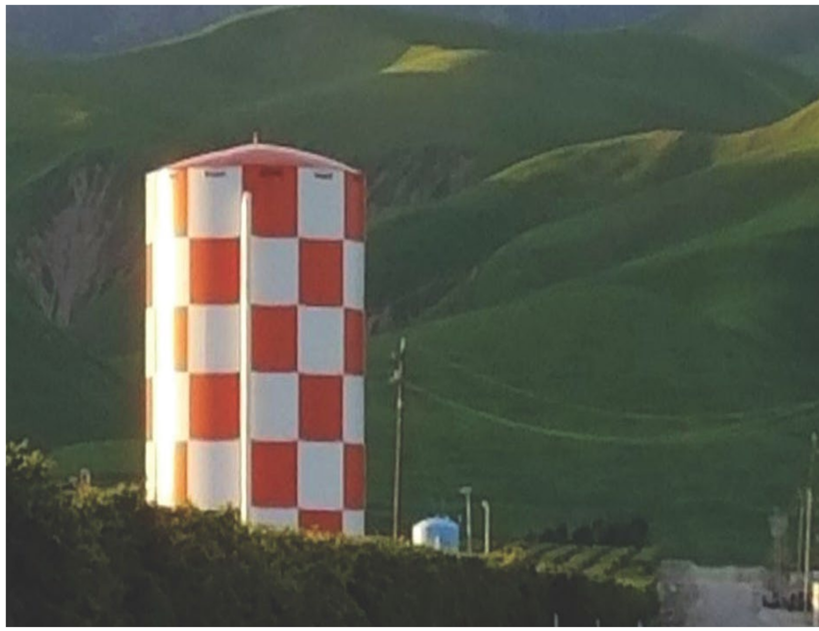
June 2022

# South of Kern River Groundwater Sustainability Plan

## for the Kern County Subbasin

**PUBLIC DRAFT**



ARVIN-EDISON WATER STORAGE DISTRICT

WHEELER RIDGE - MARICOPA WATER STORAGE DISTRICT

TEJON-CASTAC WATER DISTRICT

ARVIN CSD

eki environment & water

# South of Kern River Groundwater Sustainability Plan

## Kern County Subbasin

**Prepared by:**

**EKI Environment & Water, Inc.**

for

**Arvin GSA**
**Wheeler Ridge-Maricopa GSA**
**Tejon-Castac Water District GSA**

**PUBLIC DRAFT**

**June 2022**

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| | |
|---|---|
| AB | Assembly Bill |
| ACSD | Arvin Community Services District |
| AEM | airborne electromagnetic |
| AEWSD | Arvin-Edison Water Storage District |
| AF | acre-feet |
| AFW | Amec Foster Wheeler |
| AFY | acre-feet per year |
| API | American Petroleum Institute |
| APN | Assessor's Parcel Number |
| AWMP | Agricultural Water Management Plan |
| BMP | Best Management Practices |
| BO | Biological Opinion |
| BOS | bottom of screen |
| BRIC | Building Resilient Infrastructure and Communities |
| BVCSD | Bear Valley Community Services District |
| BVWSD | Buena Vista Water Storage District |
| C&LU | Conservation and Land Use |
| CA | California |
| CASGEM | California Statewide Groundwater Elevation Monitoring |
| CASP | California Aqueduct Subsidence Program |
| CCR | California Code of Regulations |
| CDEC | California Data Exchange Center |
| CDM | California Division of Mines |
| CDMG | California Division of Mines and Geology |
| CE | Conservation Easement |
| CEQA | California Environmental Quality Act |
| cfs | cubic feet per second |
| CG | coarse grid |
| CGS | California Geological Survey |
| CIMIS | California Irrigation Management Information System |
| COC | Constituents of Concern |
| CV | Central Valley |
| CVHM | Central Valley Hydrologic Model |
| CVP | Central Valley Project |
| CVRWQCB | Central Valley Regional Water Quality Control Board |
| CVSALTS | Central Valley-Salinity Alternatives for Long-term Sustainability |
| CWC | California Water Code |
| DAC | Disadvantaged Community |
| DBCP | 1,2-Dibromo-3-chloropropane |
| DEM | digital elevation model |
| DMS | Data Management System |
| DOGGR | Division of Oil, Gas and Geothermal Resources |
| DTSC | Department of Toxic Substances Control |

| | |
|---|---|
| DTW | Depth to Water |
| DWR | Department of Water Resources |
| EC | electrical conductance |
| EIR | Environmental Impact Report |
| ENCSD | East Niles Community Services District |
| EO | Executive Order |
| ESA | European Space Agency |
| ET | evapotranspiration |
| FEMA | Federal Emergency Management Agency |
| FG | fine grid |
| FKC | Friant-Kern Canal |
| ft | feet |
| ft bgs | feet below ground surface |
| ft msl | feet above mean sea level |
| ft/day | feet per day |
| ft/yr | feet per year |
| FWA | Friant Water Authority |
| GAMA | Groundwater Ambient Monitoring and Assessment |
| GDE | groundwater dependent ecosystem |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| GSA | Groundwater Sustainability Agency |
| GSP | Groundwater Sustainability Plan |
| GWE | groundwater elevation |
| GWMP | Groundwater Management Plan |
| GWSA | Groundwater-only Service Area |
| GWSP | Groundwater Service Program |
| HCM | hydrogeologic conceptual model |
| HMWD | Henry Miller Water District |
| ID | Irrigation District |
| ILRP | Irrigated Lands Regulatory Program |
| IM | Interim Milestone |
| InSAR | Interferometric Synthetic Aperture Radar |
| IRWMP | Integrated Regional Water Management Plan |
| IS | Initial Study |
| ITRC | Irrigation Training and Research Center |
| JPA | Joint Power Authority |
| JPL | Jet Propulsion Laboratory |
| KCPHSD | Kern County Public Health Services Department |
| KCWA | Kern County Water Agency |
| KDWD | Kern Delta Water District |
| KGA | Kern Groundwater Authority |
| KRF | Kern River Formation |
| KRWCA | Kern River Watershed Coalition Authority |

| | |
|---|---|
| LAFCo | Local Agency Formation Commission |
| LCJA | Leadership Counsel for Justice and Accountability |
| LUST | Leaking Underground Storage Tank |
| M&I | municipal and industrial |
| MA | Management Area |
| MCL | Maximum Contaminant Level |
| MCWD | Mettler County Water District |
| meq/L | milliequivalents per liter |
| METRIC | Mapping EvapoTranspiration at high Resolution with Internalized Calibration |
| mg/L | milligrams per liter |
| MN | Monitoring Network |
| MND | Mitigated Negative Declaration |
| MO | Measurable Objective |
| MOA | Memorandum of Agreement |
| MOU | Memorandum of Understanding |
| MRP | Monitoring and Reporting Program |
| MT | Minimum Threshold |
| MWD | Metropolitan Water District |
| NASA | National Aeronautics and Space Administration |
| NCCAG | Natural Communities Commonly Associated with Groundwater |
| ND | Negative Declaration |
| NED | National Elevation Dataset |
| NEPA | National Environmental Policy Act |
| NHD | National Hydrography Dataset |
| NILP | North In-Lieu Project |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollution Discharge Elimination System |
| NRCS | National Resources Conservation Service |
| NWIS | National Water Information System |
| O&M | operations and maintenance |
| OCAP | Operations Criteria and Plan |
| PBP | Priority Basin Project |
| PLSS | Public Land Survey System |
| PWRPA | Power & Water Resources Pooling Authority |
| RMS | Representative Monitoring Site |
| RMSE | root-mean squared error |
| RP | Reference Point |
| RPE | reference point elevation |
| RRBWSD | Rosedale Rio-Bravo Water Storage District |
| RWA | Recovered Water Account |
| RWMP | Ranch-Wide Management Plan |
| SAGBI | Soil Agricultural Groundwater Banking Index |
| SAR | synthetic aperture radar |
| SB | Senate Bill |

