Groundwater Sustainability Plan

Castac Lake Valley Groundwater Basin

Prepared by:

EKI Environment & Water, Inc.

for

Castac Basin GSA

17 September 2020

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Glossary / Abbreviations

AF	acre-feet
AFY	acre feet per year
BMP	Best Management Practices
CalTrans	California Department of Transportation
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CE	Categorical Exemption
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGS	California Geological Survey
COCs	constituents of concern
CVRWQCB	Central Valley Groundwater Water Quality Control Board
CWC	California Water Code
DEM	Digital Elevation Model
DAC	Disadvantaged Community
DMS	Data Management System
DOGGR	Division of Oil, Gas, and Geothermal Resources
DRINC	Drinking Water Information Clearinghouse
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EIR	Environmental Impact Report
ET	Evapotranspiration
ETo	reference evapotranspiration
FEMA	Federal Emergency Management Agency
FMHS	Frazier Mountain High School
ft^3	cubic feet
ft bgs	feet below ground surface
ft msl	feet above mean sea level
ft/d	feet per day
ft/yr	feet per year
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDEs	Groundwater Dependent Ecosystems
GIS	Geographic Information System
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSE	ground surface elevation
GSP	Groundwater Sustainability Plan
GWC	groundwater conditions
GWE	groundwater elevation

HCM	Hydrogeologic Conceptual Model
IM	Interim Milestone
in/yr	inches per year
InSAR	Interferometric Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Plan
IS	Initial Study
ITRC	Irrigation Training and Research Center
JPA	Joint Powers Authority
Kc	Crop coefficient
KCWA	Kern County Water Agency
KMWC	Krista Mutual Water Company
LCWD	Lebec County Water District
LUST	Leaking Underground Storage Tank
meq/L	milliequivalents per liter
MCL	Maximum contaminant level
mg/L	milligrams per liter
MN	Monitoring Network
MND	Mitigated Negative Declaration
MODFLOW-NWT	United States Geological Survey modular three-dimensional groundwater flow modeling software -a Newton formulation
MO	Measurable Objective
MPE	measuring point elevation
MT	Minimum Threshold
NA	not applicable
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NCCAG	Natural communities commonly associated with groundwater
ND	Negative Declaration
NDMI	Normalized Derived Moisture Index
NDVI	Normalized Derived Vegetation Index
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NWIS	National Water Information System
O&M	operation and maintenance
P&MA	Projects and/or Management Action
PA	Plan area
PGE	Pacific Gas and Electric
PI	plan implementation
PLSS	Public Land Survey System
QA/QC	quality assurance/quality control

RMW	Representative Monitoring Well
RPE	reference point elevation
RWQCB	Regional Water Quality Control Board
SCEP	Stakeholder Communication and Engagement Plan
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SGMA	Sustainable Groundwater Management Act
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMCs	Sustainable Management Criteria
SRF	State Revolving Fund
SSURGO	US Department of Agriculture Soil Survey Geographic Database
SWP	State Water Project
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TBD	to be determined
TCWD	Tejon-Castac Water District
TDS	Total dissolved solids
TMV	Tejon Mountain Village
TRC	Tejon Ranch Corporation
ug/L	micrograms per liter
USACE	United States Army Corps of Engineers
USDA-NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
USEPA	United States Environmental Protection Agency
U.S.FWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WB	water budget
WY	Water Year (begins 1 October of previous calendar year)

This groundwater sustainability plan is dedicated to the memory of
Bill Hopper,
who lived in service to his community.

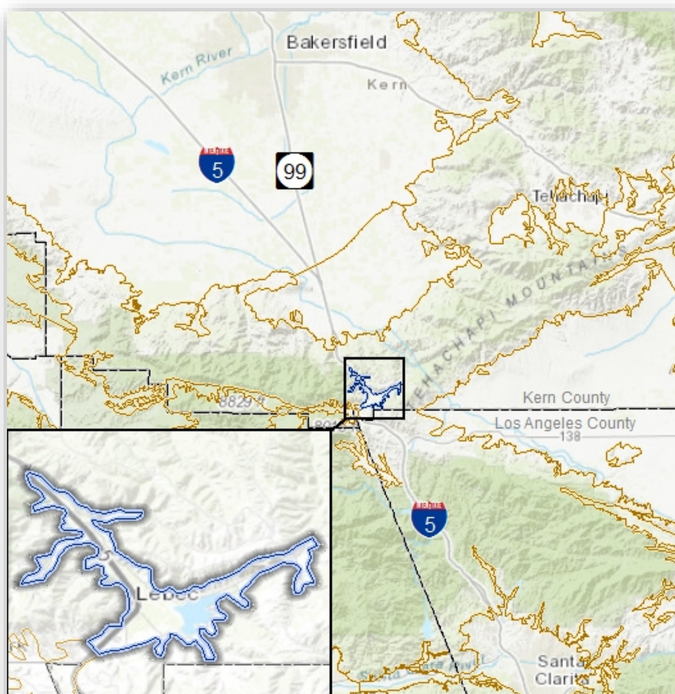
EXECUTIVE SUMMARY

> *§ 354.4. Each Plan shall include the following general information:*
> *(a) An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.*

ES.1. Introduction

On 16 September 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) - the primary purpose of which is to achieve and/or maintain sustainability within the state's high and medium priority groundwater basins. Key tenets of SGMA are the concept of local control, the use of best available data and science, and the active engagement and consideration of all beneficial uses and users of groundwater. In high and medium priority basins, SGMA requires local agencies to form Groundwater Sustainability Agencies (GSAs) and to adopt Groundwater Sustainability Plans (GSPs) to manage basins sustainably. SGMA encourages and authorizes, but does not require, low- and very low- priority basins to be managed under a GSP or an alternative (California Water Code § 10720.7).

The Castac Lake Valley Groundwater Basin (also referred to herein as "the Basin"), California Department of Water Resources (DWR) Basin No. 5-029, is located at the southern end of Kern County. The Basin is identified by DWR as being a very low priority basin, and as such, this GSP and associated SGMA compliance efforts have been conducted on a voluntary basis.



Castac Lake Valley Groundwater Basin

The Castac Basin GSA is the exclusive GSA for the Basin. In 2018, in response to SGMA, a Joint Powers Agreement (JPA) was executed and the Castac Basin GSA Board was formed, which is comprised of two representatives from Tejon-Castac Water District (TCWD), two representatives from Lebec County Water District (LCWD), and one non-voting representative from Kern County. As part of a Memorandum of Agreement executed in 2018, a non-voting Board position was added for one representative from Krista Mutual Water Company (KMWC).

This GSP includes, among other things: (1) a description of the Hydrogeologic Conceptual Model of the Basin, (2) a description of current groundwater conditions, (3) estimates of the historical and projected water budgets, (4) an assessment of SGMA-defined Undesirable Results, (5) development of Sustainable Management Criteria, (6) identification of a monitoring network to demonstrate SGMA compliance, and (7) identification of Projects and/or Management Actions to increase the sustainability of the Basin.

This GSP has been developed on a voluntary basis to meet SGMA regulatory requirements[1] while reflecting local needs and preserving local control over groundwater resources. This GSP provides a path to maintain and document sustainable groundwater management within 20 years following GSP adoption, promoting the long-term sustainability of locally-managed groundwater resources now and into the future.

ES.2. Sustainability Goal

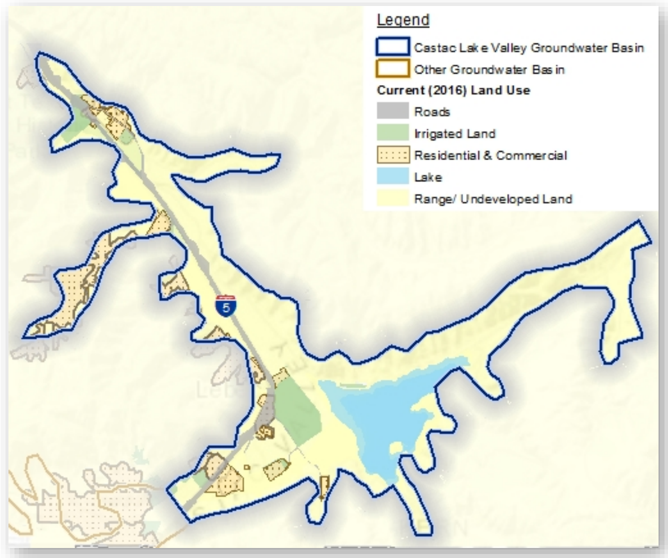
The Sustainability Goal is to cooperatively manage groundwater sustainably in the Basin to support current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental uses) and to avoid undesirable results throughout the planning horizon. Groundwater movement and storage in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale. Nonetheless, the goal of the Castac Basin GSA's projects and management actions will be to maintain groundwater storage in the Basin to the extent possible, in order to supply beneficial uses and users of groundwater.

ES.3. Plan Area

The Basin encompasses 3,563 acres within the Tehachapi and San Emigdio Mountains at the southern end of Kern County. The entire Basin extent (as defined by DWR) is covered by the Castac Basin GSA. The Basin is bordered on the southwest by Cuddy Canyon Valley Groundwater Basin (DWR Basin No. 5-082); there are no other groundwater basins directly adjacent to the Basin.

[1] Regulations for GSP development are contained within Title 23 of the California Code of Regulations (CCR) Division 2 Chapter 1.5 Subchapter 2

Land use within the Basin is primarily range and undeveloped lands (69%); lake area (11%); and residential and commercial lands (9%). Forty-two acres of state-owned lands associated with Fort Tejon State Historic Park, managed by the California Department of Parks and Recreation, fall within the northwest corner of Basin. The unincorporated community of Lebec (with a population of approximately 1,500 residents) is located in the southwest portion of the Basin and is considered by the State of California to be a Disadvantaged Community[2] based on 2016 median household income reported by the U.S. Census Bureau.



Current (2016) Land Use

The potable consumption of groundwater in the Basin includes pumping by domestic and public water systems. The LCWD public water system (2 wells) serves the community of Lebec and the KMWC public water system (1 well) serves the Los Padres Estates area located in O'Neil Canyon. The active participation of both LCWD and KMWC on the Castac GSA Board and in the preparation of this GSP is an important mechanism in which the interests of disadvantaged communities have been considered herein.

ES.4. Stakeholder Outreach Efforts

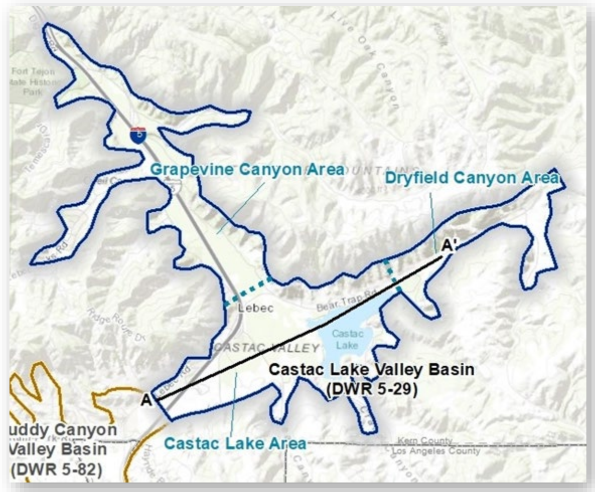
The Castac Basin GSA developed and is implementing a Stakeholder Communication and Engagement Plan (SCEP) to fulfill SGMA notice and communication requirements, and to address the interests of beneficial users of groundwater within the Basin during the GSP development and implementation process. The goal of the outreach efforts to date has been to encourage open and transparent engagement by diverse Basin stakeholders, including the incorporation of knowledge and perspectives from various parties into the GSP process. Stakeholders have been asked to provide input and comments throughout GSP development at venues including the Castac Basin GSA Board meetings and Stakeholder Workshops. Other outreach to stakeholders during the GSP development process included distribution and collection of a *Landowner Data Request Form* and *Stakeholder Survey*, and direct outreach to public water systems within and up-gradient of the Basin. The Castac Basin GSA also hosts a website https://www.castacgsa.org/,

[2] The DWR presents information regarding U.S. Census Blocks, Tracts and Places that are defined as disadvantaged communities (DAC) or severely disadvantaged communities (SDAC) based on the median household income (MHI) of an area compared to the statewide MHI (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer). DAC communities are those with a MHI of less than 80% the statewide MHI, and SDAC communities are those with a MHI of less than 60% of the statewide MHI (California Code, Public Resources Code § 75005(g)).

which contains outreach resources including GSA Board meeting dates and associated materials, the *Landowner Data Request Form* and *Stakeholder Survey*, and Fact Sheets developed by the Castac Basin GSA throughout the GSP development process.

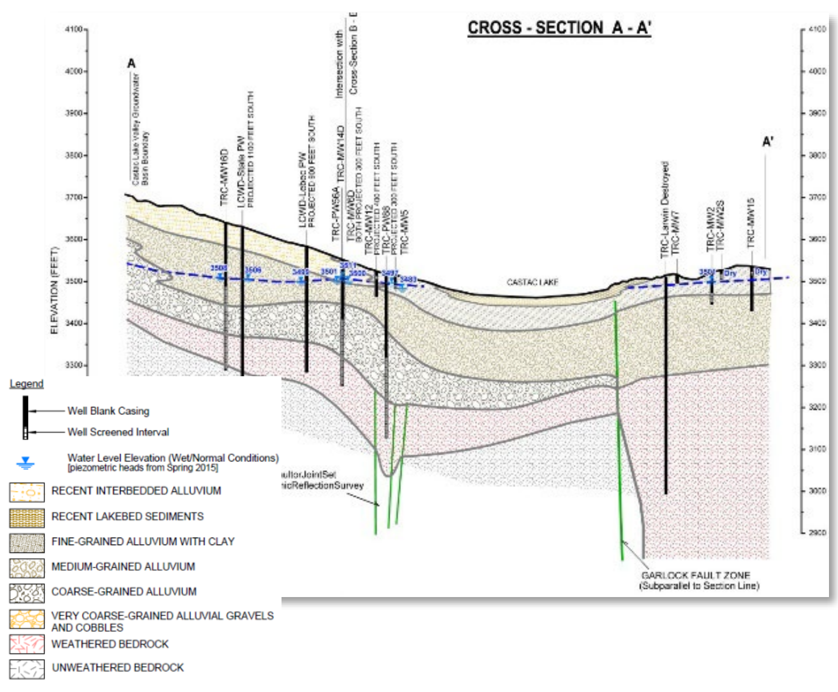
ES.5. Hydrogeologic Conceptual Model

The Basin is located within the Tehachapi and San Emigdio Mountains, in a region of faulted, deformed, and uplifted igneous and metamorphic rocks near the intersection of the San Andreas and Garlock faults. The Basin can be divided generally into three areas: Castac Lake, Dryfield Canyon, and Grapevine Canyon. The Castac Lake area is bounded by the northern and southern splays of the Garlock Fault Zone, by the Cuddy Canyon Basin on the west, and by the western extent of alluvial fill in Dryfield Canyon on the east. The Grapevine Canyon area is bounded by the extent of alluvial fill on all sides but the south (i.e., where it abuts the Castac Lake area).



General Basin Areas

Available hydrogeologic information indicates that bedrock within the Basin generally is very low permeability and therefore forms the bottom of the Basin. Unconsolidated clastic sediments, including interbeds of sands and gravels with varying amounts of silts and clays, have filled the Basin over time. The Basin is comprised of one principal aquifer, which can be vertically divided into two hydrostratigraphic "zones" (i.e., the Shallow and Deep Aquifer zones). Based on water level data, results of aquifer pumping tests, and water quality data, these zones appear to be hydraulically connected, despite having variable but distinct sets of geologic and hydraulic properties.



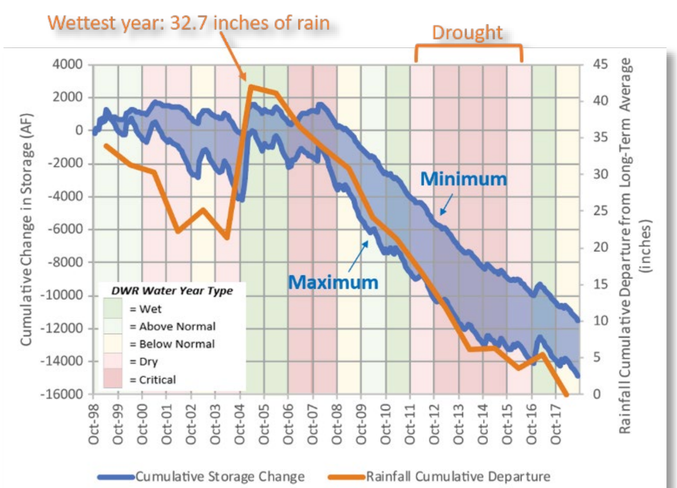
Sources of water to the Basin groundwater system include recharge from precipitation, surface inflow from Cuddy Creek, subsurface groundwater inflows from the up-gradient Cuddy Canyon Basin, return flows from irrigation and septic tanks, and Castac Lake seepage. Outflows from the Basin include groundwater pumping, evapotranspiration by phreatophytic plants and groundwater dependent ecosystems (GDEs; mostly located near the often-dry Castac Lake), inflow seepage to Castac Lake (under certain conditions), and surface outflow into Grapevine Creek.

ES.6. Existing Groundwater Conditions

Information on groundwater conditions in the Basin is presented with respect to the six "Sustainability Indicators" defined under SGMA, which include the following:

Chronic Lowering of Groundwater Levels: Groundwater levels are presented using both contour maps depicting recent (2015) seasonal high (spring) and seasonal low (fall) conditions, and hydrographs from various monitoring wells located throughout the Basin that have sufficient historical records. The available data indicate that groundwater generally flows from the southwest and southeast Basin margins toward the Castac Lake area in the center of the Basin, and then out through Grapevine Canyon to the north. Well hydrographs further indicate that groundwater levels correspond to climatic cycles, in which groundwater level changes are driven by observed trends in the rainfall cumulative departure from average. In the Castac Lake area of the Basin (where the period of record is longest), groundwater levels reached their historical low in the 1950s and 1960s, recovered through the 1990s, remained relatively high from the late 1990s through 2006 (when some wells were seasonally flowing artesian), declined again from 2007 through mid-2017, and stabilized from mid-2017 through 2019.

Reduction in Groundwater Storage: Change in groundwater storage was estimated for the historical water budget based on water level data, a spreadsheet analytical model, and a transient numerical flow model. During the historical water budget period (1998 through 2017), the Basin's mean annual groundwater storage change was approximately -400 acre-feet per year (AFY) while annual changes in groundwater storage between seasonal highs (February to March) were estimated to range from -1,700 AFY to +1,210 AFY. Similar to the groundwater level trends, change in Basin storage appears to be



Estimated Cumulative Groundwater Storage Change (1998-2018)

significantly influenced by climate whereby change in storage is negative during dry years (when the rainfall cumulative departure decreases), and generally positive during wet years (when the rainfall cumulative departure increases).

Seawater Intrusion: The Basin is located far from coastal areas, and therefore seawater intrusion is not considered to be a threat to groundwater resources.

Degraded Water Quality: Potable consumption is a significant use of groundwater within the Basin. Total dissolved solids (TDS), nitrate, arsenic, fluoride, and uranium concentrations have been detected in groundwater above drinking water standards. An evaluation of the available water level and water quality data show that: (1) some wells do show a weak correlation between water levels and certain constituent concentrations, (2) some wells show no correction between water levels and constituent concentrations, and (3) most wells have insufficient data to conduct statistical analyses.[3] Wells with available water quality data suggest that the constituents nitrate, TDS, uranium, and arsenic are increasing in at least one well, and that nitrate, uranium and fluoride are decreasing in other wells. Future monitoring efforts will include routine compilation of water quality data from public water systems and supplemental monitoring wells, which will fill the current water quality data gaps. These data will be reviewed periodically and water quality trends will be evaluated as part of future GSP implementation efforts.

Land Subsidence: There has been little to no historical land subsidence within the Basin. Given the geologic and stratigraphic characteristics of the Basin, namely the lack of thick clay layers in which declining water levels could cause irreversible compaction, land subsidence does not appear to have occurred historically, and is not likely to occur in the Basin. Existing groundwater levels are higher than the historical lows observed in the 1960s and therefore subsidence-related issues within the Basin are not considered a threat.

Depletions of Interconnected Surface Water: Castac Lake, while often dry, has historically been observed to be connected with the surrounding aquifer, and groundwater seepage has occurred both into and out of the lake, depending on the difference between groundwater levels and lake surface levels. The DWR dataset of Natural Communities Commonly Associated with Groundwater (NCCAG) shows potential GDEs located near and downgradient of Castac Lake primarily in the Grapevine Canyon area of the Basin. Furthermore, species reliant on freshwater may potentially inhabit the Basin. The water levels in the Grapevine Canyon area of the Basin show much less variability than those in the other areas of the Basin and are commonly near or within the maximum rooting depths of plant species associated with potential GDEs.

[3] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.

ES.7. Water Budget

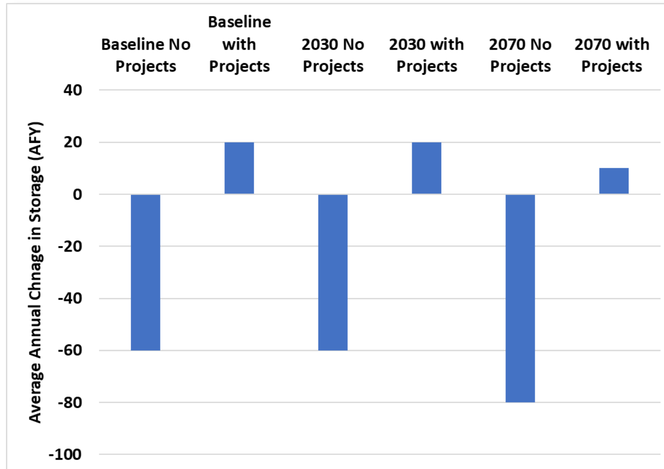
A spreadsheet analytical water budget was developed to simulate historical and current conditions (Water Years 1998 to 2018), which account for inflows to the Basin (including precipitation, subsurface inflows, and surface water inflows) and outflows from the Basin (including evapotranspiration by crops and native vegetation, agricultural and municipal use, subsurface outflows, and surface water outflows). Additionally, a numerical groundwater flow model, the "Castac Basin Numerical Model," was developed to support analysis of future conditions, including quantifying the effects of climate change and future Projects and Management Actions (P&MAs). The numerical groundwater flow model was calibrated to historical conditions (Water Years 1999 to 2018) and then extended to predict groundwater conditions 50 years into the future.

The analytical spreadsheet water budget for the Basin shows an average net change in groundwater storage of -360 AFY averaged over the historical 20-year period (Water Years 1998-2017), and -1,200 AFY during the current period (Water Year 2018).

The sustainable yield is the amount of pumping that can occur from a basin without causing an undesirable result. It can be estimated by subtracting the average annual groundwater pumping from the average annual change in storage, which corresponds to the volume of water that, if pumped over the water budget period of interest, would have resulted in zero storage change due to pumping. Based on the analytical water budget (Water Years 1998-2018), the Basin's estimated sustainable yield ranges from 500 AFY to 1,190 AFY depending on the time period considered; thus, sustainable yield estimates are time-dependent and contain significant uncertainty. Average Basin pumping over the historical water budget period (WYs 1998 - 2017) was approximately 920 AFY, which falls within the upper end of the sustainable yield estimates, however current (Water Year 2018) Basin pumping is estimated at 440 acre-feet, which is less than the estimated sustainable yield range.

Future water budget scenario projections were developed to account for projected water use and anticipated climate change effects using DWR-provided inputs for climate variables (i.e., adjusted precipitation and evapotranspiration; DWR, 2018): a Historical (Baseline) Climate Scenario reflecting no climate change effects, a DWR moderate (2030) Climate Change Scenario, and a DWR extensive (2070) Climate Change Scenario. In addition, three land-use scenarios were considered: current land-use, proposed Tejon Mountain Village (TMV) development, and proposed TMV Development with implementation of P&MA #1 *Aquifer Replenishment Project*.

Change in groundwater storage under all projected scenarios is generally stable, ranging from -80 AFY to 20 AFY. Projected scenarios with implementation of P&MA #1 show a net average annual surplus of groundwater in storage. However, each projected estimate has varying degrees of accuracy and uncertainty. Compared to the historical period, the future period has approximately half of the pumping, more recharge due to increased infiltration from imported and recycled water used within the TMV development, and reduced groundwater outflows, resulting in minimal changes in groundwater storage. However, as noted above, groundwater movement and storage in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale.



Comparison of Average Annual Change in Storage Estimates (AFY) under Projected Scenarios

For example, projected scenarios are most sensitive to estimates of groundwater inflow from the upgradient Cuddy Canyon Basin; thus, future groundwater level monitoring at the Basin boundary would improve the conceptual understanding of groundwater inflow volumes. As part of GSP implementation, these groundwater inflow estimates will be refined as additional information is collected.

ES.8. Sustainable Management Criteria

Sustainable Management Criteria (SMCs) are the metrics by which groundwater sustainability is judged under SGMA. Key terms related to SMCs under SGMA include the following:

Sustainability Indicators refer to adverse effects caused by groundwater conditions occurring throughout the Basin that, when significant and unreasonable, cause undesirable results. The Sustainability Indicators identified by DWR are the following:

- Chronic lowering of groundwater levels
- Reduction in groundwater storage
- Seawater intrusion
- Degraded water quality
- Land subsidence

- Depletions of interconnected surface water

Undesirable Results are the significant and unreasonable occurrence of conditions, for any of the six Sustainability Indicators, that adversely affect groundwater use in the Basin. Where appropriate, groundwater levels are used as proxy for measuring Undesirable Results for other Sustainability Indicators.

Minimum Thresholds (MTs) are the numeric criteria for each Sustainability Indicator that, if exceeded, may cause Undesirable Results. Where appropriate, the MTs for the Sustainability Indicators have been set using groundwater levels as a proxy.

Measurable Objectives (MOs) are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions. MOs use the same units and metrics as the MTs and are thus directly comparable.

Interim Milestones are a set of target values representing measurable groundwater conditions in increments of five (5) years over the 20-year statutory deadline for achieving sustainability.

Summary of Undesirable Results Definition

Sustainability Indicator	Undesirable Results Definition
Chronic Lowering of Groundwater Levels	If groundwater levels decline below the MT in any two representative monitoring wells (RMWs) for four consecutive semi-annual sampling events.
Reduction of Groundwater Storage	If groundwater storage is reduced by an amount that causes groundwater levels to decline below the MT in any two RMWs for four consecutive semi-annual sampling events (*Chronic Lowering of Groundwater Levels to be used as a proxy*).
Seawater Intrusion	No Undesirable Results definition. Not applicable to the Basin due to geographic distance from the ocean.
Degraded Water Quality	No Undesirable Results definition. Limited historical water quality measurements are available and the relationship between water levels and water quality is not yet established. In addition to the public water system well water quality monitoring per Title 22, water quality samples will be collected from selected supplemental monitoring wells in the Basin to establish a current groundwater quality baseline. If data suggest that water quality is being affected by groundwater management practices, SMCs for water quality will be revisited.
Land Subsidence	No Undesirable Results definition. Not applicable to the Basin. No historical evidence of subsidence and geologic strata are unfavorable to inelastic deformation.
Depletions of Interconnected Surface Water	If groundwater levels decline below the MT in any two RMWs for four consecutive semi-annual sampling events; (*Chronic Lowering of Groundwater Levels used as a proxy*).

Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator, as it influences several other key Sustainability Indicators, including Reduction of Groundwater Storage and Depletions of Interconnected Surface Water. The SMCs for Chronic Lowering of Groundwater Levels were developed through time-series analysis of long-term groundwater level data at the three representative monitoring wells (RMWs). The linear trend of groundwater elevations at each RMW between Water Years 2008 through 2018 was projected forward 10 years to establish the MO and 20 years to establish the MT. These SMCs were evaluated against known domestic and public supply well construction information to assess the potential for dewatering. The process for developing the MTs and MOs and the results were presented on multiple occasions in public meetings and workshops to allow for stakeholder input.

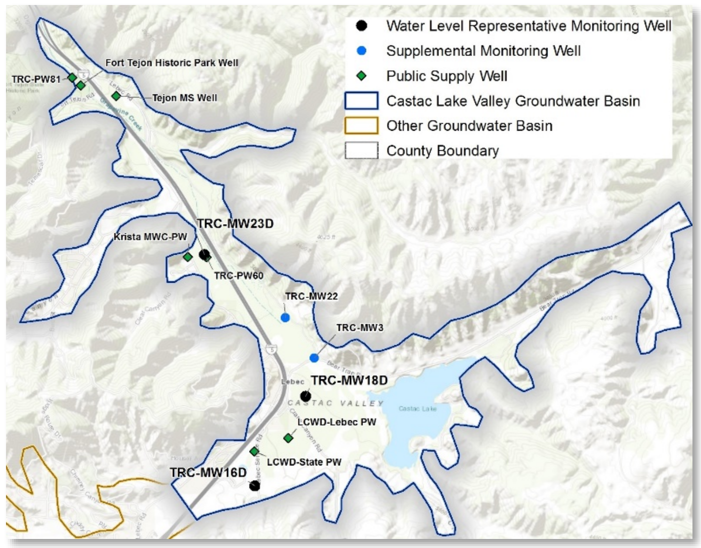
Reduction of Groundwater Storage is closely tied to Chronic Lowering of Groundwater Levels. The cumulative storage decline between March 2008 and March 2018 (as estimated using the Castac Basin Numerical Model) was approximately 13% of the total maximum aquifer storage. Because the water level declines over this period (and projected forward into the future as part of water level MO/MT development) is similar to historical conditions observed within the Basin, and results in a relatively small loss of groundwater storage, it was determined that the use of SMCs for Chronic Lowering of Groundwater Levels as a proxy for the SMCs for Reduction of Groundwater Storage would be sufficiently protective.

The SMCs for Degraded Water Quality are not currently defined for the Basin. An evaluation of the available water level and water quality data show that: (1) some wells do show a weak correlation between water levels and certain constituent concentrations, (2) some wells show no correction between water levels and constituent concentrations, and (3) most wells have insufficient data to conduct statistical analyses. Therefore, on-going compilation of water quality data from the public water systems within the Basin, supplemented with water quality sampling from other monitoring wells, will be used to establish a water quality baseline with which future GSP updates can better assess water quality conditions. If future data suggest that water quality is being affected by groundwater management practices, the need to develop SMCs for water quality will be revisited.

Depletions of Interconnected Surface Water is closely tied to Chronic Lowering of Groundwater Levels. Most creeks in the Basin are ephemeral under natural conditions, which means that flows are brief and generally occur following a rainfall event. Although it is often dry, Castac Lake is the most prominent surface water feature in the Basin and has been historically and intermittently full and/or interconnected to groundwater. Potential GDEs have been mapped near the lake and in the Grapevine Canyon area of the Basin, where groundwater levels typically are shallower. Given the observed shallow depths to groundwater in the Grapevine Canyon RMW (TRC-MW23D), the known range of GDE plant rooting depths, and the maximum water depth allowed by the MTs for Chronic Lowering of Groundwater Levels, these MTs also are protective of the potential GDEs. As such, it was determined that the use of SMCs for Chronic Lowering of Groundwater Levels as a proxy for the SMCs for Depletions of Interconnected Surface Water was sufficiently protective.

As discussed above, Seawater Intrusion and Land Subsidence are not considered a threat to the Basin's groundwater resources. Therefore, no SMCs are defined for these Sustainability Indicators.

ES.9. Monitoring Network



SGMA Monitoring Network

The objectives of the SGMA Monitoring Network are to collect sufficient data for the assessment of the Sustainability Indicators relevant to the Basin and to evaluate potential impacts to the beneficial uses and users of groundwater. The proposed SGMA Monitoring Network was developed to ensure sufficient spatial distribution and spatial density and consists of three RMWs for groundwater levels and by proxy groundwater storage and interconnected surface water. The RMWs are TRC-MW16D near the upgradient border of the Basin, TRC-MW18D in the Castac Lake area of the Basin, and TRC-MW23D in the Grapevine Canyon area of the Basin. The spatial distribution of the RMWs provides the ability to collect data near the boundary with the sole adjoining basin (the Cuddy Canyon Valley Basin, located upgradient of the Castac Basin), which allows monitoring of future water level and groundwater storage trends at their common boundary. Thus, potential adverse effects on the upgradient basin due to groundwater management practices in the Basin can be monitored using the RMWs. Public water system wells are subject to water quality monitoring requirements (external to SGMA regulations); data collected from these wells will be assembled and analyzed to allow for ongoing future water quality trend analysis, supplemented by water quality samples collected from two supplemental monitoring wells in the Grapevine Canyon area of the Basin (e.g., TRC MW-3 and TRC-MW22).

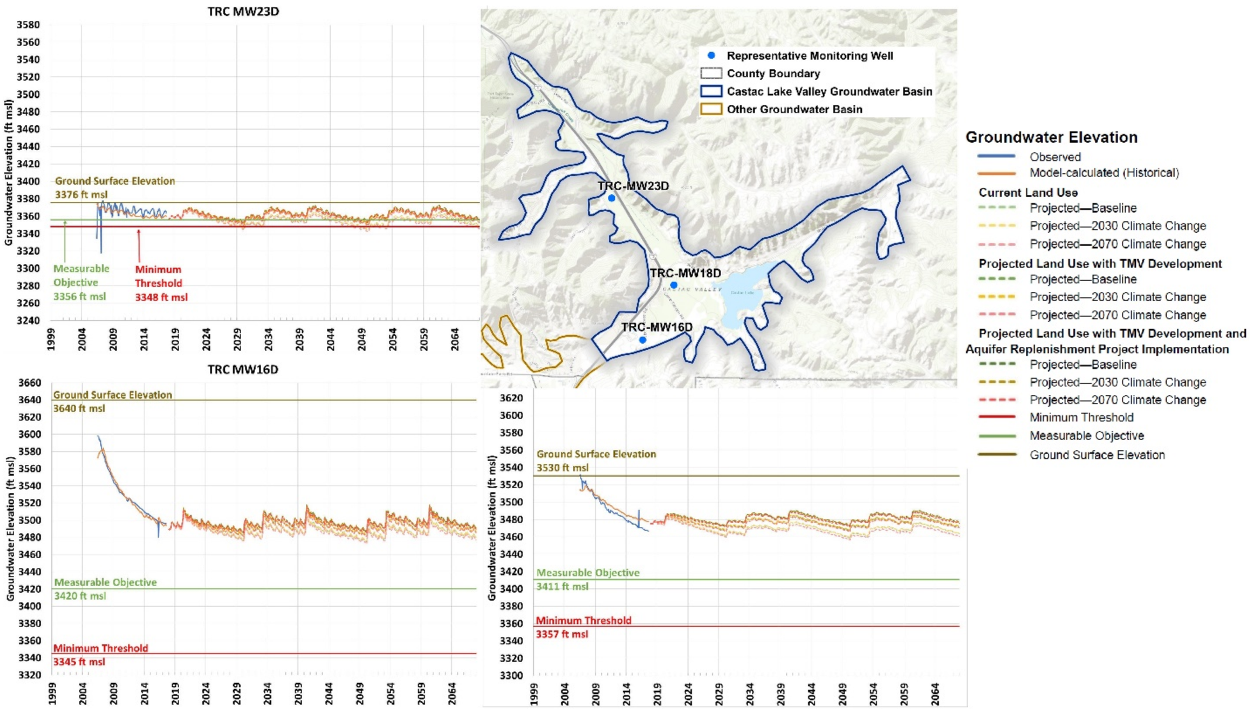
Data collected from the SGMA Monitoring Network will be uploaded to the Data Management System (DMS) maintained for the Basin and reported to DWR in accordance with the Monitoring Protocols developed by the Castac Basin GSA. Additional data collected by other entities as part of other regular monitoring programs may also be used for annual reporting and five-year updates or as otherwise deemed necessary.

ES.10. Projects and Management Actions

The Castac Basin GSA is proactively pursuing Basin management options and has identified several potential P&MAs, each with specific expected benefits. Certain P&MAs will be initiated within the first five years of GSP adoption, whereas others will be implemented incrementally on an as-needed basis to achieve the Sustainability Goal for the Basin. Most P&MAs have expected benefits related to water supply augmentation with other secondary benefits:

1. Enhanced Recharge: Aquifer Replenishment Project
2. Manage and/or Capture Floodwater: Cuddy Creek Bank Modifications Project
3. Increase Delivery Flexibility: KMWC Emergency Interconnect with LCWD
4. Develop New Supplies: Wastewater Reclamation Project
5. Water Quality Improvements: Frazier Mountain High School Water Project
6. Improved data collection for ongoing reporting compliance and water budget quantification: Well Metering and Data Collection

Based on the projected Castac Basin Numerical Model results, upon implementation, the P&MA#1 *Aquifer Replenishment Project* is estimated to add an additional 70 to 100 AFY of groundwater replenishment to the Basin (and up to 300 AFY on certain years), resulting in a net increase in groundwater storage of approximately 30 AFY under each climate scenario. Furthermore, projected groundwater elevations in all RMWs are expected to remain at or above the MTs under P&MA #1 *Aquifer Replenishment Project* implementation scenarios. The modeling results support the notion that the proposed P&MA implementation strategy is expected to result in sustainable management of groundwater levels within the Basin, as measured against the definition of Undesirable Results. It should be noted that the P&MA #1 scenario has been modeled assuming that surplus imported surface water supplies remain available. The effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed at that time.



Projected RMW Hydrographs with and without P&MA #1 Implementation

Many of the P&MAs require further analysis, permitting, and water rights processes to determine feasibility and cost-effectiveness. In general, the P&MAs being considered for implementation will be discussed during regular Castac Basin GSA Board Meetings, which are open to the public. Additional stakeholder outreach efforts will be conducted prior to and during P&MA implementation, consistent with the SCEP.

ES.11. GSP Implementation

Key GSP implementation activities to be undertaken by the GSA over the next five (5) years include:

- Monitoring and data collection of water levels, water quality, groundwater extraction volumes, and surface water volumes, if applicable;
- Data gap filling efforts, including monitoring well installation, outreach to domestic well and public water system well owners, and use of new tools and guidelines;
- Intra-basin coordination;
- Continued outreach and engagement with stakeholders;
- Annual reporting;

- Evaluation and updates, as necessary, of the GSP as part of the required periodic evaluations (i.e., "five-year updates"); and
- P&MA implementation.

ES.12. GSP Implementation Costs and Funding

Costs to implement this GSP can be divided into several groups, as follows:

1. Costs of groundwater monitoring and reporting activities;
2. Costs associated with stakeholder outreach; and
3. Costs to implement P&MAs, including capital/one-time costs and ongoing costs.

Costs associated with continued GSA activities (groups 1 and 2) are estimated to range between approximately $64,000 to $165,000 per year, not including GSA and GSA member agency staff time. Estimated annual costs for individual P&MAs (group 3) will be determined in the future, as the Castac Basin GSA moves forward with specific P&MA implementation. The Castac Basin GSA will likely meet the estimated costs through a combination of contributions from landowners, grant funding, if available, and through rate payers.

ES.13. Conclusion

The passage of SGMA in 2014 ushered in a new era of groundwater management in California. The law and regulations emphasize the use of best available science, local control and decision making, and active engagement of affected stakeholders. Achieving and maintaining sustainability in the face of uncertain future water supply conditions while addressing and balancing the needs of all beneficial uses and groundwater users will require significant effort, creative solutions, and unprecedented collaboration. Although the Castac Basin is a very low priority basin in the eyes of DWR, the Castac Basin GSA recognizes the importance of maintaining groundwater sustainability to support the beneficial users within the Basin. Therefore, as the implementing agency, the Castac Basin GSA is committed to facing these challenges in a manner that upholds the interests of local landowners and constituents.

INTRODUCTION

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). The 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." Undesirable results are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout the basin (California Department of Water Resources [DWR], 2017):

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply;
- Significant and unreasonable reduction of groundwater storage;
- Significant and unreasonable seawater intrusion;
- Significant and unreasonable degraded water quality;
- Significant and unreasonable land subsidence; and
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The Castac Lake Valley Groundwater Basin (referred to herein as "the Basin"), DWR Basin No. 5-029, is prioritized as a "very low priority" basin (DWR, 2019). The SGMA Legislation does not require very low priority basins be managed under GSPs, however "encourages and authorizes" basins designated as very low priority to be managed under a GSP (Section 10720.7(b)).

This GSP has been developed to meet SGMA regulatory requirements (see *Appendix A*) while reflecting local needs and preserving local control over water resources. This GSP provides a path to achieve and document sustainable groundwater management within 20 years following GSP adoption, promoting the long-term sustainability of locally-managed groundwater resources now and into the future.

2. SUSTAINABILITY GOAL

§ 354.24 Sustainability Goal

Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.

The Sustainable Groundwater Management Act (SGMA) requires that a Sustainability Goal be defined for the Basin (CWC §10727(a)), and the Groundwater Sustainability Plan (GSP) Emergency Regulations further clarify that the sustainability goal "culminates in the absence of undesirable results within 20 years of the applicable statutory deadline" (23 CCR §354.24).

The Sustainability Goal of the Castac Basin GSA (Water Code §10721(u)) is to cooperatively manage groundwater sustainably in the Basin to support current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental uses) and to avoid undesirable results throughout the planning horizon.

Groundwater recharge in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale. Nonetheless, the goal of Castac Basin GSA's projects and management actions will be to maintain groundwater storage in the Basin to the extent possible, in order to supply beneficial uses and users of groundwater.

3. AGENCY INFORMATION

> *§ 354.6. When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:*
> *(a) The name and mailing address of the Agency.*
> *(b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.*
> *(c) The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.*
> *(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.*
> *(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.*

3.1. Name and Mailing Address of the Groundwater Sustainability Agency (GSA)

The Castac Basin Groundwater Sustainability Agency (GSA) is the exclusive GSA for the Castac Lake Valley Groundwater Basin, California Department of Water Resources (DWR) Basin No. 5-029 (referred to herein as the "Basin").

The mailing address for the Castac Basin GSA is:

Castac Basin Groundwater Sustainability Agency
PO Box 478
Lebec, CA 93243

3.2. Organization and Management Structure of the GSA

As outlined in the Joint Powers Agreement (JPA) dated 20 March 2018 (*Appendix B*), the Castac Basin GSA is governed by five JPA Board Members. Tejon-Castac Water District (TCWD) and Lebec County Water District (LCWD) each have two votes on the GSA Board and are designated as "voting parties." Kern County is a non-voting Board member and is designated as an "Additional Entity." Additionally, Krista Mutual Water Company (KMWC) holds a non-voting position designated as an "Interested Party" established by a Memorandum of Agreement (MOA) approved by the GSA Board on 4 September 2018 (*Appendix B*). Information regarding current Castac Basin GSA Board members and representatives can be found on the GSA's website at https://www.castacgsa.org/board. Current Board members include:

- Board Co-Chairman – Angelica Martin, TCWD;
- Board Co-Chairman – William Hopper, LCWD;
- Allen Lyda, TCWD;

- Rick Puckett, LCWD;
- Alan Christianson, Kern County; and
- Sandi McElhenny, KMWC

Each Party may appoint one or more alternate GSA Board members, and as outlined on the Castac Basin GSA website (https://www.castacgsa.org/board), TCWD, LCWD, and KMWC all have alternates appointed.

3.3. Plan Manager

The Plan Manager is Angelica Martin, Co-Chairman of the Castac Basin GSA. Ms. Martin can be reached at:

Angelica Martin
4436 Lebec Road
Lebec, CA, 93243

Telephone: (661) 663-4262

Email: amartin@tejonranch.com

3.4. Legal Authority of the GSA

The Castac Basin GSA applied for and was granted exclusive GSA status under the Sustainable Groundwater Management Act (SGMA) (California Water Code [CWC] § 10723(c)). The Castac Basin GSA therefore has legal authority for the following actions outlined in this GSP:

- Implement P&MAs as defined in CWC Section 10726.2(b) and
- Collect groundwater extraction volumes and install well meters, if needed, as established under CWC Section 10725.8.

3.5. Estimated Cost of GSP Implementation and the Agency's Approach to Meet Costs

As discussed in more detail in Section *18.2 Plan Implementation Costs*, costs associated with continued GSA activities, including monitoring, reporting, and stakeholder outreach, are estimated to range between approximately $64,000 to $165,000 per year, not including GSA and GSA member agency staff time. Estimated annual costs for individual P&MAs will be determined in the future, as the Castac Basin GSA moves forward with specific P&MA implementation. The Castac Basin GSA will likely meet the estimated costs through a combination of contributions from landowners, grant funding, if available, and through rate payers.

4. GSP ORGANIZATION

This GSP is organized as follows:

- Sections 1 through 4 comprise the **Introduction**, including the following sections:
    - Section 1. Purpose of the Groundwater Sustainability Plan
    - Section 2. Sustainability Goal
    - Section 3. Agency Information
    - Section 4. GSP Organization
- Section 5 provides a **Description of the Plan Area**.
- Sections 6 through 10 present the **Basin Setting**, including the following sections:
    - Section 6. Introduction to Basin Setting
    - Section 7. Hydrogeologic Conceptual Model
    - Section 8. Current and Historical Groundwater Conditions
    - Section 9. Water Budget Information
    - Section 10. Management Areas (as Applicable)
- Sections 11 through 15 present the **Sustainable Management Criteria**, including the following sections:
    - Section 11. Introduction to Sustainable Management Criteria
    - Section 12. Sustainability Goal
    - Section 13. Undesirable Results
    - Section 14. Minimum Thresholds
    - Section 15. Measurable Objectives and Interim Milestones
- Section 16 presents the **Monitoring Network**.
- Section 17 presents the **Projects and Management Actions**.
- Section 18 presents **Plan Implementation**.
- **References and Technical Studies** are included at the end of this document.
- Supporting information is provided in Appendices as follows:
    - Appendix A. GSP Submittal Checklist
    - Appendix B. Joint Powers Agreement and Memorandum of Agreement

- Appendix C. Stakeholder Communication and Engagement Plan
- Appendix D. GSP Public Comments
- Appendix E. Temporal Characteristics *of* Available Groundwater Data
- Appendix F. Supplemental Wetlands, Vegetation, and Special Species Maps
- Appendix G. The Nature Conservancy Freshwater Species List for the Castac Lake Valley Basin
- Appendix H. Historical Water Budget Spreadsheet Model Approach
- Appendix I. Castac Basin Numerical Groundwater Flow Model Documentation
- Appendix J. Project / Management Action Information Forms

PLAN AREA

5. DESCRIPTION OF THE PLAN AREA

This section presents a description of the Basin Plan Area, and a summary of the relevant jurisdictional boundaries and other key land use features potentially relevant to the sustainable management of groundwater in the Basin. This section also describes the water monitoring programs, water management programs, and general plans relevant to the Basin and their influence on the development and execution of this Groundwater Sustainability Plan (GSP).

5.1. Summary of Jurisdictional Areas and Other Features

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:

(1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.

(2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.

(3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.

(4) Existing land use designations and the identification of water use sector and water source type.

(5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.

(b) A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.

5.1.1. Area Covered by the Plan

The Castac Lake Valley Basin (Basin; California Department of Water Resources [DWR] Basin No. 5-029) encompasses 3,563 acres within the Tehachapi and San Emigdio Mountains at the southern end of Kern County (**Figure PA-1**). The entire Basin extent is covered by the Castac Basin Groundwater Sustainability Agency (GSA), which is the exclusive GSA for the Basin. Along the southwest upgradient edge of the Basin lies the Cuddy Canyon Valley Groundwater Basin (Cuddy Canyon Basin or DWR Basin No. 5-082). There are no other groundwater basins directly adjacent to the Basin to the north or east.

5.1.2. Adjudicated areas, Other Agencies, and Alternative areas

The Basin is not adjudicated and does not contain any areas covered by an Alternative Plan. Krista Mutual Water Company (KMWC) is an "other agency" (i.e., not a Joint Powers Authority [JPA] member of the Castac Basin GSA) located within the Basin (**Figure PA-1**). Additionally, Kern County Water Agency's (KCWA) governance area includes all lands within Kern County, which includes the Basin.

5.1.3. Jurisdictional Boundaries

As shown on **Figure PA-1**, there are 42 acres of state-owned lands associated with Fort Tejon State Historic Park, managed by the California Department of Parks and Recreation, that fall within the northwest corner of Basin. There are no federally owned lands within the Basin. According to the information made available by DWR[4] in support of GSP development, there are no tribal lands within or in the vicinity of the Basin. No incorporated cities lie within the Basin, which falls entirely within Kern County. Lebec, an unincorporated community of approximately 1,500 residents and some commercial development (U.S. Census Bureau, 2012), is located within the Basin (**Figure PA-1**). As shown on **Figure PA-1**, agencies with water management responsibilities within the Basin include Tejon-Castac Water District (TCWD), Lebec County Water District (LCWD), and KMWC.

The DWR further presents information regarding U.S. Census Blocks, Tracts and Places that are defined as disadvantaged communities (DAC) or severely disadvantaged communities (SDAC) based on the median household income (MHI) of an area compared to the statewide MHI.[5] DAC communities are those with a MHI of less than 80% the statewide MHI and SDAC communities are those with a MHI of less than 60% of the statewide MHI (California Code, Public Resources Code § 75005(g)). **Figure PA-2** shows the DAC/SDAC designations within the Basin based on 2016 MHI from the 2013-2017 American Community Survey 5-Year Estimates. The area located to the west of Interstate-5 (I-5) comprising a substantial portion of the residential community of Lebec is considered a SDAC based on the Census Block Group and a DAC based on the Census Tract characterizations. Additionally, the unincorporated community of Lebec is defined as a SDAC based on the Census Place characterization. Most of the DAC/SDAC areas within the Basin are within a public water system service area.

The Basin is located within the Kern County General Plan area, which is discussed in more detail below in Section 5.3.1 *General Plans and Other Land Use Plans*. The Kern County General Plan further identifies several Specific Plan areas, including the Tejon Mountain Village (TMV), O'Neil Canyon, and Frazier Park/Lebec Specific Plans which cover portions of the Basin and are discussed in more detail below in Section 5.3.1 *General Plans and Other Land Use Plans*.

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[4] SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer

[5] Ibid [4]

5.1.4. Existing Land Use and Water Use

Figure PA-3 shows land use within the Basin and **Table PA-1** summarizes land use by area. Land use within the Basin is primarily range and undeveloped lands (69%); lakebed area (11%); and residential and commercial lands (9%).

Table PA-1. Current Land Use

Land Use	Acres	Percent
Range / Undeveloped	2,438	69%
Lakebed Area	393	11%
Residential & Commercial	337	9%
Right of Way & Roadway	212	6%
Irrigated Land	171	5%

The potable consumption of groundwater in the Basin includes domestic well owners and public water systems. TCWD is the water supplier for portions of the Tejon Ranch Corporation (TRC) property in the eastern part of the Basin including the planned TMV development, but TCWD does not operate any potable supply wells within the Basin. LCWD supplies water to parts of Lebec along the western edge of the Basin; LCWD operates water supply wells in both the Basin and upgradient Cuddy Canyon Basin. KMWC operates one well within the Basin, which supplies water to the Los Padres Estates area located in the O'Neil Canyon portion of the Basin. LCWD also recently began efforts to drill an additional well in the Basin on TRC lands. Other public water systems include the TRC main headquarters, El Tejon Middle School, Fort Tejon Historic State Park, and Tejon Ranch Grapevine Water, each of which is serviced by one active groundwater well. The TRC main headquarters well serves as an emergency backup supply for the Tejon Ranch Grapevine Water supply system (Safe Drinking Water Information System [SDWIS], 2018). The TRC also uses groundwater from several wells within the basin for stock watering and irrigated agriculture (pasture, vineyards, and orchards).

5.1.5. Well Density Per Square Mile

Figure PA-4 shows approximate locations of supply wells in the Basin (obtained from non-DWR sources), and polygons published by DWR indicating the density of supply wells per square mile, based on DWR Well Completion Report records[6]. According to these records, 25 domestic wells, one production well, and no public supply wells have been constructed within the Public Land Survey System (PLSS) sections[7] that fall partially or entirely within the Basin. This summary conflicts with data from the Basin's Data Management System (DMS), which includes data obtained from private landowners and other sources. The DMS has records of two domestic

[6] DWR Well Completion Report Map Application website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37, accessed 10/23/2018.
[7] Each PLSS section represents approximately 1 square mile of area (i.e., 640 acres).

wells, 20 production wells, and eight public supply wells that have been constructed within the Basin over time. Of these, four production wells have been abandoned. Based on the locally-obtained data, DWR records appear to be out of date.

As groundwater management in the Basin proceeds under the Sustainable Groundwater Management Act (SGMA), discrepancies between the databases (e.g., DWR vs. the various data from the DMS) will be corrected using improved field-based well locations, and other data.

Communities that are dependent upon groundwater include the unincorporated community of Lebec and residents of O'Neil Canyon served by KMWC or private domestic wells.

5.2. Water Resources Monitoring and Management Programs

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:

(c) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.

(d) A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.

(e) A description of conjunctive use programs in the basin.

5.2.1. Existing Monitoring and Management Programs

Existing Monitoring Programs

- TRC currently conducts routine water level monitoring of its wells, however there is no officially established monitoring program.
- The Groundwater Ambient Monitoring and Assessment Program (GAMA) monitors groundwater quality trends throughout California. One well within the Basin was sampled once in 2008 under GAMA.
- The State Water Resources Control Board (SWRCB)'s Division of Drinking Water monitors groundwater quality from public water system wells. There are six public water systems located within the Basin (i.e., those serving a least 25 individuals daily for at least 60 days out of the year [California Health and Safety Code §116275]) with data available.
- Streamflow along Cuddy Creek is monitored by Kern County, in which the gaging station measures peak seasonal flow.

- Temperature and precipitation are measured at the National Oceanic and Atmospheric Administration (NOAA) Lebec station (ID 044863).

- Land subsidence data in the vicinity of the Basin is available through the University Navstar[8] Consortium (UNAVCO) Plate Boundary Observatory's continuous and conventional Global Positioning System (GPS) network.

Staff of TCWD, LCWD, and KMWC will coordinate to establish the SGMA Monitoring Network on behalf of the Castac Basin GSA. To the extent applicable, the GSA plans to incorporate these monitoring programs into its SGMA Monitoring Network, as appropriate. The Basin's SGMA Monitoring Network is described in more detail in Section *16 Monitoring Network* below.

Existing Management Programs

The Basin falls within the Tulare Lake Basin portion of the Kern County Integrated Regional Water Management Region (Kern Region) and is included in the March 2020 Kern County Integrated Regional Water Management Plan (Kern IRWMP; Provost & Pritchard, 2020). The Kern Region covers approximately 5,690 square miles of Kern County and a small portion of southern Kings County. The Kern Region is separated into nine subregions, in acknowledgement of the variation in geography, agency boundaries, and water management strategies. These subregions are: (1) Greater Bakersfield, (2) Kern Fan, (3) Mountains/Foothills, (4) Kern River Valley, (5) North County, (6) South County, (7) West Side, (8) Kern County Water Agency (KCWA) and (9) the County of Kern. The Basin falls within the Mountains/Foothills subregions (Provost & Pritchard, 2020).

The key issues, needs, challenges, and priorities for the Mountains/Foothills subregion, according to the Kern IRWMP (Provost & Pritchard, 2020), include the following:

- Groundwater overdraft;
- Watershed protection;
- Aging and/or duplicative infrastructure;
- Urban growth and water demand (South Mountains);
- Climate change; and
- Water quality/groundwater contamination.

5.2.2. Operational Flexibility Limitations

The existing water resources monitoring programs and infrastructure are not expected to limit operational flexibility in the Basin. In fact, the TRC monitoring well network will be integral to the

[8] Navstar is a network of U.S. satellites that provide GPS services.

on-going monitoring and reporting that will be conducted pursuant to this GSP (see Section *16 Description of Monitoring Network*).

The IRWMP and GSP development are complimentary management processes. To the extent that the issues identified for the greater IRWMP region affect the Basin, these issues will be discussed in the following sections of this GSP. The implementation of this GSP will contribute to the sustainable use of water supplies within the IRWMP region and the IRWMP is therefore not expected to limit operational flexibility in the Basin.

5.2.3. Conjunctive Use Programs

There are no formal conjunctive use programs within the Basin.

5.3. Land Use Elements or Topic Categories of Applicable General Plans

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:

(f) A plain language description of the land use elements or topic categories of applicable general plans that includes the following:

(1) A summary of general plans and other land use plans governing the basin.

(2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.

(3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.

(4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.

(5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.

5.3.1. General Plans and Other Land Use Plans

Kern County General Plan

The Basin is located with the Kern County General Plan area (Kern County, 2009). The current Kern County General Plan was first adopted in 2004 and has undergone several amendments, the most recent amendment approved in 2009 (i.e., the "2009 General Plan"). The County is currently working to update its General Plan through 2040 (i.e., the "2040 General Plan"). This section identifies relevant policies in the current General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the GSP's ability to achieve sustainable groundwater use, and (3) affect implementation of the 2009 General Plan land use policies.

Figure PA-5 shows the current General Plan land use designations within the Basin. The land use designations primarily include designated Specific Plan areas and public or private recreation areas.

The Land Use, Open Space, and Conservation Element (Chapter 1) of the 2009 General Plan includes the following goals, policies, and implementation measures that are related to groundwater or land use management, and that could potentially influence the implementation of this GSP.[9] The following are direct excerpts from the 2009 Kern County General Plan:

Physical and Environmental Constrains

- **Implementation Measure C.** Cooperate with the KCWA to classify lands in the County overlying groundwater according to groundwater quantity and quality limitations.

Public Facilities and Services

- **Goal 5.** Ensure that adequate supplies of quality (appropriate for intended use) water are available to residential, industrial, and agricultural users within Kern County.
- **Goal 7.** Facilitate the provision of reliable and cost-effective utility services to residents of Kern County.
- **Policy 2.** The efficient and cost-effective delivery of public services and facilities will be promoted by designating areas for urban development which occur within or adjacent to areas with adequate public service and facility capacity.
- **Policy 2.a.** Ensure that water quality standards are met for existing users and future development

Residential

- **Goal 6.** Promote the conservation of water quantity and quality in Kern County.
- **Goal 7.** Minimize land use conflicts between residential and resource, commercial, or industrial land uses.

Industrial

- **Goal 2.** Promote the future economic strength and well-being of Kern County and its residents without detriment to its environmental quality.

Resource

[9] The 2009 General Plan goals, policies, and implementation measures were in effect at the time that components of this GSP were under development (i.e., 2018 and 2019). To the extent that these goals, policies, and implementation measures are updated as part of the 2040 General Plan, those will be incorporated and considered in future five-year GSP updates (i.e., in 2025).

- **Policy 7.** Areas designated for agricultural use, which include Class I and II and other enhanced agricultural soils with surface delivery water systems, should be protected from incompatible residential, commercial, and industrial subdivision and development activities.
- **Policy 10.** To encourage effective groundwater resource management for the long-term economic benefit of the County the following shall be considered:
  - **Policy 10.a.** Promote groundwater recharge activities in various zone districts.
  - **Policy 10.c.** Support the development of groundwater management plans.
  - **Policy 10.d.** Support the development of future sources of additional surface water and groundwater, including conjunctive use, recycled water, conservation, additional storage of surface water and groundwater and desalination.

General Provisions

- **Goal 1.** Ensure that the County can accommodate anticipated future growth and development while maintaining a safe and healthful environment and a prosperous economy by preserving valuable natural resources, guiding development away from hazardous areas, and assuring the provision of adequate public services.
- **Policy 40.** Encourage utilization of community water systems rather than the reliance on individual wells.
- **Policy 41.** Review development proposals to ensure adequate water is available to accommodate projected growth.
- **Policy 45.** New high consumptive water uses, such as lakes and golf courses, should require evidence of additional verified sources of water other than local groundwater. Other sources may include recycled stormwater or wastewater.
- **Implementation Measure U.** The Kern County Environmental Health Services Department will develop guidelines for the protection of groundwater quality which will include comprehensive well construction standards and the promotion of groundwater protection for identified degraded watersheds.

Specific and Community Plans (Specific Plans)

The General Plan identifies several Specific Plan areas, including the TMV, O'Neil Canyon, and Frazier Park/Lebec which cover the majority of the Basin (see **Figure PA-6**). Specific Plans are similar to the General Plan but include more detailed direction for a particular development:

- The Frazier Park/Lebec Specific Plan was approved in 2003 and targets the residential and commercial development of the Frazier Park/Lebec area. The plan main objectives were to enhance resident's life quality and increase the commercial and touristic appeal of the region. The plan is approaching its final stages, as the term of the Specific Plan is through the year 2020 (Kern County Planning Department, 2003).

- The O'Neil Canyon Specific Plan was approved in 1992, updating the prior Specific Plan adopted in 1978 to reflect policy changes (Kern County Department of Planning and Development Services, 1992); and
- The TMV development has an accepted Specific Plan document (2009) and is currently undergoing development. As such, only the TMV Specific Plan is described further below.

The TMV Specific Plan area covers most of the Basin to the east of I-5, excluding Castac Lake. The entire TMV area (a large part of which extends outside of the Basin) will include 5,082 acres designated to residential, commercial and recreational uses, including 160,000 square feet of commercial development adjacent to I-5, and two golf courses (Kern County Planning Department, 2009a).

The Specific Plan identifies the following planning principles and objectives outlined in its Introduction (Chapter 1) that are related to groundwater or land use management, which could potentially influence the implementation of this GSP.

- **Principal 5. Preserve key features of the natural environment**. Infrastructure and Building Areas are located to avoid existing streams, wetlands and riparian areas.
- **Principal 10. Conserve water resources.** To maximize conservation of the water supply, the water and wastewater plans will: utilize a state-of-the-art treatment plant design; incorporate provisions to require low-water use plant materials and irrigation systems; and require on-site recycling of water and solid wastes.
- **Principal 11. Protect water quality**. TMV shall implement a water quality program that will include: construction period Best Management Practices as required by the SWRCB General Permit pertaining to discharges associated with construction activities; and the design and construction of an extensive system of vegetative swales, basins, and landscape source controls as required to protect water quality standards.
- **Objective 5**. Incorporate planning, development and building practices that conserve and protect significant on-site natural resources and minimize consumption of energy and water.

Tejon Ranch Conservation & Land Use Agreement

As shown on **Figure PA-7**, 33 acres within the Basin are specified as a Future Dedicated Conservation Easement Area and are protected under the Tejon Ranch Conservation & Land Use Agreement ("Agreement"; TRC, 2008). The Agreement states in Exhibit M Paragraph 1(b)(3): "In managing Owner's future native groundwater extraction activities within the Conservation Easement Area, Owner will avoid changes to or expansion of groundwater extraction practices as of the Effective Date that would cause significant groundwater related adverse impacts to the surface Conservation Values existing as of the Effective Date. In addition, Owner shall not make any alterations or improvements to the surface of the Conservation Easement Area in connection with water storage, including storage of water in underground aquifers, except as permitted by Paragraph 1(b)(1)(G)."

5.3.2. Implementation of Existing Land Use Plans

The above goals, policies and implementation measures established by the General Plan are complementary to sustainable groundwater management of the Basin relative to future land use development and conservation (i.e., the plan encourages development of the County's groundwater supply to ensure that existing users have access to high quality water, and states that future growth should be accommodated only while ensuring that adequate high-quality water supplies are available to existing and future users). Successful implementation of this GSP will help to ensure that the Basin groundwater supply is managed in a sustainable manner. Therefore, implementation of General Plan policies is not expected to affect the Basin's ability to achieve groundwater sustainability. Given that the General Plan is being updated concurrently with the development of this GSP, and the County is engaged in the process of GSP development through its participation in the Castac Basin GSA, it is anticipated that the 2040 General Plan will consider this GSP and incorporate water supply assumptions consistent with this GSP over the 2040 planning horizon.

The above goals, policies and implementation measures established by the TMV Specific Plan are complementary to sustainable groundwater management of the Basin relative to future land use development and conservation (i.e., the plan encourages protecting the natural environment and water conservation). The TMV Specific Plan outlines changes in land use in which 710 acres within the Basin will shift from range and undeveloped lands to residential and commercial (**Figure PA-7**).

As outlined in the TMV Specific Plan and TMV Facilities Plan (NV5, 2018), if and when TMV is developed, <u>all potable water demands associated with the TMV development will be met by State Water Project (SWP) surface water imported from the California Aqueduct. Groundwater will not be pumped to meet any of the TMV development demands.</u> Non-potable water demands (e.g., irrigation to golf courses) will be met by blending SWP water and treated recycled water to the maximum extent possible, to reduce overall water demands. Therefore, the TMV development is anticipated to act as a net benefit to groundwater recharge within the Basin and implementation of TMV Specific Plan policies is not expected to negatively affect the Basin's ability to achieve groundwater sustainability.

The Tejon Ranch Conservation & Land Use Agreement specifically outlines that groundwater extractions cannot cause significant undesirable results, so it is complimentary to sustainable groundwater management, and is not expected to limit the Basin's ability to achieve groundwater sustainability.

5.3.3. Implementation of the GSP

Successful implementation of this GSP will help to ensure that the Basin groundwater supply is managed in a sustainable manner. Therefore, implementation of General Plan policies is not expected to affect the Basin's ability to achieve groundwater sustainability. In general, implementation of this GSP is not anticipated to significantly affect the County's current water supply assumptions or land use plans. However, implementation of this GSP may limit the availability of potential local groundwater sources to be used for future demands above current rates of groundwater extraction. It is anticipated that the 2040 General Plan will consider this GSP and utilize consistent water supply assumptions over the 2040 planning horizon.

Although the TMV development will result in a shift in land use and water supply assumptions, implementation of this GSP should not affect the water supply assumptions of the TMV Specific Plan, as all water demands for the development will be met by surface water imported from the California Aqueduct or local recycled water.

5.3.4. Well Permitting Process

Well permits with the Basin are issued by the Kern County Public Health Services Department Water Well Program. The Water Well Program issues permits to construct, reconstruct, and destroy water wells. All wells must be constructed in accordance with Kern County Ordinance Code, Section 14.08, and the DWR's Bulletin 74-81 and Bulletin 74-90, except as modified by subsequent revisions. The ordinance requires, among other things, that domestic and agricultural wells be installed a minimum distance from potential pollution and contaminant sources, water quality be tested for new and reconstructed wells, an NSF 61 approved flowmeter be installed, and the final well construction be inspected by County staff. It is expected that as part of GSP implementation, the Water Well Program may be more closely coordinated with Castac Basin GSA activities to support long-term sustainability within the Basin.

5.3.5. Implementation of Land Use Plans Outside the Basin

This section may include information as applicable regarding implementation of land use plans outside the Basin that could affect the ability of the GSA to achieve sustainable groundwater management, if identified by the GSA. Currently, no applicable land use plans have been identified.

5.4. Additional GSP Elements

> *§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:*
> *(g) A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.*

Per California Water Code Section 10727.4, a GSP shall include, where appropriate and in collaboration with the appropriate agencies, all of the following:

1) Control of saline water intrusion

Because the Basin is located far from coastal areas, seawater intrusion is not considered to be a threat to groundwater resources and therefore no control measures for saline water intrusion have been established.

2) Wellhead protection

The Kern County Public Health Services Department Water Well Program issues permits to construct, reconstruct and destroy water wells (see Section 5.3.4 *Well Permitting Process*).

3) Migration of contaminated groundwater

The mitigation, remediation, and management of groundwater contamination plumes is regulated by the Regional Water Quality Control Board (RWQCB), Department of Toxic Substances Control (DTSC), and the County of Kern. As discussed in Section 8.5.4 *Point-Source Contamination Sites*, 12 Leaking Underground Storage Tank (LUST) sites and one cleanup program site are contained within the Basin, but all of the sites have achieved case closure. Identified contaminants of concern at the closed LUST sites include gasoline (ten sites), motor oil (one site), and lead (one site). The cleanup program site (Mobil M-1 Crude Oil Pipeline; SL205724284) was closed as of December 2018. A land disposal site (Lebec Sanitary Landfill; L10005571106) also is located directly up-gradient from the Basin. The landfill is closed, with active monitoring ongoing.

4) Well abandonment and well destruction program

The Kern County Public Health Services Department Water Well Program issues permits to construct, reconstruct and destroy water wells (see Section 5.3.4 *Well Permitting Process*).

5) Replenishment of groundwater extractions

The groundwater system underlying the Basin is recharged from multiple natural and anthropogenic sources, including percolation of precipitation, runoff from adjacent watershed areas, return flow from excessive irrigation water, subsurface inflow from up-gradient basins, and seepage from Castac Lake when gradients are favorable (see Section 7.3.4 *Recharge and Discharge Areas*).

6) Conjunctive use and underground storage

There are no formal conjunctive use projects within the Basin.

7) Well construction policies

The Kern County Public Health Services Department Water Well Program issues permits to construct, reconstruct and destroy water wells (see Section 5.3.4 *Well Permitting Process*).

8) Groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects

There are no open groundwater contamination cleanup sites within the Basin (see Section 8.5.4 *Point-Source Contamination Sites* for closed cleanup sites); oversight of groundwater contamination cleanup in this area is provided by the RWQCB, DTSC, and County of Kern.

No active recharge, diversions to storage, water recycling and conveyance projects exist within the Basin, although planning and permitting processes are underway for the TMV development water and wastewater infrastructure. LCWD has begun the process of drilling and construction of a new groundwater supply well within the Basin.

There are no major urban water suppliers (i.e., more than 3,000 connections or supplying more than 3,000 acre-feet of water annually) within the Basin, and therefore water conservation is not mandated.

9) Efficient water management practices

Groundwater use within the Basin is primarily (85%) for public and domestic supply. Efficient institutional and domestic water-use practices will be encouraged by the GSA. Irrigated farming practices and landscape irrigation are a small part (15%) of Basin water use, but the GSA will encourage implementation of efficient irrigation and water management techniques, potentially including zonal irrigation to address soil types, quantitative soil moisture monitoring, Geographic Information System (GIS) data management and analysis, and/or other methods.

10) Relationships with State and federal regulatory agencies

TCWD has a direct relationship with DWR related to the Beartrap turnout off of the State Water Project (SWP) system and via the purchase, use and transfer of SWP water.

11) Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity

Applicable land use planning documents and processes are discussed in Section 5.3 *Land Use Elements or Topic Categories of Applicable General Plans*.

12) Impacts on Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) have been identified within the Basin. An assessment of GDE presence is provided in Section 8.8 *Groundwater Dependent Ecosystems (GDEs)*.

5.5. Notice and Communication

§ 354.10. Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:

(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.

(b) A list of public meetings at which the Plan was discussed or considered by the Agency.

(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

(d) A communication section of the Plan that includes the following:

(1) An explanation of the Agency's decision-making process.

(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.

(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.

(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

The GSA adopted its Stakeholder Communication and Engagement Plan (SCEP) in October 2018 to fulfil notice and communication requirements. The SCEP is available on the GSA's website (https://www.castacgsa.org/) and is included herein as *Appendix C*.

5.5.1. Beneficial Uses and Users of Groundwater

Per 23-California Code of Regulations (CCR) §354.10(a), beneficial uses and users of groundwater shall include land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.

As part of the SCEP, beneficial uses and users of groundwater in the Basin were identified (see SCEP Section 3) including agricultural users, domestic well owners, commercial and industrial users, municipal well operators, public water systems, Kern County, groundwater dependent ecosystems and interconnected surface water users, and disadvantaged communities. Additionally, a Stakeholder Constituency "Lay of the Land" exercise was developed which identified Basin stakeholders, key interests and issues, and the level of engagement expected with each stakeholder (see SCEP Table 1). This information will be updated during select phases of GSP development and/or implementation.

5.5.2. Public Meetings Summary

The list below identifies public meetings, workshops, and direct outreach specific to GSP development. Detailed meeting minutes and materials are available on the GSA's website (https://www.castacgsa.org/).

GSA Board Meetings

Castac Basin GSA Board meetings are open to the public and regular meetings were previously held quarterly at 6:00 pm on the 1st Tuesday of the month at the LCWD office (323 Frazier Mountain Park Road, Lebec, CA 93243). The COVID-19 pandemic has interfered with some GSA Board activities, but following June 2020, Board meetings will be held on a regular quarterly schedule which will be posted on the GSA website when finalized. The list below provides a complete history of Castac Basin GSA Board meetings to date:

- 4 September 2018
- 10 October 2018
- 4 June 2019
- 3 September 2019
- 15 November 2019
- 6 March 2020
- 22 June 2020
- 8 September 2020

The list above will be updated throughout GSP development and/or implementation.

Stakeholder Workshops

In order to inform the public on the GSP development, the following public workshops were held at the Lebec Community Church (2350 Lebec Road, Lebec, CA 93243):

- 16 July 2019
- 15 November 2019
- 26 May 2020

This list will be populated throughout GSP development and/or implementation.

5.5.3. Public Comments on the GSP

As described in the above sections and in the remainder of this section, the Castac Basin GSA has conducted stakeholder engagement throughout the GSP development process. During this time, input and feedback from the public has been encouraged. **Table PA-2** below summarizes key public comments and input received and how that input was incorporated into the GSP. In some cases, more detailed responses can be found in Appendix *D*.

Table PA-2. Public Comments and Input Received During GSP Development

Source	Date	Type of Input	How Input was Incorporated
Stakeholder Surveys	January and February 2019	Written: • "My only concern would be that those corporations, organizations, water purveyors, water customers, and owners within the district be treated equitably with favor shown to no one particular interest over another." • "Overdevelopment in the mountain communities, with such a limited water resource." • "Running out of clean water" • "Conservation/sustainability"	The GSP addresses future developments by incorporating land use changes in the projected water budget scenarios. The results indicate that planned future development that relies on imported surface water brings a net benefit to the Basin. The GSP sets a sustainability goal for the Basin, which outlines that the GSA aims to cooperatively manage groundwater sustainably to support current and future beneficial uses of groundwater.
Stakeholder Workshop #1	7/16/2019	Verbal comment: "Trillions of gallons of groundwater are being pumped"	The historical water budget quantifies the historical pumping volumes based on well counter readings or estimates from power records for the main production wells in the Basin.

The Castac Basin GSA welcome further comments during GSP implementation. In addition to **Table PA-2** above, a detailed list of public comments received and the GSA response can be found in *Appendix D*.

5.5.4. <u>Communication</u>

The SCEP outlines the GSA's communication goals.

<u>Decision-making process</u>

The SCEP Section 2.2 outlines the Castac Basin GSA's decision-making process. Key GSP development and implementation decisions are made by the Castac Basin GSA's Board of Directors.

<u>Public engagement opportunities</u>

The SCEP Section 6 discusses public engagement opportunities and the SCEP Sections 5 and 6 discuss how public input and responses will be handled. These opportunities include Castac Basin GSA Board meetings, stakeholder workshops, the planned public hearing at which the Draft GSP will be available for public comments, and the Stakeholder Survey and Landowner Data Request Form.

Stakeholder Involvement

The SCEP Section 5 outlines the GSA's goals, including open and transparent engagement with diverse stakeholders. Additionally, the SCEP Section 4 describes the Stakeholder Survey and Landowner Data Request in which the GSA used to gain additional knowledge on Basin stakeholders. Surveys were sent to approximately 200 stakeholders within the Basin via direct mail and additionally the Survey is posted on the GSA's website and available in hard-copy form at all GSA Board meetings. Results from the seven Stakeholder Survey responses received indicate that:

- Most stakeholders who responded obtain their water supply from KMWC;
- Primary interests in water resource management are water conservation, sustainability and utilization of gray water;
- Most stakeholders are concerned about overdevelopment in the mountain communities with such limited water resources; and
- Some stakeholders are not familiar with SGMA.

As a result of the Stakeholder Survey and Data Request, two Basin stakeholders provided data on their wells to the Castac Basin GSA for consideration and inclusion in the GSP. Data included well location, well construction information, one water level measurement and one set of water quality data. These data were added to the Data Management System (DMS) for the Basin and considered during assessment of groundwater conditions.

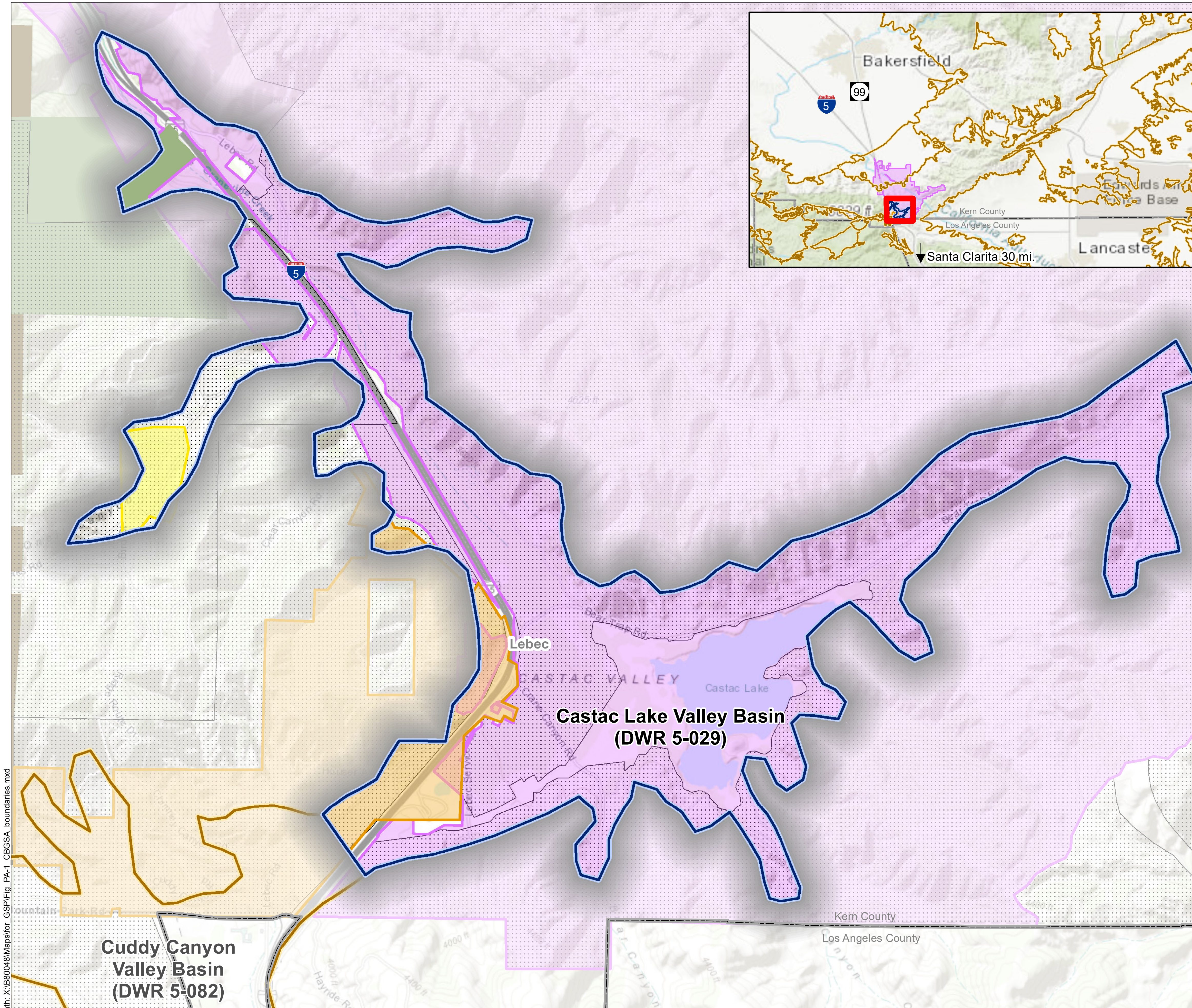
Data Requests were also sent to 15 public water supply systems located within the Basin and in upgradient basins. Four public water supply systems (TCWD, KMWC, Lake of the Woods Mutual Water Company, and LCWD) provided data on their wells. Data included well location, well construction information, water level data, water quality data, and pumpage data. These data were added to the DMS for the Basin and considered during assessment of groundwater conditions, development of the historical water budget, and development of Sustainable Management Criteria (SMCs).

Public Notification

The SCEP Sections 5 and 6 detail the methodology that is being followed to inform the public on GSP updates, status, and actions, which includes making key GSP development decisions in an open and transparent fashion during public GSA Board meetings and holding periodic stakeholder workshops to communicate progress on GSP technical components to stakeholders, and to receive input on upcoming decisions and work efforts. The GSA will publicize all Board meetings and stakeholder workshops on its website (https://www.castacgsa.org) and will provide notice to the GSA list of interested parties. The GSA also will coordinate with individual GSA member bodies (TCWD, LCWD, and County) to distribute additional emails and postal mailings, as deemed necessary and appropriate.

Public Comment

Additional public comments received on the draft GSP will be listed in *Appendix D*, which will be updated and incorporated throughout the GSP drafting and development process.



