~~DRAFT FINAL~~ GROUNDWATER SUSTAINABILITY PLAN

VINA GROUNDWATER SUBBASIN

Prepared by

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Project Number: SAC282

~~August 31~~December 15, 2021

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~~DRAFT FINAL~~ **~~DRAFT FINAL~~**

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Groundwater Sustainability Agencies

Rock Creek Reclamation District GSA

Vina GSA
Member Agencies
City of Chico, County of Butte, Durham Irrigation District

Rock Creek Adhoc Committee

Vina GSA Stakeholder Advisory Committee

Vina GSA Management Committee

Cooperating Agencies

Butte College

Consultant Teams

GSP Completion
Geosyntec Consultants

Basin Setting Project
Davids Engineering, Inc.
GEI Consultants, Inc.
Woodard and Curran

In Remembrance of Byron Alan Clark, PE
(February 4, 1976 - April 3, 2021)
With thanks for his excellent leadership and foundational work
on the Basin Setting Project for the Vina Subbasin GSP

PREFACE

Development of the Vina Subbasin Groundwater Sustainability Plan (GSP), like many others throughout California, has coincided with one of the most severe and extensive droughts that has ever gripped the western United States. As of this writing in December 2021, as the final Vina Subbasin GSP is being assembled, drought conditions throughout most of California, including the Vina Subbasin (Subbasin), are classified as "exceptional", the most extreme classification defined by the U.S. Drought Monitor (USDM).[1] Historically, observed impacts during exceptional drought generally include: widespread water 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 USDM. All of these conditions are currently being experienced to some degree across California and, at least in part, within the Subbasin.

As of November 29, 2021, the County of Butte had received 44 reports of dry wells through the My Dry Water Supply Reporting System, and another approximately 20 from residents calling the Butte County Department of Water and Resource Conservation Department. While a number of the reported dry wells are in the foothills outside of the Subbasin, about one-quarter lie within the Vina Subbasin. Most reported dry wells are used for domestic water supply. Counts of dry wells are likely to be low because some landowners choose not to report well problems to the county.

At the State level and as a result of the unprecedented dry conditions, Governor Gavin Newsom declared a drought emergency on April 21, 2021, which was subsequently expanded on May 10 to include new drought-impacted areas including the Sacramento-San Joaquin Delta Watershed. Most recently, on October 19, Governor Newsom issued a proclamation extending the drought emergency statewide. On August 20, the State Water Resources Control Board (SWRCB) issued surface water curtailment orders to approximately 4,500 water right holders in the Sacramento-San Joaquin Delta Watershed to protect drinking water supplies, prevent salinity intrusion into fresh water supplies, and minimize impacts to fisheries and the environment. Given that these curtailment orders are in place for a period of one year, these curtailments have immediate impacts on existing surface water supplies and could impact surface water suppliers' ability to store water this coming winter, thereby potentially impacting available surface water supplies for 2022 and beyond. Given the recent curtailments and an already bleak surface water supply condition, there is an increased reliance on groundwater in the region. Currently, all of California's 58 counties have declared drought emergencies, including Butte County.

The reported numbers of dry wells discussed above, many of which were reported relatively early in the dry season raise concerns among landowners and residents, and prompted mitigation

[1] The U.S. Drought Monitor (https://droughtmonitor.unl.edu/) is produced through a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Center. Information for the State of California is available online at: https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?CA.

and response actions by the county. The county is tracking the well water shortage reporting to identify localized areas where wells are going dry and/or where other groundwater issues may exist. The county is also supporting the public through local and regional programs offered through the county, such as providing an emergency potable water filling station. The county has also applied for drought relief funding through DWR and other programs. At this time, prior to completion and adoption of the GSP, drought response efforts in the Subbasin are the responsibility of the county, cities, and other local agencies. At some point following adoption of the GSP, those responsibilities may shift to or be coordinated with the GSAs. A strategy for guiding potential inter-basin coordination between the GSAs is described in Section 6.7 of the GSP. Additional coordination with the county, cities, and local agencies would ensure preservation of public health and safety (the purview of the counties and cities) and groundwater sustainability for all beneficial users and uses (the purview of the GSAs).

Technical work and related public involvement processes supporting development of the Vina Subbasin GSP began in earnest in 2018 and are nearing completion as of December 2021. Development of the GSP has utilized the best available science and tools, with the most sufficient and credible information and data available for the decisions being made and the time frame available for making those decisions. Current and historical groundwater conditions and water budgets have been evaluated for the Subbasin in alignment with the GSP regulations. The technical work is based primarily on historical records of surface water and groundwater conditions from 1970 through 2018 which includes the prior drought conditions from approximately 2007 to 2015, but not the current drought in 2020 to 2021.

Unfortunately, drought conditions in 2020 and 2021 have coincided with development of the GSP, a timing that has not permitted complete evaluation and inclusion of data from these years in the GSP at this time. Due to the schedule mandated by the Sustainable Groundwater Management Act (SGMA) for completion of GSPs by January 31, 2022, it has not been possible to include conditions that have manifested due to the current drought in development of the GSP. Records of drought-related conditions in 2020 to 2021 will not be systematically compiled, quality-controlled, and made publicly available until after the Vina Subbasin GSP has been adopted. However, those conditions will be factored into the required GSP annual reports and particularly the periodic (five-year) evaluations as they become available.

Ongoing management of the Subbasin under the GSP will follow an "adaptive management" strategy that involves active monitoring of Subbasin conditions and addressing any challenges related to maintaining groundwater sustainability by scaling and implementing projects and management actions (PMAs) in a targeted and proportional manner in accordance with the needs of the Subbasin. Notwithstanding the information noted above regarding the challenges with GSP preparation and the current drought, some of the planned projects contained within this GSP could be fast tracked to address impacts associated with the current drought. GSP annual reports provide an opportunity each year to review current Subbasin conditions. Using annual reporting information, the Vina GSA and Rock Creek Reclamation District GSA Boards can assess the need for further PMAs. During the periodic five-year evaluations, the GSP will also be reviewed and revised, as needed and as more is known about the effects of current and future conditions.

The Vina GSA and Rock Creek Reclamation District GSA and the stakeholders within the Subbasin recognize that this GSP is not the finish line; it is the starting line for sustainable management of the Subbasin. As conditions within the Subbasin change, the GSAs within the Subbasin are committed to an open, transparent, and all-inclusive adaptive management strategy aimed at tackling the important local issues that they face. At the heart of SGMA is the power for locals to solve local problems with local resources. All parties in the Subbasin are committed to doing just that.

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ACRONYMS AND ABBREVIATIONS

µS/cm	microsiemens per centimeter
AB	Assembly Bill
ACS	American Community Survey
AEM	airborne electromagnetic
AF	acre-feet
AFY	acre-feet per year
Agreement	Joint Powers Agreement
BBGM	Butte Basin Groundwater Model
BCDWRC	Butte County Department of Water and Resource Conservation
bgs	below ground surface
BMOs	Basin Management Objectives
BMPs	Best Management Practices
C&E Plan	Communication and Engagement Plan
Cal Water	California Water Service
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CECs	chemicals of emerging concern
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CNRA	California Natural Resources Agency
~~CSU~~CSUC	California State University, Chico
CWE	Center for Water and the Environment
DACs	Disadvantaged Communities
DMS	data management system
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
GAMA	Groundwater Ambient Monitoring and Assessment
~~GDE~~GDEs	Groundwater Dependent Ecosystems

GIS	geographical information systems
GPS	Global Positioning System
GQTMWP	Groundwater Quality Trend Monitoring Work Plan
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
ILRP	Irrigated Lands Regulatory Program
IM	interim milestone
InSAR	Interferometric Synthetic Aperture Radar
IRWM	Integrated Regional Water Management
~~ITF~~	~~Interagency Task Force~~
JPL	Jet Propulsion Laboratory
~~LID~~	~~Low Impact Development~~
~~LT~~	~~Lower Tuscan~~
MA	Management Area
MAF	million acre-feet
MHI	median household income
mm	millimeters
MO	measurable objectives
msl	mean sea level
MT	minimum thresholds
NASA	National Aeronautics and Space Administration
NAVD88	North American Vertical Datum 1988
~~NNCAG~~NCCAG	Natural Communities Commonly Associated with Groundwater
NEPA	National Environmental Policy Act
NOI	Notice of Intent
NRCS	National Resource Conservation Service
OSWCR	Online System for Well Completion Report
PAC	Interagency Task Force and Public Advisory Committee
PCE	tetrachloroethene
PG&E	Pacific Gas and Electric Company

PID	Paradise Irrigation District~~(~~
PPFS	parks, public facilities, and services
PVC	polyvinyl chloride
RCRD	Rock Creek Reclamation District
RMS	representative monitoring sites
SAGBI	Soil Agricultural Groundwater Banking Index
SB	Senate Bill
SDACs	Severely Disadvantaged Communities
~~SDWIS~~	~~State Drinking Water Information System~~
SGMA	Sustainable Groundwater Management Act
SHAC	Stakeholder Advisory Committee
~~SI~~SIs	sustainability ~~indicator~~indicators
SMC	sustainable management criteria
SMCL	Secondary Maximum Contaminant Level
SOI	Sphere of Influence
~~Subbasin~~	~~the Vina Groundwater Subbasin~~
~~SVWQCB~~SVWQC	Sacramento Valley Water Quality Coalition
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TAF/~~yr~~year	thousand acre-feet per year
TCE	trichloroethene
TNC	The Nature Conservancy
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTT	Upper Tuscan/Tehama
UWMP	Urban Water Management Plan
Vina Subbasin	the Vina Groundwater Subbasin
WCR	well completion report
WDL	Water Data Library

WMP	Water Master Plan

EXECUTIVE SUMMARY

Sustainability Goal:

to ensure that groundwater is managed to provide a water supply of adequate quantity and quality to support rural areas and communities, the agricultural economic base of the region, and environmental uses now and in the future.

Introduction

In 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) in response to continued overdraft of California's groundwater resources. ~~-~~SGMA provides for local control of groundwater resources while requiring sustainable management of the state's groundwater basins. Under the provisions of SGMA, local agencies must establish governance of their subbasins by forming Groundwater Sustainability Agencies (GSAs) within the authority to develop, adopt, and implement a Groundwater Sustainability Plan (GSP or Plan) for the ~~subbasin.~~Vina Groundwater Subbasin. Under the GSP, GSAs must adequately define and monitor groundwater conditions in the ~~subbasin~~Vina Groundwater Subbasin and establish criteria to maintain or achieve sustainable groundwater management within 20 years of GSP adoption. Within the framework of SGMA, sustainability is generally defined as long-term reliability of the groundwater supply and the absence of undesirable results.

Critical Dates for the Vina Groundwater Subbasin	
2022	By January 31, submit GSP to DWR
2027	Evaluate GSP and update, if warranted
2032	Evaluate GSP and update, if warranted
2037	Evaluate GSP and update, if warranted
2042	Achieve sustainability for the ~~Subbasin~~subbasin

The Vina Groundwater Subbasin (Vina ~~or~~ Subbasin) is identified by the California Department of Water Resources (DWR) as being in a high priority subbasin. For high priority basins, SGMA requires that preparation of the GSP by January 31, 2022. ~~t~~

The Vina Subbasin is managed by two GSAs, the Vina GSA and the Rock Creek Reclamation District (RCRD) GSA. ~~–~~The Vina GSA was formed through the execution of a Joint Powers Agreement (~~JPA~~Agreement) by three member agencies - the County of Butte, City of Chico, and Durham Irrigation District. ~~-~~The Vina GSA Board of Directors (Board) is composed of ~~5~~five seats, each with equal and full voting rights, which consists of an elected official from each member agency, an agricultural groundwater user, and a domestic well user (non-agricultural); the latter two positions being appointed by the Butte County Board of Supervisors. The Vina GSA covers the portions of the Vina ~~subbasin~~Subbasin outside of the RCRD GSA jurisdictional boundary. In addition, in 2017 Butte College withdrew GSA status and agreed to participate in the development of the GSP by way of a Memorandum of Understanding ~~(MOU)~~ with the Vina GSA.

The RCRD provides flood control and groundwater sustainability services to approximately 4,625 acres of agricultural and single-family residential parcels in northern Butte County. On

October 18, 2016, the RCRD elected to become a GSA and sent notice to DWR of its intent to undertake sustainable groundwater management over its jurisdictional boundaries.

The Vina GSA and RCRD ~~haves~~GSA has assumed all SGMA authorities. The GSAs entered into a Coordination Agreement for the purpose of developing and implementing a single GSP for the Vina ~~subbasin~~Subbasin.

The purpose of the Coordination Agreement was to (a) ~~to~~ develop, adopt, and implement a GSP for the Vina ~~subbasin~~Subbasin to implement SGMA requirements and achieve the sustainability goals; and (b) involve the public and ~~subbasin~~Vina Subbasin stakeholders through outreach and engagement in developing and implementing the GSP. At the heart of the Coordination Agreement is the focus to maximize local input and decision-making and address the different water demands and sustainability considerations in the municipal and rural areas of the Vina ~~subbasin~~Subbasin.

The ~~JPA~~ Agreement also defines three Management Areas (MAs) within the ~~Vina Subbasin,~~subbasin; Vina North, Vina Chico, and Vina South. ~~A Management Area~~An MA refers to an area within a basin for which a GSP may identify different minimum thresholds~~,~~ (MT), measurable objectives~~,~~ (MO), monitoring, and projects and 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 ~~Management Areas~~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. The RCRD GSA is part of the Vina North ~~Management Area.~~MA.

SGMA requires development of a GSP that achieves groundwater sustainability in the ~~Subbasin~~subbasin by 2042. A pragmatic approach to achieving sustainable groundwater management requires an understanding of ~~(~~1) historical trends and current groundwater conditions in the subbasin, based on evaluating six sustainability indicators (SIs) that include groundwater levels, groundwater storage, groundwater quality, land subsidence, depletion of interconnected streams, and seawater intrusion; and ~~(~~2) what must change in the future to ensure sustainability without causing undesirable results (described and defined in ~~Chapter~~Section 3) or negatively impacting beneficial uses and users of groundwater, including groundwater dependent ecosystems.

The GSP is organized as follows and the various components of each ~~chapter~~section are summarized further below:

1. ~~Chapter~~Section 1: Agency Information, Plan Area~~.~~, Communication. This ~~chapter~~section includes agency information, description of the Plan Area, and applicable programs and data sources used to prepare the GSP as well as a description of beneficial users and uses within the Basin and a summary of stakeholder communications and engagement.
2. ~~Chapter~~Section 2: Basin Setting. This ~~chapter~~section discusses the Hydrogeologic Conceptual Model (HCM), groundwater conditions and water budget.

3. ~~Chapter~~Section 3: Sustainable Management Criteria~~.~~ (SMC). This ~~chapter~~section discusses undesirable results, identifies the ~~minimum thresholds~~MT, and ~~measurable objectives~~MO for each of the six ~~sustainability indicators.~~SIs.
4. ~~Chapter~~Section 4: Monitoring ~~Network~~Networks. This ~~chapter~~section describes the methods used to monitor the ~~sustainability indicators.~~SIs.
5. ~~Chapter~~Section 5: Project Management Actions. This ~~chapter~~section describes projects and management actions that will achieve sustainability within the ~~Subbasin~~subbasin.
6. ~~Chapter~~Section 6: Plan Implementation. This ~~chapter~~section describes how the GSA will partner with other groundwater users to implement the GSP to achieve groundwater sustainability.

The GSP outlines the need to address overdraft and related conditions and has identified 15 projects for potential development that either replace groundwater use (offset) or supplement groundwater supplies (recharge) to meet current and future water demands. In addition, the GSP also identifies seven management actions that can be implemented to focus on reduction of groundwater demand. The estimated sustainable yield, or the amount of groundwater that can be withdrawn without causing undesirable results, for the ~~Subbasin~~subbasin is 233,000 acre-feet per year (AFY). This estimate is based on average annual historical groundwater pumping of 243,000 AFY and an annual decrease in storage of 10,000 AFY. As such, groundwater pumping offsets and/or recharge on the order of 10,000 AFY may be required to achieve sustainability although additional efforts are needed to confirm ~~the level of pumping offsets and/or recharge required to achieve sustainability.~~these levels. These efforts include collecting additional data and a review of the ~~Subbasin~~subbasin groundwater model, along with other efforts as outlined in the GSP.

~~GSP Plan Area~~

A Public Draft GSP was prepared and made available for public review and comment on September 10, 2021, for 40 days, ending on October 19, 2021. The GSAs received numerous comments from the public, reviewed and prepared responses to comments, and revised the Draft GSP. Comment letters and responses are included as Appendix 1-F to this GSP.

Groundwater Sustainability Plan Area

The Vina Subbasin is in Butte County within the Sacramento Valley, as shown in Figure ES-1. The Vina GSA jurisdictional area is defined by the boundaries of the Vina Subbasin in DWR's 2003 Bulletin 118 as updated in 2016 and 2018 except for the area overseen by the RCRD GSA. The RCRD GSA is defined as the jurisdictional boundaries of the RCRD. Figure ES-2 shows the boundaries of the Vina Subbasin, jurisdictional areas for both GSAs, and the three MAs.

Outreach Efforts

A stakeholder engagement strategy was developed to solicit and discuss the interests of all beneficial users of groundwater in the ~~Subbasin~~subbasin and Plan Area. The strategy included monthly meetings of the Vina GSA and RCRD Board of Directors ~~-~~and the Stakeholder Advisory Committee (SHAC), meetings of the Subbasin Technical Working Group, numerous public workshops and events and a website where all announcements, meeting dates, times, and materials were posted.

The Vina GSA also prepared and implemented a Communication and Engagement Plan to encourage involvement from diverse social, cultural, and economic elements of the population of the Vina Subbasin, in addition to meeting SGMA requirements for intrabasin coordination.

In addition, various ~~chapters~~sections of the GSP were available for preliminary review and comment prior to the final ~~draft~~Public Draft version released on September 10, 2021.

Figure ES-1 placeholder page

Figure ES-2 placeholder page

Comments received on preliminary draft ~~chapters~~sections were incorporated as deemed appropriate and helped guide and shape the ~~final draft document~~Public Draft. As part of the 40-day public review period initiated on September 10, 2021, with issuance of the Public Draft of the GSP, the GSA Management Committee worked with numerous entities to inform them about the plan and encourage their involvement. In addition, a special GSP Advisory Committee meeting was held after the 40-day public comment period on November 4, 2021, to solicit comments. All comments received via the comment form, letter, or email were provided to the SHAC and Vina GSA Board in agenda packets for review.

On November 15, 2021, the Vina and RCRD GSAs conducted a joint public hearing where the GSA Management Committee provided an overview of public comments and the methods for responding to these comments. In addition, three proposed revisions to the Public Draft were presented to the GSA Boards. The GSA Boards reviewed the revisions and took action for functional changes to the Public Draft GSP. Additional public comments were received and recorded for each of the proposed revisions and to the overall Public Draft GSP. A revised GSP based on the public comments was provided to the GSAs on December 9, 2021. The GSA Boards reviewed the recommended changes and took action to approve the functional changes to the Public Draft GSP on December 15, 2021.

Basin Setting

The Vina Subbasin lies in the eastern central portion of the Sacramento Groundwater Basin. The northern boundary is the Butte-Tehama County line, the western boundary is the Butte-Glenn County line, the southern boundary is a combination of the property boundaries owned by the M&T Ranch, the service area boundaries of RD 2106 and Western Canal Water District, and the eastern boundary is the edge of the alluvium as defined by ~~the~~ DWR Bulletin 118 Update 2003. It is bounded by the following subbasins: Los Molinos to the north~~,~~; Corning to the west~~,~~; and Butte to the south. The lateral boundaries of the ~~Subbasin~~subbasin are jurisdictional in nature, and it is recognized that groundwater flows across each of the defined boundary lines to some degree.

Continental sediments of the Tehama, Tuscan, and Laguna Formation compose the major fresh groundwater-bearing formations in the valley with the Tuscan Formation and, to a lesser degree, the Tehama Formation compose the major fresh groundwater-bearing formations in the ~~Subbasin.~~ subbasin. Figure ES-3 shows a cross section within the ~~Subbasin~~subbasin using data from an Airborne Electromagnetic (AEM) survey conducted in 2018 funded through a grant from DWR. The base of these continentally derived formations is generally accepted as the base of fresh water in the northern Sacramento Valley. Locally, the base of fresh groundwater fluctuates depending on local changes in the subsurface geology and geologic formational structure~~. In the Vina Subbasin, this is~~, especially ~~the case~~ in the southeastern area of the ~~Subbasin where marine sediments occur at shallower depths on the margins of the valley.~~Vina Subbasin. Generally, it ranges from 800 to 1,200 feet below ground surface (bgs).

Groundwater flows from the north toward the southwestern corner of the ~~Subbasin.~~ subbasin. While groundwater elevations are lower in the fall than spring, the general direction and gradient of flow are similar during both periods. The Sacramento River borders the Vina Subbasin on its western side and flows from north to south. The larger surface water bodies generally flow from east to west towards the Sacramento River and include Big Chico Creek and Butte Creek.

Figure ES-3 placeholder page

Other smaller or ephemeral streams also generally flow from east to west and include Pine Creek, Rock Creek, Mud Creek, Sycamore Creek, Little Chico Creek, Hamlin Slough, Little Dry Creek, and Clear Creek. The location of the Vina Subbasin along with surface water features is shown in Figure ES-4.

Existing Groundwater Conditions

Groundwater conditions in the Vina Subbasin are continually monitored and ~~are~~have been comprehensively described in reports produced by Butte County since 2001. These documents and other reports portray a subbasin that has adequate groundwater resources to meet demands under most hydrologic conditions. ~~However, comparison of the reports illustrates how in the period between their issuance, groundwater use has increased and as forces ranging from population growth to climate change play out, well-informed water management policies and practices will become necessary. In short, while groundwater conditions in the Subbasin remain stable, maintaining this posture in the future may become less the result of a state of nature and more the reward for thoughtful management.~~

~~Groundwater levels in the Subbasin indicate that groundwater elevations are relatively stable except for localized cones of depression. Localized depressions have been observed under the City of Chico and in the Durham area.~~ However, hydrographs from monitoring wells show cyclical fluctuations of groundwater levels over a four- to seven-year cycle consistent with variations in water year type. Groundwater levels typically decline during dry years and increase during wet years. Superimposed on this four- to seven-year short-term cycle is a long-term decline in groundwater levels beginning around 2000. In other words, groundwater levels during more recent dry-year cycles are lower than groundwater levels in earlier dry-year cycles. This downward trend during dry years indicates an overall decline in groundwater storage. Groundwater quality in the basin is good except in areas where anthropogenic sources have impacted the groundwater. Figure ES-5 shows the locations of known impacted groundwater from these sources.

Groundwater storage in ~~Subbasin~~the subbasin is relatively stable ~~except~~and changes in ~~the areas noted above with depressions.~~ groundwater storage reflect groundwater level trends. The Sacramento River and streams that cross the Vina Subbasin stabilize storage volumes by providing recharge to the Vina Subbasin. The total fresh groundwater in storage was estimated at over 16 million acre-feet (MAF). The amount of groundwater in storage has decreased by approximately 0.07 percent per year between 2000 and 2018. As such, it is highly unlikely that the Vina Subbasin will experience conditions under which the volume of stored groundwater poses a concern. However, the depth to access that groundwater across the Vina Subbasin does pose a concern.

Land subsidence has not historically been an area of concern in the Vina Subbasin, and there are no records of land subsidence caused by groundwater pumping. Seawater intrusion is not applicable to the Vina Subbasin due to distance from the Delta and Pacific Ocean.

Surface waters can be hydraulically interconnected with the groundwater system, where the stream baseflow is either derived from the aquifer (gaining stream) or recharged to the aquifer (losing stream). If the water table beneath the stream lowers as a result of groundwater pumping, the stream may disconnect entirely from the underlying aquifer. Both situations exist in the Vina Subbasin. Within the floodplain of the Sacramento River, there is a continuous saturated zone that connects the shallowest aquifer to the river. The connectivity between shallow and deeper aquifer zones will dictate the overall connectivity to the ~~River.~~ river. In the upland areas outside of the Sacramento River floodplain, there are creeks that flow seasonally and often dry up in late summer or are dry for an entire year during dry conditions. In this case, the upland creeks may not be influenced by "high groundwater connectivity" and the presence of an undesirable result is not clear cut with respect to surface water depletion. The streams dry up regardless of the groundwater condition, and streams that are already dry are not considered interconnected surface water.

Figure ES-4 placeholder page

Figure ES-5 placeholder page

However, the upland streams are an important source of recharge to the aquifer, so the health of these stream channels and their adjacent riparian zones is important to groundwater sustainability.

Potential impacts of the depletion of interconnected surface water were discussed by stakeholders during technical discussions covering the fundamentals of groundwater-surface water interactions and mapping analysis of groundwater dependent ecosystems (GDEs) prepared by Butte County Department of Water ~~Resources.~~and Resource Conservation (BCDWRC). Potential impacts identified by stakeholders were:

- Disruption to GDEs
- Reduced flows in rivers and streams supporting aquatic ecosystems and water right holders
- Degradation of "Urban Forest" habitat in the City of Chico
- Streamflow changes in upper watershed areas outside of the Vina GSA's boundary
- Water table depth dropping below the maximum rooting depth of Valley Oak (*Quercus lobata*) or other deep-rooted tree species
- Cumulative groundwater flow moving toward the Sacramento River from both the Vina Subbasin and surrounding GSAs on both the east and west side of the river

The Vina Subbasin acknowledges that overall function of the riparian zone and floodplain is dependent on multiple components of the hydrologic cycle that may or may not have relationships to groundwater levels in the principal aquifer. For example, hydrologic impacts outside of the Vina Subbasin, such as upper watershed development or fire-related changes in ~~run-off~~runoff, could result in impacts to streamflow, riparian areas, or GDEs that are completely independent of any connection to groundwater use or conditions within the Vina Subbasin.

Sustainable Management Criteria

SGMA introduces several terms to measure sustainability. The sustainability goal is the culmination of conditions resulting in a sustainable condition (absence of undesirable results) within 20 years. The sustainability goal for the Vina Subbasin is:

> *to ensure that groundwater is managed to provide a water supply of adequate quantity and quality to support rural areas and communities, the agricultural economic base of the region, and environmental uses now and in the future.*

~~Sustainability indicators (~~SIs~~)~~ refer to any of the effects caused by groundwater conditions occurring throughout the Vina Subbasin that, when significant and unreasonable, cause undesirable results. The six ~~sustainability indicators~~SIs identified by DWR are:

1. Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
2. Significant and unreasonable reduction of groundwater storage

3. Significant and unreasonable degraded water quality
4. Significant and unreasonable land subsidence that substantially interferes with surface land uses
5. Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water
6. Significant and unreasonable seawater intrusion

Undesirable results are the significant and unreasonable occurrence of conditions that adversely affect groundwater use in the Vina Subbasin, including reduction in the long-term viability of domestic, agricultural, municipal, or environmental uses of the Vina Subbasin's groundwater. Categories of undesirable results are defined through the ~~sustainability indicators.~~SIs.

Minimum thresholds (MT) are numeric values for each ~~sustainability indicator~~SI and are used to define when undesirable results occur. Undesirable results occur if ~~minimum thresholds~~MTs are exceeded in an established percentage of sites in the Vina Subbasin's representative monitoring network. Measurable objectives~~ (MO)~~ are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions. The margin of operational flexibility is the range of active management between the MT and the MO. Interim milestones (~~IM~~IMs) are targets set in 5-year increments over the implementation period of the GSP offering a path to sustainability. Figure ES-6 illustrates these terms using the groundwater level ~~sustainability indicator~~SI.

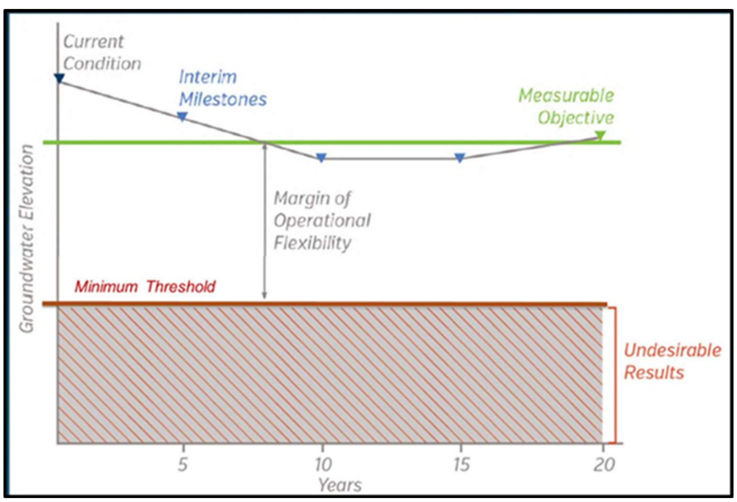
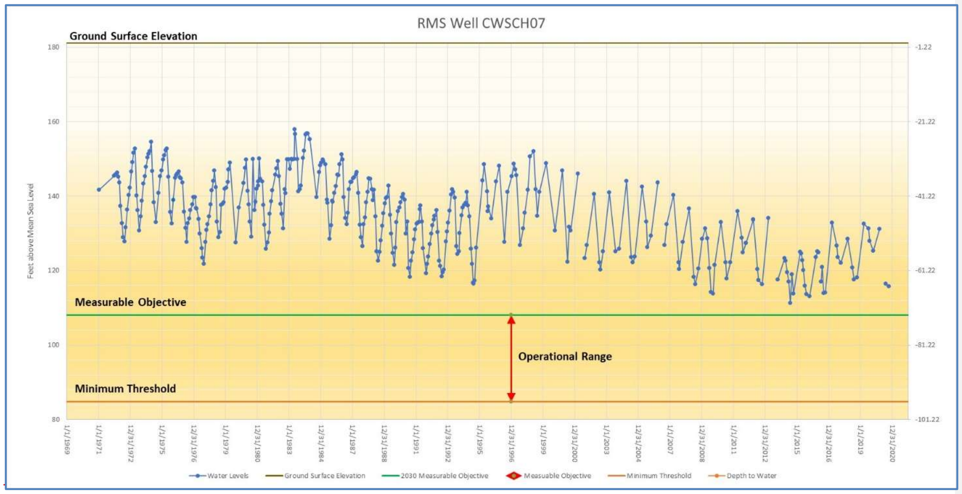


Figure ES-6: Illustration of Terms Used for Describing Sustainable Management Criteria Using the Groundwater Level Sustainability Indicator

A total of 17 representative ~~wells~~monitoring sites (RMS) were identified for measurement of groundwater levels in the ~~Subbasin~~subbasin, and ~~8 representative wells~~eight RMS were identified for groundwater quality monitoring. The GSP uses groundwater quality data as a basis for evaluating conditions from saline water below the fresh water and uses groundwater level data as the basis for evaluating conditions for groundwater levels, groundwater storage, and subsidence. The GSP has identified a data gap for development of ~~sustainable management criteria (SMC)~~SMC for depletion of interconnected surface waters and has provided a framework for evaluation of this ~~Sustainability Indicator (SI).~~SI. However, for this GSP, the SMC developed for groundwater levels are used as a proxy for interconnected surface water in an interim manner until data gaps are addressed. As such, the ~~representative monitoring sites (~~RMS~~)~~ described above provide the basis for measuring the five relevant ~~sustainability indicators~~SIs across the ~~Subbasin~~subbasin.

Minimum thresholds and ~~measurable objectives~~MOs were developed for each ~~of the representative wells.~~RMS. Figure ES-7 shows a typical relationship of the ~~minimum thresholds, measurable objectives~~MSs, MOs, and historical groundwater level data for a sample groundwater level ~~representative monitoring well~~RMS.



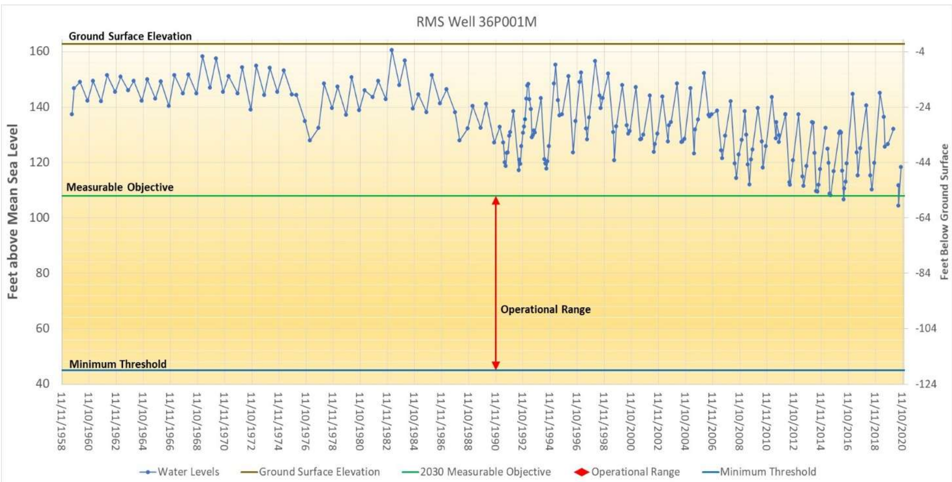
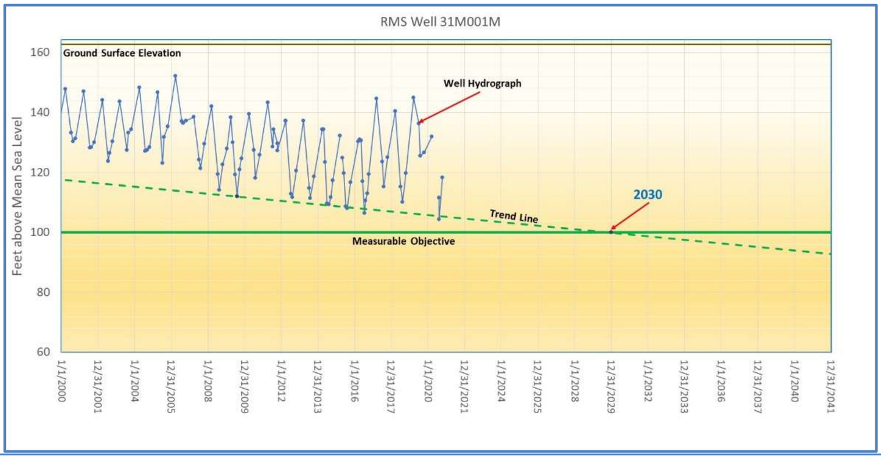


Figure ES-7: Representative Monitoring Site ~~For~~for Groundwater Levels ~~With~~with Relationship ~~Of~~of Measurable Objectives, Minimum Thresholds, and Operational Range

Minimum thresholds for groundwater levels were developed with reference to domestic well depths. ~~For the Vina North and South, the management areas were~~Each MA was divided into polygons that represent proximate areas to each representative monitoring site ~~-~~well. The size of each polygon depends on the density of the RMS network. For example, the higher the density of RMS wells in ~~a management area~~an MA, the smaller the polygons. Each polygon is a different shape and size, determined by the distribution of the RMS wells in the ~~management area.~~MA. The result is a more refined dataset that more proximately reflects the relationship of domestic wells with each RMS well. In addition, rather than just looking at a percentage of domestic wells to protect, the elevation levels were examined in comparison to what would be considered sustainable domestic wells for the area. For the Vina Chico MA, due the area, the ~~MT for all RMS wells was based on the 15 percentile of total well depth for wells completed after 1980.~~polygon was the entire MA. The DWR database used for information on total depths of the domestic wells is not always accurate or precise, nor is it known which of the wells in the database are in use or have been abandoned or replaced. ~~As such, the GSP has identified these data as a data gap that will be further investigated.~~As such, additional characterization of active domestic wells within the subbasin may be considered during GSP implementation (see Section 5.4.3).

To establish the MO, the water-level hydrograph of observed groundwater levels at each RMS was evaluated. The historical record at these locations shows cyclical fluctuations of groundwater level over a four- to seven-year cycle. The MO for groundwater levels at each RMS well was set at the trend line for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030. Figure ES-8 shows an example of this trend line for an RMS well. Table ES-1 shows the MTs and MOs for groundwater levels at each ~~of the~~ RMS ~~wells~~well.



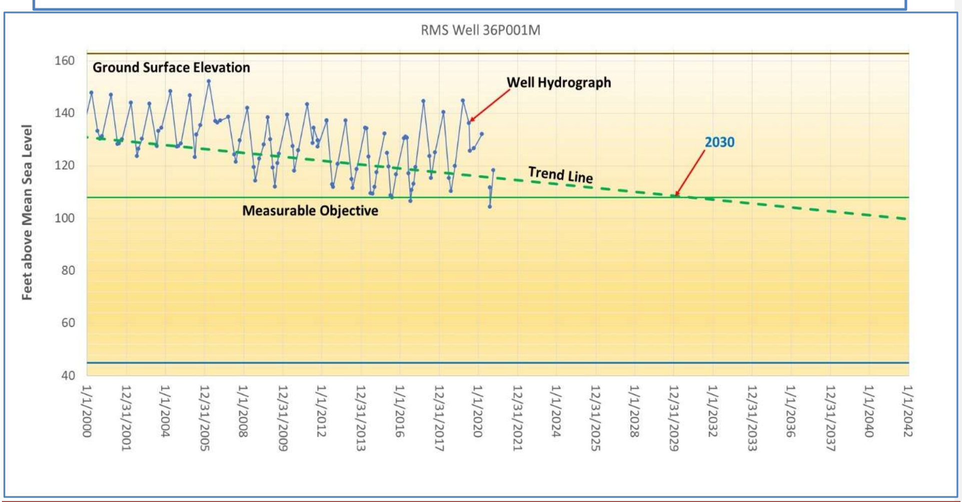


Figure ES-8: Illustration of Long-Term Trend Using Historical Water Levels Extended to 2030 for Development of ~~MO~~Measurable Objectives

Table ES-1: Groundwater Levels ~~SMC~~Sustainable Management Criteria by ~~RMS~~Representative Monitoring Site in Feet Above Mean Sea Level

RMS Well ID	MT	MO	IM 2027	IM 2032	IM 2037
Vina Subbasin – North Management Area					
25C001M	50	130	~~131~~ 130	130	130
10E001M	80	136	~~139~~ 137	136	136
07H001M[a]	72	136	~~145~~ 140	136	136
05M001M	31	115	116	115	115
36P001M	45	108	110	108	108
33A001M	72	125	~~126~~ 128	125	125
Vina Subbasin – Chico Management Area					
CWSCH01b	85	106	~~108~~ 107	106	106
~~28J001M~~		~~110~~	~~111~~	~~110~~	~~110~~
~~CWSCH03~~		~~108~~	~~110~~	~~108~~	~~108~~
CWSCH02		105	108	105	105
~~CWSCH07~~ CWSCH03		108	109	108	108
CWSCH07		95	97	95	95
28J003M		111	113	111	111
Vina Subbasin – South Management Area					
21C001M	~~44~~ 10	64	~~66~~ 67	64	64
18C003M	65	130	~~134~~ 132	130	130
10C002M	20	92	~~95~~ 93	92	92
24C001M	18	77	~~82~~ 81	77	77
09L001M	30	91	~~94~~ 93	91	91
26E005M	36	95	~~96~~ 97	95	95

Note:

~~Note:~~

[a] MO is associated with GSP Well ID 18A001M.

MTs and MOs for water quality were defined by considering two primary beneficial uses, drinking water and agricultural uses, that would be at risk of undesirable results as ~~it relates~~they relate to specific conductance, a measure of the water's saltiness. ~~Minimum thresholds~~MTs are 1,600 micro-siemens per centimeter (µS/cm) for each representative monitoring well, consistent with the upper limit of the California Secondary Maximum Contaminant Level (SMCL) for electrical conductivity. ~~Measurable objectives~~MOs are 900 µS/cm for each representative monitoring well, consistent with the California SMCL for electrical conductivity.

Data needed to develop the ~~Secondary MCs~~SMCs for interconnected surface waters ~~includes~~include definition of stream reaches and associated priority habitat, streamflow measurements to develop profiles at multiple time periods, and measurements of groundwater levels directly adjacent to stream channels, first water bearing aquifer zone, and deeper aquifer zones. These data are not available and are a data gap for the GSP. The GSAs in the Vina Subbasin intend to further evaluate this SMC to avoid undesirable results to aquatic ecosystems and GDEs. To that ~~at~~ end, an Interconnected Surface Water SMC framework has been developed for the GSP. As such, for this GSP the groundwater levels SMC are used by proxy and the MT and MO for interconnected surface water is the same as for groundwater levels.

The MTs and MOs for groundwater levels are also used for the land subsidence and groundwater storage ~~sustainability indicators~~SIs, as both are strongly linked to groundwater levels. The groundwater levels MTs are found to be protective of land subsidence and groundwater storage.

Water Budgets

The groundwater evaluations conducted as ~~a~~ part of GSP development have provided estimates of the historical, current, and projected groundwater budget conditions. The current analysis was prepared using the best available information and through use of the Butte Basin Groundwater Model (BBGM). The BBGM was initially developed in 1992 and has been updated over time to simulate historical conditions through 2018. To prepare water budgets for this GSP, historical BBGM results for water years 2000 to 2018 have been relied upon, and four additional baseline scenarios have been developed to represent current and projected conditions utilizing 50 years of hydrology. It is anticipated that as additional information becomes available, the model will be updated, and more refined estimates of annual pumping and overdraft can be developed.

Based on these analyses and an evaluation of declining water levels, the estimated long-term groundwater pumping offset and/or recharge required for the ~~Subbasin~~subbasin to achieve sustainability is approximately 10,000 AFY. The estimated sustainable yield for the ~~subbasin~~ Vina Subbasin is 233,000 AFY. Groundwater levels are expected to continue to decline based on projections of current land and water uses. Projects~~,~~ identified in ~~Chapter~~Section 5~~,~~ that offset groundwater pumping and/or increase recharge will help the ~~Subbasin~~subbasin reach sustainability.

The projected ~~Subbasin~~subbasin water budget was also evaluated under climate change conditions, which simulate higher demand requiring increased groundwater pumping despite more precipitation and streamflows. The climate change scenario used for the analysis was based on the 2030 and 2070 central tendency climate change datasets provided by DWR to support GSP development. Figure ES-9 illustrates the cumulative change in groundwater storage for current and future conditions.

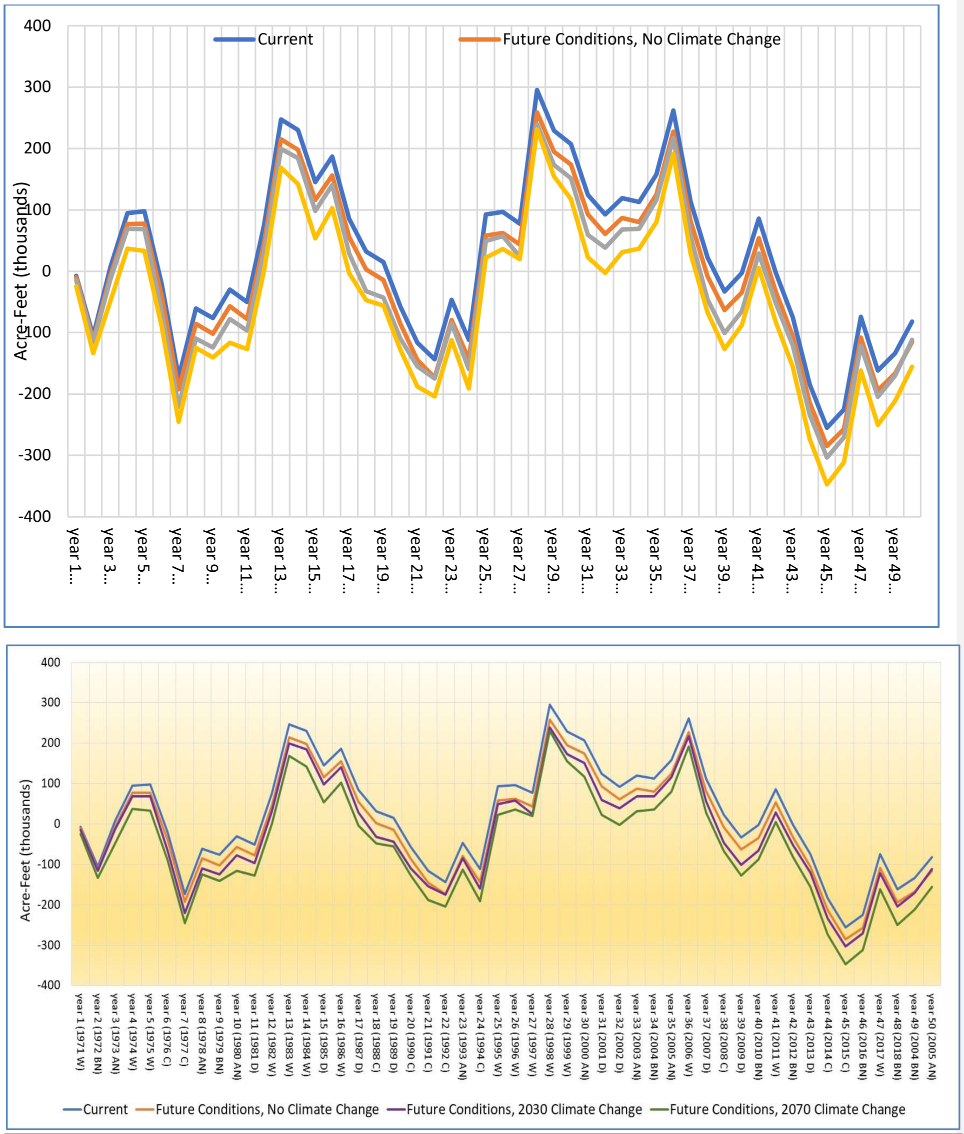


Figure ES-9: Cumulative Change in Groundwater Storage for Current and Future Conditions Baseline Scenarios

Monitoring Networks

The GSP outlines the monitoring networks for the six ~~sustainability indicators.~~SIs. The objective of these monitoring networks is to monitor conditions across the ~~Subbasin~~subbasin and to detect trends toward undesirable results. Specifically, the monitoring network was developed to do the following:

- Monitor impacts to the beneficial uses or users of groundwater
- Monitor changes in groundwater conditions relative to ~~measurable objectives and minimum thresholds~~MO and MT
- Demonstrate progress toward achieving ~~measurable objectives~~MO described in the GSP

There are five monitoring networks in the Vina Subbasin: a representative network for water levels; a broad network for water levels; a representative network for water quality; a broad network for water quality; and a broad network for land subsidence. Representative networks are used to determine compliance with the ~~minimum thresholds~~MT, while the broad networks collect data for informational purposes to identify trends and fill data gaps. The two monitoring networks for water quality will additionally be used to develop an electrical conductivity isocontour to monitor for potential intrusion ~~for~~from underlying saline waters, and water ~~levels~~level data will inform depletions of interconnected surface water.

The monitoring networks were designed by evaluating data from Butte County's existing ~~BMO~~Basin Management Objectives (BMOs) program, the United States Geological Survey (USGS), and participating GSAs. The monitoring network consists largely of wells that are already being used for monitoring in the ~~Subbasin~~subbasin. Figure ES-10 shows the location of groundwater monitoring wells for the groundwater level representative monitoring network.

Figure ES-10 placeholder page

Wells in the monitoring networks will be measured on a semi-annual schedule. Historical measurements ~~have been~~will be entered into the Vina Subbasin Data Management System (DMS), and future data will also be stored in the DMS. A summary of the ~~wells~~monitoring sites in the monitoring networks is shown in ~~the table~~Table ES-2 below.

Table ES-2: Summary of Network Site Wells

Summary of Monitoring Network Site Wells	
Representative Networks	**~~Well~~Monitoring Site Count**
Groundwater Level	17
Groundwater Quality	8
Broad Network	
Groundwater Levels	78
Groundwater Quality	7
Subsidence	~~19~~19

Data Management System

The DMS that will be used is a geographical relational database that will include information on water levels, land elevation measurements, and water quality testing. The DMS will allow the GSAs to share data and store the necessary information for annual reporting.

The DMS will be on local servers, and data will be transmitted annually to form a single repository for data analysis for the ~~Subbasin's~~subbasin's groundwater, as well as to allow for preparation of annual reports. GSA representatives have access to data and will be able to ask for a copy of the regional DMS. The DMS currently includes the necessary elements required by the regulations, including:

- Well location and construction information for the representative monitoring points (where available)
- Water level readings and hydrographs including water year type
- Land~~-~~-based measurements
- Water quality testing results
- Estimate of groundwater storage change, including map and tables of estimation
- Graph with Water Year type, Groundwater Use, and Annual Cumulative Storage Change

Additional items may be added to the DMS in the future as required. Data will be entered into the DMS by each GSA. The majority of the data will then be aggregated to the entity that is responsible for the regional DMS and summarized for reporting to DWR.

Projects and Management Actions

As stated above, the GSP outlines the need to address overdraft and related conditions and has identified 15 projects for potential development that either replace groundwater use (offset) or supplement groundwater supplies (recharge) to meet current and future water demands. In addition, the GSP also identifies seven management actions that can be implemented to focus on reduction of groundwater demand.

Projects

Each of the projects are in various stages of development ranging from planned to those still in the conceptual phase. Thus, each of the projects have a different level of development. The GSA will maintain a list of proposed projects and track their development status. The GSA will use this list to help secure funding as opportunities become available. Projects presented in this Plan will remain a part of the potential projects that the GSA may choose to implement, however as other projects come up those will be added to the list. The projects currently being considered are listed below and are listed from planned to conceptual.

Planned:

- Agricultural Irrigation Efficiency
- Residential Conservation
- Scoping for Flood Managed Aquifer Recharge (FloodMAR)/Surface Water Supply and Recharge
- Community Water Education Initiative
- Fuels Management for Watershed Health

Potential:

- Paradise Irrigation District Intertie
- Agricultural Surface Water Supplies
- Streamflow Augmentation
- Community Monitoring Program
- Recycled Wastewater
- Rangeland Management
- Removal of Invasive Species
- Surface Water Supply and Recharge

Conceptual:

Extend Orchard Replacement~~**PLAN IMPLEMENTATION**~~

-
- Recharge from Miocene Canal

Management Actions

GSAs have a variety of tools to use to achieve sustainable groundwater management. Projects focus primarily on capture, use, and recharge of surface water supplies while management actions focus on groundwater demand.

The GSP presents several management actions that the GSA may consider during GSP implementation. It is expected that the GSA will further develop and modify management actions in response to stakeholder input and available information. The management actions identified in this GSP include:

- General Plans Updates
- Domestic Well Mitigation
- Well Permitting Ordnance
- Landscape Ordnance
- Prohibition of Groundwater Use for Ski (Recreational) Lakes
- Expansion of Water Purveyors' Service Area
- Groundwater Allocation

Plan Implementation

The adoption of the GSP is official start of plan implementation for the Vina Subbasin. The GSAs will continue their public outreach efforts and work to secure funding to implement projects and management actions. The estimated budgets and implementation schedule for the proposed projects and management actions are presented in Section 6.

Implementing the Vina Subbasin GSP will require numerous management activities that will be undertaken by the GSAs, including:

- Monitoring conditions relative to applicable ~~sustainability indicators~~SIs at specified frequency and timing
- Entering updated monitoring data into the ~~Subbasin~~subbasin DMS
- Refining the ~~Subbasin~~subbasin model and water budget planning estimates
- Preparing annual reports summarizing the conditions of the ~~Subbasin~~subbasin and progress towards sustainability and submitting them to DWR
- Updating the GSP once every five years
- Overseeing and monitoring projects, management actions, and collection of data identified as "data gaps" within the GSP~~.~~
- Identify funding sources
- Coordinating with neighboring subbasins

~~The GSP also presents a schedule of implementation of the items discussed above as described in Chapter 6.~~

1. AGENCY INFORMATION, PLAN AREA, COMMUNICATION

1.1 Introduction and Agency Information

1.1.1 Purpose of the Groundwater Sustainability Plan

The purpose of this Groundwater Sustainability Plan (GSP) is to meet the regulatory requirements set forth in the three-bill legislative package consisting of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA). SGMA defines sustainable groundwater management as "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results," which are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout the basin (Department of Water Resources [DWR], 2018a):

- Chronic lowering of groundwater levels, indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

The Vina Groundwater Subbasin (Vina Subbasin ~~or Subbasin~~) has been identified by ~~the~~ DWR as a high priority basin. The Vina Groundwater Sustainability Plan (Vina GSP) was developed to meet SGMA regulatory requirements by the January 31, 2022, deadline for high priority basins while reflecting local needs and preserving local control over water resources. Requirements for the GSP are provided in California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5. Appendix 1-A provides a checklist of where to find the information required by these regulations.

The Vina GSP provides a path to achieve and document sustainable groundwater management within 20 years following Vina GSP adoption, promoting the long-term sustainability of locally managed groundwater resources now and into the future.

While the Vina GSP offers a new and significant approach to groundwater resource protection, it was developed within an existing framework of comprehensive planning efforts. Throughout the Vina Subbasin, several separate, yet related, planning efforts have occurred previously or are concurrently proceeding. In November 1996, the voters in Butte County approved "An Ordinance to Protect ~~The~~the Groundwater Resources ~~In~~in Butte County." One of the stated purposes of the ordinance was that "the groundwater underlying Butte County is a significant water resource which must be reasonably and beneficially used and conserved for the benefit of the overlying land by avoiding extractions which harm the Butte basin aquifers, causing exceedance of the safe yield or a condition of overdraft." Other significant reports prepared in the Vina Subbasin include integrated regional water management~~,~~, (IRWM), urban water management, habitat conservation, basin assessment, and general planning. The Vina GSP fits in with these prior planning efforts, building on existing local management and basin characterization. A description of prior planning efforts can be found in Section 1.2 of this document.

1.1.2 Sustainability Goal

A sustainability goal is the culmination of conditions resulting in a sustainable condition (absence of undesirable results) within 20 years. The sustainability goal reflects this requirement and succinctly states the GSP's objectives and desired conditions of the ~~Subbasin~~subbasin.

The sustainability goal for the Vina Subbasin is "to ensure that groundwater is managed to provide a water supply of adequate quantity and quality to support rural areas and communities, the agricultural economic base of the region, and environmental uses now and in the future."

Additional discussion of the sustainability goal can be found in Section 3: Sustainable Management Criteria~~.~~ (SMC).

1.1.3 Contact Information

The Vina Groundwater Sustainability Agency (GSA) has been tasked with submitting a single, jointly composed GSP to DWR on behalf of the entire ~~Subbasin~~subbasin. Contact information for the submitting agency and Plan Manger is provided below:

Submitting Agency: Vina Groundwater Sustainability Agency
308 Nelson Avenue
Oroville, California 95965
https://www.vinagsa.org

Plan Manager: Dr. Christina Buck
308 Nelson Avenue
Oroville, California 95965
530.552.3595
cbuck@buttecounty.net

1.1.4 Agency Information

The Vina GSA and the Rock Creek Reclamation District GSA are the two GSAs in the Vina Subbasin, as shown in Figure ~~1-1.~~1-1. The two GSAs intend to submit one GSP for the Vina Subbasin. The GSAs entered into a Cooperation Agreement for the purpose of developing and implementing a single GSP for the Vina Subbasin (Appendix 1-~~A~~B).

Additional information for the two GSAs is provided below.

1.1.4.1 Vina GSA

The Vina GSA was formed through the execution of a Joint Powers Agreement (Agreement) by the County of Butte, City of Chico, and Durham Irrigation District (Appendix 1-~~B~~C). The Vina GSA filed to be a GSA on June 5, 2019. The purpose of the Agreement was to create the Vina GSA to: (a) ~~to~~ develop, adopt, and implement a GSP for the Vina Subbasin in order to implement SGMA requirements and achieve the sustainability goals; and (b) involve the public and subbasin stakeholders through outreach and engagement in developing and implementing the GSP. The Vina GSA covers the portions of the Vina Subbasin outside of the Rock Creek Reclamation District GSA jurisdictional boundary. At the heart of the Agreement is the focus to maximize local input and decision-making and address the different water demands and sustainability considerations in the municipal and rural areas of the Vina Subbasin.

The Vina GSA Board serves as the policy-making role for SGMA implementation in the Vina GSA. All GSA Board meetings are subject to the Brown Act and are noticed and open to the public. The GSA Board is composed of five seats, each with equal and full voting rights, including:

1. Butte County – ~~1~~one seat (Member Agency)
2. City of Chico – ~~1~~one seat (Member Agency)
3. Durham Irrigation District – ~~1~~one seat (Member Agency)
4. Agricultural groundwater user – ~~1~~one seat (Butte County Appointed~~-~~)
5. Domestic well user (non-agricultural) – ~~1~~one seat (Butte County Board Appointed~~-~~)

The Vina GSA Board possesses the ability to exercise those powers specifically granted by the Joint Powers Act and SGMA. The Agreement states that the GSA shall possess the ability to exercise those powers specifically granted by the Joint Powers` Act and SGMA. Additionally, the GSA has the ability to exercise the common powers of its Members related to the purposes of the GSA, including, but not limited to, the following:

- To designate itself as the exclusive GSA for the ~~Basin~~Vina Subbasin pursuant to SGMA~~.~~
- To develop, adopt, and implement a GSP for the ~~Basin~~Vina Subbasin pursuant to SGMA~~.~~
- To adopt rules, regulations, policies, bylaws, and procedures governing the operation of the GSA and adoption and implementation of a GSP for the ~~Basin.~~Vina Subbasin
- To adopt ordinances within the ~~Basin~~Vina Subbasin consistent with the purpose of the GSA as necessary to implement the GSP and otherwise meeting the requirements of the SGMA~~.~~
- To obtain legal, financial, accounting, technical, engineering, and other services needed to carry out the purposes of this Agreement~~.~~
- To perform periodic reviews of the GSP, including submittal of annual reports~~.~~
- To require the registration and monitoring of wells within the ~~Basin.~~Vina Subbasin

Figure 1-1 placeholder page

- To issue revenue bonds or other appropriate public or private debt and incur debts, liabilities, or obligations~~.~~
- To exercise the powers permitted under Government Code section 6504 or any successor statute~~.~~
- To levy taxes, assessments, charges and fees as provided in SGMA or otherwise provided by law~~.~~
- To regulate and monitor groundwater extractions within the ~~Basin~~Vina Subbasin as permitted by SGMA, provided that this Agreement does not extend to a Member's operation of its systems to distribute water once extracted or otherwise obtained, unless and to the extent required by other laws now in existence or as may otherwise be adopted~~.~~
- To establish and administer projects and programs for the benefit of the ~~Basin.~~Vina Subbasin
- To cooperate, act in conjunction and contract with the United States, the State of California, or any agency thereof, counties, municipalities, special districts, GSAs, public and private corporations of any kind (including, without limitation, Public Utilities Commission~~-~~-regulated utilities and mutual water companies), and individuals, or any of them, for any and all purposes necessary or convenient for the full exercise of powers of the GSA~~.~~
- To accumulate operating and reserve funds and invest the same as allowed by law for the purposes of the GSA and to invest funds pursuant to California Government Code section 6509.5 or other applicable State Law~~.~~
- To apply for and accept grants, contributions, donations, and loans under any federal, state, or local programs for assistance in development or implementing any of its projects or programs for the purposes of the GSA~~.~~
- To acquire by negotiation, lease, purchase, construct, hold, manage, maintain, operate, and dispose of any buildings, property, water rights, works, or improvements within and without the respective boundaries of the Members necessary to accomplish the purposes described herein~~.~~
- To sue and be sued in the GSA's own name~~.~~
- To exercise the common powers of its Members to develop, collect, provide, and disseminate information that furthers the purposes of the GSA, including but not limited to the operation of the GSA and adoption and implementation of a ~~Groundwater Sustainability Plan~~GSP for the ~~Basin~~Vina Subbasin, to the Members' legislative, administrative, and judicial bodies, as well as the public generally~~.~~
- To perform all other acts necessary or proper to carry out fully the purposes of this Agreement~~.~~

The Vina GSA Board aspires to seek consensus. If the Vina GSA Board cannot reach consensus, the Vina GSA Board defaults to the following voting structure.

- Quorum: A majority of the members of the Vina GSA Board members shall constitute a quorum for purposes of transacting business.
- Director Votes: Each member of the Vina GSA Board shall have one vote.
- Supermajority Voting Requirement (four affirmative votes) for the following:
    1. Bylaws adoption, modification, or alteration.
    2. GSP adoption, modification, or alteration.
    3. Adoption of assessment, charges, and fees.
    4. Adoptions of regulations and ordinances.
    5. Adoption or modification of annual budget, including capital projects.
    6. Property acquisition (excepting rights of way~~)~~).
    7. Removal of Advisory Committee Members.
    8. Modifications to the composition and number of Advisory Committee Members.
    9. Removal of stakeholder board seats as is consistent with the Agreement.

The Vina GSA Board does not have the authority to limit or interfere with the respective Member Agency's rights and authorities over their own internal matters, including, but not limited to, legal rights to surface water supplies and assets, groundwater supplies and assets, facilities, operations, water management and water supply matters. The Member Agencies made no commitments by entering into the Agreement to share or otherwise contribute their water supply assets as part of the development or implementation of a GSP. Nothing in the Agreement modifies or limits a Member Agency's police powers, land use authorities, or any other authority. The Member Agencies cooperate to obtain consulting, administrative and management services needed to efficiently develop a GSP and to identify mechanisms for the management and funding commitments reasonably anticipated to be necessary for the purposes of this Agreement.

Each Member Agency (Butte County, City of Chico, and Durham Irrigation District) designates a staff person (in-kind support) to participate on the Vina GSA Management Committee. The Mechoopda Indian Tribe of Chico Rancheria, California (Tribe) is a federally recognized Tribe in the Vina Subbasin. The Vina GSA is collaborating with the ~~Mechoopda~~ Tribe on the development of the GSP, and the Tribe has a staff member designated as an ex-officio member of the Management Committee for the purpose of GSP development and implementation.

The Management Committee receives direction from the Vina GSA Board, makes recommendations and generates staff reports and proposals to the Vina GSA Board. The Management Committee staffs the Advisory Committee and reports to the Vina GSA Board recommendations and actions from the Advisory Committee. The Management Committee assures that staff and other resources are provided to prepare ~~and implement~~ the GSP and administer the governance for the Vina GSA.

The Vina GSA does not and will not have any employees. However, the Vina GSA has the power to employ consultants to fulfill the objectives and purposes of SGMA and complete a GSP. Butte County is leading the development of technical aspects of the GSP, including contracting for professional services in coordination with the Management Committee and the Vina GSA Board. The Management Committee may form ad hoc technical working groups to provide input on technical matters pertaining to the GSP. Preparation of the Vina GSP and carrying out governance requires various administrative activities such as meeting management, website development and maintenance, public outreach, and communication.

