- Future water levels projected through 2096 in the UWCD 2070CF model do not go below historical lows, thereby minimizing the potential for subsidence.

The FPBGSA can use a variety of monitoring techniques for subsidence:

Water Levels: There is an extensive historical water level database in these basins and it is expected that a robust monitoring program will continue into the future. These datasets can be used to identify when, or if, the water levels are approaching the estimated historical low water levels. Based on historical and projected future groundwater level trends, the basins are at low risk for water level declines that would suppress water levels to elevations lower than the estimated historical lows.

Geodetic / InSAR data: The available geodetic and InSAR datasets are effective monitoring tools that document current and recent (e.g., within the past year) subsidence. The DWR plans on continuing to provide InSAR subsidence data covering the groundwater basins, allowing a low-cost method of the monitoring future land surface elevation changes. Prevention of future inelastic subsidence is reliant on maintaining water levels above historical lows.

Based on the review of these readily available data sets, the susceptibility ranking is considered Low for both the Fillmore and Piru basins.

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Fillmore and Piru Basins
Groundwater Sustainability Agency

Appendix G

Summary of Past Groundwater Models and Water Budgets (United, 2020c)

SUMMARY OF PAST GROUNDWATER MODELS AND WATER BUDGETS FOR THE PIRU, FILLMORE, AND SANTA PAULA GROUNDWATER BASINS

United Water Conservation District
Open-File Report 2020-02
November 2020

WATER RESOURCES DEPARTMENT
UNITED WATER CONSERVATION DISTRICT

THIS REPORT IS PRELIMINARY AND SUBJECT TO MODIFICATION BASED UPON FUTURE ANALYSIS AND EVALUATIONS

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EXECUTIVE SUMMARY

This report summarizes the water budgets of the Piru, Fillmore, and Santa Paula groundwater basins based on major hydrologic investigations that have taken place over the past century. Reviewing these previous investigations related to numerical groundwater modeling and water budgets of the groundwater basins supports United's efforts in the expansion of United's active numerical groundwater flow model domain to include the remaining groundwater sub-basins of the Santa Clara River Valley within Ventura County, California.

Table E-1 summarizes the hydrologic investigations which contributed water budget components related to the Piru, Fillmore, and Santa Paula groundwater basins. Table E-2 summarizes the range of reported water budget component values for each of the groundwater basins which were presented in the previous hydrologic studies that are listed in Table E-1. The majority of the values presented in Table E-2 were extracted from a California Department of Water Resources (DWR, 1956) or Mann (1959), with other primary sources being CH2M HILL (2004, 2005), CH2M HILL and HydroGeoLogic (CH2M HILL/HGL, 2008), LWA and others (2015) and DBS&A and RCS (2017). Values of lower and upper ranges were sourced from all the investigations reported. Each of the reports used for this review are representative of varying, sometimes overlapping, climatic periods and conditions (Table E-1). Since the values reported from DWR (1956) and Mann (1959) provided the most complete summaries of water budgets, most of the lower and upper bounds of the reported range for many of the components, presenting the results in this way is considered appropriate, and helpful, for comparison purposes.

Reviewing previous water budget component estimates helps during numerical model development and calibration by confirming that values of various water budget components from the new model are reasonable, and that differences may be explained due to physical changes or processes considered. The numerical groundwater model expansion efforts further support United's ability of regional water management planning, with the most immediate need in supporting local Groundwater Sustainable Agencies (GSAs) in developing Groundwater Sustainability Plans (GSPs).

Based on this review, United offers the following conclusions related to the previous studies and reported water budgets for the Piru, Fillmore, and Santa Paula groundwater basins:

- There are extensive previous studies available for these basins that were based on field, analytical, and numerical studies, dating back to the 1920s (Table E-1).
- The most significant inflows to each basin consist of recharge from streamflow (Santa Clara River) percolation, areal recharge from precipitation and applied water from groundwater and surface water sources, and incoming subsurface underflow from upstream groundwater basins.
- The most significant outflows to each basin consist of groundwater extractions for beneficial use and outgoing subsurface underflow to downstream groundwater basins.

- With the Santa Clara River (SCR) being the largest source of recharge (especially for Piru and Fillmore Basins), these basins are highly variable due to the dependence on local rainfall within the SCR watershed. This variability and dependence on surface water inflows leads to the large range observed in the previously reported water budget components (Table E-2). This dependence to surface water flows is expected to continue in the future, resulting in variable water budgets of similar ranges.
- Basin boundary modifications have recently been adopted that expanded the extent of the Piru, Fillmore, and Santa Paula groundwater basins. The majority of the studies reviewed for this document utilized boundaries that captured most of the water-bearing and productive alluvial deposits and underlying aquifers along the valley floor, and the overall effect on the ranges for many of the water budget components is not expected to be significant. Changes to the upstream extent of the Piru basin will however result in an increase in the subsurface underflow into Piru basin from the east. This value is expected to increase using the Department of Water Resources (DWR, 2019) boundary moving forward due to the substantial increase in saturated aquifer thickness near the Los Angeles County line compared to the downstream locations used in previous studies. The increased area will also result in increased recharge to the underlying aquifers due to precipitation.

Table E-1: Chronology of hydrologic investigations which contributed water budget components related to Santa Clara River Valley groundwater basins (Piru, Fillmore, and Santa Paula).

Entity	Year Published	Reference	Budget Components Provided?	Representative Years
California Department of Public Works, Division of Water Resource[1]	1933	DWR, 1933	All, various	1927 - 1932
California State Water Resources Board[1]	1956	DWR, 1956	All, various	1936 - 1951
John F. Mann and Associates	1959	Mann, 1959	All, various	1936 - 1957
California Department of Water Resources	1974	DWR, 1974a	Piru, subsurface inflow	1956 - 1967
Law/Crandall Inc.	1993	Law/Crandall, 1993	Fillmore, subsurface outflow	1956 - 1990
United States Geological Survey	2003	Reichard and others, 2003	Fillmore, subsurface outflow	1984 – 1993
CH2M HILL	2004	CH2M HILL, 2004	Piru, subsurface inflow	1980 - 1999
CH2M HILL	2005	CH2M HILL, 2005	Piru, subsurface inflow	1980 - 2005
CH2M HILL/ HydroGeoLogic Inc; HydroMetrics (United-sponsored analysis)	2008	CH2M HILL/ HGL, 2008	Piru and Fillmore, subsurface inflow	1975 - 2005
HydroMetrics (United-sponsored updates)	2015	LWA and others, 2015	All, various	1996 - 2012
Steve Bachman	2015	Bachman, 2015	Fillmore, subsurface outflow	1947 - 2014
Daniel B. Stephens and Associates, Inc/ Richard C. Slade and Associates LLC	2017	DBS&A and RCS, 2017	Fillmore and Santa Paula, various	1999 - 2012

[1] One of the predecessor agencies to California's current Department of Water Resources (DWR). DWR was formed in 1956 with legislation that simultaneously dissolved the Water Project Authority and Division of Water Resources within the Department of Public Works as well as took over duties of a reconstituted State Water Resources Board (DWR, 2020).

Table E-2: Range of water budget components for the study area's groundwater basins that were presented in previous studies listed in Table E-1. Majority of values extracted from DWR (1956) or Mann (1959), with other references being CH2M HILL (2004, 2005), CH2M HILL/HGL (2008), LWA and others (2015) and DBS&A and RCS (2017). Values rounded to nearest 10 AF.

	Piru		***Fillmore***		***Santa Paula***	
Budget Components (AFY)	*Lower*	*Upper*	*Lower*	*Upper*	*Lower*	*Upper*
Inflows						
Subsurface underflow	240	18,800	12,570	111,210	3,900	30,910
Stream Percolation	6,400	61,850	1,790	49,130	4,210	24,440
Precipitation Recharge	190	20,200	470	54,200	40	25,590
Mountain Front Recharge	2,620	2,620	3,530	3,530	3,600	3,600
Managed Recharge	0	11,800	--	--	--	--
Local Wastewater Treatment Percolation Ponds	210	210	1,040	1,040	2,230	2,230
Imported	0	5,840	4,900	11,770	4,220	8,570
Outflows						
Subsurface underflow	12,570	111,210	3,900	30,910	1,800	7,350
Rising groundwater	0	37,800	6,030	48,200	2,040	17,340
Consumptive use*	6,450	15,000	20,590	36,200	15,420	33,730
Exported	2,200	6,450	0	5,160	310	2,100
Change in Groundwater Storage****	***-19,600***	***44,600***	***-20,170***	***49,300***	***-10,900***	***21,680***

*Of applied water and precipitation on basin (including phreatophytes)

**Reported changes in annual storage (not calculated from inflows and outflows presented here)

TABLE OF CONTENTS

TABLE OF FIGURES

(Figures begin on Page 56)

1 INTRODUCTION

United Water Conservation District (United) is a California special district (i.e., a public agency) with a service area of approximately 335 square miles (214,000 acres) of southern Ventura County. United's service area includes the Ventura County portion of the Santa Clara River Valley and much of the Oxnard coastal plain, including the lower part of the Calleguas Creek watershed, as shown on Figure 1-1. United serves as a steward for managing the surface water and groundwater resources within all or part of eight groundwater basins. It is governed by a seven-person board of directors elected by region, and receives revenue from property taxes, pump charges, recreation fees, and water delivery charges. United is authorized under the California Water Code to conduct water resource investigations, acquire water rights, build facilities to store and recharge water, construct wells and pipelines for water deliveries, commence actions involving water rights and water use, prevent interference with or diminution of stream/river flows and their associated natural subterranean supply of water, and to acquire and operate recreational facilities (California Water Code, section 74500 et al).

1.1 PURPOSE

This report summarizes the water budgets and hydrologic investigations of the Piru, Fillmore, and Santa Paula groundwater basins based on investigations that have taken place over the past century. The investigations described herein often included the Piru, Fillmore, and Santa Paula groundwater basins as parts of regional efforts to better understand the quantity of water resources available for current use and future planning. Other studies were motivated by water quality issues. The field investigations that took place in the earlier portion of the 20th century ultimately lead into numerical modeling development and additional field investigations that have estimated hydrologic components of the groundwater basins' water budgets over various periods of analysis.

Additionally, this report supports United's efforts in the expansion of United's active numerical groundwater flow model domain to include the remaining groundwater sub-basins of the Santa Clara River Valley within Ventura County, California. The basins are connected sub-basins in the larger groundwater system of the Santa Clara River Valley (DWR basin number 4-004), but the common vernacular is to refer to them as basins. United's groundwater flow model extension study area will include the remaining groundwater basins of the Santa Clara River Valley within Ventura County: Piru (DWR 4-004.06), Fillmore (DWR 4-004.05), and Santa Paula (DWR 4-004.04; Figure 1-2). The current effort of extending the numerical groundwater modeling builds from United's initial groundwater flow model development (UWCD, 2018) which included the coastal basins of the Santa Clara River Valley (Oxnard (DWR 4-004.02) and Mound (DWR 4-004.03)) as well as the Pleasant Valley groundwater basin (DWR 4-006) and a western portion of the Las Posas Valley groundwater basin (DWR 4-008). Following the completion of this model expansion, United’s numerical groundwater flow model will include all of its direct service area as well as portions of the adjacent region.

1.2 PHYSICAL SETTING

The Santa Clara River is located in Southern California, with a total watershed area of approximately 1,625 square miles (Figure 1-3). The main channel is oriented east to west and runs approximately 83 miles from its headwaters along the northern slopes of the San Gabriel Mountains in Los Angeles County and through Ventura County until it meets the Pacific Ocean (Figures 1-2 and 1-3). The Santa Clara River is the largest river in the Southern California region that remains in a relatively natural state (Los Angeles Regional Water Quality Control Board [Regional Board], 2006). After flowing through the Santa Clarita Valley within Los Angeles County, the Santa Clara River then flows through a narrow and thin geologic constriction near the Ventura County line, where the river and minor groundwater underflow enters the Santa Clara River Valley within Ventura County. The Santa Clara River then flows down the valley through the alluvial Piru, Fillmore, and Santa Paula groundwater basins of Ventura County before entering the Oxnard and Mound basins near the Pacific Ocean.

The Santa Clara River watershed encompasses three significant tributary watersheds within Ventura County -- those of Piru, Sespe, and Santa Paula Creeks (Figure 1-3), which enter the Piru, Fillmore, and Santa Paula groundwater basins, respectively. Land surface elevations in the watershed range from sea level at the coast to nearly 8,850 feet at the headwaters of Piru Creek near the border between Ventura and Kern Counties. Much of the discharge in the Santa Clara River is derived from streamflow originating in the mountain regions drained by these tributaries. The flows within the Santa Clara River watershed is highly variable with nearly all of the flows coming during the winter and spring months.

Along the Santa Clara River Valley, the river is the primary source of recharge to the underlying groundwater basins. Beneficial users, such as agricultural, domestic, and municipal are wholly dependent upon the groundwater resources stored in the groundwater basins for their water supply, which are extracted with groundwater pumping wells. The alluvial groundwater basins of interest for this report contain about 29 miles of the main channel of the Santa Clara River and represent a total of 55,600 acres (86.8 mi^2) within Piru (10,900 acres, 17.0 mi^2); Fillmore (22,580 acres, 35.3 mi^2); and Santa Paula (22,110 acres, 34.5 mi^2).

2 PREVIOUS INVESTIGATIONS RELATED TO HYDROLOGIC DATA AND CONDITIONS

The Santa Clara River Valley has been the subject of geologic and hydrologic investigations for nearly a century now. Many of these studies included the Piru, Fillmore, and Santa Paula groundwater basins as part of regional efforts for hydrologic understanding and planning of water resources by various agencies (e.g. United Water Conservation District, Ventura County, the cities of Fillmore, Santa Paula, Ventura, and Oxnard, as well as agricultural pumpers associations). This section summarizes these previous reports relating to the Santa Clara River Valley and describes their relevance to the Piru, Fillmore, and Santa Paula groundwater basins.

2.1 VENTURA COUNTY INVESTIGATIONS

Western practices of stock-raising and small-scale agriculture were introduced to the Ventura County region following the founding of the San Buenaventura Mission in 1782 (SFEI, 2011). Prior to the 1880s, the Ventura County region predominantly supported large cattle (up to about 1864) and sheep ranchos. An extremely dry year in 1877 lead to significant losses to the sheep populations, and landowners within the region quickly transitioned to commercial agricultural land uses, which developed during the period dating from the 1880s to the 1920s (SFEI, 2011). With increased interest from landowners to turn to agriculture production for their livelihoods, increased use of groundwater brought reductions to water table elevations which caused some shallow wells to go dry. As a result of increased demand and reduced supply in the region, numerous applications for water rights were submitted to the State of California (State) in the early 1920s. Competing applications sought to appropriate water from Sespe Creek (Fillmore basin) and Piru Creek (Piru basin) and convey water out of the Santa Clara River watershed into other portions of the County. Little was known about Ventura County water resources at that time and the State reasoned that a study was required before significant water rights could be granted.

Field work for the Ventura County Investigation was initiated in August 1927 and was completed in September 1932. Findings were presented in Bulletin 46 in order to provide additional data to aid in determining the available water supply and inform decision makers at the State (California Department of Public Works, Division of Water Rights; DWR, 1933). Bulletin 46 characterized five years of records from the groundwater basins of Ventura County, including Piru, Fillmore, and Santa Paula basins, and included measurements of rainfall, streamflow, and percolation rates from various stream channels (including Santa Clara River, Piru Creek, Sespe Creek, and Santa Paula Creek) to the underlying groundwater basins (Figure 2-1). Of these five years of records, the region received unusually little rainfall in the first four years, and average to above-average rainfall in the final year.

From the surface water data that had been gathered, Bulletin 46 provided estimates of costs and yields related to potential water supply projects (storage reservoirs, spreading activities, and conveyance). The study also included a crop survey and provided statistics on irrigated area and estimated draft on storage from the groundwater basins at that time. Relating to developing a plan for the area's water supply, the report concluded that due to the extremely expensive nature of surface reservoirs, "consideration should be given to spreading work and other methods of utilizing the natural underground reservoirs prior to construction of reservoirs" (DWR, 1933; page 26). Bulletin 46 concluded that spreading works in the Montalvo (Oxnard) Forebay would be enough at that time for conservation of Santa Clara River water because spreading alone could put sufficient volumes of water into storage and was also the cheapest option (DWR, 1933; page 27). Relating to groundwater basin hydrologic budgets for Piru, Fillmore, and Santa Paula basins, Bulletin 46 presented changes in storage from fall 1927 through fall 1932 (pages 77 – 79 in DWR, 1933) and estimated consumptive use representative of the crops and land use at that time (Table 20 in DWR, 1933).

2.2 VENTURA COUNTY INVESTIGATIONS UPDATE

In 1950, the Ventura County Board of Supervisors and the Ventura County Flood Control District requested that the State Water Resources Board perform a comprehensive investigation related to the water resources of the County. In 1956, the final version of Bulletin 12 was published and provided an update to the earlier Ventura County Investigations in order to reevaluate the "water problems in the County of Ventura and the formulation of plans for their solution" (DWR, 1956). The scope of this expanded Ventura County Investigation included analysis of water quality, the replenishment and utilization of the underground water supplies, and preliminary plans and cost estimates for the development of several surface water reservoirs.

Bulletin 12 utilized previous reports and data dating back to Bulletin 46 (DWR, 1933), primarily analyzing available data from 1936 to 1951, and the newly acquired data from field investigations performed from 1951 to 1953. Additionally, Bulletin 12 identified seven groundwater basins of the Santa Clara River Hydrologic Unit as the most important in Ventura County, from an economic standpoint (Figure 2-2; Piru, Fillmore, Santa Paula, Mound, Oxnard Forebay, Oxnard Plain, and Pleasant Valley). Whereas Bulletin 46 described the area downstream of Santa Paula Basin as the Montalvo Basin (Figure 2-1), Bulletin 12 now identified that area in more detail as the Mound Basin and the Oxnard Forebay.

Consistent with earlier investigations, groundwater occurring in the Piru, Fillmore, and Santa Paula groundwater basins was classified as unconfined, with westerly and northwesterly portions of alluvium in the Santa Paula basin showing localized pressure conditions. Relating to recharge mechanisms for the unconfined aquifers, DWR (1956) identified that "the unconfined ground water basins are replenished by percolation of flow in the Santa Clara River and its tributaries, percolation of direct precipitation, artificial spreading and percolation of surface waters [Piru Creek and Santa Clara River], and by percolation of the unconsumed residuum of water applied for irrigation and other uses." DWR (1956) also identified the major mechanisms for groundwater losses from the basins as "effluent discharge to lower basins [groundwater rising to the surface and flowing as surface water downstream], by pumped extractions to meet beneficial consumptive uses, by consumptive use of phreatophytes in areas of high ground water, and by subsurface flow to lower basins."

Relevant to the water budgets for Piru, Fillmore, and Satna Paula basins, Bulletin 12 estimated detailed annual budgets for each of the groundwater basins. A summary of these results for Piru and Fillmore are presented in Tables 2-1 to 2-3, below. The time periods analyzed were the studies' base period (1936 - 1951) as well as sub-periods within the base periods that represented both wet conditions (1936 - 1944) and dry conditions (1945 - 1951). The period under consideration began and ended with the same available storage value for the Piru, Fillmore, and Santa Paula groundwater basins, resulting in zero change in storage over the analyzed period. Subsurface inflow into the Piru basin was not estimated or described in Bulletin 12.

Table 2-1. Estimated average water budget components for the Piru basin; representative average base period (1936 - 1951), wet conditions (1936 - 1944) and dry conditions (1945 - 1951) from DWR's Bulletin 12 (1956; Table 12).

Budget Components (AFY)	Average for base period (1936 - 1951)	Average for wet period (1936 - 1944)	Average for dry period (1945 - 1951)
Surface inflow	102,000	161,500	34,000
Import	1,800	1,000	2,800
Precipitation	9,600	124,00	6,200
Total inflow	**113,400**	**174,900**	**43,000**
Surface outflow	72,900	123,100	15,500
Subsurface outflow	20,600	21,100	19,900
Export	5,700	5,600	5,700
*Total consumptive use**	14,200	14,500	14,000
Total outflow	**113,400**	**164,300**	**55,100**
Change of storage over period	0	--	--
Minimum	-19,600	--	--
Maximum	44,600	--	--
Average annual storage depletion	38,410	--	--
Minimum	8,000	--	--
maximum	94,300	--	--

*Of applied water and precipitation on basin (including phreatophytes)

Table 2-2. Estimated average water budget components for the Fillmore basin; representative average base period (1936 - 1951), wet conditions (1936 - 1944) and dry conditions (1945 - 1951) from DWR's Bulletin 12 (1956; Table 13).

Budget Components (AFY)	Average for base period (1936 - 1951)	Average for wet period (1936 - 1944)	Average for dry period (1945 - 1951)
Surface inflow	176,900	290,900	46,600
Subsurface inflow	20,600	21,100	19,900
Import	5,700	5,600	5,700
Precipitation	25,800	33,500	17,000
Total inflow	**229,000**	**351,100**	**89,200**
Surface outflow	181,300	296,800	49,200
Subsurface outflow	11,500	11,500	11,500
Export	1,400	400	2,400
*Total consumptive use**	34,800	35,300	34,200
Total outflow	**229,000**	**344,000**	**97,300**
Change of storage over period	0	--	--
Minimum	-16,200	--	--
Maximum	49,300	--	--
Average annual storage depletion	17,570	--	--
Minimum	1,400	--	--
Maximum	61,000	--	--

*Of applied water and precipitation on basin (including phreatophytes)

Table 2-3. Estimated average water budget components for the Santa Paula basin; representative average base period (1936 - 1951), wet conditions (1936 - 1944) and dry conditions (1945 - 1951) from DWR's Bulletin 12 (1956; Table 14).

Budget Components (AFY)	**Average for base period (1936 - 1951)**	**Average for wet period (1936 - 1944)**	**Average for dry period (1945 - 1951)**
Surface inflow	209,700	342,800	57,600
Subsurface inflow	11,500	11,500	11,500
Import	1,400	400	2,400
Precipitation	18,500	24,500	11,700
Total inflow	**241,100**	**379,200**	**83,200**
Surface outflow	203,200	338,700	48,300
Subsurface outflow	7,200	7,200	7,200
Export	1,300	1,400	1,100
*Total consumptive use**	29,400	29,600	29,100
Total outflow	**241,100**	**376,900**	**85,700**
Change of storage over period	0	--	--
Minimum	-10,800	--	--
Maximum	15,600	--	--
Average annual storage depletion	9,210	--	--
Minimum	2,200	--	--
Maximum	22,600	--	--

*Of applied water and precipitation on basin (including phreatophytes)

2.3 UNITED GROUNDWATER MANAGEMENT PLAN

In the 1950s, John F. Mann, Jr. and Associates was contracted by United to conduct several investigations and provide reports (e.g. Mann, 1952; Mann, 1953; Mann, 1958). Mann (1959) synthesized available information from previous investigations and data collected by United staff and other agencies, with the following objectives:

1. “A refinement of the ground water geology of the District (United), in order to analyze the influence of the geologic complexities on ground water management;

2. A recalculation of the District’s ground water inventories on the basis of the refined geologic framework;

3. A detailed study of ground water quality to spell out the influence of poor-quality waters on continued ground water development;

4. A description of the current status of sea-water intrusion, and the development of a general plan for combating it.”

Mann’s (1959) final report estimated potential groundwater yields from the various basins, delineated hydrostratigraphic units (HSUs), and reported on water quality problems specific to certain aquifers and locations (Figure 2-3). Concerning estimated water budgets, Mann performed similar analysis that was presented in Bulletin 12 (DWR, 1956) and previous United investigations (Wilde and Long, 1953; Kawano and Parson, 1956). These “Ground Water Inventories” were a major component of Mann’s report and were based largely on the previous United investigations (Wilde and Long, 1953; Kawano and Parson, 1956), extending them over the representative time period of 1936 – 1957. The water budgets for each of the individual groundwater basins included estimates of inflows, outflows, change in storage as well as estimated available storage for each year considered. Like Bulletin 12, the period of investigation contained wet and dry variability throughout. Water budget inventories were made on a monthly basis, but annual summaries were provided for the water year for each of the water budget components that Mann (1959) included (Table 2-4).

Notably, this report described and included in their reported water budgets the occurrence of groundwater underflow between the various groundwater basins within the District, including subsurface underflow into Piru basin (DWR, 1956 did not estimate this value) as well as the occurrences of rising groundwater within the Piru, Fillmore, and Santa Paula basins. Subsurface underflow was based on available observed water level fluctuations near the basin boundaries. Related to pumping demand and water demand by natural vegetation from the groundwater basin, Mann determined the pumping demand within a basin “by applying unit consumptive use values to acreages devoted to the various crops or other uses” and also considered consumptive use by phreatophytes as part of the pumping demand. Water used in excess of this calculated demand was returned to the groundwater system.

Additionally, more detailed importation and exportation of water for each basin were included in comparison with Bulletin 12. For the Piru, Fillmore, and Santa Paula groundwater basins these considered pumping of groundwater by various entities (e.g. Newhall Land and Farming Company, California Department of Fish and Wildlife at the Fillmore Fish Hatchery, La Cienega Water Company, Southside Improvement Company, and Farmers Irrigation Company) which extracted groundwater outside of a given basin and applied within another, typically downstream, basin. In some cases, these groundwater extraction operations were previously surface water diversion operations in areas of rising groundwater near basin boundaries (e.g. Farmers Irrigation Company).

Lastly, Mann's "Plan for Ground Water Management" (1959) provided safe yield estimates, which defines "the maximum perennial rate of extraction which will not produce certain undesirable conditions," such as:

- "Lower water levels so far as to make pumping uneconomical;
- Causing a serious deterioration of water quality;
- interfering unreasonably with existing water rights."

Mann (1959) stated that to date of the report, the Piru, Fillmore, and Santa Paula groundwater basins had not yet exceeded safe yield during the historical period from 1936 – 1957 considered. Within these basins Mann considered safe yield equal to:

- "The amount of water supplied to satisfy consumptive use requirements for urban and irrigation purposes, and the draft on ground water by phreatophytes;
- Plus the total pumpage exported or surface diversions delivered to the next basin downstream;
- Minus the total imported water"

The safe yield values for Piru, Fillmore, and Santa Paula groundwater basins are provided within Table 2-4, below.

Table 2-4. Piru, Fillmore, and Santa Paula Basin's Average Annual Summary of Groundwater Inventory (AFY) representative of 1936 – 1957 (Mann, 1959).

Average Budget Components (AFY)	Piru	Fillmore	Santa Paula
Flood inflow	75,180	127,880	135,610
Imports	2,580	8,170	6,250
Rising water inflow	--	14,170	27,600
Underflow inflow	240	17,200	5,400
Total inflow to basin[1]	**78,000**	**167,420**	**174,860**
Rainfall penetration	4,070	10,010	5,630
Stream percolation	30,410	24,680	15,420
Artificial spreading	5,140	--	--
Total to groundwater basin[1]	**39,860**	**51,890**	**26,450**
Net consumptive use requirement	8,750	25,140	19,340
Net extraction from groundwater basin	5,520	17,890	13,580
Underflow out	17,200	5,400	1,800
Rising water outflow	14,170	29,040	11,340
Export	3,860	980	580
Total from groundwater basin[2]	**40,750**	**53,310**	**26,720**
Flood outflow	44,770	117,370	147,390
Total outflow from basin[1]	**85,520**	**170,680**	**174,110**
Annual change of storage	**-900**	**-1,420**	**-270**
Minimum[3]	-17,770	-20,170	-10,900
Maximum[3]	44,530	42,970	21,680
Annual available storage	**55,050**	**38,250**	**12,330**
Minimum[3]	12,320	5,380	4,420
Maximum[3]	103,220	91,700	27,330
Safe Yield	**12,600**	**23,100**	**18,500**

[1] Total inflow and outflow to and from each basin/groundwater basin were calculated as the sum of the components inflowing or outflowing

[2] Total from gw basin = Net extraction from gw basin + Underflow out + Rising water outflow + Export

[3] All values are average annual values except for minimum and maximum components related to storage

2.4 VENTURA COUNTY COOPERATIVE INVESTIGATION

As awareness of saltwater intrusion increased, other water quality issues and concerns about long-term water reliability grew within the Oxnard plain. DWR and the Ventura County Flood Control District entered into a cooperative agreement to conduct additional investigations to provide comprehensive studies of geology, hydrology, water quality, and operation-economics of the major groundwater basins within the county (DWR, 1976). These studies would: 1) provide an update to the data compiled in DWR's Bulletin 12 (DWR, 1956) and 2) support development of numerical modeling for regional water resources management planning purposes. The study area included the Piru, Fillmore, Santa Paula, Mound, Oxnard Plain and Forebay basins associated with the Santa Clara River, as well as Las Posas, Pleasant Valley, and Arroyo Santa Rosa Valley (Santa Rosa) basins within the Calleguas Creek watershed. This update was released in two volumes that contained a compilation of various Technical Information Records prepared by Ventura County Department of Public Works' Flood Control and Drainage Department staff (Mukae and Turner, 1975) and DWR staff (DWR, 1975). Mukae and Turner (1975) performed and presented geologic studies that reviewed previous reports, water-well logs, and oil- and gas-well logs to update geologic maps and cross-sections. DWR (1975) presented hydrologic, operational, and economic studies, some of which included new and reinterpreted evaluations of groundwater and surface-water parameters for much of the study area (Figure 2-4). DWR used the data compiled by these investigations (Mukae and Turner, 1975; DWR, 1975) to develop numerical modeling that would be used for future water resources management planning (DWR, 1974a,b), described in Section 3.1, below. The results of these investigations were then summarized in DWR Bulletin 104-8 (DWR, 1976).

2.5 USGS SANTA CLARA RIVER VALLEY INVESTIGATIONS

Beginning in the late 1980s and extending through the 1990s, the United States Geological Survey (USGS) performed investigations within the Santa Clara River and Calleguas Creek watersheds in cooperation with UWCD, The Fox Canyon Groundwater Management Agency and Calleguas Municipal Water District. This cooperative effort also helped to support the USGS' Southern California investigation as part of their Regional Aquifer-System Analysis program (RASA; Sun and Johnston, 1994). Several studies were conducted that focused on data collection and analysis of regional groundwater conditions (Izbicki and others., 1995; data collected from 1989 - 1993), seawater intrusion in the coastal plains (Densmore, 1996; data collected 1989 – 1995), and interactions between groundwater and surface water along the Santa Clara River Valley (Densmore and others, 1992; Reichard and others, 1999; data collected in 1991 and between 1993 – 1995, respectively). Reichard and others (1999) measured discharge and water quality during several time periods that included both base flows as well as conservation releases from Lake Piru (Figure 2-5). In addition to surface water measurement, a monitoring site was installed (RP1) in the Piru basin, about 8,000 ft downstream of the confluence of Piru Creek and the Santa Clara River. The RP1 site consists of five wells which were screened at various intervals below the land surface in order to understand the vertical gradients at that location within the region. Co-located with this well site was a drive point piezometer within the stream bed of the Santa Clara River that provided an estimate of the changes in the stream stage. Continuous monitoring of water levels within the drive point piezometer and the shallow aquifer well at RP1 (RP1-5; perforations at the interval of 50 – 70 feet below land surface) allowed for analysis of the gradients and interaction between the surface water and the groundwater. The USGS report summarized "…the groundwater system and stream-aquifer interactions along the Santa Clara River," and included additional technical discussion of the observed hydrologic conditions (e.g., rising groundwater at subbasin boundaries, correlations of water quality with surface water flow magnitudes, interaction between various aquifers) in the Santa Clara River Valley (Reichard and others, 1998).

2.6 UWCD BASIN CONDITIONS REPORTS

With the USGS well installations and RASA program data collection ending by the mid-1990's, United expanded their own monitoring programs. These efforts continue and have increased over time, and include measuring groundwater elevations in wells, collecting water quality samples from a lessor number of wells, measuring surface water discharge, and collecting surface water samples for water quality analysis (e.g. UWCD, 2017). As water wells have come in and out of operation across the basins, United has revised their program to expand and enhance the monitoring network for increased spatial and temporal resolution. These data collection efforts have supported numerous studies performed by United to better understand the movement of water and change of conditions within the eight groundwater basins within the District's boundaries (Piru, Fillmore, Santa Paula, Mound, Oxnard Forebay, Oxnard Plain, Pleasant Valley, and West Las Posas).

Related to Piru and Fillmore groundwater basins, United helped to prepare a Groundwater Management Plan for the Piru and Fillmore Basin Groundwater Management Planning Council, which represented United, the City of Fillmore, and the Pumpers of the Piru and Fillmore basins (Piru and Fillmore Groundwater Planning Council, 1996). Following this, United produced an Annual Groundwater Conditions Reports from 1997 to 2009 (e.g. UWCD, 1997 and 2010) and Biennial Groundwater Conditions Reports from 2010 to 2015 (e.g. UWCD, 2013, 2015, and 2016). These Fillmore and Piru reports were produced to support water resource initiatives and activities, and summarized recent data related to basin location and dimensions, hydrogeology, precipitation, groundwater recharge and surface flows, reservoir releases, groundwater pumping, groundwater elevations, surface water quality, groundwater quality. Specific topic of interest included Santa Clara River Chloride Total Maximum Daily Load (TMDL) requirements, wastewater reclamation plant discharges, landfills, conditions near the basin boundaries and changes in agricultural land uses over time.

Related to Santa Paula basin, United has produced a *Santa Paula Basin Annual Report* each year since 1997 (e.g. UWCD, 1998, 2019a, and 2020) as a requirement of a 1996 stipulated judgement by the Superior Court of the State of California for the County of Ventura. The judgement established pumping allocations for the Santa Paula basin (United Water Conservation District vs. City of San Buenaventura, original March 7, 1996, amended August 24, 2010). The judgment requires annual reports summarizing results of the monitoring program, and further specifically provides that "United Water Conservation District shall have the primary responsibility for collecting, collating, and verifying the data required under the monitoring program, and shall present the results thereof in annual reports to the Technical Advisory Committee" (UWCD, 2018).

3 PREVIOUS INVESTIGATIONS RELATED TO NUMERICAL MODELING DEVELOPMENT

Several numerical modeling efforts have taken place within Ventura County that focused on the groundwater basins associated with the Santa Clara River and the Calleguas Creek watersheds. The efforts began in the late 1960s and early 1970s, with the initial focus primarily being the coastal plain basins and concerns related to seawater intrusion. However, once modeling tools were developed along the coast, efforts pushed up the Santa Clara River Valley groundwater basins. The following sections briefly detail each of the numerical modeling efforts as well as detail and discuss water budget components that were estimated for the Piru, Fillmore, and Santa Paula groundwater basins.

3.1 CALIFORNIA DEPARTMENT OF WATER RESOURCES

The earliest numerical groundwater flow model of the aquifers underlying the Santa Clara River Valley and Oxnard coastal plain was completed in the early 1970s by DWR. The groundwater flow model developed (DWR, 1974a) used a digital Thiessan-Weber Polygon superposition methodology (adaptation of DWR software, reference not available) that was combined with a newly developed solute-transport model (DWR, 1974b). This work was summarized in Bulletin 104 (DWR, 1976). A total of 158 grid nodes were used for the study area (Figure 3-1) and each represented areal extents ranging from hundreds of acres to several thousand acres. The Piru, Fillmore, Santa Paula, Mound, Las Posas, Pleasant Valley, and Arroyo Santa Rosa Valley basins were simulated using a single layer, and the Oxnard Plain and Forebay basins were simulated using two layers.

The numerical modeling simulated historical transient hydraulic and water-quality conditions for the verification period from the spring of 1957 to the spring of 1967 using 201 time-steps. The model was calibrated using measured groundwater elevations over the entire time period. As part of the calibration process, recharge, transmissivity, and storage coefficients were adjusted to obtain better matches between measured and simulated groundwater levels. Using the calibrated model, DWR selected five management alternatives for analysis over a time period representing the years 1970 – 2020, for the purpose of long-term regional water resources planning (DWR, 1976).

The detailed documentation of the numerical modeling developed by DWR for this investigation (DWR, 1974 a,b) provided some water budget information, but was often presented as net inflows into the modeling sub-domains. The one relevant piece of information related to water budgets of groundwater basins was the estimation of approximately 245 AFY of subsurface underflow into Piru basin representative from 1957 – 1967 (DWR, 1974a; Table 14).

3.2 UNITED STATES GEOLOGICAL SURVEY

In parallel with their data collection efforts of the late 1980s (Section 2.5 above), the USGS also initiated a major numerical modeling effort of the regional alluvial-aquifer systems of the Santa Clara River and Calleguas Creek watersheds. This study of the hydrogeology of the Santa Clara-Calleguas watersheds was completed as part of the Southern California Regional Aquifer-System Analysis (RASA) program (Sun and Johnston, 1994). The regional groundwater system in southern Ventura County was selected as a representative southern California basin for study, with cultural practices and hydrogeologic processes common to other basins or groups of basins.

3.2.1 GROUNDWATER SURFACE WATER OPTIMIZATION STUDY

The first local modeling effort by the USGS (Reichard, 1995) focused on the current study area groundwater basins as part of the Santa Clara River and adjacent region (Figure 3-2). This study was an extension of the original DWR modeling described in Section 3.1, above (DWR, 1974a,b; 1976). The USGS developed a stochastic simulation-optimization model and used it to analyze a hypothetical 15-year planning period for the Santa Clara - Calleguas basin beginning in October 1989. In order to do so, Reichard (1995) applied the hydrogeological data that was included in the original digital Thiessan-Weber Polygon to be used with the USGS's recently-developed groundwater flow modeling code, MODFLOW (McDonald and Harbaugh, 1988). Like the original DWR modeling, this work simulated the multiple aquifers of the region using one or two model layers. The Upper Aquifer System (UAS) was the only layer represented in the Piru, Fillmore, Santa Paula, and Mound basins. The Lower Aquifer System (LAS) was the only layer represented in the Las Posas, Pleasant Valley, and Arroyo Santa Rosa Valley basins. The Oxnard Plain and Forebay basins were simulated with both the UAS and LAS present. Model cells were 0.5 mile x 0.5 mile in extent, and the system was modeled assuming heterogenous, isotropic confined flow in both layers. Previously simulated water levels representing 1967 (DWR, 1976) were used to represent initial conditions for a six-year transient simulation (using annual stress periods) from 1984 to 1989. The initial simulation used average measured pumping and artificial recharge over the simulated period. The final water level elevations from the six-year transient simulation were then used as initial conditions for Reichard's stochastic simulation-optimization modeling over the 15-year planning period which was constrained to meet demands (pumping and pipeline deliveries) across 13 "water-demand sectors" representative of 1984 – 1989 conditions on an annual basis. Reichard's (1995) work included uncertainty using probability distributions of streamflow within the Santa Clara River available for diversion and artificial recharge, and presented allocation alternatives for the region that optimized groundwater and surface water management strategies to satisfy the demands and minimize seawater intrusion.

3.2.2 RASA MODEL

Building upon Reichard’s (1995) work, the USGS published a significant numerical modeling update for the Santa Clara River and Calleguas Creek watersheds in 2003 (Hanson and others, 2003; commonly referred to as “the USGS RASA model” due to its contribution to the USGS’ RASA program). The domain was again discretized into 0.5 mile x 0.5 mile cells which included the Piru, Fillmore, Santa Paula, Mound, Oxnard Plain, Oxnard Forebay, Pleasant Valley, Santa Rosa, East Las Posas, West Las Posas, and South Las Posas basins, and extended farther offshore than the previous regional modeling domains (Figure 3-3). The USGS RASA model was also constructed using their groundwater flow modeling code, MODFLOW (McDonald and Harbaugh, 1988), but this time included two layers across the entire modeling domain in order to represent UAS and LAS aquifers within each basin (Figure 3-4). The USGS RASA model simulated the UAS as unconfined within the Piru, Fillmore, and Santa Paula basins, as well as the Oxnard Forebay, the Northeast Oxnard Plain, Las Posas Valley, and parts of Santa Rosa Valley (Figure 3-4, blue shaded area labeled as subareas with valley-floor recharge). In all other areas UAS aquifers were simulated as confined, and all basin LAS layers were simulated as confined. Additional modeling packages were included in order to simulate routing of streamflow (Prudic, 1989), land subsidence (Leake and Prudic, 1991), and faults as horizontal-flow-barriers to groundwater flow (Hsieh and Freckleton, 1993).

In the upper basins of the Santa Clara River Valley (Piru, Fillmore, and Santa Paula), data from shallow wells (depths less than 50 feet) were noted to have had higher observed water levels than water levels observed in nearby wells completed within the same upper aquifer system, but deeper in comparison (note: there are very limited wells this shallow). The USGS RASA report (Hanson and others., 2003; Page 69) commented that this “may indicate some degree of hydraulic separation between the Shallow (recent alluvium) aquifer and the underlying aquifer along the Santa Clara River.” Observed water levels within the UAS of the Santa Paula and Piru basins were observed to be 10 – 25 feet higher than water levels in the LAS, which illustrates downward vertical gradients within those basins. Calibration within the Piru, Fillmore and Santa Paula basins were dependent on about a dozen wells across the LAS (4) and UAS (9) (Hanson and others., 2003; Page 99, Figures 13, 14, 15, and 21). This split between the targets available in the UAS and LAS calibrations was likely due to the availability of drilled wells being skewed toward shallower depths, given the relatively higher water-table and water production capacity of wells within those basins.

The USGS RASA model investigation included results from three model runs: one “historical” model and two “forward” model simulations to represent projected future groundwater conditions. The historical model scenario was simulated from 1891 – 1993 using estimated and reported pumping for agricultural, municipal and industrial users as well as estimated and measured streamflow and diversions. The historical model was used for calibration, with targets of estimated historical surface-water flows and measured groundwater levels during the period from 1891 –

1993. The years 1984 – 1993 were the only period when reported pumping records were available for most of the model domain. The initial conditions for transient calibration were derived from predevelopment steady-state conditions, which were considered adequate when having water levels of 40 to 50 feet above sea level near the coast, based on early hydraulic conditions previously reported (Freeman, 1968). The 103-year transient model simulation used 3-month stress periods in order to represent season changes, and 12 equal time-steps for each stress period in order to represent seasonal variability. Hydrologic budget components were estimated in the report, however, many were representative of the entire SCR-Calleguas domain, rather than detailed budgets for each basin. The Fillmore and Piru groundwater basins were often lumped with Santa Paula for analysis of the Santa Clara River Valley basins as a unit.

Following calibration efforts, the model was used to project future groundwater flows and to evaluate several alternatives to future groundwater flow, including six proposed water-supply projects. These future assessments were not focused on the upper basins, but rather were related to overdraft in the coastal basins and assessing the risk of increased seawater intrusion. The primary forward model scenario was based on historical hydrologic records for the years 1970 – 1993 in order to simulate a 24-year projection of future groundwater flows representing the years 1994 – 2017. The historical record period (1970 – 1993) contained 13 “dry” and 11 “wet” years, and the average wet and average dry pumping and streamflow values across the entire period were used for each individual wet and dry year, accordingly. In addition to the primary forward modeling approach, another approach was used for a 44-year projection of future groundwater flows representative of 1994 – 2037, that used statistical and time-series signal processing of long-term historical annual precipitation totals (1905 – 1993) in order to estimate precipitation into the future.

3.3 MODELING UPDATES SPONSORED BY UWCD

The USGS RASA model (Hanson and others., 2003) described in the previous section was an outcome of decades of geologic and hydrologic investigations within the Santa Clara River and Calleguas Creek watersheds. However, its use of only two model layers to represent the multiple aquifers within the UAS and LAS was a simplification that limited the degree to which it could be calibrated. This limitation prevented it from being able to evaluate impacts of future pumping/recharge scenarios on specific aquifers, particularly in coastal areas impacted by seawater intrusion.

Following the completion of the USGS RASA model, United went on to support subsequent efforts intended to further refine and enhance the model in order to apply it for better regional understanding and planning of water resources. These efforts extended over a period of about seven years in which United supported three different organizations for model updates and refinements, including:

- ETIC Engineering (2002 to 2006)
- CH2M HILL (early 2006)
- HydroMetrics: (mid 2006 – 2008)

The various refinements and modifications from the USGS RASA model were noted in the *Groundwater Management Plan* for the Fox Canyon Groundwater Management Agency (FCGMA and others, 2007), including:

- Refinement of cell size from 1/2 mile x 1/2 mile to 1/6 mile x 1/6 mile for the alluvial basins (Figure 3-5, this report).
- Reduction in grid size. In the original USGS RASA model only 28% of the grid cells were active and in the modified model 47% of grid cells were active (ETIC, 2003).
- Extension of the historical and forward model to include 1994 to 2000 hydrology.
- Addition of a zone of lower hydraulic conductivity in the Lower Aquifer System extending in a linear trend from the Camarillo Hills to Port Hueneme.
- Addition of a third layer in the Piru, Fillmore and Santa Paula basins to better simulate the more permeable alluvium along the Santa Clara River, Sespe Creek, Santa Paula Creek and Piru Creek. In other words, this partitioned the UAS into two-separate UAS layers.
- Recalibration of the Forebay and Oxnard Plain portions of the model over the period 1983 to 1998 to better reflect the increased diversions and recharge that had occurred in this area since the USGS originally calibrated the model (HydroMetrics, 2006).
- Expansion of the forward model period to a full 55 years to reflect the climate and hydrology of the years 1944 to 1998. This period was a commonly-used base period because it starts and ends in very wet years, spans several dry cycles, and represents zero cumulative departure for rainfall across the period.

- Refinement of time discretization from 3-month stress periods to 1-month stress periods (using 300 time-steps per stress period).

As the various revisions and updates were completed, the regional groundwater flow model was used for several local studies related to proposed water projects and management strategies (FCGMA and others, 2007):

- Oxnard Plain LAS and UAS overdraft analysis – UWCD (2001)
- GREAT Project EIR – UWCD and City of Oxnard
- Las Posas Basin ASR project operations – Calleguas MWD
- City of Fillmore water supply planning – UWCD and City of Fillmore
- Pleasant Valley AB303 grant study – UWCD
- Fox Canyon Groundwater Management Agency Groundwater Management Plan – UWCD and FCGMA

3.4 LOWER SANTA CLARA RIVER SALT AND NUTRIENT PLAN

A consultant team consisting of Larry Walker Associates, in association with HydroMetrics, Carollo Engineers, Rincon Consultants, and Dr. Norm Brown (affiliated with University of California, Santa Barbara) prepared the Lower Santa Clara River (LSCR) Salt and Nutrient Management Plan (SNMP) under the direction of the Ventura County Public Works Agency's Watershed Protection District (LWA and others, 2015; Figure 3-6). The purpose of the SNMP was to understand the potential impacts of increased future use of recycled water upstream and within the basins containing the LSCR. The plan was created in order to satisfy the requirement set by the State Water Resources Control Board (State Water Board) following the State Water Board's adoption of the Recycled Water Policy (State Water Resources Control Board Resolution No. 2009-0011) in February 2009, which required the development of regional or sub-regional SNMPs for groundwater basins within California.

3.4.1 LSCR SNMP GROUNDWATER BASIN WATER BUDGETS

The LSCR SNMP provides the most recent summary of the water budgets for the Piru, Fillmore and Santa Paula groundwater basins based on numerical modeling. Because the area included in the LSCR SNMP is almost entirely dependent on groundwater for water supply, the SNMP was focused on sources and sinks related to the groundwater basins. The consultant team leveraged HydroMetrics' experience with the previous modeling updates supported by United, and as well as work HydroMetrics performed for United to acquire numerical modeling output from other entities relating to fluxes into and between the basins of the groundwater basins (see Section 4.2).

The hydrologic numerical modeling supporting the SNMP was based on the primary forward modeling run and relevant modifications of the USGS RASA model (Hanson and others, 2003) sponsored by United and described in Section 3.3, above. In the model, the Piru, Fillmore, and Santa Paula basins have three layers, with layers 1 and 2 defining the UAS and layer 3 defining the LAS (LWA and others, 2015, Section 7.1.2). The results represent surface water modeling and groundwater modeling over 17 total water years (WYs), from 1996 - 2012. Climatic statistics were calculated based the United-sponsored forward modeling run (see section 3.3) using 1944 – 1998 data. Each WY from 1996 – 2012 was then classified as wet, dry, or average, and forced with the values calculated from the historical climatic data accordingly. These transient groundwater flow results were then used to inform a steady-state mass balance model which calculated groundwater concentrations for certain salts the UAS each year, using surface water inflows and outflows and groundwater flow data available over the 1996 – 2012 simulation period. Each groundwater basin was divided into various subdomains in calculating the annual steady-state concentrations, and estimated flows were adjusted for each year to maintain equilibrium (inflows approximately equal to outflows). Results presented in this report are the average values of each water budget component considered, as summarized below in Tables 3-1 to 3-3 for the Piru, Fillmore, and Santa Paula groundwater basins.

Table 3-1. Piru Basin Salt and Nutrient Management Plan Water Budget; Average values of Water Years 1996 – 2012 (LWA and others, 2015; Tables 7-3, 7-4, and 7-5).

INFLOW	Component	RATE (AFY)
GW Flows	Upper Santa Clara River Aquifer Underflow	360
Non-Land Use Surface Flows	Managed Recharge	1150
	Precipitation Recharge	1990
	Santa Clara River and Tributaries	60670
	Mountain Front Recharge	2620
Land Use Surface Flows	Ag irrigation with SW	1240
	Ag irrigation with GW	2760
	Water Treatment Percolation Ponds	210
	Septic Systems	67
OUTFLOW		
GW Flows	Seepage to Santa Clara River	1990
	GW production	9210
	Upper Aquifer Underflow to Fillmore basin	10480
	Net Lower Aquifer Underflow to Fillmore basin[1]	25220

Table 3-2. Fillmore Basin Salt and Nutrient Management Plan Water Budget; Average values of Water Years 1996 – 2012 (LWA and others, 2015; Tables 7-6, 7-7, and 7-8).

INFLOW	Component	RATE (AFY)
GW Flows	Piru Upper Aquifer Underflow to Filmore Basin	10480
	Net Lower Aquifer Underflow to Fillmore[1]	25220
Non-Land Use Surface Flows	Precipitation	9170
	Santa Clara River and Tributaries	12470
	Mountain Front Recharge	3530
Land Use Surface Flows	Municipal irrigation	230
	Ag irrigation with GW	9480
	Water Treatment Percolation Ponds	1040
	Urban irrigation recycled water	50
	Septic Systems	210
OUTFLOW		
GW Flows	Underflow to Santa Paula Basin	16990
	Seepage to Santa Clara River	14420
	GW production	39470

Table 3-3. Santa Paula Basin Salt and Nutrient Management Plan Water Budget; Average values of Water Years 1996 – 2012 (LWA and others, 2015; Tables 7-9, 7-10, 7-11, and 7-12).

INFLOW	Component	RATE (AFY)
GW Flows	Santa Paula Aquifer Underflow from Fillmore Basin	16,990
Non-Land Use Surface Flows	Precipitation	8,770
	Santa Clara River and Tributaries	1,370
	Mountain Front Recharge	3,600
Land Use Surface Flows	Municipal irrigation	960
	Ag irrigation with GW	7,310
	Water Treatment Percolation Ponds	2,230
	Ag irrigation with SW	90
	Septic Systems	180
OUTFLOW		
GW Flows	Underflow to Oxnard Forebay Aquifer	8,090
	Underflow to Mound Aquifer	1,010
	GW production	41,040

4 PREVIOUS INVESTIGATIONS DETAILING SUBSURFACE UNDERFLOW ESTIMATES

In addition to the studies that focused on all three of the study area groundwater basins, there have been several investigations and numerical modeling efforts that have focused on: 1) The Santa Clara River Valley East basin, located directly upstream of the Piru basin and 2) the Santa Paula groundwater basin, with work related to technical support and resulting management and updates following adjudication of the basin. The following sections will provide some background related to the studies and detail the relevant water fluxes that were estimated by those studies.

4.1 SANTA CLARITA VALLEY REGIONAL GROUNDWATER FLOW MODELING

The Santa Clarita Valley Regional Groundwater Flow Model (SCVRGFM) was developed as part of the work of scope contained in an August 2001 Memorandum of Understanding that was signed by the Upper Basin Water Purveyors in the Santa Clarita Valley of Los Angeles County and by United Water Conservation District in Ventura County. The final numerical model documentation was completed in April 2004 (CH2M HILL, 2004). This modeling effort used MicroFEM (Hemker and de Boer, 2003), a finite-element numerical modeling tool for the groundwater modeling. MicroFEM was used to calibrate and simulate a steady-state model over the calendar years 1980 – 1985, which provided the initial conditions to a transient model that was calibrated and simulated over the calendar years 1980 – 1999. The modeling extended over the Santa Clara River Valley East groundwater basin (Figure 4-1). The relevant information from this work related to the downstream Piru groundwater basin is the estimated groundwater underflow that moves between the basin near the Los Angeles/ Ventura County Line. The SCVRGFM estimated the groundwater underflow across the county line using a specified head boundary (805 feet) in the alluvial aquifer material based on groundwater elevation contours interpreted by Richard C. Slade (1986, 2002; using spring 2000 water table elevations). Estimates of subsurface underflow entering across the Los Angeles/ Ventura County Line for the steady-state and the transient model simulations are shown in Table 4-1, below. There are believed to be issues in the assumption made during this investigation that considered hydrogeologic conditions east of the Los Angeles/ Ventura County Line to be the same at the USGS County Line gage, where streamflow was compared. Because of this, subsurface underflow at the County Line and surface flows at the USGS County Line gage were essentially presented as being co-located, which is now understood to be problematic (Figure 4-2). For that reason, we present the underflow results from this investigation as being representative as the underflow entering across the Los Angeles/ Ventura County Line. These differences are described in more detail in Section 4.4. Lastly, streamflow was simulated in this investigation at the USGS County Line gage and monthly discharges were compared with observational records. Annual streamflow out of the modeling domain were not presented alone in the investigation's water budget summary, but as part of "total discharge", which included all discharge to the Santa Clara River, evapotranspiration, subsurface outflow, and pumping.

Table 4-1. Subsurface underflow at County Line related to initial Santa Clarita Valley regional groundwater flow modeling (CH2M HILL, 2004).

Model Run	Period	Subsurface underflow (AFY)
Steady-State	1980 - 1985	6,600
Transient, minimum	1980 - 1999	6,520
Transient, maximum	1980 - 1999	7,017
Transient, average	1980 - 1999	6,703
Transient, median	1980 - 1999	6,657

A calibration update to the SCVRGFM occurred within the following year (CH2M HILL, 2005), which extended the modeling period by a little more than 5 years for validation purposes. The original simulation period of January 1980 – December 1999 became a simulation period of January 1980 – February 2005. This revised transient simulation resulted in updated estimates of subsurface flow at the county line, which are shown in Table 4-2, below. From this update, subsurface underflow at the Los Angeles/ Ventura County Line increased nearly three-fold. As part of the calibration update, changes in the boundary condition representing underflow into their domain at the eastern portion of their model boundary were reported and a previously neglected underflow component from the upstream Acton basin was introduced following additional field visits along the Santa Clara River channel. This underflow component was estimated to be a considerable volume (average of 16,538 AFY from 1980 – 2005), which appears to have propagated down-gradient and significantly increasing in the estimated subsurface underflow outflowing downstream into Ventura County.

Table 4-2. Subsurface underflow at the County Line related to updated Santa Clarita Valley regional groundwater flow modeling (CH2M HILL, 2005).

Model Run	Period	Subsurface underflow (AFY)
Transient, minimum	1980 - 2005	18,059
Transient, maximum	1980 - 2005	18,802
Transient, average	1980 - 2005	18,324
Transient, median	1980 - 2005	18,315

4.2 UPPER SANTA CLARA RIVER TRANSPORT MODELING

Following finalization of SCVRGFM reports mentioned above, development of a new hydrologic model was completed for the eastern portions of the Santa Clara River watershed that would allow for improved simulation of the interaction between groundwater and surface water (CH2M HILL/HGL, 2006 and 2008). This work focused on simulating the fate and transport of chloride and total dissolved solids throughout the Santa Clara River Valley East groundwater basin, the Piru groundwater basin, and extended slightly into the Fillmore groundwater basin (Figure 4-3). This new effort was motivated by requirements set by the Los Angeles Regional Water Quality Control Board to perform several major studies related to a Total Maximum Daily Load for chloride within the Santa Clarita Valley. One of these major studies included the need to develop a Groundwater/Surface-water Interaction Model (GSWIM) in order to assess long-term impacts in the Piru basin.

For the GSWIM modeling effort, CH2M HILL collaborated with HydroGeoLogic, Inc. (HGL) and used a hydrologic modeling code called MODHMS (HGL, 2006). MODHMS was based on the USGS' MODFLOW model and was developed and enhanced by HGL in order to conduct simulations of fully-integrated groundwater and surface-water flow (including saturated and unsaturated flow) and solute transport. The model calibration started with a steady-state simulation using January 1975 for average boundary conditions (groundwater elevations, streamflow locations, and solute concentrations) throughout the modeling domain (CH2M HILL/HGL, 2008, Task 2B-1, Section 3.5). The steady-state groundwater elevation solution was then used as initial conditions for a transient integrated groundwater and surface water simulation over calendar years 1975 – 2005. Initial calibration was performed using monthly stress periods and without considering chloride concentrations, but the final calibration was performed using daily stress periods which allowed comparison of daily streamflow discharge rates and chloride concentrations to calibration targets. After GSWIM was calibrated at the daily temporal resolution, the model was used to simulate future scenarios in order to evaluate potential future basin conditions given the anticipated future loads of chloride and total dissolved solids within the watershed.

Like the previous Santa Clarita Valley modeling described in Section 4.1 above, the relevant groundwater information from this work that relates to the downstream Piru groundwater basin is the estimated groundwater underflow that moves between the basin near the Los Angeles County/Ventura County line. The results of calibrated underflow coming across the county line were not explicitly detailed within the numerical modeling report for this work (CH2M HILL and HGL, 2008). United contracted HydroMetrics to review the numerical modeling effort and report. As part of that analysis HydroMetrics requested additional data from the CH2M HILL team regarding the flow, both surface and subsurface, across the county line and into the Piru groundwater basin. From that work, HydroMetrics reported to United that the CH2M HILL/HGL numerical model simulated most of the water flux across the county line occurred as surface water, with relatively little water flowing into the Piru groundwater basins as subsurface flow within the underlying alluvium surrounding the streambed (Figure 4-4; HydroMetrics, 2008). Though not calculated by HydroMetrics, the plot referenced here suggests the CH2M HILL/HGL numerical modeling estimated annual average subsurface flow into the Piru groundwater basin at approximately 1,084 AFY. This value was computed for this document using an average daily value of 1.5 cfs for subsurface flow within the alluvium (from Figure 4-4) and converting that to AFY (1 cfs equates to approximately 1.98 AFD; 365 days within 1 year).

Additionally, HydroMetrics noted that the simulated surface water flows showed a good match with measured flows, but with slight overprediction during low-flow periods (Figure 4-5). If the overall estimate of flow in the Blue Cut area is correct, this overprediction of streamflow during summer baseflow periods could mean that actual subsurface flow in this area was less than what was simulated within the CH2M HILL/HGL (2008) numerical modeling.

During CH2M HILL/HGL’s GSWIM model development, it was determined that United’s numerical model used an estimated value of approximately 2,000 AFY flowing into the Piru groundwater basin as subsurface flow (CH2M HILL/HGL, 2006; Table C-1). Additionally, The USGS RASA model (2003) only specified stream inflow and mountain-front recharge into Piru basin and did not explicitly state that subsurface underflow from the Santa Clarita Valley was included.

4.3 SANTA PAULA SAFE YIELD

The Santa Paula groundwater basin is located downstream of the Fillmore basin. Several past studies have investigated hydrologic budget components within the Santa Paula basin, with the USGS numerical model and United-sponsored modifications thereafter providing the only estimates from numerical groundwater models.

The first report that documented the subsurface outflow from Fillmore basin to Santa Paula basin in the context of adjudication and legal decision making was the *Water Resources Evaluation Santa Paula Ground Water Basin Ventura County, California* (Law/Crandall, 1993). This report used wells near the basin boundaries which had corresponding water level measurements for most of the period 1973 – 1987. Using observed well tests for aquifer properties and hydraulic gradients, Darcy's Law was used to calculate the estimated average subsurface flow from the Fillmore basin to the Santa Paula basin as 3,914 AFY for the period 1956 – 1990. These methods were very similar to previous methods used by DWR (1956) and Mann (1959), and the report briefly mentioned subsurface outflow from Santa Paula basin and agreed with Mann (1959) that "the average subsurface outflow through the recent river deposits is approximately 1,800" AFY, mentioning that it was "consistent with their estimates of the transmissivity, outflow area, and local gradient."

The most-recent report that estimated the subsurface outflow from Fillmore basin to Santa Paula basin was the *Santa Paula Basin Hydrogeologic Characterization and Safe Yield Study Ventura County, California* (DBS&A and RCS, 2017). This report used observed well test results for hydraulic conductivity for both the undifferentiated alluvium and the more consolidated San Pedro Formation, as well as observed groundwater elevations from 2000, 2010, and 2013 to calculate groundwater flux using Darcy's Law (Figure 4-6). From this analysis, the average subsurface flow from the Fillmore basin to the Santa Paula basin was estimated to be 25,244 AFY. Within this report they also present the findings of a similar study from Bachman (2015), which estimated groundwater flux across the same basin boundary area to be 19,700 AFY. DBS&A and RCS (2017) also reported estimated subsurface outflow from the Santa Paula basin to be 7,349 AFY, using similar methodology to Santa Paula basin subsurface inflow calculation.

4.4 SUMMARY OF SUBSURFACE UNDERFLOW ESTIMATES

For the purpose of comparison, this section summarizes the previously estimated subsurface underflow budget components. Previous estimates of subsurface underflow into Piru groundwater basin ranges from 240 AFY to 18,300 AFY (Table 4-3). Previous estimates of subsurface underflow into Fillmore groundwater basin ranges from 17,200 AFY to 39,300 AFY (Table 4-4). Previous estimates of subsurface underflow into Santa Paula groundwater basin ranges from 3,900 AFY to 25,200 AFY (Table 4-5). Previous estimates of subsurface underflow out of Santa Paula groundwater basin ranges from 1,900 AFY to 9,100 AFY (Table 4-6).

Table 4-3: Summary of previous estimates made by various entities relating to average annual subsurface underflow into Piru groundwater basin

INFLOW (AFY)	Representative Years	Source
240	1936 – 1957	Mann, 1959
245	1957 – 1967	DWR, 1974a
6,703	1980 - 1999	CH2M HILL, 2004
18,324	1980 - 2005	CH2M HILL, 2005
2,084	1986 - 2000	UWCD (presented in CH2M HILL/HGL, 2006)
1,084	1975 - 2005	HydroMetrics (2008) review of CH2M HILL/HGL (2008)
360	1996 - 2012	SNMP (HydroMetrics), 2015

Table 4-4: Summary of previous estimates made by various entities relating to average annual subsurface underflow into Fillmore groundwater basin

INFLOW (AFY)	Representative Years	Source
20,600	1936 - 1951	DWR, 1956
17,200	1936 – 1957	Mann, 1959
44,287	1975 - 2005	CH2M HILL/HGL, 2008
35,700	1996 - 2012	SNMP (HydroMetrics), 2015

Table 4-5: Summary of previous estimates made by various entities relating to average annual subsurface underflow into Santa Paula groundwater basin

INFLOW (AFY)	Representative Years	Source
11,500	1936 - 1951	DWR, 1956
5,400	1936 – 1957	Mann, 1959
3,900	1956 - 1990	Law/Crandall, 1993
16,990	1996 - 2012	SNMP (HydroMetrics), 2015
19,700	1947 - 2014	Bachman, 2015*
25,244	1999 – 2012	DBS&A and RCS, 2017**

*Representative years weighted using of wet (2005), average (2010), and dry (2012) years, respectively, using spring and fall conditions for each

**Average value derived from representative median (2000), 75th percentile (2010), and 25th percentile (2012) water years, respectively, based on precipitation from rain gauges located in Saticoy and Ventura over the hydrologic base period of 1999 – 2012. Minimum value reported was 22,320 AFY and maximum value reported was 30,909 AFY.

Table 4-6: Summary of previous estimates made by various entities relating to average annual subsurface underflow out of Santa Paula groundwater basin

OUTFLOW (AFY)	Representative Years	Source
7,200	1936 - 1951	DWR, 1956
1,800	1936 – 1957	Mann, 1959
1,800	1956 - 1990	Law/Crandall, 1993
9,100	1996 - 2012	SNMP (HydroMetrics), 2015
7,350	1999 – 2012	DBS&A and RCS, 2017**

**Average value derived from representative median (2000), 75th percentile (2010), and 25th percentile (2012) water years, respectively, based on precipitation from rain gauges located in Saticoy and Ventura over the hydrologic base period of 1999 – 2012.

The various investigations described in the previous sections of this report all represented various time periods over the last century, and because of that we expect to see differences due to natural variability in water inputs into the systems as well as systematic changes in certain inputs (such as increased flows from Los Angeles County waste water due to increased development).

Related to the range of estimated inflowing subsurface underflow values reported for Piru basin, there is a significant issue in comparing these values because different studies estimated subsurface underflow at different locations. Most of the values were representative of flows entering into previous Piru basin boundary (Mann, 1959), prior to DWR's 2003 update (DWR, 2003) and the most recent 2019 modifications (DWR, 2019; Figure 4-7). The CH2M Hill (2004 and 2005) numerical modeling estimates are the only estimates affected by this discrepancy because of where their investigation terminated. An important concern related to the presentation of the CH2M Hill (2004 and 2005) underflow estimates is that the investigators made the assumption that the hydrogeologic conditions several miles east of the Los Angeles/ Ventura County Line also represented the conditions in an around the County Line gage (Figure 4-2). In fact, the Los Angeles/ Ventura County Line is located approximately 2/3-mile approximately upstream from the USGS County Line streamflow gage.

For context, when the CH2M Hill (2004 and 2005) projects were conducted, there was no groundwater well information in the County Line area and groundwater well data from several miles into the eastern groundwater basin within Los Angeles County was used to inform aquifer thickness in Ventura County. With subsequent investigations conducted related to the data gap in the County Line gage area (e.g. Geomatrix, 2006; CH2M Hill/HGL, 2008), thickness of water-bearing aquifer material within the County Line gage location was approximated to be 10 feet at the gage location. United staff estimate the thickness of water-bearing aquifer material increases to approximately 30 feet in the Newhall gage area where more groundwater well information is known (Figure 4-7). Therefore, the CH2M Hill (2004 and 2005) reported subsurface underflow values are likely largely overestimated for subsurface underflows at the County Line gage, but good initial estimates for subsurface underflow at the Los Angeles/ Ventura County Line as well as the recently updated Piru basin boundary (Figure 4-7).Following the field investigations near the County Line gage location, the CH2M HILL/HGL (2008) estimate into the Piru basin boundary (Mann, 1959) is believed to be the best approximation for the historical basin boundary given that additional information was known in the vicinity of the USGS County Line gage as well as the fact that no numerical model boundary conditions were located near this area of interest to affect estimates.

