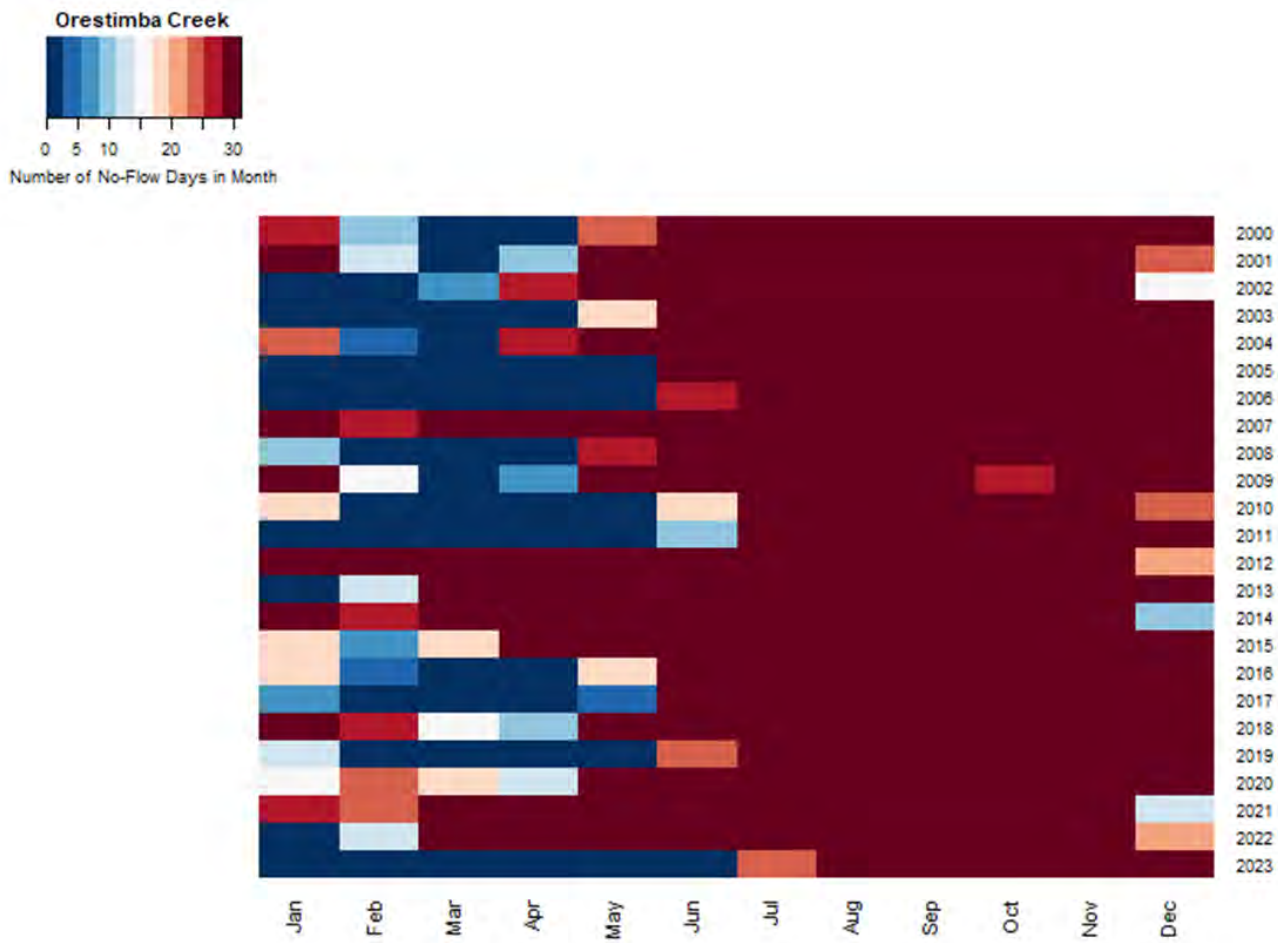
ft = Feet
GWE = Groundwater Elevation

Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Fresno Slough Streambed and Groundwater Elevation along Fresno Slough