Legend

- Castac Lake Valley Groundwater Basin and Castac Basin GSA Boundary
- Other Groundwater Basin
- Tejon-Castac Water District
- Lebec County Water District
- Krista Mutual Water Company
- Federal Lands
- State Lands
- Specific Plan Area
- County Boundary

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
LCWD = Lebec County Water District
TCWD = Tejon-Castac Water District

Notes

1. All locations are approximate.
2. Castac Basin GSA boundary is coterminous with the Castac Lake Valley Groundwater Basin (5-029) boundary.
3. The entire displayed area within Kern County is covered by the Kern County General Plan.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. LCWD service area obtained from LCWD on 16 March 2017.
4. TCWD service area obtained from TCWD on 11 May 2017.
5. Federal and State Lands from California Protected Areas Database (CPAD) August 2017. www.calands.org
6. Kern County General Plan information obtained on 16 August 2018 from http://esps.kerndsa.com/gis/gis-download-data

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(Scale in Miles)

Castac Lake Valley Groundwater Basin Plan Area and Relevant Boundaries

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Kern County, California
September 2020
B80048.00

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Figure PA-1

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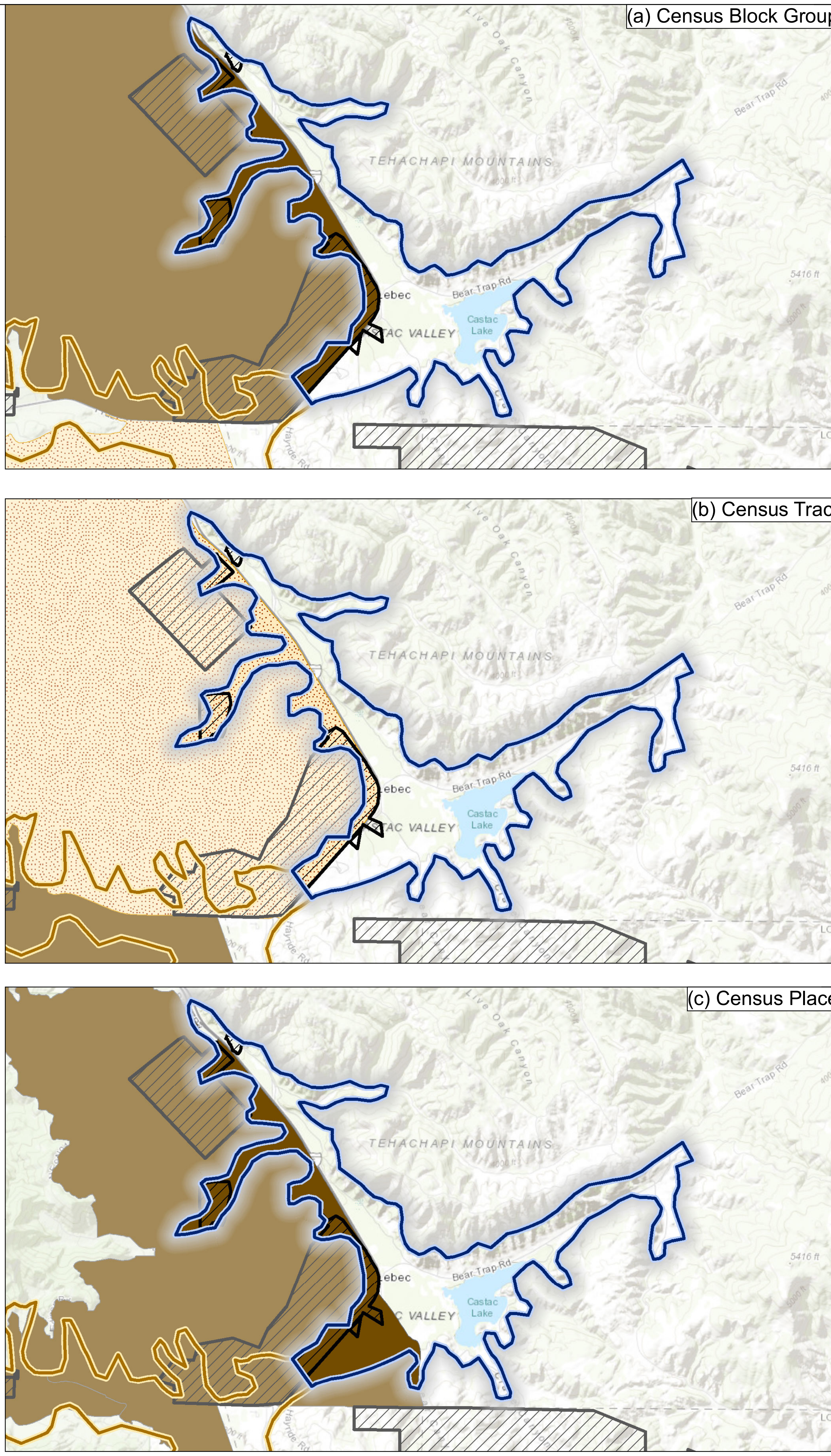

Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Public Water System Service Area

Disadvantaged Communities

- Severely Disadvantaged Communities
- Disadvantaged Communities

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Not all public water system service areas are mapped.
3. Disadvantaged communities defined based on 2016 median household income.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Disadvantaged Communities information downloaded on 4 October 2018 from the SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer. Last updated 2016.
4. Public Water System Service area boundaries are from the California Department of Public Health Drinking Water Systems Geographic Reporting Tool. (https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/water_supplier.shtml)

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(Scale in Miles)

Disadvantaged and Severely Disadvantaged Communities

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Figure PA-2

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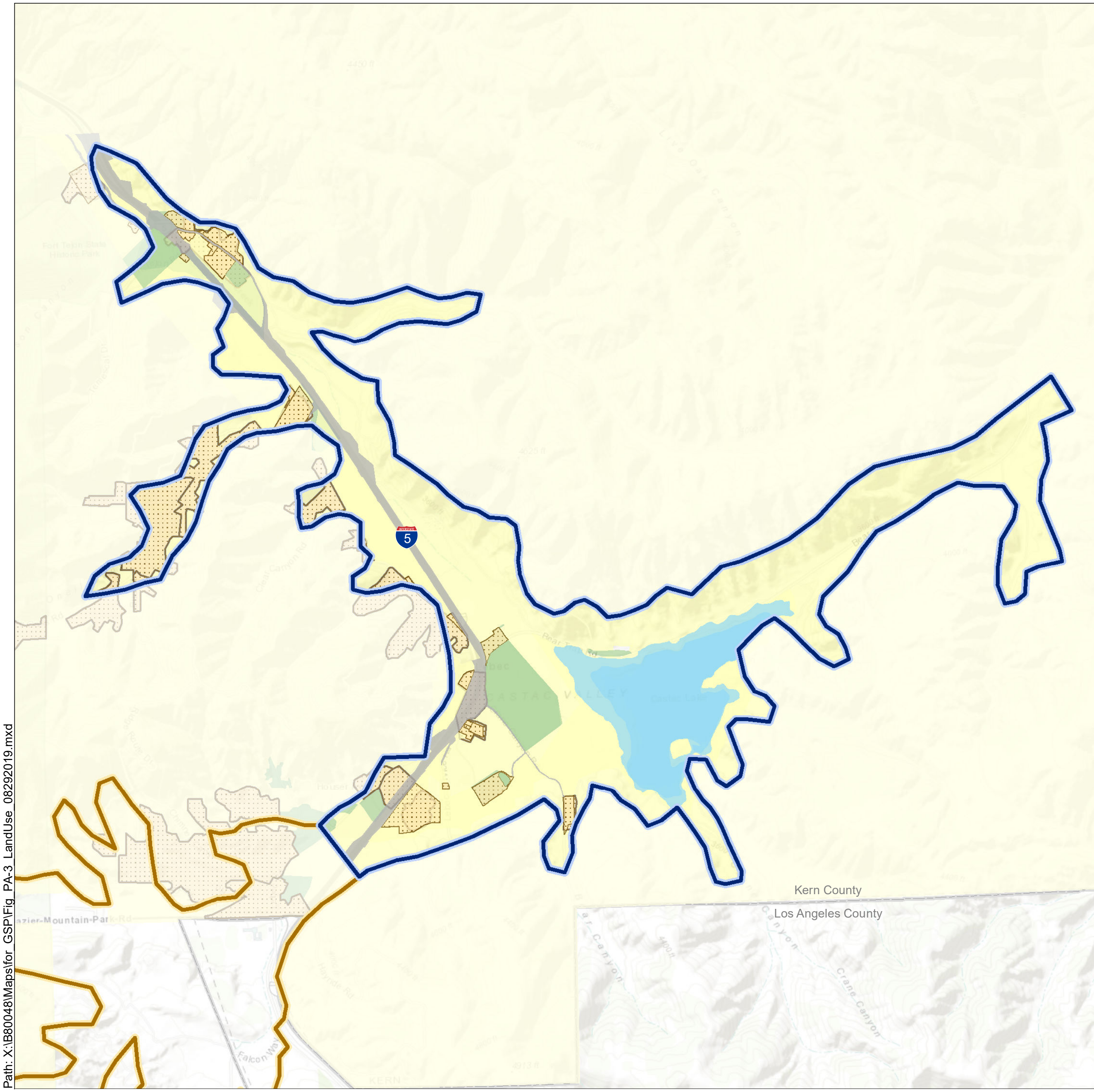

Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin

Current (2016) Land Use

- Roads
- Irrigated Land
- Residential & Commercial
- Lake
- Range/ Undeveloped Land

Abbreviations

DWR = California Department of Water Resources
TCWD = Tejon-Castac Water District

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Current Land Use data from TCWD 31 May 2019 and California Department of Conservation Important Farmland, Kern County 2016.

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Current (2016) Land Use

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Figure PA-3

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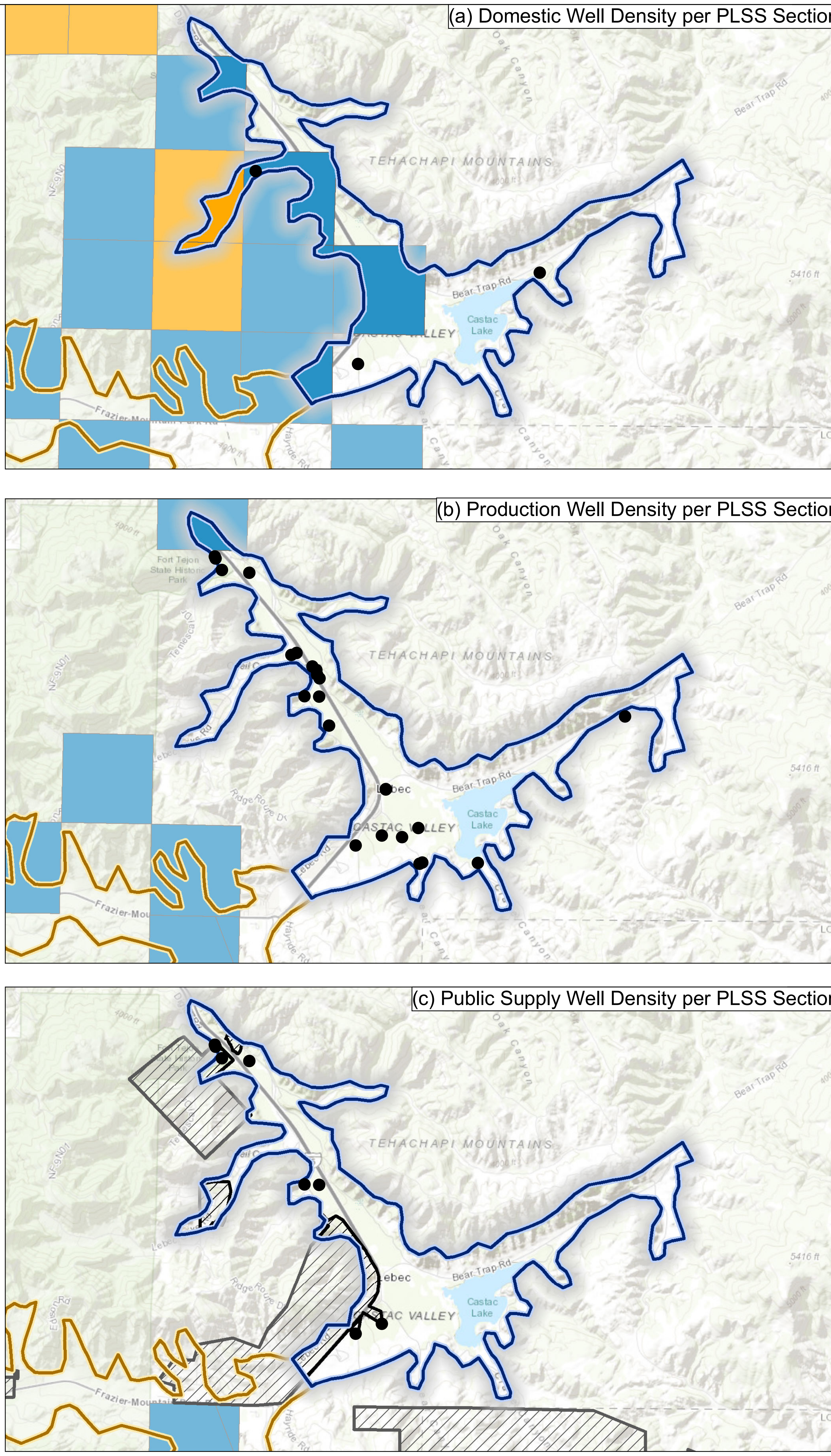

Legend

- Well
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin

Well Density per PLSS Section

- 1 - 2
- 2 - 3
- 3 - 4
- > 4

Public Water System Service Area

Abbreviations
DWR = California Department of Water Resources
PLSS = Public Land Survey System

Notes
1. All locations are approximate.
2. Not all public water system service areas are mapped.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Well count per square mile (PLSS section) from DWR's Well Completion Report Map Application, obtained on 23 October 2018 (https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37).
4. Public Water System Service area boundaries are from the California Department of Public Health Drinking Water Systems Geographic Reporting Tool. (https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/water_supplier.shtml)

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Well Density from DWR Well Completion Reports and Basin Wells

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Kern County, California
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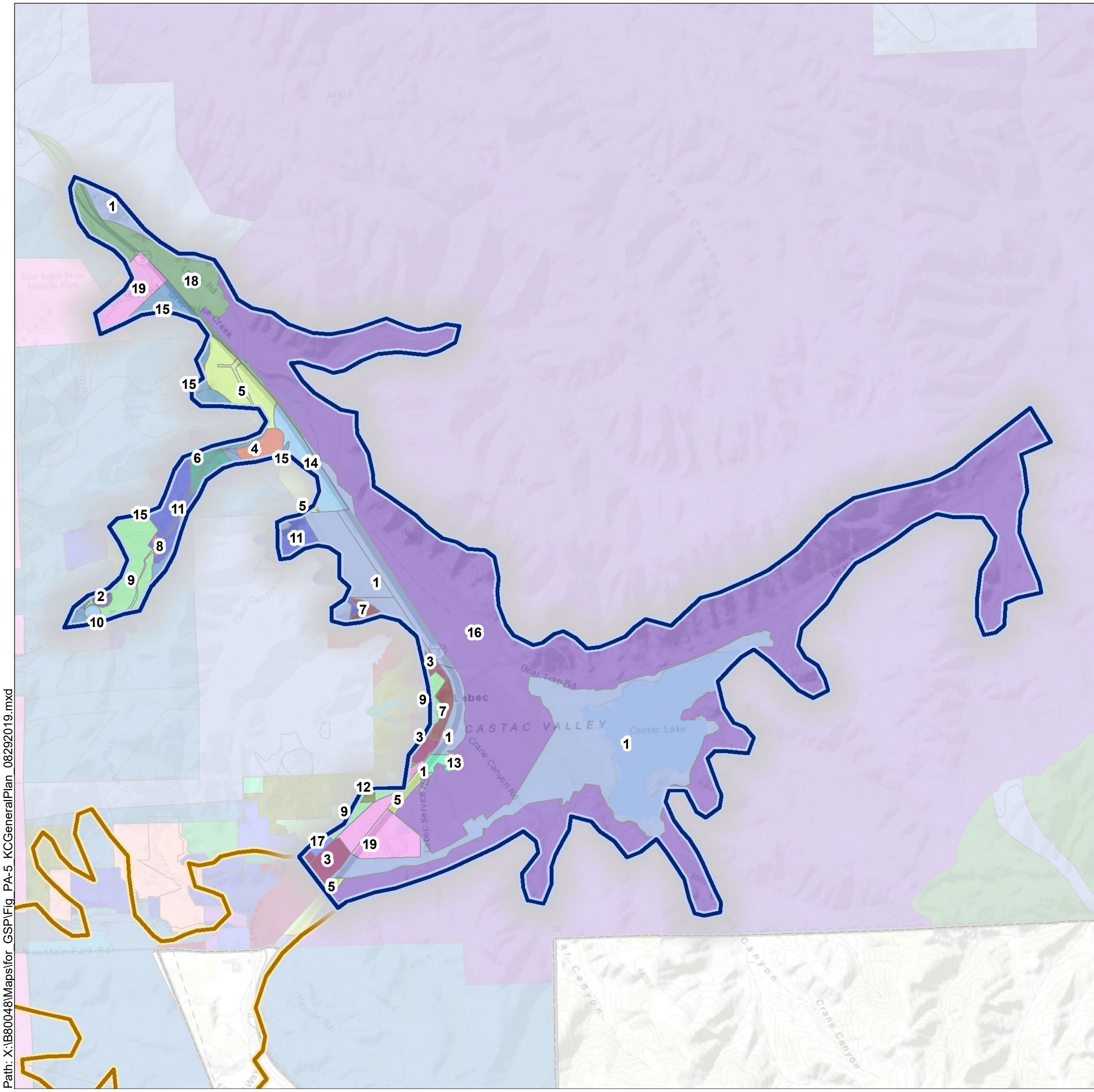
Figure PA-4

Path: X:\B80048\Maps\for_GSP\Fig_PA-4_WellDensity_DWR.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Kern County General Plan Land Use Designation

- 1 Extensive Agriculture (Min. 20 Acre Parcel Size)
- 2 Educational Facilities
- 3 General Commercial
- 4 Heavy Industrial
- 5 Highway Commercial
- 6 Maximum 1 Unit/Net Acre
- 7 Maximum 10 Units/Net Acre
- 8 Maximum 2 Units/Net Acre
- 9 Maximum 4 Units/Net Acre
- 10 Minimum 10 Gross Acres/Unit
- 11 Minimum 2.5 Gross Acres/Unit
- 12 Minimum 20 Gross Acres/Unit
- 13 Other Facilities
- 14 Public or Private Recreation Areas
- 15 Resource Management (Min. 20 Acre Parcel Size)
- 16 TMV Specific Plan Area
- 17 Service Industrial
- 18 Specific Plan Required
- 19 State or Federal Land

Abbreviations

DWR = California Department of Water Resources
TMV = Tejon Mountain Village

Notes

1. All locations are approximate.
2. Specific Plan areas shown on Figure PA-5.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Kern County General Plan information obtained on 16 August 2018 from http://esps.kerndsa.com/gis/gis-download-data

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Kern County General Plan - Land Use Designation

Tejon-Castac Water District
Kern County, California
September 2020
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Figure PA-5

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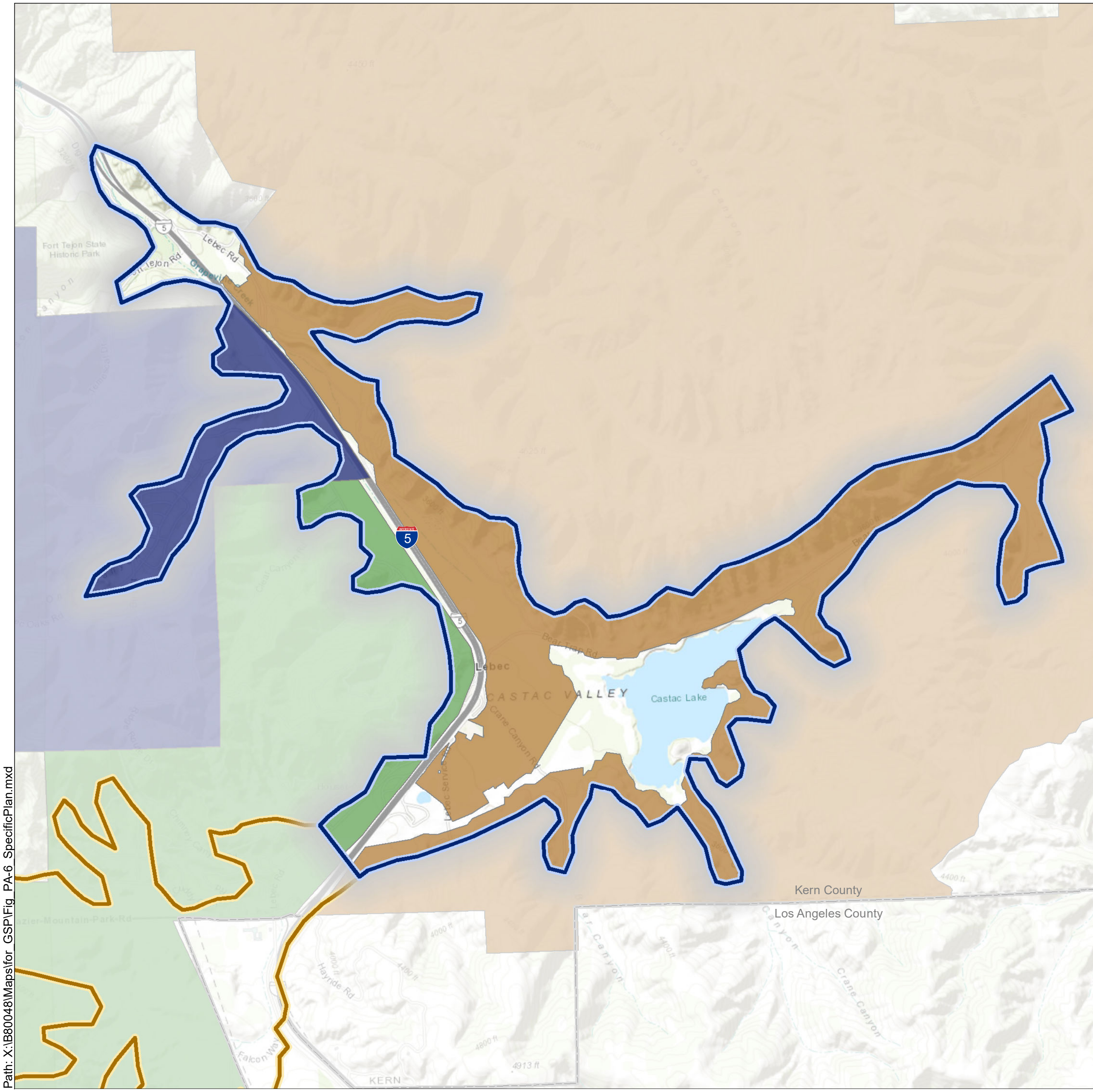

Legend

Castac Lake Valley Groundwater Basin

Other Groundwater Basin

County Boundary

Specific Plan Area

Frazier Park/Lebec

O'Neil Canyon

Tejon Mountain Village

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Kern County General Plan information obtained on 16 August 2018 from http://esps.kerndsa.com/gis/gis-download-data

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Kern County General Plan - Specific Plan Areas

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Kern County, California
September 2020
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Figure PA-6

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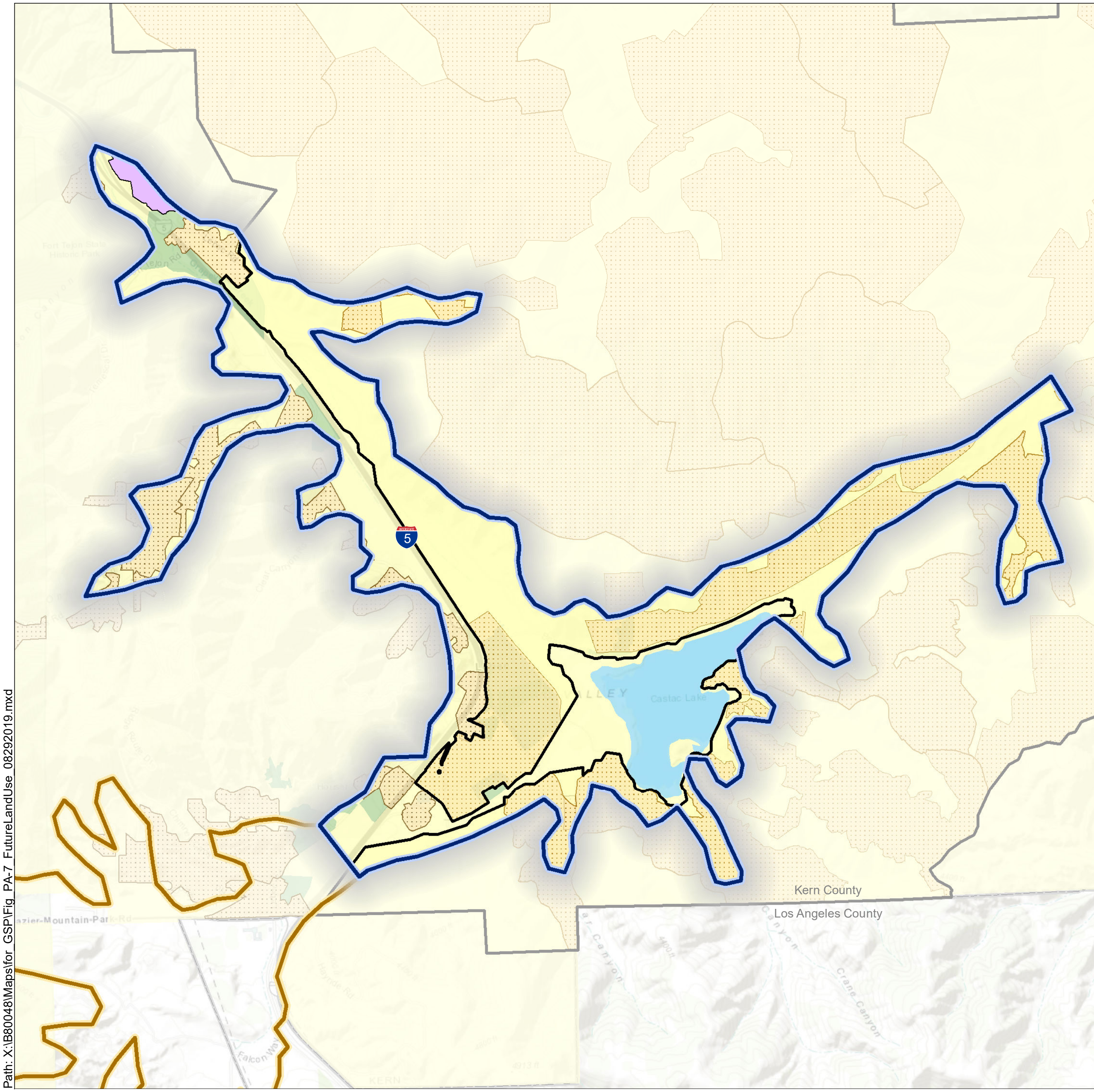

Projected Future Land Use

Tejon-Castac Water District
Kern County, California
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Figure PA-7

BASIN SETTING

6. INTRODUCTION TO BASIN SETTING

> *§ 354.12. Introduction to Basin Setting*
> *This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.*

This section presents Basin Setting information for the Basin (**Figure HCM-1**). In some cases, Basin Setting information for areas proximal to, but outside of, the Basin is provided for context. Basin Setting information includes the Hydrogeologic Conceptual Model (HCM), Groundwater Conditions, and Water Budget.

7. HYDROGEOLOGIC CONCEPTUAL MODEL

§ 354.14. Hydrogeologic Conceptual Model
(d) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

This section presents the HCM for the Basin. As described in the HCM Best Management Practices (BMP) document (California Department of Water Resources [DWR], 2016a), an HCM provides, through descriptive and graphical means, and understanding of the physical characteristics of an area that affect the occurrence and movement of groundwater, including geology, hydrology, land use, aquifers and aquitards, and water quality. This HCM serves as a foundation for subsequent Basin Setting analysis including water budgets (Section 9) and analytical models, monitoring network development (Section 16), and the development of sustainable management criteria (Sections 11 through 15).

7.1. General Description

§ 354.14. Hydrogeologic Conceptual Model
(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:
- *(1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.*
- *(2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.*
- *(3) The definable bottom of the basin.*
- *(4) Principal aquifers and aquitards, including the following information:*
  - *(A) Formation names, if defined.*
  - *(B) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.*
  - *(C) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.*
  - *(D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.*
  - *(E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.*
- *(5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model*

7.1.1. Geological and Structural Setting

The Basin lies within the Tehachapi and San Emigdio Mountains, in a region of faulted, deformed, and uplifted igneous and metamorphic rocks (**Figure HCM-1**). The mountains are part of an abrupt east-west trending range that is bisected by narrow, steep-sided linear valleys. This unusual geomorphic terrain is controlled by the presence of two very large strike-slip faults and their associated fault zones, the San Andreas Fault and the Garlock Fault, which intersect approximately 3.5 miles west of the western Basin boundary (Dibblee and Minch, 2006; Vedder and Wallace, 1970). Tectonic stresses induced by these major faults have produced much of the current landscape and have controlled, in large part, the structure and lithology of the local bedrock and the stratigraphy and lithology of alluvium within the local groundwater basins. The Basin contains a total aerial extent of 3,563 acres, and includes two linear valleys together shaped vaguely like an inverted "T". The primary axis of the Basin follows the local northeast-southwest trace of the Garlock Fault, and the Grapevine Canyon area of the Basin extends northwest at a high angle to the primary axis (**Figure HCM-1**).

The Basin can be divided generally into three areas: the Castac Lake area, the Dryfield Canyon area, and the Grapevine Canyon area (**Figure HCM-1**). The Castac Lake area of the Basin is structurally controlled, as it is bounded on the north and south by the extent of the Garlock Fault Zone, on the west by the Cuddy Canyon Basin, and on the east by the alluvial fill of Dryfield Canyon. The Grapevine Canyon area of the Basin is bounded by the extent of alluvial fill on all sides but the south (i.e., the portion which abuts the Castac Lake portion of the Basin). The Dryfield canyon area of the Basin is bounded by the extent of alluvial fill, except where it intersects the Castac Lake area.

Over geologic time, the movement of huge blocks of bedrock along the San Andreas Fault and to a lesser extent the Garlock Fault has provided a variety of local rock types for weathering and deposition into the Basin. Erosion has filled the Basin with several hundred feet of alluvial materials. Fault movement has redistributed the alluvial basin fill to varying degrees. Local bedrock may provide most of the material for alluvial fill within Grapevine Canyon, although alluvium from the upgradient basins has also been transported into the Basin and then into Grapevine Canyon.

7.1.2. Lateral Basin Boundaries

Various igneous and metamorphic bedrock units bound the Basin on all sides and at its base, as drawn in geologic maps produced by the California Geologic Survey (CGS) (Olson, 2014; Swanson and Olson, 2016; Olson and Swanson, 2017). These include Cretaceous age granite, granodiorite, and quartz diorite orthogneiss, with some schist and marble, See Section 7.3 *Physical Characteristics* below for additional discussion.

The Basin is located adjacent to, and immediately downgradient of, the Cuddy Canyon basin. The Cuddy Canyon basin is in turn downgradient of the Cuddy Ranch Area Groundwater Basin (DWR Basin No. 5-84) and the Cuddy Valley Groundwater Basin (DWR Basin No. 5-83). The location of these groundwater basins relative to the Basin and each other is shown on **Figure HCM-2**. These basins were formed by the same geological and tectonic processes that formed the Basin. The three upgradient groundwater basins and their associated watersheds are potential sources for water inflows to the Basin.

7.1.3. Bottom of the Basin

As described below, multiple sources of information can be relied on to define the "bottom of the basin" for purposes of the Sustainable Groundwater Management Act (SGMA), including elevation maps of the basement bedrock surface, information on the base of fresh water, the presence, location and depth of oil and gas fields, "exempted" aquifers under the Safe Drinking Water Act (SDWA), and depth of groundwater extraction. Each of these is discussed below and a summary comparison for depth information relevant to the bottom of the Basin definition is included in **Table HCM-1**.

Table HCM-1. Information Relevant to Definition of the Bottom of the Basin

Type of Information	Source(s)	Bottom of the Basin
		Depth Range (ft bgs)
Depth to Bedrock Basement	Well logs within Castac Basin DMS	95 to 355
Deepest Groundwater Extractions from Well Construction Information	Pumping well logs within Castac Basin DMS	166 to 400

Abbreviations:
DMS = data management system
ft bgs = feet below ground surface

Depth to Basement Bedrock

Available hydrogeologic information indicates that bedrock within the Basin is generally of very low permeability and therefore forms the bottom of the basin. In general, the Basin is mostly underlain by igneous granitic or granodioritic bedrock of Cretaceous age (Olson, 2014; Swanson and Olson, 2016; Olson and Swanson, 2017).

Figure HCM-3 displays depth to bedrock based on encountered bedrock depths in boreholes for several wells in the Basin. The total depth of alluvium in the basin is estimated to vary from approximately 95 feet below ground surface (ft bgs) near the southern margin of the Basin, to approximately 350 ft bgs near the center axis of the Basin. Boreholes drilled in the Grapevine Canyon area of the Basin generally encountered granitic bedrock at depths ranging from 280 to 300 ft bgs. The exception is a borehole drilled at the head of Grapevine Canyon at the boundary between the Castac Lake and Grapevine Canyon areas of the Basin, in which weathered bedrock was encountered at approximately 200 ft bgs.

Additionally, seismic reflection data infer a general bedrock depth of approximately 360 ft bgs in the central part of the Cuddy Creek alluvial fan deposits (Engeo, 2008).

Base of Fresh Water

In some deeper basins, it can be more appropriate to consider geochemical properties (i.e. water quality) in determining the definable bottom of the Basin (DWR, 2016a), specifically where water becomes unsuitable for consumption or irrigation, as defined by total dissolved solids (TDS) concentrations exceeding 3,000 milligrams per liter (mg/L).[10] Castac Basin, however, is relatively shallow and cannot easily be defined in terms of water quality. Samples collected from wells throughout the Basin indicate that the concentrations of TDS in groundwater are around 615 mg/L and range from 258 to 1,800 mg/L. Therefore, wells with available water quality all are screened within fresh water.

Oil and Gas Fields

No oil or gas fields have been mapped within the Basin, based on available published data (California Department of Conservation Division of Oil, Gas, and Geothermal Resources [DOGGR], 2019).

Exempted Aquifers

Under the SDWA, the United States Environmental Protection Agency (USEPA, and through a primacy agreement, the State Water Resources Control Board [SWRCB]) regulates injections into underground sources of drinking water. One such type of injections, known as Class II injections, involve either enhanced oil recovery or for disposal of fluids associated with oil and gas production. In general, Class II injections are prohibited under the SDWA, except in "exempted aquifers." The DOGGR and SWRCB consider proposals for aquifer exemptions on a case by case basis. No existing or proposed exempted aquifers have been designated within the Basin.[11]

Deepest Groundwater Extractions

The DWR BMP guidance for HCMs (DWR, 2016a) states that "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions." As shown on **Figure HCM-4**, construction information is available for 15 existing pumping wells (i.e., well depth, screen interval, and/or borehole depth), and all wells have depths of 400 ft bgs or less[12].

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[10] The United States Environmental Protection Agency (US EPA) defines water with a TDS concentration of less than 3,000 mg/L to be suitable for livestock consumption or crop irrigation. Water between 3,000 mg/L and 10,000 mg/L is defined as "usable quality water" and water exceeding 10,000 mg/L is defined as "brine." The United States Geological Survey (USGS) commonly refers to water with a TDS concentration of less than 1,000 mg/L as freshwater. A recent USGS report (Osborn et al., 2013) completed as part of the Brackish Groundwater Assessment defined saline groundwater as follows: "slightly saline" groundwater containing a TDS concentration between 1,000 and 3,000 mg/L; "moderately saline" groundwater containing a TDS concentration between 3,000 and 10,000 mg/L; "very saline" groundwater containing a TDS concentration between 10,000 and 35,000 mg/L; and "brine" containing a TDS concentration exceeding 35,000 mg/L.

[11] https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=426ef9d346f9487e96ee5899ab67a2e4

[12] One well, which has since been abandoned, had a depth of 562 ft bgs.

Given the above information, the controlling factor for the definable "bottom of the basin" is determined to be the depth to basement bedrock. Therefore, for the purposes of this GSP, the bottom of the basin is defined to be approximately 400 ft bgs in the Castac Lake area of the Basin.

7.1.4. Principal Aquifers and Aquitards

Principal aquifers are defined in the GSP Emergency Regulations (23-California Code of Regulations [CCR] §351) as "aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems" (23-CCR §351(aa)). Unconsolidated clastic sediments, including interbeds of sands and gravels with varying amounts of silts and clays, have filled the Basin over time. The Basin generally contains one Principal Aquifer, which can be vertically divided into two hydrostratigraphic "zones," each with a variable, but distinct, set of geologic and hydraulic properties.

Based on water level data, results of aquifer pumping tests, and water quality data, it appears that the Deep and Shallow Aquifer zones within the Basin are somewhat hydraulically connected. Water-level measurements from wells screened in the Deep Aquifer Zone indicate that it is semi-confined and historically under artesian pressure, with heads seasonally above ground surface in some wells during wet years. During aquifer pumping tests conducted in Deep Aquifer Zone wells within both the Castac Lake and Grapevine Canyon areas of the Basin, slight drawdowns were observed in Shallow Aquifer Zone wells (EKI, 2008b). The data suggest that connectivity to the Deep Aquifer Zone increases with depth within the Shallow Aquifer Zone (EKI, 2008b), which is attributed to the effect of interbedded sedimentary sequences of relatively finer and coarser materials within the shallow subsurface.

Formation Names and Occurrence

The **Shallow Aquifer Zone** coincides generally with Holocene sediments of the upper portion of a fine-grained alluvial unit generally located within the upper 100 ft bgs. This fine-grained alluvium consists of granitic-dominated alluvial sands with locally-extensive clays and minor gravels, locally coarsens downward, and extends from near the surface to as deep as 160 ft bgs (EKI, 2008e). Other, less-common shallow stratigraphic units include a shallow interbedded alluvial unit encountered only in two boreholes adjacent to the current Cuddy Creek channel, which is attributed to recent Cuddy Creek mixed alluvium (interbedded sands and gravels with variable clay content, clayey interbeds, and moderate to weak pervasive iron-oxide staining), and the fine-grained clayey-sand alluvium (interbedded granitic-dominated medium clayey sands, clays, and sand-clay interbeds with minor gravels, coarsening below 65 ft bgs), which was encountered only in upper Grapevine Canyon (EKI, 2008e).

The **Deep Aquifer Zone** is generally made up of the lower fine-grained alluvium, the medium-grained alluvium, and, where present, the coarse-grained alluvium and the very coarse-grained alluvium, terminating at the weathered bedrock contact generally located below 100 ft bgs. The medium-grained alluvium consists of interbedded sands and gravels of variable composition, with rare clay interbeds, and extends from as little as 50 ft bgs to as much as 400 ft bgs (EKI, 2008e). The coarse-grained alluvium consists mostly of gravels and sands of mixed igneous and metamorphic lithology, with rare interbeds of iron oxide-stained clay and silt and is encountered at depths between 200 to 270 ft bgs in two boreholes in the Basin (EKI, 2008e). The very coarse-grained alluvium consists of a coarse clastic basal sequence of gravel, cobbles, and local zones of boulders, comprised of mixed igneous and metamorphic rocks and is encountered in only one borehole within Basin, located near the axis of the Cuddy Creek alluvial fan west of Castac Lake (EKI, 2008e).

Physical Properties of Aquifer(s) and Aquitard(s)

Table HCM-2 provides estimates of the water storage and transmitting properties based on hydraulic testing of multiple deep and shallow-aquifer wells (EKI, 2008b).

Table HCM-2. Water Storage and Transmitting Properties

Aquifer	Zone	Approximate Depth (ft bgs)	Transmissivity (ft^2/d)	Hydraulic Conductivity (ft/d)	Storage Coefficient (unitless)
Principal	Shallow	0-100	430	10	0.0025
	Deep	100-400	3,100 – 12,000	18 – 86	$6x10^{-4} – 3.5x10^{-3}$
n/a	Bedrock	>400	4.3	0.014	n/a

Abbreviations:
ft/d = feet per day
ft^2/d = feet squared per day
ft bgs = feet below ground surface
n/a = not applicable

Structural Properties of the Basin that Restrict Groundwater Flow Within the Principal Aquifers

Based on the geomorphology of the Basin, the Castac Lake area of the Basin appears to be a sag feature related to bounding splays of the Garlock Fault on its northern and southern sides (Clark, 1973; DWR, 2003). The surface expression of the Garlock Fault in the Basin is obscure and discontinuous (**Figure HCM-1** and **Figure HCM-2**) and may indicate that (1) movement locally along the westerly portion of Garlock Fault is relatively minor and old relative to the more active, eastern portions of the Garlock Fault or that (2) the movement is highly distributed amongst numerous subparallel shear planes (Clark, 1973). ECI (2006) conducted a subsurface investigation using Cone Penetration Testing in the Castac Lake area of the Basin and interpreted fault vertical offsets of approximately 1 to 10 feet in shallow alluvial beds. ECI (2006) attributed the apparent vertical offset in the shallow alluvial beds to various splays of the Garlock Fault within the alluvium west of Castac Lake, and noted that this apparent, recent vertical movement actually may represent the vertical component of oblique or other complex fault movement.

Significantly steepened water level gradients observed in the vicinity of the intersection of the San Andreas and Garlock Fault (i.e., just east of Frazier Park) indicate that restrictions to groundwater flow may exist in this region. Complex geologic movement within fault zones such as the San Andreas and Garlock Fault can offset and deform alluvial beds and can create clay-rich gouge zones of increased weathering, either of which could impede groundwater flow within the affected aquifer area. However, the actual effects, if any, on aquifer hydrogeologic properties at the fault intersection and associated splays of the San Andreas and Garlock Faults are currently unknown (DWR, 2003). Further upgradient (i.e., west of the fault intersection), the degree of subsurface hydraulic connection between the Cuddy Canyon, Cuddy Valley, and Cuddy Ranch groundwater basins is also not well understood and may be limited by the presence of complex splays of the San Andreas Fault (DWR, 2003; Bookman and Edmonston, 1965; Barto, 1985).

Seismic reflection and resistivity profiling may indicate the presence of additional unmapped splays of the Garlock Fault or other related faults (Engeo, 2008). On a seismic profile constructed subparallel to the Garlock Fault, a set of three opposing faults were interpreted with uncertain strike orientation which apparently dip steeply toward the center of the Cuddy Creek alluvial fan, forming a graben-like feature with an apparent vertical movement of approximately 50 feet (Engeo, 2008; Norcal, 2007). On two seismic profiles constructed approximately perpendicular to the Garlock Fault, a different set of three, closely-spaced steeply-dipping to vertical faults or joints that may be traceable across the two seismic profiles were interpreted, indicating a possible north-northeast strike, subparallel to Grapevine Canyon on its eastern side (Engeo, 2008; Norcal, 2007). Displacement on this set of interpreted fault structures is not readily discernable from the seismic data, though they appear to be subparallel and along-strike of “inactive” faults mapped by ECI (2006) in Crane Canyon and Hamilton Canyon, on the south side of the Basin.

Aquifer pumping test results (EKI, 2008b) indicate that there is no substantial barrier to flow from the Castac Lake area of the Basin into Grapevine Canyon across the observed bedrock high (i.e., the observed bedrock high appears not to be high enough to impede flow, and no fault-related barriers appear to exist).

During hydraulic testing, drawdown was measured in observation wells in response to pumping in wells located across unmapped, but probable Garlock Fault splays (EKI, 2008b). The observed results suggest that the splays of the Garlock Fault do not appear to form an important hydraulic barrier to groundwater flow in the deep alluvium of the Basin (EKI, 2008b).

General Water Quality of the Principal Aquifer(s)

General water quality types can be inferred from the ionic composition of water samples, plotted on either a Piper Diagram or Stiff Diagrams which display the relative proportions of cations and anions in water samples. In a Piper Diagram, the proportions of anions (chloride, sulfate, bicarbonate and carbonate) and cations (calcium, magnesium, potassium, and sodium) are plotted as points in lower triangles and the data points are projected into the central diamond plotting field along parallel lines. The Stiff Diagram plots cations concentrations (sodium, calcium, and magnesium, in milliequivalents per liter [meq/L]) sequentially on each axis to the left of zero and anions concentrations (chloride, bicarbonate, and sulfate) sequentially on each axis to the right of zero. The resulting points are connected to give an irregular polygonal shape, which can provide a distinctive method of comparing water composition where the width of the pattern approximately indicates the sample's total ionic content. The Piper Diagram presented in **Figure HCM-5** plots samples collected between 1995 and 2018 and suggests water in the Principal Aquifer is predominately bicarbonate/carbonate. Stiff diagrams presented in **Figure HCM-6** plot the most recent well-water samples collected and suggest the Principal Aquifer is primarily bicarbonate-sulfate, except in Dryfield Canyon where wells show a calcium carbonate signature.

Further discussion of specific constituents of particular relevance to the beneficial uses within the Basin, including maps of these constituent distributions, is provided in Section 8.5 *Groundwater Quality Concerns* below.

Primary Uses of Each Aquifer

The predominant use of groundwater is for a source of public water supply by a small number of public water systems, irrigated agriculture, and to supply some private domestic wells. **Figure HCM-7** shows the distribution of wells within the Basin by well type (i.e., public supply, domestic, domestic/irrigation, irrigation, monitoring, or unknown) based on the best available data.

7.1.5. Data Gaps

Key data gaps and uncertainties identified during development of this HCM for the Basin include:

- Uncertainty in the restriction of groundwater flow between the Cuddy Canyon and Castac Basins;
- Current groundwater quality in monitoring wells, specifically for dates after 2008;
- Uncertainty about well construction details (i.e., well depth and screened intervals) for 28 wells that are mapped as being constructed within the Basin;
- Uncertainty about well measuring point elevations for 38 wells that are mapped as being constructed within the Basin;
- Uncertainty about well use and status (i.e., whether wells are active) for 17 wells that are mapped as being constructed within the Basin;
- Monthly pumping data from Tejon Middle School and Historical Fort Tejon public water system wells prior to 2013;
- Water level data from Tejon Middle School and Historical Fort Tejon public water system wells, and up-gradient wells;
- Measured evapotranspiration; and

- Stream flow measurements from Cuddy Creek and Grapevine Creek.

7.2. Cross Sections

> *§ 354.14. Hydrogeologic Conceptual Model*
> *(c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.*

Two hydrogeologic cross-sections (A-A' and B-B') were developed for this HCM (see **Figure HCM-8** and **Figure HCM-9**, respectively). The locations of the cross-sections with respect to the surficial geology are shown on **Figure HCM-10**. These cross-sections cut approximately parallel to, and orthogonal to, the main axis of the Cuddy Creek and Grapevine Canyon valleys and are based on published maps, site-specific geologic information from drilling (EKI, 2008a; ECI, 2006; Schmidt, 2002; Galli, 2005; Stetson, 2001a,b; Dudek & Associates, 1999), and subsurface geophysical profiling (Engeo, 2008). Cross-section A-A' (**Figure HCM-8**) is drawn to extend from up-gradient Cuddy Canyon basin through the Basin from approximately southwest to northeast. Cross-section B-B' (**Figure HCM-9**) is drawn orthogonal to cross-section A-A' and runs approximately southeast to northwest through Grapevine Canyon. The cross-sections extend vertically down to an elevation of 2,900 feet mean sea level (ft MSL), include the entire thickness of aquifer materials down to unweathered bedrock, and therefore include all materials that could reasonably be tapped for groundwater supply purposes. The cross-sections and/or the HCM include data from the following sources:

- Land surface elevation extracted from the U.S. Geological Survey 30-meter digital elevation model (DEM), Cuddy Valley, Frazier Mountain, Grapevine, Lebec, and Pastoria Creek 1:24K topographic quadrangles;
- Surficial geologic units after Dibblee & Minch, 2006;
- Water supply and monitoring wells proximal to the cross-section lines, showing well depth and screened interval information. The locations of wells included on the cross-sections are shown on inset maps in the cross-section figures;
- Subsurface geologic units, informed by EKI, 2008a; ECI, 2006; Schmidt, 2002; Galli, 2005; Stetson, 2001a,b; Dudek & Associates, 1999; and Engeo, 2008;
- Groundwater levels from Spring 2015; and
- Depth to bedrock.

Cross-Section A-A'

Cross-section A-A' (**Figure HCM-8**) extends for approximately three and a half miles in a southwest to northeast direction along the axis of the Basin. The cross-section is approximately parallel to the Garlock Fault zone and cuts through the center of the Basin and Castac Lake. The surficial geology encountered in the southwest portion of the Basin is mapped in **Figure HCM-10** as modern alluvium ("Qa"). Moving northeasterly, this transitions to modern alluvial fan deposits ("Qf") and then to lake deposits ("Ql") found beneath the historical extent of Castac Lake. To the east of Castac Lake in the Dryfield Canyon area of the Basin, the cross-section intersects mostly Qa with interspersed areas of older alluvium ("Qoa") and Qf.

The subsurface geologic units include the Shallow and Deep Aquifer zones in which deposits coarsen downward throughout the center of the Basin beneath Castac Lake. Shallow fine-grained alluvium with clay transitions to recent interbedded alluvial deposits to the west of Grapevine Canyon.

The Spring 2015 groundwater elevations range from 3,550 ft MSL on the southwestern part of the Basin to 3,482 ft MSL on the northeastern side of the Basin.

Cross-Section B-B'

Cross section B-B' (**Figure HCM-9**) extends for approximately four miles in a southeast to northwest direction along the axis of Grapevine Canyon. The cross-section is orthogonal to cross-section A-A' and is perpendicular to the Garlock Fault zone. The surficial geology mapped in **Figure HCM-10** includes a short amount of modern alluvial fan deposits ("Qf") at the start of the line, which transition to the modern alluvium ("Qa") found down the length of Grapevine Canyon. Near the end of the cross-section in the northwest, the cross-section crosses the mapped approximate surface expression of the Pastoria thrust fault, though the existing borehole data did not indicate the obvious presence of a thrust fault in this area and so no fault is shown on the cross section. Continuing northwesterly, an area of artificial fill ("af") associated with the crude oil pipeline site is mapped, which transitions to mostly Qf with Qa in Grapevine Creek's streambed.

Subsurface geologic units represented on the cross sections include the Shallow and Deep Aquifer zones in which deposits generally coarsen downward. In the southwestern portion of the Basin, where the cross-section intersects the Garlock Fault zone, a mixture of igneous and metamorphic gravel, cobbles, and boulders were encountered at depth above bedrock (EKI, 2008e). Alluvial aquifer materials decrease in thickness and lateral extent in the lower Basin, near Fort Tejon Historic Park.

The Spring 2015 groundwater elevations ranges from 3,510 ft MSL in the southeastern part of the Basin to 3,110 ft MSL in the northwestern part of the Basin.

7.3. Physical Characteristics

§ 354.14. Hydrogeologic Conceptual Model
(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:
(1) Topographic information derived from the U.S. Geological Survey or another reliable source.
(2) Surficial geology derived from a qualified map including the locations of cross- sections required by this Section.
(3) Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.
(4) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.
(5) Surface water bodies that are significant to the management of the basin.
(6) The source and point of delivery for imported water supplies.

7.3.1. Topographic Information

Figure HCM-11 shows topography within the Basin. The land generally slopes toward Castac Lake from the west, and then toward the northwest in Grapevine Canyon. Elevations within the Basin range from approximately 3,000 ft MSL in the northwest area of Grapevine Canyon to 3,700 ft MSL at the intersection with Cuddy Canyon basin.

The Basin is bordered by the San Emigdio Mountains and the Tehachapi Mountains. Elevations steepen moving outside the alluvium of the Basin into these mountain ranges, rising to approximately 5,000 ft MSL in the mountainous areas directly adjacent to the Basin.

7.3.2. Surficial Geology

Figure HCM-10 shows the surficial geology within the Basin, based on the Preliminary Geologic Maps of the Lebec, Frazier Mountain, and Grapevine 7.5' Quadrangles (Olson, 2014; Swanson and Olson, 2016; Olson and Swanson, 2017) and associated map explanations. Some details of surficial geology shown on this map were generalized on the cross-sections discussed in Section 7.2. The predominant surficial geologic units covering the Basin area are "Qa" and "Ql," late Holocene age Modern alluvium and Lake deposits, respectively. On the up-sloped areas and within the smaller drainage valleys, the predominant surficial geologic unit is "Qf," late Holocene age Modern alluvial fan deposits. Other minor units in the Basin include "Qoa" (Older alluvium), "Qof" (Older fan deposits), "Qw" (Wash deposits), and "Qya" (Younger alluvium and terrace deposits). Artificial fill and disturbed areas, "af," are primarily mapped in the north-west Grapevine area near the crude oil pipeline site, as well as along Quail Canal near the northern intersection of the Castac Lake "Ql" deposits, and along the Interstate-5 (I-5) interchange near Lebec.

In the Dryfield Canyon area of the Basin, metamorphic units of "Pzm" (Marble), "Pzh" (Hornfels), "Kle" (Lebec Granodiorite), and "Ktl" (Tejon Lookout Granite) are mapped along the northern side of the Garlock Fault Zone.

7.3.3. Soil Characteristics

Soils within the Basin are shown on **Figure HCM-12**, based on the U.S Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Soil Survey Geographic Database (SSURGO). Soils are relatively coarse in texture with the predominant type being sandy loam. The infiltration rate of the soils is generally in the range of 1.98 to 5.95 inches per hour (3.96 to 11.9 feet per day).

Hydrologic Soil Group identification provides an indication of the relative runoff and infiltration potential of the soils with Hydrologic Soil Group A having the lowest runoff potential and highest infiltration potential and Hydrologic Soil Group D having the highest runoff potential and the lowest infiltration potential. Soils are predominantly in the A and B Hydrologic Soil Groups, with some areas of Hydrologic Soil Group D mapped in the upper areas of Dryfield Canyon (**Figure HCM-12**).

7.3.4. Recharge and Discharge Areas

Figure HCM-13 shows existing and potential groundwater recharge and discharge areas within the Basin. Sources of water to the Basin groundwater system include recharge from precipitation, subsurface groundwater inflows from the Cuddy Canyon Basin, return flows from irrigation and septic tanks, and Castac Lake seepage. Outflows from the Basin include groundwater pumping, evapotranspiration by wetlands and Groundwater Dependent Ecosystems (GDEs) along the Castac Lake margins, surface outflow into Grapevine Creek, and subsurface groundwater outflow.

Some fraction of the rainfall that falls directly on the Basin floor percolates through the soil zone and reaches the groundwater table via deep percolation.[13] Rainfall that percolates into the soil on the slopes of the Basin watershed travels through fractures in the underlying bedrock or at the soil-bedrock interface until it reaches the valley floor and enters the alluvial aquifer in a process called mountain front recharge (Schmidt, 2002; Wilson and Guan, 2004).

Groundwater enters the Basin from the up-gradient Cuddy Canyon basin as subsurface inflow. Although the rate of groundwater inflows is not well understood, it is a function of the volume of upgradient groundwater available (i.e., as a function of local recharge), the slope of the water

[13] Under natural conditions a portion of the total precipitation (as measured in a rain gauge) will be intercepted by vegetation before it reaches the ground surface in a process called interception. This water will then evaporate and is hence unavailable for vegetative use or groundwater recharge. The fraction of rainfall that is intercepted depends on storm event characteristics such as depth and intensity, and vegetation characteristics such as leaf area index, and can range from approximately 10 to 30 percent of total measured rainfall (Shuttleworth, 1993).

table (i.e., the hydraulic gradient), the saturated cross-sectional area of the aquifer, and the permeability of the aquifer materials. As mentioned above in Section 7.1.4, the hydrologic connection across faults and between up-gradient basins in not well understood, however regardless of the possibility of a subsurface hydraulic disconnect, there is demonstrably an ephemeral surface water connection along Cuddy Creek. If groundwater were prevented from flowing in the subsurface across the San Andreas and Garlock fault zones intersection it would back up and spill over as surface flow, creating wetlands or springs on the upgradient side of fault splays, and re-infiltrating on the downgradient side. Therefore, although these features are not obvious in the Castac Basin, the upper groundwater basins (i.e., Cuddy Canyon basin above the fault zone, Cuddy Ranch basin, and Cuddy Valley basin) are considered to contribute flow to the Basin, either through surface or subsurface inflow.[14]

Agricultural and municipal demands are met with groundwater. Return flows represent the volume of water that is "returned" to the aquifer either as a result of deep percolation of water that is used for irrigation, or via seepage from individual residential septic fields. Additionally, a lined wastewater pond associated with the Caltrans rest stop is present next to I-5; this pond is lined so there is likely no seepage to groundwater. Surface water flows within Cuddy Creek and Grapevine Creek also can contribute to groundwater recharge, when flowing. Runoff from storms contribute to streamflow within the Basin, however storm flows are typically short-lived, limiting the time available for recharge.

Wetlands and GDEs found along the fringes of Castac Lake rely on shallow groundwater. Surface water in Castac Lake also can seep in or out, exchanging water with the aquifer beneath and near the lake, depending on hydraulic gradients. Between 2001 and 2008 and in 2012, pumped groundwater was added to Castac Lake to maintain lake levels; once supplemental additions ceased, Castac Lake levels declined. Without supplemental water additions, Castac Lake is seasonal, with some water retention after large precipitation events. The prevailing hydraulic gradients, discussed in more detail in Section 8.2 *Groundwater Elevations and Flow Direction,* show groundwater flows in a convergent pattern from the up-gradient basin and foothill areas towards Castac Lake, which then flows north into Grapevine Canyon. Because the water table in some years is close to or above the ground surface in the northern part of Grapevine Canyon, this is an area of potential "rejected" recharge where not all of the local recharge in the northern part of Grapevine Canyon can be accepted into groundwater storage, and therefore some fraction of the potential recharge may be lost from the Basin as surface outflow in Grapevine Creek.

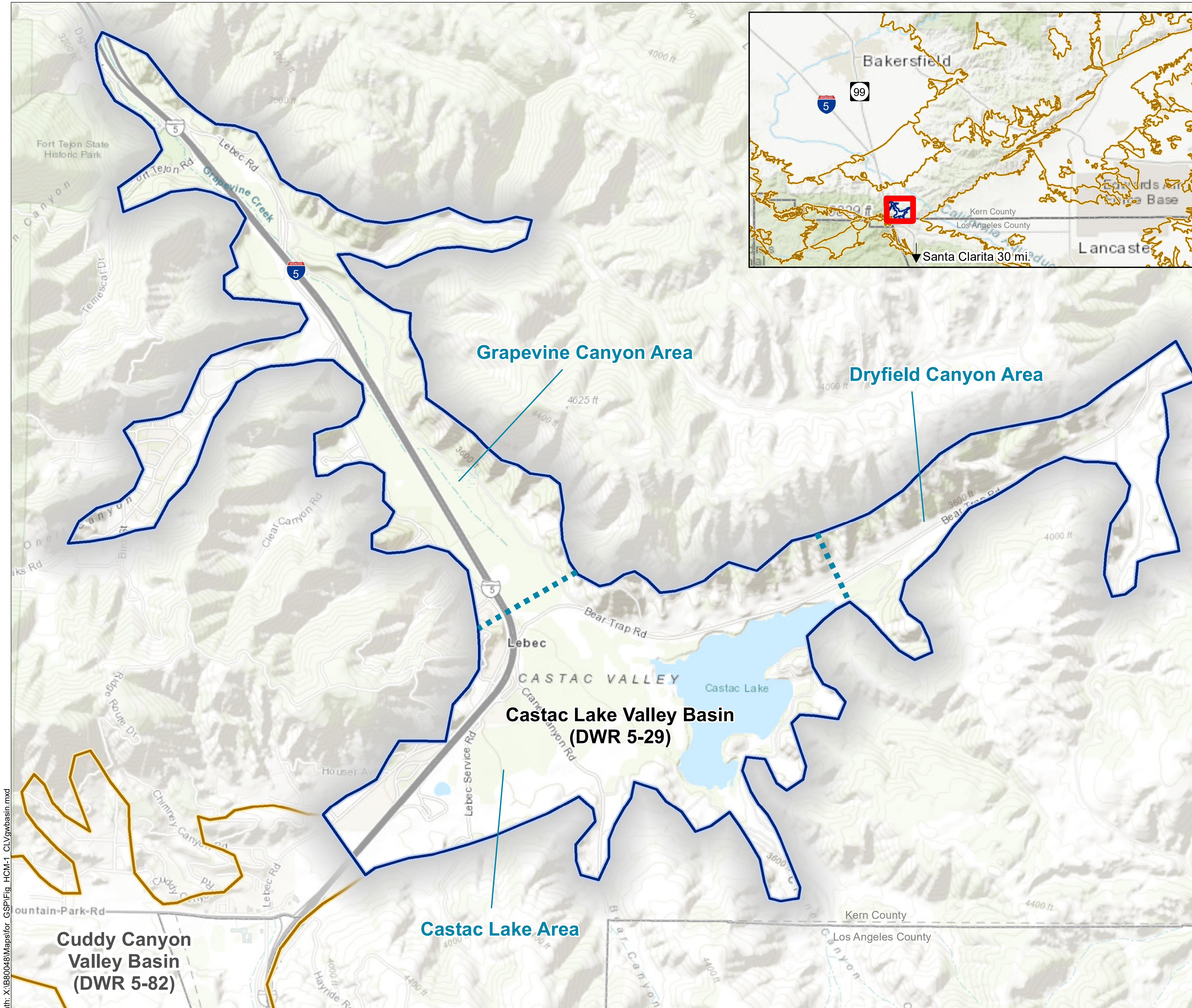
[14] Further support for the argument that the upstream watersheds and groundwater basins contribute flow to the lower basins is the fact that there are no other known sinks of sufficient size for the water (i.e., recharge from precipitation) that enters those upper basins, and therefore flow into the downstream basins is the only logical outflow mechanism.

7.3.5. Surface Water Bodies

Surface water bodies significant to the management of the Basin include Castac Lake, Cuddy Creek, and Grapevine Creek. **Figure HCM-14** depicts the location of the surface water features and the two watersheds that are assumed to contribute runoff to the Basin, Castac Lake Watershed and O'Neil Canyon-Grapevine Greek Watershed. The Basin is surrounded by approximately 47,100 acres of upland watershed and up-gradient groundwater basin areas that drain into the Basin. During individual storm events, when the soils are too saturated to accept more water from rainfall, or when the rainfall rate exceeds the infiltration capacity of the soil, surface runoff (i.e., stormflow) is generated, which travels downslope until it reaches Cuddy Creek, which flows to Castac Lake, then Grapevine Creek, and eventually may flow out of the Basin via Grapevine Creek. There are several smaller drainages that originate in the hills south, east and north of the Basin that contribute some surface water runoff to both the Basin and Castac Lake (Bookman Edmonston, 1965).

7.3.6. Source and Point of Delivery for Imported Water Supplies

Currently, the Basin does not receive any State Water Project (SWP) surface water supplies or any other surface water deliveries. Therefore, no infrastructure currently exists for the conveyance and distribution of imported water supplies. As part of the Tejon Mountain Village (TMV) development, Tejon-Castac Water District (TCWD) will import SWP water to meet all future TMV water demands.



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Fault Zone

Fault Traces

- Mapped
- Approximately Located
- Concealed
- Boundary Between Castac Lake Valley Groundwater Basin Subareas

Abbreviations

CGS = California Geological Survey
DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Fault trace and fault zone locations from CGS https://maps.conservation.ca.gov/cgs/EQZApp/app, accessed 6 November 2018.

N

0 0.5 1
(Scale in Miles)

Castac Lake Valley Groundwater Basin

Tejon-Castac Water District
Kern County, California
September 2020
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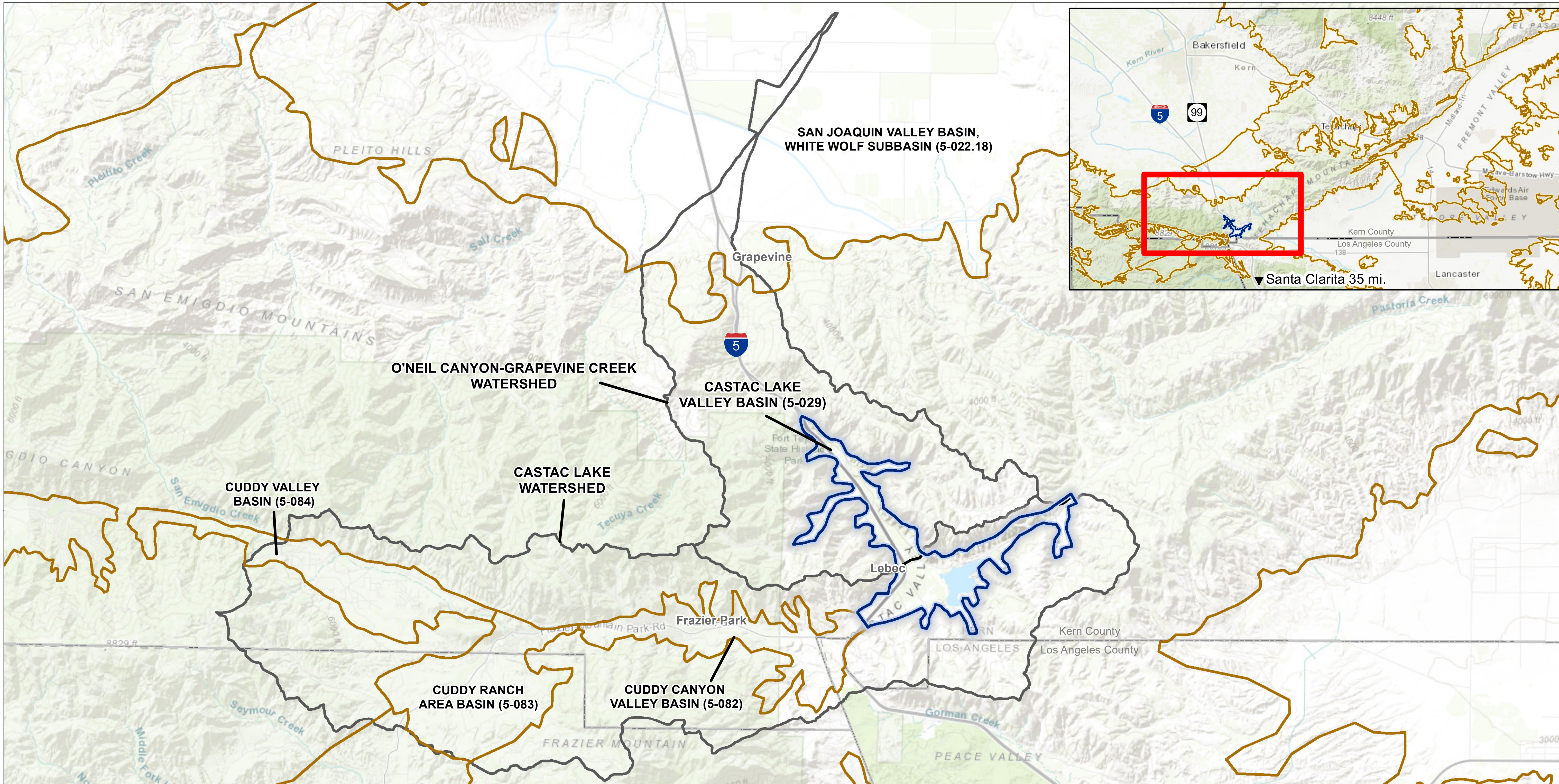
Figure HCM-1

Path: X:\B80048\Maps\for_GSP\Fig_HCM-1_CLVgwbasin.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Watershed Boundary
- County Boundary
- Fault Zones

Fault Traces

- Mapped
- Approximately Located
- Concealed

Abbreviations

DWR = California Department of Water Resources
CGS = California Geological Survey

Notes

1. All locations are approximate.
2. Only groundwater basins which are either directly upgradient or downgradient of Castac Lake Valley Groundwater Basin are shown.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Watershed boundaries HUC12 obtained from USDA NRCS on 16 July 2018.
4. Fault trace and fault zone locations from CGS https://maps.conservation.ca.gov/cgs/EQZApp/app, accessed 6 November 2018.

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0 2 4

(Scale in Miles)

Castac Lake Valley Groundwater Basin and Upgradient Groundwater Basins

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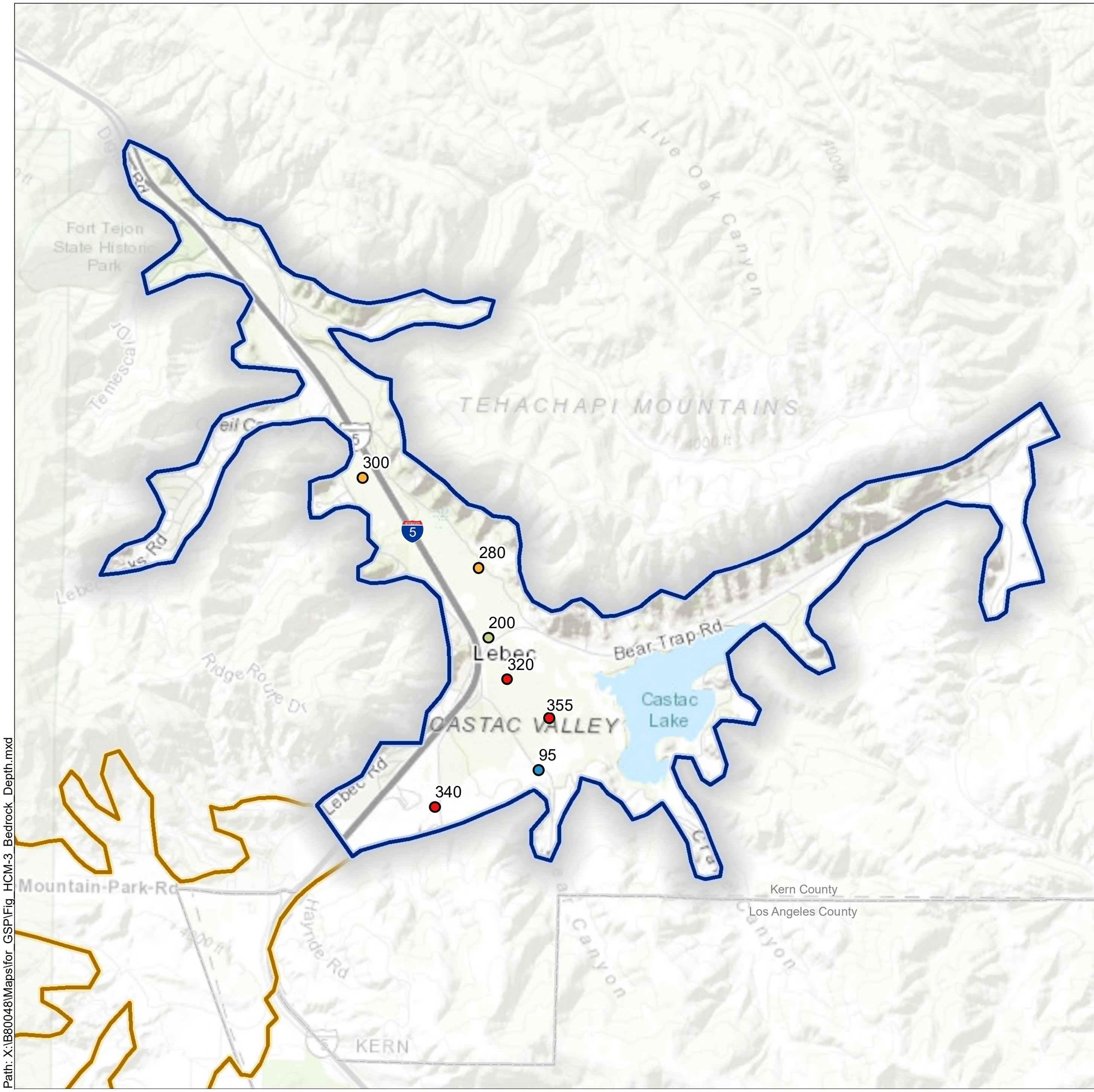
Figure HCM-2

Path: X:\B80048\Mapsfor_GSP\Fig_HCM-2_Basins_regional_08292019.mxd



Path: X:\B80048\Maps\for_GSP\Fig_HCM-3_Bedrock_Depth.mxd

Legend

Depth to Bedrock (ft bgs)

- < 100
- 101 - 200
- 201 - 300
- 300 - 400

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources
ft bgs = feet below ground surface

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

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Depth to Bedrock

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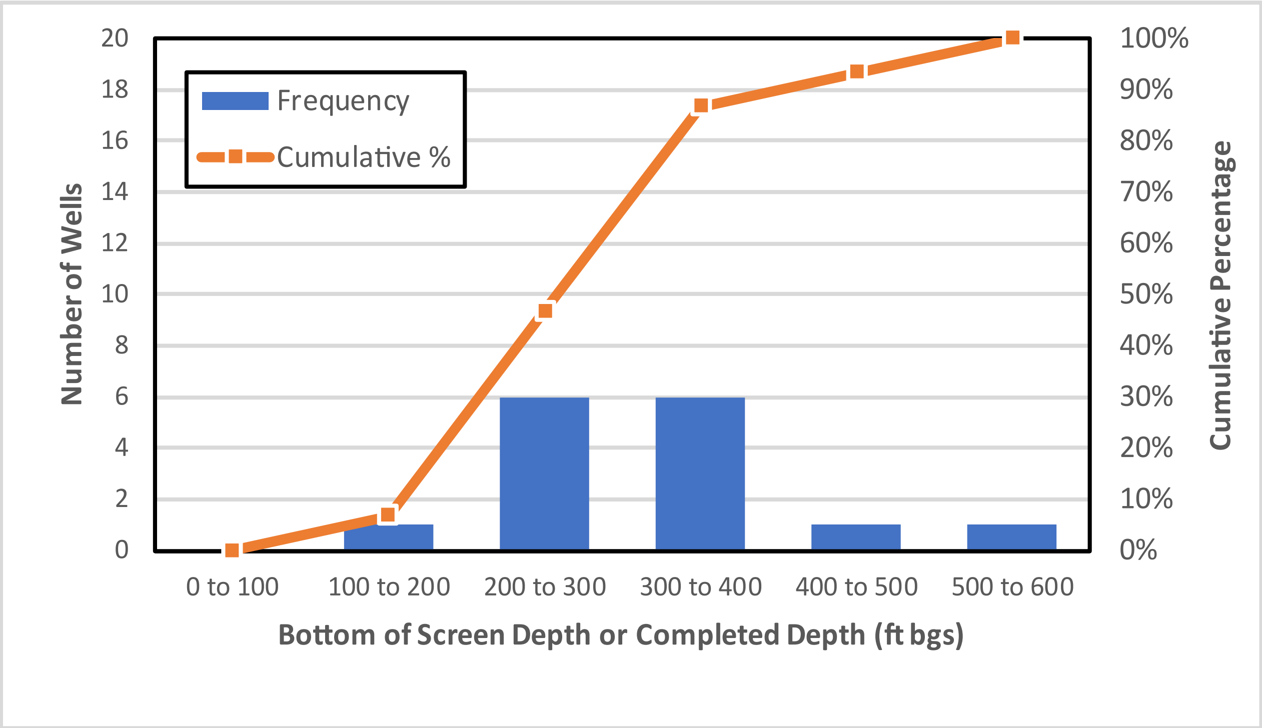
Figure HCM-3



<u>Abbreviations</u>

ft bgs = feet below ground surface

<u>Notes</u>

1. Well depth data is based on well records for 15 wells in the Castac Lake Valley Basin.
2. Completed depth was used when bottom of screen depth was not available.

