ANNUAL REPORT | APRIL 2024

# VINA SUBBASIN (5-021.57)
# GROUNDWATER SUSTAINABILITY PLAN
# ANNUAL REPORT – 2023

SUBMITTED BY

VINA AND ROCK CREEK RECLAMATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCIES

PREPARED UNDER CONTRACT WITH

BUTTE COUNTY DEPARTMENT OF
WATER AND RESOURCE CONSERVATION

PREPARED BY

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on behalf of the GSAs in the Vina Subbasin.

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## LIST OF ACRONYMS AND ABBREVIATIONS

| Acronym | Meaning |
|---|---|
| µS/cm | micro siemens per centimeter |
| AEM | Airborne Electromagnetic |
| AF | acre-feet |
| AFY | acre-feet per year |
| AMSL | above mean sea level |
| BBGM | Butte Basin Groundwater Model |
| CSUC | California State University, Chico |
| DMS | Data Management System |
| DWR | Department of Water Resources |
| DID | Durham Irrigation District |
| GSP | Groundwater Sustainability Plan |
| GSA | Groundwater Sustainability Agency |
| MA | Management Areas |
| MO | Measurable Objective |
| MT | Minimum / Maximum Threshold |
| PMAs | projects and management actions |
| RCRD | Rock Creek Reclamation District |
| RMS | representative monitoring site |
| SI | sustainability indicator |
| SGMA | Sustainable Groundwater Management Act |
| SMC | sustainable management criteria |
| Subbasin | Vina Subbasin |
| SWRCB | State Water Resources Control Board |
| WY | Water Year (October 1-September 30) |

# EXECUTIVE SUMMARY

The Vina Subbasin (Subbasin) (5-021.57) Annual Report was prepared on behalf of the Vina Groundwater Sustainability Agency (GSA) and the Rock Creek Reclamation District (RCRD) GSA to fulfill the statutory requirements set by the Sustainable Groundwater Management Act (SGMA) legislation (§10728) and the Groundwater Sustainability Plan (GSP) regulations (§354.40 and §356.2) developed by the California Department of Water Resources (DWR). The regulations mandate the submission of an Annual Report to DWR by April 1st after the reporting year, which spans the water year (WY) from October 1st to September 30th. This Annual Report includes information from the recent WY 2023 for the Vina Subbasin, located within Butte County and shown in **Figure ES-1.**

Measured conditions in the Subbasin were in compliance with all Minimum/Maximum Thresholds (MTs) for all applicable sustainability indicators (SIs). A Minimum Threshold is the quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with minimum thresholds at other monitoring sites, may cause an undesirable result(s) in the basin per DWR's definition. If groundwater levels are lower than the value of the Measurable Objective (MO) for that site, they are moving in the direction of the MT. On the contrary, for the groundwater quality SMC, as the value of the electrical conductivity concentration increases from the MO established for that site, they are moving in the direction of the MT. The SIs and sustainable management criteria (SMC), including MTs, are summarized in **Table ES-1.** Note that seawater intrusion is not an applicable SI in this Subbasin. Each SI is measured at Representative Monitoring Sites (RMS).

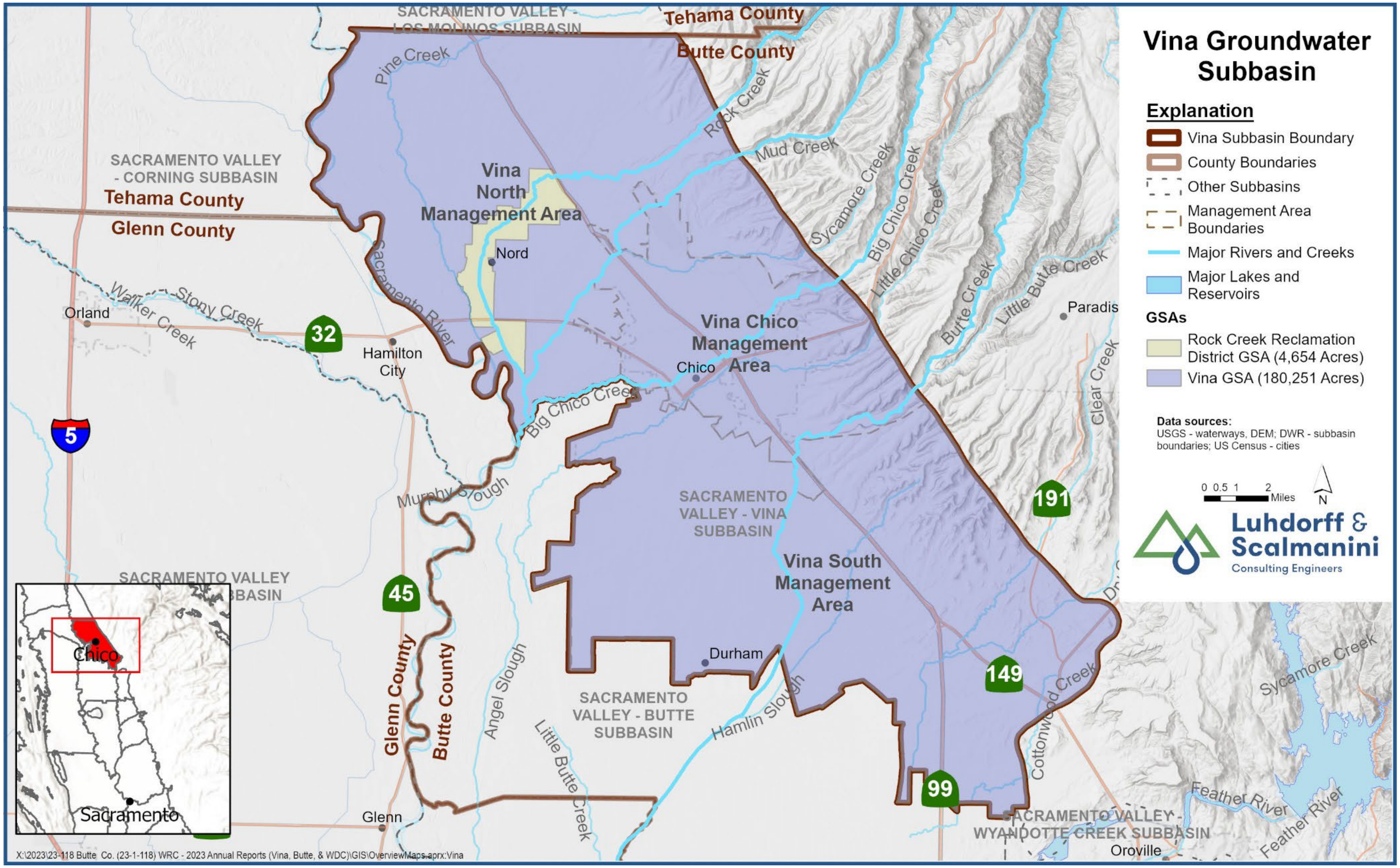


Figure ES-1. Vina Subbasin and Groundwater Sustainability Agency Boundaries

**Table ES-1. Sustainability Indicator Summary**

| 2023 Status | Undesirable Result Identification | Measurable Objective (MO) Definition | Minimum Threshold (MT) Definition |
|---|---|---|---|
| **Chronic Lowering of Groundwater Levels** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | When 2 RMS wells within a management area reach their MT for two consecutive non-dry year types. | The groundwater level is based on the groundwater trend line for the dry periods (over the period of record) of observed short-term climatic cycles extended to 2030 for each RMS well. | An elevation protective of sustainably constructed domestic wells (based on their well depths for wells drilled since 1980) within the polygon associated with the RMS well |
| **Reduction of Groundwater Storage** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. |
| **Degraded Water Quality** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with electrical conductivity levels above their MTs in 2023, a non-dry year. The first year of monitoring, 2022, was a dry year. | When 2 RMS wells exceed their MT for two consecutive non-dry years. | Measured electrical conductivity less than or equal to the recommended Secondary Maximum Contaminant Level (900 µS/cm) based on State Secondary Drinking Water Standards at each well. | The upper limit of the Secondary Maximum Contaminant Level for electrical conductivity (1,600 µS/cm) is based on the State Secondary Drinking Water Standards. |
| **Land Subsidence** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. |

**Table ES-1. Sustainability Indicator Summary**

| 2023 Status | Undesirable Result Identification | Measurable Objective (MO) Definition | Minimum Threshold (MT) Definition |
|---|---|---|---|
| **Depletion of Interconnected Surface Water** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | Uses groundwater levels as a proxy. GSP identifies data gap and describes "Interconnected Surface Water Sustainable Management Criteria Framework." | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. |

***Notes:***

*Salinity is the primary water quality constituent of concern, which is evaluated by measuring electrical conductivity (EC).*

*MO = Measurable Objective, MT = Minimum/Maximum Threshold, RMS = representative monitoring site, µS/cm = micro siemens per centimeter*

## Current Groundwater Level and Storage Conditions

The current groundwater conditions in the Subbasin are characterized by groundwater elevations that have remained consistently near or above the Measurable Objectives (MO), have stayed well above the corresponding MT, and remain within the Subbasin's established margin of operational flexibility for each RMS well. Importantly, none of the RMS wells experienced a decline below the MT for two consecutive non-dry years, hence avoiding undesirable results as defined in the GSP.

Generally, groundwater elevations are, on average, 65 feet above the MT throughout the Subbasin and, on average, 16 feet above the MOs in WY 2023. Elevations are mostly near or slightly higher than those observed in recent years. This positive trend is influenced by the wet conditions experienced in WY 2023, which resulted in increased natural recharge, reliable surface water supplies, and reduced groundwater extractions.

Fluctuations in groundwater levels and storage within the Subbasin are influenced by the balance between aquifer recharge and extraction. Groundwater levels are used as a proxy for estimating changes in groundwater storage, with observed patterns closely mirroring those in the broader Sacramento Valley. In years characterized by drought and low precipitation, diminished surface water supplies lead to increased extraction and reduced recharge, causing a decline in groundwater storage.

In contrast, WY 2023, classified as a Wet WY (CDEC, 2023), marked an increase in groundwater storage of approximately 70,200 acre-feet (AF) in the Primary Aquifer (a 177% change from the previous WY). For context, in the past 23 years the largest decrease in groundwater storage is estimated to be -151,700 AF and the greatest increase was estimated to be 144,100 AF. **Figure ES-2** shows groundwater pumping, as well as annual and cumulative change in groundwater storage from WY 2000 to WY 2023.

## Water Use

Groundwater extraction was approximately 242,000 AF in WY 2023, about 37,700 AF lower than the 278,700 AF extracted in WY 2022. The annual volume of surface water delivered to the Subbasin from surface water features such as Butte Creek was about 27,200 AF in WY 2023, higher than the 20,500 AF delivered in WY 2022.

Groundwater provided the majority (89%) of the water for agriculture in the Subbasin, and surface water was the source for the remainder. Groundwater also met the demand for municipal and rural residential users in the 2023 WY. The volume of groundwater and surface water used on an annual basis within the Subbasin is summarized directly from measured and reported groundwater pumping and surface water diversions when available; however, a water budget approach has been used to estimate the remaining unmeasured volume of groundwater extraction. The water use analysis methodology is discussed in **Appendix E. Table ES-2** provides a summary of water use by water sector. Numbers are rounded to the nearest 100.

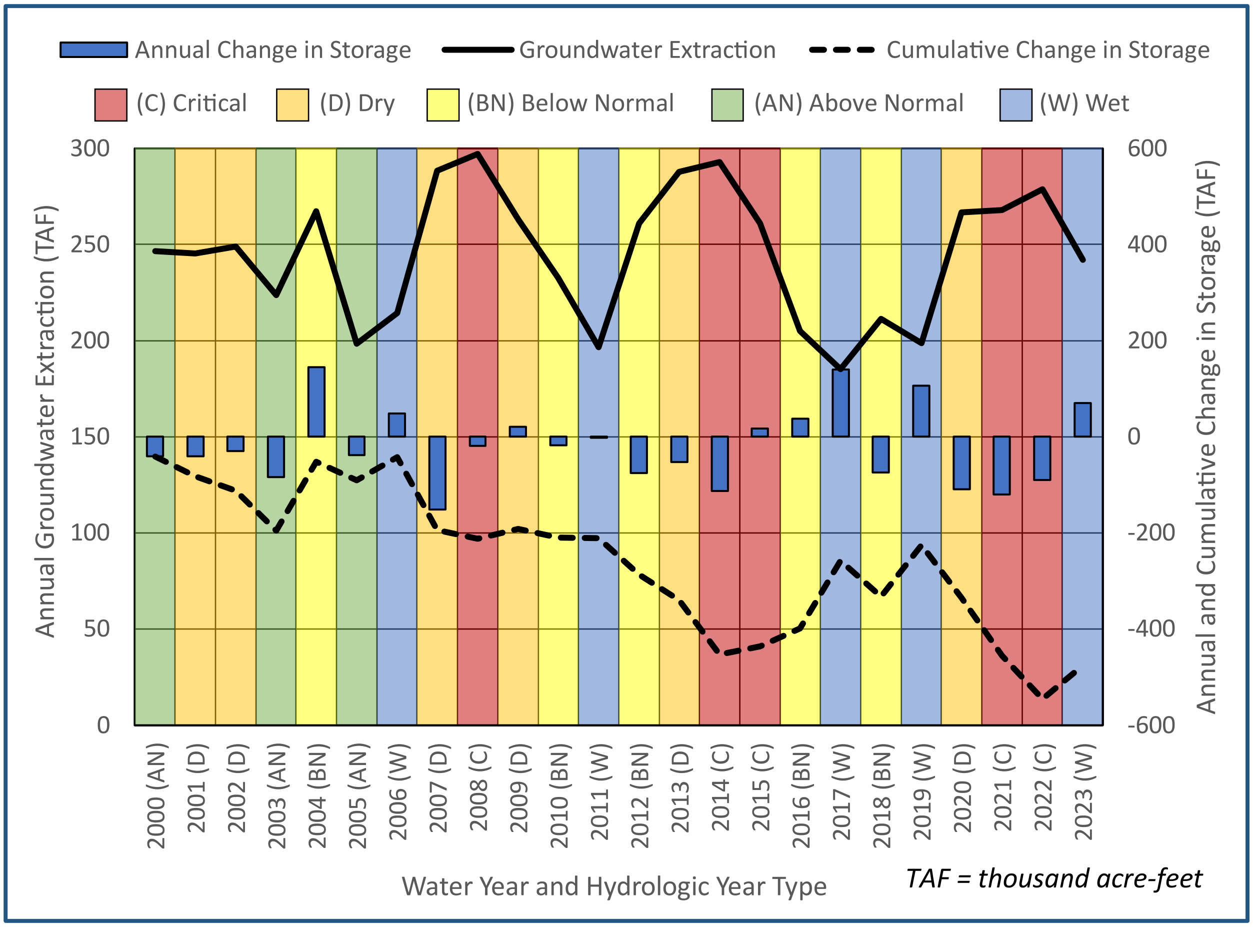


**Figure ES-2. Groundwater Pumping, Annual and Cumulative Change in Storage from WY 2000 to WY 2023**

**Table ES-2. Total Water Use by Water Use Sector**

| Sector | WY 2023 (AF) | | | |
|---|---|---|---|---|
| | Groundwater | Surface Water | Total | Total Irrigated Area (acres) |
| Agricultural | 218,600 | 27,200 | **245,800** | **74,900** |
| Municipal | 21,900 | 0 | **21,900** | **--** |
| Rural Residential | 1,500 | 0 | **1,500** | **--** |
| **Total** | **242,000** | **27,200** | **269,200** | **74,900** |

## GSP Implementation Progress

Since the previous Annual Report (Butte County, 2023), the Vina Subbasin GSAs have coordinated with stakeholders to seek funding through DWR's Sustainable Groundwater Management Grant Program for projects and management actions (PMAs) previously identified in the GSP. An awards list for the grant application was released by DWR in September 2023. Additionally, several actions by the GSAs continue to fulfill GSP requirements, such as monitoring groundwater levels and quality, updating the Data Management System (DMS), and annual reporting to DWR.

Also, since the previous Annual Report, DWR has formally approved the Vina Subbasin GSP. The Vina Subbasin GSAs acknowledge and will address the three key recommended corrective actions listed in the DWR's **GSP determination letter** (https://sgma.water.ca.gov/portal/service/gspdocument/download/9927), including:

1. Providing additional information on historical and current groundwater quality conditions in the Subbasin,
2. Providing more information about the sustainable management criteria for land subsidence and,
3. Filling data gaps, collecting additional monitoring data, and implementing the current strategy to manage depletions of interconnected surface water.

In 2023, the GSAs in the Subbasin prepared to implement future projects to address recommended corrective actions, which will be largely funded by the SGM Implementation Grant Program. The ongoing implementation of PMAs, described in **Section 5**, aims to address these corrective actions effectively through the Periodic Evaluation of the GSP, which is due in January 2027.

# 1 GENERAL INFORMATION §356.2(A)

The Annual Report for the Vina Subbasin (Subbasin) (5-021.57) was prepared on behalf of the Vina Groundwater Sustainability Agency (GSA) and the Rock Creek Reclamation District (RCRD) GSA to fulfill the statutory requirements of the Sustainable Groundwater Management Act (SGMA) legislation (§10728) and regulatory requirements developed by the California Department of Water Resources (DWR) included in the Groundwater Sustainability Plan (GSP) regulations (§354.40 and §356.2). The regulations require the GSAs to submit an Annual Report to DWR by April 1st following the reporting year, which spans the water year (WY) from October 1st to September 30th. This Annual Report is the third Annual Report submitted on behalf of the Subbasin and includes data for the most recent WY 2023 (October 1, 2022, to September 30, 2023). Public seeking information on Vina Subbasin and GSP Implementation, Vina Advisory Board meeting schedules and recordings, and other resources should visit the **Vina Sustainable Groundwater website** (https://www.vinagsa.org/sgma).

## 1.1 Report Contents

This report is the third Annual Report prepared for the adopted Vina Subbasin GSP submitted in January 2022. The first Annual Report included data elements for the first reporting year, WY 2021, as well as a "bridge year," WY 2020. The second and third Annual Reports contain data only for the current reporting year, WY 2022 and WY 2023, respectively. Data elements presented in this report refer to WY 2023, the 12-month period spanning October 2022 through September 2023 unless otherwise noted. Pursuant to GSP regulations, the Annual Report includes:

- Groundwater Elevation Data
- Water Supply and Use
- Change in Groundwater Storage
- GSP Implementation Progress

## 1.2 Subbasin Setting

The Subbasin is a 289 square mile (184,917 acres) area on the eastern side of Butte County. The Subbasin is managed by the Vina and Rock Creek Reclamation District GSAs. The two GSAs worked cooperatively to develop and submit a single GSP for the Subbasin and to submit Annual Reports every year.

The Subbasin is shown in **Figure 1-1** and **Figure 1-2**. The Subbasin lies in the eastern central portion of the Sacramento Groundwater Basin, **Figure 1-1**. The Subbasin's northern boundary is the Butte-Tehama County line, the western boundary is the Butte-Glenn County line, the southern boundary is a combination of property boundaries owned by the M&T Ranch, Reclamation District 2106 and Western Canal Water District, and the eastern boundary is the edge of the alluvium as defined by DWR Bulletin 118 (DWR, 2018), **Figure 1-2**. There are several surface water features located in the Subbasin, including the Big Chico Creek, Butte Creek, Mud Creek, and Rock Creek. Generally, the streams traverse the Subbasin, moving northeast to southwest. Groundwater generally flows from north to southwest.

The GSP defines three management areas (MAs) in the Vina Subbasin: Vina North, Vina Chico, and Vina South. An MA refers to an area within a subbasin for which a GSP may identify different minimum thresholds (MTs), measurable objectives (MOs), monitoring, and projects and management actions (PMAs) based on unique local conditions or other circumstances as described in the GSP regulations. Although all stakeholders have a shared interest in the sustainable management of groundwater in this predominantly groundwater-dependent Subbasin, the landscape of beneficial users varies between MAs. Vina North is dominated by irrigated agriculture dependent on wells with sparsely distributed rural residential domestic well users and the small community of Nord. The Vina-Chico MA is predominantly an urban area with California Water Service, Chico (Cal Water-Chico), providing groundwater supplies for residential and municipal/industrial use. To a very limited extent, private domestic wells provide the primary source of water to households or, in some cases, provide a secondary supply for outdoor water use. The Vina South MA is dominated by irrigated agriculture dependent on groundwater and, to a lesser extent, surface water diversions (primarily from Butte Creek). In and around the community of Durham, significant numbers of rural residents and ranchettes depend on groundwater, typically from relatively shallow domestic wells interspersed with agricultural land uses. In addition, Durham Irrigation District serves household water needs using groundwater from district wells for a portion of the Durham community.

The Vina Subbasin GSP estimates the sustainable yield of the Subbasin to be 233,500 acre-feet per year (AFY) based on historical groundwater pumping averages of 243,500 AFY and an annual decrease in storage of 10,000 AFY (Geosyntec, 2021). Water use in the Subbasin is dominated (91%) by agricultural uses, including irrigation of nut and fruit trees, vineyards, row crops, grazing, and rice fields. Municipal and household water use accounts for the rest (9%) of water used. Groundwater constitutes the majority (89%) of the Subbasin’s water supplies, while surface water constitutes the remaining 11%.

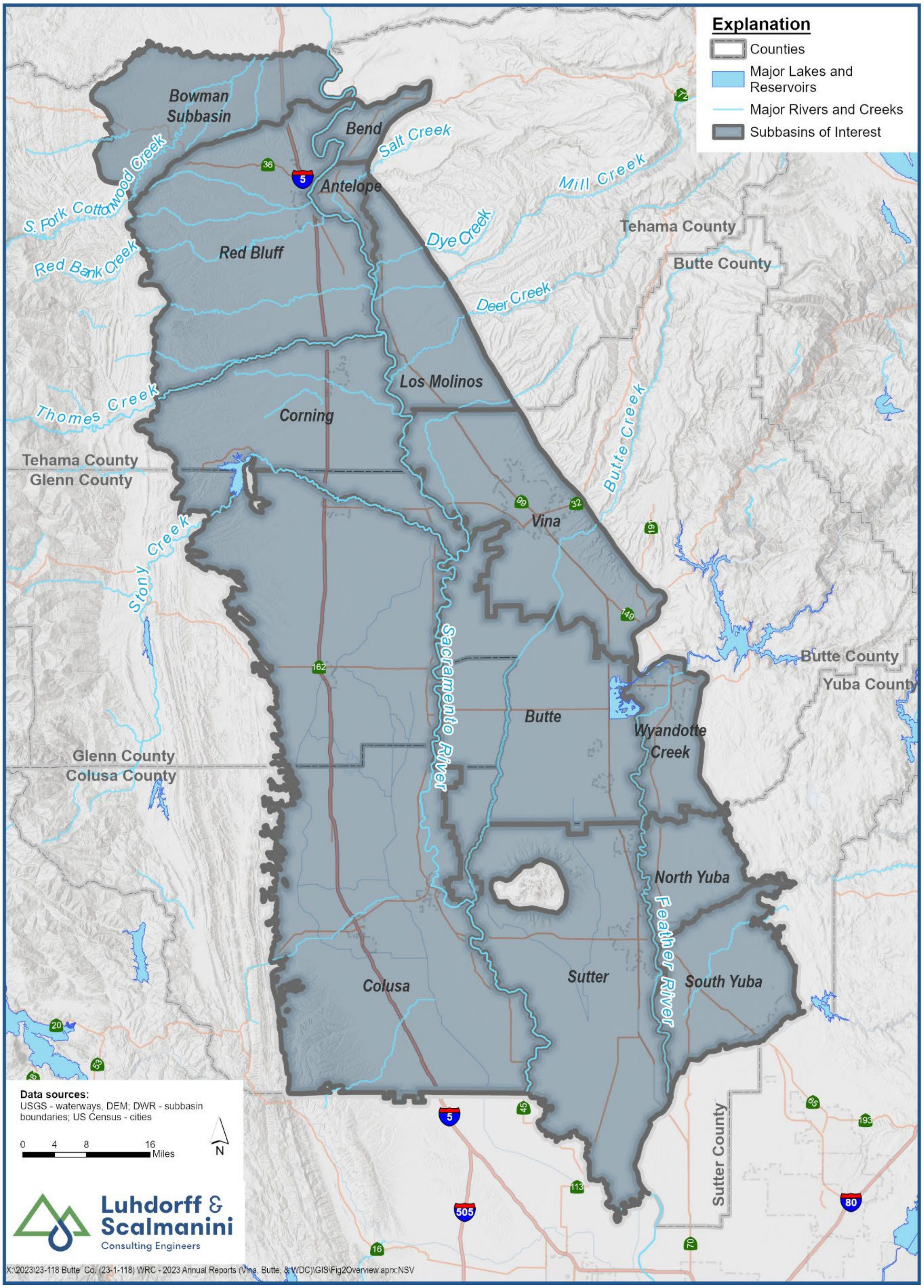


Figure 1-1. Subbasins in the Northern Sacramento Valley

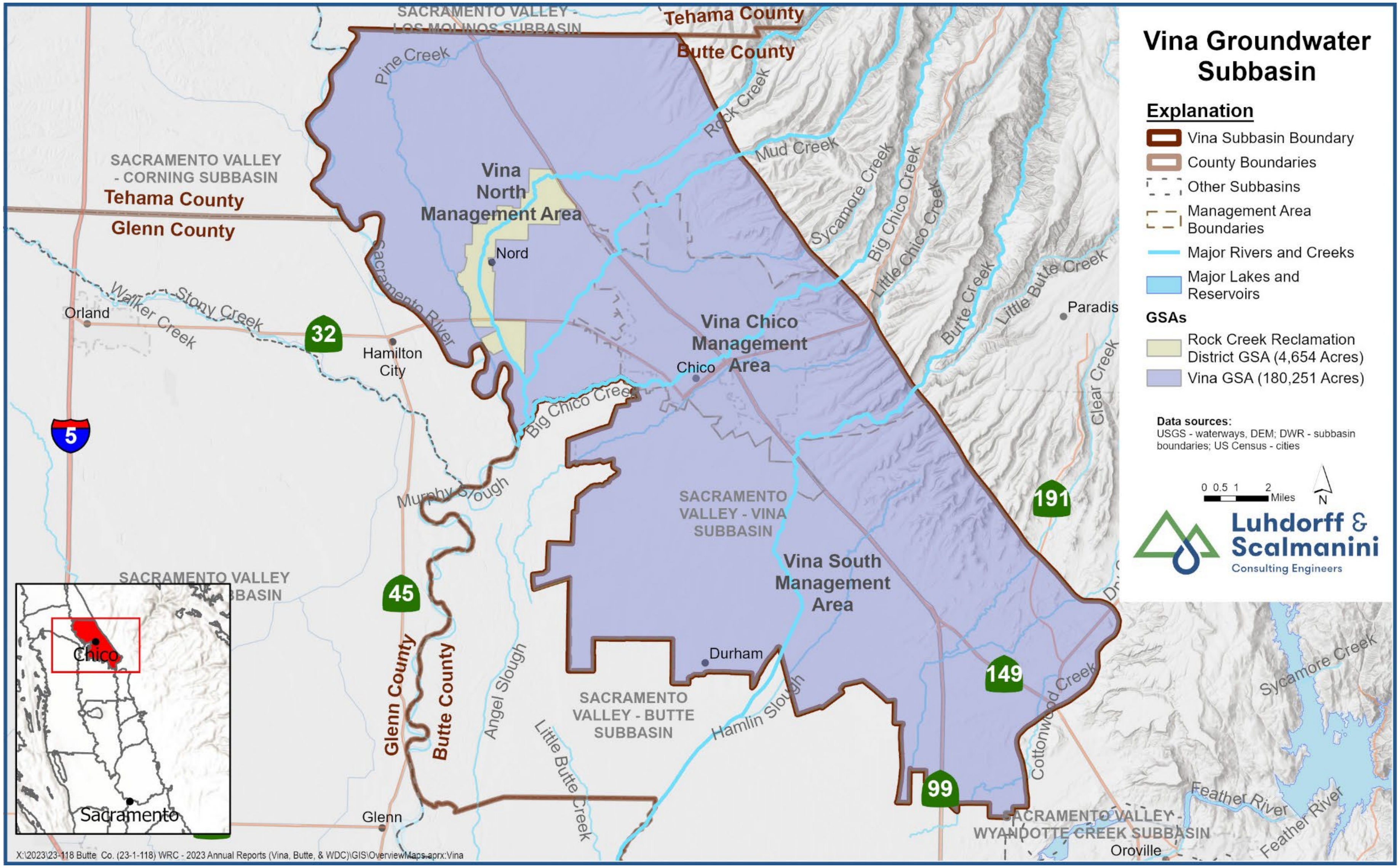


Figure 1-2. Vina Subbasin and Groundwater Sustainability Agency Boundaries

# 2 GROUNDWATER ELEVATIONS §356.2(b)(1)

Groundwater elevations in the Subbasin typically fluctuate seasonally between and within water years, particularly in groundwater-dependent areas or during drought years when groundwater is used to compensate for diminished surface water supplies. Seasonal fluctuations of groundwater levels occur in response to groundwater pumping and recovery, land and water use activities, recharge, and natural discharge. Sources of recharge into the groundwater system include precipitation, applied irrigation water, and seepage from local creeks and rivers.

Groundwater pumping for irrigation typically occurs from April to September, although depending on the timing of rainfall, it may shift earlier and/or later into the season. Consequently, groundwater levels are usually highest in the spring and lowest during the irrigation season in the summer months. Fall groundwater measurements (typically measured in October) provide an indication of groundwater conditions after the primary irrigation season. Groundwater levels follow a variety of patterns in different areas of the Subbasin; depth to groundwater ranges from about 20 feet below ground surface to over 150 feet below ground surface.

Groundwater levels in the Subbasin are monitored in representative monitoring site (RMS) wells that were selected in the GSP to represent localized groundwater conditions for specified areas of the Subbasin. RMS wells include a mixture of domestic wells, irrigation wells, and dedicated observation wells. In total, 17 RMS wells are used to monitor conditions in the Primary Aquifer. **Appendix A** includes a map of the approximate locations of the RMS wells and hydrographs depicting groundwater elevations in the RMS wells. Sustainable management criteria (SMC), described in **Appendix B**, are assigned for groundwater levels at the RMS wells.

Certain RMS wells measured by DWR and Butte County are equipped with data loggers and pressure transducers, which continuously monitor and record hourly changes in groundwater levels. These and the remaining wells in the network are measured by hand at least twice in Spring and Fall but up to four times each year in March, July, August, and October. Data from groundwater level monitoring wells is available from DWR's online SGMA Data Viewer tool
(https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer).

Spring and Fall 2023 groundwater elevation measurements from RMS wells in the Primary Aquifer systems are summarized in **Table 5-2**. Groundwater elevation data in the Subbasin is collected by DWR and Butte County and is publicly available from DWR's online SGMA Data Viewer tool (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer). The groundwater level monitoring methods are consistent with the protocols described in the Vina Subbasin GSP. Depending on the well, groundwater elevations are measured using steel tape, electric sounder, or pressure transducers. The accuracy of groundwater level measurements is typically either 0.01 feet or 0.1 feet, depending on the equipment used.

The following sections provide a summary of groundwater elevations and conditions during WY 2023 through the presentation and description of groundwater elevation contours (**Section 2.1**) and hydrographs of groundwater elevations (**Section 2.2; Appendix A**).

## 2.1 Groundwater Elevation Contour Maps – §356.2(b)(1)(A)

Groundwater elevation contour maps for Spring and Fall 2023 were prepared for the Primary Aquifer, as shown in **Figures 2-1** through **2-2**. Spring contours are intended to generally represent seasonal high groundwater elevations (shallower depth to water), while fall contours are intended to generally represent seasonal low groundwater elevations (deeper depth to water). Groundwater elevation contours were developed by creating a continuous groundwater elevation surface based on available monitoring well data using the kriging interpolation method. Questionable groundwater elevation measurements were excluded, and minor adjustments to the contours were made based on professional judgment.

The contour maps of the Primary Aquifer (**Figures 2-1** and **2-2**) each show that groundwater elevations are generally higher in the northern and eastern areas of the Subbasin versus the southern and western areas, indicating a general gradient – and thus groundwater flow, from the northeast to the southwest. The contour maps illustrate several general features of the groundwater flow system in the Vina Subbasin, including:

- Overall, west-southwest groundwater flow is consistent with recharge from the north and along the eastern foothills.
- Convergence of groundwater flow toward pumping areas west of Butte Creek and near Durham in the Vina South MA.
- The higher concentration of contours in the southeast portion of the Subbasin indicates a steeper gradient and could suggest higher groundwater flow. However, given the characteristics of aquifer materials on the eastern portion of the Subbasin, the steep gradient is likely evidence of aquifer materials with lower transmissivity. Nonetheless, the contours are consistent with the current understanding of recharge coming from the lower foothills. New sources of information and data may improve understanding of this area.

Elevations in Fall 2023 tend to be ten feet lower than elevations in Spring 2023 throughout the Subbasin. Groundwater levels are typically lower in the fall in valley floor locations due to irrigation season pumping. Maps showing the regional context of groundwater contours, including groundwater contours in the Vina, Butte, and Wyandotte Creek Subbasins, are included in **Appendix A**.