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-59



Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

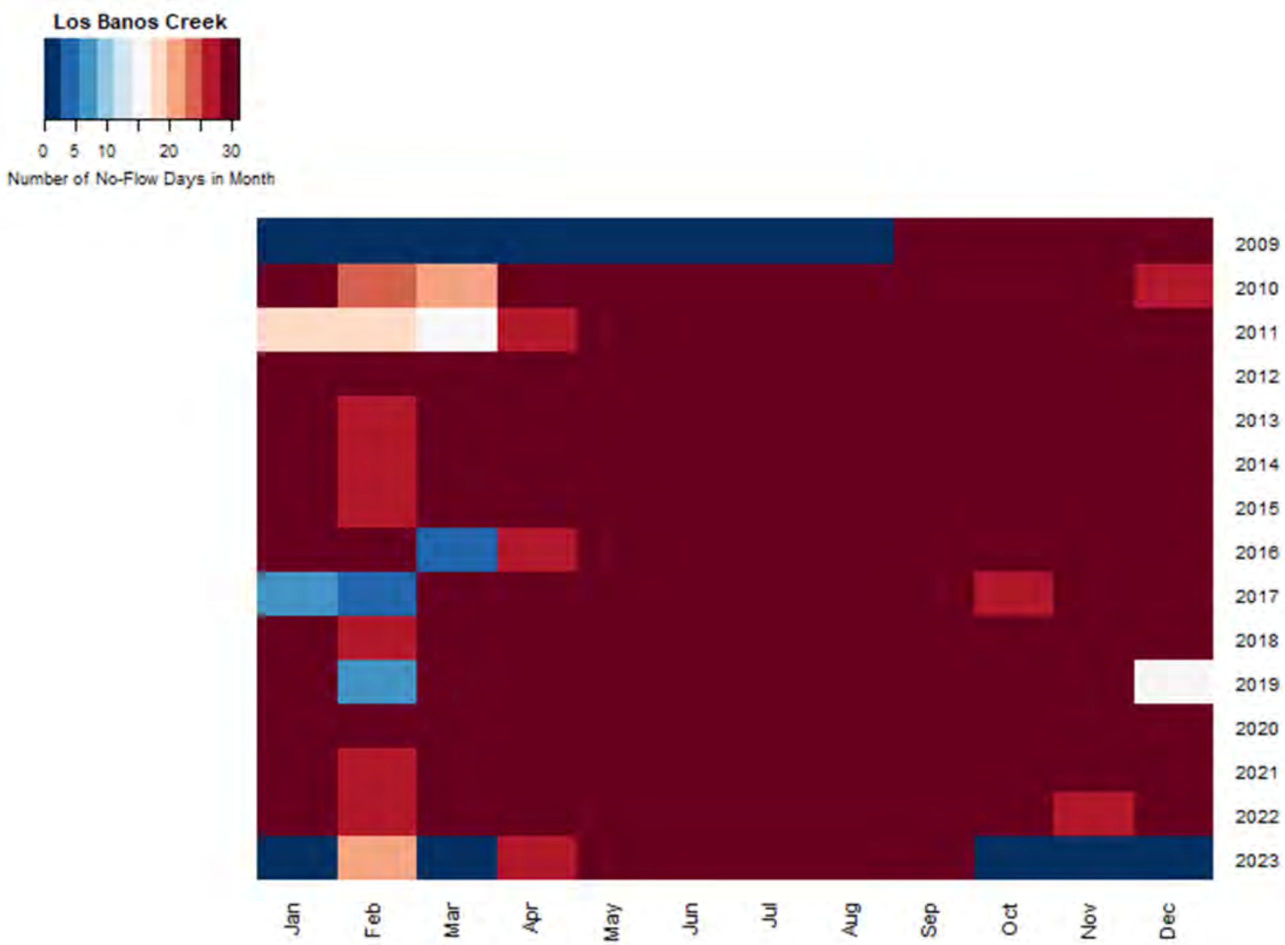
Source

USGS Gage 11274500 Surface Water Data: https://waterdata.usgs.gov/nwis/sw

Historical Record of Zero-Flow Days in Orestimba Creek

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-60

eki environment & water



<u>Notes</u>

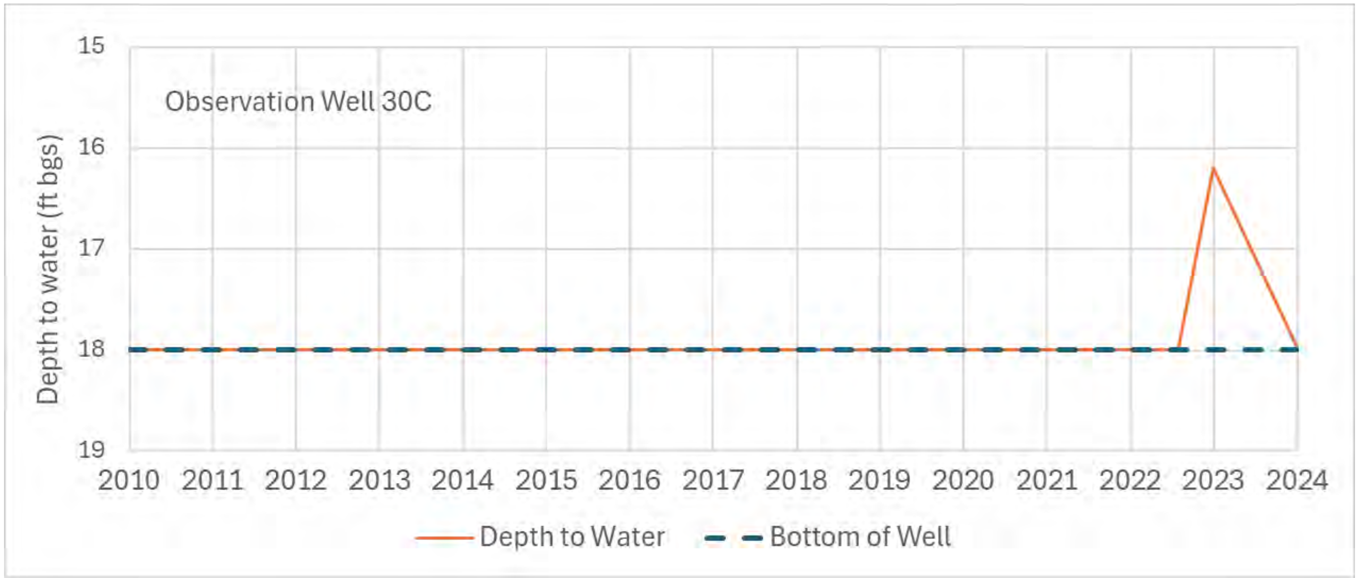
1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

