Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report: Covering Water Year 2021

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Fox Canyon Groundwater Management Agency

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Executive Summary

The Fox Canyon Groundwater Management Agency (FCGMA), the Groundwater Sustainability Agency (GSA) for the portions of the Oxnard Subbasin (Subbasin) within its jurisdictional boundaries, in coordination with the other two GSAs in the Subbasin, has prepared this third annual report for the Oxnard Subbasin Groundwater Sustainability Plan (GSP) in compliance with the 2014 Sustainable Groundwater Management Act (SGMA) (California Water Code, Section 10720 et seq.). This annual report covers the entire Subbasin. The GSP for the Oxnard Subbasin was submitted to the Department of Water Resources (DWR) on January 13, 2020 and approved by DWR on November 18, 2021. SGMA regulations require that an annual report be submitted to the Department of Water Resources (DWR) by April 1 of each year following the adoption of the GSP. This annual report provides an update on the groundwater conditions for water year 2021 (October 1, 2020 through September 30, 2021).

Water year 2021 was a critical water year, in which precipitation was approximately 20% of the historical average precipitation within the Subbasin. Despite the critically low precipitation received in the 2021 water year, groundwater elevations measured in spring 2021 were higher than spring 2015 groundwater elevations in the majority of the representative monitoring points, or key wells, in the Oxnard, Mugu, Hueneme, Fox Canyon, and Grimes Canyon aquifers. The largest recoveries measured in the Subbasin between spring 2015 and spring 2021 were recorded in the Oxnard Pumping Depression Management Area, near the boundary with the Pleasant Valley Basin, where groundwater elevations were approximately 30 feet higher. Spring 2021 groundwater elevations were higher than Spring 2020 groundwater elevations in 15 of the 28 representative monitoring points measured in the Subbasin.

In the Upper Aquifer System (UAS), groundwater elevations in the spring of 2021 were higher than spring 2020 groundwater elevations at six representative monitoring points, and lower than spring 2020 groundwater elevations at five representative monitoring points. Overall, there was a net increase in groundwater storage within the UAS of approximately 6,600 AF between spring 2020 and spring 2021. In the Lower Aquifer System (LAS), Spring 2021 groundwater elevations were higher in 10 of the 18 representative monitoring points. Groundwater in storage in the LAS increased by approximately 50 AF between spring 2020 and 2021.

Data gaps identified in the GSP remain in this annual report. Some of the critical data gaps include the timing and number of groundwater elevation measurements available for preparing spring and fall contour maps, and the availability of data on surface water diversions from agencies reporting to FCGMA. Spatial data gaps are being filled with groundwater elevation measurements collected from newly installed nested groundwater monitoring wells located adjacent to Revolon Slough, within the Oxnard Pumping Depression Management Area. The first data from these wells was collected during the 2021 water year. The data gaps identified in the GSP will continue to be addressed as implementation of the GSP progresses.

FCGMA has undertaken several steps toward implementing the GSP, with implementation planning occurring concurrently with the GSP development process and throughout the past year. The extraction allocation ordinance adopted by the FCGMA Board of Directors in 2020 is being implemented. This ordinance transitions to water year reporting and provides the regulatory framework to manage extraction consistent with the sustainable yield of the Subbasin. Additionally, FCGMA successfully conducted ongoing stakeholder engagement and meetings that resulted in the development of a recommended suite of projects that were modeled and evaluated as part of an overall basin optimization and seawater intrusion mitigation strategy for ongoing basin management. Additional projects were also identified during this process and FCGMA solicited project details from stakeholders to create an updated list of feasible projects for the Subbasin. The FCGMA Board of Directors continues to prioritize stakeholder feedback in the implementation phase of the GSP because of the vital role stakeholders play in ensuring the long-term sustainable use of groundwater resources in the Oxnard Subbasin.

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1 Background and Plan Area

1.1 Background

FCGMA, the GSA for the portions of the Subbasin within its jurisdictional boundaries, in coordination with the other two GSAs in the Subbasin, has prepared this annual report for the Oxnard Subbasin GSP in compliance with SGMA (California Water Code, Section 10720 et seq.). SGMA requires that an annual report be submitted to DWR by April 1 of each year following the adoption of the GSP. FCGMA adopted a GSP for the Oxnard Subbasin in December 2019 and submitted the GSP to DWR on January 13, 2020 (DWR 2020) for the entire Subbasin. DWR approved the GSP on November 18, 2021. The 2022 annual report is the third annual report for the Subbasin since the GSP was submitted.

FCGMA is one of three Groundwater Sustainability Agencies (GSAs) in the Subbasin. The other two GSAs are the Camrosa Water District (CWD)–Oxnard GSA and the Oxnard Outlying Areas GSA (County of Ventura). This annual report applies to the entirety of the Subbasin, including those portions of the Subbasin that lie outside FCGMA's boundary. To coordinate management and reporting in the Subbasin, FCGMA and CWD have executed a Memorandum of Understanding, and FCGMA and the County have formed a Joint Powers Authority.

1.1.1 Fox Canyon Groundwater Management Agency

FCGMA is an independent special district formed by the California Legislature in 1982 to manage and protect the aquifers within its jurisdiction for the common benefit of the public and all agricultural, and M&I users (FCGMA et al. 2007). FCGMA's boundaries include all land overlying the Fox Canyon aquifer (FCA) and includes the majority of the Oxnard Subbasin (4-004.02) and the Las Posas Valley Basin (LPVB) (4-008), the Pleasant Valley Basin (PVB) (4-006), and a portion of the Arroyo Santa Rosa Valley Basin (ASRVB) (4-007).

FCGMA is governed by a Board of Directors (Board) with five members who represent: (1) the County of Ventura (County), (2) the United Water Conservation District (UWCD), (3) seven mutual water companies and water districts within the Agency[1], (4) five incorporated cities which are all or a portion of each is within the FCGMA jurisdictional area[2], and (5) a farmer representative. The Board members representing the County, UWCD, the mutual water companies and water districts, and the incorporated cities are appointed by their respective organizations or groups. The representative for the farmers is appointed by the other four seated Board members from a list of candidates jointly supplied by the Ventura County Farm Bureau and the Ventura County Agricultural Association. An alternate Board member is selected by each appointing agency or group in the same manner as the regular member and acts in place of the regular member in case of absence or inability to act. All members and alternates serve for a 2-year term of office, or until the member or alternate is no longer an eligible official of the member agency. Information regarding current FCGMA Board representatives can be found on the FCGMA website.

1 The seven mutual water companies and water districts are: Alta Mutual Water Company, Pleasant Valley County Water District (PVCWD), Berylwood Mutual Water Company, Calleguas Municipal Water District (CMWD), CWD, Zone Mutual Water Company, and Del Norte Mutual Water Company.

2 The five incorporated cities which are all or in part within the FCGMA jurisdictional area are: Ventura, Oxnard, Camarillo, Port Hueneme, and Moorpark.

1.1.2 Oxnard Subbasin Groundwater Sustainability Plan

The GSP for the Oxnard Subbasin defined the conditions under which the groundwater resources of the entire Oxnard Subbasin will be managed sustainably in the future (FCGMA 2019a), with periodic evaluation of GSP to assess changing conditions (California Water Code, Section 10728.2.). Groundwater conditions were evaluated in five primary aquifers in the Subbasin. These aquifers are commonly grouped into an upper and lower aquifer system. The Oxnard and Mugu aquifers compose the Upper Aquifer System (UAS), and the Hueneme, Fox Canyon, and Grimes Canyon aquifers compose the Lower Aquifer System (LAS). The primary sustainability goal for the Oxnard Subbasin, set forth in the GSP, is "to increase groundwater elevations inland of the Pacific coast in the aquifers that compose the Upper Aquifer System and the Lower Aquifer System to elevations that will prevent the long-term, or climatic cycle net (net), landward migration of the 2015 saline water impact front; prevent net seawater intrusion in the UAS; and prevent net seawater intrusion in the LAS." (FCGMA 2019a). This goal was established based on both historical and potential future undesirable results to the groundwater resources of the Subbasin from six sustainability indicators: chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletions of interconnected surface water.

The GSP established minimum threshold groundwater elevations, defined for the Oxnard Subbasin, as groundwater levels that: (1) limit seawater intrusion, and (2) allow declines in groundwater elevations during periods of future drought to be offset by recoveries during future periods of above-average rainfall (FCGMA 2019a). The GSP also established measurable objective groundwater elevations, which were defined as "the groundwater levels throughout the Subbasin at which there is neither seawater flow into, nor freshwater flow out of the UAS or LAS." (FCGMA 2019a). Minimum threshold and measurable objective groundwater elevations were established at 34 representative monitoring points (or "key wells") in the Oxnard Subbasin (Table 1). Collectively, these wells are screened in each of the five primary aquifers and are located in four of the five management areas established for the Subbasin (FCGMA 2019a).

The GSP documented conditions throughout the Oxnard Subbasin through the fall of 2015. The first and second annual reports evaluated progress toward sustainability based on a review of groundwater elevation data, groundwater extraction data, surface water supply used, or surface water supply available for use, total water used, and change in groundwater storage between the fall of 2015 and the end of water year 2020[3]. This annual report documents the conditions in the Oxnard Subbasin and the progress toward sustainability for water year 2021.

1.2 Plan Area

The Oxnard Subbasin of the Santa Clara River Valley Groundwater Basin (DWR Bulletin 118 Groundwater Basin 4-004.02) is a coastal alluvial groundwater subbasin, underlying the Oxnard Plain in Ventura County, California (Figure 1-1 Vicinity Map for the Oxnard Subbasin). The Oxnard Subbasin is in hydrologic communication, to varying degrees with, the LPVB and PVB to the east, the Mound and Santa Paula Groundwater Subbasins of the Santa Clara River Valley Basin to the north, and with the Pacific Ocean to the west and southwest (FCGMA 2019a). The contact between permeable alluvium and semi-permeable rocks of the Santa Monica Mountains defines the southeastern boundary of the Oxnard Subbasin, and the Oak Ridge and McGrath faults form the northern boundary of the Oxnard Subbasin (DWR 2018). A facies change between the predominantly coarser-grained sand

[3] A water year begins on October 1 and ends on September 30 of the following year. The convention for naming the water year is to name the water year based on the year in which it ends. For example, the 2021 water year begins on October 1, 2020, and ends on September 30, 2021.

and gravel deposits that compose the UAS to the west and the finer-grained clay and silt-rich deposits of the UAS to the east defines the boundary between the Oxnard Subbasin and PVB. The boundary between the Las Posas Valley Basin to the northeast and Oxnard Subbasin to the southwest is a jurisdictional boundary that follows parcel lines (DWR 2018).

The Oxnard Subbasin is divided into five management areas in anticipation of future management strategies and to reflect the current understanding of the hydrogeologic characteristics of the Subbasin (FCGMA 2019a). These management areas are the Forebay Management Area, the West Oxnard Plain Management Area, the Oxnard Pumping Depression Management Area, the Saline Intrusion Management Area, and the East Oxnard Plain Management Area (Figure 1-2). These management areas are separated by hydrogeologic and water quality characteristics (FCGMA 2019a).

1.2.1 Climate

The climate of the Oxnard Subbasin is typical of coastal Southern California, with average daily temperatures ranging generally from 50°F to 78°F in summer and from 40°F to 75°F in the winter (FCGMA 2019a). The majority of the precipitation in the Ventura County region falls between November and April. Precipitation is measured at several stations in the Oxnard Subbasin (Figure 1-2; Precipitation and Stream Gauges in the Oxnard Subbasin). Water year precipitation, measured at Station 168, in the northwestern portion of the Subbasin is highly variable, ranging from 2.8 inches in 2021 to 38.1 inches in 1998 (Figure 1-3; Oxnard Subbasin Historical Water Year Precipitation). On average, the Subbasin received approximately 13.9 inches of precipitation per water year between 1957 and 2021.

The GSP for the Oxnard Subbasin included precipitation through the 2015 water year (FCGMA 2019a). Since 2015, the Subbasin experienced two above normal[4] water years (2017 and 2019), one below normal water year (2020), and three critical water years (2016, 2018, and 2021). In water year 2021, the Subbasin received 2.8 inches of rainfall, which is approximately 20% of the long-term historical average and is the lowest water year precipitation recorded at this station since measurements began in 1957. Since 2015, average annual water year precipitation has been approximately 25% lower than the average annual water year precipitation measured between 1957 and 2015, indicating that the Subbasin has been experiencing drier than average conditions.

1.2.2 Surface Water Bodies and Gauging Stations

The Santa Clara River, Revolon Slough, and Calleguas Creek are the predominant surface water bodies in the Oxnard Subbasin (FCGMA 2019a). All three surface water bodies drain watersheds that extend beyond the boundaries of the Subbasin. Neither the Revolon Slough nor Calleguas Creek are in direct contact with the primary aquifers in the Subbasin. These surface water bodies are separated from the underlying groundwater aquifers by extensive clay layers. In contrast, flow in the Santa Clara River, which generally parallels the northern boundary of the Subbasin, infiltrates into sediments overlying the Forebay Management Area (Figure 1-2) and is a critical source of recharge to the primary groundwater aquifers in the Subbasin. In addition to recharge provided by flow in the river channel, UWCD, under permit, diverts surface water from the Santa Clara River at the Freeman Diversion and

4 Water years have been classified into five types based on their relationship to the mean water year precipitation. The five types are: critical, dry, below normal, above normal, and wet. Critical water years are < 50% of the mean annual precipitation. Dry water years are ≥ 50% and <75% of the mean annual precipitation. Below normal water years are ≥ 75% and <100% of the mean annual precipitation. Above normal water years are ≥ 100% and <150% of the mean annual precipitation. Wet water years are ≥ 150% of the mean annual precipitation.

discharges the diverted Santa Clara River flows to infiltration basins overlying the Forebay Management Area (Figure 1-2). West of the Forebay Management Area, the Santa Clara River channel overlies a confining clay layer and does not communicate directly with the confined aquifers of the UAS and the LAS.

Streamflow on the Santa Clara River has been measured at gauge 723, maintained by the Ventura County Public Works Agency -Watershed Protection District (VCWPD), between water years 2010 and 2017 (Table 1-1; Figure 1-4). VCWPD notes that this gauge is still active, however, average daily flows for water years 2018 through 2021 were not available during preparation of the water year 2022 Annual Report. In addition, flow on the Revolon Slough has been measured at VCWPD gauge 776 (Table 1-1; Figure 1-4). Average daily flows measured at gauge 776 for water year 2021 were not available during preparation of the 2022 Annual Report.

Table 1-1. Cumulative Daily Average Flows at VCWPD Gauges 723 and 776 in the Oxnard Subbasin

Water Year	Average Flow (cfs) at Gauge 723	Average Flow (cfs) at Gauge 776
2010	102.5	12.6
2011	167.5	19.3
2012	13.0	10.1
2013	0.6	11.2
2014	40.3	6.1
2015	5.0	7.0
2016	97.5	5.5
2017	1,049.5	5.7
2018	-Data Not Available-	12.2
2019	-Data Not Available-	9.0
2020	-Data Not Available-	11.9
2021	-Data Not Available-	-Data Not Available-

Notes: cfs = cubic feet per second

1.3 Annual Report Organization

This is the third Annual Report prepared since the GSP for the Oxnard Subbasin was submitted to DWR. This report is organized according to the GSP Emergency Regulations. Chapter 1 provides the background information regarding the GSP, the Oxnard Subbasin, and the Fox Canyon Groundwater Management Agency. Chapter 2 provides information on the groundwater conditions in the Subbasin since 2015, including groundwater elevations, groundwater extractions, surface water supply, total water availability, and change in groundwater storage. Chapter 3 provides an update on the GSP implementation process.

2 Groundwater Conditions

This chapter presents the change in groundwater conditions in the Subbasin from water year 2020. Comparison of water year 2021 conditions to water year 2020 conditions characterizes the impact that water year type, groundwater production, surface and recycled water availability, and surface water spreading in water year 2021 have had on groundwater conditions in the Subbasin. Additionally, data from water years 2016 through 2019 are provided as context. These data were discussed in detail in the first and second annual reports (FCGMA 2020a and FCGMA 2021).

2.1 Groundwater Elevations

2.1.1 Groundwater Elevation Contour Maps

Groundwater elevation contour maps for each aquifer in the Oxnard Subbasin are presented in Figures 2-1 through 2-10: the Oxnard aquifer in Figures 2-1 and 2-2, the Mugu aquifer in Figures 2-3 through 2-4, the Hueneme aquifer in Figures 2-5 through 2-6, the Fox Canyon aquifer in Figures 2-7 through 2-8, and the Grimes Canyon aquifer in Figures 2-9 through 2-10. These maps show the seasonal low (fall 2020) and high (spring 2021) groundwater elevations. Spring groundwater elevations were defined as any groundwater elevation measured within a four-week window between March 2 to March 29 of 2021. This four-week window is approximately the same measurement window used to generate spring groundwater elevation contours for the 2020 Annual Report covering water years 2016 through 2019. Fall groundwater elevations were defined as any groundwater elevation measured between October 2 and October 31 of each year. This four-week window is approximately the same measurement window used to generate fall groundwater elevation contours in the 2020 Annual Report covering water years 2016 through 2020. The 2021 Annual Report covering water year 2020 utilized a six-week measurement window to ensure similar spatial coverage of groundwater elevation measurements for comparison of groundwater contours, and corresponding changes in groundwater in storage, between water years 2016, 2017, 2018, 2019, and 2020. The GSP recommended collecting groundwater elevations within a two-week window in the future (FCGMA 2019a). FCGMA is in the process of prioritizing recommendations made in the GSP and evaluating the timeframe and feasibility of implementing these recommendations.

The groundwater elevation contour maps are based on the groundwater elevations measured at wells screened solely within an individual aquifer. The intent of using groundwater elevations from wells screened within a single aquifer is to accurately represent groundwater flow directions within an aquifer, as well as vertical gradients between aquifers. It is important to note, however, that throughout the Oxnard Subbasin, production wells are typically screened across multiple aquifers. Therefore, using wells only screened within an individual aquifer limits the spatial coverage for each contour map. This limitation is particularly apparent in an area of high groundwater production in the Oxnard Subbasin and adjoining PVB that extends south from Highway 101 (FCGMA 2019a). This area was identified as being impacted by groundwater production based on groundwater elevations measured in wells screened in multiple aquifers and was identified in the GSP as the Oxnard Pumping Depression Management Area (FCGMA 2019a). By using wells screened only within an individual aquifer, the lateral extent of the pumping depression is not well characterized.

In 2019, DWR installed a nested monitoring well cluster through its Technical Support Services (TSS) program. The nested well cluster, which has two separate completions, is located adjacent to the Revolon Slough within the Pumping Depression Management Area. The shallow well cluster, which was completed on November 22, 2019, contains three monitoring wells individually screened in the Oxnard, Mugu, and Hueneme aquifers. The deep well cluster, which was completed on March 19, 2020, contains three monitoring wells individually screened within the Fox Canyon-Upper, Fox Canyon-Basal, and Grimes Canyon aquifers. Groundwater elevations measured at the shallow and deep well clusters were used to help constrain groundwater conditions in the Oxnard Pumping Depression Management Area in the 2021 water year.

2.1.1.1 Oxnard Aquifer

Seasonal low groundwater elevations in the Forebay Management Area of the Oxnard aquifer ranged from approximately -10 feet (ft.) mean sea level (msl) to approximately 57 ft. msl (measured at wells 02N22W16R02S and 02N21W12A01S, respectively; Figure 2-1) and were approximately 5 to 10 feet higher than fall 2019. Downgradient of the Forebay Management Area, and within the Oxnard Pumping Depression Management Area, fall 2020 groundwater elevations ranged from approximately -20 ft. msl to approximately -1 ft. msl (measured at wells 01N21W19C01S and 01N21W16P07S, respectively; Figure 2-1). In this part of the Subbasin, groundwater elevations were approximately 5 to 12 feet higher than fall 2019 (measured at wells 01N22W03F08S and 01N21W07H01S, respectively).

Along the coast, fall 2020 groundwater elevations ranged from a low of approximately -27 ft. msl to a high of approximately 1 ft msl (measured at wells 02N23W36C04S and 01N23W01C05S, respectively; Figure 2-1) and were 1 to 2 feet higher than fall 2019 conditions. South of these wells, and within the Saline Intrusion Management Area, groundwater elevations ranged from approximately -22 ft. msl to approximately -8 ft. msl (measured at wells 01N22W26J04S and 01S2108L04S; Figure 2-1). Fall 2020 groundwater elevations in the Saline Intrusion Management Area were 4 to 5 feet higher than fall 2019 conditions.

Fall 2020 groundwater elevations (Figure 2-1) were higher than fall 2015 elevations across the Subbasin in the Oxnard aquifer. In the Forebay Management Area, fall 2020 groundwater elevations were approximately 5 to 30 feet higher than fall 2015 conditions. Along the coast and in the central portion of the Subbasin, groundwater elevations were approximately 2 to 10 feet higher than fall 2015 conditions.

Spring 2021 groundwater elevations in the Forebay Management Area of the Oxnard aquifer ranged from approximately -7 ft. msl to approximately 44 ft. msl (measured at wells 02N22W16R02S and 02N21W12A02S, respectively; Figure 2-2) and were approximately 7 to 25 feet lower than spring 2020 conditions. Downgradient of the Forebay Management Area, within the West Oxnard Plain Management Area, spring 2021 groundwater elevations ranged from approximately -26. ft msl to approximately 1 ft. msl (measured at wells 02N23W36C04S and 01N23W01C05S, respectively; Figure 2-2). In the Oxnard Pumping Depression Management Area, seasonal high groundwater elevations ranged from approximately -14 ft. msl to approximately 2 ft. msl (measured at wells 01N21W19C01S and 01N21W16P07S, respectively; Figure 2-2). Groundwater elevation changes from spring 2019 in the Oxnard Pumping Depression Management Area ranged from declines of approximately 2 feet (measured at well 01N21W07H01S) to rebounds of approximately 0.5 feet (measured at well 01N21W06L04S).

Along the coast, and within the Saline Intrusion Management Area, spring 2021 groundwater elevations ranged from approximately -13 ft. msl to approximately -5 ft. msl (measured at wells 01N22W31A08S and 01N22W20J08S, respectively; Figure 2-2). Spring groundwater elevations changes from 2020 in this part of the Subbasin ranged from declines of approximately 0.5 feet (measured at well 01N22W28G04) to recoveries of approximately 1.5 feet (measured at well 01N22W27R04S). Since 2015, spring groundwater elevations in this region have increased by approximately 0.5 feet (measured at well 01S21W08L04S) to 5 feet (measured at well 01N21W31A09S).

2.1.1.2 Mugu Aquifer

Seasonal low groundwater elevations increased across the majority of the Mugu aquifer between fall 2019 and fall 2020. Along the coast, near Port Hueneme, fall 2020 groundwater elevations were approximately 5 to 10 feet higher than 2019 conditions and ranged from approximately -10 ft. msl to -8. ft msl (measured at wells 01N22W29D04S and 01N22W20J07S, respectively; Figure 2-3). Groundwater elevation recoveries during this period were largest in the southwestern part of the Subbasin, near Point Mugu. In this part of the Subbasin, groundwater elevations rose up to 25 feet (measured at 01N21W32Q05S) and ranged from -71 ft. msl to -19 ft. msl (measured at wells 01N21W32Q05S and 01N22W35E04S, respectively; Figure 2-3). Fall 2020 groundwater elevations were approximately 5 to 25 feet higher than those measured in fall 2015.

The only groundwater elevation decline measured in the Mugu between fall 2019 and 2020 was in the far northern section of the Forebay Management Area. In this part of the Subbasin, the groundwater elevation measured at well 02N21W07L06S declined by approximately 9 feet. Downgradient of this well, and within the Forebay Management Area, groundwater elevations in fall 2020 were 3 to 10 feet higher than those measured in fall 2019.

Groundwater elevation changes varied across the Mugu aquifer between spring 2020 and spring 2021. During this period, groundwater elevations near Port Hueneme declined by approximately 0.5 to 2.0 ft and ranged from approximately -5 to -7 ft. msl (measured at wells 01N22W29D04S and 01N22W20J07S, respectively; Figure 2-2). Similar declines occurred near Point Mugu, where groundwater elevations ranged from -61 ft. msl to -3 ft. msl (measured at wells 01N21W32Q07S and 01N22W35E04S, respectively; Figure 2-4). In the Forebay Management Area, groundwater elevations declined by approximately 5 to 30 feet (measured at wells 02N22W14G04S and 02N21W07L05S, respectively). Groundwater elevations in the Forebay, which ranged from approximately 13 to -8 ft. msl, are 5 to 13 feet higher than spring 2015, reflecting UWCD's spreading operations during water years 2019, 2020, and 2021 (see Section 2.3).

2.1.1.3 Hueneme Aquifer

In fall 2020, the seasonal low groundwater elevation measured at well 02N22W12N03S, which is located in the Forebay Management Area, of 16 ft. msl was approximately 60 feet lower than the corresponding measurement collected in fall 2019. Downgradient of this well, and within the Forebay Management Area, groundwater elevations increased by approximately 1 to 15 feet from fall 2019 conditions. Adjacent to the coast, groundwater elevations were approximately 6 to 9 feet higher than fall 2019 and ranged from approximately -23 ft. msl to -15 ft. msl (measured at wells 01N22W29D02S and 01N22WM03S, respectively; Figure 2-5). Near the boundary with PVB, at well 02N21W31P03S, groundwater was measured at an elevation of -68 ft. msl (Figure 2-5), which is approximately 6 feet lower than fall 2019.

Fall 2020 groundwater elevations were consistently higher than those measured in fall 2015. Fall groundwater elevation recoveries during this period were largest in the central part of the Subbasin, near PVB, where groundwater elevations rose by approximately 10 to 50 feet (measured at wells 02N21W31P06S and 02N21W31P03S, respectively).

Spring 2021 groundwater elevations in the Forebay Management Area of the Hueneme aquifer ranged from approximately -58 ft. msl to approximately 18 ft. msl (Figure 2-6). The groundwater elevation low in the Forebay of -58 ft. msl (measured at well 02N22W23B04S; Figure 2-6) is approximately 5 feet higher than the corresponding low measured in spring 2020. This 5-foot recovery was the largest rebound measured between spring 2020 and spring 2021 in the Forebay Management Area. Adjacent to the coast, groundwater elevations ranged from -21 to -11 ft. msl (measured at wells 02N22W29D03S and 02N22W29D02S, respectively; Figure 2-6), which is approximately 1 to 3 feet higher than spring 2020. Southwest of Port Hueneme and inland from the coast, groundwater elevations declined by up to 10 feet between spring 2020 and spring 2021 (e.g. well 01N22W26M03S). Near the boundary with PVB, groundwater elevations declined by approximately 5 feet (e.g. well 01N21W31P06S).

Spring 2021 groundwater elevations measured in the Hueneme aquifer were consistently higher than those measured in spring 2015. In the Forebay Management Area, groundwater elevations were approximately 8 to 22 feet higher than fall spring 2015. Similarly, in the central portion of the Subbasin, near the boundary with PVB, groundwater elevations were approximately 27 feet higher in spring 2021 than spring 2015. Along the coast, groundwater elevations were measured approximately 1 to 4 feet higher than spring 2015 conditions.

2.1.1.4 Fox Canyon Aquifer

Seasonal low groundwater elevations in the Fox Canyon aquifer increased across the Subbasin between fall 2019 and fall 2020. In the Forebay management area, the groundwater elevation low of -62.6 ft. msl measured at well 02N22W23B03S was approximately 18 feet higher than fall 2019 conditions. During this same period, groundwater elevations in the Saline Intrusion Management Area increased by approximately 5 to 34 feet (measured at wells 01N22W19D01S and 01N21W31A05S, respectively), and ranged from a low of approximately -80 ft. msl to a high of approximately -25 ft. msl (measured at wells 01N22W36K05S and 01N22W20M01S, respectively; Figure 2-7). In the Oxnard Pumping Depression Management Area, groundwater elevations in fall 2020 were approximately 20 to 50 feet higher than fall 2019 (measured at wells 01N21W19L10S and 02N21W32E01S, respectively), and ranged from approximately -110 ft. msl to -75. ft msl (measured at wells 01N21W06J05S and 01N21W19L10S, respectively; Figure 2-7). The groundwater elevation recoveries between fall 2020 and fall 2019 are similar to those calculated when comparing fall 2020 to fall 2015.

Spring 2021 groundwater elevations in the Forebay Management Area of the Fox Canyon aquifer ranged from approximately -57 ft. msl (measured at well 02N22W23B08S) to approximately -4 ft. msl (measured at well 02N22W07L04S; Figure 2-8). The groundwater elevation low within the Forebay Management Area, measured at well 02N22W23B08S, was approximately 6 feet higher than spring 2020 measurement and 20 feet higher than spring 2015. In the northern region of the Forebay Management Area, and adjacent to the West Las Posas Management Area of the Las Posas Valley Basin, groundwater elevations declined by approximately 10 to 12 feet compared to spring 2020 conditions (Figure 2-8). In this same area, spring 2021 groundwater elevations were approximately 10 to 45 feet lower than spring 2015 conditions.

Spring 2021 groundwater elevation changes varied geographically within the Saline Intrusion Management Area. Near Port Hueneme, spring 2021 groundwater elevations in this part of the Subbasin ranged from approximately -31 ft. msl to -15 ft. msl (measured at wells 01N22W28G02S and 01N22W19D01S, respectively; Figure 2-8). These groundwater elevations are approximately 3 to 5 feet higher than spring 2020 and 2015 conditions. Farther south, near Point Mugu, groundwater elevations declined by approximately 1 to 9 feet compared to spring 2020 conditions. These declines corresponded to groundwater elevations that ranged from approximately -69 ft. msl to -39 ft. msl (measured at wells 01N21W31A05S and 01S22W01H02S, respectively; Figure 2-8). The groundwater elevation declines in this area were greatest at well 01N21W31A05S, which is located near the Oxnard Pumping Depression Management Area (Figure 2-8). Groundwater elevations in this part of the Subbasin ranged from approximately 4 feet lower to approximately 5 feet higher than spring 2015 conditions.

Spring 2021 groundwater elevations in the Oxnard Pumping Depression Management Area ranged from approximately -58 ft. msl to -75 ft. msl (measured at wells 01N21W19L10S and 01N21W16P09S, respectively; Figure 2-8). Groundwater elevation changes within the Oxnard Pumping Depression Management Area varied geographically. Between spring 2020 and spring 2021, groundwater elevations at well 01N21W19L10S declined by approximately 8 feet (Figure 2-8). Farther north, near the boundary with PVB, groundwater elevations increased by 1 to 2 feet. The largest groundwater elevation recovery between spring 2020 and spring 2021 occurred at well 01N21W09C04S, which is located adjacent to PVB (Figure 2-8). Groundwater elevations measured in the Oxnard Pumping Depression were approximately 5 to 32 feet higher than spring 2015 conditions.

2.1.1.5 Grimes Canyon Aquifer

There are seven wells screened solely in the Grimes Canyon aquifer in the Oxnard Subbasin. Six of these wells are located in the southwestern part of the subbasin, within the Saline Intrusion Management Area (Figure 2-9 and 2-10). In March 2020, DWR installed a nested monitoring well cluster through its TSS Program. The construction of this well cluster provides additional characterization of groundwater elevations in the Grimes Canyon aquifer north of the Saline Intrusion Management Area, within the Oxnard Pumping Depression Management Area (Figure 2-9 and 2-10).

Fall 2020 groundwater elevations in the Grimes Canyon aquifer ranged from approximately -88 ft. msl to approximately -30 ft. msl (measured at wells 01N21W16P08S and 01N22W28G01S, respectively; Figure 2-9). The groundwater elevation measured at well 01N21W16P08S indicates that groundwater elevations in the Grimes Canyon aquifer generally decline from Port Hueneme south and southeast towards Point Mugu and into the Oxnard Pumping Depression Management Area. The fall 2020 groundwater elevations were approximately 7 to 25 feet higher than 2019.

Spring 2021 groundwater elevations in the Grimes Canyon aquifer ranged from approximately -75 ft. msl to -30 ft. msl (measured at wells 01N21W16P08S and 01N22W28G01S, respectively; Figure 2-10). Groundwater elevation changes in the Grimes Canyon aquifer varied between spring 2020 and spring 2021. During this period, the groundwater elevation measured at well 01N2132WQ03S increased by approximately 12 feet. West of this well, the groundwater elevation measured at well 01N22W36K05S declined by approximately 5 feet. Spring 2020 groundwater elevations were up to 15 feet higher than spring 2015 conditions.

The spring 2021 groundwater elevation measured at this well, 01N21W16P08S, was approximately 10 feet lower than the deepest groundwater elevation measured within the Saline Intrusion Management Area.

2.1.2 Groundwater Elevation Hydrographs

Groundwater elevation hydrographs for each of the key wells identified in the GSP are presented in Figures 2-11 through 2-15. These key wells are the designated representative monitoring sites for the Subbasin (FCGMA 2019a). The fall 2020 and spring 2021 water levels measured at each of these representative monitoring sites are presented in Table 2-1, which also provides a comparison to: (i) water year 2020 conditions, (ii) the established minimum threshold groundwater elevations, (iii) the established measurable objective groundwater elevations, and (iv) the interim milestones for dry climate conditions. The dry climate interim milestone is used for comparison in this annual report because the precipitation measured in the Subbasin between water years 2016 and 2021 is below average. However, it should also be noted that the first interim milestone is set for 2025, and the groundwater elevations in the representative wells have three years to reach this first interim milestone.

Oxnard Aquifer

In the fall of 2020, the groundwater elevations in the representative monitoring points screened in the Oxnard aquifer were approximately 6 to 25 feet below the minimum thresholds and 1 to 8 feet below the interim milestones described in the GSP for dry climate conditions (Table 2-1; Figure 2-11; FCGMA, 2019a). In the spring of 2021, groundwater elevations in the representative wells screened in the Oxnard aquifer were approximately 6 to 14 feet below the minimum threshold for each well (Table 2-1; Figure 2-11). During this period, groundwater elevations measured at wells 01N21W32Q06S, 01N22W26J04S, and 01N22W27C03S were higher than the 2025 interim milestones described in the GSP for dry climate conditions (Table 2-1; FCGMA 2019a).

Fall groundwater elevations at all wells except 01N22W26J04S increased by approximately 2 to 5 feet compared to Fall 2019 conditions. At well 01N22W26J04S, the Fall 2020 groundwater elevation was approximately 0.4 feet lower than that measured in Fall 2019. Similarly, Spring 2021 groundwater elevations measured in the Oxnard aquifer were approximately 1 to 2.5 feet higher than those measured in Spring 2020 at all but one key well. In Spring 2021, the groundwater elevation measured at 01N21W32Q06S was approximately 0.4 feet lower than that measured in Spring 2020.

Mugu Aquifer

In Fall 2020, groundwater elevations were 17 to 73 feet below the minimum threshold groundwater elevations in all representative monitoring wells screened in the Mugu aquifer (Table 2-1; Figure 2-12). In spring 2021 groundwater elevations ranged from approximately 14 to 63 feet below the minimum threshold groundwater elevations (Table 2-1; Figure 2-12).

Groundwater elevations were above the 2025 interim milestones in the Mugu aquifer in fall 2020 at wells 02N21W07L06S and 02N22W23B07S, which are both located in the Forebay Management Area (Table 2-1). Groundwater elevations measured at wells 01N21W32Q05S, 01N21W32Q07S, 01N22W20J07S, and 01N22W27C02S were below the 2025 interim milestone groundwater elevations in fall 2020 but were higher than the 2025 interim milestone groundwater elevations in spring 2021 (Table 2-1). These four wells are located near the coast, within the saline intrusion management area (Figures 2-3 and 2-4). Groundwater elevations in wells 01N21W32Q05S and 01N21W32Q07S declined by approximately 4 and 2 feet, respectively, from spring 2020 to spring 2021.

Hueneme Aquifer

In the Hueneme aquifer, fall 2020 groundwater elevations measured at the representative monitoring sites were approximately 21 to 65 feet below the established minimum threshold groundwater elevations (Table 2-1; Figure 2-13). Groundwater elevations were 18 to 55 feet below the established minimum thresholds in spring 2021. Groundwater elevations remained below the 2025 interim milestones in all representative monitoring sites screened in the Hueneme aquifer except wells 02N22W23B05S and 02N22W23B06S in both fall and spring, and 01N23W01C04S and 02N22W23B04S in Spring 2021. The fall 2020 groundwater elevations at 02N22W23B05S and 02N22W23B06S, located in the Forebay Management Area, were approximately 9 feet higher than the 2025 interim milestones (Table 2-1; Figure 2-13).

Fox Canyon Aquifer

In the fall of 2020, groundwater elevations in the representative monitoring points screened in the Fox Canyon aquifer (FCA) were approximately 25 to 60 feet lower than the minimum threshold groundwater elevations (Table 2-1; Figure 2-14). In spring 2021, groundwater elevations in the representative monitoring points screened in the FCA were approximately 21 to 54 feet lower than the minimum threshold groundwater elevations (Table 2-1; Figure 2-14).

Groundwater elevations along the coast increased by approximately 7 feet (e.g., 01N22W20J04S) to 26 feet (e.g., 01N21W32Q04S) between fall 2019 and fall 2020. Fall groundwater elevation changes in the Forebay Management Area varied between fall 2019 and fall 2020, increasing by approximately 17 feet at well 02N22W23B03S and decreasing by approximately 4 feet at well 02N21W07L04S (Table 2-1).