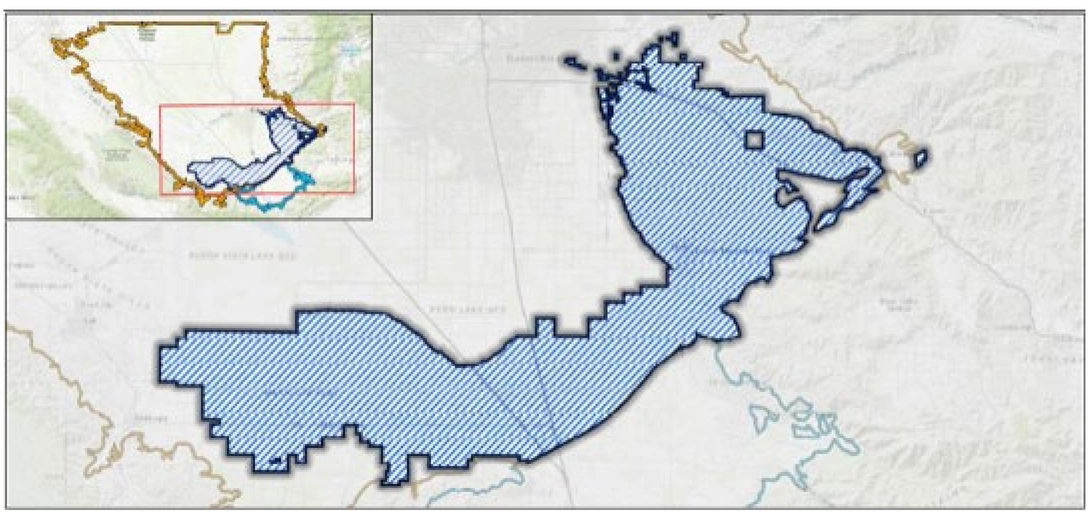
| | |
|---|---|
| SCEP | Stakeholder Communication and Engagement Plan |
| SDAC | Severely Disadvantaged Community |
| SDWA | Safe Drinking Water Act |
| SGMA | Sustainable Groundwater Management Act |
| SJRRP | San Joaquin River Restoration Project |
| SJVAPCD | San Joaquin Valley Air Pollution Control District |
| SMARA | Surface Mining and Reclamation Act |
| SMC | Sustainable Management Criteria |
| SOKR | South of Kern River |
| SSURGO | Soil Survey Geographic Database |
| SVOCs | semi-volatile organic compounds |
| SWP | State Water Project |
| SWRCB | State Water Resources Control Board |
| SWSA | Surface Water Service Area |
| SWSD | Semitropic Water Storage District |
| 1,2,3-TCP | 1,2,3-trichloropropane |
| TCCWD | Tehachapi-Cummings County Water District |
| TCWD | Tejon-Castac Water District |
| TDS | total dissolved solids |
| TNC | The Nature Conservancy |
| TOS | top of screen |
| TRC | Tejon Ranch Company |
| TUMSHCP | Tehachapi Uplands Multiple Species Habitat Conservation Plan |
| UCMR | Unregulated Contaminant Monitoring Rule |
| ug/L | micrograms per liter |
| UNAVCO | University Navstar Consortium |
| UR | Undesirable Result |
| URF | Unreleased Restoration Flows |
| USBR | United States Bureau of Reclamation |
| USDA | United States Department of Agriculture |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| UWMP | Urban Water Management Plan |
| VOCs | volatile organic compounds |
| WAPA | Western Areas Power Administration |
| WCR | Well Completion Report |
| WDR | Waste Discharge Requirement |
| WKWD | West Kern Water District |
| WMP | Water Management Plan |
| WRMWSD | Wheeler Ridge-Maricopa Water Storage District |
| WY | Water Year |

# EXECUTIVE SUMMARY

☑ 23 CCR § 354.4(a)

## ES.1. Introduction

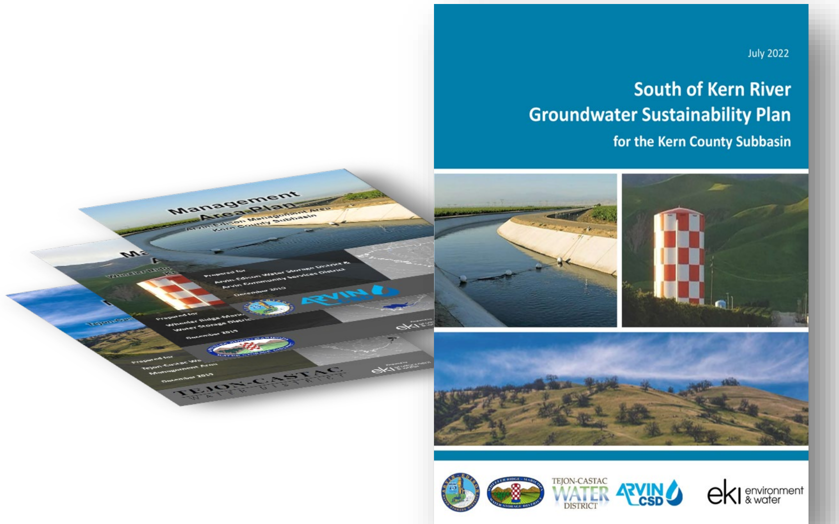
On 16 September 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) for the primary purpose of achieving and maintaining sustainability within the state's high and medium priority groundwater basins. Key tenets of SGMA are preservation of local control, use of best available data and science, and active engagement and consideration of all beneficial uses and users of groundwater. As such, SGMA empowers certain local agencies to form Groundwater Sustainability Agencies (GSAs) for the purpose of managing basins sustainably through the development and implementation of Groundwater Sustainability Plans (GSPs). Under SGMA, GSPs must contain certain elements, the most significant of which include: a Sustainability Goal; a description of the area covered by the GSP ("Plan Area"); a description of the Basin Setting, including hydrogeologic conceptual model, historical and current groundwater conditions, and a water budget; locally-defined sustainability criteria; monitoring networks and protocols for sustainability indicators; and a description of projects and/or management actions that will be implemented to achieve or maintain sustainability. SGMA also requires a stakeholder outreach plan to ensure that all beneficial uses and users of groundwater are given the opportunity to provide input into the GSP development and implementation process.



***SOKR GSP Plan Area***

The Kern County Subbasin (Department of Water Resources [DWR] Basin No. 5-022.14; referred to herein as the "Kern Subbasin" or "Basin") is one of 21 basins and subbasins identified by the DWR as being critically overdrafted, a designation that triggers an accelerated timetable for GSP development by 2020 and achievement of sustainability by 2040.

This South of Kern River (SOKR) GSP has been jointly prepared by the Arvin GSA, the Wheeler Ridge-Maricopa GSA, the Tejon-Castac Water District (TCWD) GSA, and Arvin Community Services District (ACSD) as an amended GSP (i.e., as a synthesis of three of the Management Area Plans that were originally submitted as part of the Kern Groundwater Authority GSP in January 2020) for submission to DWR in response to their 28 January 2022 letter entitled *Incomplete Determination of the 2020 Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Kern County Subbasin*. The SOKR GSP has been developed to meet SGMA regulatory requirements[1] while reflecting local needs and preserving local control over water resources. The SOKR GSP is coordinated with the other GSPs for the Basin to collectively comply with SGMA. Together, these documents (i.e., the six GSPS and the Coordination Agreement constituting the "Kern Subbasin Plan") provide a path to maintain the long-term sustainability of the Basin's groundwater resources now and into the future.




***The SOKR GSP Synthesizes Three Management Area Plans into a Single GSP that has been Coordinated with the other Basin GSPs***

It is recognized that additional, more recent data (i.e., through 2022) are available at the time of preparation of this amended SOKR GSP. However, as the SOKR GSP does not constitute a five-year update to a GSP, but rather a response to the DWR determination letter, those additional data are not incorporated herein, with minor exceptions.

## ES.2. Sustainability Goal

The Basin-wide Sustainability Goal adopted by all Basin GSAs, is as follows:

"The sustainability goal of the Kern County Subbasin is to:

- Achieve sustainable groundwater management in the Kern County Subbasin through the implementation of projects and management actions at the member agency level of each GSA
- Maintain its groundwater use within the sustainable yield of the basin.
- Operate within the established sustainable management criteria, which are based on the collective technical information presented in the GSPs in the Subbasin.
- Implement projects and management actions that include a variety of water supply development and demand management actions.

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

- Collectively bring the Subbasin into sustainability and to maintain sustainability over the implementation and planning horizon.

