ANNUAL REPORT | APRIL 2023

BOWMAN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN
ANNUAL REPORT – 2022

PREPARED FOR

TEHAMA COUNTY FLOOD CONTROL AND
WATER CONSERVATION DISTRICT
TEHAMA COUNTY - GSA

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AEM	airborne electromagnetic
af	acre-feet
af/ac	acre-feet per acre
bgs	below ground surface
CASGEM	California Statewide Groundwater Elevation Monitoring Online System
CVP	Central Valley Project
District	Tehama County Flood Control and Water Conservation District
DMS	data management system
DWR	Department of Water Resources
ET	evapotranspiration
eWRIMS	Electronic Water Rights Information Management System
ft	feet
GAMA	Groundwater Ambient Monitoring and Assessment Program
GIS	geospatial information system
GPCD	gallons per capita per day
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IM	interim milestone
InSAR	interferometric synthetic aperture radar
km	kilometer
m	meter
MO	measurable objective
MT	minimum threshold
NAVD 88	North American Vertical Datum of 1988
PMAs	Projects and Management Actions
PRISM	Parameter-elevation Regression on Independent Slopes Model
RMS	representative monitoring site
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
Subbasin	Bowman Groundwater Subbasin
SVSim	Sacramento Valley Groundwater-Surface Water Simulation Model
SWRCB	State Water Resource Control Board
Tehama IHM	Tehama Integrated Hydrogeological Model
Tehama County FCWCD	Tehama County Flood Control and Water Conservation District

TNC	The Nature Conservancy
USGS	United States Geological Survey
UWMP	urban water management plan
WY	water year

EXECUTIVE SUMMARY

ES 1. Introduction

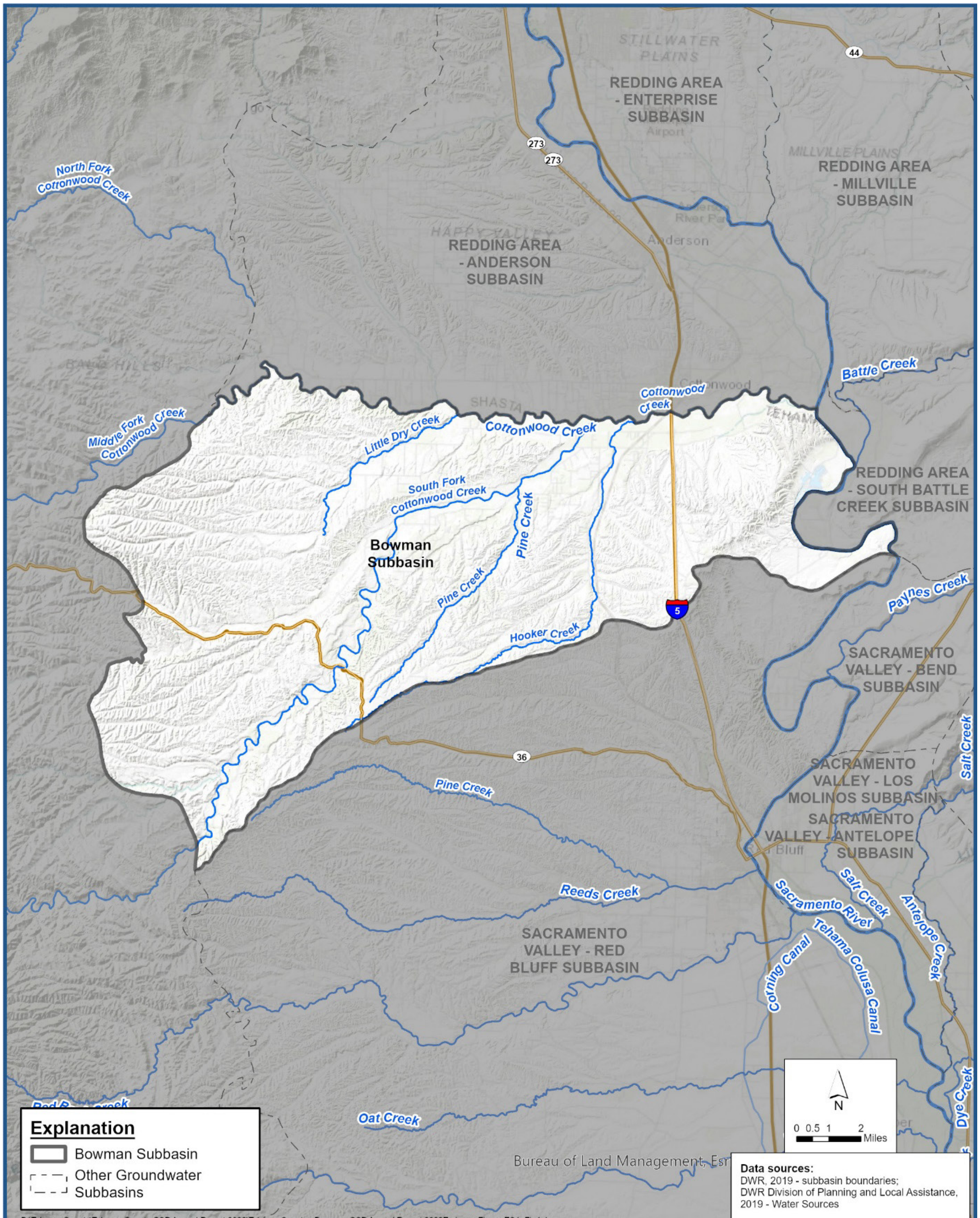
The annual report for the Bowman Subbasin (Subbasin) (5-006.01) was prepared on behalf of the Tehama County Groundwater Sustainability Agency (GSA) to fulfill the statutory requirements of the Sustainable Groundwater Management Act (SGMA) legislation (Section 10728) and regulatory requirements developed by the California Department of Water Resources (DWR) included in the Groundwater Sustainability Plan (GSP) Regulations (Section 354.40 and Section 356.2). The Regulations require the GSA to submit an Annual Report to DWR by April 1, 2023 following the reporting year (October through September).

The Bowman Subbasin covers 122,500 acres and is located in the Redding Area Groundwater Basin (**Figure ES-1**). Bowman is one of seven (7) groundwater subbasins within Tehama County. The Tehama County FCWCD is the exclusive GSA for six (6) of those subbasins: Antelope, Bend, Bowman, Los Molinos, Red Bluff, and South Battle Creek. The seventh is the Corning Subbasin which extends into Glenn County, that subbasin is managed in a coordinated effort between the Tehama County FCWCD and the Corning Sub-basin GSAs.

This report is the second Annual Report prepared to support the adopted Bowman Subbasin GSP submitted in January 2022. This Annual Report includes data elements for the current reporting Water Year (WY) of 2022. Pursuant to GSP Regulations, the Annual Report includes:

1. Groundwater Elevation Data
2. Water Supply and Use
3. Change in Groundwater Storage
4. GSP Implementation Progress

This Annual Report coincides with one of the most severe and extensive droughts in the western United States' recorded history. In WY 2022, drought conditions in this subbasin were classified as ranging from "extreme" to "exceptional," the most extreme classification defined by the U.S. Drought Monitor. Historically, observed impacts during exceptional drought generally include: widespread water supply shortages, depleted surface water supplies, extremely low federal and state surface water deliveries, curtailment of water rights, extremely high surface water prices, increased groundwater pumping to satisfy water demands, dry groundwater wells, increased well drilling and deepening, increased pumping costs, wildfire, decreased recreational opportunities, and poor water quality, among other potential impacts reported by the U.S. Drought Monitor. All of these conditions were experienced to a degree across California in 2022 and, at least in part, within the Subbasin.



TEHAMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
LSCE Team

Subbasin Area Map

Figure ES-1

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

ES 2. Groundwater Elevations

Groundwater elevation data in the Upper and Lower Aquifers for WY 2022 was analyzed. The Water Year is defined as October through September. Groundwater elevation contour maps for seasonal low and seasonal high-water levels were prepared for WY 2022. Four Representative Monitoring Site (RMS) wells exist that monitor groundwater levels in the Upper Aquifer while three RMS wells are screened in the Lower Aquifer. Seasonal high groundwater elevations were all above the measurable objectives during WY 2022.

ES 3. Water Supply and Use

Table ES-1 includes groundwater use data by sector for WY 2022, numbers are rounded to two significant digits, except totals which are unrounded. The agricultural sector had the greatest increase in use from 6,800 af in WY 2021 to 12,000 acre-feet (af) in WY 2022. Native vegetation experienced an increase from 1,500 af in WY 2021 to 2,100 af in WY 2022, while urban groundwater use saw a slight decrease from 1,300 af in WY 2021 to 1,000 af in WY 2022. In WY 2021 Urban use included estimated Rural Residential use, in the WY 2022 Annual Report they are reported separately. WY 2022 has been preliminarily classified as Critical by DWR (DWR, 2022).

Table ES-1. Groundwater Use by Water Use Sector

Sector	2022 (af)
Agricultural	12,000
Urban	580
Rural Residential	430
Native Vegetation (Plant groundwater uptake)	2,100
Total	**15,110**
Total (excluding Native Vegetation[1])	**13,010**

[1] Excludes native vegetation which involves only natural plant uptake of shallow groundwater, not direct pumping, and extraction.

Total surface water deliveries have been estimated from total surface water diversions by accounting for conveyance losses, reuse, and boundary outflows for WY 2022 and are presented in **Table ES-2**, numbers are rounded to two significant digits, except totals which are unrounded. Total surface water deliveries for the Bowman Subbasin were estimated to be about 210 af for WY 2022.

Table ES-2. Surface Water Deliveries by Water Use Sector and Source		
Sector	2022 (af)	
	Supply Source	
	CVP	Local
Agricultural	210	0
Urban	0	0
Native Vegetation	0	0
Total	**210**	

ES 4. Groundwater Storage

Changes in groundwater storage from Spring 2021 to Spring 2022 were calculated using measured groundwater levels and a storage coefficient for the Upper and Lower Aquifers. Changes in groundwater levels from Spring 2021 to Spring 2022 at selected wells were interpolated to estimate the groundwater elevation change in areas where sufficient data was available. Estimated elevation change was multiplied by a storage coefficient (0.066) available from the Tehama Integrated Hydrogeological Model (Tehama County FCWCD, 2022) to estimate the groundwater storage change volume in the Upper and Lower aquifers. Changes in storage calculations are described further in **Section 2.1**. **Table ES-3** presents the annual storage change values for the Upper and Lower Aquifers.

Table ES-3. Change in Groundwater Storage Based on Seasonal High Groundwater Levels	
Aquifer	2022 (af)
Upper Aquifer	-6,000
Lower Aquifer	-11,000
Total	**-17,000**

ES 5. GSP Implementation Progress

ES 5.1 Progress Towards Achieving Sustainability

Groundwater conditions were above the established Minimum Thresholds (MTs) for the chronic lowering of groundwater levels sustainable management criteria (SMC) in Spring 2022. Overall, water levels in Spring 2022 were lower than Spring 2021 due to extended drought conditions.

The GSA is on track to stay above the Measurable Objective (MO) for the land subsidence SMC. The land subsidence MT is 0.5 feet (ft) per five years.

The depletion of interconnected surface water SMC uses spring groundwater elevations in wells within the monitoring network, and all interconnected surface water RMS wells' water levels were above MT levels.

ES 5.2 Progress Towards PMA Implementation

Updates and activities since the previous Annual Report include the Tehama County FCWCD GSA submitting a proposal for funding through DWR's SGM Grant Program in order to further develop and fund project and management actions (PMAs) for monitoring, recharge, and conjunctive use. A draft awards list for the grant application is anticipated to be released by DWR in June 2023. The GSA also coordinated with DWR who conducted an airborne electromagnetic (AEM) survey in the summer of 2022 to address data gaps in the subbasin. Other actions include monitoring and recording of groundwater levels and quality data, maintaining, and updating the Data Management System (DMS), annual reporting of subbasin conditions, and ongoing intra- and inter-basin coordination.

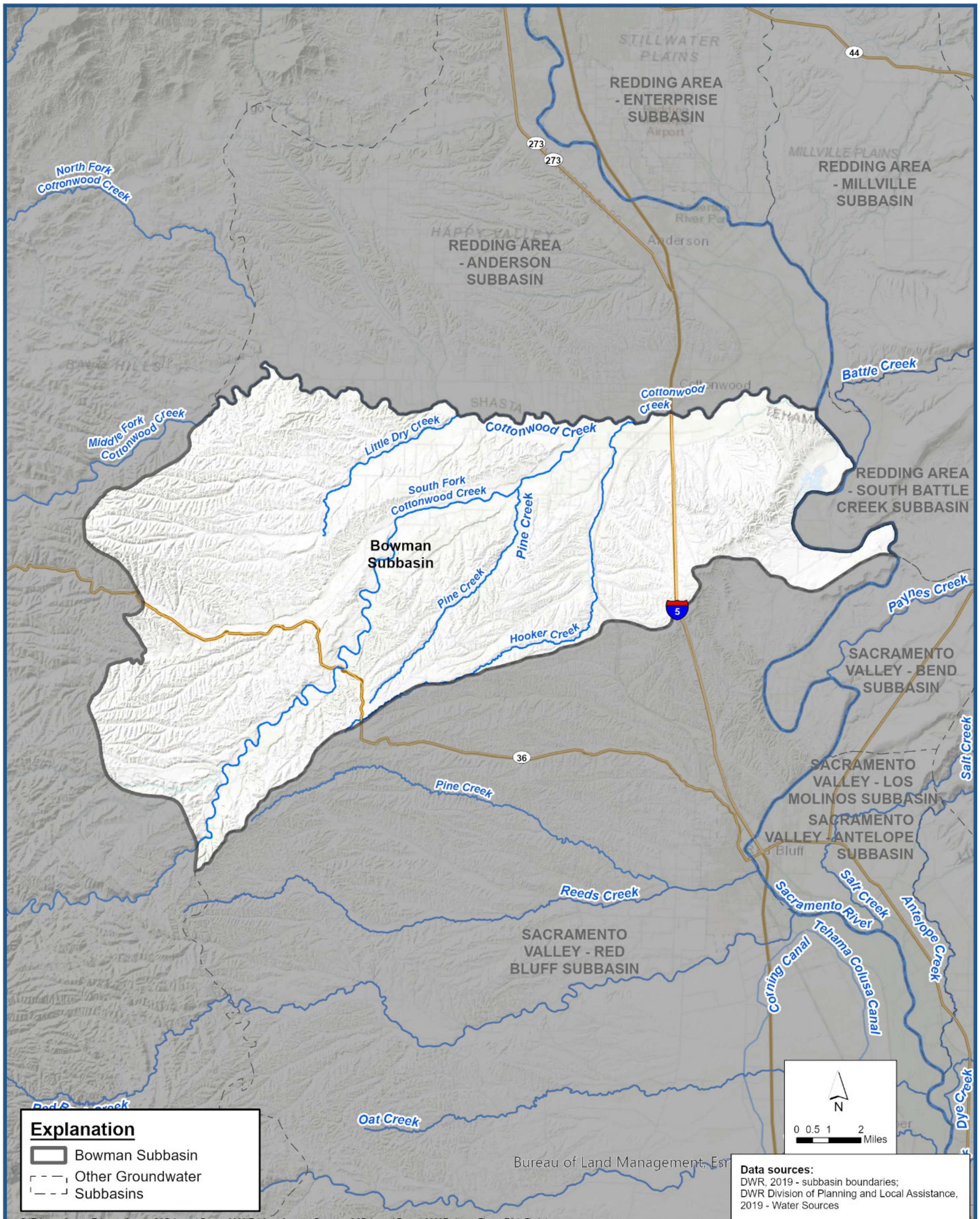
1. GENERAL INFORMATION

The annual report for the Bowman Subbasin (Subbasin) (5-006.01) was prepared on behalf of the Tehama County Flood Control and Water Conservation District (Tehama County FCWCD or District), Groundwater Sustainability Agency (GSA) to fulfill the statutory requirements of the Sustainable Groundwater Management Act (SGMA) legislation (Section 10728) and regulatory requirements developed by the California Department of Water Resources (DWR) included in the Groundwater Sustainability Plan (GSP) Regulations (Section 354.40 and Section 356.2). The Regulations require the GSA to submit an Annual Report to DWR by April 1st following the reporting year (October through September).

1.1. Subbasin Setting

The Bowman Subbasin (DWR Subbasin No. 5-006.01) covers 122,500 acres and is located in the Redding Area Groundwater Basin. The lateral extent of the Subbasin is defined by the Subbasin boundaries provided in Bulletin 118 (DWR, 2018) It is bounded on the north by the Anderson Subbasin (DWR Subbasin No. 5-006.03), on the south by the Red Bluff Subbasin (DWR Subbasin No. 5-021.50), on the east by the South Battle Creek Subbasin (DWR Subbasin No. 5-006.06), and on the west by the Northern Coast Mountain Ranges. The northern and eastern boundaries of the Subbasin generally follow Cottonwood Creek and the Sacramento River, respectively, and the western boundary generally aligns with the Northern Coast Mountain Range (**Figure 1-1**).