Related to the range of estimated inflowing subsurface underflow values reported for Fillmore basin, the estimates for the average have variability that could be explained by the various time periods examined. The CH2M Hill/HGL (2008) estimates ranged from 23,345 AFY to 111,205 AFY, with the upper range representative of 2005, which was an extremely wet year. The implementation of a specified head boundary condition that completed their modeling domain was located just downstream of the Piru and Fillmore basin boundary and set to a constant elevation of 10 feet below the surface of the Santa Clara River channel. Their subsurface underflow estimate should also be viewed as having potential issues because the proximity of the boundary condition to the water budget component of interest as well as the implementation of a specified head boundary condition which could be influencing the gradient across the basin to conditions that are not present during a given wet or dry period. Specifically, the upper value of 111,205 AFY of subsurface underflow during 2005 is likely to be greatly overestimated because the specified head boundary just downstream of this boundary creates a sink that results is a large amount of water draining out of the Piru basin when really the basins would be extremely full during this exceptionally wet period.

Finally, related to the range of estimated inflowing and outflowing subsurface underflow values reported for Santa Paula basin, the estimates for the averages have variability that could be explained by the various time periods examined. Although more recent numerical modeling estimates are not available to detail these components, Bachman (2015) and DBS&A and RCS (2017) did both look at these values during more recent time periods, and produced similar results in line with earlier estimates.

5 GROUNDWATER BASIN BOUNDARY MODIFICATIONS

This section briefly describes and illustrates recent changes to the DWR groundwater basin boundaries. The historical boundaries that have been used in the previous studies discussed in this report differ from the new boundaries. A comparison of the new basin boundaries to the older boundaries is warranted, as the most recent boundaries will be used in upcoming and future numerical modeling reports from United and the GSAs in their reporting to DWR for the Piru, Fillmore, and Santa Paula basins.

5.1 BACKGROUND AND MODIFICATIONS

The groundwater basin boundaries for the Piru, Fillmore, and Santa Paula basins were first presented in DWR's Bulletin 46 (1933). DWR (1956) updated these and Mann (1959) refined the basin boundaries presented by DWR (1956). Most of the studies previously discussed in this report utilized these Mann (1959) boundaries, or close variations, for their own studies and water budget component estimates (Mann, 1959; Hanson and others., 2003; LWA and others, 2015).

Figure 5-1 shows the groundwater basin boundaries that have historically been used by United and others during investigations along the Santa Clara River within Ventura County. These basin boundaries are all largely based on the delineation presented by Mann (1959). DWR updated their basin boundaries in 2003 (DWR, 2003) , which saw: 1) the expansion of Piru basin to include lower Piru Creek as well as extend east toward the Ventura/Los Angeles County line, 2) expansion of Fillmore basin up the hillslopes where aquifer material outcrops beyond the extent of alluvial deposits, and 3) expansion of Santa Paula basin up the hillslopes where aquifer material outcrops and to include Santa Paula Creek. The update to Santa Paula basin aligned it more closely, but not exactly, with the settlement boundary (see Section 2.6).

With the development of the GSA and defining their boundaries, DWR revised their Bulletin 118 groundwater basin boundaries from 2003 (DWR, 2003) and released the updated extents for review and requests for modifications in 2016 (DWR, 2016). Local agencies that were in the process of forming the GSAs for those basins were tasked with reviewing the revised DWR boundaries and submit requests for modifications. DWR was to accept modifications that were either scientifically or jurisdictionally motivated and based on relevant geologic and geographic data. Two separate rounds of modifications (2016 and 2018) were used by DWR to finalize the extents of the forming GSAs groundwater basin boundaries in February of 2019 (DWR, 2019).

For the Fillmore and Piru basins, United played the lead role in the analysis and submission of requests for modifications to the updated boundaries. Mound Basin GSA requested modifications for the shared boundary between the Santa Paula and Mound basins. Four notable modifications were made relating to the connection between these basins: 1) Scientific Internal modification of the Fillmore Basin and Piru subbasins, which better reflected the location of hydrologic connection manifested at the surface between the Fillmore and Piru basins (rising groundwater into the Santa Clara River); 2) Scientific External modification along the northern and southern portions of the Fillmore and Piru subbasins boundaries, which edited some misplaced geologic contacts as well as included alluvial deposits running upward in various canyons that drain into the basins; 3) a Jurisdiction Internal modification of the Santa Paula and Fillmore subbasins boundaries, which aligned the western end of the Fillmore Basin with the stipulated judgment boundary of the Santa Paula Basin; 4) a Jurisdiction Internal modification of the Mound and Santa Paula subbasins boundaries, which aligned the eastern end of the Mound subbasin with the stipulated judgment boundary of the Santa Paula Basin The formal documentation of the accepted modifications requests can be found on the DWR website at (last accessed: November 2020):

https://sgma.water.ca.gov/basinmod/modrequest/preview/191

and

https://sgma.water.ca.gov/basinmod/modrequest/preview/230

A comparison of the representative previous basin boundaries (Mann, 1959) to the current and official basin boundaries (DWR, 2019) can be seen in Figure 5-1 and Table 5-1, below.

Table 5-1: Piru, Fillmore and Santa Paula groundwater basin boundary modifications areal comparison

	Groundwater Basin Area (acres)		
	Mann (1959)	DWR (2019)	% increase
Piru	7,201	10,896	51
Fillmore	18,497	22,583	22
Santa Paula	14,205	22,110	56

From the DWR 2003 update and the 2019 modifications to the DWR boundaries, there was a noticeable increase in size for the Piru, Fillmore, and Santa Paula groundwater basins when compared to the Mann (1959) delineations. As mentioned above, the Piru basin increase was largely due to the inclusion of lower Piru Creek. The Fillmore basin increase was primarily from the extension of the groundwater basin up into areas of alluvial deposits at the base of the mountain slopes, including Timber Canyon to the north, and areas where the Saugus Formation outcrops along the margins of the basin. However, due to changes in the groundwater basin areal extents, future basin-specific hydrologic budgets will also be different compared to all previous investigations due to changes in total inflows, outflow, and available storage. Santa Paula's increase was a combination of the extension of the groundwater basin up into alluvial deposits at the base of the mountain slopes as well as the inclusion of Santa Paula Creek on the north, and where the San Pedro/Saugus Formation outcrops. Along the valley floor the DWR (2019) Piru/Fillmore boundaries were modified to align with the Mann (1959) delineation. Likewise, the DWR (2019) Fillmore/Santa Paula and Santa Paula/Mound basin boundaries were also were modified to align with the Mann (1959) delineation, which also coincides with the Santa Paula settlement boundary (see Section 2.6) that relied on Mann's work.

5.2 WATER BUDGET IMPACTS

With the majority of previous modeling efforts and reported water budgets based on analysis of the Piru, Fillmore, and Santa Paula basins as delineated by Mann (1959), water budgets that are estimated moving forward using the DWR (2019) basin boundaries are expected to have some differences. As mentioned above, the DWR (2019) modifications adjusted the previous DWR basin boundaries for the Piru/Fillmore shared boundary (scientific internal modification), Fillmore/Santa Paula shared boundary (jurisdiction internal modification) and the Santa Paula/Mound shared boundary (jurisdiction internal modification). These modifications brought the shared boundaries to coincide with those that Mann (1959) delineated, which allows for no changes moving forward at the boundary compared to most previous studies for these basins.

Several water budget components that would be expected to increase with the expanded basin boundaries include: 1) increased areal recharge from precipitation and applied water from groundwater and surface water sources, 2) increased groundwater extractions, and 3) increased groundwater and surface water exchange with the inclusion of creek deposits. As mentioned in the section above, the largest changes in these basins occurred by adding deposits underlying Creeks (Lower Piru Creek and Santa Paula Creek) as well as including the furthest extent of the outcrop and alluvial deposits extending up the hillslopes. With Mann's basin delineations having captured most of the water bearing and productive alluvial deposits and underlying aquifers along the valley floor, the effect on overall water budgets in not expected to be much from the additions. Relating to the addition of the creeks, Piru Creek is expected to have some groundwater and surface water interaction. Santa Paula Creek was previously believed to be a source of recharge for the Santa Paula basin, but more recent analysis has suggested that changes in the channel from flood control projects in the late 1990s have potentially reduced the recharge within Santa Paula Creek to be very minor (UWCD, 2013, 2019b). Relating to the addition of the hillslope alluvial deposits, not much change impact is expected from these additional areas because the water sources and uses within these areas were previously included in previous studies (estimated recharge from the hillslopes) or are minor (only a handful of wells are located in these higher elevation areas). As mentioned above, additional applied water will be included for these areas that were previously not considered to be within part of the groundwater basins, and the applied water is in some cases sourced from small creek diversions that capture storm flows draining from the northern hillslopes.

A significant change in the water budget estimates due to basin boundary changes between Mann (1959) and DWR (2019) is expected to be the location of Piru Creek's eastern basin boundary near the Ventura/Los Angeles County Line and the impacts it has on the underflow estimates moving from the Eastern basin into Piru basin. With the underflow estimates increasing substantially when Mann's Piru basin boundary was moved to the east for the DWR update (2003) and modifications (2019) because the water-bearing material is much thicker at the Ventura/Los Angeles County Line location compared to the previous boundary locations where alluvial deposits of limited depth and width are present. This was Piru basin change was detailed in Section 4.4, above.

6 OTHER NOTABLE CHANGES TO CONSIDER

As Section 5 details, Mann (1959), or very similar, basins boundaries were used for many of the studies from the 1950s through the more recent, which helps in the comparison of values. However, land use changes have occurred within the groundwater basins since the periods that the DWR (1956) and Mann (1959) reports considered (1937 – 1957), which affect water budgets in these basins and must be considered when comparing results from investigations during later periods. Several changes include: 1) the construction of Santa Felicia Dam on Piru Creek and related water conservation activities, 2) moderate urbanization and development within the groundwater basins, 3) changes in agricultural practices (e.g. crop changes, crop locations, and available water efficiency technology), and 4) significant urbanization and development within upstream Santa Clara groundwater basins.

Another change over time and perhaps the most systematic change that has affected Piru, Fillmore, and Santa Paula groundwater basins average annual water budgets components following construction of Santa felicia Dam is related to base flows arriving from the Eastern basin in Los Angeles County. Beginning in 1980, State Water Project water was imported to the eastern Santa Clara River Valley groundwater basin, augmenting local groundwater resources to meet increasing water demands by extensive urbanization. Large portions of this increased water use have historically been discharged as treated wastewater effluent into the Santa Clara River, resulting in increased streamflow and subsurface underflow entering Piru basin, compared to periods prior to 1980. The increased in water use upstream could explain the increase from about 240 AFY estimated in DWR (1956) and Mann (1959) to approximately 1100 AFY in CH2M HILL/HGL (2008) numerical modeling (HydroMetrics, 2008; analysis for United) for underflow near the Mann (1959) eastern Piru basin boundary. As such, changes in water use and demand upstream in Los Angeles County (e.g. increased development, potential increased recycled water) is expected to affect the water budgets of Piru and the remaining downstream groundwater basins within Ventura County.

7 SUMMARY AND CONCLUSIONS

Extensive efforts by various entities have provided foundational knowledge of the hydrology of the Piru, Fillmore, and Santa Paula groundwater basins as well as provided detailed datasets and estimates of various water budgets components for each basin. Table E-1 summarizes the hydrologic investigations which contributed water budget components related to the groundwater basins that make up the current study area. Table E-2 summarizes the range of reported water budget component values for each of the groundwater basins which were presented in the previous hydrologic studies that are listed in Table E-1.

The majority of the values presented in Table E-2 were extracted from DWR (1956) or Mann (1959), with other primary sources being CH2M HILL (2004, 2005), CH2M HILL/HGL (2008), LWA and others (2015) and DBS&A and RCS (2017). Values of lower and upper ranges were sourced from all the investigations reported. Each of the reports used for this review are representative of varying, sometimes overlapping, climatic periods and conditions (Table E-1). Since the values reported from DWR (1956) and Mann (1959) provided the most complete summaries of water budgets, most of the lower and upper bounds of the reported range for many of the components, presenting the results in this way is considered appropriate, and helpful, for comparison purposes.

In relation to United's efforts in the expansion of United's active numerical groundwater flow model, reviewing all available previous water budget component estimates helps during the numerical modeling development and calibration in order to ensure values of water budget components from the new model are reasonable. Additionally, it highlights where less information is known from a quantitative perspective and where additional monitoring and/or coordination with neighboring agencies can help further inform during the development process. With this review of previous water budgets estimates, United staff is continuing its ongoing numerical groundwater model expansion efforts that will support United's ability of regional water management planning, with the most immediate need satisfied through supporting local GSAs in developing GSPs.

Based on this review, United offers the following conclusions related to the previous studies and reported water budgets for the Piru, Fillmore, and Santa Paula groundwater basins:

- There are extensive previous studies available for these basins that were based on field, analytical, and numerical studies, dating back to the 1920s (Table E-1).
- The most significant inflows to each basin consist of recharge from streamflow (Santa Clara River) percolation, areal recharge from precipitation and applied water from groundwater and surface water sources, and incoming subsurface underflow from upstream groundwater basins.
- The most significant outflows to each basin consist of groundwater extractions for beneficial use and outgoing subsurface underflow to downstream groundwater basins.
- With the Santa Clara River (SCR) being the largest source of recharge (especially for Piru and Fillmore Basins), these basins are highly variable due to the dependence on local

rainfall within the SCR watershed. This variability and dependence on surface water inflows leads to the large range observed in the previously reported water budget components (Table E-2). This dependence to surface water flows is expected to continue in the future, resulting in variable water budgets of similar ranges.

- Basin boundary modifications have recently been adopted that expanded the extent of the Piru, Fillmore, and Santa Paula groundwater basins. The majority of the studies reviewed for this document utilized boundaries that captured most of the water-bearing and productive alluvial deposits and underlying aquifers along the valley floor, and the overall effect on the ranges for many of the water budget components is not expected to be significant. Changes to the upstream extent of the Piru basin will however result in an increase in the subsurface underflow into Piru basin from the east. This value is expected to increase using the Department of Water Resources (DWR, 2019) boundary moving forward due to the substantial increase in saturated aquifer thickness near the Los Angeles County line compared to the downstream locations used in previous studies. The increased area will also result in increased recharge to the underlying aquifers due to precipitation.

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FIGURES

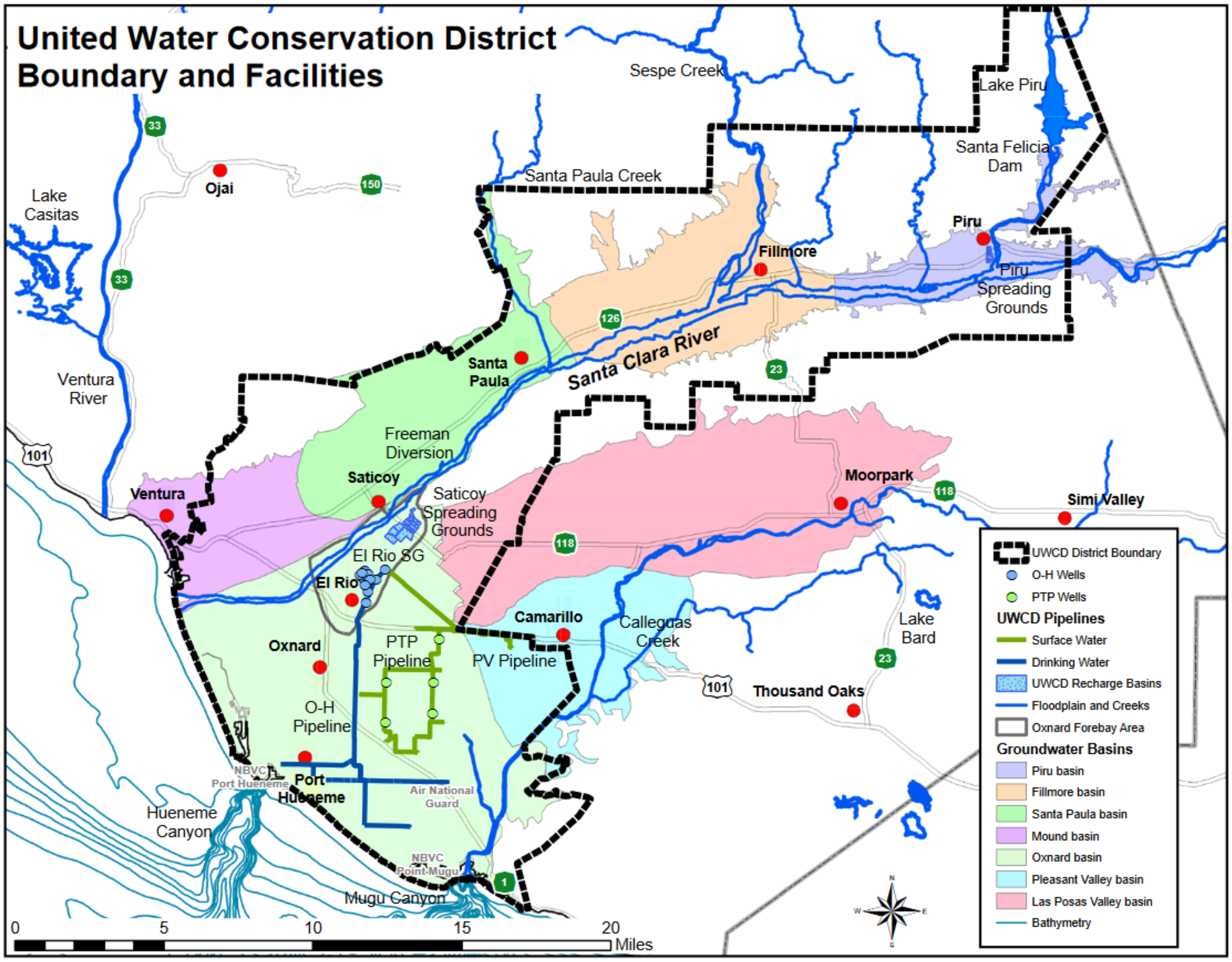

Figure 1-1. United's district boundaries, major recharge and conveyance facilities and groundwater basins.

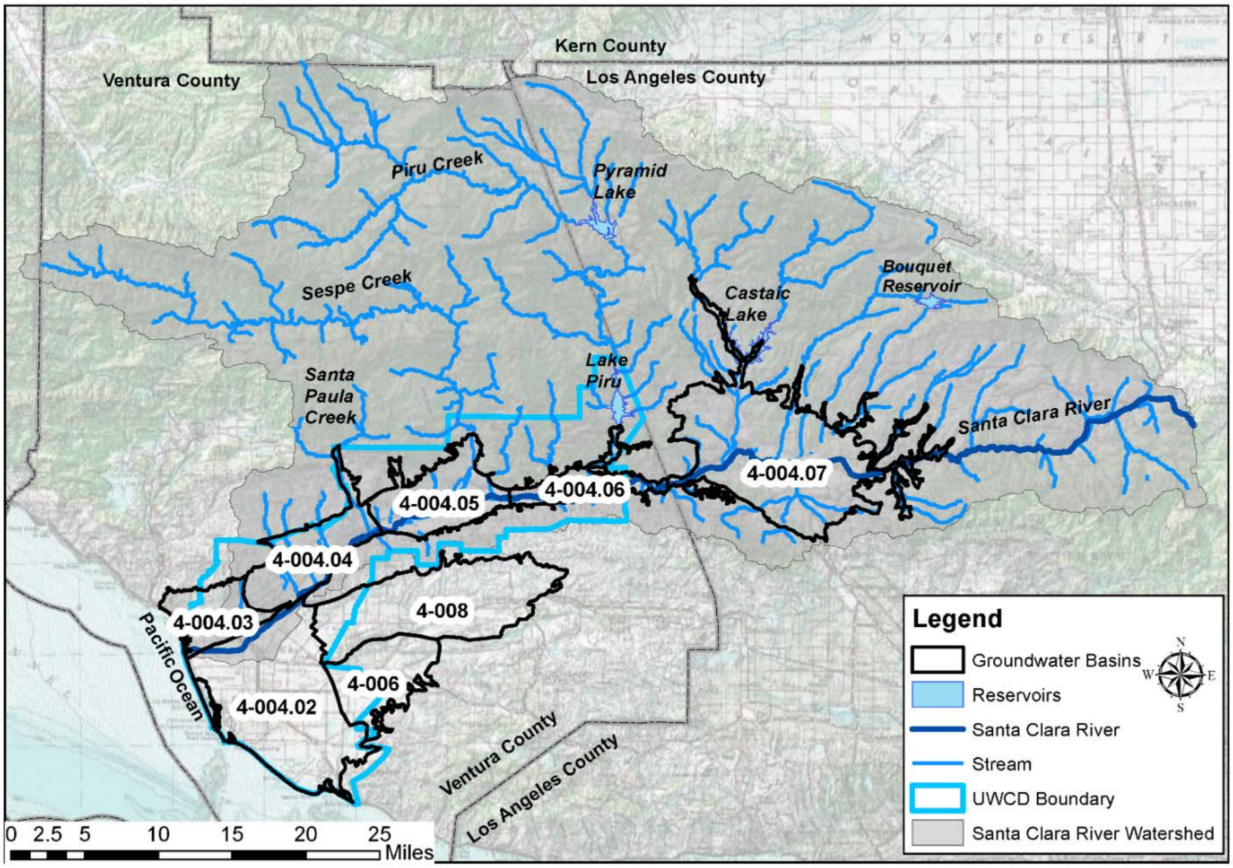

Figure 1-2. Study area and adjacent basins, with California Department of Water Resources groundwater basin boundary numbering.

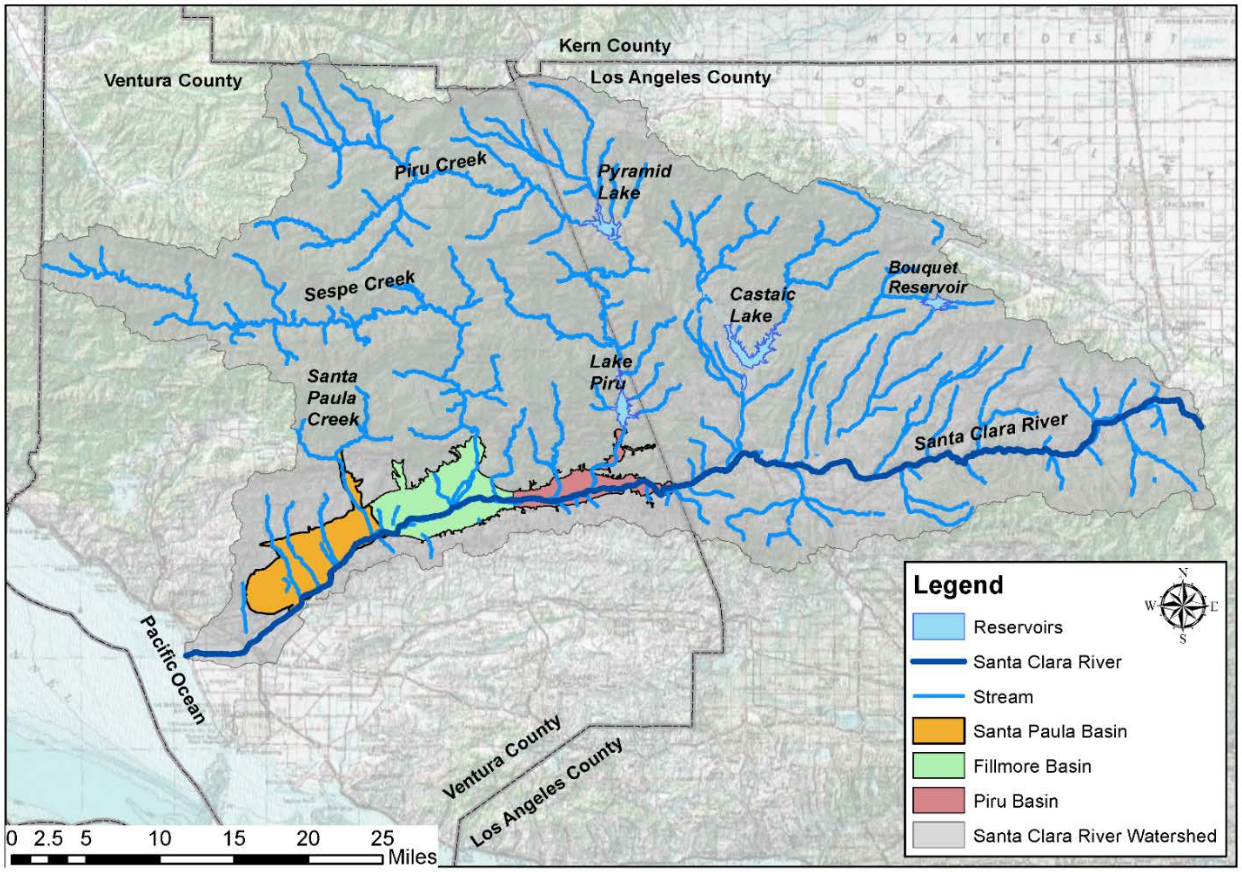

Figure 1-3. Watershed of the Santa Clara River, and the Piru, Fillmore and Santa Paula groundwater basins.

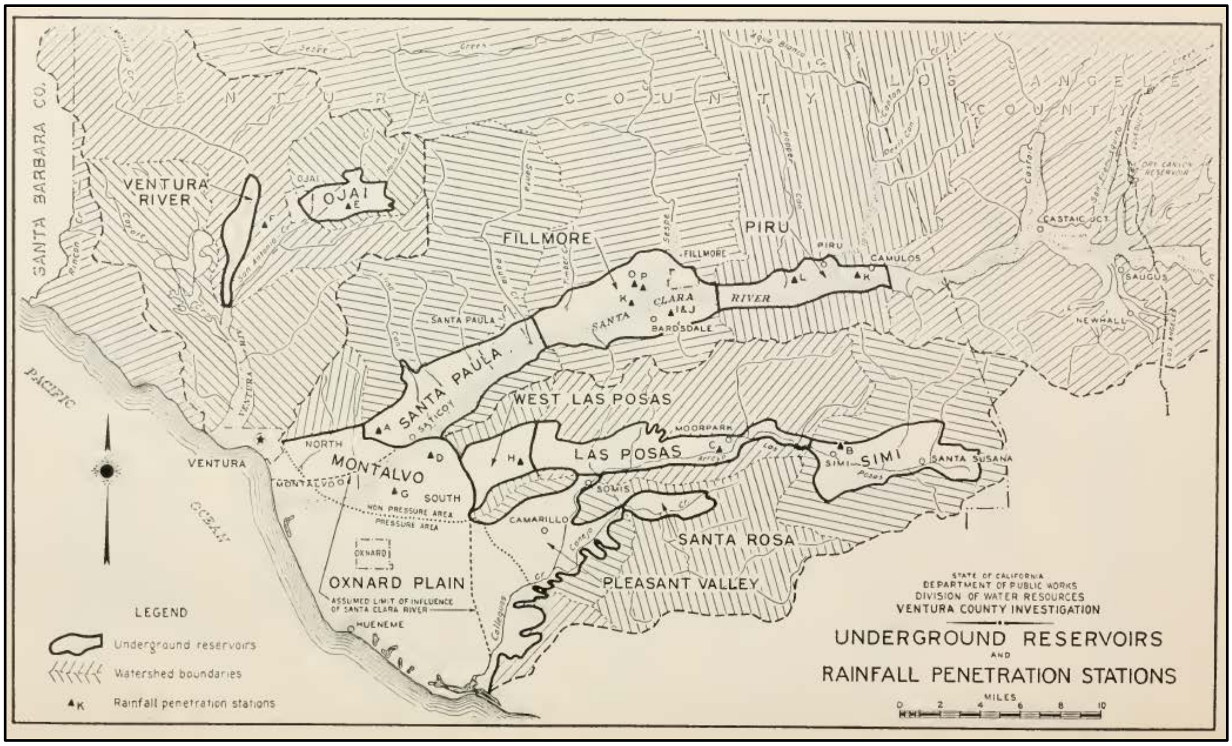

Figure 2-1. Underground reservoirs and rainfall penetration stations as of 1932 (DWR 1933, Plate 1).

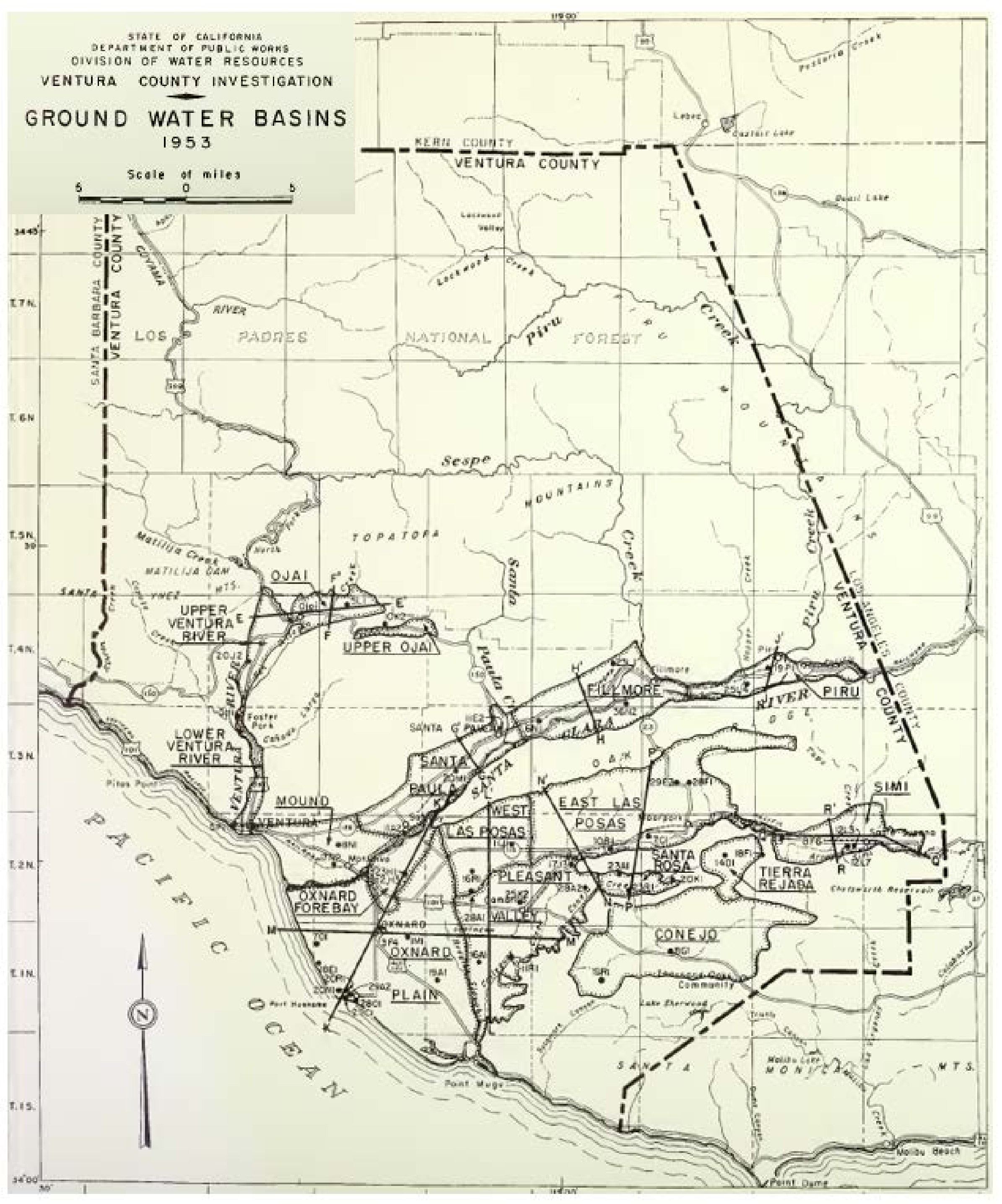

Figure 2-2. Ventura County groundwater basins as of 1953 (DWR, 1956, Plate 11).

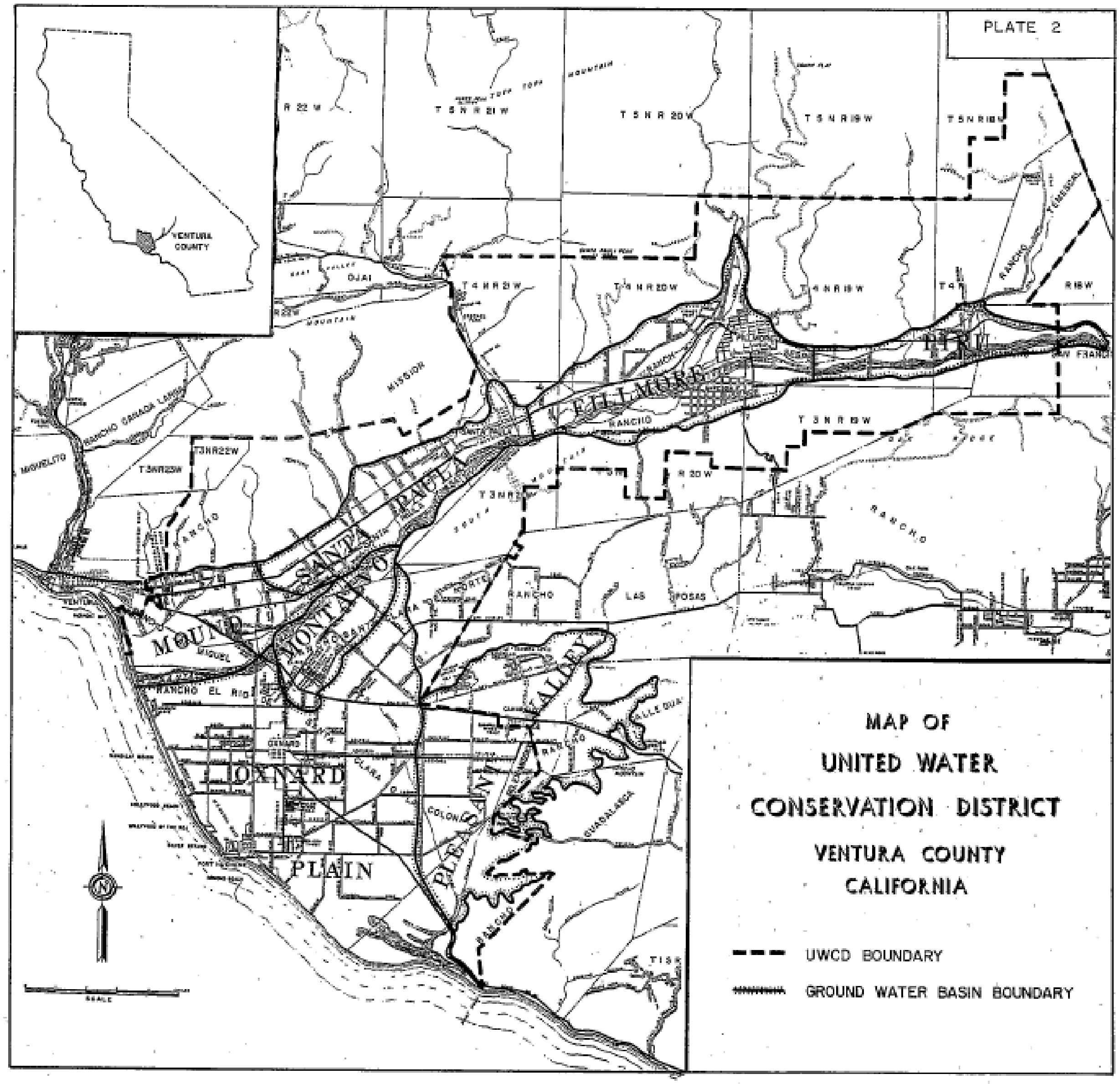

Figure 2-3. Map of United Water Conservation District and groundwater basins as described by (Mann, 1959; Plate 2). *Note: “Oxnard Forebay” groundwater basin presented in Bulletin 12 (DWR, 1956) is called “Montalvo.” Like Bulletin 12, Mound basin is now identified.*

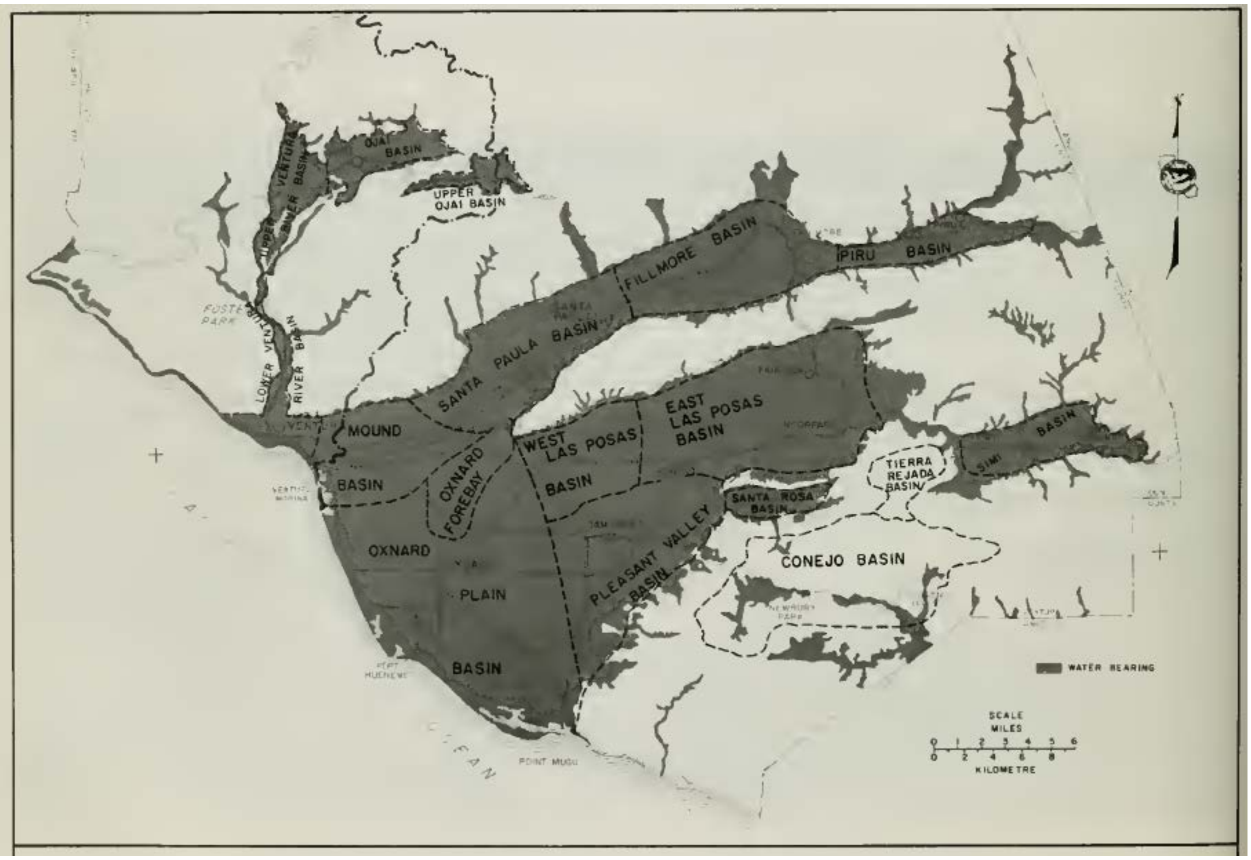

Figure 2-4. Groundwater basins (DWR, 1976; Figure 8).

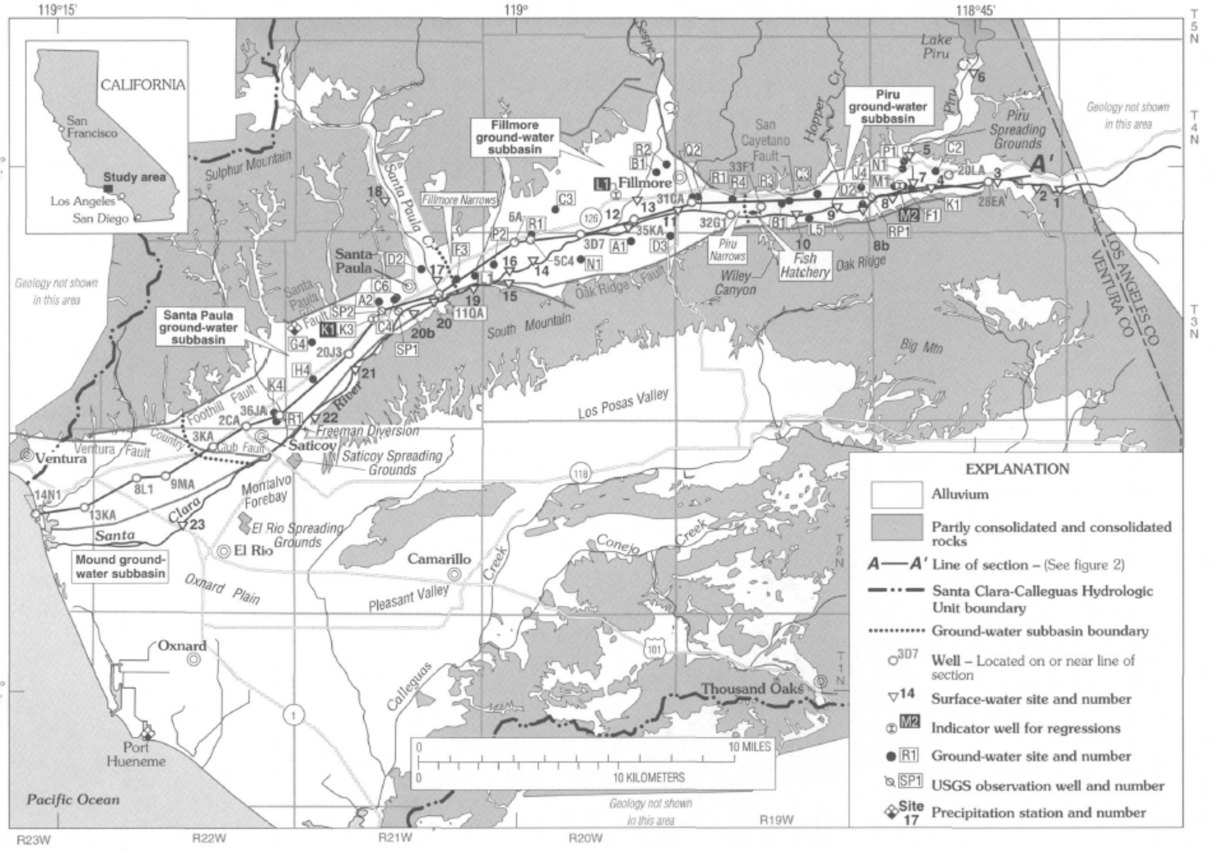

Figure 2-5. Surface water and groundwater sampling sites in the study area, Santa Clara River basin, Ventura County, California (Reichard and others, 1999; Figure 1).

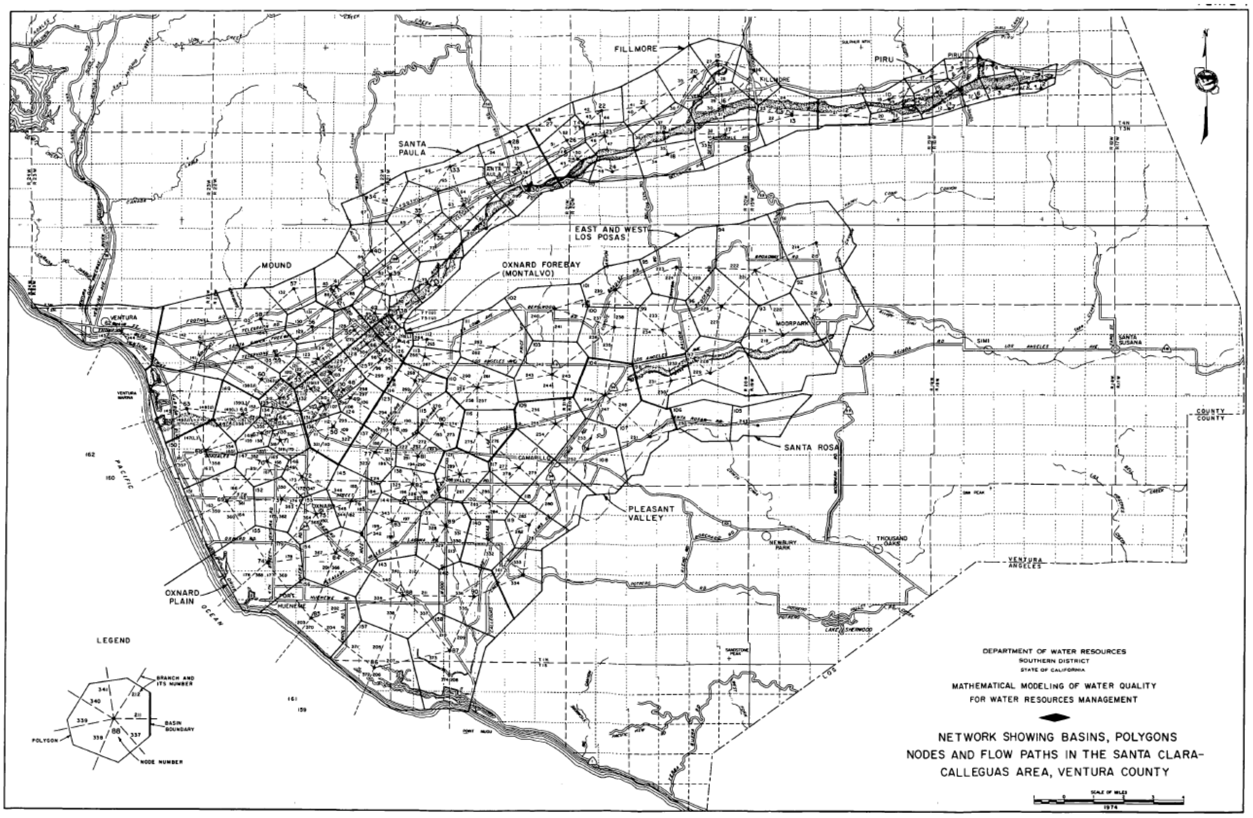

Figure 3-1. Network showing basins, polygons nodes and flow paths in the Santa Clara-Calleguas area, Ventura County based in DWR modeling (DWR 1974a; Plate 1).

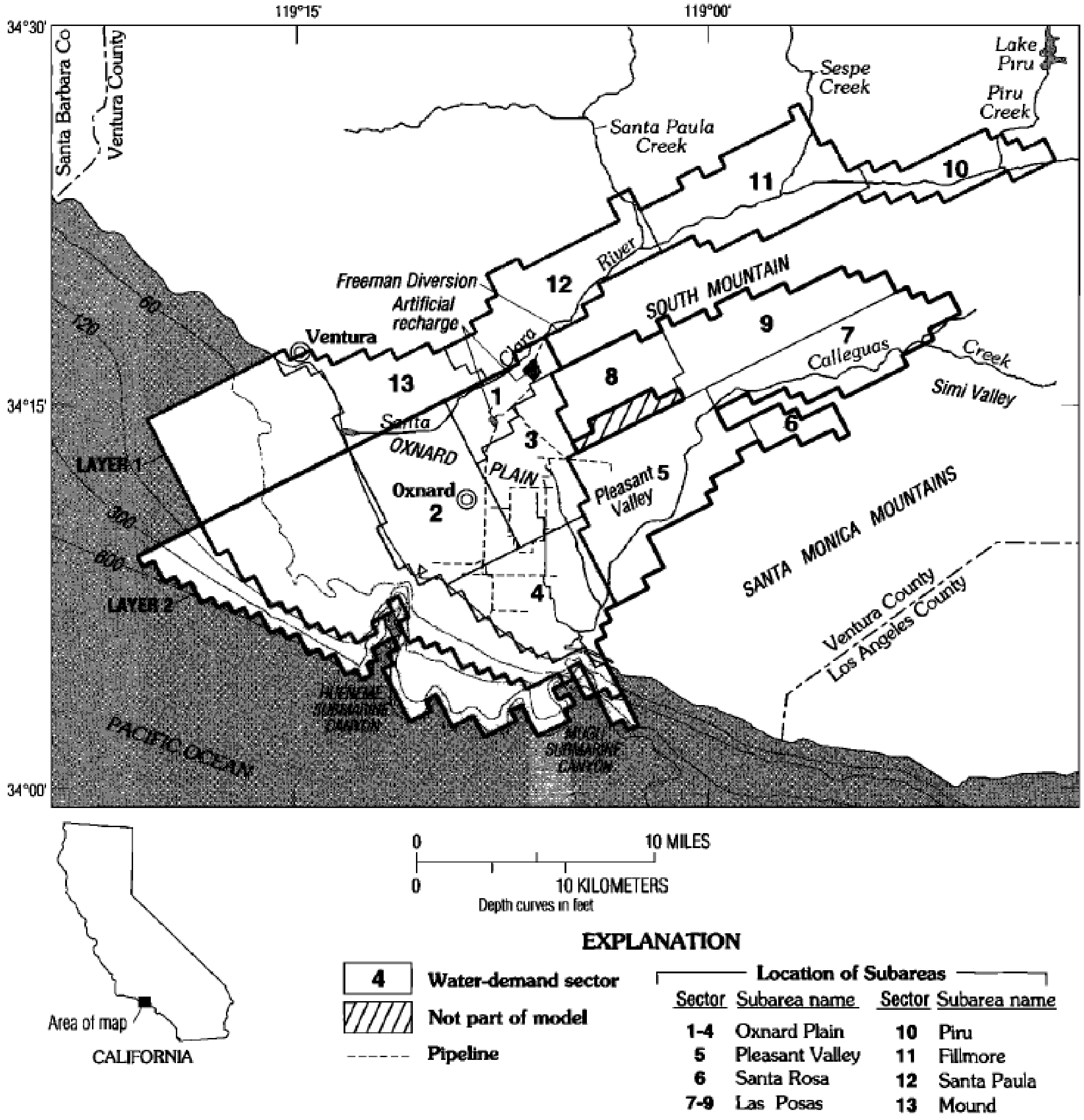

Figure 3-2. Santa Clara-Calleguas basins used by Reichard (1995; Figure 1).

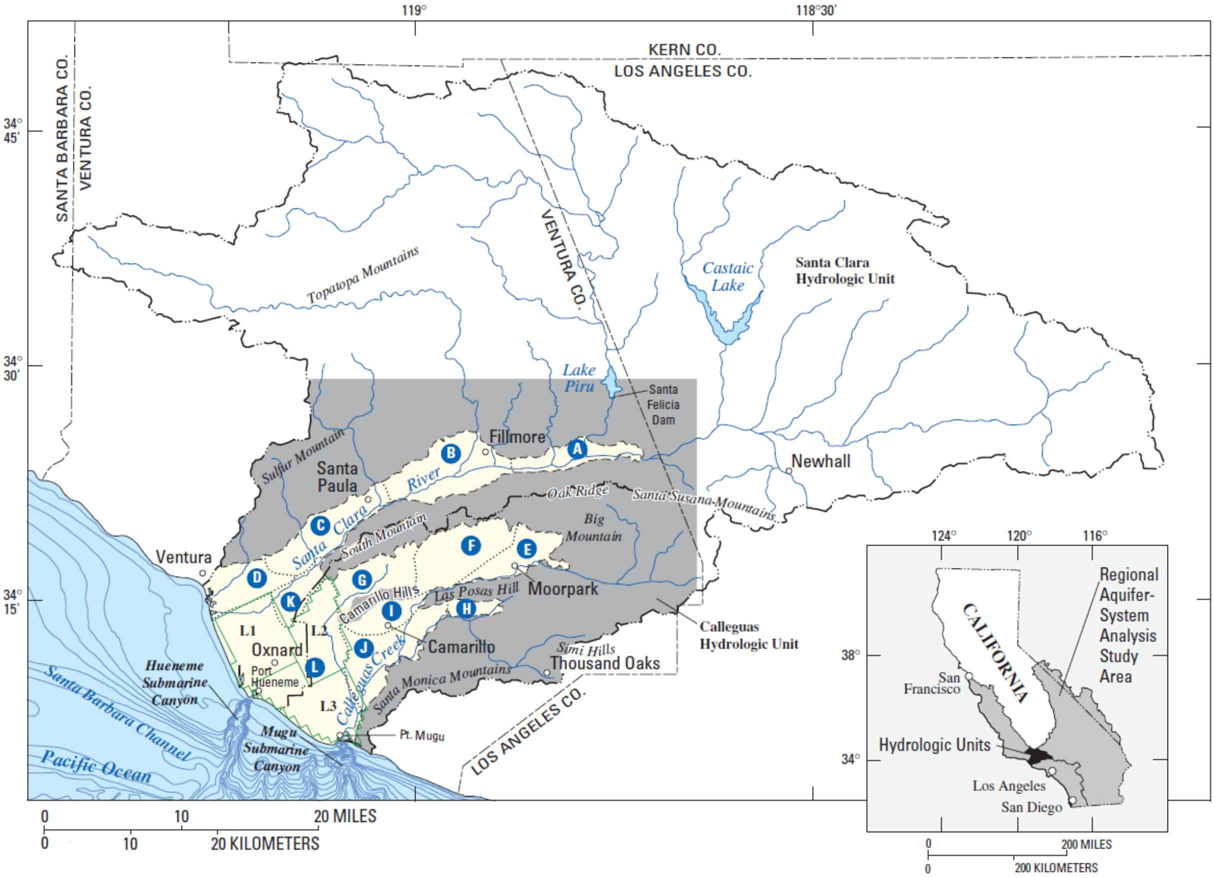

Figure 3-3. Santa Clara-Calleguas hydrologic unit and groundwater basins, (Hanson and others, 2003; Figure 1).

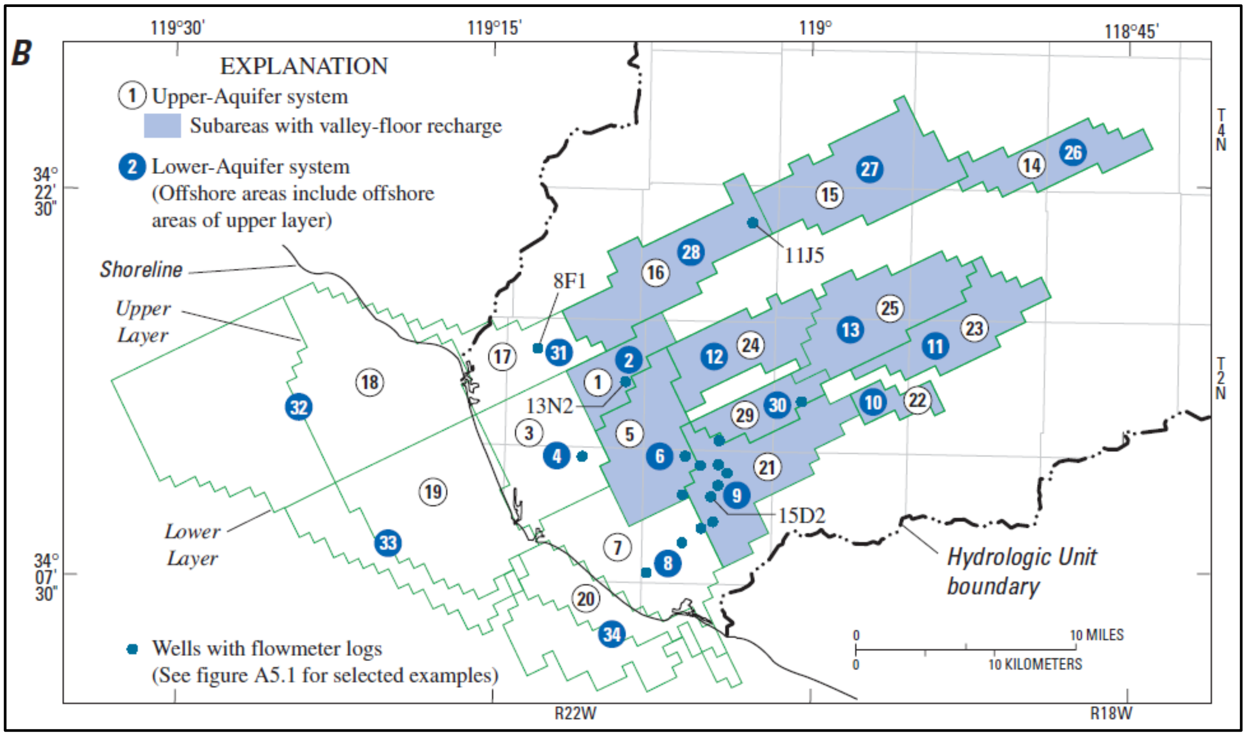

Figure 3-4. Modeled subareas for the upper-and lower-aquifer systems (Hanson and others., 2003; Figure 17B).

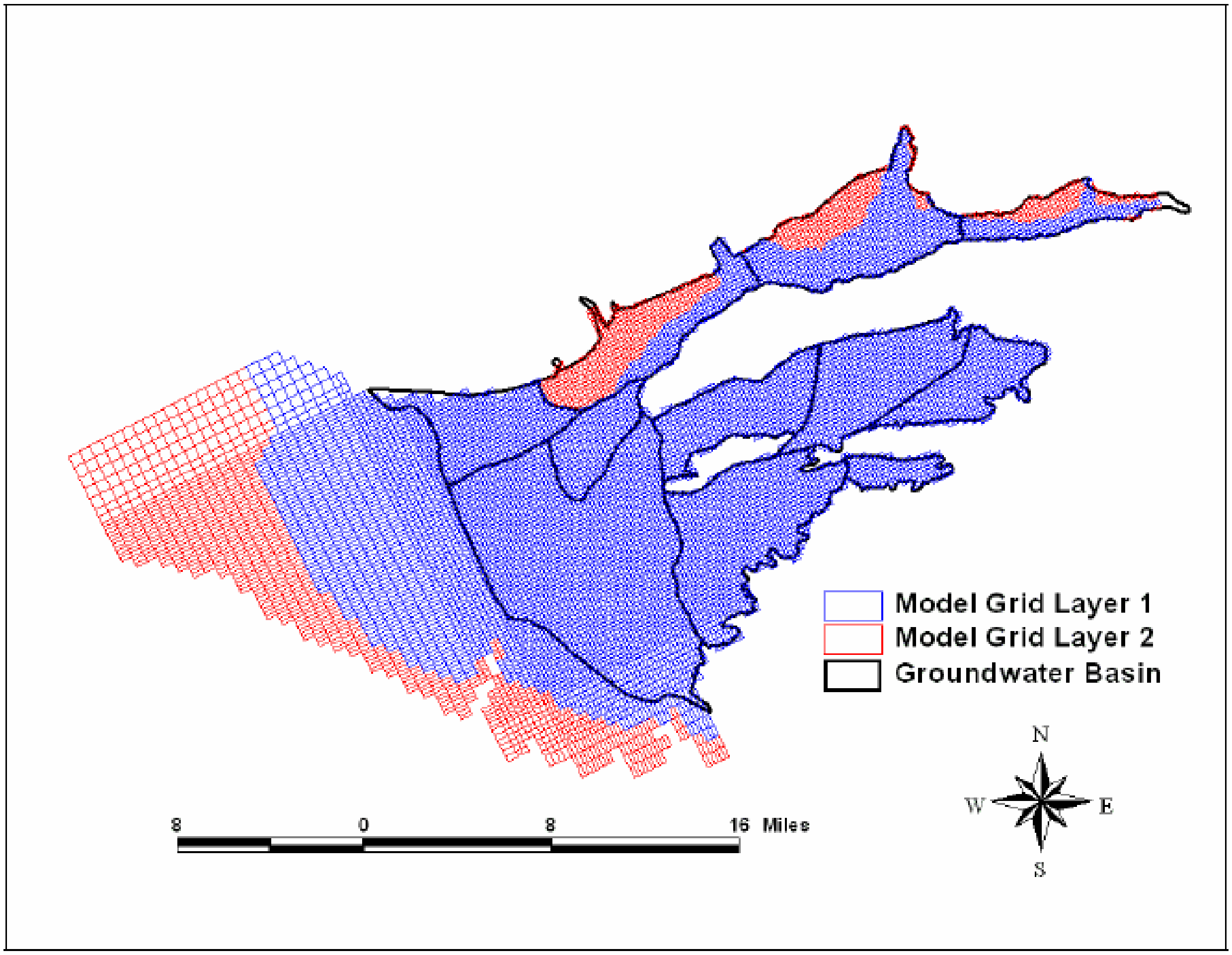

Figure 3-5. Updated model grid for Ventura Regional Groundwater Model (FCGMA and others, 2007; Figure 57).

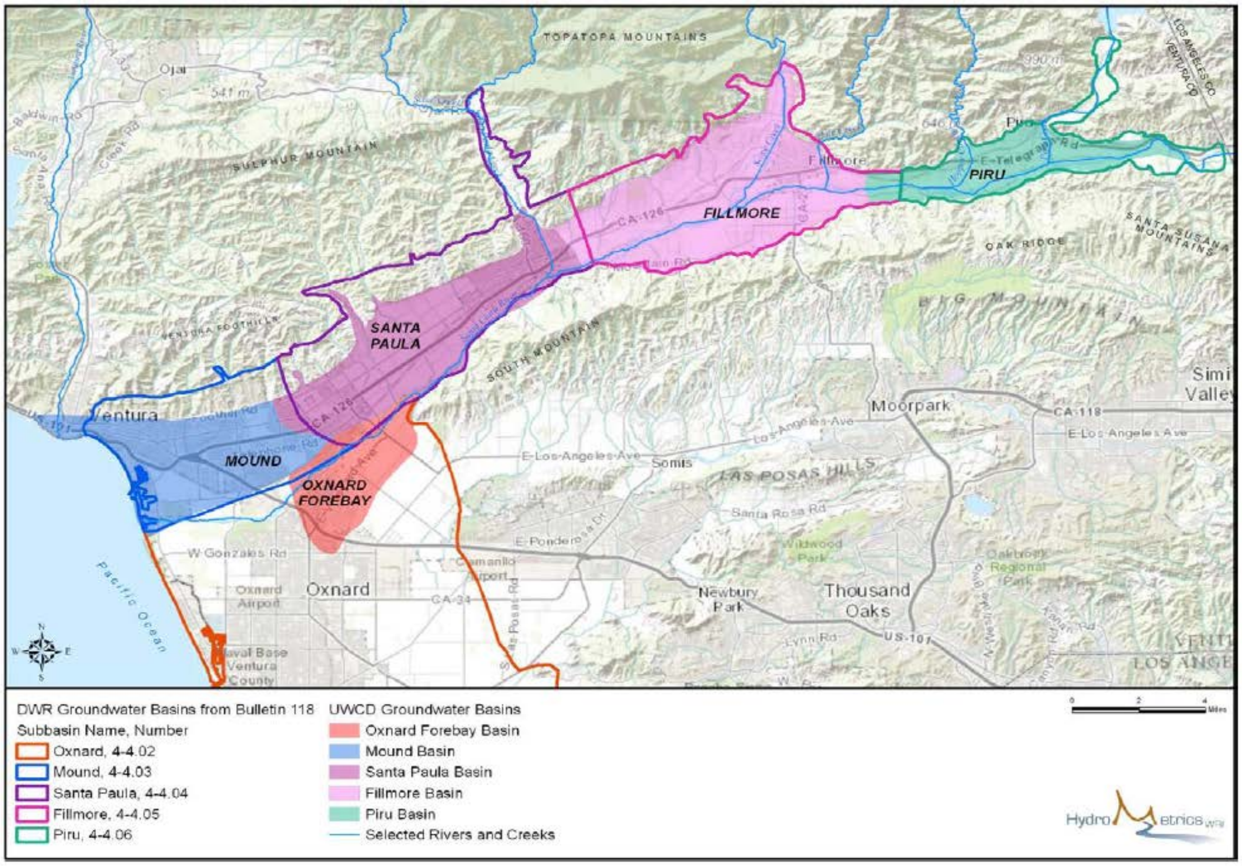

Figure 3-6. Lower Santa Clara River SNMP area comparison of DWR (Update 2003) and UWCD groundwater basins delineations (LWA and others, 2015; Figure 3-2). Note: LWA and others (2015) used United's basin boundaries for analysis.

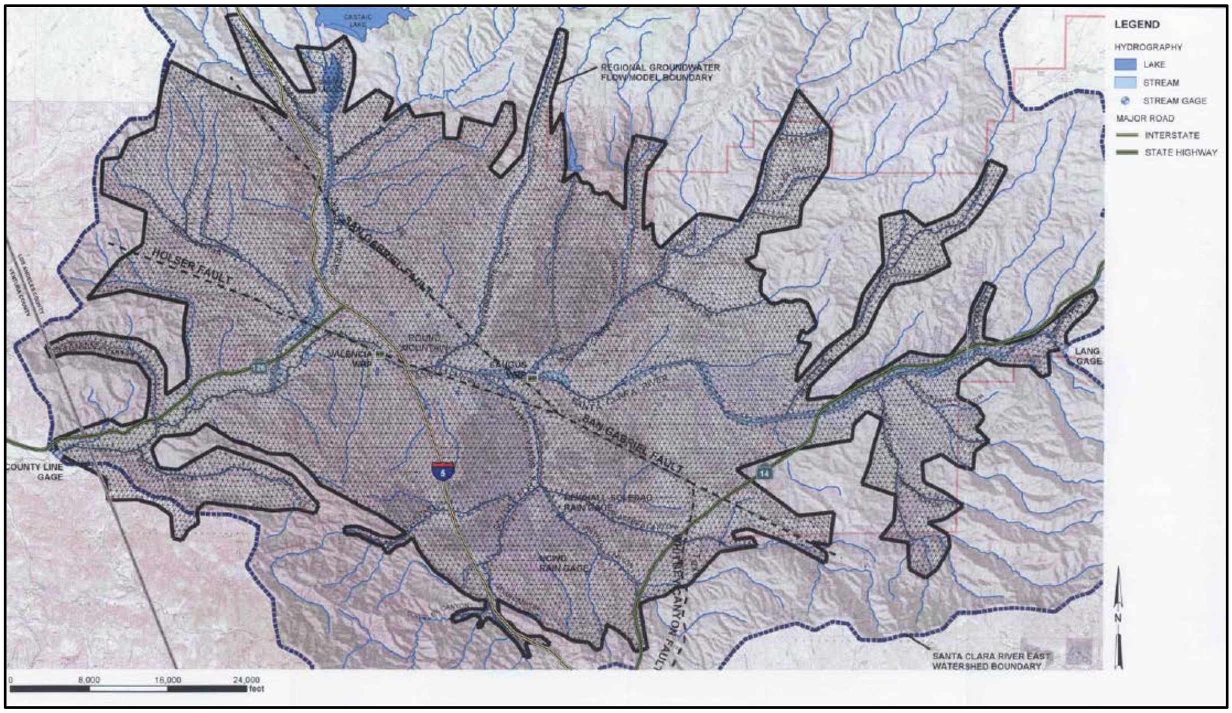

Figure 4-1. Groundwater flow model grid for the Santa Clarita Valley, (CH2M HILL, 2004; Figure 3-1).