Summary of Pumping Well Depth Data

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Kern County, California
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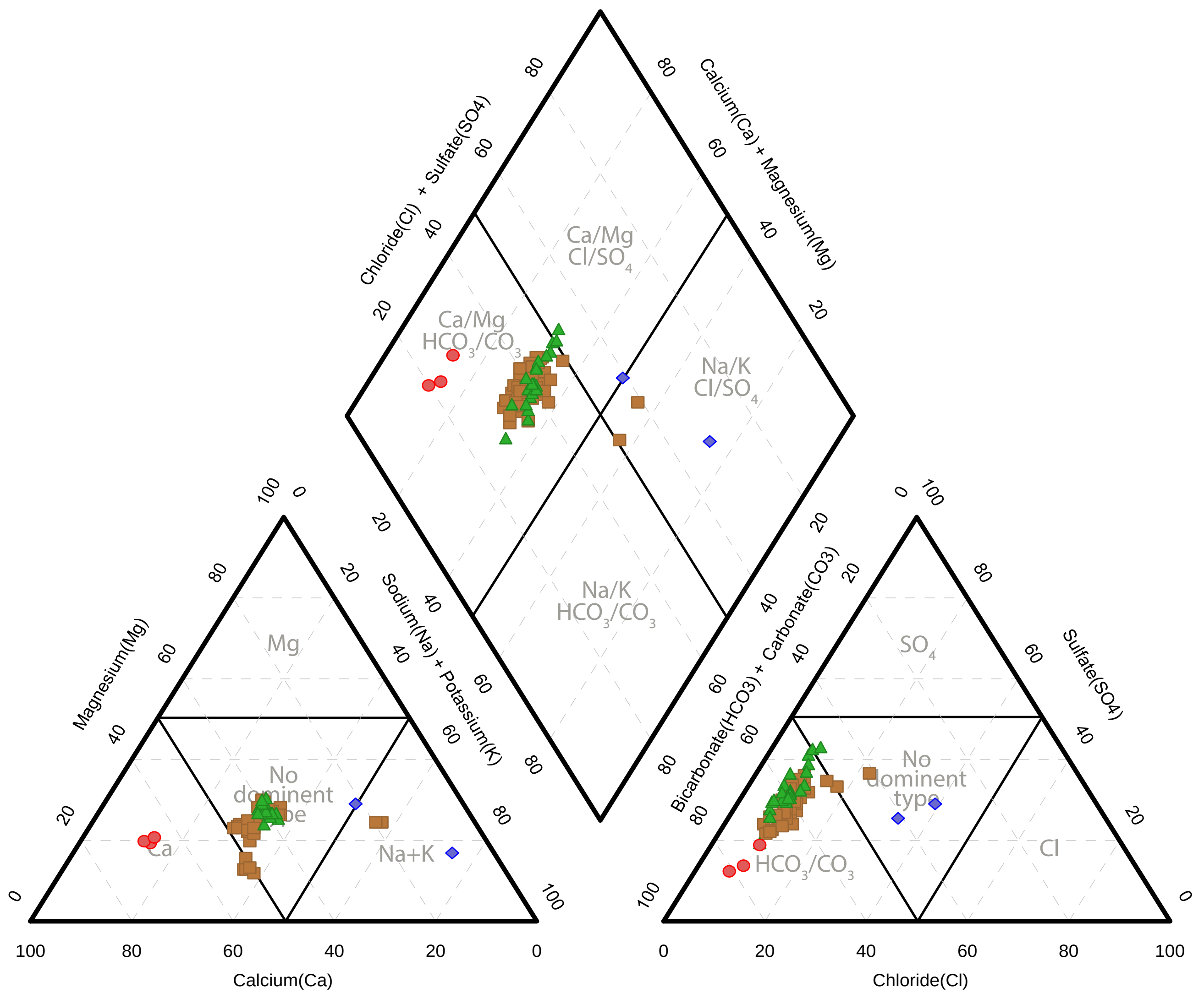
Figure HCM-4



Legend

- Castac Lake Valley area Well
- Dryfield Canyon area Well
- Grapevine Canyon area Well
- Castac Lake

Notes

1. Samples collected between 1998 and 2019.
2. Dominant water type is labeled in grey.

Sources

1. Standard ion concentration data from the Castac Basin Data Management System.

Piper Diagram

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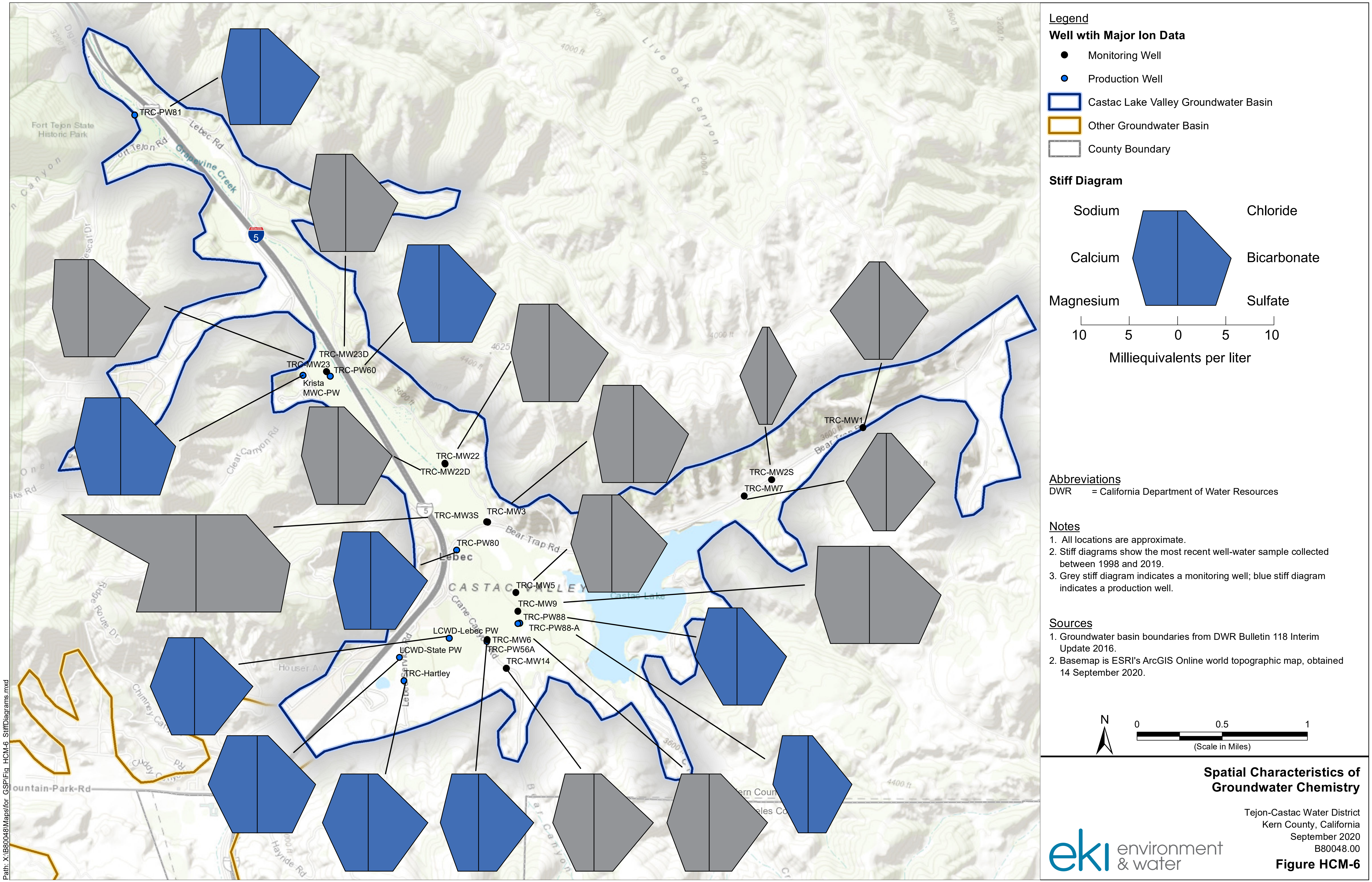
Figure HCM-5



Spatial Characteristics of Groundwater Chemistry

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Kern County, California
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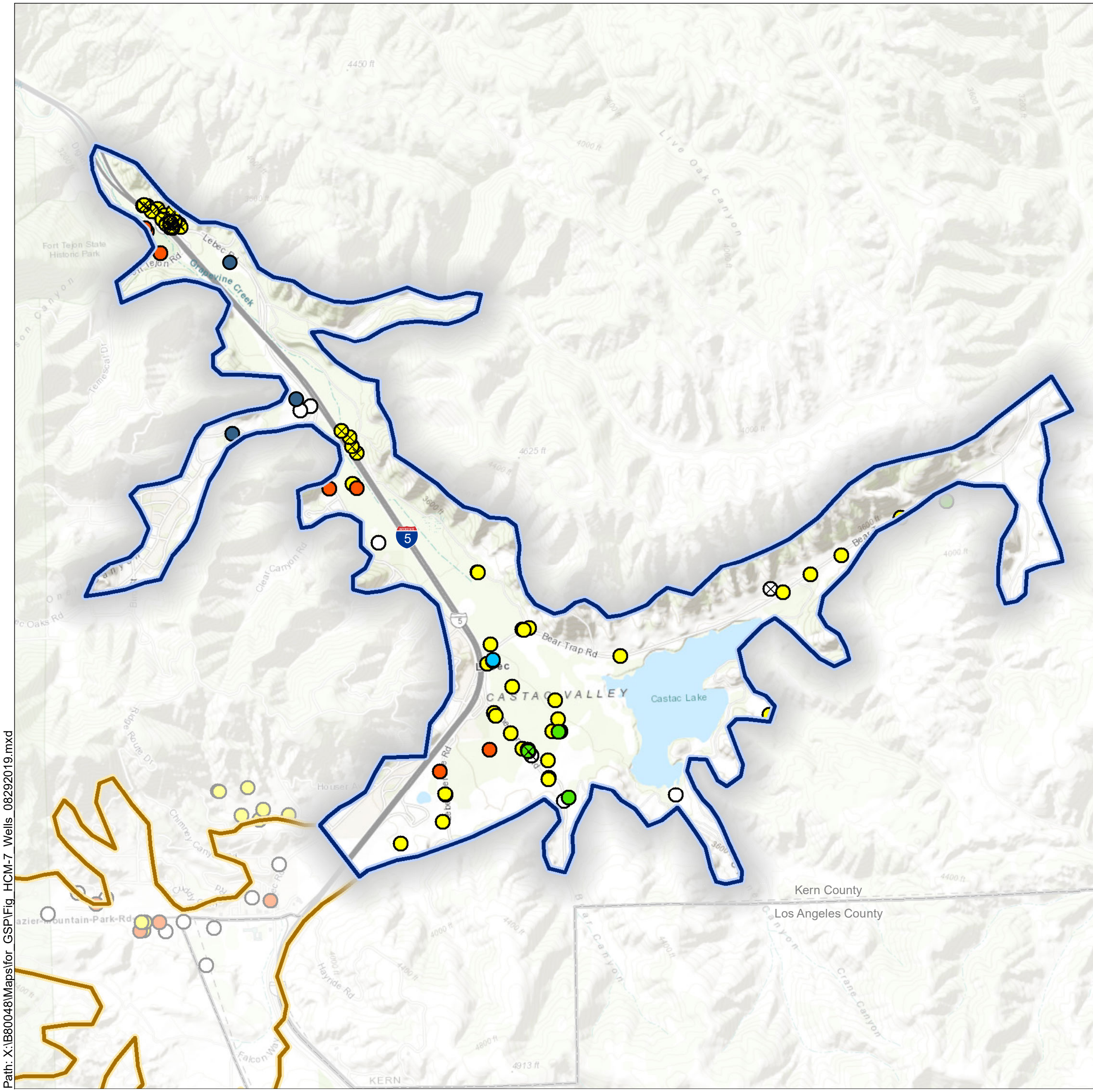
Figure HCM-6



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Well Use

- Public Supply
- Domestic
- Domestic/Irrigation
- Irrigation
- Monitoring
- Unknown
- Abandoned

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

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Miles

Well Location, Use, and Status

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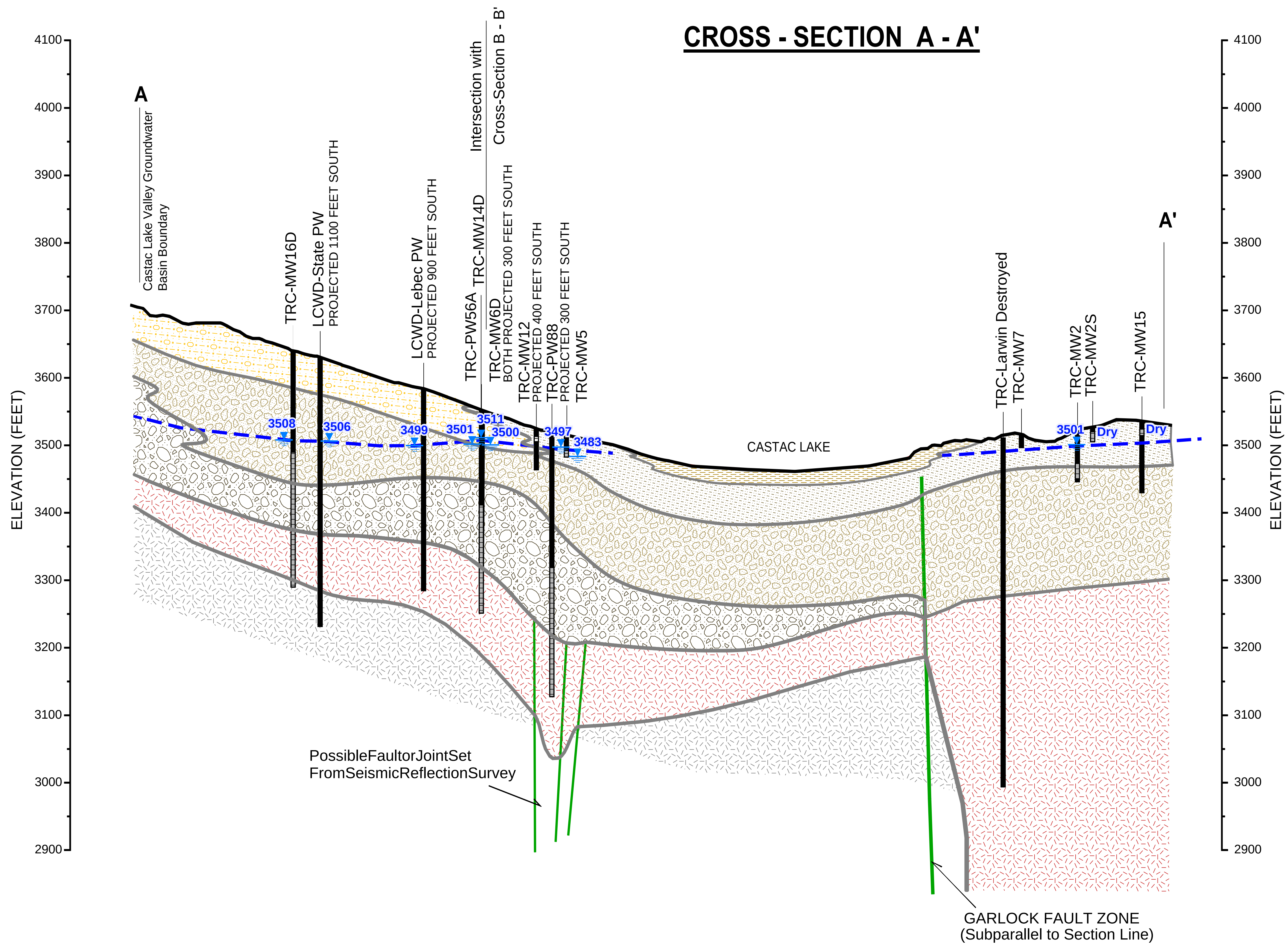
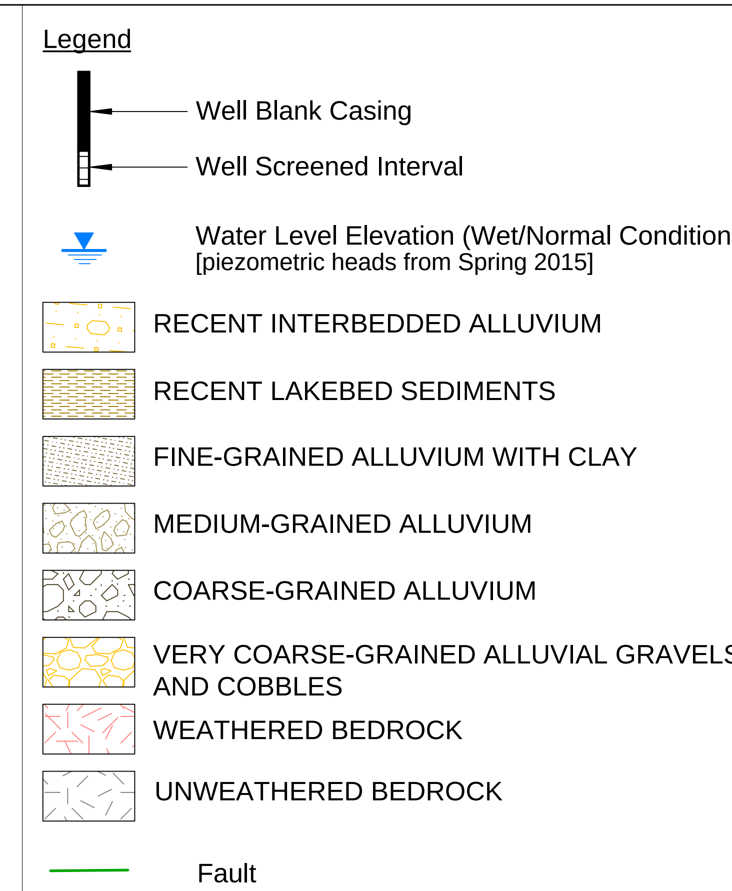
Figure HCM-7

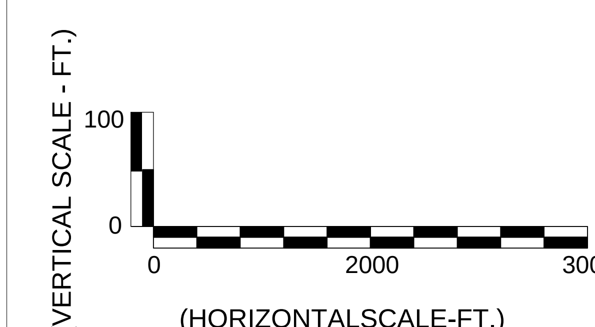
Path: X:\B80048\Maps\for_GSP\Fig_HCM-7_Wells_08292019.mxd





NOTES:

1. All locations, depths, and dimensions are approximate.
2. Wells and boreholes are projected as much as 500 ft perpendicular to cross-section.
3. Wells with unknown screened intervals are shown with all blank casing.



Geologic Cross-Section A - A'

Tejon-Castac Water District
Kern County, California
September 2020
B80048.00

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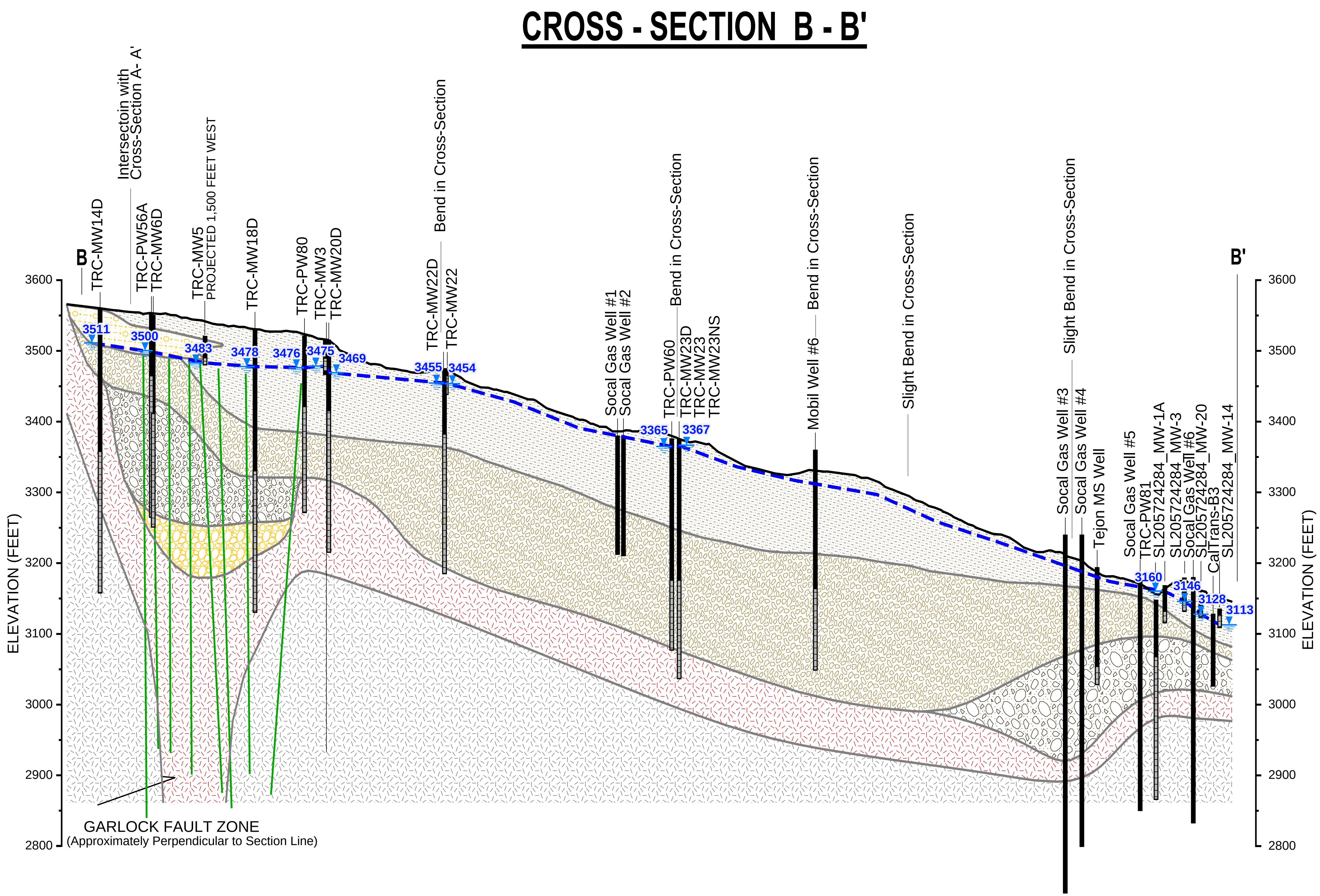
Figure HCM-8



Legend

- Well Blank Casing
- Well Screened Interval
- Water Level Elevation (Wet/Normal Conditions) [piezometric heads from Spring 2015]
- RECENT INTERBEDDED ALLUVIUM
- RECENT LAKEBED SEDIMENTS
- FINE-GRAINED ALLUVIUM WITH CLAY
- MEDIUM-GRAINED ALLUVIUM
- COARSE-GRAINED ALLUVIUM
- VERY COARSE-GRAINED ALLUVIAL GRAVELS AND COBBLES
- WEATHERED BEDROCK
- UNWEATHERED BEDROCK
- Fault

NOTES:

1. All locations, depths, and dimensions are approximate.
2. Wells and boreholes are projected as much as 500 ft perpendicular to cross-section.
3. Wells with unknown screened intervals are shown with all blank casing.

(VERTICAL SCALE - FT.) 0 100

0 1000 2000

(HORIZONTALSCALE-FT.)

Geologic Cross-Section B - B'

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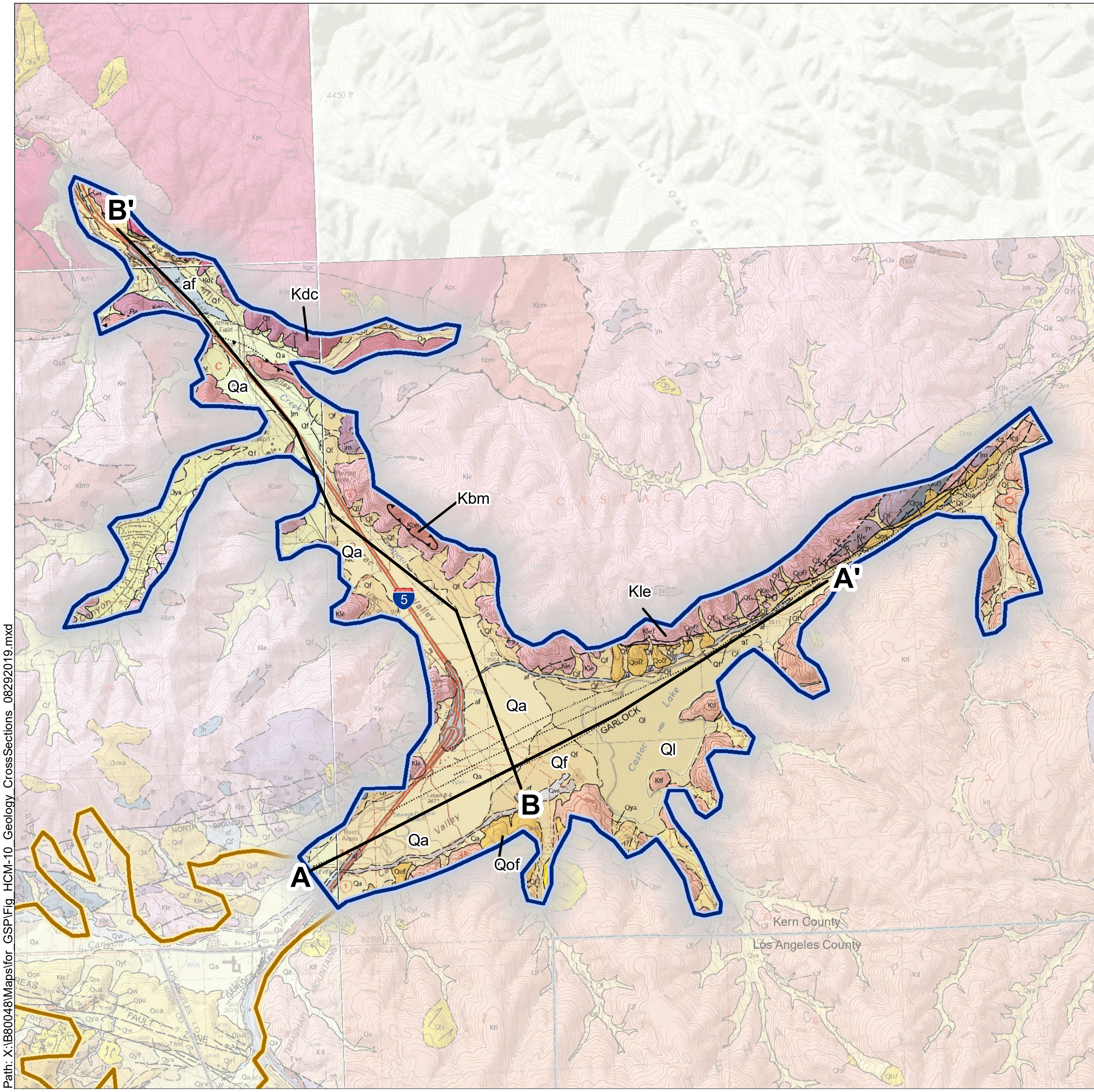
Kern County, California
September 2020
B80048.00

Figure HCM-9



Legend

- Cross-Section Line
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

af	Artificial fill and disturbed areas
Qw	Wash deposits
Qf	Modern alluvium fan deposits
Qa	Modern alluvium
Ql	Lake deposits
Qof	Older fan deposits
Qoa	Older alluvium
Qya	Younger alluvium and terrace deposits
Qyf	Younger alluvial fan deposits
Qls	Landslide deposits
Kle	Lebec Granodiorite
Ktl	Tejon Lookout Granite
Kbm	Granite of Bush Mountain
Kdc	Digier Canyon Quartz Diorite Orthogneiss
Pzm	Marble

Abbreviations

DWR = California Department of Water Resources
CGS = California Geological Survey

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Olson BPE, 2014. Preliminary Geologic Map of the Grapevine 7.5' Quadrangle, Kern County, California: A Digital Database. Version 1.0. CGS.
4. Olson BPE and Swanson BJ, 2017. Preliminary Geologic Map of the Lebec 7.5' Quadrangle, Kern, Los Angeles, and Ventura Counties, California. Version 1.0. CGS.
5. Swanson BJ and Olson BPE, 2016. Preliminary Geologic Map of the Frazier Mountain 7.5' Quadrangle, Kern, Los Angeles, and Ventura Counties, California. Version 1.0. CGS.

N

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Miles

Geologic Map and Location of Cross-Section Lines

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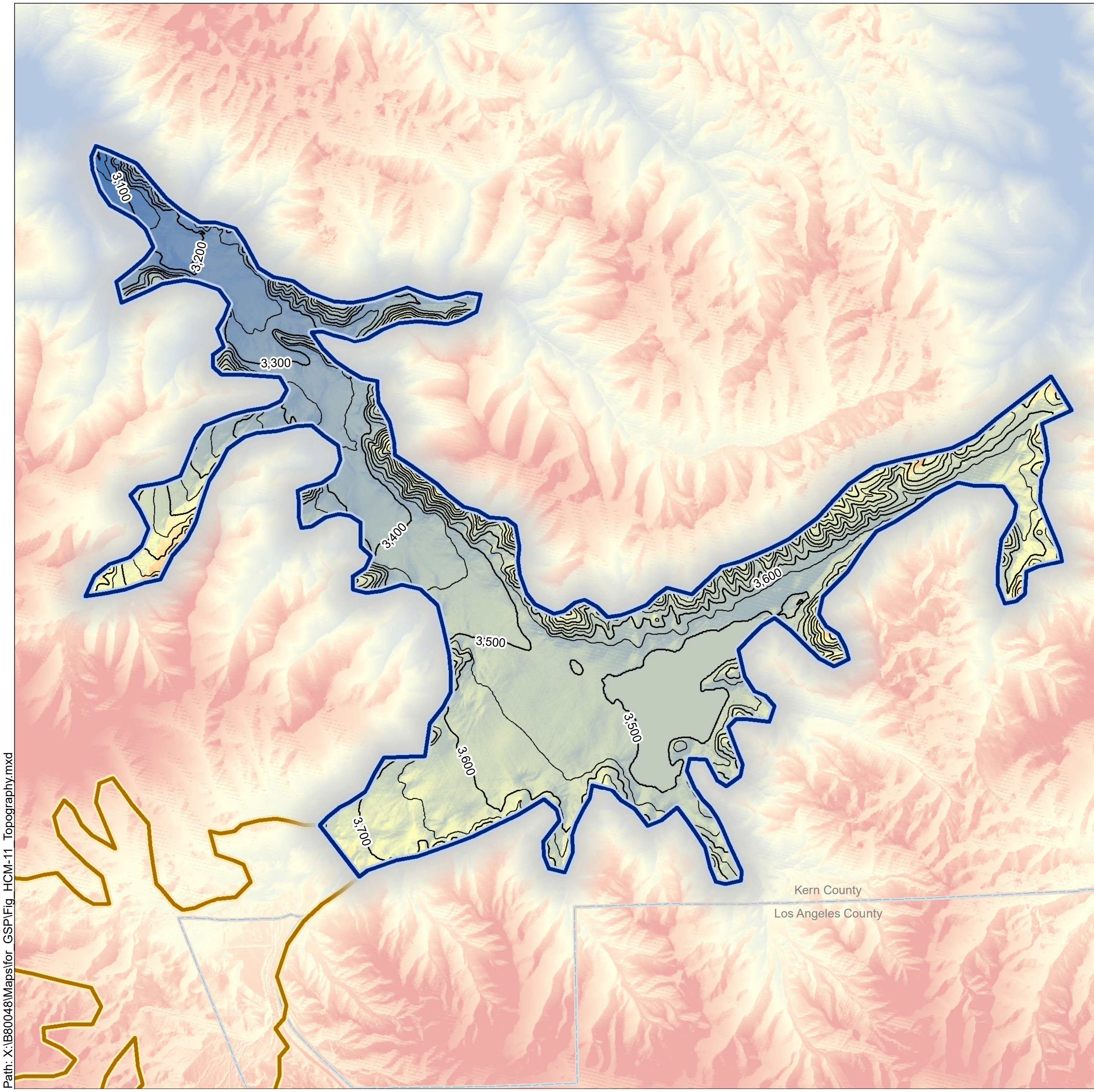
Figure HCM-10

Path: X:\B80048\Maps\for_GSP\Fig_HCM-10_Geology_CrossSections_08292019.mxd



Path: X:\B80048\Maps\for_GSP\Fig_HCM-11_Topography.mxd

Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Land Surface Elevation Contour (ft MSL)

Land Surface Elevation (ft MSL)

High : 5000

Low : 3000

Abbreviations

DWR = California Department of Water Resources
ft MSL = feet above mean sea level
NED = National Elevation Dataset
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. Color scale is based on minimum and maximum elevations within the Castac Lake Valley Basin.
3. Land surface elevation contours shown with a 50 foot contour interval.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Land surface elevation data obtained from USGS NED (https://viewer.nationalmap.gov/basic/).

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Miles

Topography

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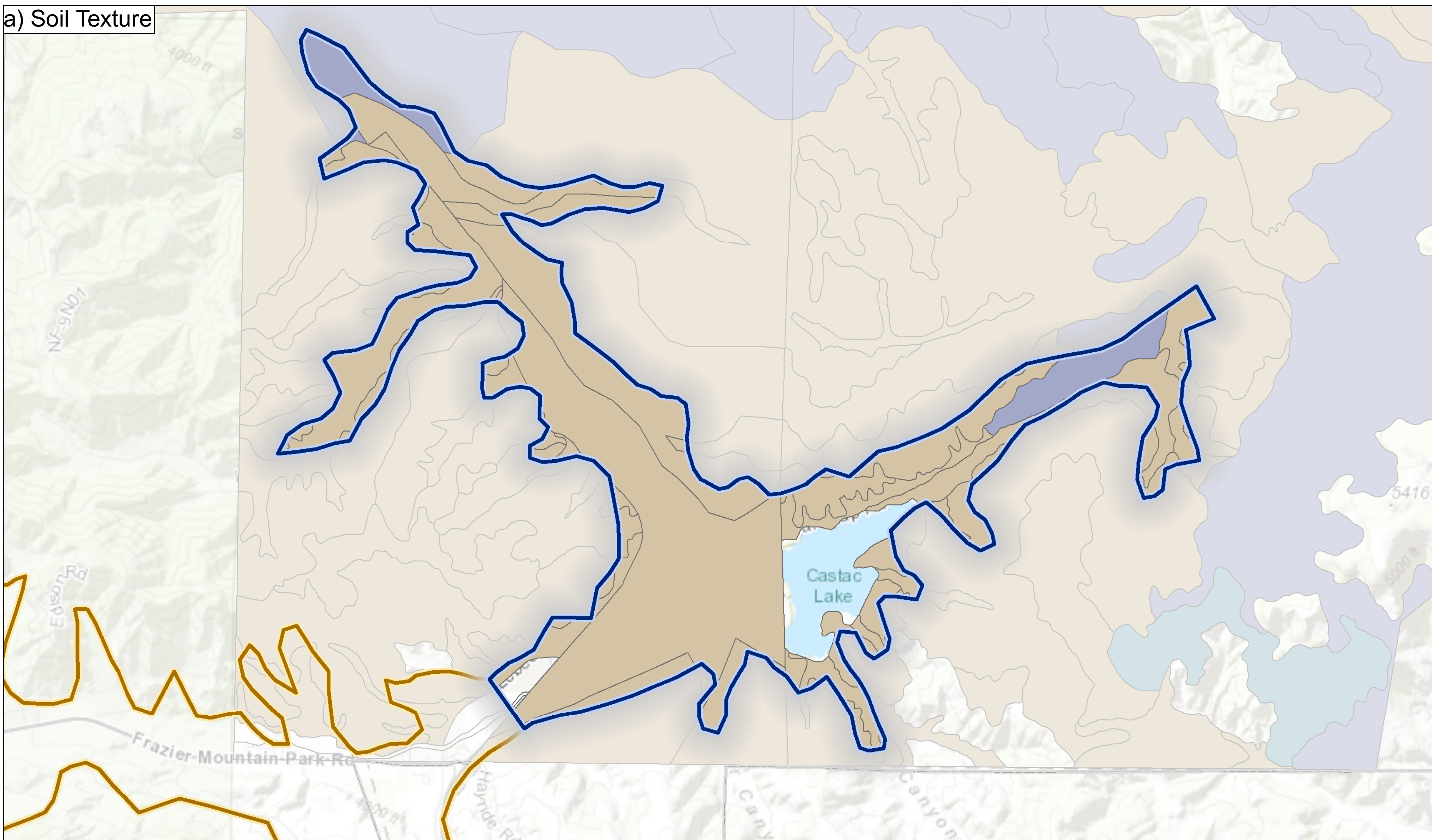
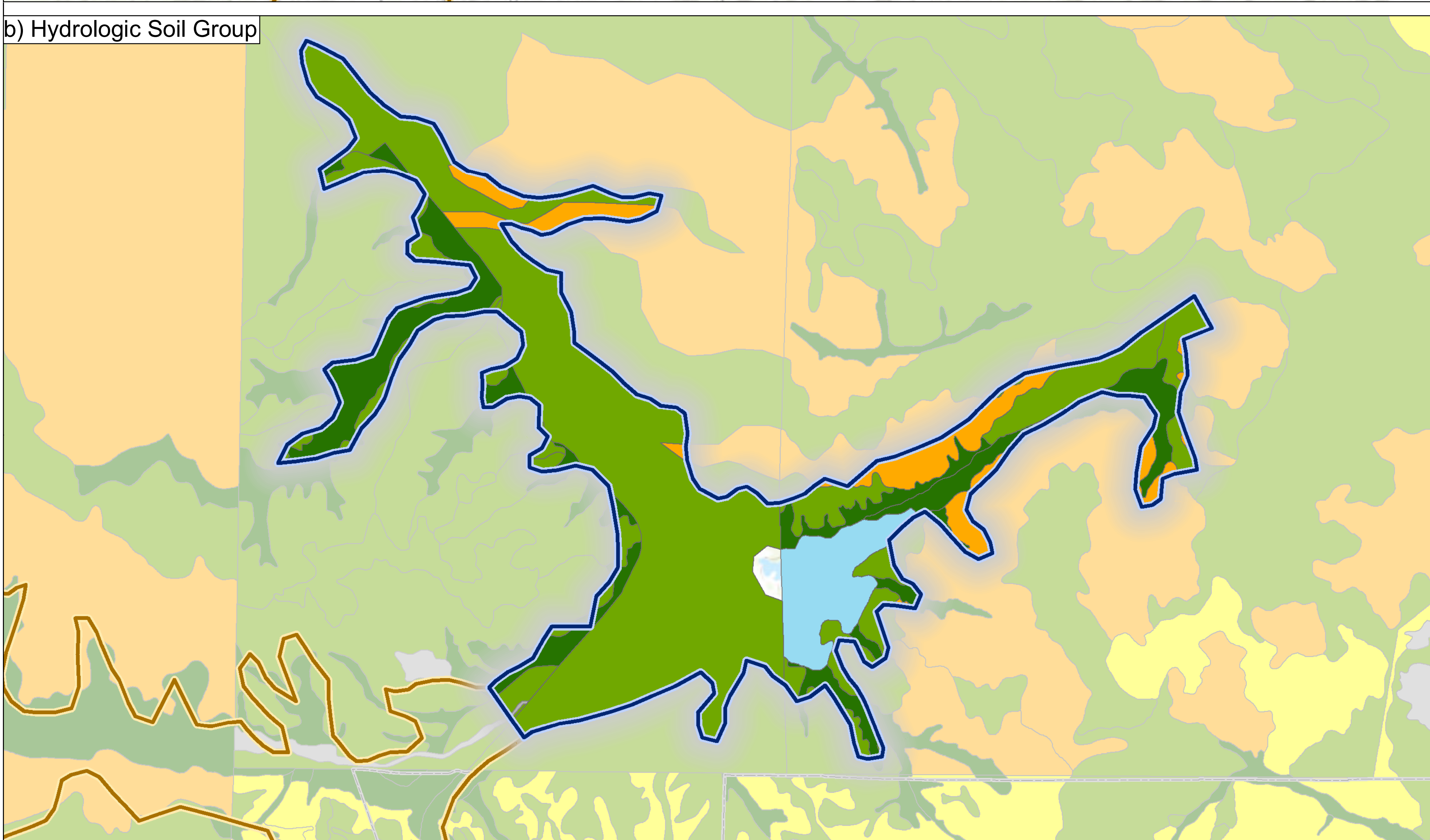
Figure HCM-11

a) Soil Texture



b) Hydrologic Soil Group



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Soil Texture

- Sandy Loam
- Sandy Clay Loam
- Clay Loam
- Loamy Sand
- Loam
- Other
- Not Identified

Hydrologic Soil Groups

- A
- B
- C
- D
- Not Identified

N

0 0.5 1
(Scale in Miles)

Abbreviations

DWR = California Department of Water Resources
SSURGO = Soil Survey Geographic Database

Notes

1. All locations are approximate.
2. Only soil units of greatest extent are labeled.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Soil data from United States Department of Agriculture SSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

Soil Texture and Hydrologic Soil Group

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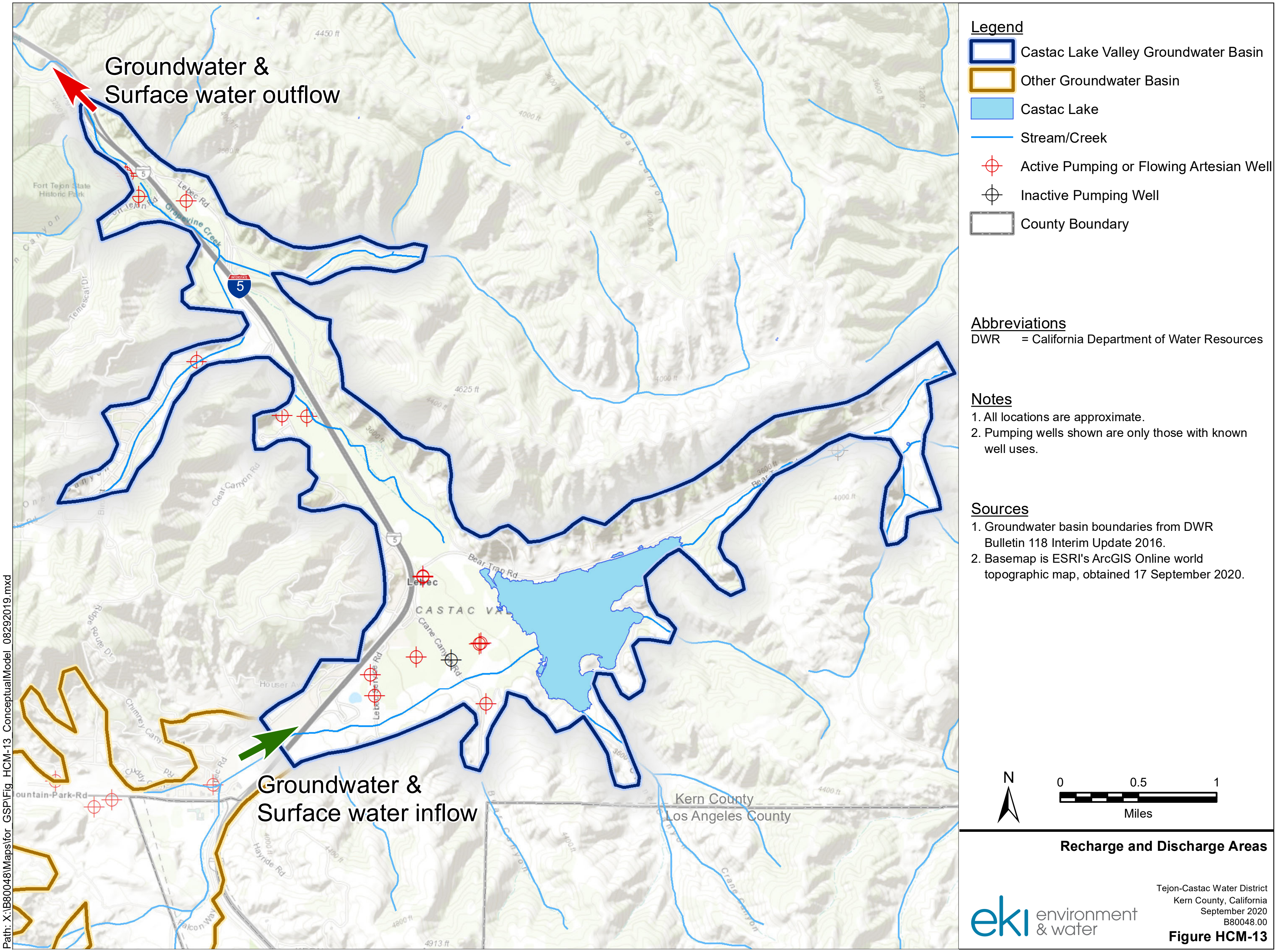
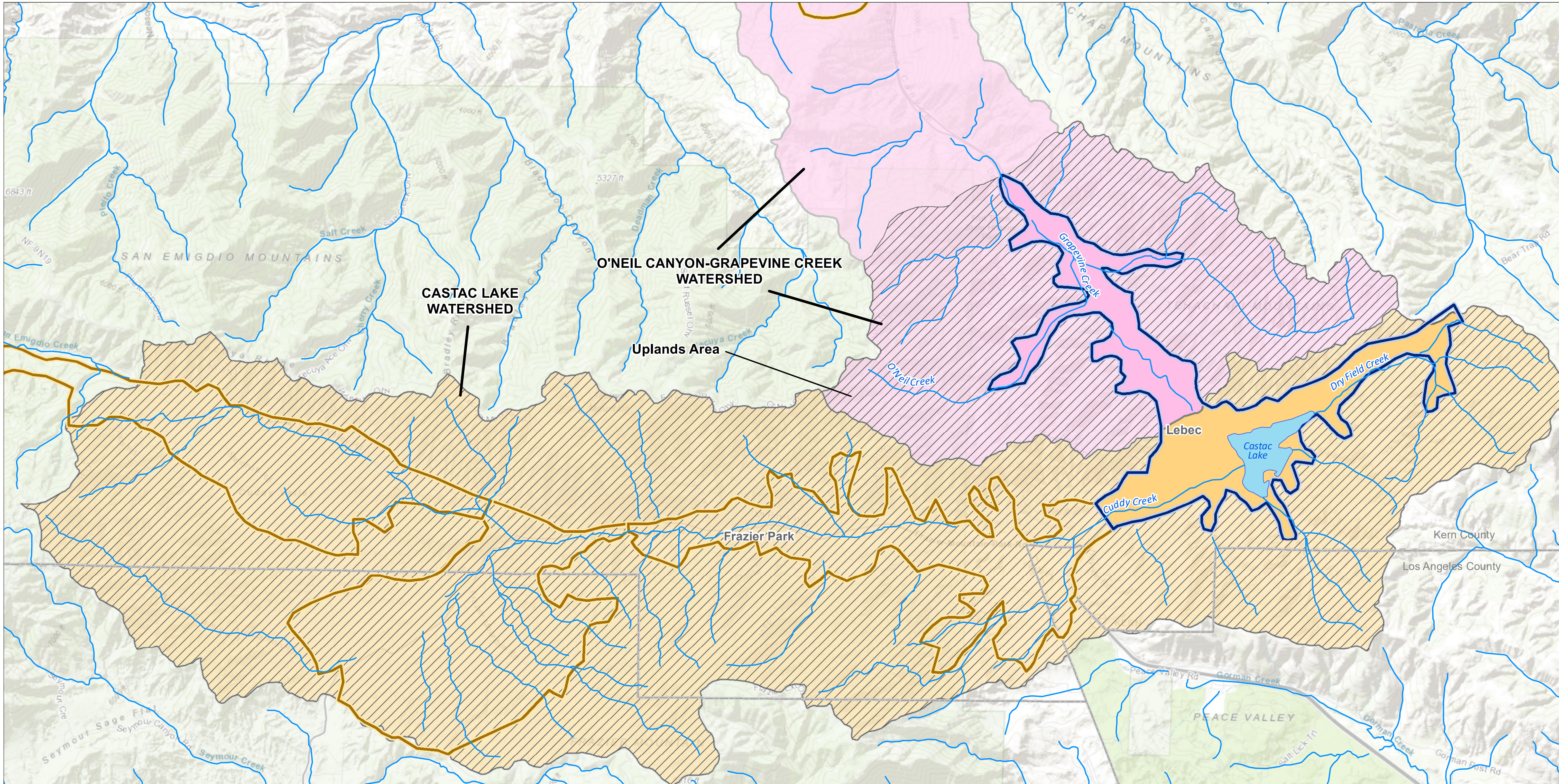
Figure HCM-12

Path: X:\B80048\Maps\for GSP\Fig_HCM-12_Soils_08292019.mxd



Path: X:\B80048\Maps\for_GSP\Fig_HCM-13_ConceptualModel_08292019.mxd



Legend

- Stream/Creek
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Watershed Boundary

- Castac Lake
- O'Neil Canyon-Grapevine Creek
- Uplands Area

Abbreviations

DWR = California Department of Water Resources

NHD = National Hydrography Dataset

Notes

1. All locations are approximate.
2. Only groundwater basins which are either directly upgradient or downgradient of Castac Lake Valley Groundwater Basin are shown.
3. Uplands Area signifies the watershed area contributing runoff to Castac Lake Valley Groundwater Basin.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Watershed boundaries HUC12 obtained from USDA NRCS on 16 July 2018.
4. Surface water features and watersheds from NHD (https://viewer.nationalmap.gov/basic/).

N

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(Scale in Miles)

Natural Surface Water Features

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Figure HCM-14

Path: X:\B80048\Maps\for_GSP\Fig_HCM-14_SurfaceWater.mxd

8. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

§ 354.16. Groundwater Conditions
Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:

This section presents information on historical and current groundwater conditions within the Basin based on available data. For the purpose of this assessment, "current conditions" refers to conditions in calendar year 2015 (i.e., the effective date of SGMA). For historical conditions, we've examined the last 22 years (i.e., 1998 through 2019) in detail, along with older data, when available.

8.1. Castac Basin Data Management System

The Castac Basin Data Management System (DMS) manages available well, groundwater level, groundwater quality, and other pertinent data for the Basin. The DMS consists of a Microsoft Access database file linked with a Geographic Information Systems (GIS) geodatabase. Data within the DMS include:

- Historical well location, well construction, water level, and water quality data from analyses conducted during 2006-2008;
- Historical soil borehole information;
- Water level data for monitoring and production wells, provided by Tejon-Castac Water District (TCWD);
- Water level and water quality data from Lebec County Water District (LCWD) production wells, provided by LCWD;
- Water level and water quality data from the Krista Mutual Water Company (KMWC) production well, provided by KMWC;
- Data from the State Water Resources Control Board (SWRCB) online public GeoTracker environmental database[15], including well locations, well construction information, water level data, and water quality data for the Mobil M-1 Crude Oil Pipeline site (SL205724284) and the Lebec Sanitary Landfill site (L10005571106);
- Data from United States Geological Survey (USGS) National Water Information System (NWIS)[16] including water quality data from one public supply well within the Basin and six wells located in up-gradient basins; well construction and elevation data for existing wells

[15] https://geotracker.waterboards.ca.gov/
[16] https://waterdata.usgs.gov/nwis

in the DMS; and available peak streamflow measurements from Cuddy Creek during the late 1970s;

- Measured streamflow along Grapevine Creek for 2000-2007;
- Peak streamflow measurements from Cuddy Creek at Lebec and Grapevine Creek below the Basin for 1980-2017 and 2005-2017, respectively, provided by Kern County;
- Pumping data as counter units from Tejon Ranch Corporation (TRC) production wells through 2019, provided by TCWD;
- Pumping estimates from TRC production wells calculated from electrical use records for 1997-2001;
- Monthly pumping data provided by KMWC and LCWD from their production wells for 2010-2019 and 2013-2019, respectively; and
- Monthly pumping data from public water systems as reported to the Drinking Water Information Clearinghouse (DRINC) portal[17] for 2013 through 2015, as available.

The DMS will continue to be updated as additional data are received through Castac Basin GSA-led stakeholder outreach and data collection efforts.

During DMS preparation and population, quality assurance/quality control (QA/QC) checks were conducted prior to analysis of groundwater conditions. These QA/QC efforts included:

- Removing duplicate wells and combining records for wells with multiple names and multiple entries, renaming data associated with previous well names to the standardized well name, and reconciling location, use, status, and data inventory information for each well;
- Plotting well locations and flagging wells whose locations are incorrect based on topographic maps and aerial imagery;
- Comparing well-specific ground surface elevation (GSE) information to the USGS Digital Elevation Model (DEM) data for the Basin to help determine that wells are plotted in the correct locations;
- Comparing GSE for a given well to its measuring point elevation (MPE) as a check on the validity of the MPE;
- Formatting water quality data to ensure flags such as non-detected concentrations were accurately represented, and standardizing the analyte names;
- Converting depth to water data to water level elevations based on the MPEs;

[17] https://drinc.ca.gov/drinc/DWPRepository.aspx

- Flagging suspect water level data in pumping wells. Inspection of hydrographs provided evidence for differentiation between non-pumping and pumping water levels in production wells based on observed differences in water levels, so likely pumping water levels were flagged; and
- Removing duplicate water level and water quality data entries.

The resulting dataset used to inform the analysis and discussion of groundwater conditions herein consists of:

- 15,614 groundwater elevation data points from 72 wells over the period from 9/1/1946 to 6/4/2019; and
- Groundwater quality data from 56 wells over the period from 1/7/1963 to 8/27/2018 which include 651 sample dates.

8.2. Groundwater Elevations and Flow Direction

§ 354.16. Groundwater Conditions
(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:
(1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

For the purposes of this analysis, the periods of Spring and Fall 2015[18] are used to represent seasonal high and low conditions under current land and water use.

8.2.1. Groundwater Elevation Contour Maps

Groundwater elevation contour maps for "current conditions" – Spring 2015 and Fall 2015 – are presented on **Figure GWC-1** and **Figure GWC-2**, respectively for the Principal Aquifer. Groundwater flow is driven by differences in potentiometric head (i.e., groundwater gradients) and groundwater generally flows perpendicular to groundwater elevation contours, moving from higher to lower hydraulic head.

Under 2015 conditions, groundwater levels decrease from west to east in the Castac Lake area of the Basin, from east to west in the Dryfield Canyon area of the Basin, and from south to north in the Grapevine Canyon area of the Basin. This indicates that groundwater flows towards Castac

[18] Spring 2015 includes water level measurements taken between 1/15/15 and 4/15/15. Fall 2015 includes water level measurements taken between 8/15/15 and 11/15/15.

Lake from the eastern and western areas of the Basin and then flows northward and out of Grapevine Canyon.

8.2.2. Vertical Gradients

Water levels in well pairs screened at various depths can indicate vertical flow between aquifer zones. Evaluation of vertical gradients can be accomplished by examination of water levels in well pairs where one well is representative of the upper aquifer zone (i.e., the Shallow Aquifer zone) and the other well is representative of the lower aquifer zone (i.e., the Deep Aquifer zone). This approach requires water level information from wells that:

a) have known well construction information;
b) are screened in different depth zones;
c) have contemporaneous measurements (i.e., water levels measured at least in the same year and season); and
d) are in close spatial proximity to each other (i.e., to reduce the influence of lateral gradients effects).

Two multi-depth monitoring well sites[19] (i.e., a pair of wells, one screened in the Shallow Aquifer zone, and the other screened in the Deep Aquifer zone) have been identified that meet the above criteria. Both sites are located within the Grapevine Canyon area of the Basin, and contemporaneous water level measurements are available for the time period 2007 through 2018. Vertical gradients are calculated for each site as the difference in groundwater elevation between the shallow and the deep well divided by the vertical distance between the midpoints of the screened intervals. A negative vertical gradient signifies upward flow between aquifer zones whereas a positive vertical gradient signifies downward flow between aquifer zones. Site locations and hydrographs are provided in **Figure GWC-3** and **Table GWC-1** summarizes the vertical gradients for "current conditions" – Spring 2015 and Fall 2015.

- Site 1, located in the southern part, closer to Castac Lake: Wells TRC-MW22 (screened 5-34 ft bgs) and TRC-MW22D (screened 89-289 ft bgs).

- Site 2, located more northerly, farther from Castac Lake: Wells TRC-MW23 (screened 20-35 ft bgs) and TRC-MW23D (screened 140-340 ft bgs).

At Site 1, data show that water levels within the Shallow Aquifer and Deep Aquifer zones generally moved in similar patterns over time (**Figure GWC-3**). Between March 2007 and August 2008, TRC-MW22D was flowing artesian (i.e., water levels in the well were above ground surface, and groundwater flowed from the well without being pumped). Since water-level measurements are difficult to obtain under such conditions, groundwater elevations and the subsequent

[19] Three additional multi-depth monitoring well sites exist within the Basin, however the wells screened within the shallow aquifer zone were dry during 2015 and therefore no vertical gradient could be calculated.

gradient calculations for that period are based on the well head (top of casing) elevation. From 2007 through 2011, the groundwater elevations were greater in the Deep Aquifer zone than in the Shallow Aquifer zone, indicating that an upward vertical gradient existed between the zones during that time. Groundwater elevations generally declined between 2007 and 2018, but the Deep Aquifer zone lost hydraulic head more rapidly than the Shallow Aquifer zone between 2007 and 2011. As head in the Deep Aquifer zone declined, upward gradients diminished (i.e., became less negative). Piezometric head in the Deep Aquifer zone remains greater than in the Shallow Aquifer zone through May 2016; starting in June 2016, the gradient intermittently switches between negative and positive (upwards and downwards). "Current" gradients represented by Spring and Fall 2015 are both slightly upward with gradient values of -0.0056 and -0.0017 ft/ft, respectively (**Table GWC-1**). Measured gradient magnitudes are greater at Site 1, indicating a greater driving head for water movement, or potentially the presence of greater restriction to flow, i.e., a local aquitard, more pronounced bedding, or other forms of aquifer anisotropy at that site, as compared to Site 2 further down the valley.

At Site 2, data show that water levels within the Shallow Aquifer and Deep Aquifer zones changed more or less in unison over time. In contrast to Site 1, the Deep Aquifer zone well at Site 2 has a shallower declining trend in groundwater elevations between 2007 and 2011. Therefore, the gradients from 2007 through 2018 remain around zero and fluctuate between negative and positive (upwards and downwards) with the seasonal fluctuations observed in the wells. "Current" gradients represented by Spring and Fall 2015 are slightly upward in the spring and slightly downward in the fall with gradient values of -0.0005 and 0.0002 ft/ft, respectively (**Table GWC-1**).

Table GWC-1. Vertical Gradients

Site	Well	Screen Interval (ft bgs)		Aquifer Zone	Spring 2015[a] Groundwater Elevation (ft MSL)	Spring 2015[a] Gradient (ft/ft)	Fall 2015[b] Groundwater Elevation (ft MSL)	Fall 2015[b] Gradient (ft/ft)
		Top	Bottom					
1	TRC-MW22	5	34	Shallow	3453.71	-0.0056	3452.20	-0.0017
	TRC-MW22D	89	289	Deep	3454.66		3452.49	
2	TRC-MW23	20	35	Shallow	3366.57	-0.0005	3362.75	0.0002
	TRC-MW23D	140	340	Deep	3366.38		3362.68	

Abbreviations:
ft bgs = feet below ground surface
ft MSL = feet above mean sea level

Notes:
a) Spring 2015 represents average values between 1/15/15 and 4/15/15.
b) Fall 2015 represents average values between 8/15/15 and 11/15/15.

8.2.3. Long-Term Groundwater Elevation Trends

Long-term trends in groundwater elevations were evaluated based on examination of hydrographs for nine wells throughout the Basin (**Figure GWC-4**) . Wells were selected for hydrograph analysis based on their length of record, their spatial distribution throughout the Basin, and their representativeness of conditions in their area.

Water level data collected from wells screened in the Deep Aquifer zone of the Castac Lake area of the Basin indicate that in the 1950's and 1960's, groundwater elevations declined to historically low values that are approximately 140 feet lower than the maximum groundwater elevations observed in 2006. As discussed below, this decline in groundwater elevations appears to be caused by climatic conditions at the time.

Water levels in this area recovered in the late 1970's through the 1990's. The water levels remained relatively high from the late 1990's through 2006, with some of the wells seasonally flowing artesian. Water levels from wells screened in the Shallow Aquifer zone are only available from approximately 1999 onward. Both Shallow Aquifer and Deep Aquifer zone wells in the Grapevine Canyon area of the Basin show fairly stable water levels over the historical record. In contrast, both Shallow Aquifer and Deep Aquifer Zone wells in the Castac Lake and Dryfield Canyon areas of the Basin show water levels generally declined from 2000 through 2004, partially recovered from 2005 through 2006, and declined again from 2007 through mid-2017, and stabilized from mid-2017 through 2018.

Review of historical rainfall data indicates that the large historical fluctuations in groundwater elevations in the Castac Lake and Dryfield Canyon areas of the Basin are likely the result of climatic variability. **Table GWC-2**, below, shows the DWR Water Year (WY)[20] Hydrologic Classification Index for the San Joaquin Valley[21] (i.e., water year type) for WY 1998 through 2018. For the 21 water years from 1998 through 2018, there were five "critical" (dry) years, five dry years, three below normal years, three above normal year, and five wet years.

[20] DWR defines a Water Year as extending from October 1 of the previous year to September 30 of the year in question. For example, Water Year 2015 extends from October 1, 2014 through September 30, 2015.
[21] http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

Table GWC-2. Summary of DWR Water Year Types, 1998-2018

Water Year	WY Index	Water Year	WY Index
1998	Wet	2009	Below Normal
1999	Above Normal	2010	Above Normal
2000	Above Normal	2011	Wet
2001	Dry	2012	Dry
2002	Dry	2013	Critical
2003	Below Normal	2014	Critical
2004	Dry	2015	Critical
2005	Wet	2016	Dry
2006	Wet	2017	Wet
2007	Critical	2018	Below Normal
2008	Critical	--	--

The climatic trends are reflected in the hydrographs for wells located within the Castac Lake and Dryfield Canyon areas of the Basin which tend to exhibit water level declines between 2000 and 2005 (dry years), water level increases between 2005 and 2006 (wet years), and water level decreases from 2007 onward (mostly dry and critically dry years). Hydrographs showing groundwater elevations in recent years (**Figure GWC-5**) show stabilization of and increases in water levels from mid-2017 onward.

The water levels at well TRC-PW60, which is located approximately a third of the way down Grapevine Canyon from Castac Lake (see **Figure GWC-4**), indicate that groundwater elevations have remained within 35 feet of the ground surface at that well throughout the historical record. Similarly, based on historical observations (Bookman and Edmonston, 1965), well TRC-PW81 remained flowing artesian throughout the 1950s and 1960s, which was a drought period. These data suggest that, in the Grapevine Canyon area of the Basin, long-term drought conditions have not historically resulted in significant groundwater elevation declines despite reduced recharge from precipitation and groundwater inflows from the Castac Lake area of the Basin.

8.3. Change in Groundwater Storage

> *§ 354.16. Groundwater Conditions*
> *(b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating 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.*

The Basin storage volume was estimated as the product of the aquifer volume and the assumed specific yield of the aquifer sediments. Based on a summation of sub-volumes for portions of the irregularly shaped Basin, the total volume of the aquifer materials is estimated to be approximately 2.02E+10 cubic feet (ft^3), or 465,000 acre-feet (AF). The total porosity of the aquifer materials was estimated to be 20 percent. This value has been previously used by both Schmidt (2002) and Galli (2005) for storage estimates of similar aquifer materials in the upgradient Cuddy Canyon Basin. Therefore, the maximum storage volume of the aquifer is estimated based on these assumptions to be approximately 93,000 AF.

An initial ("first-order") estimate for the Basin's change in groundwater storage was estimated using data for the most recent ten-year period (WY 2009-2018). This period encompasses the highest resolution water level data available, paired with extreme climatic conditions. The method used to estimate storage change for uses water level data collected at the start and end of the period, spatially-variable specific yield information, and the following relationship, applied in a distributed manner:

*Change in Storage = [Ending Water Level – Starting Water Level] * Specific Yield * Area*

Representative wells used in the long term and recent hydrographs, as shown on **Figure GWC-4** and **Figure GWC-5**, were selected to calculate changes in water levels. Since the Castac Lake and Dryfield Canyon areas of the Basin share similar aquifer and hydrogeologic properties, they were grouped together for the purpose of this analysis. The acreage of sub-areas is shown in **Table GWC-3**. Three representative wells are located within the Grapevine Canyon area of the Basin, and nine representative wells are within the Castac Lake and Dryfield Canyon areas of the Basin. An average trend from these representative wells over the most recent ten-year period (WY 2009-2018) were calculated for each sub-area, and represents the change in water level.

As part of the historical water budget approach, specific yield was calibrated using the average groundwater elevation for the Castac Lake and Dryfield Canyon areas, and a general assumption of unconfined conditions for the entire Basin. This calibrated specific yield value of 0.12 is greater than the storage coefficients estimated from aquifer pumping tests (**Table HCM-2**) likely due in part to the limited spatial variability represented in the historical water budget approach. Using 0.12 value as a Basin-wide specific yield therefore likely overestimates the average change in Basin groundwater storage.

Using the parameters specified in **Table GWC-3** below, and the equation presented above over the period WY 2009-2018, an estimate for the average change in storage within the Grapevine Canyon area was calculated to be a loss of 70 acre-feet per year (AFY), and the estimated average change in storage within the Castac Lake and Dryfield Canyon areas was calculated to be -1,150 AFY; thus, the total estimated groundwater storage loss over the period is approximately 1,200 AFY. As mentioned above, these values represent an upper-end range of the average change in storage. If the storage coefficient estimated from aquifer pumping tests in the Shallow Aquifer zone (0.0025) was used instead, the average change in storage would decrease to -1.5 AFY in Grapevine Canyon and -24 AFY in Castac Lake and Dryfield Canyon, totaling approximately 26 AFY of groundwater storage loss. The actual change in storage therefore likely falls somewhere between the two estimates.

Table GWC-3. Approximate Change in Storage Calculated from Water Levels, 2009-2018

Area	Acres	Storativity	Average Trend (ft/yr)	Average Change in Storage (AFY)
Grapevine	1,402	0.12	-0.43	-70
Castac Lake and Dryfield Canyon	2,161	0.12	-4.45	-1,150

Abbreviations:
AFY = acre-feet per year
ft/yr = feet per year

Notes:
1. Average change in storage is rounded to the nearest 10 AF.

Another, more detailed analysis of annual changes in groundwater storage was completed using output from the historical Water Budget model, described further in Section 9 *Water Budget Information* below. **Figure GWC-6** shows the estimated annual change in storage between seasonal water level highs (i.e., from March of each year to February of the following year) and WY type based on DWR's San Joaquin Valley WY Index for WY 1998-2018. As shown on **Figure GWC-6**, annual change in storage ranged from an increase of approximately +1,200 AF for the period from March 1998 – February 1999 to a decrease of approximately -1,700 AF for the period from March 2009 – February 2010, which approximately agrees with the first-order estimate shown in **Table GWC-3** above.

Change in Basin storage appears to be significantly influenced by climate. **Figure GWC-7** plots the estimated historical cumulative storage change and rainfall cumulative departure from average, based on the record measured at the Lebec National Oceanic and Atmospheric Administration (NOAA) station between 1948 and 2019.[22] As shown in **Figure GWC-7**, change in storage is negative during dry years when the cumulative departure decreases, and generally positive during wet years when the cumulative departure increases. **Figure GWC-7** also plots the estimated annual volume of groundwater pumping in the Basin. During the water budget period considered, groundwater pumpage decreased over time.

[22] NOAA Lebec climate station Coop ID #44863 www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4863

8.4. Seawater Intrusion

> *§ 354.16. Groundwater Conditions*
> *(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.*

The Basin is located far from coastal areas, therefore seawater intrusion is not considered to be a threat to groundwater resources.

8.5. Groundwater Quality Concerns

> *§ 354.16. Groundwater Conditions*
> *(d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.*

Groundwater quality constituents that may affect the supply and beneficial uses of groundwater in the Basin were identified by comparing the highest measured concentration detected at individual wells for several constituents to applicable Maximum Contaminant Levels (MCLs). Primary MCLs are drinking water standards set by the United States Environmental Protection Agency (USEPA) and California Environmental Protection Agency (CalEPA) based on human health considerations. Secondary MCLs are non-health related standards set by the State Water Resources Control Board (SWRCB) based on aesthetic characteristics of drinking water such as taste, odor, and color. For four common constituents (i.e., total dissolved solids [TDS], specific conductance, chloride, and sulfate), the SWRCB sets three levels of secondary MCLs for consumer acceptance, referred to as (lowest to highest concentration): “recommended”, “upper”, and “short term”. Very limited water quality data is available from the last 10-years, therefore we examined water quality data between 1998 through 2019 for recent conditions. **Table GWC-4** below tabulates the MCLs and summarizes the number of wells sampled from 1998 through 2019 with MCL exceedances. In addition to data available from the Castac Basin DMS, the online water quality data sources identified in *Appendix E* were reviewed and used to supplement the analysis described in this and the following sections.

As discussed in more detail below, based on the limited water quality data for the Basin, constituents in well-water samples associated with potential health risks (i.e., exceeded the primary MCL) are identified as the primary potential water quality constituents of concerns within the Basin: arsenic, fluoride, uranium, and TDS.

Table GWC-4. Well-water samples exceeding MCLs, 1998-2019

Constituent	MCL (mg/L)		Number of Wells Sampled	Number of Wells Exceeding MCL
	Primary	Secondary		
Arsenic	0.01	-	25	1
Fluoride	2	-	28	8
Lead	0.015[(a)]	-	24	0
Nitrate as N	10	-	28	0
Selenium	0.05	-	24	0
Uranium	0.03	-	13	4
TDS	-	500	26	21
Chloride	-	250	25	0
Iron	-	0.3	22	5
Manganese	-	0.05	23	4
Sulfate	-	250	24	2

Abbreviations:
MCL = maximum contaminant level
mg/L = milligrams per liter

Notes:
(a) The MCL for lead was rescinded with the adoption of a Regulatory Action Level in 1995 in which systems must take certain actions if an Action Level is exceeded. The Action Level replaces the MCL.

8.5.1. Primary MCL Exceedances

Constituents for which samples exceeded the primary (i.e. health risk-based) MCL include arsenic, fluoride and uranium:

- **Arsenic** ingestion has been associated with an increased risk of cancer and other chronic health effects, and concentrations that exceed the MCL in drinking water sources are a significant human health concern (USEPA, 2001). The primary MCL for arsenic is 10 micrograms per liter (ug/L; 0.01 milligrams per liter [mg/L]) and the Agricultural Water Quality Goal is 100 ug/L (0.1 mg/L). As shown in **Figure GWC-8**, the maximum historical (prior to 1998) arsenic concentrations were detected at concentrations below the MCL, and only one well has had a detection above the MCL in recent (1998-2019) sampling events.

- **Fluoride** concentrations in drinking water can be a significant health concern, including bone disease and pain or bone tenderness, associated with concentrations exceeding 4 mg/L, and mottled teeth in children ("dental fluorosis") associated with concentrations exceeding the MCL (Title 22 CCR Article 18 § 64465). The primary MCL for fluoride is 2 mg/L. As shown in **Figure GWC-9**, eight wells have had detections above the MCL in recent (1998-2019) sampling events. High fluoride concentrations have been a concern for the

KMWC public supply well. As shown in the chemograph for the KMWC well in *Appendix E*, in recent years fluoride concentrations exceed the MCL, which has resulted in KMWC conducting a Fluoride Mitigation Project in which various alternatives for addressing increased levels of fluoride were analyzed (Quad Knopf, Inc., 2019).

- **Uranium** is a naturally-occurring groundwater constituent within the Basin, and is occasionally detected at low levels in some wells (LCWD, 2019). Ingestion of drinking water which contains uranium concentrations exceeding the MCL may cause kidney problems or an increased risk of cancer (Title 22 CCR Article 18 § 64465). The source of uranium and other radioactive trace groundwater constituents has been attributed to the slow weathering of granitic rocks in the Basin (EKI, 2008c). Associated alpha radiation also may be potentially driven by the movement of radon gas along local fault splays or fractured bedrock zones (EKI, 2008c). The primary MCL for uranium is 30 micrograms per liter (ug/L; 0.03 mg/L). Limited water samples analyzed for uranium (**Figure GWC-11**) show that wells exceeding the MCL in recent years are scattered throughout the Basin.

Nitrate can pose a significant health concern for pregnant women and infants if concentrations exceed the MCL, as elevated levels of nitrate can cause methemoglobinemia ("blue baby syndrome") (McCasland et al., 2012). The primary MCL for nitrate as nitrogen is 10 mg/L or nitrate as nitrate is 45 mg/L. The available analytical data, both historical (prior to 1998) and recent (1998-2019) for nitrate as nitrogen from sampled wells have been below the MCL (see **Figure GWC-10**). Two temporary grab groundwater samples collected in 1999 exceeded the MCL, but these are by their nature variable "snapshots", sampled under relatively uncontrolled conditions, which cannot be re-sampled for confirmation, thus they generally are not considered representative of long-term groundwater conditions. Therefore, although nitrate has been detected in samples from Basin groundwater, it is not considered a constituent of concern based on the existing data.

8.5.2. Secondary MCL Exceedances

Constituents for which samples exceeded the secondary (i.e. aesthetically-based) MCLs include TDS, iron, manganese, and sulfate:

- Historical (prior to 1998) and recent (1998-2019) TDS concentrations detected within Basin groundwater generally have been above the recommended secondary MCL of 500 mg/L. Concentrations exceeding the upper secondary MCL and short-term secondary MCLs (1,000 mg/L and 1,500 mg/L, respectively) were detected in a Shallow Aquifer zone monitoring well located down gradient of Castac Lake (see **Figure GWC-12**). The average measured TDS value for the Castac Lake water was approximately 1,600 mg/L. Additionally, elevated TDS concentrations measured in areas located adjacent to the Grapevine Canyon wetlands, where high evaporative losses are likely to occur, may have historically increased the concentration of constituents in the groundwater. Although TDS is not generally considered to effect human health, it is an indication of aesthetic characteristics of drinking water and can include an aggregated broad array of potential chemical contaminants. Therefore, TDS is considered a potential water quality COC for the Basin.

- Iron is an essential element in the metabolism of animals and plants, however if concentrations are excessive it can cause staining and is therefore considered an objectionable impurity (Hem, 1970). As detailed in **Table GWC-4** above, five wells have recent (1998-2019) concentrations which exceed the secondary MCL of 0.3 mg/L.
- Manganese is an essential element for plants and animals, but it is an undesirable impurity in water supplies as black oxide stains can occur if concentrations are sufficiently high (Hem, 1970). As detailed in **Table GWC-4** above, three wells within the Basin have recent (1998-2019) concentrations which exceed the secondary MCL of 0.05 mg/L.
- Sulfate occurs widely in soil and water (Hem, 1970). As detailed in **Table GWC-4** above, two wells (TRC-MW3S and TRC-MW23W) have recent (1998-2019) concentrations which exceed the recommended secondary MCL of 250 mg/L. These wells both are screened in the upper part of the shallow aquifer zone; concentrations from wells screened in the deeper aquifer zone do not have sulfate concentrations which exceed the secondary MCL.

8.5.3. Water Quality Trends

Available concentration data for constituents which exceeded the primary MCL or were considered a potentially significant health concern or COC were evaluated with respect to changes over time, and in relationship to groundwater levels. Available TDS, fluoride, arsenic, uranium, and nitrate chemographs (plots of concentration versus time) are presented in Appendix E. *Temporal Characteristics of Available Groundwater Data*. Several online sources from public agencies have been queried for additional data (see *Appendix E*), but additional available data are limited.

A total of 15 wells within the Basin have at least four water quality measurements between 1998 and present. A Mann-Kendall trend analysis was performed on these wells to determine whether concentrations exhibit a significant trend. For the purpose of this analysis, a trend identified from the Mann-Kendall test with p-value that is less or equal to 0.05 is considered to be significant. Among the 15 wells examined, three of the wells show statistically significant decreasing trends in fluoride (well TRC-PW81), nitrate (well TRC-PW81 and Tejon MS Well), and uranium (well LCWD-Lebec PW) concentrations. Seven of the wells show statistically significant increasing trends in arsenic (well Krista MWC-PW), nitrate (well TRC-MW90, TRC-PW56A, TRC-PW60, TRC-PW80, LCWD-Lebec PW and LCWD-State PW), TDS (well TRC-PW60 and LCWD-State PW), and uranium (well TRC-PW60 and LCWD-State PW). **Table GWC-5** below summarizes the number of wells exhibiting statistically significant trends for each COC.

Table GWC-5. Wells with Significant Water Quality Trends, 1998-2019

Constituent of Concern	Total Number of Wells[(a)]	Number of Wells with Decreasing Trend	Number of Wells with Increasing Trend
Arsenic	11	0	1
Fluoride	11	1	0
Nitrate as N	15	2	6
TDS	9	0	2
Uranium	11	1	2
Total Trend	-	4	11
Total Well	15	3	7

Notes:
a) Wells with at least four water quality measurements between 1998 and present.

Recent water quality concentration data within the Basin are very limited. An evaluation of the available water level and water quality data show that (1) some wells do show a weak correlation between water levels and certain potential COCs concentrations, (2) some wells show no correction between water levels and potential COCs concentrations, and (3) most wells have insufficient data to conduct statistical analyses.[23] As shown in *Appendix E*, in some cases when concentrations show a statistically significant increasing trend, water levels exhibit a decreasing trend in the same well, suggesting a potential correlation that may need further investigation once additional data are available.

Three correlation models, Pearson (linear), and Kendall and Spearman (non-linear), were considered when evaluating the potential relationship between water levels and water quality. The correlation is considered to be significant when the p-value of the correlation coefficient is less or equal to 0.05. Monthly average values were calculated for both water level and water quality data, and the correlation was evaluated when at least five data points were available in each well. As shown in *Appendix E*, only four wells (Krista MWC-PW, LCWD-Lebec PW, LCWD-State PW, and TRC-PW60) have more than five data points. All three correlation models suggest that the wells LCWD-Lebec PW and LCWD-State PW show negative correlation between water level and nitrate concentration. LCWD-State PW also shows negative correlation between water level and uranium concentration. In general, limited water level data exist for the wells for which water quality data are available. As discussed in Section *16 Description of Monitoring Network*, future monitoring efforts will include compilation of water quality data from public water system

[23] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.

wells and the collection of water quality data from supplemental monitoring wells. These data and any associated trends will be evaluated in future reporting.

8.5.4. Point-Source Contamination Sites

In addition to the non-point source groundwater quality COCs detailed above, there are a small number of point-source contamination sites within the Basin as identified on the SWRCB GeoTracker website[24]. These sites, shown on **Figure GWC-13**, are typically associated with certain industrial or commercial land uses (e.g. gas stations). Within the Basin, there are 12 Leaking Underground Storage Tank (LUST) sites and one cleanup program site. All 12 LUST sites are closed and inactive and the identified contaminants of concern include gasoline (ten sites), motor oil (one site), and lead (one site).

The one cleanup program site (Mobil M-1 Crude Oil Pipeline; SL205724284) has been closed as of December 2018. Potential contaminants of concern in soil and groundwater included crude oil, gasoline, and polynuclear aromatic hydrocarbons (PAHs)[25]; the Basin aquifer was identified as a potentially affected media of concern. In 2017, a site assessment determined that residual hydrocarbon concentrations present in soil, soil vapor, and groundwater met the Low-Threat Closure Policy and therefore do not pose a significant risk to human health (Central Valley Regional Water Quality Control Board [CVRWQCB], 2018a). Water supply well TRC-PW81, which services the public water system associated with the TRC headquarters, is located approximately 750 feet in a cross-gradient direction from the plume area; water samples collected from TRC-PW81 did not contain detectable concentrations of hydrocarbons (CVRWQCB, 2018a). In December 2018, site data indicated that criteria for No Further Action status under the Low-Threat Underground Storage Tank Case Closure Policy was achieved and the site was granted closure (CVRWQCB, 2018b).

A land disposal site (Lebec Sanitary Landfill; L10005571106) is located directly up-gradient from the Basin. The landfill is closed, with active monitoring ongoing. Although the landfill is located outside of the Basin, groundwater flow is estimated at approximately 190 feet per year to the southeast (towards the Basin), based on estimated aquifer dimensions, monitoring well water-level data from 2017, and a hydraulic conductivity of 6.1×10^{-4} feet per day (Kern County Public Works Department, 2017). Volatile Organic Compounds (VOCs) and inorganic general chemistry are monitored within on-site monitoring wells. In April 2018, low concentrations of some VOCs were detected, but these generally have decreased from historical concentrations, suggesting effective site remediation by natural attenuation (Kern County Public Works Department, 2018). In April 2018, nitrate, sulfate and TDS exceeded their respective MCLs in samples collected from three monitoring wells, however concentrations were generally consistent with historical concentrations (Kern County Public Works Department, 2018).

[24] http://geotracker.waterboards.ca.gov
[25] https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL205724284

8.6. Land Subsidence

> *§ 354.16. Groundwater Conditions*
> *(e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

Publicly available recent data on land subsidence (Farr et. al, 2016) shows that it is not likely to be a significant concern in the Basin. **Figure GWC-14** reproduces recent subsidence maps produced from Interferometric Synthetic Aperture Radar (InSAR) data between May 2015 and July 2016[26], and shows no major subsidence has occurred in the recent period of groundwater level decline associated with dry climatic conditions. The amount of subsidence mapped within the Basin falls within the range of possible error in subsidence measurement methods using remote sensing (i.e., on the order of 0.25 to 1 inch [Farr et. al, 2016]).

The closest continuous subsidence monitoring site, Grapevine_CS2005, is located on bedrock or in very thin soil outside the Basin to the west (**Figure GWC-14**). This site has experienced 0.16 inches of accretion (increases in land surface elevation) between 2005 and 2018[27], which indicates bedrock movement along existing faults or fracture sets. This structural movement in the underlying bedrock may complicate interpretation of seismic data in alluvial sediments of the Basin.

Inspection of hydrographs presented in **Figure GWC-4** and **Figure GWC-5**, show that current groundwater elevations are approximately 20 to 60 feet above historical lows. Irreversible subsidence typically occurs when groundwater levels decline below historical lows and subsurface sediments contain a large fraction of clay-sized particles, or when clay interbeds make up a significant fraction of the stratigraphic thickness of the aquifer. The observed stabilization and general recovery in water levels over much drier conditions in the past fifty years has reduced the threat of subsidence in the Basin. Thus, subsidence-related problems within the Basin are not likely to be a concern as long as water levels remain above historical low levels observed in the 1960s.

8.7. Interconnected Surface Water Systems

> *§ 354.16. Groundwater Conditions*
> *(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

[26] https://data.cnra.ca.gov/dataset/nasa-jpl-insar-subsidence
[27] https://www.unavco.org/instrumentation/networks/status/pbo/data/P553

Interconnected surface water is defined in the GSP regulations [23-CCR §354(o)] 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." Furthermore, the definition of interconnected surface water requires that the surface water feature not be completely depleted (i.e., not dry). **Figure GWC-15** depicts the location of potentially interconnected surface water systems, including Cuddy Creek, Grapevine Creek, and Castac Lake.

Cuddy Creek flows intermittently from the up-gradient Cuddy Canyon Basin towards Castac Lake. However, due to the permeable nature of the alluvium in the bottom of Cuddy Creek, flows from Cuddy Creek only reach Castac Lake during significant rainfall events (Wood, 1912). Very limited historical flow data is available for Cuddy Creek. Peak streamflow values measured between 1980 and 2017 near Lebec[28] ranged from 0 cubic feet per second (cfs) to 2,400 cfs (see **Figure GWC-15** for station location). As can be seen on **Figure GWC-15**, most of Cuddy Creek streamflow is associated with runoff from winter precipitation events, as very little to no flow occurs in the summer months (June to October). Depth to groundwater measurements in monitoring well TRC-MW16D, which is located near the Cuddy Creek gaging station, show a continual decline since measurements began in 2007. Spring 2015 depth to groundwater was greater than 60 feet below ground surface (ft bgs). As Cuddy Creek typically has very little to no flow and as of Spring 2015, the measured deep depth to groundwater in adjacent monitoring well TRC-MW16D (i.e., 134 ft bgs) suggests Cuddy Creek is disconnected from the groundwater system.

The channel of Grapevine Creek originates at Castac Lake, however overflows from Castac Lake into Grapevine Creek only occur on rare occasions when the lake has water in it and water surface elevations exceed the spillway elevation. Springs located near Fort Tejon and the TRC headquarters, approximately one-mile northwest of Castac Lake, are the primary source of perennial feedwaters (Wood, 1912; Bookman Edmonston, 1965). Grapevine Creek flows were measured intermittently between 2000 and 2007 (see **Figure GWC-15** for station locations). As can be seen on **Figure GWC-15**, streamflow measurements near the headwaters (Tejon Lake Drive) were less than those measured downstream (I-5 Undercrossing and Lebec Road). Spring 2015 depth to groundwater at the Grapevine Creek headwaters range from 30 ft bgs to 60 ft bgs, however moving northward (and downslope) into Grapevine Canyon, depth to groundwater decreases to typically less than 15 ft bgs. As shown in **Figure HCM-9** and **Figure HCM-10**, alluvial aquifer materials decrease in thickness and lateral extent moving north towards the Basin outlet which causes groundwater to discharge to the surface into Grapevine Creek as baseflow. Since Grapevine Creek has segments which seemingly are fed by groundwater, and depth to groundwater is shallow near the northern end of the Basin within Grapevine Creek, it appears that some segments of Grapevine Creek are a gaining stream in which surface flow rates increase due to inputs from groundwater.