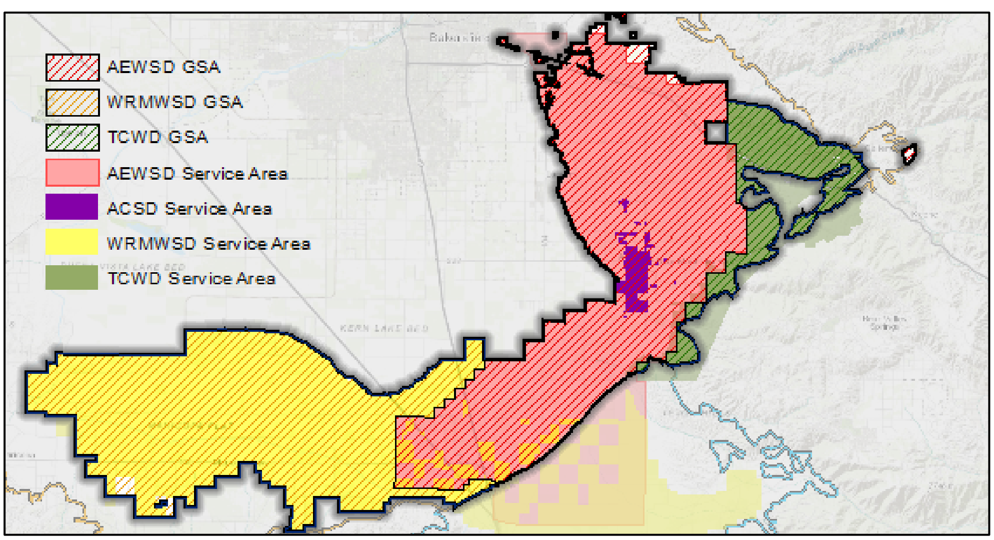
> Further, the sustainability goal includes a commitment to monitor and report groundwater conditions, as required by [the Sustainable Groundwater Management Act] SGMA, and to continue coordination among all GSAs in the [Basin] to identify the potential for, or presence of, undesirable results and actions to prevent undesirable results. The coordination process established in the development of this [Groundwater Sustainability Plan] GSP and memorialized in the Coordination Agreement will ensure that the [Basin] is managed as a shared groundwater resource and that the districts within the [Basin] work collaboratively towards achieving and maintaining sustainable groundwater use."

In addition, each SOKR GSA has developed a local Sustainability Goal to support SGMA implementation within their respective Management Areas.

## ES.3. Plan Area

The Arvin GSA, Wheeler Ridge-Maricopa GSA, TCWD GSA, and ACSD have entered into a Memorandum of Agreement (MOA) that establishes a governance structure for how the GSAs will cooperate and coordinate in exercising their authorities under SGMA to develop and implement a joint GSP, i.e. the SOKR GSP, that covers the collective area within their GSA boundaries, and in other matters related to sustainable groundwater management . Pursuant to the SOKR MOA, each agency has designated representatives to participate in the SOKR GSP Executive Committee which, with the support of the agencies' respective staff and consultants, is responsible for guiding the joint development and implementation of the SOKR GSP in a manner that is coordinated with the other Basin GSAs/GSPs to achieve sustainable groundwater management in accordance with SGMA and implementing regulations.

To facilitate the implementation of the SOKR GSP, the Plan Area is divided into three management areas that coincide with the portions of the Basin that underlie each SOKR GSA. These management areas, which together cover the entire SOKR GSP Area, include the Arvin-Edison Management Area, Wheeler Ridge-




***SOKR GSP Management Areas are Coincident with the GSA Areas***

Maricopa Management Area, and Tejon-Castac Management Area. Lands within the Arvin-Edison Water Storage District (AEWSD), Wheeler Ridge-Maricopa Water Storage District (WRMWSD) and TCWD service areas that are located outside the Kern Subbasin in the adjacent White Wolf Subbasin are managed under a separate GSP developed and adopted by the White Wolf GSA. Under the SOKR MOA, each GSA is responsible for implementing the SOKR GSP within its management area. In addition, the SOKR GSP Executive Committee may recommend measures to be implemented in the event insufficient or unsatisfactory progress is being made in implementing the GSP within the Plan Area to satisfy the requirements of the Act.

*Arvin-Edison Management Area*

The Arvin-Edison Management Area is located in the southeastern portion of the Kern Subbasin and encompasses 105,630 acres of the AEWSD service area that is not overlapped by the urbanized East Niles Community Services District (ENCSD); the area of overlap between AEWSD and ENCSD is managed under a separate GSP prepared by the Kern River GSA. Most lands within the Arvin-Edison Management Area are developed for irrigated agriculture, which use a combination of imported surface water provided by AEWSD and groundwater from AEWSD and/or private wells as water supply. AEWSD has a water supply contract with the Friant Division of the Central Valley Project and has invested considerably over the years in water management programs (additional supplies) and infrastructure to import, convey, recharge/recover, and distribute water to its customers and partners. Through its conjunctive management of water supplies, AEWSD has provided a substantial net benefit to groundwater conditions within its service area.

The City of Arvin (population of approximately 21,000) is located in the west-central portion of the Arvin-Edison Management Area and is served with municipal and industrial (M&I) water supply by ACSD. The source for this M&I water supply is local groundwater. Several other small public water systems exist within the Arvin-Edison Management Area, most serving small populations of residents/customers or employees at various industrial/food processing facilities. Several domestic wells are also understood to supply drinking water to rural residents. Most of the Arvin-Edison Management Area is designated by the United States Census Bureau as a Disadvantaged Community (DAC) or Severely Disadvantaged Community (SDAC). The City of Arvin is classified as an SDAC. The active participation of ACSD, whose customers are the residents of the City of Arvin, in the preparation of this SOKR GSP is just one way in which the interests of DACs have been considered herein.

*Wheeler Ridge-Maricopa Management Area*

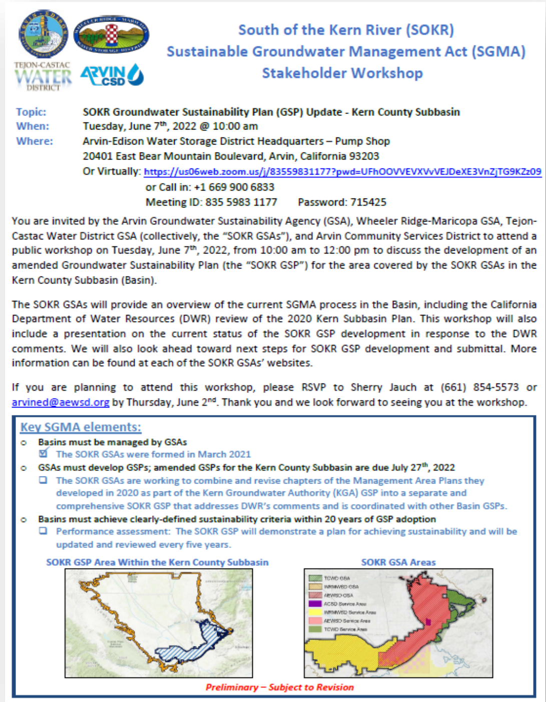
The Wheeler Ridge-Maricopa Management Area is located in the southern-southeastern portion of the Kern Subbasin and encompasses 91,430 acres of the WRMWSD service area. The Wheeler Ridge-Maricopa Management Area includes all WRMWSD lands within the Basin except for 2,809 acres that overlap the West Kern Water District (WKWD) and lands that overlap with the AEWSD service area. For purposes of SGMA monitoring and management, WRMWSD and AEWSD have agreed that the Arvin GSA will cover the overlap areas between the two districts.

Irrigated agriculture is the primary land use within the Wheeler Ridge-Maricopa Management Area, followed by idle/non-irrigated lands. Agricultural water demands are met with surface water imported by WRMWSD and/or groundwater depending on location within the Management Area. WRMWSD has a contract for 197,088 acre-feet per year (AFY) of Table A water from the State Water Project through the

Kern County Water Agency (KCWA) that is delivered to agricultural water users for irrigation within its surface water service area. The remainder of the Wheeler Ridge-Maricopa Management Area relies solely on groundwater to meet demands. The potable consumption of groundwater in the Wheeler Ridge-Maricopa Management Area is limited to a small number of domestic wells.

*Tejon-Castac Management Area*

The Tejon-Castac Management Area is located in the southeastern portion of the Kern Subbasin and encompasses approximately 19,280 acres of the TCWD service area. The Tejon-Castac Management Area is bounded to the west and north by the TCWD administrative/jurisdictional boundary and to the east and south by the boundaries of the Kern Subbasin and the White Wolf Subbasin, respectively. The Tejon-Castac Management Area is located directly to the east of the Arvin-Edison Management Area.



South of the Kern River (SOKR)
Sustainable Groundwater Management Act (SGMA)
Stakeholder Workshop

Topic: SOKR Groundwater Sustainability Plan (GSP) Update - Kern County Subbasin
When: Tuesday, June 7th, 2022 @ 10:00 am
Where: Arvin-Edison Water Storage District Headquarters – Pump Shop
20401 East Bear Mountain Boulevard, Arvin, California 93203
Or Virtually: https://us06web.zoom.us/j/83559831177?pwd=UFhOOVVEVXVvVEJDeXE3VnZjTG9KZz09
or Call in: +1 669 900 6833
Meeting ID: 835 5983 1177 Password: 715425

You are invited by the Arvin Groundwater Sustainability Agency (GSA), Wheeler Ridge-Maricopa GSA, Tejon-Castac Water District GSA (collectively, the "SOKR GSAs"), and Arvin Community Services District to attend a public workshop on Tuesday, June 7th, 2022, from 10:00 am to 12:00 pm to discuss the development of an amended Groundwater Sustainability Plan (the "SOKR GSP") for the area covered by the SOKR GSAs in the Kern County Subbasin (Basin).