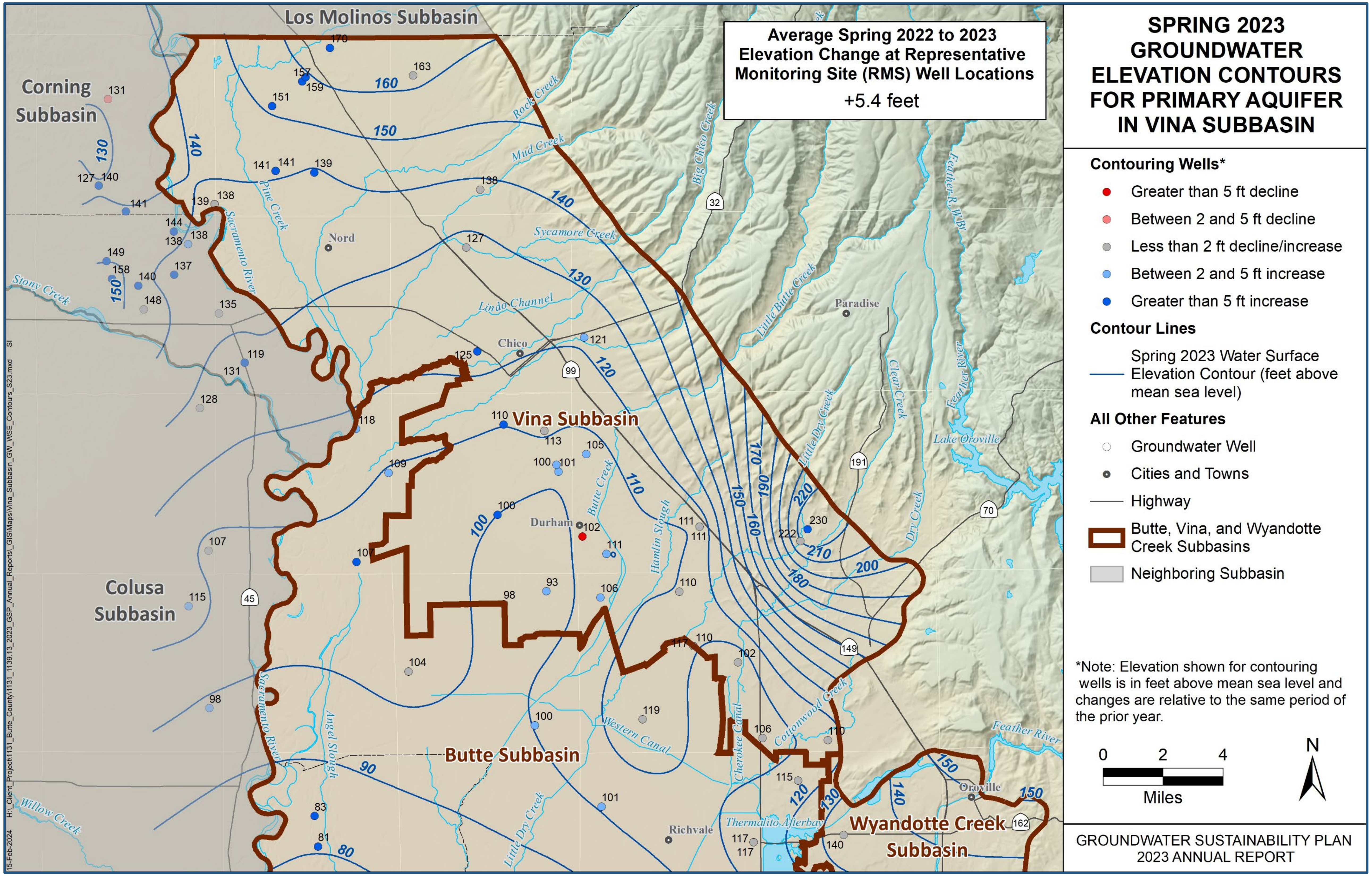


Figure 2-1. Subbasin Contours of Equal Groundwater Elevation for the Primary Aquifer, Spring 2023 (Seasonal High)

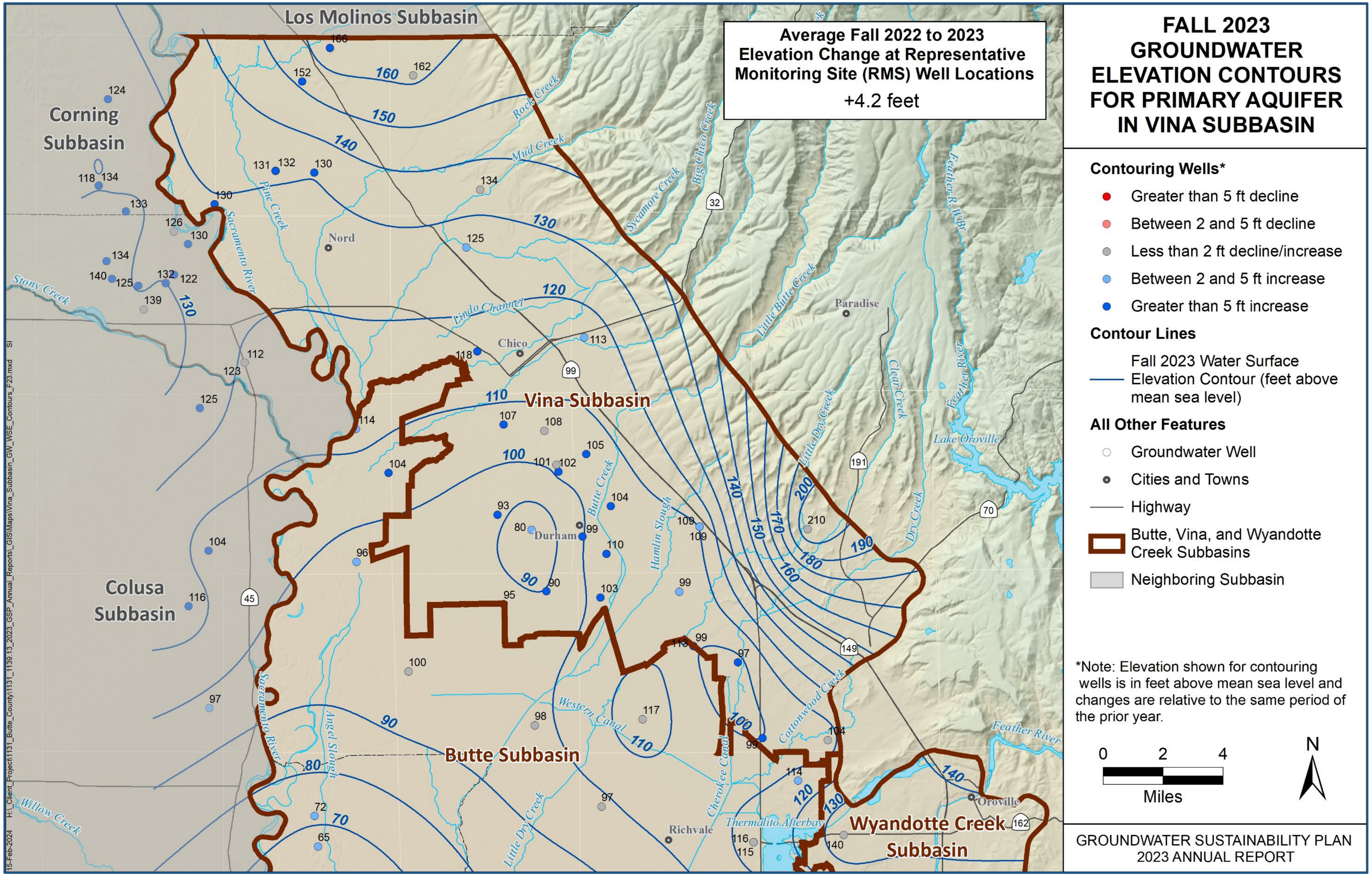


Figure 2-2. Subbasin Contours of Equal Groundwater Elevation for the Primary Aquifer, Fall 2023 (Seasonal Low)

## 2.2 Hydrographs of Groundwater Elevations – §356.2(b)(1)(B)

Groundwater elevation hydrographs for each RMS well are presented in **Appendix A**. **Appendix B** provides an explanation of the SMC terminology defined in Section 3 of the GSP (e.g., Minimum Threshold [MT], Measurable Objective [MO], Interim Milestone [IM]). **Table 5-1** summarizes the MOs, MTs, and identification of undesirable results for WY 2023, and **Table 5-2** contains a summary of the Spring 2023 (Seasonal High) and Fall 2023 (Seasonal Low) groundwater elevations measured at each RMS well. **Table 5-2** also summarizes the established MO and MT for groundwater elevations, the IM for 2027, the changes in groundwater elevations from WY 2022 to WY 2023, and the differences between the 2023 groundwater elevations and the MO.

Historically, groundwater levels have typically remained at or above their respective MOs in the Subbasin. The GSP also established IMs to provide numerical metrics for GSAs to track the Subbasin's conditions relative to the overall sustainability goal, ensuring that the groundwater management of the Subbasin remains sustainable.

Spring and Fall 2023 groundwater elevations were generally near or slightly higher than seasonal groundwater elevations in previous years, particularly WY 2022. In WY 2023, the average seasonal high was 128 feet above mean sea level (AMSL), and the average seasonal low was 118 feet AMSL. In WY 2022, the average seasonal high was 123 feet AMSL, and the average seasonal low was 115 feet AMSL. Increases in groundwater levels generally were expected to result from decreased groundwater extraction in WY 2023 relative to WY 2022, as well as increased recharge due to wet climate conditions.

All wells remained above the MO during Spring 2023 and Fall 2023. All measured groundwater elevations also remained above the corresponding MT of that RMS well, avoiding undesirable results related to groundwater levels as defined in the GSP. Groundwater levels in RMS wells were on average about 65 feet higher than MT elevations over both spring and fall 2023. All measured groundwater levels remained within the Subbasin's margin of operational flexibility and above the MTs.

# 3 WATER SUPPLY AND USE

As required by §356.2, this section summarizes water supply and use in the Subbasin, categorized by groundwater supply, surface water supply, and total supply. The total water available for use in the Subbasin was tabulated from groundwater extraction volumes reported in **Table 3-1** and the surface water supply reported in **Table 3-2**. The total water available is summarized in **Table 3-3** for WY 2023. Groundwater extraction volumes are either based on measured data or are estimates from a water use analysis based on 2023 land use data and climate conditions. The water use analysis methodology is discussed in **Appendix E**. Surface water use was estimated from historic deliveries when records were not available.

## 3.1 Groundwater Extraction – §356.2(b)(2)

Groundwater extraction in the Subbasin is summarized in **Table 3-1**. Groundwater extraction is reported from pumping records where available, while the remaining groundwater extraction is estimated through the water use analysis approach described in the previous section and in **Appendix E**.

The majority of the Subbasin uses groundwater supplies for agricultural irrigation, although portions of the Subbasin may rely on surface water for irrigation. In years characterized by drought and low precipitation, diminished surface water supplies lead to increased extraction and reduced recharge and can cause a decline in groundwater storage. Contrastingly, in wet years, such as WY 2023, substantial surface water supplies help to increase recharge and offset extraction and can increase groundwater storage.

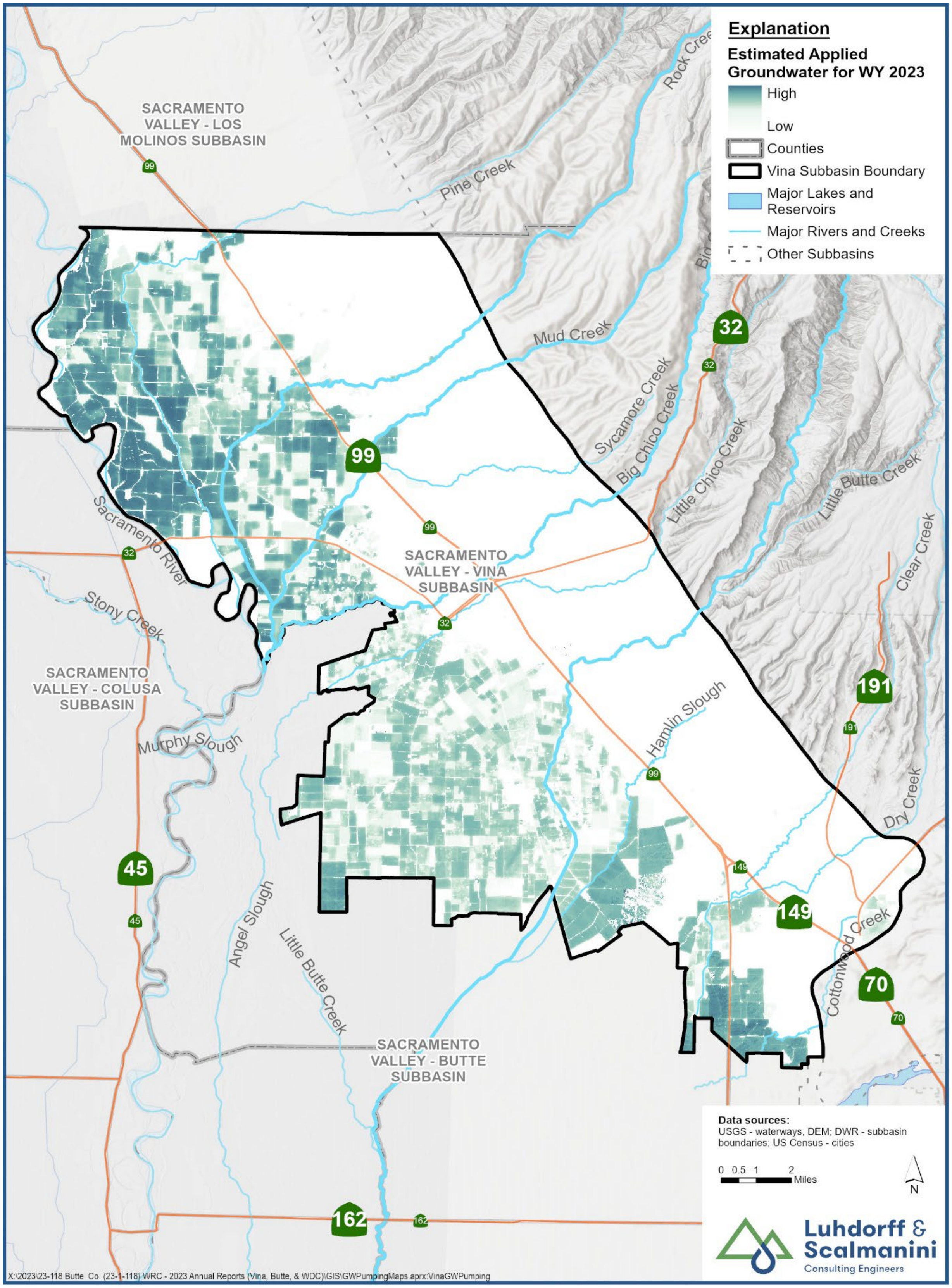
Municipal water users extracted approximately 21,900 AF in the Subbasin in WY 2023. Municipal water supplies are measured and were provided by Cal Water, Chico, and Durham Irrigation District (DID). The record of municipal supplies does not distinguish between urban and industrial water uses.

Rural residential water users rely on private domestic wells to meet their household water needs and extracted approximately 1,500 AF in WY 2023. Rural residential groundwater extraction was quantified based on average per capita water use and estimated population. The average per capita water use reported in the California Water Service Chico-Hamilton City District 2020 Urban Water Management Plan 2020 (Cal Water Chico, 2020) was 181 gallons per capita per day. This is considered representative of rural residential per capita water use in the region. Parcels were chosen within the Subbasin, except for those in municipal service areas. Residential parcels were selected based on Butte County's general plan zoning codes from the general plan. Population estimates were derived from these zoning codes and average household sizes from the US census. The resulting population estimate was used to estimate residential groundwater pumping.

The total estimated groundwater extraction was approximately 242,000 AF in WY 2023, the majority of which was used to meet agricultural water demands (approximately 218,600 AF). The total groundwater extraction is about 3,100 AF less than the historical (2000 – 2022) groundwater pumping average (245,100 AFY; **Table 4-1**) but higher than 198,600 AF, which was the average annual extraction of the last four wet WYs on record (2006, 2011, 2017, and 2019). **Figure 3-1** shows the general areas and pumping rates where extraction occurs by sector. Roughly 90% of the total groundwater extraction was used by the agricultural sector, while the remaining 10% was used for municipal and rural residential water needs.

**Table 3-1. Groundwater Use by Water Use Sector**

| Sector | WY 2023 (AF) |
|---|---|
| Agricultural | 218,600 |
| Municipal | 21,900 |
| Rural Residential | 1,500 |
| **Total** | **242,000** |



Data sources:
USGS - waterways, DEM; DWR - subbasin boundaries; US Census - cities

X:\2023\23-118 Butte Co. (23-1-118) WRC - 2023 Annual Reports (Vina, Butte, & WDC)\GIS\GWPumpingMaps.aprx:VinaGWPumping

Figure 3-1. Estimated Applied Groundwater – WY 2023

## 3.2 Surface Water Supply – §356.2(b)(3)

Surface water supplies used or available for use in the Subbasin are summarized in **Table 3-2.** Surface water supplies are reported directly from water supplier records or collected from publicly available sources (water rights diversion records, etc.) where available. Missing surface water supply data was estimated based on available historical diversions data in similar water years.

Surface water provided about 11% of the agricultural water demand in the Subbasin for WY 2023. Diversions from Butte Creek were accessed from the State Water Resource Control Board's (SWRCB) Electronic Water Rights Information Management System (SWRCB, 2023) or direct request from diverters. Data from eWRIMS on surface water delivery indicated which water rights holders on Butte Creek had made diversions during WY 2023. There are currently no surface water supplies for municipal use in the Vina Subbasin. Total surface water diversions and deliveries for the Vina Subbasin are estimated to be about 30,400 AF and 27,200 AF, respectively.

In contrast with the curtailments and reduced surface water supplies experienced in WY 2022, WY 2023 was a Wet WY with more substantial surface water supplies. These, combined with wet climate conditions and increased stream flows, supported groundwater recharge and offset groundwater extraction volumes compared to WY 2022.

**Table 3-2. Surface Water Use by Water Use Sector for WY 2023**

| Sector | Diverted (AF) | Applied (AF) |
|---|---|---|
| Agricultural | 30,400 | 27,200 |
| **Total** | 30,400 | 27,200 |

## 3.3 Total Water Use by Sector – §356.2(b)(4)

Groundwater supplied approximately 89% of the agricultural water demand in the Subbasin in WY 2023, while surface water supplied the remaining approximately 11% of the agricultural water. The total water available for use in the Subbasin was tabulated from groundwater extraction volumes reported in **Table 3-1** and the surface water supply reported in **Table 3-2**. The total water available is summarized in **Table 3-3** for WY 2023. The results are either based on measured data or estimates, as described in the previous two sections. **Table 3-3** also shows the total irrigated area in WY 2023 within the Subbasin.

**Table 3-3. Total Water Use by Water Use Sector**

| Sector | WY 2023 (AF) | | | |
|---|---|---|---|---|
| | Groundwater | Surface Water | Total | Total Irrigated Area (acres) |
| Agricultural | 218,600 | 27,200 | **245,800** | **74,900** |
| Municipal | 21,900 | 0 | **21,900** | **--** |
| Rural Residential | 1,500 | 0 | **1,500** | **--** |
| **Total** | **242,000** | **27,200** | **269,200** | **74,900** |

## 3.4 Uncertainties in Water Use Estimates

Estimated uncertainties in the water budget components are presented in **Table 3-4**. The uncertainty of these water budget components is based on typical accuracies given in technical literature and the cumulative estimated accuracy of all inputs used to calculate the components.

**Table 3-4. Estimated Uncertainty in Water Use Estimates**

| Water Budget Component | Data Source | Estimated Uncertainty (%) | Source |
|---|---|---|---|
| **Groundwater** | | | |
| Agricultural | Measurement | 20% | Typical uncertainty from water balance calculation. |
| Municipal/Industrial | Measurement/ Estimate | 5% | Typical accuracy of municipal water system reporting. |
| Rural Residential | Calculation | 15% | Estimated from per capita water use and Census information. |
| **Surface Water** | | | |
| Agricultural | Calculation | 10%[1] | Estimated from Senate Bill 88 measurement accuracy standards. |

[1] *Higher uncertainty of 10%-20% is typical for estimated surface water inflows, including un-gaged inflows from small watersheds into creeks that enter the Subbasin.*

# 4 Groundwater Storage

Long-term fluctuations in groundwater levels and groundwater in storage occur when there is an imbalance between the volume of water recharged into the aquifer and the volume of water removed from the aquifer, either by extraction or natural discharge to surface water bodies. If, over a period of years, the amount of water recharged to the aquifer exceeds the amount of water removed from the aquifer, then groundwater levels will increase and groundwater storage increases (i.e., positive change in storage). Conversely, if, over time, the amount of water removed from the aquifer exceeds the amount of water recharged, then groundwater levels decline, and groundwater storage decreases. These long-term changes can be linked to various factors, including increased or decreased groundwater extraction or variations in recharge associated with wet or dry hydrologic cycles.

A review of the RMS well hydrographs (**Appendix A**) indicates that groundwater elevations are either relatively stable or showing a declining trend over time. Declines may be influenced by the significant percentage of water years since 2006 that have been dry (i.e., characterized as Below Normal, Dry, or Critical). Since groundwater storage is closely related to groundwater levels, measured changes in groundwater levels can serve as a proxy for and be utilized to estimate changes in groundwater storage. Changes in groundwater storage in the Subbasin follow a pattern typically seen in the majority of the Sacramento Valley. During normal to wet years, groundwater is withdrawn during the summer for irrigation and is replenished during the winter through recharge of precipitation and surface water inflows, allowing groundwater storage to potentially rebound by the following spring. During dry years and drought conditions, this pattern is disrupted when more groundwater may be pumped to meet irrigation demand, and less recharge may occur due to reduced precipitation, diminished or curtailed surface water supplies, and lower stream levels.

In WY 2023 (a Wet WY), groundwater storage increased by approximately 70,200 AF in the Primary Aquifer. Decreased groundwater extraction in WY 2023 relative to WY 2022 contributed to the increase, as well as increased recharge due to wet climate conditions. These and related factors, such as flood irrigation with surface water and increased stream flows, resulted in higher groundwater levels in Spring 2023 compared to Spring 2022.

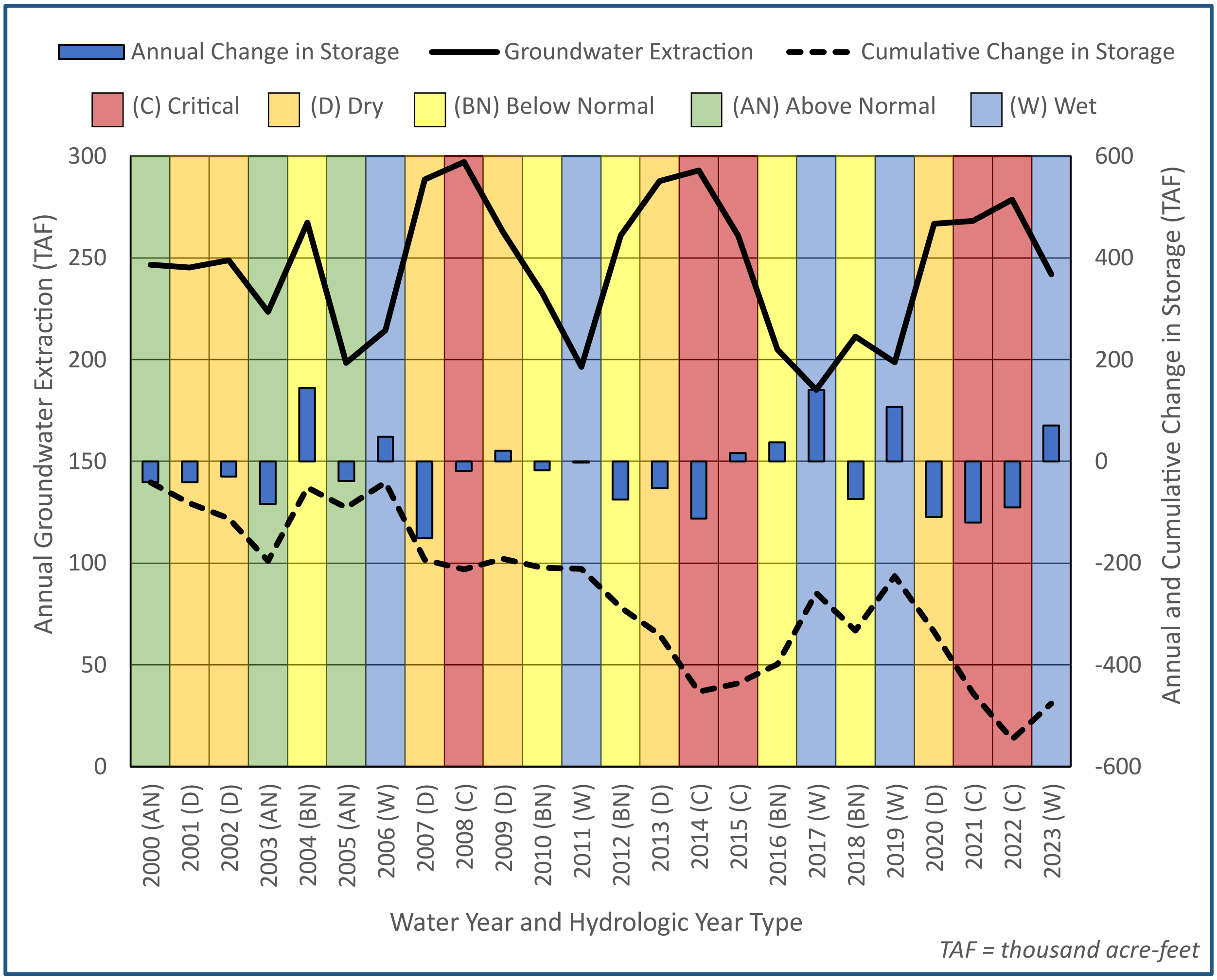
The following sections present a summary of groundwater use and change in storage over time, along with a description of the uncertainty in storage change estimates.

## 4.1 Change in Groundwater Storage – §356.2(b)(5)(B)

Annual groundwater pumping, groundwater storage changes, and the cumulative change in storage over time are presented for WY 2000 through WY 2023 in **Table 4-1** and **Figure 4-1**. In contrast to the Critically Dry conditions of WY 2022, WY 2023 was a Wet WY and correspondingly saw a marked increase in groundwater storage, totaling approximately 70,200 AF in the Primary Aquifer. For context, in the past 23 years the largest decrease in groundwater storage is estimated to be -151,700 AF and the highest increase was estimated to be 144,100 AF.

The historical record since 2000 includes multiple data sources. Groundwater extractions for WY 2000 through WY 2018 were obtained from the Butte Basin Groundwater Model (BBGM, BCDWRC, 2021), and the water budgets were prepared as part of the Vina Subbasin GSP (Geosyntec, 2021). The WY 2019 and WY 2020 groundwater extraction values were calculated as the average based on the hydrologic year type from WY 2000 to WY 2018. The WY 2021 and WY 2022 groundwater extraction values were obtained from prior Annual Reports and were developed using the same methods as WY 2023, as described in **Section 3** and **Appendix E**. Groundwater extractions for the entire period include pumping for agricultural, municipal, and rural residential purposes.

The annual and cumulative changes in groundwater storage are both calculated for the period from WY 2000 through WY 2023 based on the methodology described below in **Section 4.2**. This methodology differs from the change in groundwater storage estimates available through the BBGM. An evaluation of a total of 20 pairs of concurrent annual storage changes over the period from WY 1999 through WY 2018 was assembled from the BBGM, and the methodology described in **Section 4.2** was completed to evaluate the consistency of the new methodology with the BBGM results. Although groundwater storage changes differ in some cases, the general trends are similar, and there is agreement between the methodologies. It is anticipated that the methodology described in **Section 4.2** will be utilized for Annual Report updates until the BBGM model is updated from 2018 through the present (anticipated to be completed as part of the Periodic Evaluation of the GSP due in January 2027, if not sooner).



*TAF = thousand acre-feet*

**Figure 4-1. Groundwater Pumping and Annual and Cumulative Change in Storage from WY 2000 to WY 2023**

**Table 4-1. Annual Groundwater Extraction and Change in Storage**

| Water Year (Hydrologic Year Type) | Groundwater Extraction[1] (AF) | Annual Change in Storage (AF) | Cumulative Change in Storage (AF) |
|---|---|---|---|
| **Storage Change and Cumulative Change in Storage** | | | |
| 2000 (AN) | 246,600 | -41,000 | -41,000 |
| 2001 (D) | 245,200 | -40,800 | -81,800 |
| 2002 (D) | 248,900 | -30,300 | -112,100 |
| 2003 (AN) | 223,500 | -83,900 | -196,000 |
| 2004 (BN) | 267,200 | 144,100 | -51,900 |
| 2005 (AN) | 198,400 | -38,800 | -90,700 |
| 2006 (W) | 214,400 | 48,700 | -42,000 |
| 2007 (D) | 288,400 | -151,700 | -193,700 |

| Table 4-1. Annual Groundwater Extraction and Change in Storage | | | |
|---|---|---|---|
| Water Year (Hydrologic Year Type) | Groundwater Extraction[1] (AF) | Annual Change in Storage (AF) | Cumulative Change in Storage (AF) |
| 2008 (C) | 297,100 | -18,900 | -212,600 |
| 2009 (D) | 263,000 | 20,700 | -191,900 |
| 2010 (BN) | 232,700 | -17,600 | -209,500 |
| 2011 (W) | 196,500 | -2,100 | -211,600 |
| 2012 (BN) | 261,000 | -75,700 | -287,300 |
| 2013 (D) | 287,600 | -53,000 | -340,300 |
| 2014 (C) | 293,000 | -112,600 | -452,900 |
| 2015 (C)[2] | 260,900 | 16,800 | -436,100 |
| 2016 (BN) | 205,100 | 37,200 | -398,900 |
| 2017 (W) | 185,000 | 140,300 | -258,600 |
| 2018 (BN) | 211,400 | -73,900 | -332,500 |
| 2019 (W) | 198,600 | 106,700 | -225,800 |
| 2020 (D) | 266,600 | -109,400 | -335,200 |
| 2021 (C)[2] | 267,980 | -120,400 | -455,600 |
| 2022 (C)[2] | 278,700 | -90,700 | -546,300 |
| 2023 (W) | 242,000 | 70,200 | -476,100 |
| **Historic Averages (2000 – 2022)[3]** | | | |
| 2000-2022 (22 years) | 245,100 | -23,800 | |
| W (4 years) | 198,600 | 73,400 | |
| AN (3 years) | 222,800 | -54,600 | |
| BN (5 years) | 235,500 | 2,800 | |
| D (6 years) | 266,600 | -60,800 | |
| C (6 years) | 279,500 | -65,200 | |

*Positive values indicate inflows to the groundwater system and negative values indicate outflows from the groundwater system.*

*GW = Groundwater, AF = acre-feet*

*Water Year Types Classified According to the Sacramento Valley Water Year Index:*
*AN = Above Normal, BN = Below Normal, C = Critical, D = Dry, W = Wet*

[1] *Groundwater extraction values from 2000 to 2018 were determined using BBGM (Geosyntec, 2021). Values for 2019-2020 are averages from that period. Estimates for 2021 were based on a drought impact analysis (**Appendix E**), while estimates for 2022-2023 are based on a GEEEO process, described in the same appendix.*

[2] *Indicates curtailment year with reduced surface water supply allocations to Feather River water districts.*

[3] *The historical average calculation covers the period from 2000 to 2022, excluding the current water year.*

## 4.2 Groundwater Storage Maps – §356.2(b)(5)(A)

The spatial distribution of estimated changes in groundwater storage for the period from Spring 2022 to Spring 2023 are shown in **Figure 4-2** and **Figure 4-3** for the Primary Aquifer. Since groundwater storage is closely related to groundwater levels, measured changes in groundwater levels can serve as a proxy for and be utilized to estimate changes in groundwater storage. Change in groundwater storage was estimated based on the change in measured spring-to-spring groundwater levels at each RMS well, multiplied by the area of a Thiessen polygon surrounding that RMS well (defining a representative area for each RMS well) and a representative storage coefficient of 0.1 for the Primary Aquifer.

Spring measurements used to calculate the change in groundwater storage were computed as the average of all available groundwater level measurements from March and April of the respective year. The representative storage coefficient was established by roughly calibrating the estimated change in storage based on changes in observed groundwater levels (i.e., calculated using groundwater level data, representative area, and a storage coefficient parameter) with estimated change in storage outputs from the BBGM, as reported in the GSP to aggregate characteristics across all zones of the Primary Aquifer system. A total of 20 pairs of concurrent annual storage changes assembled from both methods over the period from WY 1999 through WY 2018 were used for calibration. Determination of a representative storage coefficient allows for estimating the change in volume of groundwater storage based on the measured change in groundwater levels and known representative area (i.e., Thiessen polygon) associated with each groundwater level measurement.

Negative changes in storage values indicate lowering groundwater levels and depletion of groundwater storage, whereas a positive change in storage values represents rising groundwater levels and accretion of groundwater in storage. As shown in **Figure 4-2**, the change in storage for each representative area (i.e., Thiessen polygon) in the Primary Aquifer over the previous year ranged from roughly zero to 10,000 AF. The representative areas around the northwestern and central portions of the Subbasin had a larger positive change in storage, while the areas in the northeastern and southeastern portions of the Subbasin had a very slight negative change in storage. Total groundwater storage change in the Primary Aquifer was estimated to be approximately 70,200 AF between Spring 2022 and Spring 2023.

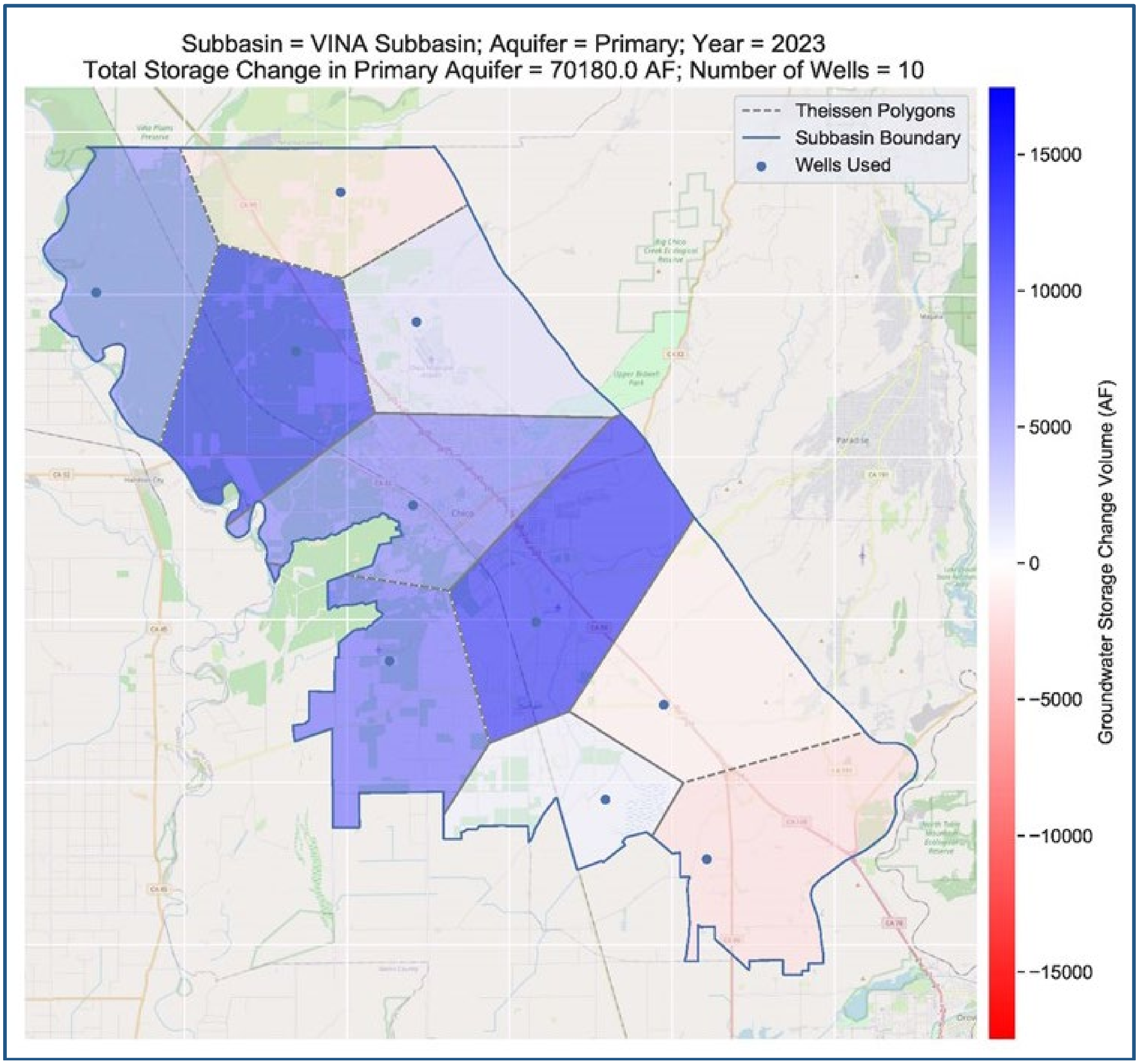


Figure 4-2. Change in Groundwater Storage from Spring 2022 to Spring 2023 in the Primary Aquifer

## 4.3 Uncertainty in Groundwater Storage Estimates

The uncertainty associated with the change in groundwater storage estimates depends in part on the underlying uncertainty of the groundwater level data, the representative area (i.e., Thiessen polygon), and the calibrated storage coefficient parameter used to calculate the change in groundwater storage. As described in **Section 4.2**, a calibration process was conducted to roughly align the estimated change in groundwater storage based on observed groundwater levels to the estimated change in groundwater storage outputs from the BBGM. Thus, the uncertainty of the estimated change in groundwater storage reported in **Table 4-1** and **Figure 4-2** is estimated to be approximately equal to the uncertainty of the estimated change in groundwater storage outputs from the BBGM (typically 20-30% for integrated hydrologic models).