[28] Kern County Station 108C Cuddy Creek (Lebec) M-35-9-20

Although it is often dry, Castac Lake historically has been observed to be connected with the surrounding aquifer, with groundwater seepage occurring both into and out of the lake when gradients are favorable (Bookman Edmonston, 1965; Trihey and Associates, 1997; Dudek & Associates, 1999). The volume of shallow groundwater seepage to and from the lake is difficult to quantify, however. Seepage out of the lake returning into the groundwater system ("return flow") only occurs when groundwater elevations at the mouth of Grapevine Canyon (i.e., at well TRC-MW3S) are less than the Castac Lake water elevation. Historically, Castac Lake has been partially full to empty over the past 100 years with rare instances of lake filling caused by large rainfall events (Bookman Edmonston, 1965; Laskowski, 1968; Trihey and Associates, 1997; Dudek & Associates, 1999). Further, between 2001 and 2008 and in 2012, groundwater was pumped into the lake by Tejon Ranch Corporation (TRC) to maintain lake water levels, which were consistently higher than nearby groundwater elevations. Once groundwater pumping into the lake ended, Castac Lake levels declined due to seepage and drought conditions. In recent years, Castac Lake has little to no water.

Return flow from Castac Lake to the Basin can be estimated using Darcy's Law in which groundwater flow (Q) is calculated by multiplying an estimated hydraulic gradient ($\frac{dh}{dl}$), hydraulic conductivity (K), and area of flow (A) as follows:

$$Q = K\frac{dh}{dl}A$$

where:

- K is estimated to be 5.25 feet per day (ft/d) based on the average horizontal hydraulic conductivity estimated for the Shallow Aquifer zone (10.5 ft/d) and the calibrated vertical hydraulic conductivity of the lake bed sediments from the Castac Basin Numerical Model (0.001 ft/d);
- dh is the change in water levels elevations between Castac Lake and the Shallow Aquifer zone groundwater elevation at the mouth of Grapevine Canyon, represented by well TRC-MW3S;
- dl is the distance between Castac Lake and TRC-MW3S; and
- A is the cross-sectional area through which the water seeps out of Castac Lake, estimated to be approximately 12 acres.

Castac Lake levels are only available between 2000 and 2007 and intermittently between 2010 and 2015; the average volume of water estimated to seep out of Castac Lake over this period was approximately 40 AFY. After 2015, Castac Lake was primarily dry, with seasonal shallow levels attributed to direct precipitation events. For example, Castac Lake contained water during Spring 2019, however lake levels were relatively shallow (less than 1-foot deep). High-resolution water level data collected from the lake, and shallow monitoring wells adjacent to the lake suggest lake levels and nearby groundwater elevations are affected by evapotranspiration. Furthermore, stable isotope data collected from the lake, nearby wells, and Grapevine Creek corroborates a highly evaporative signature within the lake that is also slightly evident in nearby wells (see Appendix *E* for stable isotope plot).

8.8. Groundwater Dependent Ecosystems (GDEs)

> *§ 354.16. Groundwater Conditions*
> *(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

Groundwater Dependent Ecosystems (GDEs) are those natural communities that depend on near-surface groundwater as a source of water. DWR has developed a map of natural communities commonly associated with groundwater (NCCAG) for use by GSAs in identifying land areas by vegetation categories that may indicate the potential for GDEs. **Figure GWC-16** shows the distribution of NCCAG areas identified within the Basin; approximately 26% of the Basin is covered by potential NCCAG areas, with 11% classified as potential wetland (including Castac Lake) and 14% classified as vegetation. These classifications are estimates based on remotely-obtained data and as such do not necessarily indicate the presence of actual GDEs.

As shown on **Figure GWC-16**, Castac Lake is the primary area in which NCCAG areas were identified, with emergent wetlands vegetation surrounding Castac Lake in the areas that historically were inundated with water during periods of high lake levels. A direct hydrologic connection may exist between the soil and alluvium beneath the lake, and the surrounding potential wetlands. During periods of relatively lower lake levels, lake water could be drawn into these wetlands through saturated lakebed sediments and alluvium to feed the evaporative demands of this vegetation.

The vegetation NCCAG located within the Basin may include groups or species such as Fremont Cottonwood, Riparian Mixed Hardwood, Valley Oak, Wet Meadows, Willow, and Willow (shrub). It is important to note that the actual presence of these plant species or groups has not been field-verified in the Basin for over a decade, and the true areas of GDEs under current groundwater depth conditions may vary widely from the NCCAG dataset.

Table GWC-6 (below) summarizes maximum plant rooting depths for the indicator species, as compiled by The Nature Conservancy (TNC), to assist in determining if vegetative species within the NCCAG dataset are accessing groundwater.[29] Groundwater depth measured in shallow wells near the NCCAG areas ranges from less than 15 ft bgs in the Grapevine Canyon area of the Basin, to greater than 30 ft bgs in the Castac Lake area of the Basin (**Figure GWC-16**). The groundwater depths in the Grapevine Canyon area of the Basin may support the maximum rooting depths of plants potentially included in the NCCAG, however, in the Castac Lake area of the Basin, current groundwater depths likely are below the GDE maximum rooting depths shown in **Table GWC-6**.

[29] https://groundwaterresourcehub.org/sgma-tools/gde-rooting-depths-database-for-gdes/

Thus, most of the existing plant community in the Basin is likely using little groundwater under current conditions. Ephemeral communities of phreatophytes may colonize areas of shallow groundwater in wet years, and become dormant or die out in dry periods, as has occurred in the past.

Mapping of vegetation and wetland areas was conducted in 2008 as part of the Tejon Mountain Village (TMV) Environmental Impact Report (Kern County Planning Department, 2009b). *Appendix F* contains copies of these maps, which generally agree with the NCCAG mapped areas. As part of the TMV Habitat Management Plan, some areas within the Grapevine Canyon area of the Basin were mapped as wetlands in 2007 (Appendix F).

Table GWC-6. Maximum Plant Rooting Depths (after TNC)

NCCAG	Maximum Rooting Depth (feet)[a]
Fremont Cottonwood	0.66 to 6.89
Riparian Mixed Hardwood	--
Valley Oak	24.02 to 24.31
Wet Meadows[b]	0.69 to 24.31
Willow	2.362
Willow (shrub)	2.362

Notes:

(a) Maximum rooting depth was not available for all NCCAG.

(b) Based on the maps provided in *Appendix F*, wet meadows may contain various species including red willow, common three-square, rush riparian grassland, valley oak, tule, creeping ryegrass grassland, and perennial pepperweed.

The GDE Pulse Interactive Map[30] developed by TNC, which uses remote sensing data from satellites to monitor the health of vegetation, can be used to assess long-term temporal trends of vegetation metrics in the Basin. The vegetation metrics include Normalized Derived Vegetation Index (NDVI) which estimates vegetation color ("greenness") and Normalized Derived Moisture Index (NDMI) which estimates vegetation moisture, both of which can indicate vegetation health for GDEs.

The GDE Pulse tool calculates linear trends in NDVI and NDMI over three timeframes: 1985-2018, 2009-2018, and 2010-2014. Over the long term (i.e., 1985 - 2018), Basin NDVI and NDMI trends generally have been stable, with local or shorter term declines or in some cases, increases. Over the past 10 years which have been primarily dry, both NDVI and NDMI show large decreasing trends in the central Basin, and NDVI shows a moderate increasing trend in the northern portions of the Basin. Over the drought period of 2010-2014, both NDVI and NDMI show large decreasing

[30] https://gde.codefornature.org/#/map, accessed on 17 March 2020.

trends in area southwest of the Castac Lake, and NDMI shows a large increasing trend in the central Basin.

Appendix F includes screenshots of the GDE Pulse Interactive Map for three selected polygons that are spatially representative of the Basin. The NDVI and NDMI trends shown in the GDE Pulse generally align with the long-term water level trend discussed in Section 8.2.3. Specifically, the Grapevine Canyon area of the Basin shows fairly stable water levels over the historical record. In contrast, water level in the Castac Lake and Dryfield Canyon areas of the Basin generally declined from 2000 through 2004, partially recovered from 2005 through 2006, declined again from 2007 through mid-2017, and stabilized from mid-2017 through 2018.

In addition to vegetation and wetland communities, other environmental users of groundwater also may include species reliant on surface water. TNC has compiled a list of freshwater species potentially located within each groundwater basin, for use by GSAs to evaluate the possible presence of these species[31]. *Appendix G* contains copies of this TNC list, which includes 31 unique species grouped into four taxonomic groups: herps (i.e., reptiles), mollusks, birds, and plants.

As of April 2015, the bald eagle and tricolored blackbird are on the Federal Endangered Species List as “Birds of Conservation Concern” and the California red-legged frog is listed as “Threatened”. Also, seven species on the California Endangered Species or Sensitive Species lists including the western pond turtle, California red-legged frog, tricolored blackbird, redhead, American white pelican, two-striped garter snake, and Pringles’ yampah (a member of the parsley family) are listed as of “Special Concern”, and the bald eagle is listed as “Endangered”.

Mapping of wildlife species conducted as part of the TMV Environmental Impact Report did not detect the California red-legged frog on the site, the bald eagle was observed infrequently during winter, and the tricolored blackbird was observed to be nesting near fresh water and emergent wetlands (Kern County Planning Department, 2009b). Appendix F *Supplemental Wetlands, Vegetation, and Special Species Maps* contains copies of the TMV Environmental Impact Report maps, which show occurrences of special status species within and surrounding the Basin. In general, the maps (completed in 2008 during wetter conditions) show a few spatially-limited occurrences of special-status species within the Basin, including Tehachapi slender salamander, coast horned lizard, two-striped garter snake,

As discussed above, before areas of the Basin can be classified as hosting GDEs, additional field-based data may need to be collected over different seasons, such as ground-mapping of plant and animal communities, examination of soil moisture and groundwater levels, and other factors.

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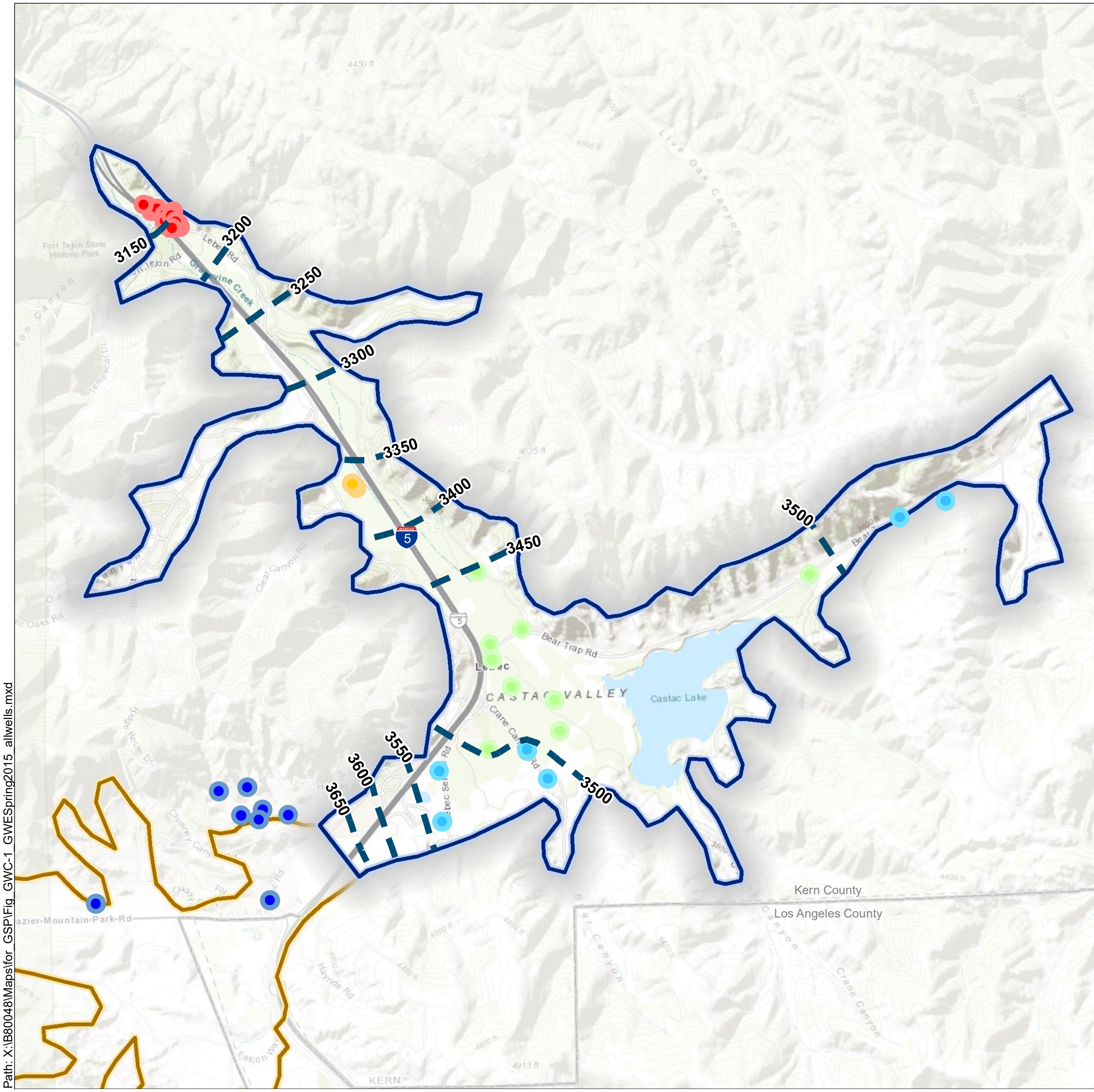
[31] https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/



Legend

Groundwater Elevation Contour (ft msl)

Spring 2015 Groundwater Elevation (ft msl)

- <3,200
- 3,200-3,400
- 3,400-3,500
- 3,500-3,600
- >3,600

Castac Lake Valley Groundwater Basin

Other Groundwater Basin

County Boundary

Abbreviations

DWR = California Department of Water Resources

ft msl = feet above mean sea level

Notes

1. All locations are approximate.
2. Contour interval: 50 feet
3. Groundwater elevation contours were created using an interpolation process called kriging and are less certain in areas with sparse data.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

N

0 0.5 1

Miles

Groundwater Elevations Spring 2015

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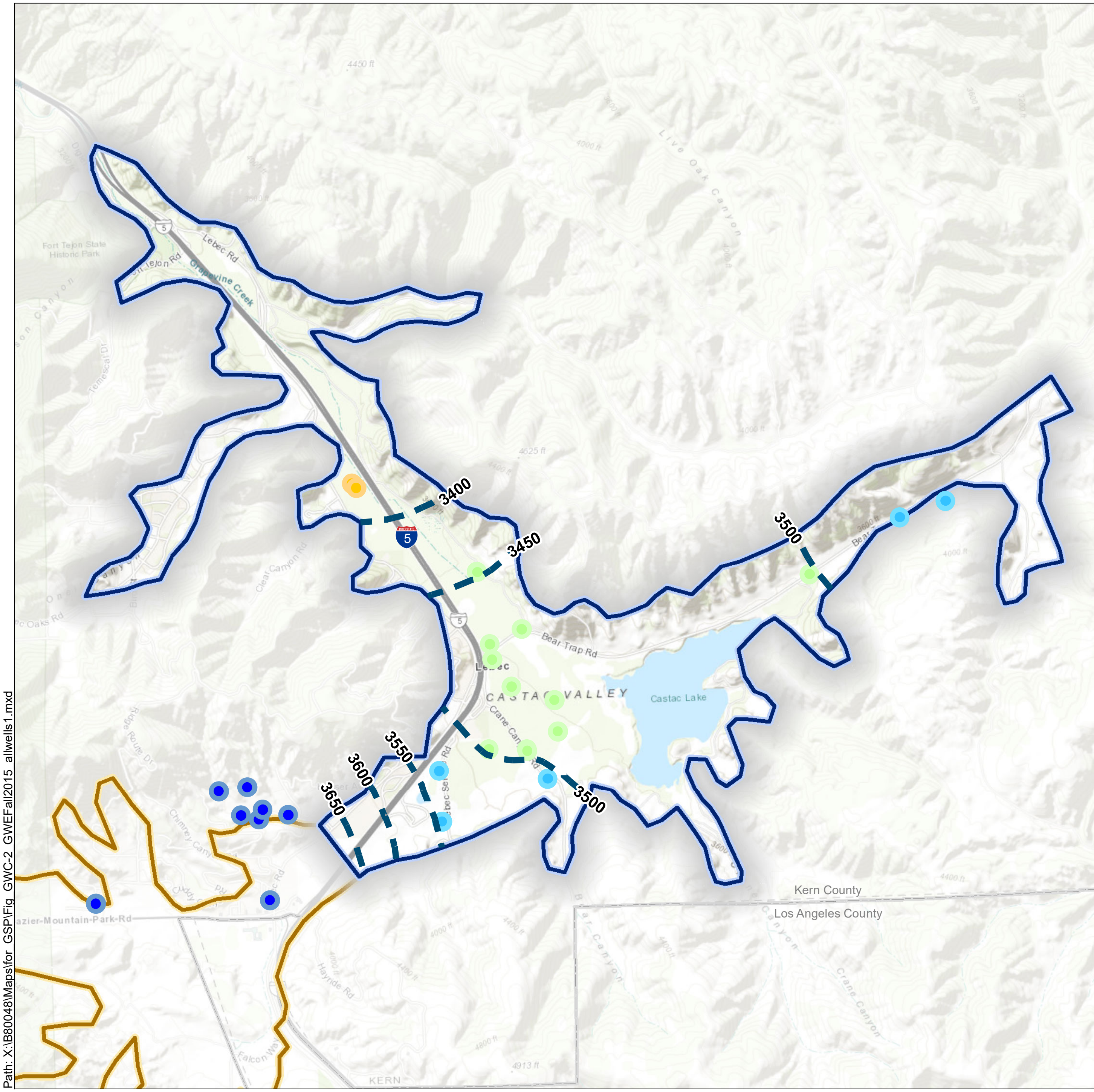
September 2020
B80048.00

Figure GWC-1

Path: X:\B80048\Maps\for_GSP\Fig_GWC-1_GWESpring2015_allwells.mxd



Legend

Groundwater Elevation Contour (ft msl)

Fall 2015 Groundwater Elevation (ft msl)

- <3,200
- 3,200-3,400
- 3,400-3,500
- 3,500-3,600
- >3,600

Castac Lake Valley Groundwater Basin

Other Groundwater Basin

County Boundary

Abbreviations

DWR = California Department of Water Resources

ft msl = feet above mean sea level

Notes

1. All locations are approximate.
2. Contour interval: 50 feet
3. Groundwater elevation contours were created using an interpolation process called kriging and are less certain in areas with sparse data.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

N

0 0.5 1

Miles

Groundwater Elevations
Fall 2015

Tejon-Castac Water District
Kern County, California
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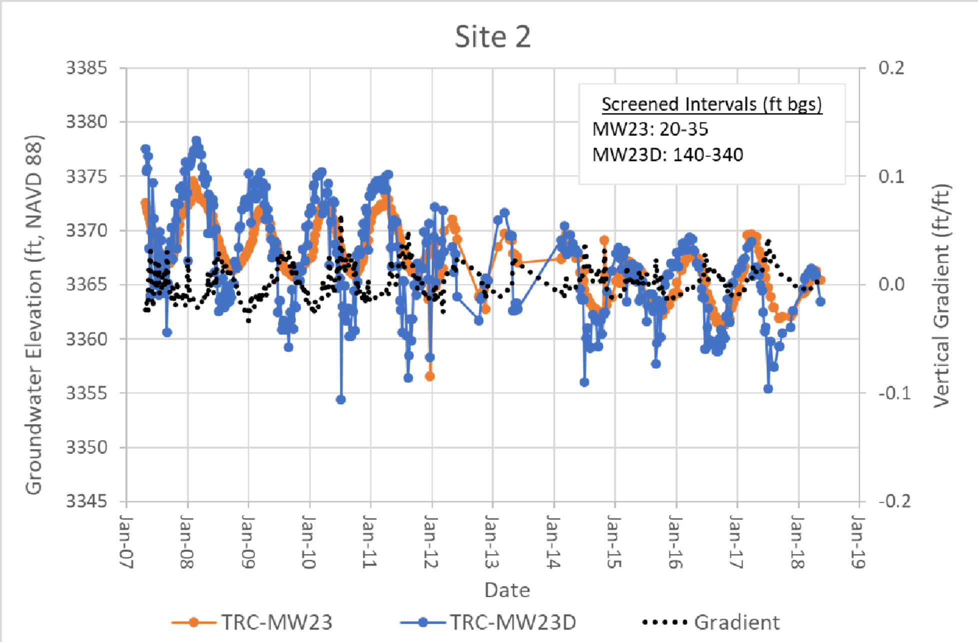
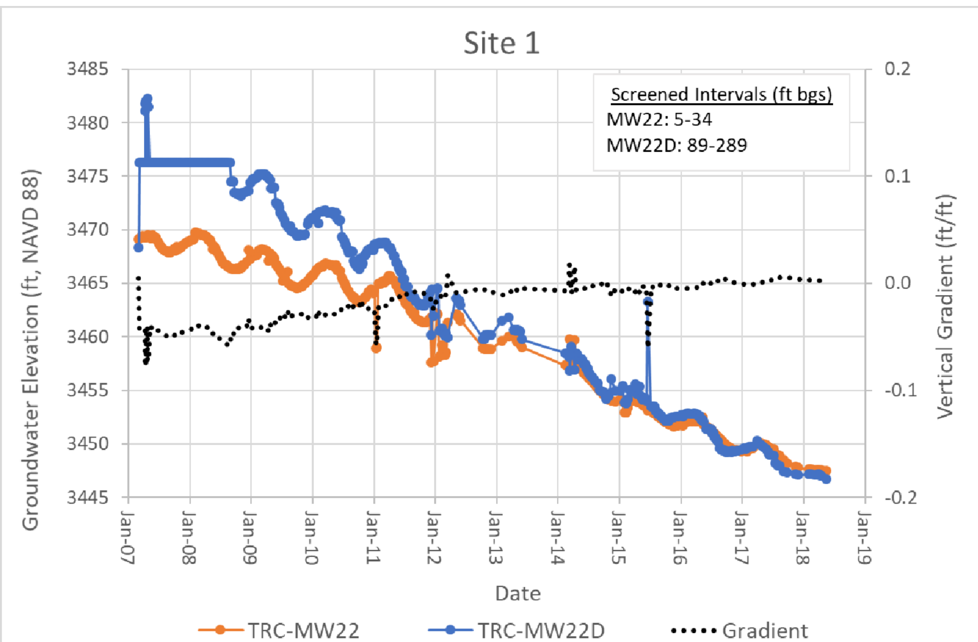
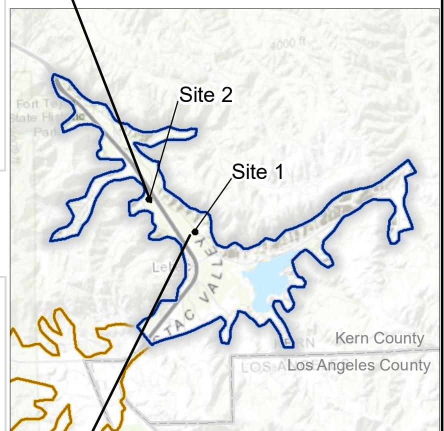
Figure GWC-2

Path: X:\B80048\Maps\for_GSP\Fig_GWC-2_GWEFall2015_allwells1.mxd







Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Monitoring Well

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

N

0 2 4

Miles

Vertical Gradient Hydrographs

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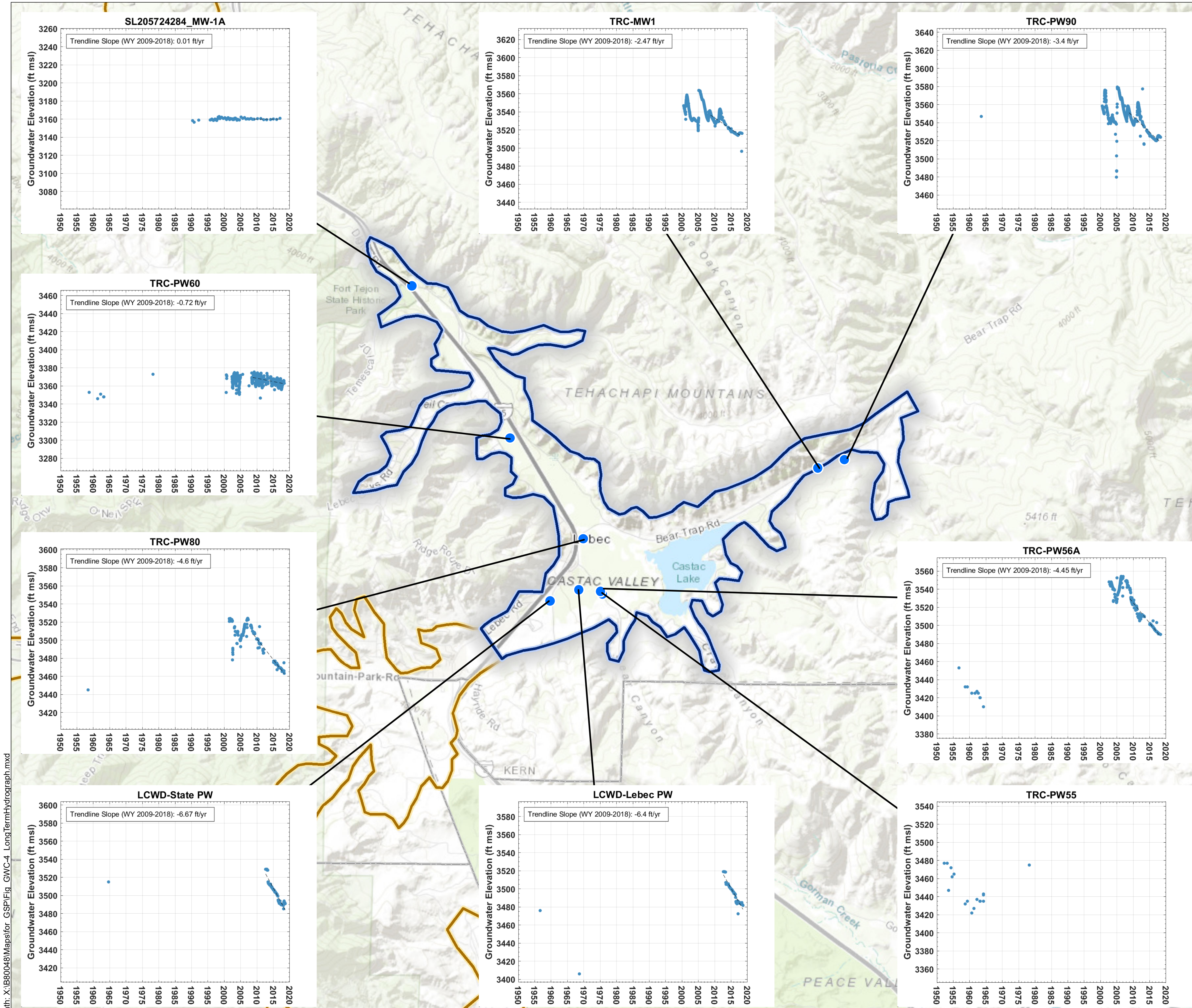
Figure GWC-3

Path: X:\B80048\Maps\for_GSP\Fig_GWC-3_VerticalGradients.mxd



Path: X:\B80048\Maps\for_GSP\Fig_GWC-4_LongTermHydrograph.mxd

Legend

- County Boundary
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Groundwater Monitoring Well

Abbreviations

DWR = California Department of Water Resources
ft msl = ft above mean sea level
ft/yr = ft per year

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

N 0 1 2 (Scale in Miles)

Historical (1950-2018) Groundwater Elevation Hydrographs

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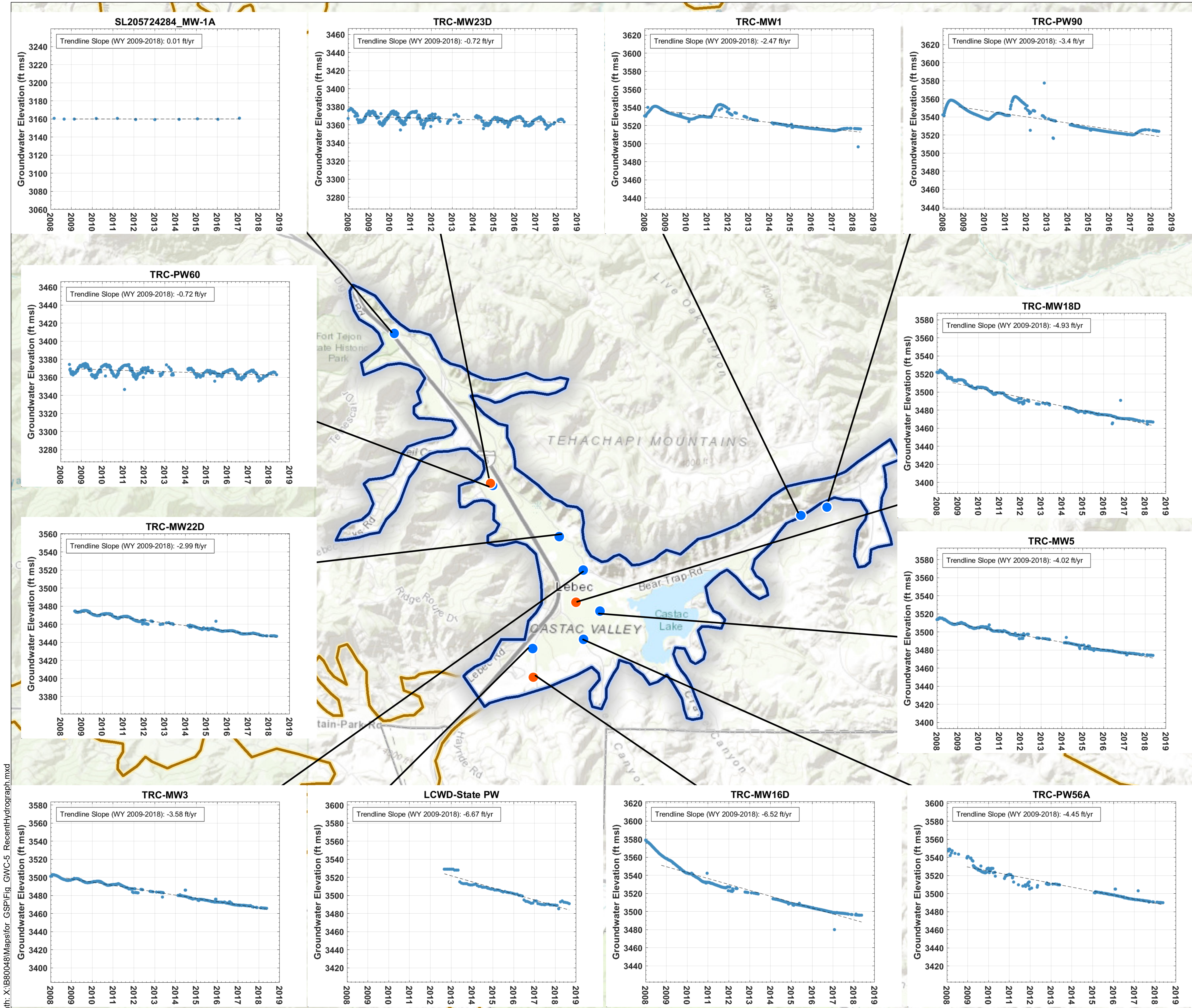
Figure GWC-4



Legend
- County Boundary
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Representative Monitoring Well
- Groundwater Monitoring Well

Abbreviations

DWR = California Department of Water Resources
ft msl = ft above mean sea level
ft/yr = ft per year

Notes
1. All locations are approximate.
2. Representative Monitoring Wells are those defined as the SGMA Monitoring Network (see Section 16).

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

N

0 1 2

(Scale in Miles)

Recent (2009-2018) Groundwater Elevation Hydrographs

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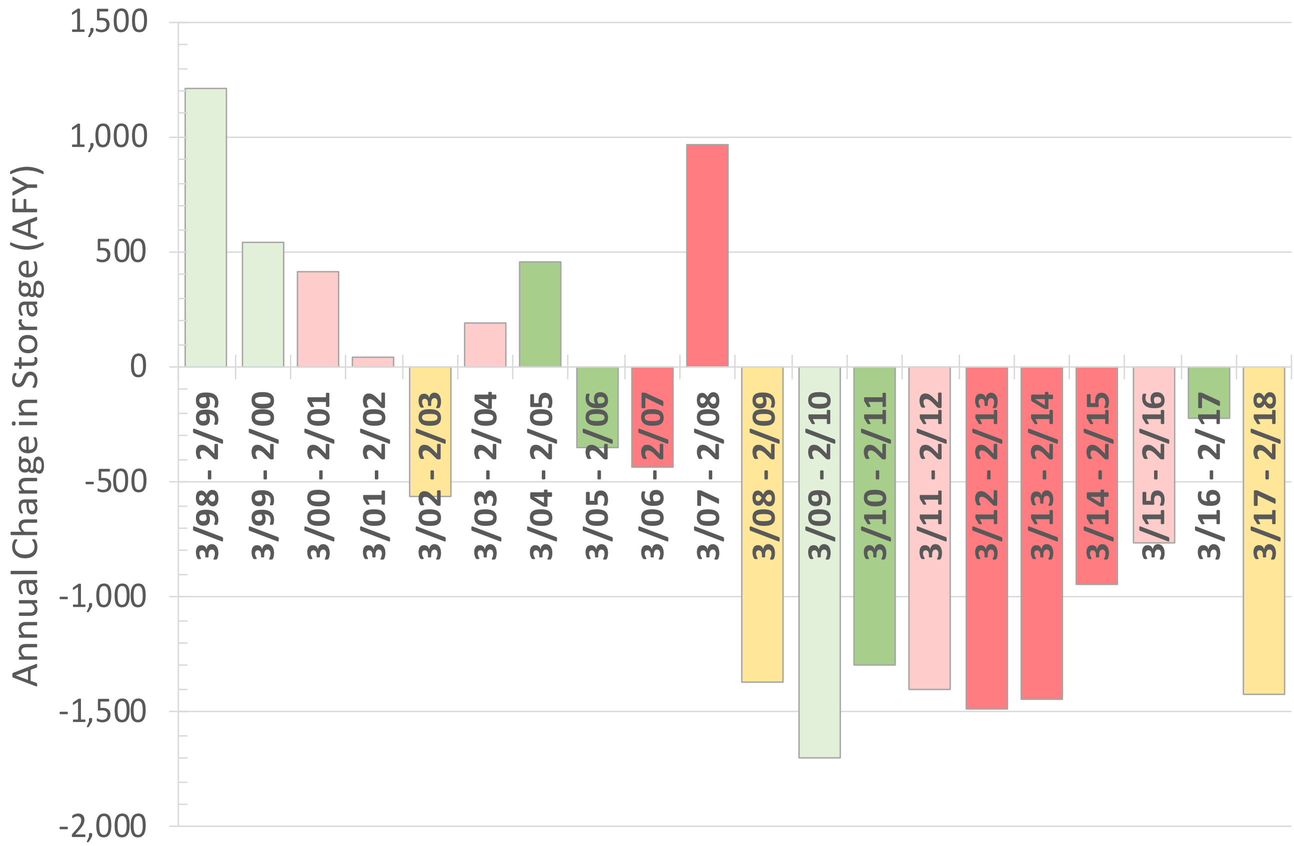
Figure GWC-5

Path: X:\B80048\Maps\for_GSP\Fig_GWC-5_RecentHydrograph.mxd



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources

Notes

1. "Seasonal high" condition is defined as March of the current year through February and the subsequent year.
2. The color of each bar chart is based on the Water Year type that begins in the October between the March and February represented by the bar.

Sources

DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)

Annual Change in Storage Between Seasonal Highs vs. DWR Water Year Type

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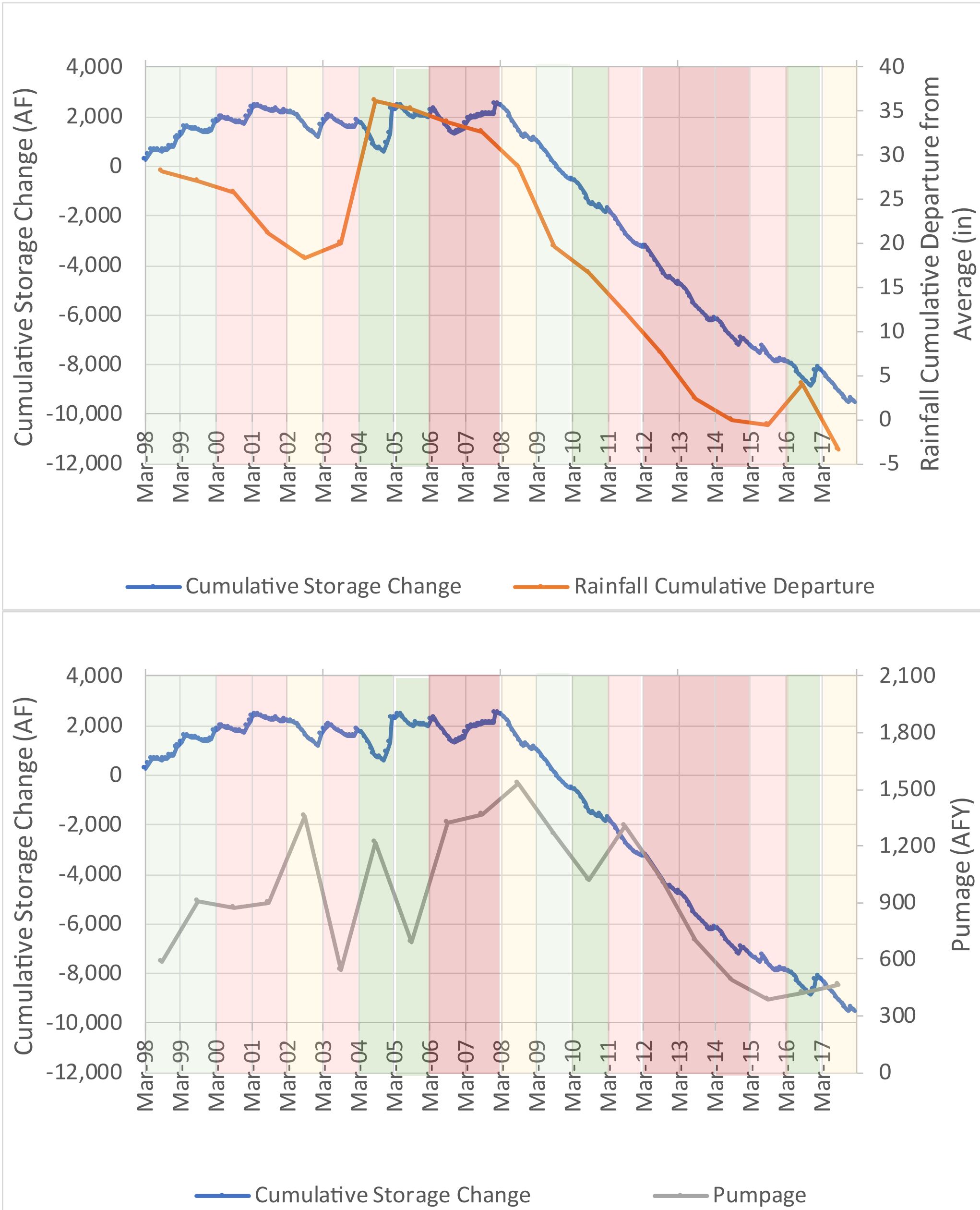
Figure GWC-6



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

- Cumulative Storage Change
- Rainfall Cumulative Departure
- Estimated Groundwater Pumpage

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources
NOAA = National Oceanic and Atmospheric Administration

Notes

1. "Seasonal high" condition is defined as March of the current year through February and the subsequent year.
2. The color of each bar chart is based on the Water Year type that begins in the October between the March and February represented by the bar.
3. Rainfall cumulative departure from average is calculated based on rainfall measured at the Lebec station between Water Years 1949 and 2018.

Sources

1. DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)
2. NOAA Lebec climate station Coop ID #44863 (www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4863)

Modeled Cumulative Change in Storage, Rainfall Cumulative Departure from Average, and Pumpage vs. DWR Water Year Type

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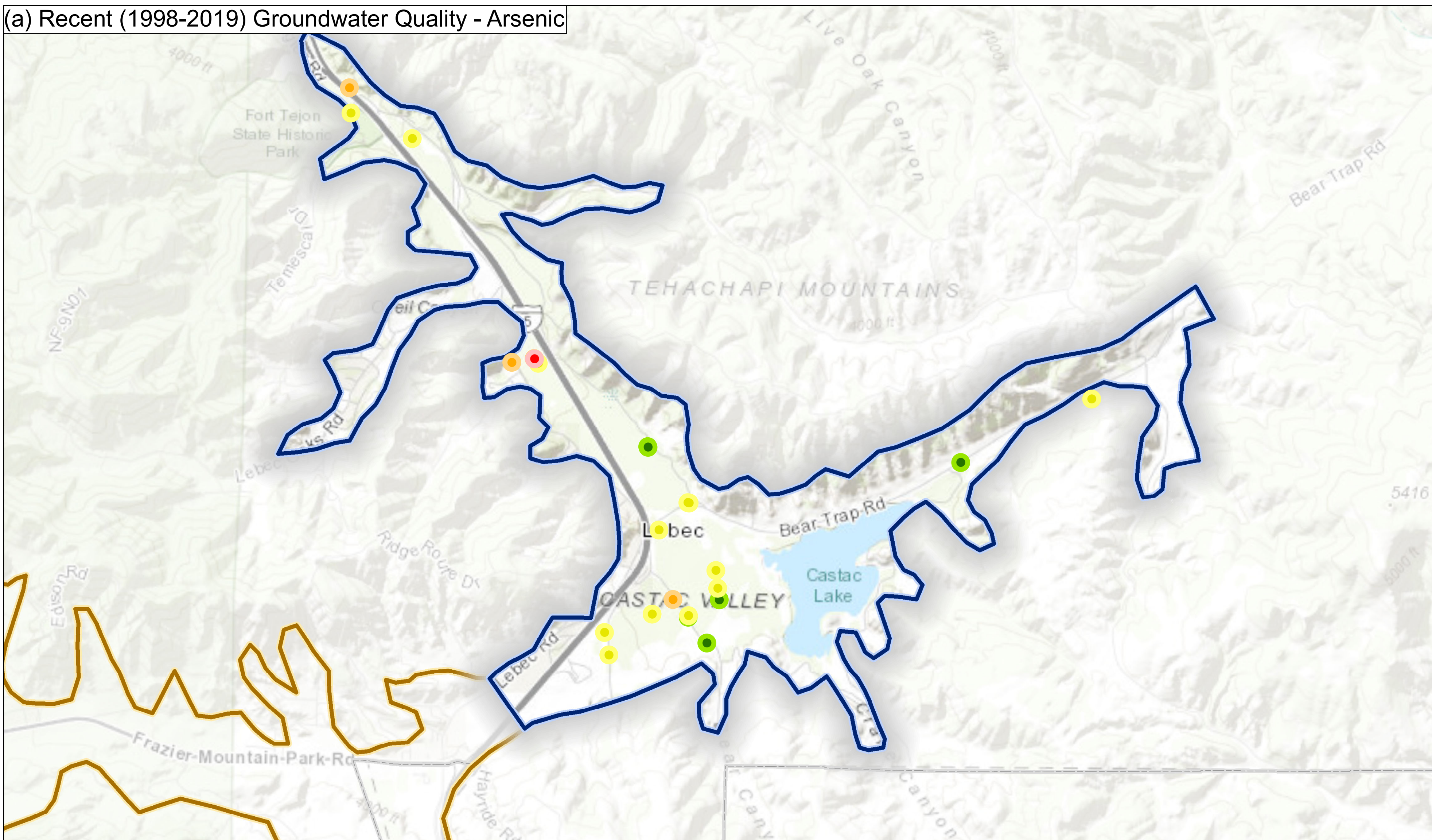
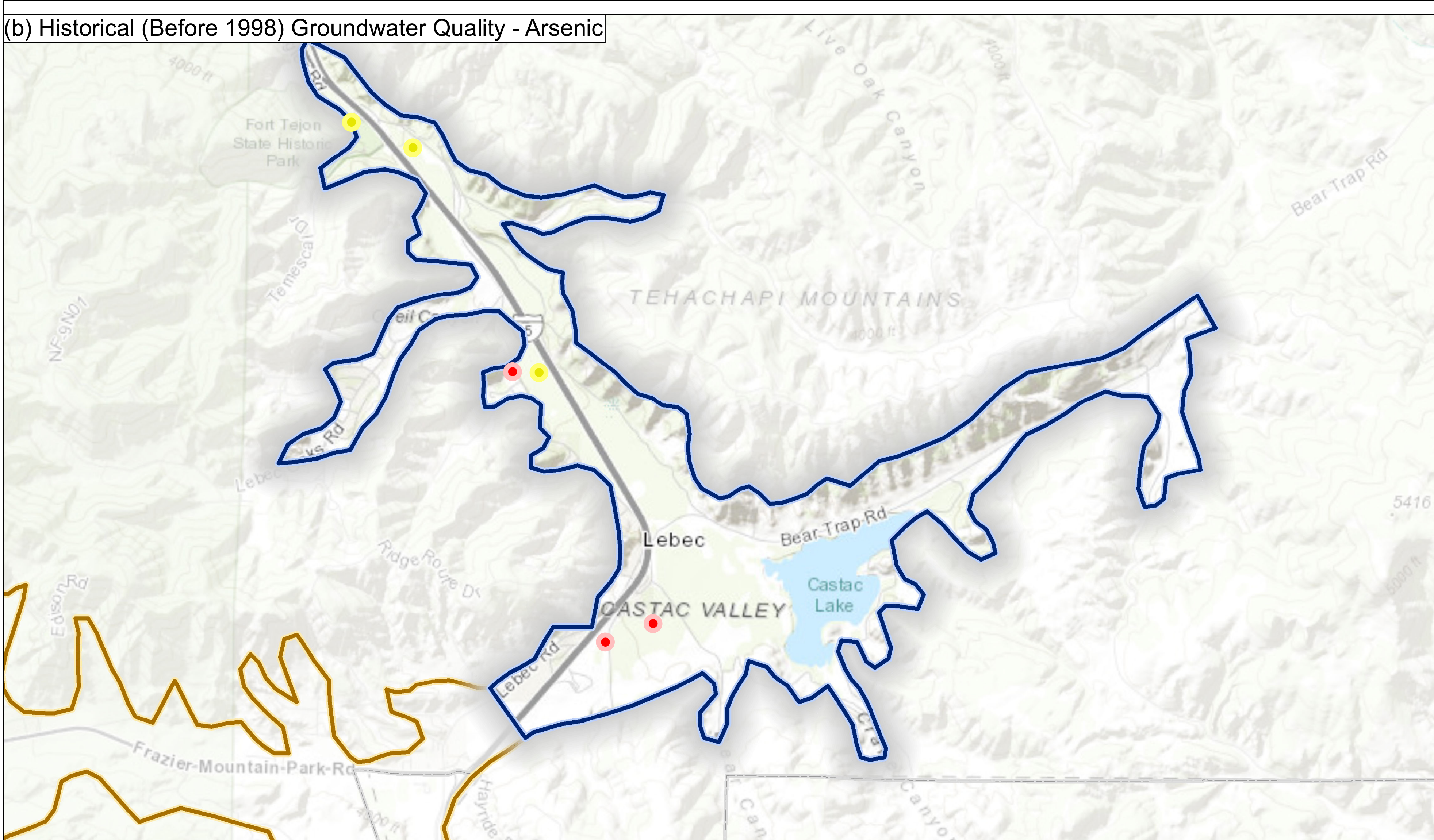
Figure GWC-7

(a) Recent (1998-2019) Groundwater Quality - Arsenic



(b) Historical (Before 1998) Groundwater Quality - Arsenic



Legend
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Arsenic Concentration (mg/L)
- < 0.001
- 0.001 - 0.004
- 0.004 - 0.009
- > 0.01 (Exceeding MCL)

Abbreviations
DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter

Notes
1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019(Figure GWC-8(a)) and before 1998 (Figure GWC-8(b)).
3. Arsenic has a MCL of 0.01 mg/L.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 22 November 2019.

N
0 0.5 1
(Scale in Miles)

Path: X:\B80048\Maps\for GSP\Fig_GWC-8_WQ_Arsenic_Current_Historical.mxd

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) Aresnic Concentrations

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Kern County, California
September 2020
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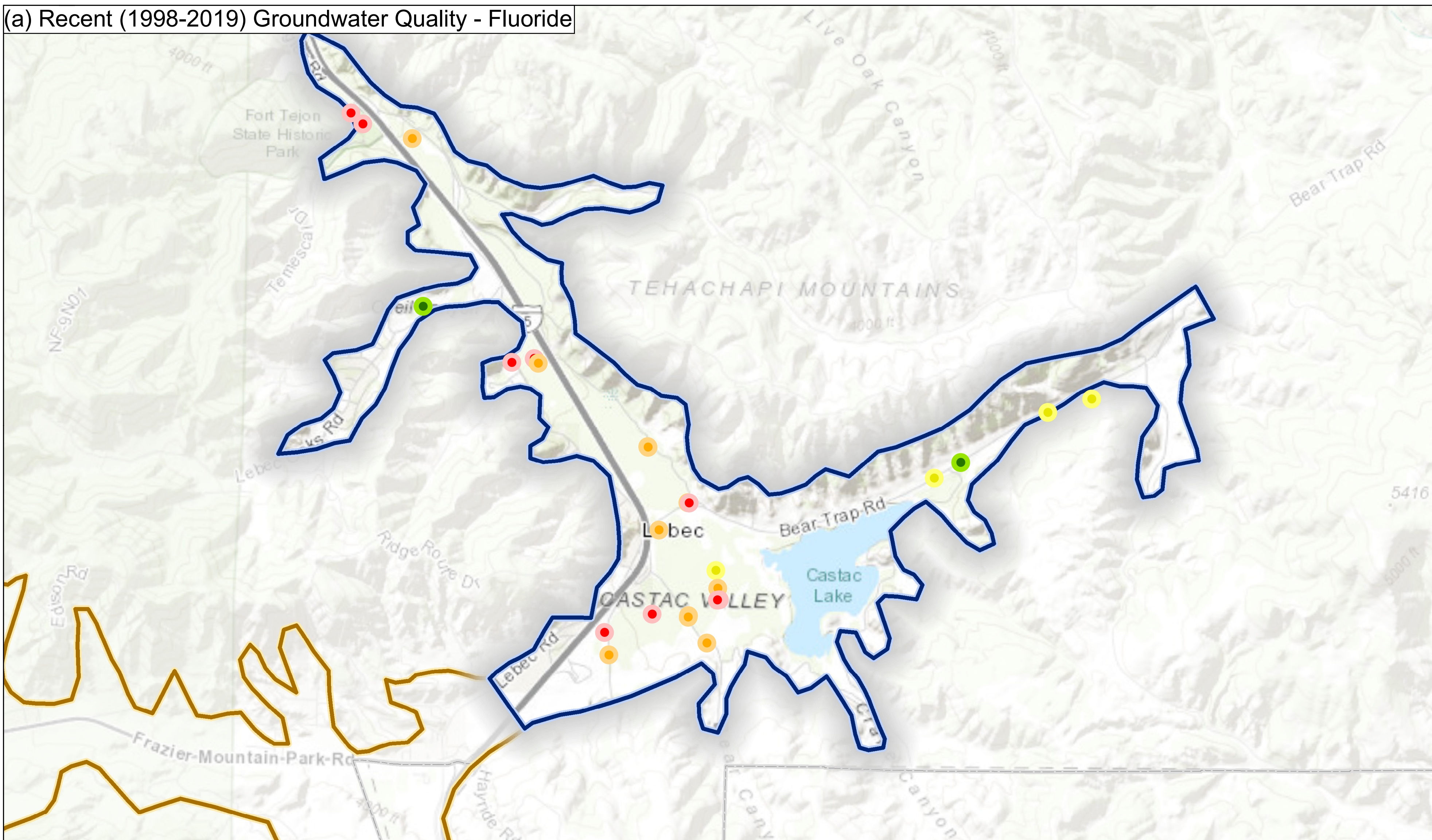
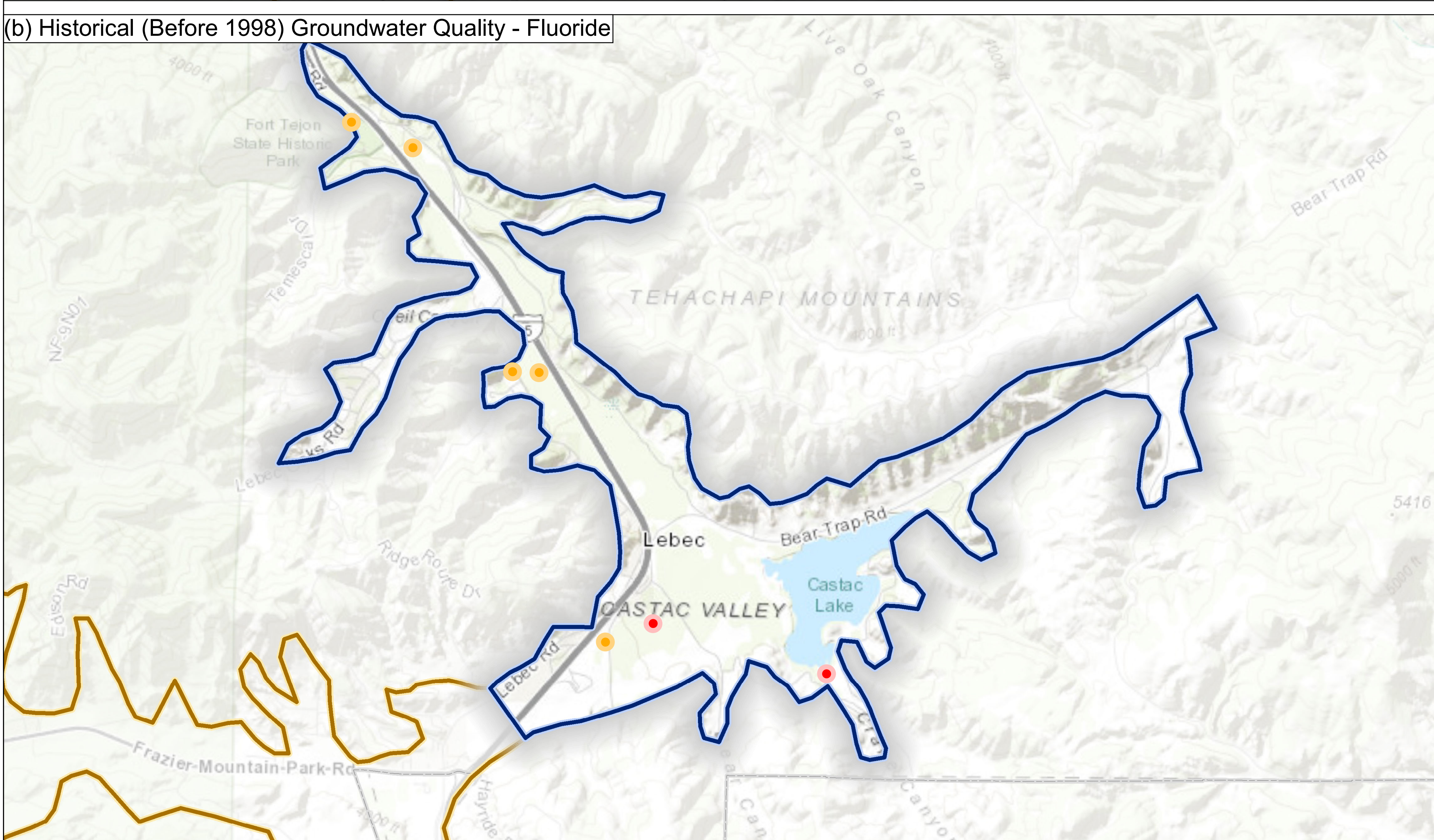
Figure GWC-8

(a) Recent (1998-2019) Groundwater Quality - Fluoride



(b) Historical (Before 1998) Groundwater Quality - Fluoride



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Fluoride Concentration (mg/L)

- < 0.5
- 0.5 - 1
- 1 - 2
- > 2 (Exceeding MCL)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-9(a)) and before 1998 (Figure GWC-9(b)).
3. Fluoride has a MCL of 2 mg/L.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 22 November 2019.

N
0 0.5 1
(Scale in Miles)

Path: X:\B80048\Maps\for GSP\Fig GWC-9 WQ Fluoride Current Historical.mxd

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) Fluoride Concentrations

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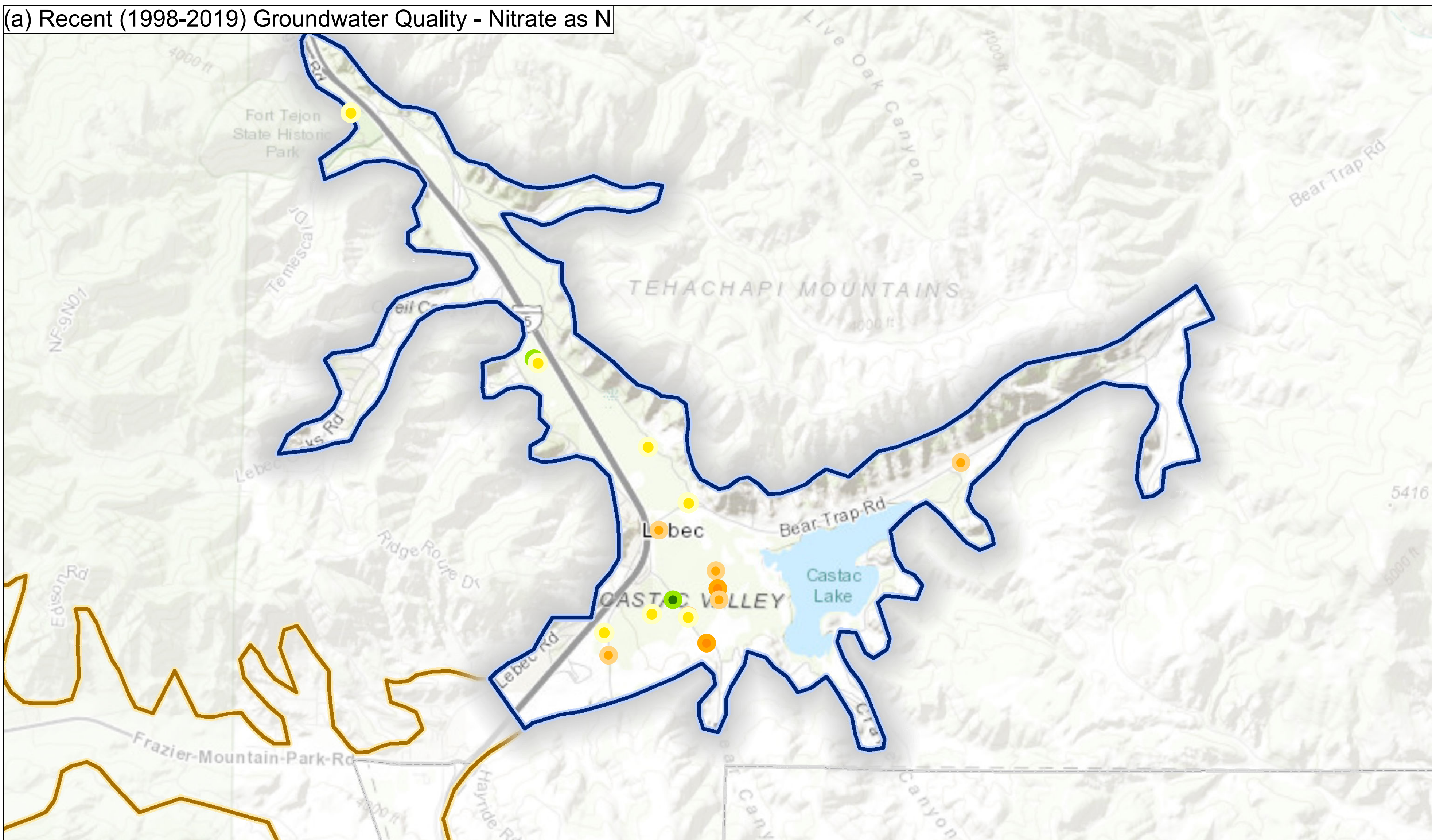
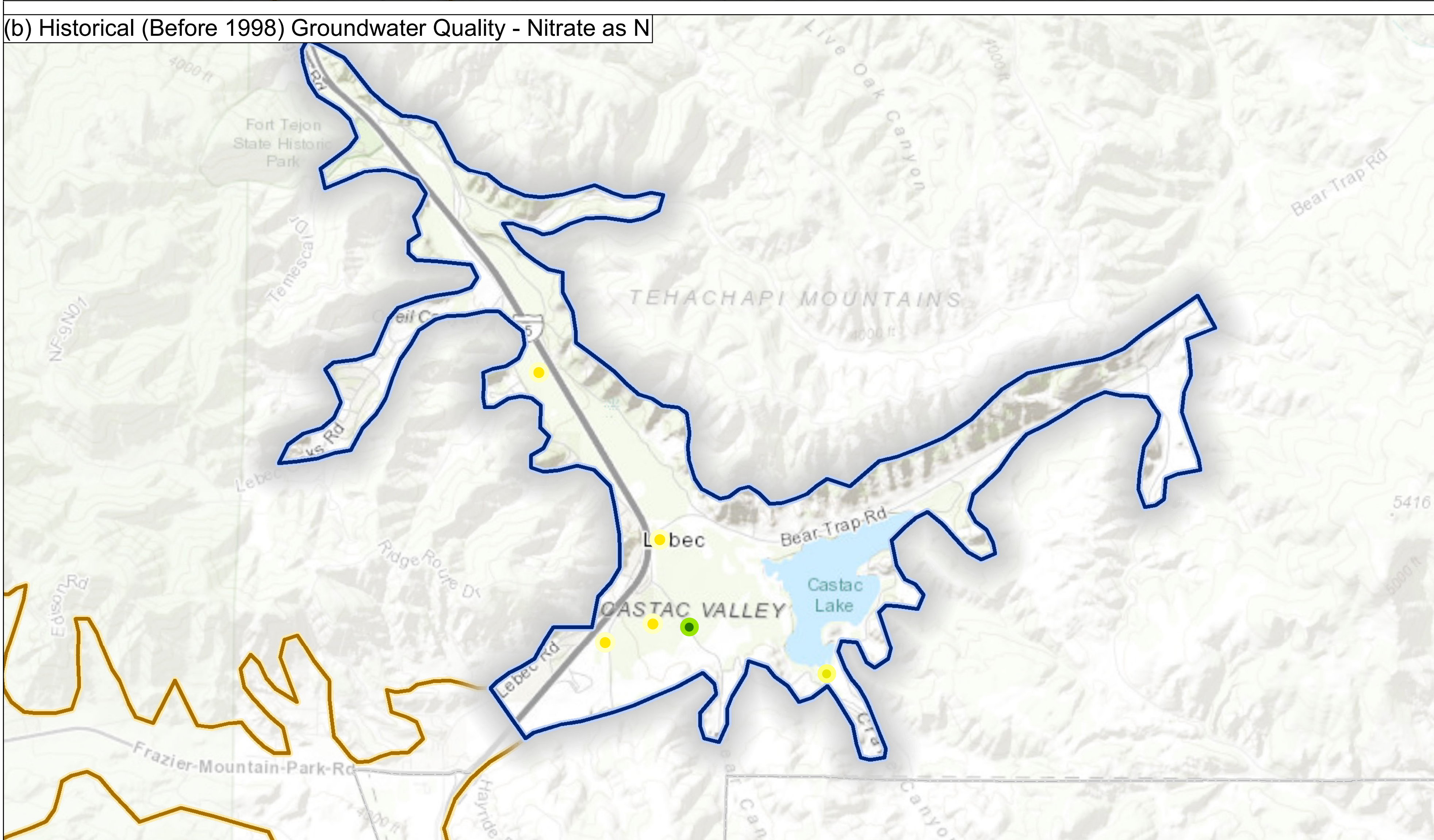
Figure GWC-9

(a) Recent (1998-2019) Groundwater Quality - Nitrate as N



(b) Historical (Before 1998) Groundwater Quality - Nitrate as N



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Nitrate as N Concentration (mg/L)

- < 1
- 1 - 5
- 5 - 9
- > 10 (Exceeding MCL)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter
N = Nitrogen

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-10(a)) and before 1998 (Figure GWC-10(b)).
3. Nitrate as N has a MCL of 10 mg/L.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 May 2020.

N 0 0.5 1 (Scale in Miles)

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) Nitrate as N Concentrations

Tejon-Castac Water District
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September 2020
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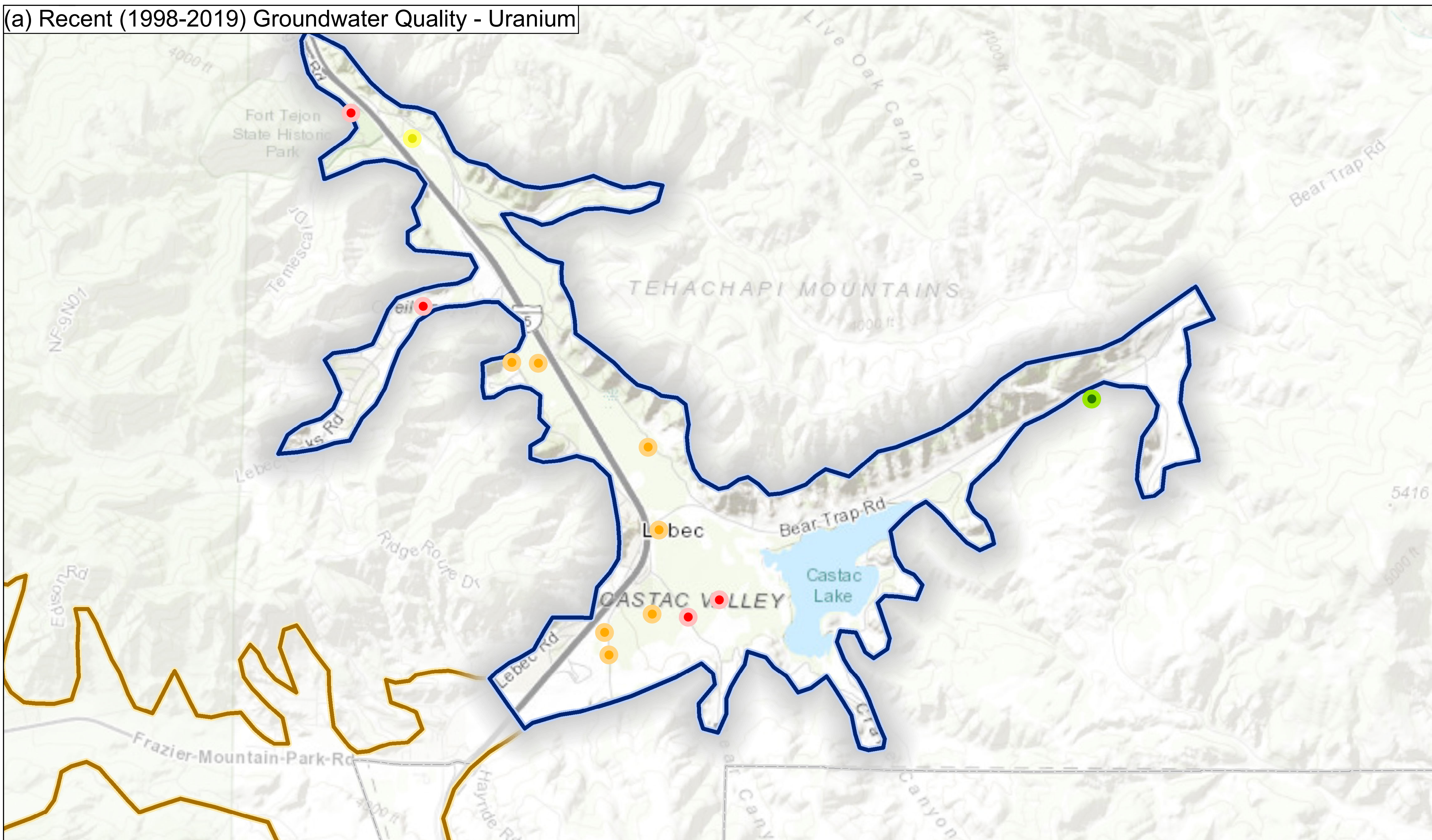
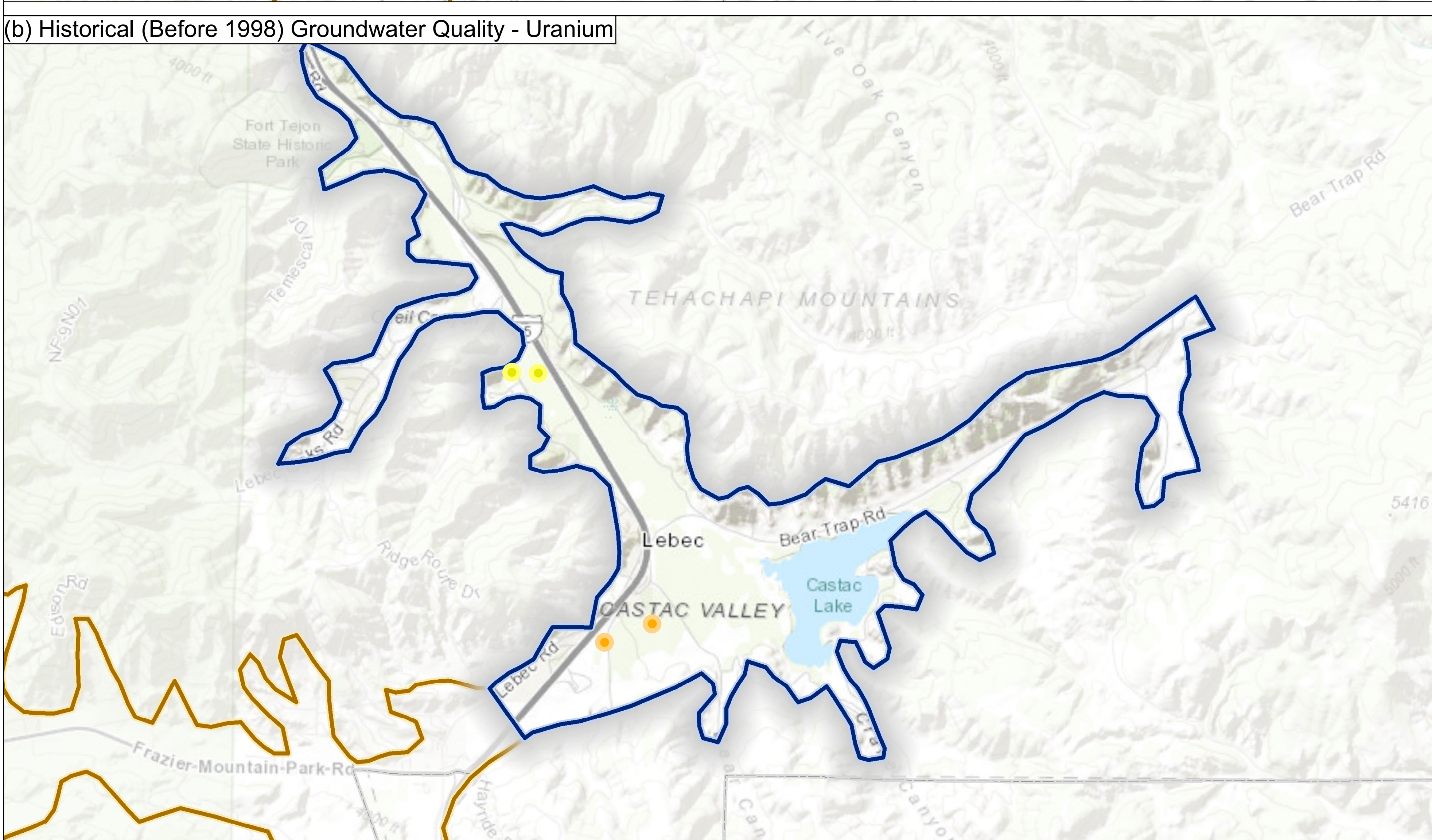
Figure GWC-10

Path: X:\B80048\Maps\for GSP\Fig GWC-10(mod) WQ Nitrate Current Historical.mxd

(a) Recent (1998-2019) Groundwater Quality - Uranium



(b) Historical (Before 1998) Groundwater Quality - Uranium



Legend
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Uranium Concentration (mg/L)
- < 0.01
- 0.01 - 0.02
- 0.02 - 0.03
- > 0.03 (Exceeding MCL)

Abbreviations
DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter

Notes
1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-11(a)) and before 1998 (Figure GWC-11(b)).
3. Uranium has an MCL of 0.03 mg/L

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 22 November 2019.

N
0 0.5 1
(Scale in Miles)

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) Uranium Concentrations

Tejon-Castac Water District
Kern County, California
September 2020
B80048.00

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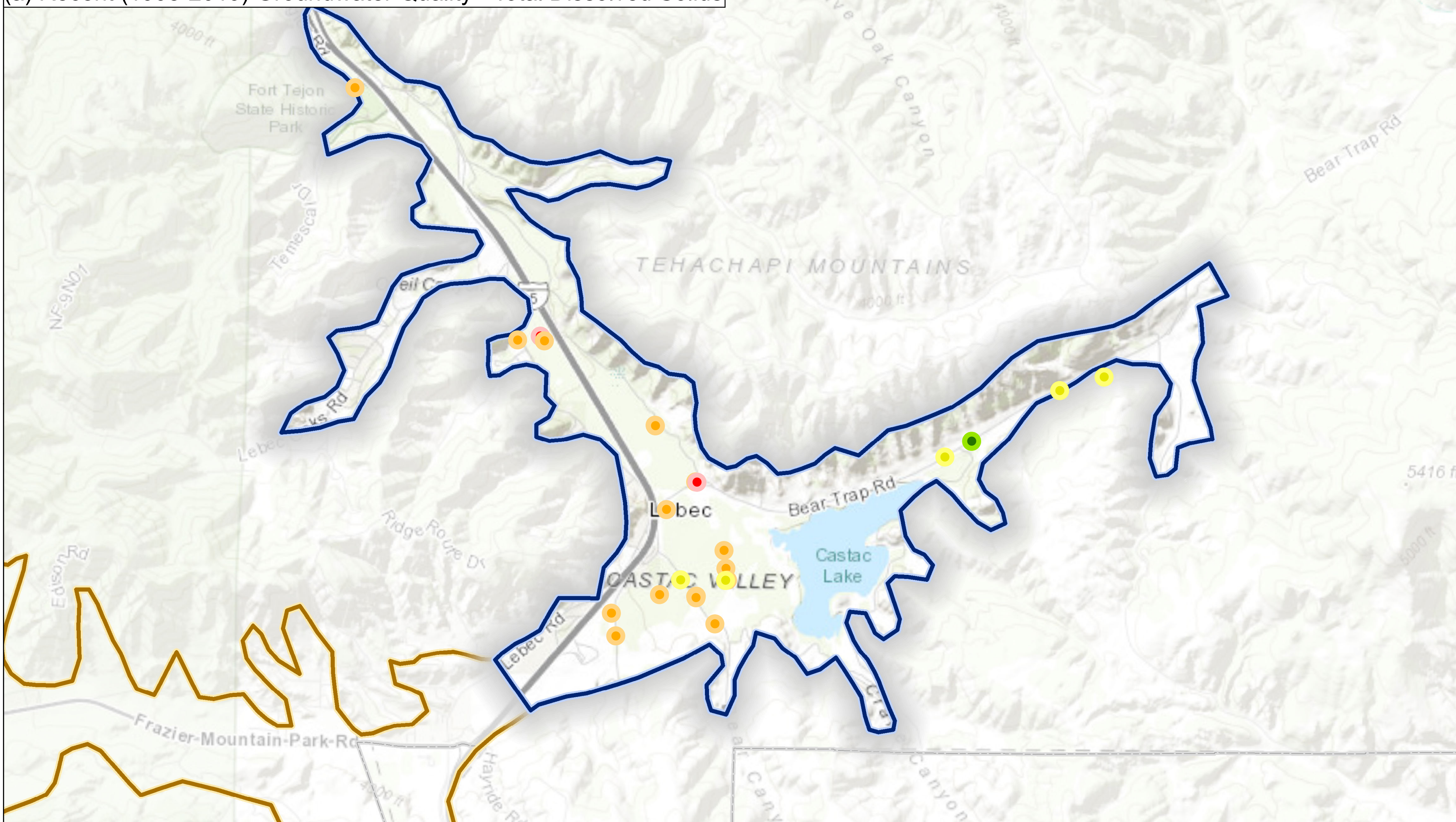
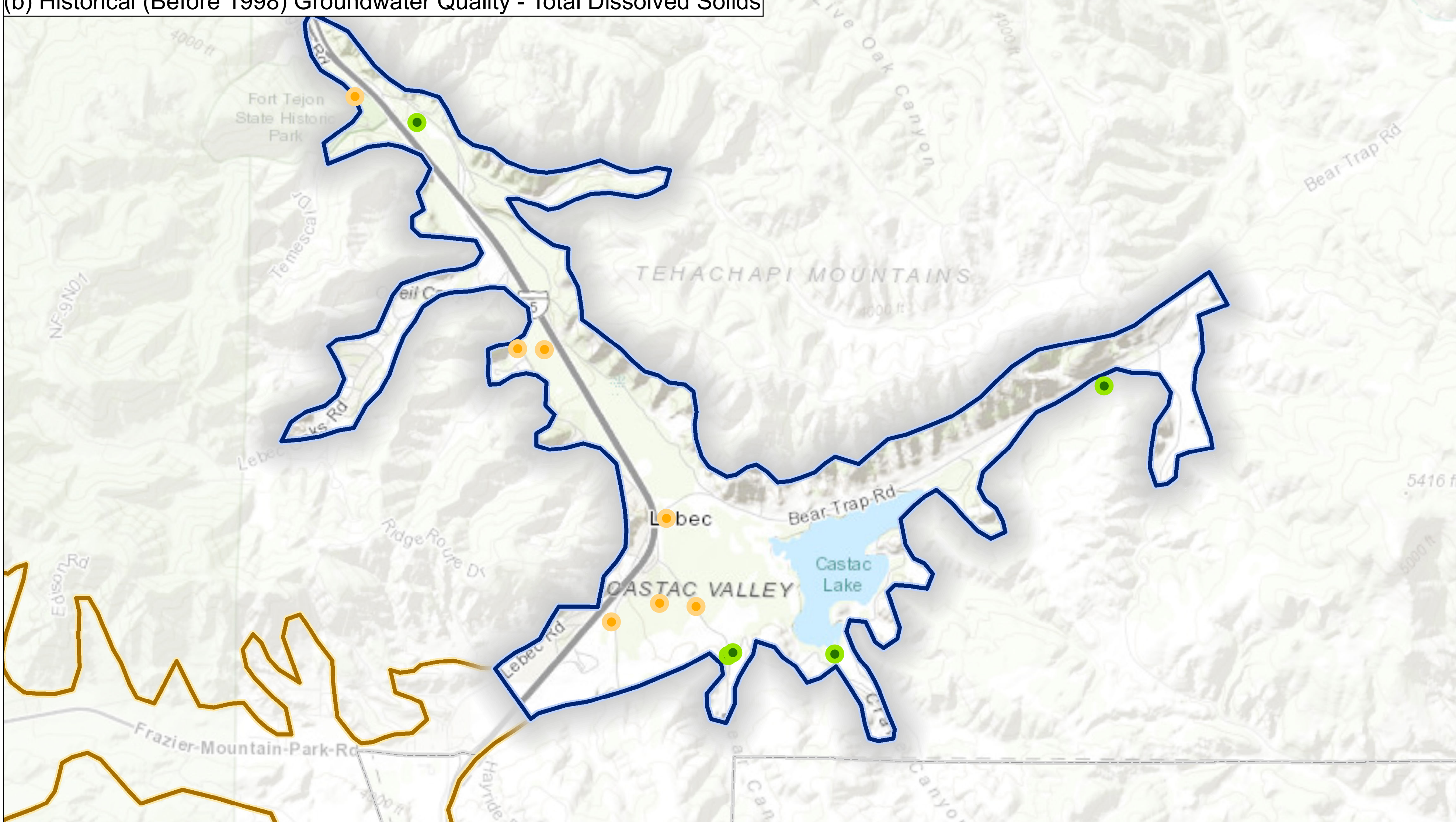
Figure GWC-11

Path: X:\B80048\Maps\for_GSP\Fig_GWC-11_WQ_Uranium_Current_Historical.mxd

(a) Recent (1998-2019) Groundwater Quality - Total Dissolved Solids



(b) Historical (Before 1998) Groundwater Quality - Total Dissolved Solids



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

TDS Concentration (mg/L)

- < 400
- 400 - 500
- 500 - 1,000 (Exceeding MCL)
- > 1,000 (Exceeding MCL)

N

0 0.5 1

(Scale in Miles)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = milligrams per liter
TDS = Total Dissolved Solids

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 22 November 2019.

