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Chapter 5

Paso Robles Subbasin Groundwater Sustainability Plan

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Pending the Cooperative Committee's recommendation on October 17, 2018, the Draft GSP Chapter 5 will be distributed to the five Paso Robles Subbasin GSAs to receive and file.

Draft
Paso Robles Subbasin
Groundwater Sustainability Plan
Chapter 5

*Prepared for the Paso Robles Subbasin
Cooperative Committee and the
Groundwater Sustainability Agencies*

October 10, 2018

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CHAPTER 5. GROUNDWATER CONDITIONS

This chapter describes the current and historical groundwater conditions in the Alluvial Aquifer and the Paso Robles Formation Aquifer in the Paso Robles Subbasin. In accordance with the SGMA emergency regulations §354.16, current conditions are any conditions occurring after January 1, 2015. By implication, historical conditions are any conditions occurring prior to January 1, 2015. The chapter focuses on information required by the GSP regulations and information that is important for developing an effective plan to achieve sustainability. The organization of Chapter 5 aligns with the five sustainability indicators applicable to the Subbasin including:

1. Chronic lowering of groundwater elevations,
2. Changes in groundwater storage,
3. Seawater intrusion,
4. Subsidence,
5. Depletion of interconnected surface waters, and
6. Groundwater quality.

5.1 GROUNDWATER ELEVATIONS

The following assessment of groundwater elevation conditions is largely based on data from the San Luis Obispo County Flood Control and Water Conservation District's (SLOFCWCD) groundwater monitoring program. Groundwater levels are measured by the SLOFCWCD through a network of public and private wells in the Subbasin. Additional groundwater elevation data for wells were obtained from other available data sources, including the California Statewide Groundwater Elevation Monitoring (CASGEM) database, USGS, and other regulatory compliance programs. Locations of the wells (about 50 to 55 depending on year) used for the groundwater elevation assessment are shown on Figure 5-1. Data from some of the wells on this figure were collected under confidentiality agreements. To remain consistent with these confidentiality agreements, the well owner information and specific locations for these wells are not provided in this GSP.

The set of wells shown on Figure 5-1 were selected from a larger set of monitor wells in the SLOFCWCD database based on the following criteria:

- The wells have groundwater elevation data for 1997 and/or 2017;
- Sufficient information exists to assign the well to either the Alluvial Aquifer or Paso Robles Formation Aquifer; and
- Groundwater elevation data were deemed representative of static conditions based on a check of consistency with nearby wells.

Additional information on the monitoring network is provided in Chapter 8 – Monitoring Networks.

Based on available data, the following information is presented in subsequent subsections for both aquifers in the Subbasin.

- Groundwater elevation contour maps for the seasonal high and low periods for 1997 and 2017
- A map depicting the change in groundwater elevation between 1997 and 2017
- Hydrographs for wells with publicly available data
- Assessments of horizontal and vertical groundwater gradients

5.1.1 ALLUVIAL AQUIFER

Groundwater elevation data for the Alluvial Aquifer are limited. The locations of the Alluvial Aquifer monitor wells with available groundwater elevation data are shown on Figure 5-1.

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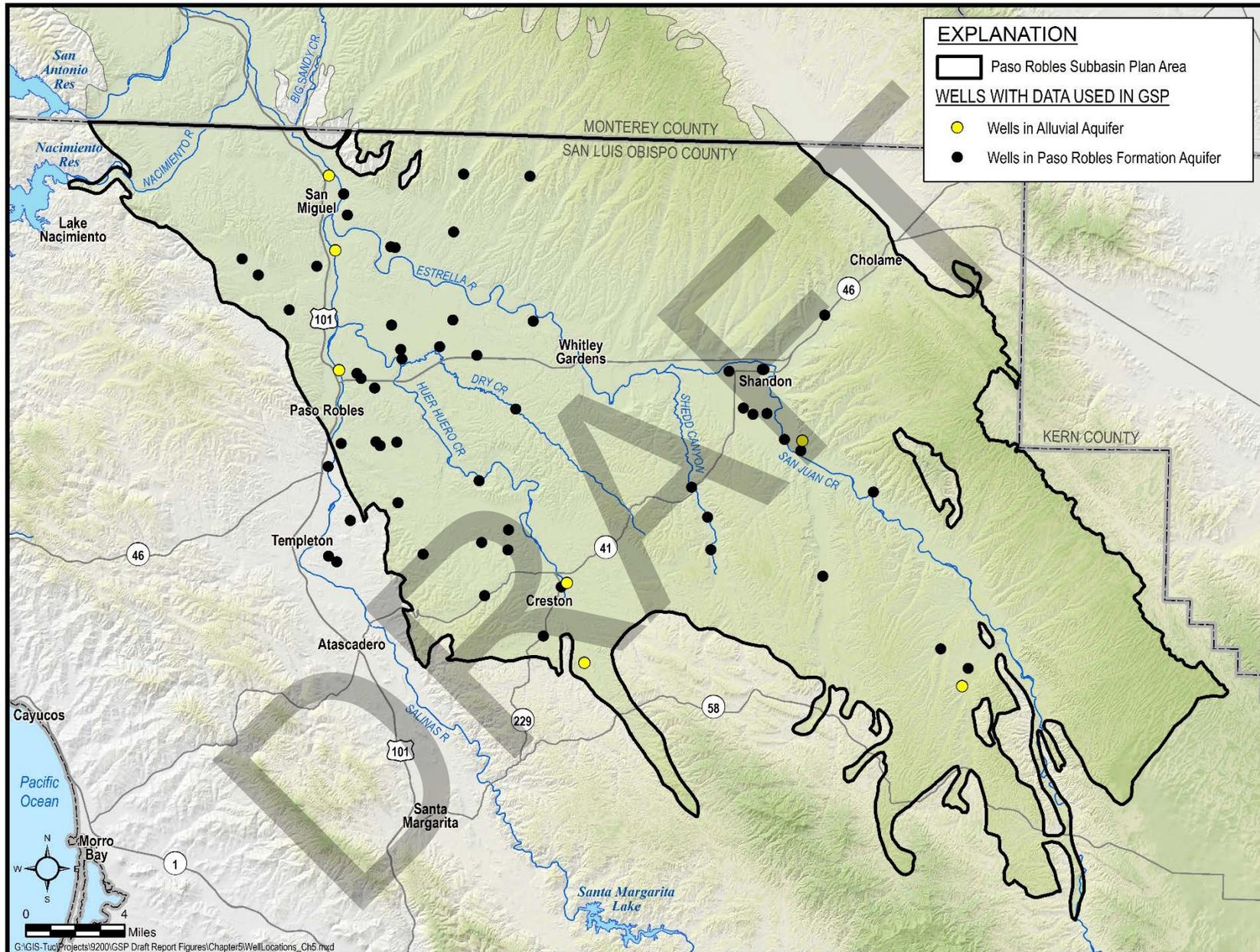


Figure 5-1. Location of Wells used for the Groundwater Elevation Assessments

5.1.1.1 ALLUVIAL AQUIFER GROUNDWATER ELEVATION CONTOURS AND HORIZONTAL GROUNDWATER GRADIENTS

Groundwater elevation data for the Alluvial Aquifer are too limited to prepare representative contour maps for the seasonal high and seasonal low groundwater elevations, or to prepare maps for historical groundwater elevations. Figure 5-2 shows current groundwater elevation contours for the Alluvial Aquifer. The contours were developed using 2017 data when available and the most recent data prior to 2017. Contours are only depicted on the map in areas near the wells that are shown on Figure 5-1.

Groundwater elevations range from approximately 1,400 feet above mean sea level (ft msl) in the southeastern portion of the Subbasin to approximately 600 ft msl near San Miguel. Groundwater flow in the Alluvial Aquifer generally follows the alignment of the creeks and rivers. Overall, groundwater in the Alluvial Aquifer flows from southeast to northwest across the Subbasin. Groundwater elevation data in the Alluvial Aquifer are too sparse to develop meaningful estimates of local horizontal groundwater gradients. On a basin-wide scale, the average horizontal hydraulic gradient in the alluvium is about 0.004 from the southeastern portion of the Subbasin to San Miguel.

5.1.1.1 ALLUVIAL AQUIFER HYDROGRAPHS

Groundwater level data for all of the Alluvial Aquifer wells shown on Figure 5-1 were collected under confidentiality agreements. Therefore, hydrographs for the Alluvial Aquifer are not included in this GSP. The lack of publicly available groundwater level data for the Alluvial Aquifer is a significant data gap.

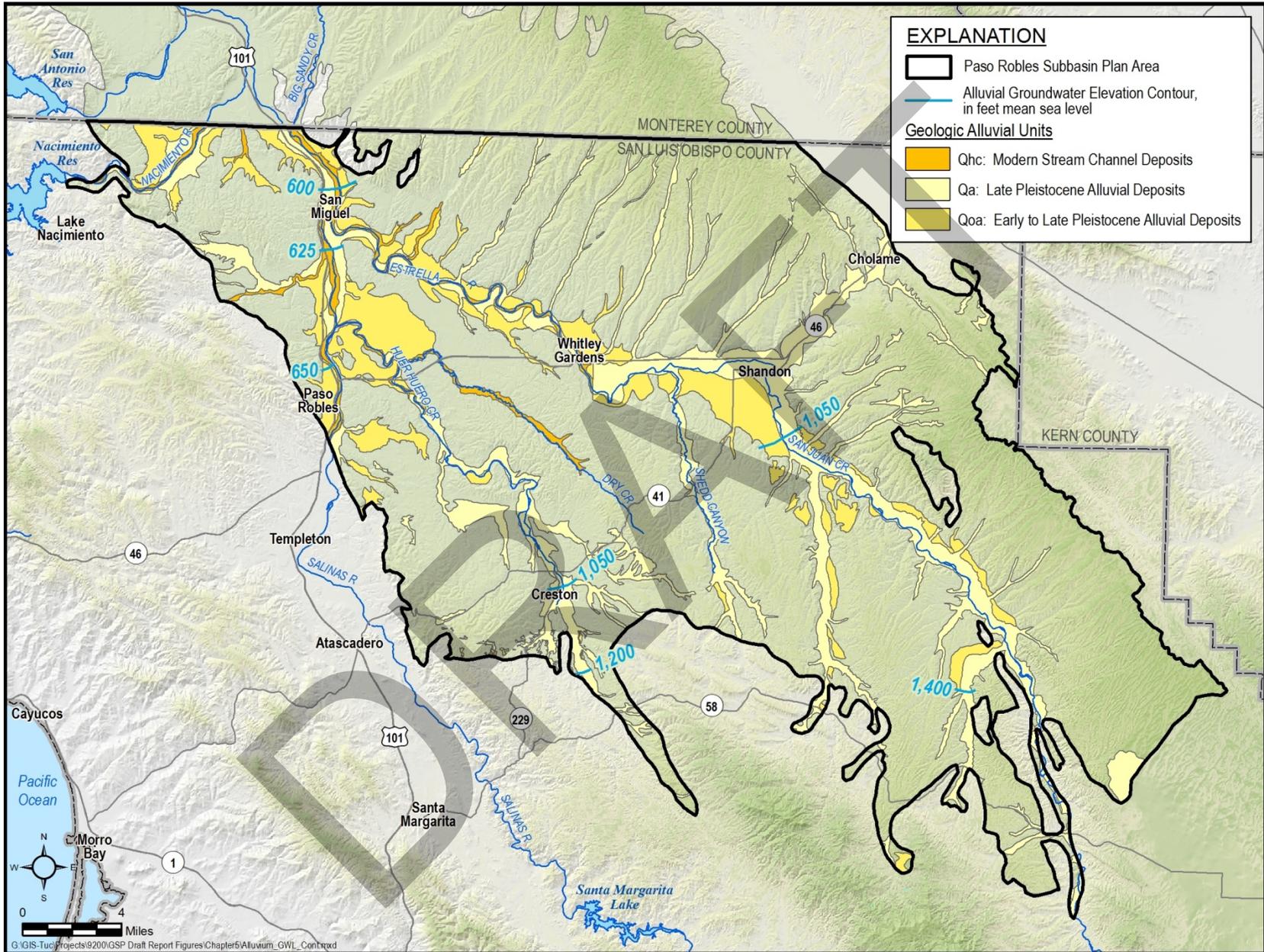


Figure 5-2. Groundwater Elevation Contours for the Alluvial Aquifer

5.1.2 PASO ROBLES FORMATION AQUIFER

The locations of the Paso Robles Formation Aquifer monitor wells used to assess the hydrogeologic conditions of the Paso Robles Formation Aquifer are shown on Figure 5-1. Groundwater occurs in the Paso Robles Formation Aquifer under unconfined, semi-confined, and confined conditions.

5.1.2.1 PASO ROBLES AQUIFER GROUNDWATER ELEVATION CONTOURS AND HORIZONTAL GROUNDWATER GRADIENTS

Groundwater elevation data for 1997 and 2017 for the Paso Robles Formation Aquifer were contoured to assess current spatial variations, groundwater flow directions, and horizontal groundwater gradients. Contour maps were prepared for the seasonal high groundwater levels, which is typically in the spring, and the seasonal low groundwater levels, which is typically in the fall. In general, the spring groundwater data are for April and the fall groundwater data are for October. Data from public and private wells were used for contouring; information identifying the owner or detailed location of private wells is not shown on the maps. The contours are based on groundwater elevations measured at the well locations shown on Figure 5-1. Contour maps were generated using a computer-based contouring program and checked for representativeness by a qualified hydrogeologist. Groundwater elevation data deemed unrepresentative of static conditions or obviously erroneous were not used for contouring. Similar to groundwater elevation contour maps prepared for previous studies, close inspection of the maps indicates localized areas where interpolated groundwater elevations are above land surface. This typically occurs near streams and incised drainages where land surface tends to be locally lower than surrounding areas. While it is hydrologically possible that groundwater elevations in the Paso Robles Formation Aquifer are above land surface in some local areas, our assessment is that this is more likely an artifact of the computer contouring of sparse groundwater elevation data.

Figure 5-3 and Figure 5-4 show contours of historical groundwater elevations in the Paso Robles Formation Aquifer for spring 1997 and fall 1997, respectively. Overall, groundwater conditions in the Subbasin in the spring and fall of 1997 are similar. Close inspection of the contour maps indicates that groundwater elevations are generally lower in the fall than spring. Groundwater elevations ranged from about 1,300 ft msl in the southeast portion of the Subbasin to about 550 ft msl near the City of Paso Robles and the town of San Miguel (Figure 5-3 and Figure 5-4). Groundwater flow is generally to the northwest and west over most of the Subbasin, except in the area north of the City of Paso Robles where groundwater flow is to the northeast. In general, groundwater flow in the western portion of the Subbasin tends to converge toward areas of low groundwater elevations. These areas of low ground-

water elevation are caused by pumping in the area between the City of Paso Robles, and the communities of San Miguel and Whitley Gardens.