Current data sources (discussed in **Section 3.2**) estimate 91% of the Subbasin is native vegetation, 4% is agricultural, and 1% is riparian vegetation. The Subbasin's agricultural water users rely on both surface water and groundwater to irrigate their crops. The Subbasin receives surface water supplies from the Central Valley Project (CVP) through surface water diverted by small CVP contractors to irrigated land along the Sacramento River.



Subbasin Area Map

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 1-1

Fresh groundwater bearing geologic deposits in the Subbasin are subdivided from previous studies into two units: The Upper Aquifer and the Lower Aquifer (DWR, 2003; DWR, 2004). The two-aquifer designation is based on an examination of groundwater elevation time-series, electric resistivity data from geophysical logs, lithologic logs, well construction details, and review of previous studies in the Subbasin. Generally, semi-confined, and confined aquifer conditions are encountered at depth and unconfined conditions are seen in the shallower porous media. The complexity of the geologic materials and the formations makes it difficult to define a singular widespread aquitard or distinctive change in geologic materials separating an Upper and Lower Aquifer. To delineate between areas with a higher likelihood of confined conditions, well construction data throughout the Subbasin were examined. Water bearing geologic units in the Upper Aquifer include the Quaternary formations and the upper portions of the Tehama and Tuscan Formations. Wells screened in the Upper Aquifer are largely for domestic purposes. The depth to the bottom of the Upper Aquifer is approximately 350-450 feet (ft) below ground surface (bgs).

The Lower Aquifer is defined as the freshwater bearing geologic units throughout the Subbasin from the bottom of model layer 5 at approximately 350-450 ft bgs, to the bottom of the Subbasin. The aquifer is confined to semi-confined conditions. Water bearing geologic units include the lower portions of the Tehama and Tuscan Formations. Wells screened in the Lower Aquifer are largely for non-domestic purposes.

1.2. Report Contents

This report is the second Annual Report prepared to support the adopted Bowman Subbasin GSP submitted in January 2022. The Annual Report includes data elements for the current reporting Water Year (WY), 2022. Data elements presented in this report refer to the Water Year (the 12-month period from October through September) unless otherwise noted. Pursuant to of the GSP Regulations, the Annual Report includes:

1. Groundwater Elevation Data
2. Water Supply and Use
3. Change in Groundwater Storage
4. GSP Implementation Progress

2. GROUNDWATER ELEVATIONS SECTION 356.2(B)(1)

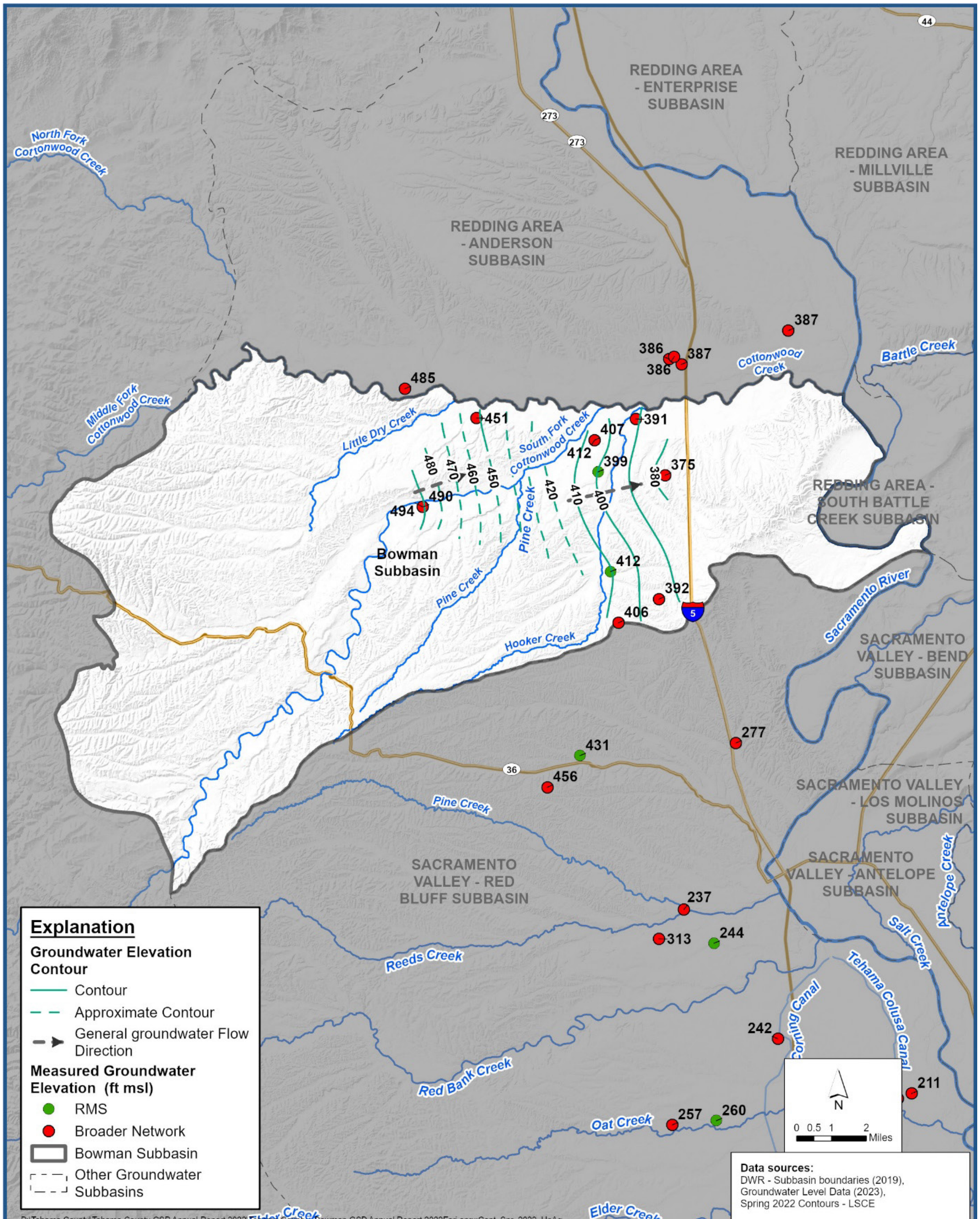
Currently, 32 wells are monitored as part of a broad network for groundwater levels and seven are Representative Monitoring Site (RMS) wells assigned Sustainability Management Criteria (SMC). The wells are measured at least in the spring and fall each year. Groundwater elevation data in each of the principal aquifers for WY 2022 were analyzed. Hydrographs for these wells are included in **Appendix A**. **Appendix B** includes a copy of the monitoring data used to generate this Annual Report pursuant to GSP regulations (Section 354.40). Groundwater elevation contour maps for seasonal low and seasonal high-water levels were prepared for WY 2022. Groundwater level data collected at RMS and other wells used to develop groundwater contours and RMS well hydrographs are collected by DWR, United States Geological Survey (USGS), The Nature Conservancy (TNC) and the District and records are maintained by the State Water Resources Control Board (GAMA) and DWR (CASGEM). Records of groundwater elevations are also maintained in the GSA's data management system (DMS).

2.1. Groundwater Elevation Contours – Section 356.2(b)(1)(A)

Seasonal high and seasonal low groundwater elevation contour maps for WY 2022 are presented for the Upper Aquifer on **Figures 2-1** and **2-2** and in the Lower Aquifer on **Figures 2-3** and **2-4**. The seasonal high contours were prepared based on observed maximum springtime (February-May) water levels, while the seasonal low contours were prepared based on minimum water levels measured in July-October. Due to the limited number of wells in the subbasin and to resolve data gaps near the edge of the subbasin wells neighboring the Bowman Subbasin were included in the contouring process. Wells were not displayed in contour maps if data did not exist at that well during the mapping period. Contours are shown solid if there is good confidence in the contour placement whereas contours are shown dashed if their position is inferred from data yet generally representative of the contour's true location. Contours are not drawn if confidence in contours is poor. Most notably this occurs on the far east side of the subbasin where coverage of monitoring wells is poor. Groundwater elevations on the contour maps are shown as feet above mean sea level (ft amsl) based on the North American Vertical Datum of 1988 (NAVD 88).

The contour maps illustrate general features of the groundwater flow system in the Bowman Subbasin, including:

- Strong gradients indicate groundwater flow moving west to east.



TEHAMA COUNTY
FLOOD CONTROL AND WATER CONSERVATION DISTRICT

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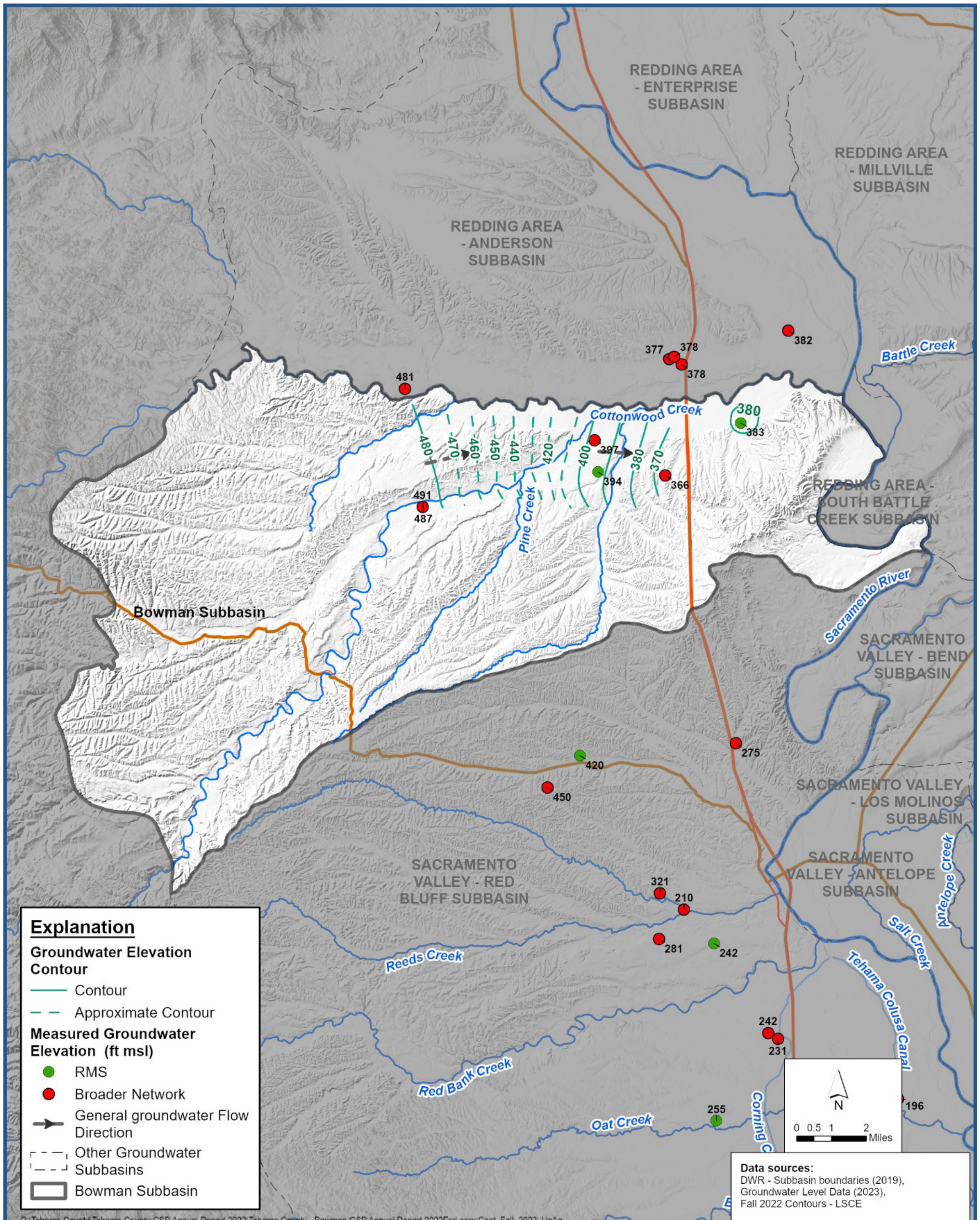
Contours of Equal Groundwater Elevation, Upper Aquifer - Spring 2022

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 2-1



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TEHAMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

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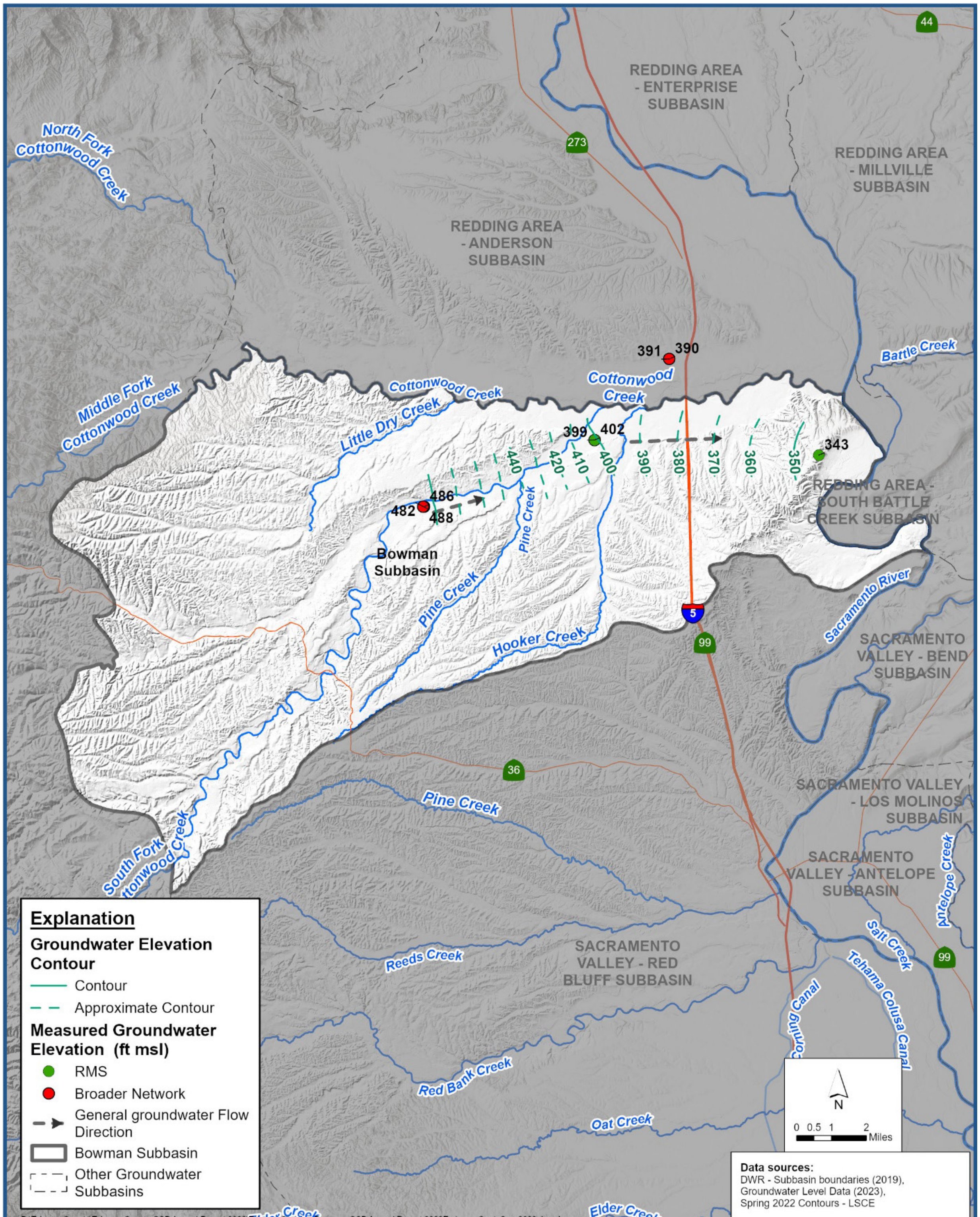
Contours of Equal Groundwater Elevation, Upper Aquifer - Fall 2022