The Vina Advisory Committee provides input and recommendations to the Vina GSA Board on ~~GSA policies and~~ GSP development and implementation as well as other items outlined in their Charter. There are 10 Advisory Committee members, including:

- Agricultural groundwater users (3)
- At-large domestic well users (2)
- At-large environmental representative (1)
- At-large business representative (1)
- Cal Water-Chico (1)
- ~~CSU~~California State University, Chico (CSUC) (1)
- Butte College (1)

The Management Committee participates in Advisory Committee meetings. The Vina GSA Board appoints at-large members to fill Advisory Committee seats. Eligible individuals interested in participating on the Advisory Committee from the community or organizations within the ~~subbasin~~Vina Subbasin can apply to the Vina GSA to become a member. At-large members must live, farm, or be employed by a firm operating in the Vina GSA. To inform the Vina GSA Board and assist in decision-making, the Advisory Committee will provide written recommendations that will be included in Management Committee reports. The recommendations will identify areas of agreement and disagreement. The Advisory Committee will strive for consensus when possible, but reaching consensus is not necessary. Consensus means that everyone can at least "live with" the recommendation. When unable to reach consensus on recommendations, the Advisory Committee will outline the areas in which it does not agree, providing some explanation to inform the Vina GSA Board decision-making. The Vina GSA Board will consider Advisory Committee recommendations when making decisions. If that Board does not agree with the recommendations of the Advisory Committee, the Vina GSA Board shall state the reasons for its decision. The Advisory Committee will be staffed by a member of one of the Member Agencies. All Advisory Committee meetings are subject to the Brown Act and will be noticed and open to the public.

1.1.4.2 Rock Creek Reclamation District GSA

The Rock Creek Reclamation District (RCRD) provides flood control and groundwater sustainability services to approximately 4,625 acres of agricultural and single-family residential parcels in northern Butte County. The District is located in the Big Chico Creek and Pine Creek

~~Watersheds~~watersheds. RCRD is governed by a seven-member Board of Trustees elected by the landowners to staggered four-year terms. The Board of Trustees conducts its regular meetings quarterly~~,~~ and holds special meetings as needed. Board meetings are open to the public and are conducted in accordance with the Brown Act. Members of the public regularly attend meetings virtually or in~~-~~ person. RCRD regularly contracts with a District Counsel and a Secretary to the Board, who provide professional services (legal and secretarial, respectively) at the discretion of and as directed by the Board of Trustees. Most other RCRD services, including reclamation and flood control work, are performed by contracted parties on a seasonal or ad-hoc basis at the direction of the Board of Trustees.

Initially formed in 1985 under the State Reclamation Act (California Water Code Section 50000 et seq.) and Butte County Board of Supervisors Resolution No. 85-167, RCRD has a long track record of undertaking flood projects for the benefit of its landowners and will continue to provide services and benefits to the community in this area. In 2018, RCRD expanded its Sphere of Influence (SOI) to approximately 19,027 acres (total 23,652 acres).

RCRD provides for repair, maintenance, and improvement of natural channel water conveyance and flood protection facilities within the area. RCRD is empowered to construct, maintain, and operate drains, canals, sluices, bulkheads, watergates, levees, embankments, pumping plants, dams, diversion, or irrigation works, and all other facilities reasonably necessary or convenient to accomplish District purposes.

As a local agency with water supply, water management, or land use responsibilities within the Vina Subbasin, RCRD is authorized to become a GSA over the Vina Subbasin, pursuant to Water Code sections 10723 and 10721(n). On October 18, 2016, RCRD elected to become a GSA over its boundaries, in accordance with the notice and hearing requirements of Water Code section 10723 and Government Code section 6066. On or around October 26, 2016, the RCRD GSA sent notice to DWR of its intent to undertake sustainable groundwater management, pursuant to Water Code sections 10723(d) and 10723.8. RCRD became the exclusive GSA over its jurisdictional boundaries.

The RCRD GSA is managed by the Board of Trustees of RCRD with meetings conducted in accordance with the Brown Act. The RCRD GSA formed an ad-hoc SGMA Committee to provide assistance to the RCRD Board of Trustees on development of the GSP. The ad-hoc committee consists of two RCRD trustees. The RCRD GSA's SGMA committee members are uncompensated and assist the Board of Trustees with in-kind contributions of time and resources. All GSA powers are retained and exercised by the Board of Trustees of RCRD. Upon formation, and as of 2021, the committee is staffed by RCRD's Chair, Hal Crain, and RCRD's Vice-Chair, Darren Rice. The function of the ad-hoc committee is to provide input and make recommendations to the RCRD Board of Trustees on development of the GSP~~,~~ and to serve as the point of contact between the Vina GSA and RCRD GSA. A member of the committee attends Vina GSA meetings and Vina GSA Stakeholder Advisory committee meetings. Additionally, several joint meetings of the boards of Vina GSA and RCRD GSA were held during the development of the GSP.

Development and implementation of the GSP is funded primarily by a DWR grant administered by Butte County on behalf of the GSAs and pursuant to a Cooperation Agreement between the

Vina GSA and RCRD GSA. RCRD GSA additionally provides in-kind contributions of its SGMA committee members' time and resources. Other incidental RCRD GSA costs are funded by RCRD's annual special assessment. RCRD GSA's implementation of the GSP will be funded by these sources and any additional sources of revenue or funding that the Board of Trustees of RCRD deems proper and consistent with applicable law and its obligations as a GSA and Reclamation District.

~~1.2 GSP Area~~

1.1.5 Memorandum of Understanding

The Vina GSA also signed a Memorandum of Understanding (MOU) with Butte College to work cooperatively to advance the purposes of SGMA and groundwater sustainability. As part of the MOU, the Vina GSA agreed to the following conditions: not to impose fees, assessments, or other charges pertaining to groundwater management to Butte College, to not limit groundwater extraction, to not alter the current boundaries of the Vina Subbasin or consolidation of the Vina Subbasin or regulate or interfere with the surface water rights or groundwater rights of Butte College. These conditions could be altered upon written consent from Butte College. In addition, Butte College agreed to support the efforts of the Vina GSA, to provide associated data as it relates to the Vina Subbasin, and to work cooperatively with the GSA in the review, development, and implementation of the GSP. Butte College appointed a member to the Vina Advisory Committee to provide input and recommendations to the Vina GSA Board on GSA development and implementation.

1.2 Groundwater Sustainability Plan Area

This section provides a detailed description of the Vina Subbasin, including major streams and creeks, institutional entities, agricultural and urban land uses, locations of groundwater wells, and locations of state lands. The GSP Area document also describes existing surface water and groundwater monitoring programs, existing water management programs, and general plans in the GSP Area.

1.2.1 Summary of Jurisdictional Areas and Other Features

The Vina Subbasin falls within the larger Sacramento Valley Groundwater Basin (Figure 1-2). Basin designations by DWR were first published in 1952 in Water Quality Investigations Report No. 3, Ground Water Basins in California, and subsequently updated in Bulletin 118 in 1975, 1980, 2003, and draft update in 2020. As shown in Figure 1-3, the Vina Subbasin (Bulletin 118 Basin Number 5-021.57) is bordered to the north by the Los Molinos Subbasin (Bulletin 118 Basin Number 5-021.56), the Corning Subbasin (Bulletin 118 Basin Number 5-021.51), and the Butte Subbasin (Bulletin 118 Basin Number 5-021.40); to the south by the Wyandotte Creek Subbasin (Bulletin 118 Basin Number 5-021.69); and to the east by the Sierra Nevada geomorphic province.

Figure 1-2 placeholder page

Figure 1-3 placeholder page

The Vina Subbasin is located within Butte County. Geologic units in the Vina Subbasin consist of consolidated rocks and unconsolidated deposits, as discussed in detail in Section 2. No adjudicated areas or areas covered by an alternative to a GSP exist within the Vina Subbasin.

Figure 1-4 shows the Vina Subbasin's key geographic features, including city boundaries. The Vina Subbasin encompasses an area of about 289 square miles. There are two entities within the Vina Subbasin with land use jurisdiction: Butte County and the City of Chico.

~~Figure 1-5~~Figure 1-5 shows the tribal areas within the Vina Subbasin that includes the Mechoopda Tribal Designated Statistical Areas. Figure 1-6 shows the spatial extent of Disadvantaged Communities (DACs) and Severely Disadvantaged Communities (SDACs) in the Vina Subbasin. DWR defines DACs as census geographies (census tracts, census block groups, and census-designated places) with an annual median household income (MHI) that is less than 80% of the statewide annual MHI. SDACs are defined as census geographies with an MHI less than 60 percent of the statewide annual MHI. DWR uses the most recently available ~~5~~five-year American Community Survey (ACS) dataset to identify these areas. For this GSP, the 2012-2016 ACS dataset was used, establishing statewide MHI as $63,783 (DWR, Mapping Tools).

Figure 1-~~6~~7 shows a map of land use in the Vina Subbasin across four general categories: cropland, industrial, undeveloped, and urban. These categories were mapped based on categories provided by 2015 land use from the United States Department of Agriculture's (USDA) CropScape 2015 dataset.

Land use patterns in the Vina Subbasin are dominated by agricultural uses, including nut and fruit trees, vineyards, row crops, grazing, and forage. Throughout the Vina Subbasin, both agricultural and urban land use rely on a combination of surface water and groundwater. Land use is primarily controlled by local agencies. Land use patterns in the low foothills to the east are dominated by native vegetation and unirrigated pasture lands (USDA, ~~2015~~2020).

Crop type varies by region, with fruit and nut trees and rice fields comprising the majority of agriculture in the Vina Subbasin. Almond and walnut orchards dominate the northern and central portion of the Vina Subbasin, and rice fields dominate the southern portion of the Vina Subbasin (Figure 1~~-7~~-8). Figure 1-~~8~~9 shows a map with boundaries of federal and state public lands within the region that includes the Vina Subbasin.

Figure 1-~~9~~10 to Figure 1-~~12~~13 show the density of domestic, public, industrial, and irrigation wells per square mile in the Vina Subbasin, as classified by the DWR Online System for Well Completion Reports (OSWCR), which is discussed in Section 1.4.4. Though there are overlaps and discrepancies in the designation of wells, domestic wells are largely private residential wells, public wells are municipal operated wells, and production wells are for irrigation, municipal, public, and industrial purposes (DWR, 2019a). Areas with few wells exist in the Vina Subbasin, particularly in the northwestern corner of the Vina Subbasin and to the east. Wells containing groundwater level data are described further in Section 1.4.

Figure 1-~~13~~14 shows locations of major rivers, streams, and creeks within the Vina Subbasin. The Sacramento River borders the Vina Subbasin on its western side. Other larger surface water bodies traversing the Vina Subbasin include Big Chico Creek and Butte Creek.

Figure 1-4 placeholder page

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Figure 1-14 placeholder page

Smaller local or ephemeral streams entering and traversing the Vina Subbasin include Pine Creek, Rock Creek, Mud Creek, Sycamore Creek, Little Chico Creek, Hamlin Slough, Little Dry Creek, and Clear Creek. Additional information regarding surface waters can be found in Section 2, Basin Setting.

1.2.2 Management Areas

A Management Area (MA) refers to an area within a basin for which a GSP may identify different minimum thresholds~~,~~ (MT), measurable objectives~~,~~ (MO), monitoring, and projects and actions based on unique local conditions or other circumstances as described in the GSP regulations. The GSP must describe each MA, including rationale for approach and demonstrate it can be managed without causing undesirable results within or outside the MA. Three MAs are defined in the Vina Subbasin ~~by the joint powers agreement forming the Vina GSA,~~: Vina North, Vina Chico, and Vina South (Figure 1-1).

~~***1.2.2.1 Definition and Reason for Creation***~~

~~The Vina North MA overlies the Butte County area north of the City of Chico and Big Chico Creek, within the jurisdictional boundary of the GSA. The Rock Creek Reclamation District GSA is situated in this MA. The Vina GSA and the Rock Creek Reclamation District GSA have committed through a Cooperation Agreement to develop a single GSP for the Vina Subbasin. The two GSAs will coordinate their efforts in the Vina North MA. The second MA encompasses the area that overlies the municipal area within and adjacent to the City of Chico (Vina Chico MA). The Vina South MA overlies the Durham Irrigation District and the Butte County areas south of the City of Chico. The Vina GSA is the exclusive GSA for the Vina Chico and Vina South MAs.~~

Although all stakeholders have a shared interest in sustainable management of groundwater in this predominantly groundwater dependent ~~subbasin~~Vina Subbasin, the landscape of beneficial users varies ~~between management areas. Vina North is dominated by irrigated agriculture dependent on wells with sparsely distributed rural residential domestic well users and the small community of Nord. The Sacramento River flows along the western boundary but otherwise, ephemeral streams are present including Pine Creek, Rock Creek, and Mud Creek. It contains the jurisdictions of Rock Creek Reclamation District GSA and Vina GSA.~~

~~Vina Chico is predominantly an urban area with California Water Service (Cal Water) providing groundwater supplies for residential and municipal use. To a very limited extent, private domestic wells provide the primary source of water to households or in some cases provide a secondary supply for outdoor water use. Several creeks traverse Vina Chico including Big Chico Creek, Little Chico Creek, and Butte Creek.~~

~~Vina South is dominated by irrigated agriculture dependent on groundwater and to a lesser extent surface water diversions primarily from Butte Creek. In and around the community of Durham, significant numbers of rural residents and ranchettes depend on groundwater typically from relatively shallow domestic wells interspersed with agricultural land uses. Both perennial and ephemeral streams traverse Vina South including but not limited to Butte Creek, Little Dry Creek, and Dry Creek, which becomes the Cherokee Canal.~~

among MAs. The interests and vulnerability of stakeholders and groundwater uses in these ~~management areas~~MAs vary based on the nature of the water demand (agricultural, domestic, municipal), numbers and characteristics (i.e., depth) of wells supplying groundwater, and to some degree the hydrogeology and mix of recharge sources (i.e., the presence of Butte Creek in Vina South compared to ephemeral streams in Vina North). The reason for creating these ~~management areas~~MAs in the Vina Subbasin is to focus development of ~~minimum thresholds, measurable objectives~~MT, MO, monitoring, and projects and actions in a way that best meets the mix of needs of the uses and users of groundwater unique to the MA. The defined MAs also allow Member Agencies to focus efforts and staff resources on development of portions of the GSP most relevant to stakeholders within their jurisdiction. These established MAs facilitate successful development and long-term implementation of the GSP by effectively targeting the needs, vulnerabilities, and opportunities of local conditions in these areas.

1.2.2.1 Vina North Management Area

The Vina North MA overlies the Butte County area north of the City of Chico and Big Chico Creek, within the jurisdictional boundary of the GSA. The Rock Creek Reclamation District GSA is situated in this MA. The Vina GSA and the Rock Creek Reclamation District GSA have committed through a Cooperation Agreement to develop a single GSP for the Vina Subbasin. The two GSAs will coordinate their efforts in the Vina North MA. Vina North is dominated by irrigated agriculture dependent on wells with sparsely distributed rural residential domestic well users and the small community of Nord. The Sacramento River flows along the western boundary but otherwise, ephemeral streams are present including Pine Creek, Rock Creek, and Mud Creek. It contains the jurisdictions of Rock Creek Reclamation District GSA and Vina GSA.

1.2.2.2 Vina Chico Management Area

The second MA encompasses the area that overlies the municipal area within and adjacent to the City of Chico (Vina Chico MA). The Vina Chico MA is predominantly an urban area with California Water Service (Cal Water) providing groundwater supplies for residential and municipal use. To a very limited extent, private domestic wells provide the primary source of water to households or in some cases provide a secondary supply for outdoor water use. Several creeks traverse the Vina Chico MA including Big Chico Creek, Little Chico Creek, and Butte Creek. The Vina GSA is the exclusive GSA for the Vina Chico MA.

1.2.2.3 Vina South Management Area

The Vina South MA overlies the Durham Irrigation District and the Butte County areas south of the City of Chico. The Vina South MA is dominated by irrigated agriculture dependent on groundwater and to a lesser extent, surface water diversions primarily from Butte Creek. In and around the community of Durham, significant numbers of rural residents and ranchettes depend on groundwater typically from relatively shallow domestic wells interspersed with agricultural land uses. Both perennial and ephemeral streams traverse the Vina South MA, including but not limited to, Butte Creek, Little Dry Creek, and Dry Creek, which becomes the Cherokee Canal. The Vina GSA is the exclusive GSA for the Vina South MA.

1.3 Management Programs

Existing management programs within the Vina Subbasin are described below.

1.3.1 Groundwater Management Plan

The County of Butte has a Groundwater Management Plan (GMP) that covers the entire County except for areas covered by Urban Water Management Plans~~.~~ (UWMPs). The GMP supports the long-term maintenance of high-quality groundwater resources within the Plan Area for agricultural, environmental, rural domestic and urban needs. Specifically, the Butte County Groundwater Management Plan endeavors to:

- Minimize the long-term drawdown of groundwater levels;
- Protect groundwater quality;
- Prevent inelastic land surface subsidence from occurring as a result of groundwater pumping;
- Minimize changes to surface water flows and quality that directly affect groundwater levels or quality;
- Minimize the effect of groundwater pumping on surface water flows and quality; and
- Evaluate groundwater replenishment and cooperative management projects.

The Butte County Groundwater Management Plan can be found at:

http://www.buttecounty.net/waterresourceconservation/groundwatermanagementplan

1.3.2 Urban Water Management Plans

~~Cal Water and Durham Irrigation District have prepared Urban Water Management Plans.~~

Urban Water Management Plans provide an assessment of long-term water supply reliability, demand management measures, water shortage contingency plans, progress towards reduced per capita consumption, and the planned use of recycled water. An UWMP has been developed for the City of Chico by Cal Water, 2020. This document provides water system descriptions, supplies and demands, and supply reliability to ensure that adequate water supplies are available to meet existing and future needs. An UWMP is prepared every five years by law to support Cal Water's long-term resource planning.

1.3.3 Northern Sacramento Valley Integrated Regional Water Management Plan

Six counties, including Butte, Shasta, Tehama, Glenn, Colusa, and Sutter counties (Figure 1-~~14~~15), of the Northern Sacramento Valley have been working together for over 10 years to lay the foundation for an integrated regional plan to address water-related issues such as economic health and vitality; water supply reliability; flood, stormwater, and flood management; water quality improvements; and ecosystem protection and enhancement. The counties have completed the development of a valley-wide ~~Integrated Regional Water Management~~IRWM Plan and have committed to continuing the efforts of regional water management through this plan. The ~~Integrated Regional Water Management (~~IRWM~~)~~ is a collaborative effort to enhance coordination of the water resources in a region. IRWM involves multiple agencies, stakeholders, tribes, individuals, and groups to address water-related issues and offer solutions which can provide multiple benefits to the region. Representatives of the six counties are working in partnership with community stakeholders, tribes, and the public to identify the water-related needs of the region. This information was used to develop goals and objectives of the IRWM Plan, and the identification of projects and programs to be included in the GSP. The ~~GSP~~IRWM Plan was adopted in April 2014 and will better position the region and local partners to receive funding for high-priority projects.

1.3.4 Drought Management Plan

The Butte County Drought Preparedness and Mitigation Plan (Drought Plan) was adopted in 2004 and was developed to protect the County from the effects of a drought. The Drought Plan includes: an overview of Butte County's drought background; institutional framework to approach drought; a monitoring plan; a response and mitigation plan; and a discussion of water transfers during a drought. The purpose of the Drought Plan is to provide an efficient and systematic process for Butte County that results in a short- and long-term reduction in drought impacts to the citizens, economy, and environment.

~~1.3.4~~1.3.5 Conjunctive Use Programs

There are no conjunctive use programs in the Vina Subbasin.

~~1.3.5~~1.3.6 General Plans in the Plan Area

The Vina Subbasin is subject to the Butte County General Plan 2030 and the City of Chico General Plan. In 2018, the Camp Fire destroyed 18,000 structures in Butte County, displacing over 27,000 residents. In 2020, the North Complex Fire destroyed homes in Berry Creek, Feather Falls, and other areas. While the Town of Paradise, Concow, Berry Creek, and other impacted areas rebuild, many residents have relocated to other parts of Butte County. The existing General Plans may not fully account for the relocation of wildfire survivors. The GSP accounts for changes in population and updates to General Plans during GSP implementation.

~~1.3.5.1~~1.3.6.1 *Butte County General Plan 2030*

The Butte County General Plan 2030 was adopted by the Butte County Board of Supervisors in October 2010. The General Plan 2030 identifies the goals, policies, and actions governing land use in the unincorporated portions of Butte County. The General Plan 2030 reflects the community desire to conserve and enhance the legacy of their forebears, namely, sustainable development.

Figure 1-15 placeholder page

To this end, the General Plan 2030 envisions and supports a Butte County in 2030 where:

- Urban development will be primarily centralized within and adjacent to the existing municipal limits and larger unincorporated communities. Urban development will have efficient, reliable public facilities and infrastructure. Employment centers and a range of services will be located near residential areas so that people spend less time in their cars. Residential communities will be walkable, bicycle facilities will be provided, and there will be access to public transit.
- Small unincorporated areas will be well-planned through community-driven planning processes so that community character is preserved~~,~~ and adequate public services and facilities are provided. Rural residential development will be limited and will strive to be compatible with agricultural and environmental uses and will address wildfire risks and public service's needs.
- Agriculture and open space will continue to dominate Butte County's landscape and be an important part of the County's culture and economy. Existing agricultural areas will be maintained, and an array of agricultural services will support agriculture while providing new jobs to Butte County residents.

The General Plan 2030 includes an optional Water Resources Element in addition to the mandatory elements of Land Use, Housing, Economic Development, Agriculture, Circulation, Conservation and Open-space, Health and Safety, and Public Facilities and Services. In adopting the Water Resources Element, the General Plan 2030 recognized the importance and interrelationship between land use and water resources management. The General Plan 2030 Water Resources Element has six goals:

1. Maintain and enhance water quality~~.~~
2. Ensure an abundant and sustainable water supply to support all uses in Butte County~~.~~
3. Effectively manage groundwater resources to ensure a long-term water supply for Butte County~~.~~
4. Promote water conservation as an important part of a long-term and sustainable water supply~~.~~
5. Protect water quality through effective ~~storm water~~stormwater management~~.~~
6. Improve stream bank stability and protect riparian resources~~.~~

Key Water Resources Element policies include:

- W-P1.4: Where appropriate, new development shall be Low Impact Development ~~(LID)~~ that minimizes impervious area, minimizes runoff and pollution, and incorporates best management ~~practices.~~
- ~~W~~practicesW-P2.1: The County supports solutions to ensure the sustainability of community water supplies.

- W-P2.3: Water resources shall be planned and managed in a way that relies on sound science and public participation.
- W-P2.5: The expansion of public water systems to areas identified for future development on the General Plan land use map is encouraged.
- W-P2.6: The County supports water development projects that are needed to supply local demands.
- W-P2.8: The County supports Area of Origin water rights, the existing water right priority system, and the authority to make water management decisions locally to meet the county's current and future needs, thereby protecting Butte County's communities, economy and environment.
- W-P2.9: Applicants for new major development projects, as determined by the Department of Development Services, shall demonstrate adequate water supply to meet the needs of the project, including an evaluation of potential cumulative impacts to surrounding groundwater users and the environment.
- W-P3.1: The County shall continue to ensure the sustainability of groundwater resources, including groundwater levels, groundwater quality, and avoidance of land subsidence~~,~~ through a basin management objective program that relies on management at the local level, utilizes sound scientific data, and assures compliance.
- W-P3.2: Groundwater transfers and substitution programs shall be regulated to protect the sustainability of the County's economy, communities and ecosystem, pursuant to Chapter 33 of the Butte County Code.
- W-P3.3: The County shall protect groundwater recharge and groundwater quality when considering new development projects.
- W-P4.1: Agricultural and urban water use efficiency shall be promoted.
- W-P4.2: Water conservation efforts of local Resource Conservation Districts, the Natural Resource Conservation Service, and irrigation districts should be coordinated.
- W-P4.3: The County shall work with municipal and industrial water purveyors to implement water conservation policies and measures.
- W-P4.4: Opportunities to recover and utilize wastewater for beneficial purposes shall be promoted and encouraged.
- W-P4.5: The use of reclaimed wastewater for non-potable uses shall be encouraged, as well as dual plumbing that allows graywater from showers, sinks, and washers to be reused for landscape irrigation in new developments.
- W-P4.6: New development projects shall adopt best management practices for water use efficiency and demonstrate specific water conservation measures.
- W-P5.2: New development projects shall identify and adequately mitigate their water quality impacts from stormwater runoff.

- W-P5.3: Pervious pavements shall be allowed and encouraged where their use will not hinder mobility.

Implementation of the Vina GSP will provide for sustainable groundwater management and is not anticipated to affect water supply assumptions in the General Plans. Information on the Butte County General Plan 2030 and related documents can be found at www.buttegeneralplan.net.

~~1.3.5.2~~1.3.6.2 City of Chico

The Chico City Council adopted the Chico 2030 General Plan in April 2011. The General Plan was comprehensively reviewed and updated in 2017. Chico's 2030 General Plan reflects the community's commitment to meeting the challenge of creating and maintaining a sustainable community. Sustainability in Chico means maintaining a culture of stewardship to enhance our natural environment, economic strength, and quality of life for present and future generations. The Chico General Plan's goals, policies, and actions are intended to work together to achieve sustainability. The Chico General Plan recognizes that sustainability is an organizing principle, and that the City must consider the interdependent interests of protecting the environment, promoting social equity, and achieving a healthy economy in its actions and programs.

To establish a sustainable development trend for the community, the Chico General Plan identifies and promotes certain development patterns, including compact urban development, infill development and redevelopment, mixed-use development, complete neighborhoods, and a variety of housing types. The Chico General Plan further seeks to preserve and enhance its older neighborhoods, promote economic development, protect sensitive environmental resources, and provide open space and parks. To achieve these sometimes-competing goals, the Chico General Plan addresses three distinct areas of the City: areas of stability~~,~~; areas of potential change~~,~~; and areas for new growth.

The State General Plan Guidelines call for the Chico General Plan to address all land within the City limits, land within the City's designated ~~Sphere of Influence (~~SOI~~)~~, and other land in unincorporated Butte County ~~which~~that relates to the City's planning efforts.

Chico General Plan Organization

State law requires the General Plan to address the subjects of land use, circulation, housing, noise, safety, conservation, and open space. Additional topics (or "elements") may be covered at the discretion of the jurisdiction, provided that they are consistent with one another. Chico's General Plan includes the following optional elements: Sustainability; Downtown; Community Design; Economic Development; Parks, Public Facilities and Services; and Cultural Resources and Historic Preservation.

Parks, Public Facilities, and Services Element

This Element addresses parks, greenways, preserves and recreational open space as well as wastewater service, water facilities, and storm drainage.

The Chico 2030 General Plan Parks, Public Facilities, and Services Element acknowledges:

> *The Tuscan aquifer is the primary groundwater reservoir underlying and providing municipal and agricultural water to the Planning Area. The groundwater supply is largely recharged by infiltration in the foothills located east of Chico, from Big Chico*

and Little Chico Creeks, Lindo Channel, and to a lesser extent from precipitation throughout the area. The California Water Service Company (Cal Water), the City's water supplier, has adopted a Water Master Plan (WMP) which analyzes the aquifer's supply. The WMP concludes that no substantial overdraft of the aquifer is currently occurring within the Planning Area. In addition, Butte County continually monitors the groundwater basin and maintains a series of monitoring and test wells located throughout the County to provide information on water supply.

Relevant Goals, Policies, Actions from the Water Supply and Water Quality ~~is~~section of the Element are provided below:

- Goal OS-3: Conserve water resources and improve water quality.
- Policy OS-3.1 (Surface Water Resources) – Protect and improve the quality of surface water.
- Action OS-3.1.1 (Comply with State Standards) – Comply with the California Regional Water Quality Control Board's (CRWQCB) regulations and standards to maintain, protect, and improve water quality and quantity.
- Policy OS-3.2 (Protect Groundwater) – Protect groundwater and aquifer recharge areas to maintain groundwater supply and quality.
- Action OS-3.2.1 (Protect Recharge Areas) – Avoid impacts to groundwater recharge areas through open space preservation, runoff management, stream setbacks, and clustering of development.
- Action OS-3.2.2 (Map Recharge Areas) – Work with local, state, and regional agencies to identify and map groundwater recharge areas within the ~~Sphere of Influence~~SOI.
- Action OS-3.2.5 (Groundwater Protection) – Oppose regional sales and transfers of local groundwater.
- Policy OS-3.3 (Water Conservation and Reclamation) – Encourage water conservation and the reuse of water.
- Action OS-3.3.1 (Water Conservation Program Funding) – Work with Cal Water to implement a water conservation program to reduce per capita water use 20 percent by 2020 pursuant to the requirements of the State Water Plan.
- Action OS-3.3.4 (Reclaimed Water) – Determine the feasibility and costs and benefits of reusing the City's treated wastewater for irrigation.

The Chico 2030 General Plan Parks, Public Facilities, and Services Element acknowledges:

Water service in the City is provided by the California Water Service Company (Cal Water). Cal Water is a private company whose Chico District was formed in 1926. Residents not supplied by Cal Water obtain water through private wells. Cal Water currently uses a system of 65 wells which deliver approximately 27 million gallons of water to customers each day. The delivery system is composed of over 355 miles of pipeline, seven storage tanks and six booster pumps.

> *Cal Water maintains two primary management plans for the Chico area water system, as required by state law. Their Urban Area Management Plan, adopted in 2007, provides an overview of Cal Water and the Chico area water system, establishes policies and programs concerning water delivery and treatment, as well as water conservation and management practices. The Water Supply and Facilities Master Plan, adopted in 2008, guides the growth and development of their water delivery system to meet the community's future needs.*[2]

Per California Water Code, which requires urban water suppliers to update their plan once every five years, the Cal Water Urban Water Management Plan (UWMP) was updated and adopted in June 2021.

The Water Supply and Facilities Master Plan will be updated in the near future along with a Reliability Study being planned for 2023 for the Cal Water Districts in the region.

Relevant Goals, Policies, Actions from the Water Facilities ~~is~~section are provided below:

- Goal Parks, Public Facilities, and Services (PPFS-~~)~~-5: Maintain a sustainable supply of high-quality water, delivered through an efficient water system to support Chico's existing and future population, including fire suppression efforts.
- Policy PPFS-5.1 (Protect Aquifer Resources) – Protect the quality and capacity of the upper and ~~lower~~Lower Tuscan and Tehama aquifers underlying the Chico Planning Area.
- Action PPFS-5.1.1 (Groundwater Protection Advocacy) – Oppose regional sales and transfers of local groundwater, including water export contracts, and actively participate in county-wide and regional discussions and advocacy for the protection of groundwater resources.
- Action PPFS-5.1.2 (Groundwater Supplies and Budgeting) – Support periodic evaluation of groundwater availability using the Butte Basin Groundwater Model (BBGM) and Cal Water's work to establish a water supply budget with specific measures to assure sustainable levels of groundwater.
- Action PPFS-5.1.3 (Groundwater Recharge and Quality) – Where feasible given flood management requirements, maintain the natural or existing condition of waterways and floodplains and protect watersheds to ensure groundwater recharge and water quality.
- Action PPFS-5.1.5 (Monitor Groundwater Levels) – Utilize the annual comprehensive groundwater monitoring data collected by the Butte County Department of Water and Resource Conservation (BCDWRC) to assess the quality and quantity of water for the Chico area.

[2] Per California Water Code, which requires urban water suppliers to update their plan once every five years, the Cal Water Urban Water Management Plan (UWMP) was updated and adopted in 2020.

- Policy PPFS-5.2 (Future Water System) – Consult with Cal Water to ensure that its water system will serve the City's long-term needs and that State regulations SB 610 and SB 221 are met.
- Action PPFS-5.2.3 (Water Services for New Development) – Work with Cal Water to ensure that water treatment and delivery infrastructure are in place prior to occupancy or assured through the use of bonds or other sureties to the City and Cal Water's satisfaction.
- Policy PPFS-5.3 (Water Conservation) – Work with Cal Water to implement water conservation management practices.
- Action PPFS-5.3.1 (Treated Wastewater) – Explore the feasibility of using treated wastewater to provide irrigation to landscaped areas and other suitable locations to reduce the demand for groundwater.

Implementation of the Vina GSP will provide for sustainable groundwater management and is not anticipated to affect water supply assumptions in the City's General Plan. Information on the City of Chico 2030 General Plan and related documents can be found at https://chico.ca.us/general-plan-other-planning-documents

~~1.3.5.3~~1.3.6.3 Permitting of New Wells

The construction, repair, or destruction of wells ~~is~~are subject to permitting by the Butte County Division of Environmental Health pursuant to Chapter 23B of the Butte County Code, Water Wells. The chapter provides minimum procedures for the proper construction of water wells and for the proper destruction of abandoned wells ~~in order~~ to ensure that water obtained from wells within the County of Butte will be suitable for the purposes for which it is used, and that wells constructed or abandoned pursuant to this chapter will not cause pollution or impairment of the quality of the groundwater within the county. An additional purpose is to reduce potential well interference problems to existing wells and potential adverse impacts to the environment ~~which~~that could be caused by the construction of new wells or the repair or deepening of existing wells where a permit is required. Important provisions of the chapter include:

- The construction, repair, reconstruction, deepening, abandonment ~~and~~, or destruction of wells in Butte County must follow the standards in Bulletin 74-81 and its supplement bulletin 74-90, Water Well Standards, State of California.
- After July 25, 1996, the pumping capacity of a new well cannot be greater than 50 gallons per minute (gpm) per acre to reasonably serve the overlying land, including contiguous parcels of land under the same ownership as the land upon which the well is located.
- Wells can only be drilled by a person licensed to drill water wells pursuant to the provisions of Business and Professions Code section 7000 et seq. possessing a C-57 water well contractor's license required by section 13750.5 of the California Water Code.
- Domestic well owners are required to ensure that a new well will operate properly, assuming a repeat of the groundwater conditions experienced during the period 1987 through 1994 in the area in which the new well is located.

- Well drillers reports must be filed with Butte County as well as with ~~the Department of Water Resources~~DWR.
- Notification of well permit applications ~~are~~is required in specific instances to adjoining landowners and/or local agencies with an adopted groundwater management plan pursuant to part 2.75 of division 6 of the California Water Code (commencing at section 10750). Landowners and/or local agencies are provided 30 days to provide comments prior to permit issuance.
- Wells with a casing diameter greater than 8 inches are required to be drilled at specific distances away from existing wells.
- In addition to well sealing requirements specified within state well standards bulletin 74~~-~~-81 and bulletin 74-90, the seal shall be extended 5 feet into the first consolidated formation encountered below 15 feet to a maximum required sealing depth of 50 feet.

~~1.3.5.4~~1.3.6.4 Land Use Plans Outside of the ~~Basin~~Vina Subbasin

The Tehama County General Plan and the Glenn County General Plan and zoning ordinances are the land use plans adjacent to the Vina Subbasin. The Vina GSA will continue to monitor amendments to the Tehama County and Glenn County General Plans.

1.4 Groundwater Level Monitoring and Data Sources

Groundwater level programs predominantly used for development of the GSP include BCDWRC, Cal Water, California Statewide Groundwater Elevation Monitoring (CASGEM), and the CA DWR Water Data Library. Each of these programs are discussed below.

~~1.4.1 BCDWRC Program~~

1.4.1 Butte County Department of Water and Resource Conservation Program

As discussed above, in November 1996, the voters in Butte County approved “AN ORDINANCE TO PROTECT THE GROUNDWATER RESOURCES IN BUTTE COUNTY.” The ordinance is now codified as Chapter 33 of the Butte County Code relating to groundwater conservation. Section 3.01 of this code, Groundwater Planning Process, requires the preparation of a groundwater status report based upon the data gathered and analyzed pursuant to Section 3.02, Groundwater Monitoring. In 2000, the Butte County Board of Supervisors amended Chapter 33, the Groundwater Conservation Ordinance, to require the delivery of the Groundwater Status Report by February of each year. In 2010, the Water Commission designated the BCDWRC as the entity responsible for creating and submitting the annual report.

In February 2004, the Butte County Board of Supervisors adopted the Groundwater Management Ordinance, which was codified as Chapter 33A of the Butte County Code. Chapter 33A calls for the establishment of a monitoring network and Basin Management Objectives (BMOs) for groundwater elevation, groundwater quality related to saline intrusion and land subsidence. The BMO concept was incorporated into California Water Code §10750 et. seq., as a component of AB 3030 Groundwater Management Plans. On September 28, 2004, the Butte County Board of Supervisors formally approved Resolution 04-181 adopting the countywide AB 3030 Groundwater Management Plan that includes components of the BMO program.

In 2011, Chapter 33A was amended and retitled to "Basin Management Objectives" requiring a report each February describing conditions in the basin relative to established basin management objectives. The foregoing actions by the Board allow the consolidation of reporting of groundwater conditions from both Chapter 33 and 33A into a single report submitted by ~~the Department~~BCDWRC on an annual basis in February. Groundwater level measurements occur four times per year following this program. Appendix 1-~~C~~D provides the Groundwater Status Report for the 2020 Water Year following this program. With the new requirements of SGMA, revisions to Chapter 33A were approved in 2019 and will sunset on January 31, 2022, to continue the transition of groundwater management in Butte County from the BMO program to implementation of SGMA in each of the three subbasins in Butte County, including the Vina Subbasin.

~~1.4.2 CASGEM~~

1.4.2 California Statewide Groundwater Elevation Monitoring

DWR maintains several groundwater level monitoring programs, tools, and resources covering California. The CASGEM Program is DWR's primary resource for groundwater level data and has been used extensively in the development of this GSP. The CASGEM Program was authorized in 2009 by SB X7-6 to establish collaboration between local monitoring parties and DWR to collect and make public statewide groundwater elevation data. The program provides the framework for local agencies or other organizations to "assume responsibility for monitoring and reporting groundwater elevations in all or part of a basin or ~~subbasin~~Subbasin" (Water Code §10927). The BCDWRC is the CASGEM monitoring entity for the Vina Subbasin. The groundwater monitoring program discussed above for BCDWRC complies with the reporting requirements of the CASGEM program.

1.4.3 Water Data Library

DWR's Water Data Library (WDL) contains measurements of groundwater elevations from water supply and monitoring wells monitored by numerous entities, such as DWR and local agencies. Groundwater level measurements available from the WDL are either continuously or periodically measured. Continuous measurements are provided by automatic water level measuring devices that take readings at wells; periodic measurements are manual recordings typically occurring at monthly or semi-annual time intervals. Measurements displayed through the WDL are taken through other programs, such as CASGEM. The WDL lists the organization responsible for collecting each water level measurement. The WDL water level measurements are available through the California Natural Resources Agency (CNRA) Open Data website as a bulk download, or through the WDL website on a per station basis.

1.4.4 Online System for Well Completion Reports

The OSWCR is a DWR program used to document and compile boring or well completion records throughout California. There are as many as two million domestic, irrigation, and monitoring water wells in California included in this dataset, including more than 4,000 domestic wells located in the Vina Subbasin. However, as discussed in Section 3, the well characteristics in this database are not always accurate or precise, and, unfortunately, it is not known which of the wells in the database are in use or have been abandoned or replaced. When a well is constructed, modified, or destroyed, drilling contractors are required to submit a Well Completion Report (WCR) to DWR for upload to the interactive OSWCR website. OSWCR is used as a data source for wells identified for monitoring. In this GSP, the OSWCR database was used to describe the GSP area and identify ~~sustainable management criteria.~~SMC.

1.5 Groundwater Quality Monitoring and Data Sources

Groundwater quality programs predominantly used for development of the GSP include BCDWRC, Sacramento Valley Water Quality Coalition (SVWQC), State Water Resources Control Board (SWRCB) Geotracker/ Groundwater Ambient Monitoring and Assessment Program (GAMA) and the DWR WDL. Each of these programs are discussed below.

~~1.5.1 BCDWRC Program~~

1.5.1 Butte County Department of Water and Resource Conservation Program

As discussed in Section 1.4.1, the BMO program developed by Butte County includes groundwater quality monitoring that is presented annually in the Groundwater Status Reports. Appendix 1-~~C~~D provides the Water Year 2020 Groundwater Status Report summarizing the results of this groundwater quality monitoring.

~~1.5.2~~ Sacramento Valley Water Quality Coalition~~SVWQC~~

1.5.2

Because irrigated agriculture is the predominant land use in the Vina Subbasin, monitoring of the groundwater quality data developed through the Groundwater Quality Trend Monitoring Work Plan (GQTMWP) being implemented by the SVWQC for compliance with the Central Valley Regional Board's Irrigated Lands Regulatory Program (ILRP) is an important source of information to GSAs in the Vina Subbasin. This program is implemented by California Rice Commission that submits annual reports on groundwater quality throughout the region.

1.5.3 Geotracker/~~GAMA~~Groundwater Ambient Monitoring and Assessment

GeoTracker, operated by the SWRCB, contains records for sites that require cleanup, such as leaking underground storage tank (LUST) sites, Department of Defense sites, and cleanup program sites. GeoTracker also contains records for various unregulated projects as well as permitted facilities including~~:~~ ILRP, future CV-SALTS, oil and gas production, operating permitted underground storage tanks, and land disposal sites. GeoTracker receives records and data from SWRCB programs and other monitoring agencies.

The Geotracker System also contains links to GAMA. The GAMA Program is California's comprehensive groundwater quality monitoring program that was created by the SWRCB in 2000. It was later expanded by AB ~~Assembly Bill~~ 599 - the Groundwater Quality Monitoring Act of 2001. AB 599 required the State Water Board, in coordination with an Interagency Task Force ~~(ITF)~~ and Public Advisory Committee (PAC) to integrate existing monitoring programs and design new program elements as necessary, resulting in a publicly accepted plan to monitor and assess groundwater quality in basins that account for 95% of the state's groundwater use. The GAMA Program is based on interagency collaboration with the State and Regional Water Boards, ~~Department of Water Resources~~DWR, Department of Pesticide Regulations, ~~United~~

~~States Geological Survey~~USGS, and Lawrence Livermore National Laboratory, and cooperation with local water agencies and well owners.

1.5.4 Water Data Library

DWR's WDL contains groundwater quality data in addition to the groundwater level records described previously. This information includes data from discrete groundwater quality samples collected by DWR and other cooperating entities. These water quality data list the entity responsible for taking the sample but do not specify what program the sample was taken under. The WDL water quality measurements are available through the CNRA Open Data website as a bulk download~~,~~ or through the WDL website on a per-station basis. WDL water quality measurements in this GSP are utilized for basin characterization but are acquired from the other programs.

1.6 Subsidence

To determine whether subsidence is occurring, a subsidence monitoring network has been established throughout Butte County consisting of observation stations and extensometers managed by DWR. The observation stations are a result of DWR's efforts to establish a subsidence monitoring network across the valley to capture changes in the ground surface elevation. The observation stations are established monuments with precisely surveyed land surface elevations. They are distributed throughout the valley such that the entire county is well represented. In 2008, DWR along with numerous partners performed the initial Global Positioning System (GPS) survey of the observation stations to establish a baseline measurement for future comparisons. The network was resurveyed in 2017 using similar methods and equipment as those used in the 2008 survey and results were analyzed to depict the change in elevation at each station between those years. Results of the survey are available here, https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub

Extensometers are installed in wells or boreholes and are a more site-specific method of measuring land subsidence as they can detect changes in the thickness of the sediment surrounding the well due to compaction or expansion. These instruments are capable of detecting very slight changes in land surface elevation on a continuous basis with an accuracy of +/- 0.01 feet or approximately 3 millimeters (mm). The three extensometers in Butte County have a period of record beginning in 2005 and were chosen by DWR based on a high likelihood of seeing subsidence in these areas if it were to occur, based on the presence of known clay and other fine-grained deposits in these areas. Data are available through July 2020 from the DWR Water Data Library. A summary of the historic information within the Vina Subbasin obtained from these networks is presented in Section 2, Basin Setting, and the monitoring network for implementation of the GSP is discussed in Section 4, Monitoring Networks.

1.7 Interconnection of Databases

Several of the databases discussed above utilize the same water level or water quality data. These records often specify the monitoring entity responsible for the measurement. Although these data overlap between databases, the correlation between databases is not specified. For example, water level data in the WDL are also in CASGEM, but this link is not mentioned in WDL records. This lack of connection poses problems for gathering water level and quality data throughout California. Efforts have been made in the development of this GSP to overcome the issue related to overlap and poor correlation between databases, but the issue remains. It is recommended that agencies work together to utilize a common unique identifier to ease use of multiple datasets.

1.8 Notice and Communication (23 ~~CCR~~California Code of Regulations § 354.10)

1.8.1 Notice of Intent to Adopt ~~GSP~~Groundwater Sustainability Plan

A notice of intent (NOI) to adopt a GSP was signed by the GSAs and distributed on June 28, 2021. The hard copies of the NOI were mailed to cities and counties within the Vina Subbasin including the following:

- Butte County
- City of Chico

Copies of the NOI are provided in Appendix 1-~~A~~B.

1.8.2 Overview

California's SGMA of 2014 requires broad and diverse stakeholder involvement in GSA activities and during the development and implementation of GSPs for groundwater basins around the state, including the Vina Subbasin. The intent of SGMA is to ensure successful, sustainable management of groundwater resources at the local level, success of GSP development and implementation will require cooperation by all beneficial users (defined below). Therefore, coordinated communication and consistent messaging of valid information and facilitation of opportunities for the involvement of beneficial users will guide the path forward.

To facilitate stakeholder involvement in the GSA process, a Communication and Engagement Plan (C&E Plan) (Appendix 1-~~D~~E) was created for the Vina GSA. The desired outcomes and goals of the C&E Plan were to:

Outcomes: The desired outcome of the C&E Plan was to achieve understanding and support for GSP adoption and implementation in consideration of the people, economy, and environment within the ~~subbasin~~Vina Subbasin and in coordination with adjacent subbasins.

Plan Goals:

1. Enhance understanding and inform the public about water and groundwater resources in the Vina Subbasin, the purpose and need for sustainable groundwater management, the benefits of sustainable groundwater management, and the need for a GSP.
2. Engage diverse interested parties and stakeholders and promote informed feedback from stakeholders, the community, and groundwater-dependent users throughout the GSP preparation and implementation process.

3. Coordinate communication and involvement between the GSA (Board, Stakeholder Advisory Committee and Management Committee), Rock Creek Reclamation District GSA, and other local agencies, elected and appointed officials, and the general public.
4. Rely on the Stakeholder Advisory Committee to facilitate a comprehensive public engagement process.
5. Employ a variety of outreach methods that make public participation accessible and that encourage broad participation.
6. Respond to public concerns.
7. Provide accurate and up-to-date information.
8. Create public value and use GSA resources wisely by managing communications and engagement in a manner that is resourceful and efficient.

1.8.3 Description of Beneficial Uses and Users in the ~~Basin~~Vina Subbasin

SGMA calls for consideration of all interested parties that the GSA must consider when developing and implementing the GSP. GSAs must encourage the active involvement of diverse social, cultural, and economic elements of the population. Therefore, stakeholders or beneficial users are any stakeholders who have an interest in groundwater use and management in the Vina Subbasin. Their interest may be related to GSA activities, GSP development and implementation, and/or water access and management in general.

To assist in identifying categories of beneficial users in the Vina Subbasin, the C&E Plan listed broad categories of interested parties to be considered during development and implementation of the GSP. These include, but are not limited to:

- General public
- Agricultural users of water
- Domestic well owners
- Municipal well operators
- Public water systems
- Land use planning agencies
- Environmental users of groundwater
- Surface water users
- The federal government
- California Native American tribes
- Disadvantaged communities and historically underrepresented groundwater users (including those served by private domestic wells or small community water systems~~).~~)

Table 1-1 further identifies potential stakeholder groups and engagement purpose.

Table 1-1: Stakeholder Engagement Chart for ~~GSP~~Groundwater Sustainability Plan Development

Category of Interest	Examples of Stakeholder Groups	Engagement purpose
General Public	• Citizens groups • Community leaders • Service clubs and professional organizations	Inform to improve public awareness of sustainable groundwater management
Private users	• Private pumpers • Domestic users • School/College systems; Butte College • Hospitals	Inform and involve to minimize negative impact to these users
Urban/ Agriculture users	• Water agencies • Colleges/Universities; Butte College, ~~CSU Chico~~CSUC • Water associations; Groundwater Pumpers Advisory Committee, Agricultural Groundwater Users of Butte County • Irrigation districts; Durham Irrigation District (member agency), Rock Creek Reclamation District (a GSA within Vina Subbasin) • Mutual water companies • Resource conservation districts • Farm Bureau: Butte County Farm Bureau	Collaborate to ensure sustainable management of groundwater
Industrial users	• Commercial and industrial self-supplier • Local trade association or group	Inform and involve to avoid negative impact to these users
Land Use Planning Agencies	• Municipalities (City, County planning departments): • Regional land use agencies	Consult and involve to ensure land use policies are supporting GSPs
Environmental and Ecosystem	• Regional agencies: Butte County Resource Conservation District • Federal and State agencies: California Department of Fish and Wildlife (CDFW~~)~~); National Oceanic and Atmospheric Administration; United States Fish and Wildlife Service • Environmental groups: Butte Environmental Council, The Nature Conservancy~~,~~	Inform and involve to sustain a vital ecosystem
Economic Development	• Chambers of commerce: City of Chico • Business groups/associations • Elected officials (Board of Supervisors, City Council) • State Assembly members • State Senators	Inform and involve to support a stable economy
Human right to water	• Disadvantaged Communities • Small community systems • Environmental Justice Groups: Leadership Council for Justice and Accountability, Self-Help Enterprises, Community Water Center	Inform and involve to provide a safe and secure groundwater supplies to all communities reliant on groundwater
Tribes	• Federally Recognized Tribes and non-federally recognized Tribes with Lands or potential interests in ~~Chowchilla Subbasin~~the Vina	Inform, involve and consult with tribal government

Category of Interest	Examples of Stakeholder Groups	Engagement purpose
	Subbasin such as the Meechoopda Indian tribe of Chico Rancheria	
Federal lands	• United States Bureau of Reclamation (USBR) • Bureau of Land Management • United States Fish and Wildlife Service (USFWS)	Inform, involve and collaborate to ensure basin sustainability
Integrated Water Management	• Regional water management groups (IRWM regions); Upper Feather River IRWM and the North Sacramento Valley ~~(NSV)~~ IRWM group • Flood agencies	Inform, involve and collaborate to improve regional sustainability

1.8.4 Communications

1.8.4.1 Decision-making Processes

As noted above, two GSAs were formed in the Vina Subbasin ~~is consists of two GSAs~~ for GSP development~~,~~: the Vina GSA and the ~~Rock Creek~~RCRD GSA. The two GSAs have jointly developed this coordinated GSP.

GSA Boards are the final decision-makers for the Vina Subbasin. To assist in GSP development, the Vina GSA convened a Stakeholder Advisory Committee (SHAC) in 2019. The composition of the SHAC is intended to represent the beneficial uses and users of groundwater in the Vina GSA. The SHAC is comprised of seven at-large members appointed by the GSA Board and three members representing Cal Water, City of Chico, ~~CSU Chico~~CSUC, and Butte College. The SHAC is charged with actively engaging with the public for input and feedback. The SHAC has been meeting approximately monthly since its formation.

Generally, the representatives attending the GSA ~~management committee~~Management Committee meetings are designated staff from the member agencies. In addition to ~~coordinating~~administering the SHAC and GSA Board, the GSA ~~management committee~~Management Committee assists the SHAC in identifying and clarifying recommendations for GSP development, which are presented to the GSA Boards in public meetings.

1.8.4.2 Public Engagement Opportunities

There were a number of different meetings at which the public had the opportunity to engage during the GSP development process:

- GSA Board meetings: The Vina GSA Board and the ~~Rock Creek~~RCRD GSA Board in the Vina Subbasin held regular public meetings, including joint meetings, to facilitate public input. The ~~Rock Creek~~RCRD GSA held regular public meetings in many cases in conjunction with the Reclamation District's standing board meetings.
- Subbasin-wide ~~Technical~~technical meetings.
- SHAC meetings.
- Farm Bureau Water Forum meetings.
- City of Chico meetings.

- Regional Water Management Group meetings.

1.8.4.3 Encouraging Active Involvement

The GSAs carried out community engagement during the development of the GSP, which included meetings and presentation materials to inform the public. The GSP has been revised to incorporate public feedback. There were also activities related to encouraging involvement and building capacity for engagement. The GSAs Management Committees used a variety of tools to solicit input, including maintaining an up-to-date website with announcements, calendar of events and meetings, and links to draft ~~chapters~~sections of the GSP; establishing an interested parties list; email newsletters; brown bag seminars, workshops, webinars, and public notices. These documents and events encouraged and prepared community members to participate in GSP development by providing technical information, as well as information about opportunities for engagement.

As part of the 40-day public review period initiated on September 10, 2021, with issuance of ~~this~~the Public Draft of the GSP, the GSA Management Committee ~~will work~~worked with the numerous entities to inform them about the plan and encourage their involvement. Appendix 1-~~C~~E lists the SGMA public meetings that were held throughout the ~~GSA~~GSAs formation and GSP preparation process.

1.8.4.4 Soliciting Written Comments

In addition to soliciting feedback at GSA meetings, opportunities were provided to offer written comments on the various ~~chapters~~sections of the GSP as draft versions became available. Stakeholders could provide comments via an online comment form, letter, or email. An informal comment period began when the draft of the first ~~chapter~~section of the GSP was released in April 2019, and an official 40-day comment period ~~begans~~began with issuance of ~~this~~the Public Draft of the GSP on September 10, 2021 ~~and continues~~, that continued through October 19, 2021. In addition, a special GSP Advisory Committee meeting ~~will be~~was held after the 40-day public comment period ~~endsd~~on November 4, 2021, to solicit comments. All comments received via the comment form, letter, or email ~~will be~~were provided to the SHAC and Vina GSA Board in agenda packets for review.

On November 15, 2021, the Vina and RCRD GSAs conducted a joint public hearing where the GSA Management Committee provided an overview of public comments and the methods for responding to these comments. In addition, three proposed revisions to the Public Draft were presented to GSA Boards. Additional public comments were received and recorded for each of the proposed revisions and to the overall Public Draft GSP.

A revised GSP based on the public comments was provided the GSAs on December 9, 2021. The GSA Boards reviewed the recommended changes and took action to approve the functional changes to the Public Draft GSP on December 15, 2021. The written comments and responses can be found in Appendix 1-~~E~~F.

1.8.5 Informing the Public ~~about GSP~~About Groundwater Sustainability Plan Development Progress

1.8.5.1 Interested Parties List

An email distribution list of Vina Subbasin-wide stakeholders and beneficial users was developed for outreach throughout the GSP planning process. Any interested member of the public may request to be added to the list via this link: Contact Us - Vina Groundwater Sustainability Agency (vinagsa.org)

1.8.5.2 Distribution of Flyers

Typically, before a public meeting in the Vina Subbasin, an email flyer was created with key information provided. The flyer was emailed out to the Interested Party list.

1.8.5.3 Press Outreach

Press releases were issued at key junctures and decision-making points for the Vina Subbasin.

1.8.5.4 A Centralized Vina GSA Website

Throughout the planning process (and beyond~~)~~), the Vina GSA has maintained a website with information about Vina Subbasin-wide planning efforts related to SGMA.

The Vina Subbasin website contains:

- Homepage with links to key pages within the site
- About Us, with an overview of the Vina GSA and SGMA
- Governance that describes the structure of the ~~GSA~~GSAs, Board Members, SHAC Members, Meeting Dates and Agendas, and Transparency Documents
- Calendar of Board and SHAC Meetings and Workshops
- Library Links, including the GSP
- Contact Us page for email correspondence

~~*1.8.5.5 Engagement Matrix*~~

~~The Engagement Matrix, in Appendix 1-F, provides details about the implementation of each of the communication methods outlined above. The matrix presents each communication strategy, as required by statute or laid out in the C&E Plan, along with details about specific instances of that strategy. For example, each public GSP-related meeting is listed with information about the date, topic, and location of the meeting as well as how it was publicized, to whom it was targeted, what opportunities for feedback were provided, and who participated.~~

~~1.8.5.6~~1.8.5.5 Stakeholder Input and Responses

The engagement opportunities described above provided various avenues for stakeholders to provide input on GSP development. The matrix in Appendix 1-~~F~~E summarizes the public comments received, organized by commenter, organization, ~~chapter/~~section/line of comment location, comment, and location of where the comment was addressed or changed within the final document, as applicable.

1.9 Human Right to Water

Not formerly included in DWR's GSP checklist, but still important to address, is human right to clean water. California Water Code Section 106.3, Human Right to Water, states that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." Private domestic well groundwater pumper representation on the Advisory Committee and community engagement via public workshops and outreach are venues through which those potentially most vulnerable to loss of clean drinking water are able to share information and concerns throughout the GSP development and implementation. During preparation of this GSP public meetings were held at times, locations, and in a manner, both in-person and remotely online that supported and allowed for effective engagement of all stakeholders.

2. BASIN SETTING

2.1 Hydrogeologic Conceptual Model

A Hydrogeologic Conceptual Model (HCM) identifies the major factors contributing to groundwater flow and movement and how physical features and characteristics affect conditions within a subbasin. This section describes the HCM for the Vina Subbasin. The HCM serves as an important component of the basin ~~settings~~setting, providing the framework for understanding groundwater conditions and water budgets.

Much of the information in this section is drawn from existing reports detailing the hydrogeology of the Sacramento Valley and the formations making up the aquifer systems in the groundwater basin. These reports ~~by the Department of Water Resources~~ include the Geology of the Northern Sacramento Valley~~, 2014~~ (DWR, 2014~~),~~) and the Butte County Groundwater Inventory Analysis, 2005 (DWR, 2005~~), and~~). Local studies include the Butte County Lower Tuscan Aquifer Monitoring, Recharge, and Data Management Project Final Report~~, 2013 (Brown and Caldwell, 2013).~~ (Brown and Caldwell, 2013), the Stable Isotope Recharge Study (Brown and Caldwell, 2017), Butte County Water Inventory and Analysis Report (Davids Engineering, 2016), and the Hydrostratigraphy and Pump-Test Analysis of the Lower Tuscan/Tehama Aquifer, Northern Sacramento Valley (Greene and Hoover, 2015). Better understanding the hydrogeology, aquifer dynamics, and recharge paths of the aquifer systems in the Northern Sacramento Valley region is an area of active study and research.

2.1.1 Basin Boundaries

2.1.1.1 Lateral Boundaries

The Vina Subbasin lies in the eastern central portion of the Sacramento Groundwater Basin. It is bounded by the following subbasins: Los Molinos Subbasin to the north~~,~~; Corning Subbasin to the west~~,~~; Butte Subbasin to the south~~.~~; and a small portion of the Wyandotte Creek Subbasin on the southeast border (Figure 1-3).

The lateral boundaries of the Vina Subbasin are jurisdictional in nature, and it is recognized that groundwater flows across each of the defined boundary lines to some degree.

The northern boundary is the Butte-Tehama County line, the western boundary is the Butte-Glenn County line, the southern boundary is a combination of the property boundaries owned by the M&T Ranch, and the service area boundaries of RD 2106 and Western Canal Water District, and the eastern boundary is the edge of the alluvium as defined by ~~the~~ DWR Bulletin 118 Update 2003 (DWR, 2003).

2.1.1.2 Bottom of Basin

Continental sediments of the Tehama, Tuscan, and Laguna Formation compose the major fresh groundwater-bearing formations in the valley. The base of these continentally derived formations is generally accepted as the base of fresh water in the northern Sacramento Valley (Berkstresser, 1973; Olmsted and Davis, 1961, as cited in DWR, 2014). DWR has corroborated this assertion through analysis of geophysical logs and water quality sampling results obtained from groundwater level observation wells that ~~were~~have been drilled, installed, and tested since the year 2000 in the northern Sacramento Valley (DWR, 2014).

Locally, the base of fresh groundwater fluctuates depending on local changes in the subsurface geology and geologic formational structure (DWR, 2005). In the Vina Subbasin, this is especially the case in the southeastern area of the Subbasin where marine sediments occur at shallower depths on the margins of the valley. Figure 2-1 shows the base of fresh groundwater in the ~~Subbasin~~Vina Subbasin ranging from 800 to 1,200 feet below ground surface (bgs) (Berkstresser, 1973).

2.1.2 Topography, Surface Water and Recharge

2.1.2.1 Terrain and Topography

Elevations within the Vina Subbasin generally decrease from the northeast to the southwest, with elevations ranging from about 700 feet above mean sea level (msl) in the low foothill area in the east to approximately 150 feet msl along the Sacramento River in the northwest area of the Vina Subbasin and 130 feet above msl along the boundary of Western Canal Water District. The topography encourages drainage towards the Sacramento River and to the south. More significant topographic relief occurs along the eastern margin of the basin and in the southeastern area of the Vina Subbasin~~, including the Butte Valley area~~. Figure 2-2 shows the topography of the Vina Subbasin.

2.1.2.2 Soils

The area generally west of Highway 99 and north of Butte Creek where the dominant crops are orchards is underlain by lighter textured soils consisting of loamy sands and sandy loams. Heavier soils with slower infiltration or a restrictive layer located in the southeastern area of the Vina Subbasin are well suited for growing rice. Figure 2-3 shows the distribution of ~~Hydrologic Soil Groups~~hydrologic soil groups for the Vina Subbasin. ~~Note that soils~~Soils designated as C/D are lands having soils ~~with~~ that would have been classified as having very low infiltration rates (Group D) but have characteristics such as natural slope or management improvements that improved their drainage relative to that of similar soils.

Based on the Digital General State Soil Geographic dataset~~, or~~ (STATSGO2~~,~~), soil data for the Vina Subbasin, the dominant soil mapping unit within the area is well-drained Vina-Brentwood (s642), which represents approximately 30.6% of the Vina Subbasin. Other common well-drained soils within the Vina Subbasin ~~includes~~include Toomes-Supan (16.6% of area), Vina-Riverwash-Reiff-Columbia (12.3% of area), and Stockton-Clear Lake-Capay (5.9% of area). The Corning-Anita (9.8% of area) is somewhat poorly drained. Characteristics of these soils are summarized in Table 2-1. The distribution of dominant soils (e.g., "map units") in the Vina Subbasin is shown in Figure 2-4.