Horizontal groundwater gradients range from approximately 0.003 foot/foot in the southeast portion of the Subbasin to approximately 0.01 foot/foot in the areas both southeast of the City of Paso Robles and northwest of Whitley Gardens. The steepest horizontal groundwater gradients in the Subbasin are on the margins of the pumping depression in the vicinity of the city of Paso Robles and community of San Miguel.

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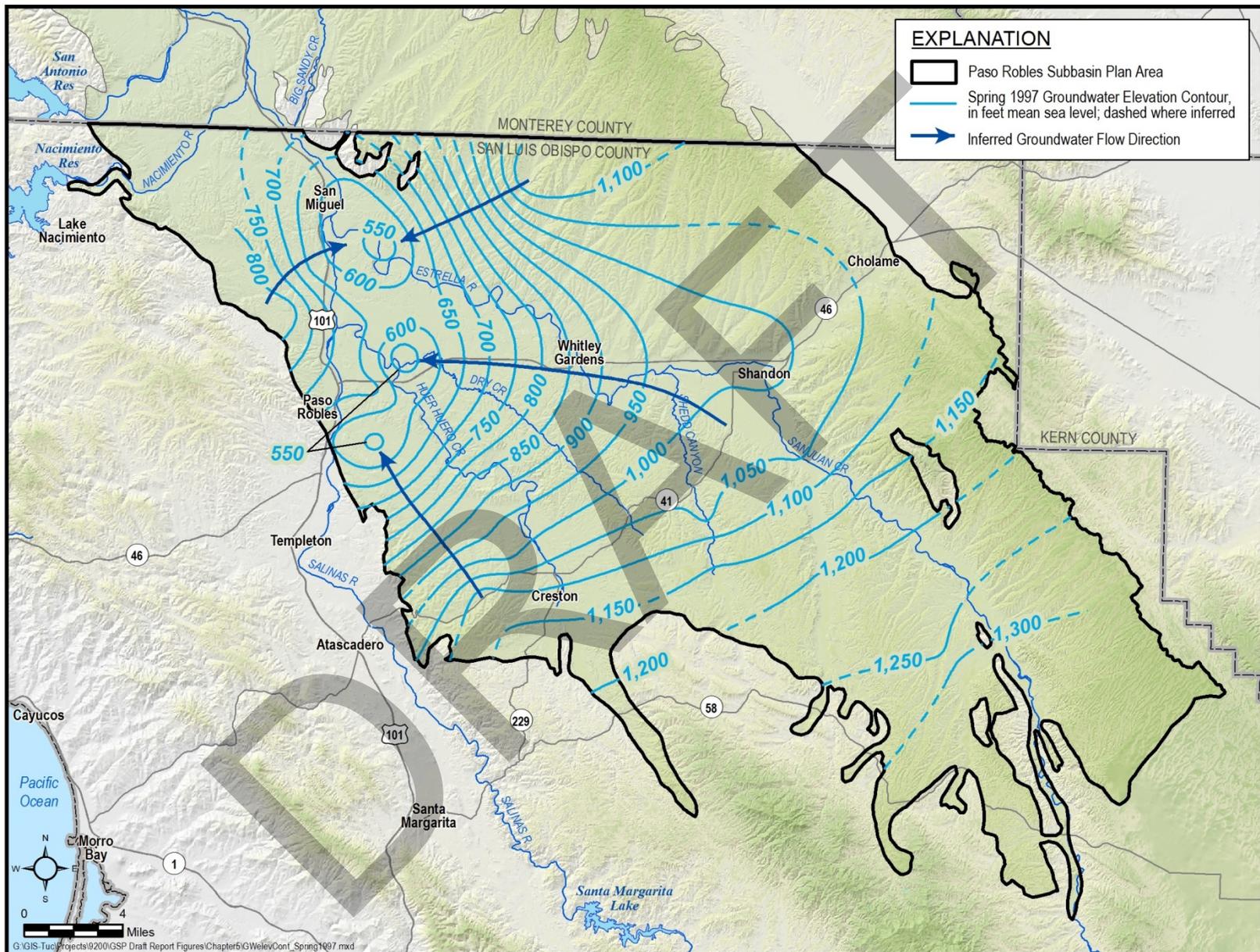


Figure 5-3. Spring 1997 Paso Robles Formation Aquifer Groundwater Elevation Contours

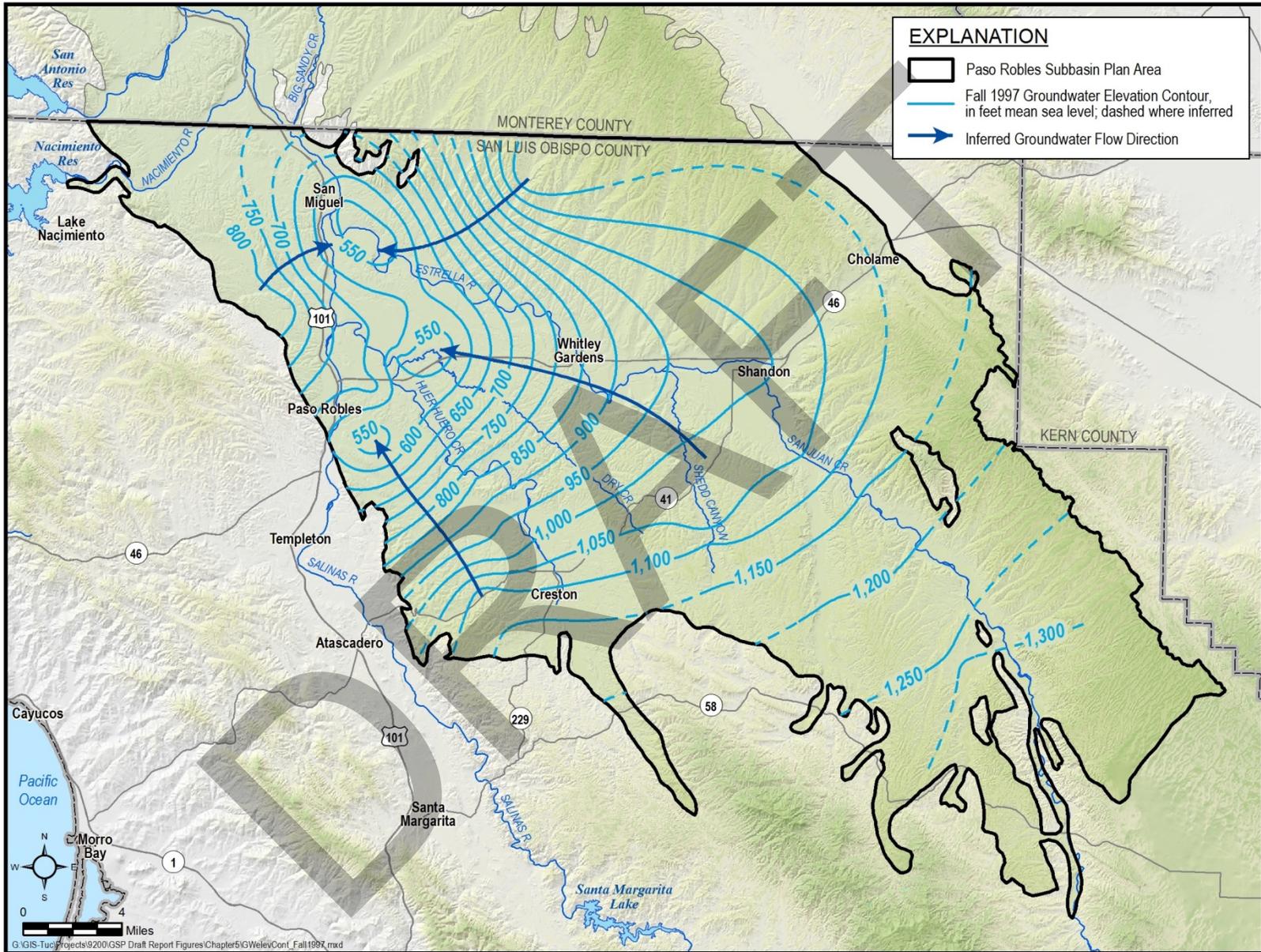


Figure 5-4. Fall 1997 Paso Robles Formation Aquifer Groundwater Elevation Contours

Figure 5-5 and Figure 5-6 show contours of current groundwater elevations in the Paso Robles Formation Aquifer for spring 2017 and fall 2017, respectively. Overall, groundwater conditions in the Subbasin in the spring and fall of 2017 were similar. Close inspection of the contour maps indicates that groundwater elevations are generally lower in the fall than spring. Groundwater elevations in 2017 are also lower than groundwater elevations in 1997. Groundwater elevations in 2017 ranged from about 1,250 ft msl in the southeast portion of the Subbasin to about 500 ft msl east of the City of Paso Robles (Figure 5-5 and Figure 5-6). Groundwater flow is generally to the northwest and west over most of the Subbasin, except in the area north of the City of Paso Robles where groundwater flow is to the northeast. In general, groundwater flow in the western portion of the Subbasin tends to converge toward areas of low groundwater elevations. These areas of low groundwater elevation are caused by pumping in the area between the City of Paso Robles and the communities of San Miguel and Whitley Gardens. Horizontal groundwater gradients range from approximately 0.002 foot/foot in the southeast portion of the Subbasin to approximately 0.02 foot/foot in the area southeast of the City of Paso Robles. The steepest horizontal groundwater gradients in the Subbasin in 2017 are on the margins of the pumping depression east of the city of Paso Robles and southeast of the community of San Miguel.

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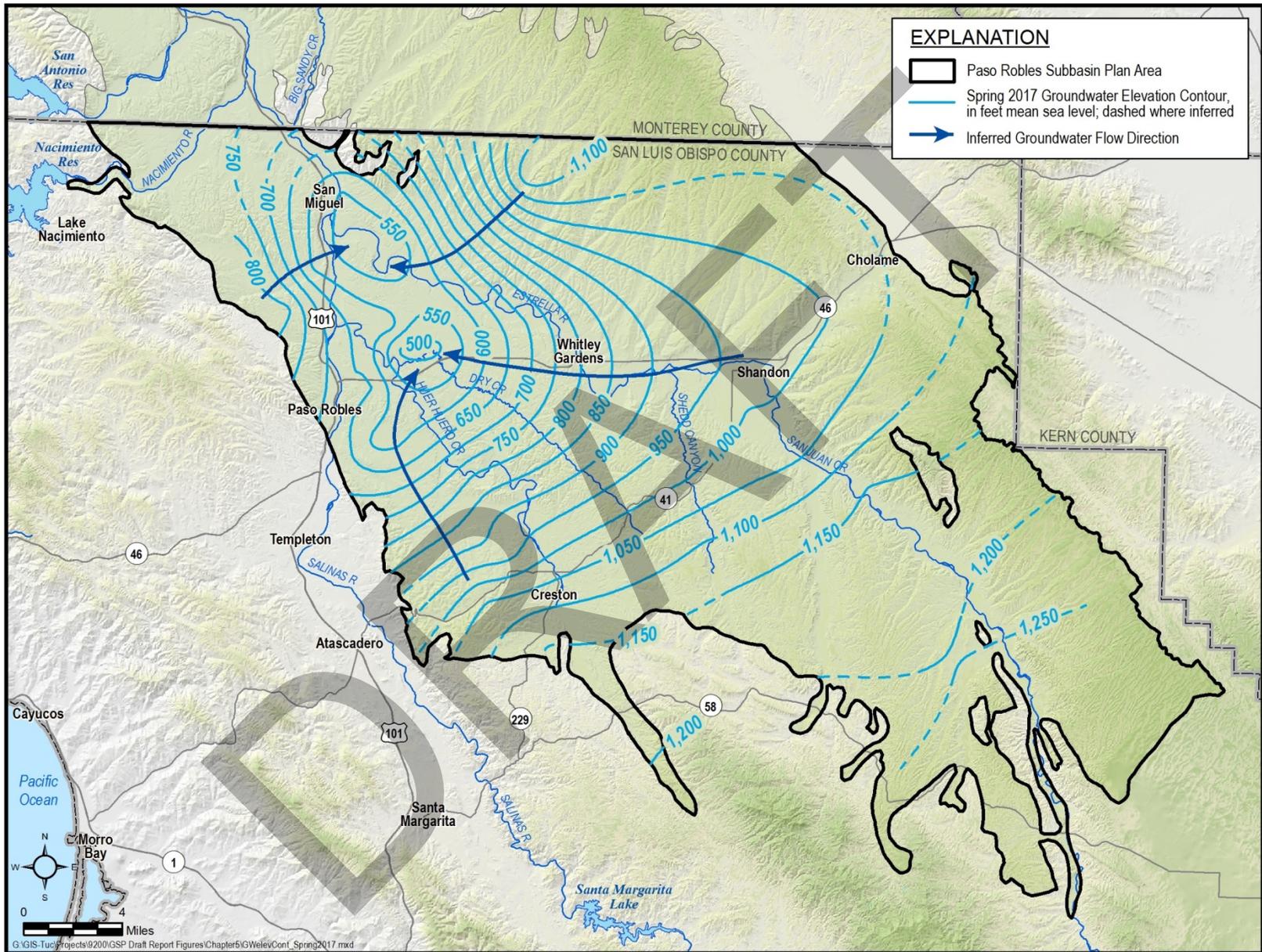


Figure 5-5. Paso Robles Formation Aquifer Spring 2017 Groundwater Elevation Contours