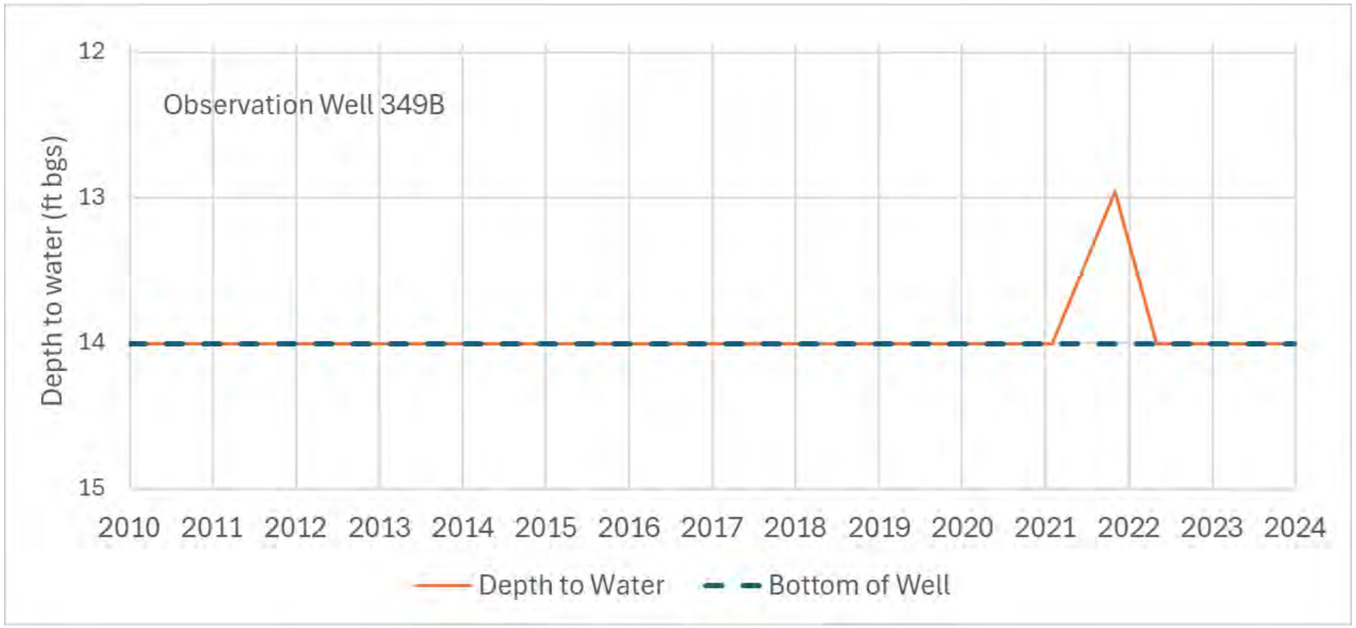
<u>Source</u>

Los Banos Creek Flow Data: https://www.spk-wc.usace.army.mil/plots/california.html#SANJOA