Groundwater elevation changes between spring 2020 and spring 2021 were less variable than the changes measured between fall 2019 and fall 2020. Between spring 2020 and spring 2021, groundwater elevations along the coast decreased by a maximum of approximately 10 feet (measured at well 01N22W26K03S) and rose by a maximum of approximately 4 feet (measured at well 01N23W01C02S). In the Forebay management area, groundwater elevations rose by approximately 6 feet at well 02N22W23B03S and decreased by approximately 10 feet at well 02N21W07L04S (Table 2-1).

Spring 2021 groundwater elevations were higher than the 2025 interim milestone groundwater elevation for a dry climate in wells except 01N23W01C02S and 02N21W07L04. Spring 2021 groundwater elevations measured in wells 01N21W01C02S and 02N21W07L04S were approximately 1 to 3 feet lower than the 2025 interim milestone groundwater elevations for a dry climate (Table 2-1).

Grimes

Groundwater elevations measured at wells 01N21W32Q02 and 01N21W32Q03 in the Grimes Canyon aquifer were approximately 51 to 62 feet lower than the minimum threshold groundwater elevation in the fall of 2020 (Table 2-1). In the spring of 2020, groundwater elevations in these wells were approximately 38 to 43 feet lower than the minimum threshold groundwater elevations (Table 2-1; Figure 2-15). The spring 2020 groundwater elevations were approximately 7 to 20 feet higher than the interim milestone groundwater elevations for a dry climate (Table 2-1).

Table 2-1. Water Year 2021 Groundwater Elevations, Minimum Thresholds, Measurable Objectives, and Interim Milestones for Representative Monitoring Points in the Oxnard Subbasin

Well Number	Aquifer	Fall Groundwater Conditions		Spring Groundwater Conditions		Minimum Threshold (ft MSL)	Measurable Objective (ft MSL)	2025 Interim Milestone Dry Climate (ft MSL)
		2020 Groundwater Elevation (ft MSL)	Change from 2019 to 2020 (feet)[a]	2021 Groundwater Elevation (ft MSL)	Change from 2020 to 2021 (feet)[a]			
01N21W32Q06S	Oxnard	-14.87	4.81	-11.18	**-0.36**	2	17	-12
01N22W20J08S	Oxnard	-10.08	4.30	-6.26	2.45	7	17	-6
01N22W26J04S	Oxnard	-22.68	**-0.42**	-11.65	1.36	2	17	-15
01N22W27C03S	Oxnard	-10.61	5.13	-6.34	2.14	7	17	-8
01N23W01C05S	Oxnard	0.87	2.34	0.83	0.77	7	17	2
02N22W36E06S	Oxnard	-10.06	-	NM	-	12	37	-9
01N21W32Q05S	Mugu	-70.64	24.07	-61.40	**-3.87**	2	17	-63
01N21W32Q07S	Mugu	-48.06	15.68	-40.79	**-2.25**	2	17	-41
01N22W20J07S	Mugu	-10.41	4.87	-7.03	2.58	7	17	-8
01N22W26J03S	Mugu	NM	-	NM	-	2	17	1
01N22W27C02S	Mugu	-16.88	5.76	-11.93	1.04	7	17	-13
02N21W07L06S	Mugu	24.91	**-8.82**	13.35	**-29.86**	27	62	10
02N22W23B07S	Mugu	-5.70	7.86	-8.28	**-9.06**	17	47	-14
02N22W36E05S	Mugu	-7.41	16.4	NM	-	12	37	-9
01N22W20J05S	Hueneme	-19.41	5.33	-16.09	3.07	2	17	-18
01N23W01C03S	Hueneme	-20.92	5.20	-20.05	2.21	7	22	-19
01N23W01C04S	Hueneme	-18.51	4.47	-15.93	2.90	7	22	-16
02N22W23B04S	Hueneme	-68.48	17.82	-58.02	5.53	-3	17	-63
02N22W23B05S	Hueneme	-46.88	9.86	-45.47	5.62	-3	17	-56
02N22W23B06S	Hueneme	-8.40	7.37	-9.59	**-5.69**	17	47	-18
02N22W36E03S	Hueneme	-15.07	6.6	NM	-	12	37	3
02N22W36E04S	Hueneme	-9.02	19.9	NM	-	12	37	-11
01N21W32Q04S	Fox Canyon	-74.88	26.10	-67.60	**-4.79**	-23	2	-74
01N22W20J04S	Fox Canyon	-27.44	7.03	-24.06	3.16	2	17	-25
01N22W26K03S	Fox Canyon	NM	-	-53.48	**-9.74**	-18	2	-54
01N23W01C02S	Fox Canyon	-17.79	13.54	-24.80	3.67	7	22	-22

Table 2-1. Water Year 2021 Groundwater Elevations, Minimum Thresholds, Measurable Objectives, and Interim Milestones for Representative Monitoring Points in the Oxnard Subbasin

Well Number	Aquifer	Fall Groundwater Conditions		Spring Groundwater Conditions		Minimum Threshold (ft MSL)	Measurable Objective (ft MSL)	2025 Interim Milestone Dry Climate (ft MSL)
		2020 Groundwater Elevation (ft MSL)	Change from 2019 to 2020 (feet)[a]	2021 Groundwater Elevation (ft MSL)	Change from 2020 to 2021 (feet)[a]			
02N21W07L04S	Fox Canyon	-15.04	**-3.86**	-4.11	**-10.09**	17	42	-3
02N22W23B03S	Fox Canyon	-62.66	17.64	-57.38	6.26	-3	17	-62
01N21W32Q02S	Grimes Canyon	-74.39	24.14	-66.30	**-5.24**	-23	2	-73
01N21W32Q03S	Grimes Canyon	-85.10	24.98	-60.73	11.64	-23	2	-80
01N21W07J02S	Multiple	NM	-	NM	-	-38	2	-92
01N21W21H02S	Multiple	-94.29	34.34	NM	-	-68	-8	-111
02N21W07L03S	Multiple	-15.42	**-4.55**	-8.40	**-6.89**	17	37	-3
02N21W07L05S	Multiple	22.43	**-5.30**	22.18	**-20.16**	27	57	18

Notes: NM = Not Measured
[a]Data in this column shows the difference between water year 2021 and water year 2020 groundwater elevations measured at each representative monitoring site. Positive (+) values indicate that seasonal high or low groundwater elevations have increased from water year 2020 conditions. Negative (-) values indicate that seasonal high or low groundwater elevations have decreased from water year 2020 conditions.

2.2 Groundwater Extraction

On October 23, 2019, the FCGMA Board of Directors adopted an Ordinance to Establish an Allocation System for the Oxnard and Pleasant Valley Groundwater Basins. The new allocation system went into effect on October 1, 2020 and is designed to “facilitate adoption and implementation of the groundwater sustainability plan and to ensure that the Basins are operated within their sustainable yields” (FCGMA, 2019c). To facilitate implementation and assessment of the new allocation system, FCGMA transitioned the groundwater extraction reporting period from a calendar year to a water year basis. The new reporting period went into effect on October 1, 2020 and requires local groundwater producers to report production from October 1 through March 31, and April 1 through September 30.

Historically, groundwater extractions in the FCGMA have been reported in two periods over the course of a single calendar year. Because groundwater extractions are not reported monthly, groundwater production prior to 2020 cannot be reported on a water year basis. Therefore, the groundwater extractions for 2016 through 2019 reported in Table 2-2, and shown on Figures 2-23 and 2-24, follow the historical precedent and represent calendar year extractions. Due to the transition from calendar year to water year reporting in 2020, groundwater extractions reported for 2020 represent extractions for the nine-month period from January 1, 2020 through September 30, 2020 (Table 2-2). Groundwater extractions for water year 2020 are preliminary and will be updated as additional data becomes available.

Water year 2021 groundwater extractions reported in Table 2-2 represent a combination of reported and estimated extractions. FCGMA has experienced some delay in reporting for the second reporting period of the 2021 water year (April 1,2021 through September 30, 2021). To estimate groundwater extraction for this period, FCGMA multiplied the groundwater extractions reported during the first half of the water year by the average ratio of validated AMI data for agricultural production wells and assumed that production rates remained constant for domestic and municipal and industrial users. Groundwater extraction values for water year 2021 will be updated as additional data becomes available.

Table 2-2. Groundwater Extractions in the Oxnard Subbasin by Aquifer System and Water Use Sector

Year	Upper Aquifer System (Acre-Feet)				Lower Aquifer System (Acre-Feet)				Wells in multiple or unassigned aquifer systems (Acre-Feet)				TOTAL (Acre-Feet)
	AG	*Dom*	*M&I*	*Sub-Total*	*AG*	*Dom*	*M&I*	*Sub-Total*	*AG*	*Dom*	*M&I*	*Sub-Total*	
CY 2016	16,045	166	12,654	28,865	31,801	24	10,655	42,480	6,863	5	125	6,993	78,342[a]
CY 2017	16,167	91	14,826	31,084	29,204	27	8,612	37,843	7,722	4	165	7,891	76,818
CY 2018	14,746	70	17,040	31,857	26,191	24	6,596	32,811	7,489	2	184	7,675	72,343
CY 2019	13,238	57	17,540	30,835	22,447	26	6,564	28,128	7,146	36	580	7,761	66,724
2020[b]	7,348	40	14,724	22,112	13,040	8	4,629	17,677	5,327	17	675	6,019	45,808
WY 2021[c]	13,874	41	20,521	34,436	21,513	10	6,180	27,703	7,494	17	598	8,109	70,248

Notes: CY = Calendar Year; WY = Water Year; AG = Agriculture; Dom = domestic; M&I = Municipal and Industrial

a Total pumping in 2016 includes 4 acre-feet of groundwater production from the semi-perched aquifer that were used by the M&I sector.

b Groundwater extraction reporting is from January 1, 2020 through September 30, 2020, due to transition to water year reporting.

c Groundwater extractions in the second half of the water year (April 1 through September 30, 2021) are estimated values; extraction reporting was not available at the time of preparation of the 2022 Annual Report.

The available data characterizing groundwater extractions between 2016 and 2021 indicate that groundwater extractions from the UAS increased in the Oxnard Subbasin while extractions from the LAS decreased (Table 2-2). This change in UAS and LAS extractions largely reflects a transition of M&I production to the UAS (Table 2-2). Based on the available data, the total groundwater production in the Subbasin has decreased since 2016 (Table 2-2). However, as previously noted, the water year 2021 groundwater extraction values are estimates and will be updated upon receipt of additional extraction data.

2.3 Surface Water Supply

The primary source of surface water in the Oxnard Subbasin is the Santa Clara River. UWCD operates the Freeman Diversion, which allows UWCD to divert surface water from the Santa Clara River for delivery to agricultural users in the Oxnard Subbasin and PVB. Diverted surface water is also used to recharge groundwater aquifers in the Oxnard Subbasin via the UWCD spreading basins located in the Forebay Management Area. In addition to diversions from the Santa Clara River, a portion of the surface water diverted from Conejo Creek by CWD is supplied to Pleasant Valley County Water District (PVCWD) for agricultural irrigation in the Oxnard Subbasin[7]. Surface water deliveries to the Oxnard Subbasin for water years 2016 through 2021 are reported in Table 2-3.

Table 2-3. Summary of Surface Water Deliveries to the Oxnard Subbasin

Water Year	PVCWD	United Water Conservation District			TOTAL (acre-Feet)
		Diversions of Santa Clara River Water			
	Conejo Creek Flows Delivered by CWD to PVCWD for Agriculture (acre-feet)	*PTP (Oxnard Subbasin Only) (acre-feet)*	*Used in Oxnard Subbasin (acre-feet)*	*Recharge to UWCD Spreading Basins (acre-feet)*	
		Total PTP Surface Water	*Total PVP Water for Agriculture*		
2016	1,038	0	0	2,209	3,247
2017	1,774	0	0	10,297	12,071
2018	1,854	0	0	3,126	4,980
2019	2,795	1,059	309	36,768	40,931
2020	2,310	2,494	944	28,327	34,097
2021	2,035	3,823	1,049	12,820	19,727

Notes: PVCWD = Pleasant Valley County Water District; CWD = Camrosa Water District; PTP = Pumping Trough Pipeline; PVP = Pleasant Valley Pipeline

[7] 56% of the total CWD deliveries to PVCWD, and 56% of the total PVP surface water deliveries from UWCD, were assigned to the Oxnard Subbasin based on an analysis of the size of PVCWD's service area (FCGMA 2019a).

2.4 Total Water Available

Total water available was tabulated from the groundwater extractions reported in Table 2-2, the surface water supply reported in Table 2-3, and imported water, and recycled water used in the Subbasin. The total water available is reported in Table 2-4 by water year. In order to convert the reported groundwater production from calendar year to water year prior to water year 2020, 25% of the groundwater production from a given calendar year was assigned to the following water year, and the 75% of the calendar year production was assigned to the current water year. This division, while approximate, is based on the monthly split between water year and calendar year, with January through September (75% of the calendar year) belonging to the current water year, and October through December (25% of the calendar year) belonging to the following water year. Because the reported 2020 groundwater extractions covered the period from January 1 through September 30, total water year extractions for 2020 were estimated by adding 25% of the 2019 calendar year extractions to the reported 2020 water year extractions.

Similar to Table 2-2, the groundwater extractions for water year 2021 presented in Table 2-3 represent reported and estimated extractions for the period from October 1, 2020 through September 30, 2021.

Table 2-4. Total Water Available in the Oxnard Subbasin

	Groundwater [a] (acre-feet)			Surface Water (acre-feet)				Imported Water (acre-feet)	Recycled Water [b] (acre-feet)	
Water Year	*Ag*	*Dom*	*M&I*	*Ag*	*Dom*	*M&I*	*Recharge*	*M&I*	*Ag*	TOTAL (acre-feet)
2016	55,025	195	23,741	1,038	0	0	2,209	11,313	136	93,657
2017	53,479	141	23,562	1,774	0	0	10,297	10,740	1,135	101,128
2018	49,593	103	23,766	1,854	0	0	3,126	12,171	2,194	92,807
2019	44,230	13	23,786	4,163	0	0	36,768	9,998	0	119,675
2020[c]	36,424	94	25,971	5,770	0	0	28,327	9,712	0	106,297
2021[c]	42,881	68	27,299	6,907	0	0	12,820	10,089	1,206	101,270

Notes: NR – not reported

a) Groundwater production by water year is estimated from groundwater production by calendar year for 2016 through 2020. Water Year 2021 extractions represent reported and estimated extractions for the period from October 1, 2020 through September 30, 2021.
b) Recycled water is from reported GREAT program deliveries to SSF, DRIS-2, and DAVIS
c) Groundwater extraction reporting for 2020 and 2021 is preliminary and expected to change. Additional extraction reporting is anticipated.

2.5 Change in Groundwater Storage

Change in storage estimates were calculated for each principal aquifer in the Subbasin by comparing seasonal high groundwater elevations between 2015 and 2021. Annual and cumulative change in storage for water years 2016 through 2021 are presented in Tables 2-5a and 2-5b. The change in storage for each principal aquifer between spring 2020 and spring 2021 is shown on Figures 2-18 through 2-22. Annual and cumulative change in storage for the UAS and LAS are shown in Figures 2-23 and 2-24.

Change in groundwater in storage was calculated using a series of linear regression models that correlate measured groundwater elevations to simulated storage change values extracted from the Ventura Regional Groundwater Flow Model (UWCD, 2018). These regression models were computed using seasonal high elevations and corresponding model-calculated storage change values for water years 1986 through 2015 (Appendix B). This methodology differs from previous estimates of storage change presented in the 2020 and 2021 Annual Reports. The methodology presented in Appendix A builds on the approach used in the previous Annual Reports and addresses identified data gaps by: (1) removing the influence of contouring algorithms on the resulting estimates of storage change, and (2) estimating storage change across the entire Subbasin.

The change in groundwater in storage was recalculated for water years 2016 through 2020 using the linear regression method. The updated estimates are presented in Table 2-5A, Table 2-5B, and Figures 2-23 and 2-24. A comparison of the estimated change in storage using the two methodologies is provided in Appendix A.

2.5.1 Oxnard Aquifer

Groundwater in storage increased between spring 2020 and spring 2021 by approximately 6,600 AF (Table 2-5a). This increase in storage was the result of a rise in groundwater elevations within, and downgradient of, the Forebay Management Area (Figure 2-18). Adjacent to the PVB, groundwater elevations declined by approximately 9 feet, which corresponded to a local decline in groundwater in storage of approximately 90 AF in the central portion of the Subbasin (Figure 2-18). Along the coast, groundwater in storage increased by an average of approximately 7 AF (Figure 2-18). Since spring 2015, groundwater in storage within the Oxnard aquifer has increased by a cumulative volume of approximately 10,100 AF (Table 2-5a).

2.5.2 Mugu Aquifer

Groundwater in storage within the Mugu aquifer decreased by approximately 180 AF between spring 2020 and spring 2021 (Table 2-5a). Change in the volume of groundwater in storage varied geographically across the Subbasin in the Mugu aquifer (Figure 2-19). In the Forebay Management Area, groundwater elevation declines of approximately 9 to 30 feet resulted in a local storage decline of approximately 260 AF. Downgradient of the Forebay Management Area, groundwater elevations increased, resulting in groundwater storage increases along the coast, north of Port Hueneme, and across the majority of the Oxnard Pumping Depression Management Area. Groundwater in storage declined locally by less than 10 AF directly adjacent to the PVB and in the southeastern portion of the Saline Intrusion Management Area, near Point Mugu (Figure 2-19).

Since spring 2015, groundwater in storage within the Mugu aquifer has increased by a cumulative volume of approximately 370 AF (Table 2-5a).

2.5.3 Hueneme Aquifer

The volume of groundwater in storage in the Hueneme aquifer increased by approximately 170 AF between spring 2020 and spring 2021 (Table 2-5a). Figure 2-20 illustrates that groundwater in storage increased relatively uniformly across the Subbasin in the Hueneme aquifer as a result of groundwater elevation increases that ranged from approximately 2 to 20 feet.

Since spring 2015, groundwater in storage within the Hueneme aquifer has increased by a cumulative volume of approximately 260 AF (Table 2-5a).

2.5.4 Fox Canyon Aquifer

Between spring 2020 and spring 2021, groundwater in storage in the Fox Canyon aquifer declined by approximately 60 AF (Table 2-5a). Within the Forebay Management Area, groundwater in storage declined by approximately 130 AF; this reduction reflects the 10-foot decline in groundwater elevation measured at 02N21W07L04S (Figure 2-21). Downgradient of the Forebay Management Area, adjacent to the coast, and north of Port Hueneme, groundwater in storage increased by approximately 190 AF. Within the majority of the Saline Intrusion Management Area and Oxnard Pumping Depression Management Area, groundwater in storage declined between spring 2020 and 2021.

Since the spring of 2015, groundwater in storage within the FCA has increased by approximately 850 AF (Table 2-5a).

2.5.5 Grimes Canyon Aquifer

The Grimes Canyon aquifer is limited to the southern and eastern parts of the Oxnard Subbasin (Turner 1975). Between spring 2020 and spring 2021, groundwater in storage in the Grimes Canyon aquifer decreased by approximately 70 AF. This groundwater in storage decline was estimated using a single well, 01N21W32Q02S, located in the southeastern part of the Subbasin (Figure 2-23).

Since the spring of 2015, groundwater in storage within the Grimes Canyon aquifer has declined by approximately 20 AF (Table 2-5a).

Table 2-5a. Annual Change in Groundwater Storage in the Oxnard Subbasin

Water Year	Water Year Type	Oxnard Subbasin							
		Oxnard Aquifer (acre-feet)	*Mugu Aquifer (acre-feet)*	*UAS Annual (acre-feet)*	*Hueneme Aquifer (acre-feet)*	*Fox Canyon Aquifer (acre-feet)*	*Grimes Canyon Aquifer (acre-feet)*	*LAS Annual (acre-feet)*	*Combined Annual (acre-feet)*
2016	Critical	-9,391	-480	-9,871	-277	-687	-301	-1,266	-11,136
2017	Above Normal	-1,565	170	-1,395	269	710	432	1,411	16
2018	Critical	-4,737	-401	-5,138	-310	-965	-183	-1,457	-6,596
2019	Above Normal	9,282	802	10,084	243	1,639	256	2,138	12,222
2020	Below Normal	9,704	467	10,170	159	214	-155	218	10,388
2021	Critical	6,752	-185	6,657	170	-63	-70	38	6,605

Annual storage change estimates revised for water years 2016 through 2020

Table 2-5b. Cumulative Change in Groundwater Storage in the Oxnard Subbasin

Water Year	Water Year Type	Oxnard Subbasin		
		UAS Cumulative (acre-feet)	*LAS Cumulative (acre-feet)*	*Combined Cumulative Change in Storage (acre-feet)*
2016	Critical	-9,871	-1,266	-11,136
2017	Above Normal	-11,266	146	-11,120
2018	Critical	-16,404	-1,312	-17,716
2019	Above Normal	-6,319	826	-5,493
2020	Below Normal	3,851	1,044	4,895
2021	Critical	10,418	1,081	11,500

Annual storage change estimates revised for water years 2016 through 2020

2.5.6 Total Change in Storage in the Subbasin

The change in groundwater in storage was calculated for each aquifer in the Subbasin and summed by aquifer system (Tables 2-5a and 2-5b; Figures 2-23 and 2-24). Between spring 2020 and spring 2021, groundwater in storage increased by approximately 6,600 AF, which resulted in a cumulative increase in storage in the UAS since spring 2015 of approximately 10,400 AF. In the LAS, groundwater in storage increased by approximately 40 AF between spring 2020 and spring 2021. Since spring 2015, groundwater in storage in the LAS has increased by a cumulative volume of approximately 1,000 AF (Table 2-5b). The combined change in storage within the UAS and LAS since spring 2015 is an increase of approximately 11,500 AF (Table 2-5b). However, it should be noted that the change in storage volumes reported in Tables 2-5a and 2-5b are an approximate change in storage estimated using groundwater elevations measured at wells screened only in single aquifers.

Annual and cumulative change in storage from 1985 through 2015 were reported in the GSP (FCGMA 2019a). The change in storage volumes reported in the GSP were extracted from the UWCD model and incorporated local responses to changing recharge and pumping conditions. The results presented here provide an estimate of storage change based on a subset of wells screened solely within individual aquifers across the Subbasin, and therefore do not capture local variations in storage change simulated by the UWCD model. In general, however, the trends shown in the GSP and Annual Report are in good agreement (Appendix A).

Additionally, the change in storage reported for this annual report does not account for seawater intrusion that is known to occur in the Subbasin when groundwater elevations are below the minimum thresholds described in the GSP (FCGMA 2019). As groundwater elevations decline, seawater intrudes the Subbasin, which slows the decline of the groundwater elevations, but replaces fresh water in storage with saltwater. Therefore, the change in storage calculated for this annual report using groundwater elevations that are influenced by potential seawater intrusion may be an underestimate of the total change of fresh water in storage experienced by the Subbasin between water years 2016 and 2020.

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3 GSP Implementation Progress

The GSP for the Oxnard Subbasin was submitted to DWR in January 2020. This is the third annual report to be prepared since the GSP was submitted. The GSP implementation progress reported in this report covers work begun during development of the GSP as well as development of projects and management actions over the 2 years since the GSP was submitted.

Project Implementation Progress

During development of the GSP, FCGMA identified the Oxnard Pumping Depression Management Area, adjacent to the boundary between the Oxnard Subbasin and the PVB, as a critical area in which aquifer specific groundwater elevations were not available due to a lack of monitoring wells. This is an area of known groundwater production, with wells in the area typically screened in multiple aquifers in the LAS. At the Agency's request, DWR installed two nested monitoring well clusters to monitor water levels in the individual principal aquifers in the Oxnard Subbasin Pumping Depression Management Area based on FCGMA's design (Figure 2-22). These nested monitoring wells were installed specifically to address the spatial data gap identified in the GSP. The first groundwater elevation data from these wells was used in this annual report, to better represent groundwater conditions in the Oxnard Subbasin and adjacent PVB.

Since completing the GSP, FCGMA continued conducting stakeholder meetings and in June 2020 a facilitator provided through DWR's Facilitation Support Services program began leading meetings. Participants in these meetings, which targeted stakeholders in both the Oxnard Subbasin and PVB, identified a suite of projects that could help the basins achieve sustainability by 2040. Significant additional projects to those identified in the GSP were discussed as part of these meetings. Upon additional evaluation, the projects committee of the stakeholder group recommended a subset of the projects identified for further assessment and modeling. FCGMA is working with UWCD to develop the numerical groundwater model scenarios that will be used to evaluate the potential effectiveness of the projects identified.

As a result of the stakeholder driven project discussions, FCGMA solicited project descriptions and details for projects that were not included in the initial GSP, but have been identified since the GSP was prepared. For the Oxnard Subbasin, these projects include:

- Additional expansion of the City of Oxnard's Advanced Water Purification Facility;
- A seawater intrusion barrier project for the UAS, currently relying on extraction of brackish groundwater;
- An updated version of the Freeman Expansion project discussed in the GSP, and associated project components;
- Expansion of extension of the existing Freeman Diversion conveyance structures to the Ferro-Rose basin to allow for more recharge and increase diversions during high-flow events;
- Construction of a new pipeline interconnection along Laguna Road to allow conveyance of recycled water from Pleasant Valley County Water District's system to UWCD's Pumping Trough Pipeline (PTP);
- Construction of a new pipeline interconnection along Nauman Road to allow conveyance of recycled water from Oxnard's AWPF system to UWCD's Pumping Trough Pipeline (PTP);

- Purchase of supplemental State Water Project water;
- Destruction of abandoned wells screened across both the UAS and LAS;
- New multi-depth monitoring wells to resolve data gaps identified in the GSP;
- New shallow monitoring wells to assess groundwater conditions along Revolon Slough, Calleguas Creek, and the Santa Clara River;
- Installation of pressure transducers at representative monitoring points, or key wells, to better constrain temporal variations in groundwater conditions;
- A seawater intrusion barrier project relying on targeted injection wells to protect the LAS in the vicinity of Port Hueneme and Point Mugu.

The details of each of these projects is provided in Appendix B. As demonstrated by the efforts undertake to identify additional projects since the GSP was adopted, the FCGMA Board of Directors continues to prioritize stakeholder feedback in the implementation phase of the GSP and recognizes the vital role stakeholders play in ensuring the long-term sustainable use of groundwater resources in the Oxnard Subbasin.

Management Action Implementation Progress

FCGMA has made progress on several management actions since publication of the 2021 annual report. First, the allocation system for the Oxnard and Pleasant Valley Basins adopted by the FCGMA Board in 2019 went into effect on October 1, 2020. This allocation system is designed to “facilitate adoption and implementation of the groundwater sustainability plan and to ensure that the Basins are operated within their sustainable yields” (FCGMA, 2019c). As part of the new allocation system, FCGMA changed the reporting time periods for groundwater production to better quantify groundwater production by water-year, rather than calendar year. The transition to water year reporting is underway. Additionally, under the new allocation system pumpers are transitioning from a well-based to a land-based reporting system. Both sets of changes allow for improved management of the Oxnard Subbasin and PVB, which are managed jointly by the FCGMA, and a more comprehensive understanding of the water use requirements that drive groundwater production in the two basins.

Second, in anticipation of the additional reporting associated with implementing the allocation ordinance, FCGMA is conducting an analysis of its data management system needs. The updated data management system will incorporate the new AMI data and will be structured to allow for land-based extraction assignments. Changes to the data management system will target the specific needs of the FCGMA moving toward sustainable management of the Oxnard Subbasin and PVB by 2040.

Third, FCGMA has continued to evaluate implementing a replenishment fee that could be used to purchase water for recharge in the Oxnard Subbasin or to help fund a voluntary temporary fallowing program to reduce groundwater demand. These management actions can be implemented over a shorter time period than large capital projects and, while not sufficient on their own to achieve sustainability, play an important role in progressing toward sustainable use of the groundwater resources in the Oxnard Subbasin.

The progress made over the past year on projects and management actions applicable to the Oxnard Subbasin demonstrates FCGMA’s commitment to allocating the necessary time and resources to achieve long-term sustainable management of the groundwater resources of the Oxnard Subbasin.

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4 References

DWR (California Department of Water Resources). 2018. *California's Groundwater, Bulletin 118*. 2018 Groundwater Basin Boundaries – 4-004.02 Santa Clara River Valley- Oxnard. Published https://water.ca.gov/SearchResults?sort=asc&search=B118%20Basin%20Boundary%20Description%202016&primaryFilters=&secondaryFilters=&tab=documents. Accessed February 17,2020.

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FCGMA (Fox Canyon Groundwater Management Agency). 2019b. Groundwater Sustainability Plan for the Las Posas Valley Basin – Appendix K.

FCGMA (Fox Canyon Groundwater Management Agency). 2019c. Ordinance to Establish a New Pumping Allocation System for the Oxnard and Pleasant Valley Basins.

FCGMA (Fox Canyon Groundwater Management Agency). 2020a. Oxnard Subbasin Groundwater Sustainability Plan 2020 Annual Report: Covering Water Years 2016 through 2019.

FCGMA (Fox Canyon Groundwater Management Agency). 2021. Oxnard Subbasin Groundwater Sustainability Plan 2021 Annual Report: Covering Water Year 2020.

Turner, J.M. 1975. "Aquifer Delineation in the Oxnard–Calleguas Area, Ventura County." In *Compilation of Technical Information Records for the Ventura County Cooperative Investigation: Volume I,* 1–45. Prepared by the Ventura County Public Works Agency Flood Control and Drainage Department for the California Department of Water Resources.

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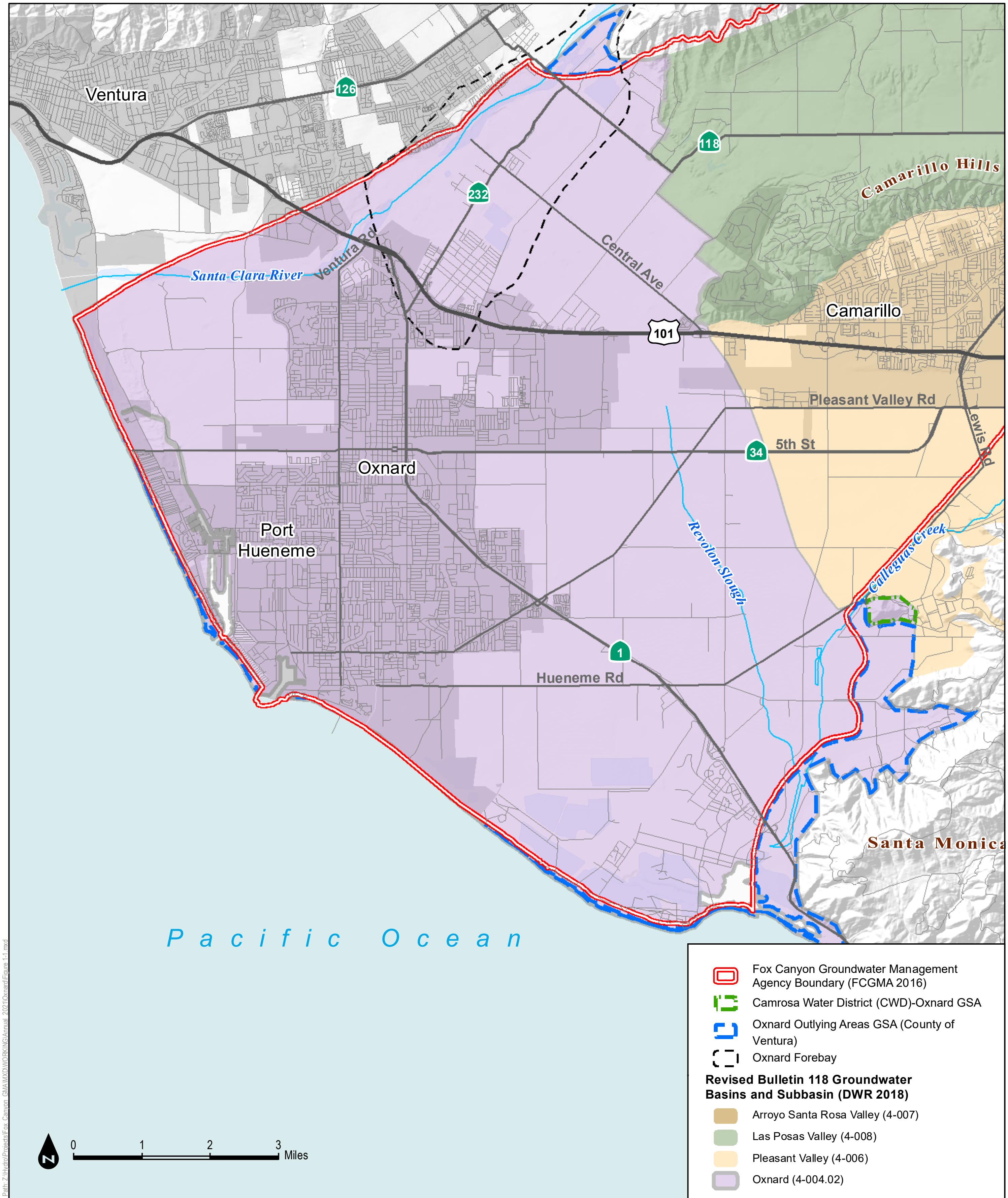
Figures



SOURCE: DWR; Santa Barbara County; FCGMA

FIGURE 1-1

Vicinity Map for the Oxnard Subbasin

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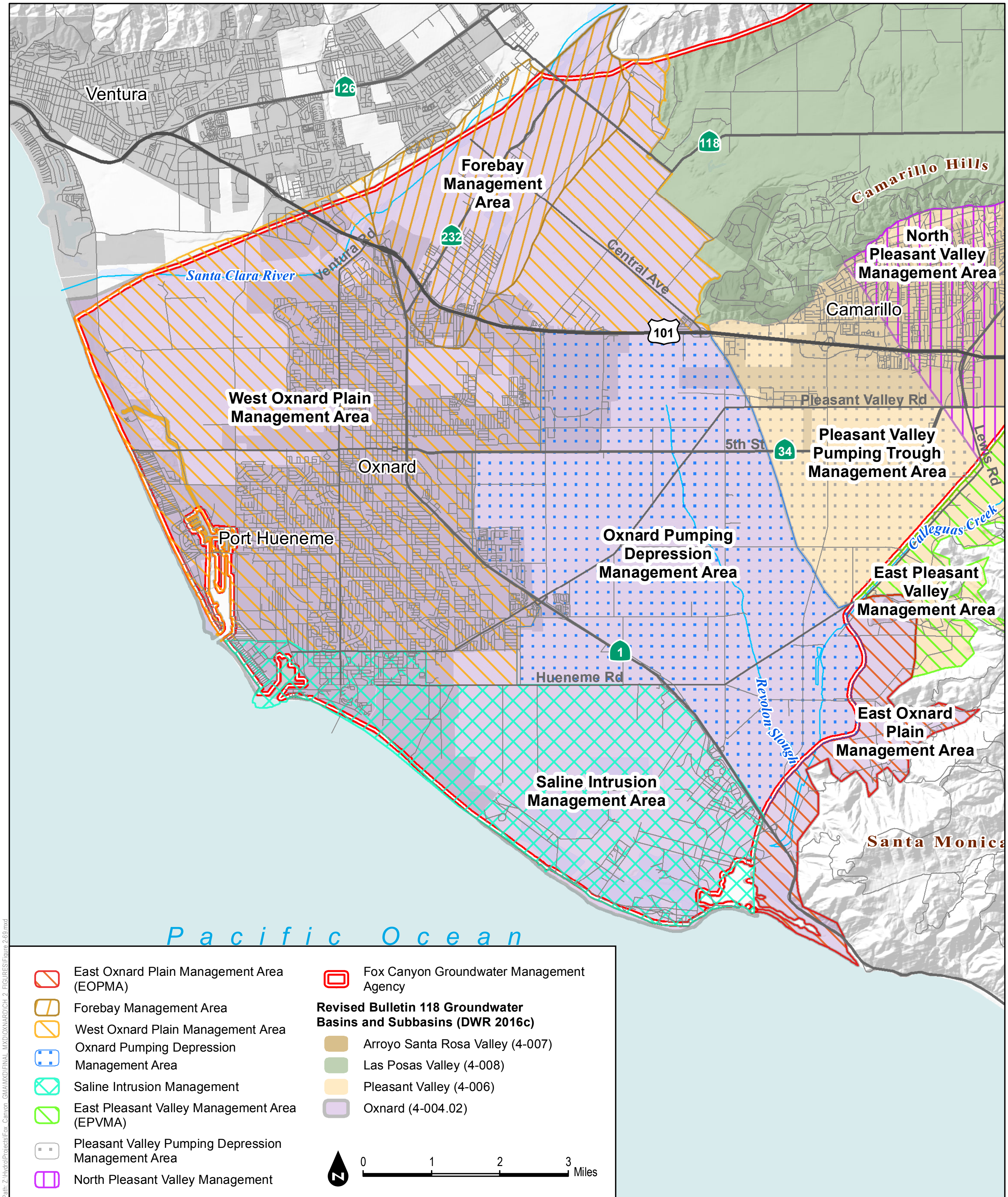
Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report