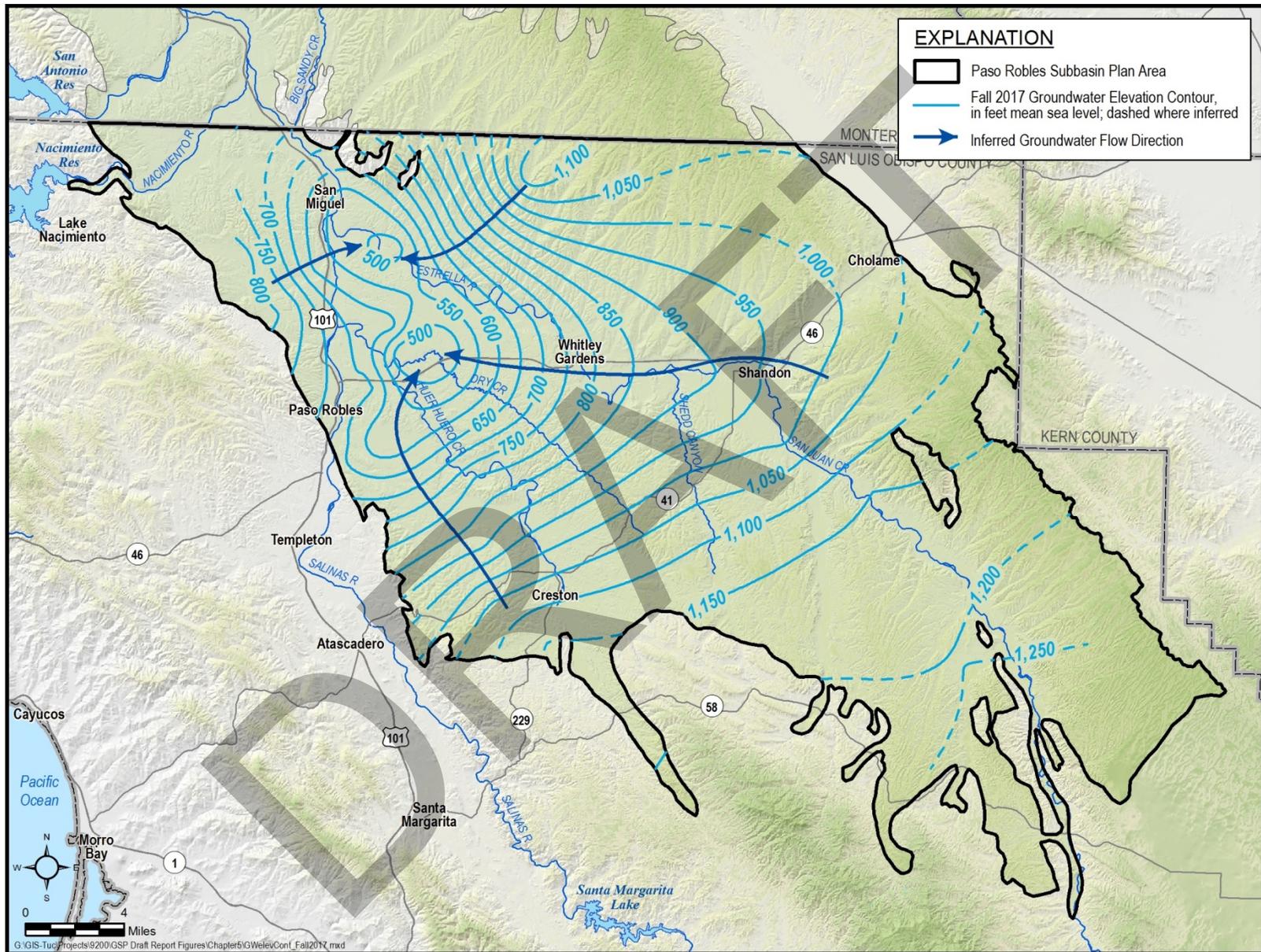


Figure 5-6. Paso Robles Formation Aquifer Fall 2017 Groundwater Elevation Contours

Figure 5-7 depicts the change in spring groundwater elevations in the Paso Robles Formation Aquifer between 1997 and 2017. Figure 5-8 depicts the change in fall groundwater elevations in the Paso Robles Formation Aquifer between and 1997 and 2017. Groundwater elevations are lower in 2017 than 1997 throughout most of the Subbasin. In general, the pattern of groundwater level decline in the spring and fall are similar, with a more pronounced area of decline extending toward Shandon in the fall. More than 80 feet of decline is observed in places during this period. Areas of largest decline are east of the city of Paso Robles, near Creston, and in the southeastern portion of the basin. Limited data suggest an area of higher groundwater elevations exists in the vicinity of the city of Paso Robles in 2017 compared to 1997. The increase may be related to reductions in groundwater pumping in the area.

The groundwater level contours and groundwater level change maps in this GSP are based on a reasonable and thorough analysis of the currently available data. As discussed in Chapter 8, the monitoring network should be expanded to more completely assess Subbasin conditions and demonstrate compliance with the sustainability goal for the Subbasin. Expanding the monitoring network and acquiring more groundwater elevation data will allow the GSAs to refine and modify this GSP in the future based on a more complete understanding of Subbasin conditions.

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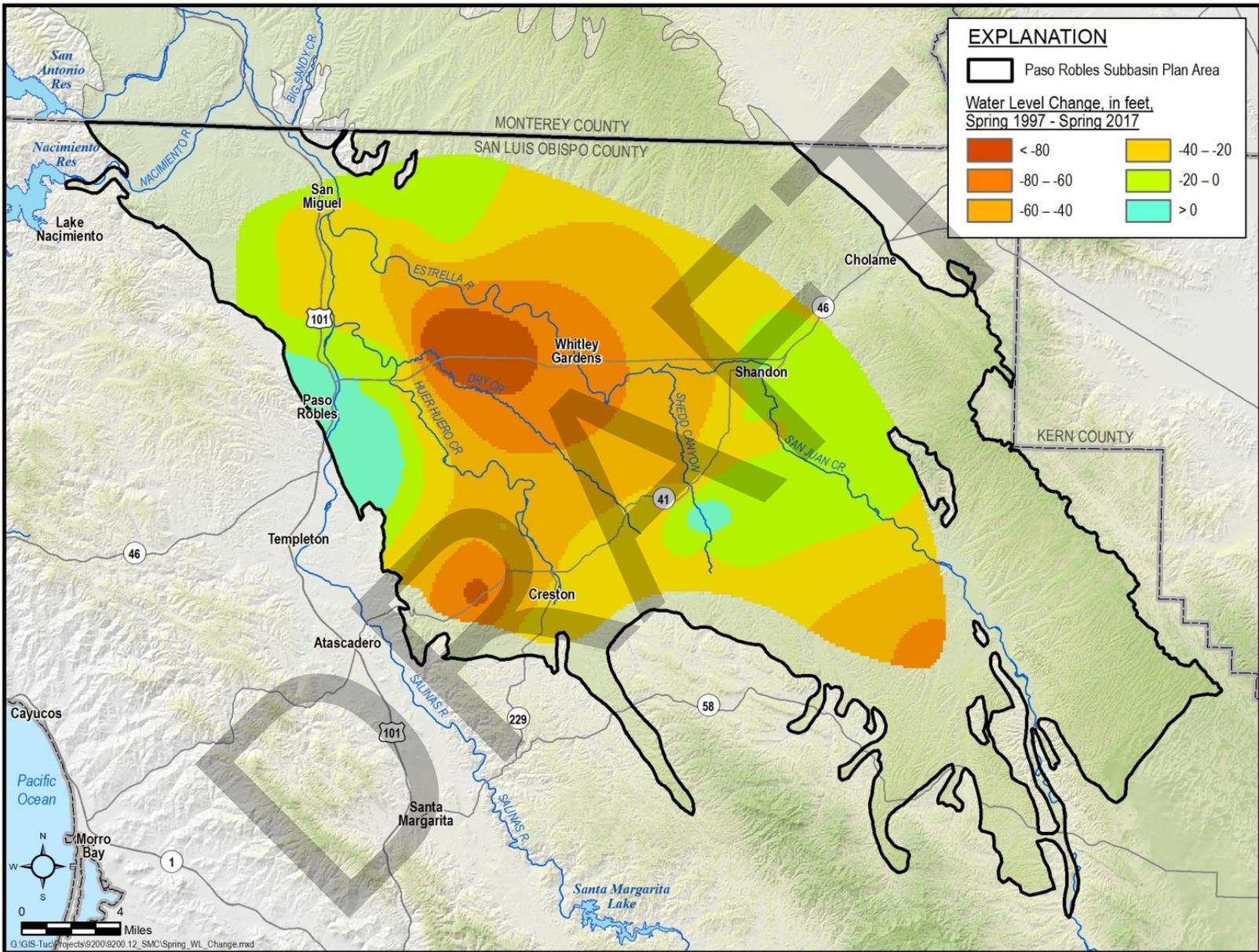


Figure 5-7. Paso Robles Formation Aquifer Change in Groundwater Elevation – Spring 1997 to Spring 2017

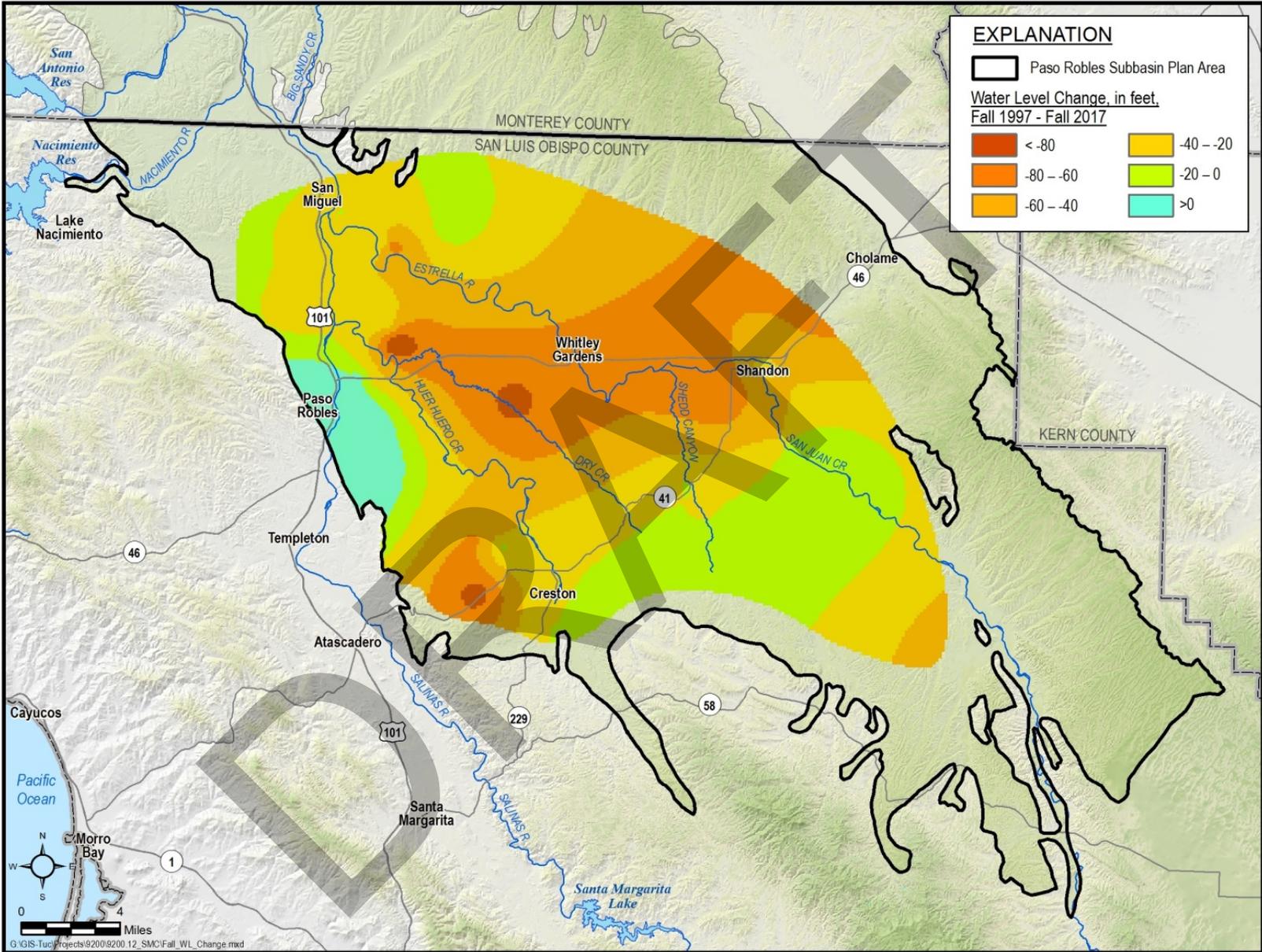


Figure 5-8. Paso Robles Formation Aquifer Change in Groundwater Elevation – Fall 1997 to Fall 2017

5.1.2.2 PASO ROBLES FORMATION AQUIFER HYDROGRAPHS

Appendix 5A includes hydrographs for wells in the Paso Robles Formation Aquifer that have publicly available data. Only 18 of the monitor wells have groundwater elevation data that were not collected under confidentiality agreements. The lack of publicly available groundwater level data for the Paso Robles Formation Aquifer is a significant data gap.

Figure 5-9 through Figure 5-11 show example hydrographs for wells located in the Estrella, Shandon, and Creston subareas of the Paso Robles Subbasin. Wells with publicly available data do not exist in the San Juan subarea. Long-term groundwater elevation declines are evident on all three hydrographs. The magnitude of measured declines over the period of record is generally more than 50 feet at well 25S/12E-06L01, 26S/15E-20B02, and 27S/13E-28F01.

The hydrographs show periods of climatic variations grouped by the following designations: wet, dry, or average/alternating wet and dry. Precipitation data were reviewed and analyzed to determine the occurrence and duration of wet and dry periods for the Paso Robles Subbasin. Precipitation from the Paso Robles weather station (NOAA station 46730) was used for this analysis because it is representative of conditions in the Subbasin and has the longest period of record of any station in the Subbasin. Figure 5-12 shows total annual precipitation by water year recorded at the Paso Robles station. Mean annual precipitation over the period 1925 to 2017 was 14.6 inches.

Wet and dry periods were determined based on a calculation and review of the Standardized Precipitation Index (SPI), which quantifies deviations from normal precipitation. The SPI was calculated at 1-, 2-, and 5-year time scales using the SPI Generator Tool developed by the National Drought Mitigation Center (NDMC, 2018). The 5-year, or 60-month SPI was selected as representative of multi-year meteorological fluctuations in the basin based on review of the data and computed SPI time series. For a given water year, the 60-month SPI quantifies the wetness or dryness of the preceding 60 months relative to the overall period of record. The annual time-series of the 60-month SPI was reviewed and generalized to determine wet and dry periods from 1930 to 2017 (Figure 5-12). A third category, "Average/alternating", is included for years during which the preceding 60-month period does not show a strong and persistent deviation from normal precipitation.