Historical Record of Zero-Flow Days in Los Banos Creek

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-61





Abbreviations

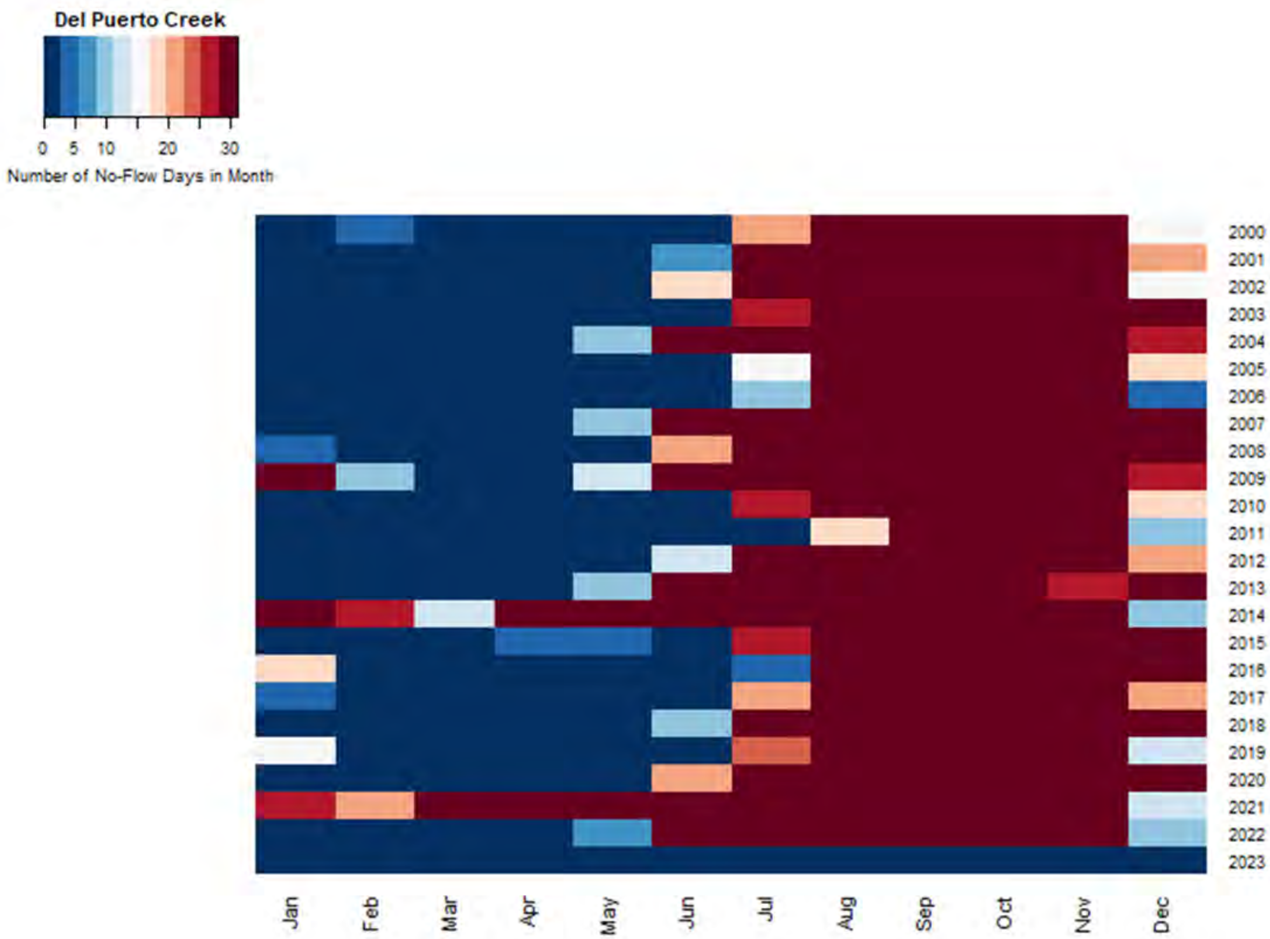
bgs = below ground surface
ft = Feet

Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Orestimba Creek Shallow Well Hydrographs

Delta-Mendota Subbasin
July 2024
C00041.09
Figure GWC-62



Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Source

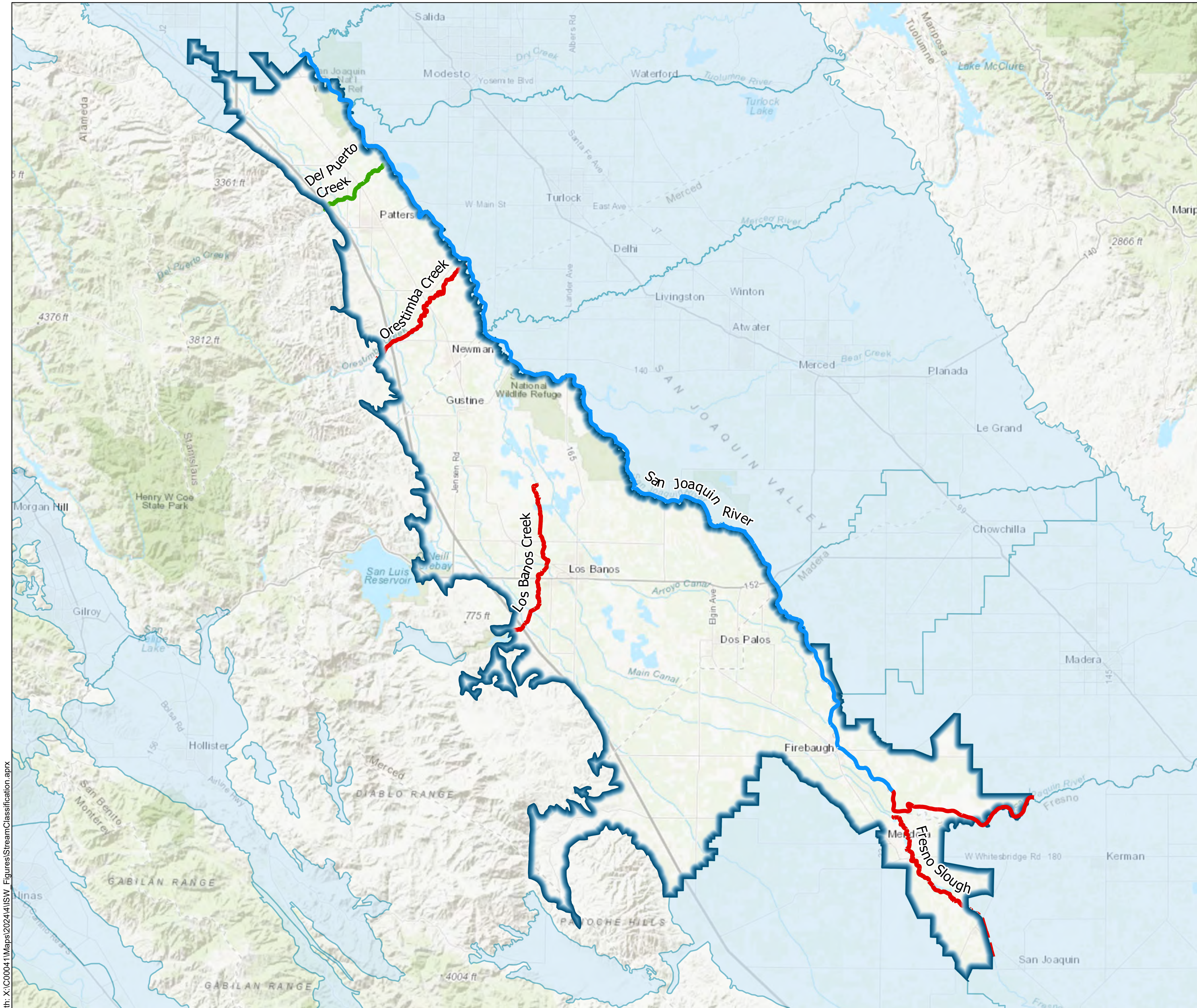
USGS Gage 11274630 Surface Water Data: https://waterdata.usgs.gov/nwis/sw

