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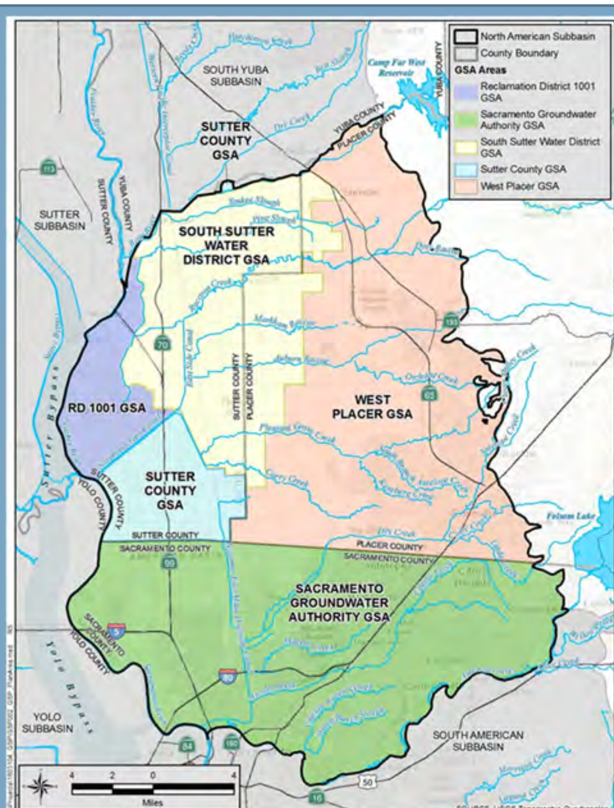
Water Year 2021
Annual Report for the North American Subbasin

March 2022



Prepared for the North American Subbasin GSAs:

- RD1001
- Sacramento Groundwater Authority
- South Sutter Water District
- Sutter County
- West Placer

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Abbreviations and Acronyms

AF	acre-feet
CII	Commercial, industrial, institutional
DWR	California Department of Water Resources
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
InSAR	interferometric synthetic-aperture radar
MAF	million acre-feet
msl	mean sea level
MT	minimum threshold
N	Nitrogen
NASb	North American Subbasin
RD 1001	Reclamation District 1001
RMS	Representative Monitoring Site
SGA	Sacramento Groundwater Authority
SGMA	Sustainable Groundwater Management Act
Subbasin	North American Subbasin
SVSim	Sacramento Valley Simulation Model
TDS	Total Dissolved Solids
WSE	Water Surface Elevation
WY	water year

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Executive Summary

Introduction

This report summarizes Water Year (WY) 2021 (October 1, 2020 – September 30, 2021) conditions and groundwater management actions in the North American Subbasin (NASb or Subbasin). The NASb Groundwater Sustainability Agencies (GSAs) submitted the adopted Groundwater Sustainability Plan (GSP) for review by the California Department of Water Resources (DWR) on January 24, 2022. This represents the first required Annual Report under the Sustainable Groundwater Management Act (SGMA) of 2014.

The Subbasin encompasses an area of about 535 square miles in portions of Placer, Sacramento, and Sutter counties. The Subbasin is being managed by five GSAs comprised of the Reclamation District 1001 GSA; Sacramento Groundwater Authority; South Sutter Water District GSA; Sutter County GSA; and West Placer GSA.

Hydrologic Conditions

WY 2021 was extremely dry with both precipitation and runoff experiencing less than half of historical averages. Temperatures were also higher than their averages from 2000 through 2020.

Water Supply

Water supplies to the Subbasin in WY 2021 consisted of about 60 percent groundwater (381,300 acre-feet [AF]), with the remainder coming from combined surface water (242,400 AF) and recycled water (6,600 AF). This compares to groundwater meeting slightly less than 50 percent of supply in an average of recent years. About one-third of water supply was used by the urban and industrial sector (206,710 AF) and about two-thirds of water supply was used by the agricultural and other rural uses sector (423,590 AF).

Groundwater Levels

Water level hydrographs were updated for all 41 NASb representative monitoring sites (RMS). In general, most RMS readings for both the spring (seasonal high) and fall (seasonal low) levels in 2021 were below their readings from the same periods in 2020. The NASb RMS, with supplemental monitoring well data, were used to create spring and fall 2021 groundwater contour maps.

Change in Groundwater Storage

The change in storage in the Subbasin was estimated through the difference of groundwater contours for both spring (seasonal high) and fall (seasonal low) for 2021 as compared to the same periods in 2020. The spring-to-spring change in storage is estimated at -85,700 AF and the fall-to-fall change in storage is estimated at -110,500 AF. Change in storage was also estimated using the regional groundwater model. The model estimated the change at the end of the WY (fall to fall) at about -134,200 AF. The model estimate is subject to change, because updated 2021 land use was not available to incorporate into the model for this Annual Report.

GSP Implementation

Although the NASb GSP was just recently adopted and submitted in January 2022, GSAs have already begun preparatory activities toward implementing projects and management actions. Full implementation of project and management actions remains on schedule as documented in the GSP.

Sustainability Indicators

The two recent consecutive dry years have resulted in some of the NASb RMS locations exceeding their minimum threshold values established in the NASb GSP. However, the Subbasin is not experiencing any of the defined undesirable results for any of its sustainability indicators.

1. Introduction

1.1 Purpose

The purpose of this report is to summarize Water Year (WY) 2021 (October 1, 2020 – September 30, 2021) conditions and groundwater management actions in the North American Subbasin (NASb or Subbasin). The NASb Groundwater Sustainability Agencies (GSAs) submitted the adopted Groundwater Sustainability Plan (GSP) for review by the California Department of Water Resources (DWR) on January 24, 2022. This represents the first required Annual Report under the Sustainable Groundwater Management Act (SGMA) of 2014.

1.2 North American Subbasin

The NASb is identified by DWR in Bulletin 118[1] as Subbasin No. 5-021.64. The Subbasin is part of the greater Sacramento Valley region of California. **Figure 1-1** shows the location of the Subbasin and surrounding subbasins. The Subbasin encompasses an area of about 342,516 acres (535 square miles) in Sacramento, Placer, and Sutter counties. The NASb is bounded on the north by the Bear River, on the south by the American River, to the west by the Feather and Sacramento rivers, and on the east by the Sierra Nevada foothills (**Figure 1-1**).

1.3 North American Subbasin GSAs

The Subbasin is managed by five GSAs that cover the entire Subbasin (**Figure 1-1**) and is comprised of:

- Reclamation District 1001 (RD 1001)
- Sacramento Groundwater Authority (SGA)
- South Sutter Water District
- Sutter County
- West Placer

1.4 Organization of this Report

The required contents of an Annual Report are provided in the GSP Regulations. Organization of the report is meant to follow the regulations where possible to assist in the review of the document. Sections of the WY 2021 Annual Report include the following:

- **Section 1. Introduction:** a brief background of the Subbasin GSAs and a location map.
- **Section 2**. **Hydrologic Conditions:** a summary of WY 2021 precipitation, runoff, and temperature.
- **Section 3. Water Supply:** a summary of the sources and uses of supply.

[1] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Bulletin-118/Files/Statewide-Reports/Bulletin_118_Update_2003.pdf

- **Section 4. Groundwater Levels:** contour maps of seasonal highs and lows and a summary of levels at individual monitoring wells in response to hydrologic and supply and demand conditions.
- **Section 5. Change in Groundwater in Storage:** a description of the methodologies and presentation of changes in groundwater in storage.
- **Section 6. GSP Implementation:** a summary of progress toward implementing management activities and projects and management actions since adoption of the GSP.
- **Section 7. Sustainability Indicators:** a summary of the status of adopted sustainability indicators for the Subbasin.

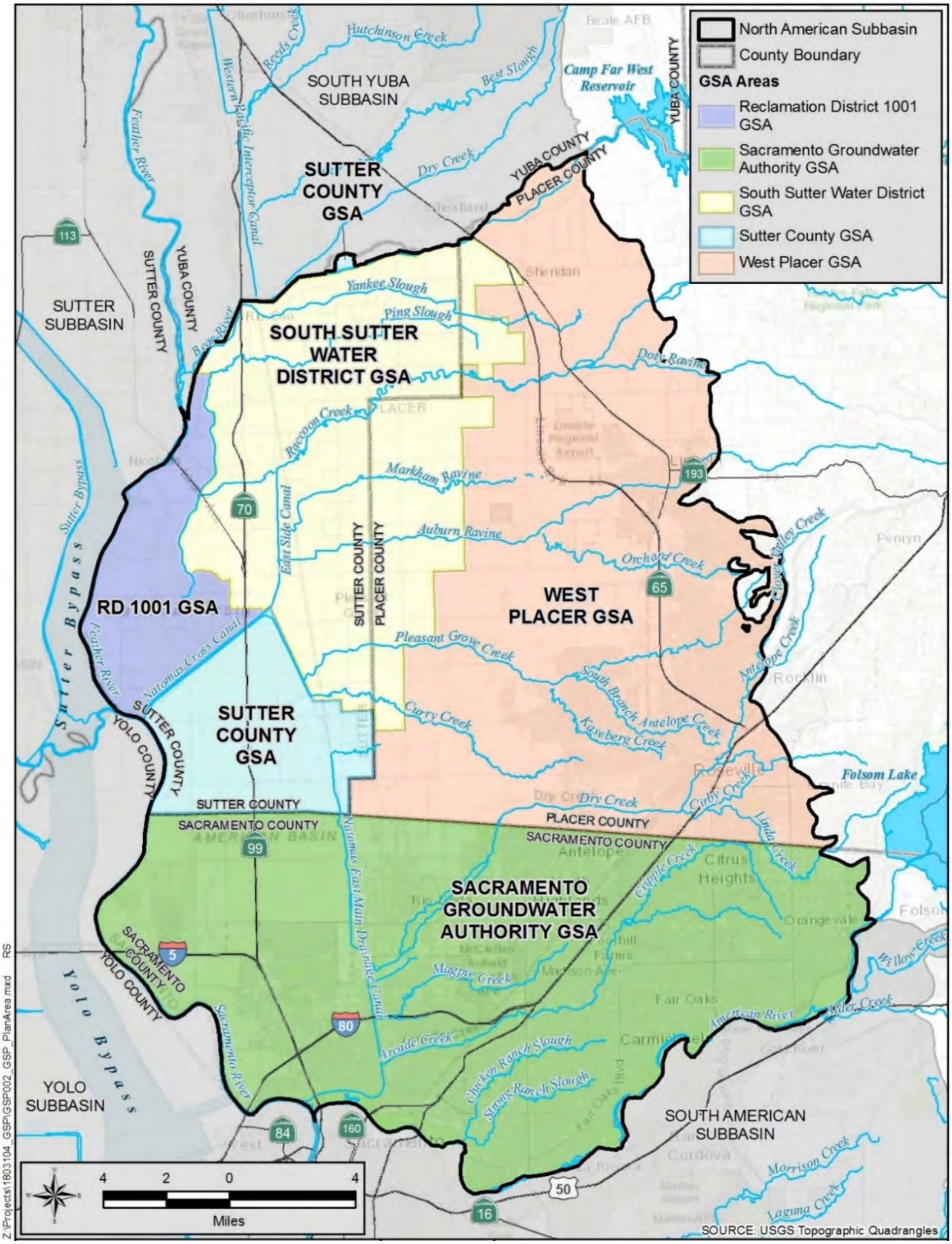

Figure 1-1. North American Subbasin

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2. Hydrologic Conditions

This section provides a brief description of the Subbasin hydrologic conditions in WY 2021. In the last two years, both the NASb and the State have been experiencing abnormally dry hydrologic conditions. Throughout WY 2021, the Governor of California issued multiple proclamations of a state of emergency related to drought. The April 21, 2021 proclamation[2] added the counties of Placer, Sacramento, and Sutter, which are all part of the NASb.

2.1 Precipitation

Like WY 2020, WY 2021 was an extreme year in terms of lack of precipitation. Precipitation is measured at 29 stations in the Subbasin, although many of the stations do not have a long period of record. The closest station to the Subbasin with a long period of record, dating back into the 1880s, is the Sacramento 5ESE station, which is just south of the Subbasin, but is representative due to its geographic location. The average precipitation, using recent years that may be more representative of current and potentially future conditions with climate change, WYs 2000 through 2020, is 17.87 inches. During WY 2021, precipitation was 7.74 inches, less than half of the average precipitation (**Figure 2-1**).

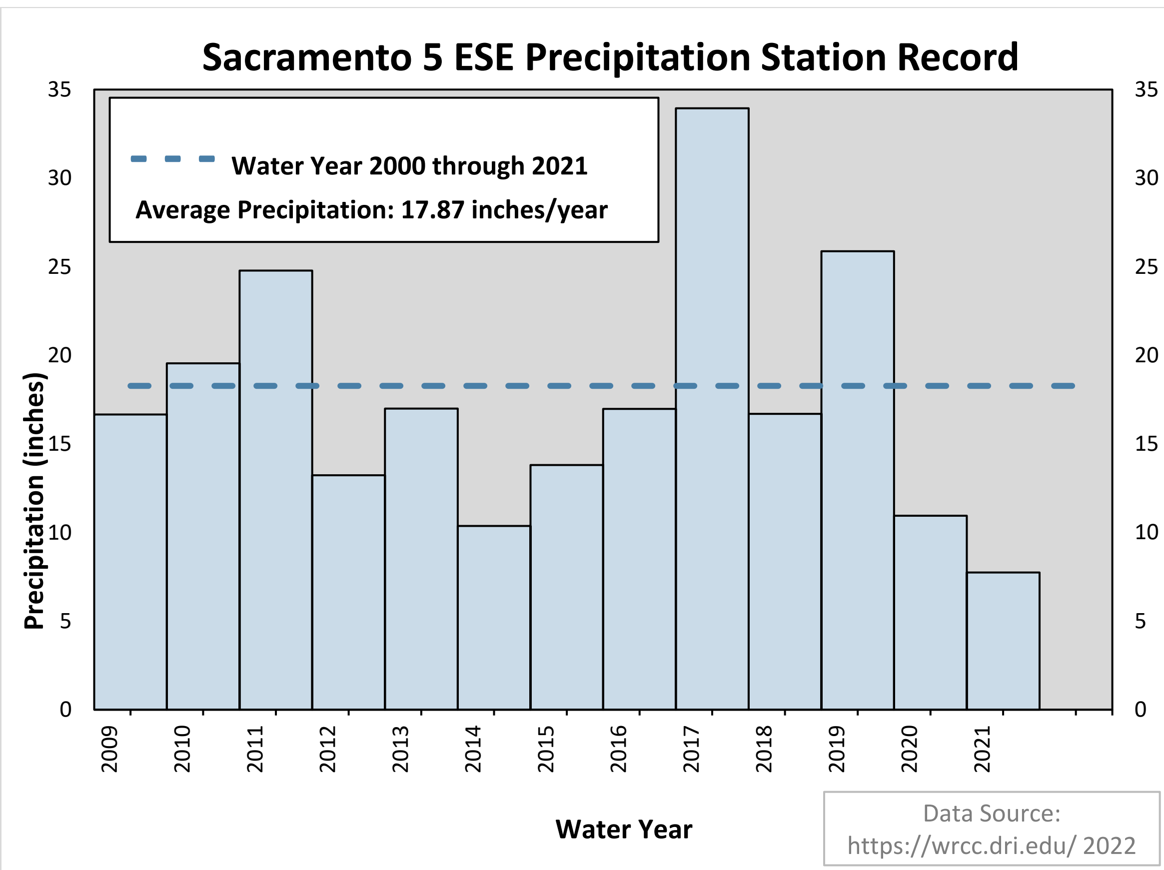

Figure 2-1. 5ESE Precipitation Station Water Year Record

[2] https://www.gov.ca.gov/wp-content/uploads/2021/04/4.21.21-Emergency-Proclamation-1.pdf

As shown in **Figure 2-2**, every month in WY 2021 was below the monthly average for the period 2000 through 2020.

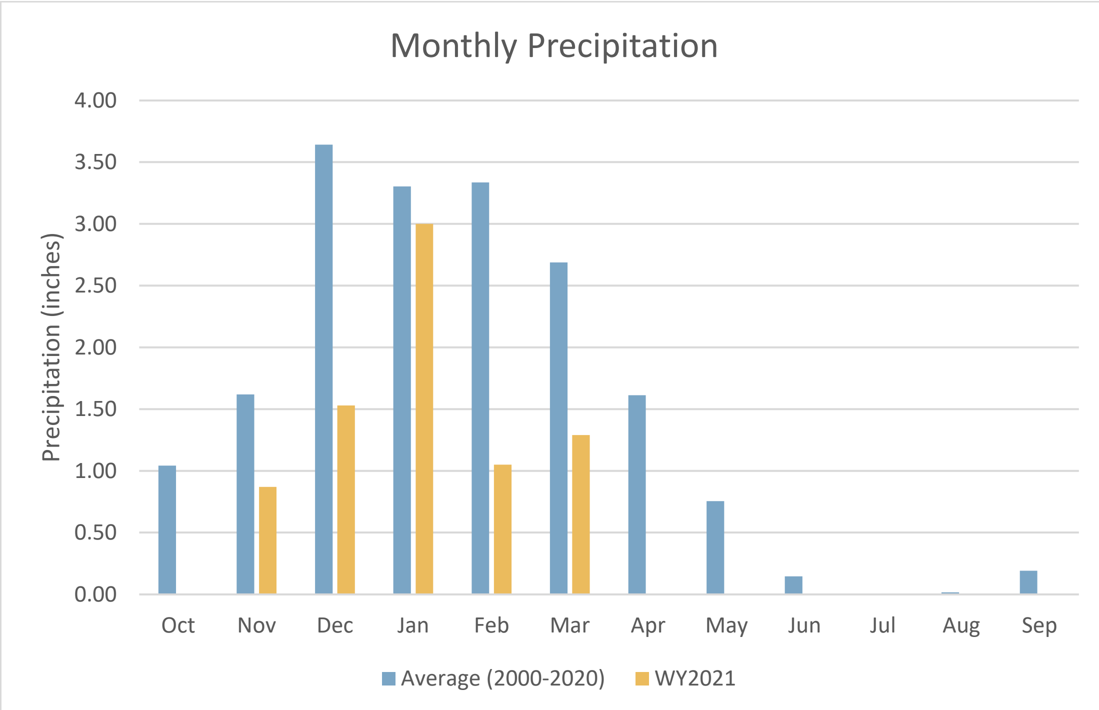

Figure 2-2. 5ESE Precipitation Station Monthly Record

2.2 Runoff

WY 2021 was the second driest on record based on statewide runoff[3]; this was preceded by WY 2020, which was California's fifth driest year. The Sacramento Valley Water Year Index is calculated by DWR on a water year basis. WY 2021 was classified as a critically dry year[4], with only 3.8 million acre-feet (MAF) of runoff compared to a 1991 to 2020 average of 7.9 MAF.

2.3 Temperature

The average annual temperature in WY 2021 was approximately 0.4 degrees Fahrenheit (°F) warmer than the 2000 through 2020 average (60.5 compared to 60.1 °F). Eight of the 12 months in WY 2021 exceeded the 2000 through 2020 average for the same month as shown in **Figure 2-3** below.

