ANNUAL REPORT | APRIL 2023

WYANDOTTE CREEK SUBBASIN (5-021.69) GROUNDWATER SUSTAINABILITY PLAN ANNUAL REPORT – 2022

SUBMITTED BY

Wyandotte Creek
GROUNDWATER SUSTAINABILITY AGENCY

WYANDOTTE CREEK GROUNDWATER SUSTAINABILITY AGENCY

PREPARED UNDER CONTRACT WITH

BUTTE COUNTY DEPARTMENT OF WATER AND RESOURCE CONSERVATION

PREPARED BY

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
°F	Degrees Fahrenheit
AF	Acre-Feet
AFY	Acre-Feet per Year
BBGM	Butte Basin Groundwater Model
Cal Water Chico	California Water Service, Chico
BBGM	Butte Basin Groundwater Model
CFS	Cubic Feet per Second
CIMIS	California Irrigation Management Information System
DWR	Department of Water Resources
EH	Butte County Environmental Health Division of Public Health
ET	Evapotranspiration
GPCD	Gallons per Capita per Day
GSP	Groundwater Sustainability Plan
GSA	Groundwater Sustainability Agency
MA	Management Area
MO	Measurable Objective
MT	Minimum Threshold
NSV	Northern Sacramento Valley
OEM	Office of Emergency Management
OSWCR	Online System of Well Completion Reports
PID	Paradise Irrigation District
PMA	Projects and Management Action
RCRD	Rock Creek Reclamation District
RMS	Representative Monitoring Site
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
SRSC	Sacramento River Settlement Contractors
Subbasin	Butte Subbasin
SWP	State Water Project
SWRCB	State Water Resources Control Board
USBR	United States Bureau of Reclamation
UWMP	Urban Water Management Plan
WY	Water Year

EXECUTIVE SUMMARY

The Wyandotte Creek Subbasin (Subbasin) (5-021.69) Annual Report was prepared on behalf of the Wyandotte Creek Groundwater Sustainability Agency (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 GSA is formed through a Joint Powers Agreement (Agreement) of three member agencies including Butte County, the City of Oroville, and Thermalito Water and Sewer District. The regulations mandate the submission of an Annual Report to DWR by April 1st after the reporting year, which spans from October 1st to September 30th. This second Annual Report includes information from the recent water year (WY) 2022 for the Wyandotte Creek Subbasin, located within Butte County and shown in **Figure ES-1.**

The western United States is currently experiencing one of the worst and most extensive droughts in its history, and during the summer of 2022, drought conditions in the Subbasin were classified as "severe" and "extreme" by the U.S. Drought Monitor (https://droughtmonitor.unl.edu/). The Northern Sierra 8-Station summary showed that WY 2022 had lower precipitation than roughly 60% of the previous years since measurement began in WY 1921. The Northern Sacramento region was classified as a critically dry water year according to the 40-30-30 Water Year Index for WY 2022. Above-average evapotranspiration and below-average precipitation were observed in Butte County and below average flow rates were observed in the Feather River. Drought conditions have resulted in reduced surface water supplies due to curtailment of water rights by the State Board, increased groundwater pumping to satisfy water demands, dry groundwater wells, increased well drilling and deepening, increased pumping costs, and decreased recreational opportunities in the Subbasin during 2022. In WY 2022, 26 reports of dry or reduced capacity wells have been made by residents through various programs tracking drought conditions within the Subbasin. However, according to a well vulnerability analysis, no wells were identified as potentially going dry or having reduced capacity next year.

Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestone for groundwater levels at each of the Representative Monitoring Network (RMS) wells. Groundwater elevations in the Subbasin continued to be stable as seen in years past and were generally near or slightly lower than groundwater elevations in recent years. New historical water level lows were reached in some wells however, lower groundwater conditions are likely to recover once the drought ends during wetter hydrological conditions. Groundwater elevations remained near or above the Measurable Objectives (MO) and above the corresponding Minimum Thresholds and therefore remained within the subbasin’s Margin of Operational Flexibility established for each RMS well, hence avoiding undesirable results related to groundwater levels as defined in the GSP.

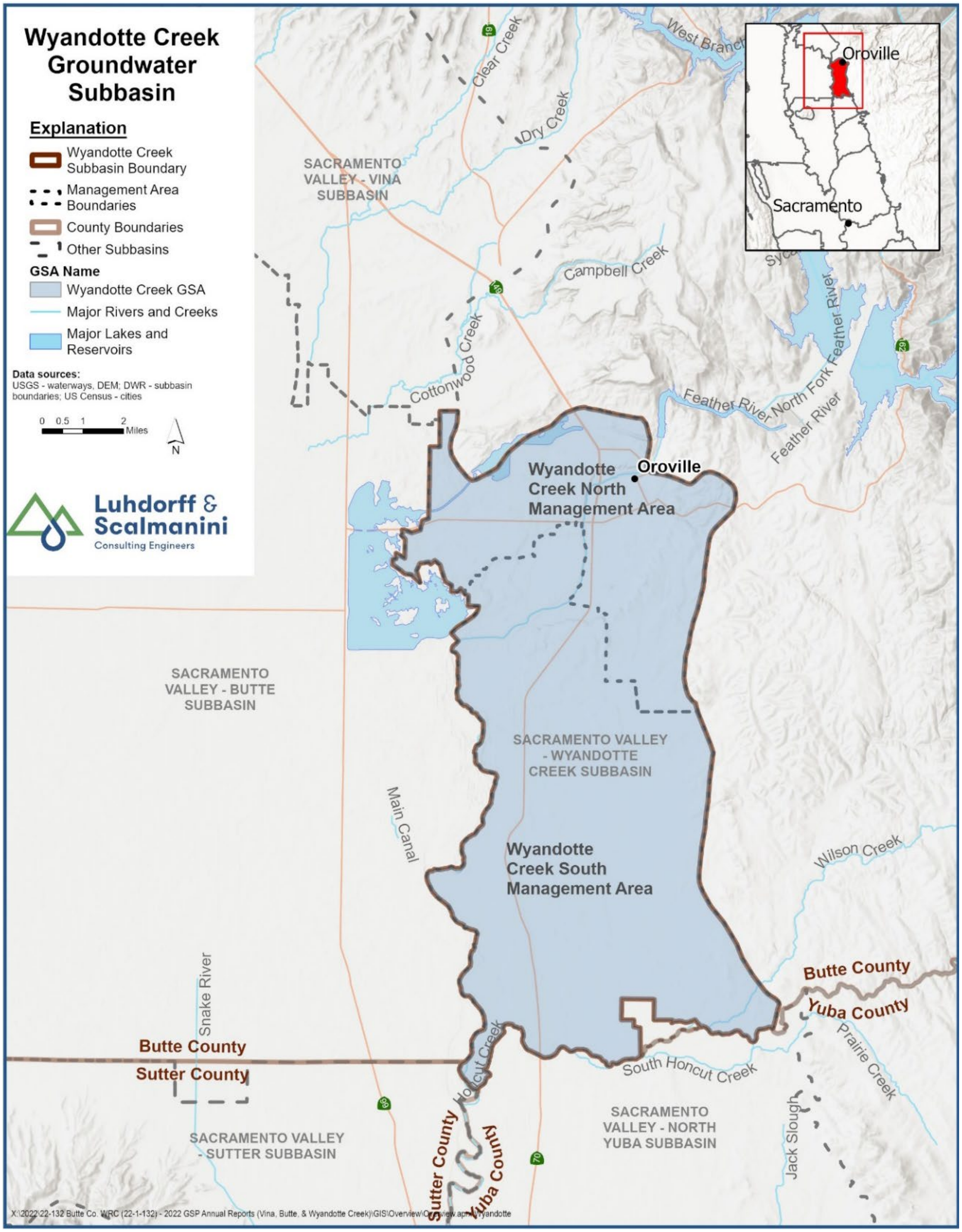

Figure ES-1. Wyandotte Creek Subbasin Boundaries and Management Areas

Last WY, outside of precipitation, groundwater supplied the majority (74%) of water used within the Subbasin. Agriculture demand used the majority of the water in the subbasin, however municipal and rural users and native vegetation also rely on these water supplies. 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. Groundwater extractions were about 45,700 acre-feet (AF) in WY 2022, lower than the average annual extractions of the last four Critical WYs on record (2008, 2014, 2015 and 2021) which was 52,850 AF. In drought years, agricultural groundwater extraction increases relative to long-term average demand due to less rainfall and increased evapotranspiration associated with hotter, drier conditions.

Surface water supplied 20% of the agricultural water demand in the Subbasin in the 2022 WY and 26% of the total water used within the Subbasin. The annual volume of surface water delivered to the Subbasin was about 16,200 AF in 2022. **Table ES-1** provides a summary of water use by source and sector.

Table ES-1. Wyandotte Creek Subbasin Total Water Use by Water Use Sector

Sector	WY 2022 (AF)		
	Groundwater	Surface Water	Total
Agricultural	43,500	10,900	54,400
Municipal	700	4,000	4,700
Rural Residential	1,500	0	1,500
Native Vegetation (Plant groundwater uptake)	36,300	1,300	37,600
Total	**82,000**	**16,200**	**98,200**
Total (excluding Native Vegetation[1])	**45,700**	**16,200**	**61,900**

[1] *Since native vegetation use involves natural plant uptake of shallow groundwater, not direct pumping and extraction, a total volume is calculated that excludes it.*

Fluctuations in groundwater levels and storage occur when there is an imbalance between the amount of water recharged into the aquifer and the amount of water removed from it. Groundwater levels can be used as a proxy to estimate changes in groundwater storage. The pattern of changes in groundwater storage in the Subbasin typically follows the majority of the Sacramento Valley. During dry years and drought conditions, groundwater storage decreases due to increased extraction and reduced recharge. In 2022, a Critical WY, the groundwater storage decrease was approximately -13,200 AF. For context, in the past 22 years the largest decrease in groundwater storage is estimated to be -28,800 AF and the highest increase was estimated to be 36,500 AF. **Figure ES-2** shows groundwater pumping, as well as annual and cumulative change in groundwater storage from 2000 to 2022.

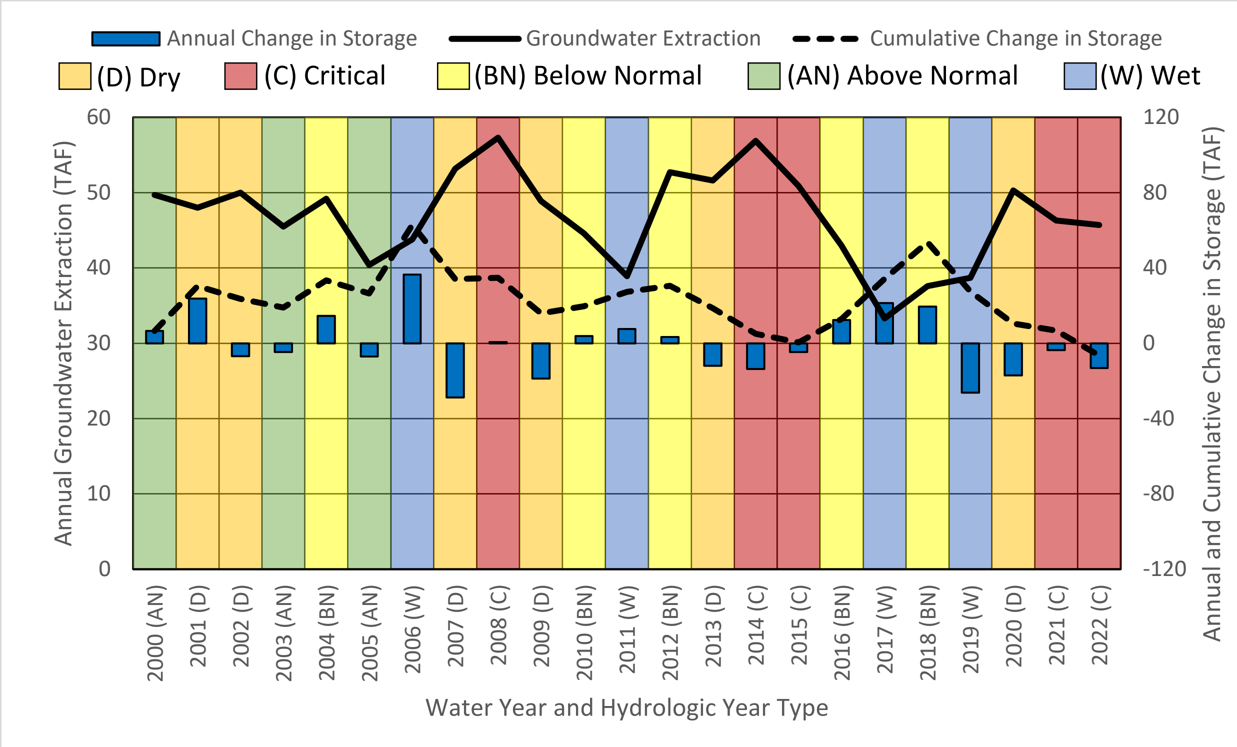

Figure ES-2. Groundwater Pumping, Annual and Cumulative Change in Storage from 2000 to 2022

Since the previous Annual Report, the Wyandotte Creek GSA coordinated with stakeholders to seek funding through DWR's Sustainable Groundwater Management Grant Program for a number of projects previously identified in the GSP. A draft awards list for the grant application is anticipated to be released by DWR in June 2023. Additionally, several actions continue to fulfill GSP requirements, such as monitoring groundwater levels and quality, updating the Data Management System, and annual reporting to DWR. The Wyandotte Creek GSA has also recently made progress made on various projects and management actions, demonstrating the GSAs' commitment to allocating the necessary time and resources to achieve long-term sustainable management of groundwater resources in the Subbasin.

1 GENERAL INFORMATION §356.2(A)

The Annual Report for the Wyandotte Creek Subbasin (Subbasin) (5-021.69) was prepared on behalf of the Wyandotte Creek Groundwater Sustainability Agency (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 GSA is formed through a Joint Powers Agreement (Agreement) of three member agencies including Butte County, the City of Oroville, and Thermalito Water and Sewer District. The regulations require the GSA to submit an Annual Report to DWR by April 1st following the reporting year (October through September). This Annual Report is the second Annual Report submitted on behalf of the Subbasin and includes data for the most recent water year (WY) 2022.