# 5 GSP IMPLEMENTATION PROGRESS – §356.2(B)(5)(C)

## 5.1 Main Activities of Water Year 2023

The main activities and updates since the previous Annual Report are as follows:

- The GSAs completed the WY 2023 Annual Report and other critical tasks. Butte County agreed to serve as the fund administrator for the GSA.
- The Vina GSA adopted a property-related service fee to fund the operations of the GSA and implementation costs to comply with SGMA.
- The GSAs coordinated a proposal seeking funding through DWR's SGM Grant Program. Coordination efforts included planning and refinement of PMAs, evaluating and ranking PMAs, and preparing and submitting the grant application. The grant application was submitted in December 2022, and a final award list was released by DWR in September 2023. The application was fully funded; results are summarized below in **Table 5-3**.
- An airborne electromagnetic (AEM) survey by DWR took place in the summer of 2022. The data collected provides a better understanding of aquifer characteristics and will help support future efforts to refine the current hydrogeologic conceptual model. Data is available at: **https://data.cnra.ca.gov/dataset/aem**.
- All sustainability indicators (SIs) are in compliance with their MTs (see summary **Table 5-1**).
- Progress has been made on 10 PMAs since the last annual report (**Tables 5-3** and **5-4**).

Several other actions continue in the Subbasin to fulfill the requirements of the GSP. These include:

- Monitoring and recording groundwater levels and groundwater quality.
- Maintaining and updating the DMS with newly collected data.
- Annual reporting of Subbasin conditions and submission to DWR as required by SGMA.
- Ongoing intra- and inter-basin coordination.

The GSP was approved in July of 2023, and DWR proposed three recommended corrective actions that will enhance the GSP:

1. Providing additional information on historical and current groundwater quality conditions in the Subbasin,
2. Providing more information about the sustainable management criteria for land subsidence and,
3. Filling data gaps, collecting additional monitoring data, and implementing the current strategy to manage depletions of interconnected surface water.

In 2023, the GSAs prepared to implement future projects to address recommended corrective actions, which will be largely funded by the SGM Implementation Grant Program. The ongoing implementation of

PMAs, outlined in this section (**Section 5**), aims to address these corrective actions effectively by the periodic evaluation of the GSP, which is due in January 2027.

## 5.2 Progress Toward Achieving Interim Milestones

Observed conditions for all SIs are in compliance with their MTs (see summary **Table 5-1**). An MT is a quantitative value that represents the groundwater conditions at an RMS that, when exceeded individually or in combination with MTs at other monitoring sites, may cause a UR in the basin per DWR's definition. If groundwater levels are lower than the value of the MO for that site they are moving in the direction of the MT. On the contrary, for the groundwater quality SMC, as the value of the electrical conductivity concentration increases from the MO established for that site, they are moving in the direction of the MT. Seawater Intrusion is not an applicable SI.

Groundwater elevations have remained near or above their MOs and above their corresponding MTs and, therefore, remained within the Subbasin's margin of operational flexibility established for each RMS well. Therefore, none of the RMS wells fell below the MT for two consecutive non-dry years, hence avoiding undesirable results as defined in the GSP.

Overall, groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestones for groundwater levels at each of the RMS wells. Groundwater elevations are all above the MTs throughout the Subbasin, with elevations mostly near or slightly higher than those observed in recent years (**Appendix A**). This positive trend is influenced by the wet conditions experienced in WY 2023, which resulted in increased surface water supplies and reduced groundwater extractions. **Table 5-2** shows measurements from WY 2023 for spring seasonal highs and fall seasonal lows, along with measurable objectives and minimum thresholds. It also compares the WY 2023 measurements to those from WY 2022 and to the measurable objectives. Spring and Fall 2023 groundwater elevations were all at or above the established MOs (**Table 5-2**).

**Table 5-1. Sustainability Indicator Summary**

| 2023 Status | Undesirable Result Identification | Measurable Objective (MO) Definition | Minimum Threshold (MT) Definition |
|---|---|---|---|
| **Chronic Lowering of Groundwater Levels** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | When 2 RMS wells within a management area reach their MT for two consecutive non-dry year types. | The groundwater level is based on the groundwater trend line for the dry periods (over the period of record) of observed short-term climatic cycles extended to 2030 for each RMS well. | An elevation protective of sustainably constructed domestic wells (based on their well depths for wells drilled since 1980) within the polygon associated with the RMS well |
| **Reduction of Groundwater Storage** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. |
| **Degraded Water Quality** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with electrical conductivity levels above their MTs in 2023, a non-dry year. The first year of monitoring, 2022, was a dry year. | When 2 RMS wells exceed their MT for two consecutive non-dry years. | Measured electrical conductivity less than or equal to the recommended Secondary Maximum Contaminant Level (900 µS/cm) based on State Secondary Drinking Water Standards at each well. | The upper limit of the Secondary Maximum Contaminant Level for electrical conductivity (1,600 µS/cm) is based on the State Secondary Drinking Water Standards. |
| **Land Subsidence** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. |

**Table 5-1. Sustainability Indicator Summary**

| 2023 Status | Undesirable Result Identification | Measurable Objective (MO) Definition | Minimum Threshold (MT) Definition |
|---|---|---|---|
| **Depletion of Interconnected Surface Water** | | | |
| **No indication of undesirable results**<br>There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT. | Uses groundwater levels as a proxy. GSP identifies data gap and describes "Interconnected Surface Water Sustainable Management Criteria Framework." | Groundwater levels are a proxy, per SGMA regulations. | Groundwater levels are a proxy, per SGMA regulations. |

***Notes:***

*Salinity is the primary water quality constituent of concern, which is evaluated by measuring electrical conductivity (EC)*

*MO = Measurable Objective, MT = Minimum/Maximum Threshold, RMS = representative monitoring site, µS/cm = micro siemens per centimeter*

**Table 5-2. Measurable Objectives, Minimum Thresholds, and Seasonal Groundwater Elevations of Representative Monitoring Site Wells**

| State Well Number[1] | Groundwater Elevation (feet above mean sea level) | | | | Spring 2023 vs. MO (ft) | Fall 2023 vs. MO (ft) | Spring 2023 vs. Spring 2022 (ft) (seasonal high) | Fall 2023 vs. Fall 2022 (ft) (seasonal low) |
|---|---|---|---|---|---|---|---|---|
| | 2023 Measurements | | MO | MT | | | | |
| | Spring (seasonal high) | Fall (seasonal low) | | | | | | |
| **Vina North Management Area** | | | | | | | | |
| 23N02W**25C001M** | 140.8 | 134.1 | 130 | 50 | 10.8 | 4.1 | 5.2 | 2.9 |
| 23N01W**10E001M** | 158.68 | -- | 136 | 80 | 22.7 | -- | 6.5 | -- |
| 23N01E**07H001M** | 163.6 | 161.7 | 136 | 72 | 27.6 | 25.7 | -0.3 | 0.5 |
| 22N01W**05M001M** | 138.13 | -- | 115 | 31 | 23.1 | -- | 9 | -- |
| 23N01W**36P001M** | 128.95 | 115.2 | 108 | 45 | 21 | 7.2 | 11.1 | 7.3 |
| 23N01E**33A001M** | 137.74 | 133.59 | 125 | 72 | 12.7 | 8.6 | 1.3 | 1.4 |
| **Vina Chico Management Area** | | | | | | | | |
| **CWSCH01b** | 117 | 110 | 106 | 85 | 11 | 4 | 7 | 7 |
| **CWSCH02** | 118 | 111 | 105 | 85 | 13 | 6 | 6 | 3 |
| **CWSCH03** | 120 | 115 | 108 | 85 | 12 | 7 | 3 | 5 |
| **CWSCH07** | 109 | 102 | 95 | 85 | 14 | 7 | 8 | 2 |
| 22N01E**28J003M** | 128.39 | 122.36 | 111 | 85 | 17.4 | 11.4 | 5.2 | 7.7 |
| **Vina South Management Area** | | | | | | | | |
| 21N01E**21C001M** | 94.44 | 86.94 | 64 | 10 | 30.4 | 22.9 | 7.5 | 6.9 |
| 21N02E**18C003M** | 167.26 | 160.7 | 130 | 65 | 37.3 | 30.7 | 13.6 | 10.1 |
| 20N01E**10C002M** | -- | -- | 92 | 20 | -- | -- | -- | -- |
| 20N02E**24C001M** | 102.67 | 91.42 | 77 | 18 | 25.7 | 14.4 | 1.7 | 0 |
| 20N02E**09L001M** | 111.73 | 105.83 | 91 | 30 | 20.7 | 14.8 | 0.9 | 4.6 |
| 21N02E**26E005M** | 111.04 | 104.33 | 95 | 36 | 16 | 9.3 | 1.1 | 0.2 |

[1] *The portion of the State Well Number shown in bold underlined text is the RMS ID.*

*MO = measurable objective, MT = minimum/maximum threshold, -- = Indicates missing or questionable measurements.*

### 5.2.1 Chronic Lowering of Groundwater Levels and Reduction in Groundwater Storage SMC

The reduction in groundwater storage SMC utilizes the chronic lowering of groundwater levels SMC as a proxy (**Table 5-1**). Thus, groundwater conditions related to storage and chronic lowering of groundwater levels are discussed together. Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestones and avoid undesirable results for groundwater levels at each of the RMS wells. In Spring 2023, all groundwater elevations were above the established MOs and MTs (as indicated in **Table 5-2**). Higher water levels were observed in Spring 2023 compared to Spring 2022 due to wet conditions, which has helped to increase recharge and offset extraction, bolstering groundwater storage in the Subbasin.

### *5.2.2 Degraded Water Quality SMC*

The degraded water quality MT and MO are summarized in **Table 5-1**. Salinity is the main constituent of concern in the Subbasin and is evaluated by electrical conductivity (EC). Salinity (i.e., EC) is measured at RMS wells throughout the Subbasin, and data was collected by the GSA in WY 2023. There were no wells above the MT in 2023. A summary of groundwater quality monitoring data is available in **Appendix F**. Groundwater conditions are on track to avoid undesirable water quality results.

### *5.2.3 Land Subsidence SMC*

The land subsidence SMC utilizes the chronic lowering of groundwater levels SMC as a proxy (**Table 5-1)**. Interferometric Synthetic Aperture Radar (InSAR) data provided by DWR (DWR, 2024) was analyzed from October 2022 to October 2023 to track annual changes. Subsidence estimates based on InSAR methodology were reviewed and compared to continuous GPS measurements (Towill, 2023). The accuracy report found that a one-year measurement error, reported as a root-mean-squared error (RMSE), was approximately 0.025 feet. **Figure 5-1** shows maximum vertical displacement between 0.5 feet and -0.04 feet occurred within the subbasin from October 2022 to October 2023. Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestones and avoid undesirable results for land subsidence. Conditions indicate that there has not been any inelastic land subsidence during the reporting period.

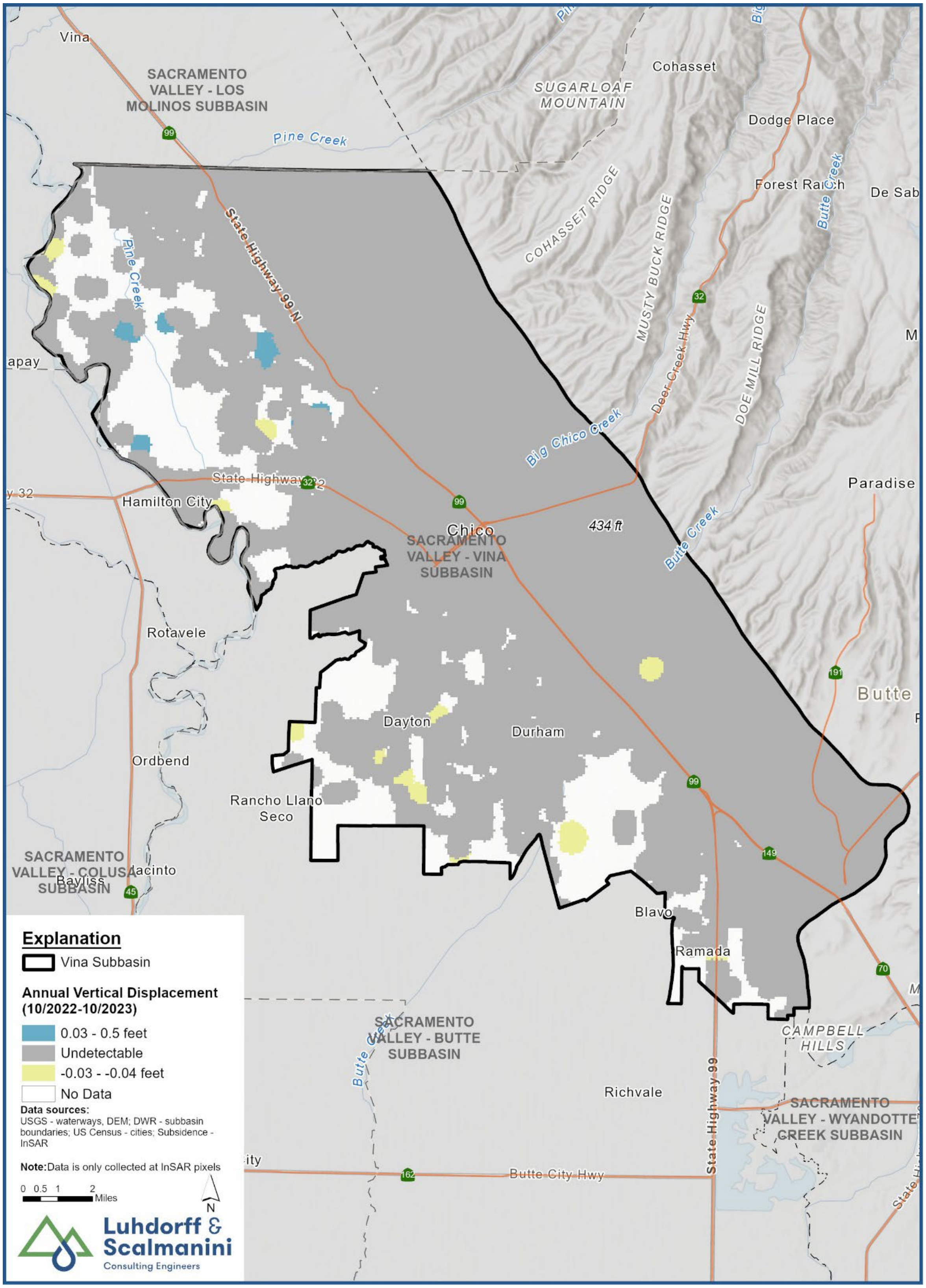


Figure 5-1. Vertical Displacement in Ground Surface from 10/2022 to 10/2023

### *5.2.4 Depletion of Interconnected Surface Water SMC*

The depletion of interconnected surface utilizes the chronic lowering of groundwater levels SMC as a proxy (**Table 5-1**). Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestones and to avoid undesirable results for groundwater levels at each of the RMS wells.

## 5.3 Progress Toward PMA Implementation

The following sections summarize the GSAs' progress towards implementing PMAs that were developed to manage groundwater conditions in the Subbasin and achieve the groundwater sustainability objectives described in the GSP. Projects as outlined in the GSP are provided below and summarized in **Table 5-3**. Updates on the status of management actions are described below and summarized in **Table 5-4**.

**Table 5-3. Summary of Project Implementation Status**

| GSP Section Reference | Project (Proponent) | Current Status | Notable Progress Since Last Annual Report |
|---|---|---|---|
| 5.2.3.2 | Residential Water Conservation Project | Ongoing | Conservation programs saved ~400 acre-feet per year of water |
| 5.2.3.3 | Scoping for Flood Managed Aquifer Recharge (FloodMAR)/Surface Water Supply and Recharge | Funded | DWR SGM Grant Program application submitted in December 2022 was funded for the planning phase of the project. |
| 5.2.4.3 | Streamflow Augmentation Projects | Funded | DWR SGM Grant Program application submitted in December 2022 was funded, for the feasibility phase. |
| 5.2.4.4 | Community Monitoring Program | Funded | DWR SGM Grant Program application submitted in December 2022 was funded to expand monitoring. |
| 5.2.4.6 | Rangeland Management and Water Retention Project | Funded | Grant awarded in December 2023 |
| 5.2.4.7 | Removal of Invasive Species | Funded | Grant awarded in Fall 2023 |
| 5.2.4.8 | Surface Water Supply and Recharge Project | Funded | DWR SGM Grant Program application submitted in December 2022 was funded, in the feasibility/initial design phase |
| 5.2.5.1 | Extend Orchard Replacement Program | Funded | DWR SGM Grant Program application submitted in December 2022 was funded to support the program design and implement pilot project. |

**Table 5-4. Summary of Management Actions**

| GSP Section Reference | Management Action | Current Status | Notable Progress Since Last Annual Report |
|---|---|---|---|
| 5.3.1 | General Plan Updates | In Progress | The 2040 general plan update was adopted in March 2023. |
| 5.3.2 | Domestic Well Mitigation | Funded | Not in effect. Grant funds were secured to conduct a domestic well survey to address the data gap identified in the GSP. |

## 5.4 GSP Project Implementation Progress

### *5.4.1 Residential Water Conservation Project (GSP Section 5.2.3.2)*

Notable progress on this project since 2022 has included continued implementation of water conservation practices by municipal/industrial water providers such as the California Water Service Company in Chico (Cal Water-Chico), which is reliant on groundwater, in accordance with their 2020 Urban Water Management Plan. In WY 2023, urban pumping declined by about 400 AF compared to WY 2022, resulting in a benefit to the Subbasin.

### *5.4.2 Scoping for Flood Managed Aquifer Recharge (FloodMAR) / Surface Water Supply and Recharge (GSP Section 5.2.3.3)*

Notable progress on this project since 2022 has included the Vina GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program for two efforts that directly support this project: a Groundwater Recharge Feasibility Analysis and Site Evaluation, which will focus on the initial scoping and identification of specific recharge opportunities in the Subbasin and an analysis of the legal implications associated with actively managing recharge water in the Subbasin. This project was fully funded.

### *5.4.3 Streamflow Augmentation Project (GSP Section 5.2.4.3)*

Notable progress on this project since 2022 has included the submittal of two grant applications. The first was an application to the Wildlife Conservation Board's Stream Flow Enhancement Project Program by the Friends of Butte Creek to fund the Butte Creek Integrated Stream Flow Enhancement Planning Project to increase flows in Butte Creek to benefit both irrigators, threatened fish species and recharge of the Vina Subbasin aquifer.

The second was the Vina GSA's December 2022 application to pursue funds through DWR's SGM Grant Program for the Agricultural Surface Water Supplies Feasibility Analysis project, which is expected to support the overarching goals of the Streamflow Augmentation Projects through efforts aimed at increasing surface water supplies to meet both agricultural and urban water demands by identifying and refining, in preparation for future implementation efforts, the two most promising agricultural surface water supply projects in the Subbasin. This project was fully funded.

### *5.4.4 Community Monitoring Program (GSP Section 5.2.4.4)*

Notable progress on this project since 2022 has included the Vina GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program for a Community Monitoring and Domestic Well Survey project with a focus on monitoring groundwater level conditions in domestic wells. This project was fully funded.

### *5.4.5 Rangeland Management and Water Retention Project (GSP Section 5.2.4.6)*

Notable progress on this project since 2022 has included Big Chico Creek Ecological Reserve (BCCER) securing grant funds through the Wildlife Conservation Board to gather baseline information and develop a long-term master management plan for all 7,835 acres of the Reserve's properties. This includes baseline surveys and biological and cultural resource surveys to inform management recommendations and provide data for long-term comparative analysis of land management actions. It also includes management planning on CSE Reserve properties and associated CEQA compliance that includes:

- Hydrologic resource data collection—surface/spring water flow and quality & ground water monitoring and,
- Botanical surveys and mapping—species composition, diversity, vegetation alliances, and locations.

### *5.4.6 Removal of Invasive Species (GSP Section 5.2.4.7)*

Notable progress on this project since 2022 has included BCCER securing grant funds through the US Fish and Wildlife Service to manage invasive species on approximately nine acres around two springs in the areas of interest. BCCER is currently pursuing funds through Point Blue to install wildlife-friendly spring enclosure fencing on approximately 10 acres around two springs and to conduct approximately 20 acres of invasive species management and blue oak restoration.

### *5.4.7 Surface Water Supply and Recharge Project (GSP Section 5.2.4.8)*

Notable progress on this project since 2022 has included progress on four projects that seek to increase the surface water supply to the Subbasin through:

- direct application of surface water to crops,
- application of surface water and/or flood water to land surface (i.e., existing orchards) for recharge purposes and
- application of surface water and/or flood water to recharge basins and/or recharge ponds or other applications.

First, funding for the Rock and Sand Creek Flood Mitigation Project has been secured by the Rock Creek Reclamation District through the Integrated Regional Water Management Program Proposition 1 program. A feasibility study was completed in 2023 to consider solutions to flooding, public safety, and recharge of the aquifer, focusing on potential floodwater detentions on Sand Creek.

Notable progress on the other three projects (the Lindo Channel Surface Water Recharge Implementation project, the Agricultural Surface Water Supplies Feasibility Analysis project, and the Groundwater Recharge Feasibility Analysis and Site Evaluation project) has included the Vina GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program to support the projects. Funding has been secured for these projects.

### *5.4.8 Extend Orchard Replacement Program (GSP Section 5.2.5.1)*

Notable progress on this project since 2022 included the Vina GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program for the Extend Orchard Replacement Program, which seeks to reduce overall groundwater pumping demand from the Vina Subbasin through increased temporary land fallowing. This is intended to be a demand-side intervention aimed at extending the fallowing period an additional year during orchard replacement, which may then reduce the average annual evapotranspiration of groundwater. This project has been funded for program design and implementation of a pilot program.

## 5.5 GSP Management Action Implementation Progress

Below are Management Action Updates and their progress in implementation since the last Annual Report.

### *5.5.1 General Plan Updates (GSP Section 5.3.1)*

Notable progress on this project since 2022 has included updates from Butte County (Vina GSA Management Committee members) on the 2040 General Plan Update in cooperation with the Butte County Water Commission and Department of Development Services to the Water Resources Element and applicable General Plan Goals, Policies, and Actions. These updates ensured that important components of the GSP are supported by the 2040 General Plan, available at: https://www.buttecounty.net/DocumentCenter/View/7749/Butte_County_General_Plan_2040_Compiled_Appendix_Optimized---Updated?bidId=.

### *5.5.2 Domestic Well Mitigation (GSP Section 5.3.2)*

Notable progress on this project since 2022 has included the Vina GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program for a Community Monitoring and Domestic Well Survey project that would support the goals of this management action by creating a registry of domestic wells in the region. The Domestic Well Survey project has been funded.

# 6 Conclusions

The Vina Subbasin GSAs adopted and submitted the GSP to DWR in January 2022 and continue to actively work on sustainable groundwater management in the Subbasin directly and with partners. As presented in **Section 5** of this report, recent progress made on activities applicable to the GSA demonstrates the commitment of the GSA to implement the GSP by allocating the necessary time and resources to achieve long-term sustainable management of the groundwater resources in the Vina Subbasin.

# 7 References

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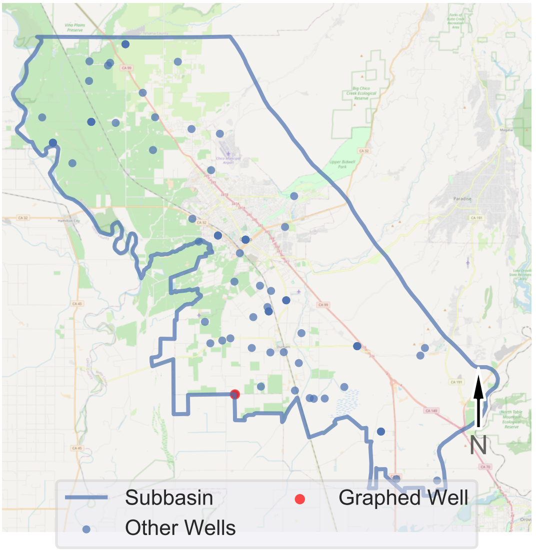
Water Year 2023 Annual Report

# Appendix A

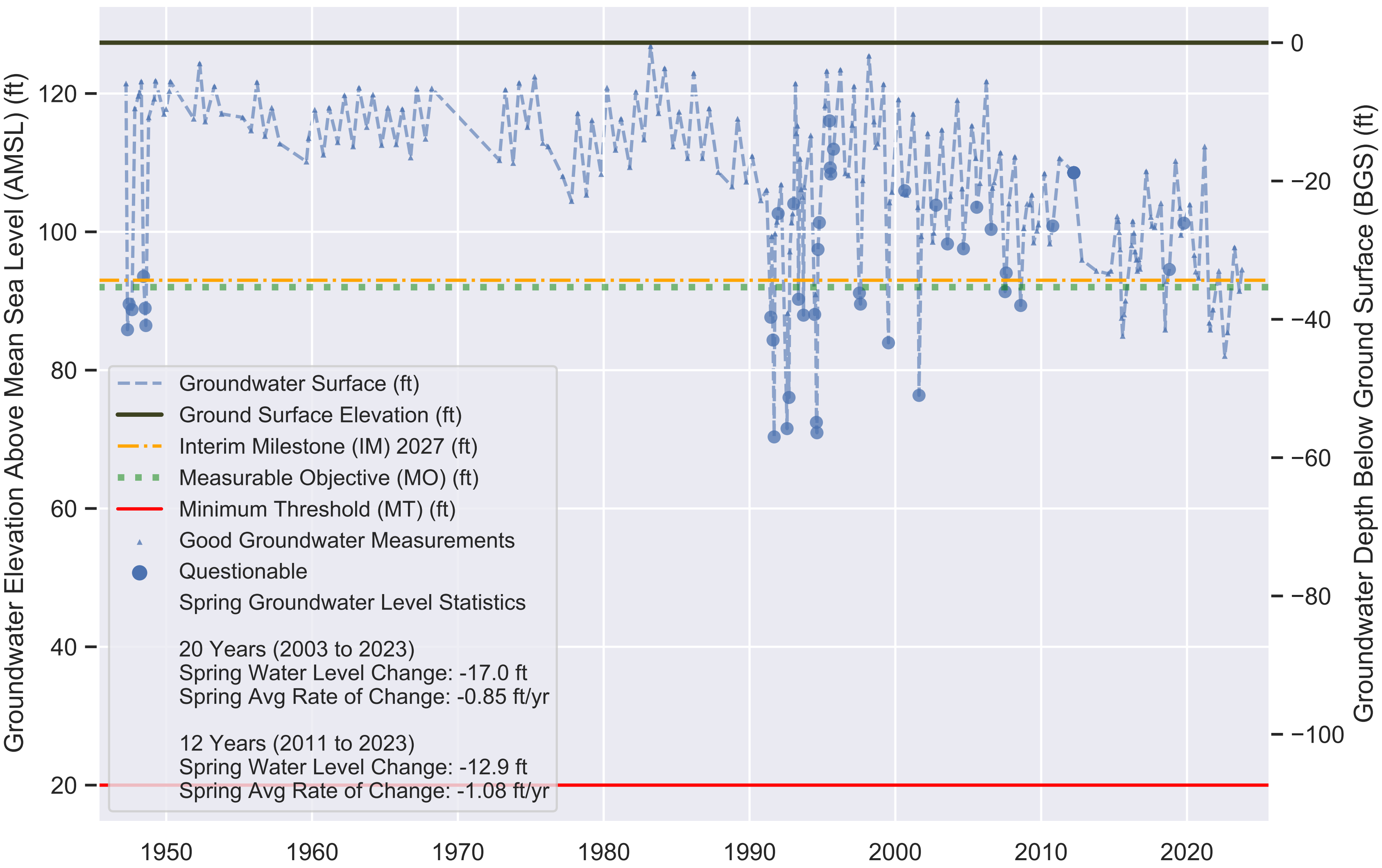
## Characteristics and Hydrographs of Representative Monitoring Site (RMS) Wells and Regional Groundwater Contour Maps

# VINA Subbasin - State Well Number (SWN): 20N01E10C002M

Well Location Map



Perforation 1: 20.0 - 120.0 ft BGS



Spring Groundwater Level Statistics

20 Years (2003 to 2023)
Spring Water Level Change: -17.0 ft
Spring Avg Rate of Change: -0.85 ft/yr

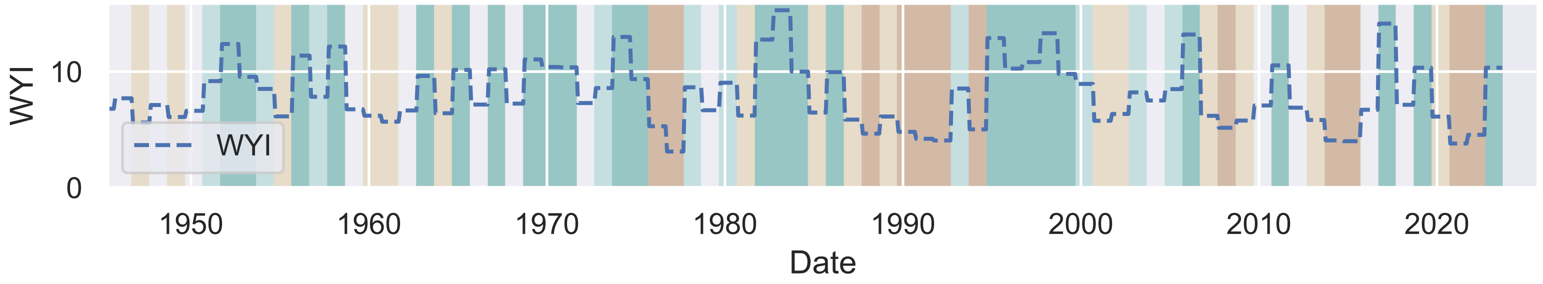
12 Years (2011 to 2023)
Spring Water Level Change: -12.9 ft
Spring Avg Rate of Change: -1.08 ft/yr

Sustainable Management Criteria:

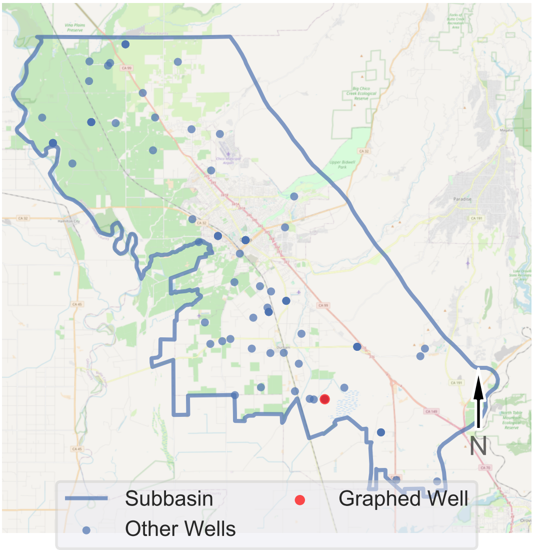
IM (2027) = 93.0 ft AMSL
MO = 92.0 ft AMSL
MT = 20.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

■ Wet (W)
■ Above Normal (AN)
■ Below Normal (BN)
■ Dry (D)
■ Critical (C)



# VINA Subbasin - State Well Number (SWN): 20N02E09L001M

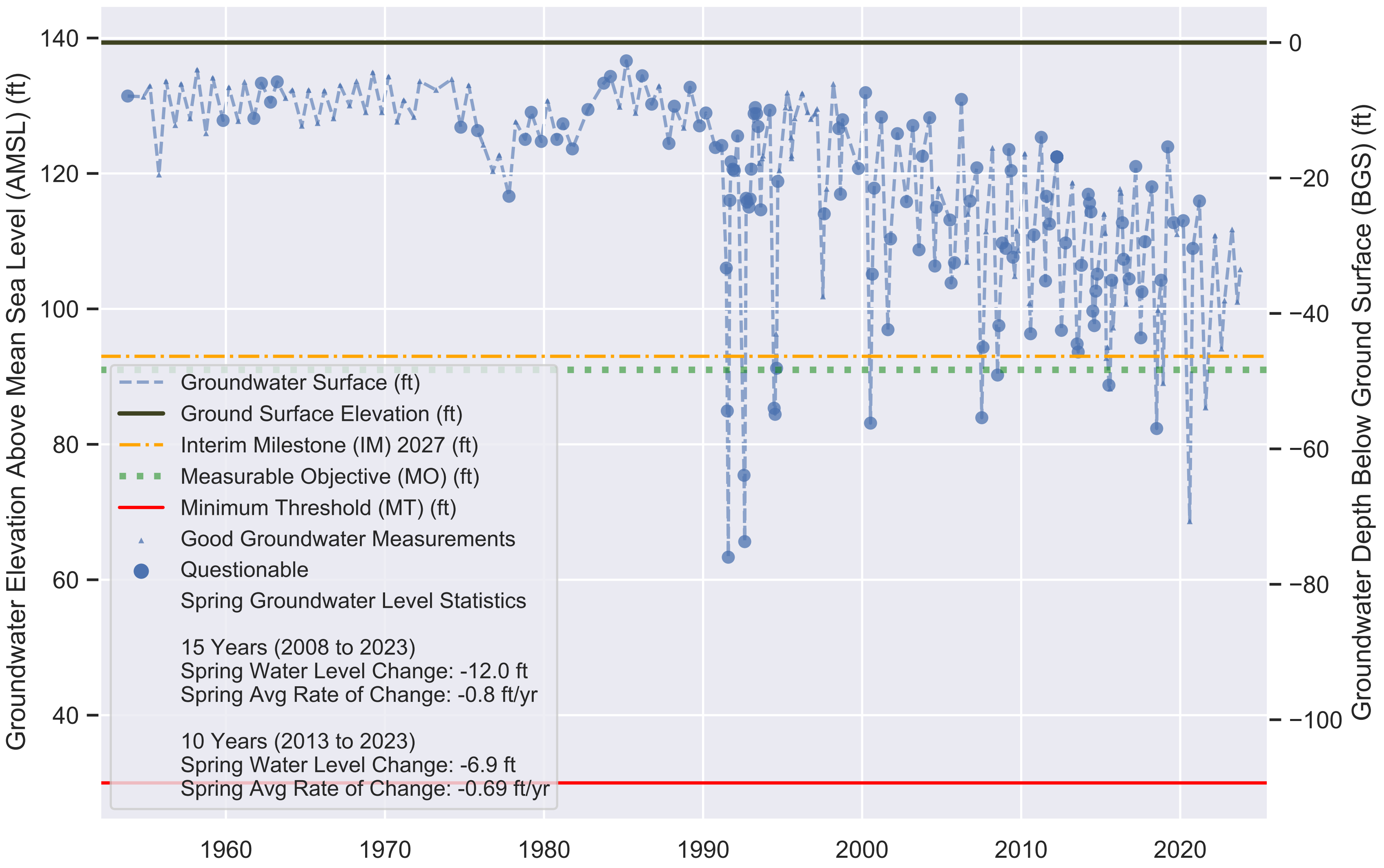

Well Location Map

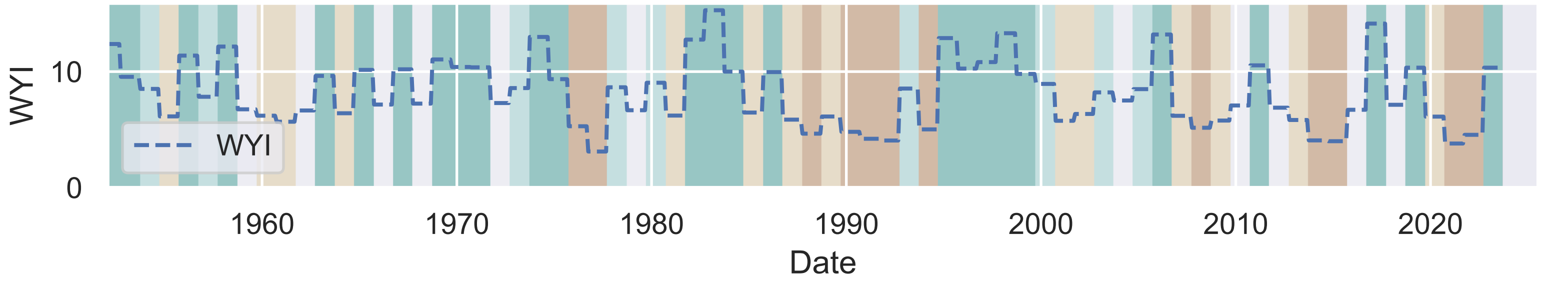
Sustainable Management Criteria:

IM (2027) = 93.0 ft AMSL
MO = 91.0 ft AMSL
MT = 30.0 ft AMSL

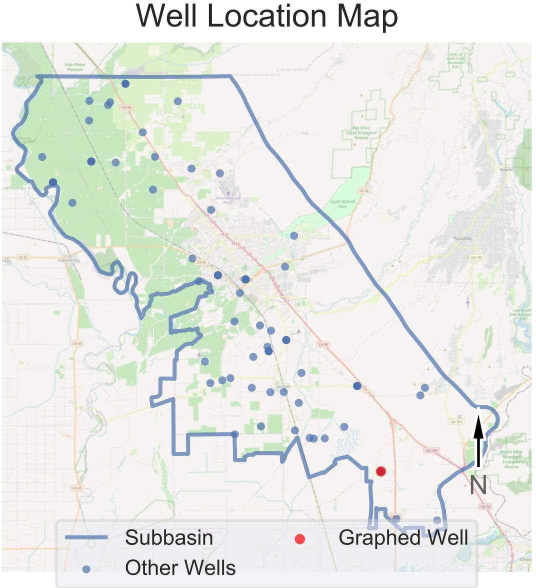
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟩 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)


Perforation 1: 460.0 - 710.0 ft BGS



# VINA Subbasin - State Well Number (SWN): 20N02E24C001M

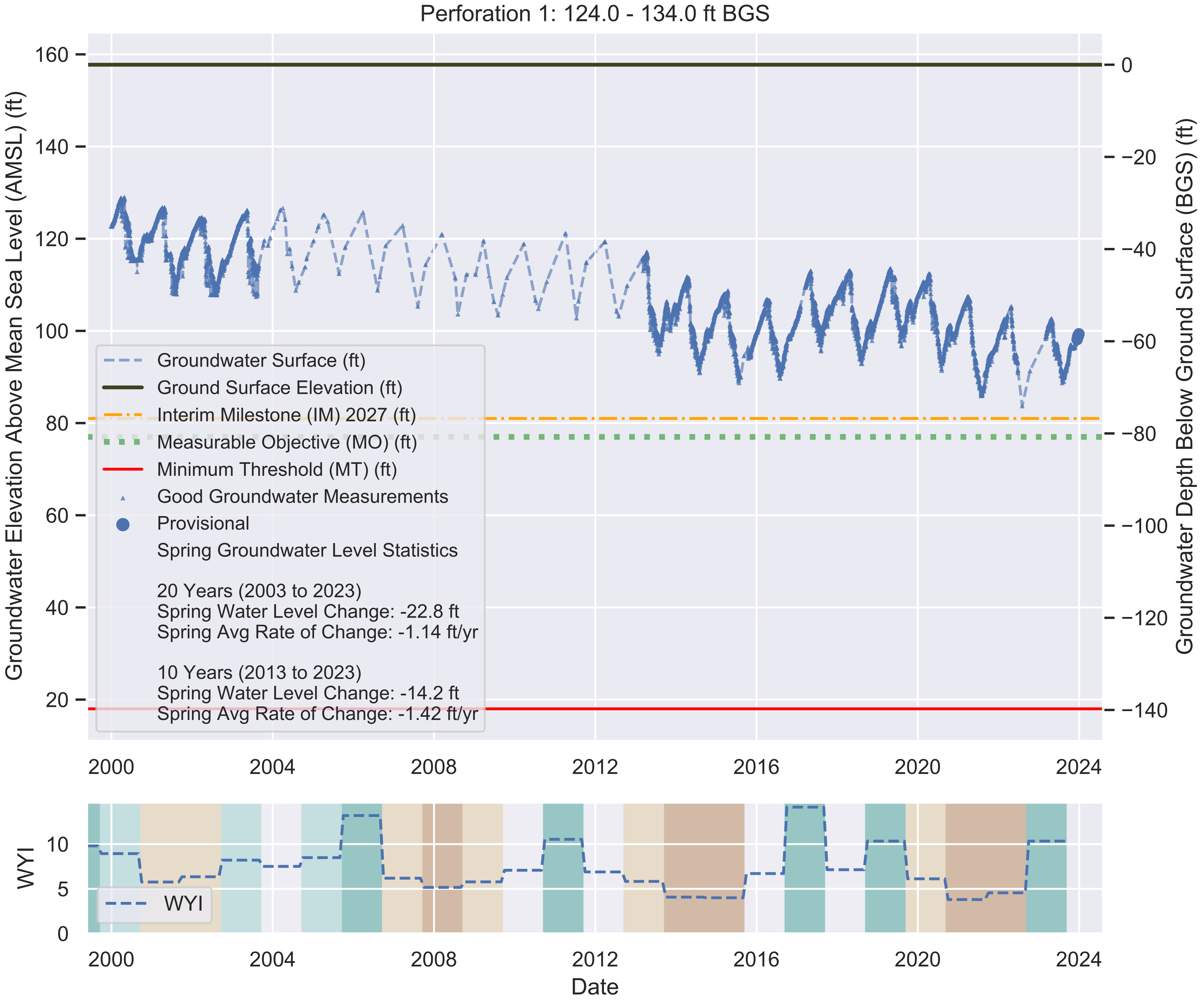

Well Location Map

Sustainable Management Criteria:

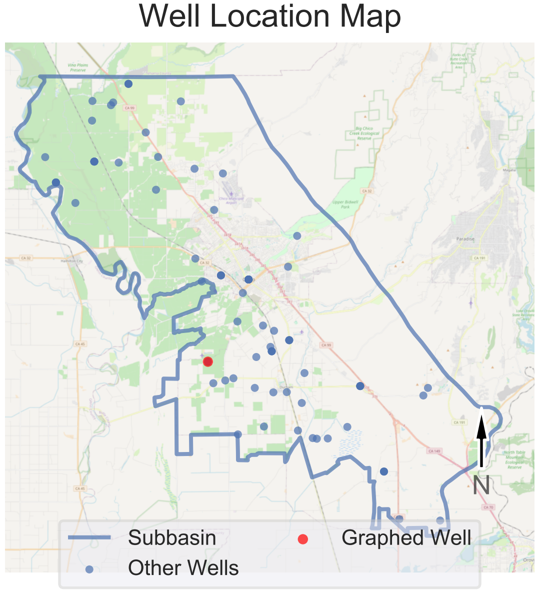
IM (2027) = 81.0 ft AMSL
MO = 77.0 ft AMSL
MT = 18.0 ft AMSL

Sacramento Valley Water Year
Index (WYI) shown on lower right.
Meaning of colors defined below.

- 🟩 Wet (W)
- 🟩 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)


Perforation 1: 124.0 - 134.0 ft BGS

# VINA Subbasin - State Well Number (SWN): 21N01E21C001M

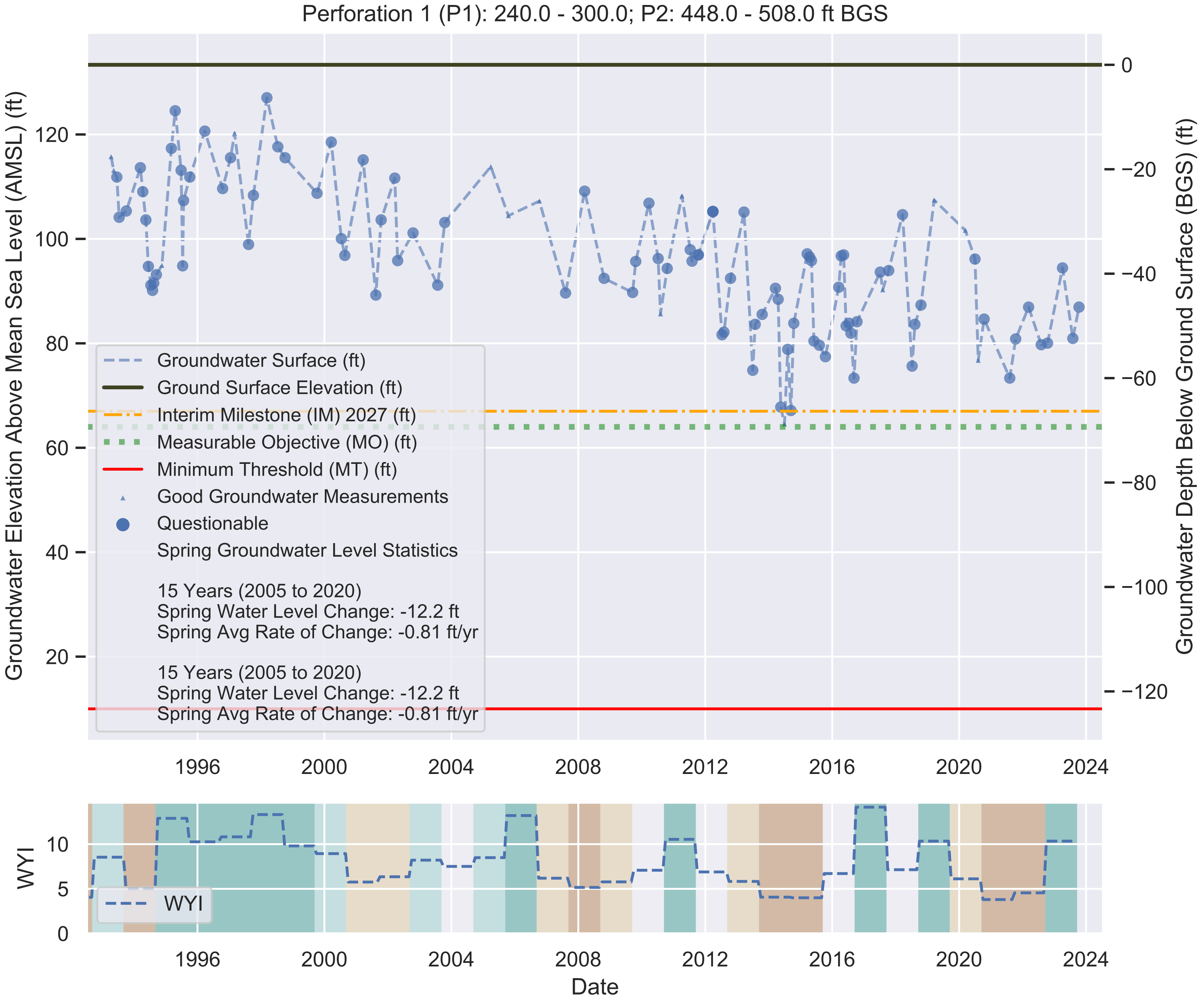


Sustainable Management Criteria:

IM (2027) = 67.0 ft AMSL
MO = 64.0 ft AMSL
MT = 10.0 ft AMSL

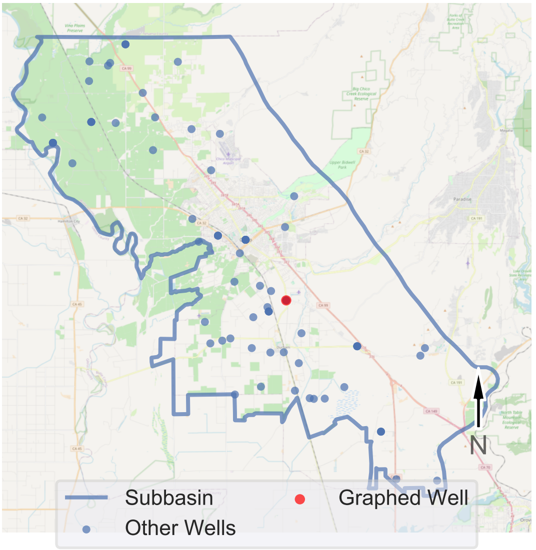
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟦 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)



# VINA Subbasin - State Well Number (SWN): 21N02E18C003M

Well Location Map



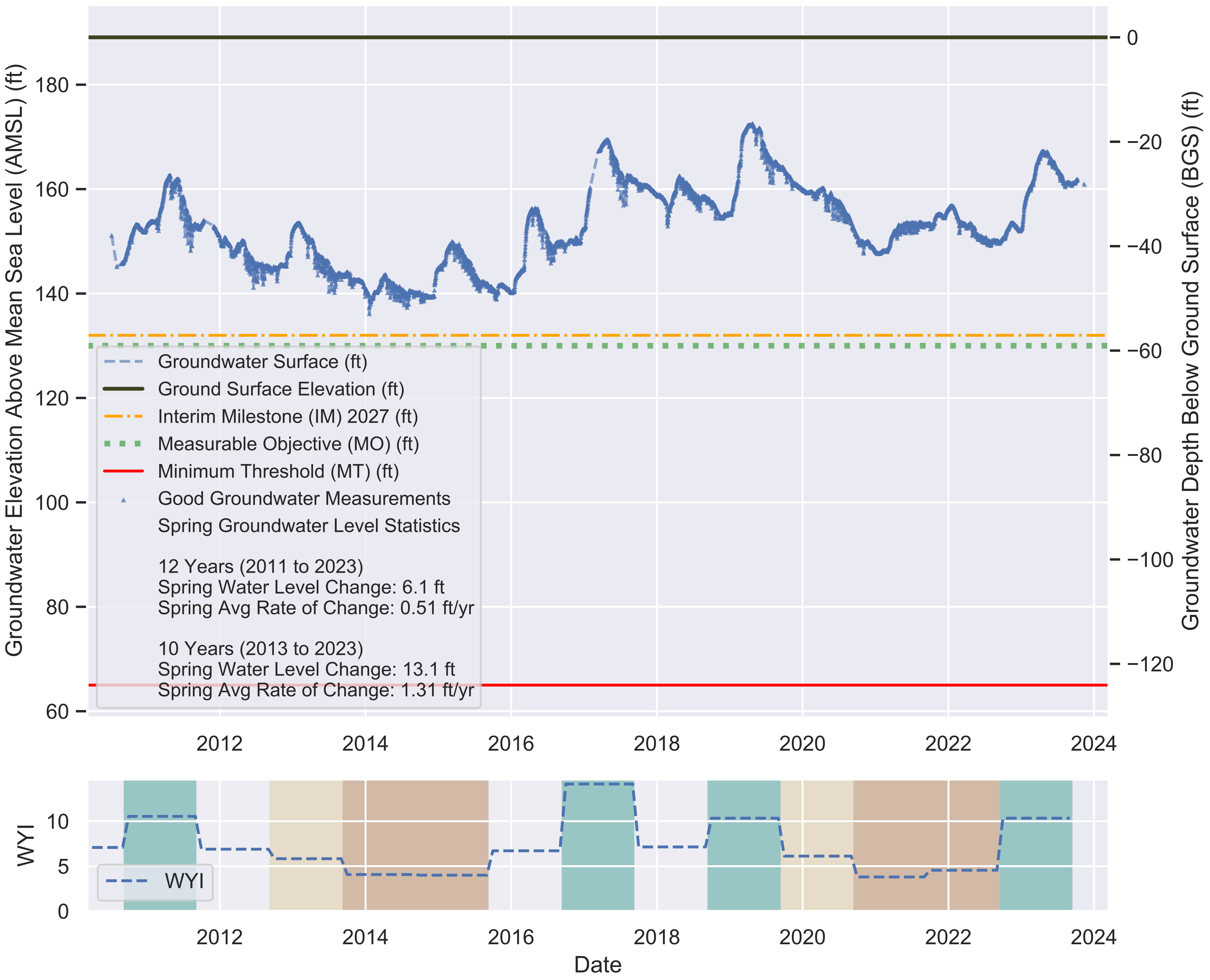
Sustainable Management Criteria:

IM (2027) = 132.0 ft AMSL
MO = 130.0 ft AMSL
MT = 65.0 ft AMSL

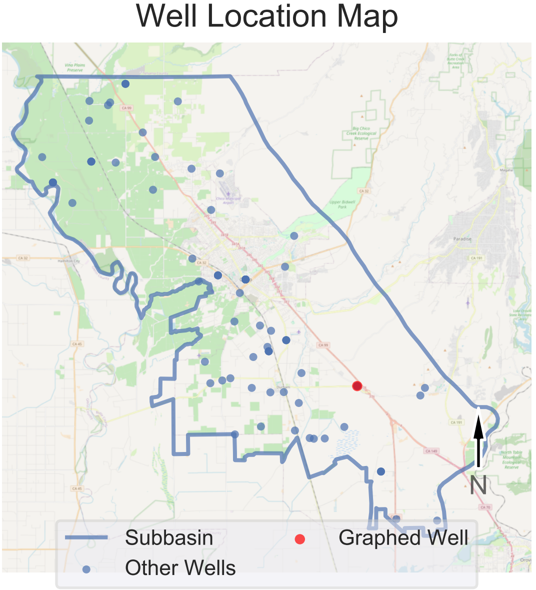
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟩 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)

Perforation 1 (P1): 130.0 - 140.0; P2: 160.0 - 170.0; P3: 190.0 - 200.0 ft BGS



# VINA Subbasin - State Well Number (SWN): 21N02E26E005M

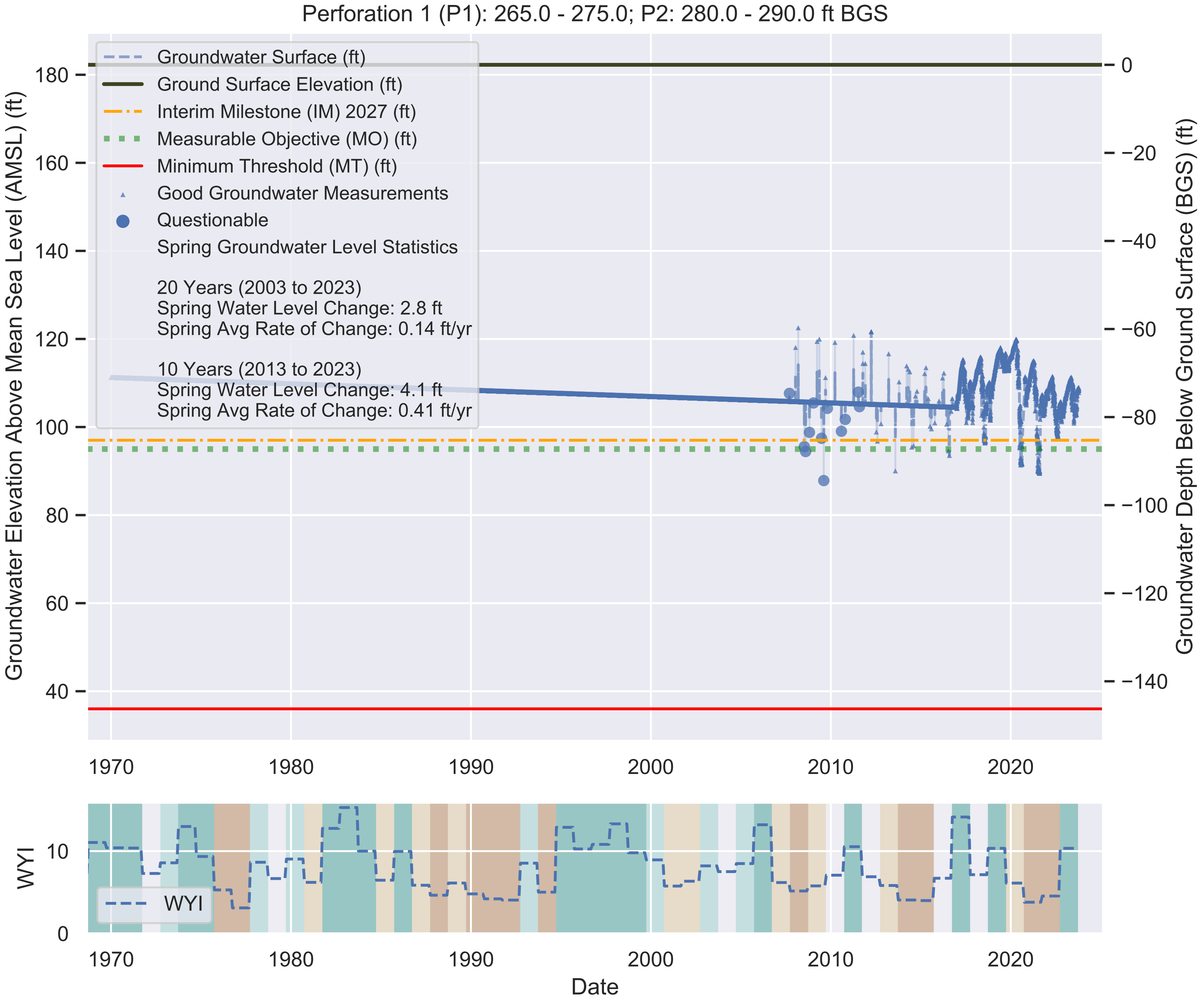


Sustainable Management Criteria:

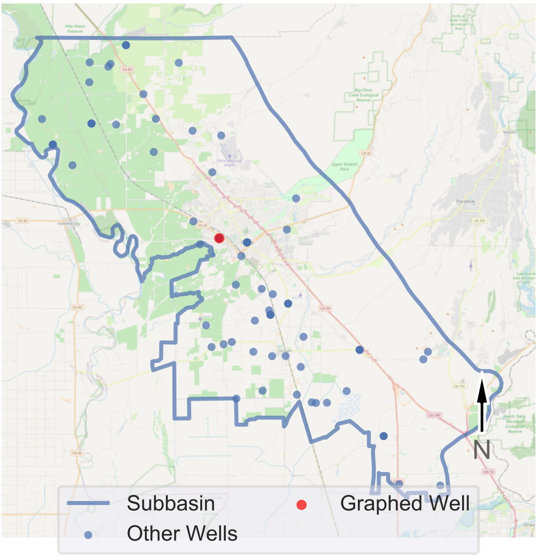
IM (2027) = 97.0 ft AMSL
MO = 95.0 ft AMSL
MT = 36.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- ▨ Above Normal (AN)
- ☐ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)



# VINA Subbasin - State Well Number (SWN): 22N01E28J003M

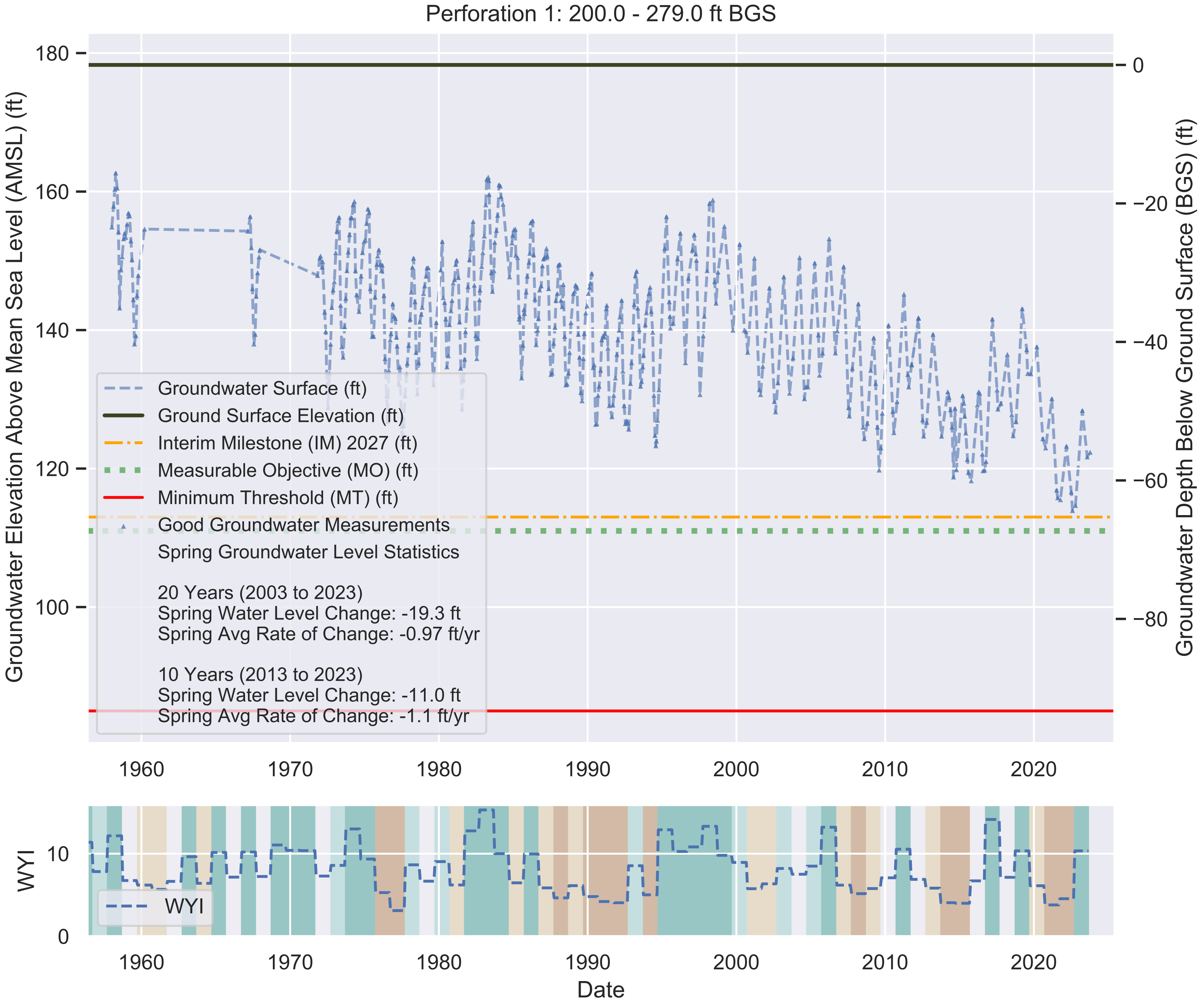

Well Location Map

Sustainable Management Criteria:

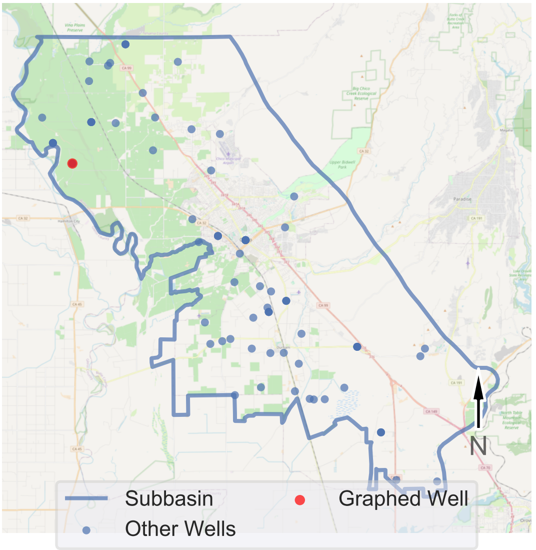
IM (2027) = 113.0 ft AMSL
MO = 111.0 ft AMSL
MT = 85.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟩 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)


Perforation 1: 200.0 - 279.0 ft BGS

# VINA Subbasin - State Well Number (SWN): 22N01W05M001M

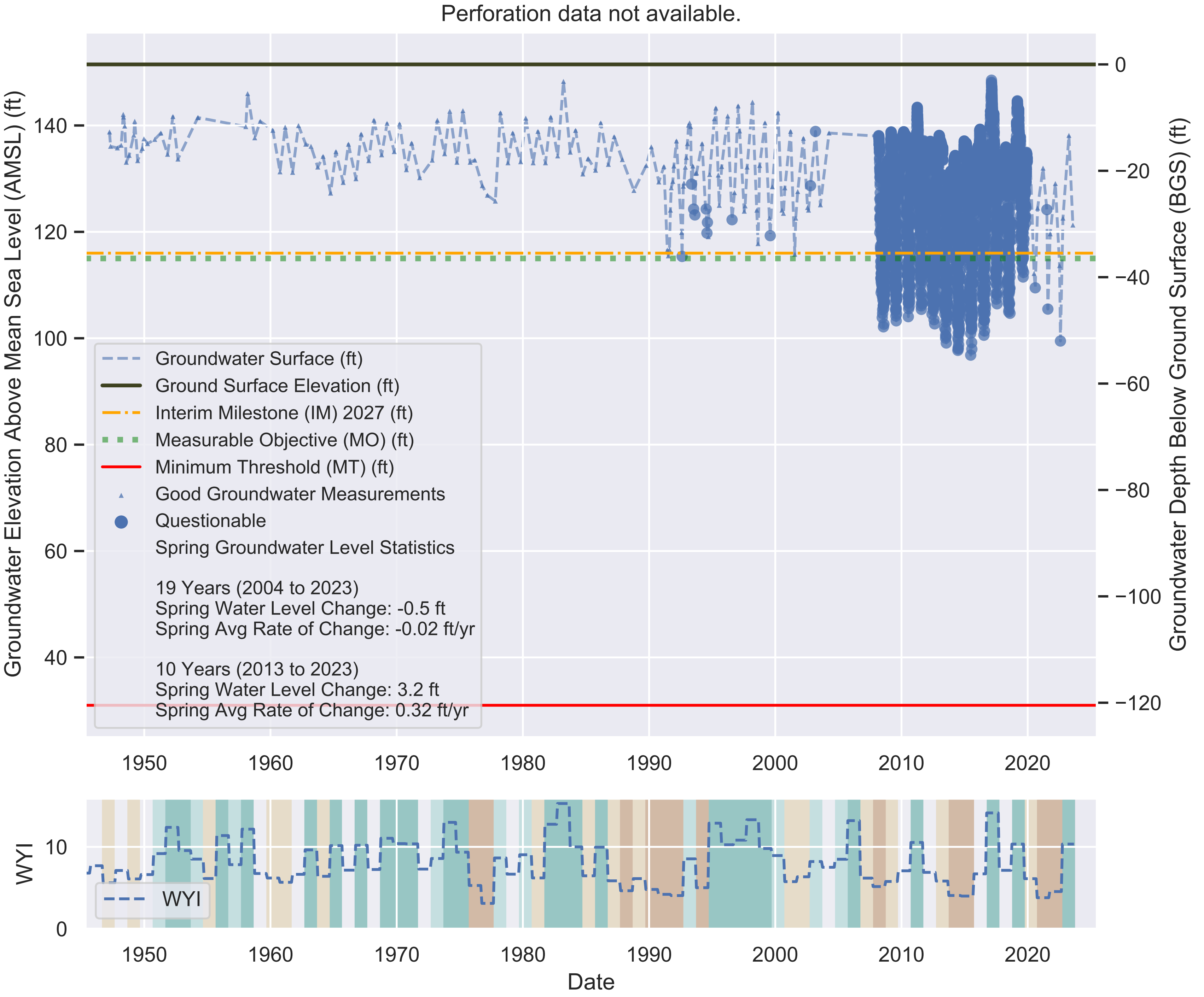

Well Location Map

Sustainable Management Criteria:

IM (2027) = 116.0 ft AMSL
MO = 115.0 ft AMSL
MT = 31.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

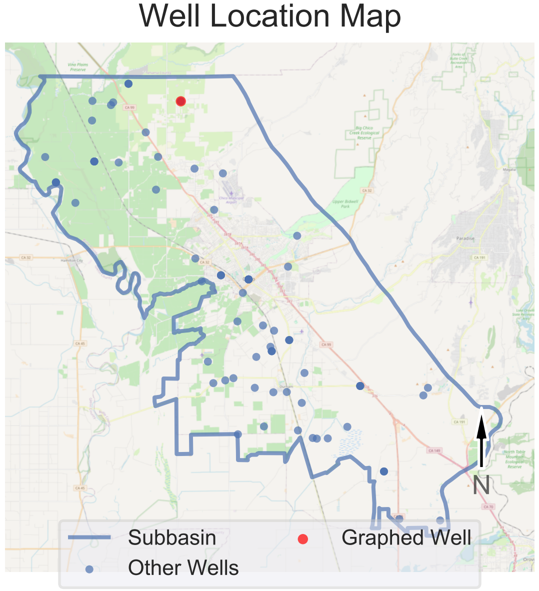
- 🟩 Wet (W)
- 🟩 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)


Perforation data not available.