Figure 2-1 placeholder page

Figure 2-2 placeholder page

Figure 2-3 placeholder page

Figure 2-4 placeholder page

Table 2-1: STATSGO2 Soils Table for Vina Subbasin

Soil Map Unit	Percent of Area	Sum of Acres	Slope Range	Drainage
~~Vina Subbasin~~	~~100%~~	~~184,918~~	-	-
Corning-Anita (s643)	9.8%	18,159	4.3	Somewhat poorly drained
Goulding-Auburn (s646)	0.0%	14	1	Somewhat excessively drained
Landlow-Clear Lake (s630)	0.4%	684	5.3	Moderately well drained
Redding-Corning (s821)	4.9%	9,121	2.6	Well drained
Riverwash-Dumps-Cortina (s648)	0.5%	936	1	Poorly drained
Riverwash-Orland-Los Robles-Cortina (s631)	0.4%	709	1	Well drained
Stockton-Clear Lake-Capay (s824)	5.9%	10,967	1.1	Poorly drained
Tisdale-Kilaga-Conejo (s870)	5.3%	9,868	2.6	Well drained
Toomes-Supan (s622)	16.6%	30,721	27.8	Well drained
Tuscan-Anita (s644)	7.6%	14,096	1.2	Well drained
Tuscan-Keefers-Inks (s621)	5.5%	10,244	25.8	Well drained
Vina-Brentwood (s642)	30.6%	56,675	3.1	Well drained
Vina-Riverwash-Reiff-Columbia (s623)	12.3%	22,723	9.4	Well drained
Vina Subbasin	100%	184,918		_

2.1.2.3 Surface Water

Surface Water Sources and Channels

The Sacramento River borders the Vina Subbasin on its western side. Other larger surface water bodies traversing the Vina Subbasin include Big Chico Creek and Butte Creek. Smaller local or ephemeral streams entering and traversing the Vina Subbasin include Pine Creek, Rock Creek, Mud Creek, Sycamore Creek, Little Chico Creek, Hamlin Slough, Little Dry Creek, and Clear Creek. ~~Figure 2-5 shows the locations of rivers, streams, and major water supply, and drainage features.~~

~~Diversions from Butte Creek supply water for irrigation in portions of the Subbasin.~~ Lindo Channel (Sandy Gulch) and the Sycamore Bypass Channel are flood control channels for the City of Chico. Figure 2-5 shows the locations of rivers, streams, and major water supply, and drainage features.

~~At Oroville-Thermalito, Toadtown, and De Sabla-Centerville, water~~Water for power generation is transferred from the Feather River watershed to the Butte Creek watershed. Water from the West Branch of the Feather River is diverted to the Toadtown Canal for power generation and cold water for fish by the Pacific Gas and Electric Company (PG&E). The Butte Canal carries Toadtown Canal and Butte Creek water to the De Sabla power plant forebay. Hydropower is also generated at several other locations. Operations at all of these sites affect the timing of water releases. Diversions from Butte Creek supplies water for irrigation in portions of the Vina Subbasin.

Stream-groundwater interaction is an important component of groundwater dynamics in the Vina Subbasin. In some areas, runoff and streamflow in creeks and streams provide a source of recharge to the aquifer system. Additionally, in some places and at times, groundwater contributes to streamflow and is an outflow from the groundwater system.

Figure 2-5 placeholder page

2.1.2.4 Groundwater Recharge Areas

Groundwater recharge is the downward movement of water from the surface to the groundwater system. This can include percolation of water from rainfall, irrigation, or water bodies (rivers, lakes). Several water sources and mechanisms recharge the groundwater system in the Vina Subbasin.

The Stable Isotope Recharge Study (Brown and Caldwell, 2017) delineated three areas based on land surface elevation that are general sources of precipitation and serve as water sources to the surface water and groundwater systems in Butte County. Figure 2-6, reproduced from Brown and Caldwell (2017~~)~~), shows these areas labeled as Upper Watershed, Lower Foothills, and Valley Floor. ~~The reddish colored area on this figure represents outcrops of the Lower Tuscan Formation.~~ Identifying these source areas and then observing the destination of that source water within the aquifer system using stable isotope analysis for samples from multi-completion wells led to insights about recharge sources and mechanisms in the Vina Subbasin.

The Vina Subbasin is located primarily within the Valley Floor area, as shown in Figure 2-6. The Upper Watershed receives rain and snow, primarily during the winter and spring months. Rainfall runoff and snowmelt from the Upper Watershed enters the Valley Floor via streamflow of major streams and rivers that originate at higher elevations, including Butte Creek and the Sacramento River. Geologically, the Upper Watershed consists primarily of volcanic, granitic, and metamorphic rocks that do not have any appreciable primary porosity. Fracturing within these rock units may occur locally, but the fractures are not pervasive on a regional scale, which limits the amount of water that can percolate into the bedrock geologic units and the volume of groundwater available to migrate to other regions such as the valley alluvial groundwater basin on the Valley Floor (Brown and Caldwell, 2017).

The Lower Foothills region occurs within a relatively narrow topographic band along the eastern edge of the Sacramento Valley and contains the outcrop of the Tuscan Formation in addition to small alluvial fans and other Recent sedimentary deposits that directly overlie the Lower Tuscan Formation. Rainfall that occurs in the Lower Foothills may percolate into the Tuscan Formation and the recent alluvial sediments or it may ~~runoff~~run off through local, ephemeral streams to the Valley Floor. In both cases, this precipitation source is potentially a direct source of recharge to the aquifer system.

Recharge mechanisms vary both by depth and area across the Vina Subbasin. Results from stable isotope data indicated that the only route by which the Upper Watershed provides recharge to the groundwater system in the vicinity of Butte Creek in the Vina South ~~Management Area~~MA is through percolation of water from water bodies (i.e., streamflow) at the surface within the Valley Floor. This includes percolation from Butte Creek and possibly the Sacramento River as they traverse the Vina Subbasin, or via percolation of applied surface water for irrigation diverted from Butte Creek or the Sacramento River. Evidence of the Upper Watershed water source was observed in isotope data in relatively shallow portions of the aquifer system (400 feet ~~below ground surface~~bgs or shallower).

Isotope data from well samples indicated that intermediate and deeper depth intervals are recharged from rainfall and percolation in the Lower Foothills region. Rainfall in this region

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percolates directly into the Tuscan Formation at the outcrop or may percolate into the small alluvial fans and other sedimentary deposits in the Lower Foothills area.

Figure 2-6 placeholder page

Aquifer testing conducted as part of the Lower Tuscan Aquifer study (Brown and Caldwell, 2013) indicated that there is also the potential for Upper Watershed recharge in the shallow aquifer interval to move down to greater depths due to irrigation pumping, causing a mixing of recharge sources in the intermediate and possibly deeper aquifer zones in the Vina South ~~Management Area.~~MA.

Further south and to the east in the area of the Esquon Ranch, the shallow aquifer intervals are likely to be recharged by direct percolation primarily from Valley Floor precipitation, supplemented by some rainfall recharge at the base of the Lower Foothills. The intermediate and deep aquifer intervals are recharged from the lowest elevation part of the Lower Foothills region, most likely from percolation directly into the Tuscan Formation at the outcrop or through recharge into the local alluvial fans and sedimentary deposits and subsequent downward vertical migration into deeper aquifer zones. This demonstrates that precipitation on the valley floor and in the Lower Foothill area is a predominant source of recharge for much of the Vina Subbasin.

Additional recharge through management activities of flood flows or irrigation practices has potential in the Vina Subbasin. The Soil Agricultural Groundwater Banking Index (SAGBI) is a suitability index for groundwater recharge on agricultural land based on five major factors: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. This dataset can serve as a starting point indication for areas conducive to natural or managed recharge. Large portions of the Vina Subbasin generally received a moderately good to good rating (Figure 2-7), except for in the southeastern area of the Vina Subbasin. Additional considerations will be important for specific evaluation of any proposed recharge project.

2.1.3 Regional Geologic and Structural Setting

The regional structure of the Sacramento Valley groundwater basin consists of an asymmetrical trough tilting to the southwest with a steeply dipping western limb and a gently dipping eastern limb (Page, 1986). Older granitic and metamorphic rocks underlie the valley forming the basement bedrock on which younger marine and continentally derived sediments and volcanic rock have been deposited. Along the valley axis and west of the present-day Sacramento River, basement rock is at considerable depth, ranging from 12,000 to 19,000 feet ~~below ground surface.~~bgs. Overlying marine and continentally derived sediments have been deposited almost continuously from the Late Jurassic period to the present. Of these deposits, older sediments in the basin were emplaced in a marine environment and usually contain saline or brackish groundwater. Younger sediments were deposited under continental conditions and generally contain fresh groundwater. Sediments thin near the margins of the basin, exposing older metamorphic and granitic rocks underlying and bounding the Sacramento Valley sediments (DWR, 2005).

2.1.4 Geologic Formations

The region is composed of a diverse mix of geologic units ranging from very productive water-bearing sedimentary units to non-water-bearing plutonic and metamorphic rocks. The main hydrogeologic unit and source of groundwater in the Vina Subbasin is the Tuscan Formation. Other units that are less predominant are the Tehama, Riverbank, and Modesto formations (DWR, 2005).

Figure 2-7 placeholder page

Groundwater occurs under both unconfined and confined conditions. Unconfined conditions are generally present in the surficial Quaternary Deposits and in the Pliocene deposits that are exposed at the surface. Confined conditions usually exist at a depth of 100 feet or more, where one or more confining layers rests above the underlying aquifer deposits. Although the Tuscan Formation is unconfined where it is exposed near the valley margin, at depth, the Tuscan Formation is semi-confined or confined and forms the major aquifer system in the Vina Subbasin.

Figure 2-8 is the Surficial Geologic Map for the Vina Subbasin, which shows the surface distribution of geologic units. The surface geology is composed mostly of alluvial deposits, including stream floodplains and channels. The Tuscan Formation outcrops on the eastern side of the basin and then is present at depth throughout the Vina Subbasin as the source material of the aquifer system. Table 2-2 provides brief descriptions of the significant geologic units that are found in the Vina Subbasin.

The following is a discussion of groundwater producing geologic units found within the Vina Subbasin and region.

Figure 2-8 placeholder page

Table 2-2: Geologic Units

System and Series		Geologic Unit	Lithologic Character		Maximum Thickness,~~(~~, ~~(~~a) feet	Water-bearing Character
Quaternary	Holocene	Alluvium, Qa	Unconsolidated unweathered gravel, sand, silt, and clay[a].		80	Deposits are moderately to highly permeable with high permeability gravelly zones yielding large quantities to shallow wells[b]. Although deposits along Big Chico Creek are important recharge areas[b], extensive water-bearing capacity is restricted by thickness and areal extent[a].
		Basin Deposits, Qb	Unconsolidated[~~e~~d] fine-grained silts and clays, locally interbedded with stream and channel deposits along the Sacramento River[a].		150	Deposits are typically saturated nearly to the ground surface[b]. The low to moderate permeability results in yields of small quantity and poor groundwater quality to domestic wells[a,b].
	Pleistocene	Modesto Formation, Qm	Poorly sorted unconsolidated weathered and unweathered gravel, sand, silt, and clay[c].	Upper Member Modesto Formation, Qmu: Unconsolidated, unweathered gravel, sand, silt and clay.	200	Moderately to highly permeable[a].
		~~Upper Member Modesto Formation, Qmu~~	~~Unconsolidated, unweathered gravel, sand, silt and clay.~~			
		~~Lower Member Modesto Formation, Qml~~		Lower Member Modesto Formation, Qml: Unconsolidated, slightly weathered gravel, sand, silt and clay.		

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System and Series		Geologic Unit	Lithologic Character		Maximum Thickness~~,(~~ [a] feet	Water-bearing Character
		Riverbank Deposits, Qr	Poorly sorted unconsolidated to semi-consolidated(c) pebble and small cobble gravels interlensed with reddish clay, sand, and silt[a].	Upper Member Riverbank Formation, Qru: Unconsolidated but compact, dark brown to red alluvium composed of gravel, sand, silt and with minor clay.	200	Water-bearing capability is limited by thickness. These poorly to highly permeable deposits supply moderate groundwater amounts to domestic and shallow irrigation wells. Deeper irrigation wells may be supplied if the wells contain multiple perforation zones[a].
		~~Upper Member Riverbank Formation, Qru~~	~~Unconsolidated but compact, dark brown to red alluvium composed of gravel, sand, silt and with minor clay.~~			
		~~Lower Member Riverbank Formation, Qrl~~		Lower Member Riverbank Formation, Qrl: Red semiconsolidated gravel, sand, and silt.		
		Red Bluff Formation, Qrb	A thin veneer of distinctive, highly weathered bright-red gravels beveling and overlying the Tehama, Tuscan, and Laguna Formations.		-	Cemented, does not transmit water well.
Neogene & Quaternary	Pliocene & Pleistocene	Laguna Formation, Tla	Fluviatile moderately consolidated and poorly to well cemented; heterogeneous mixture of interbedded alluvial gravel, fine sand, silt, and clay of granitic and metamorphic origin[~~c~~d].		500	Generally has low to moderate permeability, except in scattered gravels in the upper portion. Yields moderate quantities of water to wells along the south eastern margin of the valley[~~c~~d].
		Tehama Formation, Tte	Fluviatile moderately consolidated pale green, gray, and tan sandstone and siltstone enclosing lenses of sand and gravel; silt and gravel; and cemented conglomerate derived from the Coast Ranges[a,c].		2,000	Local high permeability zones within this characteristically low to moderate permeability unit, widespread distribution, and deep thickness cause this formation to be the principal water bearing unit in the area. Deep well yields are typically moderate but are highly variable[b].
		Olivine Basalt of Cohasset Ridge (Tbc)	Gray vesicular porphyritic basalt flows with olivine phenocrysts as much as 6 mm in diameter set in diktytaxitic matrix of plagioclase and clinopyroxene.		-	-

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Inserted Cells

System and Series		Geologic Unit	Lithologic Character		Maximum Thickness,[a] feet	Water-bearing Character
		Nomlaki Tuff Member, (Ttn)	White, light-gray, locally reddish-tan to salmon dacitic tuff and pumice lapilli tuff exposed in widely separated areas at or very near the bases of the Tuscan and Tehama Formations.		-	-
Neogene	Pliocene	Tuscan Formation, Tt	This series of ~~volcanic~~volcaniclastic flows~~,~~ (lahars), consolidated tuff breccia, tuffaceous sandstone, and volcanic ash derived from the Cascade Range interfingers with the Tehama Formation as it westerly grades into volcanic sands, gravels, and clays(a,b). The formation is divided ~~by layers of thin tuff or ash units~~ into four lithologically similar units A-D[a].	Unit C, Tuscan Formation (Ttc): Lahars with some interbedded volcanic conglomerate and sandstone locally, north of Antelope Creek, separated from overlying units by partially stripped soil horizon.	1,500	Within this formation, moderately to highly permeable volcanic sediments are hydraulically confined by layers of ~~tuff~~volcaniclastic breccias and clays[b]. Units A and B are the primary water-bearing zones and are composed of volcanic conglomerate, sandstone, and siltstone layers interbedded with ~~lahars.~~volcaniclastic breccias. Stratigraphically higher, the massive ~~lahar~~breccia deposits of unit C confine groundwater in the permeable beds of units A and B1.
		~~Unit C, Tuscan Formation (Ttc)~~	~~Lahars with some interbedded volcanic conglomerate and sandstone locally, north of Antelope Creek, separated from overlying units by partially stripped soil horizon.~~			

Inserted Cells

System and Series	Geologic Unit	Lithologic Character	Maximum Thickness~~,~~ [a] feet	Water-bearing Character
	~~Unit B, Tuscan Formation (Ttc)~~	Unit B, Tuscan Formation (Ttc): Defined along the Chico ~~monocline~~Monocline as interbedded lahars, volcanic conglomerate, volcanic sandstone, and siltstone similar to Unit C, but underlying the Ishi Tuff Member.		
	~~Unit A, Tuscan Formation (Tta)~~	Unit A, Tuscan Formation (Tta): Interbedded lahars, volcanic conglomerate, volcanic sandstone, and siltstone all containing scattered fragments of metamorphic rocks.		
Miocen	Upper Princeton Valley Fill, Tupg	Non-marine sandstone containing mudstone, conglomerate, and sandstone conglomerate interbeds[c]	1,400	Largely non-water bearing or contains interstitial confined fresh to brackish water
Mioc	Lovejoy Basalt (Tl)	Black, dense, hard, microcrystalline to extremely grained, equigranular to sparsely porphyritic basalt.	-	-
	Lower Princeton Submarine Valley Fill, Tlpg	Marine conglomerate and sandstone interbedded with silty shale	2,400	Largely non-water bearing or contains saline water.
Eocene	Ione Formation (Ti)	Light-colored, commonly white conglomerated, sandstone, and claystone. Argillaceous sandstone and claystone comprise about 75 percent of the Ione along the southeast side of Sacramento Valley; northward the rest of the unit consists of interbedded siltstone, conglomerate, and shale.	-	-
Cretaceous	Chico Formation (Kc)	Tan, yellowish-brown to light-gray, fossiliferous marine sandstone with lenticular beds of pebble to fine cobble conglomerate and minor siltstone.	-	-

Inserted Cells

System and Series	Geologic Unit	Lithologic Character	Maximum Thickness, ~~,(~~ (a) feet	Water-bearing Character

Source: This table was originally included as part of the HCM for Colusa Subbasin Hydrogeologic Conceptual Model Report (Davids Engineering et al., 2018). This table has been revised and expanded to include the HCM units for the study area represented in this report.

Notes:

(a) WR, web page (www.wq.water.ca.gov).
(b) DWR, 1978. Bulletin 118-6.
(c) DWR, Bulletin 118-7 (Draft, not published).
(d) DWR, Geology of the Northern Sacramento Valley, 2014.

~~Notes:~~
~~(a) DWR, web page (www.wq.water.ca.gov).~~
~~(b) DWR, 1978. Bulletin 118-6.~~
~~(c) DWR, Bulletin 118-7 (Draft, not published).~~
~~(d) DWR, Sacramento River Basin-Wide Water Management Plan-Draft, 2000.~~
~~(e) DWR, Geology of the Northern Sacramento Valley, 2014.~~

2.1.5 Groundwater Producing Formations

Groundwater resources come from the alluvial groundwater basin where spaces between gravel, sand, and clay particles of various formations store and transmit water in the aquifer systems. Principal hydrogeologic units of the Sacramento Valley groundwater basin consist of Pliocene sedimentary deposits, such as the Tuscan, Laguna, and Tehama formations, comprising primarily a semi-confined to confined aquifer system. Younger Quaternary deposits, such as the Riverbank and Modesto ~~formations~~Formations, overlie these and comprise a relatively shallow and generally an unconfined aquifer system (DWR, 2005, as cited in Davids Engineering, 2016). All post-Tuscan sediments in the area, including the Riverbank and Modesto ~~formations~~Formations and recent deposits of the various stream channels, are designated as Quaternary Deposits. Primary groundwater producing formations are described below.

2.1.5.1 Tuscan Formation

Tuscan Formation deposits are characterized by their Cascade Range origin and volcanic signature. The formation extends from Redding south to near Oroville, where surface exposures of the Tuscan formation are seen on the east side of the Sacramento Valley. In the subsurface, the volcanic sediments of the Tuscan Formation intermix with the metamorphic sediments of the Tehama Formation (Garrison, 1962; Lydon, 1968). The westward extent of the intermixed sediments generally occurs in the subsurface west of the Sacramento River (DWR, 2014).

Overall, the Tuscan Formation is composed of a series of volcanic lahars (~~mudflows~~debris flows) that includes volcanic ~~conglomerate~~breccia, sandstone, and siltstone, and pumiceous tuff layers that were deposited over a period of about ~~1~~one million years (Lydon, 1968; Helley and Harwood, 1985). The source areas of the lahars were the eroded ancestral volcanoes, Mount Yana and Mount Maidu, that were historically located northwest and south of Lassen Peak in the Cascade Range (Lydon, 1968). As the lahars flowed westward off of the ancestral volcanoes and onto the valley floor, they fanned out, causing deposition to vary in thickness and in topographic elevation. Over time, ancient streams and rivers flowed downslope over the lahars, forming channels which were then infilled with reworked volcanic sand and gravel sediments whose pore spaces contain fresh groundwater. Subsequent lahars flowed over and covered the reworked sediments, creating a confining layer over the sand and gravel aquifers (DWR, 2014).

The Tuscan Formation has been divided into four units, A, B, C and D by Helley and Harwood (1985~~).~~) based on outcrop photo geology. It is difficult to apply this nomenclature to the subsurface. The oldest and deepest unit, A, is composed of interbedded lahars, volcanic conglomerate, volcanic sandstone, and siltstone that contain minor amounts of metamorphic rocks. Overlying Unit A in places is Unit B, which is more widespread throughout the eastern part of the northern Sacramento Valley. It is composed of interbedded lahars, volcanic conglomerate, volcanic sand, volcanic sandstone, and siltstone, but no metamorphic rocks, and shows a more regularly layered sequence (Helley and Harwood 1985). Units A and B together are referred to as the ~~"~~Lower Tuscan~~" (LT)~~ unit. Units C and D overlie Unit B and are composed of a series of lahars with some interbedded volcanic conglomerate and sandstone (DWR, 2014).

The Tuscan Formation is~~ unconformably and~~ intermittently overlain by the youngest deposits of the Tehama Formation toward the center of the valley; or by the Red Bluff, Modesto, or Riverbank ~~formations~~Formations; or by stream channel and basin deposits in varying locations (together, referred to as Quaternary Deposits). However, in some places the Tuscan Formation interfingers with the lower portion of the Tehama Formation in the center of the valley (Greene and Hoover, 2015). In the south part of the valley, the tuff breccia of the Sutter Buttes overlies and possibly interfingers with the Tuscan Formation north of the Sutter Buttes (DWR, 2014).

2.1.5.2 Tehama Formation

Exposures of the Tehama Formation are seen on the west side of the valley from Redding south to Vacaville. In the subsurface, the metamorphic and sedimentary deposits of the Tehama Formation intermix with the volcanic sediments of the Tuscan Formation (Helley and Harwood, 1985). Previous studies inferred that the eastward extent of the intermixed sediments generally occurs in the subsurface west of the Sacramento River. Recent DWR efforts ~~confirm~~supported the intermixing of Tehama and Tuscan formation sediments from analysis of lithologic cuttings and geophysical logs (DWR, 2014).

The Tehama Formation is composed of noncontiguous layers of metamorphic pale green, gray, and tan sandstone and siltstone, with lenses of pebble and cobble conglomerate (Helley and Harwood, 1985). The source area of the Tehama Formation sediments is the Coast Ranges to the west and, to a lesser extent, the Klamath Mountains to the north. Sediments were deposited by streams flowing from the west under floodplain conditions. These fluvial deposits are characterized by a series of poorly sorted sediments, by channels of coarser sediments in the finer-textured strata, and by the lenticular character of the coarser beds (Russell, 1931 as cited in DWR, 2014).

The Tehama Formation is~~ unconformably~~ overlain intermittently by the Tuscan Formation toward the center of the valley; or by the Red Bluff, Modesto, or Riverbank ~~formations~~Formations; or by the Stony Creek fan alluvium in varying locations (DWR, 2014).

2.1.5.3 Riverbank and Modesto Formations (Quaternary Deposits)

Together, the Riverbank and Modesto ~~formations~~Formations, along with other post-Tuscan deposits, will be referred to as Quaternary Deposits for hydrogeologic layering.

The Riverbank Formation consists of poorly to highly permeable pebble and small cobble gravels interbedded with reddish clay, sand, and silt. The formation is exposed throughout the Sacramento Valley and the San Joaquin Valley, extending discontinuously from Redding south to Merced (Marchand and Allwardt, 1981). Terrace deposits of the Riverbank Formation appear in stream cuts that are topographically above the younger Modesto Formation terrace deposits. The terraces were formed by streams carrying eroded material from the surrounding mountain ranges to the base of the foothills, where they were deposited in wide alluvial fans and terrace deposits. Groundwater generally occurs under unconfined conditions. The Riverbank Formation is overlain by the Modesto Formation, basin deposits, or surficial alluvium.

The Riverbank Formation was formed by streams carrying eroded material from the Coast Ranges, Cascade Range, Sierra Nevada, and foothill areas to the base of the foothills where it was deposited in wide alluvial fans. It is present in discontinuous surface exposures, primarily from west of Oroville southward. In many places, the Riverbank Formation has been covered by more recent alluvial fan development. The thickness of the formation varies from less than 1 foot to over 200 feet, depending on location (Maps: California, 1985). The Riverbank Formation primarily overlies the Laguna Formation in the southern portion of Butte County and the Tuscan Formation in the northern portion of the county (DWR, 2005).

The Modesto Formation consists of moderately to highly permeable gravels, sands, and silts and is widespread throughout the Sacramento Valley, occurring from Redding south into the San Joaquin Valley. The most notable occurrences are found along the Sacramento and Feather rivers and their tributaries. The Modesto sediments were deposited by streams that still exist today, and they are seen in the terrace and alluvial fan sediments that border present-day streams (Helley and Harwood, 1985). The source area for the formation sediments are the surrounding Coast Ranges, Klamath Mountains, Cascade Range, and Sierra Nevada. Fresh groundwater occurs under unconfined conditions (DWR, 2014).

Wells penetrating the sand and gravel units of the Riverbank and Modesto Formations produce up to about 1,000 ~~gallons per minute (~~gpm~~)~~,; however, the production varies depending on local formation thickness. Wells screened in the Riverbank and Modesto Formations are generally domestic and relatively shallow irrigation wells (DWR, 2004).

2.1.6 Cross Sections

2.1.6.1 Airborne Electromagnetic (AEM) Survey

Figure 2-9A was developed using data from a 2018 study (The Stanford Groundwater Architecture Project~~ [GAP]),~~, which used the ~~Airborne Electromagnetic (~~AEM~~)~~ method calibrated to existing well data added considerable detail to the known aquifer-bearing units in portions of the Vina Subbasin ~~(~~[Kang et al., ~~in preparation).~~2021]). Therefore, preliminary interpretations from the AEM study are presented here that have not yet been applied to areas outside the study area to contrast the value of these types of studies to understanding the overall hydrogeologic structure.

Pre-existing ideas about the aquifer units have not changed substantially~~,~~; however, more detail into delineating the properties of the shallower units is now possible. In addition, all~~ of~~ the layers can now be represented as having more realistic lateral changes in sediment type (gravel/sand vs. silt/mud), which can be related to hydraulic conductivity and confined/unconfined conditions for more detailed groundwater studies.

Figure 2-9A is a general east-west cross~~-~~ section spanning two main AEM acquisition areas. Superimposed with lithology and electric-logs from ~~well completion reports (WCR)~~WCRs and monitoring wells~~ (MW)~~ is the AEM interpretation showing the relative probability of encountering coarse-dominated material (i.e., sand/gravel) along the cross~~-~~ section (Kang et al., ~~in preparation~~2021, for methodology). Warm colors represent zones that have a high probability of being coarse~~-~~ dominated; inversely, cold colors represent zones that have a lower probability of being coarse~~-~~ dominated but have a high probability of being fine~~-~~ dominated (e.g., silt/clay). The cross~~-~~ section represents the overall knowledge gained from examining all 800 line-kilometers of the AEM study, but greater detail is available for certain individual areas.

The AEM cross~~-~~ section depicts three main units previously described: 1) Tuscan Formation~~,~~; 2)~~-~~ Tehama Formation~~,~~; and 3) Quaternary Deposits. It is important to realize the Tuscan and Tehama ~~formations~~Formations interfinger within individual layers toward the western side of the cross~~-~~ section.

Figure 2-9A placeholder page

In the upper portions of the Tuscan and Tehama ~~formations~~Formations it is often not possible to know the location of that boundary; those layers are called Upper Tuscan/Tehama (~~UTT) 1, UTT2,~~UTT1 and ~~UTT3.~~UTT2). However, the lower portion of the Tuscan Formation ~~(LT)~~ is readily noticeable with no lower Tehama represented in the cross~~-~~ section. Overlying all of these units is the Quaternary Deposits (~~Qd) unit~~Q1 and Q2) which includes the Riverbank and Modesto ~~formations~~Formations.

The ~~LT~~Lower Tuscan layer is mostly coarse-grained material that thickens to the west to 500~~-~~ to 600 feet thick. The overlying ~~UTT3~~UTT2 layer only exists in the western portion (200~~-~~ to 500 feet thick) and is fine~~-~~ dominated with intermittent coarse-dominated channels. ~~UTT2~~UTT1 is mostly a coarse-dominated unit 100 to 200 feet thick that combines with the ~~LT~~Lower Tuscan in the eastern portion of the cross~~-~~ section. ~~UTT1~~Q2 is mostly fine~~-~~ dominated (~50 feet thick) that has rare occurrences of coarse-dominated material~~ within it. The Quaternary Deposits unit (Qd)~~. Q1 is 50 to 100 feet thick and consists of mostly coarse~~-~~ dominated with small zones of fine-dominated material. Finally, there is an interpreted ancient valley that formed during the time of Tuscan deposition that filled with coarse-dominated material in the vicinity of Butte Creek. This valley fill was then buried by ~~UTT2,~~ UTT1, Q2, and ~~Qd~~Q1 sediments.

2.1.6.2 Additional Cross~~-~~ Sections

Figure 2-9B is a cross~~-~~ section key ~~which~~that shows the location of Vina cross~~-~~ sections developed from studies performed by DWR (DWR, 2014) and GEI Consultants (GEI, 2018) and the extensions of these sections into the adjacent Wyandotte Creek and Butte subbasins. Figure 2-9C shows a southwest to northeast cross~~-~~ section in the northern portion of the Vina Subbasin, and Figure 2~~-~~-9D shows a southwest to northeast cross~~-~~ section in the southern portion of the Vina Subbasin.

2.1.7 Key Geologic Features

Barriers to groundwater flow in the northern Sacramento Valley include geologic structures such as the Red Bluff Arch, the Corning domes, the Sutter Buttes, and the buried Colusa dome. In the northern part of the valley, the Red Bluff Arch acts as a groundwater divide separating the Sacramento Valley groundwater basin from the Redding groundwater basin. South of Corning, the surface expression of the Corning domes influences the flow patterns of Stony Creek and Thomes Creek. Stony Creek flows southeast of the domes, with regional flow to the confluence of the Sacramento River, whereas Thomes Creek flows northeast of the domes, against regional flow to the Sacramento River (Blake et al., 1999). In the southern part of the valley, groundwater mounds up on the north side of the Sutter Buttes before it flows westward around the Buttes and between the buried Colusa dome and southward (DWR, 2014).

2.1.7.1 Chico Monocline

The Chico monocline is a northwest-trending, southwest-facing flexure that roughly follows the northeastern boundary of the Sacramento Valley, extending from Chico to Red Bluff. The monocline was formed under an east-west compressive stress regime that steeply thrust up the Sierra Mountains (Helley and Harwood, 1985). This late Cenozoic tectonic feature was formed after deposition of the Ishi Tuff member of the Tuscan Formation, about 2.6 million years ago (Ma), and prior to the Deer Creek olivine basalt eruption, which has been age-dated at 1.08 + 0.16 Ma (Helley and Harwood, 1985). North of Chico, the Chico monocline deforms the Tuscan

Formation and has a dip of up to 25 degrees where it becomes the eastward alluvial aquifer boundary (DWR, 1978). South of Chico, beds have a gentler slope of approximately 2 to 5 degrees, and evidence of the monocline disappears north of Oroville (DWR, 2014).

Figure 2-9B placeholder page

Figure 2-9C placeholder page

Figure 2-9D placeholder page

2.1.8 Principal Aquifers and Aquitards

2.1.8.1 Overview

The Vina Subbasin groundwater system is comprised of a single principal aquifer composed of the Quaternary Deposits~~,~~, (Q1, Q2), Upper Tuscan/Tehama (UTT1~~, UTT2, UTT3)~~ and ~~LT~~UTT2) and Lower Tuscan units creating various aquifer zones with different hydrogeologic properties and both unconfined and semi-confined conditions. This leaky aquifer system has varied hydraulic connectivity between different depth zones in different areas of the ~~subbasin.~~Vina Subbasin. Due the localized variation of vertical connectivity, this is identified as a data gap.

Characteristics of the groundwater system vary from the northeast to the southwest as the Tuscan Formation materials become more reworked and less consolidated with distance from their geologic source. The characteristics of the aquifer system also vary in the vicinity of the Sacramento River, Butte Creek, and the base of the eastern foothills as different processes deposited materials that make up the aquifer system at depth.

The degree of connectivity between various zones in the aquifer system are evident in some areas based on hydrographs, pumping tests, and water level measurements. Hydrographs from nested wells show slight vertical gradients in the subsurface (Section 1.2.2.2). A pump test in the northeastern area of the Vina Subbasin (at monitoring well 23N01W03H02-04) demonstrated that in some cases low~~-~~-permeability lahar units caused different discrete aquifer zones to be hydraulically disconnected while in other cases the lahar layers functioned as a leaky aquitard, allowing a delayed hydraulic connection between aquifer zones (Appendix E of Brown and Caldwell, 2013).

In the central area of the valley near the Sacramento River, thick fine-dominated layers of the ~~UTT3~~UTT2 separate coarser-dominated materials of the ~~UTT2~~UTT1 from the coarse-dominated zone of the ~~LT~~Lower Tuscan (Figure 2-9A). Yet a pump test in the area (on M&T Ranch) demonstrated hydraulic connectivity between these zones and significant storage in the aquitard of the ~~UTT3~~UTT2 separating them (Appendix E of Brown and Caldwell, 2013~~, Appendix E~~). A pump test in the vicinity of Rancho Esquon demonstrated hydraulic connectivity between an intermediate and deeper aquifer zone of the ~~LT~~Lower Tuscan unit with 100 feet or more of low permeability fines separating them. However, in the same monitoring well no connectivity was observed between the shallower aquifer zone of the ~~UTT2~~UTT1 (80~~-~~ to 150 feet ~~below ground surface~~bgs) and the ~~LT~~Lower Tuscan unit's intermediate zones ~~despite~~where 100 feet of low~~-~~-permeability fines ~~separating~~separated them (Appendix E of Brown and Caldwell, 2013~~, Appendix E~~).

Due to the variance in hydraulic connectivity between zones in different areas of the Vina Subbasin and between different depths, a single principal aquifer is defined. In most cases, patterns of groundwater levels in nested wells suggest some degree of connectivity. DWR defines "principal aquifers" under SGMA as the "aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems" (Cal. Code of Regs., title 23, § 351(aa)).

There are no known structural properties (i.e., faults) that significantly restrict groundwater flow within the Vina Subbasin within the portion of the aquifer that stores, transmits, and yields significant quantities of water.

2.1.8.2 Beneficial Uses

In 1972, the ~~California State Water Quality Control Board~~CRWQCB adopted a uniform list and description of beneficial uses to be applied throughout all basins of the State. In the revised Basin Plan for the Sacramento River and San Joaquin River Basins prepared by the ~~California Regional Water Quality Control Board~~CRWQCB, Central Valley Region ~~(Water Board) prepared in 2018~~ (Water Board, 2018) it is stated that unless otherwise designated by the Water Board, all ground waters in the Region are considered as suitable or potentially suitable, at a minimum, for municipal and domestic water supply ~~(MUN),~~, agricultural supply ~~(AGR),~~, industrial service supply ~~(IND),~~, and industrial process supply ~~(PRO).~~.

Water produced from the principal aquifer is primarily used to meet irrigation, domestic, and municipal water demand. Domestic supply is largely used to meet rural residential demands. Municipal supply is largely used to meet demand from cities and towns such as Chico and Durham. Irrigation demands in the Vina Subbasin primarily rely upon wells for applied water. Relatively shallow groundwater in some areas of the ~~subbasin~~Vina Subbasin support Groundwater Dependent Ecosystems (GDEs) and stream flows.

2.1.8.3 Storage Coefficient

Specific yield or storativity quantifies the ability of the aquifer to hold or store water. Estimates of specific yield for areas in the Vina Subbasin range from 5.9 to 7.1 percent (DWR, 2005; DWR, 2004). Specific Yield applies to unconfined aquifer conditions.

Aquifer tests conducted for the Lower Tuscan Aquifer Study (2013) estimated values for storativity (S) (Table 2-3) for three locations within or adjacent to the Vina Subbasin. Storativity is a property of a confined or semi-confined aquifer and is typically several orders of magnitude less than specific yield ~~as seen here~~.

Values for specific yield (unconfined) and storativity (confined) used in the calibrated ~~Butte Basin Groundwater Model~~BBGM throughout the ~~subbasin~~Vina Subbasin are 10 percent and 0.00001, respectively (BCDWRC, 2021). The groundwater system is a mix of confined and unconfined conditions so the average storage coefficient in the Vina Subbasin in the BBGM is 0.04 (unitless).

Table 2-3: Summary of Calculated Aquifer Parameters
Table taken from Lower Tuscan Aquifer Study Final Report (Brown and Caldwell, 2013)

Summary of aquifer parameters calculated using Moench (1985) solutions			
	T (square feet/day)	S (unitless)	K (feet/day)
Hackett Property	2,322 to 3,078	0.00004 to 0.00009	66 to 881
M&T Ranch	11,550 to 20,540	0.0003 to 0.0005	321 to 5712
Esquon Ranch	12,230 to 23,650	0.00004 to 0.001	41 to 793

~~Note:~~
~~Source: Lower Tuscan Aquifer Study Final Report (Brown and Caldwell, 2013).~~
~~1. Assumes aquifer thickness of 35 feet.~~
~~2. Assumes aquifer thickness of 36 feet.~~
~~3. Assumes aquifer thickness of 300 feet.~~

Note:

Source: Lower Tuscan Aquifer Study Final Report (Brown and Caldwell, 2013).
1. Assumes aquifer thickness of 35 feet.
2. Assumes aquifer thickness of 36 feet.
3. Assumes aquifer thickness of 300 feet.

2.1.8.4 Transmissivity

Transmissivity (T) quantifies the ability of water to move through aquifer materials. The aquifer hydraulic conductivity (K) quantifies the rate of groundwater flow and is related to the transmissivity and aquifer thickness (b) by the following formula: T = K x b. Aquifer tests conducted for the Lower Tuscan Aquifer Study (Brown and Caldwell,2013) estimated values for hydraulic conductivity (K) and transmissivity (T) (Table 2-3) for three locations within or adjacent to the Vina Subbasin.

Estimates for transmissivity can vary widely in different areas of the Vina Subbasin. Results from an aquifer performance test utilizing a well designed and constructed to draw water only from the lower confined portion of the Tuscan Formation calculated aquifer transmissivity to be approximately 75,000 gallons per day (gpd) per foot (10,026 square feet per day). From the same test, storativity was estimated between 0.0001 and 0.00001. This test was conducted in the Butte County portion of the Bulletin 118-~~2003West~~2003 West Butte Subbasin (~~CDWR~~DWR, 1995, as cited in DWR, 2005).

In the Lime Saddle area east of the Vina Subbasin, transmissivity values in the confined portion of the Tuscan Formation were estimated to be low: 1,100 ~~gallons per day~~gpd per foot (147 square feet per day) (Slade, 2000 as cited in DWR, 2005).

~~*2.1.8.5 Water Quality*~~

2.1.9 ~~The DWR Bulletin 118 Vina Subbasin Report (DWR, 2004) characterized the water quality of groundwater in the Subbasin as predominantly Calcium-magnesium bicarbonate and magnesium-calcium bicarbonate.~~ Opportunities for Improvement to the HCM

The following lists activities or projects that can be used to improve the HCM.

~~Total dissolved solids range from 48 to 543 milligrams per liter, averaging 285 milligrams per liter (DWR unpublished data as cited in DWR, 2004). Impairments include localized high calcium and high nitrates and total dissolved solids in the Chico area. Section 2.2.4 contains a more extensive description of water quality conditions in the Subbasin.~~

~~The Lower Tuscan Aquifer study also conducted water quality analysis on monitoring well and pumping wells used in the study and constructed piper diagrams. They show groundwater samples from these wells indicate Calcium bicarbonate waters (Brown and Caldwell, 2013).~~

~~**2.1.9 HCM Data Gaps**~~

2.1.9.1 Identify Areas in the County Where Additional Monitoring Would Help Increase Understanding of the Aquifer

Determine the best approach for increasing monitoring in these areas such as installation of new wells or increased monitoring at existing wells.

2.1.9.2 Assess Interaction between Sacramento and Other River Stage Response to Changes in Groundwater Levels

It is recommended additional studies be conducted to better assess the interaction between the river stage on the Sacramento River, Feather River, and other major tributaries with changes in groundwater levels in the Lower Tuscan Aquifer and other aquifers that may also provide water to the Lower Tuscan Aquifer.

2.1.9.3 Expand Isotopic Analysis to Further Assess Groundwater Recharge

Future recharge and aquifer studies should include the collection and interpretation of stable isotope data. Methodology considerations include: 1) Seasonal sampling should be performed as part of future surface water and groundwater isotope studies for purposes of assessing groundwater recharge~~;~~. 2) Monitoring wells with multiple screened intervals (multi-completion monitoring wells) are recommended to assess stable isotope data at different depths. Sampling locations ~~in this study~~ with a single well-screen interval do not provide nearly as much insight as sampling locations with wells screened at multiple depths in discrete zones~~; and~~. 3) Monitoring wells with relatively short~~-~~-screened zones (20 feet or less) are preferred to minimize mixing between aquifer zones or between aquifer zones and residual water retained within the aquitard zones between aquifers. Although not quantified, the ~~LT~~Lower Tuscan Aquifer study (Brown and Caldwell, 2013) suggested that the aquitards could release a significant volume of water to the aquifer in areas where large volumes of groundwater are extracted.

2.1.9.4 Characterize ~~recharge source with general water quality analysis~~Recharge Source with General Water Quality Analysis

Conduct general mineral analysis on groundwater samples to evaluate whether elevated electrical conductivity ~~(EC)~~ values observed during sampling are due to irrigation influences (e.g.,~~-~~ elevated nitrate, calcium, sulfate) or due to proximity to the Ione Formation (e.g., elevated sodium, chloride, and boron).

2.1.9.5 Contribution of ~~recharge~~Recharge from ~~rainfall directly~~Rainfall Directly on the Lower Tuscan ~~outcrop~~Outcrop

Stable isotope abundances indicate that a substantial proportion of local recharge is derived from elevations consistent with the outcrop of the Lower Tuscan Formation (i.e., within the Lower Foothills in Figure 2-6). Thus, it is recommended that local precipitation be collected during an entire precipitation season at varying elevations across the outcrop and analyzed for stable isotopes to better correlate or calibrate the groundwater isotope values with local precipitation sources.

2.1.9.6 Recharge ~~rate~~Rate

Most well locations and depths should be sampled and analyzed for presence of tritium to help distinguish whether recharge to individual aquifer zones is occurring over periods shorter than about 60 years~~,~~ or whether recharge is occurring over longer timeframes. This can help better understand the nature of hydraulic connection between different zones in the aquifer system.

2.1.9.7 Field Testing and Monitoring Equipment Installation to Understand the Recharge Rates and Stream Losses in the Recharge Zone

Expansion of stream ~~gauging~~gaging locations should occur to document and better understand changes in stream-aquifer interactions. In addition to the stream ~~gauging~~gaging, a series of shallow dedicated monitoring wells with temperature sensors installed along stream courses in the recharge corridor and downstream to the Sacramento River may help identify what sections of streams are losing or gaining.

2.1.9.8 Additional AEM Data Collection

Expanding the extent of AEM surveys is recommended to help address uncertainty in the structure of the Vina Subbasin and to refine the 3D hydrogeological conceptual model of the subsurface. AEM data may also help identify and better characterize recharge mechanisms and the connectivity between aquifer layers.

2.2 Groundwater Conditions

2.2.1 Description of Current and Historical Conditions

Groundwater conditions in the Vina Subbasin are regularly monitored and are described in the 2001 and 2016 Water Resource Inventory and Analysis Reports produced by Butte County. These documents and other reports indicate that the ~~subbasin~~Vina Subbasin has adequate groundwater resources to meet demands under most hydrologic conditions. However, comparison of the reports illustrates how in the period between their issuance, groundwater conditions have tightened and show a declining trend over the past 20 years, and as forces ranging from population growth to climate change play out, the value of well-informed water management policies and practices is likely to increase. ~~In short, while as shown below, groundwater conditions in the Subbasin remain stable, maintaining this posture in the future may become less the result of a state of nature and more the reward for thoughtful management. The water budget analysis presented in this section provide~~The water budget analysis presented in Section 2.3 provides a quantitative assessment of how conditions have changed in the Vina Subbasin and an indication of how conditions may change in the future.

2.2.2 Groundwater Trends

2.2.2.1 Elevation and ~~flow directions~~Flow Directions

Figures 2-10 and 2-11 show groundwater elevation contours in the Vina Subbasin for the spring and fall of 2015 and Figures 2-12 and 2-13 show elevation contours for the spring and fall of 2019. These contours show ~~first encountered~~ groundwater levels as reported by the CASGEM program. The data were processed as follows:

- Data from CASGEM were used to identify wells in the Vina Subbasin plus supplemental sites used to extend the contours to the west.
- Water level readings for 2015 and 2019 were then filtered for measurements taken between September 20 and October 30 for the fall contours and between March 20 and April 30 for the spring contours.
- Wells showing depths to first encountered groundwater deeper than 500 feet were eliminated from the data set. The remaining readings were sorted by well depth. Wells having identical state well number site codes were then filtered to select the shallowest well from each nested well cluster.

The maps shown in Figures 2-10 to 2-13 do not distinguish between completion intervals of the wells. So, the contours represent an aggregate of groundwater elevations across all zones of the principal aquifer system. The equipotential maps illustrate several general features of the groundwater flow system in the Vina Subbasin, including:

- Overall west-southwest flow consistent with recharge along ~~the Chico Fan structure~~Quaternary alluvial fans along the eastern foothills.
- Convergence of flow toward Sacramento River in the Vina North ~~Management Area.~~MA.
- Flow from the Vina Chico ~~Management Area~~MA converging toward pumping in the Vina South ~~Management Area~~MA and sub-parallel to Sacramento River floodplain. Groundwater generally flows west-southwest in the Vina Chico ~~management area~~MA towards the Sacramento River. There is evidence of convergence toward Chico and Little Chico Creek. Contours in this area are based on shallow groundwater levels, which are below the elevation of Big Chico Creek. The convergence of flow in this area may be associated with ~~wellfields supply~~wells supplying potable water for the City of Chico and/or higher permeability channelized features in this portion of the ~~Chico Fan~~Quaternary alluvial fans along the eastern foothills.
- Flow from the Vina South ~~Management Area~~MA converging toward pumping and convergence toward Sacramento River in the Vina Subbasin. Groundwater generally flows west-~~northwest~~southwest in the Vina South ~~management area~~MA towards the Sacramento River. There is evidence of convergence toward areas with higher groundwater pumping, likely associated with agricultural pumping west of Butte Creek.

Figure 2-10 placeholder page

Figure 2-11 placeholder page

Figure 2-12 placeholder page

Figure 2-13 placeholder page

Each of the four contour maps displays groundwater elevations that are higher in the north of the Vina Subbasin than in the south, indicating a gradient that would cause water to flow from north toward the southwestern corner of the Vina Subbasin. While groundwater elevations are lower in the fall than in the spring, the general direction and gradient of flow are similar during both periods.

When comparing elevations reported in 2015 with those reported in 2019, groundwater elevations reported for the spring of 2015 are generally somewhat higher than those observed in the spring of 2019. However, elevations reported for the fall of 2015 are slightly lower than those observed in 2019. This may be an indication of an increase in the volume of water recharged from upland areas flowing into the Vina Subbasin's principal aquifer during subsequent wet years (2017 and 2019).

2.2.2.2 Hydraulic ~~gradients~~Gradients

Horizontal or lateral hydraulic gradients generally reflect ground surface topography. In the foothills east of the Sacramento Valley the gradient is steep, as high as 60 feet per mile. In the floodplain of the Sacramento River, lateral gradients are relatively flat, even in the deeper zones of the aquifer. There is a transitional gradient zone between the floodplain and upland areas, which generally reflects the gradient of the main tributary creeks that flow into the Sacramento River, such as Big Chico and Little Chico creeks.

However, the gradient in most of the Vina Subbasin is gentle, reflecting the area's flat topography and the presence of the Sacramento River. Although the overall gradient is relatively flat, there are locations in the Vina Subbasin where local conditions affect the direction and gradient of flow, such as the groundwater depression under the City of Chico, where groundwater flows toward the depression. A second localized condition is a depression in the Durham area.

Regionally, there is a groundwater mound near the Thermalito Afterbay, where groundwater flows outward from the groundwater mound. Another groundwater mound occurs in the neighboring subbasin to the west near Hamilton City fed by the Stony Creek Fan.

Figures 2-14, 2-15, and 2-16 are maps of the Vina North, Vina Chico, and Vina South ~~Management areas~~MAs with hydrographs of key monitoring wells displayed on each map. Just as comparison of the spring and fall contours indicated the shift in groundwater elevations that typically occurs between the seasons, the hydrographs display annual oscillations in elevations as well as trends over the monitoring period, snapshots of which are captured in comparison between the 2015 and 2019 contours. Each ~~of the hydrographs~~hydrograph displays water surface elevations in feet above ~~mean sea level~~msl and also gives the depth of the bottom of the well, which indicates the location of the zone being measured.

Most of the hydrographs are taken from single completion wells where only one aquifer zone is screened, however a number of the hydrographs are from clusters of nested monitoring wells which measure groundwater elevations at three or four aquifer zones at a single location.

Figure 2-14 placeholder page

Figure 2-15 placeholder page

Figure 2-16 placeholder page

Hydrographs for the selected wells in the Vina North ~~Management Area~~MA echo the seasonal fluctuations illustrated in the contour maps~~,~~ with groundwater level depths at all locations being shallower in the winter and spring than in the summer and fall. Most of the hydrographs show annual changes in groundwater levels oscillating around a central axis with the three wells (23N01W10M001M, 23N01W28M, 23N01W36P001M)) lying in the interior of the ~~Management Area~~MA showing declines in annual high and low readings that correspond to the period of the recent drought while the water levels in the ~~well~~wells (23N02W25C001M and 23N01W31M) located ~~between~~near the Sacramento River ~~and Harbean Slough~~ show little impact from the drought.

Vertical groundwater gradients are indicative of the hydraulic connectivity of shallow and deep zones of the aquifer system. They are measured by comparing groundwater elevations from multi-completion or nested wells that are completed across different depth zones. A "true" vertical hydraulic gradient is measured in a nested well at the same map location, but vertical gradients can sometimes be estimated using wells completed at different depths in different locations. When groundwater levels in the shallower wells are higher than in the deeper completions, the gradient indicates downward movement of groundwater. The volume of downward flow is proportional to the gradient and the hydraulic conductivity between the shallow and deep measurement points. In locations where groundwater levels in the shallower wells are lower than in the deeper wells, the gradient indicates upward movement of groundwater, with a similar relationship defining the volume of upward flow. Groundwater levels that are similar in elevation, even with distinctly different completion depths ~~indicates~~, indicate a uniform flow field with limited vertical gradient and vertical exchange of groundwater.

Hydrographs for two nested wells in the Vina North MA are presented in Figure 2-14 and illustrate the heterogeneity of the primary aquifer laterally and vertically within different aquifer zones. The first nested well (well 23N01W31M) is located adjacent to the Sacramento River and consists of ~~4~~four individual wells screened from 65 to 75 feet ~~below ground surface (~~bgs~~)~~, 140 to 201 feet bgs, 590 to 600 feet bgs, and ~~1020~~1,020 to ~~1030~~1,030 feet bgs. This hydrograph shows that water levels in the shallowest well display little annual fluctuation, which indicates that this shallowest zone is in direct continuity with river levels and the adjacent floodplain. The deeper wells display greater fluctuation in seasonal water levels that generally tend to track each other, indicating less direct continuity with river levels and the adjacent floodplain. The second nested hydrograph (23N01W28M, Figure 2-14) is farther from the river and consists of ~~4~~four individual wells screened from 30 to 50 feet bgs, 120 to 165 feet bgs, 690 to 670 feet bgs, and 791 to ~~1021~~1,021 feet bgs. As seen on this hydrograph, there is a close correspondence in water elevations recorded at all screened intervals being monitored. This indicates a clear connection across the aquifer zones.

Hydrographs for selected monitoring wells in the Vina Chico ~~Management Area~~MA resemble those in Vina North in that they show some decline in water surface elevations during the drought. The single nested monitoring well in this ~~Management Area~~MA shows water levels in the intermediate and lower zones closely tracking those in the upper zone indicating strong ~~communication~~connection among the three zones.

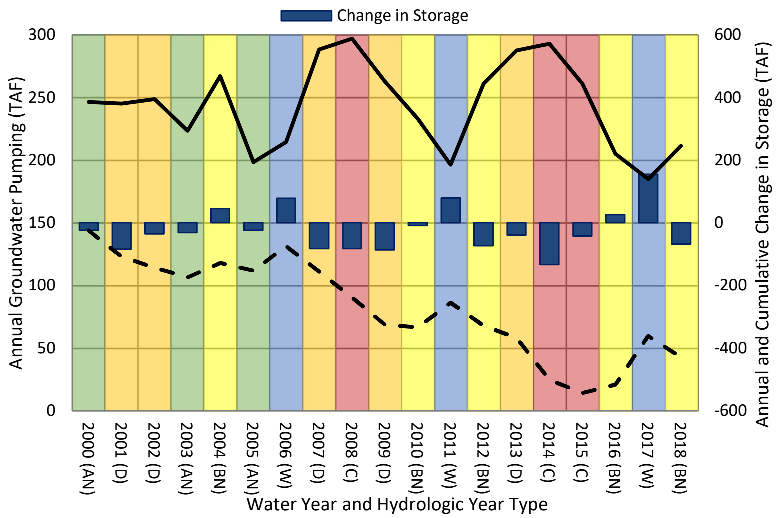
Hydrographs for selected monitoring wells in the Vina South ~~Management Area~~MA show groundwater elevations lower than those in ~~Management Areas~~MA to the north, an indication of the general north-to-south gradient of flow in the Vina Subbasin. Most of the hydrographs in the Vina~~-~~ South MA also display more pronounced responses to the drought than do wells to the north. The nested monitoring wells in the south of the ~~Management Area~~MA (Well ID Nos. ~~21N02E24C001M~~20N02E24C001M-003M) show the close communication among aquifer zones displayed in the nested sites in the Vina~~-~~ North and Vina Chico ~~Management Areas.~~MAs. However, the nested well on the Midway in the vicinity of Butte Creek (Well ID Nos. 21N02E18C001M-003M) shows weak communication between the upper zone and the two lower zones and a strong recovery in water elevations in the upper zone that corresponds with the change in hydrologic conditions between the drought and the period immediately following the drought.

2.2.2.3 Change in Storage

Hydrographs from monitoring wells show cyclical fluctuations of groundwater ~~level~~levels over a four- to seven-year cycle consistent with variations in water year type according to the Sacramento Valley Water Year Hydrologic Classification (Figure 2-17). Groundwater levels ~~are~~ typically ~~lower~~decline during dry years and ~~higher~~increase during wet years. Superimposed on this four- to seven-year short-term cycle is a long-term decline in groundwater levels. In other words, groundwater levels during more recent dry-year cycles are lower than groundwater levels in earlier dry-year cycles. This downward trend during dry years indicates an overall decline in groundwater storage.

The dynamics of the interaction between inflows, outflows, changes in groundwater elevations, and changes in storage are captured in the water budget for the Vina Subbasin and by the ~~Butte Basin Groundwater Model (~~BBGM~~)~~ (BCDWRC, 2021). A graph depicting estimates of the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type based on the Sacramento Valley Water Year Index, is provided in Figure 2-17. Water year types are identified as wet (W, shaded blue), above normal (AN, shaded green), below normal (BN, shaded yellow), dry (D, shaded orange), or critical (C, shaded red). Annual change in storage was estimated using the BBGM based on March groundwater storage amounts. Groundwater pumping was estimated using the BBGM and is shown on a water year basis. Values are reported in thousands of acre-feet (TAF).

As indicated in the figure, groundwater storage generally decreases in below normal, dry, and critical years and increases in above normal and wet years. Groundwater pumping, shown by the solid black line, generally reflects higher pumping volumes during below normal, dry, and critical years~~,~~ and lower pumping volumes during above normal and wet years. Since the year 2000, there has been a cumulative decline in March 1 groundwater storage of about 400,000 acre-feet (AF). This indicates that the cycles of groundwater pumping are not in balance with the cycles of recharge that replenish the aquifer~~,~~ and that groundwater depletion has occurred consistent with long-term decline in groundwater levels. In general, it shows that wetter periods are able to recover around 100,000 to 150,000 AF of storage, but that dryer cycles result in storage declines of 200,000 to 300,000 AF. Historical and projected changes in storage are discussed in greater detail in Section 2.3, Water Budget. The BBGM estimates the total freshwater storage of the basin at about 16,000,000 AF, indicating the estimated yearly decline in storage is about 0.1 percent.


Change in Storage
Annual Groundwater Pumping (TAF)
Annual and Cumulative Change in Storage (TAF)
Water Year and Hydrologic Year Type
2000 (AN)
2001 (D)
2002 (D)
2003 (AN)
2004 (BN)
2005 (AN)
2006 (W)
2007 (D)
2008 (C)
2009 (D)
2010 (BN)
2011 (W)
2012 (BN)
2013 (D)
2014 (C)
2015 (C)
2016 (BN)
2017 (W)
2018 (BN)

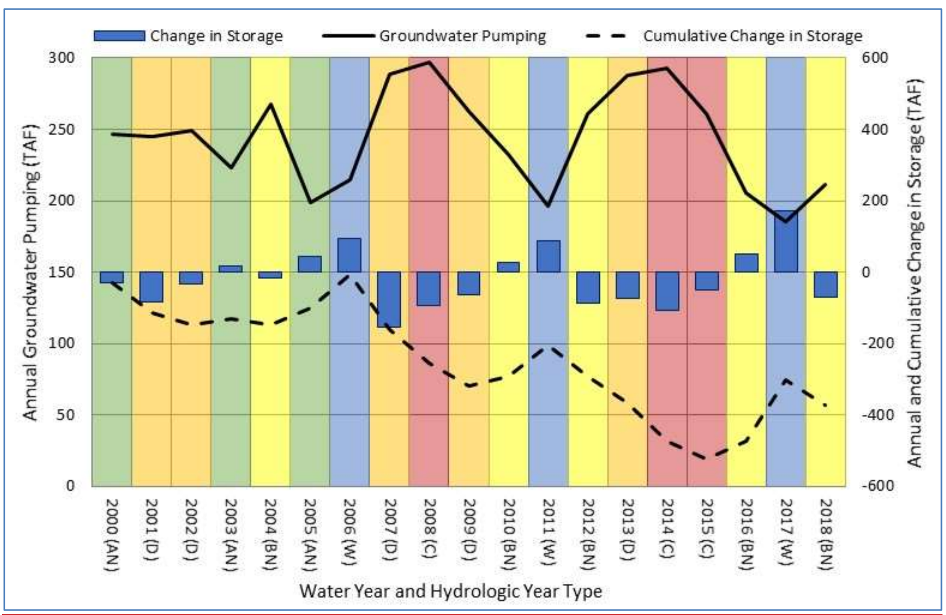

Change in Storage
Groundwater Pumping
Cumulative Change in Storage
Annual Groundwater Pumping (TAF)
Annual and Cumulative Change in Storage (TAF)
Water Year and Hydrologic Year Type
2000 (AN)
2001 (D)
2002 (D)
2003 (AN)
2004 (BN)
2005 (AN)
2006 (W)
2007 (D)
2008 (C)
2009 (D)
2010 (BN)
2011 (W)
2012 (BN)
2013 (D)
2014 (C)
2015 (C)
2016 (BN)
2017 (W)
2018 (BN)

Figure 2-~~-~~17: Change in Storage and Groundwater Pumping by Water Year Type. Values calculated from March to March for each water year. AN – above normal, D – dry, BN – below normal, W – wet, C – critical.

2.2.3 Seawater Intrusion

Intrusion of seawater is not a consideration in the Vina Subbasin because of the ~~Subbasin's~~subbasin's inland location~~.~~ and distance from the coastline where saline intrusion originates from the ocean's influence on freshwater aquifers. For this reason, no monitoring of seawater intrusion is required nor is there a need for projects and management actions to mitigate seawater intrusion.

2.2.4 Groundwater Quality

2.2.4.1 General Water Quality of Principal ~~Aquifers~~Aquifer

DWR Bulletin 118 Vina Subbasin Report (DWR, 2004) characterized the water quality of groundwater in the Vina Subbasin as predominantly Calcium-magnesium bicarbonate and magnesium-calcium bicarbonate. Total dissolved solids range from 48 to 543 milligrams per liter, averaging 285 milligrams per liter (DWR unpublished data as cited in DWR, 2004). Impairments include localized high calcium and high nitrates and total dissolved solids in the Chico area.

The Lower Tuscan Aquifer study also conducted a water quality analysis on monitoring well and pumping wells used in the study and constructed piper diagrams. They show that groundwater samples from these wells indicate calcium bicarbonate waters (Brown and Caldwell, 2013). The goal of groundwater quality management under SGMA is to supplement information available from other sources with data targeted to assist GSAs in the Vina Subbasin to comply with the requirements of SGMA. Development of groundwater quality-related ~~Sustainable Management Criteria~~SMC for the Vina Subbasin is not intended to duplicate or supplant the goals and objectives of ongoing programs, including those by Butte County, the Sacramento Valley Water Quality Coalition (SVWQC), and the State Drinking Water Information System ~~(SDWIS).~~

. Because irrigated agriculture is the predominant land use in the Vina Subbasin, monitoring of the groundwater quality data developed through the GQTMWP being implemented by the SVWQC for compliance with the Central Valley Regional Board's ILRP will be an important source of information to GSAs in the Vina Subbasin.

Among the contaminants that may affect groundwater conditions in the future are chemicals of emerging concern (CECs). These are contaminants having toxicities not previously recognized, which may have the potential to cause adverse effects to public health or the environment and are found to be building up in the environment or to be accumulating in humans or wildlife. CECs such as perfluorooctanesulfonic acid ~~(PFOS)~~ and per- and polyfluoroalkyl substances ~~(PFAS)~~ will not be monitored under the groundwater quality monitoring program established for SGMA. However, GSAs will have access to data on CECs collected by other agencies and will be attentive to the effect the presence of CECs may have on groundwater management in specific locations.

2.2.4.2 Description and Map of Known Sites and Plumes

The SGMA regulations require that ~~Groundwater Sustainability Plans~~GSPs describe locations, identified by regulatory agencies, where groundwater quality has been degraded due to industrial and commercial activity. Locations of impacted groundwater were identified by reviewing information available on the SWRCB Geotracker/GAMA website, the California Department of Toxic Substances Control (DTSC) EnviroStor website, and the United States Environmental Protection Agency's (~~EPA~~USEPA) National Priorities List~~ (NPL).~~. Cases that have been closed by the supervisory agency are not considered.