1.1 Report Contents

This report is the second Annual Report prepared for the adopted Wyandotte Creek Subbasin GSP submitted in January 2022. The first Annual Report included data elements for the first reporting, WY 2021, as well as a “bridge year”, WY 2020. This Annual Report will only include data for the current reporting year, WY 2022. Data elements presented in this report refer to WY 2022, the 12-month period starting October 2021 through September 2022 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 Basin Setting

The Subbasin is a 93 square mile (59,382 acre) area on the western side of Butte County. The Subbasin is managed the Wyandotte Creek Groundwater Sustainability Agency (GSA), formed through an Agreement by three member agencies including Butte County, the City of Oroville, and Thermalito Water and Sewer District. The GSA developed and submitted a GSP for the Wyandotte Creek Subbasin and submits a single yearly Annual Report.

The Subbasin is shown on the map, **Figure 1-1** and **Figure 1-2**. The Subbasin lies in the eastern central portion of the Sacramento Groundwater Basin, **Figure 1-2**. The Subbasin is bounded on the west by the Feather River and Thermalito Afterbay; in the south by the Butte-Yuba County Line (except for Ramirez Water District which is fully within the North Yuba Subbasin); and on the north and east by the edge of the alluvial basin (DWR, 2018). Surrounding subbasins include the Butte Subbasin to the west, the Vina Subbasin to the north, the North Yuba Subbasin to the South, and the foothills to the east **Figure 1-1**. The major river in the subbasin, the Feather River enters the subbasin in the northeast and then borders the subbasin on its western side. Smaller local streams enter and traverse the subbasin, those include North Honcut Creek, Wyandotte Creek, Wyman Ravine, and other numerous unnamed waterways. Groundwater generally flows from the north and from the foothill recharge areas in the east toward the subbasin's southwest corner.

The Agreement also defines two Management Areas (MAs) within the Wyandotte Creek Subbasin: Wyandotte Creek Oroville and Wyandotte Creek South. 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 based on unique local conditions or other circumstances as described in the GSP regulations. The interests and vulnerability of stakeholders and groundwater uses in these MAs vary based on the nature of the water demand (agricultural, domestic, municipal), numbers and characteristics of wells supplying groundwater, and to some degree the hydrogeology and mix of recharge sources.

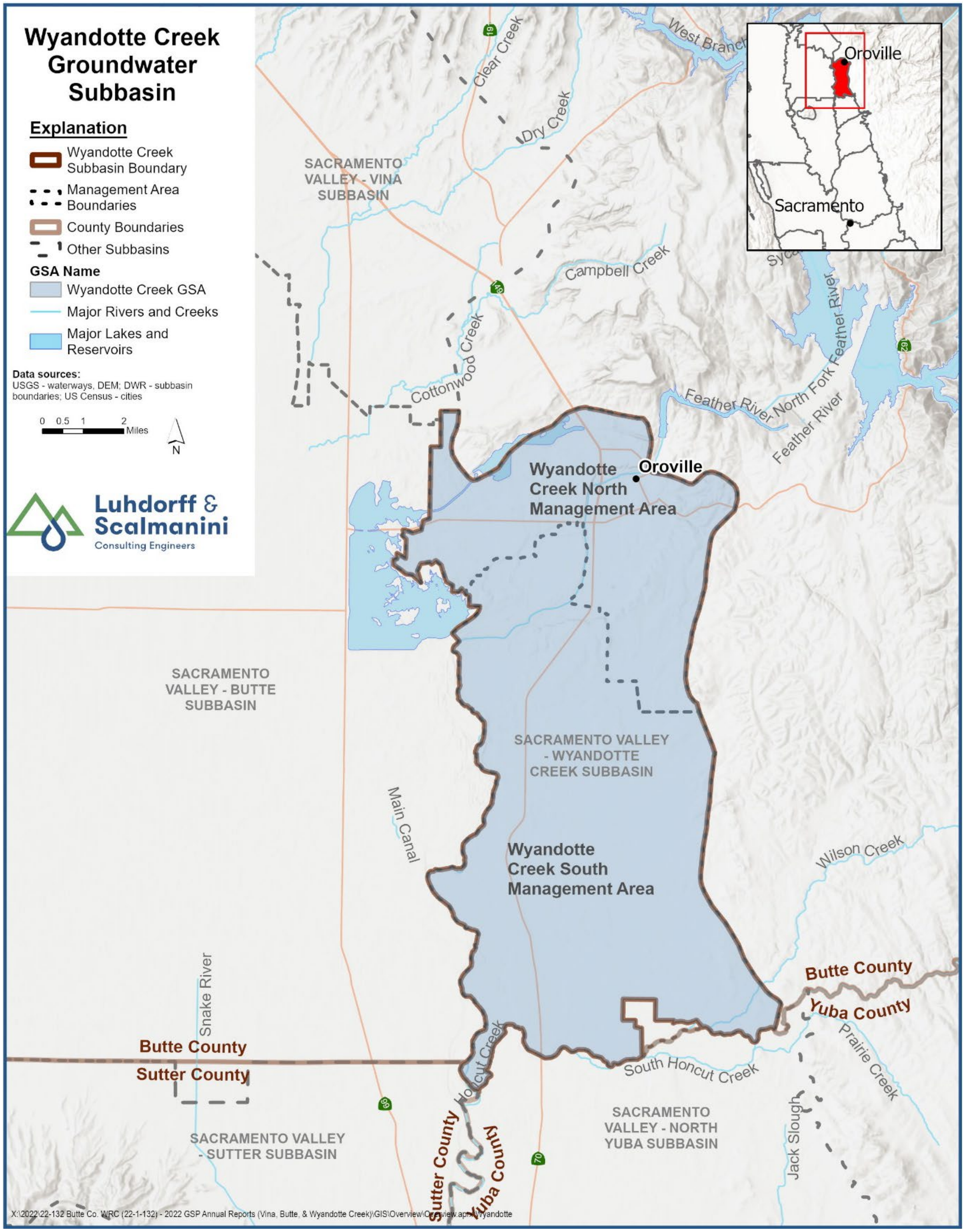

Figure 1-1. Wyandotte Creek Subbasin Boundaries and Management Areas

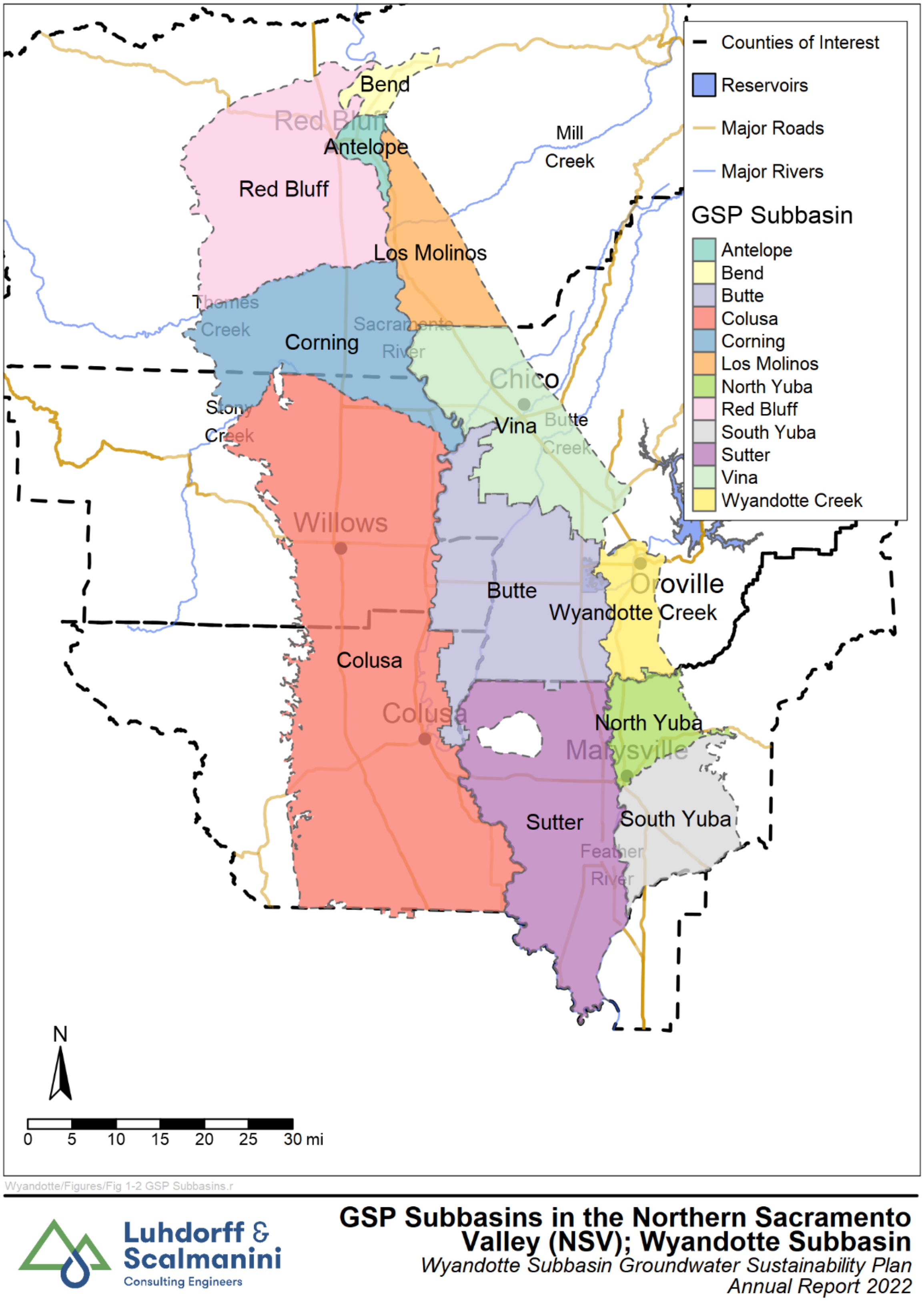

Figure 1-2. Subbasins in the Northern Sacramento Valley (NSV)

The Wyandotte Creek GSP estimates sustainable yield of the Subbasin to be 46,100 acre-feet per year (AFY) based on historical groundwater pumping averages 47,100 AFY, and an annual decrease of 1,000 AFY (Geosyntec, 2021). Water use in the Subbasin is dominated by agricultural uses including nut and fruit trees, vineyards, row crops, grazing and rice fields. Municipal water use accounts for roughly 10% of the total water. Groundwater constitutes the majority of water supplies in the Subbasin.

1.3 Current Conditions

This Annual Report coincides with one of the most severe and extensive droughts ever to occur in the western United States. Drought conditions in the Subbasin remained "severe" and "extreme" during summer of 2022 as per classifications provided by the U.S. Drought Monitor (https://droughtmonitor.unl.edu/). Drought conditions have resulted in reduced surface water supplies due to curtailment of water rights by the State Board, increased groundwater pumping to satisfy water demands, dry groundwater wells, increased well drilling and deepening, increased pumping costs, and decreased recreational opportunities in the Subbasin during 2022.

1.3.1 Climate

In WY 2022 the Durham California Irrigation Management Information System (CIMIS station No. 12) station recorded a total evapotranspiration (ET) and precipitation of 51.7 and 14.8 inches (**Figure 1-3**), respectively. The WY 2022 ET recorded is 1.4 inches above the 32-year average (1990-2022) and precipitation is 6.4 inches below. Despite the Biggs CIMIS station (station No. 244) being situated closer to the Subbasin, the Durham CIMIS station was selected due to its longer data history. Data from this station is included as an indication of climate conditions experienced in the valley and within the subbasin.

The Northern Sierra 8-Station Summary is a collection of eight precipitation gages in the mountains of Northern California. According to this summary, the 2022 WY was a moderately dry year and was dryer than roughly 60 percent of the previous years since measurement began in WY 1921 (**Figure 1-4**). The total precipitation in WY 2022 was 43.0 inches and 8.1 inches below the 102-year average. The location of the stations used in the 8-station index are shown in **Figure 1-5.** This index is included as an indication of the water year type from a more regional perspective that reflects higher elevation precipitation and resulting runoff conditions into the Sacramento Valley.