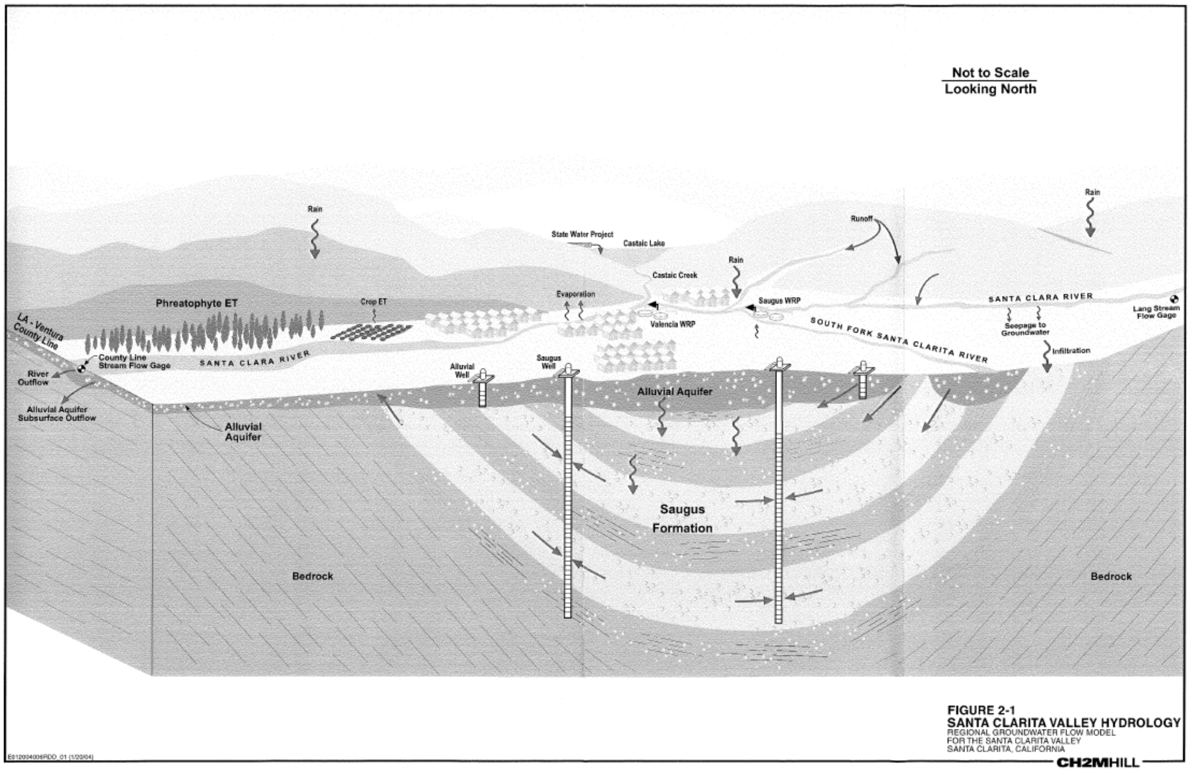

Figure 4-2. Santa Clarita Valley hydrology (CH2M HILL, 2004; Figure 2-1).

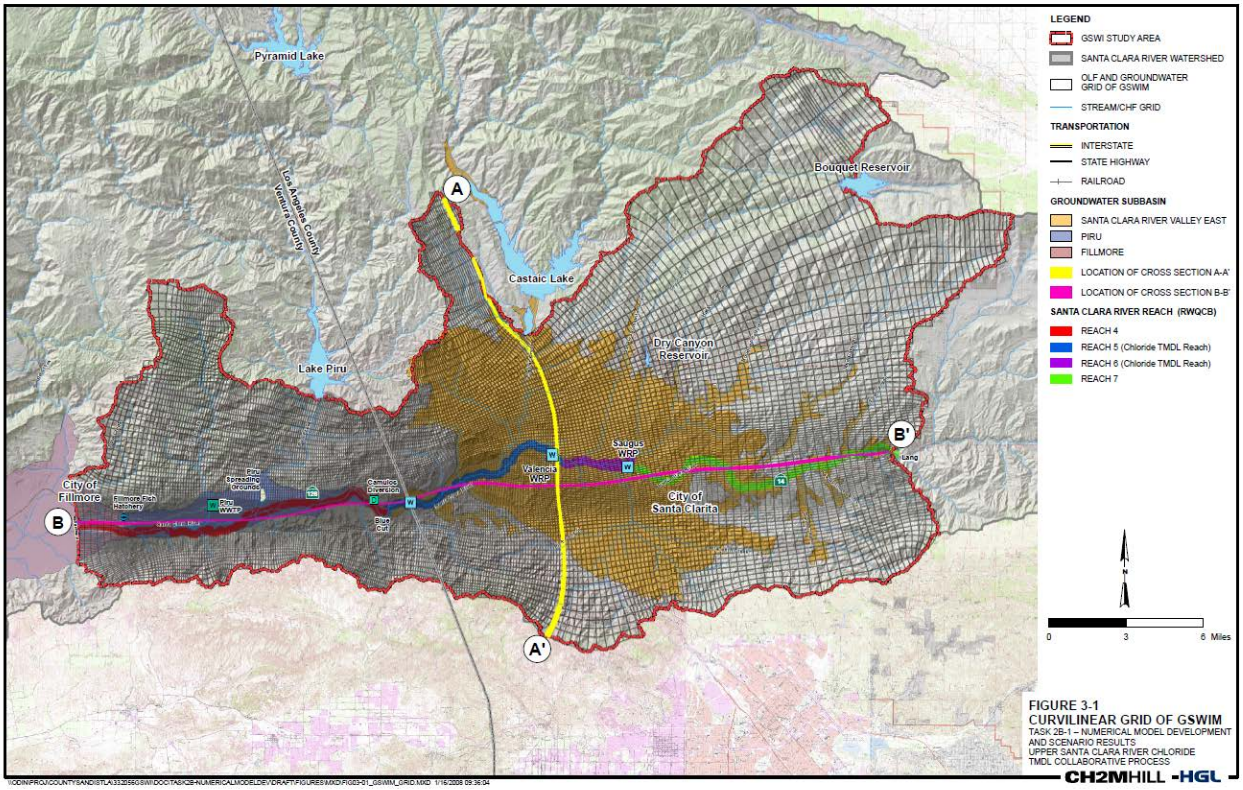

Figure 4-3. Curvilinear grid of GSWIM (CH2M HILL/HGL, 2008; Figure 3-1).

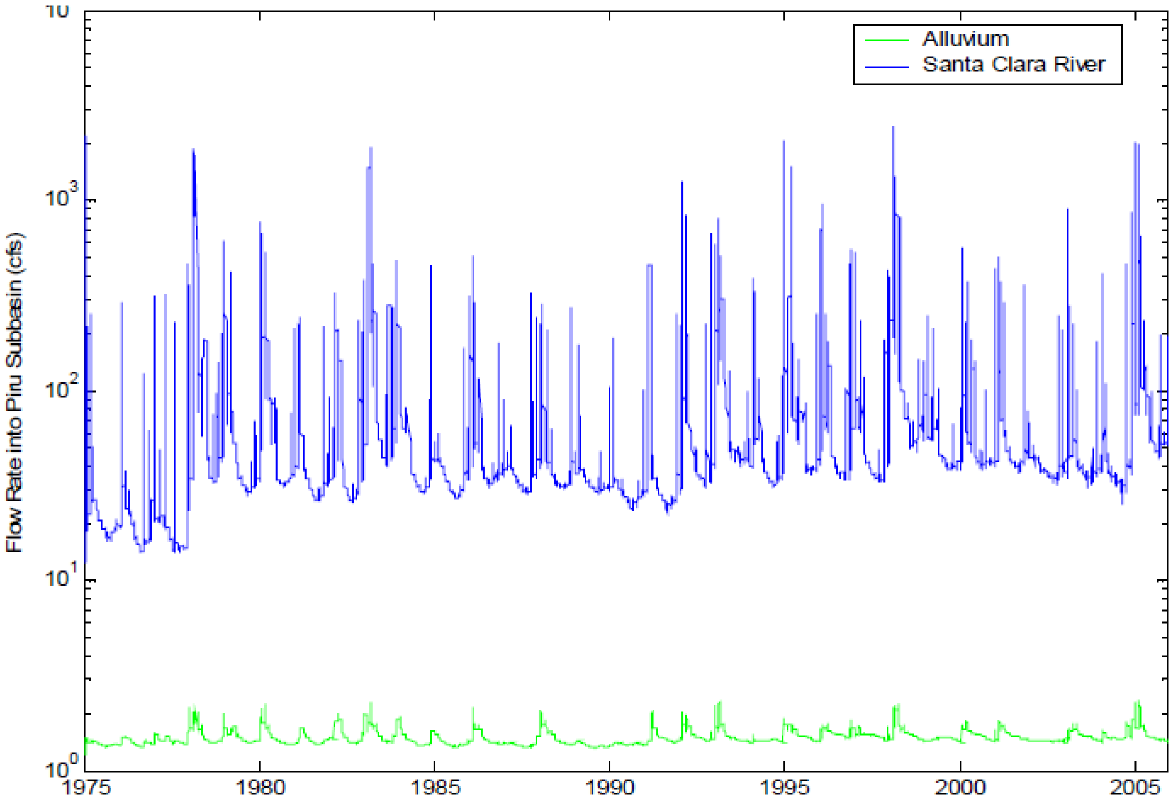

Figure 4-4. CH2M HILL and HGL modeled flow rates into Piru groundwater basin (CH2M HILL, 2008), modified from the HydroMetrics report (2008; Figure 2).

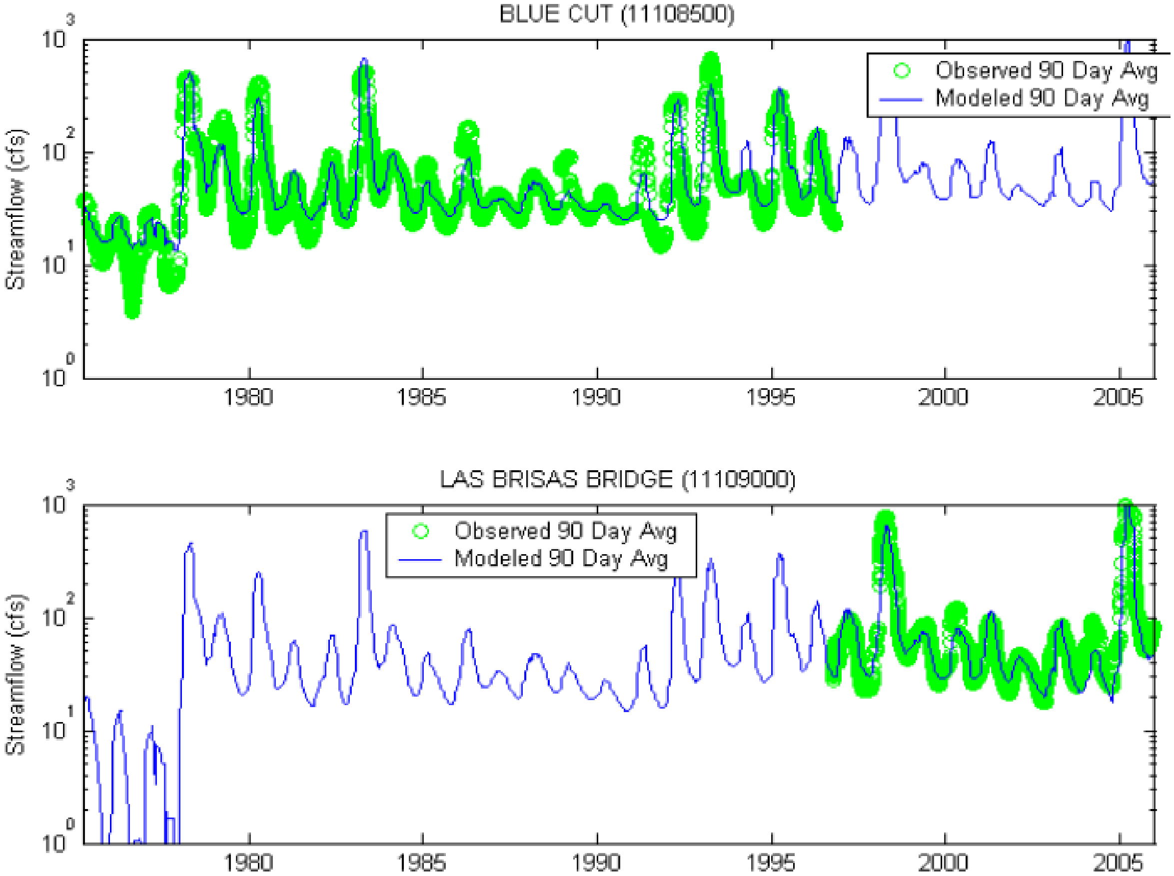

Figure 4-5. CH2M HILL/HGL 90-day averages of modeled versus observed streamflows at Blue Cut (CH2M HILL/HGL, 2008). modified from the HydroMetrics report (2008; Figure 2). *Note: that Blue Cut and Las Brisas Bridge are the two USGS streamflow locations near the Los Angeles and Ventura County Line. The USGS moved the official gaging location from Blue Cut to Las Brisas in October 1996.*

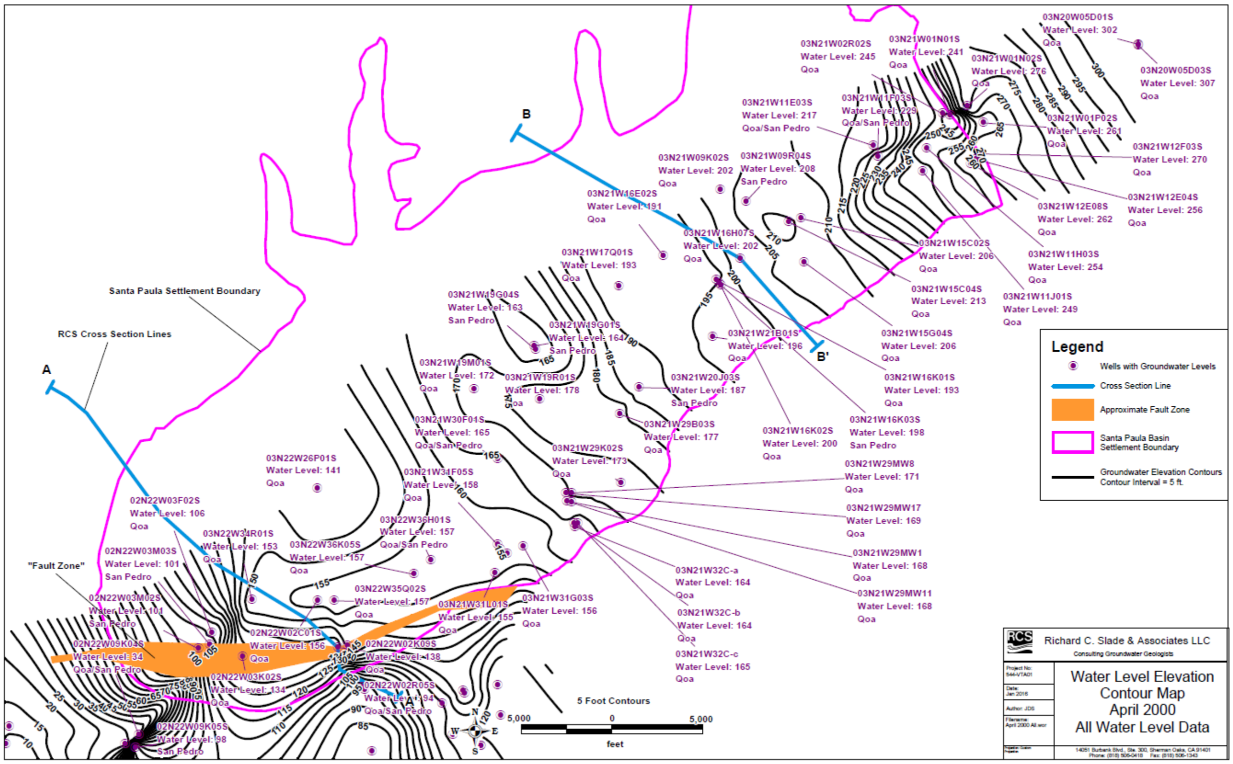

Figure 4-6. Water level elevation contour map, April 2000, all water level data (DBS&A and RCS, 2017; Figure 1 in Appendix F).

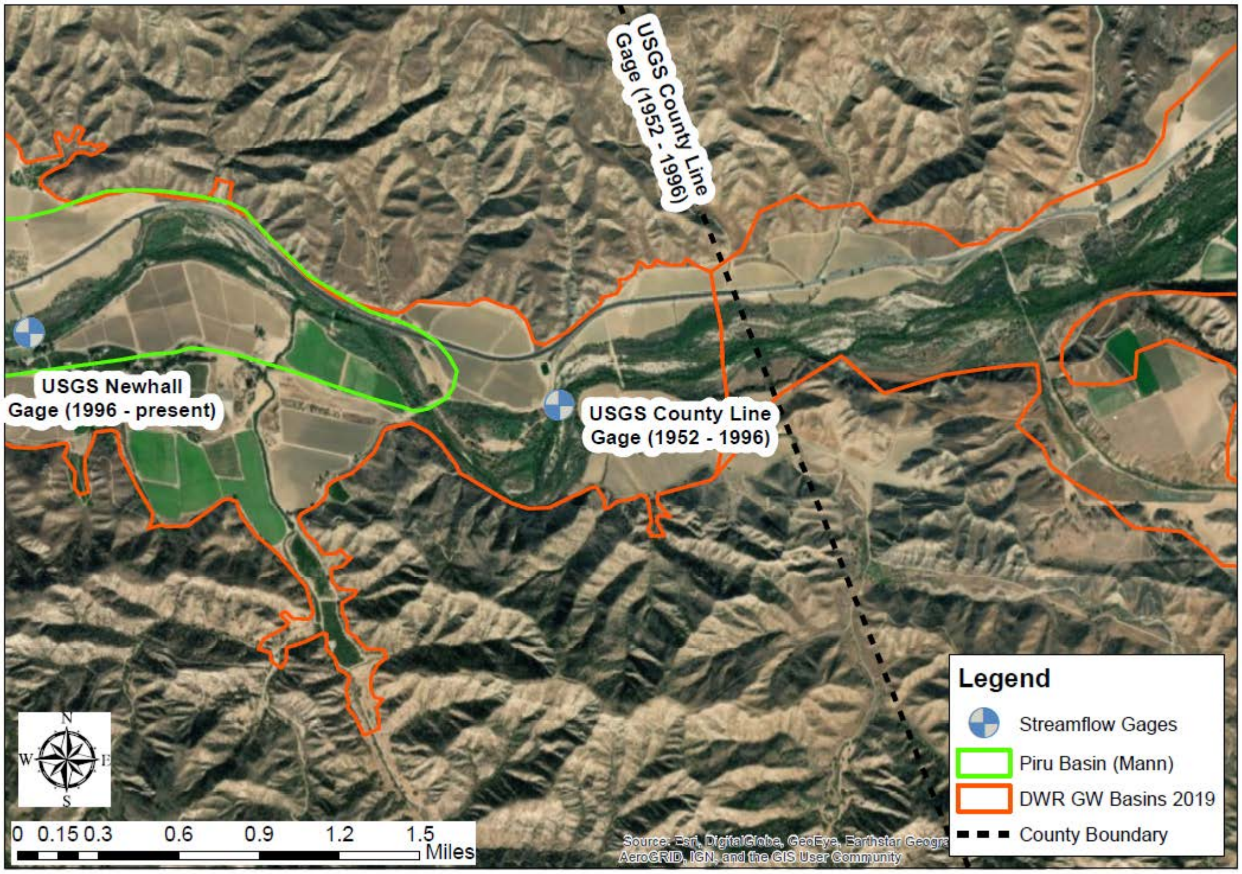

Figure 4-7. Site location of Piru Basin boundaries from Mann (1959) and DWR (2019) as well as streamgages and the Ventura/Los Angeles County Line.

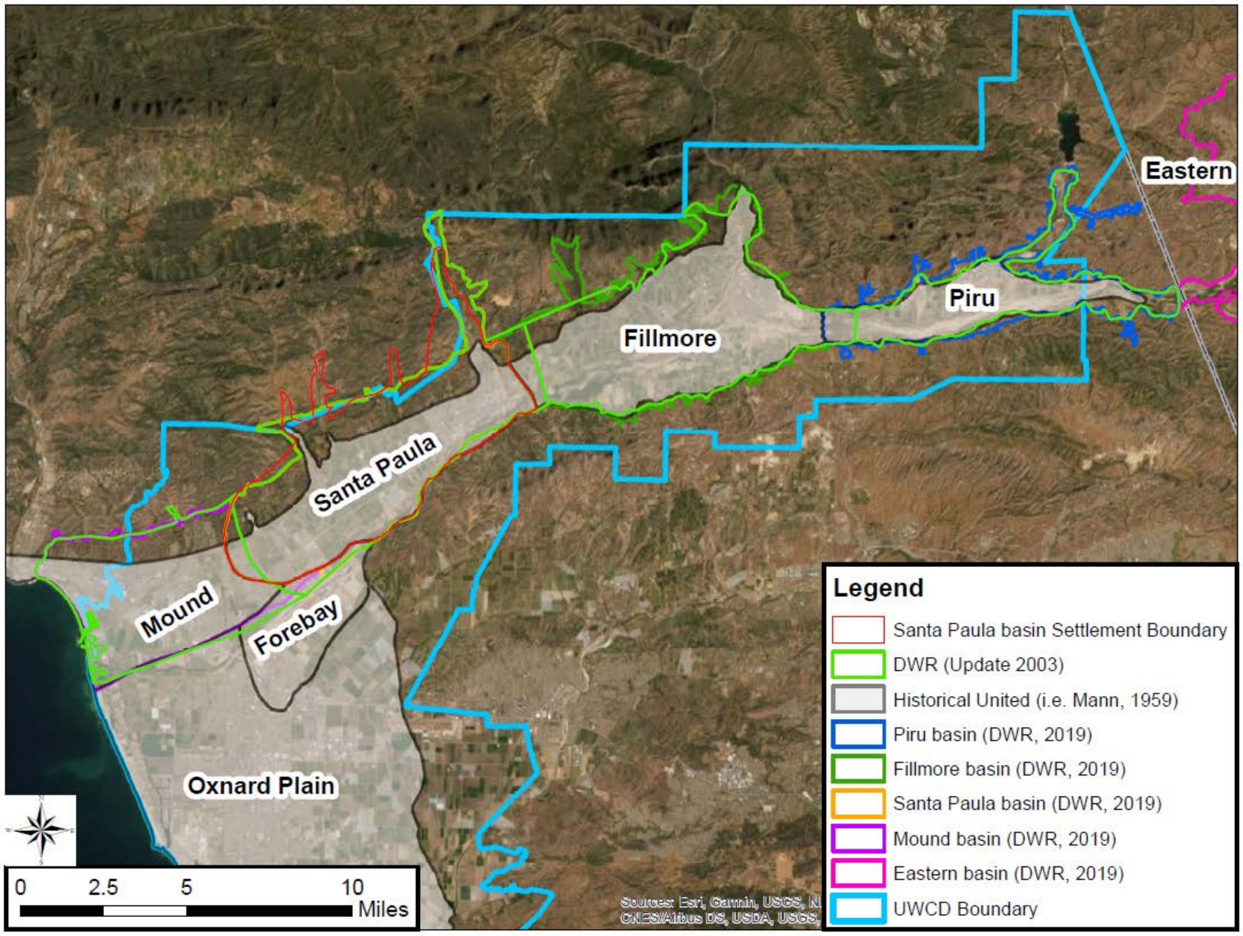

Figure 5-1. Comparison of groundwater basin boundaries along the Santa Clara River within Ventura County.

Appendix H

Historical and Current Water Budgets

Appendix H-1

Historical and Current Annual Surface Water Budget

Historic and Current Annual Surface Water Budget

			Inflows		Outflows	Inflows
Water Year	**Type**	**Sespe Creek**	**Santa Clara River (from Piru)**	**Pole Creek**	**Santa Clara River (to Santa Paula)**	**- Outflows**
1988	Dry	46,701	687	12,169	-72,462	12,905
1989	Dry	14,145	461	8,510	-30,185	7,070
1990	Critical	4,465	196	746	-12,970	7,563
1991	Dry	78,093	732	21,423	-100,892	643
1992	Wet	203,648	2,166	67,169	-260,137	-12,847
1993	Wet	460,968	4,578	229,354	-703,454	8,554
1994	Above Normal	28,845	4,701	36,368	-93,003	23,090
1995	Wet	332,734	12,759	117,371	-505,381	42,517
1996	Above Normal	29,947	1,948	28,796	-87,822	27,131
1997	Below Normal	80,970	1,473	21,928	-126,572	22,200
1998	Wet	386,503	6,468	259,158	-697,457	45,328
1999	Wet	22,665	1,152	29,933	-81,776	28,027
2000	Dry	44,231	1,043	27,837	-88,631	15,521
2001	Above Normal	145,439	2,753	48,454	-213,991	17,345
2002	Critical	7,661	525	32,596	-55,479	14,697
2003	Below Normal	52,213	683	16,717	-79,777	10,164
2004	Below Normal	28,919	1,149	9,106	-50,245	11,072
2005	Wet	541,667	12,881	400,598	-997,965	42,819
2006	Wet	152,871	2,023	49,941	-239,125	34,289
2007	Critical	11,013	373	23,382	-56,333	21,565
2008	Critical	137,048	1,490	43,937	-198,016	15,541
2009	Below Normal	28,645	484	30,248	-73,127	13,750
2010	Above Normal	71,584	668	23,114	-110,769	15,403
2011	Wet	158,553	1,036	48,170	-231,034	23,275
2012	Below Normal	15,183	962	24,437	-60,889	20,307
2013	Critical	4,316	107	12,222	-29,662	13,018
2014	Critical	18,583	108	3,007	-26,714	5,016
2015	Critical	8,556	191	3,522	-13,865	1,596
2016	Critical	6,615	28	2,012	-9,551	897
2017	Below Normal	94,766	2,747	35,899	-126,990	-6,422
2018	Dry	17,653	156	1,013	-16,718	-2,105
2019	Above Normal	143,365	1,842	47,834	-177,241	-15,801

Notes:
- Flows are in acre-feet/year (AFY), based on values from United (2021a).
- Water year types are based on those provided by DWR (2018a).

Appendix H-2

Historical and Current Annual Groundwater Budget

Historic and Current
Annual Groundwater Budget

		Inflows				Inflow/ Outflow	Outflows			Change in Groundwater in Storage		Error	
Water Year	**Type**	**Underflow from Piru**	**Recharge (Basin Floor)**	**Recharge (Mountain Front)**	**Underflow from Outside**	**Stream Exchange**	**Wells**	**Underflow to Santa Paula**	**Evapo-transpiration (ET)**	**Annual**	**Cumulative**	**Annual**	**Cumulative**
1988	Dry	43,246	22,324	6,506	2,289	-4,568	-46,352	-16,561	-13,418	-6,539	-6,539	-5	-5
1989	Dry	43,140	19,714	5,458	1,842	-1,686	-52,726	-16,794	-10,819	-11,867	-18,406	4	-1
1990	Critical	39,774	19,089	4,962	1,677	-3,933	-58,655	-17,246	-7,105	-21,435	-39,841	2	1
1991	Dry	35,280	24,296	7,955	1,553	3,816	-57,039	-17,454	-6,085	-7,678	-47,519	0	1
1992	Wet	40,111	27,606	10,023	1,320	15,029	-50,168	-17,192	-8,529	18,211	-29,308	11	12
1993	Wet	52,296	29,764	12,147	1,321	11,780	-46,023	-17,071	-14,740	29,468	160	-6	6
1994	Above Normal	53,385	17,981	5,878	1,768	-4,046	-47,536	-17,155	-14,752	-4,483	-4,323	-6	0
1995	Wet	51,179	29,241	12,135	2,138	-4,168	-41,914	-17,320	-17,143	14,143	9,820	-5	-5
1996	Above Normal	52,531	18,284	6,111	2,054	-8,201	-50,613	-17,599	-15,504	-12,941	-3,121	-4	-9
1997	Below Normal	50,856	19,404	7,014	1,843	-4,226	-45,588	-17,601	-14,875	-3,177	-6,298	-4	-13
1998	Wet	52,892	26,651	11,462	1,752	-3,799	-39,920	-17,304	-17,512	14,236	7,938	14	1
1999	Wet	53,107	16,522	4,649	1,977	-6,286	-50,890	-17,015	-15,051	-12,990	-5,052	-3	-2
2000	Dry	50,979	18,767	5,983	1,585	-1,687	-51,763	-17,372	-13,554	-7,066	-12,118	-4	-6
2001	Above Normal	50,476	25,122	8,799	1,483	-427	-47,139	-17,420	-15,027	5,862	-6,256	-5	-11
2002	Critical	48,492	16,130	4,715	1,496	-2,814	-47,918	-17,492	-13,028	-10,422	-16,678	-3	-14
2003	Below Normal	45,347	21,375	7,129	1,220	-1,057	-41,681	-17,483	-13,444	1,401	-15,277	-5	-19
2004	Below Normal	45,358	17,534	5,863	1,205	-2,646	-45,744	-17,594	-12,297	-8,326	-23,603	-5	-24
2005	Wet	48,644	30,578	14,207	1,446	2,055	-35,935	-17,766	-16,627	26,598	2,995	-4	-28
2006	Wet	53,935	20,577	7,487	1,705	-8,460	-40,074	-17,937	-17,191	40	3,035	-2	-30
2007	Critical	50,055	14,599	4,361	1,459	-4,904	-47,561	-18,803	-13,908	-14,706	-11,671	-4	-34
2008	Critical	50,217	22,999	7,497	1,303	695	-50,440	-18,702	-14,017	-451	-12,122	-3	-37
2009	Below Normal	50,837	19,387	5,760	1,123	-1,602	-47,353	-18,976	-13,375	-4,204	-16,326	-5	-42
2010	Above Normal	51,404	22,688	7,617	1,056	-2,520	-43,707	-18,924	-14,520	3,089	-13,237	-5	-47
2011	Wet	52,098	23,347	9,060	1,170	-3,951	-38,956	-18,568	-16,203	7,993	-5,244	-4	-51
2012	Below Normal	49,849	16,434	5,075	1,324	-5,408	-42,730	-18,555	-14,456	-8,473	-13,717	-6	-57
2013	Critical	45,120	13,762	4,464	1,034	-3,534	-45,680	-16,706	-11,718	-13,263	-26,980	-5	-62
2014	Critical	39,154	16,052	4,931	1,050	-881	-53,018	-17,365	-7,620	-17,699	-44,679	-2	-64
2015	Critical	34,095	14,462	5,039	1,091	1,024	-42,599	-17,629	-5,671	-10,191	-54,870	-3	-67
2016	Critical	31,342	16,543	5,316	1,020	1,938	-49,486	-17,610	-4,792	-15,732	-70,602	-3	-70
2017	Below Normal	31,643	22,665	8,848	1,119	10,306	-44,877	-17,043	-5,245	7,412	-63,190	-4	-74
2018	Dry	35,765	15,785	5,980	889	4,057	-48,399	-16,323	-4,335	-6,584	-69,774	-3	-77
2019	Above Normal	36,003	18,236	8,374	910	16,318	-34,551	-16,876	-5,998	22,412	-47,362	-4	-81

Notes:
- Flows are in acre-feet/year (AFY) from the United Water Conservation District Ventura Regional Groundwater Flow Model (United, 2021a).
- Water year types are provided by DWR; water year type for 2019 was determined based on DWR (2021).

Appendix I

Projected Water Budgets

Fillmore and Piru Basins
Groundwater Sustainability Agency

Appendix I-1

Projected Annual Surface Water Budget

Projected Annual Surface Water Budget

		Inflows			Outflows	
Water Year	**Type**	**Sespe Creek**	**Santa Clara River (from Piru)**	**Pole Creek**	**Santa Clara River (to Santa Paula)**	**Inflows - Outflows**
2022	--	131,388	172,347	1,768	-319,471	-13,968
2023	--	50,347	17,475	711	-81,788	-13,256
2024	Dry	45,006	32,454	611	-81,857	-3,787
2025	Dry	35,343	16,774	637	-54,897	-2,143
2026	Critical	3,861	466	208	-7,952	-3,417
2027	Critical	6,007	108	268	-6,956	-573
2028	Critical	12,685	914	434	-11,859	2,175
2029	Critical	1,213	31	166	-371	1,039
2030	Wet	129,413	37,856	1,842	-150,746	18,366
2031	Above Normal	14,475	24,233	578	-25,103	14,183
2032	Dry	29,631	6,777	478	-29,507	7,379
2033	Dry	13,069	3,040	422	-10,687	5,844
2034	Below Normal	27,607	5,716	726	-28,091	5,958
2035	Dry	22,480	4,204	539	-21,363	5,859
2036	Wet	188,768	36,795	2,696	-208,621	19,639
2037	Above Normal	34,389	17,989	635	-43,417	9,595
2038	Critical	10,459	17,714	296	-23,704	4,765
2039	Critical	6,254	74	297	-4,908	1,717
2040	Above Normal	172,686	43,475	2,439	-203,587	15,012
2041	Above Normal	15,213	25,307	623	-27,729	13,414
2042	Dry	10,593	1,040	430	-8,357	3,707
2043	Dry	16,942	1,312	427	-13,700	4,981
2044	Above Normal	134,239	45,618	1,941	-165,142	16,657
2045	Wet	123,891	30,820	2,468	-140,628	16,551
2046	Above Normal	18,230	17,808	709	-31,183	5,563
2047	Wet	483,111	394,113	7,173	-893,859	-9,462
2048	Wet	48,310	19,709	823	-79,862	-11,020
2049	Dry	53,242	29,436	931	-88,682	-5,073
2050	Dry	24,500	21,806	564	-46,118	753
2051	Above Normal	161,911	60,776	1,759	-223,850	596
2052	Wet	50,665	29,667	866	-83,074	-1,876
2053	Below Normal	51,465	14,583	408	-69,483	-3,027
2054	Below Normal	35,027	8,515	429	-43,001	970
2055	Below Normal	13,818	8,291	285	-23,495	-1,102
2056	Wet	419,294	210,153	4,545	-642,775	-8,783
2057	Wet	97,047	100,376	673	-222,951	-24,855
2058	Wet	157,252	153,476	3,302	-343,812	-29,782
2059	Above Normal	28,149	19,477	1,077	-60,048	-11,345
2060	Below Normal	34,768	27,657	479	-66,940	-4,037
2061	Wet	296,234	144,764	7,340	-472,948	-24,610
2062	Wet	30,193	20,726	1,341	-71,546	-19,286

Projected
Annual
Surface Water Budget

			Inflows		Outflows	Inflows
Water Year	**Type**	**Sespe Creek**	**Santa Clara River (from Piru)**	**Pole Creek**	**Santa Clara River (to Santa Paula)**	**- Outflows**
2064	Above Normal	197,448	53,739	2,713	-262,137	-8,237
2065	Dry	13,248	10,660	507	-27,586	-3,172
2066	Dry	53,738	11,523	625	-65,620	267
2067	Dry	11,655	7,201	418	-19,019	254
2068	Critical	13,394	2,038	223	-15,353	302
2069	Dry	85,142	36,467	798	-114,754	7,653
2070	Wet	198,786	76,254	2,115	-265,869	11,285
2071	Wet	367,779	261,874	4,524	-650,925	-16,747
2072	Above Normal	31,272	19,466	5,096	-67,263	-11,428
2073	Wet	325,342	176,883	12,476	-540,599	-25,899
2074	Above Normal	35,523	46,092	2,311	-98,045	-14,119
2075	Below Normal	71,001	34,489	1,292	-120,666	-13,883
2076	Wet	358,230	276,249	5,995	-679,833	-39,360
2077	Above Normal	20,580	17,779	1,046	-55,949	-16,544
2078	Dry	47,646	51,217	1,123	-109,150	-9,164
2079	Above Normal	158,826	42,327	3,006	-217,124	-12,965
2080	Critical	6,710	16,057	461	-27,786	-4,558
2081	Dry	45,351	22,879	593	-72,408	-3,585
2082	Below Normal	31,674	12,118	1,258	-48,072	-3,023
2083	Wet	534,507	359,147	12,710	-943,167	-36,803
2084	Wet	128,151	48,874	1,696	-204,386	-25,665
2085	Critical	10,725	15,986	364	-33,242	-6,167
2086	Critical	135,113	48,847	1,469	-187,848	-2,419
2087	Dry	26,358	12,100	445	-39,365	-462
2088	Below Normal	70,664	30,419	659	-100,785	958
2089	Above Normal	131,591	40,033	860	-180,704	-8,220
2090	--	12,925	16,848	818	-33,231	-2,639
2091	--	3,786	11,192	94	-19,150	-4,080
2092	--	23,618	5,891	138	-29,129	517
2093	--	8,256	1,481	184	-9,589	333
2094	--	6,853	2,088	29	-7,675	1,294
2095	--	96,584	29,090	9,321	-127,532	7,463
2096	--	17,578	2,758	156	-15,011	5,481
2097	--	146,116	43,299	1,878	-176,068	15,224

Fillmore and Piru Basins
Groundwater Sustainability Agency

Appendix I-2

Projected Annual Groundwater Budget

Projected (2070CT)
Annual
Groundwater Budget

		Inflows				Inflow/ Outflow	Outflows			Change in Groundwater in Storage		Error	
Water Year	Type	Underflow from Piru	Recharge (Basin Floor)	Recharge (Mountain Front)	Underflow from Outside	Stream Exchange	Wells	Underflow to Santa Paula	Evapo- transpiration (ET)	Annual	Cumulative	Annual	Cumulative
2022		51,292	20,134	8,636	1,135	4,820	-45,571	-17,541	-13,264	9,641	9,641	-2	-2
2023		53,437	17,016	7,358	1,159	-5,721	-45,950	-17,433	-12,895	-3,032	6,610	-1	-3
2024	Dry	52,699	15,692	6,119	1,185	-149	-55,069	-17,317	-11,869	-8,710	-2,100	-1	-4
2025	Dry	50,123	15,234	6,258	1,060	31	-50,545	-15,506	-10,877	-4,223	-6,322	0	-4
2026	Critical	46,655	13,294	4,581	1,099	-2,997	-57,425	-15,291	-7,266	-17,350	-23,672	0	-4
2027	Critical	39,662	14,471	4,709	1,278	-714	-56,633	-15,010	-4,839	-17,077	-40,748	0	-4
2028	Critical	36,874	15,714	5,628	1,354	2,021	-52,043	-16,867	-4,467	-11,784	-52,532	1	-3
2029	Critical	33,794	14,178	4,563	1,526	899	-60,253	-17,093	-3,153	-25,530	-78,062	8	5
2030	Wet	35,629	25,515	11,577	1,130	16,491	-47,720	-17,346	-3,756	21,526	-56,536	5	10
2031	Above Normal	43,642	14,254	5,358	1,085	9,697	-48,942	-16,912	-4,337	3,845	-52,691	0	10
2032	Dry	43,368	17,629	7,083	1,062	5,408	-52,677	-16,869	-4,483	521	-52,169	0	10
2033	Dry	42,056	15,313	5,723	1,115	4,681	-52,041	-17,031	-4,286	-4,471	-56,639	0	10
2034	Below Normal	39,434	16,203	6,444	1,142	5,194	-48,799	-17,035	-4,151	-1,559	-58,197	9	19
2035	Dry	37,061	16,096	5,918	1,206	5,127	-54,643	-17,039	-3,779	-10,038	-68,234	14	33
2036	Wet	39,605	24,048	11,337	1,031	18,294	-39,938	-16,931	-5,310	32,140	-36,094	4	37
2037	Above Normal	45,438	14,444	5,971	1,130	6,528	-52,061	-17,284	-5,769	-1,590	-37,684	12	49
2038	Critical	44,214	14,433	5,259	963	2,444	-52,247	-17,124	-5,535	-7,587	-45,271	5	54
2039	Critical	38,400	13,391	4,634	1,438	1,505	-60,072	-16,827	-4,290	-21,810	-67,081	10	65
2040	Above Normal	36,036	22,549	9,828	1,139	14,421	-48,846	-16,608	-4,499	14,022	-53,059	3	68
2041	Above Normal	41,149	16,362	5,961	1,162	9,213	-54,679	-16,538	-4,124	-1,486	-54,544	8	76
2042	Dry	36,902	14,263	4,897	1,029	3,332	-51,630	-15,396	-3,573	-10,176	-64,719	2	77
2043	Dry	35,460	14,316	5,880	1,246	4,836	-47,682	-16,772	-2,878	-5,589	-70,307	5	82
2044	Above Normal	36,035	19,514	8,522	920	15,442	-47,642	-15,638	-3,692	13,464	-56,843	2	84
2045	Wet	44,453	20,706	9,421	798	16,159	-37,846	-15,938	-5,275	32,479	-24,364	0	84
2046	Above Normal	50,046	15,057	5,880	1,086	4,528	-45,564	-17,382	-7,344	6,306	-18,058	0	84
2047	Wet	51,822	26,905	13,235	1,030	11,215	-44,598	-17,329	-12,451	29,827	11,769	-1	82
2048	Wet	53,497	15,685	5,978	1,340	-4,371	-49,095	-17,482	-12,787	-7,235	4,534	-1	81
2049	Dry	52,180	16,521	6,741	1,221	-1,179	-49,214	-17,465	-11,965	-3,161	1,374	-1	80
2050	Dry	52,659	15,763	5,858	1,290	840	-62,647	-16,960	-9,868	-13,057	-11,683	7	87
2051	Above Normal	53,029	22,917	9,712	1,082	3,981	-54,001	-16,906	-10,025	9,789	-1,893	0	87
2052	Wet	52,570	16,764	6,810	1,081	2,222	-49,361	-17,160	-10,794	2,132	240	0	86
2053	Below Normal	52,171	17,181	7,195	1,095	-1,085	-48,196	-17,394	-10,992	-26	215	0	86
2054	Below Normal	49,876	15,575	6,570	1,133	-495	-49,581	-17,300	-9,459	-3,682	-3,466	0	86
2055	Below Normal	47,777	15,132	5,662	1,016	-2,351	-51,220	-16,283	-8,481	-8,750	-12,215	0	86
2056	Wet	49,496	29,783	14,146	1,125	6,620	-42,694	-17,100	-12,535	28,841	16,626	-1	86
2057	Wet	54,604	20,368	8,657	1,204	-7,854	-43,912	-17,246	-14,160	1,658	18,285	-2	84
2058	Wet	53,585	23,381	10,586	1,393	-6,787	-46,258	-16,971	-15,110	3,819	22,105	-2	83
2059	Above Normal	53,714	15,774	5,929	1,640	-5,602	-53,344	-16,996	-13,526	-12,412	9,693	-1	81
2060	Below Normal	52,442	16,622	6,427	1,372	-775	-51,381	-17,087	-11,056	-3,435	6,258	0	81
2061	Wet	52,334	29,583	13,040	1,436	-1,641	-47,090	-17,131	-13,876	16,661	22,920	6	87
2062	Wet	55,393	14,992	5,750	1,920	-8,742	-48,609	-16,987	-14,524	-10,809	12,112	-1	86
2063	Critical	54,247	13,599	5,092	1,414	-5,815	-49,446	-17,062	-12,486	-10,457	1,655	-1	85
2064	Above Normal	53,274	21,277	9,631	1,406	-1,556	-41,264	-17,215	-13,049	12,502	14,157	-1	84
2065	Dry	51,319	13,712	4,239	1,459	-1,577	-57,936	-17,323	-11,059	-17,166	-3,009	0	84
2066	Dry	51,312	16,213	5,883	1,231	241	-47,508	-17,229	-10,691	-548	-3,556	0	84
2067	Dry	51,917	14,406	4,998	1,179	-505	-57,361	-16,852	-9,296	-11,513	-15,069	0	84
2068	Critical	47,563	14,373	4,971	1,189	72	-58,896	-16,811	-6,674	-14,212	-29,281	0	84
2069	Dry	44,773	19,591	8,196	1,167	6,414	-57,497	-16,899	-5,734	12	-29,269	0	84
2070	Wet	51,060	24,032	10,473	968	12,319	-50,585	-17,029	-8,932	22,307	-6,962	0	83
2071	Wet	52,442	26,881	12,768	1,276	5,464	-42,607	-16,950	-13,798	25,480	18,518	5	88
2072	Above Normal	55,249	15,400	5,832	1,891	-3,347	-53,104	-17,004	-13,069	-8,145	10,373	8	96
2073	Wet	54,437	26,402	12,628	2,092	-2,315	-47,592	-17,079	-14,879	13,695	24,069	2	98
2074	Above Normal	54,718	17,694	6,711	2,112	-6,055	-56,286	-17,134	-13,554	-11,778	12,291	14	112
2075	Below Normal	54,767	18,438	7,731	1,794	-5,605	-46,255	-17,046	-14,326	-503	11,789	-1	111
2076	Wet	54,147	29,905	14,330	1,640	-9,173	-39,306	-17,065	-14,696	19,788	31,577	3	114
2077	Above Normal	55,541	13,476	4,483	1,990	-8,510	-53,117	-16,883	-13,644	-16,652	14,926	12	126
2078	Dry	54,383	18,199	7,110	1,526	-2,447	-52,856	-16,812	-13,066	-3,963	10,963	-1	125
2079	Above Normal	54,161	21,694	9,558	1,517	-3,471	-49,574	-17,030	-13,052	3,802	14,766	-1	124
2080	Critical	51,816	11,937	4,239	1,539	-2,911	-51,412	-17,086	-11,456	-13,335	1,431	-1	124
2081	Dry	50,731	17,389	7,039	1,113	-2,211	-42,041	-17,106	-12,050	2,863	4,295	0	124
2082	Below Normal	50,211	14,337	5,864	1,211	-2,238	-48,558	-17,346	-11,263	-7,782	-3,487	0	124
2083	Wet	50,457	30,529	15,410	1,429	-1,966	-36,402	-17,102	-14,065	28,288	24,802	-2	122
2084	Wet	53,079	16,939	7,517	1,766	-10,195	-40,784	-17,040	-14,241	-2,962	21,840	-1	121
2085	Critical	51,565	10,628	3,892	1,491	-3,243	-52,170	-16,999	-12,762	-17,599	4,241	-1	120
2086	Critical	52,347	18,784	7,795	1,337	2,952	-55,199	-16,995	-12,185	-1,162	3,079	0	120
2087	Dry	52,034	14,598	5,421	1,194	823	-54,533	-17,035	-10,276	-7,775	-4,696	0	120
2088	Below Normal	51,875	18,630	7,521	1,078	2,418	-48,819	-17,225	-10,658	4,820	124	0	120
2089	Above Normal	52,526	19,503	8,748	1,095	-1,305	-43,135	-17,124	-11,964	8,345	8,469	-1	119
2090		50,208	12,154	4,250	1,294	-430	-50,779	-16,569	-11,168	-11,041	-2,571	0	119
2091		47,393	13,651	5,263	1,006	-3,187	-50,940	-15,248	-9,485	-11,548	-14,118	0	119
2092		42,536	15,268	6,003	1,115	593	-55,976	-15,318	-7,070	-12,847	-26,964	0	119
2093		39,358	14,075	5,042	1,099	211	-50,620	-15,216	-5,032	-11,082	-38,046	0	119
2094		37,420	16,355	6,310	1,032	1,662	-53,459	-15,646	-4,605	-10,932	-48,978	0	119
2095		38,770	20,956	9,183	1,344	10,476	-52,289	-15,555	-4,937	7,948	-41,030	0	119
2096		38,985	15,674	5,961	1,367	4,543	-53,054	-15,342	-4,308	-6,174	-47,204	0	119
2097		39,411	19,536	9,183	1,007	14,936	-39,164	-16,081	-5,133	23,695	-23,508	0	118

Notes:
- Information is from United (2021a,b)
- Values are in acre-feet per year (AFY).

Appendix J

Sustainable Management Criteria Technical Memorandum

Fillmore and Piru Basins Sustainable Management Criteria Technical Memorandum

Submitted to

Fillmore and Piru Basins
Groundwater Sustainability Agency

Fillmore and Piru Basins
Groundwater Sustainability Agency

Prepared by

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Certification

This Technical Memorandum was prepared in accordance with generally accepted professional hydrogeologic principles and practices. This Technical Memorandum makes no other warranties, either expressed or implied as to the professional advice or data included in it. This Technical Memorandum has not been prepared for use by parties or projects other than those named or described herein. It may not contain sufficient information for other parties or purposes.

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Table of Contents

List of Figures

List of Tables

List of Attachments

A	Beneficial Users per LARWQCB Basin Plan
B	Basin Stress Tests (from November 11, 2020 FPBGSA Board Meeting)
C	Projected Groundwater Levels (from February 18, 2021 FPBGSA Board Meeting)
D	Water Quality Objectives (from Los Angeles Regional Water Quality Control Board [LARWQCB] Basin Plan)
E	Hydrographs of Representative Monitoring Points with Measurable Objectives and Minimum Thresholds

List of Acronyms and Abbreviations

AB	assembly bill
ADCP	acoustic doppler current profiler
AF	acre-feet
AFY	acre-feet per year
Ag	agriculture
AMI	automated (or advanced) metering infrastructure
APN	assessor parcel number
B	boron
bgs	below ground surface
BMP	best management practices
BOS	bottom of screen
CA	California
CalGEM	Geologic Energy Management Division (formerly DOGGR)
CASGEM	California statewide groundwater elevation monitoring
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
cfs	cubic feet per second
CIMIS	California irrigation management information system
Cl	chloride
COC	chemical of concern
CWC	California Water Code
CWL	Critical Water Level
DBS&A	Daniel B. Stephens & Associates, Inc.
DDW	[SWRCB] Division of Drinking Water
DEM	digital elevation model
DOGGR	Division of Oil, Gas, and Geothermal Resources (reorganized as CalGEM)
DQO	data quality objective
DTW	depth to water
DWR	[CA] Department of Water Resources
DWUs	downstream water users
EGM96	Earth Gravitational Model of 1996
ENSO	El Niño Southern Oscillation

EPA	U.S. Environmental Protection Agency
ET	evapotranspiration
ET_0	reference evapotranspiration
FCGMA	Fox Canyon Groundwater Management Agency
FICO	Farmers Irrigation Company
FPBGSA	Fillmore and Piru Basins Groundwater Sustainability Agency (also called GSA or Agency)
GAMA	[USGS] groundwater ambient monitoring & assessment
GIS	geographic information system
GPS	global positioning system
GSP	groundwater sustainability plan
HASP	health and safety plan
HCM	hydrogeologic conceptual model
Hydrodata	[VCWPD] hydrologic data server
ID	identification
LARWQCB	Los Angeles Regional Water Quality Control Board
LiDAR	light detection and ranging
NCCAG	natural communities commonly associated with groundwater
M&I	municipal and industrial
MCL	maximum contaminant level
MO	measurable objective
MOU	memorandum of understanding
MS4	municipal separate storm sewer system
msl	above mean sea level
MT	minimum threshold
NAD	North American datum
NAVD88	North American vertical datum of 1988
ND	not detected
NGVD29	national geodetic vertical datum of 1929
NO3	nitrate
NWIS	national water information system
OFR	open file report
PBP	priority basin project
PDO	Pacific Decadal Oscillation
psi	pounds per square inch
PSW	public-supply well

PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RASA	regional aquifer-system analysis
RP	reference point (elevation)
RWQCB	[CA] Regional Water Quality Control Board
SAP	sampling and analysis plan
SCE	Southern California Edison
SCV-GSA	Santa Clarita Valley Groundwater Sustainability Agency
SMCs	sustainable management criteria
SNMP	Salt and Nutrient Management Plan
SO_4	sulfate
SUM	summation
SWL	static water level
SWN	[CA DWR] state well number
SWRCB	[CA] State Water Resource Control Board
TD	total depth
TDS	total dissolved solids
TFR	total filterable residue
TMDL	total maximum daily load
TNC	The Nature Conservancy
TOS	top of screen
URL	uniform resource locator (web address)
USGS	U.S. Geological Survey
United	United Water Conservation District
VC	Ventura County
VCWPD	Ventura County Watershed Protection District
VCWWD#16	Ventura County Waterworks District Number 16
VRGWFM	Ventura Regional Groundwater Flow Model
WGS84	world geodetic system 1984
WL	water level
WLE	water level elevation
WQ	water quality
WRP	water reclamation plant (also known as a wastewater treatment plant [WWTP])
WY	water year

1. Introduction

Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared this Fillmore and Piru Groundwater Basins Sustainable Management Criteria (SMCs) Technical Memorandum (Tech Memo) for the Fillmore and Piru Basins Groundwater Sustainability Agency (FPBGSA or Agency) and is under contract to prepare their mandated groundwater sustainability plans (GSPs or Plans) under the Sustainable Groundwater Management Act (SGMA) of 2014. Although SGMA requires separate Plans to be prepared for each basin, the Fillmore and Piru subbasins (Figure 1-1) (hereafter referred to as "Basins") are hydrogeologically connected and have historically been managed and monitored together. The FPBGSA board of directors has memorialized in Resolution 2021-05 their intent to continue this precedent and to manage these basins together. In keeping with this historical precedent, this Tech Memo has been prepared to cover both basins.

SMCs are foundational elements of the GSPs. This document provides a background discussion on the development of the SMCs and their potential impacts on the groundwater resources in the basins and its uses and users.

This document includes references to Appendices in the GSPs to provide supplemental information on several topics. Additional information included as a part of this Tech Memo are referred to as attachments.

2. Background

The development of the SMCs occurred over a several month period that started with an ad hoc committee of the Board of Director setting some of the introductory contextual framework for discussing how to approach establishing SMCs and their various elements. Draft SMCs were discussed by the FPBGSA board of directors and stakeholders at multiple regular board meetings, as well as a series of special board meetings and stakeholder workshops.

On January 18, 2024, the California Department of Water Resources (DWR) notified the FPBGSA that the GSPs for the Fillmore and Piru subbasins were determined to be incomplete (Appendix M of the GSPs). This was largely due to insufficient justification of proposed minimum thresholds for reductions of groundwater in storage and depletions of interconnected surface water. The FPBGSA was provided a 180-day period following the notification to address these deficiencies. During that time, the FPBGSA technical consulting team held six consultation meetings with DWR staff to discuss approaches for establishing new MTs. The outcome of these consultations was the development of new analyses using existing data and data collected after submission of the GSPs in 2021 that provided more scientifically rigorous and defensible MTs for reductions of groundwater in storage and depletions of interconnected surface water. These MTs, when combined with proposed mitigation programs, are not projected to result in undesirable results that are significant and unreasonable. These new MTs were discussed by the FPBGSA board of directors and stakeholders at multiple regular board meetings, as well as a series of special board meetings and a stakeholder workshop held during the 180-day period.

2.1 Sustainability Goal

The sustainability goal for the FPBGSA is memorialized in the guiding principles (https://bit.ly/3sQp8LR) adopted by the Board of Directors in November 2019, and includes principles of understanding covering the governance, communication and education, funding and finances, as well as SGMA implementation and sustainability. These principles describe commitments and common interests that combined leadership from the FPBGSA, and were agreed on as a way to influence current and future compliance with SGMA. The FPBGSA Joint Exercise of Powers Agreement (JPA) (GSP Appendix A) is the legal foundational document for the groundwater sustainability agency (GSA). These Guiding Principles are intended to be consistent with and in furtherance of the JPA. In the event of a conflict between the JPA and these principles, the JPA takes precedence.

These Guiding Principles can be digested into two of the General Principles:

- *Gen 6*. Sustainable groundwater conditions in the Basins are critical to support, preserve, and enhance the economic viability, social well-being, environmental health, and cultural norms of all Beneficial Users and Uses including Tribal, domestic, municipal, agricultural, environmental and industrial users; and
- *Gen 7*. FPBGSA is committed to conduct sustainable groundwater practices that balance the needs of and protect the groundwater resources for all Beneficial Users in the Basins.

The beneficial uses of water, pertaining to water rights, are defined in the California Code of Regulations (CCR) §659-672 to include domestic, irrigation, power, municipal, mining, industrial, fish and wildlife preservation and enhancement, aquaculture, recreational, stockwatering, water quality, frost protection, and heat control. Water quality control plans (basin plans) also designate beneficial uses and establish water quality objectives for waters of the State. Basin plans commonly designate beneficial uses in addition to those uses identified for water rights in CCR §659-672. (https://www.waterboards.ca.gov/rwqcb4/water_issues/programs/basin_plan/)

The basin plan pertinent to the Fillmore and Piru Basins is the Los Angeles Regional Water Quality Control Board (LARWQCB) Basin Plan for Coastal Watersheds in Los Angeles and Ventura Counties (LARWQCB, 2020), in which beneficial users of groundwater and surface water are identified (Attachment A). Based on FPBGSA stakeholder engagement over the past couple of years, the beneficial users of surface water and groundwater in the basins include domestic, agricultural, municipal, industrial, and fish and wildlife preservation and enhancement.

2.2 Historical Groundwater Management Program

The guiding principles leaned heavily upon the extensive history of groundwater monitoring, study, and management in the basins. California Assembly Bill 3030 was enacted in 1992, which established in the California Water Code sections 10750-10756, a systematic procedure for a local agency to develop a groundwater management plan. Subsequently in 1995, a Memorandum of Understanding (MOU) was signed among United Water Conservation District (United Water or United), the City of Fillmore, water companies, and other pumpers to establish how an AB 3030 groundwater management plan would be formulated for the Piru and Fillmore Basins (MOU,1995). The MOU established that the management plan would be a cooperative plan for the Basins. After adoption of the MOU, a groundwater management plan (Plan) was formulated and adopted in 1996. The Plan outlined the roles of the various parties in implementing a groundwater management program, including the establishment of a Groundwater Management Council to manage the Plan. The Council consisted of seven members: two City Council representatives from Fillmore, four pumpers (of which two were from private entities and two were from investor-owned companies or mutual water companies), and one elected board member from the United Water Conservation District (United).

SB 1938 (2002) and AB 359 (2013) required additional elements be included in all AB 3030 management plans, and an updated Draft Piru/Fillmore Basins AB 3030 Groundwater Management Plan was submitted to the AB 3030 Groundwater Management Council in 2011. The Draft Plan update included basin management objectives (BMOs) for groundwater elevations, groundwater quality, and surface water quality at various locations. It also included a groundwater export policy which provoked considerable discussion. In 2013 an updated version of the Draft Plan was submitted to the Council. The revised draft of the Plan was never adopted by the Council and therefore never finalized. The AB 3030 process has since been superseded by the SGMA.

2.3 Future Groundwater Management Considerations

The FPBGSA board of directors has carefully considered the guiding principles and the hydrologic conditions of the Basins in establishing how sustainability can be achieved in these Basins. Consideration was given to how future land use and climate change are expected to impact hydrologic conditions in the Basins. Future land use is expected to remain similar to historical (primarily agricultural with some urban) because of Ventura County policies to preserve agricultural and open space land use designations (Figure 1-1). Modest growth in urban water use is expected in both basins. Future climate change is expected to have greater variability in precipitation (e.g., more intense floods and droughts) and higher annual average air temperature (United, 2021).

2.4 Basin Hydrology

The hydrology of the Basins is strongly influenced by the wet-dry cycles (Figure 2-1) common to Southern California. The Basins exhibit a repetitive sequence of lower water levels during drought periods with recovery during subsequent wet periods (Figure 2-2). The Basins do not exhibit evidence of chronic, long-term water level declines or prolonged declines in groundwater storage based on groundwater level measurements (Appendix K). Interpretation of long-term groundwater level records indicates that water year 2011 is representative of "basin full" conditions, when water levels plateau at highest values.

The Basins' responses to varying degrees of stresses (e.g., pumping, precipitation and evapotranspiration) were evaluated using the numerical groundwater flow model developed by United Water to better understand how alternate climate/pumping scenarios can affect groundwater levels. The historical model period (1985 through 2019) was simulated with several scenarios of increased pumping (by 20%, 40%, 60%, 80%, and even 100% relative to baseline) (Figure 2-3) to evaluate how much lower groundwater levels would be and for how much longer (Attachment B). Results indicated that water levels become progressively deeper in each scenario, especially during significant drought periods (e.g., 2012-2016); yet water levels in all scenarios recover to similar "basin full" levels upon the return of wet or normal precipitation periods (implying sustainable groundwater level trends without long-term, chronic declines).

Stream flow measurements are available at a limited number of locations along the Santa Clara River within the Fillmore and Piru Basins. Hydrologists from United have identified an empirical relationship between groundwater levels in nearby wells (Figure 2-4) and the surface water flow measurements near the Cienega Springs/Fish Hatchery (hereafter referred to as "Cienega Springs") and East Grove/Willard Road (hereafter referred to as "East Grove") areas of rising groundwater (i.e., shallow groundwater discharges to the land surface). This empirical relationship allows forecasts of the rising groundwater rates at these areas to be developed for future modeled groundwater levels, which were extensively relied upon for the analysis and formulation of SMCs for multiple indicators.

During prolonged dry periods (i.e., multi-year droughts), the surface water flows in the Santa Clara River generally disappear from east to west as the drought progresses. Figure 2-5 was compiled by United hydrologists, and shows the progression of the most recent 2011-2017 drought period. Surface water in the Cienega Springs area disappears earliest, then retreats westward as the drought continues for multiple years. This is a common trend in how the rising groundwater that supplies the surface water flows slowly diminishes in the Cienega Springs area before other areas in the Fillmore Basin.

Projections of future groundwater conditions in the basins were simulated by applying climate change factors (i.e., 2070 central tendency scenario provided by DWR) to precipitation and evapotranspiration values in the United Water model, along with increases in pumping (due to urban growth and higher temperatures that should increase agricultural demand) (Figure 2-6), to evaluate groundwater level trends (Attachment C). Comparison of analogous time periods (years 1990 to 2019 vs. projected 2067 to 2096) exhibited similar patterns of groundwater level responses during dry and wet periods, indicating that the basins are resilient to projected climate change and pumping increases of about 10%.

A model scenario was also run with a 50% reduction in historical and projected pumping, by turning off wells within an approximate 1-mile band centered along the Santa Clara River channel, to evaluate the relative effects of droughts and pumping on groundwater levels near significant wildlife corridors that correspond to zones of rising groundwater (see Section 3 in this document). Results indicated that pumping near the Santa Clara River causes groundwater levels to decline faster during droughts, but groundwater levels would decrease below a critical depth of 10 feet below 2011 levels even without pumping along the Santa Clara River during the last major (2012 to 2016) drought. The critical water depth below 2011 levels applies to groundwater dependent vegetation and is based on preliminary research presented by Christopher Kibler at the January 21, 2021 Board Meeting (Kibler, 2021).

3. Sustainable Management Indicators

Table 3-1 summarizes the SMCs for the six sustainability indicators specified in SGMA.

Several definitions are integral to the understanding the process of establishing SMCs for the Fillmore and Piru basins. The following definitions are taken from §351. Definitions from the GPS Emergency Regulations and Title 23, Division 2 of the California Code of Regulations (CCR):

> **Metric** refers to how a minimum threshold will be measured (e.g., groundwater levels, water quality, rates of seawater intrusion).
>
> (t) "**Minimum threshold**" refers to a numeric value for each sustainability indicator used to define undesirable results.
>
> (s) "**Measurable objectives**" refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.
>
> (x) "**Undesirable result**" means one or more of the following effects caused by groundwater conditions occurring throughout the basin:
>
> (1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.
>
> (2) Significant and unreasonable reduction of groundwater storage.
>
> (3) Significant and unreasonable seawater intrusion.
>
> (4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

Table 3-1. Sustainable Management Criteria Matrix

SMC	Undesirable Results	Metric	MT *(June 10, 2021)*	MO	Comments
GW Elevation	Loss of ability to pump GW	GW elevation	WL declines below the base of well screens in more than 25% of representative wells	GW levels at 2011 high WL	maximizes range between MT and MO
	Significant and unreasonable GDE vegetation die-off due to GSP implementation	Depth to GW at the Fillmore - Piru basin boundary	WL declines below the Critical Water Level defined as 10 ft lower than 2011 low WL*	GW levels at 2011 high WL	*when the CWL is exceeded, mitigation water (e.g., pumped GW) will be provided to CDFW for use at the Cienega Springs restoration project site, if the WL has not recovered to CWL by the subsequent May 1st
GW Storage Reduction	inadequate GW storage to last through multi-year drought without GW extraction limitations	GW elevation	WL declines below the base of well screens in more than 25% of representative wells	GW levels at 2011 high WL	maximizes range between MT and MO
SW Depletion	Surface water flow declines due to GW extractions that interfere with the beneficial use and users	Rising GW rates at the Fillmore-Piru basin boundary (Fish Hatchery area)	A MT is not applicable for this sustainability indicator.	GW levels at 2011 high WL	**Future rising GW conditions are not expected to be materially different from historical conditions.** The GSP does not propose projects or management actions that would change the operational regime of the basins. Therefore, implementation of the GSP does not cause significant and unreasonable effects.
Land Subsidence	Land subsidence amounts that interfere with infrastructure operations	Subsidence rates	Total inelastic subsidence of 1ft/yr or 1ft over 5 yrs	Inelastic subsidence rates within +/- 0.1 ft/yr as determined by InSAR	Monitor subsidence amount - InSAR data from DWR; study to identify susceptible infrastructure (e.g., long-span bridges, gravity sewage systems) for 5 yr GSP update
Degraded WQ	Water quality degradation that impairs the beneficial use of the resource	WQ values	Water quality parameters established in existing or future regulations	FPBGSA is not a water purveyor and lacks regulatory authority for WQ compliance, but will cooperate with appropriately empowered entities	
Seawater Intrusion	NA	NA	NA	NA	

Version: Approved by the FPBGSA Board at the June 10, 2021 Board Meeting (Item 3A).

> (5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.
>
> (6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.
>
> **Significant and unreasonable -** GSAs must consider and document the conditions at which each of the six sustainability indicators become significant and unreasonable in their basin, including the reasons for justifying each particular threshold selected. These general descriptions of significant and unreasonable conditions are later translated into quantitative undesirable results, as described in this document. The evaluation of significant and unreasonable conditions should identify the geographic area over which the conditions need to be evaluated so the GSA can choose appropriate representative monitoring sites (DWR, 2017).

The following discussion of the six sustainability indicators is ordered from the least impactful to the most impactful. The order of the discussion has no other significance.

3.1 Significant and Unreasonable Seawater Intrusion

Seawater intrusion is an ongoing concern for the coastal areas of Ventura County (United, 2016) (Figure 3-1). Seawater intrusion has not historically migrated beyond the coastal plain (e.g., Oxnard Basin) even during severe drought conditions.

The Fillmore and Piru Basins are located a substantial distance inland from the coast; therefore, seawater intrusion is not a realistic threat to these basins. The western boundary of the Fillmore Basin, closest to the coast, is approximately 15 miles inland and at an elevation of about 270 feet above mean sea level (feet msl).