Historical Record of Zero-Flow Days in Del Puerto Creek

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure GWC-63



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Stream Classification

- Potential ISW (Likely Connected)
- Uncertain/Likely Disconnected
- Likely Disconnected

Abbreviations

DWR = Department of Water Resources
ISW = Interconnected Surface Water

Notes

1. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

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Interconnected Surface Water Classifications

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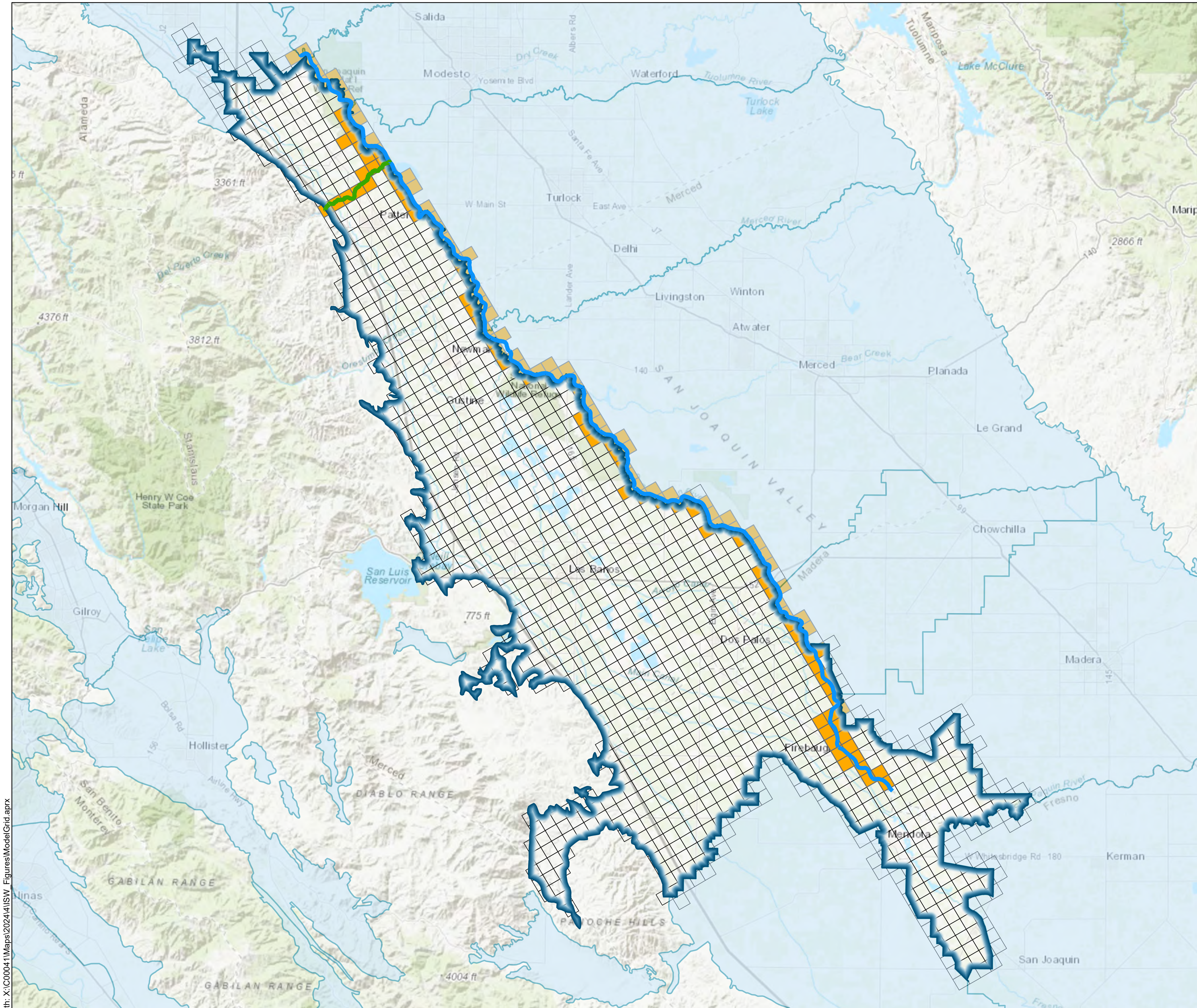
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-64