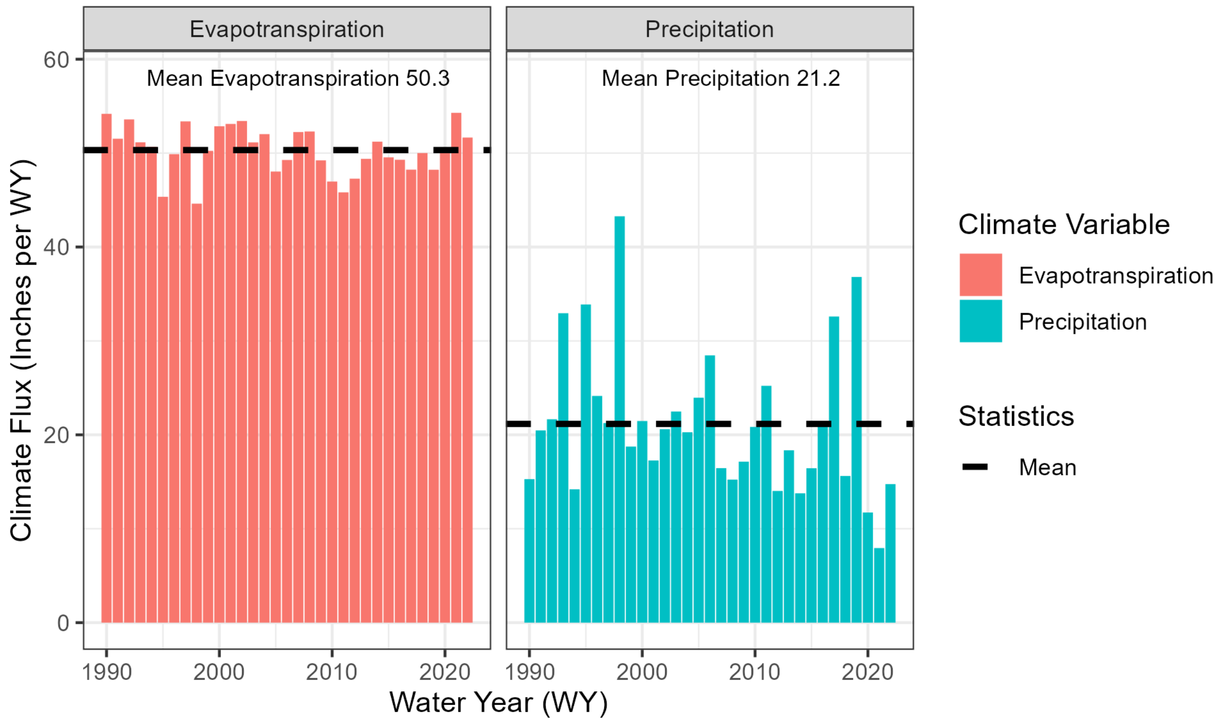

Figure 1-3. Summary of Durham CIMIS Station

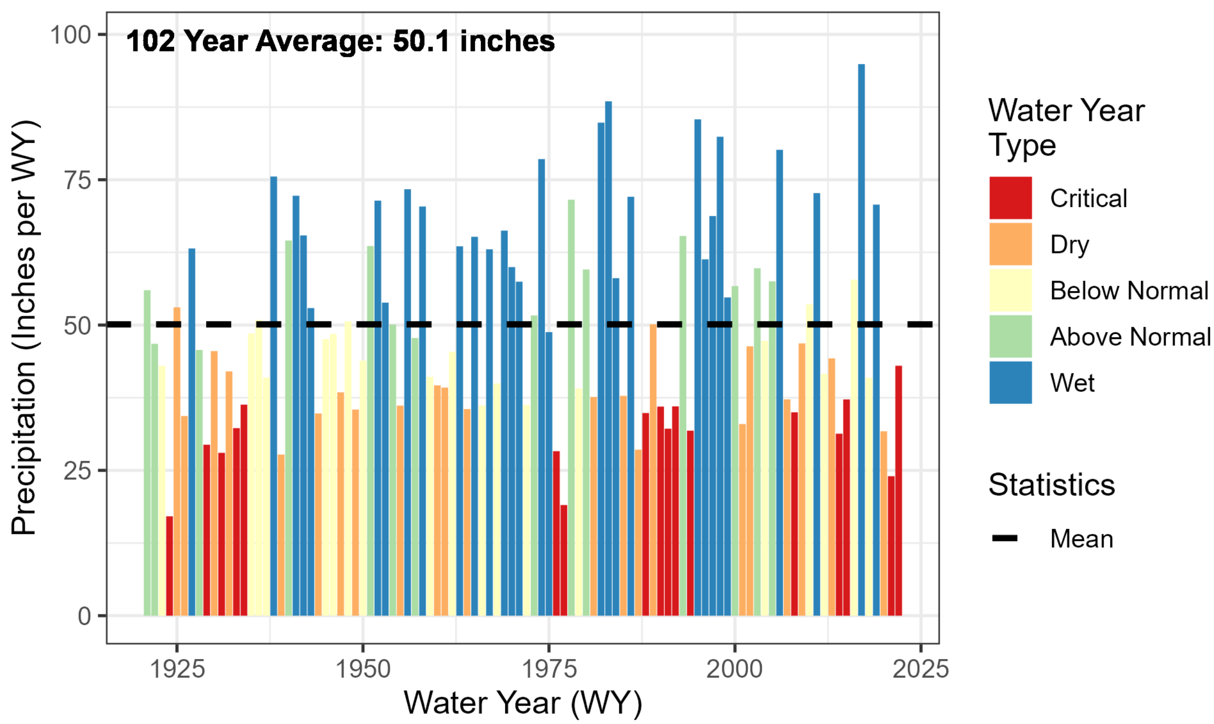

Figure 1-4. Precipitation Summary from the Northern Sierra 8-Station Index

Figure 1-5. Northern Sierra 8-Station Index (Station Locations)

1.3.2 Streamflow

Streamflow was assessed at one location within the Subbasin (**Table 1-1; Figure 1-6**). The location represents the Feather River (**Figure 1-7**) which traverses the subbasin and at times contributes recharge to the groundwater system. In general, WY 2022 saw low flow rates. The highest and lowest flow rates in recent years occurred in WYs 2017 and 2014, respectively.

Table 1-1. Mean Yearly Surface Flows of Selected Stations (cubic feet per second)

Station	River	2014 (C)	2015 (C)	2016 (BN)	2017 (W)	2018 (BN)	2019 (W)	2020 (D)	2021 (C)	2022 (C)
GRL	Feather River	1,337	1,415	3,349	11,540	3,013	5,471	2,341	1,748	2,510

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

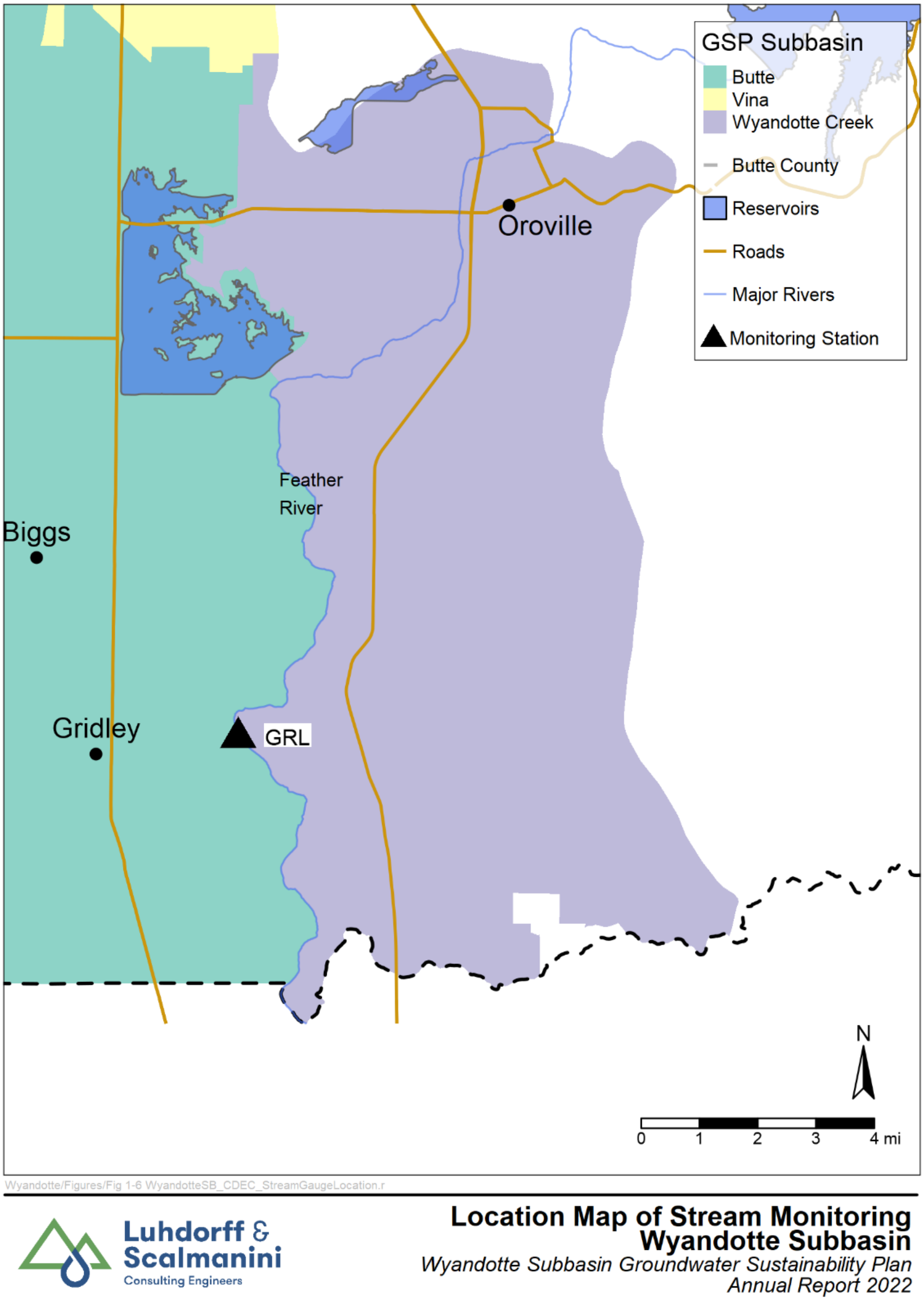

Figure 1-6. Location Map of Streamflow Monitoring

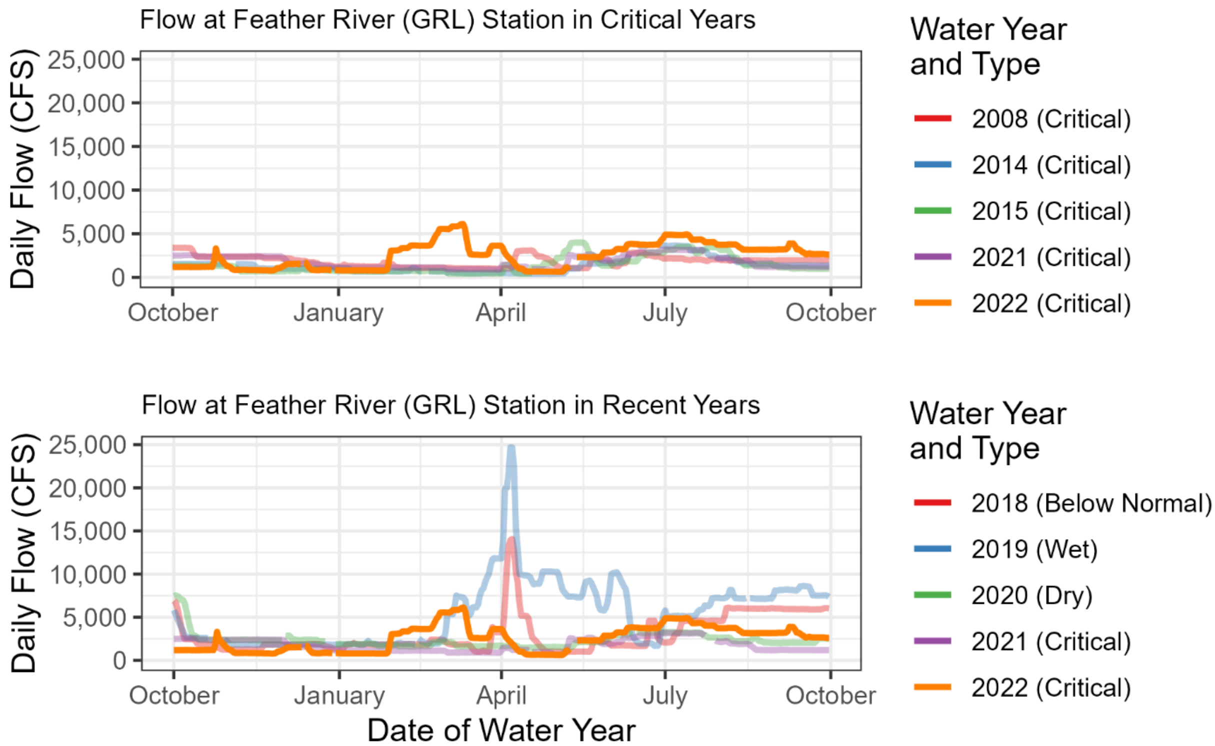

Figure 1-7. Flow at Feather River (GRL) Station

1.3.3 Agricultural Acreages

Land use trends in the Subbasin were examined based on Land IQ data (LandIQ, 2023) use classifications were kept consistent with the BBGM land use classes. Total agricultural acreage in 2022 is estimated to be 15,700 acres. Due to the availability of Land IQ data, agricultural acreages were compared from 2018 to 2022 **(Table 1-2)**. This comparison shows the change from a Below Normal (2018) to Critical (2022) Water Year type. Long term trends, like those presented in the 20-Year Land and Water Use Change in Butte County and the Vina Subbasin (1999-2019) (Land IQ, 2021), two nearby subbasins, require multi-year averages to capture true agricultural expansion and/or contraction. Orchard deciduous crops, mainly young perennials, decreased by 1,100 acres and walnut orchard acreages increased by 400 acres. Fallowed land increased by 500 acres. Almonds increased by 900 acres and grain crops decreased by 400 acres. The remaining land use classes were largely unchanged. Increased walnut acreages are attributed to conversion of deciduous, almond, and grain crops. Overall, from 2018 to 2022 agricultural acreage increased by 400 acres. A map of 2022 agricultural acreage in Wyandotte Creek Subbasin is presented below in **Figure 1-8**.

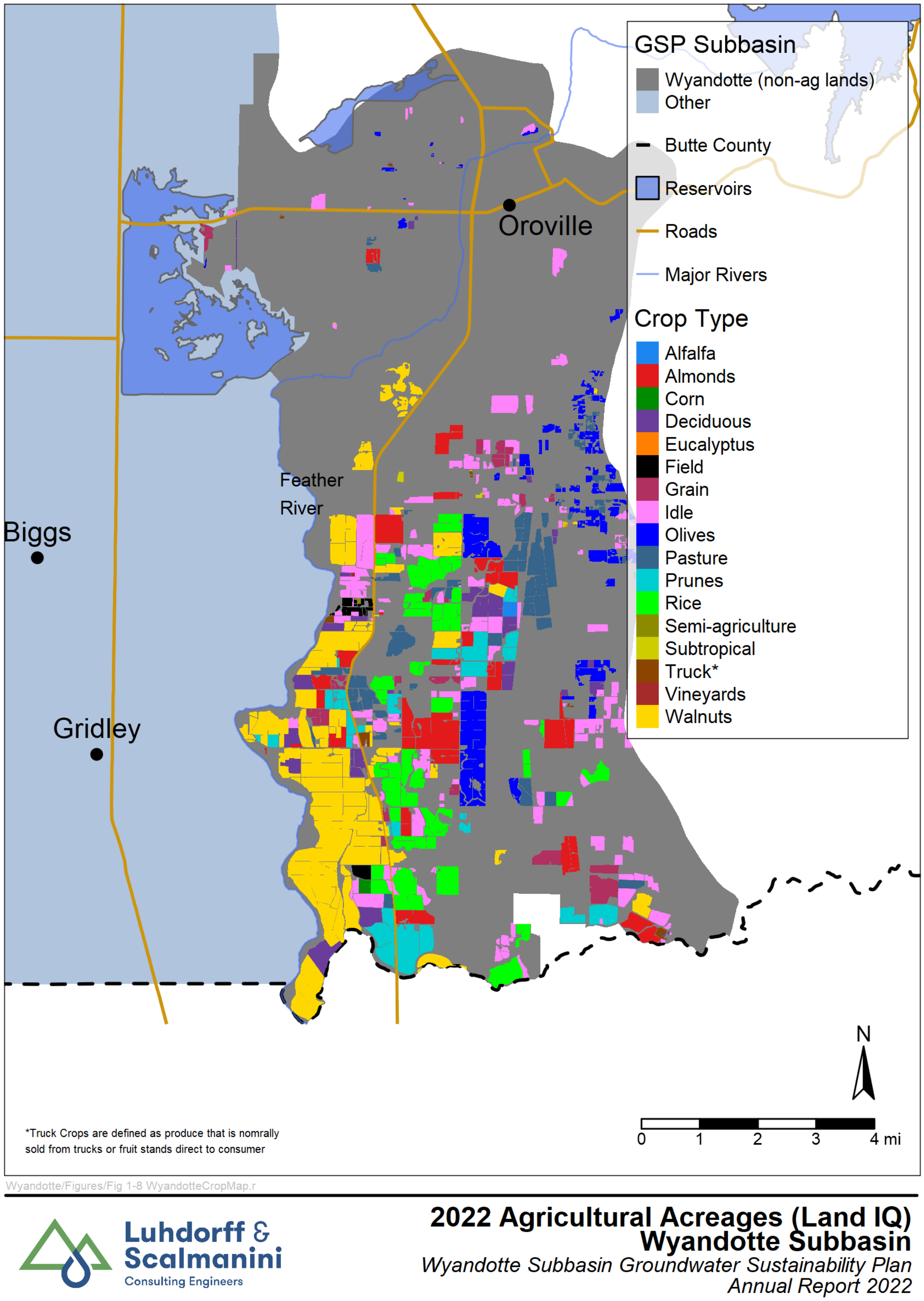

Figure 1-8. 2022 Agricultural Acreages (Land IQ)