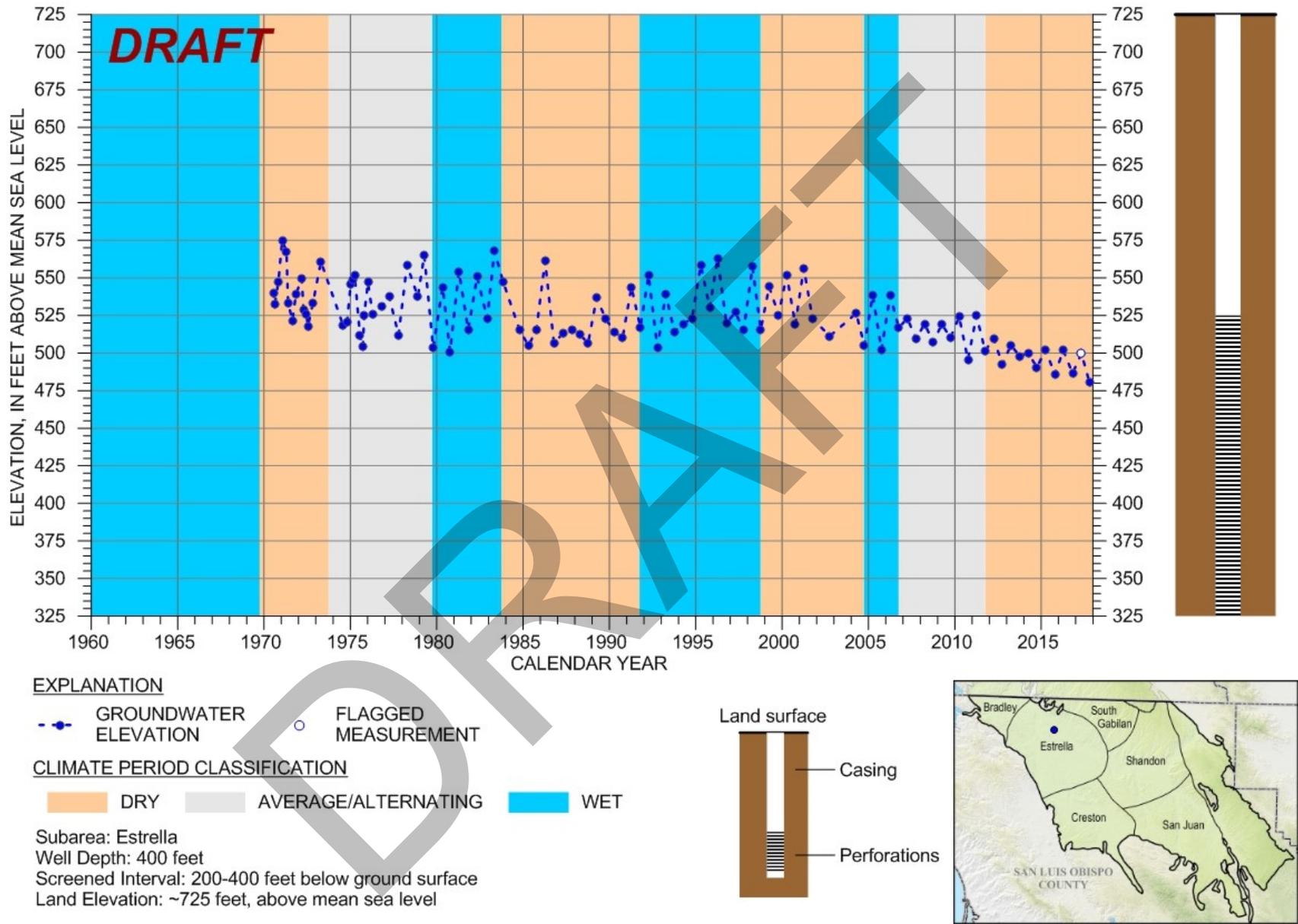


Figure 5-9. Groundwater Elevation at Paso Robles Formation Aquifer Well 25S/12E-26L01

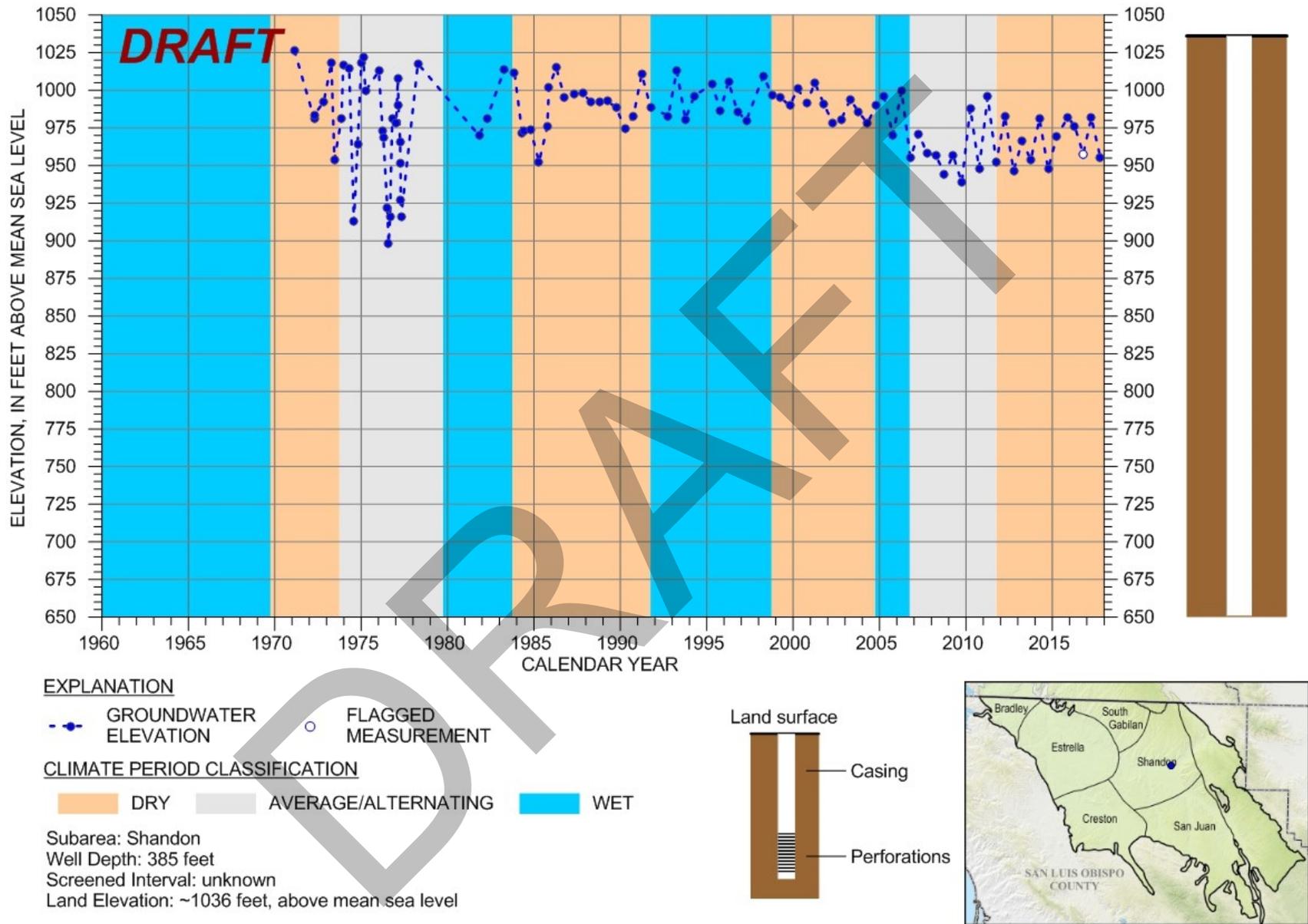


Figure 5-10. Groundwater Elevation at Paso Robles Formation Aquifer Well 26S/15E-20B02

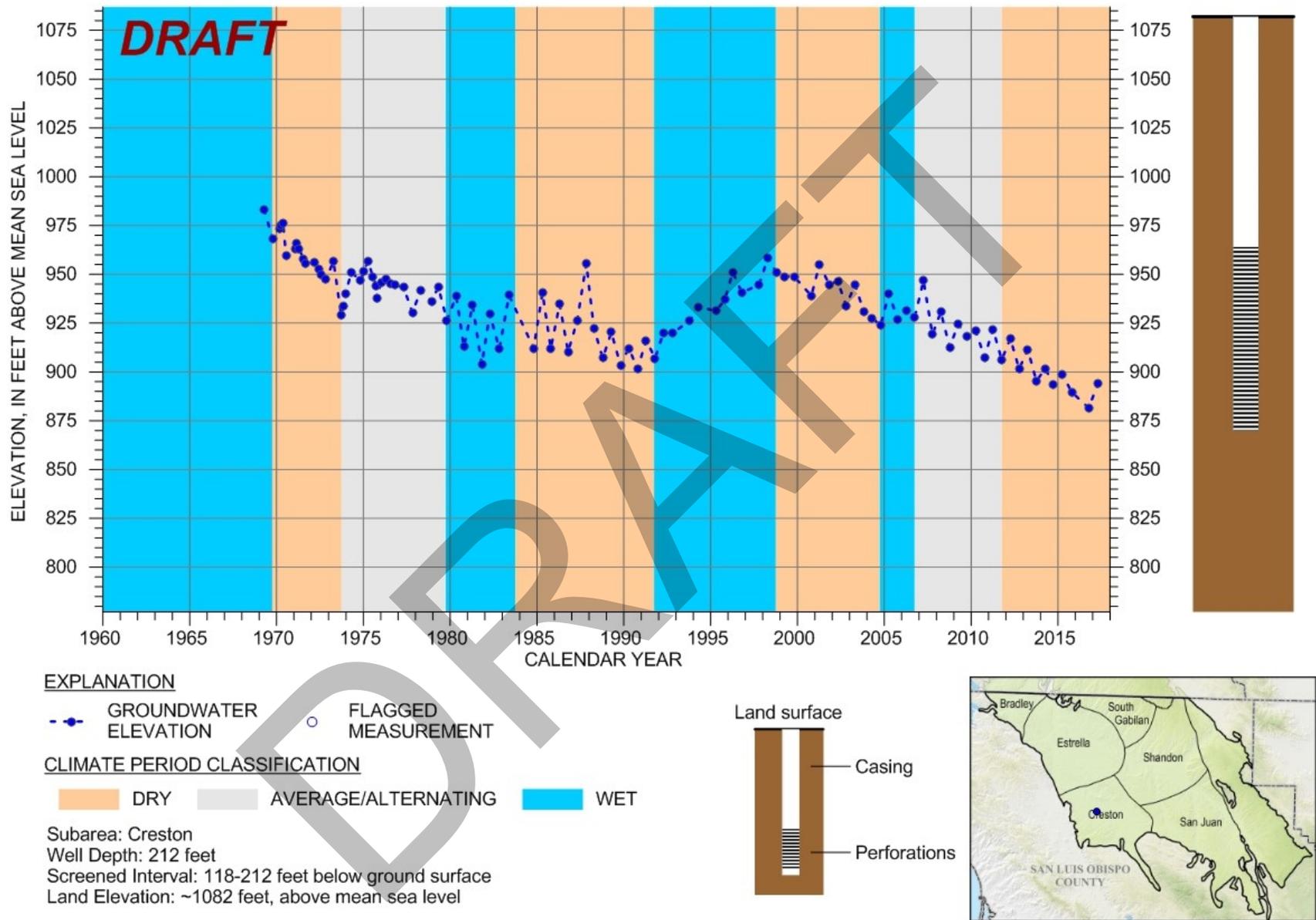


Figure 5-11. Groundwater Elevation at Paso Robles Formation Aquifer Well 27S/13E-28F01

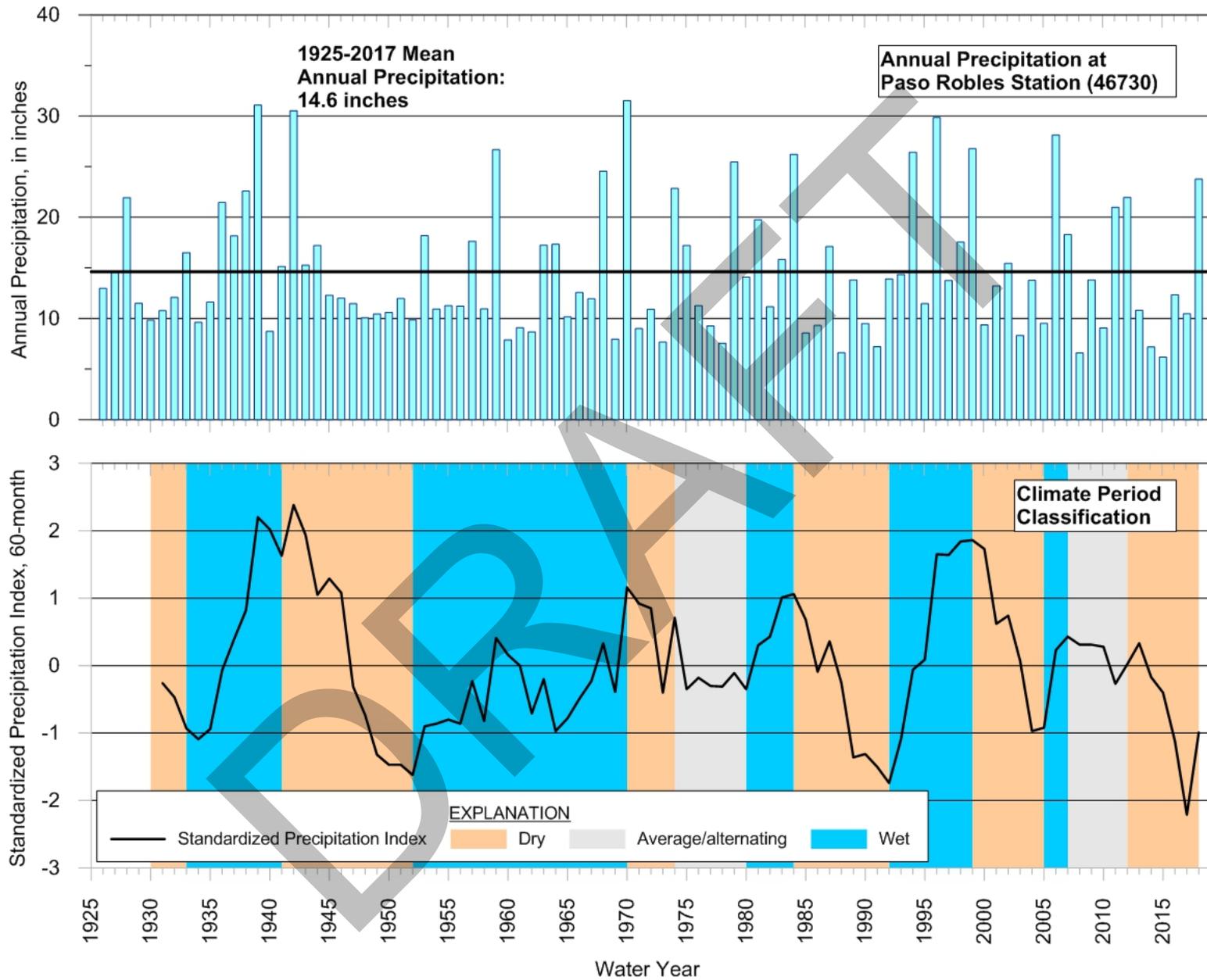


Figure 5-12. Climatic Periods in the Paso Robles Subbasin

5.1.3 VERTICAL GROUNDWATER GRADIENTS

Limited data exist to assess vertical groundwater gradients. Previous hydrologic studies of the Subbasin indicate that groundwater elevations are generally higher in the Alluvial Aquifer than the underlying Paso Robles Formation Aquifer, resulting in groundwater flow from the Alluvial Aquifer to the underlying Paso Robles Formation aquifer (Fugro, 2005). The *Paso Robles Groundwater Basin Study, Phase II* (Fugro, 2005) stated that there is an assumed upward vertical groundwater gradient near the northern portion of the Subbasin, although data were not provided to verify this assumption.