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-12(a)) and before 1998 (Figure GWC-12(b)).
3. TDS has a secondary MCL of 500 mg/L.

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) TDS Concentrations

Tejon-Castac Water District
Kern County, California
September 2020
B80048.00

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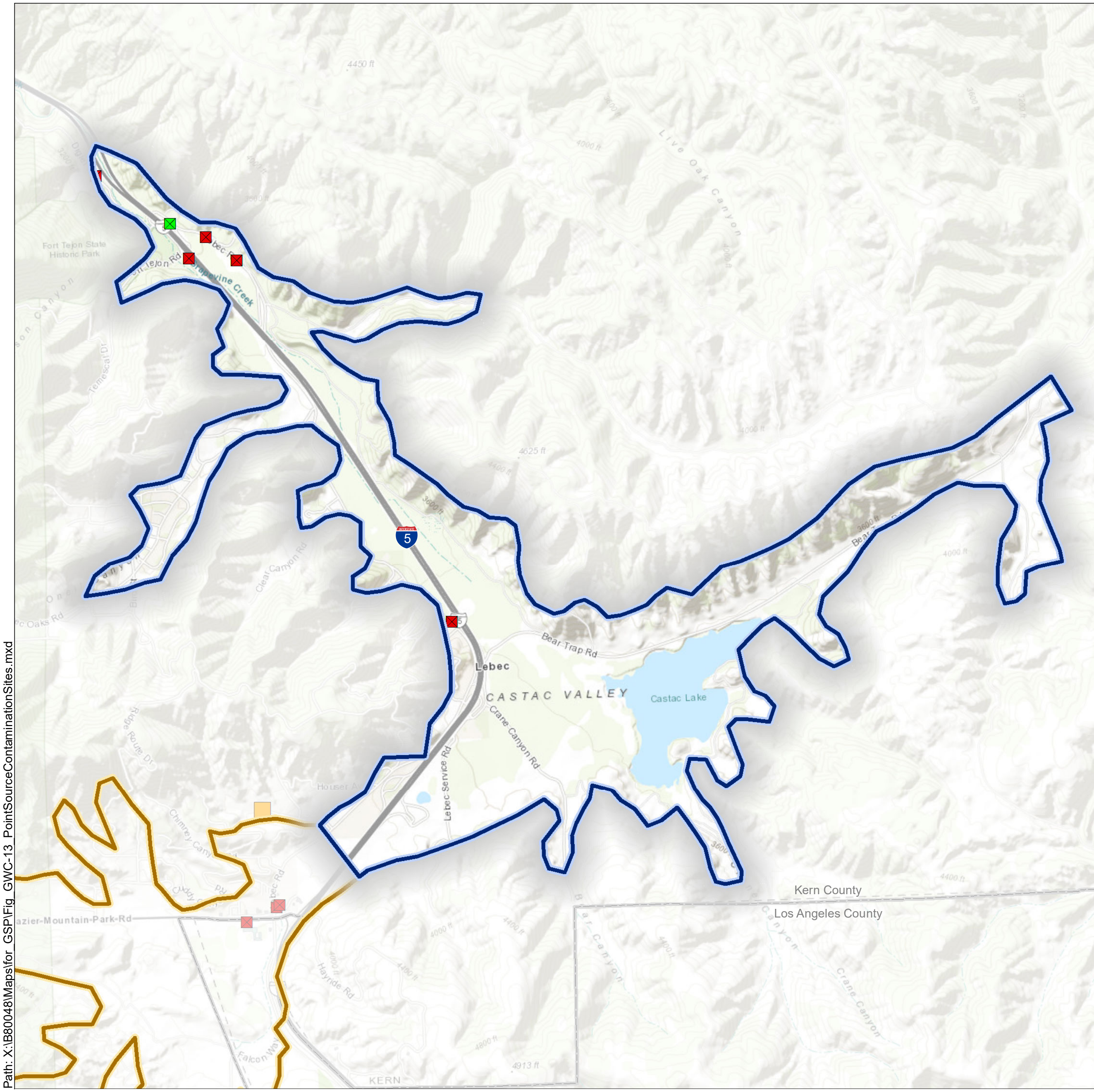
Figure GWC-12

Path: X:\B80048\Maps\for_GSP\Fig_GWC-12_WQ_TDS_Current_Historical.mxd



Legend

GeoTracker Sites

- LUST Cleanup Site, Closed
- Cleaup Program Site, Closed
- Land Disposal Site, Closed with Monitoring
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
LUST = Leaking Underground Storage Tank
SWRCB = State Water Resources Control Board

Notes

1. All locations are approximate.
2. Some GeoTracker sites overlap at the scale shown.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Locations of contamination sites from SWRCB GeoTracker website (http://geotracker.waterboards.ca.gov/datadownload) accessed 5 November 2018.

N

0 0.5 1
Miles

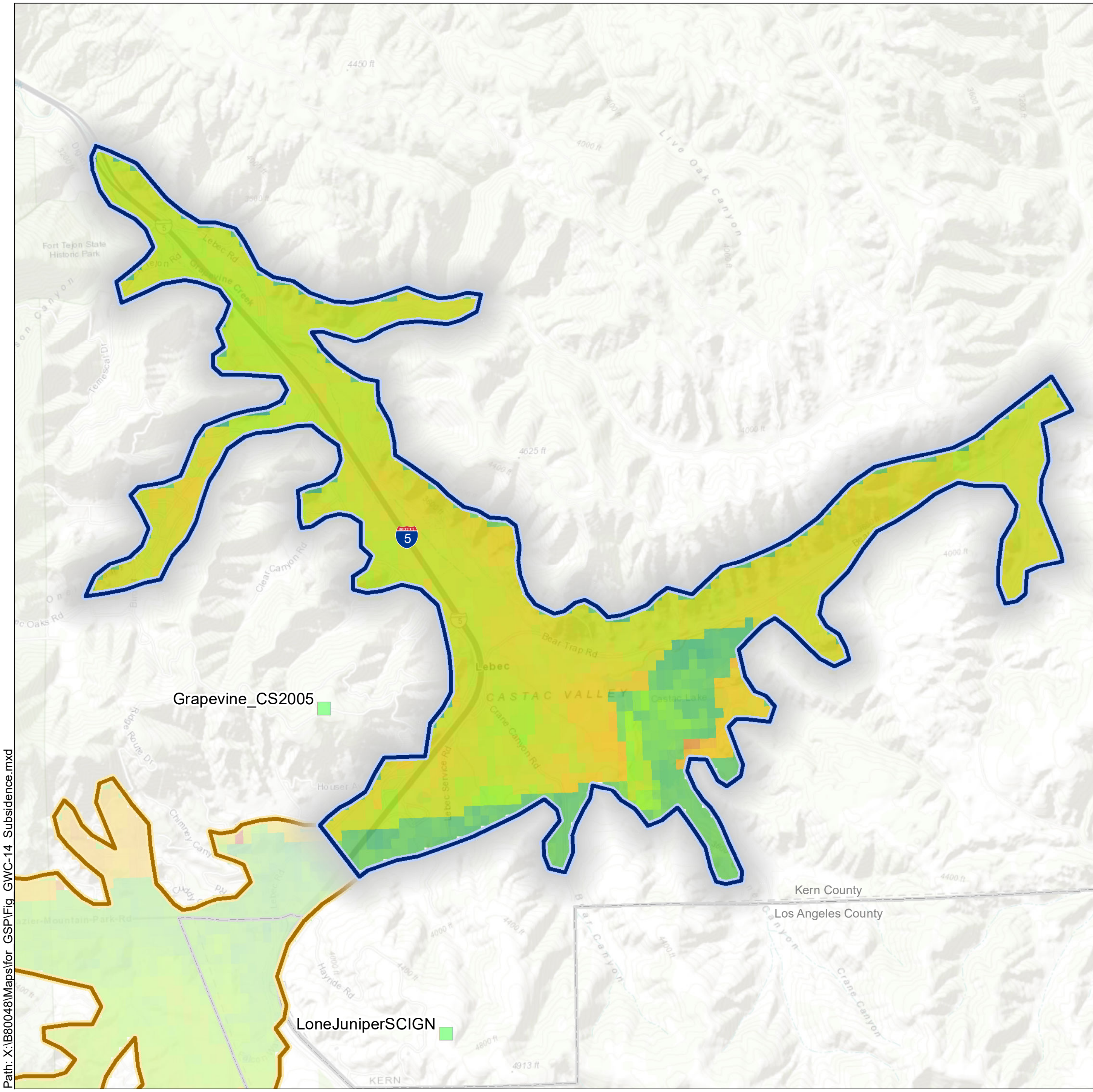
Known Point-Source Contamination Sites

Tejon-Castac Water District
Kern County, California
September 2020
B80048.00

eki environment & water

Figure GWC-13

Path: X:\B80048\Maps\for_GSP\Fig_GWC-13_PointSourceContaminationSites.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Subsidence Monitoring Station

Vertical Displacement (inches): 5/31/2015 - 7/31/2016

High : 2
1
0
-1
Low : -2

Abbreviations

DWR = California Department of Water Resources
JPL = Jet Propulsion Laboratory
NASA = National Aeronautics and Space Administration
UNAVCO = University NAVSTAR Consortium

Notes

1. All locations are approximate.
2. Positive vertical displacement signifies accretion; negative vertical displacement signifies subsidence.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Subsidence monitoring stations are from UNAVCO's Plate Boundary Observatory database. (https://www.unavco.org/instrumentation/networks/map/map.html#/)
4. Vertical displacement data from DWR, provided by NASA JPL, accessed 26 June 2018 (https://data.cnra.ca.gov/dataset/nasa-jpl-insar-subsidence)

N

0 0.5 1
Miles

Recent (2015-2016) Land Subsidence

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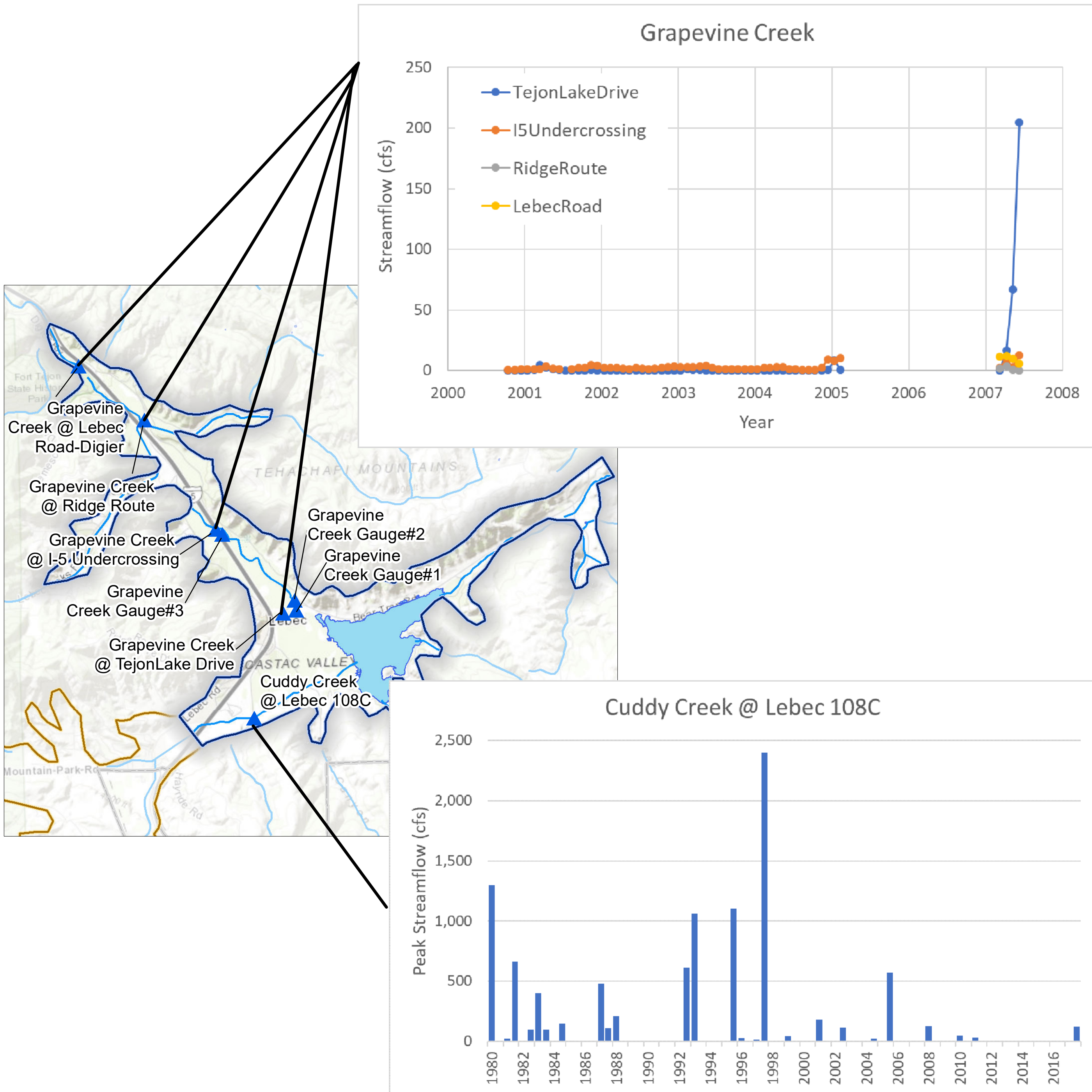
Tejon-Castac Water District
Kern County, California
September 2020
B80048.00

Figure GWC-14

Path: X:\B80048\Maps\for_GSP\Fig_GWC-14_Subsidence.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Castac Lake
- Stream/River
- Surface Water Gauge

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

N

0 1 2

Miles

Surface Water Features

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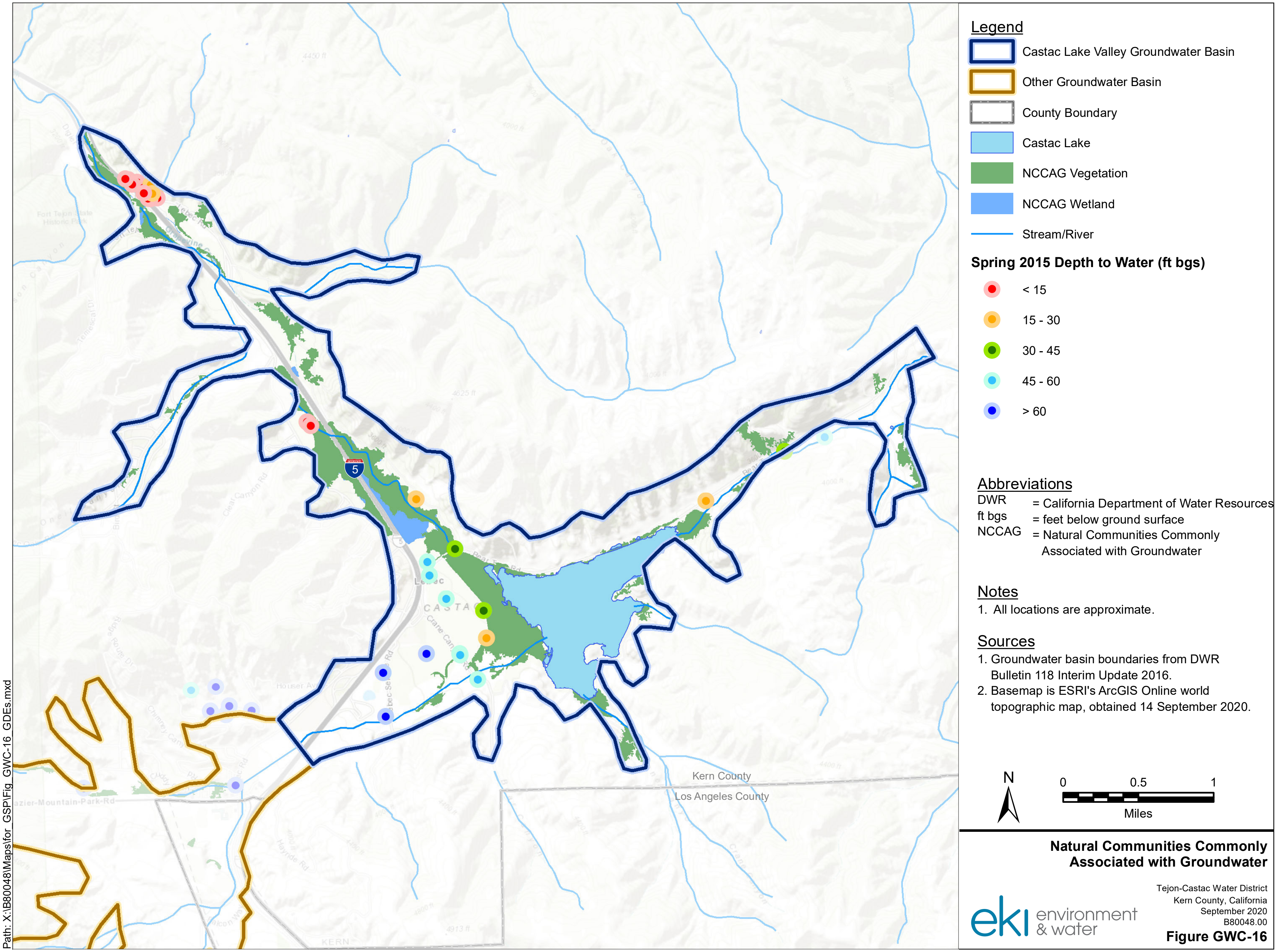
Tejon-Castac Water District
Kern County, California
September 2020
B80048.00

Figure GWC-15

Path: X:\B80048\Maps\for_GSP\Fig_GWC-15_SurfaceWater.mxd



Path: X:\B80048\Maps\for_GSP\Fig_GWC-16_GDEs.mxd

9. WATER BUDGET INFORMATION

§ 354.18. Water Budget
(a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

This section presents information on the water budget for the Basin. Consistent with the Groundwater Sustainability Plan (GSP) Regulations (23-California Code of Regulations [CCR] Division 2 Chapter 1.5 Subchapter 2) and California Department of Water Resources' (DWR) Water Budget Best Management Practices (BMP) (DWR, 2016b), this water budget provides an accounting of the total annual volume of water entering and leaving the Basin for historical, current, and projected future conditions.

9.1. Water Budget Methods and Data Sources

§ 354.18. Water Budget
(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:
(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.
(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.
(3) Projected water budget information for population, population growth, climate change, and sea level rise.
(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.
(f) The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.

The water budget information presented herein is based on the use of two complementary modeling approaches:

1) **A spreadsheet analytical model** which quantifies each flow component and uses a mass balance approach to estimate water movement between each "subdomain" (e.g., flows between groundwater in the Basin aquifer, natural surface water channels, and Castac

Lake) that collectively comprise the water budget domain (the Basin) for historical and current conditions, and

2) **A numerical groundwater flow model** for the Basin using the United States Geological Survey (USGS)'s Modular Three-Dimensional Groundwater Modeling software MODFLOW-NWT for projected future conditions.

Each of these approaches is discussed further below.

9.1.1. Spreadsheet Analytical Model Approach

The spreadsheet analytical model approach uses a variety of data and analytical methods to quantify each water budget flow component. It is not map-based. Instead, processes and groups of processes are grouped into "subdomains" and "flow components", which represent categories of water storage or movement but not necessarily spatially-distinct hydrogeologic features. These water budget flow components are quantified on a monthly basis ("monthly timestep") for the period from October 1997 through September 2018, representing Water Years (WY) 1998 through 2018. Water years represent the period of time of accumulation and depletion of precipitation, starting on 1 October of the preceding year and extending through September of the nominal water budget year. Water budget information from the spreadsheet model approach is presented in Section 9.3 below for historical and current conditions.

Water Budget Subdomains

The water budget is divided into five internal subdomains, each influenced by a number of flow components and within which mass-balance is enforced (i.e., the sum of inflow components is balanced by the sum of outflow components and/or a change in storage component). **Figure WB-1** shows the water budget domain, and the following internal subdomains:

a. Natural Channels and Castac Lake;

b. Irrigated Agricultural Lands;

c. Undeveloped Non-irrigated Lands and Wetlands;

d. Developed Areas; and

e. Groundwater Basin system.

In addition to the five internal subdomains, three external subdomains are incorporated into the spreadsheet model. These include the atmosphere which is a source of precipitation and sink for evapotranspiration, the watersheds that contribute streamflow to streams and small channels entering and leaving the Basin, and groundwater entering the Basin from upgradient groundwater basins. The spreadsheet model does not explicitly account for the vadose (unsaturated) zone between the land surface and the (saturated) groundwater system. An implicit assumption in this approach, therefore, is that the vadose zone does not experience any change in storage over time.

Water Budget Flow Components

Within and between each subdomain are 27 water budget flow components that route water through the Basin. **Figure WB-2** shows a conceptual diagram of the individual water budget flow components between subdomains as well as flow components that are external to the overall water budget domain (i.e., serve only as an inflow or outflow to the entire system, rather than a flow between subdomains).

Certain components are based on "raw" data (e.g., precipitation) which are directly measured and based on historical records. These "raw" components are considered to have a relatively high degree of certainty. Other components are estimated or indirectly measured using a variety of analytical methods (e.g., Darcy's Law to calculated subsurface flows across the domain's external boundaries) and are thus subject to uncertainty based on the parameters used in their estimation. Some components (e.g., groundwater pumping) constitute major proportions of the overall water budget and have thus been given significant attention. Others are relatively minor in magnitude (e.g., infiltration from developed areas) and thus are less significant to the overall water budget and less well defined. Details of the methods and data used in the spreadsheet model approach are provided in *Appendix H*.

9.1.2. 3-D Numerical Model Approach

The numerical model approach is based on the application of a numerical groundwater flow model developed for the Basin, herein referred to as the "Castac Basin Numerical Model," using the USGS's Modular Three-Dimensional Groundwater Model platform MODFLOW-NWT. Like all numerical groundwater flow models, the Castac Basin Numerical Model divides the spatial model domain into a network of cells (a 3-D grid in the case of Castac Basin), applies assumptions of groundwater system properties at those cells, and calculates water fluxes between cells by solving a system of equations based on groundwater flow principles (see **Figure WB-3** for the grid and cell extents). Details on the development of the Castac Basin Numerical Model are provided in *Appendix I*. Water budget information from the numerical model approach is presented in Section 9.4 below for projected future scenarios.

9.1.3. Data Sources

Per 23-CCR §354.18(e), the best-available data were used to evaluate the water budget for the Basin and include the following:

- Precipitation records from the Lebec climate station operated by the National Oceanic and Atmospheric Administration (NOAA), Monthly resolution *[October 1948 – September 2018]*.

- Evapotranspiration (ET) and associated data:
    - Reference ET (ETo) from California Irrigation Management Information System (CIMIS) stations Arvin-Edison 125 and Cuyama 88, Monthly resolution *[October 1997 – September 2018]*.
    - Tejon weather station 56A, average monthly pan evaporation values measured between 2000 and 2003, recorded by Tejon Ranch Company (TRC) staff.
    - CIMIS ETo zone map and associated monthly average ETo by ETo zone (CIMIS, 1999).
    - Crop coefficients (Kc) for pasture and idle lands, Cal Poly Irrigation Training and Research Center (ITRC), monthly values for a typical year[32].
- Land use surveys and associated spatial data:
    - Tejon-Castac Water District (TCWD), 2019
    - Kern County, 2016, Important Farmlands
    - Groundwater basin boundaries defined by DWR 2019 Basin Prioritization
    - Watershed boundaries, HUC12 obtained from United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS)[33]
- Well pumping records:
    - TRC flowmeter well counter units
    - Public water system monthly records provided by Krista Mutual Water Company (KMWC) for 2010 and 2012 through 2018
    - Public water system monthly records provided by Lebec County Water District (LCWD) for 2013 through 2018
    - Public water system monthly records for 2013 through 2015, downloaded from the Drinking Water Information Clearinghouse (DRINC) portal[34]
    - Estimates of TRC pumping based on Pacific Gas & Electric (PGE) energy consumption records
- Historical groundwater elevation records from selected wells within the Basin
- Historical Castac Lake elevations and estimates of seepage

[32] http://www.itrc.org/etdata/index.html
[33] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/watersheds/dataset/
[34] https://drinc.ca.gov/drinc/DWPRepository.aspx

9.1.4. Temporal Coverage

DWR's Water Budget BMP requires quantification of historical water budget components for at least the past 10 years (DWR, 2016b). Additionally, the water budget should represent average hydrology, with both wet and dry years. The long-term average precipitation recorded at the Lebec climate station between WY 1949 and 2018 is 12 inches per year (in/yr). As shown in **Table WB-1** and **Figure WB-4**, the average precipitation recorded at the Lebec climate station between WY 1998 and 2018 is 11.5 in/yr, similar to the long-term average (i.e., 12 in/yr). Within this 21-year period, there were five wet years, three above-normal years, three below-normal years, five dry years, and five critical (dry) years based on DWR's San Joaquin Valley WY Index[35]. This 21-year period (WY 1998-2018) therefore adequately represents average hydrologic conditions for purposes of quantifying the Basin water budget.

Table WB-1. Precipitation Recorded at the Lebec Climate Station, WY 1998-2018

Water Year	Lebec Precipitation (inches)	Water Year Type[(a)]
1998	33.43	W
1999	13.91	AN
2000	9.45	AN
2001	10.88	D
2002	3.91	D
2003	14.91	BN
2004	8.25	D
2005	32.67	W
2006	11.02	W
2007	7.52	C
2008	9.06	C
2009	9.15	BN
2010	5.38	AN
2011	9.09	W
2012	7.32	D
2013	7.24	C
2014	6.29	C
2015	12.19	C
2016	9.28	D
2017	13.99	W
2018	6.49	BN
Average	***11.5***	**--**

Notes:

[35] http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

(a) DWR Water Year types are based on the San Joaquin Valley Index that is based on unimpaired natural water runoff to the San Joaquin Valley, and are as follows: W = wet, AN = above normal, BN = below normal, D = dry, C = critical. These types represent an average value over a large area of the state and only generally correlate with local conditions in Castac Basin.

9.2. Water Budget Results

§ 354.18. Water Budget

(a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:

(1) Total surface water entering and leaving a basin by water source type.

(2) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.

(3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

(4) The change in the annual volume of groundwater in storage between seasonal high conditions.

(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.

(6) The water year type associated with the annual supply, demand, and change in groundwater stored.

(7) An estimate of sustainable yield for the basin.

This section presents historical results of the analytical spreadsheet water budget model. The 3-D numerical model was used for predictive future simulations and was compared to historical results using the analytical spreadsheet model output for past years.

Modeled historical values were calculated on a monthly time step period; however, results are presented below in terms of both annual values as well as long-term averages over the modeling period (WY 1998 to 2018)[36]. Information presented here thus aligns with the requirements of the current and historical water budgets described under Section 9.3 *Current and Historical Water Budget* below, and is therefore not repeated in the subsequent section.

[36] Water Years run from October of the previous year to September of the current year (e.g. WY 2015 is October 2014 to September 2015).

9.2.1. Surface Water Inflows and Outflows

Per 23-CCR §354.18(b)(1), **Table WB-2** presents annual summaries of the total surface water inflows to and outflows from the Basin for the historical and current periods (WY 1998-2018). Surface water inflows and outflows include: (1) precipitation, (2) natural streamflow into the Basin, and (3) natural streamflow out of the Basin. Infiltration of surface water shown in **Table WB-2** is one of the inflow sources to the groundwater system (**Table WB-3**). **Figure WB-5** shows the total surface water inflows and outflows by type. Total surface water inflows to the Basin average approximately 4,500 acre-feet per year (AFY) over WY 1998-2018 but have varied widely from year to year. On average, 76% of surface water inflows are from direct precipitation and 24% are streamflow from surrounding watersheds and up-gradient basins.

Table WB-2. Estimated Annual Surface Water Inflows and Outflows by Source Type

Water Year	INFLOWS (AFY)			OUTFLOWS (AFY)	
	Precipitation	Streamflow	Total Inflows	Streamflow	Total Outflows
1998	9,930	3,470	**13,400**	4,410	**4,410**
1999	4,130	1,340	**5,470**	1,140	**1,140**
2000	2,810	930	**3,740**	1,020	**1,020**
2001	3,230	1,090	**4,320**	1,060	**1,060**
2002	1,160	250	**1,410**	800	**800**
2003	4,430	1,550	**5,980**	1,170	**1,170**
2004	2,450	750	**3,200**	930	**930**
2005	9,700	3,390	**13,090**	4,290	**4,290**
2006	3,270	1,070	**4,340**	1,070	**1,070**
2007	2,230	590	**2,820**	900	**900**
2008	2,690	760	**3,450**	960	**960**
2009	2,720	790	**3,510**	950	**950**
2010	1,600	430	**2,030**	860	**860**
2011	2,700	880	**3,580**	1,000	**1,000**
2012	2,170	600	**2,770**	890	**890**
2013	2,150	550	**2,700**	870	**870**
2014	1,870	470	**2,340**	850	**850**
2015	3,620	1,120	**4,740**	1,060	**1,060**
2016	2,760	780	**3,540**	930	**930**
2017	4,160	1,390	**5,550**	1,150	**1,150**
2018	1,930	620	**2,550**	910	**910**
Average	**3,410**	**1,090**	**4,500**	**1,300**	**1,300**
%	*76%*	*24%*	--	--	--

Abbreviations:
AFY = acre-feet per year

Notes:
1. Values rounded to the nearest ten acre-feet.

Precipitation

Precipitation falling on lands within the Basin contributes a large percentage of water to the overall water budget and is grouped herein with "surface water inflows." Annual rainfall at the Lebec station over WY 1998 – 2018 ranged from approximately 3.9 inches in WY 2002 to over 33 inches in WY 1998, with an average of 11.5 in/yr (see **Figure WB-4** and **Table WB-1**). Overall, an average of approximately 3,400 AFY of precipitation fell on Basin lands during this period. This water serves to wet the near surface soil and then either evaporates, contributes to crop or native vegetation water demand, or (when a rainfall event is intense enough or long enough) percolates through the root zone to eventually recharge groundwater. "Effective precipitation" is the volume of precipitation that contributes to meeting evapotranspiration demands within the root zone, and is estimated to be approximately 67% of total precipitation within the Basin (see *Appendix H Section 3.4.2*). The remaining precipitation, "ineffective precipitation," either evaporates, runs off, or infiltrates the groundwater system.

Natural Streamflow into the Basin

As discussed in Section 7.3.5 *Surface Water Bodies*, Cuddy Creek drains into the Basin from the up-gradient Cuddy Canyon Basin. A stream gauge in Cuddy Creek that records peak streamflow data only is operated by Kern County in the stream channel near Lebec. The peak streamflow event data are limited, useful mostly for visualizing large streamflow events such as major storms, and periods of no flow. Peak streamflow data recorded between 1980 and 2017 indicate that most flow is minimal with large fluctuations during precipitation events (see **Figure GWC-15**). As detailed in *Appendix H,* streamflow into the Basin was estimated based on records of precipitation falling onto the up-gradient watershed areas and an assumed watershed consumptive use fraction of 95%, estimated during water budget calibration. That is, the assumption that on average only 5% of the amount of precipitation falling on the Castac Lake and O'Neil Canyon-Grapevine Creek watersheds immediately surrounding the Basin flows into the Basin as surface water through Cuddy Creek, Dry Field Creek, O'Neil Creek, and smaller drainages. A 5% recharge factor is consistent with other studies, for example Bookman and Edmonston (1965) used 5.4% for recharge from the upland watershed areas contributing to Castac Basin. For the greater Castac Lake watershed surrounding the upgradient basins feeding through Cuddy Canyon Basin, an assumed watershed consumptive use fraction of 99% was estimated during water budget calibration. This results in 1% of the rainfall on the uplands upgradient watershed areas running off and entering the Castac Basin as streamflow from Cuddy Creek.

Natural Streamflow out of the Basin

As discussed in Section 7.3.5 *Surface Water Bodies*, Grapevine Creek drains northward out of the Castac Basin. No current gauge exists on Grapevine Creek within the Basin, however historical streamflow measurements at various locations along the creek, as well as a gauge operated down-gradient of the Basin suggest streamflow within Grapevine Creek is generally stable with large influxes attributable to precipitation events. Additionally, during rare large storm events, Castac Lake overflowed, contributing surface water to Grapevine Creek. As detailed in *Appendix H*, streamflow out of the Basin is estimated to be the sum of baseflow at the Basin outlet and the fraction of streamflow from other parts of the Basin that becomes Basin outflow. Stream baseflow was estimated as 55-percent the amount of estimated groundwater subsurface outflow based on assumptions of aquifer cross-sectional area, hydraulic conductivity, piezometric (groundwater level) gradient, and canyon geometry. The fraction of streamflow from other parts of the Basin that leaves the Basin was estimated as 20-percent of total streamflow during water budget calibration. Finally, two overtopping events were estimated by the model during WY 1998 and WY 2005. Total surface water outflows averaged 1,300 AFY between WY 1998 - 2018.

9.2.2. Groundwater Inflows and Outflows

Per 23-CCR § 354.18(b)(2) and (b)(3), **Table WB-3** and **Figure WB-6** provide an annual summary of inflows to and outflows from the groundwater system by water source type for WY 1998 – 2018.

Sources of inflow to the groundwater system include:

- Infiltration from precipitation;
- Infiltration from applied groundwater (i.e., “return flows” from irrigation);
- Subsurface groundwater inflows from upgradient Cuddy Canyon Basin and to a lesser extent other tributary canyons; and
- Seepage from surface water systems (e.g., streams and Castac Lake).

Sources of outflow to the groundwater system include:

- Groundwater extraction (i.e., pumping);
- Seepage to the surface water system (e.g., Castac Lake);
- Evaporation of shallow groundwater and Groundwater Dependent Ecosystems (GDEs); and
- Subsurface groundwater outflows.

Table WB-3. Annual Inflows to and Outflows from the Groundwater System, and Change in Groundwater Storage

Water Year	INFLOWS (AFY) [a]									OUTFLOWS (AFY) [a]								CHANGE IN STORAGE [a]	
	Seepage from Lake to GW	Seepage from Streamflow to GW	Infiltration from Precipitation			Infiltration from Return Flows		Subsurface GW Inflow	Total Inflows	Groundwater Extractions				Seepage to Lake	Evaporation of Shallow GW/GDEs	Subsurface GW Outflow	Total Outflows	Storage Change (AFY) [b]	Cumulative Storage Change since WY 1998 (AF)
			Agricultural Areas	Non-Irrigated Areas	Developed Areas	Agricultural Areas	Developed Areas			Pumpage for Lake Filling	Pumpage for Agricultural Areas	Pumpage for Developed Areas	*Total Pumpage*						
1998	30	530	120	1,880	780	30	190	3,110	**6,670**	0	-170	-380	*-550*	-720	-1,330	-1,510	**-4,110**	2,560	2,560
1999	30	190	30	630	320	50	310	3,220	**4,780**	0	-230	-610	*-840*	-710	-960	-1,510	**-4,020**	760	3,320
2000	30	130	20	420	220	50	290	3,130	**4,290**	0	-280	-570	*-850*	-740	-860	-1,500	**-3,950**	340	3,660
2001	20	160	30	490	250	60	270	3,130	**4,410**	0	-310	-550	*-860*	-730	-880	-1,490	**-3,960**	450	4,110
2002	20	30	10	50	90	40	250	2,920	**3,410**	-450	-220	-500	*-1,170*	-700	-680	-1,480	**-4,030**	-620	3,490
2003	40	230	40	750	350	0	230	2,110	**3,750**	-460	0	-450	*-910*	-540	-750	-1,420	**-3,620**	130	3,620
2004	50	100	20	260	190	10	220	1,360	**2,210**	-480	-50	-440	*-970*	-370	-440	-1,450	**-3,230**	-1,020	2,600
2005	50	530	130	1,890	760	90	210	1,210	**4,870**	-290	-140	-410	*-840*	-300	-970	-1,500	**-3,610**	1,260	3,860
2006	50	160	20	510	260	40	230	2,410	**3,680**	-570	-240	-450	*-1,260*	-580	-730	-1,510	**-4,080**	-400	3,460
2007	30	80	10	180	170	220	220	4,020	**4,930**	-130	-640	-450	*-1,220*	-670	-990	-1,490	**-4,370**	560	4,020
2008	30	110	30	320	210	520	240	2,090	**3,550**	0	-1,000	-490	*-1,490*	-600	-710	-1,480	**-4,280**	-730	3,290
2009	50	110	20	330	210	520	220	970	**2,430**	0	-990	-440	*-1,430*	-370	-490	-1,470	**-3,760**	-1,330	1,960
2010	60	60	10	190	130	310	200	550	**1,510**	0	-730	-390	*-1,120*	-220	-300	-1,470	**-3,110**	-1,600	360
2011	70	130	20	480	210	420	180	400	**1,910**	0	-840	-360	*-1,200*	-70	-380	-1,480	**-3,130**	-1,220	-860
2012	100	80	10	230	170	320	220	360	**1,490**	-130	-640	-440	*-1,210*	-20	-300	-1,440	**-2,970**	-1,480	-2,340
2013	10	70	10	220	170	30	250	150	**910**	0	-200	-490	*-690*	-40	-180	-1,440	**-2,350**	-1,440	-3,780
2014	0	60	10	210	150	10	210	100	**750**	0	-70	-420	*-490*	-20	-40	-1,450	**-2,000**	-1,250	-5,030
2015	0	170	30	580	280	10	200	50	**1,320**	0	-50	-390	*-440*	0	-70	-1,460	**-1,970**	-650	-5,680
2016	0	100	20	330	220	10	190	30	**900**	0	-30	-380	*-410*	0	-40	-1,460	**-1,910**	-1,010	-6,690
2017	0	200	50	660	330	0	210	30	**1,480**	0	-10	-410	*-420*	0	-70	-1,480	**-1,970**	-490	-7,180
2018	0	90	10	260	150	0	210	30	**750**	0	-10	-430	*-440*	0	-40	-1,470	**-1,950**	-1,200	-8,380
Total	670	3,320	650	10,870	5,620	2,740	4,750	31,380	**60,000**	-2,510	-6,850	-9,450	-18,810	-7,400	-11,210	-30,960	**-68,380**	-8,380	-8,380
Average	40	160	30	520	270	130	230	1,490	**2,860**	-120	-330	-450	-900	-350	-530	-1,470	**-3,260**	-390	
%	*1%*	*6%*	*1%*	*18%*	*9%*	*5%*	*8%*	*52%*	--	*4%*	*10%*	*14%*	*28%*	*11%*	*16%*	*45%*	--	--	--

Abbreviations:
AF = acre-feet
AFY = acre-feet per year
GDEs = groundwater dependent ecosystems
GW = groundwater
WY = Water Year

Notes:
(a) Values rounded to the nearest ten acre-feet.
(b) Storage change calculated as total inflows minus total outflows.

Figure WB-7 provides a summary of the historical 20-year (WY 1998 - 2017) long-term annual average inflows to and outflows from the groundwater system. Total inflows to the groundwater system averaged 2,960 AFY. Approximately 28% of total inflows to the groundwater system were supplied from infiltration of precipitation, 53% from subsurface groundwater inflows, 6% from infiltration from surface water systems, and 12% by infiltration of applied water.

As shown on **Figure WB-7**, total outflows from the groundwater system averaged 3,320 AFY over WY 1998 – 2017. Approximately 28% of total outflows to the groundwater system were from groundwater extraction, 44% to subsurface groundwater outflows, 11% from seepage to Castac Lake, and 17% from evaporation of the shallow groundwater table and GDEs. Within the category of groundwater extraction, approximately 49% can be attributed to municipal and domestic use, 37% to agricultural pumpage, and the remaining 14% to lake filling operations, although lake filling operations only occurred throughout portions of the historical water budget period (i.e., WYs 2002 through 2007, and 2012).

9.2.3. Change in Groundwater Storage

Per 23-CCR § 354.18(b)(4), **Figure WB-8**, **Figure WB-9**, and **Table WB-4** present the annual and cumulative change in groundwater storage between seasonal high conditions, which are defined in this GSP to be March through February of the following year. Note that this time window is distinct from DWR's definition of the "Water Year", which runs from October of the previous year to September of the current year (e.g. DWR WY 2014 is October 2013 – September 2014); thus the values presented in **Table WB-4** are slightly different than the annual and cumulative change in storage estimates provided for DWR WYs 1998 – 2018 in **Table WB-3**, **Table WB-5**, **Table WB-7** and **Table WB-8**.

Annual change in groundwater storage averaged approximately -480 AFY between seasonal high conditions for the period of March 1998 through February 2018 (**Table WB-4**; **Figure WB-8**), with a cumulative change in storage equating to approximately -9,540 AF over the same period of record (**Table WB-4**; **Figure WB-9**). However, as seen in **Figure WB-8,** change in storage varied widely between years, from an approximate 1,210 AF increase in storage in 1998 to an approximate 1,700 AF decrease in storage in 2009.

Table WB-4. Annual and Cumulative Change in Groundwater Storage between Seasonal Highs (Mar – Feb)

Period of Reference (month/year)	Annual Change in Groundwater Storage (AFY)[a]	Cumulative Change in Groundwater Storage (AF)[a]
3/98 - 2/99	1,210	1,210
3/99 - 2/00	540	1,750
3/00 - 2/01	420	2,170
3/01 - 2/02	40	2,210
3/02 - 2/03	-560	1,650
3/03 - 2/04	190	1,840
3/04 - 2/05	460	2,300
3/05 - 2/06	-350	1,950
3/06 - 2/07	-430	1,520
3/07 - 2/08	970	2,490
3/08 - 2/09	-1,370	1,120
3/09 - 2/10	-1,700	-580
3/10 - 2/11	-1,290	-1,870
3/11 - 2/12	-1,400	-3,270
3/12 - 2/13	-1,490	-4,760
3/13 - 2/14	-1,440	-6,200
3/14 - 2/15	-940	-7,140
3/15 - 2/16	-760	-7,900
3/16 - 2/17	-220	-8,120
3/17 - 2/18	-1,420	-9,540
Total[b]	-9,540	-9,540
Average[b]	**-480**	**--**

Abbreviations:
AF = acre-feet
AFY = acre-feet per year
Feb = February
Mar = March

Notes:
(a) Values rounded to the nearest ten acre-feet.
(b) The total and average values do not cover the entire range of the water budget period.

Figure WB-10, **Figure WB-11**, and **Table WB-5** compare the annual and cumulative change in storage for each Water Year (October – September) between 1998 and 2018 to the Water Year type based on DWR's San Joaquin Valley Water Year Index. Annual change in groundwater storage averaged approximately -390 AFY from WY 1998 – 2018, with a cumulative change in storage amounting to approximately -8,380 AF over this period. These exhibits depict a clear relationship between change in groundwater storage to WY type, whereby change in storage becomes more positive with an increasing "wet" condition and more negative with an increasing "dry" condition. The net benefit of a "wet" period on groundwater conditions is especially evident in WYs 1998, 2005, and 2017, whereas the impact of a severe multi-year drought becomes increasingly evident over the period of WY 2007 - 2014. As evident from these two exhibits, as well as from the groundwater hydrographs shown in **Figure GWC-4** and **Figure GWC-5**, the groundwater system is highly sensitive to climatic conditions.

Table WB-5. Annual Change in Groundwater Storage vs. DWR Water Year Type

DWR Water Year (Oct - Sept)	Water Year Type[(a)]	Annual Change in Groundwater Storage (AFY)[(b)]	Cumulative Change in Groundwater Storage (AF)[(b)]
1998	W	2,560	2,560
1999	AN	760	3,320
2000	AN	340	3,660
2001	D	450	4,110
2002	D	-620	3,490
2003	BN	130	3,620
2004	D	-1,020	2,600
2005	W	1,260	3,860
2006	W	-400	3,460
2007	C	560	4,020
2008	C	-730	3,290
2009	BN	-1,330	1,960
2010	AN	-1,600	360
2011	W	-1,220	-860
2012	D	-1,480	-2,340
2013	C	-1,440	-3,780
2014	C	-1,250	-5,030
2015	C	-650	-5,680
2016	D	-1,010	-6,690
2017	W	-490	-7,180
2018	BN	-1,200	-8,380
Total		-8,380	-8,380
Average		**-390**	**--**

Abbreviations:

AF = acre-feet
AFY = acre-feet per year
DWR = California Department of Water Resources
Oct = October
Sept = September

Notes:

(a) DWR Water Year types are based on the San Joaquin Valley Index, and are as follows: W = wet; AN = above normal; BN = below normal; D = dry; C = critical
(b) Values rounded to the nearest ten acre-feet

Sources:
DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley.
http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

Figure WB-12 shows a comparison of the analytical spreadsheet model-calculated monthly groundwater elevation through time (black line), against the average of water levels measured in wells located in the Castac Lake and Dryfield Canyon areas of the Basin (blue connected dots). The analytical model groundwater elevation is calculated assuming a specific yield value of 0.12, which is the average specific yield value employed in the Castac Basin Numerical Model calibrated for the Castac Lake and Dryfiled Canyon areas of the Basin. As shown on **Figure WB-12**, the spreadsheet-calculated values track closely to the available data, indicating that the modeled elevation correlates well with the average measured water level in the Basin over time.

Between WY 2009 to 2018, the model-calculated changes in groundwater elevation (-4.5 feet per year [ft/yr]) are approximately equal to the average measured change in groundwater elevation (-4.5 ft/yr) for the Castac Lake area of the Basin (see **Table GWC-3**) indicating that the model-calculated changes in groundwater elevation reasonably replicate measured values. Although the Castac Basin Numerical Model's primary function is to estimate the future water budget, we compared the numerical model-based change in groundwater storage and groundwater elevation for validation of the spreadsheet model results. As shown in **Table WB-6**, the Numerical Model estimates an annual net decline in groundwater storage of -740 AFY throughout the historical Numerical Model period (WY 1999 – 2018), or a cumulative decline of -14,800 AF between October 1998 – September 2018. For comparison, the Spreadsheet Analytical Model estimates a net decline in storage of -550 AFY over the same time period (WY 1999 – 2018; note this period is different than the historical water budget period). Furthermore, the annual change in groundwater storage calculated from the Numerical Model tracks closely with storage change estimates produced by the Spreadsheet Analytical Model on a yearly basis and over the entire historical time-period (see *Figure 12 of Appendix I*). These results indicate that the two models are generally in close agreement. For perspective, the -190 AFY discrepancy in annual change in groundwater storage estimates between the historical Numerical Model and the Spreadsheet Analytical model represents an overall uncertainty[37] in the volumetric water budget of approximately 4%.

[37] "Overall uncertainty" is defined herein as the change in estimated annual groundwater storage relative to the total annual volumetric inflows into the Castac Basin.

Table WB-6. Comparison of Numerical Model and Spreadsheet Analytical Model Results for WY 1999 – 2018

Water Budget Component[(a)]	Spreadsheet Analytical Model Result (AFY)	Numerical Model Result (AFY)
Total Groundwater Inflows	2,670	3,430
Total Groundwater Outflows	3,210	4,170
Change in Groundwater Storage	**-550**	**-740**

Abbreviations:
AFY = acre-feet per year

Notes:
(a) The differences shown between water budget components in the Numerical Model and the Analytical Spreadsheet Model reflect their slightly different approaches to modeling of Basin streamflow inflows and outflows . See *Appendix I* for more details.

9.2.4. Overdraft Conditions

The Basin has been classified by DWR in its 2019 Basin Prioritization (DWR, 2019) as a "very low priority" basin, and is designated as not being in a condition of critical overdraft. With respect to basins in overdraft conditions, DWR has made the following statements:

- "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts." (DWR, 1980)
- Groundwater overdraft is "... the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts." (DWR, 2003)
- "Overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of water to the basin. Effects of overdraft result can include seawater intrusion, land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels".

While evaluating basins for critical overdraft conditions in its most recent Bulletin 118 update, DWR considered the time period from WY 1989 – 2009 (DWR, 2016c). This period excludes the recent drought which began in 2012, includes both wet and dry periods, is at least 10 years in length, and includes precipitation close to the long-term average; these were all criteria used in selecting the time period.

The water budget information discussed herein covers the period from WYs 1998 through 2018 (i.e., it does not cover the entire period used in DWR's evaluation). However, within the period covered by this water budget, the 12-year timeframe between WYs 1998 and 2009 (October 1997 through September 2009) meets all of the same criteria. The cumulative departure in statewide average precipitation increased by a total of 9% during this 12-year period, (DWR, 2016c, Figure 1), indicating that each year was wetter than the long-term average by a small amount (i.e., less than 1% annually). Over this time period, the cumulative change in storage within the Basin increased by approximately 1,960 AF, averaging approximately 160 AFY. Therefore, by this metric and using DWR's description of overdraft, the Basin as a whole is not in a condition of critical overdraft.

9.2.5. Sustainable Yield

The Sustainable Groundwater Management Act (SGMA) defines sustainable yield as "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" (California Water Code [CWC], §10721(w)). DWR's Water Budget BMP (DWR, 2016b), further states that "Water budget accounting information should directly support the estimate of sustainable yield for the basin and include an explanation of how the estimate of sustainable yield will allow the basin to be operated to avoid locally defined undesirable results." Inherent to the codified definition and the BMP statement is the avoidance of the SGMA-specified "Undesirable Results", which include significant and unreasonable effects for any of the six SGMA sustainability indicators. Therefore, determination of the sustainable yield for the Basin depends upon how the Undesirable Results are defined. Groundwater Sustainability Agencies such as the Castac Basin GSA have the ability to define Undesirable Results for their basin.

While no exact method for defining the sustainable yield is required by SGMA or promoted by DWR in its Water Budget BMP, the BMP does emphasize that water budget accounting information should be used. It follows that an estimate of the sustainable yield of the groundwater system in the Basin can be made by subtracting the average annual groundwater extraction, which is negative by definition, from the average annual change in storage (whether positive or negative). This simplified approach provides a sustainable yield estimate corresponding to the total volume of water that, if pumped over the water budget period of interest, would have resulted in zero change in storage due to pumping – a reasonable metric for sustainability.

For the Castac Basin, using the average annual change in groundwater storage over the water budget period from WYs 1998 – 2018 (i.e., -400 AFY) and the average annual groundwater extraction (i.e., -900 AFY), the sustainable yield is estimated at approximately +500 AFY under current supply and demand conditions. Use of other water budget periods produces a range of sustainable yield estimates for Castac Basin which vary from +500 AFY to +1,190 AFY, thus, these estimates are time-dependent and contain significant uncertainty.

Table WB-7 below provides a summary of the range of potential sustainable yield estimates for Castac Basin, based on different selected time periods. For comparison, current (WY 2018) groundwater extraction is approximately -440 AFY, which is less than the range of sustainable yield estimates.

Table WB-7. Estimated Sustainable Yield for Selected Time Periods

Time Period	Relevance of Time Period	Average Annual Change in Groundwater Storage (AFY)	Average Annual Groundwater Extraction (AFY)	Sustainable Yield (AFY)(b)
WY 1998 - 2018	Entire Water Budget Period	-400	-900	500
WY 1998 - 2017	Historical Water Budget Period	-360	-920	560
WY 1998 - 2009	Overdraft Evaluation Period (Section 9.2.4)	160	-1,030	1,190
WY 1998 - 2011	Water Budget Period Excluding the Recent Drought	-60	-1,050	990

Notes:

(a) Values rounded to the nearest ten acre-feet.

(b) Sustainable Yield is calculated as average annual change in groundwater storage minus average annual groundwater extraction.

9.3. Current and Historical Water Budget

§ 354.18. Water Budget

(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.

(2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:

(A) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.

(B) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.

(C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.

9.3.1. Current Water Budget

This section presents results for the "current" water budget, based on values extracted from the spreadsheet model for WY 2018.

Per 23-CCR §354.18(d)(1), **Table WB-8** and **Figure WB-13** provide a summary of total inflows to and outflows from the Basin for WY 2018, while **Table WB-3** and **Figure WB-14** provide a summary of groundwater-only inflows and outflows for WY 2018.

Total inflows to the Basin hydrologic system (including groundwater) were approximately 2,580 AFY for WY 2018, including subsurface groundwater inflow, precipitation, and surface water inflows. Total outflows from the Basin hydrologic system were approximately 4,140 AFY for WY 2018, including evapotranspiration (consumptive use by vegetation), evaporation, consumptive municipal and domestic water use, subsurface outflows, and surface outflows. The difference between total inflows and outflows to the Basin hydrologic system in WY 2018 was a net loss of approximately 1,560 AF.

Considering only the groundwater component of the Basin hydrologic system, inflows totaled approximately 750 AFY, which includes subsurface groundwater inflow, infiltration of ineffective precipitation, infiltration of streamflow, infiltration of return flows from agricultural applications, and infiltration of return flows from municipal/domestic water use. Outflows from the groundwater component of the Basin hydrologic system totaled approximately 1,950 AFY, including pumpage, developed areas consumptive use, net seepage to Castac Lake, evaporation from shallow groundwater and GDEs, and subsurface outflows. The difference between total inflows and outflows in the groundwater component of the hydrologic system was a net loss of approximately 1,200 AF.

Table WB-8. Annual Inflows to and Outflows from the Water Budget Domain, and Change in Storage

Water Year	INFLOWS (AFY)[a]				OUTFLOWS (AFY)[a]				CHANGE IN STORAGE[a],[b]		
	Total Precipitation	Surface Water Inflow	Subsurface GW Inflow	Total Inflows	Evapotranspiration, Evaporation, & Consumptive Use	Surface Water Outflow	Subsurface GW Outflow	Total Outflows	GW Storage Change (AFY)	Cumulative GW Storage Change since WY 1998 (AF)	Lake Storage Change (AFY)
1998	9,930	3,470	3,110	**16,510**	-7,290	-4,410	-1,510	**-13,210**	2,560	2,560	730
1999	4,130	1,340	3,220	**8,690**	-4,980	-1,140	-1,510	**-7,630**	760	3,320	300
2000	2,810	930	3,130	**6,870**	-4,200	-1,020	-1,500	**-6,720**	340	3,660	-190
2001	3,230	1,090	3,130	**7,450**	-4,430	-1,060	-1,490	**-6,980**	450	4,110	30
2002	1,160	250	2,920	**4,330**	-3,310	-800	-1,480	**-5,590**	-620	3,490	-630
2003	4,430	1,550	2,110	**8,090**	-4,450	-1,170	-1,420	**-7,040**	130	3,620	940
2004	2,450	750	1,360	**4,560**	-3,490	-930	-1,450	**-5,870**	-1,020	2,600	-290
2005	9,700	3,390	1,210	**14,300**	-6,650	-4,290	-1,500	**-12,440**	1,260	3,860	620
2006	3,270	1,070	2,410	**6,750**	-4,190	-1,070	-1,510	**-6,770**	-400	3,460	390
2007	2,230	590	4,020	**6,840**	-4,490	-900	-1,490	**-6,880**	560	4,020	-600
2008	2,690	760	2,090	**5,540**	-4,240	-960	-1,480	**-6,680**	-730	3,290	-410
2009	2,720	790	970	**4,480**	-4,050	-950	-1,470	**-6,470**	-1,330	1,960	-670
2010	1,600	430	550	**2,580**	-2,980	-860	-1,470	**-5,310**	-1,600	360	-1,140
2011	2,700	880	400	**3,980**	-3,450	-1,000	-1,480	**-5,930**	-1,220	-860	-730
2012	2,170	600	360	**3,130**	-3,220	-890	-1,440	**-5,550**	-1,480	-2,340	-930
2013	2,150	550	150	**2,850**	-2,960	-870	-1,440	**-5,270**	-1,440	-3,780	-970
2014	1,870	470	100	**2,440**	-2,280	-850	-1,450	**-4,580**	-1,250	-5,030	-890
2015	3,620	1,120	50	**4,790**	-2,940	-1,060	-1,460	**-5,460**	-650	-5,680	-20
2016	2,760	780	30	**3,570**	-2,440	-930	-1,460	**-4,830**	-1,010	-6,690	-250
2017	4,160	1,390	30	**5,580**	-3,190	-1,150	-1,480	**-5,820**	-490	-7,180	260
2018	1,930	620	30	**2,580**	-1,760	-910	-1,470	**-4,140**	-1,200	-8,380	-380
Total	71,710	22,820	31,380	**125,910**	-80,990	-27,220	-30,960	**-139,170**	-8,380	-8,380	-4,830
Average Historical (1998-2017)	3,490	1,110	1,570	**6,170**	-3,960	-1,320	-1,470	**-6,750**	-360	-7,180	-220
%	*57%*	*18%*	*25%*	--	*59%*	*20%*	*22%*	--	--	--	--

Abbreviations:

AF = acre-feet
AFY = acre-feet per year
GW = groundwater
N/A = not applicable
WY = Water Year

Notes:

(a) All values rounded to the nearest ten acre-feet.
(b) (Total inflows) + (total outflows) = (groundwater storage change) + (lake storage change), assuming inflows are positive and outflows are negative.

9.3.2. Historical Water Budget

Water budget results are presented above for the historical water budget period in Section 9.2 *Water Budget Results*, including associated figures and tables, and are not repeated here. Rather, this section focuses on providing:

(a) a quantitative evaluation of historical surface water availability and reliability (23-CCR §354.18(d)(2)(A)),

(b) a quantitative assessment of the historical water budget (23-CCR §354.18(d)(2)(B)), and

(c) a description of how historical conditions have impacted the ability of the Basin to be operated within its sustainable yield (23-CCR §354.18(d)(2)(C)).

Historical Surface Water Availability and Reliability

The Basin does not currently use surface water as a source of water supply.

Quantitative Assessment of Historical Water Budget

Based on DWR San Joaquin Valley WY Index for the 20-year period from WY 1998 through 2017, this period included five "critical" (dry) years, five dry years, two below normal years, three above normal year, and five wet years. The beginning of this period was relatively wet, the middle was a mix of wet and dry years, and the end of the period was extremely dry. This climatic factor is clearly reflected in the water budget, whereby the groundwater system shows consistent increases in storage with "wetter" conditions and decreases in storage under "drier" conditions (see **Figure WB-10**, **Figure WB-11**, and **Table WB-5**).

Table WB-8 and **Figure WB-15** provide a tabular breakdown for the entire Basin of total inflows and outflows for WYs 1998 - 2017, and **Figure WB-16** provides a graphical summary of average annual total inflows and outflows over the same period (similar information for just the groundwater system is provided in **Table WB-3** and on **Figure WB-6** and **Figure WB-7**).

Total annual inflows to the Basin of both surface water and groundwater averaged approximately 6,170 AFY for WYs 1998 - 2017, including subsurface groundwater inflow, precipitation, and surface water inflows. This resulted in an average inflow to the groundwater system of approximately 2,960 AFY, comprised of subsurface groundwater inflow, infiltration of ineffective precipitation, infiltration of streamflow, infiltration of return flows from agricultural applications, and infiltration of return flows from municipal/domestic water use.

Total annual outflows to the Basin of both surface water and groundwater averaged approximately 6,750 AFY between WY 1998 - 2017, including evapotranspiration (consumptive use by vegetation), consumptive municipal and domestic water use, evaporation, subsurface outflows, and surface outflows. This resulted in a total outflow from the groundwater system of approximately 3,320 AFY, including pumpage, developed areas consumptive use, net seepage to

Castac Lake, evaporation from the shallow groundwater table and GDEs, and subsurface outflows.

Operation within Sustainable Yield

Average annual change in groundwater storage amounted to approximately -360 AFY between WYs 1998 - 2017, resulting in a cumulative change in groundwater storage of approximately -7,180 AF during this period (**Table WB-8**; **Figure WB-11**).

Although the overall net change during this period is negative, the calculated transient change in storage and water levels measured in wells within the Basin (see **Figure GWC-7** and **Figure GWC-4**) demonstrate that the groundwater system is sensitive to climatic variability, with decreases in storage during drought followed by increases in storage during wet periods. Additionally, during the historical water budget period, groundwater pumping decreased over time. Since the change in storage became more negative during periods of declining pumping, Basin operations (e.g., groundwater pumping) appear not to drive the estimated decreases in groundwater storage. Average pumping over the historical water budget period (WYs 1998 - 2017) was 920 AFY (**Table WB-7**; **Figure WB-7**), which falls within the upper end of the sustainable yield estimates (500 to 1,190 AFY) shown in **Table WB-7**, however current (WY 2018) groundwater pumping is approximately 440 AFY, which is less than the range of sustainable yield estimates.

9.4. Projected Water Budget

§ 354.18. Water Budget

(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

(3) Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:

(A) Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.

(B) Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.

(C) Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.

Per the Groundwater Sustainability Plan (GSP) Emergency Regulations (23-California Code of Regulations [CCR] §354.18(e)(2)), projected water budgets are required to estimate future conditions of water supply and demand within a basin, as well as the aquifer response to GSP implementation over the planning and implementation horizon. To develop a projected water budget for the Castac Lake Valley Groundwater Basin (Castac Basin), the Castac Basin Numerical Model was used, with updated inputs for climate variables (i.e., precipitation and evapotranspiration [ET]), land use changes, and project and management action (P&MA) implementation.

9.4.1. Development of 50-Year Analog Period

Per the GSP Emergency Regulations 23-CCR §354.18(e)(2)(A), the projected water budgets must use 50 years of historical precipitation, ET, and streamflow information as the basis for evaluating future conditions under baseline and climate-modified scenarios. To develop the required 50 years of projected hydrologic input information, an "analog period" was created by repeating select sequences of the 20-year historical hydrologic record in a way that maintains long-term historical average hydrologic conditions[38], as detailed below. This approach allows for the simulation of a continuous 50-year period of future hydrologic data to inform the projected water budget analysis, even when certain component datasets are not available for that length of time. The sequence of actual years that were combined to create the 50-year analog period is as follows:

- Analog Years 1 to 12: Based on actual years 2003-2014
- Analog Years 13 to 32: Based on actual years 1995-2014
- Analog Years 33 to 50: Based on actual years 1995-2012

The above mapping of actual years to analog years within the required 50-year projected water budget period applies to both the precipitation and ET datasets.

9.4.2. Development of Projected Water Budget Scenarios

Three projected climate scenarios were used for this water budget analysis per the California Department of Water Resources (DWR)'s guidance (DWR, 2018):

- Historical Analog (Baseline) Climate Scenario,
- DWR moderate (2030) Climate Change Scenario, and
- DWR extensive (2070) Climate Change Scenario.

The Baseline Climate Scenario is for comparison purposes and does not include any expected effects of climate change, the 2030 Climate Change Scenario reflects a moderate level of climate change effects, and the 2070 Climate Change Scenario incorporates a more severe set of climate change assumptions. All three scenarios are used to project the water budget for the Basin through 2070 and are simulated through use of the Castac Basin Numerical Model.

In addition, three future land-use scenarios were considered for the water budget analysis, including:

- Current Land-Use Scenario,
- Tejon Mountain Village (TMV) Development Scenario, and
- TMV Development with Aquifer Replenishment Project Scenario.

The Current Land-Use Scenario is for comparison purposes and does not include completion of the TMV Development. The TMV Development Scenario includes the Phase 1 TMV development buildout within the Basin and the TMV Development with Aquifer Replenishment Project

[38] The 50-year analog period used to develop projected water budgets is informed by and consistent with the methodology employed in the Kern County Subbasin numerical groundwater flow model used for GSP development purposes (TODD Groundwater, 2020).

Scenario includes the Phase 1 TMV development plus implementation of the Aquifer Replenishment Project whereby Castac Lake levels are maintained, using imported and recycled water sources. All three scenarios are used to project the water budget for the Basin through 2070 and are simulated through use of the Castac Basin Numerical Model.

Baseline Scenario

Per the GSP Emergency Regulations 23-CCR §354.18(e)(2)(B) and 23-CCR §354.18(e)(2)(C), the projected water budgets must use "the most recent land use, evapotranspiration, and crop coefficient information" and "the most recent water supply information as the baseline condition for estimating future surface water supply." For the purpose of the Baseline Scenario, no climate change factors are applied. Instead, as described below, the Baseline Scenario represents the projected land use and water demands through the GSP implementation period (i.e., between 2020 and 2040).

- Current land use (TCWD, 2019a) (**Figure PA-3**).
- The projected groundwater extraction from the Basin includes known and anticipated public supply, domestic, and irrigation uses, and is estimated using the following assumptions:
    - The number of domestic, irrigation, and small public water system wells within the Basin is not expected to increase in the future. Therefore, modeled groundwater pumping from domestic and irrigation wells, as well as public supply system wells that support El Tejon School, Tejon Ranch Company (TRC) headquarters, and Fort Tejon is held constant (for each month) at a rate equivalent to the average monthly pumped volumes over the last five years of the historical model (i.e., DWR Water Years [WY] 2014 – 2018).
    - Lebec County Water District (LCWD) is in process of installing a new well within the Basin which will replace the existing LCWD "Chimney" well, located in the up-gradient Cuddy Canyon Basin. The replacement well is assumed to pump a total of approximately 50.6 acre-feet per year (AFY), equivalent to the average pumped volume from the Chimney Well between DWR WY 2014 - 2018. LCWD is in the process of annexing Frazier Mountain High School whose drinking water demand in 2019 was less than 1 acre-foot,[39] however anticipated delivery is 2.5 million gallons per year (approximately 7.6 acre-feet per year).[40] Based on historical trends, limited growth is expected within the LCWD service area in the future; therefore, groundwater extraction from the remaining LCWD public supply wells

[39] Personal communication, Jessica Carroll, Lebec County Water District, 6 November 2019, based on bottled water delivery volumes provided by Self-Help Enterprises.
[40] Project / Management Action Information Form "Frazier Mountain High School Water Project"

is held constant by month, based on the average monthly pumped volumes during DWR WY 2014 - 2018.

- Krista Mutual Water Company (KMWC) is currently at their maximum number of connections for their distribution system, and no additional growth can be accommodated[41]. Therefore, KMWC groundwater use is held constant by month based on the average monthly pumped volumes during DWR WY 2014 – 2018.
- Imported surface water is not currently used within the Basin. However, the TMV development will rely exclusively on imported State Water Project (SWP) water and recycled water to meet demands. No groundwater will be used (TCWD, 2008).

- Groundwater inflow from the upgradient Cuddy Canyon Basin was simulated by approximating a local gradient at the Cuddy Creek boundary using the average measured gradient between wells TRC-MW16D and TRC-PW56A over the last five years of the historical model (i.e., DWR WY 2014 – 2018), resulting in an average inflow of approximately 200 AFY. Based on the measured gradient between wells TRC-MW16D and TRC-PW56A, estimated groundwater inflow during that period was significantly reduced compared to the 20-year historical average, and as discussed in more detail in *Section 9.5.2* below, is a source of uncertainty in the projected model scenarios.

2030 Climate Change Scenario

To estimate the potential effects of climate change on the projected water budget during the GSP implementation period (i.e., between 2020 and 2040), a water budget scenario based on 2030 climate change factors published by DWR (DWR, 2018) was developed. The climate change factors published by DWR represent aerial changes in historical monthly precipitation and ET records from January 1915 through December 2011 based on various models of projected climate conditions centered around the years 2030 and 2070. For the 2030 Climate Change Scenario, Baseline monthly precipitation and ET were both adjusted based on DWR's climate change factors by up to ±75% and ±10% (depending on month), respectively, resulting in an average 0.5% decrease in precipitation and an average 3.7% increase in ET (**Figure WB-18**). For January 2012 through September 2014, analog years were assigned based on similar hydrology in which 2012, 2013, and 2014 were assigned the climate change factors associated with years 1959, 1960, and 1961, respectively. Land use, groundwater supplies, surface water supplies, and groundwater inflow are assumed to be the same as the Baseline Scenario.

2070 Climate Change Scenario

To estimate the potential effects of climate change on the projected water budget towards the end of the planning and implementation horizon (i.e., 50 years into the future), a water budget scenario based on 2070 "central tendency" climate change factors published by DWR (DWR,

[41] Personal communication, Krista Mutual Water Company, 7 November 2019.

2018) was developed. It should be noted that estimates of climate change impacts on water supplies this far into the future have significant uncertainty. For the 2070 Climate Change Scenario, Baseline precipitation and ET were both adjusted based on DWR's 2070 "central tendency" climate change factors using the same methodology described above for the 2030 Climate Change Scenario development. The 2070 Climate Change Scenario resulted in an average 3.5% decrease in precipitation and 8.1% increase in ET relative to the Baseline Scenario (**Figure WB-18**). Land use, groundwater supplies, surface water supplies, and groundwater inflow are assumed to be the same as the Baseline Scenario.

TMV Development Scenario

Current land use (**Figure PA-3**) was adjusted to reflect the planned development of TMV Phase 1 (**Figure WB-17**) by 2040 based on zoning from the Kern County Vesting Tentative Tract Map #7313 (TCWD, 2019b).

TMV Development with Aquifer Replenishment Project Scenario

To quantify the potential effects of proposed P&MAs on the projected water budget during the GSP implementation period (i.e., between 2020 and 2040), a water budget scenario was developed which simulates a managed lake scenario representing the P&MA #1 referred to as "Aquifer Replenishment Project." The Baseline Climate Change Scenario was employed with an assumption that the water level in Castac Lake would be maintained (using direct rainfall, imported surface water and/or recycled water) at a constant water depth of 10 feet, measured from the base of the lakebed, to cover approximately 200 acres.[42] This scenario has been modeled assuming that surplus imported surface water supplies remain available. However, the effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed.

9.4.3. Projected Water Budget Results

Results of the projected water budget analyses are summarized in **Table WB-9** and **Figure WB-19**. As shown in **Table WB-9**, water budget components are presented as averages over the 20-year historical period, as simulated by the Castac Basin Numerical Model,[43] and averages over the 50-year analog period for the Baseline, 2030 Climate Change, and 2070 Climate Change Scenarios. Water budget components are grouped into inflows and outflows. Also shown in **Table WB-9** is the average annual change in groundwater storage for the historical period and for each projected scenario. Annual projected changes in storage over the 50-year analog period are

[42] Personal communication, Tejon-Castac Water District, 6 November 2019

[43] The Castac Basin Numerical Model simulates water years 1999-2018, whereas the discussion of the historical water budget presented in Section *9.3.2 Historical Water Budget* is informed by results from the analytical spreadsheet model which simulates a historical period of water years 1998-2017.

presented for each climate and development scenario in **Figure WB-20** and **Figure WB-21**, respectively.

In the Baseline Scenario, the water budget components differ from the historical period primarily due to differences between the modeled long-term historical period (WY 1999 to 2018) and the last 5-year period representing recent conditions, including: (1) a reduction in pumping, (2) a reduction in groundwater inflow based on an extrapolated gradient which decreases significantly from 1998 to 2018, and (3) a reduction in ET from shallow groundwater and groundwater dependent ecosystems (GDEs) due to groundwater levels falling below the modeled extinction depth in some areas[44].

Without the TMV Development or Aquifer Replenishment Project, the change in groundwater storage shows a small decline on average over the 50-year projected scenarios. The change in groundwater storage averages -60 AFY under the Baseline and 2030 Climate Change Scenarios, and -80 AFY under the 2070 Climate Change Scenario (**Table WB-9**). Projected climate change factors have a minimal effect on change in groundwater storage and Basin groundwater levels (**Figure WB-20**).

Under the TMV Development Scenarios, an additional 330 – 340 AFY of recharge is added to the Basin from TMV's use of imported surface water supplies, resulting in generally more stable groundwater conditions (**Figure WB-21**). The change in groundwater storage averages -10 AFY under the Baseline and 2030 Climate Change Scenarios, and -20 AFY under the 2070 Climate Change Scenario, with the TMV Development (**Table WB-9**).

Upon implementation, the Aquifer Replenishment Project is estimated to add an additional 70 to 100 AFY of groundwater replenishment to the Basin (and up to 300 AFY on certain years), resulting in a net increase in groundwater storage of approximately 30 AFY under each climate scenario (**Figure WB-21**). The change in groundwater storage averages 20 AFY under the Baseline and 2030 Climate Change Scenarios, and 10 AFY under the 2070 Climate Change Scenario (**Table WB-9**).

As discussed in more detail in *Section 9.5.2 Boundary Conditions*, one of the largest drivers for projected groundwater availability, and therefore groundwater storage, in the Basin is the amount of groundwater inflow from upgradient Cuddy Canyon Basin. Model sensitivity testing shows that projected groundwater storage would increase significantly if groundwater inflows

[44] ET for shallow groundwater and groundwater dependent ecosystems (GDEs) is estimated by the Castac Basin Numerical Model based on simulated groundwater levels and a specified extinction depth of three feet below ground surface (ft bgs). This extinction depth is based on prior work performed in the Basin by Tejon Ranch (EKI, 2008d) which estimated the 90% cumulative rooting depth for various plant species mapped in the Basin, using methods from Zeng (2001), land cover from the National Land Cover Database (NLCD), and vegetation coefficients from the International Geosphere-Biosphere Program (IGBP). When model-calculated groundwater levels decline below the extinction depth, ET demands within the model are reduced. Areas with trees and other deeper-rooted phreatophyte vegetation near Castac Lake and in narrow portions of the Grapevine Canyon area may extend the extinction depth beyond the 3 ft bgs extinction depth used in the model.

were to increase to rates similar to the 20-year historical average (i.e., an increase from 200 AFY to 1,390 AFY). Further, as discussed in more detail in *Section 17.8.2 Evaluation Relative to Water Level Sustainability Criteria*, it should be noted that the results from the Castac Basin Numerical Model scenarios show that the Basin is projected to maintain its Sustainability Goal (i.e., avoids Undesirable Results).

Table WB-9. Summary of Projected Water Budget Estimates

Scenario	Climate Period	Land Use	Average Water Budget Components (AFY)[a],[b]							
			Inflows			Outflows				Inflows – Outflows
			Recharge	Groundwater Inflow	Lake (to GW)	Pumping	Groundwater Outflow	Lake (from GW)	ET from GDEs	Change in Groundwater Storage
Historical[c]	DWR WY 1999-2018	Current	2,040	1,390	0	910	2,070	570	620	-740
Projected Baseline	50-year Synthetic Hydrologic Period	Current	2,170	260	0	490	1,960	10	40	-60
Projected 2030 Climate	Scaled from Baseline-moderate climate change	Current	2,180	260	0	490	1,960	10	40	-60
Projected 2070 Climate	Scaled from Baseline-extensive climate change	Current	2,090	280	0	490	1,930	10	30	-80
Projected Baseline with TMV Development	50-year Synthetic Hydrologic Period	Projected	2,510	200	0	490	2,060	80	100	-10
Projected 2030 Climate with TMV Development	Scaled from Baseline-moderate climate change	Projected	2,520	200	0	490	2,060	80	100	-10
Projected 2070 Climate with TMV Development	Scaled from Baseline-extensive climate change	Projected	2,420	210	0	490	2,030	50	80	-20
Projected Baseline with TMV Development and Aquifer Replenishment Project	50-year Synthetic Hydrologic Period	Projected	2,510	160	80	490	2,070	10	160	20
Projected 2030 Climate with TMV Development and Aquifer Replenishment Project	Scaled from Baseline-moderate climate change	Projected	2,520	160	80	490	2,080	0	160	20
Projected 2070 Climate with TMV Development and Aquifer Replenishment Project	Scaled from Baseline-extensive climate change	Projected	2,420	180	100	490	2,050	0	140	10

Abbreviations:

AFY = acre-feet per year
DWR = California Department of Water Resources
ET = Evapotranspiration
GDEs = groundwater dependent ecosystems
GW = groundwater
WY = Water Year

Notes:

(a) Water budget components are presented as an average over their respective simulation period (i.e., 20 years for the Historical and 50 years for the Projected scenarios).
(b) Values rounded to the nearest ten acre-feet.
(c) Historical water budget values presented are from the Castac Basin Numerical Model for consistency with Projected water budget values. The period shown is different than the historical water budget period presented in Section *9.3.2 Historical Water Budget* (i.e., Water Years 1998-2017).

9.5. Water Budget Uncertainty and Limitations

Each of the values in the annual water budget is an estimate subject to some uncertainty. Limitations are due primarily to data gaps and data uncertainty.

Data gaps refer to limitations in the spatial coverage of measured data, or periods of time when no measurements are available. These occur when the locations and timing of data points are insufficient to adequately characterize conditions in model areas of interest. Data gaps require that assumptions be made regarding trends in the available data, and these assumed trends then are extrapolated into areas or time periods where data are lacking. For example, because relatively few water level measurements have been recorded at the southwest Basin boundary, estimates of groundwater levels in that location had to be extrapolated from downgradient wells. The uncertainty created by this extrapolation creates associated uncertainty in groundwater inflow boundary conditions.

Data uncertainty refers to errors or inaccuracies in the actual data used to populate the model. For example, groundwater recharge is estimated from assumptions made in the historical analytical spreadsheet model, such as the percent of ineffective precipitation that infiltrates or the fraction of water that is consumptively used in developed areas. As these values cannot be measured, they must be inferred and are uncertain.

Limitations for the water budget presented herein can be grouped into three categories: (1) those affecting simulated stresses (i.e., recharge and groundwater pumping), (2) boundary conditions, and (3) modeled water transmitting and storage properties. An overall uncertainty and therefore potential range for each category was developed based on a sensitivity analysis of simulated stresses, the variability of values in aquifer properties, and professional judgement. A more detailed description of model sensitivity and uncertainty analyses can be found in Appendix *I*.

9.5.1. Recharge and Groundwater Pumping

As discussed in Section *9.2 Water Budget Results* and shown in **Table WB-9**, the groundwater system is highly sensitive to climate conditions, specifically the amount of precipitation, which becomes groundwater recharge. The magnitude and spatial distribution of groundwater recharge is based on the assumptions and estimates calculated in the historical analytical spreadsheet model. Recharge was calculated for three primary areas, including non-irrigated areas, developed areas, and irrigated agriculture areas. Additionally, recharge entering the Basin from up-gradient watersheds was estimated as some percentage of precipitation, scaled by an orographic factor.

The most sensitive parameters (i.e., factors used in the model that when changed affect outcomes most significantly) for calculating groundwater recharge include the up-gradient watershed consumptive use fractions, followed by the consumptive use fraction for the developed areas and the percent of ineffective precipitation that infiltrates in the non-irrigated areas. The uncertainty in recharge is estimated at ±10%, which contributes to an estimated overall uncertainty[45] in the water budget of ±0.7%.

The magnitude and spatial distribution of groundwater pumping is based on supply well locations, depths, and reported or estimated pumping volumes. Although many of the wells reported monthly pumping rates, these were not available for the entire historical time period, so average values were employed for some months. The water budget also does not account for pumping from some Basin domestic wells, due to the lack of data from these wells. Furthermore, there is uncertainty associated with projected groundwater use. For modeling, we estimated pumping uncertainty at ±5%, which contributes to an estimated overall uncertainty in the water budget of ±0.9%. This analysis illustrates that based on currently-available information, uncertainty in current and projected levels of groundwater pumping do not contribute greatly to uncertainty in groundwater storage changes in the Basin.

9.5.2. Boundary Conditions

One of the largest drivers for groundwater availability in the Basin is the amount of groundwater inflow from the upgradient Cuddy Canyon Basin, but very limited water level data are available near this boundary. As such, we estimated groundwater inflow based on an extrapolated gradient between two Basin wells (TRC-MW16D and TRC-PW56A) located some distance from the boundary. This initial estimate was then refined through calibration of the historical Castac Basin Numerical Model.

This estimated boundary condition is a source of uncertainty in the historical water budget, but causes even more uncertainty in the future projected water budget. This uncertainty may be exacerbated by future changes in groundwater use and management patterns in the upgradient Cuddy Canyon, Cuddy Ranch, and Cuddy Valley Basins (e.g., replacement of the LCWD "Chimney" well), whose impacts on groundwater inflows at the Basin boundary are difficult to quantify. Employing a plausible range of projected groundwater inflows between zero, and the average inflow over the historical period (i.e., 1,380 AFY), results in an estimated overall uncertainty in the projected future water budget of -0.3% to +3.8%. To reduce this uncertainty, future efforts to address known data gaps in the Basin should prioritize quantifying the amount of groundwater inflow across the upgradient Basin boundary.

