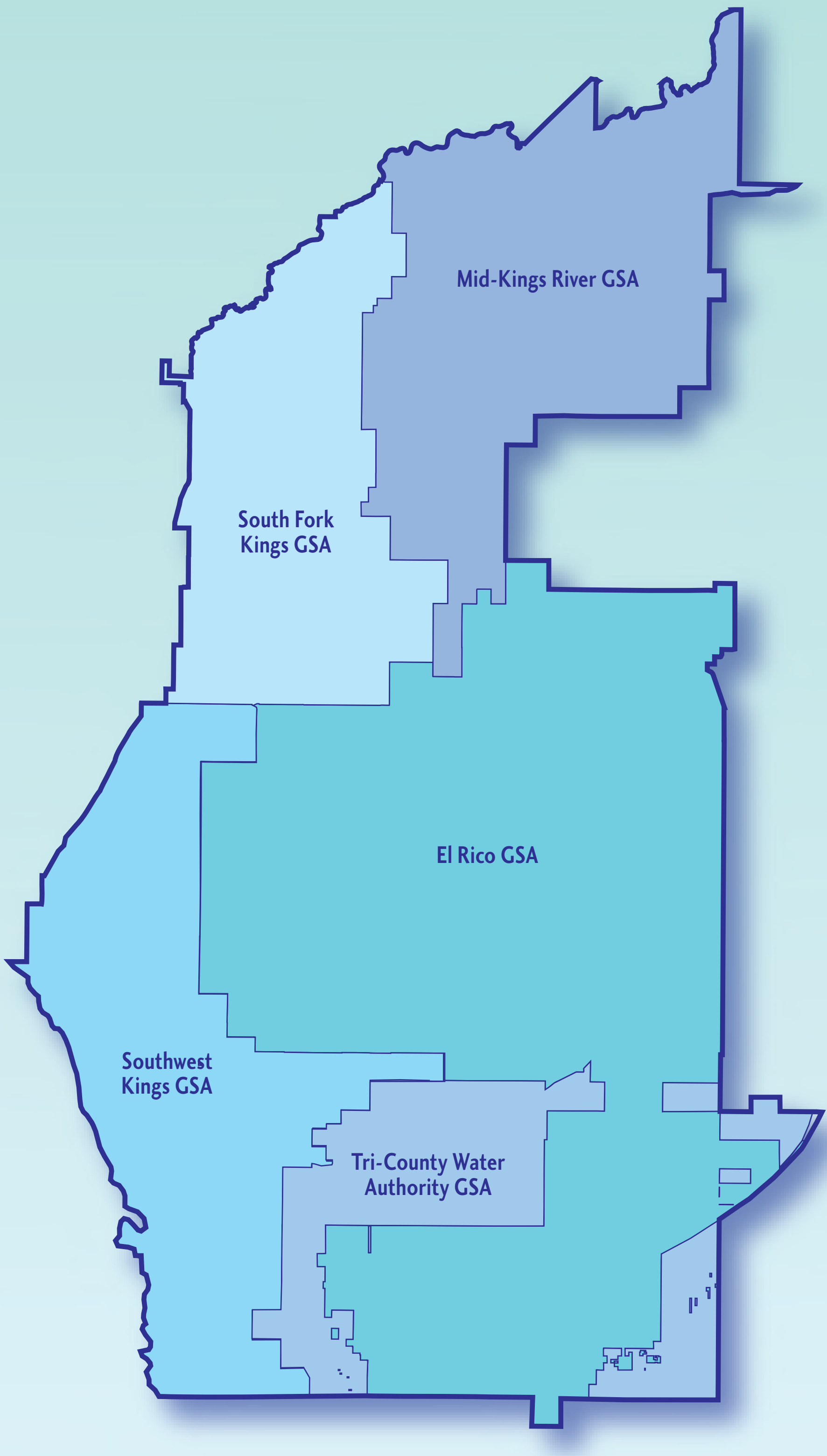
Preliminary Draft *August 2019*

Tulare Lake Subbasin Groundwater Sustainability Plan



MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY · South Fork Kings Groundwater Sustainability Agency · El Rico GSA · SWK Southwest Kings Groundwater Sustainability Agency · TRI-COUNTY WATER AUTHORITY

EXECUTIVE SUMMARY

23 CCR §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.*

SGMA established California's first comprehensive framework for the long-term sustainable management of groundwater basins in California through local agency coordination and preparation and implementation standards through GSPs (California Water Code, § 10720-10737.8).

This Groundwater Sustainability Plan (GSP) was developed pursuant to the Sustainable Groundwater Management Act of 2014 (SGMA) in order to achieve long-term groundwater sustainability in the Tulare Lake Subbasin (Subbasin). GSPs are required under SGMA to bring the Subbasin into groundwater sustainability (generally, a balanced level of pumping and recharge) by 2040. Under SGMA, Groundwater Sustainability Agencies (GSAs) were created in groundwater in subbasins to develop and implement GSPs for the subbasin. California's 515 groundwater basins are classified into four categories: high-, medium-, low, or very low-priority based on conditions identified in the California Water Code, §10933(b). Basins and Subbasins ranked as medium-or high-priority are required to develop GSPs and establish measurable objectives, minimum thresholds, and project and management actions to achieve the basin's sustainability goal.

1.0 Introduction

Chapter 1, *Introduction*, provides the Subbasin overview and sustainability goal, and information regarding the organization, management, and legal authority of the Groundwater Sustainability Agencies (GSAs).

1.1 Overview and Purpose of the Groundwater Sustainability Plan

Five Participating GSAs

- **Mid-Kings River**
- **South Fork Kings**
- **El Rico**
- **Southwest Kings**
- **Tri-County Water Authority**

The Subbasin Plan area is located within the southern portion of the San Joaquin Valley Basin in the Central Valley of California (Figure ES-1). The Tulare Lake Subbasin (Basin No. 5-22-12) is classified as a high-priority Subbasin by the Department of Water Resources (DWR) and is one of 21 basins and subbasins identified by DWR as critically overdrafted (DWR 2019a). Five local GSAs, which include the Mid-Kings River, South Fork Kings, Southwest Kings, El Rico, and the Tri-County Water Authority GSAs, cooperatively developed this GSP to address the sustainable management of current and future groundwater use within the Subbasin to avoid undesirable results (Figure ES-2). The Tulare Lake Subbasin GSP establishes how GSAs will monitor groundwater, utilize and share data, and implement projects and management actions to promote sustainable groundwater conditions in the Subbasin without triggering undesirable results.

The goal of the GSP is to reach Subbasin-wide groundwater sustainability within 20 years of the GSP's implementation in the Subbasin (DWR 2019b). The GSP will be reevaluated and updated, at a minimum, every five years (2025, 2030, 2035, and 2040) to revise, as necessary, implementation, monitoring and groundwater management strategies.

1.2 Organization and Management Structure of the GSAs

The five participating GSAs collaboratively developed this single GSP for Tulare Lake Subbasin under an Interim Operating Agreement (Appendix G). The Interim Operating Agreement establishes mechanisms to ensure collaboration and coordination of data throughout the Subbasin. Each GSA was formed by local member agencies that are represented as stakeholders on each GSA Board of Directors. The Boards of Directors and technical teams have collected and organized data from experienced groundwater consultants as well as sought feedback from groundwater users within the GSA boundaries through each SGMA phase (Appendix B).

> **Member Agencies** are local agencies including counties, cities, and water districts, within each GSA who participate in the decision-making process for GSP implementation.

2.0 Plan Area

Chapter 2, *Plan Area*, specifies the geographic extent of the GSP including but not limited to jurisdictional boundaries, existing land uses and land use policies, identification of water resource types, density of wells, and location of communities dependent on groundwater in the Subbasin.

2.1 Summary of Jurisdictional Areas and Other Features

The Plan area is mostly located within Kings County, with small portions in Tulare and Kern Counties. The groundwater basin covers approximately 837 square miles (535,869 acres) (DWR 2016b). The land overlying the Tulare Lake Subbasin has a population of 125,907 (2010), and density of 150 persons per square mile, including the City of Hanford at approximately 93,381 persons (DWR 2019a; US Census Bureau 2019). A major portion of the Subbasin's population works in the agricultural production industry, which is one of the top three industries in Kings County (Kings County 2019). The GSAs vary in acreage and location within the GSP area resulting in the need for different monitoring and management actions in some instances.

Tulare Lake Subbasin GSAs

GSA	Approximate Area	Approximate Location in the Subbasin
Mid-Kings River GSA	152 square miles (97,400 acres)	Northeastern portion
South Fork Kings River GSA	111 square miles (71,313 acres)	Northwestern portion
Southwest Kings GSA	140 square miles (90,000 acres)	Western portion
El Rico GSA	357 square miles (228,400 acres)	Center portion
Tri-County Water Authority	170 square miles (108,000 acres)	Southern portion

Source: (DWR 2019d).

2.2 Water Resource Monitoring and Management Programs

Local, state, and federal agencies conduct ongoing surface water and groundwater monitoring in the Central Valley. The National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) and the California Statewide Groundwater Elevation Monitoring (CASGEM) Program track long-term groundwater elevation trends throughout the state and monitor subsidence. The Kings River Conservation District (KRCD) is the local agency that monitors groundwater levels within the Plan area. KRCD facilitates collaboration between local monitoring entities and DWR. The data is collected twice a year, in the spring and the fall (DWR 2012). The individual agencies located within the Plan area will be responsible for collecting data for any previously established monitoring or management plan. However, historical groundwater-related decisions by other agencies and private entities limit the current flexibility and management of the Subbasin. The member agencies will report the water quality and water supply data to the GSAs, as needed.

2.3 Relation to General Plans and Other Land Use Plans

Six general plans are in effect within the boundaries of the Subbasin, each of which were adopted prior to creation of the local GSAs and preparation of the GSP. The Plan area also includes four community plans within unincorporated areas (Table 2-3). Implementation of the GSP will adhere to and improve upon, when applicable, the policies and groundwater management provisions specified under each applicable general plan, community plan, and urban water management plan in order to fulfill SGMA requirements.

2.4 Additional GSP Components

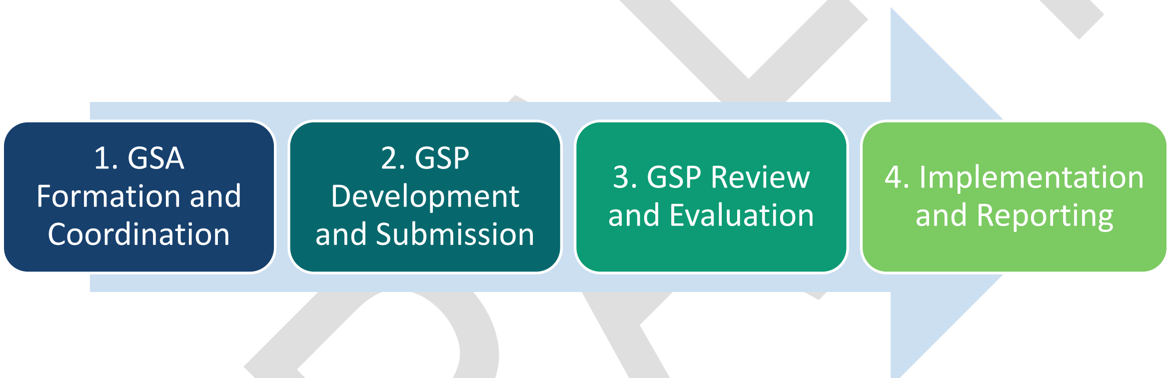
Additional GSP components include elements in the Water Code §10727.4 that the GSAs determine to be applicable. These elements address issues that have the potential to result in undesirable results including but not limited to wellhead

A **Wellhead Protection Area** is a surface and subsurface land are regulated to prevent contamination of a well that supplies a public water system.

protection areas and groundwater replenishment. Additional components also include planning aspects of the GSP relative to existing regulatory framework, including relationships with state and federal agencies, land use planning, and efficient water management practices, which are implemented locally. Section 2.4, *Additional GSP Components*, includes discussion and analysis of these potential issues to identify GSP management and monitoring strategies within the Plan area.

2.5 Notice and Communication

The GSAs considered the interests of all beneficial uses and users of groundwater within the GSP area throughout the development of the GSP (Water Code, § 10723.2). Public outreach included public meetings, which were made accessible via multiple platforms including web and print (see Appendix B). Active engagement with a diverse range of groundwater users and stakeholders occurred or will occur over four phases of GSP development and implementation:



3.0 Basin Setting

Chapter 3, *Basin Setting*, describes the physical setting and characteristics of current Subbasin conditions relevant to the GSP including a Hydrogeologic Conceptional Model (HCM) of the Subbasin. The HCM describes the hydrogeology of the Subbasin and adjacent areas, conditions, current and historic groundwater conditions, management areas, and a water budget. The HCM, is the foundation for the development of a numerical groundwater flow model of the Subbasin. Results of the modeling have been used to calculate water budgets, forecast future groundwater conditions, and evaluate the effectiveness of projects and management actions in achieving Subbasin groundwater sustainability. The groundwater model results are described in this chapter and the following chapters. Development of the model is described in the Model Report Documentation in Appendix D.

3.1 Hydrogeologic Conceptual Model and Hydrogeologic Setting

Section 3.1, *Hydrogeologic Conceptual Model*, provides the hydrogeologic setting and foundation for the numerical groundwater model and discusses data gaps and uncertainties associated with the HCM. The HCM examines interactions between groundwater and surface water, assesses the inflows and outflows to and from the Subbasin, as well as provides the foundation for the numerical groundwater model.

Inflows and outflows describe the recharge and discharge of water into and out of an aquifer, which are quantified in order to define the water budget of the aquifer system.

The San Joaquin Valley is relatively flat and elongated in a northwest-southeast direction and is bounded on the west by the Coast Ranges and on the east by the Sierra Nevada Mountains (Figure 3-4). The San Joaquin River is the principal drainage connection between the San Joaquin Valley and the Pacific Ocean receiving significant runoff from tributary rivers and streams emanating primarily from the adjoining Sierra Nevada Mountains. The Tulare Lake bed historically occupied a substantial portion of the Subbasin, which has been internally drained in recent history, with only periodic connection to the San Joaquin River during times of extreme runoff. The Subbasin is generally divided into two aquifer systems, an unconfined to semi-confined aquifer system above the Corcoran Clay layer and a confined aquifer system below the Corcoran Clay.

3.2 Groundwater Conditions

Historically, groundwater movement in the Subbasin was primarily caused by recharge of surface water within the alluvial fans of rivers and streams, as well as from evaporation from Tulare Lake and evapotranspiration from swamps and marshes. The topography of the Subbasin is generally low sloping inward from all directions toward the center of the former Tulare Lake bed (Figure 3-7).

Groundwater levels in the Subbasin and adjacent areas experience seasonal variation but have generally declined since 1990. As of 2016, groundwater was at an elevation of 230 feet above mean sea level (msl) near Kingsburg with lower levels and decreasing toward the bottom of the former Tulare Lake. The Hanford area observed groundwater levels at approximately 110 feet above msl (Davis et al. 1959). In comparison to 1990, groundwater was measured at an elevation of approximately 260 feet above msl near Kingsburg and approximately 170 feet above msl beneath Hanford. As of 2016, groundwater elevations have declined approximately 100 to 200 feet from 1952 conditions (Davis et al. 1959). The decline in groundwater levels has resulted in a change in the natural prevailing direction of groundwater flow in the Subbasin away from the former Tulare Lake bed.

The Subbasin groundwater model was used to calculate available groundwater in storage for the principal aquifers (unconfined above the E-Clay and confined below the E-Clay) within the Subbasin boundaries based on 2016 conditions. The available groundwater in storage in the unconfined aquifer zone in 2016 is estimated at 57.4 million acre-feet (AF). The available groundwater in storage in the confined aquifer zone is estimated at 162.4 million AF. Total available groundwater in storage is approximately 219.5 million AF.

Water quality conditions vary throughout the San Joaquin Valley, which can partially be attributed to variation in the characteristics of the sediments making up the aquifers. On the west side, deposits derived from marine sedimentary rocks contain high proportions of sulfur-rich materials, whereas on the east side, deposits derived from granatic rocks contain high proportions of silicates. Also, groundwater in the center and southwest potions of the Subbasin contains higher proportions of salts and chloride due to evaporative concentration in the area.

3.3 Water Budget Information and Demand by Sector

The Subbasin's water budget describes the inflows and outflows of water from the Subbasin hydrogeologic system, which provide the total amount of groundwater storage change annually. Recent historical conditions indicate that average annual demand of groundwater is much greater than the recharge rate to the groundwater system. This has led to groundwater overdraft conditions within the Subbasin.

A **Water Budget** describes the total groundwater and surface water inflows, outflows, and changes in storage throughout the hydrologic cycle.
The **Hydrogeologic System** refers to the subsurface geologic features that affect the distribution and movement of groundwater beneath the Earth's crust.

The projected water budget for the Subbasin represents a hypothetical forecast for the 54-year period from 2017 through 2070 based on an assumed "normal hydrology" period and estimated future climate change impacts. This forecast provides the Subbasin's GSAs with a tool to allow flexibility in groundwater management and planning of sustainability projects. The water budget is based off of current baseline conditions of groundwater and surface water supply, water demand, and aquifer response to the implementation of actions under the GSP.

Total inflows into the Subbasin consists of precipitation, surface water imports, flood waters, intentional recharge, seepage losses from surface water conveyances, seepage losses from WWTPs, and subsurface inflows from surrounding subbasins. During the 1990-2016 period, estimated total inflow ranged from 663,600 to 2,119,000 AF/year (AF/yr). Total outflows from the Subbasin consists of evapotranspiration, well pumping, and subsurface outflows to surrounding subbasins. During the 1990-2016 period, estimated total outflow ranged from

1,260,300 to 2,959,200 AF/yr. Municipal demand varies seasonally and peaks in the summer months, which occurs most significantly in the cities of Hanford, Lemoore, Armona, Stratford, and Corcoran. Agricultural pumping is not comprehensively monitored throughout the Subbasin, but agricultural demand can be reasonably estimated. The agricultural pumping demand during the 1990-2016 period has ranged from an estimated 184,900 to 776,200 AF/yr.

3.4 Management Areas

In order to facilitate implementation of the GSP, management areas have been created for the Subbasin. There are five Primary Management Areas and two Secondary Management Areas. Each of these types of management areas are described in the following sections.

Primary Management Areas have been formed from each of the five GSAs. (Figure 3-53). The formation of Primary Management Areas will facilitate data management and efficiently implement and manage the GSP. Furthermore, each GSA has unique surface water and groundwater allocations and usage, and they are best positioned to develop Best Management Practices (BMPs) and development of groundwater sustainability projects.

Minimum thresholds, measurable objectives, and monitoring areas developed for each GSA management area described in Chapter 4 are based on the groundwater conditions within each individual GSA management area. Each GSA will coordinate with adjacent GSAs in the Subbasin and adjacent subbasins to monitor if undesirable results in the adjacent managements areas are occurring as a result of activities within that GSA's management area and to coordinate corrective action if necessary.

Two Secondary Management Areas have been formed for the Subbasin. These two Secondary Management Areas are different from the Primary Management Areas and each other due to distinctly different groundwater conditions in each area. These two areas are the Clay Plug and the Southwest Poor Quality Groundwater Secondary Management Areas ("Secondary Management Areas A and B," respectively).

The former Tulare Lake clay beds are one of the most significant controlling factor for groundwater movement in the Subbasin. The center of the Tulare Lake deposition is made up of continuous lacustrine deposits extending like a tap root through the interior portions of the lakebed to the top of the San Joaquin Formation, which is 2,600 to 3,000 feet bgs (Figures 3-14a through 3-14c). The area with continuous lacustrine sediments from the surface to the underlying San Joaquin Formation is roughly 23 miles long by 12 miles wide. These continuous lacustrine sediment deposits are collectively called the clay plug. The clay plug does not transmit groundwater and is a hydrologic "dead" zone. As such, the area has never been developed for groundwater extraction and use.

Because this area, due to its historical depositional environment, is isolated from the regional groundwater flow regime in the Subbasin, it is being treated differently than other areas for monitoring purposes and the establishment of compliance points.

As described in Section 3.2.5, *Groundwater Quality,* and shown on Figure 3-30, groundwater in the southwest corner of the Subbasin contains elevated TDS concentrations. The groundwater in this area is of such poor water quality that there are no water supply wells in the area. Because of the poor groundwater quality in this area, and the lack of water supply development, it is being treated differently than other areas for monitoring purposes and the establishment of compliance points.

4.0 Sustainable Management Criteria

Sustainability Indicators
▶ **Groundwater Levels**
▶ **Groundwater Storage**
▶ **Land Subsidence**
▶ **Water Quality**
▶ **Interconnected Surface Water**
▶ **Seawater Intrusion**

Chapter 4, *Sustainable Management Criteria*, establishes the criteria for conditions that constitute sustainable groundwater management in the Subbasin, including how the GSAs will characterize undesirable results, as well as minimum thresholds (MT's) and measurable objectives (MO's) for the groundwater sustainability indictors. Groundwater sustainability indicators for the sustainable management of groundwater are specified by SGMA based on factors that have the potential to impact the health and general well-being of the public. These indicators will continue to be monitored throughout the GSP's planning and implementation period. The groundwater Sustainability Indicators are groundwater levels, groundwater storage, land subsidence, groundwater quality, interconnected surface water, and seawater intrusion.

> A **potentiometric surface** is the level to which water rises in a well. **Potentiometric surface maps** are contour maps of the potentiometric surface.

Groundwater levels, groundwater storage, land subsidence, and groundwater quality are the primary concerns and focuses of sustainable groundwater management in this GSP. Interconnected surface water is not present in the Subbasin and seawater intrusion is not a concern within the GSP due to the distance to the coast and lack of continuity with a seawater source.

4.1 Sustainability Goal

The Sustainability Goal for the Subbasin is to manage groundwater resources in a way that will allow an adequate water supply for existing beneficial uses and users in accordance with counties and cities general plans while meeting established MO's to maintain a sustainable yield. Further, the goal is to continue to provide adequate water supply for existing beneficial uses and users while ensuring the future, sustainable use of groundwater. The Sustainability Goal works as a tool for managing groundwater, basin-wide, on a long-term basis to protect quality of life through the continuation of existing economic industries in the area including but not limited to agriculture.

The GSAs will work collectively to manage groundwater resources in the Subbasin, develop sustainability projects, and implement management actions, where appropriate. Historic and hydrologic modeling estimates were used to develop a sustainable yield at which which future groundwater levels will stabilize, significantly reducing overdraft in the Subbasin.Under GSP implementation to reach sustainable groundwater yield, reduction of groundwater storage will be minimized, the rate of land subsidence will slow, and groundwater quality will not experience undesirable results.

> **Undesirable Results** are defined in Water Code § 10721, which include:
> - **Chronic lowering of groundwater levels**
> - **Reduction of groundwater storage**
> - **Seawater intrusion**
> - **Degraded water quality**
> - **Land subsidence**
> - **Depletion of interconnected surface** waters

The Sustainability Goal was established in a manner that is transparent to the public and stakeholders to ensure the local population has a voice in the development of the programs. With the implementation of management actions and projects, as well as the continued interim monitoring and reassessment of activities, groundwater levels will be maintained at levels that will not create undesirable results.

4.2 Undesirable Results

Undesirable results occur when groundwater conditions within the Subbasin result in significant and unreasonable impacts to a sustainability indicator (California Government Code § 354.26). MT's, when exceeded, as defined in this GSP, are considered an undesirable result for a sustainability indicator and serve as the criteria for this SGMA requirement.

4.2.1 *Primary Causes of Undesirable Results*

Historic allocation of surface water for federal, state, and court uses over time has resulted in a need for the overlying Subbasin population and enterprises to find additional viable water sources, which in this Subbasin, has fostered a reliance on groundwater. Additionally, Subbasin-wide effects to groundwater supplies may result from climate change conditions, changing crop patterns, groundwater outflows, and increased urbanization. Relevant sustainability indicators within the GSP have a range of causes of undesirable results.

Primary Causes of Undesirable Results for Each Sustainability Indicator

Sustainability Indicator	Primary Causes of Undesirable Results
Groundwater Levels	Over pumping due primarily to agricultural demands Lack of recharge in many areas of the Subbasin
Groundwater Storage	Over pumping due primarily to agricultural demands Lack of recharge in many areas of the Subbasin
Land Subsidence	Extraction of groundwater above and below the Corcoran Clay layer resulting in compaction and eventual ground surface subsidence
Groundwater Quality	Pumping activities, unrelated to GSP implementation Release of contaminants to the subsurface from human activities

4.3 Minimum Thresholds

MTs were established to avoid undesirable results for this GSP's sustainability indicators. When evaluating undesirable results, the metrics for the groundwater sustainability indicators, as measured at Representative Monitoring Sites (RMS's) will be monitored and compared to the MT to determine if undesirable results may be occurring. When the metrics measured at the RMS's, or at a combination of RMSs are not meeting the MTs, additional management actions will be implemented to meet the threshold requirement for that indicator. The table below summarizes the MTs established at each RMS and how an exceedance will be determined.

MTs for Each Sustainability Indicator

Sustainability Indicator	Minimum Threshold at RMS	Minimum Threshold Exceedance
Groundwater Levels	One standard deviation below modeled forecasted water levels	Exceed the MTs at 45% of the RMSs for 3 consecutive years
Groundwater Storage	Use groundwater levels	Groundwater levels exceed the MTs at 45% of the RMSs for 3 consecutive years
Land Subsidence	16 feet of subsidence	Significant loss of functionality of critical infrastructure
Degraded Water Quality	Regulatory standards	Regulatory standards exceeded, if caused by implementation of the GSP

4.4 Measurable Objectives

The GSP established MO's for each sustainability indicator to achieve the sustainability goal of the Subbasin among each sustainability indicator. Milestones at approximately 5-year intervals have been identified to evaluate if groundwater sustainability is on a path to being achieved and if the implemented project and management actions are effective.

4.4.1 *Groundwater Levels Indicator*

MOs were set in this GSP for groundwater levels at each of the RMS wells. The MOs were estimated through the use of hydrographs that utilize data collected during a normal period, and projecting the trend via the groundwater model through 2040. The GSAs selected a method for setting the MO's and MT's to be achieved and sustained after 2040, while providing a regional margin of operational flexibility, under adverse conditions without causing undesirable results.

4.4.2 *Groundwater Storage Indicator*

The MO for change in groundwater storage volume is to significantly reduce the reduction in groundwater storage by 2040. After 2040, it is predicted the Subbasin should see a net zero change in groundwater storage on a 10-year rolling average basis. Water levels at the RMSs will be utilized to develop contour maps to assist in estimating storage change.

4.4.3 *Land Subsidence Indicator*

Groundwater modeling forecasts with associated subsidence estimates through implementation period were used to develop the MTs for land subsidence. It is anticipated that recent subsidence rates should decrease through the implementation period as long-term groundwater level declines are significantly reduced. The 2040 forecast subsidence elevations are the MOs.

4.4.4 *Groundwater Quality Indicator*

The MOs for groundwater quality will be no exceedance of groundwater quality regulatory levels, as caused by implementation of the GSP. The GSAs will not be responsible for water quality issues currently being addressed by each coalition, nor will the GSAs be responsible for water quality issues associated with influences other than water quality issues associated with implementation of the GSP.

5.0 Monitoring Network

Chapter 5, *Monitoring Network*, describes the network that will be established by the GSAs to collect sufficient information on groundwater and other conditions and to assess the GSP implementation through a data collection and management system. Collected data will be evaluated to demonstrate short-term, seasonal, and long-term groundwater trends and related surface conditions and progress towards achieving groundwater sustainability.

5.1 Description of Monitoring Network and Objectives

A comprehensive monitoring network is essential to evaluate GSP implementation and measure progress towards groundwater sustainability based on the following indicators: groundwater levels, groundwater storage, water quality, and land subsidence. Groundwater levels, groundwater storage, and groundwater quality monitoring will utilize existing monitoring wells, irrigation, municipal, industrial, domestic wells, and proposed monitor wells as Representative Monitoring Sites (RMSs), and general-purpose monitoring locations. Representative monitoring will be utilized to represent the general trends of groundwater within a management area with data from RMSs. The Subbasin's groundwater conditions vary substantially across the area, so the use of a small number RMSs may not adequately cover varying conditions. The GSP will work to fill data gaps with existing wells and expand monitoring sites to increase to the greatest extent possible the accuracy of the data.

5.2 Groundwater Levels

Groundwater level monitoring has occurred in the Subbasin in the majority of areas on a bi-annual basis since the 1950s by local, state, and federal agencies, including the Kings County Water District (KCWD), KRCD, Department of Water Resources (DWR), and the United States Bureau of Reclamation (USBR) (Provost & Pritchard 2011; WRIME 2005). KCWD, KRCD, and Tulare Lake Bed water agencies currently participate in CASGEM and report groundwater level data on a semi-annual basis. The proposed monitoring network for groundwater levels includes wells in the B zone (above E clay) and C zone (below E clay), and wells for the A zone (above the A clay where it is present). The GSAs will develop a program to obtain additional construction information on wells in the monitoring network which have historical data.

5.3 Groundwater Storage

The groundwater model developed for the Tulare Lake Subbasin and funded by DWR was used to estimate the overall annual change in groundwater storage from 1996 to 2016 in unconfined and confined aquifers. For GSP annual reporting, annual storage change will be done by comparing annual spring-to-spring groundwater level contour maps.

> **Unconfined aquifers** are those directly beneath the Earth's surface with the water table as the upper boundary.
> **Confined aquifers** are bounded by less permeable material and occur at a significant depth below the ground surface.

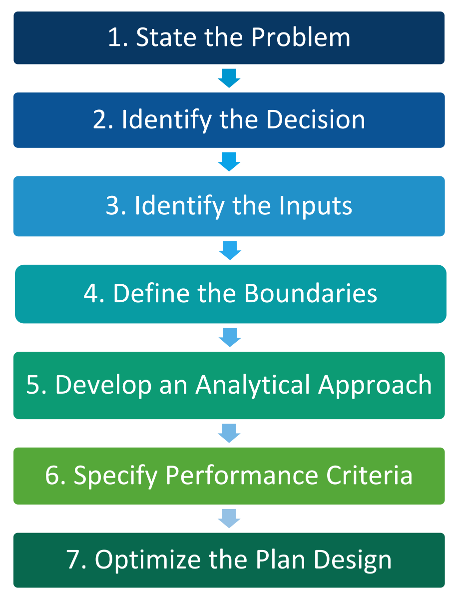
5.4 Water Quality

While intermittent water quality analysis occurs in the Subbasin for irrigation suitability, no monitoring program is in place with defined time and space distribution, with the exception of municipal water suppliers. Water quality sampling will be implemented in wells within the Subbasin as a baseline to understand existing groundwater characteristics, and every 3-5 years, water quality samples will be taken and evaluated at designated well locations.

5.5 Land Subsidence

The Tulare Lake Subbasin land subsidence monitoring network will utilize data and subsidence evaluations by a variety of agencies including the United States Geological Survey (USGS), DWR, KRCD, Kaweah Delta Water Conservation District (KDWCD), NASA, University Navigation Satellite Timing and Ranging Consortium (UNAVCO), and Central Valley Spatial Reference Network (CVSRN). These data will be evaluated annually and if subsidence rates approach measureable objectives at the nearest CGPS station then additional RMPs may be added as determined by the GSA.

Data Quality Objective Process



5.6 Consistency with Standards and Monitoring Protocols

The data gathered through the monitoring network will be consistent with the standards identified in 23 CCR §352.4 related to Groundwater Sustainability Plans. Monitoring protocols will be developed using the Data Quality Objective (DQO) process to ensure GSP implementation is meeting measurable objectives and the sustainability goal of the Subbasin.

5.7 Assessment and Improvement of Monitoring Network

The CASGEM Groundwater Elevation Monitoring Guidelines (DWR 2010) were used to estimate the density of RMP wells needed for the Subbasin per the monitoring networks BMPs. As feasible, the GSAs will continue to add additional wells either as RMPs or as wells monitored as part of existing monitoring networks in order to increase the amount of data available to prepare groundwater contour maps to monitor groundwater levels and storage. While there are existing temporal and spatial data gaps within the Subbasin, they will be filled using existing wells where possible. The GSAs plan to construct dedicated monitoring wells as funding becomes available.

5.8 Data Storage and Reporting

Monitoring programs are coordinated within the Tulare Lake Subbasin. Well location, construction, and groundwater level data are shared or will be shared among the different GSAs. In addition, the monitoring programs described in this chapter were reviewed by the GSAs, and they are consistent throughout the Subbasin. Similarly, data reported to DWR will be collected and reported in a consistent format.

The GSAs will develop a Data Management System (DMS) for implementation of the GSP. A DMS is a software application that manages data storage and retrieval in a secure and structured environment. The DMS will include clear identification of monitoring sites for the different SMCs and a description of the quality assurance and quality control checks to be performed on the data. The DMS for the Subbasin shall be secure and easily accessible to stakeholders to enter data and generate reports. Standardized data templates will help stakeholders organize their data so that it transfers to the DMS efficiently to reduce the amount of time spent on data entry and quality control.

6.0 Project and Management Actions

Chapter 6, *Project and Management Actions,* outlines the project and management actions of the GSAs to meet the sustainability goal of the Subbasin in a manner that can be maintained long-term. Selected projects and management actions will be implemented upon approval by the GSAs and DWR. Project and management actions will vary throughout the Subbasin to attain sustainable groundwater management for each relevant sustainability indicator.

6.1 Water Supply

Permits, licenses, and registrations give the right to beneficial use of surface water to various entities within a Place of Use. The Subbasin is located within the Place of Use for the State Water Project (SWP), the United States Bureau of Reclamation (USBR), Central Valley Project (CVP), the Kings River, the Tule River, the Kaweah River and the St. Johns River. The Kings River's surface water supplies are anticipated to serve as the main water supply for projects within this GSP.

6.2 Conveyance Facilities Modifications and Construction of New Facilities

Existing facility modifications may be implemented to increase the capacity of groundwater transport (conveyance). The construction of new conveyance systems in the Subbasin will facilitate the expansion of delivery areas from surface water. Existing facilities throughout the Subbasin will be improved, and existing canals will be reshaped through removal of sediment and plant growth. The objective is to reduce the chronic lowering of groundwater levels through increase in surface water deliveries.

Above ground storage tanks will be constructed in areas with clay soils throughout the Subbasin under this GSP. The objective is to increase surface water deliveries and reduce groundwater pumping to avoid further undesirable results.

6.3 Intentional Recharge Basin

Recharge basins will be constructed in areas with soils associated with high infiltration rates. Project locations will be identified within the GSAs once funding is available. The objective is to recharge surface water into the aquifer system for to increase available supplies for recovery in drier years. Recharging water in wet years will increase groundwater levels and create a buffer storage volume, or a water bank, that may be extracted during periods of dryness or drought.

6.4 On-Farm Recharge

On-farm recharge is a category of groundwater recharge created through the flooding of existing agricultural production areas. Areas containing soils with high infiltration rates will be identified and selected. Each GSA will determine the minimum acreage size for the project. The objective is to reduce chronic lowering of groundwater levels through the storing of water underground for recovery in dry years for farmland irrigation. Additionally, this would provide flood flow diversion in wet years in the Subbasin.

6.5 Aquifer Storage and Recovery (ASR)

ASR is the intentional recharge of groundwater through direct injection of surface water into an aquifer for later recovery. ASR well sites will be selected based on soil type to directly store water for recovery in drier years and/or to mitigate subsidence impacts. The objective is to reduce the chronic lowering of groundwater and to reduce subsidence.

6.6 Reduced Agricultural Demand

Agricultural demand for water will be reduced in the Subbasin as one action to achieve groundwater sustainability. It is anticipated that the Subbasin will reduce agricultural demand for water by about 25% by 2040. Current plans are for the reductions to start in 2025 at 2% per year until cumulatively the total reduction is 25%.

6.7 Management Actions

Examples of management actions include but are not limited to the following:

- Project Policies
    - Voluntary fallowing Programs
    - Above-ground surface water storage projects
- Outreach
    - Education on efficient groundwater use
- Groundwater Allocation
    - Operation and management of groundwater extractions
- New Development
    - Requirement of new developments in the Subbasin, with the exception of de minimis extractors, prove sustainable water supplies if land will be converted

Management areas vary by GSA to achieve sustainable yield throughout the Subbasin based on local conditions. The complete list of potential management actions is provided in Section 6.4, *Management Actions.*

7.0 Plan Implementation

Chapter 7, *Plan Implementation,* provides an overview of how the GSP will be implemented within the Subbasin to reach sustainable yield of groundwater by the year 2040. Implementation strategies will be reviewed and updated at each five-year interim milestone of this GSP. Costs and funding sources are currently being developed by the GSAs and will be finalized prior to DWR review.

7.1 Estimate of GSP Implementation Costs

Project costs are identified by project type and implementation agency (see Table 7-1). Additionally, Chapter 6, *Projects and Management Actions*, summarizes the cost per project within each GSA (Table 6-1 to 6-4). Selected projects will include details on the estimated benefits in acre-feet annually for the GSA's area as well as the implementing agency.

7.2 Funding Alternatives

A number of the GSAs passed the local Proposition 218 securing funds for initial GSP preparation and GSA administrative functions. Full funding sources will be identified for each GSA prior to DWR review to ensure successful implementation of project and management actions within the Subbasin.

7.3 Schedule for Implementation

Implementation of the GSP will result in sustainable yield of groundwater resources in the Subbasin by year 2040. At each five-year interim milestone, applicable updates to the schedule will occur, dependent on achievement of MOs for each applicable sustainability indicator. The anticipated schedule of implementation of project and management actions across the Subbasin are described below. Additional specifics on implementation timing with regards to selected projects will be provided prior to DWR review.

- 2020-2025-Yield 24,300 AF
  - Begin identification of management actions through policy development, dealing with demand reduction,
  - Bring on-line first projects,
- 2026-2030-Yield 66,350 AF
  - Implement Management Actions relating to demand reduction,
  - Expansion of projects and new projects on-line,
- 2031-2035-Yield 135,100 AF
  - Implement Management Actions relating to demand reduction,
  - Expansion of projects and new projects on-line,
- 2036-2040-Yield 153,000 AF
  - Implement Management Actions relating to demand reduction,
  - Expansion of projects

7.4 Annual Reporting

GSAs will provide an annual report to DWR on the progress of GSP implementation and steps towards achievement of interim milestones. The GSP Manager or Subbasin Coordinator will submit the reports to the DWR for reviewal. The schedule for completion of the annual report is as follows:

Date	Completed Action
December 31st	Deadline for GSAs to provide GSA specific information to the Subbasin
February 28th	Completion of draft of Annual Report
March 15th	Review of the Annual Report by the GSAs and Board of Directors for approval
April 1st	Submittal to DWR by Basin Coordinator

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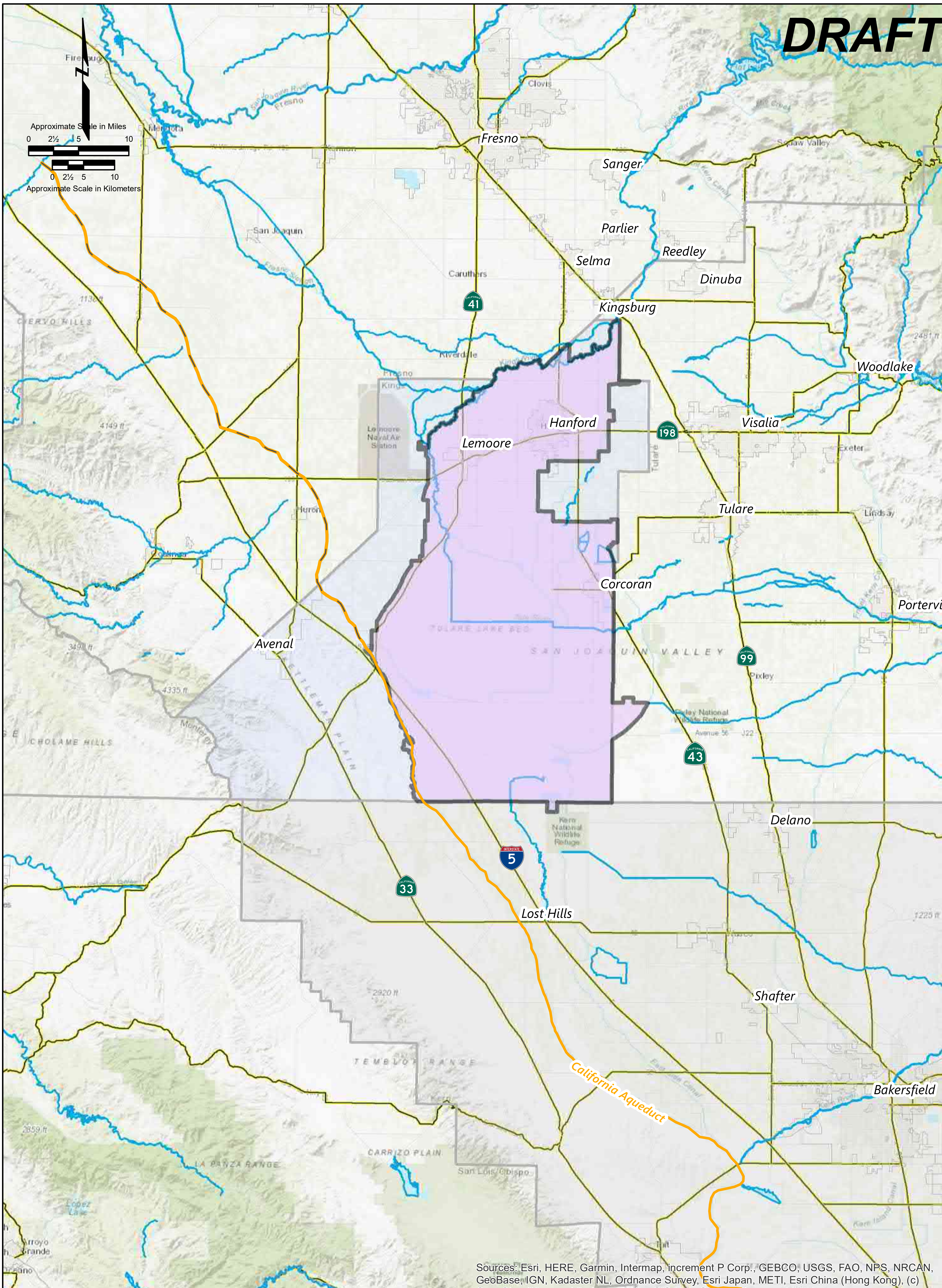

Explanation

Federal Central Valley Project Infrastructure(CVP)

State Water Project Infrastructure (SWP)

Joint Federal/State

River/Lake [1]

All Counties, US (TIGER/Line 2016)

Subbasin boundary

Cities2015

Notes:
1) All surface water data taken from the National Hydrography Dataset. USGS 2016.

Regional Location of Tulare Lake Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/30/2019	Project No.: FR18161220
		Figure **ES-1**

Date: 8/30/2019 Printed by: elizabeth.chapman
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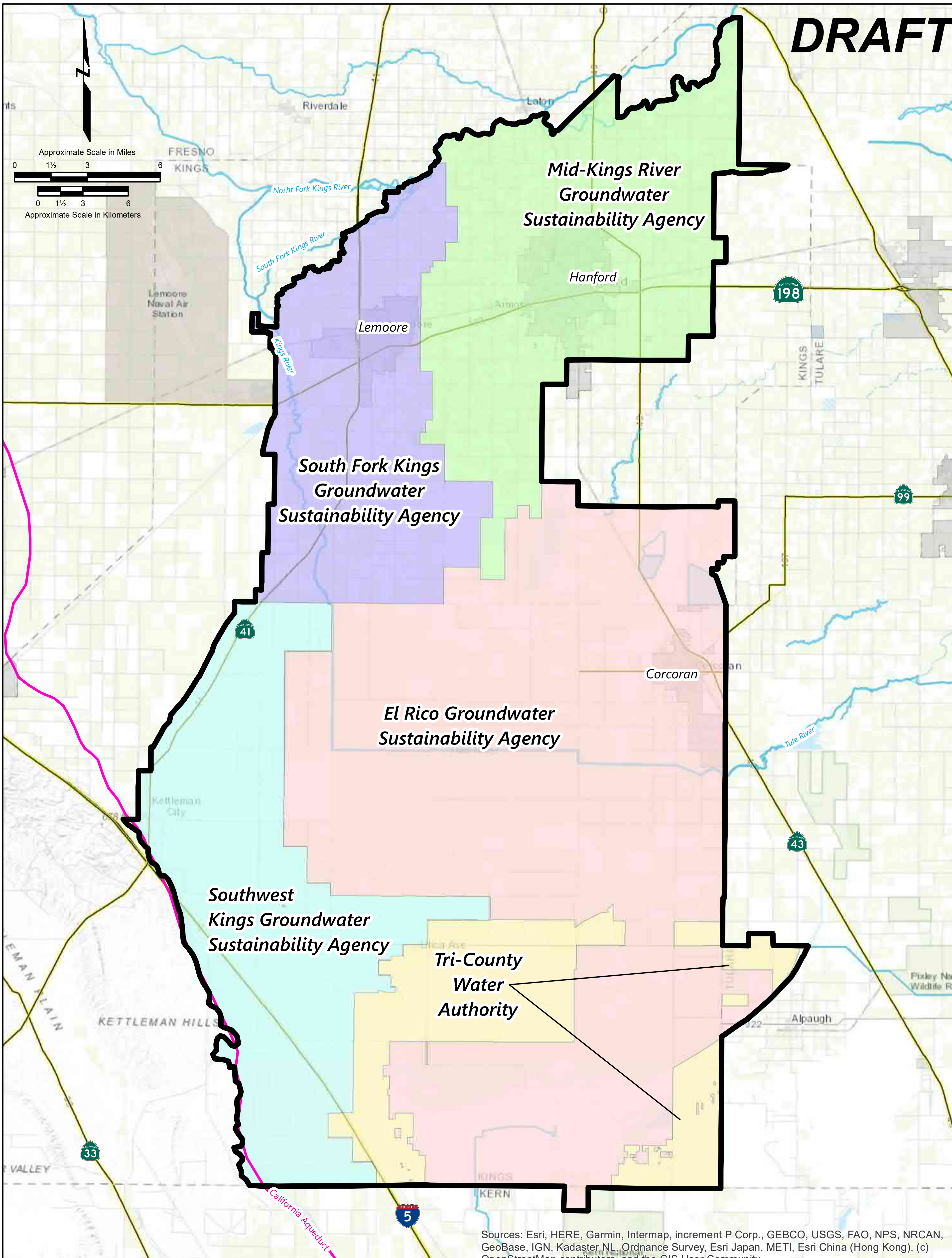

Explanation

- Governor Edmund G. Brown California Aqueduct
- River/Lake [1]
- Subbasin boundary
- Cities2015

Groundwater Sustainability Agencies (GSAs)

- El Rico GSA
- Mid-Kings River GSA
- South Fork Kings GSA
- Southwest Kings GSA
- Tri-County Water Authority GSA

Notes:
1) All surface water data taken from the National Hydrography Dataset. USGS 2016.

GSAs within the Tulare Lake Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/30/2019	Project No.: FR18161220
		Figure **ES-2**

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ACRONYMS AND ABBREVIATIONS

%	Percent
µg/L	micrograms per liter
µm/sec	micrometers per second
µS/cm	microsiemens per centimeter
AB	Assembly Bill
AC	Advisory Committee
AF	acre-feet
AF/yr	acre-feet per year
AGR	agricultural uses
AMSL	above mean sea level
ASR	Aquifer Storage and Recovery
bgs	below ground surface
BMP	Best Management Practice
BPA	Basin Plan Amendment
Caltrans	California Department of Transportation
CASGEM	California Statewide Groundwater Elevation Monitoring
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGPS	Continuous Global Positioning System
CIMIS	California Irrigation Management Information System
Coalition	Kings River Water Quality Coalition
CSD	Community Service District
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CV-SALTS	Central Valley Salinity Alternatives for Long-term Sustainability

ACRONYMS AND ABBREVIATIONS (CONTINUED)

CVSRN	Central Valley Spatial Reference Network
DAC	Disadvantaged Community
DDW	Division of Drinking Water
DMS	Data Management System
DOF	Department of Finance
DPR	Department of Pesticide Regulation
DQO	Data Quality Objective
dS/m	decisiemen per meter
DTSC	Department of Toxic Substance Control
DWR	Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection Program
EC	electrical conductivity
EPA	United States Environmental Protection Agency
ET	evapotranspiration
ETc	Crop evapotranspiration
FAO	Food and Agriculture Organization
ft	foot/feet
ft/d	foot per day
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information System
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
HS	Health and Safety
HSR	High-Speed Rail
ID	Irrigation District

ACRONYMS AND ABBREVIATIONS (CONTINUED)

ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
ITRC	Cal Poly Irrigation Training & Research Center
IWP&DC	International Water Power & Dam Construction
JPA	Joint Powers Authority
JPL	Jet Propulsion Laboratory
KCWD GWMP	Kings County Water District Groundwater Management Plan
KDSA	Kenneth D. Schmidt and Associates
KDWCD	Kaweah Delta Water Conservation District
KRCD	Kings River Conservation District
KRWA	Kings River Water Association
KRWQC	Kings River Water Quality Coalition
Ksat	saturated hydraulic conductivity
LiDAR	Light Detection and Ranging
LKB GWMP	Lower Kings Basin Groundwater Management Plan
LU	Land Use
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
mmhos/cm	millimhos per centimeter
MO	measurable objective
MSL	mean seal level
MT	minimum threshold
MUN	municipal or domestic water supplies
NASA	National Aeronautics and Space Administration
NAVSTAR	Navigation Satellite Timing and Ranging
NCCAG	Natural Communities Commonly Associated with Groundwater”
NO3-N	Nitrate as Nitrogen
NOAA	National Oceanic and Atmospheric Administration

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NRCS	Natural Resources Conservation Service
PBO	Plate Boundary Observatory
PG&E	Pacific Gas and Electric Company
PRISM	Parameter-elevation Regressions on Independent Slopes Model
Program	Kings River Fisheries Management Program
PUD	Public Utility District
RC	Resource Conservation
RD	Reclamation District
RMS	representative monitoring site
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCE	Southern California Edison
SDAC	Severely Disadvantaged Community
SGMA	Sustainable Groundwater Management Act
SJRRP	San Joaquin River Restoration Program
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMARA	Surface Mining and Reclamation Act
SOPAC	Scripps Orbit and Permanent Array Center
SR	State Route
Subbasin	Tulare Lake Subbasin
SURF	Surface Water Database
SWP	State Water Project
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TLBWSD	Tulare Lake Basin Water Storage District
TLSGSP	Tulare Lake Subbasin GSP
TNC	The Nature Conservancy

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TV	television
UC Davis	University of California at Davis
UNAVCO	University Navigation Satellite Timing and Ranging Consortium
USACE	United States Army Corps of Engineering
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VOC	volatile organic chemical
WCR	Well Completion Report
WD	Water District
WDR	wastewater discharge requirement
WEI	Wood Environment & Infrastructure
WHPA	Wellhead Protection Area
WWQC	Westside Water Quality Coalition
WWTP	wastewater treatment plant

1.0 INTRODUCTION

The legislative intent of the Sustainable Groundwater Management Act of 2014 (SGMA) is to sustainably manage California's groundwater basins. SGMA gives authority to local agencies to form Groundwater Sustainability Agencies (GSAs) and to manage groundwater basins to reach long-term groundwater sustainability through the preparation and implementation of Groundwater Sustainability Plans (GSPs) (California Water Code, § 10720-10737.8). The adoption of SGMA established California's first comprehensive framework for sustainable management of groundwater basins through local agency coordination. SGMA expands the role of the California Department of Water Resources (DWR) to enforce local implementation of sustainable groundwater management practices through the review and approval of GSPs and allows for State Water Resources Control Board (SWRCB) intervention if groundwater basins do not meet sustainability requirements.

Key Features of SGMA

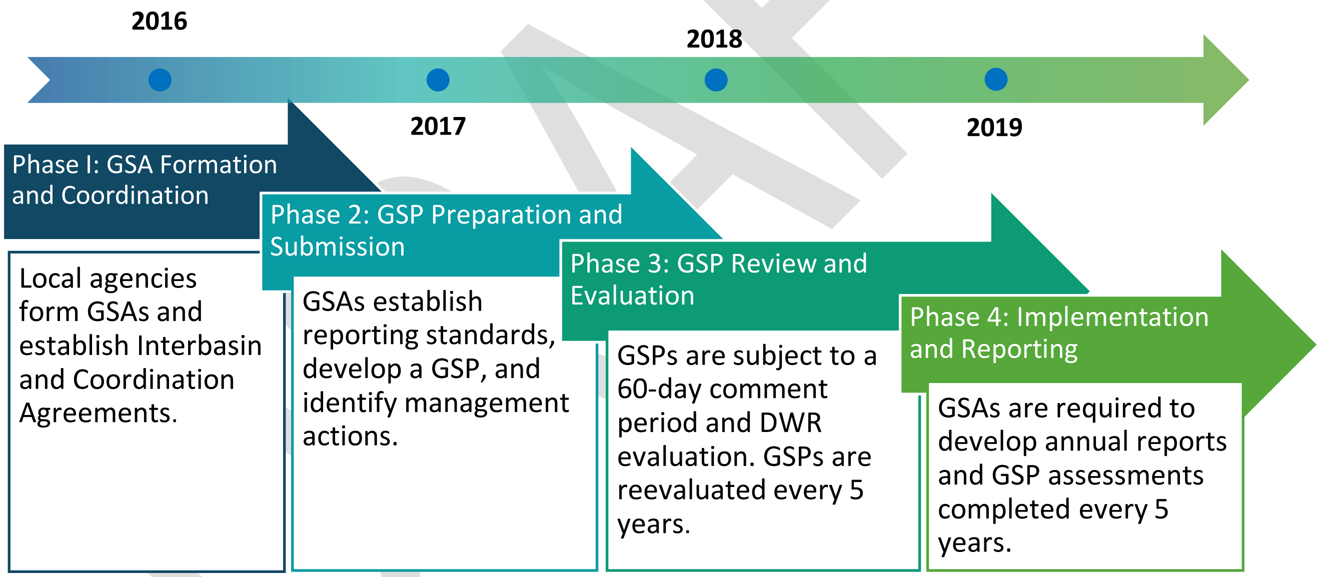
- **Senate Bill (SB) 1168 -** Requires the sustainable management of groundwater basins for long-term reliability and economic, social, and environmental benefits for future uses
- **SB 1319 -** Authorizes State Water Resources Control Board intervention to remedy a mismanaged groundwater basin
- **Assembly Bill (AB) 1739 -** Establishes criteria for sustainable management of groundwater and authorizes DWR to establish best management practices for groundwater management

DWR Statewide Bulletin 118 Report describes regional groundwater occurrence, defines California groundwater basin boundaries, identifies basins that are subject to critical conditions of groundwater overdraft, and establishes basin priority (California Water Code, § 12924). California's 515 groundwater basins are classified into four categories; high-, medium-, low, or very low-priority based on conditions identified in the California Water Code, § 10933(b). Conditions include the population and irrigated acreage overlying the subbasin, the degree to which the population relies on groundwater as their primary source of water, and exceedance of sustainable yield (DWR 2019b). Basin prioritization also considers any documented impacts on groundwater within the subbasin, including overdraft, subsidence, saline intrusion, water quality degradation, or other adverse impacts on local habitat and streamflows. A subbasin 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 2019b).

The Tulare Lake Subbasin (Subbasin) is identified as high priority by DWR and is one of twenty-one basins considered to be in a critically-overdrafted condition (DWR 2019a). Five participating

GSAs in the Tulare Lake Subbasin have coordinated to develop this comprehensive GSP in compliance with SGMA: Mid-Kings River, El Rico, South Fork Kings, Southwest Kings, and Tri-County Water Authority (Appendix G). The GSAs are committed to continued coordination and compliance with annual and 5-year reporting requirements during the implementation of their GSP.

Subbasins subject to critical conditions of overdraft are classified as medium-and high-priority basins under the above criteria and require the preparation and adoption of GSPs (California Water Code, § 10720.7). Each GSP is required to set long-term sustainability goals as well as “interim milestones” in increments of 5 years that represent measurable groundwater conditions and target values. Data collection and annual reporting to DWR is also required to ensure conformance with SGMA following GSP adoption, to the maximum extent feasible (California Water Code, § 10720.1). The GSPs therefore must be reevaluated and updated, at a minimum, every 5 years (2025, 2030, 2035, and 2040) to provide refinements to the GSPs and allow for revised management.



1.1 Subbasin Overview

The Subbasin (Basin No. 5-022.12) consists of 535,869 acres (837 square miles) in the southern region of San Joaquin Valley Groundwater Basin, within Kings County. The Kings, Kaweah, Tule, and Kern Rivers within the southern portion of the San Joaquin Valley flow into the Tulare drainage subbasin (DWR 2006). The Tulare Lake Subbasin is bounded to the south by the Kern County Groundwater Subbasin (5-022.14), to the east by the Tule Groundwater Subbasin (5-022.13) and the Kaweah Groundwater Subbasin (5-022.11), to the north by the Kings Groundwater Subbasin

(5-022.08), and the west by the Westside Groundwater Subbasin (5-022.09). The southern half of the Tulare Lake Subbasin consists of lands in the historically present Tulare Lake bed in Kings County (DWR 2016b).

The land overlying the Tulare Lake Subbasin has a population of 125,907 (2010), and density of 150 persons per square mile, including the City of Hanford at approximately 93,381 persons (DWR 2019a; US Census Bureau 2018). Agriculture is one of the top three industries in Kings County, and a significant portion of the subbasin population is involved in all facets of agricultural production (DWR 2019c). As one of the primary industries, agriculture is the largest source of employment in the County.

1.2 Purpose of the Groundwater Sustainability Plan

SGMA requires GSAs for high- and medium-priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge and expects subbasins to reach sustainability within 20 years of GSP implementation (DWR 2019c). GSAs establish minimum sustainability thresholds, measurable objectives, and long-term planning strategies through GSP development to achieve SGMA requirements (California Water Code, § 10720; 10727). GSPs must identify the existing physical setting of the groundwater basin and assess groundwater levels to inform management actions and measurable sustainability goals (California Water Code, § 10727.2).

The Tulare Lake Subbasin GSP establishes how GSAs will monitor groundwater and use the data results to improve groundwater conditions in the basin. DWR defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained

King's County is ranked the 10th largest agricultural production county in California. Top commodities include milk, cattle, cotton, almonds, pistachios, and tomatoes (Kings County Agricultural Commissioner 2017).

The Tulare Lake Subbasin contains approximately 251,994 irrigated acres of agricultural land. Approximately 50% of irrigation supplies are met by pumping groundwater (DWR 2019c).

during the planning and implementation horizon without causing undesirable results (California Water Code, § 10721 [v]). Undesirable results under SGMA are defined as:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable sea water intrusion
- Significant and unreasonable degraded water quality including the migration of containment plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Surface water depletions that have significant and unreasonable adverse impacts on beneficial uses of surface water.

The DWR GSP Emergency Regulations establish the requirements of GSP preparation and implementation in medium-and high-priority designated basins (Table 1-1; DWR 2016a).

1.3 Sustainability Goal

23 CCR §354.24 *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.*

1.3.1 Goal Description

This GSP aims to manage groundwater resources to continue to provide an adequate water supply for existing beneficial uses and users in accordance with counties and cities general plans while meeting established measurable objectives (MO) to maintain a sustainable yield. This goal aims to continue to provide adequate water supply for existing beneficial uses and users while ensuring the future, sustainable use of groundwater. Additionally, the sustainability goal works as a tool for managing groundwater, basin-wide, on a long-term basis to protect quality of life through the continuation of existing economic industries in the area including but not limited to agriculture.

The Groundwater Sustainability Agencies (GSAs) in the Subbasin will work collectively to manage groundwater resources in the Subbasin, develop sustainability projects, and implement management actions, where appropriate. Section 3.2, *Groundwater Conditions*, provides insight to current and historical groundwater conditions, as well as a model for a 50-year forecast water budget to quantify groundwater level stability. Historic and hydrologic modeling estimates were used to develop a sustainable yield, which aims to stabilize forecasted groundwater levels. This goal was established in a manner that is transparent to the public and stakeholders to ensure the local population has a voice in the development of the programs. With the implementation of management actions and projects, as well as the continued interim monitoring and reassessment of activities, groundwater levels will be maintained at levels that will not create undesirable results.

1.3.2 Discussion of Measures

To achieve the goals outlined in the GSP, a combination of measures, including continued management practices and monitoring will be implemented over the next 20 years and continued thereafter. Additional surface water supply and infrastructure projects will be a crucial component of the supply system in diverting these waters to areas that provide the most benefit for offsetting the use of groundwater. Management actions will be implemented to help mitigate overdraft based on the demand from beneficial uses and users. Projects and management actions are discussed in further detail in Chapter 6, including a general timeline on when implementation will take place. When combined with consistent monitoring practices for each of the sustainability indicators, the GSAs will coordinate how individual GSAs pursue sustainability on a Subbasin level.

1.3.3 Explanation of how the goal will be achieved in 20 years

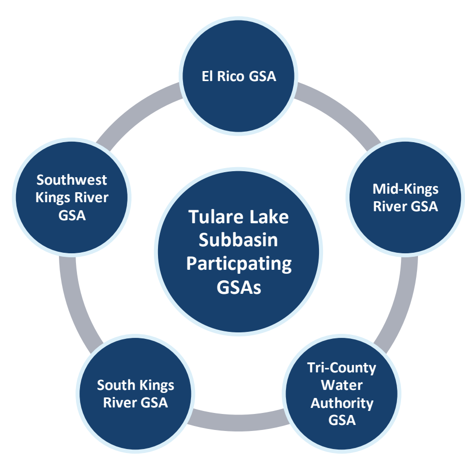
The goal of this Subbasin will be achieved in the next 20 years by the following:

- Understanding the existing condition's interaction with future conditions;
- Analyzing and identifying the effects of existing management actions on the subbasin;
- Implementing this GSP and its associated measures including project and management actions to halt and avoid future undesirable results;
- Collaborating between agencies to achieve goals and protect beneficial uses; and
- Assessing at each 5 year interim milestone implemented project and management action's successes and challenges.

1.4 Groundwater Sustainability Agency Information

23 CCR § 354.6(a) *The name and mailing address of the Agency.*

Five participating GSAs comprise the Tulare Lake Water Subbasin: Mid-Kings River, El Rico, South Fork Kings, Southwest Kings, and Tri-County Water Authority (Table 1-2). These GSAs have the authority and responsibility to sustainably manage the Tulare Lake Subbasin under SGMA (California Water Code, § 10723).



1.4.1 Organization and Management Structure of the GSA(s)

23 CCR § 354.6(b) *The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.*

The five participating GSAs collaboratively developed this single GSP for Tulare Lake Subbasin under an Interim Operating Agreement (Appendix G). Each GSA was formed by local member agencies that represent stakeholders on the GSA Board of Directors (Table 1-3). The Board of Directors and technical teams will collect and organize data from experienced consultants as well as seek feedback from groundwater users within the GSA boundaries through each SGMA phase (Appendix B). The GSA decision-making process is divided into various organization's roles. Below includes a description of each organization's responsibilities:

- **Subbasin Management Team**- Each GSA has a representative on the team who worked collaboratively to jointly develop this GSP and manage groundwater in the basin.
- **Board of Directors-** Adopts policies in regards to the development and implementation of the participating GSAs and the GSP.
- **Stakeholder/Advisory Committees-** Makes recommendations to the Board of Directors and technical consultants based on feedback from stakeholders to ensure this GSP accounts for representative local interests of all beneficial users. The committees work to encourage active involvement of a diverse, social, cultural, and economic elements of each GSA's population. Not all participating GSAs elected to have stakeholder/advisory committees.

1.4.2 Legal Authority of the GSA(s)

23 CCR § 354.6(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.*

SGMA delegates the responsibility and authority to sustainably manage groundwater to local agencies through adoption and implementation of a GSP in medium-or high-priority basins (California Water Code, § 10720). SGMA provides "local [GSAs] with the authority and the technical and financial assistance necessary to sustainably manage groundwater" (California Water Code, § 10720.1). GSAs have regulatory authority including but not limited to adoption of regulations, conduction of investigations, and requirement of registered groundwater extraction facilities to sustainability manage groundwater within the basin (California Water Code, § 10725). The five participating GSAs overlying Tulare Lake Subbasin are coordinating to develop one comprehensive GSP (California Water Code § 10723[a]). Each GSA overlies a portion of the Tulare Lake Subbasin (DWR Bulletin 118, Basin No. 5-022.12). The five GSAs have established an Interim Operating Agreement to ensure coordination in developing and implementing the GSP.

The Tulare Lake Subbasin is designated as a high-priority basin and therefore requires preparation of a GSP that will achieve groundwater sustainability in the basin within 20 years of implementation (California Water Code, § 10720.7; 10727.2[b]). GSAs are required to lead communication, outreach, and engagement efforts within the basin and develop and implement a GSP on a basin-wide scale to sustainable manage groundwater at the local level.

1.4.3 Estimated Cost of Implementing the GSP and the GSA's Approach to Meet Costs

23 CCR § 354.6(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

Half of the costs will be allocated equally between each of the five participating GSAs and half of the costs will be allocated in proportion to relative acreage of each GSA in the Tulare Lake Subbasin. Prior to DWR reviewal of this GSP, specific overall costs for each GSA will be provided based on implementation of projects and management actions. The overall proportionate cost of each GSA in the development and implementation of actions for this GSP are shown below (Table 1-4; Appendix G).

1.5 Interim Operating Agreement

Each of the five GSAs within the Tulare Lake Subbasin operate under an Interim Operating Agreement (effective September 1, 2017) to facilitate coordination and management actions (Appendix G). SGMA expects local agencies to collaborate on a subbasin-wide scale and a combination of GSAs may be formed using a "joint powers agreement, a memorandum of agreement, or other legal agreement" (California Water Code, § 10723 [b]). The Interim Operating Agreement is categorized as a legal agreement and ensures communication and coordination of the data and methodologies used by each GSA in developing the GSPs within the Subbasin for several factors, including groundwater elevation and extraction data, surface water supply, total water use, change in groundwater storage, water budget, total water use, and sustainable yield. Each GSA entered the Interim Operating Agreement to set forth their mutual intent to develop a single GSP for the Subbasin and authorize research and data collection required for the GSP according to a mutually agreeable timeline. Under this agreement, the GSAs agree to utilize their best efforts in preparing the GSP. Additionally, the Southwest Kings and South Fork Kings GSAs have a data sharing agreement with the Westside Groundwater GSP.

1.6 Groundwater Sustainability Plan Organization

The Tulare Lake Subbasin GSP is organized as follows:

- **The Executive Summary** provides a summary overview of this GSP and a description of groundwater conditions at the basin, including management strategies and implementation actions.

- **Chapter 1. Introduction:** Includes the purpose of the GSP under SGMA to sustainably manage groundwater, the sustainability goals, the specifics of the participating GSAs, and the outline of the organization to this GSP.
- **Chapter 2. Plan Area:** Specifies the geographic extent of the GSP including but not limited to jurisdictional boundaries, existing land uses and land use policies, identification of water resources types, density of wells, and location of communities dependent on groundwater in the Tulare Lake Subbasin.
- **Chapter 3. Basin Setting:** Describes the physical setting and characteristics of the current Tulare Lake Subbasin conditions relevant to the GSP, including a Hydrogeologic Conceptional Model of the basin conditions, current and historic groundwater conditions, management areas, and a water budget.
- **Chapter 4. Sustainable Management Criteria:** Establishes criteria for sustainable groundwater management in the Tulare Lake Subbasin, including how the GSAs will characterize undesirable results, and minimum thresholds and measurable objectives for the sustainability indictors.
- **Chapter 5. Monitoring Network:** Describes the GSP's monitoring network to collect sufficient data on groundwater conditions and to assess the plan's implementation through monitoring protocols on data collection and an established management system.
- **Chapter 6. Projects and Management Actions:** Outlines the project and management actions of the GSAs to meet the sustainability goal of the basin in a manner that can be maintained.
- **Chapter 7. Plan Implementation:** Consists of estimated GSP implementation costs, funding sources, GSP implementation schedule, and a plan for annual reporting and evaluation.
- **Chapter 8. References:** Includes a list of all references used to develop the GSP.
- **Appendices:** Includes additional information including but not limited to GSA contact information, the Interim Operating Agreement, Communication and Engagement Plan, Hydrogeologic Models, and the GSP checklist.

Table 1-1. GSP Requirements

Requirements
Groundwater conditions must be adequately defined and monitored to demonstrate the GSPs are achieving the sustainability goals for the basin
GSAs must be sufficiently defined and compatible to evaluate the effect of GSPs on adjacent basins
GSPs must meet substantial compliance standards
A GSA shall provide a description of basin setting and establish criteria that will maintain or achieve sustainable groundwater management
DWR will consider state policy regarding to the human right to water when implementing these regulations
The GSP sustainable groundwater management criteria, projects, and management actions should be based on the level of understanding of the basin setting including an understanding of uncertainty and data gaps
A GSP must achieve the sustainability goals for the basin in 20 years

Table 1-2. Participating GSA Contact Information

GSA	Plan Manager	Address	Telephone	Email
Mid-Kings River	Dennis Mills, Secretary	200 North Campus Dr. Hanford, CA 93230	(559) 584.6412	kcwdh20@sbcglobal.net
El Rico	Jeof Wyrick, Chairman	101 W. Walnut St. Pasadena, CA 91103	(626) 583.3000	jwyrick@jgboswell.com
South Fork Kings	Charlotte Gallock, Program Administrator	4886 E. Jensen Ave. Fresno, CA 93725	(559) 242.6128	charlotte@southforkkings.org
Southwest Kings	Dale Melville, Executive Director	286 Cromwell Ave. Fresno, CA 93711	(559) 449.2700	dmelville@ppeng.com
Tri-County Water Authority	Deanna Jackson, Executive Director	944 Whitley Ave. Suite E. Corcoran, CA 93212	(559) 762.7240	djackson@tcwater.org

Table 1-3. GSA Member Agencies

GSA	GSA Member Agencies	
Mid-Kings River	▪ Kings County Water District ▪ City of Hanford	▪ Kings County
El Rico	▪ Alpaugh Irrigation District ▪ City of Corcoran ▪ Corcoran Irrigation District ▪ Kings County ▪ Lovelace Reclamation District No. 739	▪ Melga Water District ▪ Salyer Water District ▪ Tulare Lake Basin Water Storage District ▪ Tulare Lake Drainage District
South Fork Kings	▪ City of Lemoore ▪ Empire West Side Irrigation District ▪ Stratford Irrigation District	▪ Stratford Public Utility District ▪ Kings County
Southwest Kings	▪ Dudley Ridge Water District ▪ Tulare Lake Reclamation District No. 761	▪ Kettleman City Community Services District ▪ Tulare Lake Basin Water Storage District
Tri-County Water Authority	▪ Angiola Water District ▪ Kings County	▪ Deer Creek Storm Water District ▪ Wilbur Reclamation District #825

Table 1-4. Proportionate Costs Breakdown of Each GSA

GSA	Acres	Acreage Portion	Participant Portion	Total Cost Allocation
Mid-Kings River GSA	97,384.6	0.09084	0.1	0.19084
South Fork Kings GSA	71,310.9	0.06652	0.1	0.16652
El Rico GSA/Alpaugh ID	228,653.4	0.21328	0.1	0.31328
Southwest Kings GSA	90,037.1	0.08398	0.1	0.18398
Tri-County WA	48,656.5	0.04538	0.1	0.14538
Totals	536,042.5	0.50000	0.5	1.00000

2.0 PLAN AREA

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

- *One or more maps of the basin that depict the following, as applicable:*
- *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.*
- *Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.*
- *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.*
- *Existing land use designations and the identification of water use sector and water source type.*
- *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 best available information.*

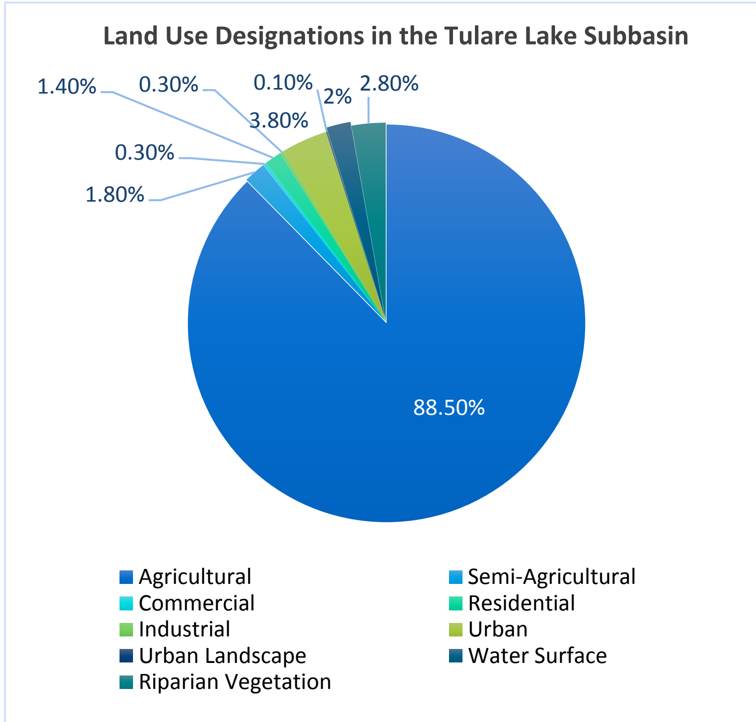
The Tulare Lake Subbasin (Subbasin) is located within the southern portion of the San Joaquin Valley Basin in the Central Valley of California. The Subbasin is defined under Department of Water Resources (DWR) Bulletin 118 as a high-priority basin (Basin No. 5-22.012). The Subbasin covers approximately 837 square miles (535,869 acres) including portions of the Kings, Kern, and Tulare counties (DWR 2016b). The five Groundwater Sustainability Agencies (GSAs) located within the Subbasin are the Mid-Kings River, South Fork Kings, Southwest Kings, El Rico, and Tri-County Water Authority (Figure 2-1). There is no overlap among the GSAs and there are no adjudicated areas in the groundwater basin.

Tulare Lake Subbasin Prioritization Factors

- **Area:** 837 square miles (535,869 acres)
- **Population (2010):** 125,907
- **Projected Population Growth (2030):** 176,446
- **Population Density:** 150 persons/square mile
- **Public Supply Wells:** 75
- **Total Wells:** 3,871
- **Irrigated Acres:** 251,994
- **Groundwater Supply:** 50% of water supplies
- **Total Storage Capacity:** 17.1 million acre-feet (AF)

Source: DWR 2019b.

There are 28 total water management entities in the Subbasin GSA Plan area (Plan area) that have local jurisdiction over groundwater use (Figure 2-2 through Figure 2-6). Federal lands located within the Plan area include Bureau of Land Management (BLM) parcels and administrative offices, the Santa Rosa Rancheria lands owned by the Bureau of Indian Affairs, and portions of the California Aqueduct regulated by the United States Bureau of Reclamation (USBR) (BLM 2019). State lands include the California State Prison Corcoran, Avenal State Prison, California Judicial Council courthouses, California Department of Transportation (Caltrans) storage facilities, portions of the Coastal and California Aqueducts regulated by DWR, State Route (SR) 41, 198, and 43, and Interstate 5 (I-5) (DGS 2019). Future planned development of these thoroughfares includes expansion to allow for additional vehicle capacity. A portion of the proposed alignment of the California High Speed Rail traverses the Subbasin and intersects the Mid-Kings River and El Rico GSAs (Figure 2-7; Figure 2-10) (High-Speed Rail Authority 2019). Tribal lands located within the Plan area include the Santa Rosa Indian Community of the Santa Rosa Rancheria (DWR 2014).



Land uses within the Plan area were surveyed by DWR in 2014, with additional surveys for Kings, Kern, and Tulare Counties in 2003, 2006, and 2007, respectively (Figure 2-7 through Figure 2-11). The Plan area is primarily comprised of agricultural and urban land use designations. Agriculture accounts for the largest percentage of land use in the Subbasin (Table 2-1). The primary land use designations for urban land are residential, commercial, and industrial, with groundwater being the main source of water (Table 2-2; DWR 2017a).

The Subbasin is supplied by surface water from the California Aqueduct, the Friant-Kern Canal, the Kings River, the Tule River, the Kaweah and St. John's Rivers, and unregulated streams including Deer Creek and Poso Creek. High precipitation rain events also convey natural surface water flows to the Plan area from Cottonwood Creek and Deer Creek. In 1995, DWR estimated the total storage capacity of the basin to be 17.1 million acre-feet (AF) to a depth of 300 feet, and 82.5 million AF to the base of fresh groundwater (DWR 2016b).

There are an estimated 9,380 known active wells within the Plan area, based on DWR continuous well records starting from 1940 (DWR 2019c). These records exclude test wells and recently drilled wells which have not been reported to DWR as of 2018. Any wells that have been decommissioned without issuance of a Kings County permit are mapped as active. DWR did not have information readily available to sort the wells based on domestic or irrigation use. The map does not necessarily show where pumping is concentrated since there is no differentiation between the different well uses.

2.1 Summary of Jurisdictional Areas and Other Features

23 CCR §354.8(b) *A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.*

2.1.1 Groundwater Sustainability Plan (GSP) Area

The Plan area includes the jurisdictional boundaries of the Mid-Kings River, South Fork Kings, Southwest Kings, Tri-County Water Authority, and El Rico GSAs (Figure 2-1). The majority of the Plan area is located within Kings County, with small areas in Tulare and Kern Counties. The Kings Subbasin is the northern boundary of the Plan area, with the Westside and Kettleman Plains Subbasins on the western boundary, the Kaweah and Tule Subbasins to the East, and Kern County Subbasin to the south (DWR 2019d). The Plan area is comprised of 5 GSAs and 20 entities, which are described further below. Water use sector and water source type vary by agency (Table 2-2). Many private domestic and private community wells are used in rural and semi-rural areas throughout the Subbasin.

2.1.2 Mid-Kings River GSA

The Mid-Kings River GSA covers approximately 152 square miles (±97,400 acres) and is located in the northeastern portion of the Subbasin (Figure 2-2) (DWR 2019d). The public and private agencies within the Mid-Kings River GSA include the Kings County Water District (WD), the City of Hanford, and Kings County. Surface water delivery entities within this area are the Riverside Ditch Company, the Peoples Ditch Company, the Settlers Ditch Company, the Last Chance Water Ditch Company, the New Deal Ditch Company, and the Lone Oak Ditch Company. The primary industries are agriculture and food processing (Appendix B).

2.1.2.1 Kings County Water District

Formed in the 1950s, the Kings County WD area is approximately 223 square miles (±143,000 acres) in northeastern Kings County in the central portion of the San Joaquin Valley. Surface water is obtained from the Kings River and Kaweah and St. John's Rivers through stock ownership. Stock owners include the Peoples Ditch Company, Settlers Ditch Company, and the Last Chance Water Ditch Company and Kaweah River supplies from Lakeside Ditch Company stock. Kings County WD also purchases surplus water from the Friant Division of the Central Valley Project (CVP), when available. Annual water demand ranges from 1.3 AF/acre to 5 AF/acre (includes multiple crops planted within a single year, colloquially known as double-cropping). There are numerous intentional recharge basins located in the Kings County WD, including the Apex Ranch Conjunctive Use Project, which is a groundwater bank that uses 50 acres of dry Kings River channel as a recharge area (Kings County WD 2011). Kings County WD is also responsible for managing floodwater deliveries to the Old Kings River channel, a former river channel, which delivered supplies through Peoples Ditch.

2.1.2.2 Kings County

Kings County, founded in 1893, is located on the western side of California's San Joaquin Valley. Kings County covers an area of approximately 1,391 square miles (890,240 acres), 1,024 square miles (±655,132 acres) of which are dedicated to harvested crops and other agricultural uses (Kings County 2019). U.S. Census Bureau estimates Kings County has a population of 151,336 as of 2018 (U.S. Census Bureau 2018) and is the 10th largest agricultural production county in the state, grossing over two billion dollars in 2017. Top commodities produced in Kings County include cattle, milk, cotton, pistachios, almonds, tomatoes, and grapes.

2.1.2.3 City of Hanford

The City of Hanford, incorporated in 1891, is located 30 miles southeast of Fresno in northern Kings County. The City of Hanford encompasses approximately 25 square miles (16,000 acres) and has a population of over 55,000. The sole source of water for the City of Hanford is groundwater, currently delivering 11,640 AF per year (AF/yr). The City of Hanford operates a wastewater treatment facility that discharges treated wastewater to percolation ponds or to farmlands for irrigation purposes (City of Hanford 2011).

2.1.2.4 City of Corcoran

The City of Corcoran, incorporated in 1914, lies on the eastern side of Kings County. The City of Corcoran has a population of approximately 22,215 and encompasses approximately 7.5 square miles (4,800 acres). The City of Corcoran relies on groundwater to supply its residents with approximately 5,000 AF/yr of domestic water supply (City of Corcoran 2014).

2.1.2.5 Peoples Ditch Company

The Peoples Ditch Company, organized in 1873, is a pre-1914 water right holder on the Kings River and delivers water to the Mid-Kings and El Rico GSAs. Peoples Ditch Company's main canal system is located within the Mid-Kings River GSA. The Peoples Ditch diversion off the Kings River is just upstream of Peoples Weir, south of Kingsburg. Peoples Ditch Company controls a portion of the storable volume behind Pine Flat Dam. The City of Hanford and Peoples Ditch Company have agreements regarding stormwater conveyance to Peoples Ditch and maintenance of facilities through the City of Hanford (City of Hanford 2017). Surface water diversions for Peoples Ditch Company average over 144,400 AF/yr over the last 100+ years of record (DWR 2012).

2.1.2.6 Last Chance Water Ditch Company

Last Chance Water Ditch Company, established in 1873, is a pre-1914 water right holder on the Kings River. The Last Chance Main Canal system and side ditches are located in the Hanford-Armona area in the central San Joaquin Valley. The Last Chance Main Canal diversion off the Kings River is just upstream of the Last Chance Weir, northeast of the 12th Avenue and Elder Avenue intersection. Last Chance Water Ditch Company controls a portion of the storable volume behind Pine Flat Dam, and surface water diversions for the company average over 62,200 AF/yr over the last 60+ years of record (KRCD 2009).

2.1.2.7 Santa Rosa Rancheria

The Santa Rosa Rancheria community is comprised of approximately 700 residents. The Rancheria encompasses 2.8 square miles (±1,800 acres) within Kings County. The Rancheria relies on groundwater pumping for the majority of its water consumption (DWR 2019b).

2.1.2.8 Armona Community Services District

Armona Community Services District (CSD) serves the unincorporated community of Armona in Kings County. Armona CSD operates two groundwater wells that supply the population of 3,200 residents with 600 AF/yr (Armona CSD 2015).

2.1.2.9 Home Garden Community Services District

Home Garden CSD serves the unincorporated community of Home Garden in Kings County. Groundwater wells provide water for 1,700 residents of the community (Home Garden CSD 2015).

2.1.2.10 Settlers Ditch Company

Settlers Ditch Company stock is a derivative of Peoples Ditch Company stock. In contrast, the Settlers Ditch Company has a separate Board of Directors and the ditch system is not viewed as part of Peoples Ditch Main Canal. Settlers Ditch delivery system is east of Hanford and generally north of Highway 198 (Kings County WD 2011).

2.1.2.11 New Deal Ditch Company

The New Deal Ditch Company holds a dry ditch stock, which gives access to deliver other stock water supplies through the New Deal Ditch. The New Deal Ditch begins at the end of the Peoples Ditch near the basin southwest of the 12th Avenue and Houston Avenue intersection. The New

Deal Ditch generally delivers surface water to Peoples Ditch Company within part of the Kings County WD service area (Kings County WD 2011).

2.1.4 South Fork Kings GSA

The South Fork Kings GSA covers approximately 111 square miles (±71,313 acres) and is located in the northwestern part of the Subbasin (Figure 2-3) (DWR 2019d). The public and private agencies within the South Fork Kings GSA include the City of Lemoore, Kings County, Empire Westside Irrigation District (ID), Stratford ID, Stratford Public Utility District (PUD), Liberty Canal Company, Lemoore Canal and Irrigation Company, John Heinlen Mutual Water Company, Jacob Rancho Water Company, and the Tulare Lake Basin Water Storage District. The primary industries within the South Fork Kings GSA are agriculture and food processing (Appendix B).

2.1.4.1 *City of Lemoore*

The City of Lemoore, incorporated in 1900, lies within the northern portion of Kings County. The City of Lemoore encompasses an area of 6.82 square miles (±4,371 acres) and includes over 25,000 residents. Water supplies are approximately 8,300 AF/yr, with groundwater acting as the sole source for the City of Lemoore. The majority of water deliveries are metered. The City of Lemoore operates a wastewater treatment plant where treated wastewater is delivered to local farms for agricultural use (City of Lemoore 2015).

2.1.4.2 *Empire Westside Irrigation District*

Empire Westside ID was formed in 1931 and is a Kings River member unit. Its service area of 6,400 acres stretches from northwest to southwest of Stratford in Kings County. The district has a storage share of the Kings River of 13,000 AF and is a State Water Project Contractor (KRCD 2009).

2.1.4.3 *Stratford Irrigation District*

Stratford ID was formed in 1916 and is a Kings River member unit. Its service area is near Stratford in Kings County and encompasses 9,800 acres. The district has a storage share of the Kings River of 11,000 AF (KRCD 2009).

2.1.4.4 *Stratford Public Utility District*

Stratford PUD serves a population of 1,300 in the unincorporated community of Stratford within Kings County. Stratford PUD operates three groundwater wells that serve 340 metered service connections (Kings County 2015).

2.1.4.5 Lemoore Canal and Irrigation Company

Lemoore Canal and Irrigation Company was established in 1870. As a mutual water company, it serves the stockholders of the Lemoore area. The Company encompasses 52,300 acres and has a storage share of the Kings River of 100,000 AF (KRCD 2009).

2.1.4.6 John Heinlen Mutual Water Company

The John Heinlen Mutual Water Company serves an area of 13,100 acres near Lemoore in Kings County. The Company has a storage share of 10,000 AF of the Kings River (KRCD 2009).

2.1.4.7 Jacob Rancho Water Company

Jacob Rancho Water Company is a private water company operating within the South Fork GSA.

2.1.5 Southwest Kings GSA

The Southwest Kings GSA covers approximately 140.6 square miles (±90,000 acres) and is located in the western portion of the Subbasin (Figure 2-4). The public and private agencies within the Southwest Kings GSA are Dudley Ridge WD, Tulare Lake Reclamation District (RD) #761, Kettleman City CSD, and Tulare Lake Basin Water Storage District (TLBWSD). Due to the poor yield and poor quality of the groundwater within the Southwest Kings GSA, only a minimal quantity of groundwater is pumped within the GSA. Groundwater levels, water quality, and subsidence are maintained at current levels. The primary industries within the GSA are agriculture, oil production, and commercial usage specific to Kettleman City (Appendix B).

2.1.5.1 Tulare Lake Basin Water Storage District

TLBWSD, formed in 1926, is primarily located in Kings County, with the exception of a 360-acre extension into Kern County. TLBWSD has a service area of 296.88 square miles (±190,000 acres). TLBWSD obtains surface water from the Kings River, with supplemental deliveries from the Tule and Kaweah Rivers and the State Water Project (SWP). In a representative year, TLBWSD delivers approximately 324,400 AF (TLBWSD 2015).

2.1.5.2 Dudley Ridge Water District

Dudley Ridge WD, organized in 1963, is located in Kings County south of Kettleman City. Dudley Ridge WD services agricultural lands and encompasses an area of 58.77 square miles (±37,615 acres). Dudley Ridge WD water supply consists of water from the SWP and local transfers. Dudley Ridge WD does not use local groundwater due to low yields and poor quality. However, landowners within Dudley Ridge WD now import groundwater from the Angiola ID well field in

Tulare County through canals across the Tulare Lake Bed. The annual water use for the district is approximately 45,000 AF (Dudley Ridge WD 2012).

2.1.5.3 Tulare Lake Reclamation District #761

Tulare Lake RD #761 is located in the central San Joaquin Valley. Its boundaries primarily lie within the TLBWSD and encompass approximately 54.69 square miles (±35,000 acres). Tulare Lake RD #761 averages annual deliveries of approximately 24,500 AF from the Kings River (DWR 2012).

2.1.5.4 Kettleman City Community Service District

Kettleman City CSD serves a population of approximately 1,500 residents in the unincorporated community of Kettleman City. Kettleman City CSD provides approximately 315 AF/yr from groundwater wells (Kettleman City CSD 2009).

2.1.5.5 Tulare Lake Canal Company

Tulare Lake Canal Company is a private water company operating within the Southwest Kings GSA.

2.1.6 El Rico GSA

The El Rico GSA covers approximately 357 square miles (228,400 acres) and is located in the center of the Subbasin (Figure 2-5) (DWR 2019d). The public and private agencies within the El Rio GSA are the City of Corcoran, Kings County, Alpaugh ID, Melga WD, Lovelace RD, Salyer WD, Corcoran ID, Tulare Lake Drainage District, and the TLBWSD. The primary industry within the El Rico GSA is agriculture. Other industries within the boundary include food processing, as well as warehousing and distribution, and commerce industry that is standard in a community of approximately 10,000 people (e.g., automotive shops, supermarkets, etc.) (Appendix B).

2.1.6.1 Tulare Lake Basin Water Storage District

TLBWSD, formed in 1926, is mostly located in Kings County, with the exception of a 360-acre extension into Kern County. TLBWSD has a service area of 296.88 square miles (±190,000 acres). TLBWSD obtains surface water from the Kings River, with supplemental deliveries from the Tule and Kaweah Rivers and the SWP. In a representative year, TLBWSD delivers approximately 324,400 AF (TLBWSD 2015).

2.1.6.2 Alpaugh Irrigation District

The Alpaugh ID was formed in 1915 and encompasses approximately 15.625 square miles (10,000 acres). It is located on the southeastern edge of the Subbasin and is within the El Rico GSA.

Alpaugh ID relies mostly on groundwater for its deliveries, operating 18 wells with the capability to deliver approximately 4,000 AF/ yr. Alpaugh ID is a subcontractor with Tulare County for up to 100 AF/yr of CVP water. Alpaugh ID does not have other surface water contracts but utilizes small allotments of flood waters in the Homeland Canal (USBR 2018).

2.1.6.3 Corcoran Irrigation District

Corcoran ID was formed in 1919 to provide irrigation water to land within its boundaries. Corcoran ID encompasses approximately 34.38 square miles (±22,000 acres). Corcoran ID obtains most of its surface water from the Kings River, with supplemental deliveries from the Kaweah and St. John's Rivers and USBR Section 215 water (Irrigation Training and Research Center 2008).

2.1.6.4 Lovelace Reclamation District #739739

Lovelace RD #739739 encompasses approximately 9.22 square miles (±5,900 acres) located north of TLBWSD. The District's primary function is flood control (DWR 2012).

2.1.6.5 Salyer Water District

Salyer WD is located in and around the TLBWSD. Salyer WD encompasses approximately 16.25 square miles (10,400 acres) (DWR 2012).

2.1.6.6 Tulare Lake Drainage District

Tulare Lake Drainage District is a private water company operating within the El Rico GSA.

2.1.6.7 Melga Water District

Melga WD was formed in 1953 and encompasses approximately 117.19 square miles (±75,000 acres) mostly within the TLBWSD. Surface water supplies are obtained from the SWP and Kings River with periodic availability from the Kaweah and Tule Rivers (DWR 2012).

2.1.7 Tri-County Water Authority GSA

The Tri-County Water Authority GSA is a collective group of local water agencies dedicated to monitoring and regulating groundwater in the Tulare Lake Hydrologic Region. The Tri-County Water Authority GSA covers approximately 170.0 square miles (108,800 acres) in the Tulare Lake and Tule Subbasins (Figure 2-6) (DWR 2019d). Approximately 75.19 square miles (±48,120 acres) of the GSA's area is located within the southeastern portion of the Subbasin. The primary industry within the Tri-County Water Authority GSA is almost entirely agriculture (Appendix B).

2.1.7.1 Tulare County

Tulare County, formed in 1852, encompasses approximately 4,839 square miles (3,096,950 acres) and is located south of Fresno County. As of the 2010 census, the population was 442,179 (U.S. Census Bureau 2018; Tulare County 2019).

2.1.7.2 County of Kern

Kern County, formed in 1866, is located in the southern portion of the San Joaquin Valley. As of the 2010 census, the population was ±839,631 and Kern County encompassed approximately 8,131 square miles (5,203,840 acres) (U.S. Census Bureau 2018). Kern County spans from the southern slopes of the Coast Mountain Ranges to the west, to the southern slopes of the Sierra Nevada Mountains to the east, and into the Mojave Desert.

2.1.7.3 Angiola Water District

Angiola WD, formed in 1957, is an agency within the Tri-County Water Authority GSA. Irrigation wells within the area are mostly owned by the Angiola WD. Groundwater pumping supplements the fluctuating surface water supplies sourced from SWP, CVP, Kings River, Tule River, Deer Creek, and floodwaters from Tulare Lake (DWR 2012).

2.1.7.4 Atwell Island Water District

Atwell Island WD encompasses approximately 11.1 square miles (±7,100 acres). Atwell Island WD delivers surface water supplies from subcontracts with the County of Tulare of up to 50 AF/yr. Atwell Island WD does not operate any groundwater wells or recharge facilities (DWR 2012).

2.1.7.5 W.H. Wilbur Reclamation District #825

W.H. Wilbur Reclamation District #825 is located within the Tri-County Water Authority GSA.

2.1.7.6 Deer Creek Storm Water District

Deer Creek Storm Water District is located within the Tri-County Water Authority GSA.

2.2 Water Resources Monitoring and Management Programs

2.2.1 Monitoring and Management Programs

> ***23 CCR §354.8(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.*

2.2.1.1 Groundwater Level Monitoring

The California Statewide Groundwater Elevation Monitoring (CASGEM) Program tracks long-term groundwater elevation trends throughout California. The Kings River Conservation District (KRCD) is the local agency that monitors groundwater levels within the Plan area. KRCD facilitates collaboration between local monitoring entities and DWR. The data is collected twice a year, in the spring and the fall (DWR 2012).

Kings County WD monitors groundwater levels on a regional scale and has monitored the groundwater since the 1950s. Kings County WD collects water level data from up to 280 wells in the spring and fall (Kings County WD 2011).

2.2.1.2 Groundwater Extraction Monitoring

It is not known how many private wells are metered. Potential future groundwater monitoring policies are discussed in Chapter 5, *Monitoring Network*.

2.2.1.3 Groundwater Quality Monitoring

See Chapter 5, *Monitoring Network,* for information on groundwater quality monitoring within the Subbasin.

2.2.1.4 Land Surface Subsidence Monitoring

Land subsidence has been measured for many years throughout the Central Valley. The Plan area contains various local monitoring networks, which can be utilized to survey existing benchmarks to measure subsidence. The United States Geological Survey (USGS), National Aeronautics and Space Administration (NASA), and KRCD also measure subsidence in the Central Valley. DWR commissioned NASA's Jet Propulsion Laboratory to utilize airborne and satellite radar data to measure ongoing land subsidence throughout California and produce maps showing how subsidence varies seasonally and regionally. USGS and NASA have published maps on their websites that show the subsidence monitoring results for a defined time period (USGS 2019; NASA 2017). KRCD also has a 7-mile grid that monitors new and existing benchmarks for land subsidence. Caltrans has a benchmark correction control network with historic elevation updates showing ground movement within the Subbasin at various locations. See Chapter 5, *Monitoring Network,* for further information regarding subsidence in the Plan area.

2.2.1.5 Surface Water Monitoring

Kings River Water Association (KRWA) monitors surface water in the Kings River and the associated watershed including seasonal snowpack, reservoir stage, reservoir inflow and outflow, Kings River flows, and Kings River diversions. The Friant Water Authority monitors San Joaquin River's water delivered through the Friant-Kern Canal. The Kaweah and St. Johns Rivers Association monitors Kaweah River water flows and deliveries, and the St. John's River that reaches the Subbasin via Cross Creek and Tule River. DWR and TLBWSD monitor the SWP and the Kings River flows that enter the Subbasin.

2.2.1.6 Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to address pollutant discharges to surface water and groundwater from commercially irrigated lands. The primary purpose of the ILRP is to address key pollutants of concern including salinity, nitrates, and pesticides introduced through runoff or infiltration of irrigation water and stormwater. Surface water quality has been monitored for several years, and in the future, groundwater quality will be monitored. The program is administered by the Central Valley Regional Water Quality Control Board (RWQCB).

Under the ILRP rules, agricultural crop growers may form "third party" coalitions to assist with required monitoring, reporting, and education requirements for irrigated agriculture. The Kings River Water Quality Coalition (KRWQC) was established in 2009 as a Joint Powers Agency to combine resources and regional efforts to comply with the regulatory requirements of the ILRP. The KRWQC area and supplemental areas cover most of the Plan area (KRWQC 2016). The Westside Water Quality Coalition (WWQC) was formed in 2013 as part of the ILRP. Dudley Ridge WD is within the boundaries of the WWQC (WWQC 2019). Regional information on surface and groundwater quality is available from the individual coalitions.

2.2.1.7 GSP Monitoring and Management Plans

The individual water entities located within the Plan area will be responsible for continuing to collect data for any current monitoring or management plan. The monitoring program is described further in Chapter 5, *Monitoring Network*.

2.2.2 Impacts to Operational Flexibility

23 CCR §354.8(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.*

2.2.2.1 Regulatory Decisions and Agreements

Regulatory monitoring and management programs outside the boundaries of the Subbasin have limited the operational flexibility and management of the Subbasin, which include the following:

- **1992 Central Valley Project Improvement Act (CVPIA)**: The CVPIA is a multipurpose federal water legislation providing for water resource management throughout the western United States. Enactment of the CVPIA mandated changes in the CVP and reallocation of water supplies and reductions in pumping, particularly for the protection, restoration, and enhancement of fish and wildlife. Water supplies in the Plan area have been reduced as a result of the CVPIA. Supplies were impacted due to pumping restrictions within the Delta and development of refuge supplies from previously available contract supplies, which led to decreased allocations for Mid-Valley Canal and Cross Valley Canal contracts.
- **2007 Wanger Decision:** A federal decision found that USBR did not consider evidence that fish, including salmon and delta smelt, would be harmed by increased water exports for the Sacramento-San Joaquin Delta. The result of this curtailed SWP and CVP pumping from the Delta, reducing overall supplies to the Subbasin.

2.2.2.2 Places of Use

Agencies use of water from Kings River, SWP, and CVP are restricted to the place of use defined by their water rights. This GSP will not alter these agreements.

2.2.2.3 Contaminant Plumes

There are no known contaminant plumes in the Subbasin. Water quality for individual monitoring wells can be found from Geotracker (SWRCB 2019a). See Chapter 3, *Basin Setting,* for more information on water quality in the Subbasin.

2.2.2.4 Kings River Fisheries Management Program

A partnership has been forged between KRCD, the KRWA, and the California Department of Fish and Wildlife (CDFW) to create the Kings River Fisheries Management Program. This program includes numerous measures to benefit the Kings River fisheries, including year-round flows, improved temperature control, and additional monitoring. However, this comes at the expense of some operational flexibility for Kings River water users. The Kings River provides the majority of the surface water used in the Subbasin area.

Several requirements are placed on Pine Flat Reservoir and Kings River operations, as a part of the program. These include maintaining a minimum of 100,000 AF in Pine Flat Reservoir, temperature control pool (10% of the reservoir's capacity), and October through March minimum fish flow releases below Pine Flat Dam (Kings River Fisheries Management Program 1999).

The local water entities have already adjusted agricultural operations to adapt to the program. In the future, additional recharge and banking facilities could help the program to further adapt by providing a place to store Kings River waters when supply exceeds irrigation demands.

2.2.3 Conjunctive Use Programs

23 CCR §354.8(e) *A description of conjunctive use programs in the basin.*

> ***Conjunctive Use*** *is the deliberate combined use of groundwater and surface water, which involves actively managing the aquifer systems as an underground reservoir.*

Conjunctive use is the coordinated and planned management of surface and groundwater resources to maximize their efficient use. Conjunctive use is utilized to improve water supply reliability and environmental conditions, reduce groundwater overdraft and land subsidence, and to protect water quality. Conjunctive use can include using surface water when it is available and relying on groundwater when surface water supplies may run out seasonally or are limited during droughts. Conjunctive use also includes cyclic storage where surplus surface waters are recharged during wet years and groundwater is pumped during dry periods. Conjunctive use should also include a robust monitoring program to help prevent negative impacts and verify the quantity of water in storage.

Surface water is also used for groundwater banking (recharge) in areas that allow surface water to be stored in the aquifer for use at a later date. Kings County WD operates numerous recharge basins within its district. Within Kings County WD, the Apex Ranch Conjunctive Use Project uses 50 acres of dry Kings River channel as a recharge area. Alpaugh ID has storage ponds that provide incidental recharge (Kings County WD 2011). Corcoran ID operates percolation basins with a 10,000 AF capacity capable of recharging 200 AF/day (DWR 2012). The City of Corcoran has an agreement with Corcoran ID to discharge stormwater into their ditch network for the purpose of recharge (City of Corcoran 2014). Additionally, the City of Hanford has a very similar agreement with Peoples Ditch Company.

2.3 Relation to General Plans

2.3.1 Summary of General Plans/Other Land Use Plans

23 CCR §354.8(f) *A plain language description of the land use elements or topic categories of applicable general plans that include the following: A summary of general plans and other land use plans governing the basin.*

Every county and city in California is required to develop and adopt a General Plan (California Government Code, §65350-65362). A General Plan is a comprehensive long-term plan for development of the county or city, which consists of a statement of development policies and identifies objectives, principles, standards, and proposals for the area. To an extent, a General Plan acts as a "blueprint" for development.

The General Plan must contain seven state-mandated elements; however, any additional elements the legislative body of the county or city wishes to adopt can be included. The seven mandated elements are: Land Use, Circulation, Housing, Noise, Open Space, Conservation, and

Safety. The General Plan may be adopted in any form deemed appropriate or convenient by the legislative body of the county or city, including the combining of elements. Within the Plan area, agencies with jurisdiction over land uses have adopted General Plans (Table 2-3).

As noted in Section 2.1.6, a relatively small portion of the El Rico GSA extends into Kern County. The extension consists of approximately 360 acres and is a portion of a 1,080-acre parcel used as evaporation ponds and owned by the TLBWSD. It is considered unlikely that any Kern County General Plan policies have any practical relevance to the Plan area.

2.3.2 Impact of GSP on Water Demands

23 CCR §354.8(f)(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.*

All of the General Plans in the Plan area were adopted prior to the development of the GSA and this GSP; therefore, the General Plans did not consider the impacts of this GSP's implementation.

The General Plans of Kings, Tulare, and Kern County, as well as the City of Hanford, Lemoore, and Corcoran make assumptions for both rural and urban development. Urban Water Management Plans (UWMPs) prepared for the City of Lemoore, Hanford, and Corcoran address assumed land use changes and growth rates. This GSP uses the land use change assumptions identified in the General Plans for forecasting the anticipated water budget, described later in this GSP. See Chapter 4, *Sustainable Management Criteria,* for more information.

2.3.3 Impact of GSP on Water Supply Assumptions within Land Use Plans

23 CCR §354.8(f)(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.*

There are six General Plans within the Plan area. The counties of Kings, Kern and Tulare and cities of Lemoore, Hanford, and Corcoran each possess a General Plan. The General Plan sections that cover water supply are summarized below.

2.3.3.1 County of Kern General Plan

There are no anticipated impacts on Kern County lands within the Subbasin. The total Kern County land area within the Subbasin is 360 acres (Kern County 2009).

2.3.3.2 Kings County General Plan

Kings County ranks as the seventh fastest-growing county in population in California. The estimated 2018 population of Kings County was 151,366 (U.S. Census Bureau 2018). Future projections from the Department of Finance (DOF) expect the population to reach 181,218 by the year 2035 (DOF 2019). The Land Use (LU), Resource Conservation (RC), and Health and Safety (HS) sections of the Kings County General Plan discuss various topics including water supply. The primary water supply goal in this plan is for reliable and cost-effective infrastructure systems that permit the County to sustainably manage its diverse water resources and agricultural needs, secure additional water, and accommodate for future urban growth (Kings County 2010).

2.3.3.3 County of Tulare General Plan

Tulare County's General Plan 2030 Update developed goals and policies to encourage sustainable groundwater management, such as to develop additional water sources, implement water conservation, and encourage demand management measures for residential, commercial, and industrial indoor and outdoor water uses in all new urban development (Tulare County 2012).

2.3.3.4 City of Hanford General Plan

The Land Use, Transportation, Water Resources, and Public Facilities sections of the City of Hanford's General Plan discuss various topics including water supply. U.S. Census Bureau estimated the 2018 population to be 56,910 (U.S. Census Bureau 2018), which accounts for approximately 37% of the population of Kings County. The 2016 General Plan anticipates the population to increase to 90,000 by 2035. The annual gross water use in 2015 was 11,640 AF or 188 gallons per capita per day. The General Plan's 2020 urban water use targets 179 gallons per capita per day, which is intended to be maintained through the 2035 plan horizon. The anticipated gross annual water use by 2035 can be expected to be 18,045 AF (City of Hanford 2011). The primary water supply goal in the plan is to maintain reliable and cost-effective infrastructure systems that permit the City to sustainably manage its diverse water resources and needs.

2.3.3.5 City of Lemoore General Plan

The City of Lemoore General Plan policies are geared towards preserving environmental resources such as open space, prime farmland, wetlands, special species, water resources, air quality, and other elements of value to Lemoore residents. The estimated 2018 population of Lemoore was 26,474 (U.S. Census Bureau 2018). Sufficient land was allocated in the General Plan to accommodate for future population projections, which are expected to reach 48,250 by 2030. According to the 2005 City of Lemoore UWMP, the City of Lemoore's 2005 maximum day demand was approximately 12.8 million gallons per day, which is well within the current supply capacity of 19.2 million gallons per day. If the City grows at the anticipated rate, demand will exceed the supply available from existing wells. Since Lemoore is not located within an adjudicated water basin, there is no restriction on the number of wells the City of Lemoore may drill within City boundaries. Water quality maintenance is a more considerable challenge to meeting water demand than water quality for the City of Lemoore (City of Lemoore 2015).

2.3.3.6 City of Corcoran General Plan

The Land Use, Circulation, Safety, Conservation and Open Space, Air Quality, and Public Services and Facilities sections of the City of Corcoran's General Plan discuss various topics including water supply. U.S. Census Bureau estimated the 2018 total population of Corcoran to be 21,676 (U.S. Census Bureau 2018). By 2030, the population is expected to reach 26,888. The City of Corcoran's entire water supply is provided by local groundwater. The average daily demand in 2010 was 5.9 million gallons per day. Projected daily demand in 2030 is expected to increase to 5.5 million gallons per day, so projected water use targets a 20% use reduction. The General Plan's primary water supply goal is to protect natural resources including groundwater, soils, and air quality in an effort to meet the needs of present and future generations (City of Corcoran 2014).

2.3.4 Permitting Process for New or Replacement Wells

> ***23 CCR §354.8(f)(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.*

In California, local jurisdictions with the authority to adopt a local well ordinance that meets or exceeds DWR Well Standards have regulatory authority over well construction, alteration, and destruction activities (DWR 2019a). After the submittal of the GSP, California Water Code §10725 - §10726.9 describes the authoritative power by the GSAs, including but not limited to imposing spacing requirements on new groundwater well construction, imposing operating regulations on existing groundwater wells, and controlling groundwater extractions. The GSA may use the powers described in the above code to provide the maximum degree of local control and flexibility consistent with sustainability goals described in the GSP.

2.3.4.1 Kings County

The Kings County General Plan Resource Conservation Policy A1.6.3 states the following regarding well installations:

- *Protect groundwater by enforcing the requirements for installation of wells in conformity with the California Water Code, the Kings County Well Ordinance, and other pertinent state and local requirements.*

Kings County adheres to DWR Well Standards guidelines for the construction of groundwater wells that are intended to protect the groundwater quality and reduce the adverse effects caused by improper well construction (DWR 1981; DWR 1991). Kings County has the sole authority for establishing and enforcing the standards for construction and deconstruction of water wells. In accordance with the California Water Code §13801, Kings County Ordinance No. 587 has provisions that require permits for well construction, reconstruction and deepening, with oversight provided by the County's Health or Building Officials, and stipulates that no person shall dig, bore, drill, deepen, modify, repair, or destroy a well, cathodic protection well, observation well, monitoring well or any other excavation that may intersect groundwater without first applying for and receiving a permit unless exempted by law (Kings County 2000; 2001). The permittee is required to complete the work authorized by the permit within 180 days of the date of issuance of the permit.

Installation of domestic supply wells in Kings County must follow separate guidelines and regulations. Domestic wells installation requires completion of necessary permits, California Environmental Quality Act (CEQA) review, DWR and Drinking Water Source Assessment and Protection Program (DWSAP), and site and well inspections. A well is not to discharge into the water distribution system until the above documents have been submitted to the Division Office and a field inspection of the well installation has been made by Kings County Environmental Health Services (Kings County Public Health Department 2009).

2.3.4.2 County of Kern

Kern County stipulates the contractor as the responsible party to construct, deepen, or reconstruct an agricultural well in accordance with Kern County Ordinance Code, §14.08 (Kern County 2019). In addition, the contractor must also meet standards set by DWR, with the exception of modifications by updated DWR revisions (DWR 1981; DWR 1991). The responsibility lies with the owner to ensure the following have been included and completed:

- Install surface slab
- Implement watertight sanitary seal
- Use of approved backflow protection device (chemigation, air gap)
- Use of down-turned, screened casing air vent
- Disinfection of access/sounding tube
- Unthreaded sample tap installation
- Approved Flow Meter-NSF 61 installed
- Collection of water samples from the well to conduct a Water Quality Analysis for Arsenic Fluoride, Ethylene dibromide, Dibromo chloropropane and Gross Alpha

The Water Quality Analysis test must be performed by a state-certified laboratory. Final approval cannot be issued until all water quality tests have been received by Kern County and the surface construction features have been approved by Kern County Public Health Services Department 2018 (Kern County 2018).

2.3.4.3 County of Tulare

Tulare County approved a water well ordinance in September 2017 (Tulare County Ordinance Code, Part IV. Health, Safety and Sanitation, Chapter 13. Construction of Wells) that addresses agricultural and domestic water wells. Well construction, destruction, and setback requirements have been altered under Tulare County Ordinance Code Part IV Chapter 13 (Tulare County 2017). This ordinance places restrictions on the drilling of new wells on previously non-irrigated land where the land has not had a well or has not had surface water in the past. Tulare County Environmental Health Services Division is responsible for the permitting and enforcement within the portion of the Subbasin in Tulare County. Tulare County Ordinance Code Part IV Chapter 13, Article 3 stipulates the following:

- *Except as otherwise provided in sections 4-13-1250 and 4-13-1255 of this Article, it shall be unlawful for any person to construct, deepen, reconstruct or destroy any well, or soil boring, or cause any of those acts to be done, unless a permit has first been issued to him or to the person on whose behalf the work is undertaken. The Tulare County Health Officer may prescribe conditions if he determines that they are required to prevent contamination or pollution of underground waters. Permit conditions are appealable pursuant to section 4-13-1275 of this Article. A well permit shall be valid for six (6) months from the date of issuance.*

2.3.5 Land Use Plans Outside the Basin

> ***23 CCR §354.8(f)(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**.*

In general, all future land use changes will need to consider the net groundwater impact to neighboring basins, and updates to agency General Plans will need to consider GSPs and the responsibility of each member and participating agency. GSPs for neighboring basins will be evaluated during the GSP review process. Coordination between subbasins is required as part of GSP implementation. A discussion of some potential management actions, including policy changes are described in Chapter 6, *Projects and Management Actions*.

Relevant land use plans for Kern and Tulare counties are discussed in Section 2.3.3, *Impact of GSP on Water Supply Assumptions within Land Use Plans*. There are no nearby cities that have land use plans.

2.3.5.1 Fresno County General Plan

The Public Facilities and Services section of the Fresno County General Plan discusses general public facilities and services; funding; water supply and delivery; wastewater collection, treatment, and disposal; storm drainage and flood control; and numerous other services (Fresno

County 2000). The goal of the water supply and delivery section is to ensure the availability of an adequate and safe water supply for domestic and agricultural consumption. The relevant policies are listed below:

- Policy PF-C.12 - The County shall approve new development only if an adequate sustainable water supply to serve such development is demonstrated.
- Policy PF-C.13 - In those areas identified as having severe groundwater level declines or limited groundwater availability, the County shall limit development to uses that do not have high water usage or that can be served by a surface water supply.
- Policy PF-C.23 - The County shall regulate the transfer of groundwater for use outside of Fresno County. The regulation shall extend to the substitution of groundwater for transferred surface water.
- Policy PF-C.26- The County shall encourage the use of reclaimed water where economically, environmentally, and technically feasible.

2.4 Additional GSP Elements

23 CCR §354.8(g) *A description of any of the additional Plan elements included in the Water Code Section 10727.4 that the Agency determines to be appropriate.*

2.4.1 Saline Water Intrusion

Saline (or brackish) water intrusion is the induced migration of saline water into a freshwater aquifer system. Saline water intrusion is typically observed in coastal aquifers where over-pumping of the freshwater aquifer causes salt water from the ocean to encroach inland, contaminating the fresh water aquifer. The Tulare Lake Subbasin is approximately 70 miles from the Pacific Ocean, and the potential for adverse impacts of saline intrusion in the Subbasin are considered low.

2.4.2 Wellhead Protection

A Wellhead Protection Area (WHPA) is defined by the Safe Drinking Water Act Amendment of 1986 as "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield" (100 U.S. Code. 764). The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates, and aquifer characteristics.

The Federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect groundwater sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land use controls, usually applied at the local level, and other preventative measures can protect groundwater.

Under the Safe Drinking Water Act, states are required to develop an Environmental Protection Agency (EPA)-approved Wellhead Protection Program. To date, California has no State-mandated program and relies on local agencies to plan and implement programs. Wellhead Protection Programs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources.

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the wellhead. A well is also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Essential to any wellhead protection program is proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources.

Wellhead protection is performed primarily during design and can include requiring annular seals at the well surface, providing adequate drainage around wells, constructing wells at high locations, and avoiding well locations that may be subject to nearby contaminated flows. Wellhead protection is required for potable water supplies and is not generally required, but is still recommended, for agricultural wells.

Municipal and agricultural wells constructed by the GSA member agencies are designed and constructed in accordance with DWR Bulletins 74-81 and 74-90. A permit is required from the applicable county prior to construction of a new well within the GSA's area. In addition, the GSA member agencies encourage landowners to follow the same standard for privately owned wells. Specifications pertaining to wellhead protection include (DWR 1981; DWR 1991):

- Methods for sealing the well from intrusion of surface contaminants;
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism; and
- Site grading to assure drainage is away from the wellhead.

2.4.3 Migration of Contaminated Groundwater

Groundwater contamination can be human-induced or caused by naturally occurring processes and chemicals. Sources of groundwater contamination can include irrigation, dairy production, pesticide applications, septic tanks, industrial sources, stormwater runoff, and disposal sites.

Contamination can also spread through improperly constructed wells that provide a connection between two aquifers or improperly abandoned/destroyed wells that provide a direct conduit of contaminants to aquifers.

The following databases provide information and data on known groundwater contamination, planned and current corrective actions, investigations into groundwater contamination, and groundwater quality from select water supply and monitoring wells.

2.4.3.1 State Water Resources Control Board

The State Water Resources Control Board (SWRCB) maintains an online database that identifies known contamination cleanup sites, known leaking underground storage tanks, and permitted underground storage tanks. The online database contains records of investigation and actions related to site cleanup activities (SWRCB 2019a).

2.4.3.2 Department of Toxic Substance Control

The State of California Department of Toxic Substance Control (DTSC) provides an online database with access to detailed information on permitted hazardous waste sites, corrective action facilities, as well as existing site cleanup information. Information available through the online database includes investigation, cleanup, permitting, and/or corrective actions that are planned, being conducted, or have been completed under DTSC's oversight (DTSC 2019).

2.4.3.3 California Department of Pesticide Regulation

The California Department of Pesticide Regulation (DPR) maintains a Surface Water Database (SURF) containing data from a wide variety of environmental monitoring studies designed to test for the presence or absence of pesticides in California surface waters. As part of DPR's effort to provide public access to pesticide information, this database provides access to data from DPR's SURF (DPR 2019).

2.4.3.4 Groundwater Ambient Monitoring and Assessment Program

The SWRCB Groundwater Ambient Monitoring and Assessment (GAMA) program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles all of the data into a publicly accessible online database (SWRCB 2019b).

2.4.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well that has not been used in over a year. Well destruction includes completely filling in a well in accordance with standard procedures listed in Section 23 of DWR Bulletin 74-81 (DWR 1981). DWR Bulletin 74-90 includes a revision in Section 23, for Subsection A and B, from Bulletin 74-81 (DWR 1991). The following revision is stated for Subsection A, Item 1:

DWR's Bulletin 74-90 establishes California Well Standards, which states:

A monitoring well or exploration hole subject to these requirements that is no longer useful, permanently inactive or "abandoned" must be properly destroyed to:

- Ensure the quality of groundwater is protected, and;
- Eliminate a possible physical hazard to humans and animals.

- *<u>Obstructions</u>. The well shall be cleaned, as needed, so that all undesirable materials, including obstructions to filling and sealing, debris, oil from oil-lubricated pumps, or pollutants and contaminants that could interfere with well destruction are removed for disposal. The enforcing agency shall be notified as soon as possible if pollutants and contaminants are known or suspected to be in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed.*

The following revision from DWR Bulletin 74-90 states for Subsection B:

- *<u>Wells situated in unconsolidated material in an unconfined groundwater zone.</u> In all cases the upper 20 feet of the well shall be sealed with suitable sealing material and the remainder of the well shall be filled with suitable fill or sealing material from Bulletin 74-81.*

The remainder of Section 23 from DWR Bulletin 74-81 is unchanged.

Proper well destruction and abandonment are necessary to protect groundwater resources and public safety. Improperly abandoned or destroyed wells can provide a conduit for surface or near-surface contaminants to reach the groundwater. In addition, undesired mixing of water with different chemical qualities from different strata can occur in improperly destroyed wells.

The administration of a well construction, abandonment, and destruction program has been delegated to the counties by the California State legislature. Kings County requires that wells be abandoned according to State standards documented in DWR Bulletins 74-81 and 74-90. Due to staff and funding limitations, enforcement of the well abandonment policies is limited.

2.4.5 Replenishment of Groundwater Extractions

Primary groundwater replenishment sources in the Plan area:
▶ Kings River
▶ Kaweah River
▶ Tule River
▶ Deer Creek
▶ Poso Creek
▶ Precipitation
▶ Various smaller streams

Replenishment of groundwater is an important technique in management of a groundwater supply to mitigate groundwater overdraft. Groundwater replenishment occurs naturally through rainfall, rainfall runoff, and stream/river seepage and through intentional means, including deep percolation of crop and landscape irrigation, wastewater effluent percolation, and intentional recharge. The primary local water sources for groundwater replenishment in the Plan area include precipitation, Kings River, Kaweah River, Tule River, Deer Creek, Poso Creek, and various smaller local streams. For more information, refer to Section 2.2.3, *Conjunctive Use Programs*, of the GSP.

2.4.6 Well Construction Policies

Proper well construction is necessary to ensure reliability, longevity, and protection of groundwater resources from contamination. All of the GSA member agencies follow State standards when constructing municipal and agricultural wells (DWR 1995; DWR 1981; DWR 1991). Kings County has adopted a well construction permitting program consistent with State well standards to help assure proper construction of private wells. Kings County maintains records of all wells drilled in the Plan area.

State well standards address annular seals, surface features, well development, water quality testing and various other topics (DWR 1981; 1991). Well construction policies intended to ensure proper wellhead protection are discussed in Section 2.4.2, *Wellhead Protection*.

2.4.7 Groundwater Projects

The GSA member agencies in general develop their own projects to help meet their water demands and will develop additional future projects to meet sustainability. Developing groundwater recharge and banking projects is considered key to stabilizing groundwater levels. Chapter 6, *Project and Management Actions to Achieve Sustainability*, provides descriptions, estimated costs, and estimated yield for numerous proposed projects.

The GSA will also support measures to identify funding and implement regional projects that help the region achieve groundwater sustainability. This can include recharge projects that take advantage of local areas conducive to recharge and areas where recharge provides the most benefit to the GSA. This can reduce the burden for certain agencies from having to recharge within their boundaries if they do not have suitable land or soils.

2.4.8 Efficient Water Management Practices

Water conservation has been and will continue to be an important tool in local water management, as well as a key strategy in achieving sustainable groundwater management. All of the GSA member agencies engage in some form of water conservation including water use restrictions, water metering, education, tiered rates, etc. These water conservation programs were tested during the 2014-2015 drought, which included State-mandated urban water restrictions for the first time. Details of water conservation programs can be found in various documents, such as individual UWMPs (City of Corcoran 2017; City of Lemoore 2015; City of Hanford 2011). Existing efficient water management practices include recycled water use and high efficiency irrigation practices.

2.4.9 Relationships with State and Federal Agencies

From a regulatory standpoint, the GSAs have numerous relationships with state and federal agencies related to water supply, water quality, and water management. Relationships that are common to all water agencies, such as regulation of municipal water by the California Division of Drinking Water (DDW), are not discussed here. Relationships unique to the region are summarized below.

2.4.9.1 Kings River Water

The Kings River provides the majority of surface water used in the area. Kings River water is impounded by Pine Flat Dam, which is owned and operated by the United States Army Corps of Engineers (USACE). The water rights permits were obtained from the SWRCB; however, allocation and management of water is largely controlled by the KRWA. The GSA member agencies work with the USACE and SWRCB to oversee and manage their Kings River water as needed. The local agencies also developed and continue to implement the Kings River Fisheries Management Program in partnership with the CDFW.

2.4.9.2 San Joaquin River Water

Several GSA member agencies receive San Joaquin River water from the Friant Division of the CVP. The Friant Dam is owned and operated by the USBR. USBR is also the lead agency for the San Joaquin River Restoration Program (SJRRP), which has resulted in delivery curtailments to Friant contractors. The GSA member agencies communicate often with USBR staff on water deliveries, water allocations, progress on the SJRRP, and the Water Management Program for the SJRRP that is intended to help mitigate water losses to Friant contractors.

Many of the GSA member agencies receive grants from various agencies for water-related projects. Grants are obtained from agencies including but not limited to DWR, SWRCB, and USBR. The GSA member agencies work closely with these state and federal agencies to track grant programs and administer and implement grant contracts.

2.4.10 Land Use Planning

Land use policies are documented in various reports, such as General Plans, specific land use plans, and plans for proposed developments. Updating some of these plans is a multi-year process and not all plan updates can be fully completed concurrently with the GSP development. These land use plans are expected to be modified gradually over time to be consistent with the goals and objectives of this GSP. Some smaller communities rely on county policies and have no formal land use. Land use is shown in Figures 2-7 through 2-11.

Each of the local member agencies and water entities of the Subbasin's GSAs have an interest in land use planning policies and how they will impact their continued development and water supplies.

The following GSA member agencies have direct land use planning authority:

- Kings County
- Kern County
- Tulare County
- City of Corcoran
- City of Hanford
- City of Lemoore

2.4.11 Impacts on Groundwater Dependent Ecosystems

The Nature Conservancy (TNC) worked with DWR to identify Groundwater Dependent Ecosystems (GDE) throughout the State. TNC primarily used vegetative indicators and applied them to historical aerial imagery. Imagery was cross-referenced with CASGEM well levels to identify possible GDEs. The data used in GDE identification pre-dates the baseline year of 2015, so all land use changes in the interim period may not be included. Such areas have been delineated within the Subbasin, but currently have not been confirmed.

2.5 Notice and Communication

Stakeholders gathered monthly to develop the recommended GSA formation governance structure for the Subbasin. Representatives from cities, counties, WDs, IDs, CSDs, and private water companies participated in the formation of the GSAs. Additionally, landowners, Disadvantaged Community (DAC) representatives, and industry representatives were present at GSA formation meetings.

2.5.1 Implementation of the GSP

SGMA implementation at the GSA level begins as DWR is reviewing this GSP. During the implementation phase, communication and engagement efforts focus on educational and informational awareness of the requirements and processes for reaching groundwater sustainability as set forth in the submitted GSP. Active involvement of all stakeholders is encouraged during implementation, and public notices are required for any public meetings, as well as prior to imposing or increasing any fees. Public outreach is also completed by the individual GSAs with collaborative efforts when target audiences span more than one GSA boundary.

2.5.2 Decision-Making Process

23 CCR §354.10 (d) *A communication section of the Plan that includes the following:*

- *An explanation of the Agency's decision-making process.*

The GSAs were formed by an Interim Operating Agreement to establish a Joint Powers Authority (JPA) (Appendix G). The governing body of the JPA consists of a five-member Board of Directors that includes GSA Members, Contracting Entities, and Interested Parties as identified in the JPA. Directors shall be elected officials who have been appointed to serve on the JPA's Board of Directors by their respective boards, councils or commissions, or are the authorized representatives of a Member, Contracting Entity, or Interested Party. All decisions require a majority vote of the present and voting Board of Directors, except the following:

The Tulare Lake Subbasin GSAs' decision-making process is broken down by the roles of the Subbasin management team, Board of Directors, and Stakeholder/Advisory Committees. The roles of the boards and GSA entities are outlined below.

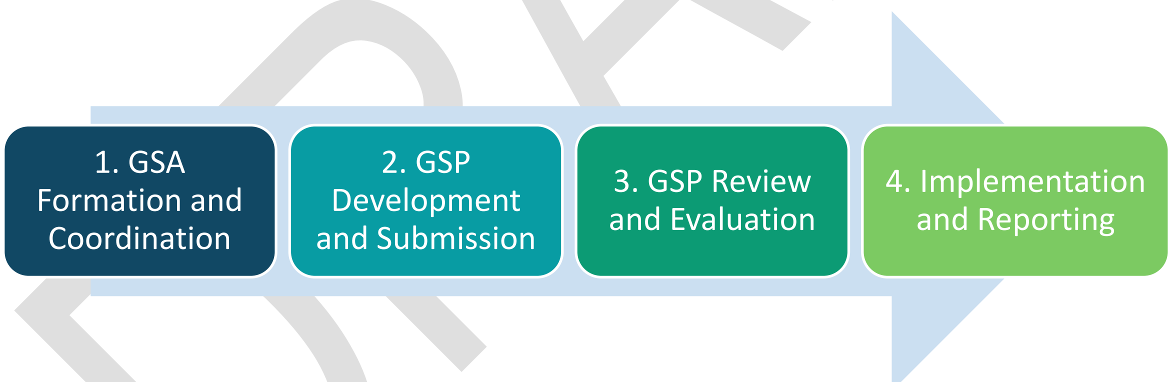
- **Subbasin Management Team –** Comprised of a representative from each of the five GSAs working collaboratively to jointly manage groundwater within the Subbasin and to develop a GSP. These individuals met on a monthly and then bi-weekly basis throughout the GSP development and public review phases.

- **Boards of Directors –** Adopts general policies regarding development and implementation of the individual GSAs and the GSP.
- **Stakeholder/Advisory Committees –** Represents all beneficial uses and users of groundwater within the individual GSA boundaries and makes recommendations to the Boards of Directors and technical consultants regarding feedback from stakeholders to account for local interests. Not all GSAs have stakeholder/advisory committees, and while allowed within SGMA, these committees are not required.

2.5.3 Beneficial Uses and Users

> ***23 CCR §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 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.*
> - *A list of public meetings at which the Plan was discussed or considered by the Agency.*
> - *Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.*

The GSAs shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing a GSP (California Water Code, §10723.2). The interests of all beneficial uses and users of groundwater within the Subbasin by GSA are identified in Table 2-4. Engagement with groundwater users occurs in the following phases of the development and implementation of the GSP:



2.5.4 Opportunities for Public Engagement

***23 CCR §354.10 (d)(2)** Identification of opportunities for public engagement and a discussion of how public input and response will be used.*

Stakeholder Key Interests related to groundwater include:
▶ Drinking Water ▶ Domestic, everyday usage ▶ Agriculture – farming, dairy, and livestock ▶ Industrial (food processing) ▶ Recreational

The GSAs within the Subbasin developed a joint Communication and Engagement Plan to address how stakeholders within the individual GSA boundaries were engaged through stakeholder education, opportunities for input, and public review during GSP development and implementation (Appendix B). Stakeholders were invited to public meetings through distribution of meeting notices to the Subbasin GSAs' district and member agency distribution lists, community organizations' contact lists, and press releases and public service announcements. Press releases were distributed to local media outlets announcing the meeting dates, times and locations. Local community organizations, such as the Kings County Farm Bureau, were asked to distribute meeting notices via email to their membership/contact lists. Public meetings held during the preparation and submission phase of the GSP were geared towards an overview of the SGMA, the GSP development process, stakeholders' expectations of public review and implementation, distribution of stakeholder surveys and solicitation of stakeholder input, and question/answer sessions. This segment of public meetings gave stakeholders an opportunity to be involved in GSP development and share their thoughts and concerns.

2.5.4.1 Communication & Outreach Methods

There were a variety of opportunities, venues, and methods for the Subbasin's GSAs to connect with and engage stakeholders throughout GSA formation, GSP development, GSP review, which will continue to be utilized through the GSP implementation phases.

Printed Communication

Printed materials incorporated the visual imagery established through individual GSA branding efforts and was tailored for specific means of communication throughout the phases of GSP development, public review, and implementation. Printed materials were also translated into Spanish, when necessary for diverse stakeholder education.

- **Fliers –** Fliers designed and tailored for stakeholder audiences, encompassed infographics and text with key messages that were pertinent for the appropriate phase of GSP development. Distribution was via GSA-website posting, direct mail, email, and direct distribution as handouts throughout communities, GSA, and Subbasin-wide outreach meetings. For outreach to DACs/Severely Disadvantaged Communities (SDACs), fliers were available in both English and Spanish languages.

- **Letter Correspondence –** When letter correspondence was necessary, particularly during the public review and implementation phases, letters were distributed via email and/or direct mail. Letters included pertinent facts and explanations communicated to specific stakeholder groups.
- **Presentation Materials –** PowerPoint presentations were utilized at educational/outreach public meetings. For a consistent Subbasin-wide message, a draft presentation was developed for the GSP development and public review phases, with placeholder slides for GSAs to update with GSA-specific information. Handouts of presentations and smaller versions of display boards were distributed to stakeholders in attendance, emailed to the Interested Parties list, and posted on individual GSAs' websites for stakeholders to access, particularly if they were unable to attend.

Digital Communication

Digital communication outlets were also designed to incorporate the Subbasin's GSA branding and was a significant means of communication through the GSP development and public review phases and will continue during the implementation phase.

- **Websites –** Public meeting notices, agendas, and minutes of the Board of Directors and Stakeholder/Advisory Committee meetings were posted on the individual GSAs' websites. These websites serve as integral resources for stakeholders within the Subbasin boundary. Electronic files of printed materials, presentations and other educational resources, and direct links to stakeholder surveys (English and Spanish versions) were also accessible via the websites. Websites will be maintained throughout the implementation phase of this GSP. This serves as a way for stakeholders to easily educate themselves on the GSP process and phases.
- **Interested Parties List –** As required by SGMA §10723.4 "Maintenance of Interested Persons List," the Subbasin's GSAs maintain contact lists and regularly distribute emails to those who have expressed interest in the GSAs' progress. These emails consist of meeting notices and other documents that are pertinent to the Subbasin GSAs and their communication efforts. This process will continue through the GSP implementation phase.
- **Email Blasts** – Email blasts for meeting notices, stakeholder surveys, public review notices, and other crucial information were coordinated with community organizations and stakeholder groups by utilizing their distribution lists. Examples of these organizations are Kings County Farm Bureau, Self-Help Enterprises, and water/irrigation districts within the individual GSAs' boundaries.

Media Coverage

Press releases were written and distributed to the media list of local newspaper publications. These press releases focused on notification of public engagement opportunities, such as targeted stakeholder meetings, public review/comment processes and opportunities. Press releases will continue during GSP implementation for meetings and notifications.

Stakeholder Surveys

Stakeholder surveys were used for the deliberate polling of stakeholders to give them a direct voice in the GSP development phase. The South Fork Kings GSA and Southwest Kings GSA circulated physical surveys, while the remaining three GSAs conducted verbal surveys through one-on-one discussions with stakeholders within their GSA boundaries. For the GSAs who administered physical stakeholder surveys, they developed both online and printed versions of their surveys. Survey links were posted as Google Forms on the individual GSAs' websites and were utilized in email blasts to the Interested Parties Lists. Hardcopies were also available for distribution throughout the respective GSA. Results from the surveys are included in the appendices of Appendix B.

2.5.5 Encouraging Active Involvement

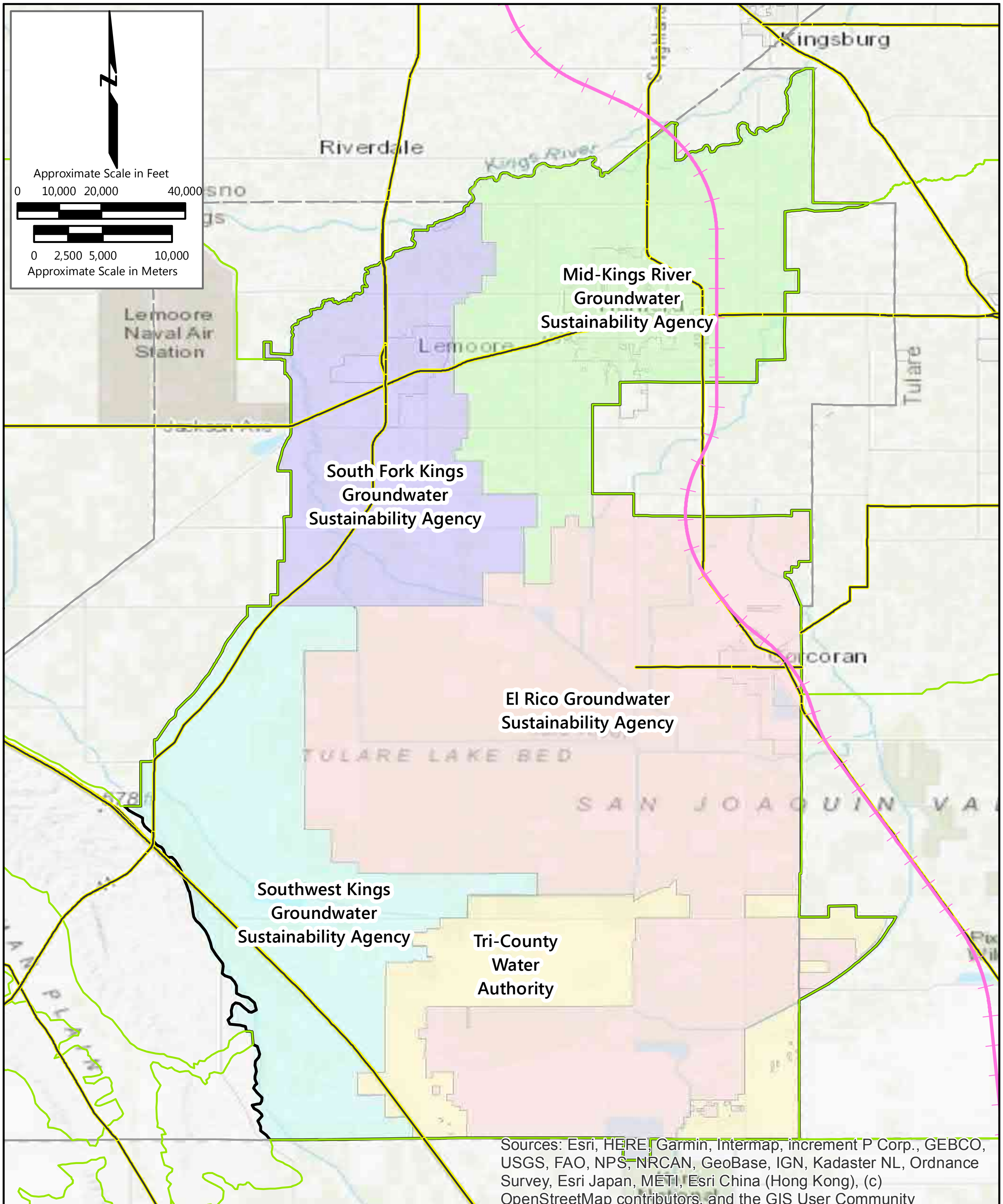
23 CCR §354.10(d) *A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin.*

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

Through Stakeholder Committees and, in some instances an, AC, GSAs are able to encourage the active involvement of diverse social, cultural, and economic elements of the population within the Subbasin prior to and during the development and implementation of this GSP. Printed materials are tailored for specific means of communication throughout the phases of the GSP development, for public review and implementation. As stated above, printed materials are translated into Spanish. Fliers, fact sheets, letter correspondence, presentation materials stakeholder surveys, and newsletters are the forms of printed communication between the public and GSAs. Digital communication and media coverage serve as an additional means of communication between the public and GSAs. During this GSP's implementation, specific stakeholders are informed of upcoming compliance requirements. Addresses of the area's property owners within the GSAs' boundaries can be obtained through Kings County. Meetings will be held in a range of areas within the Subbasin to encourage attendance.

2.5.5.1 Subbasin Public Meetings

Public meetings to ensure equitable community access occurred within each GSA throughout the GSP's phases. Each GSA provided a list of previous and ongoing public meetings to track the effectiveness of outreach efforts (Appendix B).



Explanation

- CHSR Proposed Route
- Other groundwater subbasins (DWR 2017)
- Subbasin boundary
- County Line

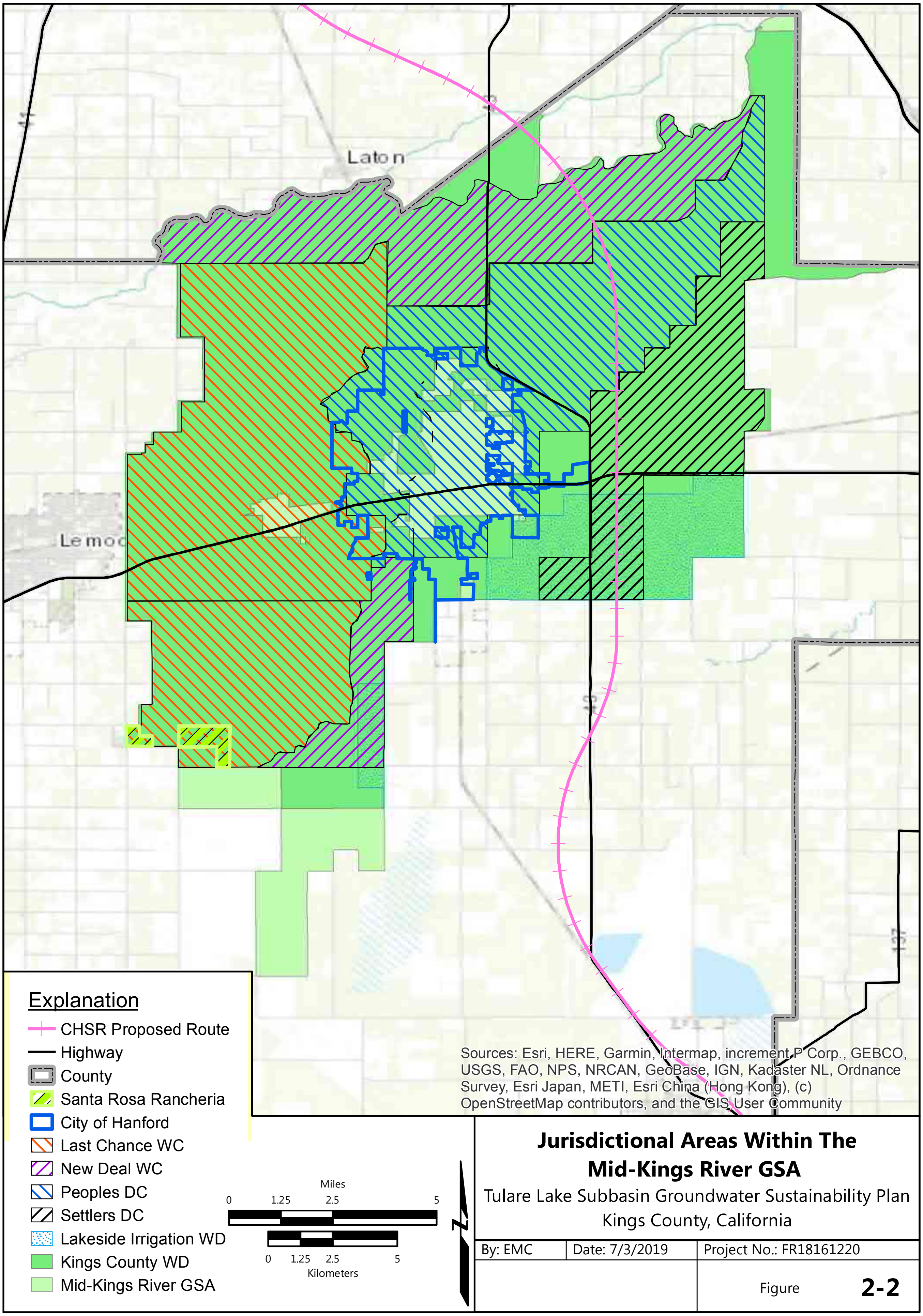
Tulare Lake Subbasin

Tulare LakeSubbasin Groundwater Sustainability Plan

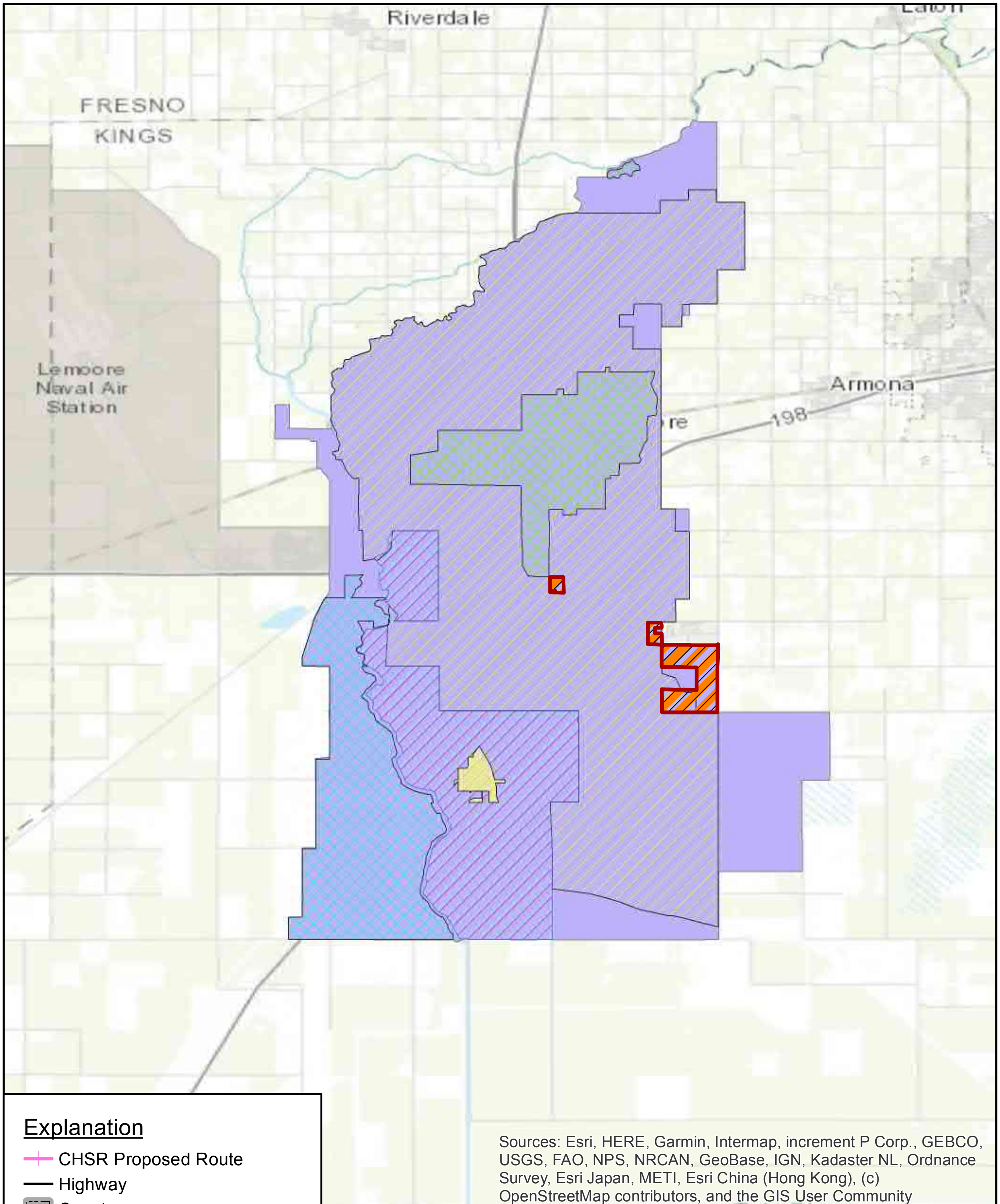
Kings County, Calfiornia

By: EMC	Date: 7/3/2019	Project No.: XXX
wood.		Figure 2-1

Date: 7/3/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-1_Subbasin.mxd



Date: 7/3/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-2_MidKingsParticipants8x11.mxd



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Explanation

- CHSR Proposed Route
- Highway
- County
- Santa Rosa Rancheria
- City of Lemoore
- Stratford PUD
- Empire Westside ID
- Stratford ID
- Lemoore Canal & Irrigation Co
- South Fork Kings River GSA

Miles
0 1.25 2.5 5

0 1.25 2.5 5
Kilometers

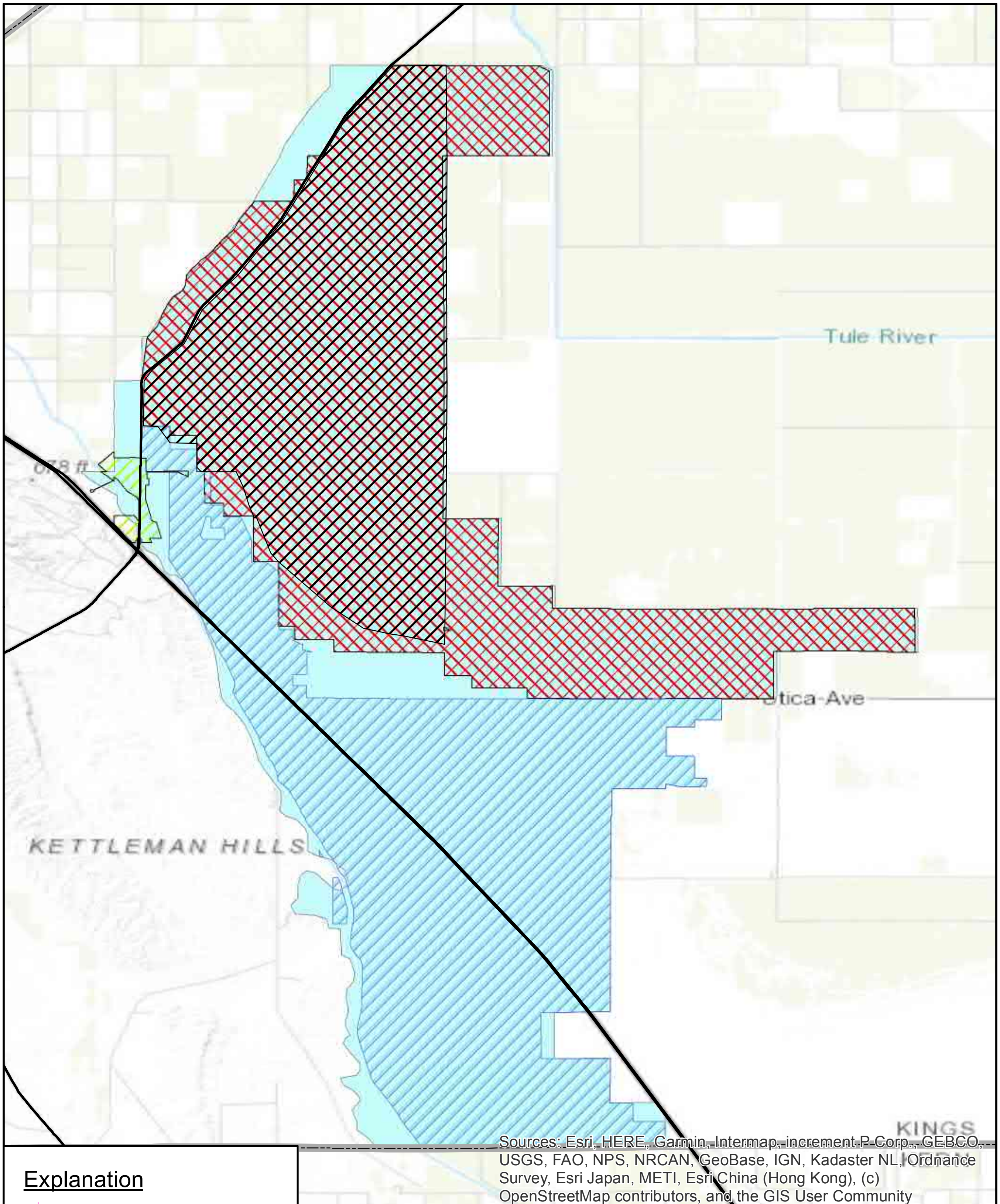
N

Jurisdictional Areas Within The South Fork Kings GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/15/2019	Project No.: FR18161220
		Figure 2-3

Date: 8/15/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-3_SouthForkParticipants_8x11.mxd



Explanation

- CHSR Proposed Route
- Highway
- County
- Reclamation District No 761
- Kettleman City CSD
- Dudley Ridge WD
- Tulare Lake Basin WSD
- Southwest Kings GSA

Miles: 0 1.25 2.5 5

Kilometers: 0 1.25 2.5 5

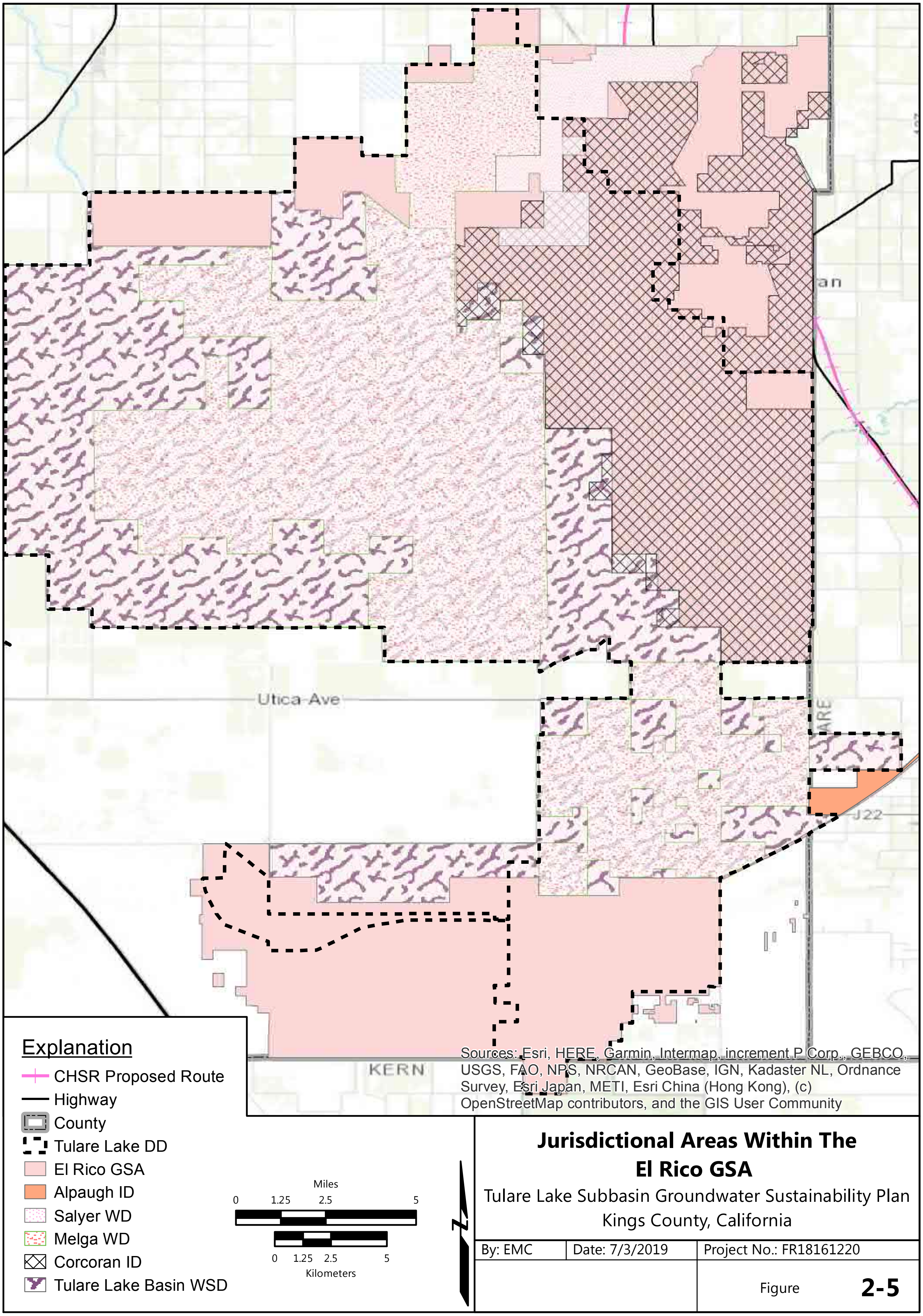
Jurisdictional Areas Within The Southwest Kings GSA

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: EMC	Date: 7/3/2019	Project No.: FR18161220
		Figure **2-4**

Date: 7/3/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-4_SWKingsParticipants_8x11.mxd



Jurisdictional Areas Within The El Rico GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 7/3/2019	Project No.: FR18161220
		Figure **2-5**

Date: 7/3/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-5_ElRicoParticipants_8x11.mxd

Date: 8/19/2019 Printed by: elizabeth.chapman
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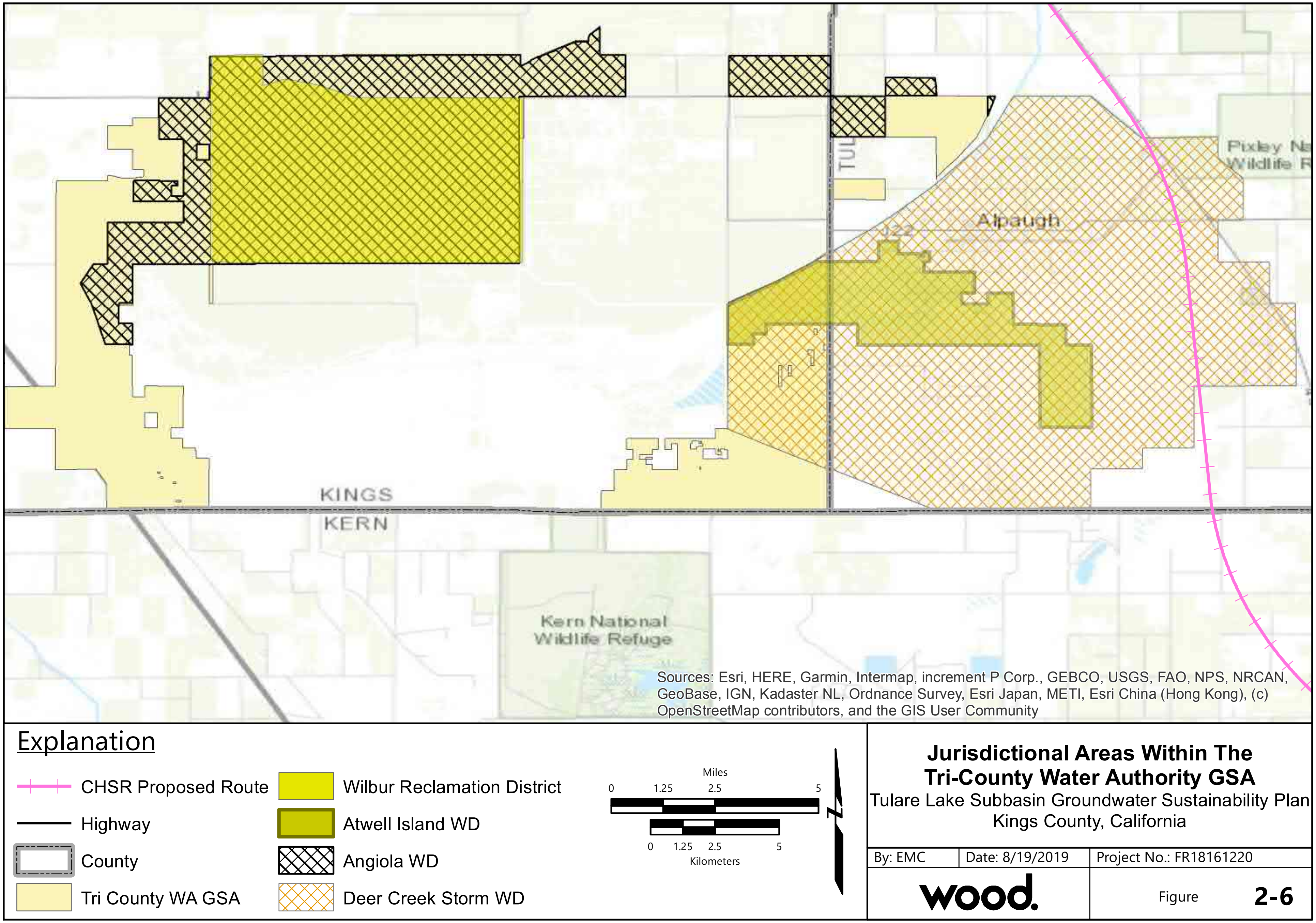
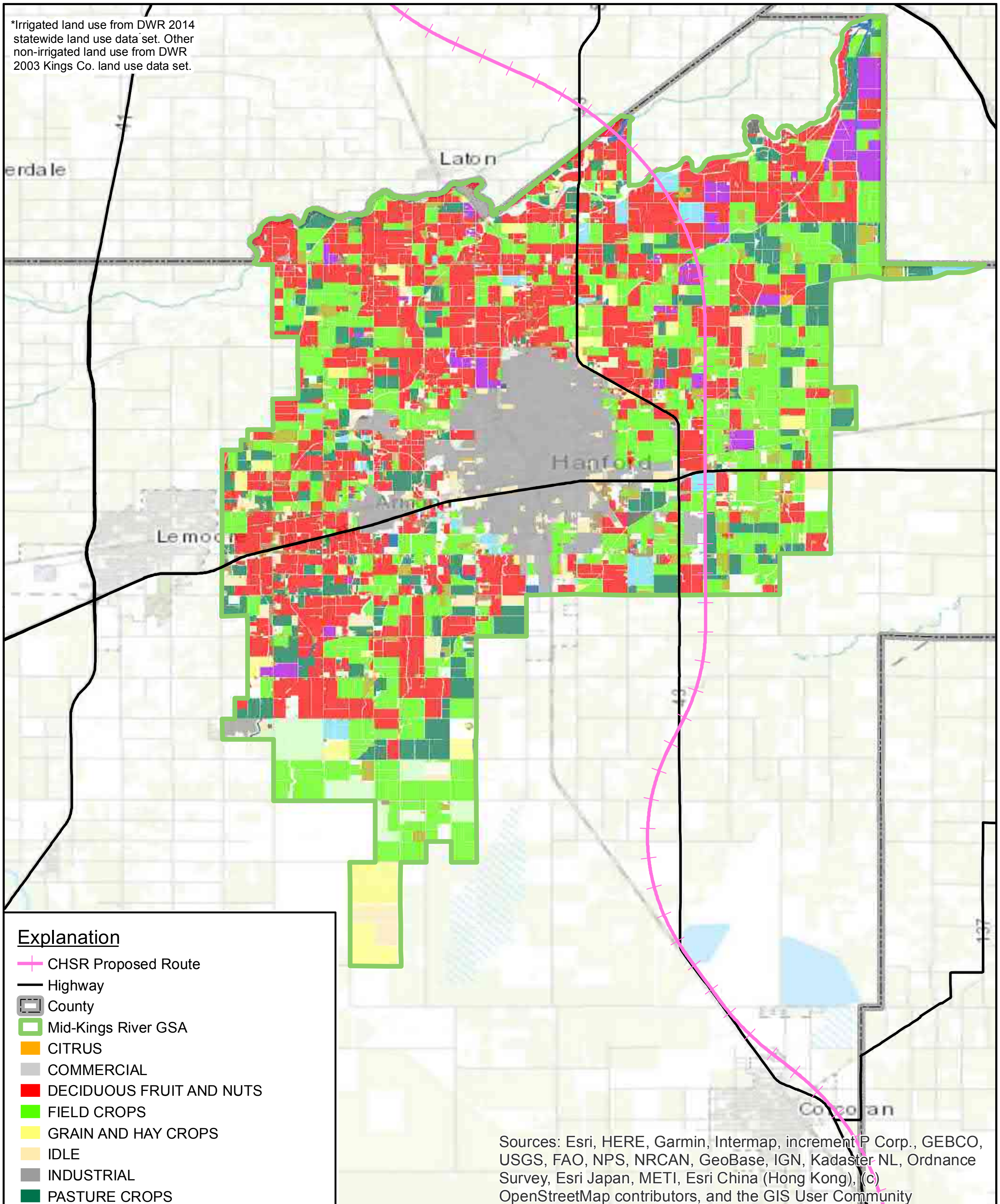


Jurisdictional Areas Within The Tri-County Water Authority GSA
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/19/2019	Project No.: FR18161220

wood.

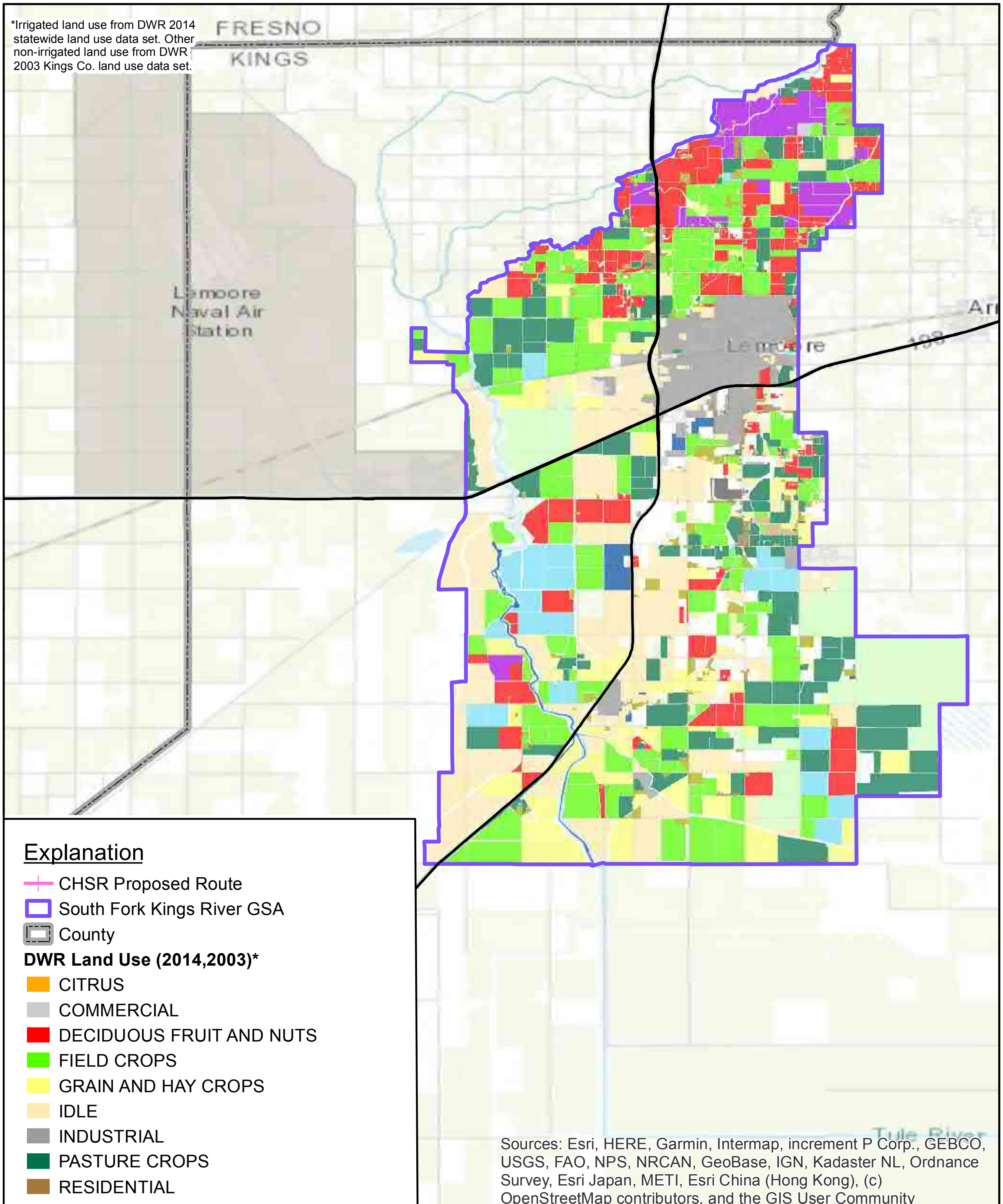
Figure **2-6**



Mid-Kings River GSA
Land Use Classification
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 7/3/2019	Project No.: FR18161220
		Figure **2-7**

Date: 7/3/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-7_MidKings_Landuse_8x11.mxd



Explanation

- CHSR Proposed Route
- South Fork Kings River GSA
- County

DWR Land Use (2014,2003)*

- CITRUS
- COMMERCIAL
- DECIDUOUS FRUIT AND NUTS
- FIELD CROPS
- GRAIN AND HAY CROPS
- IDLE
- INDUSTRIAL
- PASTURE CROPS
- RESIDENTIAL
- RIPARIAN VEGETATION
- SEMIAGRICULTURAL
- TRUCK, NURSERY AND BERRY CROPS
- URBAN
- URBAN LANDSCAPE
- VINEYARDS
- WATER SURFACES
- YOUNG PERENNIAL

Miles: 0, 1.25, 2.5, 5

Kilometers: 0, 1.25, 2.5, 5

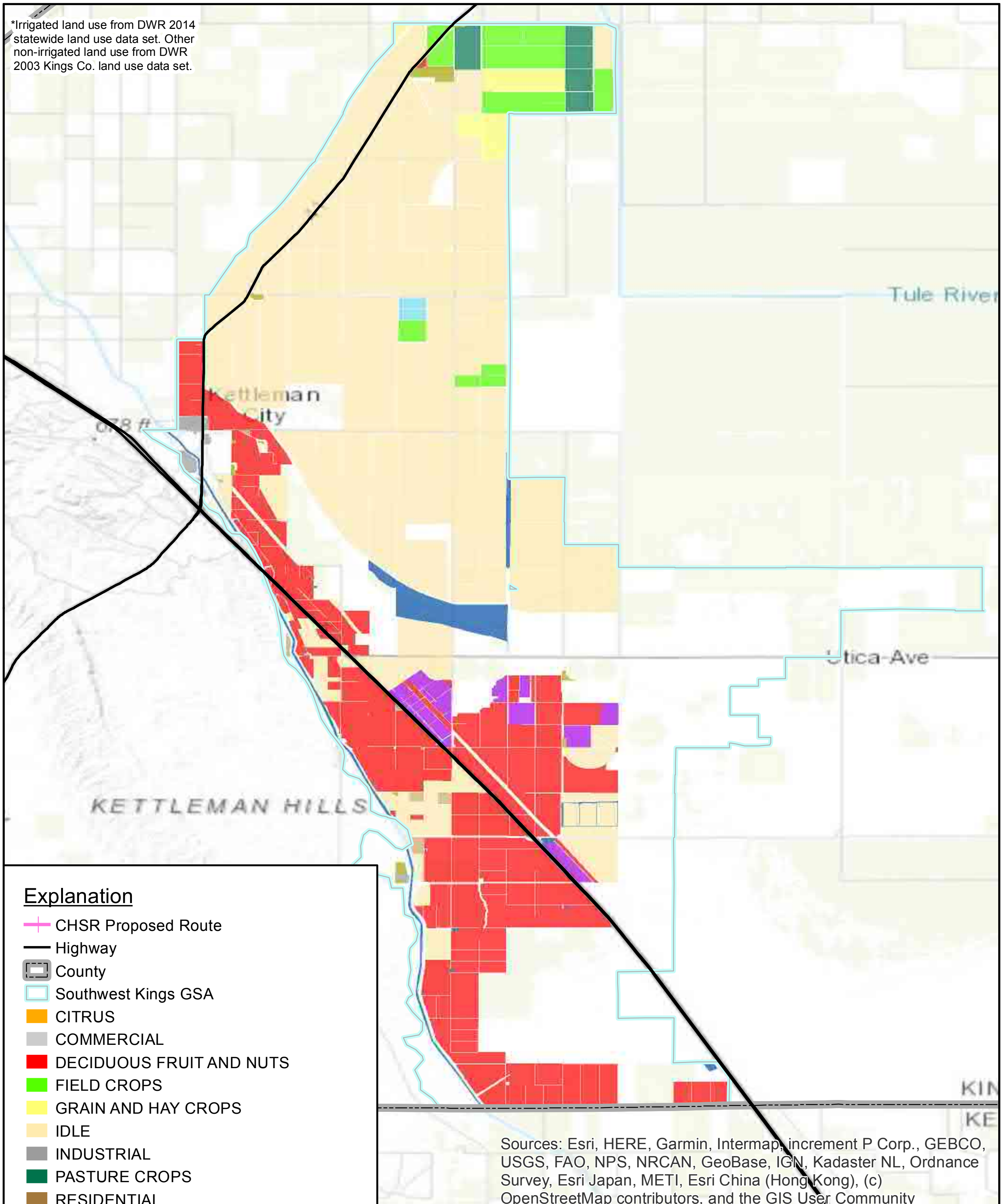
N

South Fork Kings GSA
Land Use Classifications

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/15/2019	Project No.: FR18161220
		Figure **2-8**

Date: 8/15/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-8_SouthFork_Landuse_8x11.mxd



Explanation

- CHSR Proposed Route
- Highway
- County
- Southwest Kings GSA
- CITRUS
- COMMERCIAL
- DECIDUOUS FRUIT AND NUTS
- FIELD CROPS
- GRAIN AND HAY CROPS
- IDLE
- INDUSTRIAL
- PASTURE CROPS
- RESIDENTIAL
- RIPARIAN VEGETATION
- SEMIAGRICULTURAL
- TRUCK, NURSERY AND BERRY CROPS
- URBAN
- URBAN LANDSCAPE
- VINEYARDS
- WATER SURFACES
- YOUNG PERENNIAL

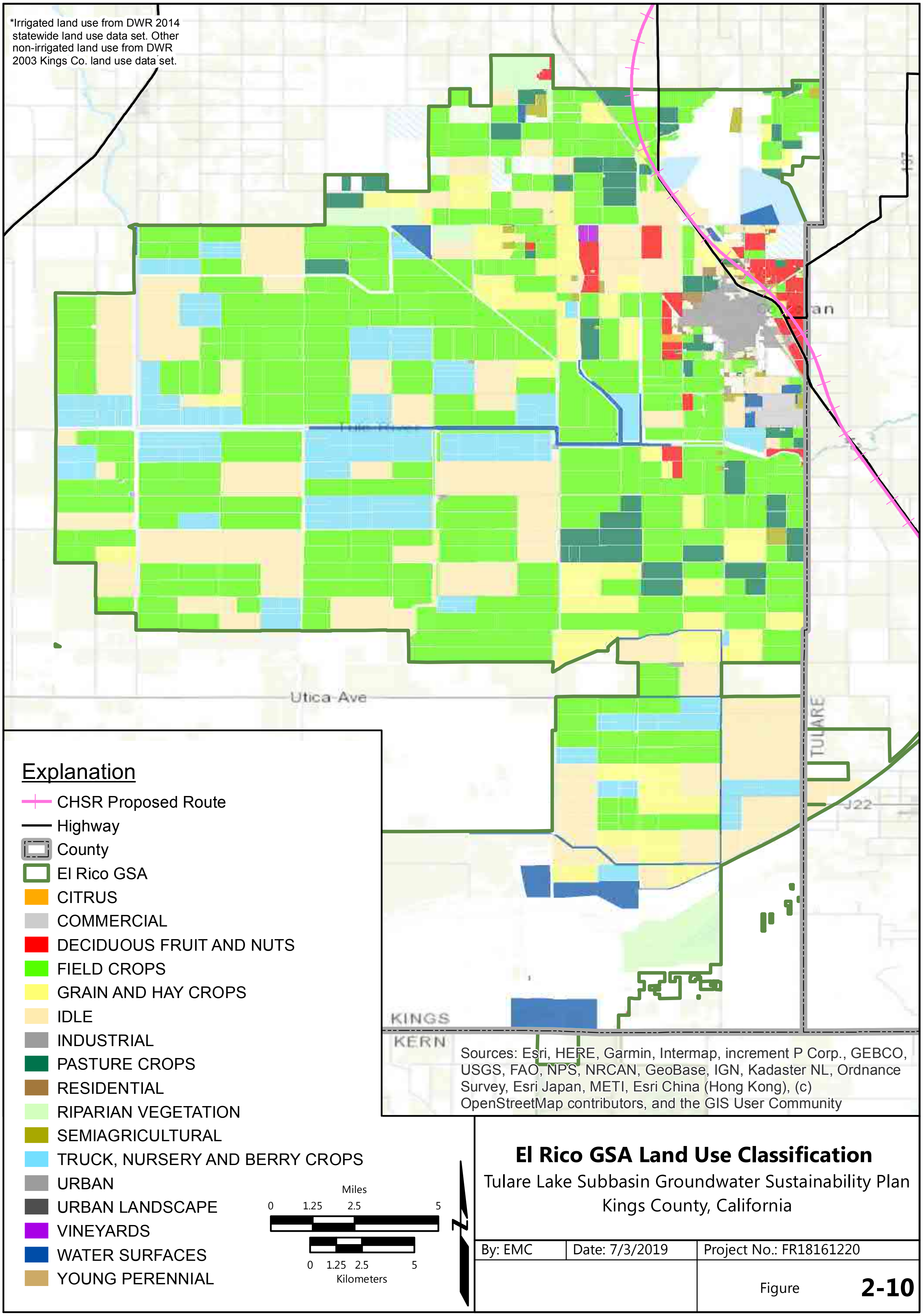
Miles: 0 1.25 2.5 5

Kilometers: 0 1.25 2.5 5

Southwest Kings GSA
Land Use Classifications
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 7/3/2019	Project No.: FR18161220
		Figure **2-9**

Date: 7/3/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-9SWKings_LandUse_8x11.mxd



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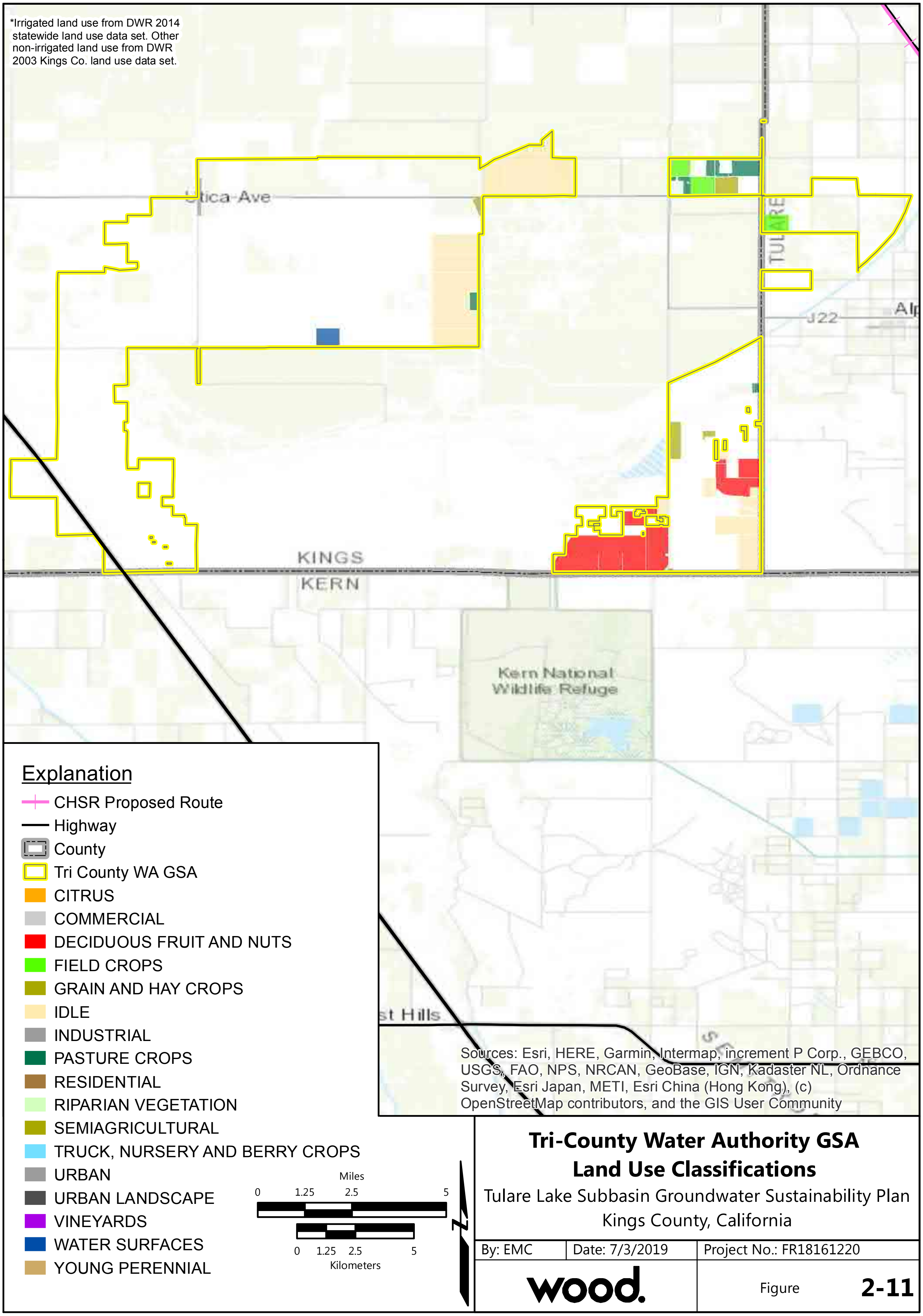


Tri-County Water Authority GSA
Land Use Classifications
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 7/3/2019	Project No.: FR18161220
wood.		Figure **2-11**

Date: 7/3/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_Area_fig2-11_TriCountyWA_LandUse_8.5x11.mxd

Table 2-1. Land Use in Tulare Lake Subbasin (2014)

Land Use Classification	Percent of Total Area
Commercial	0.3%
Deciduous Fruit and Nuts	14.6%
Field Crops	30.1%
Grain and Hay Crops	6.2%
Idle	22.9%
Industrial	0.3%
Pasture Crops	7.1%
Residential	0.4%
Riparian Vegetation	2.8%
Semi agricultural	1.8%
Truck, Nursery, and Berry Crops	6.0%
Urban	3.8%
Urban Landscape	0.1%
Vineyards	1.5%
Water Surface	2.0%
Young Perennials	0.1%
TOTAL	**100.0%**

Source: DWR 2014.