19 Years (2004 to 2023)
Spring Water Level Change: -0.5 ft
Spring Avg Rate of Change: -0.02 ft/yr

10 Years (2013 to 2023)
Spring Water Level Change: 3.2 ft
Spring Avg Rate of Change: 0.32 ft/yr

# VINA Subbasin - State Well Number (SWN): 23N01E07H001M

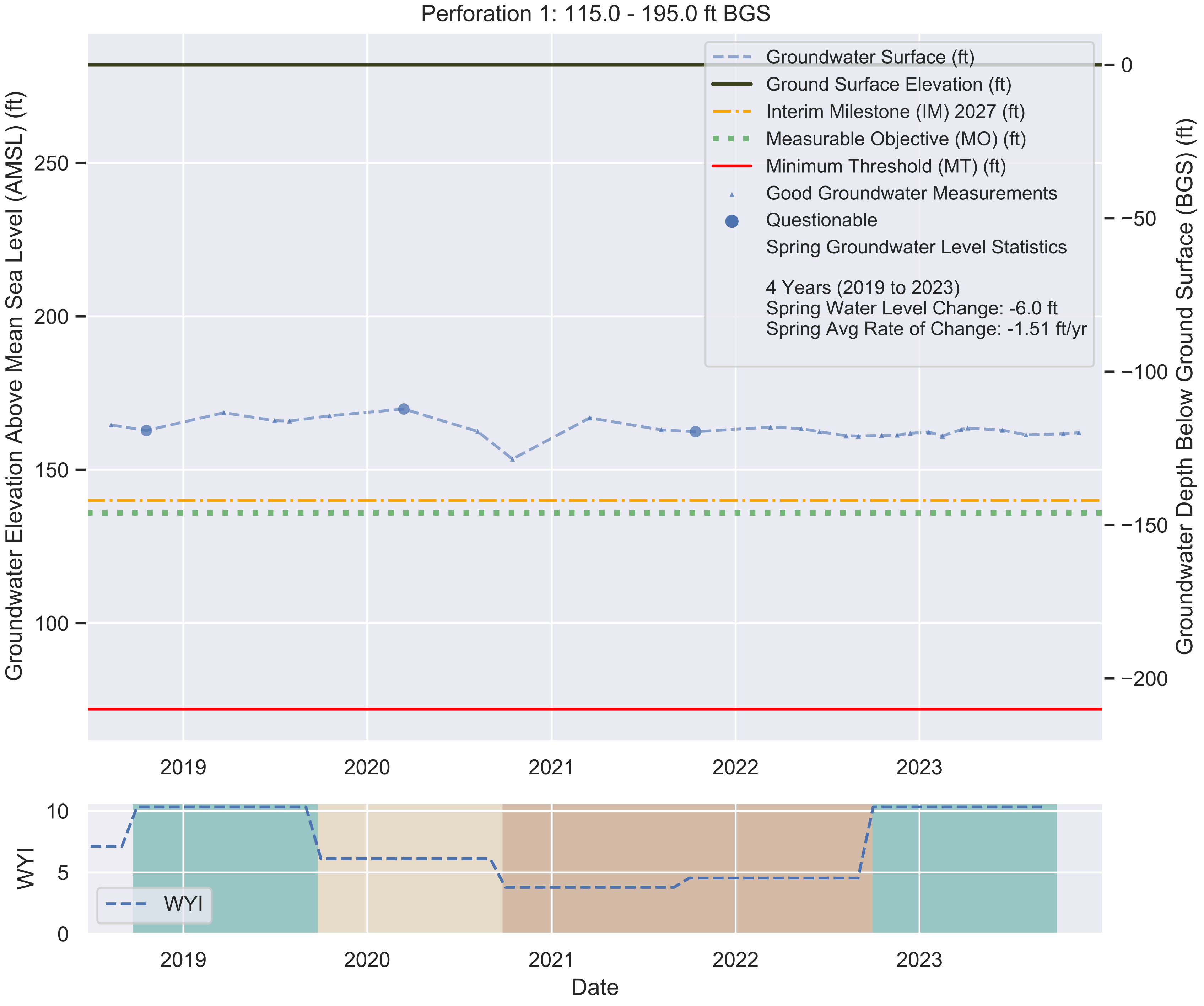


Sustainable Management Criteria:

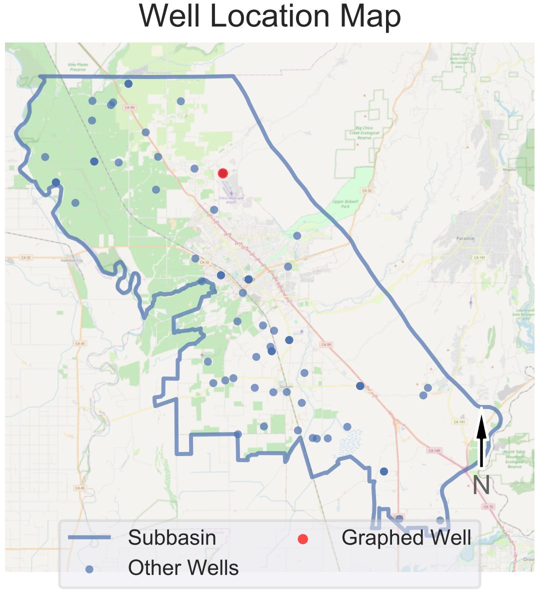
IM (2027) = 140.0 ft AMSL
MO = 136.0 ft AMSL
MT = 72.0 ft AMSL

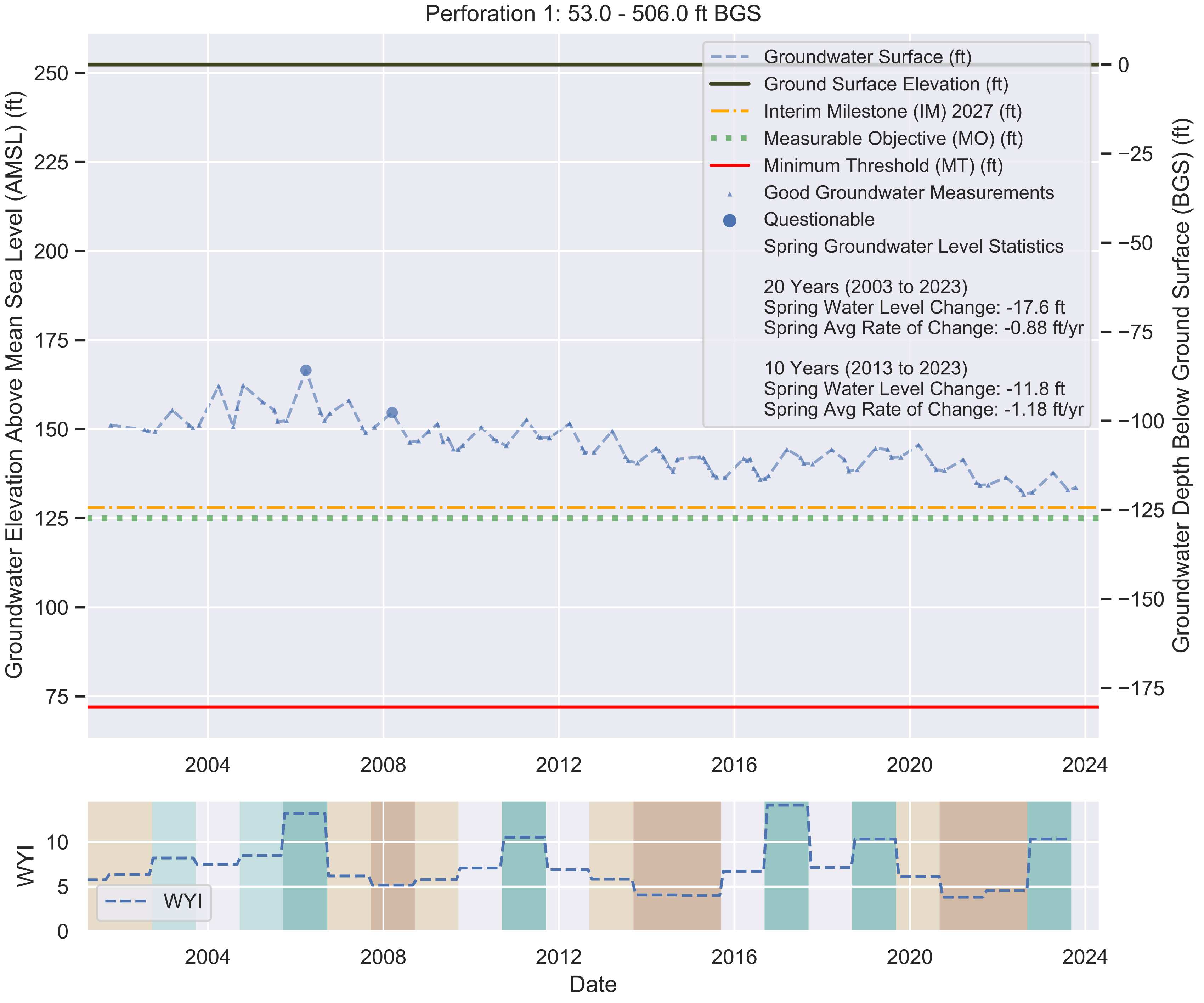
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- ▨ Wet (W)
- ▨ Above Normal (AN)
- ▨ Below Normal (BN)
- ▨ Dry (D)
- ▨ Critical (C)



# VINA Subbasin - State Well Number (SWN): 23N01E33A001M





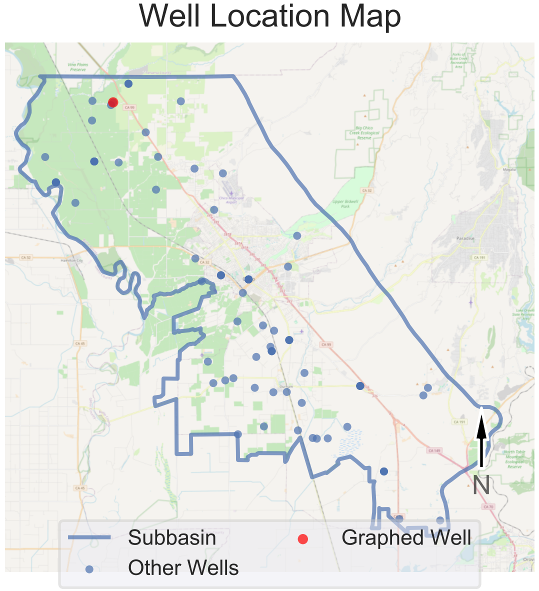
Sustainable Management Criteria:

IM (2027) = 128.0 ft AMSL
MO = 125.0 ft AMSL
MT = 72.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟦 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)

# VINA Subbasin - State Well Number (SWN): 23N01W10E001M

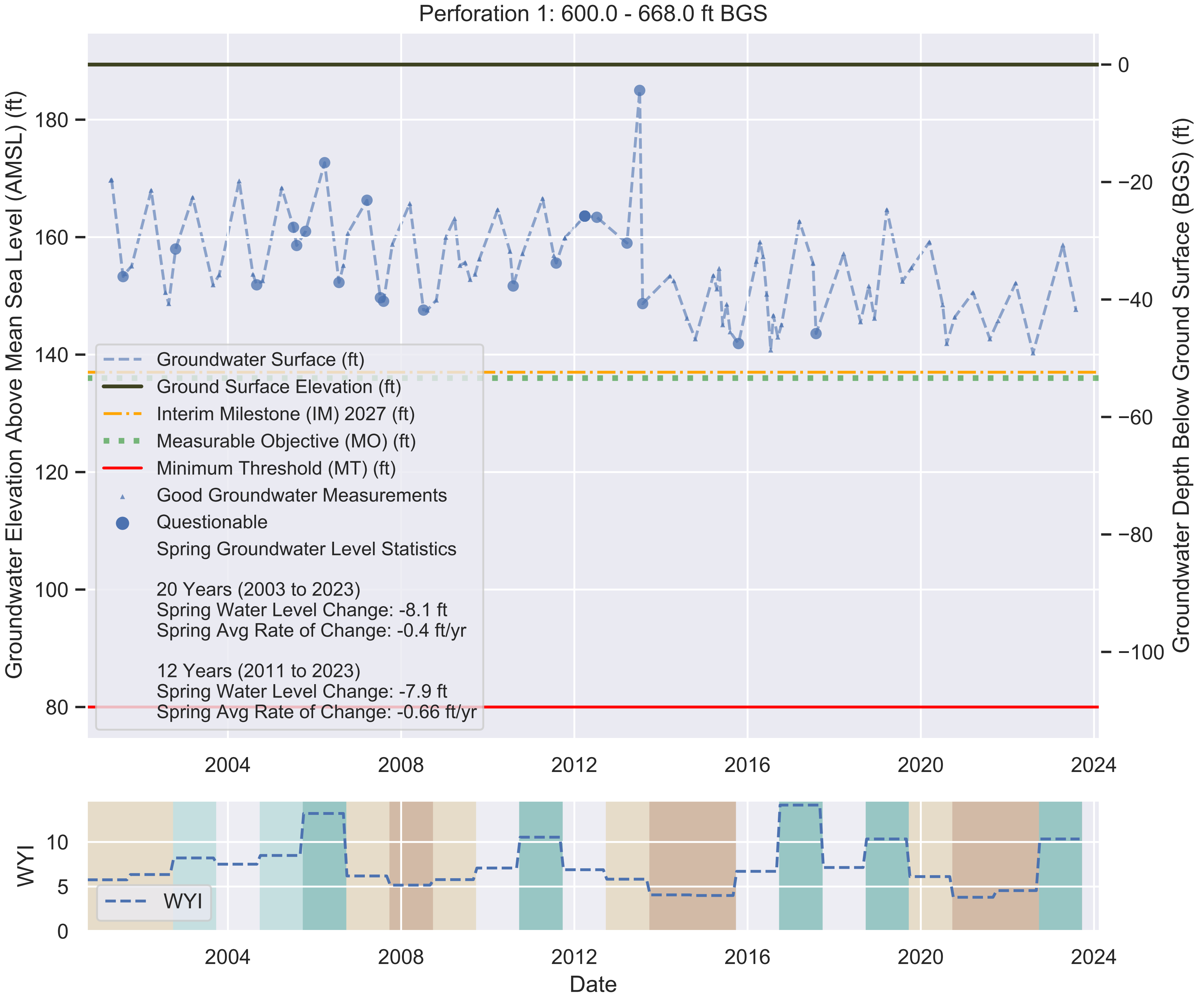


Sustainable Management Criteria:

IM (2027) = 137.0 ft AMSL
MO = 136.0 ft AMSL
MT = 80.0 ft AMSL

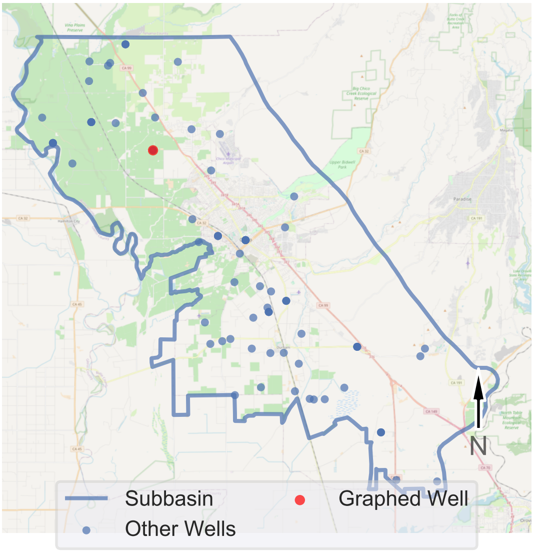
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- Wet (W)
- Above Normal (AN)
- Below Normal (BN)
- Dry (D)
- Critical (C)



# VINA Subbasin - State Well Number (SWN): 23N01W36P001M

Well Location Map

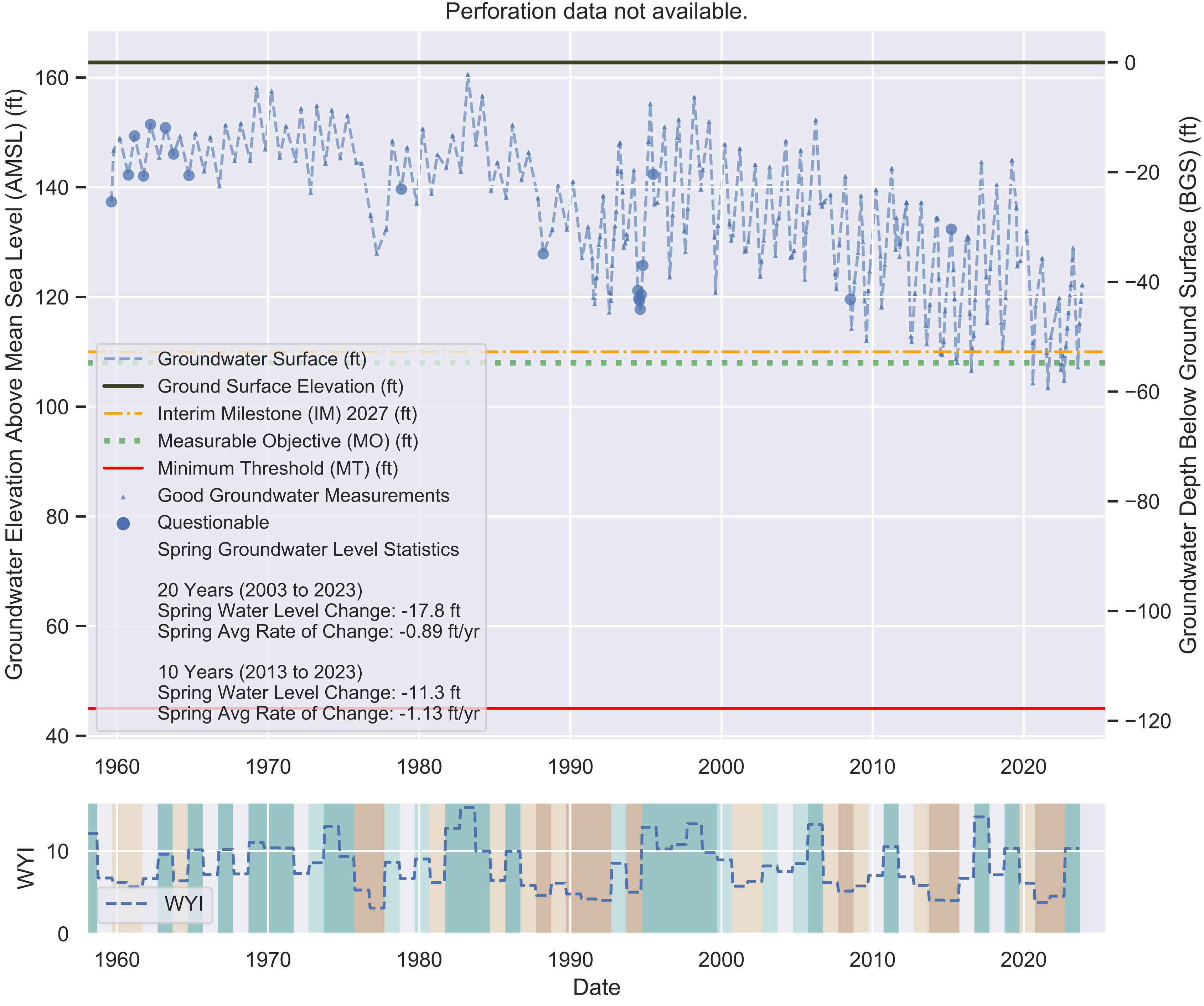


Sustainable Management Criteria:

IM (2027) = 110.0 ft AMSL
MO = 108.0 ft AMSL
MT = 45.0 ft AMSL

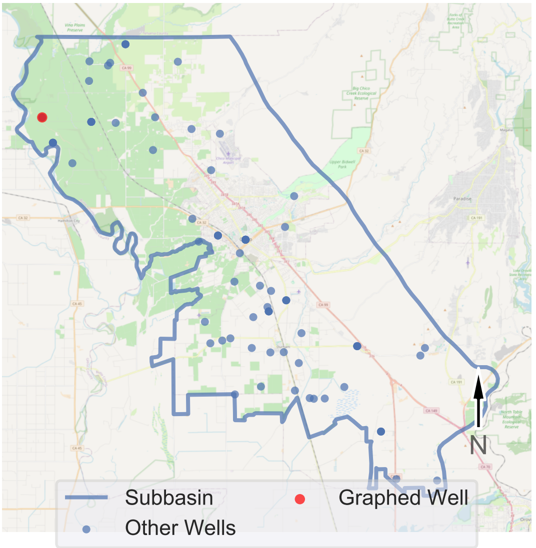
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- ▨ Wet (W)
- ▨ Above Normal (AN)
- ▨ Below Normal (BN)
- ▨ Dry (D)
- ▨ Critical (C)



## VINA Subbasin - State Well Number (SWN): 23N02W25C001M

Well Location Map



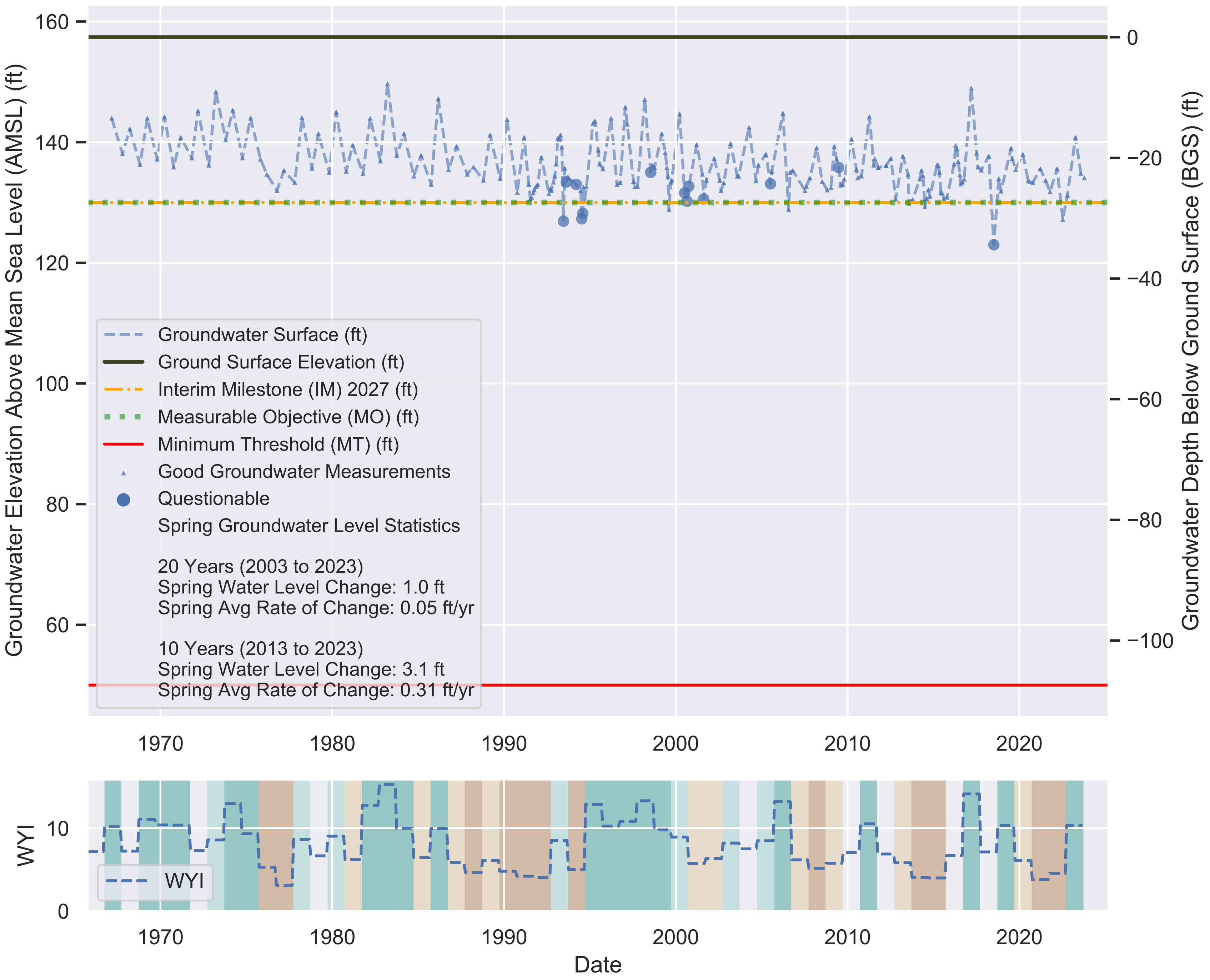
Sustainable Management Criteria:

IM (2027) = 130.0 ft AMSL
MO = 130.0 ft AMSL
MT = 50.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

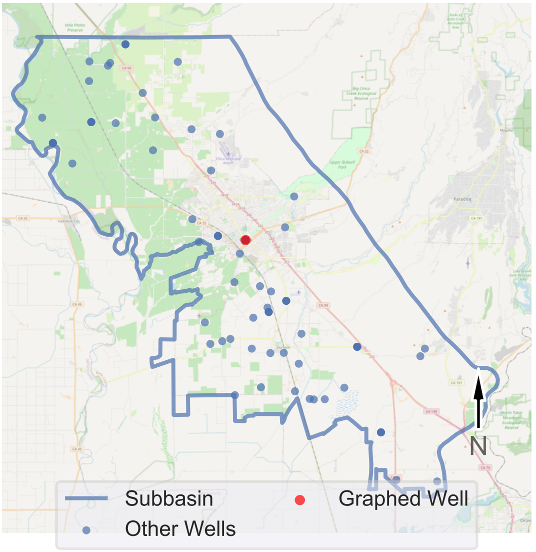
- 🟩 Wet (W)
- 🟦 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)

Perforation data not available.



# VINA Subbasin - State Well Number (SWN): CWSCH01b

Well Location Map



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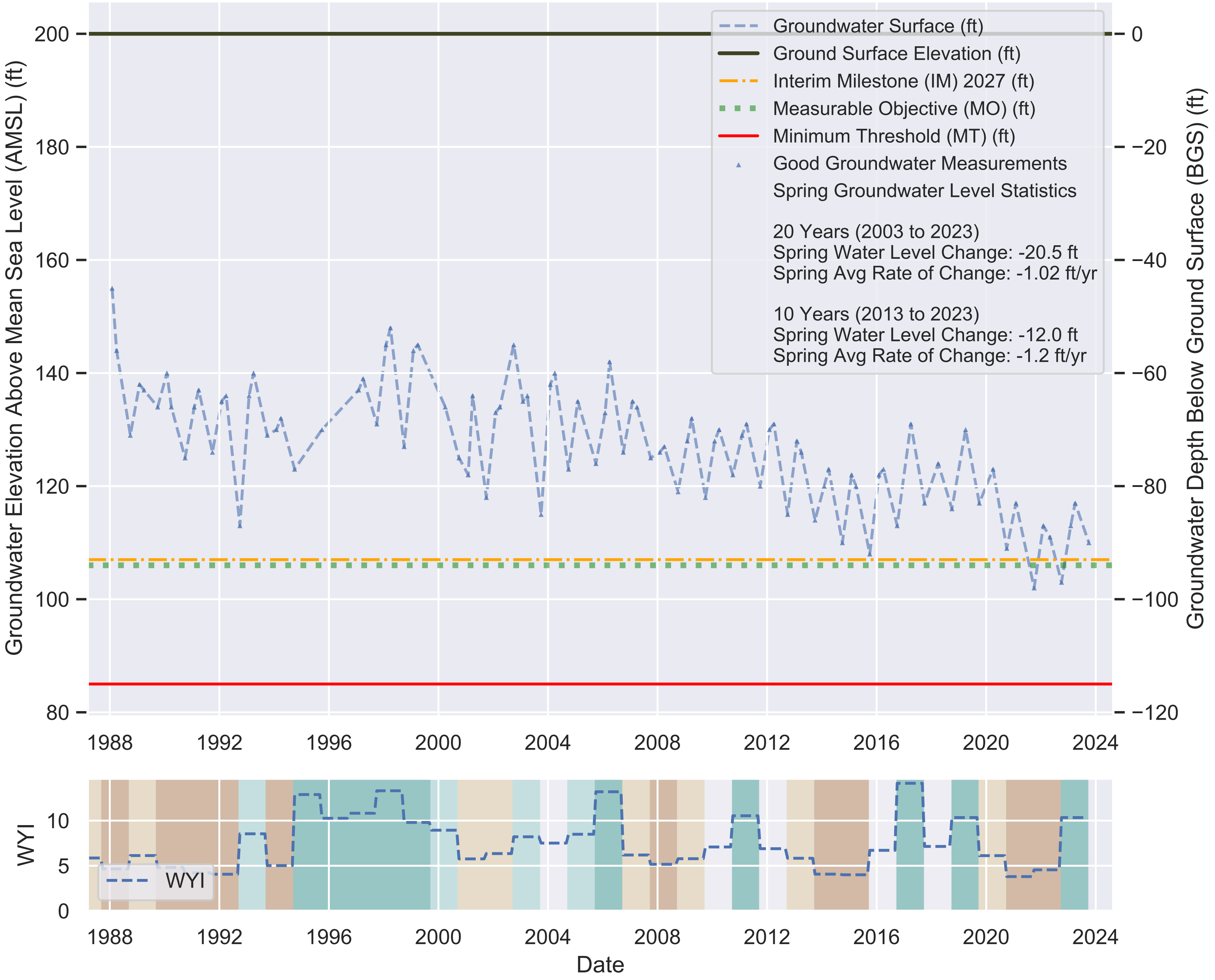


Sustainable Management Criteria:

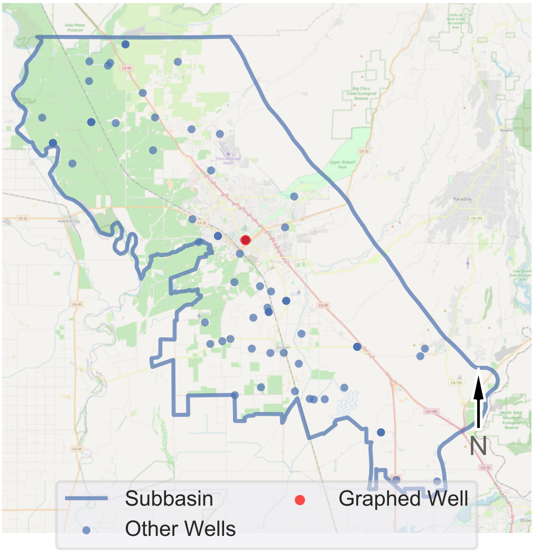
IM (2027) = 107.0 ft AMSL
MO = 106.0 ft AMSL
MT = 85.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟩 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)

# VINA Subbasin - State Well Number (SWN): CWSCH02

Well Location Map



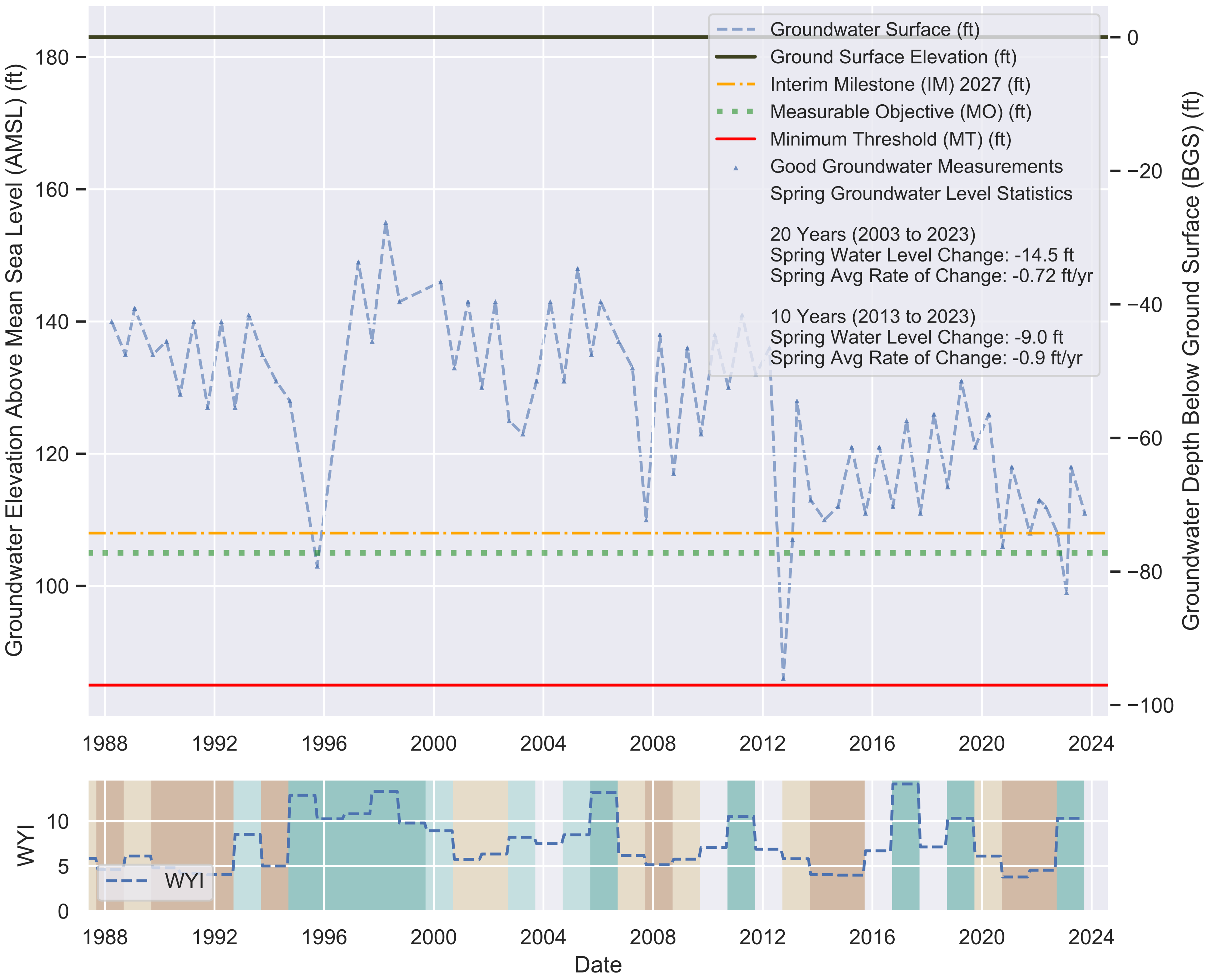
Sustainable Management Criteria:

IM (2027) = 108.0 ft AMSL
MO = 105.0 ft AMSL
MT = 85.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟩 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)

Perforation data not available.



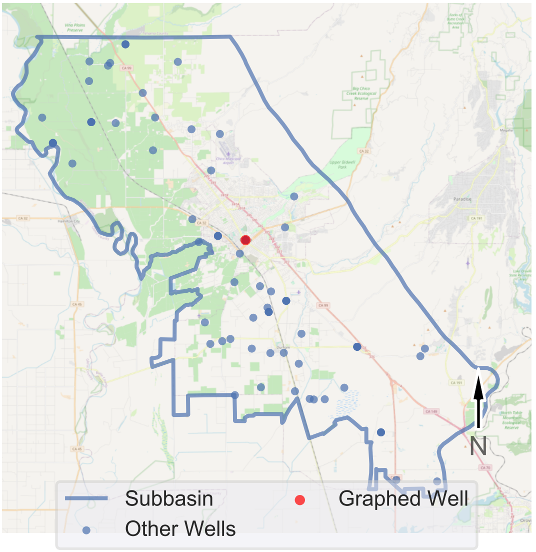
Spring Groundwater Level Statistics

20 Years (2003 to 2023)
Spring Water Level Change: -14.5 ft
Spring Avg Rate of Change: -0.72 ft/yr

10 Years (2013 to 2023)
Spring Water Level Change: -9.0 ft
Spring Avg Rate of Change: -0.9 ft/yr

# VINA Subbasin - State Well Number (SWN): CWSCH03

Well Location Map

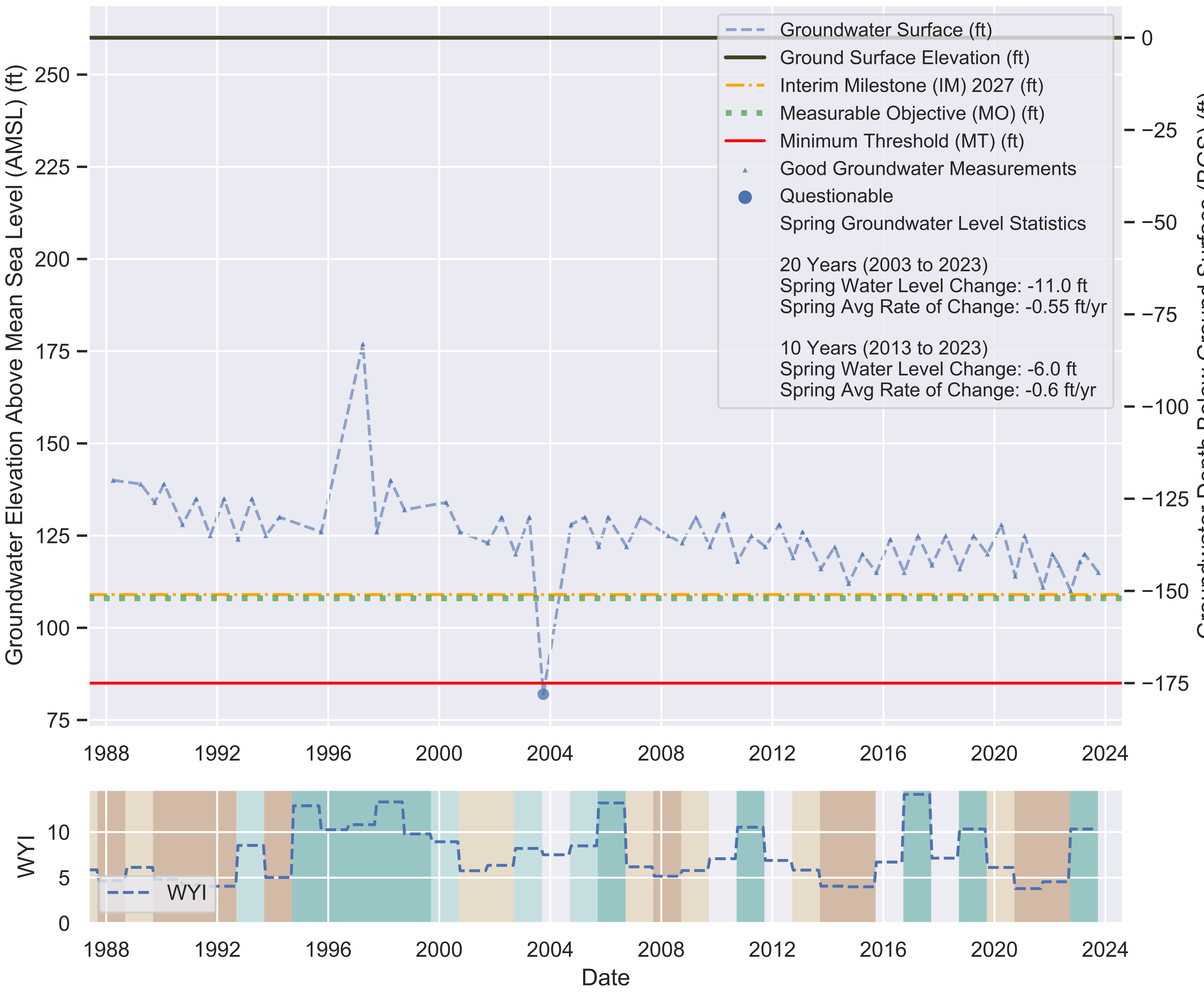


Sustainable Management Criteria:

IM (2027) = 109.0 ft AMSL
MO = 108.0 ft AMSL
MT = 85.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

Perforation data not available.