9.5.3. Aquifer Hydraulic Properties (Water Transmitting and Storage Characteristics)

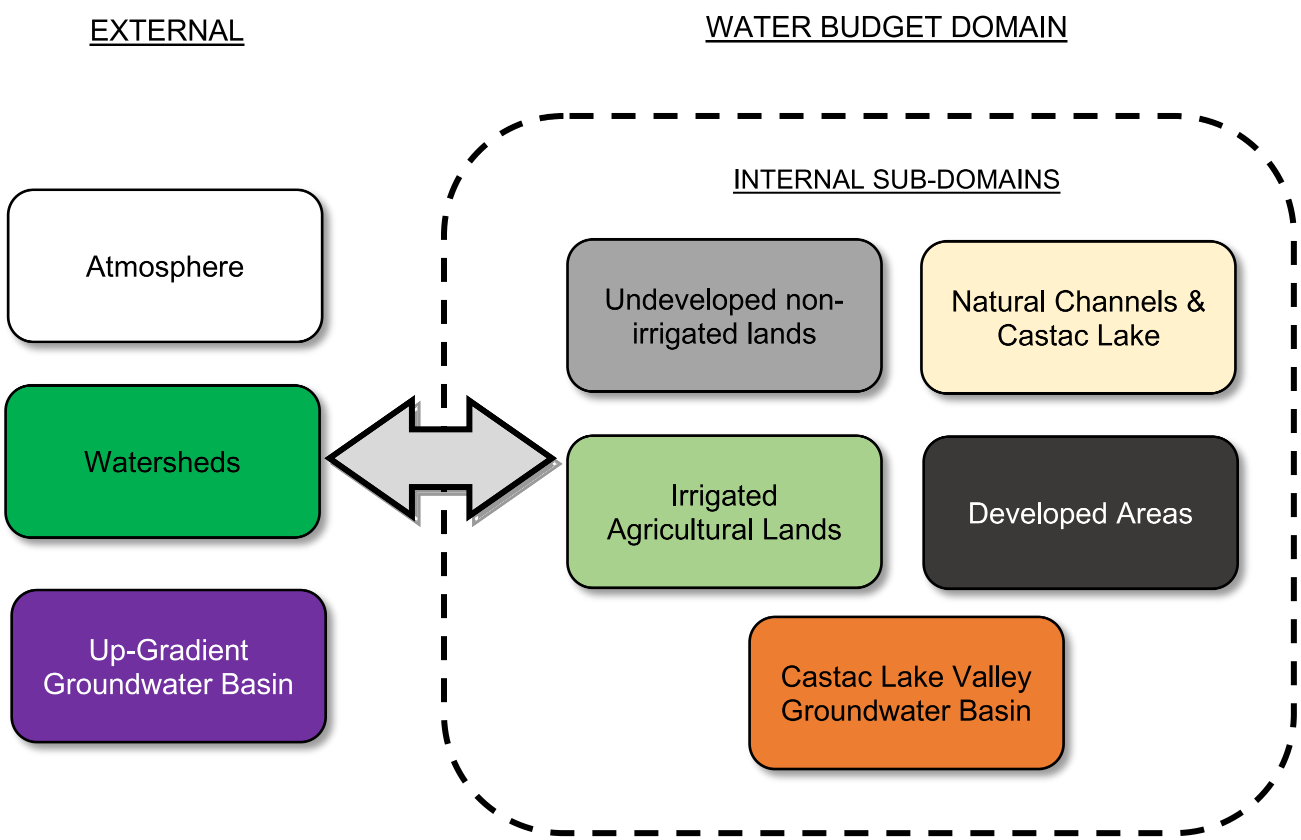
Hydraulic conductivity estimated from pumping tests conducted within the Basin range between 18 and 86 feet per day (ft/d) for the deep aquifer zone and 10 ft/d for the shallow aquifer zone (EKI, 2008a). Modeled hydraulic conductivity values were set at 10 ft/d in the shallow aquifer zone, and ranged from 25 to 70 ft/d (depending on location within the Basin) in the deep aquifer

[45] "Overall uncertainty" is defined herein as the change in estimated annual groundwater storage relative to the total annual volumetric inflows into the Basin.

zone, based on calibration to historical groundwater elevation data. Sensitivity tests show that ranges in hydraulic conductivity in the deep aquifer zone (i.e., Layer 3 of the model) contribute to an estimated overall uncertainty in the water budget of -6.3% to 7.8%.

Limited data available from Castac Lake prevents an a priori estimate of lakebed conductance. Modeled lake conductance is 0.001 ft/d, based on calibration to historical lake stage data. However, using the range of values for typical clay lakebed sediments (i.e., 1e-5 to 0.1 ft/d) results in an estimated overall uncertainty in the water budget of +2% to -0.2%.

Storativity values for the deep aquifer zone estimated from pumping tests conducted within the Basin range between 6e-4 and 0.004 (EKI, 2008a). Limited data exist to estimate specific yield properties for the shallow and deep aquifer zones. Modeled storativity values in the deep aquifer zone were set at 0.0001, and specific yield values in the shallow and deep aquifer zones ranged from 0.05 to 0.2, based on calibration to historical groundwater elevation data. Sensitivity tests show that ranges in storativity of $1x10^{-5}$ (0.00001) to 0.001 in the deep aquifer zone (i.e., Layer 3 of the model) contribute to an estimated overall uncertainty in the water budget of +1.3% to -9.0%, and ranges in specific yield of 0.025 to 0.4 in the shallow and deep aquifer zones contribute to an estimated overall uncertainty in the water budget of +3.5% to -5.9%. Thus, storativity (and to a lesser extent, hydraulic conductivity) of the aquifer materials in the Basin are the most sensitive parameters in the Castac Basin Numerical Model.



Conceptual Water Budget Domains and Subdomains

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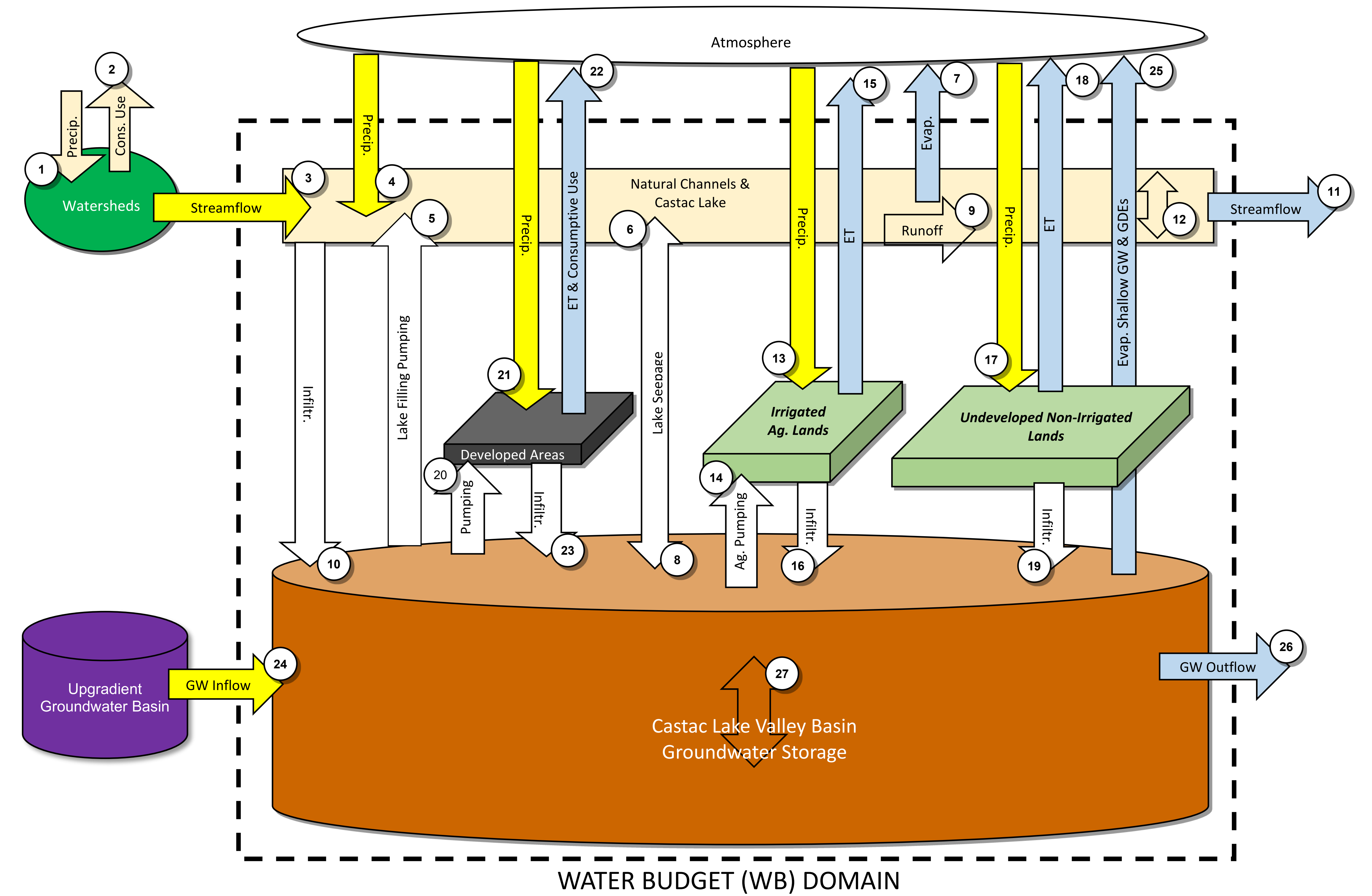
Figure WB-1



Legend:

- External
- Inflow to WB Domain
- Internal
- Outflow from WB Domain

Abbreviations:

Ag	= agricultural
Cons.	= Consumptive
Evap.	= evaporation
ET	= evapotranspiration
GDEs	= groundwater dependent ecosystems
GW	= groundwater
Infiltr.	= infiltration
Precip.	= precipitation
WB	= water budget

Notes:

1. Component numbers correspond to columns contained in the spreadsheet water budget model.
2. See Appendix H for details on the calculation for each water budget flow component.

Conceptual Water Budget Flow Components/Linkages

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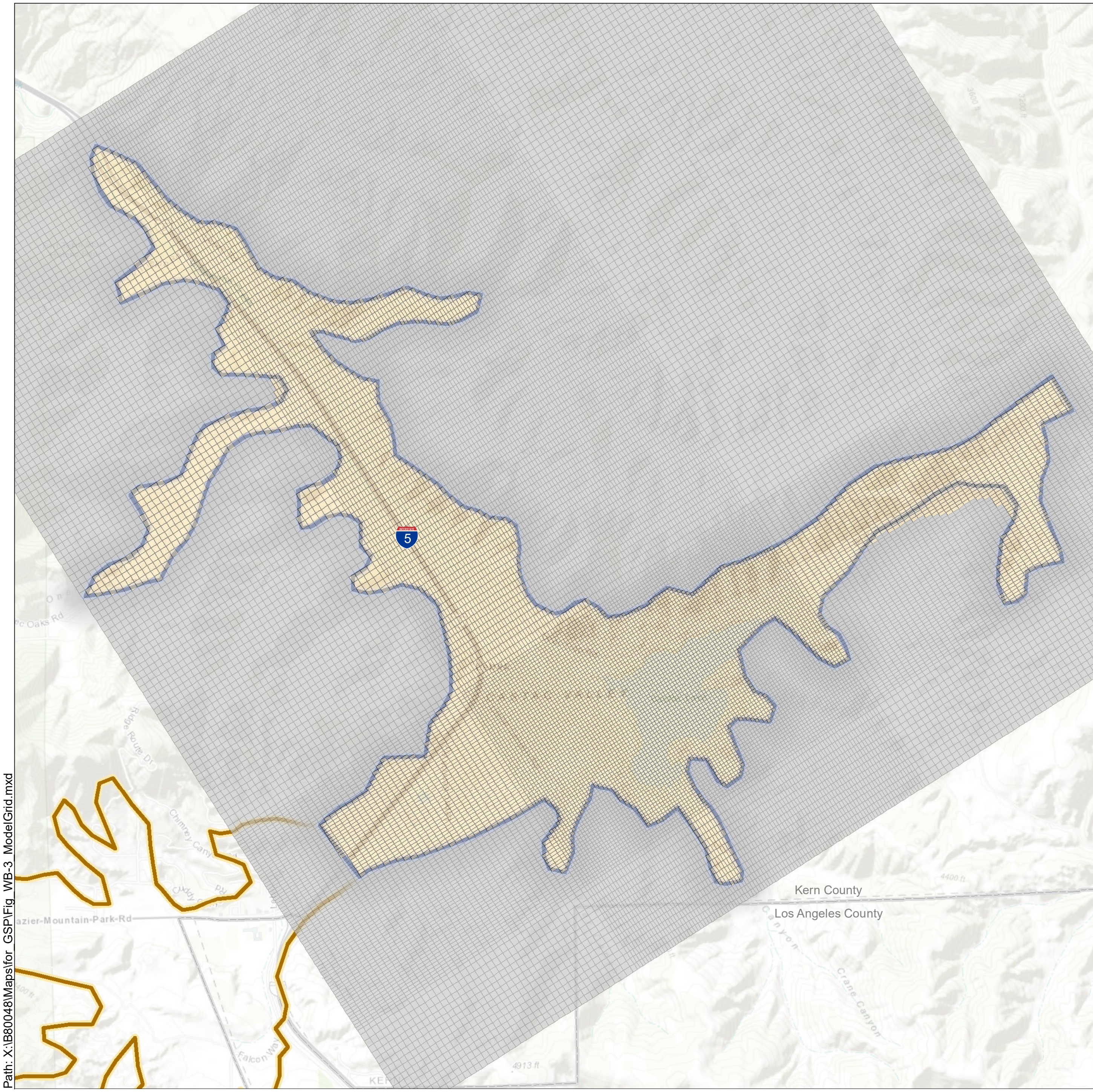
Figure WB-2



Legend

Castac Basin Model Grid

- Active Model Cell
- Inactive Model Cell
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Active model cells are extended beyond the DWR basin boundary in one area of Dryfield Canyon, based on local topography and interpreted geology.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.

N

0 0.5 1

Miles

Castac Basin Numerical Model Grid

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Figure WB-3

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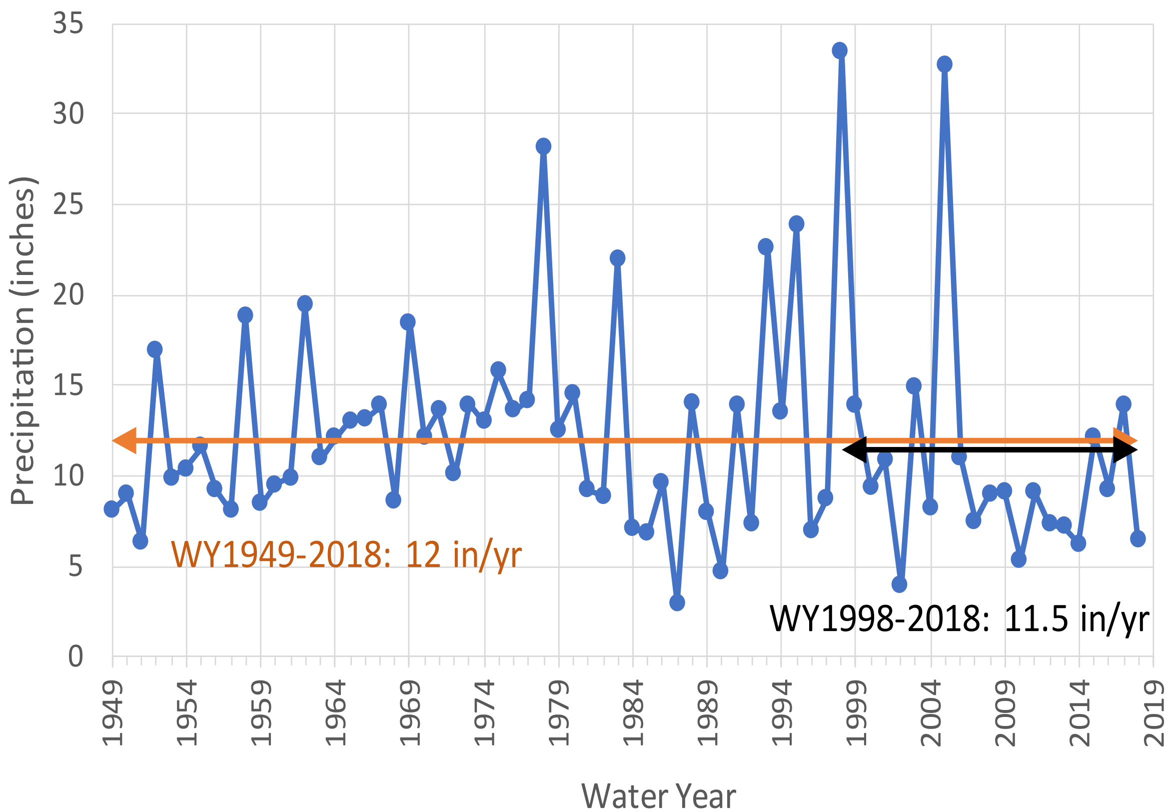

Legend

- Annual Precipitation
- Long-Term Average Rainfall (WY 1949-2018)
- Average Rainfall (WY 1998-2018)

Abbreviations

in/yr = inches per year
NOAA = National Oceanic and Atmospheric Administration
WY = Water Year

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

NOAA Lebec climate station Coop ID #44863.
www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4863

Long-Term Precipitation Record

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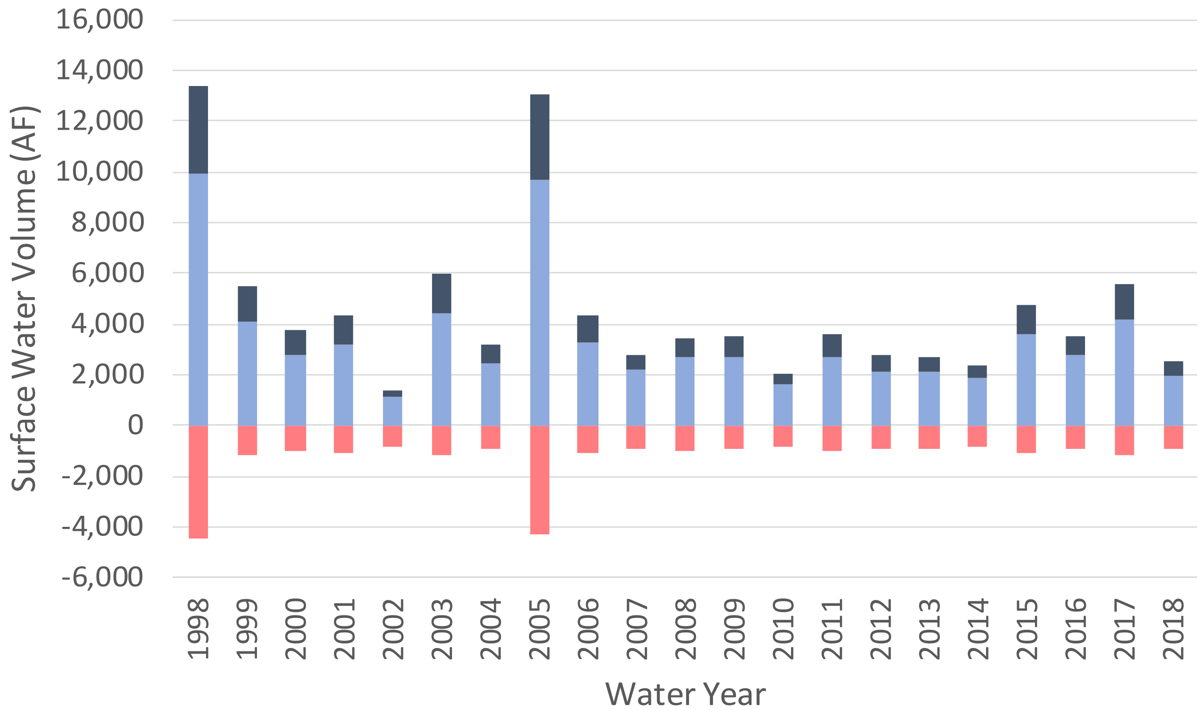
Figure WB-4



Legend

Surface Water Inflows

Streamflow

Precipitation

Surface Water Outflows

Streamflow

Abbreviations

AF = acre-feet

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to a surface water inflow and a negative volume corresponds to a surface water outflow.

Annual Surface Water Inflows and Outflows by Source

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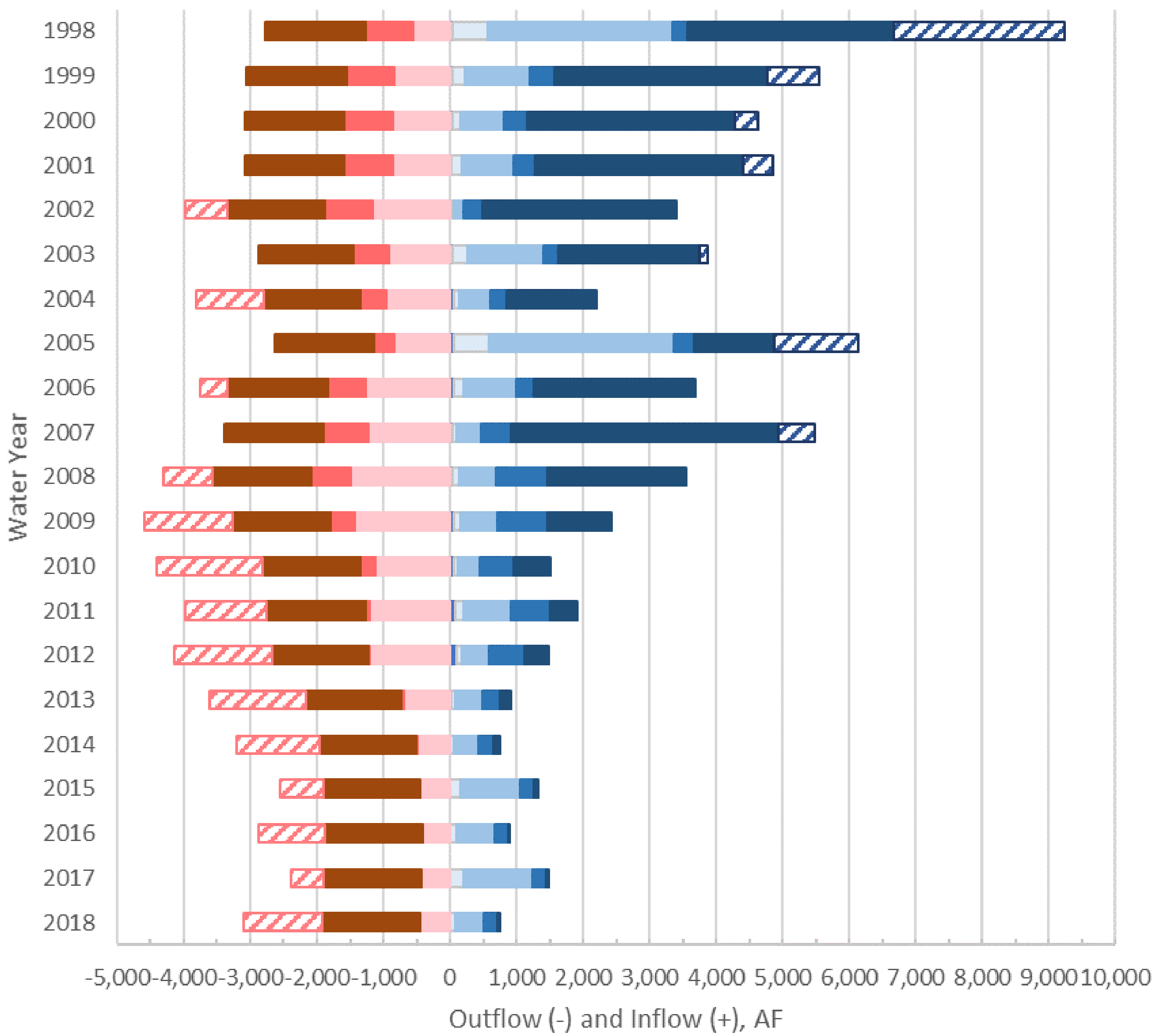
Figure WB-5



Legend

Groundwater Inflows

- Seepage From Lake
- Seepage from Streams
- Infiltration from Precipitation
- Infiltration from Return Flows
- Subsurface GW Inflow

Groundwater Outflows

- Groundwater Extractions
- Seepage to Lake
- Subsurface GW Outflow

Change in Groundwater Storage

- Gain in GW Storage
- Reduction in GW Storage

Abbreviations

AF = acre-feet
GW = groundwater

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to a groundwater inflow and a negative volume corresponds to a groundwater outflow.

Annual Groundwater Inflows and Outflows

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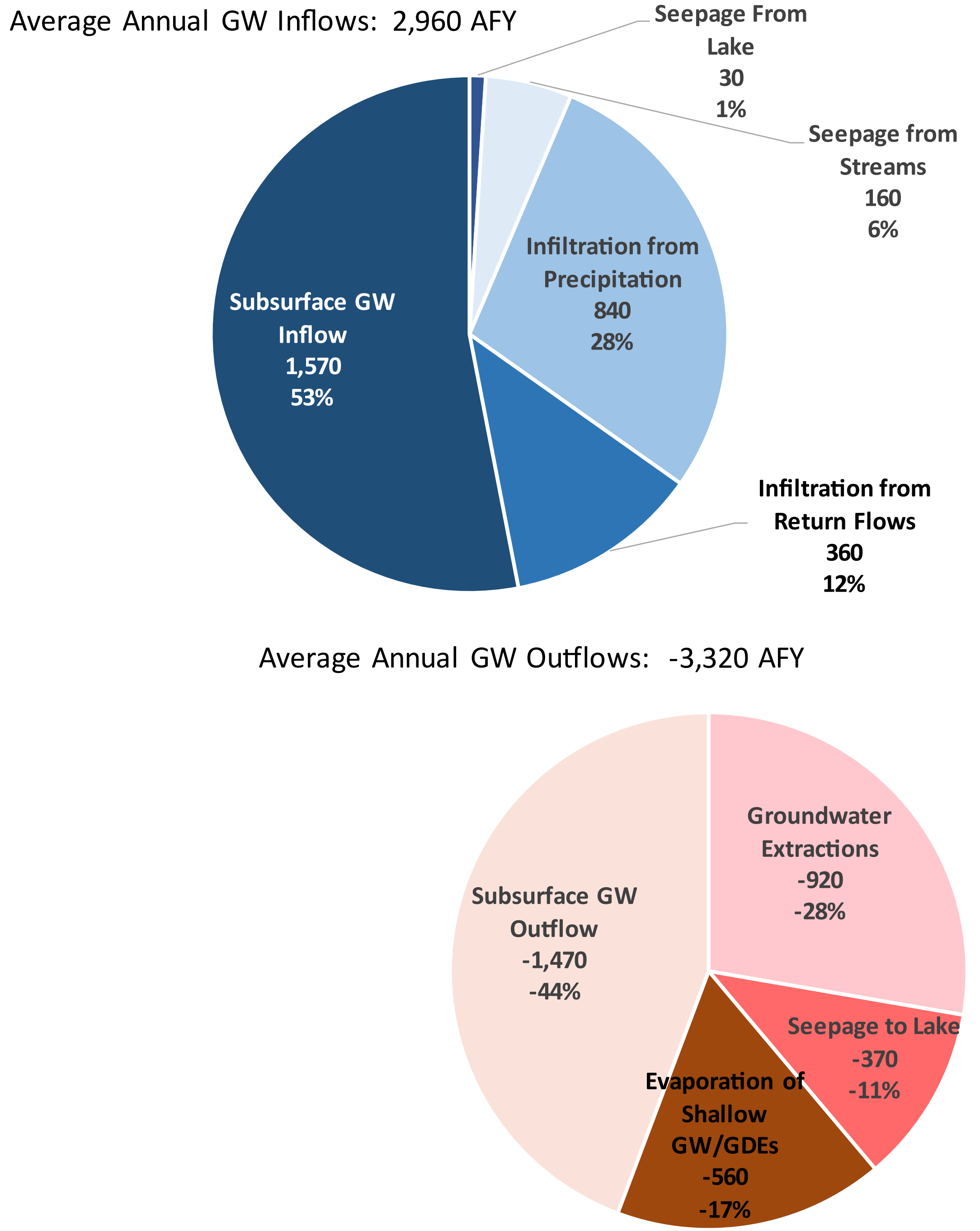
Figure WB-6



Abbreviations

AFY = acre-feet per year
GW = groundwater
WY = Water Year

Notes

1. Average values for the 20-year historical water budget period (WY 1998-2017).
2. All values are reported in AFY.

Summary of Historical Groundwater Inflows and Outflows, WY 1998-2017

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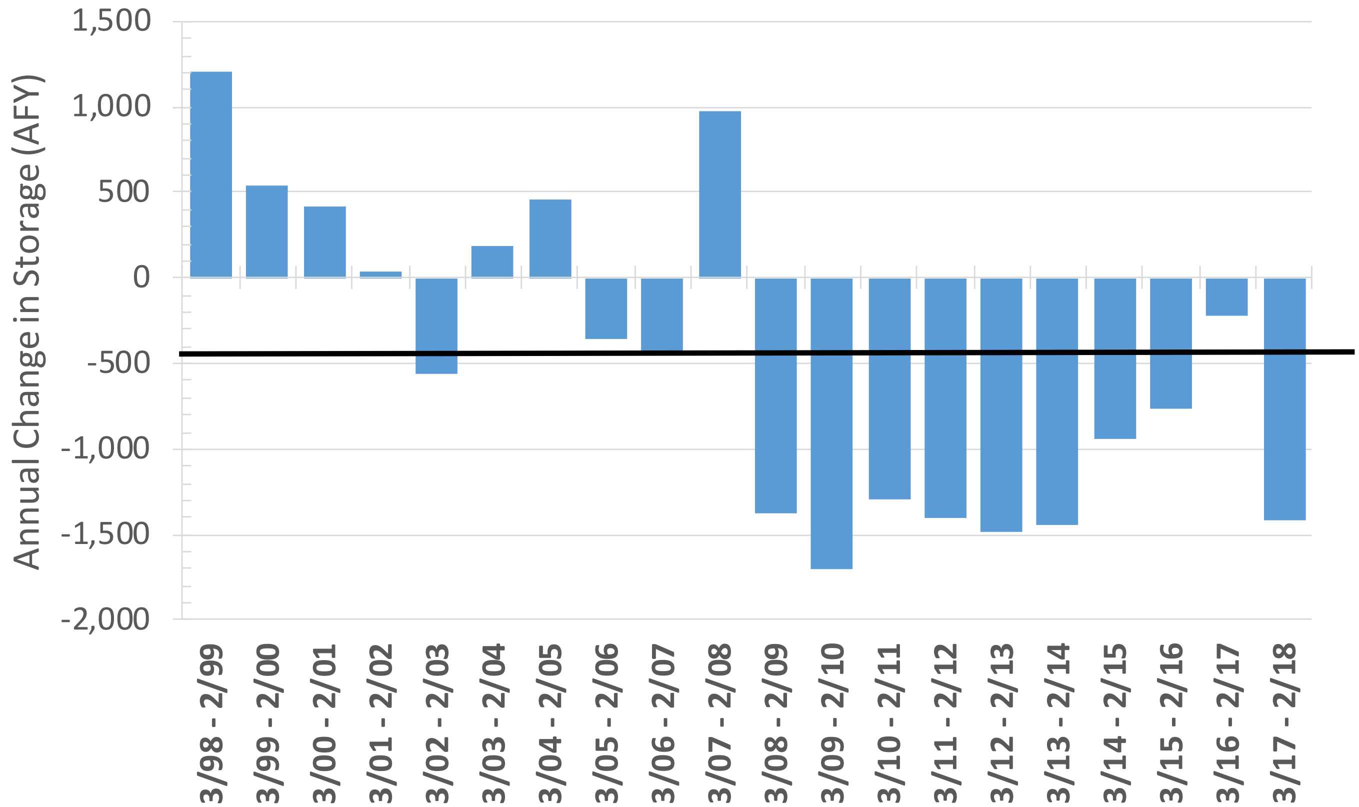
Figure WB-7



Legend

Annual Change in Storage between Seasonal Highs (Mar - Feb)

Average Annual Change in Storage, March 1998 - February 2018

Abbreviations

AFY = acre-feet per year

Notes

1. "Seasonal high" is defined as March of the current year through February of the following year.

Annual Change in Storage between Seasonal Highs

Tejon-Castac Water District
Kern County, California
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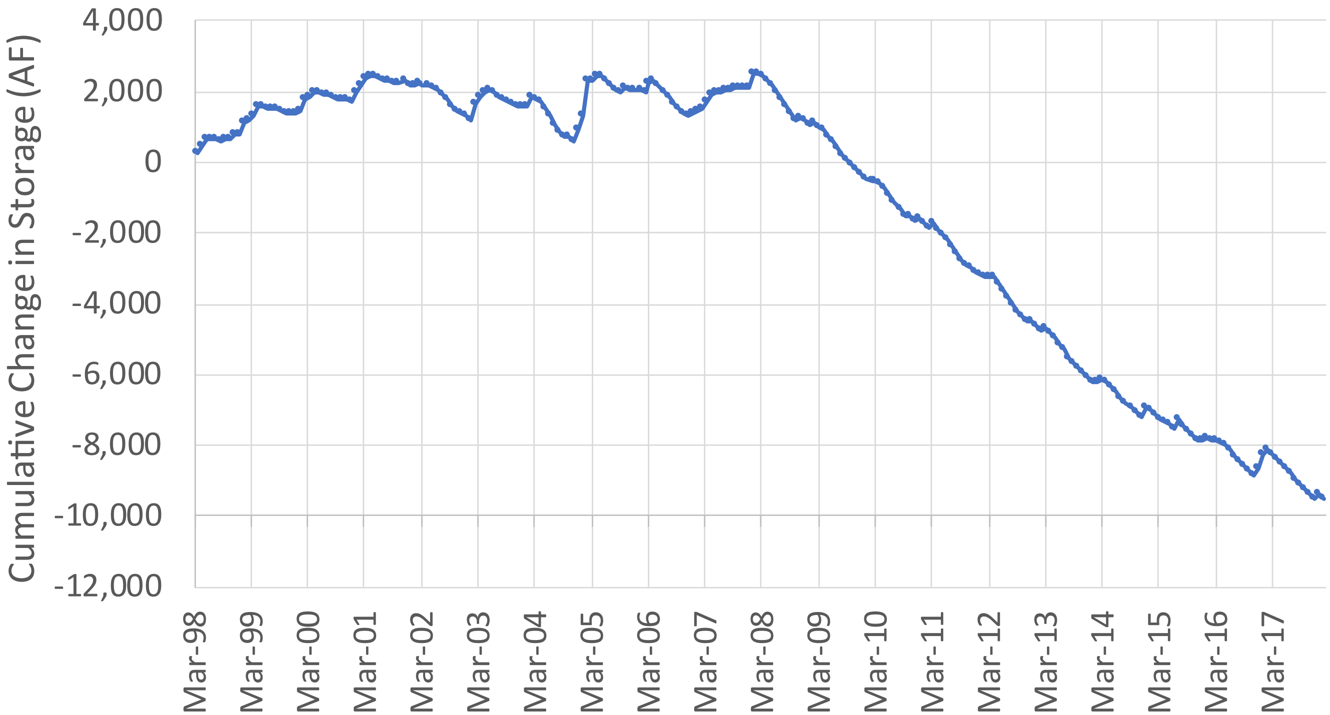
Figure WB-8



Legend

Abbreviations

AF = acre-feet

Notes

1. Values represent cumulative change in storage since the first "seasonal high" of the water budget period (March 1998).
2. "Seasonal high" is defined as March of the current year through February of the following year.

Cumulative Change in Storage, March 1998 - February 2018

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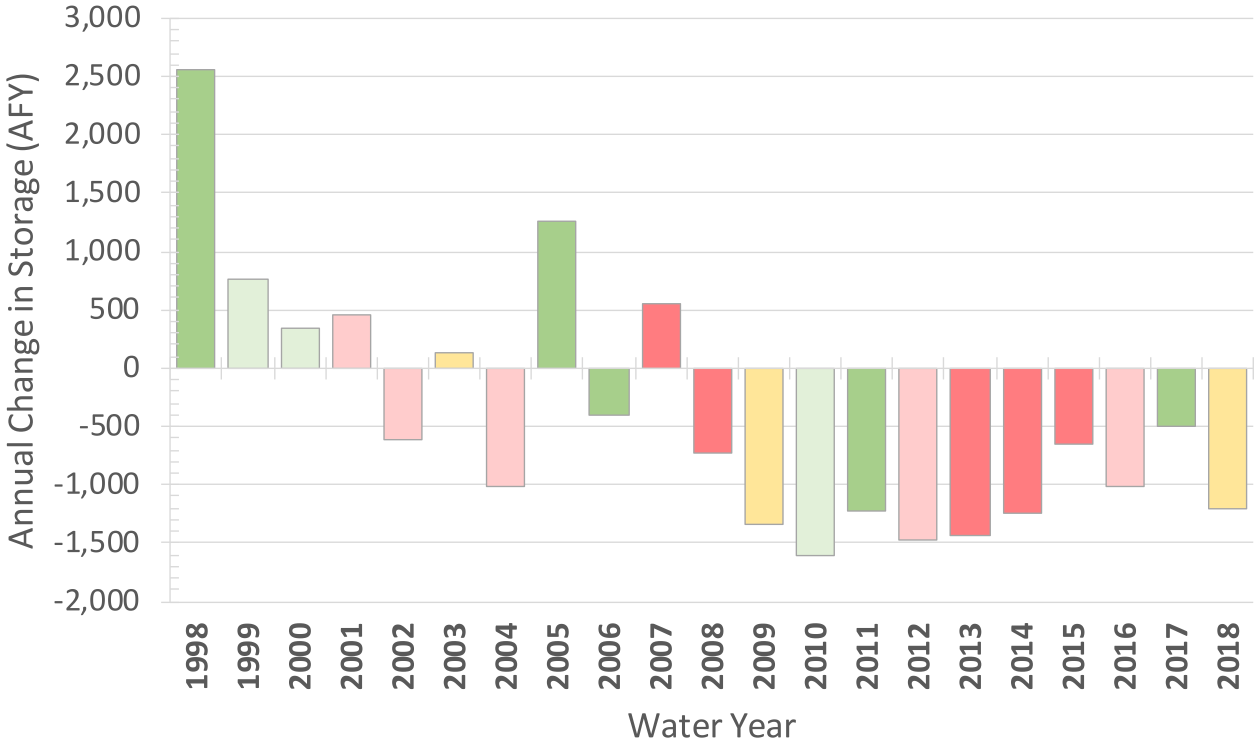
Figure WB-9



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)

Annual Change in Storage vs. DWR Water Year Type

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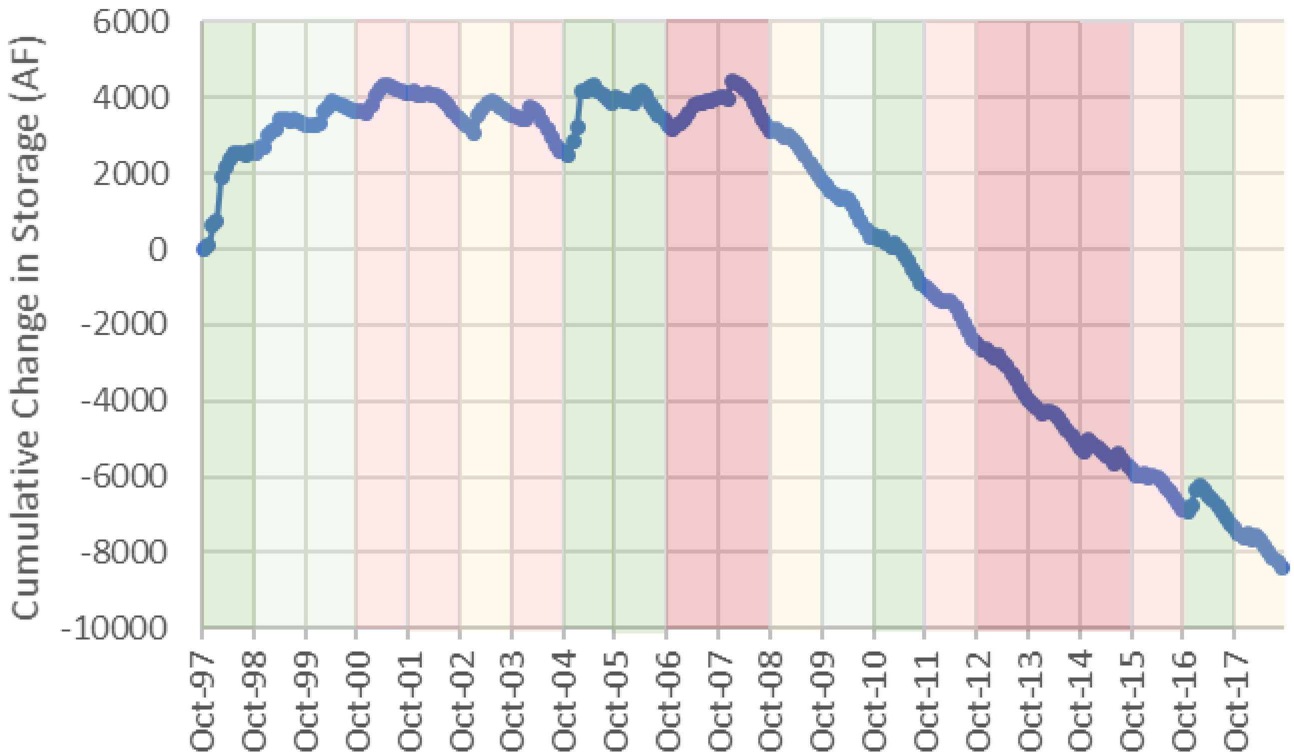
Figure WB-10



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

AF = acre-feet
DWR = California Department of Water Resources

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)

Cumulative Change in Storage vs. DWR Water Year Type

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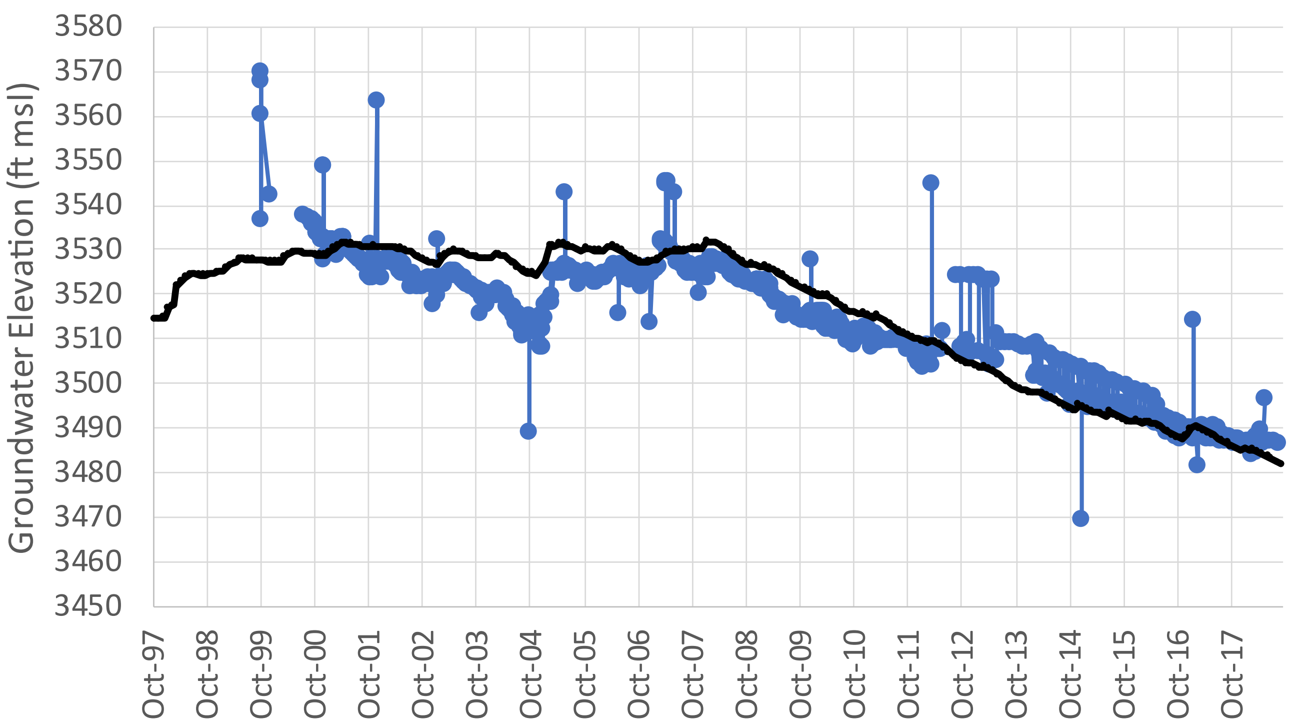
Figure WB-11



Legend

Average Measured Water Level

Water Budget Spreadsheet Model-Calculated Water Level

Abbreviations

ft msl = feet above mean sea level

Notes

1. Average water level is calculated from wells with water level measurements located within the Castac Lake and Dryfield Canyon portions of the Basin, excluding flowing and dry measurements.
2. Model-calculated water levels calculated based on a specific yield value of 0.1, assuming the storage change occurs in the Castac Lake and Dryfield Canyon portions of the Basin.

Comparison of Model-Calculated Water Levels and Average Measured Water Levels

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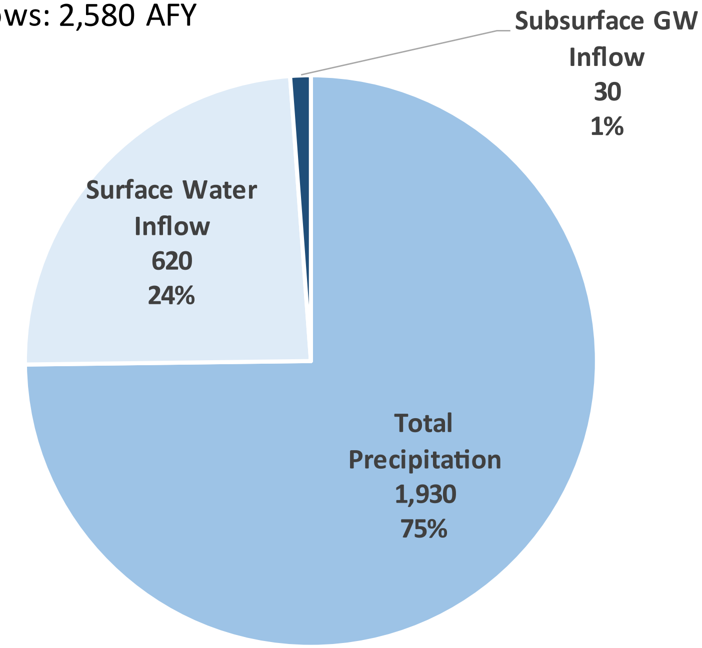
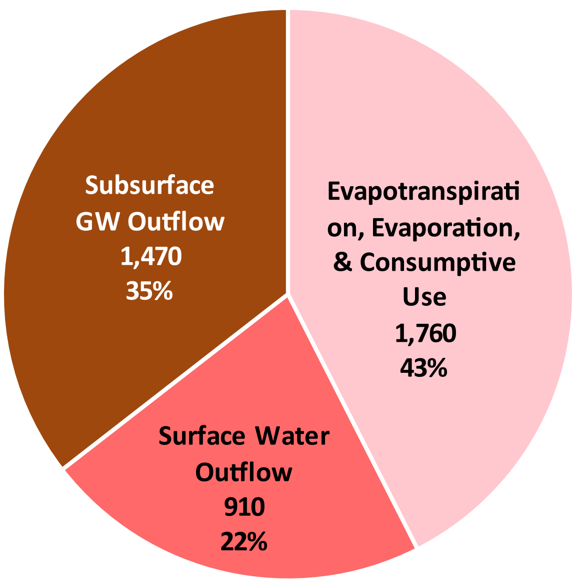
Figure WB-12

WY 2018 Inflows: 2,580 AFY



WY 2018 Outflows: 4,140 AFY



Abbreviations

AFY = acre-feet per year
GW = groundwater

Notes

1. All values are reported in AFY.

Summary of Current Surface Water and Groundwater Inflows and Outflows to the Water Budget Domain, WY 2018

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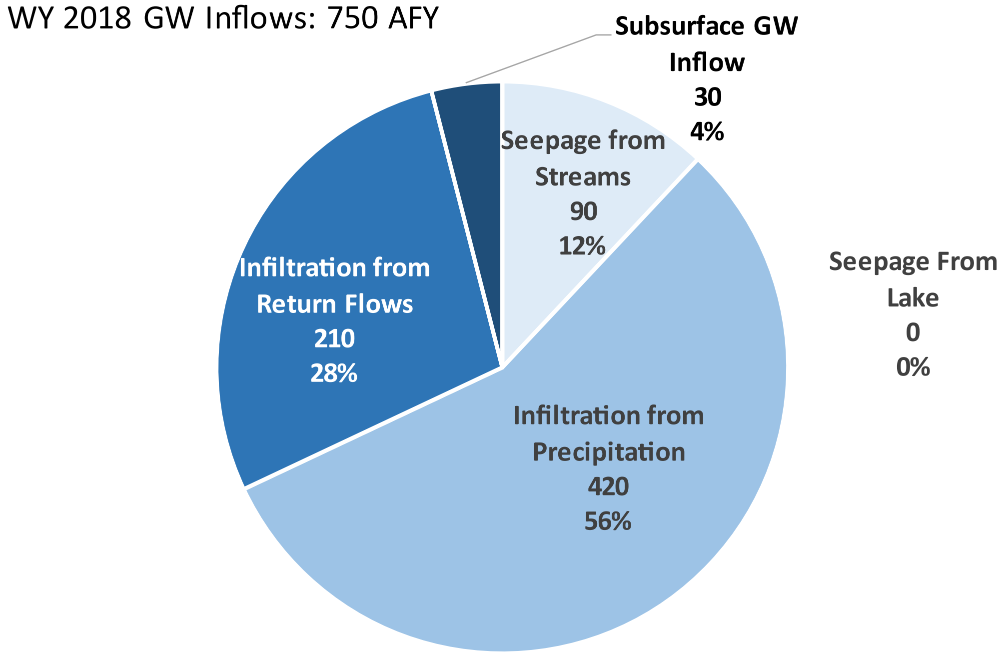
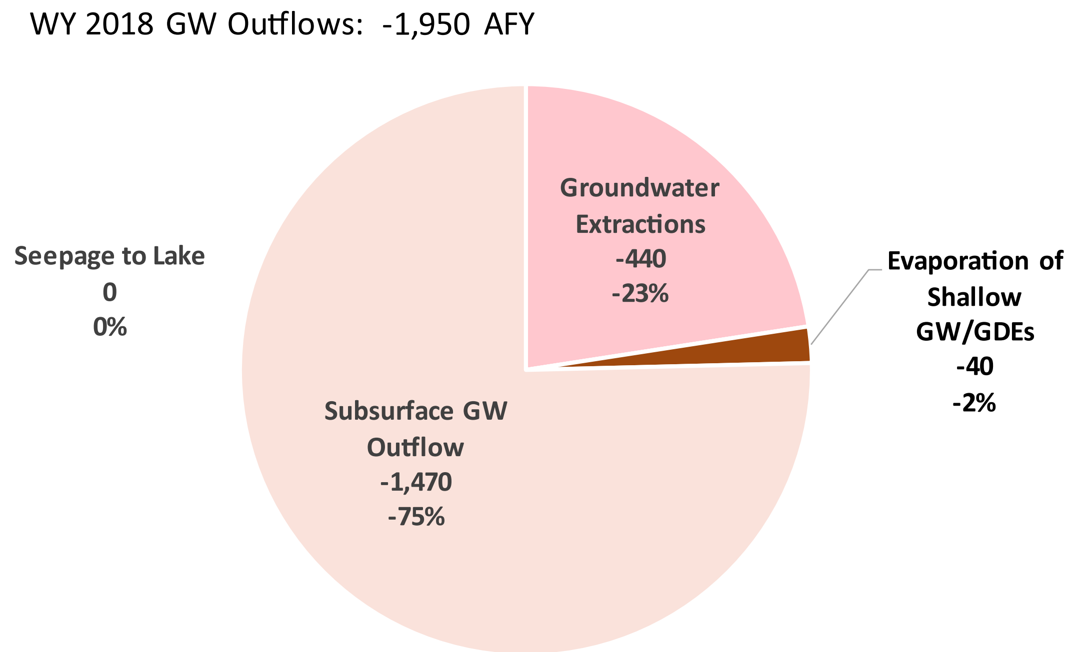
Figure WB-13





Abbreviations

AFY = acre-feet per year

GW = groundwater

Notes

1. All values are reported in AFY.

Summary of Current Groundwater Inflows and Outflows, WY 2018

Tejon-Castac Water District
Kern County, California
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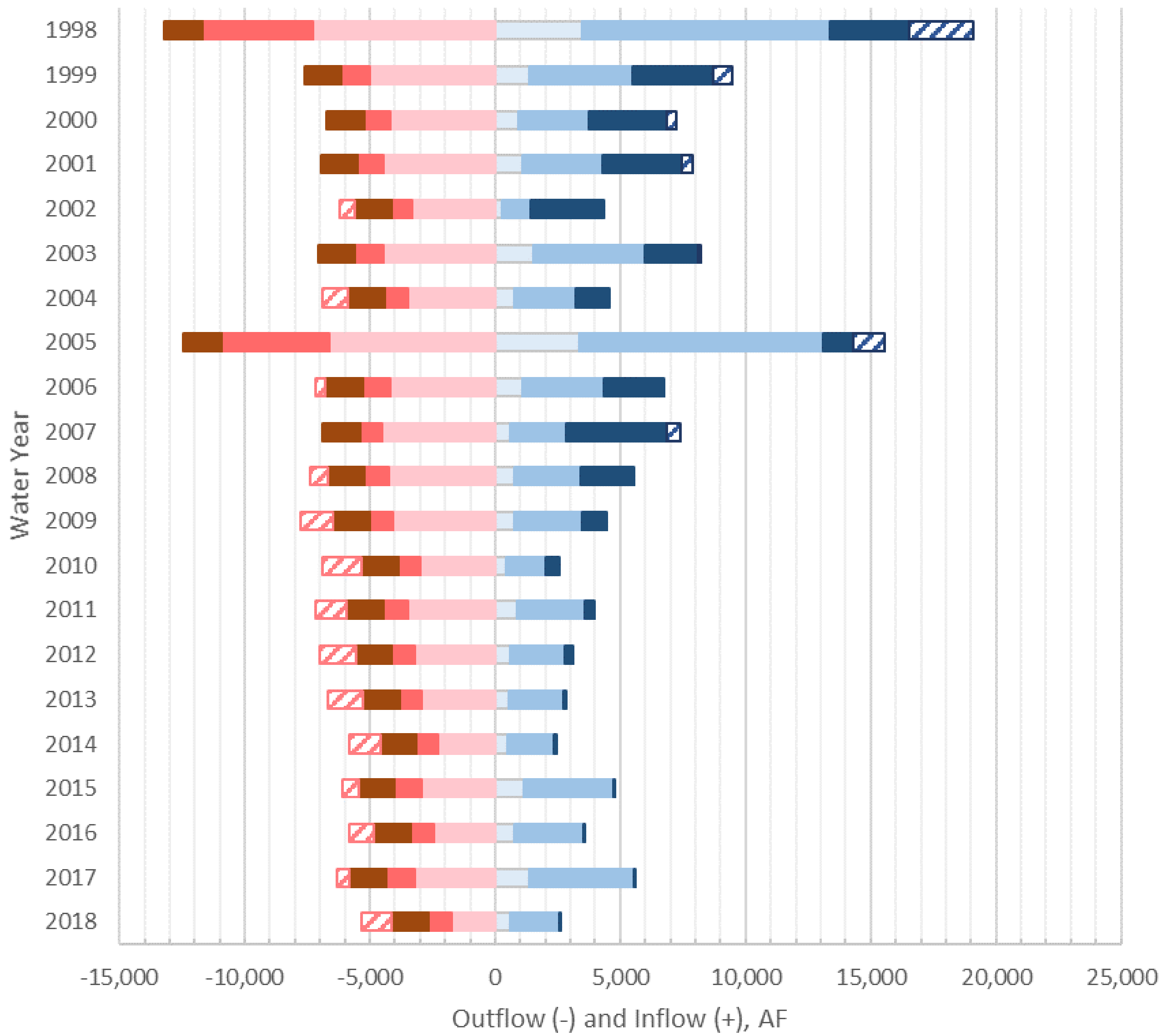
Figure WB-14



Legend

Inflows

Surface Water Inflow

Precipitation

Subsurface GW Inflow

Outflows

Evapo-transpiration, Evaporation, & Consumptive Use

Surface Water Outflow

Subsurface GW Outflow

Change in Groundwater Storage

Gain in GW Storage

Reduction in GW Storage

Abbreviations

AF = acre-feet
GW = groundwater

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to an inflow and a negative volume corresponds to an outflow.

Annual Surface Water and Groundwater Inflows and Outflows to the Water Budget Domain

Tejon-Castac Water District
Kern County, California
September 2020
B800048.00

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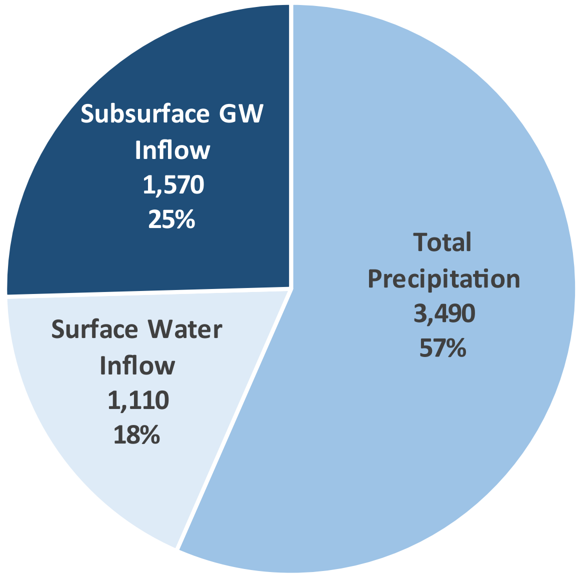
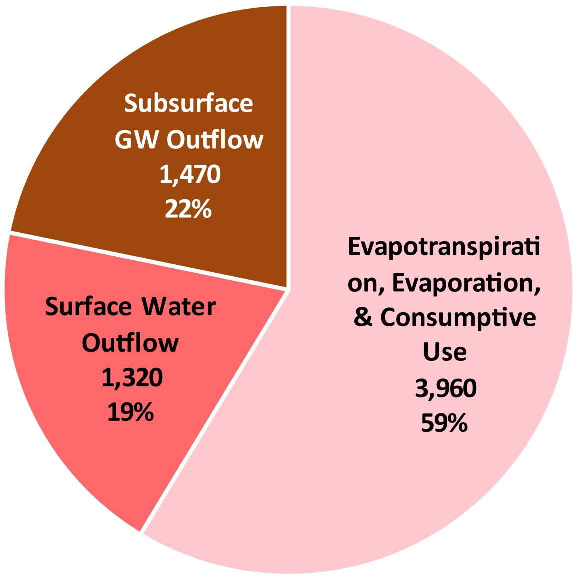
Figure WB-15

Average Annual Inflows: 6,170 AFY



Average Annual Outflows: 6,750 AFY



Abbreviations

AFY = acre-feet per year
GW = groundwater

Notes

1. All values are reported in AFY.

Summary of Historical Surface Water and Groundwater Inflows and Outflows to the Water Budget Domain, WY 1998-2017

Tejon-Castac Water District
Kern County, California
September 2020
B800048.00

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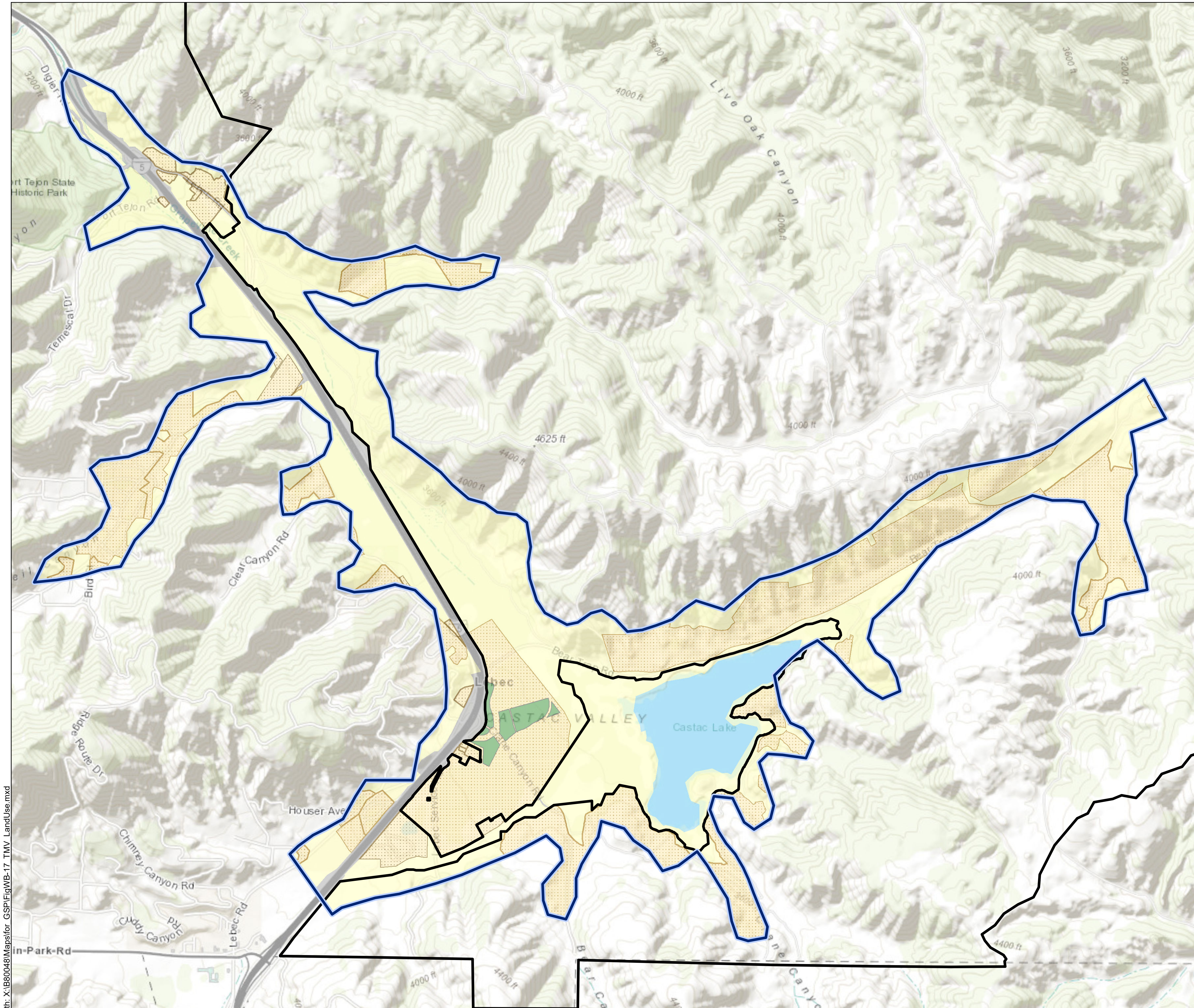
Figure WB-16



Abbreviations
DWR = Castac Basin Groundwater Flow Model
TMV =Tejon Mountain Village

Notes
1. All locations are approximate.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Future land use data from TCWD, obtained 14 June 2019.

Projected Land Use for TMV Development Scenario

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Kern County, CA
September 2020
B80048.00

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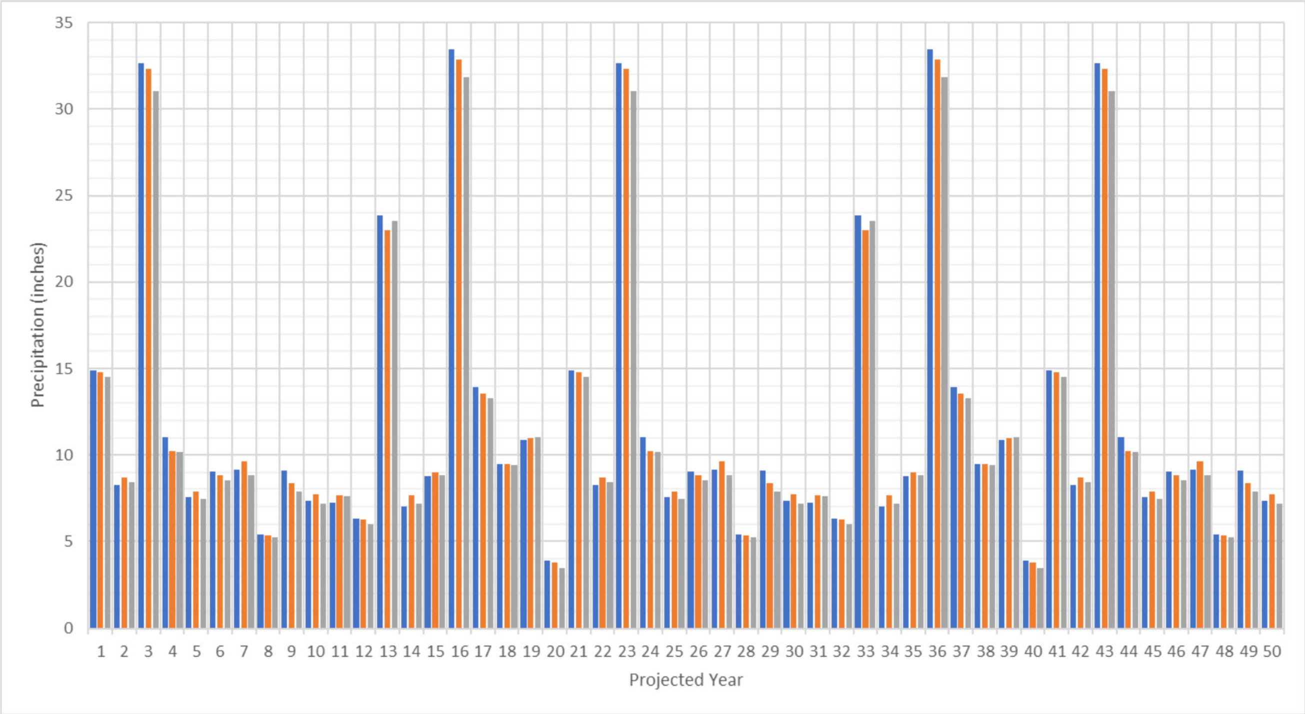
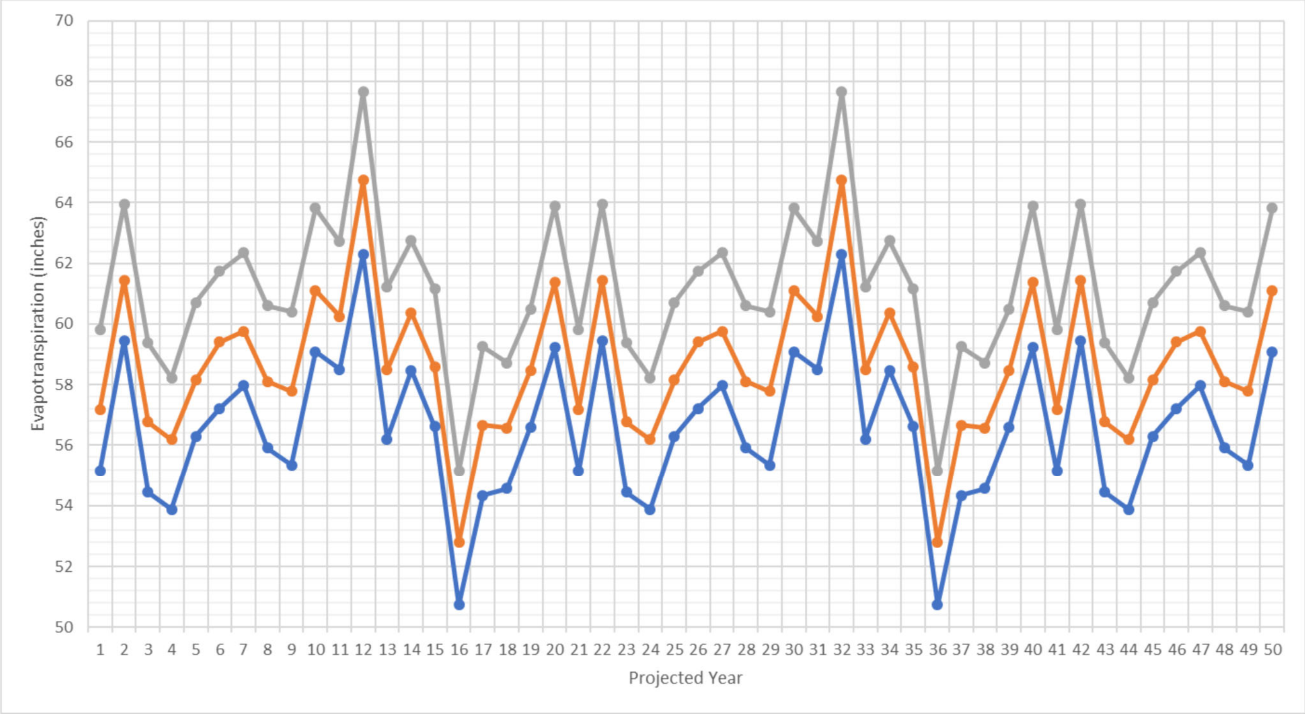
Figure WB-17

Path: X:\B80048\Maps\for_GSP\FigWB-17_TMV_LandUse.mxd





Legend

Projected Scenario

- Baseline
- 2030 Climate Change
- 2070 Climate Change

Notes

1. Precipitation and evapotranspiration were scaled using climate change factors provided by the California Department of Water Resources.

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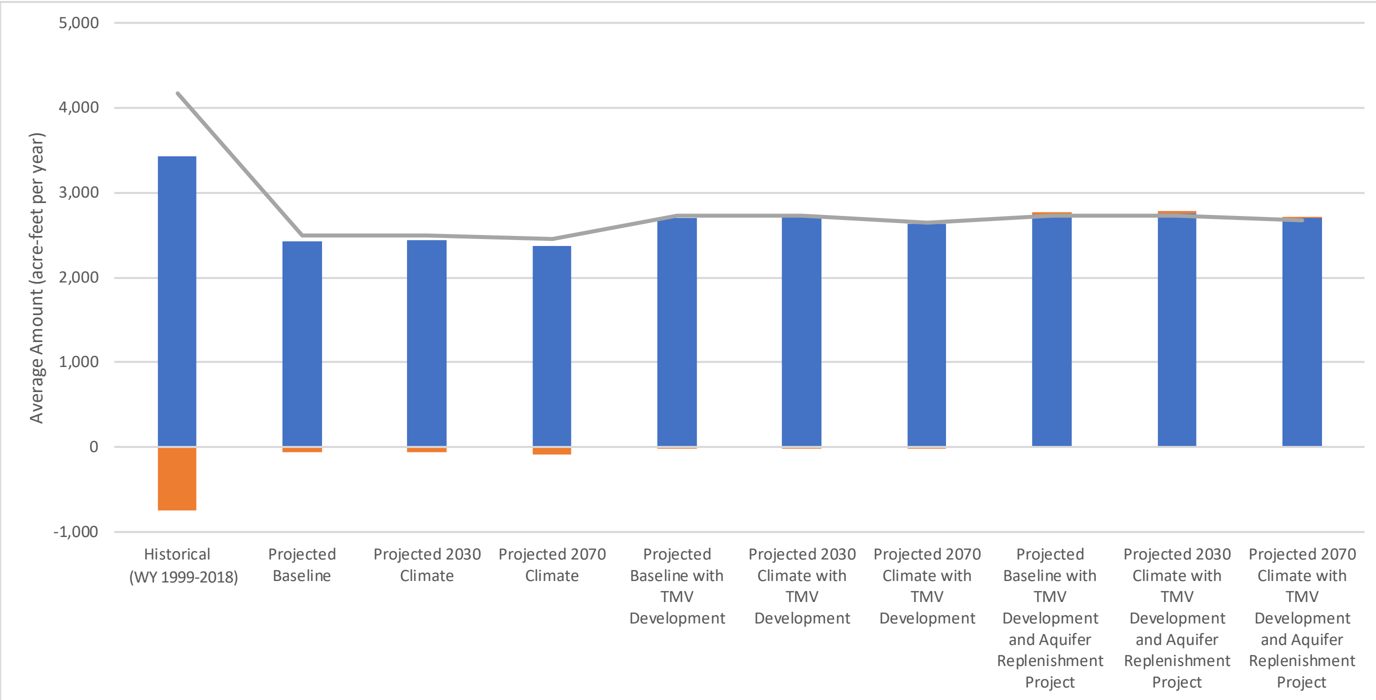
Precipitation and Evapotranspiration Inputs for Project Scenarios

Castac Basin GSA
Kern County
September 2020
B80048.00
Figure WB-18



Legend

- Supply
- Storage Change
- Demand

Abbreviations

TMV = Tejon Mountain Village
WY = Water Year

Notes

1. Historical water budget values presented are from the Castac Basin Numerical Model for consistency with Projected water budget values. The period shown is different than the historical water budget period presented in Section 9.3.2 Historical Water Budget (i.e., WYs 1998-2017).

Projected Water Budget Supplies and Demands

Tejon-Castac Water District
Kern County, California
September 2020
B800048.00

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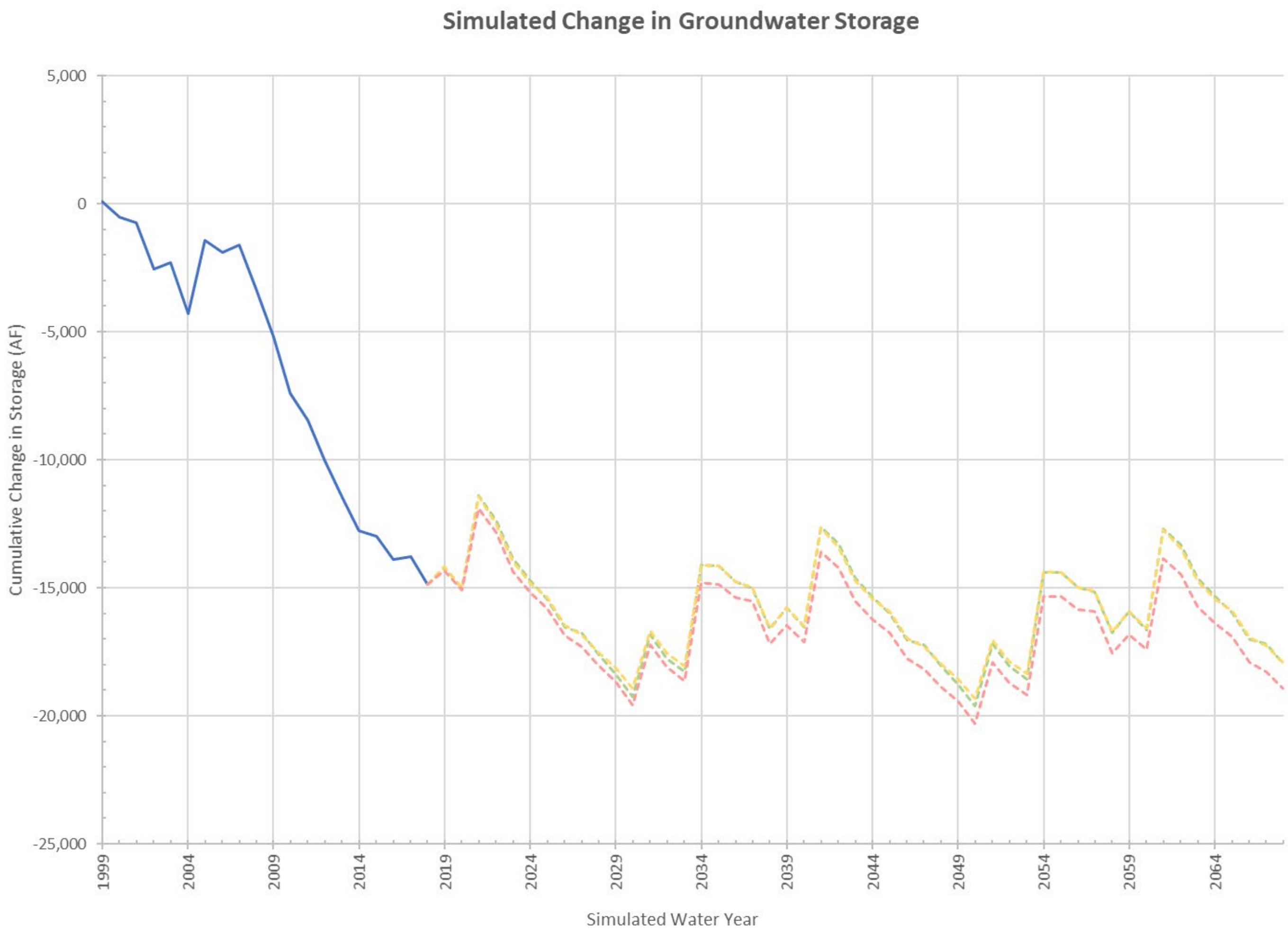
Figure WB-19



Legend

= Historical Simulation

= Baseline Scenario

= 2030 Climate Change Scenario

= 2070 Climate Change Scenario

Abbreviations

AF = acre-feet

TMV = Tejon Mountain Village

Notes

1. Scenarios shown represent Baseline (i.e., historical) land use under various climate change conditions

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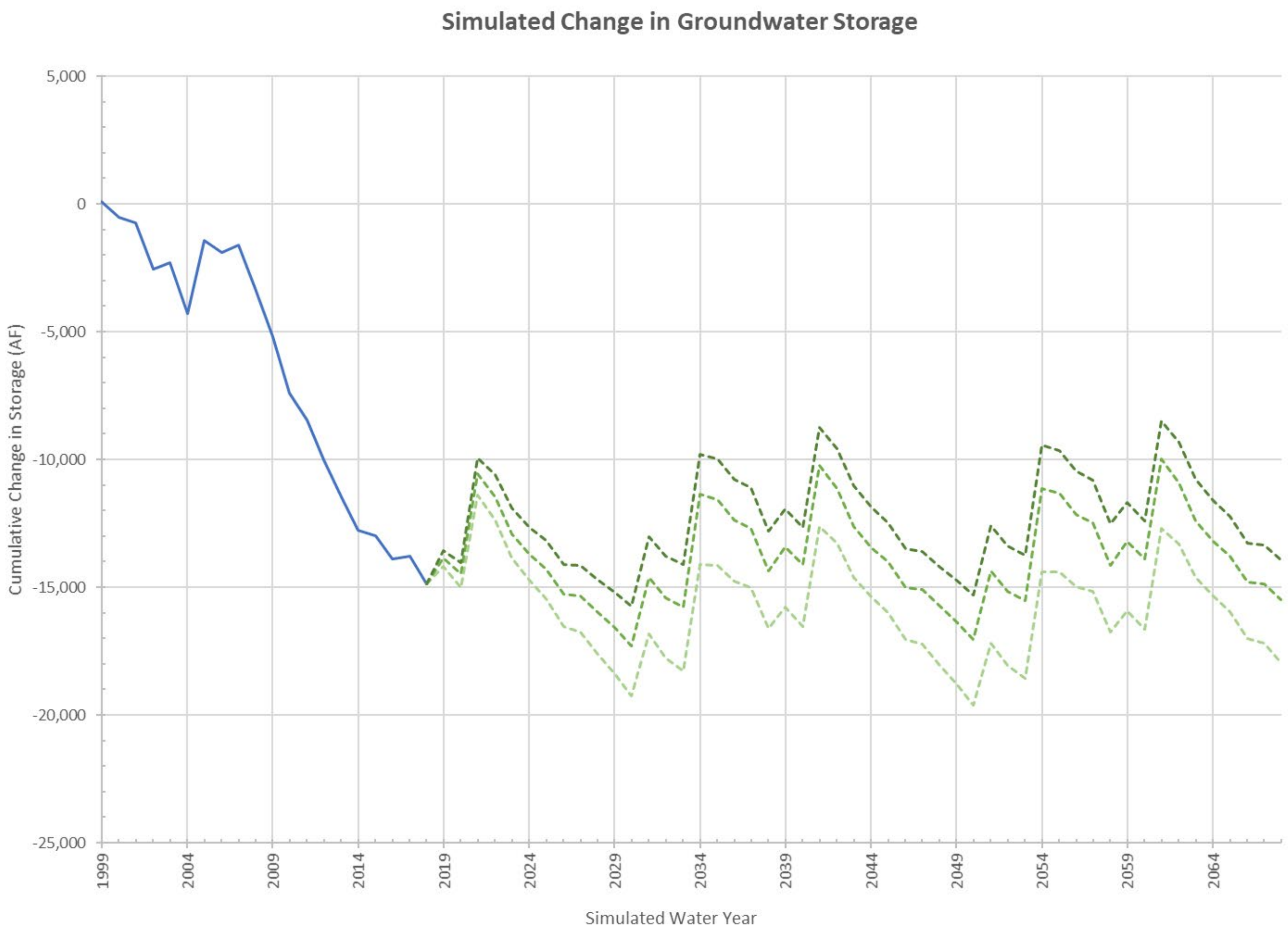
Projected Change in Groundwater Storage for Baseline, 2030 Climate, and 2070 Climate Scenarios

Tejon-Castac Water District
Kern County, California
September 2020
EKI B80048.00

Figure WB-20



Legend

- = Historical Simulation
- = Baseline Scenario
- = TMV Development Scenario
- = TMV Development with Aquifer Replenishment Scenario

Abbreviations

AF = acre-feet
TMV = Tejon Mountain Village

Notes

1. Scenarios shown represent various future development scenarios under Baseline climate conditions.

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Projected Change in Groundwater Storage for Baseline, TMV Development, and TMV Development with Aquifer Replenishment Scenarios

Tejon-Castac Water District
Kern County, California
September 2020
EKI B80048.00

Figure WB-21

10.MANAGEMENT AREAS (AS APPLICABLE)

§ 354.20. Management Areas

(a) Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.