Figure 2-18~~, Sites of Potential Groundwater Impacts~~ shows sites of known or potential groundwater impacts from EnviroStor and Geotracker/GAMA databases~~, presents the locations and details of known impacted groundwater or potentially impacted groundwater~~ in the Vina Subbasin. The sites were divided into the following categories based on regulatory designation:

- Other Sites with Corrective Action (Current~~);~~)
- Sites Needing Evaluation (Active or Inactive~~);~~)
- Federal Superfund-Listed Sites~~; and~~
- Leaking ~~Underground Storage Tank (~~LUST~~)~~ Cleanup Sites~~.~~

Active DTSC Cleanup Program Sites in the Vina Subbasin include the following:

- No. 04880002 - Chico - Skyway Subdivision groundwater plume:
  - Past use that caused contamination: Manufacturing – metal
  - Potential contaminants of concern: Halogenated solvents, ~~tetrachloroethylene~~tetrachloroethene (PCE), ~~trichloroethylene~~trichloroethene (TCE)

Figure 2-18 placeholder page

    - Potential media affected: Aquifer used for drinking water supply; well used for drinking water supply
- No. 04990002 - Chico Groundwater Plume – Southwest:
    - Past use that caused contamination: dry cleaning
    - Potential contaminants of concern: PCE
    - Potential media affected: Aquifer used for drinking water supply, other groundwater affected, well used for drinking water supply
- No. 04990003 - Chico Groundwater Plume – Central:
    - Past use that caused contamination: dry cleaning
    - Potential contaminants of concern: PCE
    - Potential media affected: Aquifer used for drinking water supply, other groundwater affected, well used for drinking water supply
- No. 04450006 - Chico Municipal Airport:
    - Past use that caused contamination: manufacturing – metal
    - Potential contaminants of concern: TCE
    - Potential media affected: Aquifer used for drinking water supply, indoor air, soil, soil vapor
- No. 4720001 - Esplanade Cleaners:
    - Past use that caused contamination: Dry cleaning
    - Potential contaminants of concern: PCE
    - Potential media affected: Groundwater uses other than drinking water
- No. 4720002 - First Avenue Cleaners:
    - Past use that caused contamination: Dry cleaning
    - Potential contaminants of concern: PCE
    - Potential media affected: Aquifer used for drinking water supply, well used for drinking water supply
- No. 4720003 - Flair Custom Cleaners:
    - Past use that caused contamination: Dry cleaning
    - Potential contaminants of concern: PCE
    - Potential media affected: Groundwater uses other than drinking water, soil, soil vapor
- No. 4720005 - North Valley Plaza Cleaners:
    - Past use that caused contamination: Dry cleaning

- Potential contaminants of concern: cis-1,2-~~dichloroethylene (cis), 1,2-dichloroethylene (~~dichloroethene, trans~~),~~-1,2-dichloroethene, PCE
- Potential media affected: Aquifer used for drinking water, well used for drinking water supply, indoor air, soil vapor

- No. 4360003 - Victor Industries:
  - Past use that caused contamination: Manufacturing – metal
  - Potential contaminants of concern: TCE
  - Potential media affected: Aquifer used for drinking water supply, well used for drinking water supply, soil

Of the nine open cases in the Vina Subbasin, all were identified as having the potential to impact groundwater. Information on these sites is available at www.envirostor.dtsc.ca.gov.

2.2.5 ~~Land subsidence~~Subsidence

2.2.5.1 Rates and locations

~~The SGMA regulations define the minimum threshold for significant and unreasonable land subsidence to be the "rate and the extent of land subsidence." The harmful effects of subsidence result from the damage it may cause to critical infrastructure and the costs of repairing or mitigating those damages. In the instance of the Vina Subbasin, critical infrastructure that could be affected by subsidence includes federal state and county roads and highways, irrigation district infrastructure, railroad infrastructure, and power transmission lines.~~

Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials often caused by groundwater or oil extraction. The potential effects of land subsidence include:

- Differential changes in elevation and gradients of stream channels, drain and water transport structures~~.~~
- Failure of water well casings due to compressive stresses generated by compaction of the aquifer system~~.~~
- Compressional strain in engineering structures and houses~~.~~

To date, no land subsidence has been recorded in Butte County. To determine whether subsidence is occurring, a subsidence monitoring network has been established throughout the Sacramento Valley, the Sacramento Valley GPS Subsidence Monitoring Network. This system consists of observation stations and extensometers managed jointly by Reclamation and DWR. The observation stations are a result of DWR's efforts to establish a subsidence monitoring network to capture changes in subsidence across the Sacramento Valley. The observation stations are established monuments with precisely surveyed land surface elevations, which are distributed throughout the County such that the entire county is well represented. In 2008, DWR along with numerous partners performed the initial GPS survey of the observation stations to establish a baseline measurement for future comparisons. The network was resurveyed again in

2017 (DWR, 2018c) using similar methods and equipment as those used in the 2008 survey, and results were analyzed to depict the change in elevation at each station between those two years.

Extensometers are installed in wells or boreholes and are a more site-specific method of measuring land subsidence, as they can detect changes in the thickness of the sediment surrounding the well due to compaction or expansion. These instruments are capable of detecting very slight changes in land surface elevation on a continuous basis with an accuracy of +/- 0.01 feet or approximately 3 mm. The three extensometers in Butte County, all located in the Butte Subbasin, have a period of record beginning in 2005 and were chosen by DWR based on a high likelihood of seeing subsidence in these areas if it were to occur, due to the presence of known clay and other fine-grained deposits in these areas. Data are available through July 2019 and can be found in the DWR ~~Water~~SGMA Data ~~Library5.~~Viewer.[3] While seasonal displacement of -9.13 mm (+/- 0.3 mm) have been recorded at one of these extensometers during 2006 (a wet water year) and 2015 (a critical water year~~,~~), changes in ground surface elevations are slight and remain at or above baseline levels in 2019.

Processes that can contribute to land subsidence include aquifer compaction by overdraft, hydrocompaction (shallow or near-surface subsidence) of moisture deficient deposits above the water table that are wetted for the first time since deposition, and subsidence caused by tectonic forces (Ireland et al., 1984). Land subsidence in the Vina Subbasin would most likely occur as a result of aquitard consolidation. An aquitard is a saturated geologic unit that is incapable of transmitting significant quantities of water. As the pressure created by the height of water (i.e., head) declines in response to groundwater withdrawals, aquitards between production zones are exposed to increased vertical loads. These loads can cause materials in aquitards to rearrange and consolidate, leading to land subsidence. Factors that influence the rate and magnitude of consolidation in aquitards include mineral composition, the amount of prior consolidation, cementation, the degree of aquifer confinement and aquitard thickness.

Subsidence has elastic and inelastic deformation components. As the head lowers in the aquifer, the load that was supported by the hydrostatic pressure is transferred to the granular skeletal framework of the formation. As long as the increased load on the formation does not exceed the pre-consolidation pressure, the formation will remain elastic. Under elastic conditions, the formation will rebound to its original volume as hydrostatic pressure is restored. However, when the head of the formation is lowered to a point where the load exceeds pre-consolidation pressure, inelastic deformation may occur. Under inelastic consolidation, the formation will undergo a permanent volumetric reduction as water is expelled from ~~aquitards4~~aquitards.

Recent subsidence studies in the Central Valley have utilized satellite- and aircraft-based Interferometric Synthetic Aperture Radar (InSAR). Much of the InSAR work has been led by the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL). However, because JPL InSAR data ~~is~~are limited to a period from 2015 through 2017, TRE ALTIMIRA InSAR available through DWR was used for this analysis, as data from this source ~~is~~are available for a period extending from June 2015 through September 2019.

[3] Accessed at https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub

2.2.5.2 *Historical and Recent Cumulative Subsidence and Rates of Subsidence*

The data shown in Table 2-4 ~~includes~~include the range of cumulative subsidence observed within the Vina Subbasin over the period between 2008 and 2017, as reported by Sacramento Valley GPS Subsidence Monitoring stations included in the Vina Subbasin Monitoring Network and a range of annual subsidence rates calculated from the cumulative totals. The range of recent cumulative subsidence and rates of subsidence over the period from June 2015 through September 2019 ~~is~~are also presented in the table and are based on InSAR data. As both the Sacramento Valley GPS monuments and InSAR monitor changes in land surface elevations, the data do not distinguish between elastic and inelastic subsidence. However, the cumulative subsidence values observed by both sources indicate that inelastic subsidence is not significant in the Vina Subbasin.

Table 2-4: Cumulative Subsidence and Approximate Annual Rate of Subsidence

Subbasin Area (square miles)	Date Range	Cumulative Subsidence (feet)	Calculated Annual Rate of Subsidence (feet/year)	Source
289	2008-2017	0.176 to -0.074	0.020 to -0.008	Sac Valley
289	2015-2019	0.25 to -0.25	0.063 to -0.063	InSAR

Figures 2-19 and 2-20 show historical and recent levels of subsidence within the Vina Subbasin. Historical levels for the period from 2008 to 2017 are shown in Figure 2-19 – Historical Subsidence, as are the locations of subsidence monitoring network monuments used to measure subsidence. Recent levels for the period from 2015 through 2019 are presented in Figure 2-20 – Recent Subsidence. The values presented in Table 2-4 and in Figures 2-19 and 2-20 support the observation that inelastic land subsidence due to groundwater withdrawal is unlikely to result in an Undesirable Result in the Vina Subbasin. Although none of the subsidence data shows substantial changes in ground ~~service~~surface elevations, the InSAR mapping presented in Figure 2-20 shows a clear distinction between changes in elevations observed on the northern and eastern flanks of the Vina Subbasin versus changes observed in the center.

2.2.6 Interconnected Surface Water Systems

2.2.6.1 Definitions

Interconnected surface water is defined under SGMA as “surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.”[4] There are two key terminology references in this statement. First, the surface water must be connected to the underlying aquifer by a “continuous saturated zone.” This implies that the connection can be via a “zone” that is not the same as the underlying aquifer, and that deeper aquifer zones are, through connections upward to shallower aquifer zones, hydraulically connected to surface water. This is consistent with most conceptual representations of how groundwater is interconnected with surface water systems. The second reference implies that an overlying surface water that is “completely depleted~~,”~~” does not represent an interconnection with the underlying groundwater.

[4] ~~(o) "Interconnected surface water" refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Cal. Code Regs. Tit. 23, § 351~~ Cal. Code Regs. Tit. 23, § 351

Figure 2-19 placeholder page

Figure 2-20 placeholder page

Both of these situations exist in the Vina Subbasin:

1. Within the floodplain of the Sacramento River, there is a continuous saturated zone (i.e., the floodplain sediments) that connects the shallowest aquifer to the river. The connectivity between shallow and deeper aquifer zones will dictate the overall connectivity to the River. ~~So~~Therefore, the Sacramento River floodplain represents a "high groundwater connectivity" zone with respect to the surface water.
2. In the upland areas outside of the Sacramento River floodplain, there are creeks that flow seasonally and often dry up in late summer or are dry for an entire year during dry conditions. In this case, the upland creeks may not be influenced by "high groundwater connectivity" and the presence of an undesirable result is not clear cut with respect to surface water depletion. The streams dry up regardless of the groundwater condition, and streams that are already dry are not considered interconnected surface water. However, the upland streams are an important source of recharge to the aquifer, so the health of these stream channels and their adjacent riparian zones is important to groundwater sustainability.

Streams and rivers are classified as either gaining, losing, or disconnected with respect to the connectivity to groundwater. The difference between gaining and losing reaches is illustrated in Figure 2-21~~.~~ and dependent upon the hydraulic gradient of the river stage and head in the principal aquifer. For gaining reaches, the water table adjacent to the stream is above the elevation of water in the stream, resulting in flow of water from the groundwater system to the stream. These are termed streamflow gains or accretions. For losing reaches, the water table adjacent to the stream is below the elevation of water in the stream, resulting flow of water from the stream to the groundwater systems. These are termed streamflow losses or depletions. In both cases, there is a continuous hydraulic gradient between the stream and the underlying sediments (i.e., there is no unsaturated or partially saturated zone present beneath the streambed). A disconnected system is present when there is an intervening unsaturated or partially saturated zone between the streambed and the water table. A disconnected system is also present when the stream is dry and therefore cannot interact with the underlying water table.

It is important to recognize that these interconnections are dynamic and are affected by many factors along an entire reach of a stream or river. Variations in local geology, hydrology, vegetation patterns, and water use can all influence how these interconnections occur. Monitoring groundwater levels in appropriate zones of the aquifer near available stream stage data is needed to understand and analyze these dynamics, which ultimately help characterize interconnected surface waters and stream depletions.

Two examples of this complexity are described below:

- At a single point in time, a stream may have both gaining, losing, and disconnected reaches. For this reason, defining stream reaches and key points in the stream system where flows are managed is very important. The volume of water that is "gained" or "lost" depends, in part, on how individual stream reaches are defined and the amount of streamflow data available to calculate gains or losses to each reach. In general, it is not possible to directly measure gains or losses to streamflow using groundwater data alone.

Streamflow data is extremely important in determining how groundwater interacts with surface water.

- Reaches that are gaining under certain seasonal~~,~~ or longer-term conditions may become losing under others. In this case, understanding the magnitude of groundwater level fluctuation adjacent to a stream reach and the hydraulic properties of the streambed is important. The volume of water that is gained or lost is proportional to the head difference between the stream, the elevation of the streambed, the elevation of the groundwater adjacent to the stream, and the hydraulic properties of the streambed.

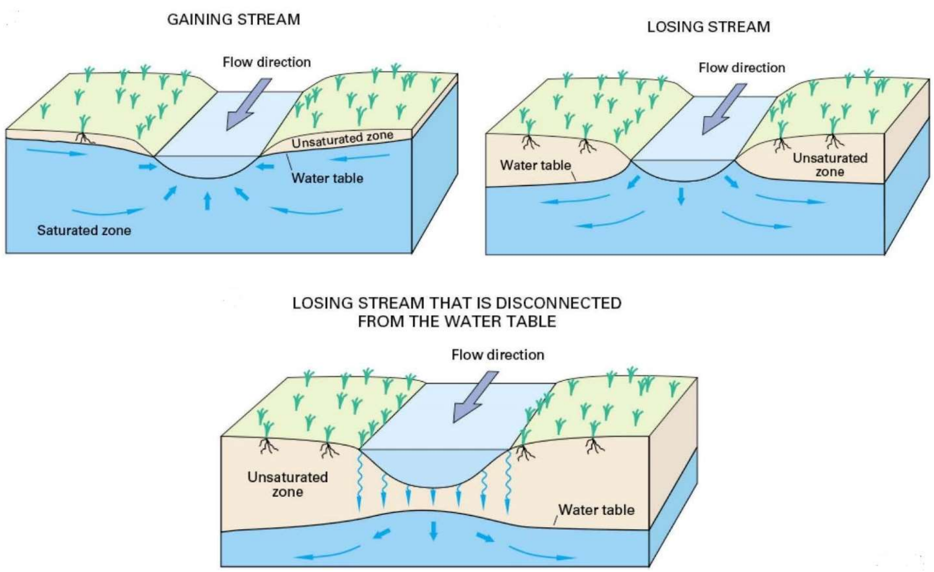


Figure 2-21: Illustration of Gaining and Losing Interconnected and Disconnected Stream Reaches (Source: United States Geological Survey [USGS])

2.2.6.2 Evaluation of Surface Water Connectivity

This section presents a general evaluation of surface water connectivity based on limited discrete data sets that do not encompass the entire Vina Subbasin. The results of the BBGM model are discussed separately in Section 2.2.6.3.

The data sets used to evaluate surface water connectivity in general include:

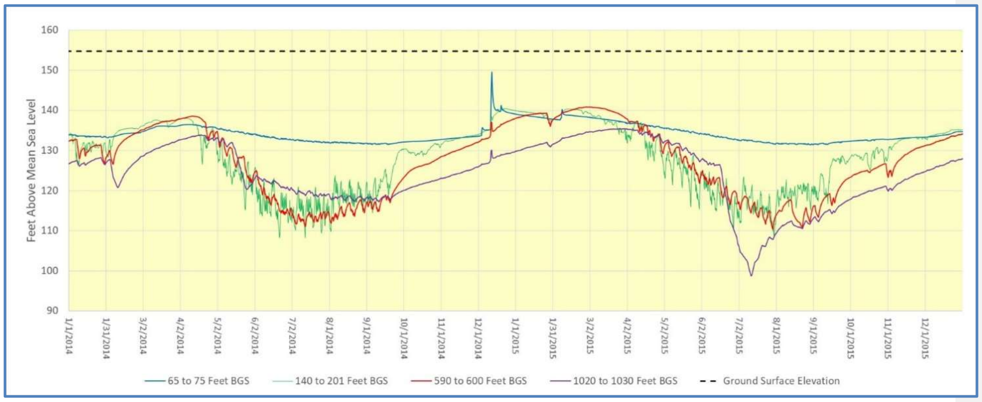
- Hydrograph for a nested well located adjacent (about 0.8 miles) to the Sacramento River, well 23N01W31M~~).~~)

- A second nested hydrograph farther from the Sacramento River, well 23N01W28M
- A streamflow gaging study conducted by Chico State University (~~Buck~~Davids et al~~,~~., 2020)
- Groundwater levels measured in seven shallow monitoring wells as part of a nitrate study conducted in the City of Chico (AECOM, 2020)

Each data set has limitations with respect to an integrated evaluation of surface water connectivity across the Vina Subbasin. Locations of the wells referenced above are provided in Figure 2-22. A summary of the findings is provided below.

- Section 2.2.2.2 provides an initial discussion of the nested wells located adjacent to and further away from the Sacramento River, and Figure 2-14 provides hydrographs for these wells covering their period of record. To allow for a more detailed assessment of trends within each of the zones screened, Figure 2-23 provides hydrographs for these wells (23N01W31M and 23N01W28M) over a shorter time period~~,~~ (January 2014 through December 2016~~.~~).

Figure 2-22 placeholder page



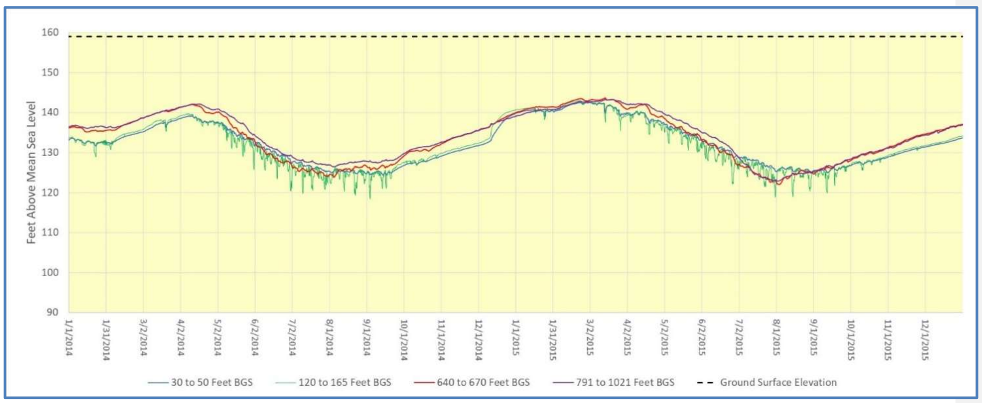


Figure 2-23: Hydrographs for Nested Well Located Near ~~Feather~~Sacramento River (Upper Hydrograph, Well 23N01W31M) and Nested Well Located Further from the ~~Feather~~Sacramento River (Lower Hydrograph, ~~well~~Well 23N01W28M)

As seen in this figure, the hydrograph for the nested well located adjacent to the Sacramento River (23N01W31M, upper graph in Figure 2-23) shows that water levels in the shallowest well display little annual fluctuation and are similar to the elevation of the river. This indicates that this shallowest well completion interval is in direct continuity with river levels and the adjacent floodplain supported by the up-tick of water levels in December 2014 that are most likely due to increases in river flows. It is likely that this shallow well is completed in what could be termed “floodplain sediments,” as opposed to a regional shallow aquifer that extends across the ~~subbasin.~~Vina Subbasin. The deeper wells within this nest display greater fluctuation in seasonal water levels that generally tend to track each other, indicating less direct continuity with river levels and the adjacent floodplain.

The hydrograph for the nested well farther from the river (well 23N01W28M, lower graph on Figure 2-23) shows a close correspondence in water elevations recorded at all screened intervals being monitored. This indicates a clear connection across the aquifer zones. The trend in these zones ~~are~~is also similar to the trends observed for the three deeper wells within the nested well located adjacent to the Sacramento River.

The streamflow gaging study conducted by Chico State University on Big Chico Creek in 2020 (~~Buck~~Davids et al., 2020) consisted of repeated measurements of streamflow at six different locations along Big Chico Creek between June and mid-October. The study consisted solely of streamflow data and no groundwater information or analysis of the floodplain/riparian area was conducted. The results clearly show a progressive decrease in streamflow from the uppermost station to the lowermost station for each of the time points measured. The results also clearly show a rapid decrease in streamflow from June to July, followed by a more gradual decrease after July. Finally, the results clearly show that the lower 8 kilometers of Big Chico Creek (below Rose Drive Bridge) become dry by early July and flows in the middle portion of the Creek decrease to below 5 cubic feet per second (cfs) by late July. ~~These~~This recent data ~~indicate~~indicates that, in general, within the subbasin Big Chico Creek is a losing stream during ~~its freshet~~high flood flows and becomes a disconnected stream in its lower reaches by early to mid-summer. There is no indication in the streamflow data at the measured time and locations to suggest groundwater interactions ~~that~~ contribute to the streamflow behavior, thereby suggesting Big Chico Creek was observed to be a losing stream disconnected from the water table. Similar conditions would be expected for other creeks that traverse the Vina Subbasin (Little Chico, Sycamore, Rock, and Butte Creek) since they flow across a similar fan topography and similar shallow subsurface geology. The overall conclusion from this study in relation to interconnected surface water is that, for significant portions of the year, the upland creeks in the Vina Subbasin would be classified as disconnected streams and the surface water would be considered "completely depleted" as defined under SGMA.

Eight shallow monitoring wells installed within the City of Chico in the vicinity of Little Chico Creek (AECOM, 2020: Figure 2-23) provide similar findings to the streamflow study on Big Chico, but are based on groundwater data. All ~~of~~ the monitoring wells were completed at depths of less than 60 feet bgs and are therefore representative of groundwater levels that could directly interact with the adjacent stream channels (i.e., Little Chico Creek and the Lindo Channel). Figure 2-24 provides hydrographs for these eight wells for data collected since 2012. All ~~of~~ the groundwater levels collected across all time periods are below the elevation of the stream channel adjacent to the monitoring wells. This indicates that groundwater levels are not capable of interacting directly with the adjacent stream channel.

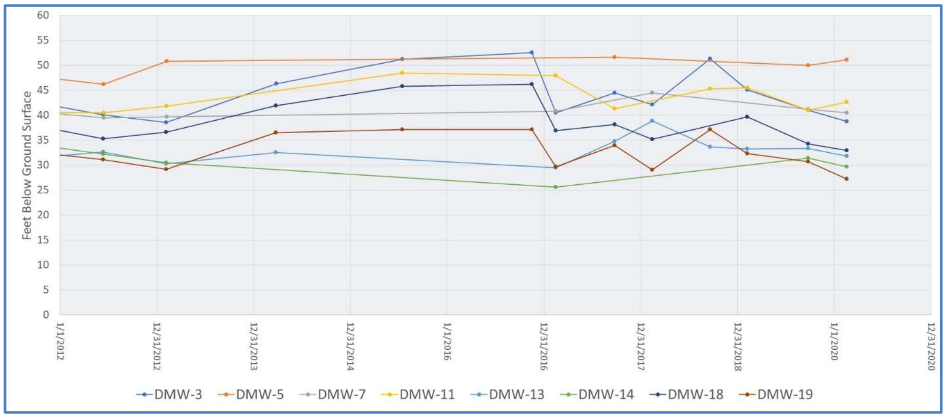


Figure 2-24: Hydrographs Showing Feet Below Ground Surface for Eight Shallow Wells Monitored as Part of Chico Nitrate Study (AECOM, 2020)

At the downstream end of the stream channel, groundwater levels were somewhat closer to the bottom of the stream channel, but still did not intersect the stream channel. This downstream area represents the edge of the upland area and the transition zone to the Sacramento River floodplain. Some groundwater interaction may occur in these lower reaches but is more representative of surface water interactions in the floodplain as opposed to the upland area.

Finally, it should be noted that only the northern portion of the Vina Subbasin extends to the Sacramento River (north of its confluence with Big Chico Creek). The southern portion of the Vina Subbasin does not extend into the Sacramento River floodplain, and therefore consists only of upland creeks that dissect the alluvial fan system emanating from the foothills. Any direct interaction with the Sacramento River south of its confluence with Big Chico Creek occurs in the Butte Subbasin.

2.2.6.3 Estimates of Surface Water Connection Based on BBGM

The interactions between groundwater systems and surface water features within the Vina Subbasin are estimated at a basin scale in the BBGM. A total of 32 stream segments traversing or bounding the ~~subbasin~~Vina Subbasin with a total length of approximately 115 miles are defined in the BBGM. The segments range in length from 1 to 9 miles with an average length of 3.6 miles and are shown in Figure 2-25. Streamflows are defined in each stream at the eastern edge of the model based on available stream gage data. Streamflow data in upland creeks between the edge of the model and the Sacramento River were not available for use in model calibration. The floodplain of the Sacramento River is not explicitly defined in the BBGM, so there is no distinction between floodplain sediments that may interact directly with the Sacramento River and more regional shallow aquifers that extend east to the recharge areas along the foothills.

Figure 2-26 shows the model-predicted stream interaction from 2000 to 2018. The results are expressed as a percentage based on number of months that either a gaining or losing condition was predicted. The figure shows that the upland stream segments above the Sacramento River floodplain are predominantly losing reaches that provide recharge to the aquifer. Streambed elevations at individual stream nodes from the BBGM were also compared to groundwater elevations from spring groundwater level measurements provided by DWR as part of the SGMA Data Viewer.[5] As indicated in Figure 2-27, the estimated average distance between the streambed and groundwater over ~~the~~ a five-year period (2014-2018) was 20 feet for upland streams before they entered the Sacramento River floodplain. This disconnection between upland streams and shallow groundwater is consistent with the evaluation of shallow well groundwater levels described previously.

Reaches of the Sacramento River showed more variable model response, with a broader distribution of gaining and losing months. As indicated in Figure 2-27, the estimated average distance between the streambed and groundwater over a five-year period (2014-2018) was 10 feet or less in the Sacramento River floodplain. This is consistent with a more complex and large-scale interaction between floodplain sediments, underlying aquifer zones, and the elevation profile of the Sacramento River.

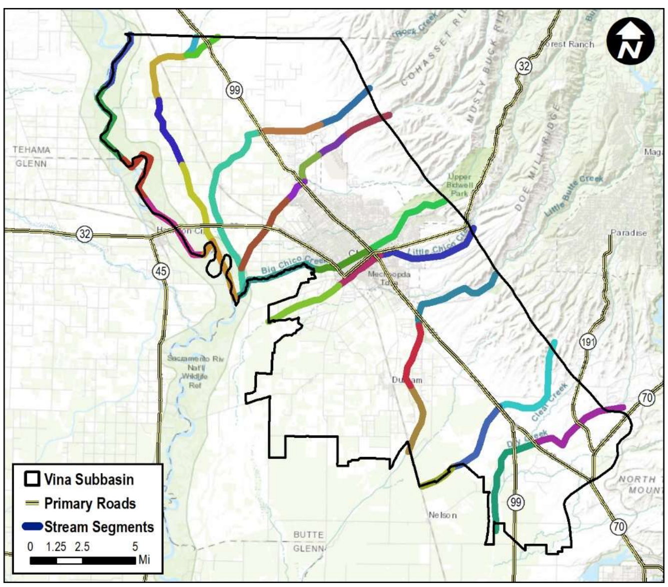


Figure 2-25: Vina Subbasin Stream Segments

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5 Accessed at https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels.

Geosyntec
consultants

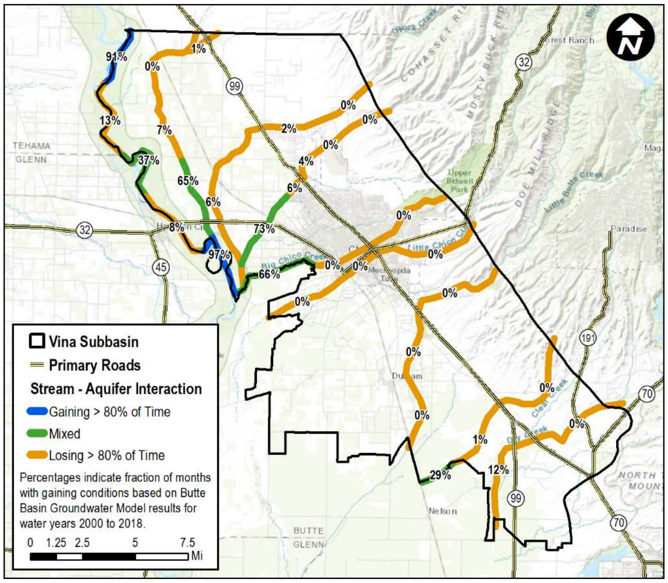


Figure 2-26: Vina Subbasin Gaining and Losing Stream Reaches based on ~~BBGM~~Butte Basin Groundwater Model, Water Year 2000 to 2018

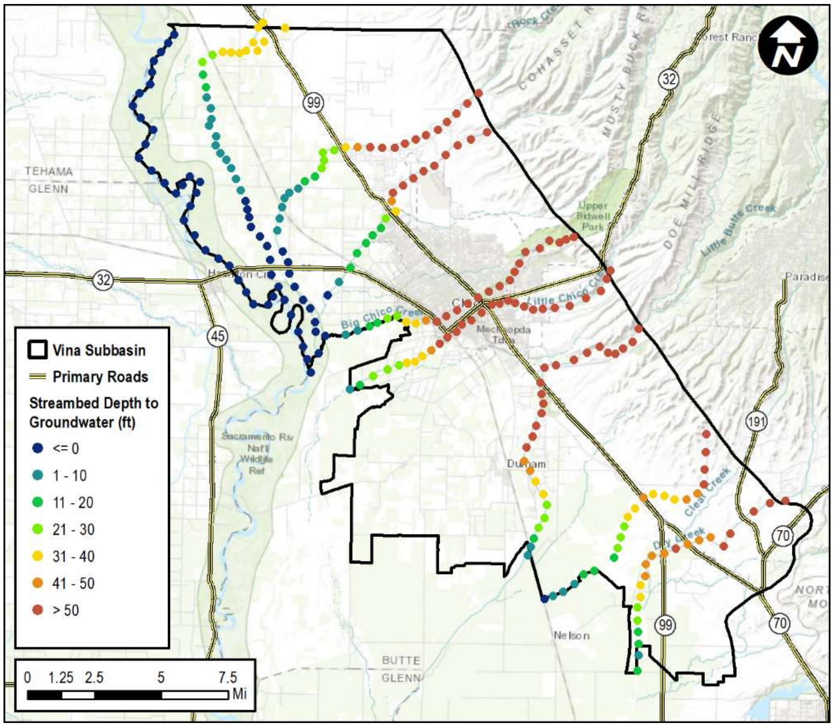


Figure 2-27: Vina Subbasin Average Streambed Spring Depth to Groundwater, 2014 to 2018

2.2.6.4 Water Balance for Surface Water – Groundwater Interaction

The water balance for surface water – groundwater interaction was estimated using the BBGM on a monthly time step. The volume of interaction was calculated across the entire length of each stream. Monthly net streamflow gains or losses from groundwater were calculated by the model water balance for the historical period from water year 2000 to 2018. These results are summarized in Table 2-5. Average monthly gains to streamflow are expressed in ~~cubic feet per second.~~cfs. Negative values denote losses from streamflow to groundwater (i.e., seepage or depletion).

Table 2-5: Average Monthly Gains to Streamflow from Groundwater, Water Years 2000 to 2018 (~~cfs~~cubic feet per second)

Stream	Monthly Gains from Groundwater (cfs)												Average (cfs)
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Angel Slough	0	0	0	0	0	0	0	0	0	0	0	0	0
Big Chico Creek	-2	-3	-6	-7	-7	-8	-5	-3	-2	-2	-2	-1	-4
Butte Creek	-7	-10	-15	-15	-18	-20	-18	-14	-10	-7	-6	-6	-12
Dry Creek	-1	-1	-3	-2	-2	-2	-1	0	0	0	0	0	-1
Little Chico Creek	-1	-1	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1
Little Dry Creek	-2	-3	-6	-6	-6	-5	-4	-2	-2	-1	-1	-1	-3
Mud Creek	0	0	-1	1	1	2	2	1	1	0	0	0	0
Pine Creek	-1	-2	-4	-1	0	2	3	3	2	1	1	0	0
Rock Creek	-3	-3	-4	-3	-3	-2	-2	-2	-2	-2	-2	-2	-2
Sac River	109	151	24	-44	20	50	181	142	91	13	33	57	69
Singer Creek	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**92**	**129**	**-17**	**-79**	**-18**	**15**	**154**	**123**	**76**	**1**	**22**	**46**	**45**

Table 2-5 shows that most of the streams that traverse the alluvial fan from the foothills to Sacramento River lose water to the groundwater system at a rate of between 1 and 12 cfs, with Butte Creek showing the highest amount of seepage to groundwater. Total streamflow loss to groundwater averages about 23 cfs or about 16,650 ~~AF per year~~AFY.

Mud Creek and Pine Creek, which are located near or within the Sacramento River floodplain, show more variation (with both gaining and losing months), but are, on an annual basis, neutral with respect to total volume of stream interaction.

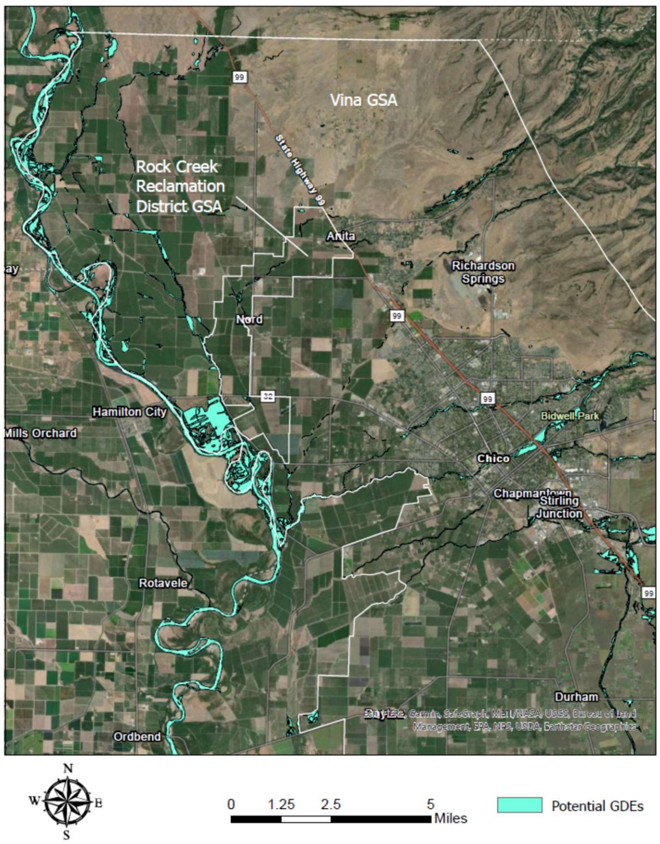
The Sacramento River shows net gaining conditions along the reaches adjacent to the Vina Subbasin for all months except January. On average, there is approximately 70 cfs ~~or~~of streamflow gain, or 50,600 AF per year, which represents about 23% of the total modeled recharge to the Vina Subbasin (Section 2.3). The remaining 77% of recharge to the Vina Subbasin discharges ~~to~~into pumping wells and model boundaries.

2.2.7 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are defined in the SGMA regulations as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (California Code of Regulations [CCR] Title 23, § 351(m)). GDEs exist within the Vina Subbasin largely where vegetation accesses shallow groundwater for survival~~;~~ and in areas with streams and creeks where a connection to groundwater exists. Without access to shallow groundwater, these plants and the ecosystems supported by the hydrology would die.

2.2.7.1 NCCAG Database

The initial identification of GDEs for this GSP was performed by using the Natural Communities Commonly Associated with Groundwater (NCCAG) database to identify and map potential GDEs (iGDEs) in the Vina Subbasin. The NCCAG database was developed by a working group comprised of DWR, CDFW, and The Nature Conservancy (TNC) by reviewing publicly available state and federal agency datasets that have mapped California vegetation, wetlands, springs, and seeps and by conducting a screening process to retain types and locations of these commonly associated with groundwater. The results were compiled into the NCCAG database with two habitat classes defined. The first class includes wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions. The second class includes vegetation types commonly associated with the sub-surface presence of groundwater (phreatophytes). Figures 2-28 and 2-29 show the locations of all iGDEs identified by the NCCAG database within the Vina Subbasin.


Vina GSA
Rock Creek
Reclamation
District GSA
State Highway 99
99
32
Anita
Richardson
Springs
Nord
Hamilton City
Mills Orchard
Bidwell Park
Chico
Chapmantown
Stirling
Junction
Rotavele
Durham
Ordbend
N
W
E
S
0
1.25
2.5
5
Miles
Potential GDEs

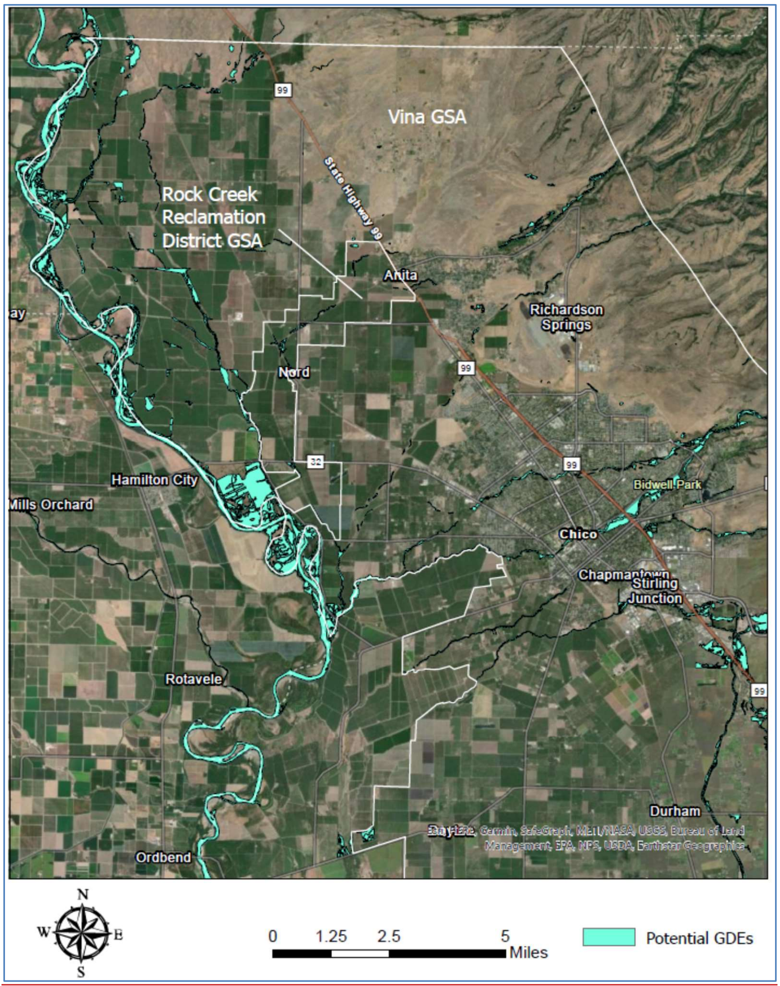
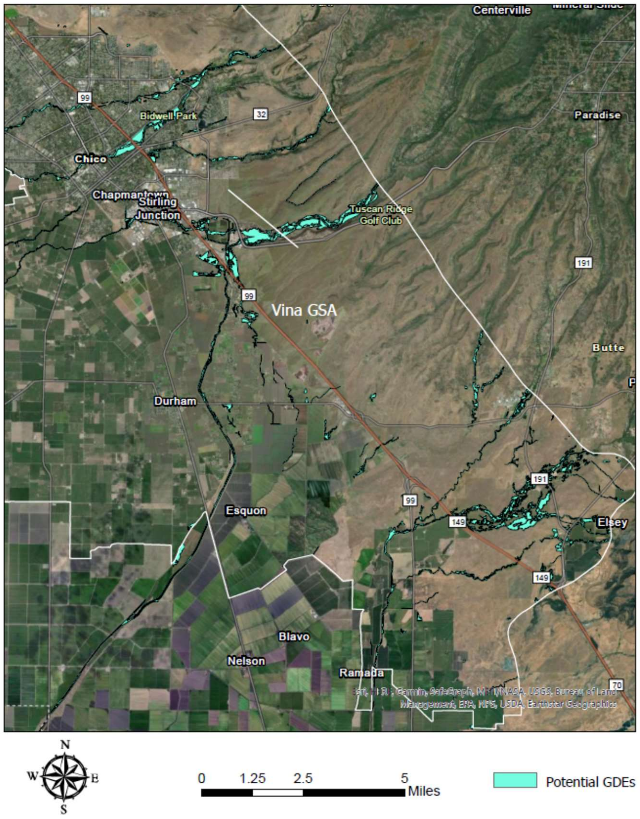


Figure 2-28: Potential Groundwater Dependent Ecosystems (iGDEs) in the ~~northern portion~~Northern Portion of the Vina Subbasin as ~~identified~~Identified in the NCCAG ~~database developed~~Database Developed by TNC


Centerville
Bidwell Park
Chico
Chapmantown
Stirling Junction
Tuscan Ridge Golf Club
Paradise
Vina GSA
Butte
Durham
Esquon
Elsey
Blavo
Nelson
Ramada
0 1.25 2.5 5 Miles
Potential GDEs

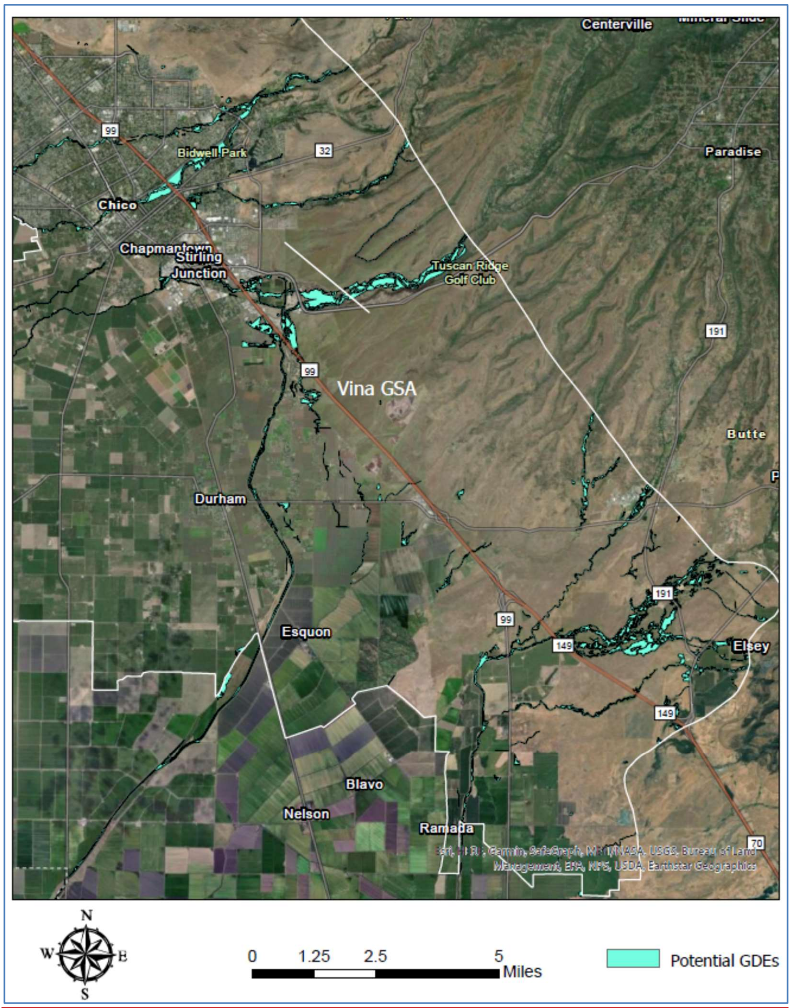


Figure 2-29: Potential Groundwater Dependent Ecosystems (iGDEs) in the ~~southern portion~~Southern Portion of the Vina Subbasin as ~~identified~~Identified in the NCCAG ~~database developed~~Database Developed by TNC

The NCCAG dataset is based on 48 layers of publicly available data developed by state or federal agencies that map vegetation, wetlands, springs, and seeps in California (DWR, 2019b). A NCCAG technical working group with representatives from DWR, CDFW, and TNC reviewed the datasets compiled to assemble the NCCAG dataset. The NCCAG dataset attempts to extract mapped vegetation and wetland features that have indicators suggesting dependence on groundwater. The data presented in NCCAG dataset display vegetation polygons that have indicators of GDEs based on published and/or field observations of phreatophytic vegetation defined as a "deep-rooted plant that obtains water that it needs from the phreatic zone (zone of saturation) or the capillary fringe above the phreatic zone" (Rohde et al., 2018). The dominance of phreatophytic plant species in a mapped vegetation type is a primary indicator of ~~GDE~~GDEs. A list of plant species considered to be phreatophytes based on peer-reviewed scientific literature on rooting depths, published lists of phreatophytes, expert field observations, and vegetation alliance descriptions is publicly available (Klausmeyer et al., 2018; DWR, 2018b).

While developing the NCCAG dataset of areas with indicators of GDEs, the technical working group attempted to exclude vegetation and wetland types and polygons that are less likely to be associated with groundwater (Klausmeyer et al., 2018). The NCCAG working group attempted to remove any polygons that are not likely to be GDEs where they occurred in areas where they are likely to be supported by alternate artificial water sources (e.g., local seepage from agricultural irrigation canals), or where appropriate available data indicated the shallow groundwater depth is located well below the rooting zone, (Klausmeyer et al., 2018).

The vegetation data presented in the NCCAG dataset is ~~a~~the latest available starting point for the identification of GDEs, as the dataset includes the best available public datasets and has been screened to include only areas that have indicators of groundwater dependent vegetation. DWR has stated that use of the NCCAG dataset is not mandatory and does not represent DWR's determination of a GDE (DWR, 2018b). Rather, the NCCAG dataset can provide a starting point for the identification of GDEs within a groundwater basin.

Additional information, such as near surface groundwater depth obtained from piezometers, information about subsurface stratigraphy and geology on confining layers, and information on local land use and hydrology can be used to confirm whether vegetation in areas identified by the NCCAG as iGDEs is, in fact, reliant on groundwater.

2.2.7.2 Initial iGDE Analysis

GSA Managers from the ~~subbasin~~Vina Subbasin used this database as a starting point to analyze a portion of the total iGDEs in the NCCAG database to evaluate local groundwater dependence. ~~The GSA Managers applied specific~~Specific criteria to each polygon ~~under analysis~~ to answer a series of questions ~~that~~ led to an eventual characterization for each iGDE. These iGDEs were designated as either "Likely a ~~GDEs~~GDE," "Not likely a ~~GDEs~~GDE," or "Uncertain" based on ~~their~~ evaluations. The criteria aimed at understanding each iGDE's dependence on groundwater, including questions about land use changes, proximity to perennial surface water supplies, irrigated agriculture and agricultural dependent surface water, condition of vegetation during drought years and water applications to the iGDEs.

The first phase of the analysis was conducted by thorough review of aerial photographs from Google Earth across multiple years specifically focusing on the 2007, 2009, 2013, and 2015 drought years as well as ~~use of~~ the Managers' local knowledge of these areas.

2.2.7.3 iGDE Designations

While there were some areas identified as “Not likely a GDE” during this effort, Managers were also able to add any iGDEs into the map that were not captured in the original NCCAG database. NCCAG areas identified as “Not likely a GDE” from the initial analysis by Managers can be categorized as follows.

Not Likely a GDE Due to Significant Land Use Change

Some areas in the NCCAG database ~~may~~ have changed in land use since the database was published. Developed areas where there have been significant land use changes to the iGDE~~,~~ (i.e., land that transitioned ~~to~~into cultivated irrigated agricultural lands, industrial, or residential development) occurred or lands had undergone man-made changes such as golf courses or other obvious anthropogenic changes were labeled as “Not likely a GDE.”

Not Likely a GDE Due to Perennial Surface Water Supplies

Areas with perennial water supplies such as those ~~subject to historical hydraulic gold mining runoff and dredging activities or those near reservoirs were labeled as ”Not likely a GDE.” In some areas historic mining activities have left tailings of cobbles and coarse gravel which rapidly transmit water. To some extent, it is assumed that pooled water in this area is tied to river stage through direct connections with the river with surface water bodies. Likewise, the reservoirs~~near reservoirs were labeled as “Not likely a GDE.” Reservoirs provide water year-round for adjacent ecosystems. If any iGDEs were located within 150 feet of reservoirs ~~or mine tailings~~, they were assumed to be able to access the nearby surface water bodies and were labeled as “Not likely a GDE.”

Not Likely a GDE Due to Supplemental Water Supplies

Irrigated agriculture, irrigated refuge / managed wetlands or irrigated urban areas with supplemental water deliveries were identified by Managers during the initial ~~GDE~~GDEs analysis effort. These areas are assumed to be accessing supplemental water supplies and not reliant on groundwater and were labeled as “Not likely a GDE.”

Not Likely a GDE Due to Adjacency to Irrigated Agricultural Fields

Agricultural lands are dependent on reliable water supplies to ensure a successful harvest. Surface water and / or groundwater pumped from the aquifer is used to irrigate crops in the Vina Subbasin. Such irrigation benefits not only the crops, but also surrounding vegetation. Potential GDEs further than 150 feet from irrigated rice fields and areas further than 50 feet from all other irrigated agriculture were assumed to be unable to access irrigation water. These distances are based on professional judgment, including past experience in the region and consideration of the physical characteristics of the Vina Subbasin, such as hydraulic conductivity. Rice fields, along with other irrigated agriculture, are known to have percolation and lateral seepage, supplying water to the aquifer and into adjacent areas. Lateral seepage in Sacramento Valley rice areas has been estimated at between 1.0% and 1.9% of the total irrigation volume (LaHue and Lindquist, 2019). A larger distance was used for rice due to the long-term ponding of water and due to restrictive layers in the subsurface that result in the horizontal spreading of irrigation water. ~~Refinement of these distances is included as a project and is discussed in Chapter 5.~~ Potential GDEs near these irrigated areas are assumed to be accessing irrigation water through lateral movement through the soils~~,~~; thus, they were labeled as “Not likely a GDE.”

Not Likely a GDE Due to Dependence on Agricultural-dependent Surface Water
Similar to areas adjacent to reservoirs, iGDEs adjacent to surface water bodies that are perennial due to agricultural practices and those near drainage canals, are able to access surface water throughout the year. Agricultural water conveyance features, i.e., the Cherokee Canal is included in this definition however, this does not include the Sacramento River, Butte Creek, or Honcut Creek because these natural waterways also convey non-agricultural water. Potential GDEs within 150 feet of these agricultural-dependent surface water bodies were assumed to be accessing water from them thus, they were labeled as “Not likely a GDE.”

Not Likely a GDE Due to Non-Survival during Drought Conditions
To assess if the iGDE was groundwater dependent, Managers reviewed the condition of the iGDE over multiple dry drought years using aerial photographs from Google Earth. Specifically, the group focused on the drought years of 2007, 2009, 2013, and 2015 in addition to the Managers’ local knowledge of these areas. Green vegetation over multiple drought years during summer months indicated survival of the iGDE as well as an assumed connection to groundwater. Potential GDEs ~~which~~that did not indicate any surviving conditions over multiple drought years were assumed to not be connected to groundwater and were labeled as “Not likely a GDE.”

Uncertain – All Other Areas
The iGDEs analyzed by the Managers in this initial effort, which did not receive a designation as either “Not likely a GDE” or “Likely a GDE” based on the conclusions from the analysis above, were labeled as “Uncertain” and were further analyzed~~ in additional analyses~~ as described below.

2.2.7.4 Additional Geographical Information Systems (GIS) Analysis

Irrigated Agricultural Land Use
After the initial analysis was completed for a selection of the total iGDEs in the NCCAG database as described above, a geographical information systems (GIS) analysis was performed for all remaining iGDEs in this ~~subbasin~~Vina Subbasin by Butte County staff to determine each iGDE’s proximity to rice and other irrigated agriculture as described below. The DWR / Land IQ land use and crop mapping data for 2016 (DWR, 2019b) was used to determine the dominant crop type throughout the Vina Subbasin.

Land classified as “Rice” for the “Crop Type 2016” in the dataset was identified. Then all polygons in the TNC iGDEs dataset within 150 feet of land classified as ~~rice~~Rice were identified and designated as “Not likely a GDE near irrigated rice” for the same reasons as described above in the “Not Likely a GDE Due to Adjacency to Irrigated Agricultural Fields” section of this document above.

Land with “Crop Type 2016” classifications other than “Managed Wetland,” “Urban,” “Rice,” and “Mixed Pasture” in the dataset were identified and for this purpose referenced as “Other Irrigated Agriculture” for this GIS analysis, as all other remaining irrigated crop types. All polygons in the NCCAG dataset within 50 feet of land classified as “Other Irrigated Agriculture” were designated as “Not likely a GDE near irrigated agriculture (Non-Rice)” for the same reasons as described above in the “Not Likely a GDE Due to Adjacency to Irrigated Agricultural Fields” section of this document.

Valley Oak Dominated Areas

The dataset provided by TNC indicates the dominant species of vegetation for each polygon, including Valley oak (*Quercus lobata*) in the Vina Subbasin. Those polygons were classified as "Likely a GDE" due to feedback from TNC staff that this species can access groundwater over a wide range of depths (M. Rohde personal communication March 2, 2021).

Sacramento River Corridor Areas

Using GIS analysis tools, polygons located within the active floodplain of the Sacramento River ~~manually~~ were selected manually. These polygons were classified as "Likely a GDE" due to their proximity to the Sacramento River, which is classified as a gaining river throughout most, if not all of its length throughout the ~~subbasin~~Vina Subbasin.

2.2.7.5 ~~Draft~~ Mapping

The ~~draft~~ maps in Appendix 2-A shown as Figures 3 and 4 show iGDEs classified as "Likely a GDE" or "Not Likely a GDE" for one of the reasons described above. ~~The draft maps in Figures 4 and 5 in Appendix 2-A show iGDEs classified as "Not Likely a GDE" along with the reason for the classification.~~ The iGDEs classified as "Not Likely a GDE" in the Vina Subbasin were designated this way due to either their proximity to irrigated agriculture as rice, proximity to irrigated agriculture other than rice, or because they did not survive dry conditions as determined during the initial analyses performed by the ~~GSA~~GSAs Managers.

2.3 Water Budget

This section describes historical, current, and projected water budgets in accordance with §354.18 of the GSP Emergency Regulations, including quantitative estimates of inflows to and outflows from the basin over time and annual changes in water storage within the basin. Components of the water budgets are depicted in Figure 2-30.

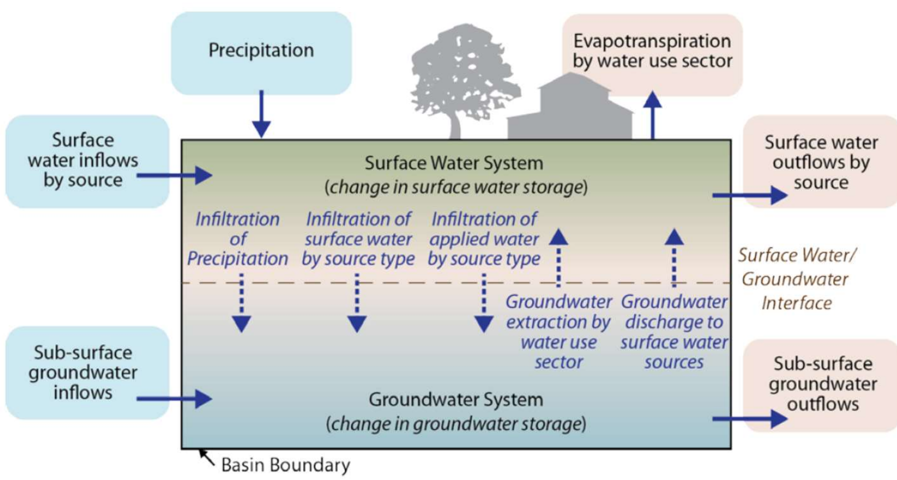


Figure 2-30: Water Budget Components (DWR, 2016)

Water budgets were developed considering hydrology, water demand, water supply, land use, population, climate change, surface water – groundwater interaction, and subsurface groundwater inflows and outflows to and from neighboring basins. Water budget results are reported on a water year basis spanning from October 1 of the prior year to September 30 of the current year.

2.3.1 Selection of Hydrologic Periods

The GSP Emergency Regulations require evaluation of water budgets over a minimum of 10 years for the historical water budget, using the most recent hydrology for the current water budget, and 50 years of hydrology for the projected water budget. Hydrologic periods were selected for each water budget category based on consideration of the best available information and science to support water budget development and based on consideration of the ability of the selected periods to provide a representative range of wet and dry conditions.

- Historical – The 19-year period from water years[6] 2000 to 2018 was selected based on the level of confidence in historical information to support water budget development considering land use, surface water availability, hydrology, and other factors.
- Current Conditions – Historical water budget information for 2018 represents the most recent hydrology~~.~~ (Appendix 2-B). To provide a broader basis for understanding current water budget conditions, a water budget scenario combining most recently available land use and urban demands with 50 years of hydrology was selected. The period selected was 1971 to 2018 (48 years) with 2004 ~~–~~and 2005 (two relatively normal years) repeated at the end of the scenario. An advantage of evaluating the current conditions water budget over a representative 50-year period is that the results provide a baseline for evaluation of the projected water budgets.
- Future Conditions – Consistent with the current conditions water budget, the period selected for the projected water budgets was 1971 to 2018 (48 years) with 2004 ~~–~~and 2005 repeated at the end of the scenarios.
- Selection of the 50-year hydrologic period for the current and projected water budget scenarios was based primarily on three considerations:
  - The BBGM, the primary tool used to develop the water budgets, has a simulation period from water years 1971 to 2018.
  - The Sacramento Valley Water Year Index[7] over the period from 1971 to 2018 has an average of 8.0, as compared to 8.1 for the 103-year period from 1906 to 2018 (1906 is the first year for which the index is available) (Figure 2-31).

[6] A water year is defined as the period from October 1 of the prior year to September 30 of the current year. For example, water year 2000 refers to the period from October 1, 1999 to September 30, 2000.
[7] Additional details describing the Sacramento Valley Water Year Index are available from the California Data Exchange Center (https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST).

- The selected period includes a combination of wet and dry cycles, including relatively wet periods in the early 1970s, mid 1980s, and late 1990s and dry periods in the late 1970s, early 1990s, and from approximately 2007 to 2015.

Additionally, annual precipitation for the 1971 to 2018 period averaged approximately 26.3~~-~~ inches per year, as compared to 24.8 inches for the 1906 to 2018 period.

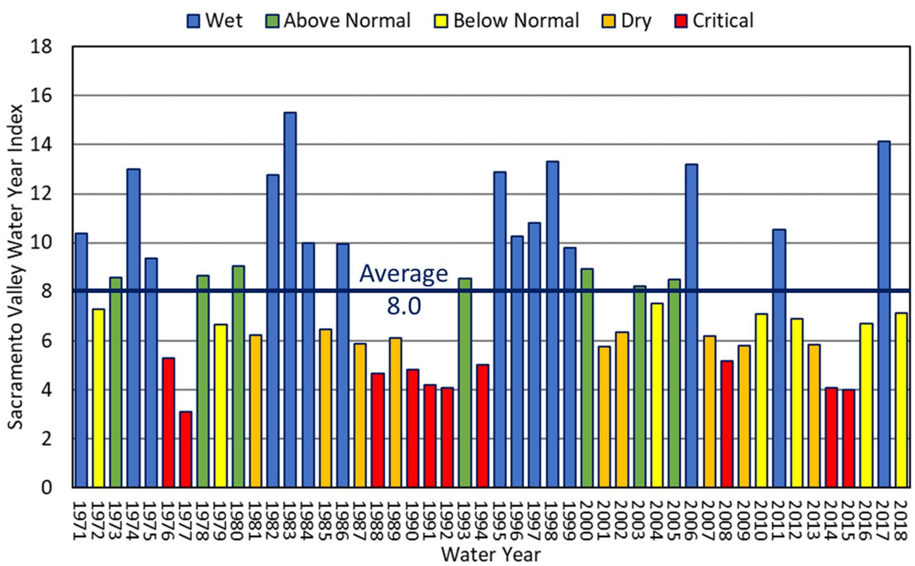


Figure 2-31: 1971 – 2018 Sacramento Valley Water Year Index and Water Year Types

2.3.2 Usage of the Butte Basin Groundwater Model

Development of the original BBGM began in 1992 under the direction and funding of the Butte Basin Water Users Association. The model has been updated over time to simulate historical conditions through water year 2018. The model performs calculations on a daily time step with some daily input (i.e., precipitation, stream inflow), some monthly input data (i.e., surface water diversions~~)~~), and some annual input data (i.e., land use). Refinements to the model over time include additional crop types to better represent ponded crops (i.e., rice and wetlands), recalibrated soil parameters, and elemental land use. The development of the BBGM ~~are~~is described in more detail in (BCDWRC, 2021).

To prepare water budgets for this GSP, historical BBGM results for water years 2000 to 2018 have been relied upon, and four additional baseline scenarios have been developed to represent current and projected conditions utilizing 50 years of hydrology (described previously). Specific assumptions associated with these scenarios are described in the following section.

2.3.3 Water Budget Assumptions

Assumptions utilized to develop the historical, current, and projected water budgets are described below and summarized in Table 2-6.