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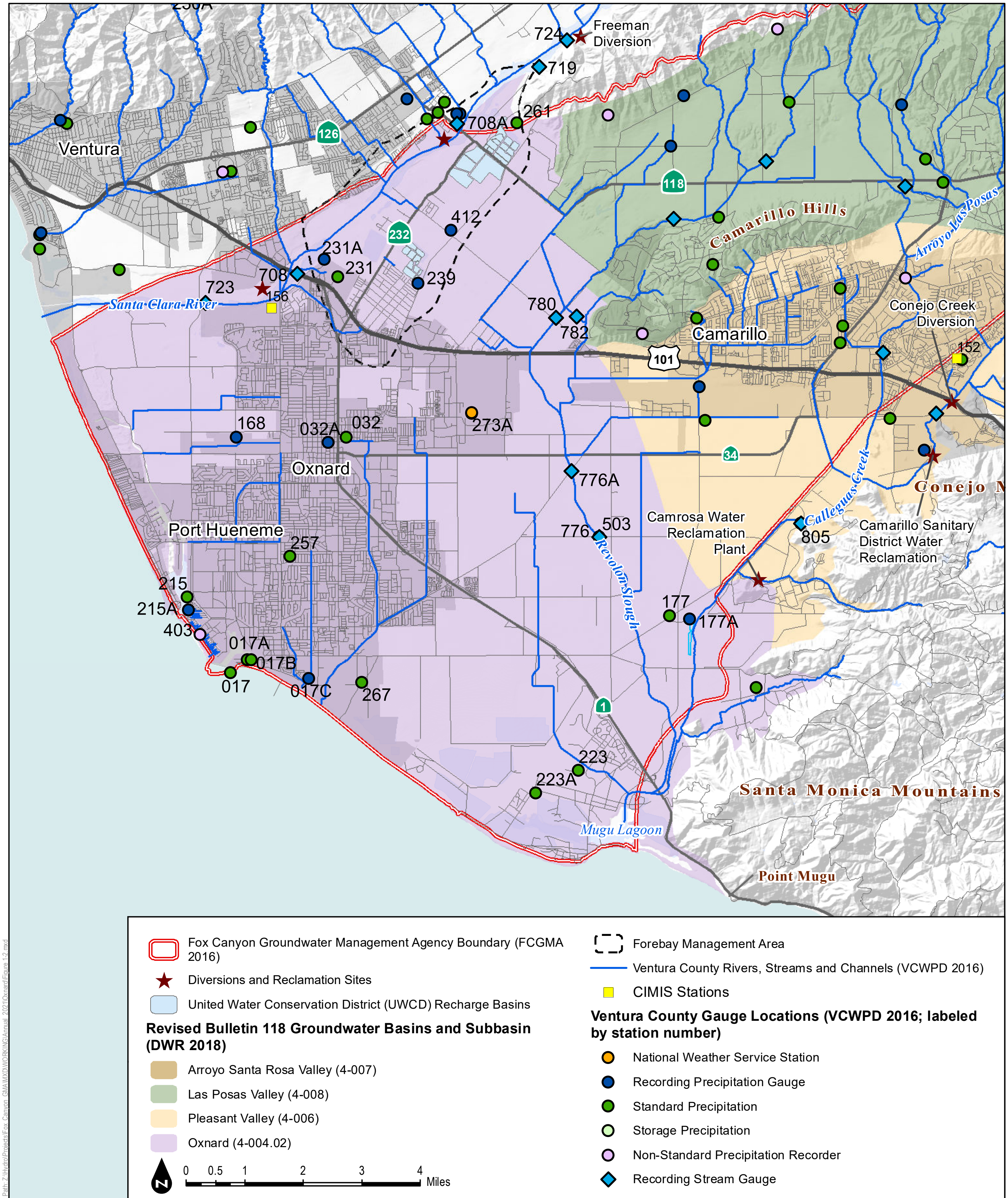
SOURCE: DWR; County of Ventura; FCGMA

FIGURE 1-2

Oxnard Subbasin Management Areas

Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report



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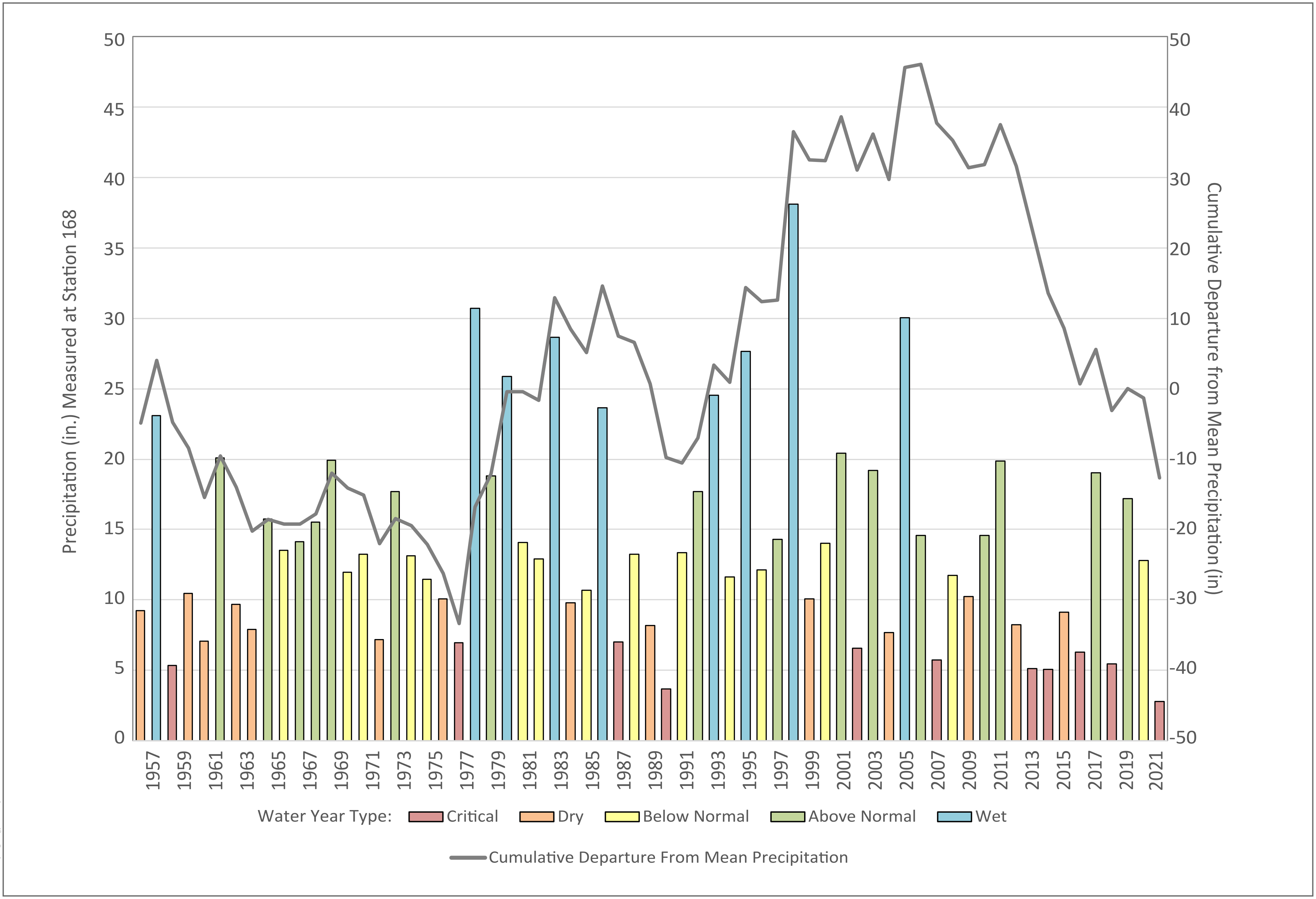
SOURCE: DWR; Santa Barbara County; VCWPD; USGS NHD

FIGURE 1-3

Weather Station and Stream Gauge Locations

Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report



Note: Water year is from October 1 through September 30. Water year type is based on the percentage of the water year precipitation compared to the mean precipitation. Types are defined as: Wet (≥150% of mean), Above Normal (≥100% to <150% of mean), Below Normal (≥75% to <100% of mean), Dry (≥50% to <75% of average), and Critical (<50% of mean)

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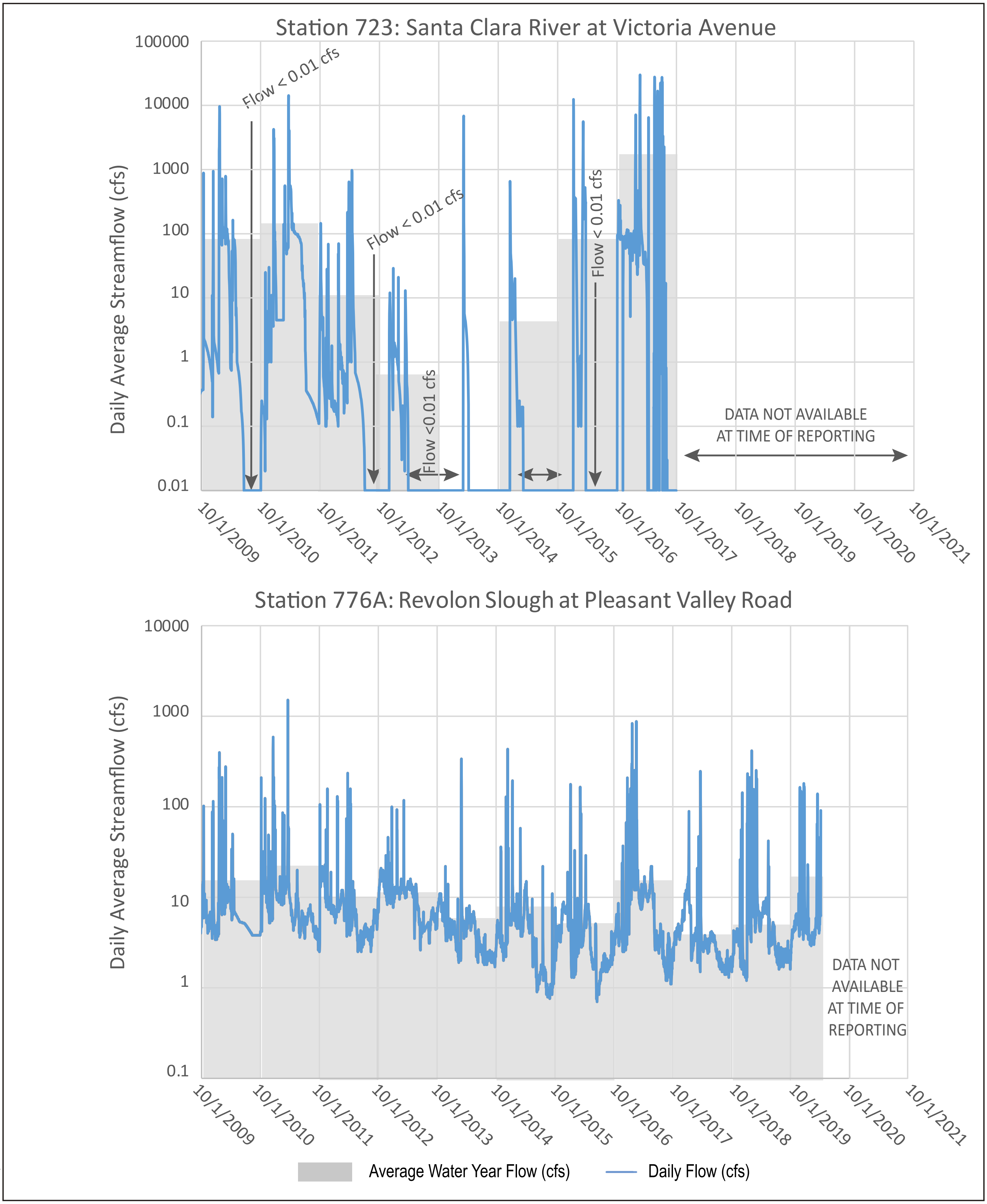
FIGURE 1-4

Oxnard Subbasin Historical Water Year Precipitation



SOURCE: Ventura County Watershed Protection District (VCWPD) Hydrologic Data Server (https://www.vcwatershed.net/hydrodata/)

FIGURE 1-5

Oxnard Subbasin Stream Gauge Data

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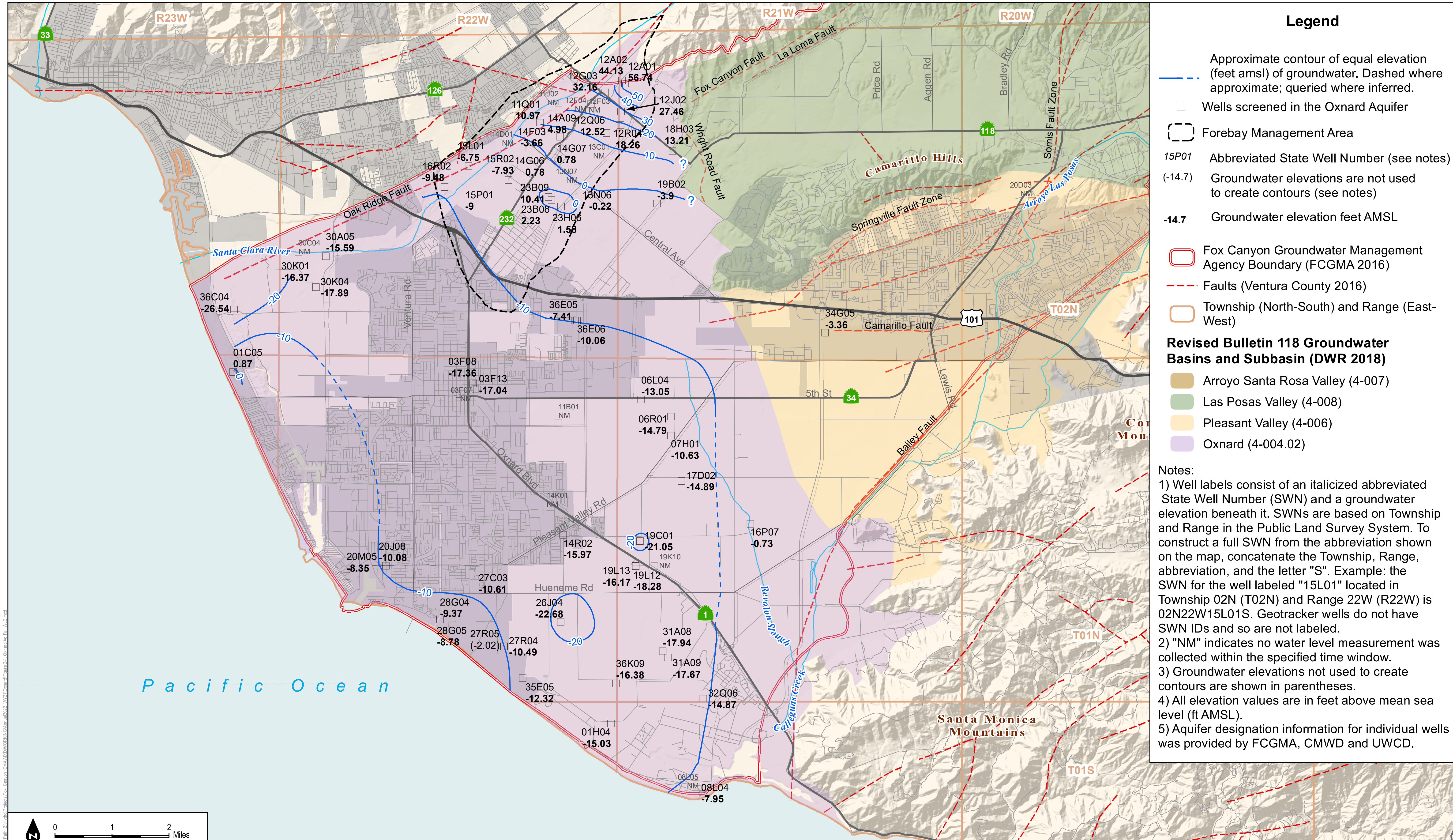
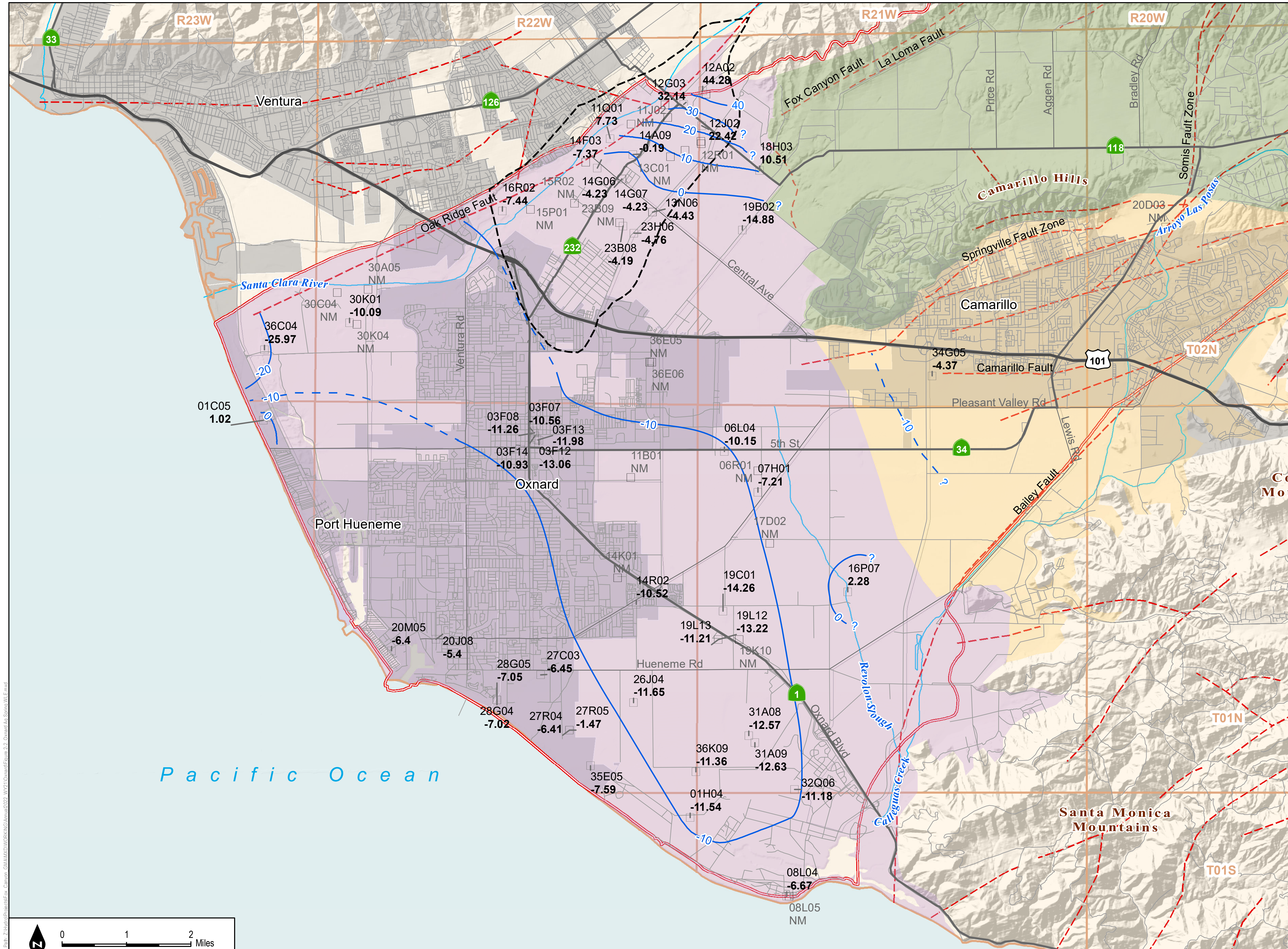


SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-1

Groundwater Elevation Contours in the Oxnard Aquifer, October 2 to October 31, 2020



Legend

Approximate contour of equal elevation (feet amsl) of groundwater. Dashed where approximate; queried where inferred.

Wells screened in the Oxnard Aquifer

Forebay Management Area

15P01 Abbreviated State Well Number (see notes)

(-14.7) Groundwater elevations are not used to create contours (see notes)

-14.7 Groundwater elevation feet AMSL

Fox Canyon Groundwater Management Agency Boundary (FCGMA 2016)

Faults (Ventura County 2016)

Township (North-South) and Range (East-West)

Revised Bulletin 118 Groundwater Basins and Subbasin (DWR 2018)

Arroyo Santa Rosa Valley (4-007)

Las Posas Valley (4-008)

Pleasant Valley (4-006)

Oxnard (4-004.02)

Notes:
1) Well labels consist of an italicized abbreviated State Well Number (SWN) and a groundwater elevation beneath it. SWNs are based on Township and Range in the Public Land Survey System. To construct a full SWN from the abbreviation shown on the map, concatenate the Township, Range, abbreviation, and the letter "S". Example: the SWN for the well labeled "15L01" located in Township 02N (T02N) and Range 22W (R22W) is 02N22W15L01S. Geotracker wells do not have SWN IDs and so are not labeled.
2) "NM" indicates no water level measurement was collected within the specified time window.
3) Groundwater elevations not used to create contours are shown in parentheses.
4) All elevation values are in feet above mean sea level (ft AMSL).
5) Aquifer designation information for individual wells was provided by FCGMA, CMWD and UWCD.

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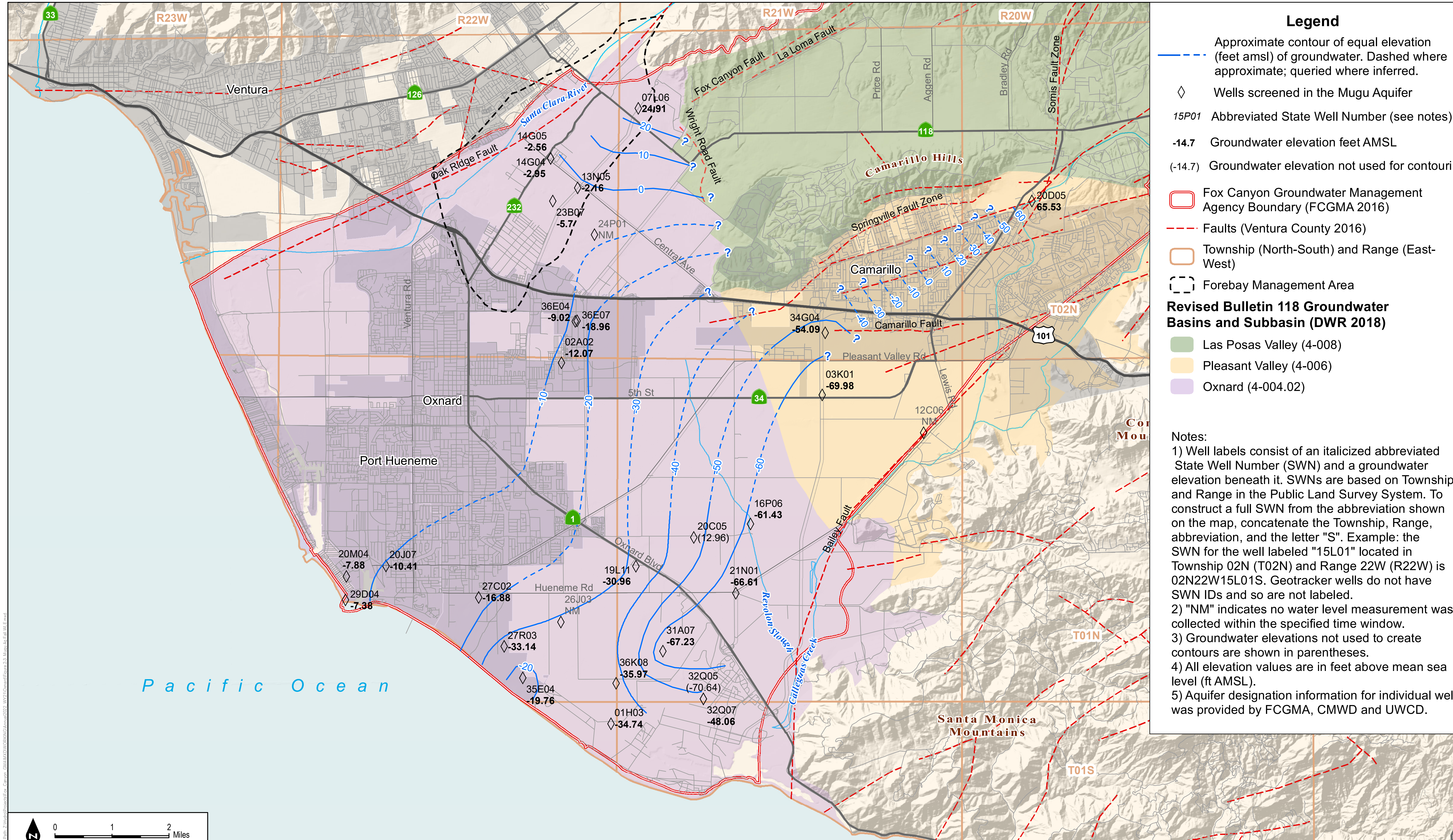
SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-2

Groundwater Elevation Contours in the Oxnard Aquifer, March 2 to March 29, 2021



SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-3

Groundwater Elevation Contours in the Mugu Aquifer, October 2 to October 31, 2020

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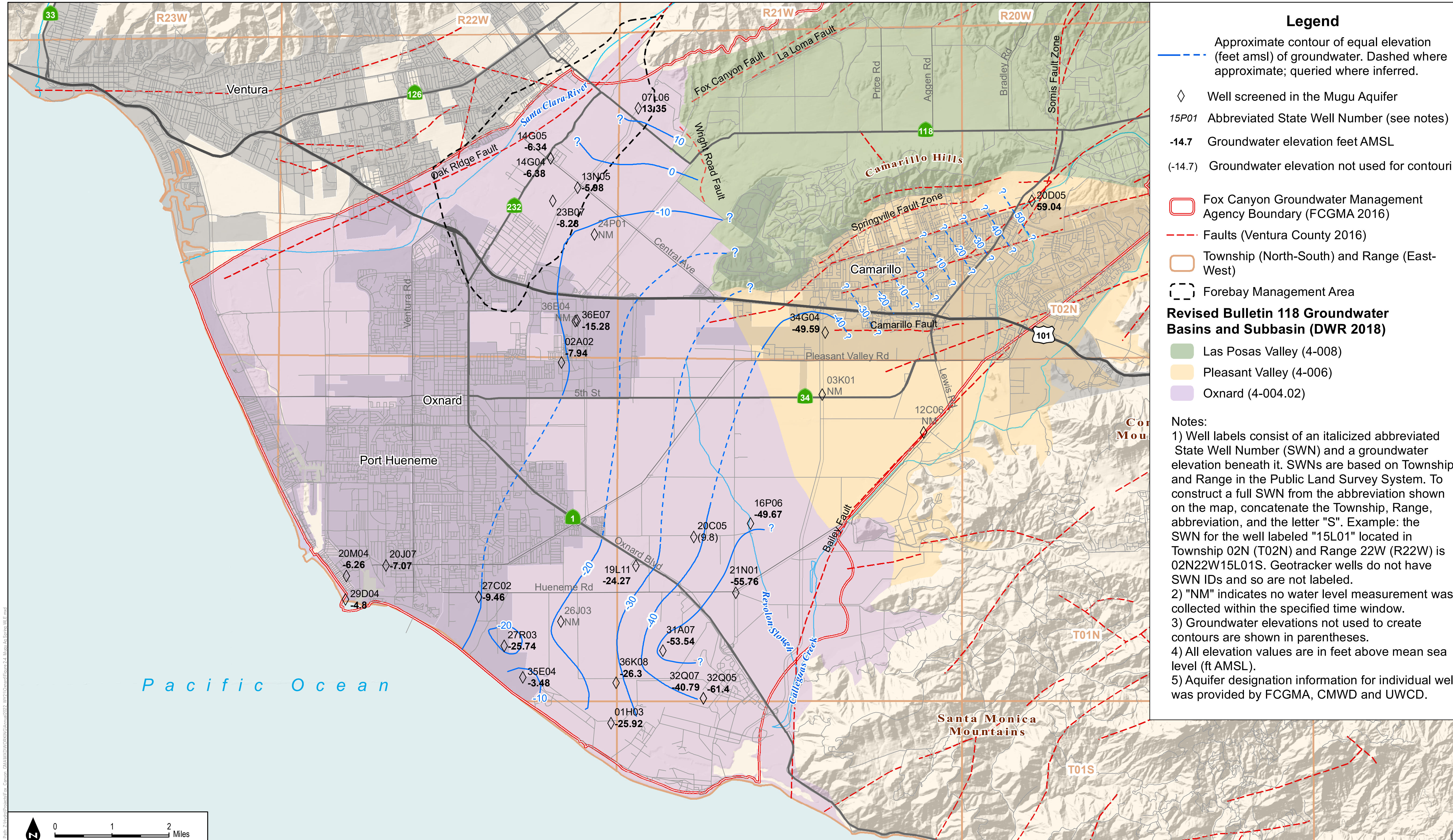
Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report

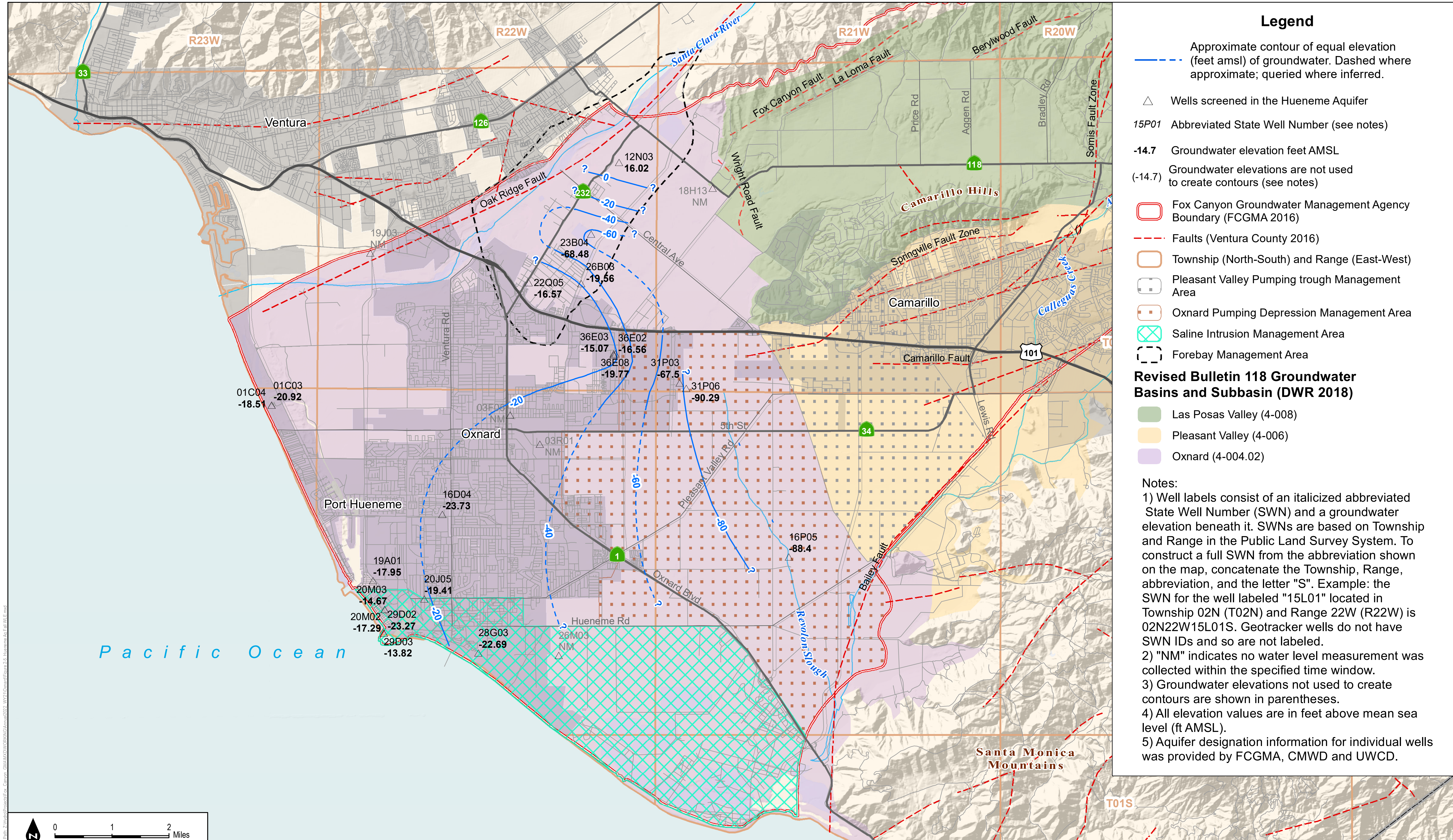


SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-4

Groundwater Elevation Contours in the Mugu Aquifer, March 2 to March 29, 2021

DUDEK



SOURCE: DWR; Ventura County; UWCD; CMWD

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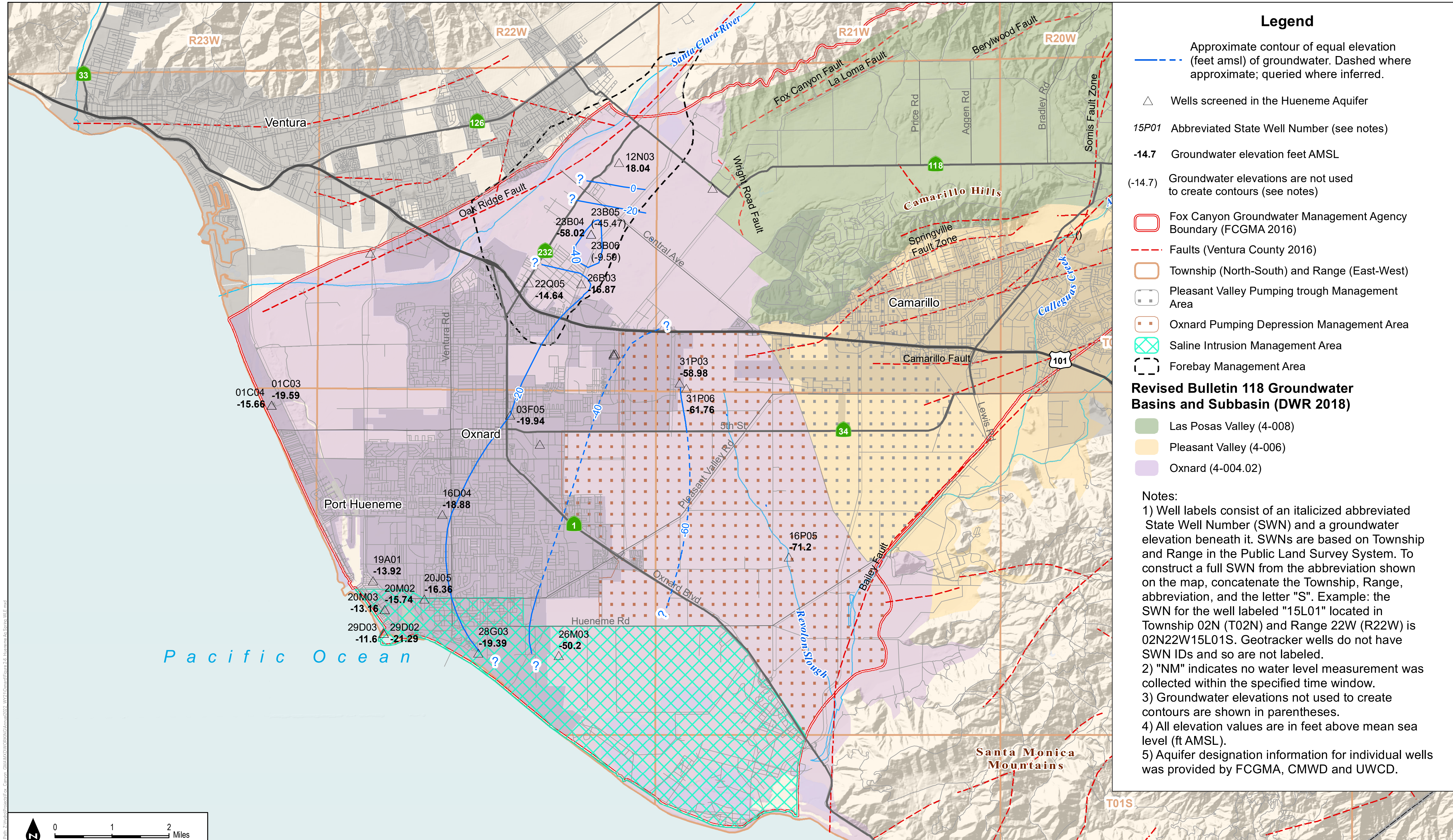
FIGURE 2-5

Groundwater Elevation Contours in the Hueneme Aquifer, October 2 to October 31, 2020