This sustainability indicator is not applicable for the Fillmore or Piru Basins.

3.1.1 Undesirable Results

Not applicable to the Basins.

3.1.2 Metric

Not applicable to the Basins.

3.1.3 Minimum Thresholds

Not applicable to the Basins.

3.1.4 Measurable Objectives

Not applicable to the Basins.

3.2 Significant and Unreasonable Degraded Water Quality

The FPBGSA recognizes the importance of monitoring the quality of water that supports the beneficial uses and users of that resource, and has developed a monitoring program building upon the water quality sampling and analysis programs conducted by the VCWPD, United Water, and various water purveyors in the basins (Figure 3-2 and Appendix K of the GSPs).

A recently developed multi-basin (including Fillmore and Piru Basins) water quality monitoring and management program is the Lower Santa Clara River Basin Salt and Nutrient Management Plan (SNMP) adopted by the LARWQCB on July 9, 2015 (Chapter 8 of LARWQCB, 2020). The overarching goal of the SNMP is to protect, conserve, and augment water supplies and to improve water supply reliability. This goal is supported by objectives of:

- Protecting agricultural supply and municipal and domestic supply beneficial uses of groundwater
- Supporting increased recycled water use in the basin
- Facilitating long-term planning and balancing use of assimilative capacity and management measures across the basin
- Encouraging groundwater recharge in the Santa Clara River valley
- Collecting, treating, and infiltrating stormwater runoff in new development and redevelopment projects

The SNMP and Agency have similar objectives to protect beneficial uses of agricultural supply and municipal and domestic supply, and to encourage groundwater recharge in the Santa Clara River (i.e., through existing recharge management operations lead by United).

3.2.1 Undesirable Results

The Agency has an established water quality monitoring program (Figure 3-2), based on the programs implemented by VCWPD and United, that will identify conditions that impair the beneficial use or users of the water.

Examples of undesirable results associated with high levels of:

- Boron can preclude agricultural use (especially for citrus crops).
- Chloride can preclude agricultural use (especially for avocadoes).
- Nitrate can preclude domestic use (especially for infants (i.e., blue-baby syndrome [Infant Methemoglobinemia]).
- Taste and odor that are an aesthetic nuisance.
- Sulfate and TDS (other inorganic minerals) can make water hard and require water softeners, which are often banned to prevent elevated levels in wastewater discharges.
- Constituents with a maximum contaminant level (MCL) listed in Title 22 of the CCR.

Because the Agency does not have authority to regulate water quality, the most pertinent actions the Agency can take to help ensure sustainable basin conditions is to monitor groundwater quality and understand how changes to groundwater conditions (e.g., groundwater levels) can affect concentrations of various constituents of concern to agencies with regulatory authority over water quality.

3.2.2 Metric

The proposed metrics are the water quality analyte values and units included in existing and future regulations including, but not limited to, for example, BPOs (included in Attachment A as an example) and maximum contaminant levels (MCLs) listed in Title 22 of the CCR. Select historical chemicals of concern (COC) MCLs in the basins are shown in Table 2.2-1 of the GSPs (Section 2.2.2.5.1)

3.2.3 Minimum Thresholds

There are many regulatory agencies in the State of California with authorities over water quality; however, the FPBGSA is not among that group. Per SGMA regulations, GSAs do not have regulatory authority over water quality. The Agency has elected to use the water quality concentrations (e.g., MCLs) established by those entities with authority over water quality as the minimum thresholds for both basins.

3.2.4 Measurable Objectives

FPBGSA is not a water purveyor and lacks regulatory authority for water quality compliance, but is committed to working cooperatively with the appropriately empowered entities. Lacking regulatory authority over water quality compliance limits the Agency's control in achieving water quality measurable objectives if the Agency were to establish MOs for specific monitoring points in the basins. Consequently, the FPBGSA will cooperate with entities such as Ventura County Watershed Protection District and the LARWQCB as they enforce regulations designed to prevent the degradation of water quality to the extent it impairs the beneficial use of and use by stakeholders.

3.3 Chronic Lowering of Groundwater Levels

This sustainable management indicator addresses changes in groundwater levels in the Fillmore and Piru Basins due to groundwater extractions and the potential impacts of those groundwater level changes on the beneficial use and users. As stated previously in Section 2.4, there is no evidence of chronic lowering of groundwater levels in either basin. Water levels fluctuate in response to natural precipitation cycles, with water levels declining during periods of severe droughts and recovering when normal or wet precipitation periods prevail.

The beneficial uses and users of groundwater throughout the basins include, but are not necessarily limited to:

- Pumping for agricultural, domestic, municipal, industrial and even aquaculture (for the CDFW owned and operated fish hatchery lands located near the eastern boundary of the Fillmore basin) (Figure 3-3; LARWQCB, 2020; Attachment A)
- Groundwater dependent ecosystems (GDEs) – vegetation element (Figure 3-3). These beneficial users depend on sustainable groundwater supplies, most simply represented by groundwater levels.

As discussed in Section 2, historical data and projected model scenarios indicate that groundwater levels do not (and are not anticipated to) exhibit chronic declines over periods of wet and drought conditions. Given the absence of evidence for chronic lowering of groundwater levels, the Agency considers the most significant potential effect of groundwater levels on beneficial users to be how long groundwater levels remain depressed during droughts and what proportion of the water level decline is attributable to groundwater extractions rather than drought.

The groundwater flow model constructed by United Water was used to help discern what portion of the water level declines during droughts, normal, and wet periods were attributable to groundwater extractions. The model included projections of water levels under future climate conditions (i.e., 2070 CF), groundwater extractions, and land use changes. The model was used to simulate how groundwater levels changed when extractions from wells within about 1 mile of the Santa Clara River were eliminated (Figure 3-4).

Figure 3-5 shows the effect groundwater extractions have on water levels at a few example wells. In general, the effect of groundwater pumping on water levels is more pronounced during drought periods and where water levels are estimated to be lowered by 5 to 40 feet.

3.3.1 Undesirable Results

The undesirable results to be avoided for this sustainability indicator are the loss of the ability to pump groundwater from the existing well network (Table 3-1 and Figure 3-3) and significant and unreasonable GDE vegetation die-off due to implementation of the GSP.

3.3.1.1 Impacts to Domestic, Municipal, and Agricultural Production Wells

The FPBGSA established the loss of ability to pump groundwater from existing wells in each basin as one undesirable result of chronic lowering of groundwater levels. Wells go dry when water levels drop below the pump intake. Unfortunately, pump intake elevations for wells are unique and generally not known. Well screen elevations are often used as a proxy for determining if a well will go dry but they are fixed, while the pump intake can be raised or lowered depending on well-specific conditions. This results in a great deal of uncertainty when predicting the number of wells that will go dry during a drought, which is further complicated due to non-flat surface topography and water table surface. Despite these significant challenges and data gaps, the FPBGSA developed a detailed analysis that estimated how many wells would go dry during three water level decline scenarios.

The first step in this analysis was to create a reference condition. Average water levels from 2011, which are considered to represent a “basin full” status, were interpolated to create a water table surface across both Basins (Figure 3-6). Projected water level decline scenarios were created by lowering this surface uniformly by 50 feet, 75 feet, and 100 feet from the original values. The water level elevations for these decline scenarios were then compared to known screen elevations for 280 wells in the Fillmore subbasin and 110 wells in the Piru subbasin within the 2011 water level interpolation area (Figure 3-7). Four qualitative categories were developed to describe the projected impact status of each well for each scenario (Figure 3-8):

- *Not Impacted:* Estimated water level above top of well screen
- *Impacted:* Estimated water level located within upper 50% screened interval
- *Severely Impacted:* Estimated water level located within lower 50% screened interval
- *Dry:* Estimated water level below bottom of well screen

This approach provides a relatively simple and easily understood classification scheme that allows for projected well impacts from estimated water level declines to be broadly quantified. It should be noted that according to the DWR Dry Well Reporting System and UWCD (Tony Emmert, personal communication), no production wells, including domestic wells, have been reported as going dry in either the Fillmore or Piru subbasin. This suggests that while wells may be impacted by water level declines during drought periods, they were still able to provide water for their respective beneficial uses and users.

3.3.1.1.1 Fillmore Subbasin

Maps showing the spatial distribution of projected groundwater levels and estimated well status for the four water level scenarios in the Fillmore subbasin are shown in Figures 3-9 through 3-12. Bar plots indicating the number of wells of each relevant type (e.g., agricultural, domestic, monitoring, etc.) that fall into the four impact status categories are shown in Figures 3-13 and 3-14. Table 3-2 provides a detailed summary of the number of wells that fall into each impact category for the four water level elevation scenarios evaluated.

Even for the 2011 average "basin full" conditions, 23 production wells are classified as impacted or severely impacted. These wells have an average top of screen depth of about 62 feet below ground surface (bgs), and all have the top of screen located within 120 feet bgs. This is relatively shallow compared to an average top of screen depth of about 163 feet bgs for wells drilled in the Fillmore subbasin after January 1, 2015, when SGMA was enacted. Nearly one-third of the production wells with impacted status for the 2011 average "basin full" condition are more than 40 years old, which is generally considered the operational lifetime of a groundwater production well for the period in which they were installed.

The three water level decline scenarios for the Fillmore subbasin were evaluated in the context of the FPBGSA's defined undesirable results (see Section 3.3.1.1) and the number of impacts estimated for "basin full" conditions. The 75-foot and 100-foot decline scenario estimates were determined to result in too many severely impacted and dry wells. The 50-foot decline scenario resulted in an estimated total of 25 severely impacted and dry wells, or approximately 9% of wells analyzed. Of these 25 wells, 4 are monitoring wells, and the FPBGSA does not consider it to be an undesirable result if monitoring wells temporarily go dry during a drought period.

Production wells estimated to be severely impacted included 9 agricultural irrigation wells, 5 domestic wells, and 1 well of unknown use. If water levels declined 50 feet from the 2011 "basin full" average, 1 agricultural irrigation well, 3 domestic wells, and 1 well of unknown use were estimated to go dry. The FPBGSA considered impacts to this number of wells to be reasonable, and have committed to developing a mitigation program for wells that do go dry (see Section 4.8 of the GSP).

Table 3-2. Projected Impacts by Well Type for Water Level Decline Scenarios in the Fillmore Subbasin

Analysis	Status	Agricultural Well	Cathodic Protection Well	Domestic Production Well	Groundwater Monitoring Well	Industrial Well	Municipal Well	Unknown	Total
Reported Wells		390	7	147	15	3	17	56	635
AIUA[1] Wells		336	7	135	15	3	11	41	548
Wells with Water Levels		25	0	7	2	0	2	1	37
Wells with Screen Data		234	2	91	12	2	10	5	356
Screened Wells Used in Analysis[2]		186	1	67	11	2	9	5	281
2011 Average	Not Impacted	167	1	65	9	2	8	4	256
	Impacted	18	0	2	1	0	1	1	23
	Severely Impacted	1	0	0	1	0	0	0	2
	Dry	0	0	0	0	0	0	0	0
50 ft Drawdown	Not Impacted	117	1	38	7	2	4	2	171
	Impacted	59	0	20	0	0	5	1	85
	Severely Impacted	9	0	6	1	0	0	1	17
	Dry	1	0	3	3	0	0	1	8
75 ft Drawdown	Not Impacted	86	1	26	3	2	2	2	122
	Impacted	71	0	21	2	0	7	0	101
	Severely Impacted	18	0	11	2	0	0	1	32
	Dry	11	0	9	4	0	0	2	26
100 ft Drawdown	Not Impacted	62	1	19	3	2	2	1	90
	Impacted	77	0	16	1	0	4	1	99
	Severely Impacted	27	0	15	0	0	3	0	45
	Dry	20	0	17	7	0	0	3	47

1. Active + Inactive + Unknown + Abandoned Wells
2. Only wells within 2011 average water level interpolation area included in analysis.

3.3.1.1.2 Piru Subbasin

Maps showing the spatial distribution of projected groundwater levels and estimated well status for the four water level scenarios in the Piru subbasin are shown in Figures 3-15 through 3-18. Bar plots indicating the number of wells of each relevant type (e.g., agricultural, domestic, monitoring, etc.) that fall into the four impact status categories are shown in Figures 3-19 and 3-20. Table 3-3 provides a detailed summary of the number of wells that fall into each impact category for the four water level elevation scenarios evaluated.

Of the 111 wells analyzed in the Piru subbasin, 5 are estimated to fall into the impacted category under 2011 average “basin full” conditions, with 2 additional wells estimated to be dry. Of these wells, 3 are used solely for groundwater monitoring, so them going dry during a drought period is not considered a significant and unreasonable undesirable result. The remaining 4 wells have an average top of screen depth of about 20 feet bgs, and all have a top of screen located within 51 feet bgs. This is much shallower than the average top of screen depth of about 177 feet bgs for wells drilled after January 1, 2015, when SGMA was enacted. The wells also range in age from about 48 to 87 years, which is well beyond the industry standard operational lifetime of about 30 years for groundwater production wells.

The three water level decline scenarios for the Piru subbasin were evaluated in the context of the FPBGSA’s defined undesirable results (see Section 3.3.1.1), and the number of impacts were estimated for “basin full” conditions. The 100-foot decline scenario estimates were determined to result in too many severely impacted and dry wells. The 50-foot and 75-foot decline scenarios resulted in generally similar impacts to production wells; therefore, the 75-foot decline was adopted by the FPBGSA as the MT to provide more operational flexibility. If reached, an estimated 20 wells would fall into the severely impacted and dry wells category, or approximately 18% of wells analyzed. Of these 20 wells, 7 are monitoring wells, so them going dry temporarily during a drought period is not considered a significant and unreasonable undesirable result.

Table 3-3. Projected Impacts by Well Type for Water Level Decline Scenarios in the Piru Subbasin

Analysis	Status	Agricultural Well	Cathodic Protection Well	Domestic Production Well	Groundwater Monitoring Well	Industrial Well	Municipal Well	Unknown	Total
Reported Wells		146	2	34	12	2	5	34	235
AIUA[1] Wells		128	2	32	12	2	4	20	200
Wells with Water Levels		17	0	2	11	0	0	0	30
Wells with Screen Data		94	0	22	12	2	3	3	136
Screened Wells Used in Analysis[2]		81	0	11	12	1	3	3	111
2011 Average	Not Impacted	78	0	11	9	1	3	2	104
	Impacted	3	0	0	2	0	0	0	5
	Severely Impacted	0	0	0	0	0	0	0	0
	Dry	0	0	0	1	0	0	1	2
50 ft Drawdown	Not Impacted	70	0	8	5	0	3	2	88
	Impacted	9	0	3	0	1	0	0	13
	Severely Impacted	2	0	0	3	0	0	0	5
	Dry	0	0	0	4	0	0	1	5
75 ft Drawdown	Not Impacted	57	0	7	4	0	1	0	69
	Impacted	15	0	2	1	0	2	2	22
	Severely Impacted	9	0	2	0	0	0	0	11
	Dry	0	0	0	7	1	0	1	9
100 ft Drawdown	Not Impacted	50	0	4	4	0	1	0	59
	Impacted	19	0	4	0	0	2	1	26
	Severely Impacted	9	0	1	0	0	0	0	10
	Dry	3	0	2	8	1	0	2	16

1. Active + Inactive + Unknown + Abandoned Wells
2. Only wells within 2011 average water level interpolation area included in analysis.

Production wells estimated to be severely impacted include 9 agricultural irrigation wells and 2 domestic wells. A total of 1 industrial well and 1 well of unknown use were estimated to go dry. The FPBGSA considered impacts to this number of wells to be reasonable, and have committed to developing a mitigation program for wells that do go dry.

3.3.1.2 Impacts to Groundwater Dependent Ecosystems

Concerns about the effect of groundwater level declines during droughts on the vegetative elements of GDEs in the Basins, especially those in the rising groundwater areas, were recognized by the FPBGSA, and additional analyses were performed to quantify water levels necessary to maintain vegetative GDE health and survival in the following critical areas (Figure 3-3):

- Del Valle area near the Piru-Santa Clara River Valley East Basin boundary
- Cienega Springs area near the Fillmore-Piru Basin boundary
- East Grove area of the Fillmore Basin near the Fillmore-Santa Paula Basin boundary

All three of these vegetative GDE areas are located along the Santa Clara River. The Cienega Springs and East Grove GDE areas are supported by rising groundwater, whereas shallow groundwater in the Del Valle GDE is predominantly supported by wastewater treatment plant (WWTP) effluent discharged to the Santa Clara River from the Valencia plant.Shallow groundwater levels are known to vary in the Cienega Springs and East Grove GDEs in accordance with major interannual precipitation trends—lower water levels during periods of drought with higher levels associated with wet to normal precipitation patterns. It is also recognized that groundwater extractions also impact water levels. While the FPBGSA is not responsible for mitigating drought impacts on water levels, it is important to understand the degree to which groundwater extractions contribute to lower groundwater levels reported during major droughts.

The impact of groundwater extractions on water levels near the Santa Clara River were evaluated for the Cienega Springs and East Grove GDE areas by comparing simulated water levels from two model scenarios:

- Current pumping practices (i.e., extraction quantities, spatial distribution of wells)
- A hypothetical 50% reduction in pumping achieved by eliminating groundwater extractions from wells within about 1 mile of the Santa Clara River (Figure 3-4)

The decision to develop SMCs for the Del Valle GDE area was made during the 180-day resubmission period; therefore, not enough time was available to analyze impacts due to groundwater pumping. This analysis will be included in the GSP 5-year update. The following subsections summarize the analyses for the Cienega Springs and East Grove GDE areas.

3.3.1.2.1 Cienega Springs GDE

Near the Cienega Springs GDE area, rising groundwater serves to limit water level fluctuations during normal to wet periods, and is the source of the surface water commonly found in this area. Rising groundwater conditions are the norm for the majority of the simulated time period. However, during prolonged drought periods, the impact of groundwater extractions on the water levels is exacerbated.

Figure 3-22 illustrates how shallow groundwater levels are impacted by extractions and by climate change. During future normal to wet precipitation periods, simulated groundwater extraction results in water levels that are about 20 feet lower than without groundwater extractions (inclusive of climate change impacts) near the fish hatchery facility. In contrast, shallow water levels during drought periods are typically 50 to 75 feet lower when compared to non-drought periods. Approximately 30 to 50 feet of water level declines during major droughts are attributable to groundwater extractions, with another 20 to 25 feet a function of the drought and the influences of climate change.

Drought impacts on the shallow groundwater level simulated for the key well (04N18W31D04S) located a short distance upstream from the Fillmore-Piru Basin boundary have much smaller groundwater extraction impacts on the water levels (typically 10 feet or less).

Critical water levels (CWLs) for GDE vegetation are defined using the system suggested by Kibler (2021) and Kibler et al. (2021), where they concluded that vegetative stress due to lower groundwater levels occurs when the water levels in the Cienega Springs area decline 10 feet below the 2011 water level. This condition is modeled to occur during multiyear droughts (Figure 3-23). The modeling results also indicate that the drought impact is not mitigated by reducing groundwater extractions within about 1 mile of the Santa Clara River. The shallow water levels tend to fluctuate slightly above or below the CWL during the drought periods, but do not remain above the CWL, as is the common condition during normal or wet precipitation periods.

3.3.1.2.2 East Grove GDE

The East Grove GDE area is located at the west end of the Fillmore Basin. This is another of the unique areas in the Fillmore and Piru Basins where rising groundwater supplies surface water that supports vegetation during periods without surface water runoff. The rising groundwater quantities are impacted by groundwater extractions; however, the simulated rising groundwater quantities are not totally depleted during droughts (Figure 3-24) like they are in the Cienega Springs GDE area. The prevalence of rising groundwater even with groundwater extractions and climatic change effects indicates that this area is not experiencing chronic groundwater level declines and is maintaining the shallow groundwater levels to support GDE vegetation. This is supported by shallow groundwater level observations in the area (e.g., at wells 03N20W08VCWPD8 and 03N20W07HRP9).

3.3.2 Metric

Groundwater elevation (level) measurements relative to the North American Vertical Datum of 1988 (NAVD 88).

3.3.3 Minimum Thresholds

Minimum thresholds for chronic lowering of groundwater levels (Table 3-4 and Figure 3-21) were selected based on projected impacts to wells and GDEs. The following subsections provide a description of the methodology used.

Table 3-4. Measurable Objectives and Minimum Thresholds

Well Name	Elevation (feet msl) Minimum Threshold	Elevation (feet msl) Measurable Objective	Notes
Fillmore Basin			
03N20W01C04S	325.86	375.86	MO from average 2011 WLE; MT set 50 feet below MO
03N20W03D03S	286.62	336.62	MO from average 2011 WLE; MT set 50 feet below MO
03N20W03J02S	290.53	340.53	MO from average 2011 WLE; MT set 50 feet below MO
03N20W05D01S	255.94	305.94	MO from average 2011 WLE; MT set 50 feet below MO
03N20W07HRP9	281	291	MO based on 2020-2022 data; MT set 10 feet below MO
03N20W08VCWPD8	310	320	MO based on 2020-2022 data; MT set 10 feet below MO
03N20W09D01S	266.29	316.29	MO from average 2011 WLE; MT set 50 feet below MO
03N21W01P02S	207.38	257.38	MO from average 2011 WLE; MT set 50 feet below MO
03N21W12H01S	268.32	278.32	MT based on pre-2015 minimum WLE; MO set to 10 feet above MT
04N19W29R07S	461	471	MO from average 2011 WLE; MT set 10 feet below MO
04N19W30D01S	348.92	398.92	MO from average 2011 WLE; MT set 50 feet below MO
04N19W32A03S	449.86	459.86	MO from average 2011 WLE; MT set 10 feet below MO
04N19W32B03S	445.54	455.54	MT based on pre-2015 minimum WLE; MO set to 10 feet above MT
04N19W32M02S	380.8	430.8	MO from average 2011 WLE; MT set 50 feet below MO
04N19W33D07S	462.83	472.83	MO from average 2011 WLE; MT set 10 feet below MO
04N20W22N01S	625	675	MO from original GSP submission; MT set 50 feet below MO
04N20W26L01S	322.02	372.02	MO from average 2011 WLE; MT set 50 feet below MO
04N20W36MW104	348.6	398.6	MO from average 2011 WLE; MT set 50 feet below MO
Piru Basin			
04N18W19R01S	507.43	582.43	MO from average 2011 WLE; MT set 75 feet below MO
04N18W20R01S	521.37	596.37	MO from average 2011 WLE; MT set 75 feet below MO
04N18W31D04S	493.98	568.98	MO from average 2011 WLE; MT set 75 feet below MO
04N19W25C02S	474.11	549.11	MO from average 2011 WLE; MT set 75 feet below MO
04N19W26P01S	459.44	534.44	MO from average 2011 WLE; MT set 75 feet below MO
04N19W34D01S	423.45	498.45	MO from average 2011 WLE; MT set 75 feet below MO
04N19W34K01S	436.2	511.2	MO from average 2011 WLE; MT set 75 feet below MO
04N19W36D01S	471.01	546.01	MO from average 2011 WLE; MT set 75 feet below MO
RGW-002	800	810	MO estimated at 5 feet bgs; MT set 10 feet below MO
RGW-003	815	825	MO estimated at 5 feet bgs; MT set 10 feet below MO

msl = Above mean sea level
MO = Measurable objective
MT = Minimum threshold
bgs = Below ground surface

3.3.3.1 Wells Outside of GDE Areas

For wells outside of the GDE areas (Figure 3-21), water levels 50 feet and 75 feet below the 2011 average were set as the minimum threshold for the Fillmore and Piru Basins, respectively. See Section 3.3.1.1 for a more detailed discussion of projected impacts if groundwater levels reach these minimum thresholds.

3.3.3.2 Wells Within or Immediately Adjacent to GDE Areas

For shallow screened wells within and immediately adjacent to the Cienega Springs and East Grove critical vegetative GDEs, minimum thresholds were set at either 10 feet below the 2011 average (see Section 3.3.1.2.1) or the pre-2015 minimum water level elevation, whichever was stricter. Wells near the Cienega Springs GDE area generally had their minimum thresholds set using the 10 feet below 2011 average criteria, whereas pre-2015 minimum water levels were generally used in the East Grove GDE area.

Because no water level data are available in the Del Valle area, interim minimum thresholds were set at 15 feet bgs at two locations (RGW-002 and RGW-003) where monitoring wells are believed to be present. A value of 15 feet bgs was used because the aquifer is presumed to be thin in this area, and the combination of little groundwater pumping and stream leakage from the Santa Clara River would likely result in shallow groundwater conditions.

3.3.4 Measurable Objectives

Average 2011 water levels represent basin-full conditions, and were selected as the measurable objective for wells where SMCs were established (Table 3-4). Groundwater conditions are considered sustainable as long as water levels recover to similar “basin full” conditions following droughts.

For the Del Valle area where groundwater data are unavailable, interim measurable objectives were set at 5 feet bgs at two locations (RGW-002 and RGW-003) where monitoring wells are believed to be present.

3.4 Significant and Unreasonable Reduction of Groundwater Storage

Groundwater storage is directly correlated with groundwater levels and estimates of storage properties of the various aquifer zones (from the calibrated United groundwater flow model) in the Fillmore and Piru Basins. As previously noted, there is no evidence of long-term, chronic decline in water levels in either Basin. Consequently, because the estimates of groundwater in storage are linked to those water levels, there is no evidence of long-term decline in groundwater storage (Figure 3-25).

Cyclic variations in the amount of groundwater in storage are evident; as water levels decline during periods of prolonged drought, the groundwater storage amount also declines. However, the hydrology of the Basins shows that water levels (and therefore storage quantities) recover when normal to wet periods return to the Basins.

3.4.1 Undesirable Results

Undesirable results associated with groundwater storage would be considered an amount of groundwater storage reduction (i.e., MT) from the MO (i.e., 2011 basin conditions) that does not permit continued groundwater production (extraction) through a multi-year drought. This is equivalent to reduction of groundwater volume in storage to less than five times the average annual groundwater extraction volume.

3.4.2 Metric

Groundwater elevation (level) relative to NAVD 88. The DWR BMP Guidance Document (2017) confirms that surrogate metrics can be used to quantify a sustainability indicator if there is a clear relationship between the proposed surrogate and the indicator. For this indicator, there is a clear relationship between groundwater elevation and groundwater storage quantities.

3.4.3 Minimum Thresholds

The MT for groundwater storage reduction is the same as that for groundwater level declines (Section 3.3.3) (i.e., 50 feet and 75 feet below the 2011 average water levels in the Fillmore and Piru Basins, respectively). The MT for this sustainability indicator does not consider GDEs, as those are dealt with under the chronic lowering of groundwater level SMCs.

3.4.4 Measurable Objectives

The MT for groundwater storage reduction is the same as that for groundwater level declines (Section 3.3.4).

3.5 Significant and Unreasonable Land Subsidence

Historical and projected land subsidence estimates are described in detail in the Subsidence Tech Memo (Appendix F of the GSPs) and subsequent annual subsidence update reports (DBS&A, 2023). Evaluation of historical subsidence, focused on land elevation changes measured with InSAR since June 2015, , have to date revealed insignificant declines (i.e., less than 0.2 foot) throughout the basins. The most significant land surface changes were observed in the western half of Piru Basin, and are correlated with decline and recovery of groundwater levels. Results indicate that most, if not all, land subsidence in this area was elastic, and therefore recoverable. This sustainability indicator is only concerned with inelastic land subsidence (i.e., land elevation declines that do not recover). Inelastic land subsidence is undesirable because at high enough magnitudes, it could damage critical surface infrastructure such as bridges, railways, and water conveyance systems.

3.5.1 Undesirable Results

Undesirable results associated with land subsidence would be considered an annual rate or cumulative amount of inelastic subsidence that occurs over a period of years that interfere with infrastructure (e.g., gravity drained systems for wastewater in urban areas, roads/bridges, pipelines).

3.5.2 Metric

Land subsidence will be monitored by changes in land surface elevation (in feet relative to NAVD 88) from InSAR datasets provided by DWR. The accuracy of InSAR land elevation change values is considered ± 0.07 foot.

3.5.3 Minimum Thresholds

The MT for land subsidence at any location in either basin is set at an annual rate of 1 foot per year (ft/yr) or 1 foot of cumulative (net total) subsidence over a period of five years.

3.5.4 Measurable Objectives

The MO for land subsidence has been set as inelastic subsidence rates within ± 0.1 ft/yr (i.e., within the error range of InSAR land surface elevation change values).

3.6 Depletions of Interconnected Surface Water

The areas of interconnected surface water and groundwater are primarily at the basin boundaries where rising groundwater conditions (i.e., gaining stream conditions) occur along the Santa Clara River. These major areas of interconnected surface water support vegetation communities, and are identified as the Del Valle, Cienega Springs, and East Grove GDE areas (Figure 3-3 and Appendix D of the GSPs). East Grove may also support fish habitat (see Appendices F and K of the GSPs). The upper reaches of Sespe Creek and Piru Creek within the groundwater basin may also be interconnected, but there is limited nearby groundwater pumping. These have been identified as data gaps and are planned to be addressed during GSP implementation (see Section 6.1 of Appendix K of the GSP).

3.6.1 Areas of Interconnected Surface Water and Groundwater

The major areas of interconnected surface water are found in the eastern portion of the Piru Basin (Del Valle), straddling the Fillmore-Piru Basin boundary (Cienega Springs), and the western end of the Fillmore basin (East Grove). The following subsections provide brief descriptions of these areas. For more detailed discussion of these GDEs and associated data gaps see Appendices D and K of the GSPs.

3.6.1.1 Del Valle

The Del Valle area is located in the extreme eastern portion of the Piru Basin. Surface and groundwater flow in this reach of the Santa Clara River are supported by the wastewater effluent releases from the upstream WWTPs (primarily the Valencia WWTP) serving the greater Santa Clarita area. These effluent releases to the Santa Clara River serve to dampen the effects of the limited groundwater extractions in the area, as well as the effects of drought. The depth to bedrock in this reach of the river is typically very shallow (e.g., less than 50 feet), so maintaining surface water flows is easier than in downstream reaches where the alluvial thickness can be greater than 1,000 feet.

This unique hydrogeologic setting, coupled with limited groundwater extractions and a continuous source of WWTP effluent, creates the conditions where surface water depletion due to groundwater extraction has very little impact on the surface water flows in this reach of the Santa Clara River.

3.6.1.2 *Cienega Springs*

This is an area where rising groundwater is the primary source of surface water during many months of the year. For the majority of the months in a typical year, the area of rising groundwater are isolated from upstream and downstream reaches. During these periods, the source of the water in these isolated pools of water is rising groundwater, as there is no contributory surface water flow from the upstream reach.

During wet years with abundant runoff or when releases from Santa Felicia Dam and/or Castaic Lake are sufficiently high, the Santa Clara River can temporarily reconnect upstream and downstream of Cienega Springs. This connection is intermittent as the runoff and/or reservoir releases abate and the losing reaches upgradient and downgradient of the rising groundwater intervals eventually return to their naturally dry state.

Figure 3-26 shows the rising water rates with and without groundwater within about 1 mile of the Santa Clara River. Rising groundwater occurs during normal and wet precipitation periods, although it can become nonexistent during periods of prolonged drought. The amount of rising groundwater/surface water is highly variable, with the higher quantities of surface water flow augmented by precipitation runoff during wet periods.

3.6.1.3 *East Grove*

Rising groundwater is the predominant source of surface water in this reach of the Santa Clara River, and the area has a less flashy hydrologic response to wet and dry cycles (Figure 3-26) than the Cienega Springs area of rising groundwater. The rising groundwater rates (after removing groundwater extractions within ~1 mile of the Santa Clara River) are estimated to be typically in the range of about 10 to 25 cubic feet per second (cfs), with the lower rates associated with dry periods.

3.6.2 Impact of Groundwater Extractions on Surface Water Flow

Stream flow measurements are recorded at only a few locations in the Basins (Appendix K of the GSPs). The impact of groundwater extractions on surface water flows was estimated using the groundwater flow model (Appendix E of the GSPs) developed by United for the Basins. The change in rising groundwater rates was estimated by reducing groundwater extractions within about 1 mile of the Santa Clara River and calculating the difference in stream flow rate with and without those extractions.

3.6.2.1 *Cienega Springs*

Figure 3-26 shows the rising water rates with normal groundwater extractions and without groundwater extractions in the nearby area (i.e., within about 1 mile of the Santa Clara River). The most apparent observation is that the impact of groundwater extractions is most pronounced during periods of prolonged droughts. During non-drought periods the impact of groundwater extraction on rising groundwater rates is in the range of 3 to 10 cfs.

Figure 3-27 shows how the groundwater extractions impact on the rising groundwater quantities varied across the historical time period, as well as the simulated future period (including the effects of climate change, future land use changes, and expansion of future pumping quantities). Comparing the mean and median differences due to groundwater extraction over the historical period with the mean and median differences from future model scenarios covering 2020 to 2096 reveals that the differences between the historical and future impacts of groundwater extraction were very similar (i.e., mean of 3.7 cfs vs. 5.1 cfs, with median of 3.8 cfs vs. 4.8 cfs).

The future projection of precipitation used in the groundwater flow model was a replication of the historical precipitation record (Appendices E and I of the GSPs). If the comparative analysis is confined to analogous time periods (those with the same precipitation trends) in the historical and future timelines, the surface water (rising groundwater) depletion due to groundwater extraction is very similar in the historical time period (mean = 3.8 cfs, median = 3.8 cfs) and future time period (mean = 5.1 cfs, median = 4.6 cfs) (Figure 3-28). The slightly greater surface water depletions in the future scenario are reflective of the influences climate change has on the hydrology of the Basins.

3.6.2.2 *East Grove*

Rising groundwater rates in this portion of the Fillmore Basin are depicted in Figure 3-26. Groundwater extractions have an impact on the rate of rising groundwater. That impact is estimated to be about 5 cfs during normal and wet periods, but could increase to about 10 cfs during prolonged dry periods. However, groundwater extractions (including the impacts of climate change) are not expected to totally eliminate the rising groundwater, even during prolonged dry periods.

3.6.3 Undesirable Results

The FPBGSA board of directors has defined the undesirable results associated with this sustainability indicator as "Surface water flow declines due to groundwater extractions that interfere with the beneficial use and users" (Table 3-1).

3.6.4 Metric

Rising groundwater rates at the Fillmore-Piru Basin boundary near the Cienega Springs area as determined from empirical crossover analysis (Figure 2-4).

3.6.5 Minimum Thresholds

Future rising groundwater conditions are not expected to be materially different from historical conditions, even with consideration of the effects of climate change. Historically, undesirable impacts have not been reported in either Basin, and surface water depletion rates due to groundwater extractions are not expected to increase in the future. The GSPs for the Fillmore and Piru Basins do not propose projects or management actions that would change the operational regime of the basins. Therefore, implementation of the GSPs does not cause significant and unreasonable effects that differ from pre-2015 conditions.

The FPBGSA conducted multiple opportunities for stakeholders and interested parties to provide input to this sustainability indicator (Section 2.1.5.3.2 of the GSPs).

A DWR consultation session was held to solicit their input on the establishment of MTs. The session included a presentation on the existing data, including the analytical approaches to quantifying the depletion of surface water due to groundwater extractions. The outcome of the consultation session was concurrence that the available data supported the conclusion that the historical and projected future conditions were not materially different (i.e., it has historically gone dry during droughts and has a very large range of flows). Therefore, the FPBGSA is using the same minimum thresholds established for chronic groundwater level declines (Section 3.3 and Table 3-4) for interconnected surface water.

3.6.6 Measurable Objectives

The MT for depletions of interconnected surface water is the same as that for groundwater level declines (Section 3.3.4).

4. Monitoring Network

The monitoring network associated with these SMCs is presented in Section 3 of the GSPs for the Fillmore and Piru Basins, and will not be further detailed in this document. Background information on the current monitoring programs in these Basins is contained in Appendix K of the GSPs.

5. Discussion/Conclusion

The Board has approved SMCs for the sustainability indicators based on the best available data and science. Seawater intrusion is not an applicable sustainability indicator to these basins due to the large horizontal and vertical distance that separates these basins from the Pacific Ocean; therefore, SMCs are not established. For the water quality sustainability indicator, the Agency does not have authority to regulate surface water or groundwater quality, but recognizes the importance of established thresholds (e.g., SNMP water quality objectives and Title 22 regulations) and will continue to monitor and evaluate how water quality metrics relate to groundwater conditions.

The groundwater level sustainability indicator (metric) controls other sustainability indicators, such as groundwater storage reduction and inelastic land subsidence. Although the groundwater level sustainability indicator concerned with preventing chronic declines in water levels (per SGMA), evaluation of measured (historical) and projected (modelled) groundwater levels indicates that these basins are resilient and recover from droughts each time, as long as occasional wet periods occur. The Basins are considered sustainable regarding groundwater levels because no chronic (long-term) trends are observed or projected. The same conclusion is made for the groundwater storage and land subsidence sustainability indicators, as storage and water levels are directly correlated and our evaluation of historical land subsidence (based on InSAR datasets) indicates insignificant (less than 0.1 ft/yr) land surface elevation changes that rebound with recovery of groundwater levels (i.e., elastic subsidence).

SMCs are established to maximize the operational flexibility of the Basins by setting the MO and MT at each representative monitoring site (wells) at basin full conditions (2011 groundwater levels) and MT at the bottom of screen of representative monitoring sites (wells), respectively. The Basins are considered sustainable regarding these three sustainability indicators; therefore, no management actions or projects are considered necessary to prevent undesirable results from groundwater level fluctuations. Although GDEs were not considered a significant factor in establishing groundwater level SMCs, the Board recognizes the importance of the ability for GDEs to recover following drought periods, and plans to support habitat restoration and preservation projects (i.e., the Cienega site).

Regarding the last sustainability indicator—depletions of surface waters that are interconnected with groundwater—the Board has determined that the anticipated future and historical reductions in the rising groundwater rates are not materially different (even with climate change) and, after consultation with DWR, has elected to not establish an MT for this sustainability indicator.

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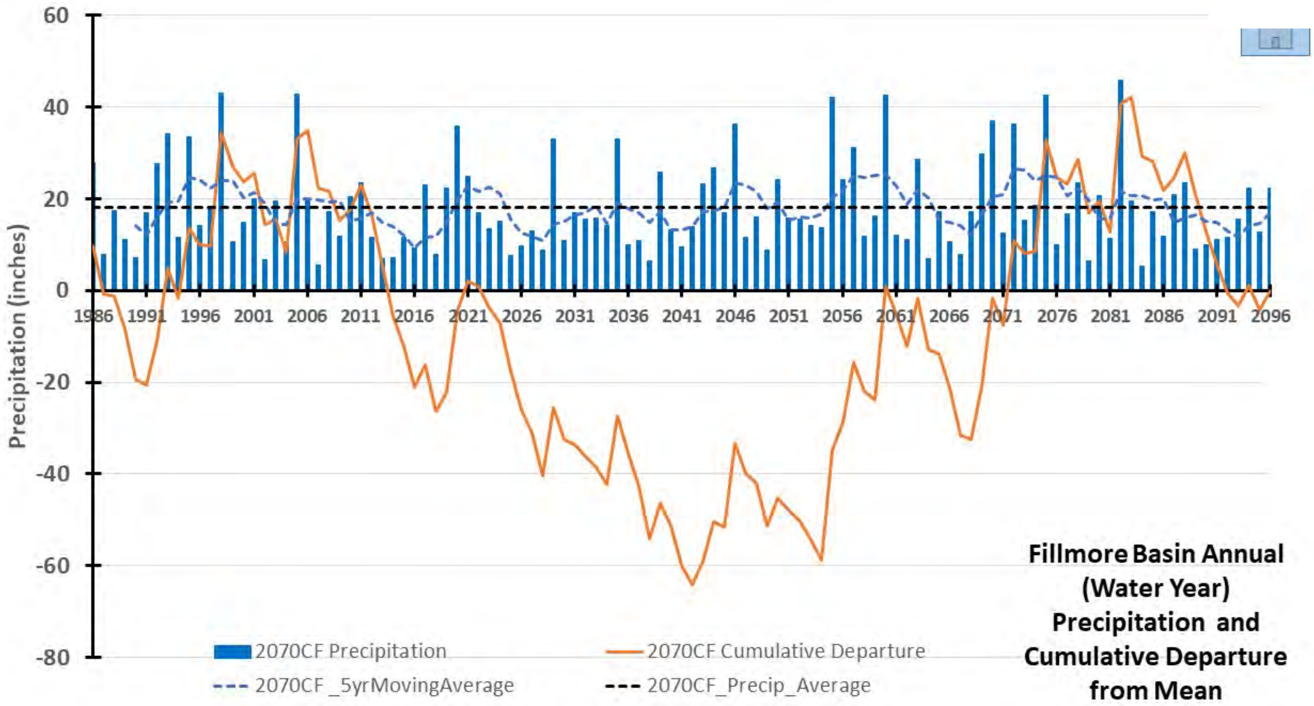
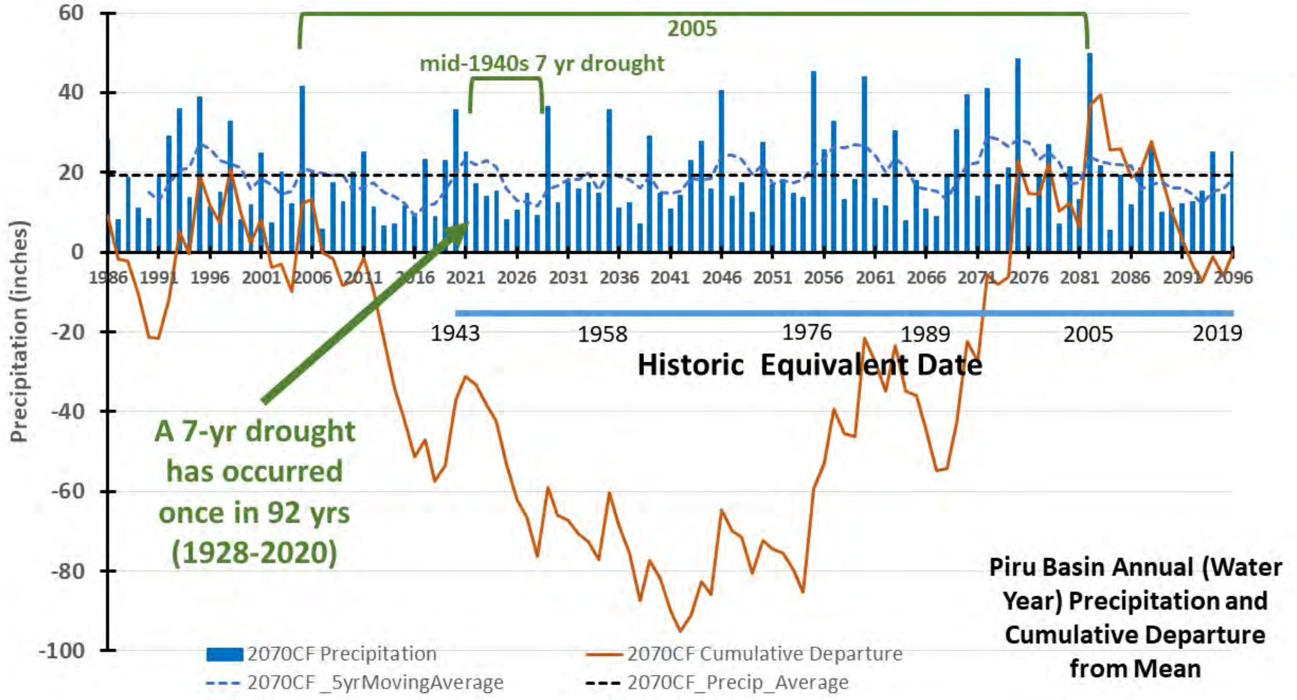
Figures



Fillmore Basin Annual (Water Year) Precipitation and Cumulative Departure from Mean



Piru Basin Annual (Water Year) Precipitation and Cumulative Departure from Mean

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Precipitation – Historical and Future Projections

Figure 2-1

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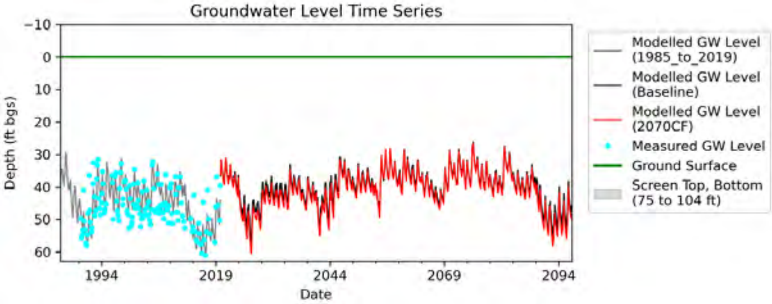
03N21W01P02S



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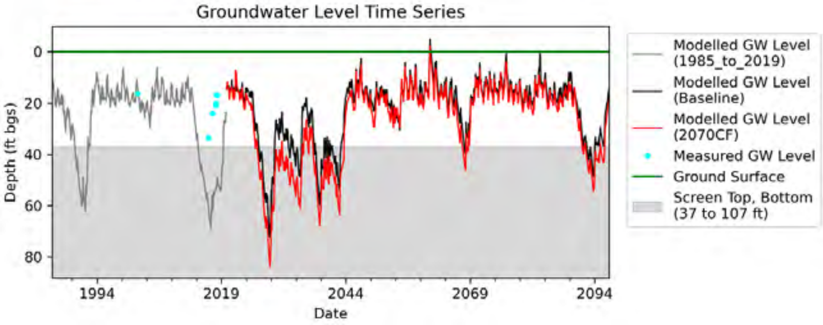

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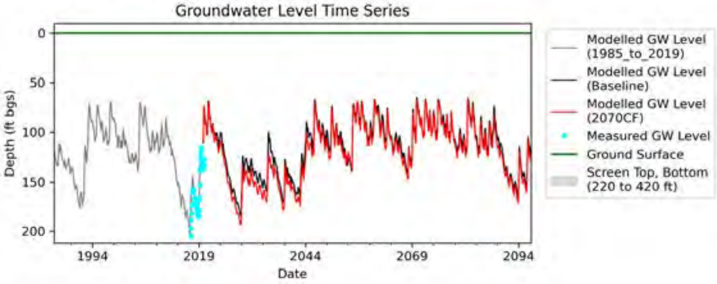

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Representative Hydrographs

Figure 2-2

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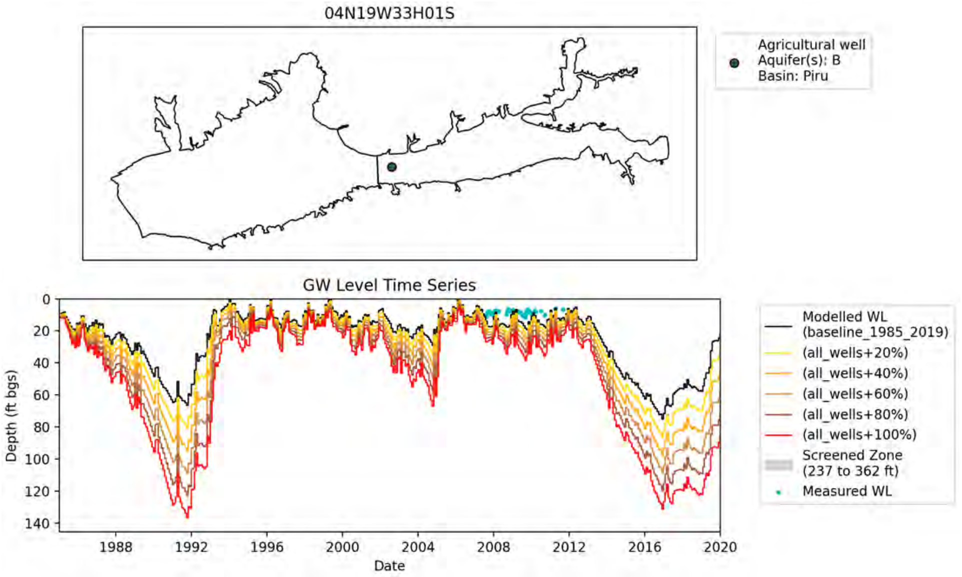
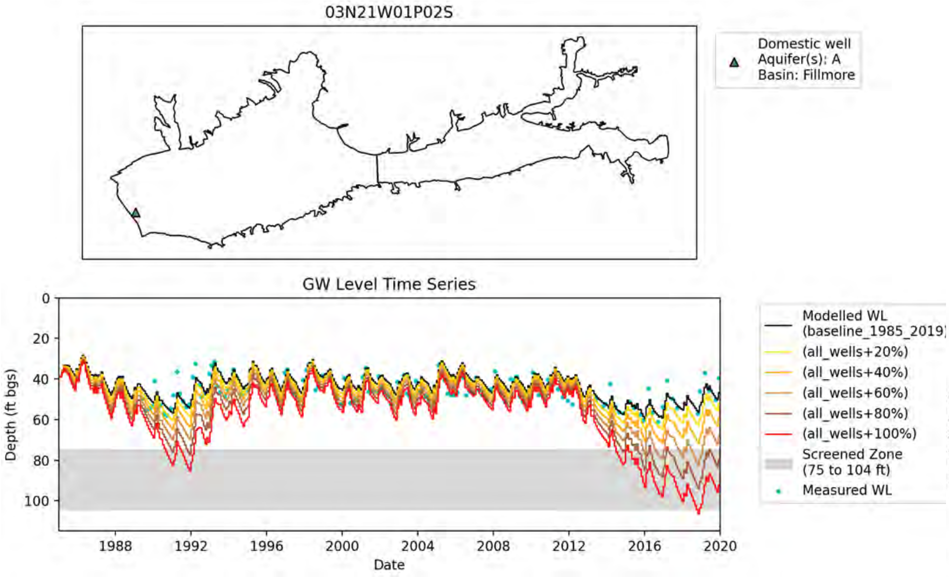
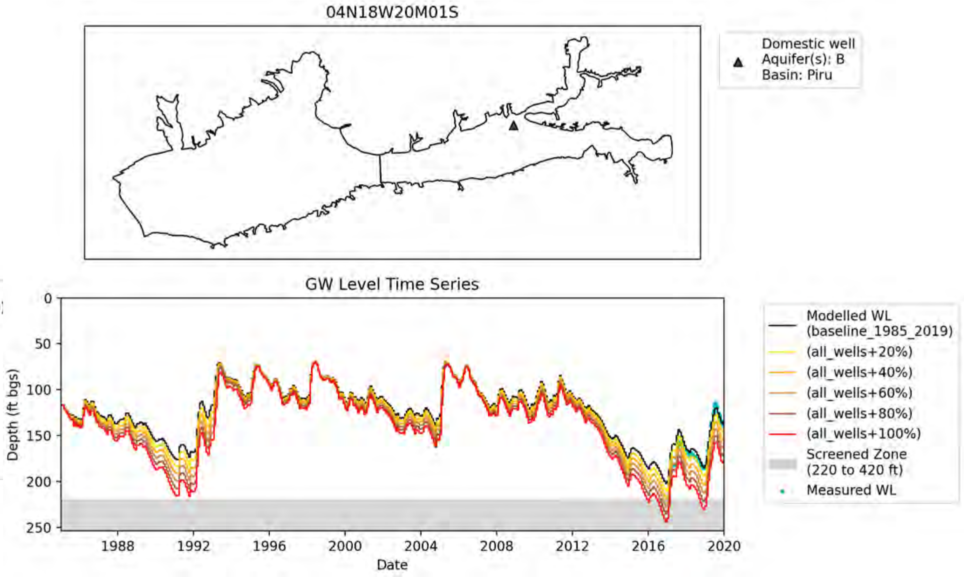
Pumping , AFY	Fillmore basin	Piru basin	Total for both basins
Baseline	46,760	11,390	58,150
Baseline + 20%	56,120	13,670	69,780
Baseline + 40%	65,470	15,950	81,420
Baseline + 60%	74,820	18,220	93,050
Baseline + 80%	84,180	20,500	104,680
Baseline + 100%	93,530	22,780	116,310

(Values rounded to nearest 10 AFY)







Sustainable Management Criteria Technical Memorandum

Basin Pumping Stress Tests

Figure 2-3

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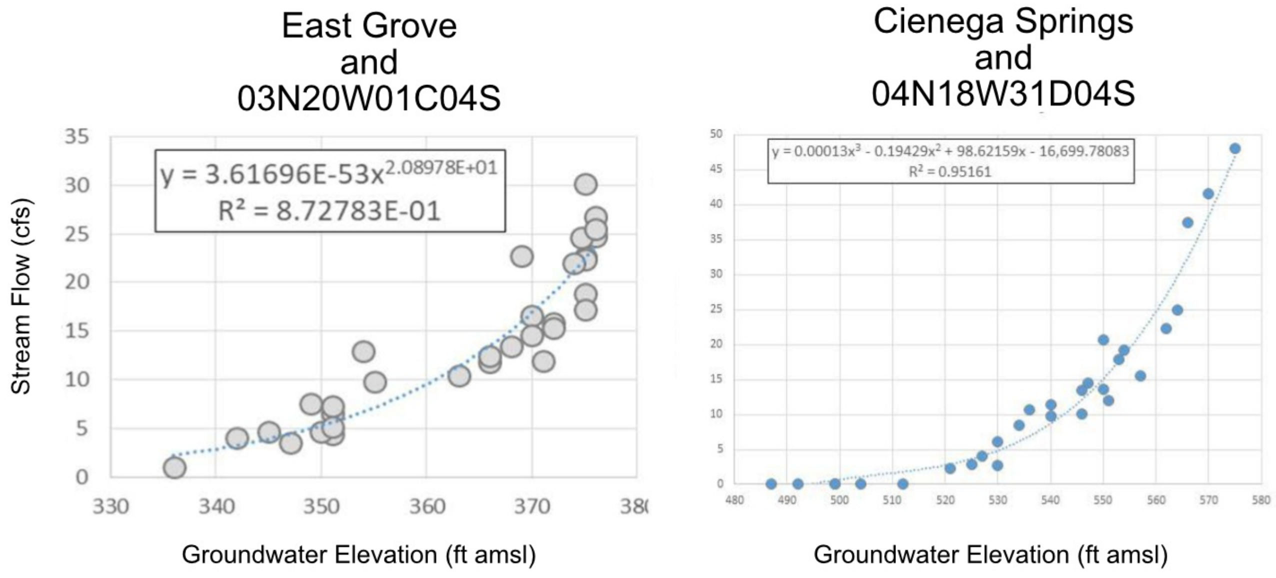
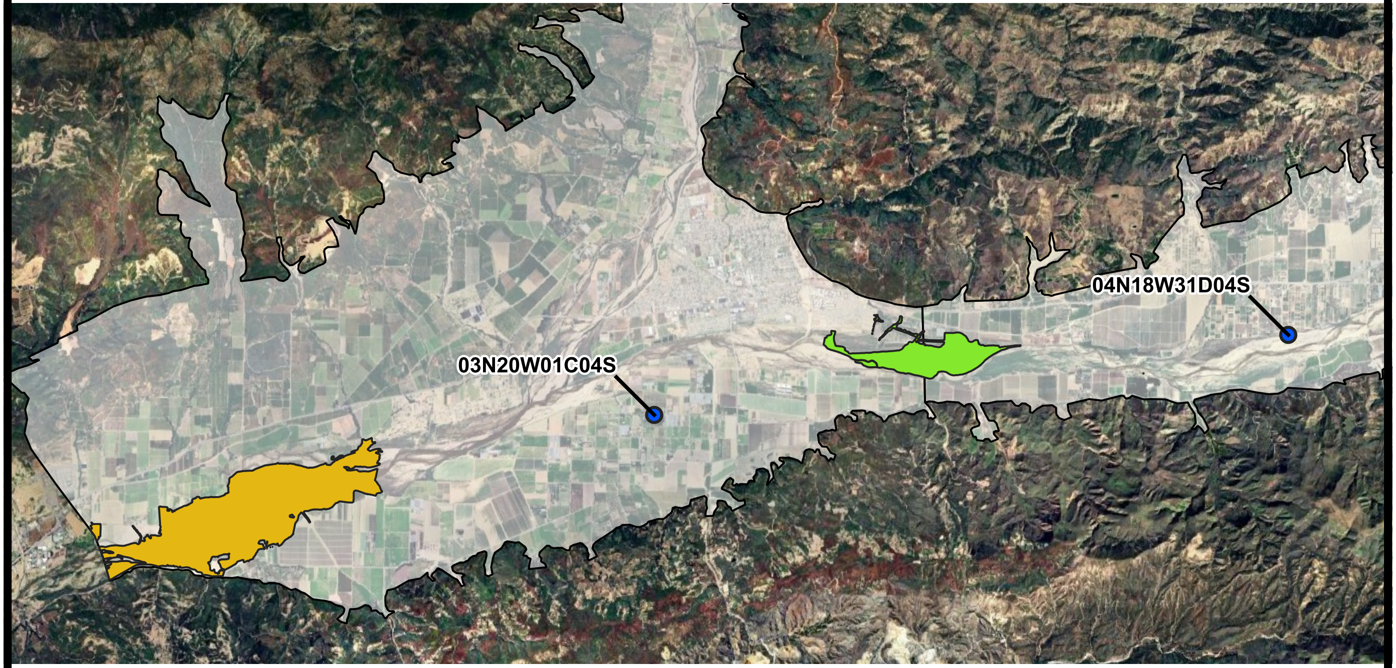
Groundwater Elevation - Stream Flow Crossover Analyses





Source: https://fillmore-piru.gladata.com/

Explanation

● Monitoring Well
🟩 Cienega Springs GDE
☐ Groundwater Basins
🟨 East Grove GDE

N

0 1 2 mi

Notes:
1. Empirical relationships developed by United Water Conservation District.