Table 1-2. Agricultural Acreages for Major Crop Types in Subbasins (2018 & 2022)				
Land Use	**2018 (Acres 1,000x)**	**2022 (Acres 1,000x)**	**Change (Acres 1,000x)**	**Change (%)**
Rice	2.0	2.0	0.0	0%
Walnuts	3.7	4.1	0.4	10%
Idle or Fallow	1.8	2.3	0.5	22%
Almonds	0.8	1.7	0.9	51%
Deciduous*	1.9	0.8	-1.1	-143%
Prunes	0.9	1.2	0.3	24%
Grain	1.0	0.6	-0.4	-77%
Pasture	1.7	1.3	-0.3	-24%
Miscellaneous**	1.6	1.7	0.2	10%
Total	**15.3**	**15.7**	**0.4**	

**Mainly young perennials .*

***Can include vineyards, olives, cotton, and field crops.*

1.3.4 Well Completion Reports

Well Completion Reports (WCRs) are submitted to DWR within 60 days of completed drilling of a new well. Information on the number of these reports submitted within the Subbasin is from the DWR Online System for Well Completion Reports (OSWCR) (DWR, 2022). Over the past nine years, the Subbasin has averaged the installation of two agricultural wells and eight domestic wells per year (**Table 1-3**). Agricultural wells are typically larger diameter and installed to deeper depths than domestic wells (**Table 1-4**). Due to the deeper construction, total number of feet drilled for agricultural wells typically exceeds that of domestic wells, although this was not the case in 2022 (**Table 1-5**). **Figure 1-9** shows the depth of new domestic wells over time represented by a box and whisker plot. A steady increase in the average domestic well depth can be seen starting roughly in the 1960's.

Table 1-3. Number of Well Completions in Subbasin by Sector									
Sector	**2014 (C)**	**2015 (C)**	**2016 (BN)**	**2017 (W)**	**2018 (BN)**	**2019 (W)**	**2020 (D)**	**2021 (C)**	**2022 (C)**
Agriculture	3	3	4	1	1	4	--	1	--
Domestic	10	4	4	5	6	13	9	14	8
Public or Industrial	--	--	1	--	--	--	1	1	1

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

Table 1-4. Median Depth of New Wells in Subbasin by Sector (feet) Over Time									
Sector	2014 (C)	2015 (C)	2016 (BN)	2017 (W)	2018 (BN)	2019 (W)	2020 (D)	2021 (C)	2022 (C)
Agriculture	502	460	310	400	160	255	--	190	--
Domestic	140	128	115	205	148	120	166	200	199
Public or Industrial	--	--	160	--	--	--	150	180	--

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

Table 1-5. Total Drilled Feet of New Wells in Subbasin by Sector (feet) Over Time									
Sector	2014 (C)	2015 (C)	2016 (BN)	2017 (W)	2018 (BN)	2019 (W)	2020 (D)	2021 (C)	2022 (C)
Agriculture	--	520	1,490	400	160	1,130	--	190	--
Domestic	140	120	850	1,050	1,029	1,875	1,969	3,510	1,598
Public or Industrial	--	--	160	--	--	--	--	180	--

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

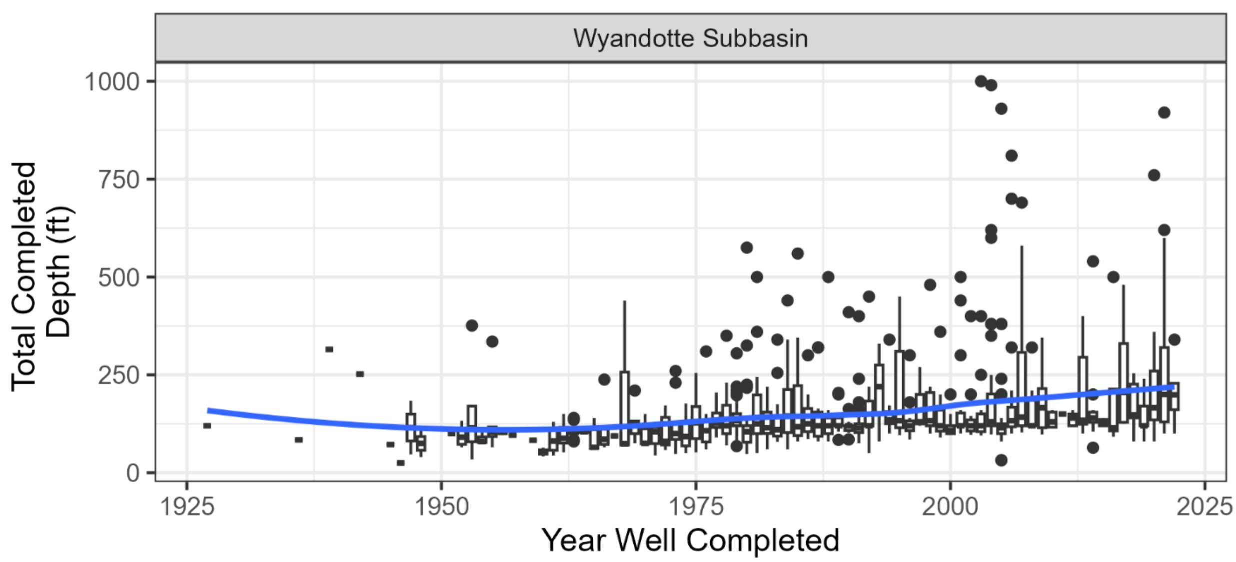

Figure 1-9. Depth of New Domestic Wells Drilled in the Wyandotte Creek Subbasin

Note: In Figure 1-9, the vertical boxes represent 75% of the well depths, while the vertical black lines and points extend to show the other 25% of well depths each year. The blue line is a regression fitted by least squares method and represents the trend of depth of domestic well depths through time.

1.3.5 Drought Restrictions and Dry Wells

The California drought stressed multiple areas of the State during WY 2022. Drought declarations and management actions have taken place at the state level. Below is a general timeline of drought restrictions within the State of California relevant to the Northern Sacramento Valley (NSV), and the actions directly affecting the Subbasin indicated in *italics*.

WY 2021

- December 1, 2020: State Water Project (SWP) announces initial allocation of 10% for 2021.
- March 23, 2021: SWP announces final 5% allocation for 2021.
- April 10, 2021: 50% curtailment in Feather River diversions by the Joint Districts (which include Richvale Irrigation District, Butte Water District and Biggs-West Gridley Water District within Butte County) and Western Canal Water District in the Butte Subbasin.
- May 20, 2021: Governor Newsom declared a drought emergency for 41 counties.
- May 26, 2021: USBR reduced Central Valley Project (CVP) water users to be 0% for agricultural water service contractors and 25% for M&I water service contractors.
- May 28, 2021: Final Temperature Management Plan for the Sacramento River (2021).
    - The Sacramento River Settlement Contractors (SRSC) agree to pump additional groundwater to leave surface water in stream for beneficial uses.
    - SRSC agreed to reduce their Shasta Reservoir diversions from 75% to 67% to aid in cold water conditions.
- August 20, 2021: The State Water Resources Control Board (SWRCB) issued curtailment orders to over 4,000 water rights holders in California.

WY 2022

- January 4, 2022, SWRCB adopted the prohibited wasteful water uses emergency regulation.
- January 20, 2022: SWP announces tentative increase to allocations to 15% for 2022.
- March 18, 2022: SWP announces final allocation of 5% for WY 2022.
- March 28, 2022: Governor Newsom issued Executive Order No. N-7-22 meant to provide response to and mitigate drought impacts.
    - This order requires additional review of well permits by local jurisdictions and groundwater sustainability agencies in groundwater basins subject to SGMA and classified as medium or high priority. The goal being that proposed wells are not inconsistent with any sustainable groundwater management program established in any GSP.

  - Both existing wells seeking alteration, and proposed wells, must first determine that extraction of groundwater from the proposed well is (1) not likely to interfere with the production and functioning of existing nearby wells, and (2) will not likely cause subsidence that would adversely impact or damage nearby infrastructure.

- April 14, 2022: Sacramento River Settlement Contractors received an 18% allocation from the Central Valley Project.

- April 19, 2022: 50% curtailment in Feather River diversions by the Joint Districts (which include Richvale Irrigation District, Butte Water District and Biggs-West Gridley Water District within Butte County) and Western Canal Water District in the Butte Subbasin.

- June 1, 2022: Drought Impact Analysis Report for Butte County released.

- June 6, 2022: *Butte County Drought Assistance Program begins taking applications from residents with dry household wells for assistance with water deliveries and water storage tank installations.*

Private well-owner reporting of dry wells can be conducted in several ways. In Butte County, reporting can be done through DWRs voluntary Household Water Supply Shortage Reporting System (mydrywell.water.ca.gov; “Dry Well Reporting System”), through the Butte County OEM Drought Assistance Program and or through Butte County EH. Those reporting to the County are encouraged to fill out the DWR Dry Well Reporting System reports as well, but not all do.

There were four reports of dry or reduced capacity wells through the DWR Dry Well Reporting System in Wyandotte Creek subbasin in 2022 **(Table 1-6; Figure 1-10)**. **Table 1-7** summarizes dry wells reported from this source by management area; and **Table 1-8** summarizes the two reports of dry wells to Butte County EH. Reports to Butte County EH are obtained through a question on well drilling applications for applicants looking to either drill a new well or deepen / repair an existing well and therefore not representative of county-wide conditions. Within WY 2022, Wyandotte Creek Subbasin residents applied for the Butte County OEM Drought Assistance Program to receive water deliveries and or water storage tanks due to a dry or reduced capacity household domestic well at their residences **(Table 1-9). Figure 1-11** shows the approximate location of the wells reported through this program.

Table 1-6. Dry Wells Reported from DWR Dry Well Reporting System

Subbasin	2014 (C)	2015 (C)	2016 (BN)	2017 (W)	2018 (BN)	2019 (W)	2020 (D)	2021 (C)	2022 (C)
Wyandotte Creek Subbasin	--	--	--	--	--	--	--	5	4

Table 1-7. Dry Wells Reported from DWR Dry Well Reporting System

Management Area	2014 (C)	2015 (C)	2016 (BN)	2017 (W)	2018 (BN)	2019 (W)	2020 (D)	2021 (C)	2022 (C)
Wyandotte Creek North	--	--	--	--	--	--	--	1	3
Wyandotte Creek South	--	--	--	--	--	--	--	4	1

Table 1-8. Dry Wells Reported to Butte County Public Health (EH)