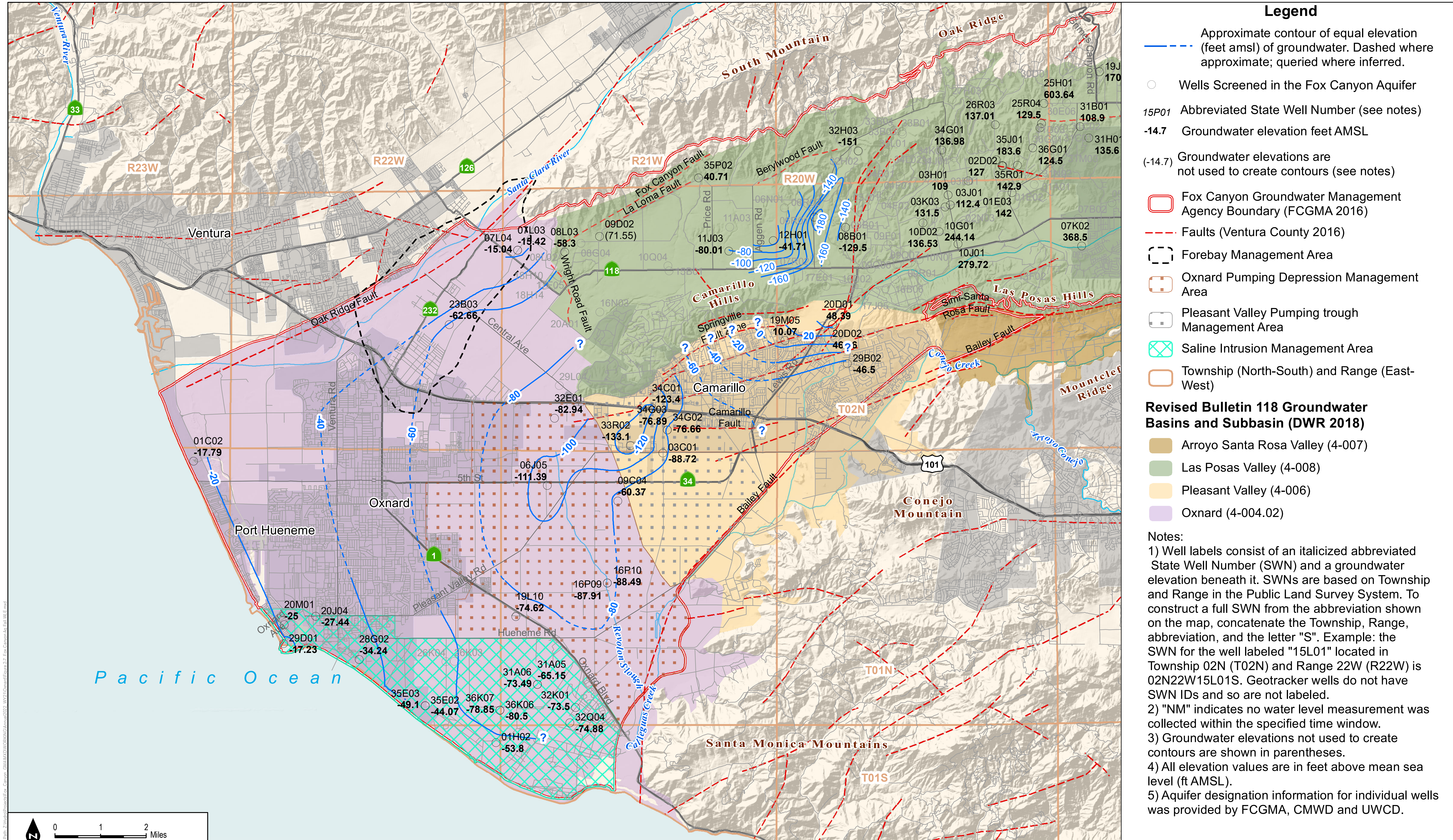


DUDEK

SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-6

Groundwater Elevation Contours in the Hueneme Aquifer, March 2 to March 29, 2021

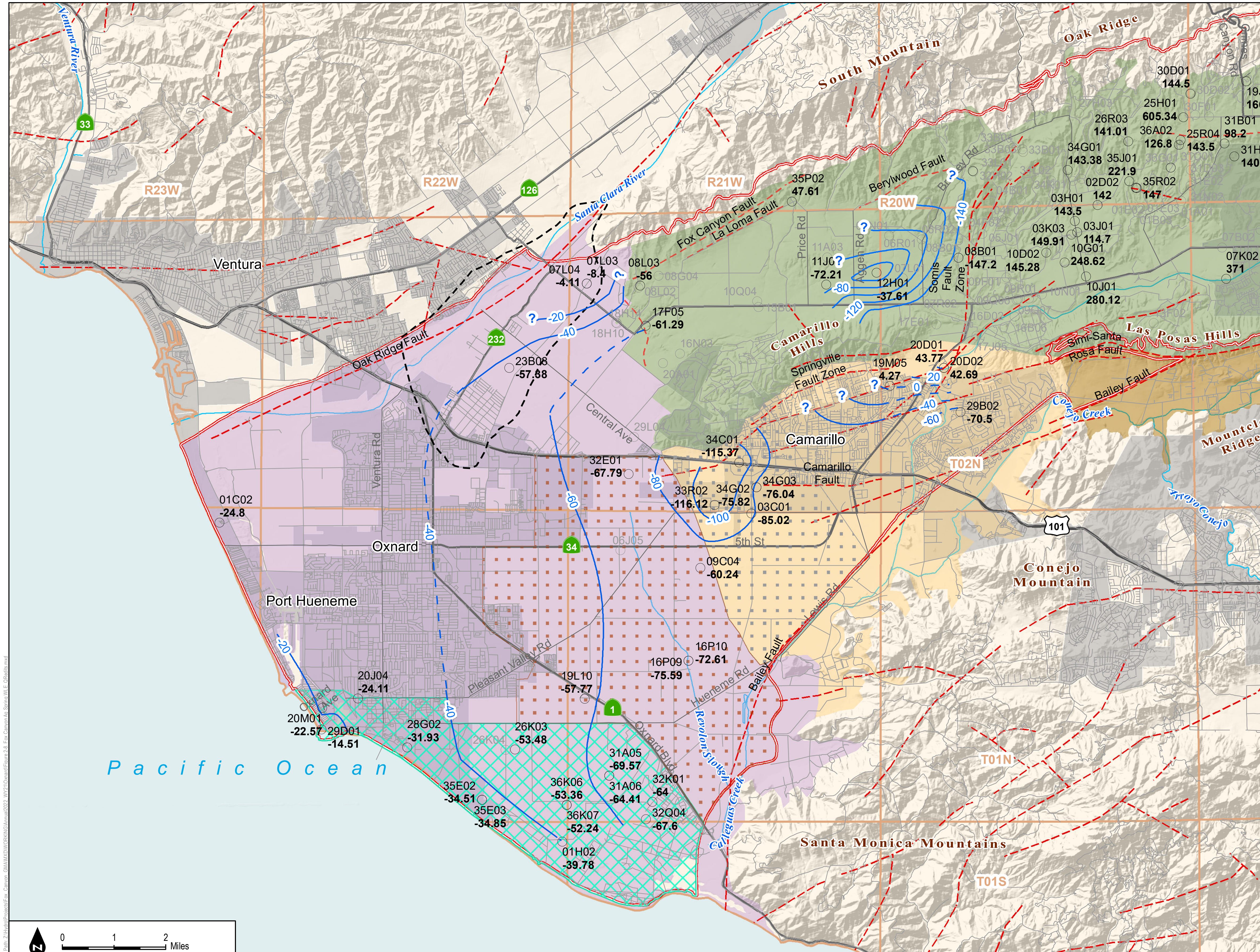


SOURCE: DWR; Ventura County; UWCD; CMWD

DUDEK

FIGURE 2-7

Groundwater Elevation Contours in the Fox Canyon Aquifer, October 2 to October 31, 2020



Legend

- Approximate contour of equal elevation (feet amsl) of groundwater. Dashed where approximate; queried where inferred.
- Wells Screened in the Fox Canyon Aquifer
- *15P01* Abbreviated State Well Number (see notes)
- **-14.7** Groundwater elevation feet AMSL
- (-14.7) Groundwater elevations are not used to create contours (see notes)
- Fox Canyon Groundwater Management Agency Boundary (FCGMA 2016)
- Faults (Ventura County 2016)
- Township (North-South) and Range (East-West)
- Pleasant Valley Pumping trough Management Area
- Oxnard Pumping Depression Management Area
- Saline Intrusion Management Area
- Forebay Management Area

Revised Bulletin 118 Groundwater Basins and Subbasin (DWR 2018)

- Arroyo Santa Rosa Valley (4-007)
- Las Posas Valley (4-008)
- Pleasant Valley (4-006)
- Oxnard (4-004.02)

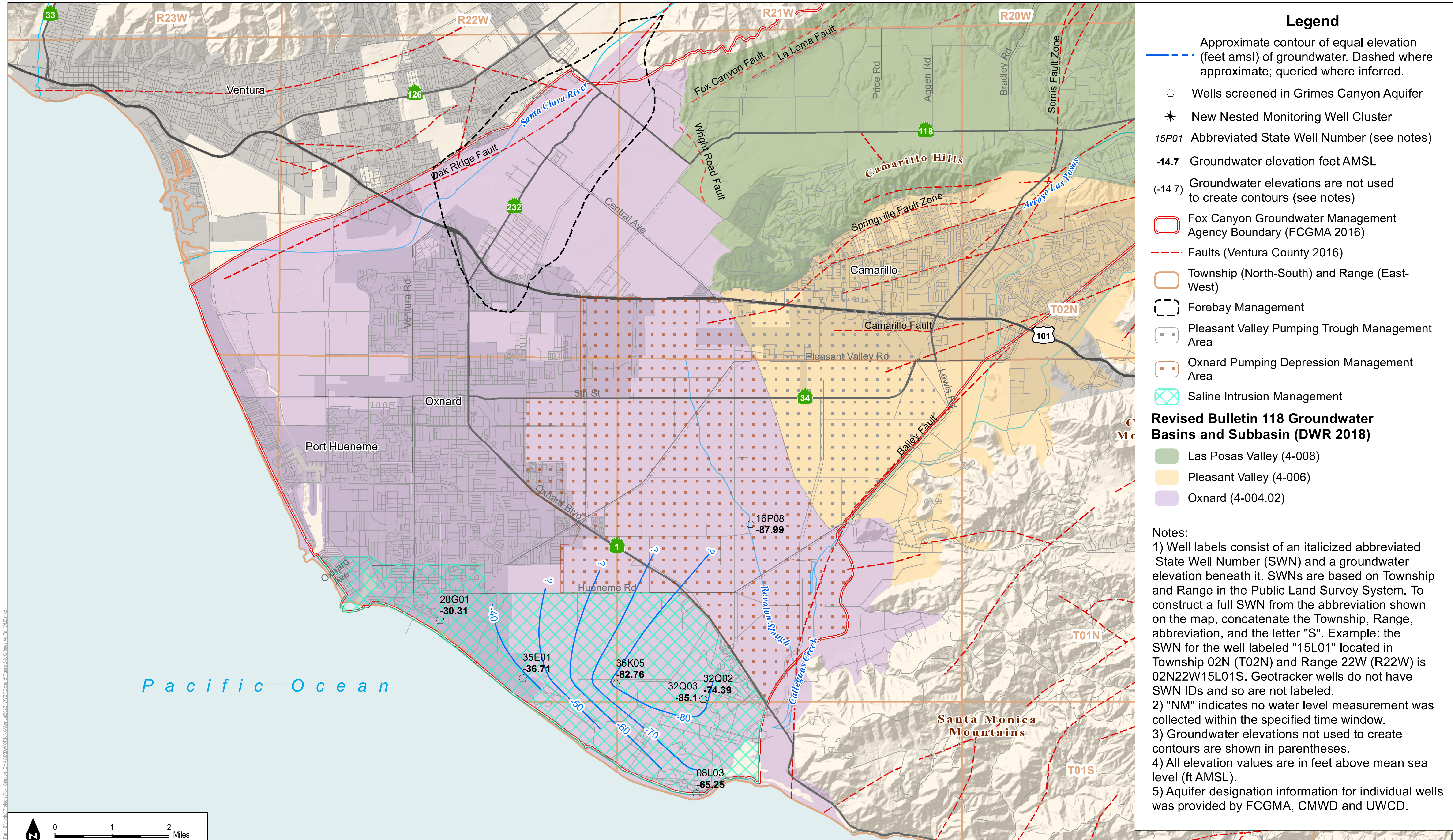
Notes:
1) Well labels consist of an italicized abbreviated State Well Number (SWN) and a groundwater elevation beneath it. SWNs are based on Township and Range in the Public Land Survey System. To construct a full SWN from the abbreviation shown on the map, concatenate the Township, Range, abbreviation, and the letter "S". Example: the SWN for the well labeled "15L01" located in Township 02N (T02N) and Range 22W (R22W) is 02N22W15L01S. Geotracker wells do not have SWN IDs and so are not labeled.
2) "NM" indicates no water level measurement was collected within the specified time window.
3) Groundwater elevations not used to create contours are shown in parentheses.
4) All elevation values are in feet above mean sea level (ft AMSL).
5) Aquifer designation information for individual wells was provided by FCGMA, CMWD and UWCD.

DUDEK

SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-8

Groundwater Elevation Contours in the Fox Canyon Aquifer, March 2 to March 29, 2021



SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-9

Groundwater Elevation Contours in the Grimes Canyon Aquifer, October 2 to October 31, 2020

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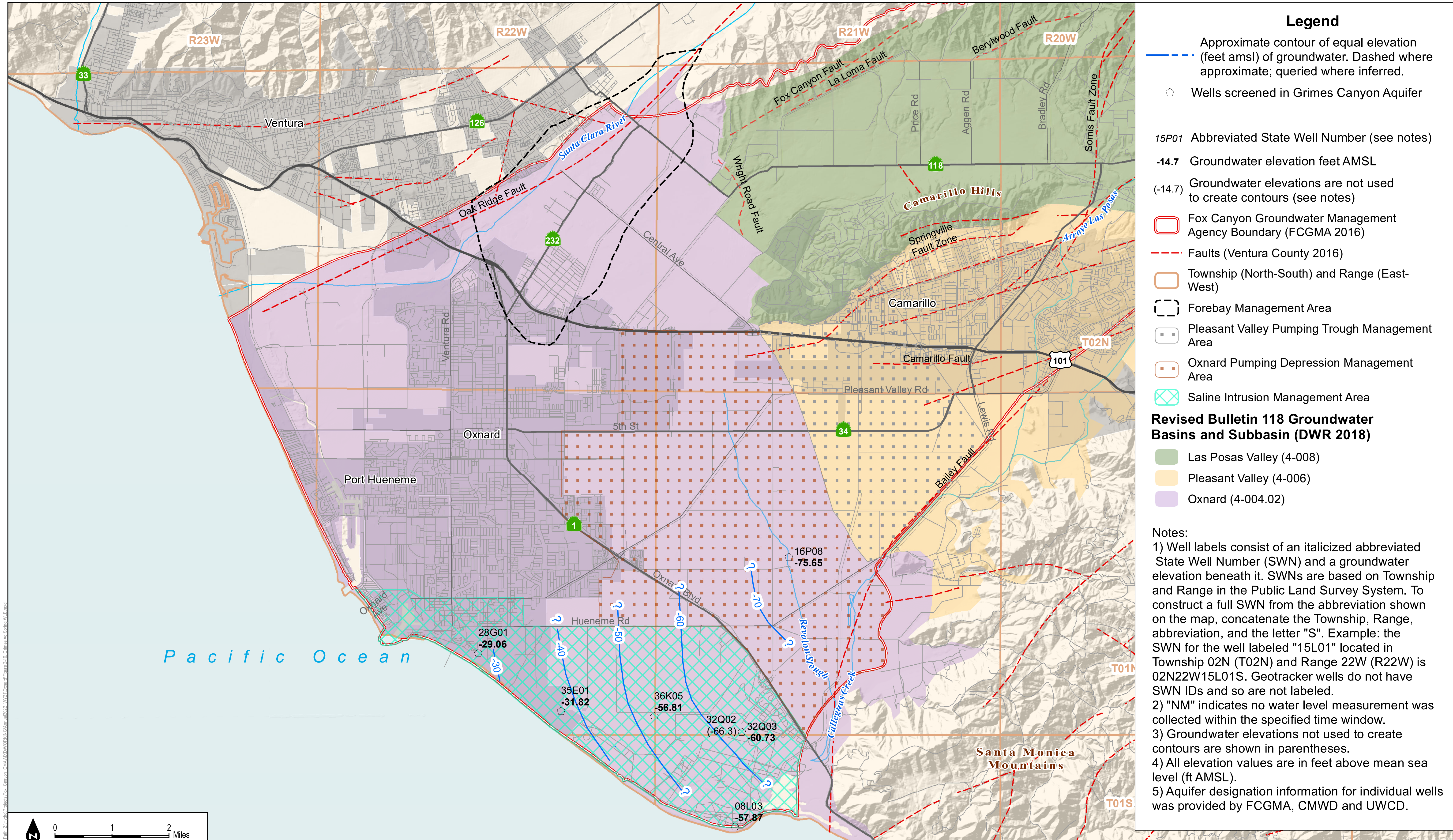
Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report



DUDEK

SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 2-10

Groundwater Elevation Contours in the Grimes Canyon Aquifer, March 2 to March 29, 2021

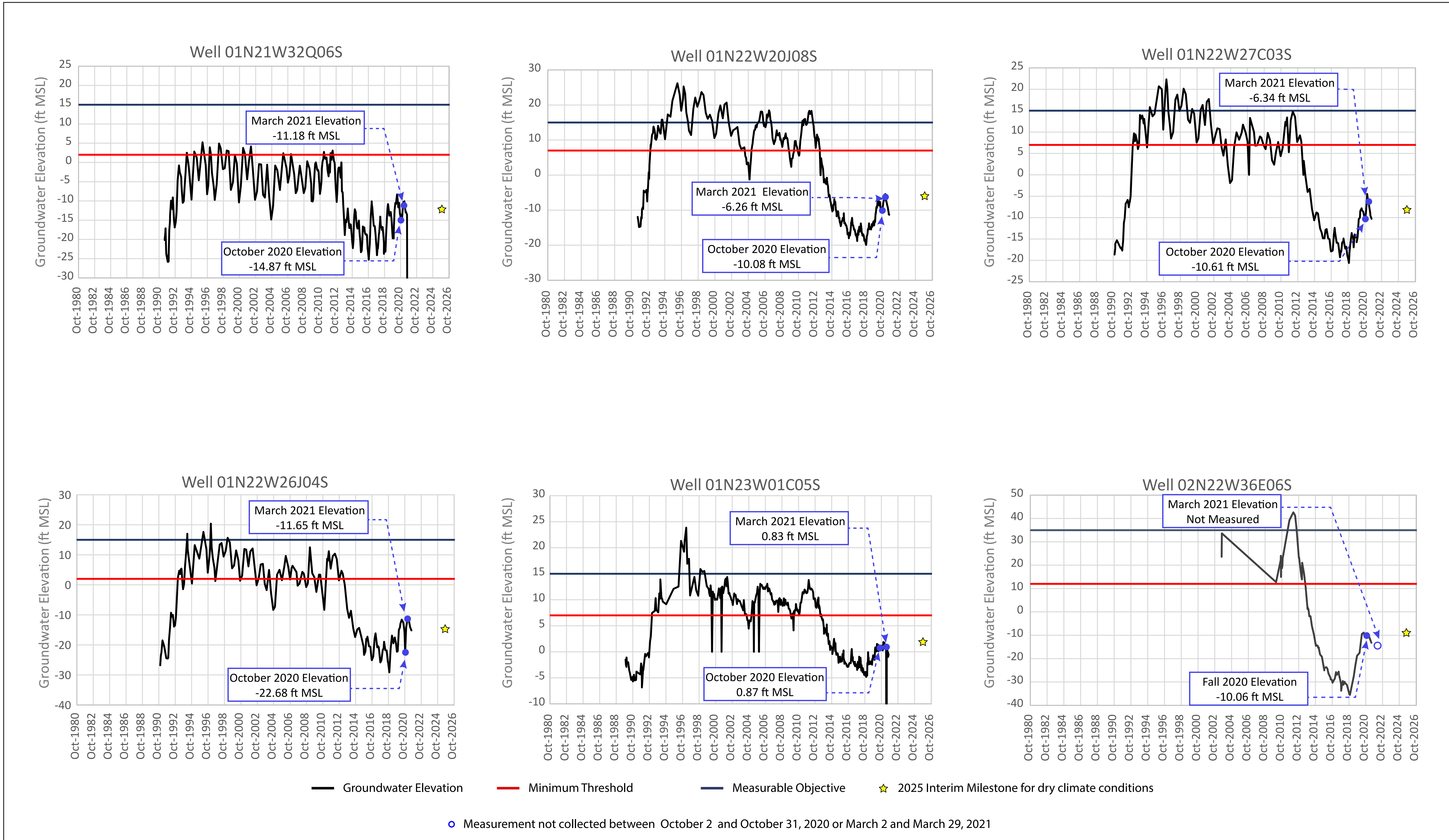


FIGURE 2-11

Groundwater Elevation Hydrographs for Representative Wells Screened in the Oxnard Aquifer

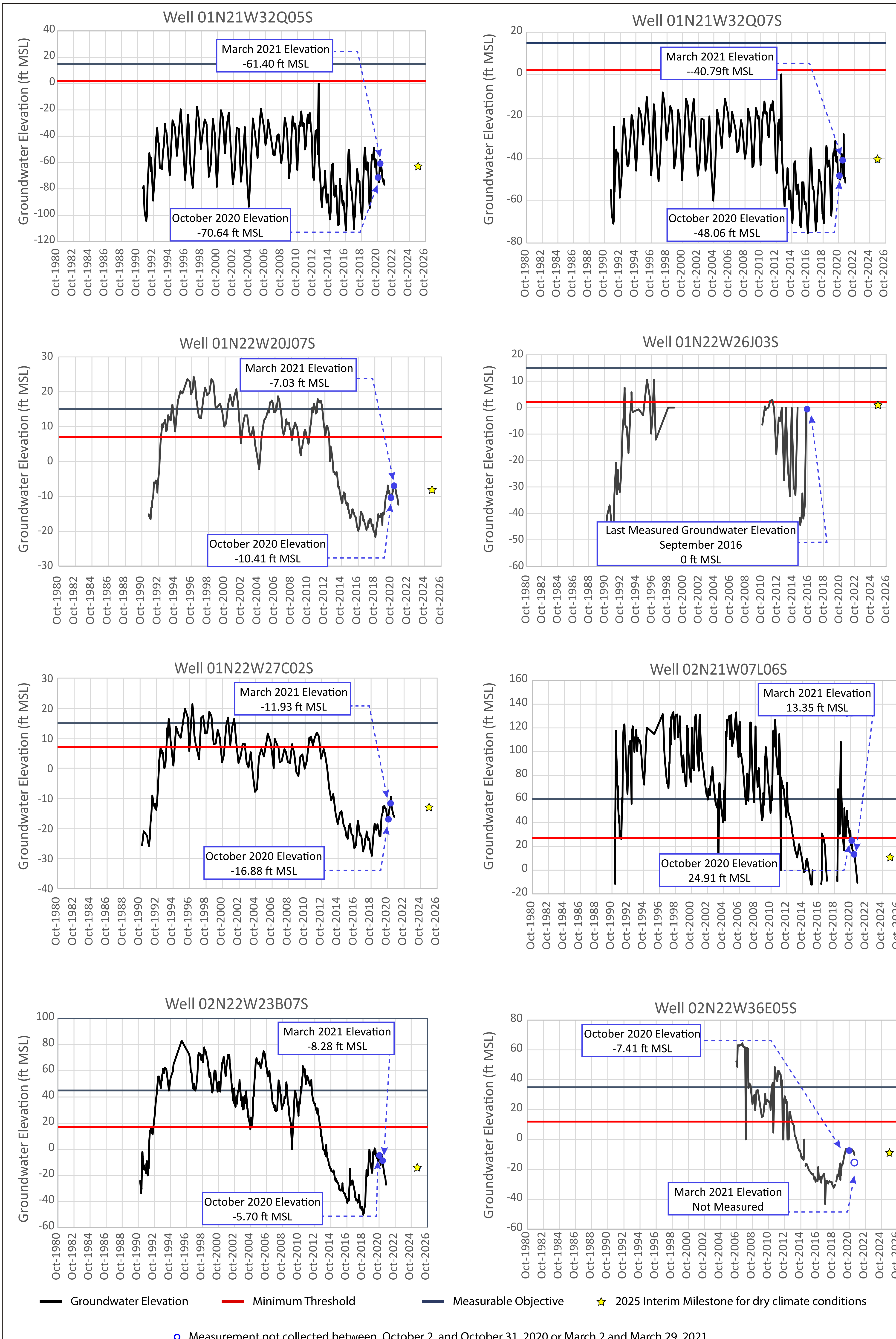


FIGURE 2-12

Groundwater Elevation Hydrographs for Representative Wells Screened in the Mugu Aquifer

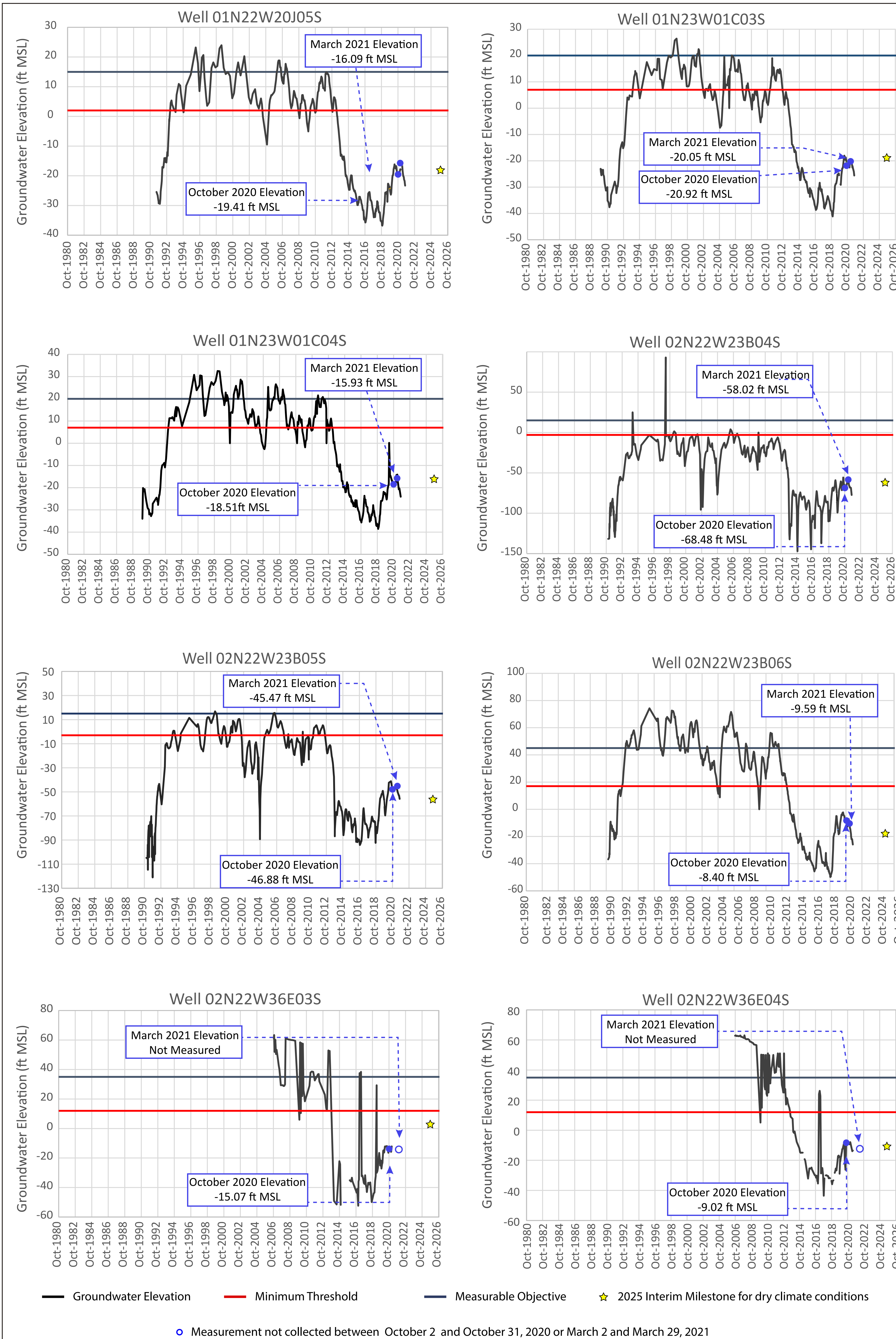


FIGURE 2-13

Groundwater Elevation Hydrographs for Representative Wells Screened in the Hueneme Aquifer

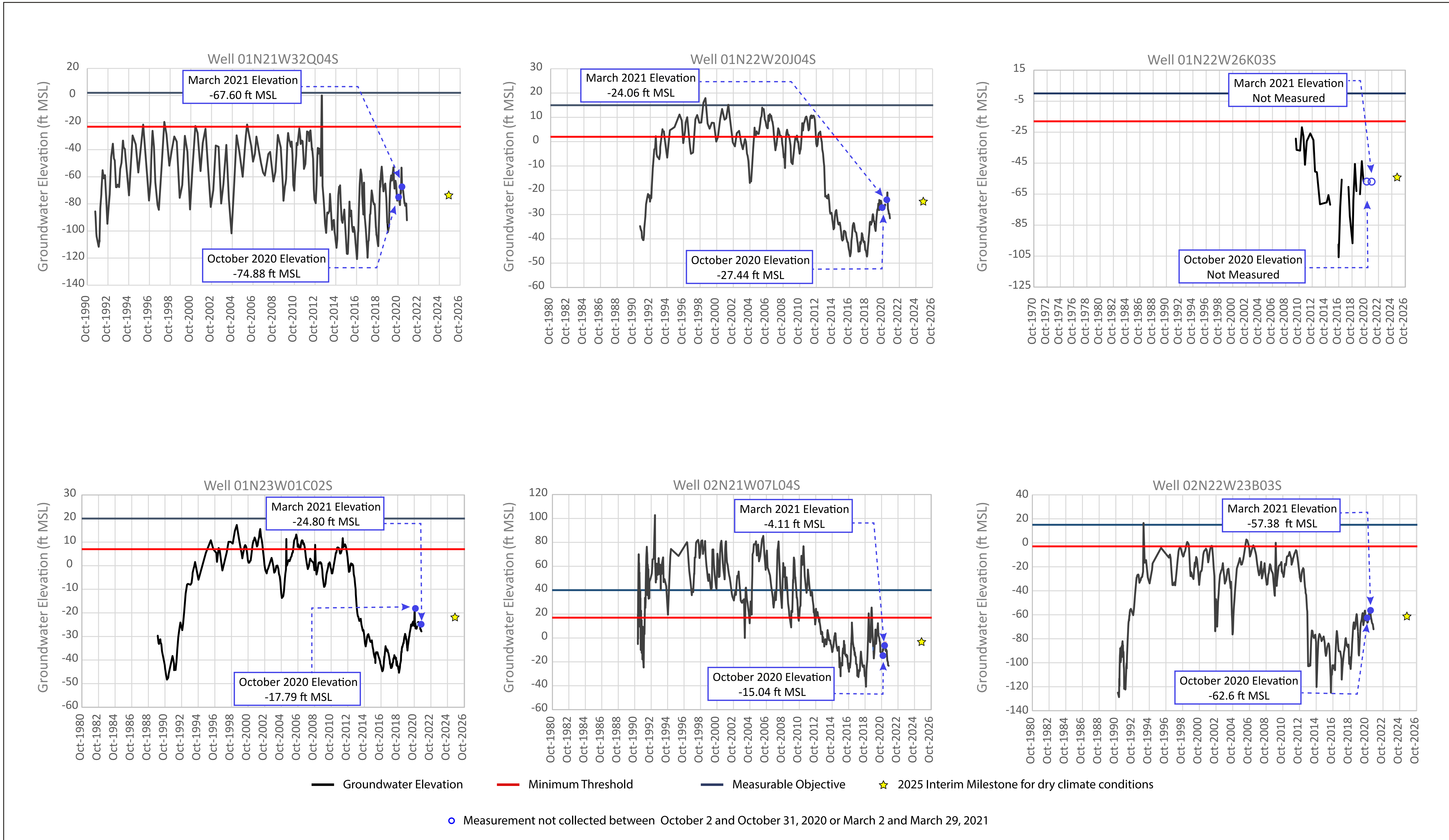


FIGURE 2-14
Groundwater Elevation Hydrographs for Representative Wells Screened in the Fox Canyon Aquifer
Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report

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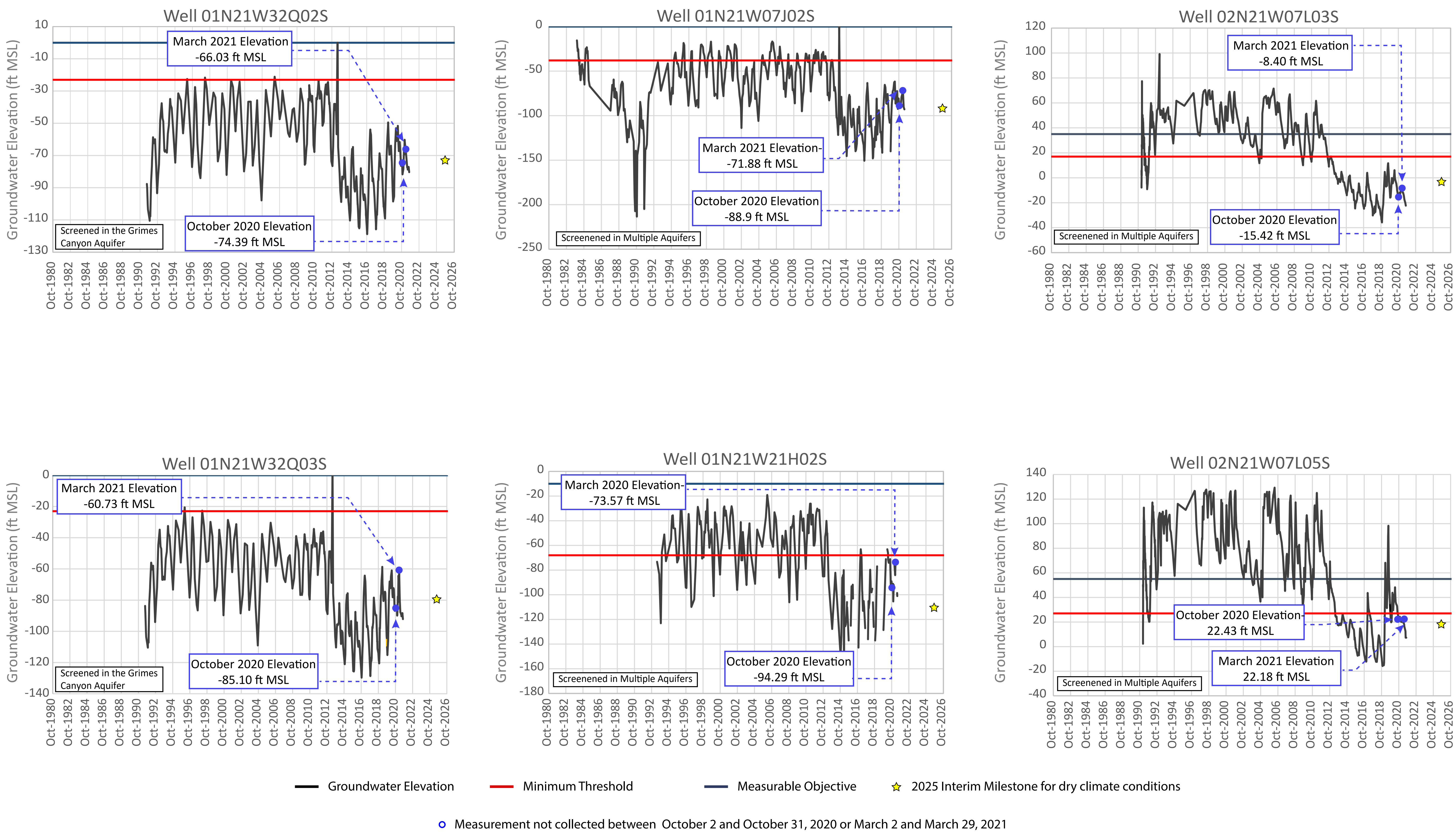
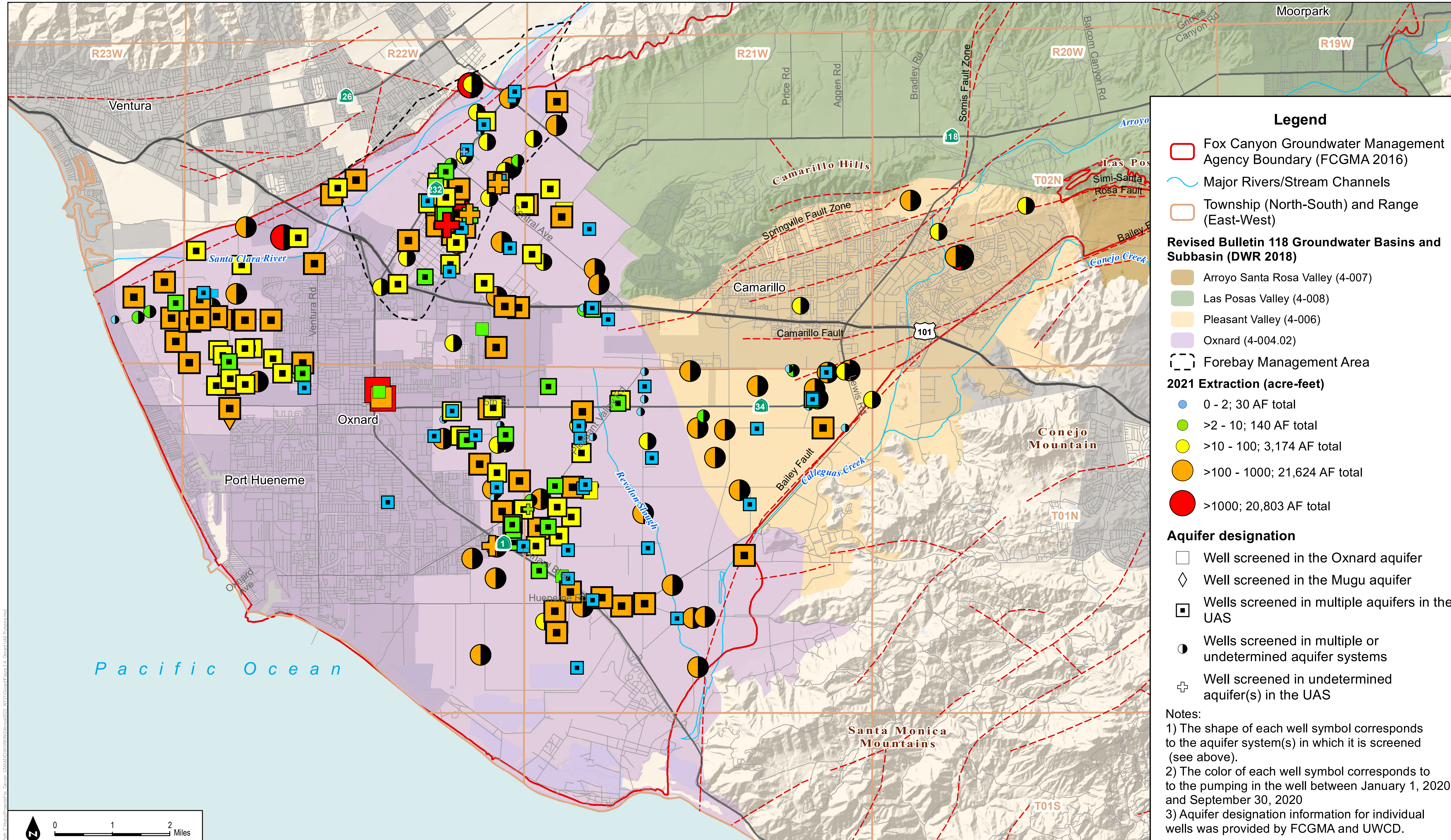