Vertical groundwater gradients can be estimated from nested or clustered wells. Wells 25S/12E-16K04, K05, and K06 are nested and provide groundwater elevation data from different depths in the Paso Robles Formation Aquifer near San Miguel. These wells are adjacent to a water supply well and therefore the vertical groundwater gradients may reflect local pumping conditions rather than broad, regional conditions. Hydrographs for these wells are shown on Figure 5-13. On this figure, groundwater levels in the shallowest well are shown with a green line, groundwater levels in the middle depth well are shown with a yellow line, and groundwater levels in the deepest well are shown with a red line. Prior to 2002, groundwater levels in the deepest well (red line) were generally higher than the groundwater levels in the middle and shallow wells, indicating an upward vertical groundwater gradient. A consistent vertical groundwater gradient is not apparent between the shallow and middle wells prior to 2002; groundwater elevations in the shallow and middle depth wells fluctuate around each other. After 2012, groundwater elevations in the deepest well were usually similar to or below the groundwater elevations in the shallow and middle depth wells; indicating a downward vertical groundwater gradient.

25S12E-16K0(4-6) Nested Well Hydrograph

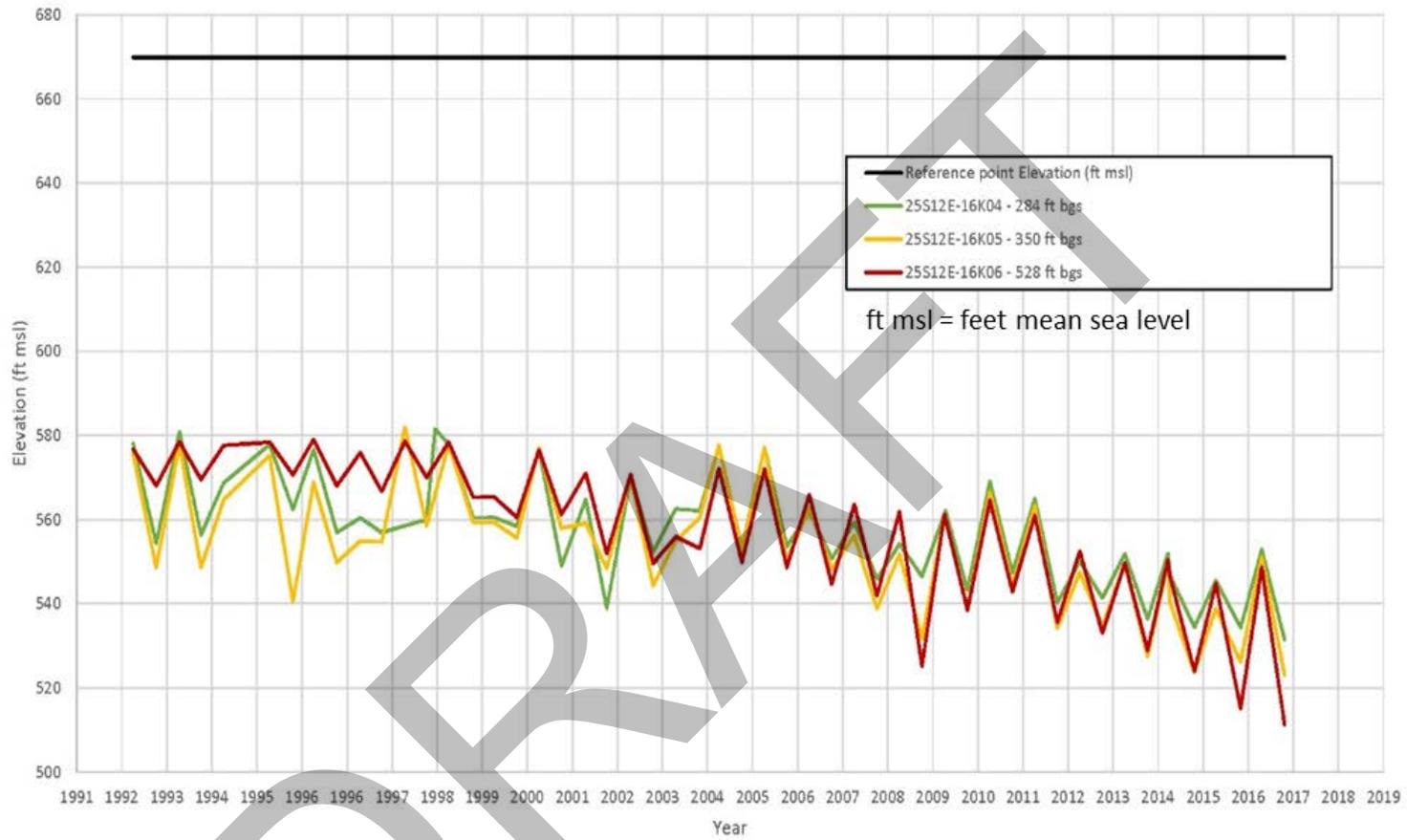


Figure 5-13. Vertical Groundwater Gradients near San Miguel

5.2 CHANGE IN GROUNDWATER STORAGE

This section summarizes changes in groundwater storage in the Subbasin within the GSP area. Change in groundwater storage was estimated for water years 1981 through 2016 using the updated Paso Robles Subbasin groundwater model.

5.2.1 ALLUVIAL AQUIFER

Figure 5-14 shows the cumulative change in groundwater storage for water years 1981 through 2016 for the Alluvial Aquifer. The period from 1981 through 2011 is considered representative on long-term hydrologic conditions prior to the drought period of 2012 through 2016. The graph also shows the estimated annual groundwater pumping derived from the updated groundwater model and wet, dry, and average/alternating climatic periods based on the analysis presented in Section 5.1.2.2.

Over the period 1981 through 2011, the model indicates no net change in storage occurred in the Alluvial Aquifer. This projection is consistent with the observed stable groundwater elevations in hydrographs for wells screened in the Alluvial Aquifer. During the drought period 2012 through 2016, the model suggests a loss of groundwater in storage in the Alluvial Aquifer of about 50,000 acre-feet (AF).

As indicated on, a decrease in groundwater storage generally occurs during dry periods and an increase in groundwater storage generally occurs during wet periods. During the period 1981 through 2011, estimated groundwater pumping from the Alluvial Aquifer decreased from about 6,000 acre-feet per year (AFY) to about 2,000 AFY as indicated by the black bars on Figure 5-14. This suggests that the loss in groundwater storage is not due to increased pumping, but is more likely a result of lack of recharge during low precipitation years. A secondary cause for the storage loss might be increased downward flow from the Alluvial Aquifer into the Paso Robles Aquifer during this period, although this is difficult to definitively assess from the data.

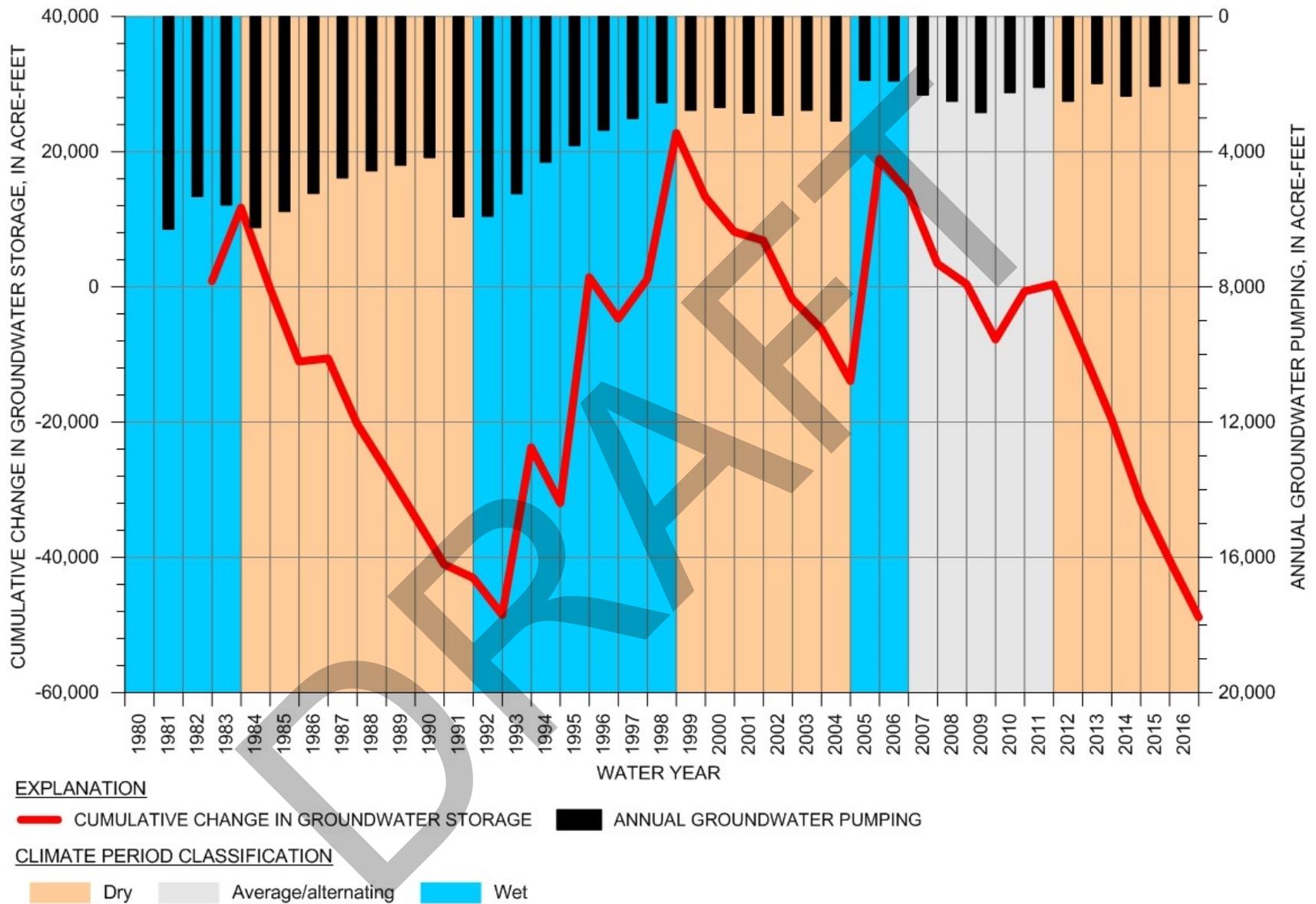


Figure 5-14. Estimated Cumulative Change in Groundwater Storage in Alluvial Aquifer

5.2.2 PASO ROBLES FORMATION AQUIFER

Figure 5-15 shows precipitation data and the cumulative change in groundwater storage for water years 1981 through 2016 for the Paso Robles Formation Aquifer. The graph also shows the annual groundwater pumping and water year type. The climatic variation shown on Figure 5-15 is the same climatic variation developed on Figure 5-12. Over the period 1981 through 2011, approximately 170,000 AF were removed from storage in the Paso Robles Formation Aquifer. Over the period 1981 through 2016, approximately 440,000 AF were removed from storage in the Paso Robles Formation Aquifer. Depletion of groundwater storage generally occurs during dry periods and increases in groundwater storage generally occur during wet periods, as indicated on Figure 5-15. Groundwater pumping decreased during the period from 1981 to 1999 and generally increased from 1999 to 2016. The loss in groundwater storage appears to be from a combination of increased pumping since 1999 and a number of dry years with limited recharge.

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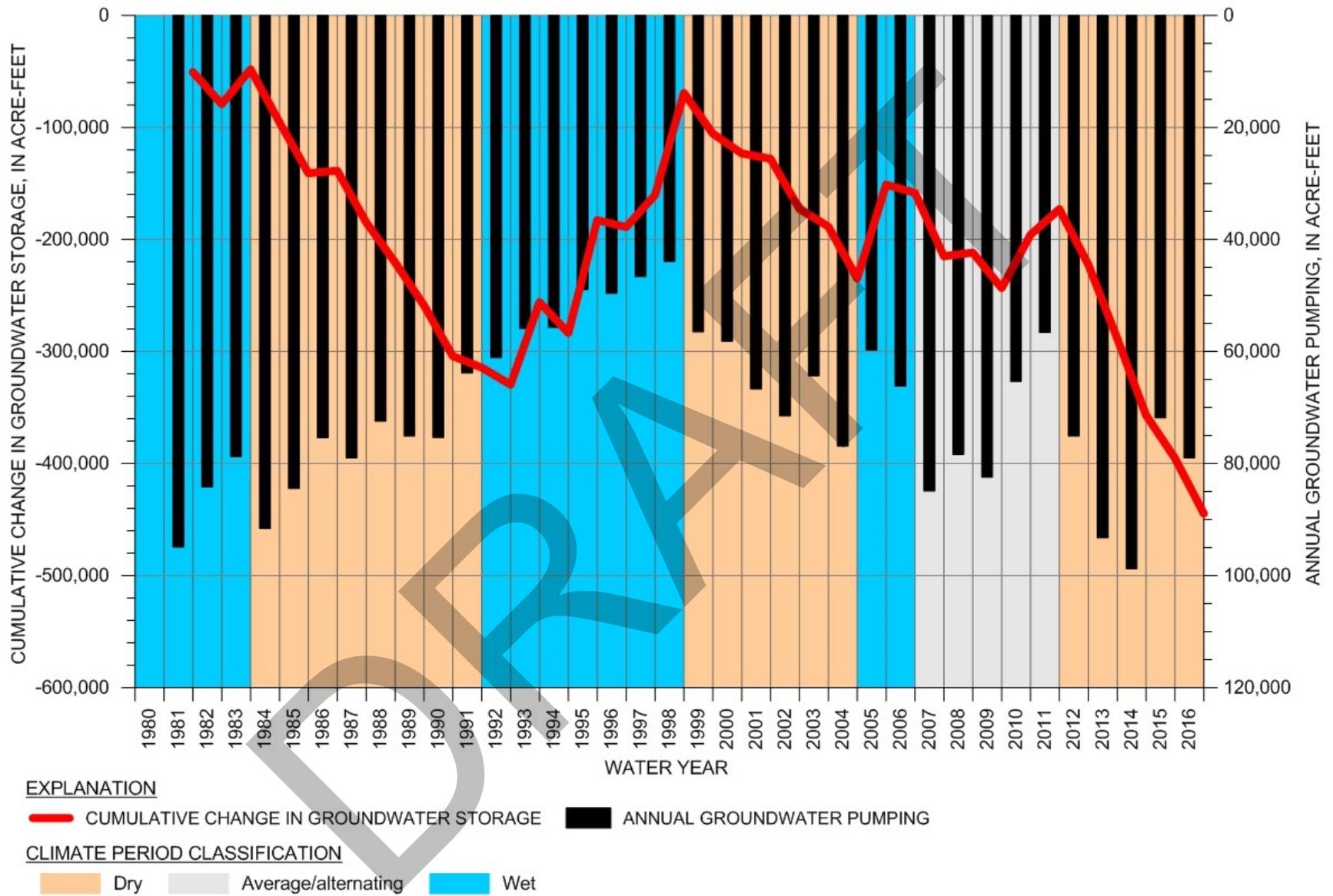


Figure 5-15. Estimated Cumulative Change in Groundwater Storage in Paso Robles Formation Aquifer

5.3 SEAWATER INTRUSION

Seawater intrusion is not an applicable sustainability indicator for the Subbasin. The Subbasin is not adjacent to the Pacific Ocean, a bay, or inlet.