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 2-2



TEHAMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
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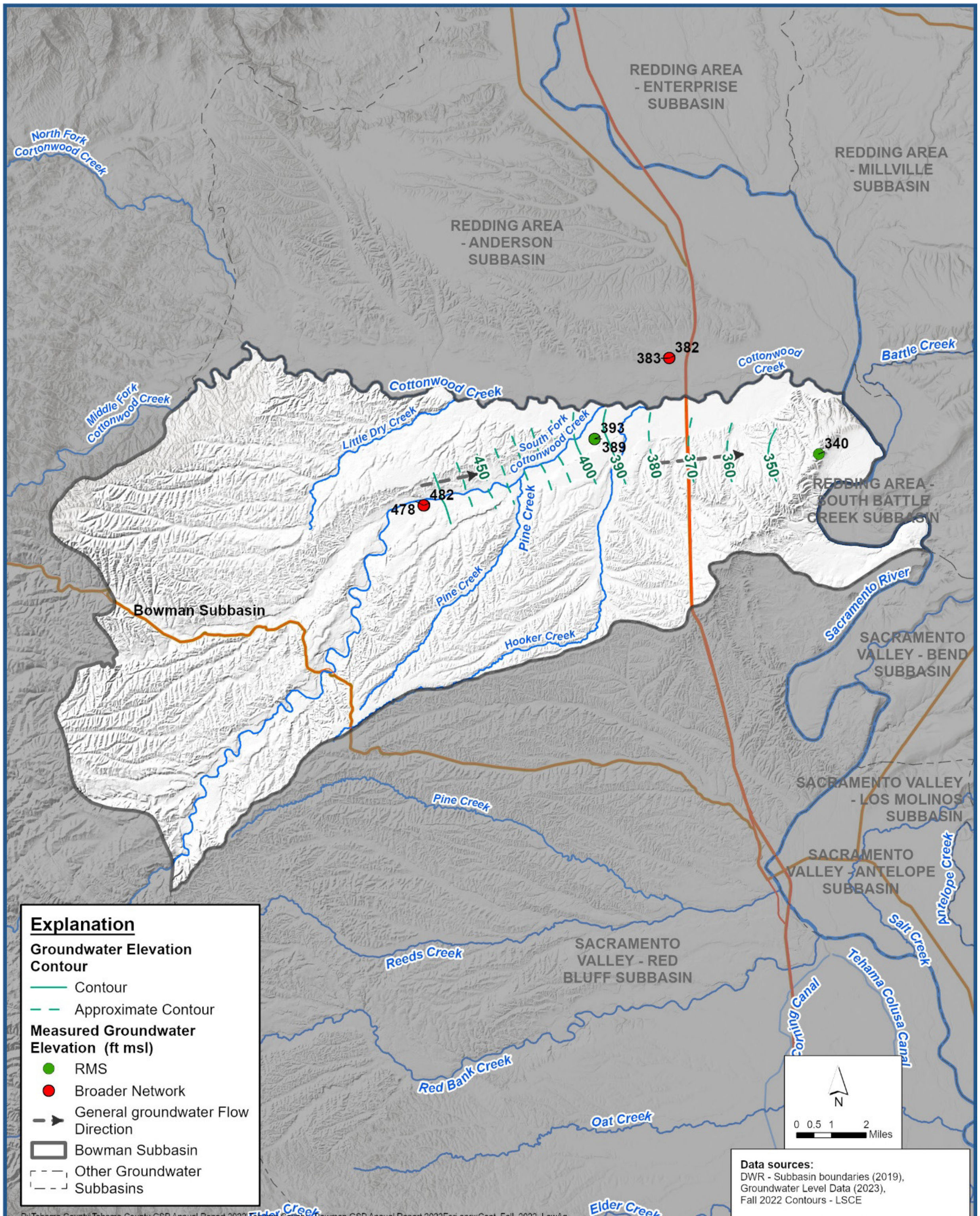
Contours of Equal Groundwater Elevation, Lower Aquifer - Spring 2022

Groundwater Sustainability Plan – Annual Report WY 2022

Figure 2-3



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Contours of Equal Groundwater Elevation, Lower Aquifer - Fall 2022

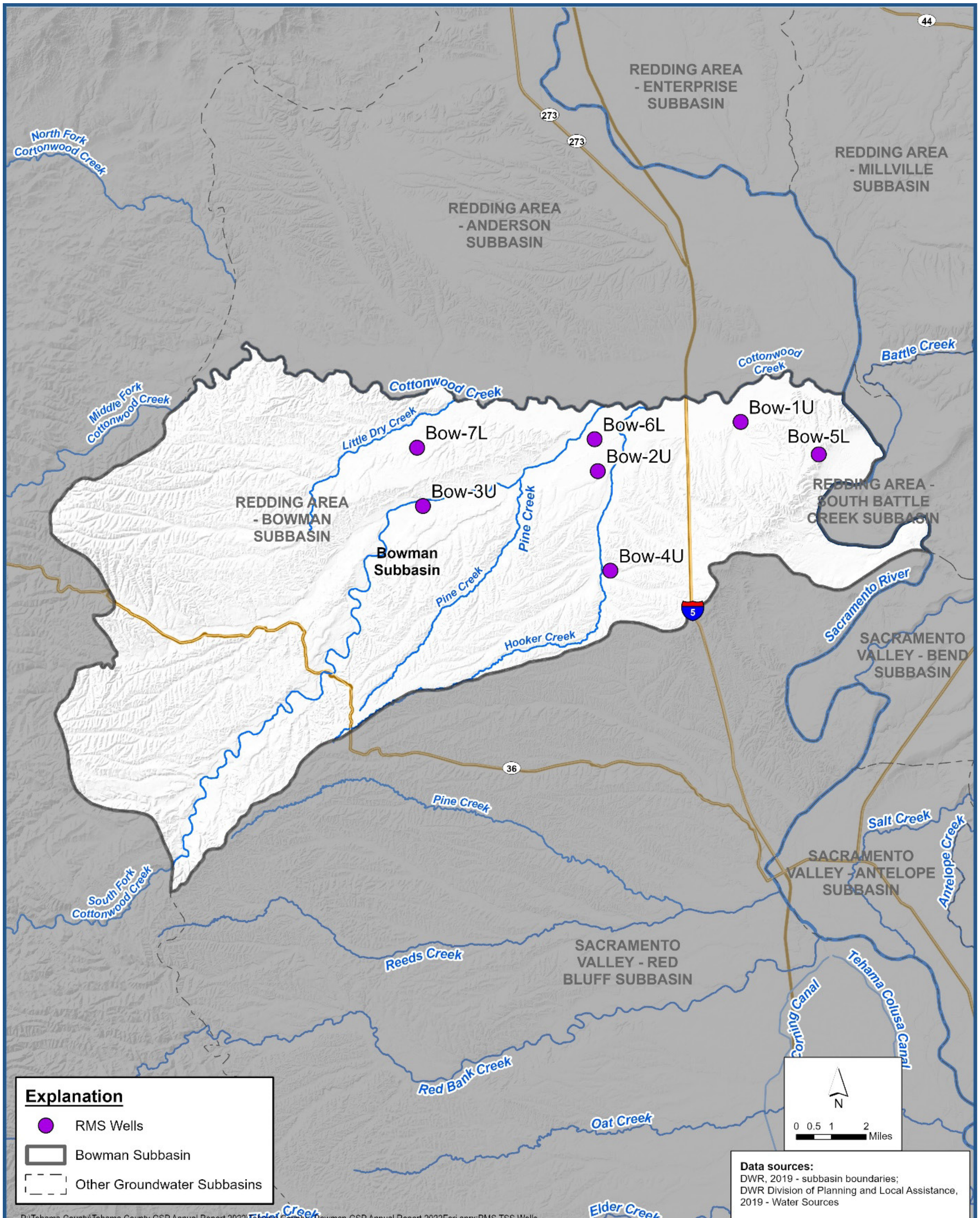
Groundwater Sustainability Plan – Annual Report WY 2021-2022
Bowman Subbasin

Figure 2-4

2.2. Groundwater Elevation Hydrographs – Section 356.2(b)(1)(B)

Hydrographs of groundwater elevations were prepared for all seven RMS wells in both the Upper and Lower Aquifers. RMS wells are distributed throughout the Subbasin to provide broad spatial coverage of the Subbasin. **Figure 2-5** shows the distribution of the current RMS wells. The process for selecting these sites is documented in the Bowman Subbasin GSP. 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. 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.

All seasonal high groundwater elevations were above the Minimum Thresholds (MT) during WY 2022. Additionally, all wells experienced spring maximums that were above the Measurable Objectives (MO). Fall measurements at four wells (Bow-1U, Bow-2U, Bow-4U, and Bow-6L) had seasonal low (fall) groundwater elevations below their MO, though all were well above their respective MT. Copies of hydrographs for all RMS wells are included in **Appendix A**.



TEHAMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

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RMS Network

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 2-5

3. WATER SUPPLY AND USE

Water supply and use information are presented below. Water use data by sector (required per Section 356.2) is summarized in **Section 3** and categorized by groundwater extraction, surface water supply and total supply using the best data available. Water use sectors are broadly identified as agricultural, urban, and native vegetation land uses.

Groundwater use data was taken from records where available and otherwise were estimated from 2022 land use data, climate conditions, and crop coefficients consistent with those used in the Tehama Integrated Hydrogeological Model (Tehama IHM). Surface water use was estimated from historic deliveries when records were not available. Numbers are rounded to two significant digits, except totals which are unrounded.

3.1. Water Budget Approach

Water supply and use in the Subbasin were quantified using the best available data sources and information. Where available, groundwater extraction and surface water supplies were quantified directly from measured and reported groundwater pumping, surface water diversions, and deliveries data. However, groundwater extraction data has historically been limited, particularly for privately-owned wells. Thus, a water budget approach has been used to estimate the remaining, unmeasured volume of groundwater extraction that has occurred to meet demand in the Subbasin.

The Tehama IHM model was used to prepare water budgets for the Subbasin during GSP development. The model was adapted from the Sacramento Valley Groundwater-Surface Water Simulation Model (SVSim, version BETA 3-19-2020; DWR, 2020). Direct measurements of groundwater extraction data could not be used in the model calibration to determine accuracy due to the limited number of observations. Instead, water levels and stream flows were used to calibrate the model resulting in a normalized root mean of squared residual error of five percent. The first Annual Report for WY 2021 leveraged information from the Tehama IHM model to quantify subregion-scale water budgets in the Subbasin through WY 2021. More information about the model's development process can be found in the GSP Appendix 2-J. In the WY 2022, a modified approach to the water budget calculation is utilized to enhance the resolution of the water budget. The method follows the framework laid out in Hessels et al. (2022).

Building on past work, the water budget approach used in this Annual Report utilizes available geospatial data and information to quantify crop water demand, precipitation, and other parameters with pixel-scale resolution (30-meter (m) x 30 m), corresponding to the spatial resolution of satellite imagery used in developing these inputs. In addition to geospatial data, available surface water supply and groundwater extraction data is incorporated into the water budget by distributing that water out to specific regions where that water is used (e.g., surface water supplier service areas). The remaining groundwater extraction needed to meet demand is then calculated based on the balance of water demand and available water supplies, with consideration for rainfall, irrigation, and soils characteristics. The result is a spatially distributed water budget calculated with a finer spatial resolution than was possible in the previous 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 budget summaries for any region of the Subbasin.

This approach was used to calculate monthly water budgets by water use sector in the Subbasin during the current reporting year (WY 2022), as required in Title 23 of the California Code of Regulations Section 356.2. Key water budget inflows and outflows calculated in this water budget approach were compared with equivalent values from the Tehama IHM model and the first Annual Report, allowing verification of the consistency between this water budget approach and previous approaches.

Data and information that is used in the water budget approach generally includes:

- Actual evapotranspiration (ET) estimates, extracted from OpenET remote sensing analyses. OpenET is a multi-agency web-based geospatial information system (GIS) utility that quantifies spatial ET using satellite imagery. 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. The OpenET modeling approaches utilize the same surface energy balance approach used in the Tehama IHM model used in GSP development. OpenET results are available in the Subbasin with a spatial resolution of 30 m x 30 m (approximately 0.22 acres), allowing easily scalable ET quantification.
    - Additional information about the OpenET team, data sources, and methodologies are available at: https://openetdata.org/.
- Precipitation estimates, 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 the Subbasin with a spatial resolution of 4-kilometer (km) x 4 km.
    - Additional information about the PRISM data and methodologies are available at: https://prism.oregonstate.edu.
- 2022 land use data, evaluated through two approaches. Both datasets were compared and evaluated to identify changes in land use as well as the spatial extent of water use sectors in the Subbasin.
    - Pixel-scale (30 m x 30 m) land use coverages of the Subbasin were prepared through analysis of the following datasets:
        - DWR 2019 statewide crop mapping dataset (https://data.cnra.ca.gov/dataset/statewide-crop-mapping)
        - United States Department of Agriculture (USDA) CropScape 2022 Cropland Data Layer coverage (https://nassgeodata.gmu.edu/CropScape/).
            - Measured surface water diversions data, reported from water supplier records, or collected from publicly available sources (water rights diversion records, etc.). Surface water diversions data are generally available at the supplier scale. In this water budget approach, diversions were distributed evenly across the irrigated pixels associated with that supplier's service area.
            - Measured groundwater extraction data, reported from municipal and agricultural water supplier pumping records and private pumping records, where available. Groundwater extraction data is generally available at the

supplier scale, and was distributed evenly across the urban or irrigated pixels associated with that supplier's service area.

- Measured boundary water outflow data, reported from water supplier records where available.

Additional details for groundwater extraction and surface water supply data sources are given in the sections below.

3.2. Groundwater Extraction – Section 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 in the Subbasin is estimated through the water budget approach described in the previous section.

A portion of the Subbasin is dependent on groundwater as the only available water source for agricultural irrigation. During dry and critically dry years, agricultural groundwater extraction increases relative to long-term average demand due to less rainfall, reduced soil moisture, increased evapotranspiration associated with hotter, drier conditions, and less surface water available for diversion. Additionally, agricultural groundwater extraction increased in 2022 compared to prior years due to reduced surface water supply availability[1]. There are a total of 4,400 cropped acres in the Bowman Subbasin, and the agricultural groundwater extraction for these lands (estimated through the water budget approach described above) for WY 2022 was 12,000 acre-feet (af).

Rio Alto Water District is the only municipal supplier in the Subbasin and is fully dependent on groundwater for their water supplies. In contrast to agricultural water use, municipal water use during drought years may decrease relative to long-term averages due to urban conservation efforts. Municipal water supplies in the Bowman Subbasin are measured and were provided by Rio Alto Water District. The total volume during WY 2022 was 580 af.

Additionally, private domestic wells provide rural residential water needs throughout the Subbasin. Rural residential groundwater extraction through domestic wells was estimated based on the City of Red Bluff's 2020 Urban Water Management Plan's (UWMP) 2020 water use (City of Red Bluff, 2020), which is considered to be representative of the area. Water use in 2020 was 253 gallons per capita per day (GPCD). The 2020 GPCD was combined with 2020 census data for parcels that are not serviced by municipal supplies. Parcel data was obtained from county GIS portals. The census designated value of 2.63 persons per household for the county was multiplied by the selected residential parcels to determine the number of people in those households. This value was then used to estimate water usage using the GPCD. The total volume during WY 2022 was 430 af.

Environmental groundwater use in the Subbasin includes uptake of shallow groundwater from deepl-rooted plants. Although no groundwater is directly pumped or extracted for use in these areas,

[1] Anderson-Cottonwood Irrigation District (ACID) did not divert or deliver any surface water supplies during the 2022 irrigation season.

the consumptive use of shallow groundwater has been estimated through the water budget approach described above for areas classified as riparian vegetation. The estimated volumes are based on the evaporative demand unable to be met through precipitation that must be met through shallow groundwater. There are roughly 1,100 acres of riparian vegetation that had a total estimated groundwater use of 2,100 af, roughly 1.8 af per acre (af/ac). This method of estimating environmental groundwater use is dependent on both precipitation and ET estimates, and small changes or uncertainties in precipitation, ET, or ET from precipitation have a large impact on the overall estimated volume. Additionally, the method does not differentiate between evapotranspiration coming from changes in root zone soil moisture storage and the shallow groundwater system. As a result, a portion of the quantified environmental groundwater demand may be met through a depletion of root zone soil moisture rather than uptake of shallow groundwater from the aquifer. All else being equal, larger depletions of root zone soil moisture are more likely to occur (1) during below normal, dry, and critical water years and (2) in landscapes with deeply rooted vegetation.

Also, there are a total of 111,000 additional acres of native vegetation, which are primarily oak woodlands in the western portion of the Subbasin. Potential shallow groundwater use from deeply-rooted plants in these areas has not been quantified for the Annual Report, but could be considered and further evaluated in future years.

The Bowman Subbasin did not have managed recharge or groundwater extractions for managed wetlands in WY 2022. The municipal supplies do not distinguish between urban and industrial water uses.

The total estimated groundwater extraction in WY 2022 was approximately 15,000 af. This is about 5,400 af greater than WY 2021 groundwater extraction of 9,600 af for the Subbasin reported in the last Annual Report (WY 2021); the difference is largely influenced by increased agricultural pumping in WY 2022 due to the increased demand for water by crops during drier conditions and the need to compensate for reduced surface water supplies during droughts. **Figure 3-1** shows the location and volume of groundwater extractions in WY 2022 for the Subbasin. **Table 3-1** shows groundwater use by sector. WY 2022 has been preliminarily classified as Critical by DWR (DWR, 2022).

The agricultural sector had the greatest increase in use from 6,800 af in WY 2021 to 12,000 af in WY 2022. Native vegetation experienced an increase from 1,500 af in WY 2021 to 2,100 af in WY 2022, while urban groundwater use saw a slight decrease from 1,300 af in WY 2021 to 1,000 af in WY 2022. In WY 2021 Urban use included an estimated Rural Residential use, in WY 2022 they reported separately. In WY 2022 the agricultural sector accounted for approximately 80 % of the total groundwater extraction, while the remaining 20 % was utilized for Urban, Rural Residential, and Native Vegetation water needs.

Table 3-1. Groundwater Use by Water Use Sector	
Sector	**2022 (af)**
Agricultural	12,000
Urban	580
Rural Residential	430
Native Vegetation (Plant groundwater uptake)	2,100
Total	**15,110**
Total (excluding Native Vegetation[1])	**13,010**

[1] Excludes native vegetation which involves only natural plant uptake of shallow groundwater, not direct pumping, and extraction.