3 https://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Publications-And-Reports/091521-Water-Year-2021-broch_v2.pdf

4 http://cdec.water.ca.gov/reportapp/javareports?name=WSI

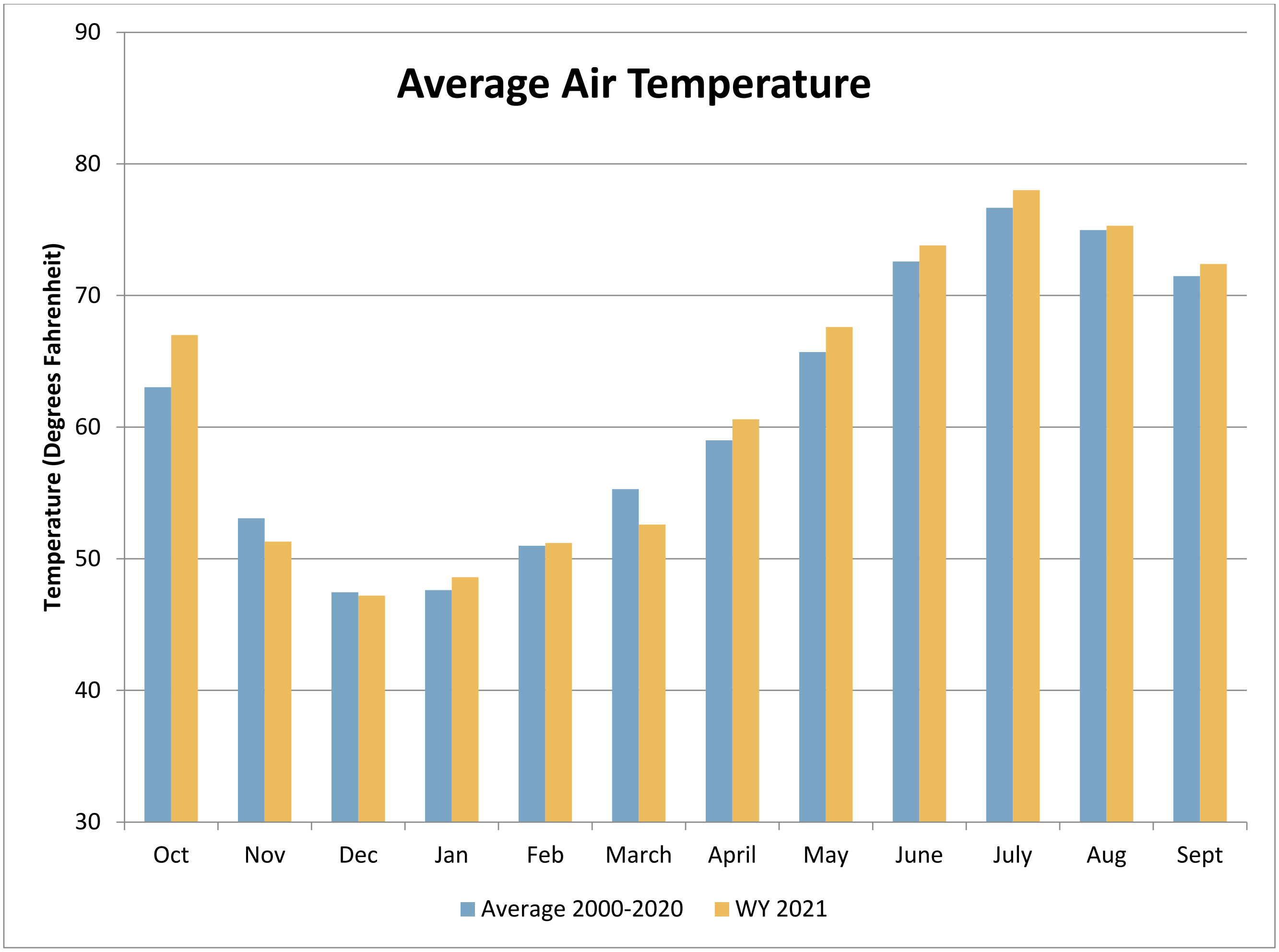

Figure 2-3. Average Monthly Air Temperature

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3. Water Supply

This section describes the total water supply by source and the total water use by sector. In addition, a description of surface water used for groundwater recharge is provided.

3.1 Water Supply by Source

Total water supply for WY 2021 was determined from a number of sources. Metered surface water deliveries on a monthly basis were reported by public water suppliers and for agriculture by SSWD, Pleasant Grove-Verona Mutual Water Company, Nevada Irrigation District, and Placer County Water Agency. Metered recycled water, sourced almost exclusively from surface water, was reported by the City of Roseville and the City of Lincoln. Smaller riparian diversions for private use and tailwater reuse of surface water were estimated by the regional Cosumnes, South American and North American subbasins integrated groundwater model – CoSANA.

Metered groundwater production on a monthly basis was reported was reported by public water suppliers. In addition, metered groundwater remediation was reported for the former McClellan Air Force Base and a portion of Aerojet remediation pumping that occurs north of the American River in the Subbasin. Agricultural groundwater pumping is by private landowners, so it is largely unmetered. However, several landowners participated in a groundwater substitution transfer in 2021, so metered pumping of 27,540 AF was reported.

The remaining groundwater pumping by private landowners was estimated by CoSANA. In general, to estimate the groundwater pumping in agricultural areas, water supplies (precipitation, metered groundwater pumping, and meter surface water diversions) were subtracted from the total crop evapotranspiration requirements with the residual being estimated groundwater pumping for agriculture and agricultural-residential uses. It should be noted that for agriculture, the latest WY 2021 land use/crop type areas were not available at the time of the model run. To estimate agricultural groundwater extractions, a 2014 land use pattern was assumed. That year had a significant idling of agricultural acres due to limited water supply. That pattern was in general confirmed by comparing 2021 to 2020 land use data downloaded from CropScape[5], which showed fallow/idle land increased by over 7,000 acres and rice fields reduced by 6,500 acres in the Subbasin.

Table 3-1 provides the estimated WY 2021 total water supply. Groundwater met approximately 60 percent of the total water demand in the Subbasin in WY 2021. This is higher than the recent 10-year average[6] (WYs 2009–2018 using the CoSANA model results) total demand met by groundwater of less than 50 percent, representing a significant shift in supply source based on the dry hydrologic conditions

5 https://nassgeodata.gmu.edu/CropScape/

6 This was the recent 10-year period used to represent current conditions during development of the GSP, so it is used here for comparison purposes

described in the previous section of this Annual Report. The remaining supply was from surface water, of which less than 3 percent is recycled and reused for non-potable water demands in the NASb.

Table 3-1. Water Year 2021 Total Water Supply

Month	Groundwater (AF)	Surface Water (AF)	Recycled Water (AF)	Total (AF)
Oct-2020	38,300	20,200	520	59,020
Nov-2020	21,300	12,400	200	33,900
Dec-2020	10,900	7,200	120	18,220
Jan-2021	5,500	4,800	40	10,340
Feb-2021	7,600	4,700	20	12,320
Mar-2021	9,900	6,100	100	16,100
Apr-2021	27,900	18,600	710	47,210
May-2021	64,700	41,600	780	107,080
Jun-2021	61,400	37,200	1,030	99,630
Jul-2021	55,000	44,500	1,170	100,670
Aug-2021	54,600	30,700	1,060	86,360
Sep-2021	24,200	14,400	850	39,450
Total WY 2021	**381,300**	**242,400**	**6,600**	**630,300**

Figure 3-1 illustrates the general location and volume of extractions in the Subbasin based on results from the CoSANA model.

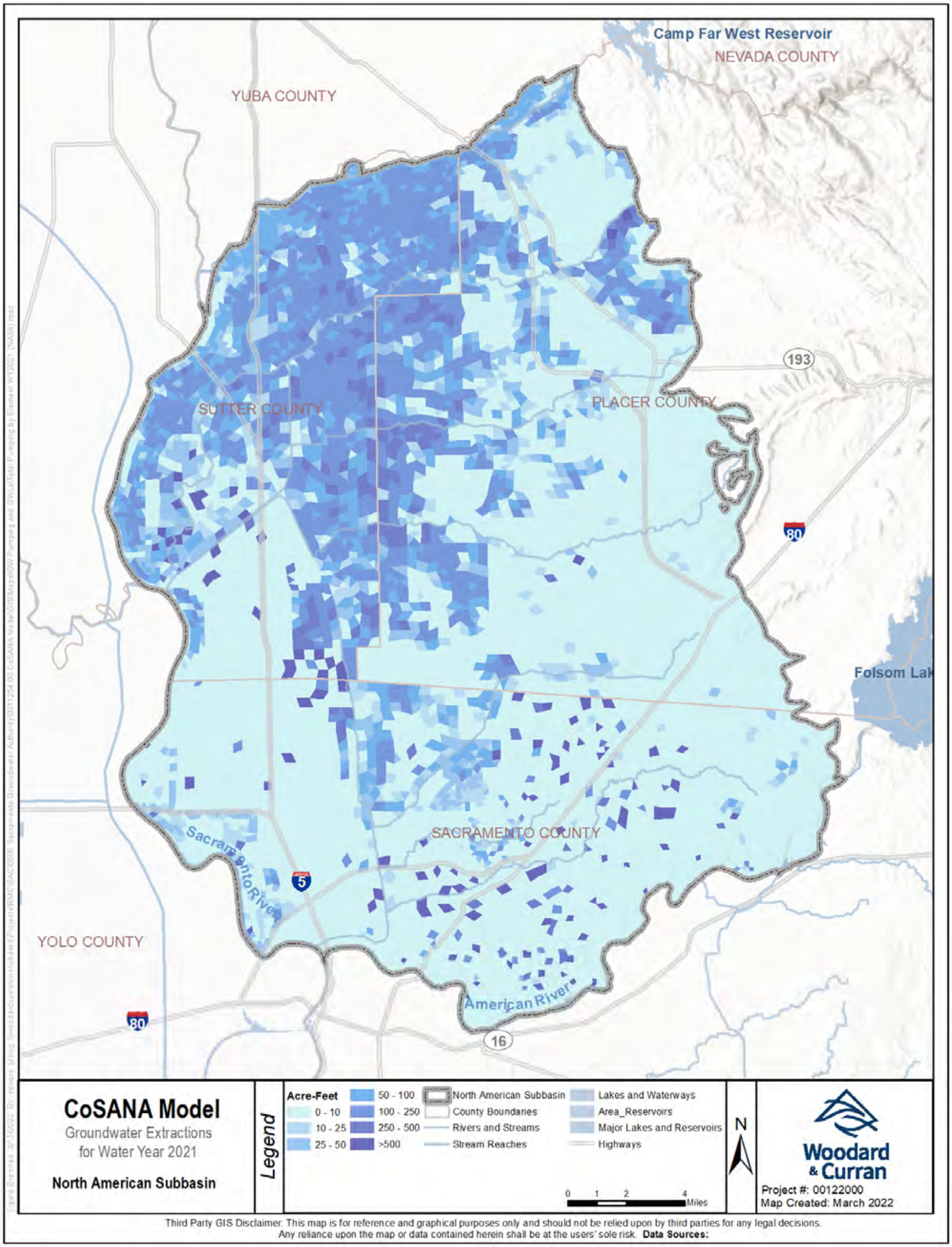

Figure 3-1. Location and Volume of Groundwater Extractions

3.2 Water Use by Sector

This section summarizes the total annual groundwater and surface water used to meet agricultural, urban and rural, industrial demands and remedial cleanup activities in the Subbasin. **Table 3-2** summarizes the total water use in the Subbasin by source and water use sector for WY 2021. The method of measurement and an estimated level of accuracy for each sector is also provided.

For WY 2021, urban uses accounted for about one-third of total demand in the Subbasin. Urban uses include: residential; commercial, industrial, institutional (CII); and, groundwater remediation extractions. Of the 90,500 AF of reported extraction, 7,100 AF was for remediation activities. Of the total urban water use, about 70 percent is estimated to be for residential uses, with the remaining 30 percent being for CII uses[7]. In general, nearly all urban sectors and uses rely on direct meter measurements, with an accuracy of about 95 percent. There are some urban uses (e.g., golf courses and parks) that are not directly metered, so the overall average accuracy of the urban users of groundwater is about 90 percent. Surface water and recycled water metering for urban uses has an estimated accuracy of 95 percent.

For WY 2021, agricultural, residential (domestic well owners), managed wetlands, and other rural uses accounted for approximately two-thirds of total water demand. For the agricultural/rural sector, only about 10 percent of groundwater extractions are metered (27,540 AF reported for WY 2021), with the remaining 90 percent estimated by the CoSANA model. The overall estimated accuracy for groundwater is about 80 percent. Extractions to meet managed wetland demands are included as part of the overall agricultural demand by the CoSANA model. For surface water, about 80 percent of diversions are directly measured through meters and weirs with about 20 percent estimated. This results in an estimated accuracy of about 85 percent. Recycled water produced for use by agriculture is directly measured with a meter, so the level of accuracy is estimated to be about 95 percent.

[7] This 70/30 ratio of residential to CII uses was determined by downloading monthly water conservation and production reports from the State Water Board at: https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.html. Monthly WY 2021 data for NASb public water suppliers was filtered from the data and a weighted average for the NASb was calculated for residential uses. Non-residential uses were classified as CII.

Table 3-2. Water Year 2021 Total Water Use by Water Sector

Urban/Industrial Sector				
Month	**Groundwater (AF)**	**Surface Water (AF)**	**Recycled Water (AF)**	**Total (AF)**
Oct-2020	9,000	11,500	370	20,870
Nov-2020	6,600	7,200	180	13,980
Dec-2020	4,600	5,600	50	10,250
Jan-2021	4,300	4,800	40	9,140
Feb-2021	4,200	4,400	20	8,620
Mar-2021	5,100	6,100	70	11,270
Apr-2021	6,400	9,500	350	16,250
May-2021	8,600	11,900	500	21,000
Jun-2021	10,700	13,300	680	24,680
Jul-2021	10,700	13,900	710	25,310
Aug-2021	10,900	12,700	660	24,260
Sep-2021	9,400	11,200	480	21,080
Total WY 2021	**90,500**	**112,100**	**4,110**	**206,710**
Method	Metered	Metered	Metered	
Accuracy	90%	95%	95%	

Agricultural/Rural Sector				
Month	**Groundwater (AF)**	**Surface Water (AF)**	**Recycled Water (AF)**	**Total (AF)**
Oct-2020	29,300	8,700	150	38,150
Nov-2020	14,700	5,200	20	19,920
Dec-2020	6,300	1,600	70	7,970
Jan-2021	1,200	-	-	1,200
Feb-2021	3,400	300	-	3,700
Mar-2021	4,800	-	30	4,830
Apr-2021	21,500	9,100	360	30,960
May-2021	56,100	29,700	280	86,080
Jun-2021	50,700	23,900	350	74,950
Jul-2021	44,300	30,600	460	75,360
Aug-2021	43,700	18,000	400	62,100
Sep-2021	14,800	3,200	370	18,370
Total WY 2021	**290,800**	**130,300**	**2,490**	**423,590**
Method	~10% Metered ~90% Estimated	~80% Metered or Gaged ~20% Estimated	Metered	
Accuracy	80%	85%	95%	

3.3 Surface Water Used for Recharge

Several urban water agencies in the NASb have access to both surface water and groundwater, so they are able to practice conjunctive use programs to adapt to changing hydrologic conditions. The SGA GSA established a Water Accounting Framework to promote conjunctive use operations in the central SGA area. The framework establishes groundwater extraction targets and tracks surface water that was used to reduce groundwater demand targets. SGA considers this surface water that was used for recharge in the SGA area. For WY 2021, the estimated surface water used for recharge was 7,200 AF.

4. Groundwater Levels

This section provides groundwater level monitoring results as displayed by hydrographs and groundwater contours. All of the data are presented as groundwater elevations. The groundwater levels were obtained by various entities including: DWR, SGA, Placer County, and from reports submitted by various agencies with groundwater quality monitoring programs overseen by the Regional Water Quality Control Board. Groundwater level measurements taken during WY 2021 are provided in the following tables and were uploaded to SGMA portal and are contained in the NASb data management system.

4.1 Groundwater Contours

Spring (seasonal high) and fall (seasonal low) water-level elevation contours were prepared for the principal aquifer for WY 2021 to illustrate groundwater conditions in the Subbasin. The seasonal low groundwater contours were developed using October 2021 groundwater level measurements, even though they are outside of the defined water year, because they represent groundwater conditions resulting from pumping during WY 2021.

Groundwater level data from 69 wells in the NASb, including all of the 41 GSP representative monitoring sites (RMS), were used to create the spring and fall 2021 groundwater elevation contour maps and data from 8 wells from the South American and Yuba subbasins were used to better align groundwater contours with adjacent subbasins. The contour maps and the locations of monitoring wells used in their creation are shown in **Figures 4-1 and 4-2** below.

Groundwater elevations were generally higher in spring than in the fall due to groundwater pumping. Groundwater flow direction is generally toward the center of the Subbasin where a pumping depression has been present for decades. In the spring, groundwater elevations ranged from near 200 feet above mean sea level in the eastern Subbasin down to -35 feet below sea level in Sacramento County near the former McClellan Air Force Base.