Table 2-2. Primary Water Uses and Water Sources

Groundwater Sustainability Agency	Water Use Sector (Agency / Water Company)	Water Use	Water Source Type
El Rico GSA	Alpaugh Irrigation District	Irrigation	Groundwater
	City of Corcoran	Residential Commercial Residential	Groundwater
	Corcoran Irrigation District & Irrigation Company	Irrigation Recharge	Kings River Kaweah River St. John's River
	Peoples Ditch Company	Irrigation Recharge	Kings River
	Last Chance Water Ditch Company	Irrigation Recharge	Kings River
	Lakeside Canal Company	Irrigation Recharge	Kaweah River St. John's River Central Valley Project (CVP)
	Tulare Lake Basin Water Storage District	Irrigation	Kings River Kaweah River St. John's River Tule River SWP
Tri-County Water Authority GSA	Angiola Water District	Irrigation Recharge	State Water Project (SWP) CVP Kings River Tule River Deer Creek Groundwater Poso Creek
	Atwell Island Water District	Irrigation	Groundwater
	Deer Creek Storm Water District	Flood Control	Deer Creek Poso Creek
	W. H. Wilbur Reclamation District #825	Irrigation	Poso Creek
Mid-Kings River GSA	City of Hanford	Residential Commercial Industrial	Groundwater
	Armona Community Services District	Residential Commercial	Groundwater

Table 2-2. Primary Water Uses and Water Sources (Continued)

Groundwater Sustainability Agency	Water Use Sector (Agency / Water Company)	Water Use	Water Source Type
Mid-Kings River GSA (Continued)	Home Garden Community Services District	Residential	Groundwater
	Kings County Water District	Irrigation Recharge Banking	Kings River Kaweah River St. John's River CVP
	Lakeside Irrigation Water District & Canal Company	Irrigation Recharge	Kaweah River St. John's River CVP
	Peoples Ditch Company	Irrigation Recharge	Kings River
	Last Chance Water Ditch Company	Irrigation Recharge	Kings River
	Santa Rosa Rancheria	Residential Commercial	Groundwater
Southwest Kings GSA	Dudley Ridge Water District	Irrigation	SWP, Groundwater
	Tulare Lake Reclamation District #761	Irrigation	Kings River SWP
	Tulare Lake Basin Water Storage District	Irrigation	Kings River Kaweah River St. John's River Tule River SWP
	Kettleman City Community Services District	Residential Commercial Industrial	SWP Groundwater
South Fork Kings GSA	Lemoore Canal and Irrigation Company	Irrigation	Kings River
	Stratford Irrigation District	Irrigation	Kings River
	Stratford Public Utility District	Residential Commercial	Groundwater
	Santa Rosa Rancheria	Residential Commercial	Groundwater

Table 2-3. Summary of Applicable Plans

County	Plan	Online Source
Kings County	Kings County 2035 General Plan (adopted January 2010, includes Land Use, Circulation, Noise, Open Space, Resource Conservation, Health and Safety, and Air Quality Elements; Housing Element updated January 2016; Dairy Element adopted July 2002)	https://www.countyofkings.com/departments/community-development-agency/information/2035-general-plan
	Armona Community Plan (2009)	https://www.countyofkings.com/home/showdocument?id=13505
	Home Garden Community Plan (2015)	https://www.countyofkings.com/home/showdocument?id=13507
	Kettleman City Community Plan (2009)	https://www.countyofkings.com/home/showdocument?id=13509
	Stratford Community Plan (2009)	https://www.countyofkings.com/home/showdocument?id=3106
	City of Hanford – 2035 General Plan (April 2017)	http://www.cityofhanfordca.com/document_center/Planning/Plans/Hanford%20General%20Plan/2035%20General%20Plan%20%20Policy%20Document.pdf
	City of Lemoore – 2030 General Plan (May 2008)	http://lemoore.com/communitydevelopment/general-plan/
	City of Corcoran – 2025 General Plan (March 2007), 2005-2025 General Plan Enhancement (November 2014)	http://www.cityofcorcoran.com/civica/filebank/blobdload.asp?BlobID=3796
County of Tulare	County of Tulare – 2030 General Plan (August 2012)	http://generalplan.co.tulare.ca.us/documents/GP/001Adopted%20Tulare%20County%20General%20Plan%20Materials/000General%20Plan%202030%20Part%20I%20and%20Part%20II/GENERAL%20PLAN%202012.pdf
Kern County	Kern County – General Plan (September 2009)	https://kernplanning.com/planning/planning-documents/general-plans-elements/

Table 2-4. Beneficial Uses and Users by GSA

Stakeholder Group	Description
Mid-Kings River GSA	
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users.
Domestic Well Owners	There are domestic wells within the Mid-Kings River GSA, and it is understood that many rural domestic users will fall into the "de minimis extractor" category, so further work is being conducted to understand to what extent domestic users will be affected by GSP requirements.
Public Water Systems	Armona CSD, Home Garden CSD and Hardwick Water Company, as well as several transient public water systems for school districts are included in this category (Kings River-Hardwick, Pioneer, Hanford Christian).
Municipal Water Systems	City of Hanford
Local Land Use Planning Agencies	City of Hanford and Kings County
California Native American Tribes	See Appendix B, Section C.2
Disadvantaged Communities (DAC)	Armona, Home Garde, Hardwick
Entities monitoring and reporting Subbasin groundwater elevations	Kings County WD monitors groundwater levels within its service area and is providing a subset of that information to the KRCD for submission to the CASGEM system.
South Fork Kings GSA	
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users.
Domestic Well Owners	
Municipal Well Operators	City of Lemoore, Stratford PUD
Local Land Use Planning Agencies	City of Lemoore, Kings County
California Native American Tribes	See Appendix B, Section C.2
Disadvantaged Communities	Community of Stratford
Entities monitoring and reporting Subbasin groundwater elevations	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. South Fork Kings GSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.
Southwest Kings GSA	
Agricultural Users	Approximately 99% of the GSA is composed of agricultural lands. Representatives of the agricultural community are currently involved on the Board of Directors and on GSA committees and subcommittees.
Domestic Well Owners	Only one or two landowners utilize a domestic well and are represented on the Board of Directors through member agencies.
Municipal Well Operators	Kettleman City CSD provides well water to residential and commercial customers within the GSA boundary.
Local Land Use Planning Agencies	Kings County
California Native American Tribes	See Appendix D, Section C.2

Table 2-4. Beneficial Uses and Users by GSA (Continued)

Stakeholder Group	Description
Disadvantaged Communities	Kettleman City
Entities monitoring and reporting Subbasin groundwater elevations	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. Southwest Kings GSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.
El Rico GSA	
Agricultural Users	Represented through many of the GSA member agencies and/or by Kings County.
Domestic Well Owners	Represented through member agencies including Kings County or via exemption for small amounts of groundwater extraction.
Municipal Well Operators	City of Corcoran
Public Water Systems	City of Corcoran
Local Land Use Planning Agencies	City of Corcoran, Kings County
Surface Water Users	Represented through GSA member agencies
Disadvantaged Communities	City of Corcoran
Entities monitoring and reporting Subbasin groundwater elevations	Represented by GSA member agencies including TLBWSD that collects and reports data for multiple members of the agency via the Tulare Lake Coordinated Groundwater Management Plan.
Tri-County Water Authority GSA	
Agricultural Users	Composed almost entirely of agricultural users, including nut grower commodity groups and other agricultural use growers.
Domestic Well Owners	There are domestic wells within the GSA area, but because SGMA excludes "de minimis extractors," it is anticipated that the GSP will exclude domestic wells from such requirements.
Local Land Use Planning Agencies	Kings County
Federal Government	Bureau of Land Management
Entities monitoring and reporting Subbasin groundwater elevations	Angiola WD, TLBWSD

Source: Appendix B.

3.0 BASIN SETTING

23 CCR §354.12 *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.*

Key Features of the Tulare Lake Subbasin
▶ **2010 Population:** ~125,907 persons
▶ **Estimated Population Growth by 2030 :** ~40%
▶ **# of Total Wells:** ~3,871 wells
▶ **Public Supply Wells:** ~ 75 wells
▶ **Subbasin Acreage:** ~ 535,869 acres
▶ **Irrigated Acreage:** ~ 251,994 acres
▶ **Groundwater Use:** ~ 506, 604 acre-ft
▶ **Groundwater % of Total Water Supply:** ~50%
Source: DWR 2019b

The Tulare Lake Subbasin (Subbasin) is located primarily in Kings County in the Tulare Lake Hydrologic Region of the San Joaquin Valley. The San Joaquin Valley is relatively flat and elongates to the northwest and is bounded on the west by the Coast Ranges and on the east by the Sierra Nevada Mountain Range. The Subbasin is located in the south-central portion of the greater San Joaquin Valley. Topography in the Subbasin slopes inward towards the center of the Tulare Lake. Land use in the Subbasin and surrounding areas is predominately agricultural with localized urban areas of Hanford, Lemoore, and Corcoran. This chapter discusses the hydrogeologic conceptual model (HCM), groundwater conditions, the water budget, and management areas for the Subbasin.

The HCM, discussed in Section 3.1, acts as a sustainable groundwater management tool for the Subbasin's Groundwater Sustainability Agencies (GSAs) and provides a basis for the numerical groundwater flow model developed for the Subbasin (Appendix D). The HCM includes a description of the geographic, geologic and hydrogeologic setting, and a discussion of data gaps and uncertainties associated with the HCM.

Groundwater conditions, provided in Section 3.2, includes current and historical groundwater conditions in support of the Groundwater Sustainability Plan (GSP) to ensure historical and present challenges are adequately described. The groundwater conditions section includes a description of current and historical groundwater conditions, current and potential subsidence in the Subbasin, a summary of groundwater quality, interconnected surface and groundwater systems, and groundwater dependent ecosystems.

The water budget, discussed in Section 3.3, provides a quantitative description of the historical, current, and 50-year projected inflows and outflows of the Subbasin. Additionally, the water budget will be used to develop an estimate of existing overdraft in the Subbasin and consider baseline conditions for the basis of understanding future water supply reliability and for development of sustainable management actions and projects within the Subbasin. The historical water budget was used to develop and calibrate a numerical groundwater model of the Subbasin (Appendix D) and develop a 50-year forecast of future conditions, assuming normal hydrologic conditions with estimated climate change. The forecast model will be used as a planning tool to evaluate overdraft, develop sustainable management projects, and to evaluate management practices and projects' abilities to meet measurable objectives to avoid undesirable results.

Additionally, management areas, discussed in Section 3.4, have been delineated to facilitate data management and GSP implementation.

3.1 Hydrogeologic Conceptual Model

> **23 CCR §354.14(a)** *Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterize the physical components and interaction of the surface water and groundwater systems in the basin.*

The HCM provides a general understanding of the physical setting, characteristics, and processes that govern groundwater occurrence and movement within the Subbasin (DWR 2016c). It comprises a compilation of available information to portray the geographic setting, regional geology, basin geometry, water quality, and consumptive water uses (municipal, agricultural, and industrial) in the Subbasin. The HCM looks at the groundwater and surface water interactions and assesses the inflows and outflows to and from the Subbasin. Subbasin boundaries are often a combination of physical and political boundaries, so subbasin boundaries often do not reflect the actual physical hydrologic boundaries of an area. Thus, the area of study in an HCM is often larger than the designated subbasin boundaries. The HCM also provides the foundation for the numerical groundwater model, delineating the boundary conditions, the hydrogeologic layers, and the model domain needed to provide an accurate representation of the groundwater flow system.

3.1.1 Geographic Setting

The Subbasin is located primarily in Kings County in the Tulare Lake Hydrologic Region of the San Joaquin Valley, California (Figure 3-1). The Subbasin covers an area of approximately 535,869 acres or about 837 square miles (DWR 2016b). The Subbasin contains five GSAs, El Rico, Mid-Kings River, Southwest Kings, South Fork Kings River, and Tri-County Water Authority (Figure 3-2). It is bounded by the Kings Subbasin to the north, the Kaweah Subbasin to the northeast, the Tule Subbasin to the southeast, the Kern County Subbasin to the south, the Kettleman Plain Subbasin to the southwest, and the Westside Subbasin to the northwest (Figure 3-3).

The San Joaquin Valley is relatively flat and elongates to the northwest and is bounded on the west by the Coast Ranges and on the east by the Sierra Nevada Mountains (Figure 3-4). The San Joaquin River is the principal drainage connection between the Valley and the Pacific Ocean receiving significant runoff from tributary rivers and streams emanating primarily from the adjoining Sierra Nevada Mountains. The Subbasin in recent history has been internally drained, with only periodic connection to the San Joaquin River during times of extreme runoff. The terminus for this internal drainage within the Subbasin historically has been Tulare Lake, whose lakebed occupies a substantial portion of the Subbasin (Figure 3-4). The lakebed is now typically dry, as levees have been built to prevent direct surface water inflow from inundating agricultural activities and areas.

Flow from the rivers and streams of the Sierra Nevada Mountains are largely regulated by a series of dams and reservoirs (Figure 3-5), which capture runoff from winter precipitation. Most of the runoff falls as snow in the adjoining highlands. The flow from the reservoirs is fed into canals and modified streambeds that carry surface water primarily to agricultural users and to a number of small municipalities.

3.1.1.1 Climate

The climate in the Subbasin is semi-arid, characterized by hot, dry summers and cool moist winters and is classified as a semi-arid climate (BSk to BSh under the Köppen climate classification), usually found within continental interiors some distance from large bodies of water. The wet season occurs from November through March with 80 percent (%) of precipitation falling during this season. The Valley floor often receives little to no rainfall in the summer months. Precipitation typically occurs from storms that move in from the northwest off the Pacific Ocean. Occasionally storms from the southwest, which contain warm sub-tropical moisture can produce heavy rains, especially during El Niño episodes that form atmospheric rivers (ECORP 2007).

Historical annual precipitation records over a span of 118 years were recorded by the Hanford weather station. The Hanford weather station is located in the northern portion of the Subbasin and averages 8.28 inches per year. In addition, from 1899 to 2017, rainfall has ranged from a minimum of 3.37 inches in 1947 to a maximum of 15.57 inches in 1983 (NOAA 2019) (Table 3-1). Monthly precipitation in the area ranges between 0.00 and 6.69 inches per month. Typically, precipitation decreases from northeast (Mid-Kings River GSA) to southwest (Southwest Kings GSA) across the Subbasin due to the rain shadow of the Coast Ranges. Figure 3-6 provides a map of the average annual precipitation across the Subbasin from January 1990 through December 2016 using the Parameter-elevation Regressions on Independent Slopes Model (PRISM) database, maintained by the Oregon State University (PRISM 2018).

3.1.1.2 Topography

The topography of the Subbasin is generally low sloping inward from all directions toward the center of Tulare Lake (Figure 3-7). From northeast to the center of Tulare Lake, bed elevation ranges from about 292 to 188 feet above mean sea level (AMSL). The highest elevations within the Subbasin of approximately 405 feet AMSL occur along the northeast flank of Kettleman Hills. The topography shows the drainage within the Subbasin is internal flowing toward the Tulare Lake bed.

3.1.1.3 Land Use

Land use in the Subbasin and surrounding areas is predominately agricultural with localized urban areas of Hanford, Lemoore, and Corcoran. Land use was evaluated using California Department of Water Resources (DWR) land use maps for 1990 through 2006 and annual United States Department of Agriculture (USDA) CropScape maps from 2006 through 2016 (DWR 2016d; USDA 2016). These maps were provided in Geographic Information System (GIS) formats, allowing for aggregation of similar land uses to simplify analysis. A total of 24 land uses were identified and evaluated (Table 3-2). Land use maps for eight different time periods between 1990 and 2016 are presented in Figures 3-8a to 3-8d.

Between 1990 and 2016, the 535,869-acre Subbasin had an average of approximately 68% of its surface area or 365,500 acres of crops, 9,980 acres of riparian land or land covered by water, 155,500 acres of fallow or undeveloped land, 9 acres of industrial parks, and about 49,500 acres of urban areas (Figures 3-8a to 3-8d; Table 3-2) (Amec 2018). The mix of crops grown, and the areas of fallow lands has changed over time as agricultural practices changed in response to agricultural markets and drought conditions. During the 2010-2016 drought, fallow acreage increased while riparian, cotton, and pasture acreage all decreased (Figures 3-8a to 3-8d) (Table 3-2) (Amec 2018). Cotton showed the most change with a decrease of more than 100,000 acres (approximately 41%) between 1995 and 2016. The data also shows an overall increase in permanent crops over time, with increases in young and mature almonds from approximately 7,680 acres in 1995 to 42,000 acres in 2016.

3.1.1.4 Soils

The Subbasin includes many soil survey areas mapped and cataloged by the USDA Natural Resources Conservation Service (NRCS) (NRCS 2018). These areas may have been mapped at different times, at different scales, and with varying levels of detail, occasionally resulting in abrupt soil survey area boundaries and incomplete data sets.

Soil texture is interrelated with groundwater flows as it affects water holding capacity and vertical water movement through the soil profile. Soil textural classifications vary across the Subbasin. Clayey soils are dominant in the interior of the Subbasin, corresponding with the Tulare Lake bed (Figure 3-9) (Soil Survey Staff 2018).

Clayey soils also dominate Tule marshes located in the Tulare Lake overflow to the San Joaquin River, the Kern River overflow channel, and the lower reaches of the Kings River. Loam and sandy loam soils border the clayey soils and are the predominant soils to the east of the lakebed, including areas of the Tule and Kaweah Rivers watersheds; to the west, along the eastern flanks of Kettleman Hills and the Coast Range; and to the north and northeast, including along the Kings River watershed.

The saturated hydraulic conductivity (K_{sat}) of a soil affects a saturated soil's ability to move water through soil pore spaces under a hydraulic gradient. K_{sat} is very low in the lakebed of the Subbasin (Figure 3-10), ranging only from 0.0-10.0 micrometers per second (µm/sec) (NRCS 2018). These clay soils tend substantially limit percolation and basin recharge in this area. As the soil textures become coarser (sandier), the conductivity tends to improve. The K_{sat} increases north of the lakebed, in the Kings River watershed, to 10.0-40.0 µm/sec. Similar conductivities are also present in alluvial fan channels emanating from the Kettleman Hills and Sierra Nevada Mountain ranges.

Salts in soil are commonly sourced from parent rock and are a result of evapotranspiration concentrating salt within irrigation water. The Tulare Lake area has high levels of groundwater salinity due to the import of salts through irrigation with the Delta water (DWR 2019b). Additionally, salts are added to the Tulare Lake area through fertilizer applications. No natural drainage is present in the Tulare Lake area with the exception of highly wet years, so imported salts have accumulated in the groundwater, increasing water salinity. High salinity degrades groundwater quality, which is critical for potable and agricultural water use. Soil salts are measured from a saturated soil extract by assessing electrical conductivity (EC) in decisiemen per meter (dS/m). Common soil salinity ranges are 0.0-4.5 dS/m (non-saline), 4.5-9.0 dS/m (slightly saline), 9.0-18 dS/m (medium saline), and >18 dS/m (highly saline) (Brouwer et al. 1985). Soil salinity within the Subbasin was averaged across all soil horizons, weighted by horizon thickness (Figure 3-11) (NRCS 2018). Salinity values are lowest (0.0-4.5 dS/m) around the margins of the Subbasin and on the Kings River alluvial fan. Salinity ranges from 4.5-9.0 dS/m, slightly saline, in the majority of the Tulare Lake bed and in distal parts of the Kings River watershed. The areas immediately surrounding the lakebed and extending to the northwest and southeast have salinity ranging from 9.0-18.0 dS/m and above.

3.1.1.5 Rivers, Streams, and Tulare Lake

Stream flow in rivers, streams, and surface water conveyances (canals) is a significant source of groundwater recharge throughout the Subbasin by direct infiltration to the subsurface and from deep percolation where surface water is applied for agricultural irrigation.

The natural hydrology of the Subbasin has been extensively altered over the last century for flood control, irrigation, land reclamation, and water conservation. Concerns about increasing water supply for agricultural development and improved flood control resulted in the construction of large dams and reservoirs on each of the four major rivers (ECORP 2007). Channelization of the rivers for flood control and water banking have further modified the Subbasin’s hydrology (ECORP 2007). The modern-day surface water conveyances that supply the Subbasin are primarily the historical lakebed, man-made canals and channelized streambeds and are described as follows (Figure 3-5):

Tulare Lake

At one time, Tulare Lake was the largest freshwater lake west of the Mississippi River, estimated to encompass approximately 505,000 acres or 790 square miles at its highest overflow elevation of 216 feet in 1862 and 1868 (ECORP 2007). The lake was shallow and had no natural outlet when the water level was below 207 feet. The increased diversion of water from the rivers and tributaries, which previously had flowed into Tulare Lake resulted in the lake drying up in the late 1800s with the exception of during times of heavy flooding.

Kings River

The Kings River is the one of the largest source of surface water supply to the subbasin, contributing most of the surface runoff that supplies the Subbasin. The Kings River is a 133-mile long river with a watershed of approximately 1,500 square miles above Pine Flat Dam (USBR 2003). It is the largest river draining the southern Sierra Nevada Mountains with headwaters in and around Kings Canyon National Park. The Kings River has three main tributaries, the North Fork, Middle Fork and South Fork. The flow of the North Fork is regulated by several dams, Courtright and Wishon Reservoirs, used to generate hydroelectric power. Pine Flat Dam at a maximum elevation of approximately 952 feet in the foothills of the Sierra Nevada Mountains captures the combined unregulated flow from the South and Middle Forks and the controlled flow from the North Fork of the Kings River (USBR 2003). The dam is owned by the U.S. Army Corps of Engineers (USACE) and has a maximum capacity of about 1,000,000 acre-feet (AF) of water (KRCD and KRWA 2009). The primary purpose of the dam is flood control and secondary purposes include irrigation, hydroelectric power generation, and recreation.

The flow in the Kings River below Pine the Flat Dam is controlled by the dam and distributed into various canals and distributary channels by diversion structures described in Section 3.1.1.6. The distributary channels come together just north of Reedley City, and the Kings River flows southwesterly through Laton City (Figure 3-5). The southerly flow takes part of the Kings River further south through Grangeville and southwest through Stratford to the Tulare Lake bed, where it is distributed to farmland through a series of canals. Diversion structures in Laton take a portion of the water to the west and north toward the Fresno Slough (ECORP 2007).

Kaweah River

The Kaweah River is located in Tulare County and drains the high Sierra Nevada Mountains, with headwaters in Sequoia National Park. Above Lake Kaweah, the main stem of the Kaweah River is about 33-miles long with a drainage area of about 561 square miles (SCE 2016). Prior to stream regulation, the main trunk of the Kaweah River historically flowed southwestward entering the San Joaquin Valley near Lemon Cove. The river separated into several distributary channels forming the alluvial plain known as the Kaweah Delta, upon reaching the edge of the Valley. During periods of high flow, these channels historically carried sufficient water to reach the Tulare Lake bed.

In the 1920's, weirs were built at McKay's Point to partition water into the St. Johns and Kaweah Rivers (KDWCD 2018). In 1962, the USACE constructed Terminus Dam to provide flood control for the cities and lands below the dam. In 2004, six fuse gates were installed on the Dam to raise the lake level by 21 feet and increase the capacity of Kaweah Lake to about 185,000 AF (IWP and DC 2004). In addition to flood control, the dam and reservoir also provide irrigation water for agriculture on the Kaweah Delta (KDWCD 2018). Below the dam, most of the flow is controlled by a network of diversions, canals, and improved distributary channels. During normal rainfall years, minimal, if any, water reaches the Tulare Lake bed; however, during years with extreme runoff, water from the Kaweah River system has reached the Tulare Lake bed.

Tule River

The Tule River is located in Tulare County and drains highlands in the southern Sierra Nevada Mountains. The Tule River has three main tributaries, the North Fork, Middle Fork, and South Fork, with a maximum length of about 28 miles at the North Fork and below the confluence of Middle Fork, as well as a drainage area of about 390 square miles above Lake Success (USACE 2017). Prior to construction of Lake Success by the USACE in 1961, the Tule River below Porterville separated into two main channels, the Tule River and Porter Slough. Eventually, these channels merged again downstream and flowed into Tulare Lake, south of Corcoran. Additionally, by the early 1900s many diversions were constructed to move water into irrigation ditches that spread across the Tule River fan. Lake Success was constructed primarily for flood control purposes and has a capacity of about 82,000 AF (USACE 2017). Since the Lake's construction, the Tule River only flows to the Tulare Lake bed on rare occasions during years with extreme runoff.

Kern River

The Kern River is located in Kern County and drains the southern slopes of the Sierra Nevada Mountains. The Kern River historically drained to the west toward Buena Vista Lake or south to Kern Lake (ECORP 2007). Occasionally, during times of extreme runoff, the Kern River would find a channel to the north sometimes through Goose Lake and move surface water into Tulare Lake. Water supply development in Kern County has nearly eliminated the Kern River as a source to the Subbasin.

Minor Streams of the Tulare Lake Subbasin

Streams emanating from the southern Sierra Nevada Mountains, south of the Tule River, drain lower elevations and more arid areas of the Sierra Nevada Mountains. These streams, White River, Deer, Cottonwood, Dry, Mill, and Poso Creeks, typically lose their discharge to percolation into the alluvial fans before entering the Tulare Lake bed. Currently, most of these streams have diversions on them, which channel their flows to delivery systems for irrigation. Cottonwood and Dry Creeks contribute to the Kaweah River system and add supplies to the Subbasin in wet years. Dry Creek's runoff is accounted for in the Kaweah and St. Johns Rivers. These streams account for about 10% of the runoff delivered by the four principal river systems (ECORP 2007).

Streams emanating from the Coast Range are typically ephemeral and do not reach any major water course or surface impoundment. Of the streams draining the Coast Range, the Arroyo Pasajero, including Los Gatos Creek, has the highest runoff (ECORP 2007). Poso Creek has few diversions for irrigation and remains important in and near the Tulare Lake bed.

3.1.1.6 Water Supply Delivery System

Extensive water supply delivery systems have been developed over the past 160 years within the Subbasin to move surface water supplies for irrigation, flood control, and land reclamation (ECORP 2007). Currently, at least 34 conveyance systems (rivers, streams, canals, and diversions) are available to deliver surface water the Subbasin (Figure 3-5). The only water generated within the Subbasin is from pumped groundwater. Pumped groundwater may be used for direct irrigation on nearby agricultural lands or piped into municipal or agricultural water delivery systems. Groundwater is also discharged into agricultural water supply delivery systems to move water, primarily for irrigation, to desired areas. However, much of the land within the Subbasin has associated water rights to the Kings, Kaweah, and Tule Rivers as well as some of the minor streams of the Subbasin. These water allocations are supplied by the many irrigation and water districts within the Subbasin.

Water is imported into the Subbasin using facilities of the State Water Project (SWP) located to the west and the Central Valley Project (CVP) located to the east of the Subbasin. Water can also be exported out of the Subbasin using the SWP and CVP facilities in combination with facilities developed by local water districts (ECORP 2007). The CVP imports San Joaquin River water into the Subbasin through the Friant-Kern Canal and SWP water through the California Aqueduct.

The Friant-Kern Canal is operated and maintained by the Friant Water Authority and is used to convey water from the San Joaquin River to Kern County. The canal originates at Friant Dam, which is operated by the United States Bureau of Reclamation (USBR). The Friant-Kern Canal flows southeasterly along the western flank of the Sierra Nevada foothills through Fresno, Tulare, and Kern counties. The Friant-Kern Canal crosses the Kings River about 10 miles west of Pine Flat Dam, where water can be released into the River (ECORP 2007). This water can be delivered to the Subbasin through a series of canals along the Kings River and its distributaries.

The California Aqueduct is operated and maintained by DWR. The Aqueduct originates in the southwestern corner of the Sacramento-San Joaquin Delta and runs down the west side of the San Joaquin Valley and over the Tehachapi Mountains into southern California. Water from the California Aqueduct can be turned out at Lateral A, which delivers water to the Subbasin at or above Empire Weir No. 2 (ECORP 2007). This water can be distributed to the Subbasin through the series of canals below the Empire Weir No. 2.

3.1.2 Geologic Setting

The Subbasin is located in the south-central portion of the greater San Joaquin Valley. The major geologic features are the San Joaquin Valley, the San Andreas Fault, the Garlock Fault, and the three bounding mountain ranges: the Coast Range to the west, the Sierra Nevada Mountains to the east, and the Tehachapi and San Emigdio Mountains to the south (Figure 3-12). The San Joaquin Valley elongates to the northwest and stretches approximately 250 miles from the Sacramento-San Joaquin delta on the north to the Tehachapi and San Emigdio Mountains on the south. The Valley is filled with marine and continental sedimentary rocks that are more than 30,000 feet in total thickness.

3.1.3 Geologic Structure

The geologic structure of the San Joaquin Valley is complex and has evolved considerably through geologic time. The San Joaquin Valley was formed generally as a structural trough subsiding between two uplifts: the tectonically-driven tilted block of the Sierra Nevada Mountains and the folded and faulted mountains of the Coast Ranges. The axis of the trough is asymmetrical, with the deepest portion of the trough closer to the Coast Ranges. The southern Sierra block comprises the eastern limb of the Valley syncline or trough (Bartow 1991). It is a southwest-plunging ridge of basement rock, primarily Mesozoic plutonics, upon which has accumulated more than 10,000 feet of Tertiary sediments in the vicinity of the Subbasin.

The west-side fold belt runs along the western portion of the Subbasin and comprises the low-lying portion of the eastern Coast Ranges (Figure 3-12). The fold belt is characterized by Cenozoic sedimentary rocks that have been deformed by thrust faults. The fold belt formed adjacent and subparallel to the San Andreas Fault, a major strike-slip transform fault between the North American and Pacific plates. These sedimentary rocks dip steeply beneath the San Joaquin Valley to the east and are found at depths of more than 3,000 feet below the Valley floor. The Kettleman Hills on the west side of the Subbasin are part of the west-side fold belt.

3.1.4 Basin Development

During late Mesozoic and early Cenozoic time, much of the current San Joaquin Valley was part of a forearc basin that was open to the Pacific Ocean allowing deep marine sediment deposition into the San Joaquin basin (Bartow 1991). As plate boundaries shifted and movement along the San Andreas Fault began in the late Miocene, the San Joaquin Basin west of the fault was beginning to close off creating an extensive inland sea. During the Pliocene, marine sediments of the Etchegoin Formation and the primarily marine San Joaquin Formation were deposited in the shallowing sea bottom of the basin.

During the late-Pliocene and early-Pleistocene, the terrestrial Tulare Formation was deposited as sediments, which were eroded and shed from the rising mountains into the subsiding San Joaquin Valley. As the San Joaquin Valley evolved during the Pleistocene, the tilting of the Sierran block and the push from the thrust belts on the west side aided in the subsidence of the Valley trough. Throughout much of the Valley, Tertiary-Quaternary sediments filled the basin with a mixture of sands, silts, and clays, which were deposited on alluvial fans and along the San Joaquin Basin axis by the rivers and streams emanating from the adjoining mountains.

The periodic glacial and wet Pleistocene climate produced times when the sediment loads from the mountains exceeded the subsidence rate in the Valley creating aggrading alluvial fans that cut off the flow of the San Joaquin Valley rivers to the sea (Atwater, et al. 1986). Large-scale lacustrine deposits accumulated in the shallow lakes that developed as a result of the internal drainage. Corcoran Lake appears to have covered most of the Valley during the mid-Pleistocene (Bartow 1991) from about present-day Stockton to Bakersfield and roughly from Interstate 5 to State Route 99 (SR 99) (Figure 3-13). During this time, the lacustrine Corcoran Clay (E-clay of Croft

1972) accumulated to thicknesses of as much as 300 feet (Figure 3-14a-c). Additionally, thick deposits of lacustrine sediments have accumulated in the Tulare Lake bed. Because of the anomalously rapid tectonic subsidence in the Tulare Lake area, and the internal drainage from the Kings, Kaweah, and Tule Rivers, as well as early-on the Kern River into the lake, thick lacustrine deposits in addition to the Corcoran Clay have accumulated beneath the Tulare Lake bed. The total thickness of the Tulare Lake clays, including the Corcoran Clay, is more than 3,000 feet as labeled as QTf on Figure 3-14a-c.

3.1.5 Stratigraphy

Table 3-3 is a generalized stratigraphic column for the Subbasin. It represents a synthesis of stratigraphic descriptions from published reports for the area (Davis, et al. 1959; Hilton, et al. 1963; Croft and Gordon 1968; Loomis 1990; and Wood 2018). Stratigraphic units and their importance to groundwater occurrence and movement are described below.

3.1.5.1 Basement Complex

The basement complex beneath the Subbasin comprises primarily Sierran plutonic and metamorphic rocks, while the western margin of the basin is underlain primarily by Coast Range ophiolite (Scheirer 2007). The depth to the basement complex ranges from about 6,000 feet on the eastern margin of the Valley to about 30,000 feet below ground surface (bgs) on the western margin (Scheirer 2007). The depth to basement complex is such that the basement rocks do not affect the usable groundwater beneath the Subbasin.

3.1.5.2 Miocene and Pre-Miocene Sedimentary Deposits

The Miocene and pre-Miocene sedimentary deposits are found deep below the Subbasin and have been encountered in deep exploration borings drilled for oil and gas deposits. The water contained in these deposits is saline or the depth to these deposits are such that that they do not affect the usable groundwater beneath the Subbasin with the exception of the Santa Margarita Formation to the east.

The Santa Margarita Formation is a gray sandstone of upper Miocene age that is present at a depth of about 1,100 feet bgs beneath Terra Bella (Hilton, et al. 1963). The formation dips steeply to the west and is about 4,300 feet deep near SR 99 at Earlimart. The Santa Margarita Formation has been tapped as an aquifer in the area from Terra Bella to Richgrove, about 25 miles east of the eastern Subbasin boundary. The Santa Margarita Formation is separated from the usable groundwater in the Plio-Pleistocene Tulare Formation by about 2,000 to 3,000 feet of mostly fine-grained marine deposits of the Pliocene San Joaquin and Etchegoin Formations. Groundwater in the Santa Margarita Formation increases in salinity content to the west and the approximate position of the saline to freshwater interface is about 20 miles east of the Subbasin. Thus, the Santa Margarita is likely too deep and too saline to yield usable groundwater beneath the Subbasin for usage.

3.1.5.3 Upper Miocene to Pliocene Etchegoin

The Etchegoin Formation is a shallow water marine formation of upper Miocene and early Pliocene age that crops out in the Kettleman Hills west of the Subbasin. The Etchegoin Formation comprises silty and clayey sands, sandy silt, silty clay, blue sandstone, and conglomeratic sandstone (Woodring et al. 1940). The Etchegoin dips steeply to the east from the Kettleman Hills. Deep exploratory borings for oil and gas have encountered the Etchegoin beneath the Subbasin at depths of 3,500 to 4,000 feet bgs. Geophysical logs indicate that water in the Etchegoin Formation is saline and its groundwater is unusable beneath the Subbasin.

3.1.5.4 Pliocene San Joaquin Formations

The San Joaquin Formation is a shallow marine formation of mid-to-upper Pliocene age that also contains some near-shore continental deposits. It comprises a basal conglomerate member and overlying thin beds of poorly-sorted, fine-grained sandstone amongst thick beds of siltstone and claystone (Loomis 1990; Woodring, et al. 1940). The formation crops out in the Kettleman Hills and dips steeply to the east beneath the Subbasin.

In the Kettleman Hills area, the top of the San Joaquin Formation is conformable with the overlying Tulare Formation and is marked by the uppermost Mya zone, which is described as a transition from marine deposits (Mya fossils) to continental deposits (Tulare Formation) of lake, swamp, and stream origin (Woodring, et al. 1940). In the Kettleman Hills area, monitoring wells indicate the sandstones within the San Joaquin Formation contain saline water and do not yield sufficient water to be classified as an aquifer (Wood 2018). The formation is in contact with the base of the Tulare Formation beneath the Subbasin, with the contact typically about 3,000 feet bgs (Page 1983). The San Joaquin Formation is considered too deep and too saline to yield usable groundwater beneath the Subbasin.

3.1.5.5 Pliocene-Pleistocene Tulare Formation – Continental Deposits

The Tulare Formation is generally regarded as the most important water-bearing formation in the southern San Joaquin Valley. The Tulare Formation is a continental deposit that overlies the San Joaquin Formation and has been assigned to the upper Pliocene and Pleistocene epochs. It has been described mostly by investigators on the west side of the Valley, where it crops out in the west-side fold belt anticlines. The type section is generally taken to be the Kettleman Hills, where 1,700 to 3,500 feet of the Tulare Formation have been described on the east and west flanks of North Dome, respectively (Woodring et al. 1940). Other investigators, particularly on the east side of the Valley, have described continental deposits, primarily of Sierran origin, that are time-correlative with the Tulare Formation such as the Kern River, Laguna, Turlock Lake, Riverbank, and Modesto Formations (Lettis and Unruh 1991).

The Tulare Formation is defined as the uppermost continental deposits deformed by the west-side fold belts (Woodring, et al. 1940). This was relatively clear in the Kettleman Hills area; however, in other west-side folds (e.g., Lost Hills), the quaternary alluvium has also been deformed as uplift continues into the Holocene. In the Tulare Lake area, the east side Plio-Pleistocene deposits that overlie the San Joaquin Formation with the Tulare Formation are mapped (Page 1983). In the subsurface, because of textural and depositional similarities, it is difficult to separate recent alluvial deposits from sediments of the Tulare Formation (Davis et al. 1959). Based on existing research in the Tulare Lake area, the Tulare Formation in this report is considered an ongoing sequence of Plio-Pleistocene continental deposits above the San Joaquin Formation that continue to be deposited today in the Holocene period. These deposits can be subdivided into Sierra and Coast Range origins. Each source area contributes different grain sizes and mineralogy that will affect potential well yields and groundwater quality. They also can be subdivided by lacustrine units, older alluvium, and younger alluvium. The different units has a bearing on groundwater occurrence and movement.

The Tulare Formation comprises unconsolidated clay, silt, sand, and gravel, as well as poorly consolidated sandstones and conglomerates. These sediments have been deposited by streams and rivers emanating primarily from the Sierra Nevada and Coast Ranges. The Coast Range is composed of gypsiferous marine shales, sandstones and volcanic rocks, sediments sourced from the Coast Ranges, which are generally gypsiferous, typically finer-grained, and contain more angular lithic fragments than Sierran sediments (Page 1983). The granitic source rocks of the Sierra yield sediments with abundant quartz, feldspars, and micas, and are typically coarser-grained and more rounded than the Coast Range sediments. Thus, areas of the Subbasin comprised of Sierran sediments tend to have greater water storage capacity due to higher levels of porosity than areas comprised of sediments from the Coast Ranges.

Sedimentary facies of the Tulare formation range from mid-to-distal alluvial fan deposits, marsh deposits, lacustrine deposits, overbank and flood deposits, and fluvial deltaic deposits entering Tulare Lake bed, and terrestrial shoreline deposits. In terms of depositional environments for the Tulare Formation, the Subbasin is dominated by the lacustrine environment of Tulare Lake in the southern portion of the subbasin (Figures 3-14a-c). In the northern portion, the depositional environment is dominated by mid-to-distal alluvial fan deposits of the Kings River. The northwestern corner of the Subbasin contains a strip of basin deposits along the South Kings

River, west of Lemoore and Stratford. To the east of the Subbasin, the depositional environment comprises mid-to-distal alluvial fan deposits of the Kaweah and Tule Rivers.

3.1.6 Lateral Basin Boundaries and Geologic Features Affecting Groundwater Flow

Groundwater flow in the Subbasin has historically been influenced by five significant bounding conditions including: Kettleman Hills on the southwest; Kings River alluvial fan on the northeast; Arroyo Pasajero fan on the northwest; Tulare Lake clay beds in the central portion of the subbasin; and the Kaweah and Tule River alluvial fans on the east (Figure 3-15).

3.1.6.1 Kettleman Hills Anticline

The Kettleman Hills anticlinal structure is located on the southwest edge of the Subbasin (Figure 3-15). The Kettleman Hills anticline exposes the late Miocene-Pliocene Etchegoin Formation along its axis, with the younger San Joaquin and Tulare Formations exposed along its flanks. To the west, these formations dip steeply beneath the Kettleman Plain, where the Tulare Formation reaches an estimated thickness of 4,000 feet (Stewart 1946). Groundwater recharge to the Subbasin from direct infiltration on the Kettleman Hills is almost non-existent due to low precipitation, low relief of the Hills, and minimal eastern exposure of the Tulare Formation. The lack of groundwater recharge is evident due to the lack of development of significant alluvial fans on the east side of the Hills. Inter-basin movement of groundwater from the Kettleman Plain to the Subbasin is blocked by the synclinal structure of the Kettleman Plain and the anticlinal structure of the Kettleman Hills, which places thousands of feet of steeply dipping marine claystones and siltstones between the Tulare Formation beneath the Kettleman Plain and the Tulare Formation beneath the San Joaquin Valley. Additionally, the Tulare Formation has been eroded off the tops of each of the Kettleman domes and the San Joaquin Formation exposed in the gaps between the domes, essentially leaving no connection between the Tulare Formation on either side of the Kettleman Hills.

3.1.6.2 Kings River Fan

The Kings River alluvial fan extends northward from the Tulare Lake bed to beyond the northeastern boundary of the Subbasin (Figure 3-15). The fan deposits comprise a series of sand beds and intervening silty to clayey layers with paleosol interludes. Coarser deposits are present higher on the fan north and east of the Subbasin and finer deposits are more prevalent toward the distal end of the fan, within the Subbasin near the center of the Valley. Where the historical Kings River entered Tulare Lake, the depositional environment changed from fluvial and alluvial to deltaic, with the sandier beds interfingering with finer lacustrine deposits within the lakebed. The Kings River, which forms the northern boundary of the Subbasin, appears to provide persistent recharge to the fan deposits along its course. Because of the size of the Kings River drainage area and the magnitude of its flows, the Kings River fan typically contains thicker and coarser sediments than the fans of the lesser Kaweah and Tule Rivers. The fan below the Subbasin is divided into upper and lower aquifers by the Corcoran Clay, which stretches east to west across the fan beneath the Subbasin, extending up fan to about SR 99 (Figures 3-14a-b). The Corcoran Clay layer often has very limited transmissivity and can confine lower aquifers beneath this layer while also preventing or limiting percolation of water from upper aquifers into lower aquifers.

3.1.6.3 Los Gatos Creek and Arroyo Pasajero Fan

Los Gatos Creek emanates from the Diablo Range, which is a part of the Coast Ranges, west of Coalinga and grades eastward toward the Valley floor. Although the Los Gatos Creek fan is not within the Subbasin, it borders the Subbasin to the northwest (Figure 3-15). The Creek is ephemeral and creek flows only reach the Valley floor and areas near the Subbasin during periods of extremely high precipitation. The fan has prograded eastward during the wetter climates of the Pleistocene. Coast Range sediments extend perhaps 15 to 18 miles into the Valley and to a depth of several hundred feet above the Corcoran Clay (Croft 1972; Miller et al. 1971). Another lobe of the Coast Range sediments lies beneath the Corcoran Clay and also extends approximately 15 to 18 miles into the Valley. These sediments comprise sands, silts, and clays of relatively fine-grained textures (Meade 1967). Additionally, sands from the Diablo Range consist of darker minerals and contain more lithic fragments. Grains are subrounded to subangular andesite, serpentinite, and chert with some weathered mica flakes. Below the Coast Range sediments are described as floodplain and deltaic/lacustrine deposits of Sierran origin (Miller et al. 1971). The Sierran deposits are described as lighter in color and micaceous, primarily biotite with more than 25% feldspars (Meade 1967). These Sierran deposits extend down to the top of the San Joaquin Formation marking the base of the Tulare Formation.

Groundwater in the Coast Range sediments show a distinct sulfate type of water derived from the marine formations from which the sediments originated (Davis and Coplen 1989). This contrasts with the bicarbonate-type water typical of the Sierran sediments. The Total Dissolved Solids (TDS) of the Coast Range sediments are also typically higher than the Sierran sediments. Wells on the Los Gatos Creek fan typically tap the Sierran deposits below the Corcoran Clay.

3.1.6.4 Tulare Lake Bed Lacustrine Clay Plug

The Tulare Lake clay beds are potentially the most significant controlling factor for groundwater movement in the Subbasin. The center of the Tulare Lake depositional Subbasin is elongate from northwest to southeast with continuous lacustrine deposits extending like a tap root through the interior portions of the lakebed to the top of the San Joaquin Formation, which beneath the

Subbasin is 2,600 to 3,000 feet bgs (Figures 3-14a-c). The area with continuous lacustrine sediments from the surface to the underlying San Joaquin Formation is roughly 23 miles long by 12 miles wide (Figure 3-15). The lacustrine deposits are primarily silts and clays with occasional interbedded fine sands. The deposits are under reduced conditions in nearly all locations where coring has occurred, which indicates little, if any, subaerial contact or oxygenated water since the sediments were emplaced (Miller et al. 1971). Although some of the clays and sand stringers are saturated, they do not produce enough water to have been developed for groundwater extraction. Near the northern, southern, and eastern peripheries of the lacustrine plug, coarser deposits interfinger with the fine-grained sediments. Coarser and more transgressive sediments are present on the eastern, Sierran periphery compared to the western, Coast Range periphery.

3.1.6.5 Kaweah and Tule River Fans

The Kaweah and Tule River fan sediments to the east of the Subbasin have similar deposition to the sediments beneath the Kings River fan; however, they are not as laterally extensive and appear to be thinner and more interbedded than the Kings River deposits (Figure 3-15). Near the toe of the Kaweah and Tule River fans, deposits become more deltaic and interbed with the lacustrine deposits of the Tulare Lake bed. Similarly, to the Kings River fan deposits, the Kaweah and Tule River fans below the Subbasin are divided into upper and lower aquifers by the Corcoran Clay, which stretches east to west across the fan beneath the Subbasin, extending up fan to the area of SR 99 (Figure 3-14b). The Kaweah and Tule River fan deposits comprise well graded course Sierran sediments with ample water storage capacity and have been extensively developed for groundwater extraction east of Tulare Lake and the Subbasin.

3.1.7 Definable Bottom of the Basin

The California DWR published Best Management Practices (BMPs) for HCMs for the sustainable management of groundwater (DWR 2016c). Identifying a definable bottom of the Subbasin is one key step in addressing the issue of total basin water storage, as well as the depth to which water can feasibly be extracted. In their section on "Definable Bottom of the Basin," DWR noted "several different techniques or types of existing information can be used in the evaluation of the definable bottom of the basin and extent of fresh water." One method would be to define the base of the water-bearing formations below which no significant groundwater movement occurs, such as the depth to bedrock or some other low permeability formation. A second method would be to evaluate the chemistry of the groundwater beneath the basin vertically and then map the elevation at which the groundwater exceeded a pre-determined criterion for fresh water.

The criteria for fresh water however, is inconsistent in that it has been defined as a TDS content at approximately 2,000 milligrams per liter (mg/L), 3,000 mg/L, and 10,000 mg/L by various sources (Page 1973; RWQCB 2015; 49 Code of Federal Regulations 146.4) Additionally, in their BMPs (DWR 2016c), DWR noted they will be constructing a freshwater map for the Central Valley that assumes the base of fresh water is defined by California's secondary maximum contaminant level recommendation of 1,000 mg/L. Because of these inconsistencies, the definable bottom of the basin will be discussed below using two different methods.

3.1.7.1 Geologic Method

A case can be made, on a geologic basis, to define the bottom of the Subbasin at the base of the Tulare Formation, above the underlying San Joaquin Formation. The Tulare Formation is a continental deposit that includes sediments deposited in the San Joaquin Basin from the Pliocene to the present. The Tulare Formation comprises the primary groundwater resource for the southern San Joaquin Valley, including the Subbasin. The Tulare Formation overlies the San Joaquin Formation, a predominantly marine formation comprising significant thicknesses of claystone and siltstone along with minor beds of fine-grained sandstone, which contain brackish water (Wood 2018). Sandstone beds are of low permeability and do not yield sufficient water to be considered an aquifer or a suitable source for agricultural or municipal uses. Even if some sandstone beds contained water that might meet water quality criteria, they are of low permeability and do not yield sufficient water to be considered an aquifer (Wood 2018). Thus, the contact between the Tulare Formation and the underlying San Joaquin Formation would fit the definition for a geologic barrier to groundwater flow under DWR criteria.

The contact between the Tulare Formation and the San Joaquin Formation was previously mapped, and the Tulare Formation was ascertained to be the top of the upper Mya zone near the central and southern portions of the Subbasin (Figure 3-16) (Page 1981; Page 1983). Sources included identifications of the upper Mya zone in well logs from 292 oil and gas exploratory borings as well as structure contour maps and geologic sections done for oil and gas fields in the area. These data show that the approximately water bearing depth of the Tulare Formation ranges from about 4,000 feet bgs near the axis of the San Joaquin syncline, which lies to the east of the Kettleman Hills to approximately 2,500 feet bgs near the southeastern corner of Kings County. The existing study's map did not extend into the northern portion of the Subbasin, so the contact between the Tulare and San Joaquin Formations has been estimated from oil and gas exploration wells in the area (Wood 2018). The depth to the base of the Tulare Formation in the northern portion of the Subbasin ranges from 2,700 to 2,200 feet bgs, rising to the north (Figure 3-16). Near the City of Corcoran, the depth of the Tulare Formation is greater at approximately 3,400 feet bgs.

Studies have shown that portions of the Tulare Formation do not yield groundwater that meets water quality criteria for beneficial uses, particularly in and surrounding the Tulare Lake bed. These criteria are examined in detail in the following section.

3.1.7.2 Water Quality Method

Several potential criteria exist for determining the extent of fresh water in a groundwater basin; however, the criteria adopted by the California Regional Water Quality Control Board (RWQCB), Central Valley Region appears to be the most appropriate for the Subbasin. The RWQCB is the state agency that has been charged with adopting and enforcing water quality control plans, or basin plans, to protect state waters. The Subbasin is within the boundaries of the Tulare Lake Hydrologic Region (Figure 3-1) as defined by the RWQCB and therefore subject to the Tulare Lake Basin Plan (Basin Plan).

The Basin Plan comprises designated beneficial uses to be protected, water quality objectives to protect those uses, and a program for implementation to achieve the objectives (RWQCB 2015). Beneficial uses of groundwater in the Tulare Lake Hydrologic Region include municipal, agricultural, and industrial. The Basin Plan incorporates the Sources of Drinking Water Policy Resolution No. 88-63, adopted by the State Water Resources Control Board (SWRCB), which states all surface and ground waters of the State are considered to be suitable, or potentially suitable for municipal or domestic water supplies (MUN) with the exception of water that has a TDS exceeding 3,000 mg/L and is additionally not reasonably expected by the RWQCB to supply a public water system (SWRCB 2006). Regarding agricultural uses (AGR), the Basin Plan is not explicit to the numerical criteria for determining beneficial use; however, the Basin Plan contains a narrative regarding an exception to the AGR designation if pollution by natural processes or human activity is documented that cannot be reasonably treated by BMPs or economically achievable treatment practices to achieve water quality suitable for agricultural uses.

In 2014, the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), a stakeholder group that was created to develop a comprehensive Salt and Nitrate Management Plan for the Central Valley, identified a need to define the salinity-related requirements for the protection of both the MUN and AGR beneficial uses. This evolved into the development of a technical information and environmental and economic analysis in support of a MUN and AGR beneficial use evaluation project for a portion of the historical Tulare Lake bed (RWQCB 2017). A beneficial use evaluation report was submitted on behalf of CV-SALTS proposing portions of the groundwater body beneath the historical Tulare Lake bed be de-designated for MUN and AGR beneficial uses (KDSA et al. 2015). The evaluation report affirmed the criteria for exemption from MUN to be a TDS of 3,000 mg/L. CV-SALTS has also provided a literature review, which affirmed guidelines that stated only the most salt-tolerant crops may be sustainably irrigated with water exceeding 3,000 microsiemens per centimeter (µS/cm) or less (a TDS of about 2,000 mg/L) (CV-SALTS 2013; Ayers and Westcot 1985). As part of the literature review, CV-SALTS also identified acceptable salt levels for livestock watering to be water with an EC of 5,000 µS/cm or less (a TDS of about 3,000 mg/L).

The RWQCB staff report proposed the preferred alternative for MUN beneficial use de-designation to be the application of the Sources of Drinking Water Policy exception 1a, where water quality exceeds an EC of 5,000 µS/cm (RWQCB 2017). The report further proposed the preferred alternative for AGR beneficial use de-designation be based on a 5,000 µS/cm EC threshold value (3,000 mg/L) taken from the Canadian Council of Ministers for the Environment for all classes of livestock (CCME 2007). These criteria were accepted by the RWQCB (Resolution R5-2017-0032) on April 6, 2017 and adopted by the SWRCB (Resolution No. 2017-0048) on September 6, 2017.

Based on the body of work by CV-SALTS and the regulatory acceptance of the criteria for de-designation of MUN and AGR of an EC of 5,000 µS/cm (approximately 3,000 mg/L TDS), the criteria for determining the extent of fresh groundwater in the Subbasin was set at 3,000 mg/L TDS. Within the Subbasin, water quality of 3,000 mg/L TDS, typically found at depths greater than 3,000 feet bgs, could define the bottom of the Subbasin using this methodology for this GSP.

3.1.8 Hydrogeologic Setting: Principal Groundwater Aquifers and Aquitards

The current hydrogeology of the Subbasin is complex in that the only physical boundaries are the Kettleman Hills on the southwestern edge and the Kings River on the northeastern edge of the Subbasin. The remaining edges of the Subbasin are based on political boundaries and water management areas, and the actual physical water-bearing formations of the Subbasin extend into these adjacent areas. Groundwater beneath the Subbasin occurs primarily in the coarser-grained Sierran sediment deposits of the alluvial fans of the Kings, Kaweah, and Tule Rivers, as well as the fans of the lesser streams that drain from the Sierra Nevada Mountains into the southeastern portion of the Subbasin. A study conducted in the 1960s subdivided the coarser-grained deposits into three units, older and younger alluvium and undifferentiated continental deposits (Croft and Gordon 1968). These deposits are primarily Sierran in origin and were deposited during the Quaternary period by the major stream channels emanating from the Sierra Nevada Mountains. On the west side of the Subbasin, some sediments may have Coast Range origin, but the axis of Tulare Lake bed is close to the Kettleman Hills and its finer-grained sediments, which leaves little room for potentially coarser-grained Coast Range sediment deposition on the west side. The Corcoran Clay underlies most of the Subbasin, which essentially subdivides the Subbasin into two aquifer systems, an unconfined to semi-confined aquifer system above the Corcoran Clay and a confined aquifer system below the Corcoran Clay.

The younger alluvium is generally thinner than the older alluvium and is present in current stream channels and as a veneer over the older alluvium as the deposits stretch to the west. The younger alluvium is primarily arkosic and is considered of Holocene age. It occurs entirely above the Corcoran Clay and is always unconfined. In places, it may contain groundwater perched above the A-clay.

The older alluvium is widespread throughout the San Joaquin Valley and represents deposition from both the Coast Ranges on the west side of the Valley and the Sierra Nevada Mountains on the east. The older alluvium is generally identified by its stratigraphic position on terraces of the major rivers, though as mentioned earlier, there is no current method to differentiate it in the subsurface from the Tulare Formation. The older alluvium is considered Pleistocene to Holocene in age and it is typically bifurcated by the Corcoran Clay such that groundwater contained in the older alluvium may be either confined or unconfined.

Beneath the older alluvium are the undifferentiated continental deposits, which beneath the Subbasin are Sierran in origin. The deposits are beneath the Corcoran Clay, and as such, groundwater contained in the undifferentiated Tulare Formation is all confined.

Lacustrine deposits have been identified in the Subbasin principally beneath the Tulare Lake bed. Geologic cross sections illustrate the thick and continuous nature of these clay deposits beneath the lakebed (Croft 1972; Croft and Gordon 1968; Davis et al. 1959). Additionally, six individual lacustrine clays were identified in the subsurface and had sufficient lateral extent to be considered important in affecting groundwater movement (Croft 1972). These clays were identified in geophysical logs and named the A through F clays, with the E-clay being equivalent to the Corcoran Clay. Though the A through D clays may be important locally in restricting downward movement of groundwater, Corcoran or E-clay is the most significant (KDSA et al. 2015). The Corcoran Clay has been identified beneath the Tulare Lake bed and extends beyond the Subbasin in all directions except for a small area in the northeast corner of the Subbasin (Croft 1972).

Marsh and flood basin deposits are found typically near the modern axis of the San Joaquin Valley, along the distal reaches of the streams in the southern Valley. These deposits comprise silts and clays that can be relatively thick in some locations creating local areas of perched groundwater above the A-Clay.

3.1.8.1 Unconfined Aquifer

The unconfined and semi-confined upper portions of the regional freshwater aquifer are found above the Corcoran Clay. This upper portion of the regional freshwater aquifer is generally comprised of coarse- to medium-grained sediments (i.e., sand and gravel) with silt and clay interbeds. The depth to first groundwater beneath a large portion of the Subbasin is less than 15 feet bgs in a perched zone situated above the A-Clay (Figure 3-17).

Groundwater within the rest of the Subbasin and surrounding areas are typically found between depths of 30 and 250 feet bgs, depending on location and the season or year when the water levels are measured. The shallow groundwater areas typically have poor water quality, and the shallow soils require drainage to grow crops (KDSA et al. 2015) (Figure 3-17). In areas where groundwater is below 15 feet, the shallow unconfined aquifer is subject to large swings in water levels due to groundwater recharge, which occurs primarily along stream channels, unlined surface water conveyances, and artificial recharge basins. In thicker sections of the unconfined aquifer, pumping for agricultural uses may create significant drawdown of the water table during the irrigation season and under prolonged drought conditions. Nearer the Tulare Lake bed, where the upper aquifer is substantially interbedded with lacustrine deposits, the groundwater producing zones are thinner and become increasingly finer-grained limiting groundwater withdrawals to primarily relatively low demand domestic uses. Within the Tulare Lake bed, no production wells exist due to the fine-grained nature of the sediments and the poor-quality water associated with the lacustrine sediments.

3.1.8.2 Confined Aquifer

The sediments below the Corcoran Clay comprise the lower confined portion of the regional freshwater aquifer. This lower portion of the regional freshwater aquifer is generally comprised of clay, silt, sand, and gravel (Page 1983).

Few maps are available showing groundwater elevations in the confined aquifer beneath the Subbasin and surrounding areas (Harder and Van de Water 2017). In fall 1998 and 1999, groundwater was at an elevation of about 100 feet below mean sea level (MSL) at a depth of about 300 feet bgs near Corcoran, decreasing in elevation to the south towards an apparent pumping center near Alpaugh. The coarser and thicker sections of sediments below the Corcoran Clay lend themselves to development of higher capacity wells that withdraw groundwater for municipal and agricultural uses. However, the limited extent of highly productive fresh groundwater aquifers within the boundary of the Subbasin, generally along the coarse-grained sediments within the alluvial fans (e.g., Kings River fan), concentrates these wells in the eastern portion of the Subbasin and in adjoining subbasins to the east, beyond the finer-grained deltaic and lacustrine deposits grading into the Tulare Lake bed. Because of the effectiveness of the Corcoran Clay as an aquitard, recharge to the confined aquifer likely occurs primarily in the upper portions of the alluvial fans beyond the Corcoran Clay's eastern extent and via wells, which are either screened both above and below the Corcoran Clay or have gravel packs that extend through the Corcoran Clay.

The sediments within the middle of the Tulare Lake bed consist of a thick, continuous sequence of clays, forming a "clay plug." There are no production wells within the clay plug due to the fine-grained nature of the sediments.

3.1.8.3 Aquitards

Fine-grained lacustrine, marsh and flood deposits underlie the Valley trough and floor and were deposited in lacustrine or marsh environments (Croft 1972). These fine-grained units are critically important in the hydrology of the basin in that they restrict the downward movement of water and act as aquitards. These nearly impermeable gypsiferous fine sand, silt and organic clay deposits are more than 3,000 feet thick beneath parts of the Tulare Lake bed and spread out laterally and interfinger with the coarser sediments found along the basin margins (Croft 1972; Page 1983). The clayey or silty clay units interbedded within the Tulare Formation are designated by letters A through F (Croft 1972). The A, C and E clay units are the primary fine-grained units underlying significant portions of the Subbasin and can isolate different waters and bounds the freshwater aquifers. However, beneath the Tulare Lake bed, these individual clay units are not distinguishable from the other clay deposits that form the massive clay plug beneath the center of the lakebed (KDSA et al. 2015).

A-Clay

The A-Clay is a dark greenish gray or blue, organic clay found approximately 60 feet bgs in the Tulare Lake area (KDSA et al. 2015). A-Clay is approximately 10 to 60 feet in thickness and in some places a sand lens separates the A-Clay into an upper and lower unit (Croft 1972). However, due to similarities in the sedimentary deposits beneath the Tulare Lake bed, A-Clay was not able to be positively identified in all areas (Page 1983). Outside of the Tulare Lake bed area and near rivers and streams, groundwater above the A-Clay can be an important source of shallow groundwater for domestic and limited AGR uses. In the Tulare Lake bed area, groundwater above the A-Clay is typically too saline for MUN or AGR usage and has been exempted from MUN and AGR beneficial use (RWQCB 2017). The delineated lateral extent of the A-Clay is shown in Figure 3-17 delineated by Croft (1972) and Page (1983) is shown on Figure 3-14a-c and Figure 3-17 (Croft 1972; Page 1983).

C-Clay

The C-Clay consists of yellowish-brown to bluish-gray silty-clay and is found approximately 230 feet bgs in the Tulare Lake area (KDSA et al. 2015). The C-Clay is about 10 feet thick and is structurally warped and folded (Croft 1972). C-Clay could not be positively identified beneath the Tulare Lake bed in previous studies (Page 1983). Outside of the Tulare Lake bed area, most of the groundwater production from public supply wells is from wells that tap water below the C-Clay (KDSA et al. 2015). In the Tulare Lake bed area, groundwater above the C-Clay in the Tulare Lake bed area is typically too saline for MUN or AGR usage (RWQCB 2017) and has been exempted from MUN and AGR beneficial use. The delineated lateral extent of the C-Clay is shown on Figure 3-18 and in cross sections A to A’, B to B’, and C to C’ (Figures 3-14 a-c) (Croft 1972; Page 1983).

Corcoran Clay (E-Clay)

The Corcoran Clay is the most extensive aquitard in the San Joaquin Valley. The Corcoran Clay is composed of dark-greenish gray, mainly diatomaceous, silt, clay, silty clay, clayey silt and sand that was deposited in a large lake that occupied the San Joaquin Valley (Croft 1972). The lateral extent and depth of the Corcoran Clay is shown on Figure 3-19a and its thickness on Figure 3-19b. The Corcoran Clay is warped into a major, asymmetric, northwest trending syncline that has been additionally deformed with smaller, subordinate folds.

Recently, a detailed evaluation of the presence of the Corcoran Clay beneath the Tulare Lake bed was undertaken in support of a de-designation of beneficial uses for groundwater beneath the lakebed (KDSA et al. 2015). This study identified the Corcoran Clay as being present at depths of about 400 to more than 800 feet bgs throughout the lakebed. The low permeability of the Corcoran Clay makes it an effective aquitard. It has sharp vertical boundaries and shows up well on borehole geophysical electric logs. The Corcoran Clay appears to extend out to the east of the Subbasin near SR 99. On the west, it rises sharply with the Tulare and underlying San Joaquin Formations. E-clay is more difficult to recognize as it approaches the west-side fold belts. Geophysical well logs indicate that the Corcoran Clay, although the largest single confining bed in the Subbasin, constitutes only a small percentage of the total cumulative thickness of clay layers in the unconsolidated sediments beneath the Tulare Lake bed clay plug.

3.1.9 Hydraulic Parameters

Two significant hydraulic parameters for groundwater resources are hydraulic conductivity and storage coefficient. The hydraulic conductivity is directly proportional to the rate at which groundwater will move under a unit hydraulic gradient. The storage coefficient is the amount of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit head change. When referring to an unconfined aquifer, the storage coefficient is called the specific yield and is related to the amount of water drained from the pore spaces in the aquifer and given as a percent of the total volume of the aquifer material. For a confined aquifer, the amount of water released is derived from limited compressibility of the water and primarily by the compression of the aquifer. No drainage of the water pores is involved.

Hydraulic conductivity and storage coefficient are most effectively derived from a pumping test of a well completed in a specific aquifer. Data from pumping tests in the Subbasin are not readily available; therefore, other means of estimated hydraulic conductivity and storage coefficient must be used. A method referred to as "*yield factor*" was utilized to approximate relative permeability, also known as hydraulic conductivity (Croft and Gordon 1968). The yield factor is equal to 100 times the specific capacity of a pumping well divided by the thickness of saturated material penetrated by the well (Croft and Gordon 1968). Specific capacity is calculated by dividing the discharge from the well by the amount of drawdown created by pumping. The study used pump-efficiency tests supplied by Pacific Gas and Electric Company (PG&E) and Southern California Edison Company (SCE) to calculate the specific capacities of numerous wells in the Tulare Lake area. This data was compiled and indicated increasing yield factor or permeability moving away from the Tulare Lake bed, largely related to the increasing coarseness of sediments further removed from the lacustrine fine-grained sediments within the lakebed (Figure 3-20).

Specific yields have been estimated for various areas of the San Joaquin Valley based on average grain size in the unconfined aquifers (Davis et al. 1964). On the Kings River alluvial fan, the specific yield was estimated to be 14.1%. On the Kaweah-Tule River fans, specific yield was estimated to be 9.5%. The storage coefficient for the confined aquifer has not been estimated specifically for the area within the Subbasin; however, a method is provided for estimating storage coefficient by multiplying the thickness of the confined aquifer in feet by a factor of 1×10^{-4} (Lohman 1972).

In support of the Central Valley Hydrologic Model (CVHM), scientists from the United States Geological Survey (USGS) developed a geologic texture model to describe the coarseness or fineness of basin-fill materials that make up the hydrogeologic system and used this model to estimate hydraulic properties including hydraulic conductivity and storage properties for every cell in the CVHM model grid (Faunt, ed. 2009) (Figure 3-21). Hydraulic conductivities derived from these texture models would range from approximately 1 foot per day (ft/d) to about 70 ft/d. Specific yields estimated for the CVHM ranged from 9% to 40% and varied based on the percentage of coarse-grained deposits with higher specific yields from coarser-grained deposits. The specific storage (storage coefficients divided by the thickness of the unit) ranged from 1.4×10^{-4} per ft of aquifer per ft for inelastic aquifers, 1.0×10^{-6} per ft for coarse elastic aquifers and 4.5×10^{-6} per ft for fine elastic aquifers. The compressibility of water is estimated to be 1.4×10^{-6} per ft and must be added to the specific storage of the matrix to determine the confined specific storage.

3.1.10 Groundwater Recharge and Discharge

Groundwater recharge in the Subbasin occurs primarily by two methods: 1) infiltration of surface water from the Kings River and unlined conveyances; and 2) infiltration of applied water for irrigation of crops. Recharge from infiltration of direct precipitation is minor owing to the low annual rainfall and the predominance of fine-grained surface soils. Some recharge enters the Subbasin by subsurface flow from adjoining subbasins; however, this is a minor component as most pumping centers for irrigation lie to the north and east of the Subbasin due to the more favorable hydraulic properties of the sediments outside of the Subbasin. Intentional recharge also occurs within the Subbasin by percolating surface water through storage ponds and old river channels, though the magnitude of this component is small compared to the groundwater demand in the Subbasin. Most surface water drainage within the Subbasin is internal.

Groundwater discharge in the Subbasin is predominantly by groundwater extraction along the eastern and northern portions of the Subbasin where water quality and well yields are higher than near the Tulare Lake bed. Some discharge is impacted by direct soil evaporation and evapotranspiration, particularly in areas where groundwater is less than 10 feet bgs. Additionally, some discharge occurs by tile drains in agricultural areas that have high groundwater levels to lower the groundwater table to below the root zone to sustain agriculture. Groundwater discharge also occurs by subsurface movement of groundwater from the Subbasin toward pumping centers in adjoining subbasins. Potential groundwater recharge based on soil classification and potential groundwater extraction based on subsurface sediment texture varies (Figure 3-22).

3.1.11 Primary Uses of Each Aquifer

The upper unconfined and semiconfined aquifer and the lower confined aquifer are sometimes used for different purposes based on economics and water quality. Primary groundwater uses within the Subbasin include domestic, municipal, agricultural, and industrial.

3.1.11.1 Domestic Pumping

Domestic pumping is primarily from the upper unconfined and semiconfined aquifer because it is easier to access and typically has sufficient yield for domestic purposes.

3.1.11.2 Municipal Pumping

Municipal pumping of groundwater occurs in the Subbasin by the cities of Hanford, Lemoore, Stratford, and Corcoran (Table 3-4). Wells for municipal purposes are typically in the deeper portions of the unconfined and semiconfined aquifer and sometimes reach into the confined aquifer. Municipal uses require larger sustained yields and typically higher quality water than domestic uses; therefore, municipal pumping looks to deeper zones with longer well screens than domestic wells. The municipal pumping demand varies seasonally, peaking in the summer months. Municipal pumping has created persistent cones of depression in the potentiometric surface near the cities of Hanford and Corcoran.

3.1.11.3 Agricultural Pumping

Agricultural pumping requires large quantities or water and water quality not impacted by elevated TDS, chloride, and boron concentrations. The requisite quantity and quality can be achieved by drilling into the deeper portions of the upper aquifer and below the Corcoran Clay into the lower confined aquifer. Thus, most of the agricultural pumping in the Subbasin and in adjoining subbasins is from deep wells.

3.1.11.4 Industrial Water Pumping

Industrial use depends on application. Groundwater used to provide steam for power generation or heating needs to contain low TDS and may require treatment. Some industrial use such as dust control may not be dependent on water quality.

3.2 Groundwater Conditions

23 CCR §354.16 *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…*

This section contains information related to historical and current groundwater conditions necessary to understand the characteristics of groundwater flow within the Subbasin, groundwater quality, and the water budget. Subsidence and its overall effect on groundwater storage, surface and groundwater interactions, and groundwater dependent ecosystems is also discussed.

3.2.1 Historical Changes in Groundwater Flow

Historically, groundwater movement in the Subbasin was dominated by recharge of surface water on the alluvial fans of the rivers and streams emanating from the Sierra Nevada Mountains and by the discharge sinks created by evaporation from Tulare Lake and evapotranspiration created by the swamps and marshes along the periphery of the Lake. Maps of unconfined groundwater conditions in the San Joaquin Valley between 1905 to 1907 (Figure 3-23) showed confined flowing wells (artesian) in the Subbasin along the center of the Valley and as far east as Goshen, Tulare, and Pixley (Mendenhall et al. 1916). Water levels indicated groundwater recharge on the Kings, Kaweah, and Tule River fans.

By 1952, groundwater development had altered the potentiometric surface such that distinct pumping cones of depression had developed in the unconfined upper aquifer east of the Subbasin beneath the Kaweah and Tule fans and within the Subbasin on the Kings River fan near Hanford (Figure 3-24) (Davis et al. 1959). These groundwater depressions interrupted the through flow of groundwater from the Sierra Nevada Mountains to the Tulare Lake area.

In 2016, groundwater cones of depression in the unconfined upper aquifer were apparent east of the Subbasin with groundwater elevations having declined 100 to more than 200 feet from the 1952 data (Figure 3-25). Based on available groundwater elevation data, the groundwater cones of depression peripheral to the Subbasin changed the natural prevailing direction of groundwater flow from west-southwest toward Tulare Lake, to east, northeast, and southeast away from Tulare Lake.

3.2.2 Recent Groundwater Elevation Data and Flow

In 1990, groundwater in the unconfined aquifer was at an elevation of about 260 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom (Figure 3-26). Groundwater elevations beneath Hanford were about 170 feet AMSL, and about 140 feet AMSL near Corcoran. There were several groundwater cones of depression in the water table near Hanford, north and south of Corcoran, and around Alpaugh. The Kings River appears to be a natural groundwater divide, a losing stream that provides a significant source of groundwater recharge to the unconfined aquifer. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule Subbasins and out of the Subbasin to the Westside Subbasin to the west-northwest (Figure 3-26).

In 1995, groundwater in the unconfined aquifer was at an elevation of about 260 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom (Figure 3-26). Groundwater elevations beneath Hanford were about 150 feet AMSL, and about 110 feet AMSL near Corcoran. By 1995, the cones of depression in the water table between Hanford and Corcoran had merged into a single large depression. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule Subbasins and out of the Subbasin to the Westside Subbasin.

In 2000, groundwater in the unconfined aquifer was at an elevation of about 250 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom (Figure 3-26). Groundwater elevations beneath Hanford were about 150 feet AMSL, and less than 100 feet AMSL near Corcoran. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings and Kaweah Subbasins and out of the Subbasin to Tule and Westside Subbasins.

In 2005, groundwater in the unconfined aquifer was at an elevation of about 260 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom. Groundwater elevations beneath Hanford were about 140 feet AMSL, about 10 feet lower than in 2000. No data was collected in the Corcoran area (Figure 3-27). Throughout the Subbasin, groundwater levels had declined about 10 feet or greater than in 2000, during a period of average rainfall. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule Subbasins and out of the Subbasin to the Westside Subbasin.

In 2010, groundwater in the unconfined aquifer was at an elevation of about 250 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom. Groundwater elevations beneath Hanford were about 130 feet AMSL, and less than 10 feet AMSL near Corcoran (Figure 3-27). Throughout the Subbasin, groundwater levels had further declined about 10 feet or more feet since 2005. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule Subbasins and out of the Subbasin to the Westside Subbasin.

In 2016 after roughly five years of severe drought, groundwater in the unconfined aquifer was at an elevation of about 230 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom. In the Hanford area, groundwater levels were about 110 feet AMSL, about 20 feet lower than in 2010 (Figure 3-27). Cones of depression in the water table west, north, and southeast of Corcoran had deepened to -40 feet AMSL. The Kings River was no longer a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings and Kaweah Subbasins and out of the Subbasin to the Tule and Westside Subbasins.

Wells with groundwater monitoring records are shown in Figure 3-28a. The hydrographs for these wells were evaluated to look at seasonal trends. Hydrographs for representative wells with unknown construction, wells completed in the unconfined aquifer, and wells completed in the confined aquifer are shown on Figures 3-28b-d respectively.

3.2.3 Vertical Groundwater Gradients

Vertical groundwater gradients between the upper unconfined aquifer and the confined aquifer separated by the Corcoran Clay are spatially and temporally variable. As of December 2016, vertical gradients range between approximately 0.0 to 0.504 feet/foot (0.0 to 50 ft/100 ft) downward.

3.2.4 Groundwater Storage Estimates

Groundwater storage is the capacity of an aquifer system to yield groundwater. Available groundwater in storage (i.e., groundwater volume) is a function of the saturated thickness of the aquifer, the area of the aquifer, and the storage coefficients of an aquifer, which is the specific yield for unconfined aquifers and specific storage for confined aquifers. The specific yield of the Subbasin's aquifer system above the E-Clay (Corcoran Clay) ranges from 0.01 to 0.3 (unconfined), while the specific storage ranges between $1x10^{-5}$/ft and $4.5x10^{-2}$/ft for semi-confined intervals above the E-Clay (Amec 2018). The specific storage of confined sediments below the Corcoran Clay ranges between $5x10^{-6}$/ft and $1x10^{-5}$/ft (Amec 2018).

The Subbasin groundwater model was used to calculate available groundwater in storage for the principal aquifers (unconfined above the E-Clay and confined below the E-Clay) within the Subbasin boundaries based on 2016 conditions. The available groundwater in storage in the unconfined aquifer zone is estimated at 57.4 million AF. The available groundwater in storage in the confined aquifer zone is estimated at 162.4 million AF. Total available groundwater in storage is approximately 219.5 million AF.

The groundwater model was also used to estimate the overall change in available groundwater storage over the model calibration period of 1996 to 2016 for the unconfined and confined aquifers. Change in available groundwater storage over time is a function of the change in hydraulic head of the aquifer, the aquifer area, and the storage coefficients. Available groundwater storage can be negatively impacted by decreasing groundwater head and an overall reduction of the aquifers area resulting from declining groundwater.

Annual changes occurred in groundwater storage from 1990 through 2016 in the upper and lower aquifer zones for each GSA area (Figures 3-29a and b). Overall there has been a loss of storage of 2.88 million AF between 1990 and 2016. For individual GSAs, the change in storage was -1.05 million AF in the El Rico GSA; -987 thousand AF in the Mid Kings GSA; -1.09 million AF in the South Fork Kings GSA; +143 thousand AF in the Southwest Kings GSA; and +98 thousand AF in the Tri-County GSA.

Permanent loss of groundwater storage occurs when dewatering of an aquifer results in compression of sediments also known as subsidence due to loss of hydrostatic pore pressure that formerly offset compressional loading of the sediment overburden. Compaction of sediments permanently reduces effective porosity of an aquifer thus reducing overall aquifer storability. Permanent loss of groundwater storage beneath the Subbasin is estimated to be on the order of -2.7 million AF between 1990 and 2016, or approximately 1.2% of the total groundwater in storage in 2016.

3.2.5 Groundwater Quality

Water quality geochemistry varies in groundwater beneath the San Joaquin Valley (Mendenhall, et al. 1916). On the west side of the Valley, groundwater was always high in sulfate compared to groundwater on the east side of the Valley. Near the center of the Valley, groundwater had a mixed character, also being high in alkalis. Most of the water sampled represented essentially pre-development conditions. The difference in chemical characteristics of the groundwater to was attributed to the source area for the sediments in which the groundwater was contained (Mendenhall, et al. 1916). On the west side, deposits were derived from marine sedimentary rocks with high proportions of sulfur-rich minerals (such as gypsum), whereas on the east side, deposits were derived from granitic rocks with high proportions of silicates. Near the center of the Valley and around the historical Tulare Lake, groundwater contained higher proportions of chloride, presumably from evaporative concentration of water in the lake. It was also noted that TDS measurements in groundwater were greater on the west side than the east.

These findings were confirmed by an additional study in 1956, which concluded groundwater quality is markedly different vertically than horizontally (David et al. 1956). The increase in groundwater development between the initial and secondary reports, resulted in the latter study subdividing groundwater into unconfined and semiconfined waters that have generally free communication with land surface, the fresh water confined beneath the Corcoran Clay, and brackish and saline marine connate waters that occur at depth beneath the useful aquifers throughout most of the Valley. These studies reported the confined fresh groundwater had lower TDS and a higher percentage of sodium than the unconfined or semi-confined aquifer. The differences between east (carbonate groundwater) and west groundwater (sulfate) continued into the 1950s. The groundwater beneath the axial trough was highly variable because of evaporative concentration, variable mixing of east and west groundwater, and recharge of surface water along stream courses of Sierran rivers.

In 2018, a study undertook a comparison of historical groundwater quality data from the historical report of 1916 and modern samples from 1993-2015 to quantify anthropogenic contributions to salinity changes in groundwater quality (Hansen et al. 2018). Findings indicate TDS had increased in most groundwater in the San Joaquin Valley over the past 100 years. However, the spatial distribution of the TDS and individual cation-anion makeup of the groundwater still reflect the geologic provenance of the containing sediments as well as the chemical characteristics of the recharge water. The greatest TDS increases in the Tulare Lake area and eastward were in the shallow portions (i.e., unconfined to semiconfined) of the aquifer.

Excluding water above the A-Clay, the historical data did not indicate any substantial differences in TDS between shallow and deep groundwater. Modern increases in TDS in the shallower groundwater were hypothesized to be due to land usage, which is primarily agricultural in this area (Hansen et al. 2018). The changes to individual cations and anions suggest dissolution of silicate minerals possibly caused by increases in carbonic acid in the soil zone due to agricultural practices. An increase in bicarbonate concentrations were the highest contributor to increases in TDS over the past 100 years. Migration of higher TDS water to deeper portions of the unconfined/semiconfined aquifer was postulated to be the result of high rates of agricultural pumping, along with more limited municipal pumping creating downward vertical movement from upper to lower portions of the upper aquifer. Only limited changes to the TDS and chemical makeup of the lower, confined aquifer were apparent, assuming that the historical chemistry reflected both native conditions for both the upper and lower aquifers (Hansen et al. 2018).

Deep groundwater near the boundary of the continental deposits and the Tertiary marine deposits (San Joaquin Formation) has been estimated to exhibit TDS upwards of 2,000 mg/L based on limited groundwater samples and interpretation of geophysical logs of deep borings. This water represents saline connate water contained or adjacent to the marine deposits.

The SWRCB maintains a database of water quality data (GeoTracker) collected from various state regulatory programs, the USGS, and the University of California Davis Nitrate Study. These datasets were obtained for the Subbasin to gain a general overview of water quality. In general, chemicals of concern that generally affect water quality in the San Joaquin Valley were screened including naturally occurring and anthropomorphic. These included salinity (TDS), arsenic, nitrate, and volatile organic chemicals (VOCs). Figure 3-30 shows the area-wide distribution of TDS in groundwater. Figure 3-31 shows the distribution of arsenic in groundwater. Figure 3-32 shows the distribution of nitrate in groundwater and Figure 3-33 shows the distribution of VOCs in groundwater.

3.2.6 Land Subsidence

Alluvial aquifer systems including those found in the San Joaquin Valley typically consist of a granular mineral skeleton of sand, silt, and clay, and pore-spaces filled with water (LSCE 2014). When water is withdrawn (i.e., pumped) from an aquifer, the fluid pressure in the pore space, also known as pore pressure, is reduced and the weight of the overlying materials must be increasingly supported by the granular mineral skeleton of the aquifer system. As the pressure on the granular skeleton including effective stress increases, some compression of the aquifer system skeleton may occur causing elastic deformation. When the effective stress exceeds the previous maximum effect stress on the aquifer skeleton (pre-consolidation stress) then some rearrangement of the mineral grains, typically clays, may occur and result in permanent compaction resulting in inelastic deformation. For individual thin clay lenses, the amount of compaction is relatively small. However, the combined compaction of many clay lenses within an aquifer system can result in significant subsidence at the ground surface.

Land subsidence due to excessive groundwater withdrawals and associated drawdown has been well documented and has affected significant areas of the San Joaquin Valley since the 1920s, including the Subbasin (Amec 2017). Between 1926 and 1970, there was approximately 4 feet of cumulative subsidence near Corcoran, 4 to 6 feet of subsidence near Hanford, and as much as 12 feet of subsidence near Pixley (Figure 3-34). Following the completion of the SWP and CVP, surface water became more readily available in the San Joaquin Valley and groundwater extraction was reduced and groundwater levels recovered. As a result, subsidence due to excessive groundwater withdrawal was temporarily slowed or stopped.

Groundwater pumping has since increased in the San Joaquin Valley in the past 10 to 25 years due to several factors including the planting of permanent crops and a reduction of available imported surface water. At the same time, many existing wells were deepened, and new wells were installed into deep, previously un-pumped and unconsolidated portions of the confined aquifer beneath the Corcoran Clay. Excessive pumping from the confined aquifer eventually exceeded the pre-consolidation stress of the aquifer system, resulting in the resumption and acceleration of compaction of the fine-grained sediments in the confine aquifer system and associated subsidence at the land surface.

Subsidence in the San Joaquin Valley was exacerbated during a moderate to severe drought from 2007 through 2009, and a severe to exceptional drought from 2012 through 2016. A Jet Propulsion Laboratory study of subsidence between June 2007 and December 2010 indicated subsidence rates were as high as 8.5 inches per year near Corcoran (Farr et al. 2015) (Figure 3-35a). A more recent study by Jet Propulsion Laboratory indicted subsidence rates accelerated in some areas during the recent drought, with annual subsidence rates of 1 to 1.5 feet near Corcoran in 2015-2016 (Farr et al. 2017) (Figure 3-35b).

Groundwater pumping and drawdown, and consequent subsidence are anticipated to continue until at least excessive withdrawals from the deep confined aquifer can be curtailed and sustainable groundwater pumping is achieved. Most of the aquifer compaction is inelastic, so subsidence is mostly irreversible even if groundwater pumping decreases and groundwater level recover. This has had negative consequences resulting in permanent loss of some groundwater storage.

3.2.7 Surface Water Systems

The established surface water system is described in detail in Section 3.1.1.5. The historical conditions of surface water flow have been significantly altered by reclamation and flood control engineering projects since the turn of the 20th century. In pre-development in the 1800s, runoff from the southern Sierra Nevada Mountains south of the San Joaquin River south to Kern River collected in three terminal lakes: Tulare Lake, Kern Lake, and Buena Vista Lake. This internal drainage configuration created vast regions of adjoining tule marshes and riparian woodland wetlands (ECORP 2007). Tulare Lake in the 1870s was reported to have an area of approximately 446,000 acres or 697 square miles and an elevation of about 200 feet AMSL (BCI 1874). The surface area of Tulare Lake was about 505,000 acres or 790 square miles at its highest overflow level of 216 feet AMSL. The lake level and its aerial extent fluctuated during wet and dry periods.

Prior to development, Tulare Lake received runoff from the South Fork Kings River, Cross Creek, Packwood Creek, Meron's Creek, Kaweah and St. Johns Rivers, Tule River, Deer Creek, White River, Poso Creek, and the North Fork of Kern River. Tulare Lake also received overflow from Buena Vista Lake which in turn received overflow from Kern Lake (Figure 3-36) (ECORP 2007). The major rivers formed broad deltaic and alluvial fans as they flowed from the Sierra Nevada foothills into the San Joaquin Valley, creating multiple distributary channels and sloughs that shifted periodically, especially during flooding events.

Natural hydrology of the Subbasin has been extensively altered over the last century for flood control, irrigation, land reclamation, and water conservation priorities. Concerns about water supplies and flood control resulted in the construction of Pine Flat Dam on the Kings River, Terminus Dam on the Kaweah River, Success Dam on the Tule River, and Isabella Dam on the Kern River (ECORP 2007). Channelization of the rivers for flood control, irrigation, and water banking have further modified the Subbasin's hydrography (ECORP 2007). The modern-day surface water conveyances that supply the Subbasin are primarily man-made canals and channelized streambeds.

3.2.8 Interconnected Surface Water and Groundwater Systems

Prior to development in the late 1800s, groundwater and surface waters were interconnected around the Subbasin, resulting in extensive wetlands, a nearly persistent Tulare Lake, and notable artesian aquifers indicating strong upward groundwater gradients (Figure 3-37). Groundwater levels were near the ground surface beneath much of the Tulare Lake Basin, and as streams and rivers flowed from the Sierra Nevada foothills and Coast Ranges towards Tulare Lake, they converted from losing streams which recharged underlying groundwater to into gaining streams which benefit from groundwater discharge (Figure 3-37).

During development, most of the streams and rivers draining into Tulare Lake were dammed and/or channelized, and Tulare Lake itself was drained. As a result, most streams and rivers draining into Tulare Lake became disconnected from the regional unconfined aquifer system (Figure 3-5). The 1952 potentiometric surface maps show the Kings River was a losing stream from the Sierra Nevada foothills to where it crossed SR 198 (Figure 3-24). South of SR 198 and north of Tulare Lake, groundwater contours converge indicating the lower reach of the Kings River may have gained water due to groundwater discharge. The Tule and Kaweah Rivers were losing streams in 1952. Potentiometric surface maps from 1990 show that the Kings, Kaweah, and Tule rivers are all losing streams (Figure 3-26).

In the past 160 years, extensive land reclamation projects and groundwater extraction have resulted in a significant lowering of the regional water table, causing isolation of surface waters from groundwater beneath most of the Subbasin. A persistent, shallow perched water table at a depth of about 30 feet bgs is often present above the A-Clay in the vicinity of surface water conveyances and below recharge facilities; however, this shallow perched zone is disconnected from the regional unconfined aquifer. Other localized shallow perched zones may exist elsewhere in the Subbasin, but these are not considered a significant source of groundwater.

3.2.8.1 Groundwater Dependent Ecosystems (GDEs)

Groundwater Dependent Ecosystems (GDEs) are ecosystems that rely upon shallow groundwater for their sustainability. Depletion of groundwater and lowering of the water table has detrimental effects on GDE existence. GDEs differ from surface water dependent wetlands because they are sustained by natural surface water or artificially conveyed surface water. In some instances, such as the Kern Wildlife Refuge at the southern border of the Subbasin, a wetland may be artificially maintained by conveyed surface water delivery and deep groundwater pumping. Historically, the Tulare Lake region appears to have supported an extensive mix of both GDEs and surface water dependent wetlands which were largely eliminated or substantially reduced in aerial extent when the lake was drained and water diversions and impoundments increased.

GDEs within the Subbasin were evaluated using the California Natural Resources Agency DWR Open Data "*Natural Communities Commonly Associated with Groundwater*" (NCCAG) database. The database contains two habitat indicators that could indicate the presence of GDEs: 1) wetland features commonly associated with surface expression of groundwater under natural unmodified conditions; and 2) vegetation types (phreatophytes) commonly associated with the subsurface presence of groundwater. It should be noted that this dataset does not represent DWRs determination of a GDE. However, it can be used as an initial screening tool for identifying GDEs within the Subbasin.

Figure 3-38 shows the distribution of remaining wetland features that could be associated with groundwater. Note how few wetlands remain compared to pre-development (Figure 3-37). The wetland consists of semi-permanent/seasonally flooded lake shore wetlands; semi-permanent/seasonally flooded or saturated marsh land; and riparian seasonally or permanently flooded wetlands. The NCCAG database identified 23 species of phreatophytes and five vegetative habitats within the Subbasin that could be associated with GDEs (Figure 3-38).

Most of these vegetation types/plant species are associated with riparian habitat that rely on surface water. Salt tolerant phreatophytes such as iodine bush, quail bush, alkali bulrush, curlyton knotweed, hardstem bulrush, shrubby seepweed, spinescale, alkali goldenbush, and tamarisk can be found in the alkali sink or in brackish water marsh habitat. These plants are typically found in areas of shallow perched groundwater with high salinity overlying the A-Clay perching zone (Figure 3-38). The lateral extent of perched groundwater above the A-Clay is dependent on available recharge associated with occasional flood events and/or agricultural irrigation, evapotranspiration, and land reclamation in areas where tile subsurface drains have been installed. The subsurface tile drains have controlled groundwater elevations by subsurface drainage.

Groundwater pumping from the principal aquifer system is not likely to impact the occurrence of perched groundwater because the two systems are separated by the A-Clay aquitard. Perched groundwater above the A-Clay is not directly interconnected with the underlying unconfined/semiconfined aquifer in that pumping from the unconfined/semiconfined aquifer does not induce increased leakage through the A-Clay aquitard.

3.3 Water Budget Information

23 CCR §354.18(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 provides a quantitative description of the water budget for the Subbasin including an account of all the inflows, outflows, and changes in storage in the Subbasin aquifer system over time. This includes historical, current, and projected water budget and the changes in the Subbasin's storage. Within a subbasin, if total outflows exceed total inflows, both groundwater levels and groundwater in storage will decline, and the subbasin may be considered in a state of overdraft. When inflows and outflows are in balance, both groundwater levels and groundwater in storage will remain stable over time. Safe Yield is that volume of groundwater that may be utilized within a subbasin without long-term overdraft.

The historical water budget information will be utilized to estimate future conditions related to supply, demand, hydrology, and surface water supply reliability to construct a baseline forecast to understand future projected conditions and for development of management actions and projects.

3.3.1 Inflows, Outflows, and Change in Storage

The Subbasin's water budget describes the inflows to and outflows from the Subbasin's hydrogeologic system. Inflow and outflow can occur from the hydraulic boundaries of the system, from various sources within the model domain such as inflow from adjacent subbasins, rainfall, lakes, and leakage from rivers and canals, and from the exit points or sinks such as wells, drainage systems, or outflow to adjacent subbasins. The boundaries, sources, and sinks identified within the model domain are discussed below.

3.3.1.1 Inflows

Inflows consist of precipitation, surface water diversions for irrigation, lake bottom storage, intentional recharge, leakage from streams and conveyances, and groundwater inflow from adjacent subbasins.

Precipitation

Precipitation can be a significant source of water to the Subbasin and surrounding area in wet years. Given the large areal extent of the Subbasin and surrounding area, it was determined using a single weather station to estimate precipitation would be inadequate to represent the entire Subbasin. Instead, the PRISM database maintained by the Oregon State University was used to estimate monthly precipitation from January 1990 through December 2016 across the Subbasin (Figure 3-6). The PRISM database contains monthly total precipitation for the entire United States using a 4-kilometer grid. The monthly precipitation values are statistically derived values based on local weather stations and corrections for topographic variations. The monthly precipitation data were summed by Subbasin area to estimate the potential annual precipitation volume (Figure 3-39).

Not all rainfall is available for use by crops – some falls on impervious surface, some is taken up by dry soils, and some is intercepted by foliage and evaporates before it can infiltrate. Monthly effective precipitation was calculated by multiplying the monthly PRISM data sets by the Precipitation / Effective Precipitation ratios presented in the Food and Agriculture Organization (FAO) 56 (Table 3-1) (Allen et al. 1998) (Figure 3-40). Effective precipitation varies annually in the Subbasin (Figure 3-39). Between 1990 and 2016, effective precipitation provided a range of 4,700

AF during a dry year (2013) to 260,000 AF in a wet year (2010) with an average of about 110,500 AF within the Subbasin.

Surface Water Diversions

Surface water diversions from external sources are another significant source of water to the Subbasin. There are 34 rivers, streams, canals, and diversions entering and within the Subbasin that have recorded diversions (Figure 3-5). Surface water delivery and diversion records within the Subbasin were obtained by Provost & Pritchard staff via direct contacts with the various GSAs and member water management agencies within the GSAs (Table 3-5). Those records were relatively complete from 1990 through 2016 for diversions off the Kings River system and SWP.

Between 1990 and 2016, surface water diversions provided an average of 573,780 acre-feet per year (AF/yr) of water across the Subbasin (Table 3-5) (Figure 3-41). The surface water diversions are not delivered uniformly across the Subbasin. Instead, there are several areas that historically have not received surface water diversions and areas with greater quantities of surface water delivery.

Lake Bottom Water Storage

One unique feature of the Subbasin is the utilization of certain portions of the historical lake bottom for storage of the excess surface water inflows also known as flood waters, which were not diverted by others. This stored surface water is later used as an irrigation supply. In some years, sufficient water can be stored in the lake bottom to eliminate the need for supplemental groundwater pumping to meet the irrigation demand (Figure 3-42). Lake bottom storage is occurring mostly in the El Rico GSA management area and also as a small area of the Tri-County GSA. There is no lake bottom storage in Mid-Kings River GSA, Southwest Kings GSA, and South Fork Kings GSA areas.

Lake bottom storage in permanent ponds can store approximately 70,000 AF/yr. During flood events, some fields can be flooded allowing for the storage of significant volumes of water, in some years up to 465,000 AF in the El Rico GSA management area. The importance of conjunctive management capability is illustrated by cumulative excess inflow stored in the lake bottom, allowing lake bottom farmers to completely turn off their groundwater well fields between January 1995 and June 1999 (Amec 2018).

Intentional Recharge

Groundwater recharge in the Subbasin also occurs from intentional percolation of surface water in storage ponds and water banks. Kings County Water District has operated a small but effective water bank on the Old Kings River Channel since 2002. Approximately 73,600 AF of water have been recharged over this 17-year period via percolation through approximately 50 acres of ponds (Figure 3-43), and approximately 48,500 AF have been recovered utilizing five recovery wells since 2002. This leaves a positive balance of approximately 25,100 AF in the unconfined aquifer system as of 2016.

Condition 8 water is also percolated into an approximately 7.75-mile reach of the Old Kings River Channel when available (Figure 3-43). During wet years, as much as 37,000 AF have been percolated into the Old River Channel.

The Corcoran Irrigation District (ID) also owns and operates nine percolation basins totaling about 2,760 acres. Estimated percolation rates are about 0.25 ft/d. A review of aerial photos suggests only one or two basins are typically utilized each year between March and September when surface water is available, percolating an estimated average of 23,500 AF/yr (Figure 3-43). During wet years, as much as 147,700 AF of water has been estimated to be percolated using these percolation basins.

Waste Water Treatment Plant Discharge

There are a number of small to mid-sized waste water treatment plants (WWTPs) throughout the Subbasin operated by, including but not limited to, various cities, municipalities, the Department of Defense, Native American facilities, and manufacturing plants. At most of the WWTPs, treated waste water is discharged into seepage ponds, used as recycled water, or utilized for irrigation by local farmers. The ratio of WWTP seepage to re-use is not well documented and needs further investigation.

River and Canal Seepage

Seepage losses from river and canals provide another source of water to the Subbasin and surrounding areas. There are over 290 miles of major streams and canals within the Subbasin, in addition to many more miles of small distribution ditches on individual farms. Most of the stream and canals are unlined and can have significant seepage losses. Little information is available on seepage losses in the Subbasin, although it has been noted that the Old River Channel, Peoples Ditch, and Lakeland Canal all have substantial losses near the head gates at Peoples Weir. River and canal seepage estimates are based on the calibrated groundwater model (Figure 3-44).

Seepage loss from rivers and streams is on the order of 57,800 to 229,000 AF/yr between 1990 and 2016. Most of the seepage loss occurs on the Kings River in Mid-Kings GSA and in El Rico GSA management areas due to its size and number of canals delivering surface water to the GSA. The Tri-County GSA management area has the lowest amount of seepage loss.

Subbasin Boundary Groundwater Inflows

The Subbasin is located within the larger Tulare Lake Hydrologic Region and, except for the Kettleman Hills bordering the southwest potion of the Subbasin, the remaining Subbasin boundaries represent political not hydrogeological boundaries. As such. groundwater is free to move across political boundaries into or out of the Subbasin. Groundwater inflows represent groundwater entering the Subbasin across its boundary from adjacent subbasins. Groundwater flowing into the Subbasin is considered a net gain of groundwater and has the potential to increase available storage with the Subbasin (Table 3-6) (Figure 3-45). Inflow into the Subbasin ranges from about 93,000 to 184,200 AF/yr. The highest inflows are from the Kings and Kern subbasins.

Total Subbasin Inflows

Total inflows into the Subbasin consists of precipitation, surface water imports, flood waters, intentional recharge, seepage losses from surface water conveyances, seepage losses from WWTPs, and subsurface inflows from surrounding subbasins. During the 1990-2016 period, estimated total inflow ranged from 663,600 to 2,119,000 AF/yr.

3.3.1.2 *Outflows*

Outflows consist of evapotranspiration, agricultural pumping, municipal pumping, agricultural drains, and groundwater outflow to adjacent subbasins. There is no reported outflow of surface water from the Subbasin.

Evapotranspiration

Crop evapotranspiration (ETc) is the largest outflow of water from the Subbasin. ETc varies seasonally and by crop type, typically peaking during the summer months (ITRC 2003). DWR crop data sets from 1995, 1998, and 2006 were used to estimate crop acreage on a 40-acre spacing from 1990 to 2006 throughout the Subbasin. Starting in 2007, CropScape started producing annual estimates of crop acreage on a 40-acre spacing. Annual crop demand was calculated for each crop type on a 40-acre basis as follows:

Annual Crop Acreage (acres) * Annual Crop ETc (feet/yr) = ET_Demand (af/y)

Note some crop types do not receive irrigation water and have zero crop irrigation demand (Table 3-7). Crop irrigation demand, also referred to as farm demand was calculated as follows to account for this variable:

(Crop ET-Demand (af/y) – Effective Precipitation (af/y)) / Irrigation Efficiency (percent) = Farm Demand (af/y)

Between 1990 and 2016, the total crop irrigation demand in the Subbasin ranged from approximately 622,830 AF in 2015 to 1,230,400 AF in 1999, with an average crop irrigation demand of approximately 1,016,500 AF over this 16-year period (Table 3-6) (Figure 3-46). As shown in the DWR and CropScape data sets, the mix of crops grown and fallow lands has changed over time as agricultural practices were altered in response to agricultural markets and drought conditions. A chart of annual crop demand shows total crop water demand has generally decreased since 2000 (Table 3-7). For example, cotton showed the most change with a decrease of near 50% between 1995 and 2016. The data also shows, during the 2011-2016 drought, there was an overall increase in crop demand primarily from tomatoes, peppers, and potatoes. Annualized tables and charts of crop demand for the Subbasin's GSAs are presented in the Model Report in Appendix D.

Municipal and Agricultural Pumping Demand

Municipal pumping of groundwater occurs in the Subbasin by the cities of Hanford, Lemoore, Armona, Stratford, and Corcoran (Table 3-4). The municipal pumping demand varies seasonally, peaking in the summer months. Municipal pumping has created persistent cones of depression in the potentiometric surface near the cities of Hanford and Corcoran.

Agricultural pumping is typically not recorded over much of California, including the Subbasin. However, agricultural pumping demand on a 40-acre spacing can be estimated as follows:

Farm Demand (af/y) – Surface Water Deliveries (af/y) = Un-Met Demand (af/y)

Un-Met Demand (af/y) – Return Flows (af/y) – Surface Water Ponds (af/y) = Ag_Pumping Demand (af/y)

The Agricultural Pumping Demand per 40-acre spacing can then be summarized by each GSA (Figure 3-47). Although this simple water balance approach does not account for the areal distribution of surface water diversions or farm delivery requirements, it does provide a reasonable estimate of agricultural pumping in the Subbasin and GSA-specific scale. Based on this analysis, pumping demand in the Subbasin from 1990 through 2016 has ranged from 184,900 to 776,200 AF/yr and averaged 510,900 AF/yr over this 16-year period (Table 3-6).

Agricultural Drains

Agricultural drains are used beneath several areas of the Subbasin to keep soil from becoming waterlogged in the root zone. Typically, a tile or French drain system is used with tiles buried approximately 4 to 6 feet bgs draining to sumps. Subsurface drainage collected in the sumps is pumped via pipeline to evaporation basins. Locations vary of subsurface drains and evaporation basins within the Subbasin (Figure 3-22). Estimates of groundwater withdrawal from agricultural drainage ranged from 0 to about -16,440 AF/yr between 1990 and 2016, with most of the withdrawal occurring in the El Rico GSA management area (Figure 3-48). The South Fork Kings River GSA management area also had some groundwater withdrawals from drains ranging from about 0 to -3,700 AF/yr between 1990 and 2016. Tri-County GSA management area also has agricultural drainage, but the discharge amounts are relatively small on the order of 0 to -72 AF/yr. Table 3-6 shows the contribution of agricultural drainage to the overall water balance.

Subbasin Boundary Groundwater Outflows

The Subbasin is located within the larger Tulare Lake Hydrologic Region, and with the exception of the Kettleman Hills bordering the southwest portion of the Subbasin. Groundwater outflows represent groundwater exiting the Subbasin across its boundary in to adjacent subbasins. Groundwater flowing out of the Subbasin is considered a net loss of groundwater and has the potential to reduce available storage with the Subbasin (Table 3-6) (Figure 3-49). Outflow from the Subbasin ranges from about -106,800 to -152,800 AF/yr. The highest outflows are to the Kaweah, Kings, and Tule Subbasins.

Total Subbasin Outflows

Total outflows into the Subbasin consists of evapotranspiration, well pumping, and subsurface outflows to surrounding subbasins. During the 1990-2016 period, estimated total outflow ranged from -1,260,300 to 2,959,200 AF/yr.

3.3.2 Annual Change in Storage

Change in storage within an aquifer is the difference between the sum of the inflows and the sum of the outflows. An increase in aquifer storage results when the sum of the inflows exceeds the sum of the outflows. Conversely a decrease in storage results when the sum of the outflows exceeds the sum of the inflows. When inflows equal outflows, no change in storage occurs. With a large basin such as the Subbasin, localized variability in the inflows verses the outflows may occur in areas where groundwater storage increases during a specific water year while conversely in other areas a decrease in storage may occur within the Subbasin. An example of this variability could be attributed to areas where recharge basins may be located as opposed to areas where heavy groundwater pumping may be occurring. During the 1990-2016 period, estimated total annual change in the Subbasin storage ranged from -397,900 to 283,500 AF/yr and averaged about -106,970 AF/yr over this 16 year period (Table 3-6) (Figure 3-29a-c).

3.3.3 Quantification of Overdraft

As defined by DWR, overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of replenishment to the basin (DWR 2016b). Effects of overdraft can include land subsidence, groundwater depletion, and degradation of water quality and/or chronic lowering of groundwater levels. DWR Bulletin 118 defines critical overdraft as "*when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts*" (DWR 2016b).

The Subbasin sits at the lowest point of the Tulare Lake Hydrologic Region and receives both surface water inflows from several streams including Kings River, Kaweah River, St. Johns River, Tule River, and Deer Creek as well as the SWP. Nonetheless in some years, especially during extended drought cycles (e.g., 2012-2016), agricultural water demand exceeds the surface water inflows. This has led to the drilling of wells to develop groundwater resources to fulfill unmet water demand. Under recent historical conditions the average annual demand on groundwater resources significantly exceeded the average existing recharge to the Subbasin's groundwater system.

Overdraft is estimated using the historical water balance record beginning at the time when the net change in storage became negative, lasting over a period with no significant recovery in storage. Estimated overdraft was calculated over the Normal Baseline Period of 1998 to 2010 and is reflected in a prolonged negative change in average storage of approximately -93,800 AF/yr. The Subbasin has been divided into management areas consisting of individual GSAs to quantify overdraft in each GSA area. The overall change in storage within the Subbasin and individual GSA management areas was calculated using the groundwater model. Table 3-6 and Figures 3-50a-c shows the annualized amount of overdraft in each GSA management area and the Subbasin for the total aquifer system, upper aquifer, and, lower aquifer.

3.3.4 Estimate of Sustainable Yield

Sustainable Yield is defined as the maximum quantity of water calculated over long-term conditions in the Subbasin including any temporary excess that can be withdrawn over a year without causing an undesirable result. Sustainability indicators are evaluated to determine when significant and undesirable results occur indicating an exceedance in sustainable groundwater yields within the basin. These criteria and significant and undesirable effects are discussed in detail in Chapter 4.

3.3.5 Current Water Budget

The current water budget is represented by the last full calendar year (2016) in which data is available. The current water budget for this period is presented on Table 3-6.

3.3.6 Historical Water Budget

The historical water budget for the Subbasin covers a period of 27 years extending back to 1990 and is based on the set of available data records. Precipitation records span a period from 1899 to 2017 (Table 3-1). Evapotranspiration from the nearest California Irrigation Management Information System (CIMIS) station covers a period of October 1982 through 2018. Surface water delivery data from the SWP is available since 1966, and GSA surface water delivery data on their canal systems are available since 1990. State and Tulare County land use records are available from 1990 to 2006 updated at 5-year intervals. USDA CropScape annual cropland data is available from 2007 to 2017. Groundwater pumping demand is based on both records of municipal pumping and projected rates of agricultural pumping as described in Section 3.3.1.2 from 1990 to the present.

Subbasin inflows and outflows are calculated in the calibrated groundwater model based on general head boundary conditions which include groundwater elevations and groundwater flux. These are estimated based on historical groundwater elevations measured in wells at or near the Subbasin boundary and estimates of aquifer hydraulic parameters such as hydraulic conductivity, aquifer thickness and specific storage.

Historical change in storage as described in Section 3.3.2 is the net difference between the inflows and the outflows. Change in storage is calculated using the groundwater models (Table 3-6).

3.3.6.1 Historical Demands and Sustainability

Historical water conditions that affect sustainable yields include: 1) population growth in urban centers; 2) changes in agricultural demand; and 3) availability of surface water. Average agricultural water demand comprises 96% of total water use within the Subbasin, while urban use comprises 4%. Surface water deliveries have declined over time from a peak of 1,036,880 AF in 1996 to a low of 107,070 AF in 2015, primarily related to reduced Kings River flow due to drought conditions and reduced CVP deliveries associated with regulatory requirements. Other surface water deliveries have remained relatively static over the last 16 years.

A review of U.S. Census Bureau data indicates the Kings County area exhibited a population growth of approximately 48,632 people between 1990 and 2017, with most growth occurring in the Hanford-Lemoore area. The major urban areas saw increases in population of 25,602 people in Hanford, 12,733 people in Lemoore, and 8,471 people in Corcoran, accounting for 96% of the population growth in Kings County. These communities rely solely on groundwater for water supply. Estimates of urban pumping within the GSP area increased from 500 AF in 1990 to 1,000 AF in 2013 (Table 3-4). Increases in urban population increased demand for groundwater resources within these communities. Continued urban population growth will likely increase the demand on groundwater resources. Some of the increase in urban demand will be offset by the conversion of agricultural land into housing; however, urban demand will continue to incrementally increase water demand unless future aggressive water conservation is implemented. Additional surface water sources or improved management of groundwater resources (e.g., increased recharge) could help offset increased urban water demand.

Historical annual agricultural pumping demand of groundwater within the Subbasin is an estimated parameter dependent on several water balance components. It is dependent on crop type and the amount of row crops fallowed in a given year due to limited availability of surface water resources or economic circumstance. Historical agricultural pumping demand is calculated based on crop coefficient multiplied by reference evapotranspiration yielding crop evapotranspiration. Farm water demand is crop evapotranspiration minus effective precipitation divided by the irrigation efficiency of the irrigation method. Agricultural pumping is farm water demand minus applied surface water minus imported groundwater. Different crop types have different water requirements and changes in cropping pattern affect the amount of agricultural demand within the Subbasin. Historical crop demand is shown in tables and graphs in the Model Report in Appendix D. As shown by the tables and graphs, overall groundwater usage for agriculture has remained the top water user in the Subbasin and has varied over time since 1990 due surface water availability, climatic conditions, and other factors.

Heavy groundwater demand is directly associated with years of limited surface water supply. Fallowing of row crops during drought years offsets this increased demand to some extent. The relationship between available surface water deliveries, groundwater pumping, farm demand, and crop demand impacts the water budget (Figure 3-51).

3.3.7 Projected Water Budget

The projected water budget for the Subbasin represents a hypothetical forecast for the 54-year period from 2017 through 2070 based on an assumed “normal hydrology” period and estimated future climate change impacts. This forecast provides the Subbasin's GSAs with a tool to allow flexibility in groundwater management and planning of sustainability projects. The projected water budget is based on current baseline conditions of groundwater and surface water supply, water demand, and aquifer response to allow for implementation of groundwater management and projects implemented under the GSP. Groundwater modeling of the forecast conditions will be used to evaluate long-term groundwater flow trends, change in storage, and long-term groundwater sustainability under different forecast conditions and hypothetical groundwater sustainability projects conducted by individual GSAs.

3.3.7.1 Establishment of the Normal Hydrology Baseline Period

Long-term precipitation records are often used to evaluate hydrologic cycles for watersheds and subbasins. Typically, the cumulative departure from the long-term mean precipitation is used to evaluate hydrologic trends. Periods where the cumulative departure starts and ends near the long-term mean are often considered a "normal" cycle. This approach is appropriate to use where the hydrologic cycle is dominated by precipitation. However, agriculture in the Subbasin is primarily dependent on surface water supplies not precipitation. Surface water deliveries to the Subbasin is dominated by deliveries from the Kings River system. The Kings River is controlled by Pine Flat dam, so surface water deliveries on the Kings River do not necessary follow precipitation. For example, annual precipitation in the City of Hanford was 15.13 inches and 9.16 inches during 2010 and 2011, respectively. However, surface water deliveries from the Kings River were the reverse, at 706,100 AF and 1,037,100 AF during 2010 and 2011, respectively. Therefore, surface water deliveries from the Kings River were used to evaluate the long-term hydrology of the Subbasin.

Annual surface water deliveries from the Kings River system to the Subbasin for the period 1966 through 2016 were used to calculate the long-term average surface water deliveries of approximately 610,725 AF/yr. A plot of the annual surface water deliveries and cumulative departure shows that Kings River hydrology and associated water deliveries fluctuate widely depending upon snow pack and rainfall (Figure 3-52). The GSA records of monthly and annual surface water deliveries between 1990 and 2017 were utilized to develop a baseline period of "normal hydrology." The cumulative departure from average surface water deliveries shows, although the period between 1994 and 2016 starts and ends at the long-term mean, it would not be considered a "normal hydrology" period because it includes a part of an exceptional drought from 2012 to 2015 (Figure 3-52). Instead, a downward offset of the historical cumulative departure shows the 13-year period from 1998 through 2010 represents a period of "normal hydrology" cycle where the average is near the long-term mean (Figure 3-52). The 1998-2010 baseline period includes 1 average, 6 above-average, and 6 below-average surface water delivery years (Figure 3-52). The range of surface water flow during this period was 379,490 to 1,042,490 AF/yr, and averaged 642,100 AF/yr, which is above the 50-year average of 610,700 AF/yr and slightly above the ~50th percentile of 633,484 AF/yr.

3.3.7.2 Normal Hydrology Forecast Period

The 13-year "normal hydrology" cycle was slightly modified by substituting the 2000 Kings River surface water flow of about 777,870 AF/yr for the 2006 "wet year" Kings River surface water flow of about 1,042,500 AF/yr. This resulted in a 13-year baseline period where surface water deliveries averaged about 621,700 AF/yr, just slightly above the 50-year long-term average of 610,700 AF/yr, approximately 1.8% greater.

The resulting "normal hydrology" cycle was used to create a 54-year forecast of future Kings River hydrology from 2017 through 2070. When the forecast was constructed in mid-2018, 2017 was already a known "wet" year with about 170% of Kings River flow, and 2018 was the shaping up to be a relatively normal year. Hence the 2017-2070 forecast was constructed using 2011 and 2010 as analogs for the 2017 and 2018 hydrology. The 13-year "normal hydrology" cycle was then repeated four times to complete the 54-year forecast (Figure 3-52).

3.3.7.3 Climate Change

The DWR provides guidance on how to incorporate climate change into hydrology forecasts . There are two basic approaches that have been used to simulate climate change in water resource modeling: 1) transient analysis; and 2) climate period analysis (DWR 2018).

In a transient analysis, the climate change signal strengthens incrementally over time such as the way it has been occurring in recent decades. In general, years further into the future are warmer than years closer to the beginning of the simulation, and the most severe changes to climate tend to occur toward the later years of the simulation. In California, where monthly precipitation variability is extreme, transient analysis can be difficult to interpret. In a transient analysis, monthly variability can completely obscure the climate change signal because each year of the simulation has both monthly variability and a climate change signal, making it difficult to determine which is causing shifts in precipitation.

In a climate period analysis, climate change is modeled as a shift from a baseline condition, usually historically observed climate where every year or month of the simulation it is shifted in a way that represents the climate change signal at a future 30-year climate period. Climate period analysis provides advantages in this situation because it isolates the climate change signal independent of the monthly variability signal. In a climate period analysis, monthly variability is based on the reference period from which change is being measured, meaning that all differences between the future simulation and the reference period are the result of the climate change signal alone.

Climate period analysis was utilized to modify the 54-year forecast of "normal hydrology" to account for future climate change. The 2017-2070 forecast incorporates climate period analysis using the 2030 and 2070 monthly change factors (CNRA 2018) for each forecast analog month (Figure 3-52). The 2030 monthly change factors were applied to the forecast months January 2017 through December 2030. The 2070 monthly change factors were applied to the forecast months January 2031 through December 2070. There is a notable increase in magnitude of the 2070 change factors compared to the 2030 change factors.

A chart of forecast Kings River surface water deliveries shows a comparison of annual normal forecasts, annual normal forecast with climate change, and the difference in annual surface water deliveries between the with- and without-climate change forecasts (Figure 3-52; Figure 3-53). The figure shows future climate change will result in more Kings River flows in some years, and less flow in other years compared to the baseline conditions.

3.3.7.4 54-Year Forecast Hydrology with Climate Change

The climate change factors were also applied to 54-year forecasts of monthly inflows (effective precipitation, surface water deliveries, lake bottom storage, and canal and river seepage) and outflows (agricultural demand) for the "normal hydrology" forecast. The historical surface water deliveries used for the forecast were also modified to account for the transfer of some SWP contracts out of the Subbasin. Outflows due to agricultural demand were based on current cropping patterns and account for maturing of young permanent tree crops and the replanting of tree crops on a 25-year cycle (except pistachios, which have a life span approaching 100 years). This methodology allows for the fallowing and replanting of non-permanent crops due to historical response of available surface waters.

Municipal and domestic groundwater pumping are estimated upward based on projected population growth at an annual rate of 0.03%.

3.4 Management Areas

23 CCR §354.20(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. (b) basin that includes one or more management areas shall describe the following in the Plan:*

(1) The reason for the creation of each management area.

(2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.

(3) The level of monitoring and analysis appropriate for each management area.

> *(4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.*
> *(c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.*

In order to facilitate implementation of the GSP, management areas have been created for the Subbasin. There are five Primary Management Areas and two Secondary Management Areas. Each of these types of management areas are described in the following sections.

3.4.1 Primary Management Areas

Primary Management Areas have been formed from each of the five GSAs. (Figure 3-54). The formation of Primary Management Areas will facilitate data management and efficiently implement and manage the GSP. Furthermore, each GSA has unique surface water and groundwater allocations and usage, and they are best positioned to develop BMPs and development of groundwater sustainability projects.

Minimum thresholds and measurable objectives developed for each GSA management area described in Chapter 4 will be based on the groundwater conditions within each individual GSA management area.

Groundwater data collected from each GSA will be entered into a Data Management System (DMS) to facilitate analysis of measurable objectives (MOs) and undesirable results. A groundwater model has been developed for the Subbasin and adjacent areas to assist sustainable groundwater management in and between individual GSAs. Each GSA will coordinate with adjacent GSAs and adjacent subbasins to monitor within the San Joaquin Valley Basin (Basin) if undesirable results in the adjacent managements areas are being contributed to by activities within that GSAs management area, The GSAs will coordinate corrective action, if necessary.

3.4.2 Secondary Management Areas

Two Secondary Management Areas have been formed for the Subbasin. These two Secondary Management Areas are different from the Primary Management Areas and each other due to distinctly different groundwater conditions in each area. These two areas are the Clay Plug (Management Area A) and the Southwest Poor Quality Groundwater Secondary Management Area (Management Area B).

3.4.2.1 Clay Plug

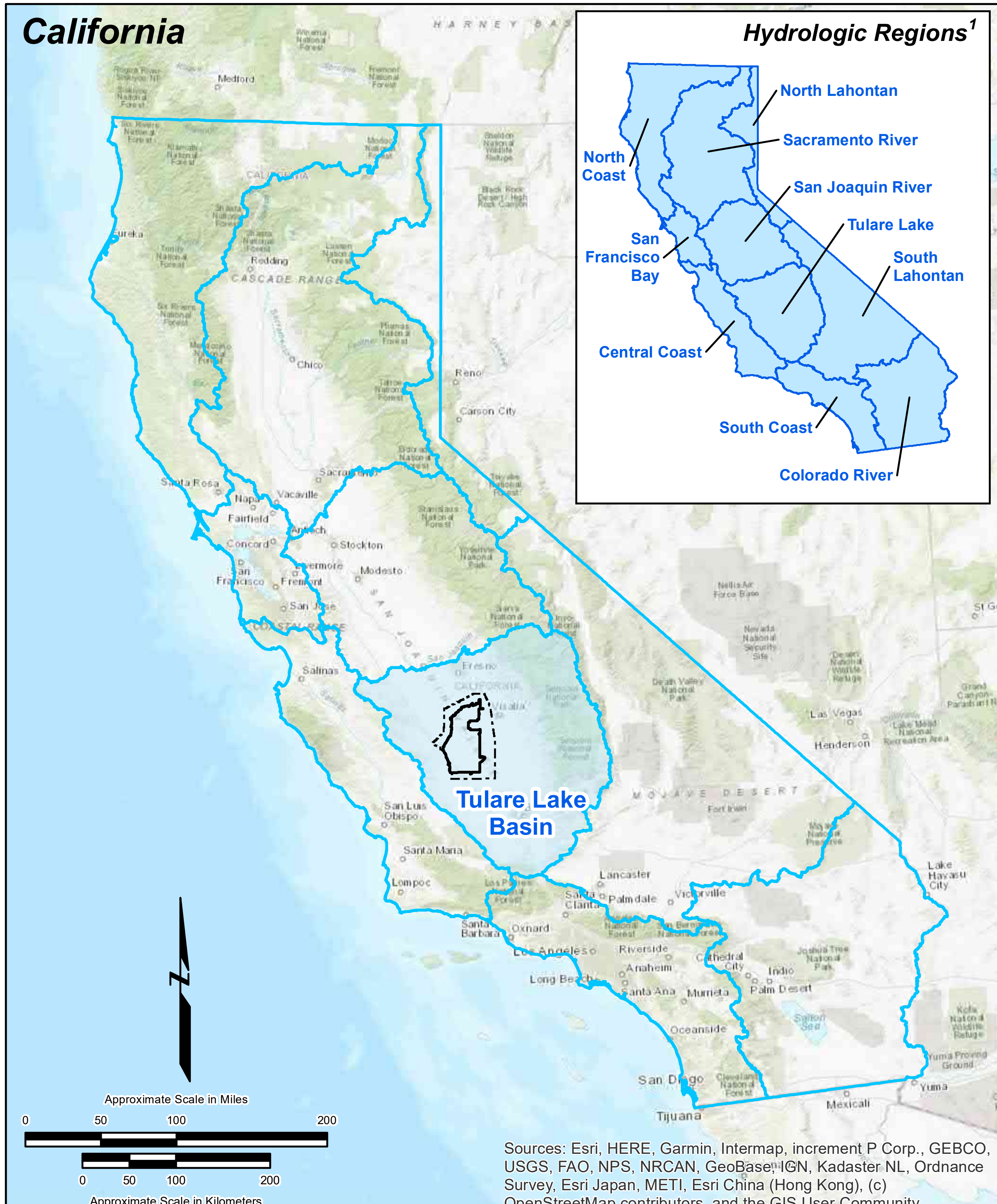
The Tulare Lake clay beds are one of the most significant controlling factor for groundwater movement in the Subbasin. The center of the Tulare Lake deposition is made up of continuous lacustrine deposits extending like a tap root through the interior portions of the lakebed to the top of the San Joaquin Formation, which is 2,600 to 3,000 feet bgs (Figures 3-14a-c). The area with continuous lacustrine sediments from the surface to the underlying San Joaquin Formation is roughly 23 miles long by 12 miles wide. These sediments of continuous lacustrine deposits is called the clay plug. The clay plug does not transmit groundwater and is a hydrologic “dead” zone. As such, the area has never been developed for groundwater extraction.

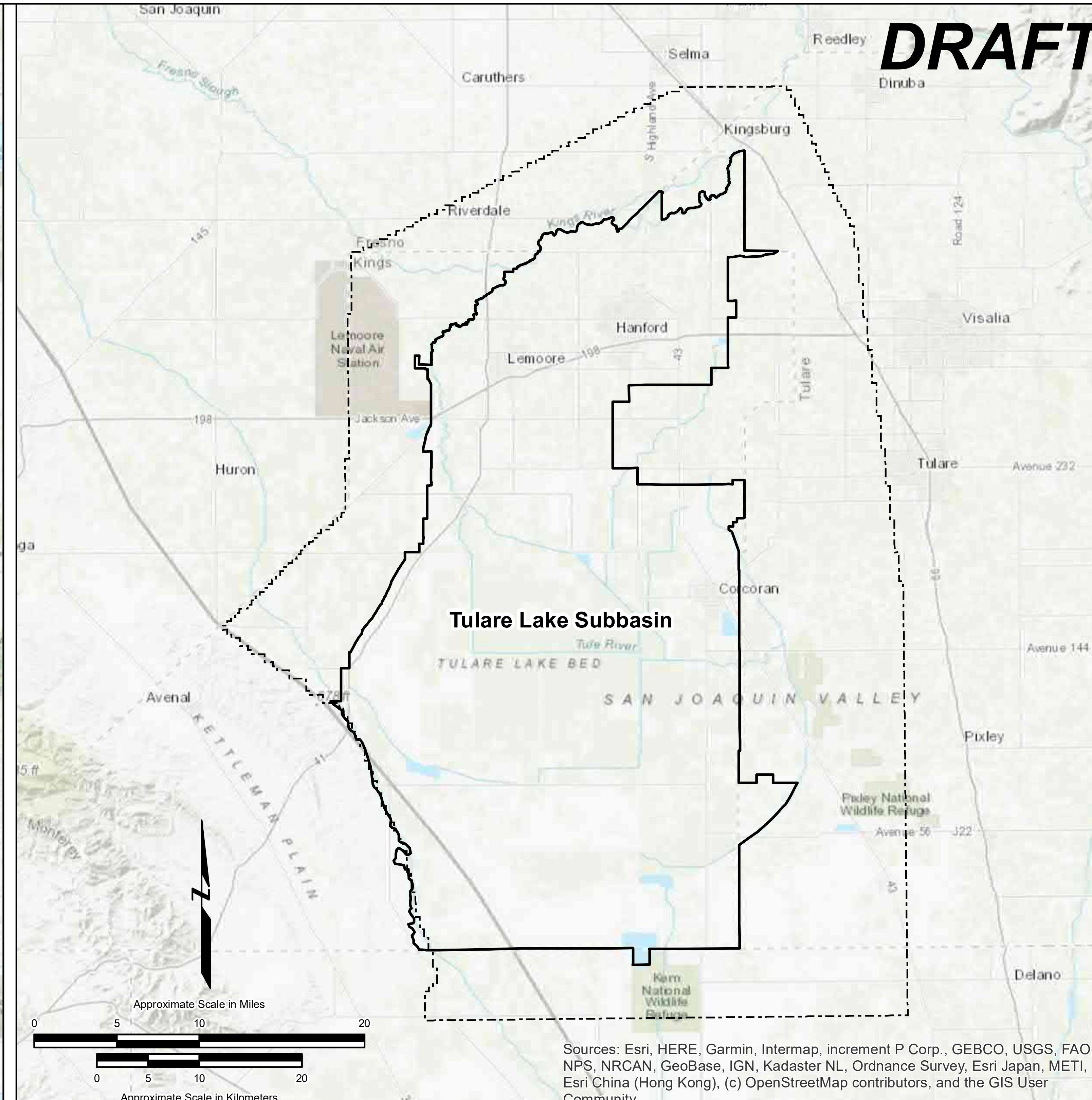
Because this area, due to its historical depositional environment, is isolated from the regional groundwater flow regime in the Subbasin, it is being treated differently than other areas for monitoring purposes and the establishment of compliance points.

3.4.2.2 Southwest Poor Quality Groundwater

As described in Section 3.2.5, and shown on Figure 3-30, groundwater in the southwest corner of the Subbasin contains elevated TDS concentrations. The groundwater in this area is of such poor water quality, that there are no water supply wells in the area.

Because of the poor groundwater quality in this area, and the lack of water supply development, it is being treated differently than other areas for monitoring purposes and the establishment of compliance points.





Explanation

- Hydrologic region
- Subbasin boundary
- Study Area

Note:
1) Hydrologic region dataset obtained from California Department of Water Resources (CA DWR), September 12, 2018.
https://data.ca.gov/dataset/hydrologic-regions

Site Location Map
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-1**

Date: 8/20/2019 Printed by: elizabeth.chapman
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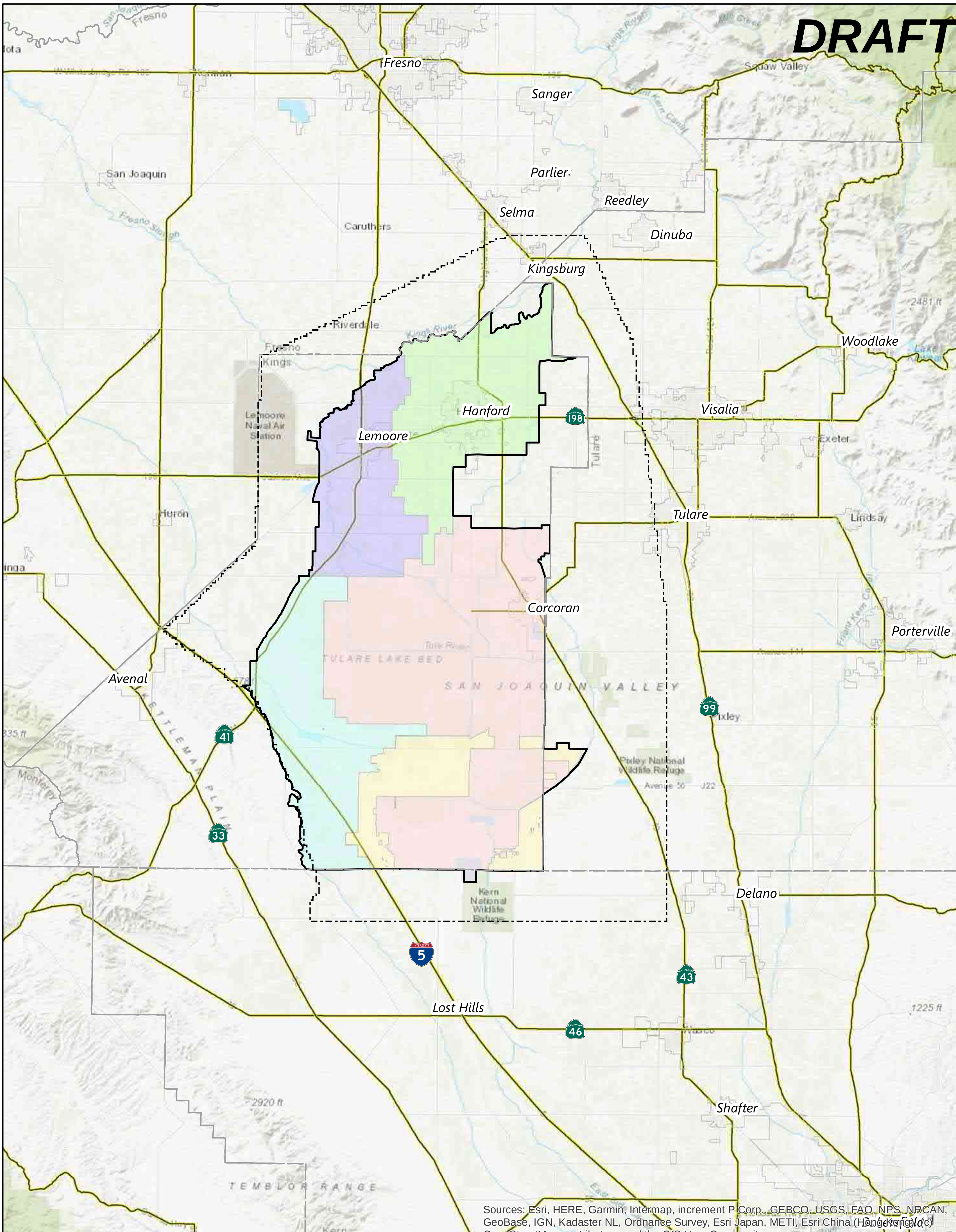
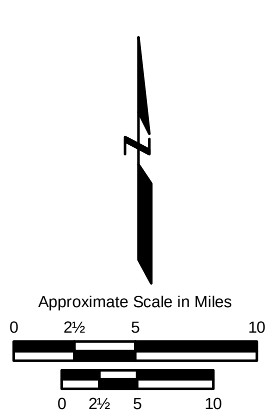


Explanation

- Study Area
- Subbasin boundary
- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority



Groundwater Sustainability Agencies in Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-2**

Date: 8/20/2019 Printed by: elizabeth.chapman
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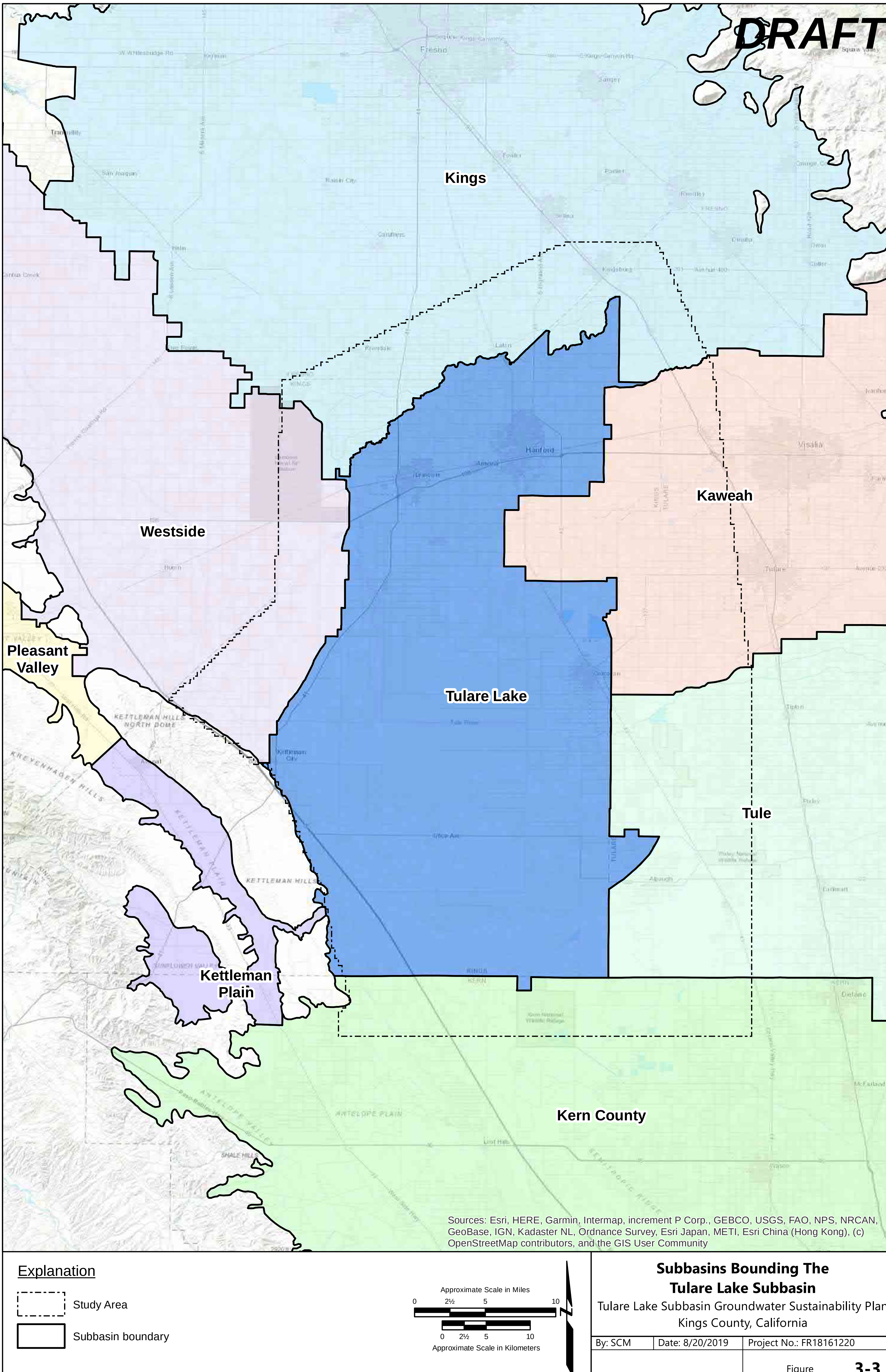

Subbasins Bounding The Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-3**

Date: 8/20/2019 Printed by: elizabeth.chapman
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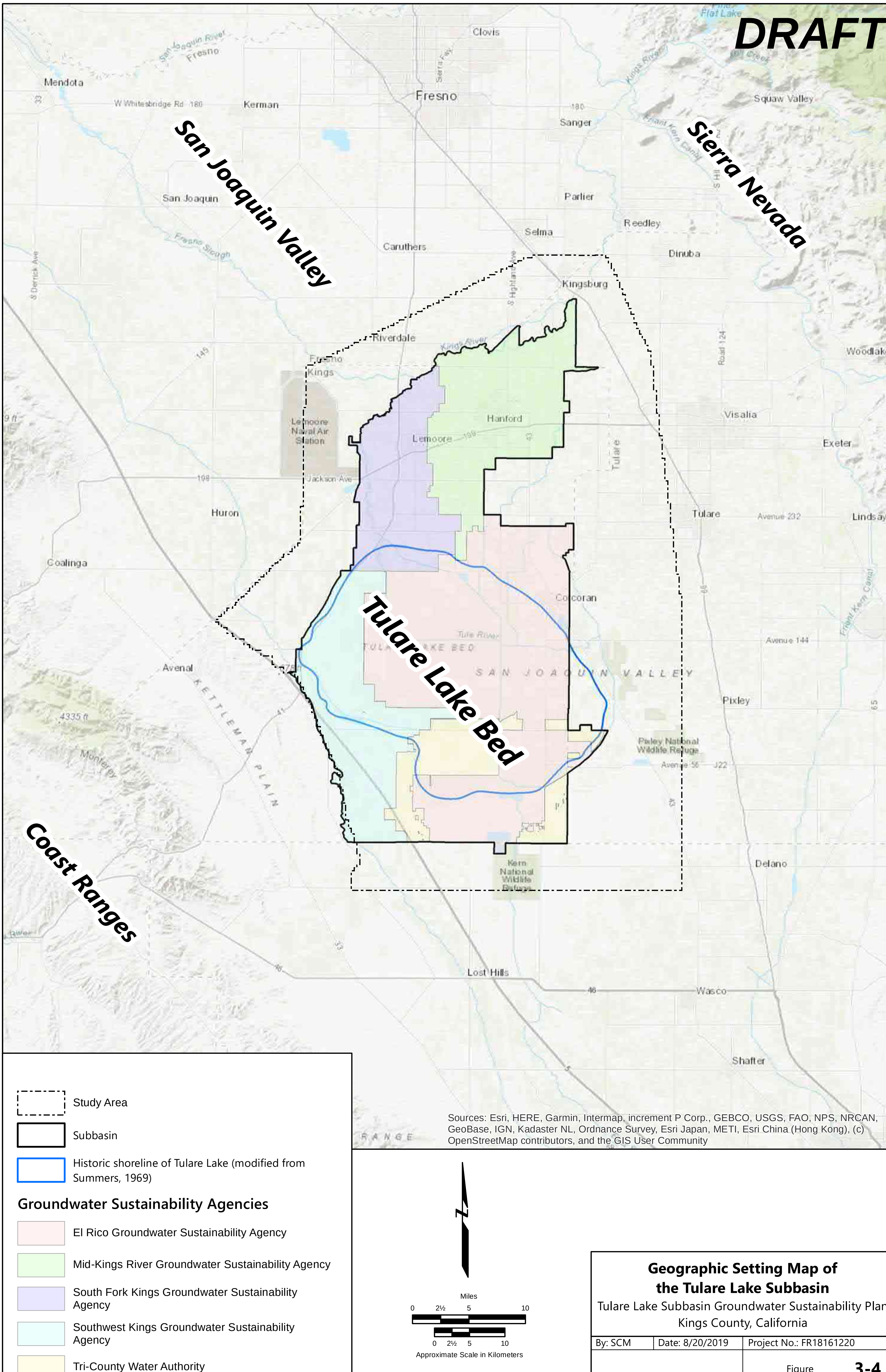

Geographic Setting Map of the Tulare Lake Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 8/20/2019	Project No.: FR18161220
		Figure 3-4

Date: 8/20/2019 Printed by: elizabeth.chapman
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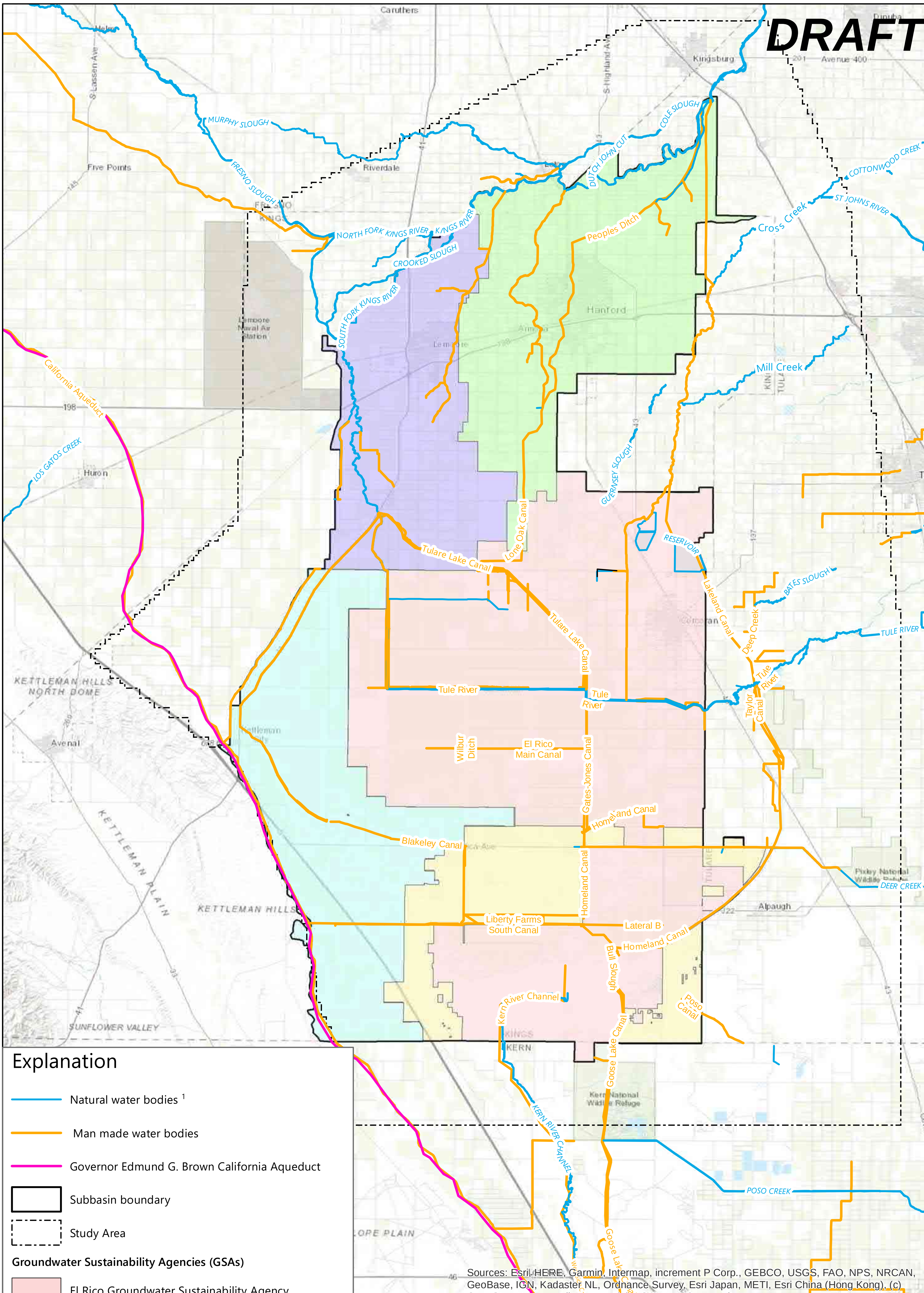

Explanation

- Natural water bodies [1]
- Man made water bodies
- Governor Edmund G. Brown California Aqueduct
- Subbasin boundary
- Study Area

Groundwater Sustainability Agencies (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Approximate Scale in Miles: 0 2 4 8
Approximate Scale in Kilometers: 0 2 4 8

Notes:
1)All surface water data taken from the National Hydrography Dataset. USGS 2016.

Surface Water System
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-5**

Date: 8/20/2019 Printed by: elizabeth.chapman
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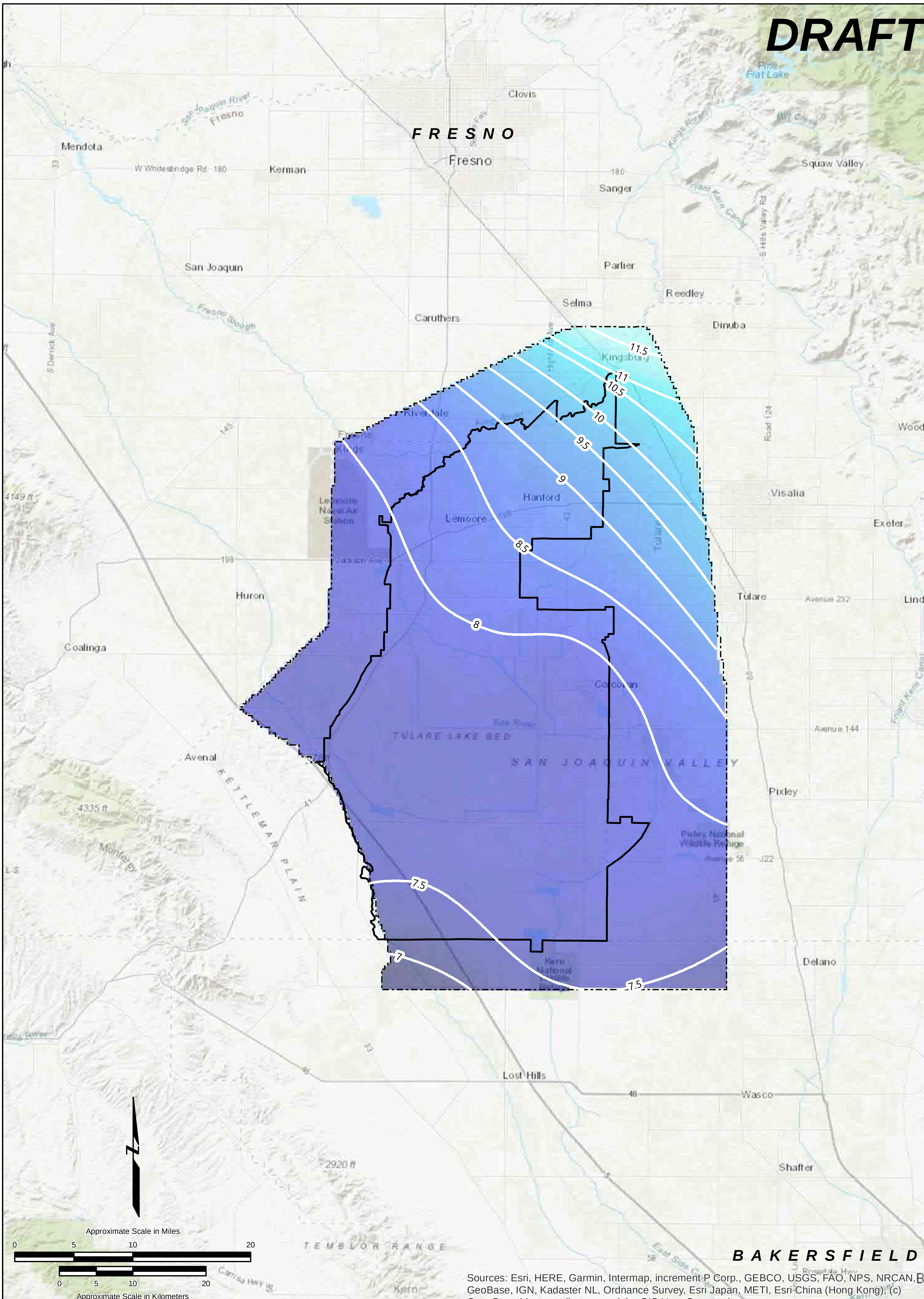


Explanation

Subbasin boundary

Study Area

Annual precipitation contours, 0.5 inch

Higher annual precipitation

8.5

Lower annual precipitation

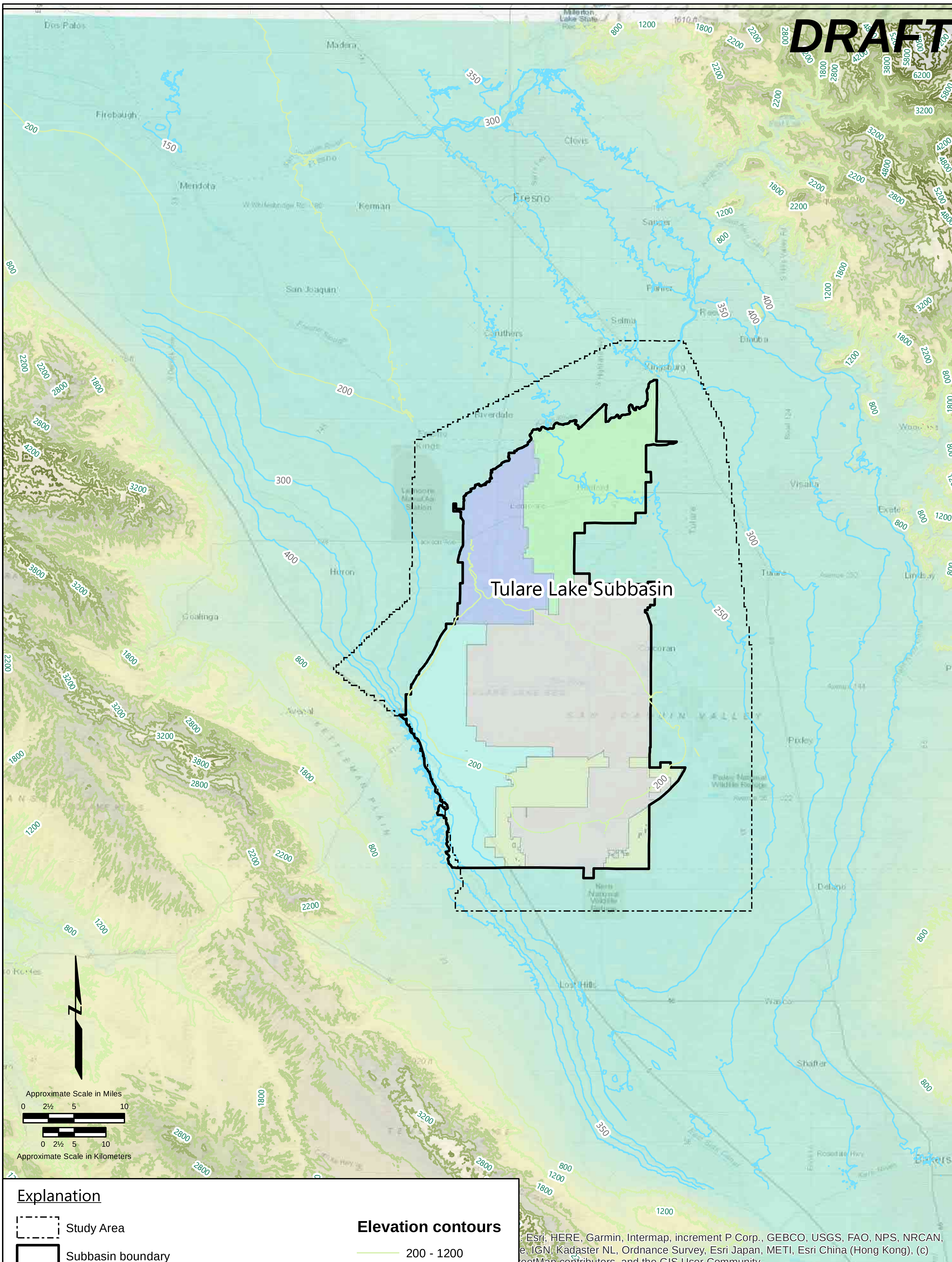
Notes:

1) PRISM climate group, Oregon State University, http://prism.oregonstate.edu, October 2018, (Prism, 2018)

Annual Precipitation Distribution Isohyetal Contour Map 1981-2010 30-year Normal

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-6**



Explanation

- Study Area
- Subbasin boundary
- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Elevation (feet above mean sea level)

High : 9000

Low : 0

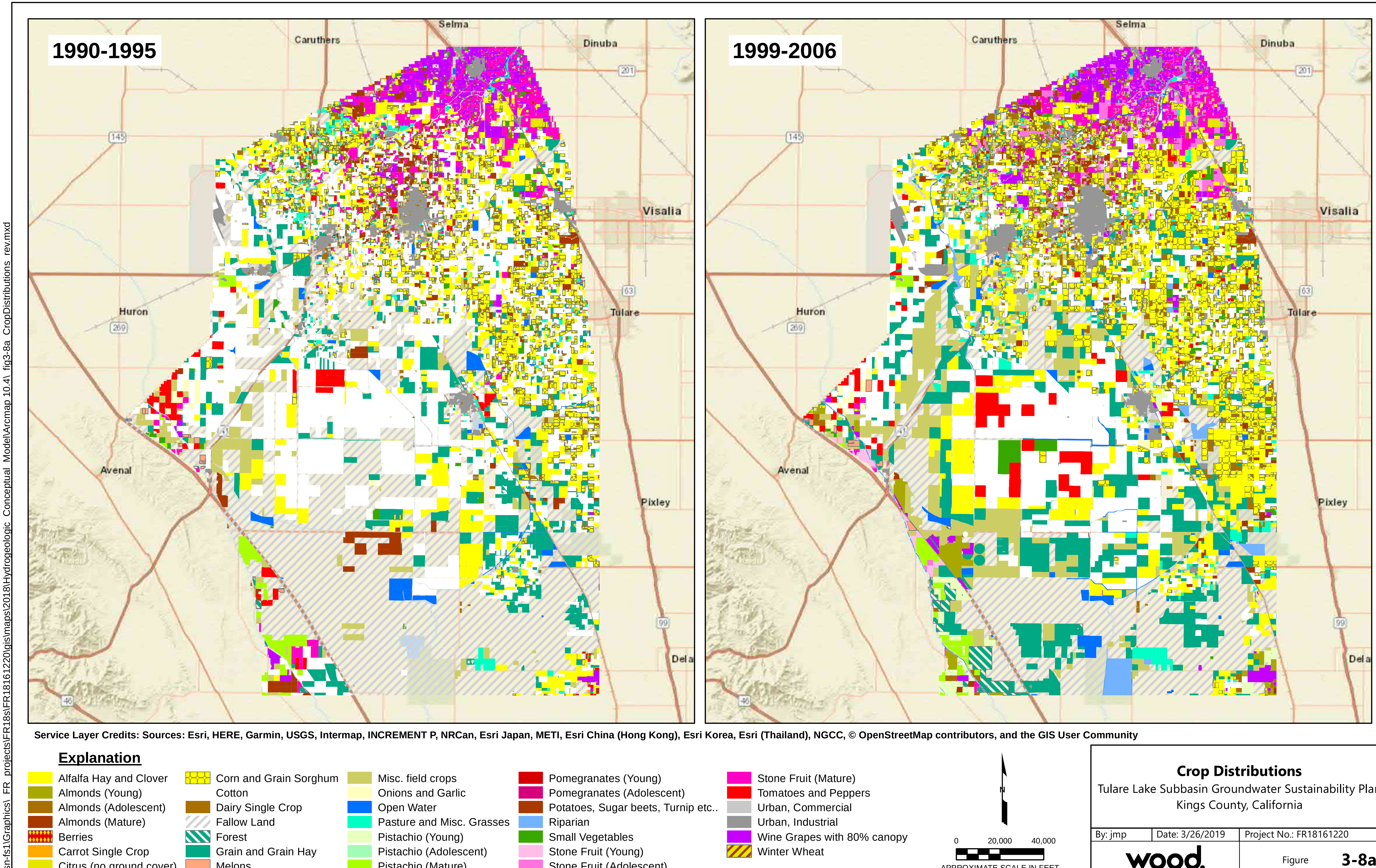
Elevation contours

- 200 - 1200
- 1201 - 2200
- 2201 - 3200
- 3201 - 4200
- 4201 - 6200
- 6201 - 8000
- **50ft elevation contour**

Topographic Map of the Tulare Lake Subbasin

Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: SCM	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-7**



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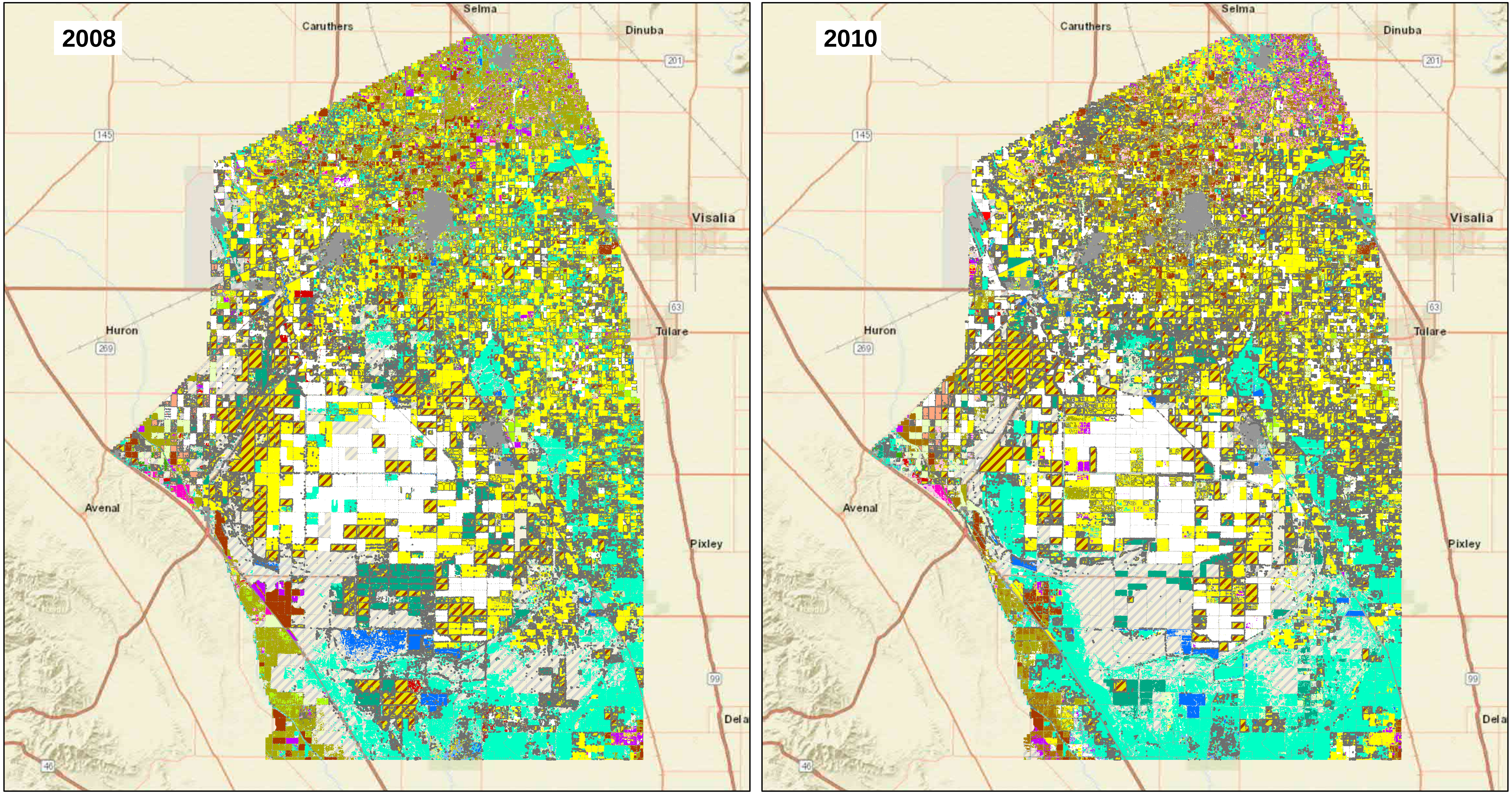

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

N

0 20,000 40,000

APPROXIMATE SCALE IN FEET

Crop Distributions

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: jmp	Date: 3/26/2019	Project No.: FR18161220
wood.	Figure	3-8b

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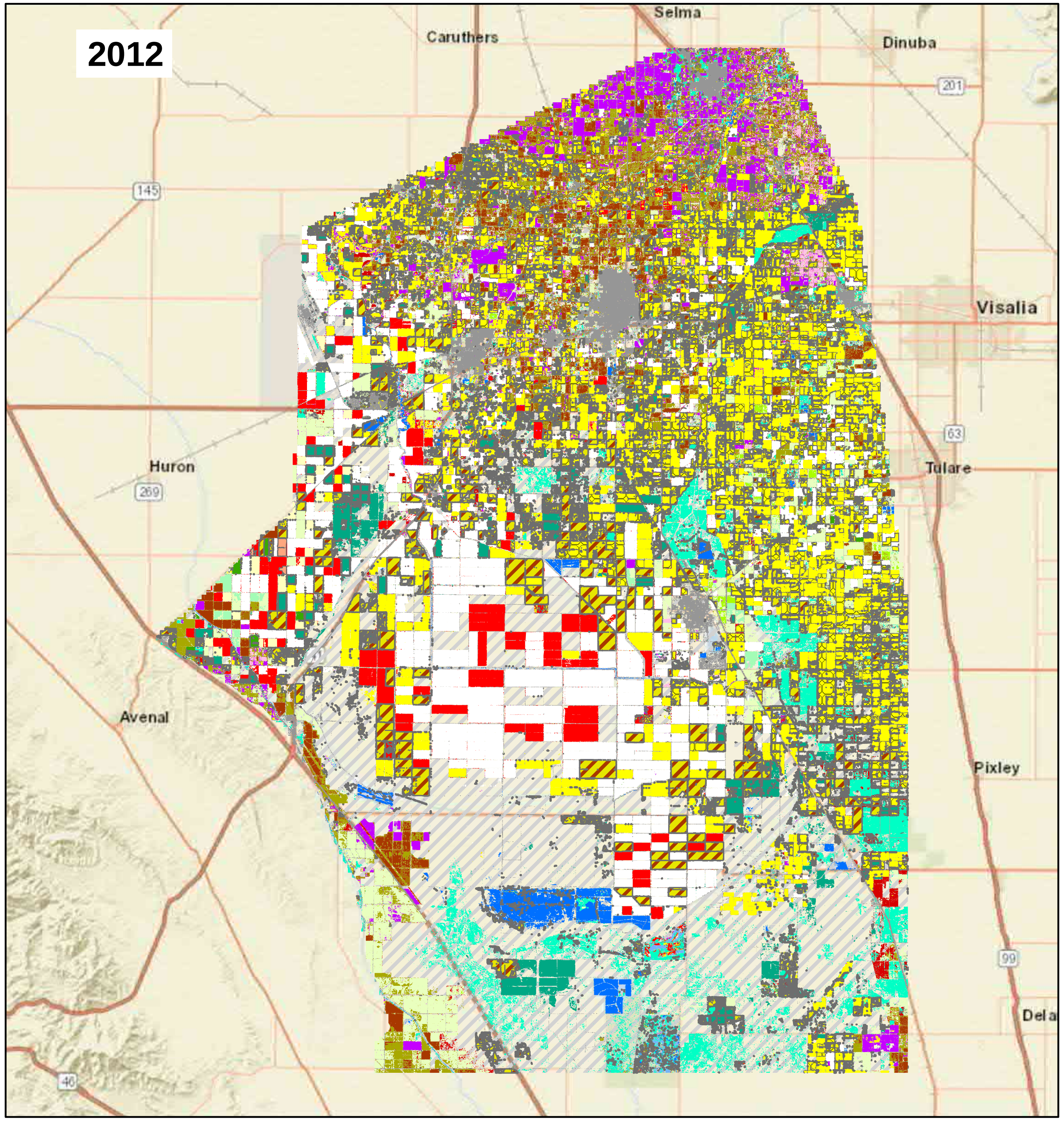
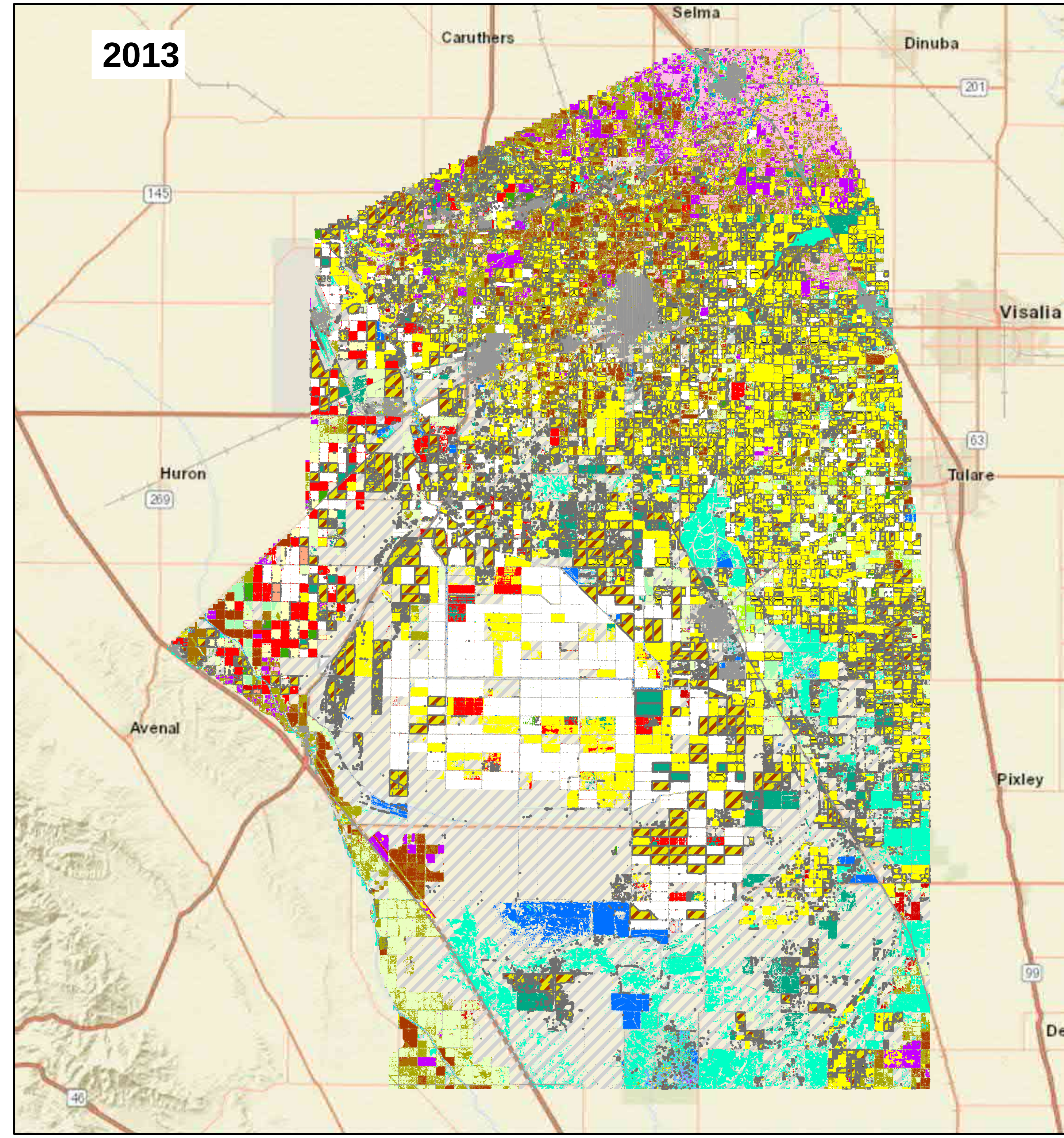




Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

N

0 20,000 40,000

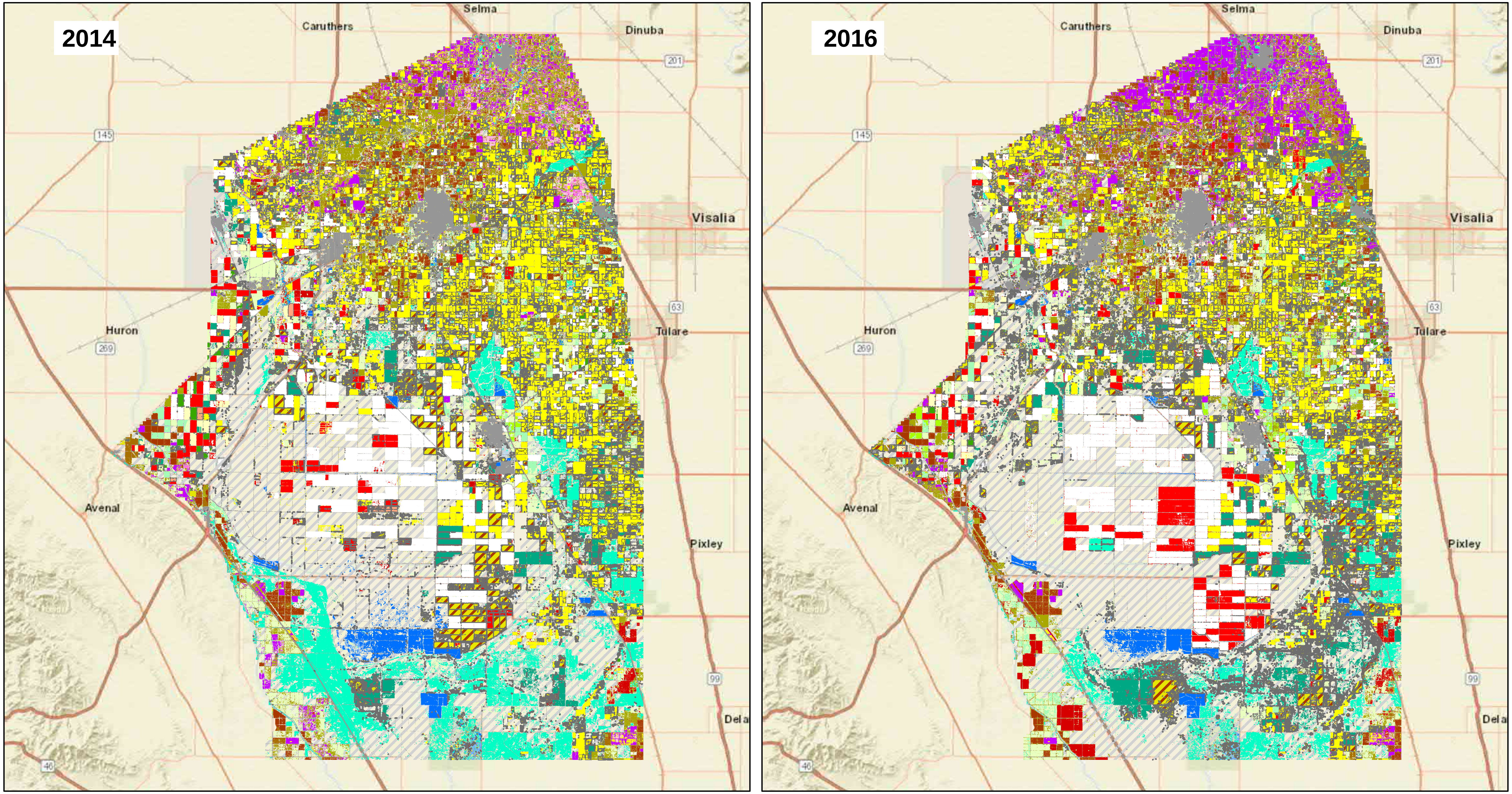
APPROXIMATE SCALE IN FEET

Crop Distributions

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: jmp	Date: 3/26/2019	Project No.: FR18161220
wood.	Figure	3-8c

\\fsn-fs1\Graphics_FR_projects\FR18s\FR18161220\gis\maps\2018\Hydrogeologic_Conceptual_Model\Arcmap 10.4_fig3-8c_CropDistributions_rev.mxd



Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

N

0 20,000 40,000

APPROXIMATE SCALE IN FEET

Crop Distributions

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

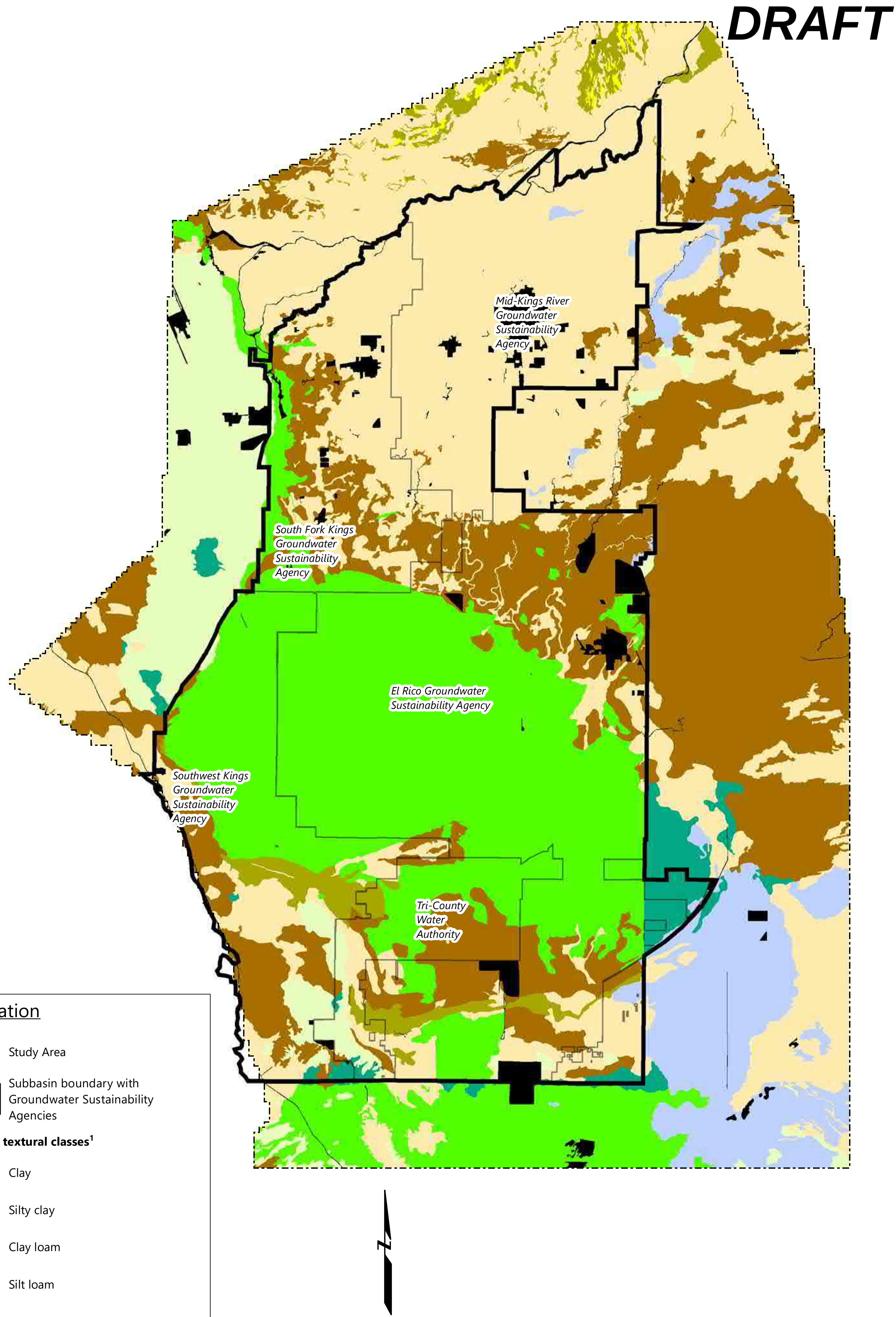
By: jmp | Date: 3/26/2019 | Project No.: FR18161220

wood.