- 🟩 Wet (W)
- 🟦 Above Normal (AN)
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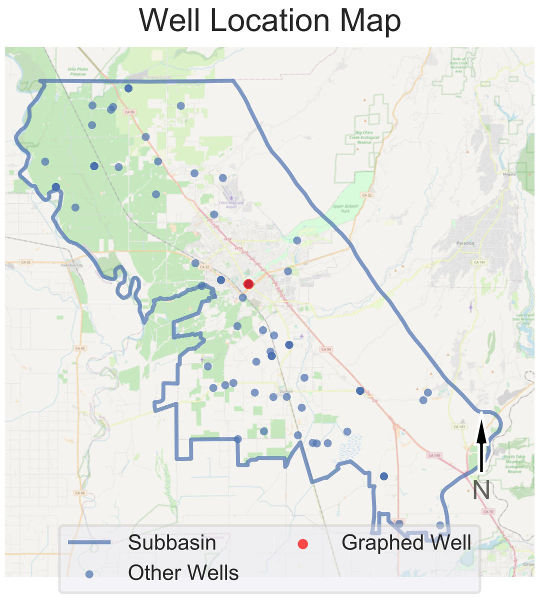
- 🟨 Dry (D)
- 🟫 Critical (C)

# VINA Subbasin - State Well Number (SWN): CWSCH07

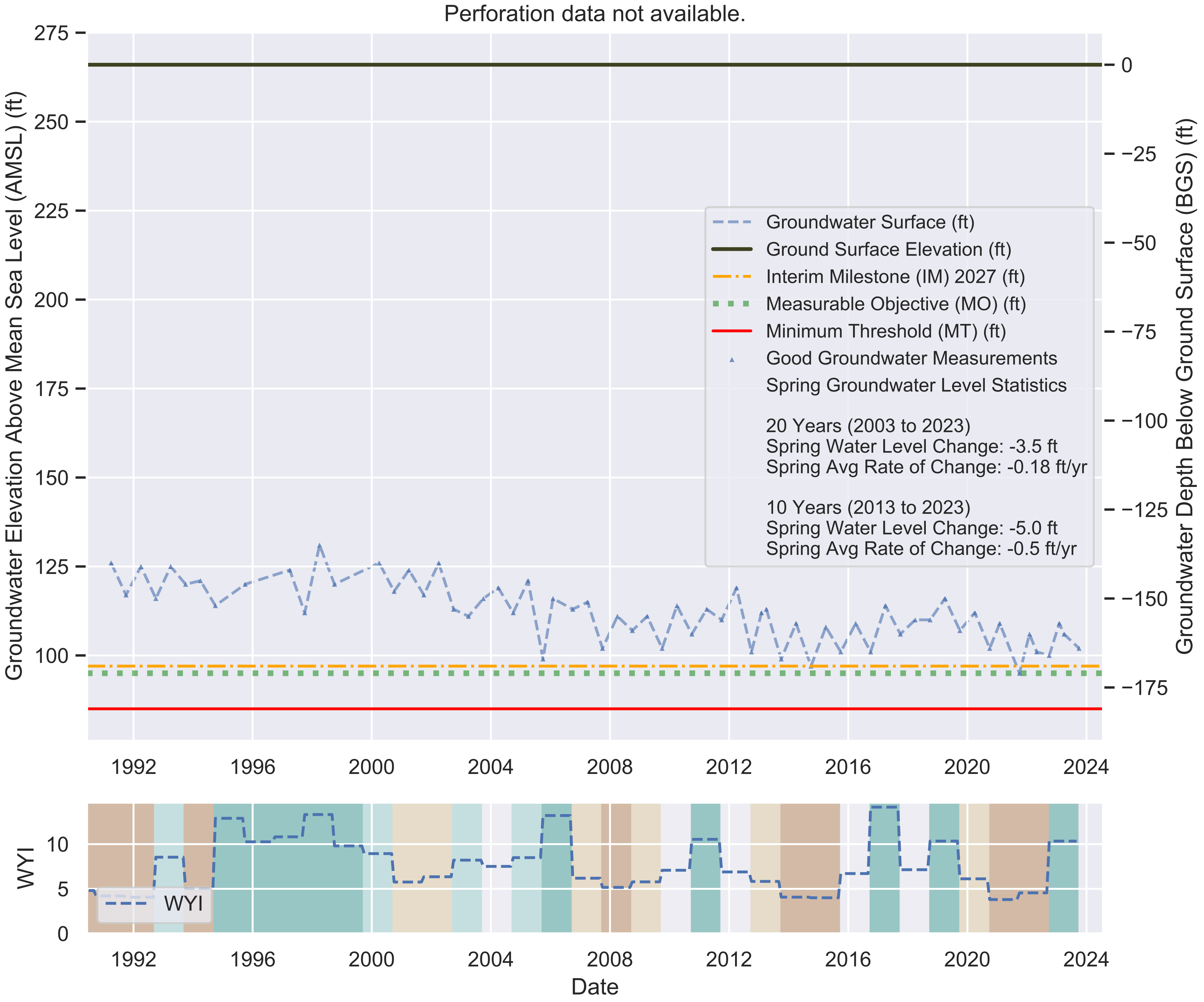


Sustainable Management Criteria:

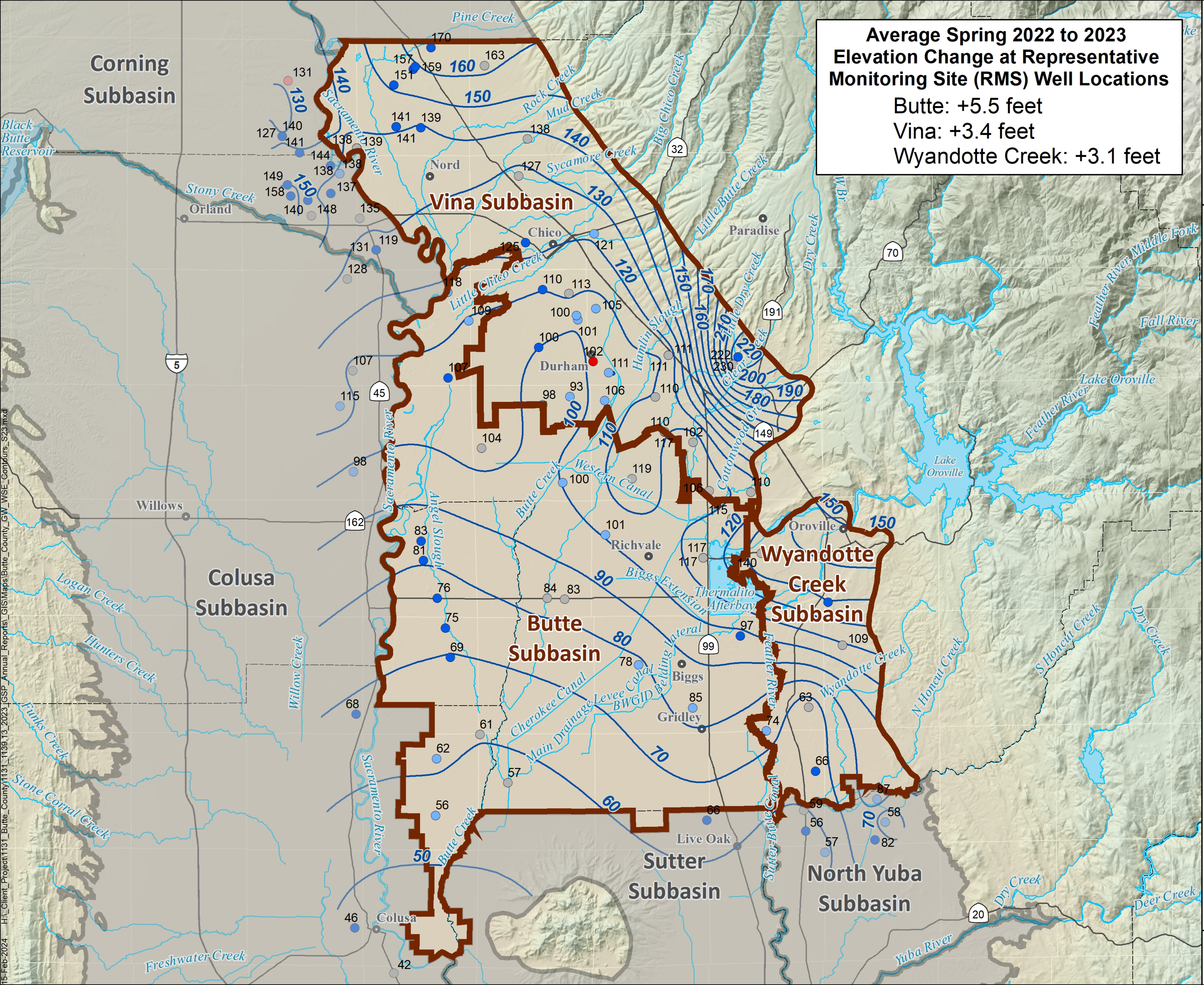
IM (2027) = 97.0 ft AMSL
MO = 95.0 ft AMSL
MT = 85.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- 🟩 Wet (W)
- 🟦 Above Normal (AN)
- ⬜ Below Normal (BN)
- 🟨 Dry (D)
- 🟫 Critical (C)



# SPRING 2023 GROUNDWATER ELEVATION CONTOURS FOR PRIMARY AQUIFER IN BUTTE COUNTY SUBBASINS



Average Spring 2022 to 2023 Elevation Change at Representative Monitoring Site (RMS) Well Locations

Butte: +5.5 feet
Vina: +3.4 feet
Wyandotte Creek: +3.1 feet

**Contouring Wells***

| | |
|---|---|
| ● | Greater than 5 ft decline |
| ● | Between 2 and 5 ft decline |
| ● | Less than 2 ft decline/increase |
| ● | Between 2 and 5 ft increase |
| ● | Greater than 5 ft increase |

**Contour Lines**

| | |
|---|---|
| — | Spring 2023 Water Surface Elevation Contour (feet above mean sea level) |

**All Other Features**

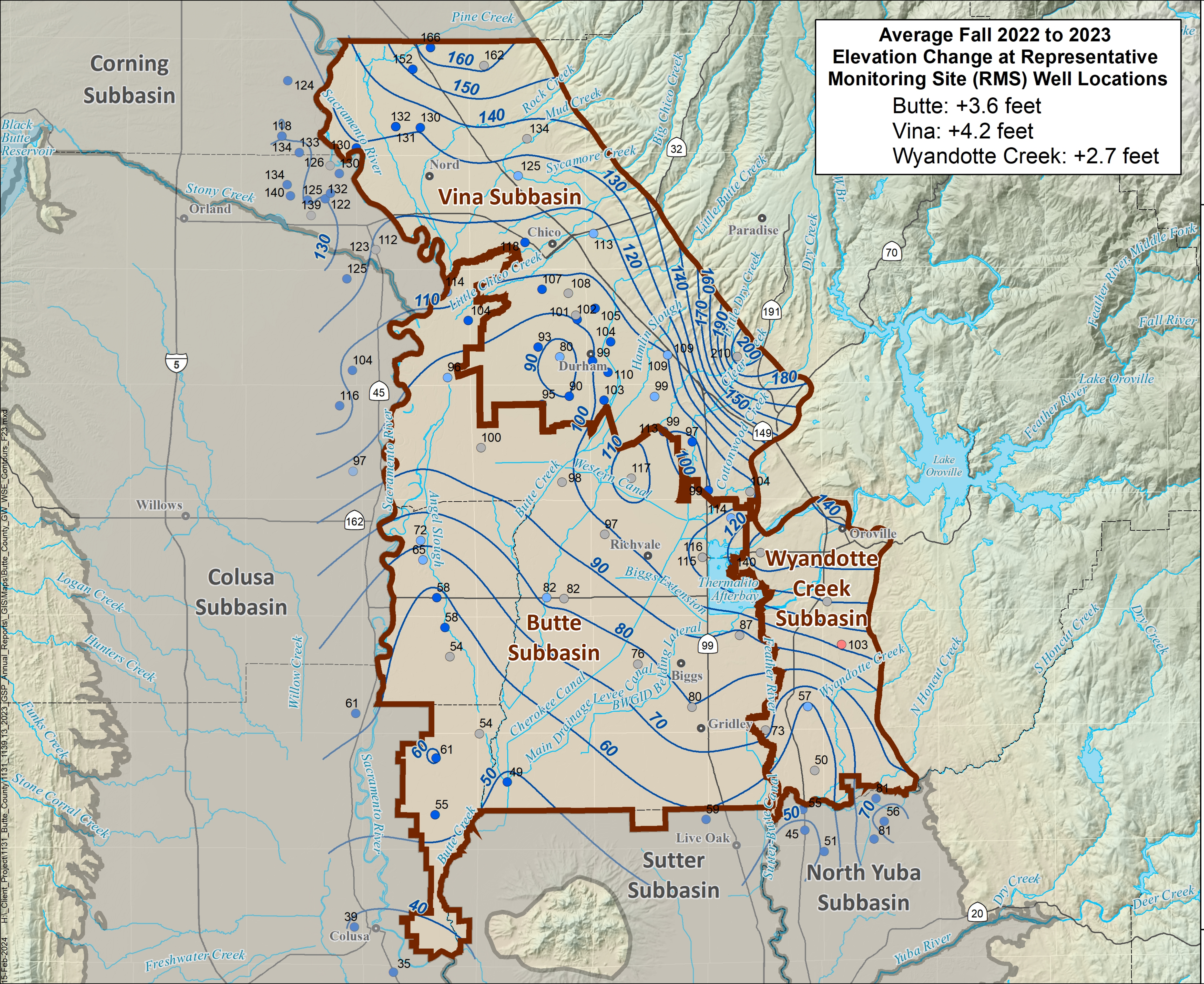
| | |
|---|---|
| ○ | Groundwater Well |
| ● | Cities and Towns |
| — | Highway |
| ▭ | Butte, Vina, and Wyandotte Creek Subbasins |
| ▭ | Neighboring Subbasin |

*Note: Elevation shown for contouring wells is in feet above mean sea level and changes are relative to the same period of the prior year.

0 4 8
Miles

N

H:\Client_Project\1131_Butte_County\1131_1139.13_2023_GSP_Annual_Reports_GIS\Maps\Butte_County_GW_WSE_Contours_S23.mxd
5-Feb-2024



Average Fall 2022 to 2023
Elevation Change at Representative
Monitoring Site (RMS) Well Locations

Butte: +3.6 feet
Vina: +4.2 feet
Wyandotte Creek: +2.7 feet

0 4 8
Miles

N

15-Feb-2024 H:_Client_Project\1131_Butte_County\1131_1139.13_2023_GSP_Annual_Reports_GIS\Maps\Butte_County_GW_WSE_Contours_F23.mxd

# FALL 2023 GROUNDWATER ELEVATION CONTOURS FOR PRIMARY AQUIFER IN BUTTE COUNTY SUBBASINS

**Contouring Wells***

- ● Greater than 5 ft decline
- ● Between 2 and 5 ft decline
- ● Less than 2 ft decline/increase
- ● Between 2 and 5 ft increase
- ● Greater than 5 ft increase

**Contour Lines**

- — Fall 2023 Water Surface Elevation Contour (feet above mean sea level)

**All Other Features**

- ○ Groundwater Well
- ● Cities and Towns
- — Highway
- ▭ Butte, Vina, and Wyandotte Creek Subbasins
- ▭ Neighboring Subbasin

*Note: Elevation shown for contouring wells is in feet above mean sea level and changes are relative to the same period of the prior year.

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# Appendix B

## Explanation of Sustainable Management Criteria

# Appendix B: Explanation of Sustainable Management Criteria

The Sustainable Groundwater Management Act (SGMA) requires a Groundwater Sustainability Plan (GSP) to define Sustainable Management Criteria (SMC) for the groundwater subbasin. The SMC offer guideposts and guardrails for groundwater managers seeking to achieve sustainable groundwater management. SGMA defines sustainable groundwater management as “the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results,” where the planning and implementation horizon is 50 years with the first 20 years spent working toward achieving sustainable groundwater management and the following 30 years (and beyond) spent maintaining it (California Water Code §10721).

“Undesirable Results” are associated with up to six Sustainability Indicators (SI), including groundwater levels, groundwater storage, water quality, seawater intrusion, land subsidence, and interconnected surface water. SGMA defines undesirable results as those having significant and unreasonable negative impacts. Failure to avoid undesirable results on the part of the GSAs may lead to intervention by the State. Once the sustainability goal and undesirable results have been locally identified, projects and management actions are formulated to achieve the sustainability goal and avoid undesirable results.

***SI and associated undesirable results, if significant and unreasonable***

The associated undesirable results for each SI have been defined similarly across the Butte Subbasin. In turn, the rationale and approach for determining Minimum Thresholds and Measurable Objectives for each SI are the same across the Butte Subbasin.

The terminology for describing SMC is defined as follows:

**Undesirable Results** – Significant and unreasonable negative impacts associated with each SI.

**Minimum Threshold (MT)** – Quantitative threshold for each SI used to define the point at which undesirable results may begin to occur.

**Measurable Objective (MO)** – Quantitative target that establishes a point above the MT that allows for a range of active management to prevent undesirable results.

**Margin of Operational Flexibility** – The range of active management between the MT and the MO.

**Interim Milestones (IMs)** – Targets set in increments of five years over the implementation period of the GSP offering a path to sustainability.

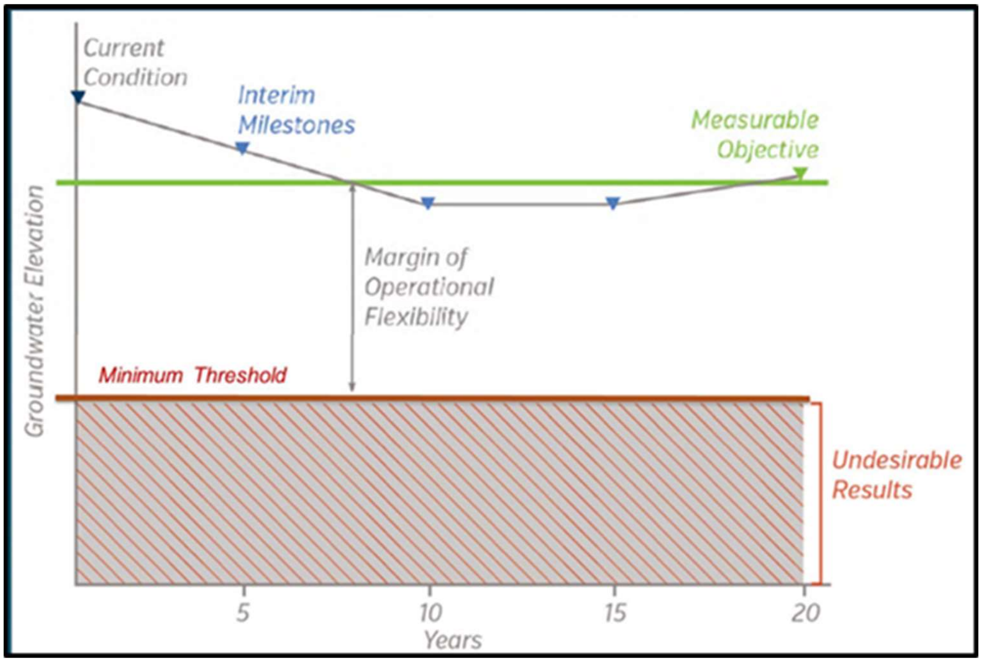

***Illustration of Terms Used for Describing Sustainable Management Criteria Using the Groundwater Level SI***

The Figure above illustrates these terms for the groundwater level SI.

SI are intended to be measured and compared against quantifiable SMC throughout a monitoring framework of Representative Monitoring Site (RMS) wells. Ongoing monitoring of SI can:

Determine compliance with the adopted GSP

Offer a means to evaluate the effectiveness of projects and management actions over time

Allow for course correction and adaptation in five-year updates

Facilitate understanding among diverse stakeholders

Support decision-making on the part of the GSAs into the future

The SMC for the Vina Subbasin is fully explained and defined in Section 3 of the GSP available

here:https://sgma.water.ca.gov/portal/gsp/preview/86

Water Year 2023 Annual Report

# Appendix C

## GSP Annual Reporting Elements Guide

# Groundwater Sustainability Plan Annual Report Elements Guide

| | | | |
|---|---|---|---|
| Basin Name | Vina Subbasin | | |
| GSP Local ID | | | |
| ***California Code of Regulations - GSP Regulation Sections*** | ***Groundwater Sustainability Plan Elements*** | **Document *page number(s) that address the applicable GSP element.*** | ***Notes: Briefly describe the GSP element does not apply.*** |
| **Article 5** | **Plan Contents** | | |
| ***Subarticle 4*** | ***Monitoring Networks*** | | |
| **§ 354.40** | **Reporting Monitoring Data to the Department** | | |
| | Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department. | 34-36; 84-99 | |
| | Note: Authority cited: Section 10733.2, Water Code. Reference: Sections 10728, 10728.2, 10733.2 and 10733.8, Water Code. | | |
| **Article 7** | **Annual Reports and Periodic Evaluations by the Agency** | | |
| **§ 356.2** | **Annual Reports** | | |
| | Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year: | | |
| | (a) General information, including an executive summary and a location map depicting the basin covered by the report. | 5-15 | |
| | (b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan: | | |
| | (1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows: | | |
| | (A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions. | 18-19 | |
| | (B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year. | 43-62 | |
| | (2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions. | 20-22;24 | |
| | (3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year. | 23;24 | |
| | (4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year. | 24 | |
| | (5) Change in groundwater in storage shall include the following: | | |
| | (A) Change in groundwater in storage maps for each principal aquifer in the basin. | 29 | |
| | (B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year. | 26 | |
| | (c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report. | 30-41 | |

Water Year 2023 Annual Report

# Appendix D

## DWR Upload Tables

### A. Groundwater Extractions

| Total Groundwater Extractions (AF) | Water Use Sector Urban (AF) | Water Use Sector Industrial (AF) | Water Use Sector Agricultural (AF) | Water Use Sector Managed Wetlands (AF) | Water Use Sector Managed Recharge (AF) | Water Use Sector Native Vegetation (AF) | Water Use Sector Other (AF) | Water Use Sector Other Description |
|---|---|---|---|---|---|---|---|---|
| 242,000 | 21,900 | 0 | 218,600 | 0 | 0 | 0 | 1,500 | Rural Residential |

### B. Groundwater Extraction Methods

| Meters Volume (AF) | Meters Description | Meters Type | Meters Accuracy (%) | Meters Accuracy Description | Electrical Records Volume (AF) | Electrical Records Description | Electrical Records Type | Electrical Records Accuracy (%) | Electrical Records Accuracy Description | Land Use Volume (AF) | Land Use Description | Land Use Type | Land Use Accuracy (%) | Land Use Accuracy Description | Groundwater Model Volume (AF) | Groundwater Model Description | Groundwater Model Type | Groundwater Model Accuracy (%) | Groundwater Model Accuracy Description | Other Method(s) Volume (AF) | Other Method(s) Description | Other Method(s) Type | Other Method(s) Accuracy (%) | Other Method(s) Accuracy Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21,900 | Metered Municipal Wells | Direct | 5-10 % | Metered connection maintained by California Water Service and Durham Irrigation District. | 0 | | | | | 218,600 | Land use estimates were derived from crop mapping and CropScape survey results | Estimate | 20-30 % | Typical uncertainty for water balance calculation | 0 | | | | | 1,500 | Rural residential groundwater extraction is estimated based on California Water Service Company's 2020 Urban Water Management Plan 2020 usage of an average per capita water use of 181 gallons per capita per day. Population data from the 2020 census was coupled with parcel data to identify total population not serviced by municipal supplies | Estimate | 10-20 % | Uncertainties are from population estimates and gallon per capita per day estimates |

### C. Surface Water Supply

| Total Surface Water Supply (AF) | Methods Used To Determine | Water Source Type Central Valley Project (AF) | Water Source Type State Water Project (AF) | Water Source Type Colorado River Project (AF) | Water Source Type Local Supplies (AF) | Water Source Type Local Imported Supplies (AF) | Water Source Type Recycled Water (AF) | Water Source Type Desalination (AF) | Water Source Type Other (AF) | Water Source Type Other Description |
|---|---|---|---|---|---|---|---|---|---|---|
| 27,200 | Diversions for local supplies are estimated based on historic State Water Resource Control Board eWRIMS (Electronic Water Rights Information Management System) data for total diversions. Surface water delivery estimates are based on historic deliveries in the area that have occurred in dry and critical years | 0 | 0 | 0 | 27,200 | 0 | 0 | 0 | 0 | |

### D. Total Water Use

| Total Water Use (AF) | Methods Used To Determine | Water Source Type Groundwater (AF) | Water Source Type Surface Water (AF) | Water Source Type Recycled Water (AF) | Water Source Type Reused Water (AF) | Water Source Type Other (AF) | Water Source Type Other Description | Water Use Sector Urban (AF) | Water Use Sector Industrial (AF) | Water Use Sector Agricultural (AF) | Water Use Sector Managed Wetlands (AF) | Water Use Sector Managed Recharge (AF) | Water Use Sector Native Vegetation (AF) | Water Use Sector Other (AF) | Water Use Sector Other Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 269,200 | Methods used are a combination of estimates based on land use and population/ per capita water use, metered municipal water use, and estimates based on historic water rights data for dry and critical years | 242,000 | 27,200 | 0 | 0 | 0 | | 21,900 | 0 | 245,800 | 0 | 0 | - | 1,500 | Rural Residential |

Water Year 2023 Annual Report

# Appendix E

## Water Use Analysis Methodology

Water Year 2023 Annual Report

# WY 2021

## Water Use Analysis Methodology

Luhdorff &
Scalmanini
Consulting Engineers

# TECHNICAL MEMORANDUM

DATE: February 16, 2024 Project No. 23-118

TO: Eddy Teasdale, PG/CHG

FROM: Cab Esposito, GIT

**SUBJECT: Butte County Groundwater Estimate Methodology WY 2021**

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## BACKGROUND

In Spring 2022, Luhdorff & Scalmanini Consulting Engineers (LSCE) was contracted by the Butte County Department of Water and Resource Conservation to assess drought impacts in Butte County. As part of this work, groundwater pumping was estimated for Butte County. These groundwater pumping estimates were utilized in the Sustainable Groundwater Management Act (SGMA) reporting for Water Year (WY) 2021. This memo is an abridged description of the methodology developed in the Drought Impact Analysis Study (LSCE, 2022).

## AGRICULTURAL WATER DEMAND

Agricultural groundwater use was estimated using a simplified water balance approach which incorporates reference evapotranspiration (ET), land use, precipitation, and surface water supplies. The water balance is conducted on a monthly time-step. Surface water supplies and pumping are aggregated based on Water Balance Subregions (WBS) and are based on the Butte Basin Groundwater Model (BBGM; BCDWRC, 2021). Soil moisture is assumed to have no carry-over from month to month. Recharge based on applied water was not estimated.

Reference ET was taken from the California Irrigation Management Information System (CIMIS) Durham Station. Land use was from Land IQ 2018 (DWR, 2021) land use survey. Land use was updated by estimating fallowed rice fields based on remotely sensed data. It was assumed that the remaining irrigated land uses did not change from 2018 to 2021. Butte County-specific crop coefficients and irrigation efficiencies were taken from the BBGM. Precipitation data was utilized from the Parameter-Elevation Relationships on Independent Slopes Model (PRISM) 4-km monthly data.

To account for differences in acreages, precipitation, reference ET, and other factors accounted for in the calibration of the BBGM, a linear adjustment was made to the total monthly water demand per WBS in the simplified water balance to better reflect estimates in the BBGM.

Surface water deliveries for WY 2019 and WY 2020 were done through Water Year Type (WYT) estimation. The Sacramento Valley WYT for WY 2019 was “Wet”, and an average monthly delivery from WY 2006, 2011, and 2017 was used. The Sacramento Valley WYT for WY 2020 was “Dry,” and an average of monthly delivery from WY 2007, 2009, and 2013 was used.

Water deliveries in WY 2021 are taken from multiple sources. For the Western Canal Water District, Richvale Irrigation District, Biggs-West Gridley Water District, and Butte Water District, deliveries were estimated based on publicly available surface water (SW) diversions information. These diversions are available from requirements outlined in Senate Bill (SB) 88, which requires all water rights holders who have previously or intend to divert in excess of 10 ac-ft per year to measure and report the water they divert. Other areas in the BBGM area did not report SW diversions; these include areas outside of irrigation districts in the Butte Subbasin, Reclamation District 1004, the Vina Subbasin, and the Wyandotte Creek Subbasin. Diversions in these areas were estimated based on a review of riparian water diversion from 2018-2020, total appropriative water rights in the region, and a review of diversion inputs in the BBGM. Diversion estimates from the above steps were then scaled to match diminished diversion in the Sacramento Valley.

## DOMESTIC AND MUNICIPAL DEMAND – VALLEY FLOOR

Dispersed domestic, i.e., household, groundwater pumping in the Butte County valley floor was estimated using the number and type of residential parcels and baseline/2020 gallon per capita per day (GPCD) water use from Chico-Hamilton City District’s 2020 Urban Water Management Plan (California Water Services Company, Chico-Hamilton City District, 2020).

Valley floor parcels were selected if their centers are located inside the Central Valley Basin and outside service area boundaries from the Division of Drinking Water of the California Water Resources Control Board and the California Environmental Health Tracking Program. Residential parcels were selected from the valley floor parcels using the General Plan Zoning Codes FR – Foothills Residential, MDR – Medium Density Residential, MHDR – Medium-High Density Residential, RR – Rural Residential, and VLDR – Very Low Density Residential.

Valley residential and rural residential parcels were considered to have households of 2.57 persons on average, as determined by the US Census Bureau for Butte County. Very low-density residential parcels may contain up to 1 household per acre and were estimated to have household densities of 0.5 households per acre (1.29 persons per acre, when adjusted for persons per household). Medium-density residential parcels may contain up to 6 households per acre and were estimated to have populations of 15.42 persons per acre. Medium-high-density residential parcels may contain up to 20 households per acre and were estimated to have populations of 25.7 persons per acre.

Municipal groundwater pumping was solicited from all applicable local agencies.

## REFERENCES

Butte County Department of Water and Resource Conservation (BCDWRC). 2021. Model Documentation v 1.0. Butte Basin Groundwater Model. November 30. Available at: https://www.buttecounty.net/waterresourceconservation/groundwater.

California Department of Water Resources (DWR). 2021. 2018 California Statewide Agricultural Land Use. gis.water.ca.gov/app/CADWRLandUseViewer/.

California Water Service Company (Cal Water-Chico). 2020. 2020 Urban Water Management Plan's (UWMP) 2020 Chico-Hamilton City District. Available at: https://www.calwater.com/docs/uwmp2020/CH_2020_UWMP_FINAL.pdf.

Luhdorff and Scalmanini Consulting Engineers (LSCE). 2022. Drought Impact Analysis Study. Available at: https://www.buttecounty.net/1240/Drought-Impact-Analysis-Study.

Water Year 2023 Annual Report

# WY 2022-2023

## Water Use Analysis Methodology

# TECHNICAL MEMORANDUM

| | |
|---|---|
| **To:** | Luhdorff and Scalmanini Consulting Engineers |
| **From:** | Davids Engineering, Inc. |
| **Date:** | Friday, February 09, 2024 |
| **Subject:** | **DRAFT - Water Use Analysis Methodology** |

## 1 Introduction

Pursuant to the Groundwater Sustainability Plan (GSP) regulations (23 CCR[1] Section 356.2), the GSP Annual Report for the Vina Subbasin (Subbasin) includes quantification of water supplies and water uses in the reporting year, including groundwater extraction by water use sector[2]. Water supplies and water uses in the Subbasin have been quantified based on the best available data sources and information, either collected from measured records or estimated where necessary.

While some groundwater extraction in the Subbasin is measured, most groundwater extraction is unmeasured, including extraction from privately owned wells. For the Vina Subbasin Annual Report (Annual Report), the approach used to estimate unmeasured groundwater extraction for the agricultural and managed wetlands water use sectors is referred to as the Groundwater Extraction Estimates from Earth Observations (GEEEO) process. In this approach, a spatial water use analysis is computed on a monthly basis using current land use data, climate conditions (e.g., precipitation and evapotranspiration), crop water demands, and other local information, allowing for estimation of total water use and estimated groundwater extraction, after accounting for the use of other available water supplies.

This approach differs from the water budget methodology used in GSP development, where the Butte Basin Groundwater Model (BBGM) was used to generate historical, current, and projected water budgets for the Subbasin. The shift toward the GEEEO process is due to the time and cost constraints associated with updating the GSP groundwater model annually. Despite this change, key inputs and results from the GEEEO process have been compared with those of the GSP groundwater model to ensure consistency in the water use analyses.

This technical memorandum (TM) describes the methodology and data sources used in the GEEEO process. Results of the GEEEO process are documented in the Annual Report.

---

[1] California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2. Groundwater Sustainability Plans.

[2] Water use sectors are identified in the GSP Regulations as "categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation" (23 CCR Section 351(al)).

# 2 GEEEO Process and Computational Approach

## 2.1 Computational Approach

The GEEEO process utilizes available geospatial data and information to quantify water use, including groundwater extraction volumes, spatially across the Subbasin:

1. First, geospatial evapotranspiration (ET) information at a pixel-scale is used to quantify the total consumptive water use and total applied water requirements during a given time period in a given area of the Subbasin, and geospatial land use information is used to help identify where irrigation water may have been applied (i.e., whether the area in question features irrigated agricultural land, versus idled land or undeveloped vegetation).
2. After quantifying total applied water requirements, available surface water supply and groundwater extraction data is incorporated into the GEEEO process by distributing that water out to specific regions where that water is applied (e.g., irrigated lands in surface water supplier service areas).
3. The remaining groundwater extraction needed to meet applied water demands is then calculated based on the difference between total applied water requirements and available water supply information, with consideration for effective precipitation.
4. Finally, the pixel-scale results can then be aggregated to the desired spatial or temporal domains of interest.

The result is a spatially distributed water use analysis calculated with a finer spatial resolution than was possible in the GSP water budgets. The pixel-scale water budget results provide greater insight into where water use occurs in the Subbasin and are configurable to create water use summaries for any region of the Subbasin. Additional details about the GEEEO computational approach are provided in Attachment A, generally following the process described in Hessels et al. (2022).