3.3. Surface Water Supply – Section 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. Surface water supplies are either local supplies or supplies available through the CVP.

Surface water supplies provided about two percent of the agricultural water demand in the Subbasin for WY 2022. Diversions from the Sacramento River and Cottonwood Creek and its tributaries were accessed from the State Water Resource Control Board's (SWRCB) Electronic Water Rights Information Management System (eWRIMS; SWRCB, 2023) data, and from CVP diversion records (USBR, 2023). CVP diversions are to Anderson-Cottonwood Irrigation District which is primarily in the Anderson Subbasin, but some lands lie within the Bowman Subbasin. The local and CVP supplies can be summed to calculate total diversions. CVP supplies constitute the entirety of supplies available within the Subbasin in WY 2022; there were no local supplies estimated to be available in WY 2022.

There are currently no surface water supplies for use by the urban or riparian/native vegetation sectors in the Bowman Subbasin; all surface water use is for agricultural purposes. Two surface water supply volumes are included and reported in this section. **Table 3-2** depicts total diverted surface water, which are the volumes obtained from the sources described above. Total surface water diversions for the Bowman Subbasin were estimated to be about 400 af for WY 2022. No surface water supplies were used during the 2022 irrigation season; the volume shown was diverted during October 2021.

Table 3-2. Surface Water Diversions by Water Use Sector and Source		
Sector	2022 (af)	
	Supply Source	
	CVP	Local
Agricultural	400	0
Urban	0	0
Native Vegetation	0	0
Total	**400**	

Table 3-3 depicts total surface water deliveries, estimated from total surface water diversions by accounting for conveyance losses, reuse, and boundary outflows. Total surface water deliveries for the Bowman Subbasin were estimated to be about 210 af for WY 2022, as shown in **Table 3-3**. No surface water supplies were used during the 2022 irrigation season; the volume shown was delivered during October 2021.

Table 3-3. Surface Water Deliveries by Water Use Sector and Source		
Sector	2022 (af)	
	Supply Source	
	CVP	Local
Agricultural	210	0
Urban	0	0
Native Vegetation	0	0
Total	**210**	

3.4. Total Water Use by Sector – Section 356.2(b)(4)

Total water use in the Subbasin was tabulated from groundwater extraction volumes reported in **Table 3-1** and the surface water supply deliveries reported in **Table 3-3**. Total water available is summarized in **Table 3-4** for WY 2022. The results are either based on measured data or estimates as described in the previous two sections.

In total, groundwater supplied approximately 98 % of the agricultural water demand in the Subbasin and also constituted approximately 98 % of the total water supplies for all water demand sectors in WY 2022.

Table 3-4. Total Water Use by Water Use Sector			
Sector	2022 (af)		
	Groundwater	Surface Water	Total
Agricultural	12,000	210	12,210
Urban	580	0	580
Rural Residential	430	0	430
Native Vegetation (Plant groundwater uptake)	2,100	0	2,100
Total	**15,110**	**210**	**15,320**
Total (excluding Native Vegetation[1])	13,010	210	13,220

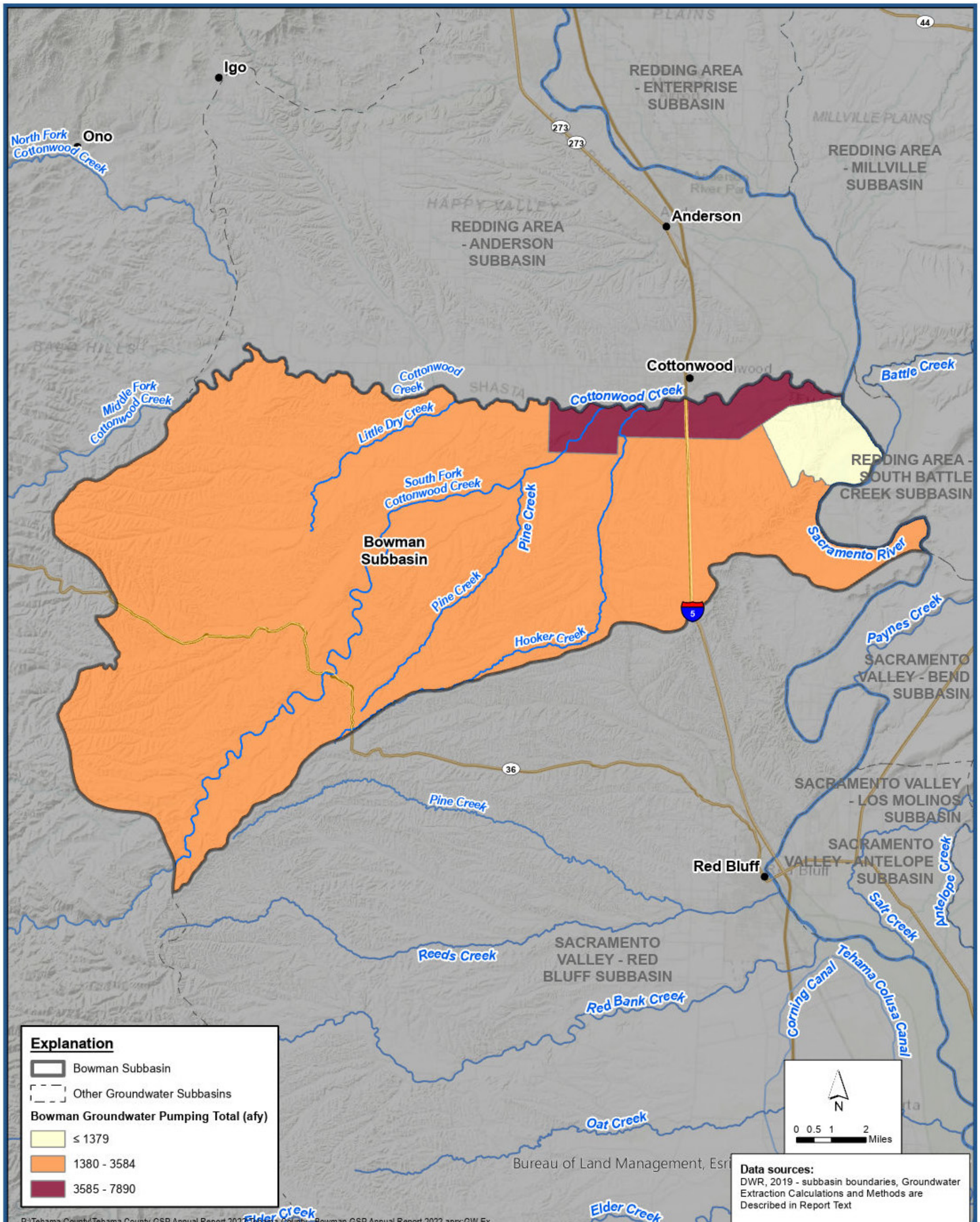
[1] Excludes native vegetation which involves only natural plant uptake of shallow groundwater, not direct pumping, and extraction.

3.5. Uncertainties in Water Use Estimates

Estimated uncertainties in the water budget components are presented in **Table 3-5**. 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 3-5 Estimated Uncertainty in Water Use Estimates			
Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Groundwater Water			
Agricultural	Measurement	20%	Typical uncertainty from water balance calculation.
Urban	Measurement/ Estimate	5%	Typical accuracy of urban water system reporting.
Rural Residential	Calculation	15%	Estimated from per capita water use and Census information.
Native Vegetation (Plant groundwater uptake)	Calculation	25%	Estimated based on land use classification, precipitation, and ET.
Surface Water			
Agricultural	Calculation	10%[1]	Estimated from SB 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 Basin.



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Groundwater Extraction in the Subbasin Water Year 2022

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 3-1

4. GROUNDWATER STORAGE

Changes in groundwater storage from Spring 2021 to Spring 2022 were calculated for the Upper and Lower Aquifers. Spring (seasonal high) groundwater levels are less influenced by groundwater pumping compared to Fall (seasonal low) groundwater levels; therefore, they are more reliable to calculate groundwater storage change.

Change of groundwater levels from Spring 2021 to Spring 2022 at wells screened in the Upper Aquifer were interpolated to estimate the groundwater elevation change in areas where sufficient data were available. Estimated elevation change was multiplied by a spatially variable aquifer storage coefficient available from the Tehama Integrated Hydrogeological Model (Tehama County FCWCD, 2022) to estimate the groundwater storage change volume in the Upper Aquifer. The spatial extent of this estimate was limited to areas where measured groundwater levels were available. (**Figure 4-1**). Therefore, an area-weighted adjustment was applied to the estimated storage to estimate the subbasin-wide change in storage.

Sufficient groundwater level data were not available to interpolate water level changes in the Lower Aquifer. Therefore, the Lower Aquifer storage change was estimated using the Upper Aquifer storage change and historical ratio of storage changes in the two aquifers for critical years. The summation of the changes in the Upper and Lower Aquifers provides the total groundwater storage change in the Subbasin. **Table 4-1** presents the annual storage change values for both the Upper and Lower Aquifers.

It should be noted that the groundwater model was not used to estimate storage changes for 2020 through 2022. Therefore, future updates to the model may result in different estimates for 2020 through 2022 groundwater storage changes. The approach of using measured groundwater elevation changes to estimate storage changes is considered reasonable and cost effective for the purposes of the annual report. **Table 4-2** includes estimates of annual groundwater pumping, groundwater uptake, storage change and cumulative storage change for WYs 1990-2022. Change in storage and cumulative change in storage for WYs 2020-2022 was estimated based on the above method. The Tehama IHM Model was used to estimate groundwater pumping, groundwater uptake, change in storage, and cumulative change in storage for WYs 1990-2019.

Table 4-1. Change in Groundwater Storage Based on Seasonal High Groundwater Levels

Aquifer	2022 (af)
Upper Aquifer	-6,000
Lower Aquifer	-11,000
Total	-17,000

Table 4-2. Change in Groundwater Storage				
Water Year & Type[a]	Groundwater Pumping (af)	Groundwater Uptake (af)	Annual Groundwater Storage Change[b] (af)	Cumulative Groundwater Storage Change (af)
1990 (C)	-5,600	-3,000	-27,000	-27,000
1991 (C)	-5,100	-2,300	-28,000	-55,000
1992 (C)	-4,900	-2,200	-6,000	-61,000
1993 (AN)	-4,100	-3,100	41,000	-20,000
1994 (C)	-5,300	-2,300	-28,000	-48,000
1995 (W)	-3,300	-3,300	49,000	1,000
1996 (W)	-4,500	-3,600	16,000	17,000
1997 (W)	-7,000	-3,500	-11,000	6,000
1998 (W)	-3,600	-4,400	54,000	60,000
1999 (W)	-3,400	-4,300	-14,000	46,000
2000 (AN)	-3,800	-4,000	-10,000	36,000
2001 (D)	-5,900	-3,300	-30,000	6,000
2002 (D)	-7,200	-3,400	-7,600	-1,600
2003 (AN)	-5,500	-3,500	20,000	18,000
2004 (BN)	-8,500	-3,700	-3,500	15,000
2005 (AN)	-6,300	-3,600	13,000	28,000
2006 (W)	-5,700	-4,000	15,000	43,000
2007 (D)	-8,000	-3,100	-47,000	-4,100
2008 (C)	-8,900	-2,900	-19,000	-23,000
2009 (D)	-6,900	-2,400	-18,000	-41,000
2010 (BN)	-7,700	-2,700	21,000	-20,000
2011 (W)	-6,200	-3,200	17,000	-3,100
2012 (BN)	-6,000	-2,300	-30,000	-33,000
2013 (D)	-7,700	-2,300	-13,000	-46,000
2014 (C)	-6,900	-1,700	-29,000	-75,000
2015 (C)	-8,800	-1,700	-3,800	-79,000
2016 (BN)	-6,700	-2,300	23,000	-56,000
2017 (W)	-5,400	-2,800	43,000	-13,000
2018 (BN)	-7,800	-1,900	-37,000	-50,000
2019 (W)	-6,000	-2,900	36,000 [b]	-14,000

Table 4-2. Change in Groundwater Storage				
Water Year & Type[a]	**Groundwater Pumping (af)**	**Groundwater Uptake (af)**	**Annual Groundwater Storage Change[b] (af)**	**Cumulative Groundwater Storage Change (af)**
2020 (D)	-7,400	-1,800	2,000 [b]	-12,000
2021 (C)	-8,100	-1,500	-31,000 [b]	-43,000
2022 (C)	-13,000	-2,100	-17,000 [b]	-60,000
Average	**-6,400**	**-2,900**	**-1,800**	**-**

Note: All volumes are rounded to two significant digits

[a] Sacramento Valley Water Year Type is provided by DWR for the years 1990-2021. Water Year 2022 has been preliminarily classified as Critical by DWR (DWR, 2022). W = Wet; AN = Above Normal; BN = Below Normal; D = Dry; C = Critical

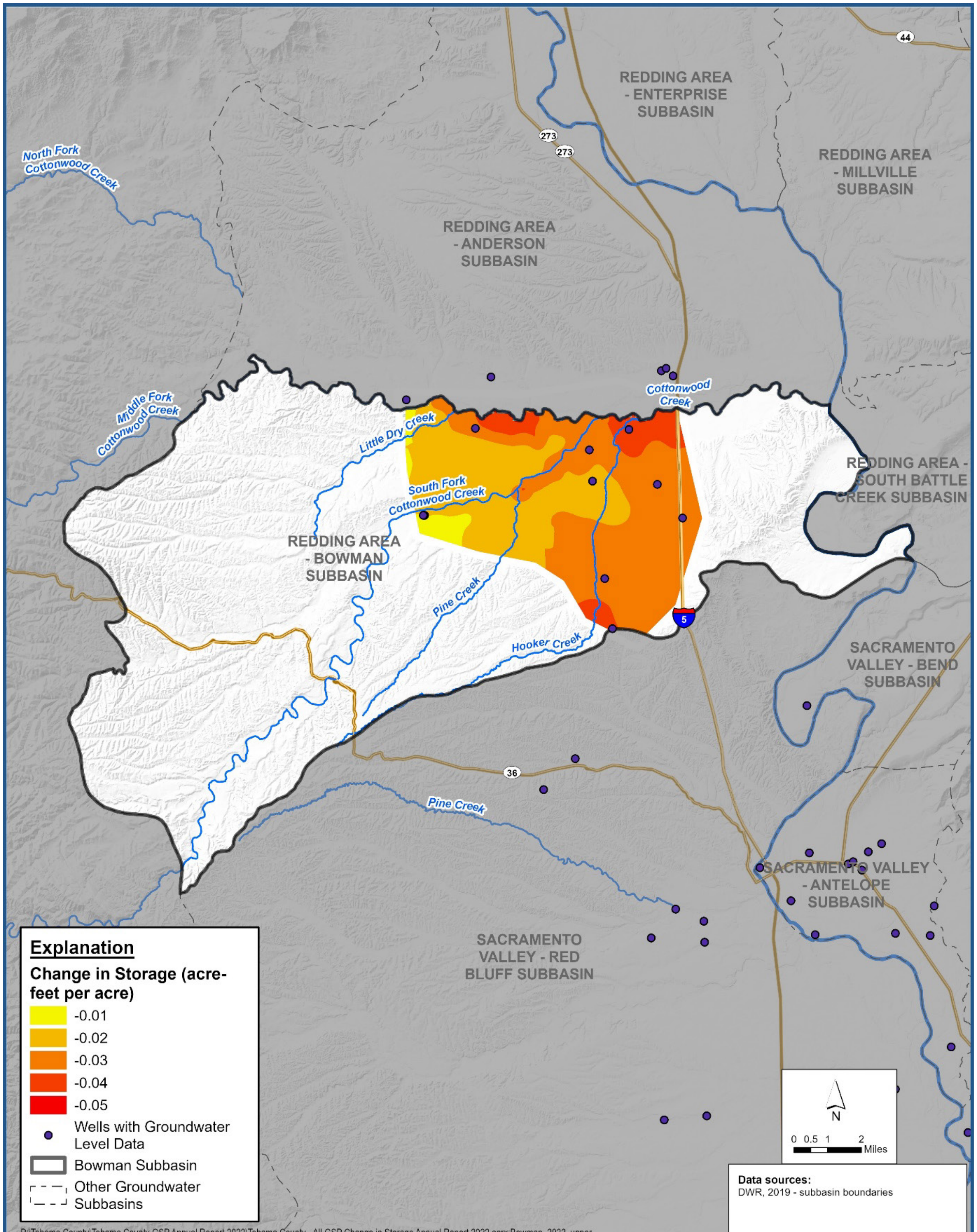
[b] Storage change in water years 2019-2022 were estimated using the change in seasonal high spring to spring water levels.

4.1. Groundwater Storage Maps – Section 356.2(b)(5)(A)

Figure 4-1 presents the distribution of storage change in the Upper Aquifer for WY 2022; and **Figure 4-2** for the Lower Aquifer. Maps include the groundwater wells used to calculate the change in storage. Groundwater storage change is not shown on **Figures 4-1** through **4-2** outside the established monitoring area to avoid extrapolating beyond the control points (i.e., reliable monitoring well data).

4.2. Subbasin Water Budget – Section 356.2(b)(5)(B)

A graph depicting Water Year type, groundwater pumping, groundwater uptake, the annual change in groundwater storage, and the cumulative change in groundwater storage is presented on **Figure 4-3**.