The SOKR GSAs will provide an overview of the current SGMA process in the Basin, including the California Department of Water Resources (DWR) review of the 2020 Kern Subbasin Plan. This workshop will also include a presentation on the current status of the SOKR GSP development in response to the DWR comments. We will also look ahead toward next steps for SOKR GSP development and submittal. More information can be found at each of the SOKR GSAs' websites.

If you are planning to attend this workshop, please RSVP to Sherry Jauch at (661) 854-5573 or arvined@aewsd.org by Thursday, June 2nd. Thank you and we look forward to seeing you at the workshop.

Key SGMA elements:
- Basins must be managed by GSAs
  - ☑ The SOKR GSAs were formed in March 2021
- GSAs must develop GSPs; amended GSPs for the Kern County Subbasin are due July 27th, 2022
  - ☐ The SOKR GSAs are working to combine and revise chapters of the Management Area Plans they developed in 2020 as part of the Kern Groundwater Authority (KGA) GSP into a separate and comprehensive SOKR GSP that addresses DWR's comments and is coordinated with other Basin GSPs.
- Basins must achieve clearly-defined sustainability criteria within 20 years of GSP adoption
  - ☐ Performance assessment: The SOKR GSP will demonstrate a plan for achieving sustainability and will be updated and reviewed every five years.

SOKR GSP Area Within the Kern County Subbasin

SOKR GSA Areas

Preliminary – Subject to Revision

***The SOKR GSAs Hosted Multiple Public Forums where the SOKR GSP was Discussed***

Within the Tejon-Castac Management Area land cover is predominantly grassland/herbaceous with lesser amounts of shrub/scrub, and the predominant land use is livestock grazing. Groundwater is used to meet limited demands associated with domestic and industrial uses.

## ES.4. Stakeholder Outreach Efforts

A Stakeholder Communication and Engagement Plan (SCEP) was completed by each SOKR GSA to fulfill notice and communication requirements in order to achieve active engagement and input of beneficial users of groundwater within the SOKR GSP Area as part of SGMA implementation. The goal of the outreach efforts described in each SCEP is to encourage open and transparent engagement by diverse stakeholders. Public participation has been welcomed throughout the SOKR GSP development[2] and amendment process. Venues for stakeholder engagement and input have included: Stakeholder Workshops, the Board meetings of each SOKR GSA, and ACSD Board Meetings. Other SGMA-related outreach to SOKR GSP Area stakeholders has included: distribution and collection of a Stakeholder Survey and an Agriculture-specific Stakeholder Survey, various letters from the SOKR GSAs to landowners, and small group or one-on-one meetings between the staff of the SOKR GSAs and interested parties. The SOKR GSAs have also conducted extensive coordination with the other GSAs in the Kern Subbasin.

[2] In 2020 AEWSD, WRMWSD and TCWD developed Management Area Plans that were incorporated into the KGA GSP for the 2020 submittal after extensive public review and engagement. As part of the response to DWR comments, the three MAPs have been amended and synthesized into the SOKR GSP, which has also included a public engagement process.

## ES.5. Hydrogeologic Conceptual Model

The SOKR GSP Area is located in the southeastern portion of the Kern Subbasin, south of the Kern River. The Kern Subbasin occupies a large structural trough filled with thick sedimentary deposits of continental and marine origin. The "principal aquifer" is defined in the SOKR GSP Area as the aquifer materials encountered within the depths of production wells in the area and is comprised of fluvial and alluvial deposits of Miocene to Recent age. In the western portion of the SOKR GSP Area, a regional clay layer (the "E"-Clay) is found at intermediate depths and creates more confined conditions in the underlying sediments. Aquifer conditions in general are more unconfined to semi-confined in the shallower and eastern areas and more confined in the deeper and western areas. Several faults are present in the SOKR GSP Area, including the White Wolf Fault that forms the southern boundary of the Kern Subbasin and the Edison Fault near the northern boundary. Both faults appear to affect groundwater flow as evidenced by higher groundwater levels on their upgradient sides.

## ES.6. Existing Groundwater Conditions

Information on groundwater conditions within the SOKR GSP Area is presented with respect to the six "Sustainability Indicators" defined under SGMA, which include the following:

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

**Water Levels:** Groundwater levels within the SOKR GSP Area are presented using contour maps depicting recent (2015) seasonal high (spring) and seasonal low (fall) conditions, as well as hydrographs from representative wells throughout the SOKR GSP Area that have extended historical records. The available data indicate groundwater flow directions are generally from the surrounding uplands towards the Basin, from south to north across the White Wolf Fault, and from west to east in the west/central portion of the SOKR GSP Area. Relative highs and lows appear to be controlled, at least in part, by the distribution of groundwater pumping versus surface water deliveries. Depths to groundwater in spring 2015 range from approximately 150 to over 500 feet below ground surface (ft bgs), indicating that connections to surface water and the existence of groundwater dependent ecosystems (GDEs) are unlikely. Hydrographs show the long-term positive effects of AEWSD's and WRMWSD's surface water importation in raising groundwater levels, tempered by the effects of the recent severe droughts.

**Groundwater Storage:** Changes in groundwater storage over selected time periods of interest were analyzed by comparing water levels at the beginning and the end of several different periods, and also show the positive impacts of AEWSD's and WRMWSD's surface water importation and the variability caused by wet and dry climate periods. Spatially, the changes in storage are more positive in the Surface Water Service Areas within each Management Area compared to areas that rely solely on groundwater for supply.

**Water Quality:** Agricultural use is by far the dominant beneficial use within the SOKR GSP Area, and groundwater quality is generally suitable for agricultural uses. Drinking water is also a beneficial use, and in some instances nitrate, arsenic, total dissolved solids (TDS), sulfate, boron, iron and manganese have been detected in groundwater (legacy and naturally occurring) within or near the SOKR GSP Area at concentrations above drinking water standards and/or agricultural water quality goals. However, no relationship has been observed between water level trends (as a surrogate for groundwater recharge or pumping) and water quality. Monitoring efforts under the SOKR GSP will include routine collection of water quality data from wells within and adjacent to the SOKR GSP Area for periodic review and trend analysis to inform GSP implementation and other Basin-wide SGMA implementation efforts.

ACSD is actively addressing elevated arsenic levels in some of its production wells through its Arsenic Mitigation Project that involves rehabilitating and/or replacing impacted wells. ACSD also provides arsenic-free water from filling stations at selected locations and has installed a treatment system for a well impacted by a newly-regulated chemical, 1,2,3-Trichloropropane (1,2,3-TCP). Ongoing and future water quality monitoring efforts throughout the SOKR GSP Area will allow for further evaluation of these constituents and improve understanding of the potential nexus between groundwater levels and quality.

**Land Subsidence:** Some amount of land subsidence has been documented within the SOKR GSP Area over both historical and recent timeframes. Subsidence due to aquitard depressurization following groundwater withdrawal tends to be greater in the areas that rely solely on groundwater for water supply and are underlain by a greater proportion of fine-grained deposits. Subsidence has the potential to affect Regional Critical Infrastructure (i.e., the California Aqueduct) within the Wheeler Ridge-Maricopa Management Area and Management Area Critical Infrastructure including gravity-driven water conveyance systems (canals) within the Arvin-Edison Management Area. Subsidence and related impacts are being actively monitored and managed by the SOKR GSAs, in coordination with Basin-wide efforts.

**Interconnected Surface Waters:** Due to the great depth to groundwater in the principal aquifer (i.e., greater than 150 ft bgs in the Arvin-Edison and Wheeler Ridge-Maricopa Management Areas) and/or the undeveloped nature of the land uses (e.g., in the Tejon-Castac Management Area) available data indicate there are no interconnected surface water systems within the SOKR GSP Area that are or will be affected by groundwater extraction.

**Seawater Intrusion:** The SOKR GSP Area is located far from coastal areas. As a result, seawater intrusion is not considered to be an issue for this Basin and the SOKR GSP Area.

## ES.7. Water Budget

For the Kern Subbasin as a whole, the GSAs coordinated on two basin-wide water budget approaches: (1) development of a numerical model based on the California Central Valley Groundwater/Surface Water Simulation Model (C2VSim) to estimate the Basin-wide water budget, and (2) development of a "Checkbook" water accounting approach that estimates supply, demand, and shortages using certain management assumptions. In addition, on a local Management Area basis within the SOKR GSP Area, spreadsheet water budget models were developed and calibrated to observed water level/storage changes to provide locally-refined water budget information for all of the timeframes required by SGMA. Each water budgeting methodology includes data gaps and has varying degrees of accuracy and/or reliability. As part of SOKR GSP implementation, these methodologies and estimates will be refined as additional information is developed in accordance with the Basin Coordination Agreement.