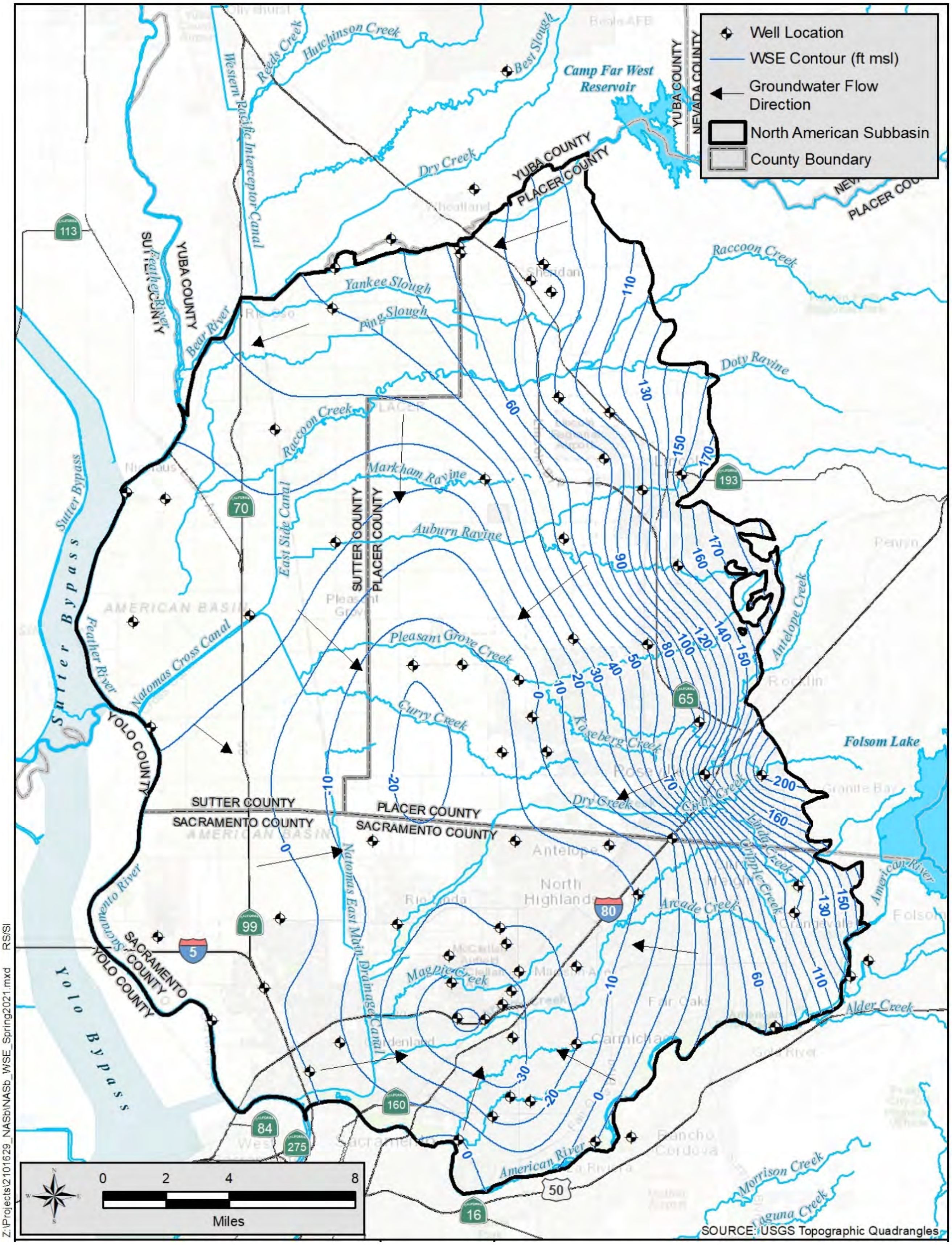

Figure 4-1. Spring 2021 Groundwater Elevation Contour Map

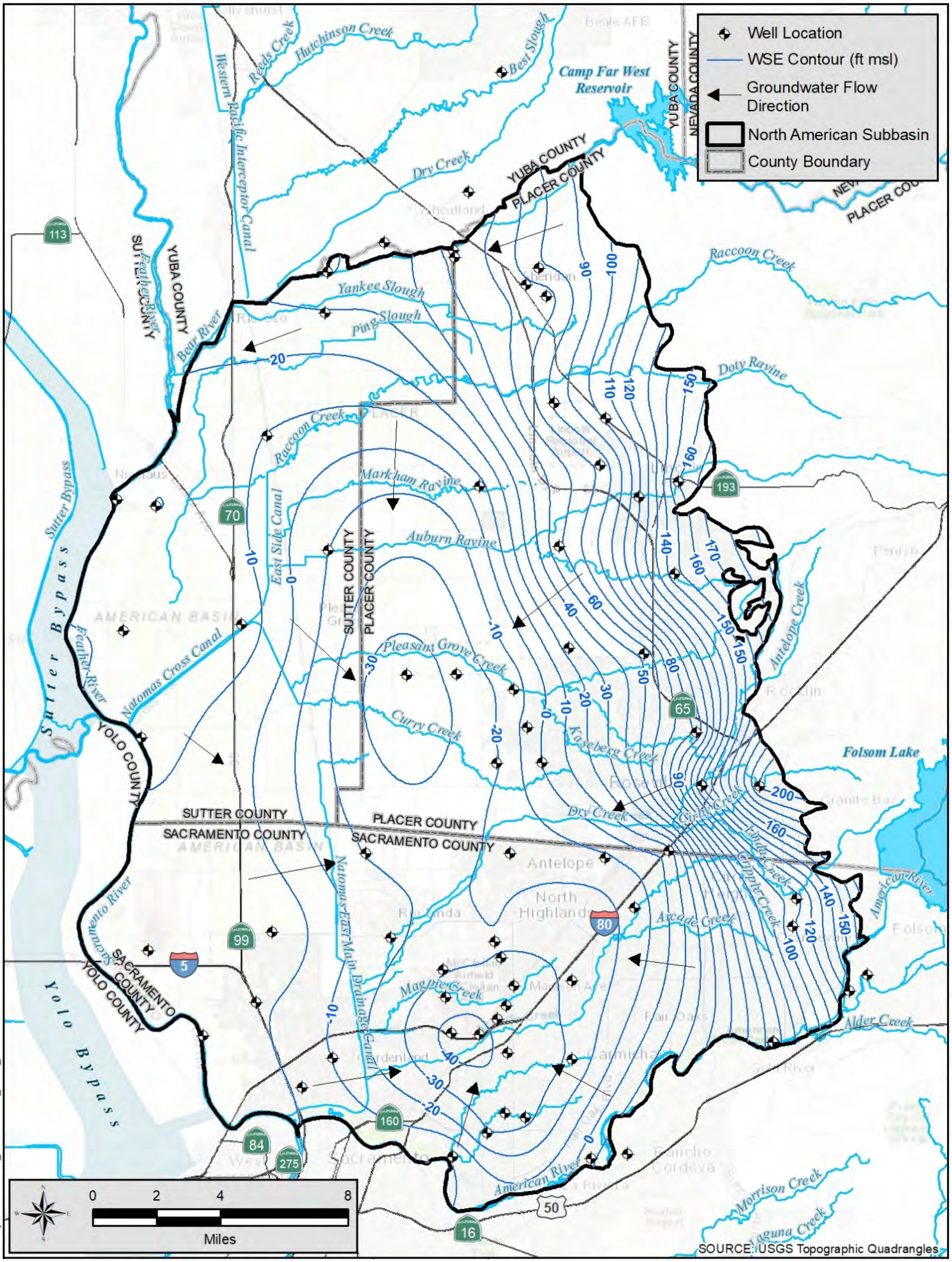

Figure 4-2. Fall 2021 Groundwater Elevation Contour Map

4.2 Hydrographs

Positive and negative changes in groundwater elevations from year to year are observed in various parts of the Subbasin, as has been observed historically. Seasonal trends of slightly higher spring groundwater elevations compared with fall levels are observed annually.

Appendix A contains hydrographs for all 41 GSP representative monitoring site wells with established minimum thresholds (MTs), showing groundwater levels through the end of WY 2021 (generally measured in October 2021). A few of the hydrographs are shown on **Figure 4-3** and provide a general representation of changes in groundwater levels during WY 2021 at representative monitoring wells. The groundwater elevations for most of the wells remained above their respective MT through WY 2021. This is discussed further in **Section 7 – Sustainability Indicators**.

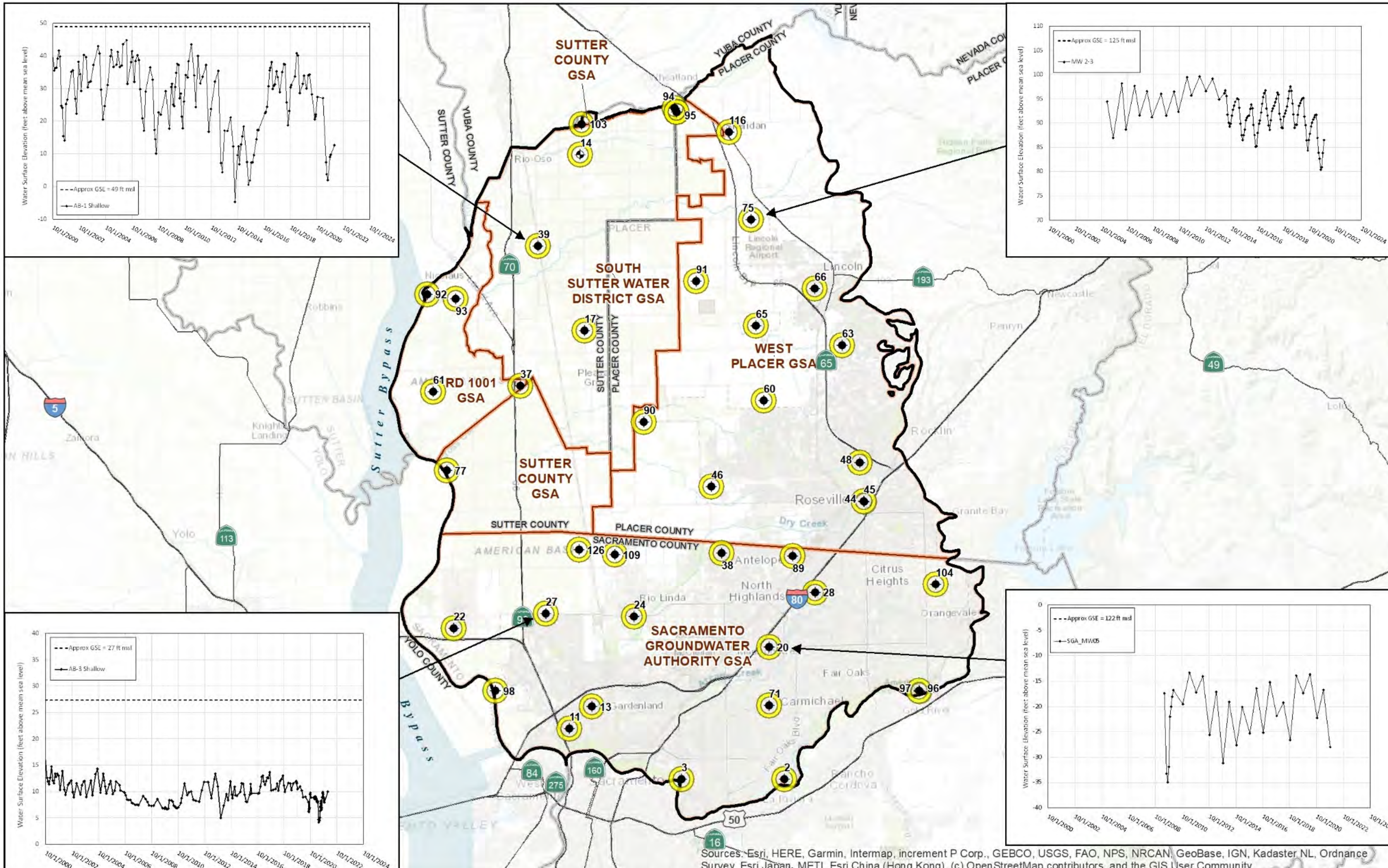

Figure 4-3. Regional Representative Hydrographs

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5. Change in Groundwater Storage

Groundwater change in storage was estimated by using two methods: 1) comparing changes in groundwater elevation contour maps, and 2) using the CoSANA groundwater flow model. Each method and its results are described below.

5.1 Change in Storage Calculated from Groundwater Levels

Annual change in storage was determined for both the spring and fall 2021 periods by using measured groundwater elevations at a consistent set of wells measured in 2020 and again in 2021 (2021 groundwater map development was discussed in **Section 4.1 – Groundwater Contours**). For each season, a change in groundwater levels comparing 2020 to 2021 was prepared (**Figures 5-1 and 5-2**). The difference in groundwater elevation maps were then used to calculate a weighted average change in groundwater levels throughout the Subbasin for both seasons. The average change in groundwater levels were then multiplied by the average specific yield of the Subbasin, which was estimated at 8.4 percent based on textural analysis of well driller logs as part of development of DWR's Sacramento Valley Simulation (SVSim) Model. The resulting calculated change in storage from spring 2020 to spring 2021 is estimated at -85,000 AF, and the change in storage at the end of WY 2021 (fall 2020 – fall 2021) was about -110,500 AF. This information is shown in **Table 5-1**.

Table 5-1. WY 2021 Estimated Change in Groundwater in Storage from Groundwater Level Difference Contours

Change in Storage Using Water Level Difference Contour Surfaces			
Basin Area (acres)	**Average Water level change (ft)**	**Average Specific Yield [1] (unitless)**	**Change in Storage (AF)[2,3]**
Spring 2020 – Spring 2021			
342,516	-2.98	0.084	-85,700
Fall 2020 – Fall 2021			
342,516	-3.84	0.084	-110,500

Notes: ft = feet
[1] Calculated average Specific Yield from DWR SVSim Model
[2] Calculated as Area x Water level change x Specific Yield
[3] The total change in storage is rounded to the nearest 100 AF

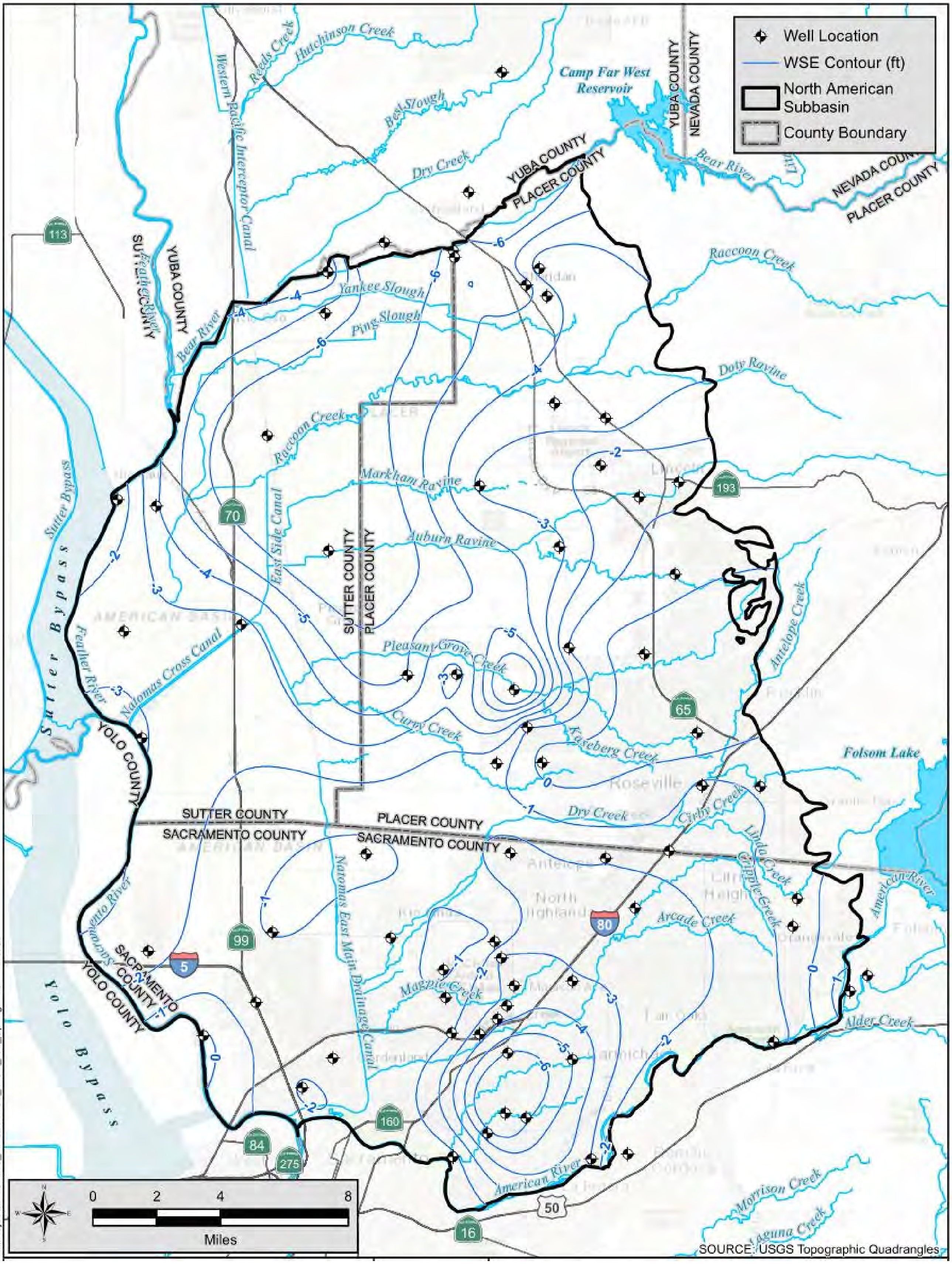

Figure 5-1. Spring 2020 to Spring 2021 Groundwater Level Difference Contours

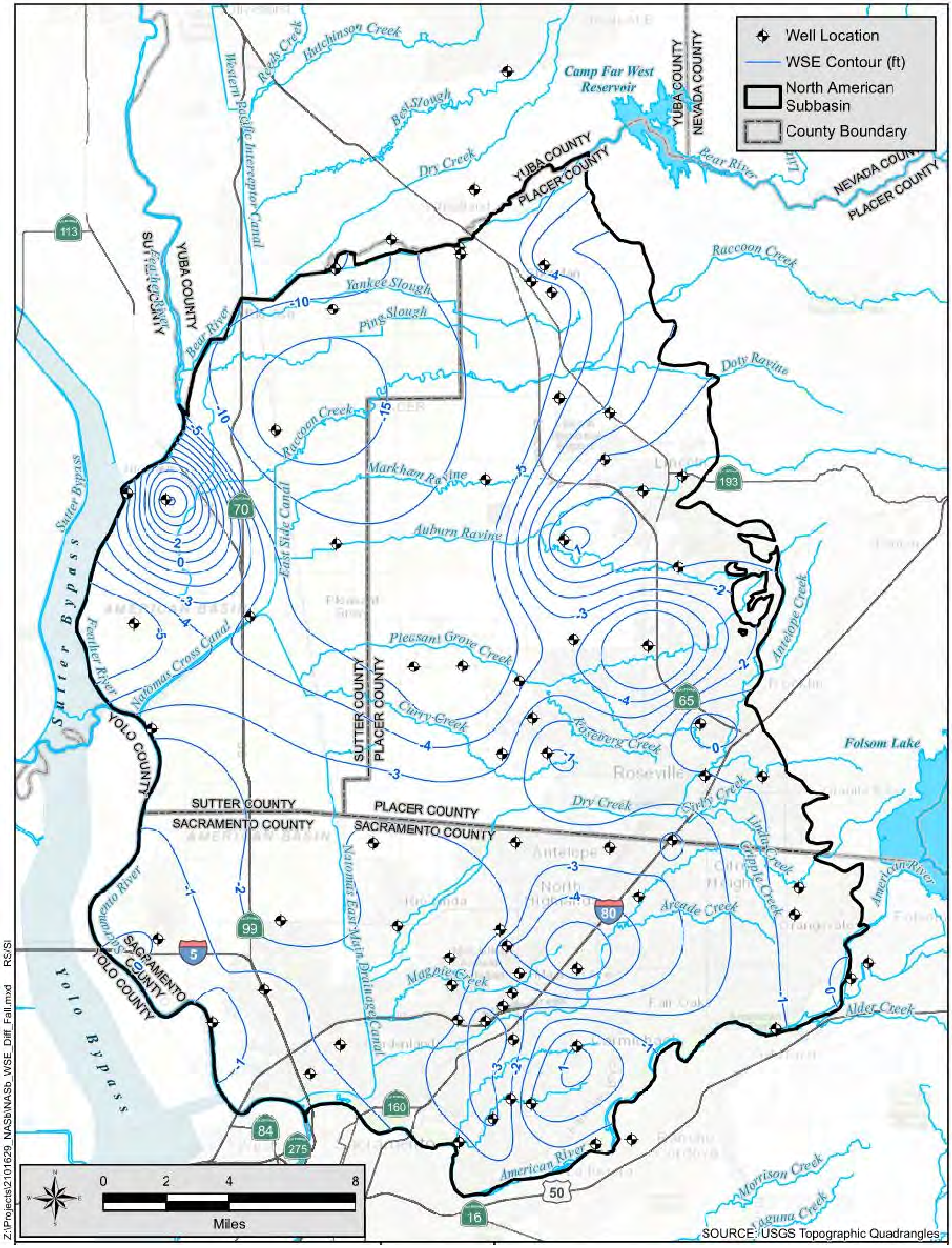

Figure 5-2. Fall 2020 to Fall 2021 Groundwater Level Difference Contours

5.2 Change in Storage Calculated from Groundwater Model

The change in groundwater storage was estimated for the entire NASb using the calibrated CoSANA groundwater model. The model was used to estimate groundwater pumping for agricultural areas in the Subbasin as a residual of crop evapotranspiration minus precipitation, groundwater pumping and surface water deliveries. **Table 5-2** shows the Subbasin-wide groundwater pumping and the change in storage for water years 2009 through 2021[8]. For WY 2021, the Subbasin had a model estimated change of groundwater in storage of about -134,200 AF. Over the measured period (WY 2009–2021), the Subbasin still maintains a positive cumulative change in storage of about 207,000 AF at the end of WY 2021. Part of the decreases are due to only having 3 wet years out of the last 13 years, with the remaining years being below normal to critical dry years as shown in the water year classification in **Table 5-2**.

Figure 5-3 shows both the annual and cumulative changes in groundwater in storage in the Subbasin from WY 2009 through 2021. Groundwater in storage increased from WYs 2009 through 2019, by a little over 430,000 AF. Because of the drought conditions and the resulting higher reliance on groundwater in WYs 2020 and 2021, groundwater storage has been depleted by about 224,000 AF over the past two years. Note that the most recent land use data was not available when the model was run for this Annual Report, so these estimates are subject to change as the latest land use information is added to the model.