Subbasin	2021 (C)	2022 (C)
Wyandotte Creek Subbasin	--	2

Table 1-9. Butte County Office of Emergency Management (OEM) Program Applicants

Management Area	2022 (C)
Wyandotte Creek North	7
Wyandotte Creek South	13

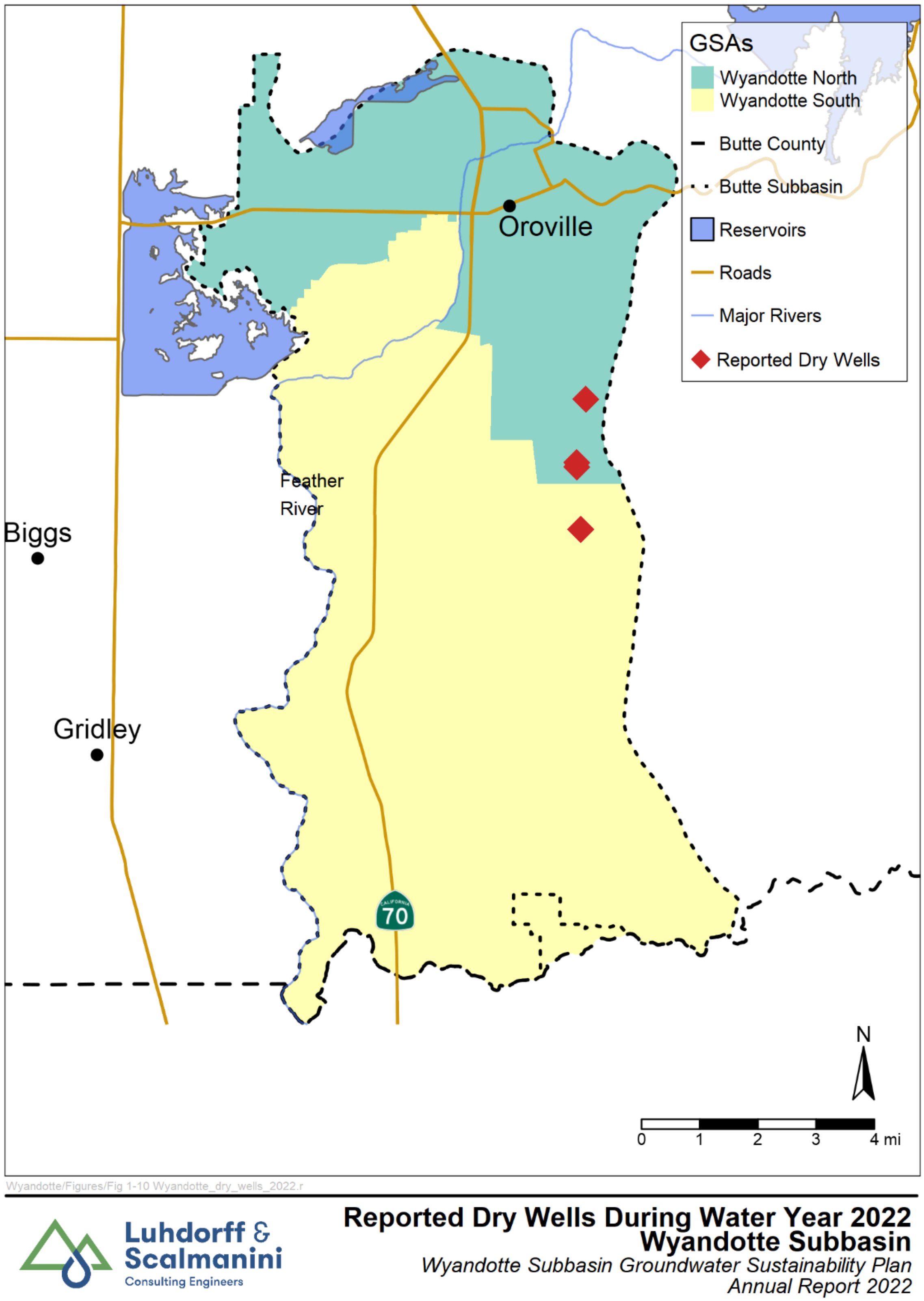

Figure 1-10. Reports to the DWR Dry Well Reporting System during Water Year 2022

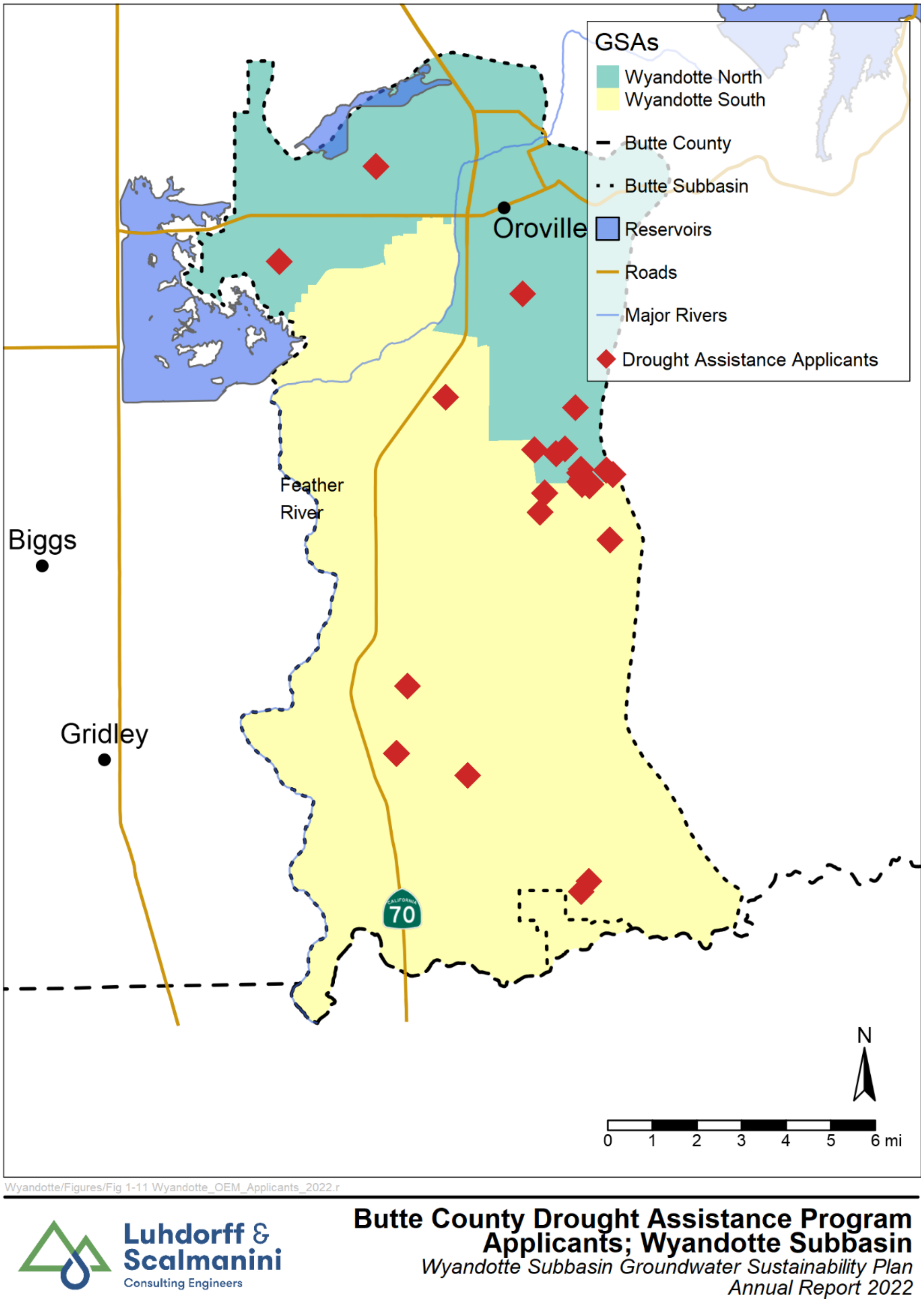

Figure 1-11. Butte County Office of Emergency Management Drought Assistance Program Applicants

1.3.6 Vulnerable Well Analysis

Most rural households within the Subbasin rely on domestic wells for their drinking water supply. If these wells go dry or experience reduced capacity due to declining groundwater levels, it can cause significant hardship for those households. A well vulnerability analysis was conducted in order to evaluate the potential number and location of vulnerable wells in the coming year (those that could go dry or experience reduced capacity in 2023) given current groundwater levels and projected future groundwater levels. The DWR Online System of Well Completion Reports (OSWCR) database was used to estimate the total depth of wells in the subbasin for wells drilled within the last 40 years. For the analysis, if the groundwater elevation was lower than ten feet from the bottom of the well, it was considered to be vulnerable.

Three scenarios were analyzed:

1. 2022 Scenario: An estimate of how many wells were vulnerable in Fall 2022 based on Fall 2022 measured groundwater levels compared to well depths within the Subbasin.

2. 2023 Moderate Scenario: An estimate of how many wells are predicted to be vulnerable in Fall 2023, assuming the same decline in groundwater levels observed between 2021 and 2022 compared to well depths within the Subbasin.

3. 2023 Extreme Scenario: An estimate of how many wells are predicted to be vulnerable in Fall 2023, assuming the same decline in groundwater levels observed between 2020 and 2022 compared to well depths within the Subbasin.

Based on the analysis, there were no wells that should have been vulnerable to dry or reduced capacity conditions in Fall 2022, nor in 2023.

2 GROUNDWATER ELEVATIONS §356.2(B)(1)

Groundwater elevations fluctuate seasonally throughout the Subbasin. 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, 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.

A broad network of thirteen wells was defined during GSP development to monitor groundwater levels in the Subbasin. Nine of these are Representative Monitoring Site (RMS) wells that were selected in the GSP for monitoring groundwater levels and were assigned Sustainable Management Criteria (SMC). The RMS wells are a mixture of domestic and irrigation wells, along with three dedicated observation wells and California Water Service Company municipal supply wells in Oroville. Hydrographs depicting groundwater elevations in the RMS wells over time (and through 2022) are included in **Appendix A**. The Broad Network and RMS wells are typically measured by hand four times per year, in March, July, August and October. From 2014 to 2016, groundwater levels were measured monthly from April through October due to severe drought conditions. Data from groundwater level monitoring wells is available from DWR's online SGMA Data Viewer tool (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer). Summary tables of groundwater elevations from Spring and Fall 2022 measurements for RMS wells are presented in **Table 2-1**.

The groundwater level monitoring methods are consistent with the protocols described in the Wyandotte Creek GSP. Groundwater elevations are measured using a steel tape, electric sounder, pressure transducers, acoustic or sonar sounder, or by airline measurements. The accuracy of groundwater level measurements are 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 2022 through presentation and description of groundwater elevation contours (**Section 2.1**) and hydrographs of groundwater elevations (**Section 2.2**).

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

The contour maps **Figure 2-1** and **Figure 2-2** show groundwater elevations that are higher in the northern portion of the Wyandotte Creek Subbasin than in the south and higher on the eastern side of the subbasin compared to the western edge. The north-south differences are more substantial than the east-west differences. This indicates groundwater flow is generally from north to south with additional flow from foothill recharge areas in the east with flows generally towards the southwestern portion of the subbasin. Because of the influence of Thermalito Afterbay and the Feather River, groundwater elevations in the north are generally stable between the spring and fall observation periods, while elevations in the south tend to be approximately 10 feet lower in the fall than the spring, a pattern typical of valley floor locations distant from major sources of recharge. Lower fall levels is a pattern typical of valley floor locations due to irrigation season pumping.

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

- Overall south-southwest flow consistent with recharge from the north and along the eastern foothills.
- Convergence of flow toward the Feather River.

The Wyandotte Creek Subbasin aquifer system is described in the GSP as a single principal aquifer and therefore the maps shown in **Figure 2-1** and **Figure 2-2** do not distinguish between completion intervals of the wells. Therefore, the contours represent an aggregate of groundwater elevations across all zones of the primary aquifer system. 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 some additional minor adjustments to the contours were made based on expert judgement. Maps showing the regional context of groundwater contours, including groundwater contours in the Butte and Vina Subbasins, are included in **Appendix A.**

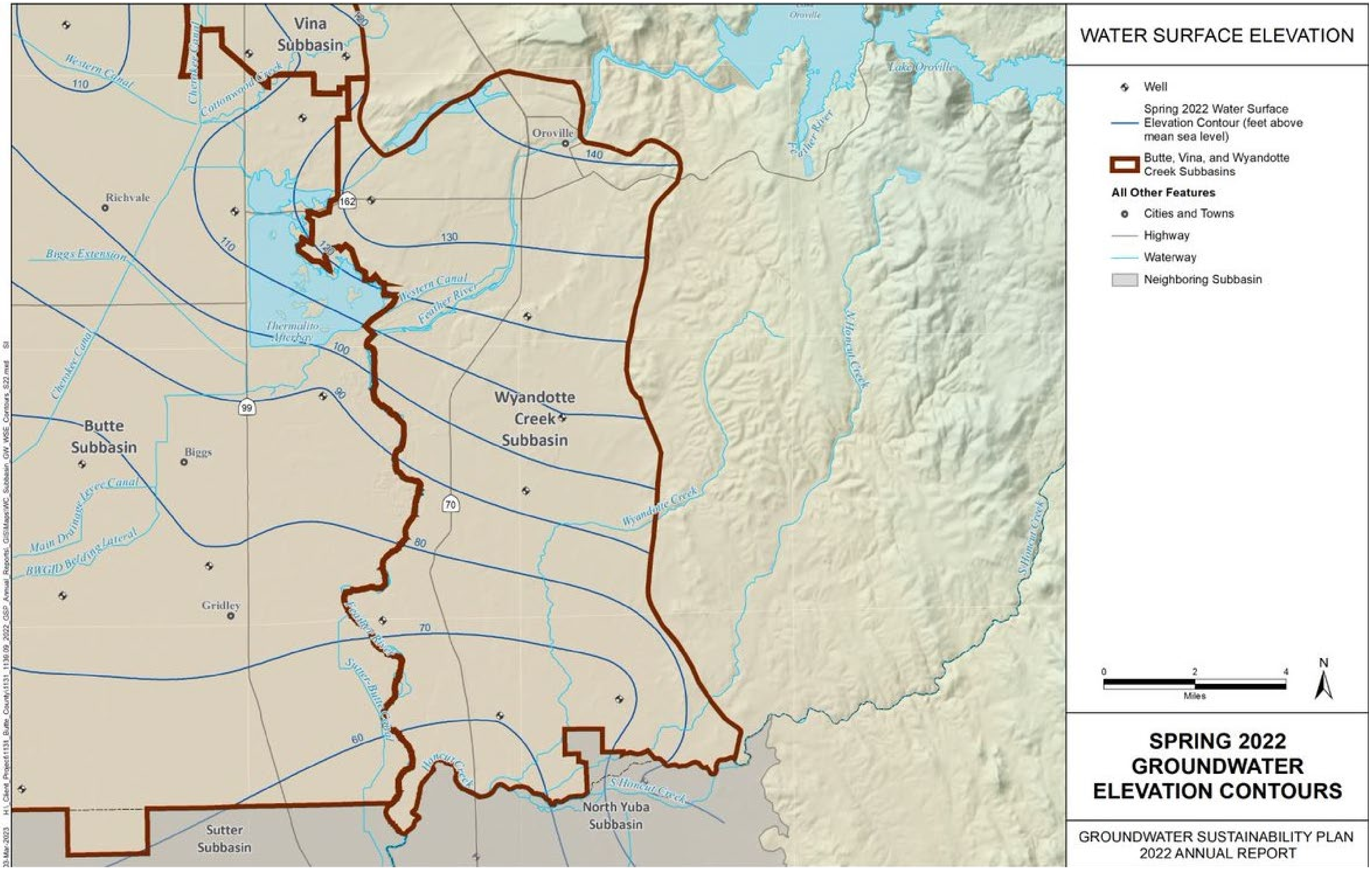

Figure 2-1. Wyandotte Creek Subbasin Contours of Equal Groundwater Elevation Seasonal High of 2022