The results of the Basin-wide model show that the Basin, as a whole, has a total storage deficit of approximately -324,326 AFY over the baseline period (i.e., 1994-2015). Based on application of the Checkbook approach, the SOKR GSAs (including associated un-districted "white" lands) collectively account for approximately -30,748 AFY of that baseline deficit.

Water budget information under projected (future) conditions was also developed using the calibrated spreadsheet water budget models, with DWR-provided inputs for climate variables (i.e., adjusted precipitation and evapotranspiration) and water supply assumptions (i.e., changes to imported water supplies). The projected water budget assesses the magnitude of the net water supply deficit under future conditions that would need to be addressed through Projects and Management Actions (P/MAs) to prevent Undesirable Results and achieve the Sustainability Goal. Consistent with the Basin-wide efforts, three projected water budget scenarios were developed for this analysis: a Baseline Scenario, a 2030 Climate Change Scenario, and a 2070 Climate Change Scenario. The projected deficit under the 2030 Climate Change Scenario (-52,130 AF) was used as the basis to develop P/MAs for the SOKR GSP Area.

| | Entire SOKR GSP Area | | |
|---|---|---|---|
| **Period / Scenario** | **Basin-wide Numerical Model** | **Local Analytical Spreadsheet Model** | **Basin-wide "Checkbook" Water Accounting Approach** |
| Historical Period (Water Year [WY] 1995 – 2014) | 9,594 | 7,325 | NA |
| Current Period (WY 2015) | -174,983 | -204,458 | NA |
| Projected Period (50 years; 2021 – 2070) Baseline w/o Projects | -2,747 | -10,080 | **-30,748** |
| Projected Period (50 years; 2021 – 2070) 2030 Climate Change w/o Projects | -10,870 | **-52,130** | NA |
| Projected Period (50 years; 2021 – 2070) 2030 Climate Change w/ Projects | 38,764 | 1,281 | NA |
| Projected Period (50 years; 2021 – 2070) 2070 Climate Change w/o Projects | -28,047 | -90,664 | NA |
| Projected Period (50 years; 2021 – 2070) 2070 Climate Change w/ Projects | NA | -930 | NA |

***The SOKR GSAs Have Identified Projects and Management Actions to Address the Projected Deficit***

## ES.8. Sustainable Management Criteria

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

- **Undesirable Results**: Undesirable Results are the significant and unreasonable occurrence of conditions, for any of the six Sustainability Indicators defined under SGMA, that adversely affect beneficial uses and users in the Basin. Definitions of Undesirable Results for the Basin have been developed through a coordinated effort of the Basin GSAs.

- **Minimum Thresholds**: Minimum Thresholds (MTs) are the numeric criteria for each Sustainability Indicator that, if exceeded in a locally defined combination of monitoring sites, may constitute an Undesirable Results for that indicator. Where appropriate, the MTs for the Sustainability Indicators have been set using groundwater levels as a proxy.
- **Measurable Objectives:** Measurable Objectives (MOs) are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions. MOs use the same units and metrics as the MTs and are thus directly comparable.
- **Interim Milestones**: Interim Milestones are a set of target values representing measurable groundwater conditions in increments of five (5) years over the 20-year statutory deadline for achieving sustainability.

Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator for the SOKR GSP, as it influences several other key Sustainability Indicators, including Reduction of Groundwater Storage and Land Subsidence. The SMCs for Chronic Lowering of Groundwater Levels were developed through temporal analysis of long-term groundwater level data at representative wells with long-term records and generalized into zones. These generalized MTs were evaluated against known well depths to assess potential impacts on local beneficial users (i.e., potential dewatering of shallow wells with attendant mitigation procedures). The process for developing the MTs and MOs and the results were presented on multiple occasions in public meetings to allow for stakeholder input.

Significant Groundwater Storage exists within the SOKR GSP Area, and it is estimated that it would take decades of zero recharge to deplete the usable storage under current extraction rates. As such, it was determined to be sufficiently protective to define the SMCs for Reduction of Groundwater Storage based on the use of SMCs for Chronic Lowering of Groundwater Levels as a proxy.

Following a systematic approach to identify constituents warranting SMCs for Degraded Water Quality, SMCs are defined for arsenic at ten water quality representative monitoring sites (RMS) in the Arvin-Edison Management Area, including three RMS from the ACSD public supply well network (Wells #14, #16, and #17), and at nine water quality RMS within the Wheeler Ridge-Maricopa Management Area. The SMCs are tied to regulatory water quality standards – the MT is set at either the California Maximum Contaminant Level (MCL) of 10 micrograms per liter (ug/L) arsenic, or for wells already in exceedance of the MCL at the SGMA-effective date, at the pre-SGMA baseline arsenic concentration plus 5 ug/L. The MO is set to 75% of the MCL (7.5 ug/L) at the three RMS within the ACSD well network, and for all other RMS the MO is set at the MCL or the pre-SGMA baseline arsenic concentrations, whichever is greater. Degraded Water Quality SMCs were not defined for the Tejon-Castac Management Area, as water quality is not a concern for the agricultural and industrial use of the single well with significant pumping. Numerous other regulatory programs address water quality, in addition to SGMA (e.g., Irrigated Lands, CVSALTS, etc.). Further, a causal nexus between measured constituent concentrations and water levels and groundwater management actions within the Management Areas has not been established based on available data. On-going monitoring for all potential constituents of concern will continue, and if a nexus between these constituent concentrations and water levels and groundwater management actions is established, then the SMCs for water quality will be revisited.

SMCs for Land Subsidence are defined with consideration of Regional and Management Area Critical Infrastructure within the SOKR GSP area. In the Arvin-Edison Management Area, SMCs are based on observed rates of subsidence from ground-based surveys collected along AEWSD's canal, recharge basin, and well infrastructure between 2014 and 2018. The MT defined as the extent of subsidence, in inches, that would occur if the maximum observed subsidence rate between 2014 – 2018 were to continue through 2040, and the MO is defined as the amount of land subsidence that would occur if the maximum observed subsidence rates (2014 – 2018) were to continue through 2030 and then cease. The rationale is that such subsidence has been historically managed by AEWSD through maintenance and improvements to its facilities (e.g., increasing additional freeboard to its canals), and AEWSD could likely continue to manage/mitigate further subsidence if it were to occur at similar or lower rates. Within the Wheeler Ridge-Maricopa Management Area, land subsidence SMCs are defined with consideration of historical and recent subsidence rates measured by DWR along the California Aqueduct. MTs are defined as the extent of subsidence that would cause a 75 percent (%) reduction in available freeboard above the DWR's design criterion for lined freeboard height, based on averages of monitoring benchmark points within each Aqueduct pool. The MO is defined as a subsidence extent that is half of the MT extent, and based on a decelerating rate of subsidence reaching zero by 2040. Within the Tejon-Castac Management Area, because subsidence has not been an issue historically and there is no significant groundwater development other than a single agricultural/industrial well, land subsidence is unlikely to occur and no SMCs are currently defined. A basin-wide subsidence monitoring program is also being developed and will be implemented.

As discussed above, Depletion of Interconnected Surface Water has not been observed within the SOKR GSP Area and is not applicable due to the great depths to groundwater in the principal aquifer. Likewise, Seawater Intrusion does not exist within the Kern Subbasin. Therefore, consistent with the rest of the Basin, no SMCs for these Sustainable Indicators are defined in the SOKR GSP.

Based on the available data, groundwater conditions within the SOKR GSP Area have been maintained above the respective SMCs, indicative of sustainable management and absence of Undesirable Results.

## ES.9. Monitoring Network

The objective of the SGMA Monitoring Networks defined in the SOKR GSP is to (continue to) collect sufficient data to allow for assessment of the Sustainability Indicators relevant to the SOKR GSP Area, and potential impacts to the beneficial uses and users of groundwater. The proposed SGMA Monitoring Network was developed to ensure sufficient spatial distribution and spatial density. In the Arvin-Edison Management Area, the SGMA network consists of 16 representative monitoring sites (RMS) for groundwater levels and (by proxy) groundwater storage, ten (10) RMS for monitoring groundwater quality, and five (5) RMS for monitoring land subsidence. In the Wheeler Ridge-Maricopa Management Area, the SGMA network consists of 14 RMS for groundwater levels and (by proxy) groundwater storage, nine (9) RMS for monitoring groundwater quality, and 40 RMS for monitoring land subsidence. In the Tejon-Castac Management Area, the SGMA network consists of one RMS for groundwater levels and (by proxy) groundwater storage.

The SGMA Monitoring Networks for the SOKR GSP Area supplement other monitoring networks and programs in the Basin such as DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) program, Irrigated Lands Regulatory Program (ILRP), Central Valley-Salinity Alternatives for Long-term Sustainability (CV-SALTS), KCWA semiannual groundwater monitoring program, etc., and Basin-wide monitoring networks related to SGMA compliance such as the Basin's land subsidence network.