5.4 SUBSIDENCE

Land subsidence is the lowering of the land surface. While several human-induced and natural causes of subsidence exist, the only process applicable to the GSP is subsidence due to lowered groundwater elevations caused by groundwater pumping.

Direct measurements of subsidence have not been made in the Subbasin using extensometers or repeat benchmark calibration; however, interferometric synthetic aperture radar (InSAR) has been used in the area to remotely map subsidence. This technology uses radar images taken from satellites that are used to create maps of changes in land surface elevation. The studies done in the area show that a localized area three miles northeast of the City of Paso Robles had a downward displacement of 0.6 to 2.1 inches between Spring 1997 and Fall 1997 (Valentine, D. W. et al., 2001).

5.5 INTERCONNECTED SURFACE WATER

Limited and ephemeral surface water flows in the Subbasin over the last 40 years make it difficult to study the interconnectivity of surface water and groundwater and to quantify the degree to which surface water depletion has occurred. The spatial extent of interconnected surface water was evaluated based on results from the basin-wide groundwater flow model of the Paso Robles Subbasin. In accordance with the SGMA emergency regulations §351 (o), "Interconnected surface water refers to 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". We estimated which surface water bodies are interconnected by comparing simulated groundwater elevations in the Alluvial Aquifer and Paso Robles Formation Aquifer with the elevation of the stream or river bottom. If model-simulated groundwater elevations in any aquifer were above the bottom of the stream or river for at least half of the time between 2010 and 2016, then the surface water was considered interconnected with the groundwater. This concept is illustrated in Figure 5-16. In this figure, both diagrams A and B represent interconnected surface waters. Diagram C shows non-interconnected surface water.

Figure 5-17 shows the extent of interconnected surface water for Water Years 2010 through 2016 based on this model evaluation.

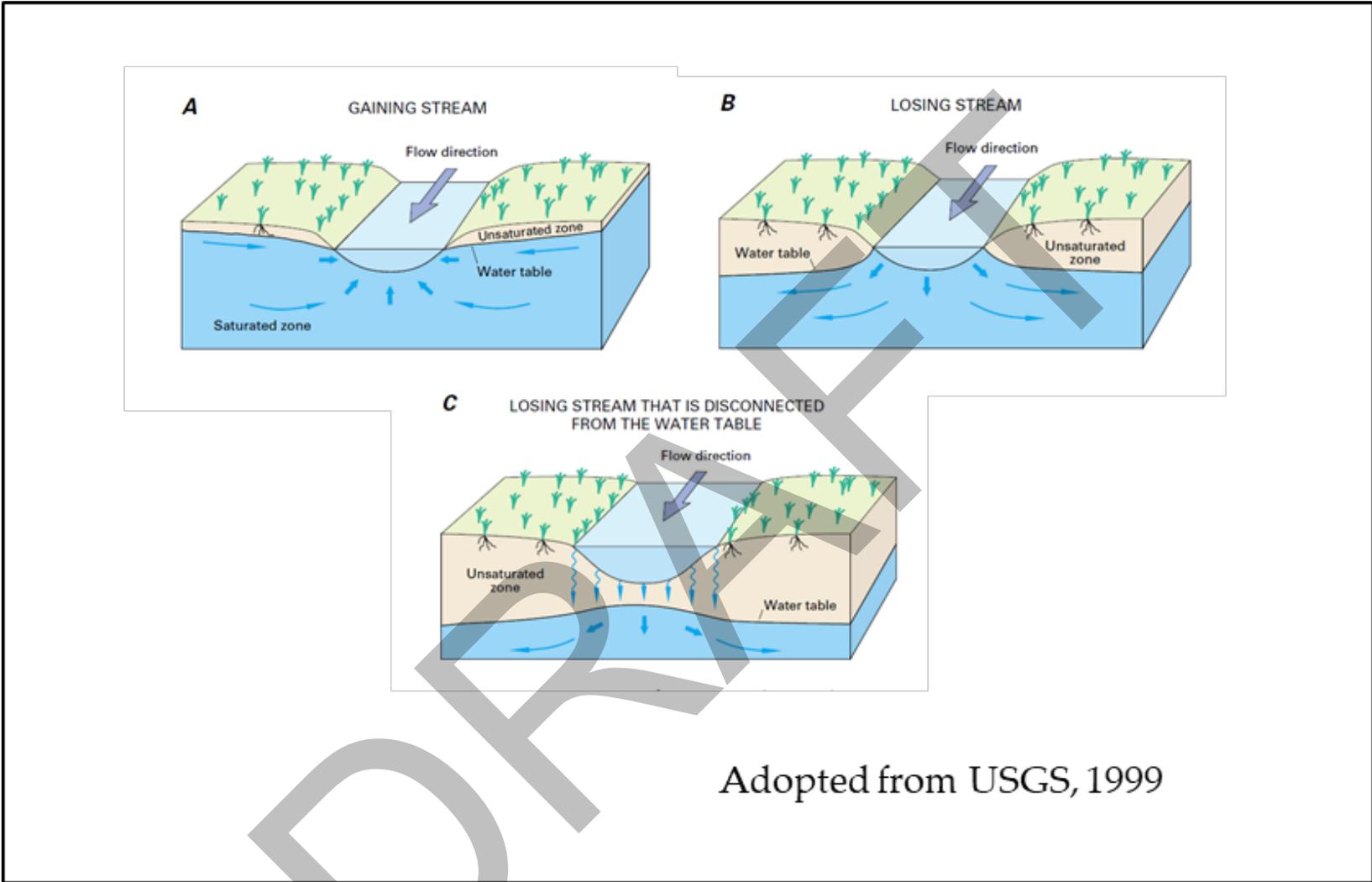


Figure 5-16. Interconnected and Non-Interconnected Surface Waters

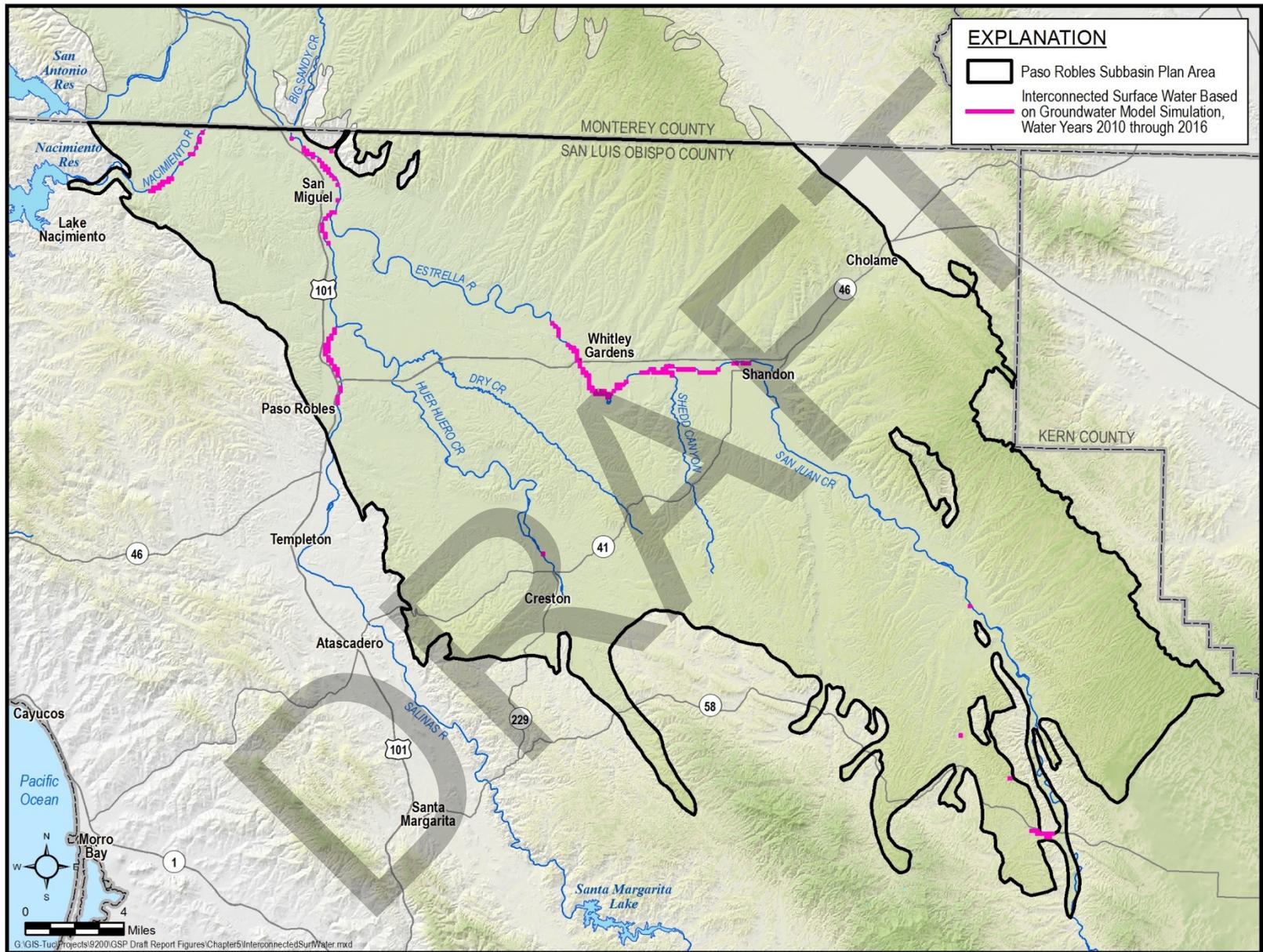


Figure 5-17. Locations of Interconnected Surface Waters

5.5.1 DEPLETION OF INTERCONNECTED SURFACE WATER

Groundwater withdrawals are balanced by a combination of reductions in groundwater storage and changes in the rate of exchange across hydrologic boundaries. In the case of surface water depletion, this rate change could be due to reductions in rates of groundwater discharge to surface water, and increased rates of surface water percolation to groundwater. These two changes together comprise the amount of surface water depletion.

Depletion of interconnected surface water was estimated by evaluating the change in the modeled stream leakage with and without pumping. A model simulation was run without groundwater pumping and was compared to the existing model with groundwater pumping. The difference in stream depletion between the two models is the depletion caused by the groundwater pumping. The stream depletion differences are only estimated for the interconnected segments identified in Figure 5-17. The methodology for quantifying stream depletion is described in detail by Barlow and Leake (2012).

Figure 5-18 shows the estimated annual depletion of the interconnected surface water along the stream segments shown in Figure 5-17 due to groundwater pumping. During the period Water Years 1991 to 2011, mean annual surface water depletion was about 7,600 AFY. During the period of time representative of current conditions (Water Year 2012 through 2016), mean annual surface water depletion was about 8,500 AFY.

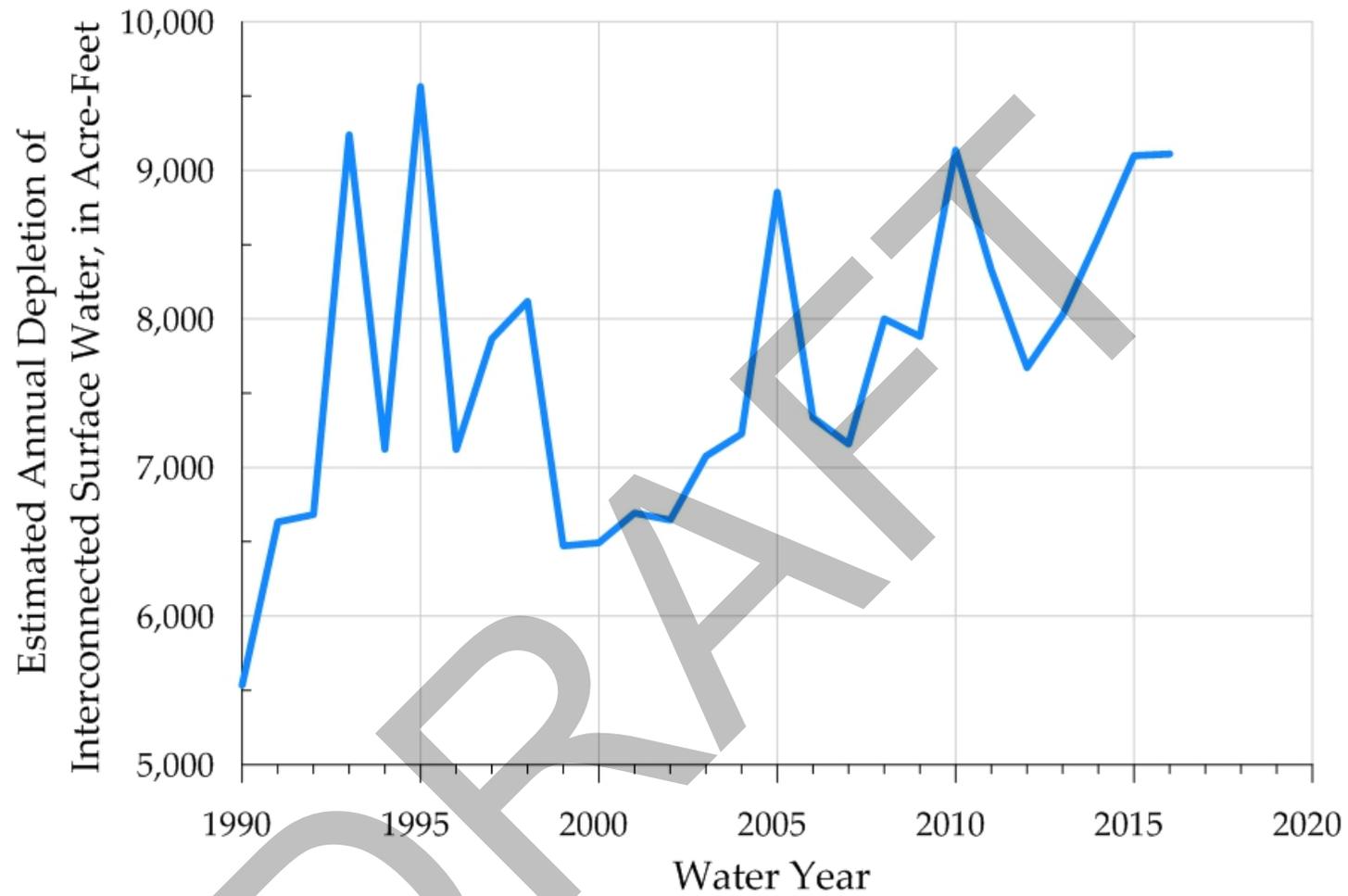


Figure 5-18. Estimated Annual Depletion of Interconnected Surface Water

5.6 GROUNDWATER QUALITY DISTRIBUTION AND TRENDS

Groundwater quality samples have been collected and analyzed throughout the Subbasin for various studies and programs. Water quality samples have been collected on a regular basis for compliance with regulatory programs. Additionally, a broad survey of groundwater quality sampling was conducted for the *Paso Robles Groundwater Basin Study, Phase I* (Fugro, 2002), and most recently by the USGS in 2018. Historical groundwater quality data were compiled for use in the Salt and Nutrient Management Plan (SNMP) (RMC, 2015).