FIGURE 2-15

Groundwater Elevation Hydrographs for Representative Wells Screened in the Grimes Canyon Aquifer and Multiple Aquifers

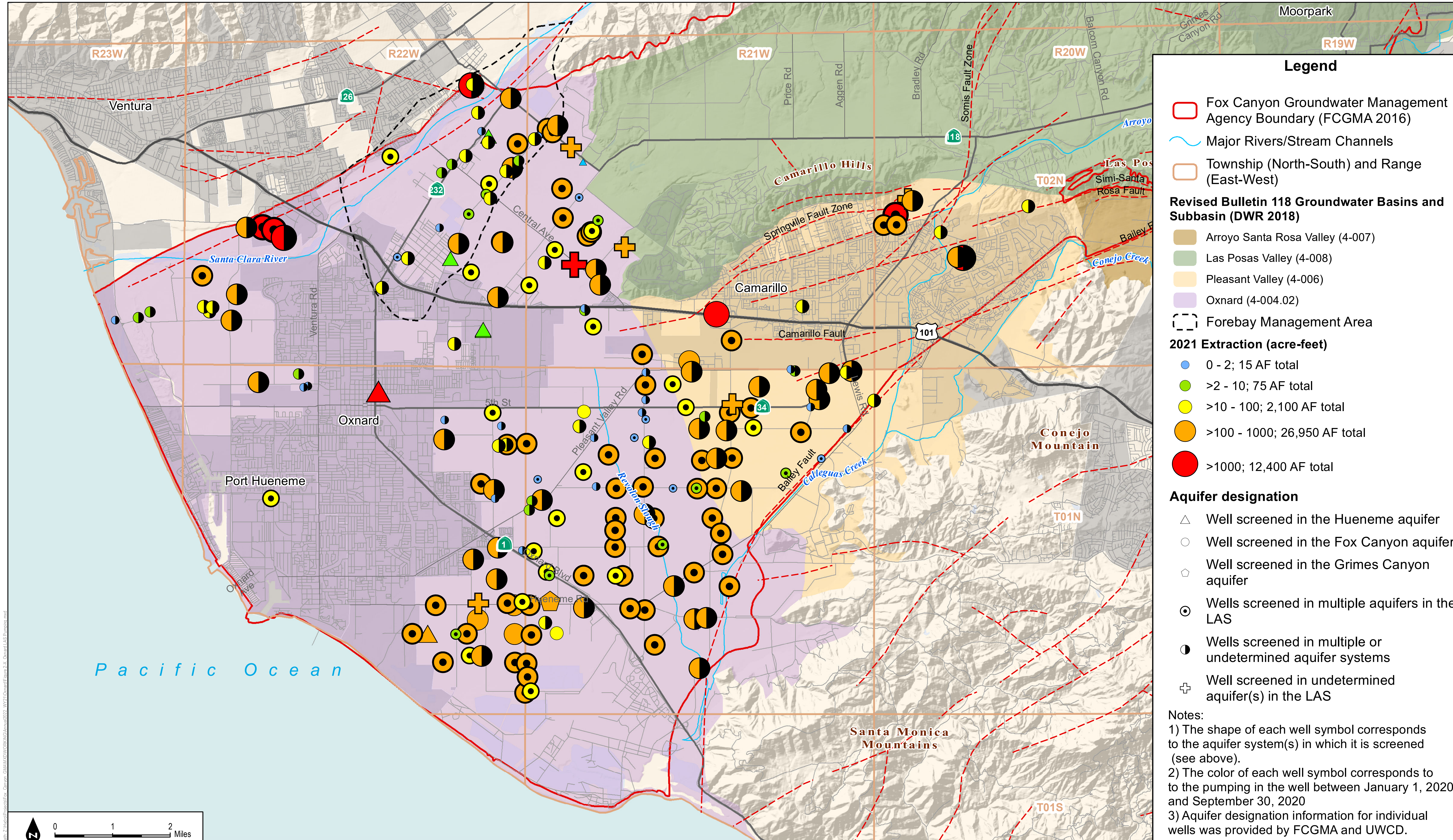


DUDEK

SOURCE: DWR, FCGMA, VCWPD, UWCD

FIGURE 2-16

Groundwater Production from the UAS between October 1, 2020 and September 30, 2021



SOURCE: DWR, FCGMA, VCWPD, UWCD

FIGURE 2-17

Groundwater Production from the LAS between October 1, 2020 and September 30, 2021

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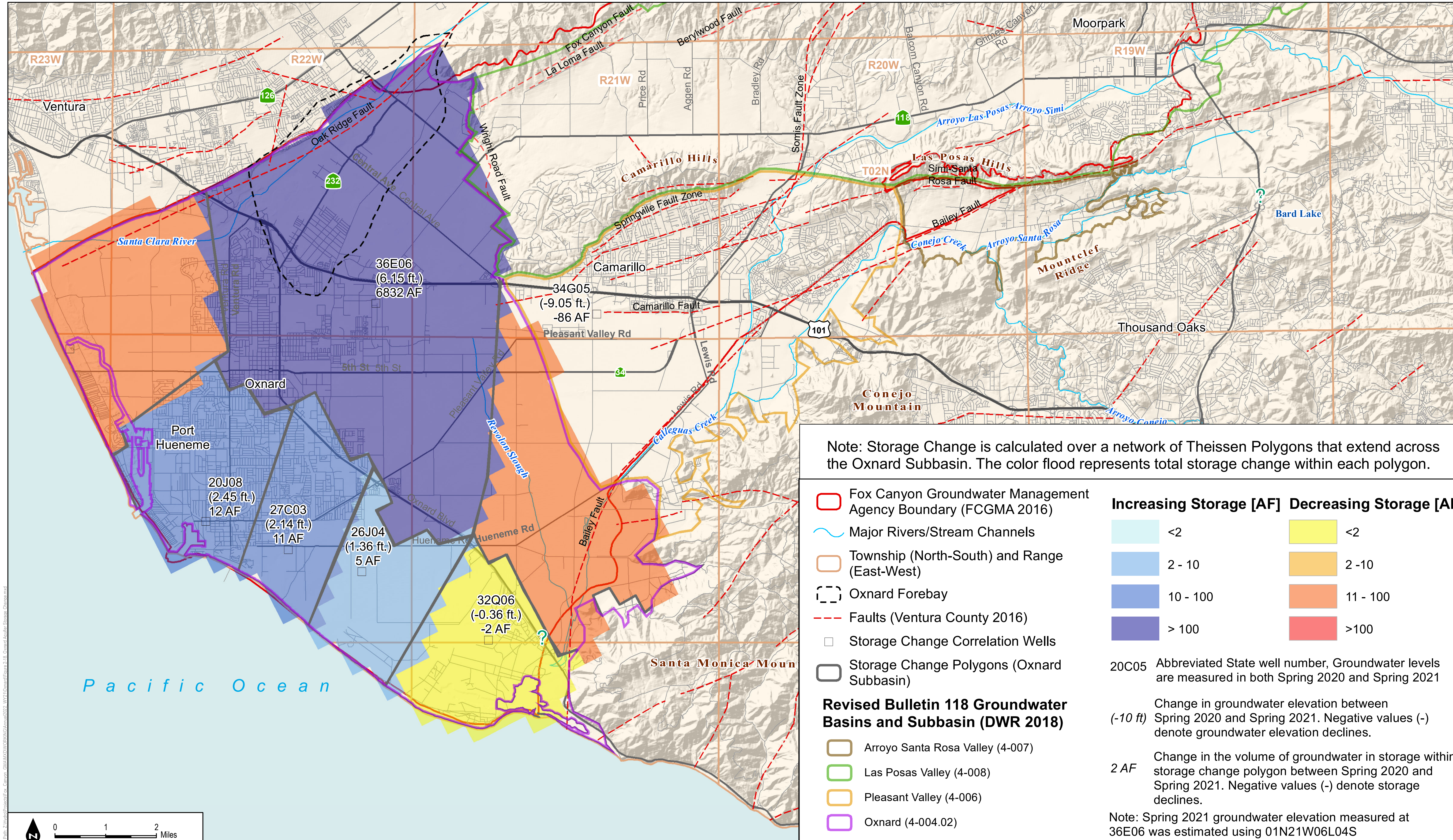
Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report



SOURCE: DWR, FCGMA, VCWPD, CMWD, UWCD

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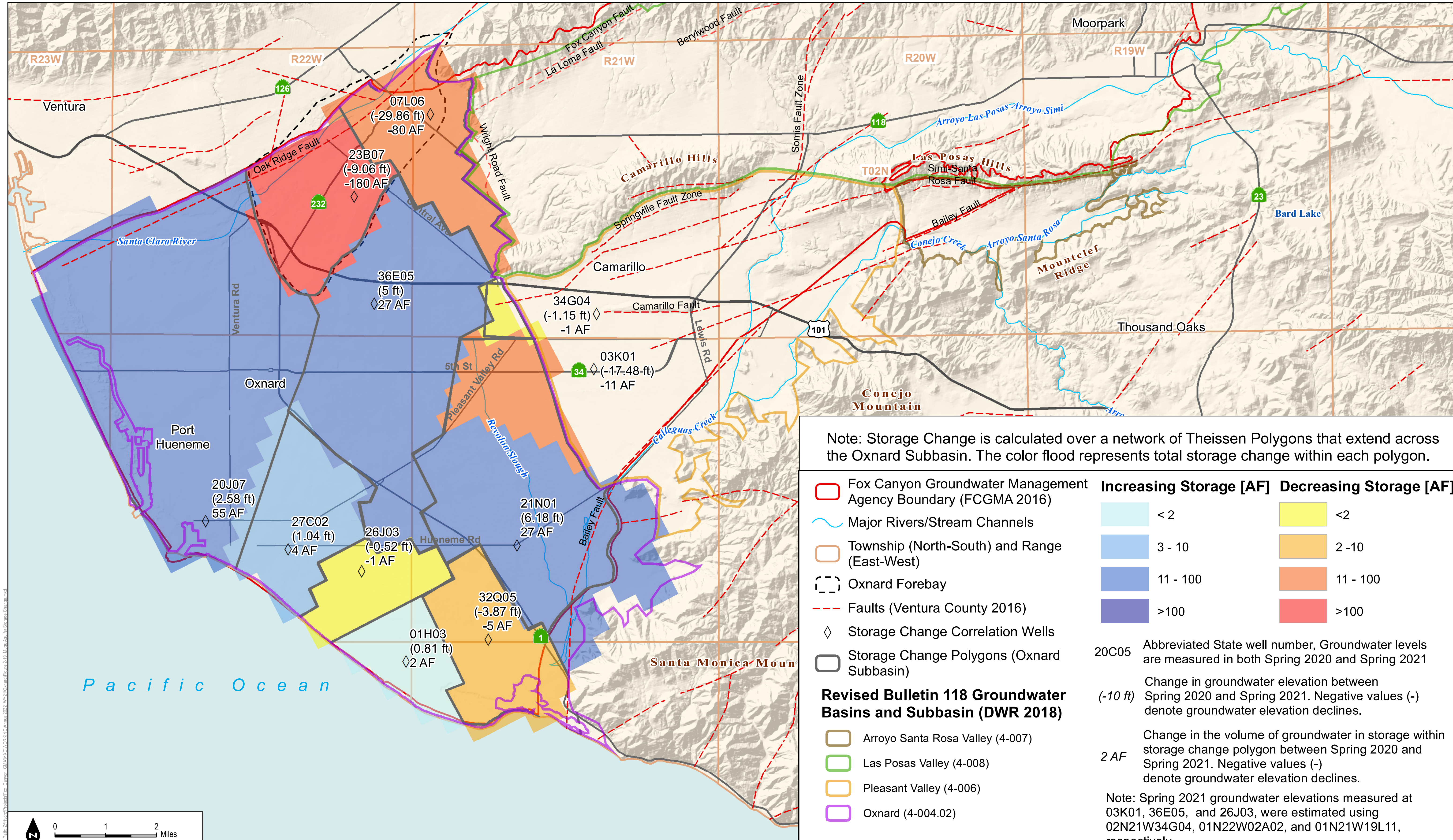
FIGURE 2-18

Change in Storage in the Oxnard Aquifer: Spring 2020 to Spring 2021

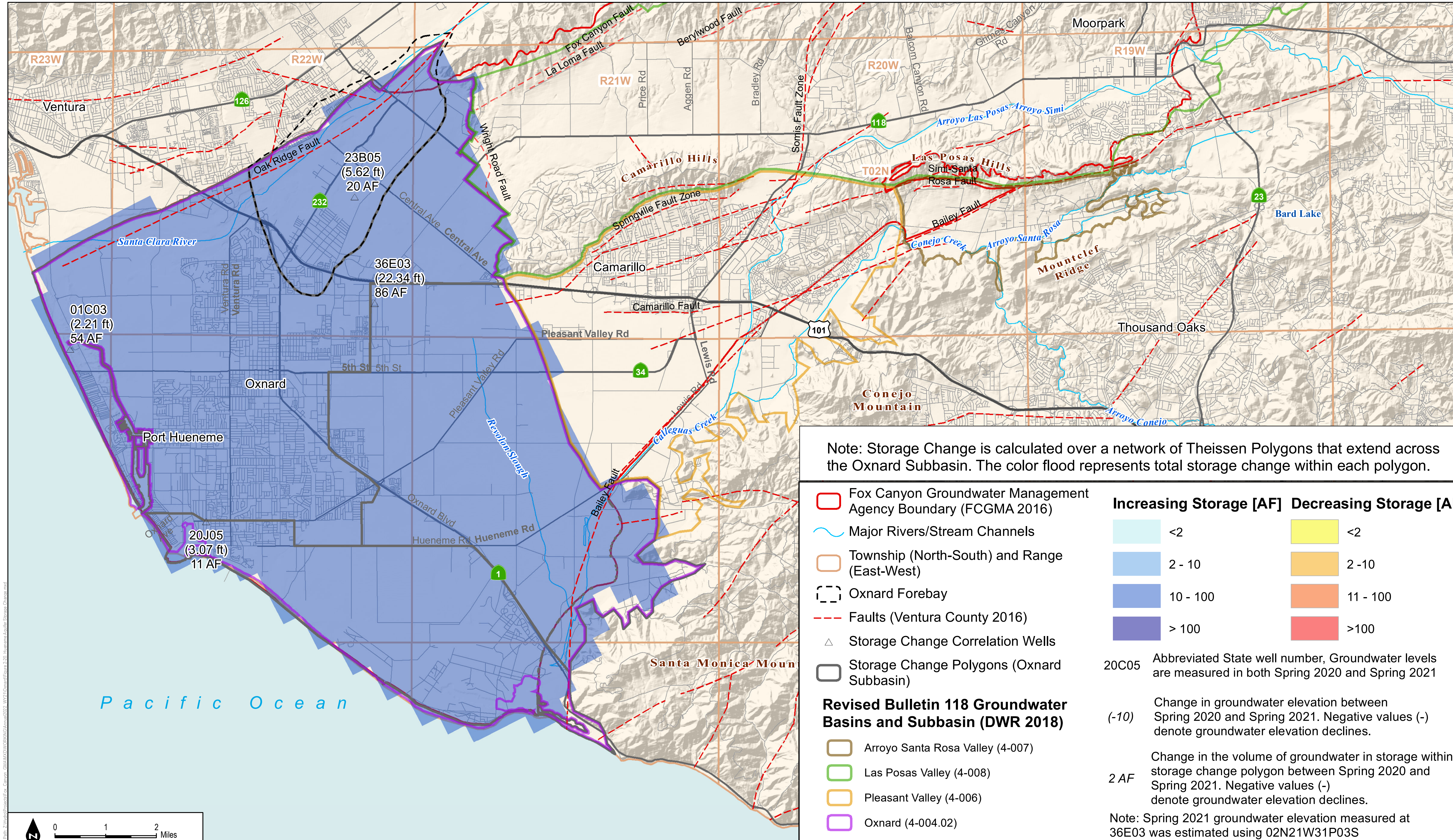


SOURCE: DWR, FCGMA, VCWPD, CMWD, UWCD

FIGURE 2-19

Change in Storage in the Mugu Aquifer: Spring 2020 to Spring 2021

DUDEK



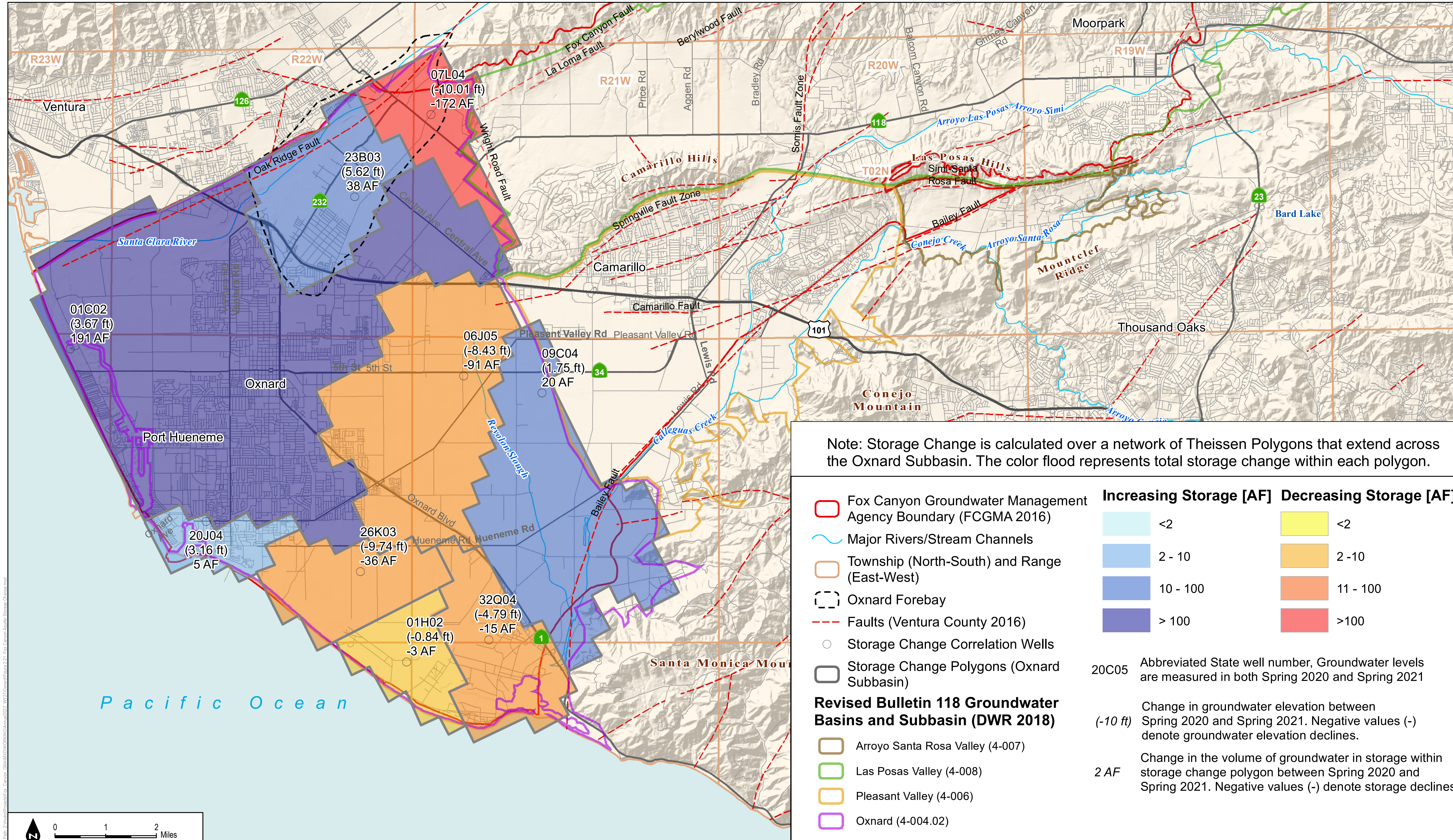
DUDEK

SOURCE: DWR, FCGMA, VCWPD, CMWD, UWCD

FIGURE 2-20

Change in Storage in the Hueneme Aquifer: Spring 2020 to Spring 2021

Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report

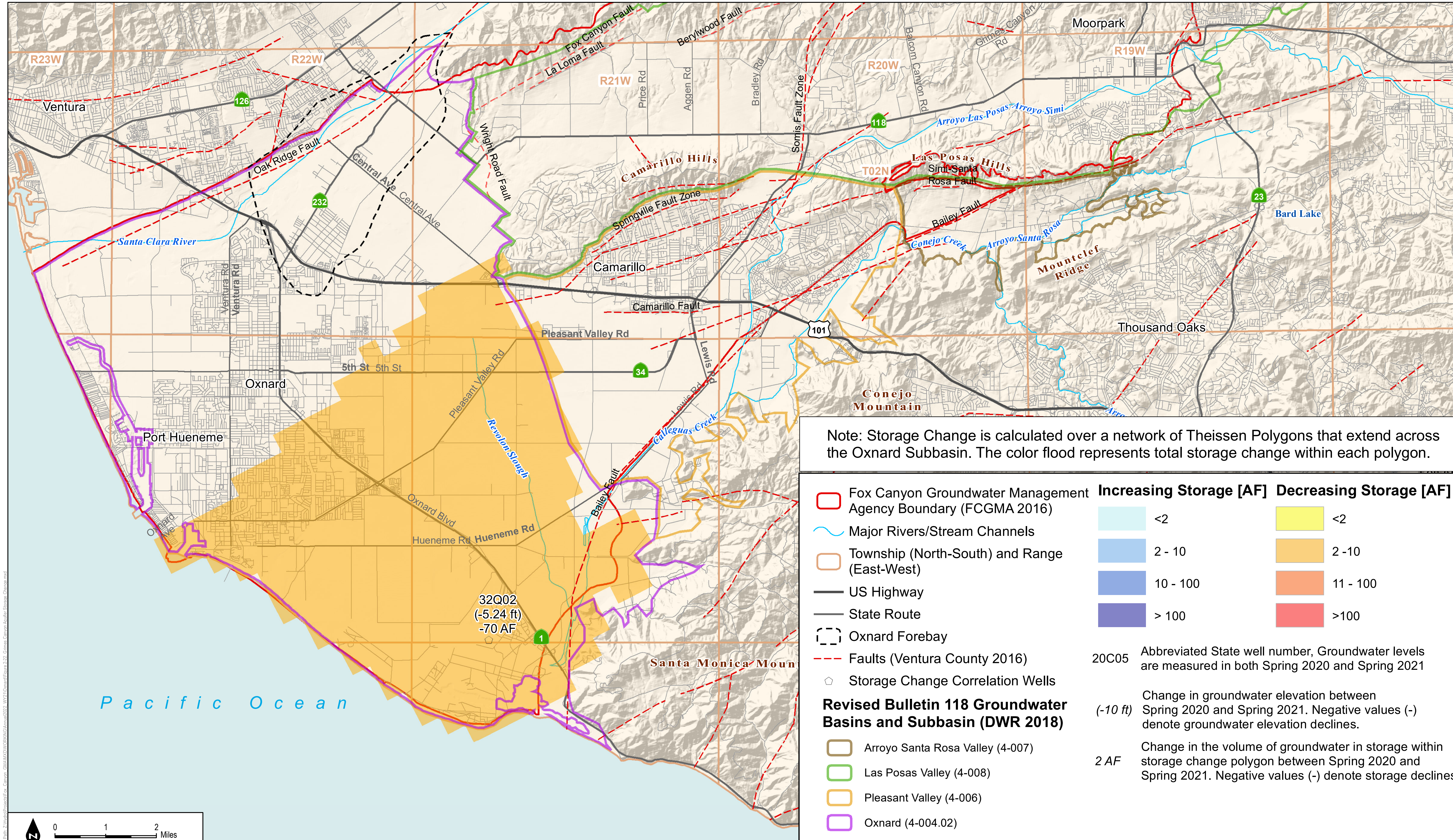


DUDEK

SOURCE: DWR, FCGMA, VCWPD, CMWD, UWCD

FIGURE 2-21

Change in Storage in the Fox Canyon Aquifer: Spring 2020 to Spring 2021



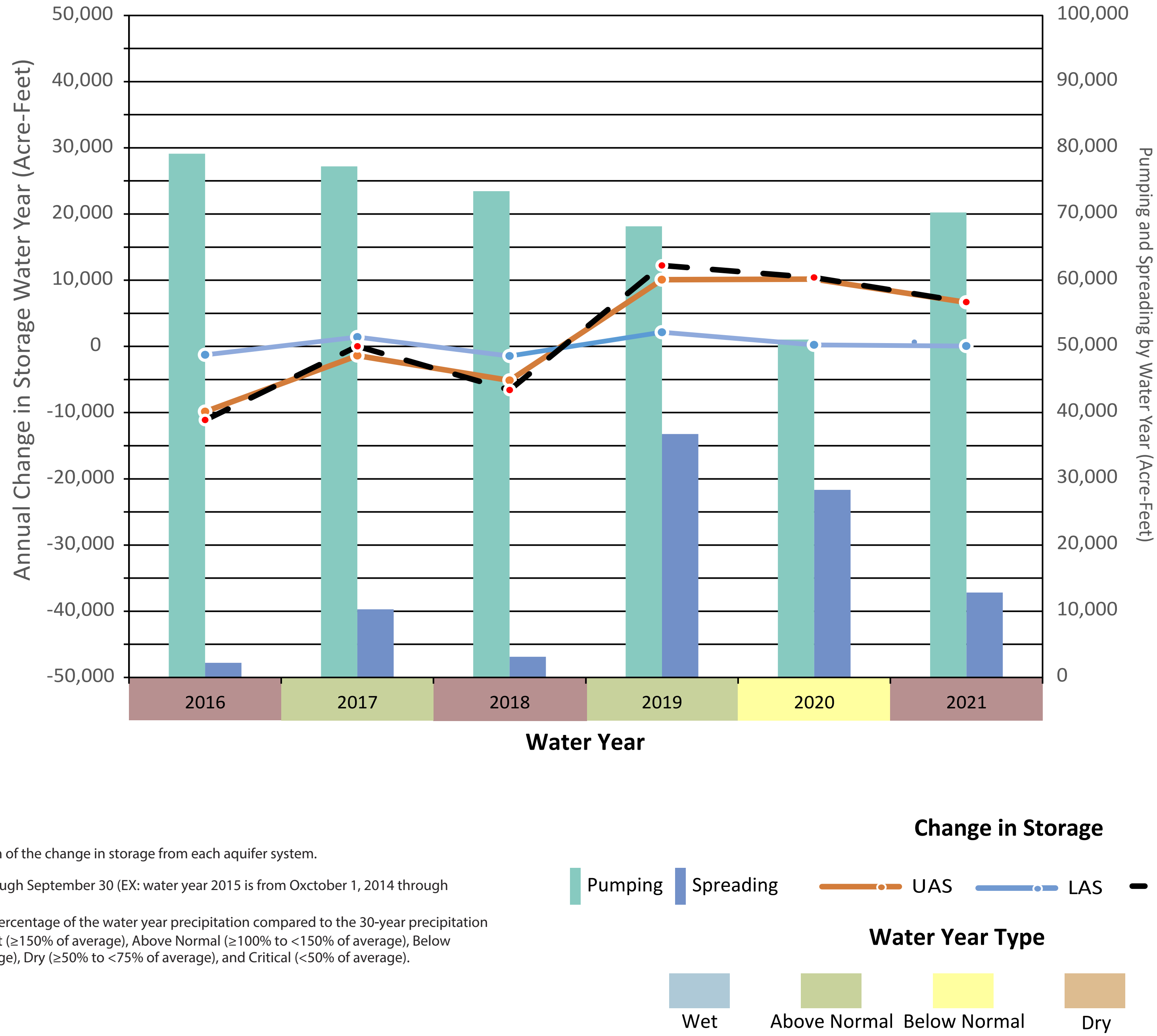
DUDEK

SOURCE: DWR, FCGMA, VCWPD, CMWD, UWCD

FIGURE 2-22

Change in Storage in the Grimes Canyon Aquifer: Spring 2020 to Spring 2021

Oxnard Subbasin Groundwater Sustainability Plan 2022 Annual Report



Notes:

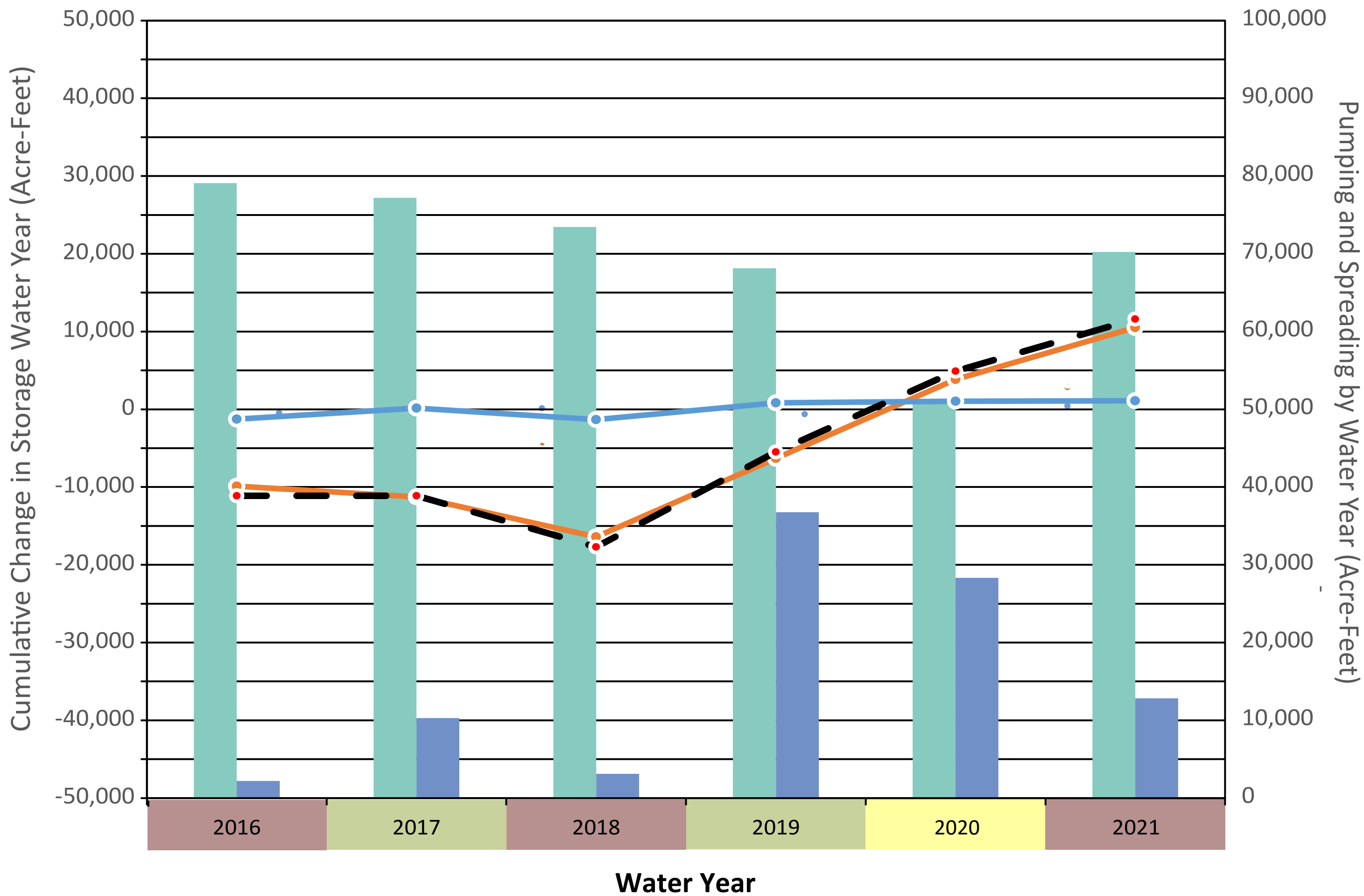
1) Total change in storage is the sum of the change in storage from each aquifer system.

2) Water year is from October 1 through September 30 (EX: water year 2015 is from Oxctober 1, 2014 through September 30, 2015).

3) Water year type is based on the percentage of the water year precipitation compared to the 30-year precipitation average. Types are defined as Wet (≥150% of average), Above Normal (≥100% to <150% of average), Below Normal (≥75% to <100% of average), Dry (≥50% to <75% of average), and Critical (<50% of average).

FIGURE 2-23

Water Year Type, Groundwater Use, and Annual Change in Storage in the Oxnard Subbasin



Notes:

1) Total change in storage is the sum of the change in storage from each aquifer system.

2) Water year is from October 1 through September 30 (EX: water year 2015 is from Oxctober 1, 2014 through September 30, 2015).

3) Water year type is based on the percentage of the water year precipitation compared to the 30-year precipitation average. Types are defined as Wet (≥150% of average), Above Normal (≥100% to <150% of average), Below Normal (≥75% to <100% of average), Dry (≥50% to <75% of average), and Critical (<50% of average).

Change in Storage

Pumping Spreading UAS LAS Total

Water Year Type

Wet Above Normal Below Normal Dry Critical

FIGURE 2-24

Water Year Type, Groundwater Use, and Cumulative Change in Storage in the Oxnard Subbasin

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Appendix A: Change in Storage Technical Memorandum

A.1 Background

The Sustainable Groundwater Management Act's Emergency Groundwater Sustainability Plan Regulations require each Agency to submit an annual report by April 1 of each year characterizing the previous water year groundwater conditions, groundwater usage, and total water supplies (CWC 10733.2). As part of this, each agency is required to quantify the water year change in groundwater storage for each principal aquifer defined in the GSP (§356.2 (5)(A) and §356.2 (5)(B)). The FCGMA has computed annual change in groundwater storage for water years 2016 through 2020 as part of the 2020 and 2021 Annual Reports prepared for the Oxnard Subbasin and Pleasant Valley Basin. These estimates of change in groundwater in storage were computed by mapping spring groundwater elevation contours for each water year onto a uniform grid that covered the areal extent of the Oxnard Subbasin, Pleasant Valley Basin, and West Las Posas Management Area of the Las Posas Valley Basin. The difference in spring groundwater elevation maps was then computed for each consecutive water year and multiplied by the aquifer properties extracted from the Ventura Regional Groundwater Flow Model (UWCD 2018) to calculate localized changes in the volume of groundwater in storage. The total change in groundwater in storage for each principal aquifer was computed by summing the change in groundwater storage values across the entire uniform grid.

As noted in the 2020 and 2021 Annual Reports, this method for estimating storage change is sensitive to the contouring methods, and, importantly, to the network of groundwater elevation monitoring wells sampled each year (FCGMA 2020a, 2020b, 2021a, 2021b). Because the same wells were not consistently monitored during consecutive water years, and data gaps exist that limit the area over which groundwater elevations are measured in the OPV, the estimated change in storage for water years 2016 through 2020 were limited to an area smaller than the entire extent of the Oxnard Subbasin and Pleasant Valley Basin (FCGMA 2020a, 2020b, 2021a, 2021b).

To address these limitations, the FCGMA has revised the approach for estimating storage change as part of the 2022 Annual Report covering the 2021 water year. This revised methodology utilizes a fixed monitoring well network and correlates groundwater elevations measured at each well to simulated change in groundwater storage computed by the Ventura Regional Groundwater Flow Model developed by UWCD (UWCD 2018). This approach expands on method utilized for the 2020 and 2021 Annual Reports by providing estimates of storage change across the entire OPV and largely eliminates the sensitivity to the monitoring well network sampled annually.

This Appendix describes the details of this revised methodology (Section A.2) and provides updated estimates of the change in groundwater storage for water years 2016 through 2021 (Section A.3). A validation of this method is provided in Section A.3).

A.2 Methodology

Estimates of the change in groundwater in storage are based on spring groundwater elevations measured at a fixed set of monitoring wells. Each of these monitoring wells are individually screened within the five principal aquifers in the Oxnard Subbasin (FCGMA 2019a), and three of the principal aquifers in Pleasant Valley Basin GSPs (FCGMA 2019b). These monitoring well networks extend across the Oxnard Subbasin and Pleasant Valley Basin and include the key wells identified in each respective GSP (FCGMA 2019a, 2019b). In addition to the key wells, the storage change monitoring network includes a set of wells that were not designated as key wells but provide localized constraints on groundwater conditions within the Oxnard and Pleasant Valley Pumping Depression Management Areas and the Saline Intrusion Management Area. The storage change well network is shown graphically in Figure 2-18 through Figure 2-22 of the 2022 Annual Report.