Data collected from the SGMA Monitoring Networks for the SOKR GSP Area will be uploaded to the Data Management System (DMS) maintained for the Basin and reported to the DWR in accordance with the Monitoring Protocols developed for the Basin as described in the Coordination Agreement. In addition, local data will be stored and managed in the local Management Area-specific DMSs that are maintained by each GSA. Additional data collected as part of AEWSD's, WRMWSD's, TCWD's and ACSD's other regular monitoring programs may be used in conjunction with data collected from the SGMA Monitoring Networks to comply with GSP Emergency Regulations regarding Annual Reporting or as otherwise deemed necessary or appropriate for the SOKR GSP Area.

## ES.10. Projects and Management Actions

Achieving sustainability in the SOKR GSP Area will require implementation of P/MAs to address projected water budget deficits that contribute to groundwater level and storage declines and land subsidence, and also to address water quality impacts. As such, the SOKR GSAs have developed a portfolio of P/MAs, each with specific expected benefits, implementation triggers, and costs. A preliminary "glide path" has been developed that will result in closing the baseline and projected "deficits"[3] of approximately -30, 748 AFY and -52,130 AFY by 2040, respectively.

Accelerated implementation of P/MAs could be triggered if MTs for Chronic Lowering of Groundwater Levels are exceeded in more than 20% of RMS defined within the Arvin-Edison and Wheeler-Ridge Management Areas or at the one RMS defined within the Tejon-Castac Management Area.

The supply augmentation and demand reduction P/MAs identified by the SOKR GSAs comprise a diverse portfolio of options that can be implemented as necessary to achieve sustainability from a total water quantity and water quality perspective. Simulation results from the projected P/MAs across the Basin utilizing the Basin-wide numerical model indicate that P/MA implementation along the planned glide path will successfully achieve sustainability and avoid Undesirable Results for Groundwater Levels (and by proxy for the other applicable Sustainability Indicators) throughout the SOKR GSP Area.

***The SOKR GSAs are Actively Implementing the P/MAs Identified in the SOKR GSP***

The implementation glide path identified by the SOKR GSAs provides a general guide to how quickly these benefits are to be realized. To date the SOKR GSAs have taken action on multiple P/MAs (e.g., development of new recharge basins), however, the exact schedule and order of

[3] The net deficit to be addressed by the 2040 GSP implementation deadline is the estimated deficit under the 2030 Climate Change scenario.

implementation for the others has yet to be determined. Further analysis will be conducted to prioritize the P/MAs in consideration of factors including permitting, engineering feasibility, cost effectiveness, need to prevent particular Undesirable Results, funding opportunities, etc. In general, P/MAs being considered for implementation will be discussed during regular Board Meetings of each SOKR GSA, which are noticed and open to the public. Additional stakeholder outreach efforts will be conducted prior to and during P/MA implementation, as required by law.

## ES.11. GSP Implementation

Key SOKR GSP implementation activities that will be performed by the SOKR GSAs through 2025 include:

- Monitoring and data collection;
- P/MA prioritization and implementation;
- Policy development to support GSP implementation;
- Technical and non-technical coordination with other water management entities in the Basin;
- Continued outreach and engagement with stakeholders;
- Annual reporting;
- Enforcement and response actions, as necessary; and
- Evaluation and updates, as necessary, of the SOKR GSP as part of the required periodic evaluations (i.e., "five-year updates").

Collectively, the GSP Implementation Activities described herein demonstrate the SOKR GSAs have been actively implementing specific P/MAs, policies, and programs to sustainably manage groundwater resources for all beneficial uses and users of groundwater and continue to meet the Sustainability Goal defined for their respective Management Areas within the Basin.

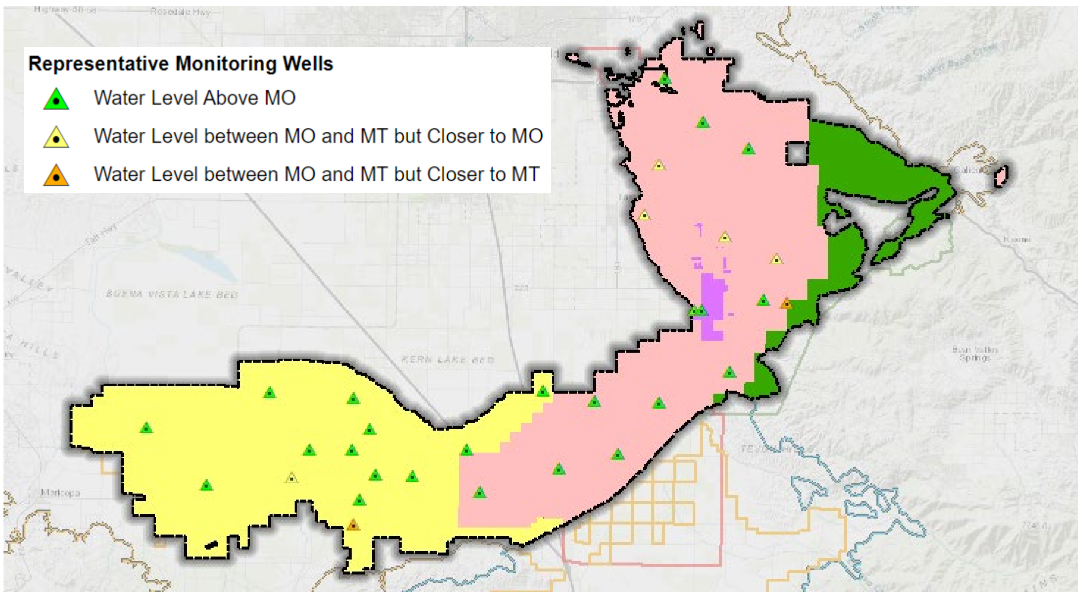
## ES.12. GSP Implementation Costs and Funding

Costs to implement the SOKR GSP can be divided into three categories, as follows:

- Costs of local groundwater management activities within each Management Area;
- Each of the SOKR GSAs' proportional share of costs for Basin-wide groundwater management activities; and
- Costs to implement P/MAs, including capital/one-time costs and ongoing costs.

Sources of funding for SGMA compliance activities will include primarily regular fees and assessments from customers and rate payers. This primary source of revenue will be supplemented to the greatest extent possible through loans and grants, and possibly by imposition of additional fees to further incentivize demand management practices. Any actions to establish fees or charges will be undertaken pursuant to applicable laws and regulations (e.g., Proposition 218 and related laws). Conclusion

The passage of SGMA in 2014 ushered in a new era of mandatory groundwater management in California's most intensively used groundwater basins. The law was followed by promulgation of a robust regulatory framework for GSA formation and GSP development and implementation. The law and regulations emphasize the use of best available science, local control and decision making, and active engagement of affected stakeholders. Given the magnitude of the groundwater management issues facing California, and the relative speed and broad scope of recent legislative and administrative actions taken to address those issues, implementing SGMA presents significant challenges for local agencies and groundwater users alike. Achieving and maintaining sustainability in the face of uncertain future water supply conditions while addressing and balancing the needs of all beneficial uses and groundwater users will require significant effort, creative solutions, and unprecedented collaboration. As the implementing agencies within the SOKR GSP Area, the Arvin GSA, Wheeler Ridge-Maricopa GSA, TCWD GSA and ACSD are committed to working together to address these challenges in a manner that protects the interests of local landowners and constituents, in close coordination with other Basin GSAs. Based on the available data, groundwater conditions within the SOKR GSP Area have been maintained above the respective SMCs, indicating sustainable management and avoidance of Undesirable Result




***Recent Groundwater Level Data (Spring 2021) Indicates that the SOKR GSP Area Continues to Achieve Sustainable Management.***

# INTRODUCTION

# 1. PURPOSE OF THE GROUNDWATER SUSTAINABILITY PLAN

The purpose of this South of Kern River Groundwater Sustainability Plan (SOKR GSP) is to meet the requirements set forth in the three-bill legislative package consisting of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA).[4] 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." Undesirable results are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout the basin:

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

The Kern County Subbasin (referred to herein as the "Kern Subbasin" or "Basin") has been identified by the California Department of Water Resources (DWR) as critically overdrafted. This SOKR GSP[5] Management Area Plans developed by the Arvin Groundwater Sustainability Agency (GSA), Wheeler Ridge-Maricopa GSA, and Tejon-Castac Water District (TCWD) GSA (collectively referred to as the "SOKR GSAs") and Arvin Community Service District (ACSD), to meet the requirements of SGMA and implementing regulations while reflecting local needs and interests and preserving local control over water resources.