Figure **3-8d**

\\fsn-fs1\Graphics_FR_projects\FR18s\FR18161220\gis\maps\2018\Hydrogeologic_Conceptual_Model\Arcmap 10.4_fig3-8d_CropDistributions_rev.mxd

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-9_SoilCharacteristics_Texture.mxd



Explanation

Study Area

Subbasin boundary with Groundwater Sustainability Agencies

USDA soil textural classes[1]

Clay

Silty clay

Clay loam

Silt loam

Loam

Sandy loam

Loamy sand

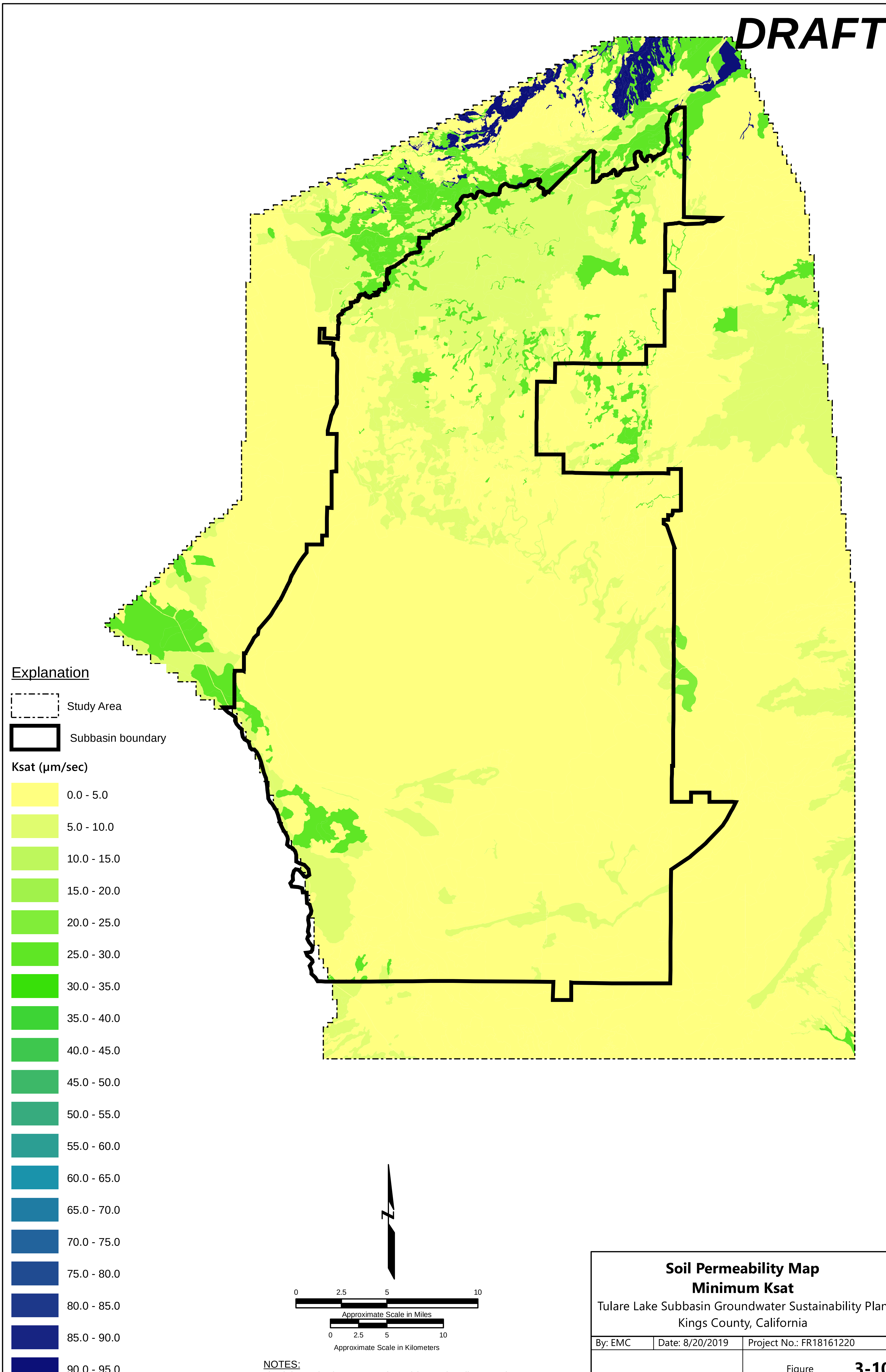
Sand

Soil data unavailable

NOTES:
1) Soil texture data adapted from:
Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database. Available online at https://sdmdataaccess.sc.egov.usda.gov. Accessed July 25, 2018.

Soil Texture Map
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

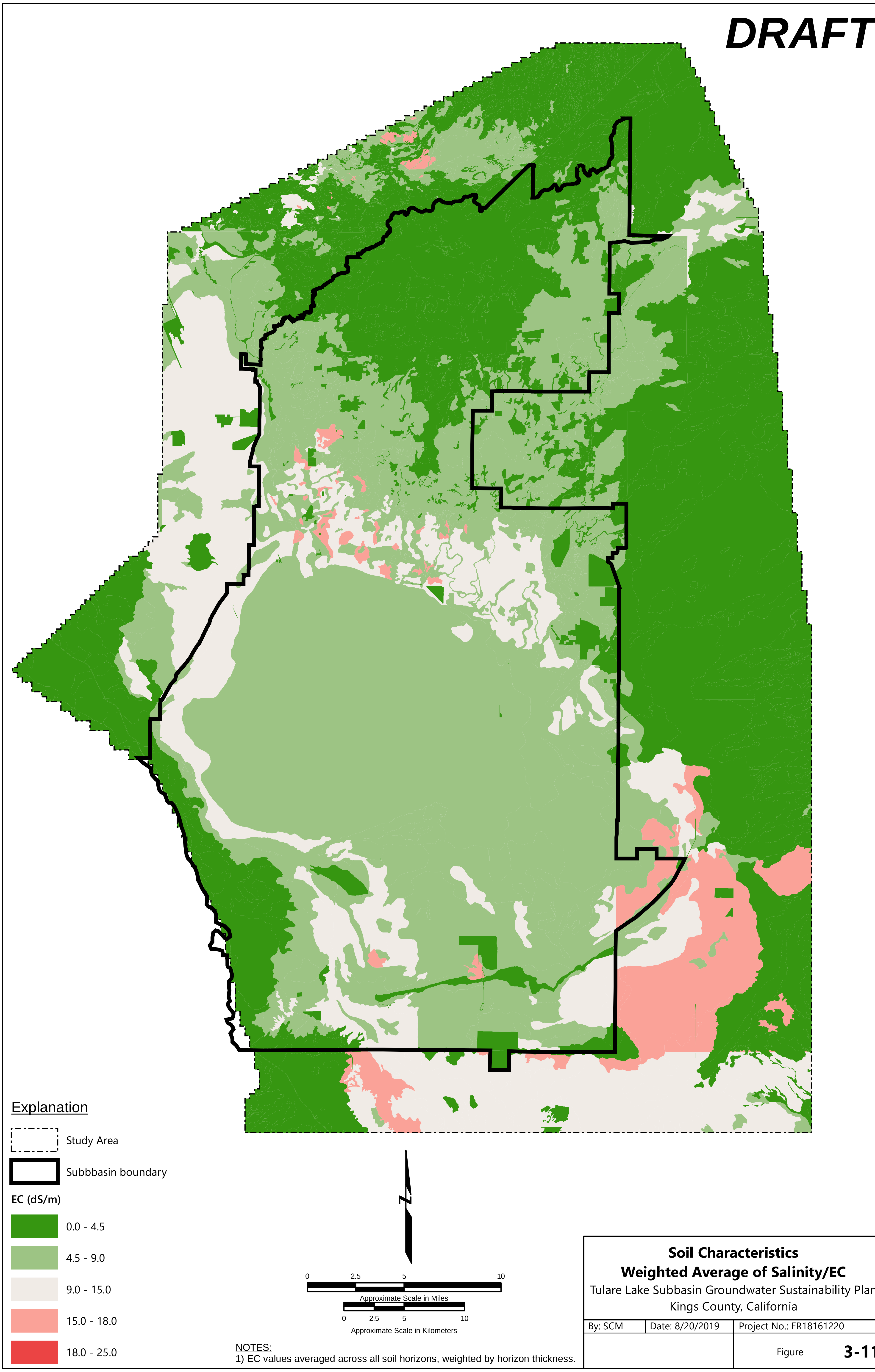
By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-9**



NOTES:
1) Minimum horizon Ksat selected for each soil map unit.

Soil Permeability Map
Minimum Ksat
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

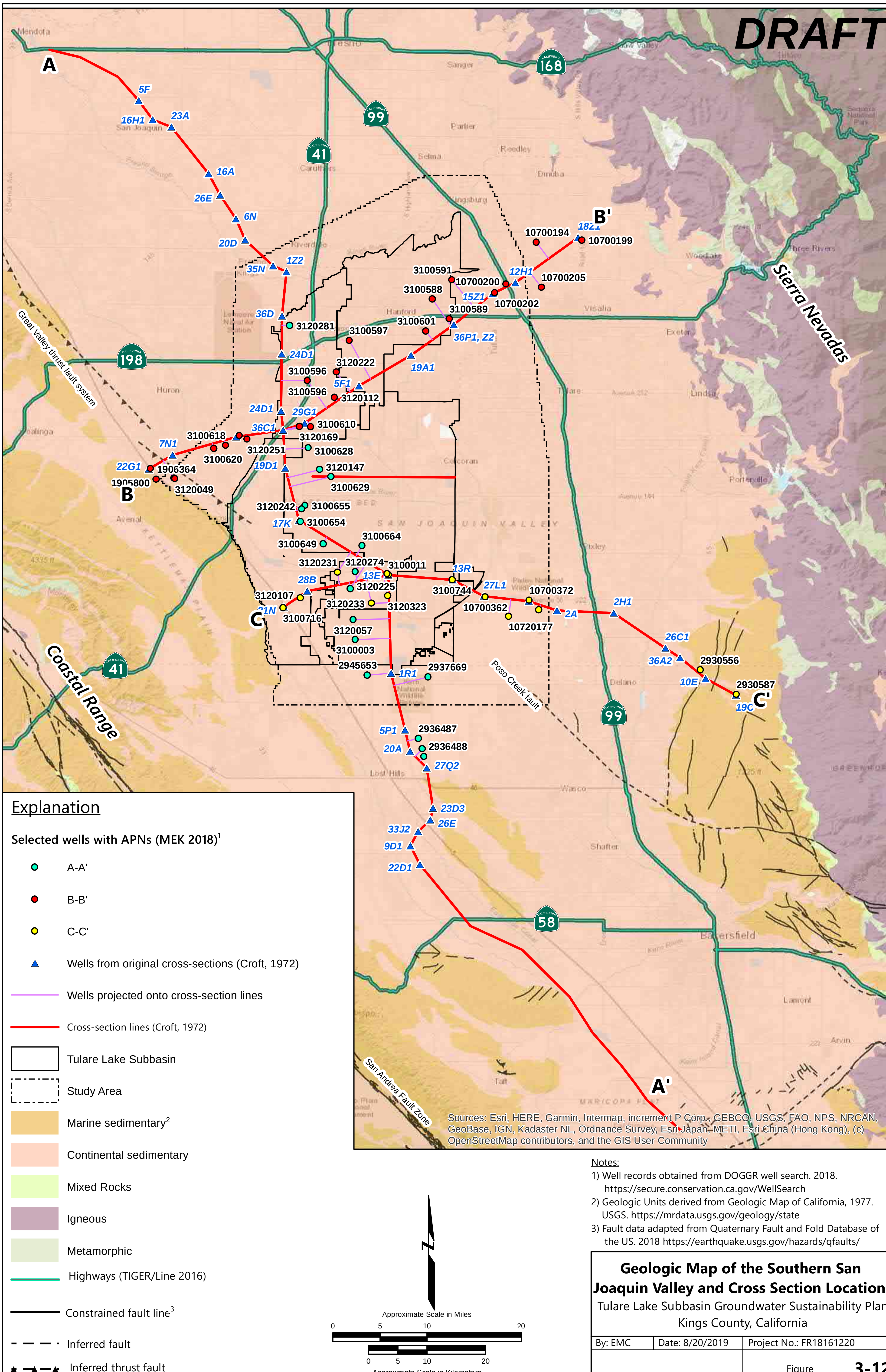
By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-10**



NOTES:
1) EC values averaged across all soil horizons, weighted by horizon thickness.

Soil Characteristics
Weighted Average of Salinity/EC
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-11**

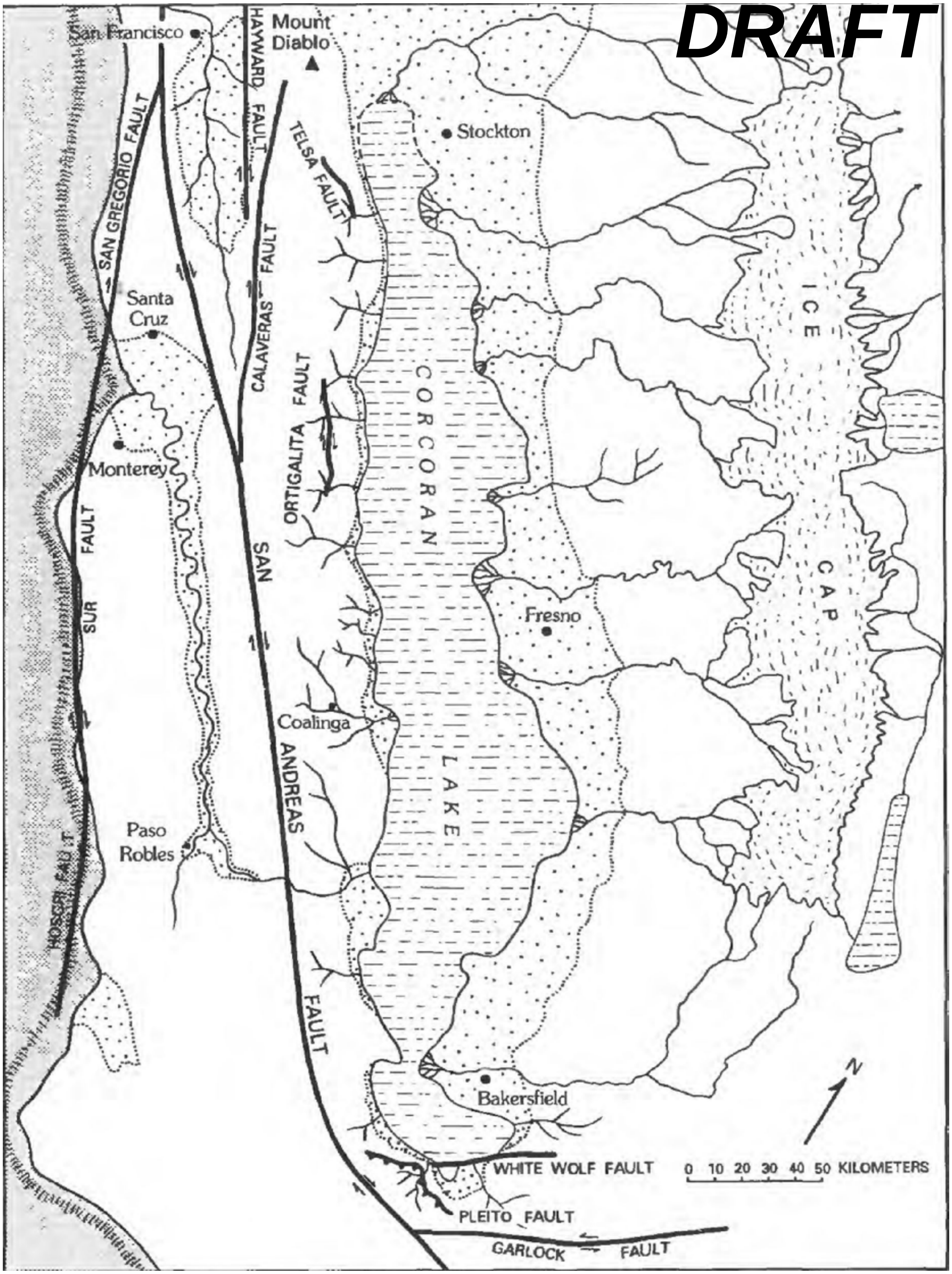


Notes:
1) Well records obtained from DOGGR well search. 2018. https://secure.conservation.ca.gov/WellSearch
2) Geologic Units derived from Geologic Map of California, 1977. USGS. https://mrdata.usgs.gov/geology/state
3) Fault data adapted from Quaternary Fault and Fold Database of the US. 2018 https://earthquake.usgs.gov/hazards/qfaults/

Geologic Map of the Southern San Joaquin Valley and Cross Section Locations

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-12**



Pleistocene Extent of Corcoran Lake

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-13**

Note:
1) Adapted from Figure 13 of Bartow (1991).

Date: 8/20/2019 Printed by: elizabeth.chapman
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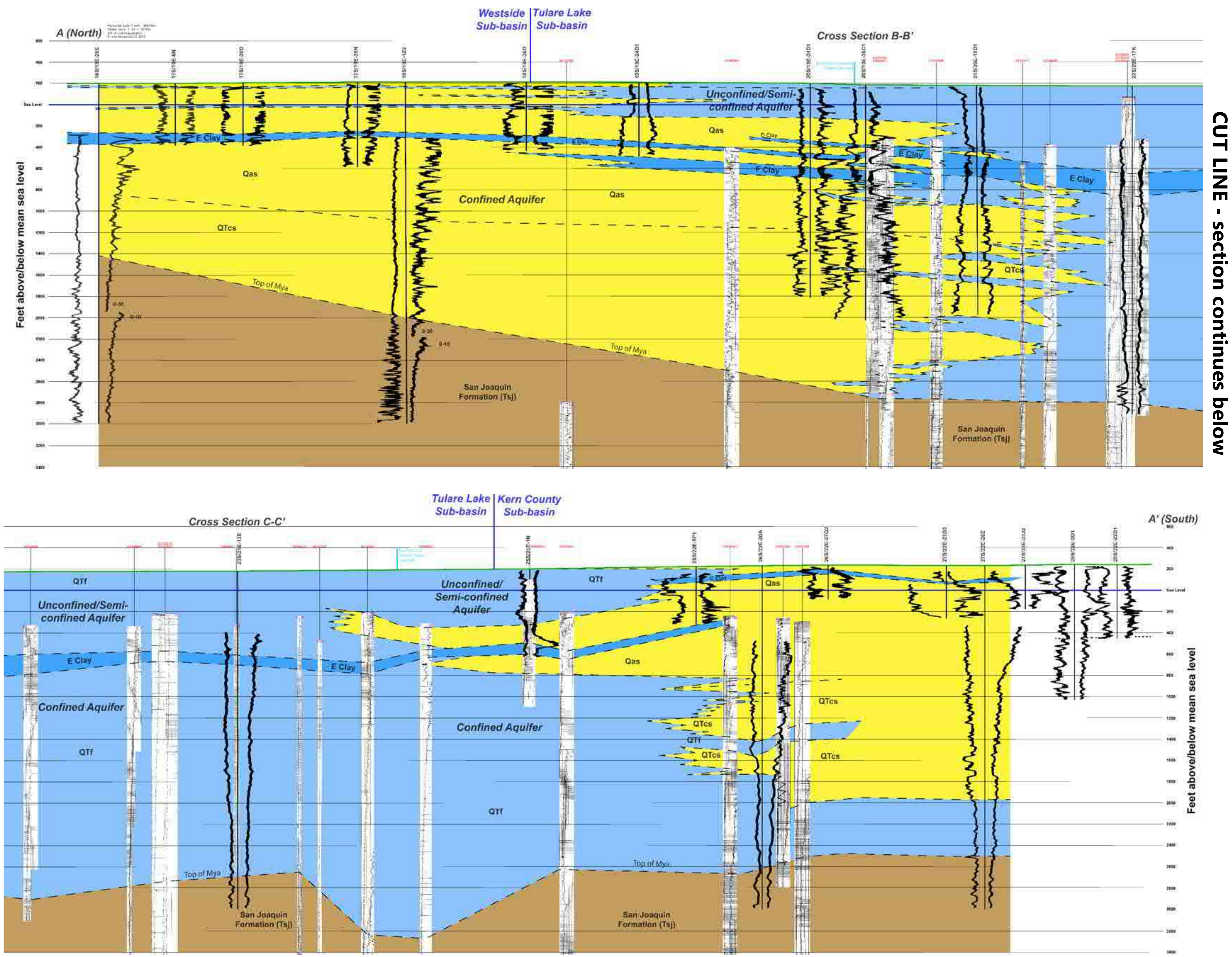


Explanation

	Coarse-grained alluvium / Tulare Formation
	San Joaquin Formation
	Alluvium / Tulare Formation lacustrine sediments
	Regional clay marker beds as defined by Croft (1972)
25S/21E-1N	CA DWR well name
03120281	CA DOGGR well APN
0 30	Electric log resistivity scale (ohmmeters)

Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

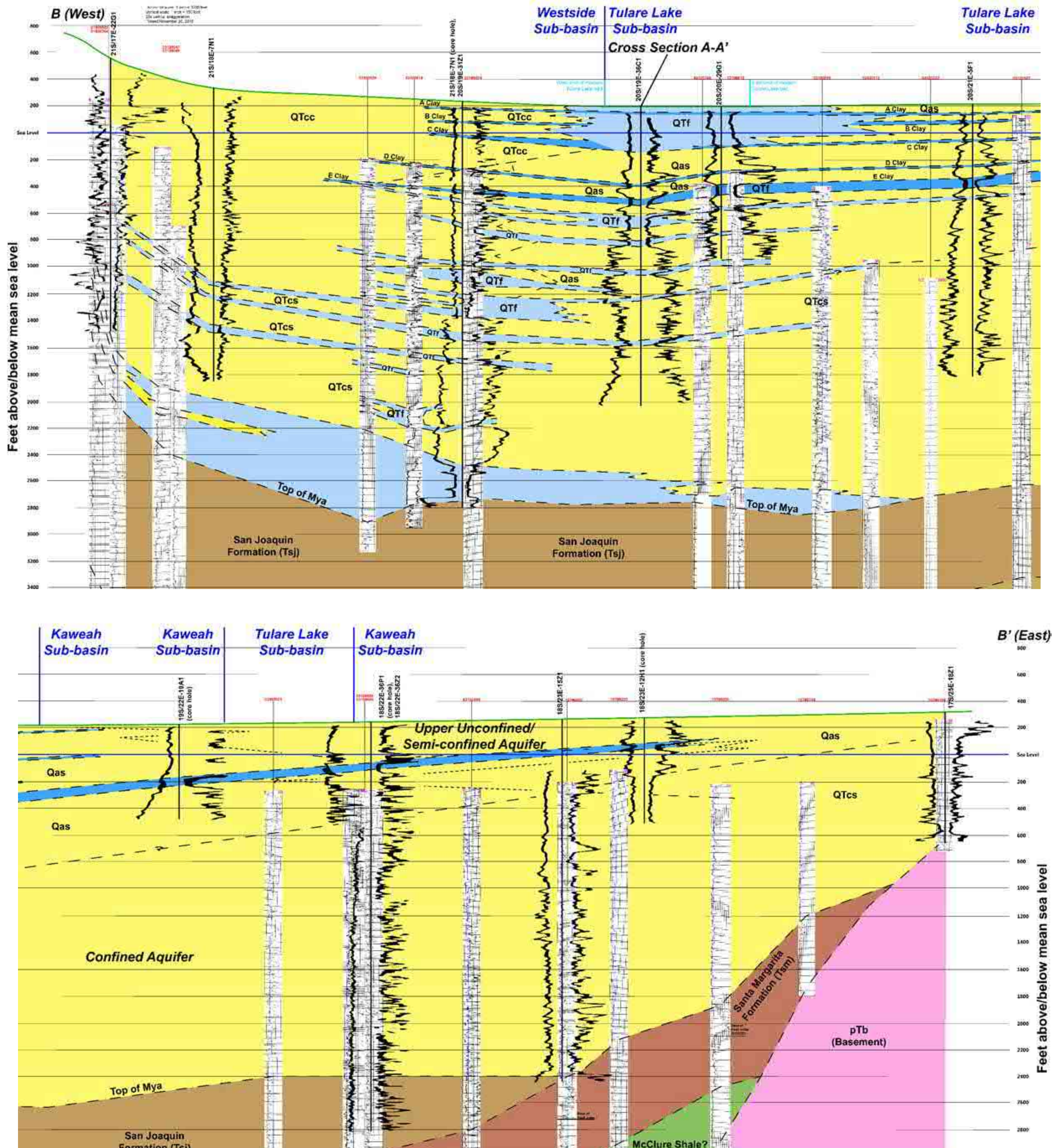
Cross Section A-A'
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings county, California

By: EMC | Date: 8/20/2019 | Project No.: FR18161220

Figure **3-14a**

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-14a_xsecA-A'.mxd

DRAFT



Explanation

- Coarse-grained alluvium / Tulare Formation
- San Joaquin Formation
- Etchegoin Formation
- Santa Margarita Formation
- Alluvium / Tulare Formation lacustrine sediments
- Regional clay marker beds as defined by Croft (1972)
- Crystalline basement
- **25S/21E-1N** CA DWR well name
- **03120281** CA DOGGR well APN
- **0 30** Electric log resistivity scale (ohmmeters)

Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

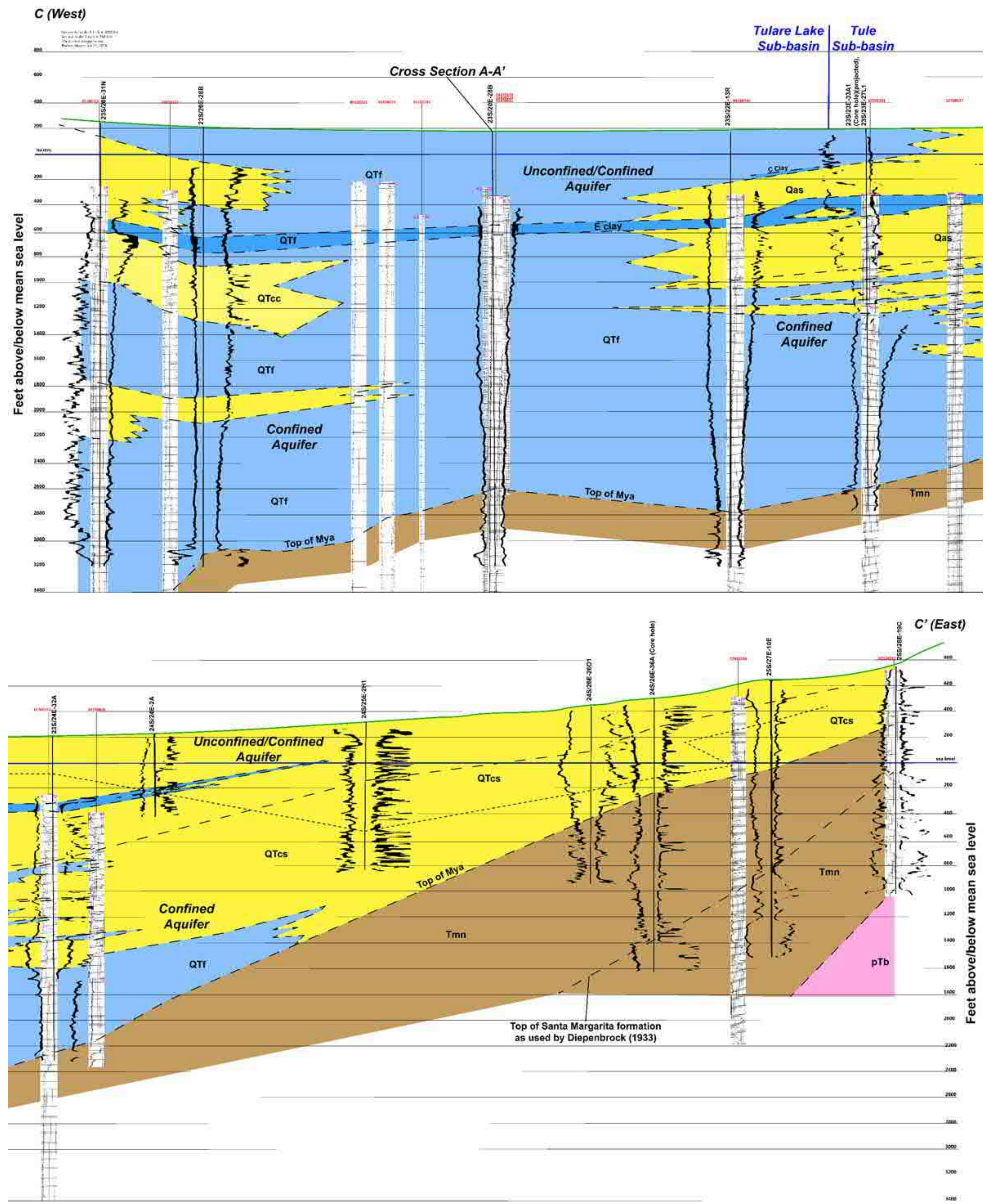
Cross Section B-B'

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-14b**

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-14b_xsecB-B'.mxd

DRAFT



Explanation

(yellow)	Coarse-grained alluvium / Tulare Formation
(brown)	San Joaquin Formation
(light blue)	Alluvium / Tulare Formation lacustrine sediments
(blue)	Regional clay marker beds as defined by Croft (1972)
(pink)	Crystalline basement
25S/21E-1N	CA DWR well name
03120281	CA DOGGR well APN
0 30	Electric log resistivity scale (ohmmeters)

Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

Cross Section C-C'
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC | Date: 8/20/2019 | Project No.: FR18161220

Figure **3-14c**

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-14c_xsecC-C'.mxd

Date: 8/20/2019 Printed by: elizabeth.chapman
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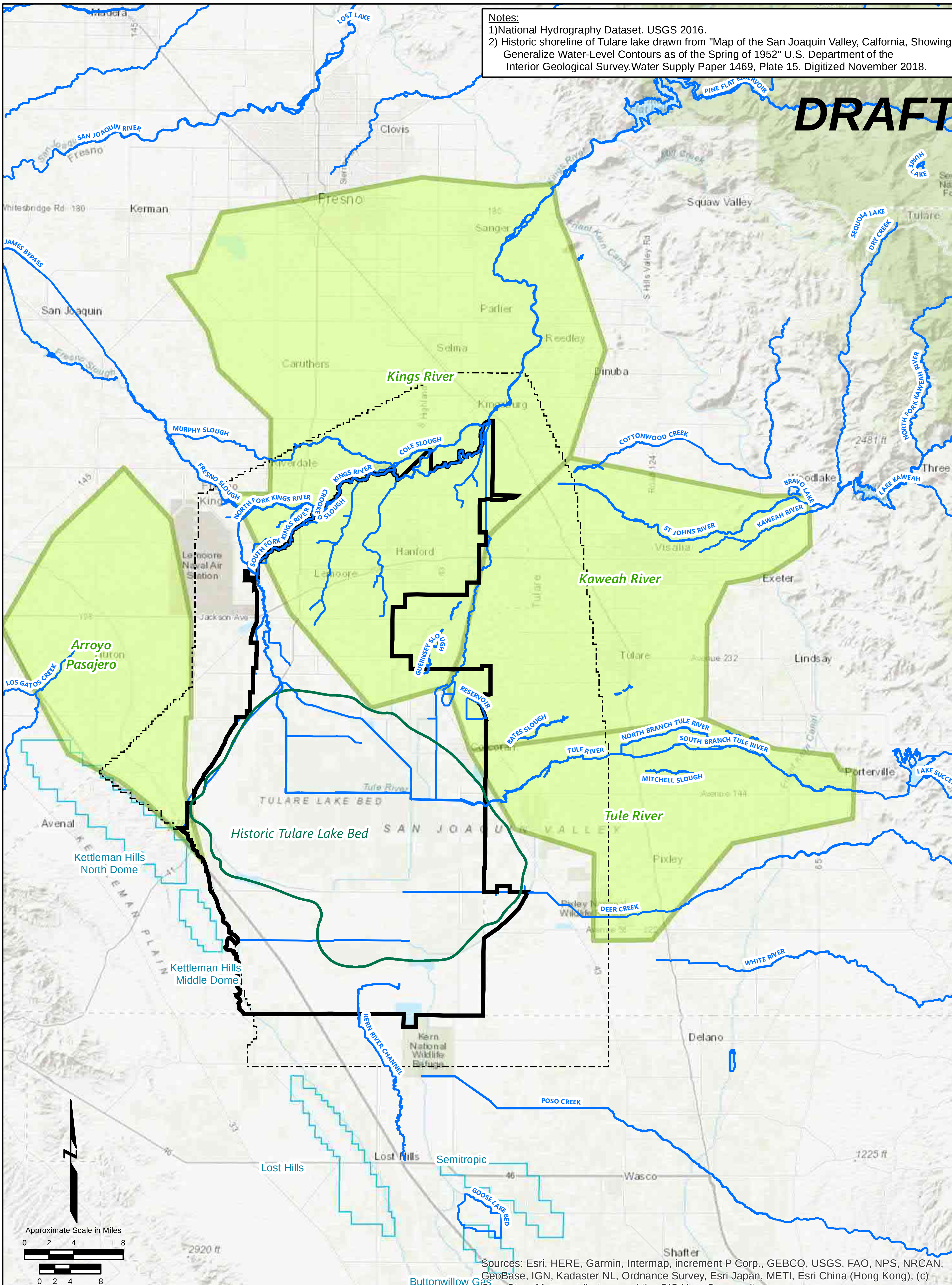


Explanation

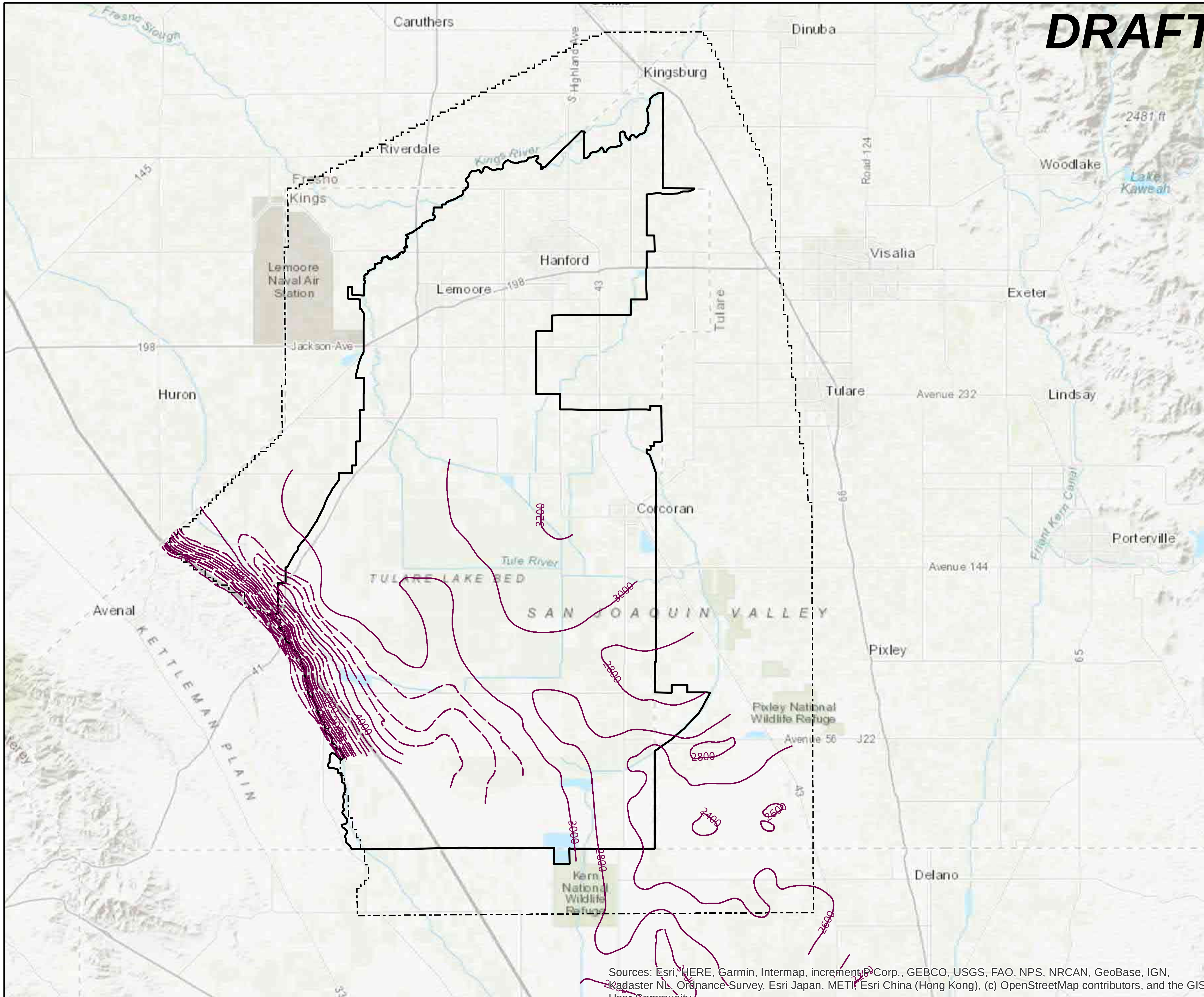
- NHD natural water bodies[1]
- Study Area
- Subbasin boundary
- Historic shoreline of Tulare Lake(modified from Summers, 1969)
- Alluvial fans (modified from Davis, 1959)
- DOGGR Oil and Gas Fields

Notes:
1)NHD= National Hydrography Dataset. USGS 2016.

Depositional Environments in the Tulare Lake Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220

Figure **3-15**



Explanation

Study Area

Boundary of Tulare Lake Subbasin

Note:
1) Adapted from Plate 1 of Page (1983).

Map of Equal Depth to Base of Tulare Formation

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure 3-16

Date: 8/20/2019 Printed by: elizabeth.chapman
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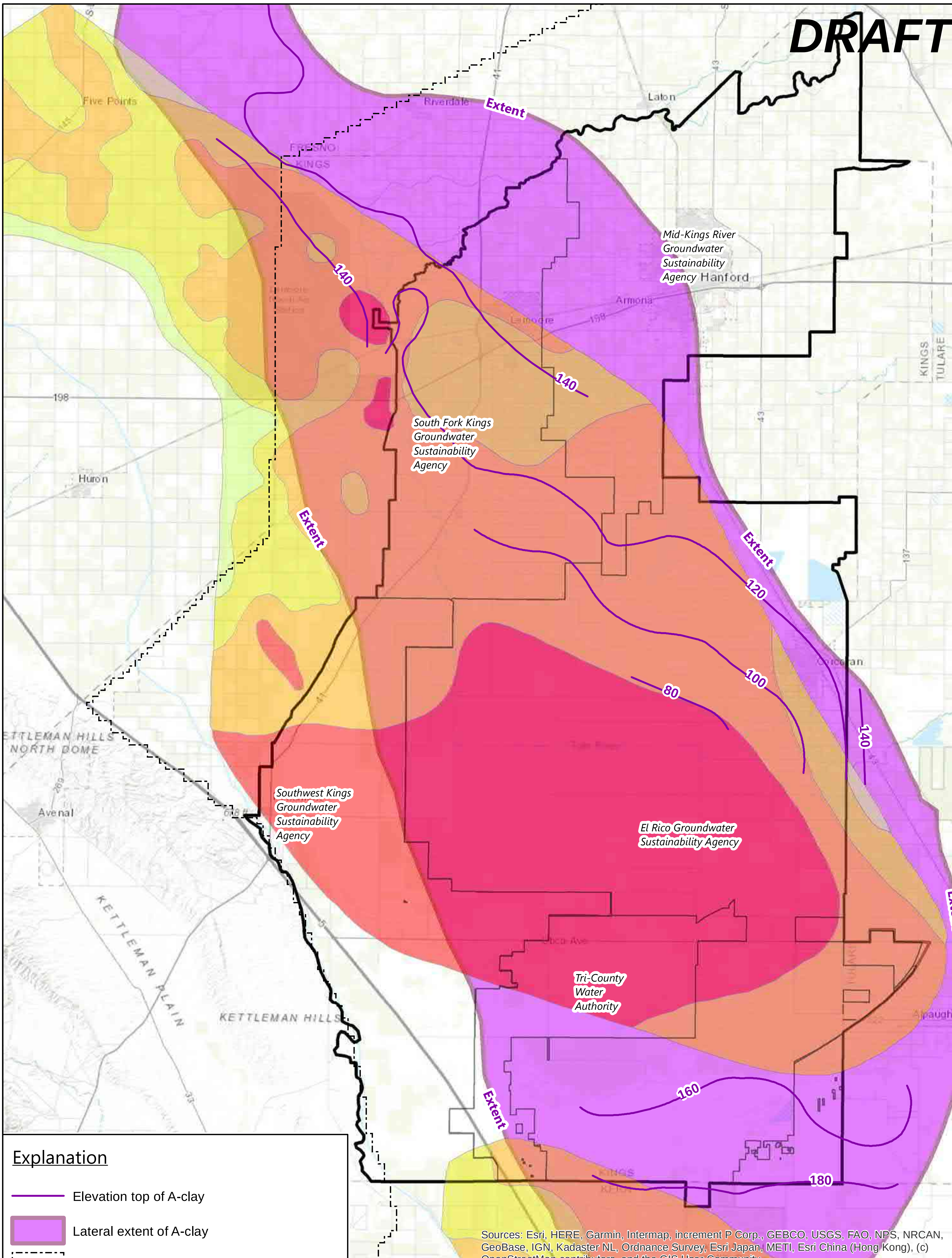

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Explanation

- Elevation top of A-clay
- Lateral extent of A-clay
- Study Area
- Subbasin boundary with Groundwater Sustainability Agencies

Depth of first encountered groundwater

- 0 to 5 Feet
- 5 to 10 Feet
- 10 to 15 Feet
- 15 to 20 Feet

Miles: 0 1 2 4 6 8

Kilometers: 0 2.5 5 10

Figure adapted from: Subsurface Geology of the Late Tertiary and Quaternary Water-Bearing Deposits of the Southern Part of the San Joaquin Valley, California, USGS Water Supply Paper 1999-H, Croft, 1972.

Lateral Extent and Elevation of the A-Clay and First Encountered Groundwater 2010

Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR16181220
		Figure **3-17**

Date: 8/20/2019 Printed by: elizabeth.chapman
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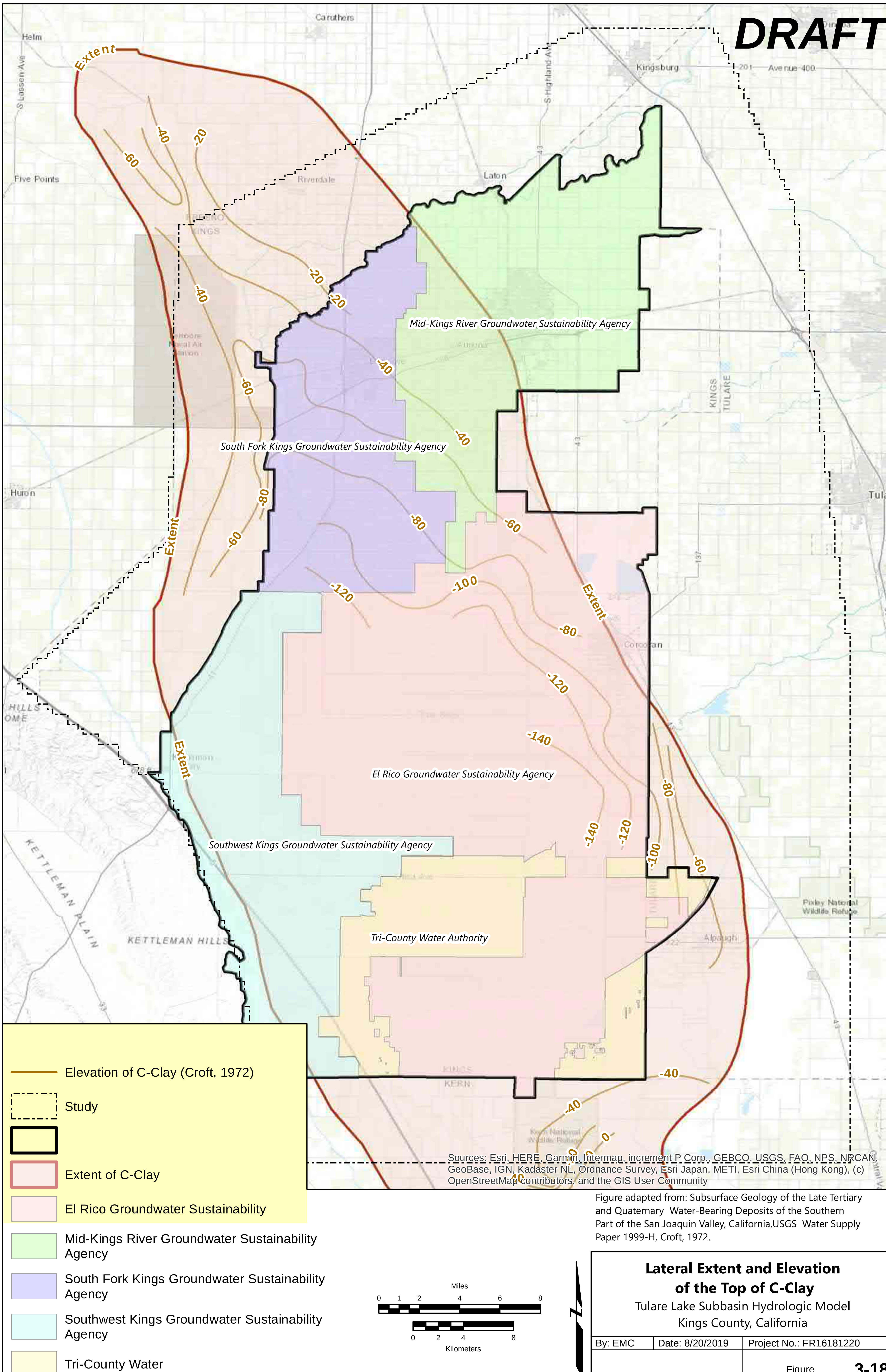

Figure adapted from: Subsurface Geology of the Late Tertiary and Quaternary Water-Bearing Deposits of the Southern Part of the San Joaquin Valley, California,USGS Water Supply Paper 1999-H, Croft, 1972.

Lateral Extent and Elevation of the Top of C-Clay

Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR16181220
		Figure **3-18**

Date: 8/20/2019 Printed by: elizabeth.chapman
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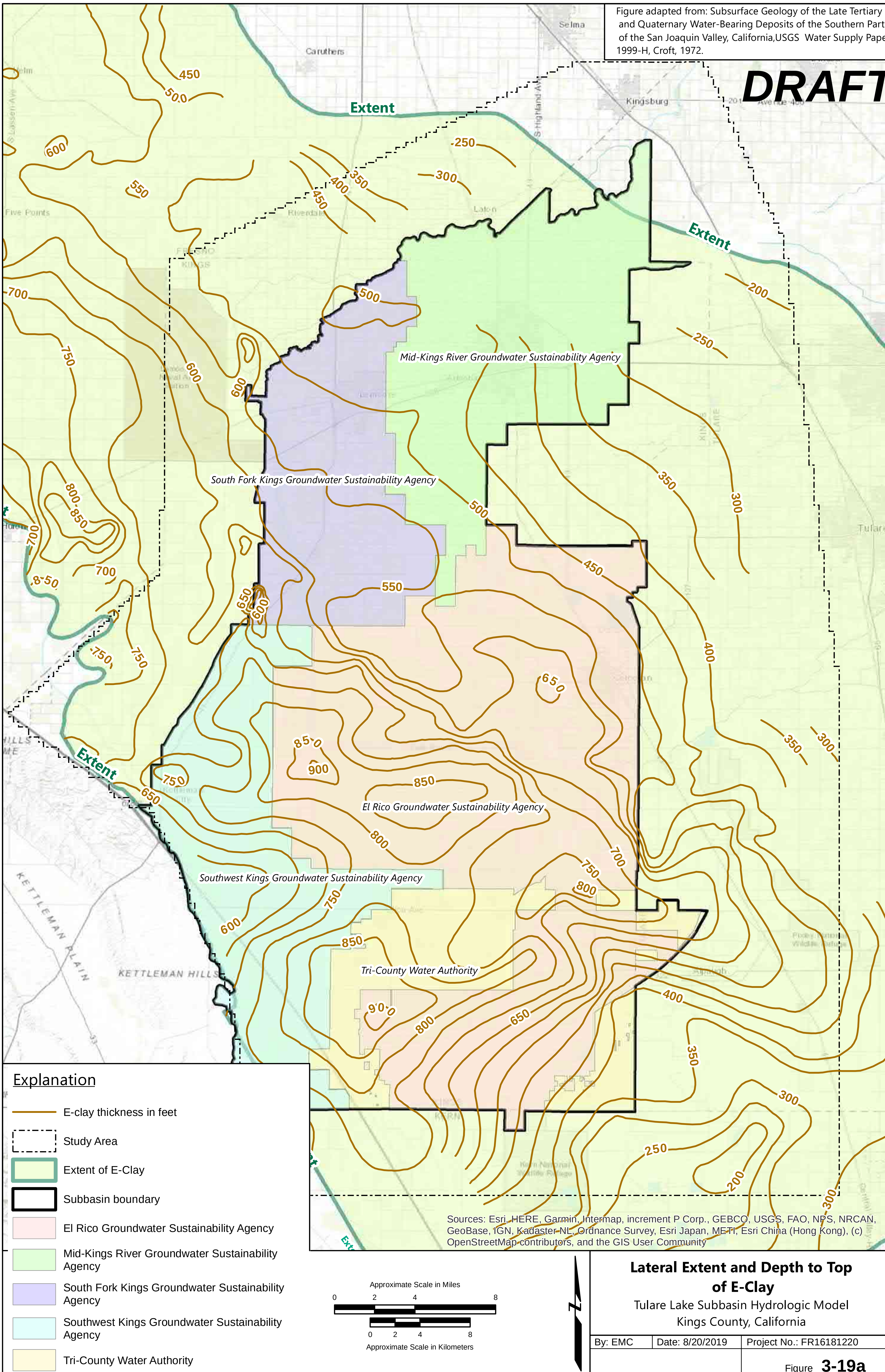

Date: 8/20/2019 Printed by: elizabeth.chapman
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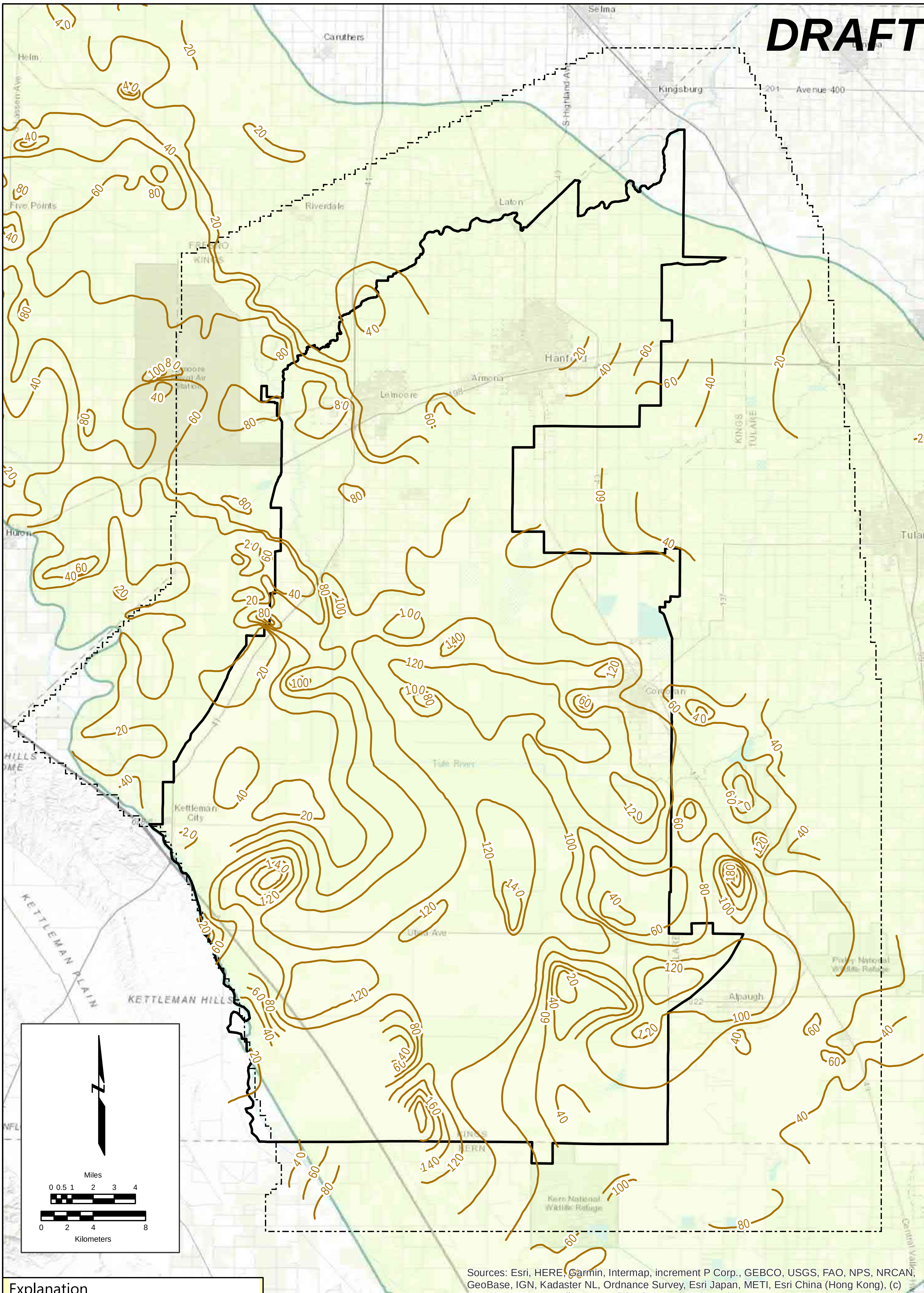


Explanation

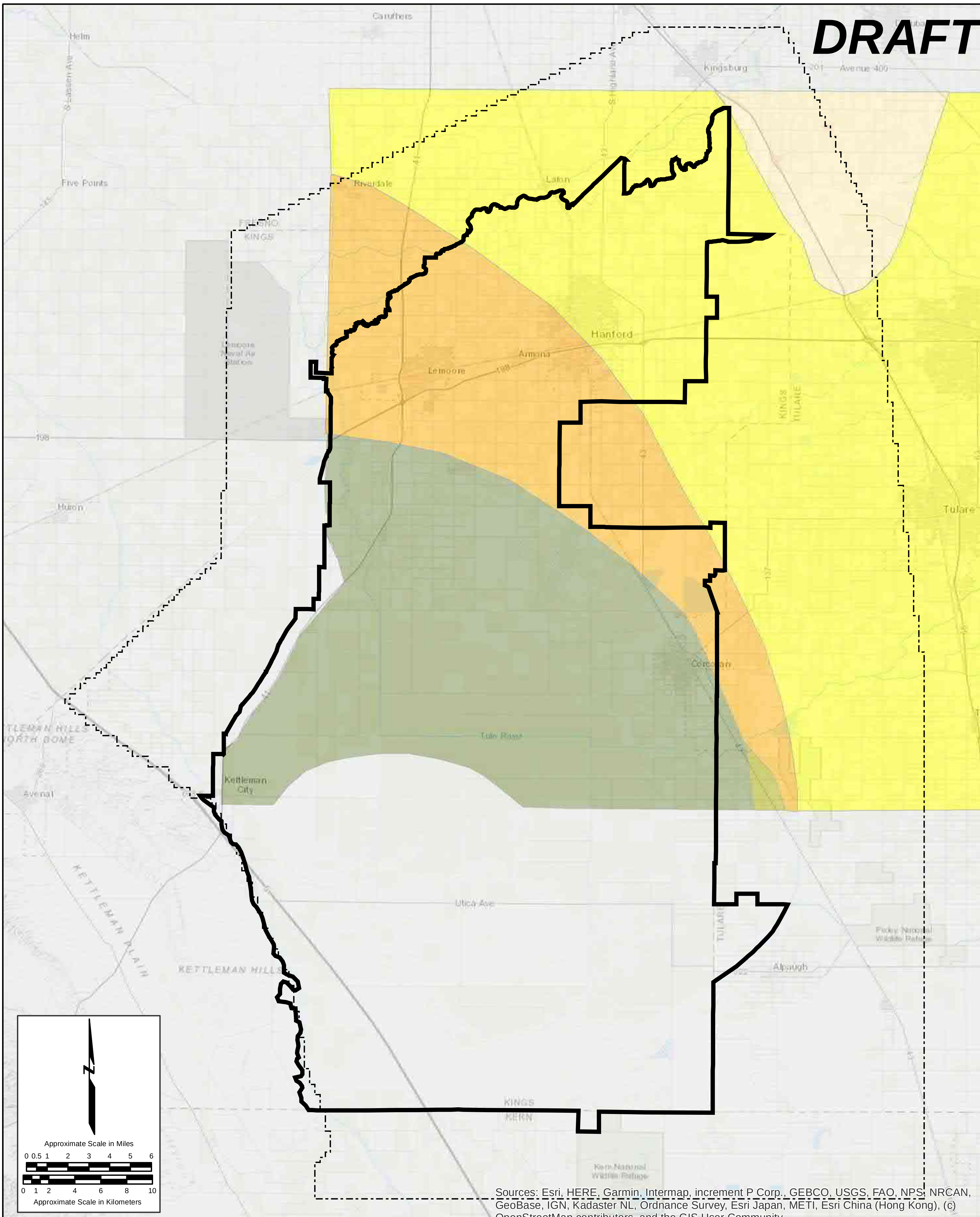
- Boundary of Tulare Lake Subbasin
- Study Area
- Extent of E-Clay
- E-Clay Thickness in Feet

Lateral Extent and Thickness of E-Clay

Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR16181220
		Figure **3-19b**

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-20_Map of Relative Permeability of Geologic Units as Interpreted from Yield Factors.mxd



Explanation

Groundwater Yield Factors

- High: Range of 3 to 185; Average of 43 From 221 Tests
- High: Range of 74 to 155; Average of 130 From 4 Tests
- Moderate: Range of 2 to 34; Average of 14 From 30 Tests
- Moderate: Range of 8 to 19; Average not calculated
- Low: Range of 1 to 10; Average of 4.3 From 46 Tests
- Undefined

Subbasin boundary

Study Area

Yield Factor (YF) = 100 x specific capacity / thickness of saturated well interval.

Adapted from Geology, Hydrology, and Quality of Water in the Hanford-Visalia Area, San Joaquin Valley, California, Plate 10. USGS Open-File Report 68-67. (Croft and Gordon, 1968).

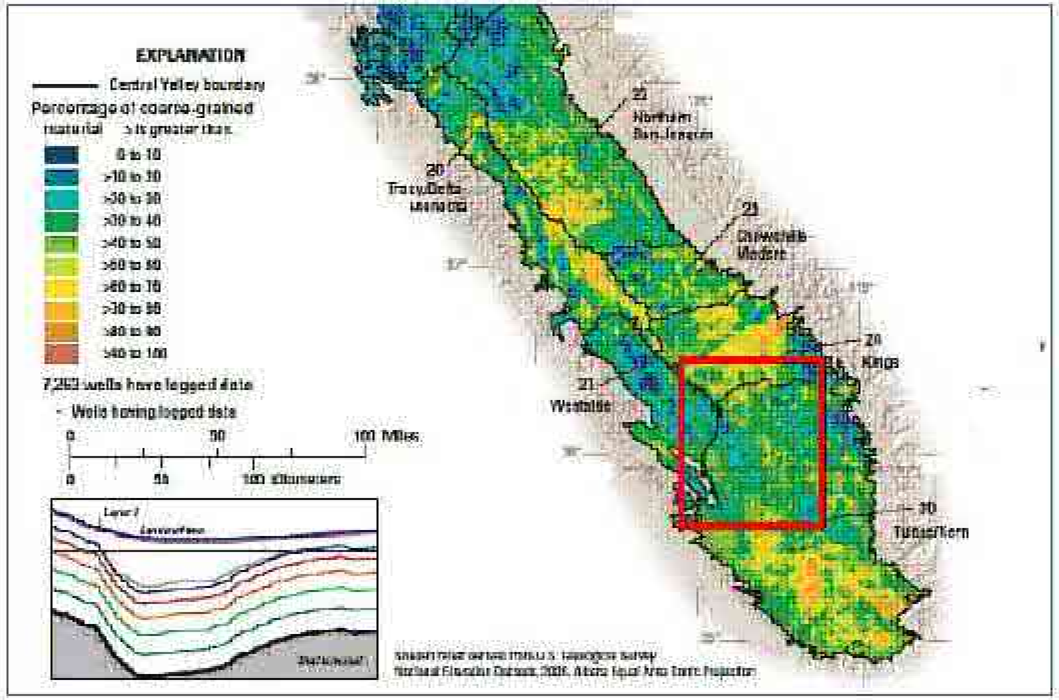
Map of Relative Permeability of Geologic Units as Interpreted from Yield Factors

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

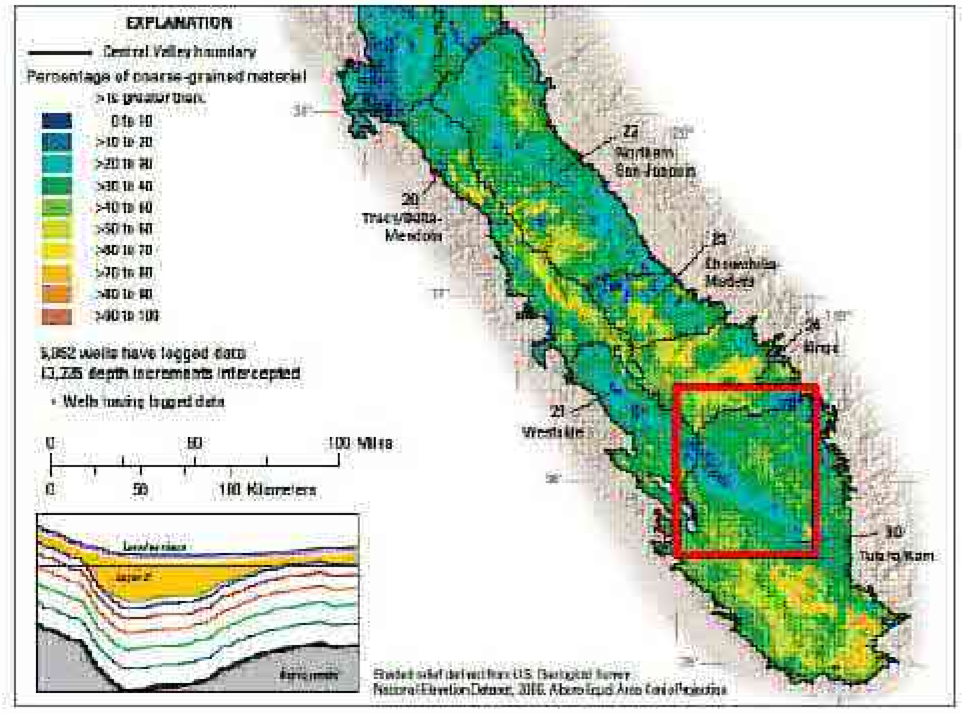
By: EMC	Date: 8/20/2019	Project No.: FR16181220
		Figure 3-20

DRAFT

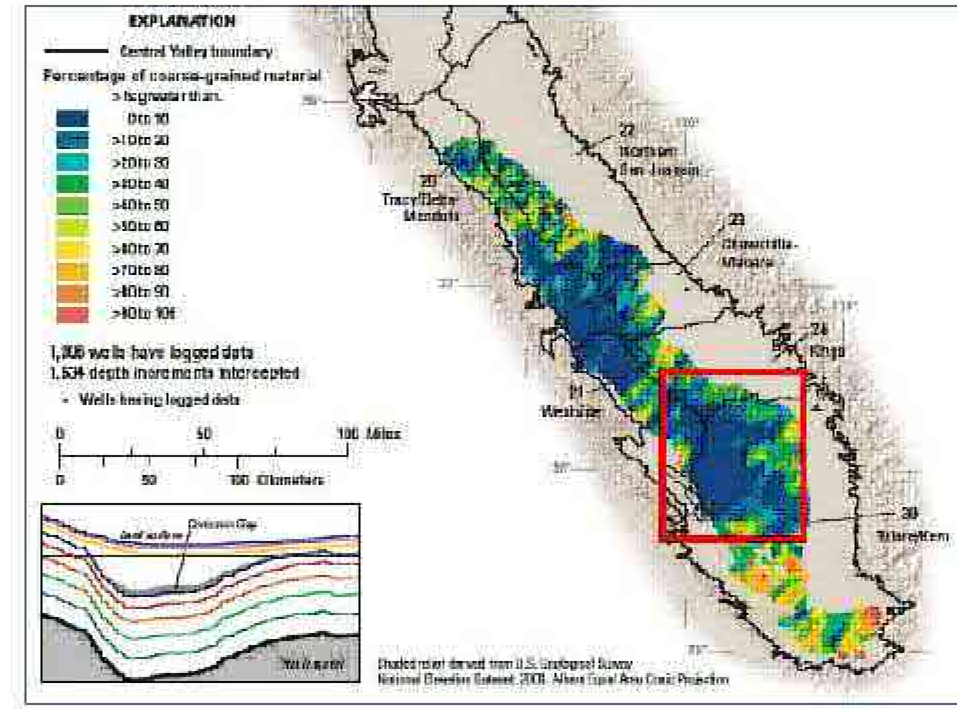
a. 0 - 50 foot depth interval



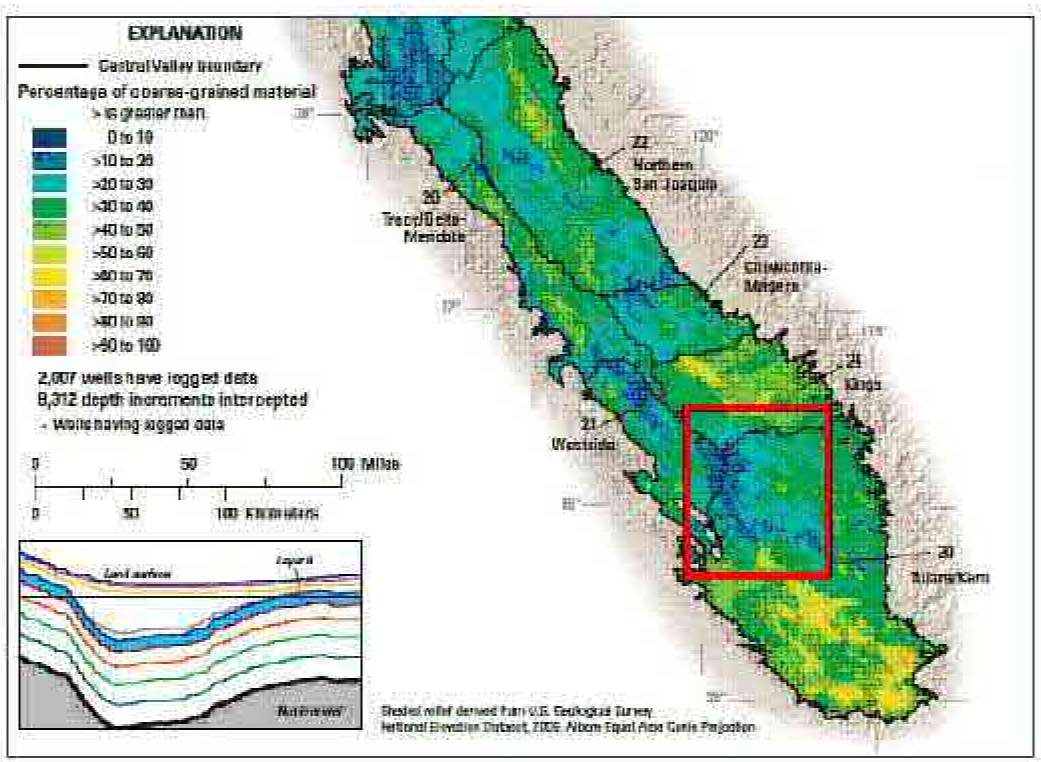
b. 50 - 200 foot depth interval



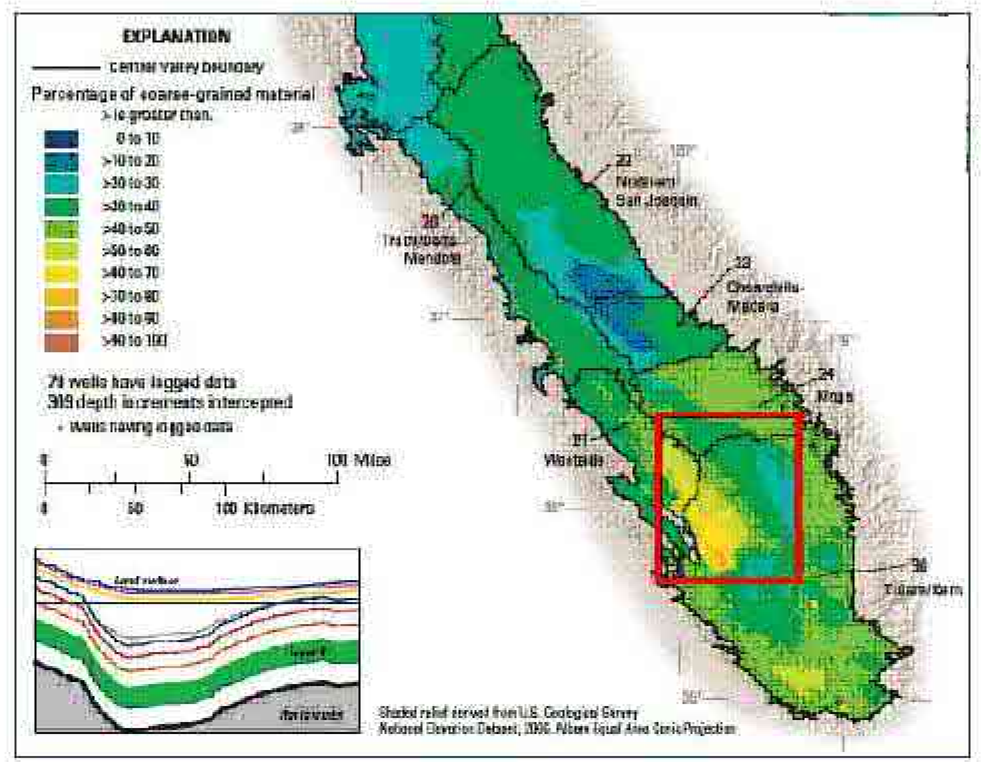
c. Corcoran Clay Depth interval



d. 100 foot depth interval immediately below Corcoran Clay



e. 200 foot depth interval from 400 to 700 feet bgs

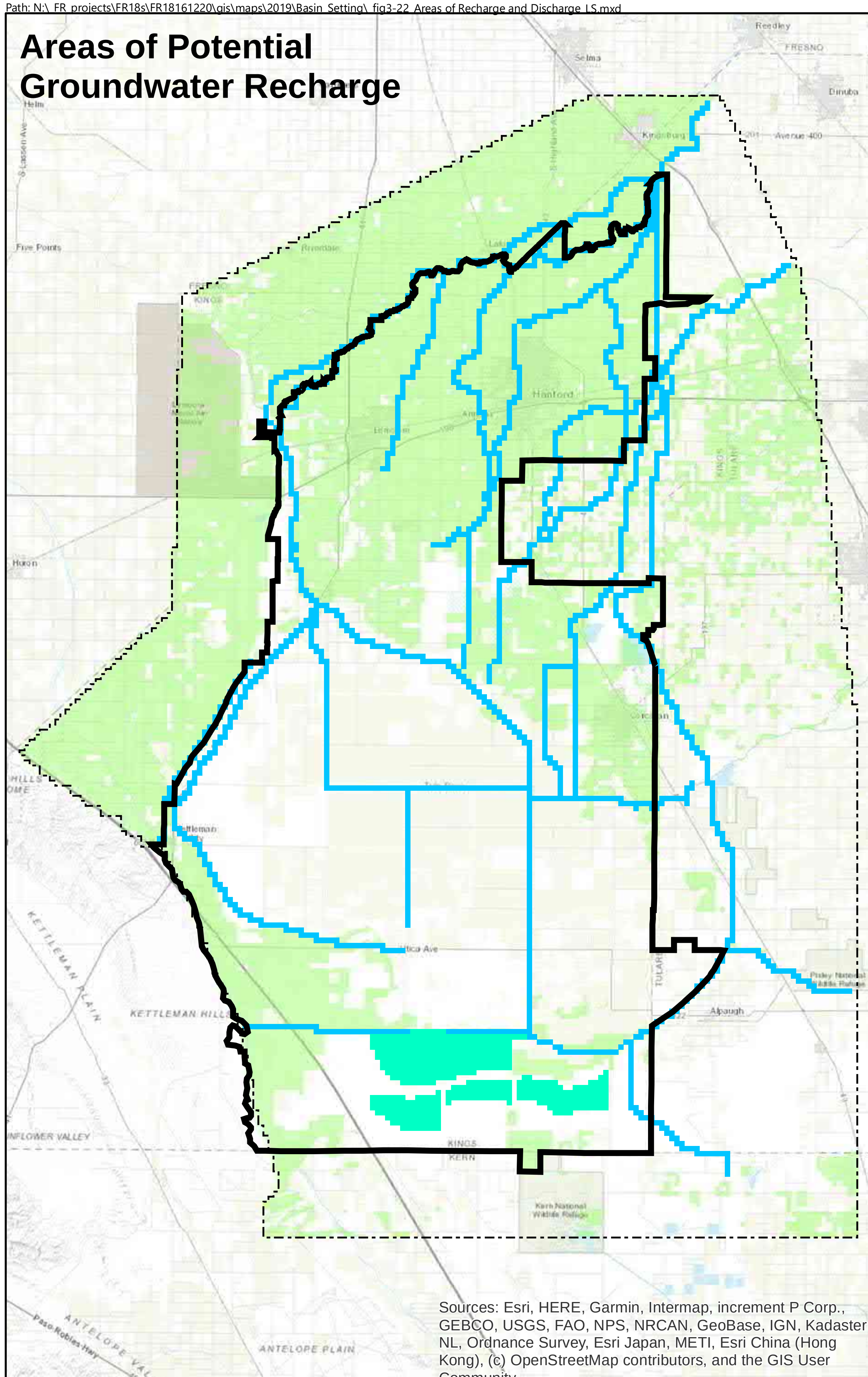


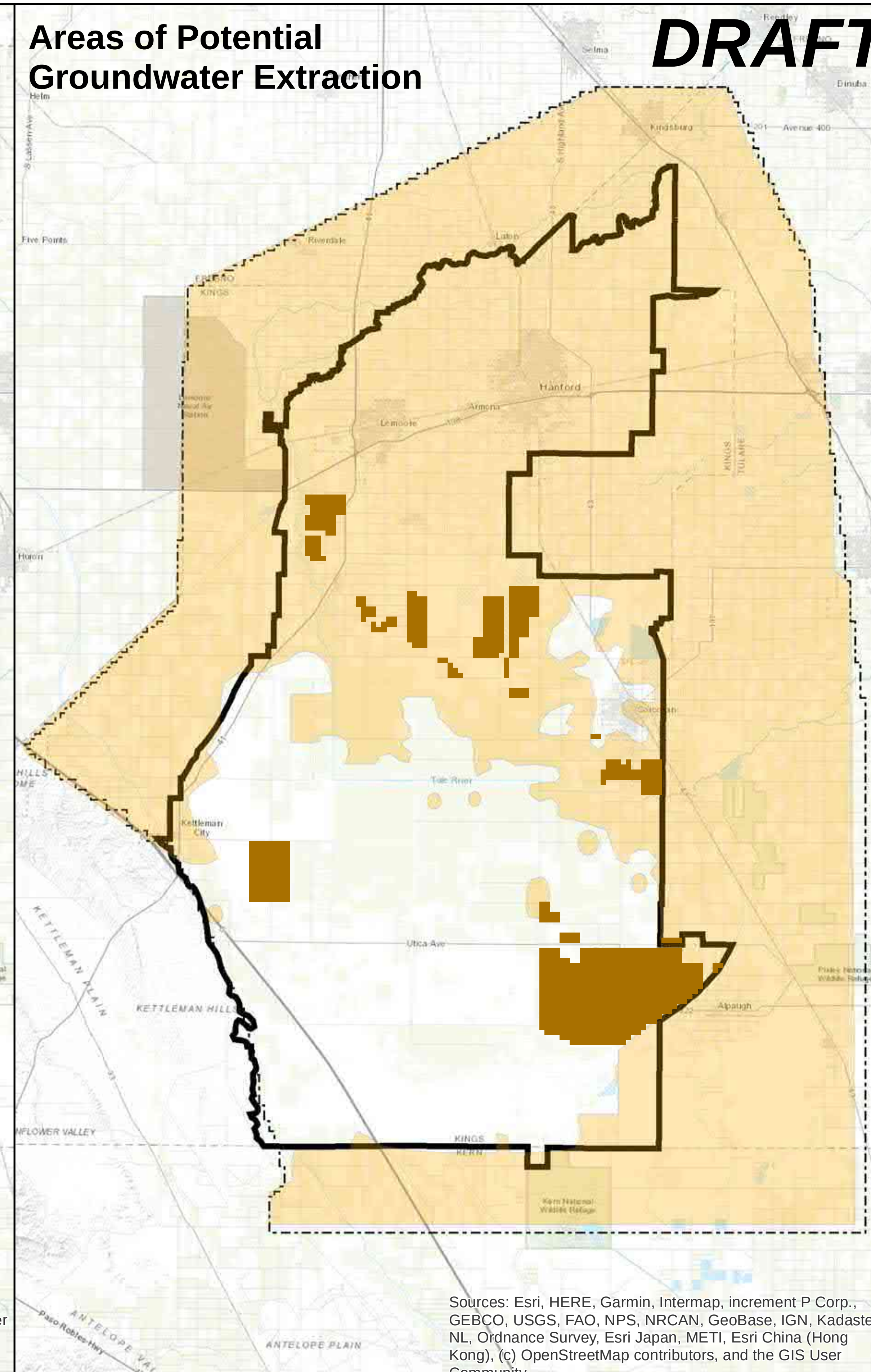
Tulare Lake Subbasin Hydrologic Model study area

Kriged Distribution of Coarse Fraction for San Joaquin Valley Basin-Fill Sediments

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/21/2019	Project No.: FR16181220
		Figure **3-21**





Explanation

- Boundary of Tulare Lake Subbasin
- Study Area
- Surface water impoundments
- Stream and canal recharge
- Potential recharge area
- Groundwater drainage area
- Area of potential groundwater extraction

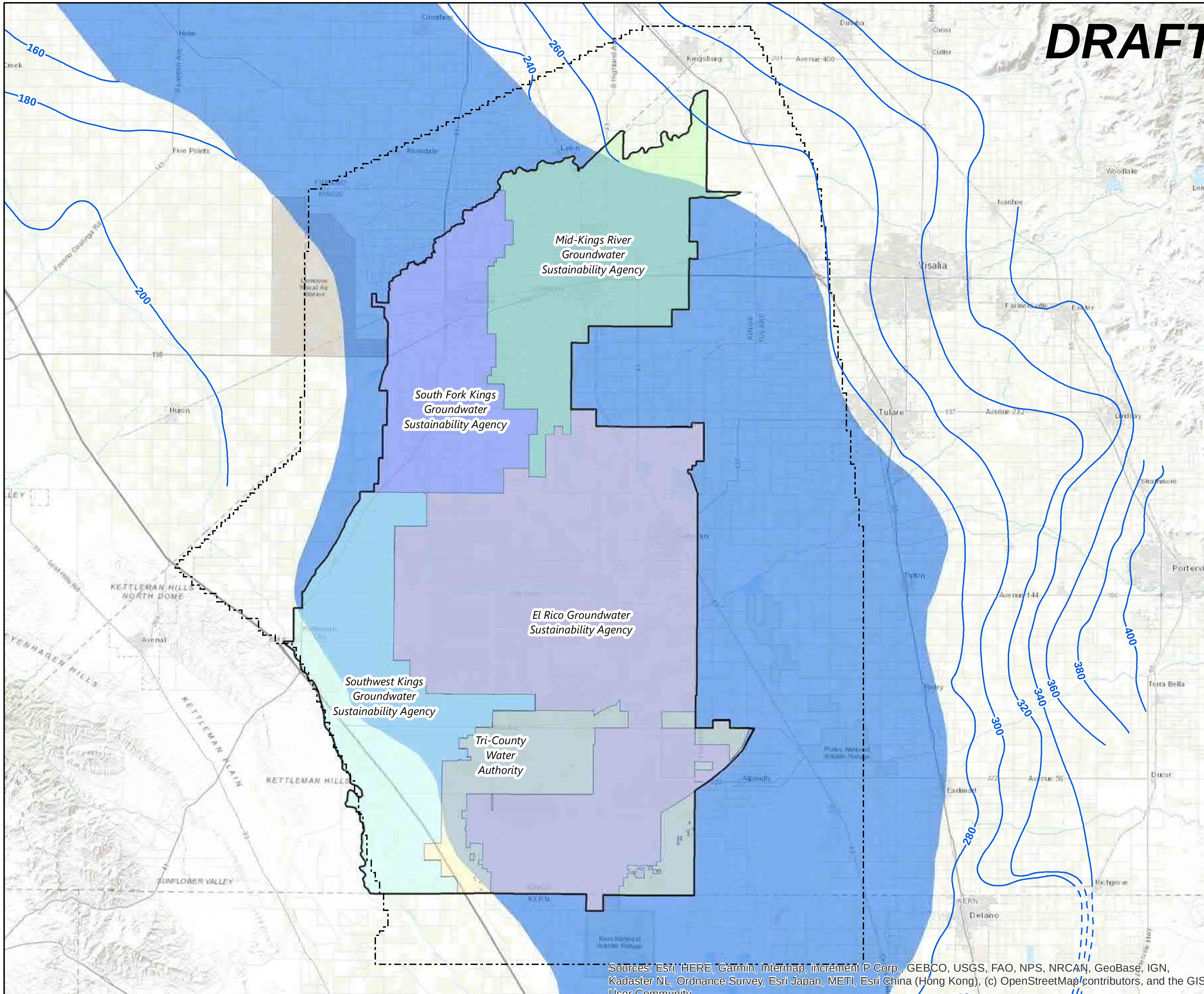
Approximate Scale in Feet
0 17,500 35,000 70,000

0 4,000 8,000 16,000
Approximate Scale in Meters

Areas of Potential Recharge and Extraction

Tulare Lake Subbasin Groundwater Sustainbility Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-22**



Explanation

- Areas of flowing wells
- Subbasin boundary
- Study Area

20-ft groundwater elevation contours (fmsl)

- Certain
- Uncertain

Groundwater Sustainability Agencies (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Notes:
1) Map adapted from Mendenhall et al (1916), Plate 1.
2) Elevations in feet above mean sea level.

N

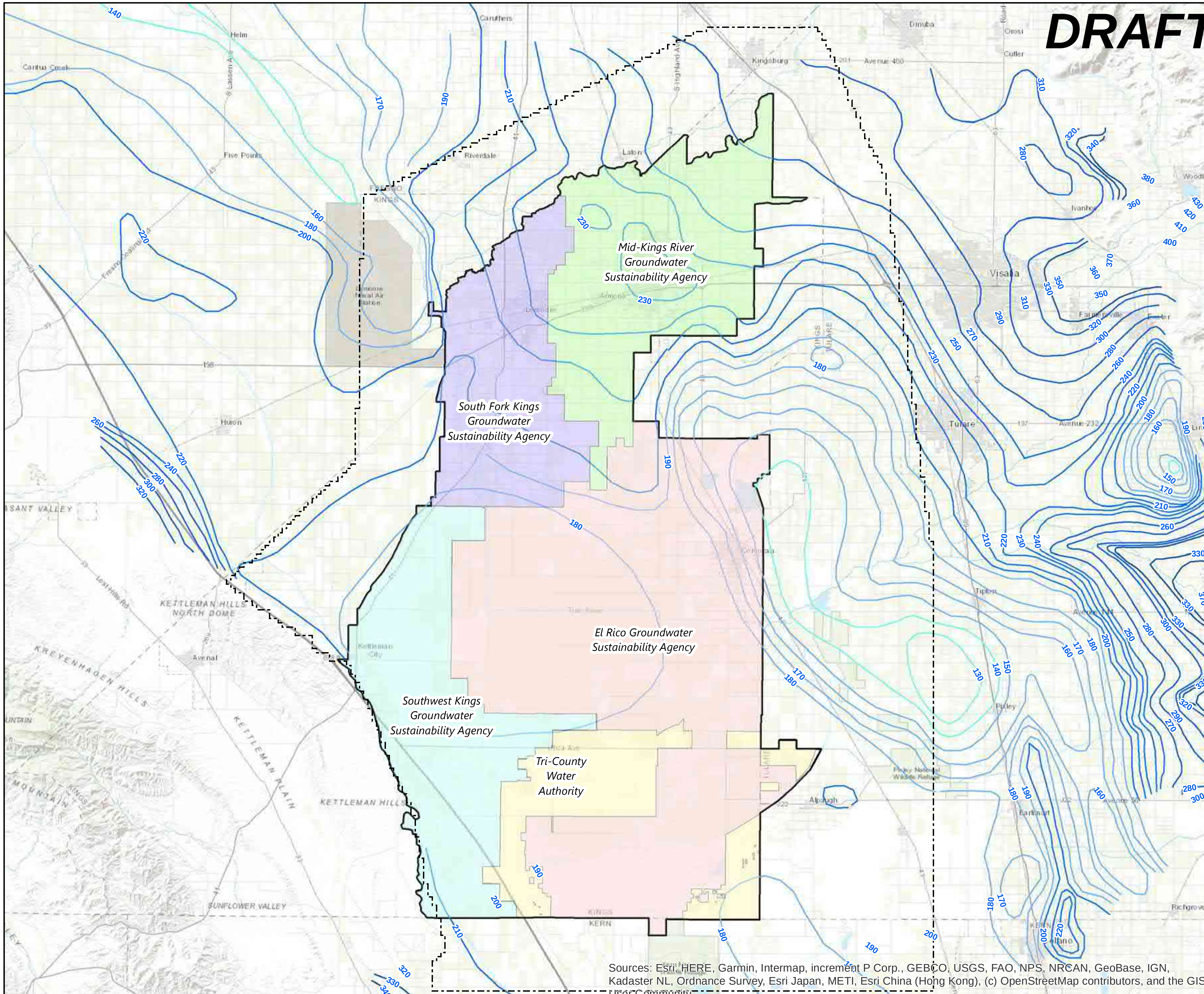
Approximate Scale in Miles: 0, 2, 4, 8
Approximate Scale in Kilometers: 0, 2½, 5, 10

Map of Unconfined Groundwater Conditions 1905-1907

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-23**

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-23_GroundwaterConditions_1907.mxd



Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-24_GroundwaterConditions_1952.mxd

Explanation

- Study Area
- Subbasin boundary

10-ft groundwater elevation contours

- 100 - 150ft
- 150 - 200ft
- 210 - 250ft
- 260 - 300ft
- 310-450ft
- 460 - 500ft
- 510-580ft

Groundwater Sustainability Agencies (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

N

Approximate Scale in Miles: 0, 2½, 5, 10

Approximate Scale in Kilometers: 0, 2½, 5, 10

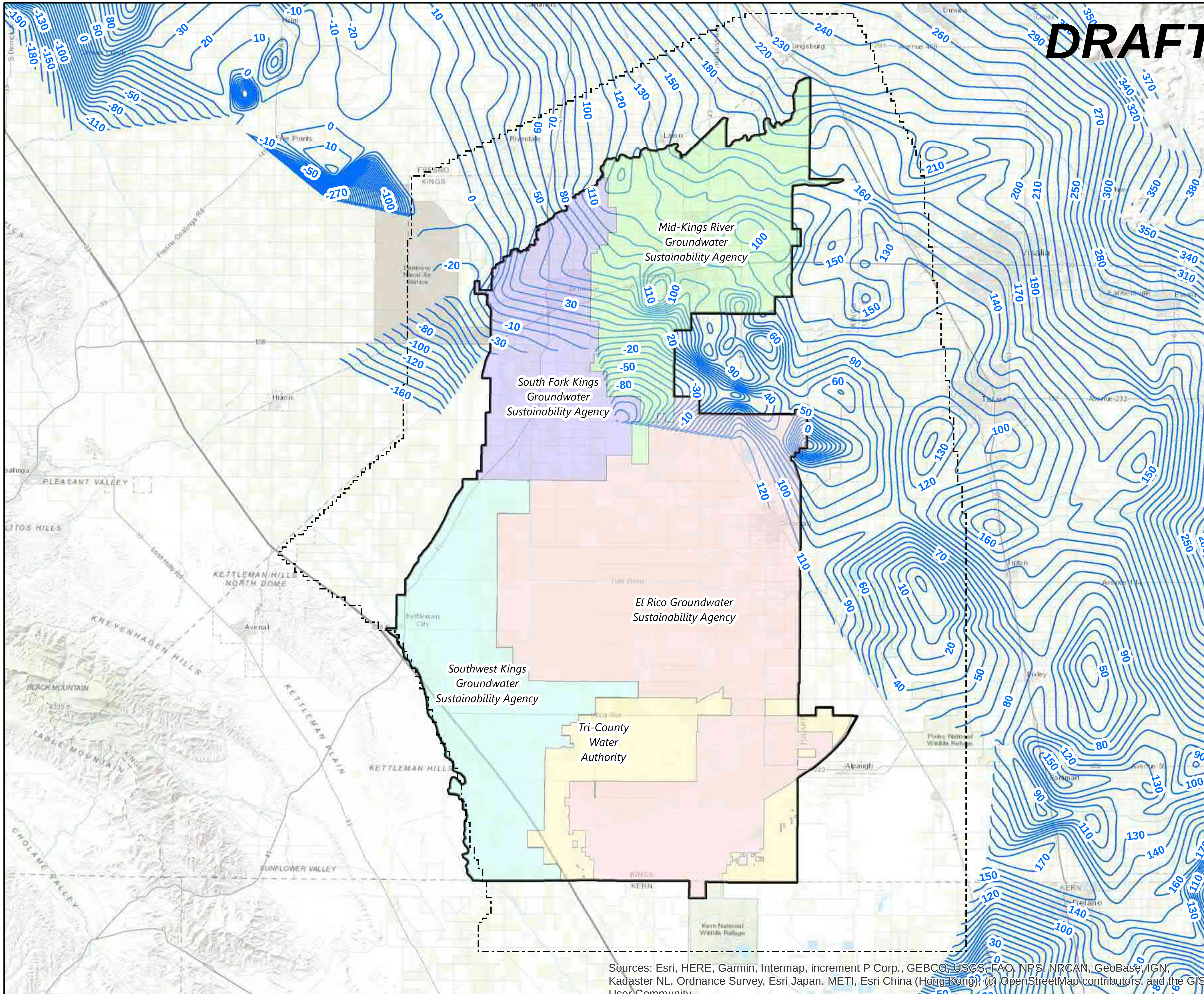
Notes:
1) Map adapted from Davis (1959), Plate 15.
2) Elevations in feet above mean sea level.

Map of Unconfined Groundwater Conditions1952

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220

Figure **3-24**



Explanation

- 10-ft lines of equal groundwater elevation
- Study Area
- Subbasin boundary
- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Approximate Scale in Miles: 0, 2½, 5, 10

Approximate Scale in Kilometers: 0, 2½, 5, 10

Notes:
1) Map adapted from DWR, June 2018.
2) Elevations in feet above mean sea level.

Map of Unconfined Groundwater Conditions 2016

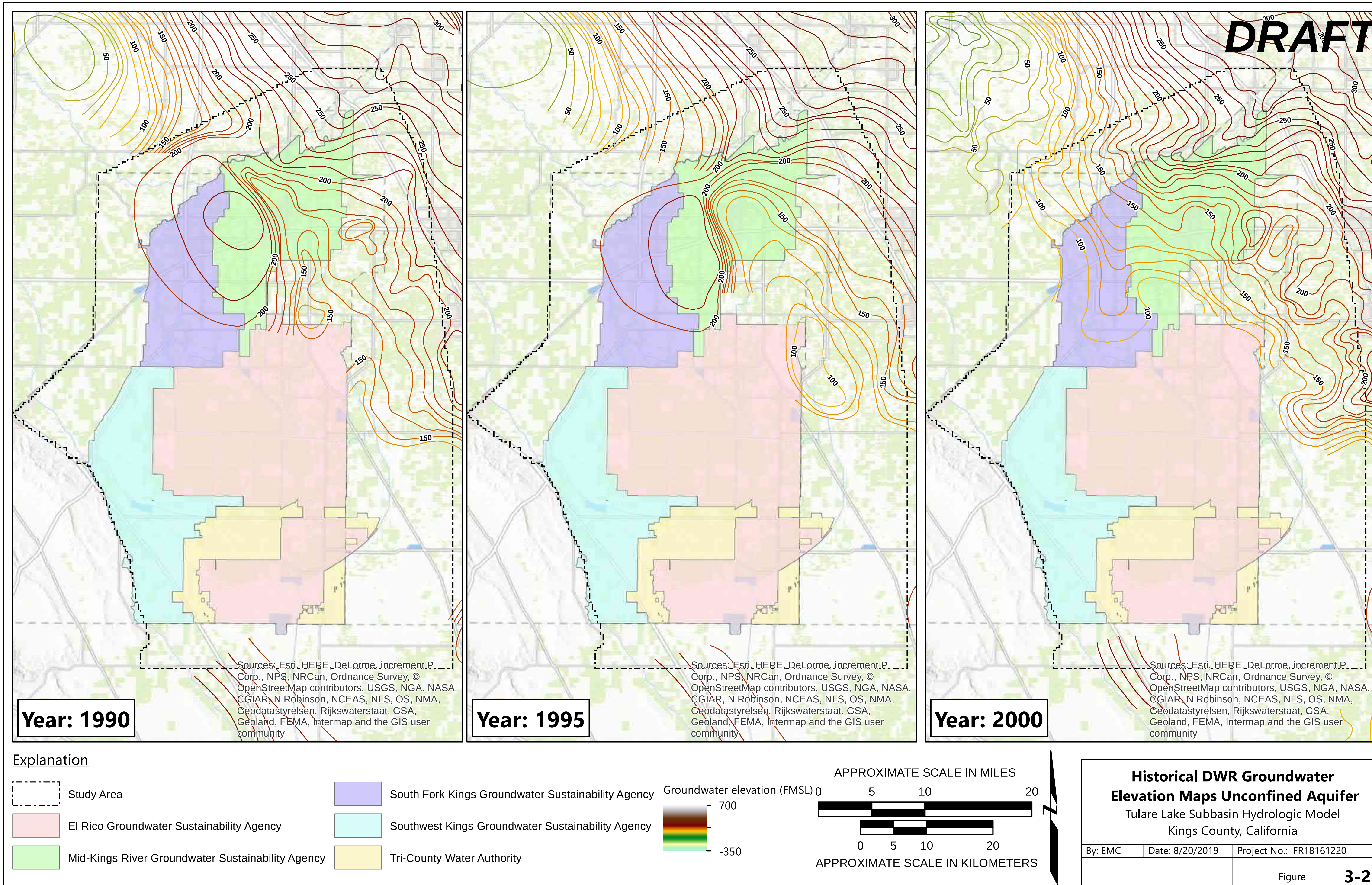
Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: EMC | Date: 8/20/2019 | Project No.: FR18161220

Figure **3-25**

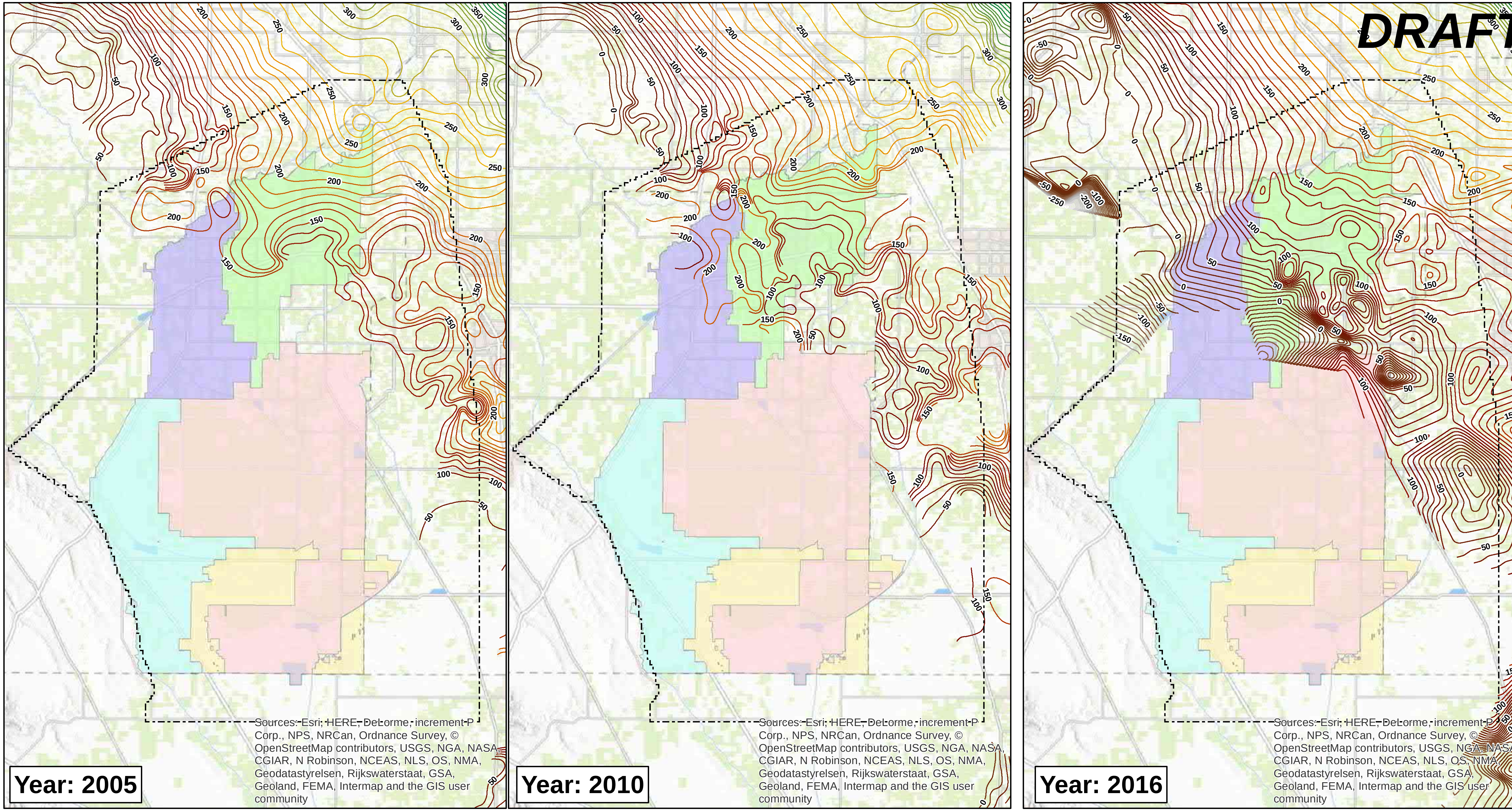
Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-25_GroundwaterConditions_2016.mxd



Historical DWR Groundwater Elevation Maps Unconfined Aquifer

Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-26**



Explanation

- Study Area
- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Groundwater elevation (FMSL)
700
-350

APPROXIMATE SCALE IN MILES
0 5 10 20

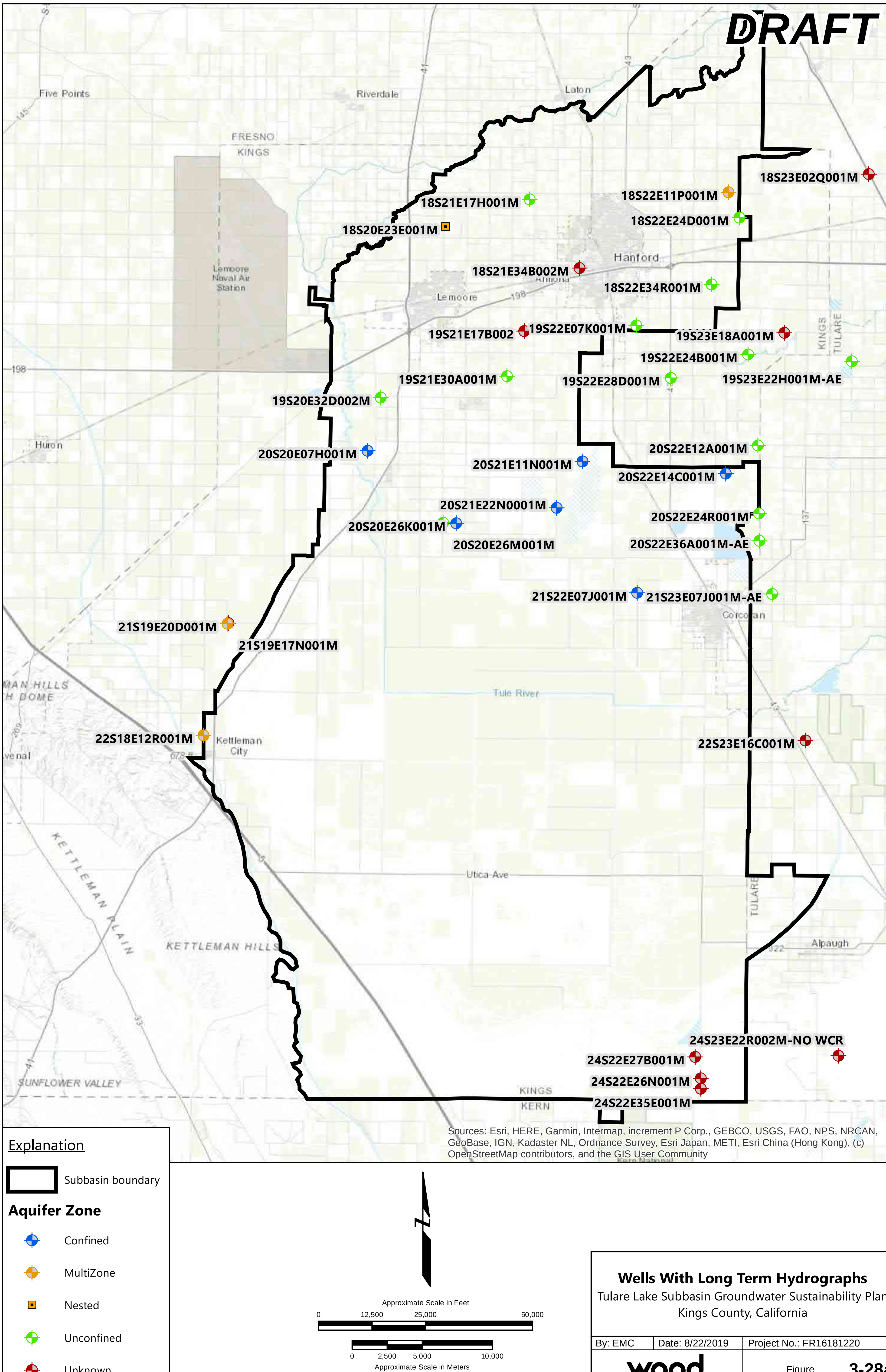
0 5 10 20
APPROXIMATE SCALE IN KILOMETERS

NOTE:
1) Groundwater elevation data obtained from California Department of Water Resources (CA DWR), June 2018: https://databasin.org/datasets/b05820cda86b4921a515065fa1deffcc
2) FMSL = Feet above mean sea level.

Historical DWR Groundwater Elevation Maps, Unconfined Aquifer
Tulare Lake Subbasin Hydrologic Model
Kings County, California

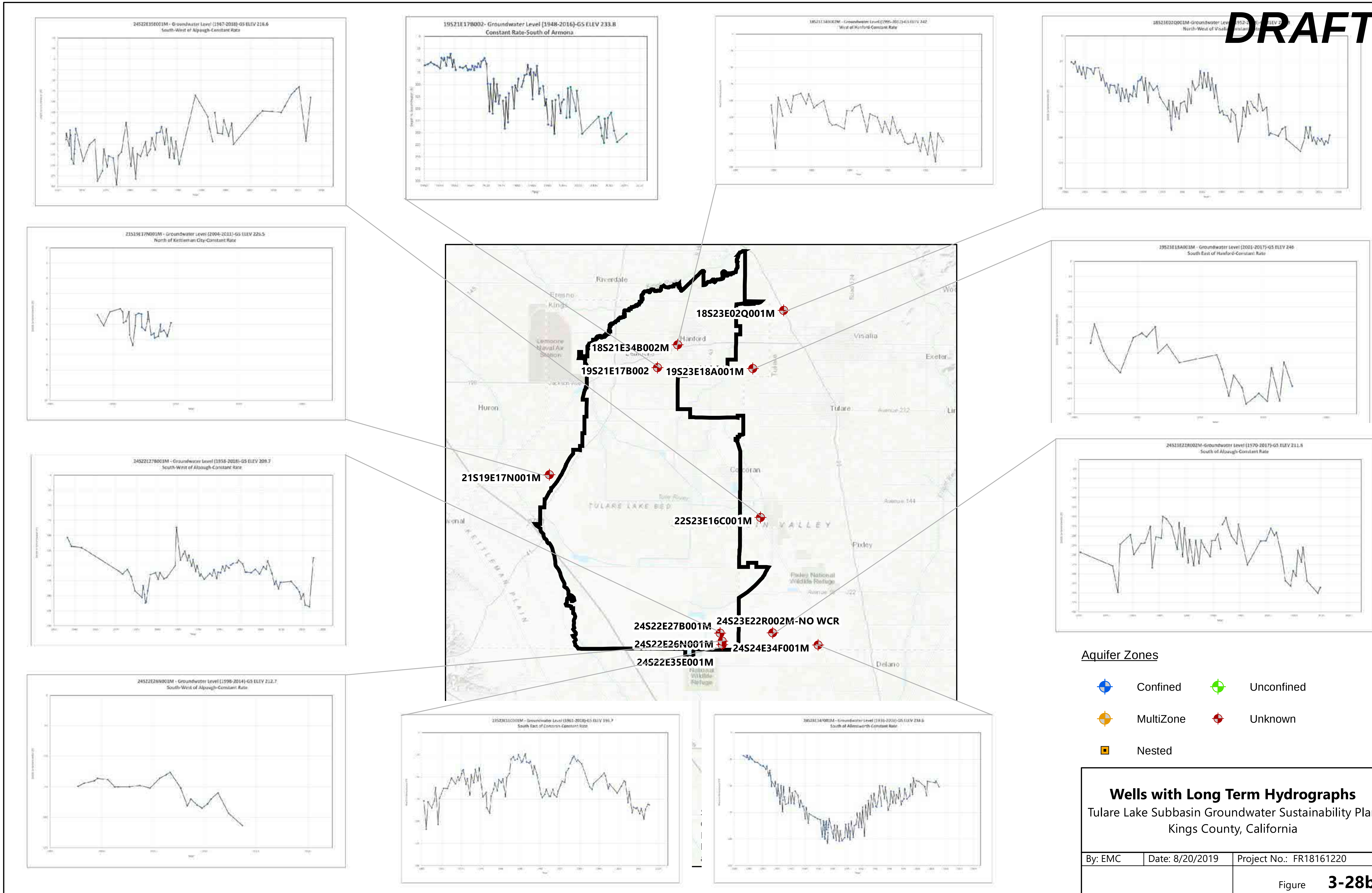
By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-27**

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-27_RecentGroundwaterConditions_2005_2010_2016.mxd



Wells With Long Term Hydrographs
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/22/2019	Project No.: FR16181220
wood.		Figure 3-28a



Wells with Long Term Hydrographs

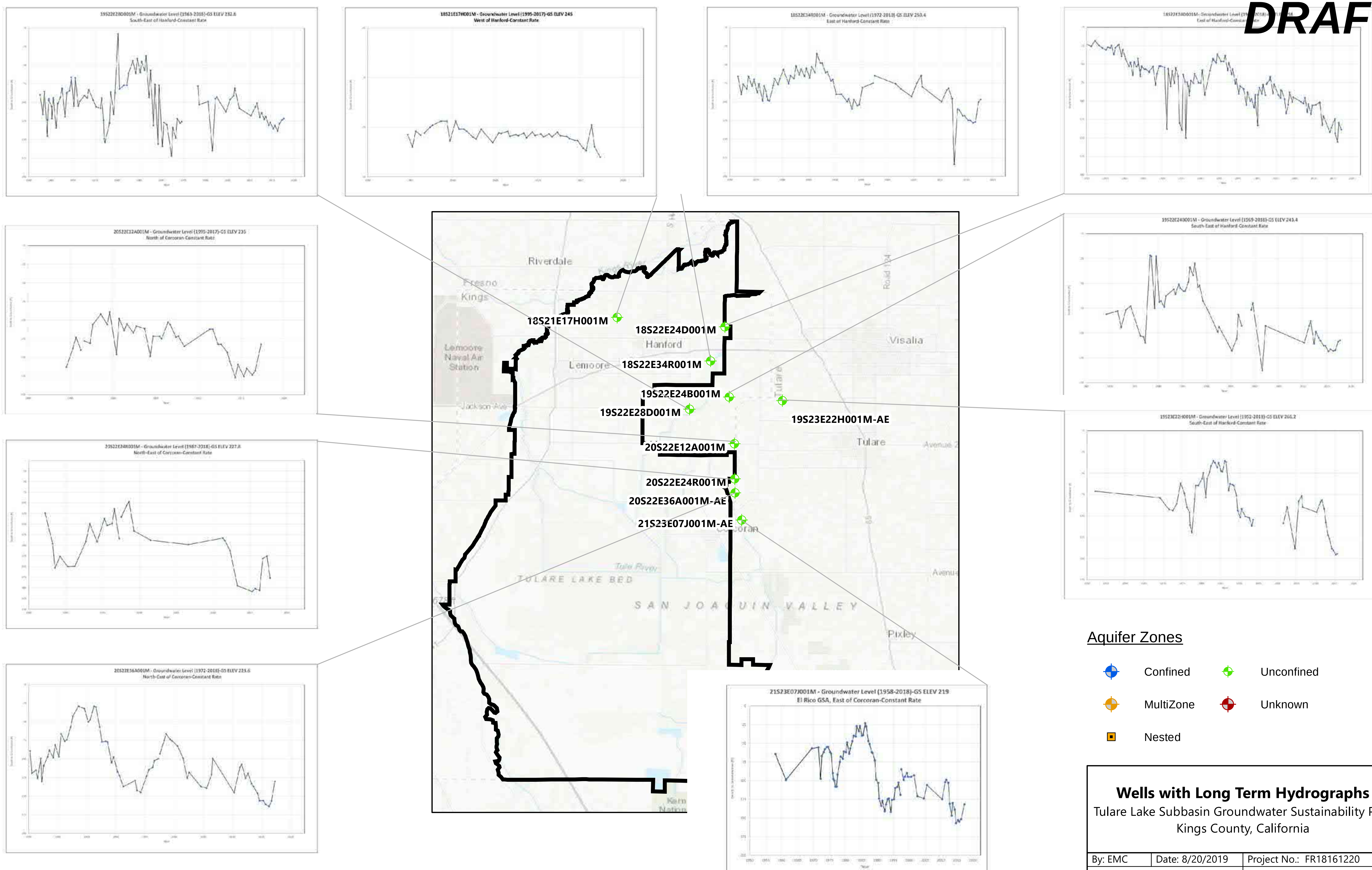
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC | Date: 8/20/2019 | Project No.: FR18161220

Figure **3-28b**

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-28b_UnknownAquiferZoneHydrograph.mxd

DRAFT



Wells with Long Term Hydrographs
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-28c**

Date: 8/20/2019 Printed by: elizabeth.chapman
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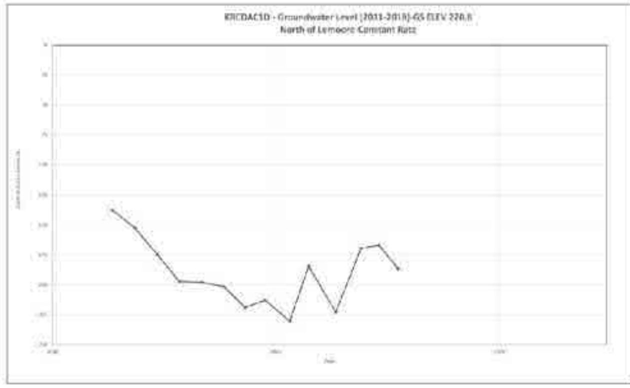
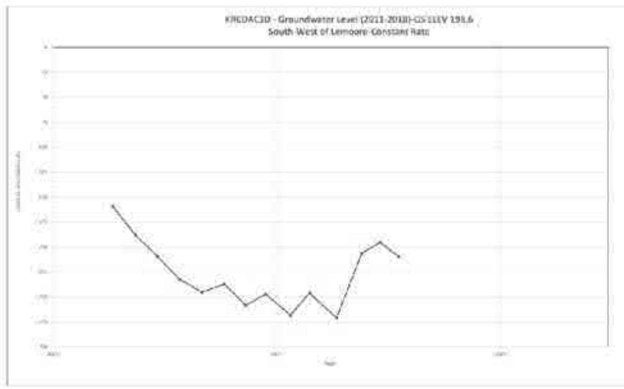
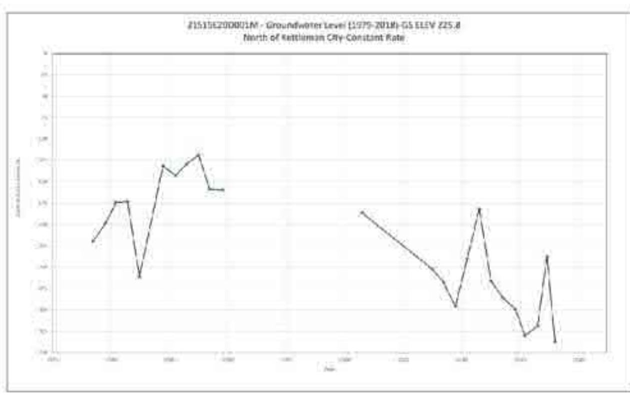
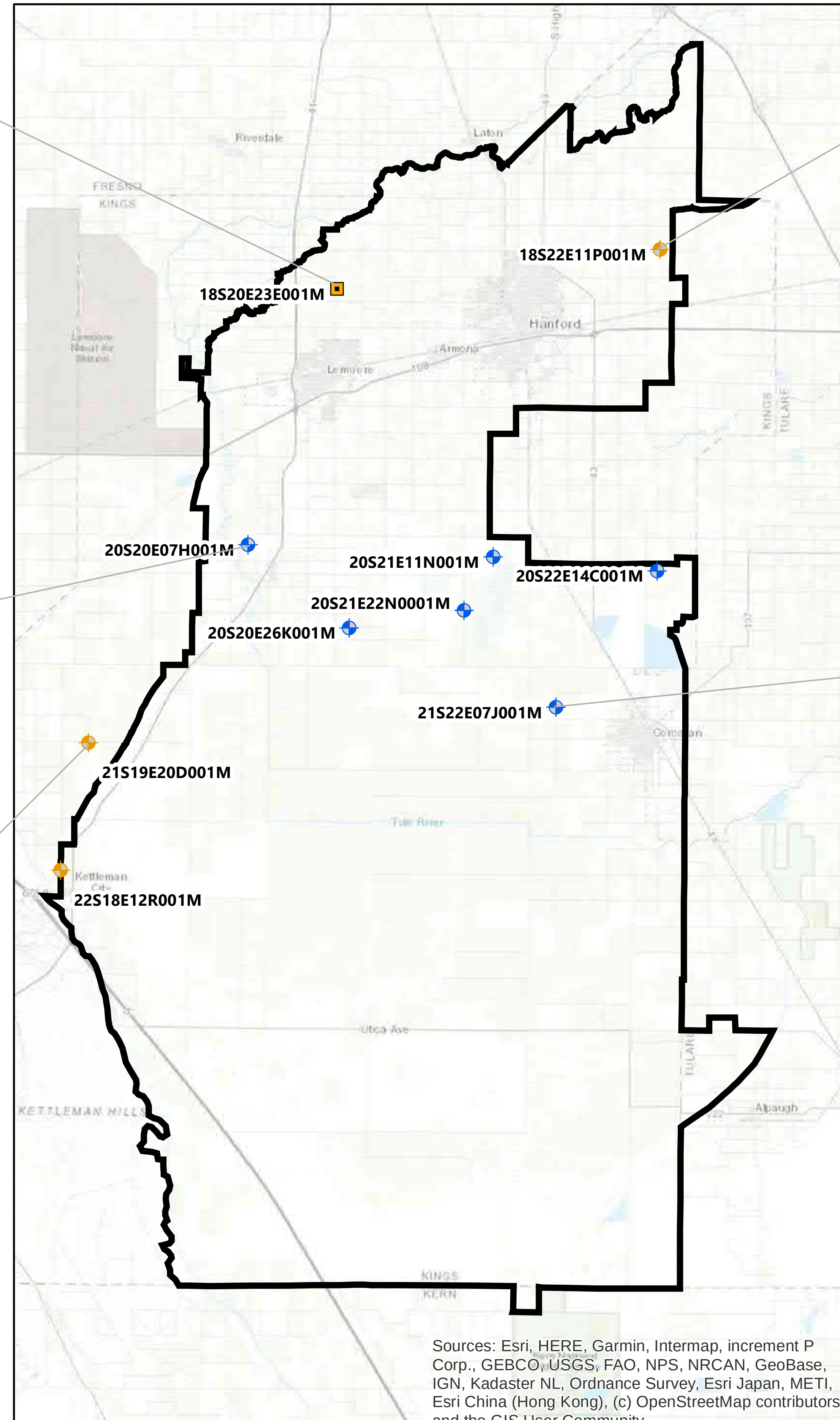
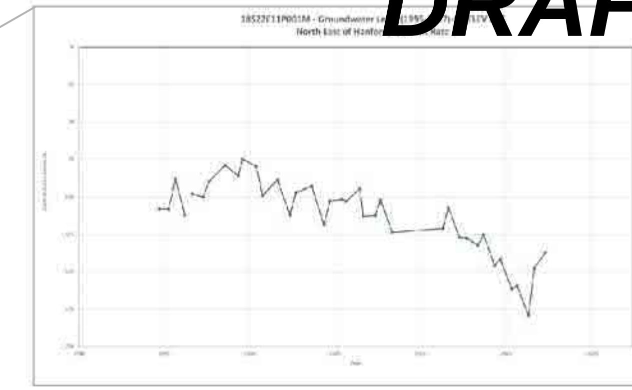
DRAFT

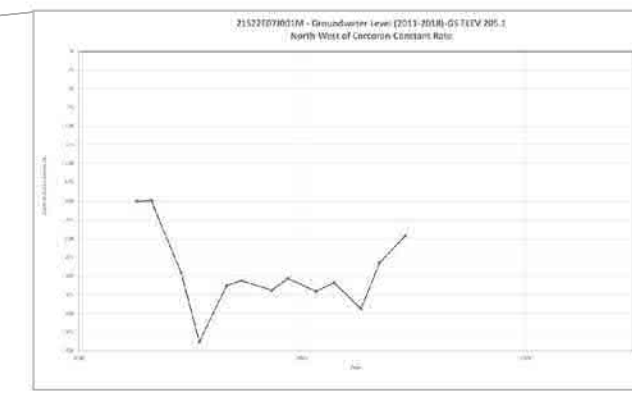












Aquifer Zones

Confined
Unconfined
MultiZone
Unknown
Nested

Wells with Long Term Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-28d**

Date: 8/20/2019 Printed by: elizabeth.chapman

Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-28D_ConfinedAquiferZoneHydrograph.mxd

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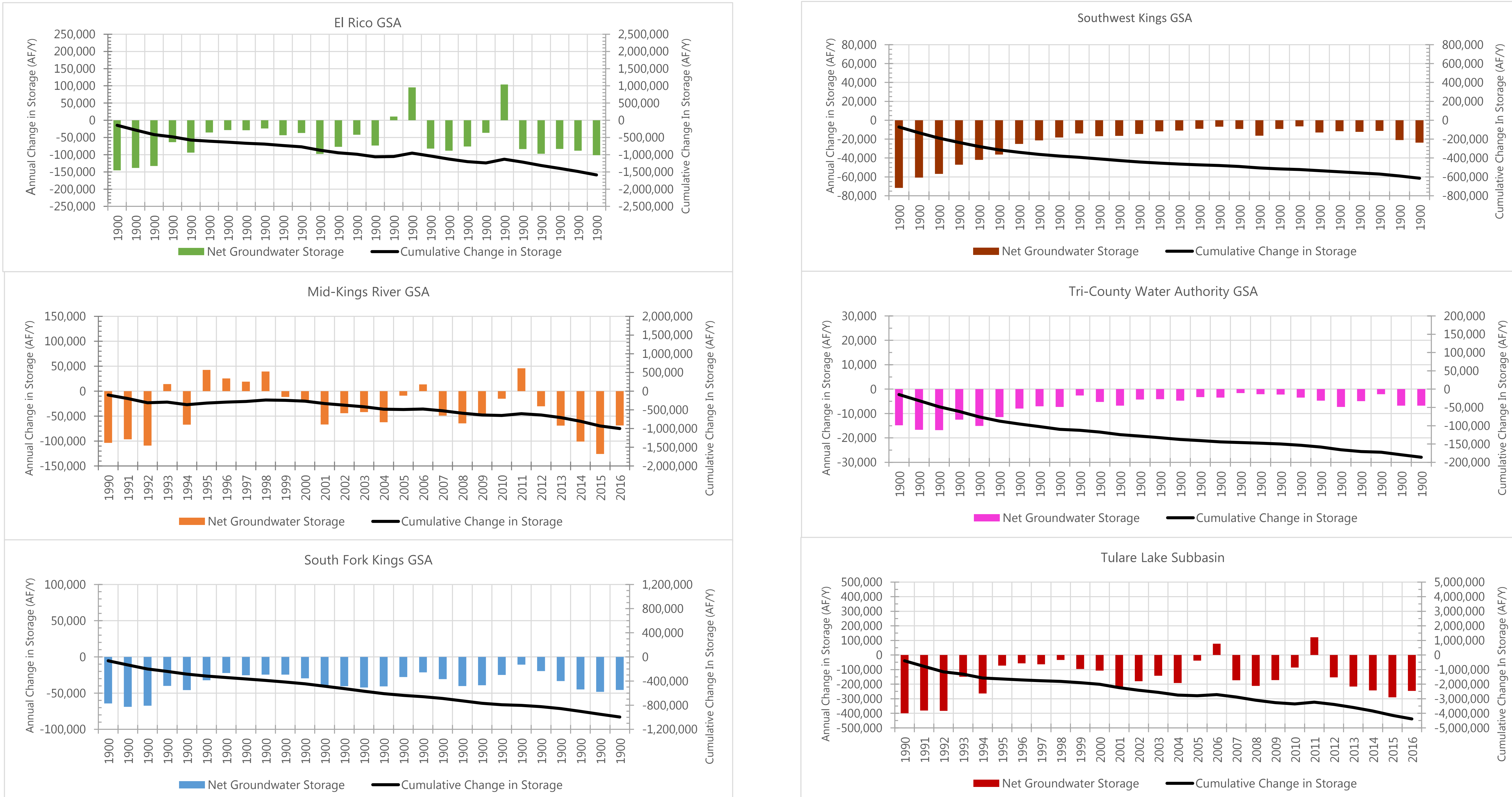
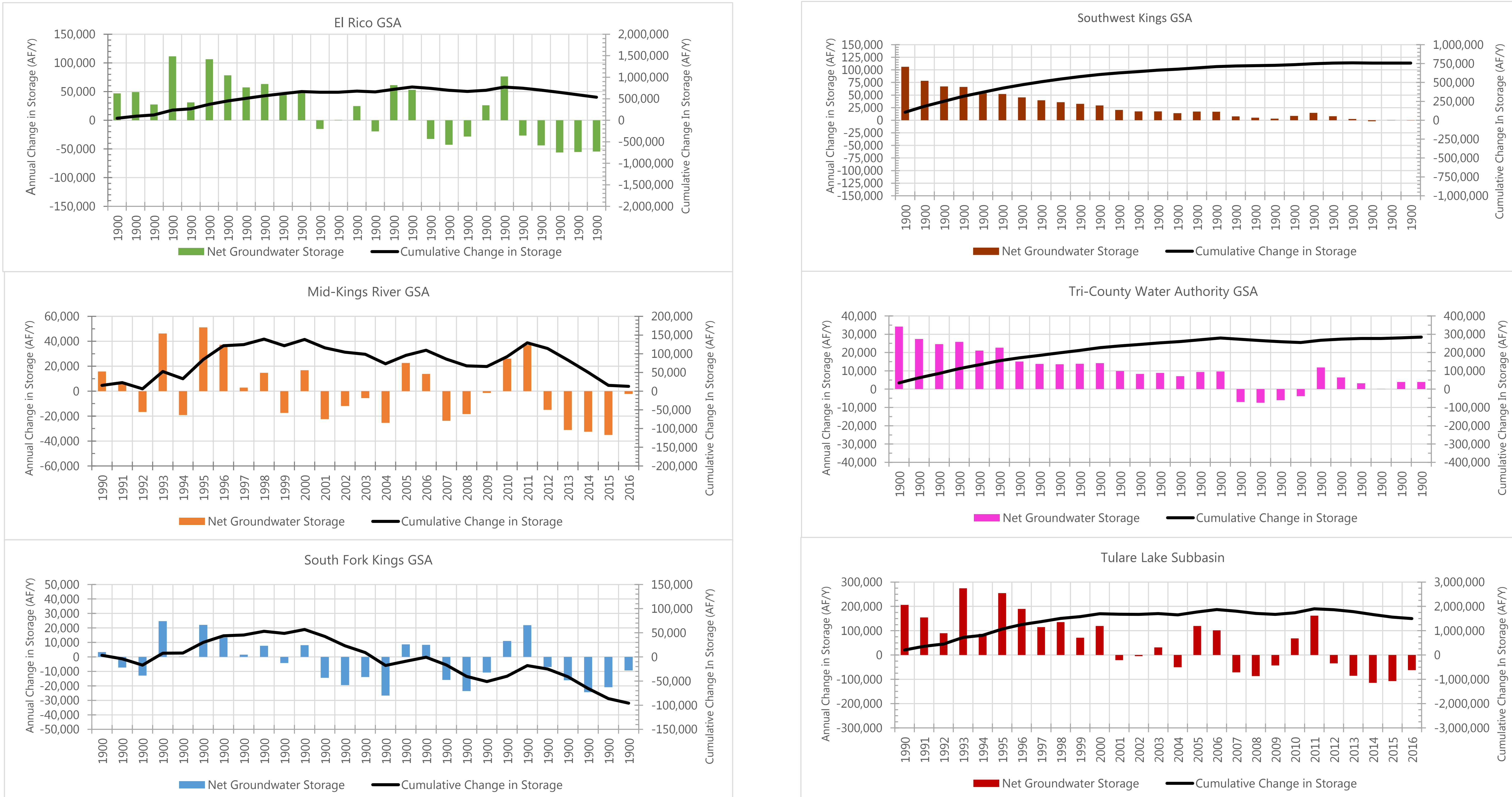


Change in Groundwater Storage
Upper Aquifer Zone 1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

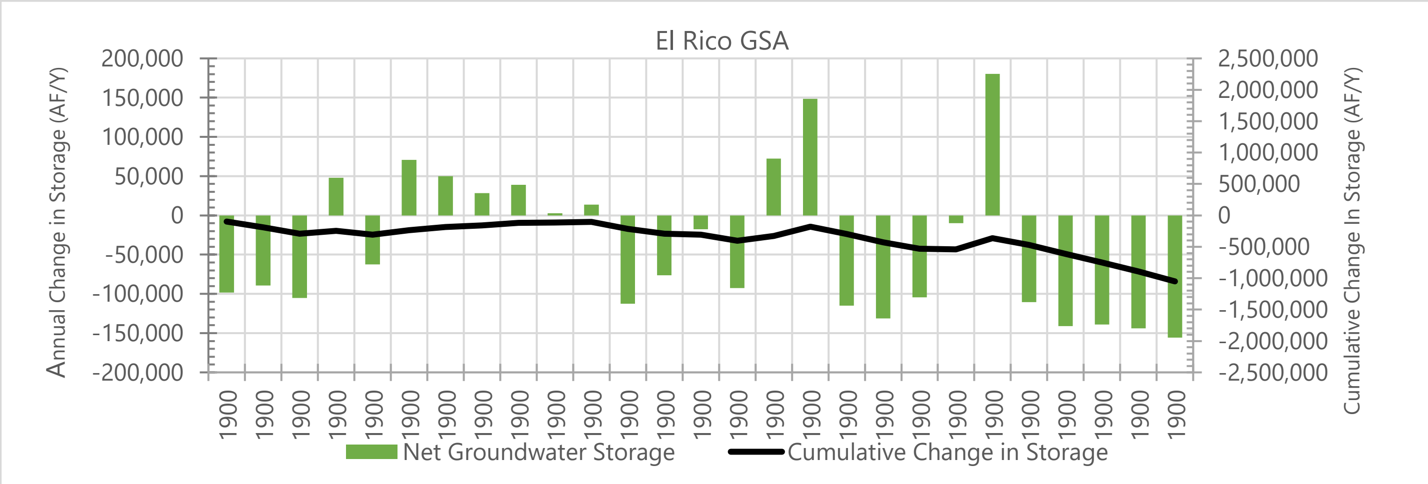
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-29a

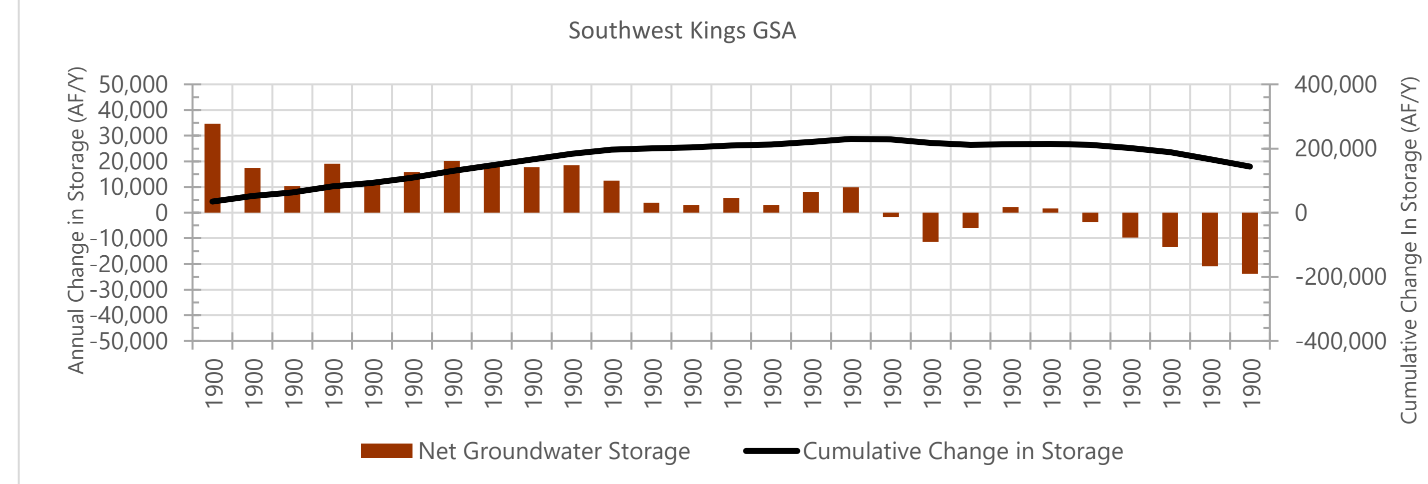


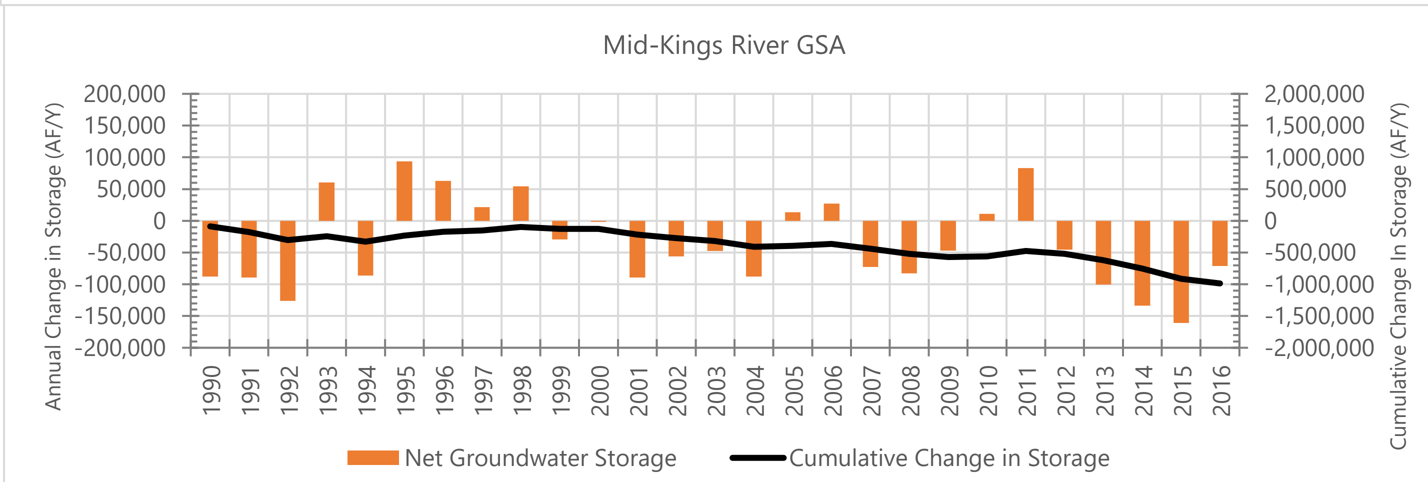
Change in Groundwater Storage
Lower Aquifer Zone 1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

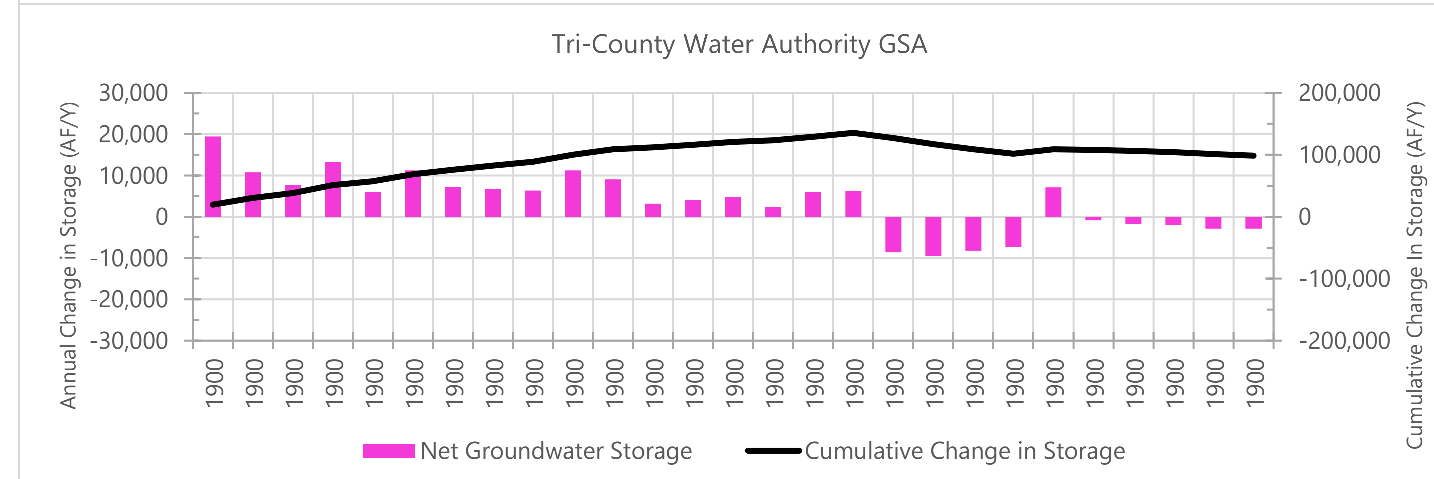
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-29b

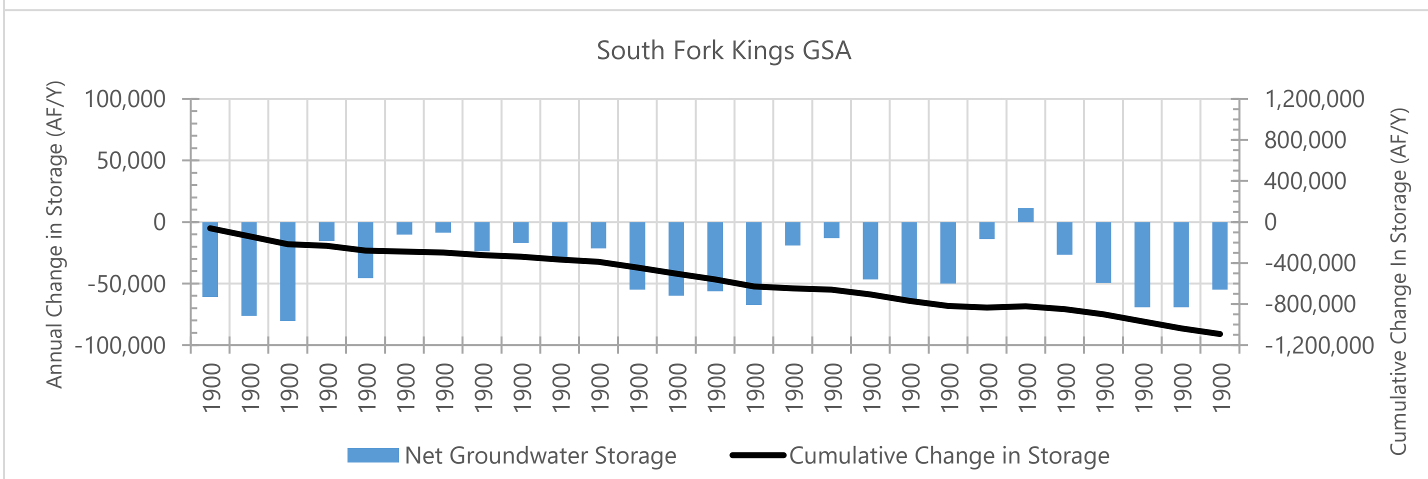
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Tables\GSP Charts v9cFigure 3-29c 8/23/2019

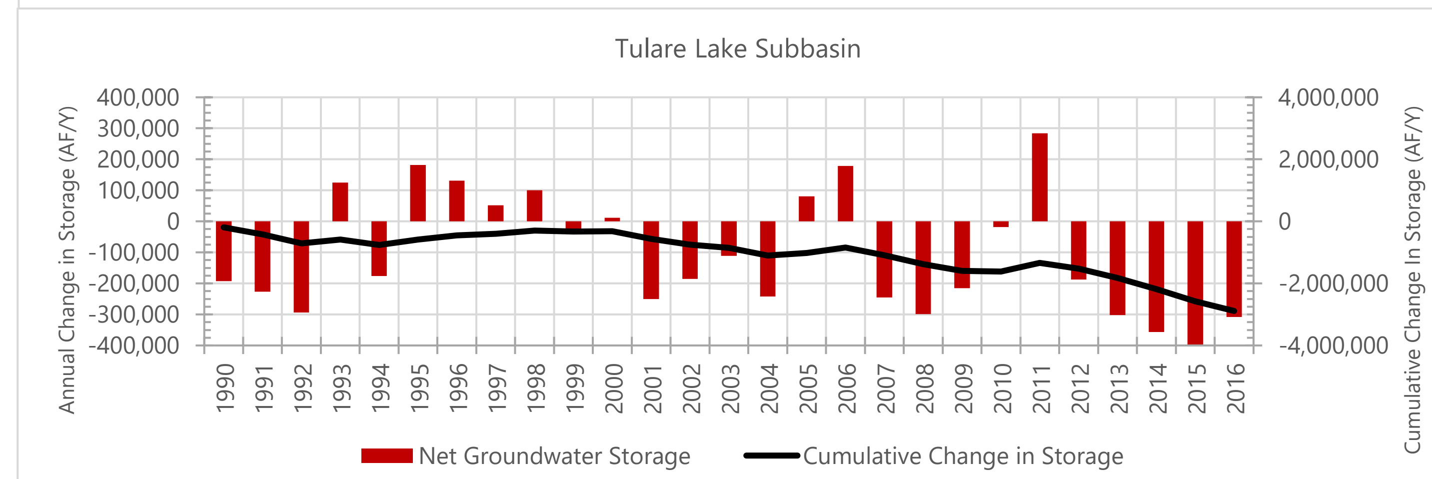






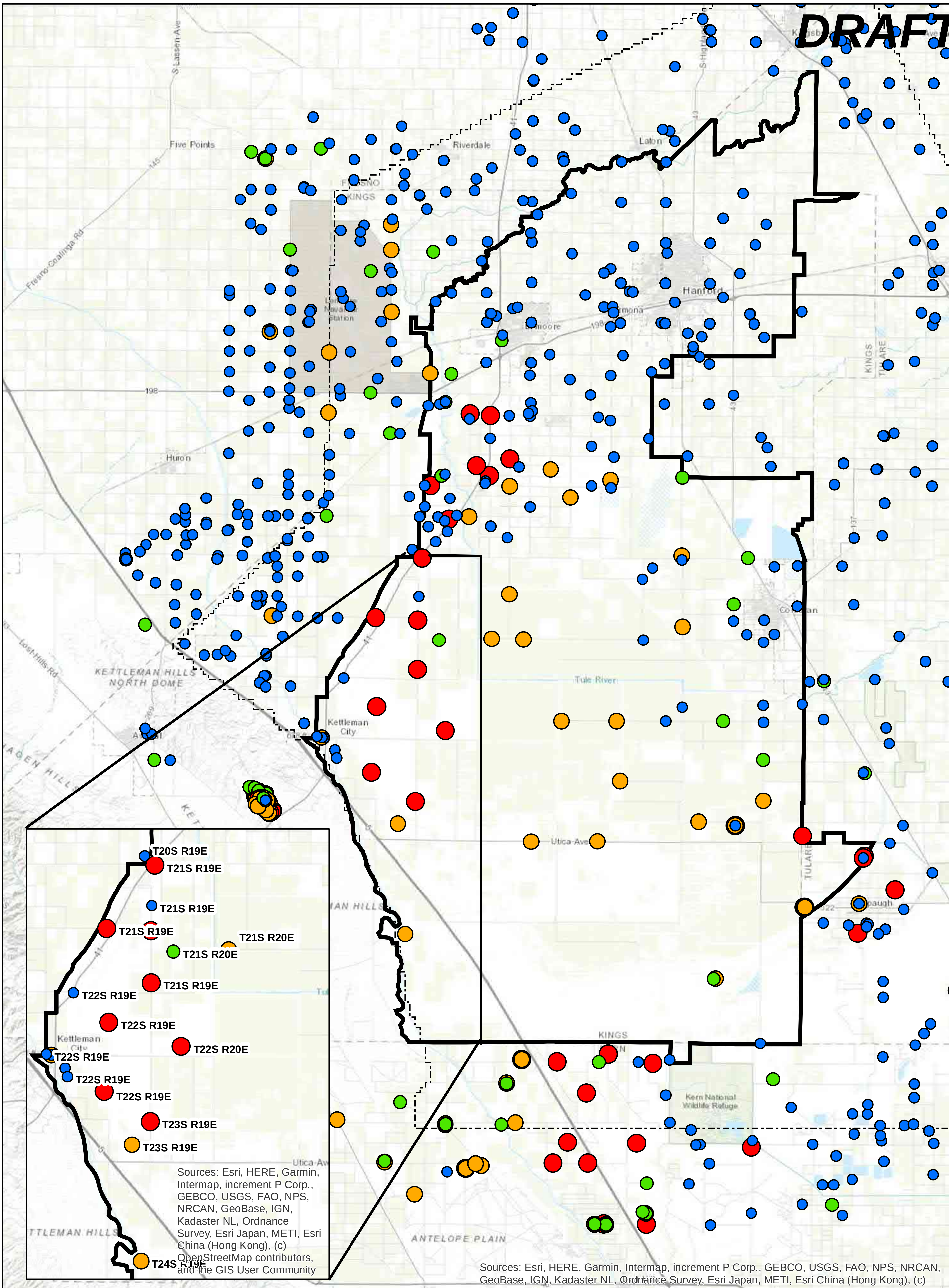






Change in Groundwater Storage
All Aquifer Zones 1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-29c



Explanation

Total Disolved Soilds (TDS)[1]

- <1500 mg/L
- 1500 - 3000 mg/L
- 3000 - 10000 mg/L
- >10000 mg/L

Study Area

Subbasin boundary

Notes:
1) Data compiled from California Water Boards Geotracker. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

Approximate Scale in Feet
0 12,500 25,000 50,000

0 2,500 5,000 10,000
Approximate Scale in Meters

Total Dissolved Solids in Groundwater
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR16181220
wood.		Figure 3-30

Date: 8/20/2019 Printed by: elizabeth.chapman
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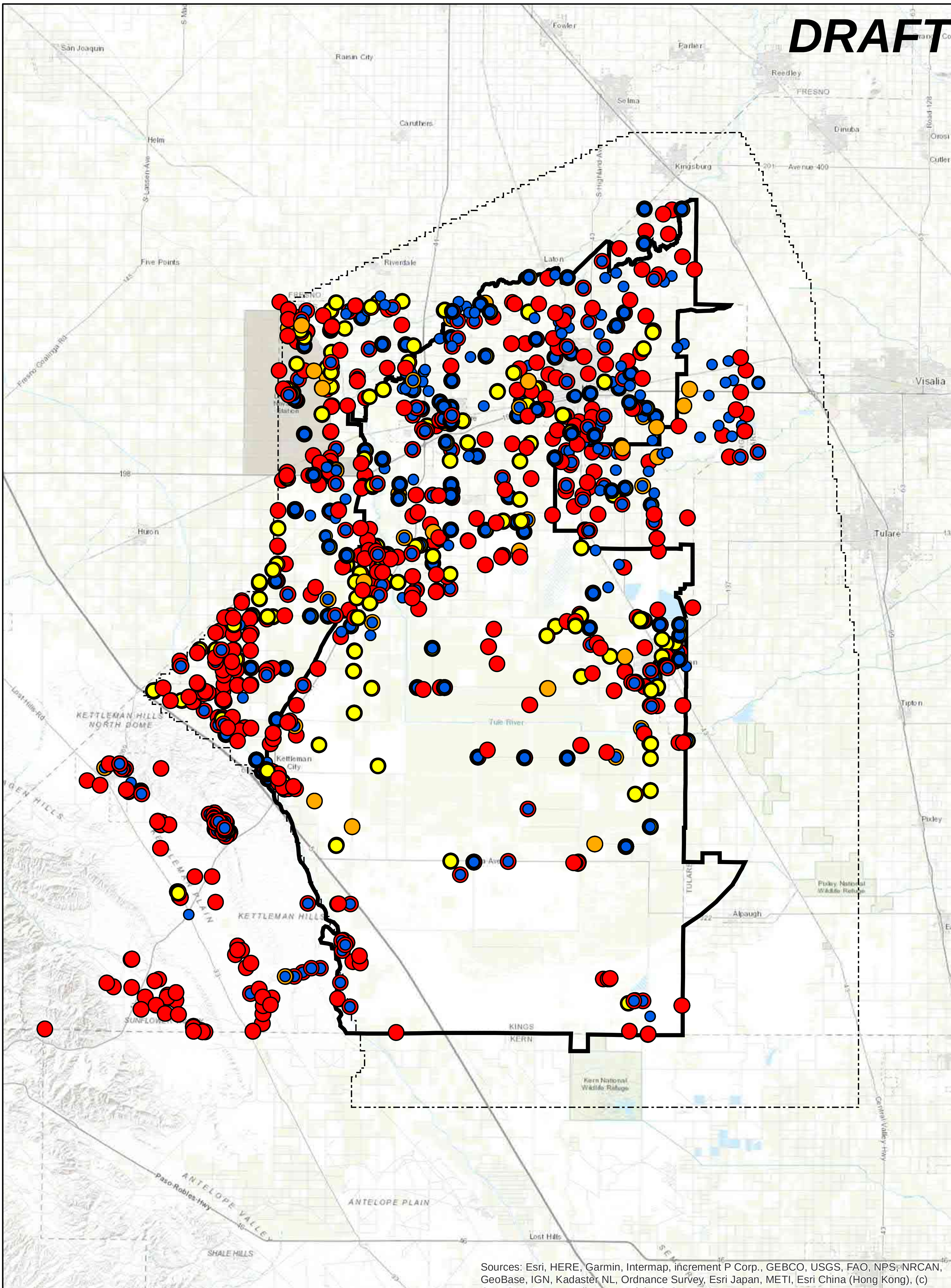

Explanation

Arsenic[1]

- <10 ug/L
- 10.01 - 50.0 ug/L
- 50.1 - 100.0 ug/L
- >100 ug/L

Subbasin boundary

Study Area

Notes:
1) Data compiled from California Water Boards. November 2018: https://gamagroundwater.waterboards.ca.gov/ gama/gamamap/public/Default.asp

Approximate Scale in Feet
0 12,500 25,000 50,000

0 2,500 5,000 10,000
Approximate Scale in Meters

Arsenic in Groundwater
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR16181220
		Figure **3-31**

Date: 8/20/2019 Printed by: elizabeth.chapman
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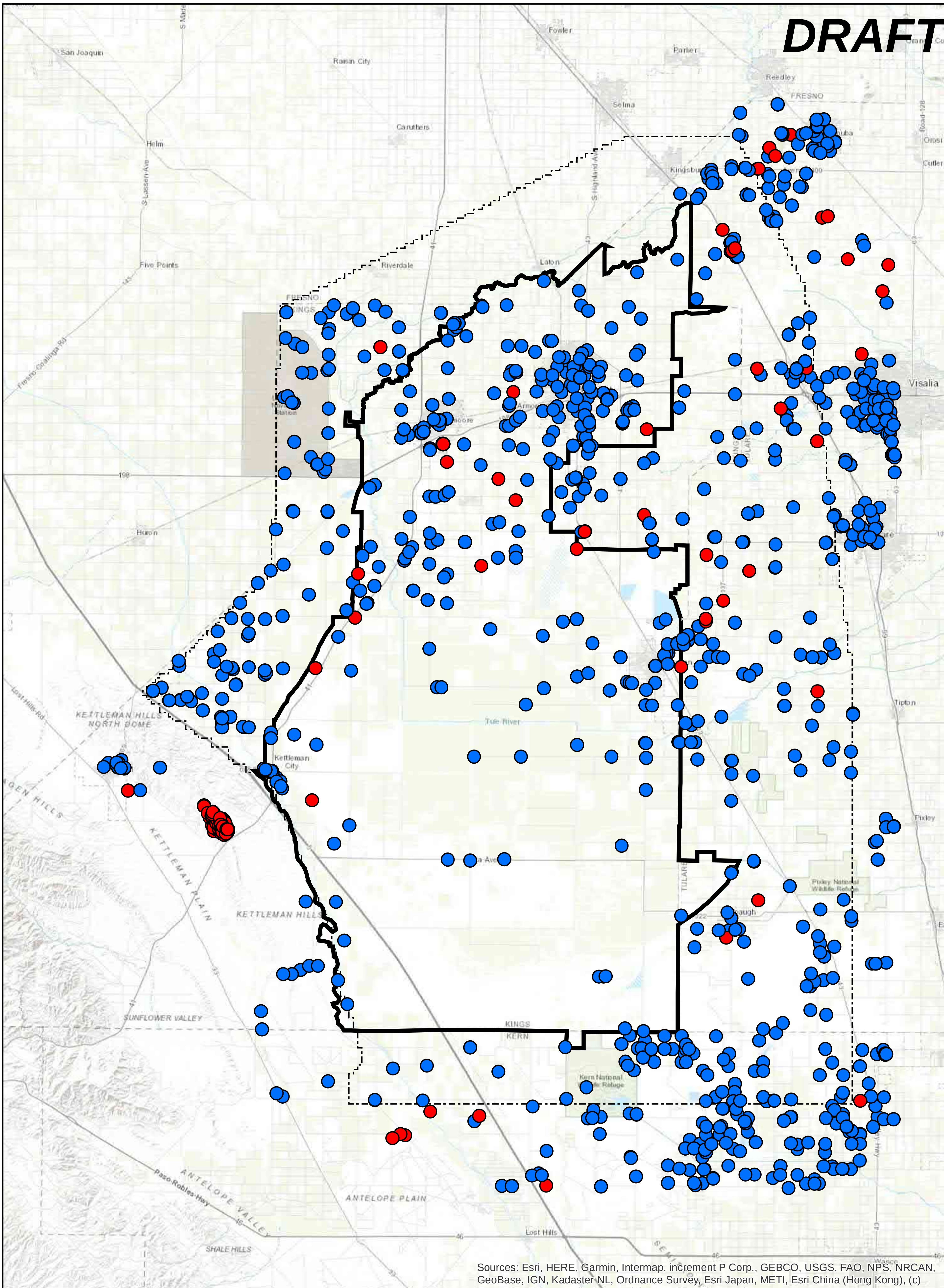

Explanation

Nitrate as Nitrogen, mg/L[1]

<10 mg/L

>10 mg/L

Subbasin boundary

Study Area

Approximate Scale in Feet: 0, 12,500, 25,000, 50,000

Approximate Scale in Meters: 0, 2,500, 5,000, 10,000

Notes:
1) Data compiled from California Water Boards.
November 2018: https://gamagroundwater. waterboards.ca.gov/gama/gamamap/public/Default.asp

Nitrate in Groundwater
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR16181220
		Figure **3-32**

Date: 8/22/2019 Printed by: elizabeth.chapman
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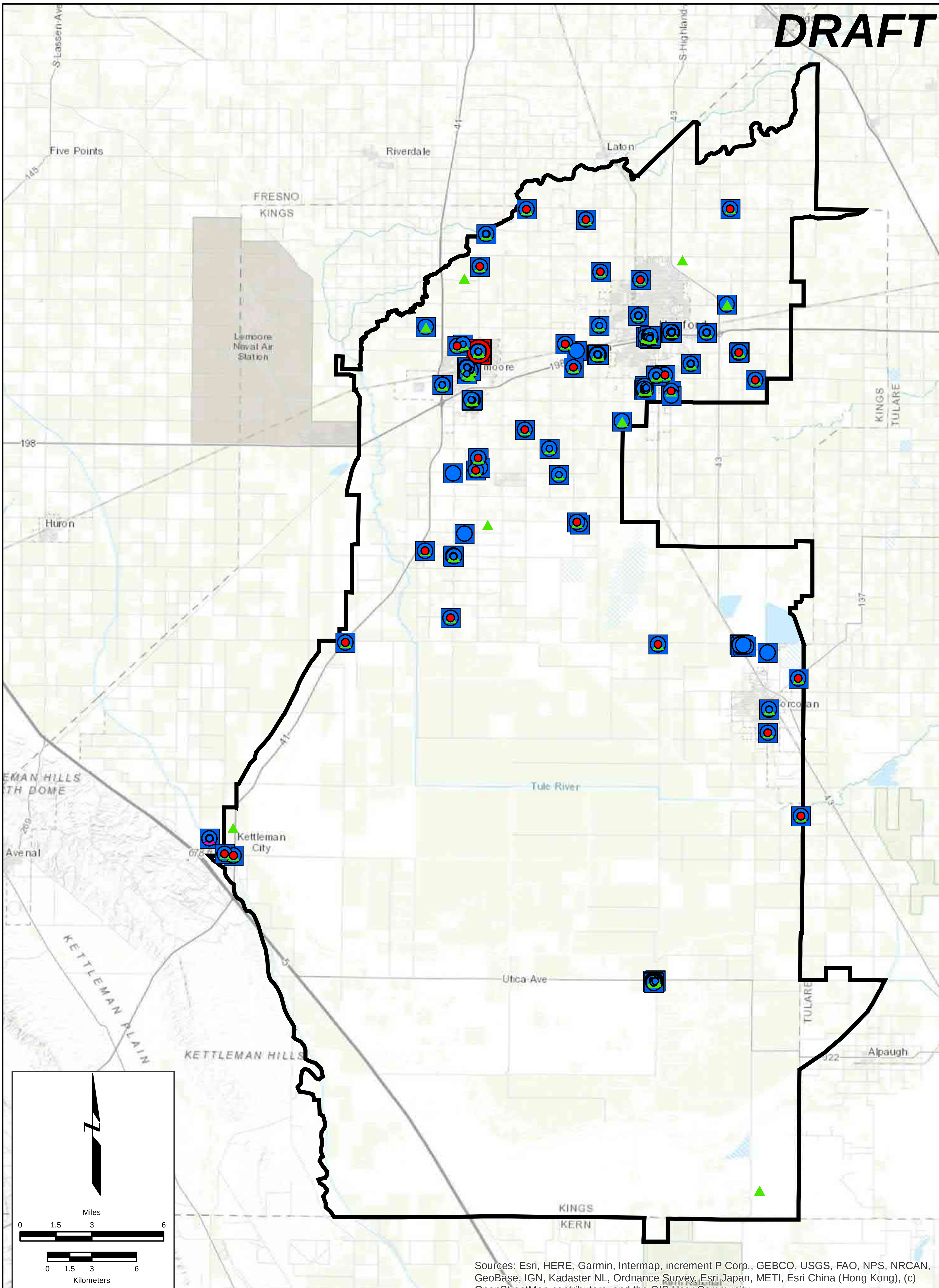

Explanation

PCE		TCE		DBCP		123 TCP	
■	<5.00 ug/L	●	<5.00 ug/L	▲	<0.20 ug/L	●	<0.005 ug/L
■	>5.01 ug/L	●	>5.01 ug/L	▲	>0.21 ug/L	●	>0.006 ug/L

Subbasin boundary

Notes:
1) Data compiled from California Water Boards. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

Volatile Organic Compounds in Groundwater

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/22/2019	Project No.: FR16181220
		Figure **3-33**

Date: 8/20/2019 Printed by: elizabeth.chapman
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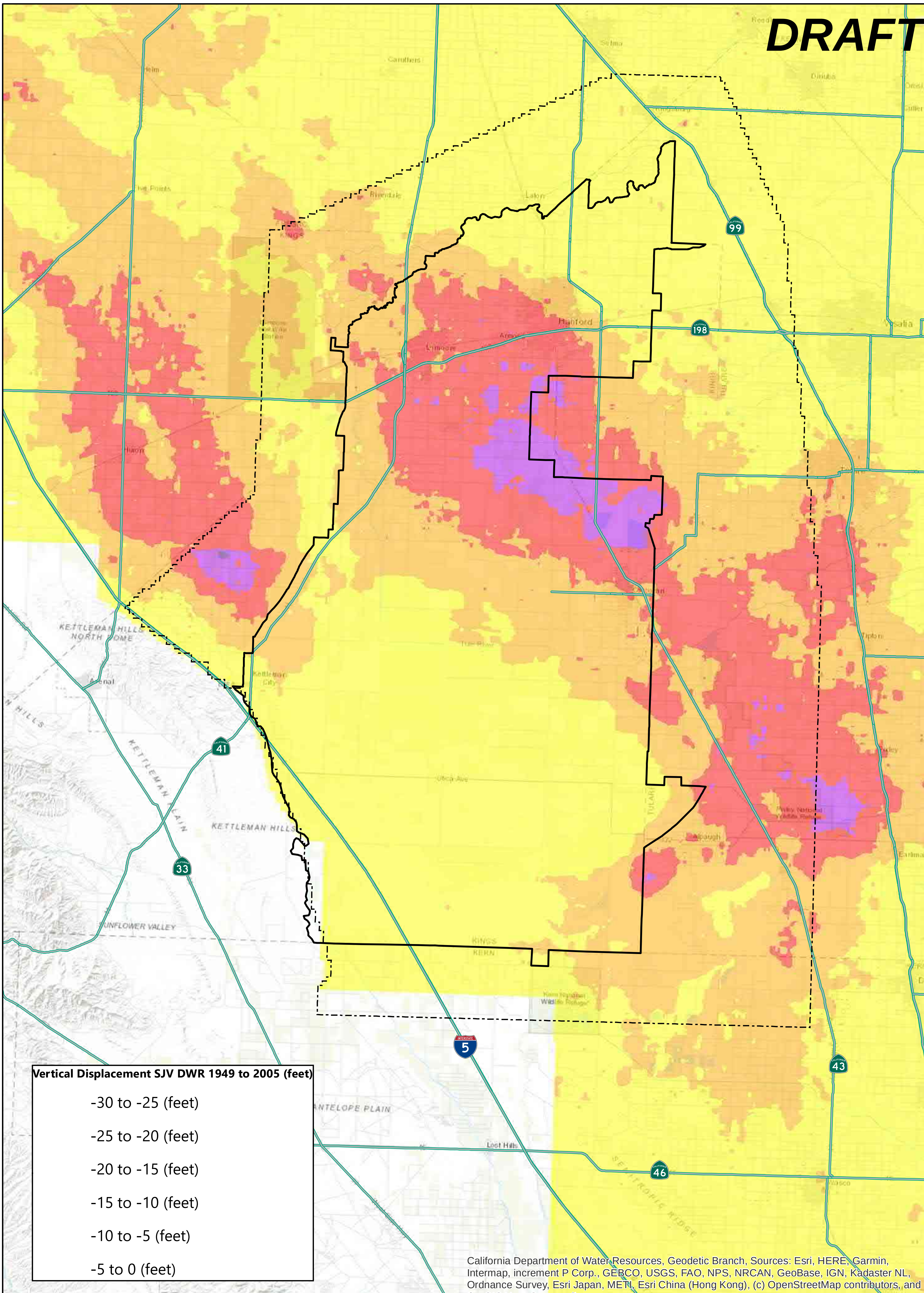


California Department of Water Resources, Geodetic Branch, Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Explanation

Subbasin boundary

Study Area

Miles: 0, 2.5, 5, 10

Kilometers: 0, 3.5, 7, 14

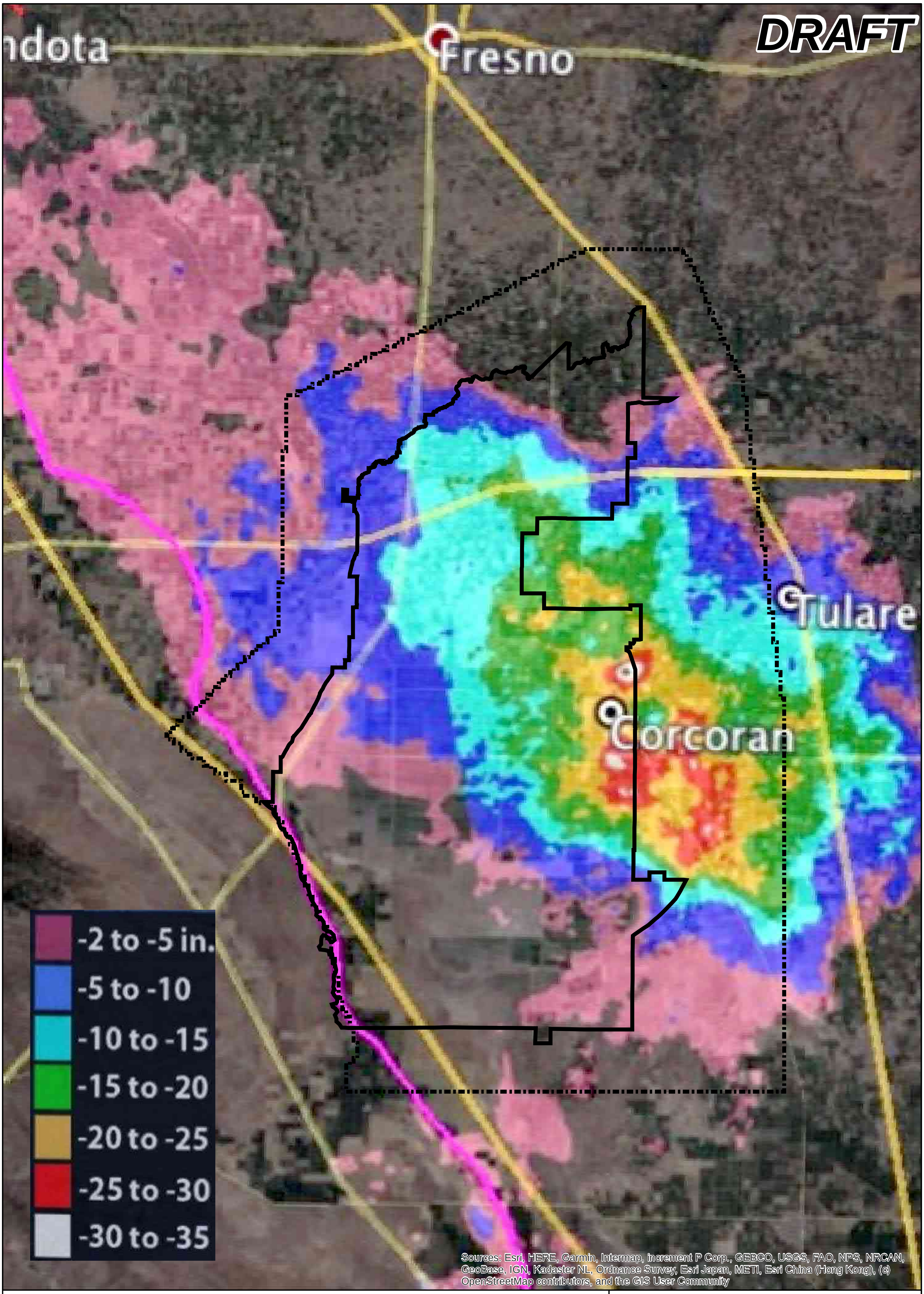
Notes:
1. Vertical Displacement dataset taken from California Department of Water Resources. https://sgma.water.ca.gov/webgis. Accessed July 9, 2019.

Historic Subsidence San Joaquin Valley 1949-2005

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-34**

Date: 8/23/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-35a_Recent Subsidence San Joaquin Valley.mxd



Explanation

- California Aqueduct
- Boundary of Tulare Lake Subbasin
- Study Area

Miles: 0, 2.5, 5, 10
Kilometers: 0, 3.5, 7, 14

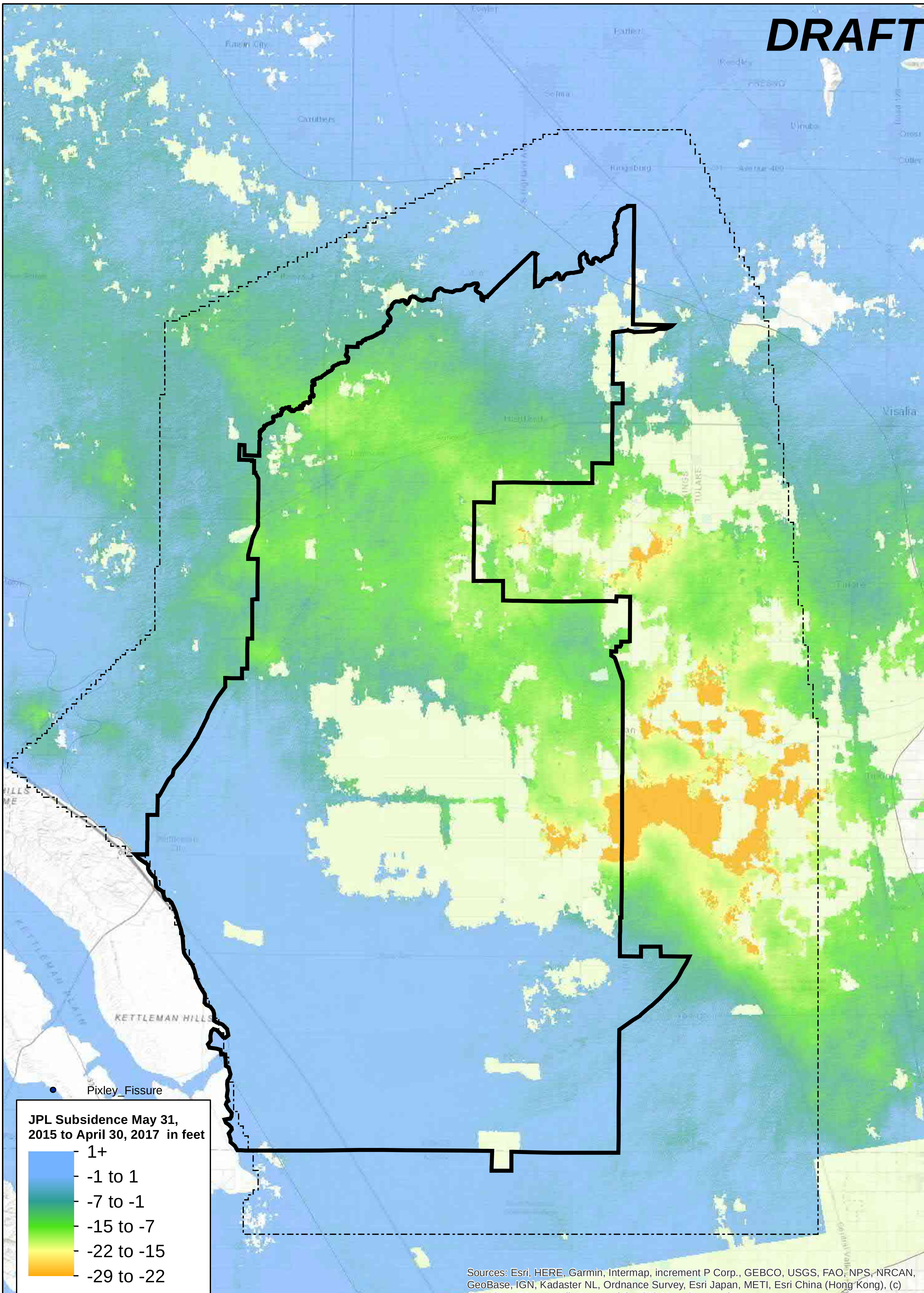
Notes:
PALSAR Satellite imaging taken from NASA's Jet Propulsion Labratory (JPL) dataset accessed from https://water.ca.gov/LegacyFiles/groundwater/docs/NASA_REPORT.pdf on July 16, 2019

Subsidence in the San Joaquin Valley 2007 to 2010

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/23/2019	Project No.: FR16181220
		Figure **3-35a**

Date: 8/23/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-35b_Recent Subsidence San Joaquin Valley.mxd



Explanation

- Pixley_Fissure
- Boundary of Tulare Lake Subbasin
- Study Area

Miles: 0, 2.5, 5, 10
Kilometers: 0, 3.5, 7, 14

Notes:
NASA's Jet Propulsion Laboratory (JPL) dataset accessed from Department of Water Resources https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub on July 15, 2019

Subsidence in the San Joaquin Valley 2015 to 2017
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/23/2019	Project No.: FR16181220

Figure **3-35b**

Date: 8/20/2019 Printed by: elizabeth.chapman
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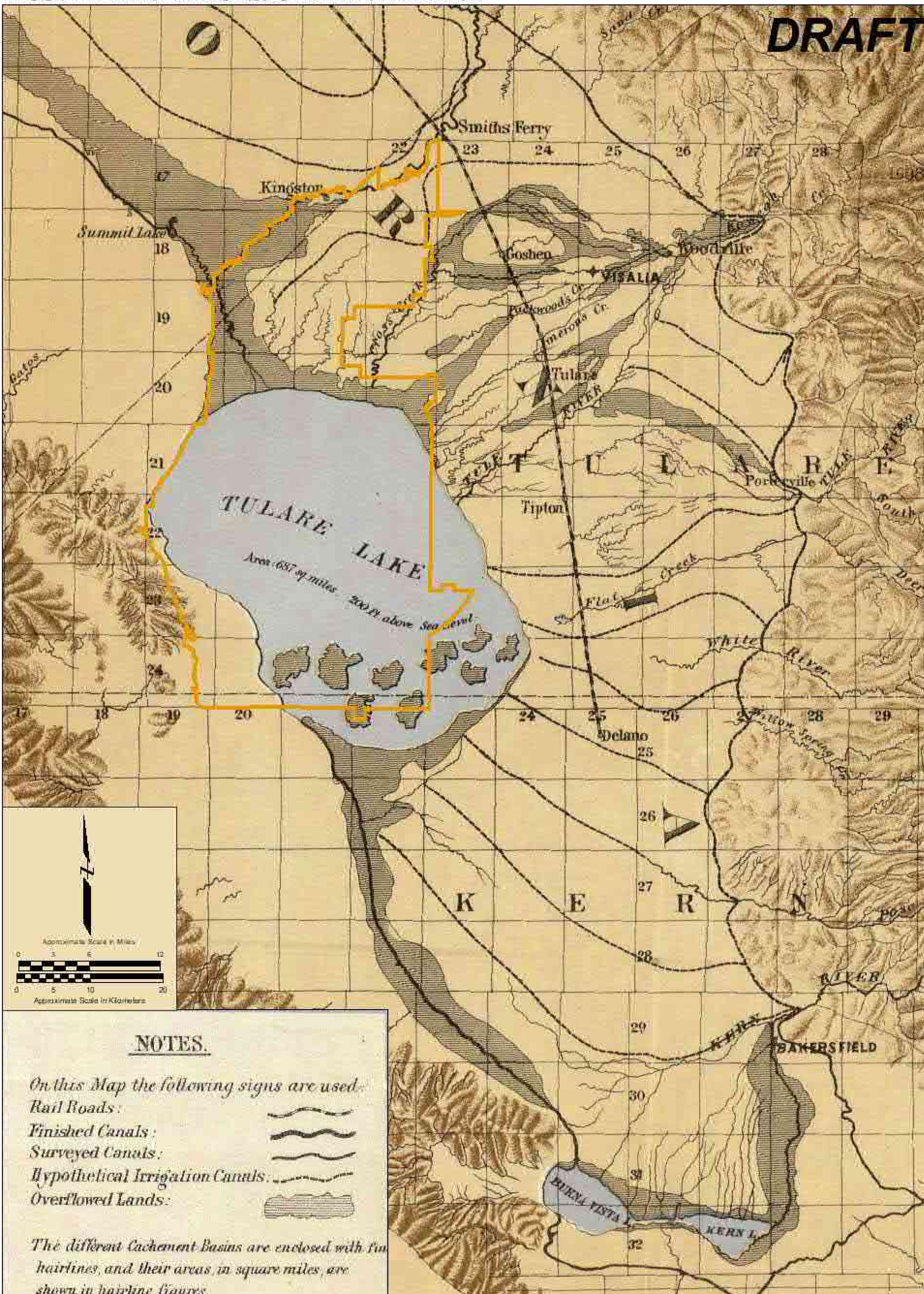


Explanation

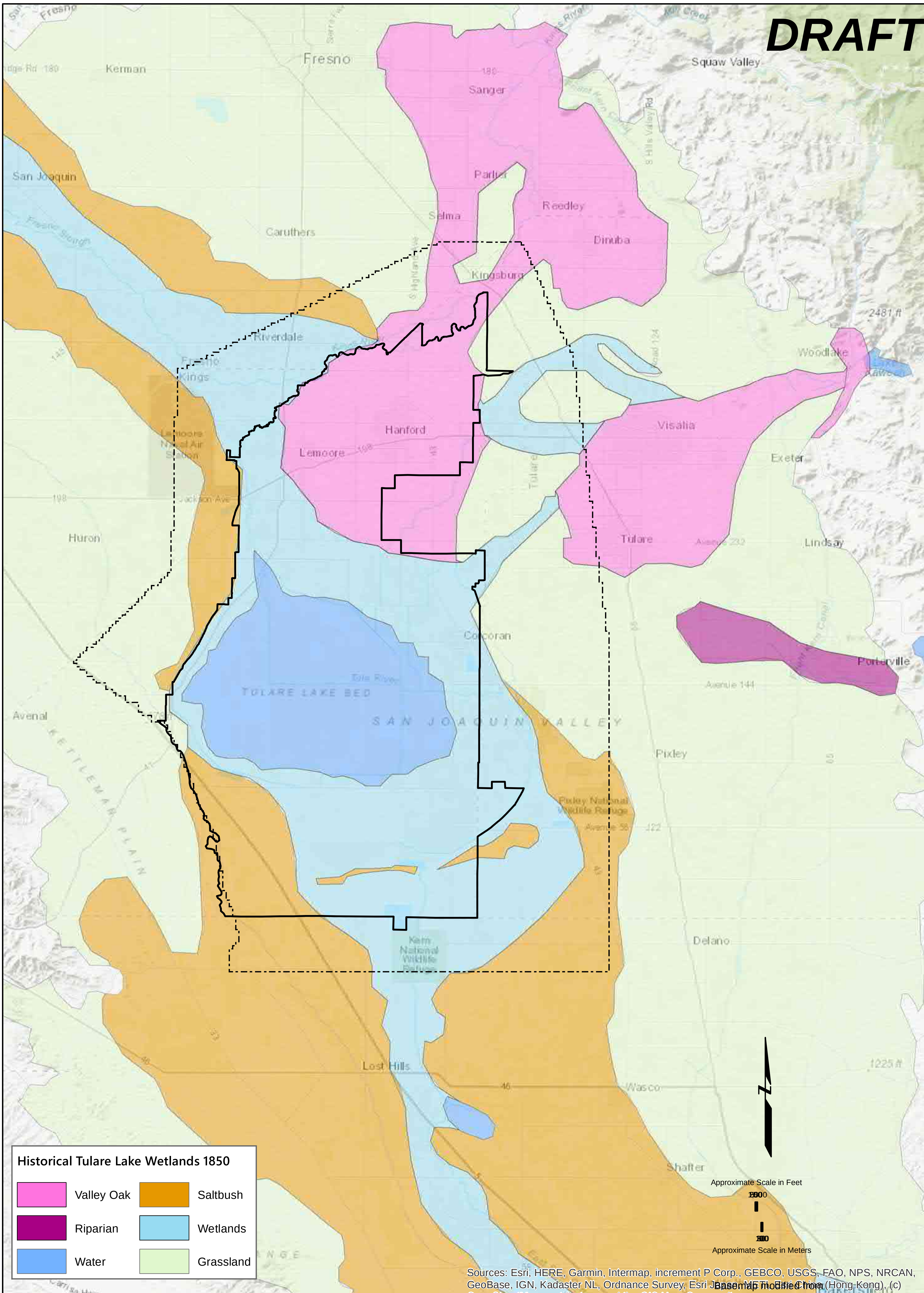
Boundary of Tulare Lake Subbasin

Note:

Adapted from "Map of the San Joaquin, Sacramento and Tulare Valleys, State of California, Prepared Under The Direction of the Board of Commissioners on Irrigation, 1873"

Historic Drainage System
Tulare Lake Basin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 8/20/2019	Project No.: FR16181220
		Figure **3-36**



Explanation

Study Area

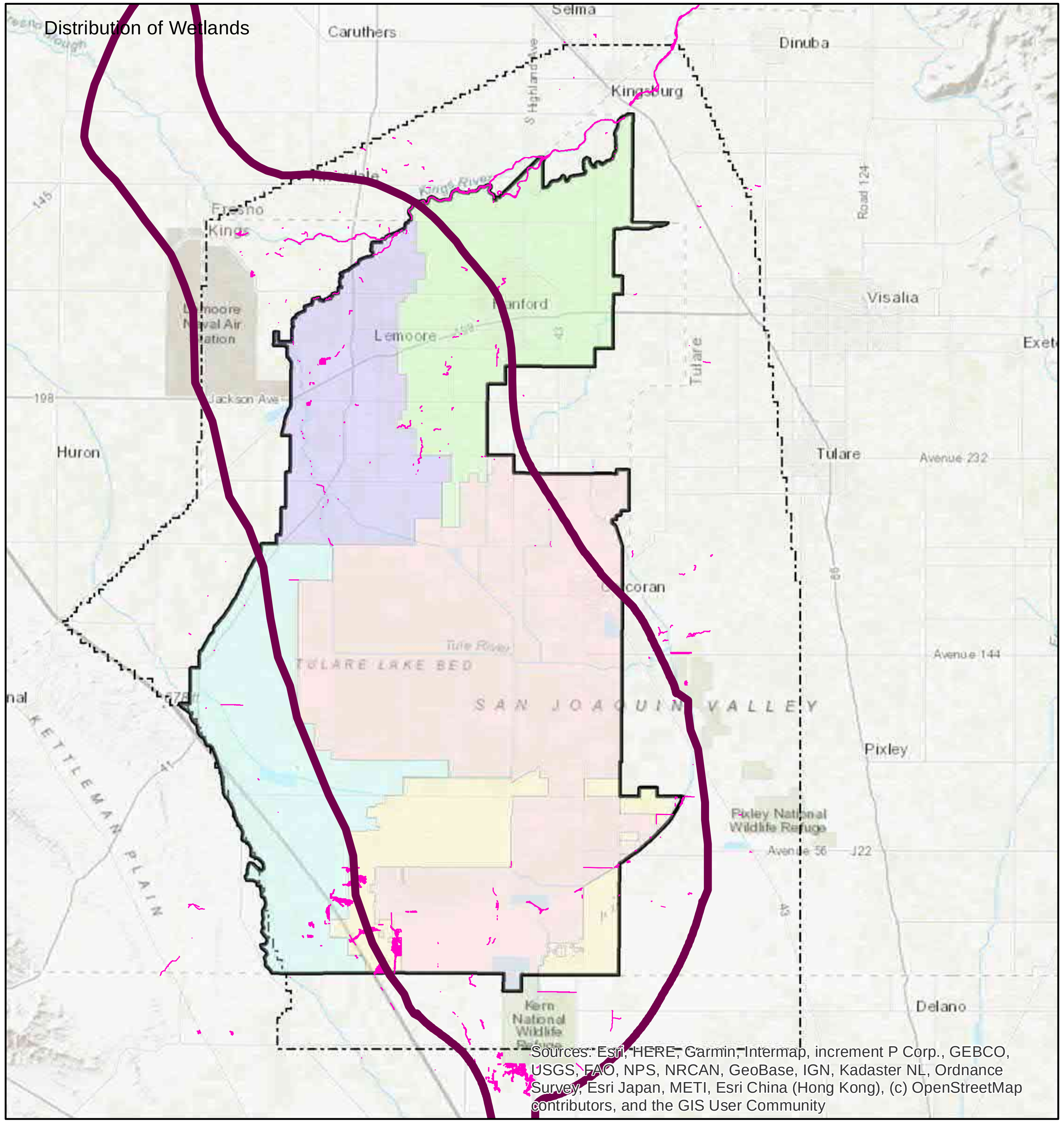
Subbasin boundary

Notes:
figure adapted from
http://www.tularebasinwildlifepartners.org/history.html.
July 16, 2019

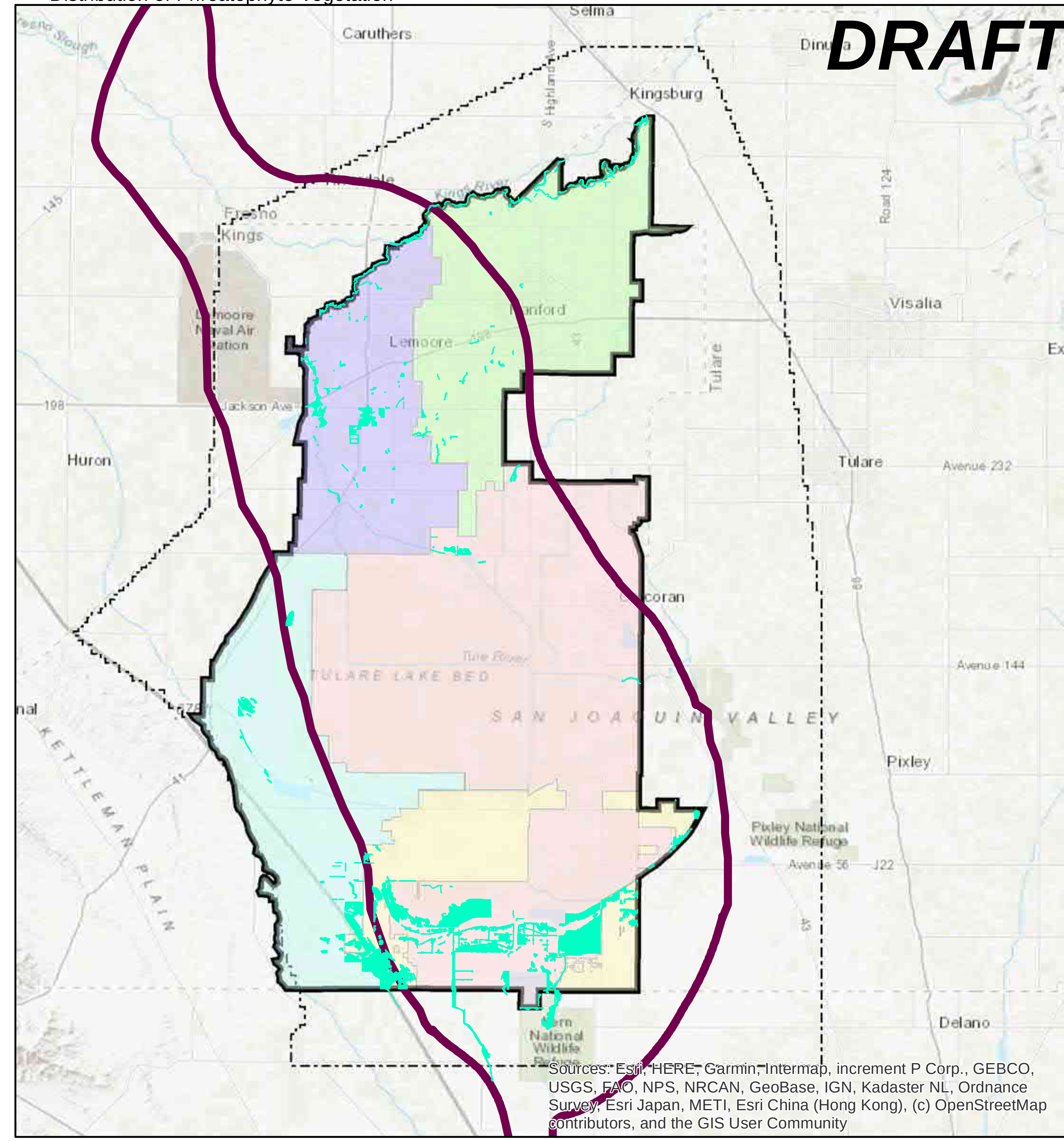
Historical Wetlands Distribution

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-37**



Distribution of Phreatophyte Vegetation



Explanation

- Subbasin boundary
- Study Area
- Extent of A-Clay
- California Natural Resources Agency Wetlands
- California Natural Resources Agency Phreatophyte Vegetation

Groundwater Sustainability Agencies (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Miles: 0, 4, 8, 16
Kilometers: 0, 5, 10, 20

Notes:
1) California Natural Resources Agency data taken from http://resources.ca.gov/wetlands/inventories/inventories.html, accessed November 2018.