5.6.1 GROUNDWATER QUALITY SUITABILITY FOR DRINKING WATER

Groundwater in the basin is generally suitable for drinking water purposes. The *Paso Robles Groundwater Basin Study, Phase I* (Fugro 2002) reviewed water quality data from public supply wells to identify exceedances of drinking water standards. The drinking water standards Maximum Contaminant Levels (MCLs) and Secondary MCLs (SMCLs) are established by Federal and State agencies. MCLs are legally enforceable standards, while SMCLs are guidelines established for nonhazardous aesthetic considerations such as taste, odor, and color. The most common water quality standard exceedance in the Subbasin was exceedance of the SMCL for total dissolved solids, which exceeded the standard in 14 samples from the 74 samples. Nitrate also exceeded the MCL in four samples. One exceedance of mercury was found in the San Miguel area in a 1990 sample.

5.6.2 GROUNDWATER QUALITY SUITABILITY FOR AGRICULTURAL IRRIGATION

Groundwater in the basin is generally suitable for agricultural purposes. Fugro (2002) evaluated the agricultural suitability of groundwater using three metrics:

1. Salinity as indicated by electrical conductivity;
2. Soil structure as indicated by sodium absorption ratio and electrical conductivity; and
3. Presence of toxic salts as indicated by concentrations of sodium, chloride, and boron.

Of the 74 samples evaluated, 37 had no restrictions on irrigation use (Fugro, 2002). This does not imply that half of the groundwater in the basin is unsuitable for irrigation; only that half of the samples had some constituent that may restrict unlimited irrigation use. Most cases of slight to moderate restriction on irrigation use were due to sodium or chloride toxicity. Severe restrictions for 13 samples were generally the result of high sodium, chloride, or boron toxicity.

5.6.3 DISTRIBUTION AND CONCENTRATIONS OF POINT SOURCES OF GROUNDWATER CONSTITUENTS

Potential point sources of groundwater quality degradation were identified using the State Water Resources Control Board (SWRCB) Geotracker website. Waste Discharge permits were also reviewed from on-line regional SWRCB websites. Table 5-1 summarizes information from these websites. Figure 5-19 shows the location of potential groundwater contaminant point sources. Based on available information there are no mapped groundwater contamination plumes at these sites, although investigations are ongoing.

Table 5-1. Potential Point Sources of Groundwater Contamination

SITE NAME	SITE TYPE	CONSTITUENTS OF CONCERN (COCs)	STATUS
Former Chevron 9-0750	LUST Cleanup Site	petroleum hydrocarbons	Remedial action plan submitted Q2 2018
Kirkpatrick Property (Unocal Portion)	Cleanup Program Site	crude oil	Impacted soil; health risk assessment prepared in 2016
Lucy Brown Road Pipeline Site (Former ConocoPhillips Site #3469)	Cleanup Program Site	crude oil, diesel, gasoline	Initial groundwater monitoring data no significant impacts to groundwater.
Estrella Airfield (Paso Robles Municipal Airport)	Military Cleanup Site	Unknown	Unknown
Camp Roberts Solid Waste Site	Land Disposal Site	metals, cyanide, sulfide, herbicides, volatile organic compounds (VOCs), pesticides, PCBs, phthalate esters, phenols, semi-VOCs	Total dissolved solids (TDS), nitrate and manganese detected in wells at concentrations above regulatory standards.
Camp Roberts South and Closed Landfill	Land Disposal Site	VOCs, chloride, sulfate, nitrate, sodium, manganese, TDS, total organic carbon	Carbon tetrachloride detected at concentrations exceeding MCL.
Paso Robles Solid Waste Site	Land Disposal Site	chloride, total alkalinity, manganese, nitrate, sodium, sulfate, temperature, TDS, VOCs, Pesticides, PCBs, organophosphorus compounds, herbicides, semi-VOCs	COCs not detected in groundwater; sulfate and barium locally elevated; no remedial activities.

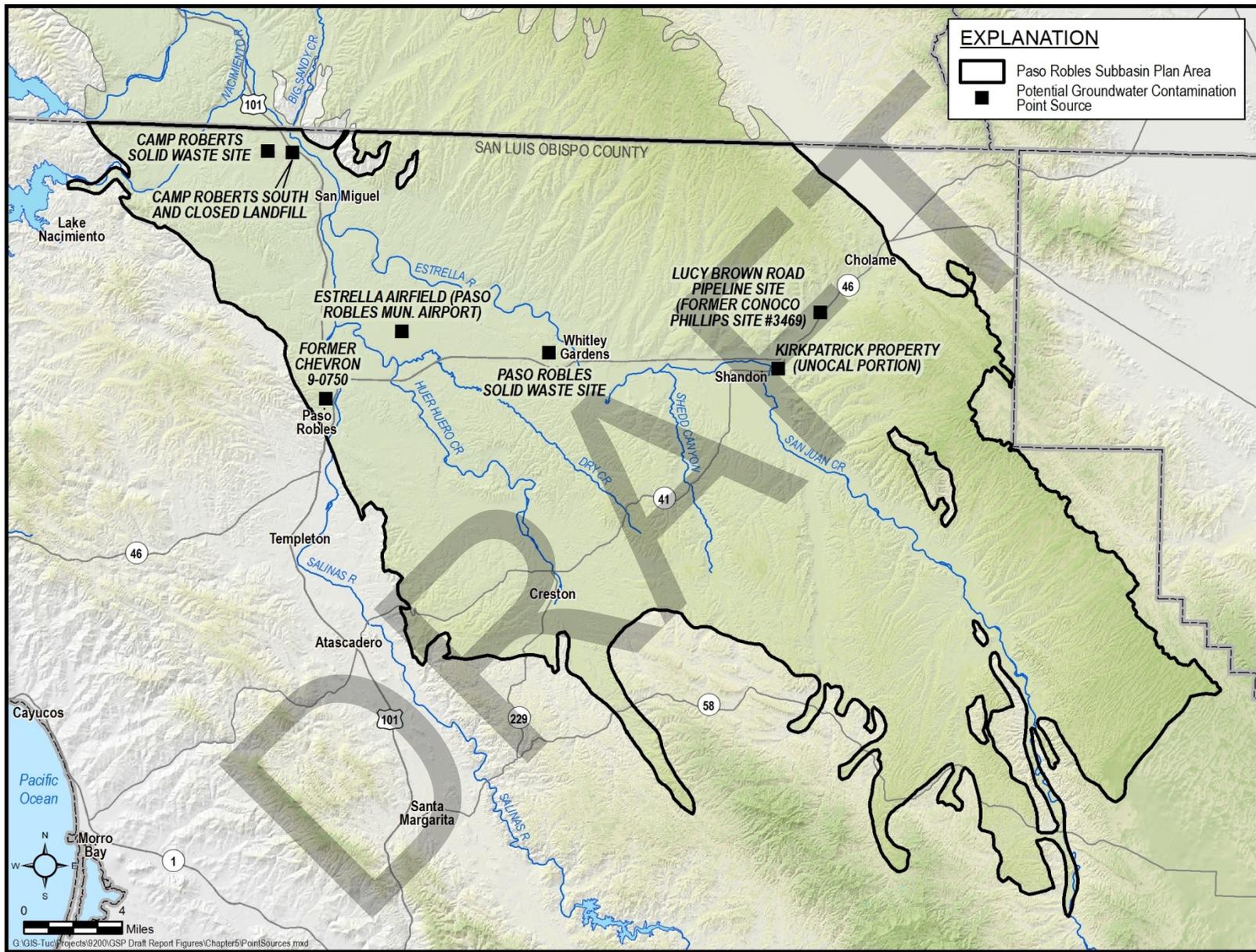


Figure 5-19. Location of Potential Point Sources of Groundwater Contaminants

5.6.4 DISTRIBUTION AND CONCENTRATIONS OF DIFFUSE OR NATURAL GROUNDWATER CONSTITUENTS

Fugro (2002) identified a number of constituents of concern that are broadly distributed throughout the Subbasin. The SNMP (RMC, 2015) provides additional data on the distribution of certain constituents. This GSP focuses only on constituents that might be impacted by groundwater management activities. The constituents discussed below are chosen because:

1. The constituent has either a drinking water standard or a known effect on crops.
2. Concentrations have been observed above either the drinking water standard or the level that affects crops.

5.6.4.1 TOTAL DISSOLVED SOLIDS

Total Dissolved Solids (TDS) is a constituent of concern in groundwater because it has been detected at concentrations greater than its SMCL of 500 milligrams per liter (mg/L). Table 5-2 shows the range and average TDS concentrations by subarea as reported in the SNMP (RMC, 2015). This table shows the average TDS concentrations are greater than the SMCL of 500 mg/L in parts of the Subbasin. This table includes data for portions of the Bradley, North Gabilan, and South Gabilan subareas that are outside the GSP area.

Table 5-2. TDS Concentration Ranges and Averages

Hydrogeologic Subarea	TDS Concentration Range (mg/L)	Average TDS Concentration (mg/L)
Estrella	350 – 1,560	552
Shandon	270 – 3,160	563
Creston	190 – 1,620	388
San Juan	160 – 2,170	425
Bradley	400 – 1,280	751
North Gabilan	370 – 1,320	856
South Gabilan	370 – 1,320	451

Source: RMC, 2015

The distribution and trends of TDS in the Subbasin are shown on Figure 5-20. This figure is from the SNMP (RMC, 2015) and includes portions of the Subbasin north of the Monterey County line which are outside the GSP area. The study area for the SNMP also did not extend as far southeast as the GSP area. TDS distribution shown on this figure is not differentiated by aquifer or well depth. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause TDS concentrations in groundwater in a well that would otherwise remain below the SMCL to increase above the SMCL.

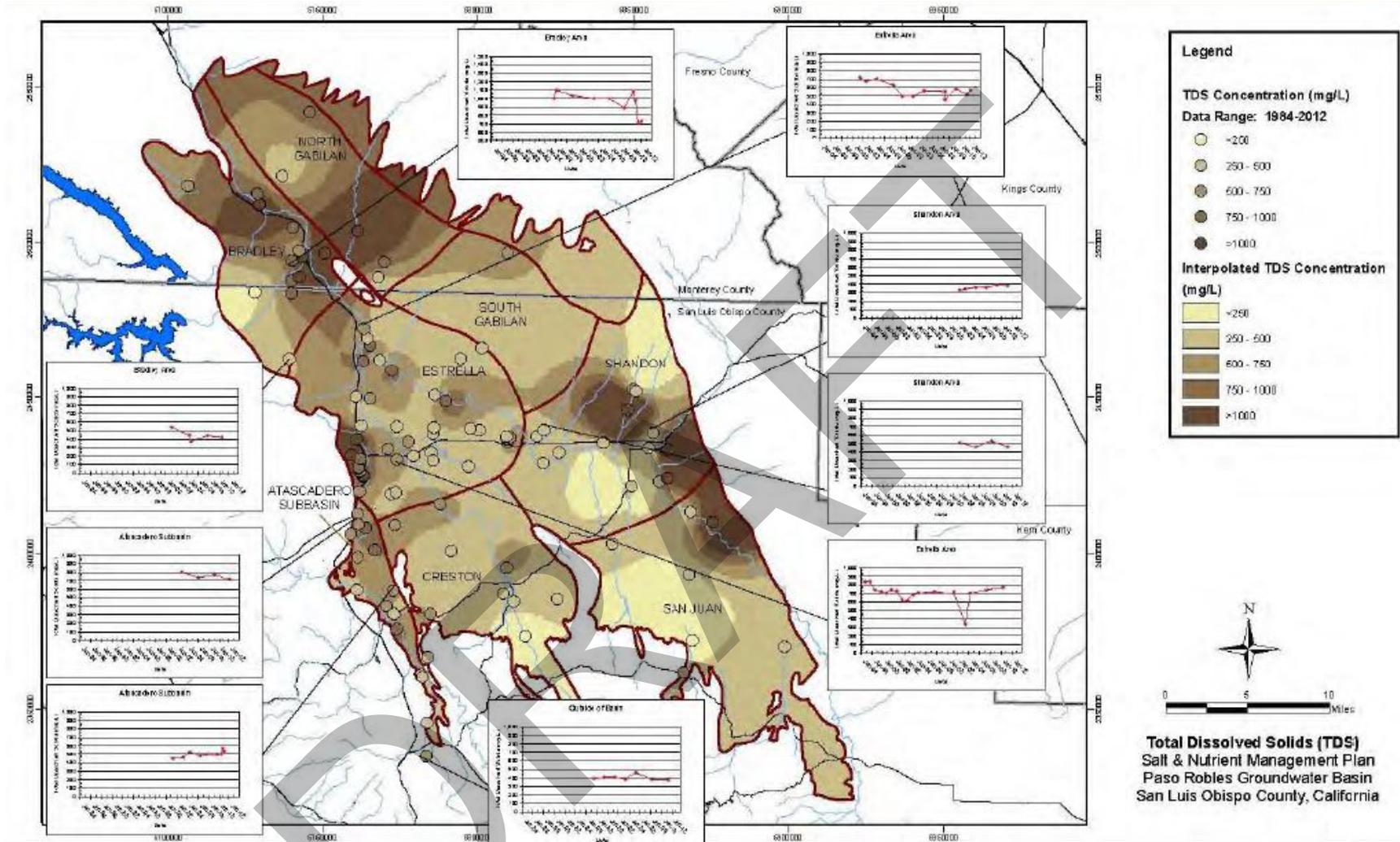


Figure 5-20. TDS Regional Distribution and Trends

Source: RMC, 2015

5.6.4.1 CHLORIDE

Chloride is a constituent of concern in groundwater because it has been detected at concentrations greater than its SMCL of 250 mg/L. Elevated chloride concentrations in groundwater can damage crops and affect plant growth. The *Paso Robles Groundwater Basin Study, Phase I* (Fugro 2002) reported that slight to moderate restrictions on irrigating trees and vines may occur when chloride concentrations exceed 100 mg/L. Severe restrictions on irrigating trees and vines may occur when chloride concentrations exceed 350 mg/L.