To estimate the change in storage corresponding to groundwater elevation changes measured at each well, a series of Thiessen Polygons were first generated using Geographical Information Software (GIS) to define representative areas surrounding each monitoring well. These Thiessen Polygons were extended to the boundary of the Oxnard

Subbasin and Pleasant Valley Basin and were locally constrained by the Management Area boundaries defined in the Oxnard and Pleasant Valley GSPs (FCGMA 2019a, 2019b). The Thiessen Polygons were then mapped onto the Ventura Regional Groundwater Flow Model grid, and model-calculated annual change in storage values were extracted from each polygon area for water years 1986 through 2014[1]. Because storage change for each annual report has been estimated using seasonal high (spring) conditions, the water year storage change extracted from the UWCD numerical model was computed from spring to spring[2].

Linear regression models were then calculated using the spring[3] groundwater elevation measured at each well and the cumulative change in storage extracted from the Ventura Regional Groundwater Flow Model. These linear regression models provide a direct estimate of the cumulative change in groundwater storage since March 1985 within each representative polygon based solely on the corresponding spring groundwater elevation. Differences in the cumulative change in storage between consecutive water years computed using the regression models were then used to calculate the annual change in storage over a given water year.

A.3 Results

1.1 Oxnard Aquifer

Change in groundwater in storage for the Oxnard aquifer was estimated using network of seven monitoring wells, six of which are located in the Oxnard Subbasin and one that is located in the Pleasant Valley Basin (Table A.3.1). The correlation between simulated storage change within each Thiessen Polygon and the corresponding spring groundwater elevation measurements are shown in Figures A.3-1 and A.3-2 and summarized in Table A.3.1.

The largest simulated changes in groundwater storage in the Oxnard aquifer occur in the Forebay Management Area, and downgradient towards the central Oxnard Subbasin and Pumping Depression Management Area. In this region of the Oxnard Subbasin, the UWCD model predicts that groundwater in storage changed at an average rate of approximately 2,400 AFY (Table A.3.1). Groundwater elevations measured at 02N2236E06S are strongly correlated with the modeled storage change results (Table A.3.1). Across the entirety of the Oxnard Subbasin, the linear regression models developed for each Thiessen polygon describe more than 95% of the simulated storage change for the Oxnard Subbasin (Figure A.3-3).

The revised storage change values presented in the Oxnard Subbasin GSP 2022 Annual Report are in general agreement with the values presented in the 2021 Annual Report (FCGMA 2021a). Estimates calculated using the linear regression models produce larger changes in storage than those estimated from the spring groundwater elevation contour maps. This is largely because the contour maps only resolved storage change associated with groundwater elevation changes larger than 10-feet from year to year. This 10-foot resolution reflects the contour spacing used to prepare water year contour maps for the Oxnard aquifer. Conversely, the storage change values calculated using the linear regression models are limited by the measurement resolution associated with groundwater elevations collected at each storage change well.

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[1] The Ventura Regional Groundwater Flow Model was designed to simulated conditions in the Oxnard Subbasin, Pleasant Valley Basin, and West Las Posas Management Area of the Las Posas Valley Basin for the period from January 1, 1985 through December 31, 2015. Accordingly, the corresponding complete water years simulated by the model are 1986 through 2014.

[2] Water year storage change was calculated as the change in storage between spring conditions. For example, the water year 1986 storage change extracted from the UWCD model corresponded to the 12-month period from March 1985 through April 1986

[3] Spring groundwater elevation was defined as a groundwater elevation measured during March or April of each year.

Table A.3.1 Oxnard Aquifer Storage Change Wells and Correlation Statistics

State Well Number	Key Well?	Basin	Region	Oxnard Subbasin		
				Avg Annual Change in Storage (AF)	Correlation Coefficient (R^2)	Change in Storage * R^2
02N21W34G05S	Yes	PVB	PDMA	-10	0.69	-7
02N22W36E06S	Yes	Oxn	-NA-	-2,404	0.97	-2,335
01N21W32Q06S	Yes	Oxn	SIMA	0	0.59	0
01N22W27C03S	Yes	Oxn	SIMA	-2	0.91	-2
01N22W26J04S	Yes	Oxn	SIMA	0	0.79	0
01N22W20J08S	Yes	Oxn	SIMA	-3	0.92	-2
01N23W01C05S	Yes	Oxn	SIMA	-8	0.72	-6
Estimated Uncertainty				**3%**		

AF = Acre-Feet; “-NA-“ = Not Applicable, “PVB” = Pleasant Valley Basin, “Oxn” = Oxnard Subbasin, “PDMA” = Pumping Depression Management Area, “SIMA” = Saline Intrusion Management Area; “FMA” = Forebay Management Area

1.2 Mugu Aquifer

Change in groundwater in storage for the Mugu aquifer was estimated using a network of eleven monitoring wells, nine of which are located in the Oxnard Subbasin and two that are located in the Pleasant Valley Basin (Table A.3.2). Two groundwater elevation monitoring wells that were not designated as key wells in the Oxnard Subbasin GSP were included in the network of storage change wells: 01N2121N01S and 01S22W01H03S. These wells were added to provide additional characterization of the relationship between groundwater elevations and storage change in the Pumping Depression Management Area and Saline Intrusion Management Area (Figure A.2-2). The correlation between simulated storage change within each Thiessen Polygon and the corresponding spring groundwater elevation measurements are shown in Figures A.3-4 and A.3-5 and summarized in Table A.3.2.

The largest changes in groundwater storage in the Mugu aquifer have historically occurred in the Forebay Management Area (Table A.3.2). There are two key wells in the Forebay Management Area of the Mugu aquifer that constrain groundwater conditions in this part of the Subbasin: 02N21W07L06S and 02N22W23B07S. Combined, groundwater elevation changes measured at these two wells describe approximately 85% of the variation in simulated storage change extracted from the UWCD Model (Table A.3.2).The series of linear regressions developed using the eleven wells in Table A.3.2 account for approximately 90% of the simulated storage change extracted from the UWCD model for the entire Mugu aquifer in the Oxnard Subbasin (Figure A.3-6).

Similar to the Oxnard aquifer, the water year 2016 through 2019 storage change estimates produced using the linear regression models are larger than those estimated using spring groundwater elevation contour maps. This difference reflects the 10-foot contour resolution utilized to prepare spring contour maps for the Mugu aquifer, as well as the limited spatial coverage of groundwater elevation measurements in the Mugu aquifer. The linear regression models provide the ability to estimate storage change associated with groundwater elevation changes less than 10-feet and also provide the ability to estimate storage change across the entirety of the Mugu aquifer.

Table A.3.2 Mugu Aquifer Storage Change Wells and Correlation Statistics

State Well Number	Key Well?	Basin	Region	Oxnard Subbasin		
				Avg Annual Change in Storage (AF)	Correlation Coefficient (R^2)	Change in Storage * R^2
01N21W21N01S	**No**	Oxn	PDMA	0	0.74	0
01N21W03K01S	Yes	PVB	PDMA	-1	0.47	0
02N22W36E05S	Yes	Oxn	-NA-	-14	0.89	-12
01N22W27C02S	Yes	Oxn	SIMA	-2	0.86	-1
01N22W26J03S	Yes	Oxn	SIMA	0	0.71	0
01N21W32Q05S	Yes	Oxn	SIMA	0	0.64	0
01S22W01H03S	**No**	Oxn	SIMA	0	0.83	0
02N21W34G04S	Yes	PVB	PDMA	0	0.77	0
01N22W20J07S	Yes	Oxn	SIMA	-6	0.93	-6
02N21W07L06S	Yes	Oxn	FMA	-20	0.90	-18
02N22W23B07S	Yes	Oxn	FMA	-67	0.80	-54
Estimated Uncertainty				**2%**		

AF = Acre-Feet; "-NA-" = Not Applicable, "PVB" = Pleasant Valley Basin, "Oxn" = Oxnard Subbasin, "PDMA" = Pumping Depression Management Area, "SIMA" = Saline Intrusion Management Area; "FMA" = Forebay Management Area

1.3 Hueneme Aquifer

Change in groundwater in storage for the Hueneme aquifer was estimated using a network of four monitoring wells located in the Oxnard Subbasin (Table A.3.3). Each of these wells are designated as key wells in the Oxnard Subbasin GSP (FCGMA 2019a). The correlation between simulated storage change within each Thiessen Polygon and the corresponding spring groundwater elevation measurements are shown in Figures A.3-7 and A.3-8 and are summarized in Table A.3.3. The change in groundwater storage in the Hueneme aquifer was not estimated for the Pleasant Valley Basin because there were no monitoring wells screened solely in the Hueneme aquifer with sufficient historical record to develop correlations with model results.

In general, there is a strong correlation between modeled storage change and the measured spring groundwater elevations (Table A.3.3). The Ventura Regional Groundwater Flow model indicates that the largest groundwater storage changes in the Hueneme aquifer have historically occurred in central part Oxnard Subbasin and along the coastline, north of Port Hueneme. In this part of the Subbasin, the linear regression model developed using spring groundwater elevations measured at 01N23W01C03S describes approximately 90% of the historical variations in groundwater in storage. A comparison of the cumulative change in storage between water year 1986 and 2015 estimated using the Ventura Regional Groundwater Flow Model (Black line and markers) and the linear regression models (Black line, grey symbols) indicates that the regression model sufficiently describes the change in storage in the Hueneme aquifer.

The water year 2016 through 2019 storage change values calculated using the linear regression models are larger than those previously estimated using spring groundwater elevation contour maps. Estimates of the change in groundwater storage calculated using the spring groundwater elevation contour maps were constrained to a small fraction of the total areal extent of the Hueneme aquifer in the Oxnard Subbasin (FCGMA 2021a). The linear regression models estimate storage change in the Hueneme aquifer across the entire Subbasin.

Table A.3.3 Hueneme Aquifer Storage Change Wells and Correlation Statistics

State Well Number	Key Well?	Basin	Region	Oxnard Subbasin		
				Avg Annual Change in Storage (AF)	Correlation Coefficient (R^2)	Change in Storage * R^2
02N22W36E03S	Yes	Oxn	-NA-	-13	0.61	-8
01N23W01C03S	Yes	Oxn	-NA-	-33	0.89	-29
01N22W20J05S	Yes	Oxn	SIMA	-4	0.74	-3
02N22W23B05S	Yes	Oxn	FMA	-9	0.97	-9
Estimated Uncertainty				**6%**		

AF = Acre-Feet; "-NA-" = Not Applicable, "PVB" = Pleasant Valley Basin, "Oxn" = Oxnard Subbasin, "PDMA" = Pumping Depression Management Area, "SIMA" = Saline Intrusion Management Area; "FMA" = Forebay Management Area

1.4 Fox Canyon Aquifer

Change in groundwater in storage for the Fox Canyon aquifer was estimated using a network of twelve monitoring wells, nine of which are located in the Oxnard Subbasin and three that are located in the Pleasant Valley Basin (Table A.3.4). Four groundwater elevation monitoring wells that were not designated as key wells in the Oxnard Subbasin GSP or Pleasant Valley GSP were included in the network of storage change wells: 01N21W09C04S, 01N21W06J05S, 01S22W01H02S, and 02N2134G03S (Table A.3.4). These wells were added to provide additional characterization of the relationship between groundwater elevations and storage change in the Pumping Depression Management Area and Saline Intrusion Management Area. The correlation between simulated storage change within each Thiessen Polygon and the corresponding spring groundwater elevation measurements are shown in Figures A.3-10 and A.3-11 and are summarized in Table A.3.4.

The correlation between spring groundwater elevations and cumulative storage change calculated by the Ventura Regional Groundwater Flow Model are in good agreement in the Oxnard Subbasin (Figure A.3-12). The Ventura Regional Groundwater Flow Model indicates that the largest changes in groundwater storage have historically occurred in the western part of the Oxnard Subbasin (represented with well 01N23W01C02S) and in the Forebay Management Area (Table A.3.4). In these regions of the Subbasin, the regression models account for, on average, approximately 85% of the variance in cumulative storage change extracted from the Ventura Regional Groundwater Flow Model.

The change in storage values calculated for water years 2016 through 2019 using the linear regression models for the Fox Canyon aquifer are in agreement with those estimated using the spring contour maps. However, the spring contour map estimates of storage change did not extend across the entire Subbasin and only resolved groundwater elevation changes that exceeded 20 feet (FCGMA 2021a). As a result, the change in groundwater storage calculated with the spring contour maps are lower than those calculated using the linear regression models.

Table A.3.4 Fox Canyon aquifer Storage Change Wells and Correlation Statistics

State Well Number	Key Well?	Basin	Region	Oxnard Subbasin		
				Avg Annual Change in Storage (AF)	Correlation Coefficient (R^2)	Change in Storage * R^2
01N21W09C04S	**No**	Oxn	PDMA	-18	0.86	-16
01N21W06J05S	**No**	Oxn	PDMA	-27	0.84	-23
01N23W01C02S	Yes	Oxn	-NA-	-62	0.96	-60
01N22W26K03S	Yes	Oxn	SIMA	-4	0.96	-4
01N22W20J04S	Yes	Oxn	SIMA	-2	0.92	-1
01N21W32Q04S	Yes	Oxn	SIMA	-5	0.52	-3
01S22W01H02S	**No**	Oxn	SIMA	-2	0.48	-1
02N21W07L04S	Yes	Oxn	FMA	-69	0.64	-45
02N22W23B03S	Yes	Oxn	FMA	-17	0.97	-17
02N21W34G03S	No	PVB	PDMA	-NA-	-NA-	-NA-
01N21W03C01S	Yes	PVB	PDMA	-NA-	-NA-	-NA-
02N20W19M05S	Yes	PVB	NPVB	-NA-	-NA-	-NA-
Estimated Uncertainty				5%		

AF = Acre-Feet; "-NA-" = Not Applicable, "PVB" = Pleasant Valley Basin, "Oxn" = Oxnard Subbasin, "PDMA" = Pumping Depression Management Area, "SIMA" = Saline Intrusion Management Area; "FMA" = Forebay Management Area, "NPVB" = North PVB

1.5 Grimes Canyon Aquifer

Change in groundwater in storage was estimated for the Grimes Canyon aquifer using one well located in the Saline Intrusion Management Area. This monitoring well is designated as a key well in the Oxnard GSP (FCGMA 2019a). The correlation between simulated storage change within each Thiessen Polygon and the corresponding spring groundwater elevation measurements are shown in Figures A.3-13 and A.3-14, and are summarized in Table A.3.5.The change in groundwater storage in the Grimes Canyon aquifer was not estimated for the Pleasant Valley Basin because there were no monitoring wells screened solely in the Grimes Canyon aquifer with sufficient historical record to develop correlations with model results.

Spring groundwater elevations measured at 01N21W32Q02S are strongly correlated with the cumulative change in storage calculated by the Ventura Regional Groundwater Flow Model (Figure A.3-15 and Table A.3.5).

The water year 2016 through 2019 estimates of change in storage calculated using the spring groundwater elevation contour maps were limited to a small fraction of the areal extent of the Grimes Canyon aquifer in the Oxnard Subbasin (FCGMA 2021a). As a result, the change in storage values calculated using the linear regression models are more than order of magnitude larger than estimates calculated using the spring groundwater elevation contours.

Table A.3.5 Grimes Canyon aquifer Storage Change Wells and Correlation Statistics

State Well Number	Key Well?	Basin	Region	Oxnard Subbasin		
				Avg Annual Change in Storage (AF)	Correlation Coefficient (R^2)	Change in Storage * R^2
01N21W32Q02S	Yes	Oxn	SIMA	-19	0.90	-17
Estimated Uncertainty				**10%**		

AF = Acre-Feet; "-NA-" = Not Applicable, "PVB" = Pleasant Valley Basin, "Oxn" = Oxnard Subbasin, "PDMA" = Pumping Depression Management Area, "SIMA" = Saline Intrusion Management Area; "FMA" = Forebay Management Area

References

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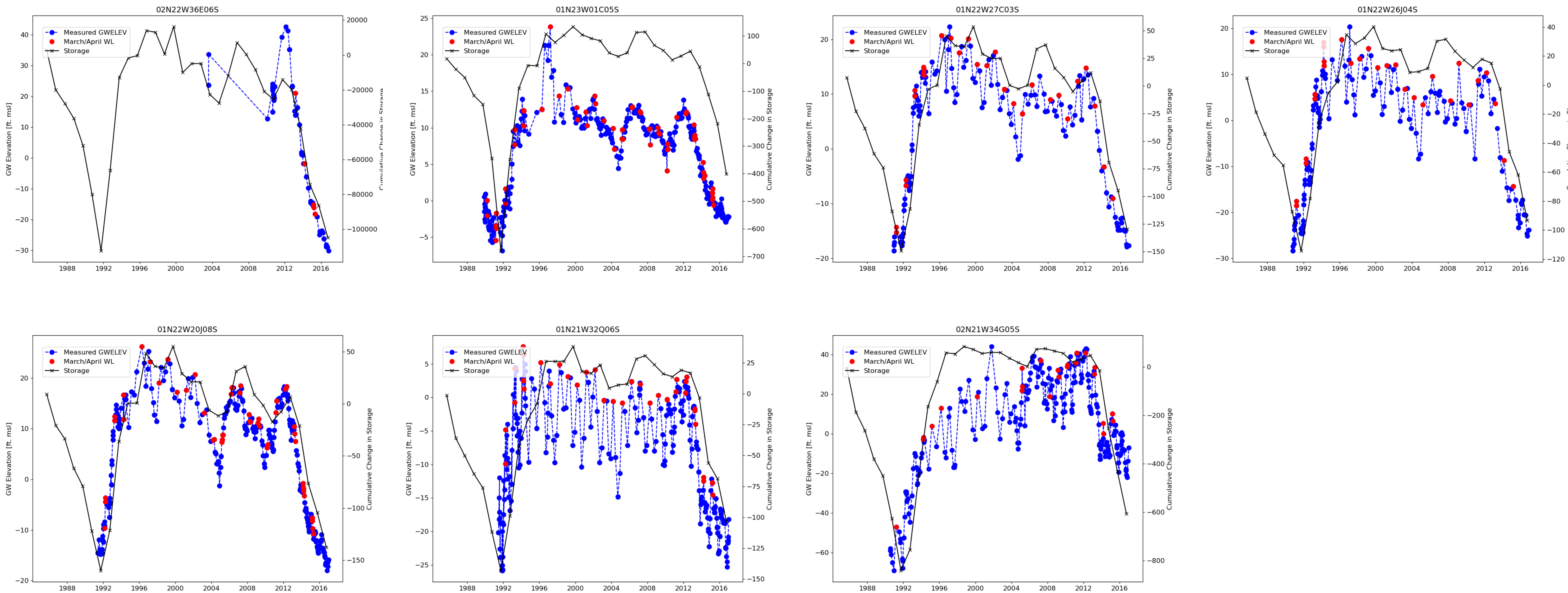

FIGURE A.3-1

Simulated Cumulative Change in Storage and Measured Groundwater Elevations in the Oxnard aquifer

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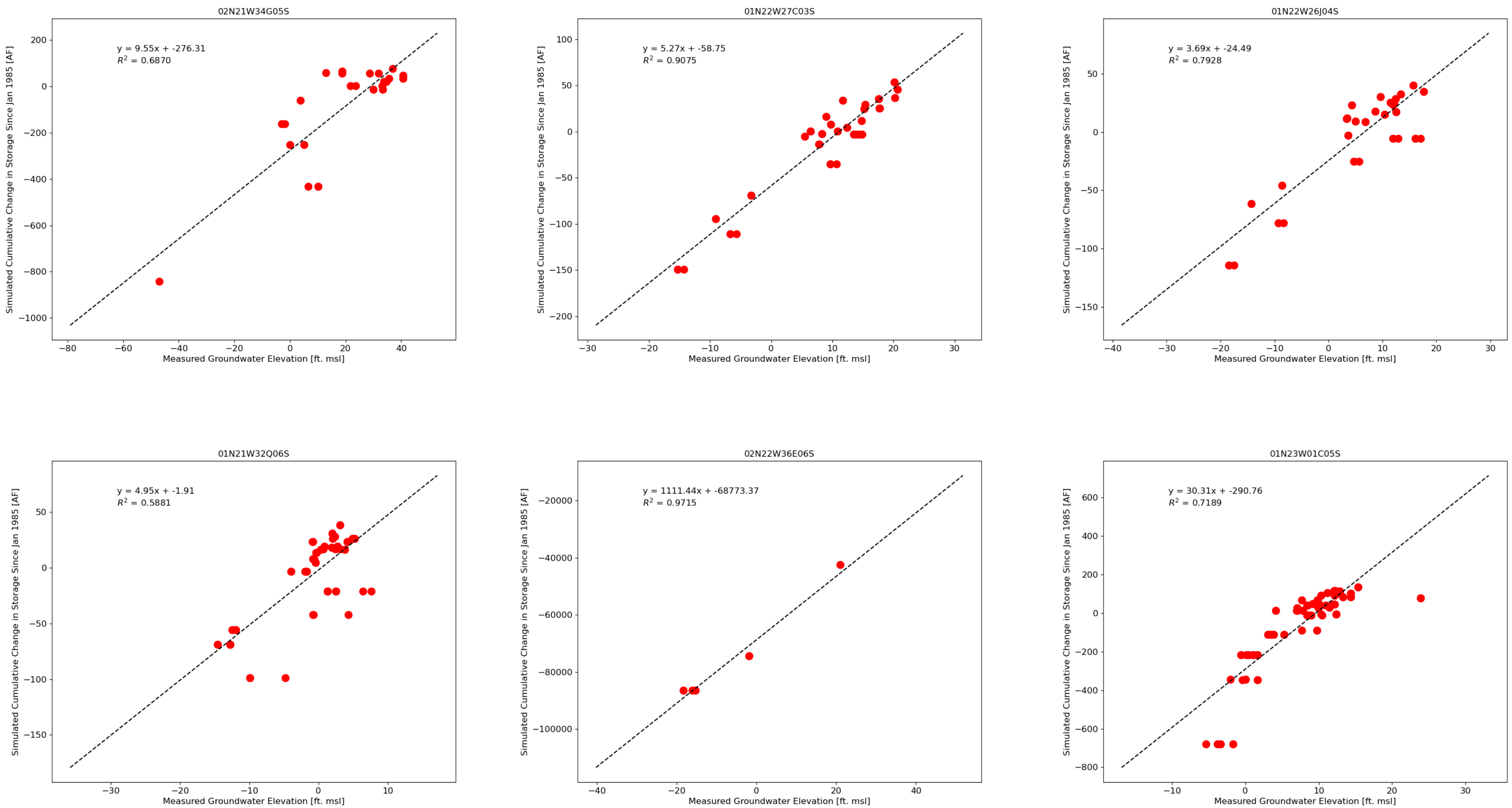

FIGURE A.3-2

Linear Regression Models Developed for the Oxnard Aquifer

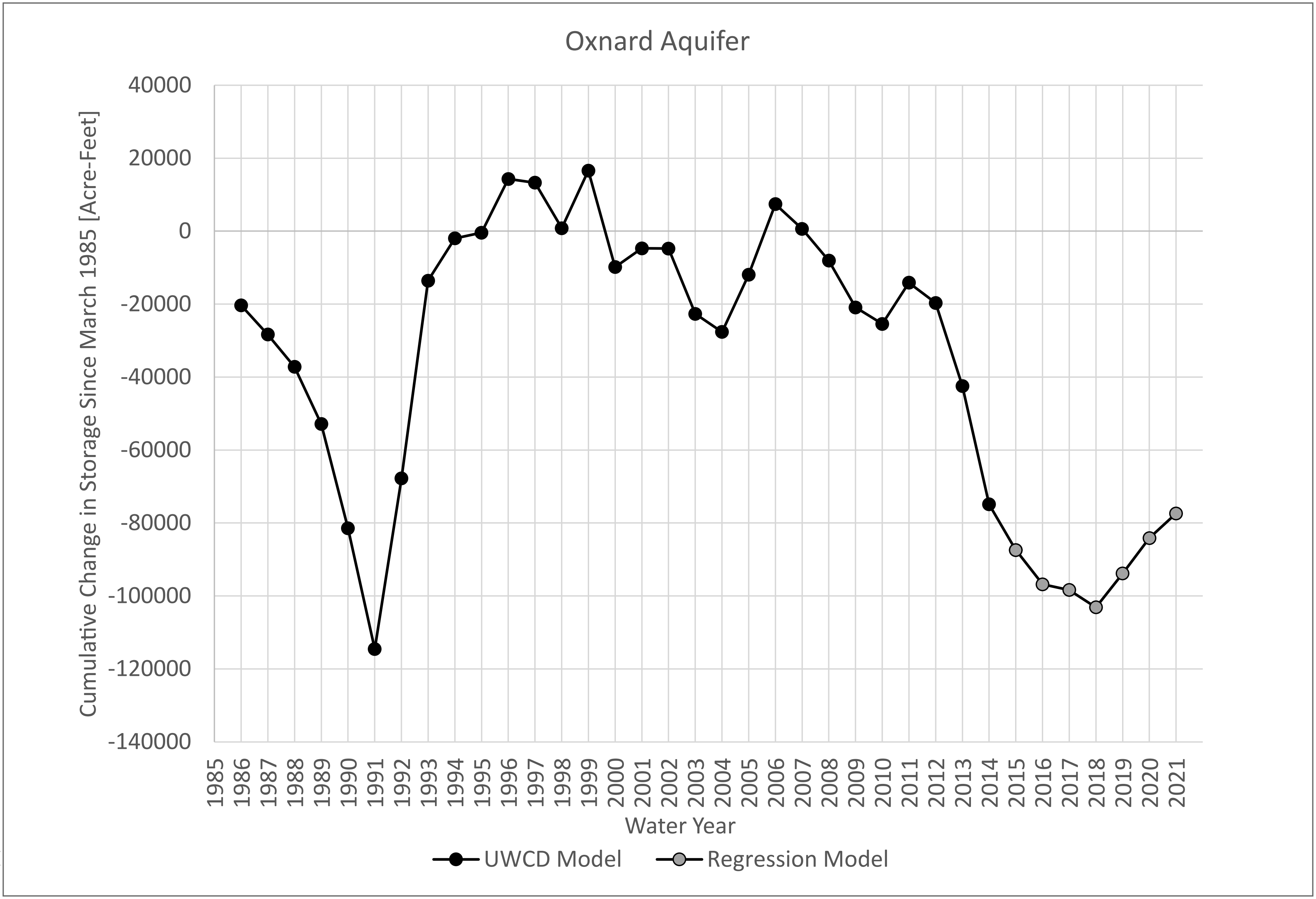

FIGURE A.3-3

Validation of Linear Regression Model - Oxnard Aquifer in the Oxnard Subbasin

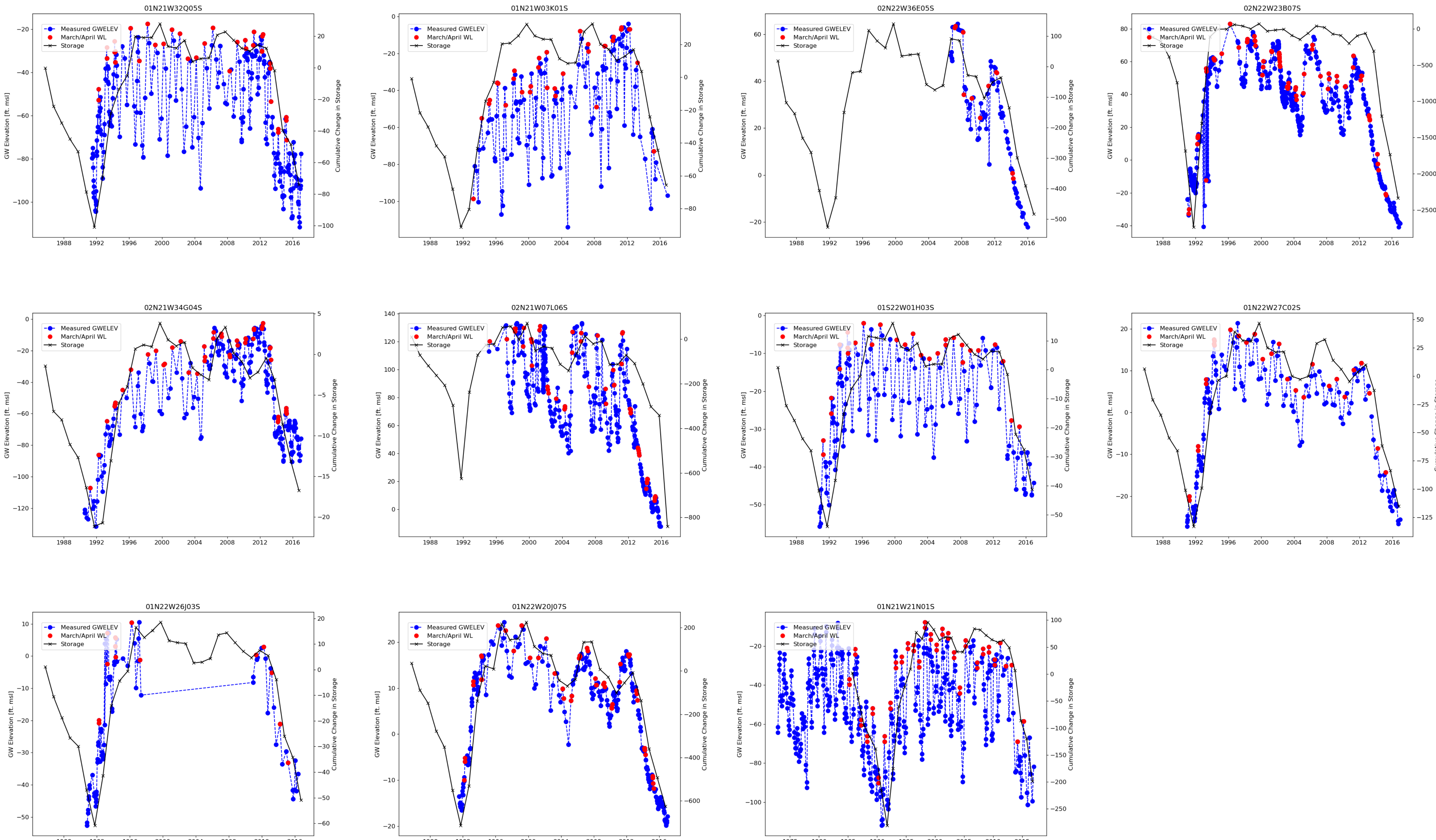

FIGURE A.3-4

Simulated Storage Change and Measured Groundwater Elevations across the Mugu Aquifer

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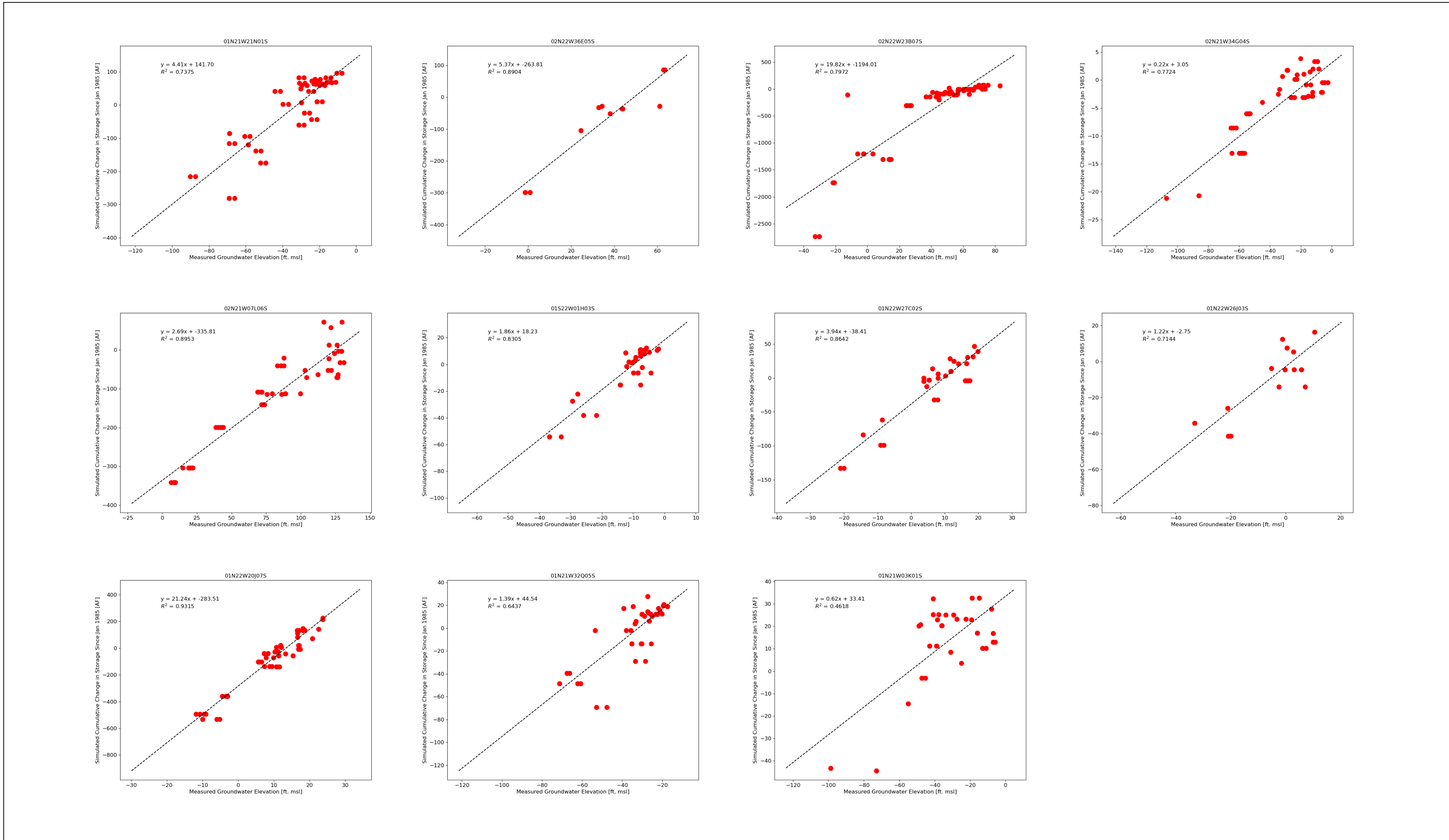