Distribution of Wetlands and Phreatophyte Vegetation
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
	Figure	**3-38**

Date: 8/20/2019 Printed by: elizabeth.chapman
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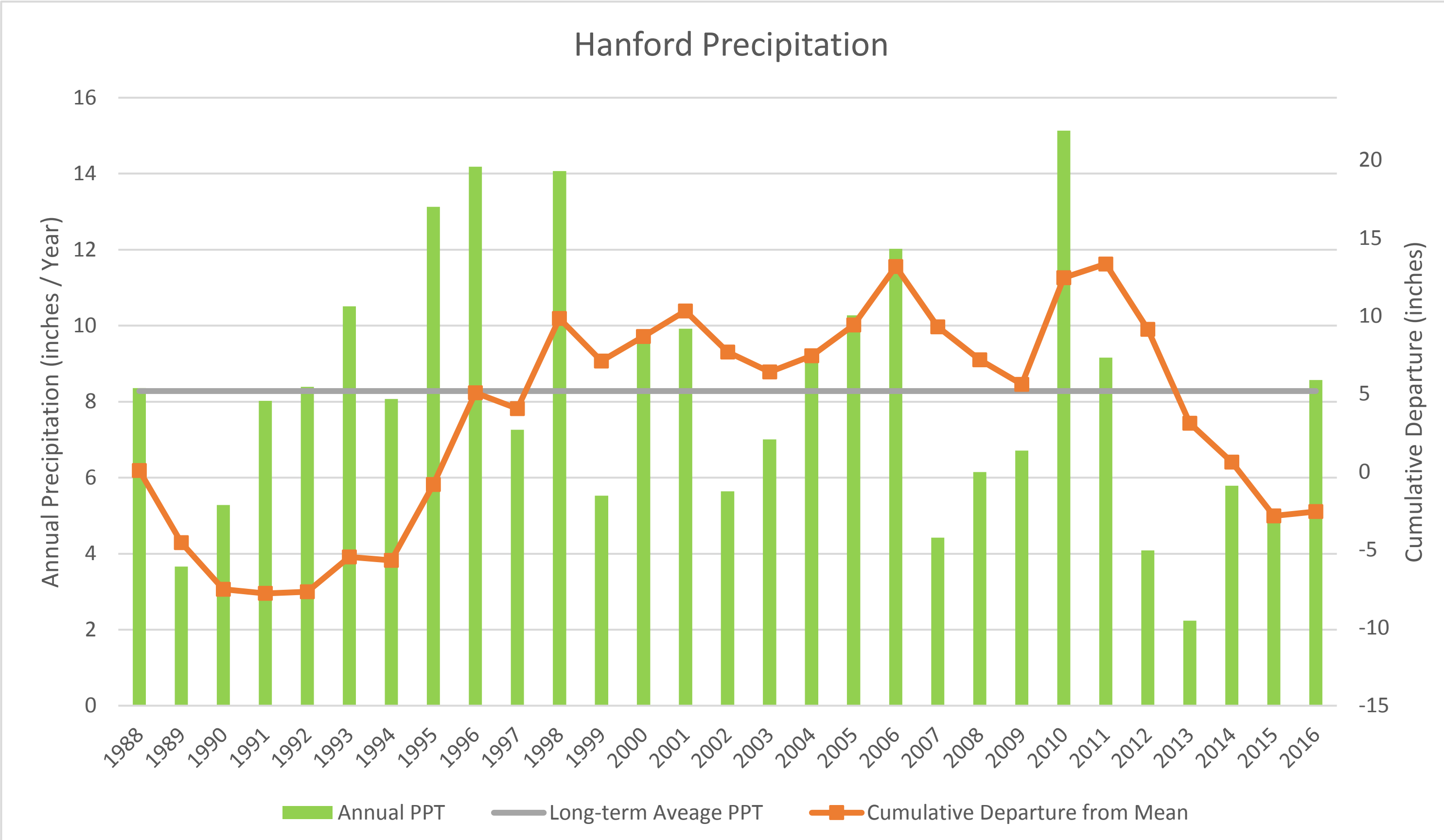
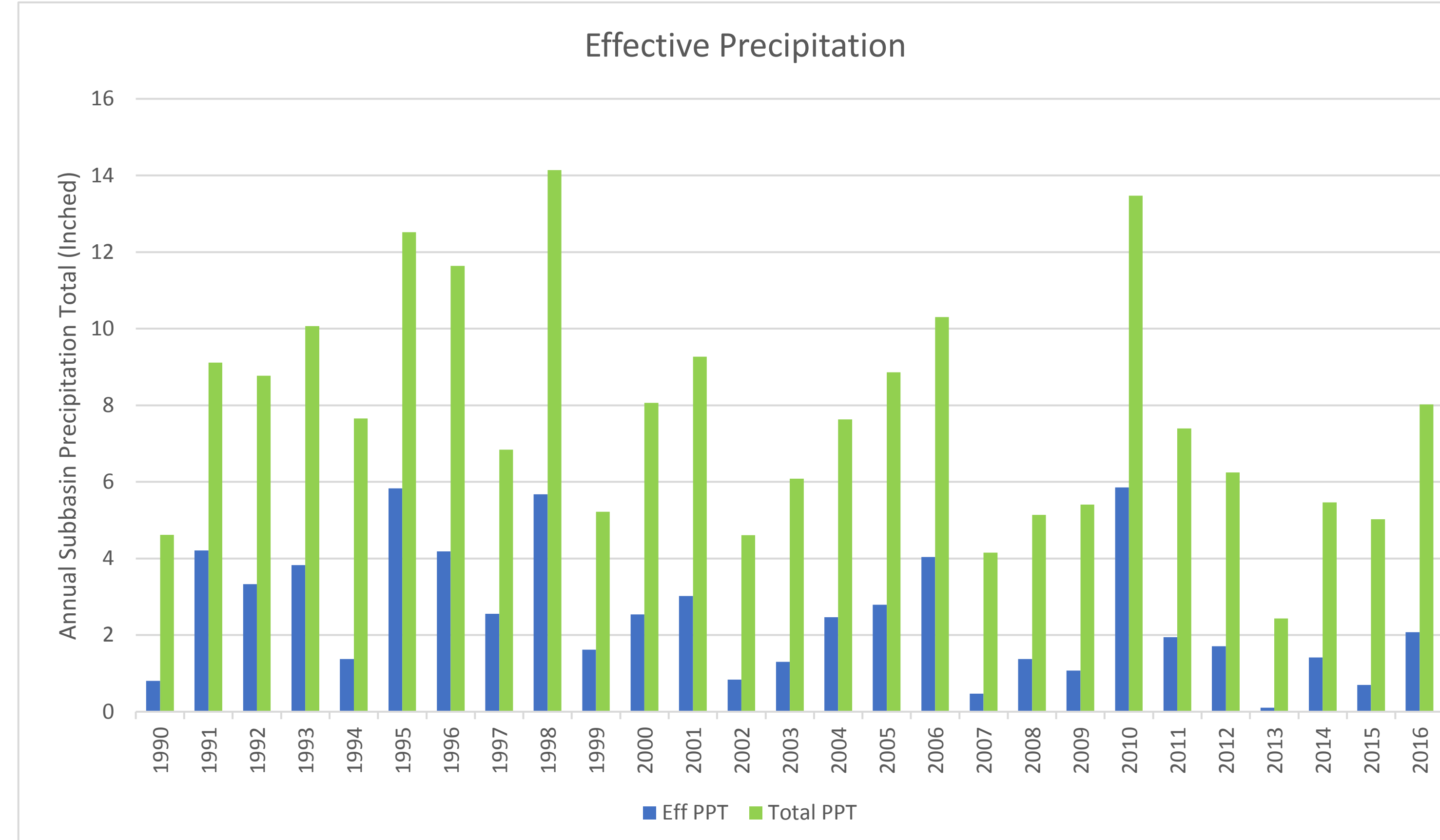
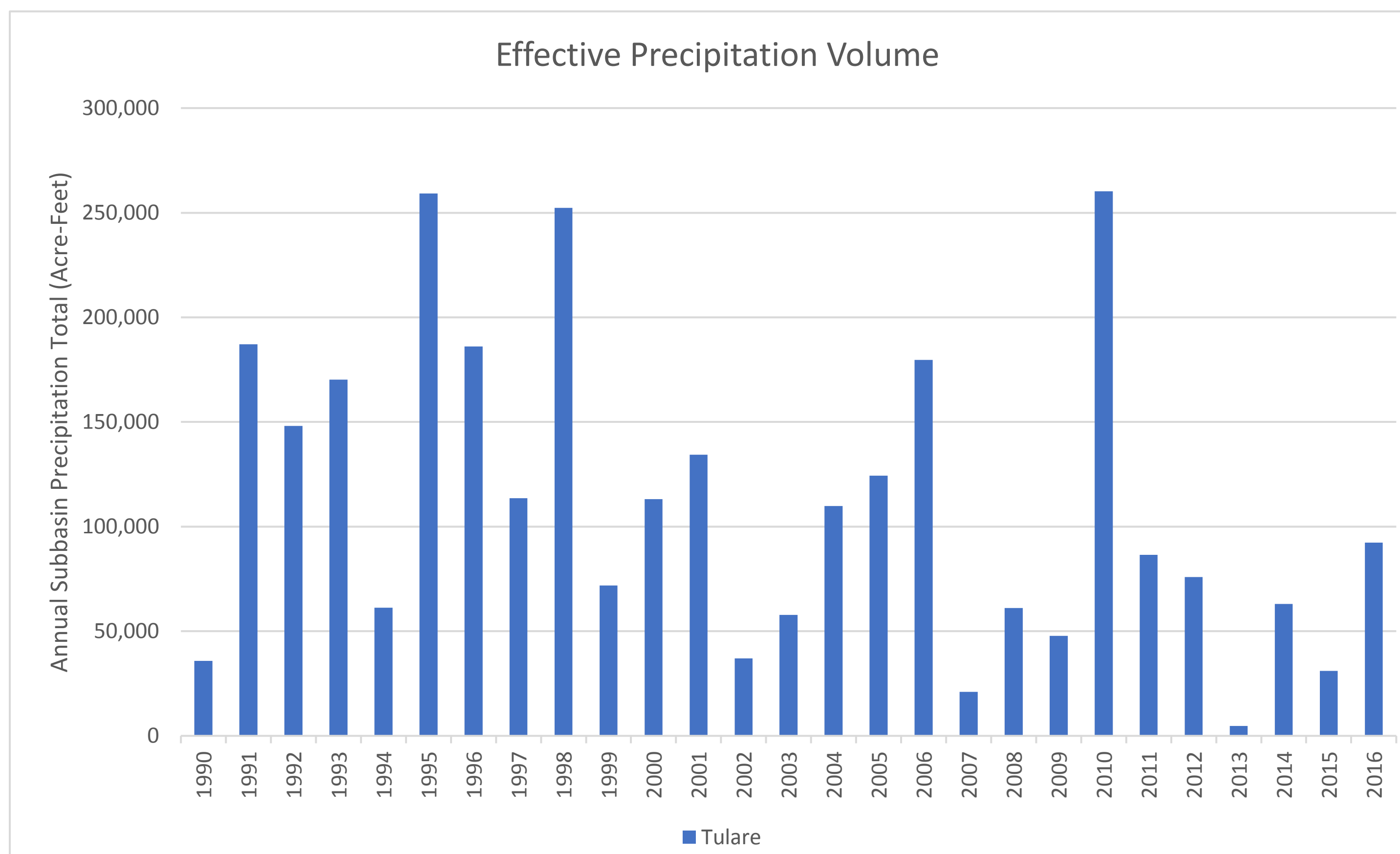


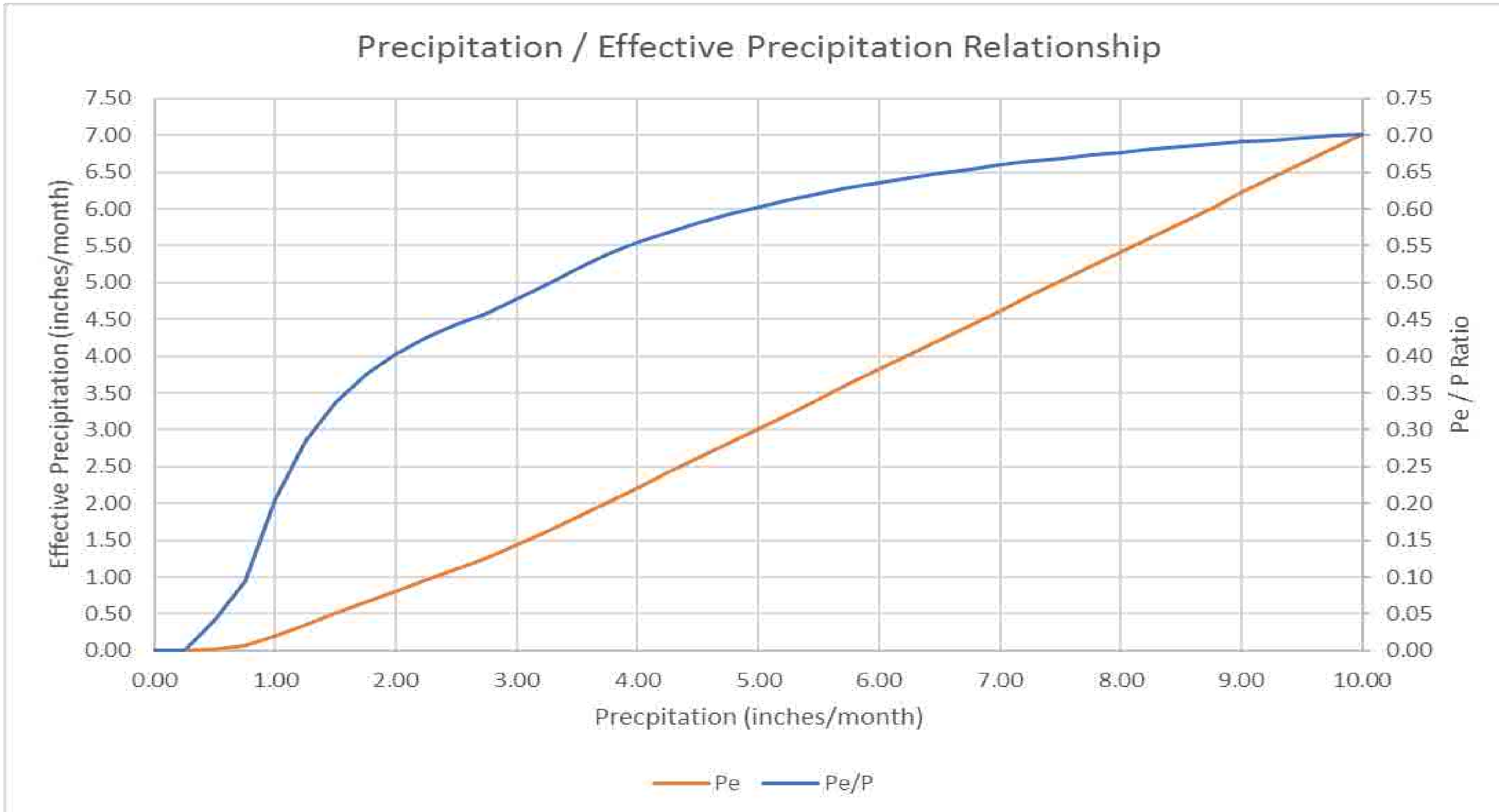




Annual Precipitation, Effective Precipitation, and Effective Precipitation Volume

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-39



Notes:

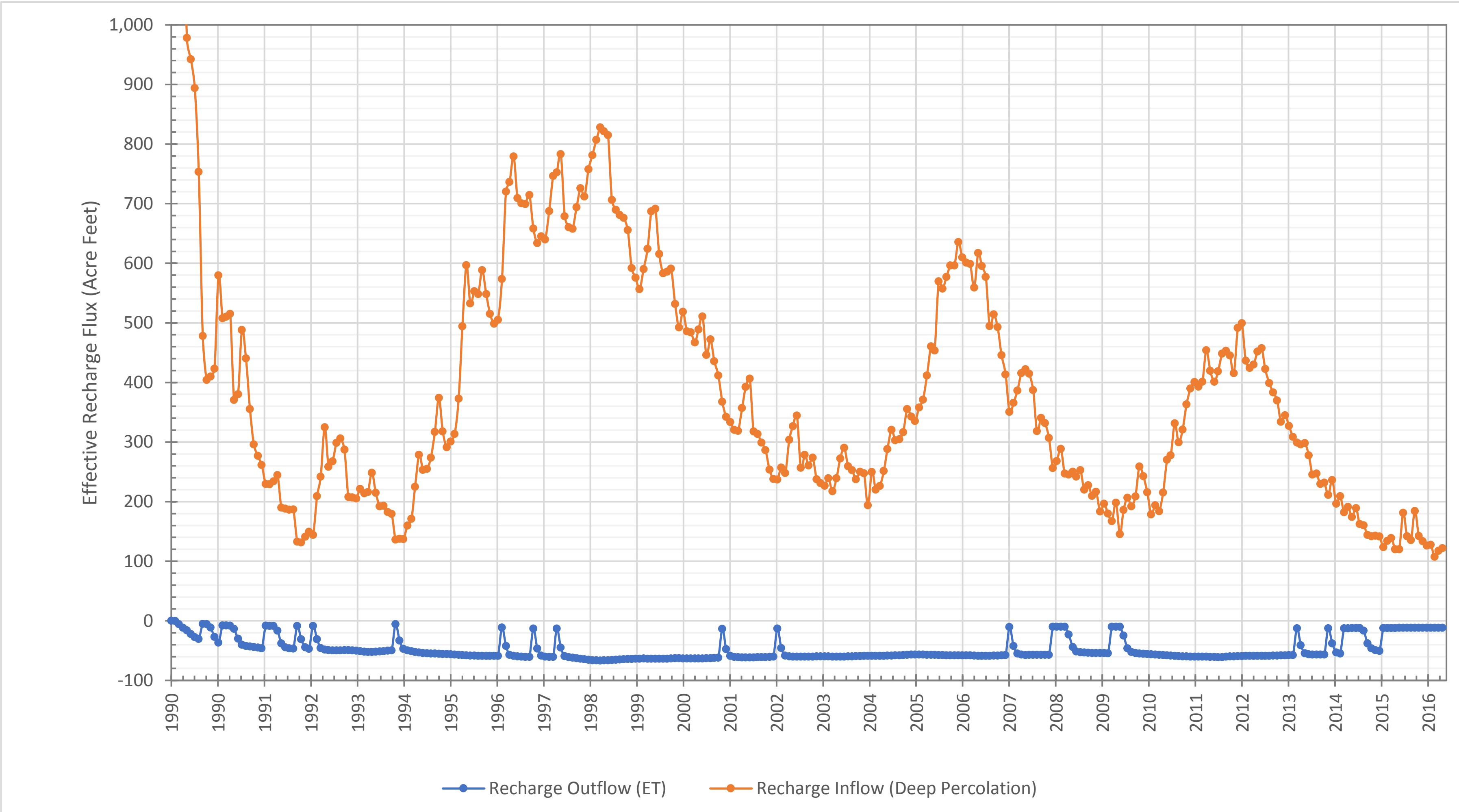
Modified from:
United Nations Food and Agriculture Organization (FAO)
FAO 56,Chapter 3 Table 6
Precipitation (P) and Effective Precipitation (Pe) in inches/month

Precipitation Versus Effective Precipitation

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-40

I:\FR18s\FR18161220 Tulare Lake GSP\Draft\phase 6-basin setting\Figures\Charts\Water BalanceFigure 3-41 11/21/2018

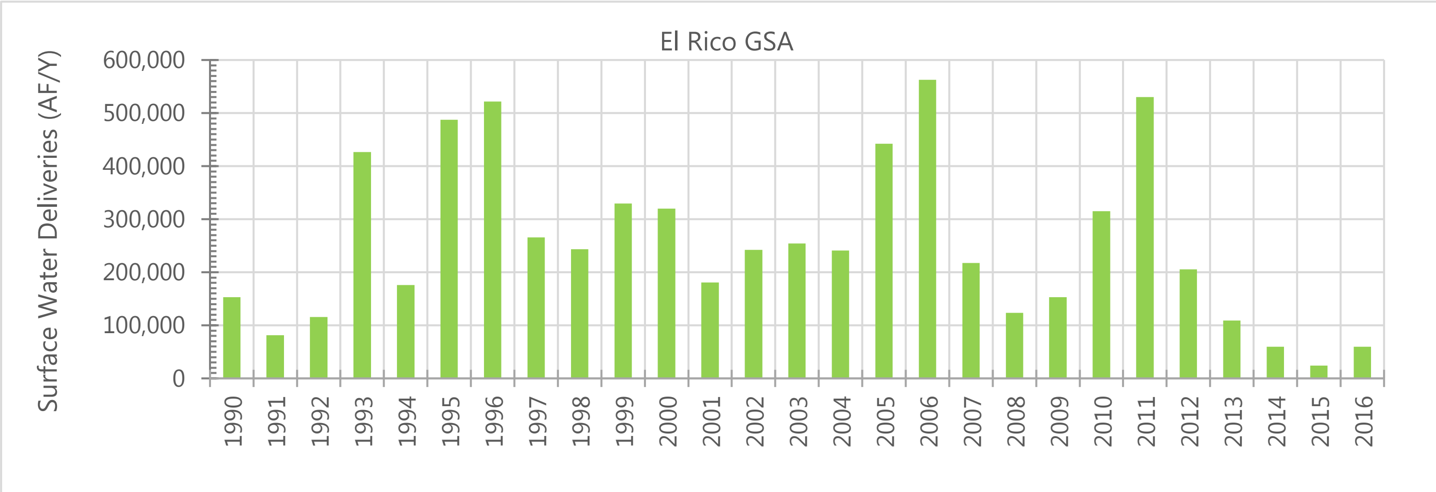


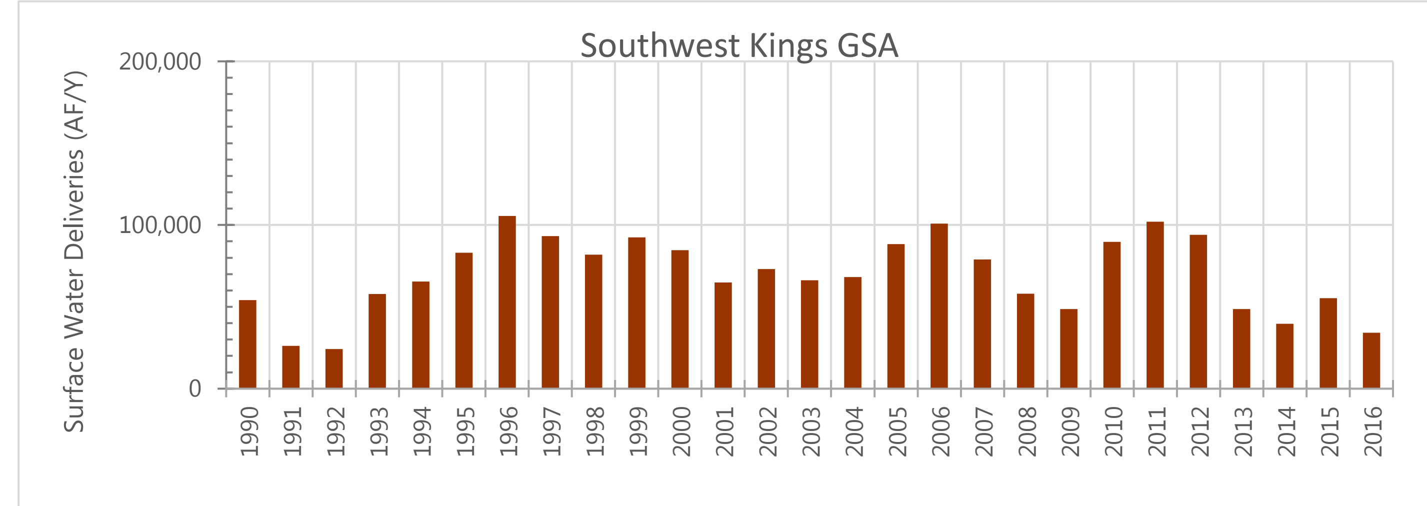
Effective Recharge 1990 to 2016

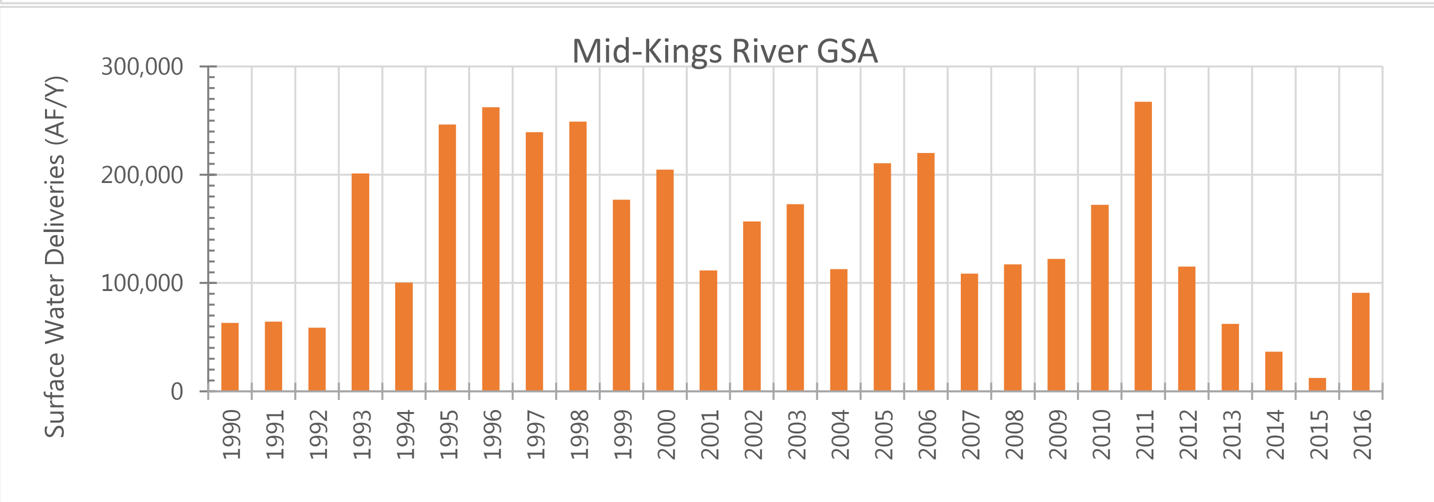
Tulare Lake Sub-Basin Groundwater Sustainability Plan

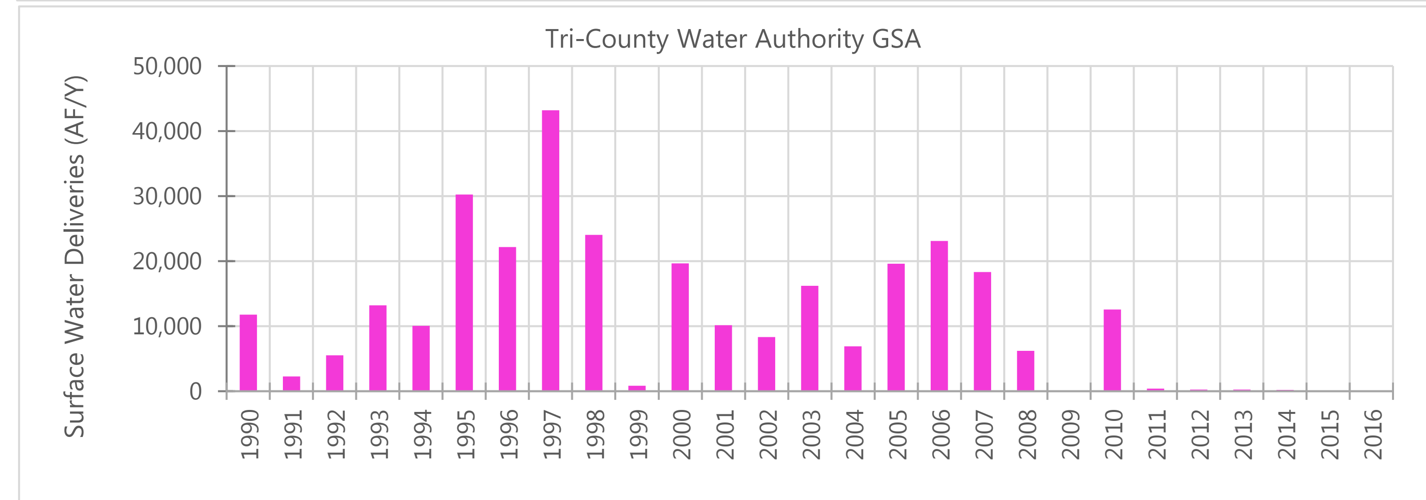
Kings County, California

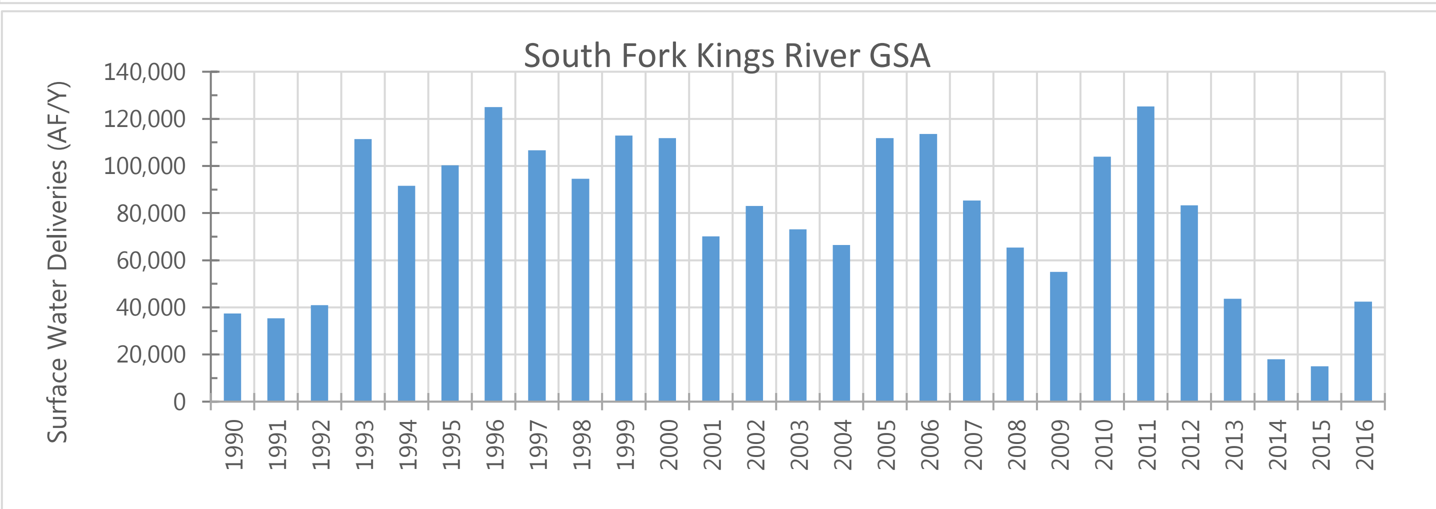
By: GLK	Date: 11/20/2018	Project No.: FR18161220
wood.		**Figure** 3-41

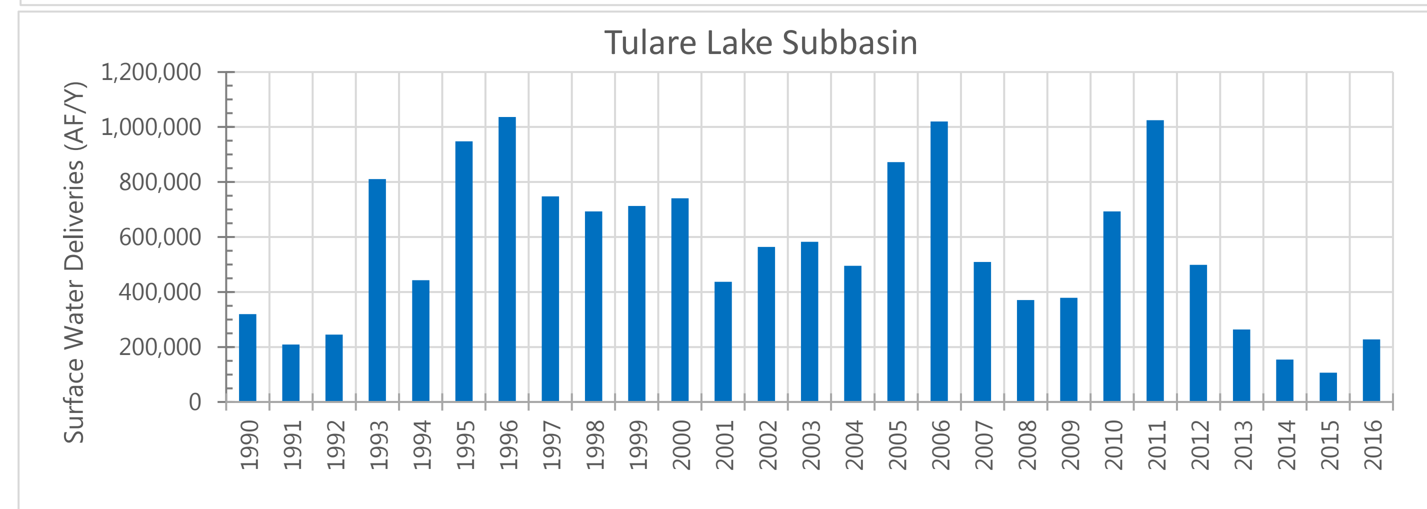






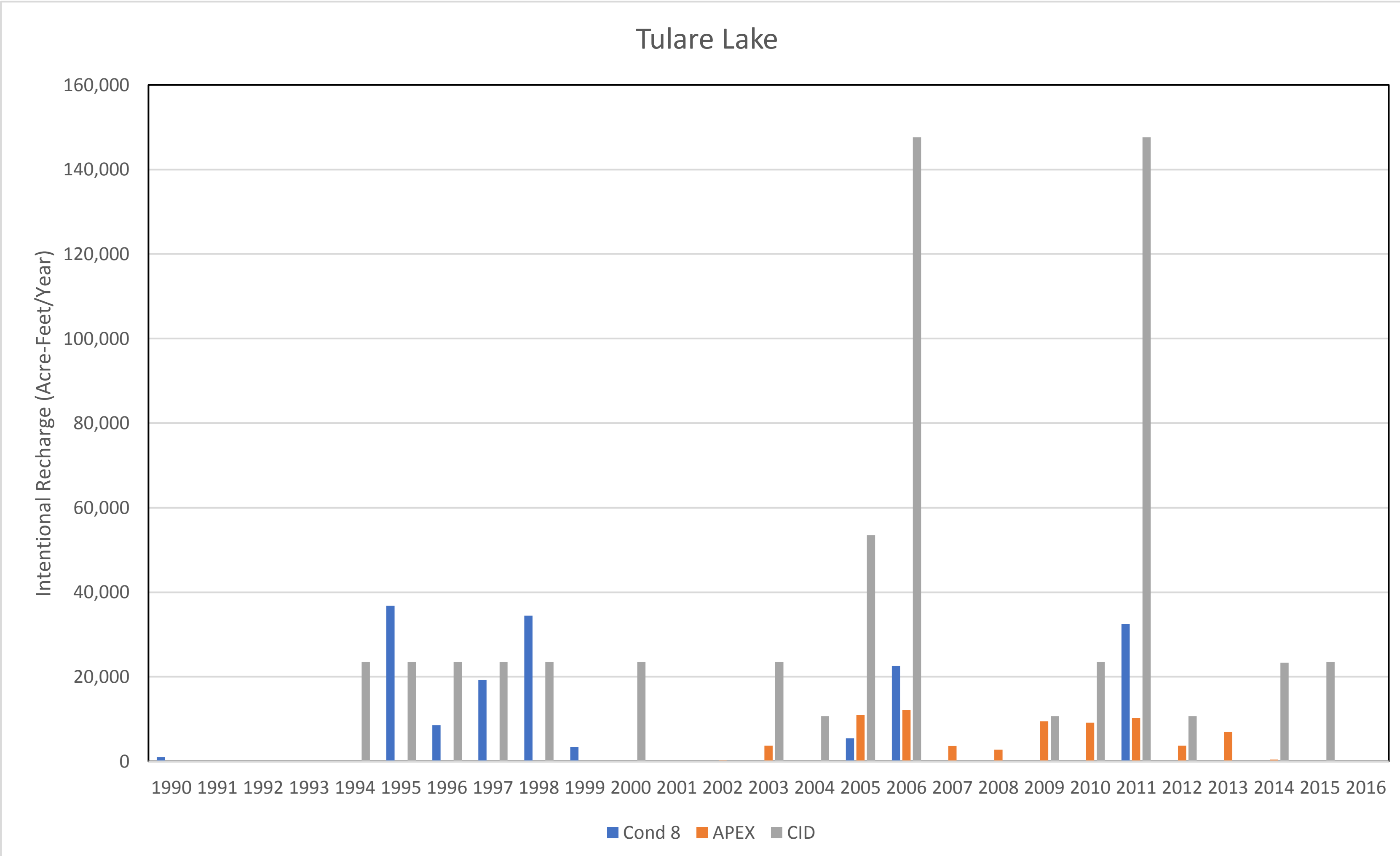






Surface Water Diversions
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

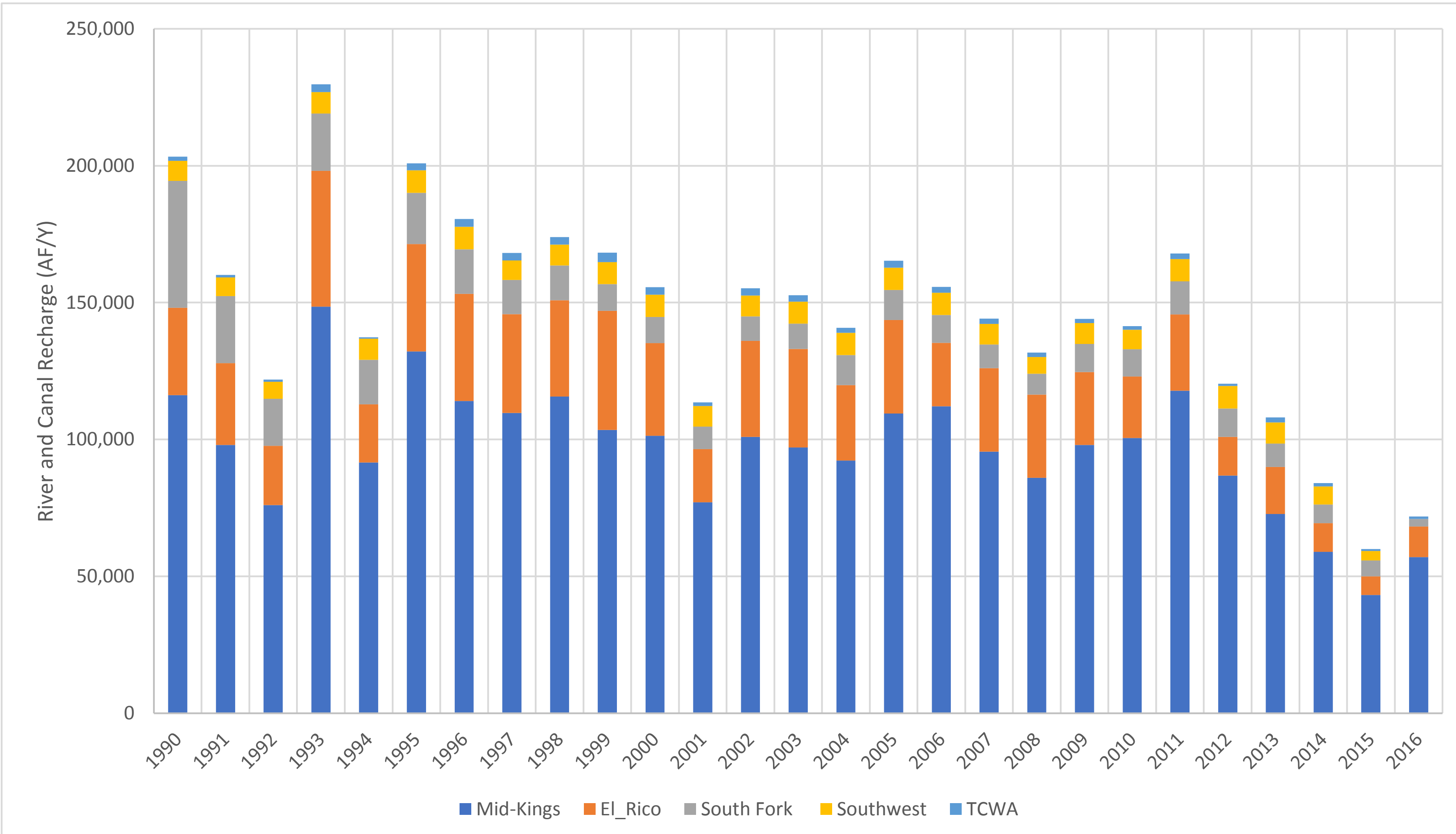
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-42



Note:
Mid-Kings River GSA, South Fork Kings GSA, and Southwest Kings GSA do not have lake inflows or outflows.

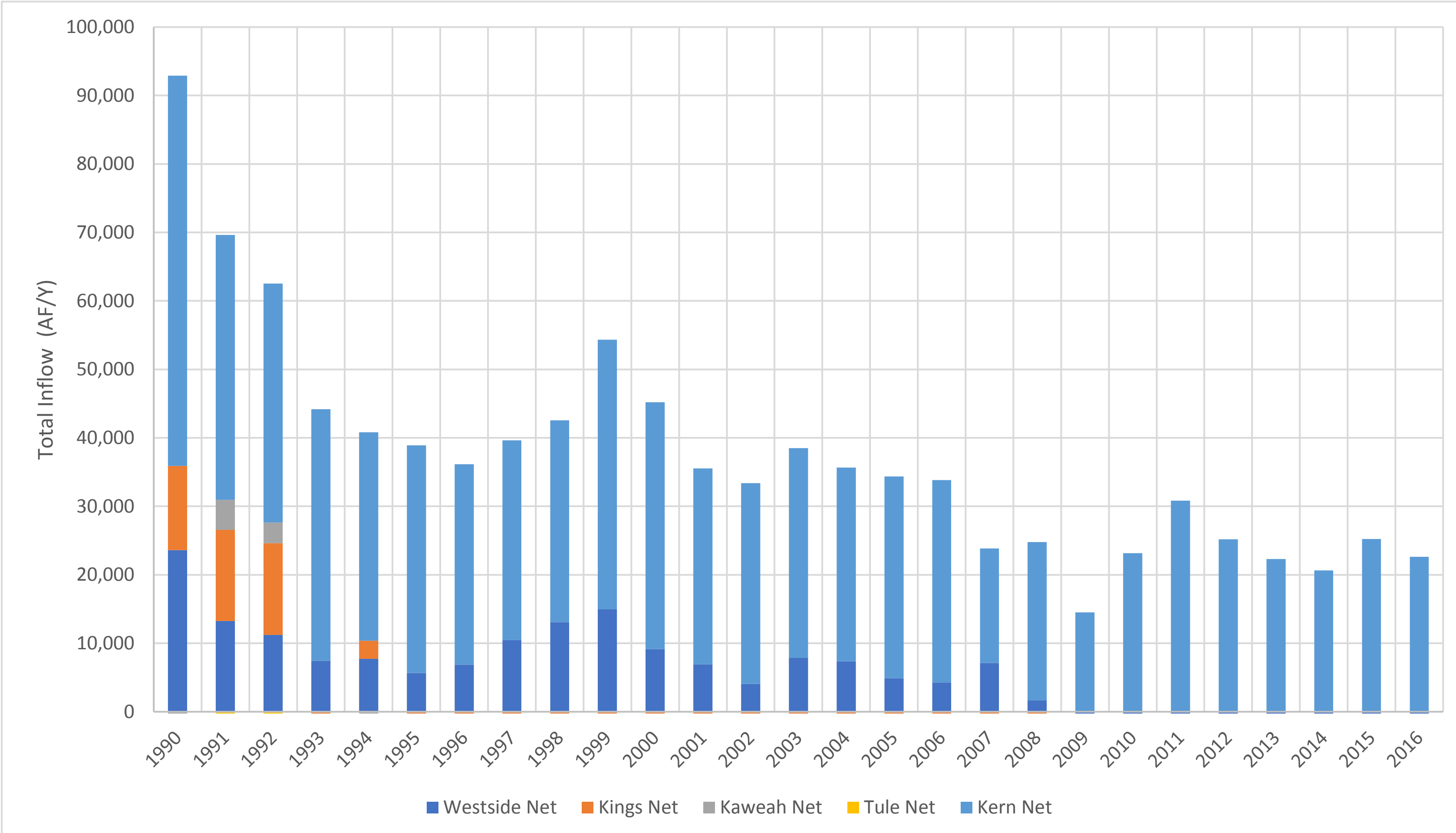
Tulare Lake Subbasin
Intentional Recharge
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-43

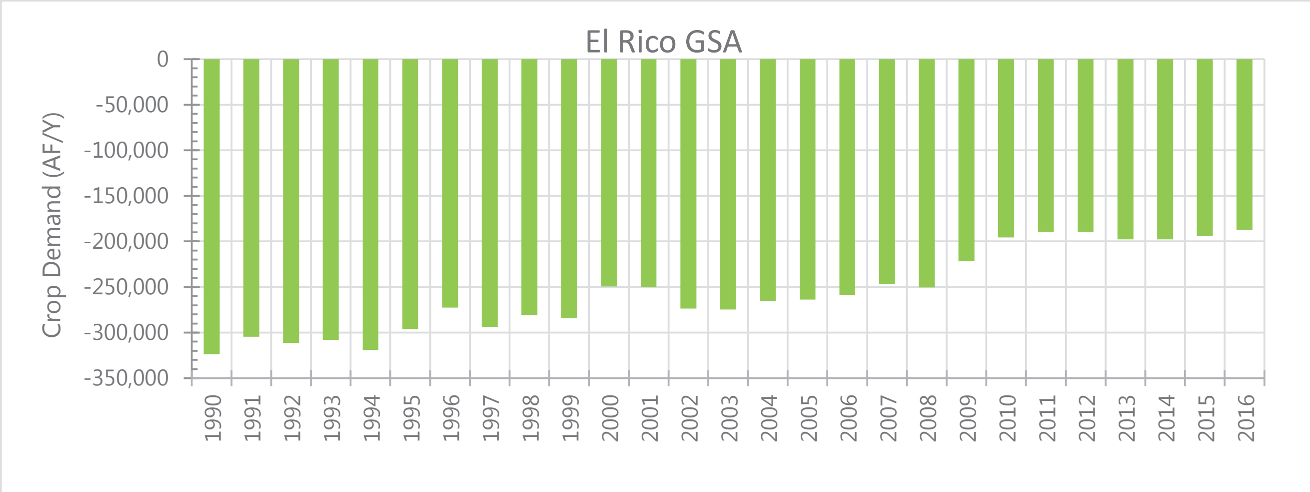


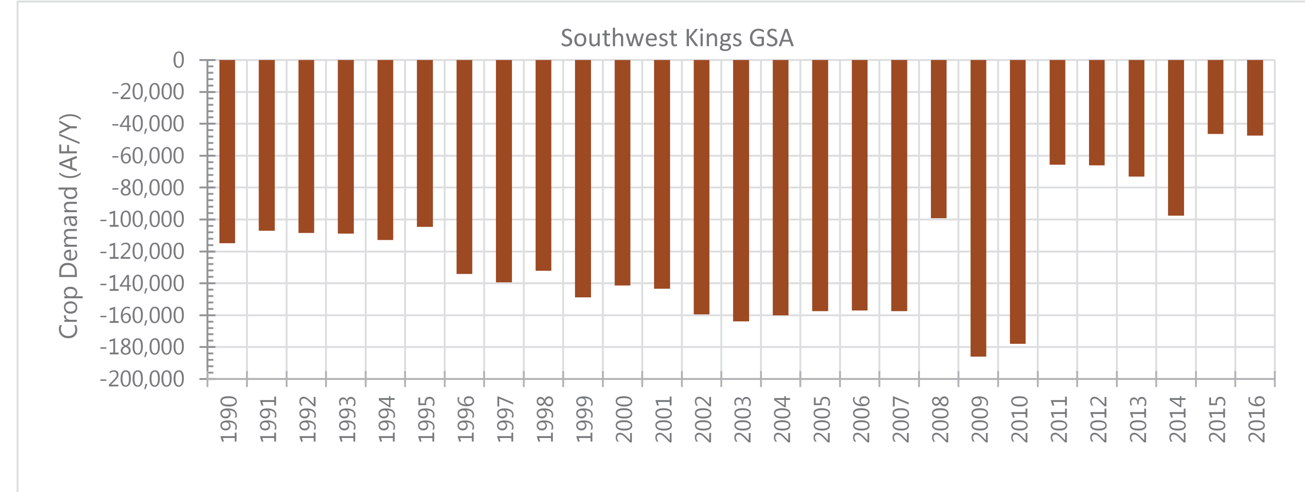
Tulare Lake Subbasin
River and Canal Recharge
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

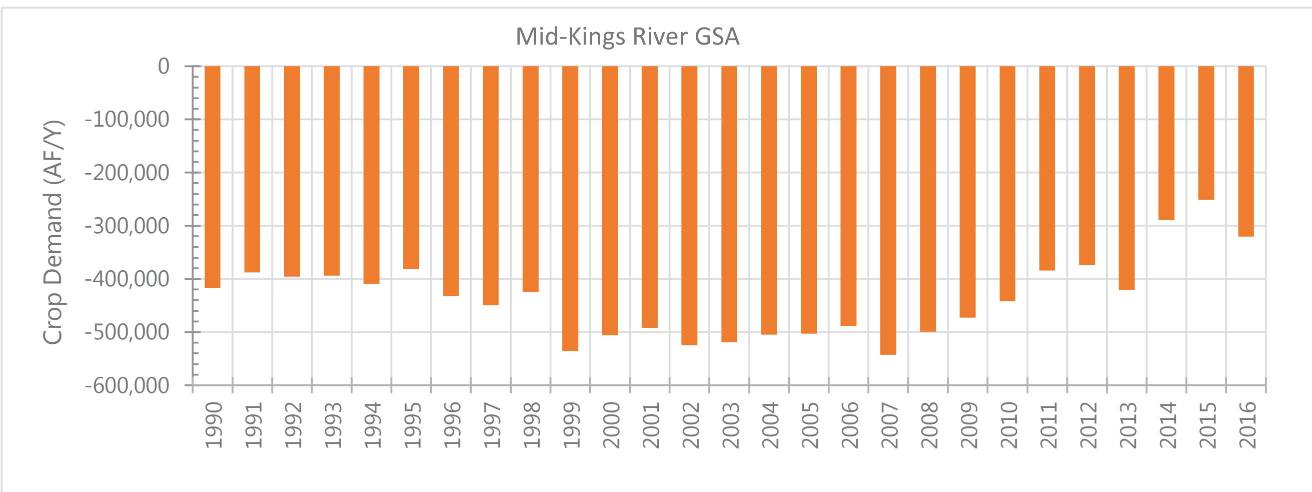
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-44

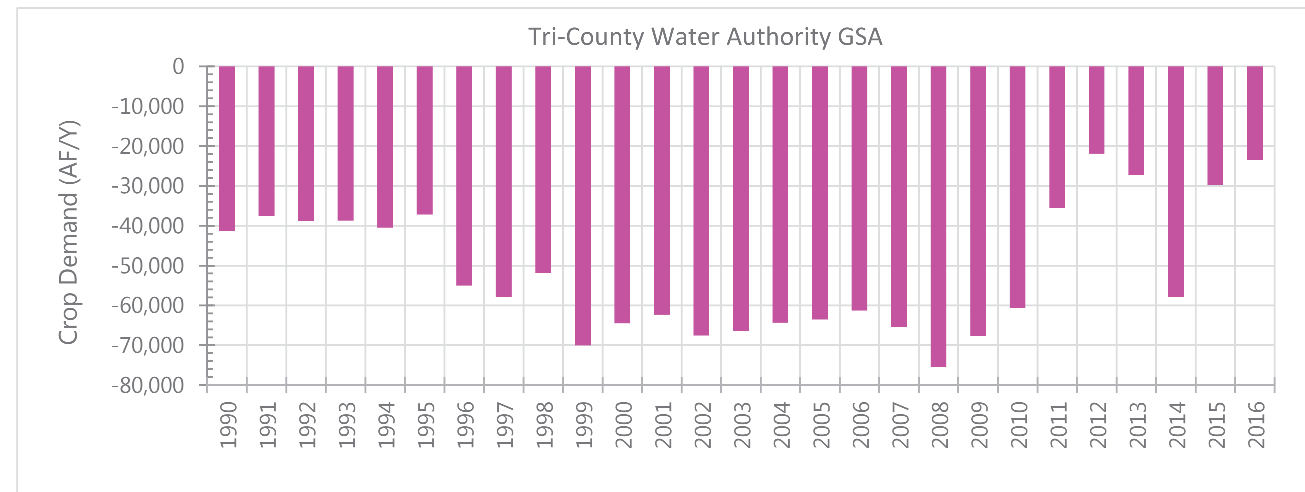


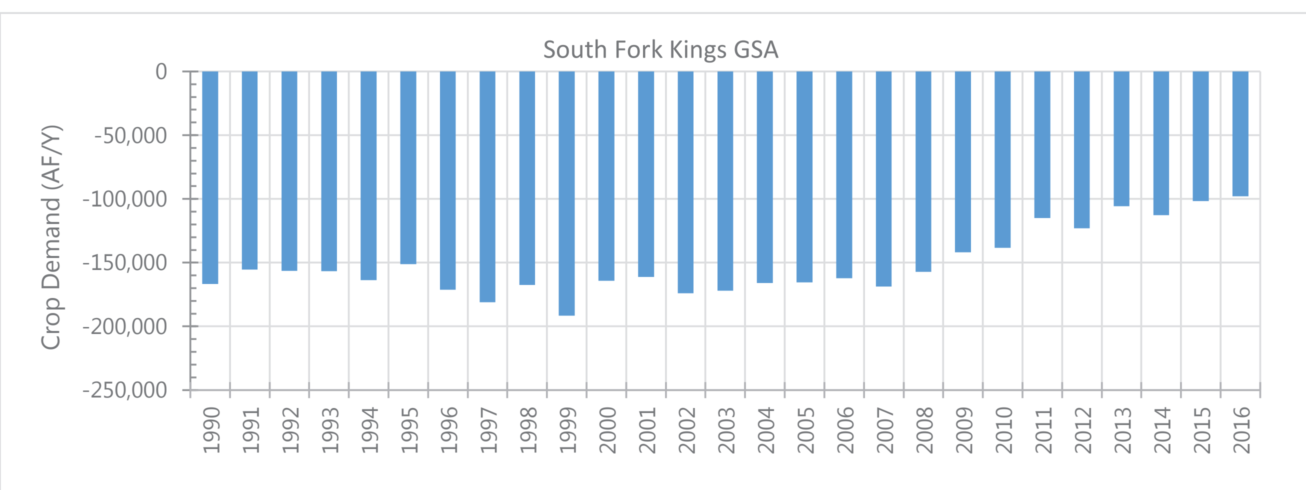
Tulare Lake Subbasin Net Subsurface Inflows 1990 to 2016 Tulare Lake Subbasin Groundwater Sustainability Plan Kings County, California		
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-45

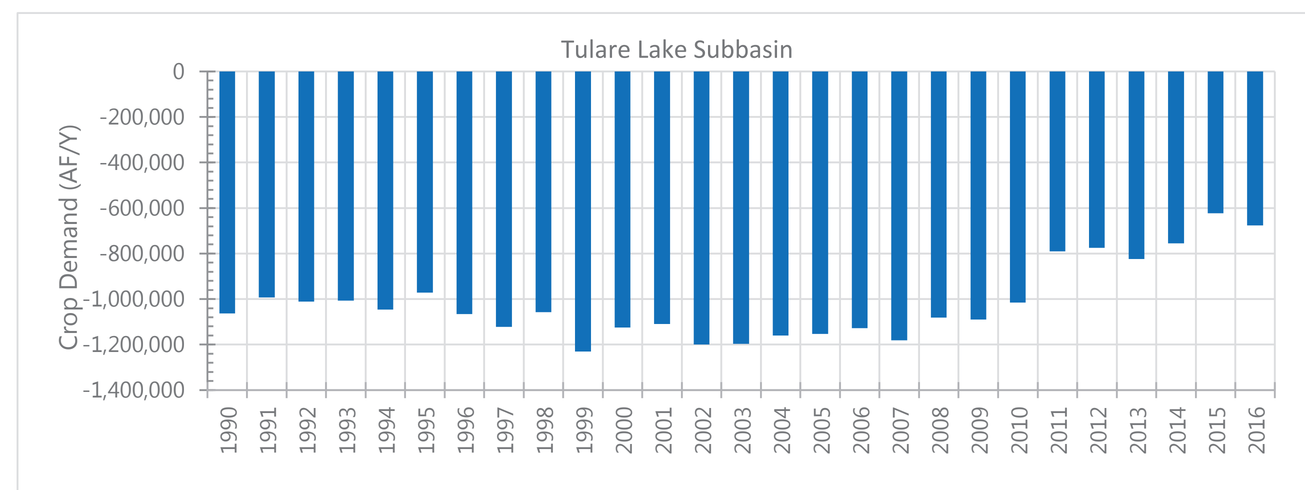






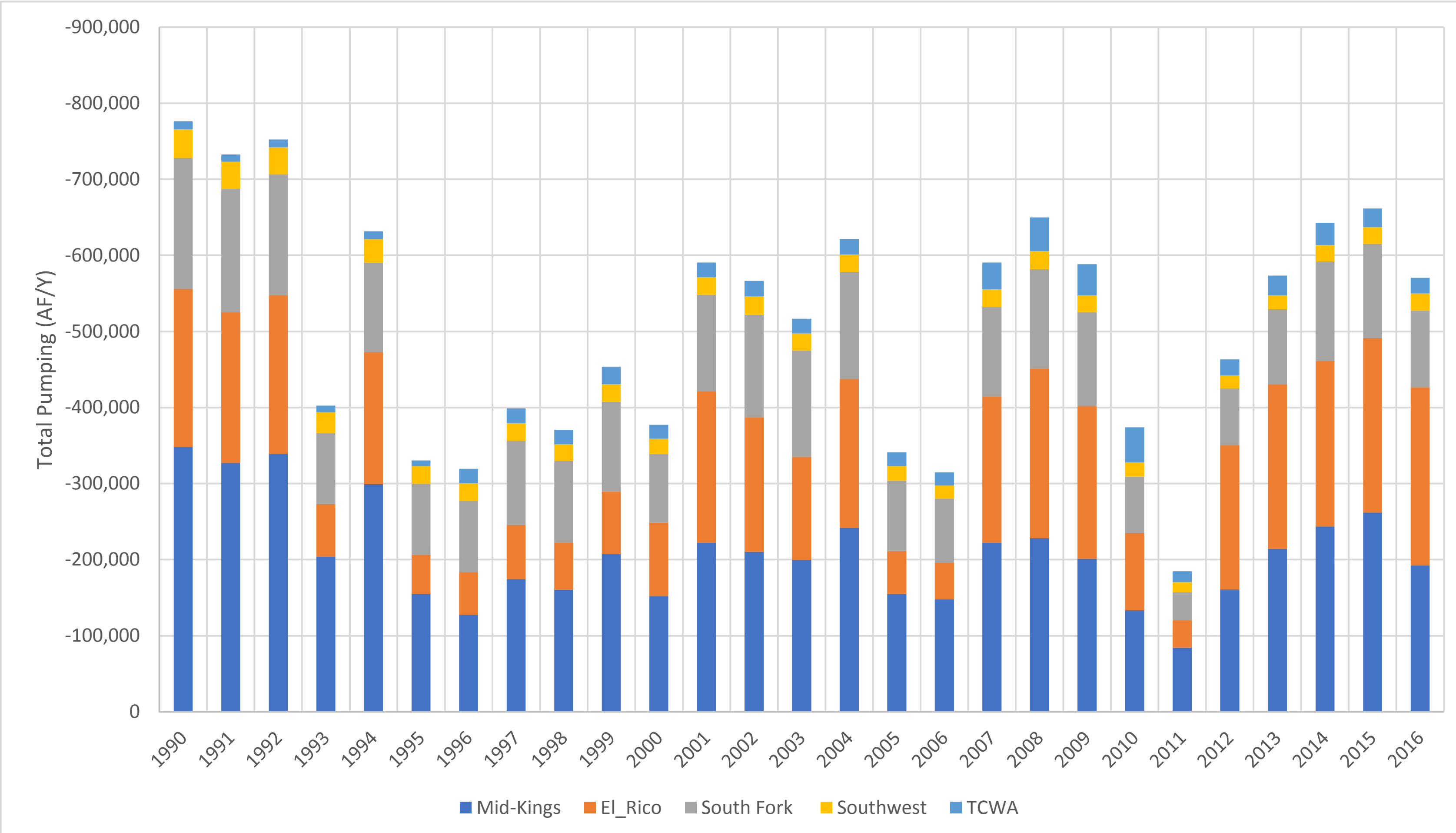






Irrigated Crop Demand
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

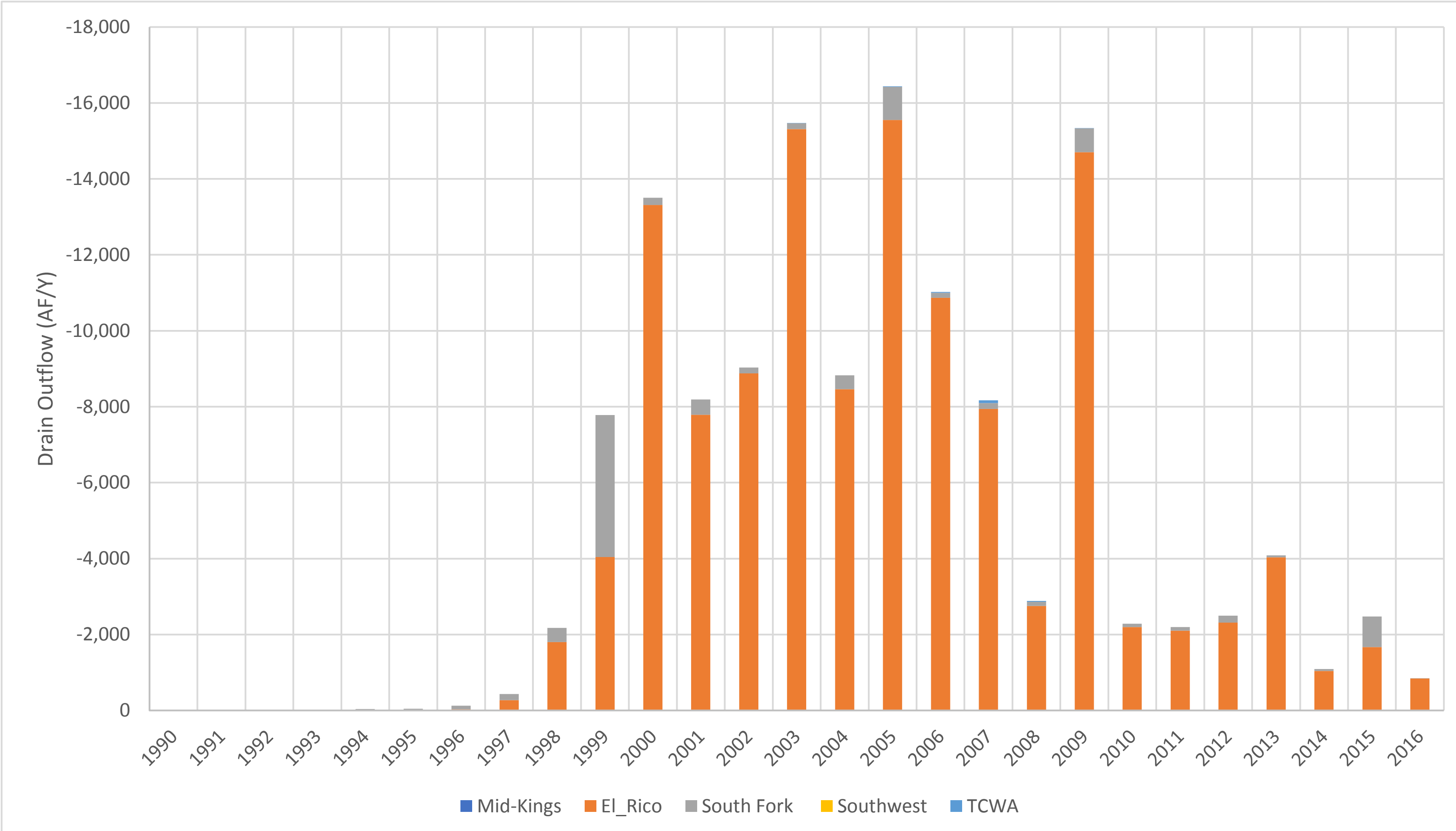
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-46



Agricultural and Municipal Pumping of Groundwater 1990 to 2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-47



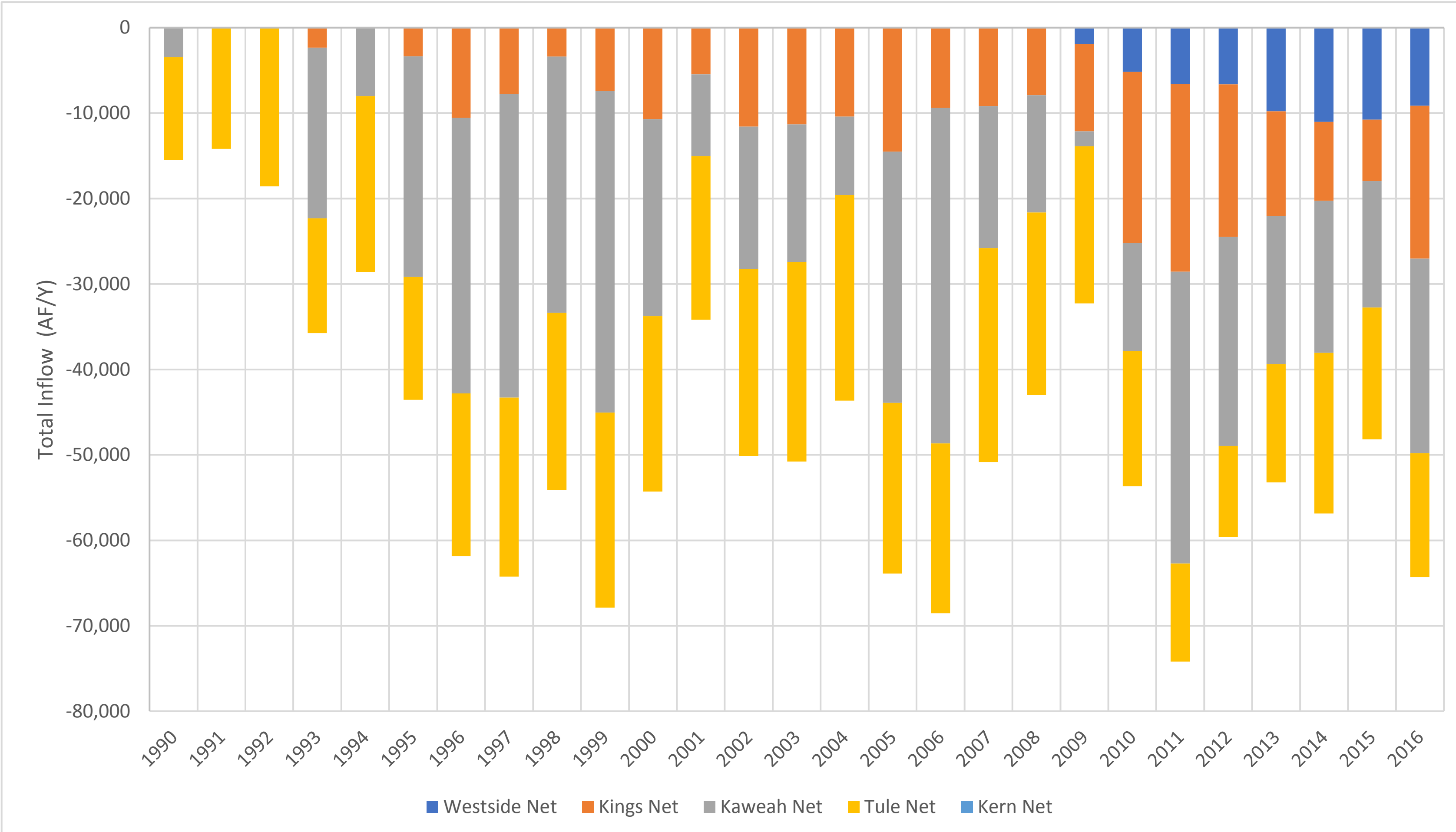
Note:
Mid-Kings River GSA, South Fork Kings GSA, and Southwest Kings GSA do not have agricultural drain outflows.

Tulare Lake Subbasin Agricultural Drainage Outflows 1990 to 2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

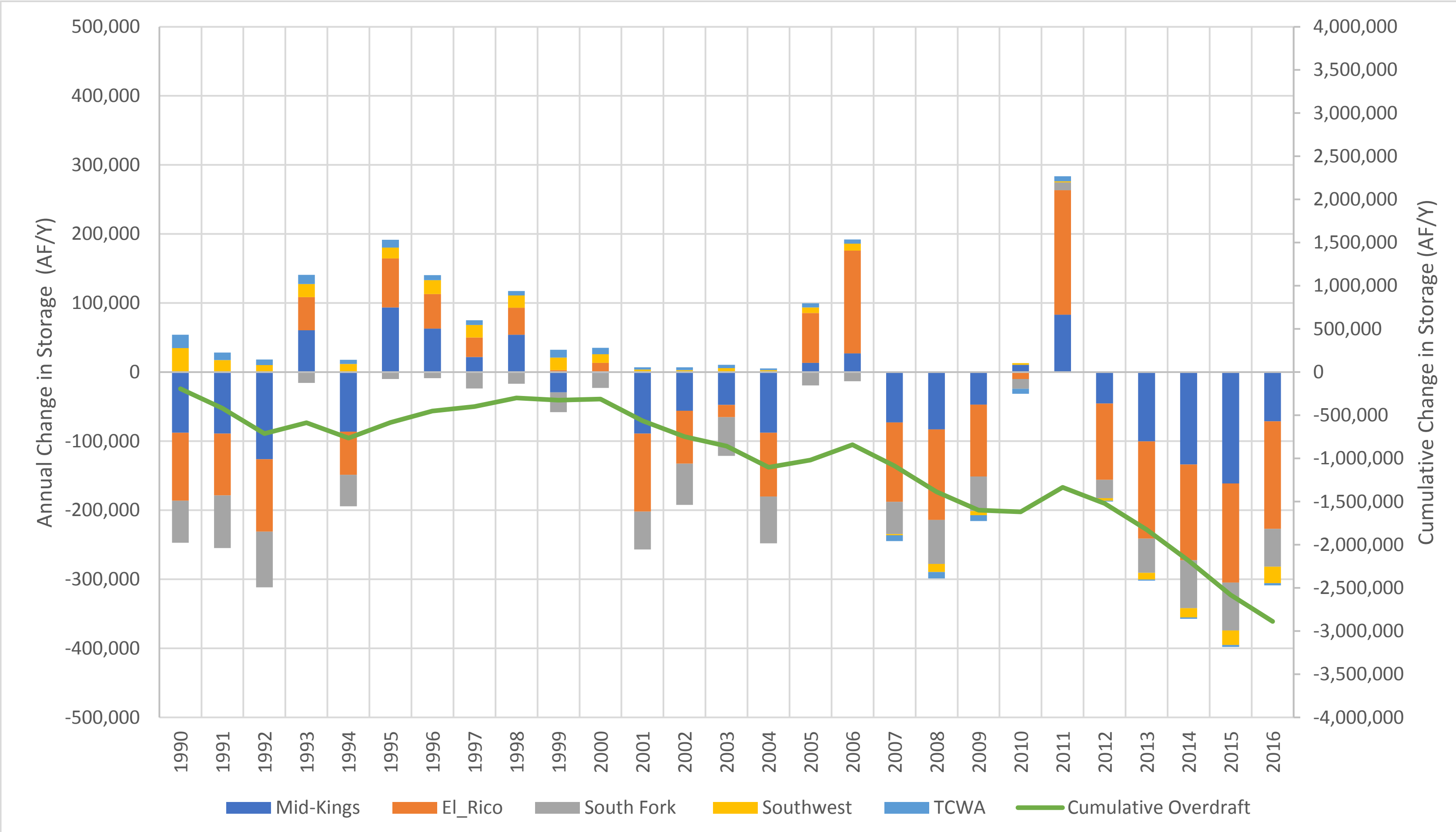
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-48

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Tables\GSP Charts v9cFigure 3-49 7/5/2019



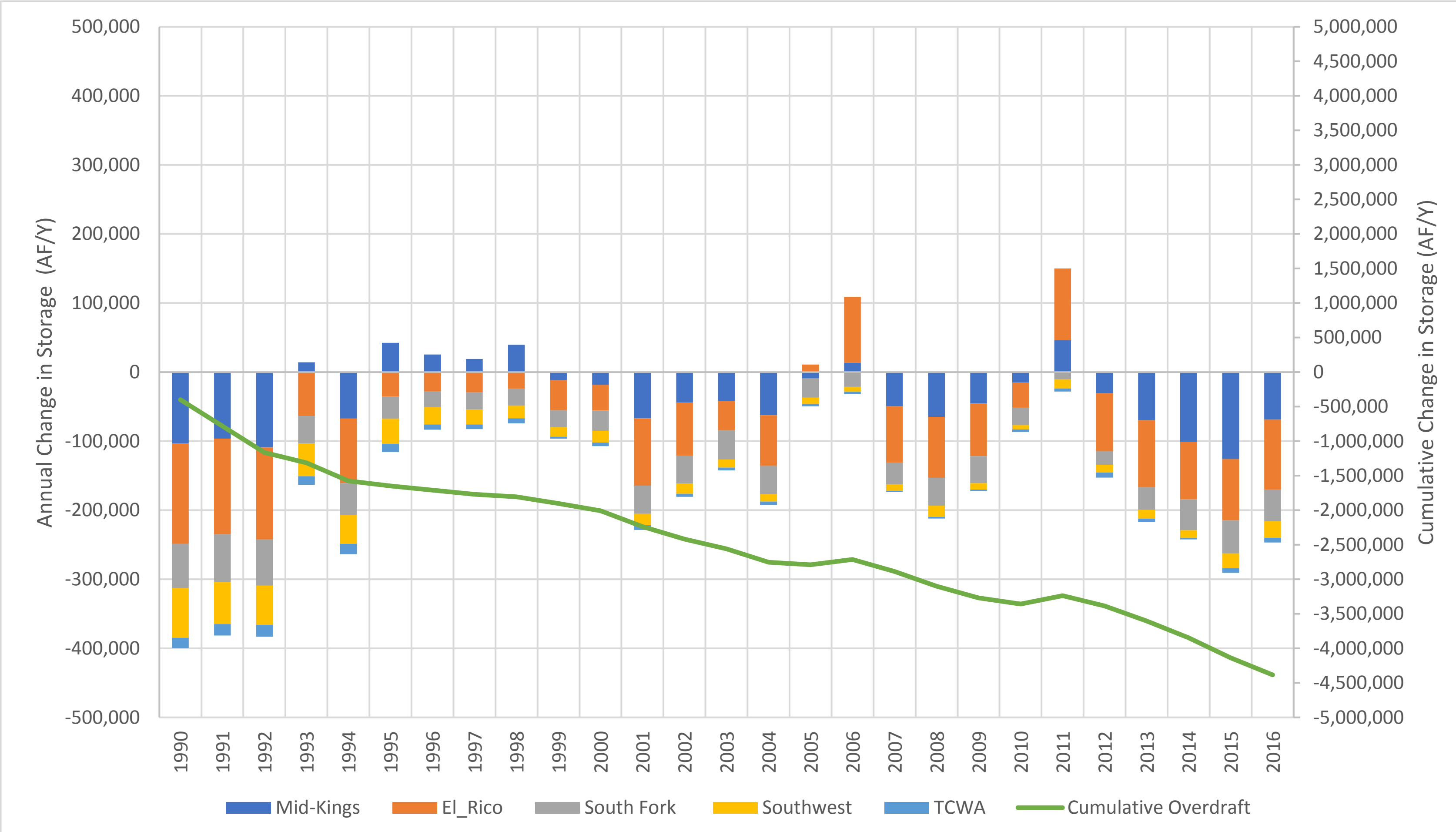
Tulare Lake Subbasin
Net Subsurface Outflows
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-49

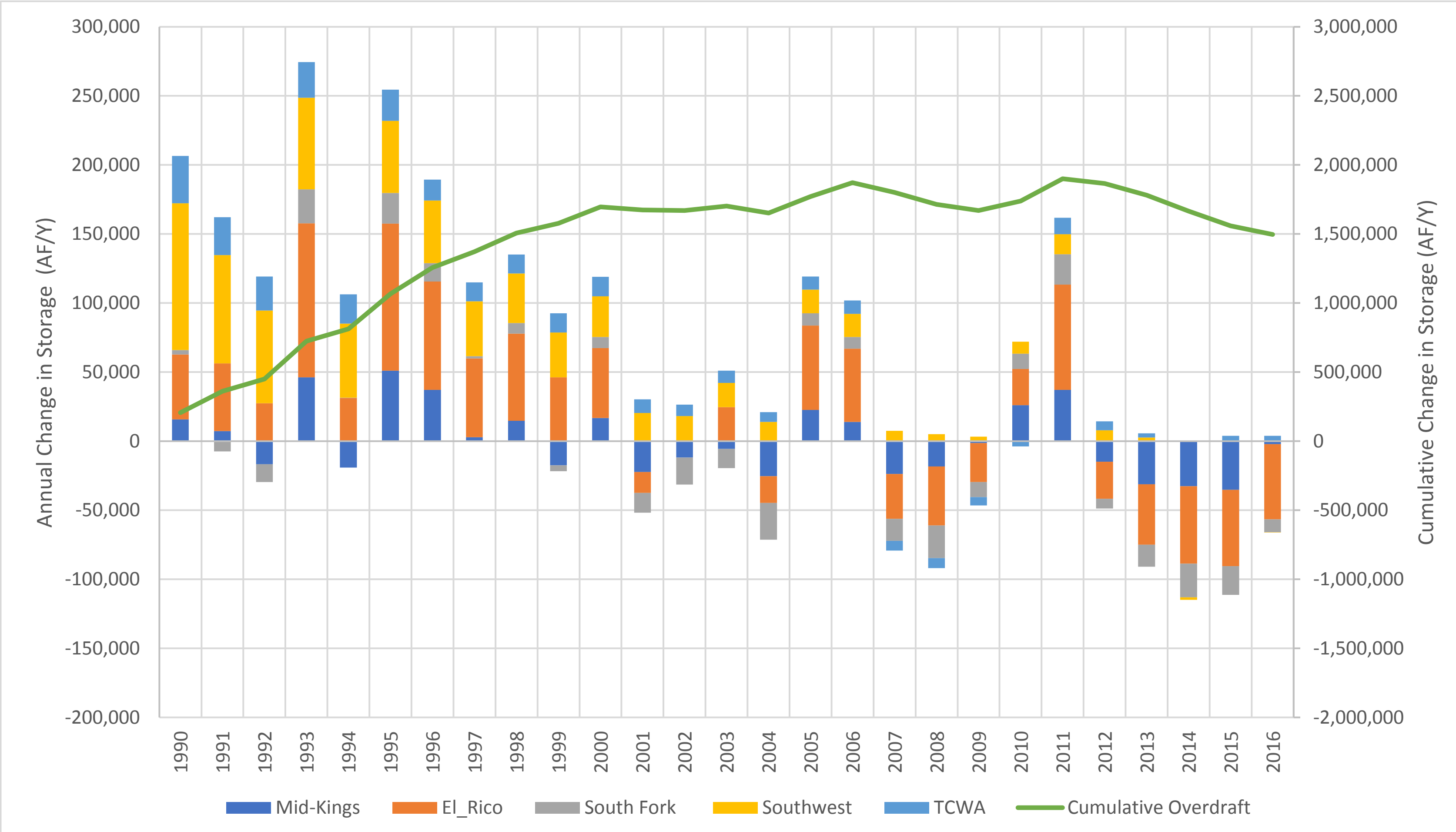


Tulare Lake Subbasin
Total Overdraft
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-50a

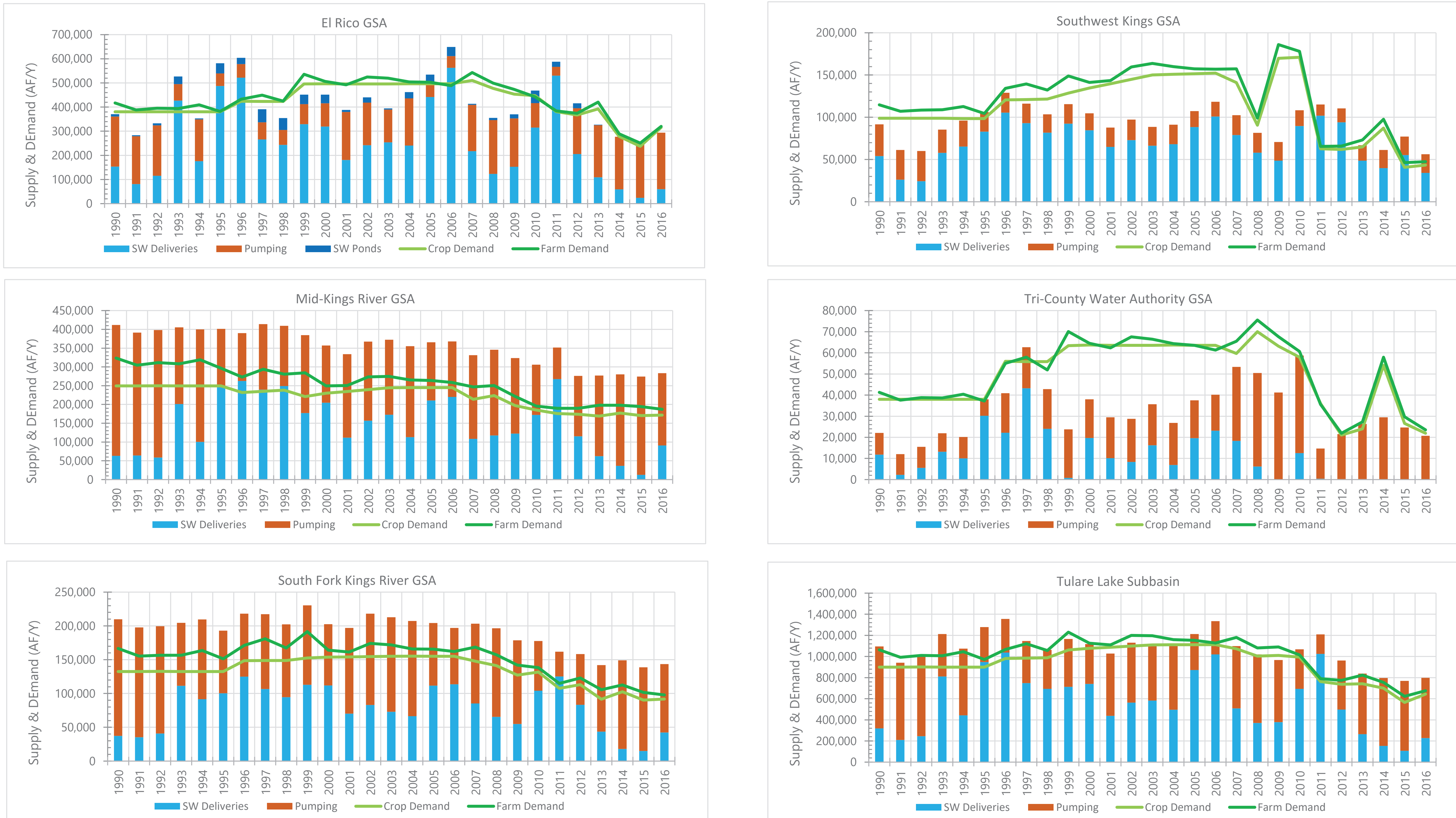


Tulare Lake Subbasin **Upper Aquifer Overdraft** **1990 to 2016** Tulare Lake Subbasin Groundwater Sustainability Plan Kings County, California		
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-50b



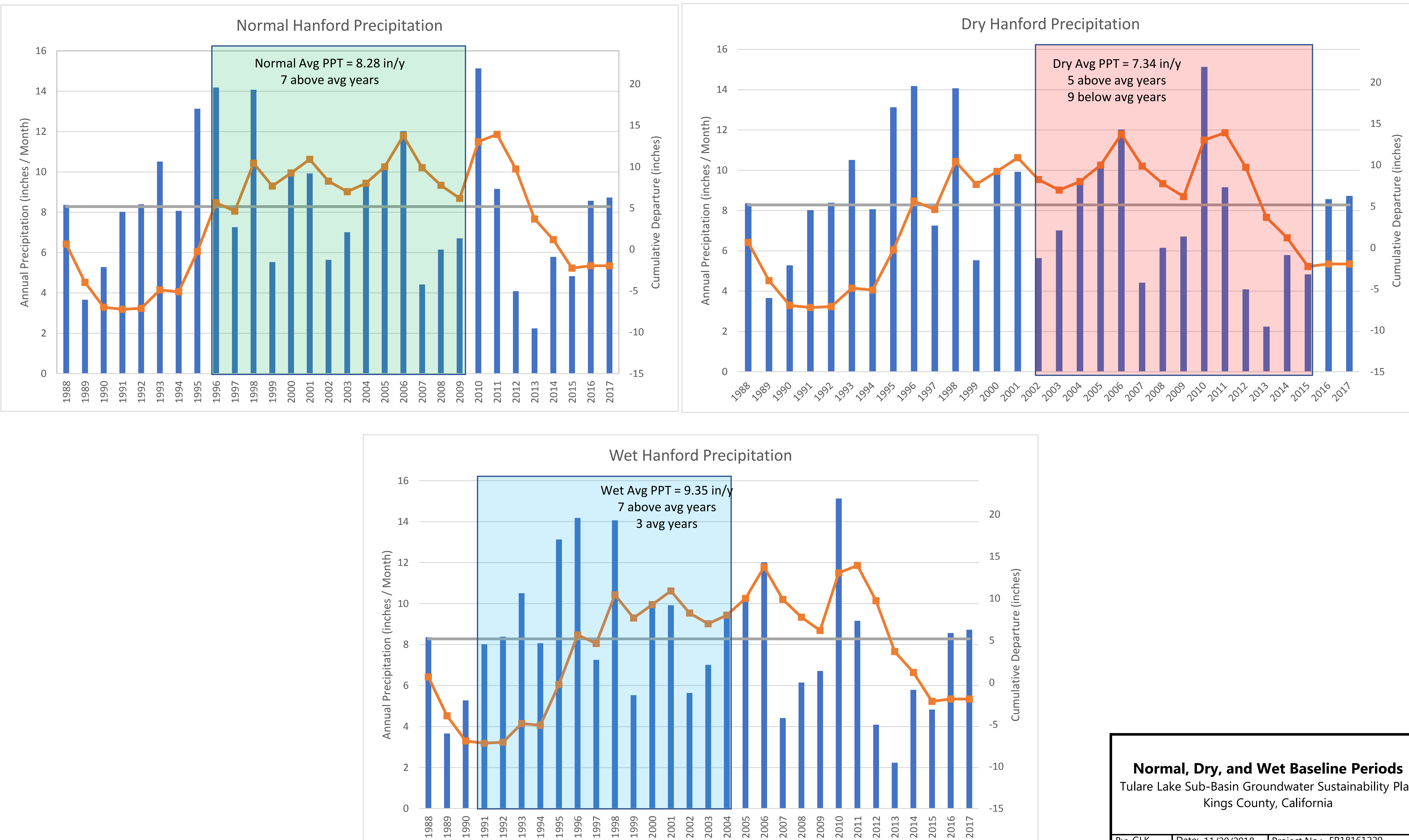
Tulare Lake Subbasin
Lower Aquifer Overdraft
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure 3-50c



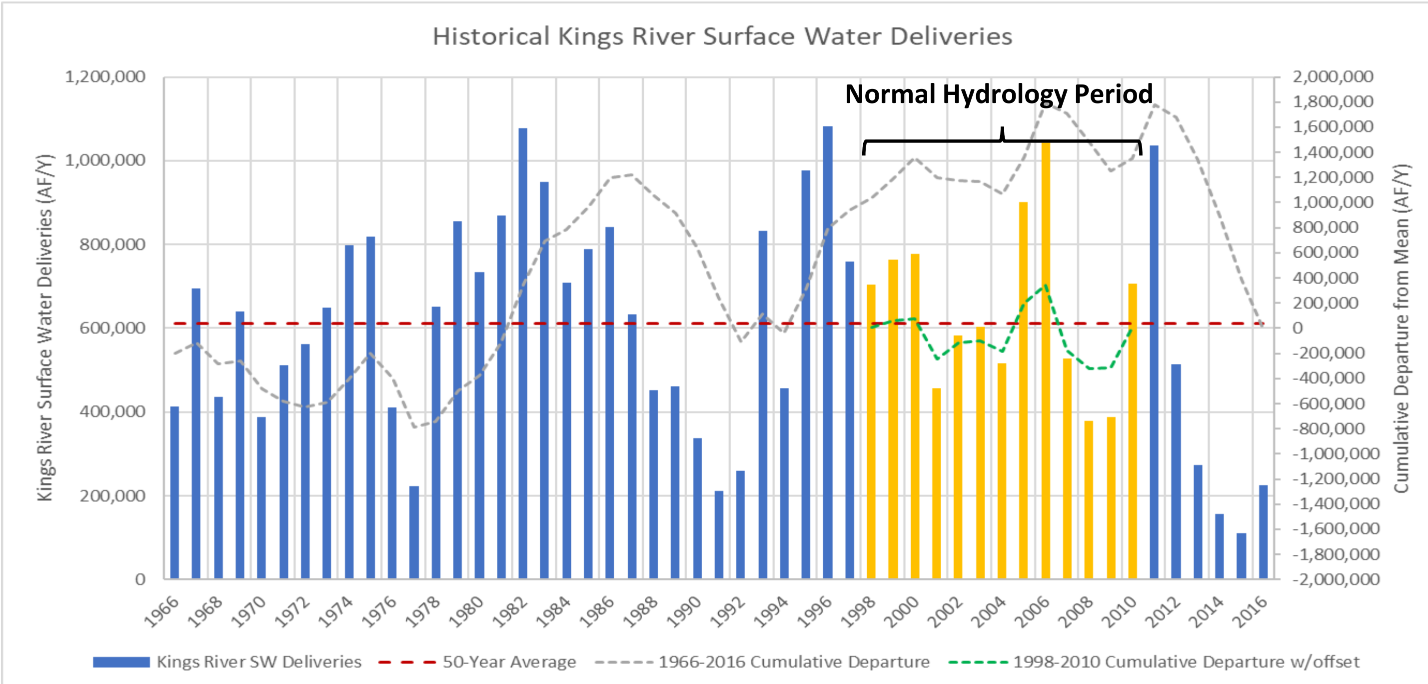
Water Supply and Demand
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

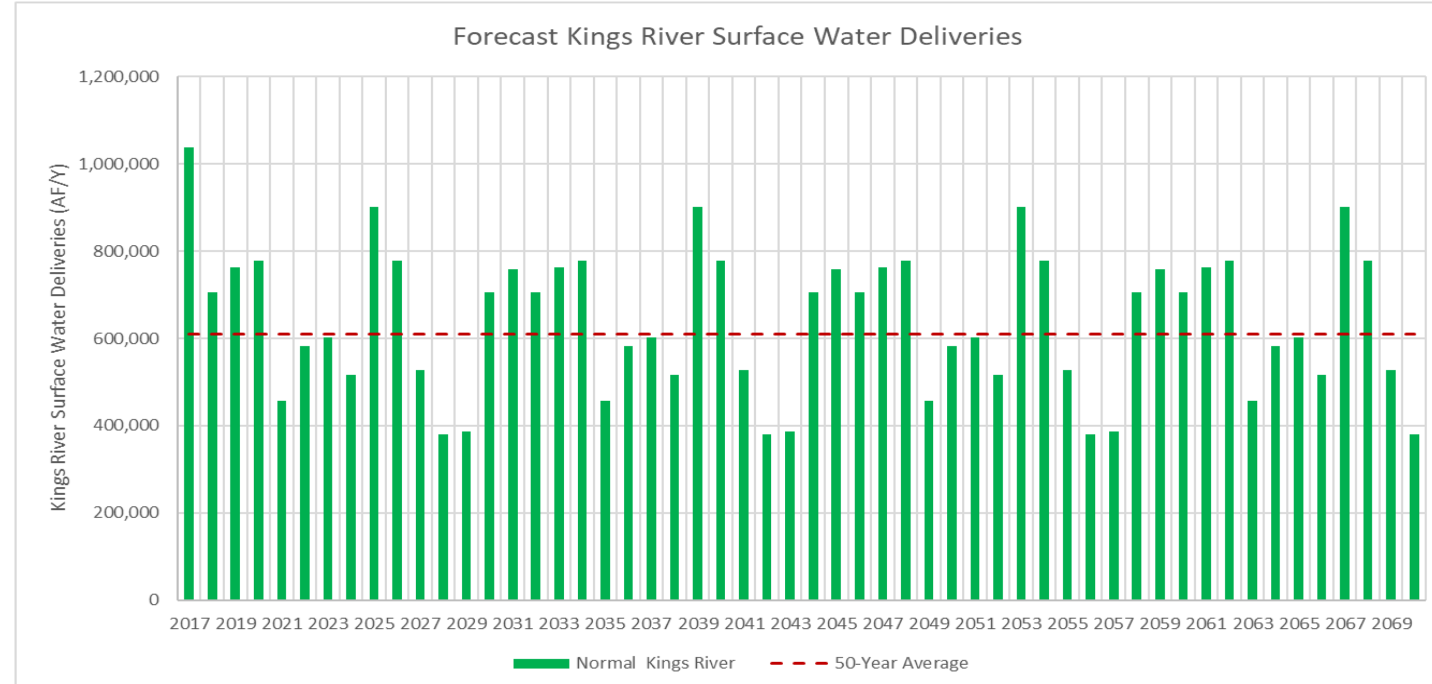
By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-51

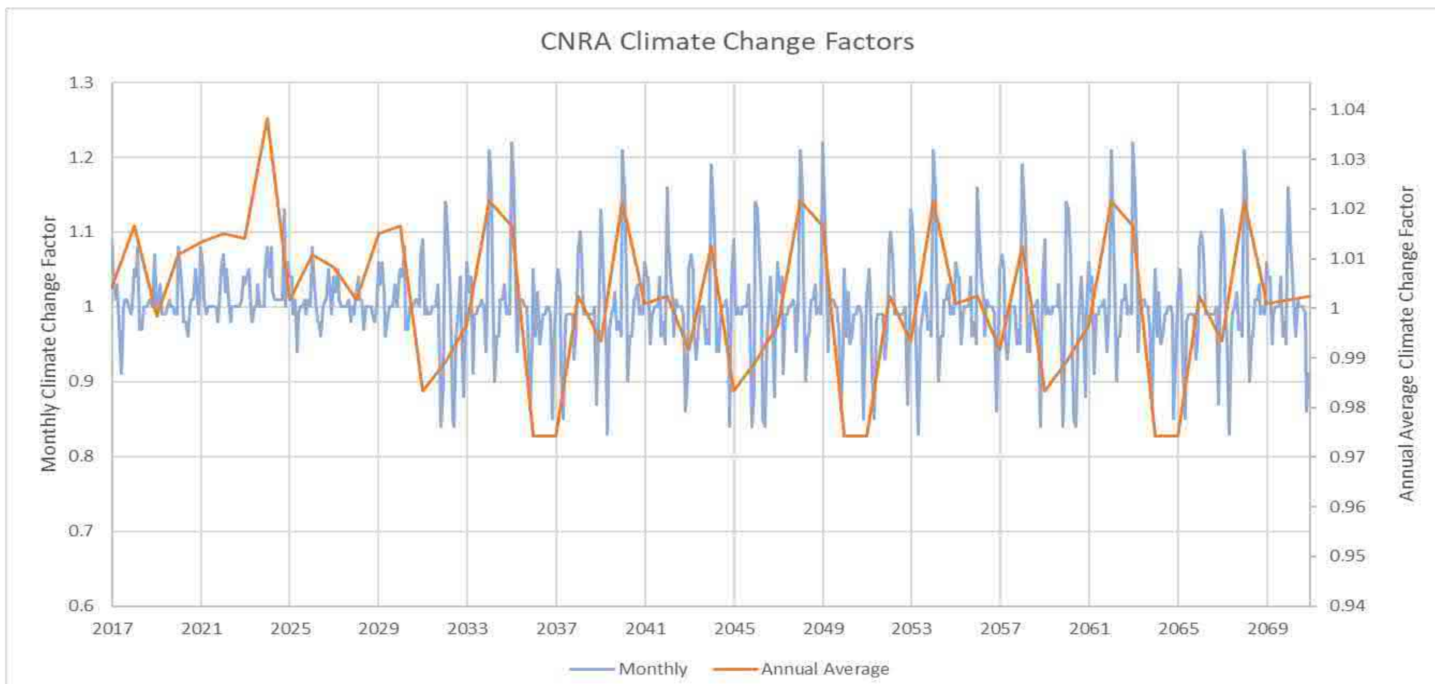


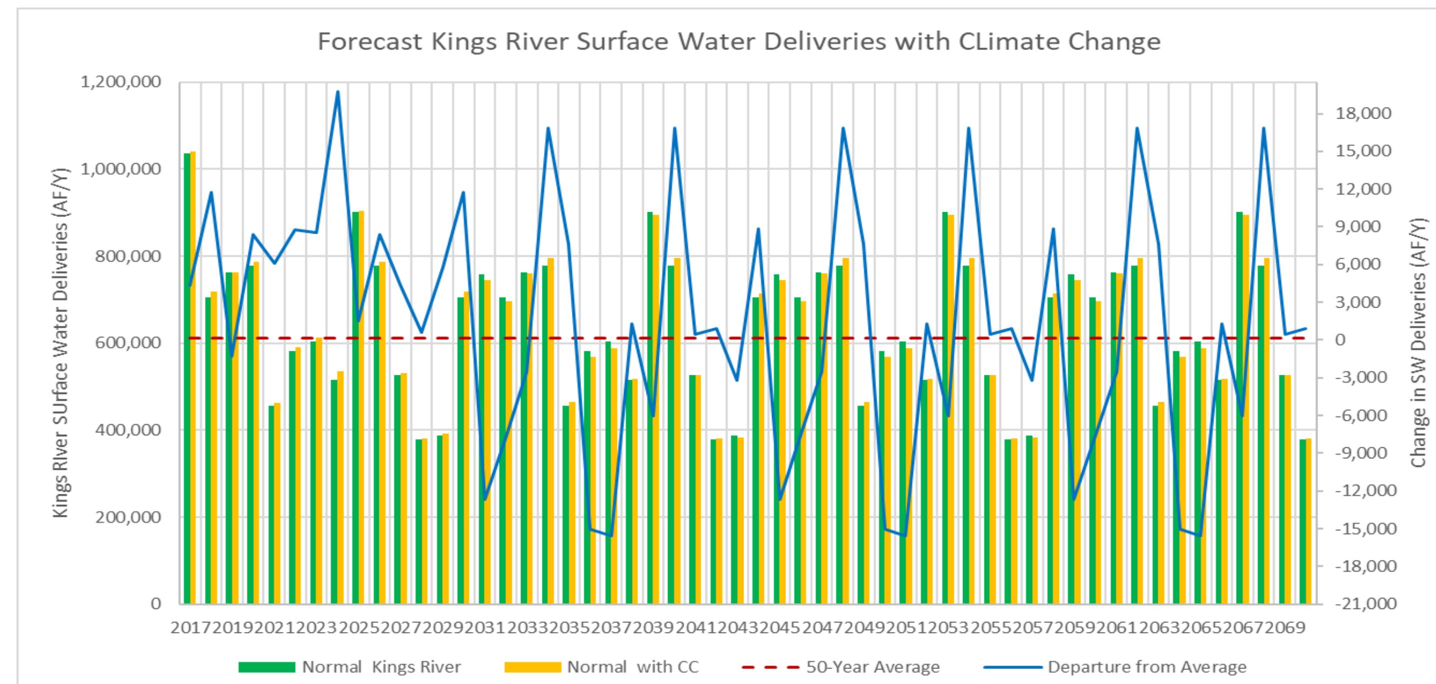
Normal, Dry, and Wet Baseline Periods
Tulare Lake Sub-Basin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
wood.		**Figure: 3-52**









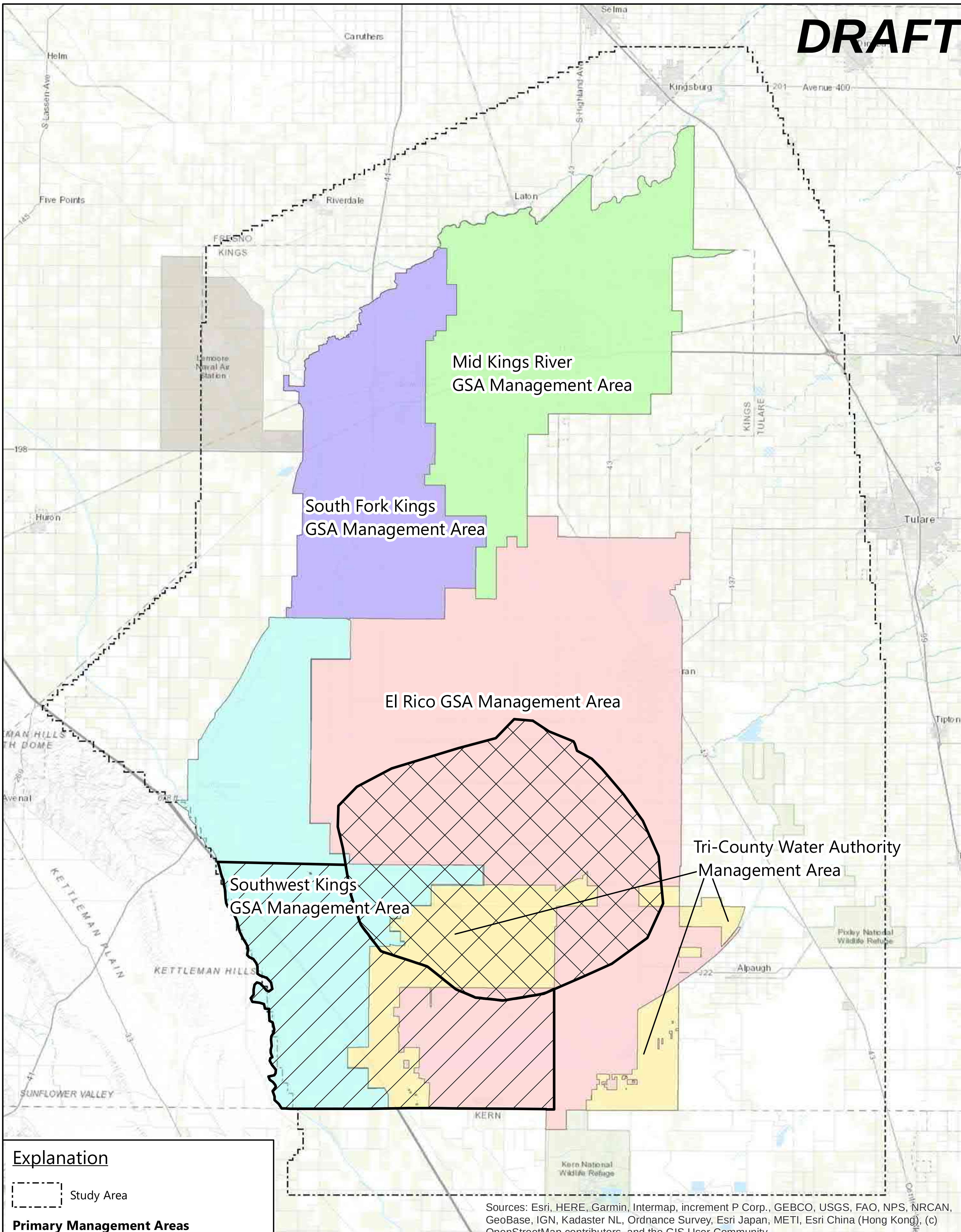
Surface Water Delivery Forecast with Climate Change

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
		Figure: 3-53

Date: 8/20/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-54_Management Areas.mxd



Explanation

Study Area

Primary Management Areas

- El Rico GSA
- Mid-Kings River GSA
- South Fork Kings GSA
- Southwest Kings GSA
- Tri-County Water Authority GSA

Secondary Management Areas

- Clay Plug
- Southwest Poor Quality Groundwater

N

Approximate Scale in Miles
0 1½ 3 6

0 1½ 3 6
Approximate Scale in Kilometers

Management Areas
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/20/2019	Project No.: FR18161220
		Figure **3-54**

Table 3-1. Historical Precipitation, Hanford, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1899	M	M	M	M	M	M	M	M	0.00	0.67	M	0.87	M
1900	1.38	0.00	1.18	1.04	M	M	M	M	M	M	M	M	M
1901	M	M	M	M	M	M	M	T	1.04	T	M	0.15	M
1902	0.40	2.00	1.78	0.47	0.09	M	0.00	M	0.00	0.36	1.67	0.56	M
1903	1.31	0.38	1.71	0.50	0.00	0.00	0.00	0.00	0.00	0.05	0.47	0.15	4.57
1904	0.52	2.03	2.05	0.72	0.00	0.00	0.00	0.00	2.48	0.84	0.31	1.16	10.11
1905	1.28	1.09	2.10	0.56	0.65	0.00	0.00	0.00	0.07	0.00	1.16	0.23	7.14
1906	1.59	1.92	4.05	0.62	2.06	0.02	0.00	0.00	0.00	0.00	M	M	M
1907	M	M	M	M	M	M	M	M	M	M	M	M	M
1908	M	M	M	M	M	M	M	M	M	M	M	0.31	M
1909	M	M	M	M	M	M	M	M	M	M	M	M	M
1910	M	M	M	M	M	M	M	M	M	M	M	M	M
1911	M	M	M	M	M	M	M	M	M	M	M	M	M
1912	M	0.02	3.24	1.52	0.27	0.00	0.00	0.00	0.00	0.00	0.61	0.21	M
1913	1.26	1.55	0.34	0.78	0.76	0.06	0.08	0.00	M	M	M	1.35	M
1914	4.36	1.25	0.37	0.11	M	1.06	0.00	0.00	0.00	0.00	0.02	M	M
1915	M	M	0.30	1.37	M	M	M	M	M	M	M	M	M
1916	4.68	M	M	M	0.16	M	M	0.28	0.47	1.09	M	1.35	M
1917	M	M	M	M	0.31	M	M	M	M	M	M	M	M
1918	M	4.50	3.43	M	M	M	M	M	0.88	0.12	M	M	M
1919	M	M	1.01	0.15	0.10	M	M	M	M	M	M	M	M
1920	M	2.72	3.05	0.24	M	M	M	M	M	M	M	M	M
1921	M	0.89	M	M	0.87	M	M	M	M	M	M	M	M
1922	M	M	M	M	M	M	M	T	M	M	M	M	M
1923	M	M	M	2.43	M	M	M	M	M	M	M	0.22	M
1924	M	M	1.86	M	0.00	M	M	T	0.00	0.65	M	2.12	M
1925	M	M	1.58	M	M	M	0.00	M	0.00	M	M	M	M
1926	0.82	1.44	0.20	2.67	T	0.00	0.00	0.00	0.00	0.76	3.67	0.65	10.21
1927	1.33	2.52	2.04	0.18	0.06	T	0.00	0.04	T	1.67	1.63	0.78	10.25
1928	0.09	0.96	1.55	0.08	0.10	0.00	0.00	0.00	0.00	T	1.47	1.69	5.94
1929	0.81	0.61	1.40	0.81	0.00	0.24	T	0.00	0.03	0.00	0.00	0.42	4.32
1930	1.66	1.00	1.66	0.15	0.37	0.00	0.00	0.02	0.38	0.07	0.67	0.30	6.28
1931	2.32	0.72	0.07	0.91	0.20	1.12	0.00	0.08	0.08	0.00	1.36	2.54	9.4
1932	1.85	1.52	0.47	0.71	0.13	0.00	0.00	0.00	0.00	0.00	0.28	0.93	5.89
1933	3.12	0.16	0.72	0.28	0.41	0.07	0.00	0.00	0.00	0.15	0.00	1.01	5.92

Table 3-1. Historical Precipitation, Hanford, California (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1934	0.17	1.53	0.05	0.00	0.22	0.14	0.00	0.00	0.00	1.06	2.15	1.84	7.16
1935	2.50	1.77	2.00	2.05	0.00	0.00	0.03	0.00	0.06	0.51	0.40	0.89	10.21
1936	0.66	4.70	0.97	0.55	T	T	0.00	0.00	0.00	1.84	0.00	2.87	11.59
1937	1.95	2.46	2.23	0.22	0.00	0.00	0.00	0.00	0.00	0.11	0.21	2.16	9.34
1938	1.76	3.51	4.59	1.15	0.11	0.17	0.07	0.00	0.13	0.19	0.19	1.42	13.29
1939	1.54	0.77	1.44	0.82	T	0.12	0.00	0.00	0.04	0.57	0.06	0.22	5.58
1940	3.53	3.61	0.99	0.18	T	T	0.00	0.00	0.00	0.85	T	3.61	12.77
1941	1.51	3.90	2.05	2.41	T	T	0.00	T	0.00	0.90	0.57	3.11	14.45
1942	1.21	0.88	0.94	1.19	0.16	0.00	0.00	M	0.00	0.00	0.43	1.10	M
1943	2.73	1.14	3.35	0.87	0.00	0.00	0.00	0.00	0.00	0.03	0.22	1.03	9.37
1944	1.28	2.97	0.22	0.86	0.28	0.23	0.00	0.00	0.02	0.23	2.25	0.97	9.31
1945	0.26	2.71	1.81	0.16	0.10	0.17	0.00	0.00	T	0.71	1.15	1.51	8.58
1946	0.34	1.53	2.56	0.07	0.41	0.00	0.11	0.00	0.00	1.33	1.10	2.06	9.51
1947	0.41	0.49	0.56	0.11	0.41	0.00	0.00	0.00	T	0.59	0.29	0.51	3.37
1948	0.00	0.44	1.46	1.55	0.54	0.00	0.00	0.00	0.00	0.03	0.01	0.99	5.02
1949	0.51	0.85	1.94	0.07	0.53	0.00	0.00	T	0.00	0.00	0.60	0.68	5.18
1950	1.93	1.13	1.10	0.40	0.00	0.00	0.08	0.00	0.00	0.34	0.63	1.06	6.67
1951	1.24	0.76	0.22	1.17	0.07	0.00	0.00	0.00	0.00	0.08	1.11	2.39	7.04
1952	3.08	0.27	2.18	0.79	0.01	0.02	T	0.00	0.17	0.05	0.65	2.96	10.18
1953	1.10	0.27	0.34	0.83	0.29	0.02	T	0.00	0.00	0.02	1.01	0.09	3.97
1954	1.89	0.78	2.21	0.52	0.34	0.08	0.00	0.00	0.00	0.00	0.66	1.61	8.09
1955	3.25	1.31	M	M	0.90	0.00	0.00	M	0.00	0.02	0.92	4.67	M
1956	1.20	0.38	0.10	0.73	0.83	0.00	0.00	0.00	0.00	0.72	0.00	0.15	4.11
1957	1.39	1.17	0.56	0.67	0.63	0.00	0.00	0.00	0.00	0.20	1.39	1.41	7.42
1958	1.85	2.30	3.92	2.04	0.24	0.00	0.00	T	0.88	0.00	0.23	0.16	11.62
1959	0.86	1.90	0.11	0.52	T	0.00	0.00	T	0.11	0.00	0.00	0.17	3.67
1960	0.80	1.71	0.61	0.57	0.00	0.00	0.02	0.00	0.00	0.53	2.61	0.03	6.88
1961	1.34	0.22	0.67	0.22	0.37	0.00	0.00	0.00	0.00	0.00	1.11	1.28	5.21
1962	0.71	4.88	1.06	0.00	0.11	0.00	0.00	0.00	0.01	0.10	0.00	0.19	7.06
1963	1.19	1.68	1.37	2.88	0.56	0.17	0.00	0.00	0.33	0.75	1.23	0.29	10.45
1964	0.61	0.02	0.94	0.64	0.20	0.00	0.00	0.34	0.00	0.95	1.31	1.44	6.45
1965	1.18	0.33	0.33	1.60	0.00	0.00	0.00	0.05	0.07	0.05	2.15	1.97	7.73
1966	0.63	0.71	0.10	0.00	0.07	0.06	0.04	0.00	0.29	0.00	1.28	2.57	5.75
1967	1.41	0.05	2.42	2.95	0.07	0.23	0.00	0.00	0.31	0.00	1.99	0.50	9.93
1968	0.57	0.64	1.00	0.50	0.08	0.00	0.00	0.00	0.00	1.33	0.98	1.64	6.74

Table 3-1. Historical Precipitation, Hanford, California (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1969	6.69	4.54	0.79	0.85	0.32	0.21	0.07	0.00	0.15	0.05	0.51	0.70	14.88
1970	1.60	1.33	1.42	0.16	0.00	T	T	0.00	0.00	T	2.40	1.23	8.14
1971	0.35	0.19	0.23	0.40	1.44	0.00	0.00	T	0.04	0.06	0.41	1.87	4.99
1972	0.04	0.35	0.00	0.23	0.00	0.00	0.00	0.00	0.24	0.21	2.90	0.65	4.62
1973	M	2.29	2.20	0.12	M	M	0.00	0.00	0.00	M	M	M	M
1974	2.97	0.11	1.75	0.03	0.00	0.00	0.00	0.00	0.00	0.65	0.24	1.40	7.15
1975	0.09	2.26	M	0.49	0.00	0.00	0.00	0.00	0.96	M	0.05	0.22	M
1976	T	2.94	0.19	1.47	0.03	0.51	0.00	0.22	1.47	0.00	1.15	0.96	8.94
1977	0.59	0.03	0.43	0.00	0.91	0.07	0.00	0.00	0.00	0.05	0.66	2.85	5.59
1978	2.22	5.05	4.12	1.71	0.00	0.00	0.00	0.00	1.10	0.00	0.79	0.50	15.49
1979	2.19	1.61	1.16	0.03	0.00	0.00	0.04	0.00	0.08	0.41	0.62	0.41	6.55
1980	2.90	2.71	1.28	0.05	0.04	0.00	0.00	0.00	0.00	0.09	0.00	0.20	7.27
1981	1.77	0.86	2.10	0.68	0.17	0.00	0.00	0.00	0.00	0.76	1.08	0.29	7.71
1982	0.84	0.38	3.52	1.75	0.00	0.45	0.18	0.00	0.64	1.03	2.15	0.71	11.65
1983	3.74	2.59	3.39	1.63	0.04	0.00	0.00	0.05	0.82	0.43	1.66	1.22	15.57
1984	0.01	0.42	0.27	0.18	0.00	0.00	0.00	0.00	0.00	M	M	M	M
1985	0.59	M	0.70	0.12	0.00	0.00	M	0.00	T	M	2.11	0.66	M
1986	1.46	2.60	3.43	0.50	0.00	0.00	T	T	0.15	0.00	0.21	0.77	9.12
1987	1.77	2.07	2.02	0.06	0.13	0.05	0.00	0.00	0.00	0.58	0.47	1.70	8.85
1988	1.37	0.40	0.93	1.99	0.07	0.00	0.00	0.00	0.00	0.00	1.31	2.29	8.36
1989	0.17	1.04	0.85	0.02	0.39	0.00	0.00	T	0.67	0.32	0.20	0.00	3.66
1990	1.66	1.10	0.30	0.97	0.87	0.00	T	T	T	0.01	0.22	0.15	5.28
1991	0.31	0.12	6.62	0.19	T	0.12	0.00	0.00	0.11	0.41	0.14	M	M
1992	1.40	2.82	0.85	0.10	T	0.00	0.01	0.01	T	0.58	T	2.62	8.39
1993	3.88	2.48	2.16	0.07	0.08	0.30	0.00	0.00	0.00	0.24	0.64	0.66	10.51
1994	0.94	1.45	1.02	0.72	0.66	0.00	T	0.00	1.06	0.35	1.54	0.33	8.07
1995	4.70	0.51	4.77	0.65	0.87	0.04	T	0.00	T	0.00	T	1.59	13.13
1996	1.68	2.89	2.27	0.85	0.10	T	0.00	0.00	0.00	2.43	0.69	3.27	14.18
1997	3.02	0.12	0.21	0.00	0.00	T	T	0.00	0.06	0.09	1.96	1.80	7.26
1998	2.00	4.05	2.63	1.68	1.31	0.44	0.00	0.00	T	0.68	0.63	0.65	14.07
1999	3.01	0.56	0.43	1.37	0.00	0.00	0.00	T	0.01	0.00	0.15	T	5.53
2000	1.80	3.28	1.59	0.97	0.48	0.35	0.00	0.00	0.03	1.31	T	0.05	9.86
2001	1.98	1.48	1.24	1.12	0.00	0.00	0.09	0.00	T	0.18	1.84	1.99	9.92
2002	0.87	0.31	1.04	0.03	0.01	0.82	0.00	0.00	0.00	0.00	1.42	1.14	5.64
2003	0.24	1.08	1.01	1.50	0.62	0.00	T	0.07	0.00	0.00	0.49	2.00	7.01

Table 3-1. Historical Precipitation, Hanford, California (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2004	2.00	2.18	0.29	0.02	0.01	0.00	0.00	0.00	0.00	2.06	0.52	2.23	9.31
2005	2.63	1.58	2.24	0.71	0.83	0.00	0.00	T	0.01	0.01	0.19	2.07	10.27
2006	3.54	0.55	2.72	3.39	0.53	0.00	0.00	0.00	0.00	0.06	0.22	1.01	12.02
2007	0.65	0.89	0.26	0.33	0.01	0.00	0.00	0.12	0.37	0.35	0.12	1.32	4.42
2008	2.18	1.18	T	0.00	0.11	0.00	0.00	0.00	0.00	0.15	1.04	1.49	6.15
2009	0.80	1.86	0.20	0.02	0.41	0.22	0.00	0.00	0.18	1.32	0.28	1.42	6.71
2010	2.64	1.91	0.34	1.65	0.17	0.00	0.00	0.00	0.00	0.64	1.32	6.46	15.13
2011	1.52	1.53	2.87	0.30	0.40	1.04	0.00	0.08	0.01	0.55	0.80	0.06	9.16
2012	M	M	M	1.39	0.03	M	T	0.00	0.00	0.28	0.49	1.90	M
2013	0.22	0.48	0.79	0.08	0.17	0.00	0.00	0.00	0.01	T	0.33	0.16	M
2014	0.30	1.38	0.27	0.35	T	0.00	0.00	0.00	0.03	0.00	0.94	2.52	5.79
2015	0.08	0.72	0.02	0.77	0.10	0.00	0.45	0.00	0.00	0.38	0.91	1.40	4.83
2016	2.56	0.58	1.99	0.57	0.02	0.09	0.00	0.00	0.00	0.76	0.40	1.60	8.57
2017	3.70	2.80	0.31	1.02	0.36	0.01	0.00	0.01	0.17	0.06	0.21	0.08	8.73
2018	1.53	0.24	2.39	0.33	0.00	0.00	0.00	0.00	0.00	0.04	1.64	0.43	6.6
Mean	1.59	1.50	1.47	0.75	0.25	0.09	0.01	0.01	0.15	0.38	0.83	1.23	8.26
Min	6.69	5.05	6.62	3.39	2.06	1.12	0.45	0.34	2.48	2.43	3.67	6.46	15.57
(Year)	1969	1978	1991	2006	1906	1931	2015	1964	1904	1996	1926	2010	1983
Max	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.37
(Year)	1948	1900	1972	2008	2018	2018	2018	2018	2018	2014	1980	1989	1947

Table 3-2. Land Use Acreage (Acres)

Crop Type	1990-1995	1995-2000	2000-2006	2,007	2,008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	Average
Fallow land	169,015	100,485	107,303	73,944	90,872	110,829	100,770	132,964	153,452	165,866	167,495	209,719	172,580	**135,023**
Riparian	70,902	83,637	121,717	157,947	172,772	140,204	145,512	119,411	114,132	120,606	91,938	70,346	67,502	**113,587**
Cotton	159,541	180,966	124,770	109,609	88,307	72,444	98,355	105,082	89,042	89,319	63,482	44,549	73,720	**99,937**
Pasture and Misc. Grasses	20,812	18,028	55,100	66,721	57,883	90,700	66,777	29,506	24,678	27,672	46,000	25,981	24,608	**42,651**
Open Water	19,591	26,441	28,690	28,154	33,013	28,385	27,959	38,048	31,669	30,639	38,244	34,813	33,887	**30,733**
Pistachios (young)		5,235	11,642	7,332	10,420	18,762	20,177	20,628	24,117	29,467	34,397	37,271	31,089	**20,878**
Potatoes, Sugar Beets, Turnip, etc.	49,360	58,022	7,809	2,448	2,324	4	949	17,868	20,938	10,024	26,816	32,502	31,071	**20,010**
Corn and Grain Sorghum	14,281	38,897	29,351	37,444	27,191	34,645	22,892	10,311	10,847	9,565	8,164	7,727	7,189	**19,885**
Almonds (young)		336	5,894	14,026	20,395	11,675	18,138	13,566	13,631	17,549	12,110	15,680	22,290	**13,774**
Tomatoes and Peppers	5,634	1,616	14,676	120	2	110	12	21,522	24,041	7,286	12,069	19,412	23,474	**9,998**
Grain and Grain Hay	32			6,953	9,306	8,830	13,990	5,211	7,094	7,375	8,685	12,486	10,714	**8,243**
Pistachios (mature)	12,395	9,393	8,502	9,183	8,466	6,056	4,341	3,845	3,636	3,423	3,320	3,141	3,076	**6,060**
Wine Grapes with 80% canopy	2,948	3,222	5,779	5,588	3,499	2,240	2,746	5,373	9,245	4,659	6,476	4,676	10,986	**5,188**
Almonds (mature)	1,796	426	368	5,479	5,107	3,035	2,491	2,918	3,028	3,356	4,508	6,122	6,016	**3,435**
Pistachios (adolescent)				4,229					404	826	1,573	3,020	5,764	**2,636**
Citrus (no ground cover)	5,277	5,330	7,780	1,621	1,754	1,362	2,094	1,012	674	1,068	907	776	692	**2,334**
Pomegranates (young)				61	1,708	550	256	5,018	806	1,400	2,212	1,516	3,123	**1,665**
Small Vegetables	842	56	299	2,460	585	1,801	2,581	506	1,215	1,114	1,896	2,927	4,008	**1,561**
Almonds (adolescent)			301				1,067	238	524	2,128	2,593	474	954	**1,035**
Misc. Field Crops	885	1,144	2,965	347	28	1,964	1,116	48	31	97	112	82	102	**686**
Onions and Garlic	457	479	770			7	1,358	452	345	94	534	307	650	**496**
Alfalfa Hay and Clover								23			0			**11**
Pomegranates (adolescent)												3	15	**9**
Urban (industrial)								11	5	12	3	2	16	**8**
Tulare Lake Subbasin Total	**533,768**	**533,713**	**533,714**	**533,666**	**533,633**	**533,604**	**533,579**	**533,562**	**533,551**	**533,543**	**533,534**	**533,530**	**533,524**	**533,609**

Note: Annual Total is by Calendar Year

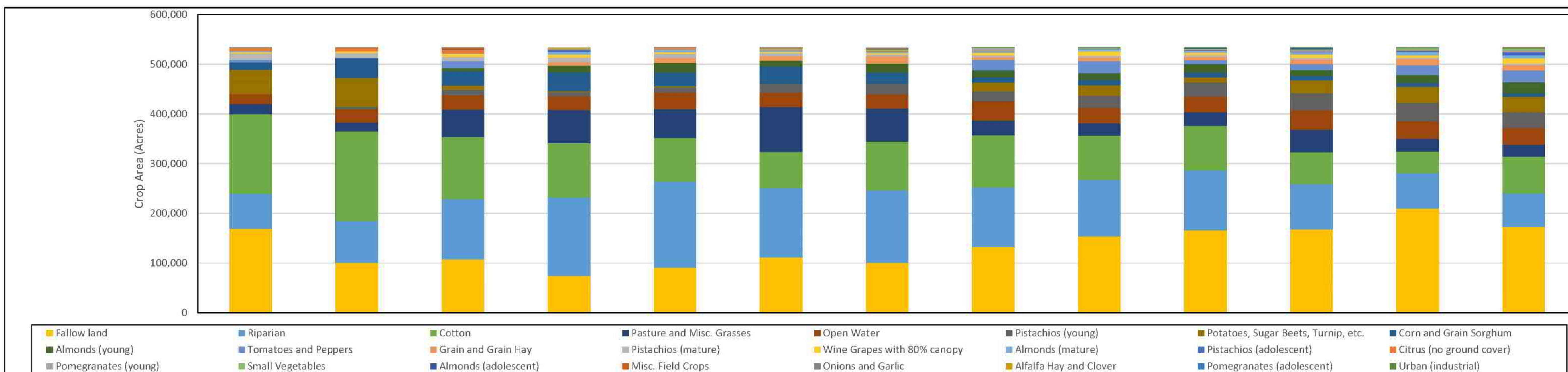


Table 3-3. Generalized Stratigraphic Column for Tulare Lake Subbasin

SYSTEM	SERIES	GEOLOGIC UNIT		LITHOLOGIC CHARACTER	MAXIMUM THICKNESS (feet)	WATER-BEARING CHARACTER	AREAS WHERE IMPORTANT
QUATERNARY	Holocene	Tulare Formation	Flood Basin Deposits	Interbedded silt, clay, and fine sand. Interfingers with and age equivalent to Younger Alluvium.	<50	Poorly permeable, poor quality water, unconfined.	Not important source of water.
			Younger Alluvium	Interstratified and discontinuous beds of clay, silt, sand, and gravel, primarily located on recent alluvial fans and along stream channels. Interfingers with flood-basin and lake bed deposits.	0 - 100	Highly permeable, but largely unsaturated or seasonally saturated. Serves as conduit for recharge to underlying units.	May provide sufficient supplies for domestic and stock use where saturated.
	Pleistocene		Older Alluvium	Poorly to well sorted fine to coarse sand, gravel, silt and clay. Represents older alluvial fan material and contains well-developed soil profiles and hardpan horizons. Interfingers with lacustrine clays.	300 - 500	Moderately to highly permeable, unconfined and semiconfined. Yields large quantities of water to wells, major aquifer.	Important source of groundwater on eastern and northern portions of TLSB.
			Lacustrine Deposits	Corcoran Clay is extensive reduced clay formed in large fresh-water lake in late Pleistocene that extended throughout most of the San Joaquin Valley. Has been deformed across valley axis and has been dated at about 600,000 Ma.	50 - 200	Poorly permeable, forms major aquitard within San Joaquin Valley.	Occurs beneath nearly the entire TLSB, including the Tulare Lake bed. Important aquitard on eastern and northern portions of TLSB.
				Tulare Lake bed clays are thick deposits that extend vertically from the surface beneath the former lake. These beds interfinger with alluvial and continental deposits to the east and west. Croft (1972) identified several of these interfingering lacustrine clay beds as the A-D and F clays. His E-clay is equivalent to the Corcoran Clay (above).	0 - 3,000	Poorly permeable, forms significant barrier to lateral groundwater flow in the TLSB and lateral tongues can form local confining conditions in alluvial and continental deposits.	Tulare Lake bed forms clay plug on western portion of TLSB. A and C clays are thin (10 - 60 feet) beds that may be important aquitards on the northern and eastern portions of TLSB.
TERTIARY	Pliocene		Continental Deposits, undifferentiated	Poorly to moderately sorted fine to medium sand, silt, gravel, and clay. Deposits may be reduced or oxidized. Provenance may be from Sierra Nevada or Coast Range. Sierran deposits typically arkosic and coarser grained than Coast Range deposits. Deposits from each provenance interfingering in an east-west line, depending upon major transgressive deposition from each mountain range.	2,000+	Poorly to moderately permeable, semi-confined to confined conditions. Yields significant quantities of groundwater, especially below Corcoran Clay.	Important source of groundwater on eastern and northern portions of TLSB and northwest and southeast of TLSB.
		San Joaquin Formation	Marine Deposits	Poorly sorted fine-grained sandstone, siltstone, and mudstone.	1,500+	Exposed in Kettleman Hills, dips steeply to east beneath Tulare formation. Semi-consolidated to consolidated, containing connate water of poor quality. Formation is poorly permeable and forms substantial aquitard at base of Tulare Formation.	No known beneficial uses of water, typical TDS of 3,000 to 20,000 mg/L.
		Etchegoin Formation	Marine Deposits	Silty and clayey sands, sandy silt, silty clay, blue sandstone, and conglomeratic sandstone.	3,000+	Exposed in Kettleman Hills, dips steeply to east beneath San Joaquin formation. Fine grained, interbedded nature, contains saline water.	No known wells into formation, not expected to be an aquifer.
	Miocene	Santa Margarita Formation	Marine Deposits	Fairly well-sorted to well-sorted gray sandstone.	0 - 600	Contains good quality water and yields significant water to wells for irrigation in places. However, sodium chloride front exists about 7 to 10 miles east of Highway 99.	Extensively used as aquifer in area from Terra Bella to Richgrove, east of Highway 99. Not an important aquifer in the TLSB.
	Eocene/Oligocene	Other Tertiary Sediments (undifferen-tiated)	Marine and Non-Marine Deposits		----	Few formations that contain usable water quality.	Too deep to be of concern in or near TLSB.
PRE-TERTIARY	Paleozoic/Mesozoic	Metamorphic and Igneous Rocks	Basement Complex	Crystalline rocks of metamorphosed sedimentary and igneous rocks invaded by largely granitic plutonic rocks.	----	Largely impermeable, contain fractures, faults, and joints that may yield small quantities of water to domestic and stock wells.	Used as water source only in foothills and mountain areas of Sierra Nevada.

Notes: Generalized stratigraphic column after Hilton, et al., 1963; Croft and Gordon, 1968; Davis, et al., 1959; Loomis, 1990; and Wood, 2018.

Table 3-4. Wells With Known Pumping Data

Well ID	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
CID_001	202.12	180.50	40.66	15.59	88.44	12.43	113.33	0.00	0.00	0.00	70.91	51.32	28.32	188.54	46.18	14.42	0.00	0.00	7.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_002	100.00	81.21	92.03	16.78	47.18	0.00	161.08	0.00	0.00	0.00	78.08	0.00	107.40	86.83	66.07	23.15	0.00	0.00	13.49	58.38	22.38	0.04	0.00	30.08	85.05	0.00	0.00
CID_003	199.37	199.59	192.31	166.57	0.00	2.14	61.66	0.00	0.00	0.00	49.79	67.24	114.13	148.82	54.22	0.00	0.00	138.42	0.00	0.00	32.17	0.00	86.16	0.00	0.00	0.00	0.00
CID_004	127.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_005	90.03	98.08	6.35	0.00	16.90	0.00	46.06	0.00	0.00	0.00	9.30	41.87	31.92	48.90	22.16	15.80	0.00	68.95	5.04	46.64	0.00	0.00	0.00	2.00	0.00	60.76	0.00
CID_006	60.19	61.30	2.12	0.00	10.61	0.00	41.90	0.00	0.00	0.00	4.29	44.05	45.06	0.00	31.89	0.00	0.00	106.03	3.07	50.98	0.00	0.00	0.00	36.24	0.00	70.49	0.00
CID_007	53.70	0.00	0.00	0.00	15.08	38.40	95.71	0.00	0.00	0.00	24.38	71.94	79.33	153.92	103.28	38.95	0.00	4.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_008	17.72	24.81	0.00	0.00	42.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_009	82.12	7.64	76.19	10.49	0.00	0.00	0.00	0.00	0.00	0.00	1.42	0.00	59.68	96.94	93.44	0.00	0.00	0.00	23.83	63.80	22.59	0.00	211.85	67.94	74.94	70.00	0.00
CID_010	111.92	102.09	0.00	0.00	29.22	0.00	47.76	0.00	0.00	0.00	12.26	0.00	36.11	50.43	31.08	22.41	0.00	89.37	0.00	50.22	29.95	0.05	0.00	84.54	86.11	100.89	0.00
CID_011	150.18	96.08	0.00	0.00	28.52	0.00	0.00	0.00	0.00	0.00	17.91	0.00	3.23	0.00	65.02	44.19	0.00	0.00	4.05	247.12	36.72	0.00	91.52	0.05	0.00	0.00	0.00
CID_012	217.95	233.67	252.27	217.79	224.75	98.42	242.17	0.00	159.92	0.00	0.00	0.00	0.00	0.00	95.94	114.40	0.00	211.09	120.35	184.39	66.88	0.00	65.72	174.89	157.08	125.79	0.00
CID_013	75.05	71.82	6.45	0.00	31.82	0.00	2.00	0.00	0.00	0.00	7.91	0.00	2.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_014	106.14	114.04	4.08	0.00	55.66	0.00	65.57	0.00	0.00	0.00	14.37	0.00	0.00	76.21	7.74	44.77	0.00	118.00	50.00	313.38	0.00	0.00	90.94	132.34	117.15	12.56	0.00
CID_015	101.32	104.66	6.20	0.00	17.23	0.00	62.77	0.00	0.00	0.00	6.07	54.88	46.67	50.06	18.95	16.97	0.00	0.00	0.00	0.77	0.00	0.00	42.03	0.00	0.00	0.00	0.00
CID_016	82.31	112.50	6.83	0.00	0.00	0.00	25.52	0.00	0.00	0.00	6.56	23.03	0.00	0.00	0.00	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_017	114.96	139.25	77.06	23.37	92.79	6.94	148.80	0.00	0.00	0.00	123.82	199.02	122.09	90.54	16.52	127.97	0.00	111.08	157.19	218.87	100.71	0.69	116.34	150.13	136.67	85.16	0.00
CID_018	48.41	9.48	33.46	10.69	82.75	7.19	0.00	0.00	0.00	0.00	101.70	100.00	64.26	100.09	85.06	229.38	0.00	165.29	149.89	63.59	41.05	0.00	122.19	104.96	96.69	80.69	0.00
CID_019	132.76	147.98	0.00	0.00	118.37	0.00	115.20	0.00	0.00	0.00	0.00	0.00	68.47	127.78	73.62	52.21	0.00	194.10	5.77	110.10	19.32	0.08	284.87	140.26	111.28	113.00	0.00
CID_020	100.34	137.92	9.35	17.56	55.36	12.94	70.10	0.00	0.00	0.00	0.00	107.87	90.53	163.54	115.88	95.47	0.00	245.95	0.00	119.53	42.81	0.00	101.74	138.19	111.38	95.79	0.00
CID_021	61.04	10.19	8.68	15.83	27.07	8.02	218.33	0.00	116.83	0.00	116.32	150.26	91.41	0.00	150.30	107.80	0.00	5.31	17.47	0.00	45.27	0.00	74.06	102.67	108.27	0.00	0.00
CID_022	98.35	86.64	31.87	12.30	78.81	8.67	80.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_023	0.00	79.81	27.31	0.00	0.00	3.45	77.46	0.00	0.00	10.61	57.64	48.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_024	113.85	96.40	19.46	36.20	201.64	9.31	215.04	0.00	130.41	0.00	164.96	119.69	122.48	187.99	0.00	137.66	0.00	245.94	28.14	0.00	85.40	0.00	160.53	187.83	183.01	0.00	0.00
CID_025	131.18	190.81	12.80	24.29	0.00	14.76	203.51	0.00	134.92	0.00	177.53	219.26	95.53	207.12	178.98	143.31	0.00	298.11	132.50	188.08	68.30	0.00	130.58	214.61	190.89	175.15	0.00
CID_026	194.10	180.50	183.27	22.54	197.85	161.67	70.62	0.00	229.09	0.00	120.79	219.26	90.88	16.06	32.30	235.04	0.00	297.50	115.24	122.14	0.00	0.00	25.03	207.93	186.89	100.80	0.00
CID_027	20.32	87.27	0.00	0.00	129.57	78.13	102.50	0.00	0.00	0.00	0.00	114.33	88.00	52.96	92.61	110.69	0.00	0.00	0.00	86.13	41.72	0.00	102.15	95.08	0.00	85.13	0.00
CID_028	134.02	229.86	143.95	57.44	231.17	45.04	254.84	0.00	94.87	0.00	286.68	376.83	128.89	295.75	203.75	0.00	0.00	299.61	260.98	35.47	82.24	0.00	0.00	0.00	174.51	80.00	0.00
CID_029	203.15	223.44	122.14	48.73	187.42	57.41	223.72	0.00	83.58	0.00	228.08	296.53	0.00	265.89	128.64	200.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	102.96	110.80	0.00
CID_030	0.00	111.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_031	66.12	81.46	8.72	11.51	20.74	4.46	0.00	0.00	0.00	0.00	56.70	73.53	32.36	125.53	51.23	52.10	0.00	141.49	24.85	33.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_032	236.31	198.55	129.16	45.67	208.17	44.86	182.72	0.00	247.42	0.00	0.00	0.00	0.00	0.00	0.00	113.50	0.00	0.00	0.00	194.48	76.47	0.00	160.49	172.94	149.75	142.28	0.00
CID_033	0.00	0.00	61.25	22.94	118.47	8.23	207.01	0.00	0.00	0.00	114.91	182.86	102.38	195.05	157.55	114.24	0.00	201.30	99.92	148.81	98.05	0.07	105.64	151.35	0.00	0.00	0.00
CID_034	160.72	154.86	104.39	0.00	108.73	4.80	0.00	0.00	0.00	0.00	118.34	158.17	65.71	0.00	124.71	38.68	0.00	173.26	107.79	96.50	4.25	0.00	124.12	0.00	137.31	107.59	0.00
CID_035	151.21	179.21	109.10	41.10	78.65	29.73	135.13	0.00	215.25	0.00	199.49	117.60	0.00	0.00	206.13	148.60	0.00	310.41	0.00	268.80	95.20	0.00	274.65	228.62	0.00	0.00	0.00
CID_036	133.03	172.32	9.56	36.02	0.00	25.18	146.97	0.00	0.00	0.00	131.65	148.96	89.02	184.46	105.80	142.20	0.00	159.36	0.00	148.56	53.07	0.00	109.43	150.59	106.04	129.53	0.00
CID_037	182.80	207.93	81.75	20.61	146.29	27.40	172.17	0.00	65.27	0.00	100.08	7.34	108.89	227.57	161.57	144.95	0.00	185.34	179.02	155.27	0.00	0.00	155.89	0.00	0.00	0.00	0.00
CID_038	215.81	262.30	158.85	33.62	246.41	47.16	227.27	0.00	0.00	0.00	221.80	187.72	174.98	266.24	66.94	216.66	0.00	305.92	250.13	223.92	79.23	0.00	229.94	201.39	0.00	0.00	0.00
CID_039	101.87	96.36	6.14	0.00	33.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_040	131.37	0.00	205.10	177.43	176.93	194.35	0.00	0.00	4.40	0.00	24.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_041	47.93	237.61	122.48	17.73	168.14	10.85	74.20	0.00	0.00	0.00	45.07	37.35	20.95	55.34	22.55	36.93	0.00	7.75	41.49	40.32	16.85	0.00	0.00	0.00	0.00	0.00	0.00
CID_042	0.00	89.73	60.25	22.31	105.87	8.84	129.60	0.00	0.00	0.00	104.73	126.96	115.69	161.09	0.00	136.70	0.00	272.27	99.72	0.00	103.07	0.00	120.44	178.11	92.85	0.00	0.00
CID_043	12.56	163.07	0.00	0.00	0.00	0.00	122.00	0.00	0.00	19.13	26.03	157.25	26.55	0.00	0.00	99.22	0.00	28.64	119.08	103.72	36.86	0.09	79.74	129.13	115.39	127.55	0.00
CID_044	127.69	197.54	154.58	133.11	137.36	173.96	178.24	0.00	29.33	0.00	107.27	204.82	59.87	120.52	34.48	0.00	0.00	0.00	92.00	159.88	42.21	0.00	0.01	59.92	0.00	0.00	0.00
CID_045	134.40	136.13	61.45	18.21	98.94	12.76	105.71	0.00	0.00	0.00	161.14	142.14	103.22	184.96	107.40	126.91	0.00	132.62	53.52	0.00	0.00	0.00	64.26	8.26	0.00	0.00	0.00
CID_046	133.25	116.03	40.21	5.69	64.74	30.28	91.01	0.00	0.00	0.00	158.33	91.35	147.69	79.53	64.90	89.45	0.00	116.42	1.85	0.00	55.60	0.00	113.85	0.00	0.00	0.00	0.00
CID_047	76.46	52.42	4.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_049	161.28	162.55	104.32	36.36	64.77	38.25	172.13	0.00	102.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_050	0.00	31.76	0.00	0.00	172.40	109.85	178.91	0.00	114.57	0.00	0.00	25.59	285.19	186.81	143.31	0.00	0.00	134.99	0.00	179.50	118.23	0.00	171.51	175.37	159.50	123.95	0.00
CID_051	160.33	131.73	3.92	0.00	0.00	0.00	125.58	0.00	0.00	0.00	24.91	50.98	74.55	0.00	67.48	12.28	0.00	37.35	13.38	0.00	0.00	0.00	0.00	0.00	112.43	120.31	0.00
CID_052	58.36	78.67	0.00	0.00	63.47	61.56	17.80	0.00	0.00	0.00	0.00	61.27	113.32	0.00	122.36	98.89	0.00	4.59	0.00	140.99	66.29	0.00	92.72	0.00	0.00	186.37	0.00
CID_053	52.21	79.74	0.00	0.00	102.65	0.00	95.73	0.00	0.00	0.00	37.53	123.60	137.73	0.00	152.00	114.41	0.00	116.63	158.94	135.65	61.25	0.00	52.67	150.06	143.19	138.26	0.00
CID_054	120.42	141.01	107.73	13.12	137.31	81.94	158.79	0.00	121.84	0.00	110.73	259.40	0.00	40.74	35.90	56.95	0.00	20.01	140.38	136.21	48.70	0.00	135.75	160.11	148.70	140.21	0.00
CID_055	232.76	184.40	5.31	74.55	17.51	19.84	186.66	0.00	0.00	0.00	99.04	223.53	34.63	188.87	177.56	0.00	0.00	249.36	132.40	219.06	180.00	0.01	117.12	219.13	181.11	120.31	0.00
CID_056	88.96	87.33	11.94	0.00	58.86	0.00	59.09	0.00	0.00	0.00	15.53	0.00	67.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_057	19.95	67.73	0.00	0.00	43.53	0.00	72.99	0.00	0.00	0.00	15.82	0.00	49.98	0.00	61.13	58.51	0.00	48.21	75.70	54.53	17.77	0.00	48.31	85.34	65.61	54.74	0.00
CID_058	34.48	199.22	0.00	0.00	145.35	8.37	178.07	0.00	0.00	0.00	34.78	197.71	78.37	160.66	175.49	128.95	0.00	20.13	0.00	297.79	41.52	0.00	0.00	159.25	134.54	0.00	0.00
CID_059	130.61	37.37	11.45	0.00	91.58	0.00	85.56	0.00	0.00	0.00	22.14	0.00	21.83	96.87	61.95	32.79	0.00	204.92	10.18	0.00	31.89	0.01	89.90	102.64	0.00	146.32	0.00

Table 3-4. Wells With Known Pumping Data (Continued)

Well ID	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
CID_060	139.25	91.49	9.47	0.00	0.50	0.00	35.40	0.00	0.00	0.00	12.91	0.00	19.53	73.12	39.84	14.96	0.00	28.93	6.76	23.72	21.54	0.04	47.42	76.31	0.00	99.69	0.00
CID_061	211.80	244.91	8.93	0.00	104.13	0.00	36.62	0.00	0.00	0.00	0.00	0.00	114.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_062	172.89	184.11	6.96	0.00	81.22	0.00	45.20	0.00	0.00	0.00	7.33	0.00	34.33	45.35	27.93	18.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_063	225.16	243.72	148.91	52.54	239.16	76.64	229.93	0.00	167.38	0.00	0.00	0.00	0.00	0.00	116.66	63.61	0.00	132.06	121.23	165.02	0.00	0.00	194.05	0.00	0.00	0.00	0.00
CID_064	241.24	0.00	0.00	71.60	0.00	0.49	1.97	0.00	126.51	0.00	0.00	0.00	0.00	0.00	85.13	98.53	0.00	177.42	0.00	0.00	49.46	0.00	166.53	0.00	97.69	115.95	0.00
CID_065	208.16	191.57	194.19	0.00	218.25	0.00	227.09	0.00	68.98	0.00	56.60	0.00	0.00	136.62	78.73	43.07	0.00	144.09	0.00	0.00	0.00	2.06	91.91	0.00	88.69	0.00	0.00
CID_066	0.00	222.86	123.67	25.88	187.23	41.20	197.38	0.00	102.26	0.00	170.48	2.53	149.67	216.79	162.81	65.74	0.00	174.25	159.61	0.00	49.75	0.00	120.03	146.07	128.56	119.31	0.00
CID_067	0.00	205.06	165.76	0.00	0.91	101.33	194.19	0.00	60.60	0.00	181.67	230.57	114.65	226.93	0.00	169.02	0.00	193.89	0.00	8.21	52.37	0.00	136.46	153.10	151.01	154.05	0.00
CID_068	0.00	245.04	191.02	57.76	248.78	122.93	0.00	0.00	75.84	0.00	218.34	226.43	126.83	304.90	215.75	226.49	0.00	257.87	161.83	0.00	93.36	0.00	237.13	231.75	206.95	216.26	0.00
CID_069	0.00	172.13	0.00	0.00	62.62	0.00	112.29	0.00	0.00	0.00	7.44	0.00	89.28	144.76	85.64	66.69	0.00	144.07	0.00	0.00	56.77	0.00	147.42	193.97	177.38	197.54	0.00
CID_070	0.00	39.14	1.09	0.00	18.64	0.00	9.49	0.00	15.16	0.00	0.00	4.73	0.83	29.57	13.68	5.23	0.00	0.00	0.00	0.00	3.63	0.00	0.00	0.00	21.52	15.37	0.00
CID_071	0.00	0.00	1.50	0.00	0.00	0.00	32.51	0.00	17.39	0.00	0.00	9.11	16.33	29.51	13.72	8.31	0.00	0.00	0.00	0.00	8.66	0.00	24.65	40.12	44.63	1.25	0.00
CID_072	0.00	0.00	1.23	0.00	14.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
CID_073	0.00	0.00	1.85	0.00	31.74	11.31	0.00	0.00	0.00	0.00	0.00	0.00	10.04	10.18	0.00	7.78	0.00	0.29	42.43	0.00	0.00	0.00	0.00	0.00	19.80	0.00	0.00
CID_074	0.00	0.00	0.00	30.84	65.74	8.22	204.92	0.00	0.00	0.00	35.41	171.95	103.28	189.08	191.84	221.64	0.00	200.31	187.22	232.51	74.86	0.00	110.17	0.00	0.00	0.00	0.00
CID_075	0.00	0.00	0.00	33.05	0.00	0.00	52.90	0.00	0.00	0.00	11.25	85.49	97.06	231.71	88.93	43.08	0.00	227.25	2.68	43.00	0.00	0.00	2.00	0.00	113.72	148.15	0.00
CID_076	0.00	0.00	0.00	0.00	0.00	85.11	113.61	0.00	0.00	0.00	0.00	149.43	125.27	202.82	146.36	115.69	0.00	296.98	177.32	156.98	84.64	0.00	126.28	231.85	219.56	0.00	0.00
CID_077	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.11	0.00	18.11	40.20	16.69	5.41	0.00	45.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_078	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.91	172.22	97.98	45.39	0.00	150.82	0.00	136.18	0.00	0.00	151.01	12.11	160.75	71.64	0.00
CID_079	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.79	197.49	118.71	40.79	0.00	129.70	0.00	126.15	37.47	0.00	123.13	0.00	97.78	76.55	0.00
CID_080	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.73	0.00	104.89	35.79	0.00	139.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CID_081	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	194.56	103.09	36.14	0.00	41.30	0.00	140.77	12.85	0.00	124.37	0.00	149.80	128.03	0.00
CID_082	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	134.39	83.16	0.00	210.47	70.50	0.00	49.23	0.05	86.70	139.35	149.48	115.58	0.00
CID_083	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.42	0.00	0.00	160.01	149.11	42.63	0.00	131.36	137.31	142.70	140.69	0.00
CID_084	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	112.37	183.97	111.59	44.55	0.00	72.56	0.00	0.00	130.15	0.00
CID_085	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	302.25	0.00	163.59	29.06	0.10	95.25	136.71	188.64	0.00	0.00
CID_086	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.76	11.32	109.28	43.79	0.00	108.00	0.00	0.00	0.00	0.00
CID_087	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	312.97	123.65	0.00	0.00	0.00	116.39	203.09	176.02	149.60	0.00
CID_088	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	146.83	9.19	0.00	40.98	0.00	190.51	21.47	0.00
CID_089	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	140.06	9.35	0.00	40.83	166.95	0.00	0.00	0.00
CID_090	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	122.84	8.94	0.00	39.46	141.88	110.13	26.71	0.00
CID_091	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	180.46	13.20	0.00	19.20	232.56	264.20	179.58	0.00
CID_092	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	141.48	29.83	0.00	100.98	148.87	151.73	159.98	0.00
CID_093	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	126.20	26.70	0.00	89.22	0.00	140.20	154.97	0.00
CID_094	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	133.23	59.39	0.00	119.75	157.96	183.77	183.89	0.00
CID_095	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	136.44	51.64	0.00	105.35	0.00	166.50	162.14	0.00
CID_096	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.02	271.24	414.38	339.34	0.00
CID_097	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	179.96	363.66	228.49	0.00
CID_098	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	173.36	80.58	0.00
CID_099	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	135.73	0.00
CID_100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	207.62	0.00
CID_101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.56	0.00
Hanford_02	2.78	2.52	2.61	2.74	2.97	2.72	2.89	2.36	2.73	2.65	2.94	2.85	3.38	14.12	3.75	7.73	4.58	7.18	13.53	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_18	10.21	9.24	9.57	10.05	10.90	9.97	10.60	8.67	10.01	9.72	10.78	10.48	12.41	51.84	1.55	1.06	11.99	0.19	60.85	65.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_31	17.86	16.17	16.75	17.58	19.06	17.45	18.54	15.17	17.51	17.00	18.87	18.33	21.71	90.70	81.55	10.22	0.00	86.14	42.74	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_32	0.41	0.37	0.38	0.40	0.44	0.40	0.42	0.35	0.40	0.39	0.43	0.42	0.50	2.07	0.29	1.80	0.49	1.45	0.49	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_33	14.54	13.16	13.64	14.31	15.52	14.21	15.09	12.35	14.25	13.84	15.36	14.92	17.67	73.84	0.00	0.00	0.00	0.00	0.00	9.60	31.75	2.60	3.26	0.00	0.00	0.63	0.71
Hanford_34	44.01	39.85	41.28	43.32	46.99	43.01	45.69	37.40	43.16	41.91	46.50	45.17	53.50	223.54	2.65	85.17	127.63	139.40	40.79	126.05	0.28	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_35	23.00	20.82	21.57	22.63	24.55	22.47	23.87	19.54	22.55	21.89	24.29	23.60	27.95	116.79	82.56	94.84	113.02	0.00	0.00	7.74	74.38	6.30	1.72	0.66	0.00	0.08	0.32
Hanford_36	12.55	11.36	11.77	12.35	13.39	12.26	13.02	10.66	12.30	11.95	13.26	12.88	15.25	63.73	2.35	32.93	26.74	43.07	103.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_38	2.58	2.33	2.42	2.53	2.75	2.52	2.67	2.19	2.52	2.45	2.72	2.64	3.13	13.08	0.26	0.00	28.05	2.26	2.86	0.12	5.33	0.00	2.74	1.19	0.00	6.55	0.00
Hanford_40	34.26	31.02	32.14	33.72	36.57	33.48	35.56	29.11	33.59	32.62	36.20	35.16	41.65	174.00	102.16	6.91	0.20	113.87	160.43	76.08	170.10	19.88	15.44	44.70	0.00	0.02	28.52
Hanford_41	22.22	20.12	20.85	21.87	23.73	21.72	23.07	18.88	21.79	21.16	23.48	22.81	27.02	112.88	37.07	128.55	36.48	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanford_42	43.51	39.40	40.82	42.83	46.45	42.52	45.17	36.97	42.66	41.43	45.97	44.66	52.90	221.00	65.85	0.00	0.00	0.00	0.00	72.54	16.07	66.54	71.57	148.77	0.00	171.15	38.37

Table 3-4. Wells With Known Pumping Data (Continued)

Well ID	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hanford_43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.06	0.29	0.00	6.83	16.22	0.00	135.93	40.24
Hanford_44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	178.76	206.21	33.10	0.00	34.15	89.62
Hanford_45(16)	52.48	47.52	49.23	51.65	56.02	51.28	54.47	44.59	51.46	49.97	55.45	53.86	63.80	266.54	4.56	21.81	13.39	28.59	0.00	0.00	204.67	156.36	166.69	200.93	0.00	1377.57	133.32
Hanford_46(8)	0.11	0.10	0.10	0.11	0.12	0.11	0.11	0.09	0.11	0.10	0.12	0.11	0.13	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	0.00	0.00	0.00	0.56
Hanford_47(22)	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.07	0.08	0.07	0.08	0.08	0.10	0.40	0.19	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.14	0.91
Hanford_48(25)	10.48	9.49	9.83	10.32	11.19	10.24	10.88	8.91	10.28	9.98	11.07	10.76	12.74	53.23	1.59	24.67	10.43	0.22	0.10	0.00	0.00	41.41	0.00	142.54	0.00	3.91	0.36
Hanford_49	9.56	8.66	8.97	9.41	10.21	9.34	9.92	8.12	9.37	9.10	10.10	9.81	11.62	48.56	0.00	0.00	10.23	2.09	1.72	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LEM_02	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	0.00	0.00	0.00	34.16	0.00
LEM_04	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	27.71	9.04	164.87	34.16	0.03
LEM_05	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	0.00	0.00	13.99	34.16	0.00
LEM_06	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	189.21	131.62	0.00	34.16	94.81
LEM_07	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	46.90	72.15	28.45	34.16	69.15
LEM_08	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	0.00	0.00	0.00	34.16	0.00
LEM_09	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	0.00	0.00	0.00	34.16	0.00
LEM_10	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	36.73	62.34	148.47	19.61	37.57	226.48	25.28	29.31	32.61	29.81	31.87	32.84	30.01	0.00	0.00	0.00	34.16	0.00
LEM_11	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	999.00	27.10	25.28	29.31	32.61	29.81	31.87	32.84	30.01	49.31	67.80	77.42	34.16	36.90
LEM_12	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	4.50	41.69	128.77	25.28	29.31	32.61	29.81	31.87	32.84	30.01	111.80	42.92	0.00	34.16	39.58
LEM_13	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	0.52	46.43	145.08	34.16	142.58
LEM_14	17.69	16.02	16.60	17.41	18.89	17.29	18.36	15.03	17.35	15.04	14.72	6.31	23.40	0.00	0.00	25.28	29.31	32.61	29.81	31.87	32.84	30.01	0.00	36.19	52.83	34.16	0.00
RW-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RW-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RW-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RW-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RW-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grand Total	13990.30	34818.67	14904.79	2182.68	21143.09	2456.05	18470.13	435.83	9504.62	736.18	10829.55	9559.58	21339.33	33746.62	18767.55	5977.98	735.48	25830.51	5114.73	27942.37	3823.89	5524.88	21211.85	26243.10	24922.43	17487.34	830.32

Notes:

1. Annual Total is by Calendar Year.
2. Volume in Acre feet

Table 3-5. Surface Water Diversions

TULARE LAKE SUB-BASIN ANNUAL ACRE FEET OF SURFACE WATER KINGS RIVER WATERSHED

Kings River Water Years	GSA	Mid Kings River				South Fork Kings							Southwest Kings										El Rico													Tri-County											GSA
	Agency	Peoples Ditch Company	Last Chance Water Ditch Company			Stratford Irrigation District	Empire West Side Irrigation District			Lemoore Canal & Irrigation Company			Dudley Ridge Water District																																		Agency
	Diversion	Peoples Canal-60% of Peoples Canal Total	Last Chance Canal-50% of Last Chance Canal Total	Imported Water	Mid Kings	Stratford Canal	Empire West Side ID total from SWP	Empire West Side Canal	Westlake Canal	Lemoore Canal	Imported Water	South Fork Kings River	Blakeley Canal-Kings River & Lateral A	TLBWSD Lateral C, T203	Dudley Ridge State Turnout (DR-1), T201	Dudley Ridge State Turnout (DR-1B), T202	Dudley Ridge State Turnout (DR-1A), T204	Dudley Ridge State Turnout (DR-2), T205	Dudley Ridge State Turnout (Paramount), T207	Dudley Ridge State Turnout (DR-3), T208	Imported Water, Angiola/Green Valley Well Fields, City of Lemoore and Westlands RD 761	Southwest Kings	Empire Weir No. 2 (over #2 weir to river extension, River Water) Modified Total-(Empire Weir No. 2 minus Tri County Kings River Water)	TLBWSD Lateral A, T200 (State Water)-Modified Total-(SWP Total for Lateral A minus Tri County Entitlement, Then 20% taken to Blakely Canal)	TLBWSD Lateral B, T206 (State Water)-Modified Total-(SWP Total for Lateral B minus Tri County Entitlement)	Lakelands Canal-Total	Tulare Lake Canal	Melga Canal-40% of Peoples Canal Total	Kern River	Deer Creek-30% of Deer Creek Total	Tule River-El Rico	Kaweah River	Loan Oak/New Deal-50% of Last Chance Canal Total	Imported Water	El Rico	Poso Creek	TLBWSD Lateral A, T200 (State Water)-Assumed Full Entitlement-25% to Lateral A	TLBWSD Lateral B, T206 (State Water)-Assumed Full Entitlement-75% to Lateral B	Tule River-Tri County	Deer Creek-70% of Deer Creek Total	White River	Kings River-Tri County	Other Water	Imported Water	Tri-County	Annual Totals	Diversion
71%	1966	107,763	35,968	-	143,731	2,158	-	4,770	3,604	96,079	-	106,612	20,559	-	-	-	-	-	-	-	-	20,559	2,404	-	-	14,225	17,831	71,842	-	-	-	-	35,968	-	142,271	-	-	-	-	-	-	-	-	-	0	413,173	1966
197%	1967	136,889	56,049	-	192,938	3,947	-	9,622	5,861	109,323	-	128,753	29,187	-	-	-	-	-	-	-	-	29,187	82,883	-	-	71,671	42,476	91,260	-	-	-	-	56,049	-	344,339	-	-	-	-	-	-	-	-	-	0	695,217	1967
49%	1968	75,809	22,770	-	98,580	3,540	1,978	13,636	12,718	91,478	-	123,351	19,692	0	3,680	1,054	2,636	12,653	11	6,326	-	46,052	4,673	7,571	12,508	17,218	49,218	50,540	-	-	-	-	22,770	-	164,498	-	1,125	3,375	-	-	-	-	-	-	4,500	436,980	1968
256%	1969	107,636	43,814	-	151,450	1,139	56	2,878	6,056	87,537	-	97,665	534	0	4,380	1,255	3,138	15,060	13	7,530	-	31,909	196,219	2,136	3,529	40,568	0	71,757	-	-	-	-	43,814	-	358,022	-	317	952	-	-	-	-	-	-	1,270	640,315	1969
78%	1970	76,723	27,694	-	104,418	1,884	3,942	5,359	7,305	93,441	-	111,932	0	0	5,641	1,616	4,041	19,395	16	9,698	-	40,407	0	0	0	52,483	0	51,149	-	-	-	-	27,694	-	131,326	-	0	0	-	-	-	-	-	-	0	388,083	1970
69%	1971	86,815	25,230	-	112,045	4,376	5,990	4,665	10,280	96,498	-	121,809	10,521	0	5,731	1,642	4,105	19,705	16	9,853	-	51,574	0	34,937	57,719	28,610	490	57,877	-	-	-	-	25,230	-	204,861	-	5,192	15,575	-	-	-	-	-	-	20,766	511,055	1971
50%	1972	51,631	27,279	-	78,909	4,062	5,795	6,188	5,133	80,465	-	101,644	20,920	0	5,925	1,698	4,244	20,373	17	10,186	-	63,363	1,099	76,174	125,847	0	7,305	34,420	-	-	-	-	27,279	-	272,124	-	11,320	####	-	-	-	-	-	-	45,278	561,318	1972
125%	1973	139,667	44,766	-	184,433	4,411	5,814	5,964	6,543	86,382	-	109,115	22,249	0	4,921	1,410	3,525	16,920	14	8,460	-	57,498	530	33,647	55,589	19,101	31,948	93,111	-	-	-	-	44,766	-	278,691	-	5,000	####	-	-	-	-	-	-	20,000	649,737	1973
122%	1974	137,406	48,896	-	186,301	4,082	4,539	9,291	10,508	102,115	-	130,535	37,966	0	9,323	2,671	6,678	32,055	27	16,027	-	104,747	14,906	41,534	68,442	55,482	28,336	91,604	-	0	-	-	48,896	-	349,199	0	6,290	####	1,402	0	0	0	0	-	26,560	797,342	1974
92%	1975	109,458	31,383	-	140,841	4,570	6,448	8,763	10,939	104,388	-	135,108	36,603	0	11,323	3,244	8,111	38,933	32	19,466	-	117,713	11,905	65,413	109,436	41,833	53,125	72,972	-	0	-	-	31,383	-	386,068	0	8,809	####	224	0	0	2,642	0	-	38,103	817,832	1975
32%	1976	37,828	1,611	-	39,439	4,284	6,457	5,915	5,004	70,925	-	92,586	22,247	0	8,633	2,474	6,184	29,685	25	14,842	-	84,090	0	34,586	58,370	3,493	45,170	25,219	-	0	-	-	1,611	-	168,447	0	4,319	####	0	0	0	9,154	0	-	26,429	410,991	1976
23%	1977	43,393	6,816	-	50,209	2,203	2,355	1,598	557	42,067	-	48,780	8,903	0	4,037	1,157	2,892	13,881	12	6,940	-	37,821	1,732	14,406	25,850	0	4,003	28,929	-	0	-	-	6,816	-	81,734	0	775	2,324	0	0	0	950	0	-	4,048	222,592	1977
201%	1978	125,769	51,127	-	176,896	2,859	454	10,627	9,312	80,567	-	103,819	26,094	0	8,283	2,373	5,933	28,480	24	14,240	-	85,427	33,029	2,608	3,748	31,904	49,511	83,846	-	3,000	-	-	51,127	-	258,773	1,500	762	2,285	2,476	7,000	1,000	11,956	0	-	26,978	651,893	1978
101%	1979	125,680	46,045	-	171,725	6,434	1,739	15,449	9,523	107,578	-	140,723	52,496	0	10,762	3,084	7,709	37,003	31	18,501	-	129,585	2,523	67,705	119,134	34,336	32,856	83,787	-	0	-	-	46,045	-	386,386	0	5,209	15,627	185	0	0	6,575	0	-	27,596	856,015	1979
178%	1980	101,388	45,975	-	147,363	3,981	894	16,100	11,566	103,714	-	136,254	53,639	0	11,179	3,203	8,008	38,438	32	19,219	-	133,718	41,353	25,284	41,623	37,277	29,258	67,592	-	1,800	-	-	45,975	-	290,162	900	3,857	11,570	2,611	4,200	600	2,819	0	-	26,557	734,053	1980
61%	1981	89,091	33,915	-	123,006	4,435	8,851	7,841	9,437	89,111	-	119,675	42,806	0	10,236	2,933	7,333	35,197	29	17,598	-	116,133	8,761	96,121	171,021	9,180	19,710	59,394	-	0	742	78,485	33,915	-	477,329	0	6,138	18,413	223	0	0	8,983	0	-	33,757	869,900	1981
181%	1982	127,200	46,724	-	173,923	4,479	4,865	9,396	20,983	100,153	-	139,876	41,213	0	7,743	2,219	5,546	26,622	22	13,311	-	96,676	45,602	26,461	44,863	54,659	77,268	84,800	-	5,660	63,476	171,808	46,724	-	621,321	2,830	3,168	9,503	3,090	13,207	1,887	12,547	0	-	46,232	1,078,028	1982
261%	1983	60,994	34,295	-	95,289	3,808	0	6,097	10,389	58,631	-	78,926	22,250	0	7,806	2,237	5,592	26,841	22	13,421	-	78,169	238,616	340	637	21,919	1,333	40,663	-	12,150	193,800	114,301	34,295	-	658,053	6,075	0	0	340	28,350	4,050	0	0	-	38,815	949,252	1983
115%	1984	97,831	38,321	-	136,151	2,533	0	2,801	3,800	99,362	-	108,496	10,003	0	9,018	2,584	6,460	31,008	26	15,504	-	74,604	17,704	1,542	2,337	42,516	0	65,220	-	####	17,566	120,846	38,321	-	325,857	9,902	370	1,109	0	46,210	6,601	0	0	-	64,191	709,299	1984
73%	1985	105,362	28,273	-	133,635	4,869	5,197	5,209	6,827	103,148	-	125,251	34,288	0	8,656	2,480	6,201	29,764	25	14,882	-	96,297	16,118	60,399	102,490	20,108	29,821	70,241	-	0	367	73,859	28,273	-	401,678	0	7,172	21,517	826	0	0	1,586	0	-	31,101	787,961	1985
190%	1986	111,962	44,612	-	156,574	7,329	2,300	7,345	16,723	87,761	-	121,457	27,361	0	7,141	2,046	5,115	24,553	20	12,276	-	78,513	28,395	28,248	50,644	50,896	51,205	74,641	-	5,144	43,384	71,918	44,612	-	449,088	2,572	1,547	4,642	1,701	12,004	1,715	11,054	0	-	35,235	840,867	1986
45%	1987	70,406	17,708	-	88,115	5,177	4,401	4,959	10,982	90,541	-	116,061	28,582	0	6,462	1,852	4,629	22,218	19	11,109	-	74,870	18,250	42,742	73,709	27,104	57,023	46,938	-	0	0	44,445	17,708	-	327,918	0	4,289	####	0	0	0	9,366	0	-	26,520	633,484	1987
48%	1988	60,312	15,603	-	75,915	3,953	3,475	4,457	2,949	76,554	-	91,388	21,261	0	6,700	1,920	4,799	23,037	19	11,519	-	69,255	8,209	28,524	49,444	18,863	17,816	40,208	-	0	0	25,873	15,603	-	204,539	0	2,692	8,076	0	0	0	984	0	-	11,752	452,850	1988
53%	1989	60,579	14,239	-	74,818	0	3,000	0	-	56,519	-	59,519	13,458	0	7,964	2,282	5,705	27,384	23	13,692	-	70,507	0	53,832	92,511	7,458	0	40,386	-	0	0	24,550	14,239	-	232,976	0	5,616	####	150	0	0	0	1,580	-	24,192	462,012	1989
40%	1990	53,292	7,078	-	60,370	0	3,310	0	-	34,465	-	37,775	6,485	0	5,117	1,466	3,666	17,595	15	8,798	14,540	57,682	0	25,940	45,327	15,114	0	35,528	-	0	0	39,853	7,078	-	168,840	0	2,207	6,622	0	0	0	0	4,556	-	13,385	338,052	1990
63%	1991	45,654	13,301	-	58,955	1,760	221	1,006	964	31,492	-	35,442	5,941	0	1,856	532	1,329	6,381	5	3,190	8,181	27,414	344	1,873	3,481	6,143	2,870	30,436	-	0	0	28,897	13,301	-	87,345	0	20	60	604	0	0	1,604	0	-	2,288	211,444	1991
41%	1992	49,394	6,686	-	56,081	1,759	1,354	0	964	37,968	-	42,045	6,003	0	1,884	540	1,350	6,479	5	3,239	6,095	25,594	0	24,010	42,904	0	0	32,930	-	279	0	23,442	6,686	-	130,252	140	1,410	4,231	0	652	93	0	0	-	6,525	260,497	1992
149%	1993	129,248	38,213	-	167,460	5,070	2,741	4,314	8,612	91,166	-	111,903	30,546	0	3,242	929	2,322	11,146	9	5,573	6,480	60,247	25,174	38,759	71,640	66,990	44,555	86,165	-	101	0	108,379	38,213	-	479,974	50	689	2,066	1,155	235	34	6,919	2,575	-	13,722	833,308	1993
50%	1994	64,549	15,369	-	79,918	2,997	1,666	3,808	6,811	76,550	-	91,833	26,295	0	4,260	1,221	3,052	14,649	12	7,325	11,642	68,456	15,625	19,310	34,395	0	49,718	43,033	-	0	0	28,376	15,369	-	205,826	0	1,207	3,622	0	0	0	6,098	0	-	10,927	456,959	1994
202%	1995	131,673	51,150	-	182,823	6,123	1,631	6,419	1,410	85,049	-	100,632	34,039	0	6,350	1,819	4,549	21,833	18	10,916	8,131	87,655	51,722	41,800	72,830	52,969	48,240	87,782	-	2,285	13,777	149,232	51,150	-	571,786	1,142	3,697	11,092	6,040	5,331	762	4,902	0	-	32,965	975,861	1995
122%	1996	148,972	47,669	-	196,641	6,774	1,868	5,576	5,778	105,398	-	125,393	41,813	0	7,651	2,192	5,481	26,308	22	13,154	14,505	111,125	33,027	73,202	131,666	61,767	36,006	99,315	-	1,847	236	139,238	47,669	-	623,973	924	3,726	11,177	1,913	4,311	616	2,219	0	-	24,884	1,082,016	1996
155%	1997	119,034	42,753	-	161,787	7,460	0	8,239	2,079	89,117	-	106,896	25,259	0	8,772	2,514	6,284	30,162	25	15,081	11,319	99,416	19,089	6,925	2,570	32,557	25,047	79,356	-	9,220	40,122	87,295	42,753	-	344,933	4,610	2,311	6,932	1,701	21,513	3,073	4,729	0	-	44,869	757,901	1997
181%	1998	130,006	38,932	-	168,937	5,578	542	4,596	8,447	75,590	-	94,753	17,157	3,528	7,728	2,214	5,536	26,573	22	13,286	11,348	87,393	4,514	7,006	21,326	32,918	16,707	86,671	-	5,590	26,731	88,211	38,932	-	328,604	2,795	1,289	3,867	2,083	13,042	1,863	50	0	-	24,989	704,676	1998
74%	1999	90,950	31,469	-	122,419	4,971	3,176	6,135	3,624	95,504	-	113,410	25,132	0	8,842	2,534	6,334	30,403	25	15,202	10,280	98,752	4,359	72,563	171,282	8,184	13,492	60,633	-	0	2,235	63,303	31,469	-	427,520	0	116	349	274	0	0	167	0	-	906	763,007	1999
90%	2000	99,151	41,263	-	140,414	4,598	1,799	2,184	4,566	99,074	-	112,221	21,426	0	8,219	2,355	5,887	28,259	24	14,130	10,299	90,598	16,796	48,692	105,301	35,062	33,304	66,100	-	871	2,900	61,231	41,263	-	411,520	435	4,799	####	1,166	2,032	290	0	0	-	23,118	777,871	2000
59%	2001	67,111	15,516	-	82,627	4,959	1,860	1,993	2,680	58,979	-	70,471	11,377	0	6,700	1,920	4,799	23,036	19	11,518	10,306	69,674	21,146	26,412	47,642	2,122	38,045	44,741	-	0	8	27,148	15,516	-	222,780	0	1,253	3,759	0	0	0	3,044	3,000	-	11,056	456,607	2001
67%	2002	86,651	26,010	-	112,661	4,104	1,405	1,364	2,202	74,196	-	83,271	13,083	0	7,700	2,206	5,516	26,476	22	13,238	10,291	78,532	14,150	25,252	40,639	46,842	7,942	57,768	-	0	490	79,124	26,010	-	298,217	0	2,444	7,331	124	0	0	0	190	-	10,088	582,769	2002
83%	2003	91,664	27,368	-	119,031	4,356	1,436	752	3,362	63,511	-	73,417	8,256	0	7,396	2,119	5,298	25,431	21	12,716	10,359	71,597	13,153	18,154	54,749	36,750	45,168	61,109	-	0	1,748	62,738	27,368	-	320,937	0	2,624	7,872	790	0	0	6,652	160	-	18,098	603,080	2003
61%	2004	72,277	13,653	-	85,931	2,019	3,562	1,650	1,480	58,257	-	66,968	12,382	0	7,092	2,032	5,080	24,385	20	12,192	10,072	73,256	17,145	27,875	51,780	40,917	16,768	48,185	-	0	1,106	64,697	13,653	-	282,127	0	323	970	559	0	0	0	5,293	-	7,145	515,426	2004
148%	2005	119,174	27,400	-	146,573	5,619	3,834	2,664	1,946	98,279	-	112,342	24,480	0	8,184	2,345	5,863	28,141	23	14,070	11,115	94,222	73,872	33,847	92,129	42,290	64,243	79,449	-	1,767	2,372	111,297	27,400	-	528,665	884	141	423	1,680	4,123	589	10,632	1,235	-	19,707	901,509	2005
172%	2006	119,516	32,729	-	152,246	6,065	3,282	5,417	2,368	96,857	-	113,989	34,147	0	8,629	2,472	6,181	29,669	25	14,834	11,115	107,072	70,800	27,371	63,980	80,614	74,920	79,678	-	2,392	17,135	196,319	32,729	-	645,937	1,196	154	461	795	5,581	797	14,253	0	-	23,236	1,042,481	2006

Table 3-5. Surface Water Diversions (Continued)

TULARE LAKE SUB-BASIN ANNUAL ACRE FEET OF SURFACE WATER KINGS RIVER WATERSHED

Kings River Water Years	GSA	Mid Kings River				South Fork Kings							Southwest Kings										El Rico													Tri-County											GSA
	Agency	Peoples Ditch Company	Last Chance Water Ditch Company			Stratford Irrigation District	Empire West Side Irrigation District			Lemoore Canal & Irrigation Company			Dudley Ridge Water District																																			Agency
	Diversion	*Peoples Canal-60% of Peoples Canal Total*	*Last Chance Canal-50% of Last Chance Canal Total*	Imported Water	Mid Kings	Stratford Canal	Empire West Side ID total from SWP	Empire West Side Canal	Westlake Canal	Lemoore Canal	Imported Water	South Fork Kings River	*Blakeley Canal-Kings River & Lateral A*	TLBWSD Lateral C, T203	Dudley Ridge State Turnout (DR-1), T201	Dudley Ridge State Turnout (DR-1B), T202	Dudley Ridge State Turnout (DR-1A), T204	Dudley Ridge State Turnout (DR-2), T205	Dudley Ridge State Turnout (Paramount), T207	Dudley Ridge State Turnout (DR-3), T208	Imported Water, Angiola/Green Valley Well Fields, City of Lemoore and Westlands RD 761	Southwest Kings	*Empire Weir No. 2 (over #2 weir to river extension, River Water) Modified Total-(Empire Weir No. 2 minus Tri County Kings River Water)*	*TLBWSD Lateral A, T200 (State Water)-Modified Total-(SWP Total for Lateral A minus Tri County Entitlement, Then 20% taken to Blakely Canal)*	*TLBWSD Lateral B, T206 (State Water)-Modified Total-(SWP Total for Lateral B minus Tri County Entitlement)*	Lakelands Canal-Total	Tulare Lake Canal	*Melga Canal-40% of Peoples Canal Total*	Kern River	*Deer Creek-30% of Deer Creek Total*	Tule River-El Rico	Kaweah River	*Loan Oak/New Deal-50% of Last Chance Canal Total*	Imported Water	El Rico	Poso Creek	*TLBWSD Lateral A, T200 (State Water)-Assumed Full Entitlement-25% to Lateral A*	*TLBWSD Lateral B, T206 (State Water)-Assumed Full Entitlement-75% to Lateral B*	Tule River-Tri County	*Deer Creek-70% of Deer Creek Total*	White River	Kings River-Tri County	Other Water	Imported Water	Tri-County	Annual Totals	Diversion
40%	**2007**	**78,217**	**10,459**	-	88,676	4,836	2,084	3,810	4,727	70,288	-	85,745	**25,308**	0	6,767	1,939	4,847	23,267	19	11,634	9,975	83,756	**21,586**	**24,995**	**48,692**	17,889	31,676	**52,145**	-	**0**	153	42,786	**10,459**	-	250,381	0	**61**	**182**	0	**0**	0	18,083	63	-	18,389	526,947	**2007**
72%	**2008**	**73,929**	**14,500**	-	88,429	2,037	947	1,470	1,081	59,988	-	65,523	**10,209**	0	5,880	1,685	4,212	20,217	17	10,108	10,016	62,343	**9,553**	**11,165**	**14,430**	8,051	5,282	**49,286**	-	**0**	158	44,426	**14,500**	-	156,851	0	**190**	**571**	828	**0**	0	4,756	0	-	6,345	379,491	**2008**
79%	**2009**	**77,535**	**15,308**	-	92,844	2,047	164	1,811	1,771	49,297	-	55,090	**7,997**	0	4,424	1,268	3,169	15,213	13	7,606	12,178	51,868	**855**	**10,811**	**16,769**	22,036	99	**51,690**	-	**0**	1,383	68,218	**15,308**	-	187,169	0	**9**	**26**	0	**0**	0	0	0	-	34	387,005	**2009**
121%	**2010**	**101,350**	**21,409**	-	122,758	4,318	2,828	3,644	2,900	90,694	-	104,384	**17,655**	0	4,605	1,319	3,298	15,832	13	7,916	42,300	92,939	**34,789**	**11,202**	**39,056**	38,210	37,297	**67,567**	-	**0**	5,059	118,857	**21,409**	-	373,444	0	**3**	**9**	1,676	**0**	0	10,587	282	-	12,557	706,083	**2010**
180%	**2011**	**148,231**	**39,794**	-	188,025	4,979	1,515	4,625	4,947	109,605	-	125,670	**43,781**	0	3,748	1,074	2,685	12,886	11	6,443	34,012	104,637	**89,121**	**16,954**	**31,663**	88,052	78,409	**98,820**	-	**0**	11,316	164,317	**39,794**	-	618,447	0	**83**	**250**	-	**0**	0	0	-	-	333	1,037,113	**2011**
49%	**2012**	**71,785**	**15,155**	-	86,939	4,203	1,279	4,594	2,289	71,207	-	83,571	**22,689**	0	3,084	884	2,209	10,603	9	5,302	51,435	96,215	**24,964**	**20,622**	**53,563**	3,483	15,977	**47,856**	-	**0**	200	65,278	**15,155**	-	247,098	0	**69**	**207**	-	**0**	0	0	-	-	277	514,100	**2012**
41%	**2013**	**45,916**	**6,440**	-	52,356	0	595	0	0	43,206	-	43,801	**3,284**	0	3,989	1,143	2,858	13,717	11	6,859	19,602	51,464	**0**	**13,135**	**15,930**	58,140	0	**30,611**	-	**-**	-	-	**6,440**	-	124,255	0	**71**	**212**	-	**0**	0	0	-	-	283	272,159	**2013**
32%	**2014**	**24,157**	**4,412**	-	28,570	0	175	0	0	17,905	-	18,080	**567**	0	2,373	680	1,700	8,161	7	4,080	23,852	41,420	**0**	**2,266**	**4,489**	41,472	0	**16,105**	-	**-**	-	-	**4,412**	-	68,745	0	**47**	**141**	-	**0**	0	0	-	-	188	157,003	**2014**
21%	**2015**	**8,954**	**-**	-	8,954	0	362	0	0	14,759	-	15,121	**184**	0	3,634	1,041	2,603	12,496	10	6,248	31,718	57,937	**0**	**738**	**0**	21,076	0	**5,969**	-	**-**	-	-	**0**	-	27,784	0	**55**	**0**	-	**0**	0	0	-	-	55	109,850	**2015**
75%	**2016**	**56,992**	**10,283**	-	67,275	0	-	0	0	42,532	-	42,532	**-**	-	-	-	-	-	-	-	34,248	34,248	**0**	**-**	**-**	32,114	0	**37,995**	-	**-**	-	-	**10,283**	-	80,392	0			-	**0**	0	0	-	-	0	224,447	**2016**
	Annual Averages	**89,274**	**27,518**		**116,792**	**3,669**	**2,396**	**4,804**	**5,334**	**77,554**		**93,757**	**20,737**	**68**	**6,150**	**1,762**	**4,406**	**21,147**	**18**	**10,574**	**8,734**	**74,004**	**26,210**	**26,444**	**48,994**	**31,229**	**26,107**	**59,516**	**0**	**1,383**	**8,586**	**####**	**27,518**		**#####**	**705**	**2,215**	**6,641**	**666**	**3,227**	**470**	**3,333**	**364**		**17,770**	**#####**	**Annual Average**

Notes

1) Values highlighted have been modified.