Table 5-3, which was compiled based on various tables and related information in the SNMP (RMC, 2015), shows the range and average chloride concentrations by subarea. This table indicates that average chloride concentrations are less than the SMCL of 250 mg/L throughout Subbasin. This table includes data for areas of the Bradley, North Gabilan, and South Gabilan subareas that are outside the GSP area.

Table 5-3. Chloride Concentration Ranges and Averages

Hydrogeologic Subarea	Chloride Concentration Range (mg/L)	Average Chloride Concentration (mg/L)
Estrella	32 - 572	94
Shandon	31 - 550	80
Creston	25 - 508	69
San Juan	13 - 699	64
Bradley	40 - 400	84
North Gabilan	35 - 209	113
South Gabilan	35 - 209	37

Source: RMC, 2015

The distribution and trends of chloride in the Subbasin are shown on Figure 5-21. This figure is from the SNMP (RMC, 2015) and includes portions of the Subbasin north of the Monterey County line which are outside the GSP area. Chloride distribution shown on this figure is not differentiated by aquifer or well depth. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause chloride concentrations in groundwater in a well that would otherwise remain below the SMCL to increase above the SMCL.

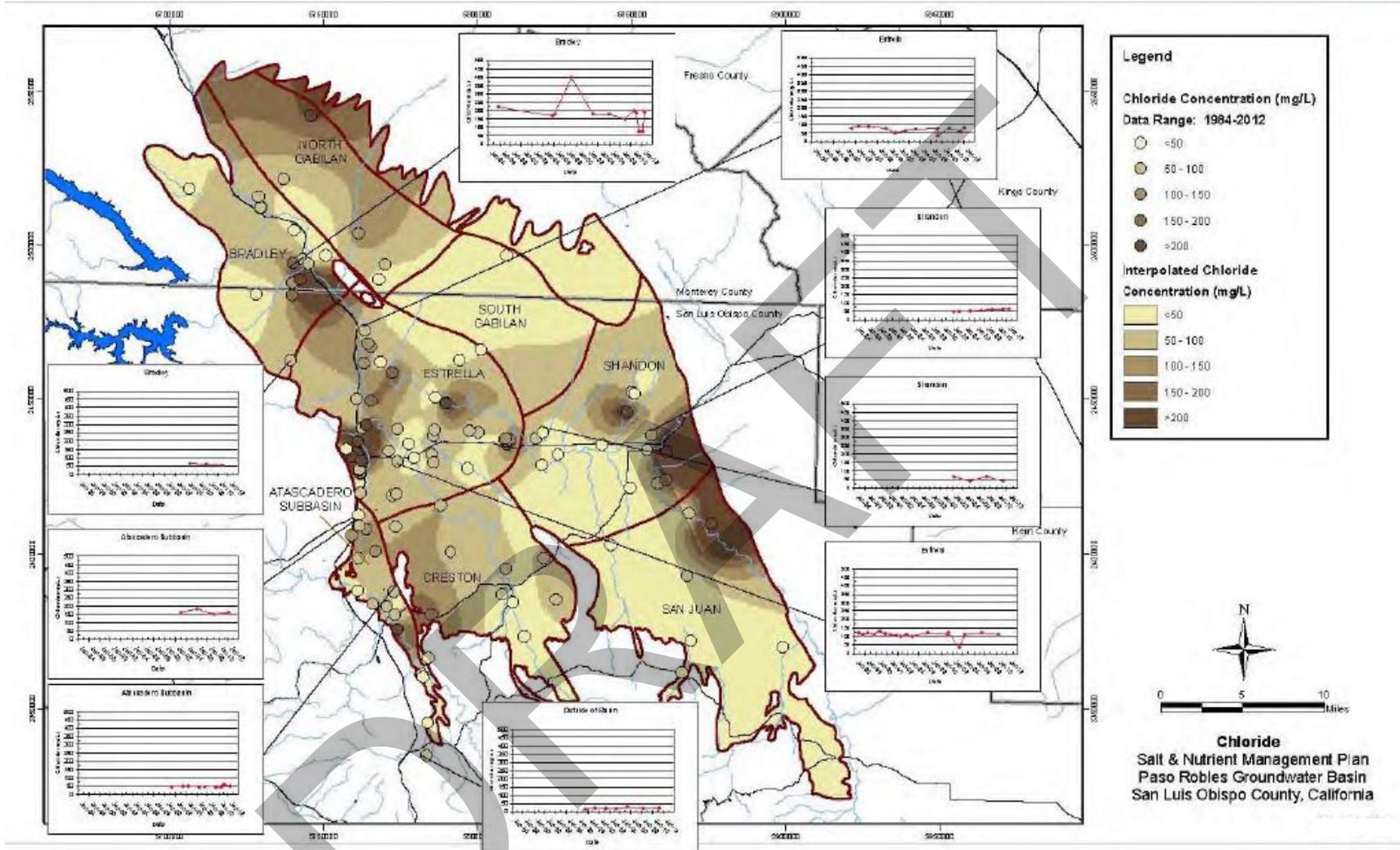


Figure 5-21. Chloride Regional Distribution and Trends

Source: RMC, 2015

5.6.4.2 SULFATE

Sulfate is a constituent of concern in groundwater because it has been observed at concentrations above its SMCL of 250 mg/L. Table 5-4 shows the range and average sulfate concentrations by subarea as reported in the SNMP (RMC, 2015). This table shows the average sulfate concentrations are greater than the SMCL of 250 mg/L in many areas of the Subbasin. This table includes data for areas of the Bradley, North Gabilan, and South Gabilan subareas that are outside the GSP area.

Table 5-4. Sulfate Concentration Ranges and Averages

Hydrogeologic Subarea	Sulfate Concentration Range (mg/L)	Average Sulfate Concentration (mg/L)
Estrella	11 - 375	129
Shandon	14 - 2,010	360
Creston	7 - 353	67
San Juan	24 - 722	248
Bradley	30 - 704	296
North Gabilan	9 - 648	194
South Gabilan	9 - 648	194

Source: RMC, 2015

Maps of sulfate distribution in the Subbasin were not found in previous studies. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause sulfate concentrations in groundwater in a well that would otherwise remain below the SMCL to increase above the SMCL.

5.6.4.3 NITRATE

Nitrate is a constituent of concern in groundwater because concentrations have been detected greater than its MCL of 10 mg/L (measured as nitrogen). Nitrate concentrations in excess of the MCLs can result in health impacts.

Table 5-5 shows the range and average nitrate concentrations by subarea as reported in the SNMP (RMC, 2015). This table shows the average nitrate concentrations are less than the MCL of 10 mg/L throughout Subbasin. The range of measured nitrate concentrations however exceeds the MCL of 10 mg/L in every subarea. This table includes data for areas of the Bradley, North Gabilan, and South Gabilan subareas that are outside the GSP area.

Table 5-5. Nitrate Concentration Ranges and Averages

Hydrogeologic Subarea	Nitrate Concentration Range (mg/L)	Average Nitrate Concentration (mg/L)
Estrella	0 – 16.2	2.5
Shandon	1.2 – 12.1	4.6
Creston	0.8 – 9.2	3.2
San Juan	0.1 – 5.8	2.8
Bradley	0.0 – 5.8	2.7
North Gabilan	5.0 – 9.8	8.4
South Gabilan	15.8	6.3

Source: RMC, 2015; data are from Table 3-12; the range of nitrate concentration in the South Gabilan subarea is uncertain

The distribution and trends of nitrate in the Subbasin are shown on Figure 5-22. This figure is from the SNMP (RMC, 2015) and includes portions of the Subbasin north of the Monterey County line which are outside the GSP area. This nitrate distribution shown on this figure is not differentiated by aquifer or well depth. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause nitrate concentrations in groundwater in a well that would otherwise remain below the SMCL to increase above the SMCL.

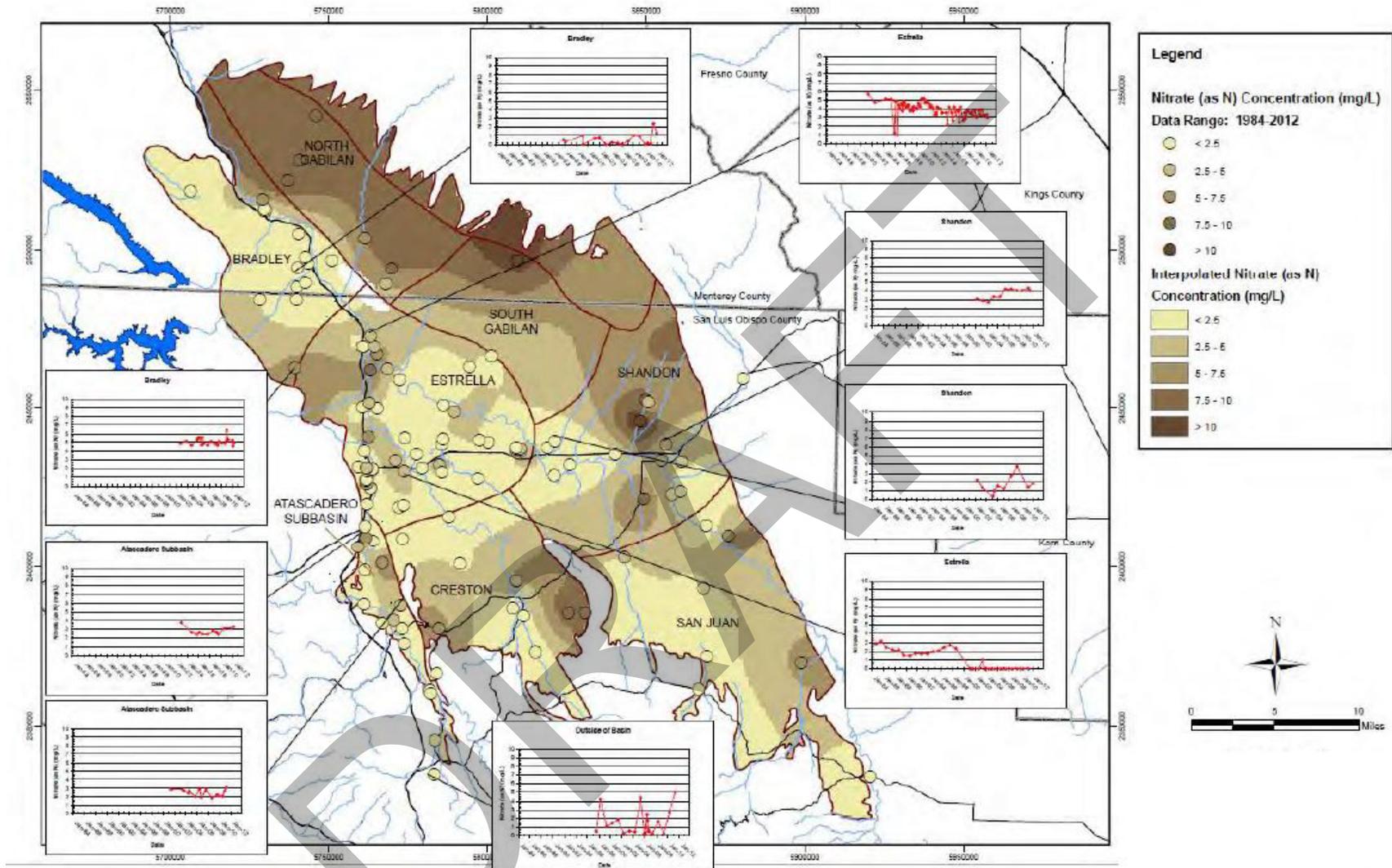


Figure 5-22. Nitrate Regional Distribution and Trends

Source: RMC, 2015. Figure 3-10

5.6.4.4 BORON

Boron is an unregulated constituent and therefore does not have a regulatory standard. However, boron is a constituent of concern because elevated boron concentrations in water can damage crops and affect plant growth. The *Paso Robles Groundwater Basin Study, Phase I* (Fugro 2002) reported that severe restrictions on irrigating trees and vines may occur when boron concentrations exceed 0.5 mg/L.

Table 5-6 shows the range and average boron concentrations by subarea as reported in the SNMP (RMC, 2015). Average boron concentration exceeds the severe irrigation restriction level of 0.5 mg/L in the Estrella, Shandon, and San Juan subareas. The table includes data for areas of the Bradley, North Gabilan, and South Gabilan subareas that are outside the GSP area.

Table 5-6. Boron Concentration Ranges and Averages

Hydrogeologic Subarea	Boron Concentration Range (mg/L)	Average Boron Concentration (mg/L)
Estrella	0.13 – 5.66	1.8
Shandon	0.08 – 2.97	0.81
Creston	0.06 – 0.31	0.14
San Juan	0.08 – 2.29	0.74
Bradley	0.12 – 0.18	0.15
North Gabilan	0.11 – 0.44	0.24
South Gabilan	0.11 – 0.44	0.24

Source: RMC, 2015

Maps of boron distribution in the Subbasin were not found in previous studies. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause boron concentrations in groundwater in a well that would otherwise remain below the SMCL to increase above the SMCL.

5.6.4.5 GROSS ALPHA RADIATION

Gross alpha radiation is a constituent of concern because it has been detected at concentrations greater than its MCL of 15 picocuries per liter (pCi/L). Fugro (2002) reports that gross alpha radioactivity is present in most areas of the basin. Gross alpha particle count activity in groundwater exceeded the MCL for drinking water in the Estrella and Bradley areas. Gross alpha data included in Fugro's 2002 report are summarized in Table 5-7.

Table 5-7. Gross Alpha Concentration Ranges and Averages

Hydrogeologic Subarea	Gross Alpha Maximum Concentration (pCi/L)	Gross Alpha Average Concentration (pCi/L)
Estrella	31	20
Shandon	3	3
Bradley	23	2

Source: Fugro, 2002

No maps exist of the gross alpha distribution in the Subbasin. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause gross alpha radiation concentrations in groundwater in a well that would otherwise remain below the SMCL to increase above the SMCL.

5.6.5 GROUNDWATER QUALITY SURROUNDING THE PASO ROBLES SUBBASIN

Poor quality groundwater has been documented in wells that screen sediments and rocks below the Paso Formation as well as sediments and rocks surrounding the Subbasin. Based on limited observations, there is a concern that this poor quality groundwater may be drawn into wells in the Subbasin and degrade the groundwater quality if groundwater levels are allowed to fall too low. Groundwater levels must be maintained at elevations that prevent migration of poor quality groundwater from beneath or around the Subbasin.