FIGURE A.3-5

Linear Regression Models Developed for the Mugu Aquifer

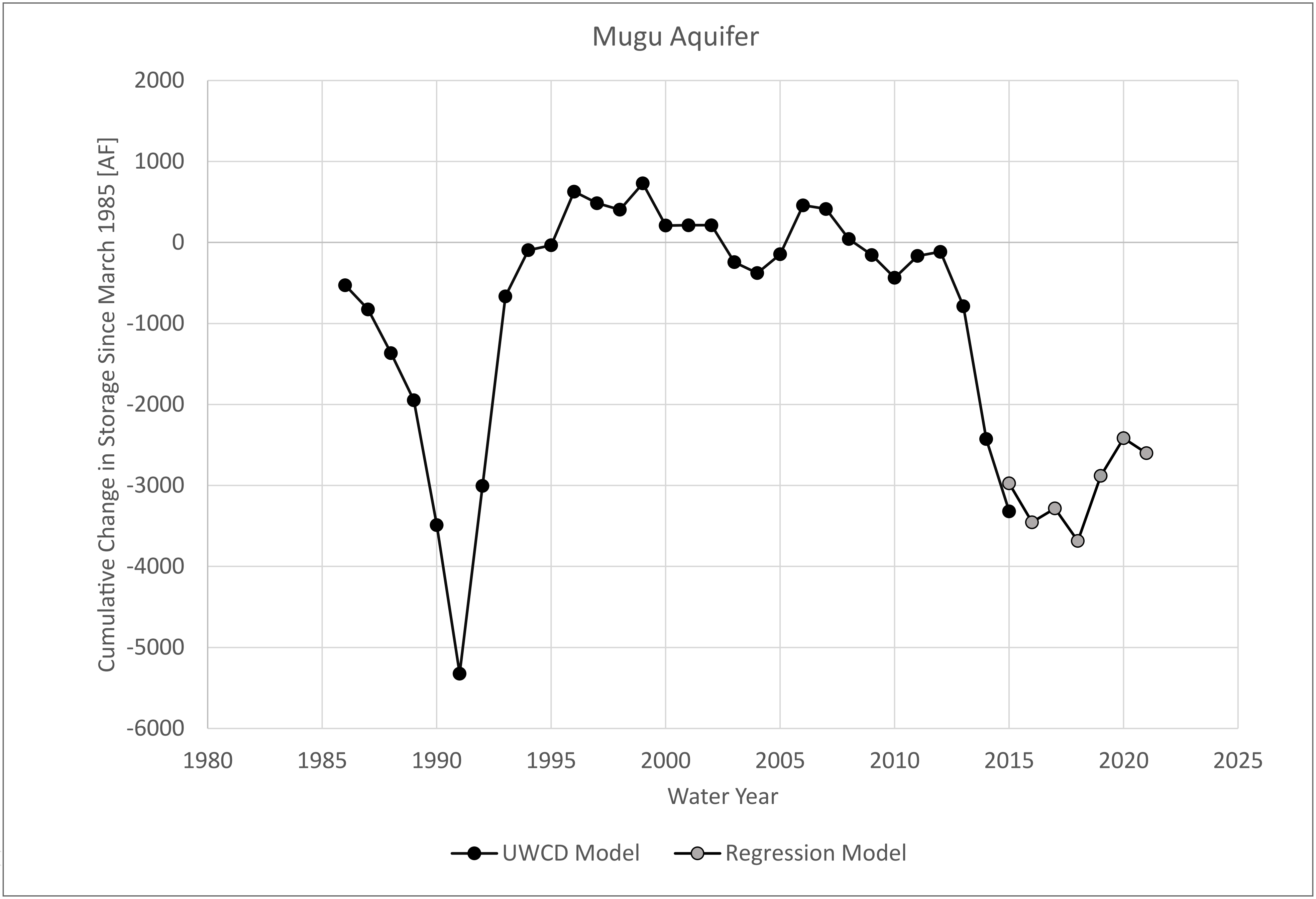

FIGURE A.3-6

Validation of Linear Regression Model - Mugu Aquifer

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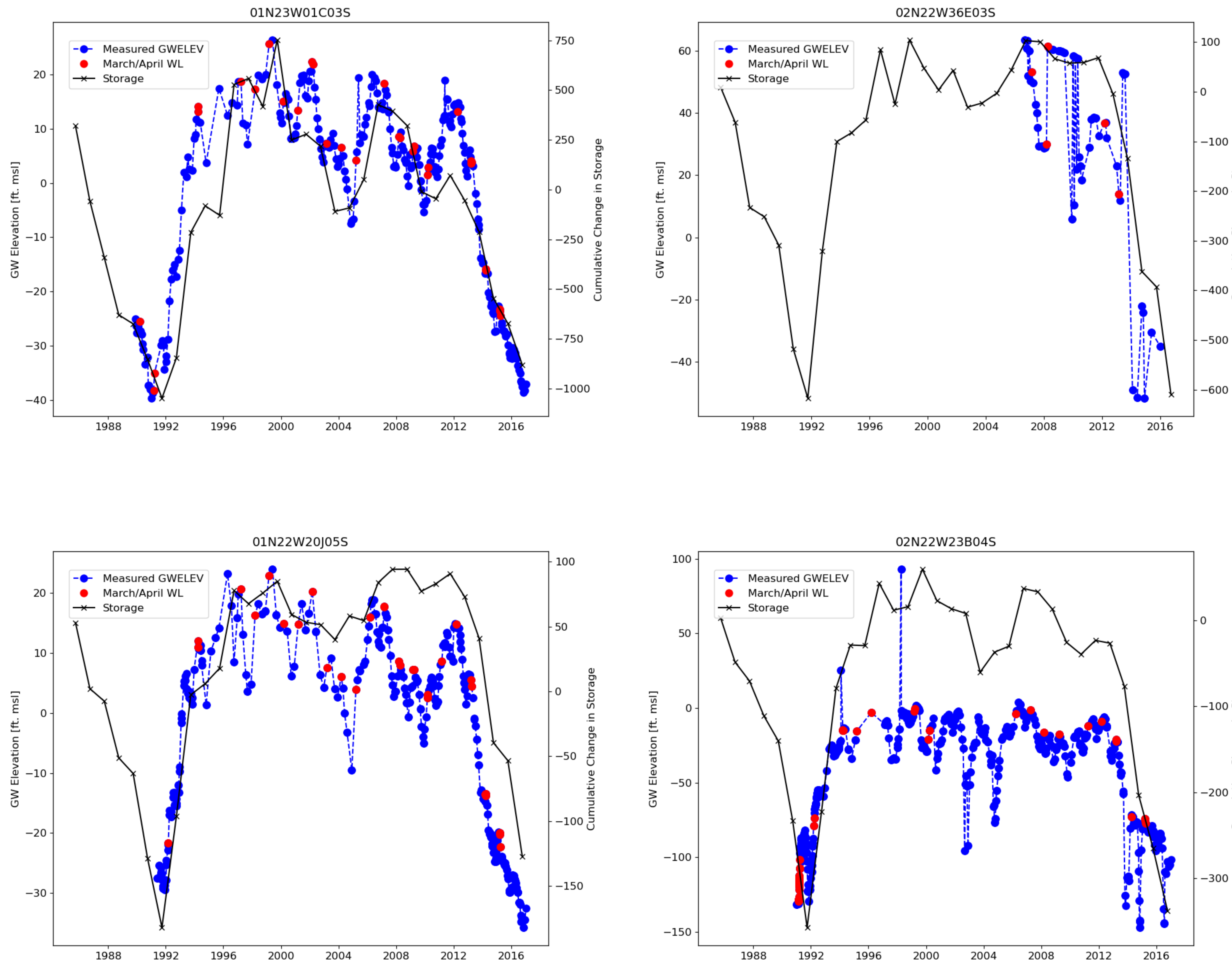
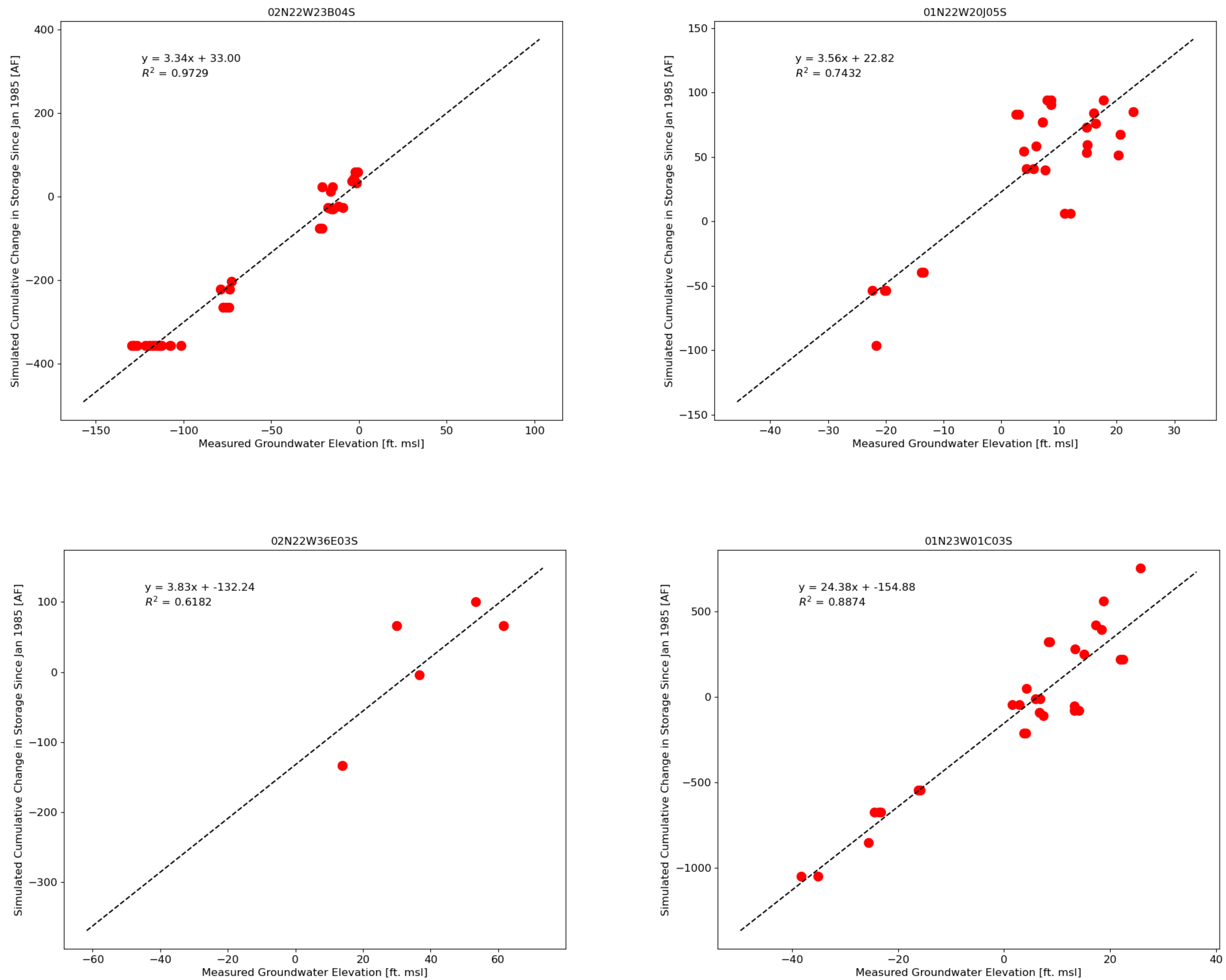


FIGURE A.3-7

Simulated Storage Change and Measured Groundwater Elevations in the Hueneme Aquifer



FIGUREA.3-8

Linear Regression Models Developed for the Hueneme Aquifer

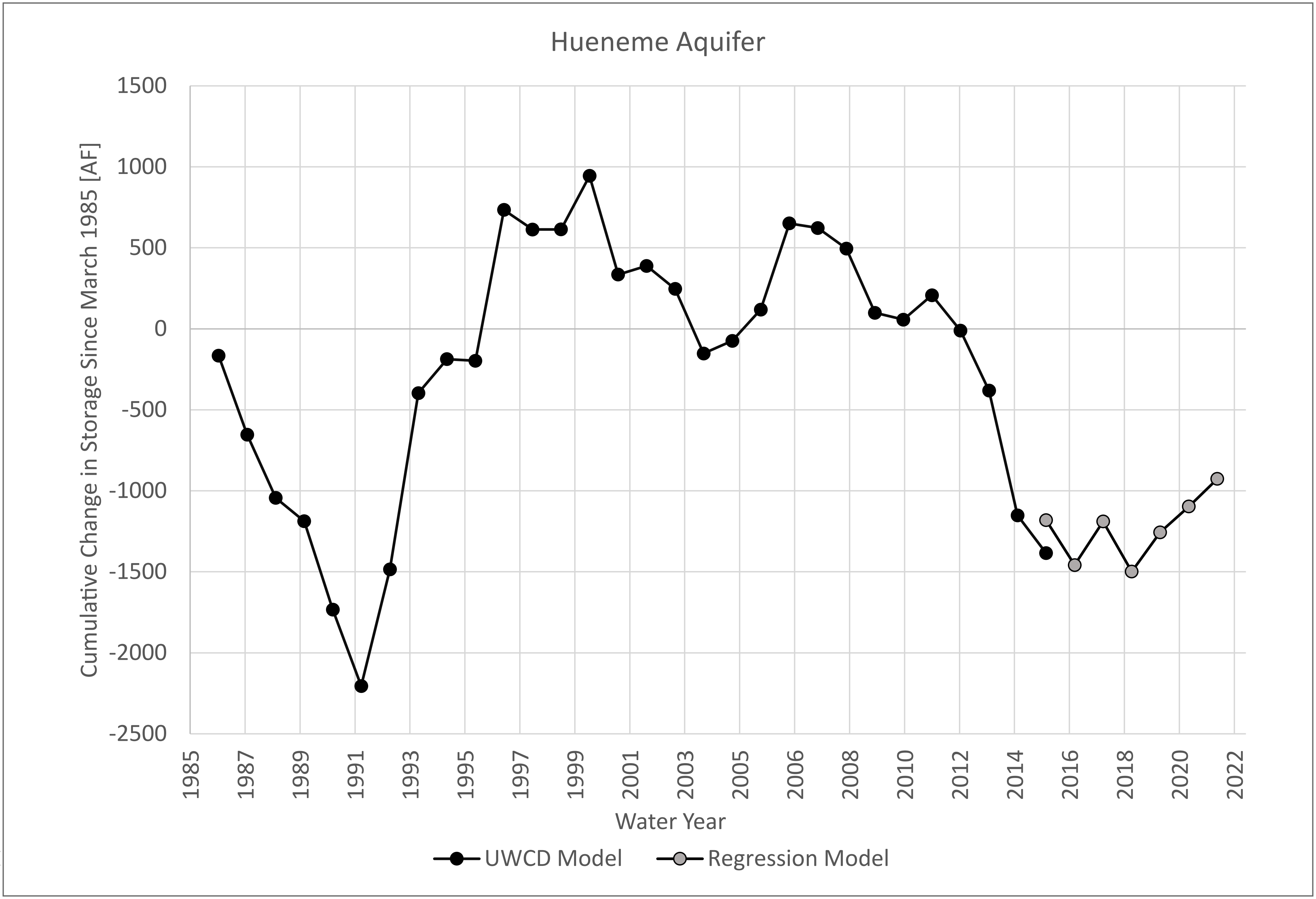


FIGURE A.3-9

Validation of Linear Regression Model - Hueneme Aquifer

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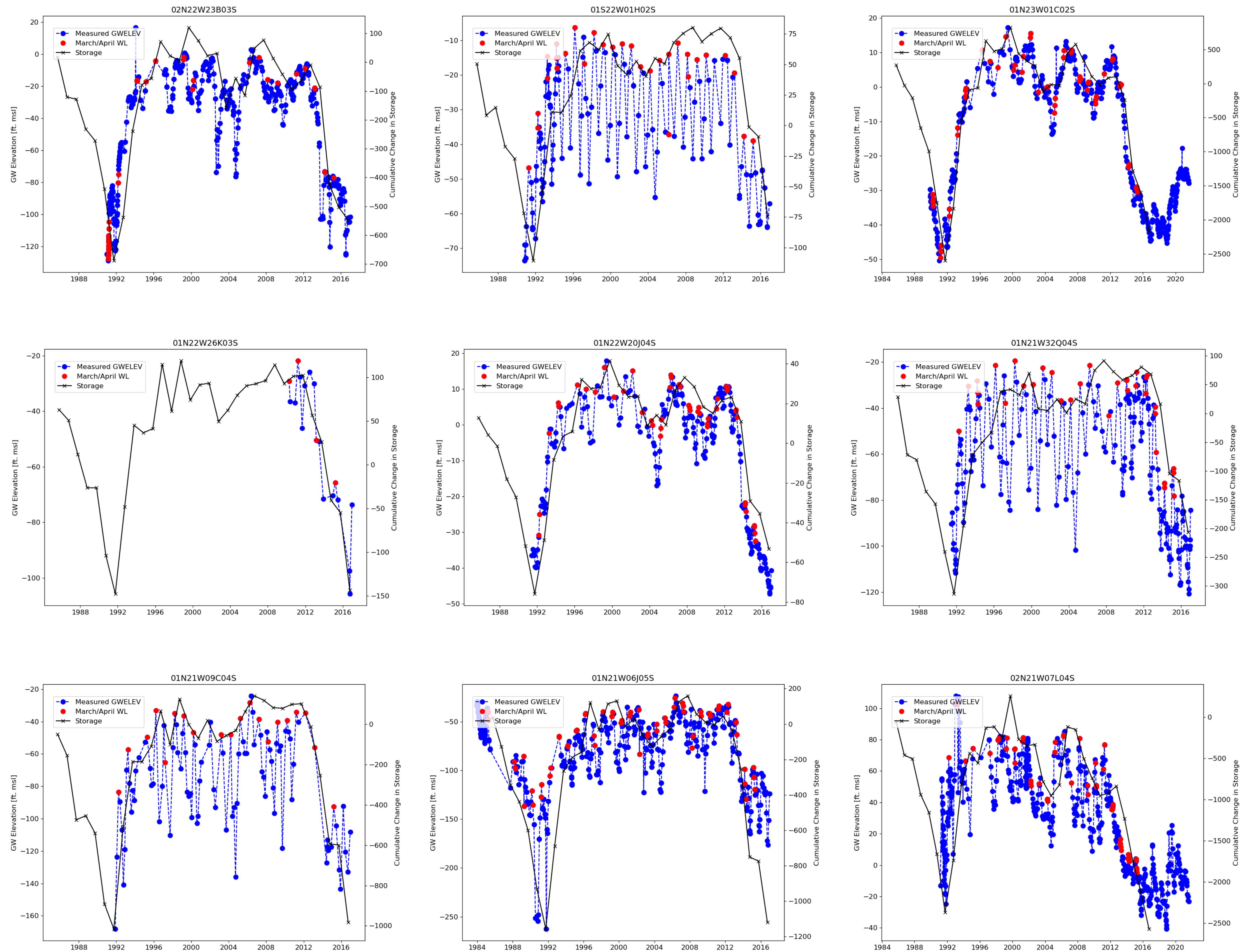

FIGURE A.3-10

Simulated Storage Change and Measured Groundwater Elevations in the Fox Canyon Aquifer

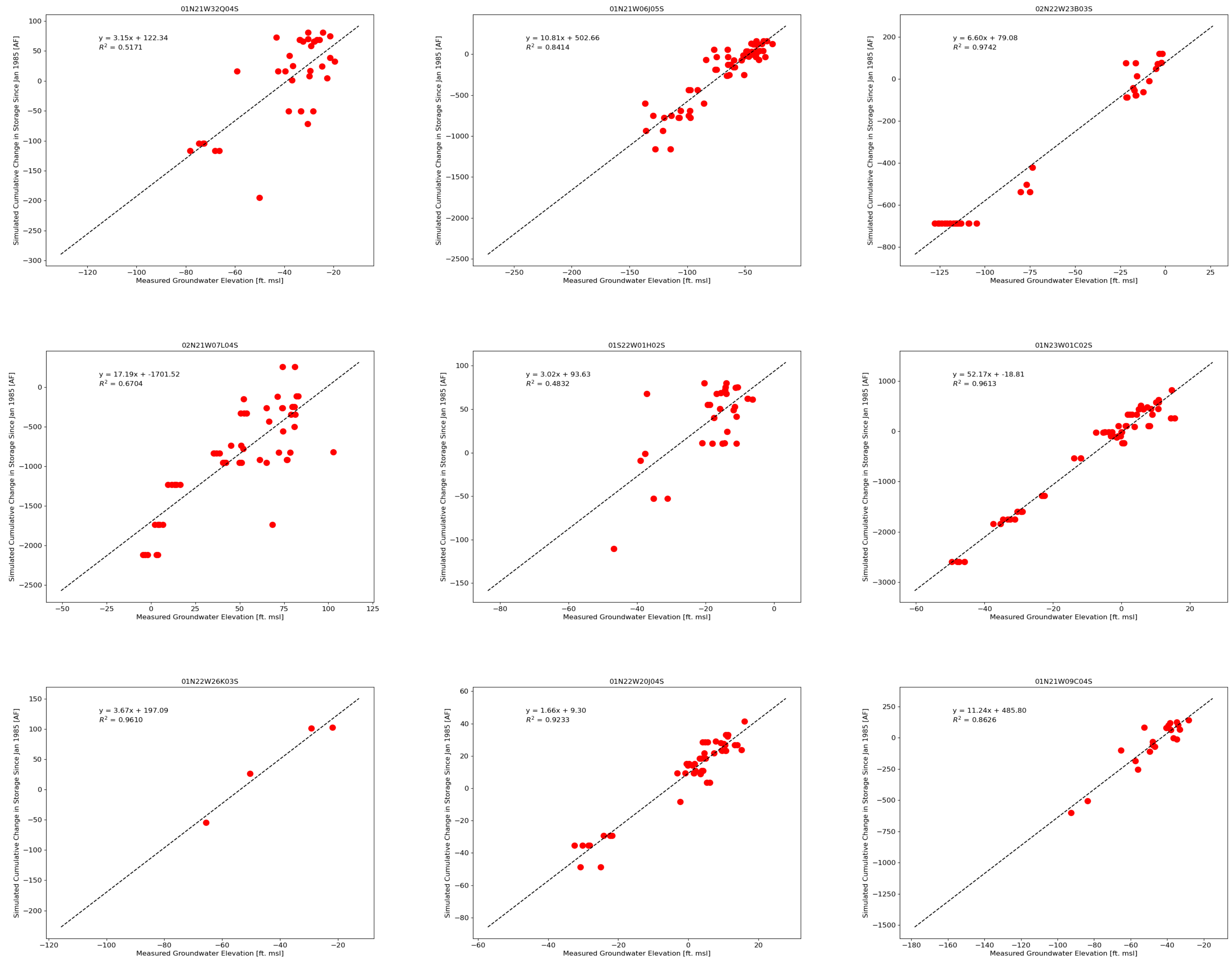

FIGURE A.3-11

Linear Regression Models Developed for the Fox Canyon Aquifer

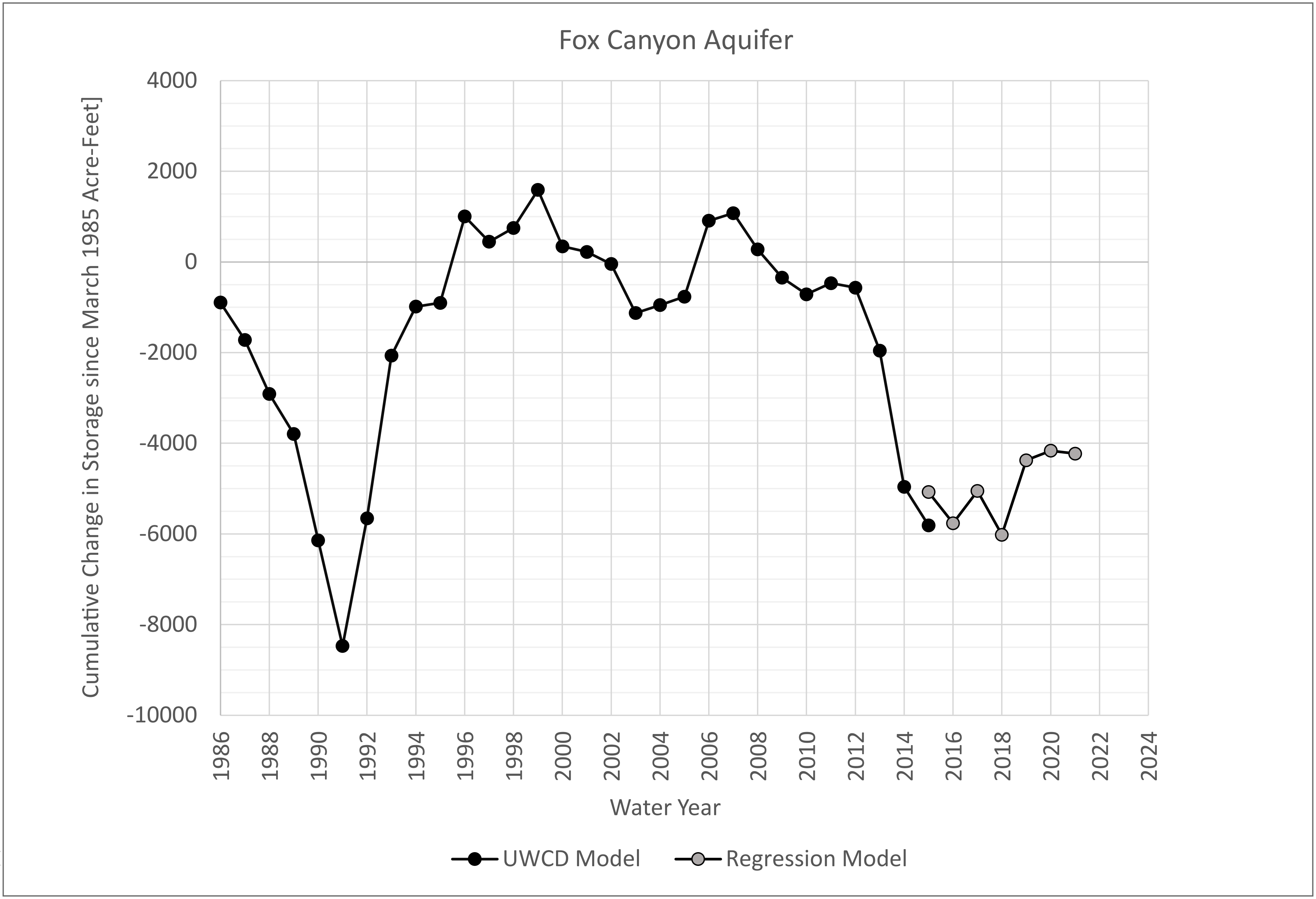

FIGURE A.3-12

Validation of Linear Regression Model - Fox Canyon Aquifer

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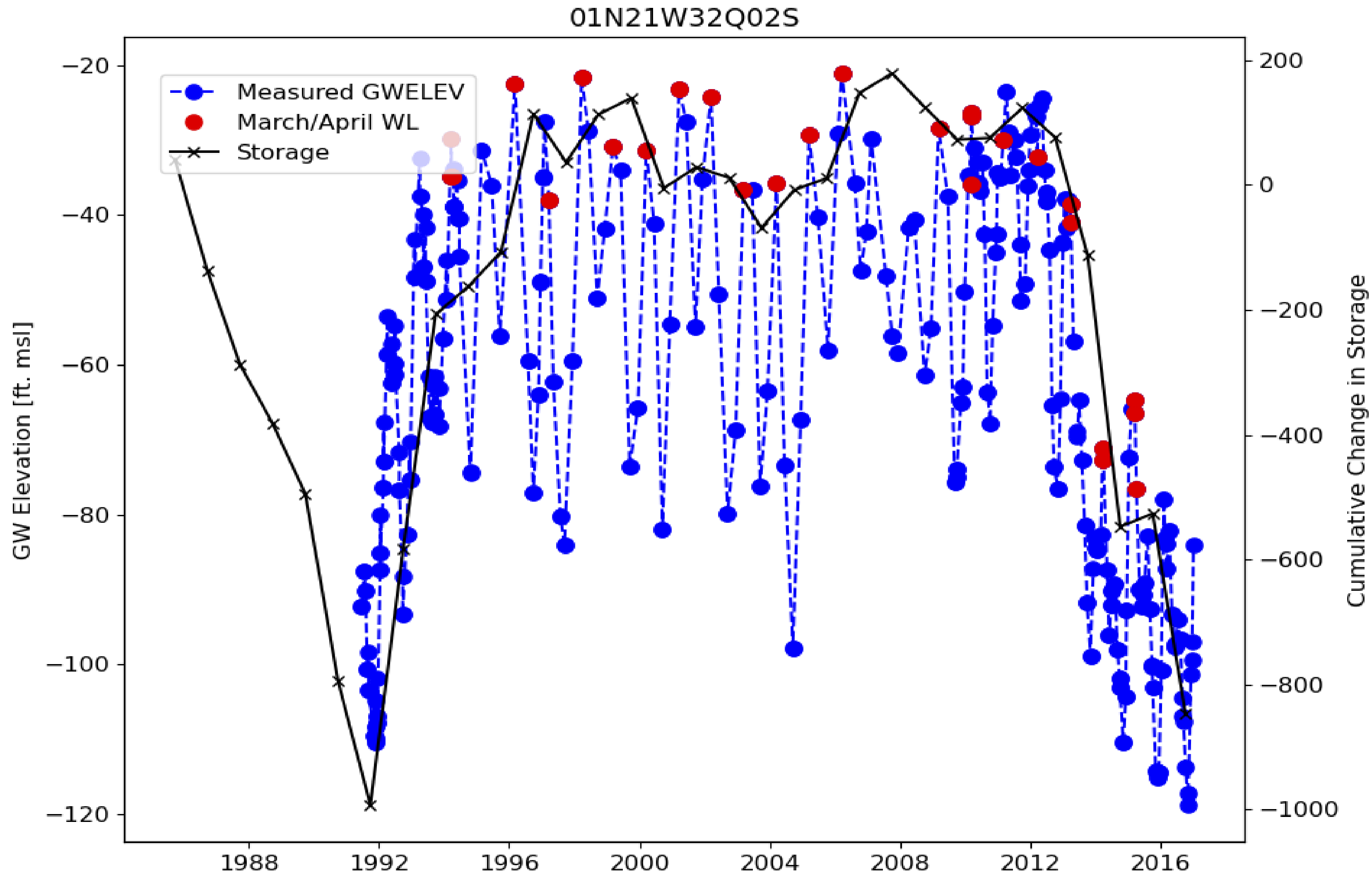

FIGURE A3-13

Simulated Storage Change and Measured Groundwater Elevations in the Grimes Canyon Aquifer

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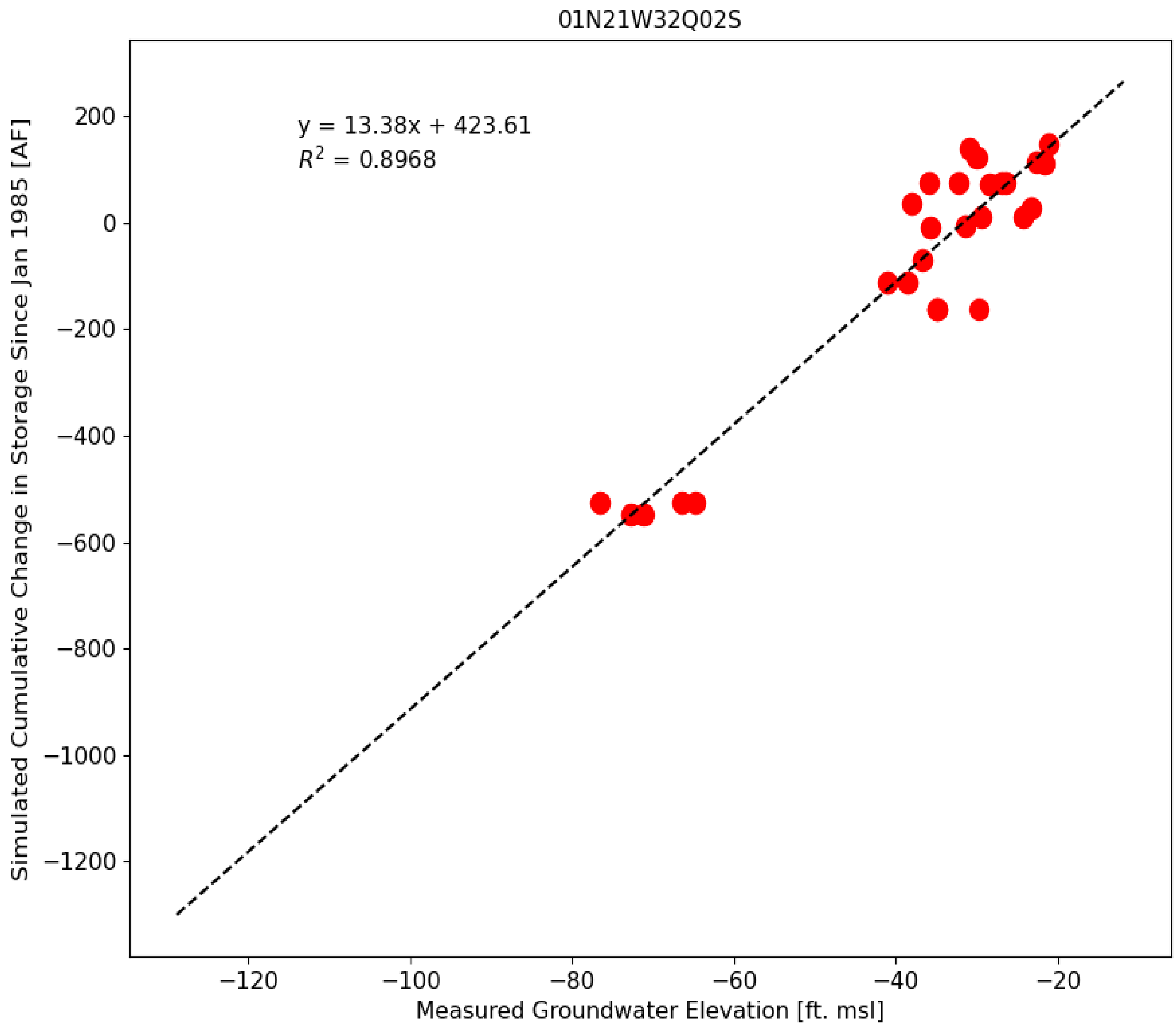

FIGURE A.3-14

Linear Regression Model Developed for the Grimes Canyon Aquifer

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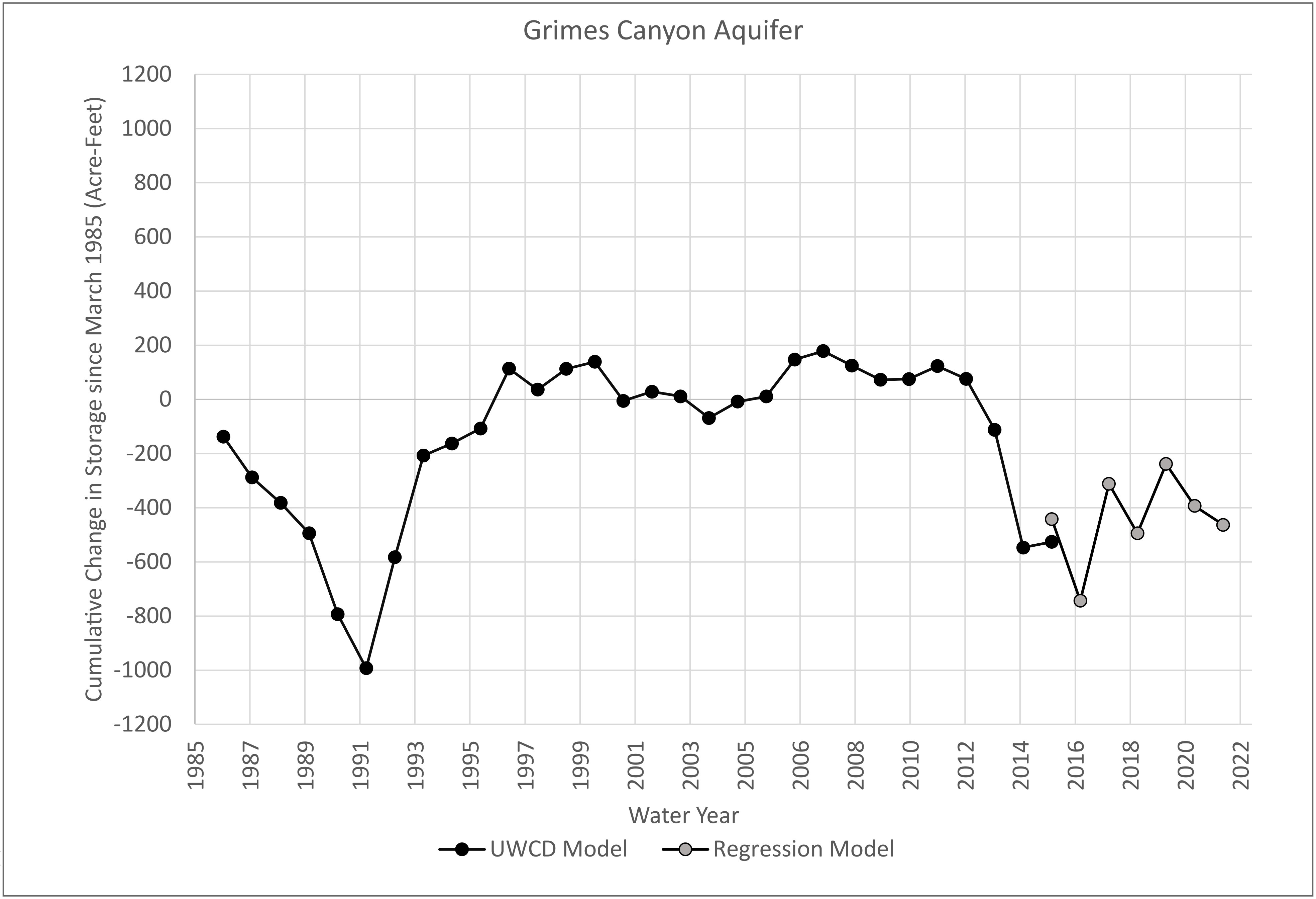

FIGURE A3-15

Simulated Storage Change and Measured Groundwater Elevations in the Grimes Canyon Aquifer

Appendix B: Projects to be Appended to the GSP

A1. Advanced Water Purification Facility Improvements – Phase II

Description

The Groundwater Recovery Enhancement and Treatment (GREAT) Program's Advanced Water Purification Facility (AWPF) is part of the City of Oxnard's GREAT Program, which focuses on using existing water resources more efficiently. The AWPF provides the City of Oxnard with a source of reclaimed water that can be used for landscape irrigation, agricultural, industrial process water, and groundwater recharge. The AWPF is designed to initially treat approximately 8 to 9 million gallons per day (mgd) of secondary effluent from the Oxnard Wastewater Treatment Plant and produce 6.25 mgd of product water for reclaimed water uses. This is equivalent to 7,000 acre-feet per year (AFY) of product water that can be delivered through existing infrastructure. The AWPF is currently producing up to 4,600 AFY. Advanced purified water was first delivered to agricultural operators in 2016.

Expansion of the AWPF capacity was included as a project in the Oxnard GSP (Expansion of the GREAT Program to Increase Groundwater Recharge by 4,500 AFY in the Saticoy Spreading Grounds). Since the GSP was submitted to DWR, the project has evolved to an expansion of the GREAT Program of approximately 4,500AFY to increase groundwater recharge and/or delivery of new water to water users in the Oxnard Subbasin. This new project description reflects the revised understanding of the project based on work completed since 2018. The City of Oxnard is now seeking to expand the AWPF to 12.5 million gallons per day. These improvements will fully utilize available recycled water to provide supply resiliency and cost stabilization for the future. Additionally, this expansion will support the regional water management actions to increase the sustainable yield of the Subbasin.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

The minimum thresholds for both the UAS and the LAS in the Oxnard Subbasin are higher than the historical low water levels and the spring 2015 water levels. In the UAS, the minimum thresholds are approximately 41 feet higher than historical low water levels and 25 feet higher than spring 2015 water levels. In the LAS, the minimum thresholds are approximately 70 feet higher than historical low water levels, and 38 feet higher than spring 2015 water levels.

Utilizing additional recycled water within the Subbasin will help reduce groundwater demand. Therefore, expansion of the AWPF is anticipated to assist with raising groundwater elevations above the minimum thresholds in the future.

Relationship to Measurable Objectives

Utilizing additional recycled water within the Subbasin will help reduce groundwater demand. Therefore, expansion of the AWPF is anticipated to assist with raising groundwater elevations, thereby increasing the likelihood of maintaining groundwater levels at or near the measurable objectives in the future.