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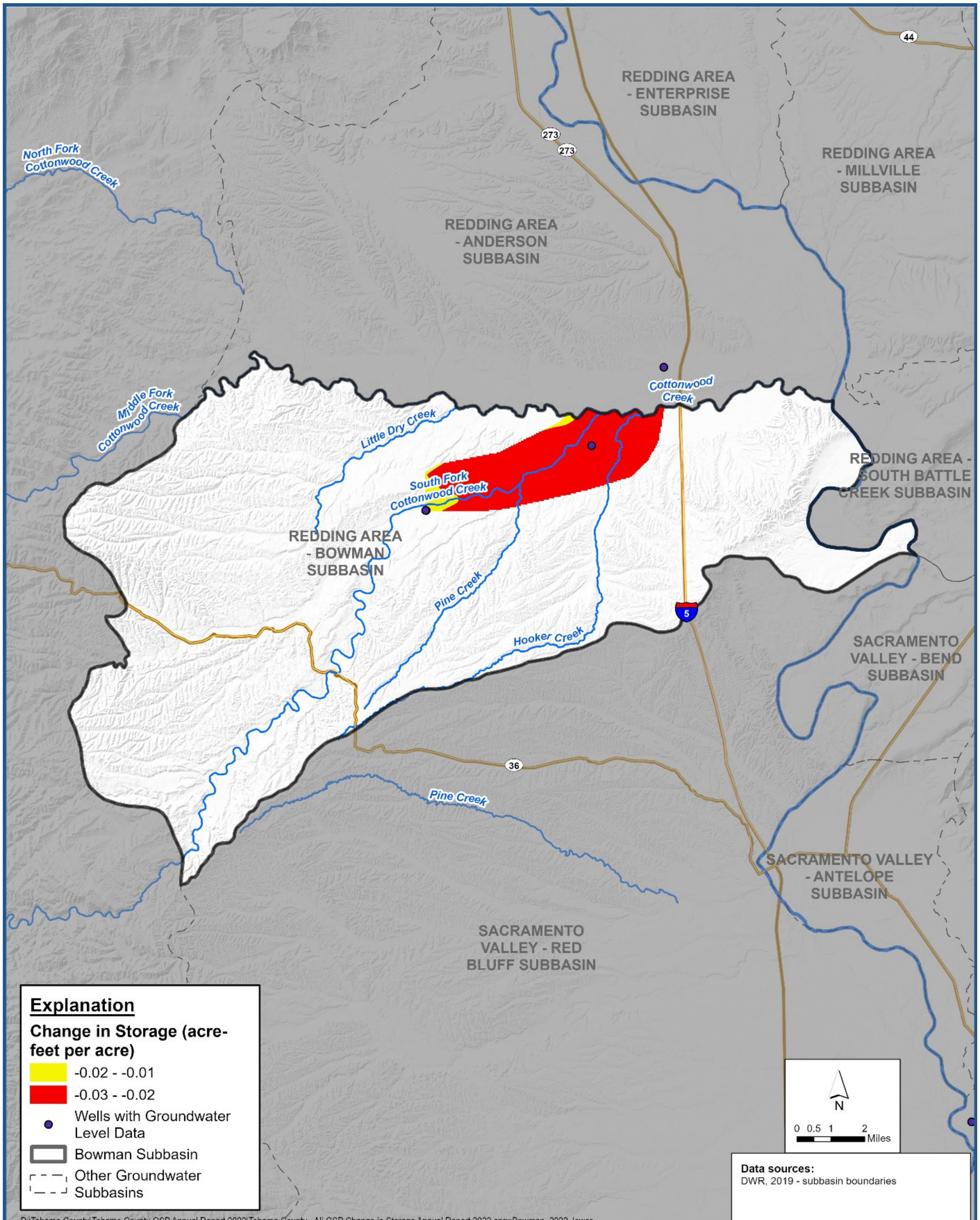
Change in Groundwater Storage, Upper Aquifer - Spring 2021 to Spring 2022

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

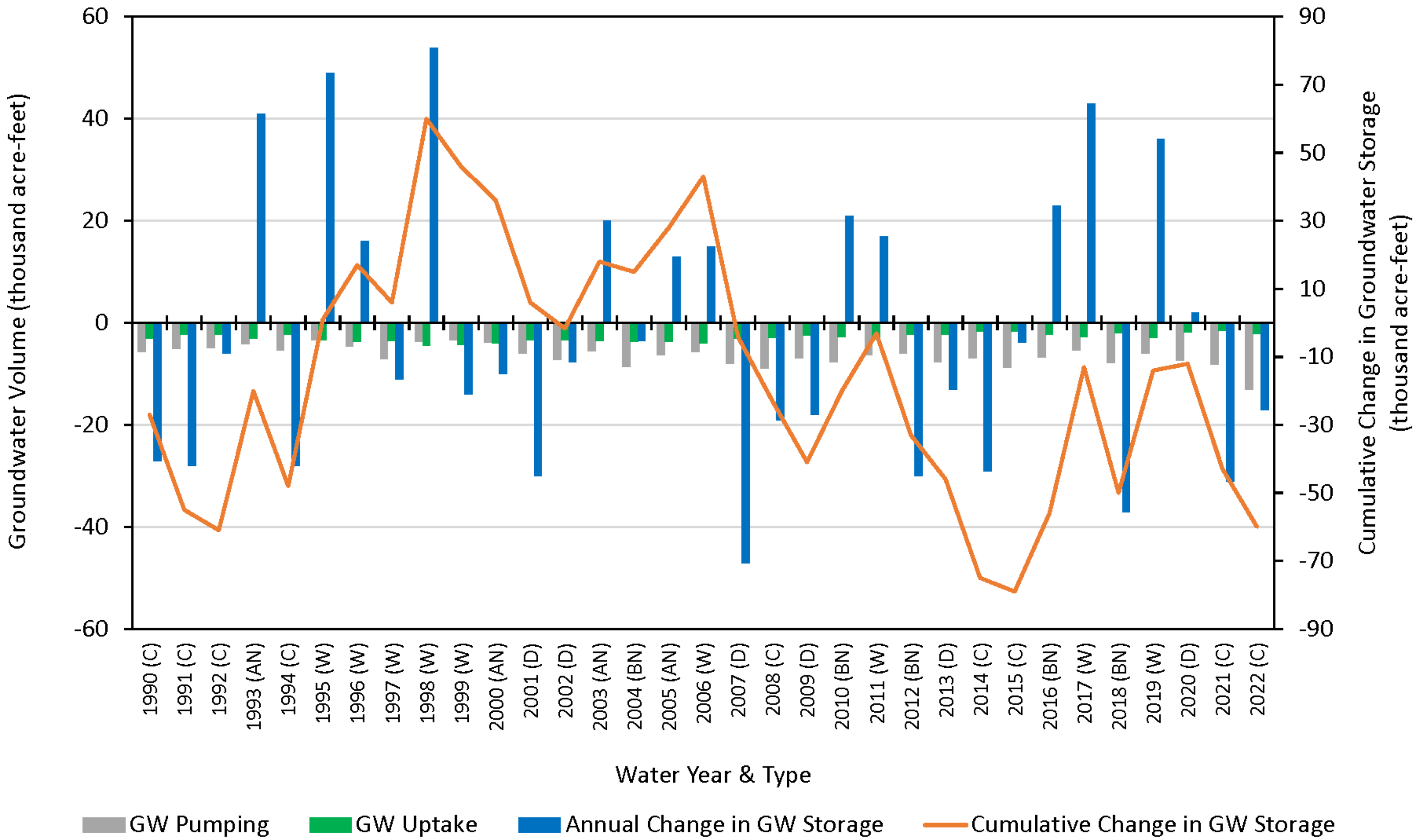
Figure 4-1



Change in Groundwater Storage,
Lower Aquifer - Spring 2021 to Spring 2022

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 4-2



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Groundwater Extraction and Change in Groundwater Storage

Groundwater Sustainability Plan - Annual Report WY 2022
Bowman Subbasin

Figure 4-3

5. GSP IMPLEMENTATION PROGRESS – SECTION 356.2(B)

The GSP for the Bowman Subbasin was adopted by the GSA in December 2021 and submitted to DWR in January 2022. This is the second annual report to be prepared since the GSP was submitted. The GSP implementation progress reported in this report covers ongoing work during WY 2022. Projects and management actions (PMAs) were developed to manage groundwater conditions in the Subbasin and achieve groundwater sustainability objectives described in the GSP.

5.1. Progress Toward Achieving Sustainability

5.1.1. 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. 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 milestone (IM) for groundwater levels at each of the RMS wells. In Spring 2022, all groundwater elevations were above the established MTs (as indicated in **Table 5-1**). Lower water levels were expected in Spring 2022 compared to Spring 2021 due to extended drought conditions, which have caused reductions in surface water supplies and increased demands for groundwater in the Subbasin.

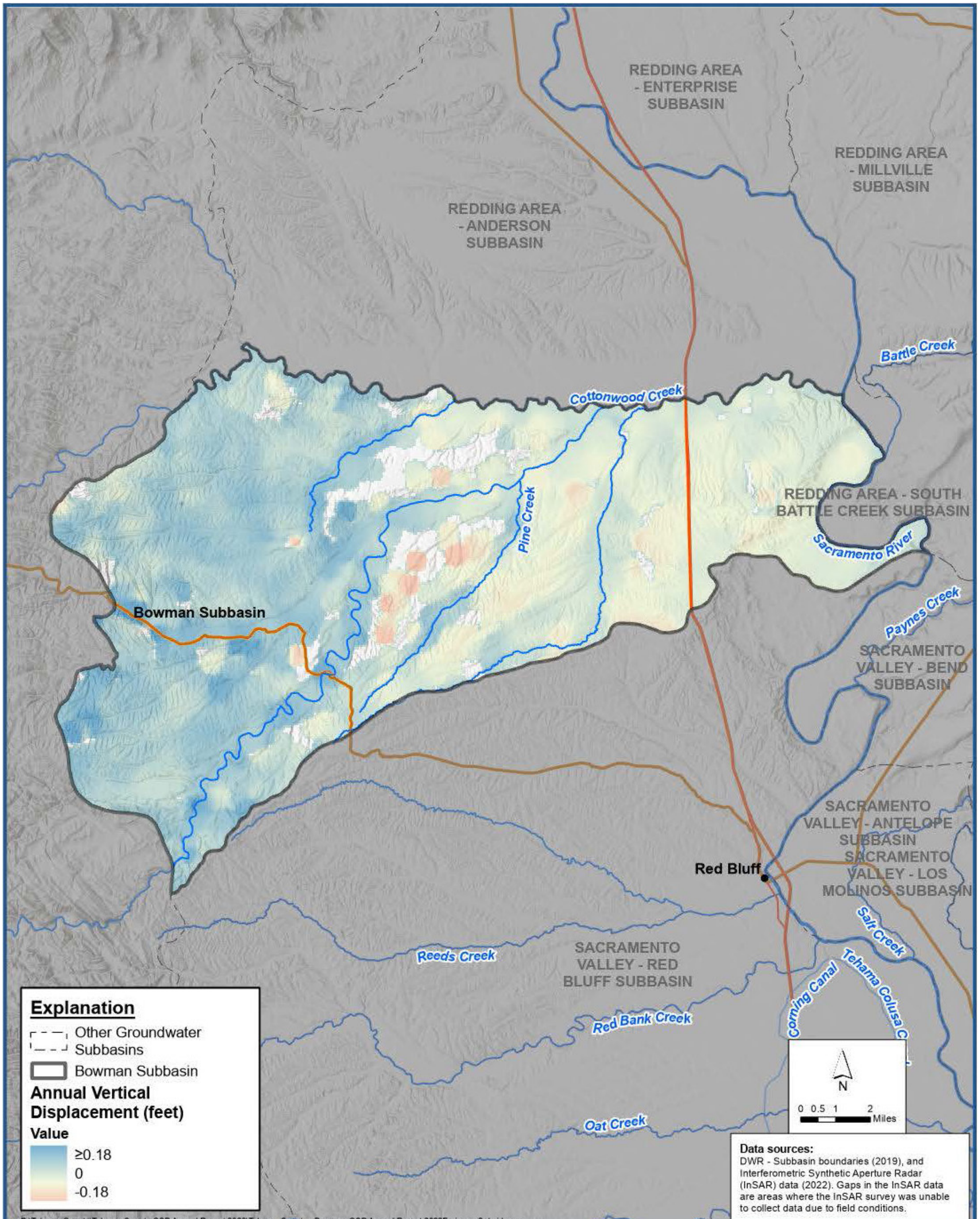
Table 5-1. Groundwater Level Measurements and MT Exceedances

Well ID	State Well Number	MT	MO	2027 IM	Recent Spring Groundwater Level Measurements		Spring 2022 MT Exceedance	Two Consecutive WY MT Exceedances
					2021	2022		
Upper Aquifer								
Bow-1U	29N03W18M001M	318.5	386.3	391.8	393.5	NA	NA	NA
Bow-2U	29N04W28D001M	372.5	395.1	399.1	400.4	399.0	No	No
Bow-3U	29N05W33A004M	419.6	484.9	490.9	492.9	490.0	No	No
Bow-4U	28N04W04P001M	377.5	404.8	412.2	414.6	411.6	No	No
Lower Aquifer								
Bow-5L	29N03W21	294.0	338.5	342.6	NA	343.3	No	NA
Bow-6L	29N04W20A002M	351.8	396.6	400.9	402.3	398.7	No	No
Bow-7L	29N05W21H001M	417.6	458.2	472.1	NA	NA	NA	NA

NA = Measurement is not reliable (i.e. well was pumping, recently pumped, access issues)

5.1.2. Land Subsidence SMC

The land subsidence MT is 0.5 feet per five years (i.e., averaged 0.1 foot per year) and the MO for land subsidence is zero throughout the subbasin. Only inelastic subsidence, defined as subsidence solely due to lowered groundwater elevations, will be considered in this SMC. Due to the measurement error of 0.1 feet associated with the Interferometric Synthetic Aperture Radar (InSAR) method, any measurements must be beyond the error to be considered inelastic subsidence. Subsidence measured by InSAR in WY 2022 (**Figure 5-1**) ranged from 0.02 feet of subsidence to 0.04 feet of uplift. No subsidence measured during WY 2022 is considered inelastic due to being less than the measurement error of 0.1 feet. The total subsidence measured from 2015 through WY 2022 (**Figure 5-2**) ranged from 0.18 feet of subsidence to 0.09 feet of uplift. The GSA is on track to stay above the MT for land subsidence.



TEHAMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

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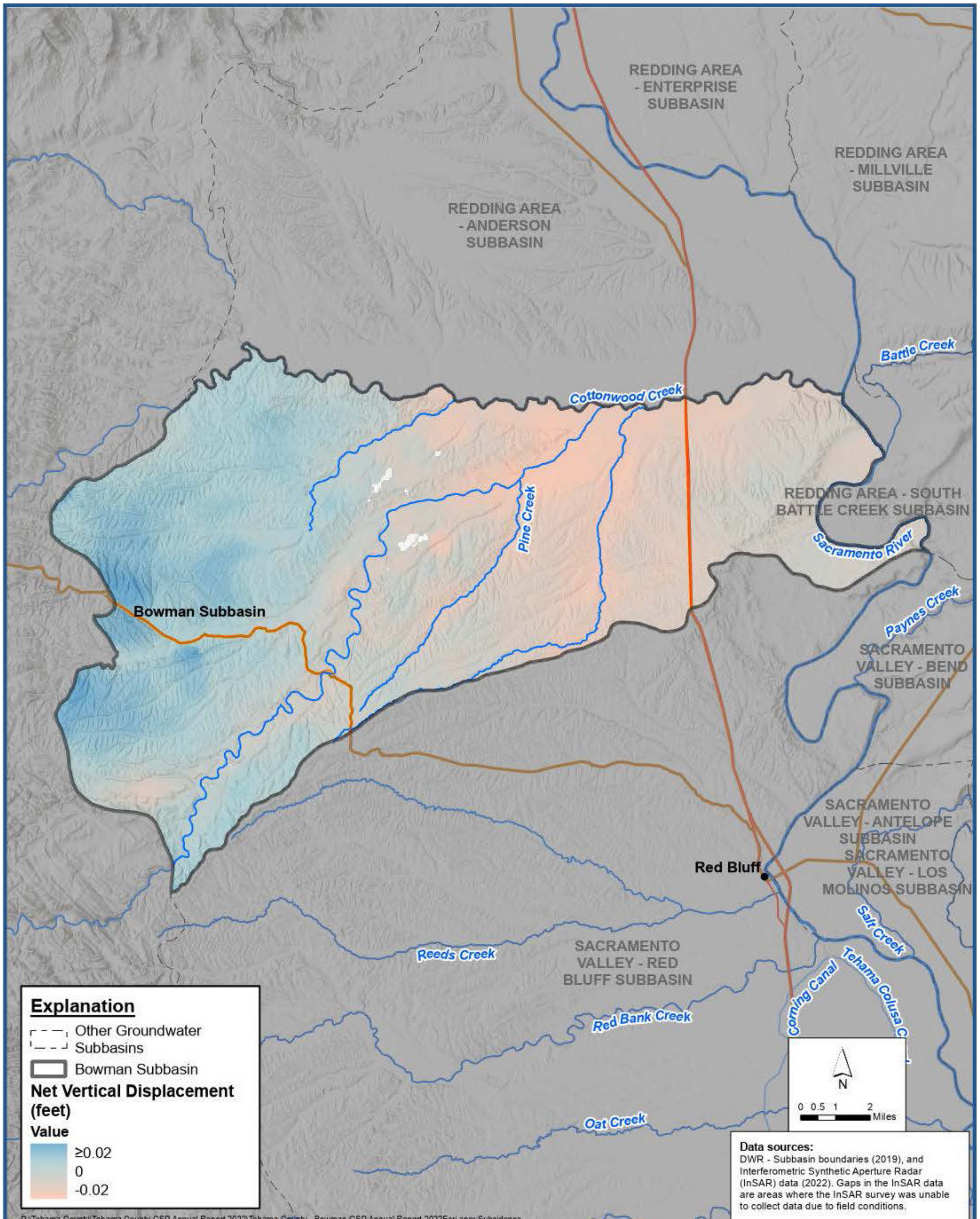
Annual Vertical Displacement in 2022

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 5-1



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Net Vertical Displacement 2015 through 2022

Groundwater Sustainability Plan – Annual Report WY 2022
Bowman Subbasin

Figure 5-2

5.1.3. Depletion of Interconnected Surface Water SMC

Depletion of Interconnected Surface Water SMC utilizes fall groundwater elevations in the shallow wells within the groundwater level monitoring network nearest the interconnected streams. All interconnected surface water RMS were above MT levels and on track to meeting the 2027 IM if trends hold (**Table 5-2**).