Table 2-6: Summary of Water Budget Assumptions

Water Budget	Analysis Period	Hydrology	Land Use	Water Supplies
Historical Simulation	2000 – 2018	Historical	Historical	Historical
Current Conditions Baseline	1971 – 2018	Historical	Current (2015 and 2016)	Current (2015 and 2016 surface water diversions, 2016-2018 average urban demands)
Future Conditions, No Climate Change Baseline	1971 – 2018	Historical	Current, adjusted based on Butte County 2030 General Plan	Current (2015 and 2016 Surface water diversions and 2050 projected urban demands)
Future Conditions, 2030 Climate Change Baseline	1971 – 2018	Historical, adjusted based on 2030 climate change	Current, adjusted based on General Plan	Current, adjusted based on climate change
Future Conditions, 2070 Climate Change Baseline	1971 – 2018	Historical, adjusted based on 2070 climate change	Current, adjusted based on General Plan	Current, adjusted based on climate change

2.3.3.1 Historical

A historical water budget was developed to support understanding of past aquifer conditions, considering surface water and groundwater supplies utilized to meet demands. The historical water budget was developed using the BBGM and incorporates the best available science and information. Historical water supplies and aquifer response have been characterized by water year type based on DWR's Sacramento Valley Water Year Index,[8] which classifies water years as wet, above normal, below normal, dry, or critical based on Sacramento River unimpaired flows.

As described previously, water years 2000 to 2018 were selected to provide a minimum of ~~ten~~10 years across a range of hydrologic conditions. This period includes relatively wet years in 2006, 2011, and 2017, as well as dry conditions between 2007 and 2009 and between 2013 and 2015.

Information utilized to develop the historical water budget includes:

- Analysis Period – Water years 2000 to 2018.
- Stream Inflows – Inflows of surface water into the basin were estimated based on stream gage data from USGS and DWR where available (e.g., Butte Creek and Big Chico Creek). For ~~ungauged~~un-gaged streams, inflows were estimated using the National Resource Conservation Service (NRCS) rainfall runoff method applied at the watershed scale, considering precipitation timing and amount, soil characteristics, and other factors.

[8] Sacramento Valley Water Year Index = 0.4 * Current Apr-Jul Runoff Forecast (in ~~maf~~MAF) + 0.3 * Current Oct-Mar Runoff in (~~maf~~MAF) + 0.3 * Previous Water Year's Index (if the Previous Water Year's Index exceeds 10.0, then 10.0 is used). This index, originally specified in the 1995 SWRCB Water Quality Control Plan, is used to determine the Sacramento Valley water year type as implemented in SWRCB D-1641.

Additional detail describing stream inflows is described in the BBGM model report (BCDWRC, 2021).

- Land Use – Land use characteristics for agricultural, native, and urban (including rural residential) lands were estimated annually based on a combination of DWR land use surveys and county agricultural commissioner cropping reports. DWR land use data were available for 1994, 1999, 2004, 2011, 2014, 2015, and 2016. Additional detail describing the development of land use estimates can be found in the BBGM model report (BCDWRC, 2021).
- Agricultural Water Demand – Agricultural irrigation demands were estimated using the BBGM, which simulates crop growth and water use on a daily basis, considering crop type, evapotranspiration, root depth, soil characteristics, and irrigation practices. For ponded land uses (rice and managed wetlands), pond depths and pond drainage are also considered to simulate demands.
- Urban and Industrial Water Demand[9] – Urban and industrial demands were estimated based on a combination of pumping data provided directly by water suppliers (e.g~~.~~., Cal Water) and estimates of population and per capita water use over time. Additional detail describing the development of urban demand estimates can be found in the BBGM model report (BCDWRC, 2021).
- Surface Water Diversions – Surface water diversions were estimated based on a combination of reported diversions by water suppliers and, in some cases, agricultural water demand estimates for areas known to receive surface water, but for which reported diversion data were not available.
- Groundwater Pumping – For urban water suppliers, historical pumping was estimated from reported pumping volumes over time. Pumping to meet agricultural and managed wetlands demands was estimated within the BBGM by first estimating the total demand and then subtracting surface water deliveries to calculate the estimated groundwater pumping required to meet the remaining demand.

2.3.3.2 Current Conditions

The current conditions water budget was developed as a baseline to evaluate projected water budgets considering future conditions and is based on 50 years of hydrology, along with the most recent information describing land use, urban demands, and surface water supplies. The 50-year hydrologic period was selected rather than the most recent year for which historical water budget information is available to allow for direct comparison of potential future conditions to current conditions. The use of a representative hydrologic period containing wet and dry cycles supports the understanding of uncertainty in groundwater conditions over time, establishment of

[9] Current estimates of industrial water use not supplied by urban water suppliers have not been explicitly included at this time and are identified as a data gap that could be filled as part of future GSP updates. These water uses are small relative to other water uses (i.e. agricultural and urban) and tend to be non-consumptive in nature. Additionally, future refinements of the BBGM to incorporate rural residential demands may also be made; these demands were estimated as part of the 2016 Water Inventory & Analysis and are also small relative to other uses.

~~sustainable management criteria~~SMC, and development of projects and management actions to avoid undesirable results.

The current water budget estimates current inflows, outflows, and change in storage for the basin using 50 years of representative hydrology and the most recent water supply, water demand, and land use information.

Information utilized to develop the current conditions baseline water budget include:

- Analysis Period – 50 years of historical hydrology were utilized representing the period from 1971 to 2018, with 2004 and 2005 repeated following 2018.
- Stream Inflows – Inflows of surface water into the basin were estimated utilizing the same information as for the historical water budget.
- Land Use – Land use for agricultural, native, and urban (including rural residential) lands was estimated annually using the most recent land use information. Specifically, 2015 and 2016 land use ~~were~~was mapped to the 50-year analysis period, with 2015 land use applied to extreme dry years and 2016 land use applied to all other years. Extreme dry years were identified based on April to July inflows of the Feather River to Lake Oroville, based on settlement agreements between Feather River water users and the State Water Project. April to July runoff to the Feather River is believed to be a reasonable indicator of surface water supplies and associated changes in cropping patterns within the basin. Land use and surface water supplies are relatively consistent in dry and normal years in the Vina Subbasin.
- Agricultural Water Demand – Agricultural irrigation demands were estimated using the BBGM, in the same manner as the historical water budget.
- Urban and Industrial Water Demand – Urban and industrial demands were estimated based on recent demands. Specifically, average demands for the period 2016 to 2018 were assumed.
- Surface Water Diversions – Similar to land use, surface water diversions were estimated based on 2015 and 2016 conditions, with 2015 ~~diversion~~diversions assumed for extreme dry years and 2016 diversions assumed for other years. For the current ~~conditions~~condition's scenario, reduced surface water was estimated for four years within the 50-year simulation period.
- Groundwater Pumping – Pumping to meet urban demands was estimated based on average 2016 to 2018 demands, as described above. Pumping to meet agricultural and managed wetlands demands was estimated using the BBGM~~,~~ as described previously for the historical water budget.

2.3.3.3 Future Conditions

Three projected water budget scenarios were developed considering a range of future conditions in the ~~subbasin~~Vina Subbasin that may occur, as documented in the Butte County 2030 General Plan. The scenarios consider future planned land use changes (i.e., development), along with changes in climate, including precipitation, surface water inflows, and evapotranspiration. These scenarios provide information regarding changes in basin conditions (e.g., groundwater storage) that may occur in the future over a series of wet and dry cycles.

The projected water budget estimates potential future inflows, outflows, and change in storage for the basin using 50 years of representative hydrology (including modifications based on climate change projections), the most recent water supply and water demand, and planned future land use information.

Information utilized to develop the future conditions water budgets include:

- Analysis Period – 50 years of hydrology were utilized representing the period from 1971 to 2018, with 2004 and 2005 repeated following 2018.
- Stream Inflows:
  - Future Conditions, No Climate Change – Inflows of surface water into the basin were estimated utilizing the same information as for the historical water budget.
  - Future Conditions, 2030 Climate Change – Precipitation, evapotranspiration, and surface water supplies were adjusted to reflect climate change based on the 2030 Central Tendency climate change datasets provided by DWR to support GSP development.
    - For precipitation and evapotranspiration, monthly change factors were applied to historical values to estimate potential future conditions.
    - For streamflows, DWR estimates of stream inflows were utilized where available; for streams without direct estimates of inflows, inflows were estimated using streamflow change factors applied at the watershed scale.
  - Future Conditions, 2070 Climate Change – Precipitation, evapotranspiration, and surface water supplies were adjusted to reflect climate change based on the 2070 Central Tendency climate change datasets provided by DWR to support GSP development.
    - For precipitation and evapotranspiration, monthly change factors were applied to historical values to estimate potential future conditions.
    - For streamflows, DWR estimates of stream inflows were utilized where available; for streams without direct estimates of inflows, inflows were estimated using streamflow change factors applied at the watershed scale.
- Land Use – Land use for agricultural, native, and urban (including rural residential) lands was estimated annually using the most recent land use information and modified based on planned development according to the 2030 General Plan. Specifically, 2015 and 2016 land use ~~were~~was mapped to the 50-year analysis period, with 2015 land use applied to extreme dry years and 2016 land use applied to all other years. 2015 and 2016 land use data were modified to reflect planned development, generally resulting in an increase in urban land through development of previously undeveloped (i.e~~.~~., native) lands.
  - Future Conditions, No Climate Change – 2015 and 2016 land use data were mapped to the 50-year analysis period in the same manner as the current conditions water

budget scenario, with modifications based on planned development based on the General Plan.

- Future Conditions, 2030 Climate Change – 2015 and 2016 land use data were mapped to the 50-year analysis period considering 2030 central tendency climate change projections, with 2015 land use used for extreme dry years and 2016 land use used for all other years.
- Future Conditions, 2070 Climate Change – 2015 and 2016 land use data were mapped to the 50-year analysis period considering 2070 central tendency climate change projections, with 2015 land use used for extreme dry years and 2016 land use used for all other years.

- Agricultural Water Demand – Agricultural irrigation demands were estimated using the BBGM, in the same manner as the historical water budget.
- Urban and Industrial Water Demand – Urban and industrial demands were estimated based on projected urban demands. Specifically, future urban demands were estimated based on preliminary draft demand estimates provided by urban water suppliers (e.g.~~.~~, Cal Water) as part of 2020 ~~Urban Water Management Plan (~~UWMP~~)~~ development.
- Surface Water Diversions – Similar to land use, surface water diversions were estimated based on 2015 and 2016 conditions, with 2015 diversions assumed for extreme dry years and 2016 diversions assumed for other years.
  - For the 2030 central tendency scenario, extreme dry conditions occurred ~~eleven~~for 11 years within the 50-year simulation period.
  - For the 2070 central tendency scenario, extreme dry conditions occurred ~~thirteen~~for 13 years within the 50-year simulation period.
- Groundwater Pumping – Pumping to meet urban demands was estimated based on draft projections from UWMPs currently under development, as described above. Pumping to meet agricultural and managed wetlands demands was estimated using the BBGM, as described previously for the historical water budget.

2.3.4 Water Budget Estimates

As described previously, water budget estimates were developed using the BBGM. Primary components of the land and surface water system water budget include the following:

- Inflows:
  - Surface Water Inflows – Inflows at the land surface through streams, canals, or other waterways. These inflows may also include overland flow from upslope areas outside ~~of~~ the basin. Although interactions with the Sacramento River along the boundary of the basin (i.e., diversions and stream-aquifer interaction) are accounted for, the flow in the stream is not considered an inflow to the basin. Inflows from streams that traverse the basin are accounted for explicitly.
  - Precipitation – Rainfall intercepting the ground surface within the basin boundary.

- Groundwater pumping – Extraction of groundwater to meet agricultural, urban, managed wetlands, or other beneficial uses.
- Stream Accretions – Gains in streamflow from shallow groundwater occurring when the water level in the aquifer adjacent to the stream is greater than the water level in the stream.

- Outflows:
  - Surface Water Outflows – Outflows at the land surface through streams, canals, or other waterways. These outflows may also include overland flow to downslope areas outside of the basin.
  - Evapotranspiration – Consumptive use of water including both evaporation and transpiration components.
  - Deep Percolation – Recharge of the groundwater system through the vertical movement of precipitation and applied irrigation water below the root zone.
  - Seepage (Also referred to as Losses or Leakage) – Recharge of the groundwater system from streams, canals, or other water bodies.
- Change in Storage – Changes in soil moisture storage within the upper several feet of soil in the root zone, as well as changes in storage in surface water bodies within the basin. These changes are generally negligible on an annual basis but vary over the course of a year based on precipitation patterns and other factors.

Primary components of the groundwater system water budget include the following:

- Inflows:
  - Deep Percolation – Described above.
  - Subsurface Inflows – Groundwater inflows from adjacent basins or from the foothill area.
  - Seepage – Described above.
- Outflows:
  - Groundwater Pumping – Described above.
  - Subsurface Outflows – Groundwater outflows to adjacent basins.
  - Accretions – Described above.
- Change in Storage – Changes in water storage in the aquifer system. These changes tend to be large compared to changes in root zone soil moisture storage and can vary substantially from year to year.

Many components of the water budget can be estimated based on measured data (e.g., precipitation, diversions, evapotranspiration, etc.) and are used to develop inputs to the BBGM to support water budget development. Other components are more difficult to measure or do not have measured values readily available (e.g., deep percolation, subsurface flows, groundwater pumping, surface water-groundwater interaction, etc.) and are estimated using the BBGM. Additional detail describing the BBGM is available in ~~(~~BCDWRC~~,~~ (2021).

Average annual water budget estimates for the historical water budgets and for the current and projected water budget scenarios are summarized in Table 2-7 for the land and surface water system and in Table 2-8 for the groundwater system.

As seen in Table 2-8, there is a significant difference in the calculated change in storage for the historical scenario (-19,600 AFY) versus the current and future scenarios (-1,~~100~~200 to -2,~~600~~700 AFY). The primary reason for this difference is the time period used for the calculations. As discussed above, the historical scenario only uses a 19-year period from 2000 to 2018; whereas. the other scenarios use a 50-year period as required by SGMA from 1971 to 2018 (2004 and 2005 repeated after 2018). Figure 2-32 illustrates the sensitivity to the time period selected for the calculation of change in storage using the current scenario graph of change in storage.

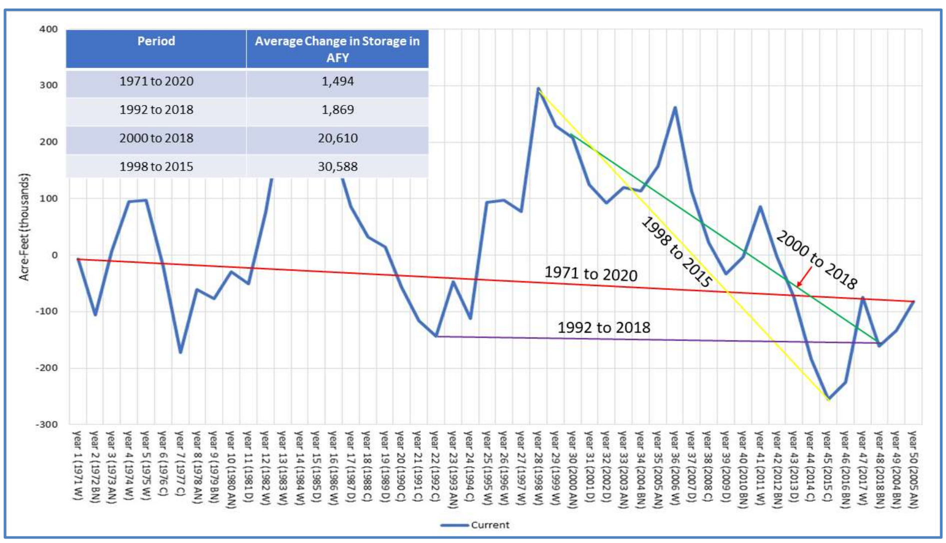


Figure 2-32: Sensitivity to the Change in Storage to ~~The~~the Time Period Selected for the Calculation.
Graph ~~Used~~used is the ~~Current Conditions Scenario~~current conditions scenario as ~~Discussed~~discussed in Section 2.3.3.2.

As seen in this figure, a wide range of change in storage values are calculated depending on the time period selected. However, for development of the ~~sustainable management criteria~~SMC, as discussed in ~~Chapter~~Section 3, it is important to view these values in relationship to the total storage of the ~~Basin.~~Vina Subbasin. As ~~discussed in BCDWRC (2021), the~~ estimated by the BBGM, total storage of the Vina Subbasin is about 16-~~-~~million acre-~~-~~feet (MAF~~)~~), indicating that the calculated annual change in storage values shown in Figure 2-32 ~~are~~is only 0.009 to 0.2

percent of the total storage of the Vina Subbasin. The calculated change in storage values ~~are~~is also within the range of error for the BBGM.

Additional information and discussion regarding the water budgets ~~is~~are provided in the following subsections. It is anticipated that the water budgets will be refined and updated over time as part of GSP implementation in the basin.

Table 2-7: Water Budget Summary: Land and Surface Water System

Component	Historical (AFY)	Current (AFY)	Future, No Climate Change (AFY)	Future, 2030 Climate Change (AFY)	Future, 2070 Climate Change (AFY)
Inflows					
Surface Water Inflows	**554,800**	**602,300**	**601,900**	**630,600**	**652,200**
Outside Diversions	*400*	*400*	*400*	*400*	*400*
Butte Creek	*298,100*	*324,900*	*324,900*	*339,200*	*348,700*
Big Chico Creek	*111,200*	*114,500*	*113,700*	*118,000*	*120,500*
Pine Creek	*13,400*	*14,200*	*14,200*	*14,800*	*15,000*
Dry Creek	*14,000*	*14,500*	*14,500*	*15,000*	*15,300*
Rock Creek	*16,600*	*17,200*	*17,200*	*17,700*	*17,700*
Little Chico Creek	*17,800*	*20,700*	*20,400*	*21,000*	*21,100*
Mud Creek	*14,400*	*17,400*	*17,300*	*17,800*	*17,900*
Singer Creek	*1,500*	*1,700*	*1,700*	*1,700*	*1,800*
Little Dry Creek	*3,200*	*5,800*	*5,800*	*6,000*	*5,900*
Precipitation Runoff from Upslope Lands	*61,600*	*69,000*	*69,900*	*77,500*	*86,300*
Applied Water Return Flows from Upslope Lands	*2,600*	*1,900*	*1,900*	*1,700*	*1,600*
Precipitation	**410,900**	**421,700**	**421,700**	**438,200**	**453,100**
Groundwater Pumping	**243,500**	**209,200**	**215,800**	**225,900**	**238,000**
Agricultural	*209,100*	*185,500*	*184,800*	*194,700*	*206,800*
Urban and Industrial	*26,500*	*20,100*	*27,500*	*27,500*	*27,500*
Managed Wetlands	*8,000*	*3,500*	*3,500*	*3,600*	*3,700*
Stream Gains from Groundwater	**3,700**	**1,100**	**1,000**	**1,000**	**1,000**
Total Inflow	***1,212,900***	***1,234,300***	***1,240,400***	***1,295,700***	***1,344,300***
Outflows					
Evapotranspiration	362,900	348,300	347,300	358,200	371,400
Agricultural	*253,500*	*243,000*	*242,000*	*250,700*	*262,300*
Urban and Industrial	*21,800*	*20,900*	*27,400*	*27,900*	*28,400*
Managed Wetlands	*6,000*	*3,000*	*3,000*	*3,100*	*3,100*
Native Vegetation	*81,200*	*80,900*	*74,400*	*76,100*	*77,200*

Component	Historical (AFY)	Current (AFY)	Future, No Climate Change (AFY)	Future, 2030 Climate Change (AFY)	Future, 2070 Climate Change (AFY)
Canal Evaporation	*400*	*500*	*500*	*400*	*400*
Deep Percolation	192,700	191,800	189,300	194,500	196,800
Precipitation	*120,200*	*125,400*	*120,400*	*123,500*	*123,600*
Applied Surface Water	*4,800*	*5,600*	*5,600*	*4,900*	*4,500*
Applied Groundwater	*67,600*	*60,900*	*63,300*	*66,100*	*68,700*
Seepage	24,000	27,700	27,800	27,800	27,400
Streams	*20,800*	*24,100*	*24,200*	*24,600*	*24,400*
Canals and Drains	*3,200*	*3,600*	*3,600*	*3,200*	*3,000*
Surface Water Outflows	633,300	666,300	675,900	715,100	748,700
Precipitation Runoff	*57,900*	*58,300*	*62,100*	*66,700*	*72,800*
Applied Surface Water Return Flows	*2,200*	*2,800*	*2,800*	*2,200*	*1,800*
Applied Groundwater Return Flows	*20,200*	*14,000*	*16,000*	*16,000*	*16,000*
Streams	*525,500*	*563,800*	*567,600*	*605,200*	*633,600*
Butte Creek Diversions to Butte Subbasin	*27,500*	*27,400*	*27,400*	*25,100*	*24,400*
Total Outflow	***1,~~213,000~~212,900***	***1,234,~~200~~100***	***1,240,300***	***1,295,600***	***1,344,300***
Change in Storage (Inflow - Outflow)	***~~-100~~0***	***~~100~~200***	***100***	***100***	***0***

Notes:
AFY = Acre feet per year.
1. Totals are the sum of numbers in bold

~~Note:~~
~~AFY = acre-feet per year~~

Table 2-8: Water Budget Summary: Groundwater System

Component	Historical (AFY)	Current (AFY)	Future, No Climate Change (AFY)	Future, 2030 Climate Change (AFY)	Future, 2070 Climate Change (AFY)
Inflows					
Subsurface Inflows	**137,400**	**143,200**	**142,800**	**144,600**	**145,500**
Foothill Area	*45,700*	*50,100*	*49,700*	*50,600*	*50,600*
Los Molinos Subbasin	*63,000*	*67,000*	*67,300*	*67,900*	*68,100*
Butte Subbasin	*28,600*	*25,900*	*25,500*	*25,800*	*26,600*
Wyandotte Creek Subbasin	*200*	*300*	*200*	*300*	*300*
Deep Percolation	**192,700**	**191,800**	**189,300**	**194,500**	**196,800**
Precipitation	*120,200*	*125,400*	*120,400*	*123,500*	*123,600*
Applied Surface Water	*4,800*	*5,600*	*5,600*	*4,900*	*4,500*
Applied Groundwater	*67,600*	*60,900*	*63,300*	*66,100*	*68,700*
Seepage	**24,000**	**27,700**	**27,800**	**27,800**	**27,400**
Streams	*20,800*	*24,100*	*24,200*	*24,600*	*24,400*
Canals and Drains	*3,200*	*3,600*	*3,600*	*3,200*	*3,000*
Total Inflow	***~~838~~354,100***	***~~844,500~~362,700***	***~~842,800~~359,900***	***~~852,700~~366,900***	***~~857,200~~369,700***
Outflows					
Subsurface Outflows	**70,400**	**76,200**	**72,000**	**70,700**	**67,800**
Foothill Area	*300*	*200*	*200*	*200*	*200*
Los Molinos Subbasin	*4,700*	*900*	*900*	*900*	*900*
Butte Subbasin	*65,400*	*75,100*	*70,800*	*69,500*	*66,600*
Wyandotte Creek Subbasin	*0*	*0*	*0*	*0*	*0*
Groundwater Pumping	**243,500**	**209,200**	**215,800**	**225,900**	**238,000**
Agricultural	*209,100*	*185,500*	*184,800*	*194,700*	*206,800*
Urban and Industrial	*26,500*	*20,100*	*27,500*	*27,500*	*27,500*
Managed Wetlands	*8,000*	*3,500*	*3,500*	*3,600*	*3,700*
Stream Gains from Groundwater	**3,700**	**1,100**	**1,000**	**1,000**	**1,000**
Western Boundary Net Outflows	**56,100**	**77,400**	**73,000**	**71,000**	**65,600**
Total Outflow	***~~857~~373,700***	***~~845,600~~363,900***	***~~844,600~~361,800***	***~~854,400~~368,600***	***~~859,800~~372,400***
Change in Storage (Inflow - Outflow)	***-19,600***	***-1,~~100~~200***	***-1,~~700~~900***	***-1,700***	***-2,~~600~~700***

Notes:
AFY = Acre feet per year.
1. Totals are the sum of numbers in bold

2.3.4.1 Historical

The historical water budget provides a foundation for how the basin has behaved historically, including insight into historical groundwater conditions (e.g., observed water levels). Also, in accordance with the GSP Regulations, the historical water budget covers a period of at least ~~ten~~10 years, is used to evaluate the availability and reliability of historical surface water supplies~~,~~ and provides insight into the ability to operate the basin within the sustainable yield. The Vina Subbasin opted to use the 19-year period from 2000 to 2018. The historical analysis period experienced somewhat less precipitation than the long-term average and included historic drought conditions from approximately 2007 to 2015.[10]

Average annual inflows to and outflows from the basin for the historical land and surface water system water budget were estimated to be 1.21 ~~million acre-feet (~~MAF~~)~~ per year. Average annual values were presented previously in Table 2-7 and are shown graphically in Figure 2-33.

Primary inflows to the land and surface water system include surface water inflows (555 TAF/year), precipitation (411 TAF/year), and groundwater pumping (243 TAF/year), with estimated stream gains from groundwater (i.e., accretions) of approximately 4 TAF/year. Surface water inflows include Butte Creek, Big Chico Creek, and several other streams, as well as overland runoff of precipitation and applied water from upslope lands.

Primary outflows from the land and surface water system include surface water outflows (633 TAF/year), evapotranspiration (363 TAF/year), deep percolation (193 TAF/year), and stream losses (also referred to as seepage) (24 TAF/year). Surface water outflows include outflows through Butte Creek, Big Chico Creek, and other streams, as well as overland runoff of precipitation and applied water to downslope lands. Additionally, water is diverted from Butte Creek for use in the Butte Subbasin. Evapotranspiration is primarily from agricultural lands but also from native vegetation, urban and industrial lands, managed wetlands, and canal evaporation. Deep percolation is primarily from precipitation, but also from applied water.

The average annual change in storage in the land and surface water system is negligible due to similar soil moisture content in the root zone, on average, across water years, and limited storage capacity exists in surface water bodies within the basin.

Additional details describing the historical land and surface water system water budget are provided in Appendix 2-B.

[10] For the 2000 to 2018 period, mean annual precipitation was 26.7 inches, compared to 23.1 inches for the 2007 to 2015 period.

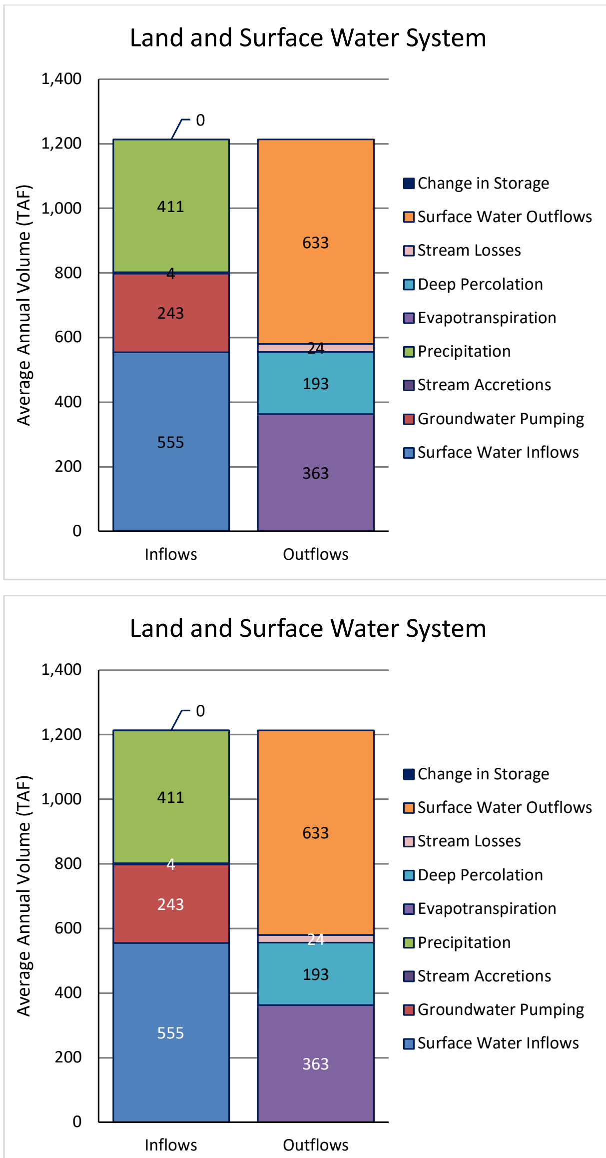


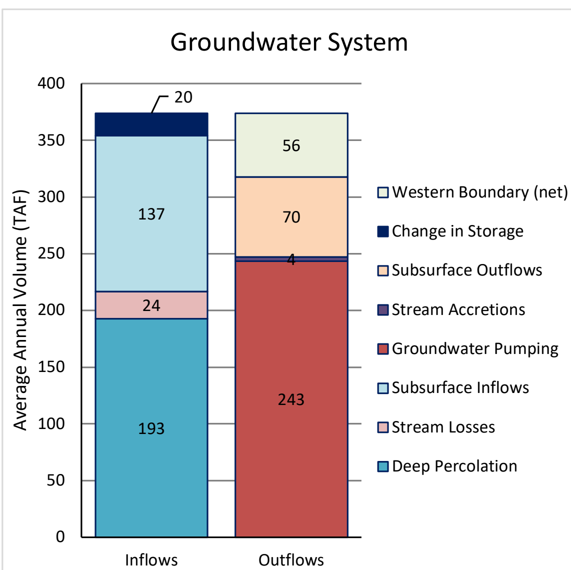
Figure 2-33: Average Annual Historical Land and Surface Water System Water Budget

Average annual inflows to and outflows from the groundwater system were estimated to be 838~~-~~ TAF and 858 TAF, respectively, with an average decrease in groundwater storage of 20~~-~~ TAF~~ per ~~\year during the historical simulation period. Average annual values were presented previously in Table 2-8 and are shown graphically in Figure 2-34.

Inflows to the groundwater system include deep percolation (193 ~~thousand acre-feet per~~ TAF/year [TAF/~~yr~~year]); subsurface inflows from the Los Molinos, Butte, and Wyandotte Creek subbasins and from the foothill area (137 TAF/~~yr~~year); and stream losses (24 TAF/~~yr~~year). Outflows from the groundwater system include groundwater pumping (243 TAF/~~yr~~year); subsurface outflows to the Butte, Los Molinos, and Wyandotte Creek ~~subbasins~~Subbasins and to the foothill area (70 TAF/~~yr~~year); western boundary net outflows (56 TAF/~~yr~~year); and stream gains from groundwater (4 TAF/~~yr~~year).

Western boundary net outflows represent Sacramento River gains from groundwater and subsurface outflows to the Corning Subbasin. The split between these outflows is uncertain at this time and identified as a data gap. It is anticipated that this data gap will be addressed through future refinements to the BBGM and through coordination and collaboration with neighboring subbasins as part of GSP implementation.

Additional details describing the historical groundwater system water budget are provided in Appendix 2-B.



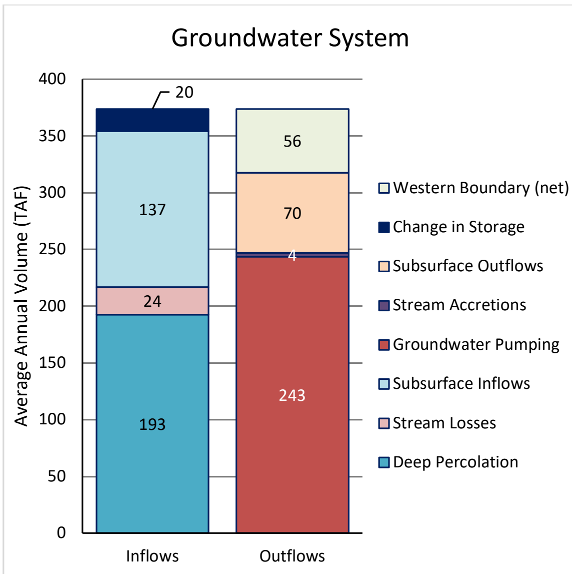


Figure 2-34: Average Annual Historical Groundwater System Water Budget

Historical water supplies and change in groundwater storage are summarized by water year type in Table 2-9 based on the Sacramento Valley Water Year Index, which classifies water years as wet, above normal, below normal, dry, or critical based on Sacramento River unimpaired runoff. Between 2000 and 2018, there were three wet years, three above normal years, five below normal years, five dry years, and three critical years. Historical surface water deliveries were greatest in wet years and least in critical years. Conversely, groundwater pumping has been least in wet years and greatest in critical years. Historically, groundwater storage in the basin has tended to increase in wet and above normal years and to decrease in below normal, dry, and critical years.

Table 2-9: Historical Water Supplies and Change in Groundwater Storage by Hydrologic Water Year Type

Water Year Type	Surface Water Deliveries (AFY)	Groundwater Pumping (AFY)	Total Supply (AFY)	Change in Groundwater Storage (AFY)
Wet	24,000	198,600	222,700	117,900
Above Normal	21,100	222,800	243,900	10,700
Below Normal	20,600	235,500	256,200	-19,200
Dry	17,300	266,600	284,000	-82,000
Critical	12,200	283,700	295,800	-84,500

Availability or Reliability of Historical Surface Water Supplies
As indicated in Table 2-9, historical surface water supplies for delivery to agricultural land vary based on water year type, with less availability in drier years. The primary source of surface water in the basin is Butte Creek, which is an undammed stream. Historically, water has been diverted to the Toadtown Canal from the West Branch of the Feather River for power generation and cold water for fish by PG&E. The Butte Canal carries Toadtown Canal and Butte Creek water to the De Sabla power plant forebay. Hydropower is also generated at several other locations. Operations at all of these sites affect the timing of water releases. At Oroville-Thermalito, Toadtown, and De Sabla-Centerville, water for power generation is transferred from the Feather River watershed to the Butte Creek watershed.

Despite the ability to convey water from the Feather River watershed to Butte Creek, flows during summer months are limited and perform important environmental functions, reducing the reliability of surface water to support other beneficial uses. Diversions claimed after 1914 including both riparian and appropriative surface water rights require permits from the State ~~Water Resources Control~~ Board. Surface water rights are subject to curtailment by the State Board during drought conditions. Water rights holders are required to report surface water diversions to the State Board. Based on the State Board's electronic Water Rights Information Management System (eWRIMs), there are an estimated 60 points of diversion in the Vina Subbasin representing 53 water rights applications and statements of use.

Suitability of Tools and Methods for Planning
The water budgets presented herein have been developed using the best available information and best available science and structured in a manner consistent with the ~~hydrogeologic conceptual model~~HCM of the basin. The BBGM, which is used to organize information for the water budgets, develop water budget scenarios, and perform water budget calculations, is currently the best available tool and is suitable for GSP development for the ~~subbasin.~~Vina Subbasin. The BBGM has been developed over the past several decades and updated over time to use updated model code, updated datasets, and updated input parameters through a series of efforts. Refinements to the BBGM have been made through extensive engagement with local stakeholders through a series of past efforts.

The water budgets developed using the BBGM support the development of ~~sustainable management criteria~~SMC, evaluation of the monitoring network, and development of projects and management actions as part of GSP development. It is anticipated that the BBGM will be updated and refined in the future as part of GSP implementation. Additional information describing the BBGM is available in BCDWRC (2021).

~~***Ability to Operate the Basin within the Sustainable Yield***~~
~~Sustainable yield refers to the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin, and including any temporary surplus that can be withdrawn annually from a groundwater supply without causing an undesirable result. As a result, determination of sustainable yield requires consideration of SGMA's six sustainability indicators. Historical water budget estimates indicate an average annual decrease in storage of 20 thousand acre-feet per year for the period from water year 2000 to 2018. In general, decreased precipitation and increased groundwater pumping in dry years leads to decreases in groundwater levels and storage and may pose challenges to operating within the sustainable yield over~~

~~multiple dry years. Operation of the basin within the sustainable yield will likely require incorporation of projects and management actions into the GSP and implementation over the 50-year SGMA planning and implementation horizon.~~ ~~The estimated sustainable yield of the basin is described in greater detail in Section 2.3.6.~~

2.3.4.2 Current Conditions

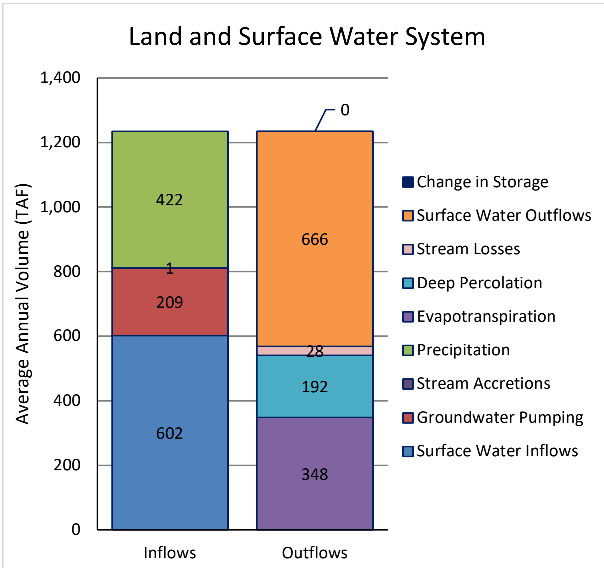
The current conditions baseline water budget provides a foundation to understand the behavior of the basin considering current land use and urban demands over a broad range of hydrologic conditions, as well as a basis for evaluating how groundwater conditions may change in the future based on comparison of water budget results to projected water budgets presented in the following section. A 50-year hydrologic period was selected, rather than a single, recent year to capture effects of long-~~-~~term hydrologic variability.

Average annual inflows to and outflows from the basin for the current conditions land and surface water system baseline water budget were estimated to be 1.23 MAF per year. Average annual values were presented previously in Table 2-7 and are shown graphically in Figure 2-35.

Primary inflows to the land and surface water system include surface water inflows (602 TAF/~~yr~~year), precipitation (422 TAF/~~yr~~year), and groundwater pumping (209 TAF/~~yr~~year), with estimated stream gains from groundwater (i.e~~.~~., accretions) of approximately ~~1~~one TAF/~~yr~~year. Surface water inflows include Butte Creek, Big Chico Creek, and several other streams, as well as overland runoff of precipitation and applied water from upslope lands. A minor inflow includes diversions of surface water that occur outside of the basin and are conveyed into the basin for use.

Primary outflows from the land and surface water system include surface water outflows (666 TAF/~~yr~~year), evapotranspiration (348 TAF/~~yr~~year), deep percolation (192 TAF/~~yr~~year), and stream losses (also referred to as seepage) (28 TAF/~~yr~~year). Surface water outflows include outflows through Butte Creek, Big Chico Creek, and other streams, as well as overland runoff of precipitation and applied water to downslope lands. Additionally, water is diverted from Butte Creek for use in the Butte Subbasin. Evapotranspiration is primarily from agricultural lands, but also from native vegetation, urban and industrial lands, managed wetlands, and canal evaporation. Deep percolation is primarily from precipitation, but also from applied water.

The average annual change in storage in the land and surface water system is negligible due to similar soil moisture content in the root zone, on average, across water years, and limited storage capacity exists in surface water bodies within the basin.



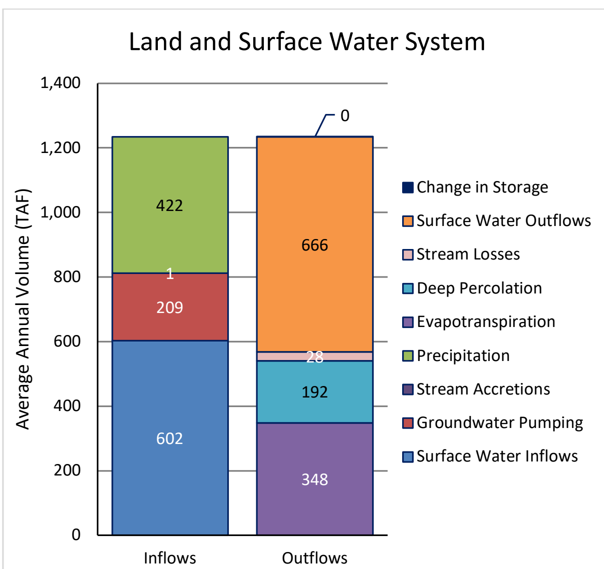


Figure 2-35: Average Annual Current Conditions Land and Surface Water System Water Budget

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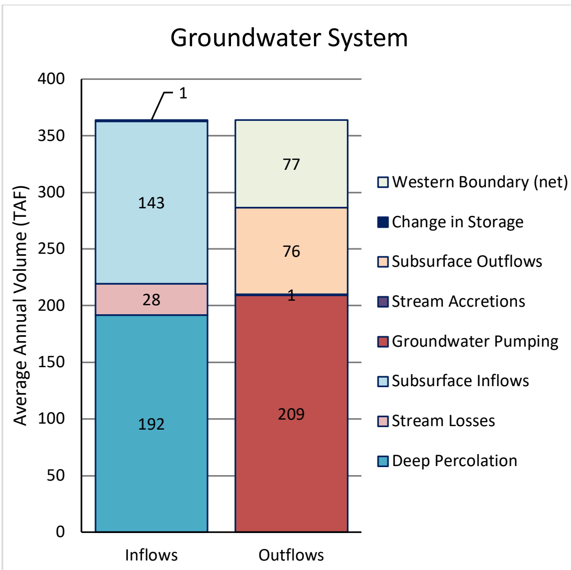
Average annual inflows to and outflows from the groundwater system were estimated to be 845 TAF and 846 TAF, respectively, with an average decrease in groundwater storage of ~~1~~one TAF per year during the 50-year simulation period. Average annual values were presented previously in Table 2-8 and are shown graphically in Figure 2-36.

Inflows to the groundwater system include deep percolation (192 TAF/~~yr~~year); subsurface inflows from the Los Molinos, Butte, and Wyandotte Creek ~~subbasins~~Subbasins and from the foothill area (143 TAF/~~yr~~year); and stream losses (28 TAF/~~yr~~year). Outflows from the groundwater system include groundwater pumping (209 TAF/~~yr~~year); subsurface outflows to the Butte, Los Molinos, and Wyandotte Creek ~~subbasins~~Subbasins and to the foothill area (76 TAF/~~yr~~year); western boundary net outflows (77 TAF/~~yr~~year); and stream gains from groundwater (1 TAF/~~yr).~~

~~Western boundary net outflows represent Sacramento River gains from groundwater and subsurface outflows to the Corning Subbasin. The split between these outflows is uncertain at this time and identified as a data gap. It is anticipated that this data gap will be addressed through future refinements to the BBGM and through coordination and collaboration with neighboring subbasins as part of GSP implementation.~~

year).

Western boundary net outflows represent Sacramento River gains from groundwater and subsurface outflows to the Corning Subbasin. The split between these outflows is uncertain at this time and identified as a data gap. It is anticipated that this data gap will be addressed through future refinements to the BBGM and through coordination and collaboration with neighboring subbasins as part of GSP implementation.



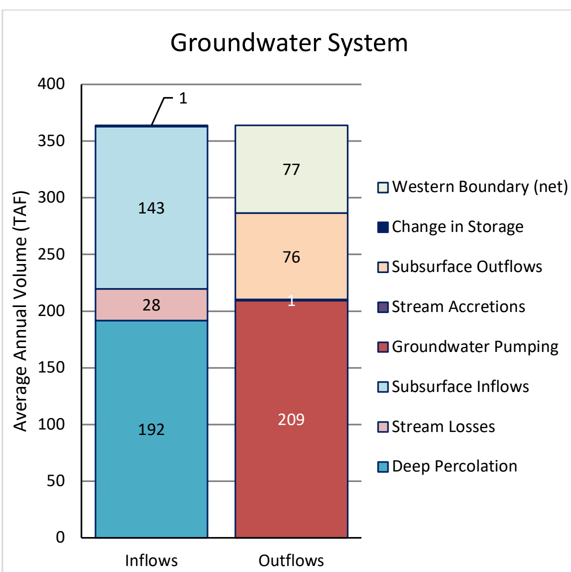


Figure 2-36: Average Annual Current Conditions Groundwater System Water Budget

2.3.4.3 Future Conditions

Three projected water budgets were developed for the basin to provide baseline scenarios representing potential future conditions considering planned development under the 2030 General Plan and climate change centered around 2030 and 2070 based on central tendency climate change datasets provided by DWR. The projected water budget scenarios provide a foundation to understand the behavior of the basin considering potential land use and urban demands over a broad range of hydrologic conditions, modified based on climate change projections). Use of a 50-year hydrologic period ~~-~~captures effects of long~~-~~-term hydrologic variability.

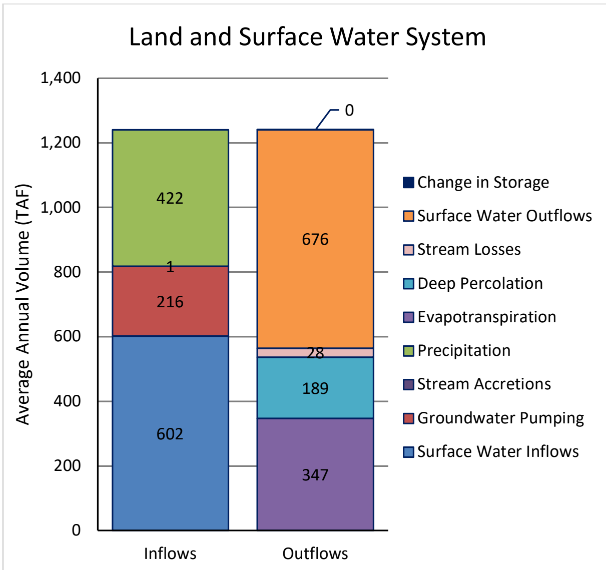
Future Conditions, No Climate Change

Average annual inflows to and outflows from the basin for the future conditions without climate change projected land and surface water system baseline water budget were estimated to be 1.24 MAF~~ per ~~/year. Average annual values were presented previously in Table 2-7 and are shown graphically in Figure 2-37.

Primary inflows to the land and surface water system include surface water inflows (602 TAF/~~yr~~year), precipitation (422 TAF/~~yr~~year), and groundwater pumping (216 TAF/~~yr~~year), with estimated stream gains from groundwater (i.e., accretions) of approximately ~~1~~one TAF/~~yr~~year. Surface water inflows include Butte Creek, Big Chico Creek, and several other streams, as well as overland runoff of precipitation and applied water from upslope lands. A minor inflow includes diversions of surface water that occur outside of the basin and are conveyed into the basin for use.

Primary outflows from the land and surface water system include surface water outflows (676 TAF/~~yr~~year), evapotranspiration (347 TAF/~~yr~~year), deep percolation (189 TAF/~~yr~~year), and stream losses (also referred to as seepage) (28 TAF/~~yr~~year). Surface water outflows include outflows through Butte Creek, Big Chico Creek, and other streams, as well as overland runoff of precipitation and applied water to downslope lands. Additionally, water is diverted from Butte Creek for use in the Butte Subbasin. Evapotranspiration is primarily from agricultural lands but also from native vegetation, urban and industrial lands, managed wetlands, and canal evaporation. Deep percolation is primarily from precipitation, but also from applied water.

The average annual change in storage in the land and surface water system is negligible due to similar soil moisture content in the root zone, on average, across water years, and limited storage capacity exists in surface water bodies within the basin.



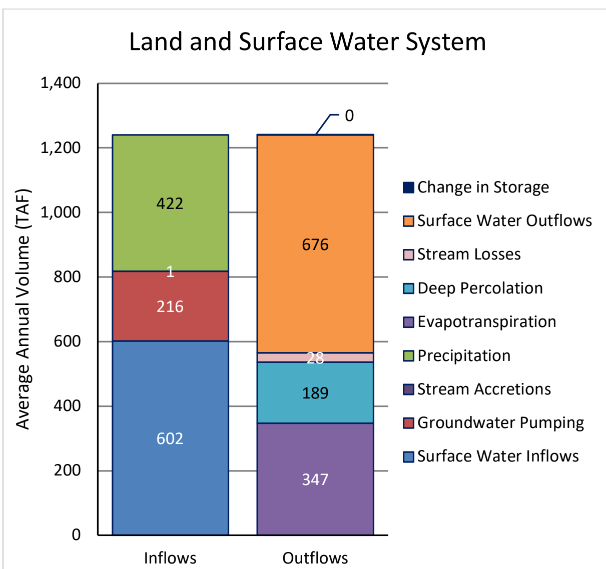
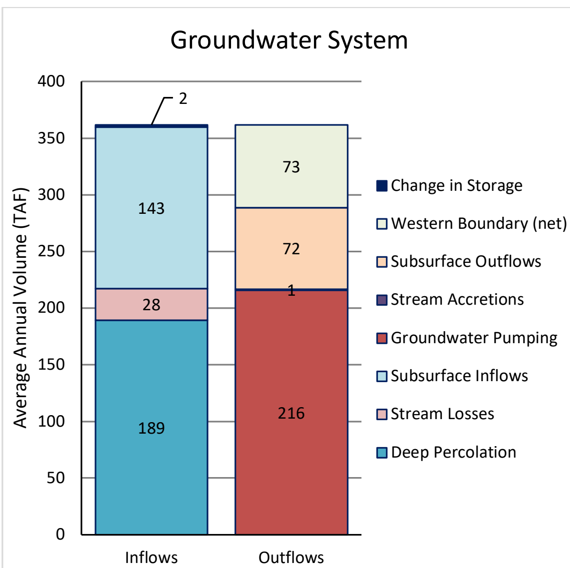


Figure 2-37: Average Annual Future Conditions without Climate Change Land and Surface Water System Water Budget

Average annual inflows to and outflows from the groundwater system were estimated to be 843 TAF and 845 TAF, respectively, with an average decrease in groundwater storage of ~~2~~two TAF ~~per~~ /year during the 50-year simulation period. Average annual values were presented previously in Table 2-8 and are shown graphically in Figure 2-38.

Inflows to the groundwater system include deep percolation (189 TAF/~~yr~~year); subsurface inflows from the Los Molinos, Butte, and Wyandotte Creek ~~subbasins~~Subbasins and from the foothill area (143 TAF/~~yr~~year); and stream losses (28 TAF/~~yr~~year). Outflows from the groundwater system include groundwater pumping (216 TAF/~~yr~~year); subsurface outflows to the Butte, Los Molinos, and Wyandotte Creek ~~subbasins~~Subbasins and to the foothill area (72 TAF/~~yr~~year); western boundary net outflows (73 TAF/~~yr~~year); and stream gains from groundwater (1 TAF/~~yr~~year).

Western boundary net outflows represent Sacramento River gains from groundwater and subsurface outflows to the Corning Subbasin. The split between these outflows is uncertain at this time and identified as a data gap. It is anticipated that this data gap will be addressed through future refinements to the BBGM and through coordination and collaboration with neighboring subbasins as part of GSP implementation.



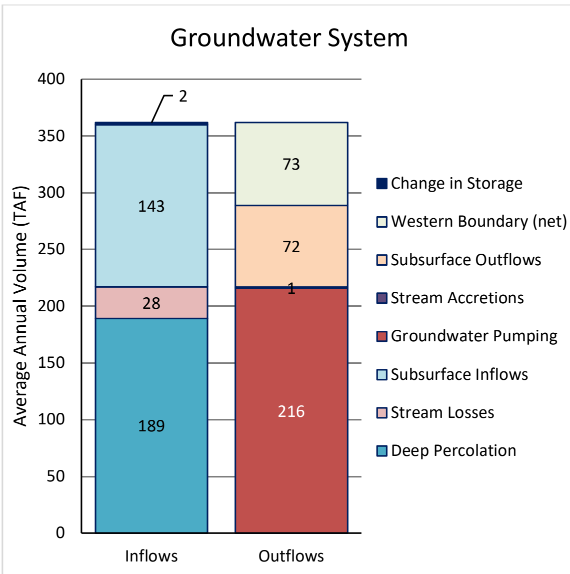


Figure 2-38: Average Annual Future Conditions without Climate Change Groundwater System Water Budget

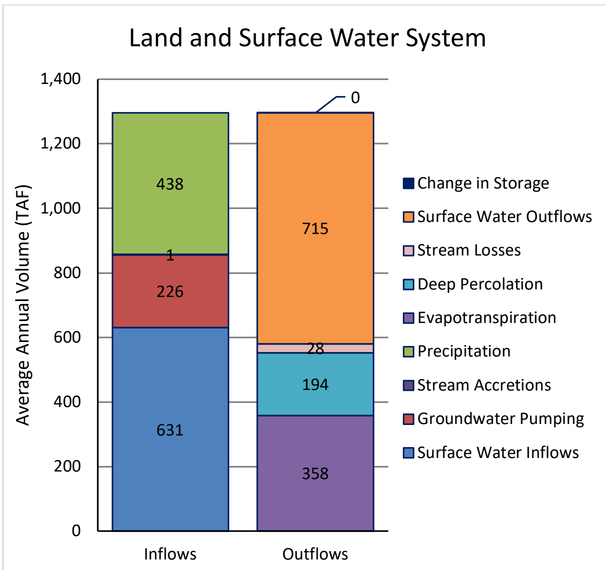
Future Conditions, 2030 Climate Change

Average annual inflows to and outflows from the basin for the future conditions with 2030 climate change projected land and surface water system baseline water budget were estimated to be 1.30 MAF~~ per ~~/year. Average annual values were presented previously in Table 2-7 and are shown graphically in Figure 2-39.

Primary inflows to the land and surface water system include surface water inflows (631 TAF/~~yr~~year), precipitation (438 TAF/~~yr~~year), and groundwater pumping (226 TAF/~~yr~~year), with estimated stream gains from groundwater (i.e., accretions) of approximately ~~1~~one TAF/~~yr~~year. Surface water inflows include Butte Creek, Big Chico Creek, and several other streams, as well as overland runoff of precipitation and applied water from upslope lands. A minor inflow includes diversions of surface water that occur outside of the basin and are conveyed into the basin for use.

Primary outflows from the land and surface water system include surface water outflows (715 TAF/~~yr~~year), evapotranspiration (358 TAF/~~yr~~year), deep percolation (194 TAF/~~yr~~year), and stream losses (also referred to as seepage) (28 TAF/~~yr~~year). Surface water outflows include outflows through Butte Creek, Big Chico Creek, and other streams, as well as overland runoff of precipitation and applied water to downslope lands. Additionally, water is diverted from Butte Creek for use in the Butte Subbasin. Evapotranspiration is primarily from agricultural lands, but also from native vegetation, urban and industrial lands, managed wetlands, and canal evaporation. Deep percolation is primarily from precipitation, but also from applied water.

The average annual change in storage in the land and surface water system is negligible due to similar soil moisture content in the root zone, on average, across water years, and limited storage capacity exists in surface water bodies within the basin.



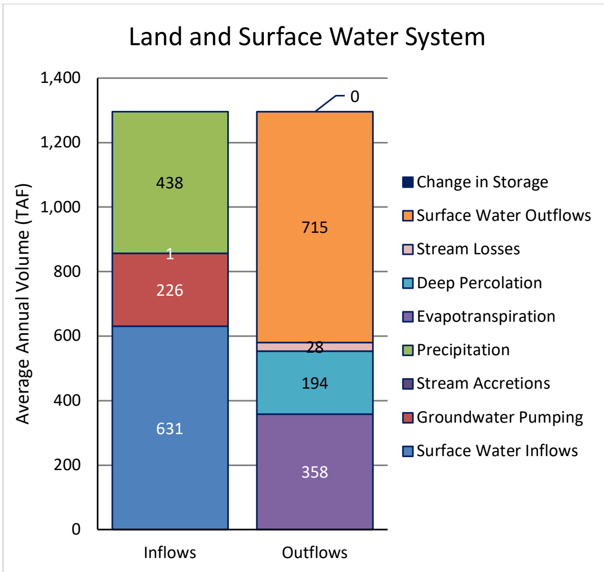
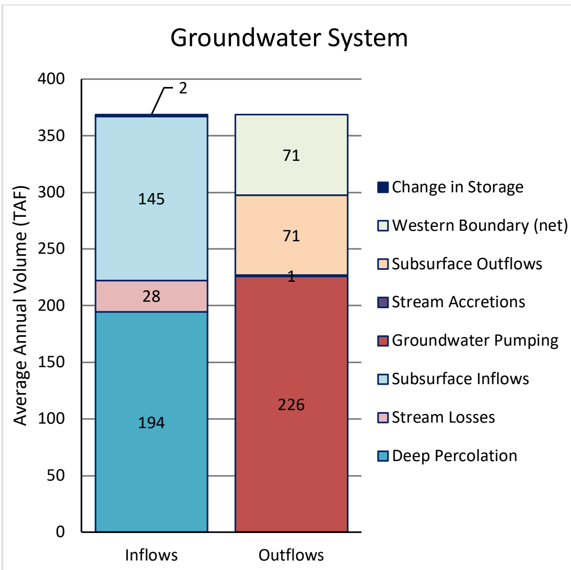


Figure 2-39: Average Annual Future Conditions with 2030 Climate Change Land and Surface Water System Water Budget

Average annual inflows to and outflows from the groundwater system were estimated to be 853 TAF and 854 TAF, respectively, with an average decrease in groundwater storage of ~~2~~two TAF ~~per~~ /year during the 50-year simulation period. Average annual values were presented previously in Table 2-8 and are shown graphically in Figure 2-40.

Inflows to the groundwater system include deep percolation (193 TAF/~~yr~~year); subsurface inflows from the Los Molinos, Butte, and Wyandotte Creek ~~subbasins~~Subbasins and from the foothill area (145 TAF/~~yr~~year); and stream losses (28 TAF/~~yr~~year). Outflows from the groundwater system include groundwater pumping (226 TAF/~~yr~~year); subsurface outflows to the Butte, Los Molinos, and Wyandotte Creek ~~subbasins~~Subbasins and to the foothill area (71 TAF/~~yr~~year); western boundary net outflows (71 TAF/~~yr~~year); and stream gains from groundwater (~~1~~one TAF/~~yr).~~year

~~Western boundary net outflows represent Sacramento River gains from groundwater and subsurface outflows to the Corning Subbasin. The split between these outflows is uncertain at this time and identified as a data gap. It is anticipated that this data gap will be addressed through future refinements to the BBGM and through coordination and collaboration with neighboring subbasins as part of GSP implementation.~~



~~**Figure 2-40: Average Annual Future Conditions with 2030 Climate Change Groundwater System Water Budget**~~

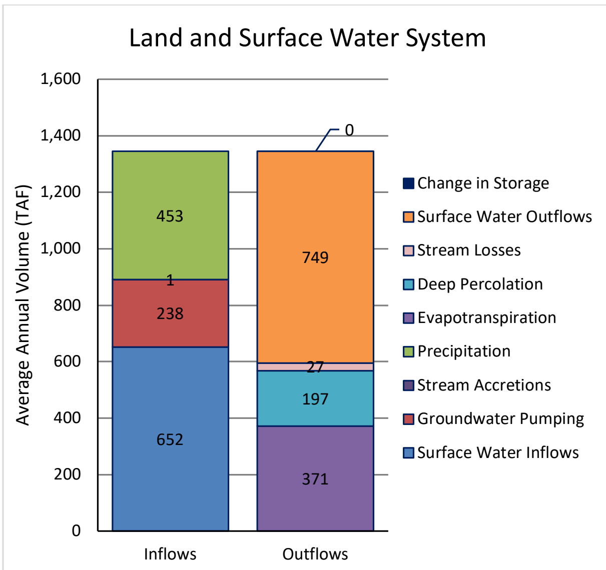
~~***Future Conditions, 2070 Climate Change***~~

~~Average annual inflows to and outflows from the basin for the future conditions with 2070 climate change projected land and surface water system baseline water budget were estimated to be 1.34 MAF per year. Average annual values were presented previously in Table 2-7 and are shown graphically in Figure 2-41.~~

~~Primary inflows to the land and surface water system include surface water inflows (652 TAF/yr), precipitation (453 TAF/yr), and groundwater pumping (238 TAF/yr), with estimated stream gains from groundwater (i.e. accretions) of approximately 1 TAF/yr. Surface water inflows include Butte Creek, Big Chico Creek, and several other streams, as well as overland runoff of precipitation and applied water from upslope lands. A minor inflow includes diversions of surface water that occur outside of the basin and are conveyed into the basin for use.~~

~~Primary outflows from the land and surface water system include surface water outflows (749 TAF/yr), evapotranspiration (371 TAF/yr), deep percolation (197 TAF/yr), and stream losses (also referred to as seepage) (27 TAF/yr). Surface water outflows include outflows through Butte Creek, Big Chico Creek, and other streams, as well as overland runoff of precipitation and applied water to downslope lands. Additionally, water is diverted from Butte Creek for use in the Butte Subbasin. Evapotranspiration is primarily from agricultural lands but also from native vegetation, urban and industrial lands, managed wetlands, and canal evaporation. Deep percolation is primarily from precipitation, but also from applied water.~~

~~The average annual change in storage in the land and surface water system is negligible due to similar soil moisture content in the root zone, on average, across water years, and limited storage capacity exists in surface water bodies within the basin.~~



~~**Figure 2-41: Average Annual Future Conditions with 2070 Climate Change Land and Surface Water System Water Budget**~~

~~Average annual inflows to and outflows from the groundwater system were estimated to be 857 TAF and 860 TAF, respectively, with an average decrease in groundwater storage of 3 TAF per year during the 50-year simulation period. Average annual values were presented previously in Table 2-8 and are shown graphically in Figure 2-42.~~

~~Inflows to the groundwater system include deep percolation (197 TAF/yr); subsurface inflows from the Los Molinos, Butte, and Wyandotte Creek subbasins and from the foothill area (145 TAF/yr); and stream losses (27 TAF/yr). Outflows from the groundwater system include groundwater pumping (238 TAF/yr); subsurface outflows to the Butte, Los Molinos, and Wyandotte Creek subbasins and to the foothill area (68 TAF/yr); western boundary net outflows (66 TAF/yr); and stream gains from groundwater (1 TAF/yr~~).

Western boundary net outflows represent Sacramento River gains from groundwater and subsurface outflows to the Corning Subbasin. The split between these outflows is uncertain at this time and identified as a data gap. It is anticipated that this data gap will be addressed through future refinements to the BBGM and through coordination and collaboration with neighboring subbasins as part of GSP implementation.

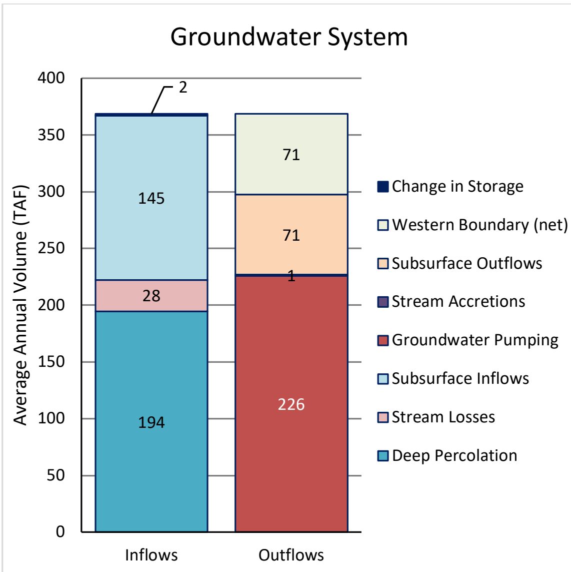


Figure 2-40: Average Annual Future Conditions with 2030 Climate Change Groundwater System Water Budget

Future Conditions, 2070 Climate Change

Average annual inflows to and outflows from the basin for the future conditions with 2070 climate change projected land and surface water system baseline water budget were estimated to be 1.34 MAF/year. Average annual values were presented previously in Table 2-7 and are shown graphically in Figure 2-41.