As described in ***Section 5 Description of the Plan Area*** and ***Section 10 Management Areas***, and shown on ***Figure PA-2***, the SOKR GSP includes three Management Areas – the Arvin-Edison Management Area, the Wheeler Ridge-Maricopa Management Area and the Tejon-Castac Management Area – which are coincident with the respective GSA boundaries. These Management Areas were formerly included in the Kern Groundwater Authority (KGA) GSP. The SOKR GSP, in coordination with the other GSPs in the Basin (collectively the Kern Subbasin Plan), provides a path to achieve and document sustainable groundwater

[4] Nothing in this Management Area Plan or in the related Groundwater Sustainability Plan determines or alters surface water rights or groundwater rights under common law, any provision of law that determines or grants surface water rights, or otherwise (see, CWC § 10720.5(b)). This Management Area Plan and the related Groundwater Sustainability Plan shall be construed consistent with Section 2 of Article X of the California Constitution, and nothing provided in this Chapter modifies rights or priorities to use or store groundwater except as expressly stated in CWC § 10720.5(a). The District reserves and retains all rights to the use of water to the extent provided by law.

[5] As part of the 2020 submission, AEWSD/ACSD, WRMWSD and TCWD had prepared Management Area Plans (MAPs) that were included in the Kern Groundwater Authority GSP. As part of the revisions made in response to DWR's comments, these MAPs have been amended and combined into the South of Kern River GSP. The KGA GSP has similarly been amended to exclude reference to the AEWSD/ACSD, WRMWSD and TCWD MAPs.

management within 20 years following Plan adoption, and preserves the long-term sustainability of locally managed groundwater resources now and into the future.

The SOKR GSP was approved by Arvin GSA on XX July 2022, by Wheeler Ridge-Maricopa GSA on XX July 2022, and by TCWD GSA on XX July 2022 as an amended GSP for submission to DWR in response to their 28 January 2022 letter entitled *Incomplete Determination of the 2020 Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Kern County Subbasin* (**Appendix N**). It is recognized that additional, more recent data (i.e., through 2022) are available at the time of preparation of this amended SOKR GSP. However, as the SOKR GSP does not constitute an updated GSP, but rather a response to the DWR determination letter, those additional data are not incorporated herein, with minor exceptions.

Since January 2022, the three SOKR GSAs have participated in numerous Basin-wide coordination efforts to develop a coordinated response to DWR's comments. Basin-wide coordination efforts have included the following:

- Weekly meetings of Basin GSA managers and GSA member entities;
- Basin Coordination Committee meetings with GSA representatives;
- Policy Committee meetings; and,
- Consultation meetings with DWR.

Specific revisions to each former Management Area Plan, as part of the synthesis into the SOKR GSP and response to DWR determination letter are summarized below.

### 1.1.1. Arvin GSA

The following revisions to the original Arvin-Edison Management Area Plan have been made in developing the SOKR GSP to address the deficiencies DWR identified in its evaluation of the five GSPs submitted for the Basin in 2020, and in an effort to improve overall Basin coordination efforts.

**Deficiency #1 – The [Basin] GSPs Do Not Establish Undesirable Results that are Consistent for the Entire Subbasin**

- Updated Local Undesirable Results Criteria (i.e., Trigger) for each applicable Sustainability Indicator to be consistent with Basin-wide definitions.
- Developed a Minimum Threshold Exceedance Policy in coordination with other GSAs in the Basin (see **Section 18**).

**Deficiency #2 – The [Basin] Plan Does Not Set Minimum Thresholds for Chronic Lowering of Groundwater Levels in a Manner Consistent with the Requirements of SGMA and the GSP Regulations**

- Clearly identified Beneficial Users for each applicable Sustainability Indicator in the Undesirable Results section (see **Section 13**).
- For each applicable Sustainability Indicator, clearly identified its relationship with other Sustainability Indicators, potential impact(s) to adjacent Management Areas within the Basin and outside of the Basin, potential impact(s) to Beneficial Users, State/Federal/Local standards, and measurement of Minimum Thresholds (MTs), as shown in ***Table SMC-2***.

- For Degraded Water Quality, added California Water Code (CWC) § 10727.2 reference[6] to the justification of Local Undesirable Results Criteria, as shown in ***Table SMC-2***.
- Expanded discussion of the Sustainable Management Criteria (SMC) development process for Degraded Water Quality, including the screening process for selecting the constituents of concern for which SMC were developed; added a figure that illustrates the screening process.
- Defined additional Water Quality SMCs for arsenic at ten Representative Monitoring Wells (RMS), including seven RMS within Arvin-Edison Water Storage District (AEWSD) and three ACSD Wells (ACSD Wells #14, #16 and #17), as shown in ***Table SMC-2***. In the original Arvin-Edison Management Area Plan, Water Quality SMC for arsenic were only defined at ACSD Well #14.
- Expanded discussion of the data and methodologies used to conduct the Well Impacts Analysis.
- For Chronic Lowering of Groundwater Levels, added a well age analysis to the justification of Local Undesirable Results Criteria.
- Expanded the description of the Impacted Well Mitigation Program, including a timeline for implementation, scope of the program, and how user impacts caused by continued groundwater level decline early in GSP implementation will be addressed.

**Deficiency #3 – The [Basin] Plan's Land Subsidence Sustainable Management Criteria Do Not Satisfy the Requirements of SGMA and the GSP Regulations**

- Added ***Figure SMC-29*** showing the GSP areas relative to Regional Critical Infrastructure within the Basin as identified by the KGA GSA. As shown in ***Figure SMC-29***, Regional Critical Infrastructure located within the Arvin-Edison Management Area includes AEWSD's canal and a high-pressure gas pipeline. There is also a railroad which the Basin GSAs have determined does not warrant further consideration (i.e., Basin is focused on the California Aqueduct and the Friant Kern Canal).
- Added ***Figure GWC-34*** showing the Arvin-Edison Management Area relative to the Interferometric Synthetic Aperture Radar (InSAR) data that represents total vertical ground surface displacement between 2015 and 2021. As shown in ***Figure SMC-29***, both historical and recent subsidence data indicate there has been notable inelastic subsidence within the Arvin-Edison Management Area, particularly east of the City of Arvin.
- Added description of Basin-wide subsidence information to both ***Table SMC-2*** and in text.
- Added description about the Arvin-Edison Management Area participating in the Subsidence Study and Basin Study being coordinated by the KGA.

**Additional Revisions**

- Described the formation of Arvin GSA.
- Defined the new SOKR GSP area that includes the Arvin-Edison Management Area, Wheeler Ridge-Maricopa Management Area, and Tejon-Castac Management Area and associated governance.

[6] Per CWC § 10727.2, GSAs only need to address degradation of water quality caused by groundwater management (i.e., extraction and recharge) in the basin, and are not required to address URs that occurred before January 1, 2015. As such, it is not under the purview of the GSA to regulate several "legacy" constituents of concern.

- Added description that AEWSD successfully organized and held election under Proposition 218 to fund administration and project service charges, including commitment to the Arvin-Edison Management Area's Projects and Management Actions (PMAs).
- Added description of progress towards the implementation of several of the planned PMAs, including construction of the Sunset Spreading Works and completion of CEQA/NEPA for the Eastside Canal Intertie.
- Added "demonstration of sustainability" to demonstrate that continued proactive sustainable management of groundwater is occurring in the Arvin-Edison Management Area.

### 1.1.2. Wheeler Ridge-Maricopa GSA

The following revisions to the original Wheeler Ridge-Maricopa Management Area Plan have been made in developing the SOKR GSP to address the deficiencies DWR identified in its evaluation of the five GSPs submitted for the Basin in 2020, and in an effort to improve overall Basin coordination efforts.

**Deficiency #1 – The GSPs Do Not Establish Undesirable Results that are Consistent for the Entire Subbasin**

- Updated Local Undesirable Results Criteria (i.e., Trigger) for each applicable Sustainability Indicator to be consistent with Basin-wide definitions.
- Developed a Minimum Threshold Exceedance Policy in coordination with other GSAs in the Basin (see **Section 18**).

**Deficiency #2 – The Plan Does Not Set Minimum Thresholds for Chronic Lowering of Groundwater Levels in a Manner Consistent with the Requirements of SGMA and the GSP Regulations**

- Clearly identified Beneficial Users for each applicable Sustainability Indicator in the Undesirable Results section (see **Section 13**).
- For each applicable Sustainability Indicator, clearly identified its relationship with other Sustainability Indicators, potential impact(s) to adjacent Management Areas within the Basin and outside of the Basin, potential impact(s) to Beneficial Users, State/Federal/Local standards, and measurement of MTs, as shown in ***Table SMC-3***.
- For Degraded Water Quality, added CWC § 10727.2 reference[7] to the justification of Local Undesirable Results Criteria, as shown in ***Table SMC-3***.
- Expanded discussion of the SMC development process for Degraded Water Quality, including the screening process for selecting the constituents of concern for which SMC were developed; added a figure that illustrates the screening process.
- Defined Water Quality SMCs for arsenic at the nine (9) water quality RMS designated for the Wheeler Ridge-Maricopa Management Area, as shown in ***Table SMC-3***. In the original Wheeler Ridge-Maricopa Management Area Plan, no Water Quality SMCs were defined and Wheeler Ridge-

[7] Per CWC § 10727.2, GSAs only need to address degradation of water quality caused by groundwater management (i.e., extraction and recharge) in the basin, and are not required to address URs that occurred before January 1, 2015. As such, it is not under the purview of the GSA to regulate several "legacy" constituents of concern.