2.) Values with "0" indicate no surface water delivery to the best of our knowledge.

3.) Values with "-" have no verified data.

4.) Total flow from Peoples Canal is split 60% to Mid Kings, 40% to Melga.

5.) Last Chance Diversion is split 50% between Mid Kings and El Rico.

6.) Blakeley has added State Water from Lateral A for Southwest.

7.) Total flow from Deer Creek split 30% to El Rico, 70% to Tri County.

8.) Tule River for El Rico includes the total of Elk Bayou and TID Spill.

8.) SWP from TLBWSD Split throughout Tri County & Southwest Kings.

9.) Kings River water in Tri County was subtracted from the total in Empire Weir No. 2. 1976 and 2010 are 0 for Emipire Weir No. 2 because of negative values.

10.) Additional Tule River flow data added for Tri County

Key

Average Annual

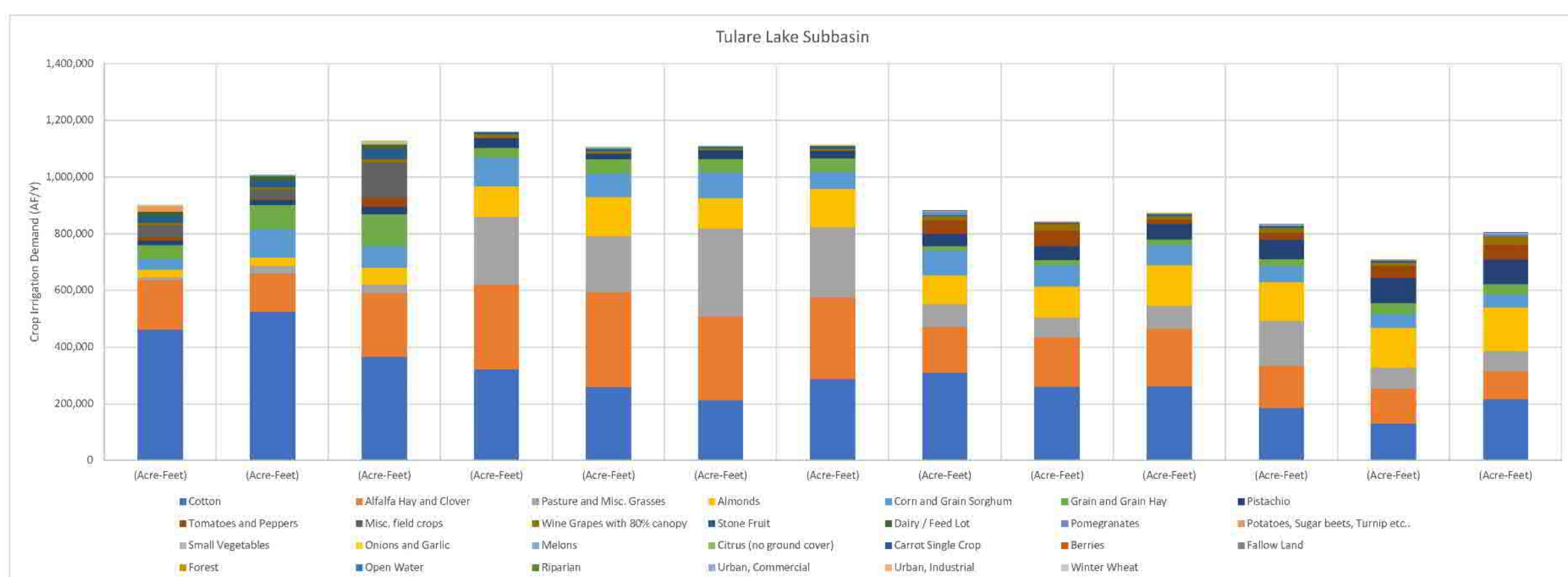
Wet Year
Dry Year
Average Precipitation
GSA Annual Totals
Kings River Watershed Total
832,814
443,503
712,463

Table 3-6. 1990 - 2016 Historical Water Balance

Tulare Lake Sub Basin	Tulare Lake SW Deliveries (Acre-Feet)	Tulare Lake Drain Net (Acre-Feet)	Tulare Lake GHB Net (Acre-Feet)	Tulare Lake Well Net (Acre-Feet)	Tulare Lake River Net (Acre-Feet)	Tulare Lake Lake Net (Acre-Feet)	Tulare Lake Recharge Net (Acre-Feet)	Tulare Lake ET Net (Acre-Feet)	Tulare Lake Storage Net (Acre-Feet)	Westside Westside Net (Acre-Feet)	Kings Kings Net (Acre-Feet)	Kaweah Kaweah Net (Acre-Feet)	Tule Tule Net (Acre-Feet	Kern Kern Net (Acre-Feet)	Total Outflow Total Net (Acre-Feet)	Cumulative Change In Storage (Acre-Feet)
1990	337,264	0	0	-948,368	331,590	105,196	242,449	-899,516	74,565	1,394	11,182	-22,681	-55,554	54,644	-40	74,565
1991	211,077	0	0	-929,079	306,071	22,965	114,001	-899,516	-194,118	-13,901	16,404	-15,950	-74,963	36,437	-34	-119,553
1992	258,969	0	0	-902,862	236,587	-1,192	48,740	-900,431	-371,376	-23,013	15,509	-19,655	-86,028	29,211	-6	-490,929
1993	831,522	0	0	-558,221	418,954	3,113	62,093	-899,516	129,490	-29,785	3,030	-31,657	-30,219	27,434	-34	-361,439
1994	456,168	0	0	-748,869	286,564	-14,344	37,241	-899,516	-271,118	-33,539	2,442	-24,555	-40,490	21,421	-174	-632,557
1995	974,181	0	0	-488,501	405,009	-3,350	56,072	-899,516	121,560	-35,687	1,734	-34,163	-25,203	21,538	1	-510,996
1996	1,079,954	0	0	-446,913	387,177	5,610	113,943	-983,631	167,214	-37,545	-4,542	-35,615	-27,830	17,053	-23	-343,782
1997	756,233	0	0	-552,397	361,499	-5,101	158,392	-986,582	65,946	-35,512	-4,255	-38,669	-31,257	16,610	-6	-277,836
1998	703,045	0	0	-547,589	395,227	-27,906	151,882	-990,571	89,146	-34,862	469	-34,998	-31,383	16,342	5	-188,690
1999	762,210	0	0	-611,068	386,850	-33,817	130,459	-1,062,711	-23,360	-36,511	-6,238	-41,795	-33,974	23,617	-51	-212,050
2000	776,473	0	0	-519,844	372,779	-31,571	105,354	-1,079,396	17,860	-38,895	-8,691	-33,936	-49,650	21,884	4	-194,189
2001	455,744	0	0	-682,326	285,319	-28,710	83,540	-1,088,850	-266,008	-41,753	-5,854	-31,590	-90,812	16,347	-104	-460,197
2002	581,260	0	0	-688,987	351,081	-25,702	75,022	-1,099,605	-208,676	-46,559	-9,873	-37,663	-84,582	16,690	-528	-668,873
2003	601,926	-267	0	-684,906	361,060	-25,184	68,068	-1,110,337	-190,478	-46,170	-8,658	-34,859	-81,784	18,181	-488	-859,352
2004	514,813	-1	0	-719,780	349,943	-24,713	59,933	-1,112,732	-247,984	-47,554	-9,134	-32,213	-83,988	17,000	-375	-1,107,335
2005	900,152	-311	0	-506,648	411,812	-19,054	77,395	-1,112,503	47,323	-50,063	-11,595	-40,200	-43,085	17,355	-190	-1,060,012
2006	1,040,676	-971	0	-458,727	411,154	-7,933	127,047	-1,113,588	130,798	-49,259	-8,908	-43,449	-34,661	17,807	-505	-929,214
2007	525,640	-1,749	0	-669,138	340,843	-25,876	136,985	-1,091,803	-140,356	-43,797	-12,100	-30,513	-44,587	9,412	-1,870	-1,069,570
2008	378,492	-260	0	-736,521	323,738	-27,554	96,881	-1,012,186	-277,307	-46,207	-9,747	-32,812	-96,246	14,869	-940	-1,346,877
2009	386,089	-318	0	-690,837	353,289	-25,035	57,832	-1,030,628	-241,573	-48,909	-12,975	-24,267	-101,697	6,137	-661	-1,588,450
2010	704,432	-71	0	-479,532	351,405	-21,161	43,071	-1,011,855	-52,251	-50,665	-20,421	-29,542	-67,391	12,919	-90	-1,640,701
2011	1,035,727	-850	0	-281,240	397,481	-14,571	64,055	-784,714	192,745	-51,979	-24,260	-41,928	-34,846	20,290	-483	-1,447,956
2012	512,893	-142	0	-462,468	300,618	-24,015	101,026	-749,585	-60,370	-54,006	-19,018	-36,337	-38,049	15,194	-72	-1,508,326
2013	271,647	0	0	-583,382	250,989	-25,082	91,381	-754,719	-220,871	-54,623	-15,580	-35,274	-43,662	12,280	-53	-1,729,197
2014	156,748	0	0	-650,807	207,208	-24,539	58,362	-713,791	-372,220	-58,420	-12,372	-38,727	-80,186	11,756	0	-2,101,416
2015	109,818	0	0	-640,249	133,580	-17,567	38,791	-574,318	-437,887	-55,985	-9,130	-36,623	-85,933	13,589	-44	-2,539,303
2016	223,209	0	0	-571,082	0	-13,529	35,189	-657,535	-440,448	-53,720	-23,403	-44,446	-91,659	10,322	-91,536	-2,979,751
1990-2016 Average	575,791	(183)	0	(620,753)	322,883	(12,245)	90,193	(945,172)	(110,361)	(41,390)	(6,888)	(33,486)	(58,878)	19,124	(3,641)	

Table 3-7. 1990 - 2016 Annual Crop Demand

Tulare Lake Subbasin	1990-1995 (Acre-Feet)	1996-1998 (Acre-Feet)	1999-2006 (Acre-Feet)	2007 (Acre-Feet)	2008 (Acre-Feet)	2009 (Acre-Feet)	2010 (Acre-Feet)	2011 (Acre-Feet)	2012 (Acre-Feet)	2013 (Acre-Feet)	2014 (Acre-Feet)	2015 (Acre-Feet)	2016 (Acre-Feet)
Cotton	463,314	525,597	365,304	320,874	258,524	212,101	287,986	309,580	260,737	261,483	186,033	130,414	215,838
Alfalfa Hay and Clover	172,485	134,953	224,869	300,267	334,305	296,174	289,146	160,995	175,216	204,321	148,508	123,048	100,548
Pasture and Misc. Grasses	10,801	26,198	29,793	238,787	199,949	309,553	246,520	82,928	68,990	79,489	158,898	75,117	70,411
Almonds	26,778	29,699	61,066	107,354	137,889	108,127	135,655	99,780	108,906	143,239	135,322	139,665	153,456
Corn and Grain Sorghum	36,889	100,480	75,822	101,461	82,079	89,513	59,523	87,459	75,521	71,241	58,667	48,672	44,971
Grain and Grain Hay	50,167	84,837	112,151	34,340	49,524	48,752	46,922	15,427	18,256	20,520	22,669	39,599	36,754
Pistachio	15,230	17,479	26,701	34,042	20,147	30,934	27,816	44,172	49,811	54,452	67,906	87,363	87,702
Tomatoes and Peppers	12,976	3,725	32,705	262	5	246	26	47,946	53,523	15,855	26,616	43,150	52,218
Misc. field crops	41,921	33,520	121,965	0	5	0	0	1	0	0	4	0	0
Wine Grapes with 80% canopy	7,589	8,298	14,698	14,210	8,899	5,699	6,988	13,666	23,517	11,848	16,488	11,901	27,970
Stone Fruit	25,784	24,835	34,447	7,187	7,792	6,356	9,368	4,280	3,114	6,346	5,108	5,078	3,343
Dairy / Feed Lot	14,252	15,221	16,378	0	0	0	0	0	0	0	0	0	0
Pomegranates	0	0	0	162	4,518	1,455	676	13,281	2,132	3,708	5,854	4,020	8,303
Potatoes, Sugar beets, Turnip etc..	18,609	4	645	19	0	10	0	29	0	127	0	7	7
Small Vegetables	2,832	1,146	7,226	33	3	20	341	228	221	391	264	127	317
Onions and Garlic	806	846	1,370	0	0	12	2,417	805	614	168	951	547	1,158
Melons	413	92	421	0	0	0	21	4	17	10	1,182	27	128
Citrus (no ground cover)	0	0	85	0	42	46	14	413	99	336	301	76	32
Carrot Single Crop	0	0	0	0	0	0	0	37	16	41	10	6	56
Berries	47	0	0	0	0	0	0	0	2	6	0	1	0
Fallow Land	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban, Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban, Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Winter Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
	900,894	1,006,932	1,125,646	1,158,997	1,103,681	1,108,998	1,113,419	881,031	840,691	873,580	834,782	708,818	803,211



4.0 SUSTAINABLE MANAGEMENT CRITERIA

23 CCR §354.22 *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) defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to the success of Groundwater Sustainability Plan (GSP) implementation. Development of the sustainable management criteria was dependent on available information and data developed and presented in the Tulare Lake Subbasin's (Subbasin) hydrogeologic conceptual model (HCM), groundwater conditions, and the water budget of the Tulare Lake GSP (DWR 2017b).

Indicators for the sustainable management of groundwater were determined by SGMA based on factors that have the potential to impact the health and general well-being of the public. The following indicators were evaluated within the Subbasin: groundwater levels, groundwater storage volume, land subsidence, water quality, interconnected surface water, and seawater intrusion. These indicators will continue to be monitored throughout the GSP planning and implementation period. This chapter of the GSP describes these indicators and defines the management thresholds for each indicator. Land subsidence, groundwater levels, and groundwater storage changes are the primary concerns and focus of sustainable management in this GSP. Interconnected surface water is not present in the Subbasin based on groundwater potentiometric surface maps; therefore, interconnected surface waters will not be monitored under this GSP. Additionally, seawater intrusion was concluded to not be a concern within the GSP due to the distance to the coast and lack of continuity with a seawater source, so no criteria will be established.

The sustainable management criteria described herein were prepared conforming to the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 3 (23 CCR §354.22 through §354.30).

4.1 Sustainability Goal

23 CCR §354.24 *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.*

4.1.1 Goal Description

This GSP aims to manage groundwater resources to continue to provide an adequate water supply for existing beneficial uses and users in accordance with county and city general plans while meeting established measurable objectives (MOs) to maintain a sustainable yield. This goal aims to continue to provide adequate water supply for existing beneficial uses and users while ensuring the future sustainable use of groundwater. Additionally, the sustainability goal works as a tool for managing groundwater, basin-wide, on a long-term basis to protect quality of life through the continuation of existing economic industries in the area, including but not limited to agriculture.

The Groundwater Sustainability Agencies (GSAs) in the Subbasin will work collectively to manage groundwater resources in the Subbasin, develop sustainability projects, and implement management actions, where appropriate. Section 3.2, *Groundwater Conditions*, provides insight to current and historical groundwater conditions, as well as a model for a 50-year forecast water budget to quantify groundwater level stability. Historical and hydrologic modeling estimates were used to develop a sustainable yield, which aims to stabilize forecasted groundwater levels. This goal was established in a manner that is transparent to the public and stakeholders to ensure the local population has a voice in the development of the programs. With the implementation of management actions and projects, as well as the continued interim monitoring and reassessment of activities, groundwater levels will be maintained at levels that will not create undesirable results.

4.1.2 Discussion of Measures

To achieve the goals outlined in the GSP, a combination of measures, including continued management practices and monitoring will be implemented over the next 20 years and continued thereafter. Additional surface water supply and infrastructure projects will be a crucial component of the supply system in diverting these waters to areas that provide the most benefit for offsetting the use of groundwater. Management actions will be implemented to help mitigate overdraft based on the demand from beneficial uses and users. Projects and management actions are discussed in further detail in Chapter 6, *Projects and Actions*, including a general timeline on when implementation will take place. When combined with consistent monitoring practices for each of the sustainability indicators, the GSAs will coordinate how individual GSAs pursue sustainability on a Subbasin level.

4.1.3 Explanation of How the Goal will be Achieved in 20 years

The goal of this Subbasin will be achieved in the next 20 years by:

- Understanding the existing condition's interaction with future conditions;
- Analyzing and identifying the effects of existing management actions on the Subbasin;
- Implementing this GSP and its associated measures including project and management actions to halt and avoid future undesirable results;
- Collaborating between agencies to achieve goals and protect beneficial uses; and
- Assessing at each 5-year interim milestone implemented project and management action successes and challenges.

4.2 Description of the Sustainability Indicators

4.2.1 Groundwater Level Indicator

Based on collected data in the Subbasin, certain areas show long-term significant decline in groundwater levels, which if not addressed, will eventually lead to a reduction in usable groundwater supplies. Given the 60- to 300-foot depth to groundwater relative to the approximately 3,000-foot-deep usable aquifer, it is understood that the long-term declines (roughly 2 feet per year) could continue for many years before developing a situation that would truly be significant and unreasonable.

Measurements of groundwater depths and respective elevations in water wells have been collected intermittently across the GSP area since the early 1900s as discussed in Section 3.2, *Groundwater Conditions*. In the 1950s, pumping altered natural groundwater flow conditions, so local groundwater depressions developed. By 2016, these cones of depression had spread, resulting in groundwater elevation declines from 100 feet to more than 200 feet from 1952 data. The 2016 groundwater elevations are mostly available for the northern third of the GSP area (see Chapter 3, Figure 3-25) and ranges from approximately 220 feet above mean sea level (MSL) in the very northern end of the GSP area to approximately -120 feet below MSL northwest of the town of Corcoran. Much of this data is obtained from composite wells. Groundwater pumping in the east and central portions of the GSP area, as well as pumping in the neighboring Subbasins has contributed to groundwater level decline, which in turn has contributed to higher energy costs and well deepening.

Groundwater level decline, due primarily to pumping for agricultural demands, if unchecked, would be expected to continue to create significant and unreasonable conditions for the area. This GSP, assuming a normal hydrological scenario, modeled groundwater flow to forecast pumping drawdown and ground subsidence. This modeling was used to develop forecasted data to evaluate potential, future undesirable conditions if pumping practices remained the same in the Subbasin. The model additionally forecasted the positive effect on groundwater elevations from implementing mitigation projects and pumping management. Where the unmitigated forecasted groundwater hydrographs intersect year 2035, using a normal groundwater condition scenario, those elevations define the MO for 2040. Details of the process of evaluating and forecasting hydrographs to determine the MO and minimum threshold (MT) elevations (or depths to water) are discussed below.

To the greatest extent feasible, hydrographs were obtained from compliance wells with water depth history, which was used to model and forecast Subbasin groundwater level conditions. Based on these models, theoretical groundwater conditions and hydrographs across the GSAs were developed using the model and data from representative monitoring wells to increase the accuracy of data through expanding monitoring locations. The proposed conceptual and existing compliance hydrograph locations were evaluated for MO and MT elevations. As more wells are identified, the conceptual compliance representative monitoring site (RMS) objective and threshold elevations will be replaced, and all MO and MT elevations will be adjusted to reflect measured data.

4.2.2 Groundwater Storage Indicator

If groundwater storage decreases to a significant and unreasonable level, as determined by the GSAs, it will be considered an undesirable result. The terms "significant and unreasonable" are not defined by regulations but are discussed above. For the Subbasin's GSP, the depletion of groundwater storage is considered significant and unreasonable when:

- The volume of water being extracted causes groundwater levels to drop below MTs, for the Subbasin in more than 45% of all monitored wells within a three-year period; or
- The volume of groundwater remaining in storage is below the MT in a three-year period.

4.2.3 Land Subsidence Indicator

Land subsidence is the lowering of the land-surface elevation from changes that take place underground. Common causes of land subsidence from human activity are pumping water, oil, and gas from underground reservoirs; dissolution of limestone aquifers (sinkholes); collapse of underground mines; drainage of organic soils; and initial wetting of dry soils (hydrocompaction) (Leake 2016).

The effects of groundwater withdrawal on subsidence are difficult to predict over time and it should be noted that factors other than groundwater withdrawal contribute to subsidence. One must also consider hydrocompaction as GSAs implement replenishment actions on the groundwater aquifer. At this time, there is no accepted procedure to predict the attenuation of subsidence after sustainability has been achieved. Based on review of several sources (see Section 3.2.6), the Subbasin has experienced land subsidence historically and the area has not seen undesirable results. Continued ground subsidence is anticipated even after sustainable groundwater pumping is achieved. It is the goal of this GSP to achieve sustainability within the 20-year horizon. With the implementation of projects and the management actions, land subsidence is predicted to be slowed. It is also the intent of the GSP participants to limit subsidence.

4.2.4 Groundwater Quality Indicator

Undesirable results are currently monitored by regulatory agencies and water quality coalitions that become impacted. The agencies and coalitions include the Irrigated Lands Regulatory Program (ILRP), Groundwater Ambient Monitoring and Assessment Program (GAMA), Regional Water Quality Control Board (RWQCB), Central Valley Salinity Alternatives for Long-term Sustainability Program (CV-SALTS), and cities within the Subbasin.

There are no known contaminant plumes within the Subbasin. Data will be gathered from the above-mentioned agencies and coalitions. Should there be data and consensus from agencies and coalitions needing to address degraded water quality, the GSAs will implement monitoring to supplement the existing programs. The determination of monitoring will be on a case-by-case basis.

Management Areas A and B are in the areas de-designated for agricultural uses (AGR) and municipal or domestic water supplies (MUN), and currently are not required to be monitored according to the RWQCB and the Tulare Lake Basin Plan Amendment unless projects are proposed that would trigger monitoring in this area.

When monitoring is warranted, as determined by the GSAs, the sampling protocols will comply with the Groundwater Monitoring Protocols, Standards and Sites Best Management Practice (BMP), December 2016, for groundwater quality and coincide with the existing regulatory monitoring plans. See the following links for additional information on the exceedance categories and monitoring schedules:

- ILRP - https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/
- GAMA - https://www.waterboards.ca.gov/gama/
- RWQCB - https://www.waterboards.ca.gov/
- CV-SALTS - https://www.waterboards.ca.gov/centralvalley/water_issues/salinity/

The basic authority of the GSAs is to locally determine the sustainable amount of groundwater that can be pumped and to manage the transition from the current groundwater usage to a groundwater usage that is sustainable. Also, GSAs do not have the authority to modify surface water rights. Federal and state agencies provide direct oversight of quality and set their own appropriate thresholds such as Maximum Contaminant Levels for drinking water. These will be utilized by the Subbasin for MOs and MTs. For these reasons, the local GSAs will focus on water quality issues that are related to groundwater pumping rather than on issues related to contamination.

4.2.5 Interconnected Surface Water Indicator

As discussed in Section 3.2.8, *Interconnected Surface Water and Groundwater Systems*, the Subbasin does not contain interconnected surface and groundwater systems based on review of groundwater potentiometric surface maps. Groundwater contours indicate the Kings River, Cross Creek, and Mill Creek are losing streams that directly recharge groundwater. Groundwater is not in contact with these streams and cannot contribute any base flow to them. Due to the lack of connected water systems, interconnected surface water will not be monitored or considered when making management decisions.

4.2.6 Seawater Intrusion Indicator

Seawater intrusion occurs when saline water from the ocean infiltrates the groundwater system and begins to flow into areas of freshwater due to pressure differentials, and in many cases, is caused by groundwater pumping. The Subbasin does not need to account for seawater intrusion since it is not located adjacent to the coast.

4.3 Undesirable Results

23 CCR §354.26(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.*

Undesirable results occur when groundwater conditions within the Subbasin result in significant and unreasonable impacts to a sustainability indicator (23 CCR §354.26). MTs discussed below, when exceeded are considered an undesirable result for a sustainability indicator.

4.3.1 Primary Causes of Undesirable Results

Historical allocation of surface water for federal, state, and court uses over time has resulted in a need for the overlying Subbasin population and enterprises to find additional viable water sources, which in this Subbasin, has fostered a reliance on groundwater. Additionally, local water project development efforts have not been successfully implemented. The following are some examples of water projects within the area which have required significant use of water, totaling approximately 2,155,000 acre-feet per year (AF/yr) of surface water within the Subbasin area (Mid-Kings River GSA Correspondence 2019):

- State Water Project (SWP) and Central Valley Project (CVP) Reductions through Central Valley Project Improvement Act (CVPIA) (~1992):
  - SWP decreased by roughly 600,000 AF/yr in average available supplies
  - CVP San Luis Unit decreased by roughly 780,000 AF/yr in average available supplies
  - Unallocated project yield being developed into contracted supplies (Cross-Valley Contracts and Mid-Valley Canal efforts)
- Biological Opinions (~2007):
  - SWP decreases by 240,000 AF/yr in average supplies
  - CVP San Luis Unit decreased by 325,000 AF/yr in average available supplies
- San Joaquin River Restoration (~2010):
  - Friant Division CVP reduced by 210,000 AF/yr in average available supplies

Additionally, Subbasin-wide effects to groundwater supplies may result from the following:

1. **Climate Change**

   a. Information developed by the State of California Department of Water Resources (DWR) suggests that warmer conditions could lead to more rain and/or earlier snow melt runoff (DWR 2017b).

   b. Studies indicate increased temperatures could result in higher evapotranspiration rates, which could increase demand.

   Both of these scenarios may lead to less efficient use of surface water and greater reliance on groundwater.

2. **Changing Crop Patterns**. An increase in crop changes from field crops to nut crops with a higher water demand could result in an increase in groundwater demand.

3. **Subbasin Groundwater Outflows.** Management actions of the subbasins in the surrounding area.

4. **Increased Urbanization**. Increases in land use for cities and communities in areas not currently cropped could result in an increase in demand in certain GSAs.

Groundwater overdraft has additional causes for each sustainability indicator outlined below:

4.3.1.1 Groundwater Level Indicator

Over-pumping due primarily to agricultural demands have resulted in groundwater level decline. The lack of recharge in many areas of the Subbasin result in furtherment of declining groundwater levels.

4.3.1.2 Groundwater Storage Indicator

Information will be provided upon further data review.

4.3.1.3 Land Subsidence Indicator

The majority of subsidence in the San Joaquin Valley has occurred due to groundwater extraction from below the Corcoran Clay layer, present at depths of 100 to 500 feet below ground surface (bgs), resulting in compaction and eventual subsidence in and below the Corcoran Clay layer (Ireland et al. 1984, Faunt et al. 2009). Land subsidence within the Subbasin has resulted from human activities including over-pumping for groundwater, oil, and gas from underground reservoirs (Leake 2016). Additionally, minimal recharge capacity within some management areas of the Subbasin, exacerbated by increasing periods of draught, have the potential to lead to future undesirable results.

Computer modeling was performed to forecast subsidence resulting from groundwater elevation lowering through 2040 with 2 scenarios. Scenario 1 does not utilize project and management actions, and Scenario 2 includes the implementation of project and management actions. The two scenarios are compared to illustrate the predicted reduction in subsidence in the Subbasin with the implementation of project and management actions. The area with the highest forecasted subsidence is on the western boundary of the south Fork Kings GSA and the northeastern boundary of the El Rico GSA.

4.3.1.4 Degraded Water Quality Indicator

Water quality degradation can result from pumping activities, as well as the known migration of contaminant plumes. Additionally, the depth of well production may cause contaminants to be drawn out, which may cause undesirable results. No contaminant plumes are known to exist within the Subbasin; however, in the early 1900s, salts and chloride were considered to be at high proportions in the Subbasin area. Additionally, water quality varies at depths above and below the Corcoran Clay. Total Dissolved Solids (TDS) measurements in groundwater were noted as greater in the western portion versus the eastern portion of the Subbasin. TDS is considered to have increased over the past 100 years.

4.3.1.5 <u>Interconnected Surface Water</u>

The Subbasin does not contain interconnected surface and groundwater systems based on potentiometric surface maps; therefore, causes leading to undesirable results are not present.

4.3.1.6 <u>Seawater Intrusion</u>

Based on the distance to the coast and lack of continuity with a seawater source, seawater intrusion does not exist and will not lead to undesirable results.

4.3.2 Criteria to Define Undesirable Results

The primary criteria to determine if an undesirable result has occurred is exceedance of a sustainability indicator's MT. MTs for each sustainability indicator will be discussed below in Section 4.4, *Minimum Thresholds*.

4.3.2.1 <u>Groundwater Level Indicator</u>

MO elevations will be measured at RMS sites across the Subbasin (Figure 4-1). Based on these models, theoretical groundwater conditions and hydrographs for 13 additional locations across the GSAs were developed using the models and data from representative monitoring wells to increase the accuracy of data through expanding monitoring locations. The proposed conceptual and existing compliance hydrograph locations were evaluated for MO and MT elevations. As more wells are installed, the conceptual compliance RMS objective and threshold elevations will be replaced, and all MO and MT elevations will be adjusted to reflect measured data.

The lowering of groundwater levels is considered significant and unreasonable if pumping of groundwater decreases the elevations below the proposed MT at 45% of the RMSs over a three-year period. The standard for undesirable results consists of excessive lowering of groundwater, resulting in a change of groundwater levels (levels below the MTs) in more than 45% in a three-year data gathering period of the monitored wells. Results of lowering groundwater below the MT would trigger a series of actions and measures as described below and in Chapter 6, *Projects and Actions*. Potential undesirable results would incur costs related to:

- Well replacement
- Lowering of pumps in existing wells
- Increased power usage from greater lifts
- Lower well yields
- Raising flood control levees to mitigate subsidence
- Raising railroad tracks to mitigate flooding impacts related to subsidence
- Re-grading canals to address grade changes related to subsidence

- Irreversible loss of storage in aquifers due to subsidence
- Impacts to critical infrastructure, including High Speed Rail report

4.3.2.2 Groundwater Storage Indicator

Undesirable results will occur to groundwater storage when the volume of groundwater extracted causes groundwater levels to drop below the MT in more than 45% of all monitored wells within a three-year period. A strong correlation exists between changes in water level and changes in groundwater storage; therefore, the groundwater storage indicator will use the same MT as the groundwater level sustainability indicator: 40% of the RMSs indicates undesirable results.

4.3.2.3 Land Subsidence

The criteria to define the undesirable result related to land subsidence will be the significant loss of functionality of a critical infrastructure or facility, so the feature cannot be operated as designed requiring either retrofitting or replacement to a point that is economically unfeasible. Modeled subsidence data was used to estimate future subsidence through the implementation period. The two simulations were existing conditions without mitigation and existing conditions with mitigation using the project and management actions. Due to inelastic soil behavior, subsidence is mostly irreversible even if groundwater pumping decreases and groundwater levels recover. It is also not known when subsidence will stop after pumping has stopped.

4.3.2.4 Groundwater Quality

Undesirable results are currently covered by existing regulatory agencies and water quality coalitions, that become impacted. The agencies and coalitions can include Irrigated Lands Regulatory Program (ILRP), Groundwater Ambient Monitoring and Assessment Program (GAMA), the Regional Water Quality Control Board (RWQCB) and the Central Valley Salinity Alternatives for Long-term Sustainability Program (CV-SALTS) and additional data from the Cities within the Subbasin.

Data will be gathered from the above-mentioned agencies and coalitions. Should there be data and consensus from agencies and coalitions needing to address degraded water quality, the GSA's will implement monitoring to supplement the existing programs. The determination of monitoring will be on a case by case basis.

4.3.3 Potential Effects to Beneficial Uses and Users

4.3.3.1 Groundwater Level

Exceedance of MTs leading to undesirable results related to groundwater level in the Subbasin would cause a diminished level of groundwater supplies for agricultural and municipal needs. Groundwater levels are anticipated to continue to decrease at current rates in the next several years before implemented programs have a positive effect on the stabilization of groundwater levels based on the variability of hydrology and availability of flood water. As stated above, agriculture is the main economic enterprise of the Subbasin, so effective management of groundwater for sustainable future use is critical to the continuation of current economic interests, which add value to the Subbasin's communities. Decreases in groundwater levels will continue to increase the cost of energy for pumping. If MT levels are reached or exceeded, wells have the potential to go dry and require deepening to reach the lowered water table. Alternatively, pumps may be lowered if the existing well casing is sufficiently deeper. However, once the Subbasin reaches sustainability in the future, the depth of the wells will be known and can be designed to meet those depths to prevent future wells from becoming dry.

4.3.3.2 Groundwater Storage

The correlation between groundwater level declines and groundwater storage impacts are interrelated and have overlapping outcomes. If declines in groundwater storage result from exceedance of MTs, agricultural and municipal water users would have a decreased capacity to access adequate groundwater during times of prolonged drought.

MTs will reasonably impact water uses and users as defined by the GSAs. The MT will require the implementation of management actions with the goal of demand reduction and/or the inclusion of additional water supply. Additional information on projects and policies are defined in Chapter 6, *Projects and Actions*.

4.3.3.3 Land Subsidence

Land Subsidence and differential settlement have the potential to cause damage to infrastructure which could result in hazards to public health and safety. Examples of infrastructure that have the potential to be impacted by subsidence include:

- Canals (e.g., conveyance capacity or inflow capacity)
- Levees (e.g., reduction in height and/or protection to populations)
- Pipelines
- Bridges
- Personal and public property

- Streets
- Railroads
- Utility infrastructure
- Groundwater wells (e.g., collapse)

4.3.3.4 Degraded Water Quality

Management Areas A and B are in the areas undesignated for AGR and MUN (see Section 3-3), and currently are not required to be monitored according to the RWQCB and the Tulare Lake Basin Plan Amendment unless projects are proposed that would trigger monitoring in this area. There are no known contaminant plums within the Subbasin. Water quality degradation may be impacted by high concentrations of salts and chloride, which are considered to have increased over the past 100 years in the Subbasin.

4.4 Minimum Thresholds

23 CCR §354.28 (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.*
(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.

MTs were established to avoid undesirable results for this GSP's sustainability indicators. When evaluating undesirable results, water levels at the RMSs will be monitored and compared to the MT to determine if conditions have been met. When RMSs are not meeting MT requirements, additional management actions will be implemented to meet the threshold requirement for that area. MTs (and *conceptual* MTs) have been set at each of the RMSs for the relevant sustainability indicators at a level that will avoid undesirable results. The methodologies to set MOs and MTs are described below, and groundwater conditions are quantified. See Chapter 5, *Monitoring Network*, for additional information on the monitoring network and RMSs.

Areas outside the Subbasin boundary are also addressing issues of subsidence and groundwater depletion. Assuming average well depths are similar in surrounding areas, reasonable thresholds set by the GSP will benefit water users in the surrounding GSP areas as well.

4.4.1 Description of the Minimum Thresholds and Processes to Establish

23 CCR §354.28(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 indictor, including and 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.

4.4.1.1 Groundwater Level Indicator

Monitoring for land subsidence will consist of evaluating available data released from regional water agencies and/or state and federal governments. Measurement and monitoring for land subsidence is performed by the United States Geological Survey (USGS), Kings River Conservation District (KRCD), United States Army Corps of Engineering (USACE), California Department of Transportation (Caltrans), University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO), National Aeronautics and Space Administration (NASA) Interferometric Synthetic Aperture Radar (InSAR), and various private contractors. The MTs are based on assumed stability of groundwater levels between 2035 and 2040. The determination that undesirable results are occurring shall depend upon measurements from multiple monitoring sites from at least KRCD and yearly InSAR mapping over the entire area of the Subbasin.

When evaluating undesirable results, water levels at the RMSs will be monitored and compared to the MT for compliance wells. When RMSs are not in compliance with the MTs, additional management actions will be implemented. The methodologies to set MOs and MTs are described below, and groundwater conditions are quantified. The proposed MOs and MTs for the RMS wells are included in Table 4-1.

4.4.1.2 Groundwater Storage Indicator

Groundwater storage change was determined using a newly developed groundwater model. The groundwater model evaluated information beyond the Subbasin boundary and used the information to estimate the groundwater inflows. Changes in groundwater levels are directly related to changes in aquifer storage volumes. Aquifer storage volume changes due to the lowering of groundwater elevations to the MOs set for the Subbasin's groundwater storage thresholds will not cause undesirable results. From a groundwater storage perspective, it is reasonable to use the MT value set for groundwater level decline considering the total change in volume of storage in the aquifer is minimal when compared to the total storage.

4.4.1.3 Land Subsidence

The groundwater model will be used to fill the data gaps for groundwater levels, groundwater storage, and land subsidence indicators until actual data can be gathered. Groundwater levels will not be used as a proxy for land subsidence. Land subsidence occurs in areas that are underlain by the Corcoran Clay layer in the Subbasin area. The Corcoran Clay layer extends into the Subbasin and underlies the majority of the GSA area. Since the Corcoran Clay is a confining layer, land subsidence would occur when water is pumped from the confined aquifer below the Corcoran Clay. To monitor land subsidence based on water levels, the well would have to only be perforated below the Corcoran Clay and not be a composite well. Groundwater modeling forecasts with associated subsidence estimates through the implementation period were used to develop Subbasin-level MTs. MTs are set to be 16 feet of subsidence by 2040. At each five-year milestone, information from the groundwater model suggests subsidence will continue for the first five years until project and management actions are fully implemented. Upon year six of implementation, subsidence is anticipated to slow through year 2040.

4.4.1.4 Groundwater Quality Indicator

Currently, as described in Section 5.4.3, groundwater quality in the northern portion of the Subbasin encompassing the Mid-Kings River GSA and South Fork Kings GSA is generally excellent for irrigation and satisfactory for municipal and industrial use (KCWD 2011). South of Stratford and Corcoran, groundwater quality diminishes, and portions of the Tulare Lakebed have been undesignated from being suitable for municipal, domestic, agricultural irrigation, and stock watering supply. Shallow groundwater contamination from fuel hydrocarbons, agricultural chemicals, or solvents are localized in the urbanized areas of Lemoore and Hanford and some smaller communities. Limited regional data is available for determining current nutrient concentrations based on groundwater depth and location. As discussed in Section 3.2.5, shallow groundwater can have elevated concentrations of nitrates and TDS, but the majority of the region is generally below Maximum Contaminant Levels (MCLs).

4.4.1.5 Interconnected Surface Water Intrusion

Interconnected surface waters are not considered present in the Subbasin area; therefore, no further discussion will occur on this indicator in terms of MTs.

4.4.1.6 Seawater Intrusion Indicator

Seawater intrusion does not exist in this Subbasin; therefore, no MT discussion will occur on this indicator.

4.4.2 Measurement of Minimum Thresholds

4.4.2.1 Groundwater Level Indicator

Groundwater elevations will be monitored, and contour maps will be generated with the available data to define the groundwater elevations throughout the Subbasin. For more information regarding wells and RMSs in the monitoring network, refer to Chapter 5, *Monitoring Network*.

4.4.2.2 Groundwater Storage Indicator

Calculations of groundwater storage change will be updated every five years. For more information regarding the wells in the monitoring network, refer to Chapter 5, *Monitoring Network*.

4.4.2.3 Land Subsidence Indicator

The MTs for land subsidence have been selected using historical subsidence and future planning to provide operational flexibility. Measurement of land subsidence is discussed above in Section 4.4.1.3, *Land Subsidence*. The monitoring density is considered of adequate density and frequency to determine subsidence annually. For more information on the monitoring network, refer to Chapter 5, *Monitoring Network*.

4.4.2.4 Groundwater Quality Indicator

MTs will follow the state, federal, and local standards related to the relevant sustainability indicators set by the coalitions. Water quality data will be obtained from the below-mentioned coalitions:

- ILRP - Irrigated Lands Regulatory Program
  - Discharge of Irrigation water
  - Evaluations Data
    - Whole Farm evaluations
    - Irrigation Well Information
    - Sediment and Erosion Control Practices
    - Farm Map(s)
- GAMA - Groundwater Ambient Monitoring and Assessment Program
  - Statewide comprehensive groundwater monitoring

  - Groundwater quality and contamination information
  - Basin-wide ambient groundwater quality
  - Groundwater sampling and groundwater quality studies data (chemicals of concern and trends in groundwater quality)
  - Other public groundwater information
- RWQCB - Regional Water Quality Control Board
  - See IRLP above
- CV-SALTS - Central Valley Salinity Alternatives for Long-term Sustainability Program
  - Salts and nitrates monitoring data

4.4.3 Selection Process of Minimum Thresholds to Avoid Undesirable Results

The selection process for MTs for each sustainability indicator was based on quantifiable data specific to the Subbasin area with consideration of the optimal efforts to prevent undesirable results.

4.4.3.1 Groundwater Level Indicator

Forecasted groundwater elevations for the RMSs were projected as described above to establish the MOs throughout the GSP area. The MT elevations are similarly set as a precursor to reaching an undesirable result. The MT is designed to be a last-resort warning before more severe measures must be taken to protect groundwater resources and lessen the impact of depleting aquifers on water users. The GSAs agreed the MT elevation would be set at one standard deviation of all observed head data in compliance wells or modeled forecasted data.

4.4.3.2 Groundwater Storage Indicator

Monitoring of the data gathered by the agencies and coalitions will be reviewed. The MTs selected were determined to avoid undesirable results by the GSAs. Hydrographs located in Appendix H provide a graphical representation of the method of selection of MTs. Overall, the percentage of storage change is small compared to the overall storage of the Subbasin.

4.4.3.3 Land Subsidence Indicator

The majority of the Subbasin has some subsidence but it has not caused undesirable results, or the subsidence has been mitigated. The GSAs will continue to monitor the intrinsic and extrinsic subsidence. When subsidence that originates from outside the GSP area is found, the GSAs will coordinate with their neighboring GSAs to address the issue. There is an understanding that there is subsidence in areas adjacent to the Subbasin and efforts will be made to determine if conditions outside the Subbasin are creating impacts within the Subbasin.

4.4.3.4 Groundwater Quality Indicator

Monitoring of the data gathered by the agencies and coalitions will be reviewed and considered for the potential degradation of water quality caused by the implementation of this GSP within the GSP's projects and management actions.

4.4.4 Potential Effects to Beneficial Uses and Users

4.4.4.1 Groundwater Level Indicator

Due to the timely process of infrastructure development and program implementation, and variability in hydrology and the availability of flood water, groundwater levels are expected to continue to decrease in the next several years before programs have a positive effect on the stabilization of groundwater levels. Decreases in groundwater levels will continue to increase the cost of energy for pumping. If MT levels are reached, there may be some wells that go dry and require deepening to reach the water table. Alternatively, pumps may be lowered if the existing well casing is sufficiently deeper. However, once the Subbasin reaches sustainability in the future, the design depth for wells will be known and will be used in planning of future well construction to minimize future wells from becoming dry.

4.4.4.2 Groundwater Storage Indicator

MTs will reasonably impact water uses and users as defined by the GSAs. The MT will require the implementation of management actions with the goal of demand reduction and/or the inclusion of additional water supply. Additional information on projects and policies are defined in Chapter 6, *Projects and Actions*.

4.4.4.3 Land Subsidence Indicator

Some level of subsidence has been occurring in the Subbasin for the last decade. The MT for subsidence recognizes both the need to address subsidence and the needed timeframe to substantially reduce it. The impact on water uses and users should decrease as project and management actions are implemented. GSAs in the Subbasin will need to regularly review and consider monitoring results that indicate an undesirable condition is developing and act to mitigate the worsening impact.

4.4.4.4 Groundwater Quality Indicator

If water quality is allowed to deteriorate to levels set by MTs, agricultural producers may experience a decrease in crop yield and/or crop quality. Poor water quality would cause a buildup of salts and nitrates in the surface layers of soil. The best way to treat nutrient build up is by leaching or over-irrigating enough to push soluble contaminants through the soil column.

4.5 Measurable Objectives

> **23 CCR §354.30** *(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 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 finding of inadequacy of the Plan.*

4.5.1 Description of Measurable Objectives

4.5.1.1 Groundwater Level Indicator

MOs were developed and set for groundwater levels for each of the RMS wells utilizing each site's hydrograph during a normal period and projecting the trend via the groundwater model through 2040. Forecasted projects and management actions were not explicitly incorporated into the water level trend analysis. The GSAs considered four alternate approaches for each compliance hydrograph for setting the MOs and MTs to be achieved and sustained after 2040, while providing a regional margin of operational flexibility without causing undesirable results. Each progressively lower MO elevation associated with each alternative approach would result in an increase in the amount of land subsidence in that area and increased well operating costs. These four approaches are listed below and are graphically depicted on a "Typical Hydrograph" (Figure 4-1):

1. Method 1 - Maintain the water elevations from 2015 as the 2040 MO. This restrictive method does not allow for operational flexibility.

2. Method 2 - Forecast a trend line (for normal hydrological period, 1998-2010) to 2035 then maintain that elevation to 2040 as the MO. The inclusion of project and management actions will not provide sufficient flexibility in this method in addition to resulting in restriction of water supply to a normal-year period.

3. Method 3 - Project a trend line through the most recent 2010 to 2015 drought portions of the hydrograph to 2035 then maintain that elevation to 2040 and beyond. This option lowers the water levels to an undesirable result.

4. Method 4 - Model and forecast the hydrograph to 2035 (for wells above or below the Corcoran Clay) then maintain the elevation to 2040 as the MO, prior to the inclusion of project and management actions. This method provides flexibility and restricts water supply to a normal period.

The GSAs determined the Method 4 alternative presented above allows the time and flexibility needed to develop projects and demand management programs to meet and sustain the MO elevations without creating undesirable results. In the selection of Method 4, GSAs have chosen to manage the Subbasin's water to a normal water supply basis. An example of hydrographs for monitoring wells showing how the respective MOs were developed using a combination of existing water level data and furcated modeling for each GSA are presented in Figures 4-2 through 4-6. The remaining modeled hydrographs for compliance locations are included in Appendix H. The hydrographs represent the conceptual development of the MOs and their respective MTs for each RMS location in the Subbasin.

4.5.1.2 Groundwater Storage Indicator

The MO for change in groundwater storage volume is to stabilize by 2040. After 2040, it is predicted the Subbasin should see a net zero change in groundwater storage on a 10-year rolling average basis. Water levels at the RMSs will be utilized to develop contour maps to assist in estimating storage change.

4.5.1.3 Land Subsidence Indicator

Groundwater modeling forecasts with associated subsidence estimates through implementation period were used to develop Subbasin-level MTs. It is anticipated that recent subsidence rates should decrease through the implementation period as long-term groundwater level declines are significantly reduced.

4.5.1.4 Groundwater Quality Indicator

MOs will coincide with the agencies and coalitions. The GSA will not be responsible for water quality issues currently being addressed by each coalition, nor will the GSAs be responsible for water quality issues associated with influences other than water quality issues associated with pumping of groundwater. The groundwater quality MO addresses groundwater that is being *applied* to the crops. For crop application, if one well on a landowner's property has high concentrations of nitrogen, it may be treated or mixed with another water source to remain below the MT. Due to lack of data, water quality cannot be directly linked to groundwater levels.

4.5.1.5 Interconnected Surface Water Indicator

As stated above, interconnected surface waters do not exist within the Subbasin, so this indicator will not be further discussed in terms of MOs.

4.5.1.6 Seawater Intrusion Indicator

MOs for water quality will coincide with the coalitions and agencies listed in Section 4.5.1.1, *Groundwater Level Indicator*, of this chapter.

4.5.2 Operational Flexibility

4.5.2.1 Groundwater Level Indicator

Operational flexibility is the difference between the MO and MT. It allows for periods of drought and seasonal variation, which are deemed reasonable to the GSAs in the Subbasin while operating under a normal water supply year. The operational flexibilities for each of the compliance wells and locations with sustainability criteria are shown on the hydrographs and were calculated using one-standard deviation of the existing data.

4.5.2.2 Groundwater Storage Indicator

The success of meeting the objective is based on an average, allowing room for expected overdraft in dry years and recovery in wet years. The path to achieve MOs also relies on the coordination effort with the surrounding Subbasin.

The MO for groundwater storage change was set with five-year interim milestones. It is the intent of the GSAs to develop and implement projects and management actions by 2035, sufficient to mitigate long-term overdraft. Existing water contracts can be more fully developed to increase the additional water supply while some management actions may decrease water demand. Projects and management actions may be adjusted over the implementation period in response to conditions driven by climate and hydrology that impact or slow the goals from being met.

4.5.2.3 Land Subsidence Indicator

For the Subbasin, the operational flexibility is minimal since subsidence is likely irreversible and the goal is to decrease settlement to a stable condition.

4.5.2.4 Groundwater Quality Indicator

Each coalition and agency listed above has guidelines that permit landowners the flexibility to continue operation while complying with the requirements set by each agency or coalition.

4.5.3 Path to Achieve and Maintain the Sustainability Goal

4.5.3.1 Groundwater Level Indicator

The MO at 2040 for each of the compliance wells was selected from the forecasted modeling data utilizing the Method 4 approach described above. Mitigation of current groundwater elevation decline will be achieved by implementing projects and management actions prior to 2035. The projects will utilize existing and potential additional water supply and the implemented programs can decrease water demand. Programs may be adjusted over the implementation period in response to conditions and if GSP MOs are being met. Each subsequent five-year milestone measurement period may propose modifications to the MO and MT or propose additional measures or actions to achieve the MO elevation or groundwater depth by 2040 and beyond.

Table 4-1 lists the interim milestones at five-year intervals with program implementation. These measurements are assuming static rather than pumping conditions. Each GSA will need to develop a plan to accommodate shutting off a compliance well for a unique time period for that compliance well to achieve a static elevation. Similarly, compliance wells located in a well field with closely spaced wells or within a city will need to shut off surrounding wells that have a direct effect on the compliance well static elevation.

4.5.3.2 Groundwater Storage Indicator

This information will be provided upon completion of further review.

4.5.3.3 Land Subsidence

Table 4-2 and Table 4-3 illustrates modeled subsidence in feet, located at the two representative monitoring points, both of which are owned by the State of California-Caltrans. One is located in the Caltrans Maintenance yard in the City of Lemoore, and the other is located on the west side of State Route 43 just north of the City of Corcoran. If land subsidence exceeds the interim milestones, outreach and education may occur to increase awareness of subsidence in the area. There may also be observation of the impacts on facilities. It is possible that subsidence may continue on its current trend until projects and management actions are implemented.

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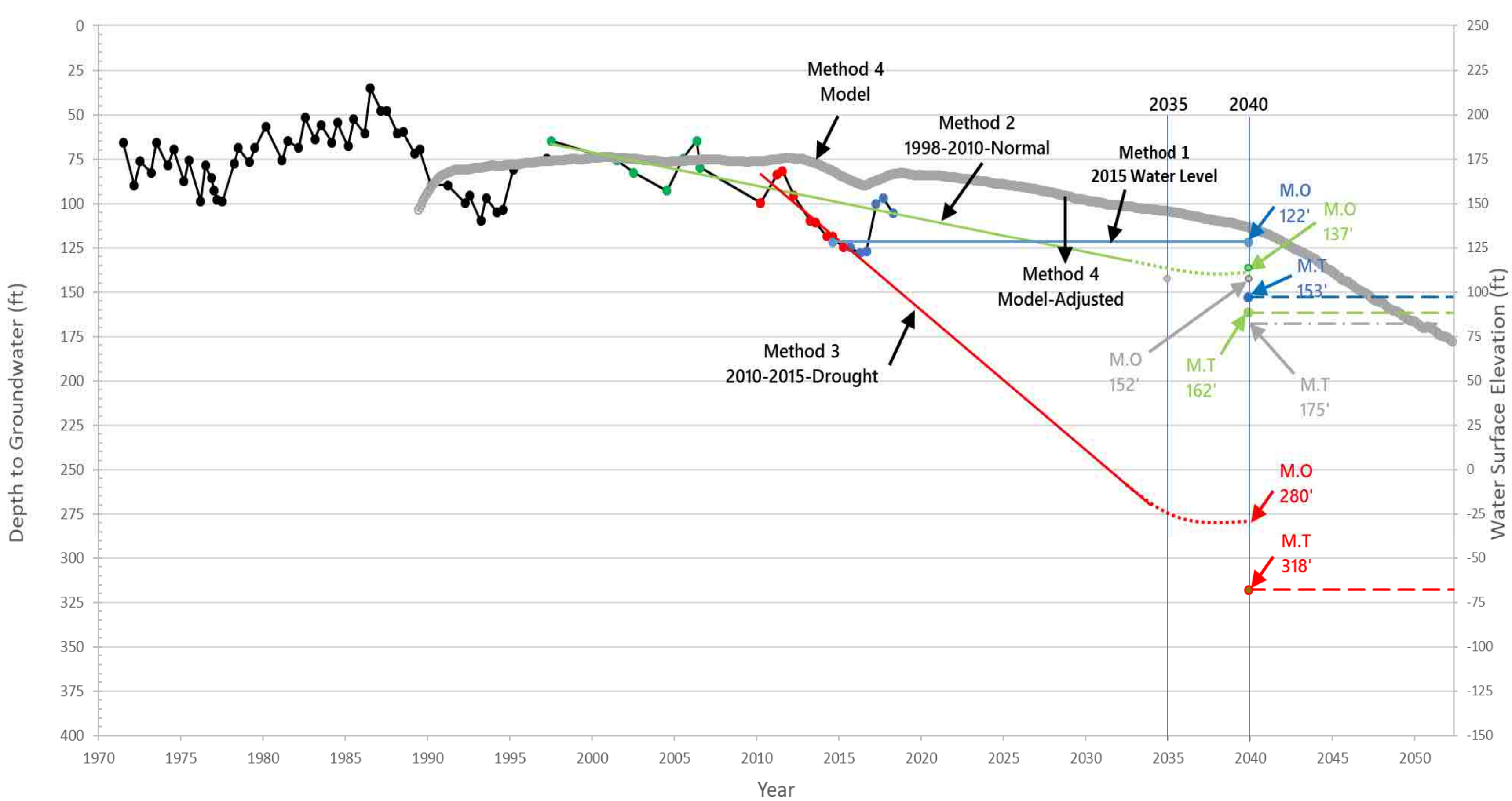


Method 1 - 2015 Water Level

Method 2 - 1998-2010 Normal Period

Method 3 - 2010-2015 Drought Period

Method 4 - Model Forecast

M.O Measurable Objective

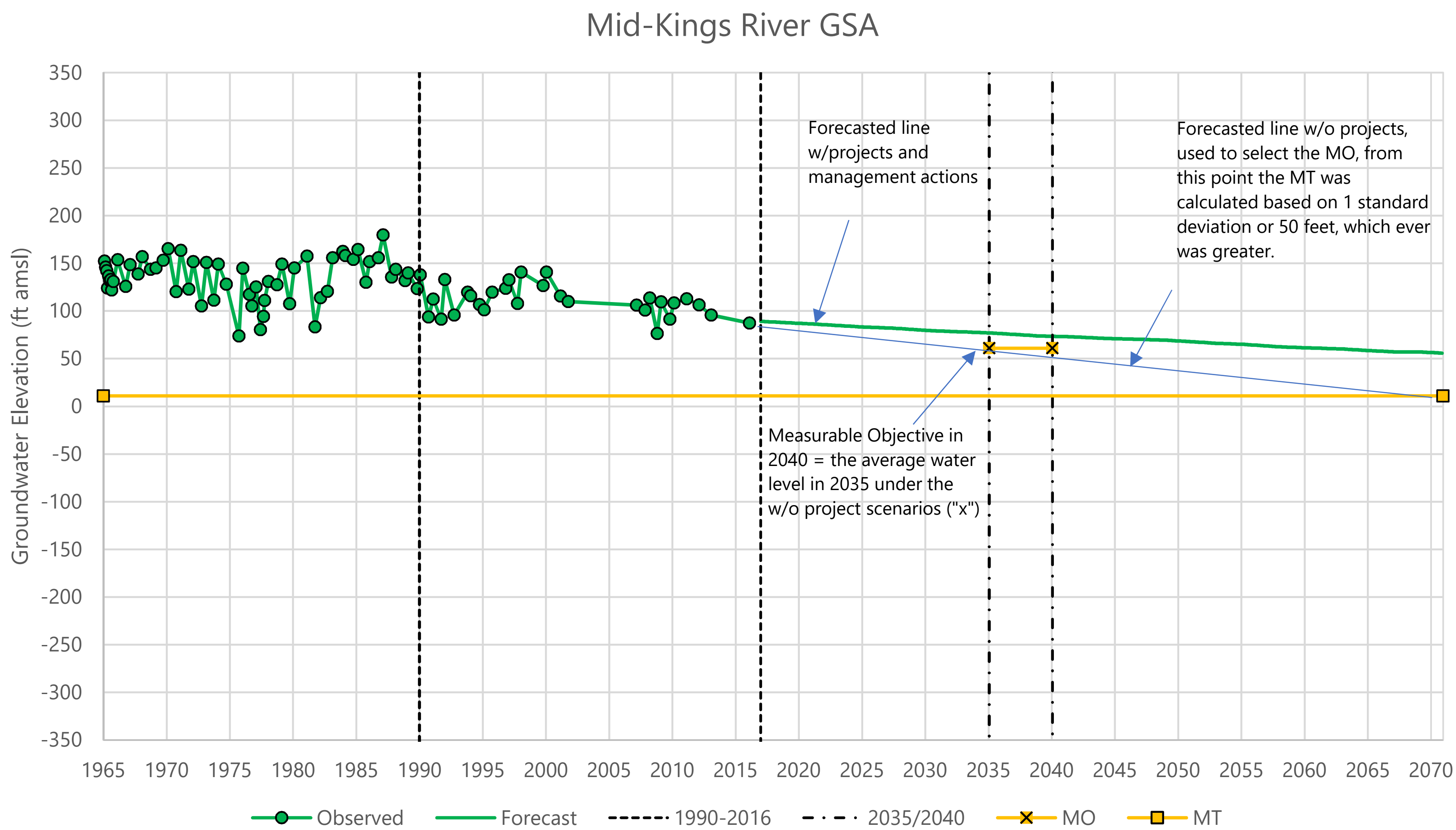
M.T Measurable Threshhold

Example Hydrograph and Sustainable Management Criteria Alternatives

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 08/28/2019	Project No.: FR18161220
		Figure **4-1**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0826_ComplianceWellsWithDataHydrographs



M.O Measurable Objective

M.T Measurable Threshhold

Example Hydrograph
and Sustainable Management Criteria
Mid-Kings River GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 08/28/2019	Project No.: FR18161220
		Figure **4-2**

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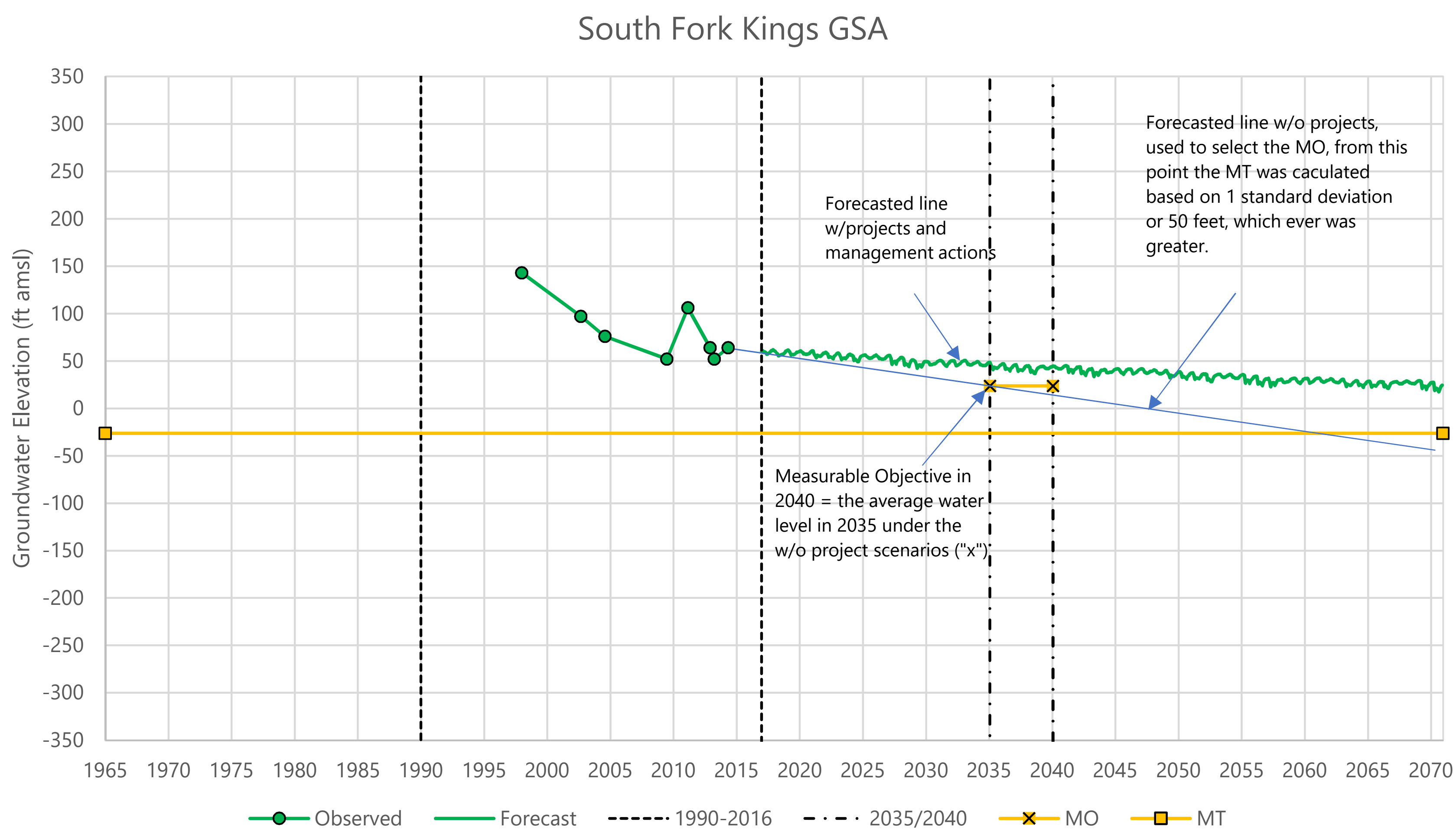

M.O Measurable Objective

M.T Measurable Threshhold

Example Hydrograph
and Sustainable Management Criteria
South Fork Kings GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 08/28/2019	Project No.: FR18161220
		Figure **4-3**

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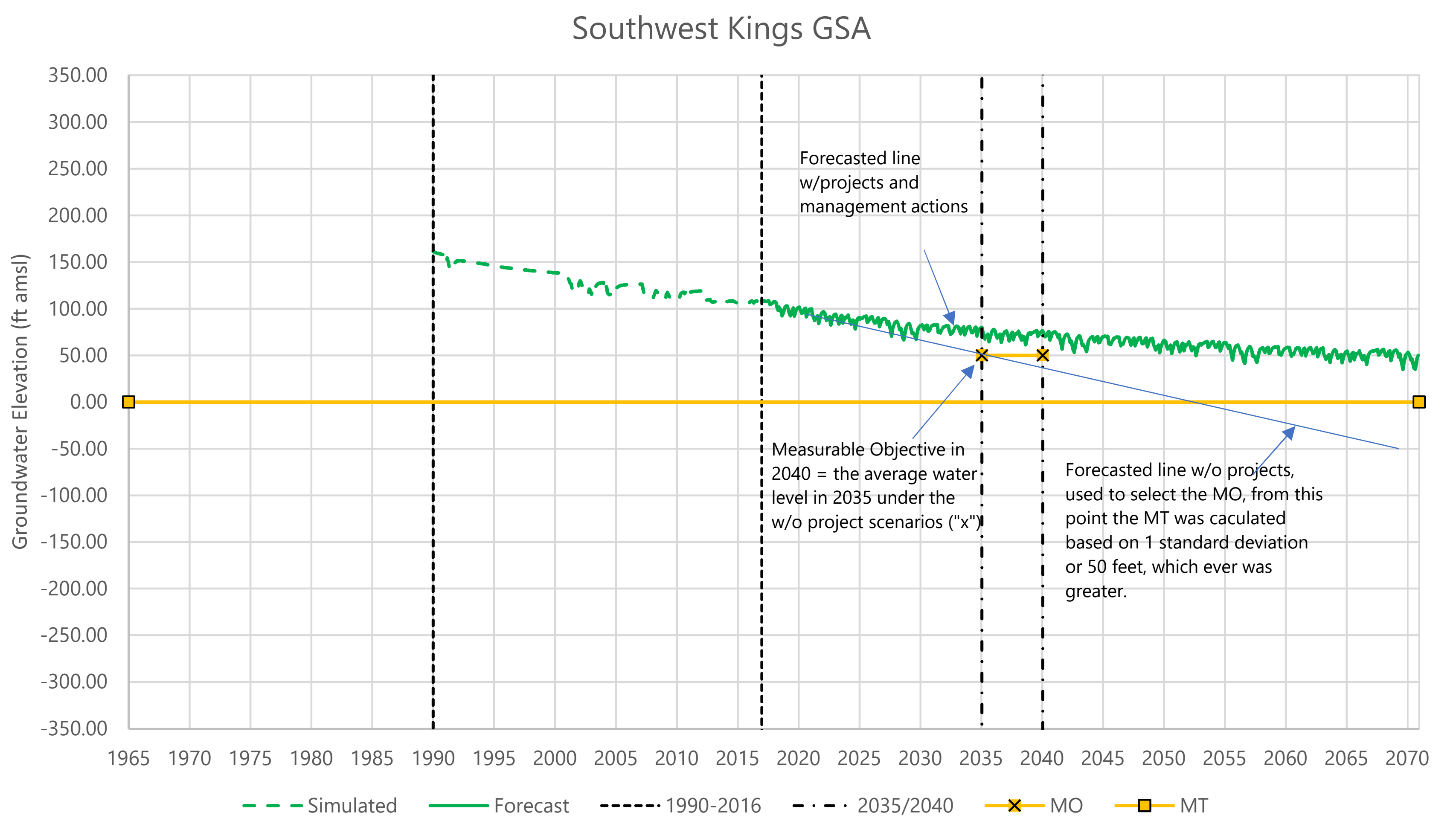

M.O Measurable Objective

M.T Measurable Threshhold

Example Hydrograph and Sustainable Management Criteria Southwest Kings GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 08/28/2019	Project No.: FR18161220
		Figure **4-4**

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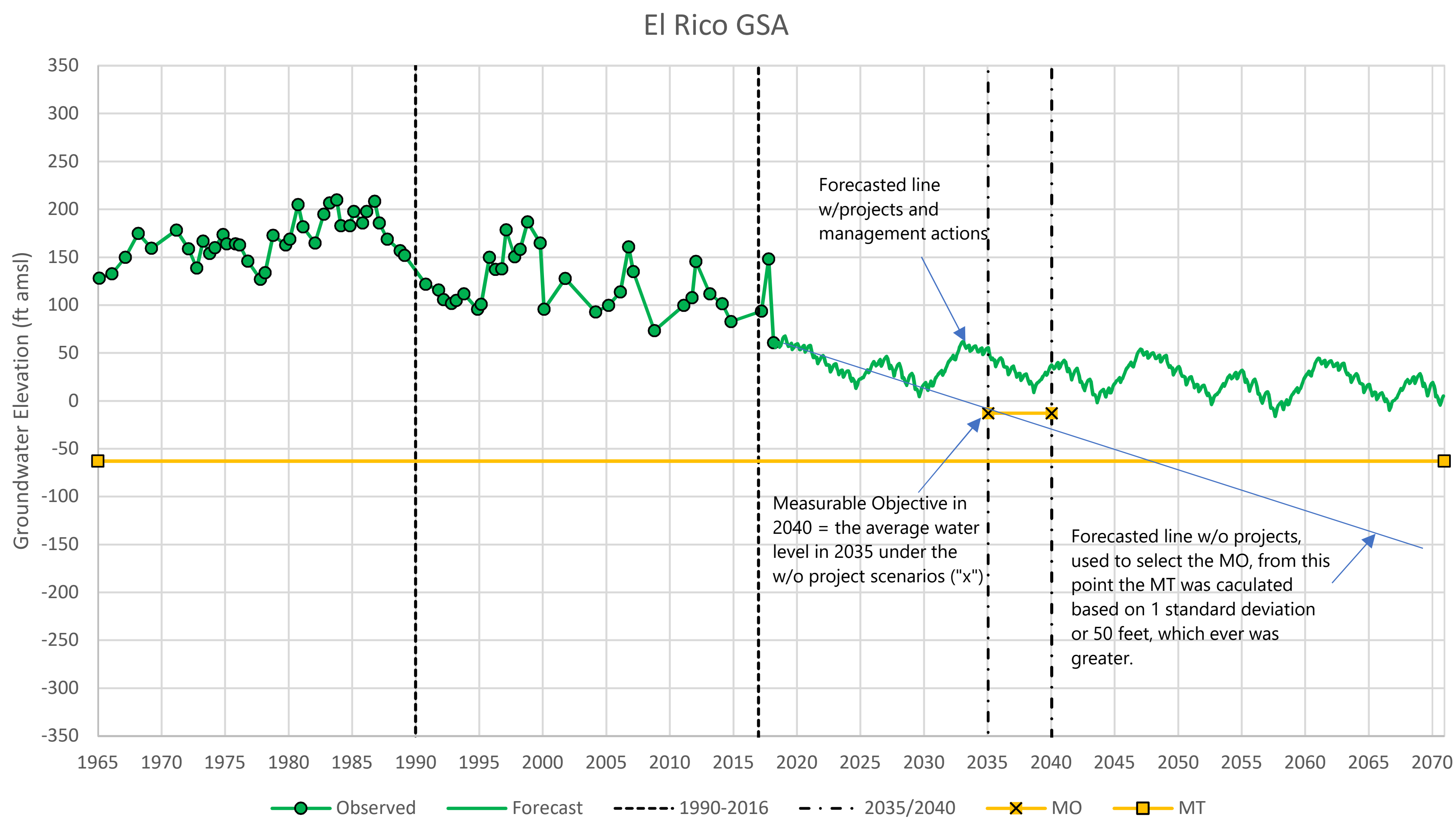


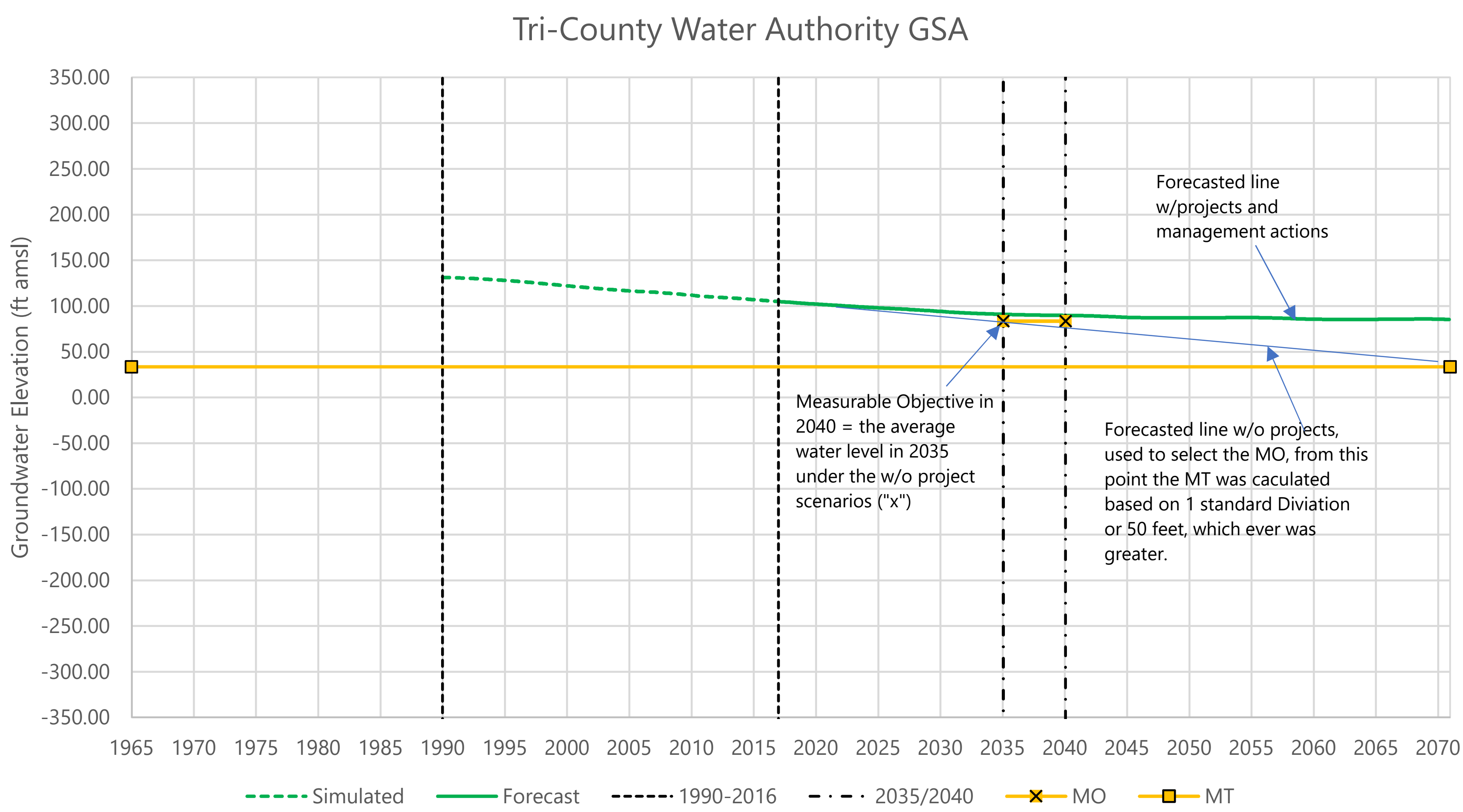
M.O Measurable Objective

M.T Measurable Threshhold

Example Hydrograph
And Sustainable Management Criteria
El Rico GSA
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 08/28/2019	Project No.: FR18161220
		Figure **4-5**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0826_ComplianceWellsWithDataHydrographs



M.O Measurable Objective

M.T Measurable Threshhold

Example Hydrograph and Sustainable Management Criteria Tri-County Water Authority GSA Tulare Lake Subbasin Groundwater Sustainability Plan Kings County, California		
By: EMC	Date: 08/28/2019	Project No.: FR18161220
		Figure **4-6**

Table 4-1. Milestones based on Measurable Objectives and Measurable Thresholds

Index	Well ID	MO	MT	2017	2025	2030	2035	2040
1	ER_A1_Proposed	197.30	147.30	216.13	189.47	184.12	205.13	188.80
2	ER_B_20S22E35R001M	-12.95	-62.95	105.37	80.21	68.08	92.52	88.81
3	ER_B1_Proposed	53.31	3.31	104.80	84.65	73.90	110.68	85.62
4	ER_B2_Proposed	75.66	25.66	101.30	94.91	91.33	88.92	86.43
5	ER_B3_Proposed	99.93	99.93	123.88	115.29	110.32	106.22	103.32
6	ER_B4_Proposed	94.92	44.92	102.19	100.50	99.74	99.11	98.43
7	ER_C_20S21E11N001M	-97.52	-151.13	29.65	37.31	23.65	-19.45	27.66
8	ER_C_20S21E24F001M	-141.29	-191.29	27.56	35.55	20.43	-10.09	25.54
9	ER_C_20S22E14C001M	-154.67	-217.99	22.44	26.98	14.51	-12.06	22.32
10	ER_C_20S22E19J001M	-145.04	-195.04	28.60	35.21	18.63	-8.74	25.85
11	ER_C_21S22E07J001M	-178.94	-228.94	23.21	29.66	12.02	-11.41	20.31
12	ER_C_CID_078	-152.63	-209.95	17.01	18.08	3.01	-17.09	12.25
13	ER_C_KRCDTL002	-8.57	-58.78	29.65	37.31	23.65	-19.45	27.66
14	ER_C_KRCDTL003	-172.76	-222.76	27.32	35.91	22.70	-4.68	27.37
15	ER_C_M-140	-56.37	-106.37	27.21	34.98	24.72	-5.65	26.75
16	ER_C_S-173	-118.15	-176.86	3.77	6.63	-14.21	-41.44	-5.27
17	ER_C_S-205	-117.22	-175.88	3.46	14.07	-2.65	-20.26	8.19
18	ER_C_S-225	-47.81	-97.81	34.72	37.36	22.51	13.01	30.58
19	ER_C1_Proposed	56.80	6.80	57.15	64.40	65.33	71.20	70.52
20	ER_C2_Proposed	12.40	-37.60	49.34	53.41	23.27	50.08	54.92
21	ER_C3_Proposed	106.22	56.22	113.35	114.08	106.96	116.58	117.52
22	ER_C4_Proposed	4.59	-45.41	40.97	47.27	36.97	35.65	45.05
23	ER_C5_Proposed	-52.87	-102.87	21.00	29.72	15.56	3.90	24.98
24	ER_C6_Proposed	-63.26	-113.26	19.22	28.13	13.02	-1.69	22.47
25	ER_C7_Proposed	-58.19	-108.19	24.53	32.10	16.66	-1.59	24.97
26	ER_C8_Proposed	-66.61	-116.61	23.26	30.69	14.10	-10.27	21.50
27	MKR_A_18S21E17N001M	213.53	163.53	229.95	229.67	228.35	230.13	229.10
28	MKR_A_19S21E20N001M	208.65	158.65	207.04	208.57	207.17	209.47	208.45
29	MKR_B_17S22E28A001M	153.82	103.82	243.72	236.54	233.13	249.84	248.79
30	MKR_B_18S21E01C001M	158.18	108.18	184.34	188.73	186.98	189.95	190.71
31	MKR_B_18S21E07R003M	183.66	133.66	112.45	108.85	105.33	102.82	100.87
32	MKR_B_18S21E27B001M	70.93	20.93	100.85	99.94	95.76	93.20	91.54
33	MKR_B_18S21E31B001M	60.99	10.99	103.82	98.10	94.44	91.75	88.32
34	MKR_B_18S22E03B001M	121.29	71.29	217.73	226.79	220.94	231.62	252.31
35	MKR_B_18S22E07A001M	115.64	65.64	198.12	202.81	201.85	208.95	211.90

Table 4-1. Milestones based on Measurable Objectives and Measurable Thresholds (Continued)

Index	Well ID	MO	MT	2017	2025	2030	2035	2040
36	MKR_B_18S22E24D001M	102.91	52.91	184.31	179.30	181.49	187.83	190.02
37	MKR_B_18S22E28A001M	84.17	34.17	174.75	174.18	174.47	177.71	178.68
38	MKR_B_18S22E34R001M	132.52	82.52	169.87	169.22	169.04	172.15	172.93
39	MKR_B_19S21E30A001M	176.89	126.89	96.64	90.86	87.37	85.11	82.20
40	MKR_B_19S22E07K001M	40.61	-9.39	122.64	121.30	119.43	120.41	119.68
41	MKR_B_MWA	242.08	192.08	242.16	250.27	247.61	248.93	251.94
42	MKR_B_MWC	185.66	135.66	270.82	252.94	252.97	258.27	257.83
43	MKR_B_MWD	184.52	134.52	258.90	249.23	248.02	256.37	253.54
44	MKR_B_MWG	175.98	125.98	223.25	222.27	224.16	230.26	228.34
45	MKR_B_MWH	100.89	50.89	167.23	166.45	166.97	168.95	170.15
46	MKR_B1_Proposed	75.61	25.61	99.43	92.99	89.79	87.33	84.67
47	MKR_B2_Proposed	77.27	27.27	101.58	95.50	92.22	89.58	86.67
48	MKR_B3_Proposed	196.97	146.97	209.01	211.51	209.38	219.21	219.20
49	MKR_B4_Proposed	79.60	29.60	111.30	101.29	93.90	91.08	89.40
50	MKR_C_19S22E08D002M	-52.15	-102.15	52.60	61.61	63.61	39.86	60.51
51	MKR_C_Hanford_43	39.81	-10.19	80.87	83.28	78.34	65.61	76.51
52	MKR_C_Hanford_48	65.05	15.05	97.23	103.29	98.86	90.35	100.38
53	MKR_C_MWD	146.75	96.75	115.10	141.32	124.45	115.41	148.22
54	MKR_C_MWG	124.11	74.11	104.24	131.79	116.42	103.98	138.89
55	MKR_C_MWH	23.76	-26.24	62.55	79.85	83.62	55.58	84.10
56	MKR_C1_Proposed	-37.30	-87.30	25.47	39.39	31.23	8.65	34.71
57	MKR_C2_Proposed	-12.18	-62.18	47.11	54.24	51.46	27.54	48.91
58	MKR_C3_Proposed	53.02	3.02	98.81	123.26	120.87	102.13	134.34
59	MKR_C4_Proposed	79.32	29.32	120.53	131.15	124.12	114.70	131.15
60	MKR_C5_Proposed	82.26	32.26	119.99	121.08	112.83	105.77	121.24
61	SFK_A_18S20E23E003M	198.96	148.96	224.10	224.92	224.62	226.37	226.91
62	SFK_A_19S20E29E002M	184.33	134.33	194.26	196.43	196.14	198.78	199.86
63	SFK_A_20S19E25A003M	200.01	150.01	189.56	192.68	191.26	193.37	194.42
64	SFK_A1_Proposed	183.70	133.70	179.34	181.04	181.00	179.44	176.58
65	SFK_A2_Proposed	193.96	143.96	199.62	197.42	196.23	196.68	197.05
66	SFK_B_18S20E11C002M	23.68	-26.32	98.33	94.18	87.22	83.88	82.71
67	SFK_B_18S20E23E001M	18.25	-31.75	94.25	88.64	83.57	80.11	76.19
68	SFK_B_18S20E23E002M	20.25	-29.75	94.25	88.64	83.57	80.11	76.19
69	SFK_B_18S20E34N001M	61.23	11.23	100.63	93.23	88.75	84.73	80.18

Table 4-1. Milestones based on Measurable Objectives and Measurable Thresholds (Continued)

Index	Well ID	MO	MT	2017	2025	2030	2035	2040
70	SFK_B_1920E19A001M	-62.16	-112.16	93.62	86.07	80.83	76.27	70.62
71	SFK_B_19S20E06C001M	0.65	-49.35	95.06	86.95	81.09	75.38	68.90
72	SFK_B_19S20E06L001M	-27.49	-77.49	95.06	86.95	81.09	75.38	68.90
73	SFK_B_19S20E07F001M	-26.84	-76.84	94.90	86.74	81.20	75.88	69.78
74	SFK_B_19S20E32D002M	-40.82	-90.82	88.19	82.28	77.35	74.48	70.71
75	SFK_B_19S20E32D003M	-40.82	-90.82	88.19	82.28	77.35	74.48	70.71
76	SFK_B_20S20E26L001M	33.09	-16.91	86.06	82.50	80.36	79.79	77.96
77	SFK_B_20S20E26L002M	-31.91	-81.91	86.06	82.50	80.36	79.79	77.96
78	SFK_B1_Proposed	76.13	26.13	96.67	90.96	87.87	85.44	82.72
79	SFK_C_19S20E26N002M	-35.41	-85.41	38.38	35.47	27.95	11.77	29.21
80	SFK_C_20S19E02A001M	-119.96	-182.16	-24.10	-17.47	-60.23	-65.43	-39.96
81	SFK_C_20S20E07H001M	-146.59	-196.59	25.10	25.93	5.21	-3.42	18.80
82	SFK_C_20S20E28E003M	-80.63	-130.63	33.92	35.09	21.87	11.63	29.79
83	SFK_C_LEM_06	-47.98	-103.78	16.80	6.57	4.46	-16.76	4.87
84	SFK_C_LEM_12	-122.98	-178.78	35.93	27.31	15.48	1.78	12.80
85	SFK_C1_Proposed	-11.50	-61.50	53.41	51.49	43.49	27.46	42.17
86	SWK_B_BeckyPease	67.35	17.35	121.50	122.51	123.20	123.35	120.86
87	SWK_B1_Proposed	176.06	126.06	172.84	174.90	176.02	178.44	179.51
88	SWK_B2_Proposed	49.94	-0.06	108.29	91.67	81.39	70.54	74.76
89	SWK_C_Well_16-8	23.52	-26.48	57.12	56.60	39.41	40.78	42.55
90	SWK_C1_Proposed	138.05	88.05	145.03	144.30	137.37	144.96	146.20
91	SWK_C2_Proposed	84.91	34.91	97.64	100.76	93.21	99.21	100.21
92	SWK_C3_Proposed	58.15	8.15	78.64	80.35	71.13	74.82	76.29
93	TCWA_A_23S23E15M001M	200.01	150.01	197.90	199.02	201.01	205.10	207.73
94	TCWA_B1_Proposed	83.42	33.42	104.42	97.64	93.61	90.78	89.69
95	TCWA_C_24S22E33C001M	17.60	-32.40	65.55	67.11	22.76	63.16	67.98
96	TCWA_C_24S22E35E001M	-39.51	-89.51	47.79	51.79	0.35	42.44	50.58
97	TCWA_C1_Proposed	-76.93	-126.93	7.83	3.25	-17.50	-22.56	-13.90

Table 4-2. Lemoore-Average Land Subsidence Interim Milestones based on Measurable Objectives for the Subbasin

Year	2020-2025	2026-2030	2031-2035	2036-2040
Interim Milestone	2.37	1.38	0.79	1.16
Modeled Subsidence w/projects and management actions	0.88	0.62	0.14	0.43

Table 4-3. Corcoran-Average Land Subsidence Interim Milestones based on Measurable Objectives for the Subbasin

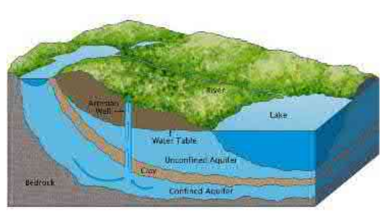
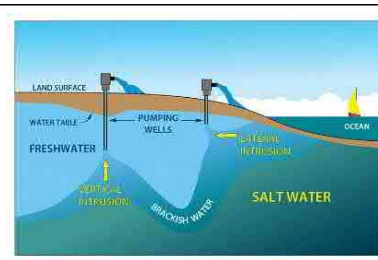
Year	2020-2025	2026-2030	2031-2035	2036-2040
Interim Milestone	1.81	2.10	0.53	1.11
Modeled Subsidence w/projects and management actions	0.07	0.58	0.06	0.00

5.0 MONITORING NETWORK

> **23 CCR §354.34(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.*

This chapter describes the existing and proposed monitoring networks as proposed by the Tulare Lake Subbasin (Subbasin) Groundwater Sustainability Agencies (GSAs). Data collected from the monitoring network will be evaluated for short-term, seasonal, and long-term trends for the following sustainability groundwater indicators: groundwater levels, related surface conditions (i.e., land subsidence), and groundwater quality. Information collected through the Subbasin's monitoring network will support the implementation of this Groundwater Sustainability Plan (GSP), be used to evaluate the effectiveness of the GSP, and provide the data needed for GSAs within the Subbasin to make decisions regarding groundwater sustainability. The results of historical monitoring efforts can be found in Section 3.2, *Groundwater Conditions*.

The Sustainable Groundwater Management Act (SGMA) requires each subbasin to establish a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term groundwater trends and related surface conditions (23 California Code of Regulations [CCR] §354.34). A comprehensive monitoring network is essential to evaluate GSP implementation and measure progress towards groundwater sustainability based on several sustainability indicators. The sustainability indicators necessary to comply with SGMA monitoring and reporting requirements include chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletions of interconnected surface water.

Groundwater Levels	Groundwater Storage	Seawater Intrusion
Static groundwater levels based on monitoring results collected each Winter in the First Quarter & Fall in the Fourth Quarter	Estimated calculation of the annual change in groundwater storage based on groundwater levels	Intrusion of seawater into local aquifers, which is not applicable to Tulare Lake Subbasin
		

Degraded Water Quality	Land Subsidence	Depletion of Interconnected Surface Water
Monitoring for water quality that could impact available groundwater supplies	Gradual settling or sinking of the Earth's surface caused by excessive confined groundwater withdrawals that impacts critical infrastructure	Depletion of stream flow due to chronic lowering of groundwater levels
		

The adequacy of the monitoring network is described for each sustainability indicator, as well as the quantitative values for the minimum thresholds (MTs), measurable objectives (MOs), and interim milestones. This chapter also includes a review of each monitoring network for monitoring frequency and density, identification of data gaps, plans to fill data gaps, and hydrogeologic rationale for future site selection. Consistent data collection and reporting standards will be incorporated into the network for reliable and accurate data. This information will be reviewed and evaluated during each five-year assessment. Monitoring programs for sustainability indicators are described, including the proposed monitoring strategies in compliance with SGMA, adequacy and scientific rationale, and history for each monitoring program. Estimates of groundwater pumping, groundwater recharge, and surface water deliveries are discussed in Section 3.3, *Water Budget Information*.

Seawater intrusion is not considered an issue in the Subbasin as its western boundary lies approximately 80 miles from the Pacific Ocean. Seawater intrusion is therefore not discussed hereafter in this chapter. Saline water intrusion from up-coning (upwelling of water below a well while it is operating) of deep saline groundwater, however, is a potential problem and will be evaluated as part of general water quality monitoring (see Section 5.4.3, *Water Quality*).

There is a historical hydrologic connection between surface water and groundwater that has been lost in the Subbasin (see Section 3.2.8, *Interconnected Surface Water and Groundwater Systems*). Interconnected surface water and groundwater in California was discussed in a document titled *The Public Trust and SGMA* by Brian Gray and posted to the California Water blog (Gray 2018). This document states "There are regions where the hydrologic connection between groundwater and navigable rivers and lakes was lost long ago. On the valley floor of the Tulare Subbasin, sustained groundwater overdraft for many decades has lowered the groundwater table by hundreds of feet" (Gray 2018). This would indicate that the hydrologic connection between surface water and groundwater no longer exists in the Subbasin. The Kings River is often dry downstream of Highway 99 and can remain dry for extended periods of time where it borders the Subbasin. Commonly, in normal water years, the Kings River only flows for four to five months of the year during the irrigation season. In wet water years, the river may run for most of the year; in dry water years, the river may only run for a few weeks. Due to extended periods when the Kings River is dry where it borders the Subbasin, it cannot have a continuously saturated zone through time connecting surface water and groundwater, nor can a dry riverbed be connected to groundwater spatially. Depletion of interconnected surface water is not discussed hereafter in this chapter.

While the Subbasin GSAs believe that surface water is not connected to groundwater in the Subbasin, shallow groundwater near the Kings River likely responds to changes in river flows. This monitoring plan recognizes that a data gap exists in this area to be filled with a shallow monitoring well. Data from shallow wells in this area, once they become available, will be evaluated to better understand the relationship between shallow groundwater above the A-Clay, flows in the Kings River, and shallow groundwater use. The need for additional monitoring of shallow groundwater in the future in this area will be evaluated by the GSAs. The GSAs may decide to implement well construction or other policies near the river such that future wells are sealed against pumping of shallow groundwater, as needed.

5.1 Description of Monitoring Network

23 CCR §354.34(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.

The number of existing and proposed representative monitoring site (RMS) locations are summarized by GSA and Sustainability Indicator in Table 5-1. The groundwater level RMS locations as discussed below are shown by aquifer zone, in Figures 5-1 to 5-3. The Groundwater Quality RMS monitoring network is composed of wells currently sampled by the local cities/municipalities/small community systems, and the Kings River Water Quality Coalition (KRWQC)-Irrigated Lands Regulatory Program (ILRP) (Figure 5-4). Figure 5-5 shows the existing land subsidence monitoring locations in the Subbasin and the general areas where future extensometers may be added. Table 5-2 through Table 5-6 summarize the RMS locations shown on Figures 5-1 through 5-5 by GSA. Tables 5-2 through 5-6 identify the location, type of facility (well, well cluster, extensometer, etc.), existing monitoring program, sustainability indicators monitored, data collection frequency, and aquifer zone monitored. MOs, interim milestones, and MTs for groundwater levels and land subsidence are defined for both existing RMS locations and general areas where groundwater RMS locations are proposed to fill data gaps (see Section 4.2, *Description of the Sustainability Indicators)*. Groundwater Level RMS (existing and proposed) locations are distributed across the Subbasin in areas where groundwater is used and by aquifer zone (discussed below). This vertical and horizontal distribution of groundwater level RMSs will allow the GSAs to develop the data needed to evaluate groundwater conditions in the various aquifer zones, discussed below, and will be used to inform the Subbasin GSAs as to plan progress in meeting MOs, interim milestones, and MTs.

Due to the complexity of the hydrogeologic setting in the Subbasin as discussed in Section 3.1, *Hydrogeologic Conceptual Model*, the aquifer is divided into three aquifer zones for groundwater level monitoring:

- The A zone is the shallow portion of the aquifer above the A-Clay and in areas where shallow groundwater is present outside of the A-Clay (Figure 5-1).
- The B zone is the unconfined portion of the aquifer above the E-Clay or Corcoran clay (Figure 5-2).
- The C zone is the confined portion of the aquifer below the E-Clay (Figure 5-3).

The groundwater level monitoring network also considers the Tulare Lake Basin Plan Amendment (BPA) in areas de-designated for municipal (MUN) and agricultural (AGR) uses (see Chapter 3, Sections 3.1.7.2, *Water Quality Method*, and 3.1.8.3, *Aquitards*, and Section 5.4.3, *Water Quality*, below for more details). Groundwater monitoring in those areas and aquifer zones is not proposed as decided by the GSAs that overly this area. These areas are Management Area A and Management Area B (Figures 5-1 to 5-5). Other sites are monitored for groundwater levels in the Subbasin and provide additional data to prepare groundwater level maps. These locations are not RMSs and the GSAs desire to keep these data private.

The C-clay is another lacustrine clay between the A-Clay and the E-Clay; therefore, it is in the B zone (see Figure 3-17 for a map of the C-Clay and Section 3.1.8.3, *Aquitards*, for details on the various lacustrin clays layers). Most of the groundwater production from public supply wells near the lakebed is from wells that tap water below the C-Clay (KDSA, et. al. 2015). Water above the C-Clay in the Tulare lake bed area is typically too saline for MUN or AGR usage and has been exempted from MUN and AGR beneficial use (RWQCB 2017a). The Subbasin GSAs will evaluate groundwater level data where the C-Clay is present, and if future groundwater data indicates a need to separate out portion(s) of the aquifer in certain areas between the C- and E-Clays as another aquifer zone, the GSAs may do so at a that time.

There are areas in the Subbasin where groundwater is not used due to poor water quality and/or, in the lakebed area, non-productive strata. Portions of the Subbasin where groundwater pumping does not occur are not proposed to be actively monitored at this time, as described further in Chapter 3, *Basin Setting*. These areas overlay portions of El Rico GSA, Tri-County Water Authority GSA, and Southwest Kings GSA. These GSAs desire to seek funding and work collaboratively with state, federal and other potential funding sources to construct monitoring facilities in Management Areas A and B (Figures 5-1 through 5-5). If monitoring facilities in these areas are constructed, they will be added to the monitoring network. Management Areas A and B are in the areas de-designated for AGR and MUN use and currently are not required to have new monitoring for water quality according to the Regional Water Quality Control Board (RWQCB), Tulare Lake BPA unless projects are proposed in these areas that would trigger new monitoring (see Chapter 3, Sections 3.1.7.2, *Water Quality Method*, and 3.1.8.3, *Aquitards*, and Section 5.4.3, *Water Quality*, below). In this event, these facilities could be incorporated into the monitoring network for SGMA.

South Fork Kings GSA

The groundwater level monitoring network for the South Fork Kings GSA consists of three A-zone RMS wells and two areas for proposed shallow RMS wells (Figures 5-1 to 5-3; Table 5-1). The three A-zone RMS locations are dedicated monitoring wells installed and monitored by Kings River Conservation District (KRCD). The GSA Groundwater Level RMS network also includes several other wells consisting of monitoring, agricultural, and municipal wells (Figures 5-1 to 5-3). Three of the RMS locations are based on existing monitoring well clusters (eight total wells) installed by the KRCD. South Fork Kings GSA will pursue existing wells to fill data gap areas. If existing wells cannot be found to monitor a given aquifer zone in a data gap area, the GSA will seek funding to install dedicated monitoring wells in data gap areas.

Mid-Kings River GSA

Mid-Kings River GSA is proposing similar actions to the South Fork Kings GSA. Mid-Kings River GSA intends to include abandoned, unused, or idle wells in the monitoring network as they become available and data can be collected on which aquifer zone a given well monitors. In the event that a given well is not perforated to monitor a specific aquifer zone, then Mid-Kings River GSA would install dedicated monitoring well(s) or use an existing well if one can be found to monitor that zone. Mid-Kings River GSA has six dedicated monitoring wells owned by Kings County Water District (WD). The Kings County WD-dedicated monitoring wells will continue to be monitored and will be used as RMSs. The long-term plan for Mid-Kings River GSA is to develop roughly seven more dedicated monitoring locations that would be used as RMSs. The Kings County WD also has an extensive groundwater monitoring network that relies on existing agricultural wells. Kings County WD intends to continue monitoring those wells to continue the historic record that has been developed. The Mid-Kings River GSA will evaluate water levels from these wells (some are perforated in a single aquifer but many are composite; perforated in multiple aquifers) to understand the relationship of water level in these wells to water level data from wells that are known to monitor a specific aquifer zone.

Other GSAs

Southwest Kings GSA, El Rico GSA, and Tri-County Water Authority GSA will concentrate their efforts to include existing or abandoned/idle wells with known construction information to minimize the need to build dedicated monitoring wells.

5.1.1 Monitoring Network Objectives

23 CCR §354.34(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 effects 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.

The objectives of the various monitoring programs include the following:

- Establish baseline groundwater levels and groundwater quality and develop long-term trends;
- Use data gathered to generate information for water resources evaluations and annual changes in water budget components;
- Determine the direction of groundwater flow, which is needed to estimate groundwater flow;
- Provide comparable data from various locales within the Subbasin;
- Demonstrate progress toward achieving MOs, interim milestones, and MTs described in the GSP as they relate to the Sustainable Management Criteria; and
- Develop the data to evaluate impacts to the beneficial uses or users of groundwater.

The path to achieving the objectives of the monitoring network includes collecting and evaluating the data needed for the Subbasin GSAs to demonstrate and monitor the Subbasin's progress in meeting MOs, interim milestones, and MTs relative to groundwater conditions and impacts to beneficial users of groundwater. The data collected through the monitoring network will also help quantify changes in the water budget components.

Groundwater level monitoring, groundwater storage estimations, and groundwater quality monitoring will utilize existing monitoring, irrigation, municipal, industrial, domestic, and proposed monitoring wells for RMSs. Below is a summary of the Subbasin GSA's planned monitoring networks. Monitoring is not proposed in areas outside of the Subbasin. Data sharing agreements are being developed or will be developed between other adjacent groundwater subbasins in order to evaluate boundary conditions. Currently, the South Fork Kings GSA has a data sharing agreement with North Fork Kings GSA, and South Fork Kings GSA and Southwest Kings GSA have data sharing agreements with Westlands Water District.

5.1.2 Design Criteria

New monitoring locations will be developed, and existing networks enhanced, when necessary, using an approach similar to the Data Quality Objective (DQO) process to guide the GSAs site selection. The DQO process follows the U.S. Environmental Protection Agency (EPA) Guidance on Systematic Planning Using the Data Quality Objective Process (EPA 2006). The DQO process is also outlined in the California Department of Water Resources (DWR) Best Management Practices for the Sustainable Management of Groundwater - Monitoring Networks and Identification of Data Gaps (DWR 2016e) and Monitoring Protocols, Standards, and Sites (DWR 2016f). While the DQO process was not developed specifically to guide the selection of new monitoring locations under SGMA, it does provide a repeatable process for site selection and evaluation so that the GSAs approach site selection in a similar manner.

The dedicated monitoring wells to be installed above the A-Clay or above the E-Clay in the Subbasin are recommended to be 4-inch Schedule 80 polyvinyl chloride (PVC) casings. Deep monitoring wells, installed below the E-Clay are recommended to be 5- or 6-inch Schedule 80 PVC casings. This will ensure that representative water quality samples may be collected at these locations. Additional water quality information will be collected and reviewed from agencies and entities currently monitoring for groundwater quality. Monitoring wells constructed in subsiding areas will need to be designed with compression sections to help avoid collapse of the casings. If abandoned wells are included in monitoring networks they need to be re-developed prior to beginning data collection to ensure they are not plugged, and to remove any accumulated down hole equipment lubricant (oil), if present. Groundwater level data collected from these wells would need to be evaluated annually to ensure they continue to provide valid data. If the collected data appears to deviate from nearby wells in the same aquifer zone, the wells will need to be re-developed as needed. Abandoned wells will likely not be included in the groundwater quality monitoring network as they will likely not have pumps in them, and evacuating enough volume to properly purge the well prior to sampling, using low-flow pumps, would not be cost effective.

Chapter 4, *Sustainable Management Criteria,* details the MTs, MOs, and interim milestones applicable to each sustainability indicator.

5.1.3 Overview of Existing Programs

Government agencies and private entities currently have existing programs in place that monitor groundwater levels, groundwater quality, and land subsidence. These programs will be utilized for future data collection and will be coordinated with SGMA monitoring requirements. If data from these sources becomes unavailable in the future, a new monitoring network will be established to monitor for the appropriate sustainability indicator. Below are the various programs currently in place that will be described further in Sections 5.1.6, *Groundwater Levels*, through 5.1.9, *Land Subsidence*.

Groundwater Levels

- Kings County WD
- Apex Ranch
- KRCD
- California Statewide Groundwater Elevation Monitoring (CASGEM)
- Municipal monitoring programs
- Corcoran Irrigation District (ID)

Groundwater Quality

- Municipal public supply wells monitoring programs
- Groundwater Ambient Monitoring and Assessment Program (GAMA)
- ILRP
- Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS)
- Groundwater monitoring at sites with RWQCB wastewater discharge requirements (WDRs)
- Groundwater monitoring at subsurface drainage evaporation ponds

Land Subsidence

- United States Geological Survey (USGS) Monitoring
- National Aeronautics and Space Administration (NASA) Monitoring
- Central Valley Spatial Reference Network (CVSRN) Continuous Global Positioning System (CGPS) Stations
- KRCD benchmarks
- California Aqueduct subsidence monitoring benchmarks
- University Navigation Satellite Timing and Ranging Consortium (UNAVCO)
- National Geodetic Survey (formerly U.S. Coast and Geodetic Survey)
- United States Army Corps of Engineering (USACE)

Existing facilities that are not associated with an existing program include private wells for AGR or domestic use. Including these wells in the existing monitoring networks will be the responsibility of the individual GSA.

5.1.4 Overview of Proposed Facilities

Proposed facilities for the groundwater level network include 34 monitoring wells (or existing wells that monitor a specific aquifer zone) to fill existing data gap areas (Figures 5-1 through 5-3). The two proposed extensometers are initially proposed to be located in the vicinity of Corcoran and an area south of Lemoore (Figure 5-5). If funding or other agreements are made for the construction of the proposed extensometers, the locations will be refined by the GSA(s) at that time based on up-to-date subsidence maps and benchmark data. The proposed monitoring wells may be necessary if existing wells cannot be identified to fill spatial data gaps in the network. There are three general types of data gaps to consider for monitoring networks.

- Temporal: Insufficient frequency of monitoring. For instance, data may be available from a well only in the Fall since it is rarely idle in the Spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc. Going forward, wells in the monitoring network will be measured at a minimum in the First and Fourth Quarters which will mitigate temporal inconsistencies.
- Spatial: Insufficient number or density of monitoring sites in a specific area.
- Insufficient quality of data: Data may be available but be of poor or questionable accuracy. Inaccurate data may at times be worse than no data, since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area, or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on well perforation depth, etc. Well location information on Well Construction Reports is often inaccurate (making it difficult or uncertain to match wells with their well logs), and these wells will need to be field located.

5.1.5 Groundwater Levels

Groundwater level monitoring has occurred in most areas of the Subbasin on a semi-annual basis since the 1950s (Provost & Pritchard 2011; WRIME 2005). Kings County WD, KRCD, DWR, and the United States Bureau of Reclamation (USBR) have measured and/or are currently measuring groundwater levels as part of existing monitoring programs (Provost & Pritchard 2011; WRIME 2005). Well logs and construction information are not available for several of these wells but will be collected in the future if they are available as described in Section 5.4.1.2., *Mid-Kings River GSA*. Since 2009, DWR has also asked local agencies to collect and report groundwater level data under the CASGEM program. KCWD, KRCD, and Tulare Lake Bed water agencies participate in

CASGEM and report groundwater level data on a semi-annual basis (Provost & Pritchard 2011; DWR 2010; Summers Engineering 2012; WRIME 2005). These agencies will continue monitoring semi-annually for future data collection and may expand, as needed, to comply with SGMA monitoring requirements. Each agency will monitor groundwater levels in the First and Fourth Quarters each year to provide consistency in the timing of measurements. Groundwater level data collection protocols will follow methods in the DWR Best Management Practices for the Sustainable Management of Groundwater - Monitoring Protocols, Standards, and Sites, December 2016 (DWR 2016f).

RMS groundwater level locations have MOs to gauge the effectiveness of plan implementation measures and evaluate MTs that define undesirable results in the Subbasin. The proposed RMS monitoring network, when built-out, will include a density of RMSs of up to two wells for the B zone (above the E-Clay) and C zone (below the E-Clay), and one well for the A zone (above the A-Clay where it is present) for the 36-square mile Townships wholly in the Subbasin where the GSAs desire to monitor (Figures 5-1 to 5-3). Generally, if more than about half of a Township is within the Subbasin, RMS well densities were kept the same as for those Townships wholly in the Subbasin. Greater RMS well densities are focused around concentrated pumping areas and cities including Hanford, Lemoore, and Corcoran and north of the lakebed. Data on the depth and perforated intervals of the monitoring wells or existing wells is required according to SGMA guidelines unless the GSA can demonstrate that such information is not needed to understand and manage groundwater in the Subbasin. The GSAs plan to obtain additional construction information on wells in the monitoring networks that lack well construction information. Some of the wells in the monitoring network do not have consistent measurements for consecutive years throughout their operational life for numerous reasons including lack of access, breaks in wells casings, wells running during data collection, damaged or broken well sounding equipment, oil in the casings, fouling sounding equipment, etc. The GSAs will work with landowners to alleviate these issues as possible and include redundancy in the monitoring networks when feasible. Groundwater levels will be measured in the monitoring network wells each First and Fourth Quarters. The timing of water level data collection will be coordinated between the GSAs so that the data is collected in as short a period as possible.

Groundwater levels are measured in the various networks and types of wells including:

- Kings County WD: The District encompasses a land area of approximately 143,000 acres between Tulare Lake Subbasin and Kaweah Subbasin. Water level measurements are taken semi-annually on average from 255 wells in both the Spring and Fall. The District's monitoring program is divided into two distinct monitoring programs: 1) Apex Ranch Conjunctive Use Project Monitoring Program and 2) a district-wide monitoring program. The District began routinely measuring groundwater levels district-wide in the 1950s

(Provost & Pritchard 2011). The district-wide data collection effort also includes data sharing with adjacent districts and groundwater basins, and evaluates groundwater levels above the A-Clay and above the E-Clay.

- Apex Ranch Conjunctive Use Project Monitoring Program: The monitoring network consists of 40 to 45 offsite and onsite, agricultural, domestic, and dedicated monitoring wells. Several of the monitoring wells, both onsite and offsite, are equipped with data loggers which allow for data collection at set intervals and flexibility in the frequency that the data can be collected. These data are considered continuous and are recorded throughout the year (Provost & Pritchard 2011).
- KRCD: Current groundwater level monitoring program includes semi-annual groundwater level measurements (WRIME 2005*)*. KRCD also samples wells for the KRWQC -ILRP Groundwater Trend Monitoring.
- CASGEM Wells: DWR collects groundwater levels reported by local agencies and reports them through the CASGEM program. There are currently 17 CASGEM wells in the Subbasin.
- Municipal Wells: Most municipal wells are available for water level and/or water quality monitoring in Hanford, Lemoore, Corcoran, Armona, Home Garden, Kettleman City, Stratford, and others.
- Private Wells: Areas outside of those monitored by local or government agencies tend to lack appropriate monitoring coverage. As a result, the Subbasin is seeking consent from numerous private well owners to monitor water levels and/or water quality in their wells. Access agreements and monitoring protocols will be needed to monitor these wells.
- Wells in Adjacent GSAs: Groundwater level data from adjoining subbasins will also be collected through data sharing agreements to help provide better interpretation of GSA boundary flow conditions. (Note: long-term agreements still need to be prepared to collect/share data with other subbasins). Wells within the Kings, Kaweah, Tule, Kern, and Westside subbasins have wells which will aid in evaluating boundary conditions.

5.1.6 Groundwater Storage

A groundwater model was originally developed for the Subbasin in 2017-2018 with grant funding from DWR. It was then further refined in 2019 through additional grant funds. The groundwater model was used to estimate the overall annual change in groundwater storage over the model calibration period of 1996 to 2016 for the unconfined and confined portions of the aquifer. Change in groundwater storage over time is a function of the change in hydraulic head of the aquifer, and the storage coefficients or specific yield of the dewatered sediments (Appendix D, *Hydrogeologic Concept Model Documentation*). In the future, for annual reporting, groundwater level contour maps will be prepared and estimates of annual storage change will be done by comparing Spring to Spring contours sets which are then multiplied by specific yield values. The storage change monitoring network is the same as the water level monitoring network. RMS well locations are linked to specific aquifer zones, as such data from these wells will be weighted heavier than wells without construction information. It should be noted that even though a well may not have construction information, the data can still be used in constructing water level maps if data is consistent with water levels from RMS wells.

For more information, please refer to Section 3.1.9, *Hydraulic Parameters*.

5.1.7 Groundwater Quality

The groundwater quality monitoring network may supplement, as needed, groundwater quality monitoring currently under the oversight of an existing regulatory agency or groundwater quality coalition. The agencies and coalitions can include ILRP, GAMA, RWQCB, CV-SALTS, and cities/municipalities within the Subbasin. The monitoring network should consist largely as supplemental monitoring locations where known contaminant plumes exist and additional safeguards for plume migration are necessary (DWR 2016e). The GSAs may work in collaboration with the existing regulatory agencies or cities/municipalities to implement supplemental monitoring and assist them with developing additional safeguards, as needed. The determination of supplemental groundwater quality monitoring need will be on a case-by-case basis and in collaboration with the applicable regulatory agency or city/municipality.

Data and reports will be gathered from the above-mentioned agencies and coalitions. Should there be consensus between a given GSA and the agency or coalition that GSA assistance is needed to address degraded water quality (or the potential for migration of a contaminant plume), the GSA may implement groundwater quality monitoring to supplement the existing programs to help the given agency or coalition achieve its goals. In addition, the GSAs may collaborate with a regulatory agency to develop a project or program that may be able to generate benefits for both parties.

Management Areas A and B are in the areas de-designated for AGR and MUN use and currently are not required to have additional monitoring according to the RWQCB and the Tulare Lake BPA unless projects are proposed that would trigger new monitoring in these areas.

When additional groundwater quality monitoring, supplemental to existing regulatory agency monitoring, is warranted as determined in collaboration between the GSA(s) and the regulatory agency or coalition, the sampling protocols will comply with the DWR Best Management Practices for the Sustainable Management of Groundwater - Monitoring Protocols, Standards, and Sites (DWR 2016b) for groundwater quality monitoring and coincide with the existing regulatory monitoring plans. See the following links for additional information on the monitoring frequencies of each:

- ILRP: https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/

- GAMA: https://www.waterboards.ca.gov/gama/
- RWQCB: https://www.waterboards.ca.gov/
- CV-SALTS: https://www.waterboards.ca.gov/centralvalley/water_issues/salinity/

Utilizing the existing data from water agencies and coalitions represents a spatial distribution of monitoring sites and quantitative values for principle aquifers in the Subbasin. Supplemental monitoring will be identified where degradation of groundwater quality occurs as evaluated by the existing water quality programs.

5.1.8 Land Subsidence

For land subsidence, the existing CVSRN CGPS in the area will be used as RMSs for the Subbasin. The land subsidence monitoring network also includes other subsidence monitoring sites monitored by KRCD, Kaweah Delta Water Conservation District (KDWCD), California Highspeed Rail Authority, and potentially others. These data will be evaluated annually and if subsidence rates approach MOs at the nearest CGPS station, then additional RMSs, either from the existing land subsidence monitoring network benchmarks or in locations determined by the GSA(s), may be added as determined by the GSA. In addition, two extensometers are proposed in areas of known subsidence, pending funding or collaboration with DWR or the USGS, in the general locations shown on Figure 5-5. In addition, regional-based Light Detection and Ranging (LiDAR) subsidence maps will be evaluated to identify areas of subsidence, in areas where there are no current benchmarks, and if subsidence approaches the MO in an area, a program for measuring pumping water levels in deep wells may be instituted. Initially, if such a program is instituted, pumping water levels from deep wells may be measured in areas experiencing the greatest subsidence and in a 1-mile radius around the subsidence depression, assuming this amount of subsidence has reached the MO. This will provide the information needed for the GSA(s) to adjust operations, or implement policies or programs to reduce subsidence by adaptively managing groundwater pumping from the deep aquifer. Deep groundwater pumping adaptive management programs or policies will be determined as needed by the GSA. Land subsidence data will continue to be obtained from local, state, and federal agencies. As funding opportunities become available, additional subsidence monitoring facilities may include extensometers for depth discrete subsidence monitoring near or in the areas shown on Figure 5-5.

Land subsidence is discussed in further detail in Section 3.2.6, *Land Subsidence*. The Subbasin is included in areas monitored for subsidence by regional water agencies or the state and federal governments. Measurement and monitoring for land subsidence is performed by USGS, KRCD, USACE, UNAVCO, and various private contractors. Interagency efforts between the USGS, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey), and DWR resulted in an intensive series of investigations that identified and characterized subsidence in the San Joaquin

Valley. NASA also measures subsidence in the Central Valley and has maps on their website that show the subsidence for defined periods (NASA n.d.).

Surface land subsidence caused by excessive confined groundwater withdrawals that impacts critical infrastructure is identified as the sustainability indicator for land subsidence by the Subbasin GSAs. Critical infrastructure currently in the Subbasin, as defined by the GSAs, includes the California Aqueduct, City of Corcoran, California State Prison-Corcoran, Highways 198, 43, 41 and Interstate 5, and the Union Pacific/Amtrak railroad line. In addition, there are main transmission lines for gas and electricity in the Subbasin. The California High-Speed Rail may be considered critical infrastructure in the Subbasin in the future if it is constructed and the alignment passes through subsiding areas in the Subbasin. Plans for infrastructure currently in the design stage can be adjusted to accommodate expected continued subsidence, for example, the California High-Speed Rail (LSCE, Borchers, and Carpenter 2014). If that happens the GSAs will work with the California High-Speed Rail Authority to mitigate potential impacts. It is not known when or if the High-Speed Rail will be constructed, but the GSAs plan to reduce subsidence in the future. As well, individual GSAs will work with the other agencies/authorities to mitigate potential effects of subsidence.

Where the California Aqueduct boarders the Subbasin from about Kettleman City and south along the western boundary of Southwest Kings GSA, is adjacent to the alluvial groundwater basin. A recent subsidence map covering the period from May 2015 to September 2016 as processed by the Jet Propulsion Laboratory (JPL) shows minimal subsidence in this area. This is the same general location of Interstate 5 in the Subbasin, which has experienced minimal subsidence over the same period as well. The GSAs will continue to collect and evaluate subsidence data from subsidence monitoring locations along the area of the California Aqueduct and Interstate 5, even though it does not appear that subsidence along these facilities where they abut the Subbasin is problematic.

The GSAs have initially defined MOs, interim milestones, and MTs for subsidence in the Subbasin at two CVSRN-CGPS locations: LEMA and CORC. For the LEMA CGPS location, the interim milestone from 2020 to 2025 is 2.37 feet of subsidence, the interim milestone from 2026 to 2030 is 1.38 feet of subsidence, from 2031 to 2035 the interim milestone is 0.79 feet, and from 2036 to 2040 it is 1.16 feet. For the CORC CGPS location, the interim milestone from 2020 to 2025 is 1.81 feet of subsidence, the interim milestone from 2026 to 2030 is 2.10 feet of subsidence, from 2031 to 2035 the interim milestone is 0.53 feet, and from 2036 to 2040 it is 1.11 feet. Therefore the MOs during GSP implementation are 5.7 feet at the LEMA location and 5.55 feet at the CORC location. These were estimated using the groundwater model under the no-project scenario.

Estimates of subsidence with projects are less than these values discussed here; see Chapter 4, *Sustainable Management Criteria*, for more details.

5.1.9 Consistency with Standards

23 CCR §354.34(g) *Each Plan shall describe the following information about the monitoring network:*
(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.

The data gathered through the monitoring networks will be consistent with the standards identified in 23 CCR §352.4 related to Groundwater Sustainability Plans. The main topics of 23 CCR §352.4 are outlined below,

- Data reporting units (e.g., water volumes including surface water deliveries, estimates of groundwater pumpage, annual storage change shall be reported in acre-feet [AF], etc.)
- Monitoring site information (e.g., site identification number, description of site location, etc.)
- Well information reporting (e.g., CASGEM well identification number or other unique identifier, measuring point elevation, casing perforations, etc.)
- Map standards (e.g., data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4 of the SGMA regulations – Procedural issues related to submission of plans and public comment to those plans, etc.)
- Hydrograph requirements (e.g., hydrographs shall use the same datum and scaling to the greatest extent practical, etc.). Hydrographs will also be plotted showing depth to water as well as groundwater elevation.

5.2 Monitoring Protocols for Data Collection and Monitoring

23 CCR §352.2 *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.

23 CCR §354.40 *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.*

The DQO process will be used to develop monitoring protocols that assist in meeting MOs and sustainability goals of this GSP (EPA 2006). The DQO process includes the following:

- State the problem;
- Identify the goal;
- Identify the inputs;

- Define the boundaries of the area/issue being studied;
- Develop an analytical approach;
- Specify performance or acceptance criteria; and
- Develop a plan for obtaining data.

Groundwater level, groundwater quality (if the GSAs participate in groundwater quality monitoring), and land subsidence monitoring will generally follow the protocols identified in the DWR Best Management Practices for the Sustainable Management of Groundwater - Monitoring Protocols, Standards, and Sites (DWR 2016f). The GSAs may develop standard monitoring forms in the future if deemed necessary.

The following comments and exceptions to the BMPs should be noted:

- SGMA regulations require that groundwater levels be measured to the nearest 0.1-foot. The BMP suggests measurements to the nearest 0.01-foot; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10- or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well then readings to the nearest foot are likely the best one can achieve. As well, a methodology will need to be developed to keep track of the amount of oil in these wells, and if possible, have the oil removed when the pump is removed for other reasons.
- If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
- Wells will be surveyed to a horizontal accuracy of 0.5-foot.
- Unique well identifiers will be labeled on all public wells, and on private wells if permission is granted.
- The BMPs state that measurements each Spring and Fall should be taken preferably within a one- to two-week period. This is likely not feasible due to the large number of wells in the Subbasin, and the GSAs will strive to measure wells in a four-week period for semi-annual monitoring to be taken in the First and Fourth quarters. In addition, where water quality and funding allows, individual GSAs may install data loggers in wells, most likely in dedicated monitoring wells and a select subset of existing wells.
- If a vacuum or pressure release is observed, then water level measurements will be measured every five minutes until they have stabilized.
- In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified by measuring the well to double-check the measurement. If there is a reason that the person measuring the well can determine for why the measurement is inconsistent, it will be noted.
- For water quality monitoring (if or when the GSAs perform water quality sampling), field parameters for pH, electrical conductivity, and temperature will only be collected when required for the parameter being monitored. Determining if a well has been purged

adequately may be ascertained by calculating a run time before sampling. For irrigation wells, samples will be taken when the well has been running for a minimum of one day to ensure an adequate purge volume has been removed.

5.3 Representative Monitoring

> **23 CCR §354.36** *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…*
> *(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.*

DWR has referred to representative monitoring as utilizing a subset of sites in a management area. The GSP has developed a monitoring network of RMS wells where MOs, MTs and interim milestones are defined. Groundwater conditions can vary substantially across the Subbasin and the use of a small number of representative wells in the Subbasin is not practical to cover such a large area with varying conditions. The network will strive to fill data gaps with existing wells that have well construction information and historical groundwater level data. Proposed monitoring sites may include clustered wells, if existing wells cannot be identified and used, that will be able to provide data for different aquifer zones at a single location.

The GSP does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage change estimation, but the groundwater elevation monitoring will not replace or be used as a proxy for storage change estimations.

The GSAs believe that the distribution of existing subsidence monitoring points coupled with the regional-based subsidence mapping sufficiently covers the Subbasin, initially, and that the two CGPS locations are generally located in potentially viable subsidence RMS locations.

5.4 Assessment and Improvement of Monitoring Network

> **23 CCR §354.34(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.*

This section reviews and evaluates the adequacy of the monitoring network, identifies data gaps, and describes methods to fill data gaps.

5.4.1 Groundwater Levels

5.4.1.1 Monitoring Frequency and Density

The CASGEM Groundwater Elevation Monitoring Guidelines (DWR 2010) were used to estimate the density of RMS wells needed for the Subbasin per the DWR's Best Management Practices for the Sustainable Management of Groundwater - Monitoring Networks and Identification of Data Gaps (DWR 2016e). The Subbasin GSAs collect water level data from more wells than the density requirements for RMSs as discussed below. The density of RMS wells outlined here is meant to meet the density requirements in the DWQ Best Management Practices for the Sustainable Management of Groundwater - Monitoring Networks and Identification of Data Gaps (DWR 2016e), but data will continue to be collected from the various networks at higher densities needed to prepare groundwater contour maps. As feasible, the GSAs will continue to add additional wells either as RMSs or as wells monitored as part of existing monitoring networks in order to increase the amount of data available to prepare groundwater contour maps.

CASGEM guidelines (DWR 2012) reference the Hopkins and Anderson (Hopkins 2016) approach which incorporates a relative well density based on the amount of groundwater used within a given area (DWR 2016e). The densities range from 1 well per 100 square miles to 1 well per 25 square miles, based on the quantity of groundwater pumped. A minimum density of 1 well per 25 square miles is recommended for basins pumping over 10,000 AF of groundwater per year per 100 square miles. Groundwater use varies throughout the Subbasin with many areas currently exceeding 10,000 AF/year per 100 square miles. As a result, a well density of approximately 1 RMS well per 25 square miles will be used. For this evaluation, well density is tracked per 36-square mile Township, which results in about 1.5 wells per Township. A more practical value of 2 wells per Township per aquifer zone is adopted resulting in a density of about 1 RMS well per 18 square miles. The RMS well density above the A-Clay and in areas of shallow groundwater outside of the A-Clay is recommended to be 1 well per Township because groundwater use is estimated to be less than the amount needed for a 2 well per Township density. Areas that have little to no pumping (de-designated areas or poor strata for groundwater production in the Tulare Lakebed area; reference Section 3.1.7.2, *Water Quality Method*, for more information), may have 0 to 1 well per Township. In general, each proposed RMS monitoring site, assuming a dedicated monitoring well is constructed if an existing well cannot be found for a given aquifer zone, will include monitoring above the A-Clay (where it is present and is used as a major water source), and above and below the Corcoran Clay where it is present. When economically feasible and practical, and existing wells cannot be identified for use, dedicated monitoring wells will be installed. Continuous data loggers are recommended at dedicated monitoring wells to record short-term, seasonal, and long-term trends. It should be noted that the use of data loggers in areas of the Subbasin that have poor groundwater quality can be problematic and use of data loggers (or the continued use) will be evaluated on a case-by-case basis.

Monitoring sites include RMS wells, which are defined as wells with reliable access in the First and Fourth Quarters each year, known information on the well depth and perforated interval (or the GSA is reasonably certain of which aquifer zone a given wells is perforated in), and have adequate depth to accommodate seasonal fluctuations. Wells that do not meet these guidelines will be maintained in the network as monitoring locations, as they can still provide useful information. Well construction information on these wells may be obtained in the future, and assigned to a specific aquifer zone, if applicable. Regardless of the how these wells are constructed, water level data will continue to be collected in them to continue the record and provide valuable operational information for the well owner.

If more frequent data collection is required to demonstrate progress toward sustainability; monitor impacts to beneficial use of groundwater; monitor groundwater levels more closely; and/or quantify annual or seasonal changes in groundwater conditions, then the GSAs will re-evaluate the monitoring network and make changes as appropriate. One of the main methods to obtain more frequent water level and certain water quality parameters is by the use of data loggers. Data loggers will be deployed on a case-by-case basis as evaluated by the GSA. Data loggers, when they work successfully, can provide valuable data to evaluate short-term, seasonal, and long-term trends. Use of data loggers can also reduce the number of manual measurements needed to develop meaning full-seasonal, short-term and long term trends. The data collected from the RMS wells will be compiled into a single database to assist with regional evaluations, be a subset of the data used to prepare groundwater contour maps, assess groundwater flow, and for annual reporting. Data will also be shared with adjacent subbasins as data sharing agreements are developed to provide data to evaluate boundary flow conditions.

Groundwater levels will be measured in the First Quarter (January through February) and the Fourth Quarter (October through December) of each year. Winter measurements are designed to capture the recovery of groundwater levels after a seasonal period of minimal demand. The Fall measurement would capture a period after peak irrigation and summertime peak urban demands have declined, thereby showing the cumulative impacts on the groundwater basin before the seasonal Winter and Spring recovery has taken place.

5.4.1.2 *Identification of Data Gaps*

> **23 CCR §354.38** *(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:*
> *The location and reason for data gaps in the monitoring network.*
> *Local issues and circumstances that limit or prevent monitoring.*

Temporal Data Gaps

Some of the current wells used for data collection have not been measured consistently year after year, and therefore, temporal data gaps exist ranging from one year to over a decade. The GSAs designed a data collection program which assures semi-annual data collection. The GSAs' future monitoring efforts will increase the reliability of groundwater level readings given their importance to active management and compliance documentation. If a water level reading cannot be taken at a given well, the reason will be documented. The individual GSAs will determine if or when additional attempts will be made to collect that data. Temporal adjustments may be made for the different aquifer zones or in certain areas. For example, semi-annual water level reading above the A-Clay wells is probably sufficient to capture seasonal and long-term trends in most of that aquifer zone because water levels in the aquifer are relatively stable in most of the area. Near the Kings River it may be desirable to collect more frequent data from above the A-Clay to better understand the relationship between the river and shallow groundwater. As well, in areas where there is more pumpage from below the E-Clay, it may be desirable to collect data more frequently due to relatively rapid changes in head pressure in confined aquifers. More frequent data may also be needed from the aquifer above the E-Clay in areas where it is the main aquifer that wells are perforated in. The need to collect more frequent data and from which aquifer zone will be evaluated by the individual GSA.

Spatial Data Gaps

Currently, there are spatial data gaps throughout the Subbasin. Spatial data gaps are primarily in the southern/southwestern region of the Subbasin where groundwater is not used due to poor water quality, and in the lakebed area due to lack of productive strata and poor water quality. These areas are delineated as Management Area A and Management Area B (Figures 5-1 to 5-5). Consequently, groundwater levels are unknown for most of this area and minimal monitoring sites are proposed there to fill this data gap, since groundwater is not a resource that needs to be managed in this area to the benefit of the overlaying landowners. There are active wells east of the lakebed clay plug, and RMS wells are located in these areas. In other areas of the Subbasin, data gaps are primarily due to the lack of known well construction. There are also spatial data gaps in the northern portion of the Subbasin, primarily related to well distribution in the various aquifer zones (Figures 5-1 to 5-3). Since the aquifer above the A-clay is not used as a primary water source in most of the Subbasin, the spatial coverage does not have to be as dense as the more heavily pumped portions of the aquifer (B zone and C zone).

Insufficient Quality of Data

Currently, most of the wells monitored in unincorporated areas are privately owned. Specific well construction information, including depth and perforated interval, are not known for most of these wells. While these wells may not provide ideal data points, they will continue to be monitored even if well construction data is collected which indicates the well is a composite well (perforated across multiple aquifer zones in the Subbasin usually across the Corcoran clay). Many well owners and water management agencies find this data relevant to their operations, and while these wells may not be compliant for SGMA reporting, data will continue to be collected from them. Collecting well construction information is especially important throughout the Subbasin which is underlain, to a large extent, by the Corcoran clay layer and other smaller aquitards; therefore, knowing a well's construction is needed even though the aquifer zone it is perforated in can often be determined based on groundwater elevation. However, it is still desirable to know a well's construction, and if a Well Completion Report (WCR) is not available, other methods, including television (TV)/video surveys or sonic logs can be used to determine well construction. Once a well's construction is known, the aquifer zone(s) it is perforated in can be confirmed. When funding permits and an existing well cannot be found to monitor a specific aquifer zone, dedicated monitoring wells will be installed at targeted depths and perforated intervals to fill spatial data gaps.

5.4.1.3 Plans to Fill Data Gaps

23 CCR §354.38(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.*

The RMS groundwater level network has data gaps, such as missing construction or partial construction information for some RMS wells. The goal is to have accurate well construction information for RMS wells monitored for groundwater level that currently lack construction information within 5 years of plan implementation if possible. Well construction information will be needed for at least 5 existing A zone wells, 1 existing B zone well and 7 existing C zone wells. As well, as shown on Figures 5-1 to 5-3 there are 3 A zone data gaps areas, 13 B zone data gaps areas, and 18 C zone data gaps areas that need to be filled to achieve the RMS well density of 2 wells per Township for the B and C aquifer zones, and one well per Township density in the A zone. The GSAs prefer to fill these data gaps areas with existing wells, if possible, but will construct dedicated monitoring wells as funding becomes available. These data gaps can be filled using the four alternatives below:

- **Collect Well Completion Reports.** WCRs will provide the needed information if a WCR can be positively linked to a well. These could be collected from the landowner or DWR; however, several challenges exist since so many have been drilled in the area and location information in the reports can be inaccurate. However, WCRs for private wells may not always be available to the GSAs.
- **Perform a video inspection of wells to obtain construction information.** A video inspection or TV survey can be performed on desired wells to determine the total depth and perforated interval. Video inspections can be performed when the pump is pulled for other reasons. As well, the GSAs can work with well owners to obtain existing videos or TV surveys. Recognize that video inspection would not provide information on the aquifer material.
- **Construct a dedicated monitoring well:** Dedicated monitoring wells are relatively expensive to construct, and their installation will depend on available funding. Dedicated monitoring wells will only be constructed if an existing private well cannot be found.
- **Replace monitor point with another alternate private well:** Private wells without construction information could be replaced with another existing well with available well construction information. This may be simpler and less costly than a video inspection. However, changing monitoring well locations is not always desirable, since it is preferred to continue measurements in wells that have a long period of record (i.e., many years of groundwater level data).

For those GSAs that do not have known construction for some of the wells in their RMS monitoring networks, they will either collect construction information on half of the wells lacking well construction information by 2025, and the remaining half by 2030, or will fill the gaps with monitoring sites with complete data. The proposed dedicated monitoring wells, if an existing well cannot be found, will be nested (multiple casings installed in a single borehole) or clustered monitoring wells (multiple wells located close together). It is probable that with the recommended casing diameters, most multi-depth zone monitoring wells will need to be clustered as opposed to nested. This allows for monitoring groundwater levels at different aquifer zones at a single location or in close proximity to each other for clustered wells.

In the event that an existing RMS well becomes unavailable for water level monitoring, existing wells that monitor the same aquifer zone will need to be found and added to the network, or a dedicated monitoring well will need to be constructed. As well, an individual GSA may decide to continue to collect well construction information and permission to monitor additional wells so that the water level monitoring network has redundant wells that meet the criteria for an RMS well. GSAs that develop and maintain a working list or an inventory of wells available for monitoring may choose to add these as RMS wells to increase RMS density. Water levels will be collected in these wells during the semi-annual water level monitoring events so that if an existing RMS well is no longer available for monitoring, an alternate well is readily available for use in the RMS water level network. Developing an inventory of wells additional to the RMS wells, and whether or when to add these wells to the RMS water level network will be decided by the individual GSAs.

5.4.1.4 Site Selection

23 CCR §354.34(g) *Each Plan shall describe the following information about the monitoring network:* *(1) Scientific rationale for the monitoring site selection process.*

The scientific rationale for the groundwater level monitoring network includes the following:

- Existing wells with known construction information were preferentially selected for RMS wells.
- Other wells have over 20 years of water level data and are useful for long-term evaluations even though they may reflect multiple aquifer zones. These wells will continue to be monitored as this information is important to users of groundwater.
- The RMS network density follows the guidelines from DWRs' Best Management Practices for the Sustainable Management of Groundwater - Monitoring Networks and Identification of Data Gaps (DWR 2016e) to determine the RMS density.

The following scientific rationale will be used to add new RMS wells:

- Add wells, whenever necessary to maintain a minimum RMS monitoring well density (1 well/18 square miles) where groundwater pumping exceeds 10,000 AF/year per 100 square miles, and/or to augment current monitoring sites.
- Avoid wells perforated across multiple aquifer zones for RMS wells, especially wells underlain by the Corcoran clay and/or the A-Clay.
- Select wells which have access in both Winter and Fall seasons, preferably wells which do not have gates or access issues.
- Select sites for dedicated monitoring wells as far as possible from existing active wells.
- Active wells are preferred over idle or unused wells, or dedicated monitoring wells.
- Select wells with available construction information (i.e., depth, perforated interval).
- Select existing wells over constructing monitoring wells where feasible.

If data for a specific monitoring site is lacking, other wells in the vicinity which have the desired attributes, if available, can be added to increase the monitoring network's scope and breadth.

Figures 5-1 through 5-3 show existing RMS wells and areas that need additional RMS wells to fill data gap areas. As mentioned above, the GSAs will endeavor to fill data gaps with existing wells that meet the criteria above for an RMS monitoring point or will construct dedicated monitoring wells if funding is available.

5.4.2 Groundwater Storage

Groundwater storage change will be calculated using groundwater level contour maps from Spring to Spring of successive years. Groundwater storage calculations are largely dependent on the groundwater level monitoring network. Collection of well attribute information described above will also benefit groundwater storage change evaluations. In addition, groundwater stored in clays susceptible to aquifer compaction is released from storage when these materials subside. Therefore, data collected from the land subsidence monitoring network will be evaluated annually to provide estimates of the amount of water released from storage due to aquifer compaction.

5.4.2.1 Monitoring Frequency and Density

Annual groundwater storage changes by each GSA will be calculated so individual GSAs can evaluate progress towards meeting MOs. The data used to estimate storage change will be the water level data collected from the water level networks. This data will be collected, as mentioned above, at a minimum every First and Fourth Quarter. In addition, also as discussed above, the GSAs will continue to collect data at more wells than the RMSs. This additional data will be used in conjunction with data from the RMSs to prepare groundwater contour maps which are then used to estimate storage change. The individual GSA storage change information will be aggregated for reporting to the DWR for the Basin as a whole.

5.4.2.2 Identification of Data Gaps

The most significant data gaps in the groundwater storage change monitoring network include:

- Groundwater levels from wells with known construction along the Subbasin boundary that could better characterize groundwater flows in and out of the Subbasin, especially in the B and C zones;
- Shallow groundwater level data near rivers, creeks, and canal systems to characterize recharge;
- Information on well construction related to understanding groundwater pumpage from the different aquifer zones;
- The amount of groundwater being released through subsidence and how that relates to changes in groundwater storage; and
- Aquifer characteristics of storativity, specific yield, and hydraulic conductivity/ transmissivity to better define the amount of groundwater in saturated aquifers, annual storage change, and boundary flows.

Other data gaps in the groundwater storage network are the same as in the groundwater level monitoring network, as described above, since storage change is dependent on changes in groundwater levels.

5.4.2.3 Plans to Fill Data Gaps

Data gaps in the storage change monitoring network will be filled as data gaps in the groundwater level network, as discussed in Section 5.2, *Monitoring Protocols for Data Collection and Monitoring*, are filled.

- **Groundwater Pumping.** There are areas of the Subbasin where not all wells have flow meters and, therefore, no record of the amount of groundwater pumpage exists. The estimates of groundwater pumping included in this GSP, in many areas, are developed based on assumptions of how much crops require for ideal irrigation and then subtracting out effective precipitation and applied surface water. GSAs in the Subbasin plan to monitor groundwater pumping directly in the future to better understand this key water balance component. Also, the lack of construction information on many wells has led to a gap in understanding how much water is being pumped from each aquifer zone. Currently estimates are being used by the GSAs, but only after the construction of wells in the Subbasin is understood, then the amounts being pumped from each aquifer zone can begin to be managed.
- **Coordination with Adjacent Subbasins.** The Subbasin is surrounded by five other critically overdrafted subbasins. Coordination with adjacent subbasins and the development of additional groundwater level monitoring facilities will be needed along the edge of the Subbasin to more accurately estimate the amount of groundwater flow in and out of the subbasins. From the groundwater modeling evaluations, it is clear that if conditions in adjacent subbasins don't improve significantly, it will impact the ability of the Subbasin to achieve sustainability.
- **Recharge/Conveyance Loss Measurements.** There are many surface water right holders in the Subbasin that are partnering with local GSAs. The current measuring facilities on rivers, creeks and canals have been developed for surface water delivery and flood control purposes. Developing new measuring locations in order to refine information on recharge and conveyance losses will be important for water budgets and change in storage estimates. Local GSAs will work with their partners to develop new facilities as needed.
- **Aquifer Characteristics.** Significant assumptions are currently being made about the specific yield or storativity of aquifers in the Subbasin. The GSAs will implement requirements relating to the development of new wells to develop a broader understanding of the variability of aquifer parameters throughout the Subbasin. This broader understanding will over time help refine estimates of groundwater in storage and groundwater flows.
- **Geology.** The current conceptual model for the Subbasin is based on the most current scientific information, but that information is limited. Much of the work that USGS and

others have done on mapping the most significant geologic/hydrogeologic features in the Subbasin are from evaluations of oil wells or water wells. Data from these wells, especially electronic logs, are useful in developing understanding of the subsurface at that location, but these data may not be available at a sufficient density to fill gaps in the Hydrogeologic Conceptual Model for an area of over half a million acres. New technologies like SkyTEM and others may be able to fill in some of the missing information and provide a more accurate or complete conceptual model for the Subbasin. It is hoped that grant funding may be available for this type of effort or that the state develops this information on behalf of its groundwater basins to improve its understanding of this important resource.

5.4.2.4 Site Selection

The site selection process for wells in the storage change monitoring network used the same criteria as the groundwater levels monitoring network. As well, the same criteria as additionally outlined in Section 5.1.3, *Design Criteria*, will be used to add additional wells into the storage change monitoring network as the water level monitoring network is the same.

5.4.3 Water Quality

Though water quality has been periodically analyzed within the Subbasin for irrigation suitability, monitoring programs are generally not in place with defined temporal and spatial distribution, except for municipal water suppliers, RWQCB sites with WDRs, and monitoring at evaporation ponds. South of Stratford and Corcoran, groundwater quality diminishes, and portions of the Tulare Lakebed have been de-designated as not suitable for municipal, domestic, agricultural irrigation, and stock watering supply (RWQCB 2017). The primary constituents of concern for the de-designated areas included boron, chloride, sodium, salinity (electrical conductivity), and total dissolved solids (RWQCB 2017).

Prior to amendment of the Water Quality Control Plan for the de-designation of MUN and AGR use of groundwater in areas of poor water quality in the Subbasin, characterization studies were conducted to evaluate the potential for the migration of poor water quality from the de-designated areas or the capture of poor quality water by wells near the de-designated area (KDSA et. al. 2015). The results of these characterization studies are summarized in RWQCB Resolution R5-2017-0032 as follows: basin-wide groundwater flows to the center of the Tulare Lakebed, poor water quality is present in a shallow saline aquifer above the Corcoran Clay, and better water quality is present in the aquifer located below the Corcoran clay.

A zone-of-capture analyses was also completed that determined if areas outside of the proposed de-designated areas could extract groundwater from within the de-designated area. The results indicated that wells near the horizontal boundary would not draw water from within the proposed de-designated area nor influence groundwater flow direction (RWQCB 2017b). The characterization studies and the zone-of-capture analyses confirmed that no active wells in the fringe areas will draw water within the proposed de-designation area zone nor be impacted by groundwater from within the proposed de-designated zone.

The State Water Resources Control Board (SWRCB) Staff Report, issued April 2017, states that, "although no new monitoring or surveillance is being proposed as part of the current BPA, this section describes two elements that would pertain to new projects and changes to existing discharge drainage patterns which may be proposed within the proposed de-designated area to determine whether these discharges to the de-designated area may cause or contribute to beneficial uses not being met outside the of the de-designation boundary." The RWQCB identified two monitoring elements that may be triggered by future projects in the de-designated area. These are Monitoring Element A and Monitoring Element B. Monitoring Element A would be triggered if new projects and changes to the existing discharge drainage patterns may be proposed along the periphery of the de-designated boundary, and Monitoring Element B addresses all other new projects proposed within the interior of the de-designated area. For proposed new projects, the Central Valley RWQCB has the discretion to require monitoring if available information indicates that such monitoring is necessary and appropriate to protect beneficial uses.

A more detailed groundwater quality assessment for the Subbasin is provided in Section 3.2.5, *Groundwater Quality*.

5.4.3.1 Monitoring Frequency and Density

As mentioned above, the GSA(s) desire to use existing groundwater quality sampling programs for tracking of groundwater quality. Figure 5-4 shows the relative density of groundwater quality well locations. The monitoring frequency is dependent on those existing monitoring schedules. In general city/municipal wells are sampled quarterly but the frequency of sampling can vary significantly for different constituents and can also vary considerably from well to well. Sampling schedules for city/municipal and other community system wells are determined by the SWRCB Division of Drinking Water. The KRWQC-ILRP samples annually. Data, reports, and/or pertinent evaluations from the various programs will be retrieved annually.

5.4.3.2 Identification of Data Gaps

There are currently no data gaps in monitoring water quality within the Subbasin. Additional monitoring will be triggered through evaluation of the existing data from the agencies and coalitions, and in conjunction and collaboration with the agencies or coalitions, on a case-by-case case basis.

5.4.3.3 Site Selection

Groundwater quality monitoring site selection is driven, in part, by the location of city/municipal and other community wells locations. As well, the KRWQC-ILRP has several well locations north of the clay plug. At this time, the Subbasin GSA(s) are proposing not to sample for groundwater quality in de-designated areas which includes Management Areas A and B. Locations of future groundwater quality sampling will likely be from monitoring wells that are constructed with funds from a state or federal programs in data gap areas. As described above, the Subbasin GSA(s) would like to work collaboratively with the agencies currently performing groundwater quality monitoring.

5.4.4 Land Subsidence

The Subbasin land subsidence monitoring network will utilize data and subsidence evaluations by a variety of agencies including USGS, DWR, KRCD, KDWCD, NASA, UNAVCO, and CVSRN to verify areas of subsidence. If data from these sources becomes unavailable in the future, a new or expanded monitoring network will be established to monitor land subsidence. The agencies and methods used for measuring subsidence are discussed below.

5.4.4.1 USGS Monitoring Network

A land subsidence monitoring network consisting of 31 extensometers was installed in the 1950s to quantify subsidence occurring in the San Joaquin Valley. This monitoring did not target the Tulare Lakebed area, even though it is one of the areas in the valley experiencing the greatest subsidence. By the 1980s, the land subsidence monitoring efforts decreased. Since then, a new monitoring network has been developed. The new network includes refurbished extensometers from the old network, CGPS stations, and use of Interferometric Synthetic Aperture Radar (InSAR). The USGS network does not have an extensometer in the Subbasin. Below is a description of the various methods used in the USGS Monitoring Network.

- **Extensometers.** Extensometers measure changes in the length of an object. As the surrounding soils move, or in the case of land subsidence fine grained soils compact, the distances between reference points change, which allows for continuous measurement of subsidence. Extensometers provide data for specific depth intervals in the subsurface where compaction of clays is occurring as well as the amount. These data are considered necessary to enable future predictions and mitigation of land subsidence. Extensometers are costly to install and require frequent maintenance and calibration.

- **InSAR.** During the last decade, the USGS and other groups have been using data from radar emitting satellites referred to as InSAR. This form of remote sensing compares radar images from each pass of an InSAR satellite over a study area to determine changes in the elevation of the land surface (USGS, 2017). InSAR has a relative accuracy within fractions of an inch.
- **LiDAR.** DWR and USBR utilize LiDAR coupled with land elevation surveys to monitor subsidence. LiDAR utilizes a laser device that is flown above the Earth's surface. The accuracy of LIDAR is known to be less than a tenth of a foot as measured in root-mean-square deviation and very similar to that of surveying.

NASA Monitoring Network

NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, InSAR observations from satellite and aircraft have been used to produce the subsidence maps (NASA n.d.). More information can be found on the California Open Data Portal under NASA JPL InSAR Subsidence Data (California Open Data Portal 2019).

Continuous Global Positioning System Stations

The CGPS stations provide daily horizontal and vertical data, with records starting as early as 2004. One CGPS station is located south of Kettleman City. The Plate Boundary Observatory (PBO) and the Scripps Orbit and Permanent Array Center (SOPAC) upload and process data from the network of CGPS stations and produce graphs depicting the horizontal and vertical change in a point's location through time. More Information on CGPS stations can be found at the UNAVCO website (UNAVCO 2019).

Central Valley Spatial Reference Network

The California Department of Transportation's Central Region has developed a network that is comprised of CGPS stations that are permanently in place and operate continuously. These stations are known as the CVSRN. The network has stations along highway corridors to provide real time corrections for surveyors and data that can also be post-processed as well. Two CVSRN stations are located within Subbasin near Corcoran and Highway 43, and Lemoore and Highway 198. In addition, PBO CGPS stations will be included in the CVSRN network in the future. The network was not designed to monitor subsidence, but the network is used by a variety of disciplines which benefit from the data collected at the stations (Caltrans 2019).

Kings River Conservation District

KRCD has a 7-mile grid that monitors new and existing benchmarks for land subsidence. Figure 5-5 shows the locations of the benchmarks in their monitoring system (Theide 2016).

Kaweah Delta Water Conservation District

KDWCD has a subsidence monitoring program with one benchmark monument in the Subbasin in the Mid-Kings River GSA (Figure 5-5). KDWCD surveys the benchmark monuments twice a year in February and September.

5.4.4.2 Monitoring Frequency and Density

The subsidence monitoring network is surveyed annually in the Subbasin. Subsidence change will generally be reported by GSA. Subsidence occurs on a regional scale with varying degrees occurring throughout the Subbasin.

5.4.4.3 Identification of Data Gaps

There is presently no known depth-discrete subsidence monitoring facilities (i.e., extensometers which can measure subsidence in specific portions of the aquifer) within the Subbasin. It is believed that the vast majority of subsidence occurs from compaction of clays from the confined portion of the aquifer beneath the Corcoran clay. However, extensometers would provide the data needed to differentiate subsidence at specific depth intervals. These data are needed to validate which portions of the aquifer are experiencing the most subsidence in order to determine the mitigation needed to address the subsidence. In addition to the regional-based LiDAR/InSAR subsidence maps, the groundwater model developed for the Subbasin has previously been used as a tool to estimate where subsidence may occur in the future as the GSAs determine where projects will be implemented and if pumping patterns change in the future. Westside, Kern County, and Tule subbasins have extensometers that are monitored by the USGS. Extensometers have a relative accuracy of approximately 1/100th of a foot and can provide information on which part of the aquifer is subsiding. When funding permits, proposed depth-discrete subsidence monitoring extensometers, in the vicinity of Lemoore and Corcoran or where subsidence is greatest, are necessary to evaluate depth-discrete subsidence, as measured by the other state and federal agencies, and provide information on which portions of the aquifer may be subsiding. Until depth-discrete monitoring becomes possible, the GSAs will pursue information on surface subsidence, groundwater pumping per well, surveys of well head elevations as needed, aquifer characteristics, and well construction to develop a scientific view of the zones and areas that can be managed to avoid subsidence.

5.4.4.4 Site Selection

Land subsidence in the Subbasin is monitored through agency and government land subsidence surveying programs. The data generated by these programs are considered adequate both spatially and temporally as InSAR/LiDAR mapping covers the entire Subbasin, and because the area is closely monitored due to the high subsidence rates. However, individual GSAs may develop subsidence monitoring programs as needed that may include surveys of wells, and potentially, measurement of pumping water levels in deep wells in known subsidence areas. The regional InSAR/LiDAR maps will be used to identify these areas.

If additional monitoring locations are added, such as the proposed extensometers, the following scientific rationale will be used:

- Add benchmark sites that can be easily accessible, surveyed, and tied back to a nearby monument.
- Add sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed.

5.5 Data Storage and Reporting

23 CCR §352.6 *Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.*

Monitoring programs are coordinated within the Subbasin. Well location, construction, and groundwater level data are shared or will be shared amongst the different GSAs. In addition, the monitoring programs described in this Chapter were reviewed by the GSAs, and they are consistent throughout the Subbasin. Similarly, data reported to DWR will be collected and reported in a consistent format.

This section will describe the Data Management System (DMS) once it has been developed for the GSP. A DMS is a software application that manages data storage and retrieval in a secure and structured environment. The DMS will include clear identification of monitoring sites for the different Sustainable Management Criteria and a description of the quality assurance and quality control checks to be performed on the data. The DMS for the Subbasin shall be secure and easily accessible to stakeholders to enter data and generate reports. Standardized data templates will help stakeholders organize their data so that it transfers to the DMS efficiently to reduce the amount of time spent on data entry and quality control.

The DMS shall also allow for upload and storage of information related to the development and implementation of the GSP, including, but not limited to:

- Unique well and site information
- Groundwater elevations
- Surface water delivery
- Land surface elevations
- Groundwater quality
- Precipitation

- Estimates of pumping

GSP development and implementation will depend on the DMS's ability to support GSP development and implementation activities.

The rest of this section to be prepared at a later date after the GSA has prepared a comprehensive Data Management System. DWR has also stated that they will provide further guidance on this topic, possible in the form a Best Management Practices Report, but it has not been released as of June 2018.

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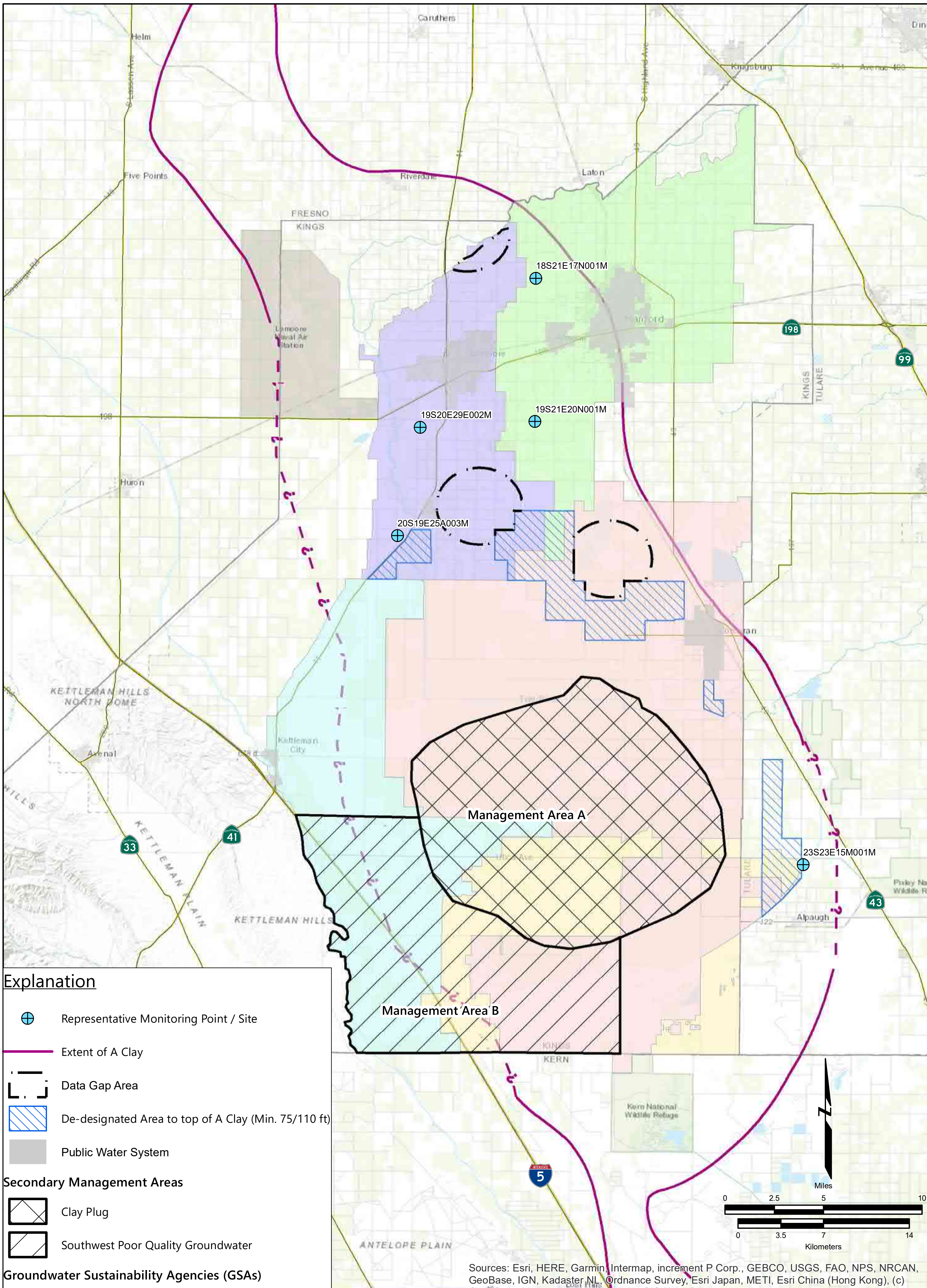

Explanation

- Representative Monitoring Point / Site
- Extent of A Clay
- Data Gap Area
- De-designated Area to top of A Clay (Min. 75/110 ft)
- Public Water System

Secondary Management Areas

- Clay Plug
- Southwest Poor Quality Groundwater

Groundwater Sustainability Agencies (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Notes:
A Clay extent adapted from USGS Water-SupplyPaper 1999-H, Plate 6, Croft (1972). See Section 3.1.8.3.

Above A Clay and Shallow Groundwater Level Representative Monitoring Network, Zone A

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/26/2019	Project No.: FR18161220
		Figure **5-1**

Date: 8/26/2019 Printed by: elizabeth.chapman
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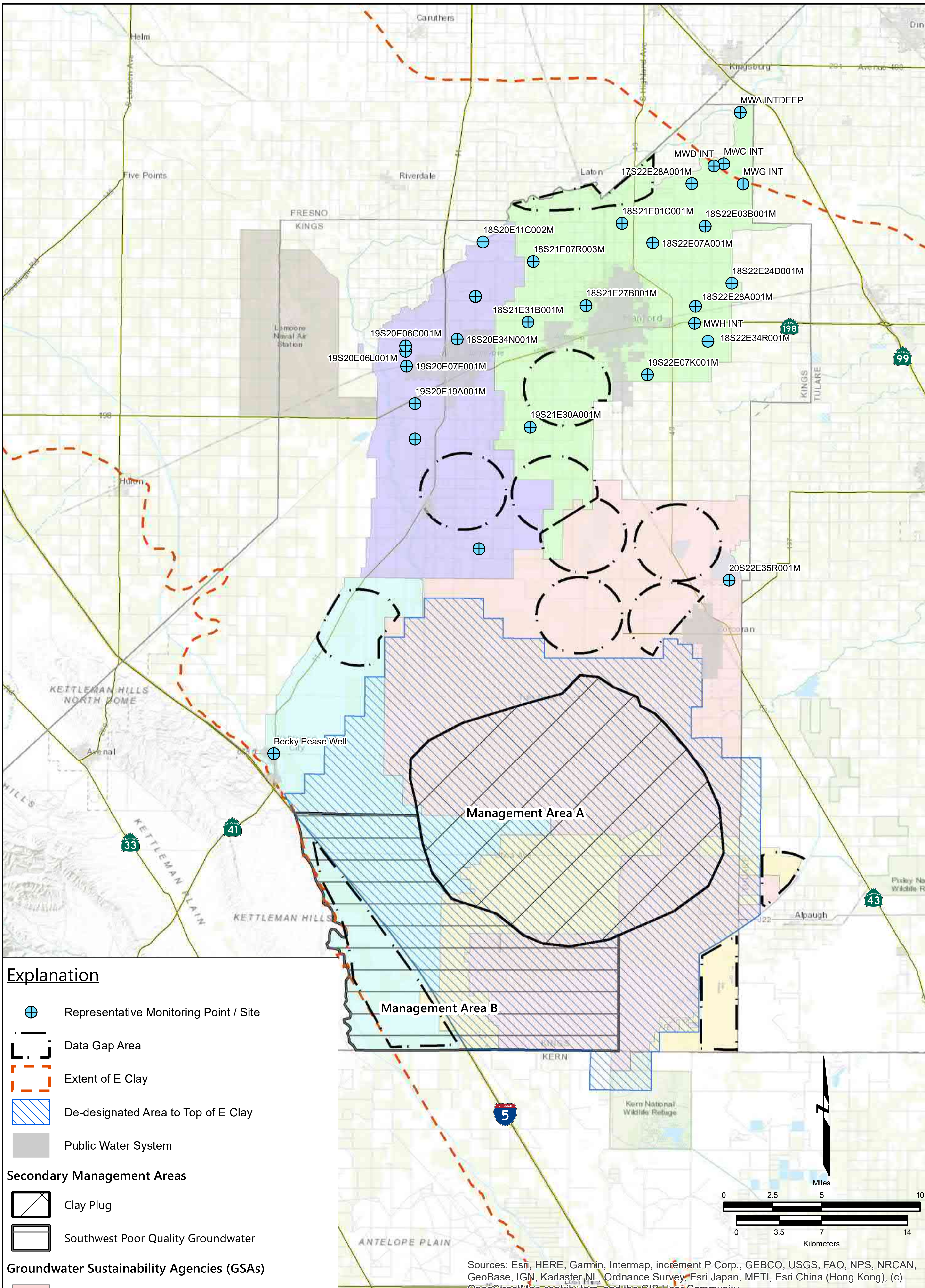

Above E Clay Groundwater Level Representative Monitoring Network, Zone B

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC | Date: 8/26/2019 | Project No.: FR18161220

Figure 5-2

Notes:
E Clay extent from USGS CVSD (2012). Based on Page (1986). See Section 3.1.8.3.

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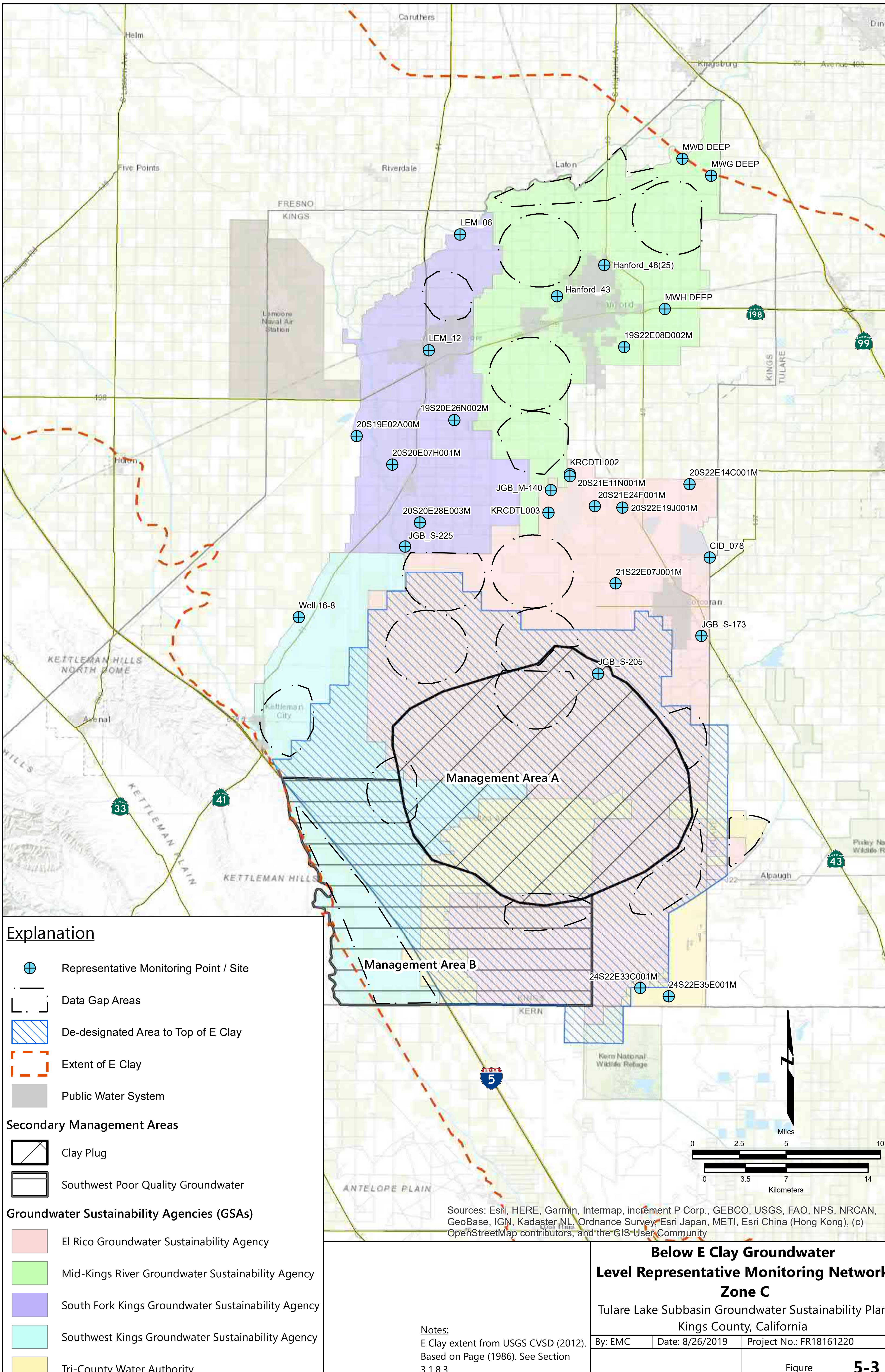

Notes:
E Clay extent from USGS CVSD (2012). Based on Page (1986). See Section 3.1.8.3.

Below E Clay Groundwater Level Representative Monitoring Network, Zone C

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/26/2019	Project No.: FR18161220

Figure **5-3**

Date: 8/26/2019 Printed by: elizabeth.chapman
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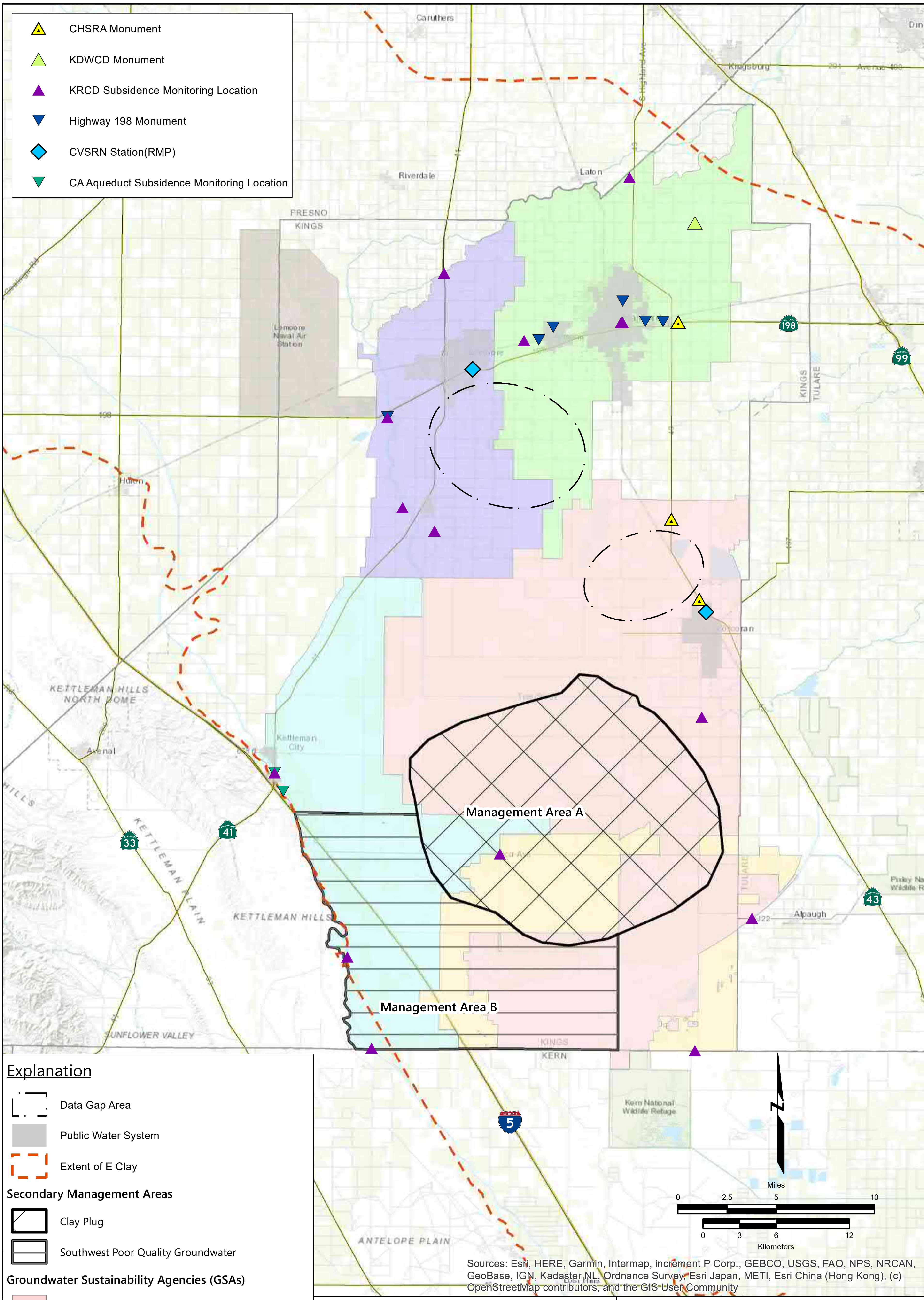

Notes:
E Clay extent from USGS CVSD (2012). Based on Page (1986). See Section 3.1.8.3.

Subsidence Monitoring Network
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/26/2019	Project No.: FR18161220
		Figure **5-4**

Date: 8/26/2019 Printed by: elizabeth.chapman
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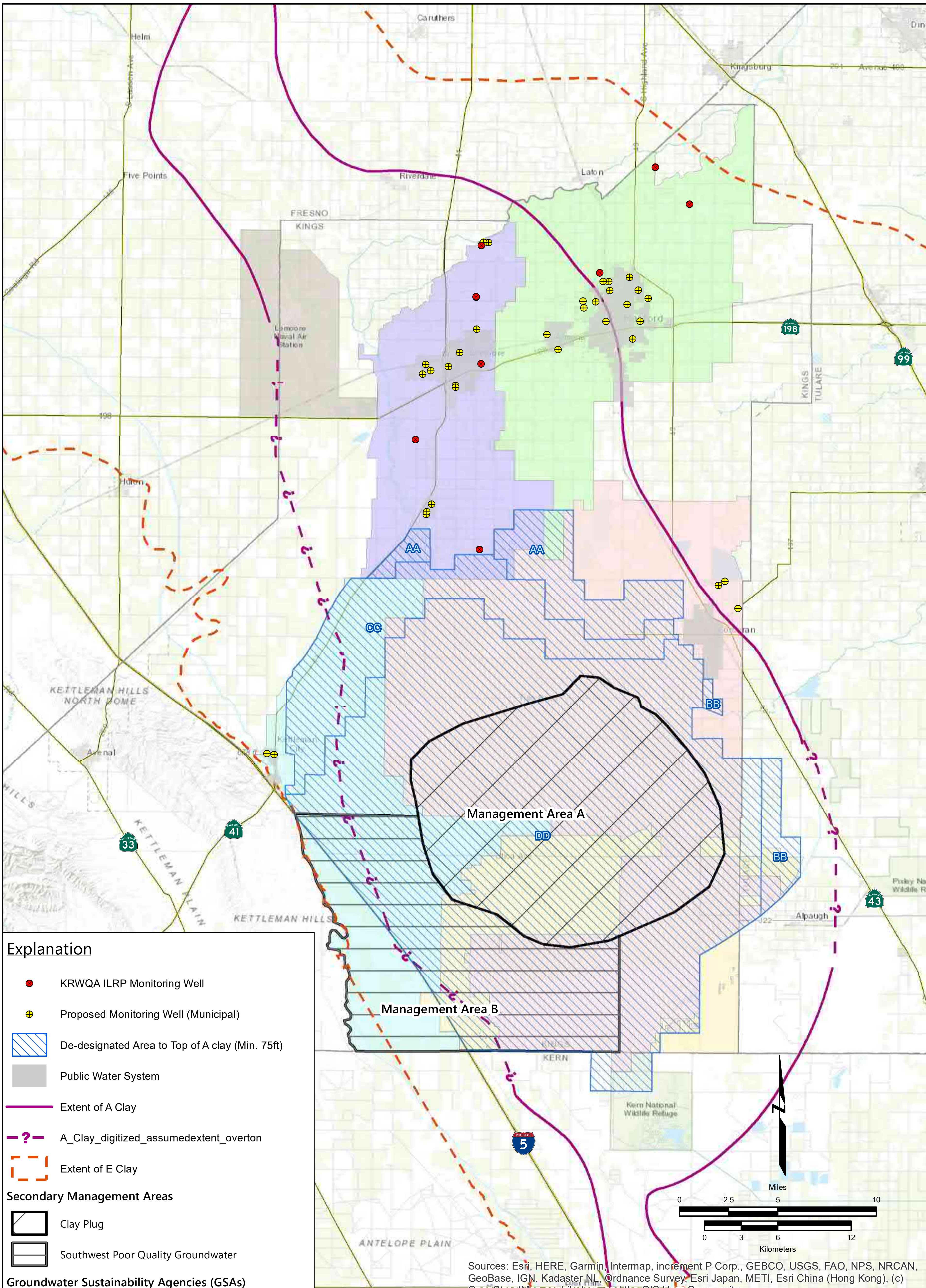

Notes:
A Clay extent adapted from USGS Water-SupplyPaper 1999-H, Plate 6, Croft (1972). See Section 3.1.8.3.