Table 5-2. Depletion of Interconnected Surface Water Data and SMC

Well ID	State Well Number	MT	MO	2027 IM	Recent Spring Groundwater Level Measurements		Spring 2022 MT Exceedance	Two Consecutive WY MT Exceedances
					2021	2022		
Upper Aquifer								
Bow-1U	29N03W18M001M	318.5	386.3	391.8	393.5	NA	NA	NA
Bow-2U	29N04W28D001M	372.5	395.1	399.1	400.4	399.0	No	No
Bow-3U	29N05W33A004M	419.6	484.9	490.9	492.9	490.0	No	No
Bow-4U	28N04W04P001M	377.5	404.8	412.2	414.6	411.6	No	No

NA = Measurement is not reliable (i.e. well was pumping, recently pumped, or had access issues)

5.2. Progress Toward PMA Implementation

Projects and management actions (PMAs) were developed to manage groundwater conditions in the Subbasin and achieve groundwater sustainability objectives described in the GSP. The implementation of PMAs has not progressed since GSP adoption. The GSA is continuing to engage stakeholders in the Subbasin as they coordinate to develop a workplan for 2023 and discuss implementation priorities.

As part of the GSA's efforts to address data gaps in the subbasin, 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 to refine the current hydrogeologic conceptual model. Data is available at data.cnra.ca.gov/dataset/aem/resource/29c4478d-fc34-44ab-a373-7d484afa38e8.

6. CONCLUSIONS

In WY 2022, groundwater conditions are considered sustainable. No water levels fell below the MTs. WY 2022 and subsidence data indicate sustainable conditions and no MTs were exceeded. Recent progress made on all of the above-mentioned activities applicable to the GSA since late 2021, 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 Subbasin.

7. REFERENCES

California Department of Water Resources (DWR). 2022. California's Groundwater Conditions, Semi-Annual Update: October 2022. https://data.cnra.ca.gov/dataset/california-s-groundwater-semi-annual-conditions-updates/resource/7e57614f-9868-4d2e-bbb8-0621be558b9c.

California Department of Water Resources (DWR). 2019. SVSim: Sacramento Valley Groundwater-Surface Water Simulation Model. https://data.cnra.ca.gov/dataset/svsim.

California Department of Water Resources (DWR). 2018. Groundwater Basin Boundary Assessment Tool https://gis.water.ca.gov/app/bbat/.

California Department of Water Resources (DWR). 2004. Redding Groundwater Basin, Bowman Subbasin, California's Groundwater, Bulletin 118. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Bulletin-118/Files/2003-Basin-Descriptions/5_006_01_BowmanSubbasin.pdf.

California Department of Water Resources (DWR). 2003. Tehama County Groundwater Inventory, Pre-Publication Draft.

California State Water Resources Control Board (SWRCB). 2023. Electronic Water Rights Information Management System (eWRIMS). Accessed March 13th 2023. Available at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/.

City of Red Bluff. 2020. 2020 Urban Water Management Plan. https://cms5.revize.com/revize/redbluff/2020_UWMP_CERTIFIED.pdf.

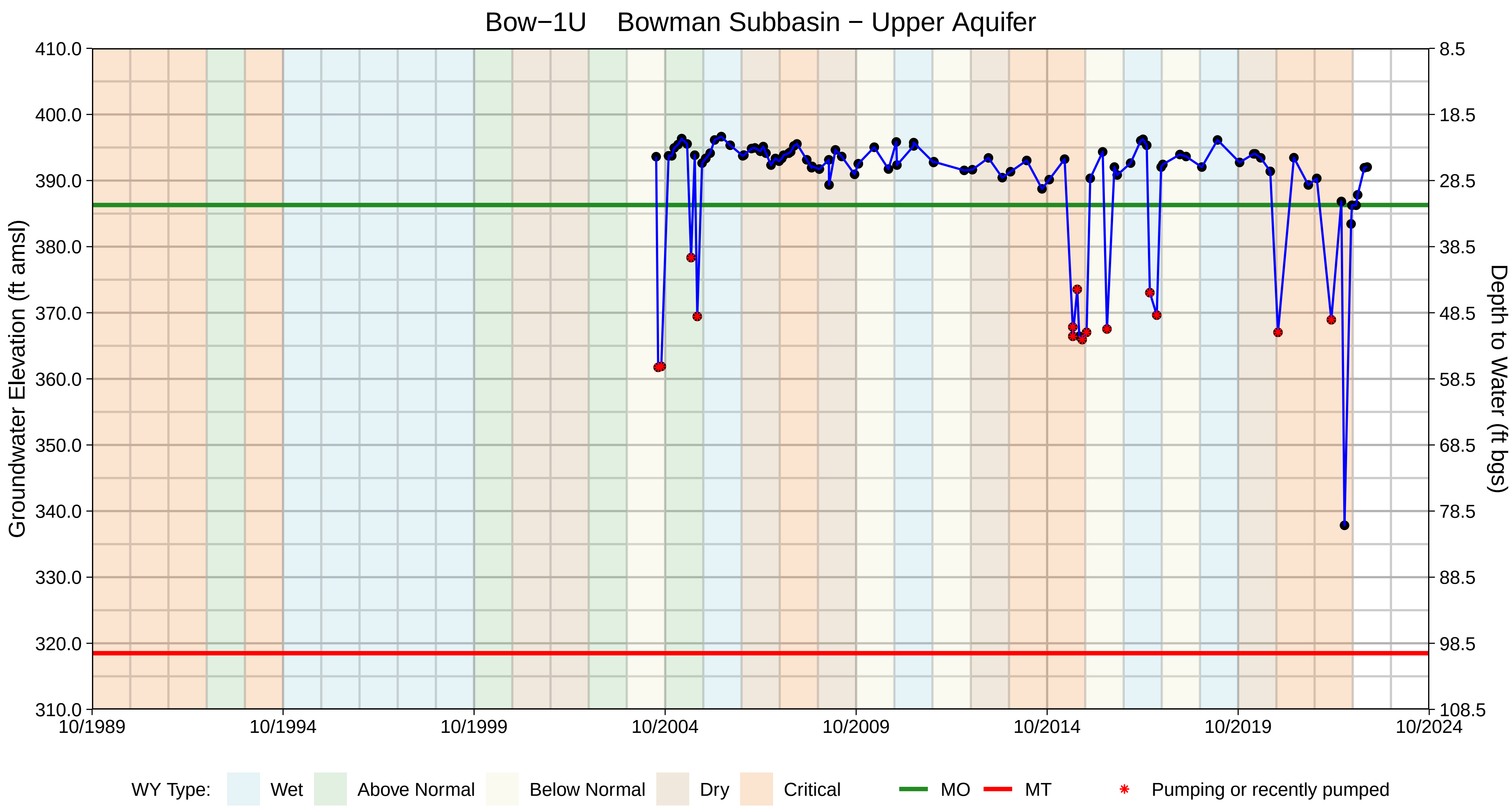
Hessels, Tim, Jeffrey C. Davids & Wim Bastiaanssen (Hessels et al.). 2022. Scalable Water Balances from Earth Observations (SWEO): results from 50 years of remote sensing in hydrology. Water International. Vol 47 No 6. Pg. 866-886. DOI: 10.1080/02508060.2022.2117896. https://doi.org/10.1080/02508060.2022.2117896.

Tehama County Flood Control and Water Conservation District (Tehama County FCWCD) 2022. Bowman Subbasin Groundwater Sustainability Plan. https://tehamacountywater.org/gsa/groundwater-sustainability-plans-public-draft/#bowman-subbasin-final-gsp.

United States Bureau of Reclamation (USBR).2023. Central Valley Operations. Accessed March 21st 2023. https://www.usbr.gov/mp/cvo/deliv.html.

Appendix A

Water Level Hydrographs of Representative Monitoring Wells for Groundwater Level



SWN: 29N03W18M001M

Site Code: 403672N1222548W001

Total Depth (ft):234

Perf. Top (ft bgs): NA

Perf. Bottom (ft bgs): NA

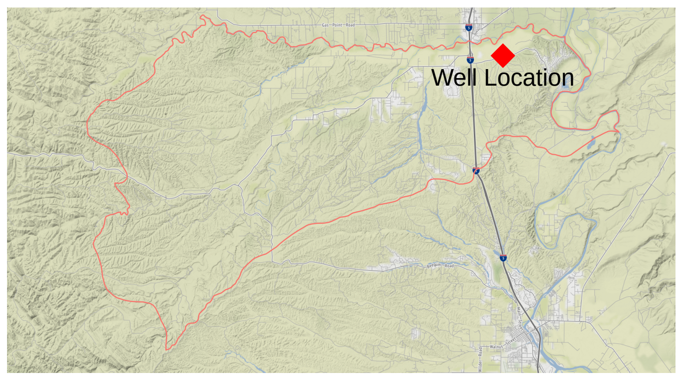
Well Type: Irrigation

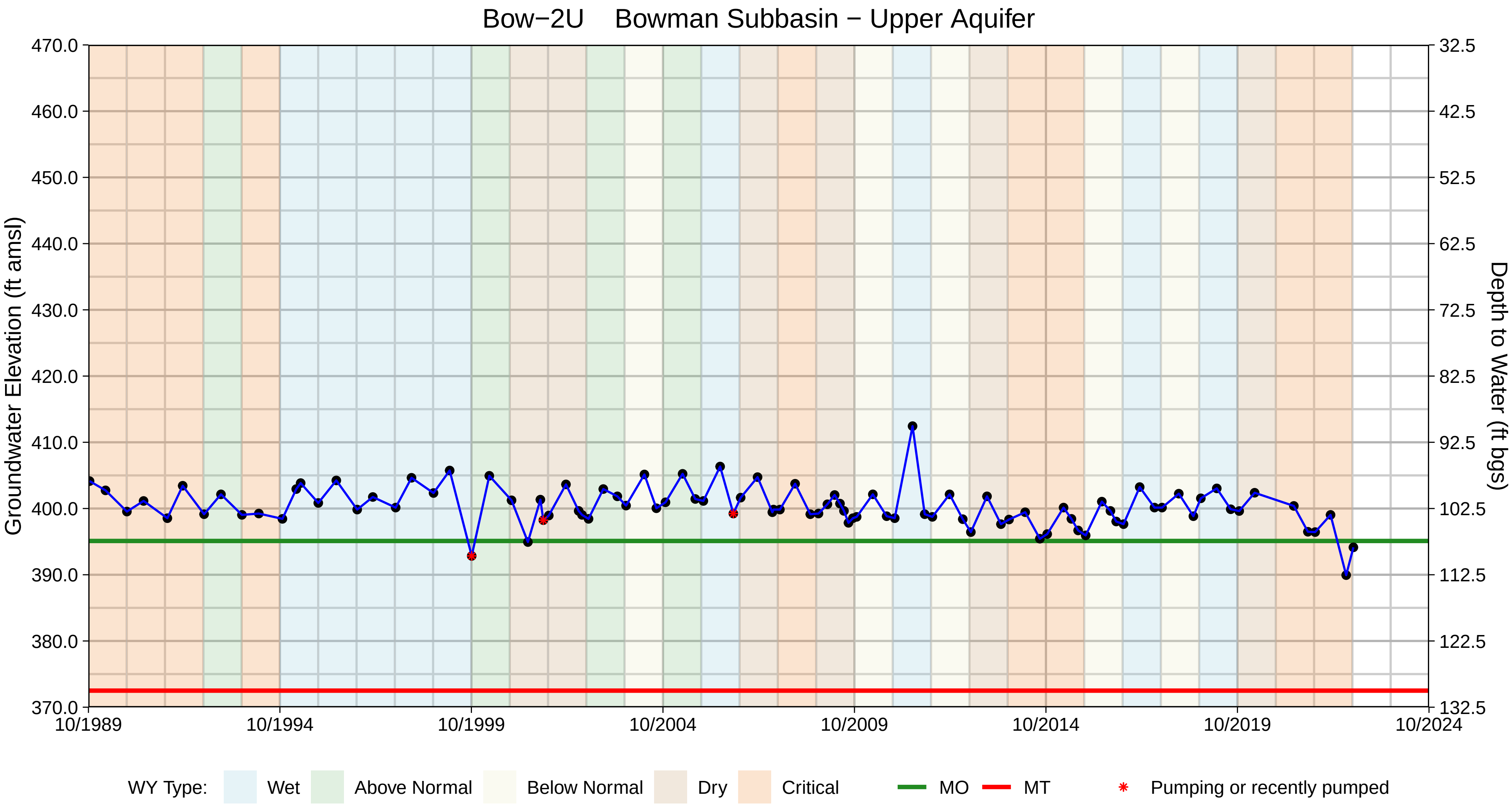
GSE (ft amsl): 418.5

Sustainable Management Criteria

MO: 386.3 ft amsl (32.2 ft bgs)

MT: 318.5 ft amsl (100 ft bgs)





SWN: 29N04W28D001M

Site Code: 403453N1223316W001

Total Depth (ft):134

Perf. Top (ft bgs): 114

Perf. Bottom (ft bgs): 134

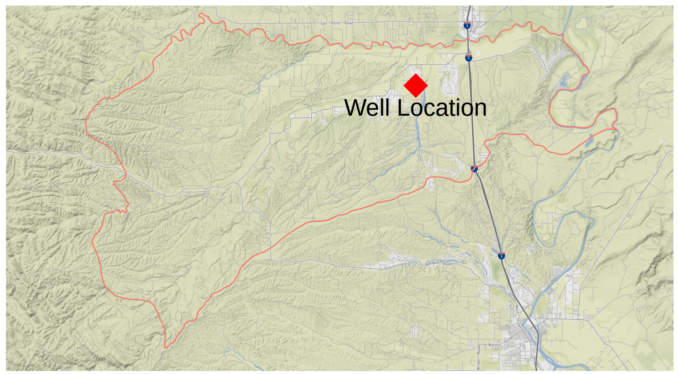
Well Type: Residential

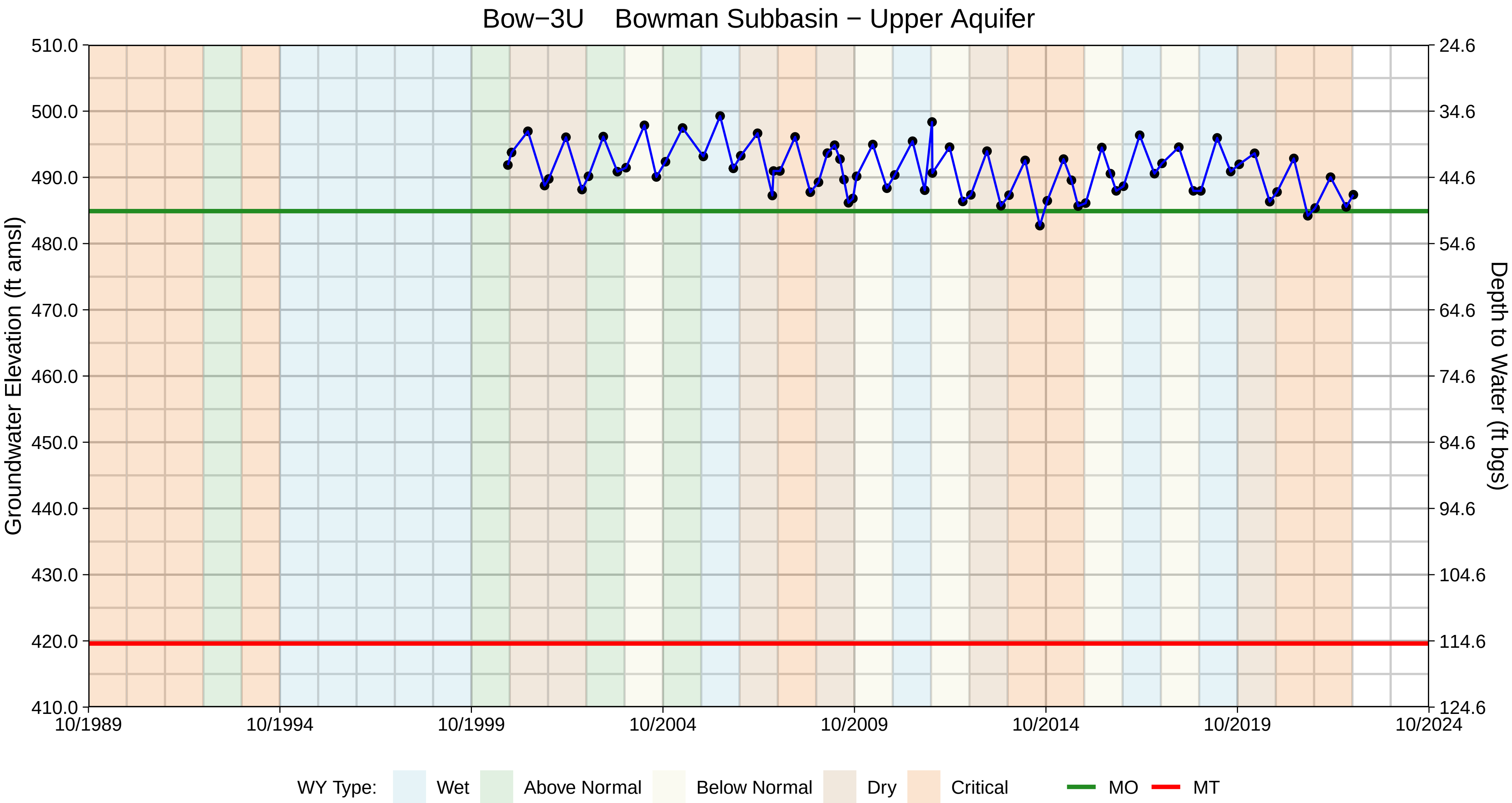
GSE (ft amsl): 502.5

Sustainable Management Criteria

MO: 395.1 ft amsl (107.4 ft bgs)