Table 5-2. Model-Estimated Annual Change in Groundwater in Storage from WYs 2009–2021

Water Year	Groundwater Extraction (Acre-Feet)	Change in Storage (Acre-Feet)	Water Year Classification[9]
2009	313,200	9,100	Dry
2010	273,800	72,400	Below Normal
2011	252,800	151,700	Wet
2012	294,700	-9,200	Below Normal
2013	299,200	-13,800	Dry
2014	302,200	-32,800	Critical
2015	357,700	-71,700	Critical
2016	279,700	54,700	Below Normal
2017	280,000	168,400	Wet
2018	307,900	-10,100	Below Normal
2019	256,900	113,000	Wet
2020	349,900	-89,900	Dry
2021	381,300	-134,200	Critical
Total	**3,949,300**	**207,600**	

[8] WYs 2009–2018 was used as the most recent 10-year period during GSP development, so WY 2009 has been used as a starting point for tracking cumulative change in storage for subsequent years.

[9] Year Type Classification: Index based on flow in million acre-feet:

Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8, and less than 9.2
Below Normal	Greater than 6.5, and equal to or less than 7.8
Dry	Greater than 5.4, and equal to or less than 6.5
Critical	Equal to or less than 5.4

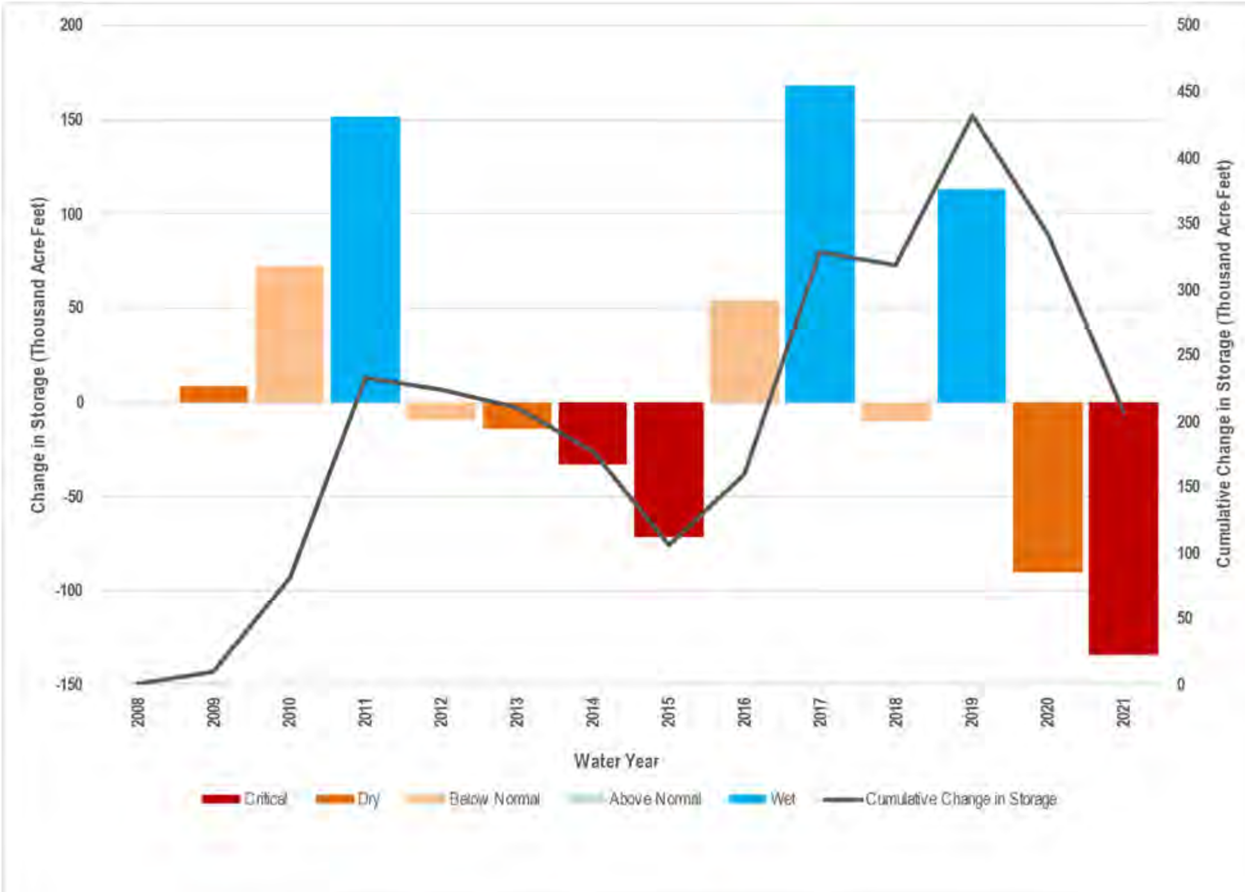

Figure 5-3. Cumulative Change in Storage Graph from WYs 2009–2021

Figure 5-4 shows that relative changes in storage within the Subbasin and is in general agreement with the difference in groundwater elevations shown on **Figure 5-2**, increasing confidence of the estimated change in storage.

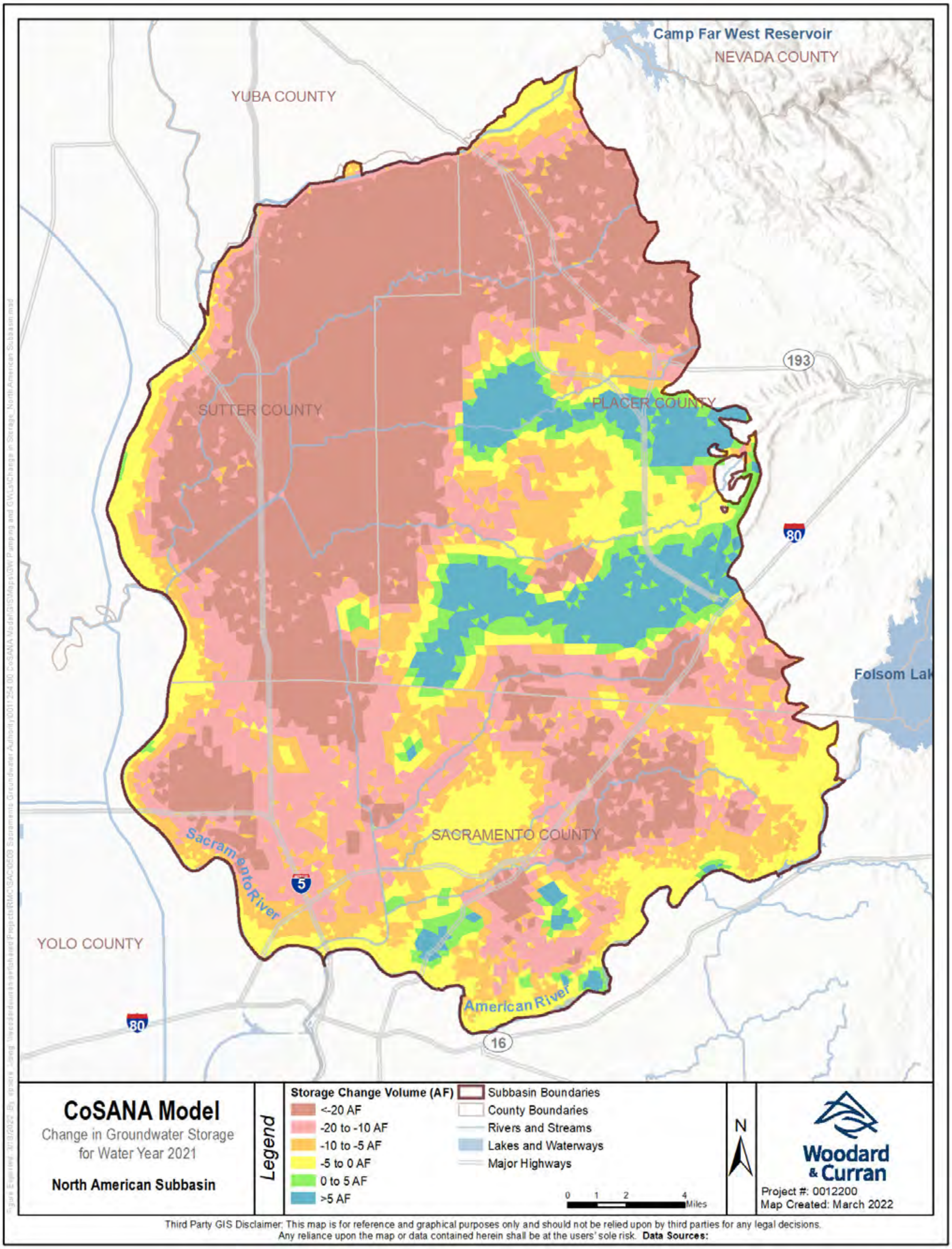

Figure 5-4. Model Estimated Change in Groundwater Storage Map

6. GSP Implementation

The Subbasin GSAs agreed to work together to protect the groundwater resources of the Subbasin to meet the current and future beneficial uses in the Subbasin by developing a GSP during WY 2021 that conforms with the requirements of SGMA. The status of each project and management action is given in tabular format below. Because the GSP was only just completed and submitted to DWR on January 24, 2022, little reportable progress has been made towards implementing the GSP or projects and management actions. A limited update, with currently planned activities occurring in WY 2022, is provided below for this first Annual Report.

The Subbasin GSAs held their first post-GSP adoption coordination meetings on February 7, 2022 and March 14, 2022. Each GSA has agreed to make its first-year implementation payment. These funds totaling about $230,000 are being collected and managed by the SGA GSA as the GSP plan manager for the Subbasin. SGA has been managing contractors for the preparation of the first Annual Report. A public meeting to present the results of the Annual Report is anticipated around May 2022. A summary of projects and management actions is included as **Table 6-1**.

Table 6-1. Projects and Management Actions

Project or Management Action	Comments
Project #1: Regional Conjunctive Use Expansion – Phase 1	Planning on schedule to commence in spring 2022 with Water Bank planning below
Project #2: Natomas Cross Canal Stability Berm and Channel Habitat Enhancements Project	Construction on schedule as planned for 2023
Management Action #1: Complete Planning for Sacramento Regional Water Bank	Planning on schedule to commence spring 2022
Management Action #2: Explore Improvements with NASb Well Permitting Programs	Held initial coordination meeting with Sacramento County in January 2022. Initial meetings with other permitting agencies expected by mid-2022
Management Action #3: Proactive Coordination with Land Use Agencies	Will send first Annual Report to respective planning agencies upon completion
Management Action #4: Domestic/Shallow Well – Data Collection and Communication Program	Secured funding for follow-up well inventory to be conducted in mid-2022 in coordination with South American Subbasin
Management Action #5: Groundwater Dependent Ecosystem Assessment Program	Methodologies to be evaluated during 2022

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7. Sustainability Indicators

The GSP applicable sustainability indicators and defined undesirable results are shown in **Table 7-1**. In the following sections are discussions of the status of each sustainability indicator as of the end of WY 2021.

Table 7-1. Sustainability Indicators and Defined Undesirable Results

Sustainability Indicator	Undesirable Result Definition
Chronic lowering of groundwater levels	*20% or more of all NASb RMS have MT exceedances for 2 consecutive Fall measurements (8 out of 41 wells)*
Reduction of storage	*20% or more of all NASb RMS have MT exceedances for 2 consecutive Fall measurements (8 out of 41 wells)*
Depletion of surface water	*20% or more of the NASb interconnected surface water RMSs have MT exceedances for 2 consecutive Fall measurements (5 out of 21)*
Land Subsidence	*The rate of inelastic subsidence exceeds 0.5 feet over a 5-year period over an area covering approximately 5 or more square miles*
Degraded groundwater quality	For public water system wells • *The basin-wide average TDS concentrations of <u>all</u> public water system wells exceeds 400 mg/l* *OR* • *The basin wide average nitrate (as N) concentration of <u>all</u> public water system wells exceeds 8 mg/l* For the shallow aquifer (i.e., domestic and self-supplied) wells *25% of the RMSs, TDS and nitrate (as N) concentrations exceed state maximum contaminant levels*

Notes: mg/l = milligrams per liter; MT = minimum threshold; RMS = representative monitoring site; TDS = total dissolved solids

7.1 Chronic Lowering of Groundwater Levels

Six representative monitoring wells out of a total 41 wells monitored (15% of the total wells) exceeded the MT at the end of WY 2021. This does not constitute an undesirable result, but the GSAs are in the process of trying to understand the potential causes of these exceedances. Of note is that three of these wells had no data for the 2012 through 2016 drought, so it is uncertain as to whether these would be normally expected levels during drought years such as the current consecutive last two WYs and/or if these representative monitoring sites (RMS) are truly effective locations for the purposes of establishing undesirable results for the Subbasin. As GSP implementation has just begun, the GSAs will be evaluating the effectiveness and corresponding applicability of these RMS as additional data and information is collected. **Table 7-2** provides a list of the wells, groundwater level measurements, their MTs along with whether they were exceeded. **Figure 7-1** shows the locations of the wells and those that exceeded the MTs.

Table 7-2. WY 2021 Groundwater Elevations in Comparison to Minimum Thresholds

Representative Monitoring Sites (i.e. Wells)			WY 2021		Spring Exceeded	Fall Exceeded	Fall 2021 - MT = Difference (ft)
Map No.	Local Name	MT (ft msl)	Spring (ft msl)	Fall (ft msl)			
2	SGA_MW06	1	10	8	No	No	6.8
3	SGA_MW04	-5	1	-1	No	No	3.6
11	Bannon Creek Park	-5	0	-2	No	No	3.5
13	Chuckwagon Park	-15	-9	-10	No	No	4.5
14	13N04E23A002M	26	40	29	No	No	2.9
17	AB-2 shallow	-17	12	-10	No	No	7.1
20	SGA_MW05	-37	-17	-28	No	No	9.0
22	AB-4 shallow	-1	7	5	No	No	5.9
24	SGA_MW02	-27	-15	-17	No	No	10.1
27	AB-3 shallow	-4	8	8	No	No	12.1
28	Twin Creeks Park	-28	-9	-16	No	No	11.9
37	SUT-P1	10	17	15	No	No	4.6
38	Lone Oak Park	-27	-13	-18	No	No	9.3
39	AB-1 shallow	3	27	10	No	No	6.7
44	WPMW-10A	133	136	134	No	No	1.0
45	WPMW-9A	135	139	137	No	No	1.8
46	SVMW West - 1A	-32	-14	-21	No	No	11.3
48	WPMW-4A	75	79	79	No	No	4.3
60	WPMW-2A	22	28	24	No	No	1.8
61	Sutter County MW-5A	10	14	11	No	No	0.9
63	WPMW-3A	145	147	147	No	No	1.6
65	MW 1-3	49	55	58	No	No	8.9
66	MW 5-2	108	109	108	No	No	0.0
71	WCMSS	-40	-20	-28	No	No	12.2
75	MW 2-3	89	92	84	No	Yes	-5.2
77	SREL-1-27-F1	9	11	12	No	No	2.6
89	Roseview Park - 315	-22	-7	-12	No	No	10.1
90	WPMW-12A	-45	-19	-37	No	No	8.0
91	WPMW-11A	3	20	6	No	No	3.0
92	RDMW-101	15	18	17	No	No	1.7
93	RDMW-102	12	16	10	No	Yes	-1.6
94	RDMW-103	58	63	54	No	Yes	-3.9
95	RDMW-104	57	62	52	No	Yes	-5.0
96	1516	67	70	69	No	No	2.4
97	1518	57	61	60	No	No	2.9
98	URS71000-700+00C	7	8	6	No	Yes	-0.7
103	BR-1B	36	40	36	No	No	0.3
104	SGA_MW08	97	107	106	No	No	9.3
109	SGA_MW01	-33	-17	-20	No	No	12.6
116	Old Well #2	68	73	67	No	Yes	-0.8
126	DeWit	-25	5	-2	No	No	22.7

Note: ft msl = feet above or below mean sea level; MT = minimum threshold

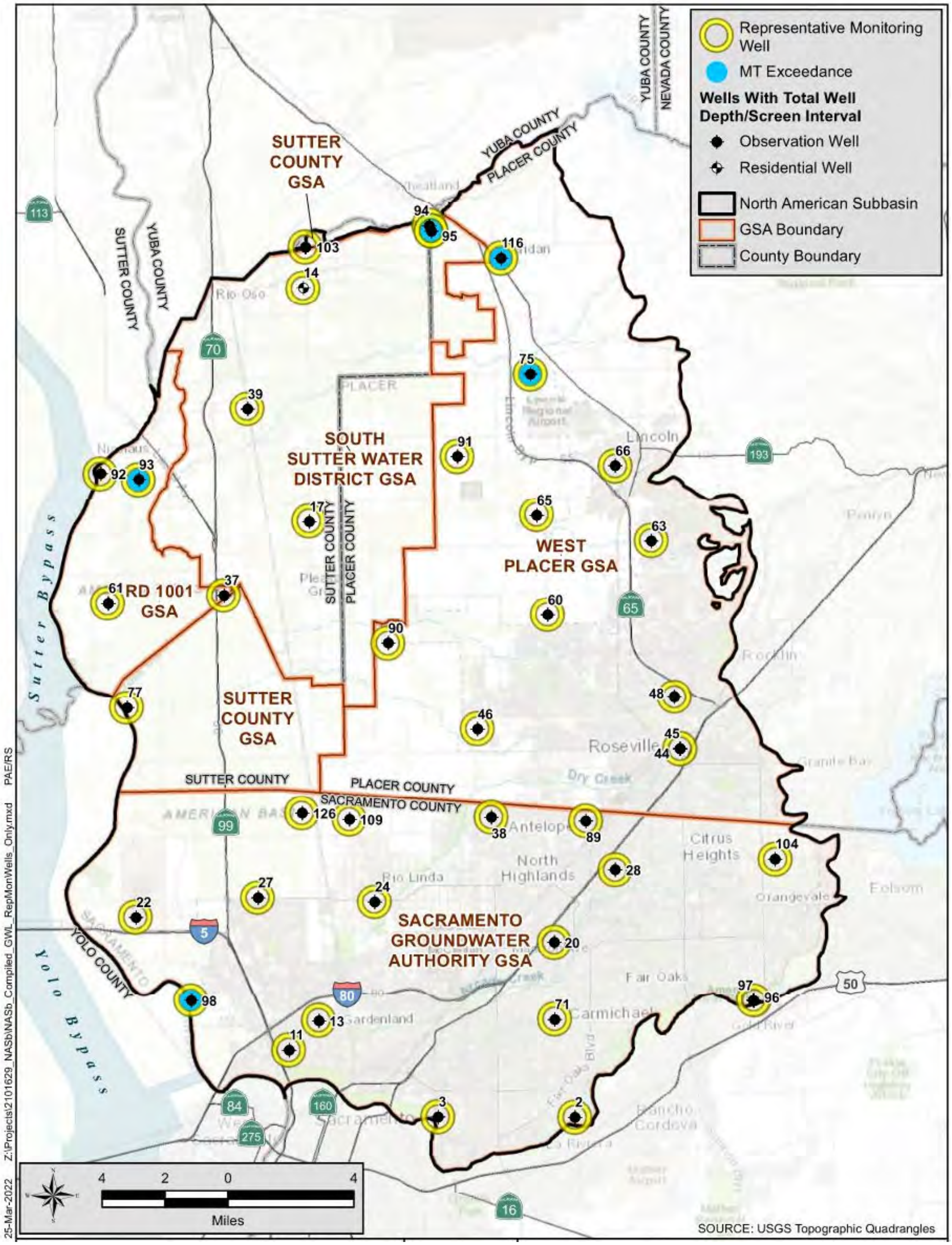


Figure 7-1. Distribution of Wells with MT Exceedances

7.2 Reduction of Storage

The GSAs used groundwater levels as a proxy for defining the quantitative thresholds for this sustainability indicator as supported in the GSP regulations. As described above, the NASb is not currently experiencing an undesirable result with respect to reduction of storage. As described above, the GSAs are evaluating potential causes of the MT exceedances and whether these could be resulting in any localized impacts.