Sustainable Management Criteria Technical Memorandum

Rising Groundwater Empirical Relationships

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Figure 2-4

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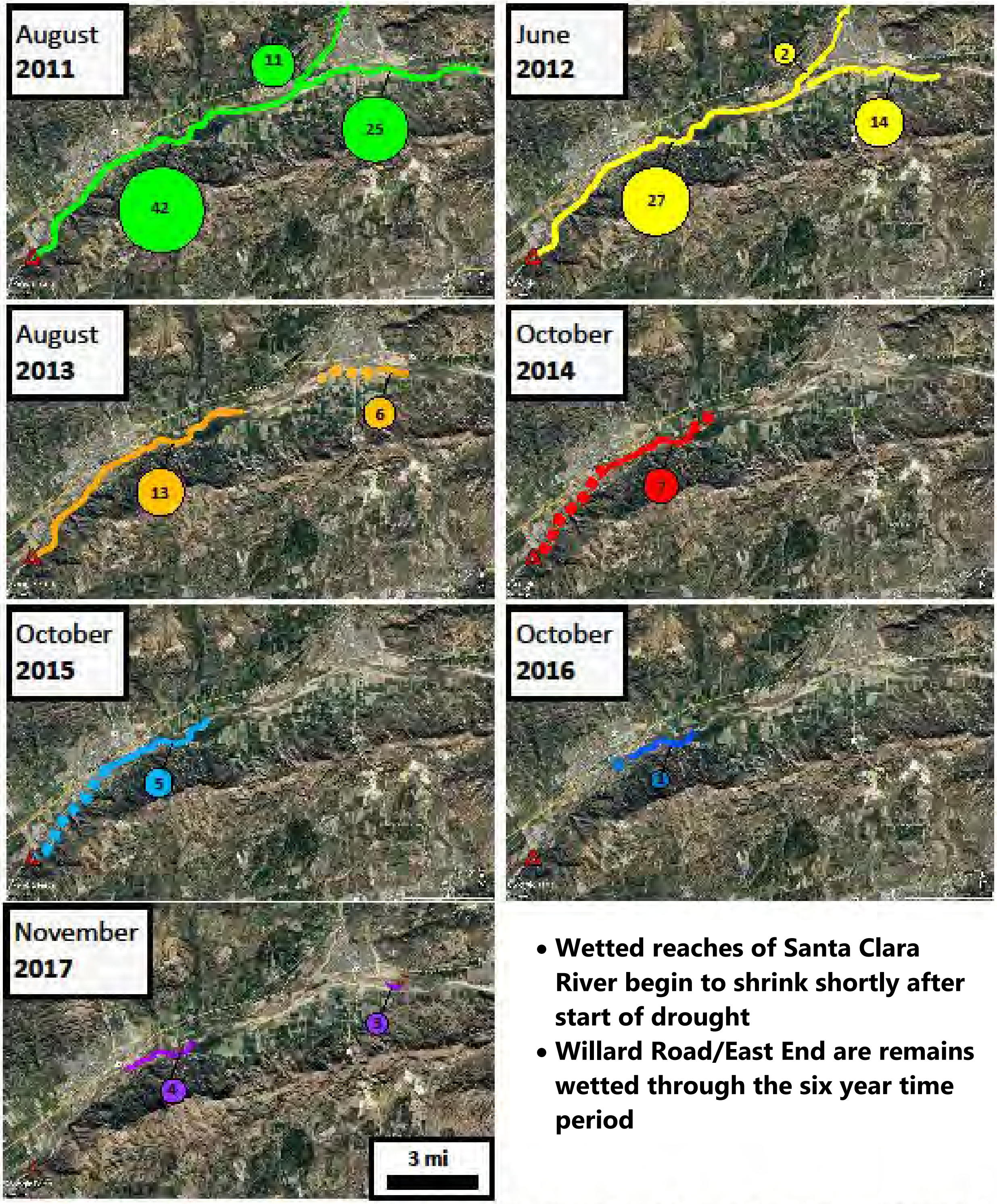


- **Wetted reaches of Santa Clara River begin to shrink shortly after start of drought**
- **Willard Road/East End are remains wetted through the six year time period**

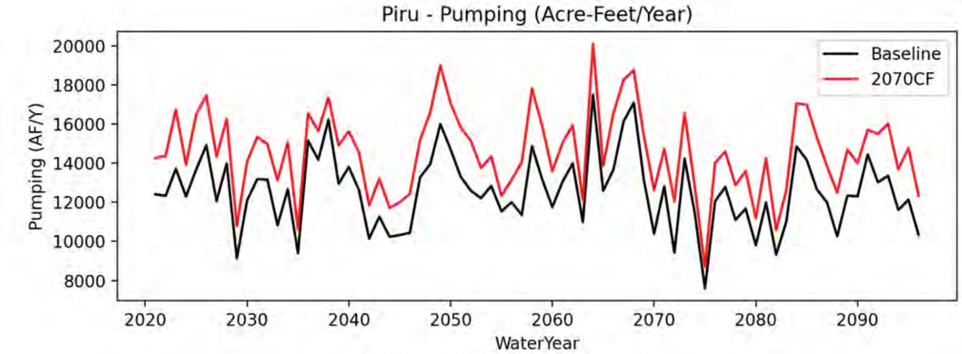
Surface water flow in cfs shown in circles

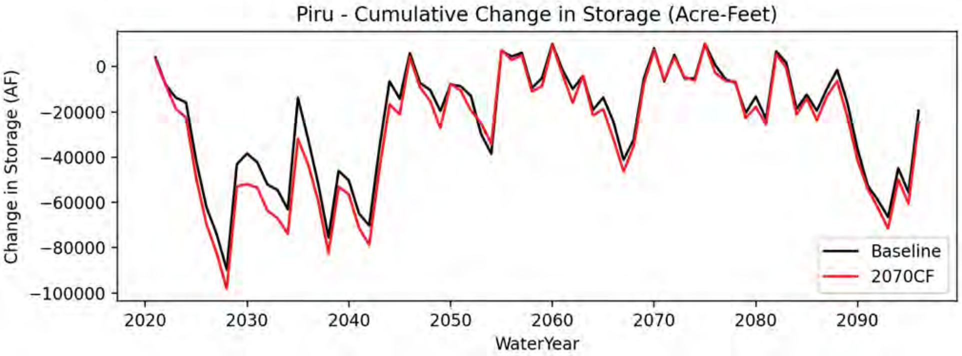
Sustainable Management Criteria Technical Memorandum

Example Surface Water Flow in Extended Drought – 2011-2017

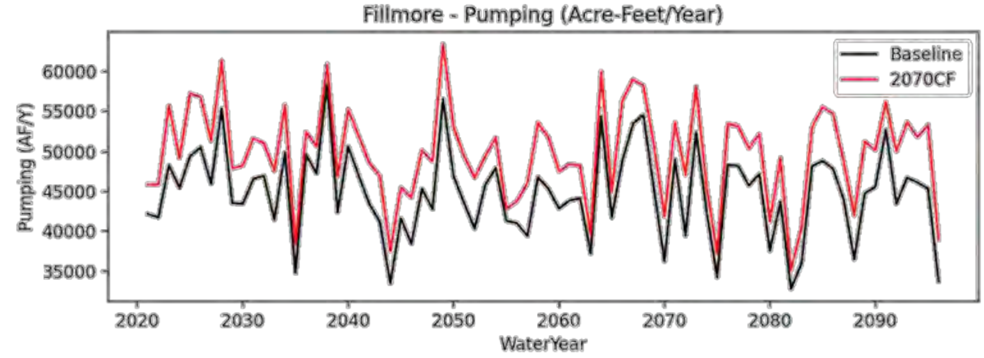
Figure 2-5

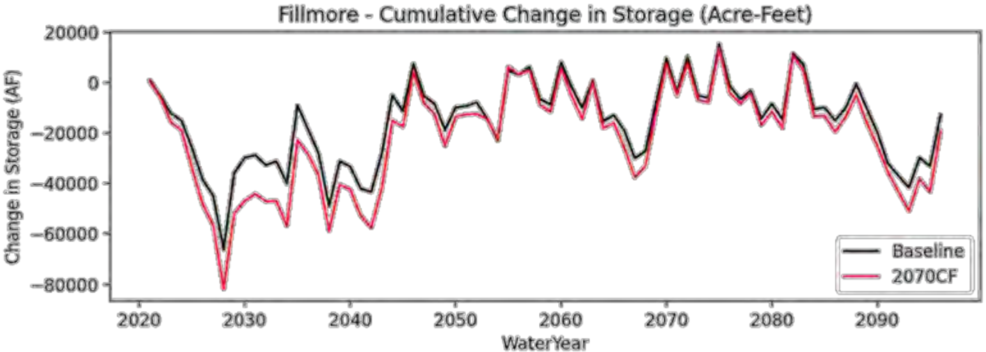
5/29/2024





	Average Pumping (Acre-Feet/Year)	
Scenario	**Fillmore**	**Piru**
Historical	**46,800**	**11,400**
Baseline	**44,800**	**12,600**
2070CF	**49,800**	**14,600**





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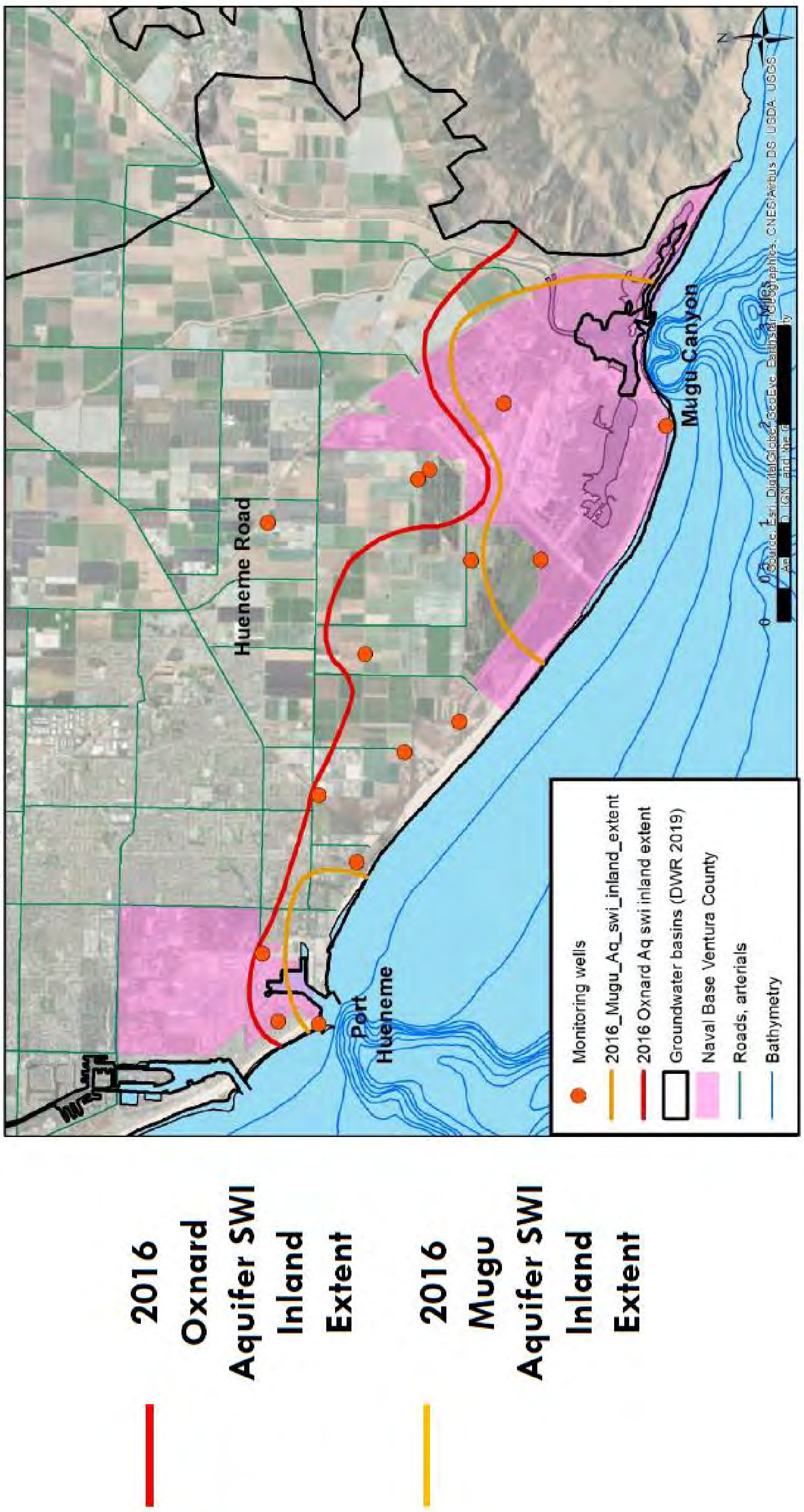
Future Groundwater Extractions and Change in Storage

Figure 2-6



UWCD, 2021, Coastal Brackish Groundwater Extraction and Treatment Project Update

Sustainable Management Criteria Technical Memorandum

Seawater Intrusion – Upper Aquifer System

Figure 3-1

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a Geo-Logic Company

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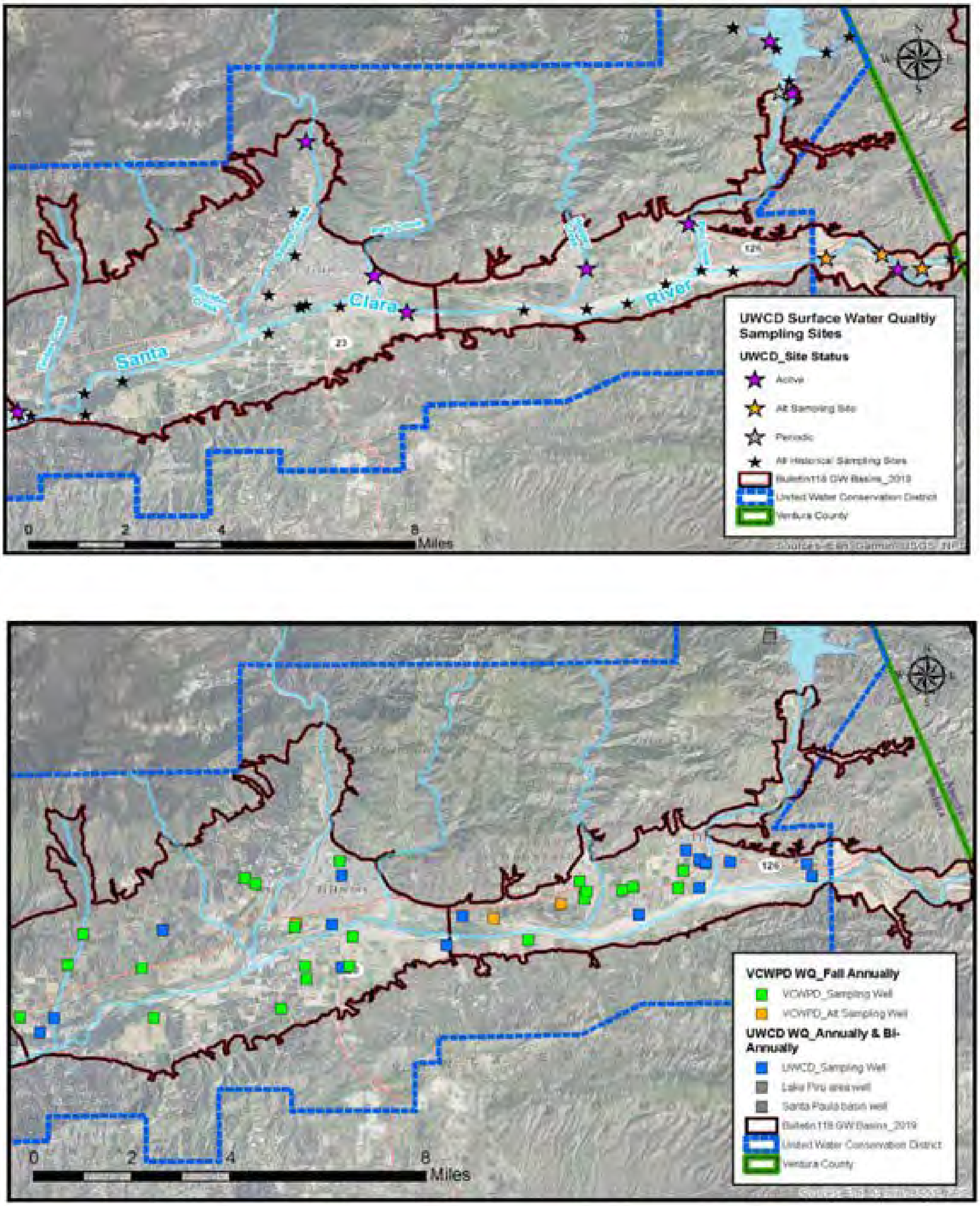

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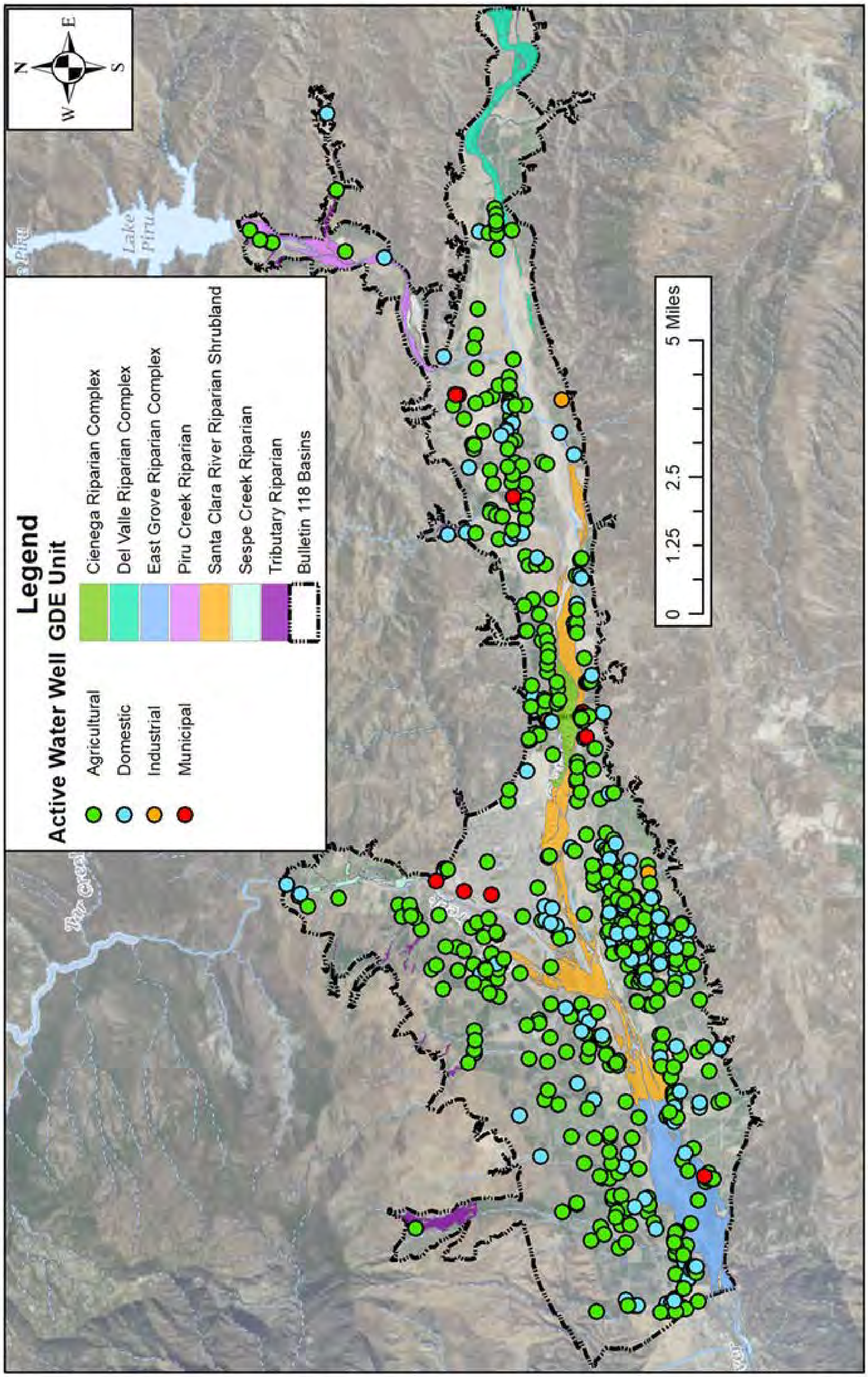
Water Quality Sampling Sites

Figure 3-2

5/29/2024

a Geo-Logic Company



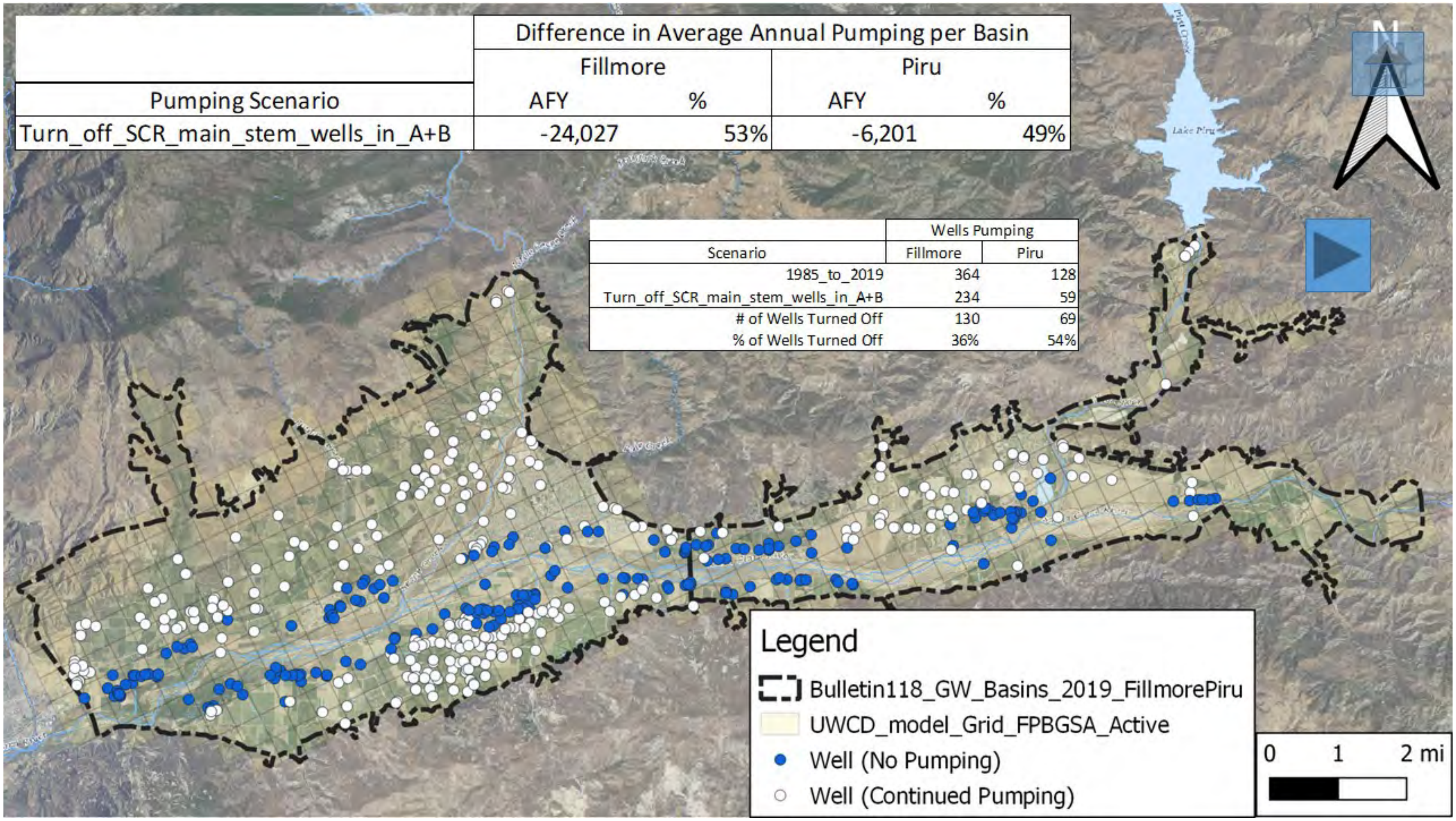
Sustainable Management Criteria Technical Memorandum

Active Water Wells and GDE Units

Figure 3-3

DBS&A a Geo-Logic Company

5/29/2024



	Difference in Average Annual Pumping per Basin			
	Fillmore		Piru	
Pumping Scenario	AFY	%	AFY	%
Turn_off_SCR_main_stem_wells_in_A+B	-24,027	53%	-6,201	49%

	Wells Pumping	
Scenario	Fillmore	Piru
1985_to_2019	364	128
Turn_off_SCR_main_stem_wells_in_A+B	234	59
# of Wells Turned Off	130	69
% of Wells Turned Off	36%	54%

Blue Wells – Pumping eliminated

White Well – Continued pumping

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Simulated Groundwater Extraction Reductions

Figure 3-4

DBS&A
a Geo-Logic Company

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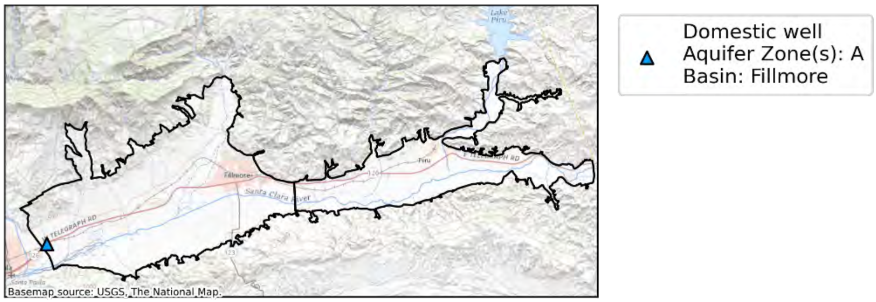
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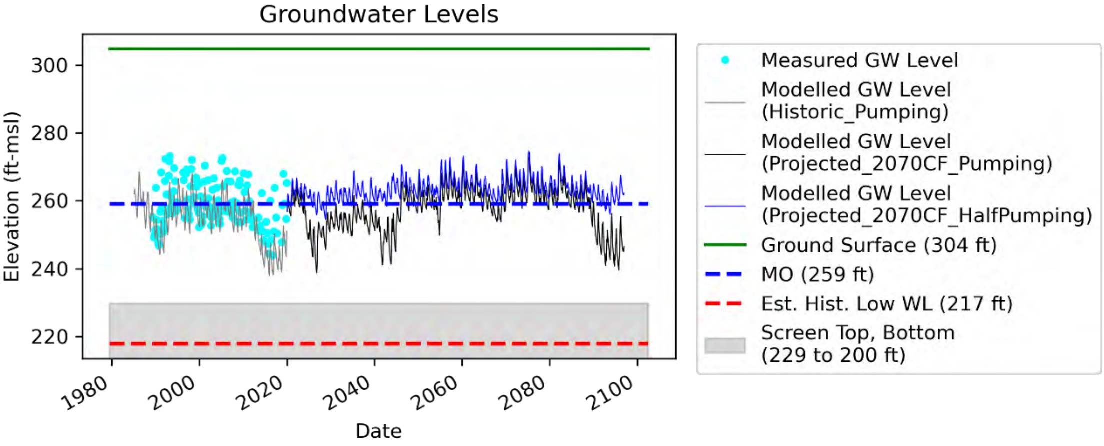
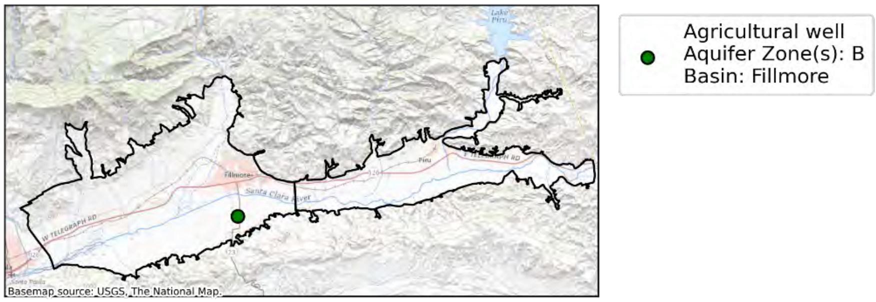

Groundwater Levels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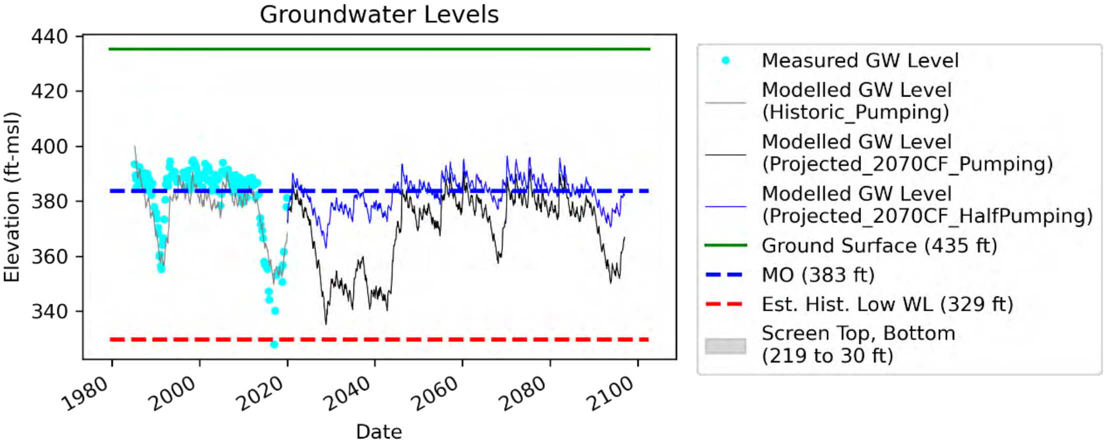
Groundwater Levels

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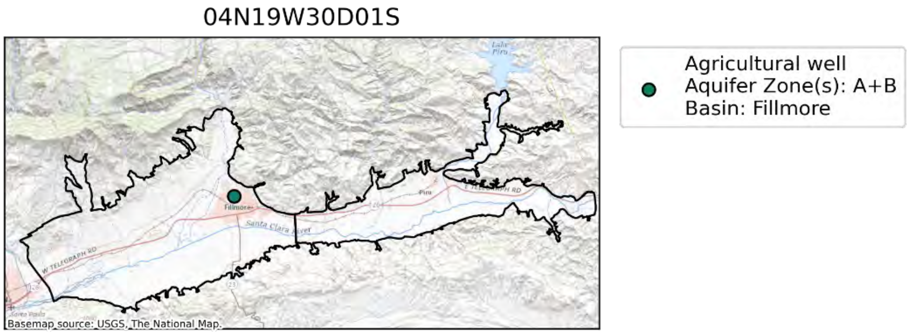
Simulated Groundwater Hyrographs with Extraction Reductions

Figure 3-5a

DBS&A
a Geo-Logic Company

5/29/2024



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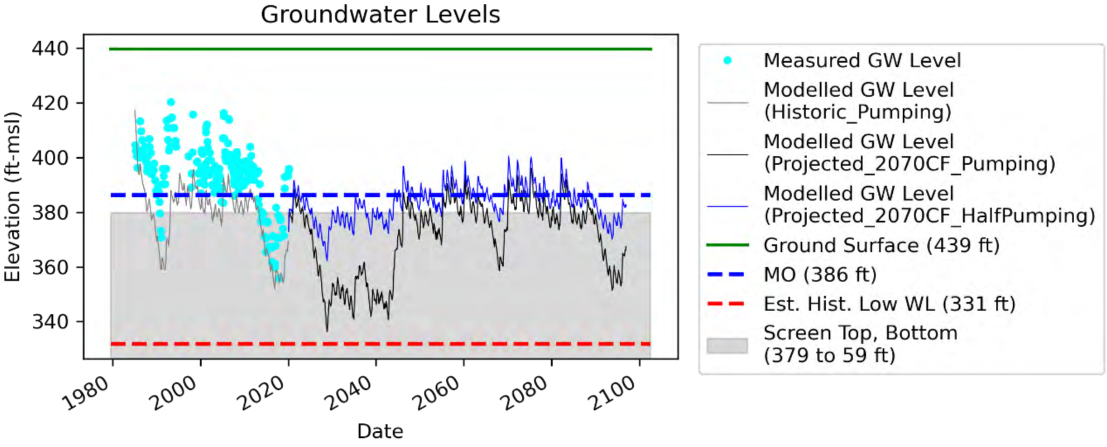
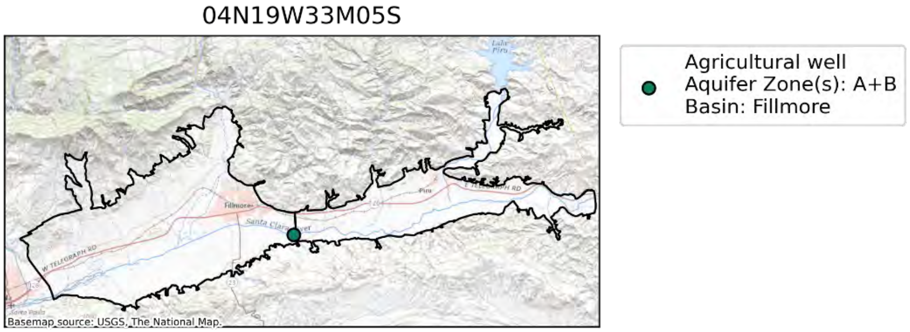


Groundwater Levels



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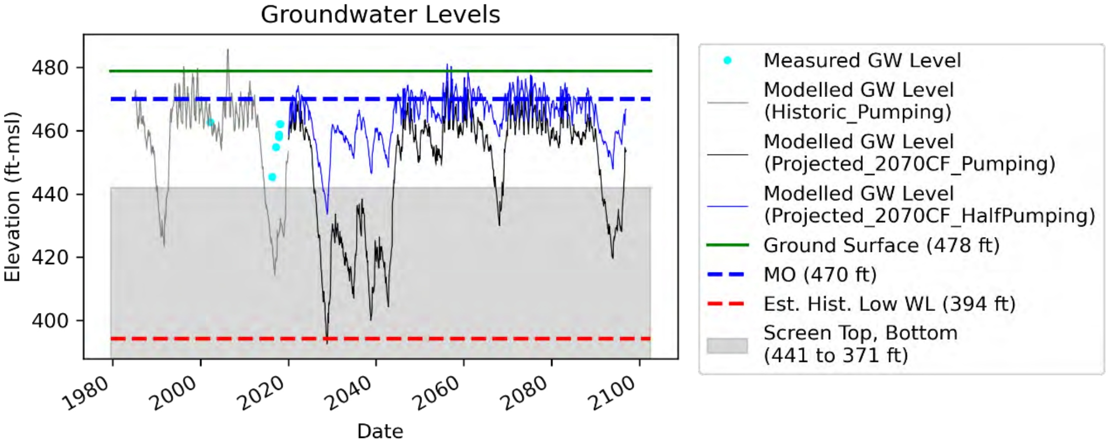


Groundwater Levels

Sustainable Management Criteria Technical Memorandum

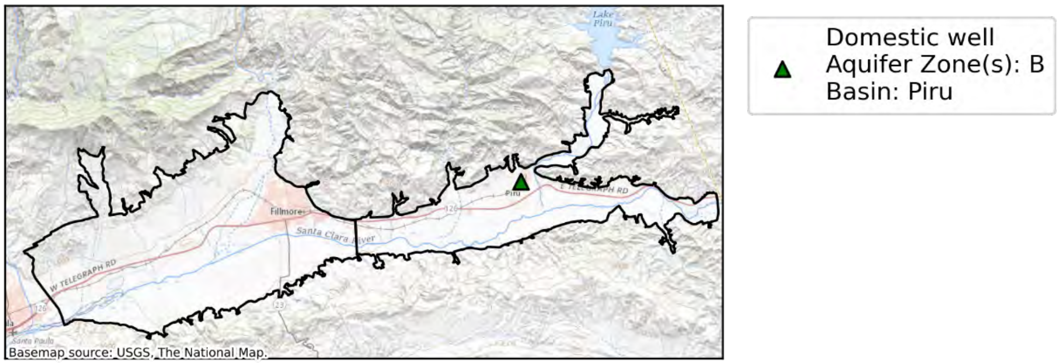
Simulated Groundwater Hyrographs with Extraction Reductions

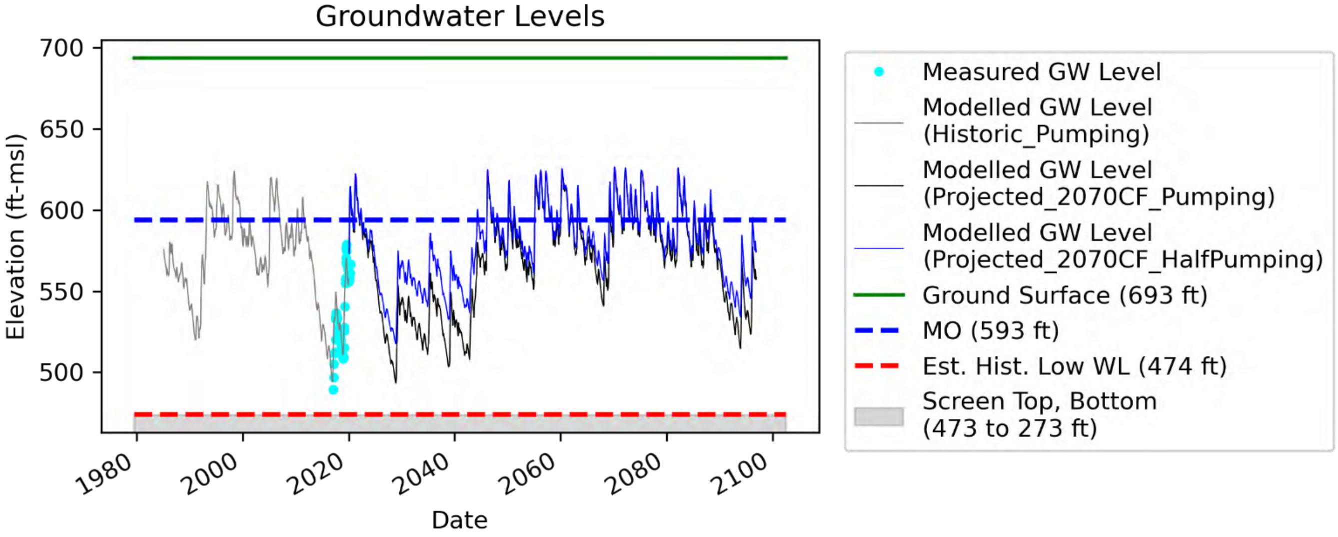
Figure 3-5b

5/29/2024

a Geo-Logic Company

04N18W20M01S





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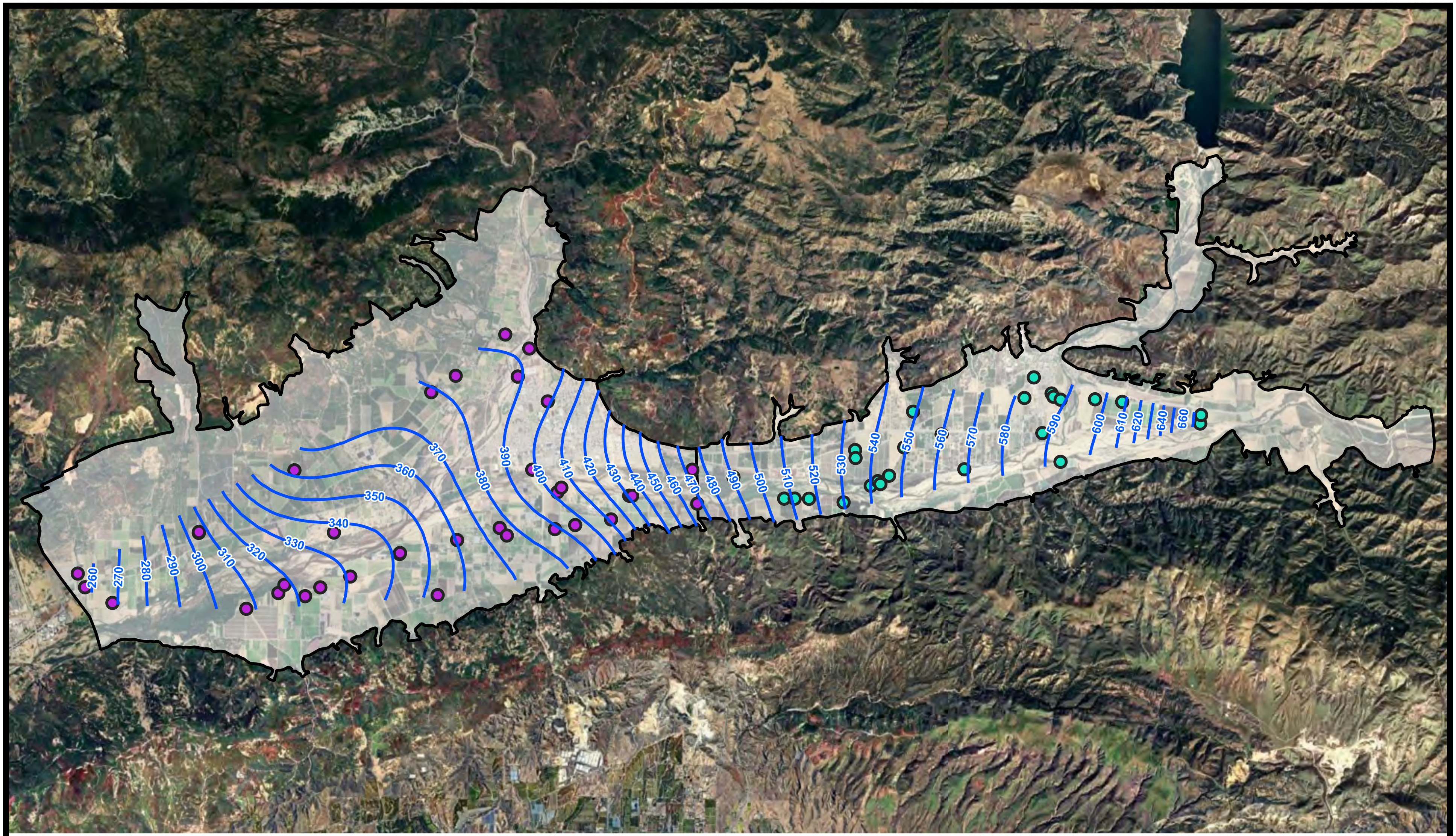
Simulated Groundwater Hyrographs with Extraction Reductions

Figure 3-5c

DBS&A
a Geo-Logic Company

5/29/2024



Source: https://fillmore-piru.gladata.com

Explanation

Wells with 2011 Water Levels
● Fillmore subbasin
● Piru subbasin

2011 Average Groundwater Elevation Contour (ft amsl)

Groundwater Basin Boundary

Sustainable Management Criteria Technical Memorandum

2011 Average Groundwater Elevations

Figure 3-6

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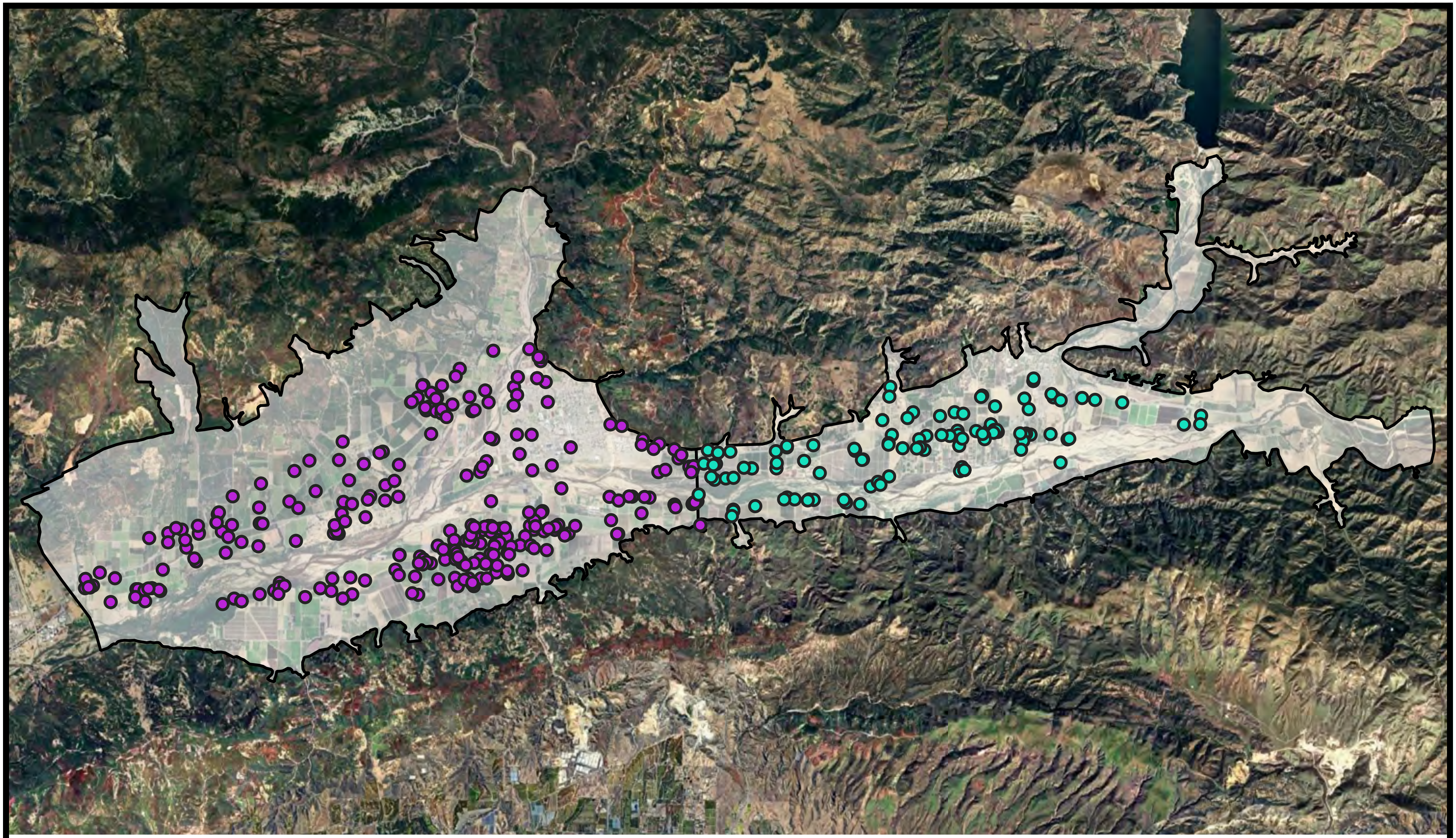

Source: https://sierra-valley.gladata.com

Explanation

Wells with Reported Screened Intervals

● Fillmore subbasin

● Piru subbasin

▭ Groundwater Basin Boundary

Notes:

1. Only wells located within the 2011 average groundwater level interpolation area included in analysis.

Sustainable Management Criteria Technical Memorandum

Wells Used in Water Level Decline Analysis

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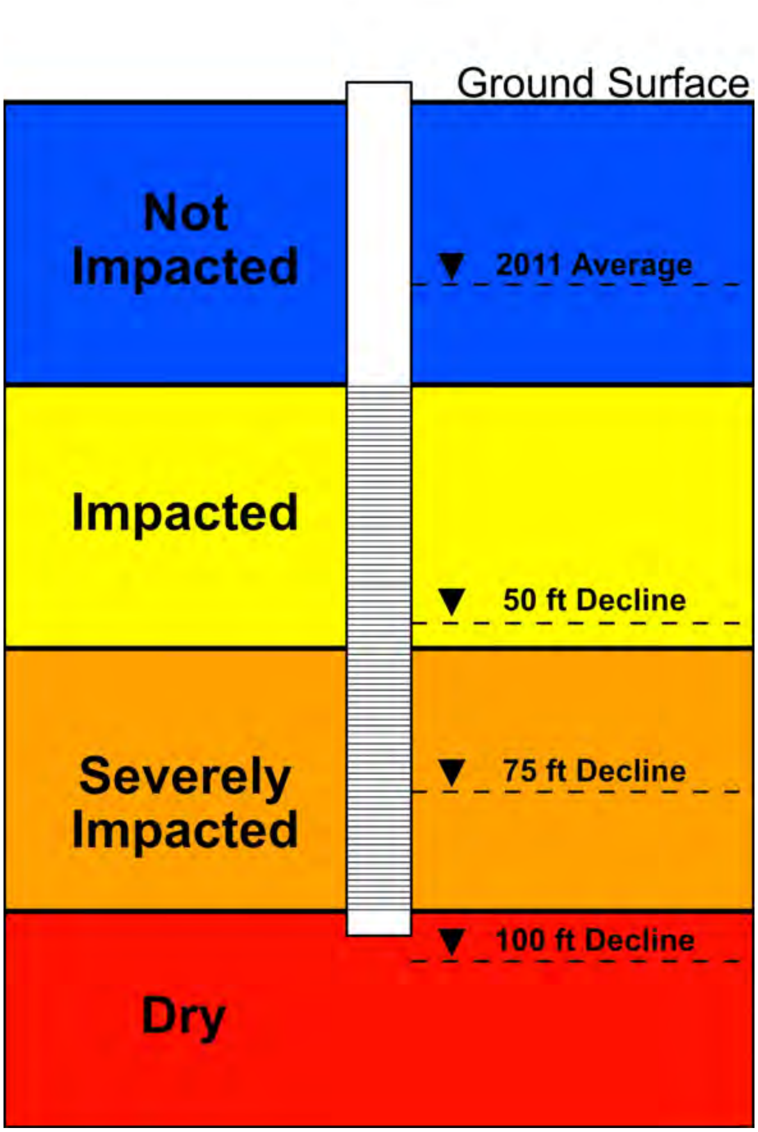
Figure 3-7



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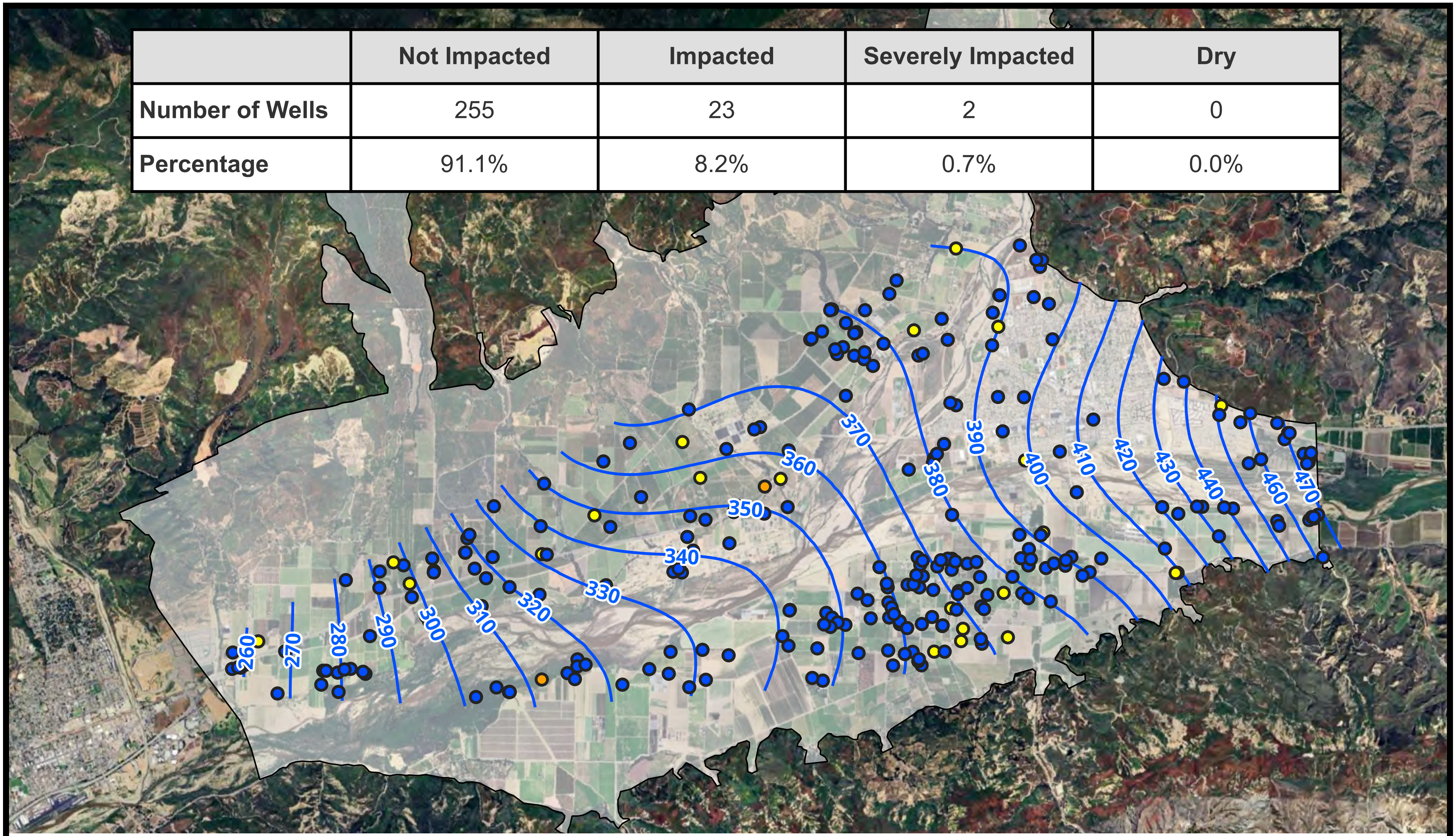
Example Well Impact Classification

Figure 3-8

C:\Users\500\OneDrive - Geo-Logic Associates Inc\Documents\Local Project Files\Fillmore-Piru\MT Evaluation\GIS\QGZs\SMC Tech Memo.qgz

	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	255	23	2	0
Percentage	91.1%	8.2%	0.7%	0.0%



Source: https://sierra-valley.gladata.com

Explanation

Estimated Well Status

- ● Not Impacted
- ● Impacted
- ● Severely Impacted
- ● Dry

Groundwater Elevation Contour (ft amsl)

Groundwater Basin Boundary

0 0.5 1 mi

N

Sustainable Management Criteria Technical Memorandum

Fillmore Subbasin Estimated Well Status
2011 Average Groundwater Level

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05/29/2024

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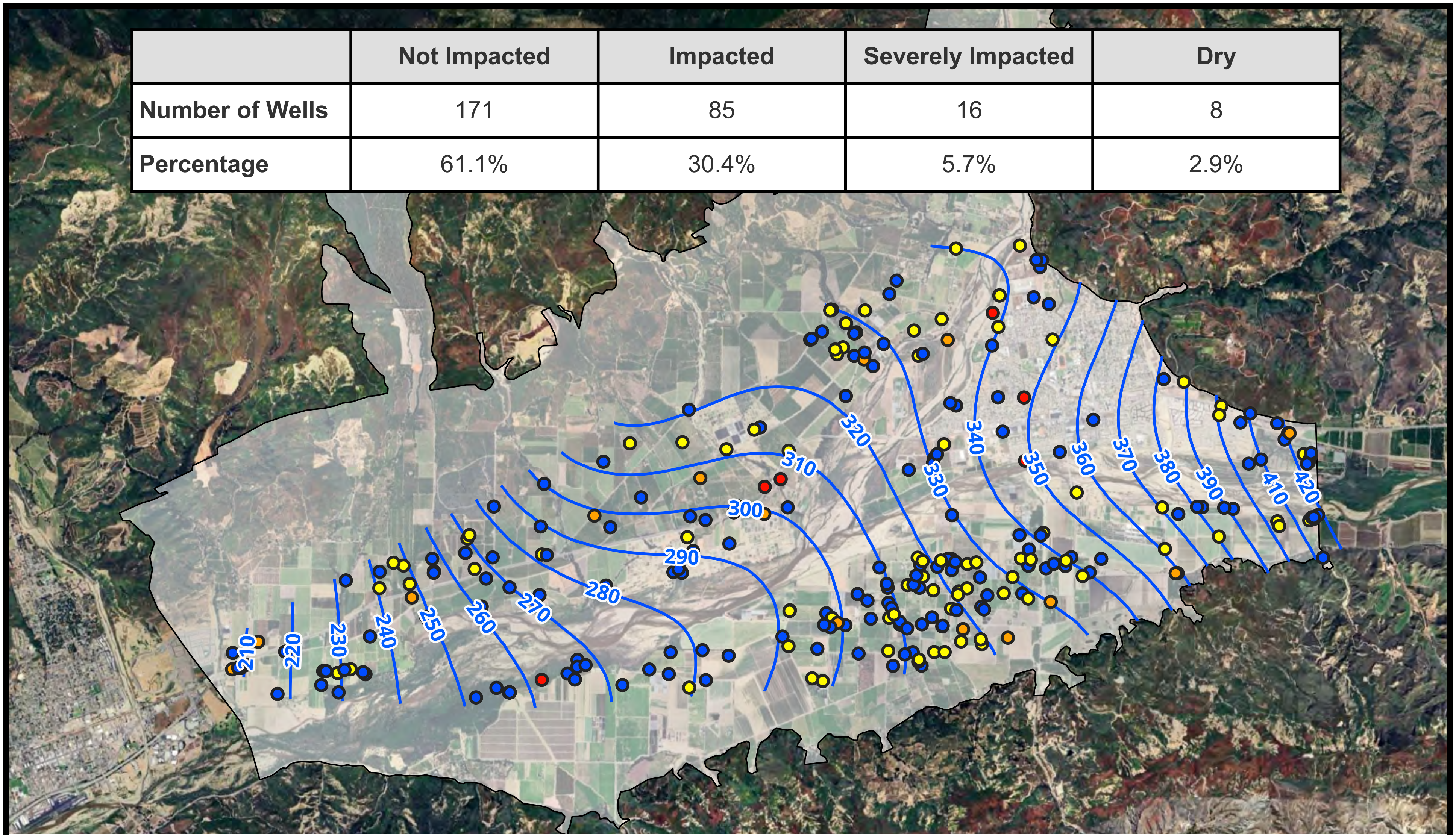
Figure 3-9



	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	171	85	16	8
Percentage	61.1%	30.4%	5.7%	2.9%

Source: https://sierra-valley.gladata.com

Explanation

Estimated Well Status

● Not Impacted

● Impacted

● Severely Impacted

● Dry

Groundwater Elevation Contour (ft amsl)

▭ Groundwater Basin Boundary

0 0.5 1 mi

N

Sustainable Management Criteria Technical Memorandum

Fillmore Subbasin Estimated Well Status 50-foot Decline from 2011 Average

DBS&A a Geo-Logic Company

06/09/2024

DB23.1279

Figure 3-10

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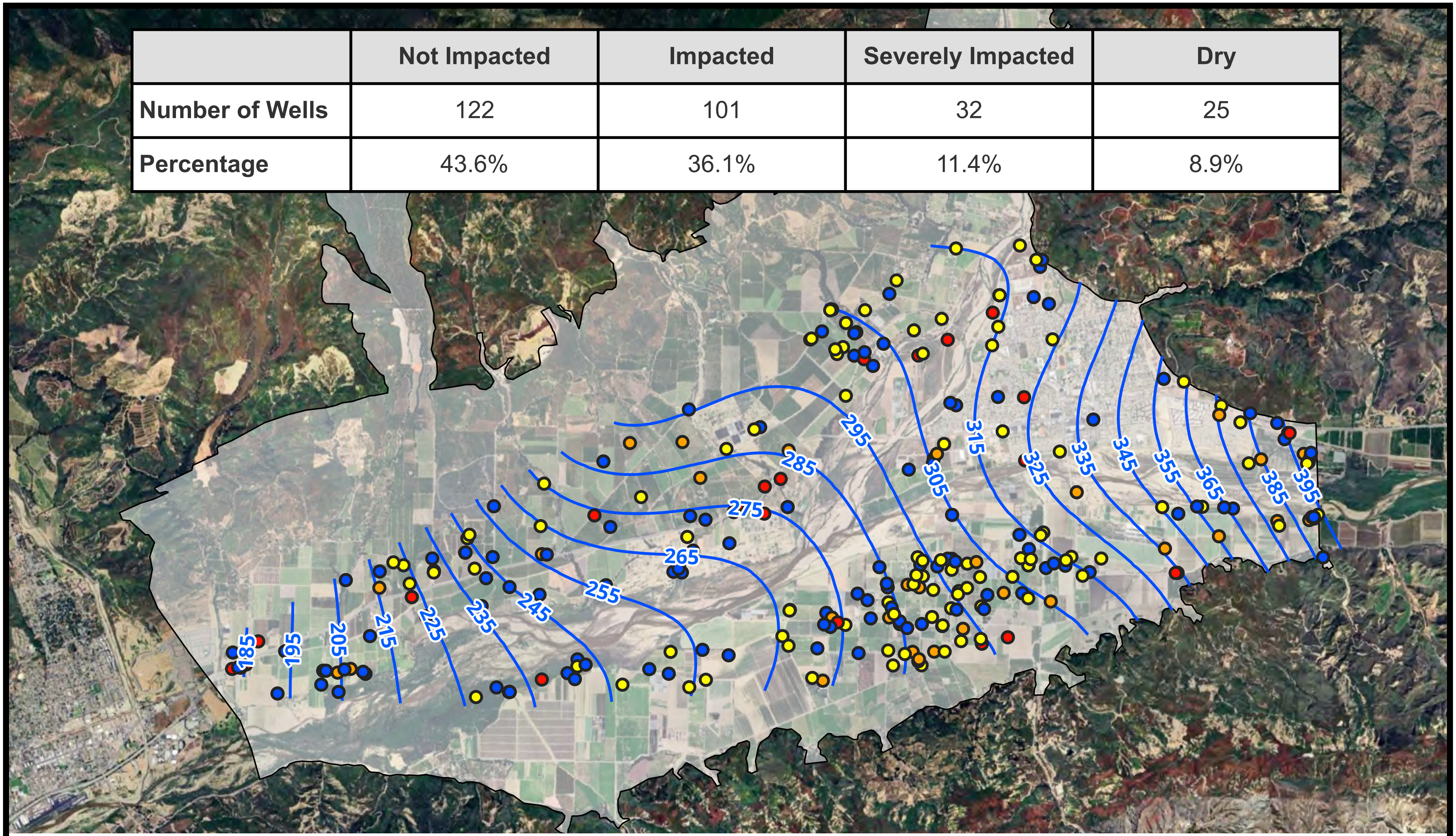

	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	122	101	32	25
Percentage	43.6%	36.1%	11.4%	8.9%

Source: https://sierra-valley.gladata.com

Explanation

Estimated Well Status

● Not Impacted

● Impacted

● Severely Impacted

● Dry

— Groundwater Elevation Contour (ft amsl)

☐ Groundwater Basin Boundary

Sustainable Management Criteria Technical Memorandum

Fillmore Subbasin Estimated Well Status 75-foot Decline from 2011 Average

Figure 3-11

DBS&A
a Geo-Logic Company

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DB23.1279

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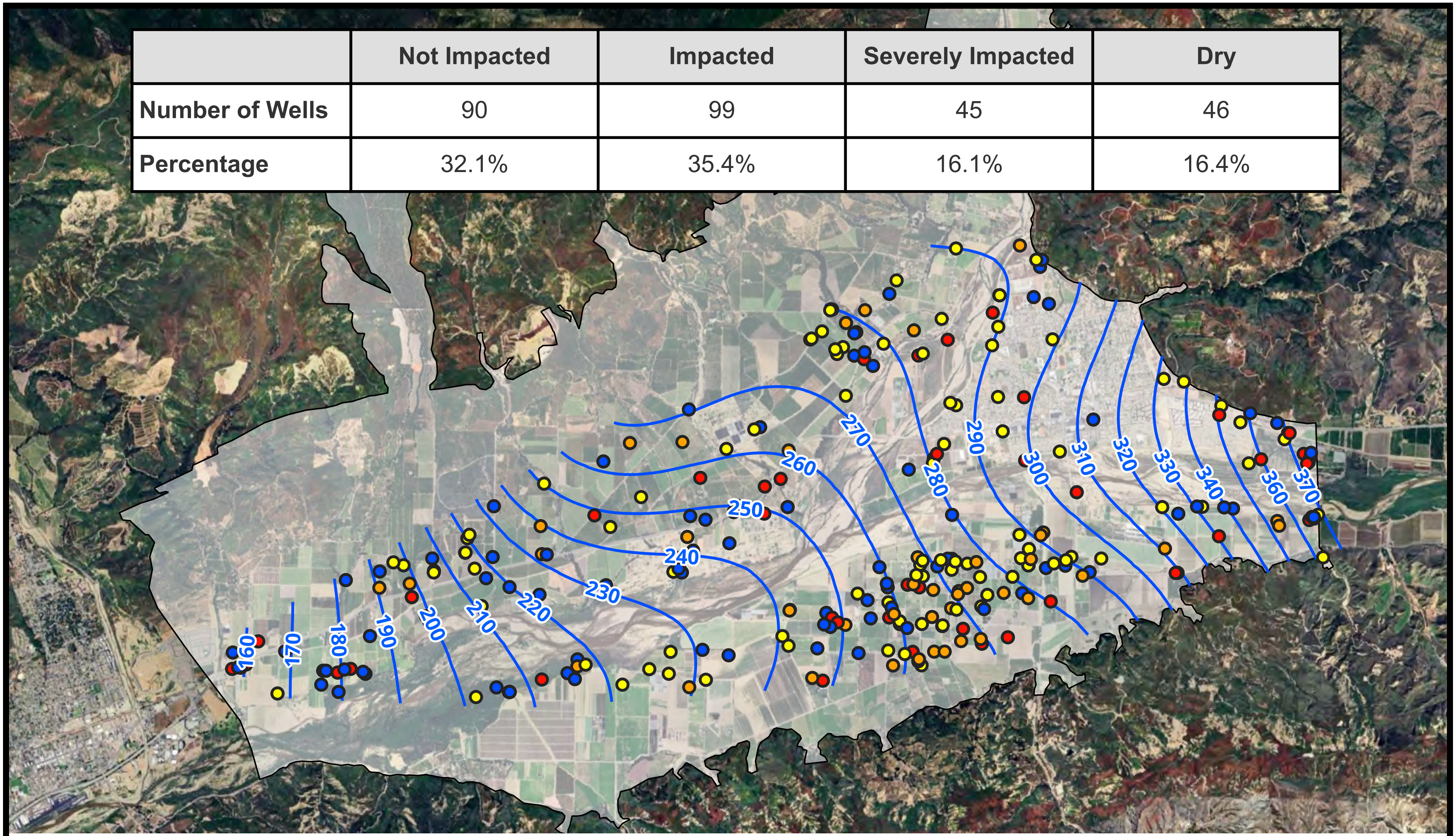
	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	90	99	45	46
Percentage	32.1%	35.4%	16.1%	16.4%



Explanation

Estimated Well Status

● Not Impacted

● Impacted

● Severely Impacted

● Dry

Groundwater Elevation Contour (ft amsl)

☐ Groundwater Basin Boundary

0 0.5 1 mi

N

Source: https://sierra-valley.gladata.com

Sustainable Management Criteria Technical Memorandum

Fillmore Subbasin Estimated Well Status
100-foot Decline from 2011 Average

DBS&A
a Geo-Logic Company

06/09/2024

DB23.1279

Figure 3-12

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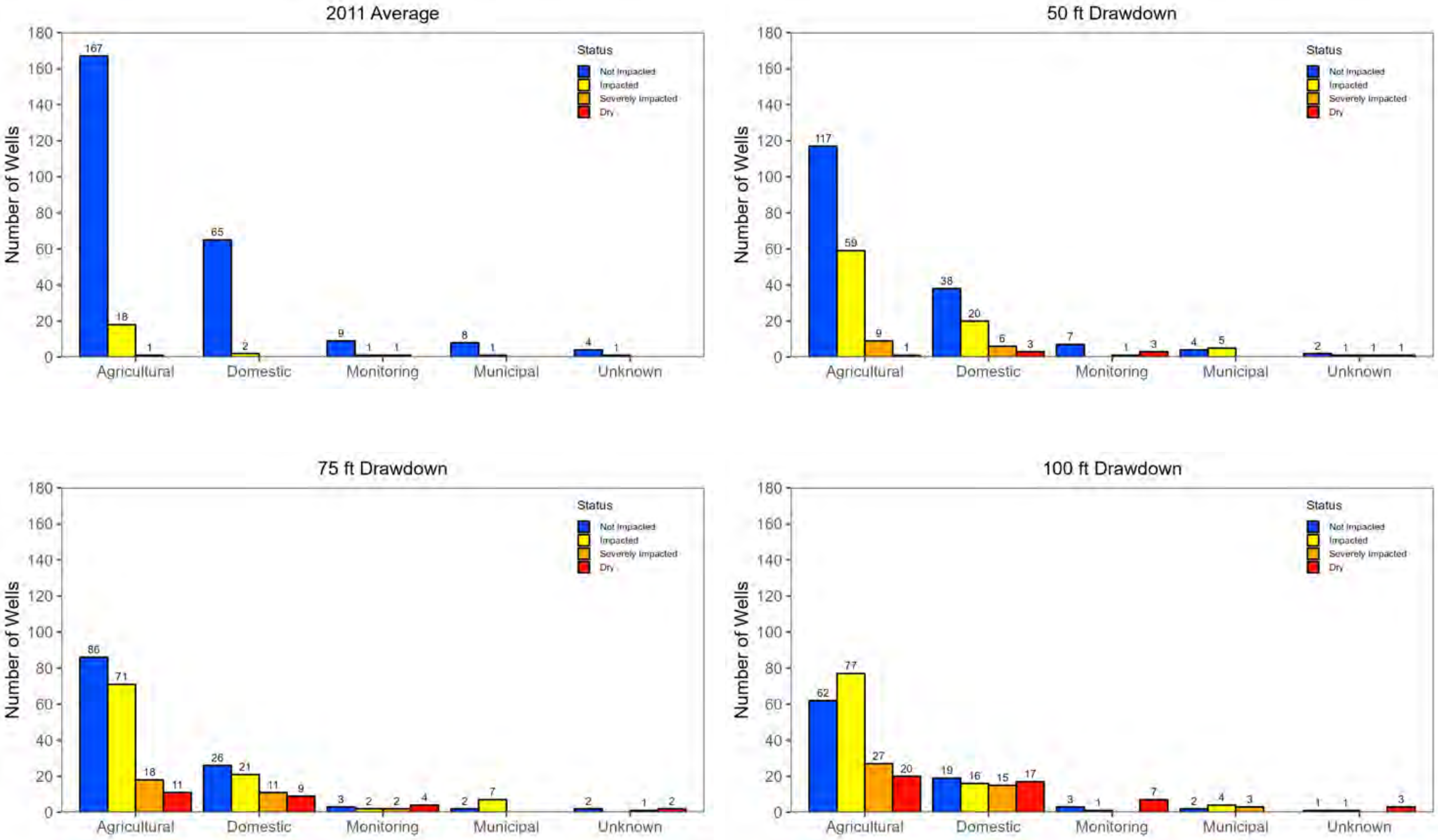

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DBS&A
a Geo-Logic Company
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Sustainable Management Criteria Technical Memorandum

Fillmore Subbasin Estimated Well Status
Grouped By Water Level Scenario

Figure 3-13

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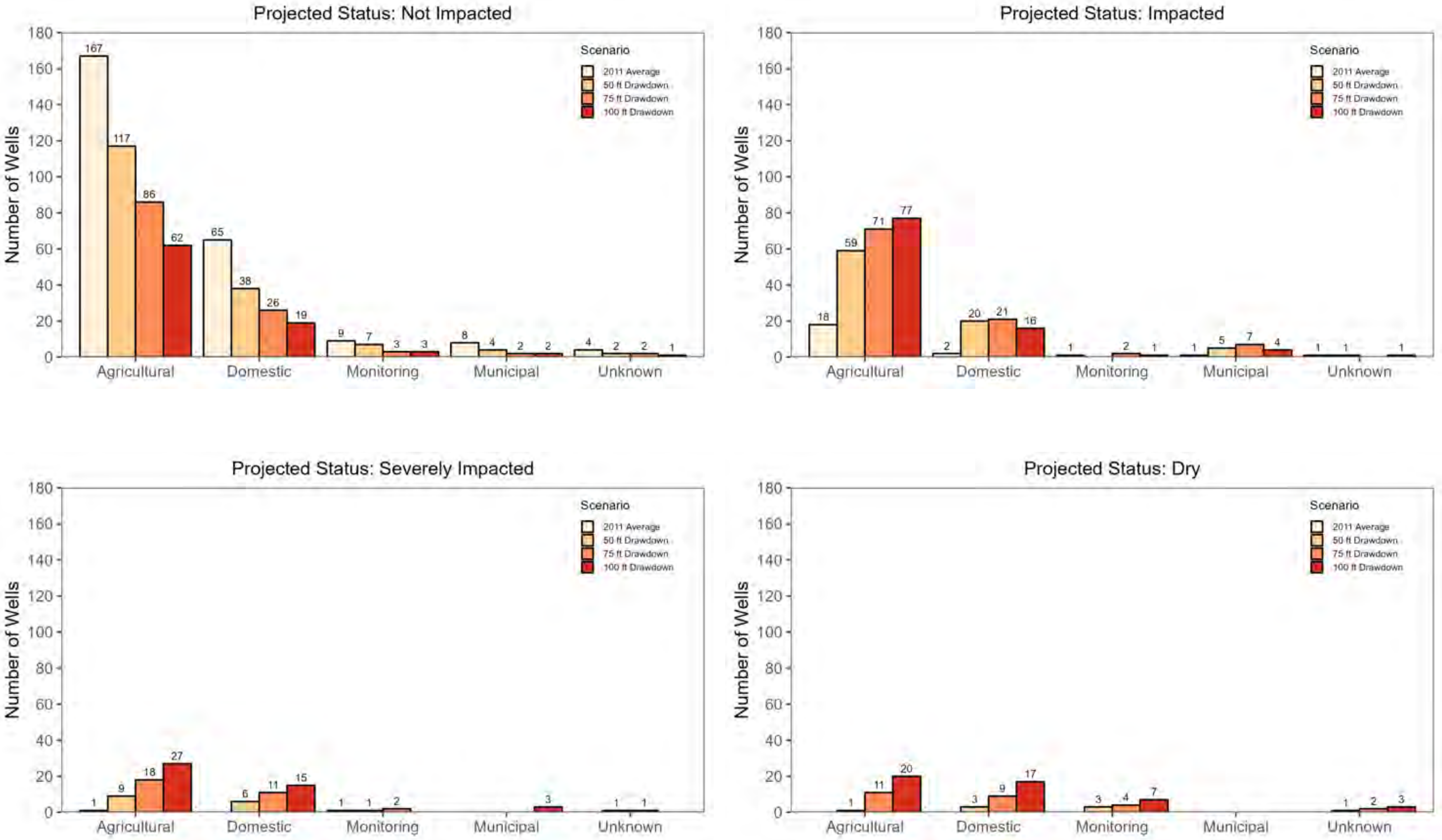