E Clay extent from USGS CVSD (2012). Based on Page (1986). See Section 3.1.8.3.

Groundwater Quality Monitoring Network
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 8/26/2019	Project No.: FR18161220
		Figure **5-5**

Table 5-1. Summary of Existing & Proposed Representative Monitoring Network Sites

Existing RMP Network	WL	WQ	LS
Mid King River GSA	22	18	11
South Fork King GSA	21	21	6
Southwest Kings GSA	2	2	4
El Rico GSA	13	3	5
Tri County GSA	3	0	2
Total	61	44	28
Proposed Additions to RMP Network	**WL**	**WQ**	**LS**
Mid King River GSA	9	TBD	0
South Fork King GSA	4	TBD	1
Southwest Kings GSA	5	TBD	0
El Rico GSA	13	TBD	1
Tri County GSA	3	TBD	0
Total	34	0	2

Table 5-2. Mid Kings River GSA: Existing & Proposed Representative Monitoring Network

	Mid Kings River GSA					Facility					
	State Well ID *(if applicable)*	Aquifer Zone	Township	Range	Section	Type	Local Agency Well ID *(if applicable)*	Existing Program	Sustainability Indicator(s)	SGMA Monitoring Frequency	Aquifer Monitored
Representative Monitoring Points	18S21E17N001M	A Zone	18S	21E	17	Unknown Use	18S21E17N001M	KCWD	WL	Semiannual	Above A Clay
	19S21E20N001M	A Zone	19S	21E	20	Unknown Use	19S21E20N001M	KCWD	WL	Semiannual	Above A Clay
		B Zone	17S	22E	1	Monitoring Well	MW-A	KCWD	WL	Semiannual	Local
	17S22E28A001M	B Zone	17S	22E	28	Irrigation Well	KRCDKCWD01	CDWR	WL	Semiannual	Above E Clay
	18S22E03B001M	B Zone	18S	22E	3	Unknown Use	18S22E03B001M	KCWD	WL	Semiannual	Above E Clay
	18S21E01C001M	B Zone	18S	21E	1	Unknown Use	18S21E01C001M	KCWD	WL	Semiannual	Above E Clay
	18S22E07A001M	B Zone	18S	22E	24	Unknown Use	18S22E07A001M	USBR	WL	Semiannual	Above E Clay
	18S22E24D001M	B Zone	18S	22E	24	Irrigation Well	18S22E24D001M	LAKESIDE IRRIGATION WD	WL	Semiannual	Above E Clay
	18S22E28A001M	B Zone	18S	22E	28	Irrigation Well	KRCDKCWD08	KCWD	WL	Semiannual	Above E Clay
	18S22E34R001M	B Zone	18S	22E	34	Residential	18S22E34R001M	KDWCD	WL	Semiannual	Above E Clay
	19S22E07K001M	B Zone	19S	22E	7	Unknown Use	KRCDKCWD11	LAKESIDE IRRIGATION WD	WL	Semiannual	Above E Clay
	18S21E27B001M	B Zone	18S	21E	27	Irrigation Well	KRCDKCWD05	KCWD	WL	Semiannual	Above E Clay
	18S21E07R003M	B Zone	18S	21E	7	Unknown Use	18S21E07R003M	CDWR	WL	Semiannual	Above E Clay
	18S21E31B001M	B Zone	18S	21E	31	Unknown Use	18S21E31B001M	KCWD	WL	Semiannual	Above E Clay
	19S21E30A001M	B Zone	19S	21E	30	Irrigation Well	KRCDKCWD06	KCWD	WL	Semiannual	Above E Clay
		B Zone	17S	22E	14	Monitoring Well	MW-C	KCWD	WL	Semiannual	Above E Clay
		B & C Zone	17S	22E	23	Monitoring Well	MW-D	KCWD	WL	Semiannual	Above/Below E Clay
		B & C Zone	17S	22E	25	Monitoring Well	MW-G	KCWD	WL	Semiannual	Above/Below E Clay
		B & C Zone	18S	22E	34	Monitoring Well	MW-H	KCWD	WL	Semiannual	Above/Below E Clay
	/1	C Zone	18S	21E	13	Municipal Well	(1610003-042) Well_48	HANFORD	WL/WQ[/3]	Semiannual	Below E Clay
	/1	C Zone	18S	21E	27	Municipal Well	(1610003-037) Well 43	HANFORD	WL/WQ[/3]	Semiannual	Below E Clay
	19S22E08D002M	C Zone	19S	22E	8	Observation	19S22E08D002M	KDWCD	WL	Semiannual	Below E Clay
Water Quality Sites	17S22E20D		17S	22E	20	Domestic Well		ILRP	WQ[/4]	Annual	
	17S22E33A		17S	22E	33	Domestic Well		ILRP	WQ[/4]	Annual	
	18S21E14M		18S	21E	14	Irrigation Well		ILRP	WQ[/4]	Annual	
			18S	21E	32	Municipal Well	1610001-008	ARMONA CSD	WQ[/3]	Annual	
			19S	21E	4	Municipal Well	1610001-009	ARMONA CSD	WQ[/3]	Annual	
			18S	21E	23	Municipal Well	1610003-031	HANFORD	WQ[/3]	Annual	
			18S	22E	30	Municipal Well	1610003-039	HANFORD	WQ[/3]	Annual	
			18S	21E	22	Municipal Well	1610003-036	HANFORD	WQ[/3]	Annual	
			18S	22E	19	Municipal Well	1610003-041	HANFORD	WQ[/3]	Annual	
			18S	21E	14	Municipal Well	1610003-033	HANFORD	WQ[/3]	Annual	
			18S	21E	25	Municipal Well	1610003-040	HANFORD	WQ[/3]	Annual	
			18S	21E	36	Municipal Well	1610003-026	HANFORD	WQ[/3]	Annual	
			18S	21E	14	Municipal Well	1610003-038	HANFORD	WQ[/3]	Annual	
			18S	21E	26	Municipal Well	1610003-028	HANFORD	WQ[/3]	Annual	
			18S	22E	19	Municipal Well	1610003-043	HANFORD	WQ[/3]	Annual	
			18S	21E	23	Municipal Well	1610003-034	HANFORD	WQ[/3]	Annual	
Land Subsidence	SUB084		NA	NA	NA	Subsidence Monument		KRCD	LS	Semiannual	All
	K021		17S	22E	34	Subsidence Monument		KDWCD	LS	Semiannual	All
	S224P2		18S	22E	28	Subsidence Monument		CHSRA	LS	Semiannual	All
	U 808		18S	22E	29	Subsidence Monument		CalTrans	LS	Semiannual	All
	U 511		18S	22E	30	Subsidence Monument		CalTrans	LS	Semiannual	All
	X 511		18S	21E	24	Subsidence Monument		CalTrans	LS	Semiannual	All
	U 157, SUB091		18S	21E	36	Subsidence Monument		KRCD	LS	Semiannual	All

Table 5-2. Mid Kings River GSA: Existing & Proposed Representative Monitoring Network (Continued)

	Mid Kings River GSA					Facility		Existing Program	Sustainability Indicator(s)	SGMA Monitoring Frequency	Aquifer Monitored
	State Well ID ***(if applicable)***	**Aquifer Zone**	**Township**	**Range**	**Section**	**Type**	**Local Agency Well ID** ***(if applicable)***				
	Hanford RM1, SUB032		18S	21E	36	Subsidence Monument		KRCD	LS	Semiannual	All
	X 931		18S	21E	32	Subsidence Monument		CalTrans	LS	Semiannual	All
	N 460 RESET		18S	21E	32	Subsidence Monument		CalTrans	LS	Semiannual	All
	SUB068		18S	21E	31	Subsidence Monument		KRCD	LS	Semiannual	All
Proposed Facilities		B Zone	17S	22E	19	Monitoring Well			WL	Semiannual	Above E Clay
		B Zone	17S	22E	27	Monitoring Well			WL	Semiannual	Above E Clay
		B Zone	19S	21E	16	Monitoring Well			WL	Semiannual	Above E Clay
		B Zone	20S	21E	8	Monitoring Well			WL	Semiannual	Above E Clay
		C Zone	17S	21E	26	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	18S	22E	3	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	18S	21E	3	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	19S	21E	8	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	19S	21E	32	Monitoring Well			WL	Semiannual	Below E Clay

Notes:

/1 Representative Monitoring Points that are also included for Water Quality

/2 Proposed monitoring areas pending funding or collaboration with DWR or USGS

/3 State Water Resources Control Board Division (SWRCB) Division of Drinking Water (DDV)

/4 Kings River Water Quality Coalition (KRWQC), Irrigation Lands Regulatory Program (ILRP), samples annually, data will be retrieved annually

Table 5-3. South Fork Kings GSA: Existing & Proposed Representative Monitoring Network

	South Fork Kings River GSA					Facility		Existing Program	Sustainability Indicator(s)	SGMA Monitoring Frequency	Aquifer Monitored
	State Well ID *(if applicable)*	Aquifer Zone	Township	Range	Section	Type	Local Agency Well ID *i(f applicable)*				
Representative Monitoring Points	18S20E23E003M[/1]	A Zone	18S	20E	23	Monitoring Well	KRCDAC1S	CASGEM	WL/WQ[/3]	Semiannual	Above A Clay
	19S20E29E002M	A Zone	19S	20E	29	Unknown Use	19S20E29E002M	CDWR	WL	Semiannual	Above A Clay
	20S19E25A003M	A Zone	20S	19E	25	Monitoring Well	20S19E25A003M	DWR	WL	Semiannual	Above A Clay
	18S20E11C002M[/1]	B Zone	18S	20E	11	Municipal Well	(1610005-009) LEM_N-5	LEMOORE	WL/WQ[/3]	Semiannual	Above E Clay
	18S20E23E002M[/1]	B Zone	18S	20E	23	Monitoring Well	KRCDAC1M	CASGEM	WL/WQ[/4]	Semiannual	Above E Clay
	18S20E23E001M	B Zone	18S	20E	23	Monitoring Well	KRCDAC1D	CASGEM	WL	Semiannual	Above E Clay
	18S20E34N001M	B Zone	18S	20E	34	Residential Well	18S20E34N001M	DWR	WL	Semiannual	Above E Clay
	19S20E06C001M	B Zone	19S	20E	6	Irrigation Well	19S20E06C001M	DWR	WL	Semiannual	Above E Clay
	19S20E07F001M	B Zone	19S	20E	7	Unknown Use		DWR	WL	Semiannual	Above E Clay
	19S20E32D002M[/1]	B Zone	19S	20E	32	Monitoring Well	KRCDAC3M	CASGEM	WL/ WQ[/4]	Semiannual	Below E Clay
	19S20E32D003M	B Zone	19S	20E	32	Monitoring Well	KRCDAC3D	CASGEM	WL	Semiannual	Above E Clay
	20S20E26L001M[/1]	B Zone	20S	20E	26	Monitoring Well	KRCDAC5M	CASGEM	WL/ WQ[/4]	Semiannual	Above E Clay
	20S20E26L002M	B Zone	20S	20E	26	Monitoring Well	KRCDAC5D	CASGEM	WL	Semiannual	Above E Clay
	19S20E06L001M	Composite	19S	20E	6	Irrigation Well	19S20E06L001M	DWR	WL	Semiannual	Above/Below E Clay
	19S20E19A001M	Composite	19S	20E	19	Irrigation Well	19S20E19A001M	DWR	WL	Semiannual	Above/Below E Clay
	18S20E11C003M[/1]	C Zone	18S	20E	11	Municipal Well	(1610005-020) LEM_N-6	LEMOORE	WL/WQ[/3]	Semiannual	Below E Clay
	19S20E09G001M[/1]	C Zone	19S	20E	9	Municipal Well	(161005-011) LEM_12	LEMOORE	WL/ WQ[/4]	Semiannual	Below E Clay
	19S20E26N002M	C Zone	19S	20E	26	Municipal Well	CU-ELEM SCHOOL	PUBLIC WATER SYSTEMS	WL	Semiannual	Below E Clay
	20S19E02A001M	C Zone	20S	19E	2	Irrigation Well	20S/19E-02A01	WESTLANDS WATER DISTRICT	WL/ WQ[/4]	Semiannual	Below E Clay
	20S20E07H001M	C Zone	20S	20E	7	Irrigation Well	20S20E07H001M	DWR	WL	Semiannual	Below E Clay
	20S20E28E003M	C Zone	20S	20E	28	Unknown Use		DWR	WL	Semiannual	Below E Clay
Water Quality Sites			20S	20E	17	Municipal Well	1610006-001	STRATFORD PUD	WQ[/3]	Annual	
			20S	20E	17	Municipal Well	1610006-002	STRATFORD PUD	WQ[/3]	Annual	
			20S	20E	17	Municipal Well	1610006-005	STRATFORD PUD	WQ[/3]	Annual	
			19S	20E	8	Municipal Well	1610005-021	LEMOORE	WQ[/3]	Annual	
			19S	20E	15	Municipal Well	1610005-007	LEMOORE	WQ[/3]	Annual	
			18S	20E	35	Municipal Well	1610005-010	LEMOORE	WQ[/3]	Annual	
			18S	20E	11	Municipal Well	1610005-003	LEMOORE	WQ[/3]	Annual	
			19S	20E	8	Municipal Well	1610005-022	LEMOORE	WQ[/3]	Annual	
			18S	20E	11	Municipal Well	1610005-005	LEMOORE	WQ[/3]	Annual	
			19S	20E	8	Municipal Well	1610005-018	LEMOORE	WQ[/3]	Annual	
			19S	20E	15	Municipal Well	1610005-008	LEMOORE	WQ[/3]	Annual	
			19S	20E	3	Municipal Well	1610005-006	LEMOORE	WQ[/3]	Annual	
	19S20E11C		19S	20E	11	Unknown Use			WQ	Annual	
	18S20E11D		18S	20E	11	Public Well			WQ	Annual	

Table 5-3. South Fork Kings GSA: Existing & Proposed Representative Monitoring Network (Continued)

	South Fork Kings River GSA					Facility		Existing Program	Sustainability Indicator(s)	SGMA Monitoring Frequency	Aquifer Monitored
	State Well ID *(if applicable)*	Aquifer Zone	Township	Range	Section	Type	Local Agency Well ID *i(f applicable)*				
Land Subsidence	SOUTHFORK, SUB086		18S	20E	16	Subsidence Monument		KRCD	LS	Semiannual	All
	LEMA (RMP)		19S	20E	10	Subsidence Monument		CVSRN	LS	Semiannual	All
	SUB028		19S	19E	24	Subsidence Monument		KRCD	LS	Semiannual	All
	Jackson Ave Bridge over Kings River		19S	19E	24	Subsidence Monument		CalTrans	LS	Semiannual	All
	SUB102		20S	20E	18	Subsidence Monument		KRCD	LS	Semiannual	All
	SUB061		20S	20E	21	Subsidence Monument		KRCD	LS	Semiannual	All
Proposed Facilities	Proposed Well	A Zone	19S	20E	32	Monitoring Well			WL	Semiannual	Above A Clay
	Proposed Well	A Zone	20S	20E	26	Monitoring Well			WL	Semiannual	Above A Clay
	Proposed Well	B Zone	19S	20E	26	Municipal Well			WL	Semiannual	Above E Clay
	Proposed Well	C Zone	18S	20E	27	Monitoring Well			WL	Semiannual	Below E Clay
	/2	All	19S	20E	35	Extensometer			LS	Semiannual	All

Notes:
/1 Representative Monitoring Points that are also included for Water Quality
/2 Proposed monitoring areas pending funding or collaboration with DWR or USGS
/3 State Water Resources Control Board Division (SWRCB) Division of Drinking Water (DDW)
/4 Kings River Water Quality Coalition (KRWQC), Irrigated Lands Regulatory Program (ILRP) samples annually, data will be retrieved annually

Table 5-4. Southwest Kings GSA: Existing & Proposed Representative Monitoring Network

	Southwest Kings GSA					Facility		Existing Program	Sustainability Indicator(s)	SGMA Monitoring Frequency	Aquifer Monitored
	State Well ID *(if applicable)*	Aquifer Zone	Township	Range	Section	Type	Local Agency Well ID *(if applicable)*				
Representative Monitoring	/1	B Zone	22S	19E	19	Municipal Well	(1610009-005) Becky Pease Well	KETTLEMAN CITY CSD	WL/WQ/3	Semiannual	Above E Clay
		C Zone	21S	19E	21	Irrigation Well	Well 16-8		WL	Semiannual	Below E Clay
Water Quality Sites			22S	19E	8	Municipal Well	(1610009-004) Maud St. Well	KETTLEMAN CITY CSD	WQ/3	Annual	
Land Subsidence	G 1445, SUB027		22S	19E	30	Subsidence Monument		KRCD, CA Aqueduct	LS	Semiannual	All
	U 1097		22S	19E	30	Subsidence Monument		CA Aqueduct	LS	Semiannual	All
	SUB030		24S	19E	11	Subsidence Monument		KRCD	LS	Semiannual	All
	SUB076		24S	19E	36	Subsidence Monument		KRCD	LS	Semiannual	All
Proposed Facilities		B Zone	21S	19E	21	Monitoring Well			WL	Semiannual	Above E Clay
	/2	B Zone	24S	20E	19	Monitoring Well			WL	Semiannual	Above E Clay
		C Zone	22S	19E	18	Monitoring Well			WL	Semiannual	Below E Clay
	/2	C Zone	23S	20E	8	Monitoring Well			WL	Semiannual	Below E Clay
	/2	C Zone	24S	20E	18	Monitoring Well			WL	Semiannual	Below E Clay

Notes:
/1 Representative Monitoring Points that are also included for Water Quality
/2 Proposed monitoring areas pending funding or collaboration with DWR or USGS
/3 State Water Resources Control Board Division (SQRCB) Division of Drinking Water (DDW)
/4 Kings River Water Quality Coalition (KRWQC), Irrigated Lands Regulatory Program (ILRP) samples annually, data will be retrieved annually

Table 5-5. El Rico GSA: Existing & Proposed Representative Monitoring Network

	El Rico GSA					Facility		Existing Program	Sustainability Indicator(s)	SGMA Monitoring Frequency	Aquifer Monitored
	State Well ID *(if applicable)*	Aquifer Zone	Township	Range	Section	Type	Local Agency Well ID *(if applicable)*				
Representative Monitoring Points	20S22E35R001M	B Zone	20S	22E	35	Irrigation Well	20S22E35R001M	CDWR	WL	Semiannual	Above E Clay
		C Zone	20S	20E	32	Unknown Use	JGB_S-225		WL	Semiannual	Below E Clay
		C Zone	20S	21E	15	Unknown Use	JGB_M-140		WL	Semiannual	Below E Clay
		C Zone	21S	22E	25	Unknown Use	JGB_S-173		WL	Semiannual	Below E Clay
		C Zone	22S	22E	6	Unknown Use	JGB_S-205		WL	Semiannual	Below E Clay
		C Zone	21S	22	1	Unknown Use	CID_078		WL	Semiannual	Below E Clay
	20S21E11N001M	C Zone	20S	21E	11	Unknown Use	20S21E11N001M	KCWD	WL	Semiannual	Below E Clay
	20S21E24F001M	C Zone	20S	21E	24	Observation	20S21E24F001M	KDWCD	WL	Semiannual	Below E Clay
	21S22E07J001M	C Zone	21S	22E	7	Observation	21S22E07J001M	KDWCD	WL	Semiannual	Below E Clay
	20S22E14C001M	C Zone	20S	22E	14	Irrigation Well	X-20S22E14C001M	KDWCD	WL	Semiannual	Below E Clay
	20S22E19J001M	C Zone	20S	22E	19	Irrigation Well	20S22E19J001M	CDWR	WL	Semiannual	Below E Clay
		C Zone	20S	21E	11	Irrigation Well	KRCDTL002		WL	Semiannual	Below E Clay
		C Zone	20S	22E	22	Irrigation Well	KRCDTL003		WL	Semiannual	Below E Clay
Water Quality Sites			21S	23E	7	Municipal Well	1610004-015	CORCORAN	WQ	Annual	
			21S	22E	12	Municipal Well	1610004-026	CORCORAN	WQ/3	Annual	
			21S	23E	6	Municipal Well	1610004-016	CORCORAN	WQ	Annual	
			21S	23E	7	Municipal Well	1610004-002	CORCORAN	WQ	Annual	
			21S	23E	6	Municipal Well	1610004-003	CORCORAN	WQ	Annual	
			21S	22E	2	Municipal Well	1610004-018	CORCORAN	WQ/3	Annual	
			21S	22E	1	Municipal Well	1610004-019	CORCORAN	WQ/3	Annual	
			21S	23E	7	Municipal Well	1610004-001	CORCORAN	WQ	Annual	
Land Subsidence	S234P2		20S	22E	16	Subsidence Monument		CHSRA	LS	Semiannual	All
	S238		21S	22E	10	Subsidence Monument		CHSRA	LS	Semiannual	All
	CRCN (RMP)		21S	22E	11	Subsidence Monument		CVSRN	LS	Semiannual	All
	SUB083		22S	22E	11	Subsidence Monument		KRCD	LS	Semiannual	All
	SUN093		23S	23E	31	Subsidence Monument		KRCD	LS	Semiannual	All
Proposed Facilities		A Zone	20S	21E	26	Monitoring Well			WL	Semiannual	Above A Clay
		B Zone	20S	21E	23	Monitoring Well			WL	Semiannual	Above E Clay
		B Zone	20S	22E	21	Monitoring Well			WL	Semiannual	Above E Clay
		B Zone	21S	21E	21	Monitoring Well			WL	Semiannual	Above E Clay
		B Zone	21S	22E	9	Monitoring Well			WL	Semiannual	Above E Clay
		C Zone	21S	20E	10	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	21S	21E	9	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	21S	21E	27	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	21S	21E	21	Monitoring Well			WL	Semiannual	Below E Clay
	/2	C Zone	22S	21E	9	Monitoring Well			WL	Semiannual	Below E Clay

Table 5-5. El Rico GSA: Existing & Proposed Representative Monitoring Network (Continued)

	El Rico GSA					Facility		Existing Program	Sustainability Indicator(s)	SGMA Monitoring Frequency	Aquifer Monitored
	State Well ID *(if applicable)*	Aquifer Zone	Township	Range	Section	Type	Local Agency Well ID *(if applicable)*				
	/2	C Zone	22S	22E	22	Monitoring Well			WL	Semiannual	Below E Clay
	/2	C Zone	23S	22E	35	Monitoring Well			WL	Semiannual	Below E Clay
	/2	C Zone	24S	21E	9	Monitoring Well			WL	Semiannual	Below E Clay
	/2	All	20S	22E	31	Extensometer			LS	Semiannual	All

Notes:
/1 Representative Monitoring Points that are also included for Water Quality
/2 Proposed monitoring areas pending funding or collaboration with DWR or USGS
/3 State Water Resources Control Board Division (SWRCB) Division of Drinking Water (DDW)
/4 Kings River Water Quality Coalition(KRWQC), Irrigated Lands Regulatory Program (ILRP) samples annually, data will be retrieved annually

Table 5-6. Tri-County Water Authority GSA Existing & Proposed Representative Monitoring Network

	Tri County Water Authority GSA					Facility					
	State Well ID (*if applicable*)	**Aquifer Zone**	**Township**	**Range**	**Section**	**Type**	**Local Agency Well ID** (*if applicable*)	**Existing Program**	**Sustainability Indicator(s)**	**SGMA Monitoring Frequency**	**Aquifer Monitored**
Representative Monitoring Points	23S23E15M001M	A Zone	23S	23E	15	Unknown Use		DWR	WL	Semiannual	Above A Clay
	24S22E35E001M	C Zone	24S	22E	35	Unknown Use		DWR	WL	Semiannual	Below E Clay
	24S22E33C001M	C Zone	24S	22E	33	Unknown Use		DWR	WL	Semiannual	Below E Clay
Land Subsidence	SUB107		23S	21E	18	Subsidence Monument		KRCD	LS	Semiannual	All
	SUB038		24S	22E	34	Subsidence Monument		KRCD	LS	Semiannual	All
Proposed Facilities		B Zone	24S	22E	24	Monitoring Well			WL	Semiannual	Above E Clay
		B Zone	23S	23E	16	Monitoring Well			WL	Semiannual	Below E Clay
		C Zone	23S	23E	16	Monitoring Well			WL	Semiannual	Above E Clay

Notes:
/1 Representative Monitoring Points that are also included for Water Quality
/2 Proposed monitoring areas pending funding or collaboration with DWR or USGS
/3 State Water Resources Control Board Division (SWRCB) Division of Drinking Water (DDW)
/4 Kings River Water Quality Coalition (KWRQC), Irrigated Lands Regulatory Program (ILRP) samples annually, data will be retrieved annually

6.0 PROJECTS AND MANAGEMENT ACTIONS TO ACHIEVE SUSTAINABILITY

23 CCR §354.44 Projects and Management Actions

(a) *Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.*

(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.*
>
> ***(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.*
>
> ***(3)*** *A summary of the permitting and regulatory process required for each project and management action.*
>
> ***(4)*** *The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.*
>
> ***(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.*
>
> ***(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.*
>
> ***(7)*** *A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.*
>
> ***(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.*
>
> ***(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.*

(c) *Projects and management actions shall be supported by best available information and best available science.*

(d) *An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.*

6.1 Introduction

The member agencies and technical advisors have developed the projects and management actions described in this chapter. Once the Groundwater Sustainability Plan (GSP) is approved, the projects and management actions previously selected by each Groundwater Sustainability Agency (GSA) will be advanced and implemented. Each GSA proposed their method to achieve sustainability utilizing a combination of projects and management actions. Section 6.5, *GSA Sustainable Methods*, describes the mix of projects and management actions chosen by each GSA to meet sustainability.

Water supply is based on historically available water and forecasted water use, which is based on information from member agencies and best available data. Historical water supply was obtained from each agency in the Tulare Lake Subbasin (Subbasin) and includes surface water and groundwater.

Projects are proposed and will be implemented in the most effective manner to create a sustainable yield for each sustainability indicator, as applicable. Costs for implementing each project was developed using information from previous projects in the Subbasin area and is in a unit of cost format in Section 6.3, *Projects*, of this chapter.

Management actions are generally programs or policies developed with the objective of management through reducing water demand, improving water data gathering, and/or protecting water quality. Management actions listed in this chapter are conceptual. Each GSA will utilize this list to further develop and refine their own management actions as needed to achieve sustainability.

6.2 Water Supply

In California, surface water cannot be owned by individuals, groups, businesses, or governmental agencies. Permits, licenses, and registrations give the right to beneficially use reasonable amounts of water within a specific area or Place of Use. The Subbasin is located within the Place of Use for the State Water Project (SWP), the United States Bureau of Reclamation (USBR) Central Valley Project (CVP), the Kings River, the Tule River, the Kaweah River, and the St. Johns River as described in Section 3.4, *Management Areas*. Furthermore, flood waters occur from controlled and uncontrolled streams including Tule River, Kaweah River, Deer Creek, Elk Bayou, and Poso Creek. The timing and volume of surface water supply varies depending on the magnitude of the water year.

6.2.1 Kings River Supplies

The Kings River is burdened with a reality shared by all southern Sierra Nevada streams: it is prone to extreme annual swings in runoff, which is directly related to mountain precipitation (Kings River Water Association 2004). The River's historically lowest runoff event was approximately 391,700 acre-feet (AF) from 1923 to 1924. In contrast, the 1982 to 1983 water year produced a record runoff of 4,476,400 AF.

Pine Flat reservoir feeds into the Kings River and has a storage capacity of approximately 1,000,000 AF. The volume of flood control storage space is determined by the U.S. Army Corps of Engineers (USACE) Reservoir Regulation Manual. On average, flood releases generally occur every three to four years and, in some instances, occur consecutively. Channel losses and fishery management periodically affect delivery flexibility through restrictions in water supply to the Subbasin (Tulare Lake Basin Water Storage District 2003). It is anticipated that surface water supplies from the Kings River will be the main source for projects advanced by the GSAs to achieve sustainability.

6.2.2 Tule River Supplies

Tule River water rights holders within the Subbasin and flood water can empty into the Subbasin in times of runoff. Tule River flows are controlled by Success Dam, approximately 35 miles east of Corcoran. Success Dam, operated by the USACE, provides flood control and irrigation water storage by creating a reservoir with a total storage capacity of approximately 82,300 AF (Tule River 2015*)*. The Success Reservoir is operated by USACE, who is undertaking a project to expand storage to 112,000 AF in 2022-2023.

6.2.3 Kaweah and St. Johns River Supplies

The headwaters of the Kaweah River are controlled by the Terminus Dam, creating a reservoir with the purpose of providing flood protection and storage for irrigation. Terminus Dam feeds into the St. Johns River and has a storage capacity of approximately 185,600 AF (KDWCD 2017). Flood control storage space is determined by the USACE Reservoir Regulation Manual, which contains a flood control diagram that is used from November 1 to March 1.

There are rights holders within the Subbasin and during times of heavy runoff, flood water is released causing higher than average flows. Depending on irrigation demand and the season, portions of this flood water will reach the Subbasin.

6.2.4 State Water Project Supplies

There are multiple SWP Contractors in the Subbasin. SWP supplies have regulatory restrictions (e.g., Endangered Species Act and Water Quality Control Plan) that result in delivery reductions, which reduces surface water reliability (Tulare Lake Water Storage District 2003). Surface water supply allocations to the Subbasin vary based on water year type and regulatory restrictions.

6.2.5 Central Valley Project Supplies

The CVP has long-term agreements to supply water to more than 250 contractors in 29 of California’s 58 counties. There are no long-term contractors in the Subbasin; however, CVP supplies can be diverted via transfers and exchanges (Correspondence El Rico GSA 2019).

6.2.6 White River

White River has no rights holders. Flood flows occasionally occur in the Subbasin.

6.2.7 Deer Creek

Deer Creek rights holders are present in the Subbasin.

6.2.8 Kern River

Kern River has rights holders in the Subbasin, but the water has been contracted to the Kern County Water Agency. Flood flows may pass into the Subbasin.

6.2.9 Import of Additional Supplies

Each GSA is proposing to use their existing contract and rights for surface water as access to import more surface water into the Subbasin.

6.3 Projects

Projects reviewed in this chapter provide options to each of the GSAs and their respective partner agencies to use in implementation of this GSP, which is discussed in Chapter 7, *Implementation*. Specific project locations will be determined prior to Department of Water Resources (DWR) review. Potential projects that may be utilized by the GSAs and partners include:

- Construction of new and modification of existing conveyance facilities;
- Above-ground surface water storage projects;
- Intentional recharge basins;
- On-farm flooding; and
- Aquifer Storage and Recovery (ASR).

6.3.1 Conveyance Facilities Modifications and Construction of New Facilities

Modifications or improvements to existing facilities can be completed to increase conveyance efficiency and allow for greater flow capacity. Improvements of an existing system would increase the delivery area. Total capacity may also be increased with the construction of new conveyance systems such as canals, check structures, and additional turnouts, to allow for surface water delivery to new areas. By providing a larger service area, more acreage would be able to use surface water, thus reducing the demand on groundwater pumping. It is anticipated that throughout the Subbasin, existing facilities will be improved by reshaping of existing canals, including sediment and plant growth, modification of canal control structures, and canal lining. Canal lining would prevent seepage losses to perched water tables where they exist and improve the total usable water volume. Conveyance construction and improvements will support other proposed projects in the area.

6.3.1.1 Location

Project locations will be identified by each GSA and their respective partners within their area as soon as funding is available.

6.3.1.2 Project Objectives

The main objective of this project type is to increase the conveyance capacity of the surface water distribution systems, allowing for increased surface diversions. This project will decrease reliance on groundwater and help to maintain groundwater levels and storage. A direct relationship exists between the volume of additional surface water that can be delivered to a site and reduction in groundwater pumping. This objective will be achieved by improving the existing system, constructing new facilities (e.g., canals, pipelines, and pump stations) to increase the delivery service area, and constructing new water management structures to manage deliveries in the expanded water delivery area. All water flows that are delivered to the Subbasin will be measured appropriately.

6.3.1.3 Project Benefits and Water Reliability

Project benefits include:

- Decreased reliance on groundwater pumping;
- Increased diversion capability at existing points of delivery; and
- Diversion in upper reaches of the Subbasin to provide flood flexibility to the lower reaches of the Subbasin.

Historically, flood releases occur every three to four years with some years being consecutive flood-release years, as discussed above in Section 6.2, *Water Supply.* This project may also be used in normal years when water is available for purchase. With implementation of the Sustainable Groundwater Management Act (SGMA), it is anticipated that surface water management by other water rights holders will also change and the available volume of surface water may decrease. However, based on historical data, the reliability and availability of flood-release water is considered effective for the purposes of this project type.

6.3.1.4 Management of Groundwater Extractions and Recharge

The project would be owned and managed by the local water agencies where the project will be constructed. GSAs may be involved in funding and coordinating these efforts in order to improve water balance conditions within the GSA service areas.

6.3.1.5 Project Cost Estimate/Acre-Foot of Yield

Although no detailed cost estimate has been prepared, preliminary estimates of typical project component costs are:

- New Canal Excavation: Approximately $45 per linear foot; assumes 8 feet deep, with a capacity of 400 cubic feet per second (cfs)
- Excavate/widen existing canal: Approximately $20 per linear foot; assumes 6 feet deep to increase capacity
- New weirs or check structures: Varies from $50,000 to $500,000 based on placement
- Pump Station: Varies from $500,000 for a 100-cfs pump station to $3,000,000 million for a 500-cfs pump station (includes cost of pumps, concrete structure, and electrical work); design would be in accordance with the Hydraulic Institute's guidelines

The yield of this type of project will be determined based on the designated delivery rates. The yield will be developed as projects are identified and funding becomes available.

6.3.1.6 Circumstances of Implementation

GSAs in the Subbasin have the flexibility to choose which types of projects and management actions to pursue in attaining sustainable management. Not all projects or management actions will be pursued. Decisions regarding projects and policies will depend on conditions and management of the GSA at the board level. Should this type of project be deemed appropriate and necessary, it will be considered an integral part of the overall effort to reach sustainability. The selection of check structures and turnouts, willing participants, and the availability of funding are circumstances considered necessary to project implementation. Prior to DWR review, project and management actions will be identified for each GSA Subbasin-wide.

6.3.1.7 Project Status and Schedule

No project schedule has been determined. Some GSAs need to secure funding to begin the planning and implementation of this project. It is expected, once funding is secured, it could take from one to five years to complete a project including meeting environmental compliance.

6.3.1.8 *Permitting and Regulatory Process*

Each project will require a permitting evaluation and compliance with California Environmental Quality Act (CEQA) requirements. This process will be performed once the projects have been selected. If construction is going to disturb more than 5 acres, a Storm Water Pollution Prevention Plan (SWPPP) will be necessary as well.

6.3.1.9 *Legal Authority*

The legal authority to acquire land, grants, water rights, etc. and to operate and maintain such facilities for the purposes of carrying out the provisions of SGMA is given to GSAs by the State of California in Division 6 the Water Code (§10726.2). Each of the GSAs may need to acquire new surface water rights or work with agencies within their boundaries that have existing rights. GSAs will likely provide funding and coordination support for this type of project.

6.3.2 Above-Ground Surface Water Storage

Above-ground storage basins will be constructed for the purpose of capturing and retaining an increased level of surface water for direct irrigation purposes. Controlled surface water storage on the valley floor would allow a higher potential storage capacity in the major reservoirs, allowing beneficial users to effectively utilize each water year's available surface water. All surface water diversions into and out of the storage basins will be measured appropriately. Groundwater pumping should decrease in direct correlation to the additional volume of surface water captured and stored in the new facilities. Additionally, if the basin were to replace an agricultural field, demand reduction would occur within the footprint of the designated storage basin.

6.3.2.1 *Location*

Prospective project locations will be identified by each GSA as funding becomes available, prior to DWR GSP review. Surface water storage basins are likely to be in locations containing a soil profile with higher clay content, due to its hydraulic properties for draining slowly. The location will likely be determined based on areas that have rights to surface water, and higher consideration will likely be given to areas near existing distribution infrastructure.

6.3.2.2 *Project Objectives*

The main objective of this project type is to increase surface water diversion and accordingly reduce groundwater pumping. Reducing the average annual volume of groundwater pumping will allow the GSAs to meet the measurable objectives (MOs) set in Chapter 4.0, *Sustainable Management Criteria*, for groundwater levels and groundwater storage change.

6.3.2.3 *Project Benefits and Water Reliability*

Project benefits include:

- Increased conjunctive use, such as water diversion to help meet irrigation demand;
- Additional storage capacity on the valley floor and below the major reservoirs (Pine Flat, Success, Terminus, and Isabella) , affording more opportunity to capture and redistribute surface water supplies; and
- Flood protection to the Subbasin by increasing the controlled storage areas.

Historically, flood releases occur on average every three to four years, with some years being consecutive flood-release years from the eastern watershed areas. These projects may also be used in normal years when water is available for purchase. With implementation of SGMA, it is anticipated that surface water management by other water rights holders will also change and the available volume of surface water may decrease.

6.3.2.4 *Management of Groundwater Extractions and Recharge*

Groundwater recharge and extraction do not pertain to surface water storage projects. However, the benefits of this type of project will be monitored by measuring the volume of additional surface water stored and used. Additionally, groundwater levels in the service area of the storage basin will be compared to historical values to measure the impact of the project.

6.3.2.5 *Project Cost Estimate/Acre-Foot of Yield*

Although no detailed cost estimate has been prepared, a preliminary engineer's opinion of estimated project cost is approximately \$25,000 to \$40,000 per acre to construct a storage project. This estimated cost includes land purchase, construction of storage basins, and inlet and outlet structures with flow measurement devices. The estimated project cost assumes the earthwork for excavation and compaction will balance and there will be no need for excess material export.

The yield of this project will be determined based on the designated acreage. For example, if constructed on farmland, a basin with a bottom area of 100 acres and a 5-foot depth will generate approximately 500 AF of storage. Additionally, agricultural demand reduction of approximately 3.0 AF per acre (based on approximate average evapotranspiration (ET) demand of alfalfa) results in a reduction of about 800 AF of annual demand.

6.3.2.6 Circumstances of Implementation

GSAs in the Subbasin have the flexibility to choose which types of projects and management actions they would like to pursue in attaining sustainable management. Not all projects or management actions will be pursued; decisions regarding projects and policies will depend on conditions and management of the GSA at the board level. Should this type of project be deemed appropriate and necessary, it will be considered an integral piece of the overall effort to reach sustainability. Accordingly, finding a low infiltration site (clay soils area), willing participants, and the availability of funding are circumstances considered necessary to its implementation.

6.3.2.7 Project Status and Schedule

No project schedule has been determined. Some GSAs need to secure funding to begin the planning and implementation of a project. Once funding is secured, it is expected that it could take up to three years to complete a water storage project including environmental compliance. Benefits would be realized when a flood event occurs.

6.3.2.8 Permitting and Regulatory Process

To implement an above-ground water storage project, the following permits and regulatory procedures required include, but are not limited to, the following:

- CEQA
- SWPPP – for construction that disturbs more than 5 acres
- Mosquito Abatement – for operation of an open body of water that could host vectors
- Surface Mining and Reclamation Act (SMARA)
- San Joaquin Valley Air Pollution Control District (SJVAPCD) – for preparation of a Dust Control Plan for construction with disturbs a surface area of 5 acres or more
- County Grading Permit (at a minimum county notification)
- Other permit requirements based on findings from biological or cultural studies

6.3.2.9 Legal Authority

The legal authority to acquire land, grants, water rights, etc. and to operate and maintain such facilities for the purposes of carrying out the provisions of SGMA is given to GSAs by the State of California in Division 6 the Water Code (§10726.2). Each of the GSAs may need to acquire new surface water rights or work with agencies or private parties within their boundaries that have existing rights.

6.3.3 Intentional Recharge Basin

Intentional recharge basins will be built with the purpose of recharging water into the aquifer system, when excess surface water is available, with the intent of extraction later on. By recharging water in wet years, groundwater levels will improve, creating a buffer storage volume, or a water bank, that may be extracted during periods of dryness or drought. Recharge basins will be constructed in areas containing soils associated with high infiltration rates; therefore, potential recharge volume realized is dependent upon the size of the recharge basin and the availability of flood water. Infiltration rates are anticipated to vary from 0.35 AF per acre per day to 1.5 AF per acre per day. Recharged water typically remains in the unconfined aquifer, above the A-Clay, above the C-Clay, and above the E-Clay. Existing wells in the area will be used for extraction of the stored water. Furthermore, demand reduction of approximately 3 AF per acre per year is also associated with this type facility due to the removal of agricultural lands. These types of facilities are anticipated to be located in the northerly (South Fork Kings GSA and Mid-Kings River GSA) and easterly portions (El Rico GSA) of the Subbasin due to coarser-grained soil profiles.

6.3.3.1 Location

Project location will be identified by each GSA and their associated partner agencies as funding becomes available and based on where the most benefit may be realized. Location of projects will be determined based on the infiltration potential of certain soil profile zones, groundwater levels, and groundwater quality within the Subbasin.

6.3.3.2 Project Objectives

The project objective is to import additional surface water and recharge into the aquifer for storage and later recovery. This objective will help to maintain groundwater levels for neighboring landowners, so that dry-year groundwater pumping will not cause levels to fall below minimum thresholds (MTs) set in Sustainable Management Criteria. This project will also benefit the MO for groundwater storage change. To quantitatively measure the project objective, all water flows that are delivered to the project site will be measured and beneficial recharge will be estimated after accounting for any system losses to determine the allowable recovery volume to be used in drier years.

6.3.3.3 Project Benefits and Water Reliability

Project Benefits include:

- Increased groundwater storage in wet years, for use in drier years;

- Operational flexibility in dry years;
- Maintained groundwater levels and groundwater storage, thus avoiding increased costs for pumping; and
- Potential for improvement of groundwater quality by recharging with higher quality surface water.

Historically, flood releases occur every three to four years with some years being consecutive flood-release years. This project may also be used in normal years when water is available for purchase. With implementation of SGMA, it is anticipated that surface water management by other water rights holders will also change and the available volume of surface water may decrease. However, based on historical data, the reliability and availability of flood-release water is considered good for the purposes of this project type.

6.3.3.4 Management of Groundwater Extractions and Recharge

Agreements between the involved parties will need to be formed on a project-by-project basis for decisions on ownership and operation. Policy for accounting of groundwater extraction and recharge as it pertains to intentional recharge projects has not yet been defined; however, flow into the recharge basin will be measured and accounted for in extractions.

6.3.3.5 Project Cost Estimate/Acre-Foot of Yield

Although no detailed cost estimate has been prepared, a preliminary engineer's opinion of estimated project construction cost is approximately $30,000 to $50,000 per acre. This estimated cost includes land purchase, construction of basin, inlet structures, and installation of flow measurement devices. Limited excavation is assumed, due to balancing the levee compaction volume with extraction. Detailed soils investigations are recommended, and in some cases, the project may require deep ripping to remove clay layers, which could increase the project cost.

The yield of this project will be determined based on the designated acreage and availability of flood water. For example, an infiltration basin with a bottom area of 100 acres and an infiltration rate of 0.35 AF per acre per day would generate approximately 35 AF per acre per day of operation, plus a reduction in annual water demand would occur at approximately 3.0 AF per acre if the basin replaced productive agricultural land.

6.3.3.6 Circumstances of Implementation

GSAs in the Subbasin have the flexibility to choose which types of projects and management actions they would like to pursue in attaining sustainable management. Not all projects or management actions will be pursued; decisions regarding projects and policies will depend on conditions and management of the GSA at the board level. Should this type of project be deemed appropriate and necessary, it will be considered an integral part of the overall effort to reach sustainability. Selecting a high infiltration area (sandy soils profile), finding willing participants, and the availability of funding are necessary circumstances to consider implementation of this type of project.

6.3.3.7 Project Status and Schedule

No project schedule has been determined. Some GSAs need to secure funding to begin planning and implementation of this type of project. It is expected, once funding is secured, it could take up to three years to complete this type of project, including environmental compliance.

6.3.3.8 Permitting and Regulatory Process

It is anticipated that the following permits and regulatory procedures will be required to implement this project:

- CEQA
- SMARA
- SWPPP
- SJVAPCD
- Mosquito Abatement
- County Grading Permit (at a minimum county notification)
- Other permit requirements based on findings from biological or cultural studies

6.3.3.9 Legal Authority

The legal authority to acquire land, grants, water rights, etc. and to operate and maintain such facilities for the purposes of carrying out the provisions of SGMA is given to GSAs by the State of California in Division 6 the Water Code (§10726.2). Each of the GSAs may need to acquire new surface water rights or work with agencies within their boundaries that have existing rights.

6.3.4 On-Farm Recharge

On-farm recharge is a form of groundwater recharge performed by flooding an existing agricultural production field. Potential locations for on-farm recharge will be determined by areas containing soil profiles with high infiltration potential. Additionally, on-farm flooding is limited by fertilization and crop type. Leaching of fertilizer chemicals into the groundwater system is not favorable, and some crops are more tolerant of saturated soils for longer periods of time than others. Alfalfa is well suited to on-farm flooding due to its ability to be inundated for long periods of time, and permanent crop types that are suitable for on-farm flooding during the dormancy period include vineyards, pistachios, and olives. It will be up to each GSA to determine the most favorable locations and decide on a minimum acreage size designated for this type of project.

Voluntary participation from the landowners and their delivery facilities will be utilized as part of the project. In this effort, existing local wells will recover recharge supplies.

6.3.4.1 Location

Projects location will be identified by each GSA, partner agencies, and landowners based on most favorable conditions. As previously discussed, locations will be selected based on best potential benefits realized from certain soil profiles and existing cropped lands.

6.3.4.2 Project Objectives

The main objective of this project type is to reduce chronic lowering of groundwater water levels by providing a space where recharge can occur in off-season months of irrigation. To quantitatively measure the project objective, all water flows that are delivered to the project site will be measured through a metering device and beneficial recharge will be estimated after accounting for any system losses to determine the allowable recovery volume. Groundwater levels in the surrounding area will be compared to historical levels to observe the benefit of this project type on groundwater levels and storage.

6.3.4.3 Project Benefits and Water Reliability

Projects benefits include:

- Increased groundwater storage for recovery in drier years;
- During wet years, additional use of flood water for recharge will provide greater flood control operation flexibility;
- Maintained groundwater levels and groundwater storage, thus avoiding increased costs for pumping;

Historically, flood releases occur every three to four years with some years being consecutive flood-release years. This project may also be used in normal years when water is available for purchase. With implementation of SGMA, it is anticipated that surface water management by other water rights holders will also change and the available volume of surface water may decrease. However, based on historical data, the reliability and availability of flood-release water is considered good for the purposes of this project type.

6.3.4.4 Management of Groundwater Extractions and Recharge

This project would be owned and managed by the GSA and their partner agency, if any, where constructed. Policy for groundwater extraction and recharge as it pertains to on-farm recharge projects has not yet been defined; however, flow into the recharge basin will be measured and accounted for in extractions.

6.3.4.5 Project Cost Estimate/Acre-Foot of Yield

Although no detailed cost estimate has been prepared, a preliminary estimated engineer's opinion of probable project cost is approximately $500 to $1,000 per acre to implement. This estimated cost assumes that the landowner voluntarily enters into a land use agreement or easement. Limited to no excavation will occur within the designated land. Cost does include the purchase of flow measurement devices.

The yield of this project will be determined based on the designated acreage and the local recharge rate. For example, a 100-acre section of land with an infiltration rate of 0.35 AF per acre per day will yield 35 AF per day. No agricultural land will be taken out of production for this type of project.

6.3.4.6 Circumstances of Implementation

GSAs in the Subbasin have the flexibility to choose which types of projects and management actions they would like to pursue in attaining sustainable management. Not all projects or management actions will be pursued; decisions regarding projects and policies will depend on conditions and management of the GSA at the board level. Should this type of project be deemed appropriate and necessary, it will be considered an integral part of the overall effort to reach sustainability. Selecting an area with high infiltration potential (sandy soils area), appropriate crop type, willing participants, and availability of funding are circumstances considered necessary to implementation of this project type.

6.3.4.7 Project Status and Schedule

No project schedule has been determined. Some GSAs need to secure funding to begin the planning and implementation of this project. It is expected, once funding is secured, preparation of the policy could take a year to complete. The physical diversion of surface water can happen immediately following implementation of policy using existing distribution facilities. The schedule of actual operation may vary based on location, since some permanent crops can only be flooded during dormancy.

6.3.4.8 Permitting and Regulatory Process

- Land use agreements

6.3.4.9 Legal Authority

The legal authority to acquire land, grants, water rights, etc. and to operate and maintain such facilities for the purposes of carrying out the provisions of SGMA is given to GSAs by the State of California in Division 6 the Water Code (§10726.2). However, in this case, the GSA is not interested in owning the land, only providing the coordination to achieve project goals. Each of the GSAs may need to acquire new surface water rights or work with agencies within their boundaries that have existing rights. Agreements with landowners will be required to use their lands for recharge.

6.3.5 Aquifer Storage and Recovery

ASR is the intentional recharge by utilizing direct injection of surface water into an aquifer for later recovery, usually through the use of wells. ASR well sites will be selected to directly store water in certain geologic zones for later recovery or to stabilize groundwater levels in order to arrest subsidence.

6.3.5.1 Location

Project locations, if feasible, will be identified by individual GSAs as funding becomes available.

6.3.5.2 Project Objectives

The main objective of this project is to reduce chronic lowering of groundwater levels and reduce subsidence by directly storing surplus water in the unconfined or confined aquifer. The objective will be measured by metering all water flows that are delivered to the project site appropriately.

6.3.5.3 Project Benefits and Water Reliability

Projects benefits include:

- Surplus water storage in the aquifer and subsequent recovery when there is demand;
- During wet years, utilization of flood flows, providing further flood protection; and
- Stabilization of groundwater levels to reduce subsidence rates.

Historically, flood releases occur every three to four years with some years being consecutive flood-release years. This project may also be used in normal years when water is available for purchase. With implementation of SGMA, it is anticipated that surface water management by other water rights holders will also change and the available volume of surface water may decrease. However, based on historical data, the reliability and availability of flood-release water is considered good for the purposes of this project type. This project would increase groundwater reliability and sustainability.

6.3.5.4 *Management of Groundwater Extractions and Recharge*

This project would be owned by landowners using their existing wells for ASR and managed by the GSA or partner agency where implemented. Policy for groundwater extraction and recharge as it pertains to ASR projects has not yet been defined. Landowners would have to enter into contracts with the GSA to allow for use of these private facilities.

6.3.5.5 *Project Cost Estimate/Acre-Foot of Yield*

Although no detailed cost estimate has been prepared, a preliminary engineer's opinion of estimated project cost is approximately $250,000 to $500,000 per well to construct. This estimated cost assumes that the owner of the well will enter into an easement and or use agreement with the GSA for use of the well. A flow measurement device will be needed.

The yield of this project will be determined based on the designated number of wells. For example, utilizing 100 wells at an estimated storage rate of 4 AF per day per well will generate approximately 400 AF of storage per day.

6.3.5.6 *Circumstances of Implementation*

If determined cost-effective, ASR projects will be considered as part of the overall effort to reach sustainability. These facilities are expected to be used in areas where surface soils are clays and are underlain by clay zones such as the A-, C-, and E-clays. The selection of wells, willing participants, and the availability of funding are circumstances considered necessary to this project's implementation.

6.3.5.7 *Project Status and Schedule*

No project schedule has been determined. It is expected that, once funding is secured, it could take up to five years to complete this project, including environmental compliance.

6.3.5.8 *Permitting and Regulatory Process*

It is anticipated that the following permits and regulatory procedures will be required to implement this project:

- CEQA
- Compliance with the Environmental Protection Agency (EPA)
- Compliance with the Regional Water Quality Control Board (RWQCB)
- Local Agency Compliance

6.3.5.9 Legal Authority

GSAs were given the authority to "perform any act necessary or proper to carry out the purposes of [SGMA]" including the adoption of rules, regulations, ordinances, and resolutions that pertain to this GSP. Chapter 5 of Division 6 of the California Water Code lays out the rest of the powers and authorities given to GSAs. Each of the GSAs may need to acquire new surface water rights or work with agencies within their boundaries that have existing rights. Agreements with landowners will be required to use their wells for recharge.

6.4 Management Actions

Management actions represent example management options available to GSAs that will help support them in the sustainable management of groundwater. Each GSA has the flexibility to choose a list of actions that they believe will be pursued and will independently develop the policies to meet the needs of their area for achieving sustainable management. The management actions will be chosen by each GSA after the implementation of this GSP. Examples of potential management actions include, but are not limited to the following:

- Projects Policies
    - Voluntary fallowing programs
    - Above-ground surface water storage projects
    - Infiltration basins (utilizing flood flows, purchased and exchanged waters)
    - On-farm recharge (utilizing existing cropped and uncropped lands to infiltrate water, mainly during dormant seasons, for recovery in a dry period)
    - ASR
    - Conveyance facilities modifications
- Outreach
    - Education of groundwater use
- Assessment
    - Pumping fees for groundwater allocation exceedances
    - Pumping fees for groundwater extractions
- Groundwater Allocation
    - Development of GSA level groundwater allocation
    - Development of landowner groundwater allocation
    - Groundwater marketing and trade
    - Operation and management of groundwater extractions
- New Development
    - Require new developments (non-de minimis extractors) to prove sustainable water supplies if land use conversion is not a conservation measure

- Monitoring and Reporting
  - Flood flows (spills into the Subbasin), including, Tule River, Deer Creek, Cross-Creeks and Kings River
  - Registration of extraction facilities
  - Require self-reporting of groundwater extraction, water level, and water quality data
  - Require well flowmeters, sounding tubes, and water quality sample ports for new well construction
- Existing Surface Water Contracts
  - Flood flows, spills into the Subbasin, including, Tule River, Deer Creek, and Cross-Creeks

6.5 GSA Sustainable Methods

Based upon work documented previously, each GSA has an estimated annual storage change target to meet to be sustainable, based upon best available data and groundwater model results. This section identifies the proposed project and management action targets envisioned to achieve sustainability. These preliminary amounts will be reevaluated, and conditions monitored while efforts are implemented. This will allow the GSA to compare the anticipated versus resulting change in groundwater levels as well as other sustainability criteria to determine if additional measures need to be employed to achieve sustainability.

6.5.1 Mid-Kings River GSA

The average annual storage change for the Mid-Kings River GSA is estimated at negative 36,800 AF. The Mid-Kings River GSA plans to pursue improvements to existing basins in the area, improvement to conveyance systems and expanded surface water delivery system, a voluntary annual fallowing program, and recharge basin development. Table 6-1 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary. Demand reduction for dedicated lands for infiltration ponds are included in the Yield column of the table below. An average annual value of 3.0 AF per acre of demand reduction will be used. The estimated annualized blended costs for this type of project, assuming a 20-year funding period and 4% interest, is approximately $85/AF. Additional costs are expected for operational costs.

6.5.2 South Fork Kings GSA

The average annual storage change for the South Fork Kings GSA is estimated at a minus 46,080 AF. Table 6-2 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary. Demand reduction costs will be determined once the policy has been developed by the GSA boards. It is unknown at this time if the GSA will fund the demand reduction program by charging farmers in the GSA or whether an allocation program will be implemented allowing growers to manage their water allocations and requiring individual decisions on cropping and water use. The estimated costs for the entire ASR project is listed in Table 6-2.

6.5.3 Southwest Kings GSA

The average annual storage change for the Southwest Kings GSA is estimated at positive 5,140 AF (surplus), thus projects to mitigate overdraft are not currently needed in this GSA. No projects have been determined at this time. Management actions may be determined at a later time and will be based upon annual monitoring results. A management area is also identified in this region. Should development of groundwater be accomplished in the management area, a set of criteria would be employed to identify the quantity of groundwater pumping and monitoring of groundwater levels. The Southwest Kings GSA has indicated to the other GSAs in the Subbasin that it would be interested in financially participating in projects elsewhere in the Subbasin if doing so would affordably increase the water supply to the Southwest Kings GSA.

6.5.4 El Rico GSA

The average annual storage change for the El Rico GSA is estimated at minus 38,770 AF. Table 6-3 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary. Demand reduction for dedicated lands for infiltration ponds are included in the Yield column of Table 6-3. An average annual value of 3.0 AF per acre of demand reduction will be used. Demand reduction is assumed to consist of crop fallowing in dry years. Since crop rotation and fallowing is assumed to be accomplished by growers within the GSA, no costs are associated with this farm practice. The estimated annual cost for the capital facilities associated with storage are estimated at $330/AF based upon a 20-year funding period and four percent interest.

6.5.5 Tri-County Water Authority GSA

The average annual storage change for the Tri-County Water Authority GSA is estimated at surplus 3,550 AF. Table 6-4 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary. Demand reduction for dedicated lands for infiltration ponds are included in the Yield column of Table 6-4. An average annual value of 3.0 AF per acre of demand reduction will be used. Demand reduction costs will be determined once the policy has been developed by the GSA. The proposed schedule for demand reduction in the Tri-County Water Authority GSA is a 10% reduction by the year 2025 and an additional reduction by the year 2030.

Table 6-1. Summary of Projects and Management Actions Chosen for Mid-Kings River GSA

Project	Implementing Agency	Cost	Annual Yield
Rehabilitation of Existing Recharge Basins	Kings County Water District	$ 800,000	1,500
Conveyance Improvements and Construction on Riverside Canal	Kings County Water District	$ 320,000	1,500
Fallowing Program	Mid-Kings River GSA	$ 1,380,000	6,250
Cartright Basin Improvements	Kings County Water District	$ 884,000	650
Last Chance Side Ditch Improvements	Kings County Water District	$ 6,798,000	??
Recharge Basin Construction	Kings County Water District	$ 93,000,000	27,700

Table 6-2. Summary of Projects and Management Actions Chosen for South Fork Kings GSA

Project	Implemented by	Annualized Benefit (AF/YR)	Priority	Estimated CAPEX ($)
GW Measurement and Reporting	SFK/Landowners	1,500	High	$ 500,000
SW Delivery Improvement	SFK/Landowners	5,000	High	$ 5,000,000
On-Farm Improvements	SFK/Landowners	2,500	Med	$ 1,000,000
Conservation Reuse	SFK/Lemoore	1,000	Med	$ 1,000,000
Cropping/Fallowing Program	SFK	13,000	High	$ 5,000,000
Demand Reduction Sub-Total		**23,000**		**$ 12,500,000**
Aquifer Storage and Recovery	SFK/Landowners	13,000	High	$ 15,000,000
Surface Storage	SFK/Landowners	2,000	Low	$ 6,000,000
Mid-Kings Recharge Basin	SFK	7,000	Med	$ 28,000,000
Supply Enhancement Sub-Total		**22,000**		**$ 49,000,000**
TOTAL		**45,000**		**$ 61,500,000**

Table 6-3. Summary of Projects and Management Actions Chosen for El Rico GSA

Project	Annual Project Use (Days)	Acreage (Acres)	Cost/Acre	Average annual Yield (AF/YR)	Total Cost	Project Life (YR)
Storage Ponds	60	5,000	$20,000	26,000	$100,000,000	60
Demand Reduction	360	5,000		15,000		
Total				41,000		

Table 6-4. Summary of Projects and Management Actions Chosen for Tri-County Water GSA

Project	Annual Project Use (Days)	Acreage (Acres)	Cost/Acre	Average annual Yield (AF/YR)	Total Cost	Project Life (YR)
Storage Ponds	60	1,500	30,000	15,000	$45,000,000	
Demand Reduction						
Total				15,000		

7.0 PLAN IMPLEMENTATION

Upon Department of Water Resources (DWR's) approval of this Groundwater Sustainability Plan (GSP), GSP implementation will commence in the Tulare Lake Subbasin (Subbasin). The Groundwater Sustainability Agencies (GSAs) will continue their efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the Plan Area to avoid future undesirable results related to groundwater usage in the Subbasin. GSAs' ongoing efforts to coordinate with a diverse range of stakeholders and beneficial users works to improve the Subbasin's monitoring networks. This GSP works in tandem with authorities of numerous agencies with the goal to coordinate activities in the region for the effective management of groundwater resources.

7.1 Estimate of GSP Implementation Costs

> **23 CCR §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.*

The Subbasin's GSP was developed by the five GSAs within the Subbasin a singular document to address groundwater overdraft. GSAs and member agencies will coordinate and implement the actions outlined in this GSP. As such, the implementation is anticipated to be performed by multiple agencies. In order to identify implementation costs, a draft structure of cost has been suggested and is included below:

1. Regular/Ongoing SGMA Compliance Activities;
2. GSP Five-Year Update;
3. Plans to Fill Data Gaps;
4. Projects
5. Management Actions.

Table 7-1 identifies estimated cost components by GSA for each of the above categories for the five-year intervals from 2020 to 2040.

7.2 Schedule for Implementation

> **23 CCR §350.4** *General Principles. Consistent with the State's interest in groundwater sustainability through local management, the following general principles shall guide the Department in the implementation of these regulations.*
> *(f) A Plan will be evaluated, and its implementation assessed, consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon.*

Implementation of the GSP will result in the sustainable yield of groundwater resources in the Subbasin by year 2040. Some areas within the Subbasin have existing projects, which will continue to contribute to the Subbasin's groundwater sustainability. These projects are included in the ground water model but will not be shown on the schedule (Appendix D). The schedule of projects and management actions are outlined below. At each five-year interim milestone, updates to the schedule will occur, as applicable, dependent on achievement of Measurable Objectives (MO) for each applicable sustainability indicator.

- 2020-2025-Yield 24,300 AF
  - Begin identification of management actions through policy development, dealing with demand reduction,
  - Bring on-line first projects,
- 2026-2030-Yield 66,350 AF
  - Implement Management Actions relating to demand reduction,
  - Expansion of projects and new projects on-line,
- 2031-2035-Yield 135,100 AF
  - Implement Management Actions relating to demand reduction,
  - Expansion of projects and new projects on-line,
- 2036-2040-Yield 153,000 AF
  - Implement Management Actions relating to demand reduction,
  - Expansion of projects and all projects on-line

7.3 Identify Funding Alternatives

23 CCR §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.

The GSP's GSAs successfully pursued grant funding to help develop the GSP. A number of the GSAs passed a local Proposition 218 in recent elections, which secured funds to generate sufficient revenue for the initial preparation of the GSP and initial GSA administrative functions. The annual operational costs have begun and are used to fund Agency operations and activities required by SGMA, including retaining consulting firms and legal counsel to provide oversight and lead the various agencies through the steps for SGMA compliance. Expenses consist of administrative support, GSP development, and GSP implementation. GSP development and GSA administrative costs are ongoing.

GSAs have not budgeted for the projects and management actions in the GSP. The existing local agencies will require supplemental funding and assessments greater than the existing rate structures. Therefore, a future Proposition 218 funding source or additional funding mechanism will most likely be required.

The Southwest Kings GSA is applying for Proposition 1 Technical Support Services grant funding to offset some of the capital improvement costs associated with the development of new monitoring wells to fill existing data gaps in the monitoring network. Proposition 3 did not pass in the last election, so the GSA will be exploring other federal and state grant funding opportunities and low interest loans to help finance the initial steps of plan implementation. It is also anticipated that the GSAs will pursue additional grant funding through Proposition 1 which is understood to allow for additional planning funds from the DWR. If local, state, and federal funding is not readily available, the GSA may consider implementation of various management actions to impose fees as discussed in Chapter 6 which, after formal adoption, would generate a continual revenue stream for future GSP implementation costs.

7.4 Data Management System

23 CCR §352.6. *Data Management System. Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.*

In development of this GSP, the five GSAs have developed a model that has been calibrated to estimate future scenarios. The data management system plans to build on existing data inputs in the groundwater model and develop a more formalized approach to collecting and capturing the data. As stated in Chapter 5, *Monitoring Network*, future data will be gathered to develop annual reports, as well as provide necessary information for future and ongoing update to the groundwater models at five-year intervals upon GSP implementation. The Data Management System (DMS) that will be used is a geographical relational database that will include information on water levels, surface water diversions, land elevation measurements, and water quality testing. The DMS will allow the GSAs to share data and store the necessary information for annual reporting.

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

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

Reporting will be generated from data from the GSA's including but is not limited:

- Seasonal groundwater elevation contours
- Estimated groundwater extraction by category
- Total water use by source

Additional items may be added to the DMS in the future as required. Data will be entered into the DMS by each GSA. The majority of the data will then be aggregated to the entity that will be responsible for the regional DMS and summarized for reporting to DWR. Groundwater contours are prepared outside of the DMS because of the need to evaluate the integrity of the data collected and generate a static contour set that has been reviewed and will not change once approved. Groundwater storage calculations are performed in accordance with the method described in Section 3.2.3, outside of the DMS. Results are uploaded to the DMS for annual reporting and trend monitoring. Since most of the pumping in the GSAs (and the Subbasin) are not currently measured, the groundwater pumping estimates are also calculated outside of the DMS using the methods developed by GSAs and uploaded to the DMS for annual reporting and trend analysis. Surface water deliveries are maintained by the surface water agencies in existing separate systems, so the data is collected by each GSA and provided to the DMS as an aggregate total by GSA. Table 7-2 provides how the DMS addresses each required element of the DMS and annual reporting requirements. The GSAs may choose to have their own separate system for additional analysis.

7.5 Annual Reporting

23 CCR § 356.2 *Annual Reports. Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:*

(a) General information, including an executive summary and a location map depicting the basin covered by the report.

(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.*
> *(c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.*

The GSAs will provide the Plan Manager or Subbasin Coordinator the required information of groundwater levels, extraction volume, surface water use, total water use, groundwater storage changes and progress of GSP implementation for the Basin Annual Report in accordance with the timelines required to meet the April 1st deadline each year. The anticipated schedule for completion of the annual report each year will be:

- Dec 31 – Deadline for GSAs to provide GSA specific information
- Feb 28 – Completion of draft annual report
- Mar 15 – Review by GSA and Board approval
- Apr 1 – Submittal to DWR by Basin Coordinator

The Subbasin annual report is anticipated to have an outline similar to the following:

- Chapter 1– Introduction
- Chapter 2– Land use and Surface Water Supplies
- Chapter 3– Groundwater Pumping
- Chapter 4– Sustainable Management Criteria
- Chapter 5– Monitoring Network Changes
- Chapter 6– Groundwater Projects and Management Actions Status

In addition to the required Subbasin-wide reporting to DWR, the annual report needs to include the following:

- Member and Participating agency project/program specific progress and status updates;
- Newly identify projects and programs added to the project list;
- Updates on changes in membership or organizational changes;
- Policy changes or modifications;
- New information collected in data gaps;
- Area specific investigations or improvements;
- Stakeholder engagement and outreach efforts; and
- GSA funding status.

7.6 Periodic Evaluations

> **23 CCR §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.
(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.

The annual report will include updates or changes to the GSP or policy changes by the GSA's. Certain components of the GSP may be re-evaluated more frequently than every five years, if deemed necessary. This may occur, for example, if sustainability goals are not adequately met, additional data is acquired, or priorities are altered. Those results will be incorporated into the GSP when it is resubmitted to DWR every five years.

In addition, the annual report will provide an assessment to DWR in accordance with the regulatory requirements, at least every five years. The assessment will include and provide an update on progress in achieving sustainability including current groundwater conditions, status of projects or management actions, evaluation of undesirable results relating to MOs and minimum thresholds (MTs), changes in monitoring network, summary of enforcement or legal actions, and agency coordination efforts in accordance with 23 CCR §356.4.

As projects and management actions are being considered to mitigate for overdraft many of the projects and management actions will have implications to the farming economy within the

Subbasin. Overdraft mitigation measures consist of the following Project and Management Actions:

- Infiltration Basins
- Storage Ponds
- New water delivery systems,
- Maintenance to existing water delivery systems,
- Crop rotation
- Fallowing of lands
- Pumping restrictions

These project and management actions will reduce the farmable acres, and initiate restriction of groundwater pumping. A reduction in farmable acres may result in adverse effects (e.g. reduction in jobs). On the other hand, groundwater pumping restrictions will result in positive effects (e.g. reduction in pumping costs and drilling of new wells).

Reduction in Farmable Acreage: Kings County anticipates a lack of water sources for agricultural production has the potential to impact employment statistics in the area (Nidever 2014). In 2014, Kings County residents experienced and average of 15 percent (%) unemployment in February, according to a report released by the state Employment Development Department. Compared to an unadjusted rate of 8.5 % for California and 7 % for the nation as a whole.

Reduction in Pumping: Transitioning the Subbasin area to sustainable groundwater management is expected to impact the agricultural sector in three key ways. First institutional restrictions on groundwater extraction are likely to alter the mix of crops grown in the region and the amount produced. Second, stabilized groundwater elevations are predicted to reduce groundwater pumping costs over time, thereby lowering costs of production. Third, stabilized groundwater elevations are expected to reduce the need for capital investment to refurbish wells and develop additional wells (RMC Water and Environment 2015).

Although, the reduction in groundwater pumping section states there will be an equalization of cost associated with higher groundwater levels due to pumping restrictions. This does not address the increase in the unemployment rate associated with the reduction in pumping (e.g. demand reduction). At this time there is not sufficient information to develop a financial impact due to demand reduction.

Table 7-1. §354.44 Projects and Management Actions

(a) Each Plan shall include a description of the projects and management actions the Agency has determined may achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.
(b) Each Plan shall include a description of the projects and management actions that include the following 1-9:
(c) Projects and management actions shall be supported by best available information and best available science.
(d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
PROJECTS												
1	Infiltration Basin Project	The Subbasin may adopt a policy to incentivize groundwater extractors through subsidies to utilize designate lands for banking only and or designate lands for scheduled banking under contract during certain periods of the season.	The goal is to encourage land owners to fallow land and replenish the groundwater, as well as encourage GSA water trading between GSA in the Tulare Lake Basin.	The policy will begin shortly after GSP approval and will solicit volunteers first. Project lands area needed will designed by GSA.	Demand reduction will be based on acreage removed from farming practices.	No permits or regulatory process is required for the Subbasin to adopt the policy. The Subbasin has the power as outlined in the SGMA, and related provisions to adopt ordinances.	Policy to be written by 2023 and implemented by 2025 and to remain indefinitely but can be revise as needed.	A direct benefit to the groundwater levels will be accomplished through this policy. Groundwater elevations will be utilized as the evaluation method.	The management action may be accomplished through policy adoption by the Subbasin. External water source is needed.	Estimated cost to draft and adopt policy, $50,000. Ongoing subsidies may range from annually.	Chronic lowering of groundwater levels or depletion of supply during periods of drought may be offset by a storing water in wetter years.	Level of uncertainty of the project is 2, in wet years there is water available for this area as well as the infrastructure to deliver it.
2	Storage Project	The Subbasin may adopt a policy to incentivize groundwater extractors through subsidies to utilize designate lands for storage only and or designate lands for scheduled storage under contract during certain periods of the season.	The goal is to encourage land owners to fallow land and replenish the groundwater, as well as encourage GSA water trading between GSA in the Subbasin.	The policy will begin shortly after GSP approval and will solicit volunteers first. Project lands area needed will designed by GSA.	Demand reduction will be based on acreage removed from farming practices.	No permits or regulatory process is required for the Subbasin to adopt the policy. The Subbasin has the power as outlined in the SGMA, and related provisions to adopt ordinances.	Policy to be written by 2023 and implemented by 2025 and to remain indefinitely but can be revise as needed.	A direct benefit to the groundwater levels will be accomplished through this policy, for in-leu groundwater supplies. Groundwater elevations will be utilized as the evaluation method.	The management action may be accomplished through policy adoption by the Subbasin. External water source is needed.	Estimated cost to draft and adopt policy, $50,000. Ongoing subsidies may range from annually.	Chronic lowering of groundwater levels or depletion of supply during periods of drought may be offset by storing water in wetter years.	Level of uncertainty of the project is 2, in wet years there is water available for this area as well as the infrastructure to deliver it.
3	Existing Infrastructure and/or Rehabilitation of New Construction	The Subbasin may adopt to fund projects to rehabilitate existing facilities, and construct new facilities to divert, or bank water in areas conducive of	The goal is to modify or develop new facilities that can deliver a larger amount of water when needed. As well as service an area that does not	Development of the project will begin shortly after GSP approval.	This project will work in conjunction with a banking project or other projects as needed.	No permits or regulatory process is required for the Subbasin to adopt the project. The Subbasin has the power as outlined in the SGMA, and related provisions	Project to be include in the GSP. Soon after adoption of GSP projects to begin development.	A direct benefit to the groundwater levels will be accomplished through this project, for in-leu groundwater supplies. Groundwater	The management action may be accomplished through policy adoption by the Subbasin. External water source is needed.	Estimated cost to draft and adopt policy, $50,000. Project costs will vary.	Chronic lowering of groundwater levels or depletion of supply during periods of drought may be offset by storing water in wetter years, trading of GW to	Level of uncertainty of the project is 2, in wet years there is water available for this area as well as the infrastructure to deliver it.

Table 7-1. §354.44 Projects and Management Actions (Continued)

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
		these activities. Including diversion systems, check structures, banking facilities, and storage facilities. Also, would allow GW trading within the Subbasin. Not intended to restrict water right holders.	have a delivery system.			to adopt ordinances or approve projects related to SGMA.		elevations will be utilized as the evaluation method.			minimize the concentration of pumping in one area.	
4	Agricultural land fallowing subsidies	The Subbasin may adopt a policy to incentive farmers to permanently fallow land. Policy will solicit volunteers first then look towards mandatory fallowing based on percentage reductions possibly on a rotation basis. To work in conjunction with New Development Policies.	The goal is to reduce irrigated acreage. The measurable objective is the acreage of fallowed land.	The policy will begin shortly after GSP approval and will solicit volunteers first. Project lands area needed will designed by GSA.	Demand reduction will be based on acreage removed from farming practices.	No permits or regulatory process is required for the Subbasin to adopt the policy. The Subbasin has the power as outlined in the SGMA, and related provisions to adopt ordinances.	Policy to be written by 2023 and implemented by 2025 and to remain indefinitely but can be revise as needed.	A direct benefit to the groundwater levels will be accomplished through this policy based on demand reduction. Groundwater elevations will be utilized as the evaluation method.	The management action may be accomplished through policy adoption by the Subbasin. No external water source is used.	Estimated cost to draft and adopt policy, $50,000. Ongoing subsidies may range from annually.	Chronic lowering of groundwater levels or depletion of supply during periods of drought may be offset by a permanent fallowing.	
OUTREACH												
1	Education of groundwater use per acre	The Subbasin may adopt a policy which provides groundwater extractors their approximate groundwater extraction on a per acre basis, and	The goal is to provide education and promote awareness of the Subbasin overdraft condition particularly for those groundwater	Implementation to occur at year one and thereafter, if extractor exceeds their extraction amount.	If individual extractors are over drafting, demand reduction will occur with compliance of this policy.	No permits or regulatory process is required for the Subbasin to adopt the policy.	The policy has not been drafted. It is expected to commence shortly after the adoption of the GSP and be completed within the first three years.	The expected benefits is to educated extractors of overdraft, this is the first step in policing SGMA. Extractors will be monitored.	The management action may be accomplished by Subbasin policy adoption. No external water source is used.	Estimated $50,000 cost to draft and adopt policy.	Within the education course a description of how recharge and ground water extraction will be credited to each extractor, during	

Table 7-1. §354.44 Projects and Management Actions (Continued)

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
		how SGMA will be enforced. As well as other policies developed by Subbasin.	extractors who do not have meters. The measurable objective is annual statements of groundwater extraction in acre-feet.								drought and other periods.	
ASSESSMENT												
1	Pumping fees for groundwater allocation exceedances	Policy for exceedance pumping beyond the current groundwater allocation. Can increase with each occurrence.	The goal is to incentivize groundwater extractors to pump only their groundwater allocation per year. The measurable objective is the volume of groundwater extraction in acre-feet.	First phase of the Policy will be written by 2023 and in implemented by Jan 2025. Fee's will increase every year after 2025 and with each occurrence.	This policy reduces and or each extractor with the budgeted amount of GW.	No permits or regulatory process is required for the Subbasin to adopt the policy. The Subbasin has the power as outlined in SGMA and related provisions to adopt ordinances, levy financial penalties, and enforce policies.	Policy is expected to be drafted and commence after the adoption of the GSP. Benefits will be added revenue to mitigated other projects in the area in addition to other assessments.	The expected benefit is the deter ground water extractors form exceeding their allocation. Other benefits will be revenue for projects to mitigate local overdraft. The method of evaluation will be a summary of over extractors and the reduction of those over extractors over time.	The management action may be accomplished by Subbasin policy adoption and enforcement. No external water source is used.	Estimated $50,000 cost to draft and adopt policy. Initial GSA assessments will be needed to fund the development of this policy.	Chronic lowering of groundwater levels or depletion of supply during periods of drought may be offset by temporary increases in fee structure or groundwater pumping restrictions.	
2	Pumping fees for groundwater extractions	The Subbasin may adopt a policy to impose fees on groundwater extractors on a per acre-foot basis. Fees are intended to support GSA activities and are not intended to be overbearing.	The goal is to incentivize groundwater extractors to reduce pumping and look for other sources of water. The measurable objective is the revenue generated to support GSA operations.	Policy to be written and implemented by 2025, and to remain indefinitely.	No direct reduction in demand.	No permits or regulatory process is required for the Subbasin to adopt the policy. The Subbasin has the power as outlined in the SGMA, and related provisions to adopt ordinances, levy financial penalties, and enforce policies.	Policy is expected to be drafted and commence after the adoption of the GSP. Benefits will be added revenue to support GSA operations.	The expected benefits will provide funding for GSA's to operate under SGMA.	The management action may be accomplished through policy adoption by the Subbasin and enforcement. No external water source is used.	Estimated $50,000 cost to draft and adopt policy. Initial GSA assessments will be needed to fund the development of this policy.	This policy in intended to be a part of the entire GSA operational Bylaws, there is no direct offset of chronic lowering of groundwater.	

Table 7-1. §354.44 Projects and Management Actions (Continued)

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
GW ALLOCATION												
1	Flood Flows, Spills into the Subbasin, include, Tule River, Deer Creek, Cross-Creeks and Kings River	The Subbasin may adopt a policy for actions to divert flows during flood releases to needed areas and a credit system for those who divert.	Validate Water Rights and existing agreements, measurable objective is to allocate water to the rightful owner.	Policy to be drafted by 2023 and implemented by 2025.	This management action alone may not generate a quantifiable demand reduction. However, it allocated water to be used in the proper service area.	No permits or regulatory process is required for the Subbasin to adopt the policy. State Water Resources Board is paying close attention to policies within a GSA that pertain to Water Rights and flood water diversion.	Policy to be written by 2023 and implemented by 2025 and to remain indefinitely but can be revise as needed.	The expected benefit is to encourage diversion of flood flows to areas to make the most ground water level impact.	Contract Holder, reliability varies based on allocation.	Estimated $25,000 cost to draft and adopt policy.	Diverted water will offset a depletion of supply during Periods of drought.	
2	Development of groundwater allocation per acre	The Subbasin may adopt a policy which provides a finite groundwater allocation on a per acre basis, either based on the modeling efforts or the sustainable yield. Ultimate groundwater allocation may take into consideration the existing water rights holders, disadvantaged communities (DACs), groundwater-dependent ecosystems (GDEs), and CA Native American tribes. The Subbasin may allocate to	The goal is to ensure a fair groundwater allocation which clearly defines the acceptable groundwater extraction volume per year at a certain rate, based on crop growing season(s). The measurable objective is the volume of groundwater extraction in acre-feet.	This policy is the first step in Subbasin sustainability. Policy to be written by 2023 and implemented by 2025.	This policy will be a direct reduction in demand as extractors will need to operate within the means of the allocation. Groundwater levels will be used as the quantification of demand reduction.	No permits or regulatory process is required for the Subbasin to adopt the policy. The Subbasin has the power as outlined in SGMA and related provisions to adopt ordinances.	Policy to be written by 2023 and implemented by 2025 and to remain indefinitely but can be revise as needed.	The expected benefits may mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner. Extractions will be monitored.	The management action may be accomplished by Subbasin policy adoption. No external water source is used.	Estimated $50,000 cost to draft and adopt policy.	Chronic lowering of groundwater levels or depletion of supply during periods of drought may be offset by a temporary change in groundwater allocation per acre.	

Table 7-1. §354.44 Projects and Management Actions (Continued)

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
		agencies or individual landowners, to coincide with assessments.										
3	Groundwater Marketing	This policy will include ground water marketing. Marketing will include groundwater from within the Subbasin with options to market within the GSA's, between GSA's and outside the Subbasin. With the GSA's having the first right of refusal for marketing outside of the Subbasin.	The goal is to set policy that encourages water marketing within the Subbasin.	Policy to be written by 2023 and implemented by 2025. Implementation trigger is to provide an extractor a method to generate revenue to offset assessments.	This policy will be a direct reduction in demand as small volume extractors will be encouraged to fallow land and market groundwater, within their allocated amount. Groundwater levels will be used as the quantification of demand reduction.	No permits or regulatory process is required for the Subbasin to conduct the study. Through the study, multiple jurisdictions and agencies may be contacted for the potential permits and regulatory requirements of new surface water supplies.	The water marketing strategy grant has been approved by the USBR, Funding opportunity to close in May of 2019. Other grant solicitations are expected.	The expected benefits include utilizing groundwater supplies within the Subbasin. Encourage demand reduction through fallowing. Groundwater levels will be evaluated.	The management action may be accomplished by Subbasin policy adoption. No external water source is used.	Estimated cost $50,00 to draft and adopt policy.	This policy will include the landowners who are a purchaser or seller of groundwater shall install a water meter on their wells and report all activities to their GSA's.	
DEVELOPMENT												
1	Require new developments (non-de minimis extractors) to prove sustainable water supplies.	This policy requires new developments (non-de minimis extractors) to prove sustainable water supplies. The Subbasin may review and comment on all new development environmental documents to ensure water balance and corresponding mitigation	The goal is to ensure all new developments (non-de minimis extractors) do not exceed the current Subbasin groundwater allocation and groundwater supplies are consumed or retained within the Subbasin boundary. The measurable objective is to	To be implemented as a revision to the Kings County's Ordinance.	Policy is to minimize undesirable effects by requiring construction of wells to be designed for minimum thresholds without familiar. To be implemented after approval of GSP.	The regulatory process may require cooperation from the County/City to ensure the Subbasin reviewed and commented on the environmental documents prior to County/City approval. The Subbasin has the power as outlined in the SGMA, and related provisions	Policy to be written and implemented by 2023.	The expected benefits may mitigate overdraft by ensuring new developments utilize groundwater supplies in accordance with current Subbasin groundwater allocations and groundwater supplies are consumed or retained within the Subbasin boundary. The method of	The management action may be accomplished through Subbasin policy adoption and coordination with the County/City. The Subbasin may request County/City development procedures to include the circulation of environmental documents and	Estimated cost to draft and adopt policy $25,000.	Policy will help in data collection and extraction reporting as part of the permitting process.	

Table 7-1. §354.44 Projects and Management Actions (Continued)

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
		measures are implemented. Requires County support.	monitor and hold everyone accountable as well as promote connection to city services where applicable.			to adopt ordinances. Potential incorporation into a Peer Review.		evaluation may be quantifying the number of new developments that are approved without Subbasin comment/approval.	approval from Subbasin prior to County/City approval. No external water source is used.			
MONITORING REPORTING												
1	Flood Flows (Spills into the Subbasin), include, Tule River, Deer Creek, Cross-Creeks and Kings River	The Subbasin may adopt a policy for actions to divert flows during flood releases to needed areas and a credit system for those who divert.	Validate the Water Right, measurable objective is to allocate water to the rightful owner.	Policy will begin soon after GSP is approved and will help fill data gaps.	This management action alone may not generate a quantifiable demand reduction. However, it allocated water to use in the proper service area.	No permits or regulatory process is required for the Subbasin to adopt the policy. State Water Resources Board is paying close attention to policies within a GSA that pertain to Water Rights and flood water diversion.	Policy to be written and implemented in 2023.	The expected benefit is the guaranty that purchased water is credited to correct area. Data gathered will fill data gaps. Groundwater Elevations will be the method of evaluation.	Contract Holder, reliability varies based on allocation.	Estimated cost to draft and adopt policy $25,000.	Utilized contract volumes to be included in the calculation of the groundwater extraction proportionate share.	
2	Registration of extraction facilities	The Subbasin may adopt a policy to require registration of a groundwater extraction facility within the Subbasin. Requires County support. Includes existing and future facilities.	The goal is to improve the Subbasin's database of groundwater extraction locations. The measurable objective is the number of new registered facilities, fill data gaps.	The policy may be implemented shortly after the adoption of the GSP and remain until the Subbasin's overdraft has ended or indefinitely. The County must also support the policy.	This policy will help fill data gaps and give a better understanding of the groundwater within the Subbasin.	The regulatory process may require cooperation from the County to ensure new well permits issued within the Subbasin adhere to the Subbasin's policy. The Subbasin has the power as outlined in SGMA and related provisions to adopt ordinances.	Policy to be written and implemented in 2023.	The expected benefits may mitigate overdraft by improving the Subbasin's knowledge of groundwater extraction locations. The method of evaluation may be comparing the number of registered wells vs. the County/State databases known wells.	The management action may be accomplished by policy adoption by the Subbasin and coordination with the County. The Subbasin may request County well permit procedures to include the Subbasin's requirements prior to issuance. No external water source is used.	Estimated cost to draft and adopt policy $25,000. There will be a cost to administer the policy, it is not known at this time.	Fill data gaps and include this information in the calculation of the groundwater extraction proportionate share.	

Table 7-1. §354.44 Projects and Management Actions (Continued)

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
3	Require self-reporting of groundwater extraction, water level, and water quality data	The Subbasin may adopt a policy to require groundwater users (excluding de minimis extractors) to self-report groundwater extractions, static water levels, and water quality data twice per year.	The goal is to improve the Subbasin's data collection of groundwater extractions, water level and quality monitoring network, and serve other management actions.	This policy will fill data gaps. To be incorporated into a well testing policy for wells with meters. The policy may be implemented shortly after the adoption of the GSP and remain indefinitely or until Subbasin's overdraft has ended.	This policy will help fill data gaps and give a better understanding of the groundwater within the Subbasin.	No permits or regulatory process is required for the Subbasin to adopt the policy. The Subbasin has the power as outlined in SGMA and related provisions to adopt ordinances, levy financial penalties, and charge administrative costs.	Policy to be written and implemented in 2023.	The expected benefits may mitigate overdraft by improving the Subbasin's knowledge of groundwater extractions, water levels, water quality and provide extractors with useful information. The method of evaluation may be reviewing the number of responses from groundwater users (excluding de minimis extractors), analyzing data validity/accuracy, and filling data gaps.	The management action may be accomplished by policy adoption by the Subbasin. The Subbasin may develop an online reporting tool. No external water source is used.	Estimated cost to draft and adopt policy $25,000. There will be a cost to administer the policy, it is not known at this time, but is expected to be high.	Fill data gaps and include this information in the calculation of the groundwater extraction proportionate share.	
4	Require well meters, sounding tubes, and water quality sample ports.	The Subbasin may adopt a policy to require meters, sounding tubes, and sample ports be installed on wells, pump and motor replacements, and well repairs (excluding de minimis extractors). Requires County support.	The goal is to improve the Subbasin's data collection of groundwater extractions, water level and quality monitoring network. The measurable objective is the number of well permits and filling the data gaps.	The policy may be implemented shortly after the adoption of the GSP and remain until Subbasin's overdraft has ended or indefinitely. The County must also support the policy.	This policy will help fill data gaps and give a better understanding of the groundwater within the Subbasin.	The regulatory process may require cooperation from the County to ensure new well permits issued within the Subbasin adhere to the Subbasin's policy. The Subbasin has the power as outlined in SGMA and related provisions	Policy to be written and implemented in 2023.	The expected benefits may mitigate overdraft by improving the Subbasin's knowledge of groundwater extractions, water levels, water quality, fill data gaps. The method of evaluation may be reviewing the number of well permits and	The management action may be accomplished by policy adoption by the Subbasin and coordination with the County. The Subbasin may request County well permit procedures to include the Subbasin's requirements prior to issuance. No	Estimated cost to draft and adopt policy $25,000. There will be a cost to implement the policy, it is not known at this time, but is expected to be high, and who is responsible.	Fill data gaps and include this information in the calculation of the groundwater extraction proportionate share.	

Table 7-1. §354.44 Projects and Management Actions (Continued)

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, & Accrual of Benefits (b)(4)	Explanation of Benefits & Method of Evaluation (b)(5)	Explanation of Water Source & Reliability (b)(6)	Cost & Funding Options (b)(8)	Management of Groundwater Extraction & Recharge (b)(9)	Level of Uncertainty associated with the basin setting, 1=uncertain 5=certain (d)
						to adopt ordinances.		confirming whether meters, sounding tubes, and sample ports were installed.	external water source is used.			
EXISTING CONTRACTS												
1	Flood Flows, Spills into the Subbasin, include, Tule River, Deer Creek, Cross-Creeks and Kings River	The Subbasin may adopt a policy for actions to divert flows during flood releases to needed areas and a credit system for those who divert.	Validate Water Rights and existing agreements, measurable objective is to allocate water to the rightful owner.	Policy to be drafted by 2023 and implemented by 2025.	This management action alone may not generate a quantifiable demand reduction. However, it allocated water to be used in the proper service area.	No permits or regulatory process is required for the Subbasin to adopt the policy. State Water Resources Board is paying close attention to policies within a GSA that pertain to Water Rights and flood water diversion.	Policy to be written by 2023 and implemented by 2025 and to remain indefinitely but can be revise as needed.	The expected benefit is to encourage diversion of flood flows to areas to make the most ground water level impact.	Contract Holder, reliability varies based on allocation.	Estimated $25,000 cost to draft and adopt policy.	Diverted water will offset a depletion of supply during periods of drought.	

*(b)1() refers to the subsection of §354.44 that the column addresses
Note: The following sections were noted below because they apply to all management actions with very little variance.
Public Notice (b)(1)(B): The Subbasin may provide public notice in multiple formats and platforms, adopted policies may reside in Subbasin Board Meeting minutes and Subbasin Policy Manual available on the Subbasin website. Electronic notice may be provided to any person who requests email notifications. The Subbasin Board may hold regular monthly meetings and annual education workshops.
Legal Authority (b)(7): The Subbasin has the power as outlined in the SGMA, and related provisions to adopt ordinances, levy financial penalties, and enforce programs.
Cost & Funding Options (b)(8): Subbasin administrative and operating costs may be funded through various financial avenues discussed further in GSP Chapter 7.2.

Table 7-2. DMS Annual Reporting Requirements

Regulation	Requirement	Input to DMS
356.2(b)(1)(B)	Hydrographs incl water year type from Jan 2015	Generated in DMS from water level data input by GSAs
356.2(b)(1)(A)	GW Elevation Contours (spring & fall)	Generated outside DMS using data from DMS then contour lines uploaded into DMS
356.2(b)(2)	GW extraction by water use sector incl method of determination and map	Determined outside DMS. Total use by sector input by each GSA then summarized for basin in DMS
356.2(b)(3)	Surface Water use by source	Total by GSA input to DMS and summarized for basin in DMS
356.2(b)(4)	Total Water use by sector	DMS summary table of water supplies by sector per GSA
356.2(b)(5)(A)	Change in GW Storage map	Calculated outside DMS from contour data using basin-wide method then total per GSA input into DMS
356.2(b)(5)(B)	Graph with Water Year type, GW use, annual & cumulative GW Storage change	DMS generated basin total graph using data in DMS

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APPENDIX A

CONTACT INFORMATION FOR GSAs

APPENDIX A

Contact Information for the Tulare Lake Subbasin Groundwater Sustainability Agencies

Groundwater Sustainability Agency	Plan Manager	Address	Telephone	Email
Mid-Kings River	Dennis Mills, Secretary	200 North Campus Dr. Hanford, CA 93230	(559) 584.6412	kcwdh20@sbcglobal.net
El Rico	Jeof Wyrick, Chairman	101 W. Walnut St. Pasadena, CA 91103	(626) 583.3000	jwyrick@jgboswell.com
South Fork Kings	Charlotte Gallock, Program Administrator	4886 E. Jensen Ave. Fresno, CA 93725	(559) 242.6128	charlotte@southforkkings.org
Southwest Kings	Dale Melville, Executive Director	286 Cromwell Ave. Fresno, CA 93711	(559) 449.2700	dmelville@ppeng.com
Tri-County Water Authority	Deanna Jackson, Executive Director	944 Whitley Ave. Suite E. Corcoran, CA 93212	(559) 762.7240	djackson@tcwater.org

APPENDIX B

STAKEHOLDER COMMUNICATION AND ENGAGEMENT PLAN

Appendix B: Stakeholder Communication & Engagement

A. Communication & Engagement Overview

As required by SGMA, GSAs must consider the interests of all beneficial uses and users of groundwater and include them in the GSP development process. The five GSAs within the Tulare Lake Subbasin developed a joint Communication & Engagement (**C&E**) Plan that addressed how stakeholders within the individual GSA boundaries (and when collaboration was plausible, at the subbasin-level) would be engaged through stakeholder education and opportunities for input and public review during the development and implementation of the GSP. This plan provides an overview of the Tulare Lake Subbasin GSAs, their stakeholders, and decision-making process; identifies opportunities for public engagement and discussion of how public input and responses would be used; describes how the Tulare Lake Subbasin GSAs encouraged the active involvement of diverse, social, cultural, and economic elements of the population within their individual boundaries and subbasin boundary; and the methods to be used to inform the public stakeholders about the progress of GSP development, public review and implementation. The Tulare Lake Subbasin GSAs' complete C&E Plan can be downloaded from the GSAs' individual websites.

As outlined by the DWR in the GSP Stakeholder Communication and Engagement Guidance Document, the Communication & Engagement Plan defines the Tulare Lake Subbasin GSAs' process for accomplishing the seven general steps in stakeholder communication and engagement:

- **Set Goals and Desired Outcomes –** Description of the situation at a high level with clear goals and objectives, identifying overriding concerns
- **Identify Stakeholders –** Development of a broad list of individuals, groups and organizations who need to be engaged in the process
- **Stakeholder Survey and Mapping –** Conducting a stakeholder survey to develop a "Lay of the Land" overview
- **Messages and Talking Points –** Definition of the key messages needed to effectively convey to the various subbasin stakeholders
- **Venues for Engaging –** Identification of opportunities (venues and methods) to engage stakeholders
- **Implementation Timeline –** Creation of a timeline to inform the process and highlight when to engage with stakeholders
- **Evaluation and Assessment –** Definition of a process to evaluate if communication and engagement goals are being met at the individual GSA level and through collaborative subbasin efforts

A.1 Communication Objectives to Support the GSP

The ultimate goal of communication objectives during the formation/coordination, GSP development, public review and implementation phases of the SGMA compliance, is to encourage active involvement of diverse, social, cultural, and economic elements of the population within the GSA boundary. The Tulare Lake Subbasin GSAs have given beneficial users and users of groundwater opportunities to engage in the GSP process, and provided educational outreach opportunities for stakeholders while reaching out through specific communication avenues. As active stakeholders, members of the Boards of Directors and Stakeholder/Advisory Committees are direct representatives of their districts, communities and industries, and they continually gather feedback/input, and the concerns/needs of their constituents and report back to their respective meetings. Any stakeholder input received was reviewed by the GSA and Subbasin technical teams and taken into consideration during GSP development.

A.1.1 Phase 1: GSA Formation and Coordination

Phase 1: GSA Formation and Coordination was the first phase completed. This phase stretched from 2015 through 2018, and consisted of forming the individual GSAs, development of a subbasin coordination agreement, establishing the List of Interested Parties, and creating the Communication & Engagement Plan to outline communication efforts for the GSP development, public review and implementation phases. Stakeholder input was utilized during the GSA formation phase, as beneficial users and stakeholders with interests in groundwater usage within the GSAs' boundaries were notified via public meeting notices as soon as the process began.

A.1.2 Phase 2: GSP Preparation and Submission

Phase 2: GSP Preparation and Submission spanned from 2018 through January 31, 2020. With the goal of having the draft GSP before the end of the third quarter in 2019, 2018 was primarily the technical development of the plan, while working with GSA Boards of Directors, technical teams/committees, and GSA management at the subbasin level, as well as stakeholders for feedback and input. During the last quarter of 2018, the first round of public outreach meetings and interaction with stakeholder groups and other community organizations and entities was held with the purpose of educating and informing stakeholders about SGMA and the GSP process, while also soliciting feedback and input from these groups to consider and possibly include feedback and input into the GSP. Public outreach for this phase was completed by the individual GSAs.

A.1.3 Phase 3: GSP Review and Evaluation

During 2019, Phase 3: GSP Review and Evaluation, the communication and engagement efforts continued. Once the draft of the GSP was completed in September 2019, the public review process began. A 90-day comment period was held, with the GSP draft posted on the Tulare Lake Subbasin GSAs' websites for all stakeholders to conveniently download and review and provide comments. Outreach meetings were held during this phase both on subbasin-wide level, as well as by individual GSAs. These meetings focused on an overview of the GSP content, while giving stakeholders a public forum to provide their feedback and comments.

Once the public review period was completed, public comments were taken into consideration and incorporated into the final version of the Tulare Lake Subbasin GSP before submitting to the DWR by January 31, 2020. Following submittal, stakeholders will be given a second 60-day comment period through the DWR's SGMA portal at http://sgma.water.ca.gov/portal/. Comments will be posted to the DWR's website prior to the state agency's evaluation, assessment and approval.

A.1.4 Phase 4: Implementation and Reporting

Phase 4: Implementation and Reporting will begin once the plan is submitted by January 31, 2020. Even while the DWR is reviewing the GSP, SGMA-implementation at the GSA-level must begin. During the implementation phase, communication and engagement efforts will be shifted to educational and informational awareness of the requirements and processes for reaching groundwater sustainability as set forth in the submitted GSP. Active involvement of all stakeholders will be encouraged during this phase, and public notices are required for any public meetings and prior to imposing, and later increasing, any fees. Public outreach for this phase will also be completed by the individual GSAs with collaborative subbasin-wide efforts when target audiences span more than one GSA boundary.

B. Tulare Lake Subbasin GSAs' Decision-Making Process

The Tulare Lake Subbasin GSAs' decision-making process is broken down by the roles of the subbasin management team, Board of Directors and Stakeholder/Advisory Committees. The roles of these subbasin and GSA entities and their responsibilities are outlined below.

- **Subbasin Management Team –** Comprised of a representative from each of the five GSAs working collaboratively to jointly manage groundwater within the Tulare Lake Subbasin and to develop a GSP. These individuals met on a monthly and then bi-weekly basis throughout the GSP development and public review phases.
- **Boards of Directors –** Adopts general policies regarding development and implementation of the individual GSAs and the GSP.
- **Stakeholder/Advisory Committees –** Representing all beneficial uses and users of groundwater within the individual GSA boundaries, makes recommendations to the Boards of Directors and technical consultants regarding feedback from stakeholders and adoption of a GSP that accounts for local interests. Not all GSAs have stakeholder/advisory committees, and while allowed within SGMA, these committees are not required.

B.1 Role of Boards of Directors

The Tulare Lake Subbasin GSAs' Boards of Directors all consistently function as the governing body of the specific GSA, formed to adopt general policies regarding development and implementation of the GSP. Governance of each GSA is described below, and meeting dates, times and locations for each board are noted. All meetings were open to the public during the formation, development and public review phases, and will continue to be open to the public during the implementation phase.

B.1.1 El Rico GSA

El Rico GSA's Board of Directors consists of seven directors: one representative appointed by the Tulare Lake Basin Water Storage District board, one representative appointed by the governing board of Salyer Water District, two representatives appointed by the Corcoran Irrigation District, two representatives appointed by Melga Water District, and one representative appointed by the Lovelace Reclamation District No. 739.

El Rico GSA's board meetings are held on the first Wednesday of each month at 1 p.m. at the Tulare Lake Basin Water Storage District's office, located at 1001 Chase Avenue in Corcoran, unless otherwise posted on the Kings River Region Groundwater Portal's calendar.

B.1.2 Mid-Kings River GSA

The Board of Directors of the Mid-Kings River GSA are appointed, three elected members of the KCWD, and one elected member of the City of Hanford. The Mid-Kings River GSA Board of Directors meet on the second Tuesday of every month at 1 p.m. at the Kings County Water District, located at 200 Campus Drive in Hanford.

B.1.3 South Fork Kings GSA

The governing board of the South Fork Kings GSA is composed of one appointee of each member agency as a "principal director." The principal director is an individual currently serving on the board or council of each of the members. Board of Directors meetings for the South Fork Kings GSA are held bi-monthly on the third Thursday of every February, April, June, August, October and December at 5:30 p.m. in the Lemoore City Council Chambers, located at 429 C Street in Lemoore.

B.1.4 Southwest Kings GSA

Southwest Kings GSA is governed by a five-person board of directors comprised of two members of the Dudley Ridge Water District, two members of the Tulare Reclamation District No. 761, and one director selected by a majority vote of the other four appointed members. The non-district member is a landowner, or his/her representative, who owns land in the white areas of the GSA boundary.

The Southwest Kings GSA's board meetings are held on the second Wednesday of every month at 3 p.m. at 286 W. Cromwell Avenue in Fresno. A monthly GSA status report is posted on the GSA's website.

B.1.5 Tri-County Water Authority GSA

The Tri-County Water Authority GSA JPA board of directors is comprised of four signatories and five board seats: Angiola Water District (general manager and a representative), Deer Creek Storm Water District (general manager and representative), Wilbur Reclamation District #825 (one representative), and County of Kings (non-voting representative). The Board of Directors meetings are held on the second Thursday of every other month at 1 p.m. at the Tri-County Water Authority Boardroom, located at 944 Whitley Avenue in Corcoran.

B.2 Role of Stakeholder/Advisory Committees

In Section 10727.8 "Public Notification and Participation; Advisory Committee" of the Sustainable Groundwater Management Act, GSAs may appoint and consult with an advisory committee for the purpose of developing and implementing a GSP. Through a stakeholder/advisory committee, a GSA is able to encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin prior to and during the development and implementation of the GSP.

B.2.1 Tri-County Water Authority GSA

The Tri-County Water Authority GSA's Technical Advisory Committee and Stakeholder Advisory Committee meet jointly on the fourth Wednesday of every month at 10 a.m. at the Tri-County Water Authority, located at the 944 Whitley Avenue in Corcoran.

C. Beneficial Uses and Users of Groundwater

Based on the applicable interests identified in SGMA, Section 10723.2 "Consideration of All Interests of All Beneficial Uses and Users of Groundwater", the five Tulare Lake Subbasin GSAs (El Rico, Mid-Kings River, South Fork Kings, Southwest Kings and Tri-County Water Authority) identified the stakeholder groups with interests within their GSA boundaries. These specific stakeholder groups have financial, political, business or personal stakes in the management of groundwater within the jurisdiction of the Tulare Lake Subbasin and were the focus of communication and engagement efforts during the GSP development and public review phases, and will continue to be engaged during the implementation phase. These stakeholders are listed by GSA in **Table 1**, **Table 2**, **Table 3**, **Table 4** and **Table 5**.

C.1 Environmental Users of Groundwater

It should be noted that environmental users of groundwater within the Tulare Lake Subbasin were investigated by the El Rico GSA, MKRGSA, SFKGSA, SWKGSA and TCWA, but there were not any identified that have specific groundwater interests within the subbasin.

C.2 Native American Tribes

The only Native American Tribe within the Tulare Lake Subbasin boundary is the Santa Rosa Rancheria Tachi-Yokut Tribe. The Tachi-Yokut Tribe was invited to participate in GSP development via a letter sent on June 28, 2016 by the then Upper Tulare Lake GSA MOU Group (now known as the South Fork Kings GSA). A copy of the letter is included in the Appendix A of the Tulare Lake Subbasin GSAs' Communication & Engagement Plan. The Tribe's EPA director attended one of the South Fork Kings GSA's board meetings, and has been on their Interested Parties List since April 2017, receiving regular updates about GSP development within the SFKGSA and the Tulare Lake Subbasin. In addition, a Sacred Lands File & Native American Contacts List Request was also sent to the Native American Heritage Commission.

C.3 Subbasin Industries and DACs

C.3.1 Industries

Collaboration meetings were held with the companies and organizations within the following industries to make sure their organizational visions and groundwater needs for facility operations were taken into consideration during GSP development and implementation phases. While an overview of the main industries within the Tulare Lake Subbasin are described below, the industries specific to each GSA are described in **Section C.4**.

Agriculture

Agriculture is one of the top three industries in Kings County. According to the 2017 Kings County Agricultural Crop Report published by the Kings County Ag Commissioner's office, the county is the tenth largest agriculture production county in California and grossed over $2 billion in 2017. With over 818,000 acres of farmland, the top commodities produced in Kings County are milk, cotton, cattle, nuts (almonds, pistachios and walnuts), tomatoes, silage corn, grapes, and stone fruit. As one of the primary industries, agriculture is the largest private employer in the county.

Because of the significant presence of agriculture production within the Tulare Lake Subbasin, agriculture industry stakeholders needed to be involved and informed during the development and public review phases of the GSP. Implementation will have a significant direct impact on the industry, and ultimately the local, state and national economies. The Tulare Lake Subbasin GSAs engaged with agriculture stakeholders routinely on an individual GSA-basis, and collaboratively at a subbasin level.

Food Processing

Kings County is a home to multiple food processors. Four of the top employers within the county are food processing facilities, accounting for over 4,000 jobs for the local workforce. Within the South Fork Kings GSA, Leprino Foods, alone, is responsible for 40 percent of water usage and provides just over 1,000 jobs. Because of their direct tie to the agricultural industry and reliance on groundwater supplies, to operate their facilities, food processors are included in the groundwater sustainability management within the subbasin boundary. The Tulare Lake Subbasin GSAs met with the food processing companies within their GSA boundaries on an individual basis for direct input and feedback during the GSP development and public review phases, and will continue to do so during the implementation phase.

Oil Production

Oil production is a main industry in certain areas of Kings County and the Tulare Lake Subbasin, primarily within in the Kettleman City area. Oil was discovered in the Kettleman Hills in 1928 at the Kettleman North Dome Oil Field. This oil field became one of the most productive oil fields in the United States in the early 1930s. Within this region, oil and agricultural production share the land surface, and will continue with joint usage of well drilling rigs and agricultural production activities such as grazing. The oil industry is considered a beneficial user of groundwater, and Tulare Lake Subbasin GSAs engaged with the oil companies within their GSA boundaries on an individual basis for direct input and feedback during the GSP development and public review phases, and will continue to do so during implementation phases.

C.3.2 DACs

Communication and educational outreach efforts with disadvantaged communities (**DAC**) and severely disadvantaged communities (**SDAC**) was needed for the development and implementation of the Tulare Lake Subbasin's GSP according to the Department of Water Resources' Best Management Practices. Information used to communicate to and engage the DACs in the GSP process, included an explanation of SGMA and soliciting feedback. GSA representatives regularly communicated with DACs and gave presentations on SGMA to community representatives, while gathering their feedback and input.

By including DACs and SDACs in communication efforts during the development, public review and implementation phases of the GSP, residents were more likely to participate and provide feedback that could be crucial to long-term solutions for groundwater sustainability within their communities. Any feedback received from DAC/SDAC residents was reviewed and evaluated by the Tulare Lake Subbasin GSAs during the GSP development and public review phases.

C.4 GSA-Specific Stakeholders

The GSAs worked cooperatively with their respective stakeholders throughout the development and public review of the GSP, and will continue to do so through the implementation phase.

C.4.1 El Rico GSA Stakeholders

The interests of the parties identified in **Table 1** were considered in the operation of the El Rico GSA and the development and implementation of the GSP. The primary industry within the El Rico GSA is agriculture. Other industries within the boundary include food processing, as well as warehousing and distribution, and standard commerce industry that is standard in a community of 10,000 people (automotive shops, supermarkets, etc.).

Table 1. Stakeholder Groups with Interests in the El Rico GSA

Stakeholder Group	Description
Agricultural Users	Represented through many of the GSA member agencies and/or by the County of Kings.
Domestic Well Owners	Represented through member agencies including the County of Kings or via exemption for small amounts of groundwater extraction.
Municipal Well Operators	City of Corcoran
Public Water Systems	City of Corcoran

Stakeholder Group	Description
Local Land Use Planning Agencies	City of Corcoran, County of Kings
Surface Water Users	Represented through GSA member agencies
Disadvantaged Communities	City of Corcoran
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	Represented by GSA member agencies including Tulare Lake Basin Water Storage District that collects and reports data for multiple members of the agency via the Tulare Lake Coordinated Groundwater Management Plan.

C.4.2 Mid-Kings River GSA Stakeholders

The interests of all beneficial uses and users of groundwater within the MKRGSA are identified in **Table 2**. The primary industries within the Mid-Kings River GSA is agriculture and food processing.

Table 2. Stakeholder Groups with Interests in the Mid-Kings River GSA

Stakeholder Group	Description
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users
Domestic Well Owners	There are domestic wells within the MKR GSA area, and it is understood that many rural domestic users will fall into the "de minimis extractor" category, so further work is being conducted to understand to what extent domestic users will be affected by GSP requirements.
Public Water Systems	Armona CSD, Home Garden CSD and Hardwick Water Company, as well as several transient public water systems for school districts are included in this category (Kings River-Hardwick, Pioneer, Hanford Christian).
Municipal Water Systems	City of Hanford
Local Land Use Planning Agencies	City of Hanford and County of Kings
California Native American Tribes	See **Section C.2**.
Disadvantaged Communities	Armona, Home Garden, Hardwick
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	Kings County Water District monitors groundwater levels within its service area and is providing a subset of that information to the Kings River Conservation District for submission to the CASGEM system.

C.4.3 South Fork Kings GSA Stakeholders

An initial list of stakeholders within the South Fork Kings GSA is described in **Table 3**. The primary industries within the South Fork Kings GSA is agriculture and food processing.

Table 3. Stakeholder Groups with Interests in the South Fork Kings GSA

Stakeholder Group	Description
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users
Domestic Well Owners	
Municipal Well Operators	City of Lemoore, Stratford Public Utility District
Local Land Use Planning Agencies	City of Lemoore, County of Kings
California Native American Tribes	See **Section C.2**.

Stakeholder Group	Description
Disadvantaged Communities	Community of Stratford
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. SFKGSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.

C.4.4 Southwest Kings GSA Stakeholders

The interests of all beneficial uses and users of groundwater within the Southwest Kings GSA are described in **Table 4**. The primary industries within the Southwest Kings GSA are agriculture, oil production and commercial usage specific to Kettleman City.

Table 4. Stakeholder Groups with Interests in the Southwest Kings GSA

Stakeholder Group	Description
Agricultural Users	Approximately 99 percent of the GSA's area is composed of agricultural lands. Representatives of the agricultural community are currently involved on the Board of Directors and on GSA committees and subcommitees.
Domestic Well Owners	Only one or two landowners utilize a domestic well, and are represented on the Board of Directors through member agencies.
Municipal Well Operators	Kettleman City CSD provides well water to residential and commercial customers within the GSA boundary.
Local Land Use Planning Agencies	County of Kings
California Native American Tribes	See **Section C.2**.
Disadvantaged Communities	Kettleman City
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. SWKGSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.

C.4.5 Tri-County Water Authority GSA Stakeholders

The Tri-County Water Authority provided stakeholder groups identified in **Table 5** with opportunities to provide input throughout the process of developing, operating and implementing the GSA and GSP. The primary industry within the Tri-County Water Authority GSA is almost entirely agriculture.

Table 5. Stakeholder Groups with Interests in the Tri-County Water Authority GSA

Stakeholder Group	Description
Agricultural Users	Composed almost entirely of agricultural users, including nut grower commodity groups and other agricultural use growers
Domestic Well Owners	There are domestic wells within the GSA area, but because SGMA excludes "de minimis extractors," it is anticipated that the GSP will exclude domestic wells from such requirements.
Local Land Use Planning Agencies	County of Kings
Federal Government	Bureau of Land Management
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	Angiola Water District, Tulare Lake Basin Water Storage District

D. Public Outreach Meetings/Stakeholder Involvement Opportunities

D.1 Communication & Outreach Methods

There were a variety of opportunities, venues and methods for the Tulare Lake Subbasin GSAs to connect with and engage stakeholders throughout GSA formation, GSP development, GSP review, and will continue to be utilized through the GSP implementation phases. Stakeholder groups identified in **Section C** were engaged through communication methods outlined in this section.

D.1.1 Printed Communication

Printed materials incorporated the visual imagery established through individual GSA branding efforts and was tailored for specific means of communication throughout the phases of GSP development, public review and implementation. Printed materials were also translated into Spanish, when necessary for thorough, diverse stakeholder education.

- **Fliers –** Fliers designed and tailored for stakeholder audiences, encompassed infographics and text with key messages that were pertinent for that phase of GSP development. Distribution was via GSA-website posting, direct mail, email, and direct distribution as handouts throughout communities, GSA and subbasin outreach meetings. For outreach to DACs/SDACs, fliers were available in both English and Spanish languages.
- **Letter Correspondence –** When letter correspondence was necessary, particularly during the public review and implementation phases, letters were distributed via email and/or direct mail. Letters included pertinent facts and explanations that needed to be communicated to specific stakeholder groups.
- **Presentation Materials –** Power Point presentations were utilized at educational/outreach public meetings. For a consistent message subbasin-wide, a draft presentation was developed for the GSP development and public review phases, with placeholder slides for GSAs to update with GSA-specific information. Handouts of presentations and smaller versions of display boards were distributed to stakeholders in attendance, emailed to the Interested Parties list, and posted on individual GSAs' websites for stakeholders to access, particularly if they were unable to attend.

D.1.2 Digital Communication

Digital communication outlets were also designed to incorporate Tulare Lake Subbasin GSAs' branding and was a significant mode of communication through the GSP development and public review phases, and will continue to be crucial during the implementation phase.

- **Websites –** Public meeting notices, agendas and minutes of the Board of Directors and Stakeholder/Advisory Committee meetings were posted on the individual GSAs' websites. These websites serve as integral resources for stakeholders within the Tulare Lake Subbasin boundary. Electronic files of printed materials, presentations and other educational resources, and direct links to stakeholder surveys (English and Spanish versions) were also accessible via the websites.

  As printed materials were created, PDFs of the same information were added to the GSAs' websites. This served as a way for stakeholders to easily educate themselves on the GSP process and phases.

Table 6. Tulare Lake Subbasin GSAs' Websites

GSA	Website
El Rico GSA	None – Meetings posted at kingsgroundwater.info
Mid-Kings River GSA	www.midkingsrivergsa.org
South Fork Kings GSA	southforkkings.org
Southwest Kings GSA	www.swkgsa.org
Tri-County Water Authority GSA	tcwater.org
Kings River Regional Groundwater Info Portal *(an additional online informational resource)*	kingsgroundwater.info

- **Interested Parties List –** As required by SGMA 10723.4 "Maintenance of Interested Persons List," the Tulare Lake Subbasin GSAs maintain contact lists and regularly distribute emails to those who have expressed interest in the GSAs' progress. These emails consist of meeting notices and other documents that are pertinent to the Tulare Lake Subbasin GSAs and their communication efforts. This process will continue through the GSP implementation phase.
- **Email Blasts –** Email blasts for meeting notices, stakeholder surveys, public review notices, and other crucial information were coordinated with community organizations and stakeholder groups by utilizing their distribution lists. Examples of these organizations are Kings County Farm Bureau, Self-Help Enterprises, and water/irrigation districts within the individual GSAs' boundaries.

D.1.3 Media Coverage

Press releases were written and distributed to the media list of local newspaper publications. These press releases focused on notification of public engagement opportunities such as targeted stakeholder meetings, public review/comment processes and opportunities, and will be distributed for meetings and notifications during the GSP implementation.

D.1.4 Stakeholder Surveys

Stakeholder surveys were used for the deliberate polling of stakeholders to give them a direct voice in the GSP development phase. The South Fork Kings GSA and Southwest Kings GSA circulated physical surveys, while the remaining three GSAs conducted verbal surveys through one-on-one discussions with stakeholders within their GSA boundaries. For the GSAs who administered physical stakeholder surveys, they developed both online and printed versions of their surveys. Survey links were posted as Google Forms on the individual GSAs' websites and were utilized in email blasts to the Interested Parties Lists. Hard copies were also available for distribution throughout the respective GSA.

Results from the surveys are included in the appendices of the C&E Plan. An outline of the survey questions is provided in **Table 7**.

Table 7. GSAs Circulating Stakeholder Surveys

GSA	Survey Questions
El Rico GSA	Conducting verbal stakeholder survey discussions.
Mid-Kings River GSA	Conducting verbal stakeholder survey discussions.
South Fork Kings GSA	1. How important are the following uses of water to you personally? *Please rank the categories with 1 being the most important use of water and 6 being the least important. (Municipal, Agricultural, Recreational, Mining/Petroleum, Manufacturing, Wildlife/Fisheries)* 2. How important are the following uses of water to the region? *Please rank the categories with 1 being the most important use of water and 6 being the least important. (Municipal, Agricultural, Recreational, Mining/Petroleum, Manufacturing, Wildlife/Fisheries)* 3. Please rank the categories with 1 being the most important for reason for managing groundwater and 5 being the least important. *(Ensure drinking water supply for domestic uses; My ability to earn a living is directly linked; Future economic growth for region; Ensure water supply for future generations; Provide reliable water for industry/business; Other)* 4. How knowledgeable do you consider yourself of local water issues? *(Circle one – Extremely Knowledgeable to Not Very Knowledge)* 5. How knowledgeable do you consider yourself of the new groundwater regulation, the Sustainable Groundwater Management Act? *(Circle one – Extremely Knowledgeable to Not Very Knowledge)* 6. Are you currently engaged in activity or discussions regarding groundwater management in your area? 7. How important to you is information on anticipated impacts of new state regulations. *(Circle one – Extremely Important to Not Very Important)* 8. Which format or formats would you prefer for receiving information about groundwater management planning process? *(Check all that apply – Newsletters, phone number to call for information, regular public meetings, electronic media, news stories, information through interest groups, don't know)* 9. Which applies to you? I am a stakeholder representing pumping for… (*Check all that apply – business use, small community use, domestic use, school use, agricultural use, federal use, industrial use, municipal use, tribal use, environmental use, does not apply)* 10. Which best describes the community in which you or your industry/business resides? *(Circle all that apply – Rural Kings County, within the City of Lemoore, within the Community of Stratford, outside of the South Fork Kings GSA service area, don't know)* 11. Please indicate your age range? *(Circle one – 25 and under, 26-35 years, 36-45 years, 46-55 years, 56-65 years, over 65 years, no answer)*
Southwest Kings GSA	1. Are you familiar with Sustainable Groundwater Management Act (SGMA) regulations? 2. Are you currently engaged in activity of discussions regarding groundwater management in this region? 3. Do you own or manage/operate land in this region? 4. Do you manage water resources? If yes, what is your role? 5. What is your primary interest in land or water resources management? 6. Do you have concerns about groundwater management? If so, what are they? 7. Do you have recommendations regarding groundwater management? If so, what are they?
Tri-County Water Authority GSA	Conducting verbal stakeholder survey discussions.

D.2 Tulare Lake Subbasin-Wide Outreach Efforts

The Tulare Lake Subbasin GSAs maintained a timeline of communication and outreach efforts completed throughout the GSA development and GSP development and public review phases, both on a subbasin-wide level and on the individual GSA level. Subbasin-wide public outreach meetings and presentations are shown in **Table 8**. **Figure 1**, **Figure 2** and **Figure 3** demonstrate a visual guide for consolidated subbasin and individual GSA stakeholder involvement completed since the GSAs were formed.

Table 8. Tulare Lake Subbasin-Wide Public Meetings, Presentations & One-on-One Meetings

Event	Date
Kings County Ag/Water Commissions Joint Meeting – SGMA Update Presentation	March 25, 2019
Kings County Board of Supervisors Meeting – SGMA Update Presentation	July 2019
Kings County Farm Bureau Meeting – GSP Public Review Presentation	September 2019
Kings County Board of Supervisors Meeting – GSP Public Review Presentation	September 2019
Subbasin-Wide Public Review Outreach Meeting – Lemoore	October 2019
Subbasin-Wide Public Review Outreach Meeting – Hanford	October 2019
Tulare Lake Subbasin GSP Public Hearing – Kings County Board of Supervisors Chambers	10 a.m., December 2, 2019

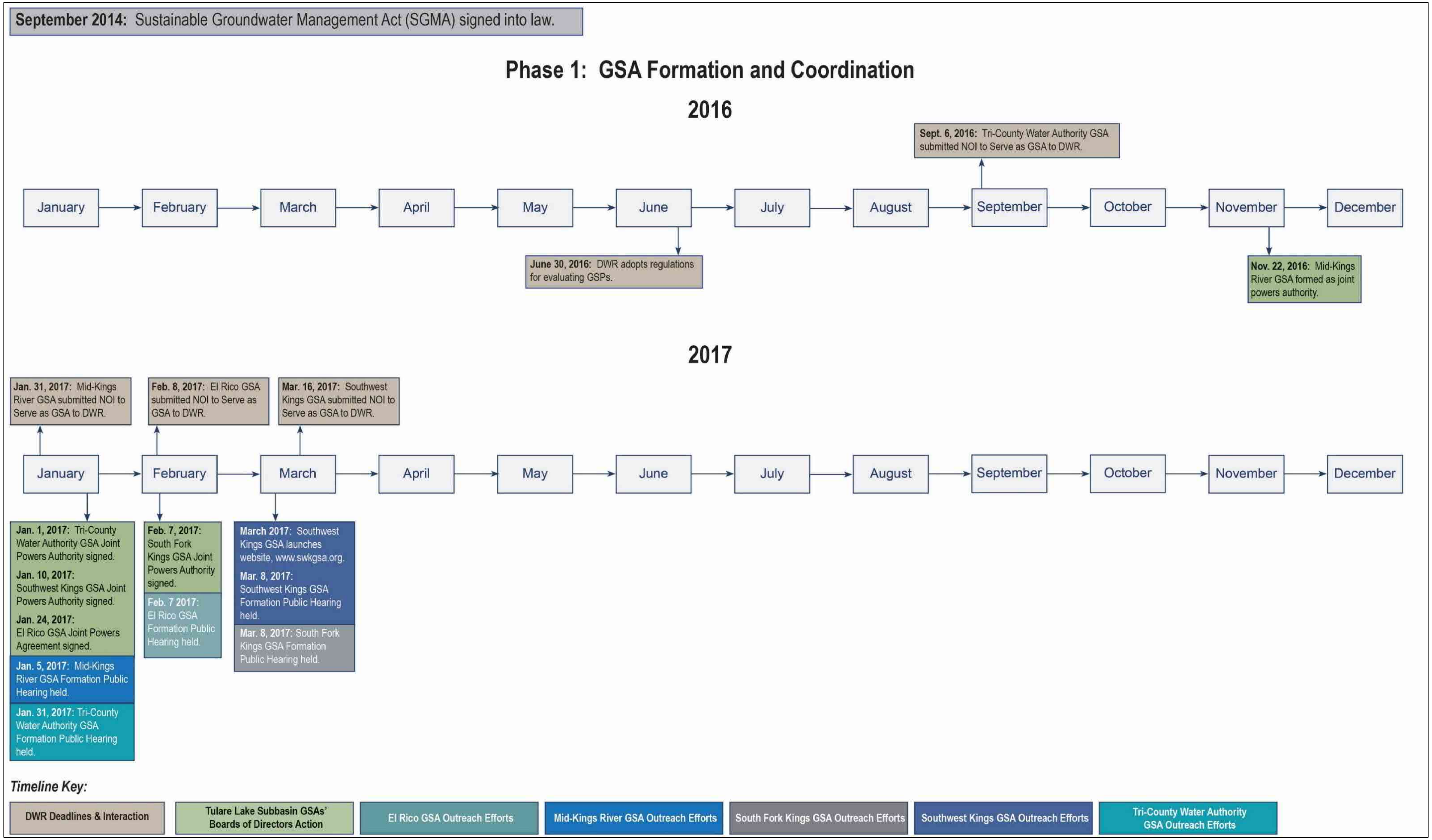


Figure 1. Tulare Lake Subbasin Communication & Engagement Timeline – Phase 1: GSA Formation and Coordination

Figure 2. Tulare Lake Subbasin Communication & Engagement Timeline – Phase 2: GSP Preparation and Submission

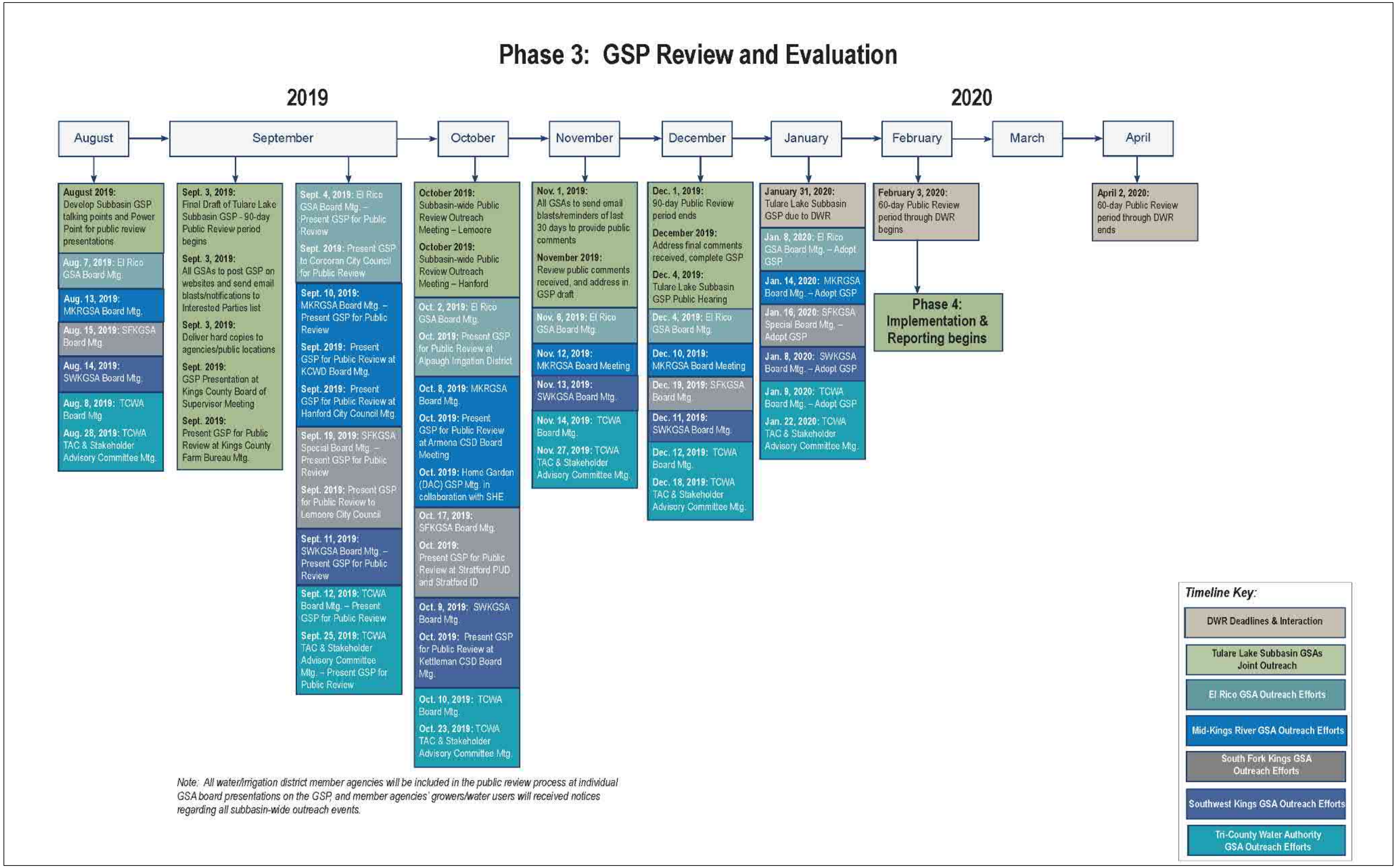


Figure 3. Tulare Lake Subbasin Communication & Engagement Timeline – Phase 3: GSP Review and Evaluation

D.3 El Rico GSA

Table 9. El Rico GSA Public Meetings, Presentations & One-on-One Meetings

Event	Date
One-on-one meetings with landowners of over 85 percent of the GSA area	Ongoing
Meetings and negotiations with City of Corcoran	Ongoing
GSA board meeting notices sent to all interested parties	Ongoing
El Rico GSA Board Meeting	1 p.m., January 3, 2018
El Rico GSA Board Meeting	1 p.m., February 7, 2018
El Rico GSA Board Meeting	1 p.m., March 7, 2018
El Rico GSA Board Meeting	1 p.m., May 2, 2018
El Rico GSA Board Meeting	1 p.m., June 6, 2018
El Rico GSA Board Meeting	1 p.m., July 4, 2018
El Rico GSA Board Meeting	1 p.m., August 1, 2018
El Rico GSA Board Meeting	1 p.m., September 5, 2018
El Rico GSA Board Meeting	1 p.m., October 3, 2018
El Rico GSA Board Meeting	1 p.m., November 7, 2018
El Rico GSA Board Meeting	1 p.m., December 5, 2018
El Rico GSA Board Meeting	1 p.m., January 2, 2019
El Rico GSA Board Meeting	1 p.m., February 6, 2019
El Rico GSA Board Meeting	1 p.m., March 6, 2019
El Rico GSA Board Meeting	1 p.m., April 3, 2019
El Rico GSA Board Meeting	1 p.m., May 1, 2019
El Rico GSA Board Meeting	1 p.m., July 3, 2019
El Rico GSA Board Meeting	1 p.m., August 7, 2019
El Rico GSA Board Meeting	1 p.m., September 4, 2019
El Rico GSA Board Meeting	1 p.m., October 2, 2019
GSP Public Review Presentation at Alpaugh Irrigation District	October 2019
El Rico GSA Board Meeting	1 p.m., November 6, 2019
El Rico GSA Board Meeting	1 p.m., December 4, 2019
El Rico GSA Board Meeting	1 p.m., January 8, 2020

D.4 Mid-Kings River GSA

D.4.1 Website – www.midkingsrivergsa.org

The Mid-Kings River GSA's website went live in May 2018 for the purpose of informing stakeholders about the GSA, public outreach opportunities, and as a resource with SGMA-related information. A site map is outlined below:

- **Homepage –** Introduction of Mid-Kings River GSA; GSA News
- **About Us –** Overview of SGMA; About the Mid-Kings River GSA; Member Agencies; Mid-Kings River GSA Information (links to Notice of Intent, JPA Members Agreement, GSA Boundary Map, Subbasin Boundary Map)
- **Board & Committees –** Board of Directors; (Agendas, Minutes, List of Board Members)
- **GSA Resources –** SGMA-Related Resources; Other Tulare Lake Subbasin GSAs (links); Partnering Agencies (links)
- **Contact Us –** Questions (telephone and email); Location/Mailing Address; Interested Parties List Sign-Up Form

Picture 1. Screenshot of www.midkingsrivergsa.org Homepage

D.4.2 Mid-Kings River GSA Outreach Tracking

Table 10. Mid-Kings River GSA Public Meetings, Presentations & One-on-One Meetings

Event	Date
Landowner Meetings for requested updates on SGMA	Ongoing
Greater Kaweah GSA Collaboration – Updates to TAC and BOD on Tulare Lake Subbasin efforts	Ongoing
Participation in local DWR meetings	Ongoing
Coordination meetings with other subbasins and South Valley Practitioners Group	Ongoing

Event	Date
MKRGSA Board Meeting – SGMA and GSP Development Updates	3 p.m., March 13, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	3 p.m., April 10, 2018
MKRGSA Special Board Meeting	9:30 a.m., April 24, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., May 8, 2018
Kings County Water Commission Meeting – SGMA Update	May 21, 2018
Kings County Farm Bureau Board Meeting – SGMA Update	June 19, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., July 10, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., August 14, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., October 9, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., November 13, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., January 15, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., March 12, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., April 9, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., May 14, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., June 11, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., July 9, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., August 13, 2019
Armona CSD Board Meeting Presentation – SGMA and GSP Development Updates	6 p.m., August 13, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., September 10, 2019
GSP Public Review Presentation at Kings County Water District Board Meeting	September 2019
GSP Public Review Presentation at City of Hanford City Council Meeting	September 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., October 8, 2019
GSP Public Review Presentation at Armona CSD Board Meeting	October 2019
GSP Public Review Outreach Meeting – Home Garden (DAC)	October 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., November 12, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., December 10, 2019
MKRGSA Board Meeting – Adoption of GSP	1 p.m., January 14, 2020

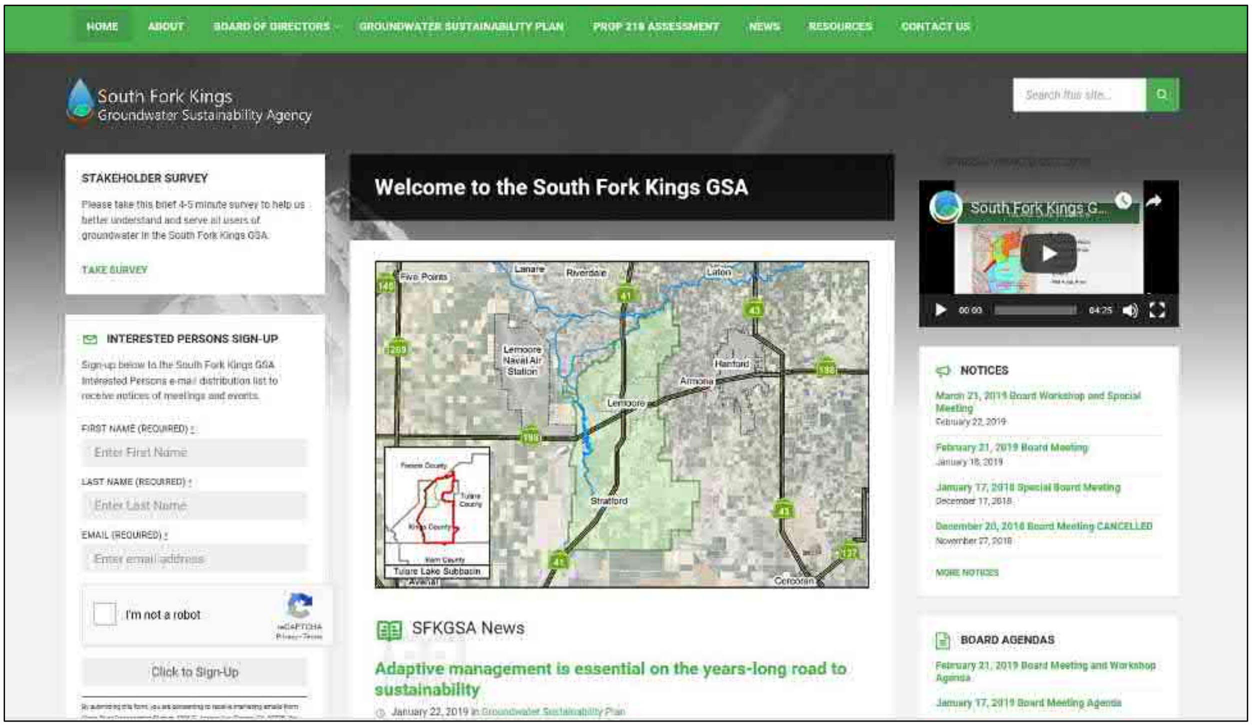
D.5 South Fork Kings GSA

D.5.1 Website – https://southforkkings.org/

The South Fork Kings GSA's website is a solid source of information for SGMA and the impacts within the GSA boundary. A site map is outlined below:

- **Homepage –** Welcome page with quick links to Stakeholder Survey, Interested Persons Sign-Up, GSA News, Notices, Board Agendas/Minutes, Proposition 218 Groundwater Assessment Resources
- **About Us –** About the South Fork Kings GSA; Quick links to Stakeholder Survey, Interested Persons Sign-Up, Board Agendas/Minutes, Documents
- **Board of Directors –** Board of Directors; Quick links to Stakeholder Survey, Interested Persons Sign-Up, Board Agendas/Minutes, Documents; Upcoming Events

- **Groundwater Sustainability Plan Portal –** Calendar, Projects, Coordination, Resources; Groundwater Sustainability Plan Development; GSP Implementation Roles (GSA, Stakeholder, DWR, SWRCB); GSP Schedule
- **Proposition 218 Assessment –** Election Results; Prop 218 Frequently Asked Questions; Prop 218 Election Documents; Overview of Groundwater Assessment
- **News**
- **Resources**
- **Contact Us –** Contact Us Inquiry Form; SGMA Update E-News Sign-Up; Quick links to Stakeholder Survey and Interested Persons Sign-Up



Picture 2. Screenshot of https://southforkkings.org/ Homepage

D.5.2 South Fork Kings GSA Outreach Tracking

Table 11. South Fork Kings GSA Public Meetings, Presentations & One-on-One Meetings

Event	Date	Attendance	Audience
Lemoore City Council Study Session	4/22/2015	15	Stakeholders
Empire Westside Water District Board Meeting	9/16/2015	7	Stakeholders
Stratford PUD Board Meeting	11/18/2015		Stakeholders (DAC)
Kings County Water Commission Meeting	11/23/2015	20	Stakeholders
Lemoore Industrial Stakeholder Meeting	1/26/2016	9	Stakeholders
Kings County Water Commission Meeting	12/22/2016		Stakeholders
Kings County Water Commission Meeting	5/23/2016	20	Stakeholders
Kings County Board of Supervisors Workshop	8/2/2016	30	Stakeholders

Event	Date	Attendance	Audience
Janice Cuara, Tribal Administrator Tachi-Yokut	9/12/2016		Stakeholders – Native American
Ag Commodities Group Update	9/21/2016	8	
Kings County Farm Bureau Membership	10/12/2016	30	Stakeholders, Landowners
SFK White Areas – Stratford	12/12/2016	0	Stakeholders (DAC)
SFK White Areas – Lemoore	12/12/2016	35	Stakeholders
Noah Ignacio, EPA Director Tachi-Yokut	3/3/2017		Stakeholders – Native American
SGMA Roundtable for Schools SFK	9/15/2017	30	Stakeholders
Hanford Rotary Club	11/2017	40	Stakeholders
Board Meeting, Lemoore City Council Chambers	2/1/2018	20	Stakeholders
Board Meeting, Lemoore City Council Chambers	3/15/2018	10	Stakeholders
Board Meeting, Lemoore City Council Chambers	4/19/2018	13	Stakeholders
Proposition 218 Assessment Workshop, Lemoore	5/1/2018	20	Landowners, City of Lemoore residents
Webinar: Proposition 218 Assessment	5/3/2018	1	Landowners
Prop 218 Assessment Workshop, Lemoore	5/21/2018	21	Landowners, City of Lemoore residents
Board Meeting/Public Hearing for Proposition 218 Election	6/21/2018	25	Landowners, stakeholders
Board Meeting, Lemoore City Council Chambers	7/19/2018	19	Stakeholders
Board Meeting, Lemoore City Council Chambers	8/16/2018	16	Stakeholders
Board Meeting, Lemoore City Council Chambers	10/18/2018	19	Stakeholders
Board Meeting, Lemoore City Council Chambers	02/21/2019		Stakeholders
Special Board Meeting, Lemoore City Council Chambers	03/21/2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	04/18/2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	06/20/2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	08/15/2019		Stakeholders
Special Board Meeting – GSP Public Review Presentation, Lemoore City Council Chambers	9/19/2019		Stakeholders
GSP Public Review Presentation – Lemoore City Council	Sept. 2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	10/17/2019		Stakeholders
GSP Public Review Presentation – Stratford Public Utilities District and Stratford Irrigation District	October 2019		Stakeholders
GSP Public Review Presentation – Empire West Irrigation District	October 2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	12/19/2019		Stakeholders
Special Board Meeting – Adoption of GSP, Lemoore City Council Chambers	01/16/2010		Stakeholders

Table 12. South Fork Kings GSA Website Articles

Title/Topic	Date	Views
Kings County Farm Bureau newsletter article	7/2015	
SFK Board Approves Contract with Hydrogeological Consultant	6/20/2017	18
Board Supports Effort to Develop a Single GSP for the Tulare Lake Subbasin	7/20/2017	16
Contract Approved with Geosyntec Consultants	8/21/2017	16
Board Approves Preparation of Engineering Report for 218 Election	9/25/2017	20
Board Approves Data Sharing Agreements with North Fork Kings GSA, Westlands Water District	2/9/2018	13
The Model, the Data and Groundwater Sustainability	2/9/2018	110
Board Approves Engineer's Report, Moves Forward with Prop 218 Assessment	3/27/2018	61
Proposition 218 Election to Fund Local Groundwater Management Passes	6/22/2018	17
Consultants update Board on the groundwater model, a Groundwater Sustainability Plan foundation	7/24/2018	
Groundwater Sustainability Plan schedule update	10/11/2018	28
Project and management action concepts discussed at Board workshop	10/22/2018	65
Adaptive management is essential on the years-long road to sustainability	1/22/2019	22

Table 13. Email Correspondence with Interested Persons List - Email Blasts

Message/Topic	Date Sent	Open Rate	Click Rate	Reach/Quantity
Board Agenda Packet	6/20/2017	43.5%	20.0%	24
Board Agenda Packet	7/21/2017	60.7%	5.9%	29
Board Agenda Packet	8/21/2017	46.4%	7.7%	30
Board Agenda Packet	9/25/2017	46.7%	7.1%	32
Board Agenda Packet	11/3/2017	53.3%	56.3%	32
Model, Data, Sustainability Tech Consultant; Data-Sharing Agreements Approved	2/9/18	49.2%	51.6%	67
Model, Data, Sustainability tech consultant; data sharing agreements approved	3/12/18	49%	51%	67
Board Agenda Packet	3/27/18	46%	50%	65
Engineer's Report Adopted; Prop 218 Election; Board meeting schedule update	4/16/18	44%	27%	68
Board Agenda Packet	5/2/18	48%	57%	76
Prop 218 Workshop Highlight, State Intervention, Groundwater Fee	5/7/18	N/A	N/A	0
Ballots mailed, local vs. state control, prop 218 resources, public hearing date	5/31/18	60%	33%	91
Submit your ballot by June 21 hearing date	7/27/18	47%	34%	106
Update to landowner on the overdraft number for the Tulare Lake Subbasin	7/16/18	N/A	N/A	1
Board Agenda Packet	7/24/18	57%	57%	113
Groundwater Model, Technical Services Continued with Geosyntec	8/13/18	52%	33%	117
Board Agenda Packet	10/15/18	54%	46%	119

Message/Topic	Date Sent	Open Rate	Click Rate	Reach/Quantity
Board Agenda Packet	10/23/18	46%	33%	120
Project and management actions discussed at workshop, DWR funding opportunity, Tulare Lake Subbasin Communicaiton & Engagement Plan adopted, Stakeholder Survey, #SGMAMadeSimple	12/13/18	47%	42%	121
Meeting Cancellation Notice	12/17/18	44%	N/A	126

D.6 Southwest Kings GSA

D.6.1 Website – www.swkgsa.org

The Southwest Kings GSA launched a website in March 2017 as a key avenue to inform stakeholders about the GSA, public outreach opportunities, and as a resource with SGMA-related information. A site map is outlined below:

- **Homepage –** Introduction of Southwest Kings GSA; Important Dates; News & Press Releases; and Quick Links to GSA Boundary Map and SGMA-Related Resources
- **About SGMA & SWKGSA –** What is SGMA?; SGMA and the Southwest Kings GSA; SWKGSA Information (links to boundary map, Bylaws & Policies, JPA Members Agreement, Cost-Sharing Agreement); Governance (Board of Directors, Alternate Directors, GSA Members, Management/Consultant Team)
- **Public Meetings –** Public Hearings; Board Meetings (agendas and minutes); Public Outreach Workshops
- **Contact the GSA –** Questions; Location; Interested Parties List Sign-Up Form

Picture 3. Screenshot of www.swkgsa.org Homepage

D.6.2 Outreach Tracking

Table 14. Southwest Kings GSA Public Meetings, Presentations & One-on-One Meetings

Meeting/Event	Date
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., February 14, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., May 9, 2018
Southwest Kings GSA Board Meeting with special presentation on Preliminary Water Budget	3 p.m., July 11, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., September 12, 2018
Kettleman City Community Services District Board Meeting – SGMA/GSA Presentation	6 p.m., October 23, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., December 12, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., February 13, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., April 10, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., May 8, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., June 20, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., July 10, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., August 14, 2019
Southwest Kings GSA Board Meeting – GSP Public Review Presentation	3 p.m., September 11, 2019
GSP Public Review Presentation – Kettleman Community Services District Board Meeting	October 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	October 9, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., December 19, 2019
Special Board Meeting – Adoption of GSP	3 p.m., January 16, 2020

D.7 Tri-County Water Authority

D.7.1 Website – http://tcwater.org

The Tri-County Water Authority launched a website to aid in achieving the Authority's goal of world class groundwater management in the Tulare Lake Hydrologic Region. A site map of the website is outlined below:

- **Homepage –** Primary goal of Tri-County Water Authority; Updates/Reports; Notifications; Quick Links to SGMA Overview; Tri-County Water Authority Map; News; Calendar; About the Water Authority
- **SGMA –** What is The SGMA?; SGMA Purpose; What Are Your Rights?; Overview of The Water Problem; Frequently Asked Questions; Tri-County Water Authority Territory
- **About Us –** About Us Overview; Board of Directors; Trusted News Sources Links – http://tcwater.org/news/ ; Calendar – http://tcwater.org/events/
- **Contact the GSA**

Picture 4. Screenshot of http://tcwater.org Homepage

D.7.2 Outreach Tracking

Table 15. Tri-County Water Authority Public Meetings, Presentations & One-on-One Meetings

Meeting/Event	Date
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., January 4, 2018
Technical Advisory Committee Meeting	10 a.m., January 24, 2018
Stakeholder Advisory Committee Meeting	1 p.m., January 24, 2018
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., March 1, 2018
Technical Advisory Committee Meeting	10 a.m., March 7, 2018
Stakeholder Advisory Committee Meeting	1 p.m., March 7, 2018
Special Board Meeting – SGMA and GSP Development Updates	1 p.m., March 13, 2018
Technical Advisory Committee Meeting	10 a.m., March 28, 2018
Stakeholder Advisory Committee Meeting	1 p.m., March 29, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., April 25, 2018
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., June 26, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., June 27, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., July 25, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., August 22, 2018
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., September 6, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., October 1, 2018
Special Board Meeting – SGMA and GSP Development Updates	1 p.m., October 11, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., October 24, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	9 a.m., December 19, 2018
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., January 23, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., February 27, 2019

Meeting/Event	Date
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., March 5, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., April 2, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., April 24, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., May 2, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., May 22, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., June 4, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., June 26, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., July 9, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., July 24, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., August 8, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., August 28, 2019
TCWA Board Meeting – Public Review of GSP Presentation	1 p.m., September 12, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting – Public Review of GSP Presentation	10 a.m., September 25, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., October 10, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., October 23, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., November 14, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., November 27, 2019
TCWA Board Meeting – SGMA and GSP Development Updates	1 p.m., December 12, 2019
Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., December 18, 2019
TCWA Board Meeting – Adoption of GSP	1 p.m., January 9, 2020

APPENDIX C

STAKEHOLDER COMMENTS AND RESPONSES

APPENDIX D

HYDROGEOLOGIC CONCEPT MODEL DOCUMENTATION

APPENDIX E

GSA APPENDICES

1) Mid-Kings River GSA Appendix
2) South Fork Kings River GSA Appendix
3) Southwest Kings GSA Appendix
4) El Rico GSA Appendix
5) Tri-County Water Authority GSA Appendix

APPENDIX F

GSP REGULATION CHECKLIST

APPENDIX G

INTERIM OPERATING AGREEMENT

Interim Operating Agreement for the Tulare Lake Subbasin to Develop and Implement a Groundwater Sustainability Plan

THIS INTERIM OPERATING AGREEMENT FOR THE TULARE LAKE SUBBASIN TO DEVELOP AND IMPLEMENT A GROUNDWATER SUSTAINABILITY PLAN (this “Agreement") is effective September 1, 2017, among the MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY, SOUTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, EL RICO GROUNDWATER SUSTAINABILITY AGENCY, SOUTHWEST KINGS GROUNDWATER SUSTAINABILITY AGENCY, TRI-COUNTY WATER AUTHORITY, and ALPAUGH IRRIGATION DISTRICT. The signatories to this Agreement are hereinafter referred to collectively as the "Parties" or individually as "Party".

RECITALS

WHEREAS, the Parties are all located within the Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin, Tulare Lake Subbasin, a groundwater subbasin recognized by the California Department of Water Resources ("DWR") Bulletin 118 (2016) as Groundwater Basin No. 5-22.12 (hereinafter “Subbasin”) and a depiction of the Subbasin is attached hereto as Exhibit "A" and incorporated herein by this reference; and

WHEREAS, the State of California has classified the entire Subbasin as an Economically Distressed Area and each community within the Subbasin as a Disadvantaged Community; and

WHEREAS, all lands within the Subbasin are included within one of the six groundwater sustainability agencies (“GSAs”) that are the Parties to this Agreement, and each Party has been or are in the process of being determined an “exclusive” GSA by DWR; and

WHEREAS, the Sustainable Groundwater Management Act ("SGMA") requires the development and establishment of groundwater sustainability plans ("GSPs"), which are designed to ensure the sustainability of groundwater basins and subbasins; and

WHEREAS, DWR has identified the Subbasin as a critically overdrafted subbasin; and

WHEREAS, SGMA allows local agencies or a combination of local agencies overlying a groundwater basin to serve as a GSA to develop and implement a GSP over an entire basin, subbasin, or a portion of a basin; and

WHEREAS, pursuant to Water Code §10727, SGMA allows for the preparation of a GSP by three methods: (a) a single GSP covering the entire basin/subbasin developed and implemented by one GSA, (b) a single GSP covering the entire basin/subbasin developed and implemented by multiple GSAs, or (c) multiple GSPs implemented by two or more GSAs that are subject to a single Coordination Agreement that covers the entire basin/subbasin; and

WHEREAS, Water Code §10727.6 requires that if multiple GSPs will be implemented within a subbasin, then a Coordination Agreement must be prepared to ensure that the GSPs utilize the same data and methodologies within that subbasin for the following items: (a) groundwater elevation data, (b) groundwater extraction data, (c) surface water supply, (d) total water use, (e) change in groundwater storage, (f) water budget, and (g) sustainable yield; and

WHEREAS, the Parties acknowledge that multiple GSAs have been formed within the Subbasin and those GSAs currently seek to explore the possibility of developing and implementing a single GSP. The Parties also acknowledge the desire to have a single GSP may not be achievable, but regardless of whether one or more GSPs are developed for the Subbasin, an interim agreement is beneficial to the Parties in proceeding to initially develop and coordinate the data and methodologies required by SGMA for the Subbasin; and

WHEREAS, the Parties acknowledge that the GSAs need to do further data collection prior to making decisions with regard to GSP preparation and implementation, but the Parties agree that in the future a Coordination Agreement or an amendment to or replacement of this Agreement will be necessary based on the additional information obtained and decisions made by the Parties under this Agreement; and

WHEREAS, the purpose of this Agreement is to provide a framework among the Parties for a cooperative means of gathering the initial data and information for a single GSP, applying for grant funding, selecting consultants, and coordinating on other SGMA-related issues for the Subbasin.

NOW, THEREFORE, in consideration of the mutual promises, covenants, and conditions hereinafter set forth and the above Recitals, which are hereby incorporated herein by this reference, it is agreed by and among the Parties hereto as follows.

SECTION 1. DEFINITIONS

1.1 "Tulare Lake Subbasin" or "Subbasin" refers to that subbasin identified and described in California Department of Water Resources Groundwater Bulletin 118 as part of the Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin, Tulare Lake Subbasin, also identified as Groundwater Basin No. 5-22.12, and is depicted in Exhibit "A" of this Agreement.

1.2 "Groundwater Sustainability Agency" or "GSA" means one or more local agencies that implement the provisions of SGMA as defined by Water Code §10721(j).

1.3. "Groundwater Sustainability Plan" or "GSP" means a plan of one or more GSAs proposed or adopted under SGMA as defined in Water Code §10721(k).

1.4 "Coordination Agreement" shall be the agreement (whether one or more GSPs are developed within the Subbasin) to ensure coordination of the data and methodologies used by each GSA in developing the GSP(s) within the Subbasin for the following assumptions: (a) groundwater elevation data, (b) groundwater extraction data, (c) surface water supply, (d) total water use, (e) change in groundwater storage, (f) water budget, and (g) sustainable yield (Water Code §10721(d); 10727.6).

SECTION 2. PURPOSES AND GOALS

2.1 The Parties are entering into this Agreement to perform the following:

(a) Set forth their mutual intent to work towards the development of a single GSP for the Subbasin.

(b) Authorize research and collection of the data required for the GSP according to a mutually agreeable timeline.

(c) The Parties agree to utilize their best efforts in selecting and fully cooperating with the consultants gathering the information, preparing grant applications, and preparing the GSP.

(d) The Parties agree that after they gather data and determine an appropriate governance structure, they will either (1) amend or replace this Agreement to reflect specifics required to finalize a GSP or (2) if a single GSP is not to occur, prepare and enter into a Coordination Agreement setting forth appropriate assumptions based on information gathered and developed as a result of this Agreement.

SECTION 3. COST SHARING AND GOVERNANCE

3.1 The Parties agree that if grant funds are available for grant applications, efforts necessary to develop a GSP(s), facilitation and/or consultant costs, and similar efforts to develop a GSP(s) for the Subbasin, then the Parties have the authority to and shall act jointly in applying for and seeking to obtain such grant funds. Any grant funds received on behalf of the Subbasin and/or all of the Parties, shall first be applied to eligible costs incurred after July 1, 2017; should any funds then remain, the Parties may develop a method for reimbursing relevant costs incurred by the Parties prior to the effective date of this Agreement.

3.2 The Parties agree to the following formula, identified in the table below, for sharing costs to develop and implement the actions taken within the confines of this Agreement. As shown below, after combining the El Rico GSA and Alpaugh Irrigation District, one-half the costs shall be allocated one-fifth to each of the participants and one-half of the costs shall be allocated in proportion to the relative acreage of each Party. The overall proportionate cost of each Party is shown as the Total Cost Allocation in the table below.

GSA	Acres	Acreage Portion	Participant Portion	Total Cost Allocation
Mid-Kings River GSA	97,384.6	0.09084	0.1	0.19084
South Fork Kings GSA	71,310.9	0.06652	0.1	0.16652
El Rico GSA/Alpaugh ID	228,653.4	0.21328	0.1	0.31328
Southwest Kings GSA	90,037.1	0.08398	0.1	0.18398
Tri-County WA	48,656.5	0.04538	0.1	0.14538
Totals	536,042.5	0.50000	0.5	1.00000

3.3 All decisions related to implementing or amending this Agreement shall require a unanimous vote of the authorized representatives of each of the five (5) entities[1] identified in the table shown in Section 3.2 of this Agreement; a quorum is represented by any four (4) authorized representatives of these five (5) entities. Decisions may include, but are not limited to hiring experts or consultants to prepare and draft documents associated with this Agreement that would exceed $100,000, developing the Coordination Agreement (if necessary), applying for grant funding, and/or developing all or portions of a GSP(s).

SECTION 4. GENERAL PROVISIONS

4.1. Term. This Agreement shall become effective on the date first above written and shall remain in effect until superseded by amendment to this Agreement or another agreement among the Parties which shall address more specifics that are not available at this time for the final development and implementation of the GSP(s).

4.2 Withdrawal. Any Party shall have the right to withdraw from this Agreement by giving each of the other Parties written notice at least 30 days prior to its date of withdrawal ("Withdrawal Date"). The withdrawing Party shall be responsible for its share of any costs incurred under this Agreement up to its Withdrawal Date. Except as set forth in the preceding sentence, and except for the withdrawing Party's obligations under Section 5 hereof relating to confidential information, effective as of the Withdrawal Date, the withdrawing Party shall be

[1] For purposes of cost sharing and voting, the El Rico GSA and Alpaugh ID are to be considered as one entity; it shall be up to those two GSAs to determine their internal cost-sharing and voting process.

relieved and released of all obligations under this Agreement.

4.3 Construction of Terms. This Agreement is for the sole benefit of the Parties and shall not be construed as granting rights to or imposing obligations on any person other than the Parties.

4.4 Good Faith. Each Party shall use its best efforts and work in good faith for the completion of the purposes and goals of this Agreement and the satisfactory performance of its terms.

4.5 Rights of the Parties and Constituencies. This Agreement does not contemplate the Parties taking any action that would (a) adversely affect the rights of any of the Parties or (b) adversely affect the constituencies of any of the Parties.

4.6 Counterparts. This Agreement may be executed in counterparts and the signed counterparts shall constitute a single instrument. The signatories to this Agreement represent that they have the authority to sign this Agreement and to bind the Party for whom they are signing.

4.7 Governing Law. This Agreement and all documents provided for herein and the rights and obligations of the Parties hereto shall be governed in all respects, including validity, interpretation and effect, by the laws of the State of California (without giving effect to any choice of law principles).

4.8 Waiver. The failure of any Party to insist on strict compliance with any provision of this Agreement shall not be considered a waiver of any right to do so, whether for that breach or any subsequent breach. The acceptance by any Party of either performance or payment shall not be considered to be a waiver of any preceding breach of the Agreement by any other Party.

4.9 Recitals and Exhibits. The Recitals and Exhibits are incorporated into the Agreement.

SECTION 5. CONFIDENTIALITY PROVISIONS

5.1 Confidential Information. The confidential information to be disclosed under this Agreement ("Confidential Information") includes data, information, modeling, projections, estimates, plans, that are not public information and in which each Party has a reasonable expectation of confidentiality, regardless of whether such information is designated as Confidential Information at the time of its disclosure.

5.2 Duty to Protect. In addition to the above, Confidential Information shall also include, and the Parties shall have a duty to protect, other confidential and/or sensitive information which is (a) disclosed in writing and marked as confidential (or with other similar designation) at the time of disclosure; and/or (b) disclosed in any other manner and identified as confidential at the time of disclosure or is summarized and designated as confidential in a written memorandum delivered within thirty (30) days of the disclosure.

5.3 Limited Use. The Parties shall use the Confidential Information only for the purposes set forth in this Agreement.

5.4 Limited Disclosure. The Parties shall limit disclosure of Confidential Information within its own organization to its directors, officers, partners, members and/or employees having a need to know and shall not disclose Confidential Information to any third party (whether an individual, corporation, or other entity) without prior written consent of all the Parties. The Parties shall satisfy their obligations under this paragraph if they take affirmative measures to ensure compliance with these confidentiality obligations through their employees, agents, consultants and others who are permitted access to or use of the Confidential Information.

5.5 Allowable Disclosure. This Agreement imposes no obligation upon the Parties with respect to any Confidential Information (a) that was possessed before receipt; (b) is or becomes a matter of public knowledge through no fault of receiving Party; (c) is rightfully received from a third party not owing a duty of confidentiality; (d) is disclosed without a duty of confidentiality to a third party by, or with the authorization of the disclosing Party; or (e) is independently developed.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement to be effective as of the date first above written.

(the remainder of this page has been intentionally left blank)

Mid-Kings River Groundwater Sustainability Agency

By: Barry McCutcheon Title: Chairman

Name: Barry McCutcheon

South Fork Kings Groundwater Sustainability Agency

By:____________________ Title:________________

Name: ____________________

El Rico Groundwater Sustainability Agency

By:____________________ Title:________________

Name: ____________________

Southwest Kings Groundwater Sustainability Agency

By:____________________ Title:________________

Name: ____________________

Tri-County Water Authority

By:____________________ Title:________________

Name: ____________________

Alpaugh Irrigation District

By:____________________ Title: ________________

Name: ____________________

Mid-Kings River Groundwater Sustainability Agency

By:__________________________ Title:__________________

Name: __________________________

South Fork Kings Groundwater Sustainability Agency

By: Joe Neves Title: Chairman

Name: Joe Neves

El Rico Groundwater Sustainability Agency

By:__________________________ Title:__________________

Name: __________________________

Southwest Kings Groundwater Sustainability Agency

By:__________________________ Title:__________________

Name: __________________________

Tri-County Water Authority

By:__________________________ Title:__________________

Name: __________________________

Alpaugh Irrigation District

By:__________________________ Title: __________________

Name: __________________________

Mid-Kings River Groundwater Sustainability Agency

By:______________________________ Title:__________________

Name: ____________________________

South Fork Kings Groundwater Sustainability Agency

By:______________________________ Title:______________________

Name: ____________________________

El Rico Groundwater Sustainability Agency

By: [signature] Title: CHAIRMAN

Name: JEOF WYRICK

Southwest Kings Groundwater Sustainability Agency

By:______________________________ Title:__________________

Name: ____________________________

Tri-County Water Authority

By:______________________________ Title:__________________

Name: ____________________________

Alpaugh Irrigation District

By:______________________________ Title: ____________________

Name: ____________________________

Mid Kings Groundwater Sustainability Agency

By:______________________________ Title:____________________

Name: ______________________________

South Fork Kings Groundwater Sustainability Agency

By:______________________________ Title:____________________

Name: ______________________________

El Rico Groundwater Sustainability Agency

By:______________________________ Title:____________________

Name: ______________________________

Southwest Kings Groundwater Sustainability Agency

By:______________________________ Title: President

Name: William D Phillimore

Tri-County Water Authority

By:______________________________ Title:____________________

Name: ______________________________

Alpaugh Irrigation District

By:______________________________ Title:____________________

Name: ______________________________

Mid Kings Groundwater Sustainability Agency

By:____________________ Title:________________

Name: ____________________

South Fork Kings Groundwater Sustainability Agency

By:____________________ Title:________________

Name: ____________________

El Rico Groundwater Sustainability Agency

By:____________________ Title:________________

Name: ____________________

Southwest Kings Groundwater Sustainability Agency

By:____________________ Title:________________

Name:____________________

Tri-County Water Authority

By: [signature] Title: Chairman

Name: MATTHEW H. HURLEY

Alpaugh Irrigation District

By:____________________ Title: ________________

Name: ____________________

Mid-Kings River Groundwater Sustainability Agency

By:______________________________ Title:__________________

Name: ____________________________

South Fork Kings Groundwater Sustainability Agency

By:______________________________ Title:_______________________

Name: ____________________________

El Rico Groundwater Sustainability Agency

By:______________________________ Title:__________________

Name: ____________________________

Southwest Kings Groundwater Sustainability Agency

By:______________________________ Title:__________________

Name: ____________________________

Tri-County Water Authority

By:______________________________ Title:__________________

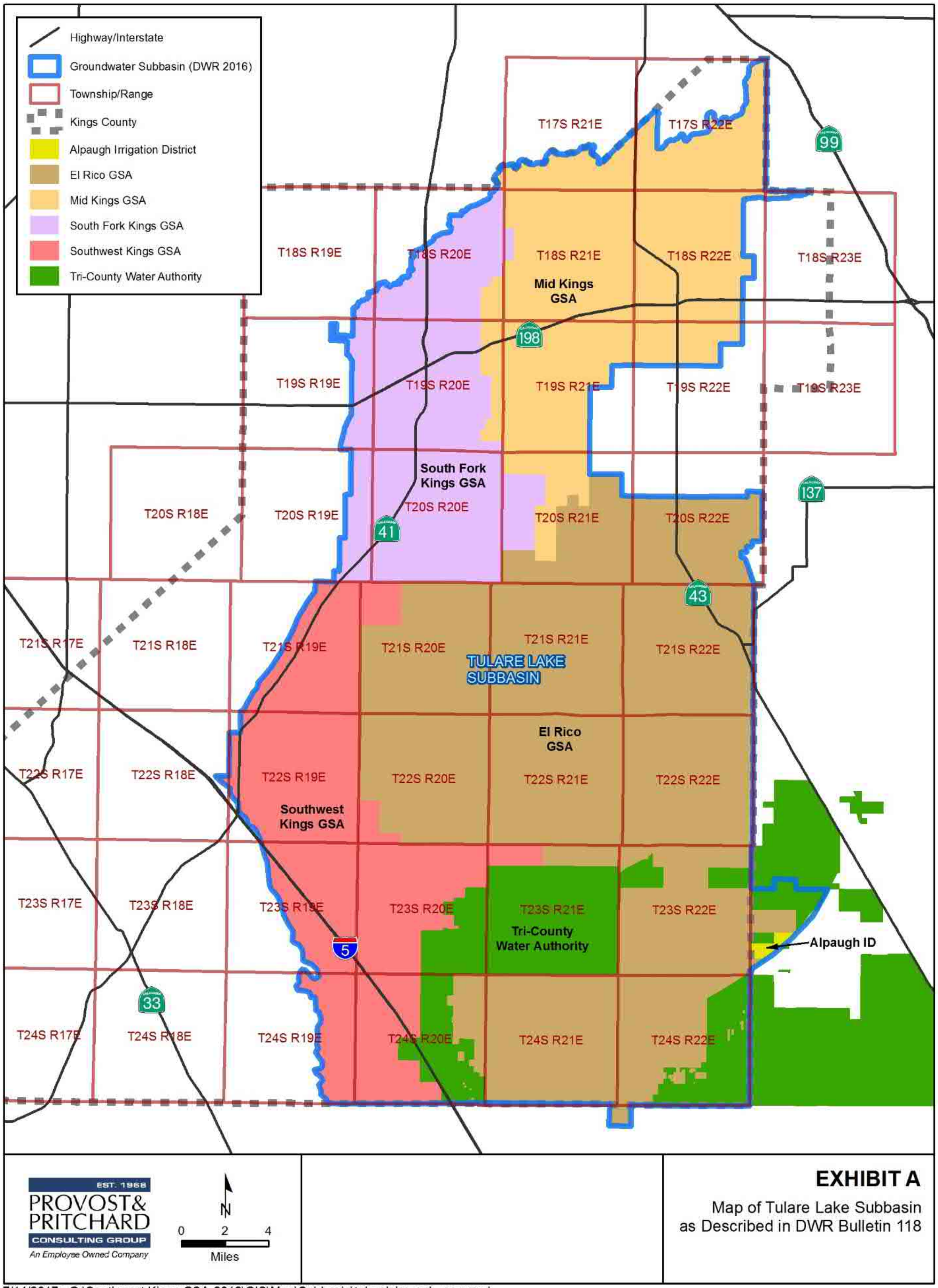
Name: ____________________________

Alpaugh Irrigation District

By: [signature] Title: G.M.