The Castac Basin Groundwater Sustainability Agency (GSA) is not considering Management Areas at this time.

SUSTAINABLE MANAGEMENT CRITERIA

11. INTRODUCTION TO SUSTAINABLE MANAGEMENT CRITERIA

> *§ 354.22. Introduction to Sustainable Management Criteria*
> *This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.*

The Sustainable Groundwater Management Act (SGMA) legislation defines a "Sustainability Goal" as "the existence and implementation of one or more groundwater sustainability plans [GSPs] that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield" (California Water Code [CWC] § 10721(u)). SGMA requires Groundwater Sustainability Agencies (GSAs) to develop and implement GSPs to meet the Sustainability Goal (CWC § 10727(a)) and defines terms related to achievement of the Sustainability Goal, including:

- Interim Milestone (IM) – "a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan" (Title 23, California Code of Regulations (23 CCR §351(q))
- Measurable Objective (MO) – "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" (23 CCR §351(s)); and
- Minimum Threshold (MT) – "a numeric value for each sustainability indicator used to define undesirable results" (23 CCR §351(t)).

Collectively, the Sustainability Goal, IMs, MOs, and MTs are referred to herein as Sustainable Management Criteria (SMCs).

The GSP Emergency Regulations specify how GSAs must establish SMCs for each applicable Sustainability Indicator. Sections *12, 13, 14*, and *15* of this GSP describe the Sustainability Goal, Undesirable Results, MTs, and MOs, respectively, developed as part of this GSP.

12. SUSTAINABILITY GOAL

> *§ 354.24 Sustainability Goal*
> *Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.*

The Sustainable Groundwater Management Act (SGMA) requires that a Sustainability Goal be defined for the Basin (CWC §10727(a)), and the Groundwater Sustainability Plan (GSP) Emergency Regulations further clarify that the sustainability goal "culminates in the absence of undesirable results within 20 years of the applicable statutory deadline" (23 CCR §354.24).

The Sustainability Goal of the Castac Basin GSA (Water Code §10721(u)) is to cooperatively manage groundwater sustainably in the Basin to support current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental uses) and to avoid undesirable results throughout the planning horizon.

Groundwater recharge, movement, and storage in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale. Nonetheless, the goal of Castac Basin GSA's projects and management actions will be to maintain groundwater storage in the Basin to the extent possible, in order to supply beneficial uses and users of groundwater.

13. UNDESIRABLE RESULTS

§ 354.26. Undesirable Results

(a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

(b) The description of undesirable results shall include the following:

(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.

(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.

(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

(c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

(d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

This section describes SGMA Undesirable Results for the Castac Lake Valley Groundwater Basin (Basin). Undesirable Results are defined in SGMA as "when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin."

13.1. Undesirable Results for Chronic Lowering of Groundwater Levels

Undesirable Results for Chronic Lowering of Groundwater Levels are "if groundwater levels fall below the Minimum Threshold (MT) for Chronic Lowering of Groundwater Levels in any two representative monitoring wells for four consecutive semi-annual monitoring events."

13.1.1. <u>Potential Causes of Undesirable Results</u>

Potential causes of Undesirable Results due to Chronic Lowering of Groundwater Levels include increased pumping and/or reduced recharge, which in the Castac Basin is heavily influenced by natural climatic conditions.

Because the primary use of Basin groundwater is for municipal, domestic, and irrigation purposes, increased groundwater pumping could be driven by increases in the groundwater-dependent population, or an increase in the acreage of groundwater-irrigated agriculture.

A more significant impact to the Basin is reduced recharge, which is heavily influenced by climatic conditions. Reduced recharge could occur due to curtailed groundwater inflows from upgradient Cuddy Canyon Basin, or climate change that results in decreased precipitation and increased evapotranspiration (ET), as discussed in Section *9.4 Projected Water Budget*.

13.1.2. Criteria Used to Define Undesirable Results

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the description of Undesirable Results must include a quantitative description of the number of MT exceedances that constitute an Undesirable Result. As detailed below in Section *14.1 Minimum Threshold for Chronic Lowering of Groundwater Levels* and shown on **Figure SMC-1**, MTs for groundwater levels have been established at three Representative Monitoring Wells (RMWs) in the Basin, based on historical trends observed over the 10-year period between DWR Water Years 2008 and 2018. This period includes the worst drought conditions on record, and the MTs were calculated assuming that these severe conditions continued unabated through 2038 (i.e., they project a "worst case scenario" that does not duplicate observed longer-term historical variation in conditions). An Undesirable Result for Chronic Lowering of Groundwater Levels would be identified if the MT is exceeded in any two of the three RMWs over four consecutive semi-annual monitoring events.

13.1.3. Potential Effects of Undesirable Results

The potential effects of Undesirable Results caused by Chronic Lowering of Groundwater Levels on beneficial uses and users of groundwater in the Basin may include interference with groundwater production from supply wells, increased pumping lift, and even potential dewatering of supply wells. Periodic well dewatering can lead to increased maintenance costs (e.g., well redevelopment, screen cleaning, pump lowering, or even well deepening or replacement) and reduced well lifespan due to corrosion of well casings and screens. Increased pumping lift results in reduced well efficiency (more energy use per unit volume of groundwater pumped) and corresponding higher pumping costs, as well as increased wear on well pumps and motors.

Other effects of Undesirable Results include lowering of groundwater levels below the root zone in areas with phreatophyte plant communities (i.e., groundwater dependent ecosystems or GDEs), which would adversely affect the biota living in these areas of shallow groundwater.

As detailed in Section *14.1.2 Well Impact Analysis* below, a Well Impact Analysis was conducted in which available well construction information was used to assess which wells would be partially or fully dewatered if groundwater levels decline to depth of MT of the closest RMW. If groundwater levels in the Basin decline to the MT values, no production wells would be fully dewatered; of the active wells with known well construction information, one irrigation well and two public supply wells would be partially dewatered.[46]

13.2. Undesirable Results for Reduction of Groundwater Storage

As discussed in more detail below, groundwater levels are used as proxy for measuring Undesirable Results for Reduction of Groundwater Storage. Therefore, the definition of Undesirable Results for Reduction of Groundwater Storage is the same as the definition of Undesirable Results for Chronic Lowering of Groundwater Levels, i.e., if groundwater levels fall below the MT for Chronic Lowering of Groundwater Levels in any two representative monitoring wells for four consecutive semi-annual monitoring events.

13.2.1. Potential Causes of Undesirable Results

Per Section 354.26(b)(1) of the GSP Emergency Regulations, Reduction of Groundwater Storage is generally correlated to Chronic Lowering of Groundwater Levels. Therefore, the potential causes of Undesirable Results due to Reduction in Groundwater Storage are generally the same as the potential causes listed above for Undesirable Results due to Chronic Lowering of Groundwater Levels (i.e., increased groundwater pumping and reduced recharge) and are predominantly influenced by climatic conditions in this Basin.

13.2.2. Criteria Used to Define Undesirable Results

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the criteria used to define Undesirable Results for Reduction of Groundwater Storage generally are consistent with the criteria used to define Undesirable Results for Chronic Lowering of Groundwater Levels. Put simply, it would be considered significant and unreasonable (i.e., an Undesirable Result) if groundwater storage were to be reduced by an amount that would cause the groundwater levels at any two RMWs to exceed their MT for Chronic Lowering of Groundwater Levels over four consecutive semi-annual monitoring events. As such, the criteria set for Chronic Lowering of Groundwater Levels are “protective” and a reasonable proxy.

13.2.3. Potential Effects of Undesirable Results

The primary potential effect of Undesirable Results caused by Reduction of Groundwater Storage on beneficial uses and users of groundwater in the Basin would be reduced groundwater supply reliability, which would be most significant during periods of drought. As discussed in Section *9.2 Water Budget Results* and shown in **Table WB-9**, the groundwater system is highly sensitive to

[46] For purposes of the well impact analysis, the depth to groundwater at the Minimum Threshold in the nearest Representative Monitoring Well is used as a proxy depth to water in the supply well. A well is identified as partially dewatered if the MT is below the mid-point of the well screen interval and fully dewatered if the MT is below the bottom of the well screen. The perforated screened intervals for three public supply wells are unknown, however the pump intake depth is known for two public supply wells. If this depth to water at the projected MT is below the supply well’s pump intake depth, the well is classified as partially dewatered.

climate conditions where water level response is directly related to precipitation, and a severe multi-year drought over the period of Water Years 2007-2016 caused increasingly evident reduction in groundwater storage.

13.3. Undesirable Results for Seawater Intrusion

The GSP Emergency Regulations state that "An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators" (23-California Code of Regulations [CCR] § 354.26(d)). Because the Basin is not located near any saline water bodies, seawater intrusion is not considered a threat to Basin groundwater resources, and no Undesirable Results for this Sustainability Indicator are defined in the Basin.

13.4. Undesirable Results for Degraded Water Quality

As discussed in more detail in Section *14.4 Minimum Threshold for Degraded Water Quality*, only limited groundwater quality data are available to assess the relationship between water quality and water levels in the Basin. Furthermore, water management actions available to the Castac Basin GSA (e.g., pumping restrictions) may have little effect on groundwater quality conditions within the Basin. Consequently, Undesirable Results for Degraded Water Quality have not been defined in this GSP.

If in the future the Castac Basin GSA initiates one or more projects, or if significant and unreasonable reductions in water quality occur and are determined to be related to water management actions available to the GSA, the criteria for development of Undesirable Results for Degraded Water Quality will be revisited as part of the next five-year GSP update.

13.4.1. Potential Causes of Undesirable Results

Potential causes of Undesirable Results due to Degraded Water Quality include the addition of constituents of concern (COCs) to groundwater in the principal aquifer through processes related to water management or land use activities. These potential processes include:

- Deep percolation of saline water associated with Castac Lake or its lakebed sediments. Potential COCs include total dissolved solids (TDS);
- Deep percolation of precipitation that mobilizes naturally occurring COCs such as uranium and fluoride;
- Deep percolation through shallow point-source contamination sites, although there currently are no known active contamination sites within the Basin; and

- Subsurface inflows from upgradient areas with degraded water quality (e.g., Lebec Sanitary Landfill, located upgradient of the Basin). Potential COCs include chlorinated solvents, nitrate and TDS.

13.4.2. Criteria Used to Define Undesirable Results

The State Water Resources Control Board's (SWRCB) Division of Drinking Water regulates the quality of water served by the public water systems in the Basin and the water quality criteria under which that program operates, i.e., State or Federal Maximum Contaminant Levels (MCLs). The authority of the SWRCB is not superseded by SGMA.

As discussed in Section *8.5 Groundwater Quality Concerns* and shown by the groundwater level hydrographs and groundwater quality chemographs (water chemistry time-series graphs) included in Appendix *E*, a Mann-Kendall trend analysis suggests some wells have statistically-significant[47] increasing or decreasing water quality trends for certain constituents. Among the 15 pairs of water level elevation and water quality constituent concentrations examined, three show statistically significant decreasing trends for nitrate, fluoride, or uranium, and seven wells show statistically significant increasing trends for nitrate, uranium, arsenic, or TDS.

Evaluation of the available water level and water quality data also show that some wells show a moderate correlation between water levels and certain water quality constituent concentrations, some show no correlation, and most wells have insufficient data to conduct statistical analyses.[48]

Water quality is not a primary focus for Undesirable Results in this GSP because: (1) very limited concurrent groundwater elevation and water quality concentration data exist for many of the wells in the Basin; (2) concentrations of potential COCs except TDS[49] remain below MCLs in most wells; and (3) except nitrate, potential COCs include TDS, uranium, and arsenic, all of which are naturally-occurring.

Additional data collection and analysis will be needed to discern the potential relationship between water management, water levels, and water quality, as discussed in more detail in Section *16.1.4 Monitoring Network for Degraded Water Quality*. Therefore, based on the existing and potential beneficial uses and users of groundwater within the Basin, Undesirable Results for Degraded Water Quality are not defined for the Basin. In the meantime, water quality issues related to drinking water will continue to be regulated by the SWRCB.

[47] A trend identified from the Mann-Kendall test with p-value that is less or equal to 0.05 is considered to be significant for purposes of this analysis.
[48] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.
[49] TDS concentrations have exceeded the secondary recommended MCL of 500 milligrams per liter (mg/L) in some wells during recent sampling events, but all concentrations remain below the secondary upper MCL of 1,000 mg/L (*Appendix E*)

13.4.3. Potential Effects of Undesirable Results

Per Section 354.26(b)(3) of the GSP Emergency Regulations, potential effects of Undesirable Results must be identified. The potential effects of Undesirable Results caused by Degraded Water Quality on beneficial uses and users of groundwater may include: increased costs to treat groundwater to drinking water standards if it is to be used as a potable supply source; increased costs to blend relatively poor-quality groundwater with higher quality sources for drinking water users; or increased costs to procure and provide alternative potable water supplies.

As discussed in Section *16.1 Description of Monitoring Network*, the Castac Basin GSA will assemble, incorporate, and analyze water quality sampling from public water systems reported to the SWRCB Division of Drinking Water in future SGMA reporting (i.e., Annual Reports and GSP updates). Furthermore, select monitoring wells throughout the Grapevine Canyon will be sampled for select water quality constituents to establish a current baseline condition. If and when project(s) are being developed, the Castac Basin GSA will revisit defining SMCs for Degraded Water Quality, if deemed necessary.

13.5. Undesirable Results for Land Subsidence

The GSP Emergency Regulations state that “An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators” (23-CCR § 354.26(d)). As discussed in Section *8.6 Land Subsidence*, no known occurrences of significant impacts due to land subsidence have been measured within the Basin. Given the geologic and stratigraphic characteristics of the Basin, which appears to lack thick clay layers in which declining water levels could cause irreversible compaction, land subsidence is unlikely to occur in the Basin. The Land Subsidence Sustainability Indicator is therefore not applicable to the Basin and no Undesirable Results for this Sustainability Indicator are defined in the Basin.

13.5.1. Potential Causes of Undesirable Results

Per Section 354.26(b)(1) of the GSP Emergency Regulations, land subsidence can be caused by several mechanisms, but the mechanism most relevant to sustainable groundwater management is the depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of compressible strata and lowering of the ground surface. Therefore, the potential causes of Undesirable Results due to Land Subsidence are generally the same as the potential causes listed above for Undesirable Results due to Chronic Lowering of Groundwater Levels. However, as discussed above, the geologic and structural properties of the Basin are such that land subsidence will most likely not occur in the future.

13.5.2. Potential Effects of Undesirable Results

Per Section 354.26(b)(3) of the GSP Emergency Regulations, potential effects of Undesirable Results caused by land subsidence on beneficial uses and users of groundwater and overlying land uses could include damage to above-ground and near-surface infrastructure, such as water conveyance channels, gas and petroleum pipelines, municipal water lines, etc. Potential effects could also include damage to below-ground infrastructure including groundwater well casing and surface appurtenances. As discussed above, no instances of impacts due to land subsidence have occurred within the Basin. Furthermore, the geologic and structural properties of the Basin are such that land subsidence will most likely not occur in the future. Therefore, although no Undesirable Results for Land Subsidence are defined, the potential effects from this Sustainability Indicator are minimal to non-existent for the Basin.

13.6. Undesirable Results for Depletions of Interconnected Surface Water

As discussed in Section *8.7 Interconnected Surface Water Systems*, potential seasonally-interconnected surface water systems within the Basin include Cuddy Creek, Grapevine Creek, and Castac Lake, all of which are ephemeral under natural conditions (i.e., streamflows and open water in the lake are brief and generally occur following a rainfall event). Since 2012, Castac Lake has been mostly dry, accumulating intermittent seasonal shallow water during some precipitation events.

The Undesirable Result associated with depletion of interconnected surface water in the Basin is the possible loss of GDE habitat. The Nature Conservancy (TNC) provides a map of Natural Communities Commonly Associated with Groundwater (NCCAG) for GSAs to identify potential GDEs (TNC, 2018). **Table GWC-*6*** summarizes the maximum estimated rooting depths of plants within the NCCAG dataset located in the Basin, based on data compiled by TNC[50]. As discussed in Section *8.8 Groundwater Dependent Ecosystems (GDEs)*, groundwater depths near these mapped potential GDEs in the Grapevine Canyon area of the Basin may vary over historical and projected future periods near the range of estimated maximum GDE rooting depths (**Table GWC-*6***; **Figure GWC-16**).

Most of the Castac Basin land identified as potentially hosting GDEs currently is covered in grasses and other presumably shallow-rooted plants. As described in Section 9.4.3, prior work by EKI (2008b) estimated a 90% cumulative rooting depth of approximately 3 ft bgs for the various plant species mapped in the Basin, using methods from Zeng (2001), land cover from the National Land Cover Database (NLCD), and vegetation coefficients from the International Geosphere-Biosphere Program (IGBP). This 90% cumulative rooting depth is the extinction depth used in the Castac Basin Numerical Model, and it is significantly less than TNC estimated maximum rooting depths shown in **Table GWC-*6***. Further, the depth to groundwater measured in shallow wells near these

[50] TNC, 2018, *Maximum-rooting depth database.* The Nature Conservancy (https://groundwaterresourcehub.org/sgma-tools/gde-rooting-depths-database-for-gdes/), published 19 April 2018.

potential GDEs ranges from less than 15 ft bgs to 30 ft bgs or deeper (**Figure GWC-16**). Thus, most of the existing plant community in the Basin (particularly outside of the Grapevine Canyon area) likely uses limited groundwater under recent and current conditions. Ephemeral communities of phreatophytes may colonize areas of shallow groundwater in wet years, and become dormant or die out in dry periods, as has occurred in the past.

Based on the above analysis, the 3-ft bgs rooting depth specified in the Castac Basin Numerical Model is more likely to be appropriate for the grasses and shrubs currently growing in much of the GDE areas identified in the Basin, thus, its use likely provides a more accurate estimate of the Basin water budget and storage parameters.

As discussed in more detail in Section *14.6.1*, the MT for Chronic Lowering of Groundwater Levels in RMW TRC-MW23D and the Grapevine Canyon area of the Basin was determined through projection of recent groundwater level trends (2008 - 2018) observed in that well. Using this method, the MT is 28 ft bgs, below the maximum rooting depth of potential GDEs in this area (**Table GWC-*6***). Direct water level measurements in well TRC-MW23D indicate that local groundwater levels measured in wells within the Grapevine Canyon area have historically varied between zero and approximately 24 ft bgs. The longer-term historical low water level in well TRC-MW23D is estimated at 26 ft bgs[51], but this estimate is uncertain, due to its extrapolation back in time several decades.

The MTs are considered a minimum management limit for water levels. The GSA will strive to maintain water levels at the Measurable Objective (MO), which is approximately eight feet higher than the MT in the Grapevine Canyon area of the Basin (i.e., 20 ft bgs). Finally, in severe droughts, some GDEs can adapt to lowering groundwater levels depending on the speed, magnitude, and longevity of the drought stress endured (Rohde et al., 2019).

Given that (a) significant variability exists in the areal distribution of GDEs in the Basin, (b) the relationship between groundwater elevation and impacts to potential GDEs is uncertain, and (c) the interconnected surface water systems within the Basin are most greatly affected by variations in natural conditions, the MT for Chronic Lowering of Groundwater Levels is assumed to be protective of potential GDEs in the Basin. As such, Undesirable Results for Depletions of Interconnected Surface Water is not currently defined, and the criteria set for Chronic Lowering of Groundwater Levels are assumed to be "protective" and a reasonable proxy.

13.6.1. Potential Causes of Undesirable Results

Depletion of Interconnected Surface Water generally correlates with Chronic Lowering of Groundwater Levels in an interconnected groundwater aquifer system. Therefore, the potential

[51] The historical low is estimated by correlation of water levels in TRC-MW23D with water levels in supply well TRC-PW56A (the Basin well with the longest data record).

causes of these Undesirable Results are generally the same as the potential causes listed above for Undesirable Results due to Chronic Lowering of Groundwater Levels (i.e., increased groundwater pumping and reduced recharge) which are heavily influenced by climatic conditions in this Basin.

13.6.2. Criteria Used to Define Undesirable Results

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the description of Undesirable Results must include a quantitative description of the combination of MT exceedances that constitute an Undesirable Result. The criteria used to define Undesirable Results for Depletions of Interconnected Surface Waters are the same criteria used to define Undesirable Results for Chronic Lowering of Groundwater Levels (Section 13.1), given the correlation between the two phenomena. As such, the criteria set for Chronic Lowering of Groundwater Levels are "protective" and a reasonable proxy.

13.6.3. Potential Effects of Undesirable Results

Potential effects of Undesirable Results of Depletions of Interconnected Surface Water may include reduced surface water flows to support downstream or in-stream uses. Furthermore, reduced surface water flows may impact environmental users, such as GDEs or freshwater species dependent on interconnected surface waters.

13.7. Undesirable Results Summary

Table SMC-1 below provides a summary of the Undesirable Results definitions for each Sustainability Indicator.

Table SMC-1. Summary of Undesirable Results Definitions

Sustainability Indicator	**Undesirable Results Definition**
Chronic Lowering of Groundwater Levels	If groundwater levels decline below the MT in any two Representative Monitoring Wells (RMWs) for four consecutive semi-annual sampling events.
Reduction of Groundwater Storage	If groundwater storage is reduced by an amount that causes groundwater levels to decline below the MT in any two RMWs for four consecutive semi-annual sampling events (*Chronic Lowering of Groundwater Levels to be used as a proxy*).
Seawater Intrusion	No Undesirable Results definition. Not applicable to the Basin due to geographic distance from the ocean.

Sustainability Indicator	Undesirable Results Definition
Degraded Water Quality	No Undesirable Results definition. Limited historical water quality measurements are available and the relationship between water levels and water quality is not yet established.
Land Subsidence	No Undesirable Results definition. Not applicable to the Basin. No historical evidence of subsidence and geologic strata are unfavorable to inelastic deformation.
Depletion of Interconnected Surface Water	If groundwater levels decline below the MT in any two RMWs for four consecutive semi-annual sampling events; (*Chronic Lowering of Groundwater Levels used as a proxy*).

14. MINIMUM THRESHOLDS

§ 354.28. Minimum Thresholds

(a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.

(b) The description of minimum thresholds shall include the following:

(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.

(2) The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

…

(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

(e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

Minimum Thresholds (MTs) are the numeric criteria for each Sustainability Indicator that, if exceeded, may cause Undesirable Results. Like The GSP Emergency Regulations (23-CCR § 354.28(c)) state that the MT for Depletions of Interconnected Surface Water "shall be the rate or volume of surface water depletions **caused by groundwater use** that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results" (emphasis added).

14.1.1. Use of Groundwater Levels as Proxy

Pursuant to the GSP Emergency Regulations (23-CCR § 354.28(d)) and as further described in the DWR Sustainable Management Criteria BMP (DWR, 2017), MTs for Depletions of Interconnected Surface Water may be set by using groundwater levels as a proxy, if it can be demonstrated that MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable depletions of interconnected surface water.

Castac Lake is the most prominent surface water feature in the Basin, and based on shallow well data near the lake, during periods when the lake contains water it likely is interconnected to groundwater. As discussed in Section *9.2 Water Budget Results*, the analytical water budget simulates net gaining lake conditions in which groundwater inflow into the lake exceeds groundwater outflow from the lake during the WY 1998-2018 time period. Under unmanaged conditions, Castac Lake levels primarily are influenced by climate and not groundwater pumping. Since 2012, Castac Lake has been mostly dry, and groundwater elevations in 2018 were below the bottom of the Lake. Other potentially interconnected surface water features include Cuddy Creek and Grapevine Creek, however the flows in these are ephemeral under natural conditions, which means that flows are brief and generally occur following a rainfall event.

Potential groundwater dependent ecosystems (GDEs) are a less obvious feature of interconnected surface water. GDEs have been mapped in the Grapevine Canyon area of the Basin, where groundwater levels typically are shallower than the main Castac Lake area of the Basin. RMW TRC-MW23D is located in the Grapevine Canyon area of the Basin.

The MT for Chronic Lowering of Groundwater Levels considered the groundwater level trends observed in Grapevine Canyon well TRC-MW23D. Although that MT is set at 28 feet below ground surface (ft bgs), below the likely maximum rooting depth of potential GDEs in this area (i.e., 24 ft bgs; see **Table GWC-6**), groundwater levels in well TRC-MW23D historically have fluctuated between land surface and approximately 24 ft bgs, and the estimated maximum depth to groundwater in TRC-MW23D is 26 ft bgs. Groundwater levels thus are unlikely to decline to the MT depth of 28 ft bgs.

MTs also are considered a *minimum* that water levels should reach, and the GSA will strive to maintain water levels at the Measurable Objectives (MO) which are approximately eight (8) feet higher than the MT in the Grapevine Canyon area of the Basin (i.e., 20 feet bgs), as described in detail in Section 15.1 *Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels*.

As discussed above, in Section *13.6 Undesirable Results for Depletions of Interconnected Surface Water*, the relationship between groundwater elevation and impacts to the potential GDEs is uncertain, as (1) the mixture of different phreatophyte plants at a given time in a given area (and their specific rooting depths) is not well known, and some GDEs can adapt to lowering groundwater levels depending on the speed, magnitude, and longevity of the stress (Rohde et al., 2019), and (2) the interconnected surface water systems within the Basin are affected by variation in natural conditions and precipitation events. Given the observed shallow depths to groundwater in RMW TRC-MW23D, the known range of GDE plant rooting depths, and the maximum water depth allowed by the MTs for Chronic Lowering of Groundwater Levels and Depletion of Groundwater Storage, these MTs also are likely protective of the potential GDEs. MTs specific to Depletions of Interconnected Surface Water therefore are not developed at this time, and MTs for Chronic Lowering of Groundwater Levels are used as proxy.

Measurable Objectives (MOs) discussed in Section 15, this section describes the MTs that have been developed to avoid Undesirable Results for each applicable Sustainability Indicator.

As shown in **Table SMC-2**, MTs within the Basin are defined at representative monitoring wells (RMWs) for relevant Sustainability Indicators. Where appropriate, the MTs for the Sustainability Indicators have been set using groundwater levels as a proxy, based on the demonstration "that there is a significant correlation between groundwater levels and other metrics" (California Department of Water Resources [DWR], Sustainable Management Criteria Best Management Practice [BMP], 2017).

Table SMC-2. Spatial Scale of Minimum Threshold Definition

Sustainability Indicator	Minimum Threshold Metric(s) defined in GSP Emergency Regulations (CCR § 354.28(c))	Sites for Minimum Threshold Compliance
Chronic Lowering of Groundwater Levels	Groundwater elevation	Three RMWs
Reduction of Groundwater Storage	Total volume of groundwater	Three RMWs (*Chronic Lowering of Groundwater Levels used as a proxy*)
Seawater Intrusion	Chloride concentration isocontour	No MTs defined. Not applicable to the Basin.
Degraded Water Quality	- Number of supply wells - Volume of groundwater - Location of isocontour	No MTs currently defined. Water quality data will be analyzed to help establish a baseline prior to any project implementation
Land Subsidence	Rate and extent of land subsidence	No MTs defined. Not applicable to the Basin.
Depletion of Interconnected Surface Water	Rate or volume of surface water depletions	Three RMWs (*Chronic Lowering of Groundwater Levels used as a proxy*)

14.1. Minimum Threshold for Chronic Lowering of Groundwater Levels

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
(B) Potential effects on other sustainability indicators.

Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator, as it influences several other key Sustainability Indicators, including Reduction of Groundwater Storage, Land Subsidence, Depletions of Interconnected Surface Water, and in certain ways, Degraded Water Quality. Groundwater levels in wells also are the most readily measurable metrics of groundwater conditions, and their use allows for a systematic, data-driven approach to MT development. There are no state, federal, or local standards that relate to this Sustainability Indicator.

14.1.1. Minimum Threshold Development

Consistent with the Groundwater Sustainability Plan (GSP) Emergency Regulations (23-CCR § 354.28(c)), the definition of MTs for Chronic Lowering of Groundwater Levels is based on consideration of historical and projected future trends in groundwater levels, and estimated potential impacts to groundwater users. Three RMWs within the Basin (i.e., monitoring network wells which have been assigned sustainable management criteria) were selected for calculation of MTs: TRC-MW16D, TRC-MW18D, and TRC-MW23D (see **Figure SMC-1)**. These wells were selected based on their spatial location and depth, the completeness of their construction and water level records, and their proximity to public supply wells (see Section *16.1.1 Monitoring Network for Chronic Lowering of Groundwater Levels*).

Minimum Threshold Algorithm

The MT values for Chronic Lowering of Groundwater Levels were developed for each RMW as shown on **Figure SMC-1,** using a simple process:

- Historical water level data were compiled from a given RMW over the 10-year period from Water Year (WY) 2008 to WY 2018;
- A best-fit linear trend was calculated for that period;
- The trend was projected 10 years into the future (from WY 2018 to WY 2028) using the same slope, to establish the MO water level elevation; and

- The trend was projected further still, 20 years into the future (to 2038) using the same slope, to establish the MT water level elevation.

Water levels in all three RMWs declined over the 10-year historical period, so trends all were negative, varying from -0.79 feet per year (ft/yr) in TRC-MW23D in the Grapevine area of the Basin, to -7.56 ft/yr in TRC-MW16D in the main Basin, near the upgradient boundary.

Water Years 2008 through 2018 were used to determine the historical trend as a conservative measure. The period includes the recent significant drought (WY 2012 to 2016), and therefore allows the MT to incorporate the possibility of another long-term drought in the future (e.g., a drought potentially exacerbated by climate change). This period also contains the most complete, highest resolution set of water level data collected from wells within the Basin.

The 20-year period of trend projection used to determine the MT was considered realistic for implementation of various Projects and Management Actions (P&MAs), some of which the Castac Basin GSA already is proactively pursuing. Twenty years also is the statutory duration of the SGMA implementation period, suggesting that by the end of the SGMA implementation period, the Basin should have achieved the Sustainability Goal.

Figure SMC-1 shows historical and projected hydrographs, MOs, and MTs for the three RMWs in the Basin, including factors considered during formulation of Sustainable Management Criteria (SMCs), such as the bottom of the well casing, and estimated[52] historical low water levels over the period of record for the Basin (1956 - 2018), for comparison to the MOs and MTs. Generally, estimated historical low water levels in the RMWs were below the MOs but above the MTs. These estimated data may not be accurate, as they are based on water levels recorded in a pumping well (TRC-PW56A) that in some cases is located some distance away from the RMW in another part of the Basin.

MTs and MOs calculated using the method described above vary as a function of their recent historical declines, which themselves vary in different parts of the Basin. In general, water levels in the RMWs located within the Castac Lake area of the Basin had steeper observed declines and greater differences between MOs and MTs (called margins of operational flexibility), while the RMW located within the Grapevine Canyon area of the Basin experienced significantly less change in water levels and has a narrower range of margins of operational flexibility (i.e., 8 feet).

[52] Significant and unreasonable impacts to beneficial uses and users of groundwater are not known to have occurred when Basin groundwater levels were at historical lows. RMWs are relatively new wells in the Basin (installed in 2007) and thus have comparatively short records of groundwater elevation measurements. Assumed historical low water levels were estimated using a best-fit linear model between historical water levels in each RMW and those from well TRC-PW56A, which has the longest record of water level measurements in the Basin, starting in 1956. The historical low for TRC-PW56A occurred in Spring 1964, with groundwater elevation of 3,410 feet above mean sea level (i.e., 143 feet below ground surface). The estimated historical low water level elevations for RMWs are shown on Figure SMC-1, and the correlation coefficients between the RMWs and TRC-PW56A are 99% (TRC-MW16D), 99% (TRC-MW18D), and 67% (TRC-MW23D), respectively.

MT values for Chronic Lowering of Groundwater Levels at each RMW are summarized in **Table SMC-3**, below.

Table SMC-3. Minimum Thresholds for Chronic Lowering of Groundwater Levels

RMW Name	**Area**	**GSE** (ft msl)	**MT** (ft msl)	**MT** (ft bgs)
TRC-MW16D	Castac Lake	3,640	3,345	295
TRC-MW18D	Castac Lake	3,531	3,357	173
TRC-MW23D	Grapevine	3,376	3,348	28

Abbreviations:

ft bgs = feet below ground surface
ft msl = feet above mean sea level
GSE = ground surface elevation
RMW = Representative Monitoring Well
MT = Minimum Threshold

14.1.2. Well Impact Analysis

If water levels in the RMWs decline, water levels in other wells in the Basin generally also will decline. A preliminary analysis was performed to examine the potential repercussions on other Basin wells of water levels declining to their MTs in each RMW, using the simplifying assumption that the depth to groundwater in any given Basin well will be similar to the depth to water in the nearest RMW. These estimated water depths were plotted graphically with available well construction information for several domestic, irrigation, and public supply wells (**Figure SMC-2**) to assess the potential for dewatering of the wells at the MT groundwater elevations.

For this analysis, wells are identified as *partially dewatered* if the water level is equal to or below the midpoint of the well screened interval, and *fully dewatered* if the water level is equal to or below the bottom of the well screen. Only wells with available well construction information could be assessed using this method. In some instances, pump intake depth was used as a surrogate for well screen.

Results from this well impact analysis are shown on Figure SMC-2. If water levels reach MTs in the Basin RMWs, approximately 31% of Basin wells will be partially dewatered, and no wells will be fully dewatered. Thus, impacts of declining water levels down to MTs are not considered to be significant and unreasonable for purposes of SGMA. As their name suggests, MTs are considered a minimum that water levels should reach, and the GSA will strive to maintain water levels at or above the MOs, which are in all cases above the MTs[53], as described in Section *15.1 Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels*.

The LCWD-Lebec PW and LCWD-State PW public supply wells, which could experience partial dewatering if water levels drop to MTs[54], are more than 50 years old and have remained viable through large water level fluctuations over the historical period of record. Historical minimum water levels in these wells are above MTs, but they are similar to what would be anticipated under MT conditions. For example, LCWD-Lebec PW measured a historical groundwater elevation low of 3,406 ft msl in 1968, which is only one foot higher than the MT elevation calculated from the depth to MT from the nearest RMW (e.g., TRC-MW18D).

14.2. Minimum Threshold for Reduction of Groundwater Storage

> *§ 354.28. Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.*

Groundwater storage is directly related to the level of the water table or piezometric surface in the Basin, and storage properties of the aquifer. Section 13.2 discusses how Undesirable Results for Reduction of Groundwater Storage are linked to a decline of groundwater levels below the MTs established in each RMW for groundwater levels.

Similarly, the MT for Reduction of Groundwater Storage is related to the MT for Chronic Lowering of Groundwater Levels, in that the MT for groundwater levels can be used as a proxy for the groundwater storage MT. As discussed in more detail below, because MTs for groundwater levels discussed above are protective of the beneficial uses and users of groundwater, a unique MT for Reduction of Groundwater Storage is not necessary. There are no state, federal, or local standards that relate to this Sustainability Indicator.

14.2.1. Estimate of Total Storage Volume

To support the use of MTs for Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage, it is informative to estimate the storage volume of the Basin.

[53] MOs are approximately 65 feet higher than the MTs in the Castac Lake part of the Basin, and eight feet higher than the MTs in the Grapevine Canyon area of the Basin.
[54] LCWD-Lebec PW and LCWD-State PW do not have known well perforated screened interval information, and therefore the pump intake depth in each well was used in the well impact analysis. If the depth to MT in the nearest RMW is below the supply well's pump intake depth, the well is classified as partially dewatered.

As discussed in Section *8.3 Change in Groundwater Storage*, the Basin storage volume was estimated as the product of the aquifer volume and the assumed specific yield of the aquifer sediments. Based on a summation of sub-volumes for portions of the irregularly shaped Basin, the total volume of the aquifer materials is preliminarily estimated to be approximately 465,000 acre-feet (AF). Using a 20% estimated total porosity[55] of the aquifer materials, the maximum aquifer storage volume is estimated to be approximately 93,000 AF.

A different approach using the Castac Basin Numerical Model provides an estimated groundwater storage volume in rough agreement with the above analysis. The total volume of aquifer materials estimated by the sum of active cells within the model equals 691,519 AF. Assuming 20% porosity yields an estimated maximum aquifer storage volume of approximately 138,000 AF, if the aquifer were completely full, but groundwater typically is some depth below land surface in most of the Basin. Groundwater elevation hydrographs using historical water level data in Basin wells generally indicate a maximum around March 2005. Using the model-calculated heads from that period, the maximum available aquifer storage volume works out to approximately 100,000 AF.

14.2.2. Use of Groundwater Levels as Proxy

The GSP Emergency Regulations (23-CCR § 354.28(d)) and the DWR Sustainable Management Criteria BMP (DWR, 2017) state that MTs for Reduction of Groundwater Storage may use groundwater levels as a proxy, if the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to prevent significant and unreasonable reductions in groundwater storage.

To test this hypothesis, an estimate was made of the groundwater volume lost from the principal aquifer if water levels were to decline from their respective MOs to MTs (for Chronic Lowering of Groundwater Levels), in order to consider the loss as a percentage of the total estimated storage. The Castac Basin Numerical Model was used to calculate the historical cumulative storage decline that occurred during a drought-related decline in groundwater levels.

Over the ten-year period between March 2008 and March 2018, approximate declines in water levels measured in RMWs include 79 feet in TRC-MW16D, 56 feet in TRC-MW18D, and 12 feet in TRC-MW23D. The cumulative storage decline over this period estimated using the Castac Basin Numerical Model was approximately 12,800 AF, representing approximately 13% of the total maximum aquifer storage. Because (a) this water level decline exerts a small effect (13% loss) on Basin groundwater storage, (b) this would be a temporary, drought-driven condition, and (c) such declines are similar to historical conditions within the Basin, it is assumed that the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of

[55] This porosity estimate is consistent with general guidance (Heath, 1983) as well as local hydrogeologic investigations. Schmidt (2002) and Galli (2005) each used 20% porosity for storage estimates of similar aquifer materials in the upgradient Cuddy Canyon Basin.

significant and unreasonable occurrences of Reduction of Groundwater Storage, and the same SMCs defined for Chronic Lowering of Groundwater Elevations can be used for the Groundwater Storage Sustainability Indicator.

14.3. Minimum Threshold for Seawater Intrusion

> *§ 354.28. Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(3) Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:*
> *(A) Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.*
> *(B) A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.*

The GSP Emergency Regulations state that "An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators" (23-CCR § 354.28(e)).

Because the Basin is located far inland, away from the ocean, seawater intrusion is not a threat to groundwater resources and the Seawater Intrusion Sustainability Indicator is not applicable. Thus, no SMCs for this Sustainability Indicator are defined in the Basin.

14.4. Minimum Threshold for Degraded Water Quality

> *§ 354.28. Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.*

The GSP Emergency Regulations (23-CCR § 354.28(c)) state that the MT of Degraded Water Quality shall be the "degradation of water, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results". The GSP Emergency Regulations further state that the MT "shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin", and that "the Agency shall consider local, state, and federal water quality standards applicable to the basin."

MTs for Degraded Water Quality have not been defined for Castac Basin, due to factors which are discussed in Section *13.4 Undesirable Results for Degraded Water Quality* and include the following:

- The powers granted to Groundwater Sustainability Agencies (GSAs) to effect sustainable groundwater management under SGMA generally revolve around managing the quantity, location, and timing of groundwater pumping and/or implementing recharge projects. Except for groundwater recharge projects, Castac Basin GSA water management actions are likely to have only limited effects on groundwater quality conditions within the Basin. Potential recharge projects may cause changes in groundwater quality by affecting mobility and concentration of various chemical species in complex ways. Until specific details of a given recharge project and the project site are well understood, the effect of any potential project on water quality is uncertain.
- Very limited concurrent groundwater elevation and water quality concentration data exist for many of the wells in the Basin. In fact, an evaluation of the available water level and water quality data show that (1) some wells do show a weak correlation between water levels and certain potential COCs concentrations, (2) some wells show no correction between water levels and potential COCs concentrations, and (3) most wells have insufficient data to conduct statistical analyses.[56]
- In most wells, concentrations for potential COCs except TDS remain below regulatory thresholds (i.e., Maximum Contaminant Levels or MCLs) and potential COCs except nitrate but including TDS, uranium, and arsenic, are naturally-occurring.
- Undesirable Results for Degraded Water Quality are not defined currently in this GSP.
- Water quality standards generally are developed and enforced by other agencies such as the State Water Resources Control Board Division of Drinking Water and Kern County.

As discussed further in Section *16 Monitoring Network*, the GSA will compile water quality data from public water systems supplemented with water quality sampling from selected monitoring wells to establish a water quality baseline in which future GSP updates can assess a change in water quality conditions. As discussed below in Section *17 Projects and Management Actions*, the GSA may re-evaluate defining Undesirable Results for Degraded Water Quality and establishing SMCs for Degraded Water Quality if additional data analyses indicate the need for

[56] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.

Water Quality SMCs, or as appropriate, when the Castac Basin GSA begins implementing one or more projects.

Consideration of State, Federal, and/or Local Standards

The State of California and the U.S. Environmental Protection Agency (USEPA) set MCLs for constituents which may cause potential human health risks. MCLs are appropriate to consider when establishing MTs for Degraded Water Quality, but given the limited regulatory authority of GSAs with respect to water quality, at present no MTs for Degraded Water Quality are proposed for the Castac Basin. Furthermore, public supply wells in the Basin sample for constituents with established primary MCLs and, except for Fluoride, concentrations are below primary MCLs.

Basing SMCs on established drinking water quality criteria would appropriately meet the requirement to consider the beneficial uses and users of groundwater, if the Castac Basin GSA obtains new information in the future that suggests the need for MTs for Degraded Water Quality.

14.5. Minimum Threshold for Land Subsidence

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(5) Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:

(A) Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.

(B) Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

The GSP Emergency Regulations state that MTs for land subsidence shall be supported by "Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects" (23-CCR § 354.28(c)).

The GSP Emergency Regulations also state that "An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators" (23-CCR § 354.28(e)).

As discussed above in Section *8.6 Land Subsidence*, available data show that land subsidence is not likely to be a significant concern in the Basin. Given the geologic and stratigraphic characteristics of the Basin (a lack of thick clay layers), land subsidence is not known to have occurred and is not likely to occur in the Basin in the future, thus no SMCs are defined herein for the Land Subsidence Sustainability Indicator.

14.6. Minimum Threshold for Depletions of Interconnected Surface Water

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(6) Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:

(A) The location, quantity, and timing of depletions of interconnected surface water.

(B) A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.

The GSP Emergency Regulations (23-CCR § 354.28(c)) state that the MT for Depletions of Interconnected Surface Water "shall be the rate or volume of surface water depletions **caused by groundwater use** that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results" (emphasis added).

14.6.1. Use of Groundwater Levels as Proxy

Pursuant to the GSP Emergency Regulations (23-CCR § 354.28(d)) and as further described in the DWR Sustainable Management Criteria BMP (DWR, 2017), MTs for Depletions of Interconnected Surface Water may be set by using groundwater levels as a proxy, if it can be demonstrated that MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable depletions of interconnected surface water.

Castac Lake is the most prominent surface water feature in the Basin, and based on shallow well data near the lake, during periods when the lake contains water it likely is interconnected to groundwater. As discussed in Section *9.2 Water Budget Results*, the analytical water budget simulates net gaining lake conditions in which groundwater inflow into the lake exceeds groundwater outflow from the lake during the WY 1998-2018 time period. Under unmanaged conditions, Castac Lake levels primarily are influenced by climate and not groundwater pumping. Since 2012, Castac Lake has been mostly dry, and groundwater elevations in 2018 were below the bottom of the Lake. Other potentially interconnected surface water features include Cuddy

Creek and Grapevine Creek, however the flows in these are ephemeral under natural conditions, which means that flows are brief and generally occur following a rainfall event.

Potential groundwater dependent ecosystems (GDEs) are a less obvious feature of interconnected surface water. GDEs have been mapped in the Grapevine Canyon area of the Basin, where groundwater levels typically are shallower than the main Castac Lake area of the Basin. RMW TRC-MW23D is located in the Grapevine Canyon area of the Basin.

The MT for Chronic Lowering of Groundwater Levels considered the groundwater level trends observed in Grapevine Canyon well TRC-MW23D. Although that MT is set at 28 feet below ground surface (ft bgs), below the likely maximum rooting depth of potential GDEs in this area (i.e., 24 ft bgs; see **Table GWC-*6***), groundwater levels in well TRC-MW23D historically have fluctuated between land surface and approximately 24 ft bgs, and the estimated maximum depth to groundwater in TRC-MW23D is 26 ft bgs[57]. Groundwater levels thus are unlikely to decline to the MT depth of 28 ft bgs.

MTs also are considered a *minimum* that water levels should reach, and the GSA will strive to maintain water levels at the Measurable Objectives (MO) which are approximately eight (8) feet higher than the MT in the Grapevine Canyon area of the Basin (i.e., 20 feet bgs), as described in detail in Section 15.1 *Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels*.

As discussed above, in Section *13.6 Undesirable Results for Depletions of Interconnected Surface Water*, the relationship between groundwater elevation and impacts to the potential GDEs is uncertain, as (1) the mixture of different phreatophyte plants at a given time in a given area (and their specific rooting depths) is not well known, and some GDEs can adapt to lowering groundwater levels depending on the speed, magnitude, and longevity of the stress (Rohde et al., 2019), and (2) the interconnected surface water systems within the Basin are affected by variation in natural conditions and precipitation events. Given the observed shallow depths to groundwater in RMW TRC-MW23D, the known range of GDE plant rooting depths, and the maximum water depth allowed by the MTs for Chronic Lowering of Groundwater Levels and Depletion of Groundwater Storage, these MTs also are likely protective of the potential GDEs. MTs specific to Depletions of Interconnected Surface Water therefore are not developed at this time, and MTs for Chronic Lowering of Groundwater Levels are used as proxy.

[57] Using a calculated linear correlation between water levels observed in TRC-MW23D and TRC-PW56A, which has the longest water level record in the Basin.

15. MEASURABLE OBJECTIVES AND INTERIM MILESTONES

§ 354.30. Measurable Objectives

(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.

(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.

This section discusses the development of Measurable Objectives (MO) and Interim Milestones for all relevant Sustainability Indicators for the Basin.

15.1. Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels

15.1.1. Measurable Objectives for Chronic Lowering of Groundwater Levels

The MOs for Chronic Lowering of Groundwater Levels were developed using a similar trendline projection method described in Section *14.1.1* above, which calculated the MO as the Spring 2018 groundwater level minus the change in water levels based on recent trends (2008 – 2018) extended over 10 years. As described in the *Sustainable Management Criteria Best Management Practices* (BMP) document (DWR, 2017), "Measurable Objectives should be set such that there is a reasonable margin of operation flexibility (or 'margin of safety'), between the minimum threshold and measurable objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities" (DWR, 2017).

Therefore, the margin of operational flexibility within the Basin is the difference between the MT and the MO. The MOs and margins of operational flexibility for RMWs within the Basin are shown in **Table SMC-4** below.

Table SMC-4. Measurable Objectives for Chronic Lowering of Groundwater Levels

RMW Name	**Area**	**GSE** (ft msl)	**MO** (ft msl)	**MO** (ft bgs)	**Margin of Operational Flexibility** (ft)
TRC-MW16D	Castac Lake	3,640	3,420	219	75
TRC-MW18D	Castac Lake	3,531	3,411	120	54
TRC-MW23D	Grapevine	3,376	3,356	20	8

Abbreviations:

ft = feet
ft bgs = feet below ground surface
ft msl = feet above mean sea level
MO = measurable objective
RMW = Representative Monitoring Wells

15.1.2. Interim Milestones for Chronic Lowering of Groundwater Levels

Interim Milestones (IMs) for Chronic Lowering of Groundwater Levels are defined herein using a trajectory for groundwater levels based on the current (Spring 2018) levels, the MTs, and the MOs. This trajectory allows for and assumes a continuation of current groundwater level trends for the first 5-year period, a deviation from that trend over the second 5-year period, a recovery to the 5-year IM in the third 5-year period, and recovery towards the MOs over the fourth (last) 5-year period. Specifically, the trajectory for groundwater levels prescribed in the IMs is as follows:

Table SMC-5. Interim Milestone Trajectory for Chronic Lowering of Groundwater Levels

Calendar Year	**Interim Milestone for Chronic Lowering of Groundwater Levels**	**Basis for Interim Milestone**
2020	Not applicable	Not applicable
2025	IM-5	*½ * (GWL$_{Spring2018}$ + MT)*
2030	IM-10	*½ * (IM-5 + MT)*
2035	IM-15	*½ * (IM-10 + MO)*
2040	MO	MO

where:

IM-5, IM-10, and IM-15 are the Interim Milestones for Chronic Lowering of Groundwater Levels after 5 years, 10 years and 15 years, respectively
$GWL_{Spring2018}$ is the measured groundwater elevations in Spring 2018;
MT is the Minimum Threshold for Chronic Lowering of Groundwater Levels (defined previously); and
MO is the Measurable Objective for Chronic Lowering of Groundwater Levels (defined previously)

Interim Milestones for Chronic Lowering of Groundwater Levels are presented in **Table SMC-6**, and are displayed relative to historical water levels at each RMW on **Figure SMC-1**.

Table SMC-6. Interim Milestones for Chronic Lowering of Groundwater Levels

Well Name	Area	Spring 2018 GWE (ft msl)	MO (ft msl)	MT (ft msl)	IM-5 (ft msl)	IM-10 (ft msl)	IM-15 (ft msl)
TRC-MW16D	Castac Lake	3,496	3,420	3,345	3,420	3,383	3,401
TRC-MW18D	Castac Lake	3,464	3,411	3,357	3,411	3,384	3,397
TRC-MW23D	Grapevine	3,363	3,356	3,348	3,356	3,352	3,354

Abbreviations:
ft msl = feet above mean sea level
GWE = groundwater elevation
IM = interim milestone
MO = measurable objective
MT = minimum threshold

15.2. Measurable Objective and Interim Milestones for Reduction of Groundwater Storage

As discussed above, the Undesirable Results definition for Reduction of Groundwater Storage refers to a decrease in storage that would cause water levels to decline below MTs established in RMWs for Chronic Lowering of Groundwater Levels. These two Sustainability Indicators (Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage) are closely linked, as the amount of groundwater in storage is directly related to groundwater levels. Therefore, their MOs also are affected by the same factors and unique MOs for Reduction of Groundwater Storage were not developed. As stated above, the MOs for Chronic Lowering of Groundwater Levels provide an adequate Margin of Operational Flexibility and are used as proxy for the Reduction of Groundwater Storage Sustainability Indicator.

15.3. Measurable Objective and Interim Milestones for Seawater Intrusion

As discussed above in Section *14.3 Minimum Threshold for Seawater Intrusion*, because the Basin is located far inland, away from the ocean, seawater intrusion is not a threat to groundwater resources and the Seawater Intrusion Sustainability Indicator is not applicable. Thus, no SMCs for this Sustainability Indicator are defined in the Basin.

15.4. Measurable Objective and Interim Milestones for Degraded Water Quality

As discussed above in Section 13.4 *Undesirable Results for Degraded Water Quality*, and in Section *14.4 Minimum Threshold for Degraded Water Quality,* groundwater quality monitoring already being conducted as part of other regulatory compliance efforts will continue during GSP implementation, and at present no MOs or MTs currently are defined for Degraded Water Quality.

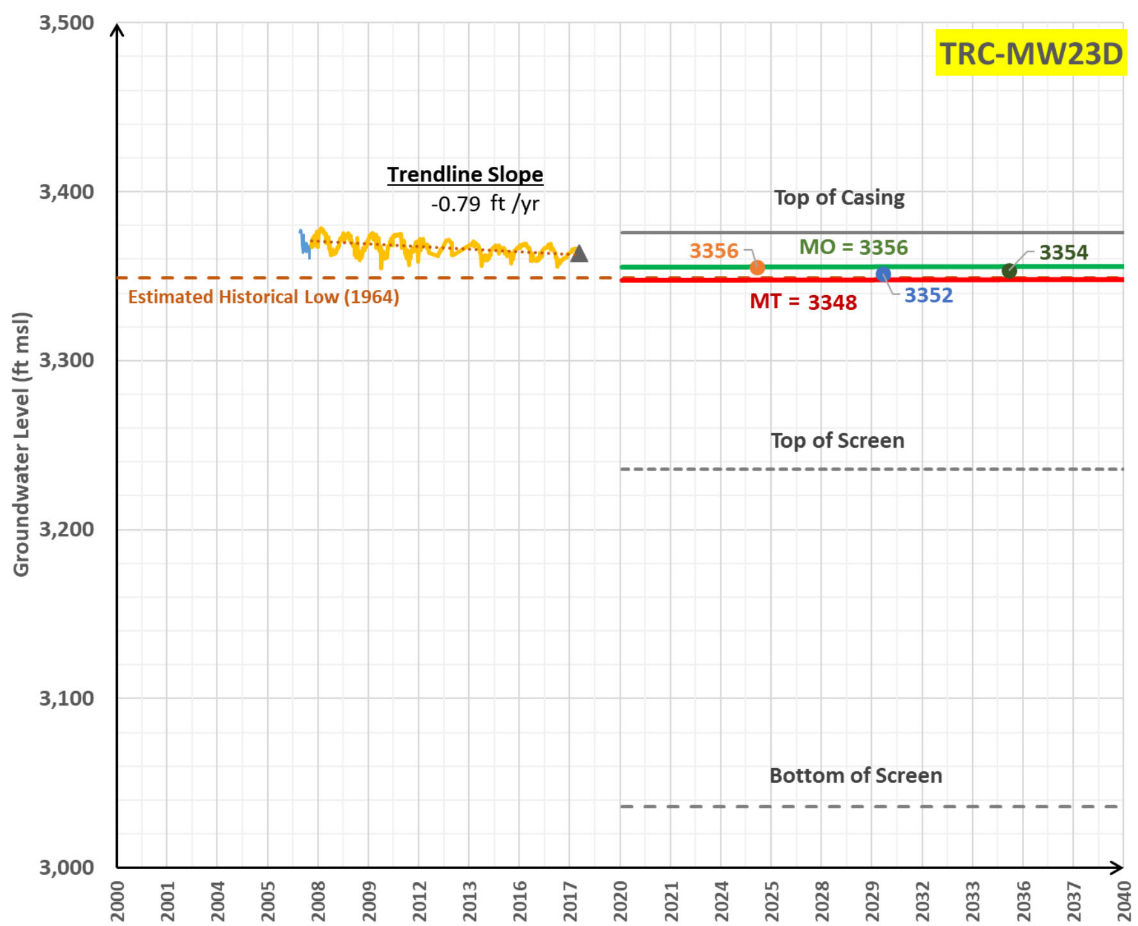
15.5. Measurable Objective and Interim Milestones for Land Subsidence

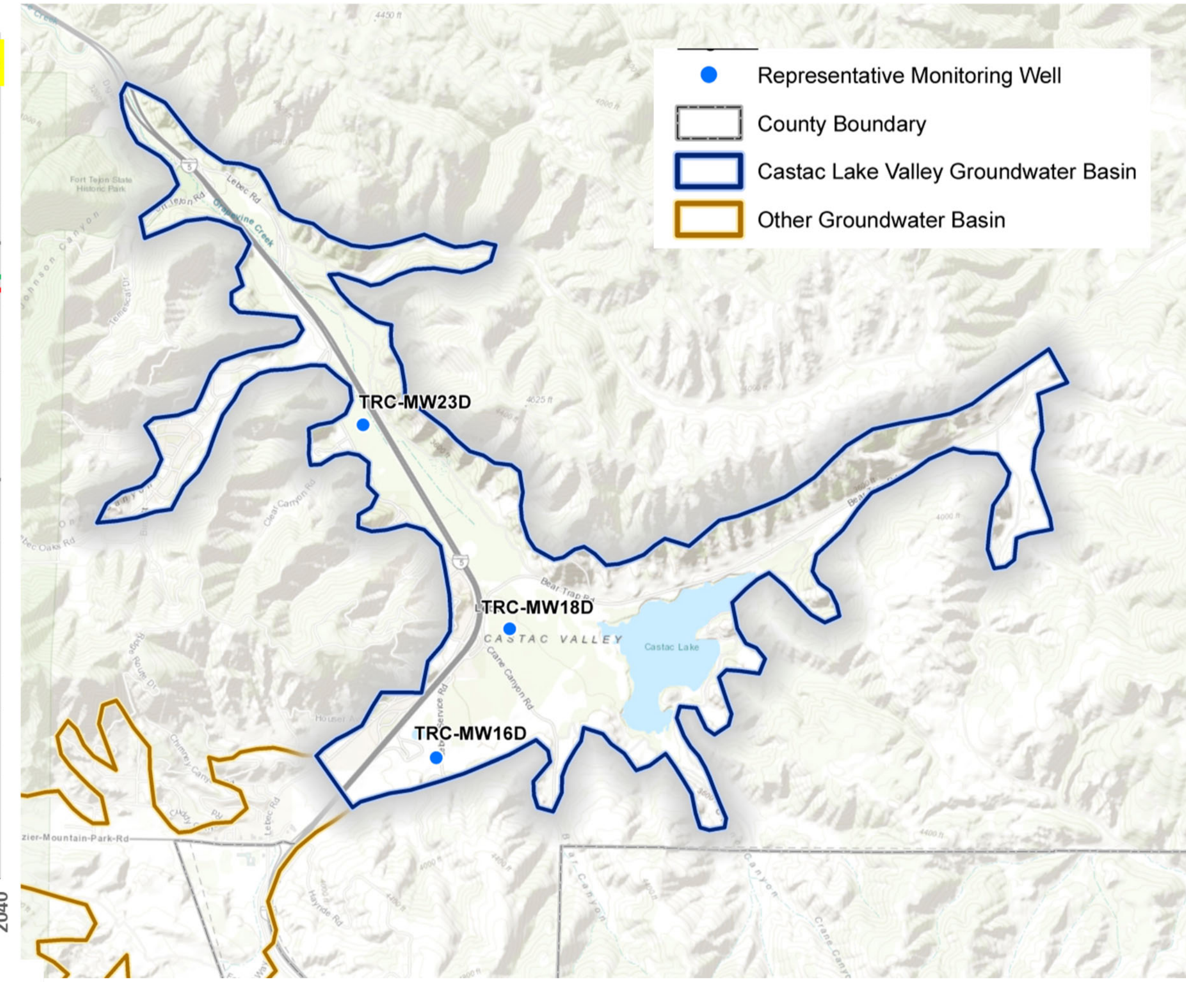
As discussed above in Section 13.5 *Undesirable Results for Land Subsidence*, and in Section *14.5 Minimum Threshold for Land Subsidence,* available data show that land subsidence is not likely to be a significant concern in the Basin. Given the geologic and stratigraphic characteristics of the Basin (a lack of thick clay layers), land subsidence is not known to have occurred and is not likely to occur in the Basin in the future, thus no SMCs are defined for the Land Subsidence Sustainability Indicator.

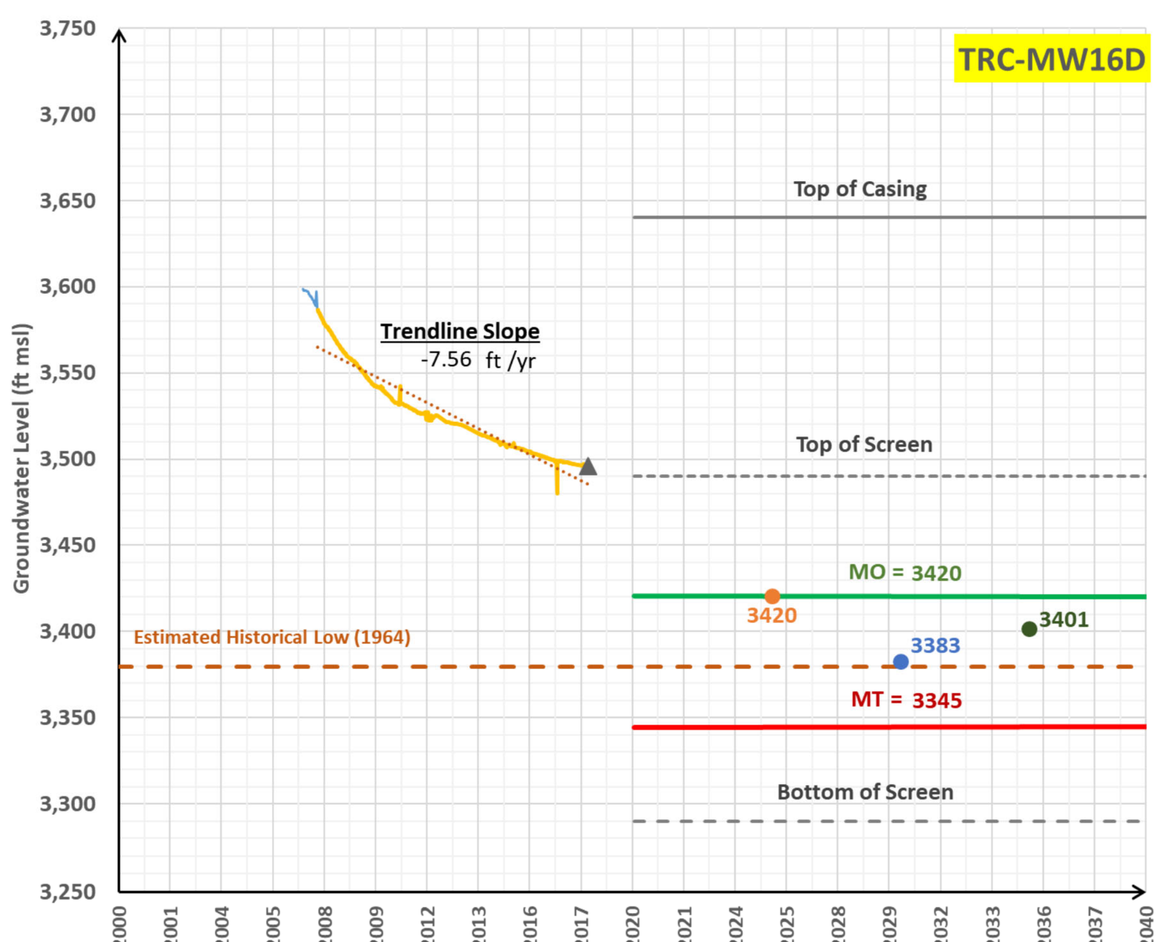
15.6. Measurable Objective and Interim Milestones for Depletion of Interconnected Surface Water

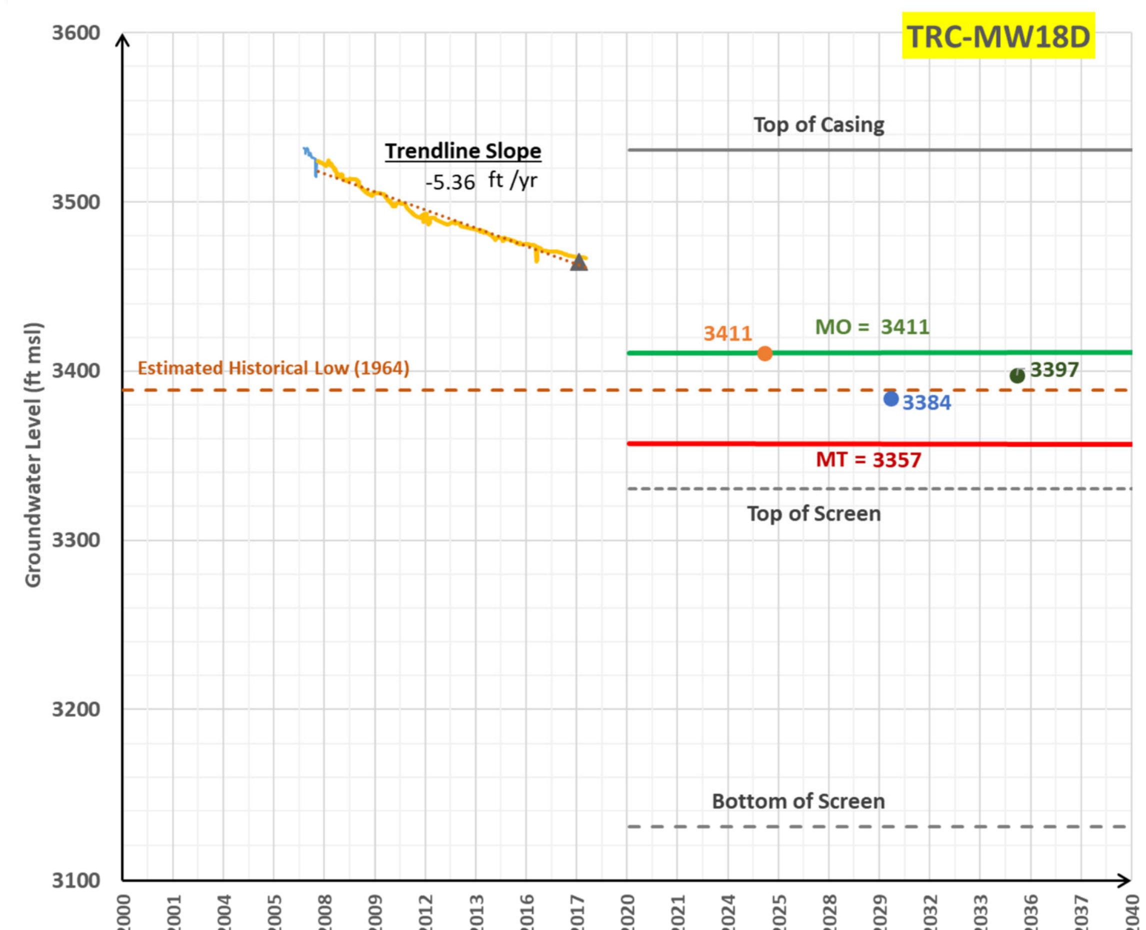
As discussed above in Section *13.6 Undesirable Results for Depletions of Interconnected Surface Water*, based on available data and information, interconnected surface water systems within the Basin are primarily influenced by climate. Potential GDEs have been mapped in both the Grapevine Canyon area of the Basin where groundwater levels are typically shallower and in the main Castac Lake area of the Basin where current groundwater levels exceed 30 feet below ground surface.

As discussed above, the Chronic Lowering of Groundwater Levels metrics will be used as proxy for the Depletions of Interconnected Surface Water Sustainability Indicator. The RMW TRC-MW23D is located in the Grapevine Canyon area of the Basin, and its MO for Chronic Lowering of Groundwater Levels is set at 20 ft bgs. This provides an adequate Margin of Operational Flexibility (i.e., 8 feet) while maintaining groundwater levels above maximum plant rooting depths (i.e., 24 ft bgs; see **Table GWC-6**).









Legend

- Water Level Measurement
- Trend Period
- (Estimated) Historical Low
- Spring 2018 Water Level
- Top of Casing
- Top of Screen
- Bottom of Screen
- MO
- MT
- IM-5
- IM-10
- IM-15
- Linear (Trend Period)

Abbreviation

DWR = California Department of Water Resources

ft msl = ft above mean sea level

ft/yr = ft per year

IM = Interim Milestone

MO = Measurable Objective

MT = Minimum Threshold

Notes

1. All locations are approximate.

Source

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.

2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 March 2020.

Representative Monitoring Well Hydrograph

Castac Basin GSA

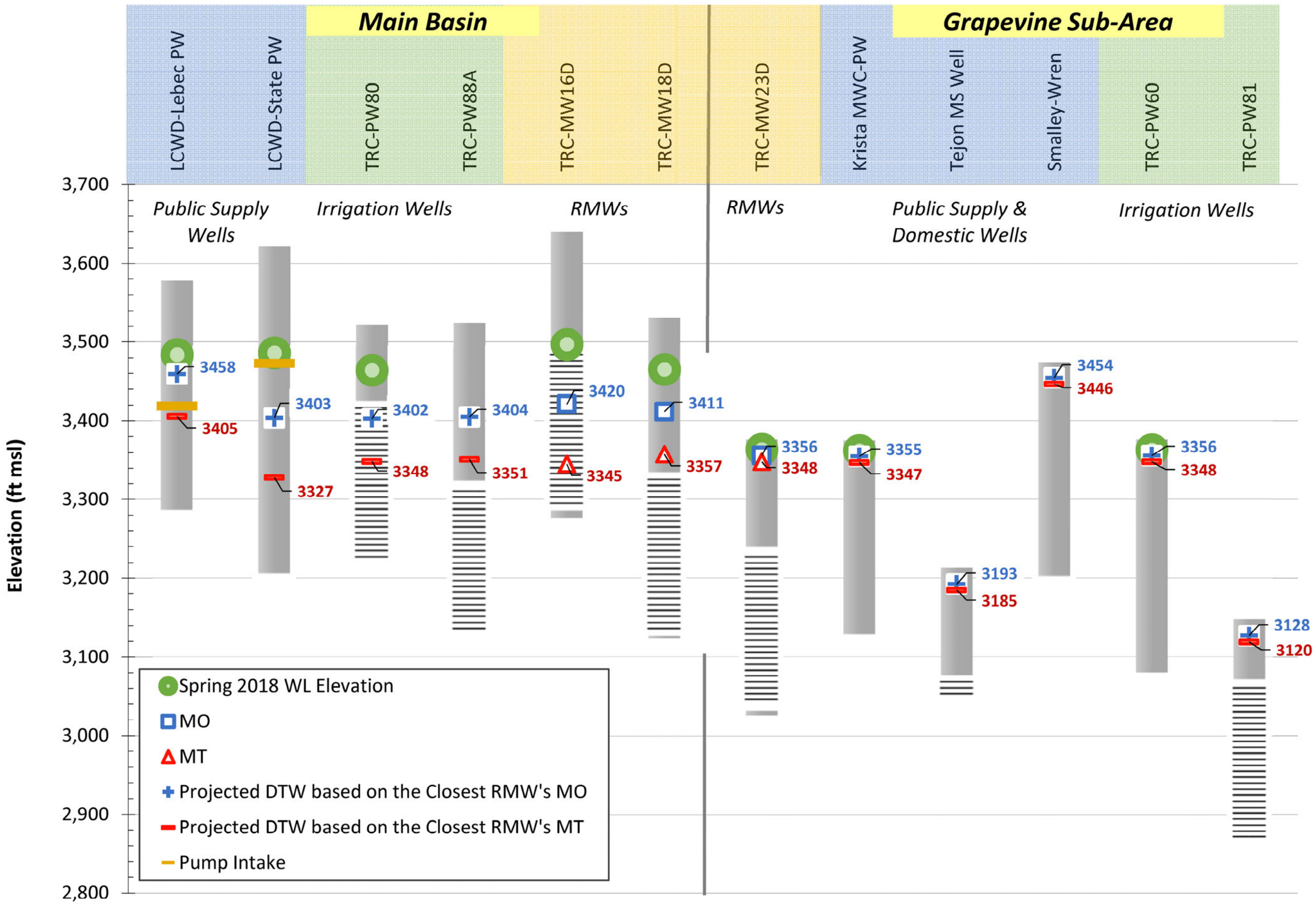
Kern County, California

September 2020

B80048.00

eki environment & water

Figure SMC-1



Fraction of Wells Affected by Water Levels Declining to Sustainable Management Criteria	Top of Screen Dewatered	Bottom of Screen Dewatered
Measurable Objective (MO)	**33%**	**0%**
Minimum Threshold (MT)	**44%**	**0%**

Legend

Blank Casing (or Well with Unknown Screened Interval)

Well Screen Interval

Abbreviations

DTW	= depth to water
ft msl	= feet above mean sea level
RMWs	= Representative Monitoring Wells

Notes

1. The fraction of wells affected shown in the table does not include wells without available screen depth (or pump intake) information.
2. Wells that used RMW TRC-MW18D's SMC information include LCWD-Lebec PW, TRC-PW80, and TRC-PW88A; Well that used RMW TRC-MW16D's SMC information include LCWD-State PW; Wells that used RMW TRC-MW23D's SMC information include Krista MWC-PW, Tejon MS Well, Smalley-Wren, TRC-PW60, and TRC-PW81.

Sources

1. Well information obtained from the Stakeholder Surveys distributed by the Castac Basin GSA in 2018-2019.

Well Construction Schematic and Sustainable Management Criteria

Castac Basin GSA

Kern County, California

September 2020

B80048.00

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Figure SMC-2

MONITORING NETWORK

16. MONITORING NETWORK

§ 354.32. Introduction to Monitoring Networks

This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

This section describes the Monitoring Network designed for the Basin, subsequently referred to as the "Sustainable Groundwater Management Act (SGMA) Monitoring Network." Pursuant to the Groundwater Sustainability Plan (GSP) Emergency Regulations (23-California Code of Regulations [CCR] Division 2 Chapter 1.5 Subchapter 2), the objective of a Monitoring Network is to collect sufficient data for the correct assessment of the Sustainability Indicators relevant to the Basin (see Section 13 *Undesirable Results*), and the impacts to the beneficial uses and users of groundwater.

Per 23 CCR § 354.32(e), the SGMA Monitoring Network incorporates elements from the existing monitoring programs occurring within the Basin (see Section *5.2.1 Existing Monitoring and Management Programs*) and includes additional components to comply with the GSP Emergency Regulations. All monitoring will be performed in accordance with the protocols developed for the Basin, as described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring*.

16.1. Description of Monitoring Network

§ 354.34. Monitoring Network

(a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.

(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

(1) Demonstrate progress toward achieving measurable objectives described in the Plan.

(2) Monitor impacts to the beneficial uses or users of groundwater.

(3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.

(4) Quantify annual changes in water budget components.

…

(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:

(1) Amount of current and projected groundwater use.

(2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.

(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.

(4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

§ 354.34. Monitoring Network

(g) Each Plan shall describe the following information about the monitoring network:

(1) Scientific rationale for the monitoring site selection process.

(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

(i) The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

As discussed in the sections above, Sustainable Management Criteria (SMC) for Chronic Lowering of Groundwater Levels have been established for the Basin and will be used as a proxy for Reduction of Groundwater Storage and Depletion of Interconnected Surface Water. As shown on **Figure MN-1** the Basin's SGMA Monitoring Network includes three water level Representative Monitoring Wells (RMWs). Two water level RMWs (TRC-MW16D and TRC-MW18D) are located in the Castac Lake area of the Basin, and one water level RMW (TRC-MW23D) is located in the Grapevine Canyon area of the Basin.

Pursuant to 23-CCR §354.34(a)-(b), the objective of the SGMA Monitoring Network is to collect data with sufficient temporal frequency and spatial density necessary to evaluate this GSP implementation as it relates to:

- Monitoring short-term, seasonal, and long-term trends in groundwater (see Section *8 Current and Historical Groundwater Conditions*);
- Demonstrating progress toward achieving Measurable Objectives (MOs) described herein (see Section *15 Measurable Objectives and Interim Milestones*);

- Monitoring impacts to the beneficial uses and users of groundwater (see Section *5.5.1 Beneficial Uses and Users of Groundwater*);
- Monitoring changes in groundwater conditions relative to MOs (see Section *15 Measurable Objectives and Interim Milestones*) and Minimum Thresholds (MTs) (see Section *14 Minimum Thresholds*); and
- Quantifying annual changes in water budget components (see Section *9 Water Budget Information*).

The SGMA Monitoring Network, as discussed in more detail below, contains a subset of three RMWs to be monitored for Chronic Lowering of Groundwater Levels. These RMWs (1) were selected from existing monitoring programs active within the Basin (see Section *5.2.1 Existing Monitoring and Management Programs*), (2) are representative of groundwater conditions, (3) are located in proximity to beneficial uses and users of groundwater (e.g., public supply wells, production wells, and potential GDEs), and (4) have SMCs (i.e., MTs, MOs, or Interim Milestones) defined for at least one of the relevant Sustainability Indicators to the Basin (see Section 13 *Undesirable Results*):

- Chronic Lowering of Groundwater Levels;
- Reduction of Groundwater Storage[58] and
- Depletions of Interconnected Surface Water[59].

Pursuant to 23-CCR §354.34(e), water quality data collected from public water systems and reported to the State Water Resources Control Board (SWRCB) Division of Drinking Water Program through the Safe Drinking Water Information System (SDWIS) Drinking Water Watch website[60] will be utilized to supplement the monitoring network to allow for future water quality trend analyses.

Pursuant to 23-CCR §354.34(f), the Monitoring Network for Chronic Lowering of Groundwater Levels consists of three RMWs with sufficient spatial distribution and spatial density. Groundwater elevations in these wells will be measured bi-annually (Spring and Fall) to allow for characterization of groundwater conditions during seasonal highs and lows. These wells are spatially distributed in areas potentially affected by groundwater users in the Basin.

Per 23-CCR §354.34(g), other factors considered in the selection of the RMWs include:

- Availability of existing technical information about the RMW (e.g., well location, construction information, condition, status, etc.);
- Quality and reliability of historical data at the RMW;

[58] Reduction in Groundwater Storage sustainability indicator will be monitored by proxy using groundwater levels.
[59] Depletions of Interconnected Surface Water sustainability indicator will be monitored by proxy using groundwater levels.
[60] https://sdwis.waterboards.ca.gov/PDWW/index.jsp

- "Representativeness" to local groundwater conditions and nearby well populations (per 23-CCR §354.36); and
- Projected availability of long-term access to the RMW.

Table MN-1 summarizes the site type, site count, measured constituent(s), measurement frequency, and spatial density of the SGMA Monitoring Network for each of the relevant Sustainability Indicators mentioned above. Further details about the SGMA Monitoring Network for each Sustainability Indicator can be found in Sections 16.1.1 through 16.1.6.

Table MN-1. Summary of SGMA Monitoring Network

Sustainability Indicator	Site Type	Site Count	Measured Constituent(s)	Measurement Frequency	Spatial Density (# sites / 1 mi^2)[a]
Chronic Lowering of Groundwater Levels	Well	3	Water Level	Semiannually	0.5
Reduction of Groundwater Storage	Well	3	Water Level	Semiannually	0.5
Depletions of Interconnected Surface Water	Well	3	Water Level	Semiannually	0.5

Notes:
(a) Spatial density recommendations by DWR are between 0.2 and ten sites per 100 square miles. As the Basin is less than 6 square miles, one site would meet the density recommendations.

Pursuant to 23-CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols specified for the Basin as described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring*.

16.1.1. Monitoring Network for Chronic Lowering of Groundwater Levels

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:
(A) A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
(B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

The SGMA Monitoring Network for Chronic Lowering of Groundwater Levels consists of three RMWs that will be used to monitor depth to groundwater. SMCs (including MTs, MOs, and Interim Milestones) have been defined for the three RMWs for the Chronic Lowering of Groundwater Levels sustainability indicator in Sections 14.1 and 15.1, respectively. Specific details regarding each of the RMWs are listed in **Table MN-2**.