Sustainable Management Criteria Technical Memorandum

Fillmore Subbasin Estimated Well Status Grouped by Projected Impact Status

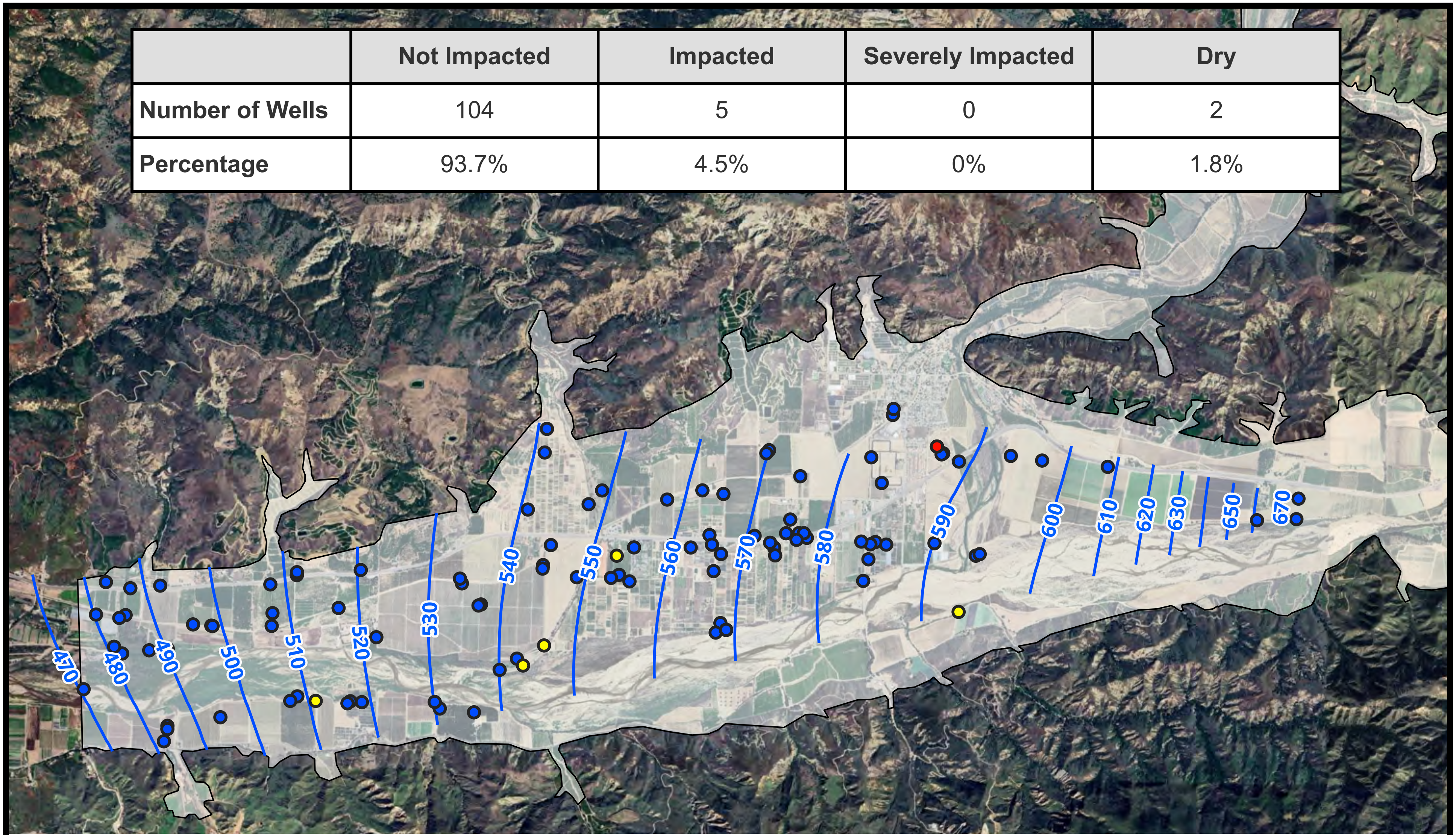
Figure 3-14

a Geo-Logic Company

05/29/2024

DB23.1279

	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	104	5	0	2
Percentage	93.7%	4.5%	0%	1.8%



Source: https://sierra-valley.gladata.com

Explanation

Estimated Well Status

● Not Impacted

● Impacted

● Severely Impacted

● Dry

Groundwater Elevation Contour (ft amsl)

☐ Groundwater Basin Boundary

0 0.5 1 mi

N

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Piru Subbasin Estimated Well Status
2011 Average Groundwater Level

DBS&A
a Geo-Logic Company

05/29/2024 DB23.1279

Figure 3-15

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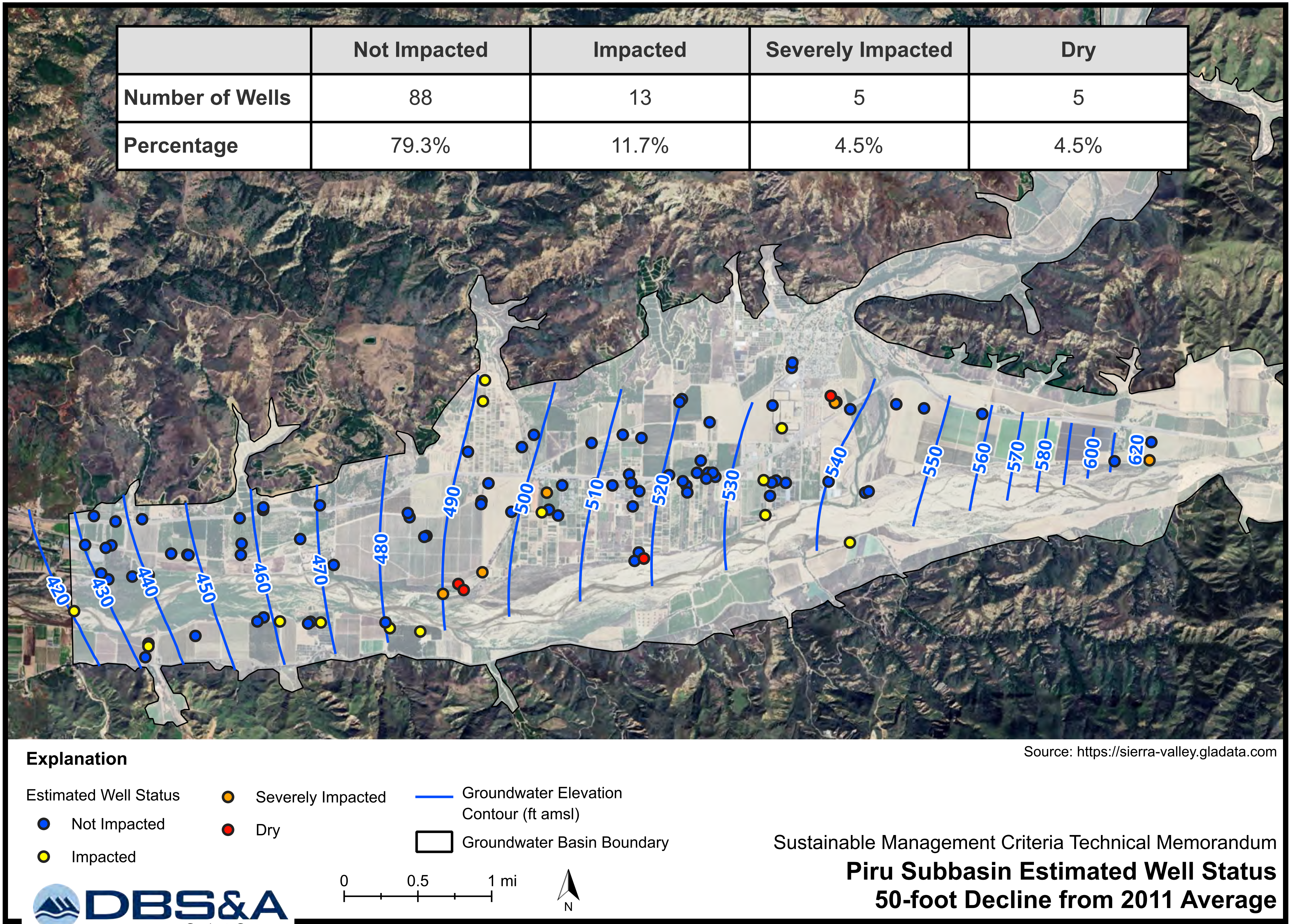
	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	88	13	5	5
Percentage	79.3%	11.7%	4.5%	4.5%



Source: https://sierra-valley.gladata.com

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Piru Subbasin Estimated Well Status 50-foot Decline from 2011 Average

Figure 3-16

DBS&A a Geo-Logic Company

06/09/2024 DB23.1279

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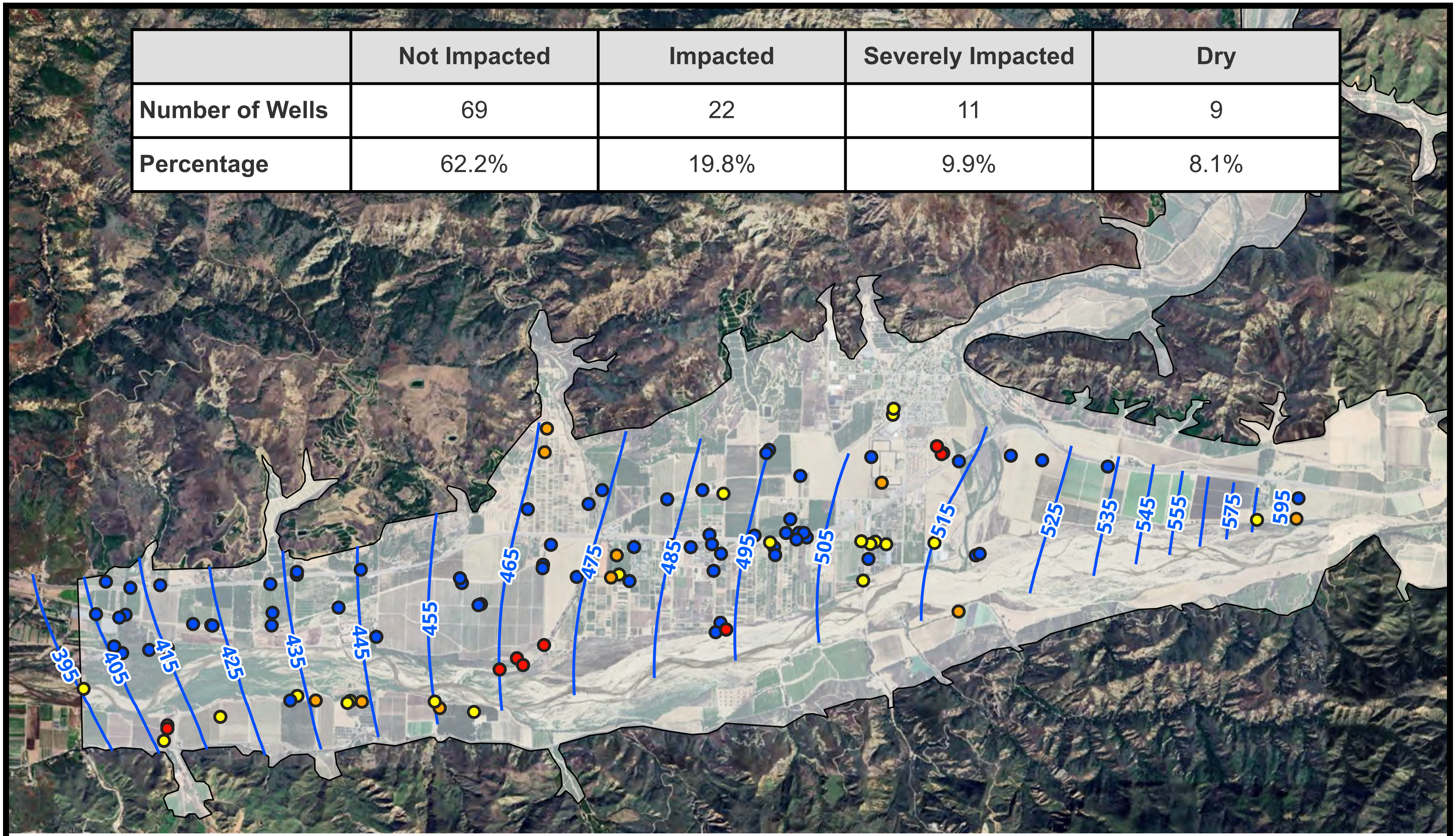

	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	69	22	11	9
Percentage	62.2%	19.8%	9.9%	8.1%

Source: https://sierra-valley.gladata.com

Explanation

Estimated Well Status

●	Not Impacted
●	Impacted
●	Severely Impacted
●	Dry
—	Groundwater Elevation Contour (ft amsl)
☐	Groundwater Basin Boundary

0 0.5 1 mi

N

DBS&A
a Geo-Logic Company

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Sustainable Management Criteria Technical Memorandum

Piru Subbasin Estimated Well Status
75-foot Decline from 2011 Average

Figure 3-17

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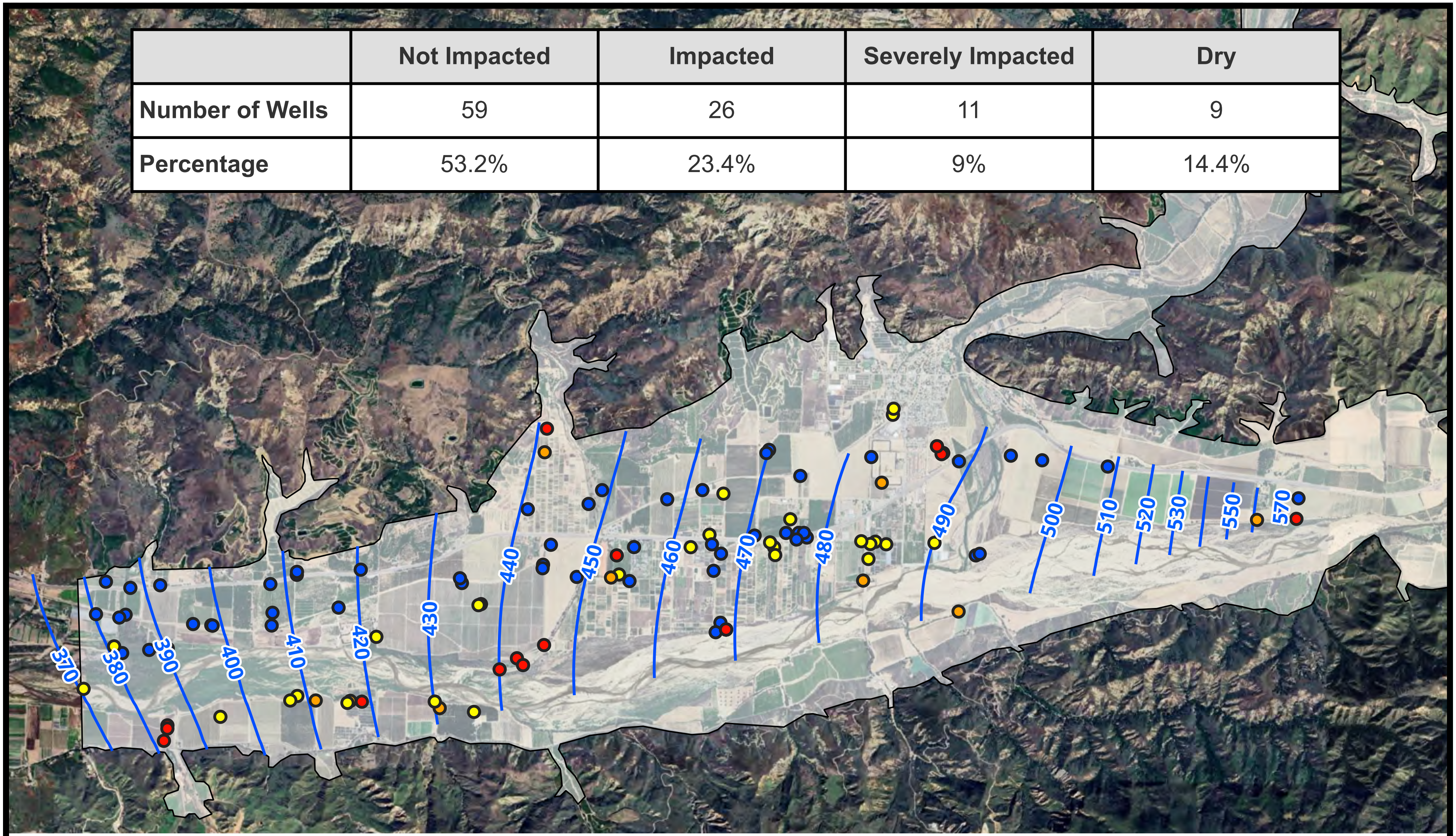

	Not Impacted	Impacted	Severely Impacted	Dry
Number of Wells	59	26	11	9
Percentage	53.2%	23.4%	9%	14.4%

Source: https://sierra-valley.gladata.com

Explanation

Estimated Well Status

- ● Not Impacted
- ● Impacted
- ● Severely Impacted
- ● Dry

Groundwater Elevation Contour (ft amsl)

▭ Groundwater Basin Boundary

0 0.5 1 mi

N

Sustainable Management Criteria Technical Memorandum

Piru Subbasin Estimated Well Status
100-foot Decline from 2011 Average

DBS&A
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Figure 3-18

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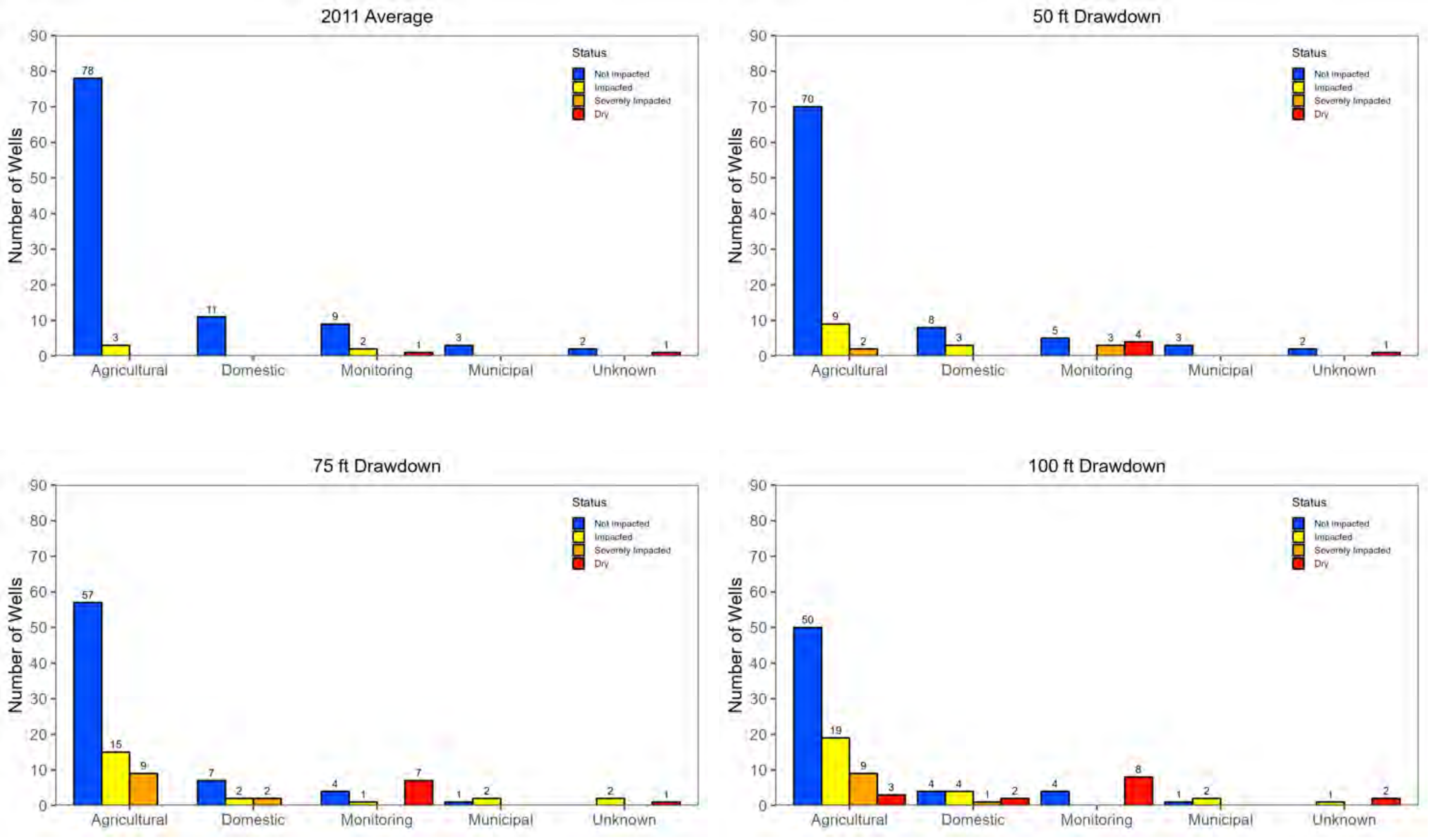

Sustainable Management Criteria Technical Memorandum

Piru Subbasin Estimated Well Status
Grouped By Water Level Scenario

Figure 3-19

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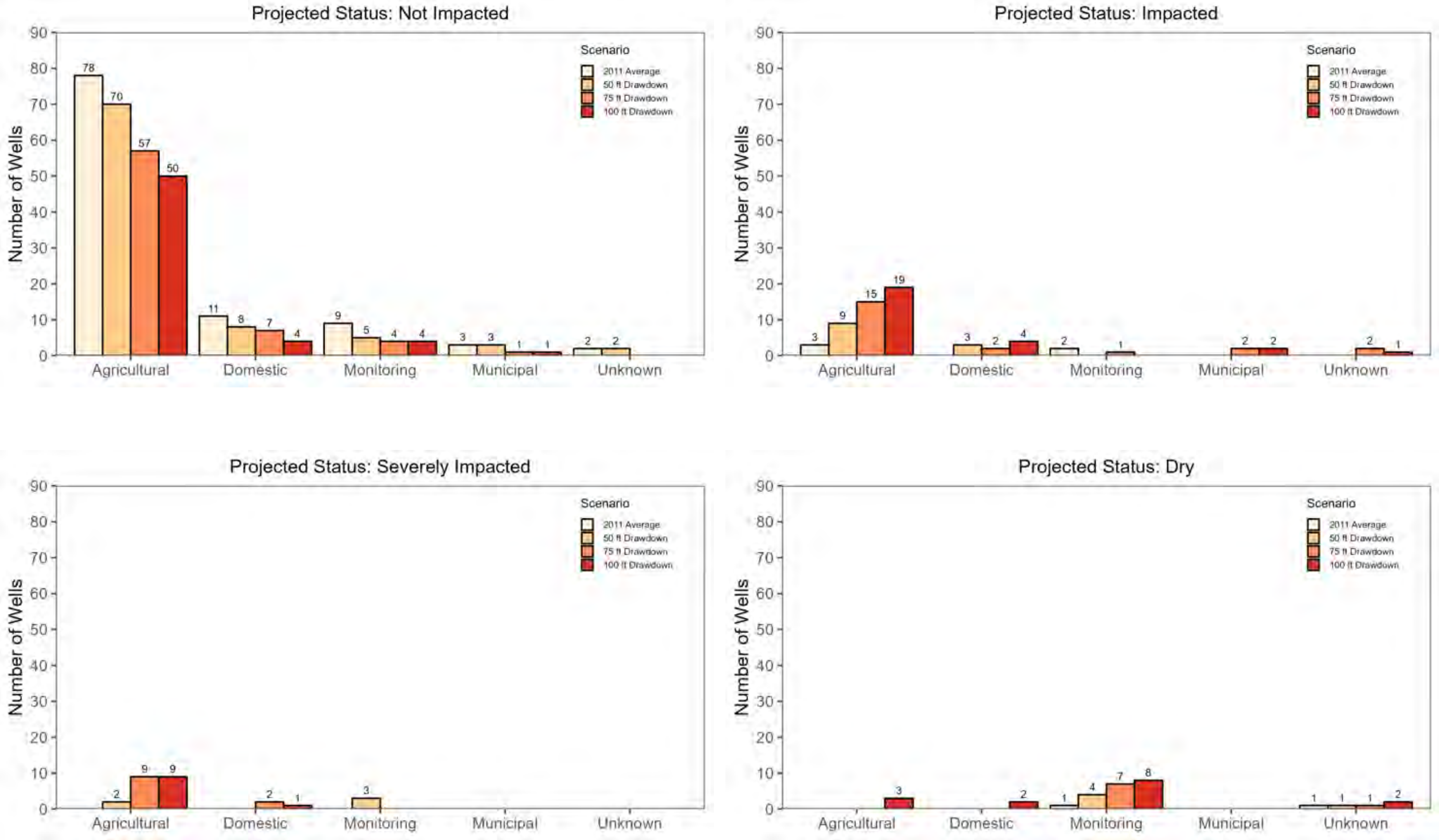

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Sustainable Management Criteria Technical Memorandum

Piru Subbasin Estimated Well Status Grouped by Projected Impact Status

Figure 3-20

DBS&A
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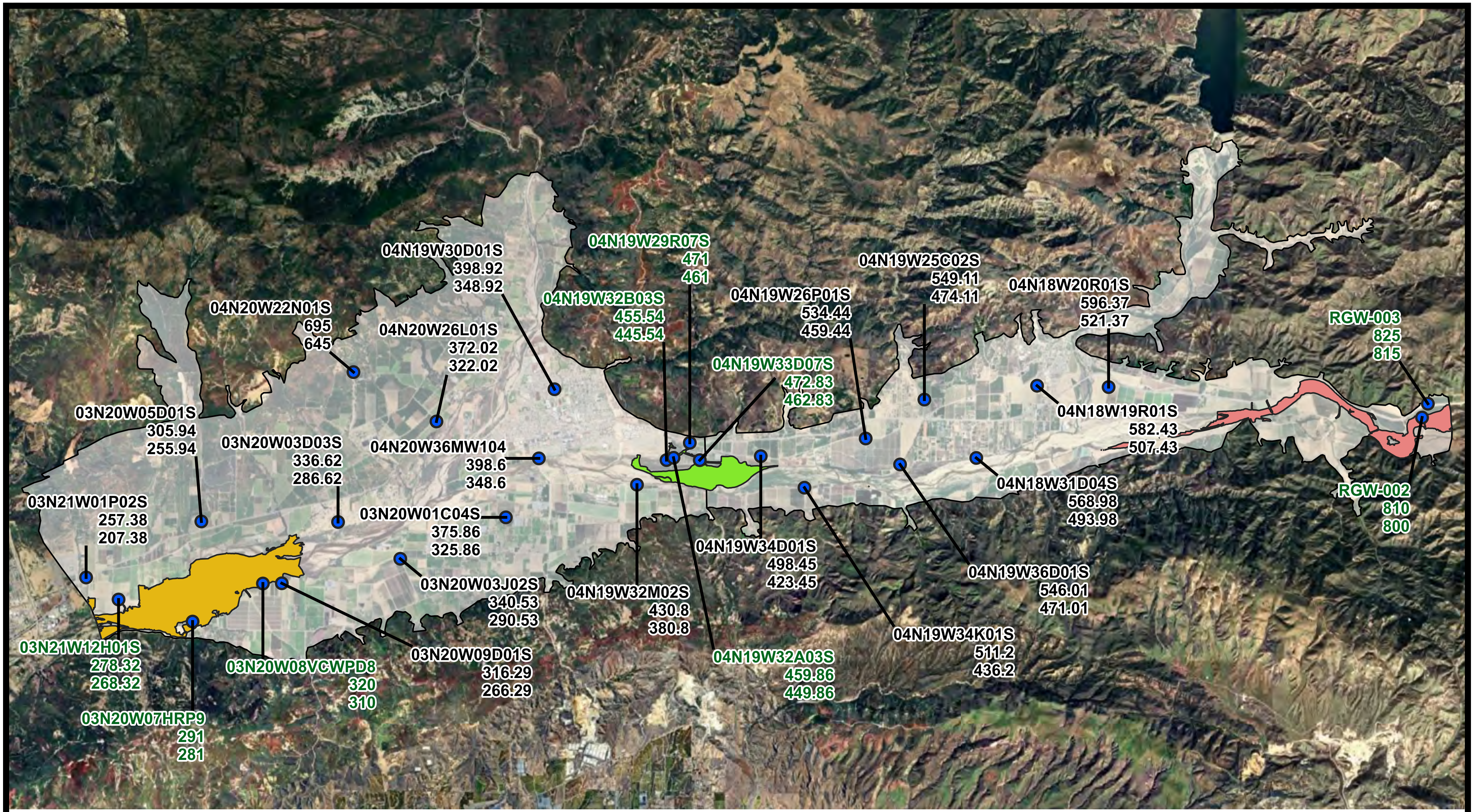

Source: https://fillmore-piru.gladata.com

Explanation

● Well Name
Measureable Objective (ft amsl)
Minimum Threshold (ft amsl)

☐ Groundwater Basin Boundary

🟩 Cienega Springs GDE

🟥 Del Valle GDE

🟨 East Grove GDE

N

0 1 2 mi

Notes:
1. Green font indicates values are protective of vegetative GDEs.

Sustainable Management Criteria Technical Memorandum

Fillmore and Piru Basins
Measureable Objectives and Minimum Thresholds

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Figure 3-21

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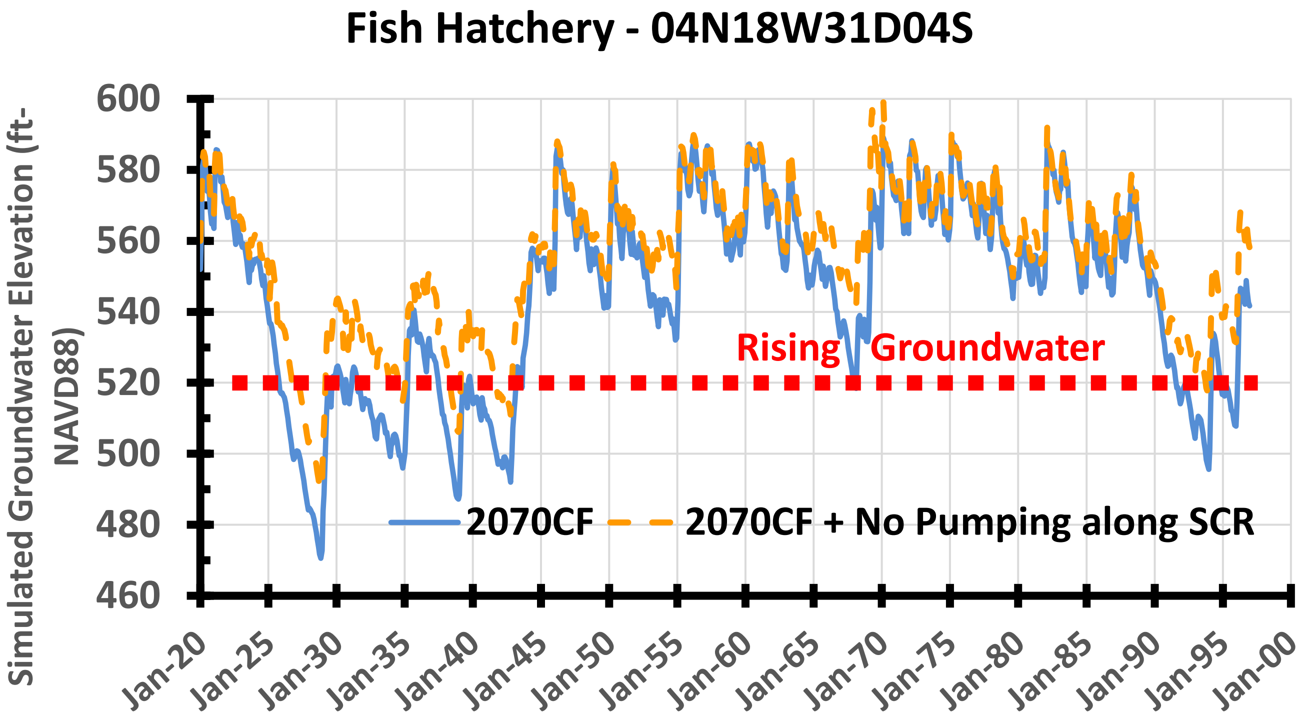

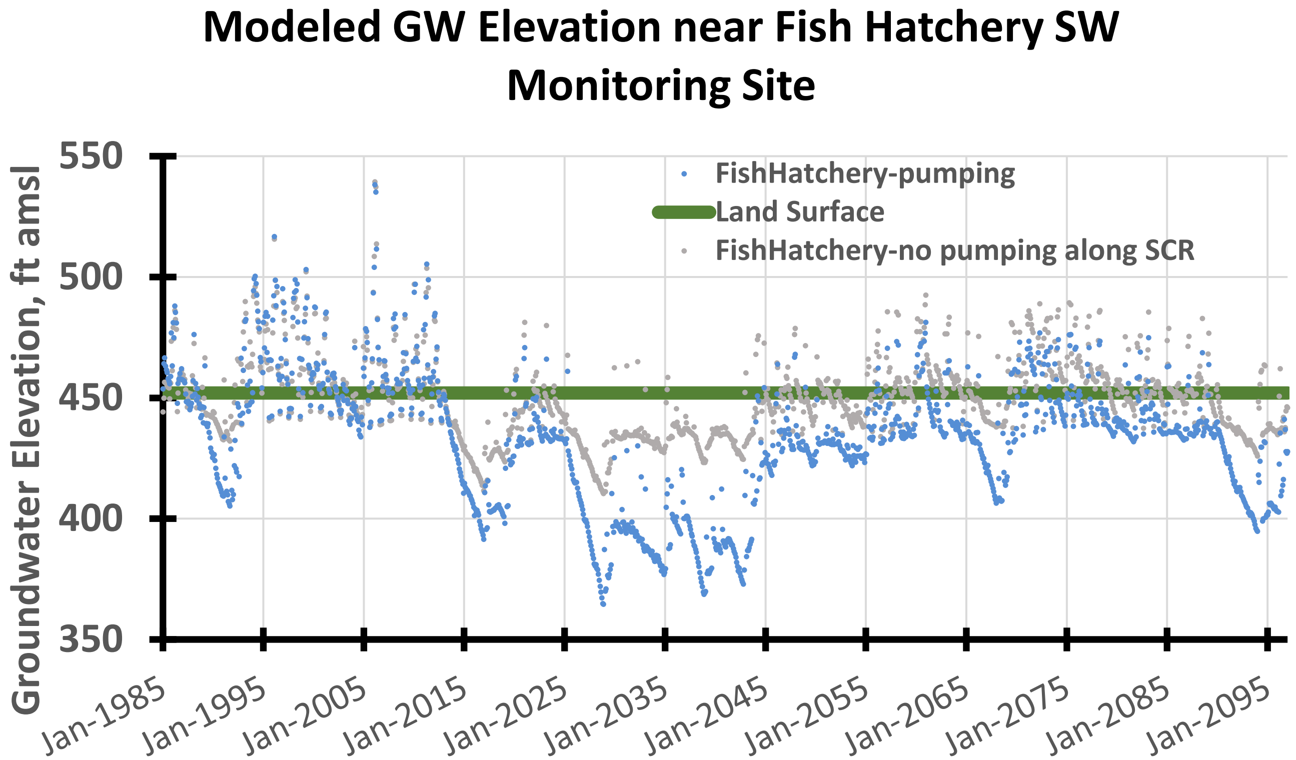

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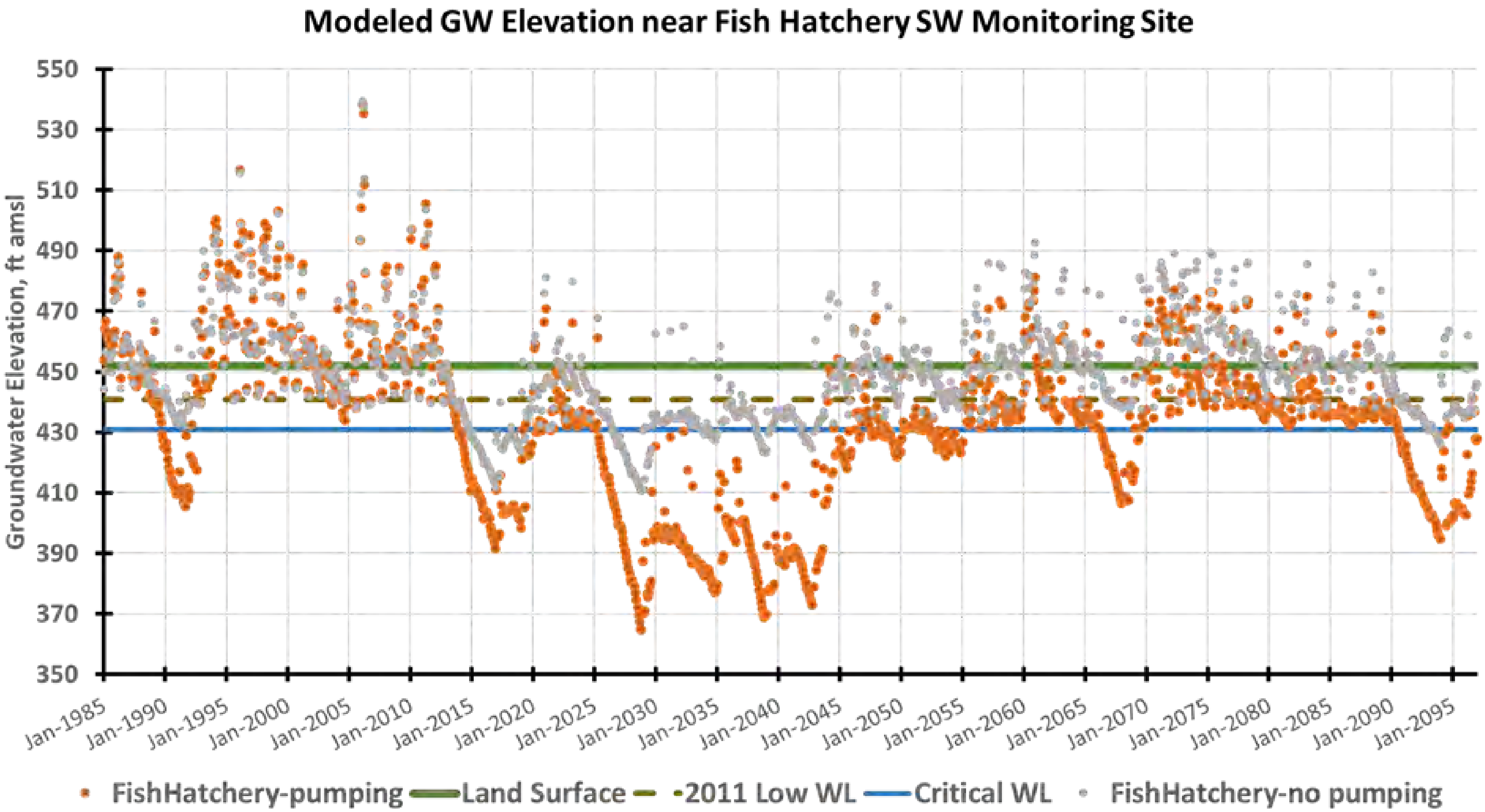
Groundwater Extraction Impacts on Water Levels at Cienega Springs

Figure 3-22

DBS&A
a Geo-Logic Company

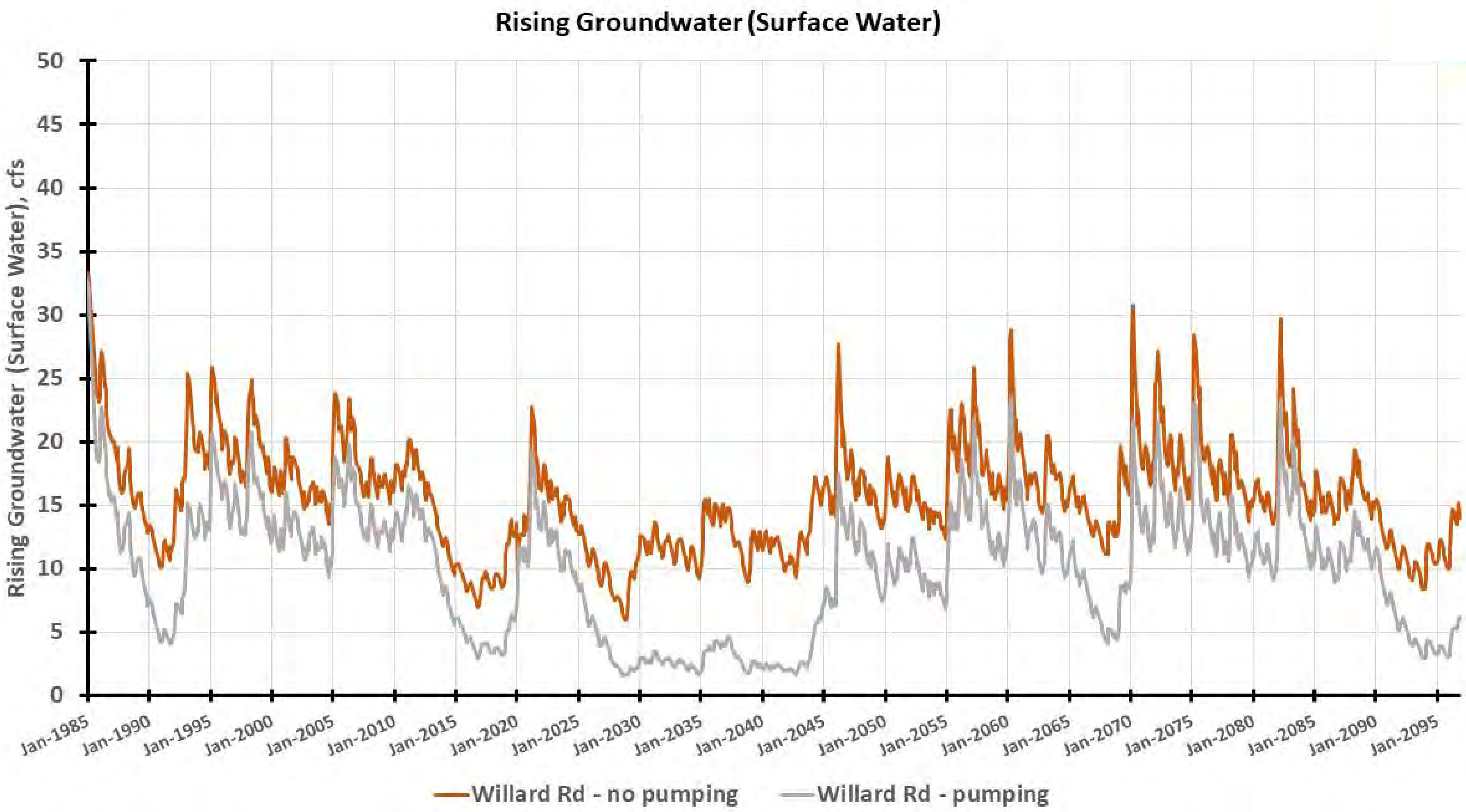
5/29/2024



SUSTAINABLE MANAGEMENT CRITERIA TECHNICAL MEMORANDUM

Critical Water Level for Vegetation at Cienega Springs

Figure 3-23



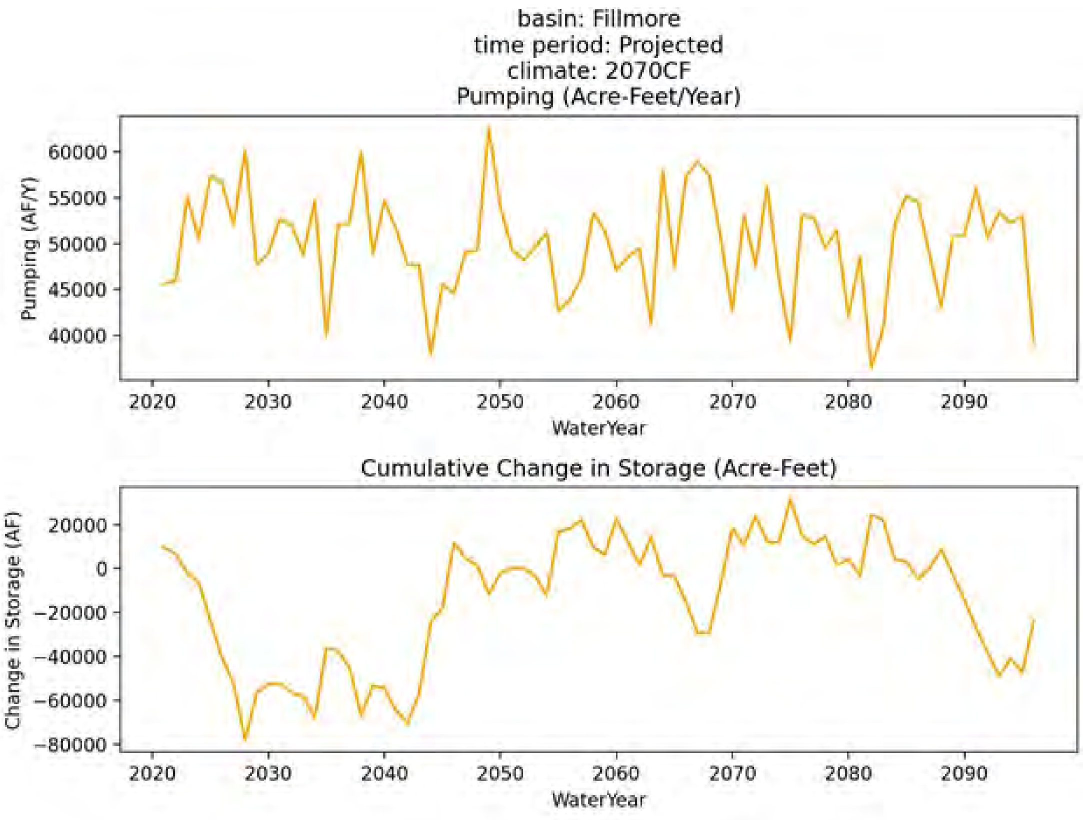
Fillmore and Piru Basins
Groundwater Sustainability Agency

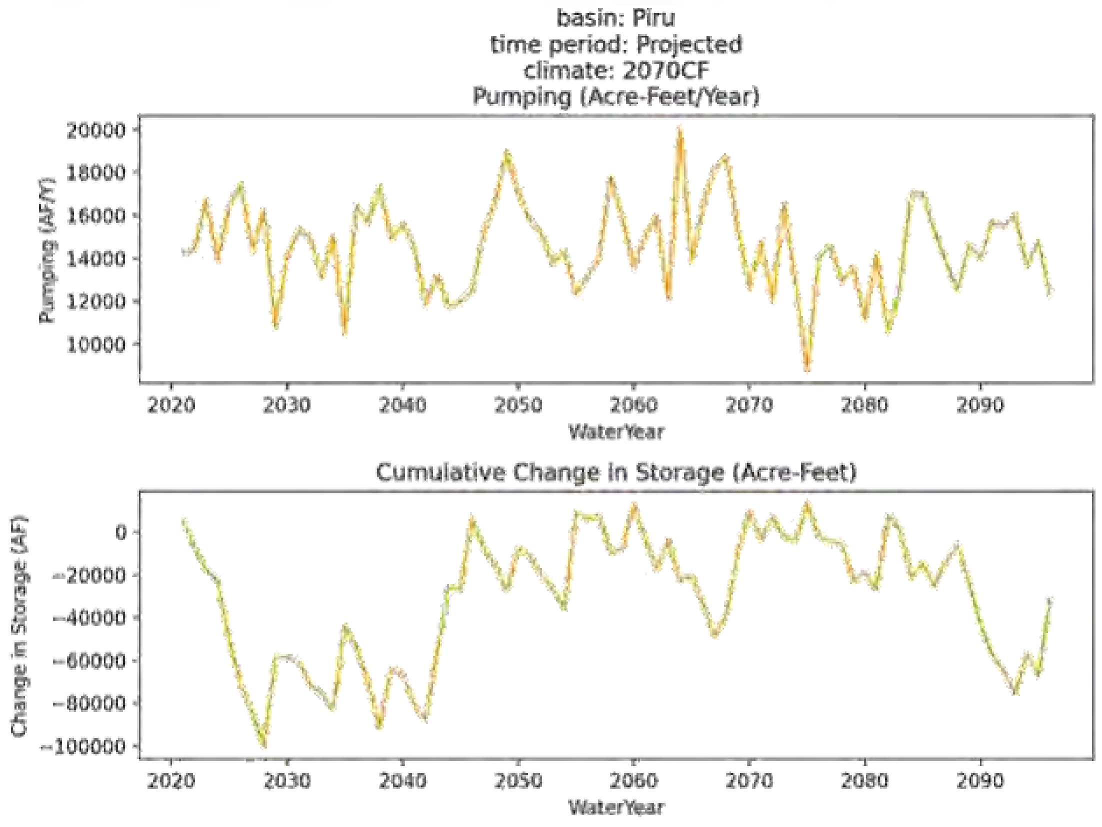
DBS&A
a Geo-Logic Company

SUSTAINABLE MANAGEMENT CRITERIA TECHNICAL MEMORANDUM

Surface Water Flow - East Grove

Figure 3-24





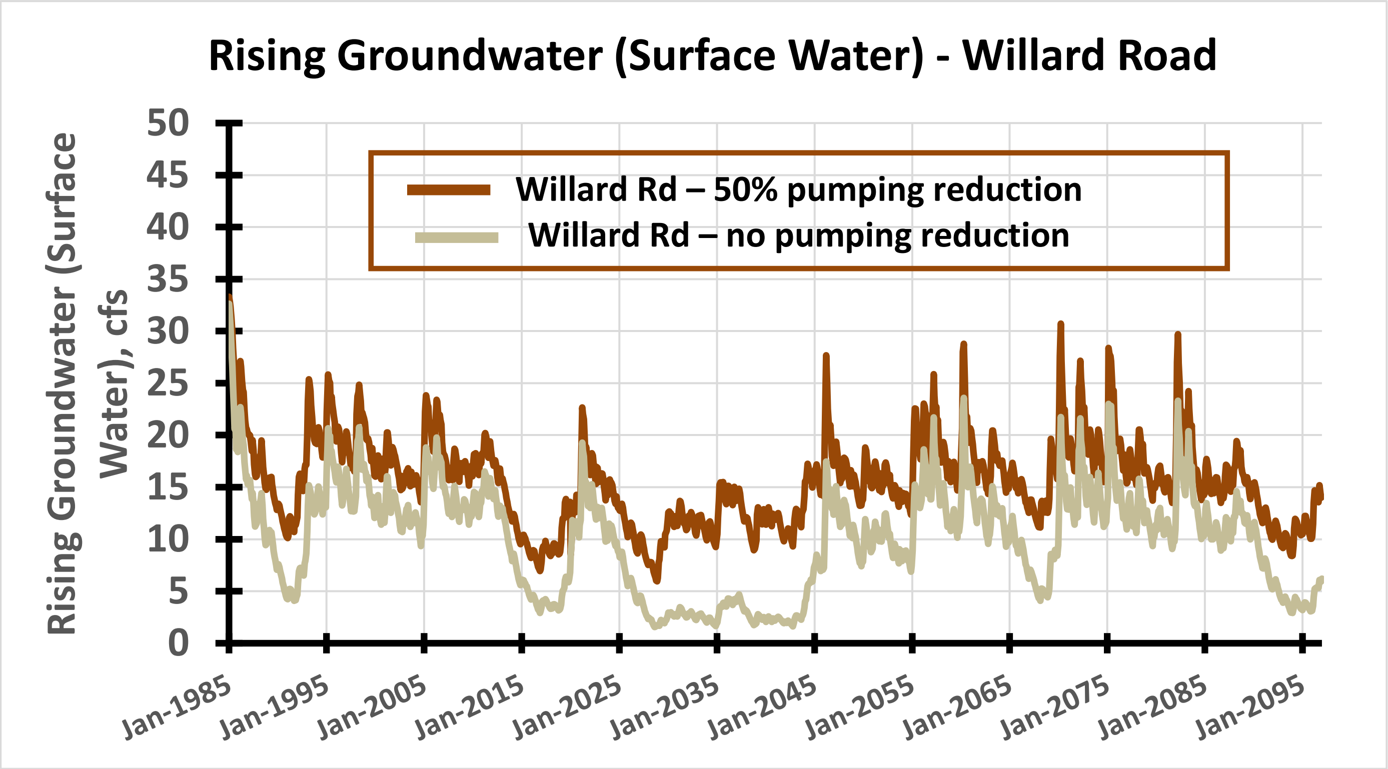
Sustainable Management Criteria Technical Memorandum

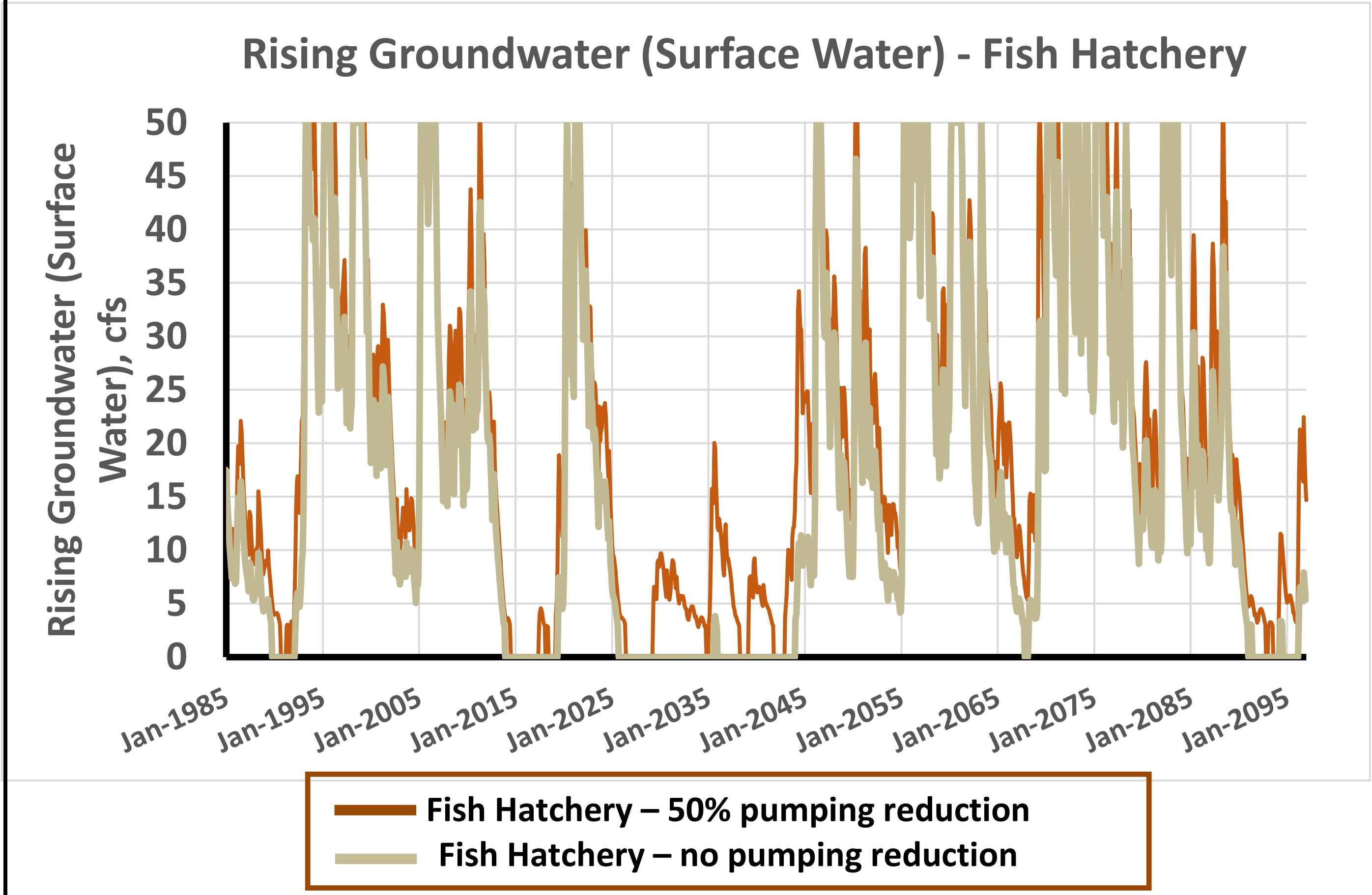
Forecasted Annual Pumping and Cumulative Changes in Storage

Figure 3-25

DBS&A
a Geo-Logic Company

5/29/2024





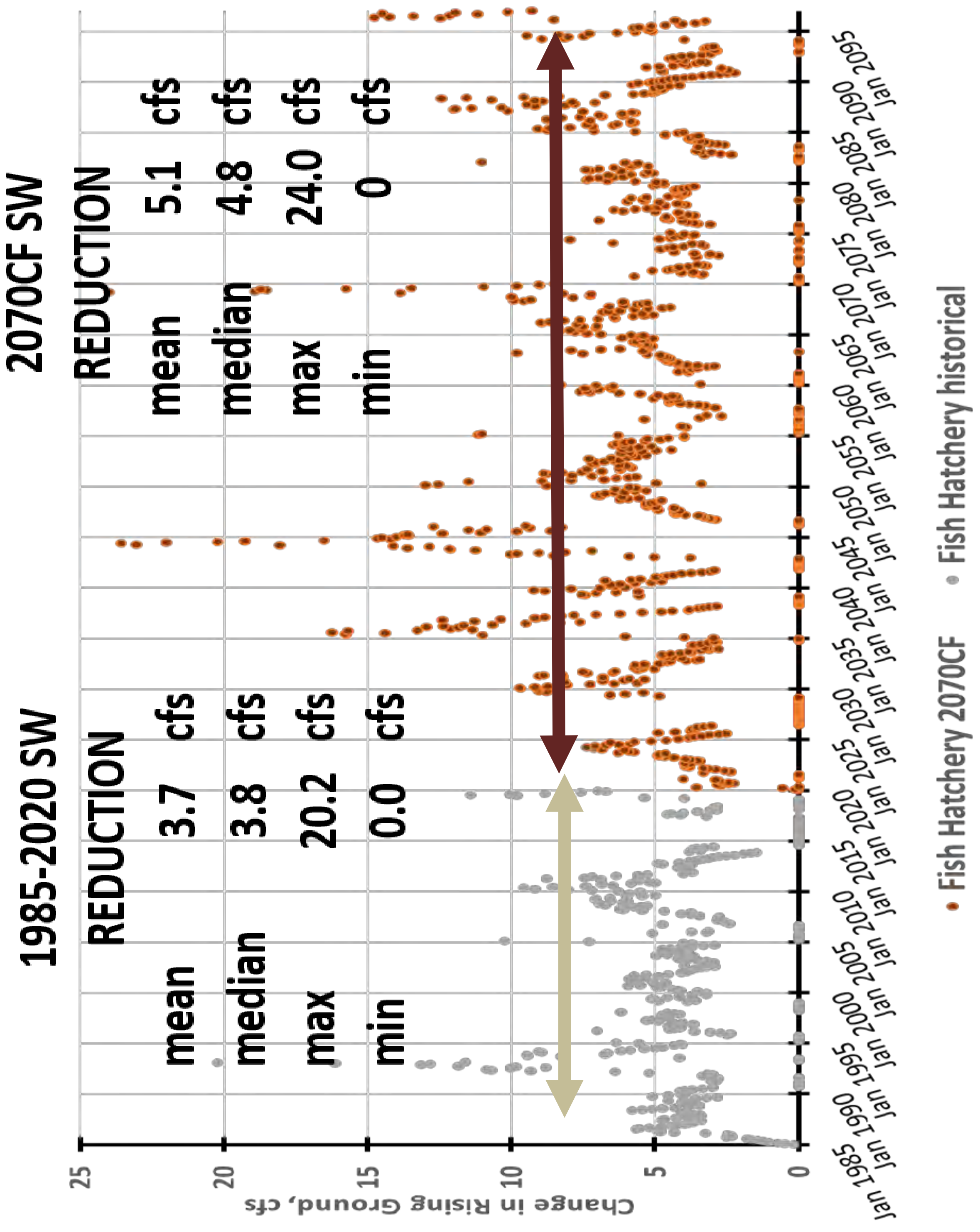
Sustainable Management Criteria Technical Memorandum

Surface Water Depletion Impacts Due to Groundwater Extraction

Figure 3-26

DBS&A
a Geo-Logic Company

5/29/2024

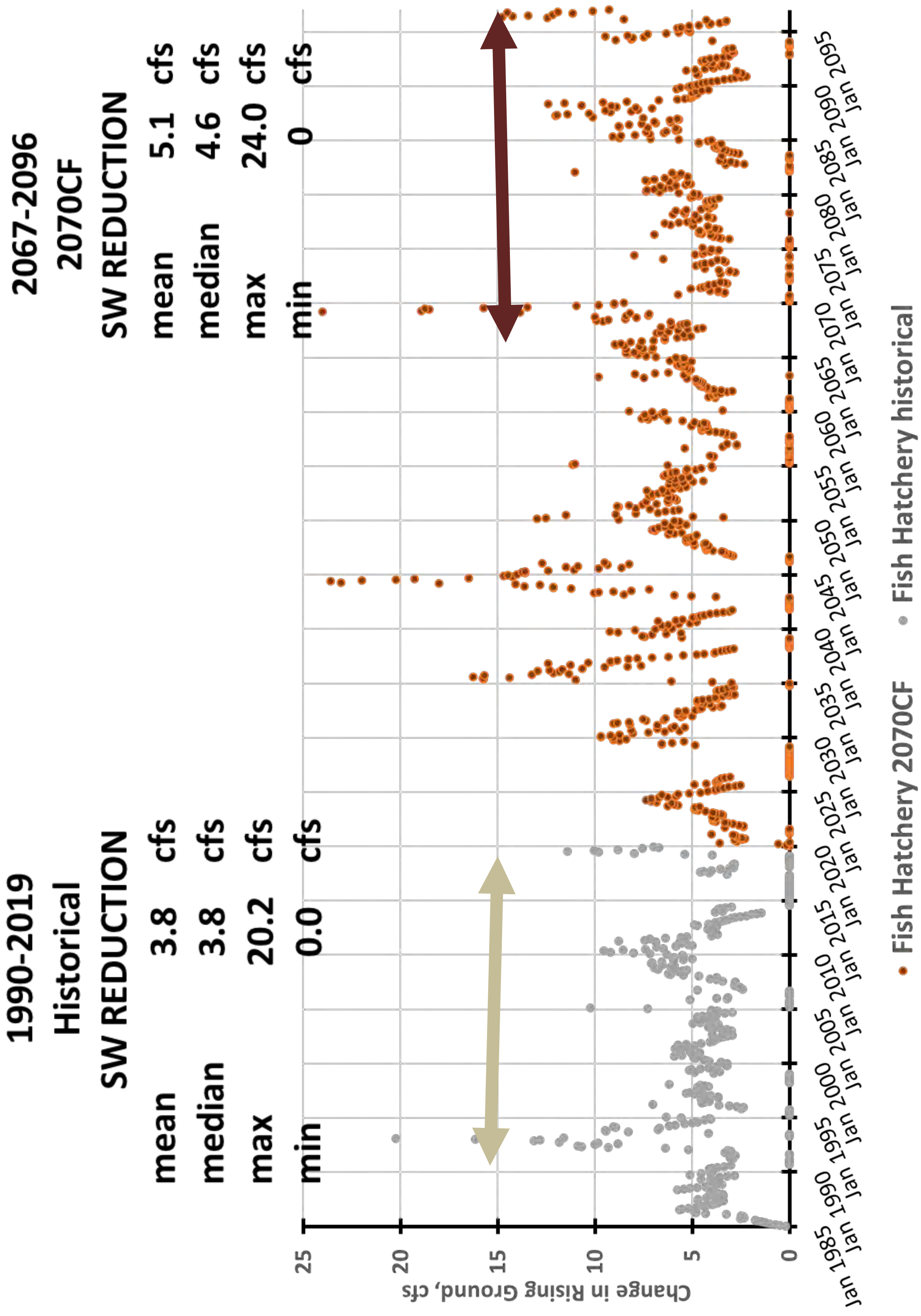


Sustainable Management Criteria Technical Memorandum

Change in Rising Groundwater due to Groundwater Extractions
Historical v. Future with Climate Change
Cienega / Fish Hatchery Area

Figure 3-27

5/29/2024



Sustainable Management Criteria Technical Memorandum

Change in Rising Groundwater due to Groundwater Extractions

Cienega Springs Analogous Time Periods

Figure 3-28

DBS&A
a Geo-Logic Company

5/29/2024

Attachment A

Beneficial Users per LARWQCB Basin Plan

DBS&A
a Geo-Logic Company

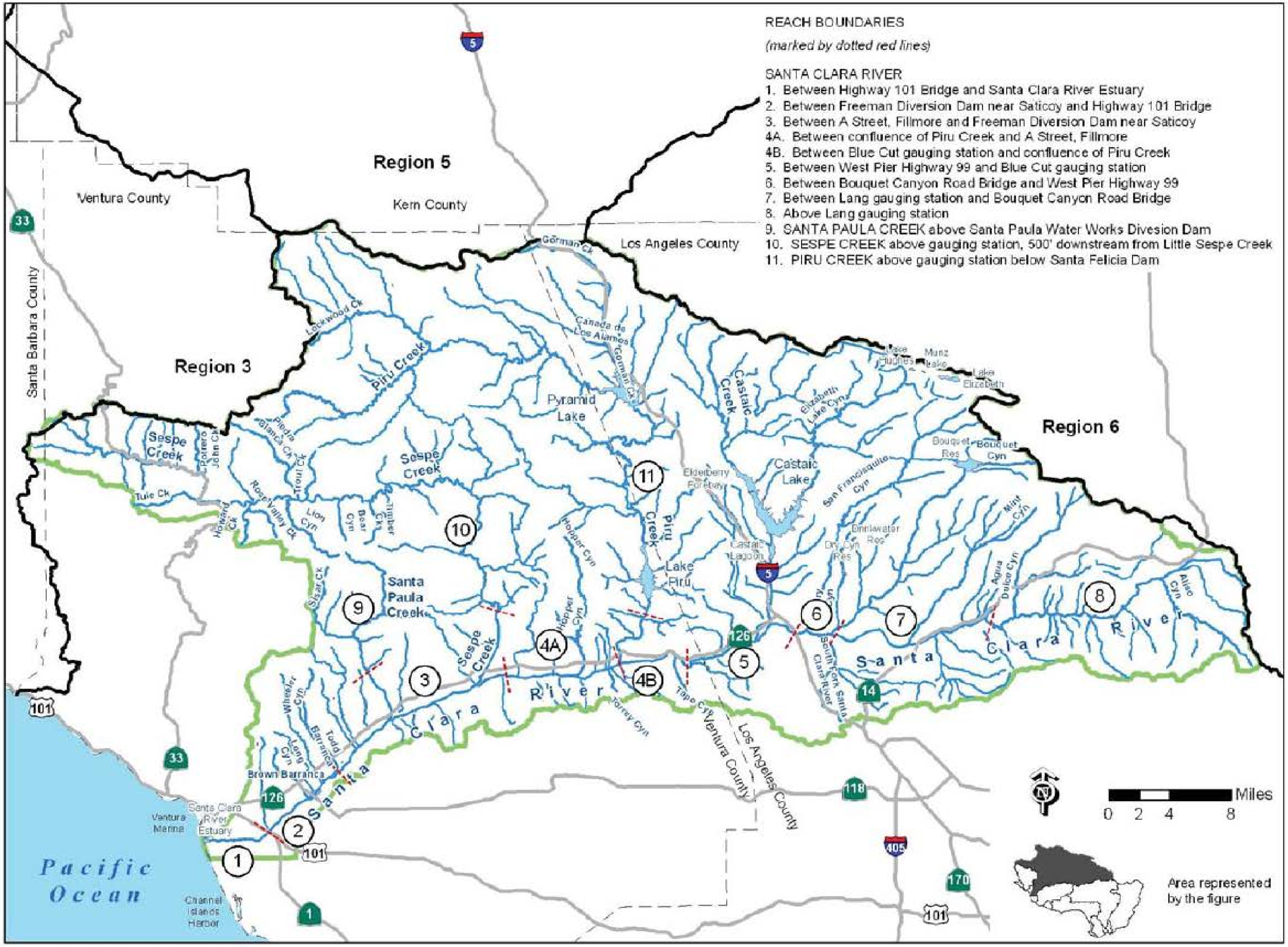
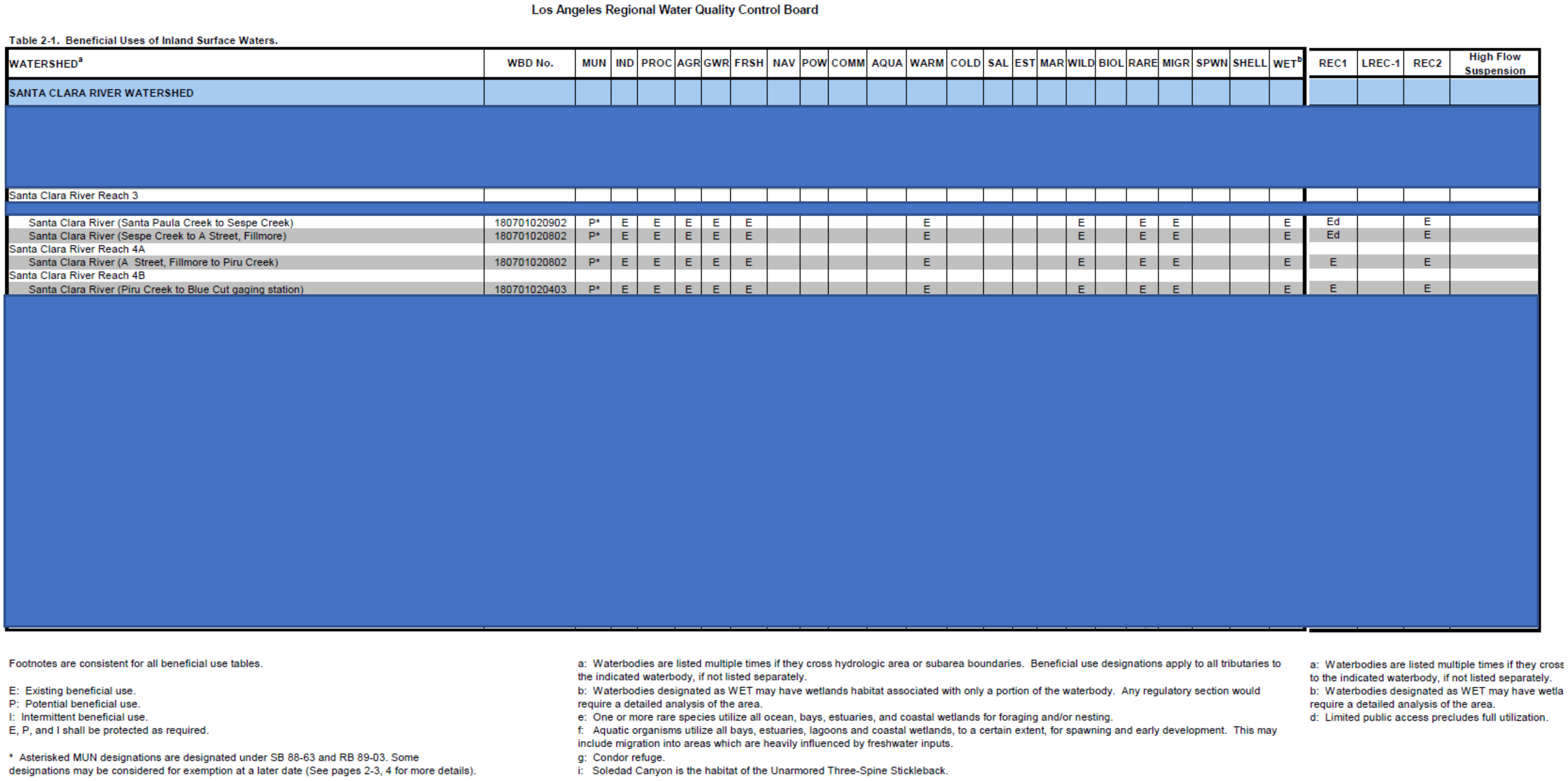


Figure 2-3. Major surface waters of the Santa Clara River watershed.