7.3 Depletion of Surface Water

Because the depletion of interconnected surface water is directly related to the gradient between the surface water system at the groundwater interface and the groundwater Subbasin, groundwater levels are used as a proxy for this sustainability indicator. There are 24 wells at 21 locations used for evaluation purposes. At the end of WY 2021, there were five wells at four locations (19%) that exceeded their MTs as shown in **Table 7-3**. The Subbasin is not currently experiencing an undesirable result with respect to this sustainability indicator. GSAs are evaluating potential causes of the MT exceedances and whether these could be resulting in any localized impacts.

Table 7-3. Surface Water Depletion Groundwater Levels versus MTs

Representative Monitoring Sites (i.e. Wells)			WY 2021		Spring Exceeded	Fall Exceeded	Fall 2021 - MT = Difference (ft)
Map No.	Local Name	MT (ft msl)	Spring (ft msl)	Fall (ft msl)			
2	SGA_MW06	1	10	8	No	No	6.8
3	SGA_MW04	-5	1	-1	No	No	3.6
11	Bannon Creek Park	-5	0	-2	No	No	3.5
13	Chuckwagon Park	-15	-9	-10	No	No	4.5
14	13N04E23A002M	26	40	29	No	No	2.9
22	AB-4 shallow	-1	7	5	No	No	5.9
27	AB-3 shallow	-4	8	8	No	No	12.1
28	Twin Creeks Park	-28	-9	-16	No	No	11.9
37	SUT-P1	10	17	15	No	No	4.6
44	WPMW-10A	133	136	134	No	No	1.0
45	WPMW-9A	135	139	137	No	No	1.8
61	Sutter County MW-5A	10	14	11	No	No	0.9
63	WPMW-3A	145	147	147	No	No	1.6
66	MW 5-2	108	109	108	No	No	0.0
75	MW 2-3	89	92	84	No	Yes	-5.2
77	SREL-1-27-F1	9	11	12	No	No	2.6
92	RDMW-101	15	18	17	No	No	1.7
93	RDMW-102	12	16	10	No	Yes	-1.6
94	RDMW-103	58	63	54	No	Yes	-3.9
95	RDMW-104	57	62	52	No	Yes	-5.0
96	1516	67	70	69	No	No	2.4
97	1518	57	61	60	No	No	2.9
98	URS71000-700+00C	7	8	6	No	Yes	-0.7
103	BR-1B	36	40	36	No	No	0.3

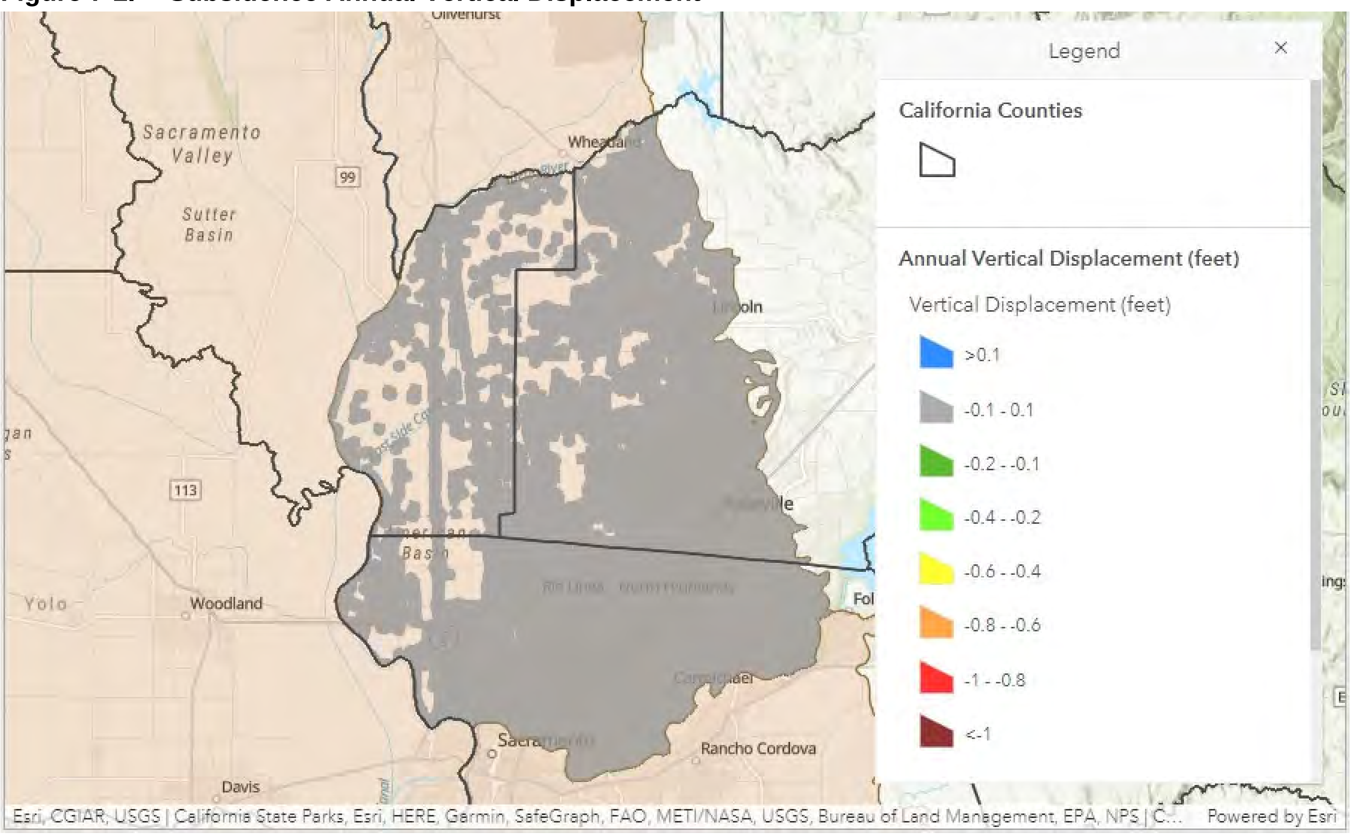
Note: ft msl = feet above or below mean sea level; MT = minimum threshold

7.4 Land Subsidence

Groundwater levels are being used as a proxy for MTs. **Table 7-4** shows the MTs as determined by the CoSANA modeled future/projected conditions, for chronic lowering of groundwater levels and the minimum measured groundwater elevation each of the designated representative monitoring wells. For WY 2021 two wells exceeded their MTs, but only by a maximum of 2 feet, as shown in **Table 7-4**, which is unlikely to cause subsidence.

The lack of subsidence in the NASb in WY 2021 is confirmed by interferometric synthetic-aperture radar (InSAR). InSAR measures ground elevation using microwave satellite imagery data. **Figure 7-2** shows InSAR measured ground surface elevations between October 1, 2020 to October 1, 2021 for the Subbasin, as provided by DWR.[10] These data show that rate of subsidence was -0.1 to +0.1 feet per year occurred in WY 2021, within method estimation error for interpretation of the data. Based on the water level measurements and InSAR data, the Subbasin is not experiencing undesirable results with respect to subsidence.

Figure 7-2. Subsidence Annual Vertical Displacement



[10] https://storymaps.arcgis.com/stories/41574a6d980b4e5d8d4ed7b90f9698d2?utm_medium=email&utm_source=govdelivery

Table 7-4. Subsidence - Groundwater Levels *versus* Minimum Thresholds

Representative Monitoring Sites (i.e. Wells)		Subsidence MT (ft msl)	WY 2021		Spring Exceeded	Fall Exceeded	Fall 2021 - MT = Difference (ft)
Map No.	Local Name		Spring (ft msl)	Fall (ft msl)			
2	SGA_MW06	1	10	8	No	No	7
3	SGA_MW04	-5	1	-1	No	No	4
11	Bannon Creek Park	-5	0	-2	No	No	3
13	Chuckwagon Park	-15	-9	-10	No	No	5
14	13N04E23A002M	15	40	29	No	No	14
17	AB-2 shallow	-21	12	-10	No	No	11
20	SGA_MW05	-37	-17	-28	No	No	9
22	AB-4 shallow	-1	7	5	No	No	6
24	SGA_MW02	-27	-15	-17	No	No	10
27	AB-3 shallow	-4	8	8	No	No	12
28	Twin Creeks Park	-28	-9	-16	No	No	12
37	SUT-P1	8	17	15	No	No	7
38	Lone Oak Park	-27	-13	-18	No	No	9
39	AB-1 shallow	-5	27	10	No	No	15
44	WPMW-10A	133	136	134	No	No	1
45	WPMW-9A	131	139	137	No	No	6
46	SVMW West - 1A	-32	-14	-21	No	No	11
48	WPMW-4A	72	79	79	No	No	7
60	WPMW-2A	21	28	24	No	No	3
61	Sutter County MW-5A	-1	14	11	No	No	12
63	WPMW-3A	145	147	147	No	No	2
65	MW 1-3	38	55	58	No	No	20
66	MW 5-2	104	109	108	No	No	4
71	WCMSS	-40	-20	-28	No	No	12
75	MW 2-3	86	92	84	No	Yes	-2
77	SREL-1-27-F1	9	11	12	No	No	3
89	Roseview Park - 315	-22	-7	-12	No	No	10
90	WPMW-12A	-65	-19	-37	No	No	28
91	WPMW-11A	-18	20	6	No	No	24
92	RDMW-101	14	18	17	No	No	3
93	RDMW-102	8	16	20	No	No	12
94	RDMW-103	36	63	54	No	No	18
95	RDMW-104	36	62	52	No	No	16
96	1516	67	70	69	No	No	2
97	1518	57	61	60	No	No	3
98	URS71000-700+00C	6	8	6	No	No	0
103	BR-1B	36	40	36	No	No	0
104	SGA_MW08	97	107	106	No	No	9
109	SGA_MW01	-33	-17	-20	No	No	13
116	Old Well #2	68	73	67	No	Yes	-1
126	DeWit	-25	5	-2	No	No	23

Note: ft msl = feet above mean sea level; MT = minimum threshold

7.5 Degraded Water Quality

The GSP identified two methods to assess if degraded water quality was occurring in the NASb. The methods included evaluation of water quality from municipal water supply wells and a network of shallow monitoring wells. The shallow monitoring wells assess potential changes in the upper portions of the aquifer, which is commonly used by domestic well owners, and the municipal wells assess changes within the deeper portions of the aquifer.

For public water system, or municipal wells, the SWRCB Division of Drinking Water (DDW) requires all active municipal wells be periodically sampled and analyzed in accordance with California Water Code Title 22 constituent standards. For the WY 2021 Annual Report, data for Total Dissolved Solids (TDS) and Nitrate (as Nitrogen) was downloaded from the GAMA Groundwater Information System[11] for annual analysis of the most recent data[12] for each active public supply well. The data are summarized in **Table 7-5**. Based on the most recent data, the Subbasin is meeting its measurable objectives and MTs with respect to public water supply water quality. Based on the municipal water quality data, the Subbasin is not experiencing undesirable results with respect to water quality.

Table 7-5. Public Supply Wells Water Quality Summary

	TDS	Nitrate (as N)
Number of Wells Sampled	224	246
Date Range of Samples	01/15/15-12/07/21	01/26/20-12/27/21
Minimum Concentration	110	Non-Detect at 0.23 mg/L
Maximum Concentration	650	7
Average Concentration (1)	264.3	1.7
Measurable Objective (average of all wells)	300	3
Minimum Threshold (average of all wells)	400	8

Notes: mg/L= milligrams per liter; TDS = total dissolved solids

(1) For average Nitrate concentrations, values below laboratory detection levels were calculated as one-half the reporting limit.

Based on the GSP implementation plan, water quality sampling of all wells in the shallow water quality monitoring network is planned to occur in WY 2023. Based on available data, displayed in **Table 7-6**, water samples collected and analyzed in WY 2021, the shallow wells are below their MTs. Based on the shallow well water quality data, the Subbasin is not experiencing undesirable results with respect to water quality.

[11] https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/#

[12] This represents a running average of the most recent data for an active well. TDS is generally sampled every three years and Nitrate is generally sampled annually in public supply wells.

Table 7-6. Shallow Aquifer Water Quality Summary

Map No.	Local Name	WY 2021 TDS Concentration (mg/L)	WY 2021 Nitrate as N Concentration (mg/L)	TDS (Secondary MCL = 500 mg/L)		Nitrate (Primary MCL = 10 mg/L)		Interim Milestones
				Selected MTs (mg/L)	Selected MOs (mg/L)	Selected MTs (mg/L)	Selected MOs (mg/L)	Year 5, 10, 15, & 20 (mg/L)
17	AB-2 shallow	---	---	500	220	10	ND	ND
20	SGA_MW05	---	---	500	300	10	1.7	1.7
24	SGA_MW02	---	---	500	300	10	4.5	4.5
27	AB-3 shallow	---	---	500	170	10	ND	ND
37	SUT-P1	---	---	500	120	10	ND	ND
39	AB-1 shallow	---	---	500	150	10	ND	ND
46	SVMWWest1A	---	---	500	TBD	10	TBD	TBD
80	Cemetery	---	---	500	290	10	TBD	TBD
89	Roseview Park - 315	---	---	500	210	10	TBD	TBD
90	WPMW-12A	210	0.73	500	230	10	0.64	0.64
91	WPMW-11A	---	---	500	240	10	1.1	1.1
99	Main Well	---	---	500	TBD	10	ND	ND
109	SGA_MW01	---	---	500	360	10	1.0	1.0
133	LW-1	200	3.6	500	220	10	4.0	4.0
177	Well 22 - Northrop	---	---	500	120	10	ND	ND
298	Tinker Road Well	---	---	500	240	10	4.26	4.26

Note: --- = sample not acquired; mg/L = milligrams per liter

Appendix A Representative Monitoring Sites Hydrographs

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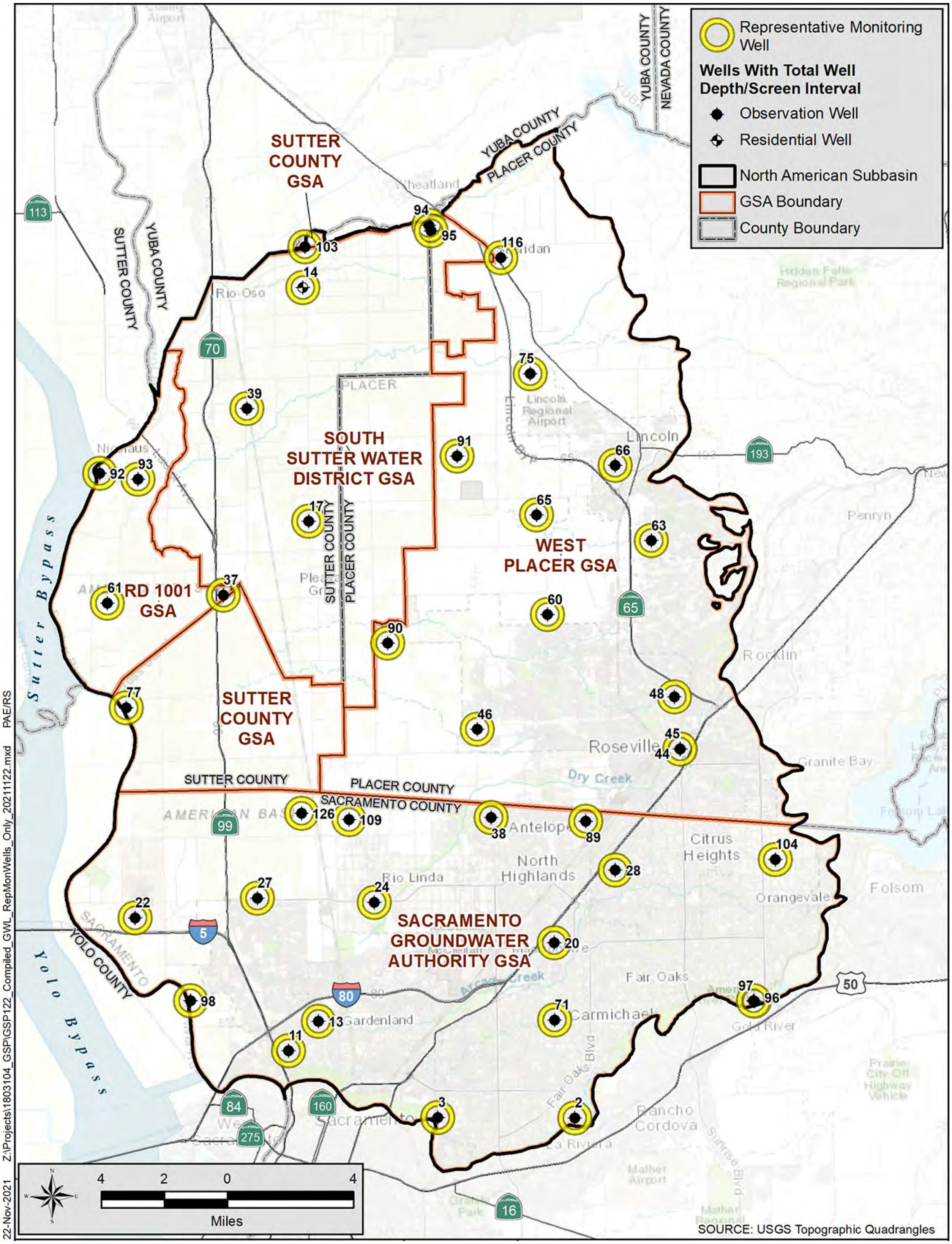

Figure A-1. Representative Groundwater Level Monitoring Wells Locations.