Table MN-2. Summary of Representative Monitoring Wells

Well ID (1)	Well Use	Well Category	Well Construction Details				Well Location Coordinates				Sustainability Metrics				
			Total Cased Depth (ft bgs)	Top of Screen Depth (ft bgs)	Bottom of Screen Depth (ft bgs)	Casing Diam. (in)	Easting (ft, SP5)	Northing (ft, SP5)	Ground Surface Elevation (ft, NAVD88)	Reference Point Elevation (ft, NAVD88)	Minimum Threshold (ft, NAVD88)	Interim Milestone #1 (5 yr) (ft, NAVD88)	Interim Milestone #2 (10 yr) (ft, NAVD88)	Interim Milestone #3 (15 yr) (ft, NAVD88)	Measurable Objective (ft, NAVD88)
TRC-MW16D	Monitoring	RMW	363	150	350	4	6,301,371.60	2,123,831.62	3639.57	3642.41	3345	3420	3383	3401	3420
TRC-MW18D	Monitoring	RMW	407	200	400	4	6,303,665.92	2,127,862.83	3530.56	3533.31	3357	3411	3384	3397	3411
TRC-MW23D	Monitoring	RMW	350	140	340	4	6,299,092.36	2,134,235.44	3375.97	3378.31	3348	3356	3352	3354	3356
LCWD-Lebec PW	Municipal Supply	SMW	295	160 (2)	295 (2)	10	6,302,890.00	2,125,983.00	3578.00	N/A	N/A	N/A	N/A	N/A	N/A
LCWD-State PW	Municipal Supply	SMW	400	150 (2)	400 (2)	12	6,301,349.00	2,125,385.00	3622.00	N/A	N/A	N/A	N/A	N/A	N/A
TRC-MW3	Monitoring	SMW	50	25	45	N/A	6,304,052.00	2,129,589.00	3504.50	3506.00	N/A	N/A	N/A	N/A	N/A
TRC-MW22	Monitoring	SMW	34	8	34	4	6,302,755.00	2,131,401.00	3473.56	3476.90	N/A	N/A	N/A	N/A	N/A
TRC-PW81	Municipal Supply	SMW	282	80	284	12.75	6,293,141.00	2,142,209.00	3148.00	N/A	N/A	N/A	N/A	N/A	N/A
Fort Tejon Historic Park Well	Municipal Supply	SMW	N/A	N/A	N/A	N/A	6,293,526.00	2,141,858.00	3176.85	N/A	N/A	N/A	N/A	N/A	N/A
Tejon MS Well	Municipal Supply	SMW	N/A	140	166	N/A	6,295,128.00	2,141,376.00	3212.99	N/A	N/A	N/A	N/A	N/A	N/A
Krista MWC-PW	Municipal Supply	SMW	250	168 (2)	250 (2)	12	6,298,354.00	2,134,132.00	3375.00	3405.00	N/A	N/A	N/A	N/A	N/A
TRC-PW60	Municipal Supply	SMW	299	80	284	16	6,299,202.00	2,134,109.00	3375.97	3375.97	N/A	N/A	N/A	N/A	N/A

Notes
(1) Only wells with known perforation depths and recently available data (i.e., water level measurements from 2015 onward) are included.
(2) Top and bottom of screen depth are not available. Pump intake depth is used as top of screen depth and total cased depth is used as bottom of screen depth.

Abbreviations
bgs = below ground surface
CASGEM = California Statewide Groundwater Elevation Monitoring
DWR = California Dep't of Water Resources
ft = feet
in = inches
N/A = not available or not applicable
NAD83 = North American Datum of 1983
NAVD88 = North Am. Vert. Datum of 1988
RMW = Representative Monitoring Well
SMW = Supplemental Monitoring Well
SP5 = Calif. State Plane Coord. Sys., Zone 5, NAD83

Source
Well information is compiled from the Castac Basin Groundwater Sustainability Agency Data Management System.

The RMW site locations and their spatial distributions (**Figure MN-1**) were selected based on the following considerations:

- **Availability of site-specific technical information** – As shown in **Table MN-2**, all three RMWs have known geographic coordinates, ground surface elevations, and reference point elevations surveyed to an accuracy of 0.01-feet. Well construction information, including total well depth and screened intervals, are known and well logs are available for all three RMWs. All three RMWs are dedicated monitoring wells and have been confirmed to be in suitable condition for recording water level measurements.

- **Quality, reliability, and availability of historical data** – Each of the RMWs have been monitored bi-monthly for at least the past ten years as part of Tejon Ranch Corporation (TRC)'s routine water level monitoring, and have associated water level records spanning back at least ten years.

- **"Representativeness" to local groundwater conditions** – The Castac Lake area of the Basin shows greater groundwater level fluctuations compared to the Grapevine Canyon area of the Basin. As such, two RMWs are located in the Castac Lake area and one RMW is located within the Grapevine Canyon subarea of the Basin (see **Figure MN-1**).

- **Proximity to beneficial uses and users of groundwater** – RMWs in both areas of the Basin were selected based on their proximity to public supply wells. As shown on **Figure MN-1**, TRC-MW16D and TRC-MW18D are located in the vicinity of both Lebec County Water District (LCWD)'s public supply wells, which provide drinking water to the Disadvantaged Community (DAC) of Lebec. Furthermore, TRC-MW23D is located near both the Krista Mutual Water Company (KMWC) public supply well, which supplies drinking water to O'Neil Canyon residents and TRC-PW60, which supplies drinking water to the TRC headquarters, and potential GDEs located in Grapevine Canyon.

- **Aquifer characteristics** – There is only one Principal Aquifer defined for the Basin, with shallow aquifer and deep aquifer zones. The three RMWs are screened in the deep aquifer zone, similar to the production wells in the Basin.

As discussed in Section *8.2 Groundwater Elevations and Flow Direction*, groundwater flow direction in the Castac Lake and Dryfield Canyon areas of the Basin are predominantly towards Castac Lake. Groundwater then flows northwest down through Grapevine Canyon. Given the location of the three RMWs, groundwater depths and flow directions can be understood through analysis of data collected using the SGMA Monitoring Network.

<u>Monitoring Well Density</u>

According to California Department of Water Resources' (DWR) "Best Management Practices #2 – Monitoring Network and Identification of Data Gaps" (DWR, 2016c), monitoring well density should be between 0.2 and ten wells per 100 square miles. The SGMA Monitoring Network is compliant with these criteria, having three RMWs per 5.5 square miles.

Monitoring Schedule

Water levels will be measured bi-annually (Spring and Fall) to document seasonal fluctuations in groundwater levels, among other things. Specifically, Spring levels will be measured in March to represent a seasonal high prior to summer irrigation demands. Fall levels will be measured in October to represent a seasonal low after the summer irrigation demands. All RMWs will be monitored in accordance with the monitoring protocol described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring*. All data will be reported to DWR per the requirements specified under Section *17116.5 Reporting Monitoring Data to the Department*.

16.1.2. Monitoring Network for Reduction of Groundwater Storage

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage

As described in Sections *14.2* and *14.2.2*, the criteria used to define Undesirable Results for Reduction of Groundwater Storage are the MTs established for Chronic Lowering of Groundwater Levels. As such, the SGMA Monitoring Network for Reduction of Groundwater Storage will be comprised of the same RMWs described in Section *16.1.1 Monitoring Network for Chronic Lowering of Groundwater Levels*. The information collected from this SGMA Monitoring Network will be sufficient to estimate the annual change of groundwater in storage.

16.1.3. Monitoring Network for Seawater Intrusion

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.

…

(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

As described in Section *13.3 Undesirable Results for Seawater Intrusion*, seawater intrusion is not present and not likely to occur within the Basin; therefore, the Seawater Intrusion Sustainability Indicator is not applicable and no Undesirable Results for this Sustainability Indicator are defined for the Basin. As such, per the stipulations defined under 23-CCR §354.34(j), a monitoring network has not been defined for the Seawater Intrusion Sustainability Indicator.

16.1.4. Monitoring Network for Degraded Water Quality

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

As described in Section *13.4 Undesirable Results for Degraded Water Quality*, limited data for groundwater quality are available to assess the relationship between water quality and water levels in the Basin. Furthermore, water management actions legally available to the Castac Basin GSA are likely to have only limited effects on groundwater quality conditions within the Basin. Therefore, Undesirable Results for Degraded Water Quality are not defined currently in this GSP and a dedicated monitoring network for the purposes of assessing SMCs for Degraded Water Quality Sustainability Indicated has not been defined.

The public water system wells in the Basin are shown on **Figure MN-1.** Public water systems are subject to water quality monitoring requirements under the SWRCB Drinking Water Program. Water quality results and monitoring schedule are reported to the SWRCB and made publicly available through the Safe Drinking Water Information System (SDWIS) Drinking Water Watch website. Data from the SDWIS portal will be assembled and analyzed to allow for future water quality trend analyses.

Benefits of using public water system wells to aid in future analyses include: (1) public water systems consider the groundwater quality of the beneficial users of groundwater, (2) public water systems are required to sample for constituents of health concern, (3) public water system wells are pumped regularly and the water being sampled is representative of the formation water, and (4) public water system wells are well-distributed throughout the Basin.

Furthermore, water quality samples will be collected from selected monitoring wells in Grapevine Canyon (such as TRC-MW3 and TRC-MW22) to establish a current groundwater quality baseline in the shallow aquifer zone in areas of potential GDEs.

16.1.5. Monitoring Network for Land Subsidence

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

As mentioned in Section *8.6 Land Subsidence* no significant subsidence has been historically observed within the Basin based on available data. Therefore, no Undesirable Results for the Subsidence Sustainability Indicator are defined for the Basin. As such, per the stipulations defined under 23-CCR §354.34(j), a Monitoring Network has not been defined for the Land Subsidence Sustainability Indicator.

16.1.6. Monitoring Network for Depletions of Interconnected Surface Water

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:
(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.
(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

The SGMA Monitoring Network for Depletions of Interconnected Surface Water Sustainability Indicator is comprised of the same RMWs described in Section *16.1.1 Monitoring Network for Chronic Lowering of Groundwater Levels*. The three water level RMWs are located in close proximity to the potential interconnected surface water systems within the Basin. Specifically, RMW TRC-MW23D is located adjacent to Grapevine Creek in an area that has historically supported GDEs, RMW TRC-MW16D is located near Cuddy Creek, and RMW TRC-MW18D is located downgradient to Castac Lake. Specific details regarding the monitoring wells are listed in **Table MN-2** and the RMW locations are displayed on **Figure MN-1**. All RMWs will have groundwater level measurements collected semi-annually in accordance with the monitoring protocol described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring.*

16.2. Monitoring Protocols for Data Collection and Monitoring

> *§ 352.2. Monitoring Protocols*
> *Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:*
>
> *(a) Monitoring protocols shall be developed according to best management practices.*
>
> *(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department,or may adopt similar monitoring protocols that will yield comparable data.*
>
> *(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.*

Pursuant to 23-CCR § 354.34(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols developed by the Castac Basin Groundwater Sustainability Agency (GSA). Protocols for data collection detailed below are compatible with DWR's guidance document *Groundwater Elevation Monitoring Guidelines* (DWR, 2010) for water level monitoring. Water levels should be collected from RMWs and reported annually to DWR. Well-water samples will be collected to establish current baseline conditions, as necessary.

16.2.1. Protocols for Groundwater Level Measurements

Groundwater level measurements shall be collected semi-annually (Spring and Fall) to document seasonal fluctuations in groundwater levels. Specifically, Spring levels will be measured in March and Fall levels will be measured in October. The following data collection protocols should be followed by the field technician:

- Upon arrival at the site, the field technician shall fill out a "Well Data Collection Form" which documents the date and time, condition at the well, and depth to groundwater measurement.
- Depth to groundwater shall be measured in feet, using an electric or acoustic sounder or datalogging pressure transducer. Data shall be recorded to the nearest 0.01 feet, if possible, given the resolution of the equipment used and the depth to water.
- Depth to groundwater shall be measured from a specific, easily identifiable, and clearly marked Reference Point on the well casing. The three RMWs were surveyed in February and April 2007 in which the elevation of the Reference Point (i.e., Reference Point Elevation [RPE]) was marked and surveyed relative to the North American Vertical Datum of 1988 (NAVD88) to an accuracy of 0.01 foot.
- Groundwater elevation (GWE) shall be calculated as GWE = RPE – depth to groundwater.
- Records of data collected shall be archived within the Castac Basin Data Management System (DMS), as described in Section *16.2.3* below.

16.2.2. Protocols for Water Quality Sampling

General steps for water quality sampling include depth to groundwater measurement prior to purging, multi-meter calibration, purging the well casing, water quality sample collection in lab-specified bottles, and following standard chain-of-custody guidelines for sample preservation and transport. The following data collection protocols should be followed by the field technician:

- A "Sampling Log" shall be completed for each sampling site which documents the date and time, condition at the well, and depth to groundwater measurement, at minimum.
- Ideally, a multi-meter shall be used to collect field parameters prior to sample collection. As applicable, multi-meter probes shall be calibrated per manufacturer specifications using standards closest to that of the anticipated well-water.
- Production wells shall be sampled while the well pump is running, with well-water collected from a spigot near the well-head. Monitoring wells shall be purged and sampled using a submersible pump or bailer. If applicable, field parameters shall be monitored using a multi-meter and flow cell during purging. Field parameters shall be allowed to stabilize during purging so that variation of each parameter is within appropriate pre-defined limits in three successive measurements collected at least three minutes apart.
- Prior to collection, new sample bottles appropriate to each analysis shall be obtained from the analytical lab contracted for chemical analysis. Each sample bottle shall be clearly labeled after sampling with the site identifier, date and time of sample collection.
- Based on the sampled constituent, water quality sample collection shall follow specific processing and treatment guidelines to assure the accuracy of the data.
- After collection, all sample bottles shall immediately be dried, labeled, sealed in zip-closure polyethylene bags, and placed on ice in an insulated cooler for temporary storage and transport to the analytical lab. All samples shall be delivered to the laboratory following standard chain-of-custody control guidelines within their prescribed holding times.
- Field duplicates monitor sample and laboratory consistency. One duplicate sample shall be collected for quality assurance purposes. Duplicate samples will be collected, processed, and analyzed in the field using the same methodology for the primary sample, with an assigned a dummy site identifier.
- One field blank sample shall be collected for quality assurances purposes. Field blank samples will be collected using deionized water, processed in the field, and then submitted to the laboratory with a dummy site identifier.
- Records of constituent concentrations shall be archived within the Castac Basin DMS, as described in Section *16.2.3* below.

16.2.3. Protocols for Data Reporting

Records of all data collected will be maintained in the Castac Basin DMS. Prior to importation, standard quality assurance and quality control (QA/QC) checks will be undertaken to help ensure the validity and accuracy of data.

- Depth to groundwater measurements shall be converted to groundwater elevation by subtracting the depth to groundwater from the reference point elevation following the protocols for groundwater level measurements described above.
- Groundwater elevation shall be plotted on individual well hydrographs. Groundwater elevations which vary by more than 20 feet between semi-annual measurements shall be flagged as questionable due to a high rate of change.
- Laboratory reports shall be checked to ensure all samples were analyzed within the prescribed holding times.
- Laboratory reports shall be checked to ensure all laboratory blank analyses were determined acceptable by the laboratory.
- Constituent detections in the field blank shall be tabulated and compared to their respective practical quantitation limit.
- Field duplicate results shall be compared to the main sample results. Ideally, concentrations should agree within 10% or have differences within their respective practical quantitation limit. If concentrations exceed by more than 25%, the GSA may ask the laboratory to re-run the constituent to confirm the result is reasonable.
- Major cations and anions represent a positive and negative charge, respectively, and therefore the sum of cations should equal the sum of anions in neutral groundwater. An anion-cation charge balance shall be calculated for each sample collected using concentrations of the major anions and cations in milliequivalents per liter (meq/L), with the difference between the two sums reported as a percentage where:

  $$\frac{Anions - Cations}{Anions + Cations} \times 100$$

  In general, a 5% percent difference is acceptable. Deviations can be greater if other constituents in the groundwater are not accounted for within the major anions and cations categories. If the anion/cation charge balance exceeds 15%, the GSA may ask the laboratory to re-run certain constituents or the entire sample to confirm the result is reasonable.
- TDS concentrations shall be plotted on individual well chemographs to ensure concentrations are reasonable.

After QA/QC, all data collected shall be imported into the Castac Basin DMS. Data will also be integrated into Annual Reports, as required by DWR, and will be uploaded to the SGMA data portal. Per the GSP Emergency Regulations (23-CCR § 352.4), the following reporting standards apply to all categories of information, unless otherwise indicated:

- Water volumes shall be reported in acre-feet (AF).
- Surface water flow shall be reported in cubic feet per second (cfs) and groundwater flow shall be reported in acre-feet per year (AFY).
- Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to seven decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

16.3. Representative Monitoring

§ 354.36. Representative Monitoring
Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:

(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.

(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

(1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

(2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

As described in Section *15316.1 Description of Monitoring Network*, the Basin has defined a SGMA Monitoring Network for each relevant Sustainability Indicator to the Basin that will be used for SGMA reporting purposes to evaluate Plan implementation with respect to meeting the Sustainability Goal defined for the Basin through compliance with the MTs and MOs described herein.

As described in Sections *16.1.2* and *16.1.6*, the Monitoring Network for Chronic Lowering of Groundwater Levels will be used as a proxy to monitor the Reduction in Groundwater Storage and Depletions of Interconnected Surface Water Sustainability Indicators. As described in Sections *14.2* and *14.6* groundwater levels are considered sufficiently protective of Reduction in Groundwater Storage and Depletions of Interconnected Surface Water, and thus no SMCs have been separately defined for these Sustainability Indicators.

As shown on **Figure MN-1**, the RMWs for Chronic Lowering of Groundwater Levels include:

- **TRC-MW16D** is a dedicated monitoring well with known well construction and location information; is near LCWD's public supply wells, the upgradient basin boundary, and Cuddy Creek; and has consistent groundwater level measurements over the last 12 years. This well will provide adequate monitoring of groundwater levels in the main Castac Lake area of the Basin near wells used for beneficial uses. This well also provides the ability to collect water level data near the boundary with the sole adjoining basin (the Cuddy Canyon Valley Basin, located upgradient of the Castac Basin), which allows monitoring of future water level and groundwater storage trends at their common boundary. Thus, potential adverse effects on the upgradient basin due to groundwater management practices in the Basin can be monitored using the RMWs.

- **TRC-MW18D** is a dedicated monitoring well with known well construction and location information; is located in the center of the Basin and is screened at depths similar to nearby domestic production wells; and has consistent groundwater level measurements over the last 12 years. This well will provide adequate monitoring of groundwater levels in the main Castac Lake area of the Basin and help quantify any potential changes in groundwater gradients when used concurrently with the groundwater level measurements obtained from TRC-MW16D.
- **TRC-MW23D** is a dedicated monitoring well with known well construction and location information; is near Krista Mutual Water Company (KMWC)'s and TRC's public supply wells; is located partway down the Grapevine Canyon area of the Basin, in an area that has historically supported GDEs; and has consistent groundwater level measurements over the last 12 years. This well will provide adequate monitoring of groundwater levels in the Grapevine Canyon area of the Basin near wells used for beneficial uses and in areas that have historical supported beneficial users of groundwater (e.g., GDEs).

Additionally, water quality data collected from public supply wells (Krista MWC-PW, LCWD-Lebec PW, LCWD-State PW, Tejon MS Well, TRC-PW60, TRC-PW81, W0601500415_1500415-003, and W0601510301_1510301-001) will be used to inform trend analyses for the Degraded Water Quality Sustainability Indicator.

16.4. Assessment and Improvement of Monitoring Network

§ 354.38. Assessment and Improvement of Monitoring Network

(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.

(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

(1) The location and reason for data gaps in the monitoring network.

(2) Local issues and circumstances that limit or prevent monitoring.

(d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

(1) Minimum threshold exceedances.

(2) Highly variable spatial or temporal conditions.

(3) Adverse impacts to beneficial uses and users of groundwater.

(4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

16.4.1. Review and Evaluation of the Monitoring Network

Per the GSP Emergency Regulations (23-CCR § 354.38), the SGMA Monitoring Network will be reevaluated in each five-year GSP update, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the Sustainability Goal for the Basin (23-CCR § 354.38(a)), and will be adjusted, as necessary.

16.4.2. Identification and Description of Data Gaps

Available information for each RMW is shown in **Table MN-2**. The RMWs conform to DWR's BMPs for monitoring networks (DWR, 2016c) and have all required information to become integrated into the SGMA Monitoring Network.

Data collected from public water system wells and reported to the SWRCB will be downloaded from the SDWIS portal and compiled to supplement trend analyses for the Degraded Water Quality Sustainability Indicator. Five out of the eight public water system wells supplementing the RMWs for Degraded Water Quality are currently missing accurate spatial location information and well screen interval information.

As identified in Section *9.5 Water Budget Uncertainty and Limitations*, upgradient groundwater inflow is a source of uncertainty in the historical and future projected water budgets. Quantifying groundwater inflow via gradients between monitoring wells located up- and down-gradient of the boundary would help quantify the Basin's water budget.

Stream gaging data is currently unavailable for Cuddy Creek and Grapevine Creek. The stream gage on Cuddy Creek at Lebec is operated by Kern County, but only measures the peak seasonal flow and is not capable of recording real time flow or stage data.

16.4.3. Description of Steps to Fill Data Gaps

The Castac Basin GSA has proposed a plan to fill the data gaps associated with the upgradient groundwater inflow by installing a new monitoring well to monitor groundwater levels and enable a better quantification of the groundwater gradient near the Basin boundary.

16.4.4. Monitoring Frequency and Density of Sites

Groundwater level data will be collected from RMWs semi-annually, in compliance with the applicable monitoring protocols outlined in Section *16.2 Monitoring Protocols for Data Collection and Monitoring* above. The SGMA Monitoring Network developed for each Sustainability Indicator includes a sufficient frequency to meet the monitoring objectives outlined in Section *16.1 Description of Monitoring Network*

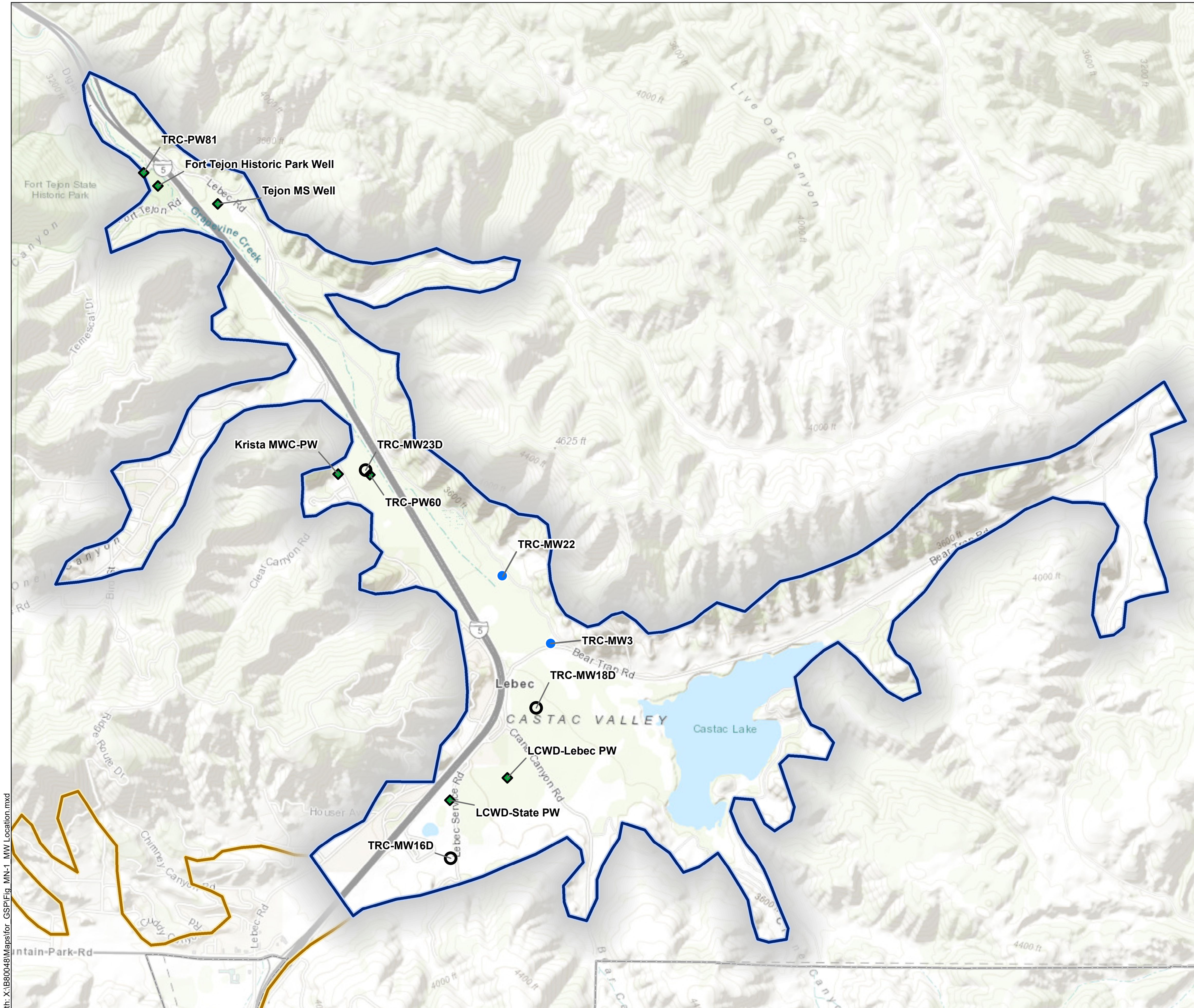
According to DWR's *Monitoring Network and Identification of Data Gaps* BMP (DWR, 2016c), monitoring well density should be between 0.2 and ten wells per 100 square miles. As Castac Basin is only 5.5 square miles, one RMW would be compliant with these criteria. However, based on the spatial distribution of production wells and groundwater level characteristics in the Basin, the GSA found it appropriate to establish three RMWs for the Chronic Lowering of Groundwater Levels Sustainability Indicator. Therefore, the density of RMWs is over 50 times that recommended by DWR.

16.5. Reporting Monitoring Data to the Department

§ 354.40. Reporting Monitoring Data to the Department

Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

Data collected from the SGMA Monitoring Network will be uploaded to the Castac Basin DMS and reported to DWR in accordance with applicable monitoring and reporting protocols (see Section *16.2 Monitoring Protocols for Data Collection and Monitoring* above). Additional data collected as part of other regular monitoring programs within the Basin (i.e., water quality sampling as reported to the SWRCB) will be used in conjunction with data collected from the SGMA Monitoring Network to meet compliance with GSP regulations associated with Annual Reporting (23-CCR §356.2) or as otherwise deemed necessary.



Legend

- Water Level Representative Monitoring Well
- Supplemental Monitoring Well
- Public Supply Well
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Water quality data monitored by public supply wells as part of their compliance with the Division of Drinking Water will be compiled to support the water quality data analysis.
3. Supplemental Monitoring Well will be monitored to establish water quality baseline conditions.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 10 March 2020.

N

0 0.5 1

(Scale in Miles)

Monitoring Network Well Locations

Castac Basin GSA
Kern County, California
September 2020
B80048.00
Figure MN-1

eki environment & water

Path: X:\B80048\Maps\for_GSP\Fig_MN-1_MW Location.mxd

PROJECTS AND MANAGEMENT ACTIONS

17. PROJECTS AND MANAGEMENT ACTIONS

§ 354.42. Introduction to Projects and Management Actions
This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.

Pursuant to the Groundwater Sustainability Plan (GSP) Emergency Regulations, this section presents the Projects and Management Actions (P&MAs) proposed to support achievement of the sustainability goal within the Castac Lake Valley Basin (Basin) (23-California Code of Regulations [CCR] § 354.42). To the extent that information was available, the P&MAs presented herein were developed by the Castac Basin Groundwater Sustainability Agency (GSA) with consideration of feasibility, costs and benefits. However, it is anticipated that some P&MAs will require further evaluation (e.g., engineering, economic, environmental, legal, etc.) prior to implementation.

This section first presents the goals and objectives of the P&MAs, including the relevant Sustainability Indicators they address and the categories of expected benefits. A list of specific P&MAs grouped by benefit category and type is presented, and provided in **Table PMA-1** (detailed P&MA Information Forms are included in Appendix *J*). This section also includes a discussion of how the P&MAs are anticipated to address Undesirable Results; a description of the various potentially applicable permitting and regulatory requirements; a discussion of the P&MA status and implementation timeline; a discussion of the expected benefits or how expected benefits will be evaluated; a description of the sources of water that will support P&MA implementation; a discussion of the legal authority required to implement the P&MAs; and a summary of estimated P&MA costs and how the GSA plans to fund PM&A implementation.

17.1. Goals and Objectives of Projects and Management Actions

17.1.1. Relevant Sustainability Indicators

Per the GSP Emergency Regulations, GSPs must include P&MAs to address any existing or potential future Undesirable Results for the identified relevant Sustainability Indicators (23-CCR § 354.44). As discussed in Sections *13, 14, 15,* and *16*, the relevant Sustainability Indicators in the Basin include: (1) Chronic Lowering of Groundwater Levels, (2) Reduction of Groundwater Storage, and (3) Depletions of Interconnected Surface Water. Because groundwater levels, groundwater storage, and interconnected surface water are directly correlated, P&MAs that address groundwater levels also address groundwater storage and interconnected surface water, and the three Sustainability Indicators are considered together in this discussion of P&MAs.

17.1.2. Benefit Categories

The primary water management "tools" by which GSAs can address conditions that may lead to Undesirable Results associated with water quantity (i.e., Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage) pertain to management of inflows (supplies) and outflows (demands). Therefore, the primary categories of expected benefits for these water quantity-related P&MAs include: (1) water supply augmentation, and (2) water demand reduction.

All of the P&MAs that have water quantity-related benefits are in the water supply augmentation category. In addition, some of the P&MAs also have secondary benefits, including:

1) Flood control;
2) Water management flexibility/efficiency;
3) Water quality improvements; and
4) Improved data collection for ongoing reporting compliance and water budget quantification.

17.2. List of Projects and Management Actions

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

This section provides a list of the six P&MAs identified to date by the Castac Basin GSA. Details of the P&MAs are provided in **Table PMA-1** and in the P&MA forms included in Appendix *J*. **Figure PMA-1** shows the approximate locations of these P&MAs within the Basin. The P&MAs are classified into six types based on the mechanism by which the primary benefit is achieved.

The P&MAs listed below have supply augmentation as their primary expected benefit:

- Enhanced Recharge: The *Aquifer Replenishment Project* (P&MA #1) consists of importing surface water through TCWD's Bear Trap turnout on the California Aqueduct to maintain Castac Lake initially at a lake depth of eight to ten feet (stage of 3,493 to 3,495 feet above mean sea level, ft msl). As discussed in more detail in Section *17.8 Expected Benefits*, based on future projected scenarios using the Castac Basin Numerical Model, it is estimated that P&MA #1, if implemented as modeled, could increase groundwater recharge to the Basin by an average of 70 to 100 acre-feet per year (AFY). This lake management scenario has been modeled assuming that surplus imported surface water supplies remain available. However, the effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed.

- Manage and/or Capture Floodwater: The *Cuddy Creek Bank Modifications Project* (P&MA #2) would entail modifying the bank of Cuddy Creek to retain floodwaters for a longer stretch of creek, thereby increasing the likelihood for groundwater recharge, subject to constraints of permitting and (as required by SGMA) in accordance with applicable water rights. The potential volumetric benefits of this project have not yet been quantified.

- Increase Delivery Flexibility: The *Krista Mutual Water Company (KMWC) Emergency Interconnect with Lebec County Water District (LCWD)* (P&MA #3) is an infrastructure project which would connect the LCWD and KMWC distribution systems so that KMWC could utilize groundwater pumped from the LCWD wells if KMWC is unable to utilize their existing public supply well. This project does not generate additional supply, but does increase water supply reliability for LCWD and KMWC and provide flexibility for shifting demands within the Basin in the event that Undesirable Results are observed.

- Develop New Supplies: The *Wastewater Reclamation Project* (P&MA #4) will combine future, highly-treated reclaimed water produced from the Tejon Mountain Village (TMV) development with imported surface water (as needed) to maintain Castac Lake levels and meet some landscape irrigation demands. The volumetric benefits to the aquifer would be similar to those of PM&A #1; this project just would reduce the demand for imported surface water through the use of recycled water.

Some P&MAs are anticipated to have other expected benefits, including:

- Water Quality Improvements: The *Frazier Mountain High School Water Project* (P&MA #5) aims to improve the drinking water quality delivered to Frazier Mountain High School, which has high uranium concentrations, by serving the high school with groundwater pumped from a planned new LCWD well located within the Basin.

- Improved data collection for ongoing reporting compliance and water budget quantification: The Management Action *Well Metering and Data Collection* (P&MA #6) entails installing meters on supply wells within the Basin and regularly collecting pumping data from those wells. Improved estimates of groundwater extraction in the Basin will aid in quantifying any relationships between groundwater use, groundwater levels, and groundwater quality, as well as provide the necessary information for annual reporting required under CCR § 356.2(b)(2). Metering pumping of wells under this project would not supersede existing requirements for metering and reporting pumping, water quality, and other data at municipal production wells in the Basin. De minimis users (i.e., those pumping 2 AFY or less) would be exempt from metering requirements.

Table PMA-1. Details of Projects and Management Actions

P&MA Name	Summary Description	Relevant Sustainability Indicators Affected: Groundwater Levels & Storage	Groundwater Quality	Interconnected Surface Water	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation
Projects to Enhance Recharge									
#1 - Aquifer Replenishment Project	Castac Lake to be maintained initially at a lake depth of approximately 8 to 10 feet (stage of 3,493 to 3,495 ft msl) via imported surface water deliveries to the lake, subject to imported surface water availability.	x	TBD	x	Upon initiation of TMV Phase 1 construction	Will be dependent on Permitting and Regulatory Process Requirements	Possibly CEQA/NEPA/CDFW/U.S.FWS/ USACE/SWPPP	Not yet initiated	Upon initiation of TMV Phase 1 construction; estimated 2023
Projects to Manage and/or Capture Floodwater									
#2 - Cuddy Creek Bank Modifications	The banks of Cuddy Creek would be modified to increase floodwater and stormwater recharge during wet years.	x	TBD	x	TBD based on future Basin groundwater levels	Will be dependent on Permitting and Regulatory Process Requirements	Water rights permitting; possibly CDFW Lake and Streambed Alteration Agreement; CEQA/NEPA/USACE/U.S.FWS	Not yet initiated	Decision by the LCWD and Castac Basin GSA Board
Projects to Increase Delivery / Flexibility									
#3 - Krista Emergency Interconnect with LCWD	Construction of new intertie between LCWD and KMWC to facilitate water exchanges between the two public water systems in emergency situations.		x		Underway	Consistent with Permitting and Regulatory Process Requirements	Construction permits, CEQA compliance	Initiated in 2019	Underway
Projects to Develop New Supplies									
#4 - Wastewater Reclamation	Future highly-treated reclaimed water produced from the TMV development will be used to maintain Castac Lake levels and meet some landscape irrigation demands.	x		x	Upon initiation of TMV Phase 1 construction	Will be dependent on Permitting and Regulatory Process Requirements	SWRCB Waste Discharge Requirements; Possibly CEQA/NEPA/CDFW/U.S.FWS/ USACE/SWPPP	Not yet initiated	Upon completion of TMV Water Resources Recovery Facility; estimated 2023 to 2026
Projects to Improve Drinking Water Quality									
#5 - Frazier Mountain High School Water Project	LCWD to provide drinking water to FMHS (FMHS well is in violation of uranium levels and has been ordered by the state to find another source) by annexing and supplying FMHS with 2.5 million gallons of drinking water per year from the new LCWD well planned in the Basin.		x		Upon receipt of grant funding	Will be Dependent on Permitting and Regulatory Process Requirements	Title 22 Standards, construction permit, encroachment permit and transport, CEQA mitigated negative declaration	Not yet initiated	Upon receipt of grant funds
Management Action / Improved data collection for ongoing reporting compliance and water budget quantification									
#6 - Well Metering and Data Collection	At the GSA's direction, groundwater extractors shall determine and report monthly pumping volumes using equipment and methods approved by the GSA, in a format satisfactory to the GSA. For individual wells in which meters are not installed, or monthly extraction volumes are not recorded or available, the GSA may require installation of temporary or permanent flow metering equipment satisfactory to the GSA, and may require monitoring and reporting of data, as described above. De minimis groundwater extractors, defined as "a person who extracts, for domestic purposes, two acre-feet or less per year" (CWC Section 10721(e)), are exempt from groundwater extraction reporting requirements (CWC Section 10725.8).	x			Upon adoption of the GSP	District flyers, direct mail, public meetings	None	Not yet initiated	In preparation of the first Annual Report; estimated 2020-2021

Table PMA-1. Details of Projects and Management Actions (continued)

P&MA Name	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits						Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
			Primary		Secondary								
			Water Supply Augmentation	Water Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects to Enhance Recharge													
#1 - Aquifer Replenishment Project	Initiation and completion dates are under evaluation	Augmented recharge is anticipated to begin upon project initiation	70 - 100 AFY		x		x		Imported Surface Water	Consistent with Castac Basin GSA authority pursuant to CWC Section 10726.2(b); Pursuant to TCWD's authority as a water district	$ 6,889,859	$ 721,092	TCWD/TMV Developer
Projects to Manage and/or Capture Floodwater													
#2 - Cuddy Creek Bank Modifications	TBD	TBD	TBD		x	x	x		Local stormwater	Consistent with Castac Basin GSA authority pursuant to CWC Section 10726.2(b)	TBD	TBD	LCWD
Projects to Increase Delivery / Flexibility													
#3 - Krista Emergency Interconnect with LCWD	Initiated in 2019, completion date TBD	Upon project completion			x		x		Groundwater	Consistent with LCWD authority as a water district and KMWC's authority as a public water system	$ 565,794	$ 37,800	SWRCB SRF Grant
Projects to Develop New Supplies													
#4 - Wastewater Reclamation	Initiate in 2023, infrastructure completed 2026, complete to full capacity in 2041	Upon project initiation	70 – 100 AFY				x		Reclaimed water	Consistent with Castac Basin GSA authority pursuant to CWC Section 10726.2(b); Pursuant to TCWD's authority as a water district	$ 2,583,132	$ 30,546	TCWD/TMV Developer
Projects to Improve Drinking Water Quality													
#5 - Frazier Mountain High School Water Project	2021	Upon project completion			x				Groundwater	Consistent with LCWD's authority as a water district	$ 1,027,600	$ 17,200	Grants: Drinking Water SRF, Senate Bill 200, Proposition 68; Service connection user payment
Management Action / Improved data collection for ongoing reporting compliance and water budget quantification													
#6 - Well Metering and Data Collection	Initiate in 2020-2021	Upon project initiation						x	NA	GSA right established under CWC Section 10725.8	TBD	TBD	Well owner or operator, potential grant funds

Abbreviations:

AFY = acre-feet per year
CDFW = California Department of Fish and Wildlife
CEQA = California Environmental Quality Act
CWC = California Water Code
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
FMHS = Frazier Mountain High School
KMWC = Krista Mutual Water Company
LCWD = Lebec County Water District
NA = Not Applicable
NEPA = National Environmental Protection Act
P&MA = Project and/or Management Action
SRF = State Revolving Fund
SWPPP = Stormwater Pollution Prevention Plans
SWRCB = State Water Resources Control Board
TBD = to be determine
TCWD = Tejon-Castac Water District
TMV = Tejon Mountain Village
USACE = United States Army Corps of Engineers
U.S. FWS = United States Fish and Wildlife Service

Note: Summary table developed based off information provided by the Castac Basin GSA, see *Appendix J* for details.

17.3. Circumstances for Implementation

The Castac Basin GSA is proactively pursuing P&MA implementation. As indicated in **Table PMA-1**, certain P&MAs will be initiated within the first five years of GSP adoption, whereas others will be implemented incrementally on an as-needed basis to achieve the Sustainability Goal for the Basin. For example, P&MA #6 *Well Metering and Data Collection* and P&MA #1 *Aquifer Replenishment Project* and are anticipated to be implemented beginning in 2020-2021 and 2023, respectively. Furthermore, the P&MA #5 *Frazier Mountain High School Water Project* and P&MA #3 *KMWC Emergency Interconnect with LCWD Project* are in engineering planning stages, pending grant funding approvals.

Other P&MAs, like P&MA #2 *Cuddy Creek Bank Modifications Project,* do not have a current timetable for implementation. It is anticipated that implementation of these P&MAs will be dependent upon the Basin response to climatic conditions throughout the GSP implementation horizon, or as deemed necessary by the Castac Basin GSA if minimum thresholds (MTs) for Chronic Lowering of Groundwater Levels are exceeded in Representative Monitoring Wells (RMWs). Additional triggers for implementation may include when grant funds are obtained, or upon completion of feasibility studies, economic evaluations, and/or other necessary planning studies.

17.4. Public Notice Process

Public notice requirements vary for the different P&MAs (see **Table PMA-1**). Some projects that involve infrastructure improvements may not require specific public noticing (other than that related to construction). In general, the P&MAs being considered for implementation will be discussed during regular Castac Basin GSA Board Meetings which are open to the public. Additional stakeholder outreach efforts will be conducted prior to and during P&MA implementation by the project proponent(s), as required by law.

17.5. Addressing Overdraft Conditions

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.

As discussed in Section *9.2.3 Change in Groundwater Storage*, although the Basin shows a negative cumulative change in storage over the entire historical period (i.e., Water Years 1998 through 2018), the Basin is primarily driven by climatic impacts whereby prior to the extreme drought, the Basin would vary between positive and negative storage change. Moreover, as discussed in Section *9.2.4 Overdraft Conditions*, over the 12-year overdraft examination period that overlaps with that used by the California Department of Water Resources (DWR)'s overdraft evaluation (i.e., Water Years 1998 and 2009), the Basin's average change in storage was positive.

Groundwater levels have shown persistent decreasing trends since 2007, closely following the decreasing rainfall cumulative departure from average (see **Figure GWC-7**). Moreover, groundwater level trends show an inverse relationship to groundwater pumping (i.e., even though groundwater pumping volumes decreased since 2007, groundwater levels continued to decline; see **Figure GWC-7**), suggesting that the groundwater system is highly sensitive to climate rather than groundwater extractions.

The results from the Castac Basin Numerical Model runs indicate that under the 2030 Climate Change Scenario and the 2070 Climate Change Scenario, the projected Basin cumulative storage change remains fairly stable (see **Table WB-9** and **Figure WB-20**). The P&MAs presented herein are expected to result in benefits (discussed below) so as to avoid Undesirable Results and maintain sustainability in the Basin. For example, P&MA #1 *Aquifer Replenishment Project* is anticipated to increase groundwater recharge by 70 to 100 AFY and the Castac Basin Numerical Model scenarios which include the *Aquifer Replenishment Project* show a positive average annual change in groundwater storage (see **Table WB-9** and **Figure WB-20**).

17.6. Permitting and Regulatory Process

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(3) A summary of the permitting and regulatory process required for each project and management action.*

As shown in **Table PMA-1**, the permitting and regulatory requirements vary for the different P&MAs depending on whether they are infrastructure projects, recharge projects, demand reduction management actions, and so forth. The various types of permitting and regulatory requirements (not all applicable to every P&MA) include the following, if applicable:

1. Federal
    - National Environmental Policy Act (NEPA) documentation, if federal grant funds are used;

- National Pollution Discharge Elimination System (NPDES) stormwater program permit administered by the California State Water Resources Control Board (SWRCB) and associated Stormwater Pollution Prevention Plan (SWPPP);
- United States Fish and Wildlife Services (U.S. FWS) permit(s); and/or
- United States Army Corps of Engineers (USACE) permit(s).

2. State
    - California Environmental Quality Act (CEQA) documentation, including one or more of the following: Initial Study (IS), Categorical Exemption (CE), Negative Declaration (ND), Mitigated Negative Declaration (MND), Environmental Impact Report (EIR);
    - State Water Resources Control Board (SWRCB) permits and regulations regarding water rights permits and recycled water use; and/or
    - California Department of Fish and Wildlife (CDFW) Lake and Streambed Alteration Agreement.
3. Regional
    - San Joaquin Valley Air Pollution Control District (SJVAPCD) permit and regulations.
4. County/Local
    - Encroachment permits – Kern County, California Department of Transportation (CalTrans), and others;
    - Kern County grading permit; and/or
    - Kern County well construction permit.

Specific, currently-identified permitting and regulatory requirements for each P&MA are listed in **Table PMA-1**. Upon initiation of each P&MA, the regulatory and permitting requirements of the P&MA will be re-examined.

As with any Projects and Management Actions planned or implemented under SGMA, actions undertaken will remain in compliance with existing water rights constraints and processes under California law.

17.7. Status and Implementation Timetable

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.

Table PMA-1 shows the current status of each P&MA. The Castac Basin GSA is proactively pursuing P&MA implementation. For example, as discussed above in Section *17.3 Circumstances* *for Implementation*, P&MA #6 *Well Metering and Data Collection* and P&MA #1 *Aquifer Replenishment Project* are anticipated to be initiated in 2020-2021 and 2023, respectively; P&MA #5 *Frazier Mountain High School Water Project* and P&MA #3 *KMWC Emergency Interconnect with LCWD Project* are in engineering planning stages, pending grant funding approvals. **Table PMA-1** presents preliminary estimates of the time required to complete/implement each P&MA and a timetable for accrual of expected benefits. These estimates will be refined, as necessary, upon further evaluation and/or initiation of the P&MAs.

17.8. Expected Benefits

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.

The different categories of expected benefits are presented above in Section *17.1.2 Benefit Categories*, and the specific expected benefits of each P&MA are presented in **Table PMA-1**. Below is a discussion of how the expected benefits will be evaluated.

Most P&MAs have expected benefits related to water quantity. Once a P&MA is implemented, it is important to evaluate, and ideally to quantify, the benefits resulting from a given P&MA. The way in which P&MA benefits are evaluated/quantified depends on the P&MA.

Expected benefits from P&MA #1 *Aquifer Replenishment Project* include increased groundwater recharge, groundwater storage, and increases in groundwater levels downgradient of Castac Lake. These benefits to the groundwater system were estimated using the Castac Basin Numerical Model and can be confirmed over the long-term using water level measurements. As discussed in more detail in Section *9.4*, the *Aquifer Replenishment Project* was simulated using the Castac Numerical Model under the assumption that the water level in Castac Lake would be maintained at a constant water depth of eight to 10 feet, measured from the base of the lakebed. This assumption may not be achievable under future conditions, so lake management will be a dynamic process, subject to re-evaluation should availability of imported surface water become more limited, or if other beneficial uses require additional water supply.

Upon implementation, P&MA# 1 *Aquifer Replenishment Project* is estimated to add an additional 70 to 100 AFY of groundwater replenishment to the Basin (and up to 300 AFY on certain years), resulting in a net increase in groundwater storage of approximately 30 AFY under each climate scenario (**Figure WB-21**).

Furthermore, the Castac Basin Numerical Model was used to assess water level responses to GSP implementation relative to proposed Sustainable Management Criteria for Chronic Lowering of Groundwater Levels. As demonstrated in **Figure PMA-2**, projected groundwater elevations in all RMWs are expected to remain at or above the MTs under P&MA #1 *Aquifer Replenishment Project* implementation scenarios. The modeling results support the notion that the proposed P&MA implementation strategy is expected to result in sustainable management of groundwater levels within the Basin, as measured against the definition of Undesirable Results (i.e., if groundwater levels fall below the MT for Chronic Lowering of Groundwater Levels in any two representative monitoring wells for four consecutive semi-annual monitoring events). It should be noted that the P&MA #1 scenario has been modeled assuming that surplus imported surface water supplies remain available. The effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed at that time.

Expected benefits from P&MA #2 *Cuddy Creek Bank Modifications Project* include increased groundwater recharge, and some amount of increased groundwater storage and groundwater levels in proximity to the creek. Once the project is better defined, these benefits could be quantified through modeling and measurement of groundwater levels in monitoring wells adjacent to Cuddy Creek (i.e., TRC-MW16D).

For P&MAs that involve indirect supply augmentation through, for example, increased delivery flexibility (P&MA #3) or use of reclaimed wastewater (P&MA #4), quantification of the benefit will require a comparison of the observed water supply condition (e.g., groundwater delivered to KMWC from LCWD wells) against a hypothetical condition where the P&MA was not in place (e.g., groundwater extractions from KMWC well). Once these P&MAs are better defined, these benefits could be quantified through modeling, water level measurements, and/or tracking of groundwater production volumes.

Expected benefits from P&MA #5 *Frazier Mountain High School Water Project* include the service of reliable drinking water with water quality constituent concentrations that fall below the State of California and the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs). Benefits will be quantified by water quality sampling, as required of public water systems under CCR Title 22.

Finally, expected benefits of P&MA #6 *Well Metering and Data Collection* include a more accurate quantification of Basin groundwater extraction for both water budget accounting and Annual Reporting. Metered groundwater extraction volumes can improve the water budget accounting for the Basin. Benefits could be quantified by integrating future metered extraction volumes into the Castac Basin Numerical Model, conducting a post audit to validate the prior model calibration, and/or re-calibrating the model based on the new data collected.

The goals and objectives of P&MA implementation are not necessarily to achieve a certain water budget outcome, but rather to increase the likelihood that Undesirable Results for relevant Sustainability Indicators are avoided by the end of the Sustainable Groundwater Management Act (SGMA) implementation period (i.e., by 2040). For this reason, ultimately the success of the collective implementation of P&MAs will be determined by whether the Sustainability Goal is achieved.

17.9. Source and Reliability of Water from Outside the Basin

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

Several of the P&MAs discussed below and shown in **Table PMA-1** rely on additional water supplies from outside of the Basin. P&MA #1 *Aquifer Replenishment Project* and P&MA #4 *Wastewater Reclamation Project* rely on the availability of imported surface water and the associated availability of reclaimed water. Because of the nature of the Tejon-Castac Water District (TCWD) surface water contracts and management options (e.g., water banking operations) and access to other water sources that can be purchased outside of its contracts, TCWD's anticipated imported surface water supply (and therefore the reclaimed water) is projected to exceed total projected demand under various average year water reliability assumptions (TCWD, 2008). The TCWD supply also is projected to exceed the County-requested water bank storage volumes under multi-year drought scenarios and is therefore assumed to be very reliable for future use (TCWD, 2008). As previously discussed, P&MA #1 implementation assumes that surplus imported surface water supplies remain available. The effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed at that time.

P&MA #2 *Cuddy Creek Bank Modifications Project* relies on the availability of rainfall runoff from upgradient watersheds during wet years to create significant flow in Cuddy Creek, thereby enabling stormwater capture. As rainfall runoff is naturally controlled by climate, the future frequency, volume and reliability of Cuddy Creek stormflows is uncertain. Additionally, constraints on increased capture due to existing water rights in the Basin and in other basins may limit the potential yield of this project.

17.10. Legal Authority Required

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

The Castac Basin GSA is organized as a Joint Powers Agreement (JPA) between TCWD, LCWD, and the County of Kern. Per California Water Code (CWC) § 10725 through 10726.8, the Castac Basin GSA possesses the legal authority necessary to implement the supply augmentation and demand management P&MAs described herein, and will enforce these P&MAs as necessary or will delegate authority to TCWD or LCWD, as appropriate, to enforce the GSP.

17.11. Estimated Costs and Plans to Meet Them

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.

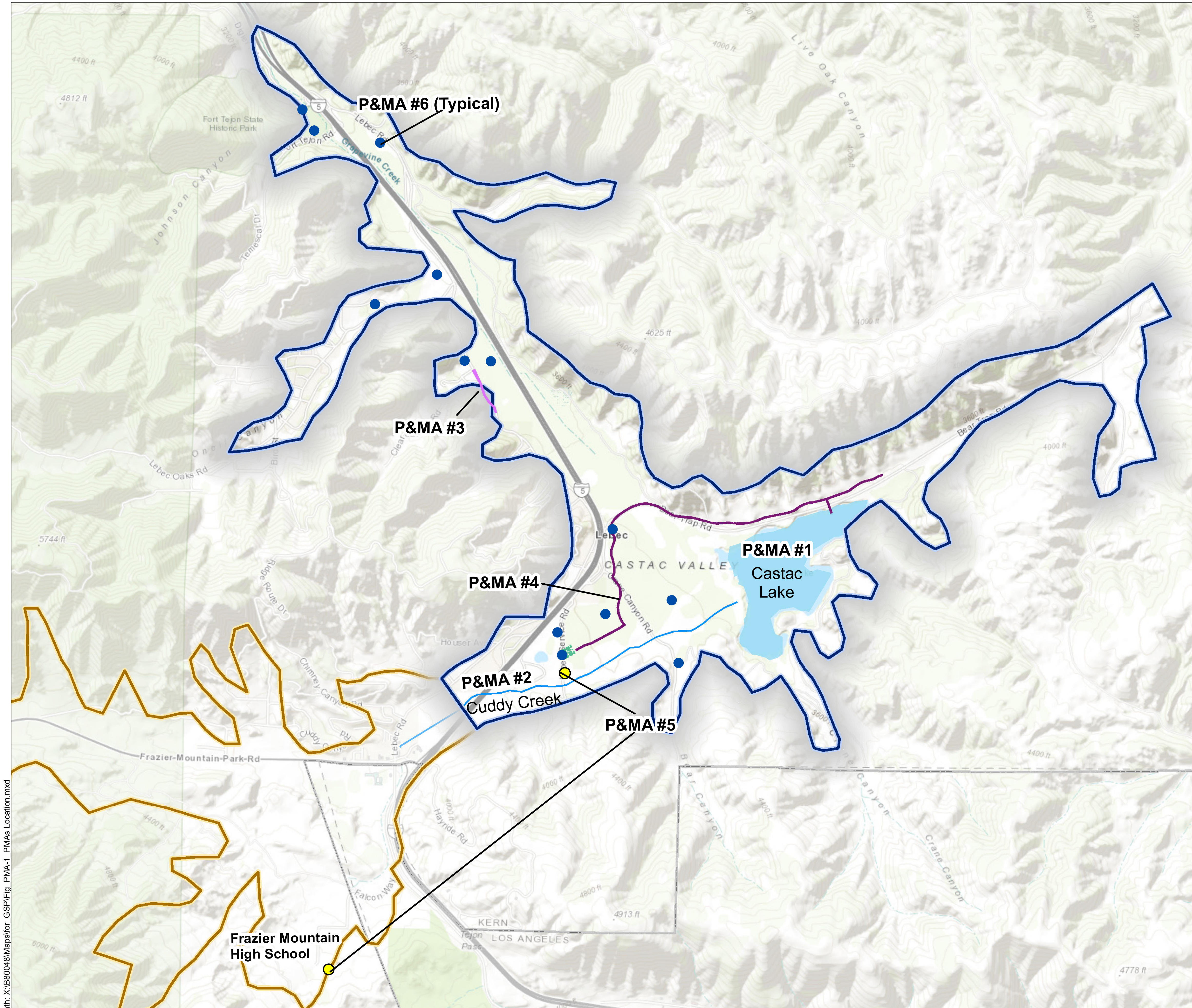
Estimated costs for each P&MA are presented in **Table PMA-1**. Given the uncertainty in the scope and timing of these P&MAs, the costs are presented as ranges. These costs include “one-time” costs and ongoing costs. The one-time costs may include capital costs associated with construction, feasibility studies, permitting, environmental (e.g., CEQA) compliance, or any other costs required to initiate a given P&MA. The ongoing costs are associated with operations & maintenance (O&M), water purchases, and/or costs to otherwise continue implementing a given P&MA. It should be noted that depending on the source and nature of funding for the P&MAs, the one-time costs may or may not be incurred entirely at the beginning of the P&MA; in some instances, grants or other financing options may allow for spreading out of “one-time” costs over time.

Potential sources of funding for the various P&MAs are also presented in **Table PMA-1**, and include TCWD funds, grant funding from sources including SWRCB State Revolving Fund (SRF) and Drinking Water SRF, LCWD or KMWC rate payers, and other potential sources. The lead agency proposing the P&MA will be responsible for securing funding for the P&MA. Upon implementation of any given P&MA, the available funding sources for that P&MA will be confirmed.

17.12. Management of Recharge and Groundwater Extractions

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.*

As stated previously in Section *9 Water Budget Information*, under historical conditions (Water Years 1998 – 2018), the cumulative storage for the Basin declined. Historical groundwater level trends and the historical water budget show that the declining trends observed in the Basin's groundwater levels and storage are primarily driven by climate, do not have a strong relationship with groundwater extraction volumes, and are sensitive to groundwater inflow volumes from up-gradient basins. The scenarios that were used to project future water budget conditions show that, on average, groundwater storage is projected to remain relatively stable, even under the modeled climate change conditions. If the P&MA #1 *Aquifer Replenishment Project* is implemented, a slight increase in groundwater storage is projected to occur (see **Figure WB-21**). Finally, the P&MA portfolio includes P&MA #2 *Cuddy Creek Bank Modifications Project* which, if implemented, would take additional advantage of wet year supplies (i.e., increased rainfall and runoff) to increase aquifer recharge, within the constraints of existing water rights in the Basin and in adjoining basins. Therefore, the Castac Basin GSA's P&MA efforts are designed to increase the likelihood that groundwater levels and storage declines during future drought periods will be offset, to the extent possible, by increases in groundwater levels and storage during other periods.



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- P&MA #1 Aquifer Replenishment Project
- P&MA #2 Cuddy Creek Bank Modifications
- P&MA #3 Krista Emergency Interconnect with LCWD

P&MA #4 Reclaimed Wastewater

- WRRF Facilities
- Proposed Water Line
- P&MA #5 Frazier Mountain High School Water Project
- P&MA #6 Well Metering and Data Collection

Abbreviations

DWR = California Department of Water Resources
LCWD = Lebec County Water District
P&MA = Projects and Management Actions
WRRF = Water Resources Recovery Facility

Notes

1. All locations are approximate.
2. For details on each P&MA, see Table PMA-1 and Appendix A - Project / Management Action Information Forms.
3. Some P&MA #6 well locations shown may be de minimis pumpers, who are exempt from well metering requirements under California Water Code Section 10725.8.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 14 September 2020.
3. Cuddy Creek from National Hydrology Dataset.
4. P&MA#3 location from Krista Mutual Water Company Preliminary Engineering Report.
5. WRRF facilities shapefiles provided by Diana Hulburt, on 28 August 2018.
6. P&MA #5 well location provided by LCWD via email on 5 November 2019.
7. P&MA #6 well locations are based on the Castac Basin Data Management System.

N

0 0.6 1.2
(Scale in Miles)

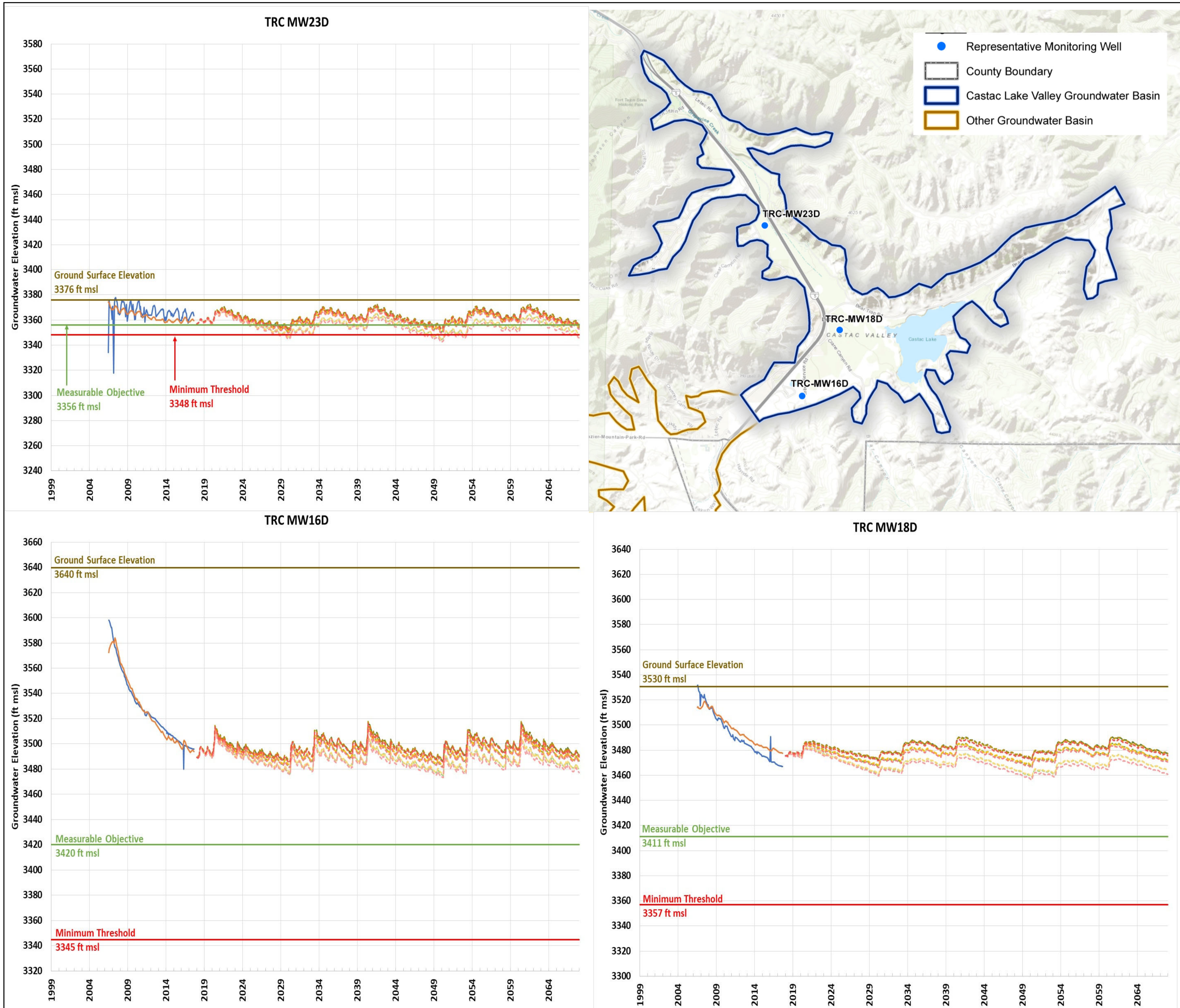
Approximate Locations of Proposed Projects and Management Actions

Castac Basin GSA
Kern County, California
September 2020
B80048.00

Figure PMA-1

eki environment & water

Path: X:\B80048\Mapsfor_GSP\Fig_PMA-1_PMAs Location.mxd



Legend

Groundwater Elevation

- Observed
- Model-calculated (Historical)

Current Land Use

- Projected—Baseline
- Projected—2030 Climate Change
- Projected—2070 Climate Change

Projected Land Use with TMV Development

- Projected—Baseline
- Projected—2030 Climate Change
- Projected—2070 Climate Change

Projected Land Use with TMV Development and Aquifer Replenishment Project Implementation

- Projected—Baseline
- Projected—2030 Climate Change
- Projected—2070 Climate Change
- Minimum Threshold
- Measurable Objective
- Ground Surface Elevation

Abbreviation

DWR = California Department of Water Resources

ft msl = ft above mean sea level

TMV = Tejon Mountain Village

Notes

1. All locations are approximate.

Source

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.

2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 March 2020.

Castac Basin Numerical Model Projected Hydrographs with and without Aquifer Replenishment Project Implementation

Castac Basin GSA

Kern County, California

September 2020

eki environment & water

B80048.00

Figure PMA-2

PLAN IMPLEMENTATION

18. PLAN IMPLEMENTATION

> *§ 351. Definitions*
>
> *(y) "Plan implementation" refers to an Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.*

Per the Groundwater Sustainability Plan (GSP) Regulations, "plan implementation" refers to "an [Groundwater Sustainability] Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities" (23-California Code of Regulations [CCR] § 351(y)). This section describes the activities that will be performed by the Castac Basin Groundwater Sustainability Agency (GSA) as part of GSP implementation within the Castac Lake Valley Basin (Basin), with a focus on the first five years (i.e., through 2025). Key GSP implementation activities to be undertaken by the Castac Basin GSA over the next five years include:

- Monitoring and data collection;
- Data gap filling efforts;
- Intra-basin coordination;
- Continued outreach and engagement with stakeholders;
- Annual reporting;
- Evaluation and updates, as necessary, of the GSP as part of the required periodic evaluations (i.e., "five-year updates"); and
- Projects and/or Management Action (P&MA) implementation.

Each of these activities is discussed in more detail below.

18.1. Plan Implementation Activities

18.1.1. Monitoring and Data Collection

Successful sustainable groundwater management relies on a foundation of data to support decision making. As such, collection of data within the Basin will be a key part of GSP implementation. These data collection efforts include monitoring of applicable Sustainability Indicators to be collected from the Sustainable Groundwater Management Act (SGMA)

Monitoring Network, as well as other data and information required for management and reporting under the SGMA, as described below.

Section *16* discusses the SGMA Monitoring Network and associated Representative Monitoring Wells (RMWs) and protocols that will be used for the applicable Sustainability Indicators in the Basin, including Chronic Lowering of Groundwater Levels, Reduction of Groundwater Storage (using groundwater levels as proxy), and Depletions of Interconnected Surface Water (using groundwater levels as proxy). Those protocols will be followed as part of GSP implementation. Data collected will be incorporated into the Castac Basin's Data Management System (DMS) and will be used to support Annual Reporting (see Section *18.1.6 Annual Reporting*). Furthermore, monitoring results will be evaluated against applicable Sustainable Management Criteria (SMCs; i.e., Undesirable Results, Minimum Thresholds [MTs], and Measurable Objectives [MOs]) to support groundwater management decisions.

The Castac Basin GSA anticipates that within the first five years of GSP implementation (i.e., in the 2020 to 2025 timeframe), the following water level monitoring related efforts will be performed:

- Semi-annual water level monitoring at the RMWs, with the potential for monitoring of additional well site(s);
- Quality assurance and quality control checks;
- DMS importation; and
- Data gap filling efforts as it pertains to the monitoring network (see Section *18.1.2 Data Gap Filling Efforts* below).

Besides the data collected to support evaluation of Sustainability Indicators described above, collection and reporting of other types of information is required under SGMA (see further discussion below in Section *18.1.6 Annual Reporting*). These other types of information include:

- Groundwater extraction information. Groundwater extraction information is currently measured by totalizer counter units in select production and public supply wells. Additional wells will have meters installed once P&MA #6 *Well Metering and Data Collection* is implemented.
- Surface water supply data, if applicable. No imported surface water is currently used within the Basin and therefore is not currently applicable. However, once P&MA #1 *Aquifer Replenishment Project* is implemented, this tracking and reporting will be implemented.

Finally, as discussed in Section *16.1.4 Monitoring Network for Degraded Water Quality*, the Castac Basin GSA anticipates that the following water quality related monitoring efforts will be performed within the first five years of GSP implementation:

- Compilation and review of water quality data from public water systems made publicly available through the Safe Drinking Water Information System (SDWIS) Drinking Water Watch website, with the potential for monitoring of additional well site(s);
- Annual water quality sampling from two monitoring wells to establish baseline water quality conditions in Grapevine Canyon;
- Quality assurance and quality control checks; and
- DMS importation.

18.1.2. Data Gap Filling Efforts

The Castac Basin GSA will prioritize and begin to fill the key data gaps identified in this GSP related to the hydrogeological conceptual model, groundwater conditions, and water budgets, among other things. These data gap filling efforts will include, but not be limited to:

- Additional monitoring infrastructure to quantify subsurface groundwater inflows. The main uncertainty identified in the Basin water budget was the amount of subsurface groundwater inflow across the Cuddy Canyon Valley Basin and Castac Basin boundary. The primary recommended data gap filling effort is monitoring groundwater levels near the upgradient Cuddy Canyon Valley Basin to help quantify the water level gradient between Cuddy Canyon Valley Basin and RMW TRC-MW16D within the Basin. To the GSA's knowledge, there are no pre-existing wells with adequate location or infrastructure for monitoring water levels, and therefore a monitoring well is proposed to be installed near the Basin boundary. It is anticipated the monitoring well will be installed in 2022 and water level monitoring will be concurrent with that of the RMWs.

- Outreach to known domestic well owners in the Basin to estimate and meter their groundwater extraction volumes for Annual Reporting, if extractions are above those defined as de minimis (i.e., 2 AFY; CWC Section 10721(e)).

- Outreach to the Tejon Middle School and Fort Tejon Park public water systems to inquire about well construction information and historical and future water quality, water level and groundwater production data collection.

- High-resolution water level data monitoring to support lake/groundwater interactions analyses. An initial round of data collection occurred in 2019, to be supplemented with future data collection.

- Conducting additional data compilation and analysis of groundwater conditions using other public datasets and tools as they become available.

18.1.3. Intra-Basin Coordination

Intra-basin coordination efforts, including ad-hoc technical committee meetings, will occur on an approximately quarterly basis to facilitate data collection and management efforts and planning for stakeholder engagement opportunities.

18.1.4. Stakeholder Engagement

The GSA's Stakeholder Communication and Engagement Plan (SCEP; *Appendix C*) will continue to be refined, updated, and executed during GSP implementation. Anticipated stakeholder engagement activities include, but are not limited to:

- Continued semi-annual GSA Board meetings;
- Hosting annual stakeholder workshops, as needed; and
- Posting of relevant announcements and information on the GSA's website (https://castacgsa.org).

18.1.5. Project and Management Action Implementation

To prevent potential Undesirable Results, P&MAs are planned as part of GSP implementation. As described in Section *17 Projects and Management Actions*, a portfolio of P&MAs has been developed with the goal of proactively addressing relevant Sustainability Indicators. **Table PMA-1** provides the required details about each P&MA, including the circumstances under which they may be implemented.

The Castac Basin GSA plans to immediately begin implementation of selected P&MAs, as shown in **Table PMA-1**. In some cases, initial steps in implementation will include performing various studies or analyses to refine the concepts into actionable projects. Studies and work efforts may include, but are not limited to, California Environmental Quality Act (CEQA) studies and documentation; and engineering feasibility studies and preliminary design reports.

Once the necessary initial studies are completed, P&MAs will undergo, as necessary, final engineering design (in the case of infrastructure projects) and public noticing and outreach. At that point, construction of projects will occur, followed by ongoing operations and maintenance, as necessary. It is anticipated that each implemented P&MA will have its own set of monitoring or data collection components to allow for P&MA assessment and, if necessary, modification.

18.1.6. Annual Reporting

§ 356.2. Annual Reports.
Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:

(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:

(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:

(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.

(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.

(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.

(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.

(5) Change in groundwater in storage shall include the following:

(A) Change in groundwater in storage maps for each principal aquifer in the basin.

(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

Per the GSP Emergency Regulations, an annual report on basin conditions and GSP implementation status is required to be submitted to the Department of Water Resources (DWR) by April 1 of each year following GSP adoption (23-CCR § 356.2). These annual reports will be prepared by the Castac Basin GSA using data collected during GSP implementation, as described above. Annual reports will include, but not be limited to, the following:

- Groundwater elevation contour maps for both Spring and Fall conditions;
- Hydrographs of groundwater elevations in the RMWs;
- Annual groundwater extraction volumes for the entire Basin, an explanation as to how groundwater extraction volumes were estimated, an accounting of accuracy, and an explanation as to how accuracy was determined;
- Annual surface water supply volumes used for the entire Basin, quantified by source type, as applicable;
- Annual total water use for the entire Basin, quantified by water use sector and type; and
- Estimates of annual change in groundwater storage. The Castac Basin Numerical Model will be updated and extended to include the groundwater elevation data, groundwater extraction volumes, and hydrology datasets (i.e., precipitation and evapotranspiration) to estimate the annual change in groundwater storage.

18.1.7. Enforcement and Response Actions

Part of successful Basin management involves the ability to adapt and respond to unforeseen or uncertain circumstances. To the extent possible, methods to address foreseeable problems should be developed before those problems arise. It is not anticipated that there will be a need to enforce compliance with this GSP and any policies adopted thereunder. However, if such actions are necessary, they will be taken by the Castac Basin GSA and/or its member agencies in accordance with applicable laws and authorities.

18.1.8. Periodic GSP Evaluations

§ 356.4. Periodic Evaluation by Agency
Each Agency shall evaluate its Plan at least every five years and whenever the Plan is amended and provide a written assessment to the Department. The assessment shall describe whether the Plan implementation, including implementation of projects and management actions, are meeting the sustainability goal in the basin, and shall include the following:

(a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.

(b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

(c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.

(d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.

(e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:

(1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.

(2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.

(3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.

(f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.

(g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.

(h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.

(i) A description of completed or proposed Plan amendments.

(j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.

§ 356.4. Periodic Evaluation by Agency

(k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733

(l) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.

(m) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733

Per the GSP Regulations (23-CCR § 356.4), the Castac Basin GSA will conduct a periodic evaluation of its GSP, at least every five years, and will modify the GSP as necessary to ensure that the Sustainability Goal for the Basin is achieved. The GSP elements that will be covered in the periodic evaluation are described below. It is anticipated that the 2025 plan will require revision, especially on matters related to the Basin Setting, SMCs, and P&MAs sections.

Sustainability Evaluation

This section will evaluate the current groundwater conditions for each applicable Sustainability Indicator, including progress toward achieving Interim Milestones and MOs.

Plan Implementation Progress

This section will evaluate the current implementation status of P&MAs, along with an updated implementation schedule and any new P&MAs that are not included in this GSP.

Reconsideration of GSP Elements

Per 23-CCR § 356.4(c), elements of the GSP, including the Basin Setting, Basin Setting, SMCs, and P&MAs sections will be reviewed and revised if necessary.

Monitoring Network Description

This section will provide a description of the SGMA Monitoring Network, including identification of data gaps, assessment of monitoring network function with an analysis of data collected to date, identification of actions that are necessary to improve the monitoring network, and development of plans or programs to fill data gaps.

New Information

This section will provide a description of significant new information that has been made available since the adoption or amendment of the GSP, or the last five-year assessment, including data obtained to fill identified data gaps. As discussed above under *Reconsideration of GSP Elements*, if evaluation of the Basin Setting or SMCs definitions warrant changes to any aspect of the GSP, this new information would also be included.

Regulations or Ordinances

The Castac Basin GSA possesses the legal authority to implement regulations or ordinances related to the GSP. This section will provide a description of relevant actions taken by the Castac Basin GSA, including a summary of related regulations or ordinances, as appropriate.

Legal or Enforcement Actions

This section will summarize legal or enforcement actions taken by the Castac Basin GSA in relation to the GSP, along with how such actions support sustainability in the Basin.

Plan Amendments

This section will provide a description of proposed or complete amendments to the GSP.

18.2. Plan Implementation Costs

§ 354.6. Agency Information

When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:

(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

Per the GSP Regulations (23-CCR § 354.6(e) and 354.44(b)(8)), this section provides estimates of the costs to implement this GSP and potential sources of funding to meet those costs.

18.2.1. Estimated Costs

The estimated costs for the Castac Basin GSA to implement this GSP can be divided into several groups, as follows:

1) Costs of groundwater monitoring and reporting activities;
2) Costs associated with stakeholder outreach; and
3) Costs to implement P&MAs, including capital/one-time costs and ongoing costs.

Table PI-1 provides a high-level estimate of the annual costs for the above groups 1 and 2 over the first 5-year period (i.e., 2020-2025). Costs associated with continued GSA activities (groups 1 and 2) are estimated to range between approximately $64,000 to $165,000 per year, not including GSA and GSA member agency staff time. Estimated annual costs for individual P&MAs (group 3) will be determined in the future, as the Castac Basin GSA moves forward with specific P&MA implementation.

Table PI-1. Estimated GSP Implementation Costs

Groundwater Management Activity	Estimated Average Annual GSP Implementation Costs[(1)]				
	Year 1	Year 2	Year 3	Year 4	Year 5
Part 1. Costs of Groundwater Monitoring and Reporting Activities					
Monitoring and Data Collection					
Water level monitoring at Representative Monitoring Wells	$2,600	$2,600	$2,600	$2,600	$2,600
Collection of water use data	$1,500	$1,500	$2,000	$2,000	$2,000
Public water system water quality data compilation	$3,000	$3,000	$3,000	$3,000	$3,000
Water quality sampling to establish baseline conditions	$2,600	$2,600	$2,600	$2,600	$2,600
Data Gap Filling					
Monitoring well installation and water level monitoring at upgradient Basin boundary	$0	$0	$52,000	$1,000	$1,000
Outreach to domestic and public supply well owners	$2,000	$2,000	$2,000	$2,000	$2,000
Groundwater conditions assessment using new DWR supported guidelines and tools, as available	$3,600	$3,600	$3,600	$3,600	$3,600
Intra-basin Coordination	$3,000	$3,000	$3,000	$3,000	$3,000
Annual Reporting	$35,000	$30,000	$30,000	$30,000	$30,000
Periodic Evaluation of GSP	$0	$0	$0	$100,000	$100,000
Annual Subtotal	**$53,300**	**$48,300**	**$100,800**	**$149,800**	**$149,800**
Part 2. Costs associated with Stakeholder Outreach					
Semi-annual GSA Board Meetings	$9,200	$9,200	$9,200	$9,200	$9,200
Stakeholder Workshop	$4,600	$4,600	$4,600	$4,600	$4,600
Website Maintenance	$1,200	$1,200	$1,200	$1,200	$1,200
Annual Subtotal	**$15,000**	**$15,000**	**$15,000**	**$15,000**	**$15,000**
Part 3. Costs to Implement Projects and Management Actions					
Annual Subtotal	To Be Determined; See **Table PMA-1**				
Total Required Costs of GSP Implementation	***$68,300 + P&MA costs***	***$63,300 + P&MA costs***	***$115,800 + P&MA costs***	***$164,800 + P&MA costs***	***$164,800 + P&MA costs***

Notes:

(1) Costs are estimated for technical consultant, laboratory, well driller, or other direct costs. It is assumed the Castac Basin GSA will conduct monitoring activities, however GSA personnel costs associated with data collection are not estimated herein.

18.2.2. Sources of Funding to Meet Costs

As shown in **Table PI-1**, required non-GSA/member agency staff costs for GSP implementation (i.e., groups 1 and 2) are estimated to range between approximately $64,000 to $165,000 annually over the next five years. The Castac Basin GSA will likely meet the estimated costs through a combination of contributions from landowners, grant funding, if available, and through rate payers.

18.3. Plan Implementation Schedule

This section discusses a general estimated schedule for GSP implementation. The GSP Emergency Regulations do not specifically require that a schedule for GSP implementation over the 20-year implementation period (i.e., 2020 through 2040) be provided, and any such schedule would be subject to considerable uncertainty. However, the following factors and constraints inherent to the GSP process guide the schedule for GSP implementation:

- The GSP Emergency Regulations require achievement of the Sustainability Goal (i.e., avoidance of Undesirable Results) within 20 years of GSP adoption, which means by 2040.
- Annual reports are due on April 1 of every year following GSP submission.

Periodic evaluations are required at least every five years, meaning this GSP will be updated no later than 2025.

REFERENCES AND TECHNICAL STUDIES

§ 354.4. General Information

Each Plan shall include the following general information:

(b) A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.

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EKI, 2008c, Technical Memorandum No. 3 Preliminary Summary and Interpretation of the Available Groundwater Quality Data for Castac Groundwater Basin Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

EKI, 2008d. *Technical Memorandum No. 4, Preliminary Estimate of Site-Specific Evapotranspiration Rates, Plant Rooting Depths, and Soil Property Information, Tejon Mountain Village, LLC*. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

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APPENDICES

Appendix A

GSP Submittal Checklist

Article 5.			Plan Contents for the Castac Lake Valley Basin Groundwater Sustainability Plan	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.	15:28	ES.1 - ES.13			
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.	260:266	References			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.	31	3.1			
(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.	31:32	3.2			
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.	32	3.3			
(d)			The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.	32	3.4			
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.	32, 257:259	3.5, 18.2		PI-1	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					
§ 354.8.			**Description of Plan Area**					
			Each Plan shall include a description of the geographic areas covered, including the following information:					
(a)			One or more maps of the basin that depict the following, as applicable:					
	(1)		The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.	35	5.1.1	PA-1		

Article 5.			Plan Contents for the Castac Lake Valley Basin Groundwater Sustainability Plan	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.	36	5.1.2	PA-1		
	(3)		Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.	36	5.1.3	PA-1, PA-5:PA-6		
	(4)		Existing land use designations and the identification of water use sector and water source type.	37	5.1.4	PA-3	PA-1	
	(5)		The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.	37:38	5.1.5	PA-4		
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.	35:38	5.1			
(c)			Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.	38:39	5.2.1			
(d)			A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.	39:40	5.2.2			
(e)			A description of conjunctive use programs in the basin.	40	5.2.3			
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.	40:44	5.3.1	PA-5:PA-6		
	(2)		A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects	44	5.3.2			
	(3)		A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.	45	5.3.3			
	(4)		A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.	45	5.3.4			
	(5)		To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.	45	5.3.5			
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	45:47	5.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					
			Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:					

Article 5.			Plan Contents for the Castac Lake Valley Basin Groundwater Sustainability Plan	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(a)			A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.	48, 293:320	5.5.1, Appendix C			
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.	48:49	5.5.2			
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.	49:50, 321:322	5.5.3, Appendix D		PA-2	
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency's decision-making process.	50:52, 293:320	5.5.4, Appendix C			
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.	50:52, 293:320	5.5.4, Appendix C			
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.	50:52, 293:320	5.5.4, Appendix C			
	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.	50:52, 293:320	5.5.4, Appendix C			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					
			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					
(a)			Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.	61:74	7	HCM-1:HCM-14	HCM-1:HCM-2	
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.	61:62	7.1.1	HCM-1		
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.	62:63	7.1.2	HCM-2		
	(3)		The definable bottom of the basin.	63:65	7.1.3	HCM-3:HCM-4	HCM-1	
	(4)		Principal aquifers and aquitards, including the following information:					