Beneficial Users - Surface Water



Los Angeles Regional Water Quality Control Board

Table 2-1. Beneficial Uses of Inland Surface Waters.

WATERSHED[a]	WBD No.	MUN	IND	PROC	AGR	GWR	FRSH	NAV	POW	COMM	AQUA	WARM	COLD	SAL	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET[b]	REC1	LREC-1	REC2	High Flow Suspension
SANTA CLARA RIVER WATERSHED																											
[redacted]																											
Santa Clara River Reach 3																											
[redacted]																											
Santa Clara River (Santa Paula Creek to Sespe Creek)	180701020902	P*	E	E	E	E	E					E					E		E	E			E	Ed		E	
Santa Clara River (Sespe Creek to A Street, Fillmore)	180701020802	P*	E	E	E	E	E					E					E		E	E			E	Ed		E	
Santa Clara River Reach 4A																											
Santa Clara River (A Street, Fillmore to Piru Creek)	180701020802	P*	E	E	E	E	E					E					E		E	E			E	E		E	
Santa Clara River Reach 4B																											
Santa Clara River (Piru Creek to Blue Cut gaging station)	180701020403	P*	E	E	E	E	E					E					E		E	E			E	E		E	
[redacted]																											

Footnotes are consistent for all beneficial use tables.

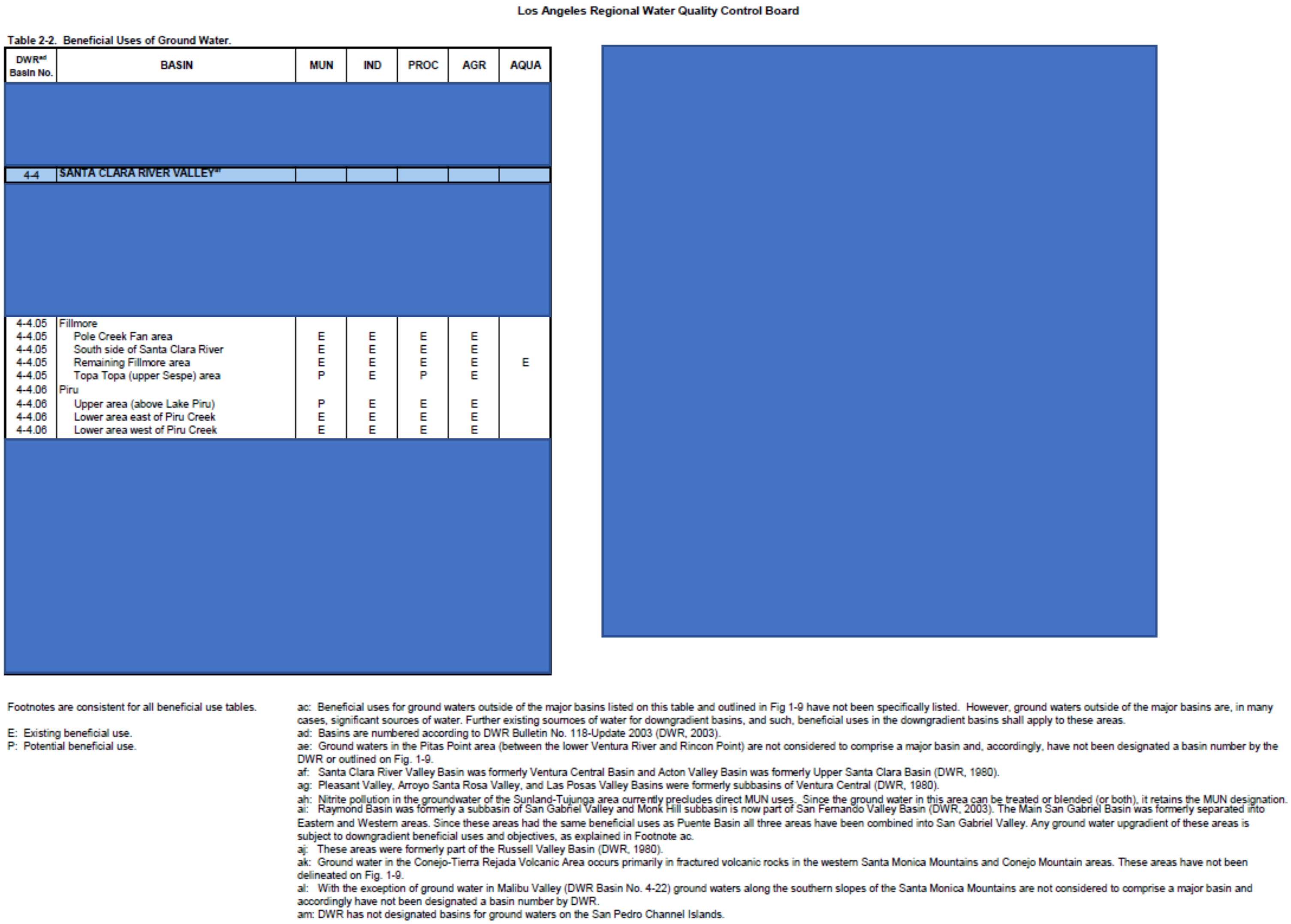
E: Existing beneficial use.
P: Potential beneficial use.
I: Intermittent beneficial use.
E, P, and I shall be protected as required.

* Asterisked MUN designations are designated under SB 88-63 and RB 89-03. Some designations may be considered for exemption at a later date (See pages 2-3, 4 for more details).

a: Waterbodies are listed multiple times if they cross hydrologic area or subarea boundaries. Beneficial use designations apply to all tributaries to the indicated waterbody, if not listed separately.
b: Waterbodies designated as WET may have wetlands habitat associated with only a portion of the waterbody. Any regulatory section would require a detailed analysis of the area.
e: One or more rare species utilize all ocean, bays, estuaries, and coastal wetlands for foraging and/or nesting.
f: Aquatic organisms utilize all bays, estuaries, lagoons and coastal wetlands, to a certain extent, for spawning and early development. This may include migration into areas which are heavily influenced by freshwater inputs.
g: Condor refuge.
i: Soledad Canyon is the habitat of the Unarmored Three-Spine Stickleback.

a: Waterbodies are listed multiple times if they cross
to the indicated waterbody, if not listed separately.
b: Waterbodies designated as WET may have wetla
require a detailed analysis of the area.
d: Limited public access precludes full utilization.

Beneficial Users - Ground Water



Los Angeles Regional Water Quality Control Board

Table 2-2. Beneficial Uses of Ground Water.

DWR[ad] Basin No.	BASIN	MUN	IND	PROC	AGR	AQUA
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
4-4	SANTA CLARA RIVER VALLEY[af]					
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
4-4.05	Fillmore					
4-4.05	Pole Creek Fan area	E	E	E	E	
4-4.05	South side of Santa Clara River	E	E	E	E	
4-4.05	Remaining Fillmore area	E	E	E	E	E
4-4.05	Topa Topa (upper Sespe) area	P	E	P	E	
4-4.06	Piru					
4-4.06	Upper area (above Lake Piru)	P	E	E	E	
4-4.06	Lower area east of Piru Creek	E	E	E	E	
4-4.06	Lower area west of Piru Creek	E	E	E	E	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

Footnotes are consistent for all beneficial use tables.

E: Existing beneficial use.
P: Potential beneficial use.

ac: Beneficial uses for ground waters outside of the major basins listed on this table and outlined in Fig 1-9 have not been specifically listed. However, ground waters outside of the major basins are, in many cases, significant sources of water. Further existing sounces of water for downgradient basins, and such, beneficial uses in the downgradient basins shall apply to these areas.

ad: Basins are numbered according to DWR Bulletin No. 118-Update 2003 (DWR, 2003).

ae: Ground waters in the Pitas Point area (between the lower Ventura River and Rincon Point) are not considered to comprise a major basin and, accordingly, have not been designated a basin number by the DWR or outlined on Fig. 1-9.

af: Santa Clara River Valley Basin was formerly Ventura Central Basin and Acton Valley Basin was formerly Upper Santa Clara Basin (DWR, 1980).

ag: Pleasant Valley, Arroyo Santa Rosa Valley, and Las Posas Valley Basins were formerly subbasins of Ventura Central (DWR, 1980).

ah: Nitrite pollution in the groundwater of the Sunland-Tujunga area currently precludes direct MUN uses. Since the ground water in this area can be treated or blended (or both), it retains the MUN designation.

ai: Raymond Basin was formerly a subbasin of San Gabriel Valley and Monk Hill subbasin is now part of San Fernando Valley Basin (DWR, 2003). The Main San Gabriel Basin was formerly separated into Eastern and Western areas. Since these areas had the same beneficial uses as Puente Basin all three areas have been combined into San Gabriel Valley. Any ground water upgradient of these areas is subject to downgradient beneficial uses and objectives, as explained in Footnote ac.

aj: These areas were formerly part of the Russell Valley Basin (DWR, 1980).

ak: Ground water in the Conejo-Tierra Rejada Volcanic Area occurs primarily in fractured volcanic rocks in the western Santa Monica Mountains and Conejo Mountain areas. These areas have not been delineated on Fig. 1-9.

al: With the exception of ground water in Malibu Valley (DWR Basin No. 4-22) ground waters along the southern slopes of the Santa Monica Mountains are not considered to comprise a major basin and accordingly have not been designated a basin number by DWR.

am: DWR has not designated basins for ground waters on the San Pedro Channel Islands.

BENEFICIAL USE DEFINITIONS

The following definitions for beneficial uses are applicable statewide (in alphabetical order by abbreviation). If a Regional Water Board has a region-specific variation on a statewide beneficial use, the region-specific definition is also defined. Additional beneficial use definitions adopted by individual Regional Water Boards, for which there is no equivalent statewide beneficial use, are listed on page 5.

Agricultural Supply (AGR) - Uses of water for farming, horticulture or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Variation:

R5: **Agricultural Supply (AGR)** - Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.

Aquaculture (AQUA) - Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Preservation of Biological Habitats of Special Significance (BIOL) - Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

Variations:

R1: **Preservation of Areas of Special Biological Significance (ASBS)** - Includes marine life refuges, ecological reserves and designated areas of special biological significance, such as areas where kelp propagation and maintenance are features of the marine environment requiring special protection.

R2: **Areas of Special Biological Significance (ASBS)** - Areas designated by the State Water Board. These include marine life refuges, ecological reserves, and designated areas where the preservation and enhancement of natural resources requires special protection. In these areas, alteration of natural water quality is undesirable. The areas that have been designated as ASBS in this Region are Bird Rock, Point Reyes Headland Reserve and Extension, Double Point, Duxbury Reef Reserve and Extension, Farallon Islands, and James V. Fitzgerald Marine Reserve, depicted in Figure 2-1. The California Ocean Plan prohibits waste discharges into, and requires wastes to be discharged at a sufficient distance from, these areas to assure maintenance of natural water quality conditions. These areas have been designated as a subset of State Water Quality Protection Areas as per the Public Resources Code.

R3: **Areas of Biological Significance (ASBS)** – Are those areas designated by the State Water Resources Control Board as requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable.

Cold Freshwater Habitat (COLD) - Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish and shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Variation:

R6: **Commercial and Sport Fishing (COMM)** - Beneficial uses of waters used for commercial or recreational collection of fish or other organisms including, but not limited to, uses involving organisms intended for human consumption.

Estuarine Habitat (EST) - Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Variation:

R2: **Estuarine Habitat (EST)** - Uses of water that support estuarine ecosystems, including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds), and the propagation, sustenance, and migration of estuarine organisms.

Freshwater Replenishment (FRSH) - Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).

Variation:

R3: **Freshwater Replenishment (FRSH)** - Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity) which includes a water body that supplies water to a different type of water body, such as, streams that supply reservoirs and lakes, or estuaries; or reservoirs and lakes that supply streams. This includes only immediate upstream water bodies and not their tributaries.

Ground Water Recharge (GWR) - Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting saltwater intrusion into freshwater aquifers.

Variation:

R3: **Ground Water Recharge (GWR)** – Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers. Ground water recharge includes recharge of surface water underflow.

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality, including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Variation:

R6: **Industrial Service Supply (IND)** - Beneficial uses of waters used for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, geothermal energy production, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

Marine Habitat (MAR) - Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Variations:

R2: **Fish Migration (MIGR)** - Uses of water that support habitats necessary for migration, acclimatization between fresh water and salt water, and protection of aquatic organisms that are temporary inhabitants of waters within the region.

R4 & R6: **Migration of Aquatic Organisms (MIGR)** - Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

Municipal and Domestic Supply (MUN) - Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water.

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Hydropower Generation (POW) - Uses of water for hydropower generation.

Industrial Process Supply (PRO) - Uses of water for industrial activities that depend primarily on water quality.

Variations:

R2, R3, R4, R9: **Industrial Service Supply (PROC)** - Uses of water for industrial activities that depend primarily on water quality.

R8: **Industrial Process Supply (PROC)** - waters are used for industrial activities that depend primarily on water quality. These uses may include, but are not limited to, process water supply and all uses of water related to product manufacture or food preparation

Rare, Threatened, or Endangered Species (RARE) - Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-Contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Inland Saline Water Habitat (SAL) - Uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters and mussels) for human consumption, commercial or sport purposes.

Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Variation:

R5: **Spawning, Reproduction, and/or Early Development (SPWN)** - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish. SPWN shall be limited to cold water fisheries.

Warm Freshwater Habitat (WARM) - Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Variation:

R5: **Warm Freshwater Habitat (WARM)** - Uses of water that support warm water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates. WARM includes support for reproduction and early development of warm water fish.

Wildlife Habitat (WILD) - Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Variations:

R5: **Wildlife Habitat (WILD)** - Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

R6: **Wildlife Habitat (WILD)** - Beneficial uses of waters that support wildlife habitats including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl.

Additional Beneficial Use Definitions Adopted By Individual Regional Water Boards and Approved By the State Water Board

Native American Culture (CUL) Uses of water that support the cultural and/or traditional rights of indigenous people such as subsistence fishing and shellfish gathering, basket weaving and jewelry material collection, navigation to traditional ceremonial locations, and ceremonial uses. North Coast Regional Board (Region 1)

Subsistence Fishing (FISH) Uses of water that support subsistence fishing. North Coast Regional Board (Region 1)

Flood Peak Attenuation/Flood Water Storage (FLD) - Beneficial uses of riparian wetlands in flood plain areas and other wetlands that receive natural surface drainage and buffer its passage to receiving waters. Lahontan Regional Board & North Coast Regional Board (Regions 6 & 1):

Limited Water Contact Recreation (LREC-1): Uses of water for recreational activities involving body contact with water, where full REC-1 use is limited by physical conditions such as very shallow water depth and restricted access and, as a result, ingestion of water is incidental and infrequent. Los Angeles Regional Board (Region 4):

Limited Warm Freshwater Habitat (LWRM) - Waters support warm water ecosystems which are severely limited in diversity and abundance as the result of concrete-lined watercourses and low, shallow dry weather flows which result in extreme temperature, pH, and/or dissolved oxygen conditions. Naturally reproducing finfish populations are not expected to occur in LWRM waters. Santa Ana Regional Board (Region 8):

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes. This includes waters that have in the past, or may in the future, contain significant shellfisheries. Central Coast Regional Board (Region 3)

Wetland Habitat (WET) Uses of water that support natural and man-made wetland ecosystems, including, but not limited to, preservation or enhancement of unique wetland functions, vegetation, fish, shellfish, invertebrates, insects, and wildlife habitat. North Coast Regional Board (Region 1)

Wetland Habitat (WET) - Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants. Los Angeles Regional Board (Region 4)

Water Quality Enhancement (WQE) Uses of waters, including wetlands and other waterbodies, that support natural enhancement or improvement of water quality in or downstream of a waterbody including, but not limited to, erosion control, filtration and purification of naturally occurring water pollutants, stream bank stabilization, maintenance of channel integrity, and siltation control. North Coast Regional Board (Region 1)

Water Quality Enhancement (WQE) - Beneficial uses of waters that support natural enhancement or improvement of water quality in or downstream of a water body including, but not limited to, erosion control, filtration and purification of naturally occurring water pollutants, stream bank stabilization, maintenance of channel integrity, and siltation control. Lahontan Regional Board (Regions 6)

Attachment B

Basin Stress Tests

DBS&A
a Geo-Logic Company

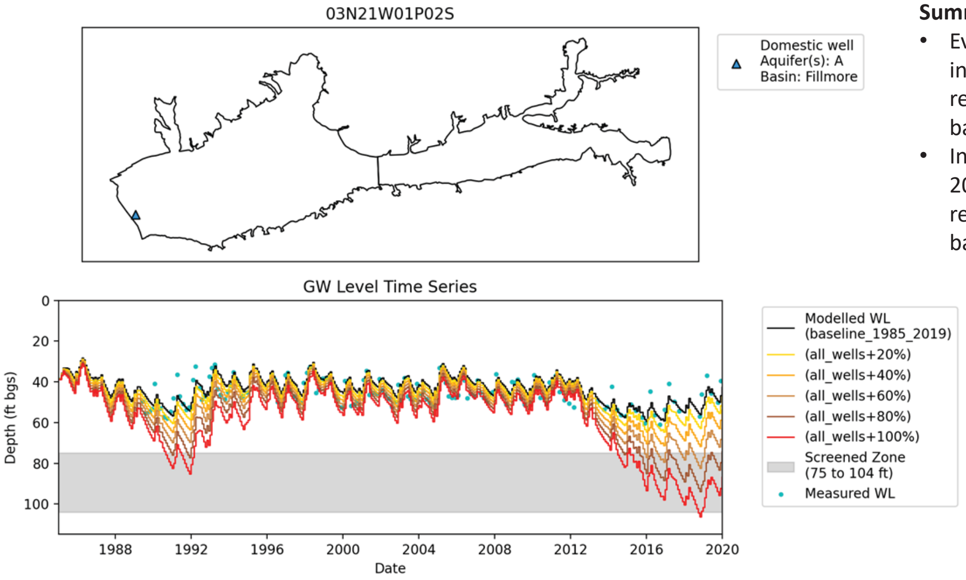
Basin “Stress Test”

- GW pumping increased for all well categories by 20%, 40%, 60%, 80%, & 100%

Pumping , AFY	Fillmore basin	Piru basin	Total for both basins
Baseline	46,760	11,390	58,150
Baseline + 20%	56,120	13,670	69,780
Baseline + 40%	65,470	15,950	81,420
Baseline + 60%	74,820	18,220	93,050
Baseline + 80%	84,180	20,500	104,680
Baseline + 100%	93,530	22,780	116,310

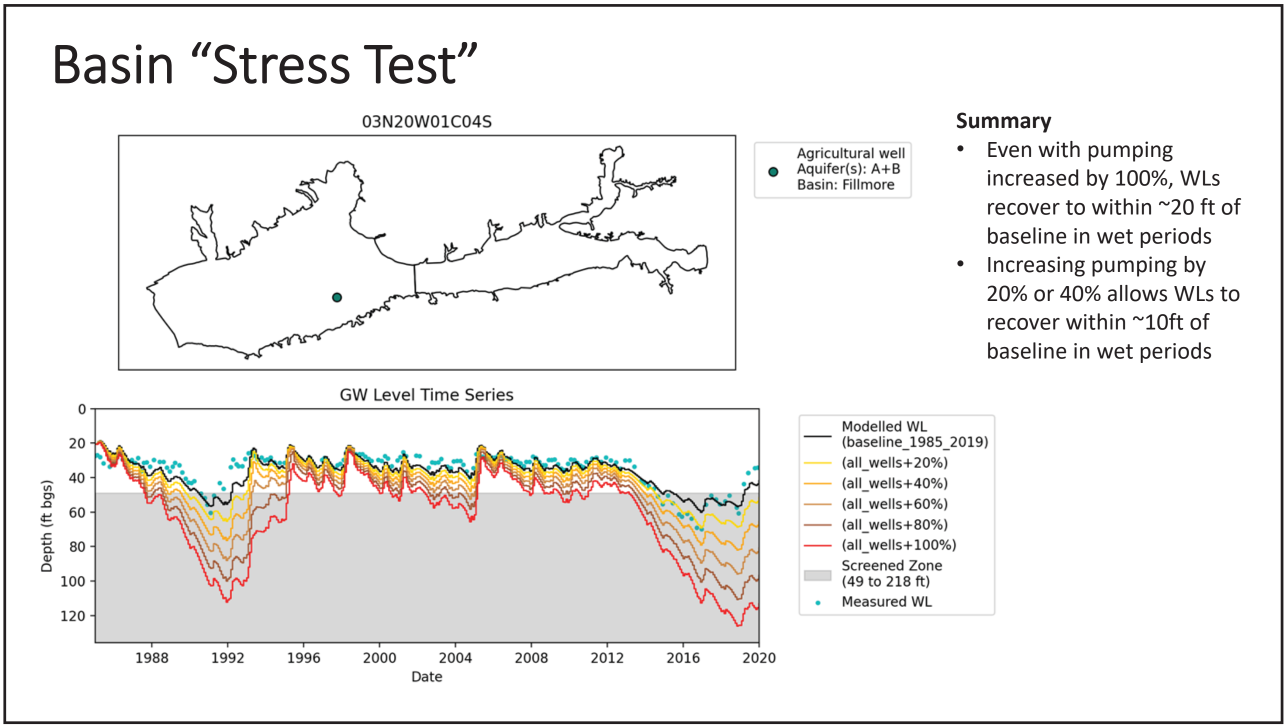
(Values rounded to nearest 10 AFY)

Basin “Stress Test”



Summary

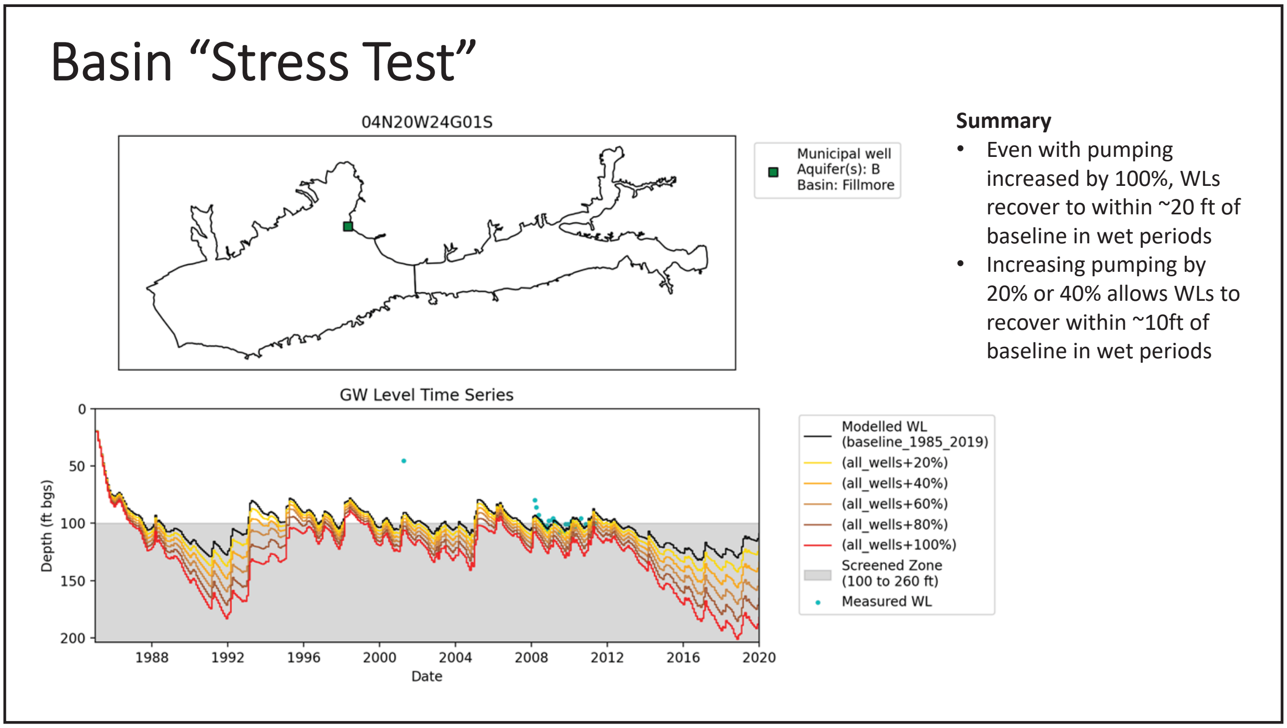
- Even with pumping increased by 100%, WLs recover to within ~10 ft of baseline in wet periods
- Increasing pumping by 20% or 40% allows WLs to recover within ~5ft of baseline in wet periods



Basin “Stress Test”

Summary

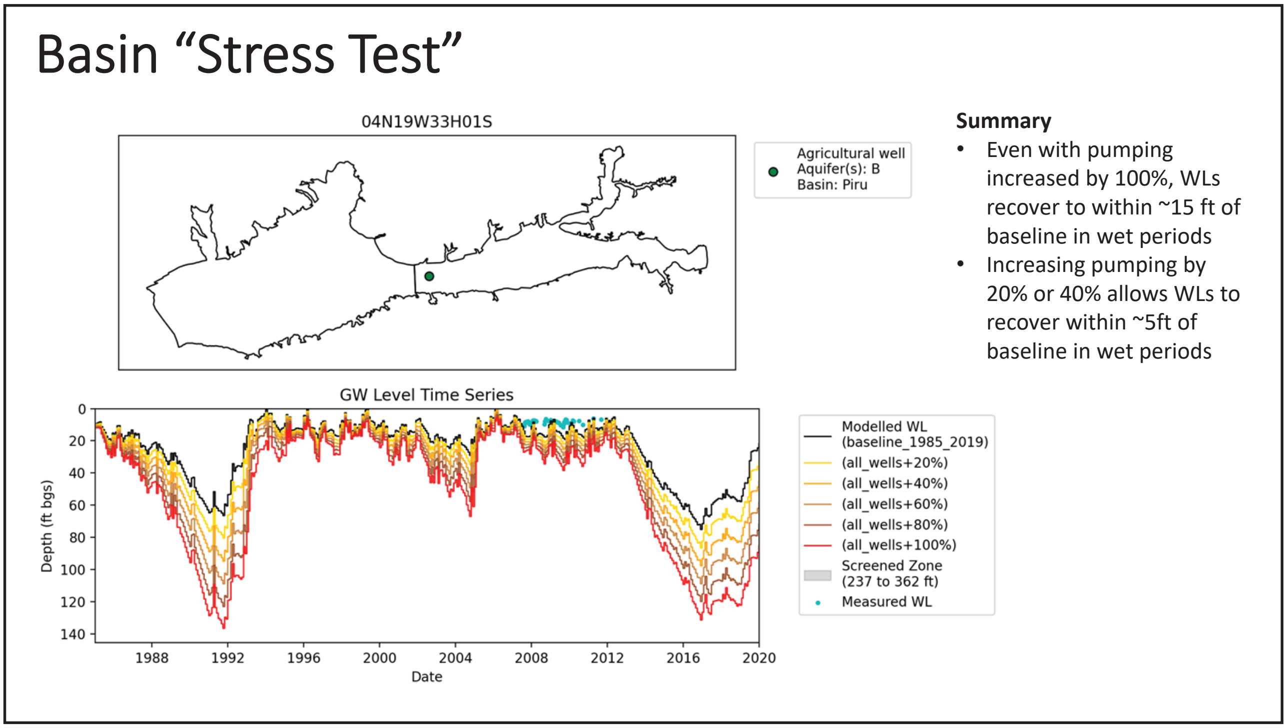
- Even with pumping increased by 100%, WLs recover to within ~20 ft of baseline in wet periods
- Increasing pumping by 20% or 40% allows WLs to recover within ~10ft of baseline in wet periods



Basin “Stress Test”

Summary

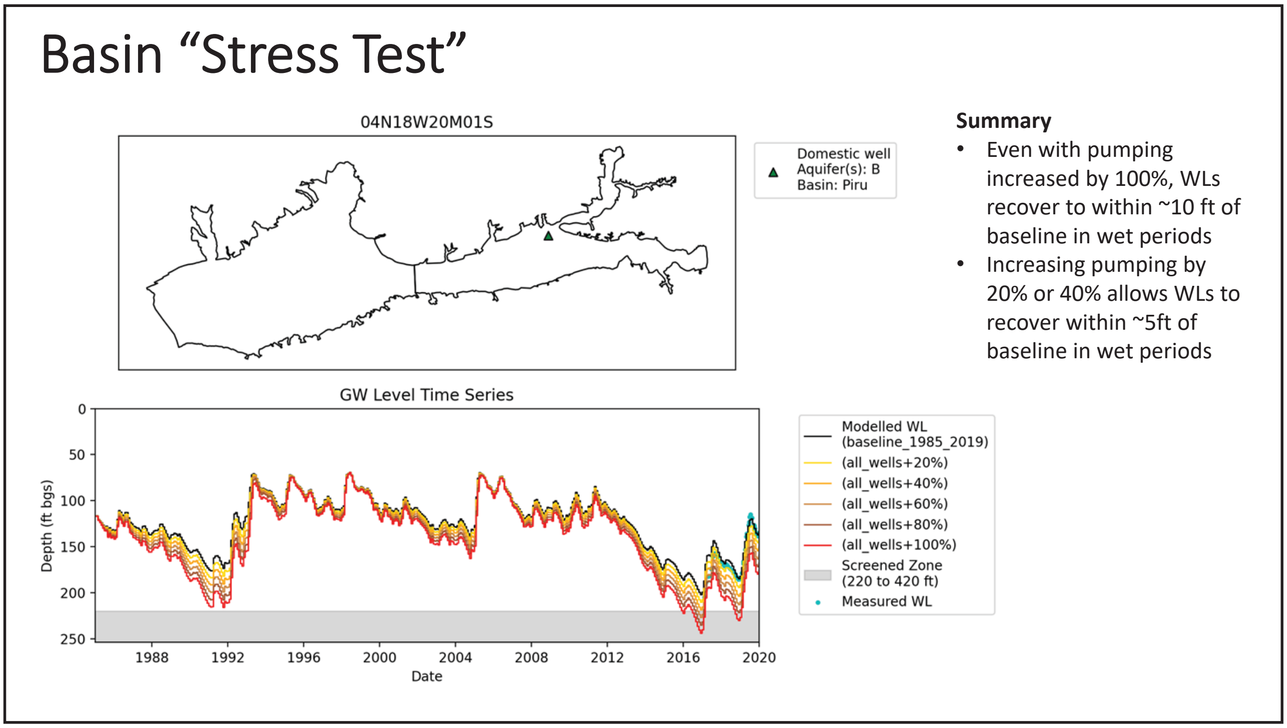
- Even with pumping increased by 100%, WLs recover to within ~20 ft of baseline in wet periods
- Increasing pumping by 20% or 40% allows WLs to recover within ~10ft of baseline in wet periods



Basin “Stress Test”

Summary

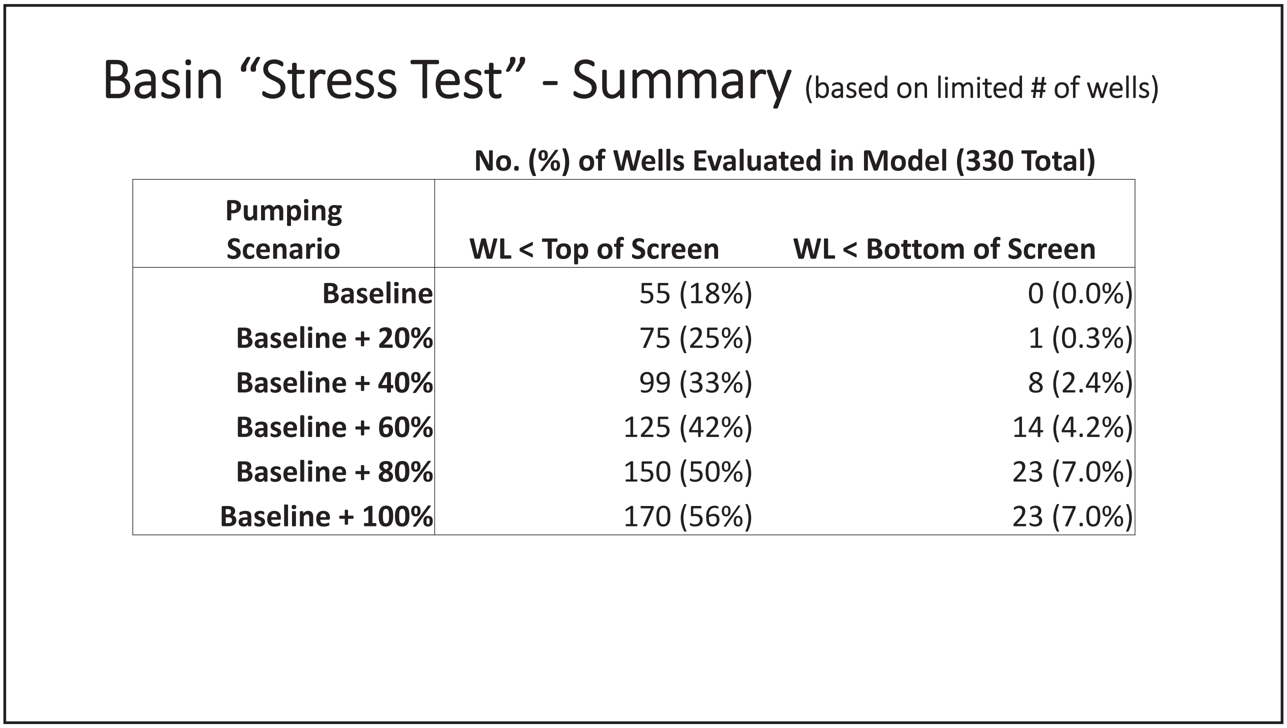
- Even with pumping increased by 100%, WLs recover to within ~15 ft of baseline in wet periods
- Increasing pumping by 20% or 40% allows WLs to recover within ~5ft of baseline in wet periods



Basin “Stress Test”

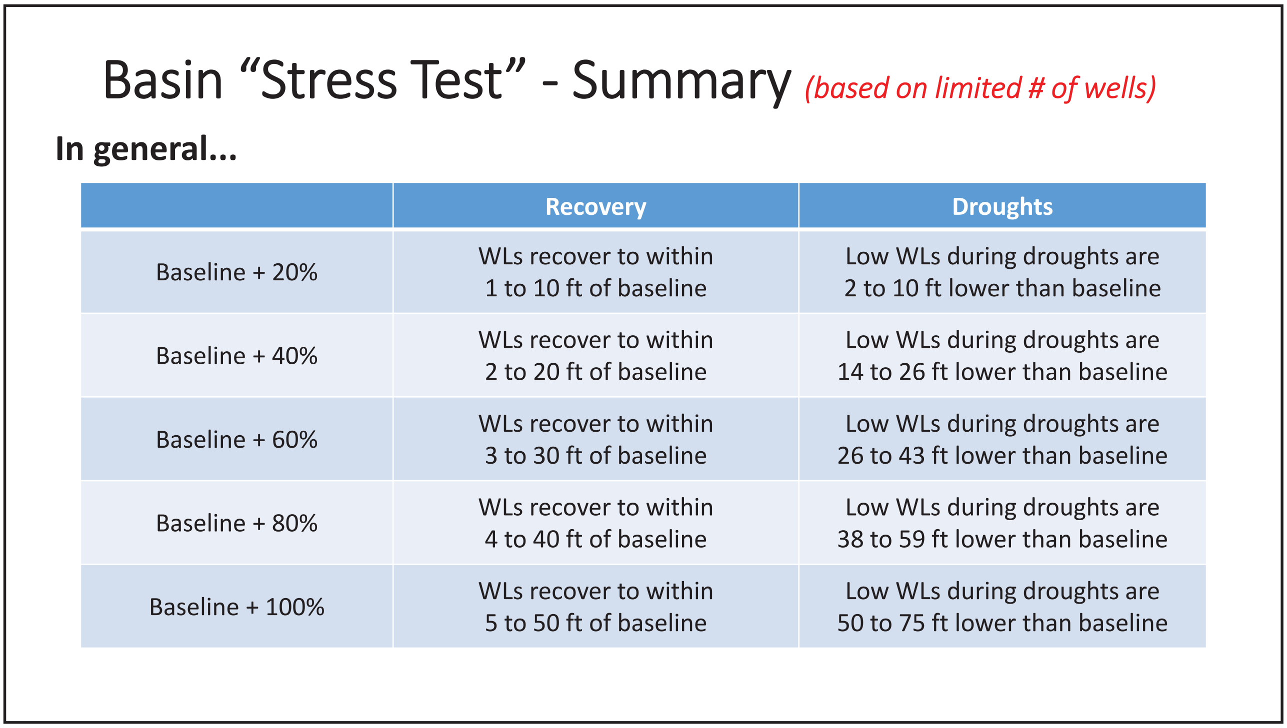
Summary

- Even with pumping increased by 100%, WLs recover to within ~10 ft of baseline in wet periods
- Increasing pumping by 20% or 40% allows WLs to recover within ~5ft of baseline in wet periods



Basin “Stress Test” - Summary (based on limited # of wells)

	No. (%) of Wells Evaluated in Model (330 Total)	
Pumping Scenario	**WL < Top of Screen**	**WL < Bottom of Screen**
Baseline	55 (18%)	0 (0.0%)
Baseline + 20%	75 (25%)	1 (0.3%)
Baseline + 40%	99 (33%)	8 (2.4%)
Baseline + 60%	125 (42%)	14 (4.2%)
Baseline + 80%	150 (50%)	23 (7.0%)
Baseline + 100%	170 (56%)	23 (7.0%)



Basin “Stress Test” - Summary *(based on limited # of wells)*

In general...

	Recovery	Droughts
Baseline + 20%	WLs recover to within 1 to 10 ft of baseline	Low WLs during droughts are 2 to 10 ft lower than baseline
Baseline + 40%	WLs recover to within 2 to 20 ft of baseline	Low WLs during droughts are 14 to 26 ft lower than baseline
Baseline + 60%	WLs recover to within 3 to 30 ft of baseline	Low WLs during droughts are 26 to 43 ft lower than baseline
Baseline + 80%	WLs recover to within 4 to 40 ft of baseline	Low WLs during droughts are 38 to 59 ft lower than baseline
Baseline + 100%	WLs recover to within 5 to 50 ft of baseline	Low WLs during droughts are 50 to 75 ft lower than baseline

Attachment C

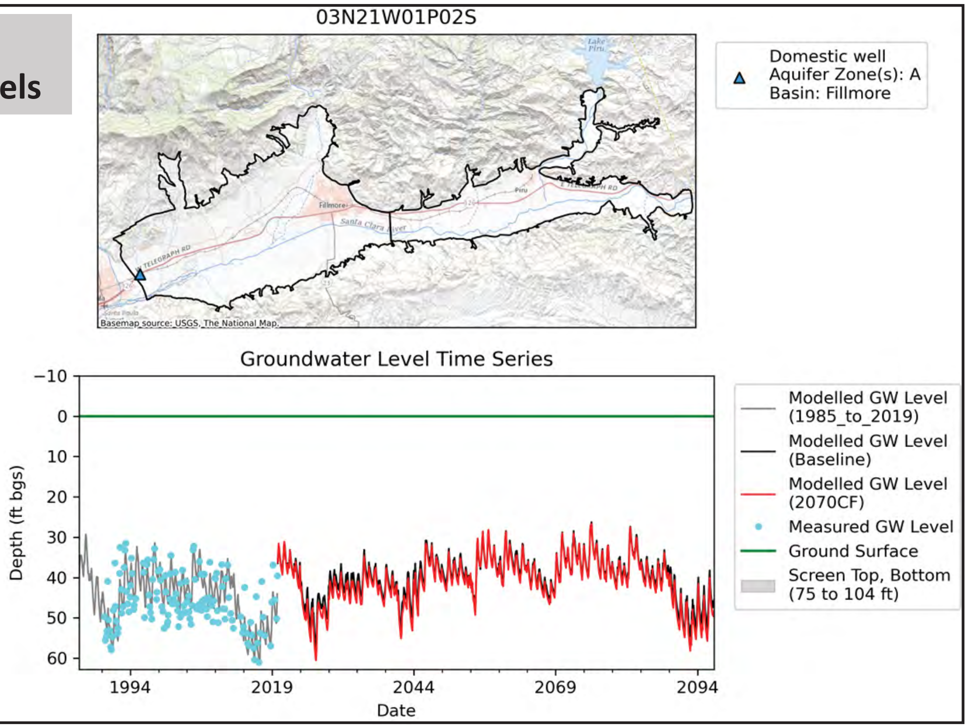
Projected Groundwater Levels

DBS&A
a Geo-Logic Company

Lowering of Groundwater Levels

Conclusions

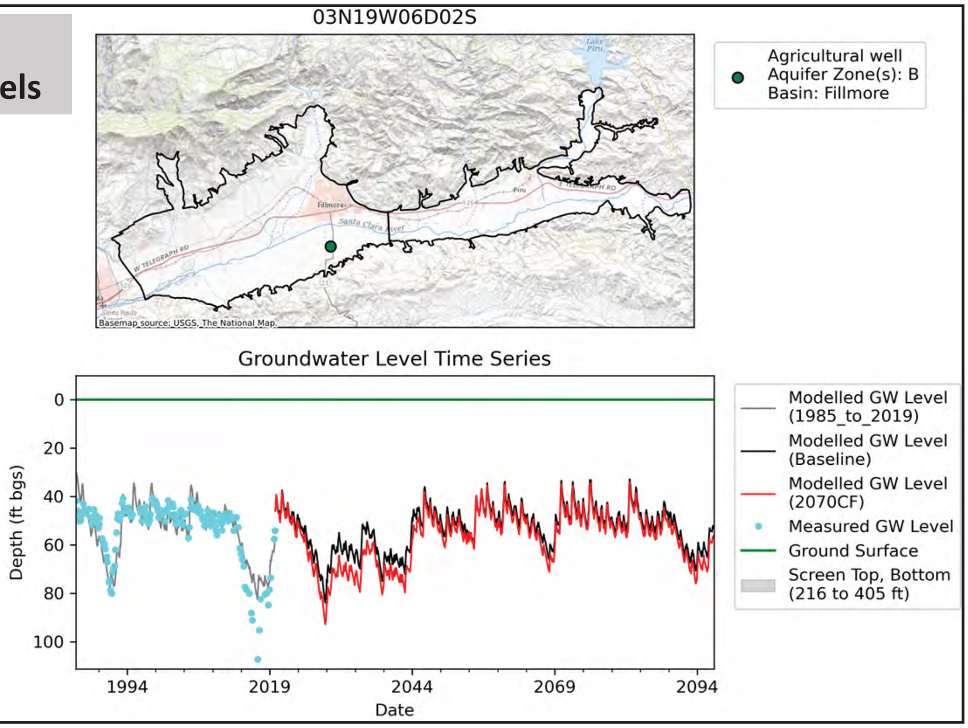
- **No evidence of chronic decline in GW levels.**
- GW level ranges are similar to the historic period.
- Difference in 2070CF scenario GW levels vs. Baseline scenario:
  - Wet periods: <5 ft
  - Droughts: <10 ft

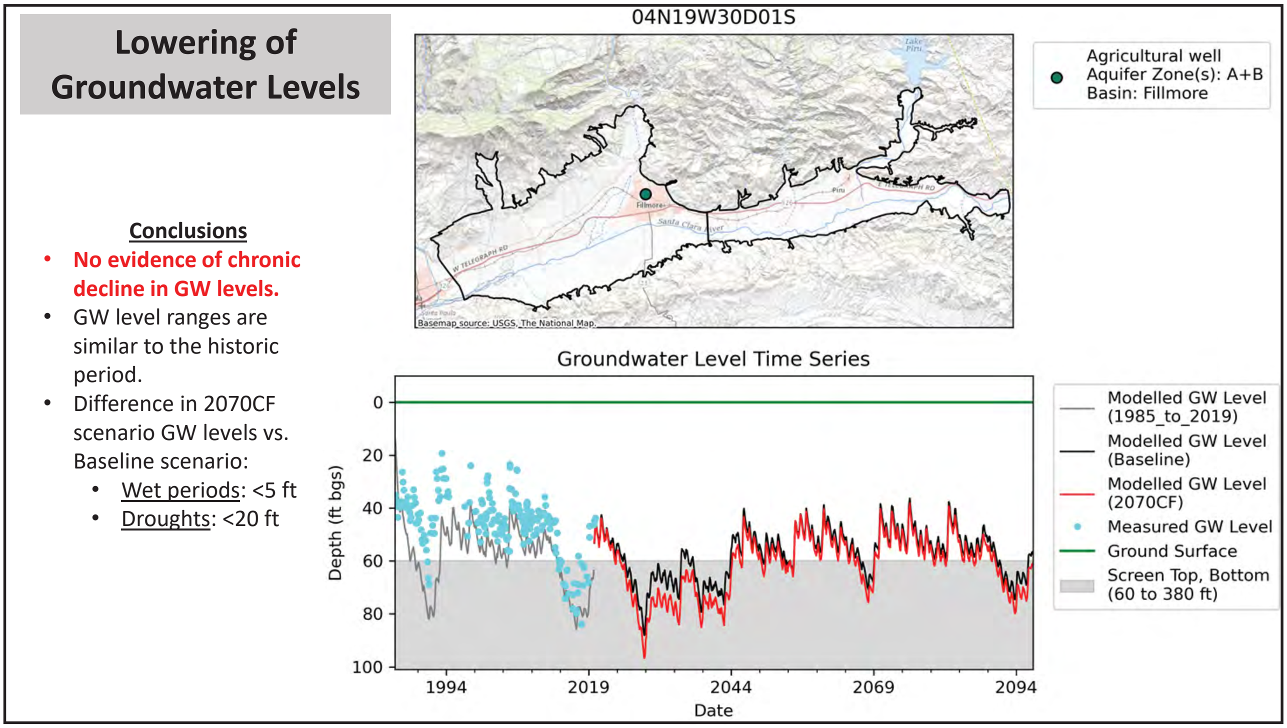


Lowering of Groundwater Levels

Conclusions

- **No evidence of chronic decline in GW levels.**
- GW level ranges are similar to the historic period.
- Difference in 2070CF scenario GW levels vs. Baseline scenario:
  - Wet periods: <5 ft
  - Droughts: <20 ft





Lowering of Groundwater Levels

Conclusions

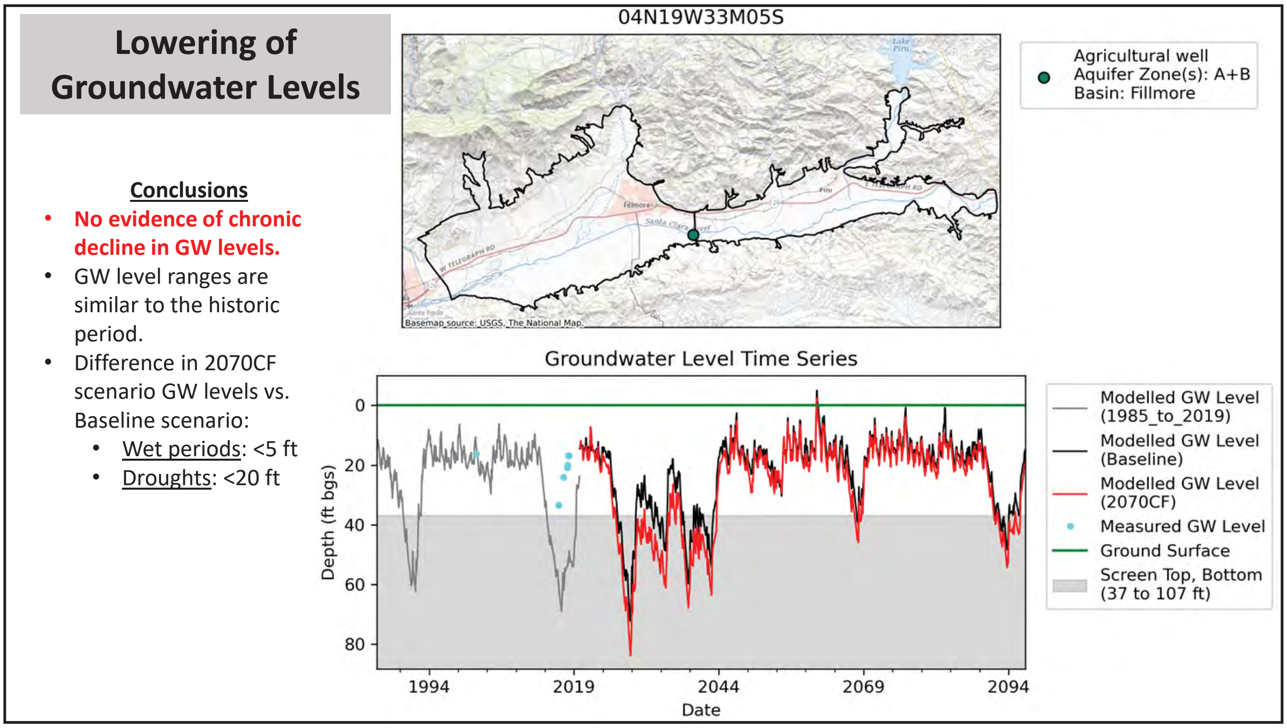
- **No evidence of chronic decline in GW levels.**
- GW level ranges are similar to the historic period.
- Difference in 2070CF scenario GW levels vs. Baseline scenario:
  - Wet periods: <5 ft
  - Droughts: <20 ft

04N19W30D01S

Agricultural well
Aquifer Zone(s): A+B
Basin: Fillmore

Basemap source: USGS, The National Map.

Groundwater Level Time Series



Lowering of Groundwater Levels

Conclusions

- **No evidence of chronic decline in GW levels.**
- GW level ranges are similar to the historic period.
- Difference in 2070CF scenario GW levels vs. Baseline scenario:
  - Wet periods: <5 ft
  - Droughts: <20 ft

04N19W33M05S

Agricultural well
Aquifer Zone(s): A+B
Basin: Fillmore

Basemap source: USGS, The National Map.

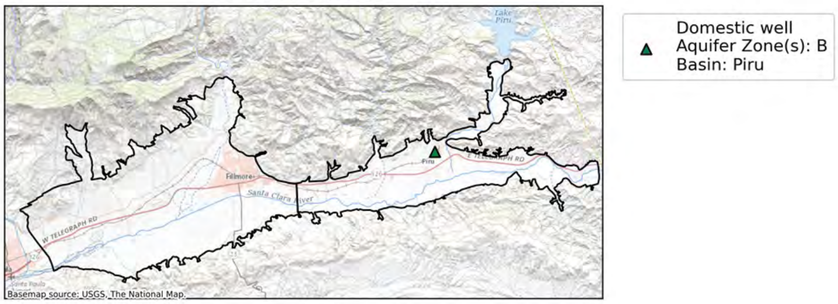
Groundwater Level Time Series

Lowering of Groundwater Levels

Conclusions

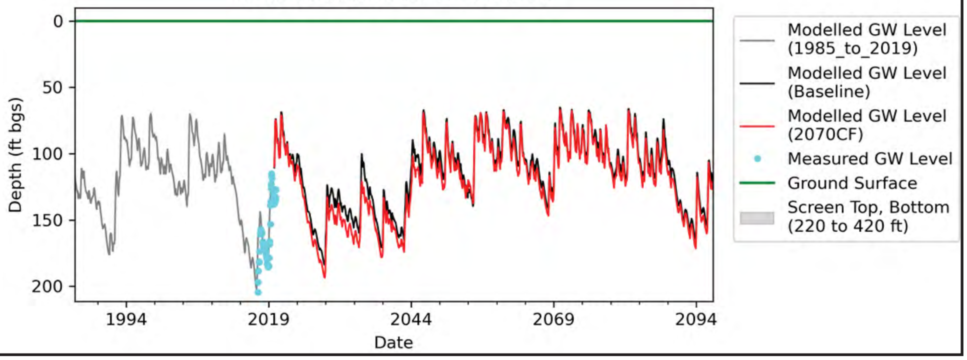
- **No evidence of chronic decline in GW levels.**
- GW level ranges are similar to the historic period.
- Difference in 2070CF scenario GW levels vs. Baseline scenario:
  - Wet periods: <5 ft
  - Droughts: <20 ft

04N18W20M01S



Basemap source: USGS, The National Map.

Groundwater Level Time Series



Attachment D

Water Quality Objectives

DBS&A
a Geo-Logic Company

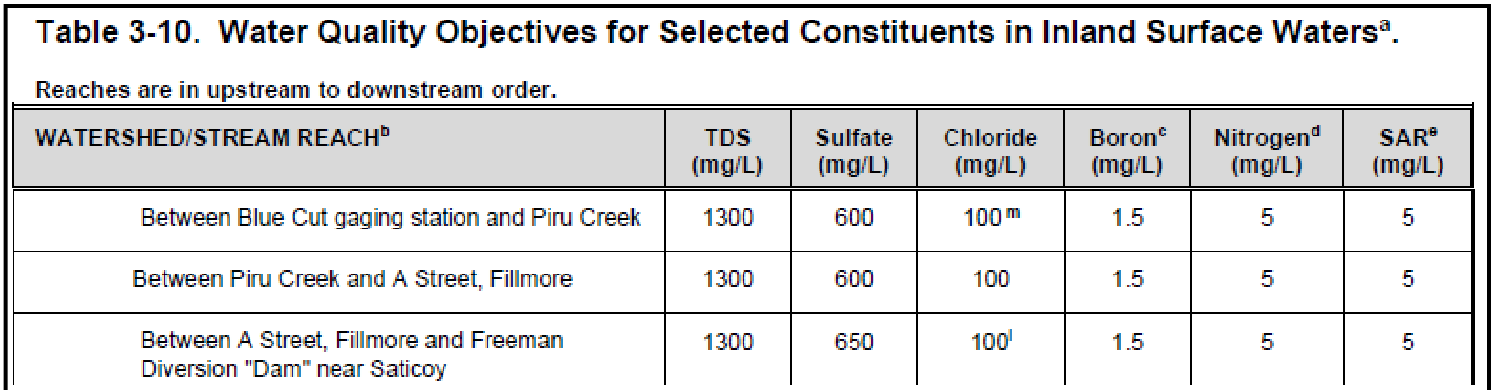


Table 3-10. Water Quality Objectives for Selected Constituents in Inland Surface Waters[a].

Reaches are in upstream to downstream order.

WATERSHED/STREAM REACH[b]	TDS (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Boron[c] (mg/L)	Nitrogen[d] (mg/L)	SAR[e] (mg/L)
Between Blue Cut gaging station and Piru Creek	1300	600	100 [m]	1.5	5	5
Between Piru Creek and A Street, Fillmore	1300	600	100	1.5	5	5
Between A Street, Fillmore and Freeman Diversion "Dam" near Saticoy	1300	650	100[l]	1.5	5	5

Notes:

- Modified from the Los Angeles Regional Water Quality Control Board (LARWQCB Basin Plan, May 6, 2019)
- a. As part of the State's continuing planning process, data will continue to be collected to support the development of numerical water quality objectives for waterbodies and constituents where sufficient information is presently unavailable. Any new recommendations for water quality objectives will be brought before the Regional Board in the future.
- b. All references to watersheds, streams and reaches include all tributaries. Water quality objectives are applied to all waters tributary to those specifically listed in the table. See Figures 2-1 to 2-10 for locations.
- c. Where naturally occurring boron results in concentrations higher than the stated objective, a site-specific objective may be determined on a case-by-case basis.
- d. Nitrate-nitrogen plus nitrite-nitrogen (NO3-N + NO2-N). The lack of adequate nitrogen data for all streams precluded the establishment of numerical objectives for all streams.
- e. Sodium adsorption ratio (SAR) predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil.
  SAR = Na+/((Ca++ + Mg++)/2)1/2
- l. This objective was updated though a Basin Plan amendment adopted by the Regional Board on November 6, 2003 (Resolution No. R03-015) and went into effect on August 4, 2004.
- m. These objectives apply as a 3-month rolling average. The 3-month averaging period for these objectives was established though a Basin Plan amendment adopted by the Regional Board on October 9, 2014 (Resolution No. R14-010) and went into effect on April 28, 2015.

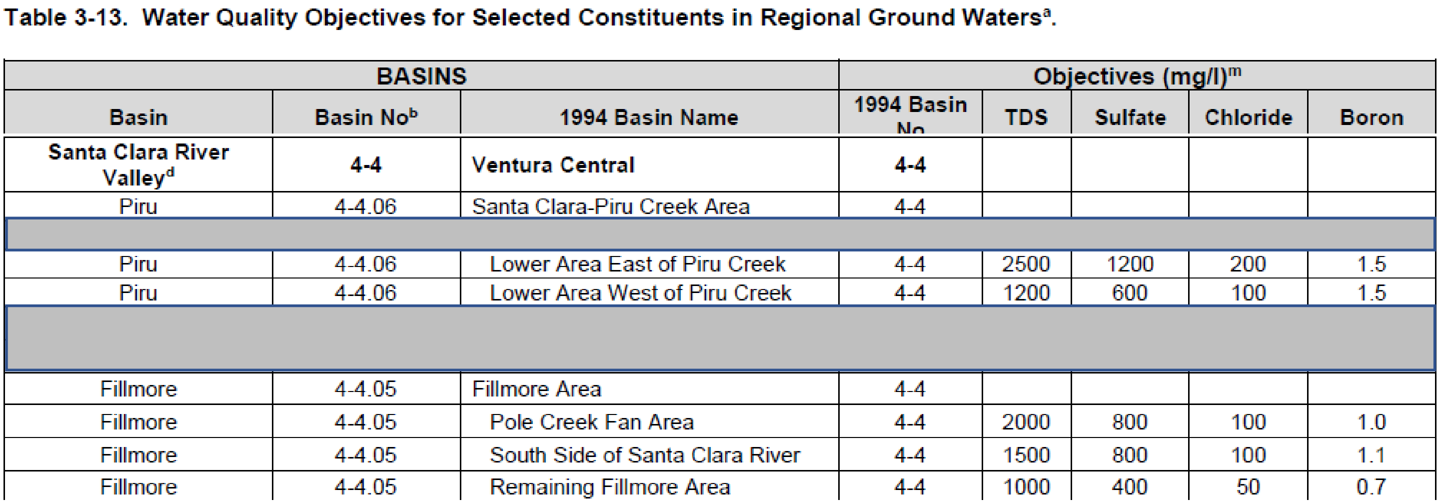


Table 3-13. Water Quality Objectives for Selected Constituents in Regional Ground Waters[a].