Name: BRUCE HOWARTH

Exhibit "A"
Map of Tulare Lake Subbasin as Described in
DWR Bulletin 118



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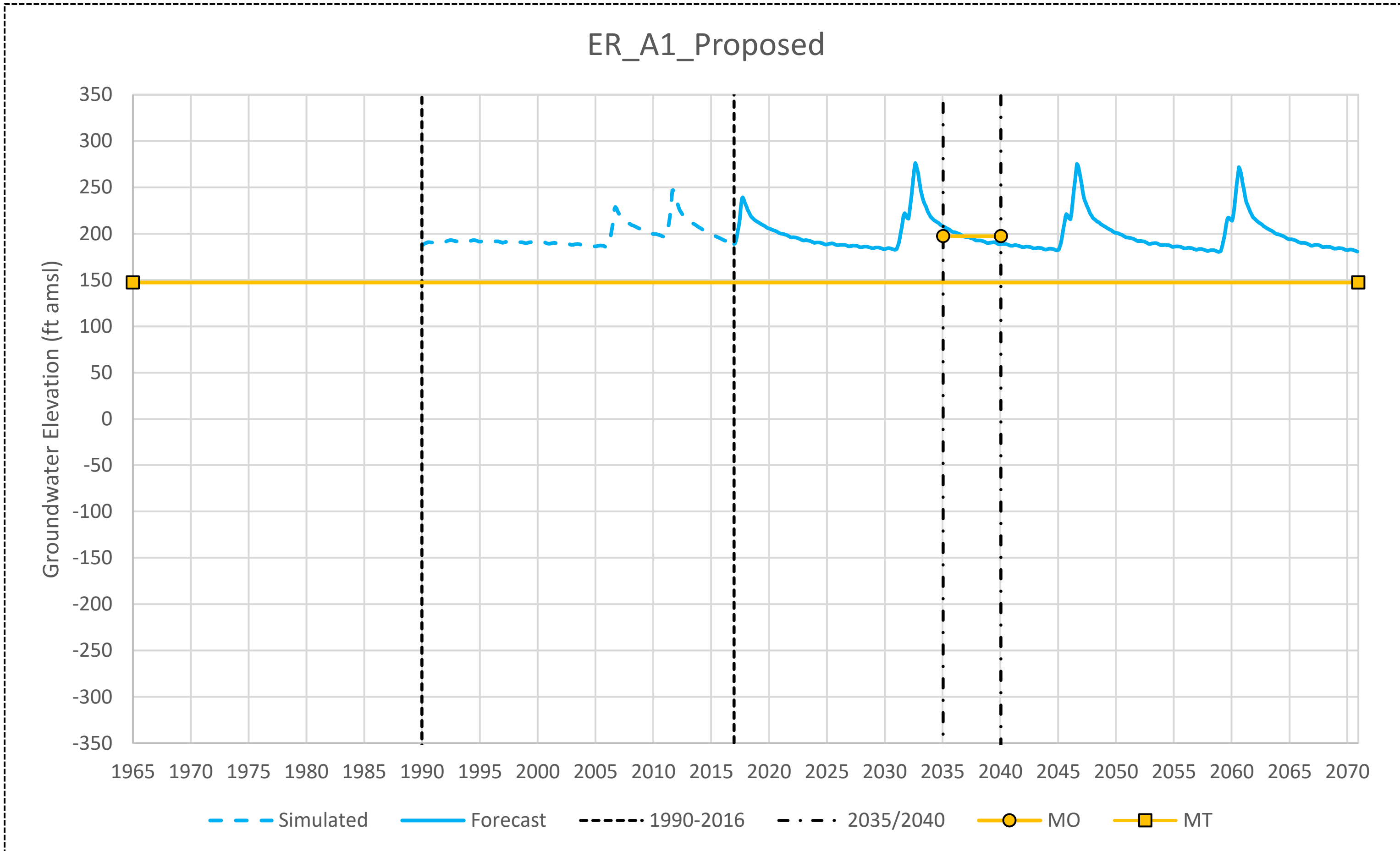
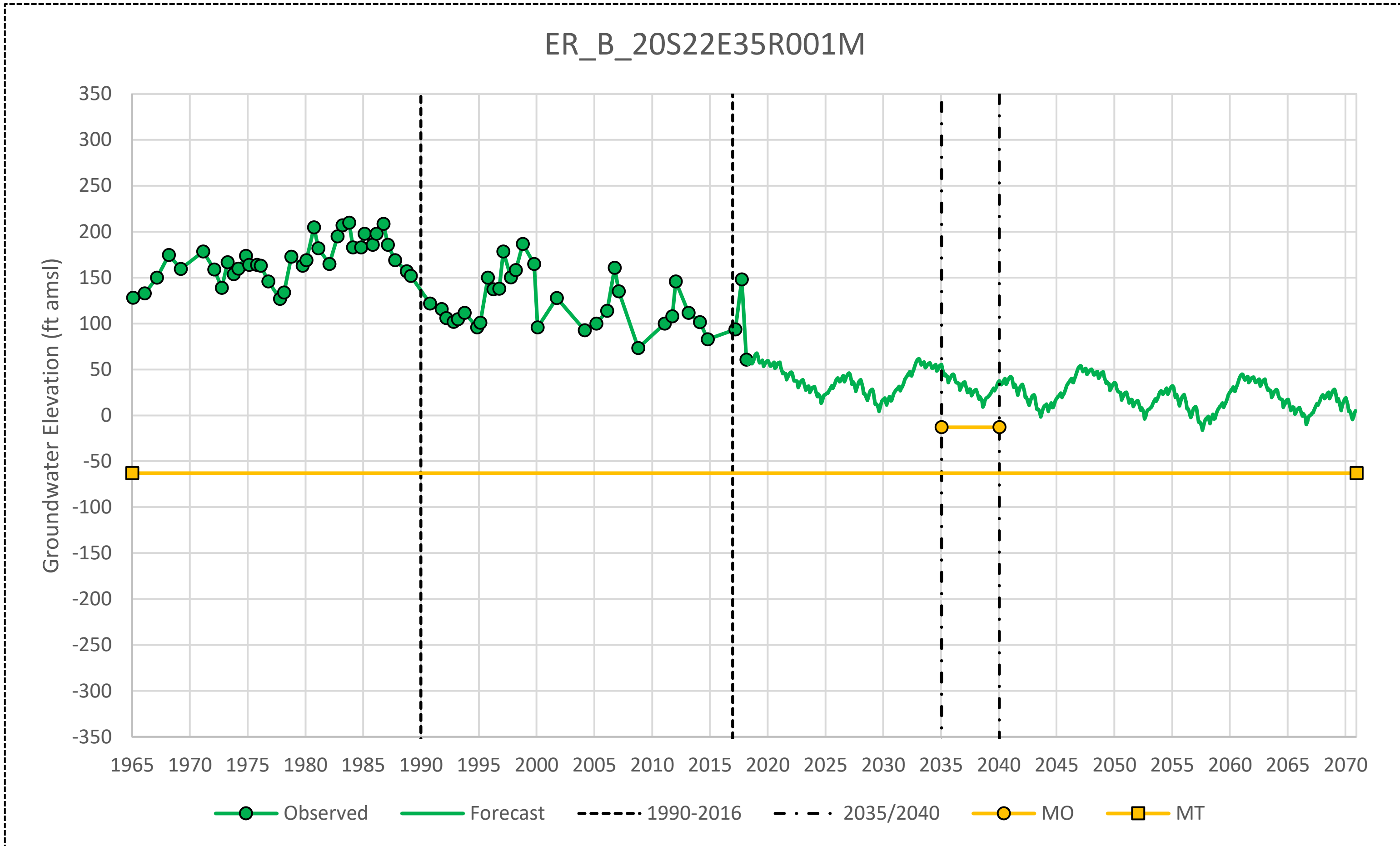
APPENDIX H

GROUNDWATER MONITORING NETWORK HYDROGRAPHS



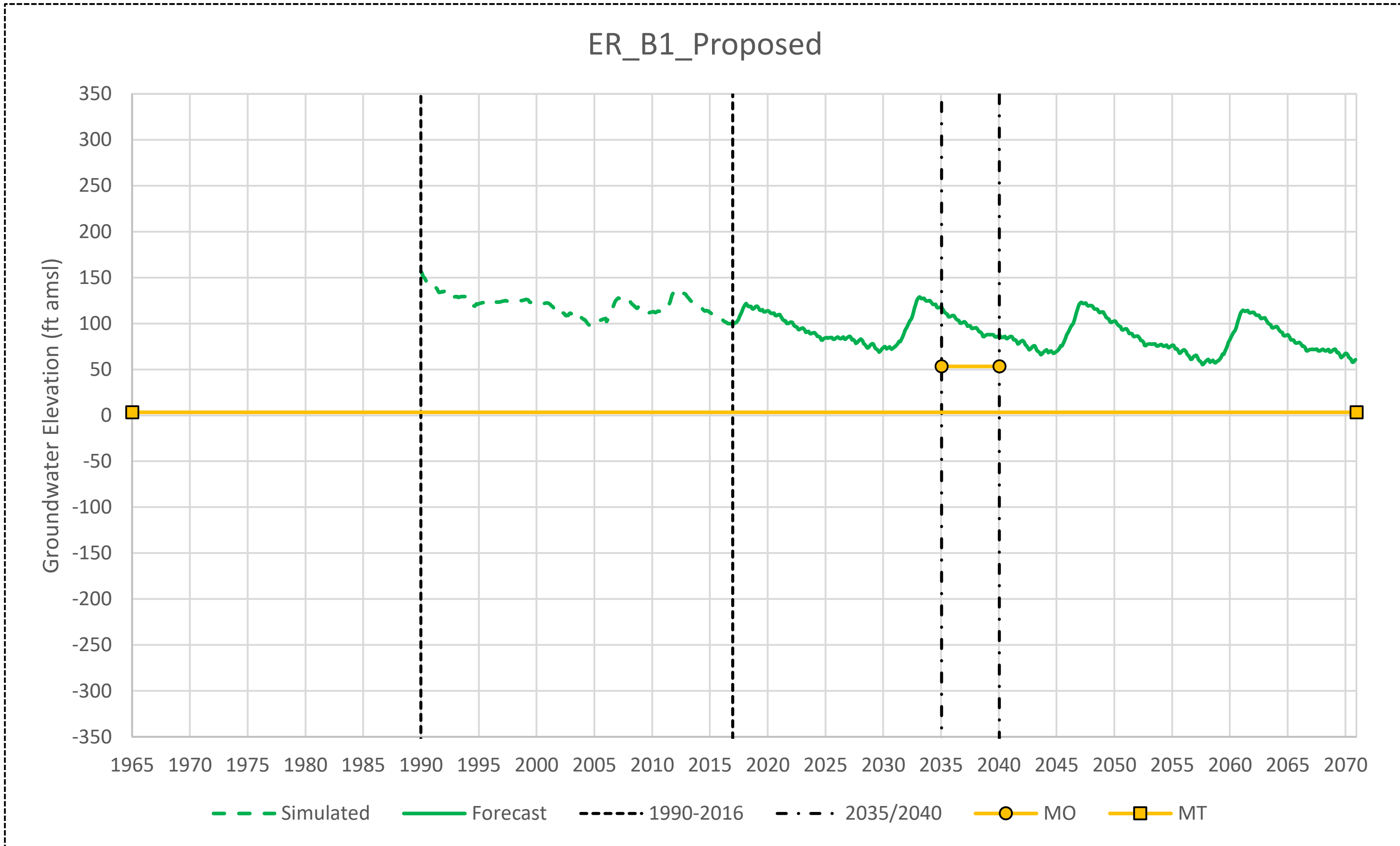
ER_A1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-1**



ER_B_20S22E35R001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

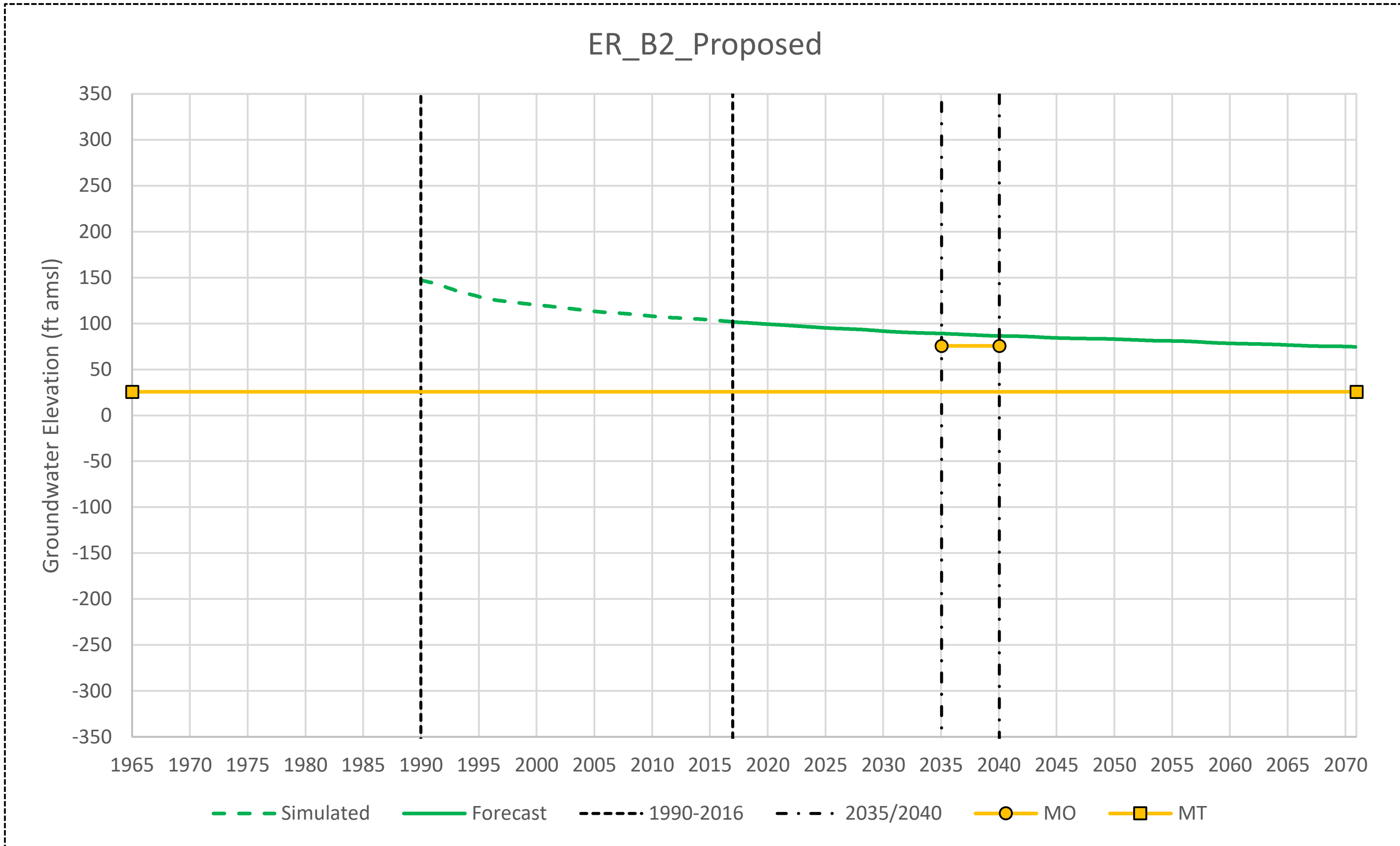
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-2**



ER_B1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

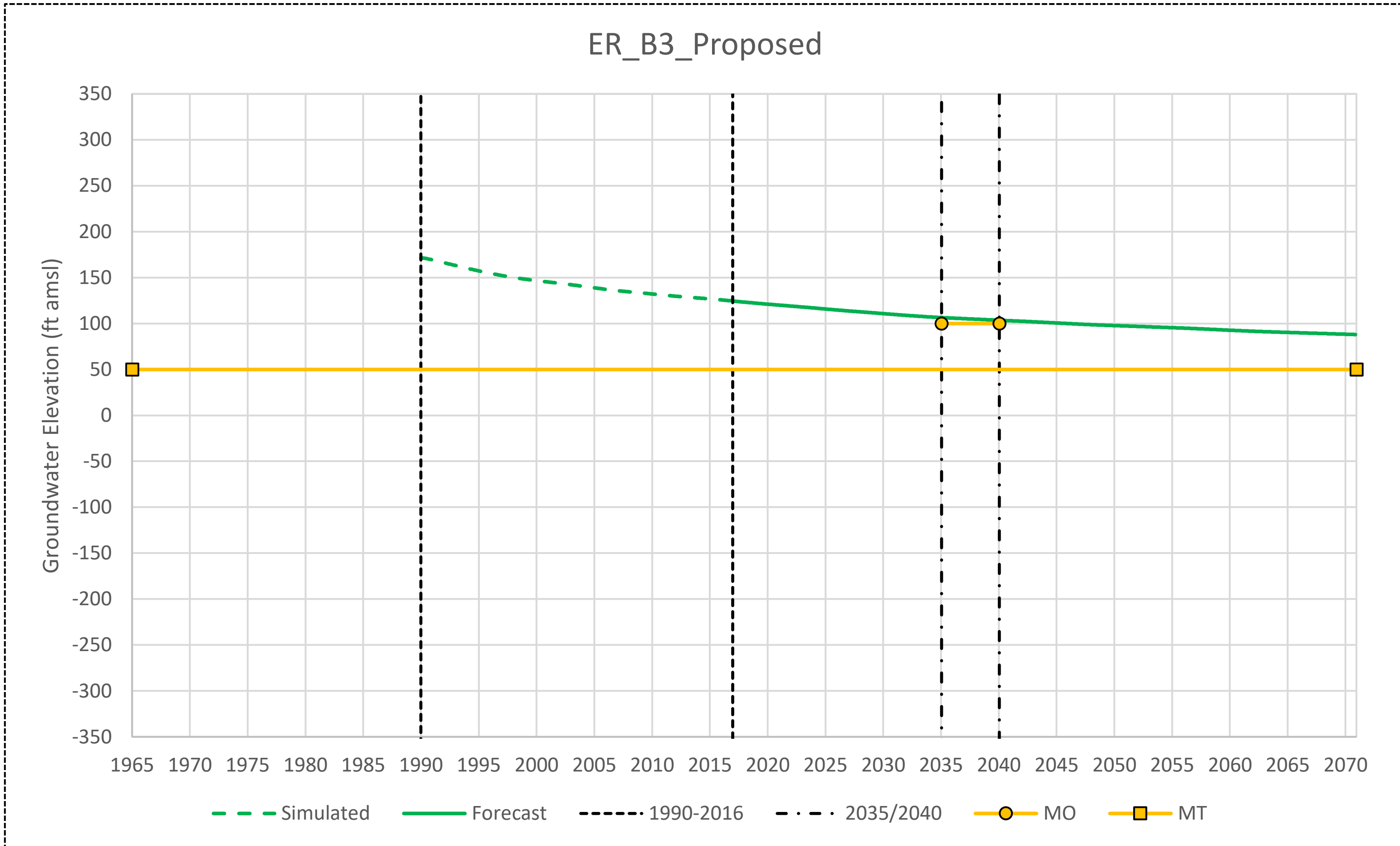
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-3**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_B2_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-4**



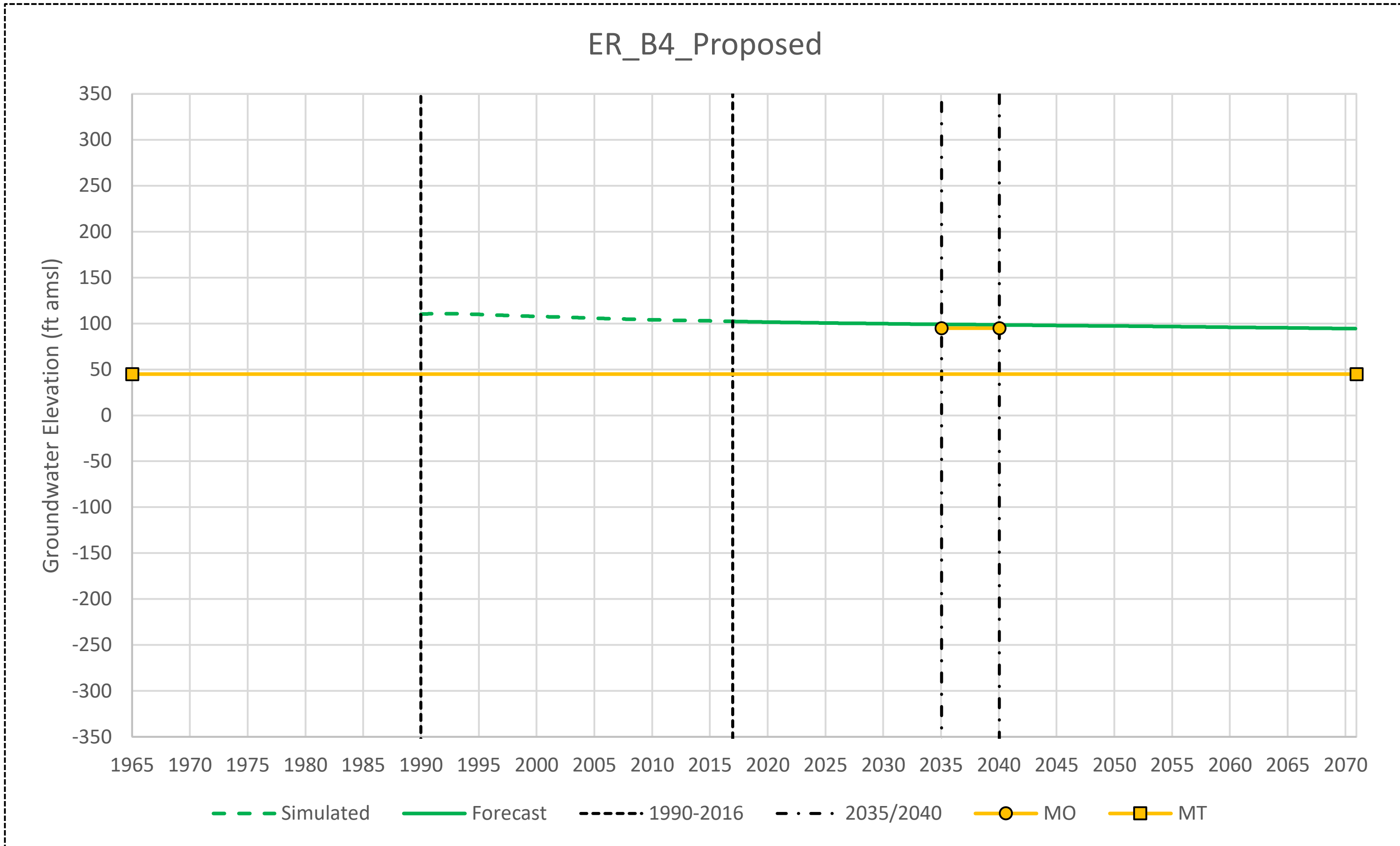
ER_B3_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-5**

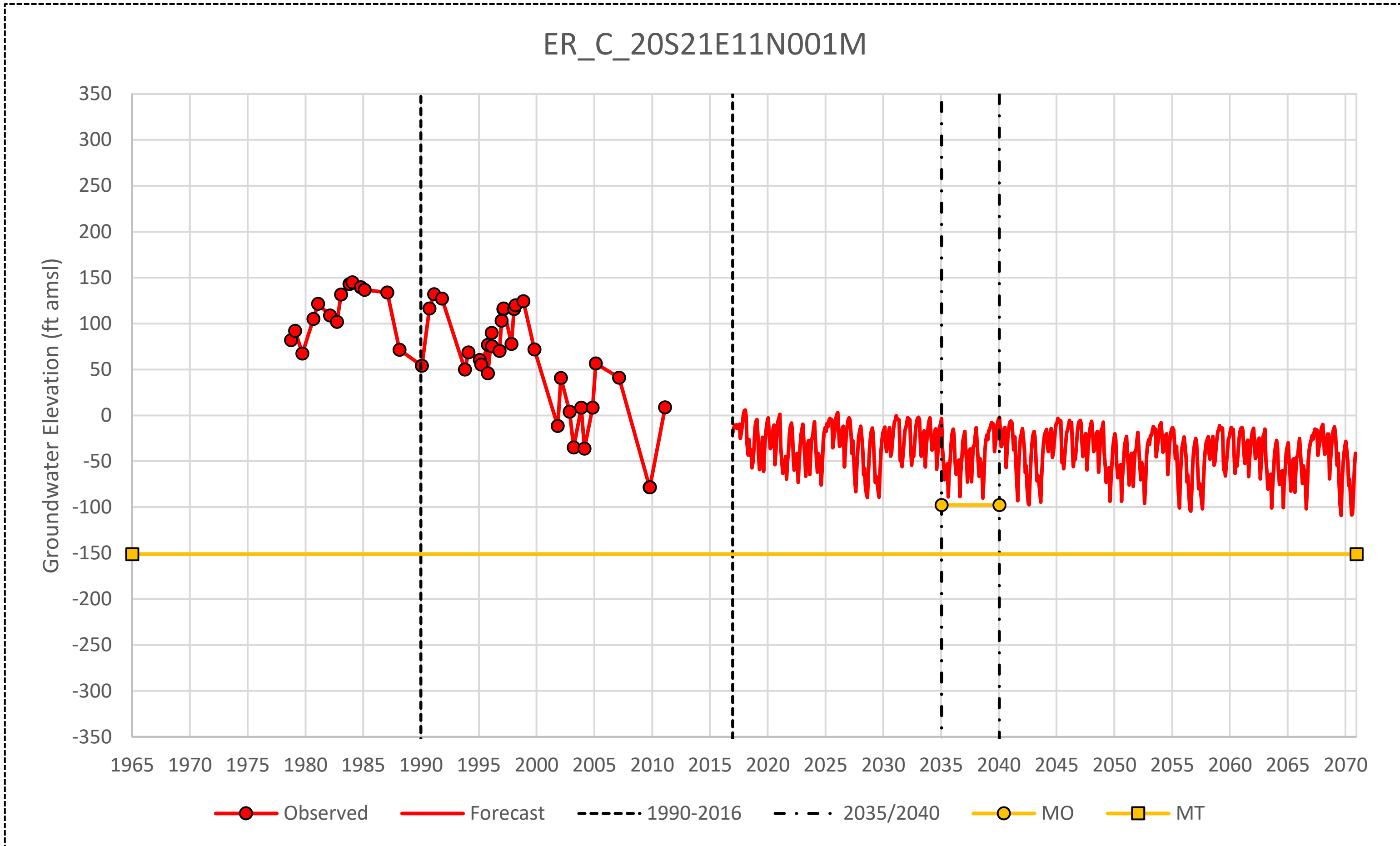
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_B4_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-6**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

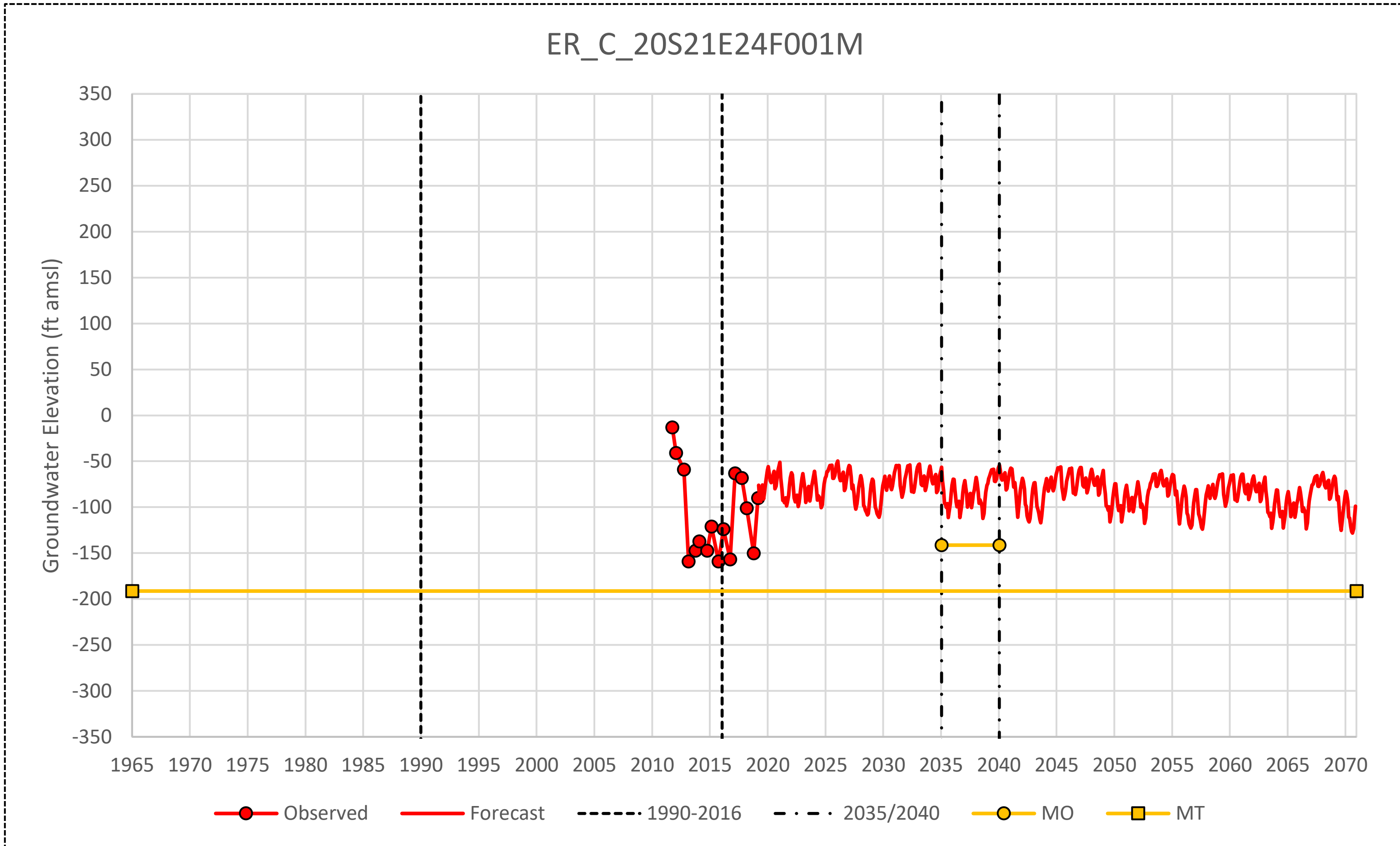


ER_C_20S21E11N001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

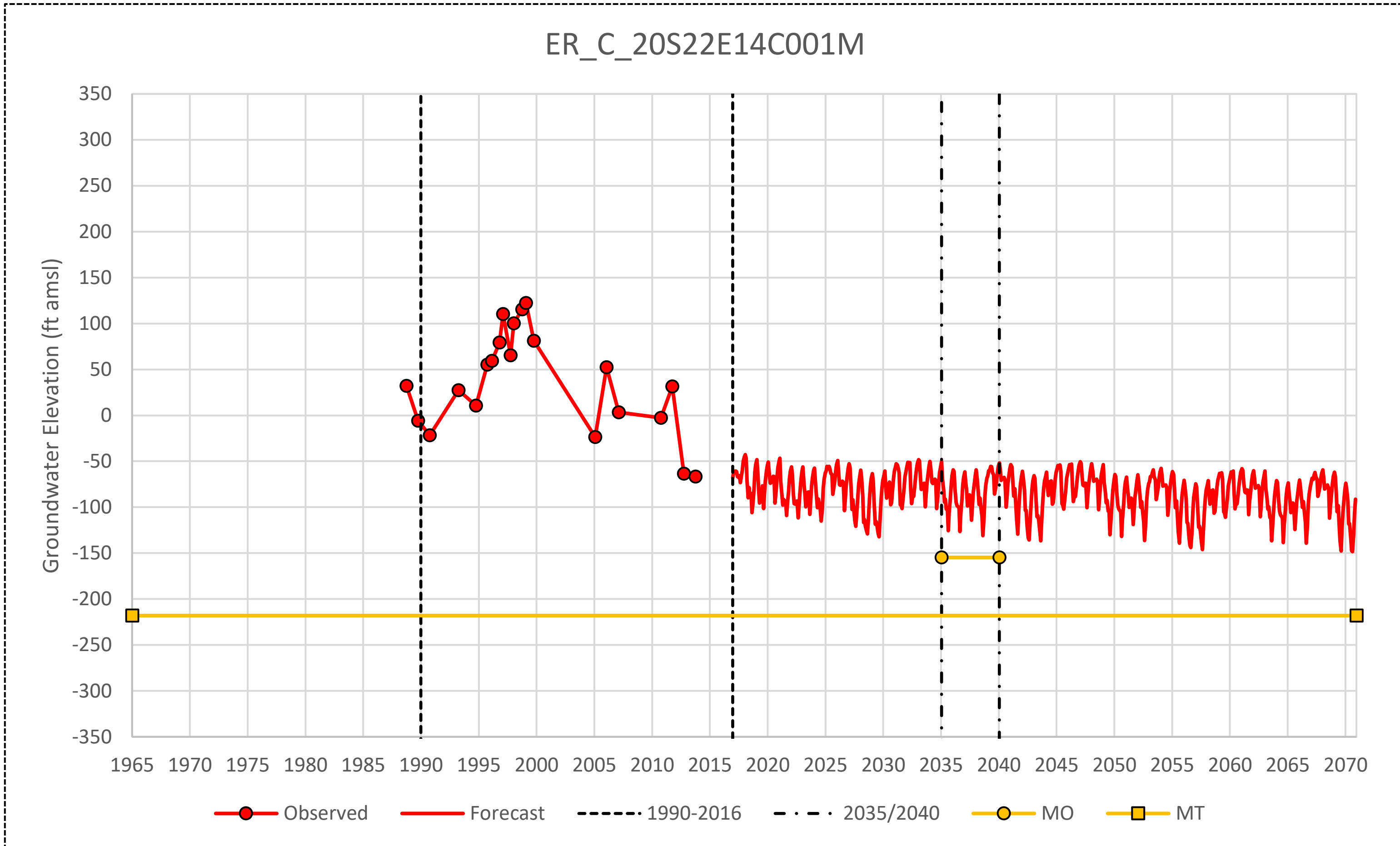
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-7**



ER_C_20S21E24F001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-8**

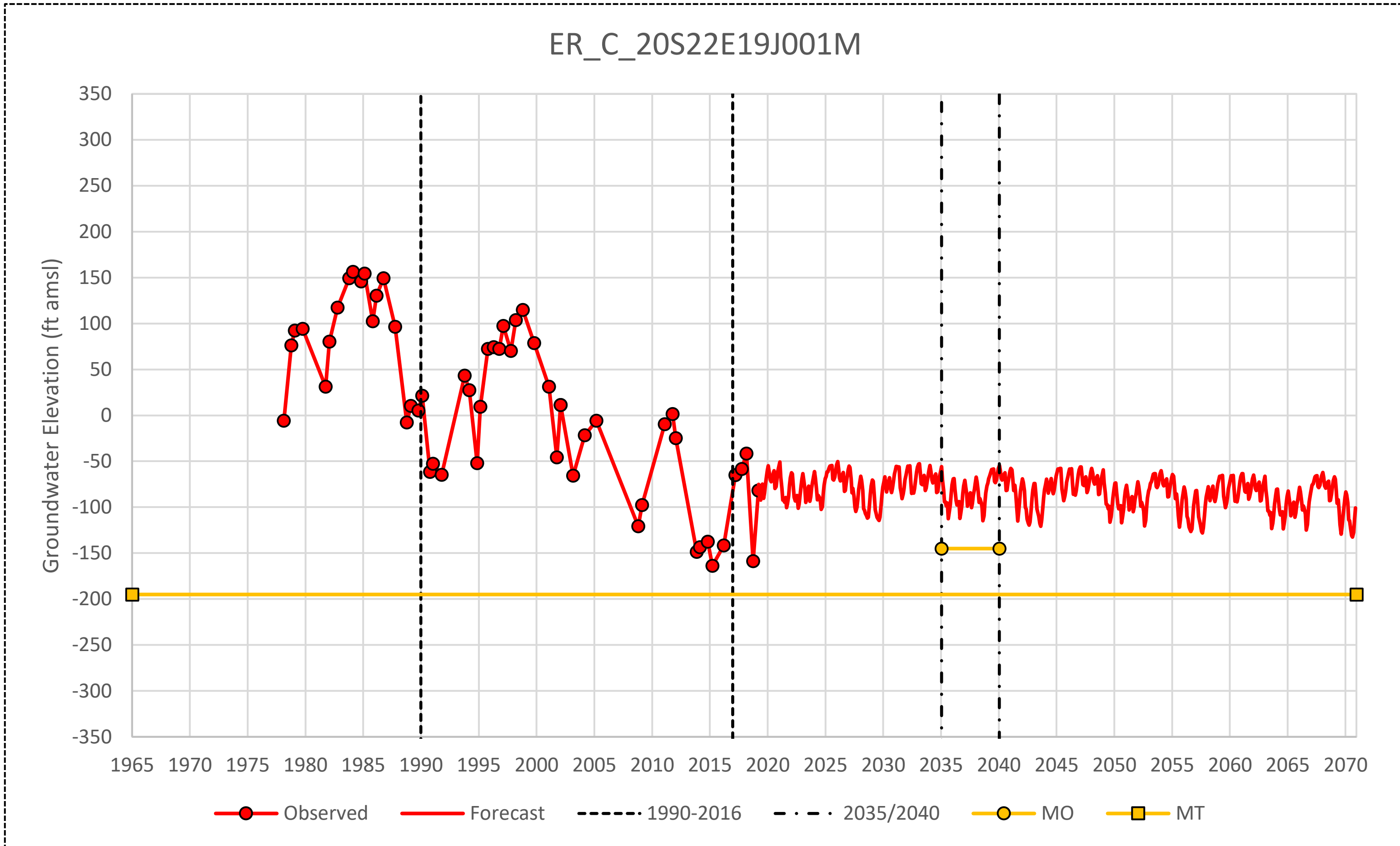


ER_C_20S22E14C001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-9**

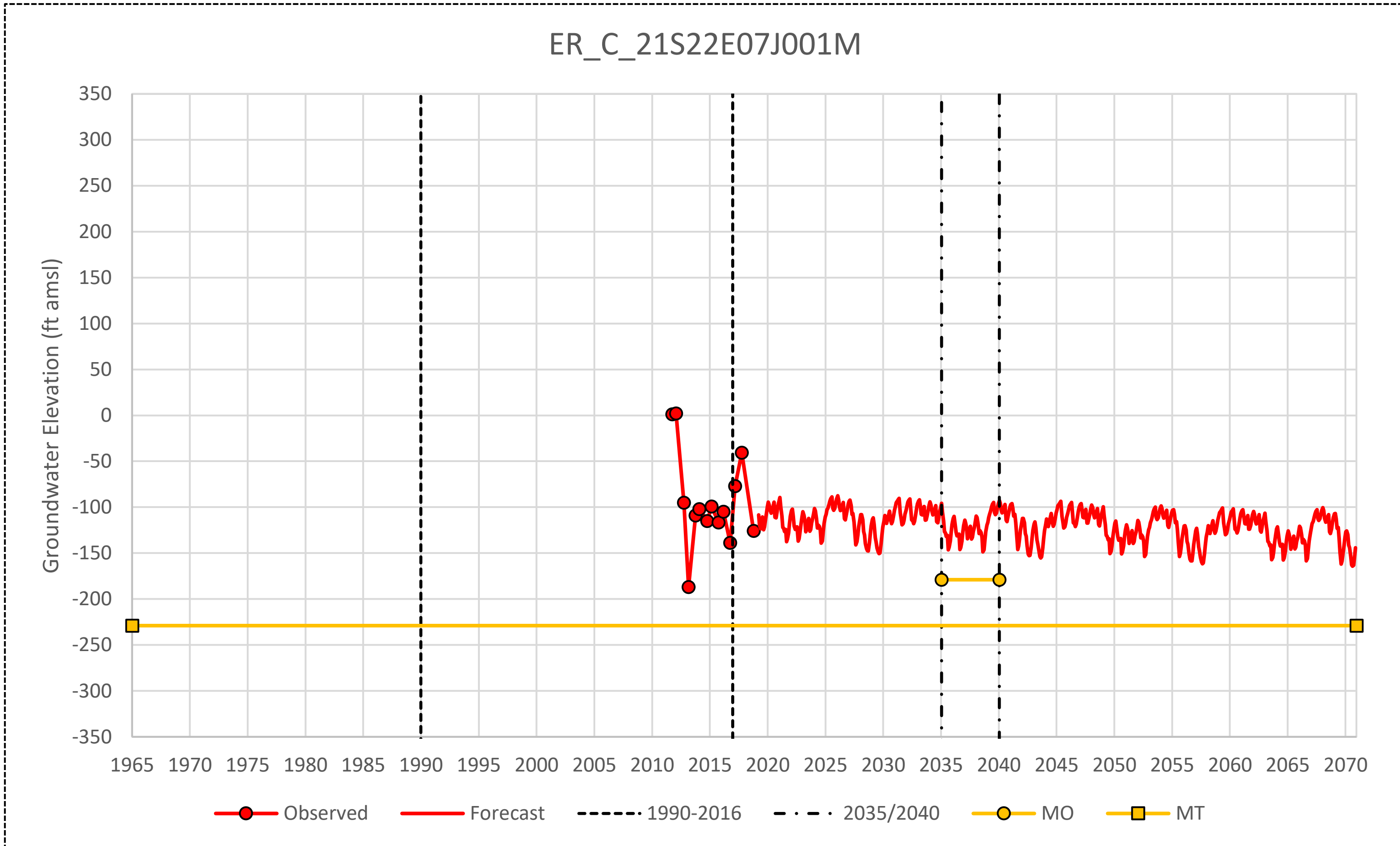
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_C_20S22E19J001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-10**

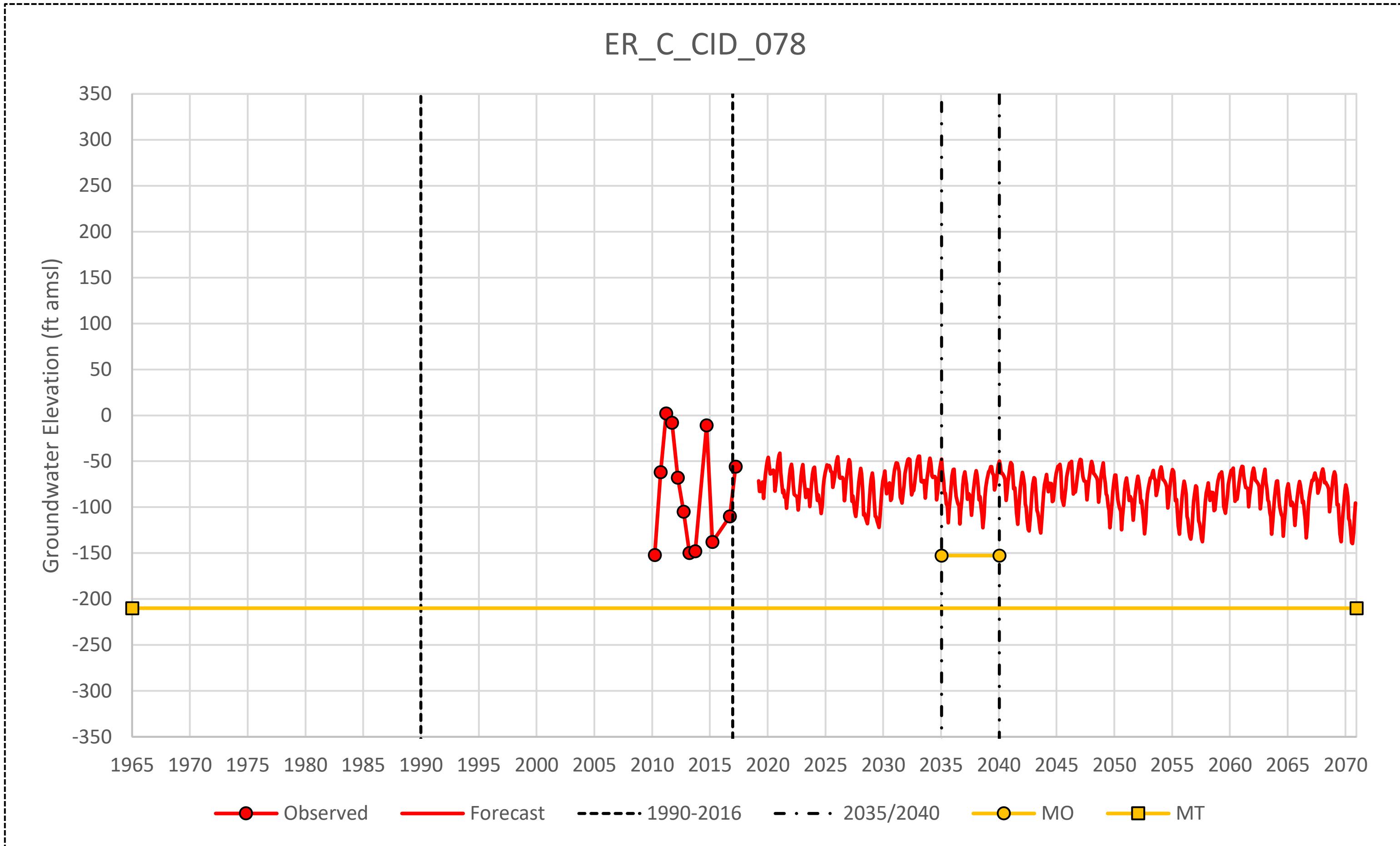


ER_C_21S22E07J001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

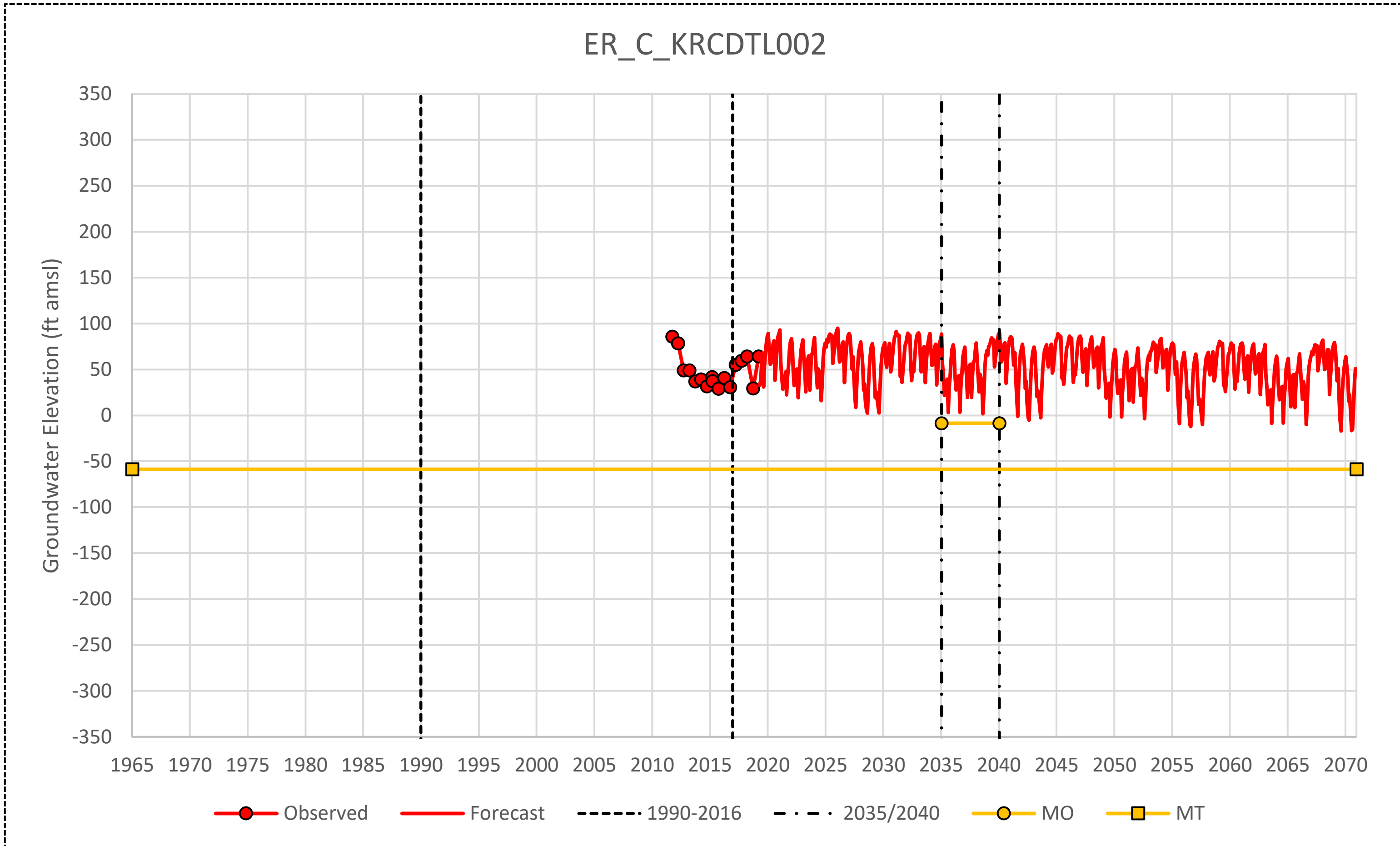
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-11**



ER_C_CID_078 Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-12**

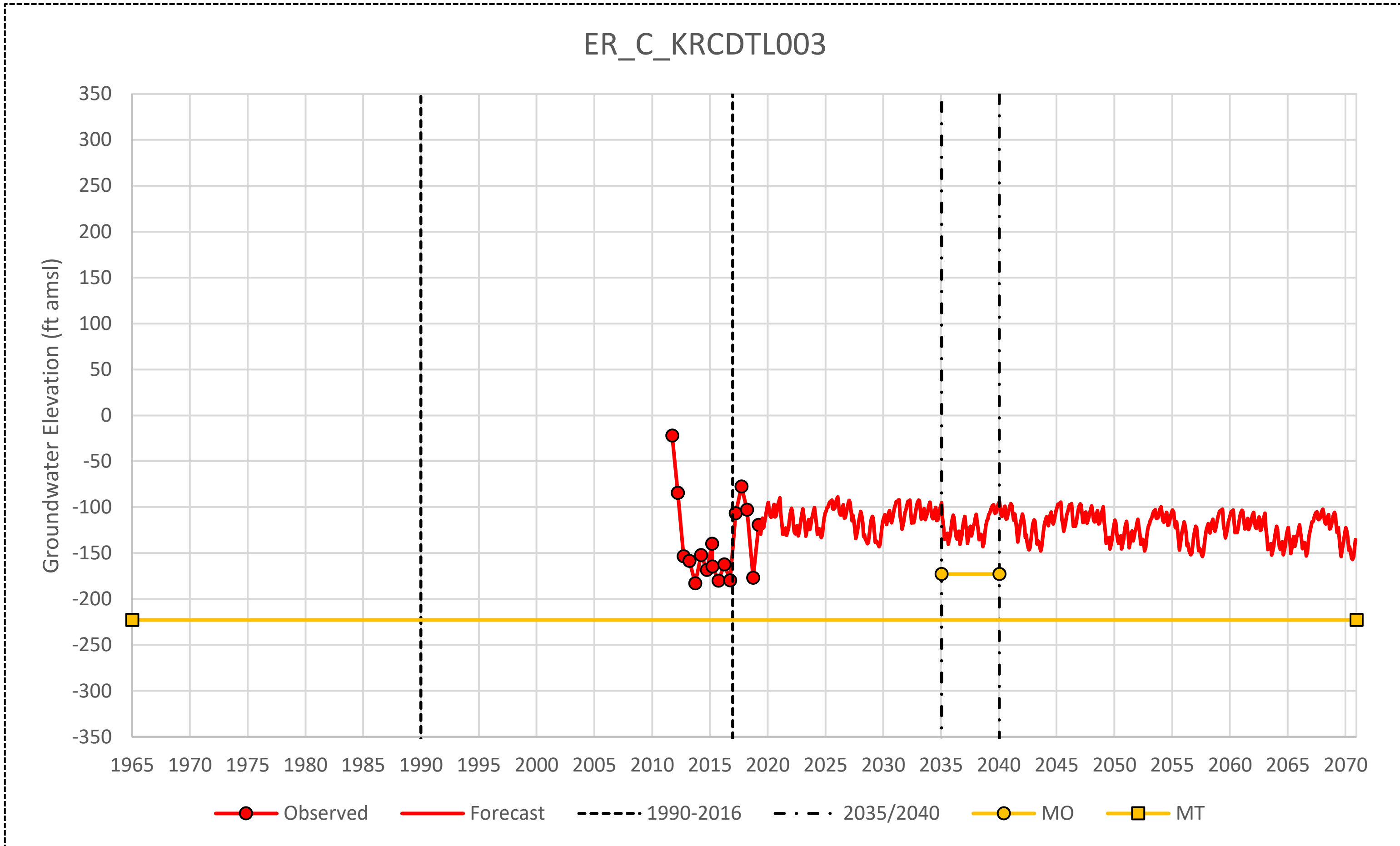
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_C_KRCDTL002 Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-13**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_C_KRCDTL003 Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-14**

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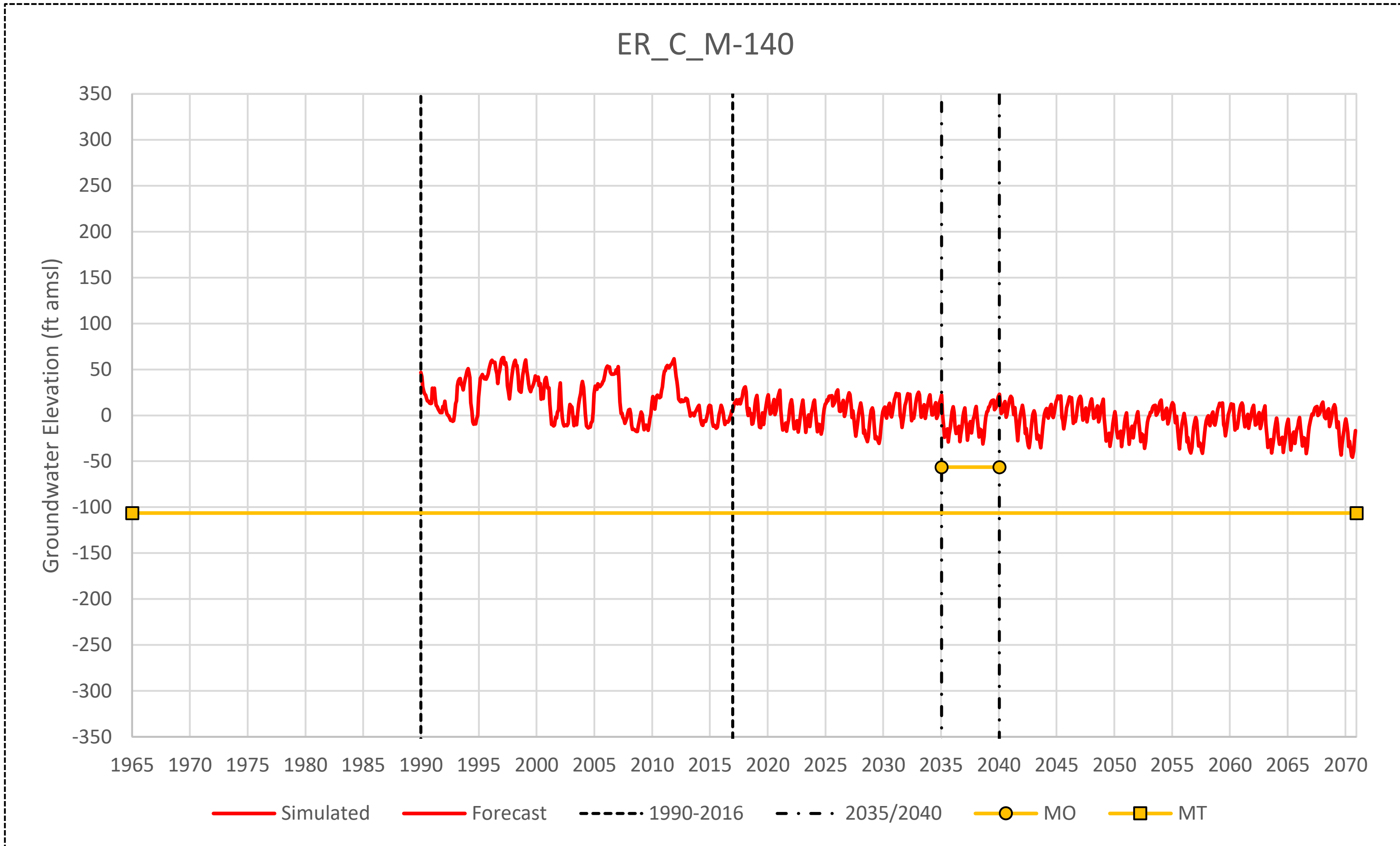
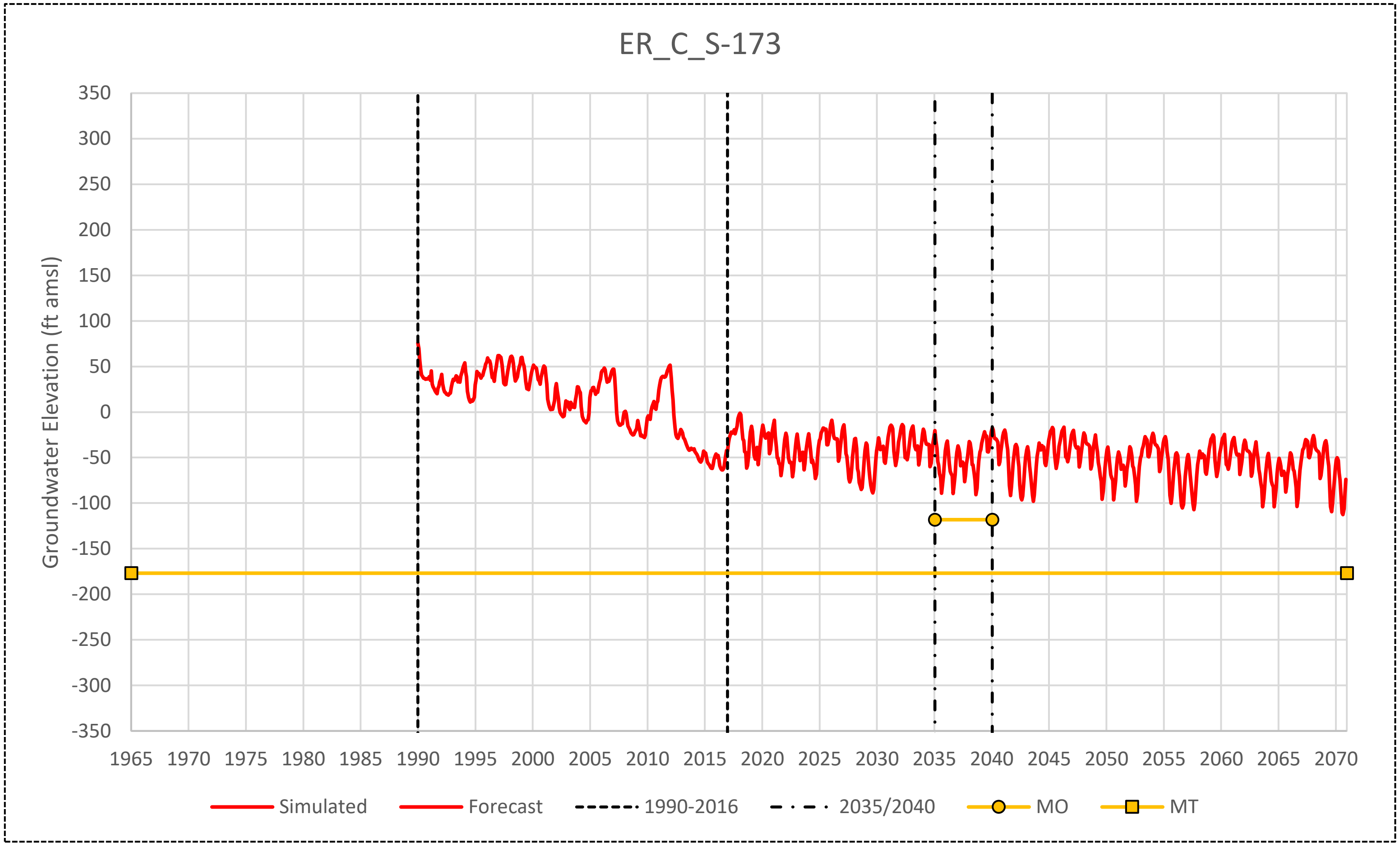


ER_CM-140 Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

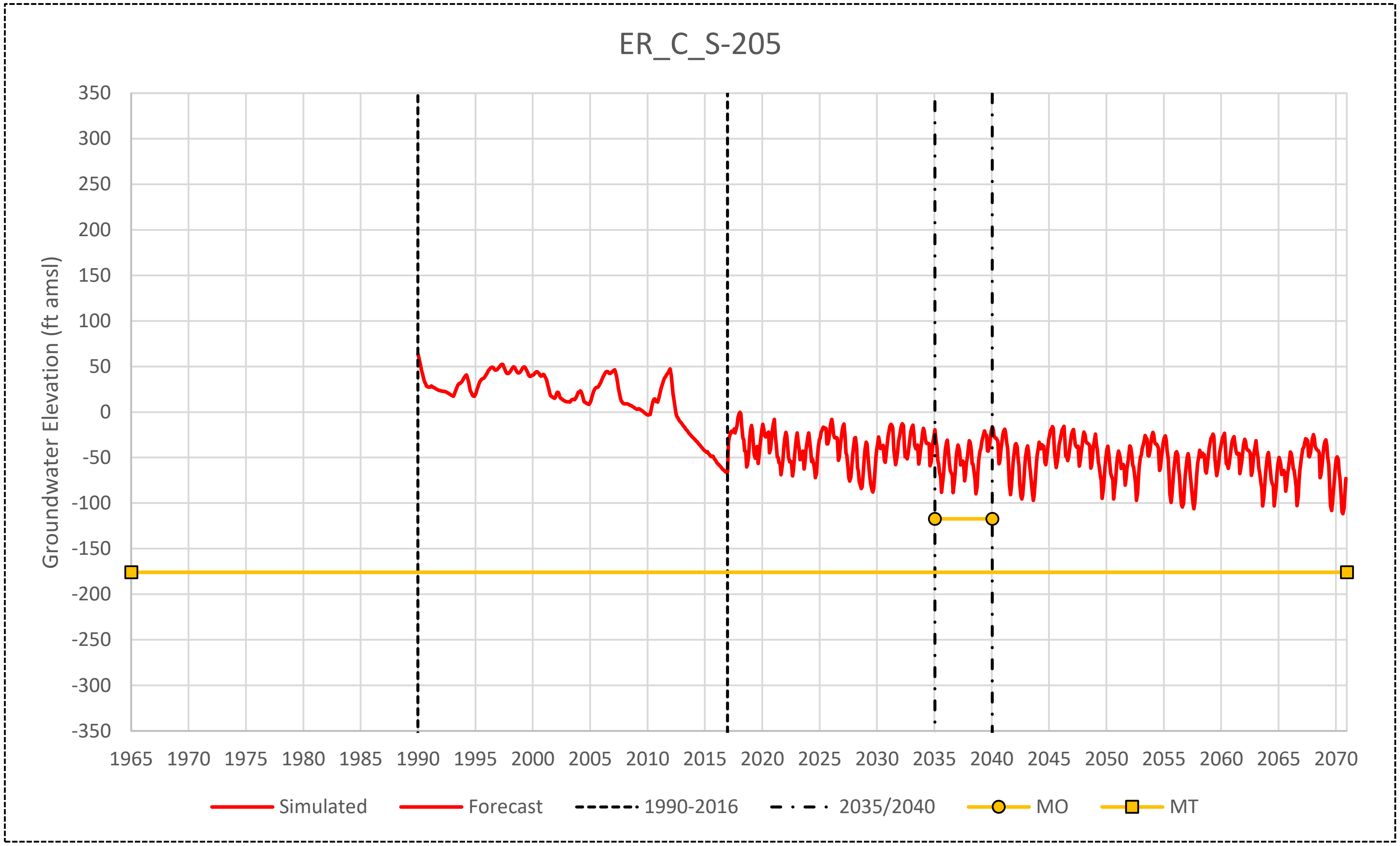
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-15**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



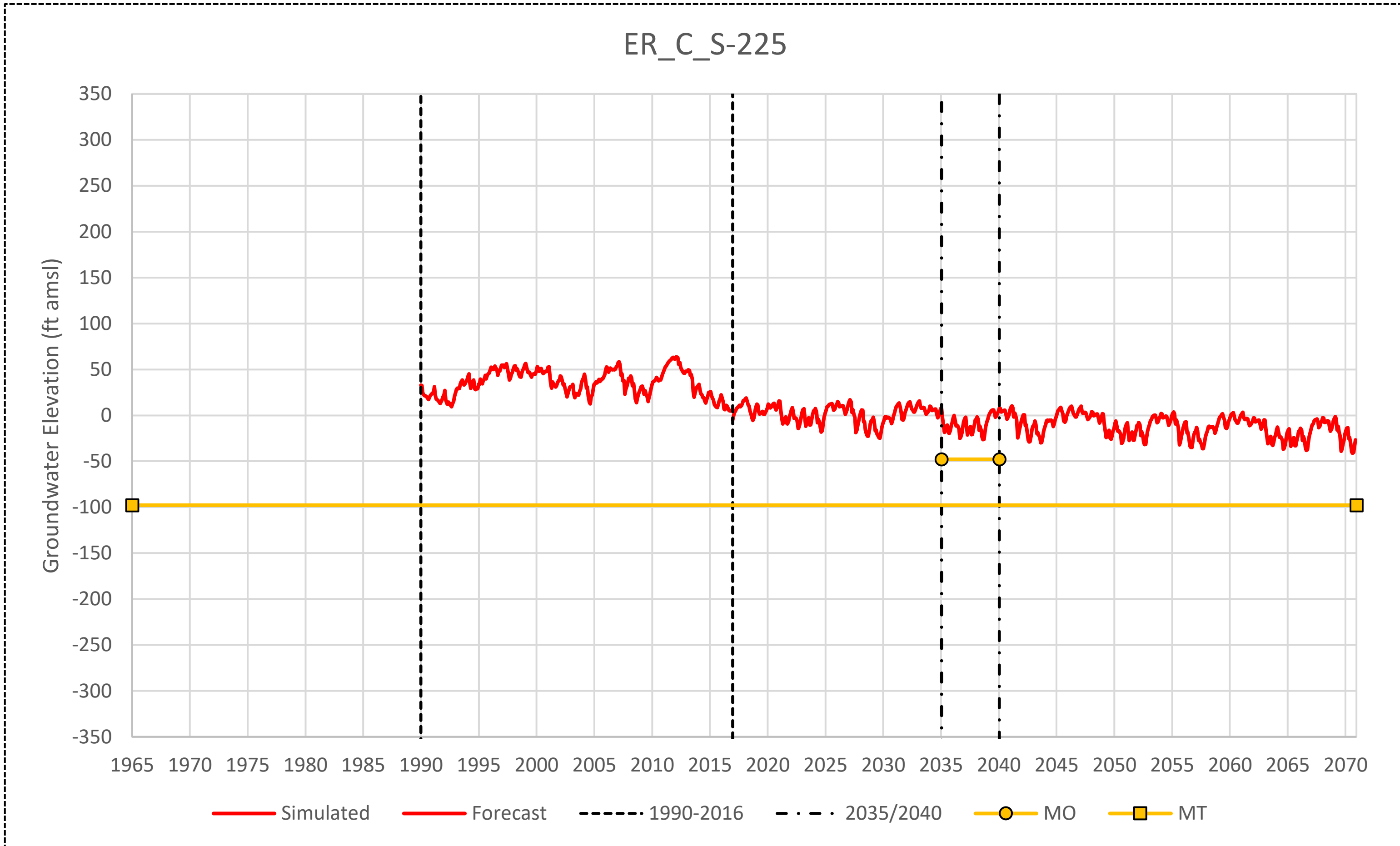
ER_C_S-173 Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-16**



ER_C_S-205 Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

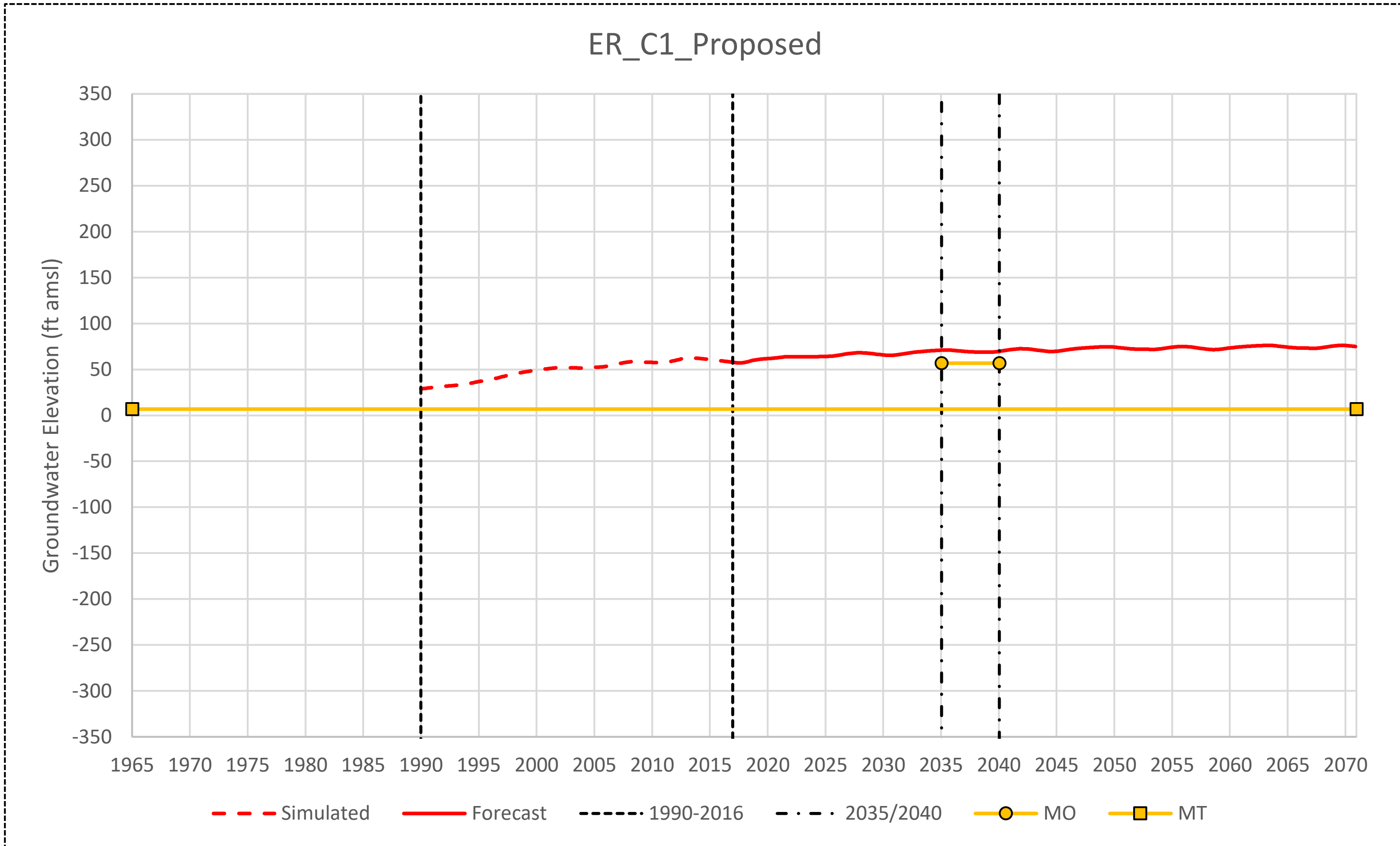
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-17**



ER_C_S-225 Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-18**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_C1_Proposed Hydrograph Tulare Lake Subbasin Groundwater Sustainability Plan Kings County, California		
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-19**

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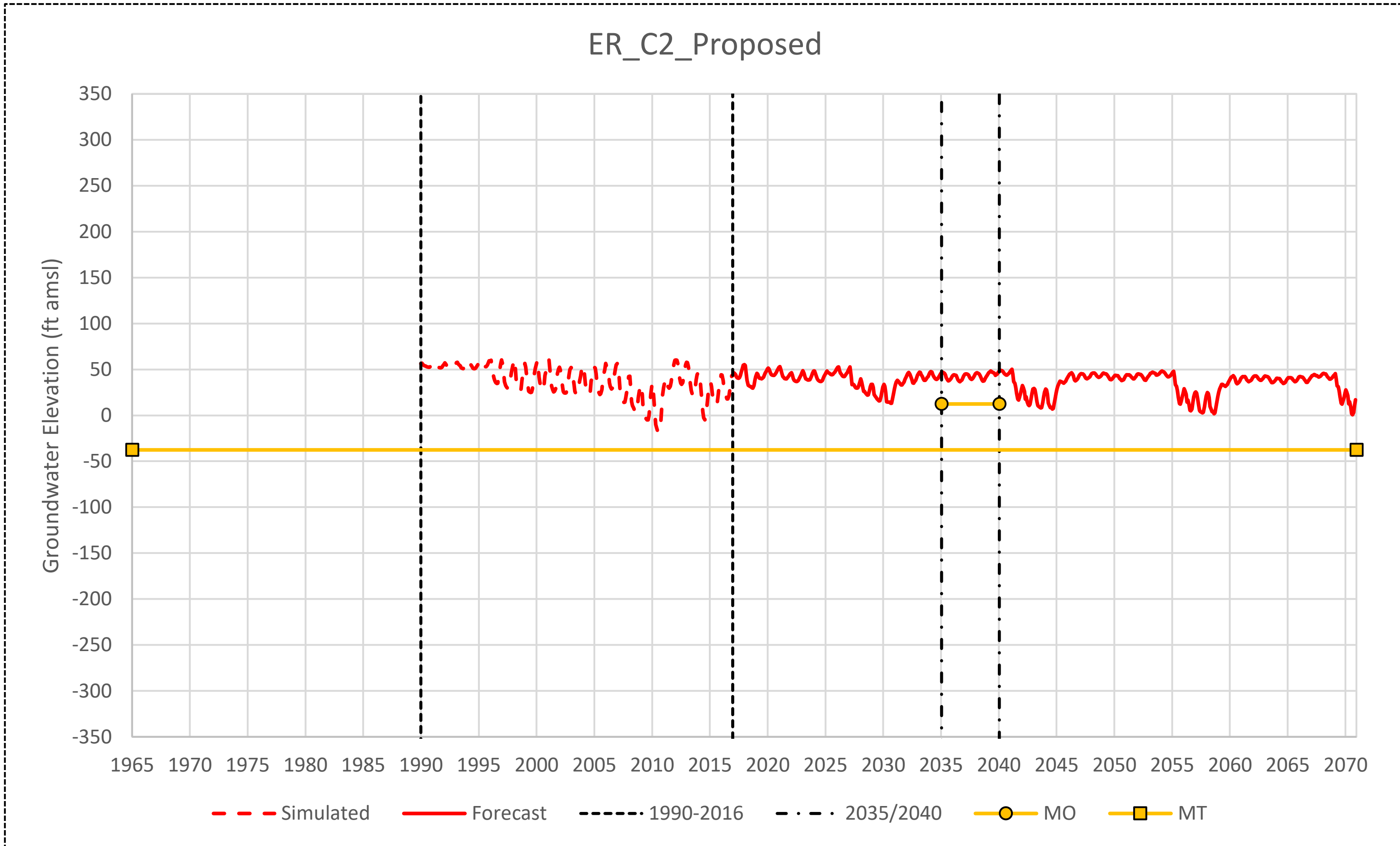
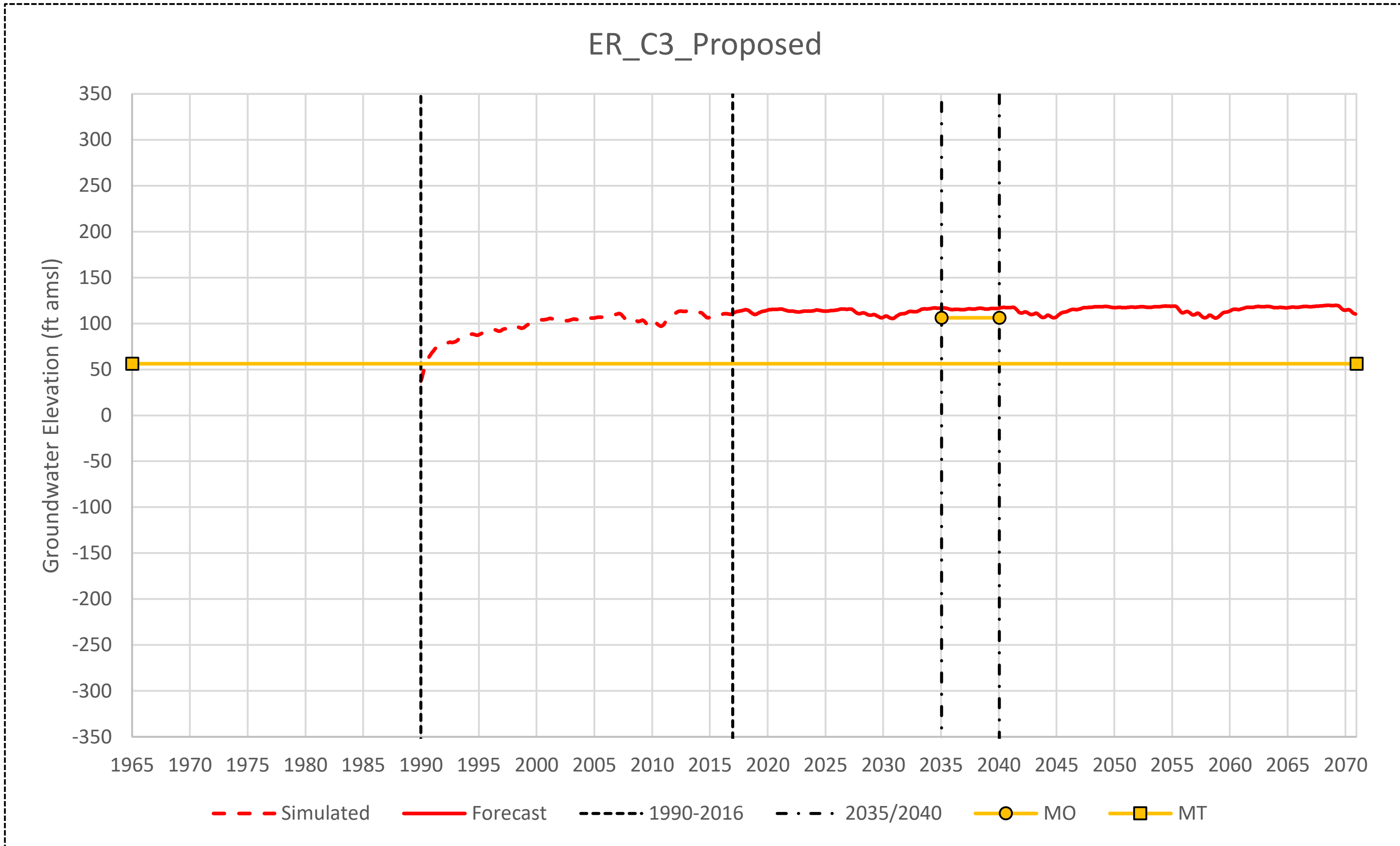


ER_C2_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-20**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_C3_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-21**

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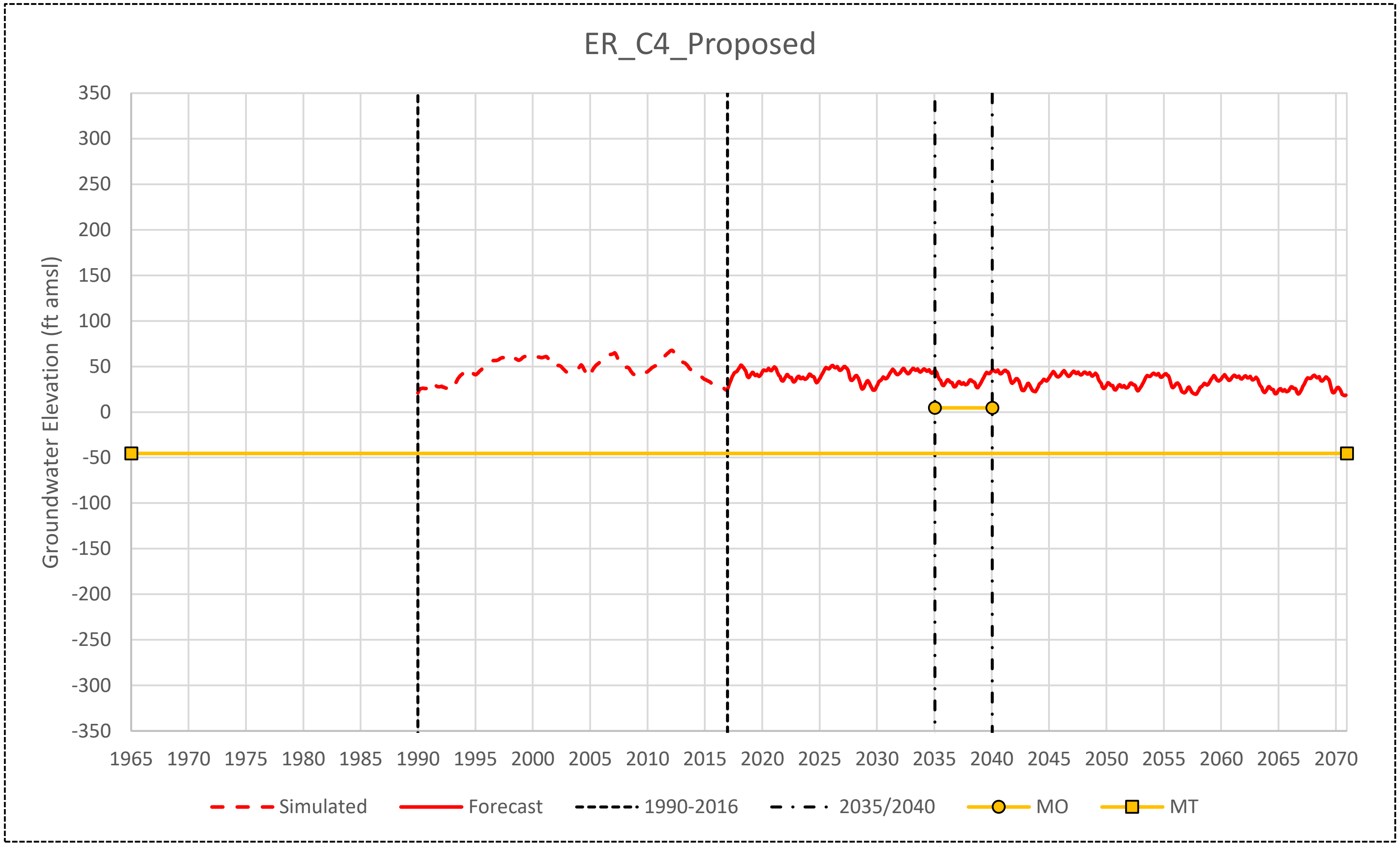
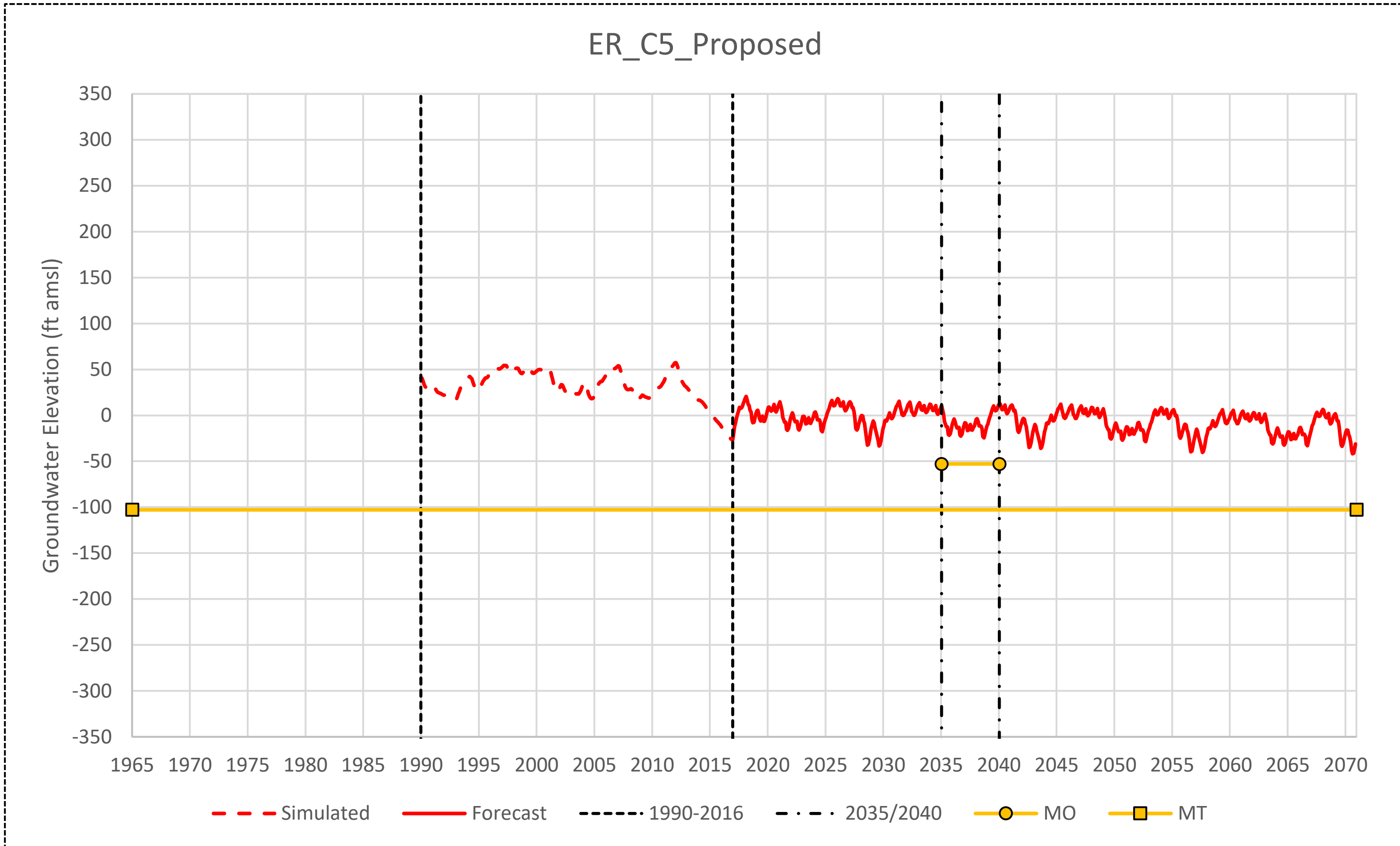


ER_C4_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-22**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



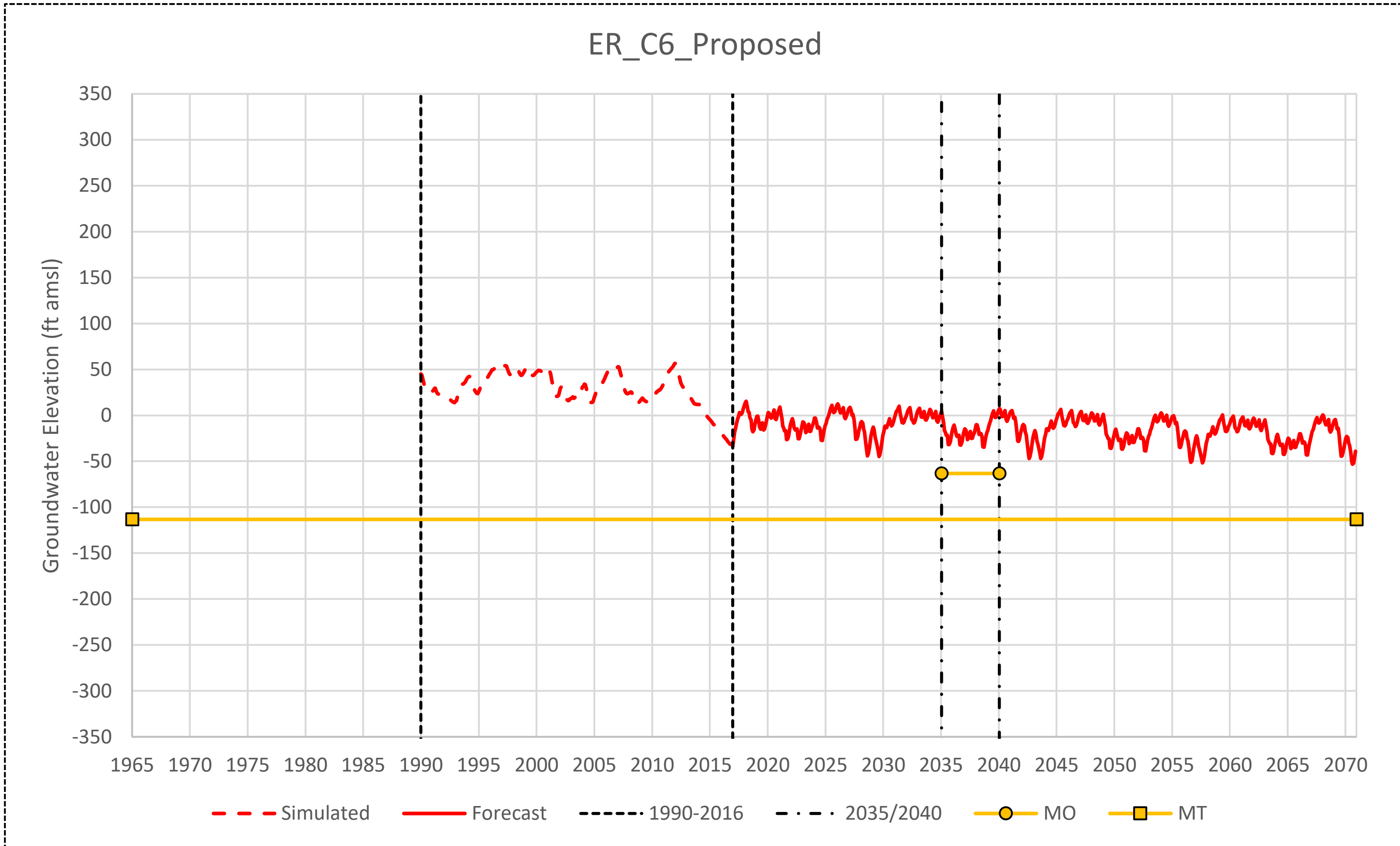
ER_C5_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-23**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

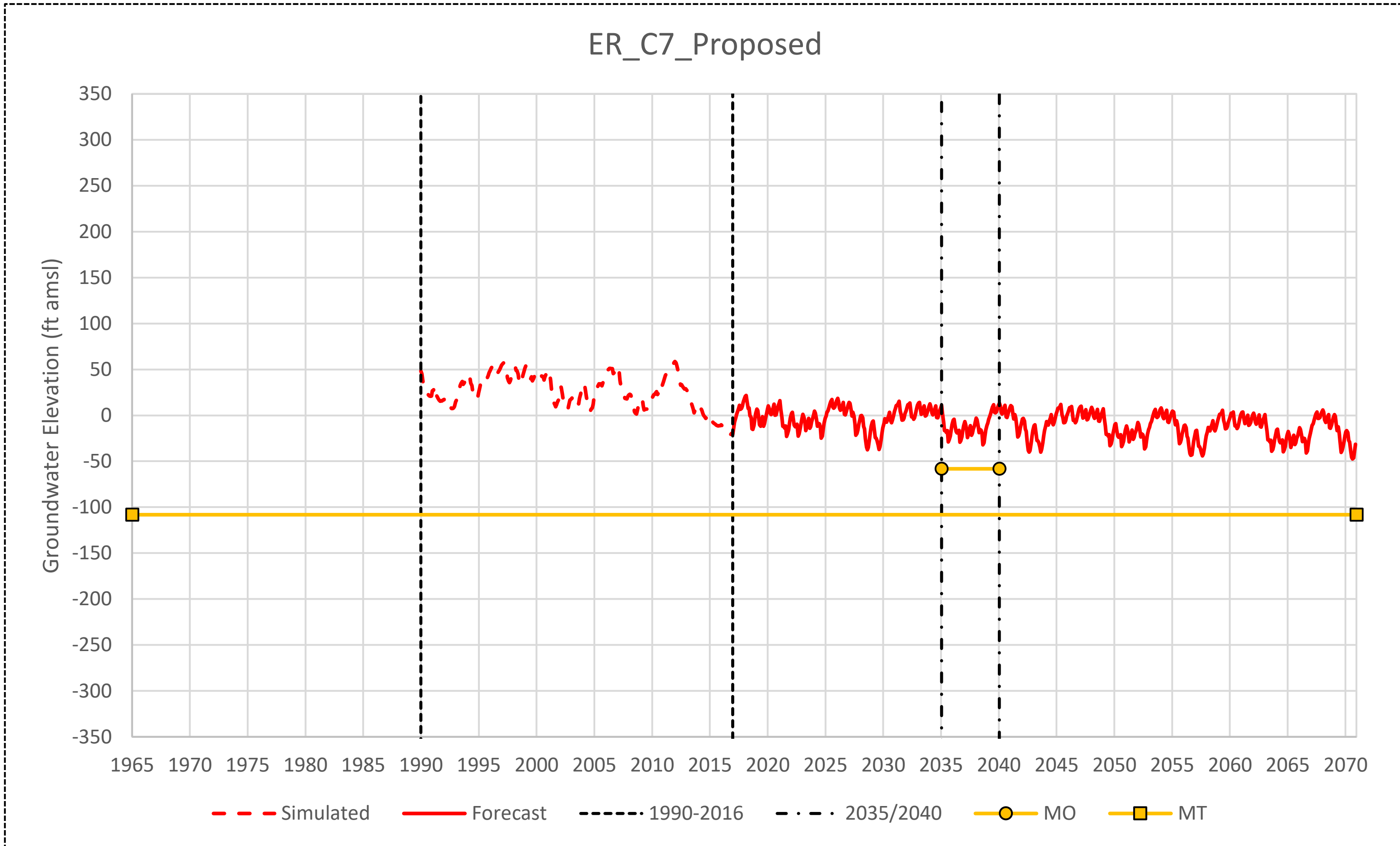


ER_C6_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-24**



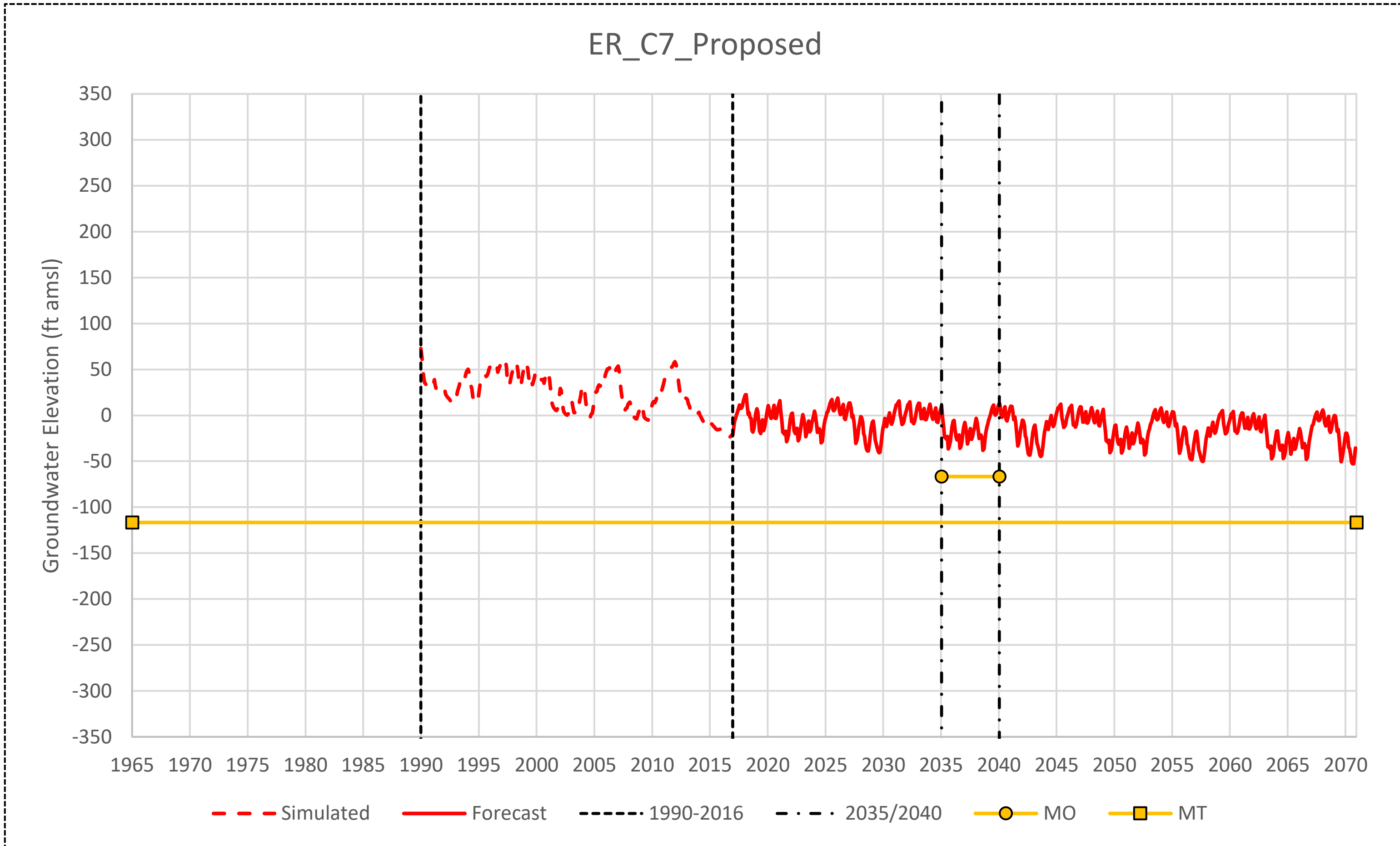
ER_C7_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-25**

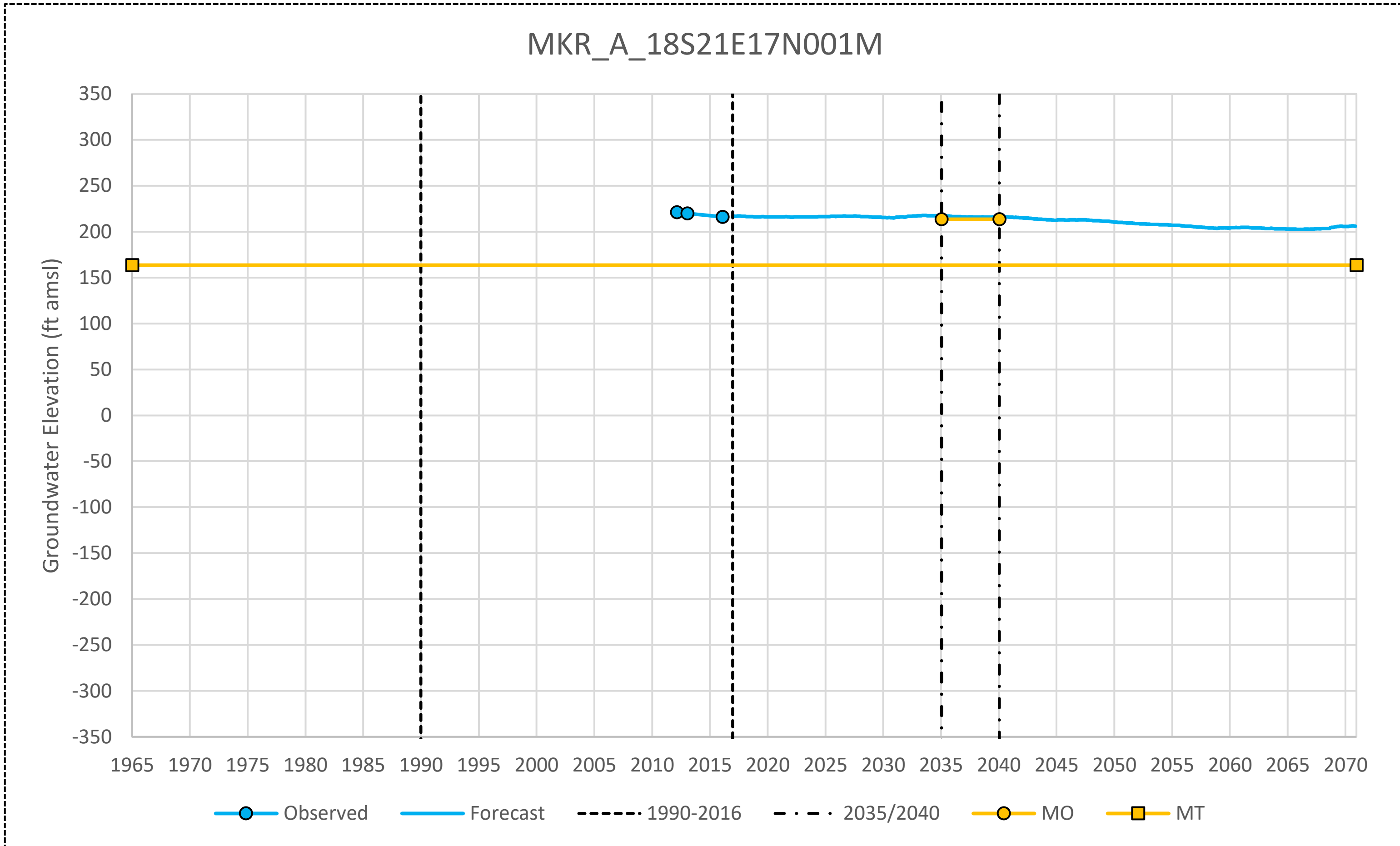
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



ER_C7_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-26**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

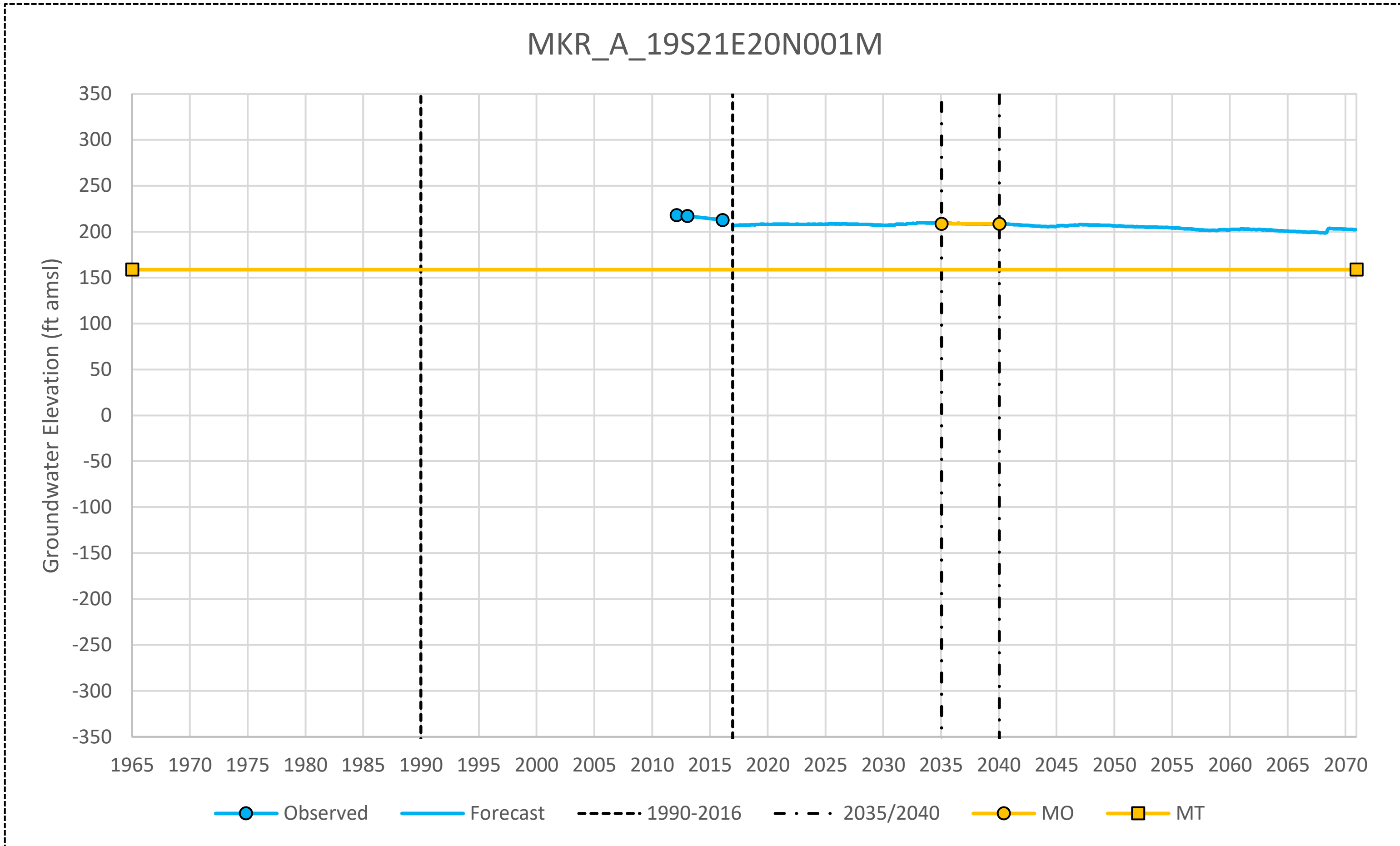


MKR_A_1S21E17N001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

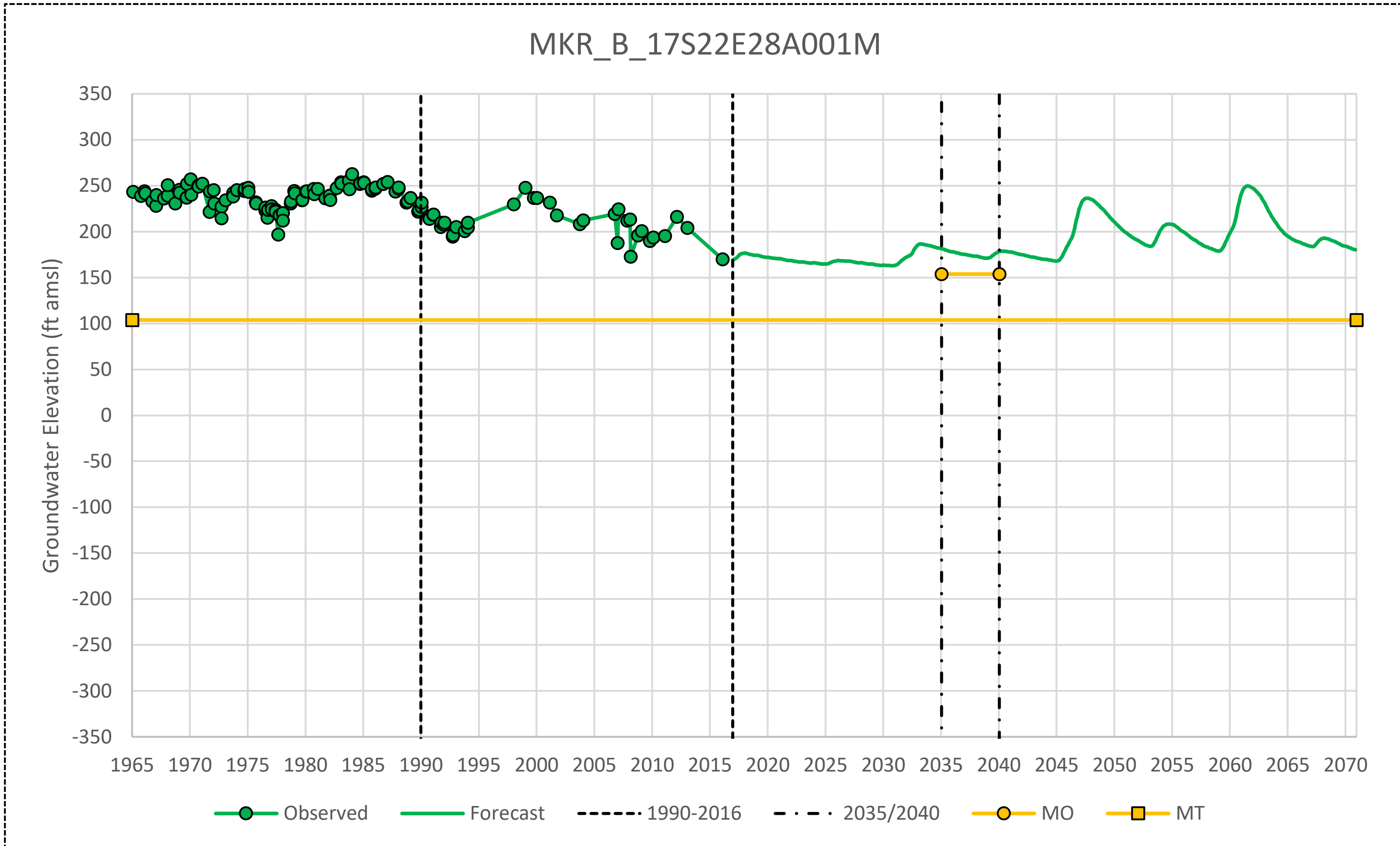
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-27**



MKR_A_19S21E20N001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-28**

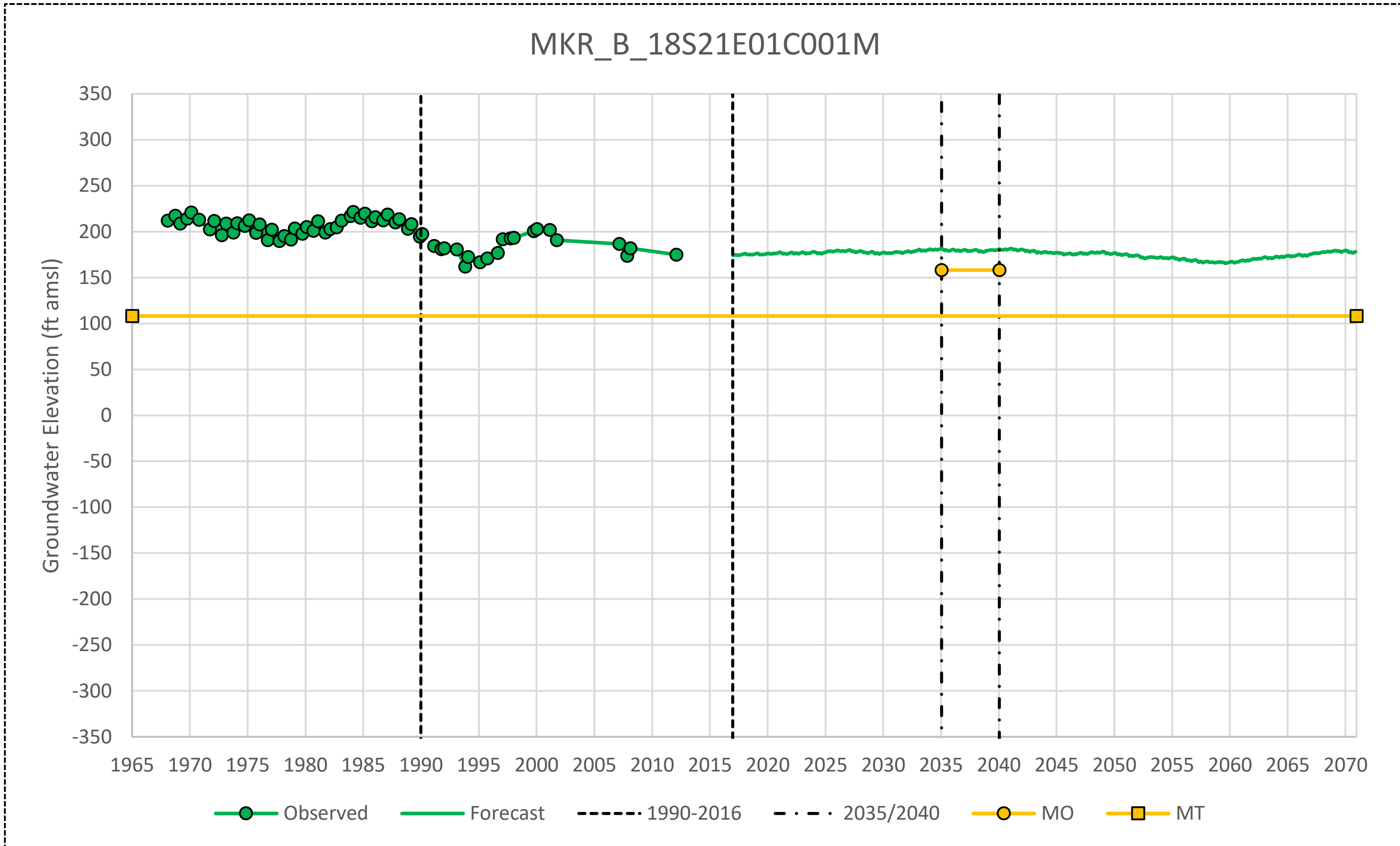


MKR_B_17S22E28A001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

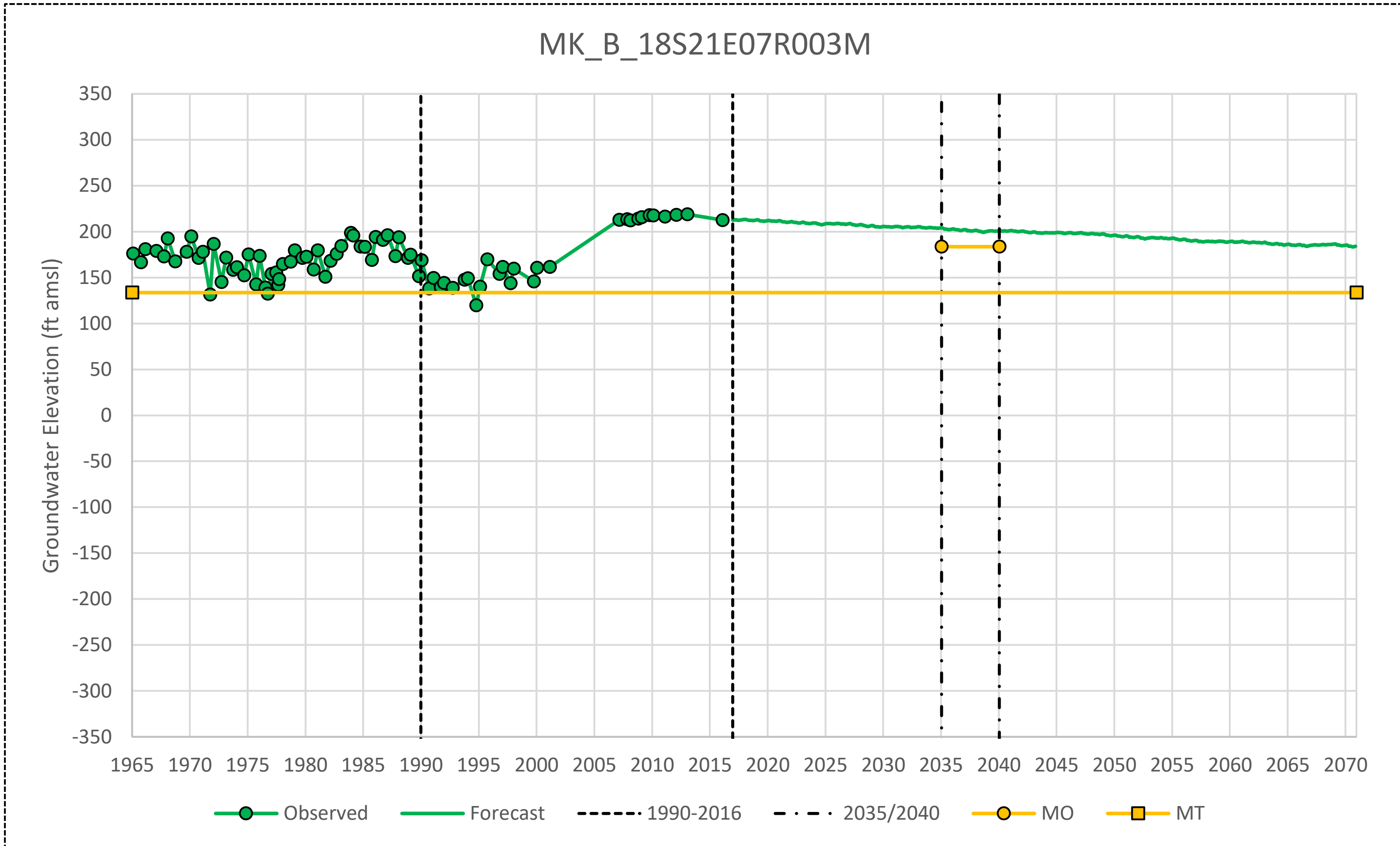
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-29**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



MKR_B_18S21E01C001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

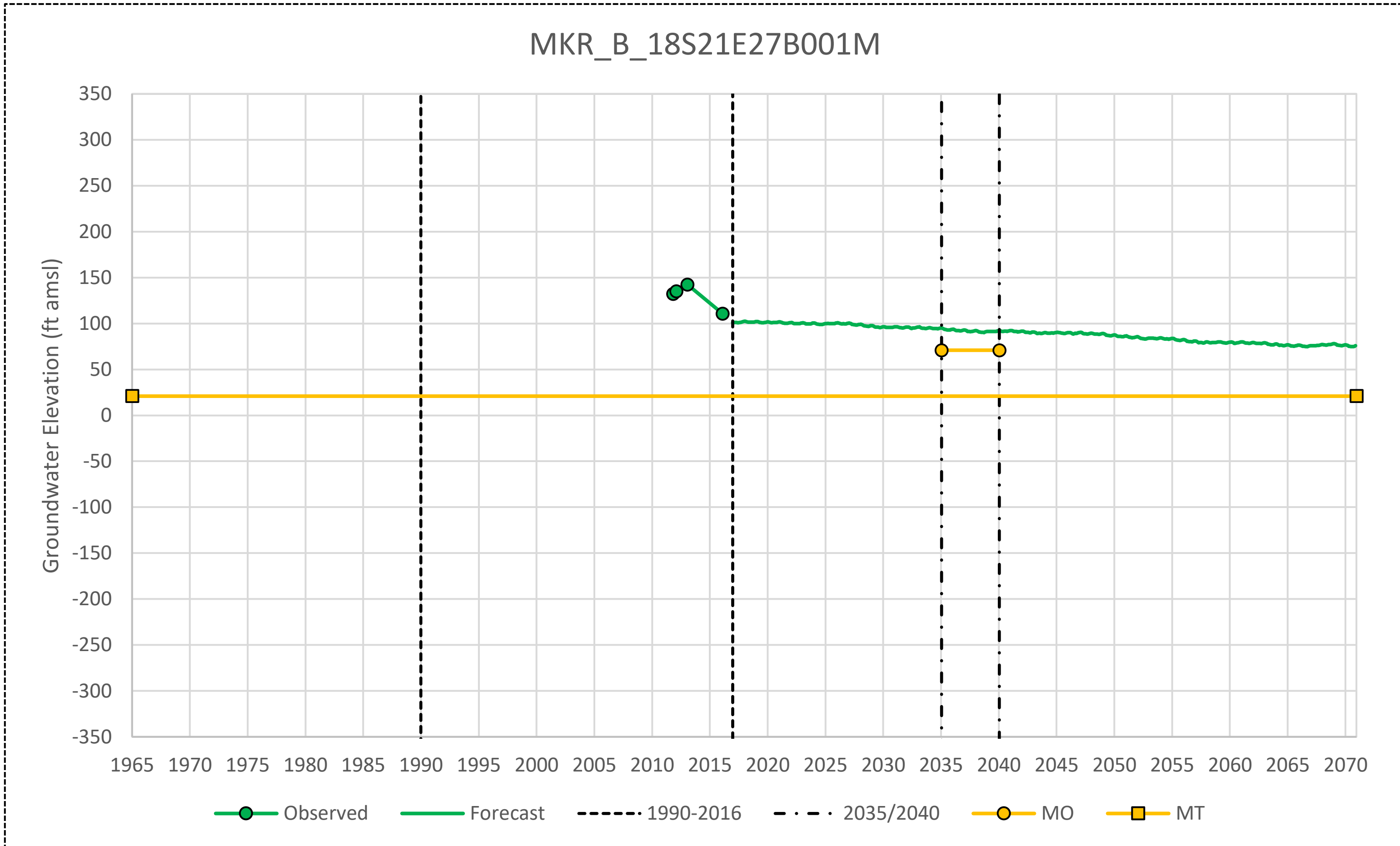
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-30**



MKR_B_18S21E07R003M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-31**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

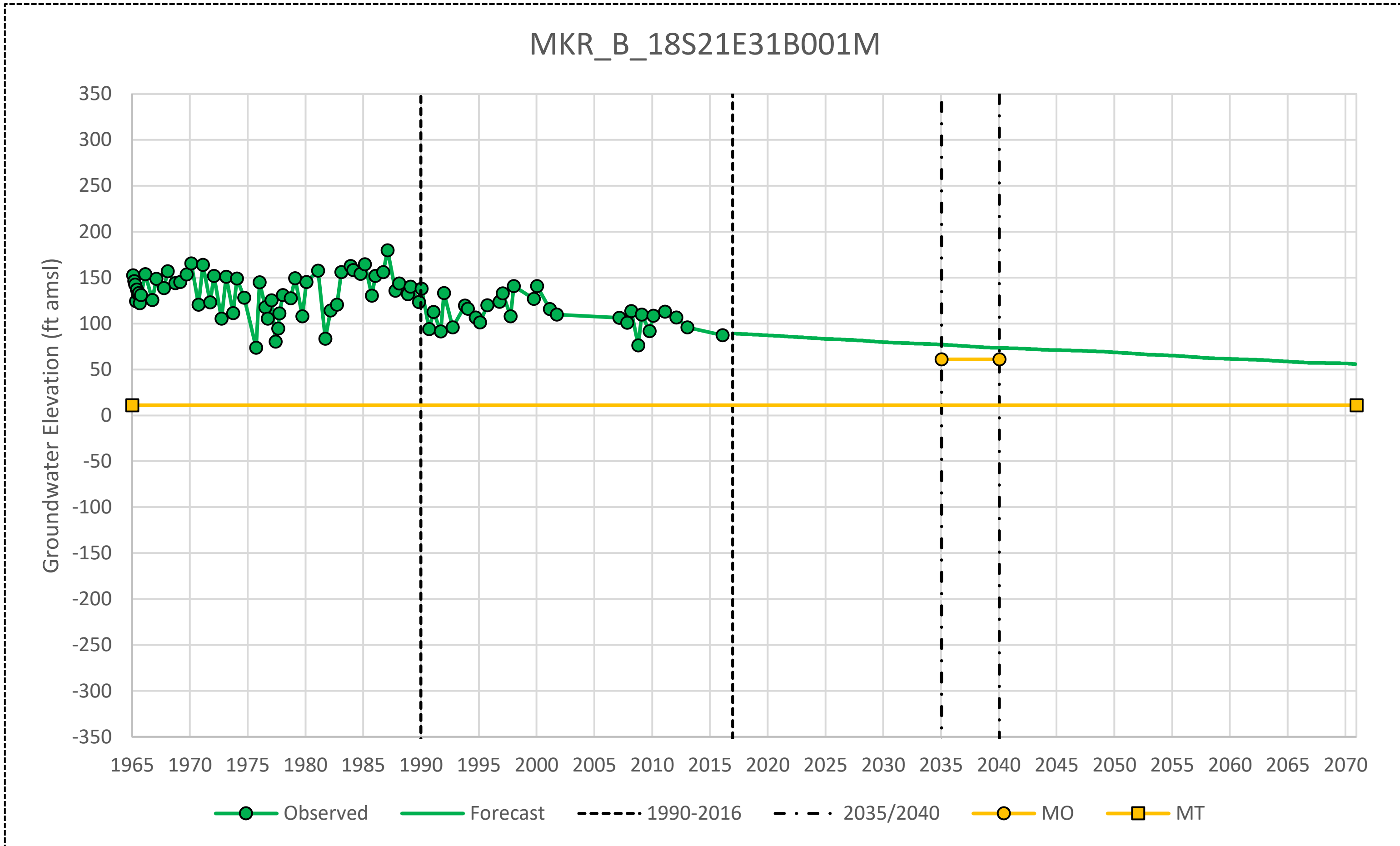


MKR_B_18S21E27B001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

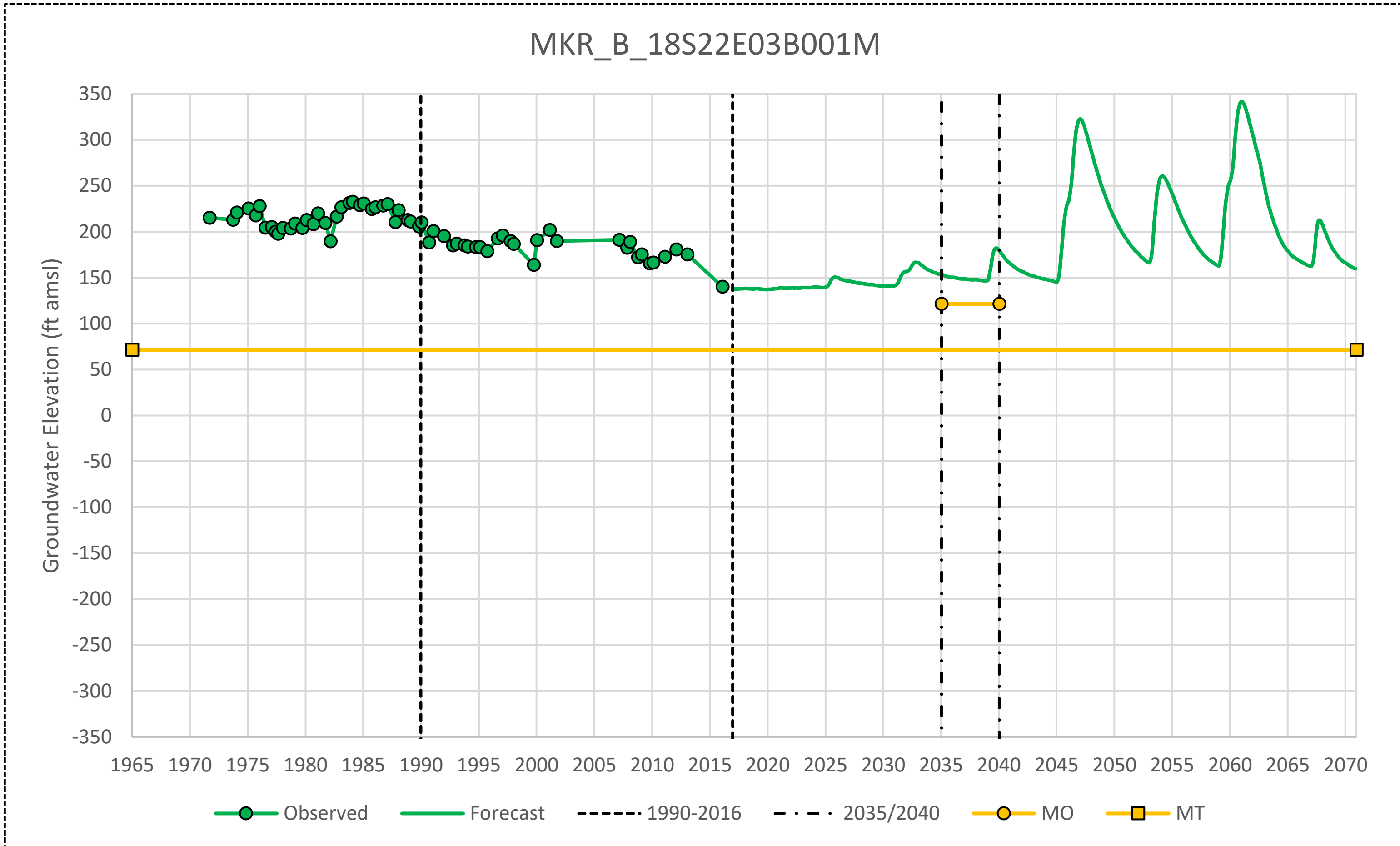
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-32**



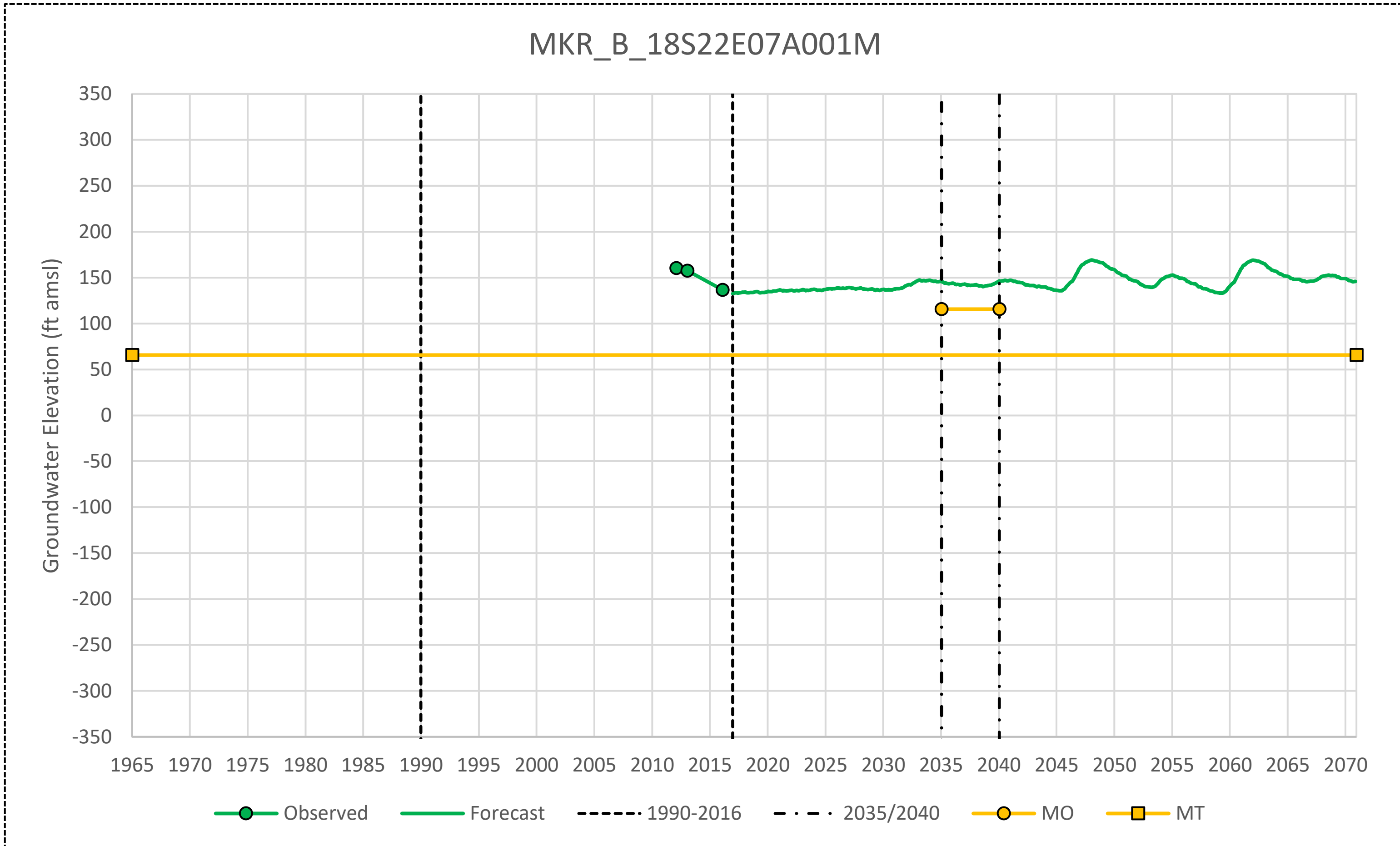
MKR_B_18S21E31B001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-33**



MKR_B_18S22E03B001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-34**

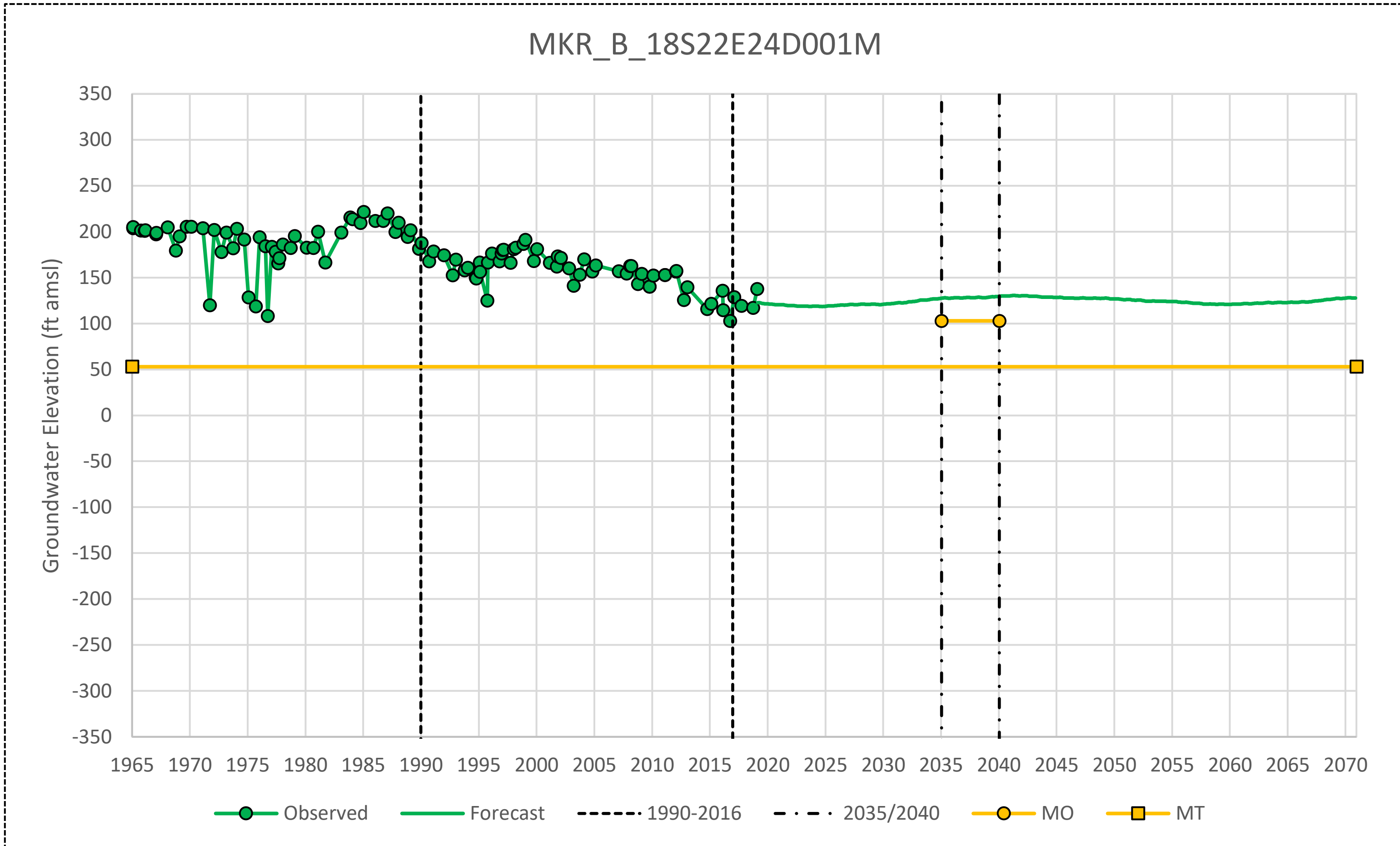


MKR_B_18S22E07A001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-35**

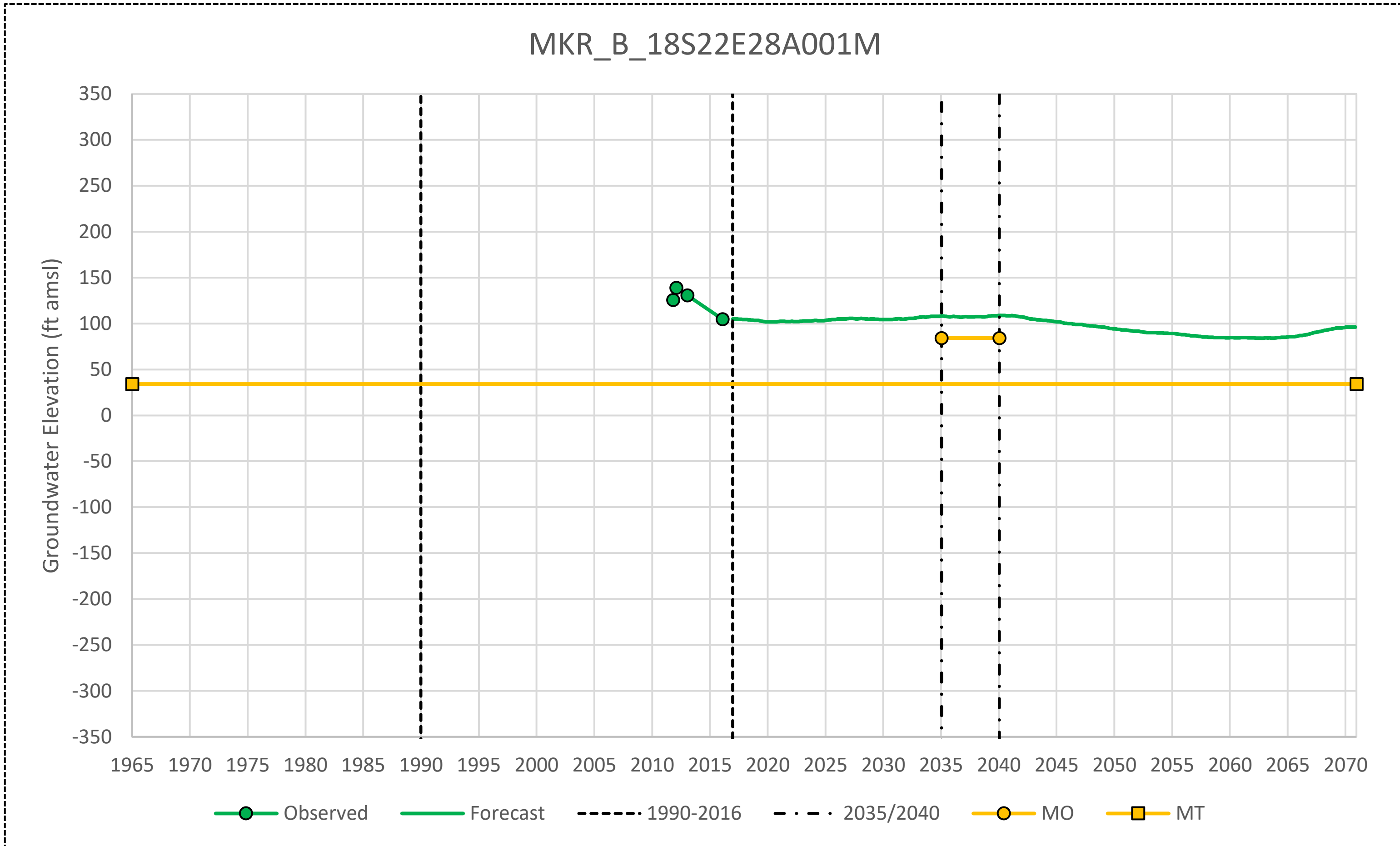


MKR_B_18S22E24D001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

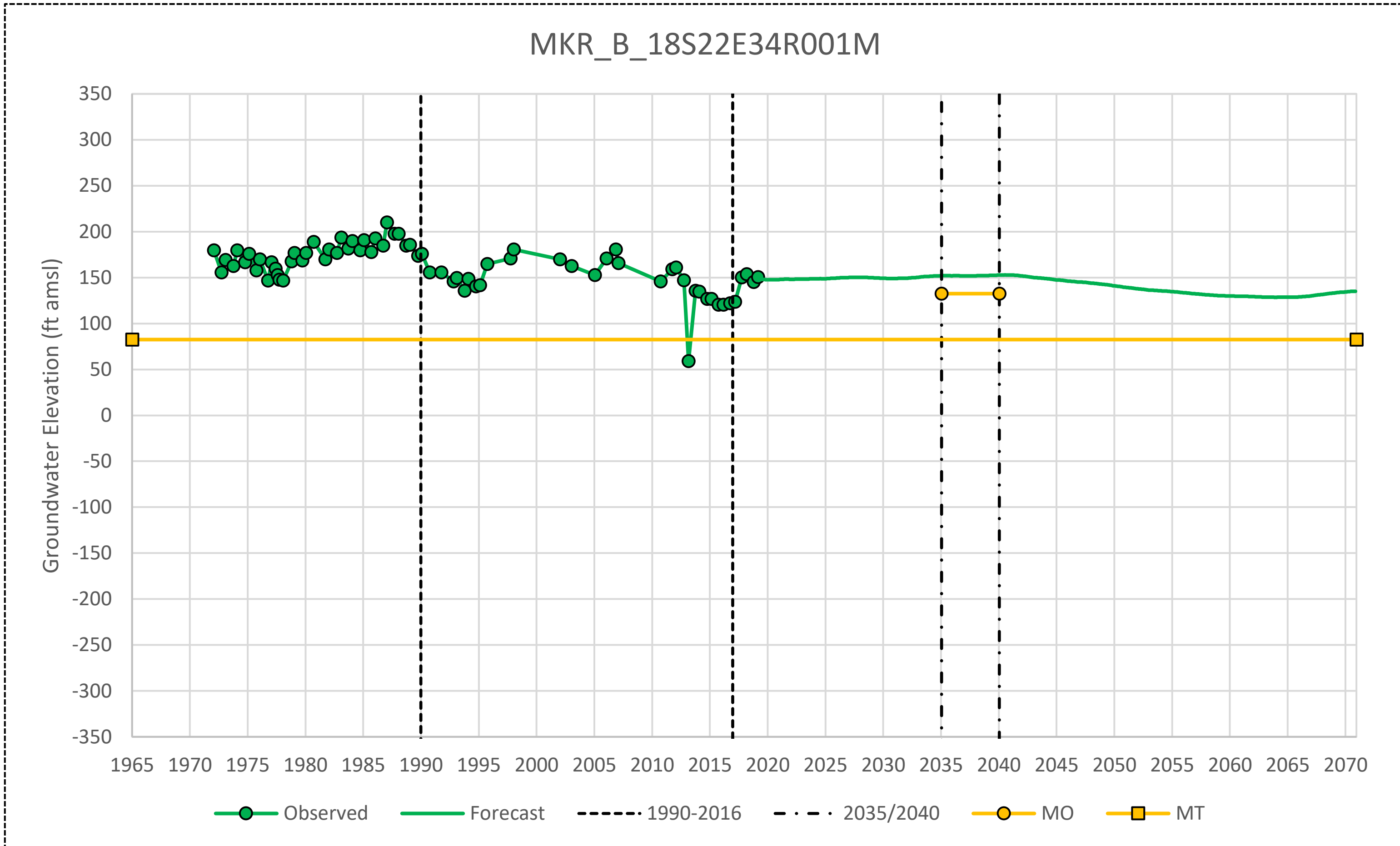
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-36**



MKR_B_18S22E28A001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

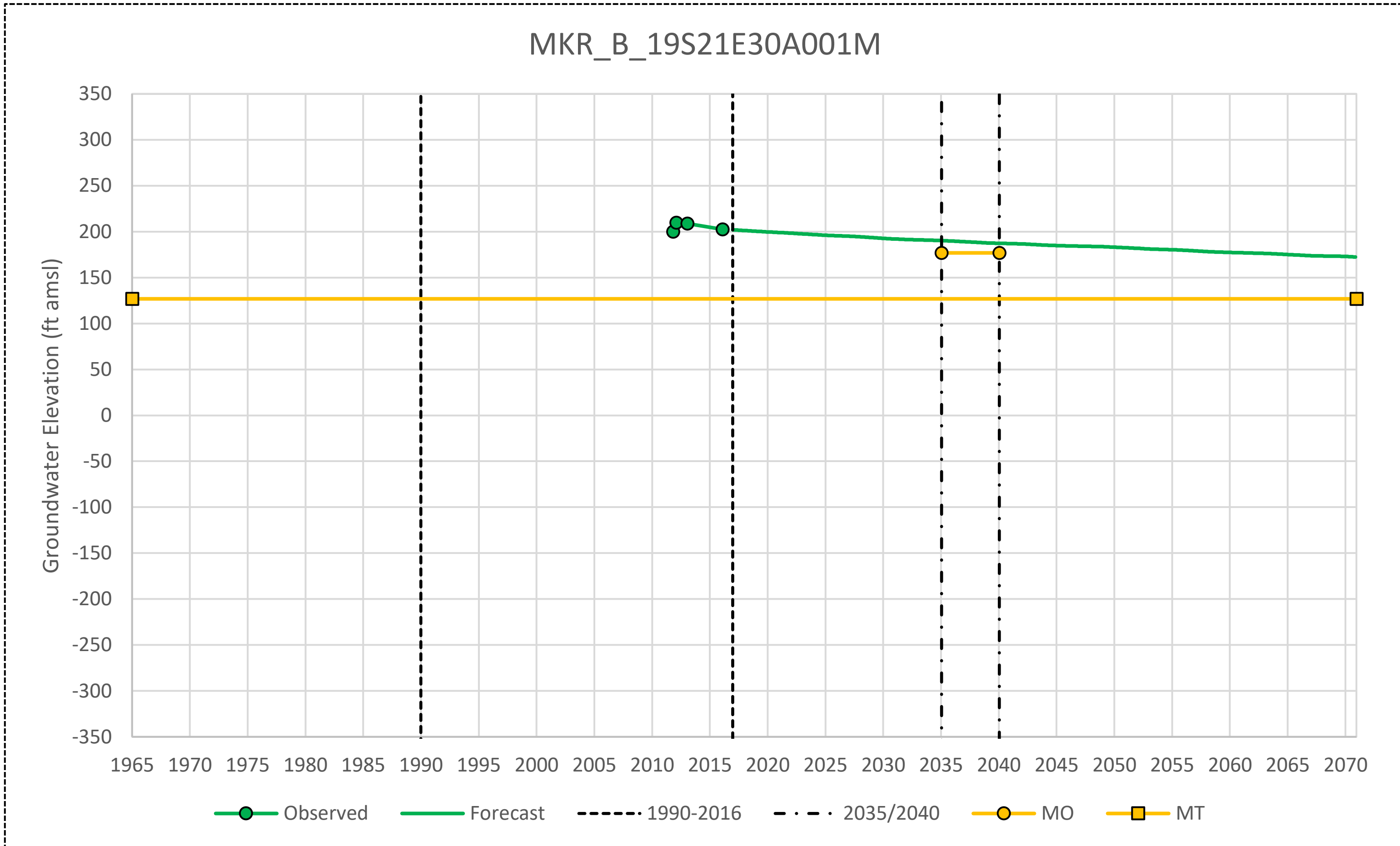
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-37**



MKR_B_18S22E34R001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-38**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



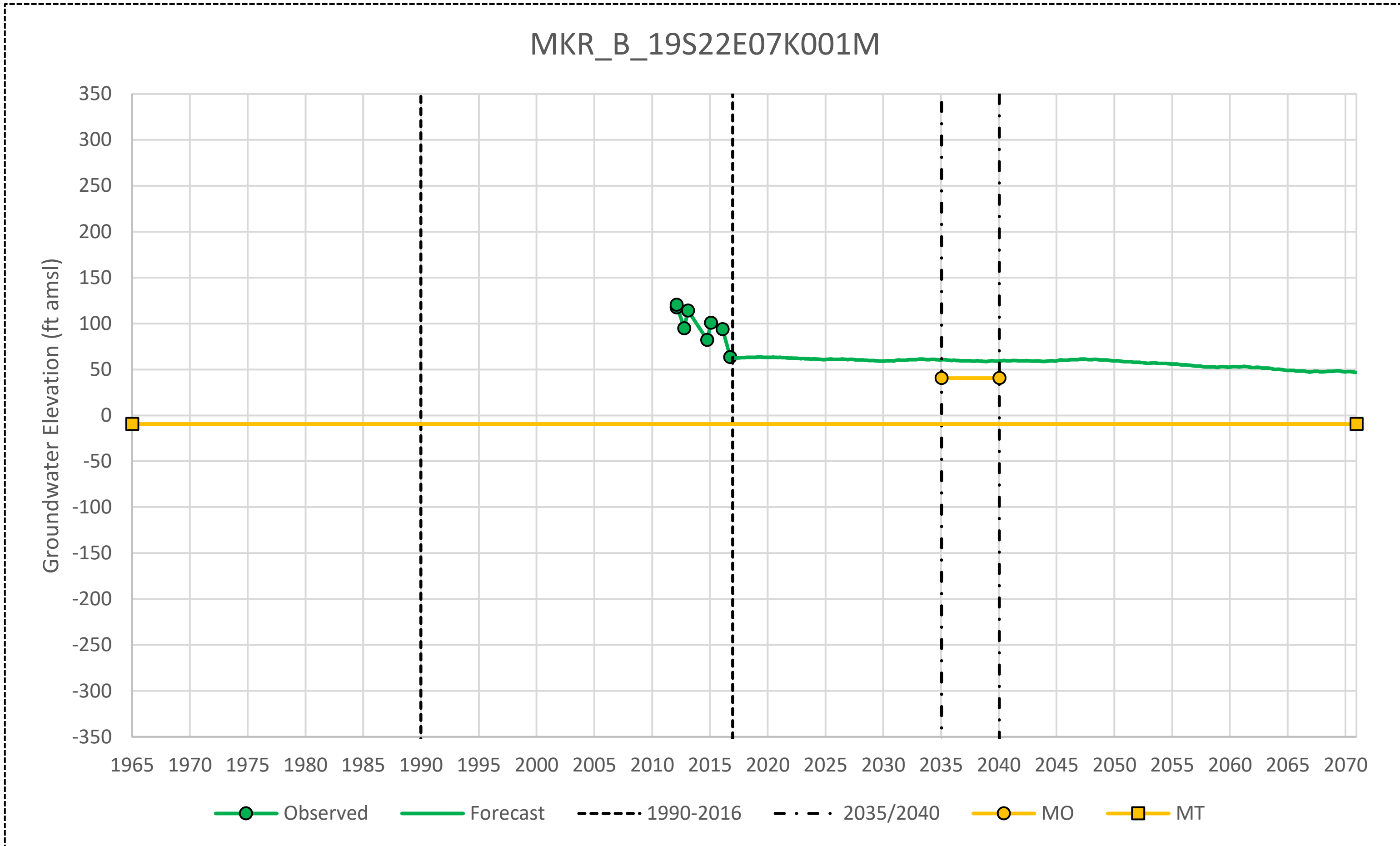
MKR_B_19S21E30A001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-39**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

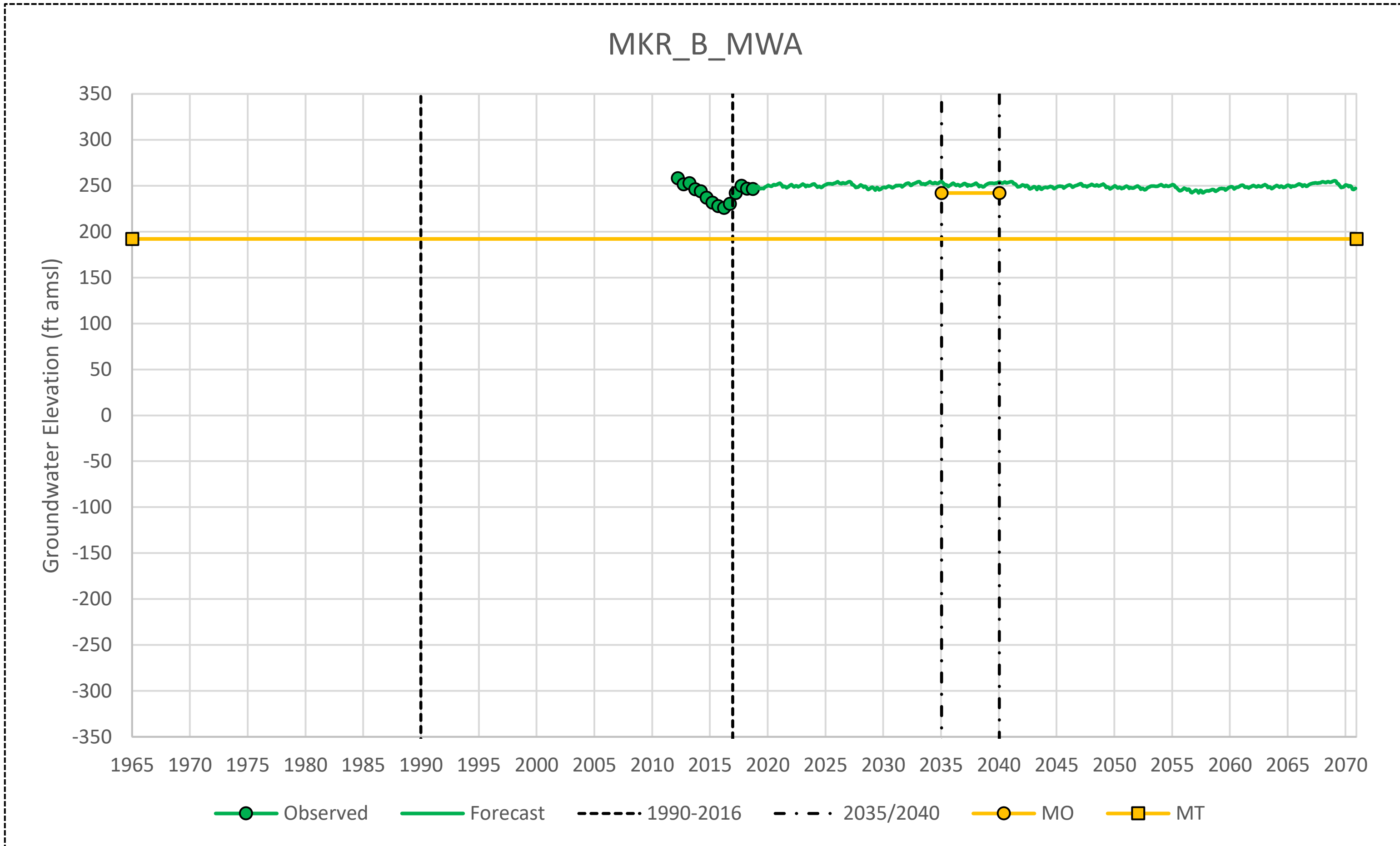


MKR_B_19S22E07K001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

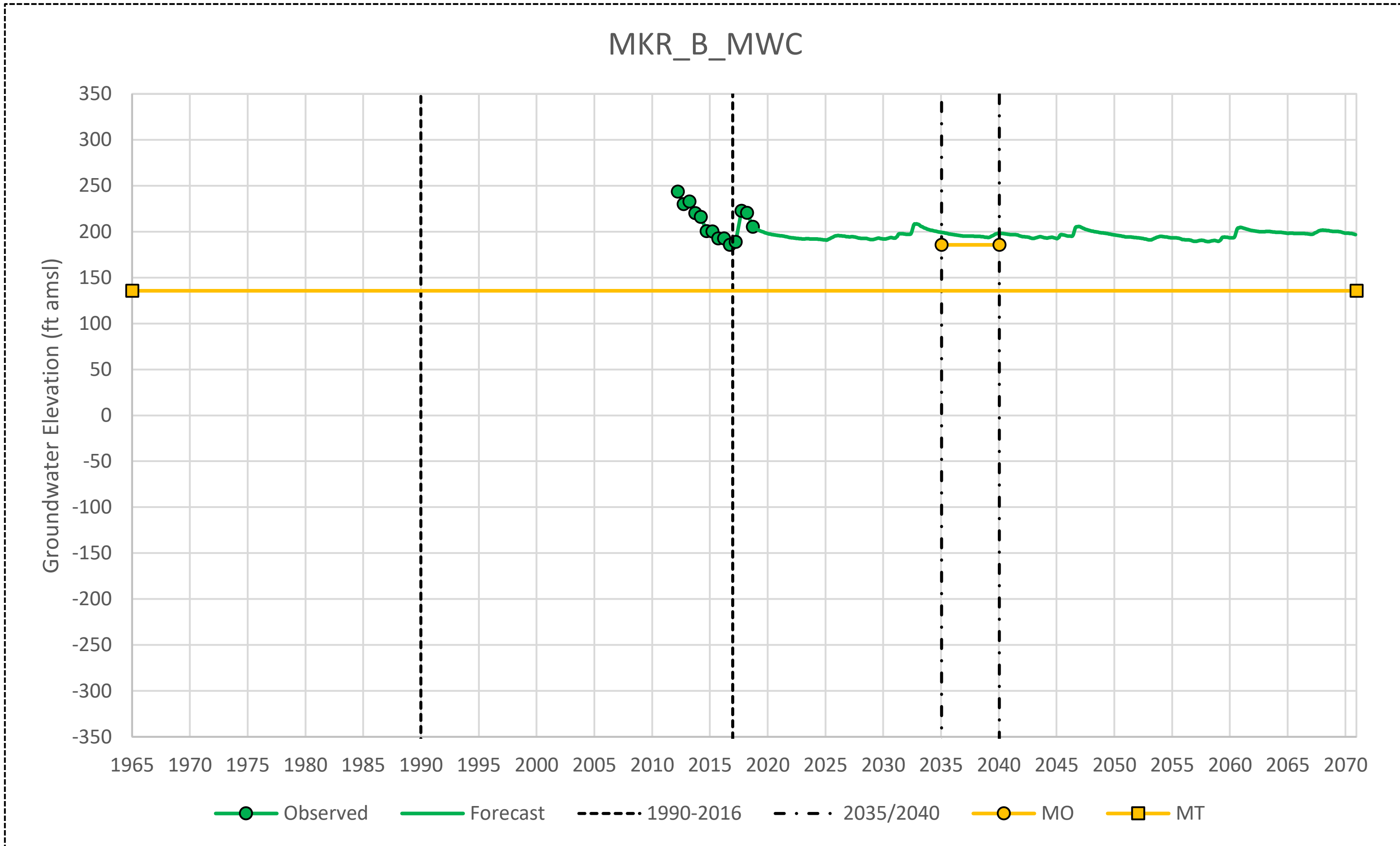
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-40**



MKR_B_MWA Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

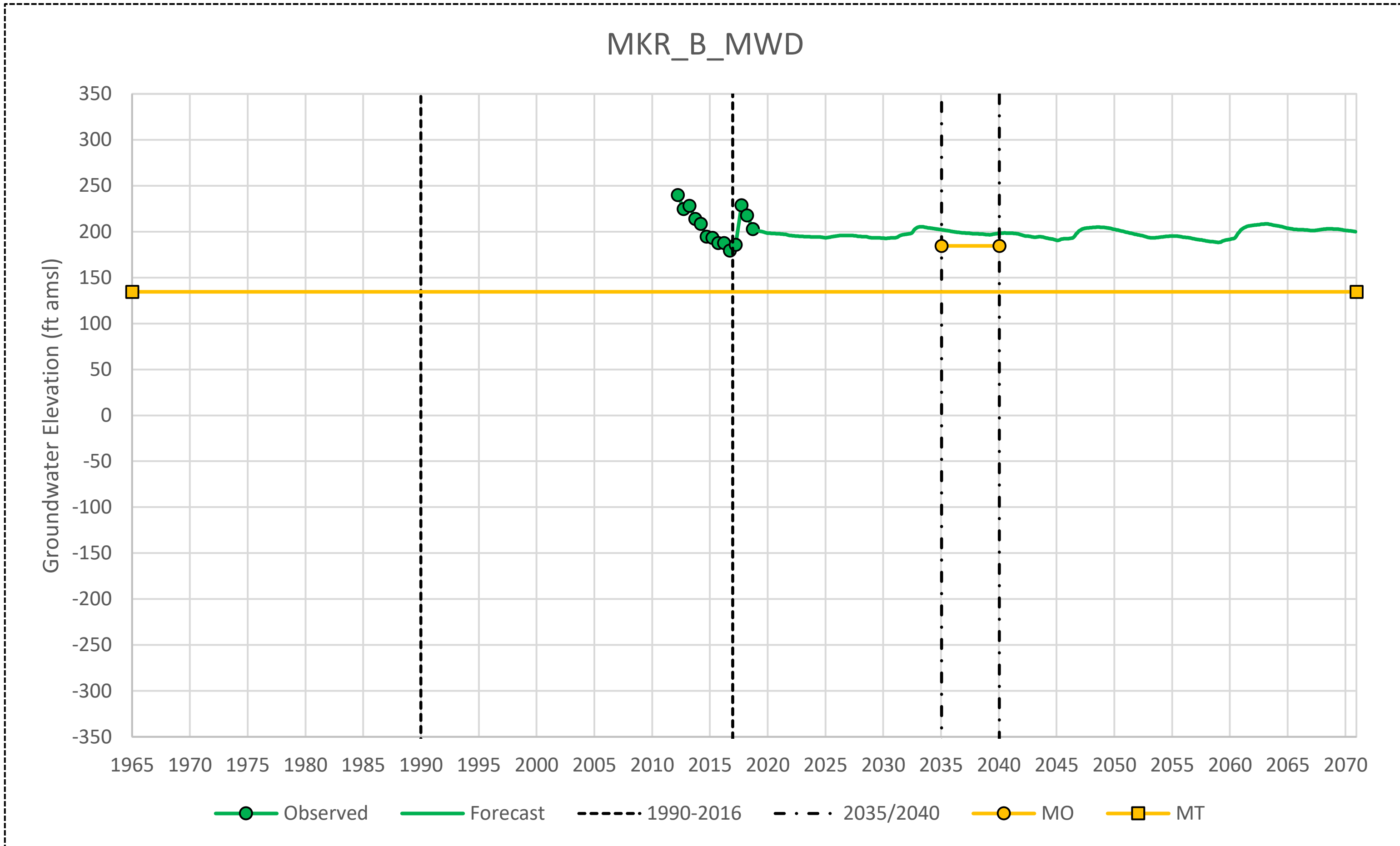
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-41**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



MKR_B_MWC Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-42**

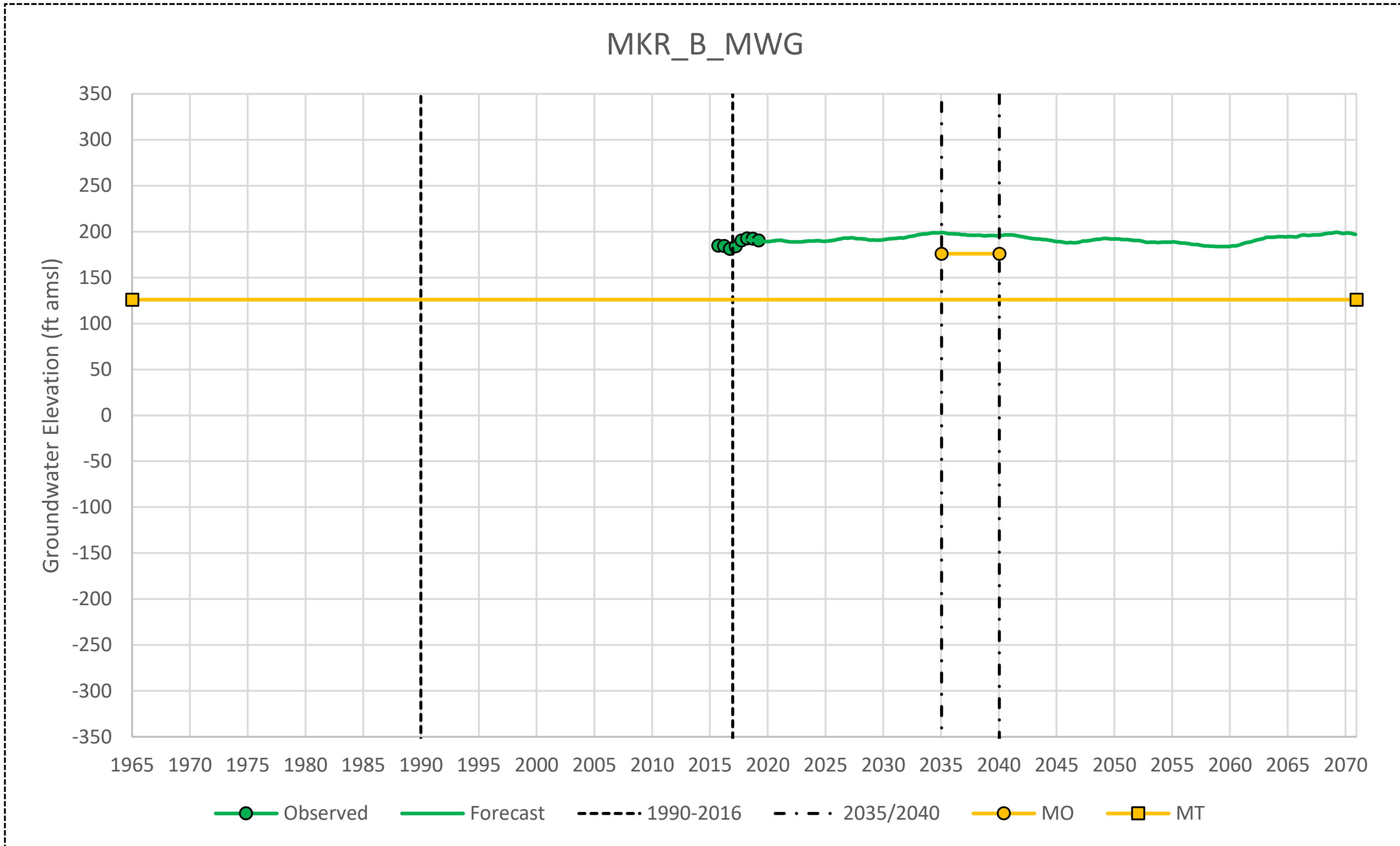


MKR_B_MWD Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

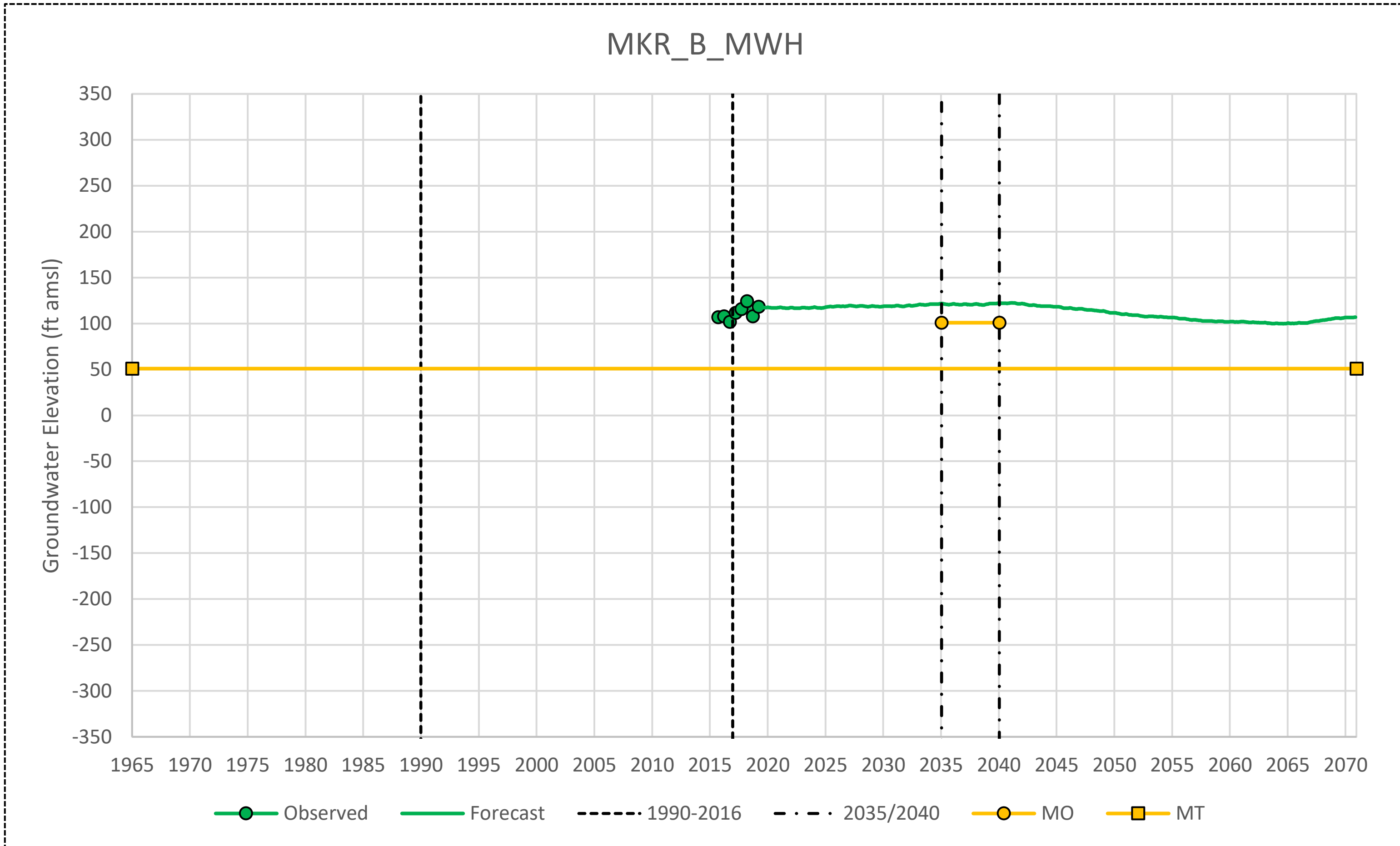
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-43**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



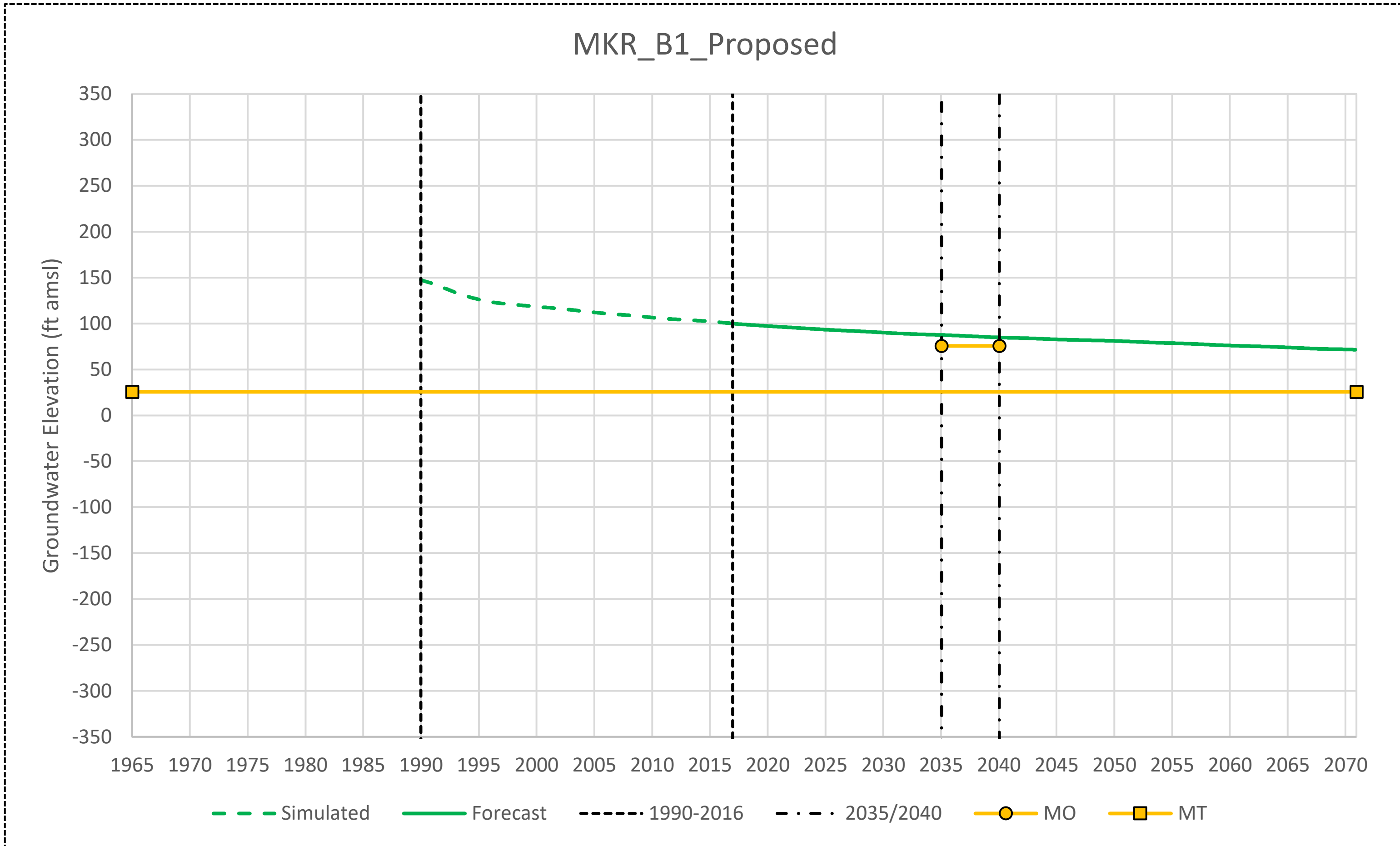
MKR_B_MWG Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-44**



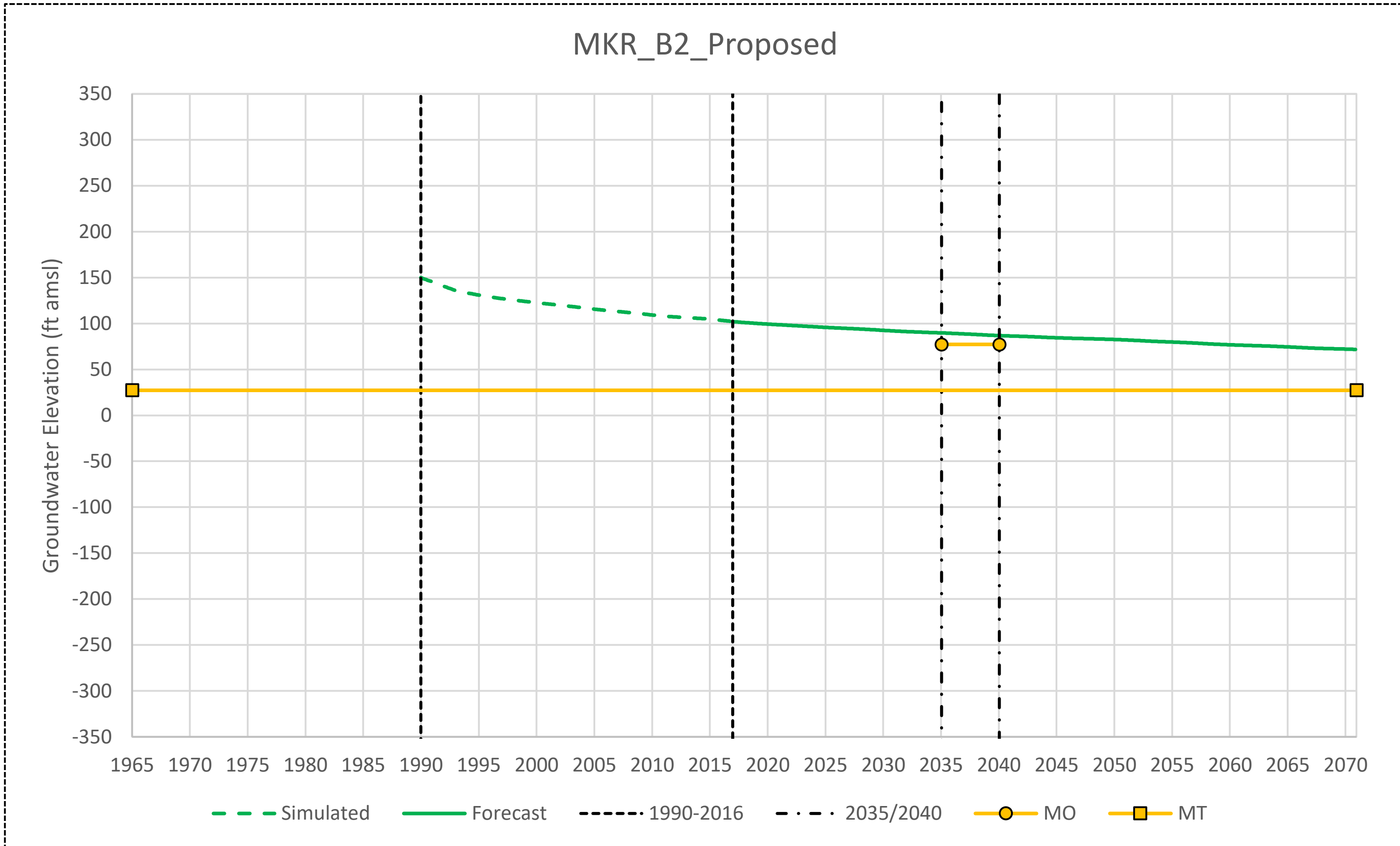
MKR_B_MWH Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-45**



MKR_B1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

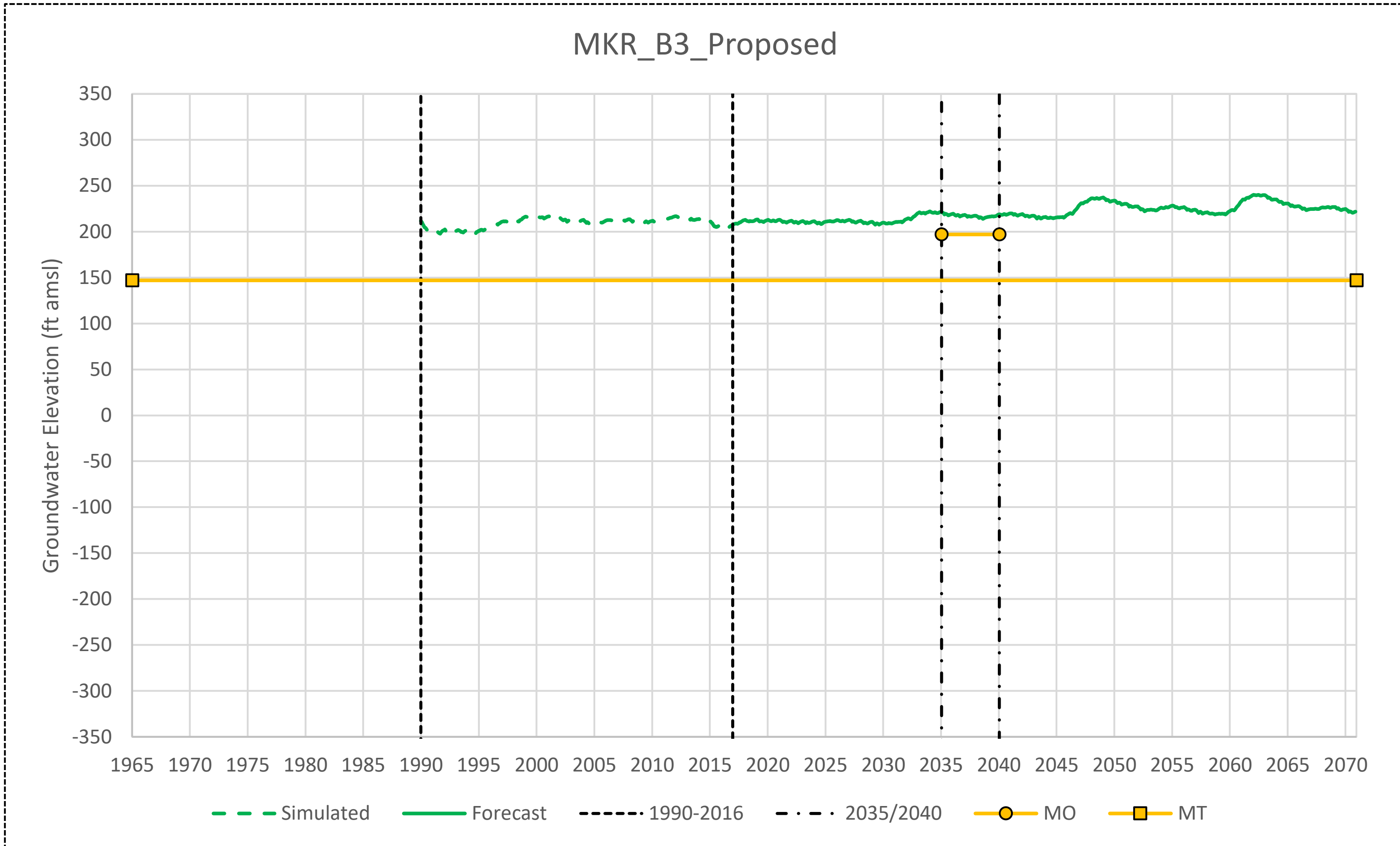
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-46**



MKR_B2_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

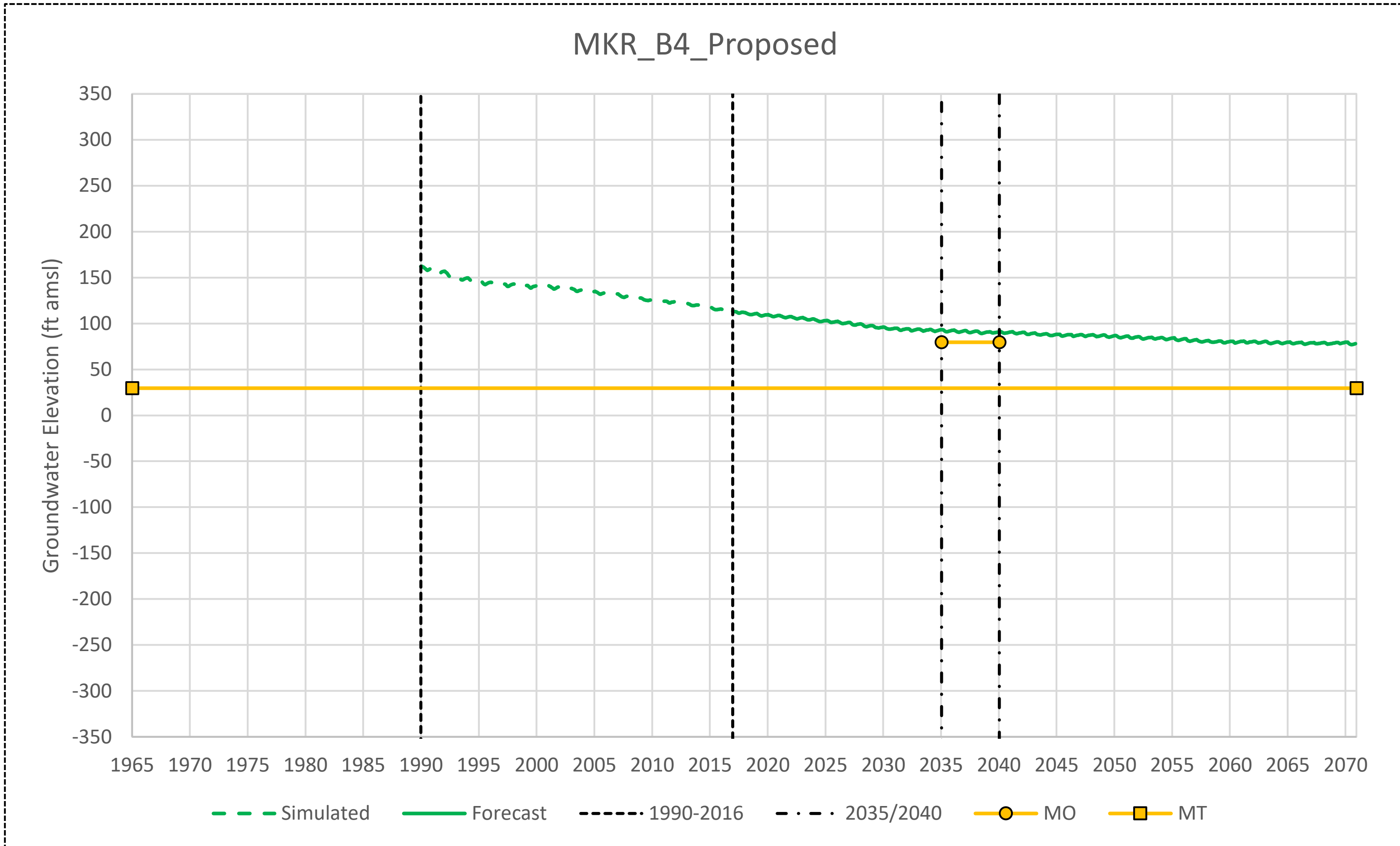
By: FAM | Date: 08/23/19 | Project No.: FR18161220

Figure **H-47**



MKR_B3_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

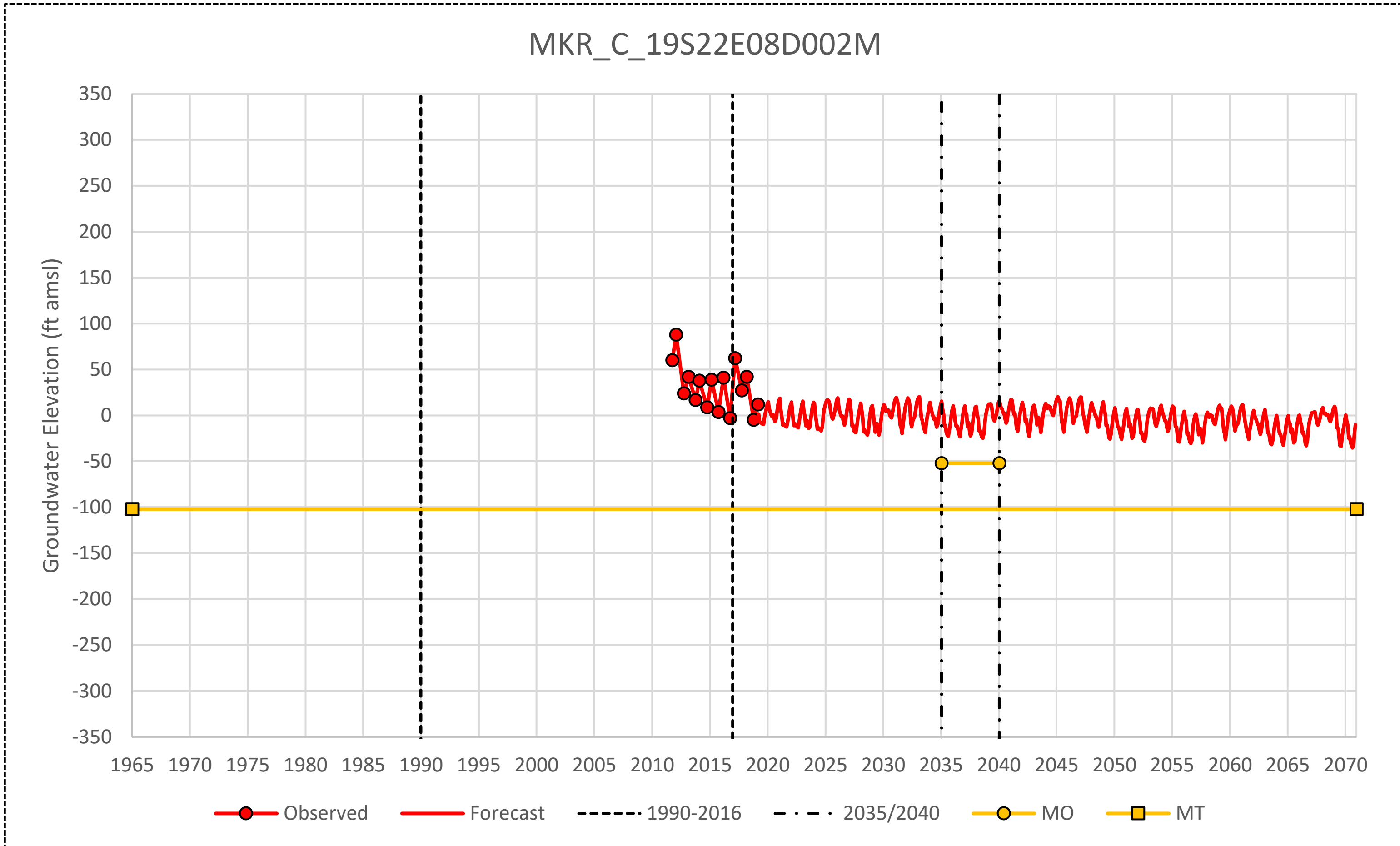
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-48**