Primary inflows to the land and surface water system include surface water inflows (652 TAF/year), precipitation (453 TAF/year), and groundwater pumping (238 TAF/year), with estimated stream gains from groundwater (i.e., accretions) of approximately one TAF/year. Surface water inflows include Butte Creek, Big Chico Creek, and several other streams, as well as overland runoff of precipitation and applied water from upslope lands. A minor inflow includes diversions of surface water that occur outside of the basin and are conveyed into the basin for use.

Primary outflows from the land and surface water system include surface water outflows (749 TAF/year), evapotranspiration (371 TAF/year), deep percolation (197 TAF/year), and stream losses (also referred to as seepage) (27 TAF/year). Surface water outflows include outflows through Butte Creek, Big Chico Creek, and other streams, as well as overland runoff of precipitation and applied water to downslope lands. Additionally, water is diverted from Butte Creek for use in the Butte Subbasin. Evapotranspiration is primarily from agricultural lands but also from native vegetation, urban and industrial lands, managed wetlands, and canal evaporation. Deep percolation is primarily from precipitation, but also from applied water.

The average annual change in storage in the land and surface water system is negligible due to similar soil moisture content in the root zone, on average, across water years, and limited storage capacity exists in surface water bodies within the basin.

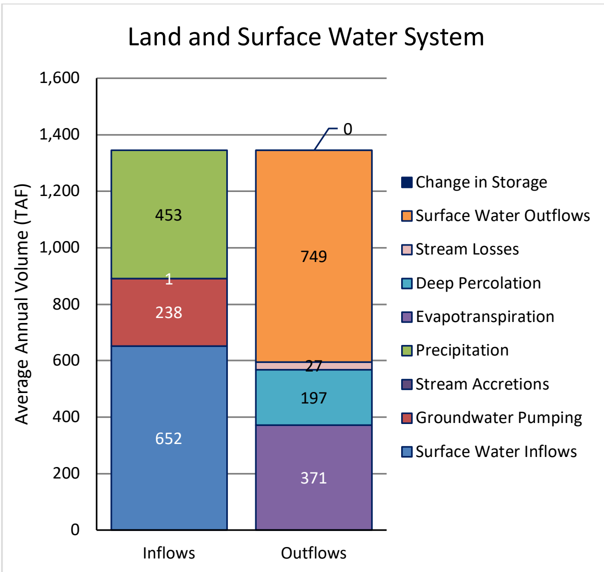
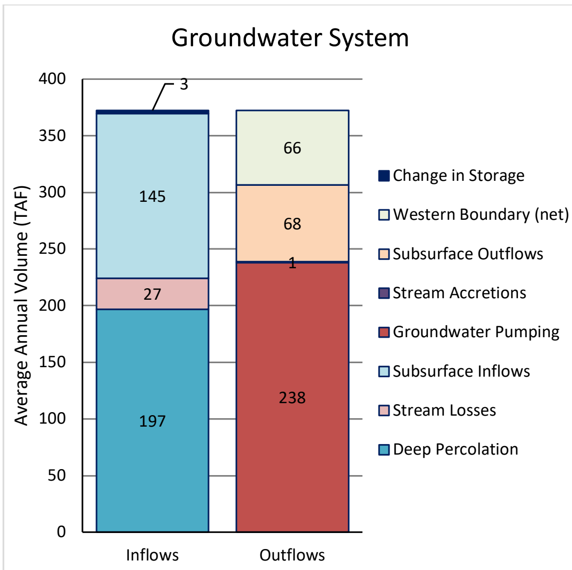


Figure 2-41: Average Annual Future Conditions with 2070 Climate Change Land and Surface Water System Water Budget

Average annual inflows to and outflows from the groundwater system were estimated to be 857 TAF and 860 TAF, respectively, with an average decrease in groundwater storage of three TAF/year during the 50-year simulation period. Average annual values were presented previously in Table 2-8 and are shown graphically in Figure 2-42.



Inflows to the groundwater system include deep percolation (197 TAF/year); subsurface inflows from the Los Molinos, Butte, and Wyandotte Creek Subbasins and from the foothill area (145 TAF/year); and stream losses (27 TAF/year). Outflows from the groundwater system include groundwater pumping (238 TAF/year); subsurface outflows to the Butte, Los Molinos, and Wyandotte Creek Subbasins and to the foothill area (68 TAF/year); western boundary net outflows (66 TAF/year); and stream gains from groundwater (one TAF/year).

Western boundary net outflows represent Sacramento River gains from groundwater and subsurface outflows to the Corning Subbasin. The split between these outflows is uncertain at this time and identified as a data gap. It is anticipated that this data gap will be addressed through future refinements to the BBGM and through coordination and collaboration with neighboring subbasins as part of GSP implementation.

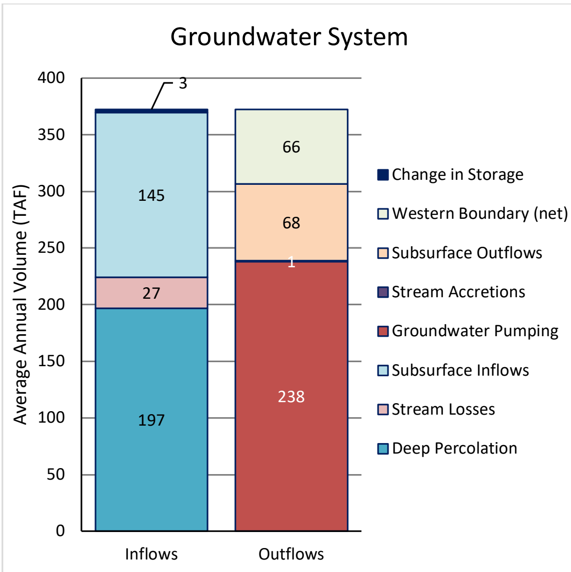


Figure 2-42: Average Annual Future Conditions with 2070 Climate Change Groundwater System Water Budget

Comparison of Water Budget Scenarios

A figure depicting cumulative change in storage for the current conditions and three future conditions baseline scenarios is provided on the following page (Figure 2-43). In the figure, the cumulative change in groundwater storage is shown for the 50-year hydrologic period. The -x-axis (horizontal axis) is labeled with the historical reference year along with the corresponding water year type based on the Sacramento Valley Water Year Index. Years are identified as wet (W), above normal (AN), below normal (BN), dry (D), or critical (C).

Figure 2-43 placeholder page

Estimated changes in storage are similar for each of the scenarios, with increased cumulative reduction in storage for the future conditions scenarios relative to the current conditions scenario. The 2070 climate change scenario suggests somewhat greater cumulative decrease in storage than the future conditions without climate change and 2030 climate change scenarios likely due to projected increases in temperature and associated irrigation demands within the ~~subbasin.~~Vina Subbasin.

2.3.5 Water Budget Uncertainty

Uncertainty refers to a lack of understanding of the basin setting that significantly affects an agency's ability to develop ~~sustainable management criteria~~SMC and appropriate projects and management actions in a GSP, or to evaluate the efficacy of plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed. Uncertainty exists in all components of each water budget and in the assumptions used to project potential future conditions related to planned development and associated urban demands as well as projections of climate change. These uncertainties are not expected to substantially limit the ability to develop and implement a GSP for the basin, including the ability develop ~~sustainable management criteria~~SMC and appropriate projects and management actions, nor the ability to assess whether the basin is being sustainably managed over time. It is anticipated that these uncertainties will be reduced over time through monitoring and additional data collection, refinements to the BBGM and other tools, and coordination with neighboring basins.

~~2.3.6 Overdraft Conditions~~

~~Based on the current conditions and future conditions baseline scenarios, which approximate long-term average conditions in the subbasin considering climate change and other factors, there is the potential for overdraft conditions to occur. Overdraft estimates range from approximately 1,100 to 2,600 acre-feet per year based on average annual estimated decrease in storage presented previously in Table 2-8 and in Table 2-10 in the following section using these scenarios. All of these scenarios use a 50-year period for data. If the historical scenario is used that only covers the period from 2000 to 2018 for predictions of future conditions, the overdraft would be about 19,600 AFY. As discussed in Section 2.3.7, overdraft estimates were also developed as part of the SMC and the GSP defines overdraft for the Subbasin as 10,000 AFY.~~

~~As discussed in the previous section, water budget estimates are subject to uncertainty, particularly for the estimated change in storage, which is small relative to total estimated inflows to and outflows from the groundwater system; adequate monitoring of groundwater conditions over time will be important to sustainably manage the subbasin as part of GSP implementation.~~

~~2.3.7~~2.3.6 Sustainable Yield Estimate

Sustainable yield refers to the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin, and including any temporary surplus that can be withdrawn annually from a groundwater supply without causing an undesirable result. As a result, determination of sustainable yield requires consideration of SGMA's six sustainability indicators (SIs). Historical water budget estimates indicate an average annual decrease in storage of 20,000 AFY for the period from 2000 to 2018. In general, decreased precipitation and increased groundwater pumping in dry years leads to decreases in groundwater levels and storage and may pose challenges to operating within the sustainable yield over multiple dry years. Operation of the basin within the sustainable yield will likely require incorporation of projects and management actions into the GSP and implementation over the 50-year SGMA planning and implementation horizon.~~As described previously, sustainable yield refers to the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin, and including any temporary surplus that can be withdrawn annually from a groundwater supply without causing an undesirable result.~~

For development of SMCs, as discussed in ~~Chapter~~Section 3, the ~~measurable objective~~MO was developed to address the long-term trend of the "peaks and valleys" of the short-term cycles and stop the long-term decline in groundwater levels during dry years. Using this method, the average depth below the ~~measurable objective~~MO at compliance points (see ~~Chapter~~Section 3 for discussion of representative monitoring sites~~)~~ [RMS]) if no actions are taken before the end of the implementation period in 2042 is about 21 feet. Using this value, a sustainable yield can be estimated based on the reduction in pumping needed to stop the observed decline in water levels across the Vina Subbasin. This value is sensitive to the specific storage.~~-~~ Specific storage is the parameter that translates the change in groundwater elevation to an associated change in volume (i.e~~.~~., change in storage).

As discussed in Section 2.1.8.3, the average specific storage value used in the BBGM is 0.~~03967~~04 (unitless). Specific storage values estimated from pumping tests by Brown and Caldwell (2013) ranged from 0.001 to 0.00004. Table 2-~~11~~10 provides estimates of sustainable yield to maintain the MO in 2042 using this range of storativity values and the average decline in water levels across the ~~subbasin~~Vina Subbasin in 2042. The groundwater pumping rate for the historical scenario is used for the calculation of sustainable yield.

Table 2-~~11~~10: Estimated Sustainable Yield Using Average Depth Below ~~MO~~Measurable Objective in 2042 and Range of Storativity Values

Feet Below MO in 2042	Specific Storage	Area of Subbasin (square miles)	Volume Storage Below MO in 2042 (acre-feet)	Average Change in Storage Between 2030 and 2042 (AFY)	Groundwater Pumping[1] (AFY)	Estimated Sustainable Yield (AFY)
21	0.1	289	388,410	32,368	243,500	211,132
21	0.~~03967~~04	289	38,841	12,840	243,500	230,660
21	0.001	289	3,884	324	243,500	243,176
21	0.0001	289	388	32	243,500	243,468
21	0.00001	289	39	3	243,500	243,497

~~Note:~~
~~1. Historical scenario pumping.~~

~~Using~~**Note:**
1. Historical scenario pumping.

As seen in the ~~information presented~~ above discussions (Section 2.3.4), the calculated decrease in storage value is highly sensitive to the time period used to assess the annual average and the specific storage value used for calculations. The range of values for the decrease in storage based on the variations for time period is 1,700 to 19,600 AFY and for specific storage is 3 to 32,368 AFY as discussed above.

Considering these variations, this GSP defines the estimate of the sustainable yield as 233,~~000~~500 AFY based on average historical groundwater pumping of 243,~~000~~500 AFY and a decrease in storage of 10,000 AFY. The historical groundwater pumping value is based on the average annual groundwater pumping that occurred between 2000 and 2018 as discussed in Section 2.3.4 and summarized in Table 2-8. The decrease in storage value of 10,000 AFY was selected based on the range of values shown in Table 2-10 and calculated for the Water budget as shown on Table 2-8.

~~2.3.8 Recommended Next Steps~~

2.3.7 Opportunities for Improvement to the Water Budget

~~2.3.8.1~~2.3.7.1 Refine Surface Water Diversion Estimates
While many of the large diversions are continuously monitored and recorded, limited information is available for others. It is recommended that GSAs in the basin work with local stakeholders to better document surface water diversions, including investigation of riparian diversions in some area and additional information describing water supplies for managed wetlands. Diversion estimates developed as part of the water budgets provide a good basis to support discussion with diverters.

~~2.3.8.2~~2.3.7.2 Refine Groundwater Pumping Estimates
Groundwater pumping for irrigation has generally been estimated based on estimates of crop irrigation requirements in areas known to rely on groundwater. It is recommended that GSAs look for opportunities to verify and refine groundwater pumping estimates to improve water budget estimates by obtaining pumping data from cooperative landowners.

~~2.3.8.3~~2.3.7.3 Refine Deep Percolation Estimates
Deep percolation in some areas may return to the surface layer through accretion in drains and natural waterways or may be consumed by phreatophytic vegetation. It is recommended that GSAs look for opportunities to further understand and investigate the ultimate fate of deep percolation from agricultural lands. Through modeling of specific waterways and shallow groundwater, the BBGM can help support these investigations.

~~2.3.8.4~~2.3.7.4 Refine Urban Lands Water Budgets
The relative proportion of non-consumed water returning as deep percolation or surface runoff does not explicitly account for percolation from stormwater retention ponds or releases from wastewater treatment plants to local waterways. There is an opportunity to refine water budgets for developed lands to verify and refine estimates of non-consumed water. Additionally, there is an opportunity to evaluate and develop refined water use estimates for industrial uses.

~~2.3.8.5~~2.3.7.5 Refine Characterization of Interbasin Flows and Net Outflows along Western Boundary

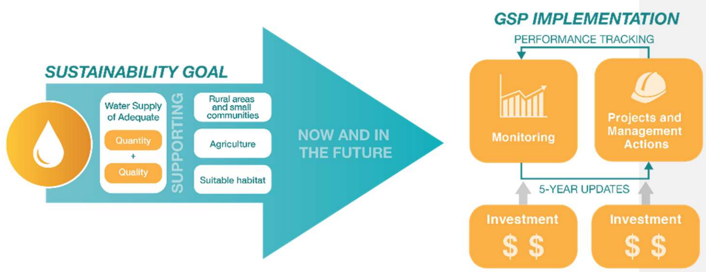
Interbasin flows are dependent on conditions in adjacent basins. It is recommended that GSAs refine estimates of subsurface groundwater flows from and to neighboring basins through coordination with GSAs in neighboring basins during or following GSP development and through review of modeling tools that cover the Sacramento Valley region, including the C2VSim and SVSim integrated hydrologic model applications developed by DWR.

~~2.3.8.6~~2.3.7.6 Land Use Changes Due to the Camp Fire

In 2018, the Camp Fire destroyed 18,000 structures in Butte County displacing over 27,000 residents. While the Town of Paradise, Concow, and other areas destroyed by the Camp Fire rebuild, many residents have relocated to the City of Chico and other portions of the Vina Subbasin. The existing General Plans may not fully account for the relocation of Camp Fire survivors. A focused accounting of changes to residential land use and associated water demands as a result of the Camp Fire should be conducted.

3. SUSTAINABLE MANAGEMENT CRITERIA

Sustainable management criteria (SMC) offer guideposts and guardrails for groundwater managers seeking to achieve sustainable groundwater management. SGMA defines sustainable groundwater management as “the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results,” where the planning and implementation horizon is 50 years with the first 20 years spent working toward achieving sustainable groundwater management and the following 30 years (and beyond) spent maintaining it (California Water Code §10721; Figure 3~~.~~-1). For the Vina Subbasin~~-~~, SMC were formulated by working with the Vina GSA and the Rock Creek Reclamation District GSA Boards of Directors, the SHAC, and members of the public. This stakeholder outreach process was facilitated by ~~CBI~~the Consensus Building Institute (CBI) with sessions documented on the Vina Subbasin GSA website. Outreach included a robust discussion and broad agreement on the Vina Subbasin sustainability goal as well as what constitutes locally defined undesirable results. The sustainability goal is meant to reflect the GSAs desired condition, maintained over time, for the groundwater basin.



~~Figure 3.1 – Flow Chart for Sustainbility~~

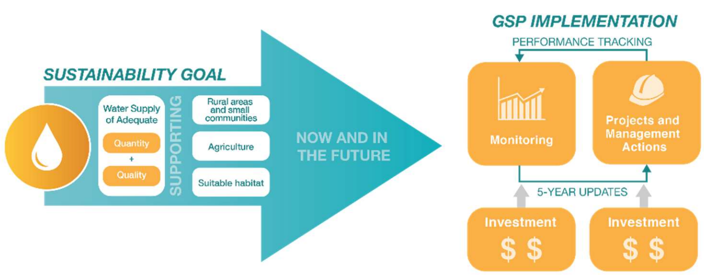


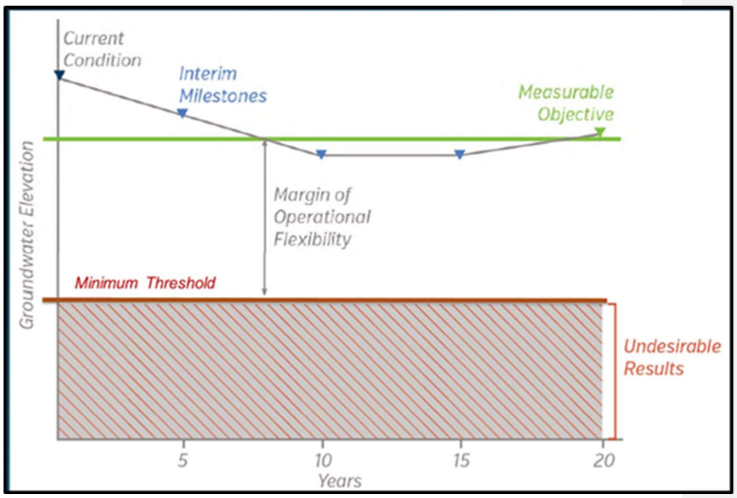
Figure 3-1: Flow Chart for Sustainability

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

The Vina Subbasin is divided into three ~~management areas~~MAs: North, Chico, and South. The associated undesirable results for each SI have been defined similarly across the three ~~management areas~~MAs within the Vina Subbasin. In turn, the rationale and approach for determining ~~minimum thresholds (~~MT~~)~~ and ~~measurable objectives (~~MO~~)~~ for each SI are the same across all ~~management areas~~MAs in the Vina Subbasin.

The terminology for describing SMC ~~are~~is defined as follows:

- Undesirable Results – Significant and unreasonable negative impacts associated with each SI.
- MT– Quantitative threshold for each SI used to define the point at which undesirable results may begin to occur.
- MO – Quantitative target that establishes a point above the MT that allows for a range of active management to prevent undesirable results.
- Margin of Operational Flexibility – The range of active management between the MT and the MO.
- Interim Milestones (~~IM~~IMs) – Targets set in increments of ~~5~~five years over the implementation period of the GSP offering a path to sustainability.



~~***Figure 3.2 Illustration of terms used for describing SMC using the groundwater level SI.***~~

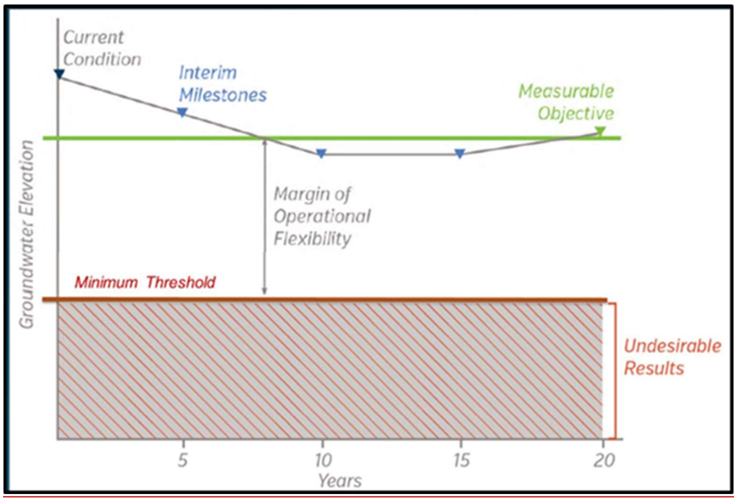


Figure 3.~~-~~2: Illustration of Terms Used for Describing Sustainable Management Criteria Using the Groundwater Level SI

Figure 3-2 illustrates these terms for the groundwater level SI.

~~Sustainability indicators~~SIs are intended to be measured and compared against quantifiable ~~sustainable management criteria~~SMC throughout a monitoring framework of ~~representative monitoring sites (~~RMS~~; see~~ (Section 4.9). Ongoing monitoring of SI can:

- Determine compliance with the adopted GSP
- Offer a means to evaluate the effectiveness of projects and management actions over time
- Allow for course correction and adaptation in ~~5~~five-year updates
- Facilitate understanding among diverse stakeholders
- Support decision-making on the part of the GSAs into the future

To quantify SMC for the Vina Subbasin, information from the HCM (Section 2), descriptions of current and historical groundwater conditions and input from stakeholders have been considered.

3.1 Sustainability Goal

The sustainability goal for the Vina Subbasin is:

> *to ensure that groundwater is managed to provide a water supply of adequate quantity and quality to support rural areas and communities, the agricultural economic base of the region, and environmental uses now and in the future.*

Implementation of the Vina GSP may achieve sustainability before 2042; however, groundwater levels in the Vina Subbasin may continue to decline during the implementation period. As projects and management actions are implemented, sustainable groundwater management will be achieved. The Vina Subbasin will be managed to prevent undesirable results throughout the implementation period, despite the possible decline of groundwater levels. This sustainability goal is supported by locally defined MT that will avoid undesirable results. Demonstration of stable groundwater levels on a long-term average basis combined with the absence of undesirable results will ensure that the Vina Subbasin is operating within its sustainable yield and the sustainability goal will be achieved. ~~Sustainable management criteria~~SMC within the Vina Subbasin emphasize management objectives related to domestic, municipal, and agricultural wells as well as suitable habitat. Groundwater management has already been occurring throughout Butte County, and the Vina Subbasin will be managed within its sustainable yield by adapting existing management objectives and strategies to address current and future conditions, or by developing new ones. Sustainable yield means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result. The Vina Subbasin intends to achieve its sustainability goal by implementing GSP projects and management actions that both augment water supply and increase efficiency of water application (see Section 5 for proposed projects and management actions and Section 6 for the implementation plan to achieve sustainability).

The BCDWRC has been participating in groundwater management activities for many years, including within the Vina Subbasin. In the last several years, the BCDWRC has increased groundwater level and water quality monitoring and has worked with other entities to collect and disseminate water data. In addition, the BCDWRC assists with other locally driven groundwater management activities. The Vina Subbasin intends to build on this ongoing county-wide process and broadly shares the objective of long-term maintenance of high-quality groundwater resources within the region for domestic, agricultural, and environmental uses.

3.2 Sustainability Indicators, Minimum Thresholds, and Measurable Objectives

3.2.1 Sustainability Indicators

Six ~~SI~~SIs are defined by SGMA and are used to characterize groundwater conditions throughout a basin or subbasin. SGMA requires development of locally defined ~~sustainable management criteria~~SMC for each SI and allows for identification of SI that are not applicable. For example, sea water intrusion is not applicable in the Vina Subbasin due to its distance from the Pacific Ocean.

SI and associated undesirable results, if significant and unreasonable

3.2.2 Minimum Thresholds

As noted earlier, MT are those quantitative thresholds for each SI used to define the point at which undesirable results may begin to occur. Undesirable results are those having significant and unreasonable negative impacts, avoidance of which is required by SGMA. Potential impacts and the extent to which they are considered "significant and unreasonable" were determined by the GSAs Boards of Directors with input from the SHAC and members of the public. The GSAs established ~~minimum thresholds~~MT intended to prevent such significant and unreasonable negative impacts from occurring. If observed data trend toward the locally defined MT, this will trigger action on part of the GSAs to reverse this trend before reaching the MT. For this reason, MT are like guardrails. Actions to reverse a trend toward a MT could be taken at any time during GSP implementation that will follow an adaptive management process working with stakeholders to ensure actions are implemented at appropriate times.

3.2.3 Measurable Objectives

MO are those quantitative targets that establish a point above the MT that allows for a range of active management to achieve the sustainability goal and prevent undesirable results. This range of active management between the MT and the MO is referred to as the margin of operational flexibility.

MO were determined by the GSAs Boards of Directors with input from the SHAC and members of the public. The GSAs established MO intended to preserve the desired condition throughout the Vina Subbasin while offering flexibility in GSP implementation. IM are targets set in increments of 5 years over the implementation period of the GSP offering a path to sustainability. For this reason, the MO and IM are like guideposts.

3.3 Groundwater Levels ~~SMC~~Sustainable Management Criteria

Groundwater Levels SMC are those meant to address the chronic lowering of groundwater levels and avoid the depletion of supply at a given location that may lead to undesirable results caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.3.1 Undesirable Result

An undesirable result caused by the chronic lowering of groundwater levels is experienced if:

> *sustained groundwater levels are too low to provide a water supply of adequate quantity and quality to support rural areas and ~~small~~ communities, and the agricultural economic base of the region, or if significant and unreasonable impacts to environmental uses of groundwater occur.*

3.3.2 Minimum Thresholds

The Groundwater Levels MT represent quantitative thresholds used to define the point at which undesirable results may begin to occur, avoidance of which is required under SGMA. To establish locally defined MT, the GSAs Boards of Directors, SHAC, and members of the public explored potential impacts of declining groundwater levels.

Potential impacts identified by stakeholders from declining groundwater levels included:

- Wells going dry
- Reduced pumping capacity of existing wells
- Need for deeper well installations and/or lowering of pumps
- Increased pumping costs due to greater lift
- Reduced flows in rivers and streams supporting aquatic ecosystems
- Water table depth dropping below the maximum rooting depth of Valley Oak ~~-~~or other deep-rooted tree species

Issues related to reduced flows in rivers and streams and/or water tables that support deep-rooted tree species are addressed in the Interconnected Surface Water SMC (Section 3.8).

In recent years, Butte County has documented a number of domestic wells that have “gone dry,” meaning groundwater levels have fallen below the depth of the well installation and/or pump. This occurred during summer months of recent drought years and heightened concern among some stakeholders. For example, in the critically dry year of 2021, 44 wells were reported dry county-wide through the State’s online reporting system. As a result, domestic well reliability and protection are the focus of the Groundwater Levels MT. From a policy perspective, sustainably constructed domestic wells going dry during non-dry year conditions would be a “significant and unreasonable” undesirable result of groundwater management. The quantitative Vina Subbasin Undesirable Result for the Chronic Lowering of Groundwater Levels occurs when:

> *Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.*

Non-dry year types include wet, above normal, and below normal as defined by the Sacramento Valley Water Year Index. Dry year types include dry and critical~~.~~ water year types. See Section 2.3.1 for more information on the Sacramento Water Year Index.

~~Domestic~~As shown in the figures presented in Appendix 3-A showing the average depth of domestic, irrigation, and public supply wells, domestic wells are generally shallower than other wells throughout the Vina Subbasin. These figures were constructed using data from DWR OSWRC. Protection of domestic wells was therefore deemed to be additionally protective of other well types, such as agricultural wells. In addition, the lowering of groundwater levels during two or more consecutive dry and/or critically dry year types is not considered significant and unreasonable and therefore not considered an undesirable result, as long as the groundwater levels rebound to levels greater than the MT following those consecutive dry and/or critically dry years.

The Vina Subbasin SMC for Chronic Lowering of Groundwater Levels is based on groundwater levels throughout the ~~subbasin~~Vina Subbasin that would support sustainably constructed domestic wells. Sustainably constructed implies wells that have been installed following the relevant County Well standards within permeable aquifer material and the wells have been appropriately maintained (e.g~~.~~., well problems are not due to clogging of well screens or silting of well). Exceeding the MT may lead to significant and unreasonable effects during drought years~~,~~ and impacts to domestic wells and other groundwater uses may occur and would not constitute an Undesirable Result. Local and state drought response play a role in addressing dry year impacts. However, once a drought period ends, it is anticipated that groundwater conditions should return to the MO levels. Year-type is defined according to the Sacramento Valley Water Year Hydrologic Classification and groundwater level is defined based on groundwater elevation above ~~mean sea level~~msl.

~~In order to~~To establish appropriate MT levels protective of sustainably constructed domestic wells, a representative zone is established for each RMS well. The DWR domestic well database provides information on all submitted ~~well completion reports~~WCRs when a well is drilled. This database contains information on characteristics of the wells, including well location, groundwater surface elevation of the well, and total well depth. These well characteristics, however, are not always accurate or precise, and, unfortunately, it is not known which of the wells in the database are in use or have been abandoned or replaced.

To refine the dataset, wells installed before 1980 were removed. This removes the oldest wells and wells likely to have been replaced as a result of historically low groundwater conditions that occurred during the 1976-1977 drought. Wells that remain are more likely to be consistent with current well standards and currently serving domestic water needs. Still, there is much information that remains to be gathered to further refine the dataset given the unknowns previously identified, as well as relationships to changes in surface elevation. ~~Therefore, a data gap has been identified that will be further investigated.~~Therefore, additional characterization of active domestic wells within the subbasin may be considered during GSP implementation (see Section 5.4.3).

Using the refined data set, each ~~management area~~MA was divided into polygons that represent proximate areas to each RMS well (see figures in Appendix 3-~~A~~B). Due to the size, the Chico ~~management area~~MA was not separated into polygons and the MT was calculated using the entire domestic well data for each RMS well (i.e. the same MT is applied to all RMS wells within the Chico ~~management area~~MA). Each point (or represented well) within each area is closer to its respective RMS well than any other RMS well. The size of each polygon depends on the density of the RMS network. For example, the higher the density of RMS wells in a ~~management area~~MA, the smaller the polygons. Each polygon is a different shape and size, determined by the distribution of the RMS wells in the ~~management area.~~MA. Ground surface elevation change across the RMS polygon was also considered when establishing the MT. The result is a more refined dataset that more proximately reflects the relationship of domestic wells with each RMS well. In addition, rather than just looking at a percentage of domestic wells to protect, the elevation levels were examined in comparison to what would be considered sustainable domestic wells as defined above for the area~~.~~ (see individual graphs for each RMS well in Appendix 3-B). The result is setting an MT for each RMS well that ~~better~~ corresponds with elevation changes and provides operational flexibility between the MO and the MT.

Figure 3-3 illustrates the graphing method for RMS well 25C001M within the Vina North MA. Each red point on the graph represents a domestic well and shows the elevation of the bottom of the well. All of the individual domestic wells are shown relative to the RMS well's ground surface elevation. The graphs were used to identify the MT that would be protective of the majority of the domestic wells in the RMS zone while recognizing the RMS well is not fully representative of wells within the zone due to changes in ground surface and water surface elevation throughout the area. Wells that plot above the MT elevation tend to be especially shallow (less than 100 feet deep) or have a significantly different (higher) ground surface elevation than the RMS well.

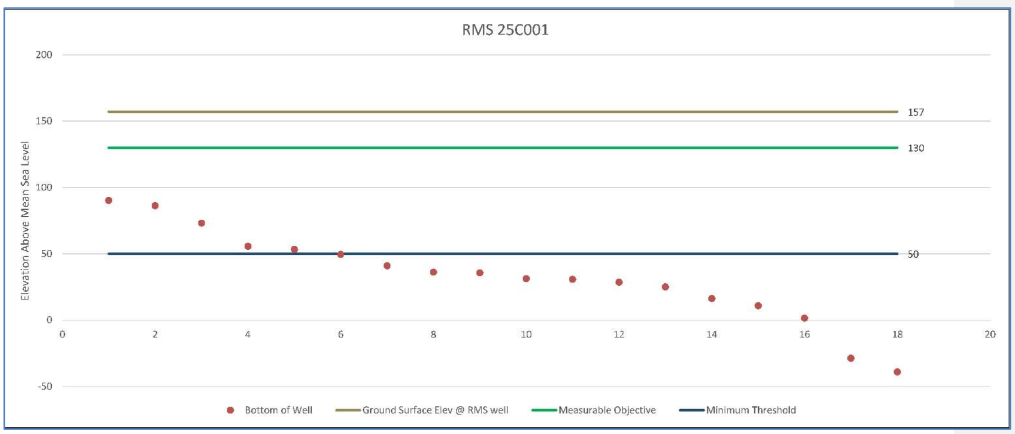


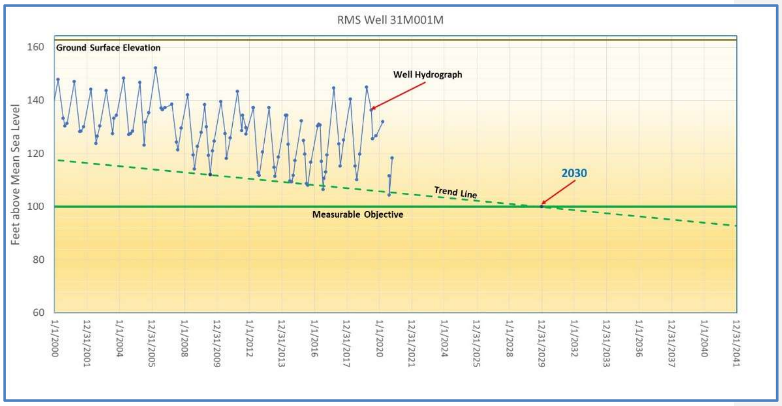
Figure 3-3: Graph Showing Graphing Method Used to Establish MTs for Each RMS Well. Red dots represent bottom elevation of each domestic well within the polygon associated with the RMS well (example is for well 25C001M in Vina North) relative to ground surface elevation at the RMS well

3.3.3 Measurable Objectives

The Groundwater Levels MO represent quantitative targets that establish a point above the MT allowing for a range of active management to prevent undesirable results and reflect the desired state for groundwater levels at the year 2042. To establish the MO, the water-level hydrograph of observed groundwater levels at each RMS was evaluated. The historical record at these locations shows cyclical fluctuations of groundwater ~~level~~levels over a four- to seven-year cycle consistent with variations in water year type according to the Sacramento Valley Water Year Hydrologic Classification. Groundwater levels are typically lower during dry years and higher during wet years. Superimposed on this four- to seven-year short-term cycle is a long-term decline in groundwater levels. In other words, groundwater levels during more recent dry-year cycles are lower than groundwater levels in earlier dry-year cycles.

The wet-dry cycles are climatically induced, and the GSAs ~~has~~have no ability to change this cyclical behavior; there will always be short-term cyclical fluctuations in groundwater levels. The MO are therefore intended to address the long-term trend of the "peaks and valleys" of the short-term cycles and stop the long-term decline in groundwater levels during dry years. Because the GSAs cannot immediately augment water supply and/or increase efficiency of water application, some continuation of the long-term decline in groundwater levels is possible in the near future. Currently (in 2021), the Vina Subbasin appears to be coming out of a wet period of a short-term cycle (2017 and 2019 being wet years) and beginning the next dry period of a short-term cycle starting in 2020. The MO was therefore based on the trend line of observed historical data extended to the year 2030. The year 2030 was chosen as a reasonable time frame in which the GSAs could implement projects and management actions to address long-term groundwater level decline while recognizing that groundwater levels may experience another dry period of the short-term cycle in the intervening years. The MO for the Groundwater Levels SMC is:

> *the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.*



~~*Figure 3.3 Illustration of long-term trend using historical water levels extended to 2030 for development of MO*~~

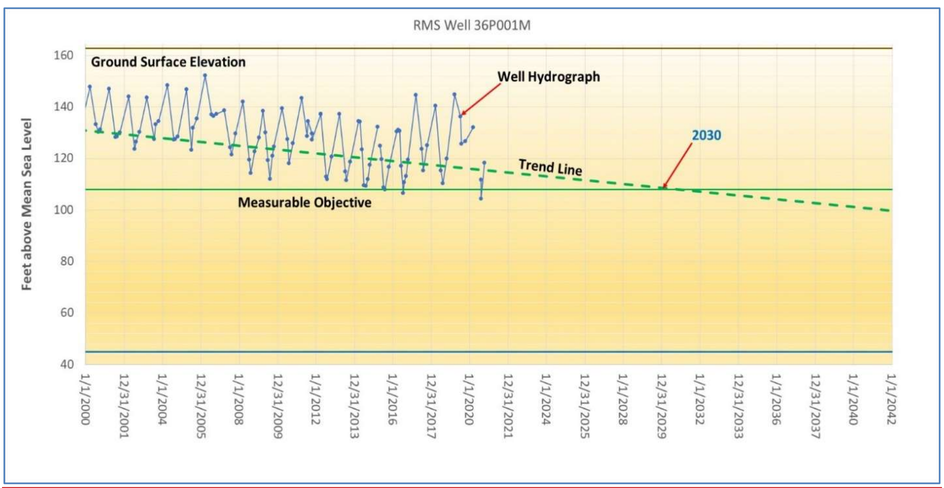


Figure 3-4: Illustration of Long-term Trend Using Historical Water Levels Extended to 2030 for Development of Measurable Objectives

The projection of groundwater levels for each RMS was based on a simple non-statistical linear projection of the observed data (Figure 3~~.~~-3). Generally, the lowest groundwater levels of a given cycle were used for the projection, unless they appeared to be outliers relative to the general long-term trend of the non-dry years in the cycle.

~~IM~~IMs for groundwater levels between 2022 and 2042 were interpolated based on the linear projection of groundwater level at each RMS. By projecting based on the dry years in the cycle, the observed groundwater levels may be higher than the IM. This will be addressed in the annual reports and interim GSP updates based on what occurs with respect to the short-term cycles in the future. Appendix 3-~~B~~C contains the hydrographs for each RMS.

3.3.4 Summary

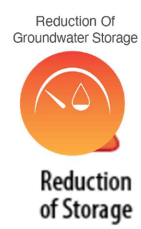
To achieve the sustainability goal and therefore preserve the desired condition for the groundwater basin over time, the GSAs, in setting Groundwater Levels SMC, will implement appropriate projects and/or management actions as necessary to maintain groundwater levels within operational flexibility to limit the decline in groundwater levels to certain values and manage groundwater levels within certain ranges at each RMS shown in Table 3-1. (See Section~~-~~ 4, Figure 4-5, and Table 4-6 for relevant information on the RMS for groundwater levels.)

Table 3-1: Groundwater Levels SMC by RMS in Feet Above Mean Sea Level

RMS Well ID	MT	MO	IM		
			2027	2032	2037
Vina Subbasin – North Management Area					
25C001M	50	130	~~131~~130	130	130
10E001M	80	136	~~139~~137	136	136
07H001M[a]	72	136	~~145~~140	136	136
05M001M	31	115	116	115	115
36P001M	45	108	110	108	108
33A001M	72	125	~~126~~128	125	125
Vina Subbasin – Chico Management Area					
CWSCH01b	85	106	~~108~~107	106	106
~~28J001M~~		~~110~~	~~111~~	~~110~~	~~110~~
~~CWSCH03~~		~~108~~	~~110~~	~~108~~	~~108~~
CWSCH02		105	108	105	105
~~CWSCH07~~CWSCH03		108	109	108	108
CWSCH07		95	97	95	95
28J003M		111	113	111	111
Vina Subbasin – South Management Area					
21C001M	10	64	~~66~~67	64	64
18C003M	65	130	~~134~~132	130	130
10C002M	20	92	~~95~~93	92	92
24C001M	18	77	~~82~~81	77	77
09L001M	30	91	~~94~~93	91	91
26E005M	36	95	~~96~~97	95	95

Note:
~~Note:~~
[a] MO is associated with GSP Well ID 18A001M.

3.4 Groundwater Storage ~~SMC~~Sustainable Management Criteria



Groundwater Storage SMC are those meant to address the reduction of groundwater storage caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.4.1 Undesirable Result

An undesirable result coming from the reduction of groundwater storage is experienced if:

sustained groundwater storage volumes are insufficient to support rural areas and communities, the agricultural economic base of the region, and environmental uses.

This undesirable result is closely related to that associated with groundwater levels. Because groundwater levels and groundwater storage are closely related, measured changes in groundwater levels can serve as a proxy for changes in groundwater storage. For this reason, the SMC developed for groundwater levels are used for groundwater storage to ensure avoidance of the undesirable result.

3.4.2 Minimum Thresholds

As Groundwater Levels SMC are used by proxy, the MT for groundwater storage is the same as for groundwater levels:

Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.

In the historical record, there are isolated incidences of shallow wells going dry during summer months of recent critically dry years. This was noted in the earlier section addressing the development of Groundwater Levels SMC. MT intended to prevent significant and unreasonable negative impacts related to the chronic lowering of groundwater levels are assumed adequate to protect against significant and unreasonable reductions of groundwater storage.

3.4.3 Measurable Objectives ~~(MO)~~

As Groundwater Levels SMC are used by proxy, the MO for groundwater storage is the same as for groundwater levels:

the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.

The aquifer system in the Vina Subbasin generally has sufficient groundwater storage capacity to take additional groundwater recharge during wet periods and remain saturated during dry periods, allowing for a range of active management reflecting the desired state for groundwater storage at the year 2042.

3.5 Water Quality ~~SMC~~Sustainable Management Criteria

Degraded Water Quality

Water Quality SMC are those meant to address degraded water quality caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.5.1 Undesirable Result

An undesirable result coming from degraded water quality is experienced if:

groundwater pumping that degrades water quality and compromises the long-term viability of rural areas and ~~small~~ communities, the agricultural economic base of the region, and environmental uses for suitable habitat.

This occurs in the Vina subbasin when two RMS wells exceed their MT for two consecutive non-dry years.

Salinity is the only water quality constituent for which ~~minimum thresholds~~MT are established in the Vina Subbasin. Although no areas with naturally occurring high salinity have been identified in the ~~subbasin~~Vina Subbasin, the potential exists for movement of underlying brackish water from greater depths into the freshwater pool where groundwater pumping for beneficial uses occurs. Other constituents, as discussed in Section 2.2.4, are managed through existing management and regulatory programs within the Vina Subbasin, such as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and the ~~Irrigated Lands Regulatory Program (ILRP),~~ILRP, which focus on improving water quality by managing septic and agricultural sources of salinity and nutrients. Additionally, point-source contaminants are managed and regulated through a variety of programs by the Regional Water Quality Control Board (RWQCB~~), Department of Toxic Substances Control (DTSC), and the U.S. Environmental Protection Agency (EPA).~~, DTSC, and the USEPA. Through coordination with existing agencies, the Vina Subbasin GSAs will know if existing regulations are being met or groundwater pumping activities in the Vina Subbasin are contributing to significant and unreasonable undesirable effects related to degraded water quality from these constituents.

3.5.2 Minimum Threshold

The Water Quality MT represents a quantitative threshold used to define the point at which undesirable results may begin to occur, avoidance of which is required under SGMA. ~~The MT is established based on.~~ To establish a locally defined MT, the GSAs Boards of Directors, SHAC, and members of the public explored potential impacts of degraded water quality.

Potential impacts identified by stakeholders were:

- Aesthetic concerns for drinking water
- Reduced crop yield and quality
- Increased reliance on surface water for “blending”

To address the potential impacts of concern related to degraded water quality, the GSAs, in setting ~~a minimum threshold~~an MT, commits to avoiding a decline in water quality as it relates to specific conductance, a measure of the water’s saltiness, which can impact the suitability of the water as a source for drinking water, agricultural irrigation, and other uses. An undesirable result is considered “significant and unreasonable” if groundwater quality degrades such that the specific conductance exceeds the upper limit of the Secondary Maximum Contaminant Level (SMCL) of 1,600 microsiemens per centimeter (µS/cm) based on State Secondary Drinking Water Standards. Values of specific conductance exceeding this number are typically unacceptable for drinking water. Secondary Drinking Water Standards are set on the basis of aesthetic concerns. For that reason, there is no public health goal or maximum contaminant level goal associated with specific conductance. The MT for the Water Quality SMCL is:

> *the upper limit of the SMCL for specific conductance based on the State Secondary Drinking Water Standards.*

Undesirable results related to water quality as a result of groundwater pumping in the Vina Subbasin have not occurred historically, are not currently occurring, and are not likely to occur in the future. Observations of specific conductance at RMS from 2008 through 2019 ranged between 148 and 364 µS/cm and demonstrated no trend (Figure 3.~~-~~4).

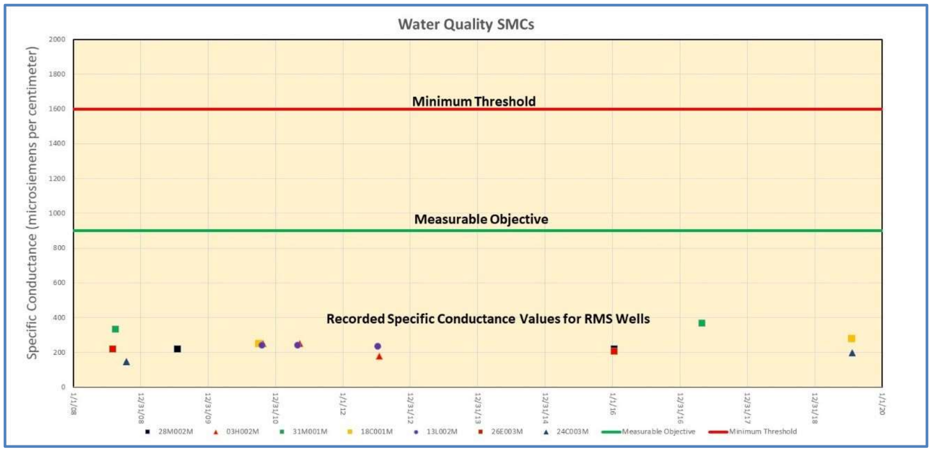


Figure 3.~~4~~-5: Water Quality Measurable Objectives and Minimum Thresholds in ~~*relationship*~~Relation to ~~*reported historical specific conductance*~~Reported Historical Specific Conductance for ~~*RMS*~~Representative Monitoring Site Wells~~.~~

3.5.3 Measurable Objective

The Water Quality MO represents a quantitative target that establishes a point above the MT allowing for a range of active management to prevent undesirable results and reflect the desired state for groundwater quality at the year 2042. To address the potential impacts of concern related to degraded water quality, the MO was established for specific conductance at the recommended SMCL of 900 µS/cm based on State Secondary Drinking Water Standards. The MO for the Water Quality SMC is:

> *the recommended SMCL for specific conductance based on the State Secondary Drinking Water Standards.*

Water quality monitoring implemented for compliance with SGMA will build upon Butte County's existing groundwater quality monitoring program. Additional monitoring by DWR and other agencies will continue to track constituents not managed by the GSAs, including minerals, metals, pesticides, and herbicides.

3.5.4 Summary

To achieve the sustainability goal and therefore preserve the desired condition for the groundwater basin over time, the GSAs, in setting the Water Quality SMC, commits to managing groundwater quality in line with the State Secondary Drinking Water Standards at each RMS shown in Table 3-2. (See ~~Chapter~~Section 4, Figure 4-6, and Table 4-8 for relevant information on the RMS for water quality.)

Table 3-2: Water Quality ~~SMC~~Sustainability Management Criteria by ~~RMS~~Representative Monitoring Site in µS/cm

GSP Well ID	MT	MO	IM		
			2027	2032	2037
Vina Subbasin – North Management Area					
28M002M	1,600	900	900	900	900
03H002M					
31M001M					
Vina Subbasin – Chico Management Area					
28J005M	1,600	900	900	900	900
Vina Subbasin – South Management Area					
18C001M	1,600	900	900	900	900
13L002M					
26E003M					
24C003M					

3.6 Seawater Intrusion ~~SMC~~Sustainable Management Criteria

Seawater intrusion is not applicable to the Vina Subbasin due to its distance from the Pacific Ocean~~.~~ (Figure 1-2) which is the source of saline intrusion to freshwater aquifers along coastal subbasins.

3.7 Land Subsidence ~~SMC~~Sustainable Management Criteria

Land Subsidence SMC are those meant to address land subsidence that substantially interferes with surface land uses caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.7.1 Undesirable Result and Minimum Thresholds

The SGMA regulations define the MT for significant and unreasonable land subsidence to be the "rate and the extent of land subsidence." The harmful effects of subsidence result from the damage it may cause to critical infrastructure and the costs of repairing or mitigating those damages. In the instance of the Vina Subbasin, critical infrastructure that could be affected by subsidence includes federal state and county roads and highways, irrigation district infrastructure, railroad infrastructure, and power transmission lines.

~~An~~Based on this definition, the undesirable result coming from land subsidence for the Vina Subbasin is experienced if:

> *groundwater pumping leads to changes in the ground surface elevation severe enough to disrupt critical infrastructure, development of projects that enhance the viability of rural areas, ~~small~~ communities, and the agricultural economic base of the region.*

Land subsidence typically occurs concurrently or shortly after significant declines in groundwater levels~~,~~; therefore, measured changes in groundwater levels can serve as a proxy for potential land subsidence. For this reason, the SMC developed for groundwater levels are used for land subsidence to ensure avoidance of the undesirable result.

As Groundwater Levels SMC are used by proxy, the quantitative Undesirable Result for land subsidence is the same as for groundwater levels:

> *~~Occurs when two~~ Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.*

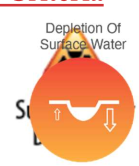
Undesirable results related to land subsidence in the Vina Subbasin have not occurred historically, are not currently occurring, and are not likely to occur in the future. To assess land subsidence in the Sacramento Valley, a subsidence monitoring network was established consisting of observation stations and extensometers managed jointly by the United States Bureau of Reclamation (USBR) and DWR. This subsidence monitoring network includes 19 GPS monuments located within the Vina Subbasin, on the boundary between Butte and Tehama counties, or on the boundary between the Vina and Butte ~~subbasins~~Subbasins. The subsidence monitoring network also includes three extensometers in Butte County with a period of record beginning in 2005. (There are no extensometers in the Vina Subbasin.) By 2019, a review of the data showed that changes in ground surface elevations were slight and remained at or above baseline levels, indicating that inelastic land subsidence has not been an observed in the Vina Subbasin. This is likely due to historically relatively stable groundwater levels and subsurface materials that are not conducive to compaction. For this reason, inelastic land subsidence due to groundwater pumping is unlikely to produce an undesirable result in the Vina Subbasin.

3.7.2 Measurable Objectives

As Groundwater Levels SMC are used by proxy, the MO for land subsidence is the same as for groundwater levels:

> *the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.*

3.8 Interconnected Surface Water ~~SMC~~Sustainable Management Criteria



Interconnected Surface Water SMC are those meant to address depletions of interconnected surface water caused by groundwater pumping. Relevant context, the Interconnected Surface Water SMC framework, and the locally defined undesirable result, MT, and MO are presented in the next sections.

3.8.1 Relevant Context

The objective of the Interconnected Surface Water SMC is to avoid significant and unreasonable adverse impacts on beneficial uses of the surface water. To address this SMC, DWR has provided various forms of guidance, including mapping of potential ~~GDE. GDE~~GDEs. GDEs are a sub-class of aquatic and riparian habitat that depend on groundwater for optimum ecological function. The distinction between an ecosystem's dependence on groundwater versus its dependence on surface water and the associated riparian zone or floodplain is important. In addition, the distinction between the shallow aquifer zone and the deep aquifer zone is also important. The deeper aquifer zone only influences surface water to the extent that it affects water levels in the shallow aquifer zone which then influences the shallow aquifer zone's connection to the stream. The Vina Subbasin includes upland streams (e.g., Big Chico Creek) and their associated riparian zones and the mainstem floodplain of the Sacramento River (Figure 3-~~1~~6). The scales of the ecosystems and associated hydrologic dependencies in these two landscapes are quite different. Streamflow and adjacent narrow riparian areas in the upland stream systems are very sensitive to watershed and climatic conditions outside of the Vina Subbasin in the foothills of the Cascades and Sierra Nevada. The Sacramento River and its floodplain are affected by much larger and cumulative hydrologic processes, including operation of multiple reservoirs and the cumulative hydrology of multiple watersheds extending to the headwaters of the Cascades.

Potential impacts of the depletion of interconnected surface water were discussed by stakeholders during technical discussions covering the fundamentals of groundwater-surface water interactions and mapping analysis of ~~GDE prepared by BCDWRC.~~GDEs as discussed in Section 2.2.7. The GDE mapping analysis is presented in ~~Appendix 3-C.~~ Chapter 2.2.7.

Potential impacts identified by stakeholders were:

- Disruption to GDEs
- Reduced flows in rivers and streams supporting aquatic ecosystems and water right holders
- Degradation of "Urban Forest" habitat in the City of Chico
- Streamflow changes in upper watershed areas outside of the Vina ~~GSAs~~Subbasin boundary
- Water table depth dropping below the maximum rooting depth of Valley Oak~~-~~ or other deep-rooted tree species
- Cumulative groundwater flow moving toward the Sacramento River from both the Vina Subbasin and surrounding GSAs on both the east and west side of the river

The Vina Subbasin acknowledges that overall function of the riparian zone and floodplain is dependent on multiple components of the hydrologic cycle that may or may not have relationships to groundwater levels in the principal aquifer. For example, hydrologic impacts outside of the Vina Subbasin, such as upper watershed development or fire-related changes in ~~run-off~~runoff, could result in impacts to streamflow, riparian areas, or ~~GDE~~GDEs that are completely independent of any connection to groundwater use or conditions within the Vina Subbasin.

Figure 3-6 placeholder page

Data needed to develop this SMC ~~includes:~~include definition of stream reaches and associated priority habitat~~,~~; streamflow measurements to develop profiles at multiple time periods~~,~~; and measurements of groundwater levels directly adjacent to stream channels, first water bearing aquifer zone, and deeper aquifer zones. These data are not available and are a data gap for the GSP. Section 2.2.6.2 discusses the limited information that is available that includes:

- One nested monitoring well (~~23N01W31M~~23N01W31M001-004; Figure 2-22) that includes a well completed in the shallow aquifer zone and three wells within deeper zones. The hydrograph for the shallow wells suggests it is completed within what could be termed "floodplain sediments" and is in direct hydraulic communication with the Sacramento River. A nested well completed further away from the Sacramento River indicates that the shallow well is in clear connection with deeper zones and does not indicate any connection to the Sacramento River.
- Hydrographs for eight shallow wells located within the City of Chico have water levels below the elevation of adjacent stream channels, indicating that groundwater levels are not capable of interacting directly with the adjacent stream channel.

The GSAs in the Vina Subbasin intend to further evaluate this SMC to avoid undesirable results to aquatic ecosystems and GDEs. To that end, an Interconnected Surface Water SMC framework has been developed for the GSP as described below. This framework will guide future data collection efforts to fill data gaps, either as part of GSP projects and management actions or plan implementation. As additional data are collected and evaluated, the Vina Subbasin GSAs will evaluate the development of additional SMC, as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

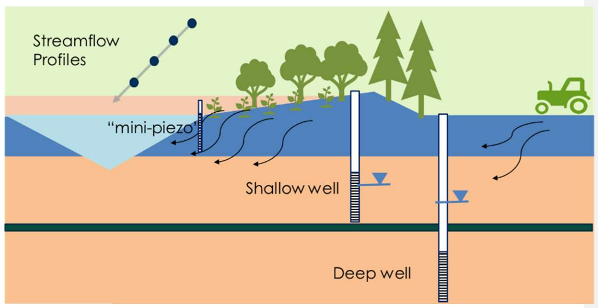
3.8.2 Interconnected Surface Water ~~SMC~~Sustainable Management Criteria Framework

To evaluate the potential for depletion of interconnected streams, an integrated assessment of both surface water and groundwater is required that includes (see Figure 3~~.~~-5 for illustration):

- Definition of stream reaches and associated priority habitat. This is typically developed using a combination of geomorphic classification of the stream channel and ecological classification of the associated habitat.
- Multiple streamflow measurements in each stream reach to develop a profile of streamflow at multiple time periods over at least one year. Comparison of flow rates in each reach defines whether the reach is gaining (water moving from the groundwater system to the stream/river) or losing (water moving from the stream/river to the groundwater system). A reach can be both gaining and losing, depending on the time of year (i.e., losing during high flow periods and gaining during low flow periods).
- Measurement of groundwater levels directly adjacent to the stream channel in the adjacent riparian zone or floodplain. Groundwater measurement of this type is typically done with piezometers, or "mini-piezos," which may be very shallow (less than 15 feet deep) and hand-driven (i.e., not requiring a drill rig). Groundwater levels are collected simultaneous to streamflow profiles.

- Measurement of groundwater levels in the first water bearing aquifer zone. This is the first regional or sub-regional aquifer that interacts with the stream by either discharging water ~~to~~into the stream or gaining water from the stream. These wells are typically between 20 and 100 feet deep and require a drill rig for installation. It is important for the screen interval of these wells to cross the water table. Groundwater levels are collected simultaneous to stage measurements along the streamflow profile. Water level differences between the shallow aquifer and the water surface elevation of the nearest stream reach are evaluated.

- Measurement of groundwater levels in deeper aquifer zones. These are typically regional or sub-regional aquifers that are used for regional supply. Water levels in these aquifers can be higher or lower than water levels in the overlying aquifer. The degree of connectivity to the nearest stream reach depends on how stratigraphically isolated the deeper zone is from the shallow zone. These wells are typically greater than 100 feet deep and require a drill rig for installation. It is important to conduct a pumping test of the deeper aquifer and measure water levels in the overlying aquifer to determine how hydraulically connected it is to the overlying aquifer. It is important to complete wells in the shallow aquifer across the water table. Groundwater levels are collected simultaneous to streamflow profiles. Additional ~~Airborne Electromagnetic~~AEM (geophysical) data would be valuable in further understanding the structure and potential interconnection of the aquifers in different zones.



~~Figure 3.5 – Illustration of monitoring points needed to developed SMC for interconnected surface waters.~~

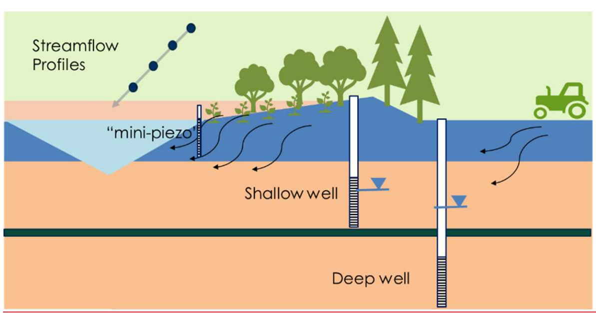


Figure 3-7: Illustration of Monitoring Points Needed to Develop Sustainability Management Criteria for Interconnected Surface Waters

This information is then integrated to define which surface water reaches are connected to the shallow aquifer zones and where those shallow aquifer zones are influenced by pumping of the deeper aquifer zones.

3.8.3 Undesirable Result

The undesirable result for this SMC is focused on connectivity where there is a measurable connection between groundwater levels in the principal aquifer and streamflow or associated aquatic habitat viability. The Vina Subbasin specifically recognizes deep-rooted tree species, such as Valley Oak~~-~~, that are common along riparian corridors in both upland streams and the Sacramento River and found elsewhere throughout the subbasin as depicted in Appendix 2-A. This connectivity is not well measured or understood in the Vina Subbasin at this time. For now, an undesirable result coming from the depletion of interconnected surface water is simply defined as:

> *Avoiding significant and unreasonable depletion of surface water flows caused by groundwater pumping that significantly impacts beneficial uses*

For this reason, the SMC developed for groundwater levels are used as a proxy for interconnected surface water in an interim manner until data gaps are addressed. As outlined in ~~Chapter~~Section 6, an aggressive schedule has been provided to fill these data gaps, and the GSAs are committed to addressing these issues and develop appropriate SMCs for the Vina Subbasin.

3.8.4 Minimum Thresholds

The potential impact of groundwater levels on aquatic habitat or ~~GDE~~GDEs is typically specific to a certain stream reach or geographic area. Groundwater modeling conducted in association with the HCM (Section 2) incorporates the interaction of surface water and groundwater at a regional scale, including all the GSAs in Butte County. While the model is a useful tool for evaluating regional behavior of the groundwater system overall, there are significant data gaps that limit calibration of the groundwater response in the uppermost layer of the model, where the dynamics and "interconnectedness" between surface water and groundwater actually occur. Therefore, at this time, Groundwater Levels SMC are used by proxy and the MT for interconnected surface water is the same as for groundwater levels:

> *Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.*

3.8.5 Measurable Objectives

As Groundwater Levels SMC are used by proxy, the MO for interconnected surface water is the same as for groundwater levels:

> *the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.*

As described previously, the historical record of groundwater levels shows fluctuations over a four- to seven-year cycle consistent with variations in water year type according to the Sacramento Valley Water Year Hydrologic Classification. It is not known whether streamflow and associated aquatic habitat and ~~GDE~~GDEs that are connected to groundwater have also experienced a long-term decline. In the upland streams, it is likely that similar long-term declines have occurred, since the recharge that produces the groundwater level fluctuations likely correlates with streamflow in the upper watershed areas. However, long-term declines in Sacramento River streamflow may have been avoided by reservoir releases aimed at maintaining streamflow levels. As described previously, the wet-dry cycles are climatically induced, and the GSAs ~~has~~have no ability to change this cyclical behavior; there will always be short-term cyclical fluctuations in surface water availability, particularly in the upland streams. The MO are therefore intended to address the long-term trend of the “peaks and valleys” of the short-term cycles. A focus on long-term trends will be maintained as more data are collected to inform future MOs for the shallowest zone of the aquifer system.