Table A-1. Representative Groundwater Level Monitoring Wells Information

Map No.	CASGEM ID	Local Name	Latitude	Longitude	Screened Interval (ft bgs)	Total Depth (ft bgs)
2	385828N1213385W001	SGA_MW06	38.58281	-121.33846	62-72	72
3	385841N1214185W001	SGA_MW04	38.58414	-121.41852	55-65	65
4	385947N1213985W003	MW12C	38.59472	-121.39847	590-610	615
11	386160N1215054W001	Bannon Creek Park	38.61603	-121.5054	33-48	48
13	386292N1214877W001	Chuckwagon Park	38.62921	-121.4877	27-37	52
14	389669N1214897W001	13N04E23A002M	38.9669	-121.4897	56-83	83
17	388593N1214885W003	AB-2 shallow	38.8593	-121.4885	135-145	155
20	386635N1213486W001	SGA_MW05	38.66347	-121.34859	205-215	215
22	386782N1215943W004	AB-4 shallow	38.6782	-121.5943	170-190	200
24	386836N1214536W001	SGA_MW02	38.68362	-121.45363	100-110	110
27	386864N1215222W003	AB-3 shallow	38.6864	-121.5222	190-210	220
28	386964N1213120W001	Twin Creeks Park	38.6964	-121.31203	183-193	193
37	388260N1215394W004	SUT-P1	38.826	-121.5394	110-120	120
38	387216N1213842W001	Lone Oak Park	38.72163	-121.38417	151-161	166
39	389116N1215238W003	AB-1 shallow	38.9116	-121.5238	170-180	190
44	387515N1212725W001	WPMW-10A	38.75149	-121.27251	26-36	36
45	387517N1212727W001	WPMW-9A	38.75167	-121.27266	26-36	36
46	387623N1213915W001	SVMW West - 1A	38.76232	-121.39153	120-140	145
48	387755N1212753W001	WPMW-4A	38.77554	-121.27525	120-140	145
60	388145N1213491W001	WPMW-2A	38.8145	-121.34914	215-225	230
61	388235N1216079W001	Sutter County MW-5A	38.82324	-121.60763	130-160	170
63	388476N1212872W001	WPMW-3A	38.84761	-121.28719	48-53	53
65	388604N1213544W003	MW 1-3	38.86038	-121.35438	184-204	204
66	388826N1213078W002	MW 5-2	38.88258	-121.30775	52-62	62
71	386280N1213493W001	WCMSS	38.62799	-121.34925	130-150	170
75	389255N1213566W003	MW 2-3	38.92547	-121.35663	75-85	85
77	387749N1215975W001	SREL-1-27-F1	38.77491	-121.59754	Unknown	46
89	387191N1213287W001	Roseview Park - 315	38.71912	-121.32879	295-305	315
90	388026N1214432W002	WPMW-12A	38.80264	-121.44322	260-280	300
91	388882N1214005W002	WPMW-11A	38.88816	-121.40046	132-152	162
92	388829N1216110W001	RDMW-101	38.88294	-121.61105	28-43	48
93	388798N1215885W001	RDMW-102	38.87987	-121.58853	28-43	48
94	389950N1214148W002	RDMW-103	38.99461	-121.41479	28-43	48
95	389919N1214141W002	RDMW-104	38.99195	-121.4135	28-43	48
96	386348N1212319W001	1516	38.63487	-121.23192	13-33	40
97	386351N1212323W001	1518	38.63513	-121.23231	55-75	80
98	386397N1215624W001	URS71000-700+00C	38.6397	-121.56244	Unknown	45
103	389857N1214880W001	BR-1B	38.9857	-121.488	78-98	98
104	387000N1212180W001	SGA_MW08	38.69998	-121.21795	130-140	140
109	387218N1214677W001	SGA_MW01	38.72178	-121.46771	100-110	110
116	389791N1213727W001	Old Well #2	38.97913	-121.37269	144-209	209
126	384330121293901	10N04E13F001M	38.72512	-121.49544	Unknown	50