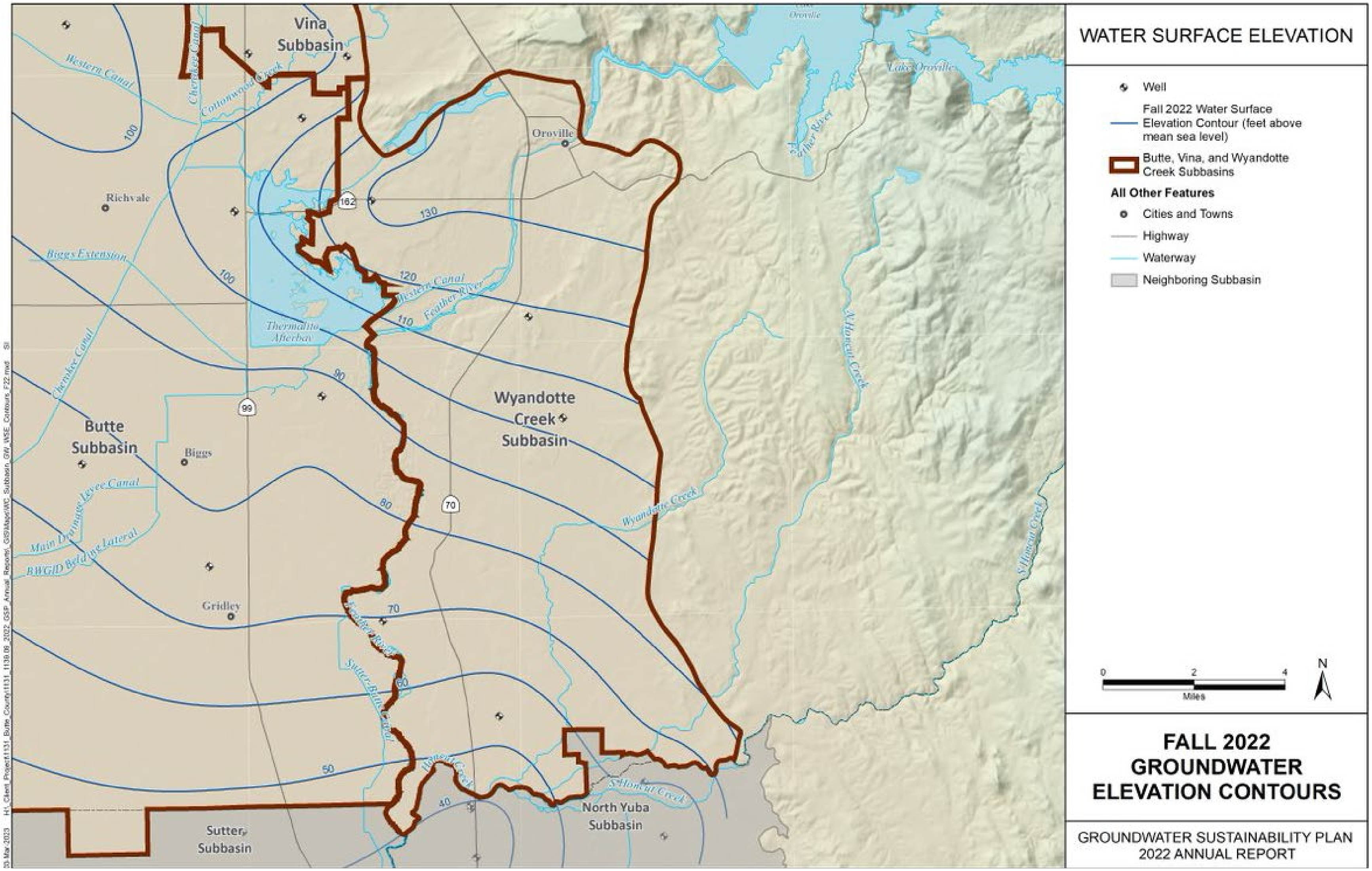

Figure 2-2. Wyandotte Creek Subbasin Contours of Equal Groundwater Elevation Seasonal Low of 2022

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

Groundwater elevation hydrographs for each RMS well identified in the GSP are presented in **Appendix A**. **Appendix B** provides an explanation of the terms making up the *Sustainable Management Criteria* defined in Section 3 of the GSP (e.g., Minimum Threshold [MT], Measurable Objective [MO]). The spring and fall 2022 water levels measured at each RMS well are presented in **Table 2-1**, which also provides a comparison of spring and fall water levels to: (i) 2021 WY conditions, (ii) the established Minimum Threshold groundwater elevations, (iii) the established Measurable Objective groundwater elevations, and (iv) the Interim Milestone for 2027, the changes in groundwater elevations from 2021 to 2022, and the differences between the 2022 groundwater elevations and the MO.

Spring and fall 2022 levels were above the Measurable Objective, with only one exception: the fall groundwater elevation in well 20N01E10C002M which was approximately three feet below the Measurable Objective. All measured groundwater levels remained within the subbasin's Margin of Operational Flexibility and well above the Minimum Threshold of each RMS well. Generally, 2022 groundwater levels were similar to 2021 conditions with some new historical lows reached in a few wells.

Table 2-1. Measurable Objectives, Minimum Thresholds and Seasonal Groundwater Elevations of Representative Monitoring Site Wells

State Well Number / Representative Monitoring Site (RMS) ID[1]	Management Area	Groundwater Elevation (feet above mean sea level)								
		MO[2]	MT[2]	Interim Milestone 2027	Seasonal High (Spring)			Seasonal Low (Fall)		
					2022	Difference (feet) from: 2021	Difference (feet) from: MO[2]	2022	Difference (feet) from: 2021	Difference (feet) from: MO[2]
19N03E**16Q001M**	Wyandotte North	133	85	134	139.3	1.0	6.3	138.2	-0.2	5.2
19N04E**32P001M**	Wyandotte North	107	78	108	128.2	-2.3	21.2	122.5	-2.7	15.5
CWS-03	Wyandotte North	133	102	135	137.0	3.0	4.0	134.0	1.0	1.0
17N03E**13B002M**	Wyandotte South	47	35	48	60.6	-1.5	13.6	51.6	-1.0	4.6
17N04E**09N002M**	Wyandotte South	49	35	51	65.4	-9.4	16.4	46.9	-0.3	-2.1
18N03E**25N001M**	Wyandotte South	52	37	53	62.2	3.1	10.2	52.8	-3.5	0.8
18N04E**08M001M**	Wyandotte South	86	59	87	109.6	-1.5	23.6	105.5	-0.7	19.5
18N04E**16C001M**	Wyandotte South	95	71	96	107.0	-4.5	12.0	95.9	-7.6	0.9
19N04E**31F001M**	Wyandotte South	99	76	101	121.5	-11.0	22.5	118.9	1.5	19.9

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

[2] *MO = measurable objective, MT = minimum threshold*

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. 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**. Total water available is summarized in **Table 3-3** for the 2022 WY. The results are either based on measured data or estimates as described in the previous two sections.

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.

During GSP development, the BBGM was used to prepare water budgets for the Subbasin that characterized historical, current, and projected water supply and water use conditions. In the first Annual Report, information from the BBGM was leveraged to quantify subregion-scale water budgets for each of the GSA areas in the Subbasin through WY 2021.

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. This water budget approach generally follows the process described in Hessels et al. (2022). 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 23 CCR §356.2. Key water budget inflows and outflows calculated in this water budget approach were compared with equivalent values from the BBGM 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 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 are also similar to the approaches used to quantify ET in the BBGM 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)
        - U.S. Department of Agriculture (USDA) CropScape 2022 Cropland Data Layer coverage (https://nassgeodata.gmu.edu/CropScape/)
    - Current field-scale land use coverage of the Subbasin in 2022 were also provided by Land IQ survey results.

- Measured surface water diversions data (as applicable), 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 (as applicable).

- Measured groundwater extraction data (as applicable), 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 (as applicable).

- Measured boundary water outflow data, reported from water supplier records (as applicable).

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

3.2 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 in the Subbasin is estimated through the water budget approach described in the previous section.

Irrigators in the Subbasin rely primarily on groundwater to meet agricultural demands. During dry and critically dry years, agricultural groundwater extraction generally increases relative to long-term average demand to offset the effects of curtailments, lower rainfall, reduced soil moisture, and/or increased ET associated with hotter, drier conditions. Agricultural groundwater extraction was estimated through the water budget approach described above.

Rural residential water users rely on private domestic wells to meet their household water needs. Rural residential groundwater extraction was quantified based on average per capita water use and estimated population (as described in the previous Annual Report). The average per capita water use reported in the California Water Service Chico-Hamilton City District 2020 Urban Water Management Plan 2020 usage was 184 gallons per capita per day. This is considered representative of rural residential per capita water use in the region. Population data from the U.S. Census Bureau in 2020 was then coupled with parcel data to identify total population not serviced by municipal supplies.

The City of Oroville, served by three different water providers, is supplied in small part with groundwater. These municipal water supplies are measured and were provided by each utility/water agency.

Environmental groundwater use in the Subbasin includes uptake of shallow groundwater from deeply rooted plants. Although no groundwater is directly pumped or extracted use in these areas, consumptive use of shallow groundwater has been estimated through the water budget approach described above for areas classified as native vegetation, riparian vegetation, or barren lands. The estimated volumes are based on the evaporative demand unable to be met through precipitation that must instead be met through plant access to shallow groundwater. There are roughly 19,700 acres of native vegetation, 2,100 acres of riparian vegetation, and 400 acres of barren lands in the Subbasin (22,200 acres total) with a total estimated groundwater use of 36,300 acre-feet (AF), or roughly 1.6 AF per acre (AF/ac). The estimated water use ranged from 1.4 AF/ac for native vegetation to 3.8 AF/ac for riparian vegetation, which has more consistent and reliable access to shallow groundwater. This method of estimating environmental groundwater use is dependent on both precipitation and ET estimates. Since environmental groundwater use is modeled over a large area, 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.

The Wyandotte Creek Subbasin did not have any managed recharge volumes or groundwater extractions for managed wetlands in the 2022 water year. The recorded municipal supplies do not distinguish between urban and industrial water uses.

The total estimated groundwater extraction was approximately 43,500 acre-feet (AF) in WY 2022. The total groundwater extraction is approximately 3,600 AF less than the average annual groundwater extraction reported in the GSP (47,100 AF per WY over 2000-2018, from GSP Tables 2-5 and 2-6 [Geosyntec, 2021]) and lower than the average annual extractions of the last four Critical WYs on record (2008, 2014, 2015 and 2021) which was 52,850 AF. **Figure 3-1** shows the water use sector and associated volumes of 2022 groundwater extractions in the Basin. The subregions shown on the map are defined in the BBGM (BCDWRC, 2021).

About 95% of the total groundwater extraction[1] was used by the agricultural sector while the remaining 5% was used for municipal and rural residential water needs.

Table 3-1. Wyandotte Creek Subbasin Groundwater Use by Water Use Sector

Sector	WY 2022 (AF)
Agricultural	43,500
Municipal	700
Rural Residential	1,500
Native Vegetation[1] (Plant groundwater uptake)	36,300
Total	**82,000**
Total (excluding Environmental[1])	**45,700**

[1] Since environmental groundwater use involves natural plant uptake of shallow groundwater, not direct pumping and extraction, a total volume is calculated that excludes it.

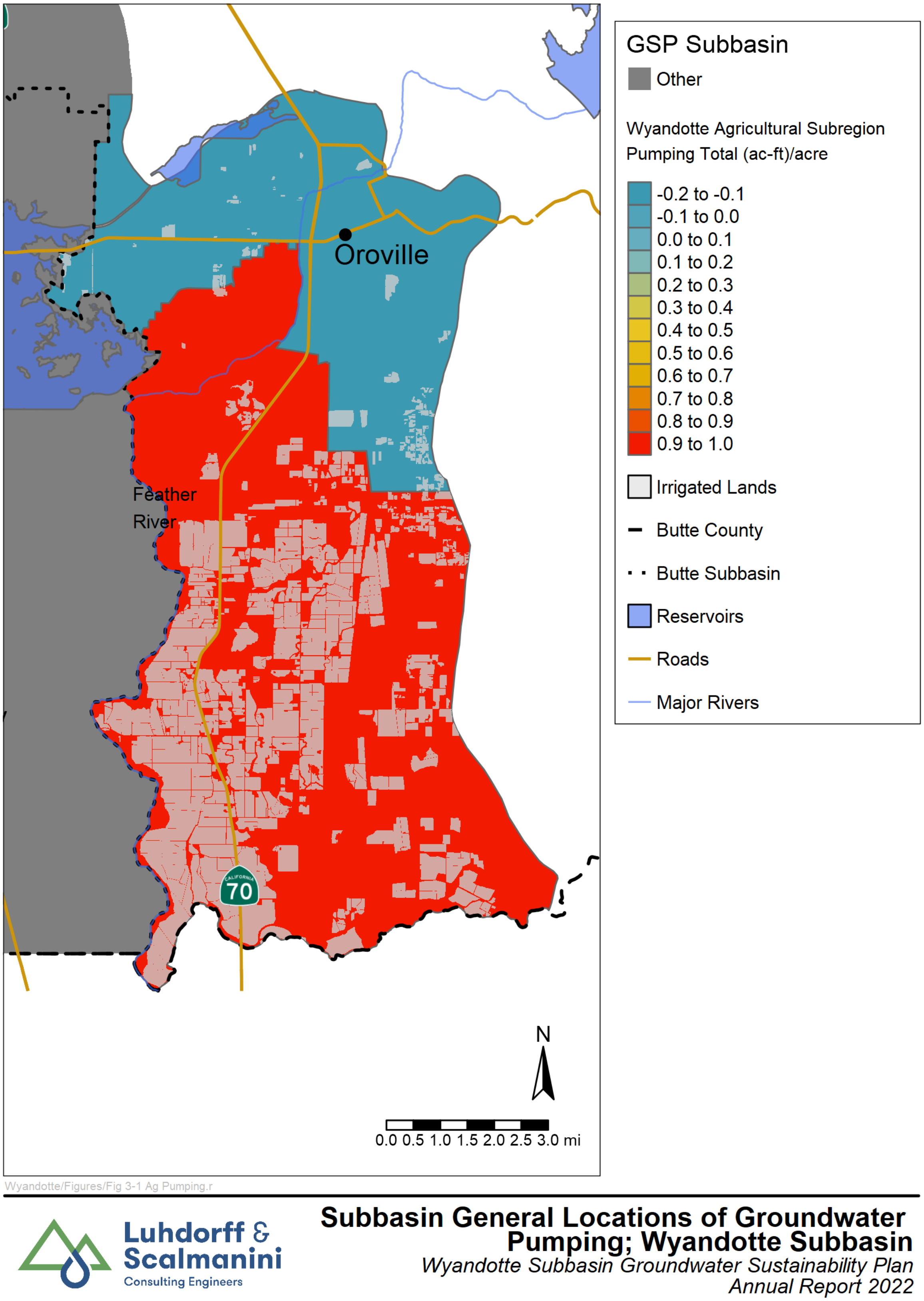

Figure 3-1. Wyandotte Creek Subbasin General Locations and Estimates of Groundwater Pumping – 2022

3.3 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.

Surface water provided approximately 10,900 AF (20%) of the agricultural water demand in the Wyandotte Creek Subbasin in 2022. Surface water is also a significant source of water supply for municipal/industrial uses in the City of Oroville (about 4,000 AF in 2022). Local supplies as well as Butte County supplies are used for agricultural and municipal purposes. Diversions from the Feather River and Honcut Creek outside of district areas are estimated based on historic State Water Resources Control Board's (SWRCB) Electronic Water Rights Information Management System (eWRIMS; SWRCB, 2023) data for total diversions. For appropriative water rights in Wyandotte Creek Subbasin, the face value of the water right was taken and scaled by a local factor of 59% due to the critically dry water year. The local factor is based on an overview of measured deliveries in the region. This estimate was compared against past dry and critical year deliveries. The eWRIMS data specifies the purpose of the diversion, allowing it to be attributed to the appropriate water use sector. Environmental diversions are one water use sector and make up 1,300 AF or roughly 8% of the total water use. The total surface water used in the Subbasin in WY 2022 is estimated to be approximately 16,200 AF (**Table 3-2**).

Table 3-2. Wyandotte Creek Subbasin Surface Water Use by Water Use Sector

Sector	WY 2022 (AF)
Agricultural	10,900
Municipal	4,000
Environmental (diversions)	1,300
Total	**16,200**

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

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**. Total water available is summarized in **Table 3-3** for the 2022 WY. The results are either based on measured data or estimates as described in the previous two sections.