4. MONITORING NETWORKS

4.1 Monitoring Network Objectives

The objective of the existing monitoring networks is to observe and record data on groundwater levels, quality, and related conditions, such as the interconnection of surface water and groundwater and subsidence. Wells included in the existing monitoring networks were selected with sufficient temporal frequency and spatial density to evaluate conditions related to the effectiveness of the GSP, specifically to detect short-term, seasonal, and long-term trends. Parameters that have been monitored provide historic baseline information for establishing the current status of relevant SI that will be useful in tracking these ~~SI~~SIs as the GSP is being implemented. The complete list of ~~SI~~SIs is presented below:

1. Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply, if continued~~;~~
2. Significant and unreasonable reduction of groundwater storage~~;~~
3. Significant and unreasonable seawater intrusion~~;~~
4. Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies~~;~~
5. Significant and unreasonable land subsidence that substantially interferes with surface land uses~~; and~~
6. Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water~~.~~

The existing monitoring networks form a pool of monitoring locations that will serve as the backbone of the representative monitoring network used to assess SGMA compliance as discussed in Section 3. The existing network will support an improved understanding of conditions in the Vina Subbasin, inform ongoing management of the ~~subbasin~~Vina Subbasin, and contribute to future updates to the GSP. These objectives will be implemented in a manner that will:

- Demonstrate progress toward achieving MOs, MTs, and IMs~~;~~
- Monitor impacts to the beneficial uses or users of groundwater~~;~~
- Monitor changes in groundwater conditions~~; and~~
- Quantify annual changes in water budget components~~.~~

Data collected from the monitoring network will be used to track changes in groundwater elevations, water quality constituent concentrations, groundwater and surface water interactions, and rates of subsidence at monitoring locations throughout the Vina Subbasin. At locations where MO differ substantially from current conditions, the monitoring data from the ~~representative monitoring sites (~~RMS~~,~~ (discussed in Section 4.9) will be used to determine whether implementation of local projects and management actions are meeting ~~IM~~IMs presented in the GSP as indicators of progress toward attainment of the MO. Measurable objectives will be monitored directly through measurement of groundwater levels and water quality constituents.

Groundwater elevations will be used as a proxy for evaluating reduction in groundwater storage, depletions of interconnected surface waters, and for land subsidence where either of these potential undesirable results is associated with declining groundwater elevations. In each of these instances, "significant and unreasonable" reductions are the guideposts used to warn of unsustainable groundwater conditions. For interconnected surface waters, the GSAs in the Vina Subbasin intend to further evaluate this SMC to avoid undesirable results to aquatic ecosystems and GDEs. To that end, an Interconnected Surface Water SMC framework has been developed for the GSP, as described in Section 3.8. This framework will guide future data collection efforts to fill data gaps, either as part of GSP projects and management actions or as plan implementation. As additional data are collected and evaluated, the Vina Subbasin commits to developing additional SMC, as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

In addition to being central to SGMA compliance by enabling tracking of SI~~,~~ data collected through the monitoring network will be used to update inputs to the water budget and to guide interpretation of water budget results. Monitoring data will also be used to assess impacts of groundwater management on various categories of beneficial uses and users and to monitor overall groundwater conditions from local and ~~subbasin~~Vina Subbasin-wide perspectives.

The monitoring networks for groundwater levels, water quality, land subsidence, and depletions of interconnected surface water are described below. The BBGM and / or groundwater level data will be used to estimate changes in groundwater storage based on observed changes in groundwater levels. The BBGM covers the extent of the Vina, Butte, and Wyandotte Subbasins but can be used to estimate the storage within each individual subbasin.

Seawater intrusion is not considered to be an SI relevant to the Vina Subbasin as seawater intrusion is not present and is not likely to occur in the Vina Subbasin due to the distance from the Pacific Ocean, bays, deltas, or inlets. However, there is some evidence that connate groundwater of a quality characteristic of its ancient marine origins is present in the Vina Subbasin and that this water has the potential to affect beneficial uses due to brackish characteristics. Ancient marine layers pose a water quality (saline) risk by contaminating groundwater from groundwater pumping. This GSP will address this risk through the water quality ~~sustainability indicator.~~SI.

The location of existing sites and the frequency of monitoring at each site are presented below as is the spatial density of locations in each of the monitoring networks. Data gaps and plans to fill these gaps are also discussed as part of the program for defining the representative monitoring network to be used in monitoring SI to ensure SGMA compliance. Explanations of how gaps identified in the monitoring network will be filled are provided in Section 4.10.

The goal of defining the existing monitoring network, identifying gaps in the network, and developing and implementing a program to fill those gaps is to develop a representative monitoring network capable of collecting information needed to address:

- Short-term trends in groundwater and related surface water conditions~~;~~

- Seasonal trends in groundwater and related surface water conditions~~;~~
- Long-term trends in groundwater and related surface water conditions~~; and~~
- Provide adequate coverage by establishing sufficient density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends listed above~~.~~

4.2 Groundwater Level Monitoring

Groundwater level monitoring is conducted through a network of monitoring wells used for observation of groundwater levels and calculation of flow directions and hydraulic gradients in the principal aquifer of the Vina Subbasin. The network also allows for characterization of the groundwater table or potentiometric surface of the principal aquifer.

The 78 wells (located across 59 individual sites) included in the network were selected based on the degree to which data from these wells represents conditions in the area, use in existing monitoring programs, permission of the well owner to access the well, and the length and continuity of the monitoring record. Of the 78 wells, 25 are located in the Vina~~-~~ North ~~Management Area~~MA, 14 in the Vina~~-~~ Chico ~~Management Area~~MA, and 39 in the Vina~~-~~ South ~~Management Area.~~MA. Table 4-1 lists wells now used for monitoring in each ~~Management Area~~MA, and Figure 4-1 shows the locations of these wells in their respective ~~Management Areas~~MAs. Multi-completion wells are sites where more than one monitoring well has been installed at a single location. The wells are drilled and screened at different depths with each well designed to measure groundwater levels at a selected depth in the underlying aquifer.

Figure 4-1 placeholder page

Table 4-1: Vina Subbasin Groundwater Level Monitoring Well Locations

State Well ID Number	Monitoring Frequency	Multi-Completion	Well Type
Vina - North Management Area			
22N01E20K001M	Quarterly	No	Residential
22N01W05M001M	Hourly	No	Irrigation
23N01E07H001M	Quarterly	No	Residential
23N01E29P002M	Quarterly	No	Irrigation
23N01E33A001M	Quarterly	No	Irrigation
23N01W03H002M	Hourly	Yes	Observation
23N01W03H003M	Hourly	Yes	Observation
23N01W03H004M	Hourly	Yes	Observation
23N01W09E001M	Quarterly	No	Irrigation
23N01W10E001M	Quarterly	No	Irrigation
23N01W10M001M	Hourly	No	Observation
23N01W14R002M	Quarterly	No	Irrigation
23N01W16E001M	Quarterly	No	Irrigation
23N01W25G001M	Quarterly	No	Irrigation
23N01W27L001M	Quarterly	No	Residential
23N01W28M002M	Hourly	Yes	Observation
23N01W28M003M	Hourly	Yes	Observation
23N01W28M004M	Hourly	Yes	Observation
23N01W28M005M	Hourly	Yes	Observation
23N01W31M001M	Hourly	Yes	Observation
23N01W31M002M	Hourly	Yes	Observation
23N01W31M003M	Hourly	Yes	Observation
23N01W31M004M	Hourly	Yes	Observation
23N01W36P001M	Quarterly	No	Residential
23N02W25C001M	Quarterly	No	Irrigation
Vina - Chico Management Area			
22N01E09B001M	Quarterly	No	Residential
22N01E28J001M	Quarterly	Yes	Observation
22N01E28J003M	Quarterly	Yes	Observation
22N01E28J005M	Quarterly	Yes	Observation
22N01E35E001M	Hourly	No	Irrigation
22N02E18J001M	Quarterly	No	Residential
22N02E30C002M	Quarterly	No	Observation
CWSCH01b	~~Quarterly~~Tri-annually	No	M&I*
CWSCH02	~~Quarterly~~Tri-annually	No	M&I
CWSCH03	~~Quarterly~~Tri-annually	No	M&I
CWSCH04	~~Quarterly~~Tri-annually	No	M&I

State Well ID Number	Monitoring Frequency	Multi-Completion	Well Type
CWSCH05	~~Quarterly~~Tri-annually	No	M&I
CWSCH06	~~Quarterly~~Tri-annually	No	M&I
CWSCH07	~~Quarterly~~Tri-annually	No	M&I
Vina - South Management Area			
20N01E02H003M	Hourly	No	Observation
20N01E10C002M	Quarterly	No	Irrigation
20N02E06Q001M	Quarterly	No	Irrigation
20N02E08C001M	Quarterly	No	Irrigation
20N02E08H003M	Quarterly	No	Residential
20N02E09G001M	Hourly	No	Observation
20N02E09L001M	Quarterly	No	Irrigation
20N02E24C001M	Hourly	Yes	Observation
20N02E24C002M	Hourly	Yes	Observation
~~20N02E24C002M~~20N02E24C003M	Hourly	Yes	Observation
20N03E31M001M	Hourly	No	Observation
20N03E33L001M	Hourly	No	Other
21N01E10B003M	Quarterly	No	Irrigation
21N01E12D001M	Quarterly	No	Irrigation
21N01E12K001M	Quarterly	No	Irrigation
21N01E13F001M	Quarterly	No	Irrigation
21N01E13L002M	Hourly	Yes	Observation
21N01E13L003M	Hourly	Yes	Observation
21N01E13L004M	Hourly	Yes	Observation
21N01E14Q002M	Quarterly	No	Irrigation
21N01E21C001M	Quarterly	No	Irrigation
21N01E25K001M	Quarterly	No	Residential
21N01E26K001M	Quarterly	No	Irrigation
21N01E27B001M	Quarterly	No	Residential
21N01E27D001M	Quarterly	No	Residential
21N01E28F001M	Quarterly	No	Irrigation
21N02E18C001M	Hourly	Yes	Observation
21N02E18C002M	Hourly	Yes	Observation
21N02E18C003M	Hourly	Yes	Observation
21N02E20P001M	Quarterly	No	Irrigation
21N02E26E003M	Hourly	Yes	Observation
21N02E26E004M	Hourly	Yes	Observation
21N02E26E005M	Hourly	Yes	Observation
21N02E26E006M	Hourly	Yes	Observation
21N02E30L001M	Hourly	No	Residential

State Well ID Number	Monitoring Frequency	Multi-Completion	Well Type
21N02E32E001M	Quarterly	No	Irrigation
21N03E22C001M	Quarterly	No	Residential
21N03E29J003M	Quarterly	No	Residential
21N03E32B001M	Hourly	No	Irrigation

* M&I – Municipal and Industrial

4.2.1 Density of Monitoring Sites and Frequency of Measurement

Each of the wells in the existing network is monitored either by Cal Water, Butte County, DWR, or the associated CASGEM collaborators in the ~~subbasin. Of the wells in the existing network, 46 are measured manually on a quarterly basis, and 32 are measured continuously (hourly intervals) using data loggers. Of the continuously monitored wells, 27 are multi-completion wells located at 8 different sites, which are monitored by DWR or Butte County using pressure transducers and data loggers. The 7 wells monitored by Cal Water are reported three times per year.~~Vina Subbasin. For each MA, wells in the existing network are measured as follows:

- Vina North: 12 wells are measured manually on a quarterly basis, and 13 wells are measured continuously using data loggers on an hourly basis. Of the continuously monitored wells 11 are multi-completion wells at three different sites monitored by DWR or Butte County using pressure transducers and data loggers.
- Vina Chico: Six wells are measured manually on a quarterly basis, seven wells are measured manually on a tri-annual basis by Cal Water, and one well is measured continuously using a data logger on an hourly basis. Of the wells monitored manually on a quarterly basis, one is a multi-completed well consisting of three wells.
- Vina South: 20 wells are measured manually on a quarterly basis, and 19 wells are measured continuously using data loggers on an hourly basis. Of the continuously monitored wells, 13 are multi-completion wells at four different sites monitored by DWR or Butte County using pressure transducers and data loggers.

For the purpose of SGMA compliance, water levels in the ~~representative monitoring sites~~RMS (Section 4.9) in the Vina Subbasin will be monitored at least bi-annually (once in the spring and once in the fall). All wells will be measured within one calendar month following a schedule that will be developed for the ~~subbasin~~Vina Subbasin in coordination with DWR, the County, and neighboring subbasins.

Groundwater pumping typically peaks during the summer growing season and slows in the fall and winter. Therefore, spring levels represent an annual high prior to summer irrigation demands while fall levels represent an annual low for static (non-pumping) conditions. In addition to the coordinated spring and fall elevation measurements made at all wells in the network, data will continue to be taken at wells now monitored at greater frequencies according to their existing monitoring schedules. For wells that cannot be observed on the regular monitoring schedule or for which readings are questionable, it will be noted in the standard data sheet that the well was unable to be measured.

Groundwater elevation data will be used to observe seasonal and annual changes and for analysis of short-term and long-term trends. Analysis of trends in groundwater levels together with data on surface water deliveries and groundwater extraction will be important tools for tracking the Vina Subbasin's progress in meeting its MO ~~and~~. It will also be important in determining the need for additional or modifications to projects and / or management actions to meet the MO.

A total of 59 monitoring sites (78 wells) are included in the network for monitoring groundwater levels. These wells are distributed over the 289 square- mile area of the Vina Subbasin with a distribution equivalent to a spatial density of 21 sites and 31 wells per 100 square miles, a network density that significantly exceeds those presented in the Best Management Practices (BMP) Monitoring Networks and Identification of Data Gaps. Table 4-2 is taken from the BMP and shows a range of recommended monitoring network densities.

Table 4-2: Monitoring Well Density Considerations

Reference	Well Density (wells per 100 square miles)
Heath (1976)	0.2 – 10
Sophocleous (1983)	6.3
Hopkins (1984)	
Basins pumping more than 10,000 AFY per 100 square miles	4.0
Basins pumping between 1,000 and 10,000 AFY per 100 square miles	2.0
Basins pumping between 250 and 1,000 AFY per 100 square miles	1.0
Basins pumping between 100 and 250 AFY per 100 square miles	0.7

Annual groundwater pumping presented in the water balance section of the GSP shows a historical rate of pumping in the Vina Subbasin of 243,500 AFY (84,256 AFY per 100 square miles) and a current condition pumping rate of 209,200 AFY (72,388 AFY per 100 square miles).

Each monitoring point is located in one of the Vina Subbasin's three ~~Management Areas~~MAs:

- Vina - North (17 sites [25 wells]) in an area of 112 square miles, spatial density of 15 sites and 22 wells per 100 square miles.
- Vina - Chico (12 sites [14 wells]) in an area of 46 square miles, spatial density of 26 sites and 30 wells per 100 square miles.
- Vina – South (30 sites [39 wells]) in an area of 130 square miles, spatial density of 23 sites and 30 wells per 100 square miles.

4.3 Groundwater Storage Monitoring

4.3.1 Background

The BMP for Groundwater Monitoring (DWR, 2016) notes:

> *While change in groundwater storage is not directly measurable, change in storage can be estimated based on measured changes in groundwater levels… and a clear understanding of the Hydrogeologic Conceptual Model…. The HCM describes discrete aquifer units and the specific yield values associated with these units. These data, together with information on aquifer thickness and connectivity, can be used to calculate changes in the volume of groundwater storage associated with observed changes in groundwater elevation.*

As suggested in the preceding passage from DWR's BMP on Groundwater Monitoring, measured changes in groundwater levels can serve as a proxy for changes in storage. For this reason, the network for monitoring changes in groundwater storage is the same as that used for monitoring changes in groundwater levels. Monitoring sites and wells included in this network are presented above in Table 4-1 with well locations shown in Figure 4-1.

4.3.2 Frequency of Measurement

The data from the bi-annual frequency of monitoring groundwater levels described above will enable observed changes in levels to serve as a proxy to indicate changes in groundwater storage. Data presented in the HCM on parameters such as aquifer layer composition and thickness and the specific yield and hydraulic conductivity of these layers are integrated in the BBGM~~,~~ and allow the model to be used to estimate changes in groundwater storage that result from observed changes in groundwater elevations. As data on aquifer characteristics and modeling capabilities improve, the methodologies used to relate changes in groundwater elevations with corresponding changes in storage will be updated.

4.4 Groundwater Quality

4.4.1 Background

Assessment of groundwater quality in the Vina Subbasin focuses on annual observation of salinity (through monitoring of specific conductance), temperature, and pH in the principal aquifer. Each of these parameters is influenced by ambient conditions and the parent material of the principal aquifer. Specific conductance and pH are also influenced by human activity. While only salinity will be used to monitor attainment of MO and avoidance of breaches in MT, changes in pH and temperature may indicate shifting groundwater conditions that trigger additional investigation.

The groundwater quality monitoring network implemented for representative monitoring under SGMA will build upon the County's existing program. Additional monitoring will continue to be conducted by DWR and other agencies to track constituents not managed under this GSP including a variety of minerals, metals, pesticides, and herbicides. Data from the ongoing monitoring by various state and federal agencies will be available to the GSAs to augment local understanding of water quality in the Vina Subbasin and can be found on the State Board's

GAMA program at https://www.waterboards.ca.gov/gama/. Water quality programs conducted by other agencies are ~~summarized~~discussed in ~~Appendix~~Section 1~~-C.~~.5.The locations of all water quality monitoring wells are in Figure 4-2.

Figure 4-2 placeholder page

A total of seven sites are included in the County's ongoing water quality monitoring programs, with these wells having been selected based on the existing period of record, depth of well screens, and the quality of data reported and subject to permission of the well owner to monitor the well. Water quality monitoring has historically been conducted by Butte County during the summer. Of the seven wells, one is located in the Vina~~-~~ North ~~Management Area~~MA, one is in the Vina~~-~~ Chico ~~Management Area~~MA, and five are in the Vina~~-~~ South ~~Management Area~~MA.

To study regional groundwater quality, DWR's Northern Region Office collects groundwater samples from DWR dedicated monitoring wells that are used exclusively for groundwater level and groundwater quality monitoring~~.~~ (DWR, 2020).

Table 4-3 presents information on each of the wells monitored by Butte County in the Vina Subbasin groundwater quality monitoring network. Figure 4-2 shows the locations of the wells.

Table 4-3: Groundwater Quality Monitoring Locations

State Well ID Number	Local Name	Well Type
Vina – North Management Area		
23N01E29L03M	Vina	Irrigation
Vina – Chico Management Area		
n/a	Chico Urban	Domestic
Vina – South Management Area		
~~0N02E24Q01M~~20N02E24Q001M	Cherokee	Irrigation
~~21N01E15E02M~~21N01E15E002M	Durham Dayton	Irrigation
~~20N02E09M02M~~20N02E09M002M	Esquon	Irrigation
~~22N01E15D02M~~22N01E15D002M	M & T	Irrigation
~~21N03E29J03M~~21N03E29J003M	Pentz	Irrigation

4.4.2 Density of Monitoring Sites and Frequency of Measurement

Following the County's ongoing water quality monitoring program, data will be collected annually for monitoring the groundwater quality sustainability in August which is near the peak season for groundwater demand. The groundwater quality monitoring sites are distributed over the 289 square- mile area of the Vina Subbasin resulting in a monitoring network with a spatial density of 2.4 sites per 100 square miles.

4.5 Land Subsidence

4.5.1 Background

Inelastic land subsidence has the potential to be of major concern in areas of active groundwater extraction due to infrastructure damage, permanent reduction in the storage capacity of an aquifer, well casing collapse, and increased flood risk in low lying areas. Inelastic subsidence typically occurs in the clay layers within aquifers and aquitards due to the withdrawal of water from storage within these layers. This water supports the structure of the clay layers, and dewatering permanently rearranges or collapses this structure, a process that cannot be reversed as groundwater cannot re-enter the clay structure after collapse.

Available data indicate that inelastic land subsidence due to groundwater withdrawal has not ~~been an issue~~occurred in the Vina Subbasin. This is likely due to relatively stable groundwater levels and subsurface materials that are not conducive to compaction.

The primary mechanism for subsidence monitoring in the Vina Subbasin is a group of GPS monuments established to create the Sacramento Valley GPS Subsidence Monitoring Network. This program has been developed jointly by DWR and Reclamation with cooperation and assistance from local entities, including Butte County. The locations of these monuments are shown in Figure 4-3. Monuments used to monitor subsidence in the Vina Subbasin network include 19 monuments located either in the interior of the Vina Subbasin or on the boundary between Butte and Tehama counties or the boundary between the Vina and Butte ~~subbasins~~Subbasins. Data from this monitoring network is collected, analyzed, and reported by DWR as the data becomes available.

Data from monuments in the Vina Subbasin portion of the Sacramento Valley GPS Subsidence Monitoring Network have been used to monitor cumulative subsidence in the Vina Subbasin in 2008 and 2017, a period used to satisfy the SGMA requirement to evaluate historical subsidence.

Observations from the GPS Subsidence Monitoring Network will be supplemented by InSAR data released by DWR. This information reports vertical ground surface displacement using data collected by the European Space Agency Sentinel-1A satellite and processed by NASA's JPL. Data released to date from DWR's InSAR program provides cumulative vertical ground surface displacements from June 2015 through September 2019 and is used in the GSP to fulfill the requirement to estimate the rate and extent of recent subsidence.

InSAR data collection and mapping is regional and is not based on a defined network of monitoring locations. Therefore, no InSAR sites are shown in Figure 4-3.

4.5.2 Location and Density of Monitoring Sites and Frequency of Measurement

The Sacramento Valley GPS Monitoring Network includes monuments that were measured in 2008 and 2017, while the InSAR program monitors subsidence on a continual basis. Data collected from both sources requires post processing and analysis, therefore the frequency of reporting is dependent on the work performed by DWR and by NASA's JPL. There are no extensometers in the Vina Subbasin.

4.6 Interconnected Surface Waters

4.6.1 Background

Monitoring depletions of interconnected surface water is conducted by monitoring water levels (stage) in streams and groundwater levels to characterize spatial and temporal exchanges between surface water and groundwater and to calibrate and apply the tools and methods necessary to estimate depletions. The existing monitoring network incorporates data from active stream gages reported to the California Data Exchange Center (CDEC), the WDL, and the USGS National Water Information System and groundwater level monitoring, utilizing a subset of the locations described under the Vina Subbasin's groundwater level monitoring network.

Figure 4-3 placeholder page

The monitoring sites for the Vina Subbasin include the stream gages found in Table 4-4 and Figure 4-4 and the groundwater quality monitoring sites shown above in Table 4-3 and Figure 4~~-~~-2. The groundwater monitoring sites selected for observing groundwater and surface water interactions include the entire array of existing wells in the groundwater level monitoring network as described in Section 4.2, above, that form the pool of potential ~~representative monitoring sites~~RMS used to assess surface water and groundwater interactions. As discussed in Section 4.1, the GSAs in the Vina Subbasin intend to further evaluate the SMC for interconnected surface waters to avoid undesirable results to aquatic ecosystems and GDEs. As additional data are collected and evaluated, the Vina Subbasin commits to developing additional SMC and installation of monitoring points, as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

As with locations used for monitoring of other ~~Sustainability Indicators~~SIs, the network of stream gages and wells used to monitor interactions between groundwater and streamflow includes sites selected for their period of record, the quality of data reported and subject to permission of the landowner to monitor the well.

In addition to being used to identify relations between groundwater levels and streamflow, data from the network of stream gages and monitoring wells may be used to update and refine the calibration of the ~~Butte Basin Groundwater Model.~~BBGM. This model will be used to combine data on groundwater levels and stream flows with data on aquifer parameters and water use to estimate the relation between groundwater conditions and stream flow and to identify instances where groundwater use depletes surface water.

Table 4-4: Vina Subbasin Surface Water Interaction Monitoring Sites

Stream Monitored	Gage ID	Gage Network	Measurement Frequency
Butte Creek Nr Durham	BCD	CDEC	hourly
Butte Creek Nr Chico	11390000	USGS	daily
Big Chico Creek Nr Chico	BIC	CDEC	hourly
Parrot Div From Butte Creek	BPD	CDEC	hourly
Lindo Canal Nr Chico	LCH	CDEC	event
Deer Creek Nr Vina	11383500	USGS	daily
Mud Creek Nr Chico	MUC	CDEC	event

A total of 78 monitoring wells and ~~7~~seven stream gages are included in the Vina Subbasin's network for monitoring groundwater and streamflow interactions.

Figure 4-4 placeholder page

4.7 Monitoring Protocols for Data Collection

4.7.1 Monitoring Protocols and Frequency for Groundwater Levels

Each ~~of the wells~~well in the monitoring network is monitored either by Cal Water, Butte County, DWR, or the associated CASGEM entity. Access agreements, including written description of each site location, access instructions, and point of contact, will be arranged prior to initiation of field data collection.

Monitoring for purposes of the GSP will be conducted in accordance with DWR guidelines (~~BMP 1~~DWR, 2016) to ensure groundwater level data are:

- Taken from the correct location, well ID, and screen interval depth~~.~~
- Accurate and reproducible~~.~~
- Representative of conditions that inform appropriate basin management data quality objectives~~.~~
- Recorded with all salient information to correct, if necessary, and compare data~~.~~
- Handled in a way that ensures data integrity~~.~~
- Taken using a CASGEM-approved water-level measurement method to ensure consistency across measurements. ~~Methods include:~~
- Methods include:
  - Establishing a reference point~~.~~
  - Using one of four approved methods (steel tape, electric sounding tape, sonic water-level meter, or pressure transducer) to measure groundwater levels~~.~~

Groundwater level data will include~~,~~ at a minimum~~,~~ the well identification number, measurement ~~time and~~ date, depth to water (to the nearest 0.1 or 0.01 foot depending on equipment used) from the established reference point, total depth, measurement method, measurement quality descriptors (for no measurement or questionable measurement), and observations on well and/or site conditions (including modifications to the well). The equipment used to collect groundwater level data will be recorded to include the equipment manufacturer, model, and serial number, as applicable. Equipment used for data collection will be operated and maintained according the manufacturer's recommendations.

Each well in the network has an established reference point in North American Vertical Datum 1988 (NAVD88).

The general procedure for groundwater level monitoring is as follows:

- The well port (cap, plug or lid) for access will be removed. Pressure inside the well casing will be allowed to equalize to ambient conditions prior to data collection.
- Non-dedicated equipment will be decontaminated by washing with a non- phosphate soap solution and triple rinse of distilled water.

- Groundwater level data (described above) will be recorded.
- Groundwater elevation will be recorded (Groundwater elevation = reference point elevation – depth to water).
- The well port (and lock, if applicable) will be replaced.

Groundwater level data will be entered into the data management system (DMS) as soon as possible following collection.

Monitoring frequency for each well will occur at a minimum of bi-annually, once during the Spring (March) and once during the Fall (October). Select wells are monitored more frequently via dataloggers, at an hourly basis, but will only be reported bi-annually. Each RMS will be monitored within one calendar month to ensure consistency for comparability over time. This monitoring frequency will achieve the goal of obtaining sufficient data to evaluate the seasonal, short-, and long-term trends in groundwater.

4.7.2 Monitoring Protocols and Frequency for Water Quality

Each of the wells in the existing network is monitored for water quality by DWR and other agencies, both private and public, including Butte County.

Monitoring for purposes of the GSP will be conducted in accordance with DWR guidelines (~~BMP 1~~DWR, 2016) to ensure water quality data:

- Are taken from the correct location
- Are accurate and reproducible
- Represent conditions that inform appropriate basin management and are consistent with the data quality objectives
- Are handled in a way that ensures data integrity
- Include pertinent information that is recorded to normalize, if necessary, and compare data

Water quality will be measured for compliance through monitoring of specific conductance. However, pH and temperature will also be recorded for informational purposes. Water quality samples will be assessed in the field and will not require laboratory analysis.

Groundwater quality data will include, at a minimum, the well identification number, sample time and date, groundwater elevation data (as described in Section 4.2), water quality values for pH, specific conductance, and temperature, sample quality descriptors (for no measurement or questionable measurement), and observations on well and/or site conditions (including modifications to the well). The equipment used to collect groundwater quality data will be recorded to include the equipment manufacturer, model and serial number, as applicable. Equipment used for data collection will be operated and maintained according to the manufacturer’s recommendations.

The general procedures for groundwater quality sampling include:

- For wells with dedicated pumps, the sample will be collected near the wellhead.
- The sampling port and/or sampling equipment will be decontaminated by washing with a non-phosphate soap solution and triple rinse of distilled water prior to sample collection.
- ~~The~~With the exception of observation wells, the well will be purged of ~~3~~three well casing volumes prior to sampling (if not equipped with dedicated low-flow or passive equipment).
- Samples will be collected under laminar flow conditions.
- ~~Field calibration of equipment~~Equipment will be calibrated in the field to assess drift.

Monitoring for water quality for each well will occur annually in July or August. Select wells may be monitored more frequently but will only be reported annually. Each RMS will be monitored within one calendar month to ensure consistency for comparability over time. This monitoring frequency will achieve the goal of obtaining sufficient data to evaluate the seasonal, short-, and long-term trends in groundwater.

4.8 Representative Monitoring Sites

RMS are wells that are selected to represent conditions in the three specified ~~management areas~~MAs (North, Chico and South) within the Vina Subbasin. They are a subset of the 78 Monitoring Network wells (across 59 sites) shown in Figures 4-1 and 4-2. The monitoring objectives, protocols, and data reporting requirements for the RMS wells are the same as the Monitoring Network wells. The RMS wells are designated as the compliance points at which the five ~~sustainability indicators~~SIs (groundwater levels, groundwater storage, water quality, land subsidence, and interconnected surface water) are monitored, and for the quantitative values for MT, MO, and IM as defined in the ~~sustainable management criteria~~SMC in Section~~-~~ 3.

4.8.1 Selection Criteria for Representative Monitoring Sites

RMS wells are intended to be representative of general conditions within the area. This approach allows for a focused and specific monitoring location to effectively represent a larger geographical area. The data gathered from the RMS will be used to quantify the ~~management areas~~MA's groundwater conditions for the five ~~sustainability indicators~~SIs and evaluate GSP implementation.

RMS wells were selected using the following criteria:

1. Adequate Spatial Distribution – Representative monitoring site were selected from the monitoring network to maximize the geographical coverage across each of the three ~~management areas~~MAs and avoid overlapping or redundant coverage.
2. Existing Data – Representative monitoring sites with a longer period of record and a greater number of historical measurements were selected to provide insight into long-term trends that can provide information about groundwater conditions through varying climatic periods such a droughts and wet periods. Historical data may also show changes in groundwater conditions through anthropogenic effects as well.

While some sites chosen may not have extensive historical data, they may still be selected because there are no wells nearby with longer records.

3. Increased Density in Heavily Pumped Areas – Selection of additional wells in heavily pumped areas such as within urban residential areas in the city of Chico will provide additional data where high groundwater use occurs.
4. Multi-Completion Wells – The utilization of wells with different screen intervals is important to collect data on the groundwater conditions at different elevations within the aquifer. This can be achieved by using wells with different screen depths that are close to one another, or by using multi-completion wells.
5. Consistency with BMPs – The BMPs provided by DWR encourage consistency across subbasins and compliance with established regulations.
6. Well Construction Data – Well data, such as perforation depths, construction date, and well depth ~~was~~, were considered for selection.
7. Accessibility – Consideration for accessibility to the physical well location and to the existing data was incorporated into the selection of RMS wells. RMS in the network include residential, municipal, agricultural, and governmental wells that are owned and operated by various private and public entities.
8. Professional Judgement – Professional judgement was used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.

4.9 Representative Monitoring Sites for Sustainability Indicators

Each of the associated ~~Sustainable Management Criteria~~SMC for each ~~Sustainability Indicator~~SI described in Section 3 have RMS wells identified for monitoring and evaluation with the exception of seawater intrusion as it is not applicable to the Vina Subbasin. The selected RMS wells for each ~~Sustainability Indicator~~SI are discussed in the following sections.

4.9.1 Groundwater Levels

The RMS wells will be used as compliance points to record groundwater elevations for the evaluation of chronic lowering of groundwater levels. SGMA allows groundwater elevations to be used as proxy for monitoring other SI if a significant correlation exists between groundwater elevations and the other SI and if the MO for groundwater elevation include a reasonable margin of operational flexibility to avoid undesirable results.

Groundwater storage is directly connected to groundwater elevation, and therefore the MO for groundwater levels will adequately serve as proxy for groundwater storage. Land subsidence occurs when compressible subsurface soils are dewatered. Soil units in the Vina Subbasin have not historically been susceptible to compression during periods of declining groundwater elevations. Therefore, the MO for groundwater levels will adequately serve as proxy for land subsidence.

Surface waters may manifest a depletion in volume if groundwater levels fall below the established MO. Such depletion is not evident in the historical records available~~,~~; however, more information may be required to adequately characterize interactions. See Section 3.8 for a discussion of interconnected surface water assessment. As indicated in this ~~Section~~section, an Interconnected Surface Water SMC framework has been developed for the GSP. This framework will guide future data collection efforts to fill data gaps, either as part of GSP projects and management actions or plan implementation. As additional data are collected and evaluated, the Vina Subbasin commits to developing additional SMC and installation of RMS as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

For the purposes of this GSP, groundwater elevations will be used as a proxy for monitoring of SMCs of groundwater storage, land subsidence, and interconnected surface water.

A total of 17 RMS wells were selected as compliance points for monitoring of groundwater levels (Figure 4-5). Six RMS were selected from the 25 Monitoring Network wells for the North ~~management area, 5~~MA, five RMS from the 14 Monitoring Network Wells for the Chico ~~management area~~MA, and ~~6~~six RMS from the 39 Monitoring Network wells for the South ~~Area~~MA. Table 4-5 summarizes the well construction details, and Table 4-6 summarizes the well location details.

Figure 4-5 placeholder page

Table 4-5: Groundwater Levels ~~RMS~~Representative Monitoring Site Well Construction Details

RMS Well ID	State Well Number (Site Name)	Total Depth (feet bgs)	Screened Interval (feet bgs)	Reference Point Elevation[1] (feet)	Reference Point Description	Ground Surface Elevation[1] (feet)
Vina Subbasin – North Management Area						
25C001M	23N02W25C001M	243	N/A	161.2	Hole cut ~~in side~~inside of casing	157.4
10E001M	23N01W10E001M	668	600-668	190.68	~~One~~ 1-inch hole inside pump base	189.38
07H001M	23N01E07H001M	195	115-195	283	Top of casing, remove blue cap	282
05M001M	22N01W05M001M	200	N/A	153.28	Hole in pump south side	151.48
36P001M	23N01W36P001M	165	N/A	164.35	Top of casing crack in north side	162.75
33A001M	23N01E33A001M	506	53-506	252.34	~~One~~ 1-inch hole in top of casing	252.34
Vina Subbasin – Chico Management Area						
CWSCH01b	~~(~~CWSCH01b~~)~~	>600	---	200	N/A	---
CWSCH02	CWSCH02~~(CWSCH 07)~~	~~<~~>600	---	~~270~~183	N/A	---
CWSCH03	~~(~~CWSCH03~~)~~	>600	---	258	N/A	---
CWSCH07	CWSCH07~~(CWSCH 02)~~	~~>~~<600	---	~~183~~270	N/A	---
28J003M	~~22N01E28J005M~~22N01E28J003M	~~>600~~279	~~---~~200-279	179.79	Top of casing easterly 1~~"~~-inch casing	178.89
Vina Subbasin – South Management Area						
21C001M	21N01E21C001M	565	240-300 448-508	133.64	Hole in pump base west side	133.34
18C003M	21N02E18C003M	240	130-140 160-170 190-200	191.15	Top of shortest PVC casing	189.07
10C002M	20N01E10C002M	210	20-120	128.35	Top of casing south side	127.35
24C001M	20N02E24C001M	155	124-134	159.65	Top of casing, northern-most piezo	157.75
09L001M	20N02E09L001M	710	460-710	143.83	Hole in pump base, southeast side	139.33
26E005M	21N02E26E005M	315	265-275 280-290	184.44	Top of next to shortest PVC casing	182.26

Note:
1 –NAVD88
N/A – Not available
PVC – polyvinyl chloride

RMS Well ID	State Well Number (Site Name)	Total Depth (feet bgs)	Screened Interval (feet bgs)	Reference Point Elevation[1] (feet)	Reference Point Description	Ground Surface Elevation[1] (feet)

--- Details of public supply wells not disclosed

~~Note:~~

~~1 NAVD88~~

~~N/A – Not available~~

~~PVC – polyvinyl chloride~~

~~--- Details of public supply wells not disclosed~~

Table 4-6: Groundwater Levels ~~RMS~~Representative Monitoring Site Well Location Details

RMS Well ID	State Well Number (Site Name)	Latitude[1]	Longitude[1]
Vina Subbasin – North Management Area			
25C001M	23N02W25C001M	39.8222	-122.0401
10E001M	23N01W10E001M	39.864	-121.972374
07H001M	23N01E07H001M	39.864821	-121.904936
05M001M	22N01W05M001M	39.787113	-122.010001
36P001M	23N01W36P001M	39.7972	-121.9297
33A001M	23N01E33A001M	39.809696	-121.863054
Vina Subbasin – Chico Management Area			
CWSCH01b	~~(~~CWSCH01b~~)~~	---	---
CWSCH02	~~(~~CWSCH02~~CWSCH07)~~	---	---
CWSCH03	~~(~~CWSCH03~~)~~	---	---
CWSCH07	~~(~~CWSCH07~~CWSCH02)~~	---	---
28J003M	~~22N01E28J005M~~22N01E28J003M	39.731678	-121.864995
Vina Subbasin – South Management Area			
21C001M	21N01E21C001M	39.665471	-121.878004
18C003M	21N02E18C003M	39.682	-121.797
10C002M	20N01E10C002M	39.609653	-121.848763
24C001M	20N02E24C001M	39.5812	-121.7026
09L001M	20N02E09L001M	39.6066	-121.7586
26E005M	21N02E26E005M	39.6468	-121.7263

Note:
1 – North American Datum 1983 (NAD83)
--- Location of public supply wells not disclosed

~~Note:~~
~~1 – North American Datum 1983 (NAD83)~~
~~--- Location of public supply wells not disclosed~~

4.9.2 Water Quality

A total of ~~8~~eight RMS wells were selected as compliance points for monitoring of water quality (Figure 4-5). They will be monitored for the SMC listed in Section 3.5. These wells were selected independently of the wells discussed in Section 4.5 and are not listed in Table 4-3. Table 4-7 summarizes the well construction details, and Table 4-8 summarizes the well location details.

Table 4-7: Water Quality ~~RMS~~Representative Monitoring Site Well Construction Details

RMS Well ID	State Well Number (GSP Number)	Total Depth (feet bgs)	Screened Interval (feet bgs)	Reference Point Elevation[1] (feet)	Reference Point Description	Ground Surface Elevation[1] (feet)
Vina Subbasin – North Management Area						
28M002M	23N01W28M002M	1044	791-801 881-891 951-961 1011-1021	160.33	Top of shortest PVC casing	159.02
03H002M	23N01W03H002M	553	510-540	218.84	Top of shortest PVC casing	216.88
31M001M	23N01W31M001M	1200	969-979 1020-1030	162.86	Top of highest PVC casing	154.75
Vina Subbasin – Chico Management Area						
28J005M	22N01E28J005M	948	740-800	179.79	Top of casing easterly 1~~"~~-inch casing	178.89
Vina Subbasin – South Management Area						
18C001M	21N02E18C001M	914	770-780 800-810 830-840 870-880	191.56	Top of tallest PVC casing	189.07
13L002M	21N01E13L002M	771	735-760	181.9	Top of casing	179.85
26E003M	21N02E26E003M	660	610-620	184.97	Top of tallest PVC casing	182.27
24C003M	20N02E24C003M	520	484-505	159.14	Top of casing, middle (shortest) piezo	157.75

Note:
1 – NAVD88

~~Note:~~
~~1 – NAVD88~~

Table 4-8: Water Quality ~~RMS~~Representative Monitoring Site Well Location Details

RMS Well ID	State Well Number	Latitude[1]	Longitude[1]
Vina Subbasin – North Management Area			
28M002M	23N01W28M002M	39.818773	-121.991188
03H002M	23N01W03H002M	39.878215	-121.95712
31M001M	23N01W31M001M	39.8028	-122.0294
Vina Subbasin – Chico Management Area			
28J005M	22N01E28J005M	39.731678	-121.864995
Vina Subbasin – South Management Area			
18C001M	21N02E18C001M	39.682	-121.797
13L002M	21N01E13L002M	39.67348	-121.8144
26E003M	21N02E26E003M	39.6468	-121.7263
24C003M	20N02E24C003M	39.5812	-121.7026

Note:
1 – North American Datum 1983 (NAD83)

~~Note:~~
~~1 – North American Datum 1983 (NAD83)~~

4.10 Network Assessment and Improvements

An assessment of the monitoring network is required to determine uncertainty and identify data gaps that could affect the achievement of sustainability goals. Improvements to the network to address data gaps will be planned and implemented to manage, focus, and prioritize monitoring.

Data gaps can result from monitoring information that is not of sufficient quantity or quality. Monitoring network data gaps can influence the development and understanding of the basin setting, including the ~~hydrogeologic conceptual model~~HCM, groundwater conditions, ~~and~~ water budget~~;~~, and proposed ~~minimum thresholds~~MT and ~~measurable objectives~~MO. Updates to the data gaps will be included with the annual reporting and ~~5~~five-year assessment of the GSP.

The following data gaps and proposed resolutions have been identified in the Vina Subbasin:

- Domestic Well Depths – The MT for groundwater levels is based on total depths of domestic wells. The dataset used for this assessment is poor and may include wells no longer in use or poorly maintained. To resolve this data gap, the GSAs will conduct surveys of active domestic wells to assess the actual total depth of these wells within the Vina Subbasin. The GSAs will also maintain a record of verifiable domestic wells that go dry during the implementation period that will include depth of these wells, screen intervals, and available maintenance records. These data will be used to modify the MT over the implementation period, as appropriate.
- Water Quality – Temporal data gaps exist for water quality samples collected within the RMS wells. However, existing data from other sites indicate that water quality in the Vina Subbasin is significantly below the MO. The frequency of sampling proposed in GSP is anticipated to provide consistent and comparable data to fill this data gap.

- Interconnected Surface Water/Associated impacts on GDEs – There is a lack of sufficient data to analyze interaction of streams and pumping within the primary aquifer system. Additional wells and other monitoring networks will be installed, as appropriate, following the framework discussed in Section 3.8.

Figure 4-6 placeholder page

5. PROJECT AND MANAGEMENT ACTIONS

This ~~chapter~~section includes relevant projects and management actions information to satisfy CCR Title 23 § 354.42 and 354.44. The projects and management actions described in this ~~chapter~~section will help achieve the Vina Subbasin's sustainability goal.

5.1 Projects, Management Actions, and Adaptive Management Strategies

The objective and purpose of the GSP is to achieve groundwater sustainability in the Vina Subbasin. This will require projects ~~aimed at increasing water supplies~~ and ~~decreasing groundwater dependence, as well as~~ management actions ~~designed~~aimed at avoiding undesirable results, achieving measurable objectives, and responding to ~~reduce groundwater demand~~changing conditions in the basin. The Vina GSA and the RCRD GSA have identified projects and management actions tailored to benefit the Vina Subbasin's groundwater supply and quality for the benefit of rural areas, communities, agricultural users and the environment. The approach targets both identifying and increasing alternative sources of supply and reducing groundwater demand. The GSP identifies groundwater monitoring programs to monitor groundwater conditions, investigation of additional water sources to supplement the use of groundwater, and conservation and educational programs to reduce groundwater demand.

5.2 Projects

5.2.1 Project Identification

Projects were identified through a lengthy outreach effort involving the SHAC and the GSAs. The process included soliciting input from governmental agencies, water purveyors, and local landowners. The Vina GSA's website allowed project proponents to input the available information on each project.

The majority of projects submitted were proposed by the Vina GSA, with some being a joint effort with the RCRD GSA. Some of the projects also include other proponents, such as ~~California State University, Chico (~~CSUC~~)~~, PG&E, Cal Water, local agricultural farmers, and others. The list of proponents and other entities involved in the projects is included in Table 5-1 below. The schedule to implement the projects is likely to vary depending upon ~~subbasin~~Subbasin conditions, and the expected benefits of PMAs may also vary year to year.

The provided project information was compiled into an initial draft list with similar and overlapping projects combined as appropriate. The draft list was presented to the ~~SHAC~~Vina GSA Stakeholder Advisory Committee in their July 15, 2021, meeting and to the GSA Boards at their August meetings. The projects were then evaluated based on the following criteria:

- Project addresses one or more of the Undesirable Results
- Project is implementable with respect to technical complexity, regulatory complexity, institutional consideration, and public acceptance
- Project is implementable within the SGMA timeframe
- Project benefits Underrepresented Communities (URCs)

- Project is in an area where water quality is suitable for use

5.2.2 Project Implementation

The purpose of planning and implementing projects is to ensure the ~~subbasin~~Vina Subbasin achieves sustainability. ~~-~~Projects are categorized in three categories - Planned, Potential, and ~~Longer-term or~~ Conceptual – based on current stage of planning or implementation. ~~-~~This ~~chapter~~section includes Planned ~~and~~, Potential ~~projects, Longer-term or~~ , and Conceptual projects. Additional projects may be added in the future once identified. The specific ~~Projects~~projects included in the GSP will be implemented, operated, and owned by the individual project proponent(s). Through annual reports, GSP updates, and the evaluation of ~~interim milestones, minimum thresholds~~IMs, MT, and ~~measurable objectives~~MO, the GSAs will evaluate whether the implementation of ~~Projects~~projects is sufficient to achieve sustainability. Depending on how ~~Projects~~projects are achieving sustainability, or otherwise impacting the ability of the ~~subbasin~~Vina Subbasin to achieve sustainability, the GSAs may prioritize the development of projects, seek funding for prioritized projects, or develop guidelines for existing projects.

5.2.2.1 List of Projects

Several projects to achieve the Vina Subbasin's sustainability goal were identified. The initial set of projects was reviewed by the SHAC. A final list of 15 possible projects is included in this GSP, and they are categorized into several project types, including direct and in-lieu recharge, intra-basin water transfers, water recycling, ~~-~~demand conservation, and monitoring. Projects are further classified into three categories based on project status: Planned, Potential, and ~~Longer-term or~~ Conceptual, as defined below. All projects, regardless of status, remain subject to available funding, any required CEQA compliance, and any required approvals. The list of possible projects identified in this GSP are an initial list that may be further expanded or modified as the GSAs work toward sustainability by 2042.

- Planned Projects – Currently, ~~4~~five Planned Projects have been identified. Projects in this category ~~will~~are anticipated to move forward to help achieve the region's sustainability before 2042.
- Potential Projects – Currently, ~~11~~eight Potential Projects have been identified. Projects in this category are currently in the initial planning stages and may move forward ~~if funding becomes available.~~as feasibility and project requirements are determined. Potential Projects represent a "menu of options" for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects.
- ~~Longer-term or~~ Conceptual Projects – ~~No specific projects~~Currently, two Conceptual Projects have been identified ~~since projects~~. Projects in this category are in the early conceptual planning states and would require significant additional work to move forward. ~~Longer-term/~~Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Vina Subbasin in the future, but that would need to be further developed.

This subsection of the GSP satisfies the requirements of CCR title 23 § 354.44. Consistent with SGMA requirements, the project descriptions for projects contain information regarding:

- The ~~Measurable Objective~~MO benefitted by the project
- Permitting and regulatory processes
- Timetable for initiation and completion
- Expected benefits
- How the project will be accomplished
- Legal authority
- Estimated costs and plans to meet costs
- Implementation circumstances
- Public noticing

Table 5-1 provides a summary of the 15 projects. Full descriptions are included below. ~~Figures 5-1 and 5-2 show the locations of these planned and potential projects.~~

Geosyntec consultants

Table 5-1: List of ~~SGMA~~Sustainable Groundwater Management Act Projects

Project Name	Project Type	Identified Project Proponent and Other Potential Participating Entities	Measurable Objective Expected to Benefit	Current Status	Timetable (initiation and completion)	Estimated Costs	Expected Groundwater Demand Reduction (Acre-Feet/year)
Planned Projects							
5.2.3.1 Agricultural Irrigation Efficiency	Conservation	Vina GSA; local landowners, other entities ~~TBD~~to be determined	Groundwater Levels, Groundwater Storage	Planning Stage	~~2022-2025~~2024-2030	~~TBD~~To be determined	Up to 4,000 ~~acre-feet~~ (based on a reduction up to 2%)
5.2.3.2 Residential Conservation	Conservation	Cal Water Chico, Vina GSA, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Planning Stage	2022-2025	~~TBD~~To be determined	100
~~5.2.3.3 Streamflow Augmentation~~	~~Direct Recharge, In-Lieu Recharge~~	~~Vina GSA, RCRD GSA, PID, PG&E, local landowners, other entities TBD~~	~~Groundwater Levels, Surface Water Depletion~~	~~Planning Stage~~	~~2022-2025~~	~~$50-$100 per acre-foot~~	~~1,000-5,000~~
5.2.3.~~4~~3 Scoping for Flood Managed Aquifer Recharge (FloodMAR)/Surface Water Supply and Recharge ~~Scoping~~	Direct Recharge, In-lieu Recharge	Vina GSA, RCRCD GSA, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Planning Stage	2022-2032	~~TBD~~To be determined	~~N/A~~Not applicable
5.2.3.4 Community Water Education Initiative	Education and Outreach	Vina GSA, CSUC, CWE, Chico State Enterprises, local landowners, other entities to be determined	Groundwater Levels, Groundwater Storage, Water Quality, Land Subsidence, Surface Water Depletion, Education and Outreach	Ready for Implementation	Currently ongoing, expansion by 2023 depending on funding	Component 1: $50-100K annually Component 2: $10,000-$200,000 annually Component 3: $10,000-$25,000 annually	To be determined
5.2.3.5 Fuels Management for Watershed Health	Conservation	Vina GSA, CSUC, Chico State Enterprises, local landowners, other entities to be determined	Groundwater Levels, Groundwater Storage, Water Quality, Surface Water Depletion	Part of project currently ongoing, rest in planning stage	450 acres ongoing; 4,000 acres 2021-2030; 6,000 to 10,000 acres 2025-2040	$8.0 million - $14.0 million	To be determined
Potential Projects							
5.2.4.1 Paradise Irrigation District Intertie	In-Lieu Recharge	Vina GSA; PID, Cal Water, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Planning Stage	~~TBD~~To be determined, after Spring 2022	~~TBD~~To be determined	5,000
5.2.4.2 Agricultural Surface Water Supplies	Intra-Basin Water Transfer	Vina GSA, RCRD, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Planning Stage	2025-2032	~~TBD~~To be determined	2,000 – 3,000

5.2.4.3 Streamflow Augmentation~~Extend Orchard Replacement~~	Direct Recharge, In-Lieu Recharge~~Conservation~~	Vina GSA, RCRD GSA, PID, PG&E, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels, Surface Water Depletion	~~Conceptual~~Initial Planning Stage	2022-2025~~TBD~~	$50-$100 per acre-foot~~TBD~~	41,000-~~8~~5,000
5.2.4.4 ~~Recharge from the Miocene Canal~~Community Monitoring Program	Monitoring~~Direct Recharge~~	Vina GSA ~~PG&E, Butte County~~, CSUC, Chico Ecological Reserves, local landowners, other entities ~~TBD~~ To be determined	Groundwater Levels	~~Conceptual~~ Planning Stage	2022-2025	~~TBD~~To be determined	~~2,000 acre-feet based on 10,000 acre-feet available for recharge (20% efficiency)~~Not applicable
5.2.4.5 ~~Community Monitoring Program~~Recycled Wastewater	Direct Recharge, Water Recycling~~Monitoring~~	Vina GSA, ~~CSUC,~~City of Chico ~~Ecological Reserves~~, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Planning Stage	2030-2038~~2022-2025~~	~~TBD~~To be determined	~~N/A~~5,000
5.2.4.6 Rangeland Management~~Recycled Wastewater~~	Conservation~~Direct Recharge, Water Recycling~~	Vina GSA, ~~City of~~CSUC, Chico~~, local landowners~~ State Enterprises, other entities ~~TBD~~ to be determined	Groundwater Levels	Planning Stage	Baseline data collection (2021-2022) Development of Master Management Plan (2022-2024)~~2030-2038~~	~~TBD~~To be determined	~~5,000~~To be determined
5.2.4.7 Removal of Invasive Species~~Community Water Education Initiative~~	Conservation~~Education and Outreach~~	Vina GSA, CSUC, ~~CWE,~~ Chico State Enterprises, ~~local landowners,~~ other entities ~~TBD~~to be determined	Groundwater Levels, Groundwater Storage~~, Water Quality, Land Subsidence, Surface Water Depletion, Education and Outreach~~	Planning Stage~~Ready for Implementation~~	~~Currently ongoing, expansion by~~ Inventory and mapping of properties: 2022-2023 ~~depending on~~ Development of invasive management for water retention plan: 2023-2024 Identify and secure funding: 2022-2026 Implement projects and measure results: 2025 and beyond	~~Component 1: $50-100K annually Component 2: $10,000-$200,000 annually Component 3: $10,000-$25,000 annually~~To be determined	~~TBD~~To be determined
5.2.4.8 Surface Water Supply and Recharge~~Rangeland Management~~	Direct Recharge~~Conservation~~	Vina GSA, ~~CSUC, Chico State Enterprises~~RCRD GSA, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Planning Stage	Sand Creek / Lindo Channel – 2022-2032; Other projects – 2022 – 2042~~Baseline data collection (2021-2022) Development of Master Management Plan (2022-2024)~~	~~TBD~~To be determined	~~TBD~~1,000 / project
~~5.2.4.9~~ **Conceptual Projects**~~Fuels Management for Watershed Health~~	~~Conservation~~	~~Vina GSA, CSUC, Chico State Enterprises, local landowners, other entities TBD~~	~~Groundwater Levels, Groundwater Storage, Water Quality, Surface Water Depletion~~	~~Part of project currently ongoing, rest in planning stage~~	~~450 acres ongoing; 4,000 acres 2021-2030; 6,000 to 10,000 acres 2025-2040~~	~~$8.0 million - $14.0 million~~	~~TBD~~

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~~5.2.4.10~~ 5.2.5.1 Extend Orchard Replacement~~Removal of Invasive Species~~	Conservation	~~-~~Vina GSA, ~~CSUC, Chico State Enterprises~~local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Conceptual Planning Stage	~~Inventory and mapping of properties: 2022-2023~~ ~~Development of invasive management for water retention plan: 2023-2024~~ ~~Identify and secure funding: 2022-2026~~ ~~Implement projects and measure results: 2025 and beyond~~To be determined	~~TBD~~To be determined	~~TBD~~4,000-8,000
5.2.~~4.11 Surface Water Supply and~~5.2 Recharge from the Miocene Canal	Direct Recharge	Vina GSA~~, RCRD GSA~~ PG&E, Butte County, local landowners, other entities ~~TBD~~to be determined	Groundwater Levels	Conceptual Planning Stage	After 2025~~Sand Creek / Lindo Channel – 2022-2032; Other projects – 2022 – 2042~~	~~TBD~~To be determined	~~1~~2,000 based on 10,000 acre-feet ~~/ project~~available for recharge (20% efficiency)

5.2.3 Planned Projects

Projects categorized as Planned Projects are expected to move forward and be completed to achieve the Vina Subbasin's sustainability goal by 2042. The estimated groundwater supply from these projects is expected to offset the projected overdraft of ~~15~~10,000 ~~AF per year.~~AFY.

5.2.3.1 Agricultural Irrigation Efficiency

A survey is currently being conducted in North and South Vina by the Vina GSA, Agricultural Groundwater Users of Butte County, and Butte County Farm Bureau in order to evaluate current irrigation methods and practices, identify opportunities and methods to improve irrigation efficiency, determine potential issues preventing the adoption of efficiency practices, and provide recommendations for increasing participation in these practices. The results of this survey are expected to be available in September ~~2021~~2022, with implementation of the project expected to be initiated between 2024 and 2030. Recommendations from the survey will be made available to the local agricultural community, and implementation of the practices will be voluntary. The Vina GSA along with participating partners will pursue grant funds to help implement these practices. It is estimated that the adoption of more efficient practices could reduce groundwater demand by up to 2%, which translates to a reduction in groundwater demand of up to 4,000 ~~AF per year~~AFY.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA; local landowners, other entities to be determined
Project Type:	Conservation
Estimated Groundwater Offset and/or Recharge:	–Up to 4,000 acre-feet/year

Measurable Objective Expected to Benefit: This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The main objective of the project is to reduce groundwater demand by modifying irrigation practices.

Project Status: This project is in the planning stages.

Required Permitting and Regulatory Process: None

Timetable for Initiation and Completion: Project will be initiated in 2024

Expected Benefits and Evaluation: A survey that consolidates data on the adoption of irrigation methods and practices by agricultural groundwater users will identify where more efficient practices can be implemented. This can help focus efforts and finances on areas where a reduction in overall groundwater demand is needed and feasible.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project. No additional water source will be utilized for this project.

Legal Authority: The project would be under the authority of Vina GSA and potential future participating partners.

Estimated Costs and Plans to Meet Costs: ~~TBD~~To be determined, funding via Proposition 1, Proposition 68, USDA, Drought Resiliency Grants

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward.

Trigger for Implementation and Termination: The project will be initiated after the recommendations from the initial survey results are available.

Process for Determining Conditions Requiring the Project to Occur: As mentioned above, the survey is already underway and once analysis is complete, recommendations based off ~~of~~ the results will be made available for voluntary implementation.

5.2.3.2 Project: Residential Conservation

Cal Water Chico, which provides water to the City of Chico via groundwater, proposed a series of conservation projects under their 2020 UWMP, including toilet replacement, urinal valve and bowl replacement, clothes washer replacement, residential conservation kits, smart controllers, high efficiency irrigation nozzles, and turf buy-back.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Cal Water Chico, Vina GSA, local landowners, other entities to be determined
Project Type:	Conservation
Estimated Groundwater Offset and/or Recharge:	100 AFY

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is in the planning stages.

Required Permitting and Regulatory Process: None

Timetable for Initiation and Completion: 2022-2025

Expected Benefits and Evaluation: The implementation of several different conservation projects for residential areas is expected to reduce groundwater demand by 100 ~~AF per year~~AFY in Chico.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project implemented by Cal Water in residential areas. No additional water source will be utilized for this project.

Legal Authority: The project would be under the authority of Vina GSA and Cal Water Chico. Cal Water Chico would initiate the conservation programs.

Estimated Costs and Plans to Meet Costs: ~~TBD~~To be determined, funding via Proposition 1, Proposition 68, Drought Resiliency Grants, Cal Water.

~~**Circumstances for Implementation:** This project is a Planned Project that is anticipated to move forward.~~ **Circumstances for Implementation:** This project is a Planned Project that is anticipated to move forward. ~~As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.~~

Trigger for Implementation and Termination: Increased groundwater demand due to an increasing number of planned residential developments in Chico (according to the City of Chico and Butte County General Plans).

Process for Determining Conditions Requiring the Project to Occur: -This is a Planned Project that is anticipated to move forward.

~~5.2.3.3~~ Project: ~~Streamflow Augmentation~~

~~Under the management of the Vina GSA, this project would transport excess untreated surface water from PID, PG&E, and / or other water right holders in the upper watershed to various parts of the Vina Subbasin through creeks and streams. The goal of the project would be to provide additional water sources to riparian water holders such as Durham Mutual, Rancho Esquon, M&T Ranch, and Gorrill Ranches as well as increase stream flows and direct and in-lieu recharge. Prior to the start of the project, Vina GSA would conduct an investigation and feasibility study to ensure that enough surface water would be available. The project would primarily take place at Comanche Creek, Butte Creek, Little Chico Creek, and Big Chico Creek.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels, Surface Water Depletion~~

~~**Project Status:** This project is in the planning stages.~~

~~**Required Permitting and Regulatory Process:** SWRCB Water Right Permit, CEQA~~

~~**Timetable for Initiation and Completion:** 2022-2025~~

~~**Expected Benefits and Evaluation:** Additional sources of surface water would help to increase surface water levels in creeks and streams, groundwater levels via direct and in-lieu recharge, and overall water availability for riparian water holders.~~

~~**How Project Will Be Accomplished/Evaluation of Water Source:** The additional water sources would come from any available surface water from PID, PG&E, and other water right holders in the upper watershed.~~

~~**Legal Authority:** The project would be under the authority of Vina GSA.~~

~~**Estimated Costs and Plans to Meet Costs:** $50 - $100/acre-foot, funding via California Wildlife Conservation Board, Resource Renewal Institute, Proposition 1, Proposition 68, Vina fee~~

~~**Circumstances for Implementation:** This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.~~

~~**Trigger for Implementation and Termination:** None~~

~~Process for Determining Conditions Requiring the Project to Occur: This is a Planned Project that is anticipated to move forward.~~

~~5.2.3.4~~5.2.3.3 Scoping for Flood MAR/Surface Water Supply and Recharge ~~Scoping~~

Under this project, Vina GSA and RCRD GSA will expand on the Flood MAR initiative, which was originally developed by ~~the~~ DWR to promote recharge programs that use fields, recharge basins, and/or recharge ponds to divert high flows in creeks and streams. Individual recharge projects will eventually occur, but this particular project will focus on the initial scoping and identify specific recharge opportunities in the Vina Subbasin. At first, Vina GSA and RCRD GSA will focus their efforts on areas with the greatest need for recharge and seek grants and other funding sources to implement the projects. Interested landowners would be identified and participation in the program would be voluntary.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, RCRCD GSA, local landowners, other entities to be determined
Project Type:	Direct Recharge, In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	Not applicable

Estimated ~~Estimated Groundwater Offset and/or Recharge:~~ **Groundwater Offset and/or Recharge:** Not applicable. Future recharge projects are possible based on results of scoping.

Measurable Objective Expected to Benefit: Future increase of groundwater levels.

Project Status: This project is in the planning stages.

Required Permitting and Regulatory Process: ~~N/A~~Not applicable

Timetable for Initiation and Completion: 2022-2032

Expected Benefits and Evaluation: This project would develop the first steps of the Flood MAR initiative and recharge efforts for the Vina Subbasin region and identify specific groundwater recharge and management projects based on feasibility, need, and available funding. The initiation of this project would then lead to future recharge projects.

How Project Will Be Accomplished/Evaluation of Water Source: This project will help to identify and develop specific recharge projects in the region, which will then individually determine recharge sources.

Legal Authority: The project would be under the authority of the Vina GSA and RCRD GSA.

Estimated Costs and Plans to Meet Costs: ~~TBD~~To be determined, funding via Proposition 1 and Proposition 68.

~~**Circumstances for Implementation:** This project is a Planned Project that is anticipated to move forward.~~

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward.

Trigger for Implementation and Termination: None

~~Process for Determining Conditions Requiring the Project to Occur: c~~ This is a Planned Project that is anticipated to move forward.