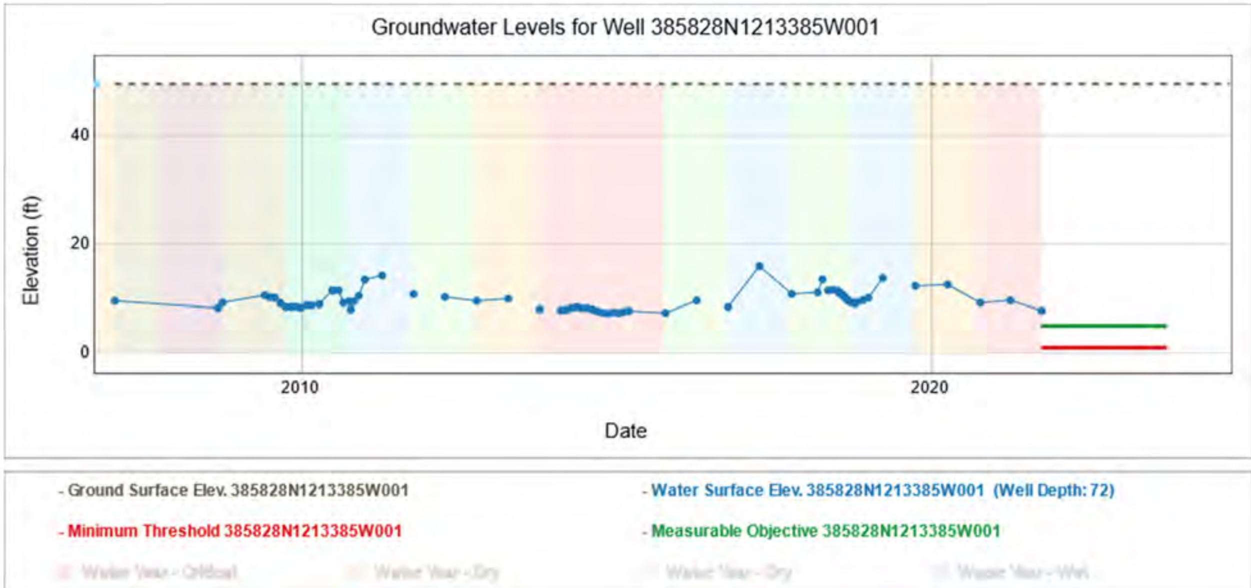

Figure A-2. SGA_MW06, Map No. 2

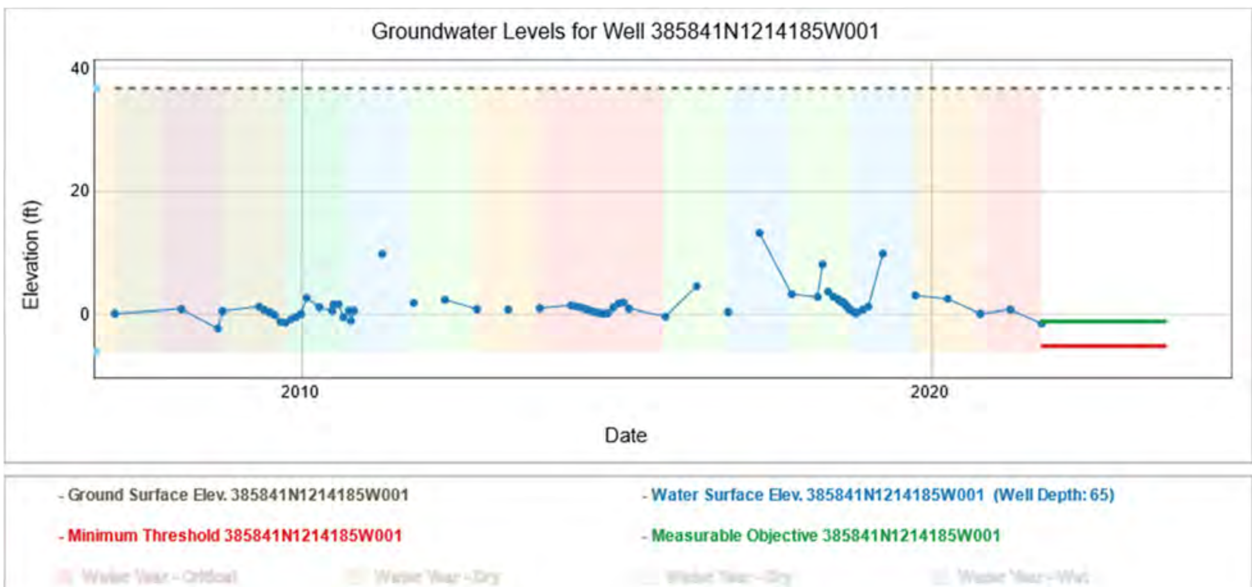

Figure A-3. SGA_MW04, Map No. 3

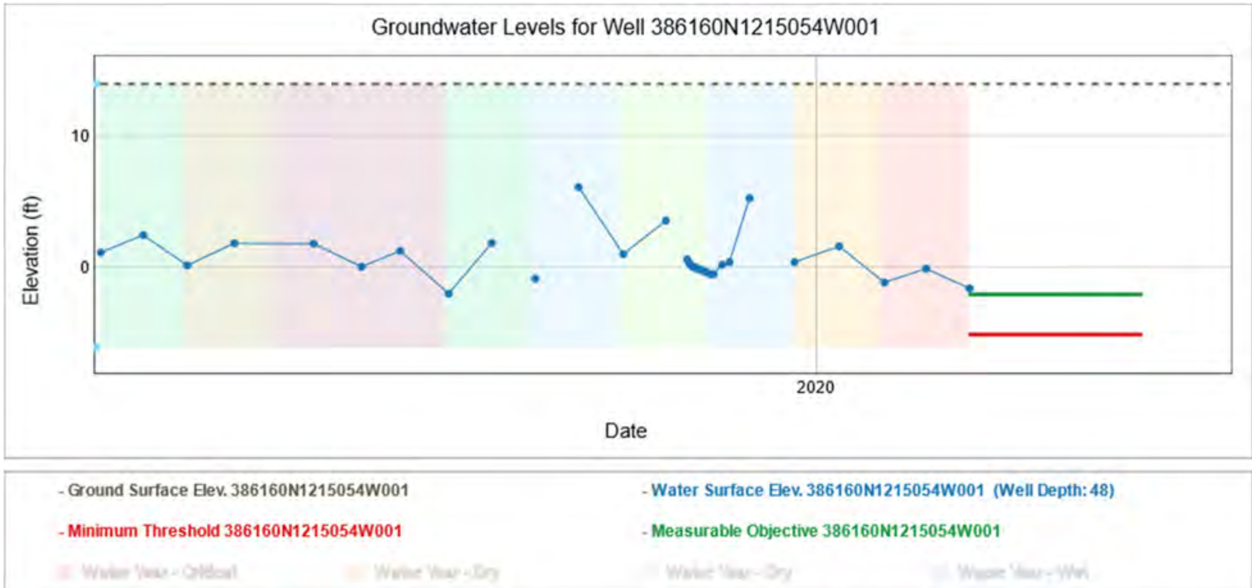

Figure A-4. Bannon Creek Park, Map No. 11

Figure A-5. Aerojet 1516, Map No. 9

Figure A-6. Chuckwagon Park, Map No. 13

Figure A-7. 13N04E23A002M, Map No. 14

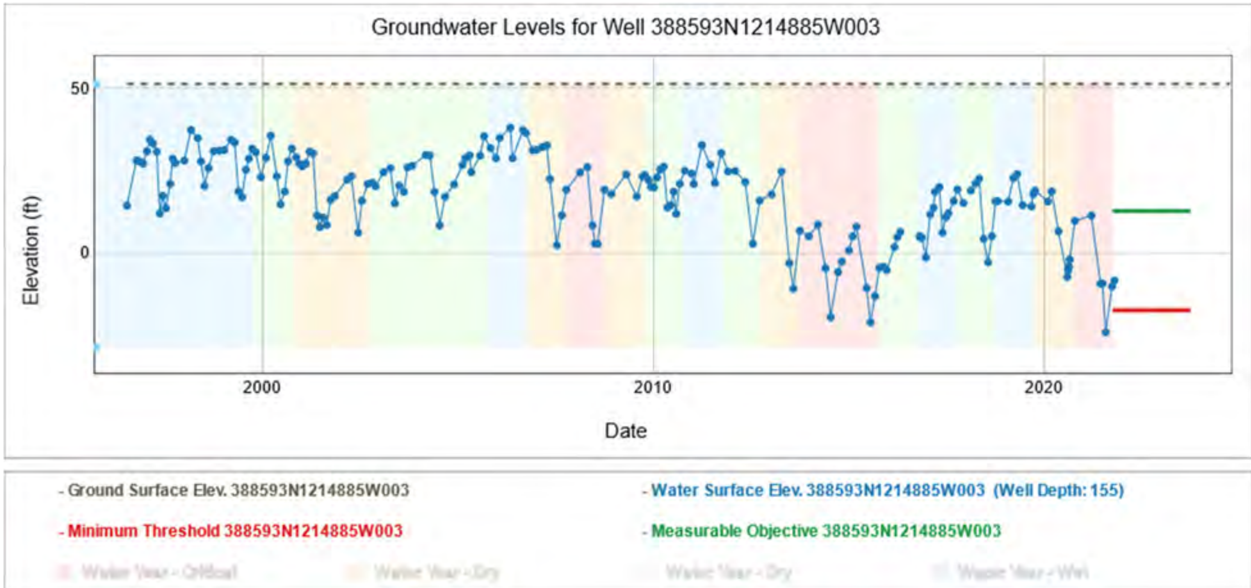

Figure A-8. AB-2 shallow, Map No. 17

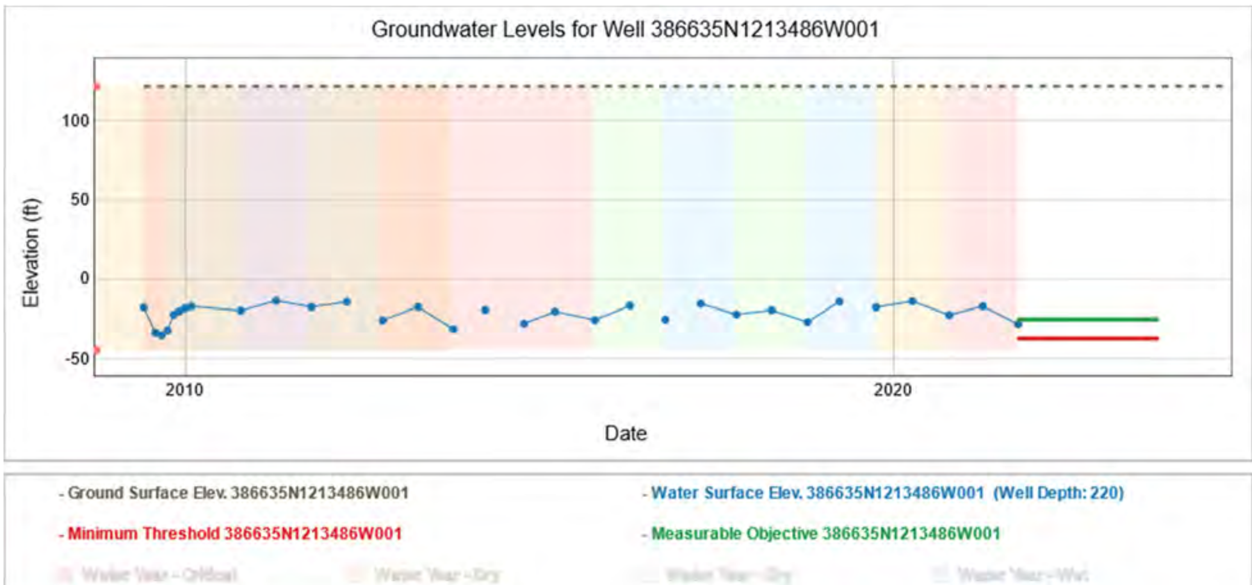

Figure A-9. SGA_MW05, Map No. 20

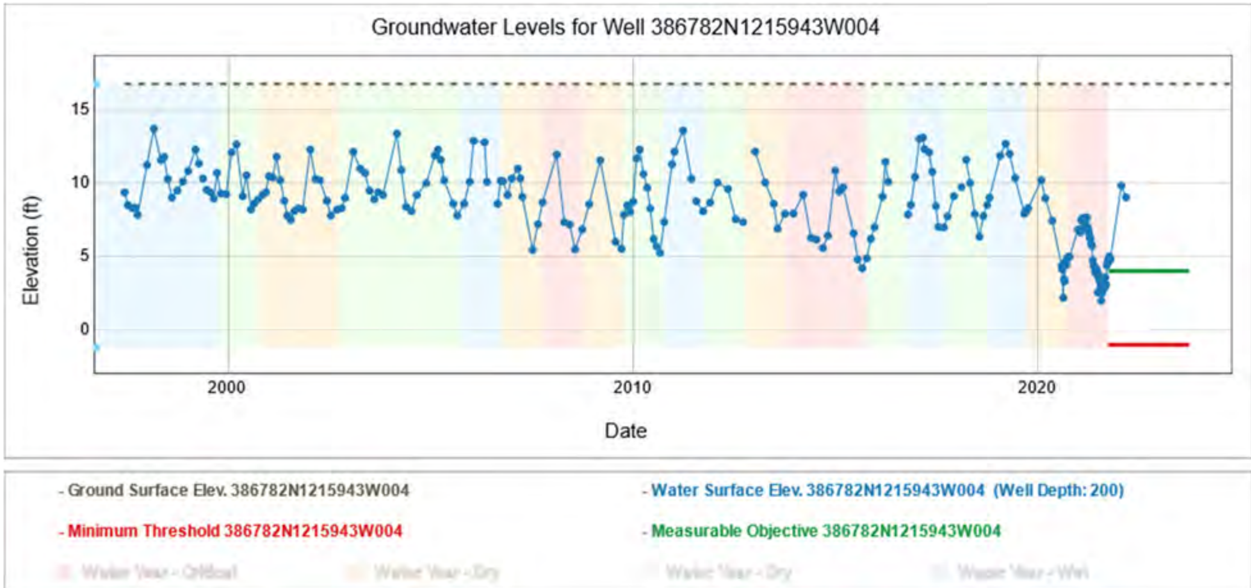

Figure A-10. AB-4 shallow, Map No. 22

Figure A-11. SGA_MW02, Map No. 24

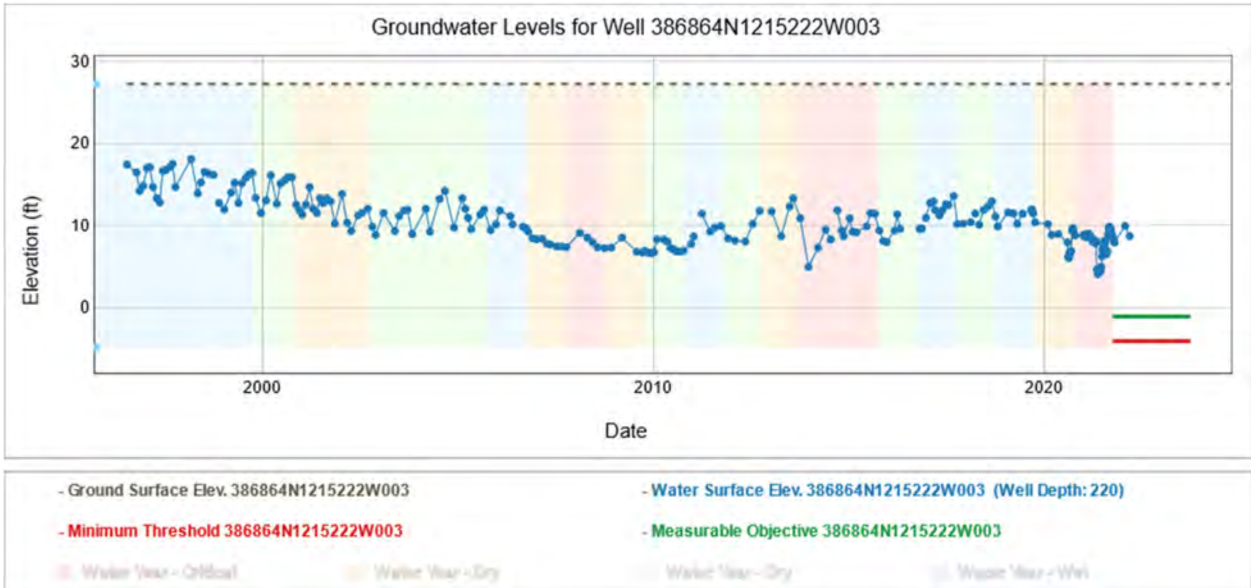

Figure A-12. AB-3 shallow, Map No. 27

Figure A-13. Twin Creeks Park, Map No. 28

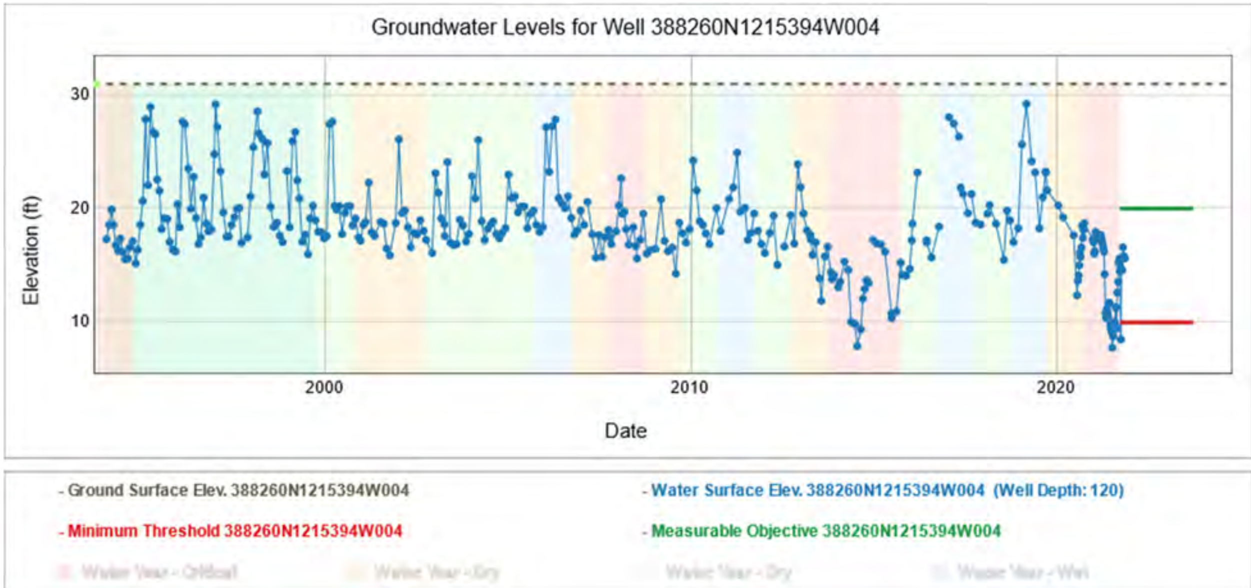

Figure A-14. SUT-P1, Map No. 37

Figure A-15. Lone Oak Park, Map No. 38

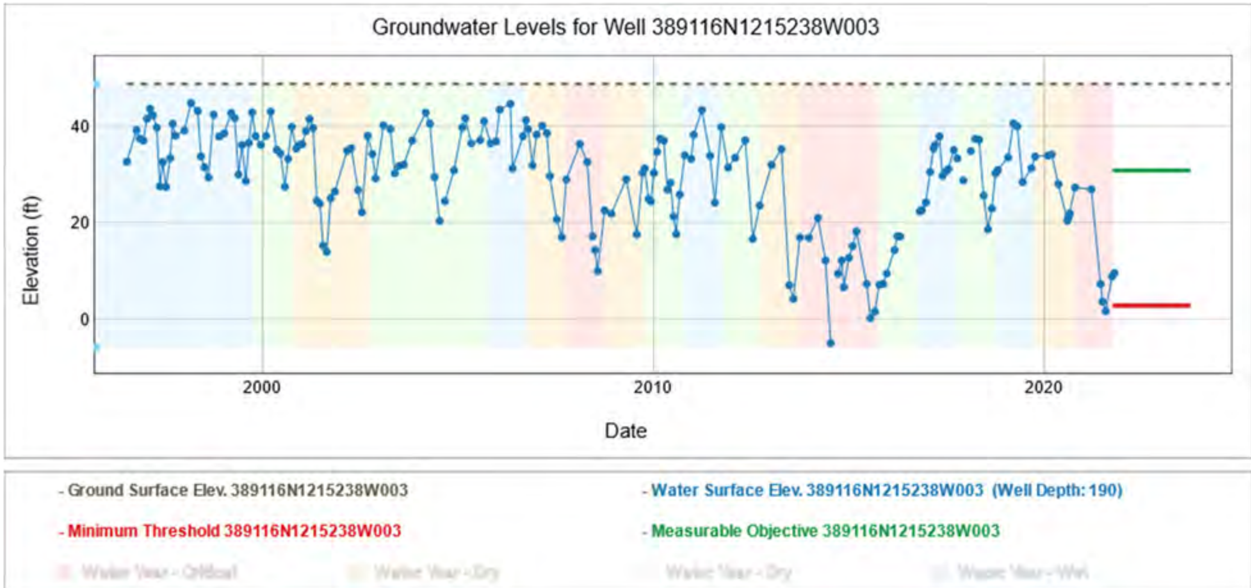

Figure A-16. AB-1 shallow, Map No. 39

Figure A-17. WPMW-10A, Map No. 44

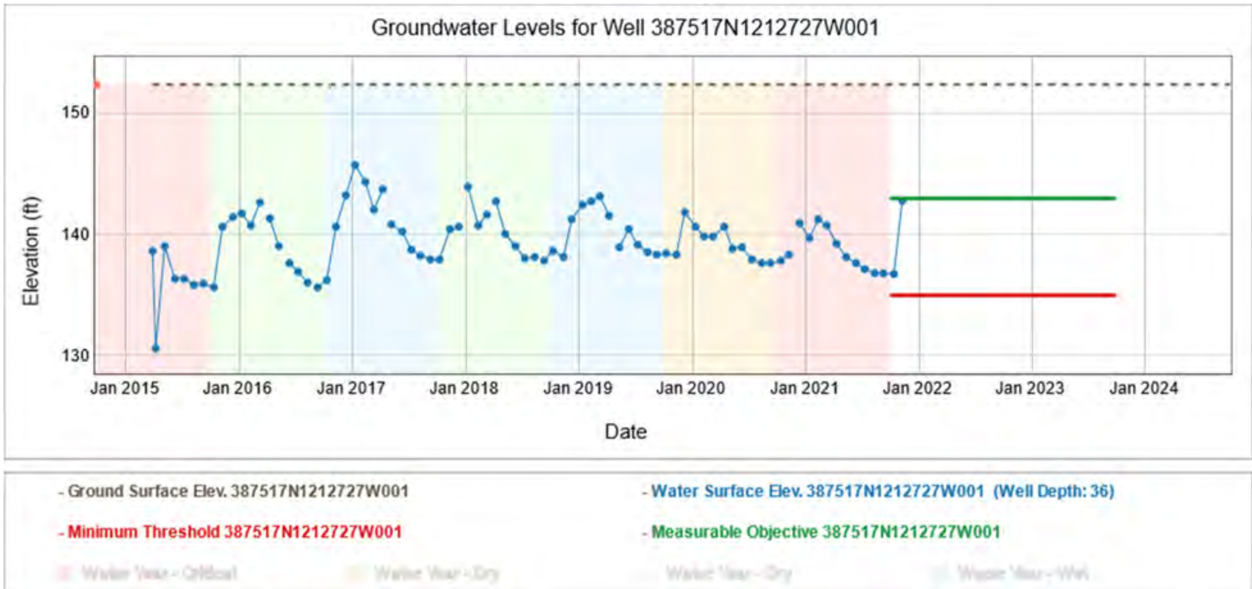

Figure A-18. WPMW-9A, Map No. 45

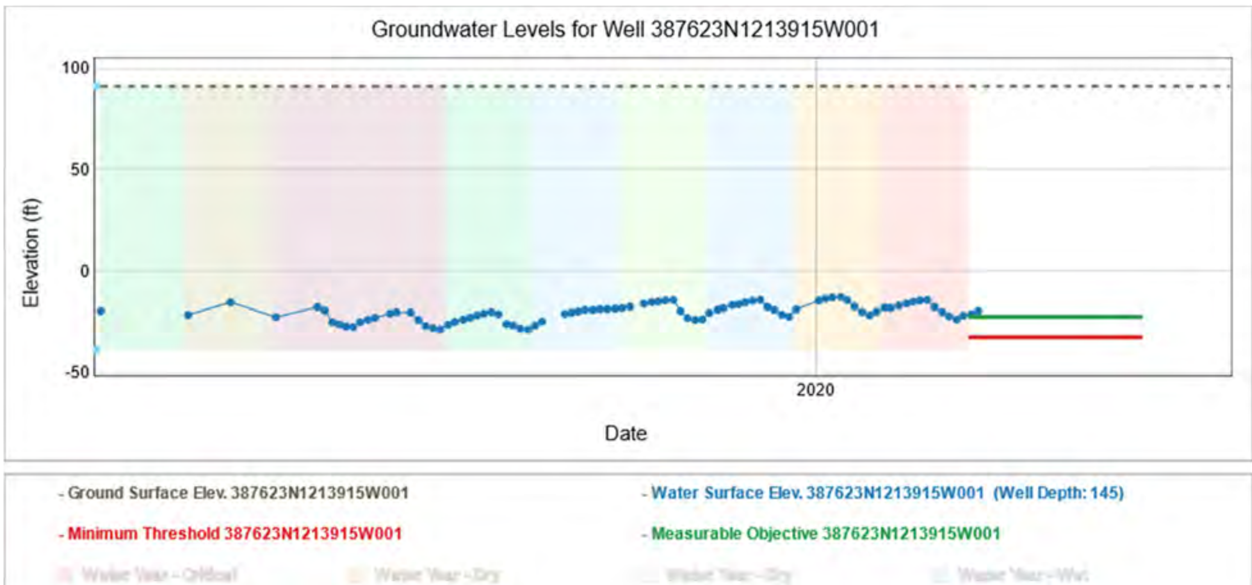

Figure A-19. SVMW West-1A, Map No. 46

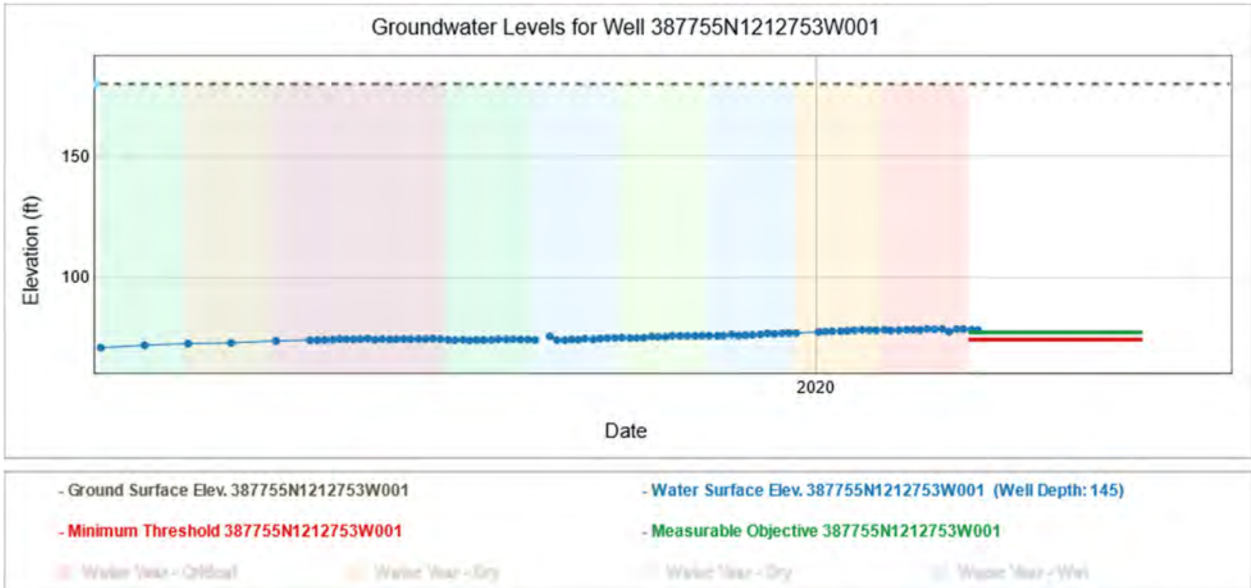

Figure A-20. WPMW-4A, Map No. 48

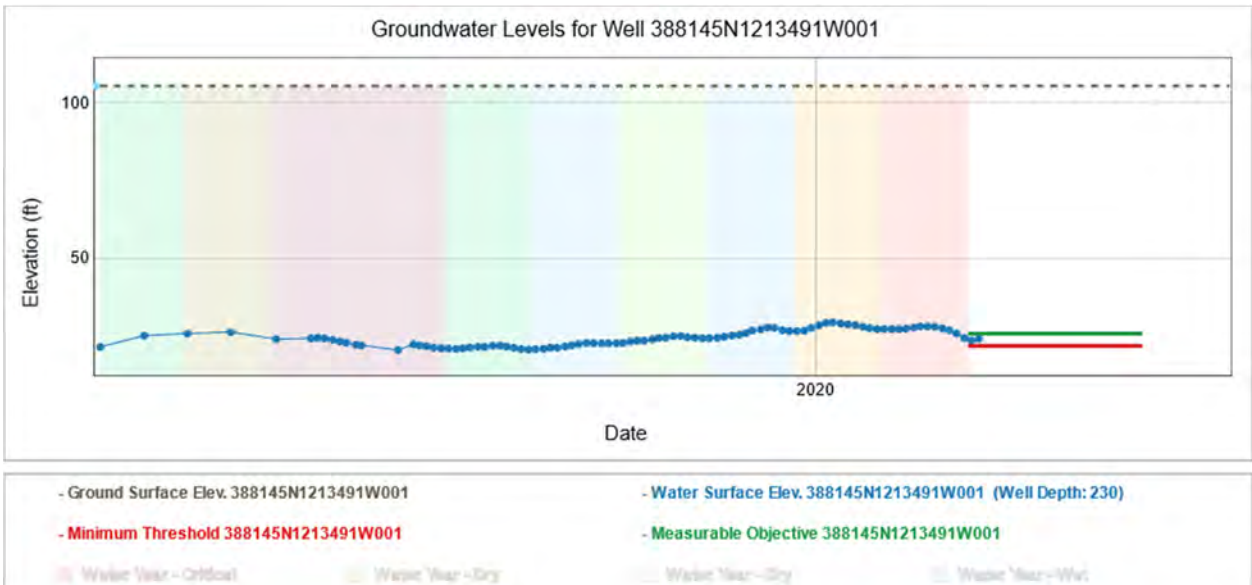