Path: X:\C00041\Maps\2024\ISW_Figures\StreamClassification.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Model Grid
- Model Grid of Non-Disconnected Streams

Straem Classificfation

- Potential ISW (Likely Connected)
- Uncertain/Likely Disconnected

Abbreviations

DWR = Department of Water Resources
USGS = United States Geological Survey

Notes

1. USGS Central Valley Hydrologic Model Version 2 - San Joaquin Valley (CVHM2-SJV) model grid for the Basin extent is displayed.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Groundwater basins and subbasins. California Department of Water Resources. August 25, 2023.

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Interconnected Surface Water Model Grids

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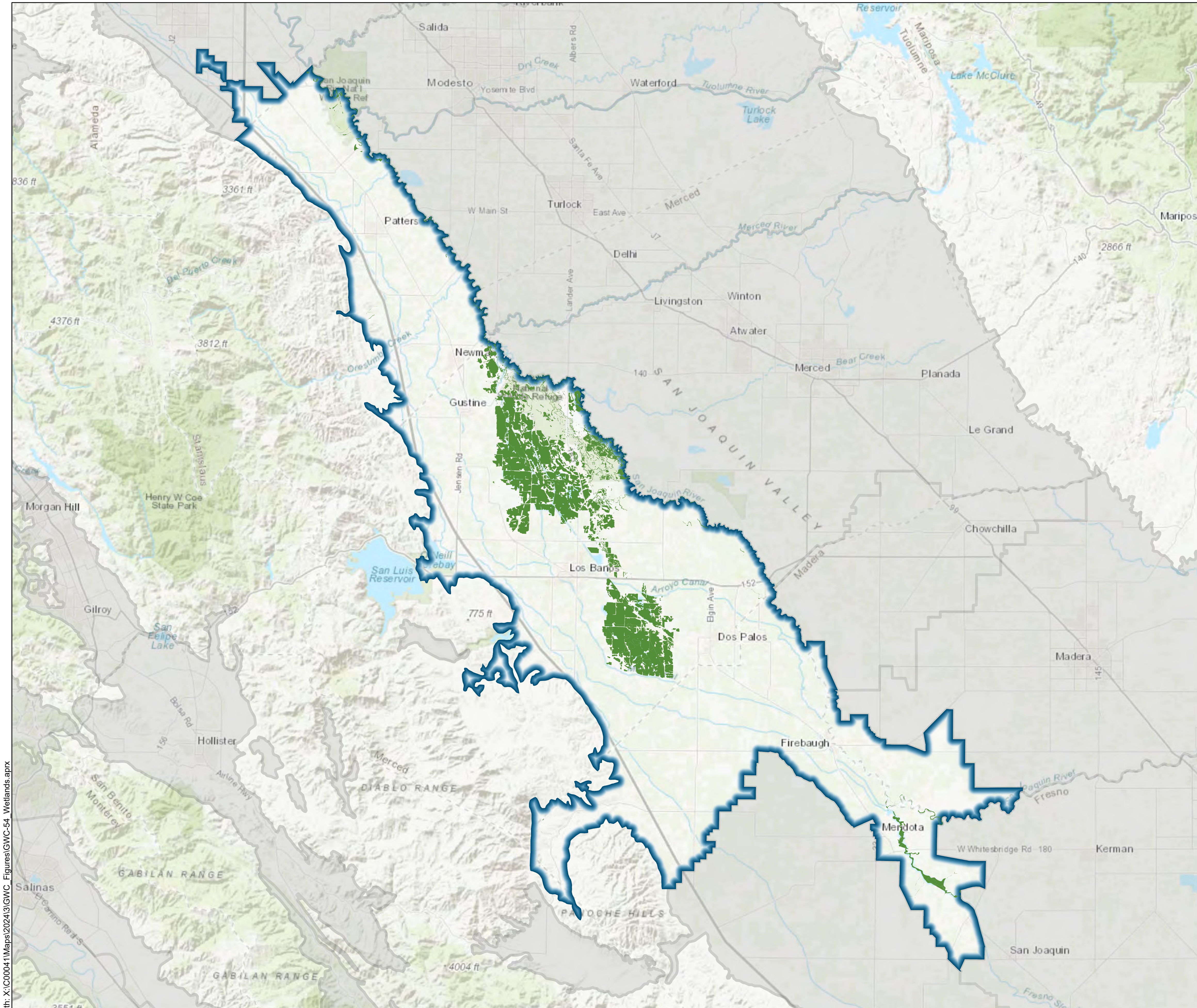
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-65