~~5.2.4~~1.1.1 ~~Potential Projects~~

~~Projects categorized as Potential Projects are currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects.~~

~~*5.2.4.1*~~*1.1.1.1 ~~Project: Paradise Irrigation District Intertie~~*

~~After the devastation of the 2018 Camp Fire in Paradise, California, PID lost 95% of their customers. In order to help PID sustain their business, this project proposes that PID supply Cal Water, which serves the City of Chico, with water from one of their surface waters sources. Currently, Chico's only water source is groundwater, and their annual demand is 25,000 AF. The additional water source would help offset the groundwater demand and help groundwater levels stabilize in the Vina Subbasin. The SWRCB is currently conducting a study through Spring 2022 to help PID evaluate their options for long-term sustainability. This study will include the feasibility of the PID-Cal Water Intertie project.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels~~

~~**Project Status:** This project is in the planning stages.~~

~~Required Permitting and Regulatory Process: County encroachment permit, CEQA~~

~~Timetable for Initiation and Completion: TBD, after Spring 2022~~

~~**Expected Benefits and Evaluation:** An additional source for Chico from surface water would help offset the demand on groundwater in the Vina Subbasin and allow groundwater levels to stabilize. In addition, this would help PID's business after they lost customers during the Camp Fire.~~

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~~**How Project Will Be Accomplished/Evaluation of Water Source:** This project will allow PID to provide a surface water source to the City of Chico to help offset groundwater demand. Groundwater is currently the only source of water for Chico.~~

~~**Legal Authority:** The project would be under the authority of Vina GSA, PID, and Cal Water~~

~~**Estimated** Costs and Plans to Meet Costs: TBD, funding via Proposition 1, Proposition 68, State Revolving Fund, Federal Infrastructure Funds~~

~~**Circumstances for Implementation:** The decision to move forward with the project will based on discussions with PID.~~

~~**Trigger for Implementation and Termination:** PID's loss of customers from the Camp Fire, decreasing groundwater levels in the Subbasin, increasing groundwater demand in Chico~~

~~Process for Determining Conditions Requiring the Project to Occur: The implementation~~

~~*5.2.4.21.1.1.1 Project: Agricultural Surface Water Supplies*~~

~~Under this project, surface water from water right holders in the neighboring Butte Subbasin and the upper watershed would provide water for the Vina North and South areas. Some of these surface water sources would include the Sacramento River and Lake Oroville. Surface water would help agricultural users reduce their groundwater usage. Agricultural users may need to install a dual irrigation system that allows them to switch between groundwater and surface water depending on the availability of the surface water. Implementation of some of the projects could also lead to recharge opportunities, as additional water may be available during off-peak irrigation season.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels Project Status: This project is in the planning stages.~~

~~Required Permitting and Regulatory Process: Projects with diversions of surface water will require a SWRCB Water Right Permit, CEQA, others TBD~~

~~**Timetable for Initiation and Completion:** 2025-2032~~

~~**Expected Benefits and Evaluation:** Surface water sources from neighboring basins would decrease the Vina Subbasin's dependence on groundwater and allow groundwater levels to stabilize.~~

~~**How Project Will Be Accomplished/Evaluation of Water Source:** The water sources for this project would include available surface water from the Butte Subbasin and upper watershed (Sacramento River, Lake Oroville, etc.).~~

~~**Legal Authority:** The project would be under the authority of Vina GSA, the RCRD GSA, local landowners or other entities TBD.~~

~~Estimated Costs and Plans to Meet Costs: TBD, funding via Proposition 1 and Proposition 68~~

~~**Circumstances for Implementation:** This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.~~

~~Trigger for Implementation and Termination: None~~

~~Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.~~

~~5.2.4.3~~1.1.1.1 ~~Extend Orchard Replacement~~

~~Under this project, various funding sources would incentivize local growers to increase the duration of their current fallowing practice between orchard removal and replanting by one growing season. The extra time would allow the soil to fallow and decrease the overall demand on groundwater and other water sources. Additionally, this program may also reduce the need for soil treatments such as fumigation and expand recycling options for the previous orchard. This project has the potential to fallow between 1,600 and 3,200 acres per year in North and South Vina. As envisioned, this project would be dependent on the availability of financial incentives and willingness of landowners to participate. Participation in the program would be voluntary.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels~~

~~**Project Status:** This project is still in the early conceptual planning stages.~~

~~**Required Permitting and Regulatory Process:** None~~

~~**Timetable for Initiation and Completion:** TBD. The timetable would be dependent on the availability of financial incentives and willingness of farmers to participate.~~

~~**Expected Benefits and Evaluation:** By increasing the time between orchard removal and replanting, the soil may be allowed to fallow, restoring its fertility, and decreasing its water demand. This would decrease the overall use of groundwater in the Subbasin.~~

~~**How Project Will Be Accomplished/Evaluation of Water Source:** This project is a demand-side conservation project. No additional water source will be utilized for this project.~~

~~**Legal Authority:** The project would be under the Vina GSA, local landowners and other entities TBD.~~

~~Estimated Costs and Plans to Meet Costs: TBD; funding via Proposition 1, Proposition 68, USDA, National Resource Conservation Service (NRCS)~~

~~Circumstances for Implementation: This is a potential project in the early planning stages and would require significant additional work to move forward.~~

~~**Trigger for Implementation and Termination:** None~~

~~Process for Determining Conditions Requiring the Project to Occur: The project proponents are in the process of determining the feasibility of this project including the possibility of securing the necessary finances to move forward.~~

~~5.2.4.4~~1.1.1.1 ~~Recharge from the Miocene Canal~~

~~During the 2018 Camp Fire, the upper Miocene Canal, which is operated by PG&E, was destroyed. Under this project, the upper canal would be rebuilt and re-watered. Additionally, PG&E would sell the Miocene Canal system by mid-2022 and modify the system to increase water supply reliability. One such modification might include establishing recharge ponds along the west side of the Miocene Canal in areas conductive to recharging the Vina South Subbasin.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels~~

~~**Project Status:** This project is still in the early conceptual planning stages.~~

~~**Required Permitting and Regulatory Process:** CEQA, SWRCB Water Rights Permit~~

~~**Timetable for Initiation and Completion:** After 2025~~

~~**Expected Benefits and Evaluation:** Rebuilding the upper Miocene Canal and making improvements to the overall system would increase recharge into the Vina South Subbasin and surface water availability for other uses.~~

~~**How Project Will Be Accomplished/Evaluation of Water Source:** This project would be initiated by PG&E, who would obtain water from the same water sources that currently supply the Miocene Canal.~~

~~**Legal Authority:** The project would be under the authority of Vina GSA and PG&E.~~

~~Estimated Costs and Plans to Meet Costs: TBD, funding via state and federal grants~~

~~Circumstances for Implementation: This project is a Longer-term/Conceptual Project, meaning it is in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future. As scenarios change, Longer-term/Conceptual Projects can come online to bring additional resources for adaptive management. The project proponents are in the process of determining the feasibility of this project including the possibility of securing the necessary finances to move forward.~~

~~**Trigger for Implementation and Termination:** None~~

~~Process for Determining Conditions Requiring the Project to Occur: Implementation of Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin.~~

~~5.2.4.5~~1.1.1.1 ~~Community Monitoring Program~~

~~This project would create routine water table monitoring programs for approximately 8,000 acres of Ecological Reserves in the region between lower Forest Ranch and Cohasset Road near Chico Airport, including the Big Chico Creek, Sheep Hollow, and Cabin Hollow tributaries.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels~~

~~**Project Status:** This project is in the planning stages.~~

~~**Required Permitting and Regulatory Process:** None.~~

~~**Timetable for Initiation and Completion:** The establishment of these new monitoring programs is planned to take place between 2022 and 2025.~~

~~**Expected Benefits and Evaluation:** Routine water table monitoring programs will track overall water table trends in the region and provide important, up-to-date data for making decisions on water management.~~

~~**How Project Will Be Accomplished/Evaluation of Water Source:** CSUC and Chico Ecological Reserves will implement the monitoring programs on a routine basis through their university programs. No additional water source will be utilized for this project.~~

~~**Legal Authority:** The project would be under the authority of CSUC and Chico Ecological Reserves.~~

~~Estimated Costs and Plans to Meet Costs: TBD, funding sources TBD~~

~~**Circumstances for Implementation:** This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.~~

~~Trigger for Implementation and Termination: None~~

~~Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.~~

~~5.2.4.6~~1.1.1.1 ~~Project: Wastewater Recycling~~

~~The City of Chico currently operates a wastewater treatment plant with a treatment capacity of 12 million gallons (36 AF) per day and discharges 13,000 AF per year of the treated wastewater to the Sacramento River (in accordance with their waste discharge permit from the California Water Resources Control Board). Under this project, the city would review the feasibility of diverting some of their recycled wastewater from the Sacramento River to recharge ponds and/or non-crop vegetation in Chico.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels~~

~~**Project Status:** This project is in the planning stages.~~

~~Required Permitting and Regulatory Process: SWRCB Water Right permit, CEQA, National Pollutant Discharge Elimination System (NPDES) permit, others TBD~~

~~**Timetable for Initiation and Completion:** 2030-2038~~

~~**Expected Benefits and Evaluation:** This project would divert treated wastewater, that would otherwise be pumped into the Sacramento River, towards recharge ponds and non-crop vegetation. This would increase groundwater recharge, decrease groundwater demand for farming, and help groundwater levels stabilize in the region.~~

~~**How Project Will Be Accomplished/Evaluation of Water Source:** This project would be initiated by the Vina GSA and the City of Chico, and the water source for this project would be the treated wastewater from the City of Chico's wastewater treatment plant.~~

~~**Legal Authority:** The project would be under the authority of Vina GSA and the City of Chico.~~

~~Estimated Costs and Plans to Meet Costs: TBD, funding via Proposition 1, Proposition 68, and SWRCB~~

~~**Circumstances for Implementation:** This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.~~

~~**Trigger for Implementation and Termination:** None~~

~~**Process for Determining Conditions Requiring the Project to Occur:** Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.~~

~~5.2.4.7~~5.2.3.4 *Project: Community Water Education Initiative*

The Community Water Education Initiative, proposed by CSUC's CWE, would consist of two main components:

~~9.~~ Community Water Education Project – The CWE would lead this component of the project to expand on community outreach and education associated with water-related topics and issues of the region. CWE would focus on topics such as regional groundwater issues, connectivity of surface and groundwater, decision-making during drought years, basic aquifer knowledge, and more, and target agricultural well users, domestic well users, and municipal customers. The scope would also include technical seminars and field trips, as well as creating educational materials such as fact sheets, printed materials, and website content.

~~10.~~ Big Chico Creek Watershed Tour – CWE currently hosts a Big Chico Creek Watershed Tour every year that lasts for four days (2 weekends in March and April) and that takes participants from the watershed's headwaters to the Big Chico Creek Ecological Reserve, through CSUC campus, and to its confluence with the Sacramento River. During the program, participants learn about the watershed, explore various water issues, and help CSUC faculty research the health of the watershed. Under this project, CSUC proposes to expand the program to include community members and more groundwater education, with a focus on the Vina Subbasin, with the goal to help community members better understand their role in sustainable groundwater management.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, CSUC, CWE, Chico State Enterprises, local landowners, other entities to be determined
Project Type:	Education and Outreach
Estimated Groundwater Offset and/or Recharge:	Not applicable

Measurable Objective Expected to Benefit: Groundwater Levels, Groundwater Storage, Water Quality, Land Subsidence, Surface Water Depletion, Education and Outreach

Project Status: This project is ready for implementation. Possible expansion by 2023 depending on funding.

Required Permitting and Regulatory Process: None

Timetable for Initiation and Completion: Currently measuring and providing community education with the possibility of expansion by 2023 depending on funding.

Expected Benefits and Evaluation: This project would expand the education and outreach on important watershed and groundwater issues in the region, helping community members better understand their role in sustainable water management.

How Project Will Be Accomplished/Evaluation of Water Source: This is an education and outreach project provided through CSUC that does not require a water source.

Legal Authority: The project would be under the authority of CSUC's CWE.

Estimated Costs and Plans to Meet Costs: $50-100K annually (Component 1); $10,000-$200,000 annually (Component 2); $10,000-$25,000 annually (Component 3). Funding via Proposition 1 and Proposition 68

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward.

~~**Circumstances for Implementation:** This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects.~~ As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.

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~~**Trigger for Implementation and Termination:** None~~

~~Process for Determining Conditions Requiring the Project to Occur:~~ Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. Trigger for Implementation and Termination: None

~~***5.2.4.8 Project: Rangeland Management and Water Retention***~~

~~Under this project, CSUC and Chico State Enterprises would initiate a study of adaptive/regenerative grazing practices on 2,000 or more acres in the region. The study, which would take place between 2021 and 2022, would measure soil compaction, erosion, groundwater retention, and biological diversity. If this study finds that water retention engineering projects would be feasible in the region, based on the collected data on local soil, then CSUC would create a master management plan and take necessary steps to complete the water retention projects.~~

~~This project would take place in two locations across 3,850 acres of historical rangeland between Musty Buck Ridge and the Cohasset Road.~~

~~**Measurable Objective Expected to Benefit:** Groundwater Levels~~

~~**Project Status:** This project is currently in the planning stages.~~

~~Required Permitting and Regulatory Process: CEQA and/or NEPA depending on project impact~~

~~Timetable for Initiation and Completion: Baseline data collection (2021-2022); Development of Master Management Plan (2022-2024)~~

~~**Expected Benefits and Evaluation:** This project would evaluate characteristics of local soil and the feasibility to initiate water retention projects. Water retention would help increase the overall water supply for the region.~~

~~**How Project Will Be Accomplished/Evaluation of Water Source:** This project is a demand-side conservation project through CSUC. No additional water source will be utilized for this project.~~

~~**Legal Authority:** The project would be conducted by CSUC.~~

~~Estimated Costs and Plans to Meet Costs: TBD, funding via state funding through watershed health grants, federal funding through USDA, private funding TBD~~

~~**Circumstances for Implementation:** This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.~~

~~**Trigger for Implementation and Termination:** Once the study is complete on soil compaction, erosion, groundwater retention, and biological diversity, and it shows that water retention is feasible, then a master management plan will be developed.~~

Process for Determining Conditions Requiring the Project to Occur: -Implementation of Potential Projects will be based on long-term management or changing needs of the ~~GSA~~GSAs or Subbasin.

~~5.2.4.9~~5.2.3.5 Project: Fuel Management for Watershed Health

This project would involve fuel management in the Upper Watershed, including multiple sites on the 3,950-acre Big Chico Creek Ecological Reserve, 1,500 acres above the Reserve in the Big Chico Creek Watershed, and on private land within the watershed. Fuel reduction projects are currently ongoing at 460 acres. Further fuel reduction is planned for an additional 4,000 acres between 2021 and 2030 and another 6,000 to 10,000 acres for 2025 through 2040 with the City of Chico Parks Department and other private landowners.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, CSUC, Chico State Enterprises, local landowners, other entities to be determined
Project Type:	Conservation
Estimated Groundwater Offset and/or Recharge:	To be determined
Other Potential Participating Entities	CSUC, Chico State Enterprises

Measurable Objective Expected to Benefit: Groundwater Levels, Groundwater Storage, Water Quality, Surface Water Depletion

Project Status: Part of this project is currently ongoing, with other parts in the planning stages.

Required Permitting and Regulatory Process: CEQA

Timetable for Initiation and Completion: 450 acres have ongoing fuel reduction; 4,000 acres planned for 2021-2030; 6,000 to 10,000 acres planned for 2025-2040

Expected Benefits and Evaluation: Improved fuel management would prevent inadvertent spillage and the degradation of water quality.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project conducted by CSUC. No additional water source will be utilized for this project.

Legal Authority: The project would be conducted by CSUC.

Estimated Costs and Plans to Meet Costs: $8.0 million -$14.0 million (based on $2,000 and $3,500 per acre with a target of 4,000 acres); funding via CAL FIRE, Sierra Nevada Conservancy, California Fire Safe Council, other state, and federal funding agencies

Circumstances for Implementation: This project is a Planned that is anticipated to move forward.

Trigger for Implementation and Termination: None

~~Potential~~ **Process for Determining Conditions Requiring the Project to Occur:** Implementation of Potential Projects will be based on long-term management or changing needs of the GSAs or Subbasin.

5.2.4 Potential Projects

~~, meaning it is~~ Projects categorized as Potential Projects are currently in the initial planning stages~~.~~ and may move forward as feasibility and project requirements are determined. Potential Projects represent a “menu of options” for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects.

5.2.4.1 Project: Paradise Irrigation District Intertie

After the devastation of the 2018 Camp Fire in Paradise, California, PID lost 95% of their customers. To help PID sustain their business, this project proposes that PID supply Cal Water, which serves the City of Chico, with water from one of their surface waters sources. Currently, Chico’s only water source is groundwater, and their annual demand is 25,000 AF. The additional water source would help offset the groundwater demand and help groundwater levels stabilize in the Vina Subbasin. The SWRCB is currently conducting a study through Spring 2022 to help PID evaluate their options for long-term sustainability. This study will include the feasibility of the PID-Cal Water Intertie project.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA; PID, Cal Water, local landowners, other entities to be determined
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	5,000 AFY

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is in the initial planning stages.

Required Permitting and Regulatory Process: County encroachment permit, CEQA.

Timetable for Initiation and Completion: To be determined, after Spring 2022

Expected Benefits and Evaluation: An additional source for Chico from surface water would help offset the demand on groundwater in the Vina Subbasin and allow groundwater levels to stabilize. In addition, this would help PID’s business after they lost customers during the Camp Fire.

How Project Will Be Accomplished/Evaluation of Water Source: This project will allow PID to provide a surface water source to the City of Chico to help offset groundwater demand. Groundwater is currently the only source of water for Chico.

Legal Authority: The project would be under the authority of Vina GSA, PID, and Cal Water.

Estimated Costs and Plans to Meet Costs: To be determined, funding via Proposition 1, Proposition 68, State Revolving Fund, Federal Infrastructure Funds

Circumstances for Implementation: The decision to move forward with the project will based on discussions with PID.

Trigger for Implementation and Termination: PID's loss of customers from the Camp Fire, decreasing groundwater levels in the Vina Subbasin, increasing groundwater demand in Chico

Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

5.2.4.2 Project: Agricultural Surface Water Supplies

Under this project, surface water from water right holders in the neighboring Butte Subbasin and the upper watershed would provide water for the Vina North and South areas. Some of these surface water sources would include the Sacramento River and Lake Oroville. Surface water would help agricultural users reduce their groundwater usage. Agricultural users may need to install a dual irrigation system that allows them to switch between groundwater and surface water depending on the availability of the surface water. Implementation of some of the projects could also lead to recharge opportunities, as additional water may be available during the off-peak irrigation season.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, RCRD, local landowners, other entities to be determined
Project Type:	Intra-Water Basin Transfer
Estimated Groundwater Offset and/or Recharge:	2,000 to 3,000 AFY

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is in the initial planning stages.

Required Permitting and Regulatory Process: Projects with diversions of surface water will require a SWRCB Water Right Permit, CEQA, others to be determined.

Timetable for Initiation and Completion: 2025-2032

Expected Benefits and Evaluation: Surface water sources from neighboring basins would decrease the Vina Subbasin's dependence on groundwater and allow groundwater levels to stabilize.

How Project Will Be Accomplished/Evaluation of Water Source: The water sources for this project would include available surface water from the Butte Subbasin and upper watershed (Sacramento River, Lake Oroville, etc.).

Legal Authority: The project would be under the authority of Vina GSA, the RCRD GSA, local landowners or other entities to be determined.

Estimated Costs and Plans to Meet Costs: To be determined, funding via Proposition 1 and Proposition 68.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: None

Process for Determining Conditions Requiring the Project to Occur: ~~-~~Implementation of Potential Projects will be based on long-term management or changing needs of the ~~GSA~~GSAs or Vina Subbasin.

5.2.4.3 Project: Streamflow Augmentation

Under the management of the Vina GSA, this project would transport excess untreated surface water from PID, PG&E, and / or other water right holders in the upper watershed to various parts of the Vina Subbasin through creeks and streams. The goal of the project would be to provide additional water sources to riparian water holders such as Durham Mutual, Rancho Esquon, M&T Ranch, and Gorrill Ranches as well as increase stream flows and direct and in-lieu recharge. Prior to the start of the project, Vina GSA would conduct an investigation and feasibility study to ensure that enough surface water would be available. The project would primarily take place at Comanche Creek, Butte Creek, Little Chico Creek, and Big Chico Creek.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, RCRD GSA, PID, PG&E, local landowners, other entities to be determined
Project Type:	Direct Recharge, In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 – 5,000 acre-feet/year

Measurable Objective Expected to Benefit: Groundwater Levels, Surface Water Depletion

Project Status: This project is in the initial planning stages.

Required Permitting and Regulatory Process: SWRCB Water Right Permit, CEQA

Timetable for Initiation and Completion: 2022-2025

Expected Benefits and Evaluation: Additional sources of surface water would help to increase surface water levels in creeks and streams, groundwater levels via direct and in-lieu recharge, and overall water availability for riparian water holders.

How Project Will Be Accomplished/Evaluation of Water Source: The additional water sources would come from any available surface water from PID, PG&E, and other water right holders in the upper watershed.

Legal Authority: The project would be under the authority of Vina GSA.

Estimated Costs and Plans to Meet Costs: $50 - $100/acre-foot, funding via California Wildlife Conservation Board, Resource Renewal Institute, Proposition 1, Proposition 68, Vina fees

Circumstances for Implementation: This project is a Potential Project. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: None

Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

5.2.4.4 Community Monitoring Program

This project would create routine water table monitoring programs for approximately 8,000 acres of Ecological Reserves in the region between lower Forest Ranch and Cohasset Road near Chico Airport, including the Big Chico Creek, Sheep Hollow, and Cabin Hollow tributaries.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, CSUC, Chico Ecological Reserves, local landowners, other entities to be determined
Project Type:	Monitoring
Estimated Groundwater Offset and/or Recharge:	Not applicable

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is in the initial planning stages.

Required Permitting and Regulatory Process: None.

Timetable for Initiation and Completion: The establishment of these new monitoring programs is planned to take place between 2022 and 2025.

Expected Benefits and Evaluation: Routine water table monitoring programs will track overall water table trends in the region and provide important, up-to-date data for making decisions on water management.

How Project Will Be Accomplished/Evaluation of Water Source: CSUC and Chico Ecological Reserves will implement the monitoring programs on a routine basis through their university programs. No additional water source will be utilized for this project.

Legal Authority: The project would be under the authority of CSUC and Chico Ecological Reserves.

Estimated Costs and Plans to Meet Costs: To be determined, funding sources to be determined.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: None

Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the GSAs or Vina Subbasin.

5.2.4.5 Project: Wastewater Recycling

The City of Chico currently operates a wastewater treatment plant with a treatment capacity of 12 million gallons (36 AF) per day and discharges 13,000 AFY of the treated wastewater into the Sacramento River (in accordance with their waste discharge permit from the California Water Resources Control Board). Under this project, the city would review the feasibility of diverting some of their recycled wastewater from the Sacramento River to recharge ponds and/or non-crop vegetation in Chico. Existing regulations will be reviewed for the use of the recycled water for crop production.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, City of Chico, local landowners, other entities to be determined
Project Type:	Direct Recharge, Water Recycling
Estimated Groundwater Offset and/or Recharge:	5,000 AFY

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is in the initial planning stages.

Required Permitting and Regulatory Process: SWRCB Water Right permit, CEQA, National Pollutant Discharge Elimination System permit, others to be determined.

Timetable for Initiation and Completion: 2030-2038

Expected Benefits and Evaluation: This project would divert treated wastewater, that would otherwise be pumped into the Sacramento River, towards recharge ponds and non-crop vegetation. This would increase groundwater recharge, decrease groundwater demand for farming, and help groundwater levels stabilize in the region.

How Project Will Be Accomplished/Evaluation of Water Source: This project would be initiated by the Vina GSA and the City of Chico, and the water source for this project would be the treated wastewater from the City of Chico's wastewater treatment plant.

Legal Authority: The project would be under the authority of Vina GSA and the City of Chico.

Estimated Costs and Plans to Meet Costs: To be determined, funding via Proposition 1, Proposition 68, and SWRCB, and other sources to be determined.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: None

Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the GSAs or Vina Subbasin.

5.2.4.6 Project: Rangeland Management and Water Retention

Under this project, CSUC and Chico State Enterprises would initiate a study of adaptive/ regenerative grazing practices on 2,000 or more acres in the region. The study, which would take place between 2021 and 2022, would measure soil compaction, erosion, groundwater retention, and biological diversity. If this study finds that water retention engineering projects would be feasible in the region, based on the collected data on local soil, then CSUC would create a master management plan and take necessary steps to complete the water retention projects.

This project would take place in two locations across 3,850 acres of historical rangeland between Musty Buck Ridge and Cohasset Road.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, CSUC, Chico State Enterprises, other entities to be determined
Project Type:	Conservation
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is currently in the initial planning stages.

Required Permitting and Regulatory Process: CEQA and/or National Environmental Policy Act (NEPA), depending on project impact.

Timetable for Initiation and Completion: Baseline data collection (2021-2022); Development of Master Management Plan (2022-2024).

Expected Benefits and Evaluation: This project would evaluate characteristics of local soil and the feasibility to initiate water retention projects. Water retention would help increase the overall water supply for the region.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project through CSUC. No additional water source will be utilized for this project.

Legal Authority: The project would be conducted by CSUC.

Estimated Costs and Plans to Meet Costs: To be determined, funding via state funding through watershed health grants, federal funding through USDA, private funding sources to be determined.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages. Potential Projects represent a "menu of options" for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: Once the study is complete on soil compaction, erosion, groundwater retention, and biological diversity, and it shows that water retention is feasible, then a master management plan will be developed.

Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the GSAs or Vina Subbasin.

~~5.2.4.10~~5.2.4.7 *Project: Removal of Invasive Species*

Invasive species negatively impact the natural ecosystem in several ways, including consuming water and hampering recharge. Under this project, invasive species and native grasses in meadows and oak savannahs would be mapped between 2022 and 2023. This would then be followed by the development of an invasive management for water retention plan between 2023 and 2024, the acquisition of funding between 2022 and 2026, and the implementation of invasive species removal projects after 2025. This project would take place in the Upper Watershed at approximately 8,000 acres between lower Forest Ranch and the Chico Airport, including the Big Chico Creek, Sheep Hollow, and Cabin Hollow drainages.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, CSUC, Chico State Enterprises, other entities to be determined
Project Type:	Conservation
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: The project will address declining water levels and the declining volume of groundwater stored in the aquifer.

Project Status: This project is currently in the initial planning stages.

Required Permitting and Regulatory Process: CEQA and/or NEPA, depending on project location and impact.

Timetable for Initiation and Completion:

- Inventory and mapping of properties: 2022-2023

- Development of invasive management for water retention plan: 2023-2024
- Identify and secure funding: 2022-2026
- Implement projects and measure results**:** 2025 and beyond.

Expected Benefits and Evaluation: The removal of invasive species would benefit the natural ecosystem and prevent them from negatively affecting the amount of available water and the ability for water to recharge.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project conducted through CSUC. No additional water source will be utilized for this project.

Legal Authority: The project would be conducted by CSUC.

Estimated Costs and Plans to Meet Costs: ~~TBD~~To be determined, funding via state and federal wildfire resiliency grants.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages. ~~Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages.~~ Potential Projects represent a “menu of options” for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: None

Process for Determining Conditions Requiring the Project to Occur: Implementation of Potential Projects will be based on long-term management or changing needs of the ~~GSA~~GSAs or Vina Subbasin.

~~5.2.4.11~~5.2.4.8 Project: Surface Water Supply and Recharge

Projects under this category would involve activities that increase the surface water supply to the Vina Subbasin through: ~~(~~1) direct application of surface water to crops along the lines of the Agricultural Surface Water Supplies Project described above; ~~(~~2) application of surface water and/or flood water to land surface (i.e. existing orchards) for recharge purposes, sometimes referred to as Flood MAR projects; ~~(~~3) surface water and/or flood water application to recharge basins and/or recharge ponds; or ~~(~~4) other applications.

The following are examples of potential projects in the Vina Subbasin:

Sand Creek Project – This project would take place in the North Chico and Nord areas and would involve obtaining data that would later be used to develop mitigation measures for flooding and recharge. The data may also be used to decide future actions towards habitat restoration and runoff management to sustain groundwater. This project is currently developing a Decision Support Tool to determine future construction scope and feasibility.

Lindo Channel – This project would divert water from Big Chico Creek when flow exceeds 75 ~~cubic feet per second~~ cfs and store the water in the Lindo Channel. The Lindo Channel can then be used as a recharge source for other areas and potentially provide 2,000 ~~acre-feet.~~AF.

Other additional recharge projects would be developed by the Vina GSA, the RCRD GSA, local landowners, and~~ / ~~/or entities ~~TBD~~to be determined.

Estimated Groundwater Offset and/or Recharge:1,000 ~~acre-feet/year~~AFY per project.

Measurable Objective Expected to Benefit: increase of groundwater levels by enhancing in-lieu recharge opportunities.

Project Status: The Sand Creek project and Lindo Channel project are in the initial planning stages. Other projects to be developed in the future.

Required Permitting and Regulatory Process: Projects with diversions of surface water will require a SWRCB permit; CEQA and others ~~TBD~~to be determined.

Timetable for Initiation and Completion: Sand Creek and Lindo Channel – 2022-2032; Other projects – 2022 – 2042.

Expected Benefits and Evaluation: This project would reduce reliance on native groundwater supply.

How Project Will Be Accomplished/Evaluation of Water Source: Evaluate and analyze results of scoping project for potential locations of recharge activity. The Sand Creek project and Lindo Channel project are in the planning stages. The Lindo Channel project is anticipated to divert water from Big Chico Creek to the Lindo Channel, which can then be used as a recharge source on-site or at other locations. The Sand Creek project is anticipated to divert water from the creek to a recharge basin.

Legal Authority: The projects would be under the authority of the Vina GSA, the RCRD GSA, local landowners and / or other entities ~~TBD~~to be determined.

Estimated Costs and Plans to Meet Costs: ~~TBD~~To be determined, potential funding via Proposition 1 and Proposition 68.

Circumstances for Implementation: These projects are Potential Projects to bring additional resources for adaptive management. Potential Projects represent a "menu of options" for the Vina Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.~~As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management.~~

Trigger for Implementation and Termination: None

~~**Trigger for Implementation and Termination:** None~~

Process for Determining Conditions Requiring the Project to Occur: ~~ ~~The Sand Creek project and Lindo Channel project are in the planning stages and will be implemented, assuming that feasibility is determined. Implementation of Potential Projects will be based on long-term management or changing needs of the GSAs or Vina Subbasin.

~~Longer-term or~~

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, RCRD GSA, local landowners, other entities to be determined
Project Type:	Direct Recharge, In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 acre-feet/project

5.2.5 Conceptual Projects

Projects categorized as ~~Longer-term or~~ Conceptual Projects are in the early conceptual stages and would require significant additional work to move forward. Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Vina Subbasin in the future, but that would need to be further developed.

5.2.5.1 Extend Orchard Replacement

Under this project, various funding sources would incentivize local growers to increase the duration of their current fallowing practice between orchard removal and replanting by one growing season. The extra time would allow the soil to fallow and decrease the overall demand on groundwater and other water sources. Additionally, this program may also reduce the need for soil treatments such as fumigation and expand recycling options for the previous orchard. This project has the potential to fallow between 1,600 and 3,200 acres per year in North and South Vina. As envisioned, this project would be dependent on the availability of financial incentives and willingness of landowners to participate. Participation in the program would be voluntary.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA, local landowners, other entities to be determined
Project Type:	Conservation
Estimated Groundwater Offset and/or Recharge:	4,000 – 8,000 acre-feet/year

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is still in the early conceptual planning stages.

Required Permitting and Regulatory Process: None

Timetable for Initiation and Completion: To be determined. The timetable would be dependent on the availability of financial incentives and willingness of farmers to participate.

Expected Benefits and Evaluation: By increasing the time between orchard removal and replanting, the soil may be allowed to fallow, restoring its fertility, and decreasing its water demand. This would decrease the overall use of groundwater in the Subbasin.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project. No additional water source will be utilized for this project.

Legal Authority: The project would be under the Vina GSA, local landowners and other entities to be determined.

Estimated Costs and Plans to Meet Costs: To be determined; funding via Proposition 1, Proposition 68, USDA, National Resource Conservation Service (NRCS)

Circumstances for Implementation: This project is a Conceptual project in the early conceptual planning stages and would require significant additional work to move forward.

Trigger for Implementation and Termination: None

Process for Determining Conditions Requiring the Project to Occur: The project proponents are in the process of determining the feasibility of this project including the possibility of securing the necessary finances to move forward.

5.2.5.2 Recharge from the Miocene Canal

During the 2018 Camp Fire, the upper Miocene Canal, which is operated by PG&E, was destroyed. Under this project, the upper canal would be rebuilt and re-watered. Additionally, PG&E would sell the Miocene Canal system by mid-2022 and modify the system to increase water supply reliability. One such modification might include establishing recharge ponds along the west side of the Miocene Canal in areas conductive to recharging the Vina South Subbasin.

Project Summary	
Identified project proponent(s) and other potential participating entities:	Vina GSA PG&E, Butte County, local landowners, other entities to be determined
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	2,000 acre-feet/year based on 10,000 acre-feet available for recharge (assuming a 20% efficiency)

Measurable Objective Expected to Benefit: Groundwater Levels

Project Status: This project is still in the early conceptual planning stages.

Required Permitting and Regulatory Process: CEQA, SWRCB Water Rights Permit

Timetable for Initiation and Completion: After 2025

Expected Benefits and Evaluation: Rebuilding the upper Miocene Canal and making improvements to the overall system would increase recharge into the Vina South Subbasin and surface water availability for other uses.

How Project Will Be Accomplished/Evaluation of Water Source: This project would be initiated by PG&E, who would obtain water from the same water sources that currently supply the Miocene Canal.

Legal Authority: The project would be under the authority of Vina GSA and PG&E.

~~Longer-term/~~**Estimated Costs and Plans to Meet Costs:** To be determined, funding via state and federal grants

Circumstances for Implementation: This project is a Conceptual Project, meaning it is in the early conceptual planning stages and would require significant additional work to move forward. Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future~~, but that would need to be further developed.~~

. As scenarios change, Conceptual Projects can come online to bring additional resources for adaptive management. The project proponents are in the process of determining the feasibility of this project including the possibility of securing the necessary finances to move forward.

Trigger for Implementation and Termination: None

Process for Determining Conditions Requiring the Project to Occur: Implementation of Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin.

5.2.6 Notification Process

The GSAs will continue to conduct public outreach and will be responsible for notification of the projects. Regular updates will be provided to the GSA Boards and presented on the websites ~~www.vinagsa.org~~www.vinagsa.org and rockcreekreclamation.~~org~~com as projects are implemented. Outreach is likely to include public notices, meetings, website, social media, and email lists.

5.3 Management Actions

~~In order to~~To achieve sustainable groundwater management, management actions can be implemented to focus on reduction of groundwater demand. The management actions can include increased data collection, education and outreach, regulatory policies, incentive programs, and enforcement actions.

An evaluation of potential GSA actions (projects or management actions) will occur on an annual basis relying on information reported in the annual report. ~~-~~The following sections will present a suite of management action options that the GSA may consider during GSP implementation. The schedule to implement the management actions is likely to vary depending upon ~~subbasin~~Vina Subbasin conditions and the expected benefits of PMAs may also vary year to year.

5.3.1 General Plan Updates

The ~~Vina GSAs~~GSA(s) will cooperate with Butte County and the City of Chico with updates to their General Plans. The ~~Vina~~ GSA(s) will participate and collaborate as appropriate with land use agencies during general plan updates to ensure that land use planning recognizes the Vina

GSP. The GSAs will collaborate to ensure that the important components of the GSP are addressed ~~by~~ in the general plans. The recognition and use of groundwater sustainability practices would remain consistent.

5.3.2 Domestic Well Mitigation

If an increasing number of domestic groundwater wells go dry in the Vina Subbasin, the GSAs could propose a series of steps to help mitigate this issue. The following steps are proposed under this management action:

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.

Creating a registry of domestic wells in the region, with information on well location and screen depths, would help the GSAs compile important data into a centralized location. This would allow the GSAs to determine which wells need to be updated to the current standards and which may need to be deepened, as well as to help them prioritize certain communities for emergency response.

5.3.3 Well Permitting Ordinance

According to the current Butte County code, domestic wells are required to be screened below the groundwater levels measured during the 1989 to 1994 drought. This management action proposes that the GSAs will work with Butte County to amend the well ordinance as it relates to small and large diameter wells to take into consideration the ~~hydrogeologic conceptual model~~HCM based on best available data (i.e. ~~Airborne Electromagnetic Survey~~AES data), adopted ~~sustainable management criteria~~SMC, historical groundwater conditions, and impacts of new wells on existing wells. The code could be amended with requirements for well screens to account for ~~Minimum Thresholds~~MT established for the Vina Subbasin. This would improve water supply reliability of future agricultural and domestic wells.

5.3.4 Landscape Ordinance

Butte County and/or the City of Chico would enact an ordinance requiring new residential, commercial, and industrial development to use drought-resistant species for landscaping and to limit the size of grass lawns that require regular irrigation. The ~~ordnance~~ordinance would focus efforts and money on reducing the amount of water used for landscape irrigation and swimming pools while promoting xeriscaping. The reduction in irrigation for landscaping and swimming pools would allow groundwater use for other purposes in the Vina Subbasin.

5.3.5 Prohibition of Groundwater Use for Ski (Recreational) Lakes

In the Vina Subbasin, there are several ski lakes that are currently supplied with groundwater. The Vina GSA would encourage Butte County to amend the zoning ordinance to prohibit the use of groundwater for future ski lakes.

5.3.6 Expansion of Water Purveyors' Service Area

The Vina GSA would encourage the expansion of water purveyors' service area to areas across the Vina Subbasin that are reliant on private groundwater wells. This would require action by individual water purveyors, support of residents, and governmental approval. By expanding the service area of water purveyors, areas that rely solely on groundwater would have another source of water and would reduce groundwater extraction.

5.3.7 Groundwater Allocation

SGMA requires that GSPs describe the projects and management actions to be implemented as part of bringing the Vina Subbasin into sustainability. As a last resort, in the event that the proposed projects fail to achieve ~~interim milestones~~IMs and the ~~subbasin~~Vina Subbasin is projected to not be able to achieve sustainability goals by 2042, the GSAs may need to consider implementation of groundwater allocations to manage groundwater demand. The implementation of this management action would be based on an evaluation by the Joint Management Committee ~~(see Appendix X).~~. The consideration of groundwater allocation would be based on the groundwater budgets and updated monitoring data throughout the ~~subbasin~~Vina Subbasin, as presented in annual reports.

Groundwater allocation management actions could include, but are not limited to, targeted maximum extraction levels to address specific ~~minimum threshold~~MT violations or ~~subbasin~~Vina Subbasin-wide adjustments to extractions to address overall chronic lowering of groundwater levels. Should the GSAs determine that groundwater allocation management actions are necessary, the GSAs will consider such management actions through a public process ultimately decided by the GSA Boards.

5.4 Data Collection

5.4.1 County Contour Mapping

As part of the efforts to collect the information necessary to fill the information needs and data gaps identified in Section 3, this project proposes to expand the existing monitoring program to include Butte, ~~Glen~~Glenn, Colusa, and Tehama counties and conduct these groundwater elevation surveys in the spring, summer, and fall. The monitoring program would gather data used to produce groundwater contours and estimates of lateral and vertical flow direction and volume. Producing ~~this~~these data for the four counties will help to identify interbasin flow patterns and influences on surface water flows and replenishment locations, thereby improving coordination between counties and water management decision-making.

Routine water table monitoring programs will track overall water table trends in the region and provide important, up-to-date data for making decisions on water management. Establishing these programs amongst the four counties will aid in the exchange of data and improve regional coordination on various water projects. The expanded water monitoring programs will be established by the Vina and RCRD GSAs, with assistance from the four counties.

5.4.2 Update the Butte Basin Groundwater Model

The existing ~~Butte Basin Groundwater Model~~BBGM covers the Vina, Butte, and Wyandotte Creek Subbasins. ~~The second~~This project ~~to~~will help fill the identified data gaps ~~will consist of~~

~~(~~by 1) updating the ~~Butte Basin Groundwater Model~~BBGM with newly acquired data; and ~~(~~2)~~ ~~ using the updated version of the model to run simulations ~~and better establish the basin's measurable objectives.~~

to support evaluation of projects or GSP updates as appropriate and warranted. Some of the new data to be ~~added~~incorporated is the ~~airborne electromagnetic (~~AEM~~)~~ data and data on the different hydraulic conductivities of each layer of the aquifer. The AEM data will be used, among other things, to adjust the various surfaces in the model to better ~~present~~represent the aquifer's hydrogeologic layers.

Once the model has been updated with the new data, it will be better suited for running simulations of different water or land use management scenarios as well as predictions for climate and precipitation fluctuations. Lateral and vertical connectivity between aquifer layers and connections to surface water features will be more accurate and help identify areas of the basin where groundwater recharge may be needed. Overall, this will help shape management actions by focusing ~~their~~ efforts on those particular areas. Ongoing updates to the model will emphasize the importance of accurate and up-to-date data and help continue monitoring efforts such as measuring water levels and stream flows. It is expected that at least two updates to the model will be prepared as the GSP is implemented and additional data is collected.

An updated groundwater model is vital for running accurate simulations that may be used to make important decisions regarding groundwater allocation, pumping, recharge, and other activities. The model should contain the most up-to-date data to represent the basin realistically and accurately.

5.4.3 Community Monitoring Program

As discussed in Section 4.10, the MT for groundwater levels is based on the depths of domestic wells. The dataset used for this assessment is limited and likely includes wells no longer in use or poorly maintained wells. To resolve this data gap, the GSAs will conduct surveys of domestic wells within the Vina Subbasin to assess if the wells are still active and collect the well construction details. As domestic well construction information may be limited, selected wells may be video logged to obtain additional information.

The GSAs will also maintain a record of verifiable domestic wells that go dry during the implementation period that will include depth of these wells, screen intervals, and available maintenance records. These data will be used to modify the MO and MT over the implementation period, as appropriate.

5.4.4 Interconnected Surface Water/Associated ~~impacts~~Impacts on ~~GDEs~~Groundwater Dependent Ecosystems

Also discussed in Section 4.10 ~~was~~and in Section 3.8 is the lack of sufficient data to analyze the interaction of streams and groundwater pumping within the primary aquifer system. Additional wells and other monitoring networks will be installed, as appropriate, following the framework discussed in Section 3.8.

5.5 Adaptive Management Strategies

The ~~Vina~~ GSAs will be requesting annual reports from the project proponents to evaluate progress on implementation. If the projects are not progressing or if monitoring efforts demonstrate that those projects are not achieving their targets, the GSAs will evaluate the need for additional or modified projects and to begin implementation of management actions.

5.6 Potential Available Funding Mechanisms

As listed above in the individual project descriptions, several funding mechanisms have been identified to help with the planning and implementation of the GSP projects. The following is an abbreviated list of some of the funding mechanisms proposed:

Project Type	Funding Type	Program	Dates
IRWM (projects included in an adopted IRWM Plan)	Implementation Grant	Proposition 1, Water Quality, Supply, and Infrastructure Improvement Act of 2014	Round 2 solicitation expected in late 2021
Recharge Projects	Planning and construction grants	Proposition 68, California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018	Round 2 solicitation to be released early 2022
Wastewater treatment for underrepresented communities projects	Planning and construction grants	Small Community Grant Fund	Applications accepted continuously
Public water systems improvement	Planning and construction grants	Drinking water grants	Applications accepted continuously
Land Conservation	USDA Farm Service Agency	Conservation Reserve Program	Applications accepted continuously

6. PLAN IMPLEMENTATION

SGMA requires the GSAs to partner with groundwater users to develop and implement GSPs to achieve groundwater sustainability. SGMA requires the Vina Subbasin to be sustainable by 2042. The GSP includes provisions to evaluate current conditions in the Vina Subbasin (Section~~-~~ 2), establish SMC (Section 3), gather and analyze groundwater data (Section 4), and report findings. The provisions in the GSP will be evaluated every ~~5~~five years and updated as necessary. The Vina Subbasin GSAs are required to submit the GSP to ~~the~~ DWR by January 31, 2022. DWR will evaluate the GSP within 24 months of submittal. Upon submittal of this GSP to DWR, GSP implementation will begin in the Vina Subbasin. The GSAs will continue their efforts with public engagement and to secure funding to monitor and manage groundwater resources. This ~~Section~~section presents the manner in which the GSAs will execute the GSP consistent with the requirements in CCR Title 23 § 354.6(e).

The GSP includes provisions for:

- Gathering data at RMS locations
- Evaluation of SMCs
- Report of findings and analysis
- Implementation of PMAs

Each of these provisions will require funding and schedule coordination to help achieve Vina Subbasin sustainability goals. The following sections describe the funding mechanisms and timetable for the GSP implementation.

6.1 Estimate of ~~GSP~~Groundwater Sustainability Plan Implementation Costs

Where feasible, the GSAs will use existing funding and/or programs for use in the GSP implementation. The GSAs, member agencies, and water purveyors will coordinate to implement the actions outlined in this GSP. The GSAs will fund the implementation of the GSP where other sources are not available. The cost of implementation of the GSP by activity is presented below.

6.1.1 Administrative Costs

These include the cost of annually operating the ~~GSA~~GSAs, including staff expenses, audit, outreach, legal and other administrative costs. This does not include agency~~-~~-specific project implementation costs. Costs are estimated to be in the range of approximately $200,000 to $400,000 annually.

Table 6-1: Estimated Administrative Costs

GSP Implementation	Estimated Annual Costs
Public Outreach	$25,000
Staff	$150,00
Legal	$30,000
Other	$20,000
Total Estimate	**$225,000**

Public outreach efforts will continue during GSP implementation with a focus on progress updates ~~-~~particularly regarding the PMAs. Staff time will likely be in-kind contribution from member agencies of the Vina and ~~Butte County~~RCRD GSAs. Outside counsel will continue to provide legal advice to the ~~GSA~~GSAs Boards. The budget also includes other miscellaneous costs such as printing and insurance.

6.1.2 Monitoring

Monitoring for compliance with SGMA regulations will include semi-annual collection of groundwater levels at 17 RMS locations and annual collection of groundwater quality at 8 RMS locations. Monitoring activity costs will include labor (field data collection, surveying, laboratory analysis, project management) and equipment (vehicles, meters, pumps, field tools/supplies).

Table 6-2: Monitoring Activities and Estimated Cost

Monitoring Activity	Frequency	Estimated Annual Cost
Groundwater Levels	Semi-Annual, 2 events	$20,000
Groundwater Quality	Annual, ~~1~~one event	$8,000

Some RMS locations include wells that are monitored and funded under existing programs.

6.1.3 Data Analysis

The data gathered from the ~~on-going~~ongoing monitoring program will be analyzed to assess trends for determination of undesirable results. Analysis of the data may lead to modifications in the RMS network, the hydrogeological conceptual model, and the priority of PMAs. Data gaps that arise from analysis may require installation of new RMS locations.

Table 6-3: Data Analysis Activities and Estimated Cost

Data Analysis Activity	Frequency	Estimated Annual Cost
Data Management System	Annual	$5,000
Review of Groundwater Data	Annual	$5,000

6.1.4 Reporting and Evaluation

Annual reports are required after GSP adoption to provide updates to general GSP information, basin conditions, and plan implementation progress. Section 6.~~3~~5 discusses the annual reporting plan in more detail. GSAs are required to conduct an evaluation of the GSP and prepare a report every ~~5~~five years or whenever the GSP is amended. Section 6.~~4~~6 discusses the evaluation report in more detail.

Table 6-4: Reporting and Evaluation Activities and Estimated Cost

Reporting Activity	Frequency	Estimated Cost
Annual Report	Annual	$30,000
5-year Evaluation Report	5 Years	$100,000

6.1.5 Data ~~Gaps~~Collection

A discussion of the data collection needed to address identified data gaps is presented in Section ~~6~~5.4, and the estimated costs are presented below.

Table 6-5: Estimated Costs for Implementing Data Gaps

Data Gaps	Estimated Costs
Interconnected Stream Monitoring	$100,000 – $250,000
Contour Mapping	$20,000 - $50,000
Community Monitoring	$50,000 - $150,000
Butte Basin Model Update 1	$50,000 - $100,000
Butte Basin Model Update 2	$50,000 - $100,000

6.1.6 Project and Management Actions

The PMAs and anticipated costs are presented in Section ~~6~~5. The PMAs with a planned initiation date in or before 2032 are presented below.

Geosyntec consultants

Table 6-6: Estimated Project Costs

Project Name	Capital Costs	Expected Groundwater Demand Reduction (AFY)
5.2.3.1 Agricultural Irrigation Efficiency	TBD **	Up to 4,000
~~Flood MAR~~ 5.2.3.2 Residential Conservation	TBD	~~1,000 per project~~100
5.2.3.3 Scoping for Flood MAR/Surface Water Supply and Recharge~~Residential Conservation~~	TBD	~~100~~ NA
~~Streamflow Augmentation~~ 5.2.3.4 Community Water Education Initiative	Component 1: $50-~~$100 per acre-foot~~-100K annually Component 2: $10,000-$200,000 annually Component 3: $10,000-$25,000 annually	~~1,000-5,000~~ NA
5.2.3.5 Fuel Management for Watershed Health~~Agricultural Surface Water Supplies~~	TBD	~~2,000 – 3,000~~ TBD
5.2.4.1 Paradise Irrigation District Intertie	TBD	5,000
~~Extend Orchard Redevelopment~~ 5.2.4.2 Agricultural Surface Water Supplies	TBD	~~4~~2,000 – ~~8~~3,000
~~Recharge from the Miocene Canal~~5.2.4.3 Streamflow Augmentation	TBD	~~2~~1,000 – 5,000
~~Recycled Wastewater~~5.2.4.4 Community Monitoring Program	TBD	~~5,000~~NA
~~Community Water Education Initiative~~ 5.2.4.5 Recycled Wastewater	~~Component 1: $50-100K annually~~ ~~Component 2: $10,000-$200,000 annually~~ ~~Component 3: $10,000-$25,000 annually~~ TBD	~~TBD~~ 5,000
~~Community Monitoring Program~~5.2.4.6 Rangeland Management	TBD	TBD
~~Rangeland Management~~5.2.4.7 Removal of Invasive Species	TBD	TBD
~~Fuel Management for Watershed Health~~5.2.4.8 Surface Water Supply and Recharge	TBD	~~TBD~~1,000 per project
~~Removal of Invasive Species~~5.2.5.1 Extend Orchard Redevelopment	TBD	~~TBD~~4,000 – 8,000
~~Surface Water Supply and~~5.2.5.2 Recharge from the Miocene Canal	TBD	~~1~~2,000 ~~per project~~

Note:
**To be Determined (TBD)

6.2 Identify Funding Alternatives

The GSAs will seek to capitalize on existing funding and programs that overlap with GSP requirements. For example, Butte County, DWR, and other entities currently fund groundwater data collection programs at locations within the Vina Subbasin. The GSAs will ensure that the existing programs meet the technical requirements of the monitoring and reporting as outlined in the GSP.

In cases where no funding or programs are established, the GSAs will be responsible for securing funding for the GSP implementation. The GSAs will coordinate funding with their respective constituent members within the Vina Subbasin. ~~GSA's will~~GSAs may fund the GSP through a cost-sharing collaboration to be determined after adoption of GSP.

Funding is anticipated to be met from one or a combination of the following sources: direct contributions from the ~~GSA~~GSAs constituent members~~, State~~; state and ~~Federal~~federal grant funding, and taxes or assessments levied on landowners and groundwater users in accordance with local and ~~State~~state law.

The GSAs are evaluating a variety of funding mechanisms, including Proposition 218 or Proposition 26, to support ongoing operational costs and to fund agency operations. These costs include retaining consulting firms and legal counsel to provide oversight and assist with SGMA compliance. Expenses consist of administrative support, GSP development, and GSP implementation.

6.3 Schedule for Implementation

Figure 6-1 presents the estimated schedule for GSP implementation for the Vina Subbasin GSP starting in 2022 through 2042. Project schedules may shift or be altered by the ~~GSA~~GSAs Board of Directors based on funding opportunities and circumstances. Some activities such as monitoring, data analysis, and reporting will begin upon submittal of the GSP and will continue through GSP implementation. Other activities such as the PMAs will be completed by priority as funding and resources become available.

6.4 Data Management Systems

In development of this GSP, the GSAs developed a groundwater model that was calibrated to estimate future scenarios. The ~~data management system~~DMS plans to build on existing data inputs in the groundwater model and develop a more formalized approach to collecting and capturing data. As stated in Section 4, Monitoring Network, future data will be gathered to develop annual reports, as well as provide necessary information for future and ongoing ~~update~~updates to the groundwater ~~models~~model at five-year intervals upon GSP implementation. The DMS that will be used is a geographical relational database that will include information on water levels, land elevation measurements, and water quality testing. The DMS will allow the GSAs to share data and store the necessary information for annual reporting.

The DMS will be on local servers and data will be transmitted annually to form a single repository for data analysis for the Vina Subbasin's groundwater, as well as to allow for preparation of annual reports. GSA representatives will have access to data and will be able to ask for a copy of the regional DMS. The DMS currently includes the necessary elements required by the regulations, including:

- Well location and construction information for the representative monitoring points (where available)
- Water level readings and hydrographs including water year type
- Land based measurements
- Water quality testing results
- Estimate of groundwater storage change, including map and tables of estimation
- Graph with Water Year type, Groundwater Use, Annual Cumulative Storage Change

Figure 6-1 placeholder page

Reporting generated from data from the ~~GSA's~~GSAs will include, but is not limited to:

- Seasonal groundwater elevation contours
- Estimated groundwater extraction by category
- Total water uses by source

Additional items may be added to the DMS in the future as required. Data will be entered into the DMS ~~by each GSA~~. The majority of the data will then be aggregated to the entity that is responsible for the regional DMS and summarized for reporting to DWR. Groundwater contours will be prepared outside of the DMS because of the need to evaluate the integrity of the data collected and generate a static contour set that has been reviewed and will not change once approved. Groundwater storage calculations will be calculated in accordance with the method described in Section 2, outside of the DMS. Results are uploaded to the DMS for annual reporting and trend monitoring. Since most of the pumping in the Vina Subbasin is not currently measured, the groundwater pumping estimates are also calculated outside of the DMS using the methods developed by GSAs and uploaded to the DMS for annual reporting and trend analysis. The GSAs may choose to have their own separate system for additional analysis.

The one-time cost of expanding the existing data systems is estimated between $50,000 to $~~2000~~200,000, as the system is still being evaluated. The Board has indicated a desire to make the data transparent and available to the public while respecting the privacy of individual landowners.

6.5 Annual Reporting

Annual reports will be submitted by April 1 for the prior year's activities. The report will include a general update in the form of an executive summary with an accompanying map of the Vina Subbasin. The body of the report will include a detailed discussion and graphical representation of the following:

- Groundwater elevation data, including contour maps at seasonal high and low conditions and hydrographs using water year type and historical data from at least 2015~~.~~
- Groundwater extraction data divided into volume by water usage sectors with accompanying map, including a description of the methodology and accuracy of the groundwater extraction estimation~~.~~
- Surface water volume used or available for use for groundwater recharge or in-lieu use, including a description of the water sources~~.~~
- Total water volume use divided into water use sector and water source type, including a description of the methodology and accuracy of the water use estimation~~.~~
- Changes in groundwater storage with accompanying map, including a graph with water year type, groundwater use, annual change in groundwater storage, and cumulative change in groundwater storage using historical data from at least 2015~~.~~

- The annual report will also include a discussion and update on the plan implementation, including the status of ~~interim milestones~~IMs and the execution of PMAs~~.~~

6.6 Evaluation Report

The ~~GSA's~~GSAs will evaluate the GSP and provide an evaluation report every ~~5~~five years or whenever the GSP is amended for submittal to DWR.

The assessment will include a detailed discussion of the following:

- Significant new information and whether the information warrants changes to the basin setting, ~~measurable objectives, minimum thresholds~~MO, MT, and ~~sustainability indicators~~SIs, including completed or planned GSP amendments~~.~~
- Current groundwater conditions relating to each ~~measurable objective, minimum threshold~~MO, MT, and ~~interim milestone.~~IMs
- Implementation of any project and management actions and the resulting effects on groundwater conditions~~.~~
- Assessment of the basin setting, ~~management areas~~MAs, undesirable results, ~~measurable objectives~~MO, and ~~minimum thresholds.~~MT
- Evaluation of the basin setting and overdraft conditions to include changes in water use, along with overdraft mitigation measures (if applicable~~).~~)
- Assessment of the monitoring network with analysis of data collected to date, including identification of data gaps and suggested improvements of the network
- Program to address data gaps, including timing and incorporation of data into the GSP, with prioritization on the installation of new data collection sites and analysis of new data based on the needs of the basin
- Relevant actions taken by the ~~GSA's~~GSAs, including a summary of regulations, ordinances, legal enforcement or action related to the implementation of the GSP and sustainability goals~~.~~

Summary of coordination by ~~GSA's~~GSAs within the basin or within hydrogeologically connected basins and land use agencies.

6.7 ~~Interbasin~~Inter-basin Coordination

The Vina Subbasin understands that in the Sacramento Valley inter-basin coordination is critical due to the interconnectedness of groundwater, as each ~~subbasin~~Vina Subbasin prepares and implements its GSP. As such, the Vina Subbasin participated with the surrounding 10 subbasins (Antelope, Bowman, Butte, Colusa, Corning, Los Molinos, Red Bluff, Sutter, Wyandotte Creek, and Yolo). Inter-basin coordination efforts were focused on establishing a foundation and guidelines for sustained inter-basin coordination by identifying priorities and resources. The main objective of the coordination efforts is to identify any significant discrepancies in the GSPs, understand why those differences exist, and evaluate to the extent they need to be reconciled.

As part of the coordination efforts, the ~~Norther~~Northern Sacramento Valley Inter-basin Coordination Report was prepared (Appendix 6-A). The report outlined a framework for inter-basin coordination for sustainable groundwater management in the Northern Sacramento Valley. It described a menu of options for ongoing communication and collaboration between and among groundwater subbasins over the ~~twenty~~20-year implementation of SGMA. The framework is intended to be used by the GSAs to support GSP development and implementation.

The Vina Subbasin intends to coordinate in the following ways with its neighboring subbasins and with subbasins in the North Sacramento River Corridor group (Antelope, Los Molinos, Red Bluff, Corning, ~~Vina,~~ Butte, and Colusa Subbasins):

1. Information Sharing

The Vina Subbasin will work with ~~GSA~~the GSA's staff of neighboring subbasins to identify lines of communication and methods for information sharing that would be agreed upon by the respective GSA Boards. This will continue throughout GSP implementation and may include:

~~5.~~1. ~~Inform~~Informing each other on changing conditions (i.e., surface water cutbacks, land use changes, policy changes that inform groundwater management)

~~6.~~2. ~~Share~~Sharing annual reports and interim progress reports

~~7.~~3. ~~Share~~Sharing data and technical information and work towards building shared data across and/or along basin boundaries (e.g., monitoring data, water budgets, modeling inputs and outputs, and Groundwater Dependent Ecosystems)

2. ~~Conduct~~Conducting Joint Analysis and Evaluation of GSPs

In the near term, the Vina Subbasin intends to pursue grant funding and collaboratively work with subbasins in the North Sac River Corridor group to:

~~8.~~1. Contract with a consultant to conduct this work

~~9.~~2. Evaluate and compare contents of GSPs with a focus on establishing a common understanding of basin conditions at boundaries

~~10.~~3. Identify significant differences, uncertainties, and potential issues of concern related to groundwater interaction at the boundaries

~~11.~~4. Engage in analysis and evaluation of SMCs between GSPs to assess impacts and identify significant differences and possible impacts between subbasins that could potentially lead to undesirable results

The North Sac River Corridor is the appropriate scale of coordination for these activities due to the shared boundary of the Sacramento River, shared data gaps, and the interconnectedness of the subbasins.

3. ~~Coordinate~~Coordination on mutually beneficial activities

The Vina ~~subbasin~~Subbasin will work collaboratively with North Sac River Corridor ~~subbasins~~Subbasins to identify items in our GSPs that are ripe for a coordinated project and pursuit of funding such as Projects and Management Actions, Data Gaps (new monitoring wells, stream gaging etc~~.)~~).

~~12.~~1. ~~GSA~~GSAs Boards will jointly identify projects/programs to coordinate on.

~~13.~~2. Vina Subbasin will pursue partnerships to obtain grant funding to support a consultant to conduct this work.

~~14.~~3. Vina Subbasin will work collaboratively with entities such as the Northern California Water Association ~~(NCWA)~~ and others in their efforts to pursue funding and support local and state agency activities to identify and fill regional data gaps.

4. Coordinated Communication and Outreach

Staff of the Vina Subbasin ~~GSA staff~~GSAs will continue to participate in regional public engagement activities and efforts related to implementation of SGMA in the Northern Sacramento Valley. These efforts will include GSA Board members and will foster transparency of communications.

This may include:

~~15.~~1. ~~Coordinate~~Coordinating and ~~collaborate~~collaborating on regional-scale public engagement and communication strategies that promote awareness on groundwater sustainability, ~~enhance~~enhancing public trust, and ~~maintain~~maintaining institutional knowledge

~~16.~~2. ~~Maintain~~Maintaining a list of GSP/subbasin staff contacts and websites

5. Issue Resolution Process

Vina Subbasin will pursue development of an issue-resolution process with neighboring subbasins in the North Sac River Corridor group.

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APPENDIX 1-A

Preparation Checklist for Groundwater ~~Management~~Sustainability Plan~~.~~

~~FIGURES~~

Submittal

APPENDIX 1~~-A~~-B

Cooperation Agreement and Notice of Intent

APPENDIX 1-~~B~~C

Joint Powers Agreement

APPENDIX 1-~~C~~D

Groundwater Status Report for the 2020 Water Year

APPENDIX 1-~~D~~E

Communication and Engagement Plan

APPENDIX ~~2-A~~1-F

Comments to the Draft ~~GDE~~Groundwater Sustainability Plan and Responses

APPENDIX 2-A

Draft Groundwater Dependent Ecosystems Maps

APPENDIX 2-B
Historical Annual Water Budget Estimates

APPENDIX 3-A

~~Figures~~

Figures Showing Average Depth of Domestic, Irrigation, and Public Supply Wells

APPENDIX 3-B

Figures of Representative Monitoring Sites

<u>APPENDIX 3-C</u>

<u>Representative Monitoring Site</u>

<u>Well</u> Hydrographs

APPENDIX 6-A
Northern Sacramento Valley Inter-basin Coordination Report