## 2.2 Spatial Resolution

GEEEO quantifies water use and groundwater extraction volumes with pixel-scale resolution (30 meters (m) x 30 m), corresponding to the spatial resolution of satellite imagery used in developing many of the GEEEO inputs. For those inputs that are not available at the 30 m x 30 m resolution, available data and information is distributed as averages over the area where that information is applicable (e.g., district-reported surface water deliveries are distributed as an average acre-feet per acre (AF/ac) over irrigated lands in that district's service area[3]). Additional information about the spatial resolution of specific data sources is provided in Section 3.

The fine spatial resolution of the GEEEO inputs and computations allows for highly configurable GEEEO results summaries. For the Annual Report, results are summarized by subregions that are defined to roughly correspond with the boundaries of the water budget regions in the GSP groundwater model, with distinction between water districts, managed wetlands and refuge areas, and out-of-district lands.

---

[3] Future refinements to the GEEEO process could potentially incorporate field-scale surface water delivery records to improve spatial detail of results rather than equally distributing surface water deliveries across the irrigated lands within the district's service area.

## 2.3 Period and Timestep

For each Annual Report, the GEEEO process operates from 2016 through the current reporting year[4] on a monthly timestep, although only the results from the current reporting year are included in the Annual Report. The period and timestep are set according to data availability and reporting needs. However, the GEEEO process is configurable to operate on different timescales (e.g., daily or weekly). The start year is currently limited by the availability of geospatial ET information from OpenET, although further historical ET information is expected to be available in the near future.

# 3 Data Sources

The GEEEO process uses data sources and information that capture the unique, local conditions within the Subbasin to the extent available. Details about the data and information used in the GEEEO process are described below.

## 3.1 Evapotranspiration

ET, or consumptive water use, is the major driver of water use in the Subbasin, particularly agricultural use. In this context, consumptive water use is defined as "*the part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment*" (ASCE, 2016). Unlike surface runoff or infiltration of water into the groundwater system (through seepage, deep percolation, managed recharge, or other means), ET is water that cannot be recovered or directly reused in the Subbasin.

In the GEEEO process, ET is quantified from satellite-based remote sensing analyses available from OpenET. OpenET is a multi-agency web-based geospatial information system (GIS) utility that quantifies ET over time with a spatial resolution of 30 m x 30 m (approximately 0.22 acres). OpenET information is available in raster coverages of the Subbasin on both a daily and monthly timestep from 2016 through present.[5] The GEEEO process utilizes monthly rasters of the ensemble ET from OpenET to calculate total water use for the Annual Report.

While OpenET is a new utility, the underlying methodologies to quantify ET apply a variety of well-established modeling approaches that are widely used in government and research applications. The OpenET modeling approaches are also similar to the approaches used to quantify ET in the GSP groundwater model. Additional information about the OpenET team, data sources, and methodologies are available at: https://openetdata.org/.

## 3.2 Land Use

Areas in each water use sector in the Subbasin were identified using the most recent and reliable spatial land use data in the region, including:

1. Statewide crop mapping, available from the California Department of Water Resources (DWR) (DWR, 2024)

---

[4] Annual Reports are required to be submitted by April 1 each year following the adoption of the GSP. The current reporting year for each Annual Report is the preceding water year (i.e., October 1 through September 30)

[5] OpenET raster information is typically available within about one month after the period has ended.

2. CropScape Cropland Data Layer coverage, available from the United States Department of Agriculture (USDA, 2024).

Land use data from these sources were compiled into 30 m x 30 m raster coverages of the Subbasin. To prepare the GEEEO process inputs, DWR data, which includes extensive ground-truthing review of results, is preferentially used to identify agricultural land (including irrigated and non-irrigated lands) and urban areas, and then USDA data is utilized to back-fill gaps of non-irrigated, idled, and non-developed land in the Subbasin. Local refinements are also applied, as needed, to account for local land use information.

These land use data sources and applications were similar to those used in development of the GSP water budgets. Comparisons were made to evaluate the consistency of the datasets and with earlier land use analyses; good correspondence was found for the major land use classes found in the Subbasin.

DWR data is typically available in provisional form approximately two years after a given year has passed. USDA data is typically available for the prior year in early- to mid-February. When data for the current reporting year is not yet available, raster coverages of the Subbasin are generally assembled utilizing land use data from the most recent, hydrologically similar year (i.e., similar water supply conditions and similar cropping patterns, to the extent possible). Idling of annual and ponded crops in a given year may also be locally refined through comparison with USDA data for the current reporting year or through an analysis of vegetation coverage in the current reporting year. However, it is noted that land use data is only used in the GEEEO process to identify areas in each water use sector where water is applied. The total water use for lands in the agricultural and managed wetlands water use sectors are determined through an analysis of OpenET data, regardless of the precise land use classification.

## 3.3 Precipitation

Spatial precipitation estimates were extracted from the Parameter-elevation Regressions on Independent Slopes Model (PRISM), developed by the PRISM Climate Group at Oregon State University. PRISM quantifies spatial precipitation estimates, among other climate parameters, based on available weather station data and modeled spatial relationships with topography and other factors influencing weather and climate.

PRISM data is available in raster coverages of the Subbasin on both a daily and monthly timestep, with a spatial resolution of 4 kilometer (km) x 4 km. The GEEEO process utilizes monthly rasters for the Annual Report analysis, and the precipitation results for each 4 km pixel are applied to each of the 30 m pixels within it (i.e., downscaled) for which ET and land use data are available. Additional information about the PRISM data and methodologies are available at: https://prism.oregonstate.edu. PRISM precipitation data is consistent with the historical precipitation inputs to the GSP groundwater model.

PRISM precipitation data along with rooting estimated mean rooting depths from the rooting depth ranges listed in Appendix B of ASCE 70 (2016) is used to create pixel-level estimates of effective precipitation (ETPR). For crops not listed in ASCE 70, rooting depths are based on rooting depths of similar crops and professional judgement. ETPR is computed using the National Engineering Handbook Part 623 method (USDA, 1993).

## 3.4 Local Water Supply Data

As described in Section 2, available surface water supply and groundwater extraction data is incorporated into the GEEEO process to quantify the amount of known water supply available, prior to estimating the remaining groundwater extraction needed to meet demand. Water supply data is distributed as averages over the area where that information is applicable (e.g., average AF/ac over lands where that water is available for use).

Surface water supply and groundwater extraction data are collected from both publicly available and local sources. Information gathered may include, where applicable:

1. Water supply contract delivery records, from the United States Bureau of Reclamation (USBR), State Water Project (SWP), or other publicly available sources as applicable.
2. Water rights diversions records, from the State Water Resources Control Board (SWRCB) through the Electronic Water Rights Information Management System (eWRIMS)
3. Data requests to local water agencies and water users, requesting surface water diversions, surface water deliveries, surface water outflows, groundwater pumping records, or other available water use data.

In cases where current surface water data is not available, general information on surface water inflows and outflows may be gathered from other local sources as available (e.g., Agricultural Water Management Plan water budgets). More information about surface water data sources is described in the Annual Report.

While groundwater extraction data is not available in many parts of the Subbasin, local data is requested each year so that new data can be incorporated into the GEEEO process as it becomes available. It is noted that while groundwater extraction for municipal water supply systems is generally reported for urban areas in the Annual Report based on SWRCB and locally provided data, groundwater extraction for municipal areas is not directly included in the GEEEO process due to underlying differences in how the majority of water is used in urban areas. This also applies to estimates of rural residential groundwater use (e.g., domestic water use pumped through private domestic wells) outside of urban areas. The data sources and approaches used to quantify municipal and rural residential groundwater extraction are described in the Annual Report.

## 3.5 Other Agronomic Data

Other agronomic and climate-related data that is incorporated into the GEEEO process includes:

1. Representative consumptive use fractions for crops (i.e., fraction of total applied water that is consumed through ET). Values are based on typical irrigation methods and efficiencies for crops.
2. Conveyance system fractions for subregions (i.e., fraction of diverted water that is delivered, accounting for losses).
3. Reuse fractions for subregions (i.e., fraction of delivered water that is reused).

Information gathered from local sources is used where available, otherwise representative values for agronomic practices in the region are used.

# 4 References

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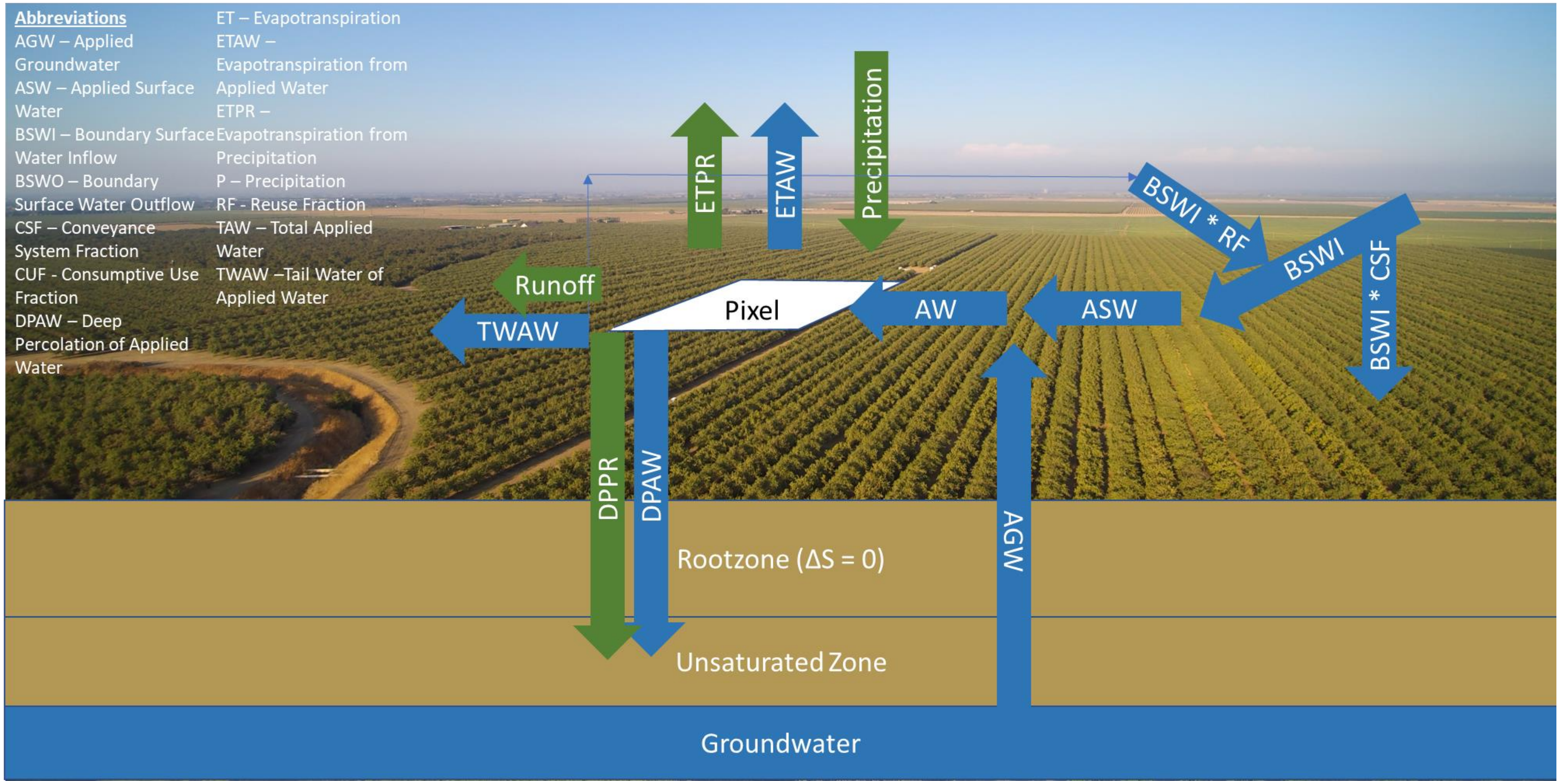
## Attachment A. GEEEO Computational Approach Details

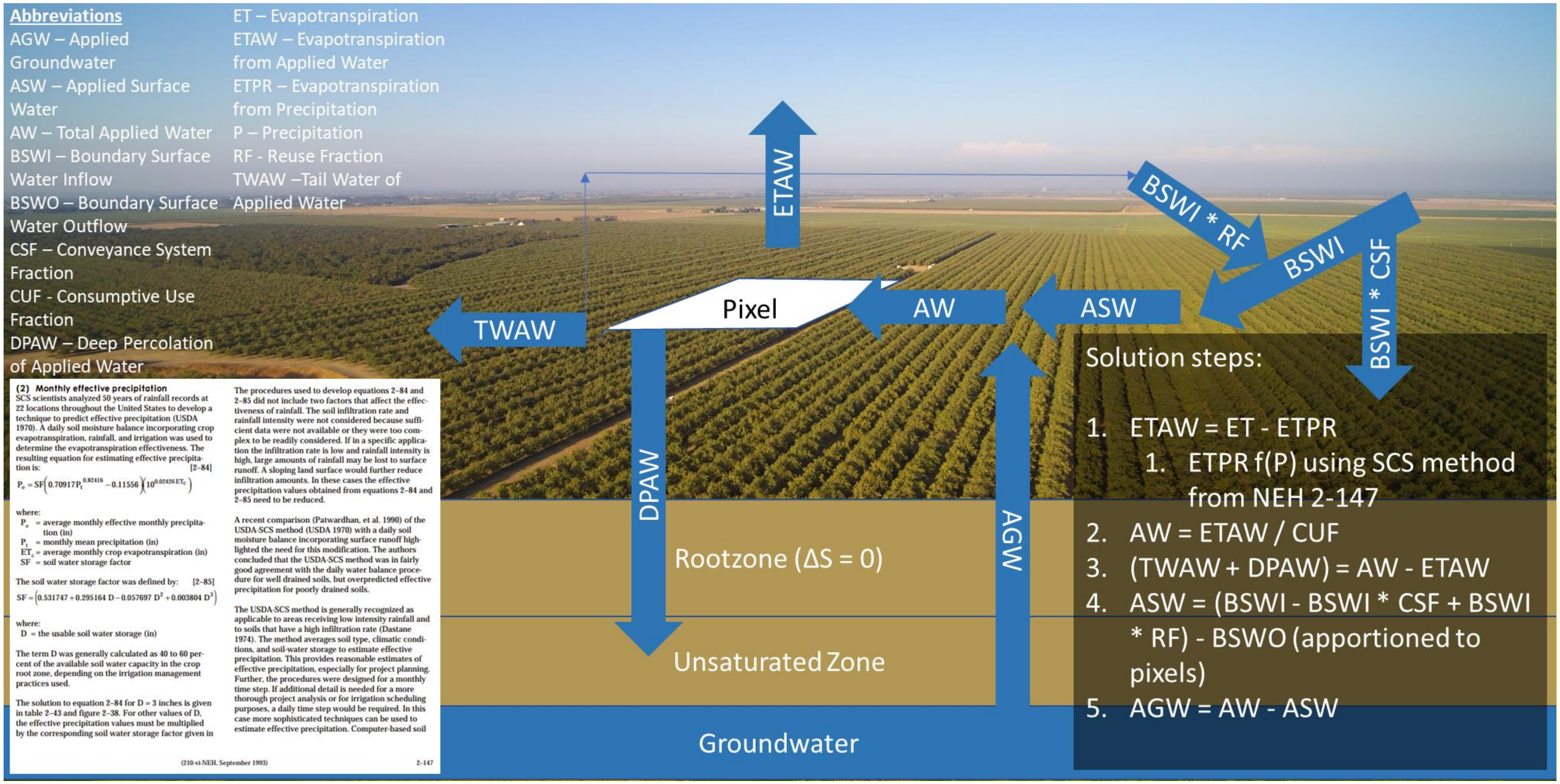
**Figures A-1 and A-2**, below, present a schematic of the GEEEO computational approach as it has been developed and is being generally applied to support Annual Report Development.



**Abbreviations**

AGW – Applied Groundwater
ASW – Applied Surface Water
BSWI – Boundary Surface Water Inflow
BSWO – Boundary Surface Water Outflow
CSF – Conveyance System Fraction
CUF - Consumptive Use Fraction
DPAW – Deep Percolation of Applied Water
ET – Evapotranspiration
ETAW – Evapotranspiration from Applied Water
ETPR – Evapotranspiration from Precipitation
P – Precipitation
RF - Reuse Fraction
TAW – Total Applied Water
TWAW –Tail Water of Applied Water

Figure A-1. Inflows and Outflows to Each 30 m x 30 m Pixel in the GEEEO Process.



**Abbreviations**

AGW – Applied Groundwater
ASW – Applied Surface Water
AW – Total Applied Water
BSWI – Boundary Surface Water Inflow
BSWO – Boundary Surface Water Outflow
CSF – Conveyance System Fraction
CUF - Consumptive Use Fraction
DPAW – Deep Percolation of Applied Water
ET – Evapotranspiration
ETAW – Evapotranspiration from Applied Water
ETPR – Evapotranspiration from Precipitation
P – Precipitation
RF - Reuse Fraction
TWAW –Tail Water of Applied Water

Solution steps:

1. ETAW = ET - ETPR
   1. ETPR f(P) using SCS method from NEH 2-147
2. AW = ETAW / CUF
3. (TWAW + DPAW) = AW - ETAW
4. ASW = (BSWI - BSWI * CSF + BSWI * RF) - BSWO (apportioned to pixels)
5. AGW = AW - ASW

**(2) Monthly effective precipitation**

SCS scientists analyzed 50 years of rainfall records at 22 locations throughout the United States to develop a technique to predict effective precipitation (USDA 1970). A daily soil moisture balance incorporating crop evapotranspiration, rainfall, and irrigation was used to determine the evapotranspiration effectiveness. The resulting equation for estimating effective precipitation is: [2–84]

$$P_e = SF\left(0.70917 P_t^{0.82416} - 0.11556\right)\left(10^{0.02426\,ET_c}\right)$$

where:

$P_e$ = average monthly effective monthly precipitation (in)
$P_t$ = monthly mean precipitation (in)
$ET_c$ = average monthly crop evapotranspiration (in)
SF = soil water storage factor

The soil water storage factor was defined by: [2–85]

$$SF = \left(0.531747 + 0.295164\,D - 0.057697\,D^2 + 0.003804\,D^3\right)$$

where:

D = the usable soil water storage (in)

The term D was generally calculated as 40 to 60 percent of the available soil water capacity in the crop root zone, depending on the irrigation management practices used.

The solution to equation 2–84 for D = 3 inches is given in table 2–43 and figure 2–38. For other values of D, the effective precipitation values must be multiplied by the corresponding soil water storage factor given in

The procedures used to develop equations 2–84 and 2–85 did not include two factors that affect the effectiveness of rainfall. The soil infiltration rate and rainfall intensity were not considered because sufficient data were not available or they were too complex to be readily considered. If in a specific application the infiltration rate is low and rainfall intensity is high, large amounts of rainfall may be lost to surface runoff. A sloping land surface would further reduce infiltration amounts. In these cases the effective precipitation values obtained from equations 2–84 and 2–85 need to be reduced.

A recent comparison (Patwardhan, et al. 1990) of the USDA-SCS method (USDA 1970) with a daily soil moisture balance incorporating surface runoff highlighted the need for this modification. The authors concluded that the USDA-SCS method was in fairly good agreement with the daily water balance procedure for well drained soils, but overpredicted effective precipitation for poorly drained soils.

The USDA-SCS method is generally recognized as applicable to areas receiving low intensity rainfall and to soils that have a high infiltration rate (Dastane 1974). The method averages soil type, climatic conditions, and soil-water storage to estimate effective precipitation. This provides reasonable estimates of effective precipitation, especially for project planning. Further, the procedures were designed for a monthly time step. If additional detail is needed for a more thorough project analysis or for irrigation scheduling purposes, a daily time step would be required. In this case more sophisticated techniques can be used to estimate effective precipitation. Computer-based soil

(210-vi-NEH, September 1993) 2–147

Figure A-2. Solution Steps for Calculating Applied Groundwater (AGW) in Each 30 m x 30 m Pixel in the GEEEO Process.

Water Year 2023 Annual Report

# Appendix F

## Water Quality

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# TECHNICAL MEMORADUM

Groundwater Quality Monitoring Update for 2022 and 2023

Prepared by: Kelly Peterson, Water Resources Scientist, Department of Water and Resource Conservation

## Purpose

The purpose of this memo is to summarize the groundwater quality conditions for salinity, measured as electrical conductivity (EC) in the Butte, Vina and Wyandotte Creek Subbasins during the first two years (2022 and 2023) of GSP related groundwater quality monitoring that occurred.

## Background

The Sustainable Groundwater Management Act (SGMA) of 2014 required Groundwater Sustainability Agencies (GSAs) to develop, then submit, and implement long-term Groundwater Sustainability Plans (GSPs) to the California Department of Water Resources (DWR) in 2022. The Butte, Vina and Wyandotte Creek Subbasin GSPs include plans to monitor EC to avoid groundwater quality degradation (Davids, 2021; Geosyntec Consultants, Inc., 2021a; Geosyntec Consultants, Inc., 2021b).

Salinity is the main constituent of concern in all three Subbasins and is measured as EC as a basic groundwater quality characteristic to evaluate a basin for evidence of saline intrusion. Groundwater quality monitoring serves to establish baseline levels for these parameters throughout the Subbasins so that any future changes may be identified and further investigation and / or monitoring can subsequently be developed. Groundwater quality monitoring for implementation of the GSPs began in 2022, spearheaded by staff from the Butte County Water and Resource Conservation Department (Department) with assistance from various volunteers and GSA Managers for the fieldwork portion of the monitoring. The focus of the monitoring is targeting deep wells within each Subbasin to track the migration of connate water upwelling from deep portions of the aquifer.

## Methodology

In 2021, the Department purchased a Solinst 107 EC meter which includes a probe that measures EC, temperature and water level (similar to an electric sounder) on a 1,000-foot-long laser-marked flat tape with markings every 1/100th ft. This meter was purchased to conduct EC monitoring at various depths within wells in the monitoring network and was used in 2022 and 2023, the first two years of GSP related groundwater quality monitoring. The meter was calibrated at the beginning of each day with known standard solutions according to the manufacturer's specifications. At each site the probe was lowered to the water surface and a depth to water measurement was recorded. It was then lowered to the midpoint of each screened interval(s) within the well to record the EC of the water entering the well from that portion of the aquifer. The Solinst EC meter was only used in wells that did not have any pumping equipment within them i.e. multi-completion observation wells, in order to avoid damage to the equipment through entanglement in the wiring or pump.

For most of the remaining wells in the monitoring network with pumps, a Hach brand portable water quality meter with a conductivity probe was used to measure a water sample after the well was purged of standing water by pumping for at least 20 minutes. One exception, well 19N01W28A001M in the Glenn County portion of the Butte Subbasin, measured by Glenn County staff, was purged and pumped for less than 20 minutes.

Electrical conductivity measurements are taken at each RMS well once per year. The wells are typically measured within the month of August during the peak of the irrigation season.

The GSAs developed these new groundwater quality monitoring Representative Monitoring Site (RMS) networks to include wells distributed spatially throughout the Subbasins with a focus on including wells screened deep enough to capture changes in EC in the deeper portions of the aquifer where any changes in EC would be expected to be detected first. While there are shallow RMS wells within some of the networks, as part of future GSP implementation, GSAs may consider modifications to the groundwater quality RMS network as needed.

The Butte, Vina and Wyandotte Creek Subbasins groundwater quality monitoring networks are comprised of the individual groundwater quality monitoring RMS wells as described in each of the Subbasin's GSPs. Each Subbasin has a monitoring network of eight RMS wells; however, modifications to the Wyandotte Creek Subbasin's RMS network have been made since adoption of the GSP due to the inaccessibility of specific wells and the subsequent addition of sites described in more detail below. In 2023 the overall revised monitoring network included the eight original sites in both the Vina and Butte Subbasins as well as seven sites in the Wyandotte Creek subbasin for a total of 23 sites. Some of the water quality monitoring sites do have historic intermittent EC data, however most sites do not. A map of each Subbasin and the network of groundwater quality RMS sites is shown in **Figure 1.**

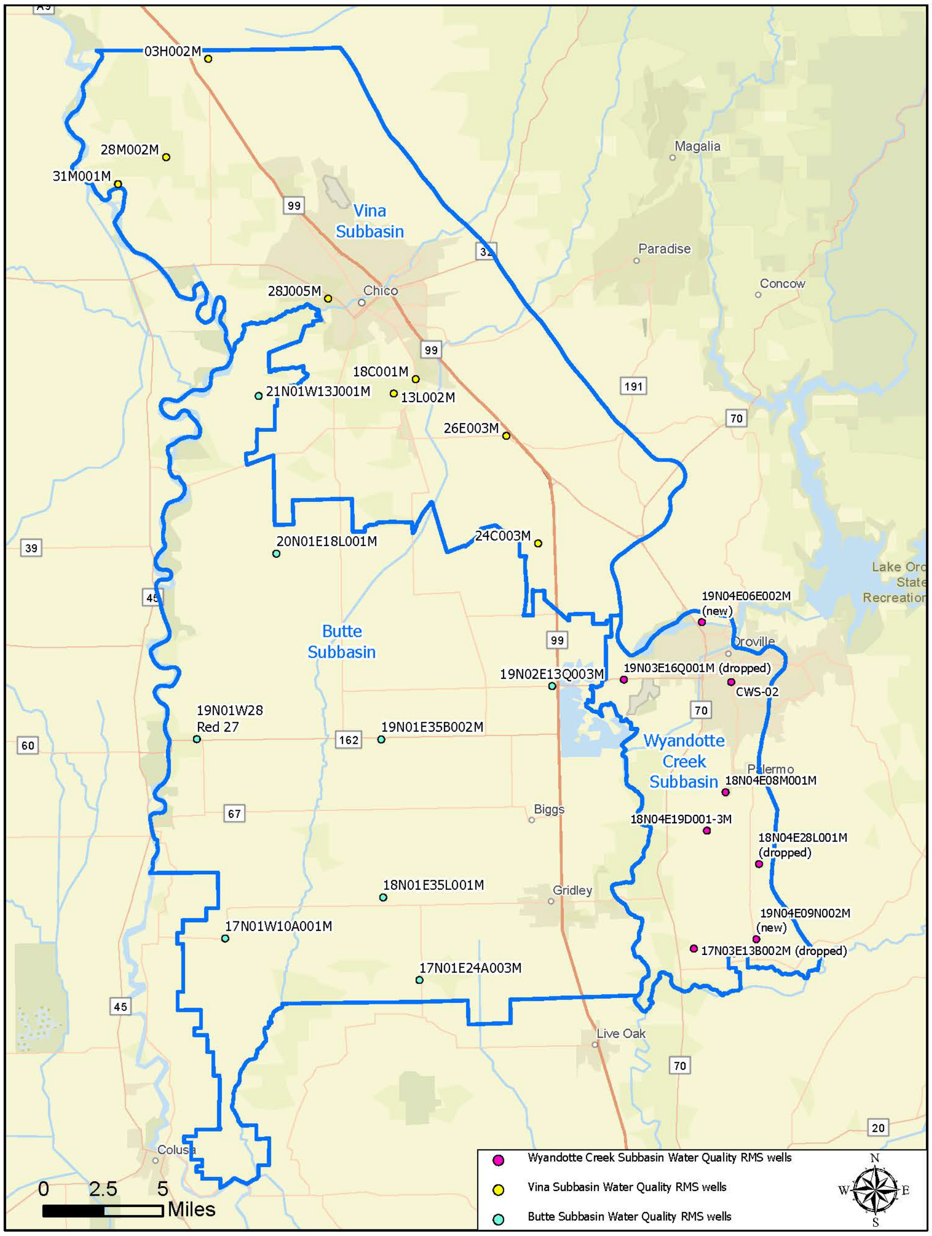


**Figure 1. Groundwater Quality Representative Monitoring Site well locations in the Vina, Butte and Wyandotte Creek Subbasins**

Modifications to the Wyandotte Creek Subbasins RMS network include removal of three original RMS wells and the addition of two wells. RMS well 13B002M was removed in 2022 due to an inoperative pump preventing access to a water sample. Two RMS wells were removed from the network per the request of the landowners, 28L001M in 2022 and 16Q001M in 2023. Efforts were made to identify other wells which could be used as alternatives in the Wyandotte Creek Subbasin. Two additional sites were identified and added to the monitoring network; 06E002M in 2022 and 09N002M in 2023. Well 06E002M has been monitored annually since 2002 as part of previous Butte County Basin Management

Objective (BMO) program groundwater quality monitoring effort sand 09N002M is a RMS well for groundwater level monitoring but a new groundwater quality monitoring well.

The RMS well details including well type, what equipment is used to monitor it, total well depth and depth of the screened zones(s) in each well are provided in **Table 1.** The RMS wells within the Butte Subbasin are predominantly multi-completion wells with the exception of 18N01E35L001M, a single observation well and 19N01W28A001M, a shallow irrigation well. Three of the RMS wells in the Butte Subbasin 18N01E35L001M, 19N01E35B002M and 20N01E18L001M are also extensometer sites which continuously monitor land subsidence. The RMS wells within the Vina Subbasin are all multi-completion wells (multiple wells at a single location screened at different depths below the ground surface) and the deepest of those wells at each location is selected for measurements. In the Wyandotte Creek subbasin, there are variety of well use types in the monitoring network including residential, irrigation, municipal and observation wells.

## Sustainable Management Criteria

Groundwater quality monitoring measures EC levels in the Representative Monitoring Site (RMS) wells in comparison to the Measurable Objective (MO) and Minimum Threshold (MT) set for each RMS well in the GSPs as a way to gauge whether undesirable results are occurring in the subbasin. In each Subbasin's GSP, MTs were established to be protective of water uses and users. When considering MTs, it is important to note that in the case of groundwater levels, exceedance of a MT is caused by groundwater levels dropping below the threshold. However, for groundwater quality, exceedance of a MT is counterintuitively caused by measuring levels higher than the threshold. The MT for groundwater quality is a highest allowable value, rather than lowest. **Table 2**. identifies the MOs, MTs, and definition of Undesirable Results for each Subbasin.

As shown in **Table 2.** in the Butte Subbasin the preliminary MO for each RMS well for EC is set at 700 µs/cm for agricultural use, consistent with the Butte County Basin Management Objective (BMO) program, the previous 19-year long Butte County-wide groundwater quality monitoring effort. The MTs at the RMS wells are set as either the higher of 900 µs/cm or the measured historical high, whichever was greater. This MT was set based on best available data, the 19-year dataset of the Butte County BMO program, and maximum contamination levels established by the State. The occurrence of an Undesirable Result occurs in the Butte Subbasin if 25% of RMS wells exceed their MTs for 24 consecutive months.

In the Vina and Wyandotte Creek Subbasins the groundwater quality Sustainable Management Criteria (SMC) are established to address degraded groundwater quality caused by groundwater pumping where the potential exists for movement of underlying brackish water from greater depths into the freshwater pool where groundwater pumping for beneficial uses occurs. In these two subbasins, the MOs for salinity are set at 900 µs/cm and the MTs are 1,600 µs/cm, which is the upper limit of the Secondary Maximum Contaminant Level (SMCL) based on State Secondary Drinking Water Standards. Values exceeding this number are typically unacceptable for drinking water.

**Table 1. Groundwater Quality Representative Monitoring Site Information**

| Subbasin | Representative Monitoring Site ID | Well Type | Monitoring Equipment | Total Well Depth (feet) | Depth of Screened Zone(s) (feet) |
|---|---|---|---|---|---|
| Butte | 19N02E13Q003M | Observation* | Solinst 107 | 690 | 670 - 680 |
| | 17N01W10A001M | Observation* | Solinst 107 | 820 | 770 – 780, 790 - 800 |
| | 21N01W13J001M | Observation* | Solinst 107 | 830 | 780 - 820 |
| | 17N01E24A003M | Observation* | Solinst 107 | 833 | 770 - 790 |
| | 18N01E35L001M | Observation | Solinst 107 | 899 | 816 - 836 |
| | 19N01E35B002M | Observation* | Solinst 107 | 980 | 930 - 950 |
| | 20N01E18L001M | Observation | Solinst 107 | 1,000 | 767 – 810, 873 - 894 |
| | 19N01W28A001M | Irrigation | Hach Sension156 | 140 | 120 - 140 |
| Vina | 03H002M | Observation* | Solinst 107 | 553 | 510 - 540 |
| | 28M002M | Observation* | Solinst 107 | 1,031 | 791 – 801, 881 – 891,<br>951 – 961, 1011 - 1021 |
| | 31M001M | Observation* | Solinst 107 | 1,055 | 969 - 979 |
| | 28J005M | Observation* | Solinst 107 | 948 | 740 - 800 |
| | 18C001M | Observation* | Solinst 107 | 900 | 770 – 780, 800 – 810<br>830 – 840, 870 - 880 |
| | 13L002M | Observation* | Solinst 107 | 771 | 735 - 760 |
| | 26E003M | Observation* | Solinst 107 | 640 | 610 - 620 |
| | 24C003M | Observation* | Solinst 107 | 520 | 484 - 505 |
| Wyandotte Creek | CWS-02 | Municipal | Hach HQd | 120 | 60 – 190, 300 - 322 |
| | 13B002M [1] | Irrigation | n/a | 320 | 120 - 320 |
| | 08M001M | Irrigation | Solinst 107 | 656 | 168 – 204, 208 - 244 |
| | 19D001M | Observation* | Solinst 107 | 1,000 | 700 - 720 |
| | 19D002M | Observation* | Solinst 107 | 1,000 | 430 – 450, 550 - 570 |
| | 19D003M | Observation* | Solinst 107 | 1,000 | 120 - 130 |
| | 28L001M [1] | Irrigation | n/a | 190 | n/a |
| | 16Q001M[2] | Residential | Hach HQd | 120 | 100 - 120 |
| | 19N04E06E002M[3] | Municipal | Hach HQd | 196 | 110 – 130, 164 – 174 |
| | 19N04E09N002M[4] | Irrigation | Hach HQd | 325 | 45 – 55 |

[1] Removed from network in 2022 [2] Removed from network in 2023 [3] Added to network in 2022 [4] Added to network in 2023 * Multi-completion well

**Table 2. Measurable Objectives and Minimum Thresholds for Electrical Conductivity [microsiemens (µs) / centimeter (cm)] in each Subbasin**

| Subbasin | Measurable Objective | Minimum Thresholds | Undesirable Result |
|---|---|---|---|
| Butte | 700 µS/cm | The greater of 900 µS/cm or the measured historical high | 25% of RMS wells exceed MTs for 24 consecutive months |
| Vina | 900 µS/cm | 1,600 µS/cm | 2 RMS wells exceed their MT for two consecutive non-dry years |
| Wyandotte Creek | 900 µS/cm | 1,600 µS/cm | 2 RMS wells exceed their MT for two consecutive non-dry years |

Secondary Drinking Water Standards are set on the basis of aesthetic concerns. The occurrence of an Undesirable Result within both the Vina and Wyandotte Creek Subbasins occurs if two RMS wells within each Subbasin exceeds their MTs for two consecutive non-dry years.