Path: X:\C00041\Maps\2024\ISW_Figures\ModelGrid.aprx



Legend

- Wetlands
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Abbreviations

DWR = Department of Water Resources

Notes:

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Wetland classification per the Delta-Mendota common chapter has been used

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Extent of Identified Wetlands in Delta-Mendota Subbasin

Delta-Mendota Subbasin

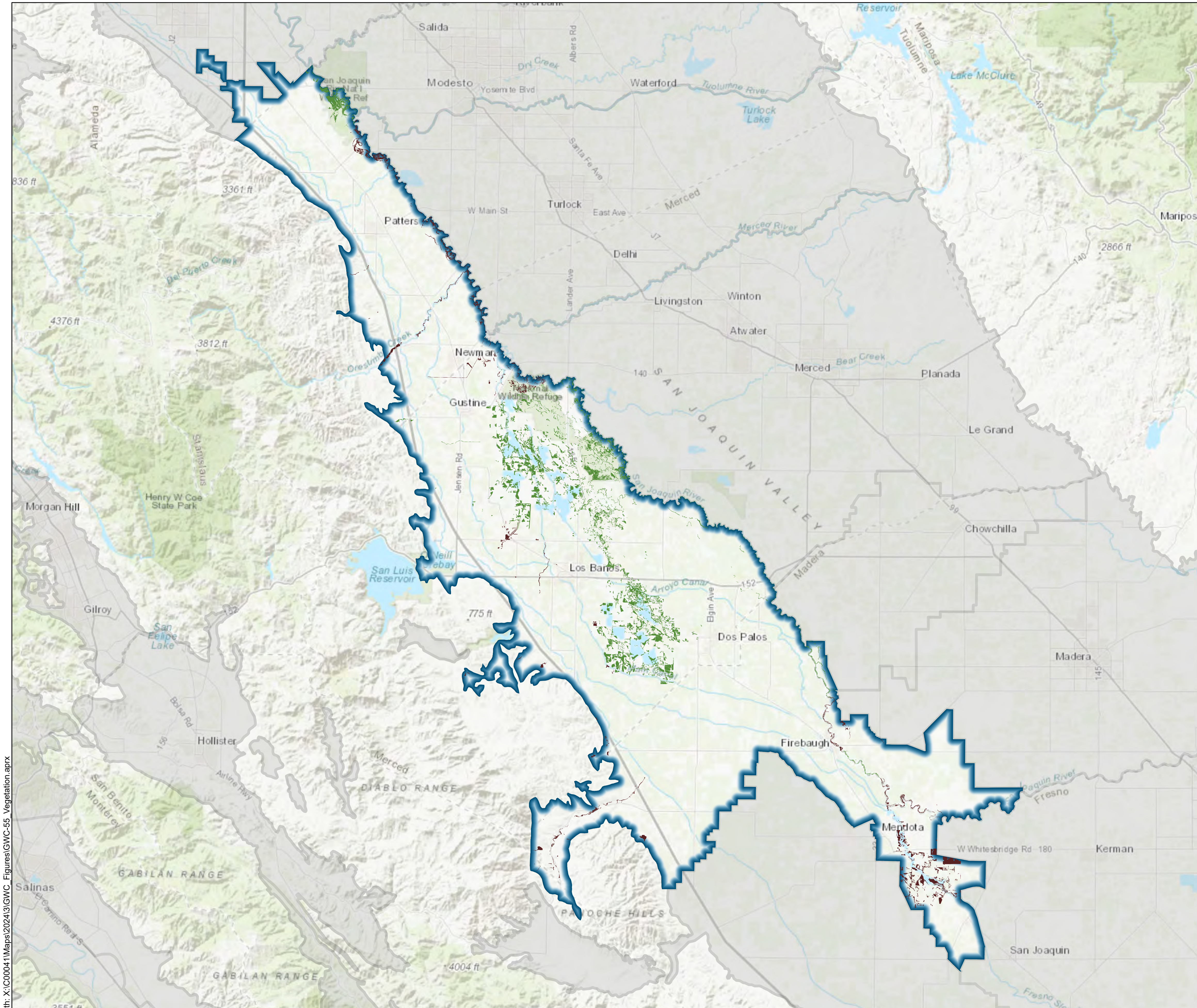
July 2024

C00041.09

eki environment & water

Figure GWC-66

Path: X:\C00041\Maps\2024\3\GWC_Figures\GWC-54_Wetlands.aprx



Legend

Vegetation

- Possible GDE
- DTW>30 feet
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Abbreviations
DWR = Department of Water Resources
GDE = Groundwater Dependent Ecosystem
DTW = depth to groundwater

Notes:
1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Vegetation dataset obtained from the Vegetation layers of NCCAG.
4. Vegetation polygons overlying areas where the Spring 2015 depth to groundwater is greater than 30 feet have been excluded.