In total, groundwater supplied approximately 80% of the agricultural water demand in the Subbasin and also constituted approximately 74% of the total water supplies[1] for all water demand sectors, except environmental groundwater use, in WY 2022.

Table 3-3. Wyandotte Creek Subbasin Total Water Use by Water Use Sector

Sector	WY 2022 (AF)		
	Groundwater	Surface Water	Total
Agricultural	43,500	10,900	**54,400**
Municipal	700	4,000	**4,700**
Rural Residential	1,500	0	**1,500**
Native Vegetation (Plant groundwater uptake)	36,300	1,300	**37,600**
Total	**82,000**	**16,200**	**98,200**
Total (excluding Environmental Groundwater[1])	**45,700**	**16,200**	**61,900**

[1]Since environmental groundwater use involves natural plant uptake of shallow groundwater, not direct pumping and extraction, a total volume is calculated that excludes it.

3.5 Uncertainties in Water Use Estimates

Uncertainties in water budget estimates are presented below 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

Sector	Data Source	Estimated Uncertainty (%)	Source
Groundwater Water			
Agricultural	Measurement/ Estimate	20%	Typical uncertainty from water balance calculation.
Municipal	Measurement/ Estimate	5%	Typical accuracy of municipal 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 SB88 measurement accuracy standards.
Municipal	Measurement/ Estimate	5%	Typical accuracy of municipal water system reporting.
Environmental	Calculation	10%[1]	Estimated from SB88 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.

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.

Review of the RMS well hydrographs **(Appendix A)** indicate that groundwater elevations are relatively stable over time. 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 2022 (a Critical WY), groundwater storage decreased by approximately 13,200 AF. Although, groundwater extractions in 2022 were slightly lower than long-term average groundwater extractions, reduced natural recharge due to dry climate conditions and decreased stream flows, resulted in slightly lower groundwater levels in Spring 2022 compared to Spring 2021. However, groundwater levels and groundwater storage did not decline uniformly in all areas of the Subbasin. RMS wells near Oroville and east of Gridley showed slight increases in groundwater levels and, consequently, groundwater storage.

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, annual change in groundwater storage, and the cumulative change in groundwater storage over time are presented for 2000-2022 in **Figure 4-1** and **Table 4-1**. Groundwater extractions in 2021 (the previous irrigation season), roughly equivalent to long-term average groundwater extractions, combined with reduced natural recharge due to dry climate conditions and decreased stream flows, resulted in slightly lower groundwater levels in spring 2022 compared to spring 2021. This amounts to an estimated reduction of groundwater in storage of approximately 13,200 AF for this time period.

The historical record back to the year 2000 includes multiple data sources. Groundwater extractions for 2000 through 2018 were obtained from the Butte Basin Groundwater Model (BBGM) and the water budgets prepared as part of the Wyandotte Creek Subbasin GSP [Geosyntec, 2021]. The 2019 and 2020 groundwater extraction values were calculated as the average based for the hydrologic year type from 2000 to 2018. The 2021 groundwater extraction values were obtained from last year's Annual Report and developed using the methods described therein. The 2022 groundwater extraction values were developed using the water budget approach described in **Section 3.1**; it excludes environmental groundwater use, since it involves uptake of shallow groundwater through deeply rooted plants, not direct pumping and extraction. In subsequent years, it is anticipated that the water budget approach used for 2022 will be applied to the prior period of 2019 through 2021 as well. Groundwater extractions for the entire period include pumping for agricultural, municipal, and rural residential purposes.

The annual and cumulative change in groundwater storage is both calculated for the period from 2000 through 2022 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 1999 through 2018 assembled from the BBGM and the methodology described in **Section 4.2** was completed to evaluate the new methodology. 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 5-year update to GSP, if not sooner).

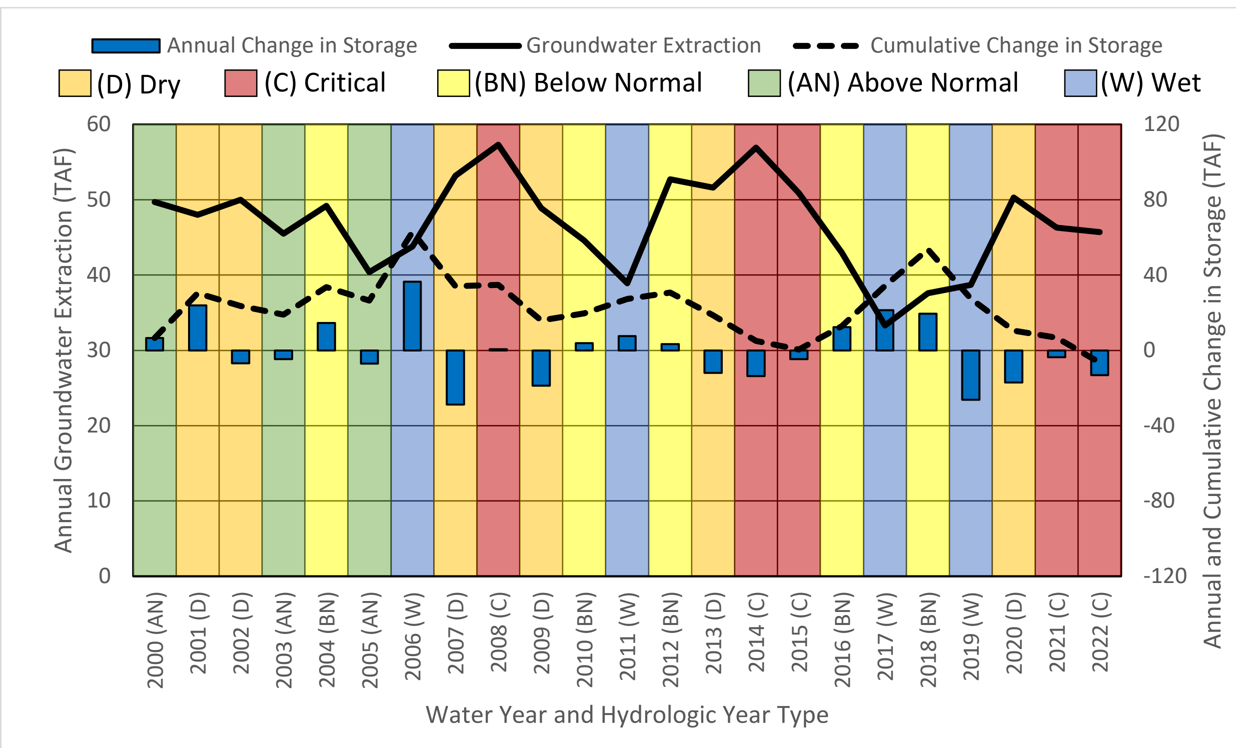

Figure 4-1. Groundwater Pumping and Annual and Cumulative Change in Storage from 2000 to 2022

Table 4-1. Groundwater Extraction, Annual Groundwater Storage Change and Cumulative Change in Storage			
Water Year (Hydrologic Year Type)	Groundwater Extraction* (AF)	Annual Change in Storage (AF)	Cumulative Change in Storage (AF)
2000 (AN)	49,700	6,600	6,600
2001 (D)	48,000	23,800	30,400
2002 (D)	50,000	-6,800	23,600
2003 (AN)	45,500	-4,600	19,000
2004 (BN)	49,200	14,500	33,500
2005 (AN)	40,400	-7,100	26,400
2006 (W)	43,800	36,500	62,900
2007 (D)	53,200	-28,800	34,100
2008 (C)	57,300	600	34,700
2009 (D)	48,900	-18,800	15,900
2010 (BN)	44,600	3,800	19,700
2011 (W)	38,900	7,600	27,300
2012 (BN)	52,700	3,300	30,600
2013 (D)	51,600	-12,000	18,600
2014 (C)	56,900	-13,600	5,000
2015 (C)	50,900	-4,600	400
2016 (BN)	43,000	12,400	12,800
2017 (W)	33,300	21,400	34,200
2018 (BN)	37,600	19,500	53,700
2019 (W)	38,700	-26,300	27,400
2020 (D)	50,300	-17,000	10,400
2021 (C)	46,300	-3,700	6,700
2022 (C)	45,700	-13,200	-6,500
Average**			
2000-2022 (23 years)	46,800	-300	
Wet (4 years)	38,700	9,800	
Above Normal (3 years)	45,200	-1,700	
Below Normal (5 years)	45,400	10,700	
Dry (6 years)	50,300	-9,900	
Critical (5 years)	51,400	-6,900	

GW = Groundwater

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

Water Year Types Classified According to the Sacramento Valley Water Year Index:

AN = Above Normal, BN = Below Normal, C = Critical, D = Dry, W = Wet

** Groundwater Extraction values are based on BBGM for 2000-2018 (See GSP Appendix 2A [Geosyntec, 2021]). Groundwater extraction values for 2019-2022 are described above. They all include agricultural, municipal, and rural residential-pumping and exclude environmental groundwater use (i.e., uptake of shallow groundwater through deeply-rooted plants).*

*** Averages of each water budget component for the entire 2000 to 2022 period, and for different water year types within this period*

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

The spatial distribution of estimated changes in groundwater storage for the period from Spring 2021 to Spring 2022 are shown in **Figure 4-2**. 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 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 principal aquifer.

Spring measurements used to calculate the change in groundwater storage were computed as the average of all available groundwater level measurements between February 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 principal aquifer system. A total of 20 pairs of concurrent annual storage changes assembled from both methods over the period from 1999 through 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 positive changes in storage values represent 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 principal aquifer over the previous year ranged between approximately +2,000 AF and -4,000 AF. Total groundwater storage change in the principal aquifer was estimated to be approximately -13,200 AF between Spring 2021 and Spring 2022.

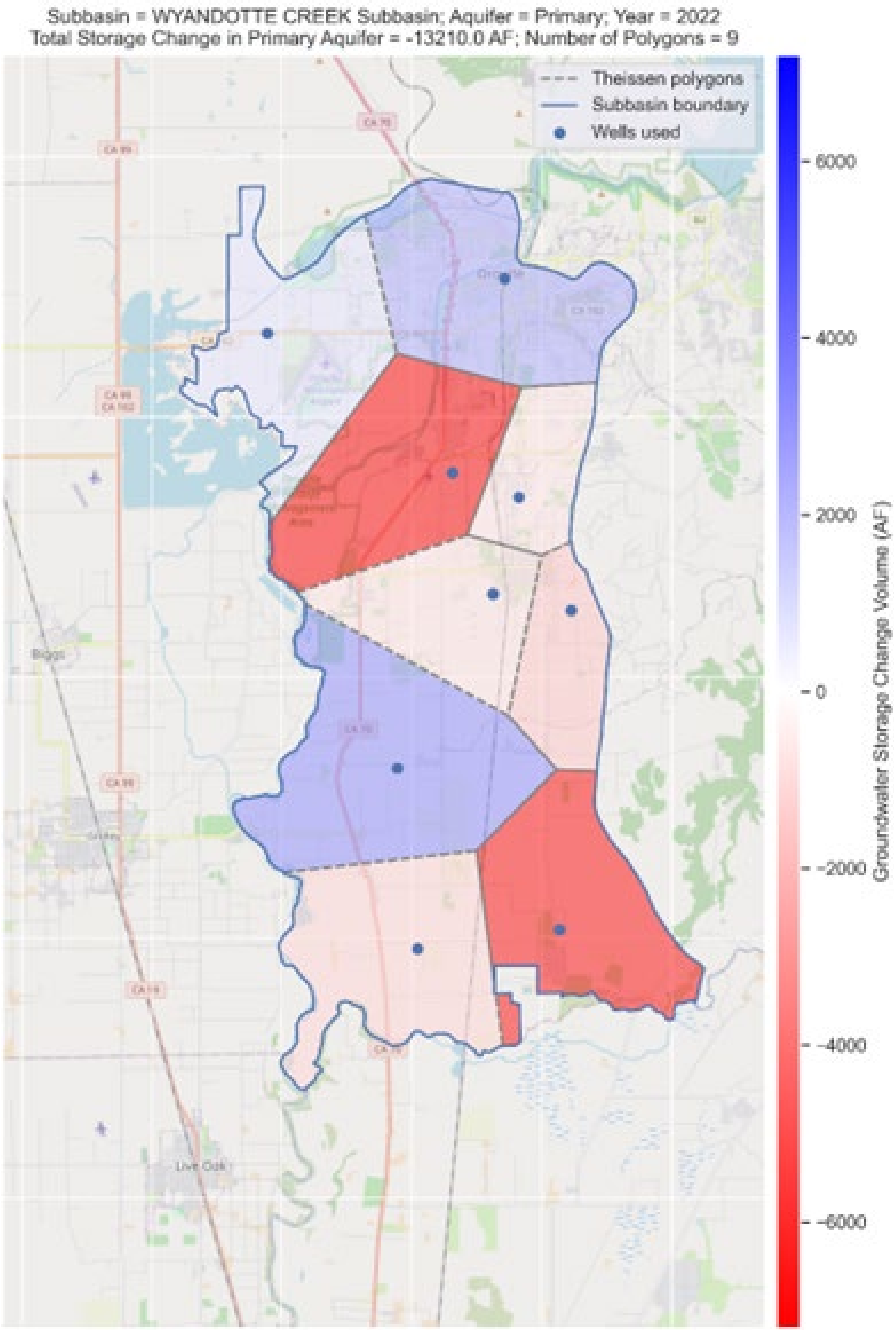

Figure 4-2. Change in Groundwater Storage from Spring 2021 to Spring 2022

4.3 Uncertainty in Groundwater Storage Estimates

Uncertainty associated with the change in groundwater storage estimates depends in part on the underlying uncertainty of the groundwater level data, representative area (i.e., Thiessen polygon), and the calibrated storage coefficient parameter that were 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 4-1** 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). Estimates would benefit from increased locations of groundwater level monitoring and improved characterization of aquifer materials.

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

5.1 Main Activities of Water Year 2022 and Updates since 2021 Annual Report

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

- Butte County, as a member agency of the Wyandotte Creek GSA, funded a project for the GSA to identify and implement a long-term funding strategy to support GSP implementation, and to complete the 2022 Annual Report.