BASINS			Objectives (mg/l)[m]				
Basin	Basin No[b]	1994 Basin Name	1994 Basin No	TDS	Sulfate	Chloride	Boron
Santa Clara River Valley[d]	**4-4**	**Ventura Central**	**4-4**				
Piru	4-4.06	Santa Clara-Piru Creek Area	4-4				
Piru	4-4.06	Lower Area East of Piru Creek	4-4	2500	1200	200	1.5
Piru	4-4.06	Lower Area West of Piru Creek	4-4	1200	600	100	1.5
Fillmore	4-4.05	Fillmore Area	4-4				
Fillmore	4-4.05	Pole Creek Fan Area	4-4	2000	800	100	1.0
Fillmore	4-4.05	South Side of Santa Clara River	4-4	1500	800	100	1.1
Fillmore	4-4.05	Remaining Fillmore Area	4-4	1000	400	50	0.7

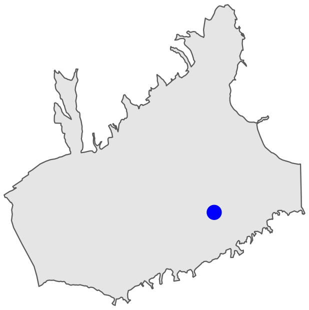
Notes:

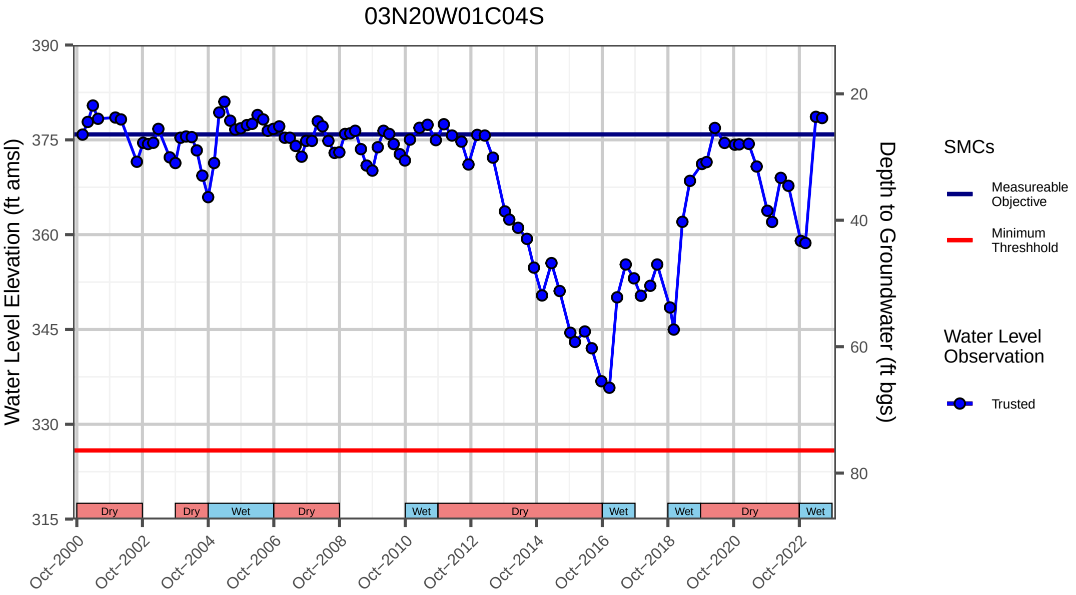
- Modified from the Los Angeles Regional Water Quality Control Board (LARWQCB Basin Plan, May 6, 2019)
- b. Basins are numbered according to Bulletin 118-Update 2003 (Department of Water Resources, 2003).
- d. The Santa Clara River Valley (4-4) was formerly Ventura Central Basin

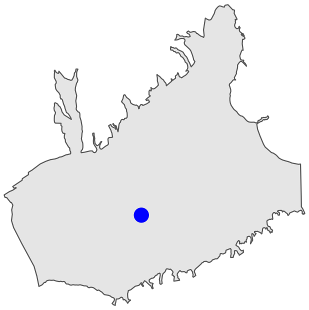
Attachment E

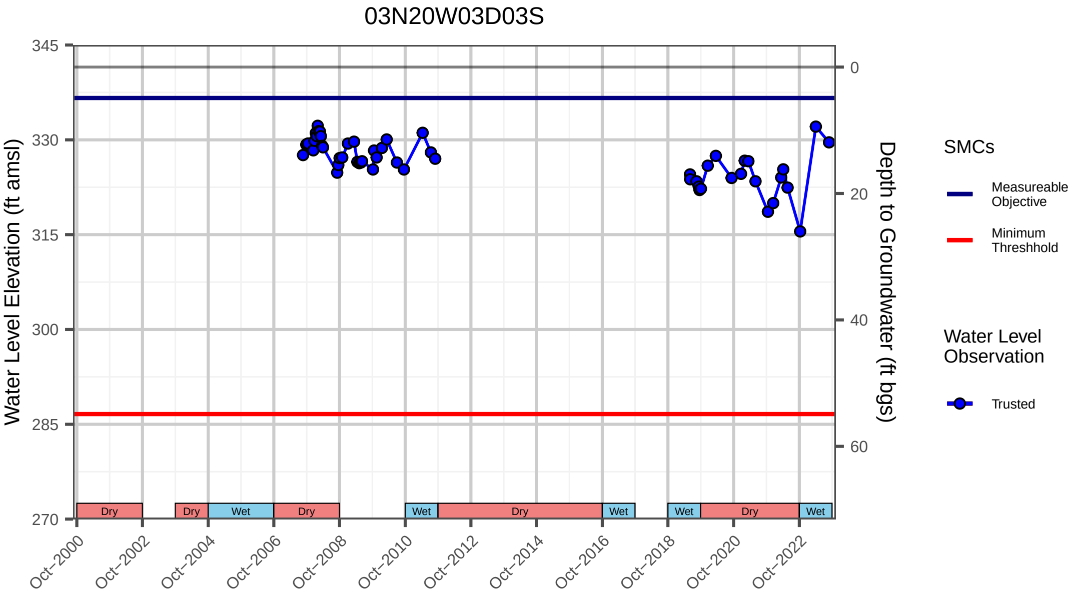
Hydrographs of Representative Monitoring Points with Measurable Objectives and Minimum Thresholds

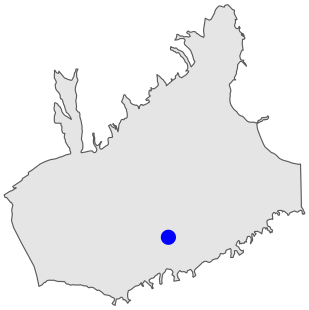
a Geo-Logic Company

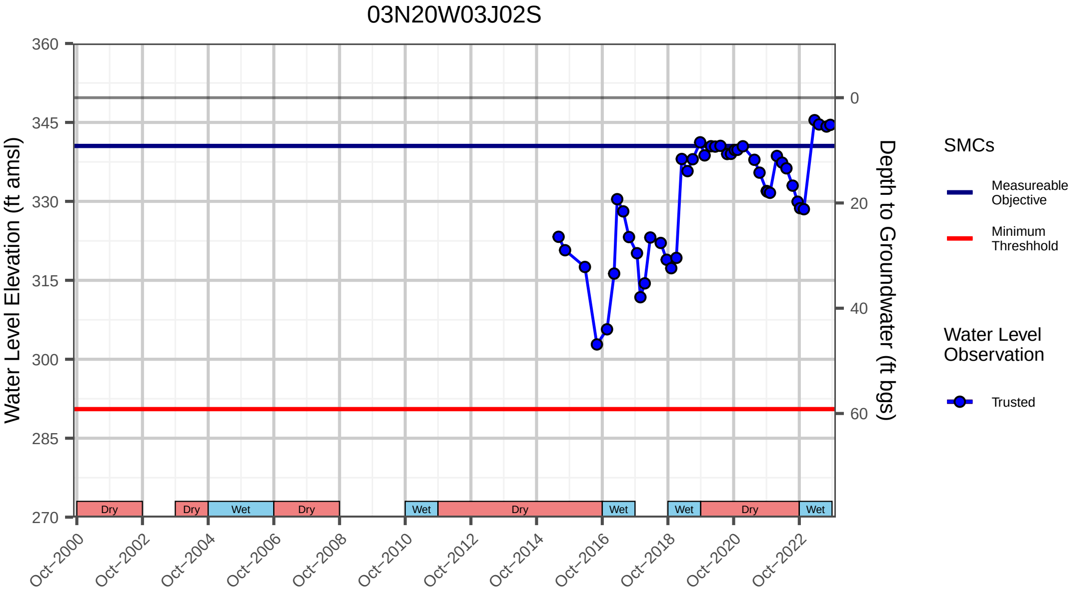


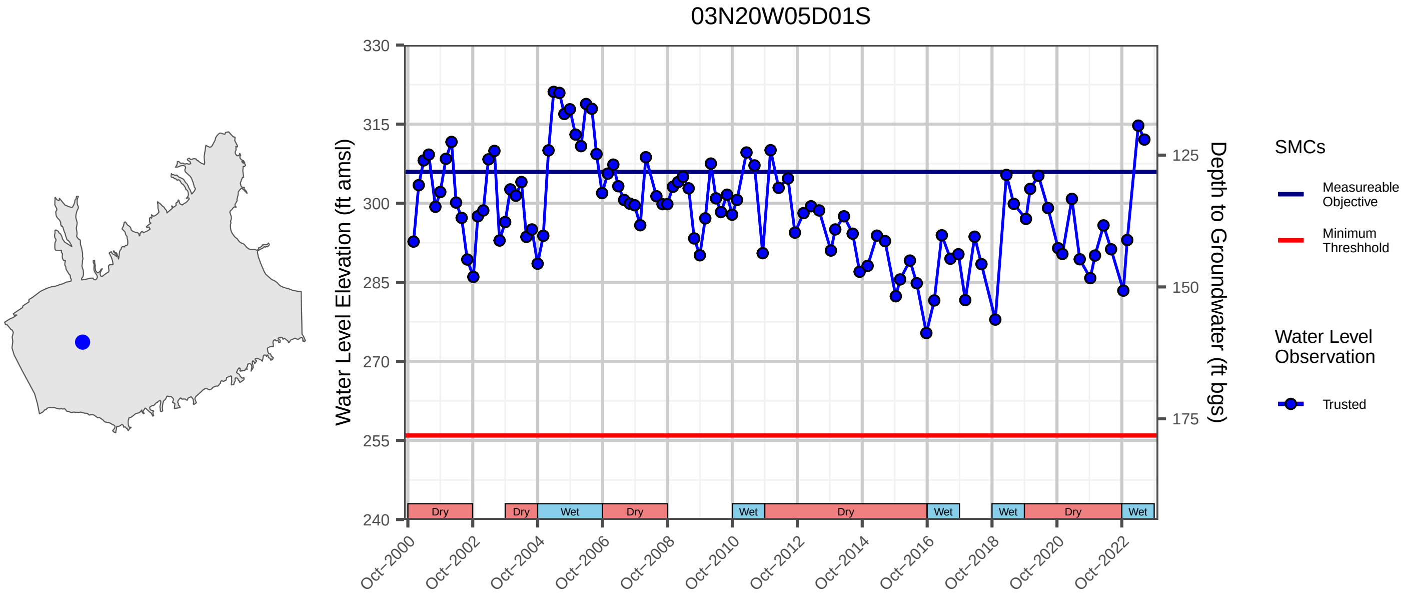

03N20W01C04S
Water Level Elevation (ft amsl)
390
375
360
345
330
315
Depth to Groundwater (ft bgs)
20
40
60
80
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted

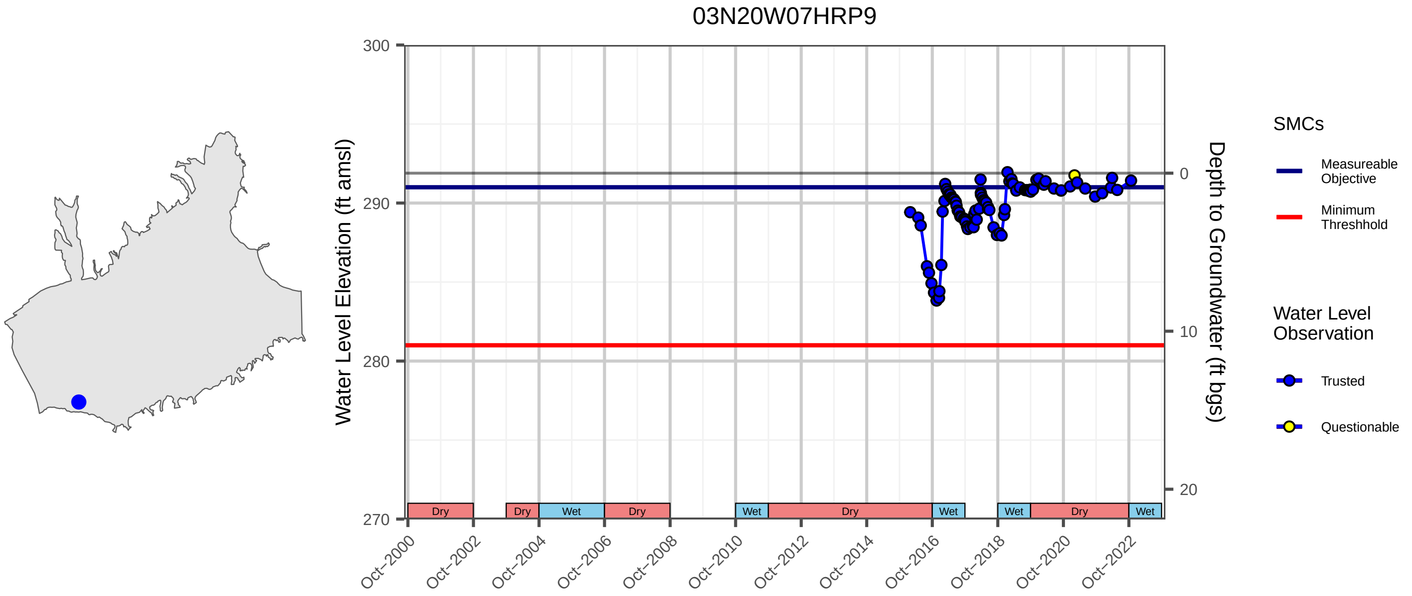


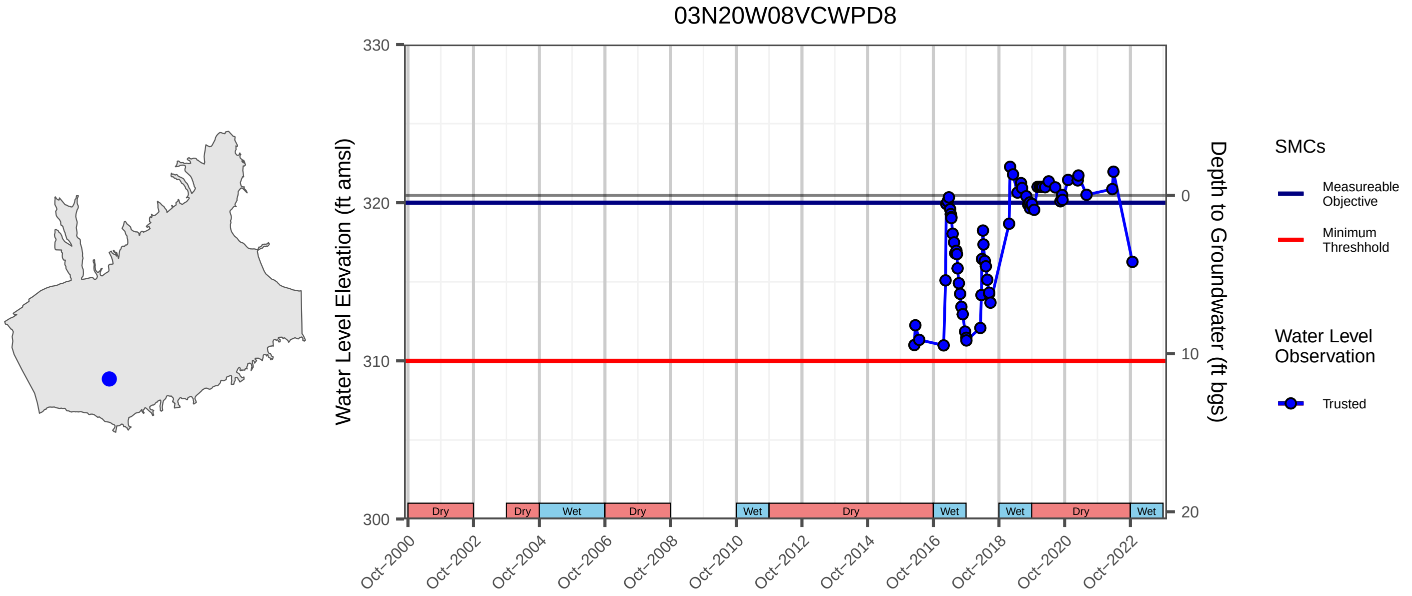

03N20W03D03S
Water Level Elevation (ft amsl)
345
330
315
300
285
270
Depth to Groundwater (ft bgs)
0
20
40
60
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted




03N20W03J02S
Water Level Elevation (ft amsl)
360
345
330
315
300
285
270
Depth to Groundwater (ft bgs)
0
20
40
60
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted


03N20W05D01S
Water Level Elevation (ft amsl)
330
315
300
285
270
255
240
Depth to Groundwater (ft bgs)
125
150
175
Oct−2000
Oct−2002
Oct−2004
Oct−2006
Oct−2008
Oct−2010
Oct−2012
Oct−2014
Oct−2016
Oct−2018
Oct−2020
Oct−2022
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted


03N20W07HRP9
Water Level Elevation (ft amsl)
300
290
280
270
Depth to Groundwater (ft bgs)
0
10
20
Oct−2000
Oct−2002
Oct−2004
Oct−2006
Oct−2008
Oct−2010
Oct−2012
Oct−2014
Oct−2016
Oct−2018
Oct−2020
Oct−2022
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted
Questionable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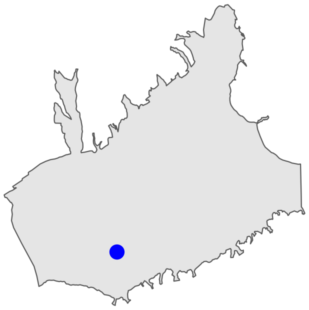
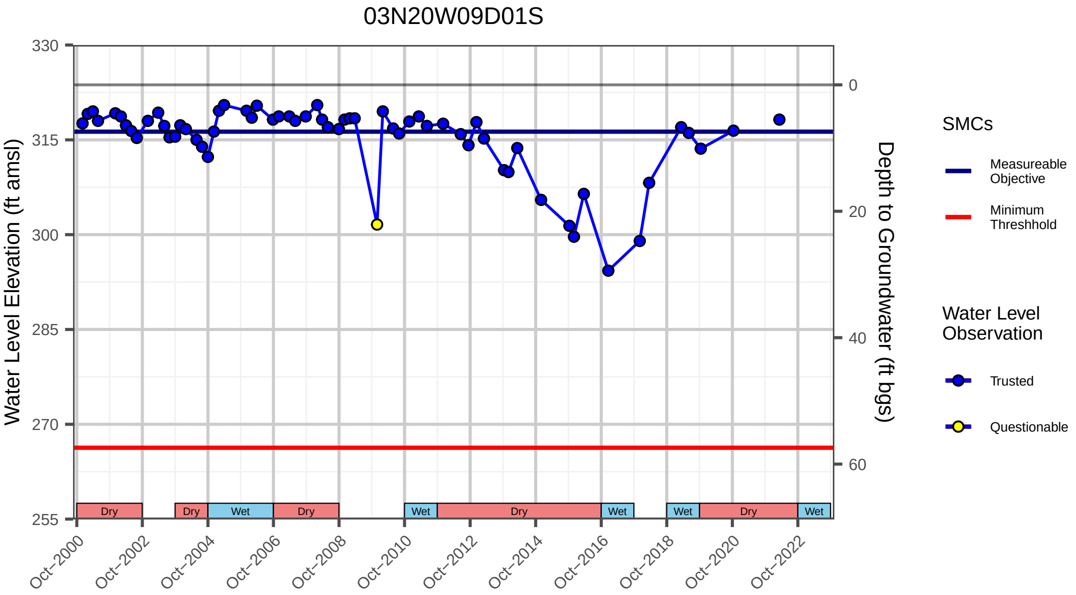
Water Level Elevation (ft amsl)
330
320
310
300
Depth to Groundwater (ft bgs)
0
10
20
Oct−2000
Oct−2002
Oct−2004
Oct−2006
Oct−2008
Oct−2010
Oct−2012
Oct−2014
Oct−2016
Oct−2018
Oct−2020
Oct−2022
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted





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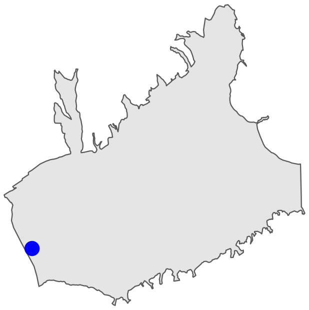

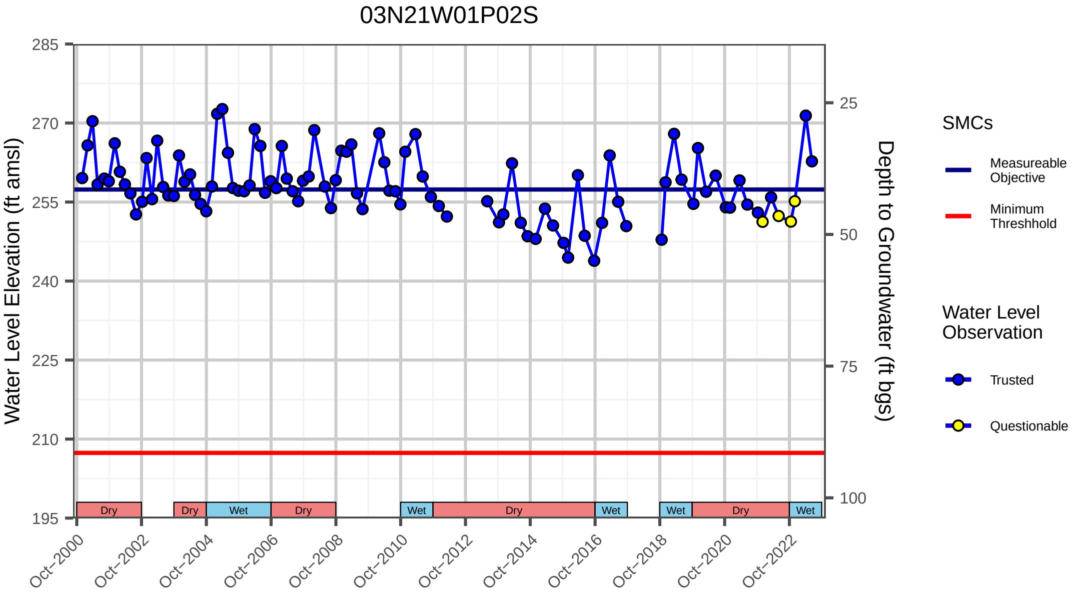

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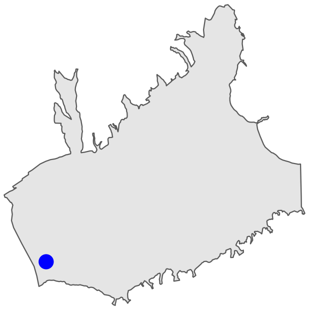

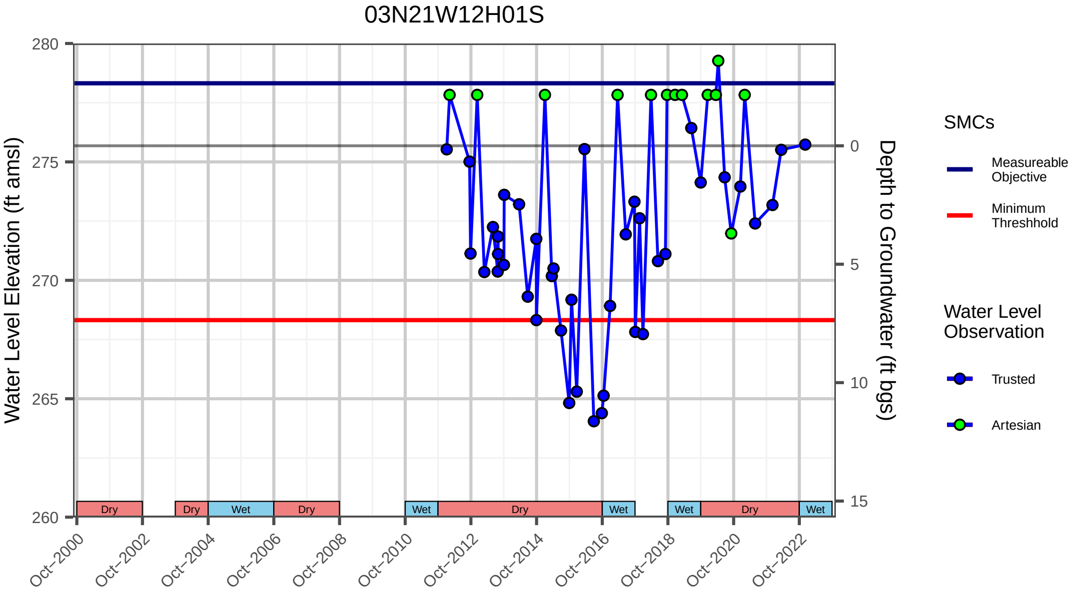

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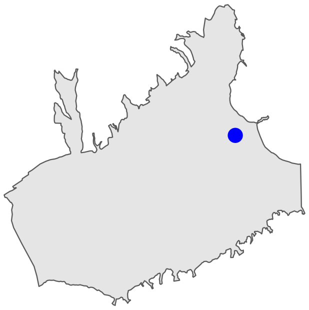
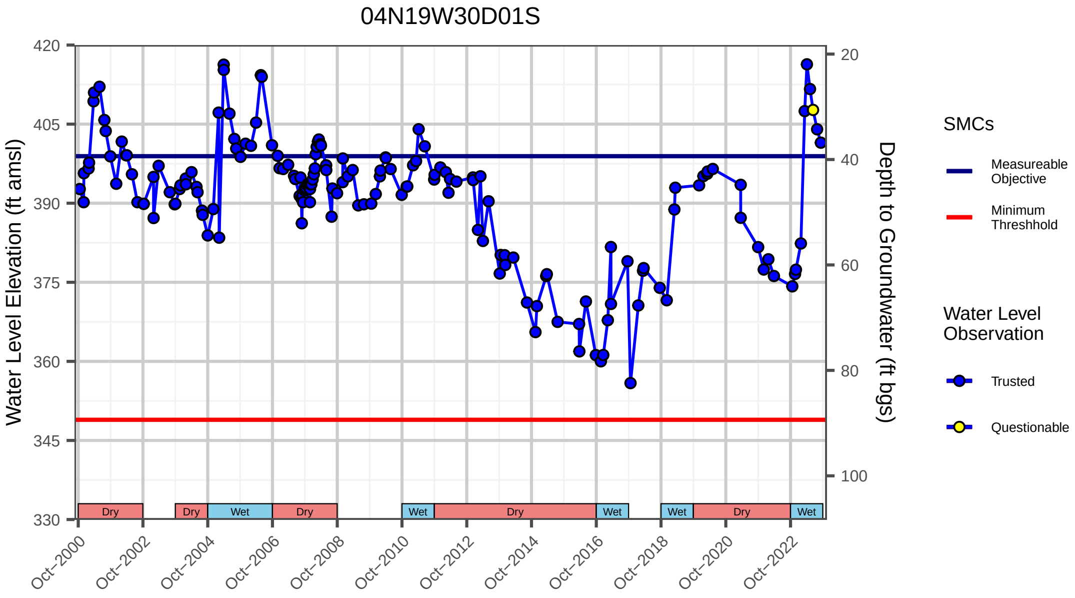
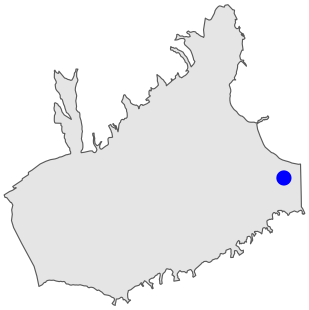
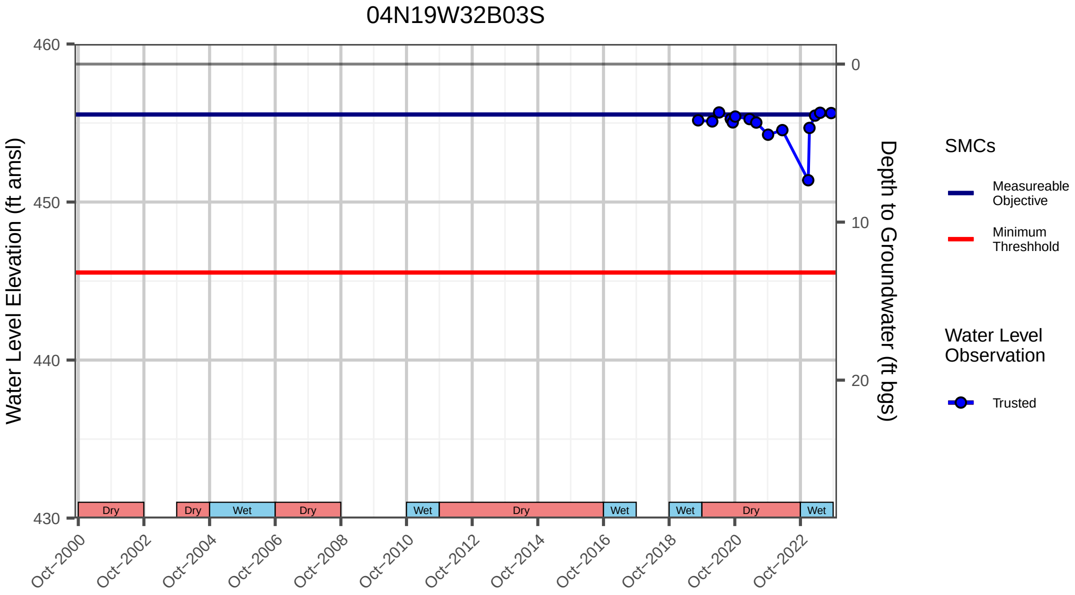
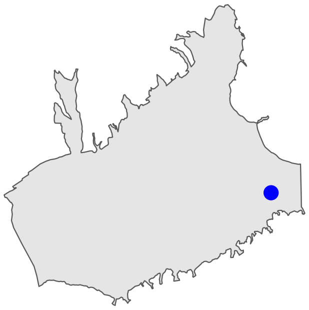
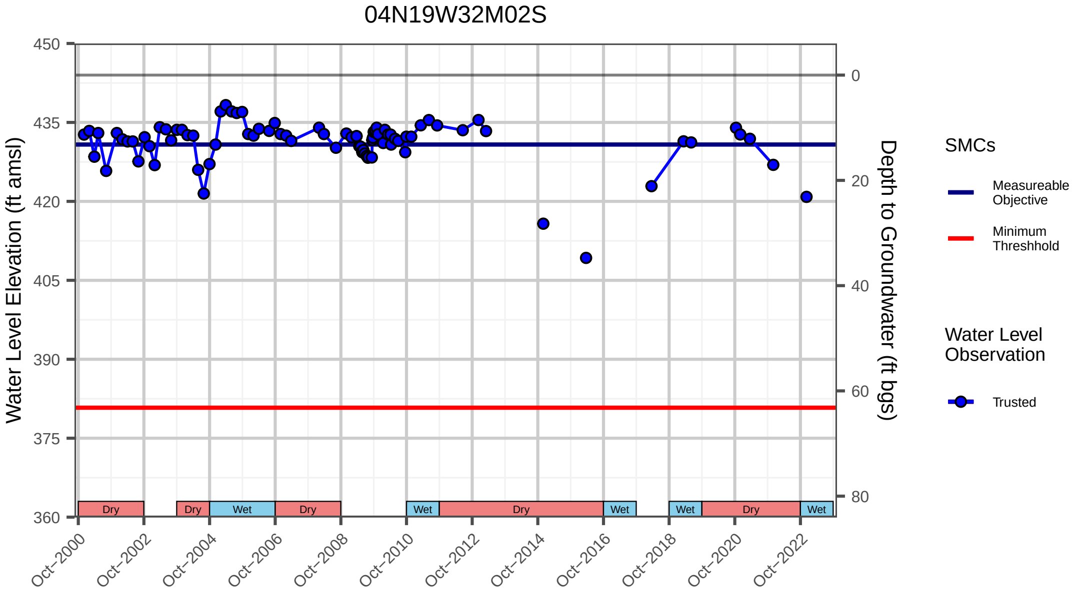


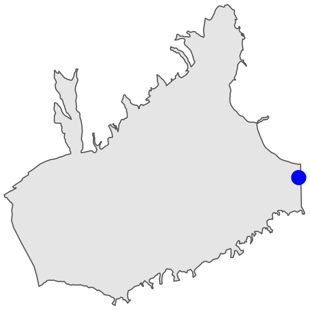

04N19W30D01S
Water Level Elevation (ft amsl)
420
405
390
375
360
345
330
Depth to Groundwater (ft bgs)
20
40
60
80
100
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted
Questionable

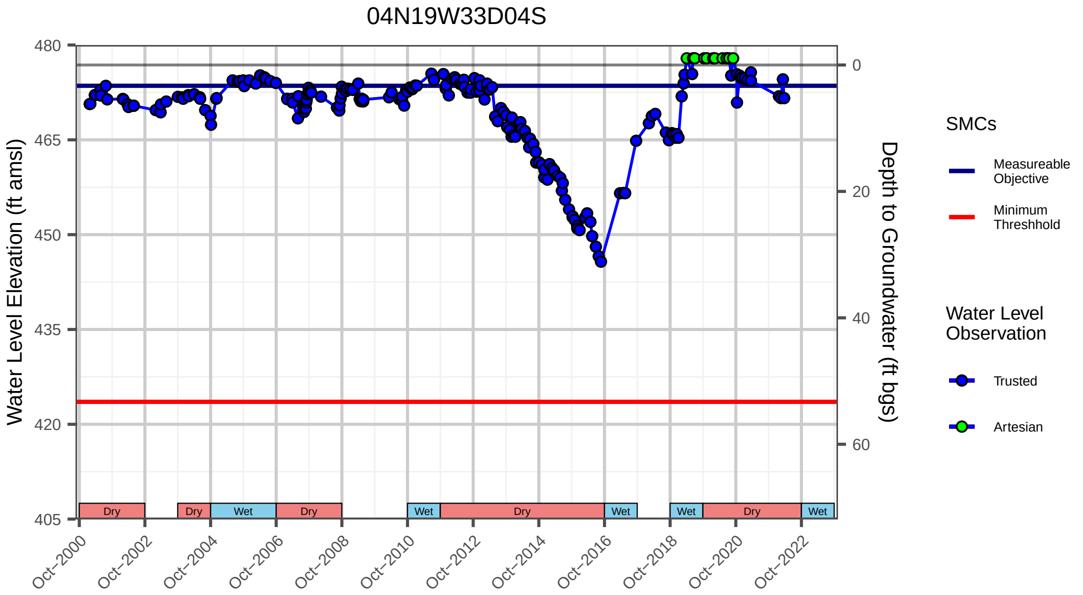



04N19W32B03S
Water Level Elevation (ft amsl)
460
450
440
430
Depth to Groundwater (ft bgs)
0
10
20
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted




04N19W32M02S
Water Level Elevation (ft amsl)
450
435
420
405
390
375
360
Depth to Groundwater (ft bgs)
0
20
40
60
80
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted

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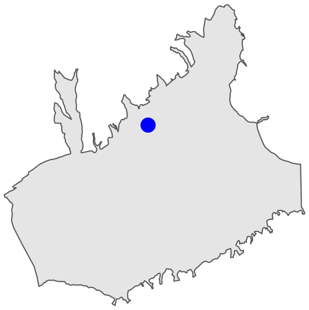

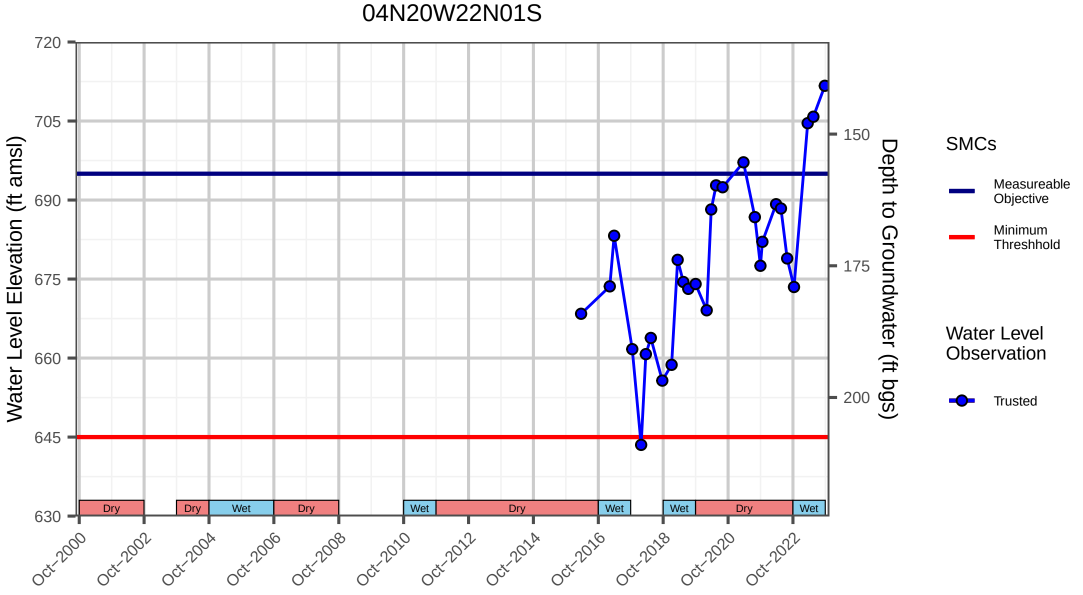
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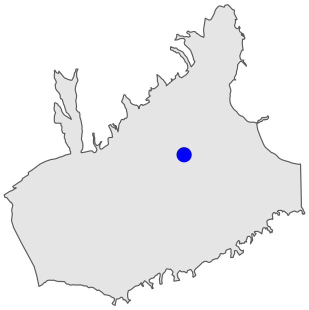

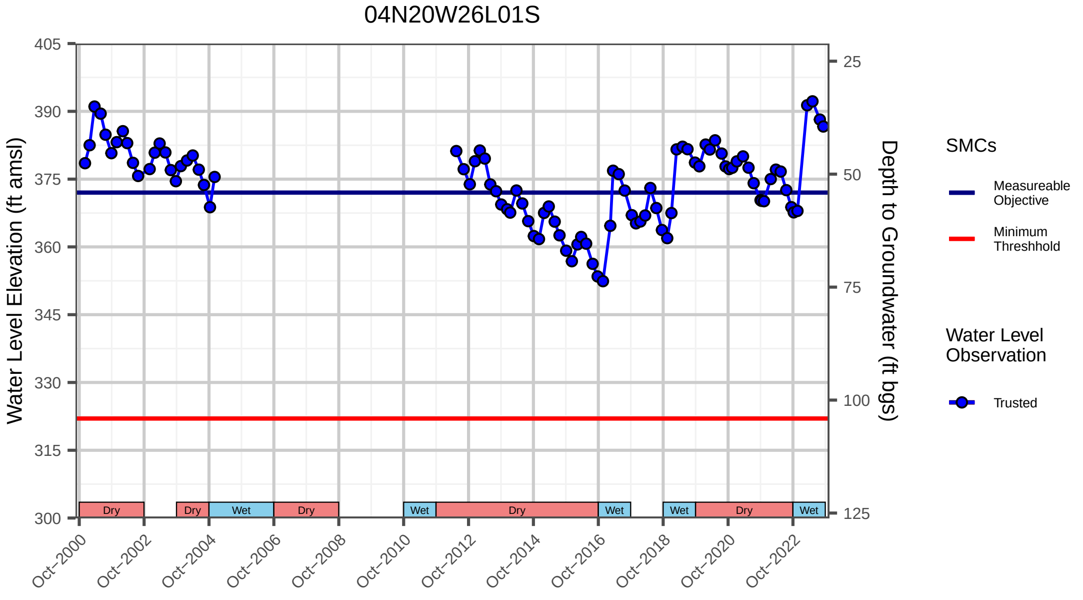
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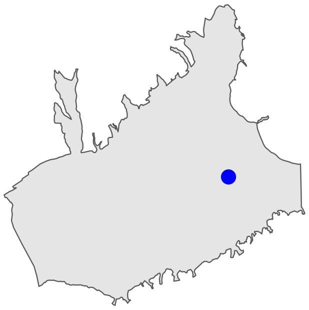
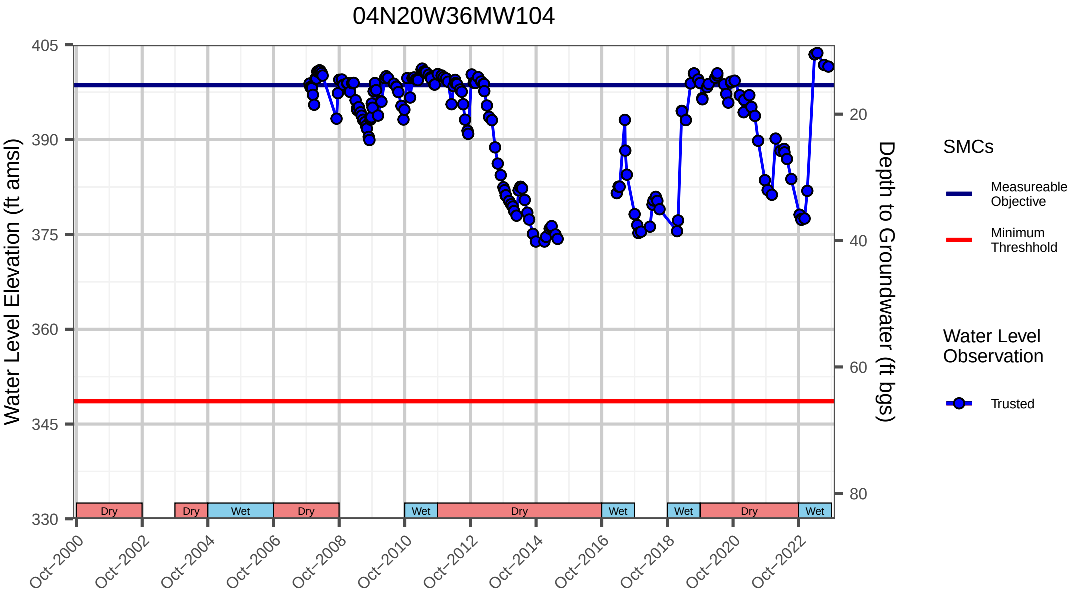
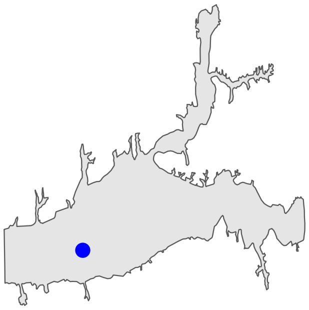
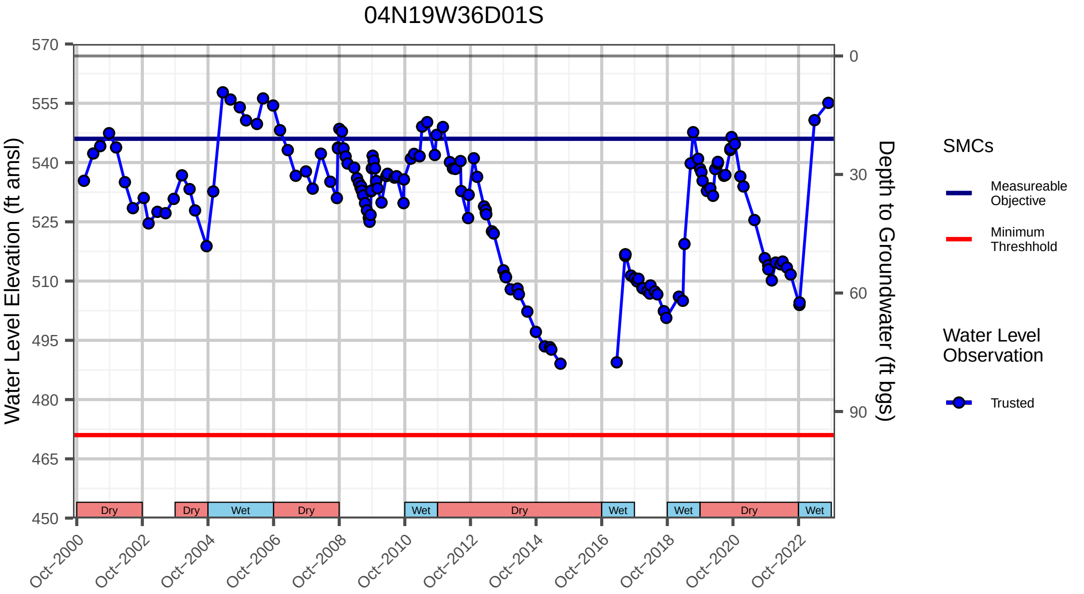
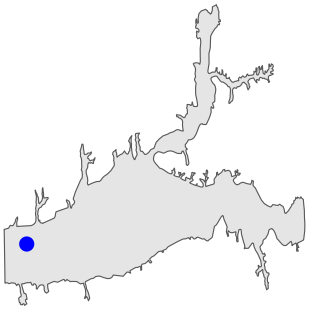
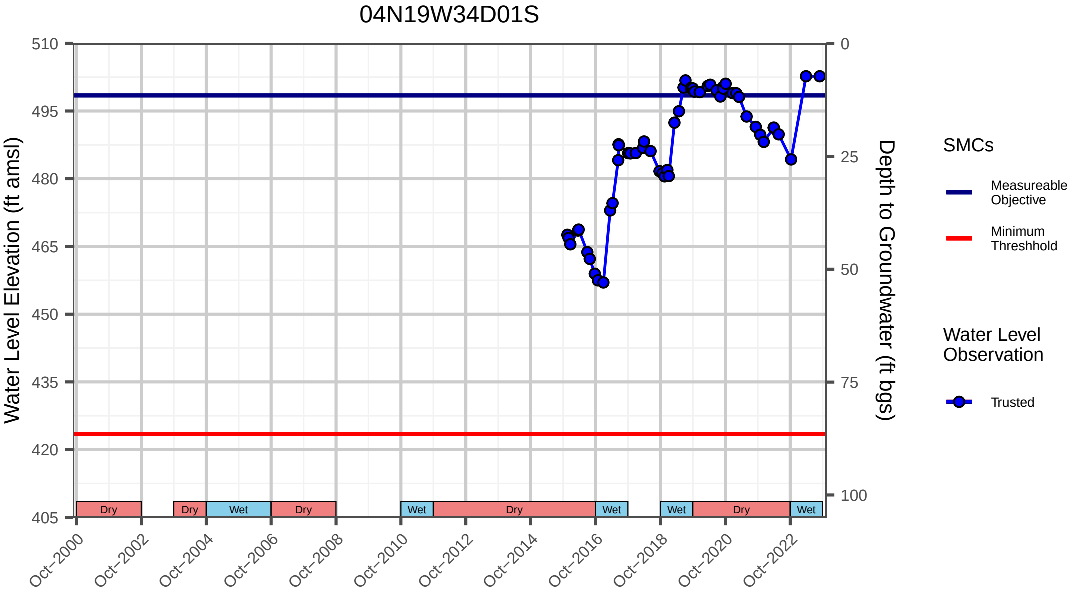


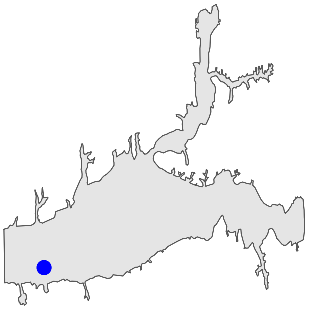

04N20W36MW104
Water Level Elevation (ft amsl)
405
390
375
360
345
330
Depth to Groundwater (ft bgs)
20
40
60
80
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted




04N19W36D01S
Water Level Elevation (ft amsl)
570
555
540
525
510
495
480
465
450
Depth to Groundwater (ft bgs)
0
30
60
90
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted




04N19W34D01S
Water Level Elevation (ft amsl)
510
495
480
465
450
435
420
405
Depth to Groundwater (ft bgs)
0
25
50
75
100
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct-2000
Oct-2002
Oct-2004
Oct-2006
Oct-2008
Oct-2010
Oct-2012
Oct-2014
Oct-2016
Oct-2018
Oct-2020
Oct-2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted



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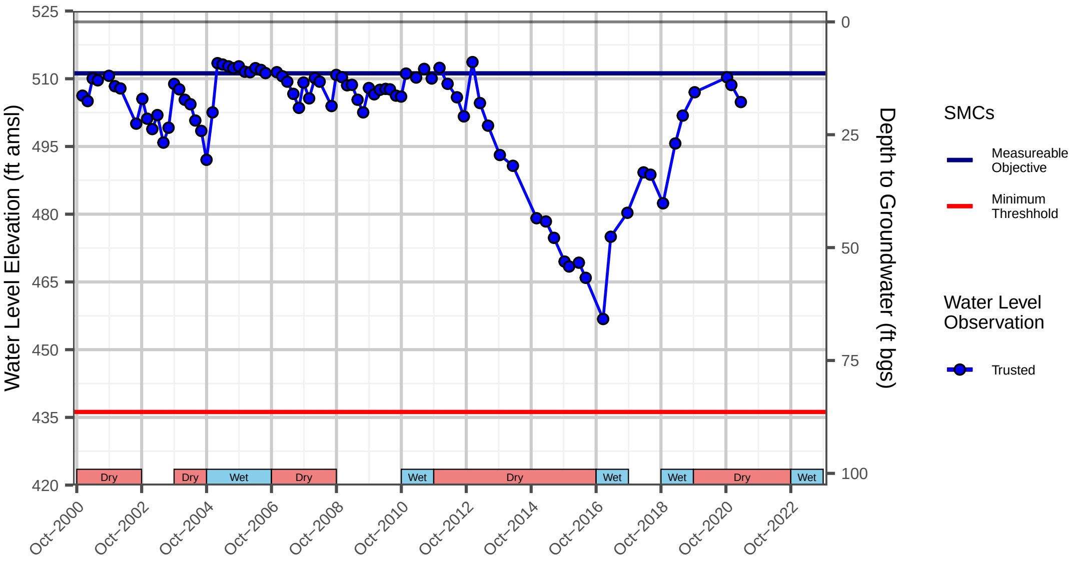

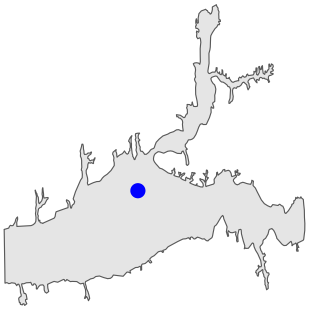

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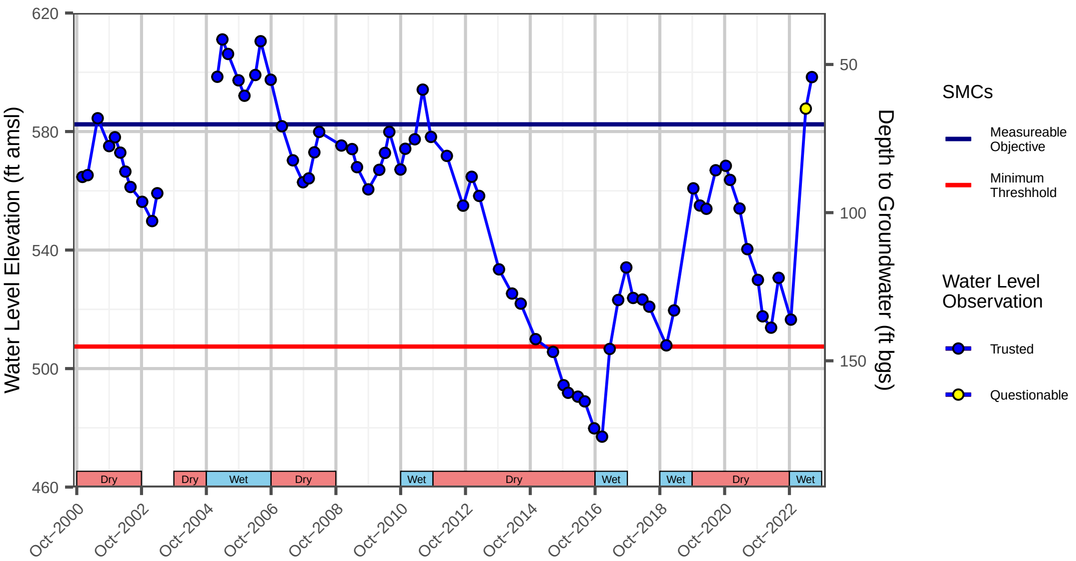

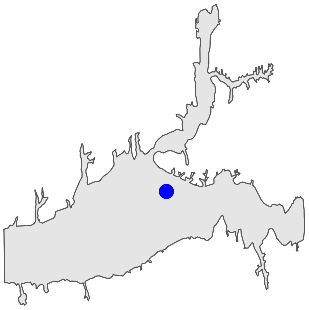

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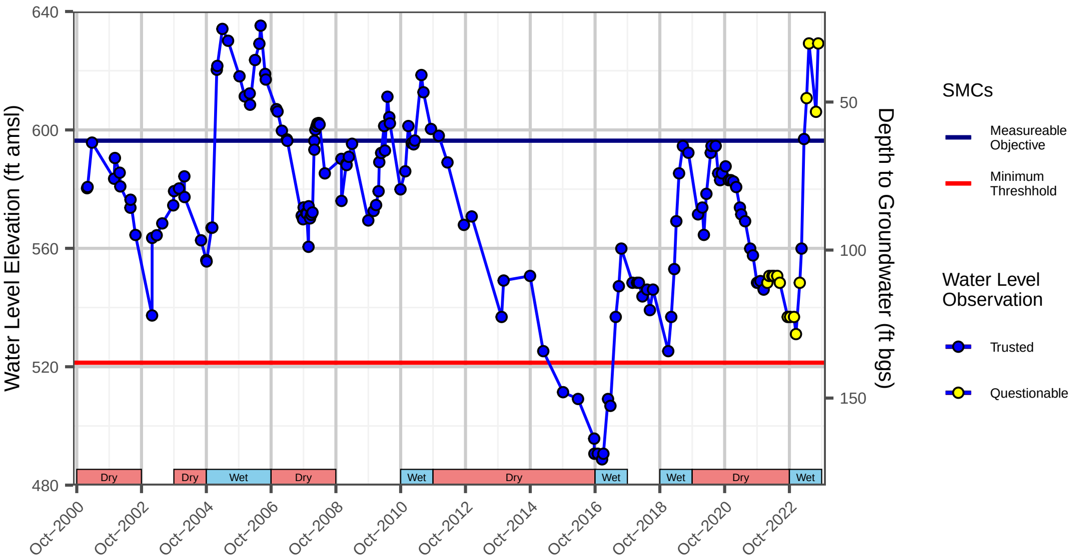

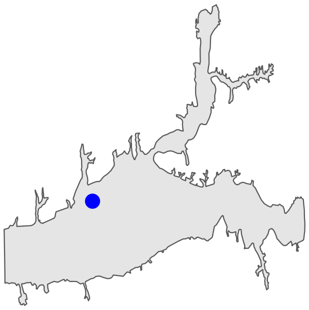

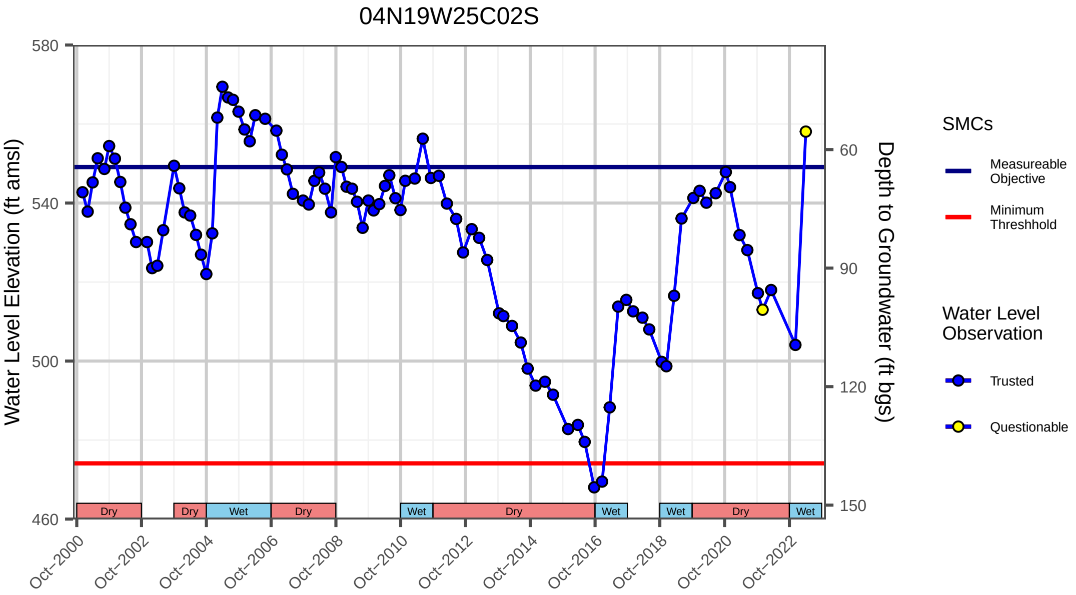

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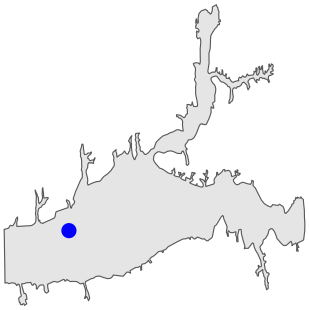

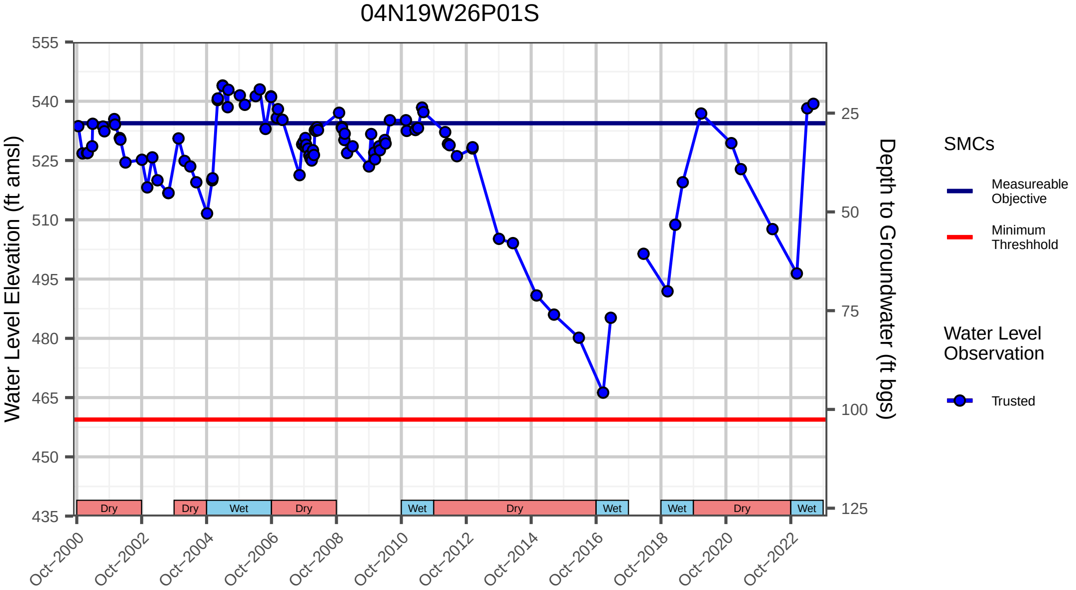

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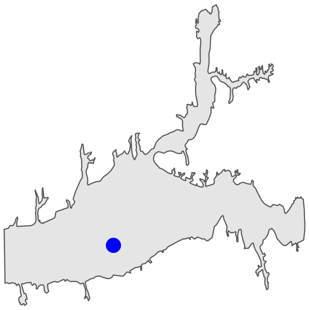

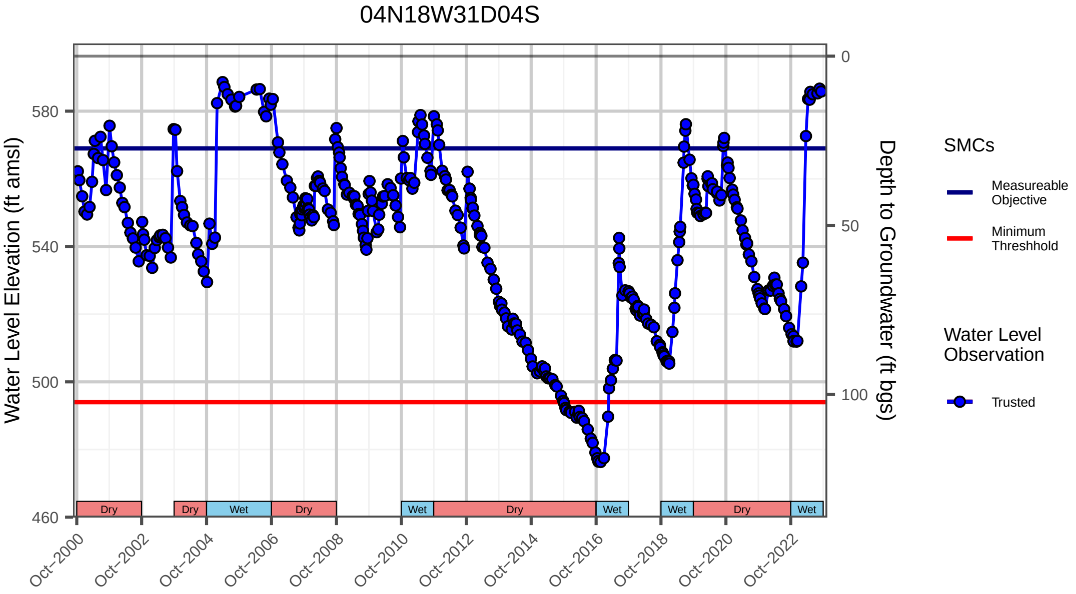

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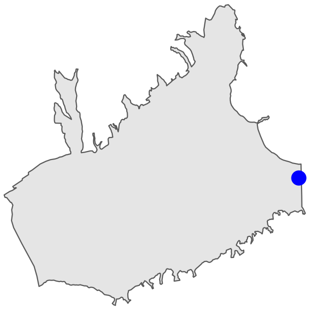
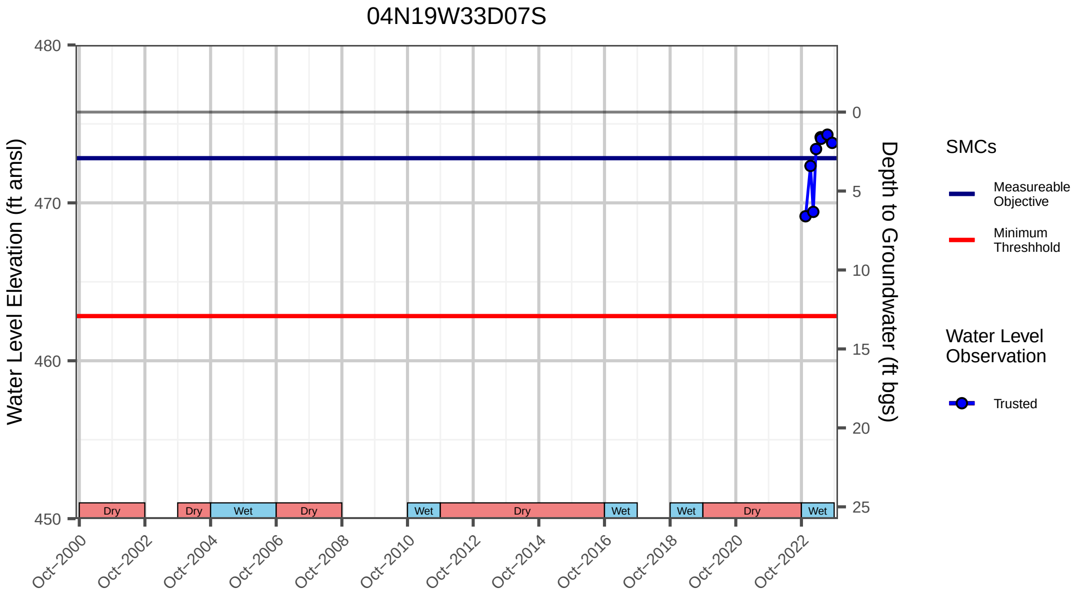
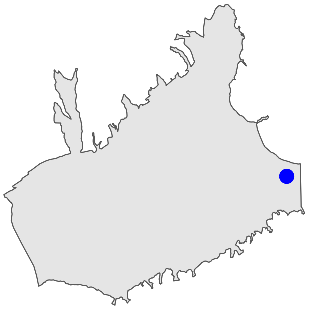
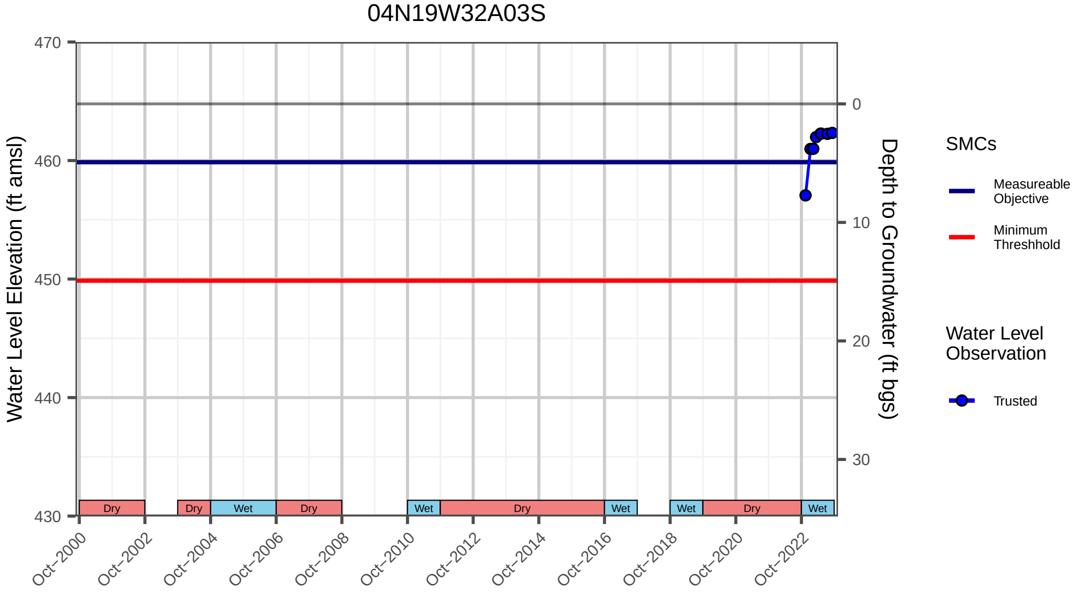
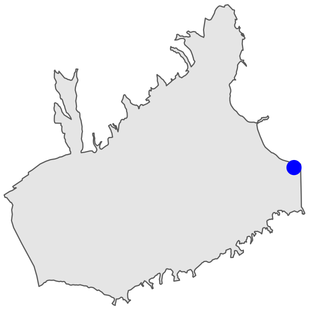
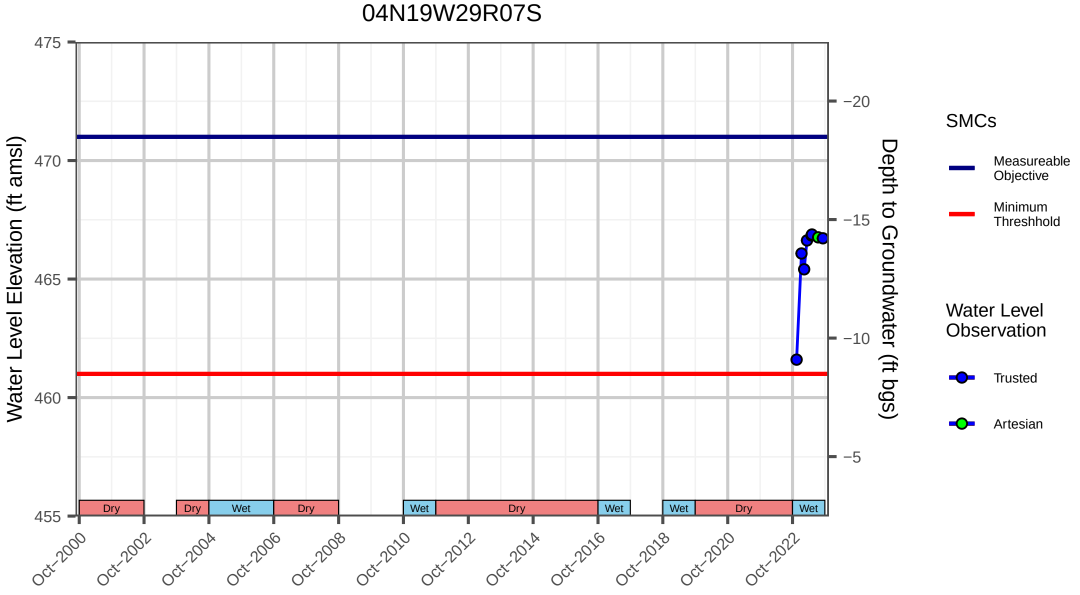



04N19W33D07S
Water Level Elevation (ft amsl)
480
470
460
450
Depth to Groundwater (ft bgs)
0
5
10
15
20
25
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct−2000
Oct−2002
Oct−2004
Oct−2006
Oct−2008
Oct−2010
Oct−2012
Oct−2014
Oct−2016
Oct−2018
Oct−2020
Oct−2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted




04N19W32A03S
Water Level Elevation (ft amsl)
470
460
450
440
430
Depth to Groundwater (ft bgs)
0
10
20
30
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct−2000
Oct−2002
Oct−2004
Oct−2006
Oct−2008
Oct−2010
Oct−2012
Oct−2014
Oct−2016
Oct−2018
Oct−2020
Oct−2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted




04N19W29R07S
Water Level Elevation (ft amsl)
475
470
465
460
455
Depth to Groundwater (ft bgs)
−20
−15
−10
−5
Dry
Dry
Wet
Dry
Wet
Dry
Wet
Wet
Dry
Wet
Oct−2000
Oct−2002
Oct−2004
Oct−2006
Oct−2008
Oct−2010
Oct−2012
Oct−2014
Oct−2016
Oct−2018
Oct−2020
Oct−2022
SMCs
Measureable Objective
Minimum Threshhold
Water Level Observation
Trusted
Artesian