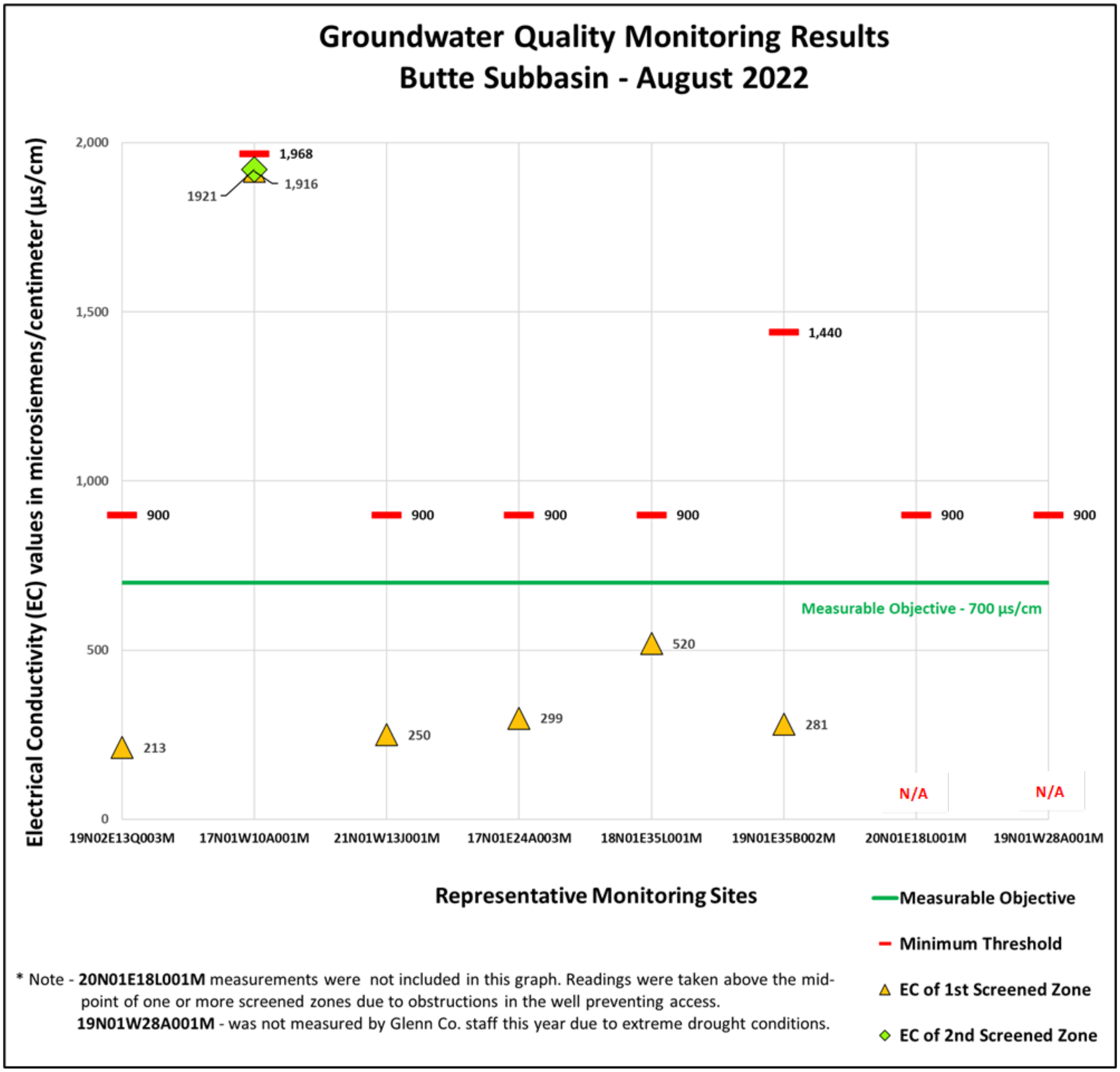
## Results

In 2022, a dry water year type, and 2023, a non-dry water year type, the majority of all wells monitored within each Subbasin had groundwater quality conditions (measured as EC) that fell within the acceptable range of groundwater quality values set forth by the GSPs and described in **Table 2.** Additionally, there were no indications of Undesirable Results in either year.

### Butte Subbasin

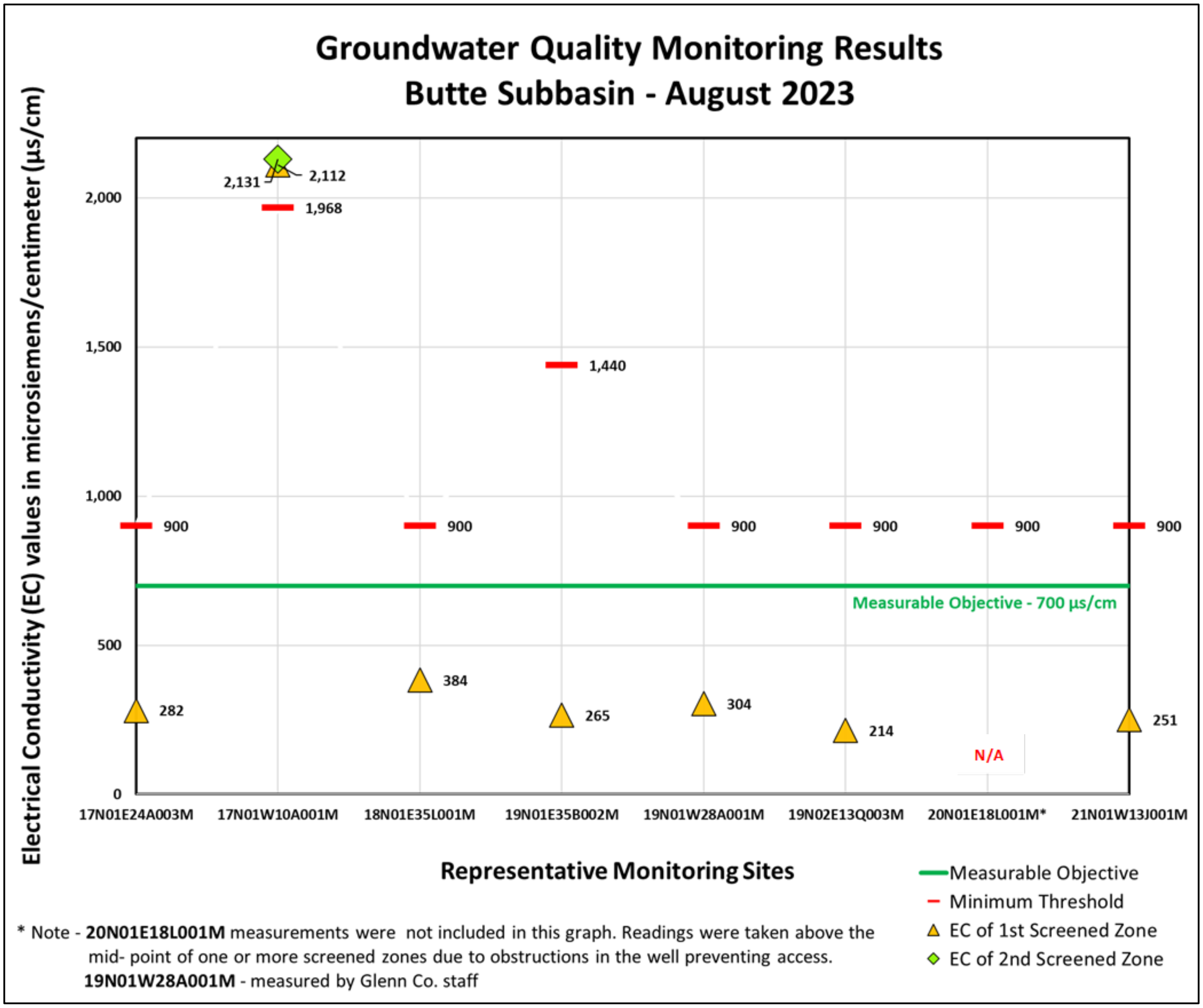
In the Butte Subbasin the majority of RMS wells measured had EC values that were lower than the MO of 700 µS/cm and therefore lower than their specific MTs in both years. The MTs vary per well since they are based on historic data, if available, as shown in **Figures 2 - 4.** Results from one RMS well 17N01W10A001M, located in Colusa County, had EC values higher than the well's MT in 2023. Historic (DWR, 2020, DWR 2023a) and recent data for this well are shown in **Figure 4**. This well is near the Sutter Buttes mountain range in an area known for high concentrations of EC (Davids, 2021). Future plans may include the formation of the Sutter Buttes Water Quality Interbasin Working Group as described in more detail in section 6.1.2.2 of the Butte Subbasin GSP (Davids, 2021) to focus on collaborative discussions, consensus building and planning to address groundwater quality matters associated with the unique geology of the Sutter Buttes area.

Results from RMS well 20N01E18L001M are not depicted in the 2022 or 2023 figures as there was an obstruction within the well each year preventing the equipment from reaching the proper depths at the mid-point of the screening interval to measure EC. As part of future GSP implementation, the GSAs will consider modifications to the groundwater quality RMS network.



* Note - **20N01E18L001M** measurements were not included in this graph. Readings were taken above the mid-point of one or more screened zones due to obstructions in the well preventing access.
**19N01W28A001M** - was not measured by Glenn Co. staff this year due to extreme drought conditions.

**Figure 2. Groundwater quality monitoring results in the Butte Subbasin for the 2022 water year**



* Note - **20N01E18L001M** measurements were not included in this graph. Readings were taken above the mid- point of one or more screened zones due to obstructions in the well preventing access.
**19N01W28A001M** - measured by Glenn Co. staff

**Figure 3. Groundwater quality monitoring results in the Butte Subbasin for the 2023 water year**

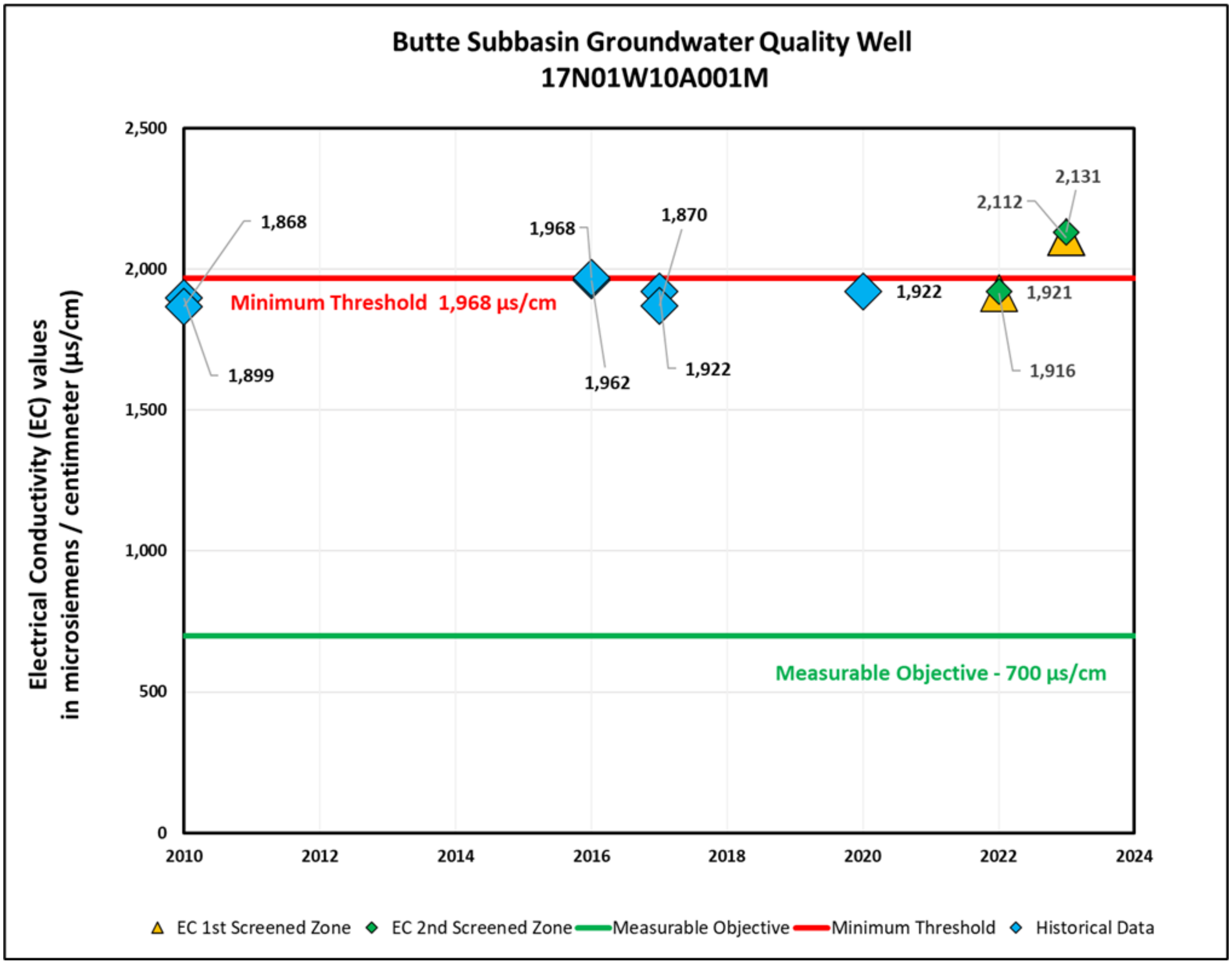


**Figure 4. Groundwater quality data for well 17N01W10A001M in the Butte Subbasin**

## Vina Subbasin

In the Vina Subbasin all RMS wells measured had EC values that were lower than the MO of 900 µS/cm and therefore lower than the MT of 1,600 µS/cm in both years as shown in **Figures 5 and 6.** Results from RMS well 28J005 were not depicted in these figures as there was an obstruction within the well each year preventing the equipment from reaching the proper depths at the mid-point of the screening interval to measure EC. The probe could only be lowered to approximately 370’ above the screened interval for this well.

Based on observations in the field it is possible that RMS well 28J005, developed in 1955 has filled in with materials due to a collapse of the walls above the screened interval of the well. As part of future

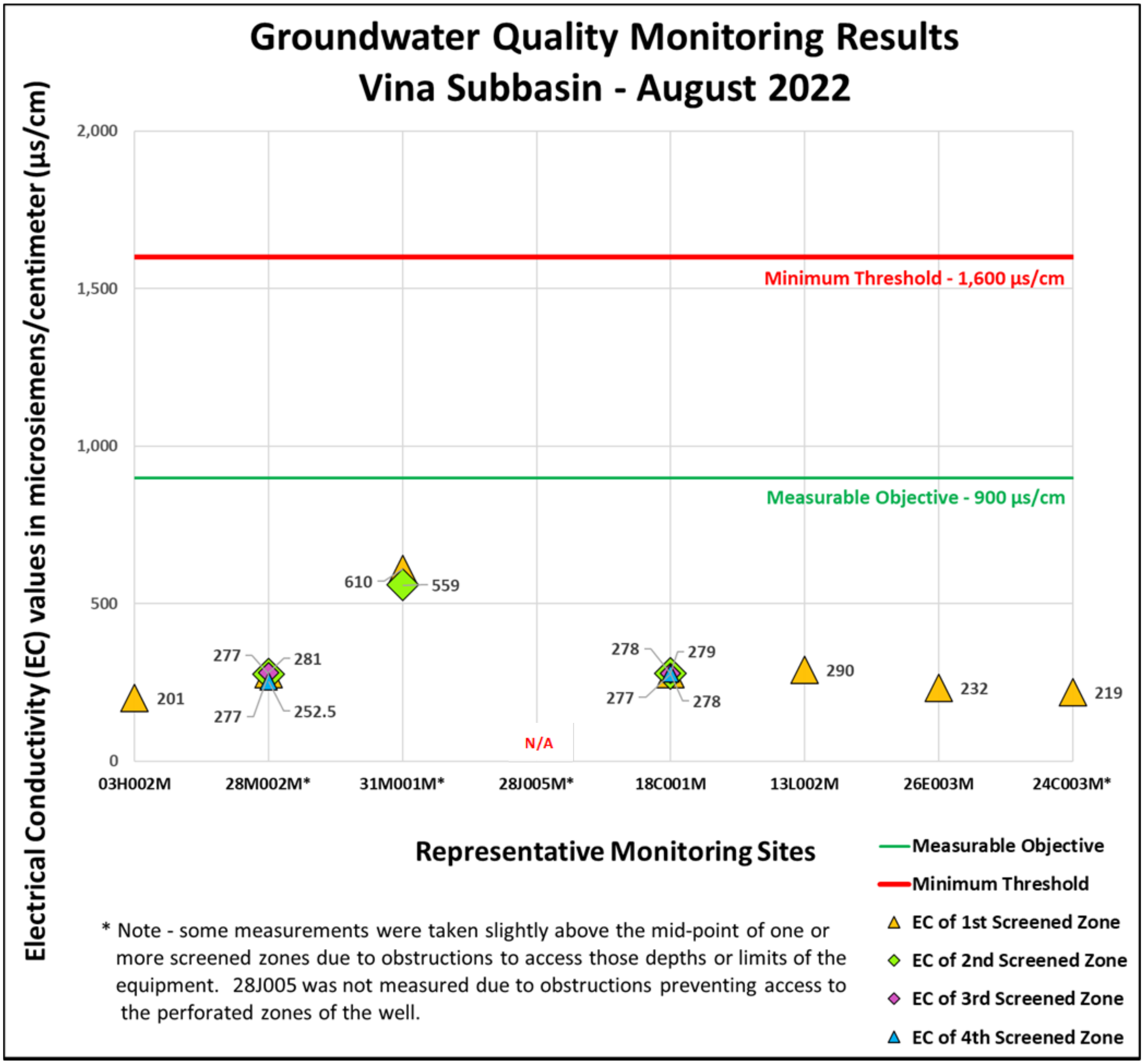


**Figure 5. Groundwater quality monitoring results in the Vina Subbasin for the 2022 water year**

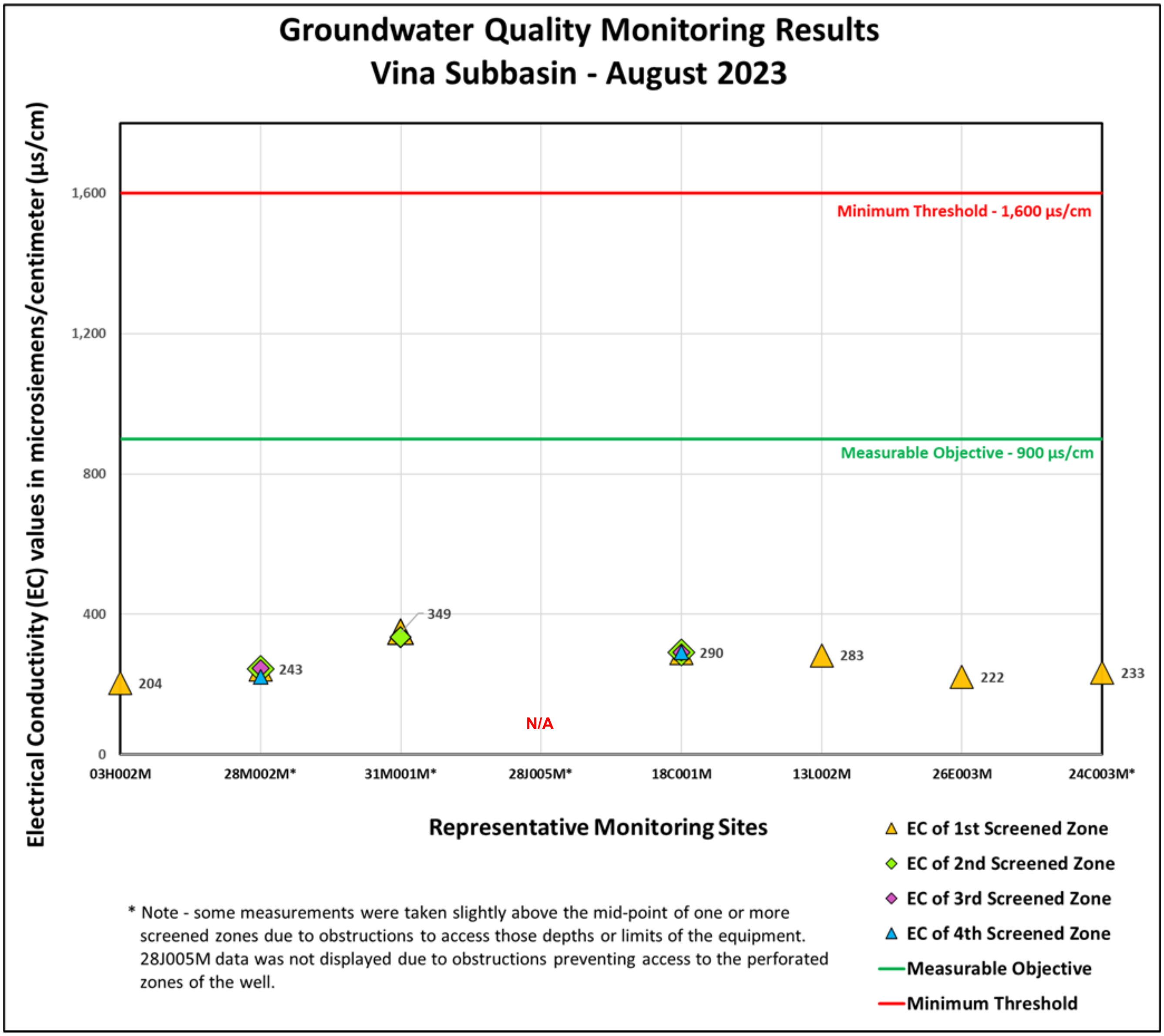


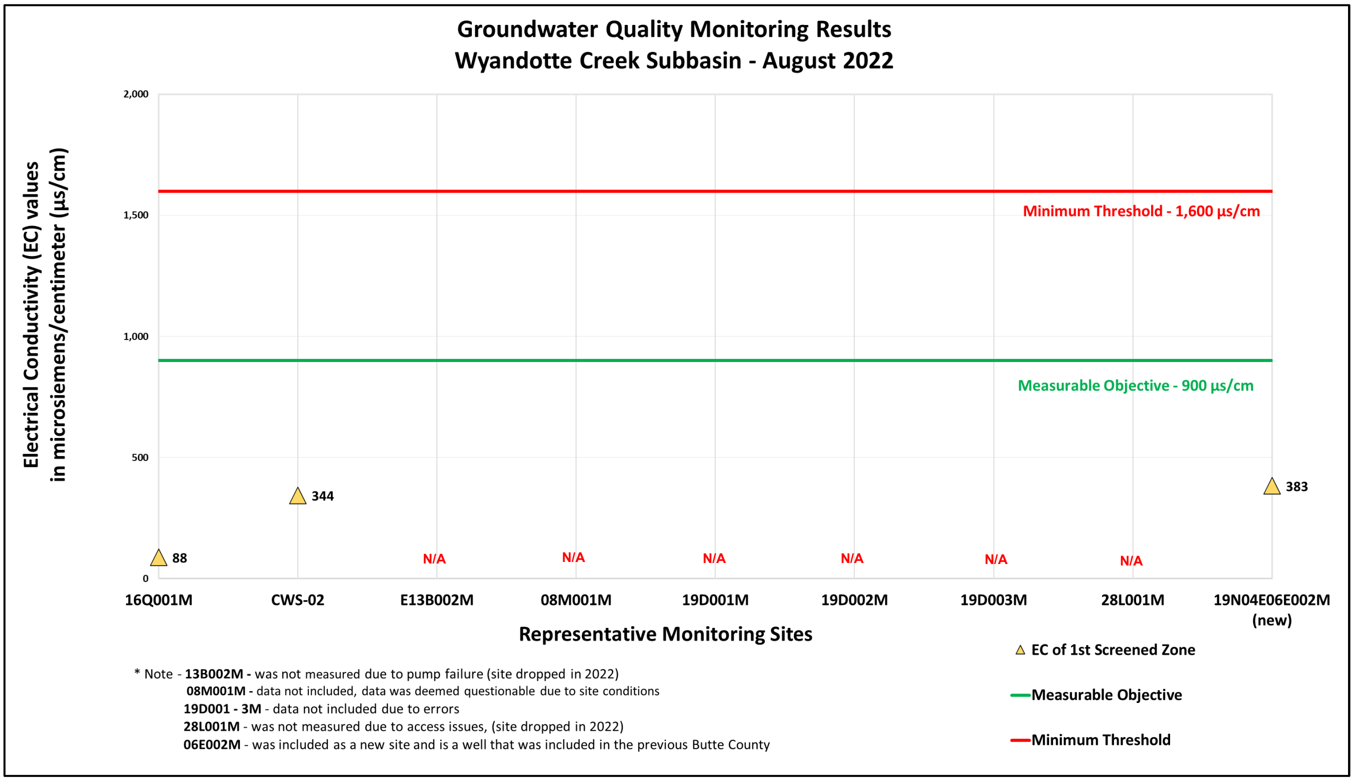
**Figure 6. Groundwater quality monitoring results in the Vina Subbasin for the 2023 water year**

GSP implementation, the GSAs may consider modifications to the groundwater quality RMS network as needed and / or technical support requests to DWR for video logging of the wells.

## Wyandotte Creek Subbasin

In the Wyandotte Creek Subbasin the majority of RMS wells measured had EC values that were lower than the MO of 900 µS/cm and therefore lower than the MT of 1,600 µS/cm in both years as shown in **Figures 7 and 8.** Results from RMS well 08M001M were not depicted in these figures as the data deemed to be questionable based on site conditions. Anecdotally, this general area of the Subbasin is known to have areas of high concentrations of salinity and natural gas.

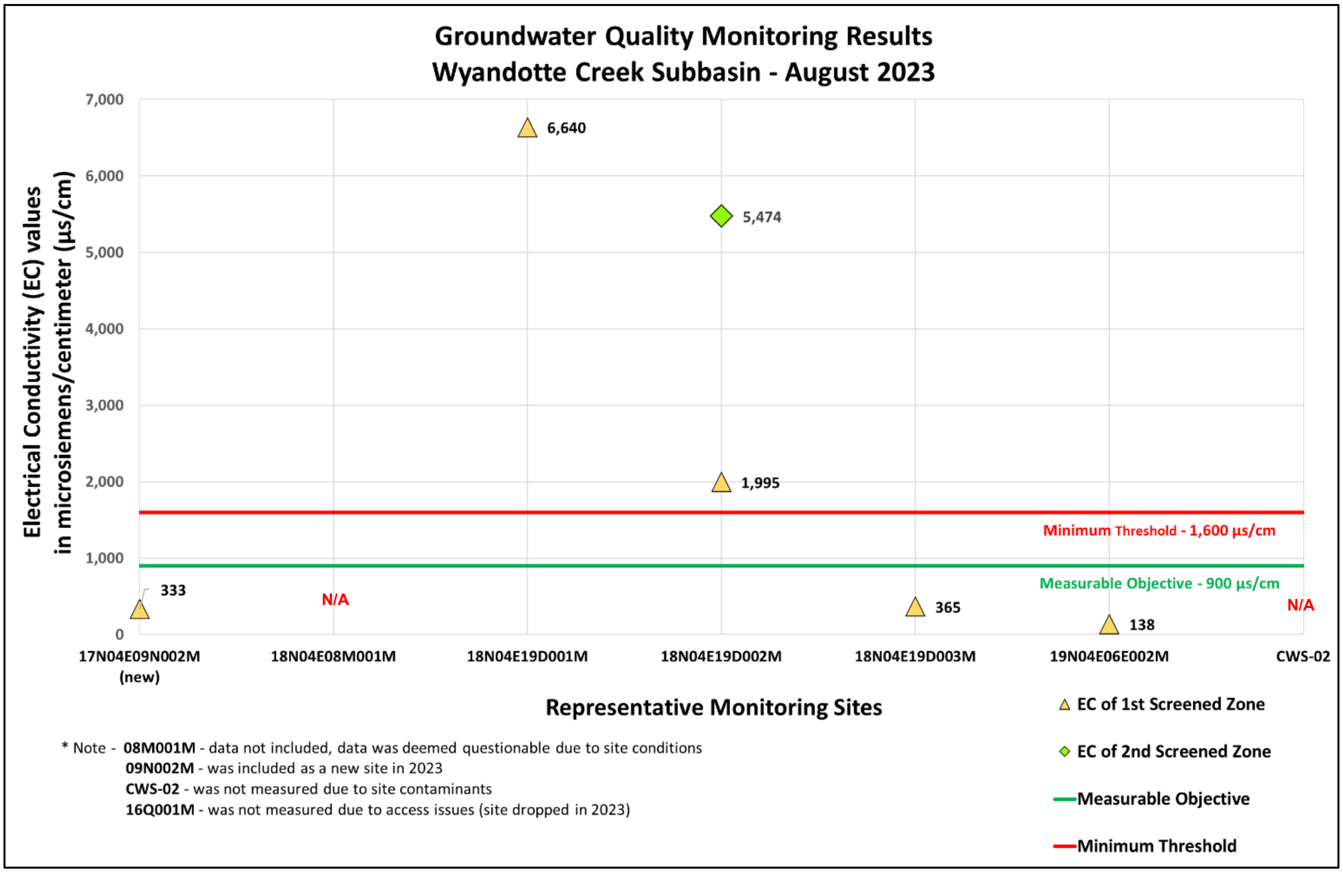
Additionally, two of the three new multi-completion wells drilled in 2021 by DWR through the Technical Support Services program exhibited high EC levels in 2023, exceeding the MT depicted in **Figures 8-9**. Wells 19D001M and 19D002M are each screened at varying intervals to monitor the deep and intermediate zones of the aquifer respectively. Both wells had high levels of EC greater than the MT when initially developed and again when the wells were re-tested months after initial development. Groundwater quality monitoring results for 2022 at these wells were not reported due to malfunctioning equipment. Better characterization of naturally occurring salinity is needed to help improve appropriate monitoring and management of groundwater with respect to water quality in this Subbasin.



Groundwater Quality Monitoring Results
Wyandotte Creek Subbasin - August 2022

* Note - **13B002M -** was not measured due to pump failure (site dropped in 2022)
**08M001M -** data not included, data was deemed questionable due to site conditions
**19D001 - 3M** - data not included due to errors
**28L001M** - was not measured due to access issues, (site dropped in 2022)
**06E002M** - was included as a new site and is a well that was included in the previous Butte County

**Figure 7. Groundwater quality monitoring results in the Wyandotte Creek Subbasin for the 2022 water year**



* Note - **08M001M** - data not included, data was deemed questionable due to site conditions
**09N002M** - was included as a new site in 2023
**CWS-02** - was not measured due to site contaminants
**16Q001M** - was not measured due to access issues (site dropped in 2023)

**Figure 8. Groundwater quality monitoring results in the Wyandotte Creek Subbasin for the 2023 water year**

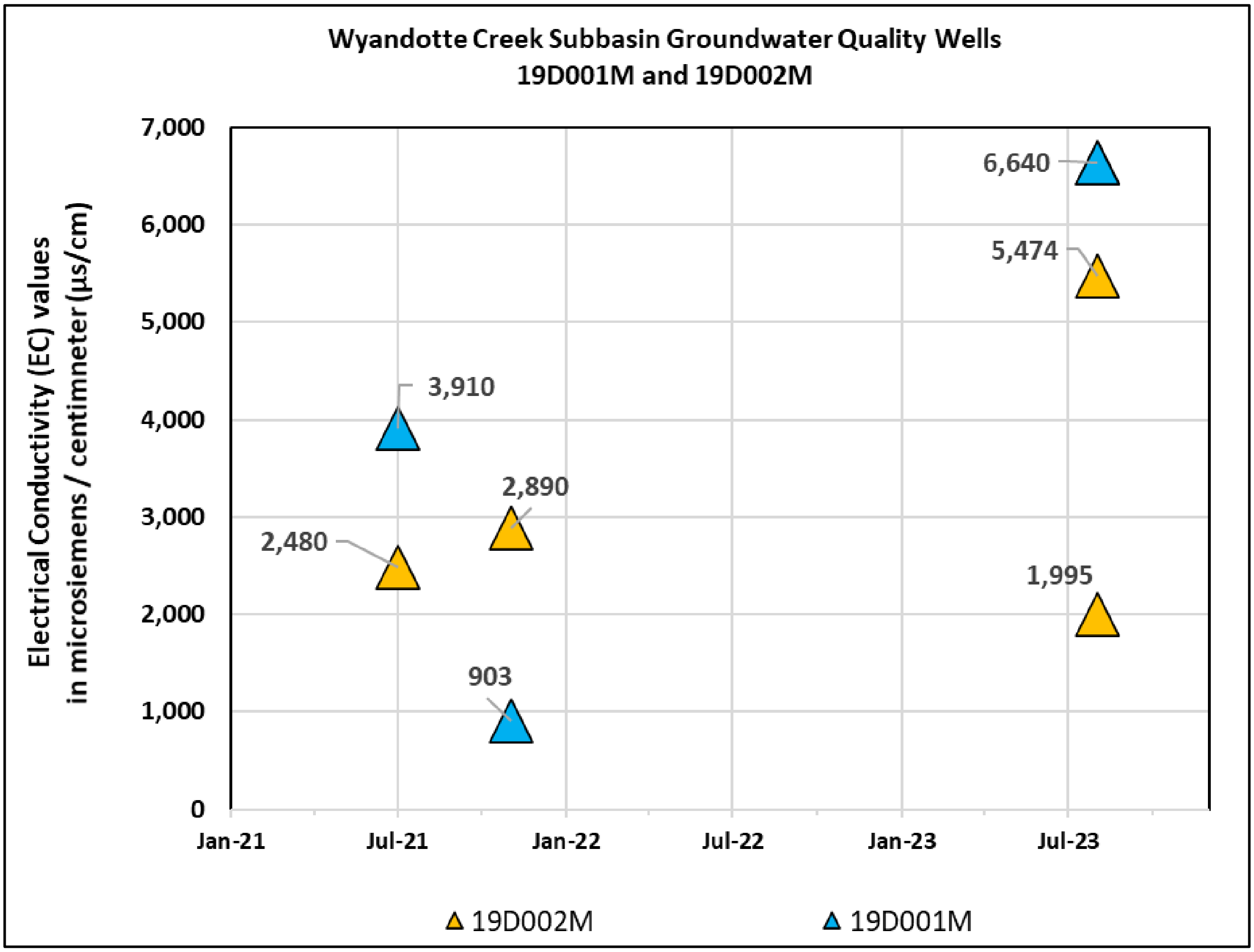


**Figure 9. Groundwater quality monitoring results for wells 19D001M and 19D002M in the Wyandotte Creek Subbasin for the 2023 water year**

## Discussion

Groundwater quality monitoring serves to establish baseline levels for EC throughout the Subbasins so that any future changes may be identified and further investigation and or monitoring can subsequently be developed. There were no RMS wells in exceedance of any MTs in the Vina Subbasin. While there were some concentrated EC levels in one well within the Butte Subbasin and two wells within the Wyandotte Creek Subbasin over the first two years of monitoring for EC as part of GSP implementation, there were no indications of Undesirable Results as defined in the GSPs. In the Butte Subbasin, 2023 was the first year any RMS wells exceeded an MT. Undesirable Results in both the Vina and Wyandotte Creek Subbasins are tied to non-dry water year types and 2022 was a dry water year type. Next year is likely to be a non-dry year and as such there may be indications of Undesirable Results in the Wyandotte Creek Subbasin as defined the GSP, if wells there continue to show elevated levels of EC. Better characterization of naturally occurring salinity is needed to help improve appropriate monitoring and management of groundwater with respect to groundwater quality in this Subbasin.

Additional monitoring will continue to be conducted by DWR and other agencies to track constituents not managed under the current GSPs, including a variety of minerals, metals, pesticides and herbicides. Data from ongoing monitoring by various state and federal agencies will be available to the GSAs to augment local datasets and understanding of groundwater quality and can be found on the State Board's Groundwater Ambient Monitoring and Assessment (GAMA) program at https://www.waterboards.ca.gov/gama.

The County will work with the GSAs to address modifications to the monitoring networks, conduct monitoring to support data collection, and ensure that data is submitted to DWR as required by SGMA.

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