MT: 372.5 ft amsl (130 ft bgs)





SWN: 29N05W33A004M

Site Code: 403290N1224261W001

Total Depth (ft):210

Perf. Top (ft bgs): 110

Perf. Bottom (ft bgs): 210

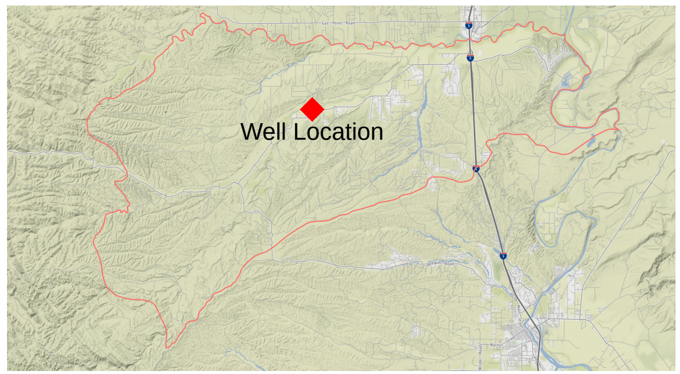
Well Type: Observation

GSE (ft amsl): 534.6

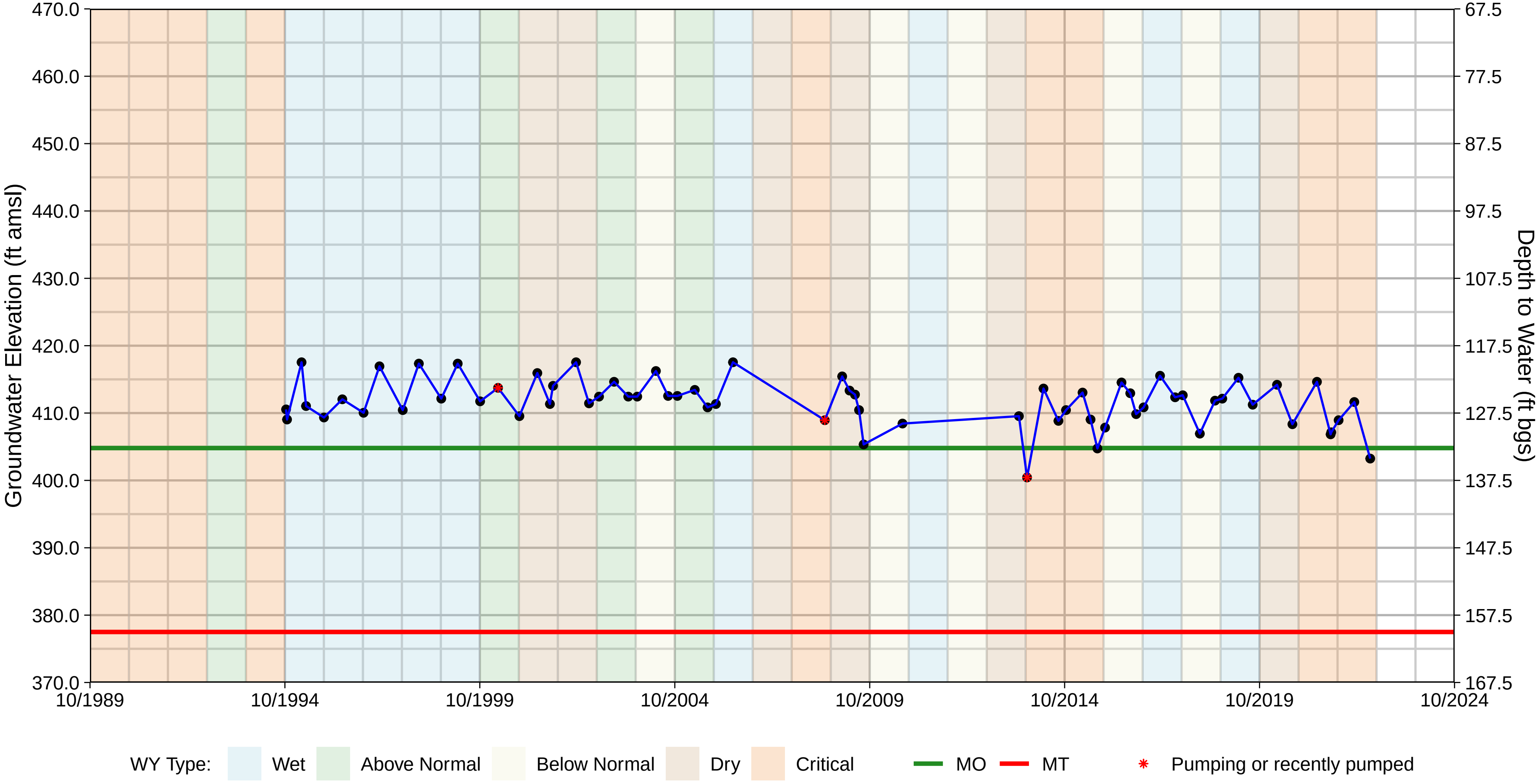
Sustainable Management Criteria

MO: 484.9 ft amsl (49.7 ft bgs)

MT: 419.6 ft amsl (115 ft bgs)



Bow−4U   Bowman Subbasin − Upper Aquifer



SWN: 28N04W04P001M

Site Code: 403036N1223221W001

Total Depth (ft):270

Perf. Top (ft bgs): NA

Perf. Bottom (ft bgs): NA

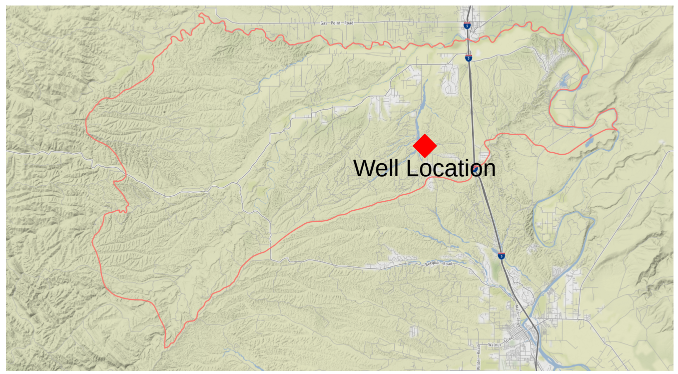
Well Type: Residential

GSE (ft amsl): 537.5

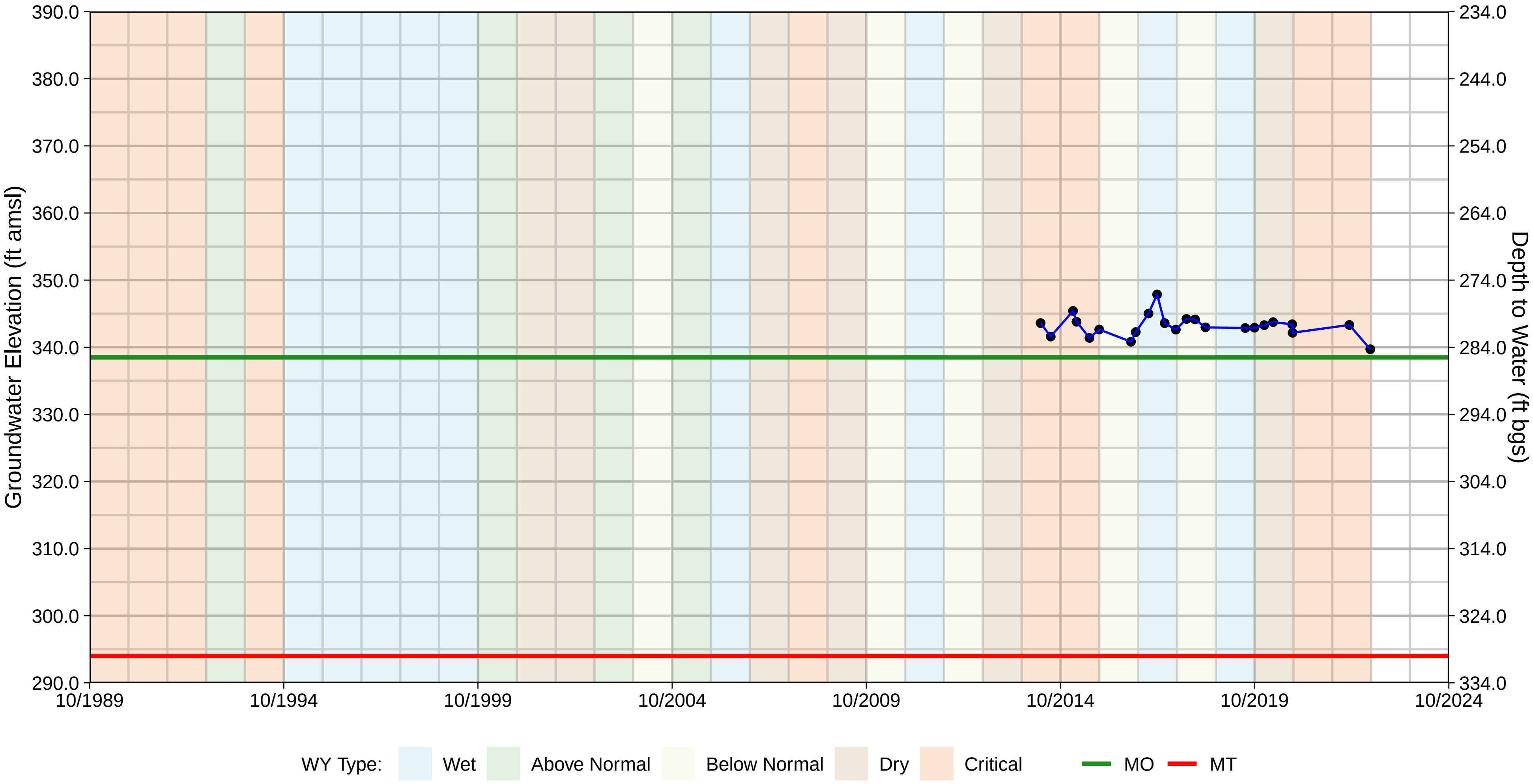
Sustainable Management Criteria

MO: 404.8 ft amsl (132.7 ft bgs)

MT: 377.5 ft amsl (160 ft bgs)



Bow−5L   Bowman Subbasin − Lower Aquifer



SWN: 29N03W21−XXX

Site Code: 403544N1222119W001

Total Depth (ft):760

Perf. Top (ft bgs): 390

Perf. Bottom (ft bgs): 750

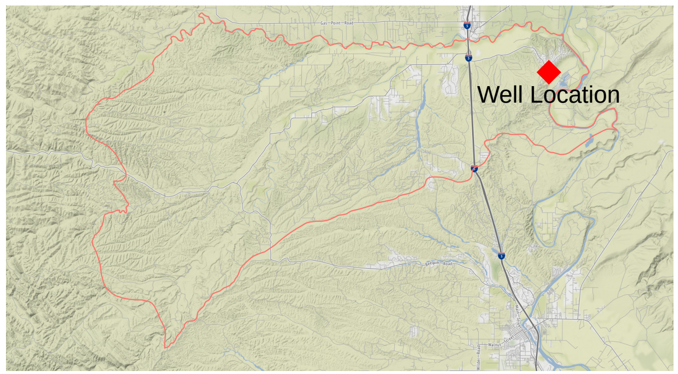
Well Type: Public Supply

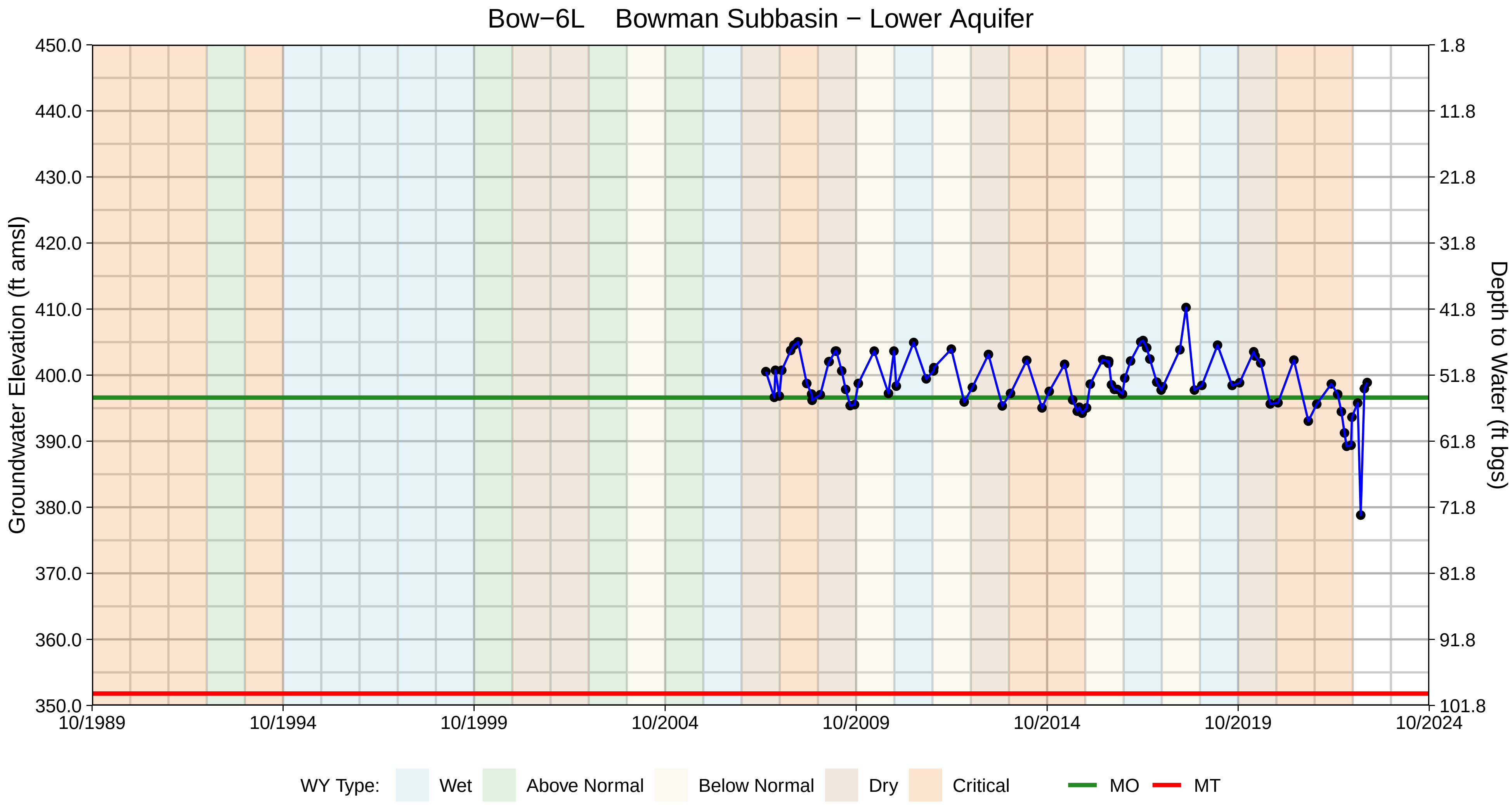
GSE (ft amsl): 624

Sustainable Management Criteria

MO: 338.5 ft amsl (285.5 ft bgs)