- The GSA has coordinated with stakeholders on the development of a proposal seeking grant funding through DWR's Sustainable Groundwater Management (SGM) Grant Program. Coordination efforts included planning and refinement of PMAs, evaluating and ranking PMAs, and preparing and submitting the grant application. In total, six components were included in the grant application. In addition to funding for specific GSP PMAs (described in each corresponding PMA section, below), the grant application sought funding to support development of long-term GSP financing options, GSP Annual Reports, GSP revisions and updates, education and outreach, inter-basin coordination, regional coordination for developing an approach to develop interconnected surface water SMC, data management system (DMS) refinements, and monitoring network improvements. The grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023.
- Progress has been made on at least 13 PMAs-since the last annual report (**Tables 5-1 and 5-2**).
    - Progress was made on ongoing conservation, and management projects resulting in a 7.8% reduction in urban pumping compared to WY 2021
    - The GSAs and project proponents have further developed and/or sought funding for 12 PMAs that would support a range of activities, including monitoring, and multi-benefit recharge.

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

- Monitoring and recording of groundwater levels and groundwater quality data
- Maintaining and updating the Data Management System with newly collected data
- Annual reporting of subbasin conditions and submission to DWR as required by SGMA
- Ongoing Intra- and Inter-basin Coordination

5.2 Progress Toward Achieving Interim Milestones

Groundwater conditions in the Subbasin are generally on track to meet the first 5-year 2027 Interim Milestones for groundwater levels at each of the RMS wells. Spring and Fall 2022 groundwater elevations were generally near or slightly lower than groundwater elevations in recent years (**Appendix A**). However, all measured groundwater elevations remained near or above the MO, and all Spring 2022 measurements remained more than 25 feet above the corresponding MT of that RMS well, avoiding undesirable results related to groundwater levels as defined in the GSP (**Table 2-1**). The lower Fall 2022 levels were expected due to extended drought conditions, which has increased demands for groundwater in the Subbasin. All measured groundwater levels remain within the Subbasin's Margin of Operational Flexibility and were more than 25 feet above the MT of each RMS well.

5.3 Progress Toward PMA Implementation

The following sections summarize the 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 in **Section 5.5** and summarized in **Table 5-1**. Updates on the status of management actions are described below in **Section 5.6** and summarized in **Table 5-2**.

Groundwater users in the Subbasin benefit from generally stable and shallow groundwater levels supported by the substantial recharge resulting from large volumes of surface water supplied throughout the Subbasin. Surface water supplies available to the Wyandotte Creek Subbasin are used, when available, for irrigation, agronomic practices, wetland habitat, and for the benefit of other recharge efforts and projects described in the GSP. Ongoing access to surface water supplies is crucial to preserving the sustainability of the Subbasin.

Table 5-1. Summary of Project Implementation Status

GSP Category	Project	Current Status	Notable Progress Since Last Annual Report
Planned	Residential Water Conservation Project	Ongoing	7.8% reduction in urban pumping compared to 2021 (TWSD)
Planned	Agricultural Irrigation Efficiency Project	Seeking funding	Recommendations report released June 2022

Table 5-1. Summary of Project Implementation Status			
GSP Category	**Project**	**Current Status**	**Notable Progress Since Last Annual Report**
			Grant application was submitted in December 2022 that would support project implementation
Planned	Flood MAR	Seeking funding	Grant application was submitted in December 2022 that would support project implementation
Planned	Oroville Wildlife Area Robinson's Riffle Project	Underway	SBFCA was awarded grant funding and work was initiated in November 2022 and is expected to be completed in summer 2024
Planned	Streamflow Augmentation	Seeking funding	Grant application was submitted in December 2022 that would support conjunctive use efforts
Planned	Thermalito Water and Sewer District Water Treatment Plant Capacity Upgrade Project	Underway, seeking additional funding	Ongoing work to design and implement the project Grant application was submitted in December 2022 that would support project construction
Planned	Palermo Clean Water Consolidation Project	Underway, seeking funding	Ready to Commence Phase 1
Potential	Intra-basin Water Transfer	Seeking funding	Grant application was submitted in December 2022 that would support project implementation
Potential	Agricultural Surface Water Supplies	Seeking funding	Grant application was submitted in December 2022 that would support project implementation

Table 5-2. Summary of Management Actions	
Management Action	**Notable Progress Since Last Annual Report**
General Plan Updates	Ongoing coordination for the 2040 general plan update
Domestic Well Mitigation	Seeking funds for domestic well survey
Expansion of Water Purveyors' Service Area	Ongoing development of the Palermo Clean Water Consolidation Project

5.4 GSP Project Implementation Progress

5.4.1 Residential Water Conservation Project

- Municipal/industrial water suppliers in the Subbasin – including the California Water Service Company, Thermalito Water and Sewer District (TWSD) and the South Feather Water and Power Agency (SFWPA) – are currently implementing water conservation projects in accordance with their 2020 Urban Water Management Plans. Water conservations projects are expected to directly benefit groundwater levels and groundwater storage by: (1) reducing demand for groundwater supplied to customers, and (2) reducing demand for additional private pumping to supplement surface water supplied to customers.

- Project implementation is ongoing. Water conservation projects in the Subbasin include the installation of low flow fixtures, toilet replacements, urinal valve and bowl replacements, clothes washer replacements, residential conservation kits, smart controllers, turf removal program, and high efficiency irrigation nozzles. Other projects include water waste prevention ordinances, household water audits, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, and other demand management measures.

- Ongoing conservation efforts in the 2022 WY resulted in a 7.8% reduction in urban pumping for the TWSD compared to 2021 (reduction of approximately 50.5 AF), resulting in a benefit to the Subbasin.

5.4.2 Agricultural Irrigation Efficiency Project

- Butte County, the Agricultural Groundwater Users of Butte County, and the Butte County Farm Bureau collaborated to conduct a survey of agricultural irrigators in the Vina Subbasin, which will also be informative for efforts in the Wyandotte Creek Subbasin. The survey was focused on evaluating current irrigation methods and practices, identifying opportunities and methods to improve irrigation efficiency, determining potential issues preventing the adoption of efficiency practices, and providing recommendations for increasing participation in these practices. The results of this survey were analyzed in December of 2021 and a summary report was published in June of 2022 (ESRA, 2022).

- Recommendations from the survey include the following:

    1. Engage in research and programs that reduce the costs of individual practices and the uncertainty involved with practice implementation. Farmers need a better understanding of how different practices will influence their agricultural productivity and economic outcomes.

    2. Use trusted information sources such as the Butte County Farm Bureau and Agricultural Groundwater Users of Butte County to communicate about groundwater management and SGMA.

3. Focus SGMA policy tools on voluntary and incentive-based practices rather than more mandatory practices that directly regulate groundwater pumping behavior.

4. Provide opportunities for farmers to learn from each other about how they are thinking about groundwater management and SGMA, because the overall community support for SGMA is more widespread than individual farmers believe.

5. Train pest control advisors (PCAs) about groundwater issues being encountered in the Subbasin. Even if PCAs are not being hired to manage groundwater or irrigation, their high level of communication with farmers is an opportunity for outreach and education.

6. The role of climate change in influencing groundwater availability is something that farmers are concerned about and may be effectively framed as changes in weather or extreme events like drought.

7. Develop programs targeting small farms, which tend to have less information, be less connected to policy discussions, and less likely to adopt practices.

- The GSA is pursuing grant funds through DWR's SGM Grant Program to implement a three-phased regional conjunctive use project that would facilitate implementation of recommended practices. The grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023.

5.4.3 Flood Managed Aquifer Recharge (FloodMAR)

- In this project, the GSA plans to expand on the FloodMAR initiative, which was originally developed by DWR to promote recharge programs that divert high flows from creeks and streams into fields, recharge basins, and/or recharge ponds. The project would specifically identify local opportunities for recharge in the Subbasin. Some projects already identified would conduct FloodMAR using seasonal high flows from Wyandotte Creek, Wyman Ravine, Wilson Creek, North Honcut Creek, Feather River, and Ruddy Creek.

- The GSA is pursuing grant funds through DWR's SGM Grant Program to support a groundwater recharge feasibility analysis, design, and construction project, consistent with the planned FloodMAR initiative. The grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023.

5.4.4 Oroville Wildlife Area Robinson's Riffle Project

- The Robinson's Riffle Project is a major restoration project for the Oroville Wildlife Area, a 12,000-acre area located in Butte County and managed by DWR and the California Department of Fish and Wildlife (CDFW). Under this project, the Feather River will undergo major grading improvements that will lower the floodplain surface to a more naturalized condition by excavating tailing piles, reconnecting the overbank areas to the main channel, and creating new side-channel and floodplain habitat. This work would increase the overall area of riverine habitat, thereby improving the flow and quality of the water, removing invasive species along the banks, and increasing the surface available for recharge into the aquifer during flood events. The Sutter Butte Flood Control Agency (SBFCA) will obtain necessary permits in partnership with DWR and CDFW. Since GSP implementation, SBFCA has conducted a series of workshops to engage with stakeholders and resource agencies and to obtain the necessary funding to move forward.

- Since the previous Annual Report, the SBFCA was awarded grant funding from the Wildlife Conservation Board to fund work to restore habitat, reduce flood stages, and increase flood conveyance and transitory storage within the Feather River. The grant-funded work was initiated in November 2022 and is expected to be completed in summer 2024.

5.4.5 Streamflow Augmentation Project

- Under this project, flood waters from water right holders in the region would be diverted to certain creeks or streams in the Subbasin. This flood waters would be used for direct and in-lieu recharge to restore groundwater levels in the basin, as well as increase stream flows. The GSA would lead the project and initially conduct an investigation and feasibility study.

- The GSA is pursuing grant funds through DWR's SGM Grant Program to support a regional conjunctive use project, which would support the goals of the streamflow augmentation project. The grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023.

5.4.6 Thermalito Water and Sewer District Water Treatment Plant Capacity Upgrade Project

- The TWSD provides domestic water services to the Thermalito community. The TWSD's water supply is provided primarily from surface water rights. Surface water is eventually conveyed to its water treatment plant before distribution to customers. While TWSD primarily uses surface water as the main water supply, backup or supplementary groundwater supply is provided by four wells in the area. Both surface and groundwater sources tie into the central distribution system extending service throughout the urban areas served by TWSD. The distribution network contains adequate surplus capacity to expand service to properties within the TWSD's existing boundaries planned for future development.

- This project will increase the capacity of the water treatment plant serving the City of Oroville and surrounding area. Treating a greater volume of surface water for, there will be a reduced need for supplemental groundwater pumping which will benefit groundwater levels and storage, and therefore potential land subsidence in the subbasin. Since GSP implementation, TWSD secured funding for the project.

- Since the previous Annual Report, TWSD has continued work to design and implement the project. TSWD is also pursuing grant funds through DWR's SGM Grant Program to provide additional financial support for project construction. The grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023. The project is expected to be completed in spring 2024.

5.4.7 Palermo Clean Water Consolidation Project

- The Palermo Clean Water Consolidation Project will provide clean and reliable potable water to 380 parcels (approximately 1,100 residents) in Palermo by connecting households to South Feather Water and Power Agency's (SFWPA) water supply. This project will reduce groundwater demand by connecting households currently served by private wells to surface water supplies provided by SFWPA. More than 100 letters of interest were received from landowners located within the proposed service area to indicate their interest in connecting to the SFWPA water system.

- Since the previous Annual Report, Butte County has completed: the CEQA process, project plans and specifications, annexation process and the funding application to the Drinking Water State Revolving Fund. The County has received funding for a portion of the project through the American Rescue Plan Act, Integrated Regional Water Management funds, and DWR small community relief funds. The SFWPA is ready to commence construction on Phase One of the project.

5.4.8 Intra-basin Water Transfer

- Under this project, surface water would be supplied to agricultural groundwater users in the Subbasin outside of the subbasin to offset groundwater pumping by with available surface water. Surface water would be sought from entities such as TWSD, Butte County, or SFWPA. The project is classified as a potential project in the GSP and is expected to provide in-lieu recharge benefits to the Subbasin.

- The GSA is pursuing grant funds through DWR's SGM Grant Program to implement a three-phased regional conjunctive use project that would include this project. The grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023.

5.4.9 Agricultural Surface Water Supplies

- Under this project, surface water would be used in place of groundwater in agricultural settings to allow groundwater levels in the Subbasin to recover. Agricultural users may need a dual irrigation system that allows them to use surface water and switch to groundwater when surface water is not available.

- The project is classified as a potential project in the GSP and builds off previous work in 2018 that identified surface water sources that could be diverted to fields, recharge basins, and/or recharge ponds in both the Vina and Wyandotte Creek Subbasins. In the Wyandotte Creek Subbasin, surface water would likely come from Lake Oroville or other water right holders in the Subbasin and upper watershed.

- The GSA is pursuing grant funds through DWR's SGM Grant Program to implement a three-phased regional conjunctive use project that would include this project. The grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023.

5.5 GSP Management Action Implementation Progress

Below are Management Action Updates and their progress in implementation since the 2021 Annual Report.

5.5.1 General Plan Updates

- Butte County staff, who serve as members of the Wyandotte Creek GSA Management Committee, have been cooperating with the Butte County Department of Development Services in the 2040 General Plan Update. Specifically, staff along with the Water Commission has made suggested revisions to the Water Resources Element and applicable General Plan Goals, Policies, and Actions. These updates will ensure that important components of the GSP are supported by the General Plan.

5.5.2 Domestic Well Mitigation

- This Management Action seeks to address dry domestic wells in the Subbasin. If a growing number of these wells go dry, the GSAs may propose the following steps to mitigate the issue:

    1. Establish a voluntary registry of domestic wells.
    2. Compile domestic well logs, screen depths, and locations.
    3. Secure financial resources to improve, deepen, or replace select domestic wells.
    4. Provide emergency response to homes with dry domestic wells, including supplying bottled water and potable water for sanitation. Priority would be given to disadvantaged communities dependent on groundwater as a drinking water resource.

- While this management action is not in effect, the Wyandotte Creek GSA, along with participating partners, is pursuing grant 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 grant application was submitted in December 2022, and a draft awards list is anticipated to be released by DWR in June 2023.

5.5.3 Expansion of Water Purveyors' Service Areas

- Under this management action, water purveyors may expand their service areas and provide drinking water to residential areas that are currently using private domestic groundwater wells. Groundwater levels in the Wyandotte Creek Subbasin would benefit by the overall decrease in groundwater demand. This action may require approval from the Butte Local Agency Formation Commission and the California Public Utilities Commission.

- Since the previous Annual Report, ongoing work has been completed to develop and fund the Palermo Clean Water Consolidation Project (described above). In addition, Butte County has applied for drought related funding to identify other areas in the county that could benefit from expanding service areas to private well owners.

6 CONCLUSIONS

The GSA submitted the adopted GSP to DWR in January 2022. Following the analyses of historical and current hydrogeological conditions presented in the GSP, the GSA has been actively working on sustainable groundwater management in the Subbasin. As presented in Section 5 of this report, recent progress made on various GSP implementation activities 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.

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