Expected Benefits

The AWPF product water that will be put to use in the Oxnard Subbasin is secondary wastewater effluent that is currently discharged to the Pacific Ocean. Therefore, this project provides a new source of water for use in the Subbasin.

Timetable for Implementation

The City of Oxnard anticipates that the improvements to the AWPF can be implemented within a 2-year period.

Metrics for Evaluation

Evaluation of the AWPF Improvement Project will be based on the quantity of water produced after the improvements are implemented.

Economic Factors and Funding Sources

The capital to construct the AWPF Improvement Project may be available through a water resource fee implemented by the City of Oxnard. Funding for operations and maintenance has not been identified. Funding may come from a replenishment fee implemented by the FCGMA Board or other approved methods.

Any action taken by the FCGMA Board, acting as the Groundwater Sustainability Agency for the portion of the Oxnard Subbasin in its jurisdiction, to impose or increase a fee shall be taken by ordinance or resolution. Should the FCGMA Board decide to fund a project through imposition of a replenishment fee, it will need to seek voter approval. This will generally require mailing written notice to the owner of each parcel on which the proposed fee will be imposed and conducting a public hearing at least 45 days after the notice.

A2. Extraction Barrier and Brackish Water Treatment Project

Description

This project is intended to create a seawater intrusion barrier in the Oxnard Subbasin, near Point Mugu, by extracting brackish groundwater in the Oxnard, Mugu, and Fox Canyon aquifers near the coast and maintaining a pumping trough that helps prevent landward migration of seawater. Creation of a barrier to seawater intrusion will increase the sustainable yield of the Oxnard Subbasin and may influence water levels in the adjacent Pleasant Valley Basin. In addition, this project will (1) produce treated brackish water for M&I use, agricultural use, or artificial recharge from currently unusable portions of the aquifers and (2) reduce the area and volume of the aquifers that are currently contaminated with seawater, thereby increasing storage capacity for fresh water.

Project components include construction of: (1) extraction barrier wells near Mugu Lagoon, (2) a reverse-osmosis treatment plant, and (3) a conveyance system for distribution of treated water. Construction of injection barriers is being evaluated where the benefit of injection could potentially be greater than that of extraction. The brackish groundwater extracted in the Point Mugu area will be treated for beneficial use, including artificial recharge and/or direct delivery to water users (e.g., Pumping Trough Pipeline [PTP], Pleasant Valley Pipeline [PVP]). Benefits will include limiting further seawater intrusion, reversing the impacts of seawater intrusion in localized areas, increasing the groundwater storage capacity, raising groundwater elevations (primarily, but not exclusively, in the LAS), and improving groundwater quality in the Forebay, PVP, PTP, and coastal areas.

Some components of this project are in currently preliminary design and permitting phases. The project is envisioned to be advanced in multiple phases. The first phase of the project includes construction of monitoring well clusters and data collection in the vicinity of the proposed project site in order to aid in optimizing the project design. The monitoring well clusters will be used to collect groundwater quality and level data from the aquifers that will be pumped as part of the extraction barrier, as well as the Semi-perched aquifer. The data collected from these wells will be used to: 1) refine understanding of horizontal and vertical conductivity of the aquifers and confining layers, to aid in design of the extraction wellfield; 2) provide additional data regarding geochemistry of the aquifers that will be pumped as part of the extraction; and 3) assess whether contaminants in some shallow portions of the Semi-perched aquifer are likely to migrate toward the extraction wells, now or in the future. The second phase of the project includes design and construction of several extraction wells and operation of the extraction wells to verify the efficacy of the extraction barrier. The final phase of the project includes design and construction of more extraction wells, design and construction of the treatment plant, and the conveyance system for treated water distribution and a connection to Calleguas Salinity Management Pipeline for RO brine discharge. Other supporting activities include additional groundwater modeling (e.g., of barrier concepts for the Port Hueneme area), geophysical studies, and operation of a pilot-scale extraction/treatment system that will help refine the extent of extraction and treatment needs.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

Groundwater elevation minimum thresholds in the Oxnard Subbasin are used as a proxy for the other sustainability indicators in the Subbasin. As a result of reduced pumping of groundwater (in response to the treated brackish water being provided as a replacement source of supply), groundwater elevations are expected to rise in the Forebay, PTP, and PVP areas. Extraction of brackish groundwater may lower the groundwater elevations near the coast to levels that are below the current minimum thresholds. However, this project is intended to maintain stable groundwater elevations, increase fresh groundwater in storage, improve groundwater quality in the UAS near Point Mugu, and mitigate seawater intrusion in the Oxnard Subbasin.

Relationship to Measurable Objectives

As with the minimum thresholds, the project will provide additional water to help groundwater elevations rise to the measurable objective water levels in parts of the Oxnard Subbasin. Along the coast, the measurable objective water levels may need to be re-evaluated in light of the expected benefits provided by the project.

Expected Benefits

This project should aid with achievement of measurable objectives and minimum thresholds for four out of six sustainability criteria by blocking seawater intrusion near the coast, raising groundwater elevations in the Forebay, improving groundwater quality, and increasing fresh groundwater in storage in the aquifers (replacing the existing intruded seawater). The project anticipates increasing the combined annual sustainable yield of the Oxnard Subbasin and Pleasant Valley Basin by approximately 15,000 acre-feet per year, considering both the quantity of treated brackish water supplied by the project and the effects on sustainable yield resulting from mitigating existing and future seawater intrusion. Of this combined increase in the sustainable yield, approximately 80%, or 12,000 acre-feet per year, is estimated to directly benefit the Oxnard Subbasin, while the remaining increase in the sustainable yield will benefit the Pleasant Valley Basin.

Timetable for Implementation

The project design and memorandum of understanding between UWCD and the U.S. Navy are currently in progress; work towards construction of a pilot extraction system is planned to commence in 2022. Construction of the initial phase of the extraction and treatment system is expected to be completed in 2025; and construction of additional extraction wells and treatment plant is expected to be complete in 2027. Potential expansion to larger scale, if needed, will be evaluated after 2027.

Metrics for Evaluation

Evaluation of the Extraction Barrier and Brackish Water Treatment Project will be based on the ability of the project to prevent seawater intrusion in the Oxnard Subbasin. Groundwater quality samples will be collected inland of the extraction barrier to evaluate chloride concentration over time. Groundwater elevations will continue to be measured at the key wells discussed in the GSP, and additional groundwater elevation monitoring wells will be incorporated into the network as part of this project. Lastly, the volume of brackish water extracted, treated, and served will be measured and reported as part of the GSP annual reporting process.

Economic Factors and Funding Sources

The capital to construct the Extraction Barrier and Brackish Water Treatment Project may be available through UWCD or FCGMA replenishment fees. Additional funding may be available from Defense Community Infrastructure grants, Federal infrastructure grants, EPA low-interest loans, and additional DWR grant funding

Any action taken by the FCGMA Board, acting as the Groundwater Sustainability Agency for the portion of the Oxnard Subbasin in its jurisdiction, to impose or increase a fee shall be taken by ordinance or resolution. Should the FCGMA Board decide to fund a project through imposition of a replenishment fee, it will need to seek voter approval. This will generally require mailing written notice to the owner of each parcel on which the proposed fee will be imposed and conducting a public hearing at least 45 days after the notice.

A3. Freeman Diversion Expansion Project

Description

As described in the GSP, UWCD operates the Freeman Diversion on the Santa Clara River for the purpose of diverting surface flows from the river into groundwater recharge facilities in the Oxnard Forebay and direct surface-water deliveries to growers via UWCD's and PCVWD pipelines. The Freeman Diversion Expansion Project proposes to construct facilities capable of diverting surface water at higher flow rates and with higher sediment loads than currently possible. Use of flows with higher sediment loads, which are less conducive to fish migration, has been encouraged by both regulatory agencies and non-governmental organizations (FCGMA 2019). The expansion project has advanced since the GSP was submitted to DWR. This project description reflects the updated understanding of the project based on work that was completed since 2018.

This project requires expansion of the existing intake, conveyance, and recharge facilities associated with Freeman Diversion and, in a subsequent phase, an associated increase in UWCD's right to divert surface water from the Santa Clara River from 375 cfs to 750 cfs instantaneous flow during periods of peak flow in the river. When constructed, this project will result in additional recharge and conjunctive use of flood/storm flows in both Oxnard and Pleasant Valley Basins. UWCD will improve fish passage and implement the new Multi-Species Habitat Conservation Plan, concurrent with this project.

Increased volume of diverted water will be used for artificial recharge and conjunctive use via the Pumping Trough Pipeline (PTP) in Oxnard Basin. Benefits will include higher groundwater levels, more groundwater in storage, reduced potential for seawater intrusion and land subsidence, and improved groundwater quality. The project will improve groundwater quality in the Forebay because the diverted surface water is of higher chemical quality (i.e., lower TDS) than the groundwater. Historical data show a direct relationship between diversion and recharge rates with groundwater quality at several water-supply wells in the Forebay. The areas served by the PTP and PVP will receive additional surface-water deliveries for conjunctive use, reducing pumping and increasing groundwater elevations. Higher groundwater elevations will reduce the potential for subsidence related to groundwater production in the Oxnard Subbasin.

Some components of this project have been designed or are constructed already. Next-step project components include expansion of existing conveyance structures (inverted siphon, 3-barrel culvert, and extension of the conveyance system to connect to UWCD's new Ferro-Rose spreading basin via a new undercrossing at Vineyard Ave.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

Artificial recharge is a critical component of the groundwater budget in the Oxnard Subbasin. Groundwater elevations, which are used as a proxy for other sustainability indicators in the Subbasin, typically rise in years when surface water is available for diversion and fall in years when it is not. Groundwater elevations in the Oxnard Subbasin are currently below the minimum thresholds Increased recharge of a portion of high storm/flood flows in the Santa Clara River will help groundwater levels recover to elevations above the proposed minimum thresholds. The magnitude of the groundwater level rise will depend on the quantity of additional recharge available via the expanded diversion facilities.

Relationship to Measurable Objectives

The relationship of the Freeman Expansion Project to the measurable objectives is the same as the relationship with the minimum thresholds. By increasing water levels in the Subbasin, the Freeman Diversion Project will help the Oxnard Subbasin meet the measurable objective groundwater levels.

Expected Benefits

This project should aid with achievement of measurable objectives and minimum thresholds for five out of six sustainability criteria by reducing the landward gradient that induces seawater intrusion near the coast, raising groundwater elevations and the volume of groundwater in storage, improving groundwater quality, and reducing the potential for land subsidence related to groundwater withdrawals. Higher groundwater levels will also reduce pump lift, and therefore energy consumption, for municipal and agricultural pumpers. The project anticipates increasing the annual sustainable yield of the Oxnard Subbasin by approximately 8,000 AFY.

Timetable for Implementation

The timetable for implementation of the Freeman Expansion Project, which will be constructed in phases, is estimated to be on the order of 3 to 15 years. Securing funding for the project and initiating the first phase of project construction will begin after the fish passage has been selected. UWCD is currently in the process of selecting the fish passage.

Metrics for Evaluation

Evaluation of the Freeman Expansion Project will be based on the increase in surface water diversions relative to recent past diversion rates. UWCD meters diversion from the Santa Clara River and would report these to FCGMA.

Economic Factors and Funding Sources

Improvements to the conveyance system, fish screens, and desilting basin inlet are estimated to cost $50 million. The annual cost, including operations and maintenance, capital, and financing costs is estimated to be $3.1 million. The capital cost per acre-foot per year produced is anticipated to be $100 over the 50+ year expected lifespan of the project. Funding sources for the project are anticipated to include grant money, UWCD rate payers, and replenishment fees from FCGMA.

Any action taken by the FCGMA Board, acting as the Groundwater Sustainability Agency for the portion of the Oxnard Subbasin in its jurisdiction, to impose or increase a fee shall be taken by ordinance or resolution. Should the FCGMA Board decide to fund a project through imposition of a replenishment fee, it will need to seek voter approval. This will generally require mailing written notice to the owner of each parcel on which the proposed fee will be imposed and conducting a public hearing at least 45 days after the notice.

A4. Ferro-Rose Artificial Recharge of Groundwater

Description

This project is a key component of the Freeman Expansion Project. It involves expansion and extension of existing conveyance structures (inverted siphon and 3-barrel culvert) and connection to Ferro-Rose basin (Vineyard Ave. crossing) to allow for more recharge and to increase diversions, within the limits of United's existing water right, from the Santa Clara River during high-flow events when suspended sediment concentrations are high.

Increased volume of diverted water will be used for artificial recharge and conjunctive use via the PTP in Oxnard Basin, and a smaller amount for conjunctive use via the PVP in Pleasant Valley Basin. Benefits will include higher groundwater levels, more groundwater in storage, improved groundwater quality, which occurs as a result of the higher quality surface water used for recharge, and reduced potential for seawater intrusion or land subsidence in both Oxnard and Pleasant Valley Basins.

This project should aid with achievement of measurable objectives and minimum thresholds for five out of six sustainability criteria by increasing recharge of low-TDS water.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

Surface water recharge is a critical component of the water budget in the Oxnard Subbasin. Groundwater elevations, which are used as a proxy for other sustainability indicators in the Subbasin, typically rise in years when surface water is available for diversion and fall in years when it is not. Groundwater elevations in the Oxnard Subbasin are currently below the minimum thresholds. Increased recharge of surface water that currently flows to the Pacific Ocean will help groundwater levels recover to elevations above the proposed minimum thresholds. The magnitude of the groundwater level rise will depend on the quantity of additional recharge available via the expanded diversion facilities.

Relationship to Measurable Objectives

The relationship of the Ferro-Rose Artificial Recharge project to the measurable objectives is the same as the relationship with the minimum thresholds. By increasing water levels in the Subbasin, the project will help the Oxnard Subbasin meet the measurable objective groundwater levels.

Expected Benefits

This project should aid with achievement of measurable objectives and minimum thresholds for five out of six sustainability criteria by reducing the landward gradient that induces seawater intrusion near the coast, raising groundwater elevations and the volume of groundwater in storage, improving groundwater quality, and reducing the potential for land subsidence related to groundwater withdrawals. Higher groundwater levels will also reduce pump lift, and therefore energy consumption, for municipal and agricultural pumpers. The project anticipates increasing the annual sustainable yield of the Oxnard Subbasin by approximately 2,000 to 3,000 AFY.

Timetable for Implementation

The timetable for implementation of the Ferro-Rose Artificial Recharge project is estimated to be approximately 3 years and the project is ready to be implemented once funding is secured.

Metrics for Evaluation

Evaluation of the Ferro-Rose Artificial Recharge project will be based on the quantity of additional surface water that can be diverted and recharged in UWCD's facilities. UWCD meters diversion from the Santa Clara River and would report these to FCGMA.

Economic Factors and Funding Sources

The capital cost for the Ferro-Rose Artificial Recharge project is expected to be $4 million. The annual cost, including operations and maintenance, capital, and financing costs is estimated to be $425,000. The capital cost per acre-foot per year produced is anticipated to be $35 over the 50+ year expected lifespan of the project. Funding sources for the project are anticipated to include grant money, UWCD rate payers, and replenishment fees from FCGMA.

Any action taken by the FCGMA Board, acting as the Groundwater Sustainability Agency for the portion of the Oxnard Subbasin in its jurisdiction, to impose or increase a fee shall be taken by ordinance or resolution. Should the FCGMA Board decide to fund a project through imposition of a replenishment fee, it will need to seek voter approval. This will generally require mailing written notice to the owner of each parcel on which the proposed fee will be imposed and conducting a public hearing at least 45 days after the notice.

A5. Laguna Road Recycled Water Pipeline Interconnection

Description

This project is a new pipeline interconnection to allow conveyance of recycled water from Pleasant Valley County Water District's system to UWCD's Pumping Trough Pipeline (PTP) system to allow full utilization of available recycled water. Benefits of using more recycled water in the PTP system will include higher groundwater levels, more groundwater in storage, improved groundwater quality, and reduce potential for seawater intrusion or land subsidence in the Oxnard Subbasin. This project will reduce pumping from the UAS and the potential for migration of high-TDS water into the aquifers. The PTP area will receive additional recycled water for agricultural use, reducing pumping in those areas, which will increase groundwater elevations and improve groundwater quality, while reducing potential for subsidence. The PTP area will receive the most direct and immediate benefit.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

Adding flexibility to the water conveyance facilities in the Oxnard Subbasin will directly impact groundwater level minimum thresholds, which are used as a proxy for other sustainability indicators in the Oxnard Subbasin by allowing recycled water to be used instead of groundwater when it is available. Reduced groundwater pumping will help groundwater levels, which are currently below the minimum thresholds in the Oxnard Subbasin, rise above the minimum thresholds over the next 18 years.

Relationship to Measurable Objectives

The relationship of the Laguna Road Recycled Water Pipeline Interconnection to the measurable objectives is the same as the relationship with the minimum thresholds. By increasing water levels in the Subbasin, the Laguna Road Recycled Water Pipeline Interconnection will help the Oxnard Subbasin meet the measurable objective groundwater levels.

Expected Benefits

This project should aid with achievement of measurable objectives and minimum thresholds for five out of six sustainability indicators. This project will help raise groundwater levels, which will reduce the landward gradient that induces seawater intrusion near the coast, increase the volume of groundwater in storage, improve groundwater quality, and reduce the potential for land subsidence related to groundwater withdrawals. Higher groundwater levels will also reduce pump lift, and therefore energy consumption, for municipal and agricultural pumpers. The project anticipates increasing the annual sustainable yield of the Oxnard Subbasin by approximately 1,500 AFY on average.

Timetable for Implementation

The timetable for implementation of the Laguna Road Recycled Water Pipeline Project is estimated to be on the order of 2 to 3 years.

Metrics for Evaluation

Evaluation of the Laguna Road Recycled Water Pipeline Project will be based on the quantity of recycled water delivered via the new pipeline, which will be metered by UWCD.

Economic Factors and Funding Sources

The total capital cost for the Laguna Road Recycled Water Pipeline Project is anticipated to be approximately $4.2 million. The annual cost, including operations and maintenance, capital, and financing costs is estimated to be $600,000 to $1.1 million. The capital cost per acre-foot per year produced is anticipated to be $56 over the 50+ year expected lifespan of the project. Funding sources for the project are anticipated to include NRCS grant money, USBR water-smart loan, and PTP enterprise fund for recycled-water purchase.

A6. Nauman-Hueneme Road Recycled Water Pipeline Interconnection

Description

This project is a new pipeline interconnection to allow conveyance of recycled water from Oxnard's AWPF system, at Hueneme Road, to UWCD's Pumping Trough Pipeline (PTP) system to allow full utilization of available recycled water. This project is a potential alternative to, or supplement for, the Laguna Road Recycled Water Pipeline interconnection. The PTP area, which will receive additional recycled water for agricultural use, will receive the most direct and immediate benefit from this project. Benefits of using more recycled water in the PTP system will include higher groundwater levels, more groundwater in storage, improved groundwater quality, and reduced potential for seawater intrusion or land subsidence in the Oxnard Subbasin. This project will reduce pumping and the potential for migration of high-TDS water into the aquifers. The PTP area will receive additional recycled water for agricultural use, reducing pumping in those areas, which will increase groundwater elevations and improve groundwater quality, while reducing potential for subsidence.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

Adding flexibility to the water conveyance facilities in the Oxnard Subbasin will directly impact groundwater level minimum thresholds, which are used as a proxy for other sustainability indicators in the Oxnard Subbasin by allowing recycled water to be used instead of groundwater when it is available. Reduced groundwater pumping will help groundwater levels, which are currently below the minimum thresholds in the Oxnard Subbasin, rise above the minimum thresholds over the next 18 years.

Relationship to Measurable Objectives

The relationship of the Nauman-Hueneme Road Recycled Water Pipeline Interconnection to the measurable objectives is the same as the relationship with the minimum thresholds. By increasing water levels in the Subbasin, the project will help the Oxnard Subbasin meet the measurable objective groundwater levels.

Expected Benefits

This project should aid with achievement of measurable objectives and minimum thresholds for five out of six sustainability indicators. This project will help raise groundwater levels, which will reduce the landward gradient that induces seawater intrusion near the coast, increase the volume of groundwater in storage, improve groundwater quality, and reduce the potential for land subsidence related to groundwater withdrawals. Higher groundwater levels will also reduce pump lift, and therefore energy consumption, for municipal and agricultural pumpers. The project anticipates increasing the annual sustainable yield of the Oxnard Subbasin by approximately 1,500 AFY on average. As noted above, the additional yield to the Subbasin will not double if both the Nauman-Hueneme Road and the Laguna Road Pipeline projects are both implemented, however building both projects may provide some supplemental yield over building just one of the two.

Timetable for Implementation

The timetable for implementation of the Nauman-Hueneme Road Recycled Water Pipeline Interconnection Project is estimated to be on the order of 4 to 5 years.

Metrics for Evaluation

Evaluation of the Nauman-Hueneme Road Recycled Water Pipeline Interconnection Project will be based on the quantity of recycled water delivered via the new pipeline, which will be metered by UWCD.

Economic Factors and Funding Sources

The total capital cost for the Nauman-Hueneme Road Recycled Water Pipeline Interconnection Project is anticipated to be approximately $ 7.5 million. The annual cost, including operations and maintenance, capital, and financing costs is estimated to be $800,000 to $1.3 million. The capital cost per acre-foot per year produced is anticipated to be $100 over the 50+ year expected lifespan of the project. Funding sources for the project are anticipated to include NRCS grant money, USBR water-smart loan, and PTP enterprise fund for recycled-water purchase.

A7. Purchase of Supplemental State Water Project Water

Description

This project proposes purchasing supplemental State Water Project (SWP) water (State Water) for recharge in the Oxnard Subbasin and delivered to users on PTP and PVCWD systems in years when the State Water is available and willing participants can be found to execute a water transfer. “Supplemental” refers to State Water purchased, exchanged, or transferred for use in the Oxnard and Pleasant Valley basins, in excess of United’s Table A allocation, which is 3,150 AFY (in an average year, only about 60 percent of allocated State Water is actually delivered by DWR). The annual volume of State Water transfers that can be purchased will depend on the volume available and the price that UWCD and other Ventura County agencies are willing to pay. UWCD anticipates that over the long-term approximately 6,000 AFY of supplemental State Water imports will be available at the Freeman Diversion for use within the Oxnard Subbasin and Pleasant Valley Basin.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

Surface water recharge is a critical component of the water budget in the Oxnard Subbasin. Groundwater elevations, which are used as a proxy for other sustainability indicators in the Subbasin, typically rise in years when surface water is available for diversion and fall in years when it is not. Groundwater elevations in the Oxnard Subbasin are currently below the minimum thresholds. Increased recharge of surface water via purchase of supplemental State Water will help groundwater levels recover to elevations above the proposed minimum thresholds. The magnitude of the groundwater level rise will depend on the quantity of additional State Water available for purchase.

Relationship to Measurable Objectives

The relationship of the purchase of supplemental State Water to the measurable objectives is the same as the relationship with the minimum thresholds. By increasing recharge to the Subbasin water levels will rise. Therefore, the purchase of supplemental State Water for recharge via the Freeman Diversion will help the Oxnard Subbasin meet the measurable objective groundwater levels.

Expected Benefits

This project should aid with achievement of measurable objectives and minimum thresholds for five out of six sustainability criteria by reducing the landward gradient that induces seawater intrusion near the coast, raising groundwater elevations and the volume of groundwater in storage, improving groundwater quality, and reducing the potential for land subsidence related to groundwater withdrawals. Higher groundwater levels will also reduce pump lift, and therefore energy consumption, for municipal and agricultural pumpers. The project anticipates increasing the combined sustainable yield of the Oxnard Subbasin and Pleasant Valley Basin by approximately 6,000 AFY.

Timetable for Implementation

Implementation of the purchase of supplemental State Water can occur immediately, as long as water and funding are available. Importation of supplemental State Water has already begun; from 2019 through 2021, United and the FCGMA imported approximately 25,000 AF (average of 8,300 AFY) of supplemental State Water for delivery to the Oxnard Subbasin and Pleasant Valley Basin. This water included purchase of Article 21 water

(15,000 AF) and exchange or transfer agreements with other SWP contractors (10,000 AF). No additional infrastructure is required to implement this project.

Metrics for Evaluation

Evaluation of the purchase of supplemental State Water will be based on the quantity of surface water delivered at the Freeman Diversion.

Economic Factors and Funding Sources

The cost for supplemental State Water obtained via transfers and exchanges is anticipated to range from approximately $500 per acre-feet to $1,000 per acre-feet based on the Nasdaq Veles California Water (NQH2O) Index value. For Article 21 purchases by SWP contractors, including UWCD, the State charges recipients only the operation and maintenance costs, which totaled approximately $200 per acre-foot for the 15,000 AF purchased by UWCD on behalf of FCGMA in 2019. Funding sources for the project are anticipated to include UWCD rate payers and replenishment fees from FCGMA.

Any action taken by the FCGMA Board, acting as the Groundwater Sustainability Agency for the portion of the Oxnard Subbasin in its jurisdiction, to impose or increase a fee shall be taken by ordinance or resolution. Should the FCGMA Board decide to fund a project through imposition of a replenishment fee, it will need to seek voter approval. This will generally require mailing written notice to the owner of each parcel on which the proposed fee will be imposed and conducting a public hearing at least 45 days after the notice.

A8. Destruction of Abandoned Wells

Description

This project proposes identifying and destroying abandoned wells in the Oxnard Subbasin in order to reduce the cross-connection provided by wells screened across multiple aquifers. There are three primary concerns with these wells. First, inland from the Point Mugu Naval Air Station, abandoned private wells may act as a conduit for seawater that has intruded the units of the UAS to migrate downward into the LAS. Second, abandoned wells in the semi-perched aquifer may provide pathways for groundwater with high chloride concentrations to migrate into the UAS and negatively impact the water quality of the Oxnard and Mugu aquifers. Third, the GSP determined that groundwater elevations that are higher than the minimum threshold groundwater elevations in the UAS and LAS adjacent to the coast may result in a return to artesian conditions in the confined aquifers. Abandoned wells can act as conduits for flow from the aquifer systems to land surface.

Because of the existing impacts to groundwater quality and the potential future impacts to infrastructure from abandoned wells, these wells need to be destroyed properly to achieve sustainable management of the groundwater conditions in the Subbasin. The initial phase of this project would address private wells inland from the Point Mugu Naval Air Station. Subsequent phases would identify and address coastal wells and wells that allow leakage from the semi-perched aquifer to the UAS.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

Groundwater elevation minimum thresholds have been defined for the Subbasin and are currently used as a proxy for other sustainability indicators. This project does not directly impact groundwater elevations, but rather improves groundwater quality, a separate sustainability indicator, in the Subbasin.

Relationship to Measurable Objectives

Groundwater elevation measurable objectives have been defined for the Subbasin and are currently used as a proxy for other sustainability indicators. This project does not directly impact groundwater elevations, but rather improves groundwater quality.

Expected Benefits

The quantifiable benefits of this project will be in improved water quality in the LAS in the vicinity of Point Mugu, by preventing migration of poor-quality groundwater from the UAS to the LAS. Secondarily, the project will provide an improved understanding of groundwater conditions in each of the principal aquifers by limiting vertical migration of groundwater. Later phases of this project will help limit future infrastructure expenditures to resolve issues that may arise when the groundwater levels in the confined aquifers recover to elevations that will restore artesian conditions on the Oxnard Plain.

Timetable for Implementation

Identification of wells eligible for destruction, coordination with property owners, and physical destruction of wells landward of the Point Mugu Naval Air Station can occur within a three-year period. Subsequent phases of the project could occur, if funding is available, over the following 5 to 10 years.

Metrics for Evaluation

The project will be evaluated based on the number of wells destroyed and the trends in groundwater quality observed before and after the wells have been destroyed.

Economic Factors and Funding Sources

The total capital cost for the first phase of the well destruction project is anticipated to be approximately $1,000,000. Funding sources for the project are anticipated to include DWR and other potential grant money.

A9. Installation of Additional Groundwater Monitoring Wells

Description

This project proposes installation of multi-depth monitoring wells in the Oxnard Subbasin to assess groundwater conditions in the principal aquifers in areas of the Oxnard Subbasin that lack data. The GSP determined that there were spatial data gaps in the understanding of aquifer conditions and identified 11 potential new well locations that would help fill the gaps identified. Since the GSP was submitted to DWR, two multi-depth monitoring wells were installed at PNW-5, one of the locations identified, adjacent to the Revolon Slough. Potential new well (PNW) location 5 was identified as a location at which additional information was required for four of the five principal aquifers in the Subbasin: the Mugu, Hueneme, Fox Canyon, and Grimes Canyon aquifers. PNW locations -3, -4, -7, and -14 also fill data gaps in four of the five principal aquifers in the subbasin and are a high priority for installing a multi-depth monitoring well. Of these, PNW-7 is of high importance for understanding the groundwater conditions in the Oxnard Subbasin adjacent to the Las Posas Valley Basin boundary.

In addition to the well locations identified in the GSP, a new well in the East Oxnard Plain Management Area (EOPMA), will help define conditions in an area of the Subbasin that does not currently have any monitoring wells. Groundwater levels to the west of the Bailey Fault are currently used as a proxy for conditions to the east of the fault. The addition of multi-depth monitoring wells, completed in each of the principal aquifers in this location, will help refine the understanding of groundwater flow directions and vertical gradients in the EOPMA.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

This project does not have a direct influence on the minimum thresholds. It will, however, provide data that can be used to help evaluate and potentially revise the minimum thresholds in the future.

Relationship to Measurable Objectives

This project does not have a direct influence on the measurable objectives. It will, however, provide data that can be used to help evaluate and potentially revise the measurable objectives in the future.

Expected Benefits

The expected benefits of this project lie in the additional data gathered from the well installation process and the ongoing monitoring of the groundwater conditions at the well sites. This data can be used to refine the conceptual and numerical models of the Oxnard Subbasin. Such refinement may result in reevaluation and adjustment of the minimum thresholds or measurable objectives.

Timetable for Implementation

Installation of monitoring wells will be phased as funding becomes available and the data from the new wells helps define the placement of subsequent wells. Installation of the first two monitoring wells can be completed within a 2-year timeframe with additional wells to follow.

Metrics for Evaluation

This project will be evaluated by the number of new dedicated monitoring wells installed.

Economic Factors and Funding Sources

The cost per new well location is anticipated to be approximately $850,000. Funding sources include DWR TSS or SGM grant funds, as well as potential funding from FCGMA.

A10. Installation of Additional Shallow Groundwater Monitoring Wells

Description

This project proposes installation of shallow monitoring wells to assess groundwater conditions along the Revolon Slough, Calleguas Creek, and the Santa Clara River. The GSP determined that there was a data gap in the understanding of how surface water and shallow groundwater interact with the deeper primary aquifers in the Oxnard Subbasin. DWR also identified "investigation of the hydraulic connectivity of the surface water bodies to the shallow aquifer and principal aquifers" as a recommended corrective action that should be addressed before the 5-year evaluation of the Oxnard Subbasin GSP. Shallow groundwater monitoring wells will be used to help understand the relationship between surface water and groundwater along the stream courses. Data from the construction of the wells will help define aquifer properties in the semi-perched aquifer and Oxnard aquifer, and data on groundwater conditions in these wells will be used to help assess groundwater gradients that may influence the source of water for groundwater dependent ecosystems.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

This project does not have a direct influence on the minimum thresholds. It will, however, provide data that can be used to help evaluate and potentially revise the minimum thresholds in the future.

Relationship to Measurable Objectives

This project does not have a direct influence on the measurable objectives. It will, however, provide data that can be used to help evaluate and potentially revise the measurable objectives in the future.

Expected Benefits

The expected benefits of this project lie in the additional data gathered from the well installation process and the ongoing monitoring of the groundwater conditions at the well sites. This data can be used to refine the conceptual and numerical models of the Oxnard Subbasin. Such refinement may result in reevaluation and adjustment of the minimum thresholds or measurable objectives associated with groundwater dependent ecosystems.

Timetable for Implementation

Installation of the monitoring wells can be completed within a 2-year timeframe.

Metrics for Evaluation

This project will be evaluated by the number of new dedicated monitoring wells installed.

Economic Factors and Funding Sources

The cost per new well location is anticipated to be approximately $165,000. Funding sources include DWR TSS or SGM grant funds, as well as potential funding from FCGMA.

A11. Installation of Transducers in Groundwater Monitoring Wells

Description

This project proposes installation of transducers in representative monitoring points, or key wells, in the Subbasin. The GSP determined that there were often temporal data gaps in the understanding of aquifer conditions. These data gaps limit the number of wells that can be used to contour spring high and fall low groundwater conditions. The temporal data gaps have persisted in reporting groundwater levels in storage for the annual reports prepared after the GSP was submitted to DWR. Additionally, as most key wells are agricultural irrigation wells, transducers will help assure that measured water levels are actual static water levels unaffected by recovery or potential well interference. The addition of transducers will help ensure that spring high and fall low water levels are collected from the representative monitoring points within a 2-week window, as recommended by DWR, and will provide a clearer understanding of groundwater conditions during the spring and fall measurement events. This will allow a better comparison for annual change in storage estimates and will facilitate better management of the Subbasin.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

This project does not have a direct influence on the minimum thresholds. It will, however, provide data that can be used to help evaluate and potentially revise the minimum thresholds in the future.

Relationship to Measurable Objectives

This project does not have a direct influence on the measurable objectives. It will, however, provide data that can be used to help evaluate and potentially revise the measurable objectives in the future.

Expected Benefits

The expected benefits of this project lie in the collection of data from a 2-week window each spring and fall and the ongoing monitoring of the groundwater conditions at the well sites including a better understanding of potential well interference and non-static conditions on water-level measurements. This data can be used make better management decisions depending on the observed groundwater conditions.

Timetable for Implementation

Installation of transducers can be completed within a 2-year timeframe.

Metrics for Evaluation

This project will be evaluated by the number of transducers installed and the evaluation of annual change in storage that results from the transducer data.

Economic Factors and Funding Sources

The cost is anticipated to be approximately $160,000 for nine well locations. Funding sources include DWR TSS or SGM grant funds, as well as potential funding from FCGMA.

A12. Seawater Intrusion Injection Barrier

Description

Seawater intrusion, which primarily occurs in the vicinity of Point Mugu and Port Hueneme, is the primary sustainability indicator that causes undesirable results in the Oxnard Subbasin. This project would prevent seawater intrusion in these targeted areas of the Oxnard coastline through installation of a network of injection wells to increase groundwater elevations at the coastline and reverse the landward gradient in the lower aquifer system by creating a ridge of freshwater within the affected aquifers. This project is in the early stages of development, though preliminary groundwater modelling suggests that in the LAS, installation of 5 to 10 injection wells landward of the eastern edge of the existing seawater intrusion front, injecting a total of 2,400 AFY, has the potential to eliminate any further inland migration of seawater in the Fox Canyon aquifer. This type of seawater barrier has been used, successfully, to prevent seawater intrusion in the West Coast Basin and the Orange County Groundwater Basin. Water supplied to the injection wells in these areas comes from a combination of advanced treated recycled water and imported water. Additional modeling needs to be done to assess: (1) the feasibility of an injection barrier in the Hueneme aquifer and the LAS, (2) the potential volume and sources of water available to inject, (3) the volume of injected water that would be recovered by inland wells, (4) the feasibility of implementing this project along with the seawater extraction barrier project proposed for the Point Mugu area, and (5) the infrastructure requirements, cost, and feasibility of constructing the project and delivering water to stakeholders west of injection barrier.

Relationship to Sustainability Criteria

Relationship to Minimum Thresholds

This project has a direct impact on the minimum threshold groundwater elevations used to assess whether the Oxnard Subbasin is being managed sustainably. By injecting water into the aquifer systems, groundwater elevations will rise in the vicinity of the injection barrier. These higher groundwater elevations will prevent seawater from migrating inland. In the event that this project is found to be feasible and is constructed, the minimum thresholds defined in the GSP will be re-evaluated and may be changed in order to reflect the new groundwater conditions under which the Subbasin could be managed sustainably.

Relationship to Measurable Objectives

As with the minimum thresholds, this project would cause groundwater elevations to rise thereby helping the groundwater conditions in the vicinity of the injection barrier approach or exceed the measurable objective groundwater levels. In the event that this project is found to be feasible and is constructed, the measurable objectives defined in the GSP will be re-evaluated and may be changed in order to reflect the new groundwater conditions under which the Subbasin could be managed sustainably.

Expected Benefits

Although not yet quantified, the expected benefit of this project would be an increase in the sustainable yield of the Oxnard Subbasin and a cessation of seawater intrusion into currently freshwater aquifers.

Timetable for Implementation

This project is in the conceptual stage of development at this time. The implementation timeframe, if the project is found to be feasible, would be a minimum of 10 years.

Metrics for Evaluation

The project would be evaluated based on the increase in the sustainable yield achieved and the migration of the seawater intrusion front. Monitoring wells would be installed east of the injection barrier to determine groundwater quality, and groundwater elevation. These monitoring wells could be incorporated into the broader monitoring network in the future.

Economic Factors and Funding Sources

This project is currently conceptual and exact costs and funding sources have not yet been determined. The infrastructure required to complete a seawater injection barrier is substantial. A replenishment fee implemented by the FCGMA Board could be a potential funding source. Grant funding would be sought to help offset local costs for this project.

Any action taken by the FCGMA Board, acting as the Groundwater Sustainability Agency for the portion of the Oxnard Subbasin in its jurisdiction, to impose or increase a fee shall be taken by ordinance or resolution. Should the FCGMA Board decide to fund a project through imposition of a replenishment fee, it will need to seek voter approval. This will generally require mailing written notice to the owner of each parcel on which the proposed fee will be imposed and conducting a public hearing at least 45 days after the notice.