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Miles

Extent of Identified Vegetative GDEs in Delta-Mendota Subbasin

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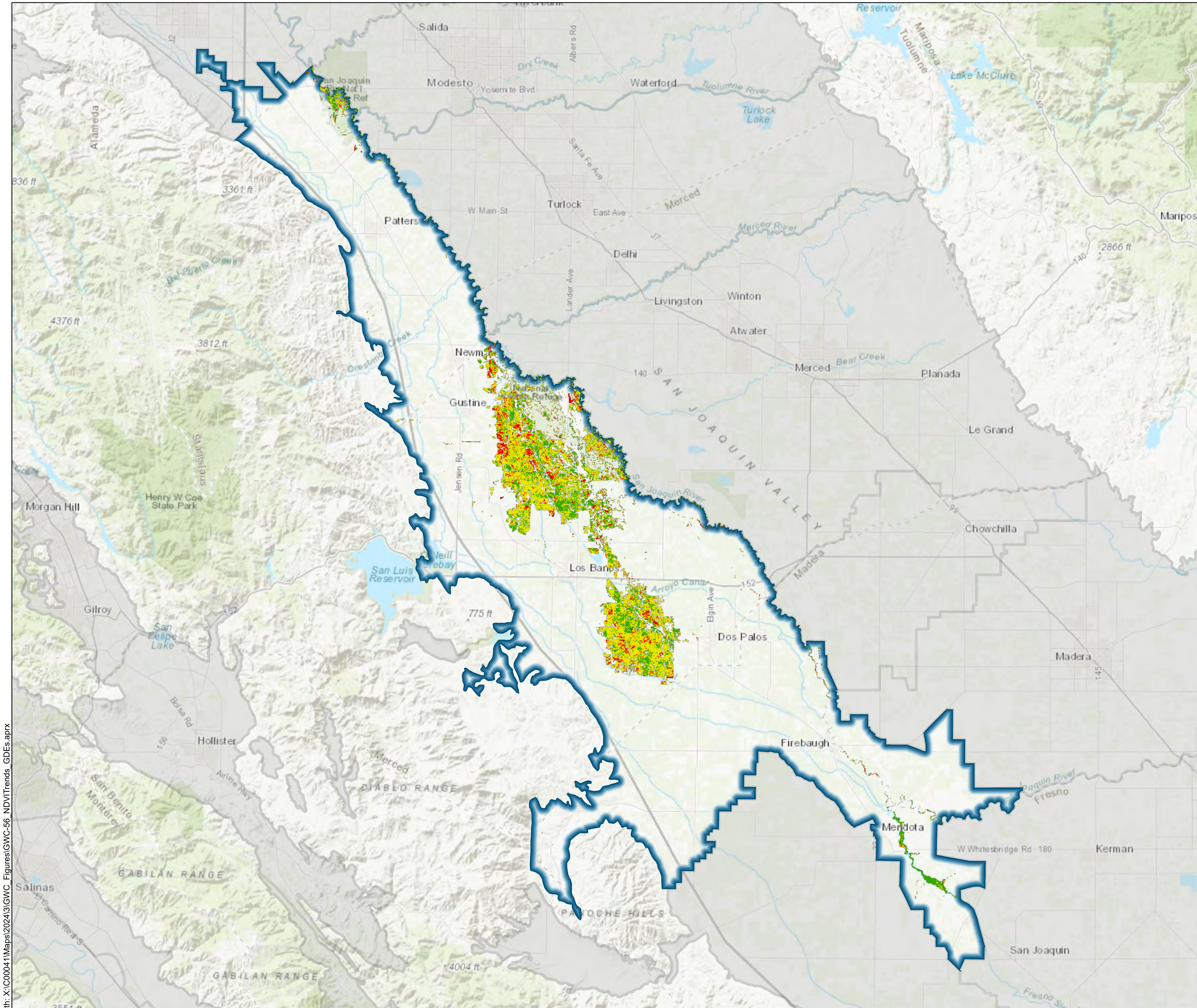
Delta-Mendota Subbasin
July 2024
C00041.09

Figure GWC-67



Legend

NDVI Trend (2013-2022)

- Large or Moderate Decrease
- Little or No Change
- Large or Moderate Increase
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Abbreviations

DWR = Department of Water Resources
GDE = Groundwater Dependent Ecosystem
NDVI = Normalized Difference Vegetation Index
TNC = The Nature Conservancy

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Raster representing change in NDVI between 2013 and 2022 obtained from TNC

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Change in NDVI Trends in the Identified GDEs

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Delta-Mendota Subbasin
July 2024
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Figure GWC-68

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