MKR_B4_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

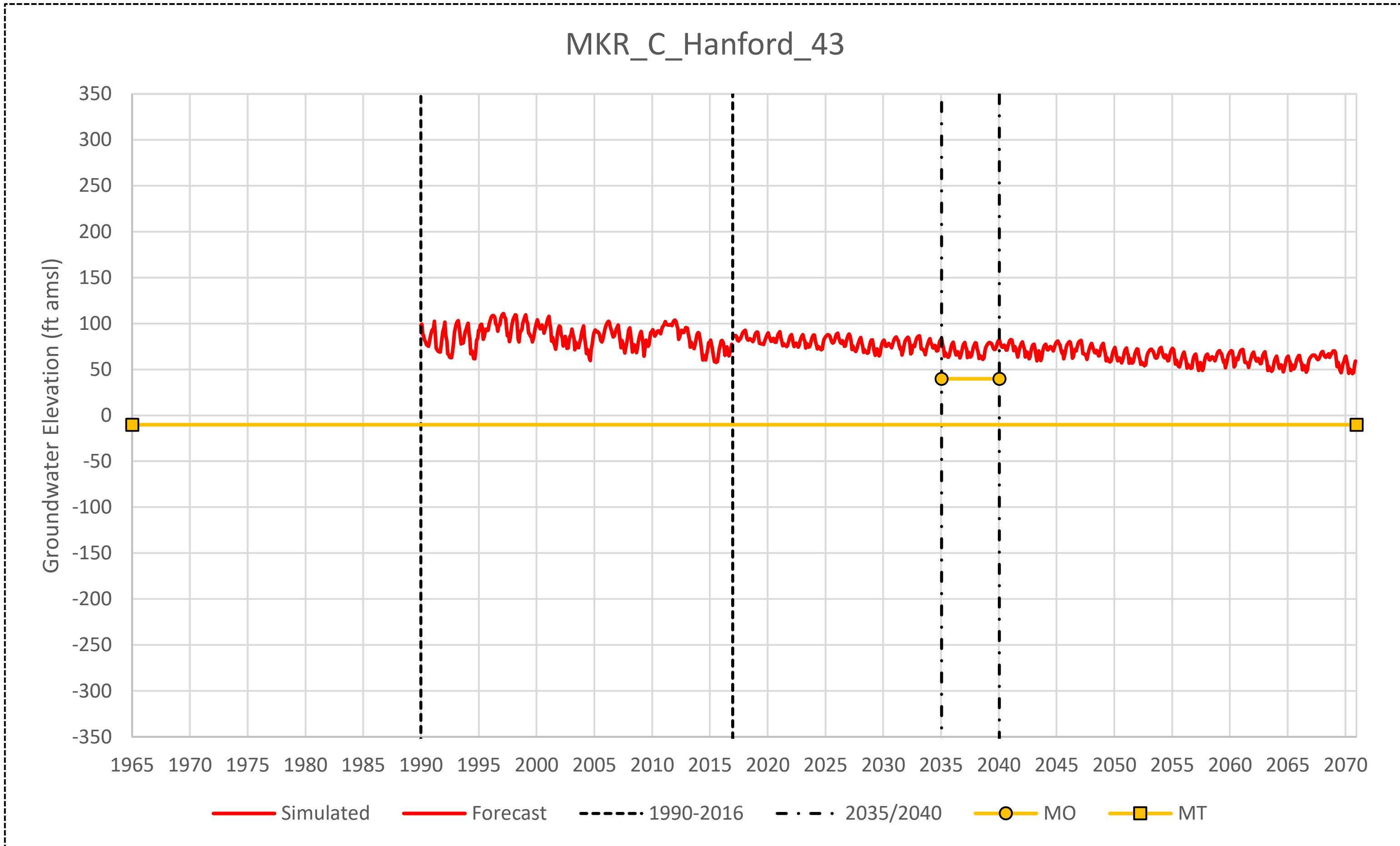
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-49**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



MKR_C_19S22E08D002M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

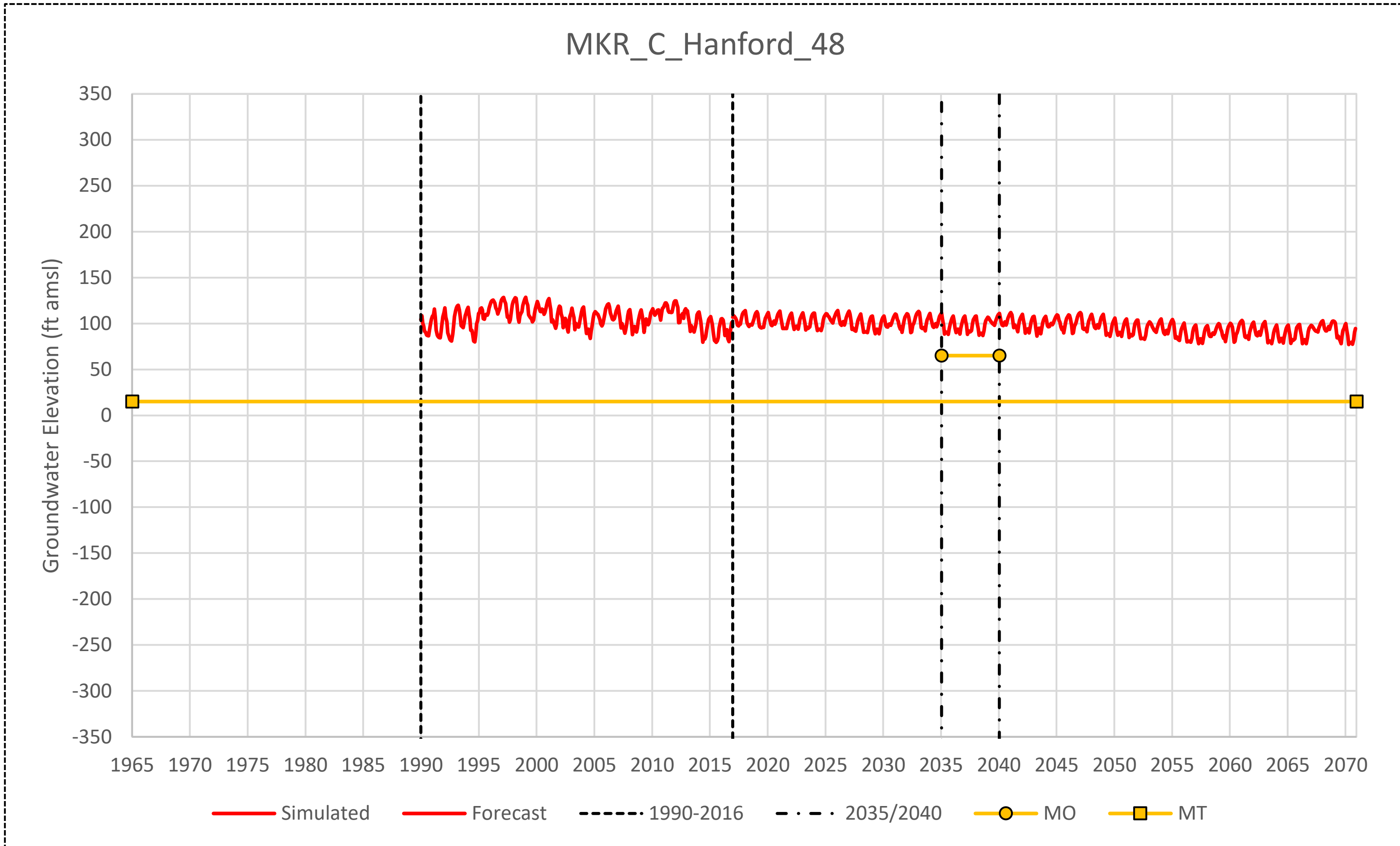
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-50**



MKR_C_Handford_43 Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-51**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

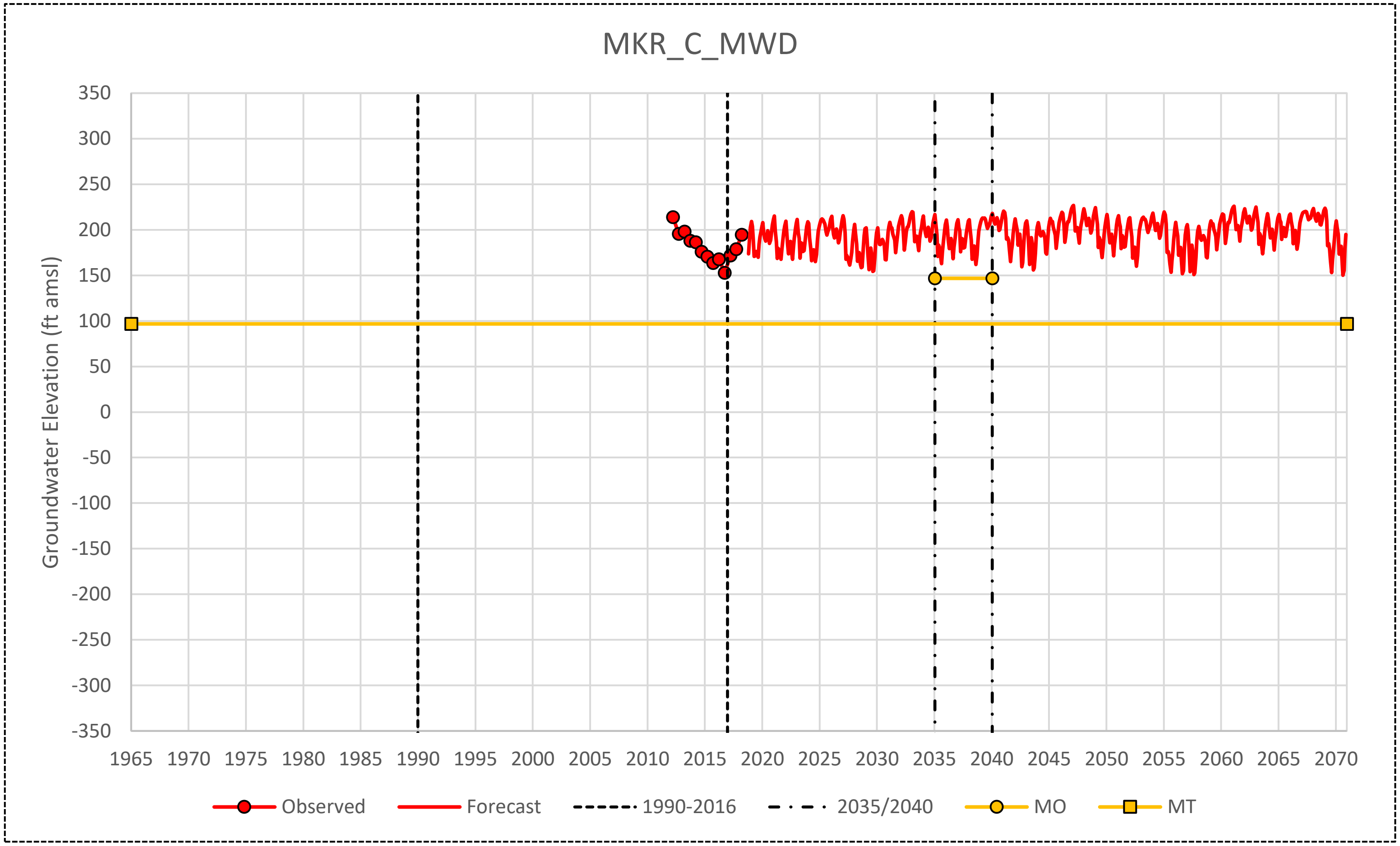


MKR_C_Hanford_48 Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

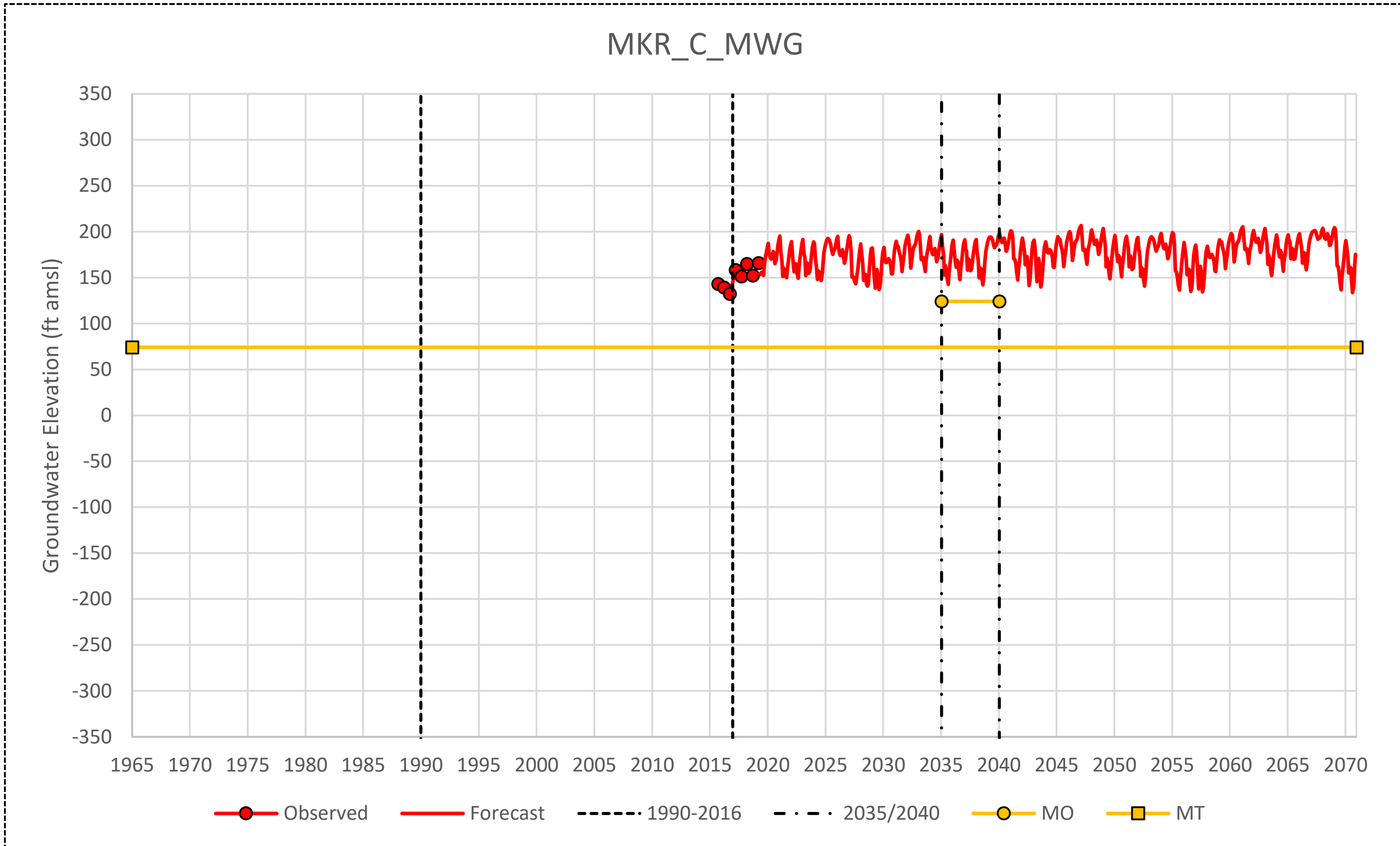
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-52**



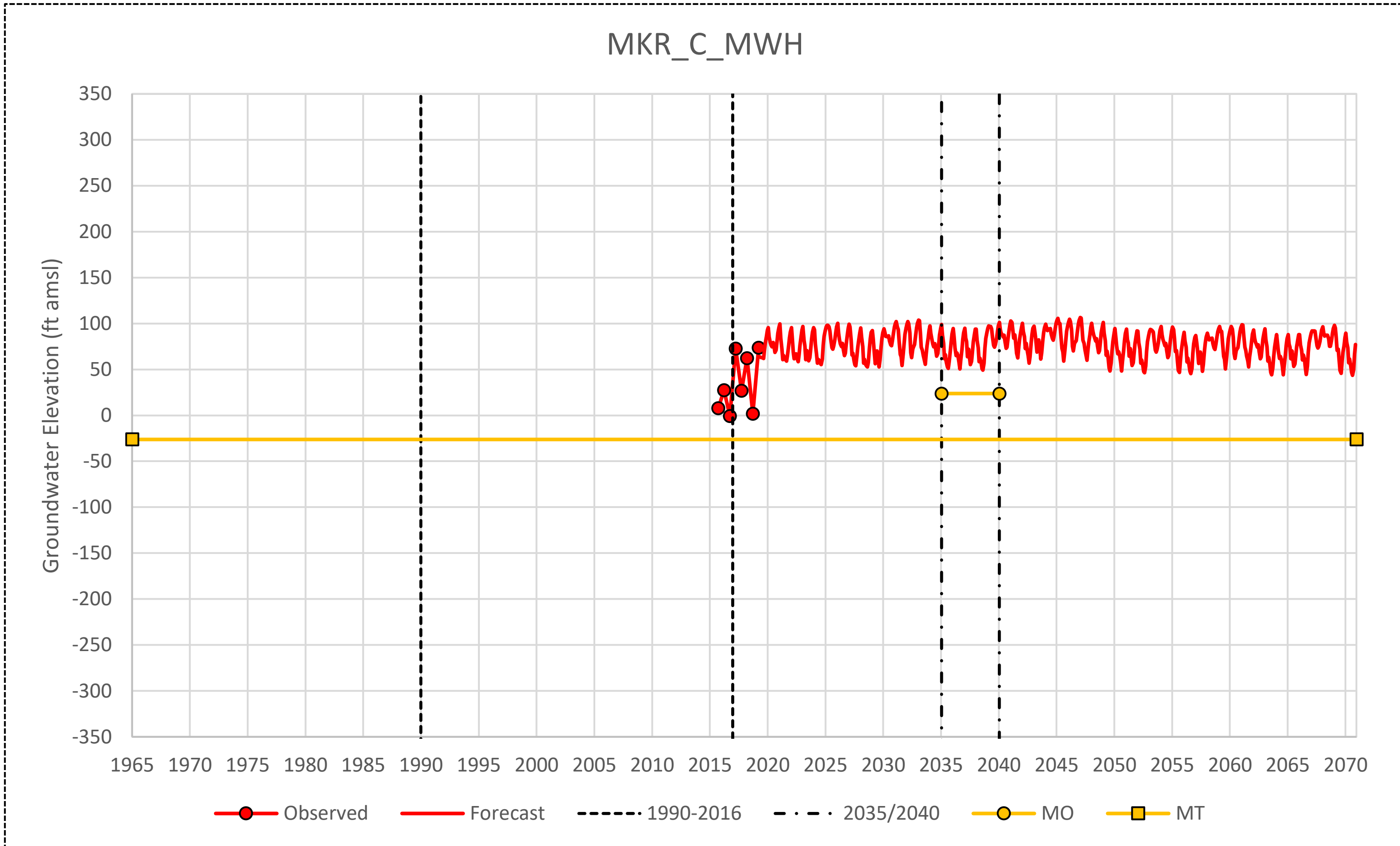
MKR_C_MWD Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-53**



MKR_C_MWG Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

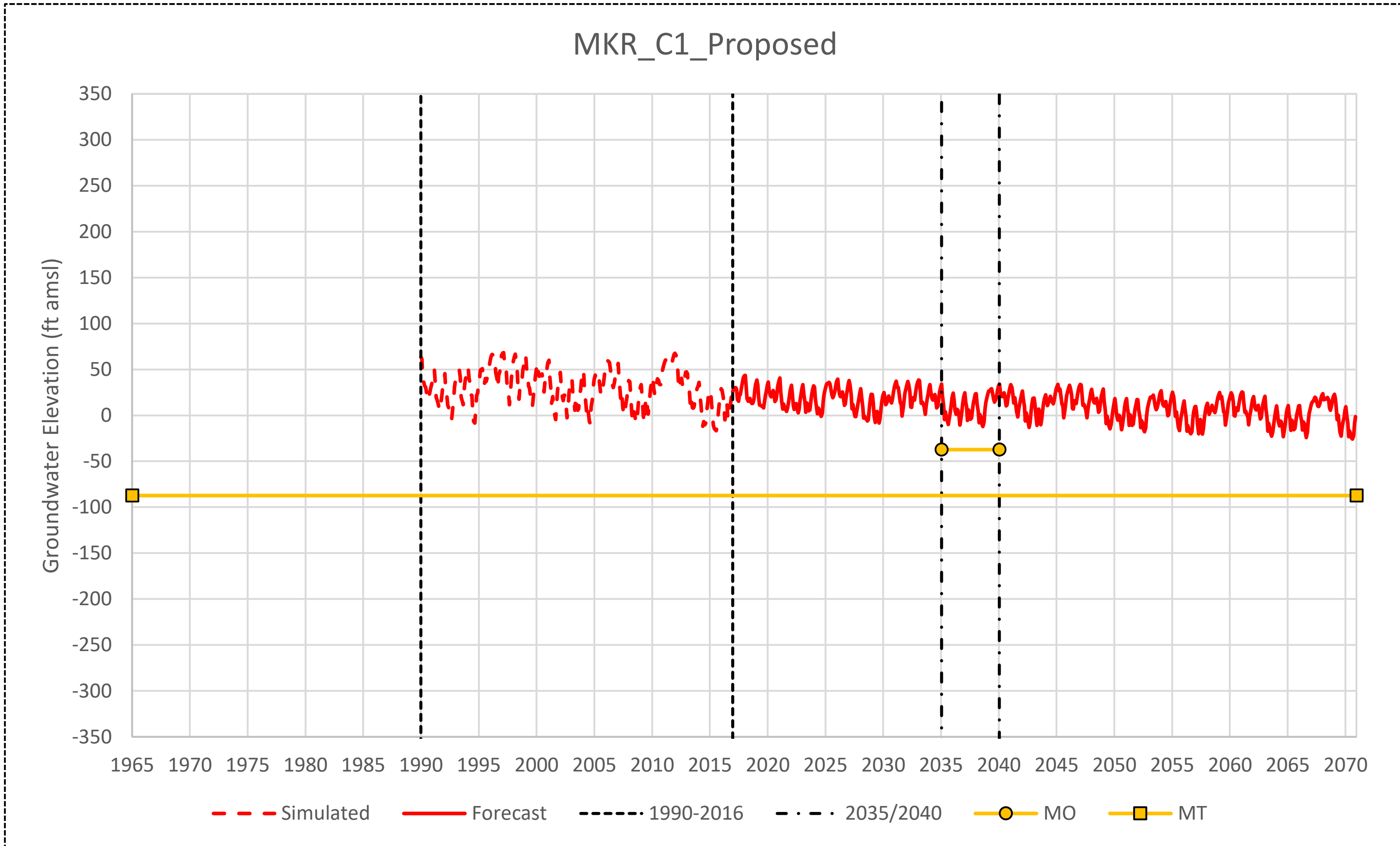
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-54**



MKR_C_MWH Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-55**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

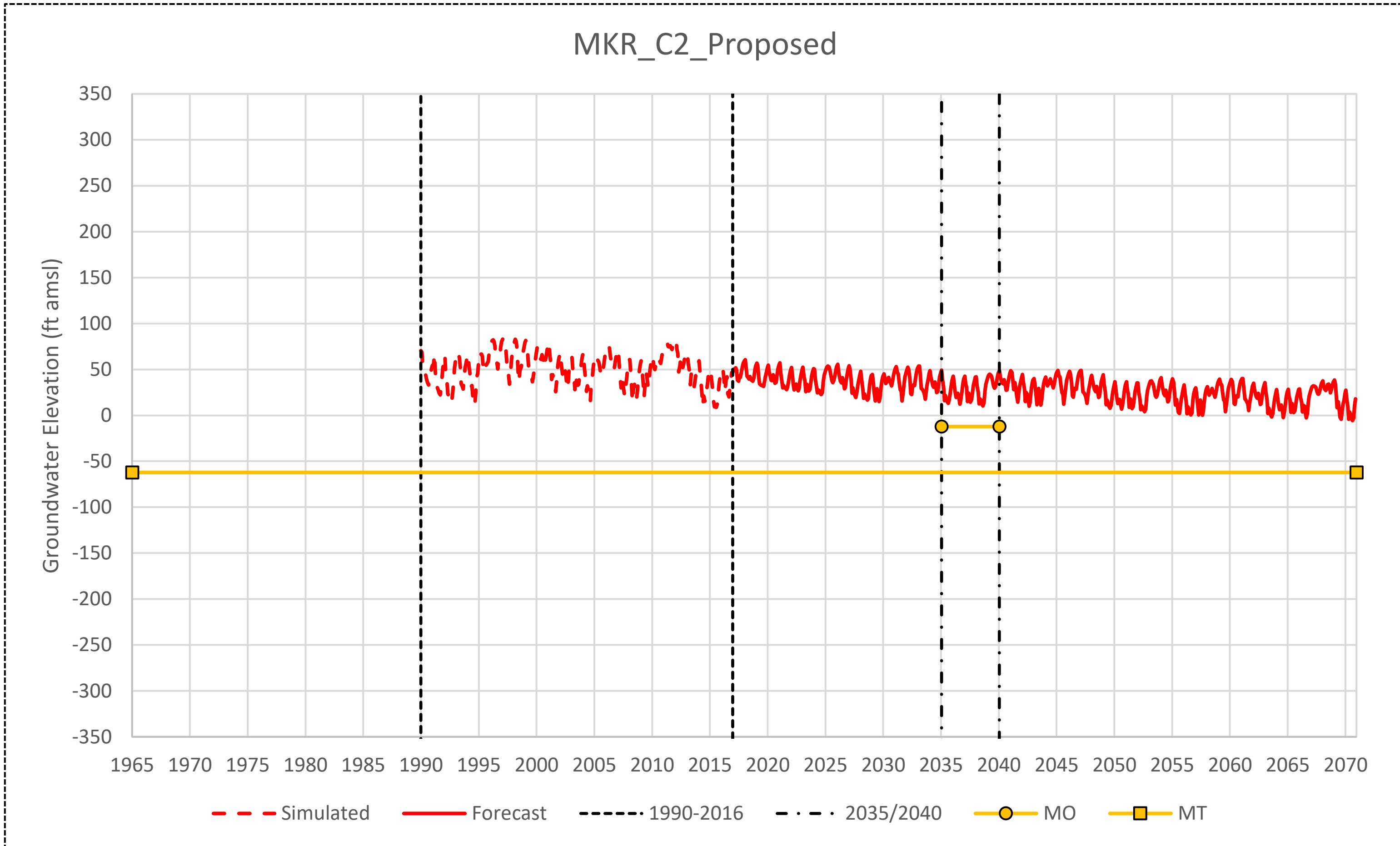


MKR_C1_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

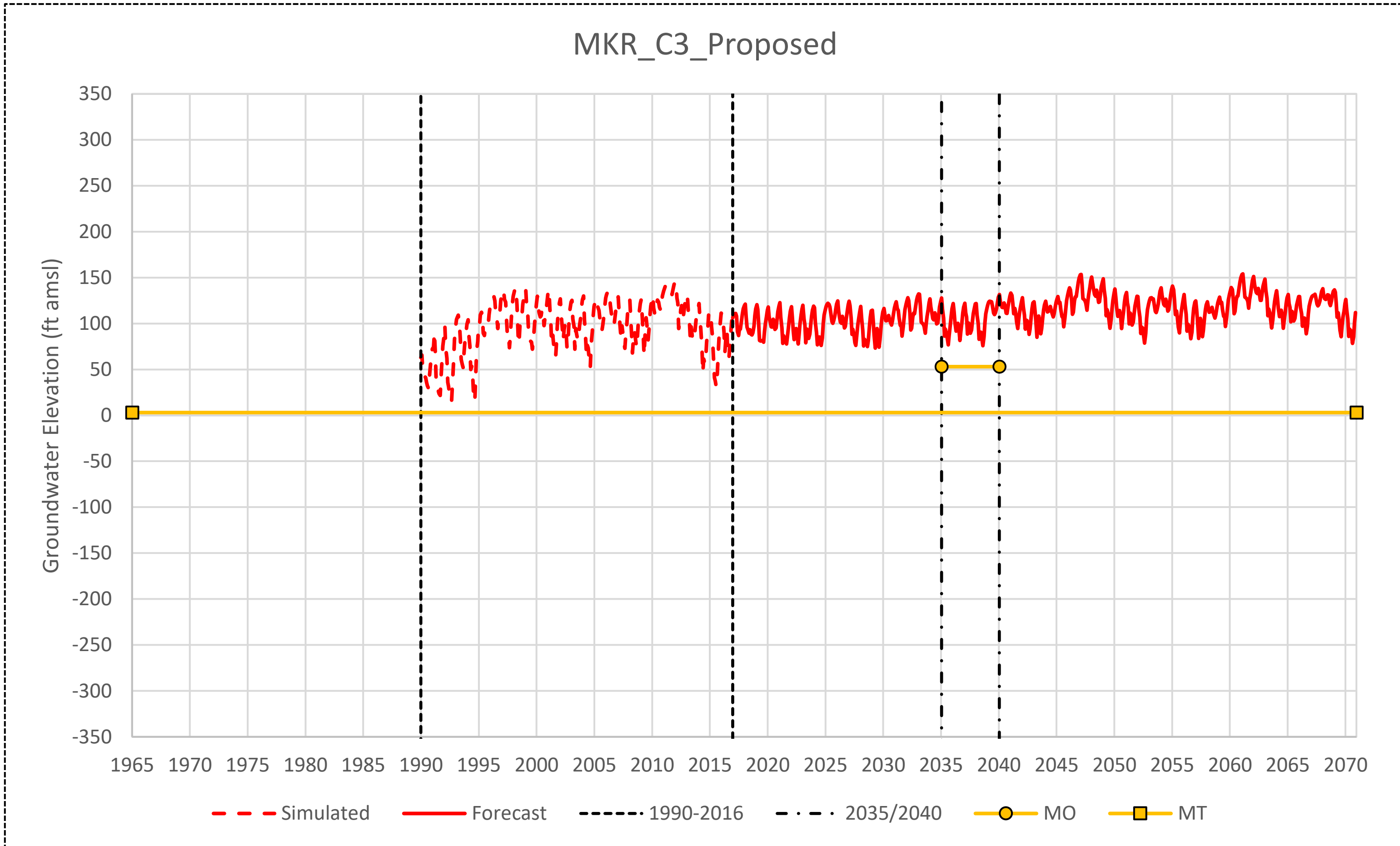
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-56**



MKR_C2_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

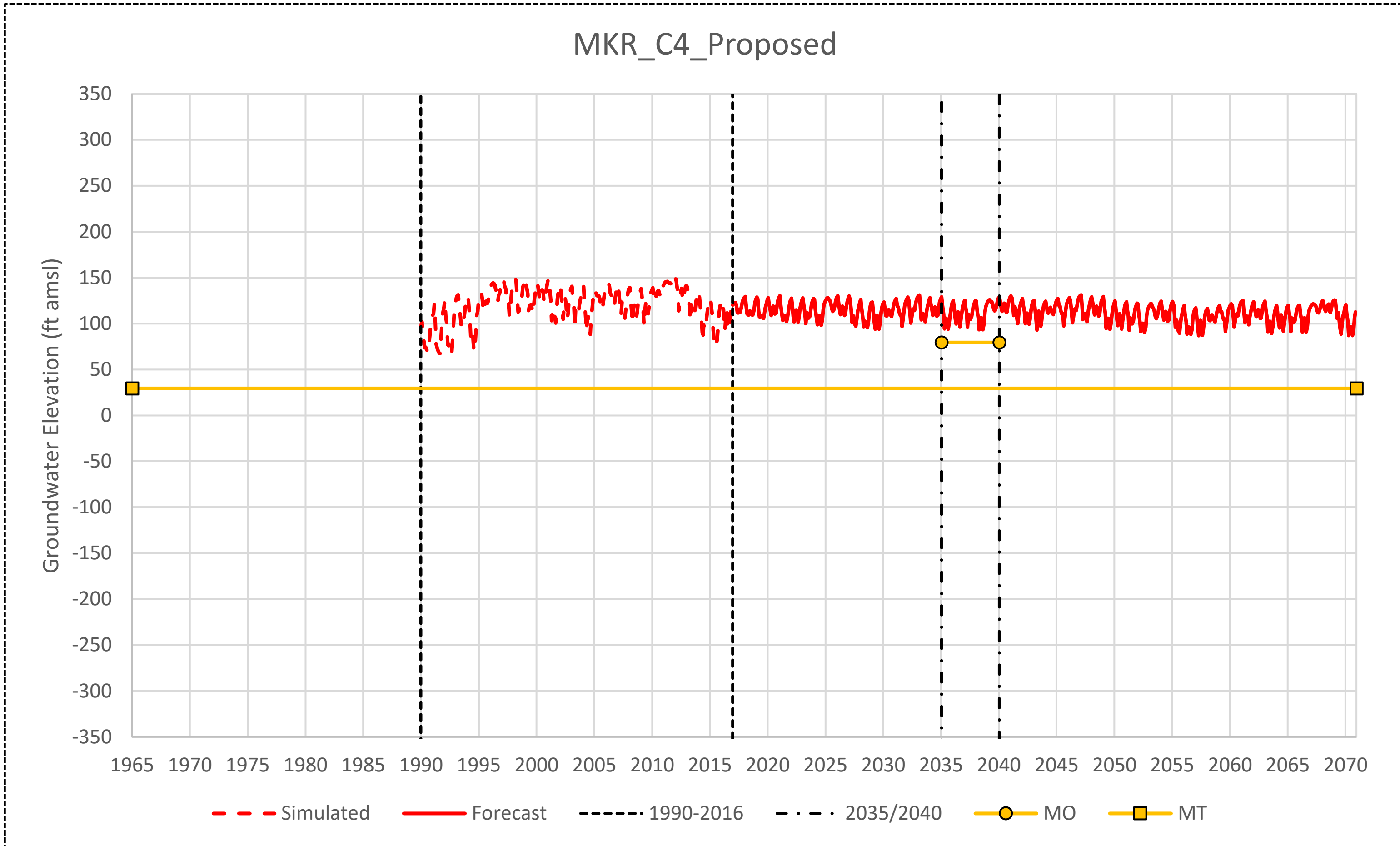
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-57**



MKR_C3_Proposed Hydrograph

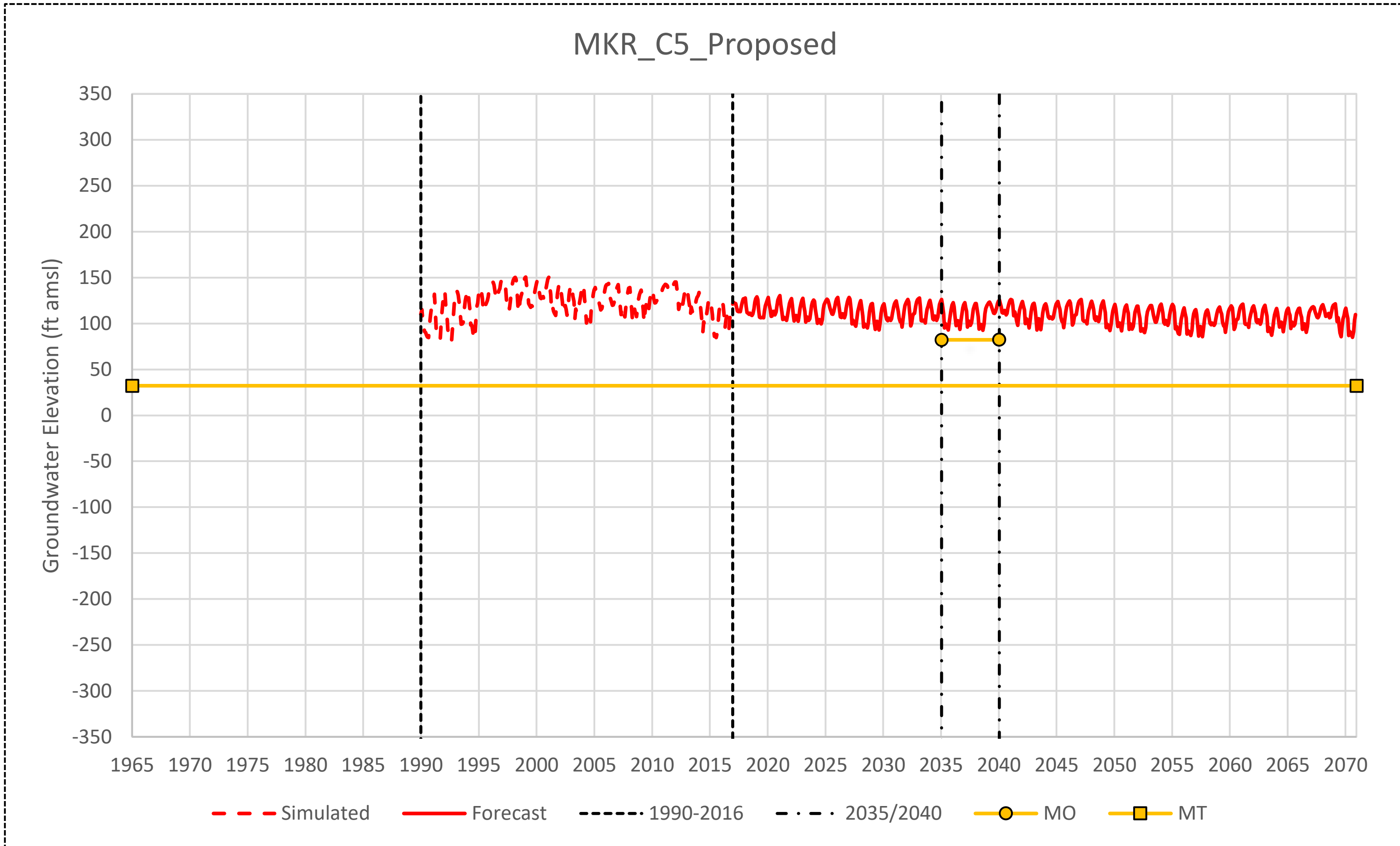
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-58**



MKR_C4_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-59**



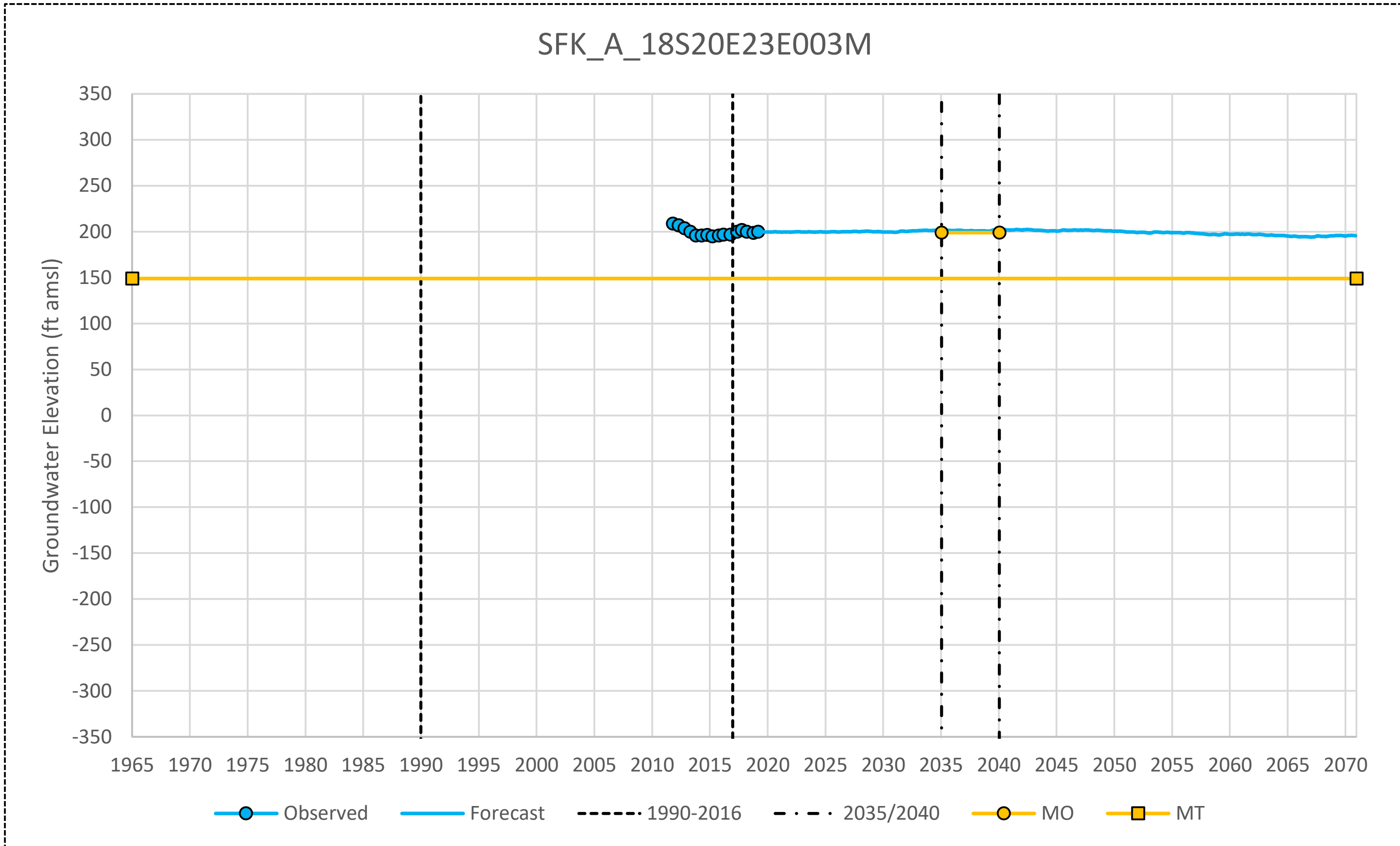
MKR_C5_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-60**

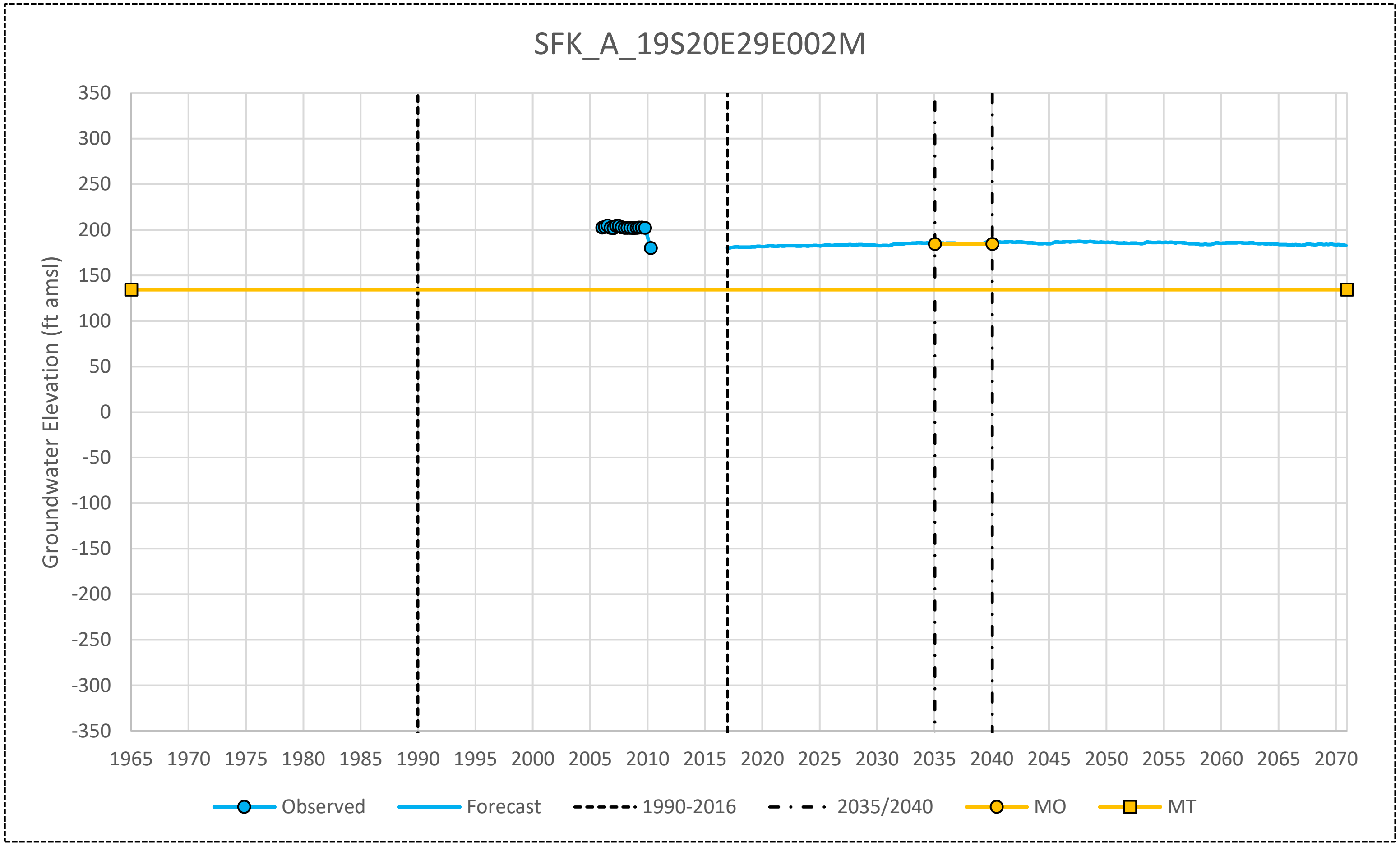
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



SFK_A_18S20E23E003M Hydrograph

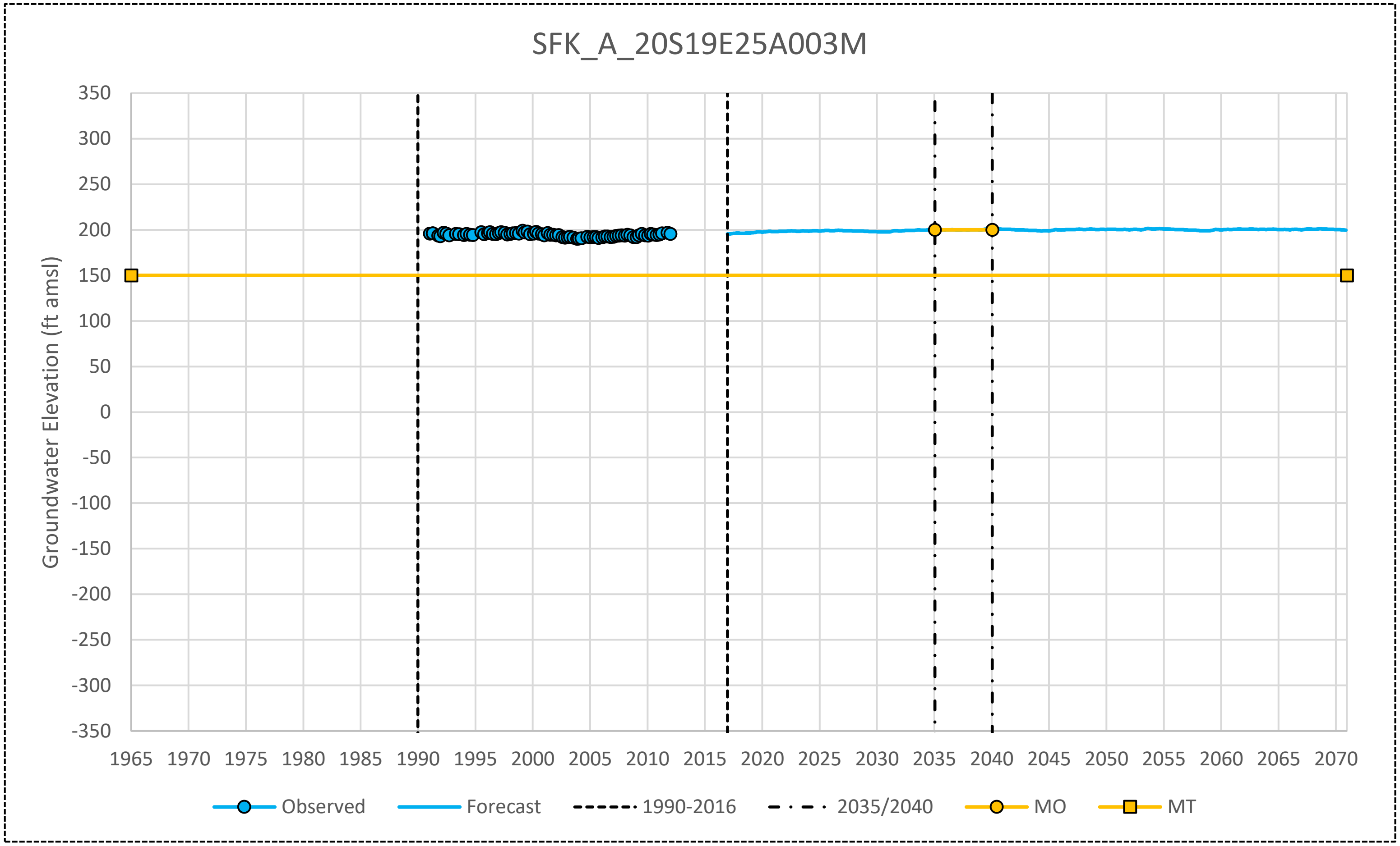
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-61**



SFK_A_19S20E29E002M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-62**

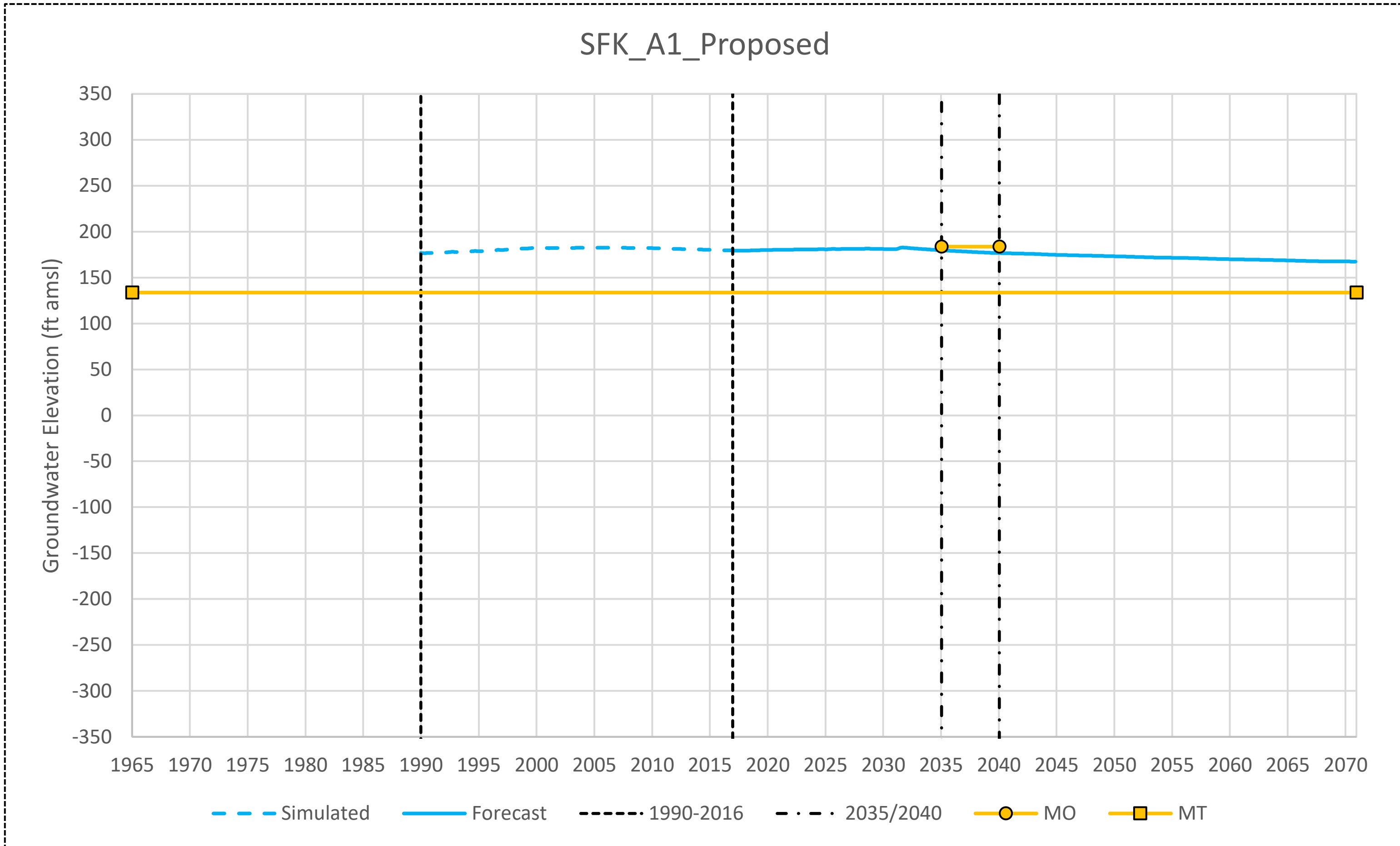


SFK_A_20S19E25A003M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

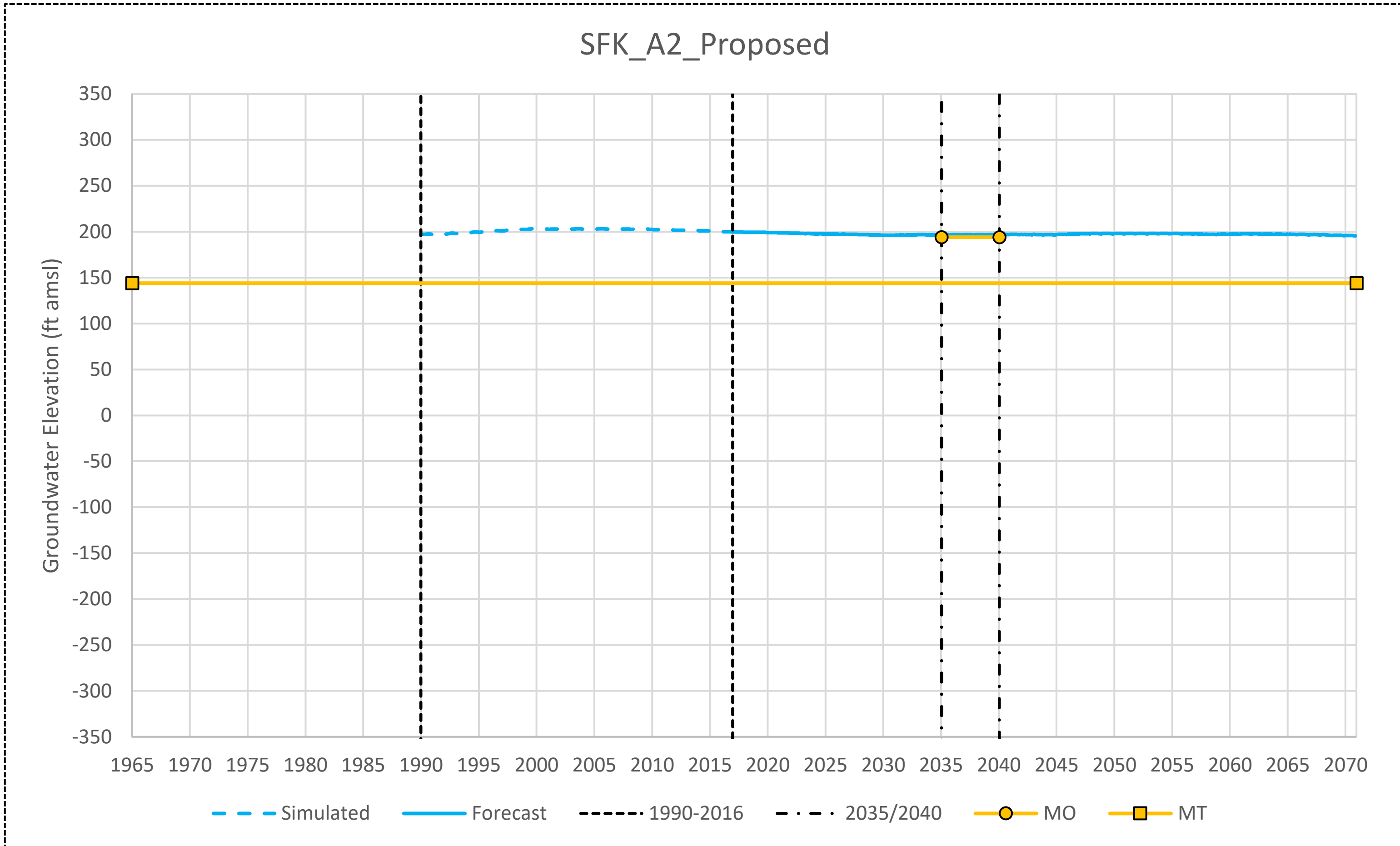
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-63**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



SFK_A1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

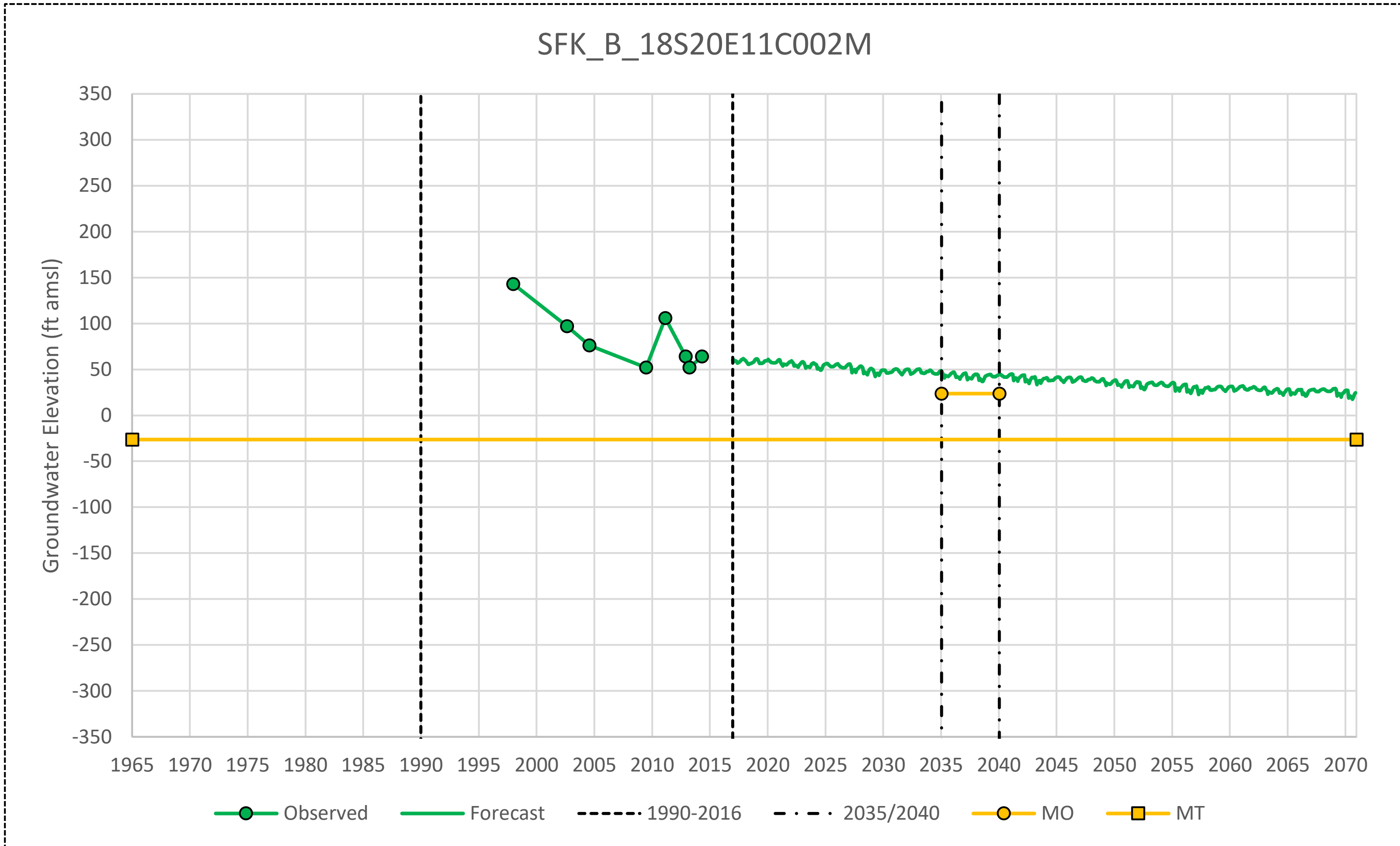
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-64**



SFK_A2_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-65**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



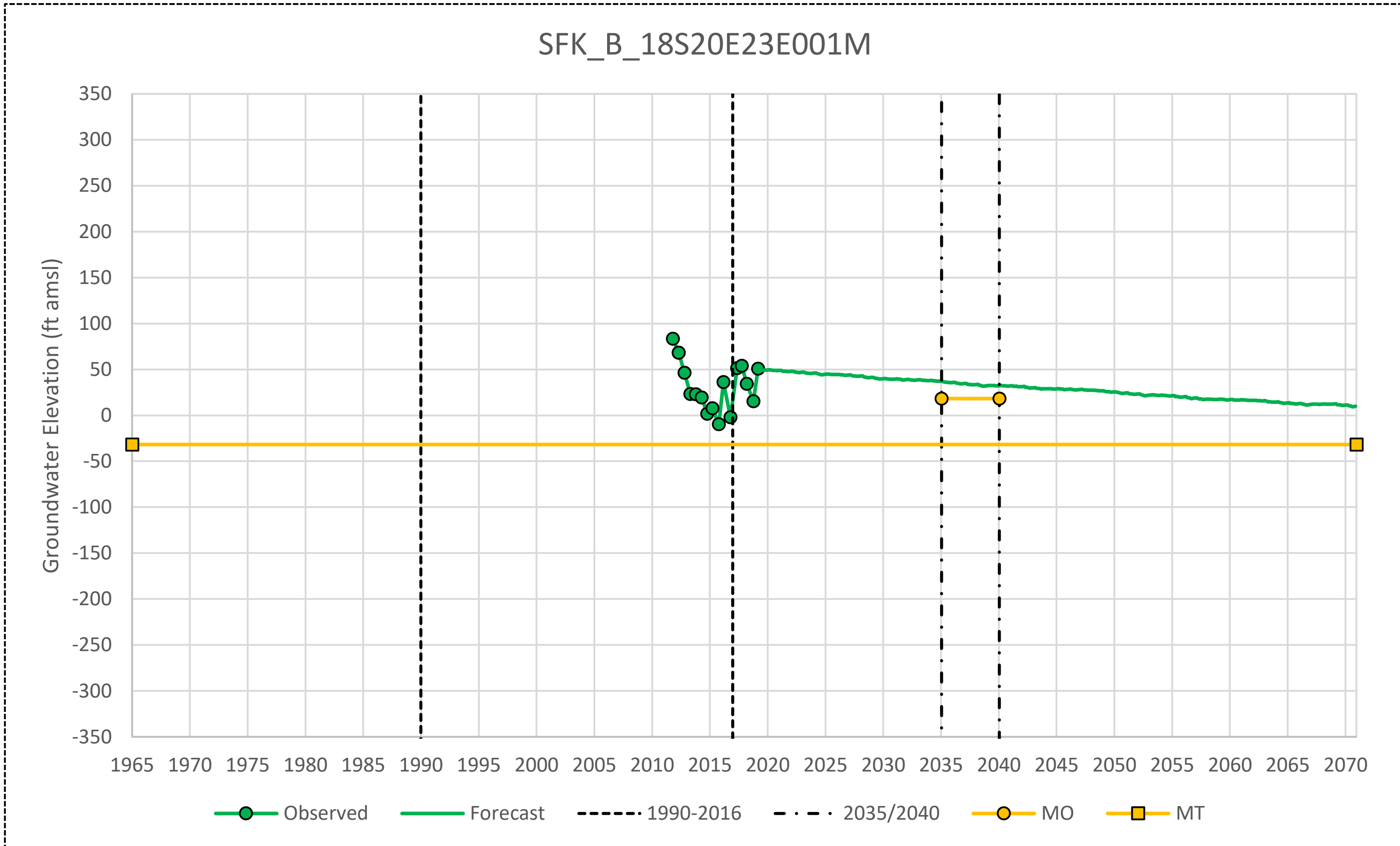
SFK_B_18S20E11C002M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-66**

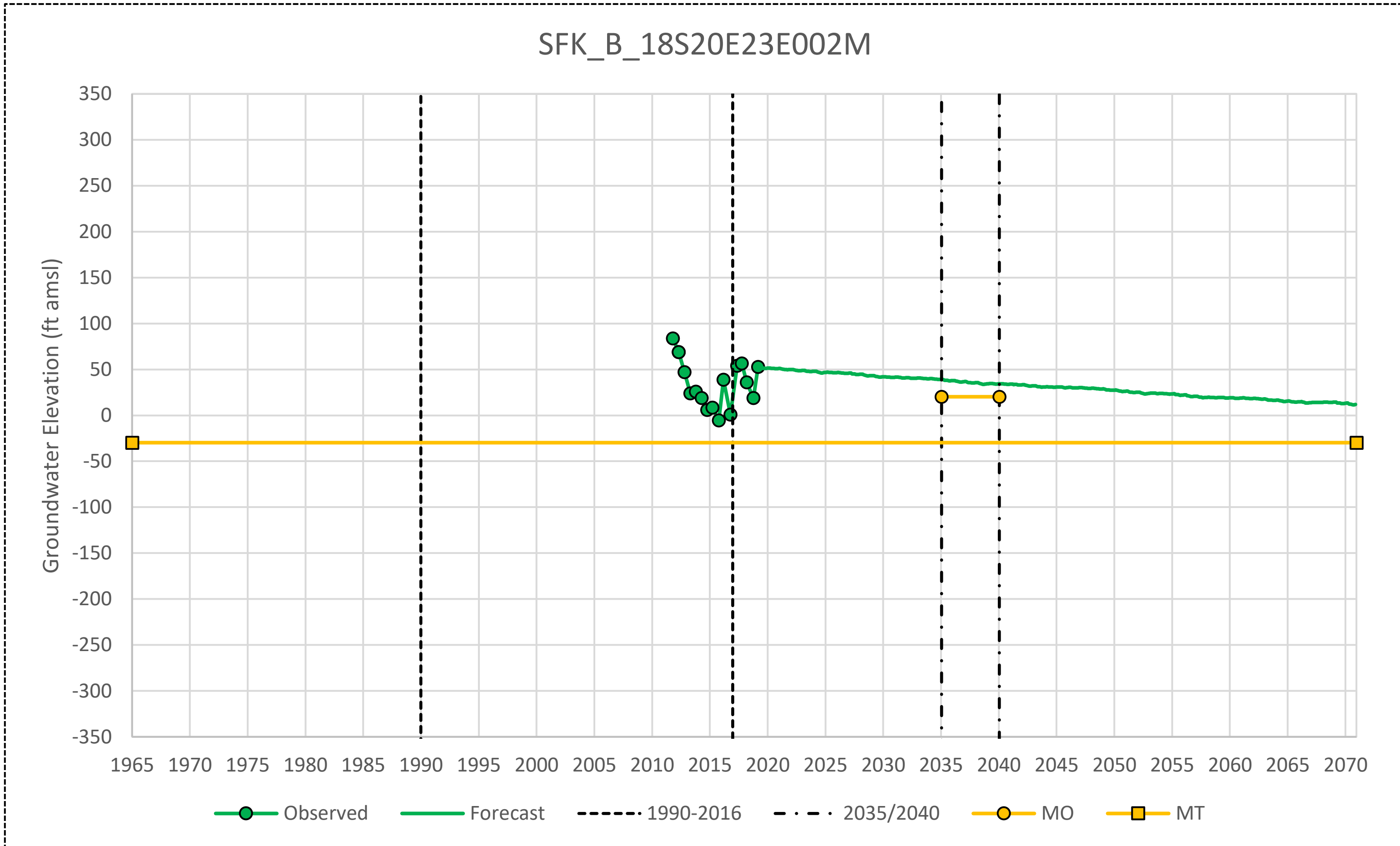
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



SFK_B_18S20E23E001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-67**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



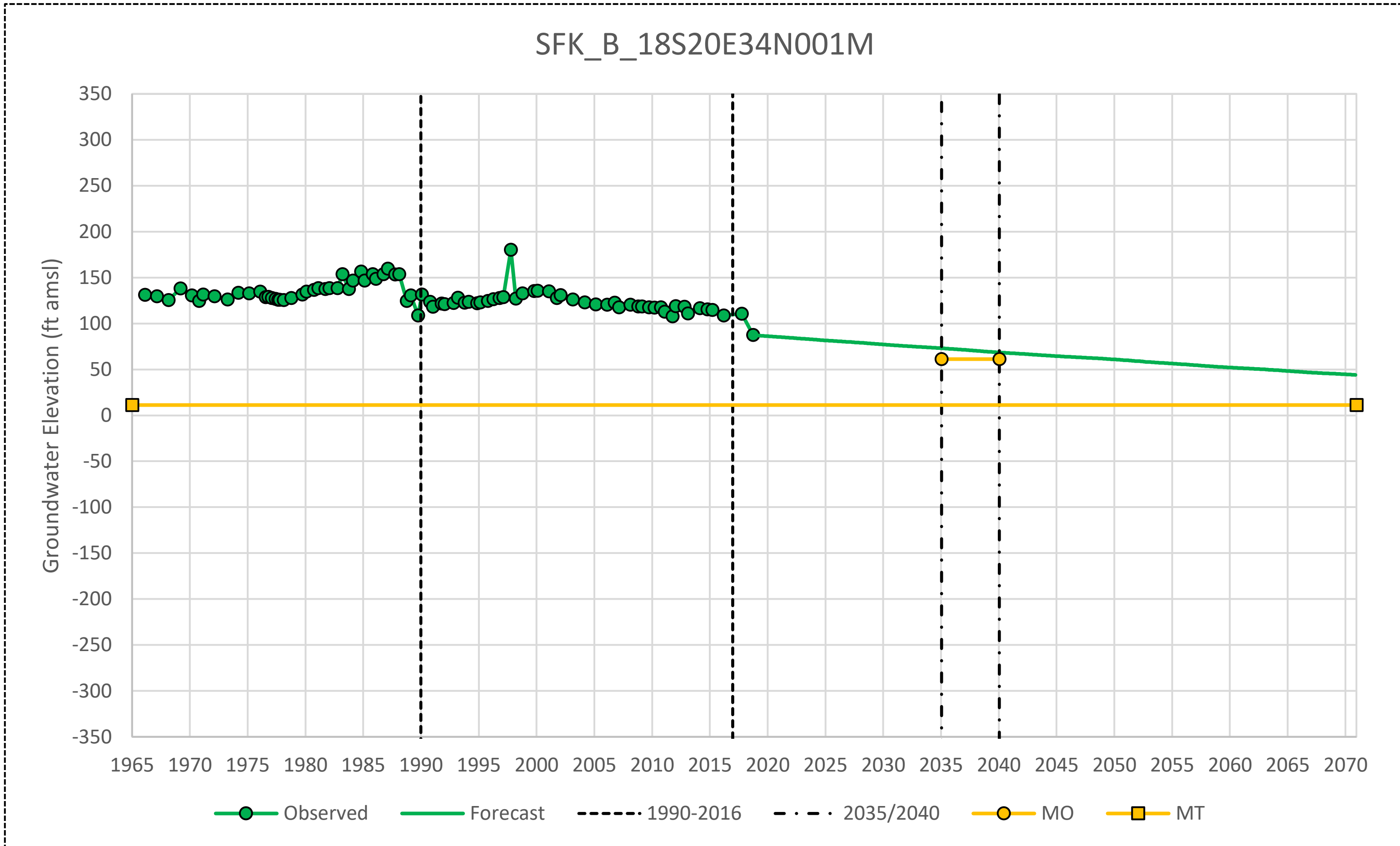
SFK_B_18S20E23E002M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-68**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



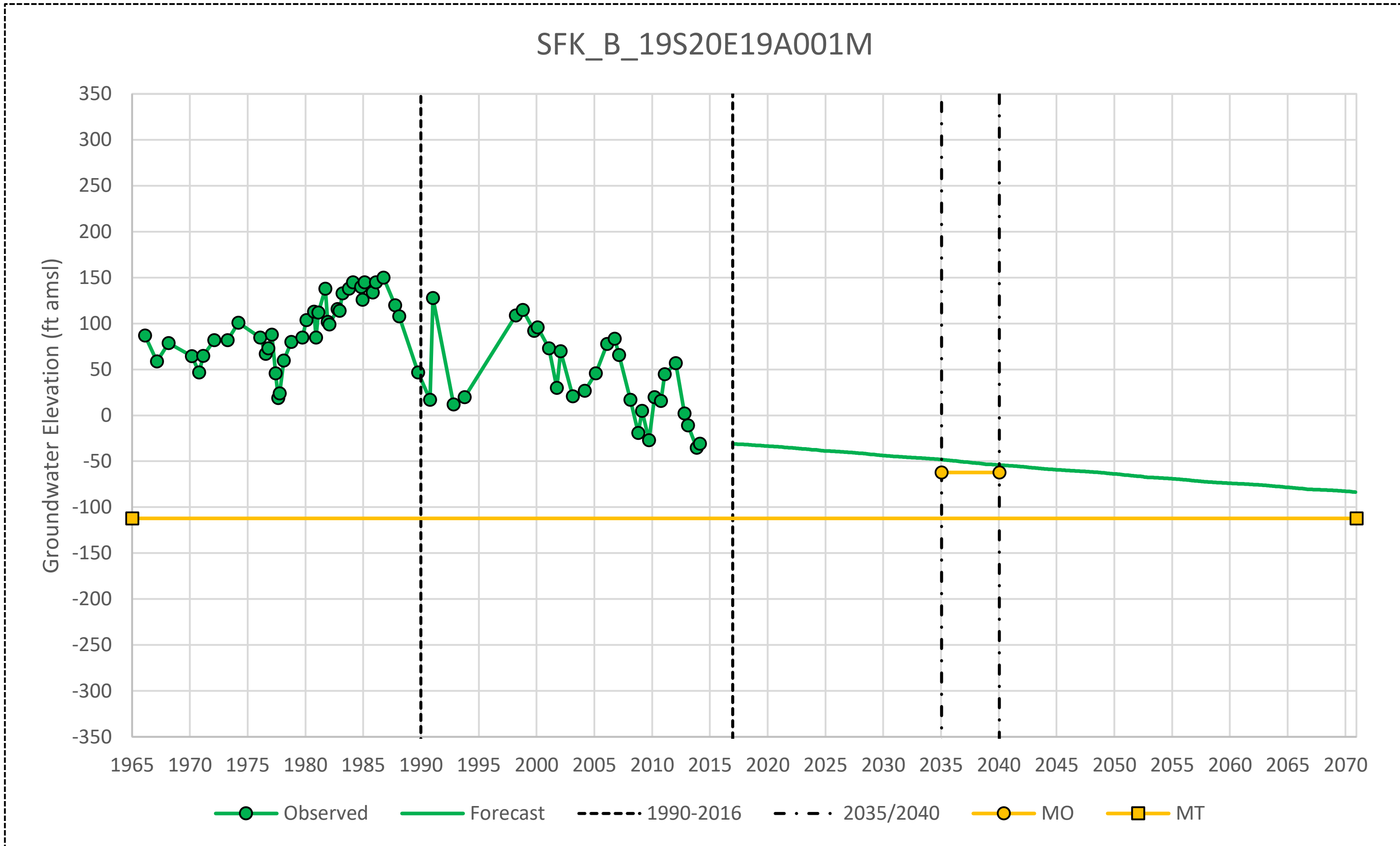
SFK_B_18S20E034N001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-69**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



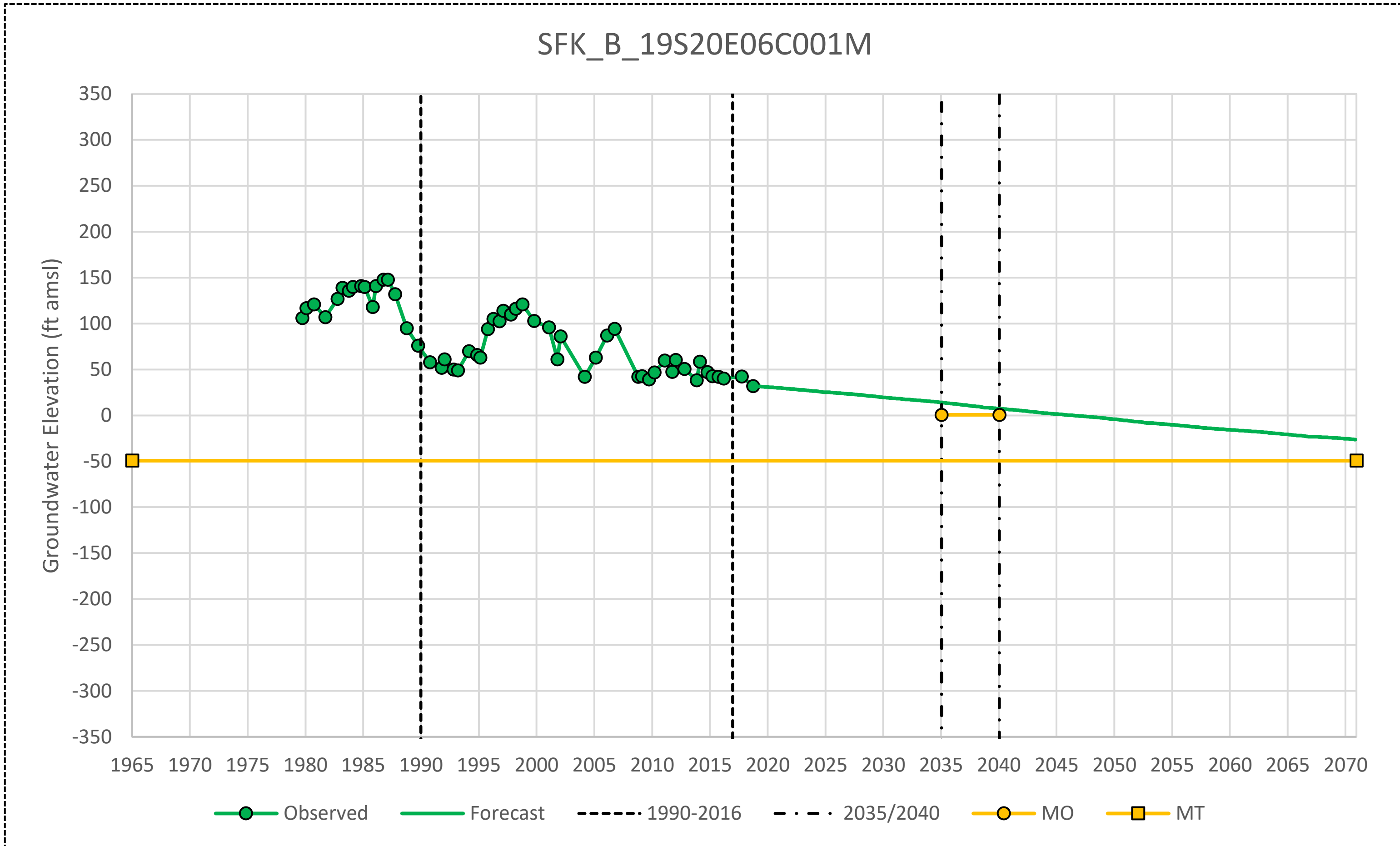
SFK_B_19S20E19A001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-70**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

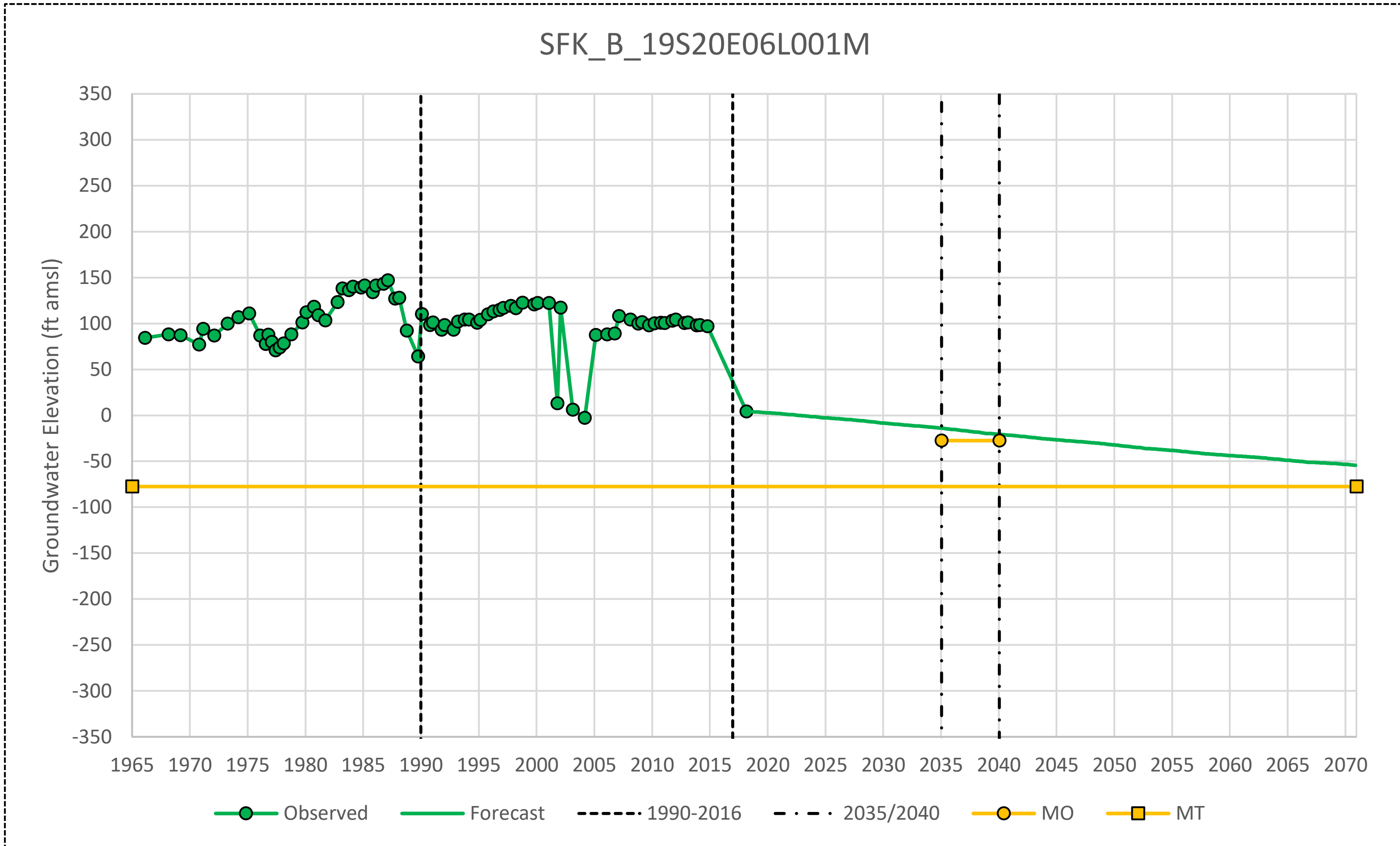


SFK_B_19S20E06C001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-71**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

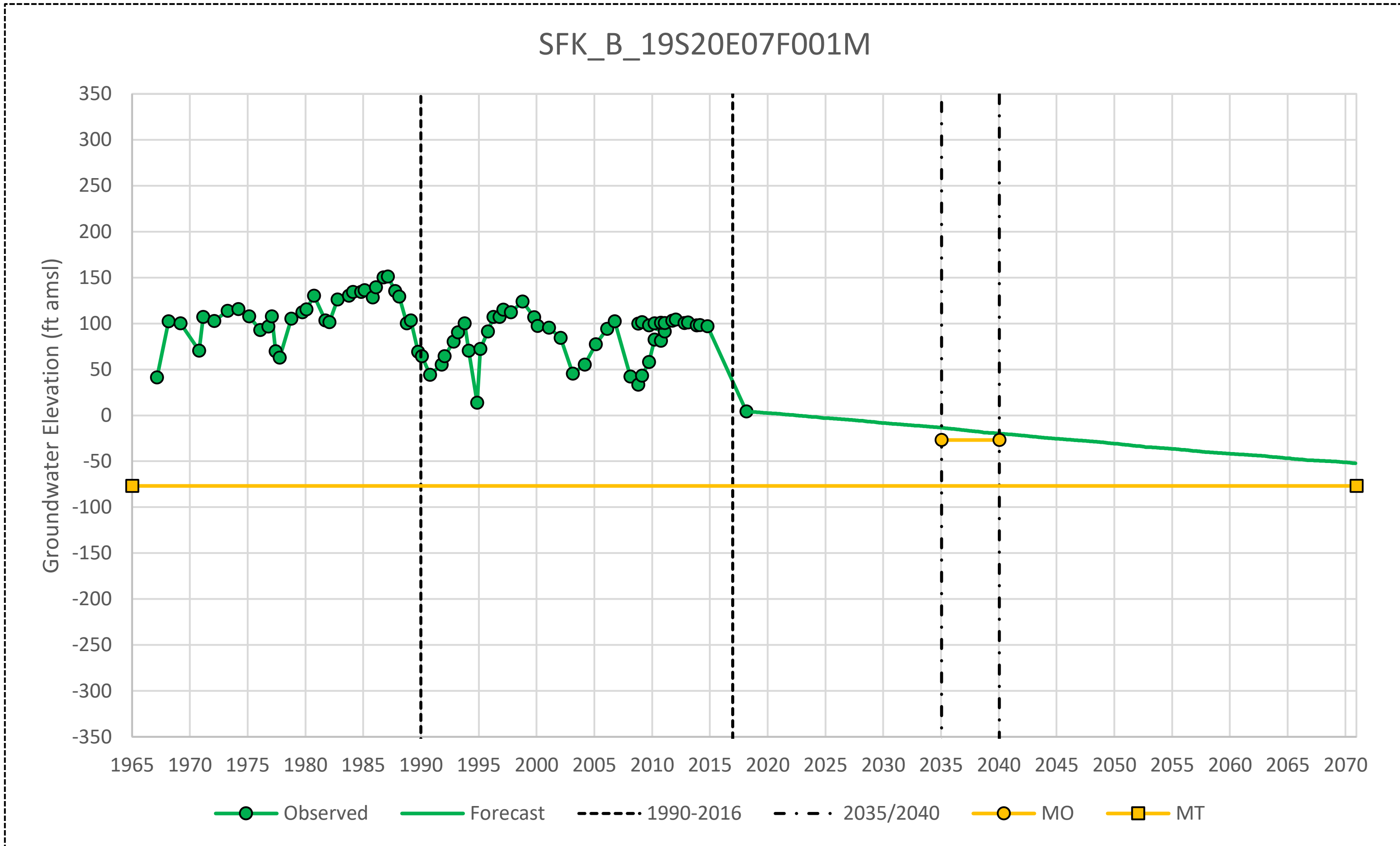


SFK_B_19S20E06L001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-72**

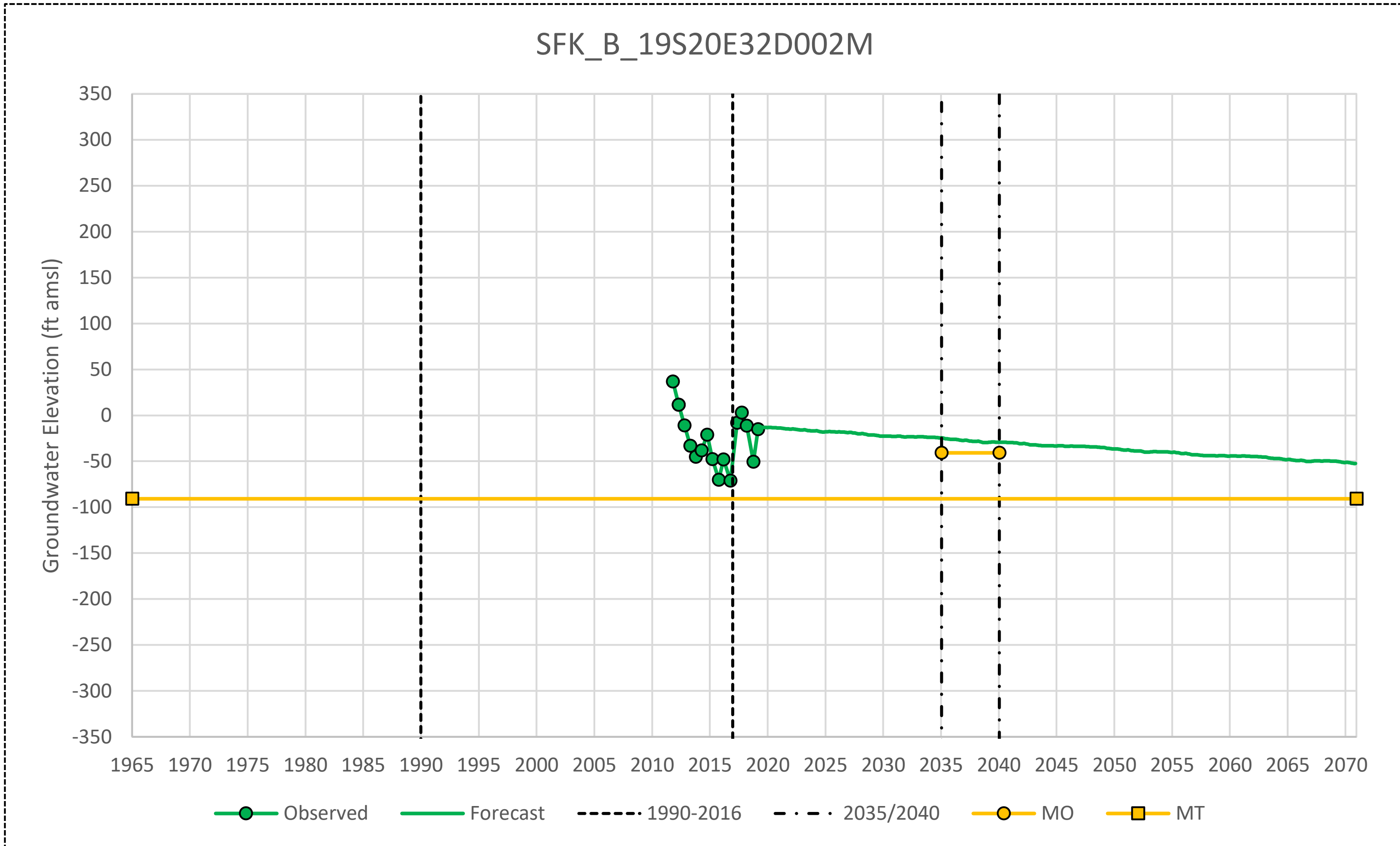
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



SFK_B_19S20E07F001M Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-73**

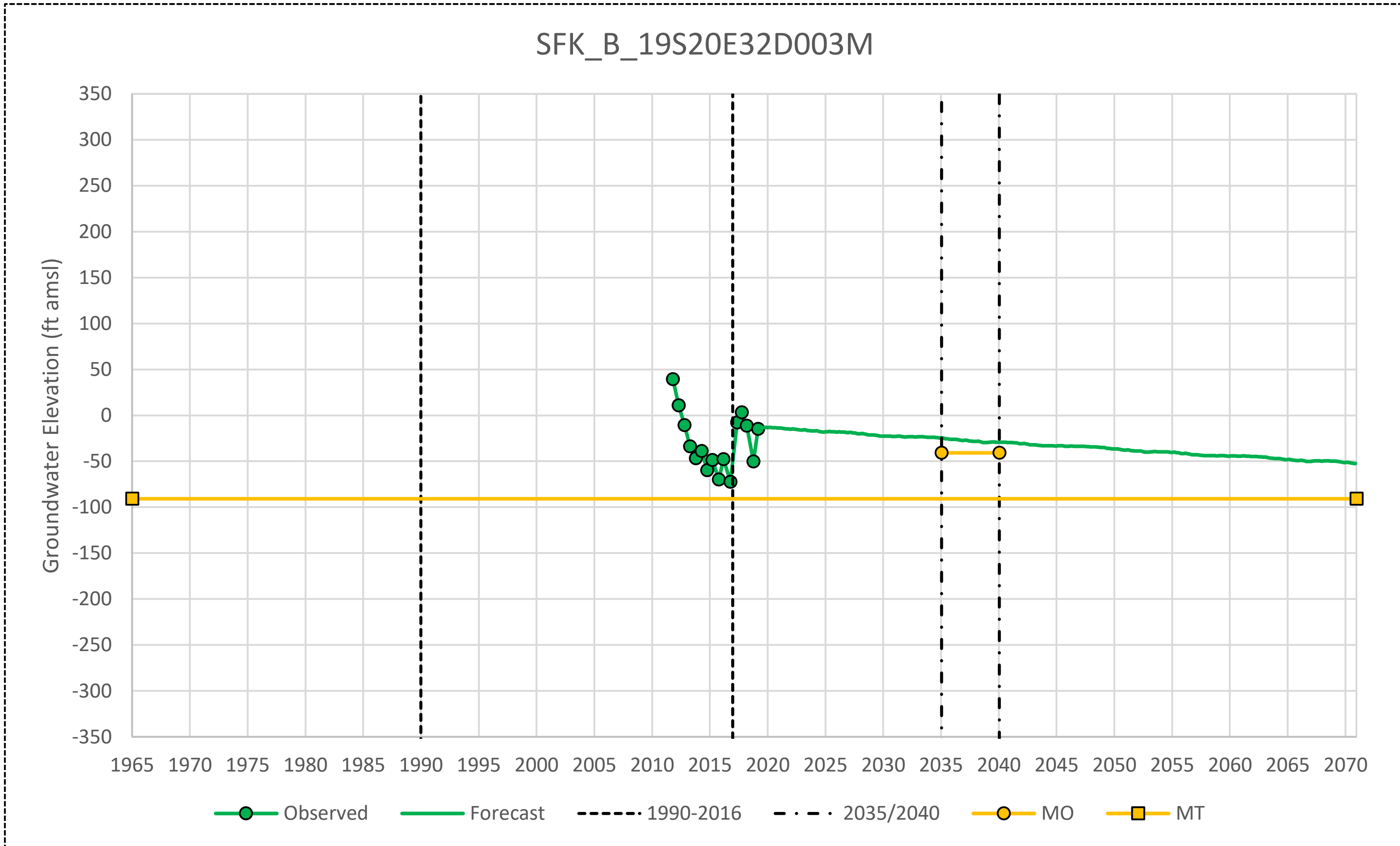
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



SFK_B_19S20E32D002M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-74**



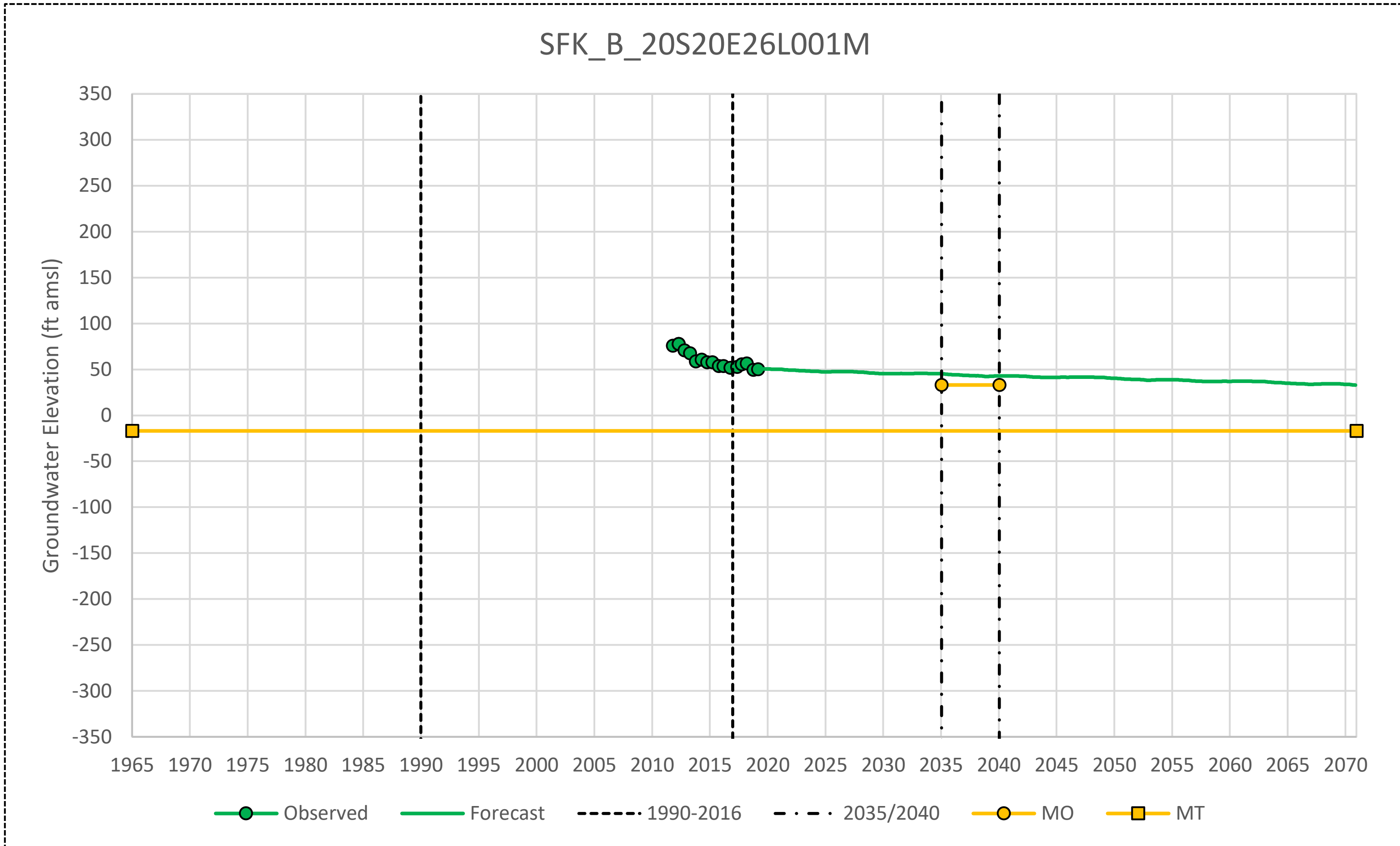
SFK_B_19S20E32D003M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-75**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

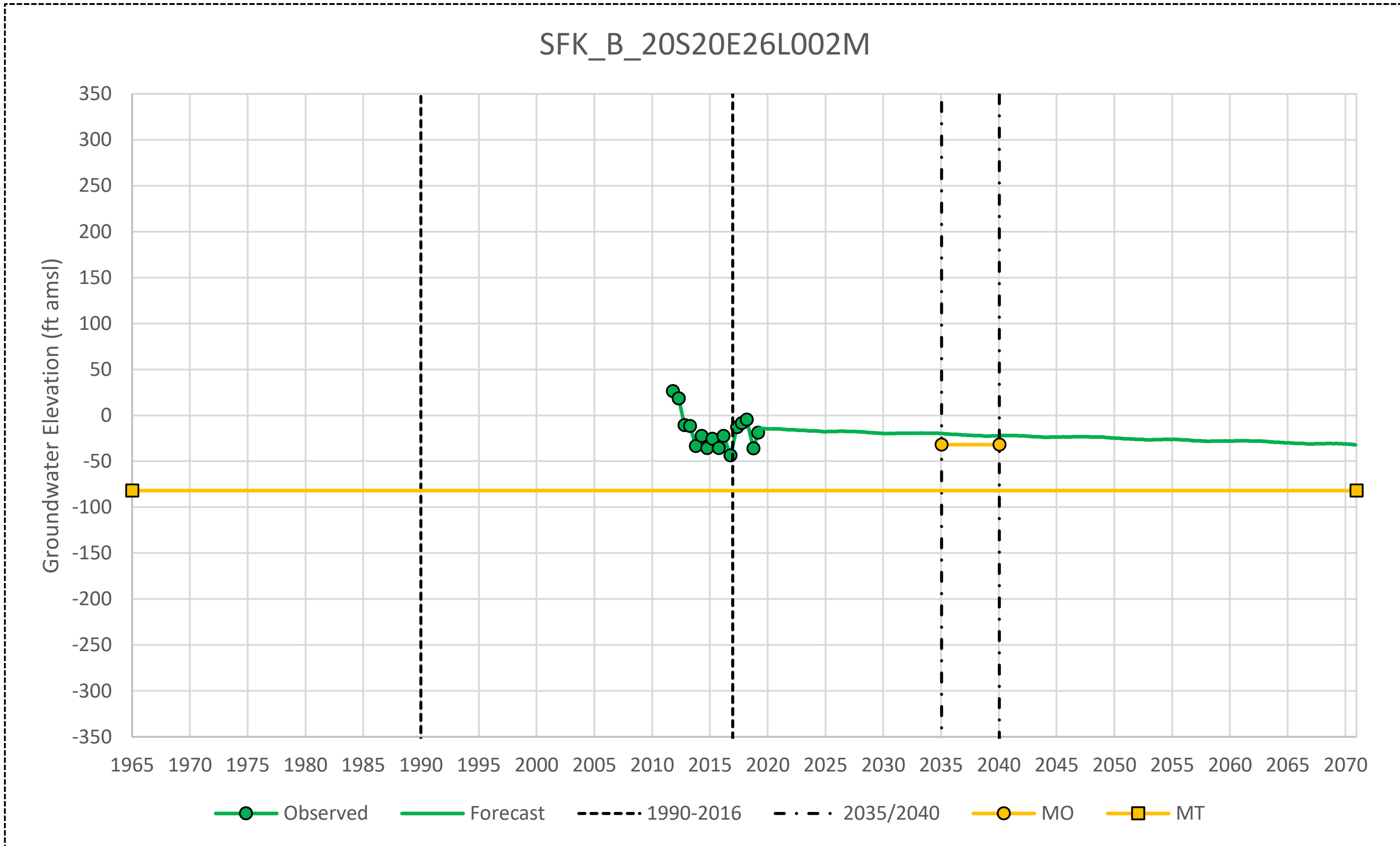


SFK_B_20S20E26L001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-76**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

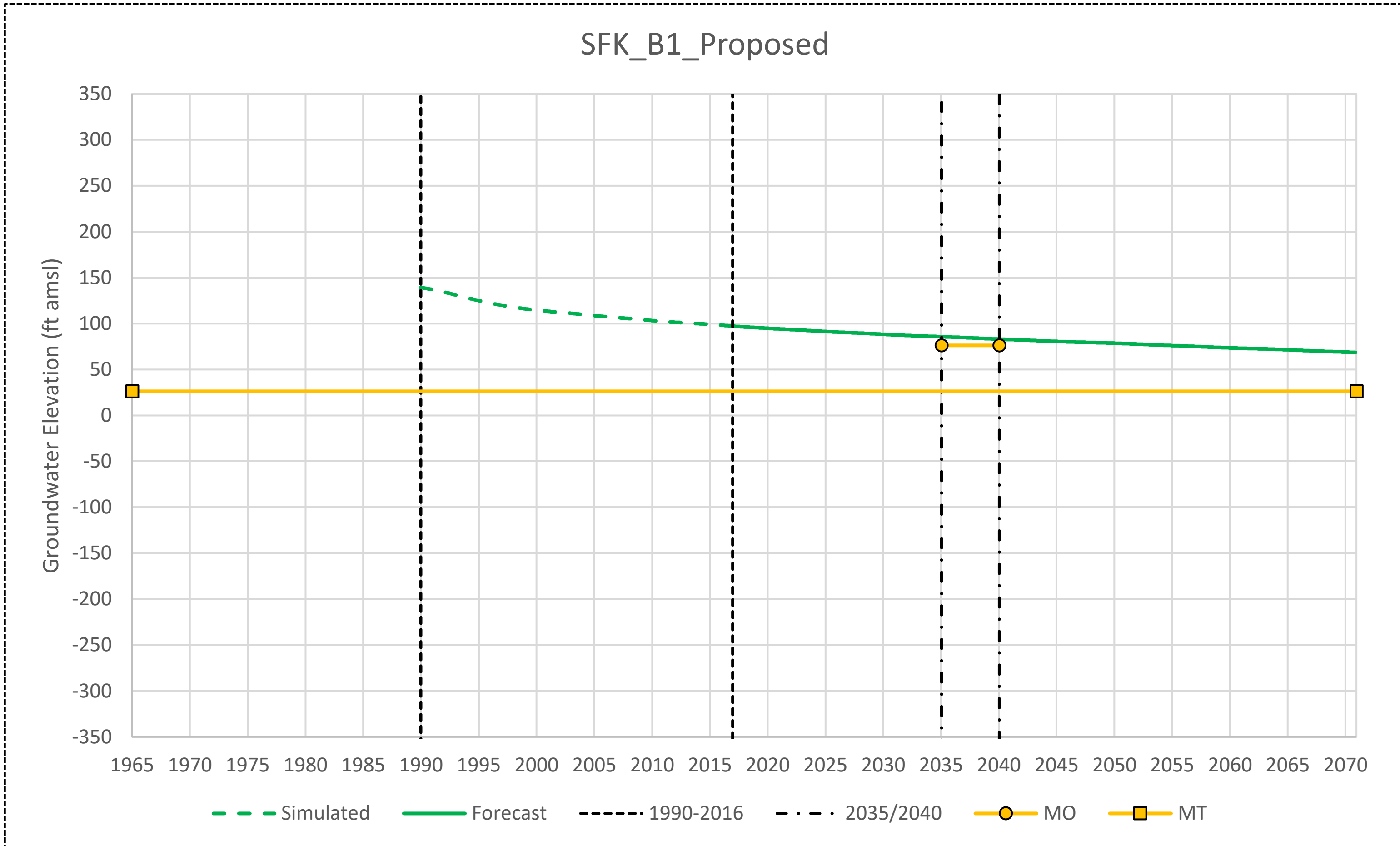


SFK_B_20S20E26L002M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

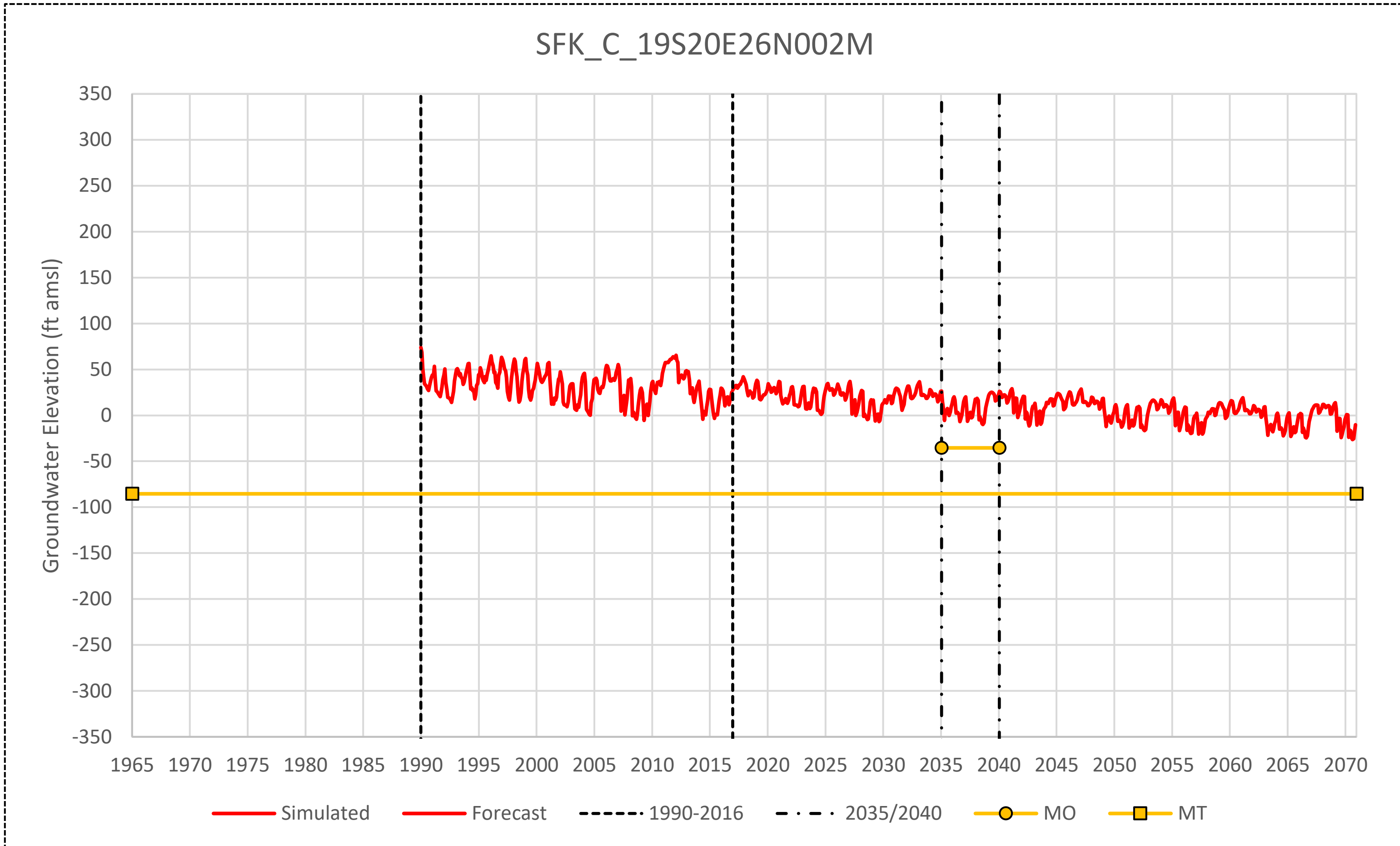
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-77**



SFK_B1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-78**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

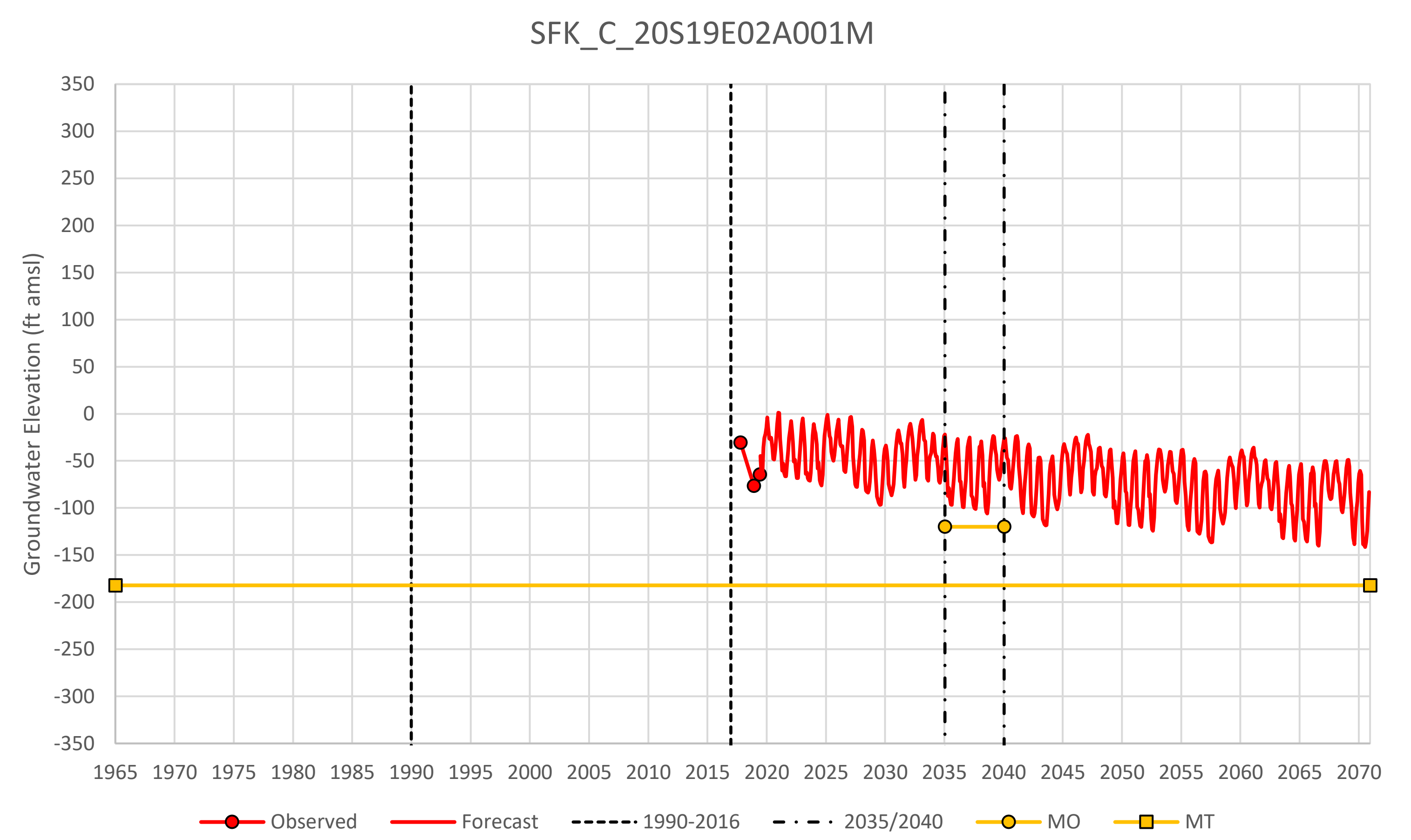


SFK_C_19S20E26N002M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-79**

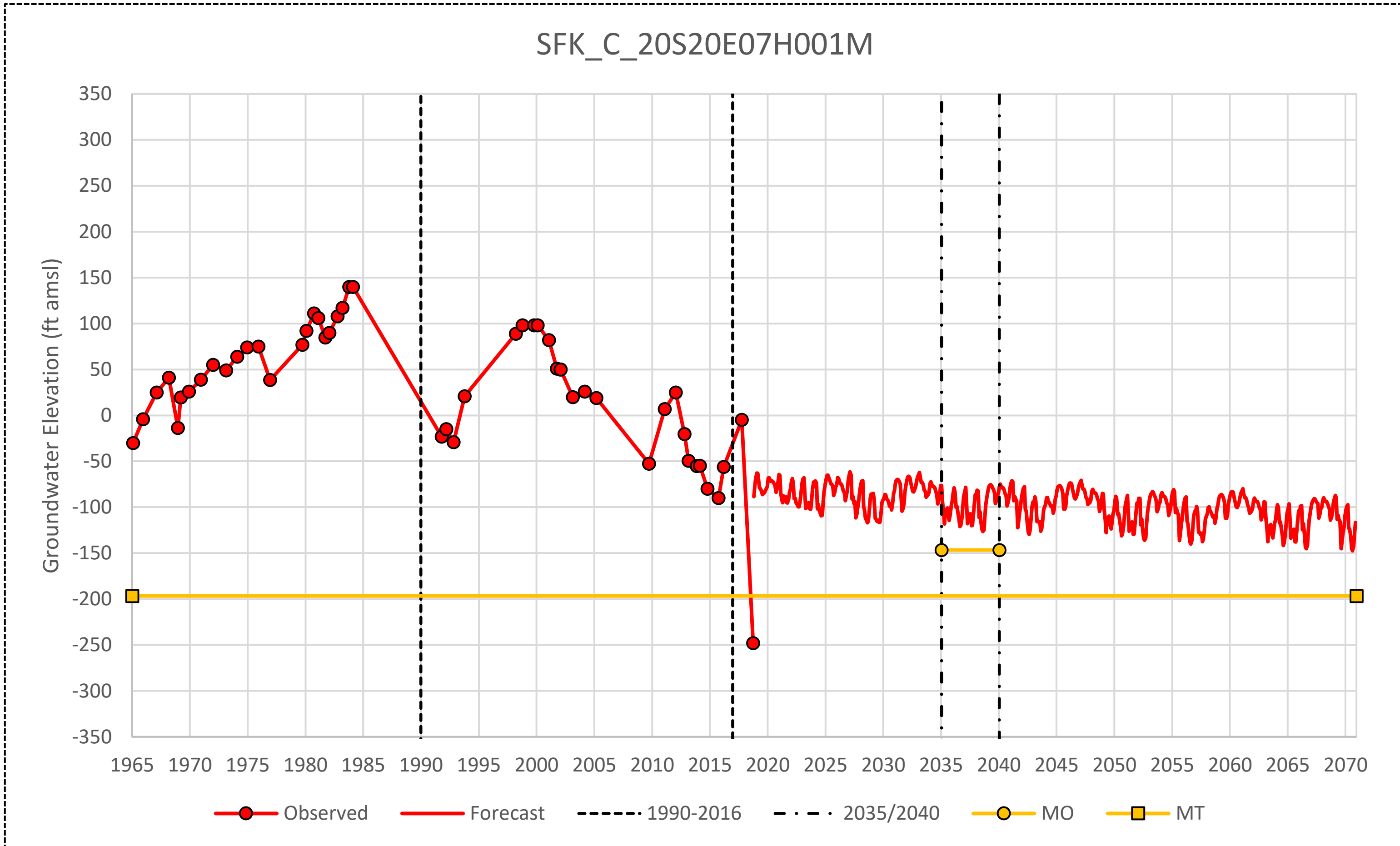


SFK_C_20S19E02A001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-80**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



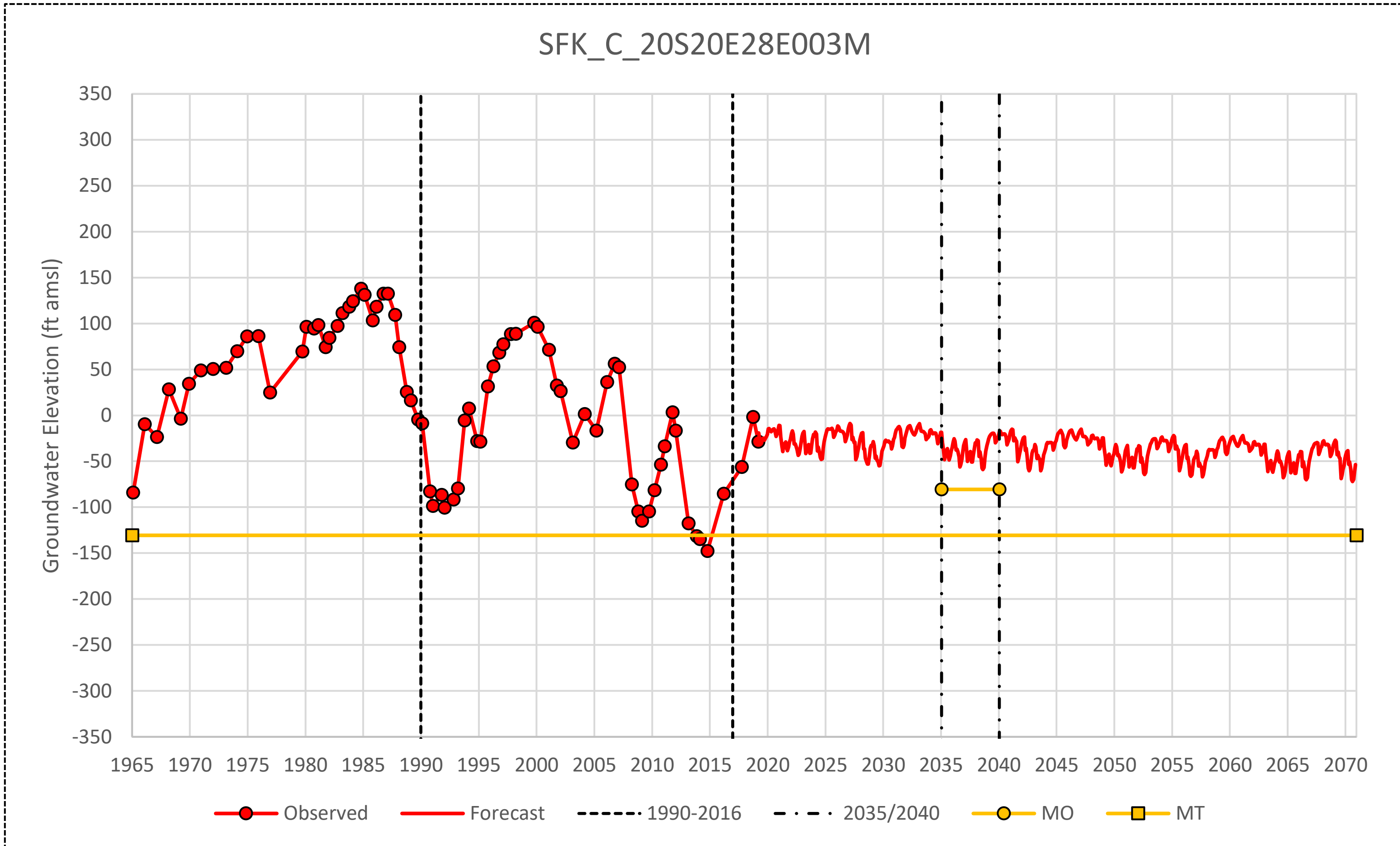
SFK_C_20S20E07H001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-81**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



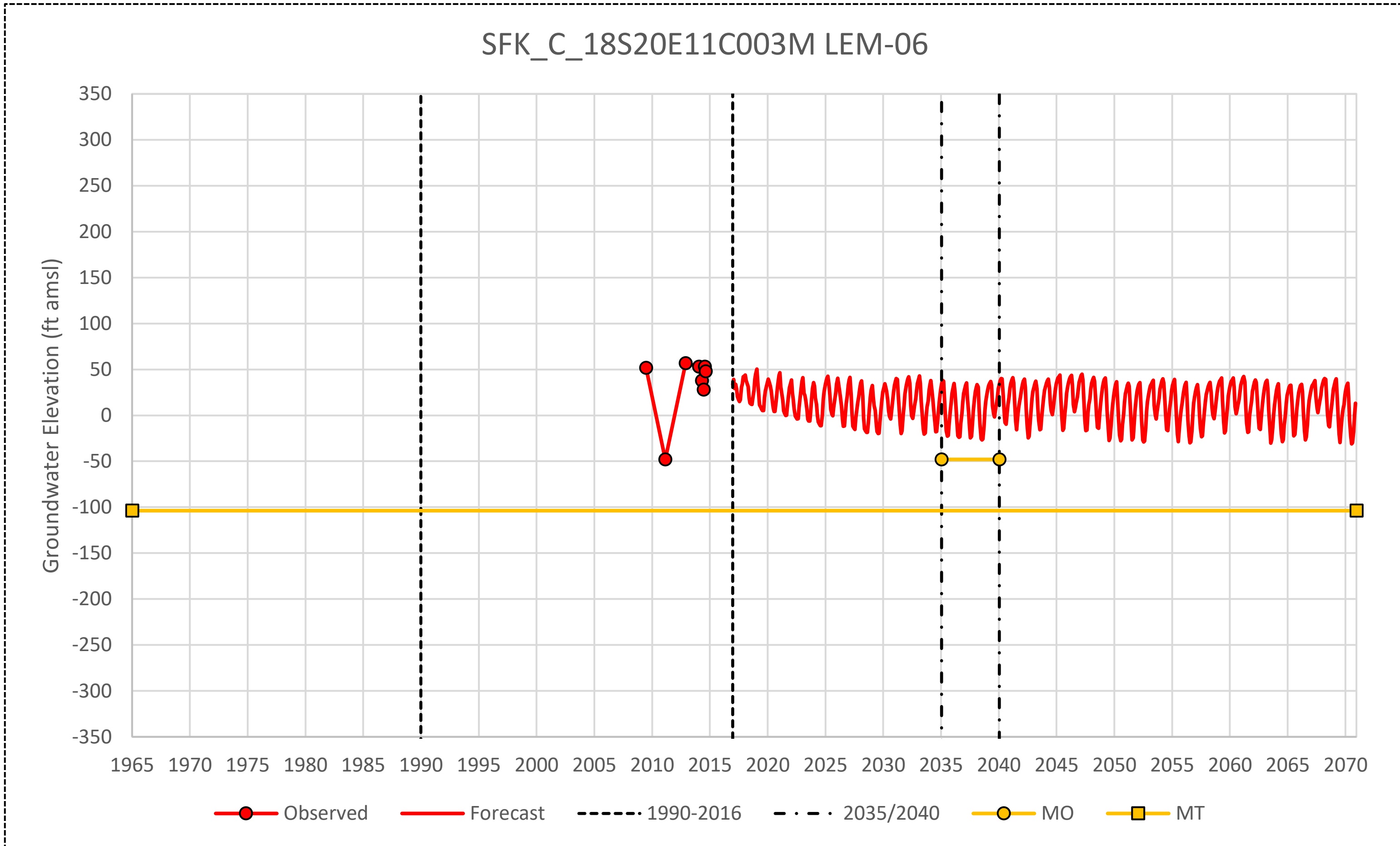
SFK_C_20S20E28E003M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-82**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



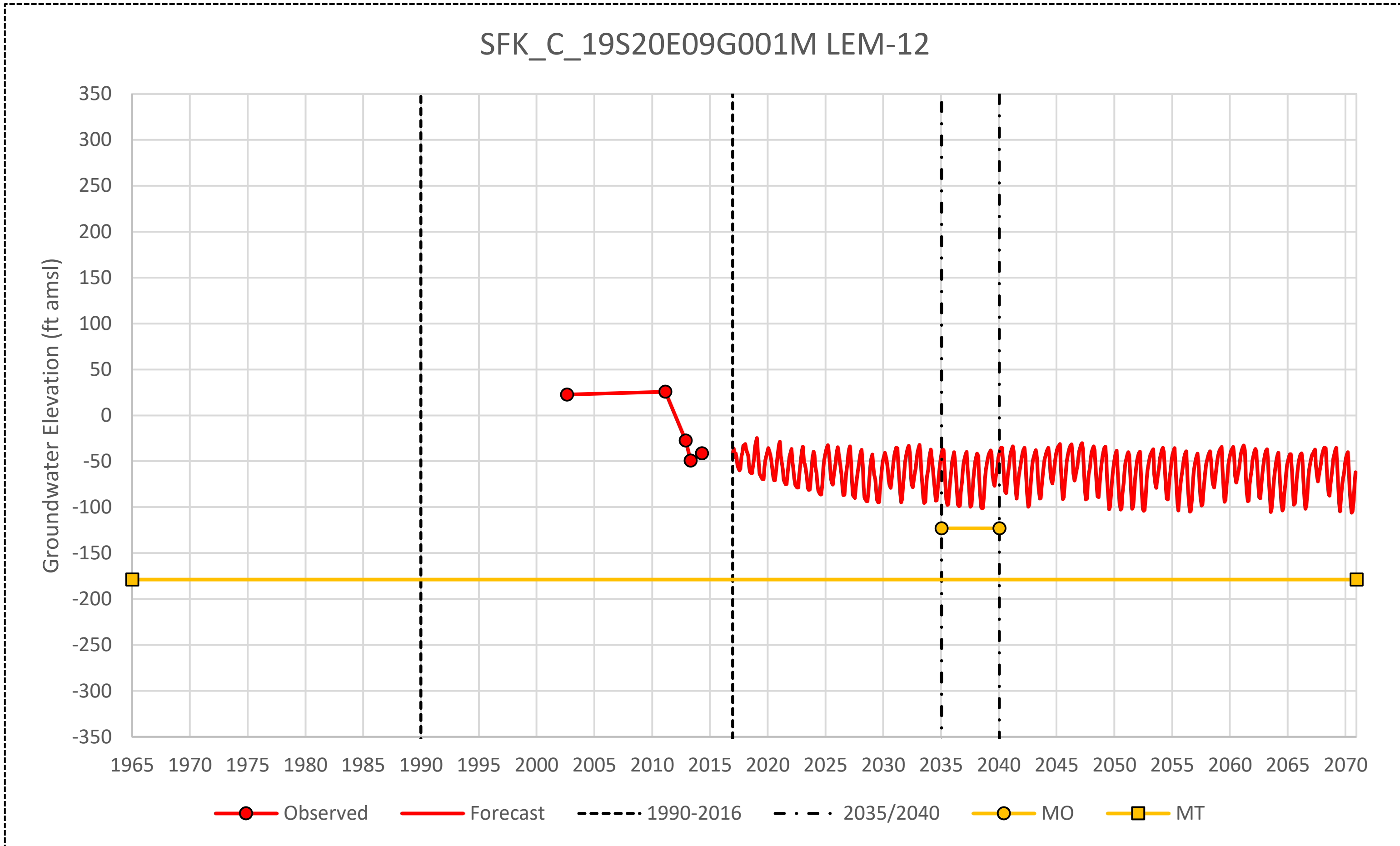
SFK_C_18S20E11C003M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

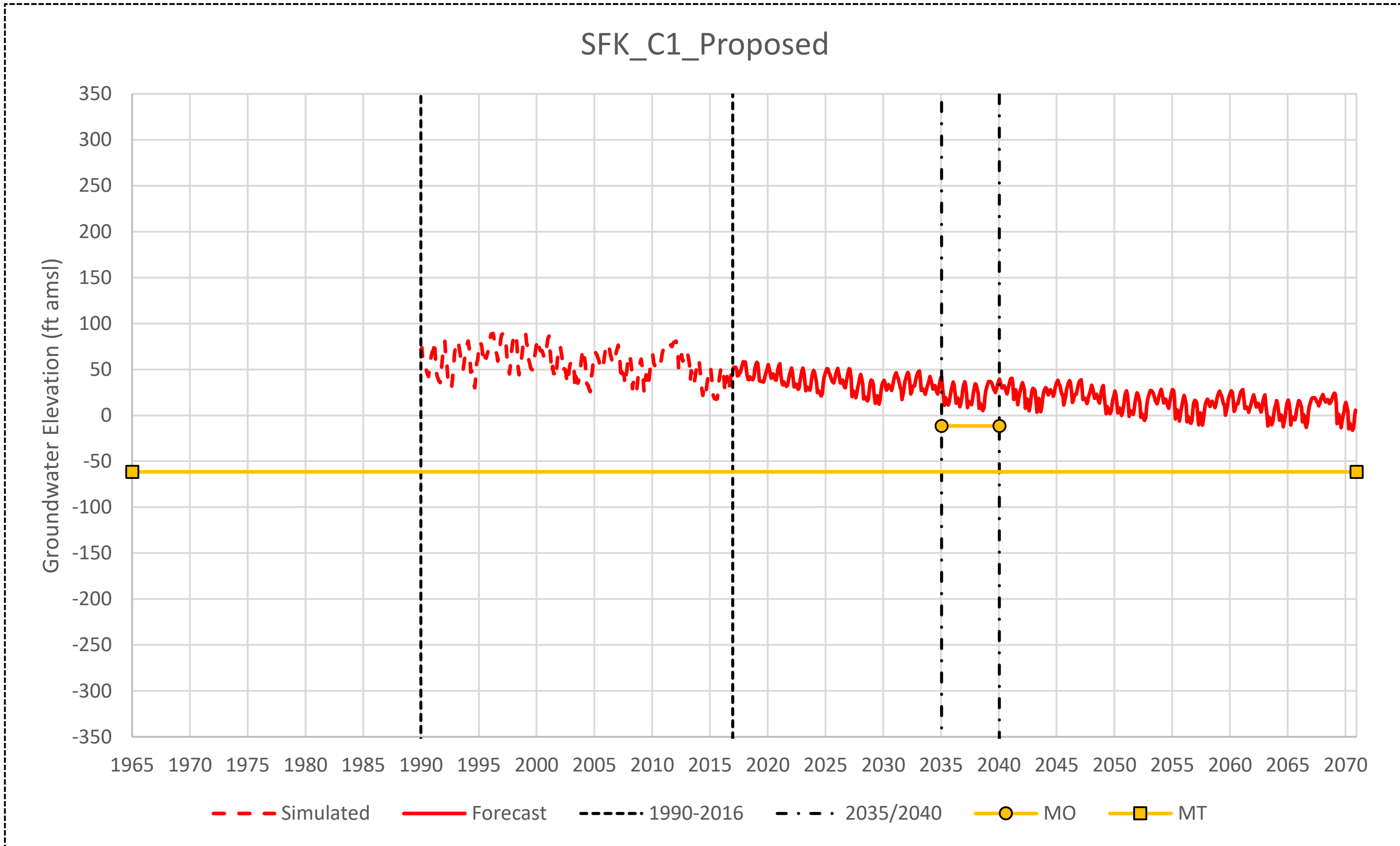
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-83**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



SFK_C_19S20E09G001M LEM-12
Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-84**

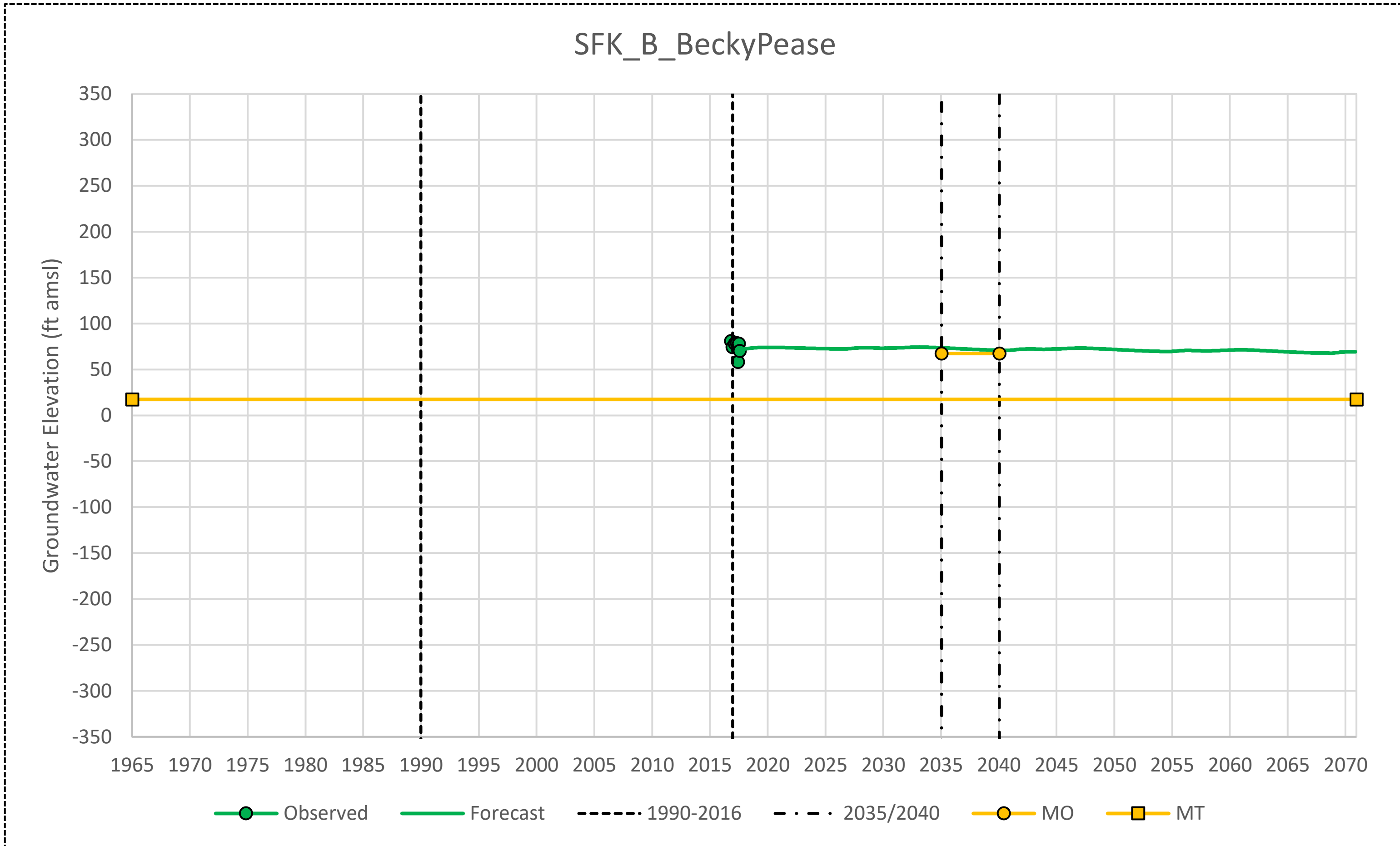


SFK_C1_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-85**

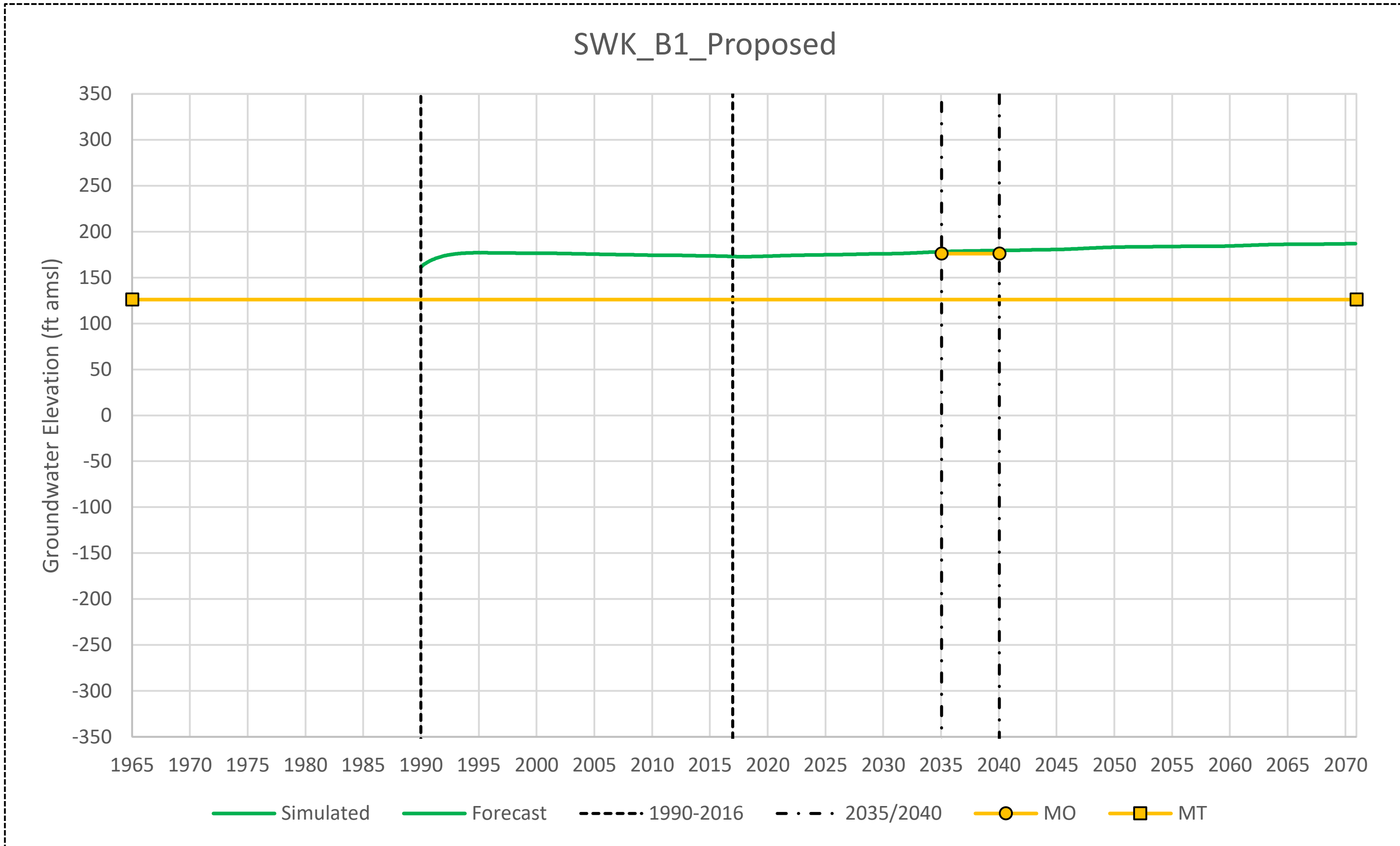


SFK_B_BeckyPease Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

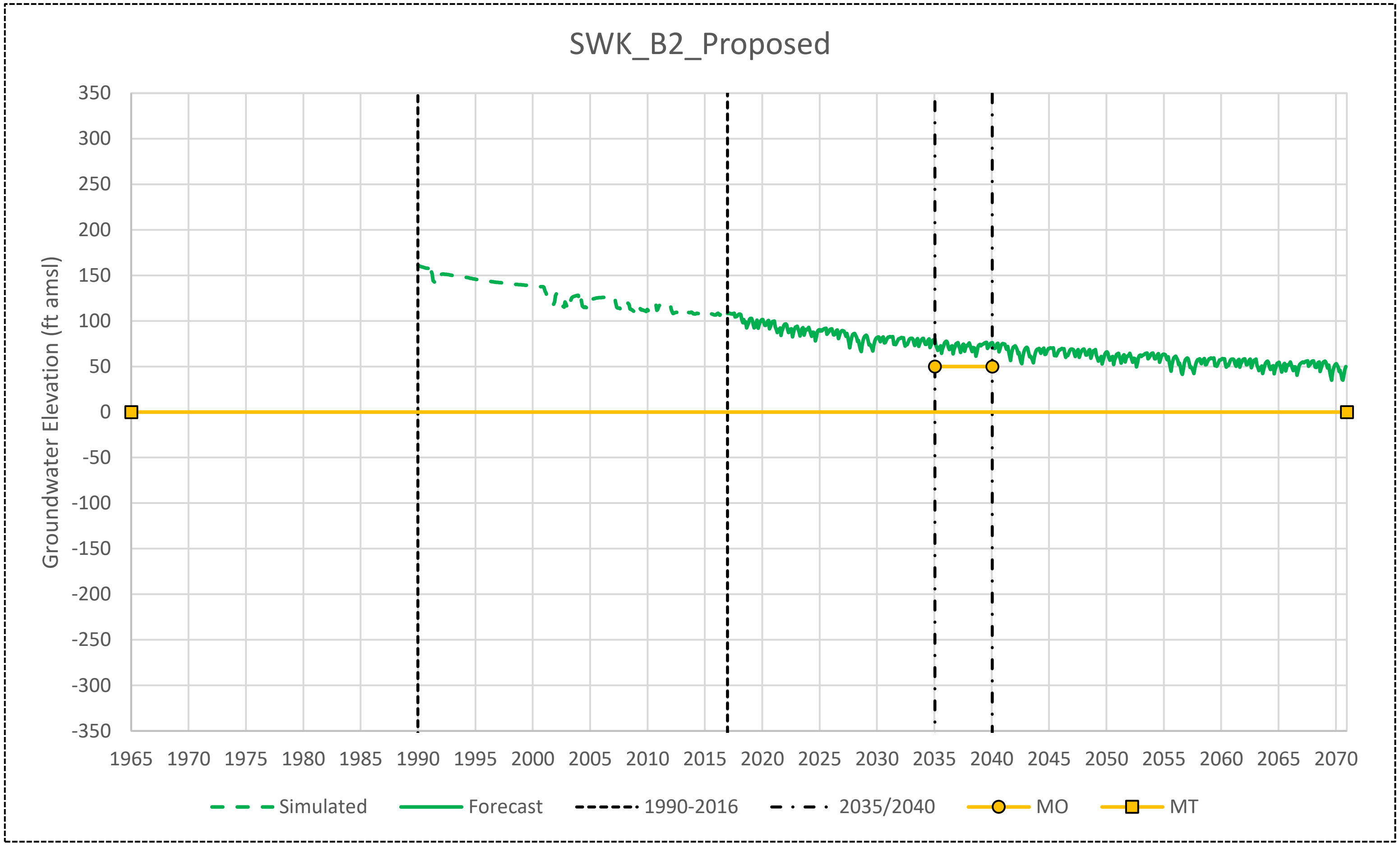
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-86**



SWK_B1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

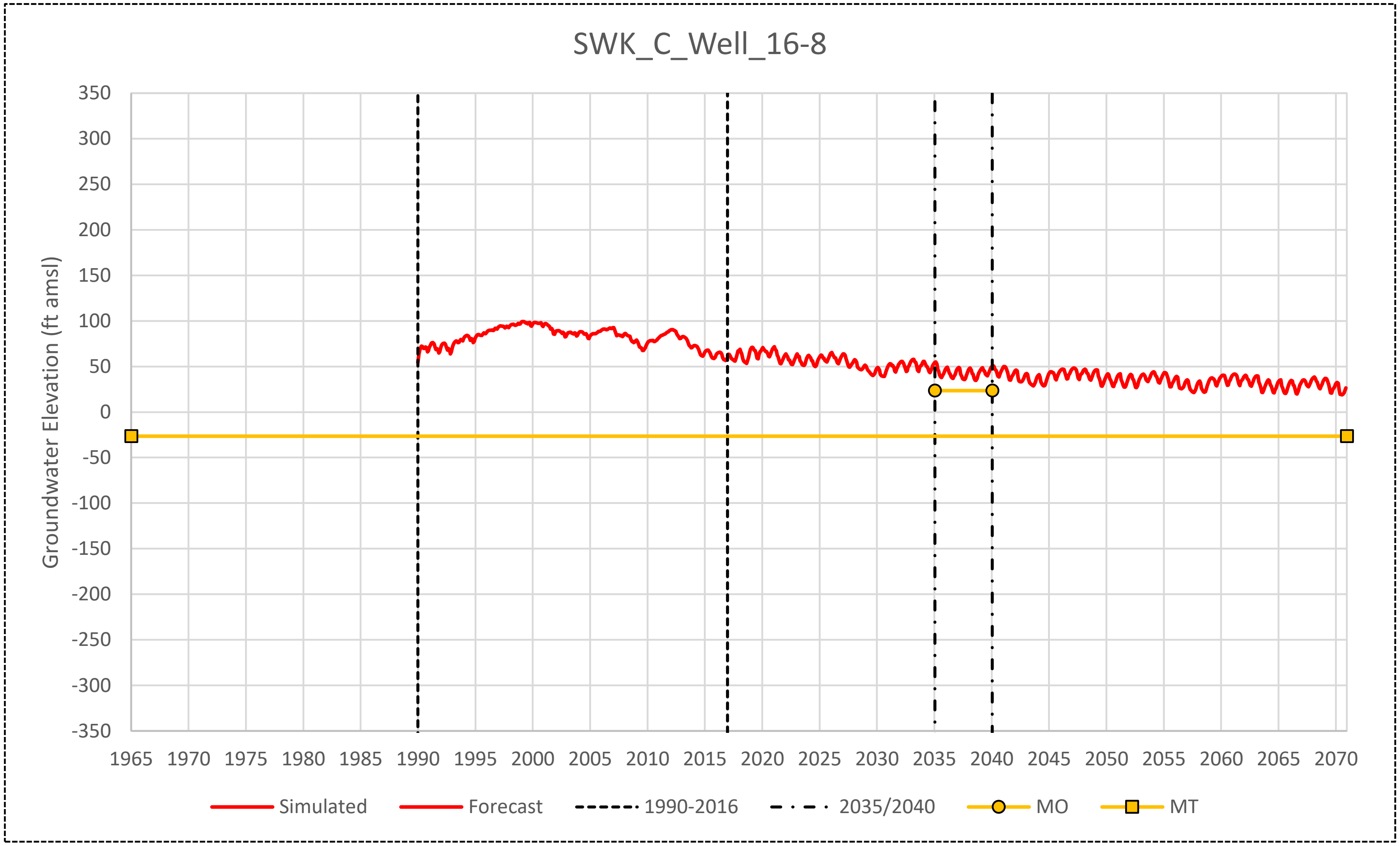
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-87**



SWK_B2_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-88**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs



SWK_C_Well_16-8 Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-89**

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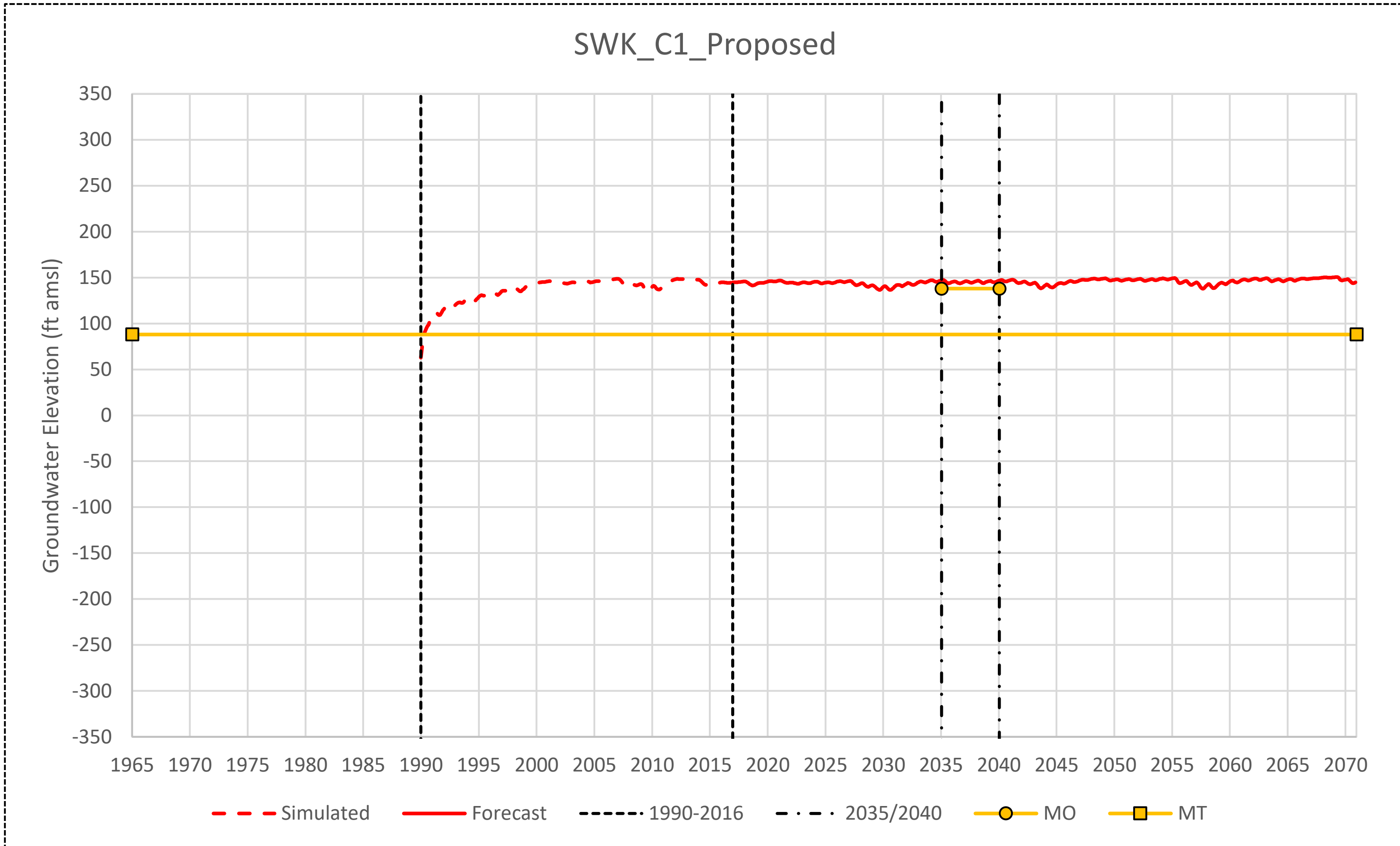
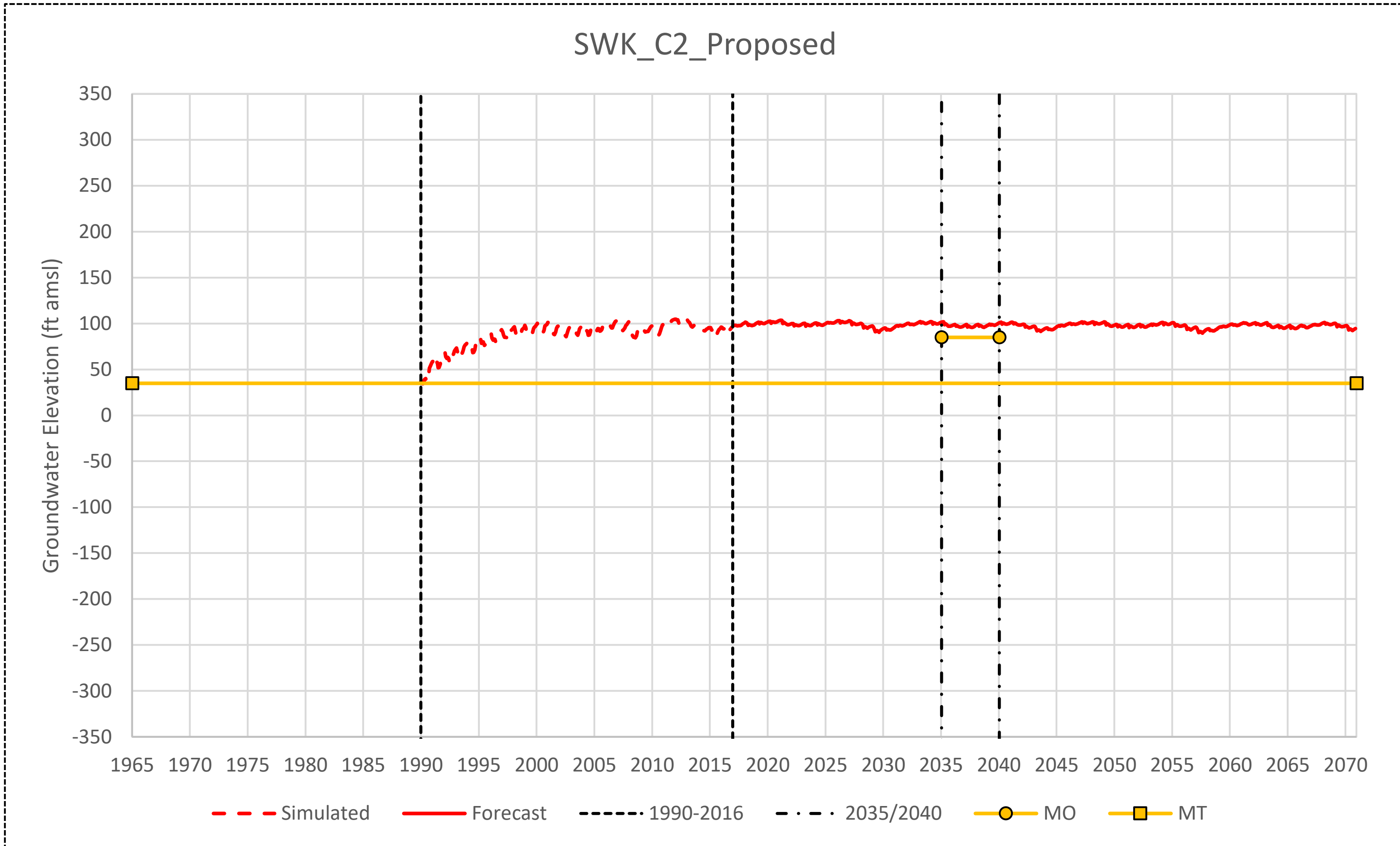


SWK_C1_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

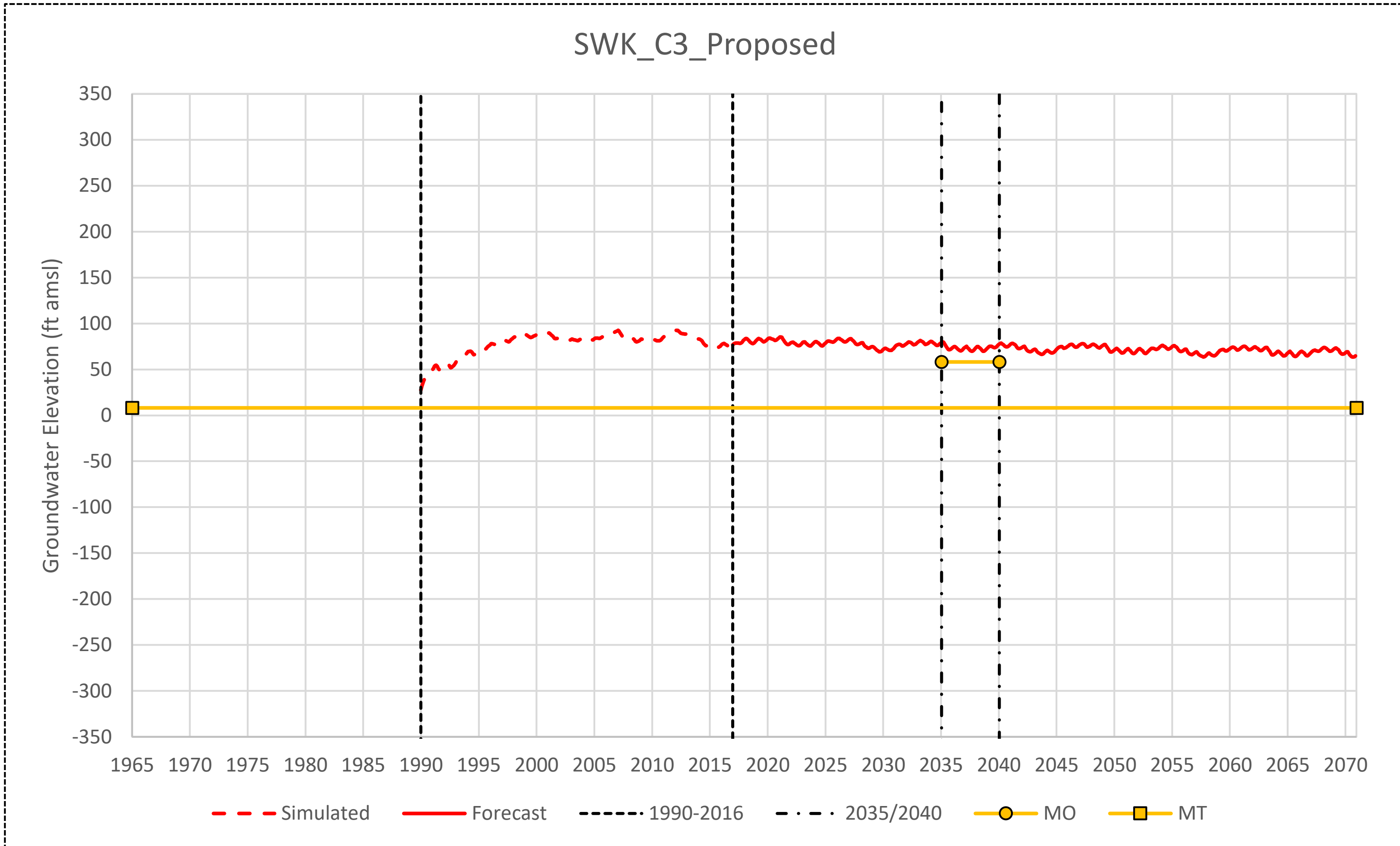
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-90**



SWK_C2_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-91**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

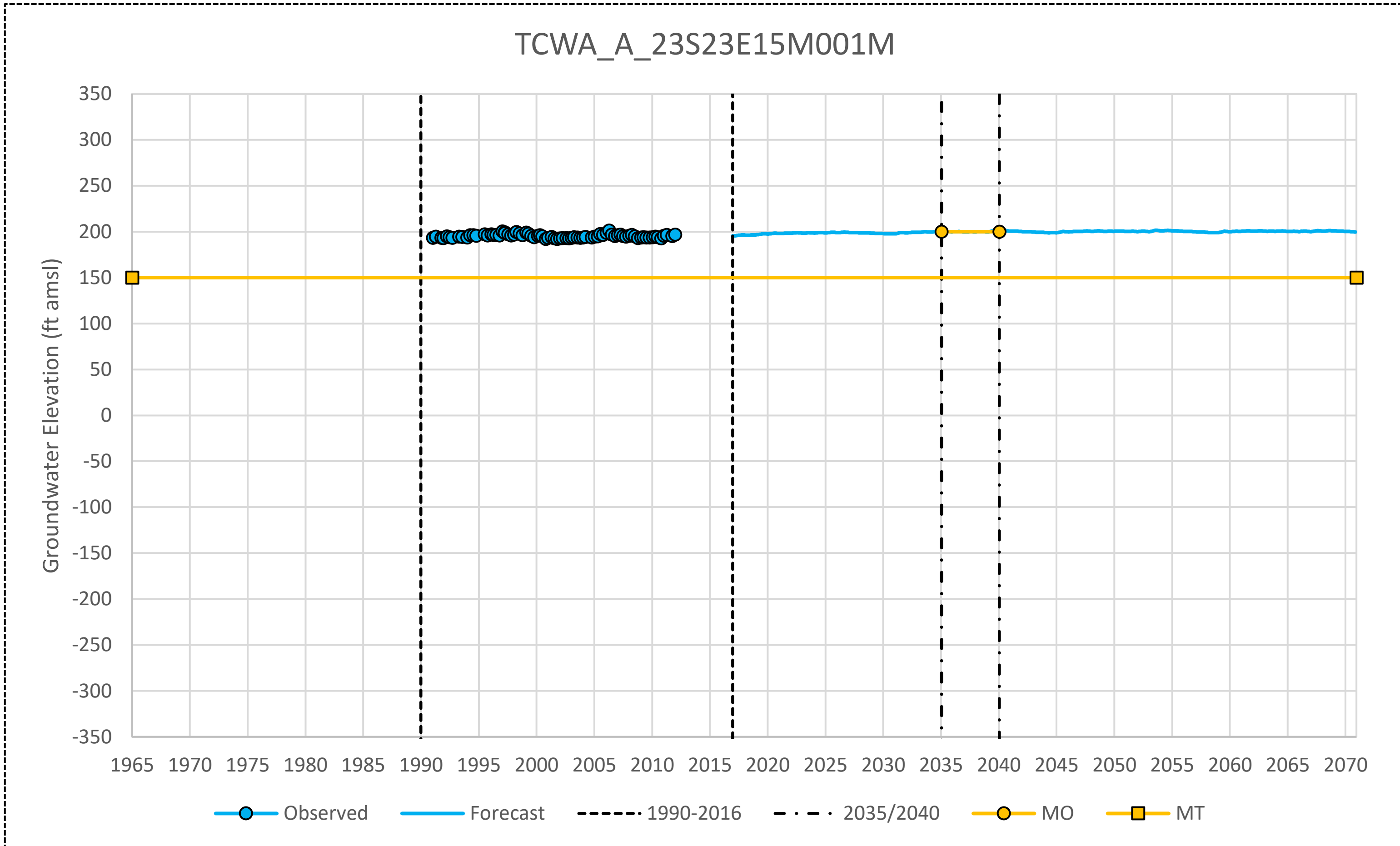


SWK_C3_Proposed Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-92**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

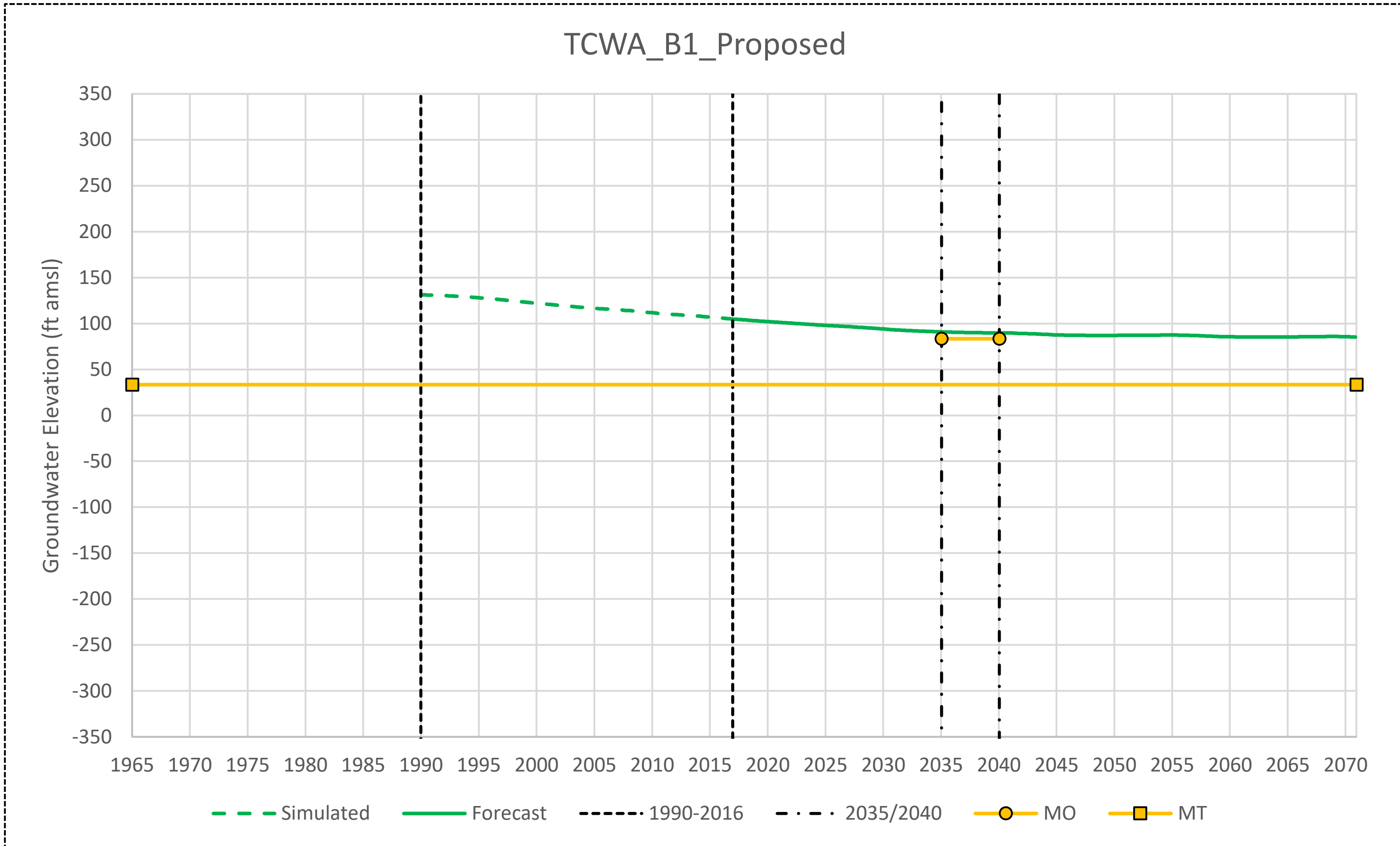


TCWA_A_23S23E15M001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

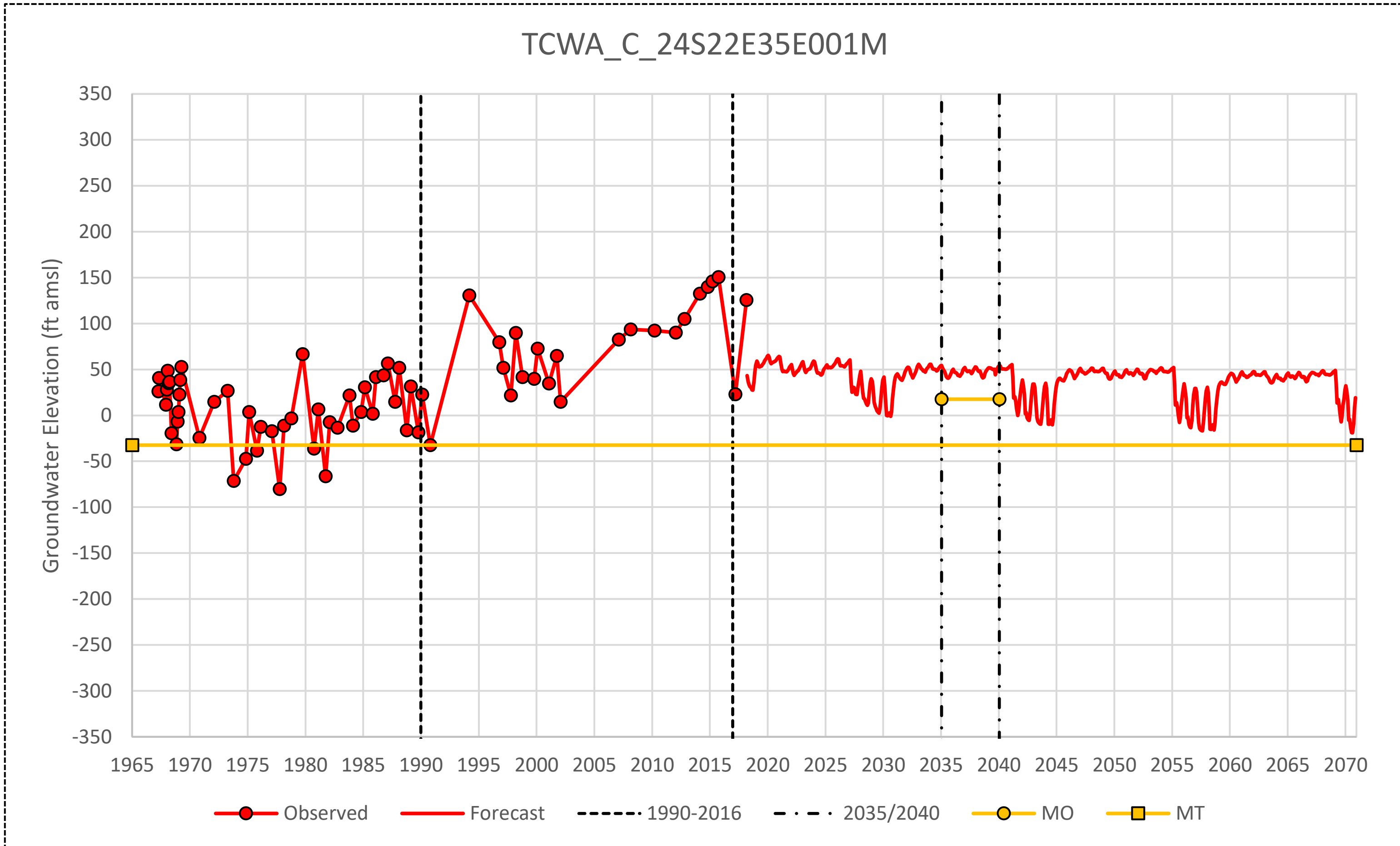
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-93**



TCWA_B1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-94**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\4-SMC\Tables\2019 0823_SMC Hydrographs

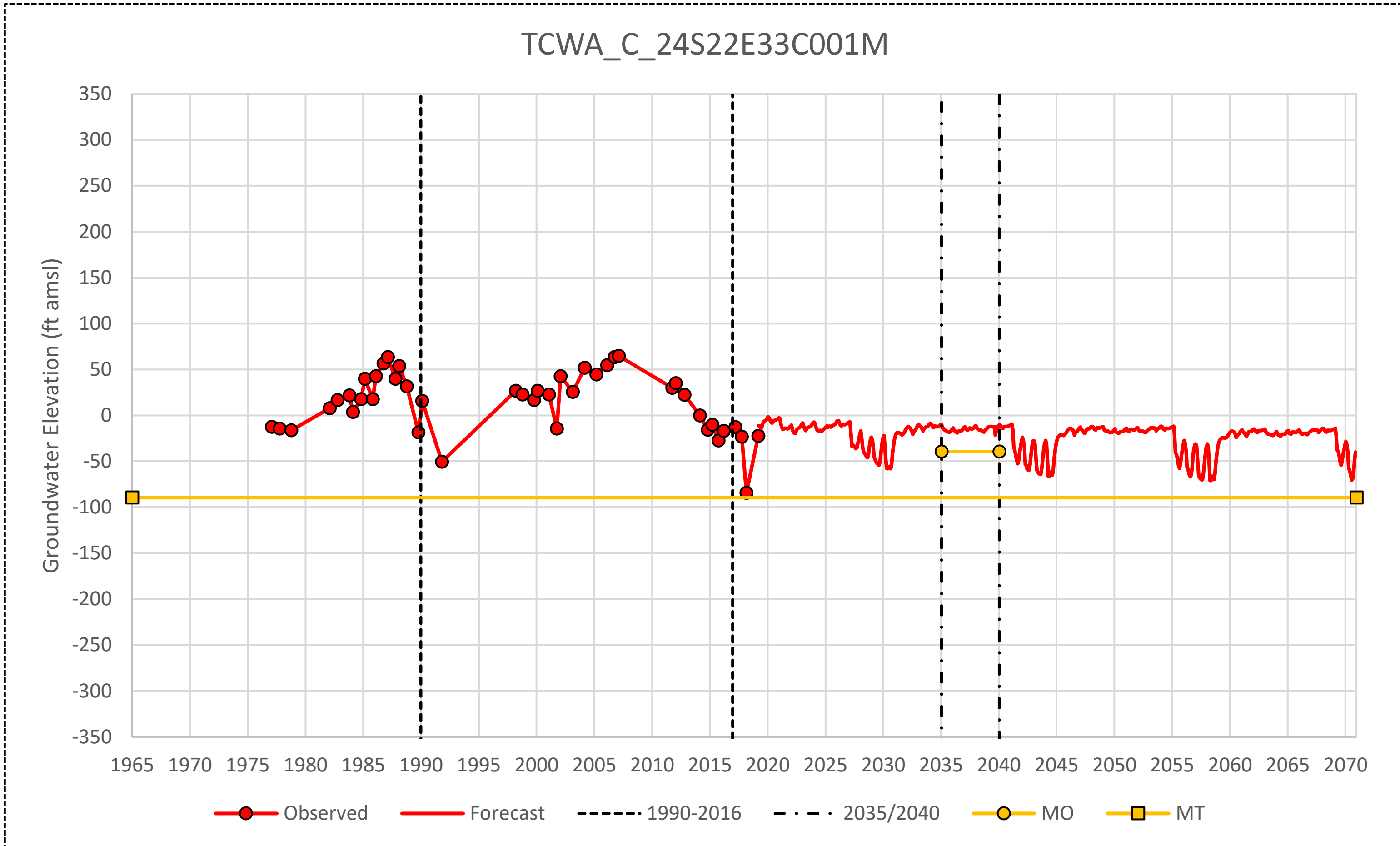


TCWA_C_24S22E35E001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

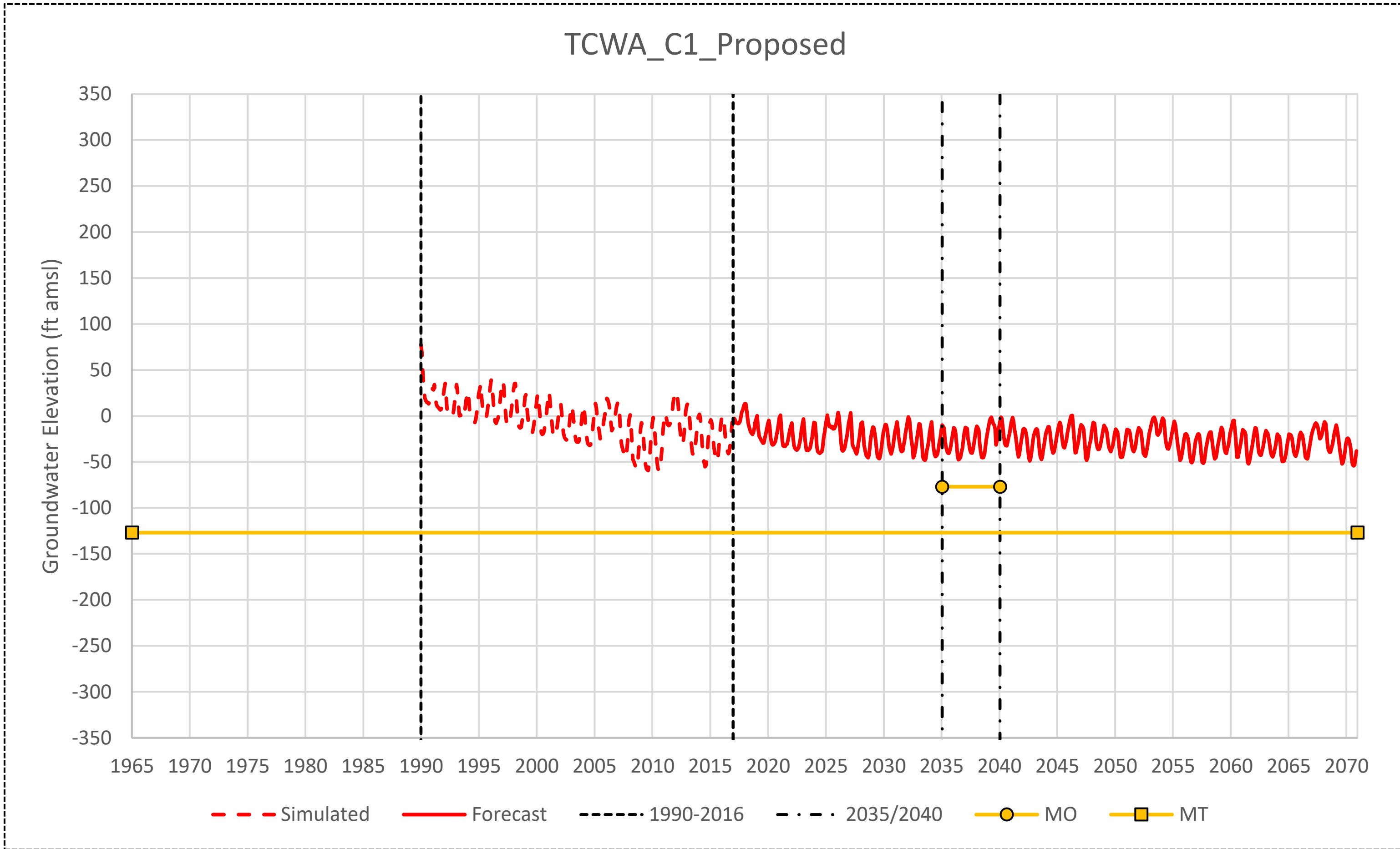
By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-95**



TCWA_C_24S22E33C001M Hydrograph

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-96**



TCWA_C1_Proposed Hydrograph
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: FAM	Date: 08/23/19	Project No.: FR18161220
		Figure **H-97**