MT: 294 ft amsl (330 ft bgs)





SWN: 29N04W20A002M

Site Code: 403585N1223338W002

Total Depth (ft):451

Perf. Top (ft bgs): 360

Perf. Bottom (ft bgs): 430

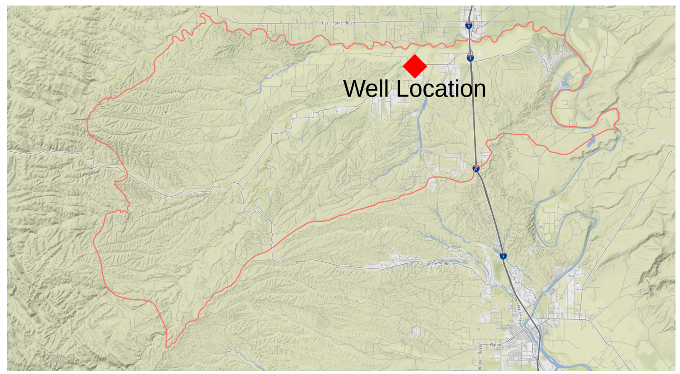
Well Type: Observation

GSE (ft amsl): 451.8

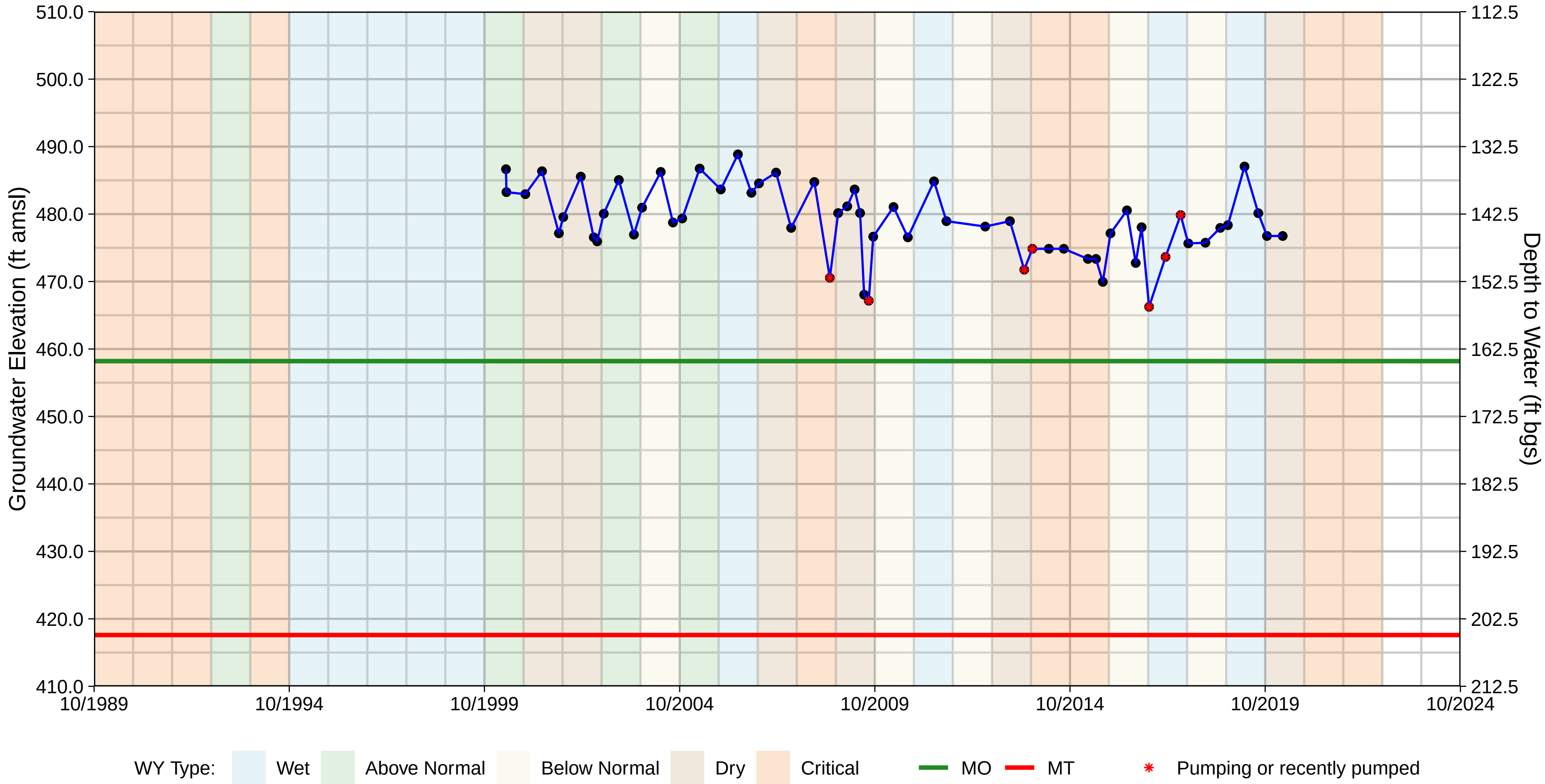
Sustainable Management Criteria

MO: 396.6 ft amsl (55.1 ft bgs)

MT: 351.8 ft amsl (99.9 ft bgs)



Bow−7L   Bowman Subbasin − Lower Aquifer



SWN: 29N05W21H001M

Site Code: 403549N1224311W001

Total Depth (ft):280

Perf. Top (ft bgs): 250

Perf. Bottom (ft bgs): 280

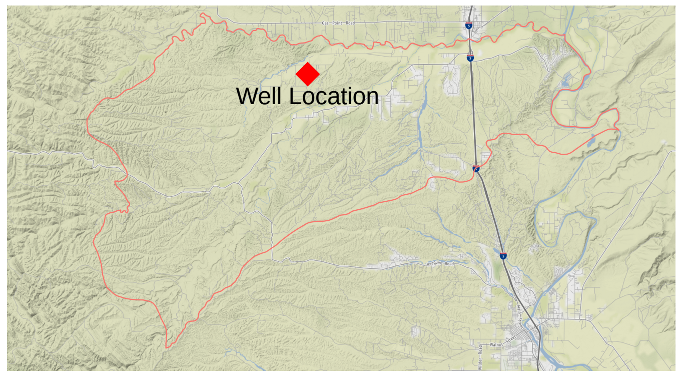
Well Type: Residential

GSE (ft amsl): 622.5

Sustainable Management Criteria

MO: 458.2 ft amsl (164.3 ft bgs)

MT: 417.6 ft amsl (204.9 ft bgs)



APPENDIX B

Annual Report Water Level Data

Data sources:

CA Department of Water Resources

Water Level Data for Water Year 2022								
Well ID	Measure Date	RPE (ft amsl)	GSE (ft amsl)	DTW (ft bgs)	DTW (ft brp)	WSE (ft amsl)	WL QM CD[1]	Comments
28N04W16G001M	3/7/2022	603.73	602.53	196.3	197.5	406.23		
28N04W16G001M	8/3/2022	603.73	602.53	194.9	196.1	407.63		
28N04W10J001M	3/7/2022	647.5	647	267.1	267.6	379.9		
28N04W10J001M	5/10/2022	647.5	647	254.8	255.3	392.2		
28N04W10J001M	7/14/2022	647.5	647	268.4	268.9	378.6		
28N04W10J001M	8/3/2022	647.5	647	274.4	274.9	372.6		
28N04W04P001M	3/7/2022	538.84	537.54	125.9	127.2	411.64		
28N04W04P001M	8/3/2022	538.84	537.54	134.3	135.6	403.24		
29N05W33A001M	3/7/2022	536.96	534.96	49.09	51.09	485.87		
29N05W33A001M	8/3/2022	536.96	534.96	54.59	56.59	480.37		
29N05W33A001M	10/11/2022	536.96	534.96	53.4	55.4	481.56		
29N05W33A002M	3/7/2022	534.56	532.56	51	53	481.56		
29N05W33A002M	8/3/2022	534.56	532.56	55.9	57.9	476.66		
29N05W33A002M	10/11/2022	534.56	532.56	54.17	56.17	478.39		
29N05W33A003M	3/7/2022	536.56	534.56	47.01	49.01	487.55		
29N05W33A003M	8/3/2022	536.56	534.56	54.28	56.28	480.28		
29N05W33A003M	10/11/2022	536.56	534.56	50.95	52.95	483.61		
29N05W33A004M	3/7/2022	536.56	534.56	44.53	46.53	490.03		
29N05W33A004M	8/3/2022	536.56	534.56	49.02	51.02	485.54		
29N05W33A004M	10/11/2022	536.56	534.56	47.18	49.18	487.38		
29N05W33A005M	3/7/2022	536.56	534.56	40.99	42.99	493.57		
29N05W33A005M	8/3/2022	536.56	534.56	44.61	46.61	489.95		
29N05W33A005M	10/11/2022	536.56	534.56	43.9	45.9	490.66		

[1]WL QM CD: 1-Pumping, 3-Casing leaking or wet, 8-Oil or foreign substance in casing

Water Level Data for Water Year 2022								
Well ID	Measure Date	RPE (ft amsl)	GSE (ft amsl)	DTW (ft bgs)	DTW (ft brp)	WSE (ft amsl)	WL QM CD[1]	Comments
29N04W35B001M	3/11/2022	541.53	537.53	88.02	92.02	449.51		
29N04W35B001M	5/10/2022	541.53	537.53	87.94	91.94	449.59		
29N04W35B001M	6/14/2022	541.53	537.53	87.92	91.92	449.61		
29N04W35B001M	7/14/2022	541.53	537.53	87.93	91.93	449.6		
29N04W35B001M	8/3/2022	541.53	537.53	87.79	91.79	449.74		
29N04W35B001M	9/15/2022	541.53	537.53	88.04	92.04	449.49		
29N04W35B001M	10/11/2022	541.53	537.53	88.08	92.08	449.45		
29N04W35B001M	11/17/2022	541.53	537.53	87.33	91.33	450.2		
29N04W35B001M	12/16/2022	541.53	537.53	88.15	92.15	449.38		
29N04W27A001M	3/8/2022	525.73	524.53	149.1	150.3	375.43	3	
29N04W27A001M	8/3/2022	525.73	524.53	175.5	176.7	349.03		
29N04W27A001M	10/11/2022	525.73	524.53	158.6	159.8	365.93		
29N04W28D001M	3/7/2022	503.04	502.54	103.5	104	399.04		
29N04W28D001M	8/3/2022	503.04	502.54	112.6	113.1	389.94		
29N04W28D001M	10/11/2022	503.04	502.54	108.4	108.9	394.14		
29N03W21	3/10/2022	624	624	280.68	280.68	343.32		
29N03W21	9/23/2022	624	624	284.3	284.3	339.7		
29N04W20A001M	5/10/2022	454.34	451.71	50.2	52.83	401.51		
29N04W20A001M	6/14/2022	454.34	451.71	54.41	57.04	397.3		
29N04W20A001M	7/14/2022	454.34	451.71	56.23	58.86	395.48		
29N04W20A001M	9/15/2022	454.34	451.71	58.55	61.18	393.16		
29N04W20A001M	11/17/2022	454.34	451.71	56.12	58.75	395.59		
29N04W20A001M	12/16/2022	454.34	451.71	54.82	57.45	396.89		

[1]WL QM CD: 1-Pumping, 3-Casing leaking or wet, 8-Oil or foreign substance in casing

Water Level Data for Water Year 2022								
Well ID	Measure Date	RPE (ft amsl)	GSE (ft amsl)	DTW (ft bgs)	DTW (ft brp)	WSE (ft amsl)	WL QM CD[1]	Comments
29N04W20A002M	3/10/2022	454.14	451.75	53.08	55.47	398.67		
29N04W20A002M	5/10/2022	454.14	451.75	54.64	57.03	397.11		
29N04W20A002M	6/14/2022	454.14	451.75	57.28	59.67	394.47		
29N04W20A002M	7/14/2022	454.14	451.75	60.5	62.89	391.25		
29N04W20A002M	8/3/2022	454.14	451.75	62.52	64.91	389.23		
29N04W20A002M	9/15/2022	454.14	451.75	62.36	64.75	389.39		
29N04W20A002M	9/23/2022	454.14	451.75	58.11	60.5	393.64		
29N04W20A002M	11/17/2022	454.14	451.75	55.97	58.36	395.78		Run 95
29N04W20A002M	12/16/2022	454.14	451.75	72.94	75.33	378.81		
29N04W20A003M	5/10/2022	456.17	454.01	46.68	48.84	407.33		
29N04W20A003M	6/14/2022	453.92	451.76	51.1	53.26	400.66		
29N04W20A003M	7/14/2022	453.92	451.76	54.51	56.67	397.25		
29N04W20A003M	8/3/2022	453.92	451.76	53.6	55.76	398.16		
29N04W20A003M	9/15/2022	453.92	451.76	55.04	57.2	396.72		
29N04W20A003M	11/17/2022	453.92	451.76	47.58	49.74	404.18		
29N04W20A003M	12/16/2022	453.92	451.76	46.38	48.54	405.38		
29N04W20A004M	5/10/2022	453.67	451.75	40.21	42.13	411.54		
29N04W20A004M	6/14/2022	453.67	451.75	42.19	44.11	409.56		
29N04W20A004M	7/14/2022	453.67	451.75	44.46	46.38	407.29		
29N04W20A004M	8/3/2022	453.67	451.75	44.73	46.65	407.02		
29N04W20A004M	9/15/2022	453.67	451.75	45.67	47.59	406.08		
29N04W20A004M	11/17/2022	453.67	451.75	43.48	45.4	408.27		
29N04W20A004M	12/16/2022	453.67	451.75	42.58	44.5	409.17		

[1]WL QM CD: 1-Pumping, 3-Casing leaking or wet, 8-Oil or foreign substance in casing

Water Level Data for Water Year 2022								
Well ID	Measure Date	RPE (ft amsl)	GSE (ft amsl)	DTW (ft bgs)	DTW (ft brp)	WSE (ft amsl)	WL QM CD[1]	Comments
29N05W14L001M	3/8/2022	493.55	492.55	41.7	42.7	450.85		
29N05W14L001M	8/3/2022	493.55	492.55	50.5	51.5	442.05		
29N03W18M001M	3/10/2022	419.04	418.54	49.6	50.1	368.94	1	
29N03W18M001M	6/14/2022	419.04	418.54	31.7	32.2	386.84		
29N03W18M001M	7/14/2022	419.04	418.54	80.7	81.2	337.84		
29N03W18M001M	9/15/2022	419.04	418.54	35.1	35.6	383.44		
29N03W18M001M	9/23/2022	419.04	418.54	32.28	32.78	386.26		
29N03W18M001M	11/2/2022	419.04	418.54	32.28	32.78	386.26		
29N03W18M001M	11/17/2022	419.04	418.54	30.7	31.2	387.84		Run 95
29N04W15E002M	3/7/2022	428.51	427.51	36.7	37.7	390.81	8	Oil in casing

[1]WL QM CD: 1-Pumping, 3-Casing leaking or wet, 8-Oil or foreign substance in casing

APPENDIX C

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
15,110	580	0	12,000	0	0	2,100	430	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
578	Metered municipal wells	Direct	5-10	Meter connection maintained by Rio Alto Water District	0					0					0					14,532	Where available, groundwater extraction and surface water supplies were quantified directly from measured and reported groundwater pumping, surface water diversions, and deliveries data. However, groundwater extraction data has historically been limited, particularly for privately-owned wells. Thus, a water budget approach has been used to estimate the remaining, unmeasured volume of groundwater extraction that has occurred to meet demand in the Subbasin. Water budget approach used in this Annual Report utilizes available geospatial data and information to quantify crop water demand, precipitation, and other parameters with pixel-scale resolution (30-meter (m) x 30 m), corresponding to the spatial resolution of satellite imagery used in developing these inputs. In addition to geospatial data, available surface water supply and groundwater extraction data is incorporated into the water budget by distributing that water out to specific regions where that water is used (e.g., surface water supplier service areas).	Estimate	20-30 %	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.

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
210	Surface water supplies are reported directly from water supplier records or collected from publicly available sources (water rights diversion records, etc.) where available.	0	0	0	210	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
15,320	Where available, groundwater extraction and surface water supplies were quantified directly from measured and reported groundwater pumping, surface water diversions, and deliveries data. However, groundwater extraction data has historically been limited, particularly for privately-owned wells. Thus, a water budget approach has been used to estimate the remaining, unmeasured volume of groundwater extraction that has occurred to meet demand in the Subbasin. water budget approach used in this Annual Report utilizes available geospatial data and information to quantify crop water demand, precipitation, and other parameters with pixel-scale resolution (30-meter (m) x 30 m), corresponding to the spatial resolution of satellite imagery used in developing these inputs. In addition to geospatial data, available surface water supply and groundwater extraction data is incorporated into the water budget by distributing that water out to specific regions where that water is used (e.g., surface water supplier service areas). Surface water supplies are reported directly from water supplier records or collected from publicly available sources (water rights diversion records, etc.) where available.	15,110	210	0	0	0		580	0	12,210	0	0	2,100	430	Rural Residential