Figure A-21. WPMW-2A, Map No. 60

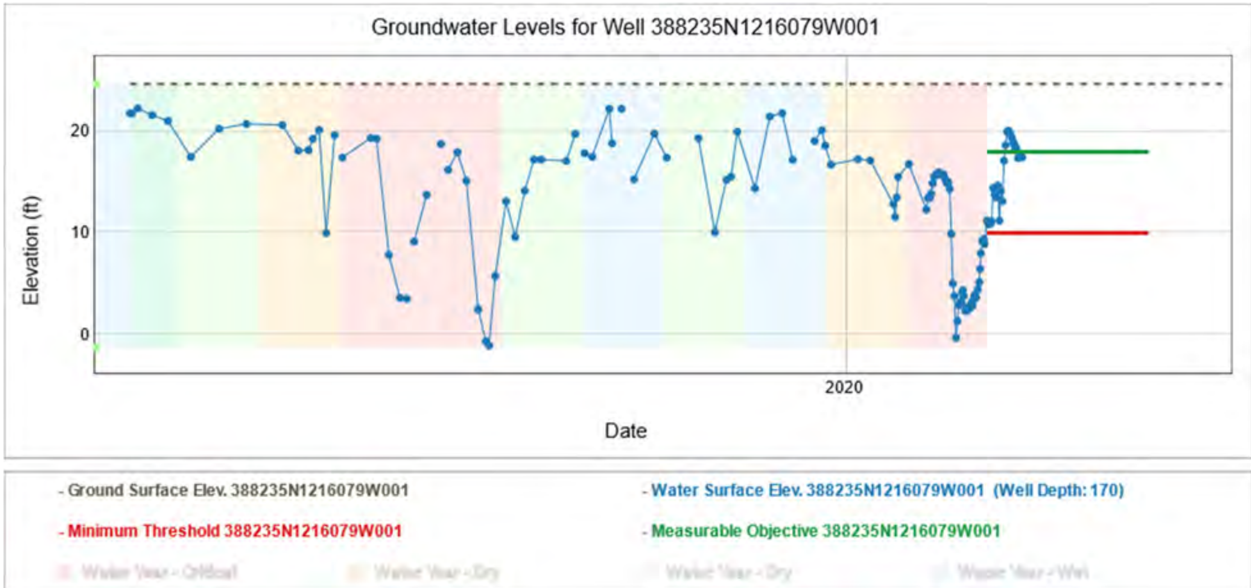

Figure A-22. Sutter County MW-5A, Map No. 61

Figure A-23. WPMW-3A, Map No. 63

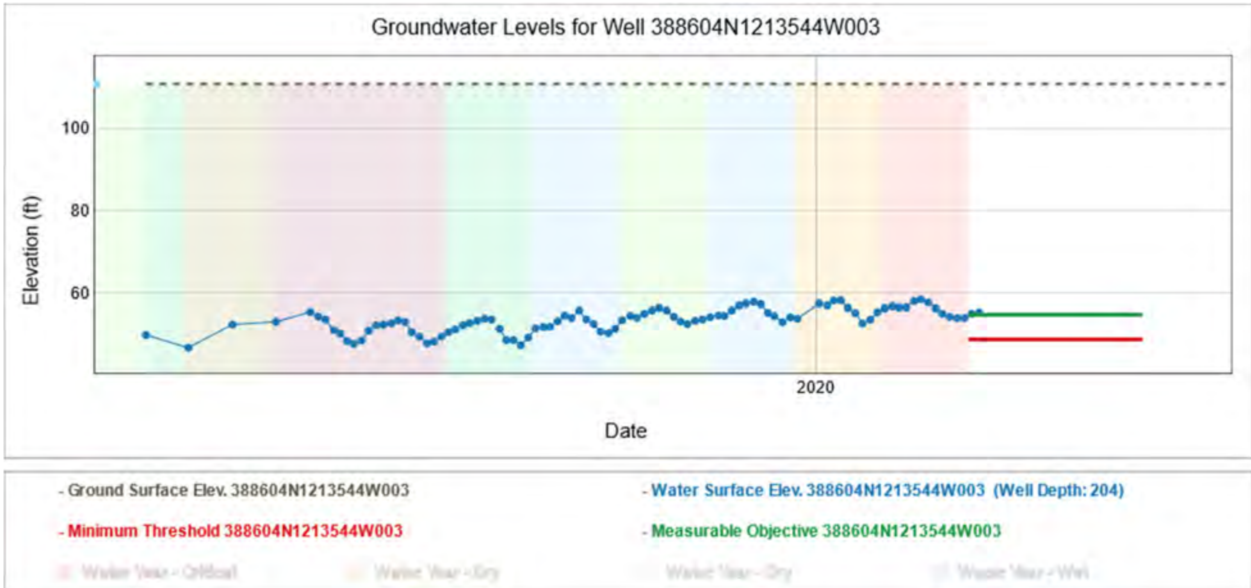

Figure A-24. MW 1-3, Map No. 65

Figure A-25. MW 5-2, Map No. 66

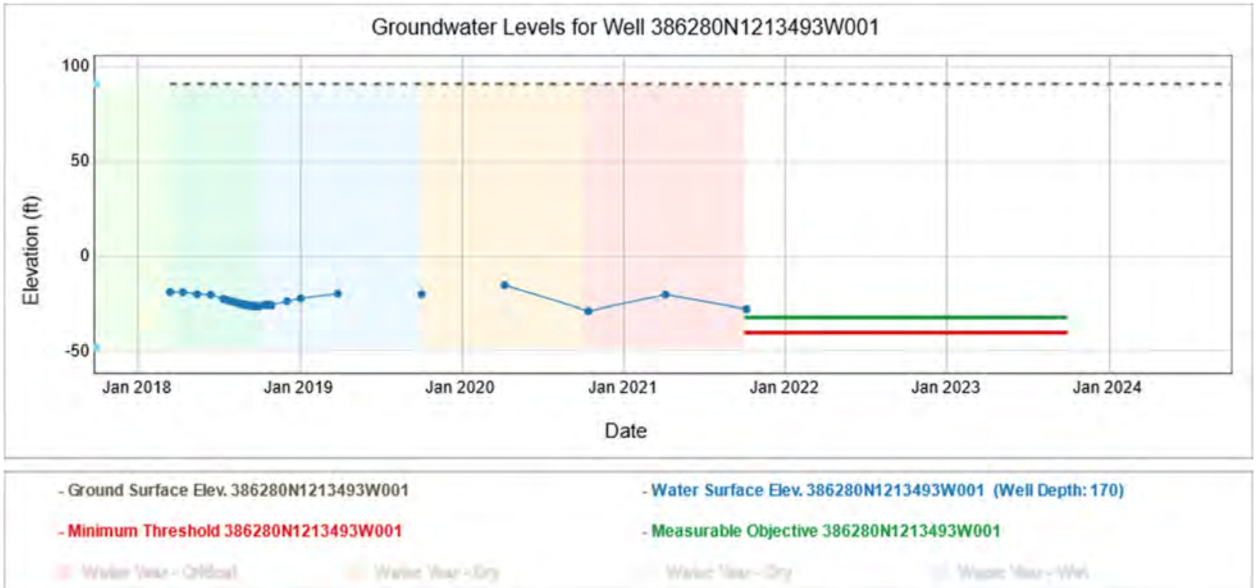

Figure A-26. WCMSS, Map No. 71

Figure A-27. MW 2-3, Map No. 75

Figure A-28. SREL-1-27-F1, Map No. 77

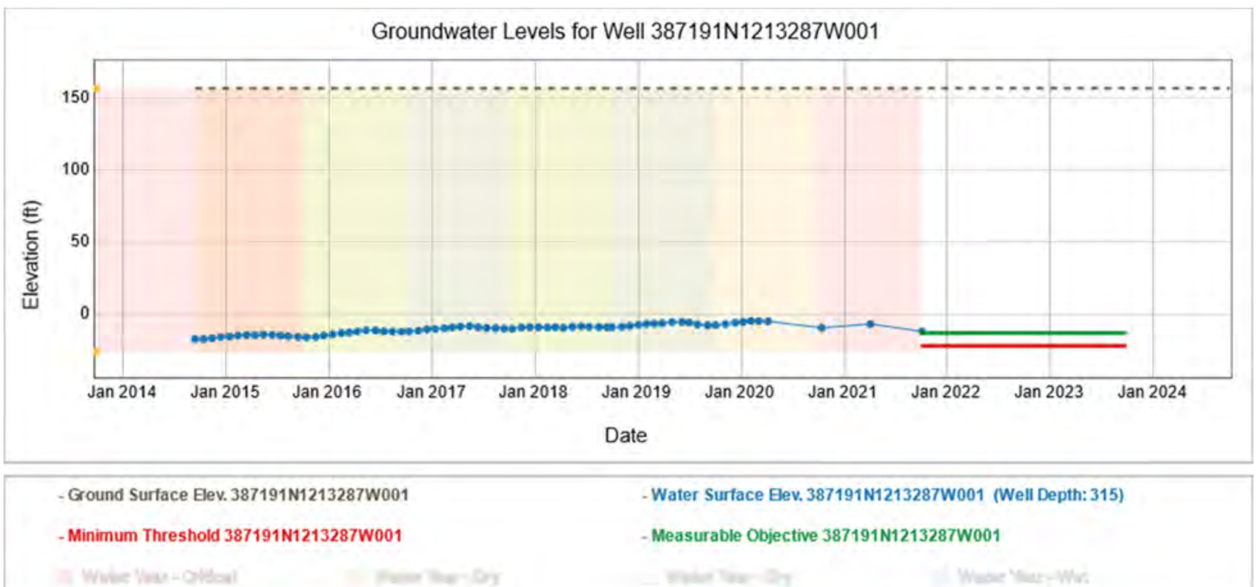

Figure A-29. Roseview Park-315, Map No. 89

Figure A-30. WPMW-12A, Map No. 90

Figure A-31. WPMW-11A, Map No. 91

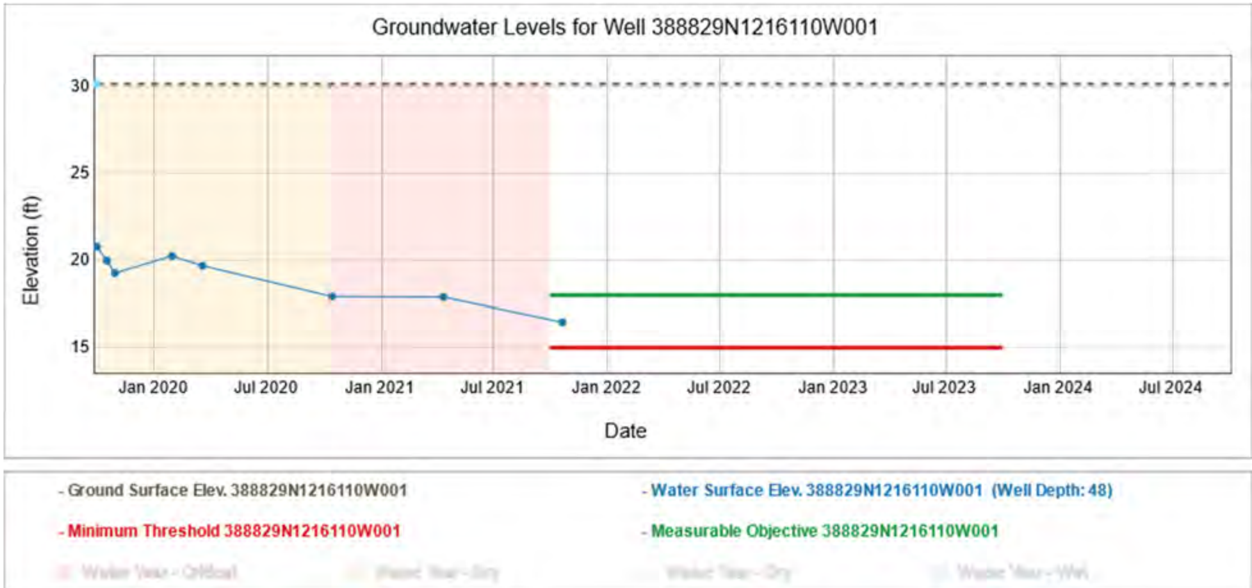

Figure A-32. RDMW-101, Map No. 92

Figure A-33. RDMW-102, Map No. 93

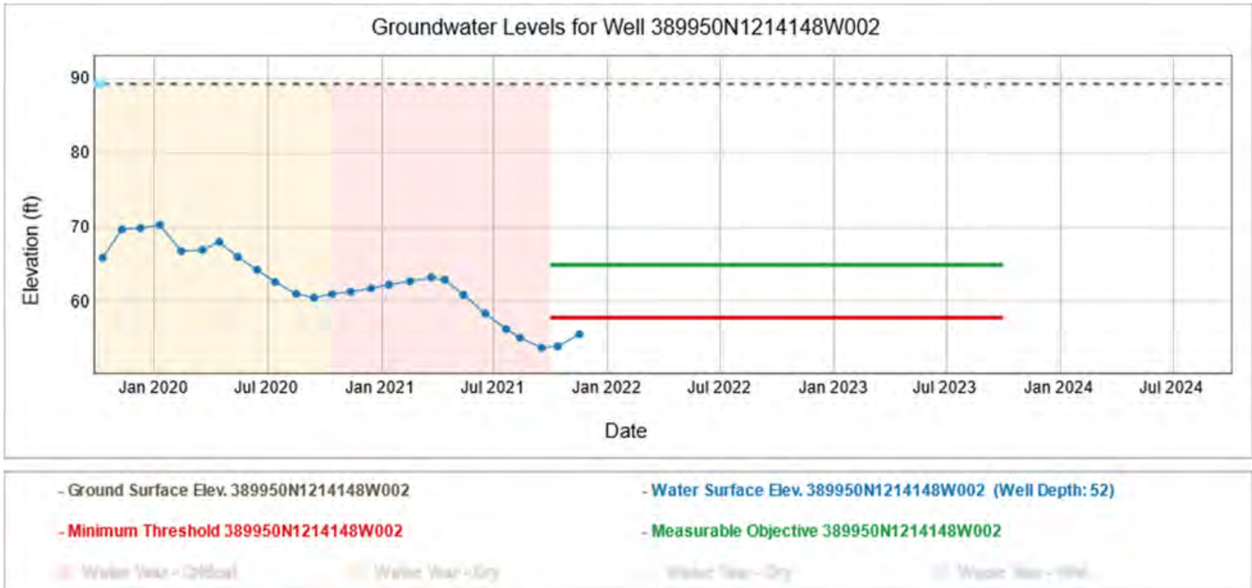

Figure A-34. RDMW-103, Map No. 94

Figure A-35. RDMW-104, Map No. 95

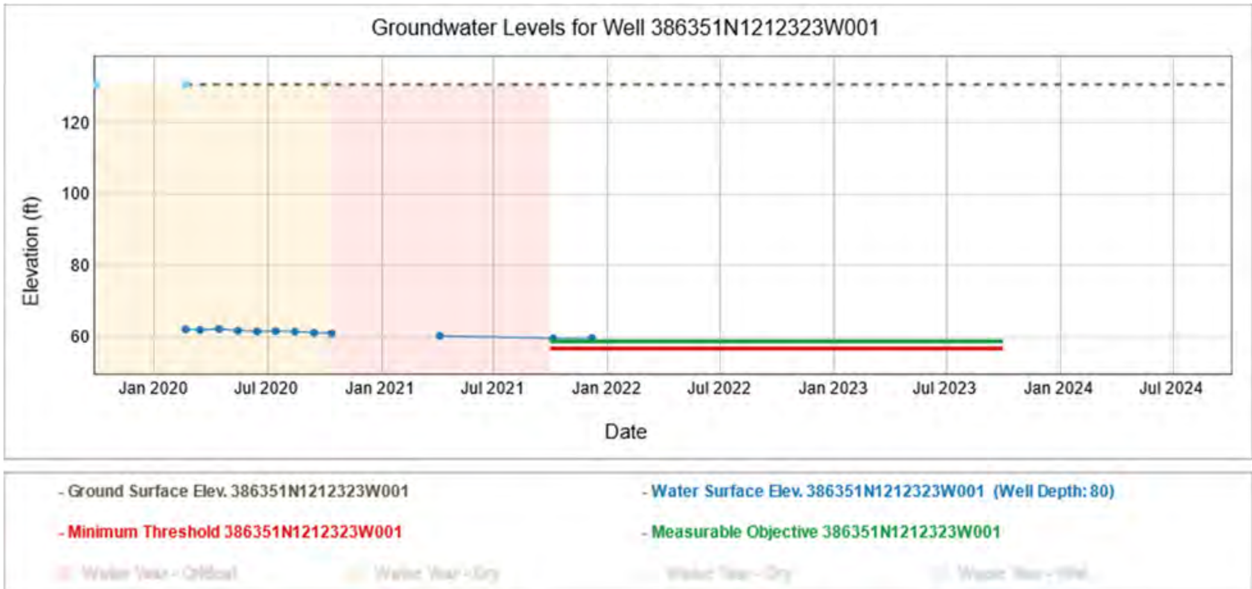

Figure A-36. Aerojet 1518, Map No. 96

Figure A-37. URS71000-700+00C, Map No. 98

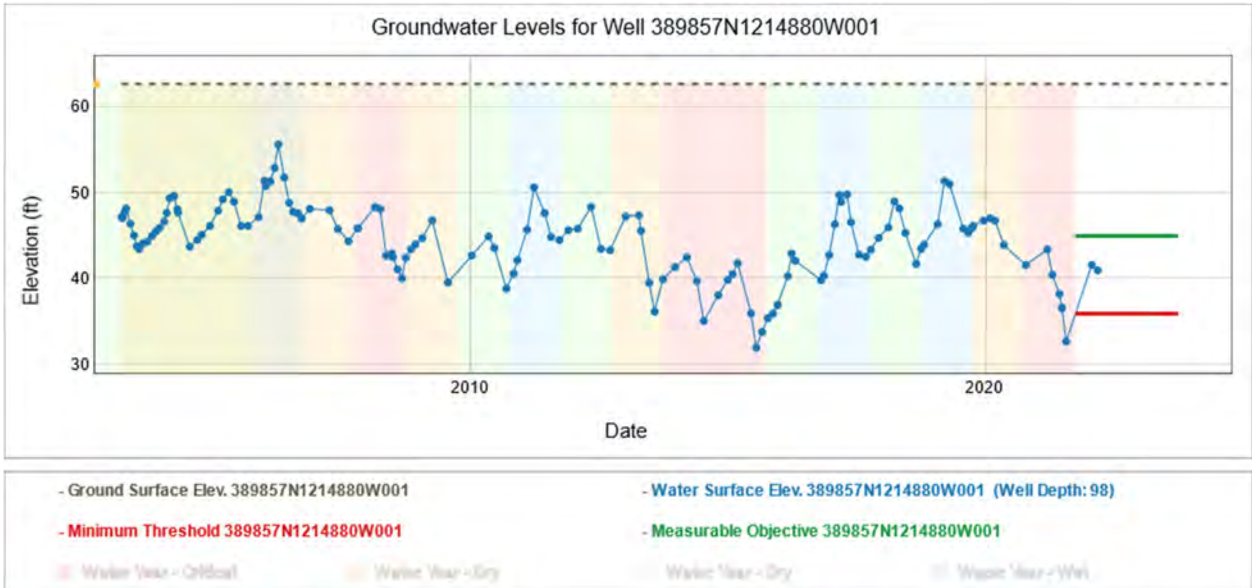

Figure A-38. BR-1B, Map No. 103

Figure A-39. SGA_MW08, Map No. 104

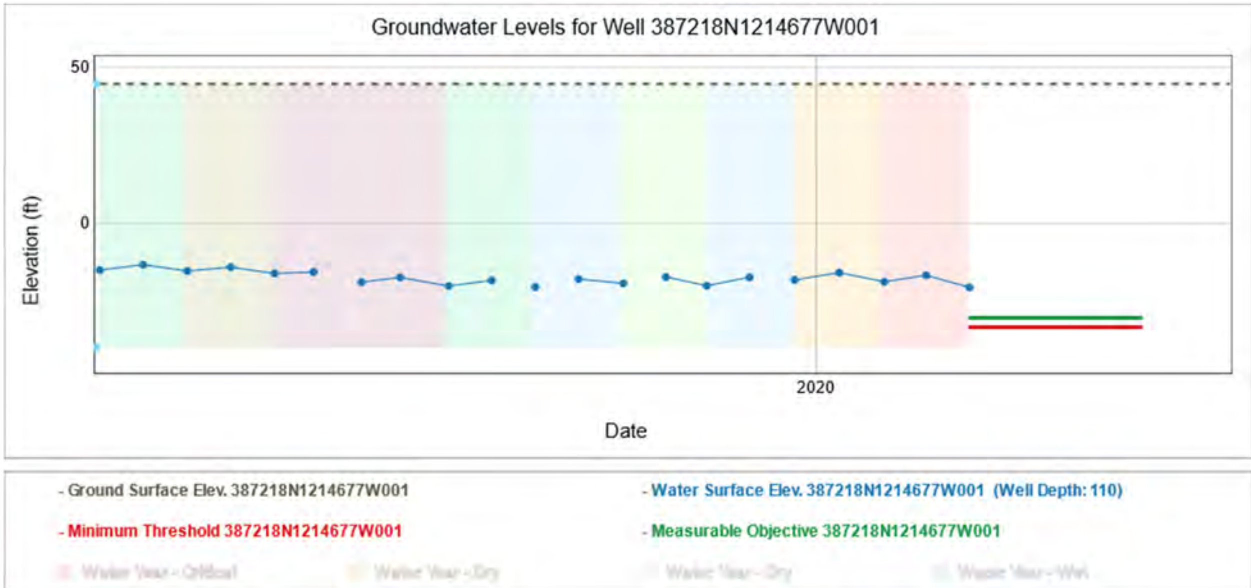

Figure A-40. SGA_MW01, Map No. 109

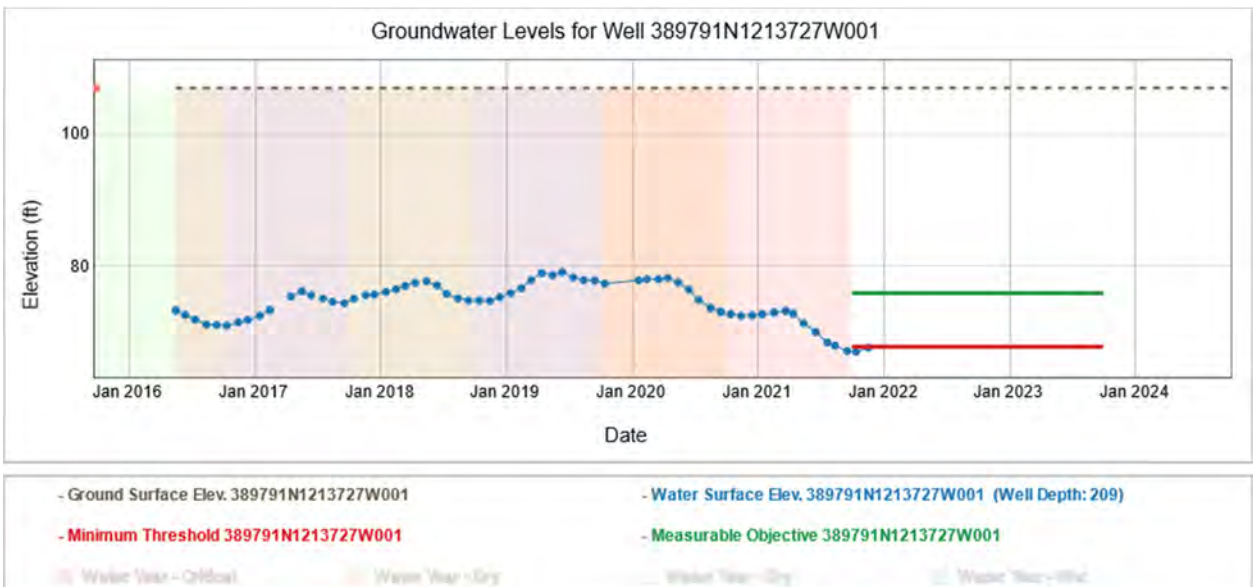

Figure A-41. Old Well #2, Map No. 116

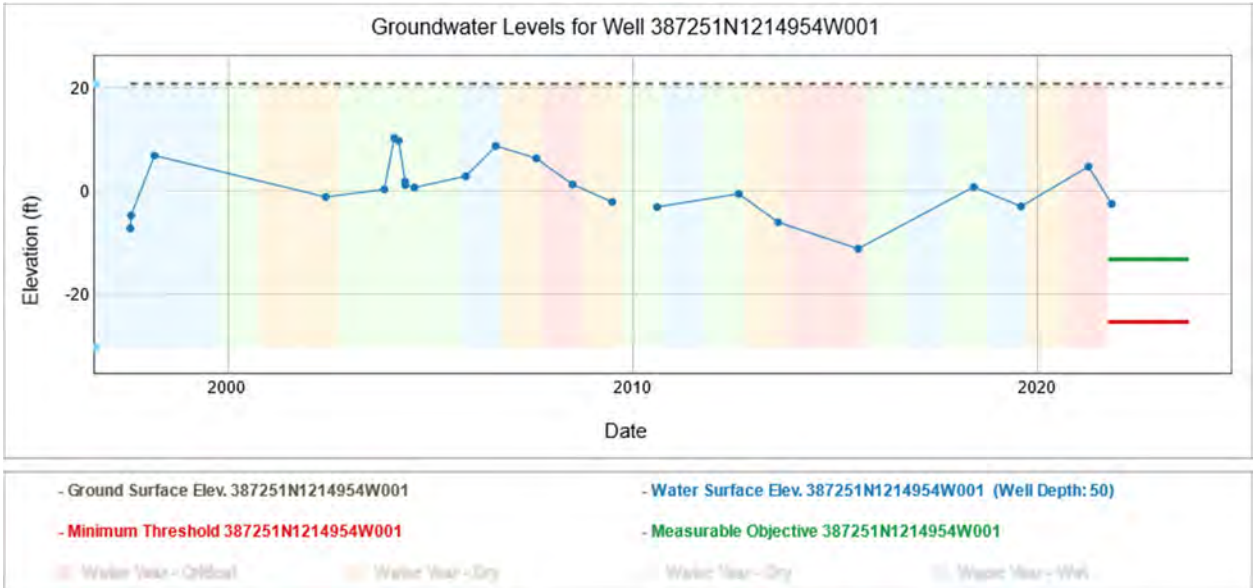

Figure A-42. DeWit, Map No. 126