Maricopa Water Storage District (WRMWSD) had only committed to "voluntary" monitoring for water quality constituents of concern (COCs) at these sites.

- Expanded discussion of the data and methodologies used to conduct the Well Impacts Analysis.
- For Chronic Lowering of Groundwater Levels, added a well age analysis to the justification of Local Undesirable Results Criteria.
- Expanded the description of the Impacted Well Mitigation Program, including a timeline for implementation, scope of the program, and how users impacted by continued groundwater level decline early in GSP implementation will be addressed.

**Deficiency #3 – The Plan's Land Subsidence Sustainable Management Criteria Do Not Satisfy the Requirements of SGMA and the GSP Regulations**

- Added ***Figure SMC-29*** showing the GSP areas relative to Regional Critical Infrastructure within the Basin as identified by the KGA GSA. As shown in ***Figure SMC-29***, Regional Critical Infrastructure located within the Wheeler Ridge-Maricopa Management Area is the California Aqueduct and several high-pressure gas pipelines which the Basin GSAs have determined do not warrant further consideration (i.e., Basin is focused on the California Aqueduct and the Friant Kern Canal).
- Added ***Figure GWC-34*** showing the Wheeler Ridge-Maricopa Management Area relative to the InSAR data that represents total vertical ground surface displacement between 2015 and 2021. As shown in ***Figure SMC-29***, both historical and recent subsidence data indicate there has been notable inelastic subsidence within the Wheeler Ridge-Maricopa Management Area, particularly north of the California Aqueduct.
- Updated definition of Land Subsidence SMCs within the Wheeler Ridge-Maricopa Management Area for RMS along that California Aqueduct so that Undesirable Results (URs) and MTs are now (1) defined at the Aqueduct pool level (as opposed to at individual DWR benchmark survey locations), and (2) tied to remaining available freeboard within each Aqueduct pool.
- Added description of Basin-wide subsidence information to both ***Table SMC-3*** and in GSP text.
- Added description about the Wheeler Ridge-Maricopa Management Area participating the Subsidence Study and Basin Study being coordinated by the KGA.

**Additional Revisions**

- Described formation of Wheeler Ridge-Maricopa GSA.
- Defined the new SOKR GSP area that includes the Arvin-Edison Wheeler Ridge-Maricopa Management Area, Wheeler Ridge-Maricopa Wheeler Ridge-Maricopa Management Area, and Tejon-Castac Wheeler Ridge-Maricopa Management Area and associated governance.
- Added description of progress towards the implementation of several of the planned PMAs, including the increase in out-of-district banking operations, implementation of demand reduction measures including land repurposing initiatives, participation in the Delta Conveyance Project, and acreage assessments.

- Added "demonstration of sustainability" to demonstrate that continued proactive sustainable management of groundwater is occurring in the Wheeler Ridge-Maricopa Management Area.

### 1.1.3. TCWD GSA

The following revisions to the original TCWD Management Area Plan have been made in developing the SOKR GSP to address the deficiencies DWR identified in its evaluation of the five GSPs submitted for the Basin in 2020, and in an effort to improve overall Basin coordination efforts.

**Deficiency #1 – The GSPs Do Not Establish Undesirable Results that are Consistent for the Entire Subbasin**

- Updated Local Undesirable Results Criteria (i.e., Trigger) for each applicable Sustainability Indicator to be consistent with Basin-wide definitions.
- Developed a Minimum Threshold Exceedance Policy in coordination with other GSAs in the Basin (see **Section 18)**.

**Deficiency #2 – The Plan Does Not Set Minimum Thresholds for Chronic Lowering of Groundwater Levels in a Manner Consistent with the Requirements of SGMA and the GSP Regulations**

- Clearly identified Beneficial Users for each applicable Sustainability Indicator in the Undesirable Results section (see **Section 13**).
- For each applicable Sustainability Indicator, clearly identified its relationship with other Sustainability Indicators, potential impact(s) to adjacent Management Areas within the Basin and outside of the Basin, potential impact(s) to Beneficial Users, State/Federal/Local standards, and measurement of MTs, as shown in ***Table SMC-4***.
- For Degraded Water Quality, added CWC § 10727.2 reference[8] to the justification of Local Undesirable Results Criteria, as shown in ***Table SMC-4***.
- Expanded discussion of the SMC development process for Degraded Water Quality, including the screening process for selecting the constituents of concern for which SMC were developed; added a figure that illustrates the screening process.
- For Chronic Lowering of Groundwater Levels, added a well impacts analysis and well age analysis to the justification of Local Undesirable Results Criteria.
- For Chronic Lowering of Groundwater Levels, reiterated that the MT is based on the approximate average historical low value for wells within the Arvin-Edison Management Area nearest to the Tejon-Castac Management Area Representative Monitoring Site, and therefore uses the same justification as the Arvin-Edison Management Area for the avoidance of Undesirable Results.

[8] Per CWC § 10727.2, GSAs only need to address degradation of water quality caused by groundwater management (i.e., extraction and recharge) in the basin, and are not required to address URs that occurred before January 1, 2015. As such, it is not under the purview of the GSA to regulate several "legacy" constituents of concern.

**Deficiency #3 – The Plan's Land Subsidence Sustainable Management Criteria Do Not Satisfy the Requirements of SGMA and the GSP Regulations**

- Added ***Figure SMC-29*** showing the GSP areas relative to Regional Critical Infrastructure within the Basin as identified by the KGA GSA. As shown in ***Figure SMC-29***, Regional Critical Infrastructure located within the Tejon-Castac Management Area is a railroad, which the Basin GSAs have determined does not warrant further consideration (i.e., Basin is focused on the California Aqueduct and the Friant Kern Canal).
- Added ***Figure GWC-34*** showing the Tejon-Castac Management Area relative to the InSAR data that represents total vertical ground surface displacement between 2015 and 2021. As shown in ***Figure SMC-29***, both historical and recent subsidence data indicate that there has not been significant inelastic subsidence within the Management Area Plan area. Further, there is no Management Area -level critical infrastructure. As such, the data indicate that they are not at risk given the low level of subsidence observed over the historical record (1949-2021).
- Reiterated the argument that subsidence is not a relevant Sustainability Indicator for the Management Area, but a Basin-level issue in this portion of the Basin.
- Added description of Basin-wide subsidence information to both ***Table SMC-4*** and in text. Reiterated that subsidence is not an issue because: 1) there is no record of historical subsidence, and 2) there is no critical infrastructure within the Management Area.
- Added description about the Tejon-Castac Management Area participating the Subsidence Study and Basin Study being coordinated by the KGA.

**Additional Revisions**

- Described formation of TCWD GSA.
- Defined the new SOKR GSP area that includes the Tejon-Castac Management Area, Wheeler Ridge-Maricopa Management Area, and Arvin-Edison Management Area and associated governance.
- Added description of progress towards the implementation of planned PMAs, including a progress update regarding the carrot wash water recharge PMA.
- Added "demonstration of sustainability" to demonstrate that continued proactive sustainable management of groundwater is occurring in the Tejon-Castac Management Area.

## 2. SUSTAINABILITY GOAL

☑ **23 CCR § 354.24**

The basin-wide sustainability goal being adopted by all Groundwater Sustainability Agencies (GSAs) in the Kern County Subbasin (Basin), is as follows:

> "The sustainability goal of the Kern County Subbasin is to:
>
> - Achieve sustainable groundwater management in the Kern County Subbasin through the implementation of projects and management actions at the member agency level of each GSA
> - Maintain its groundwater use within the sustainable yield of the basin.
> - Operate within the established sustainable management criteria, which are based on the collective technical information presented in the GSPs in the Subbasin.
> - Implement projects and management actions that include a variety of water supply development and demand management actions.
> - Collectively bring the Subbasin into sustainability and to maintain sustainability over the implementation and planning horizon.
>
> Further, the [Basin] sustainability goal includes a commitment to monitor and report groundwater conditions, as required by [the Sustainable Groundwater Management Act] SGMA, and to continue coordination among all GSAs in the [Basin] to identify the potential for, or presence of, undesirable results and actions to prevent undesirable results. The coordination process established in the development of this [Groundwater Sustainability Plan] GSP and memorialized in the Coordination Agreement will ensure that the [Basin] is managed as a shared groundwater resource and that the districts within the [Basin] work collaboratively towards achieving and maintaining sustainable groundwater use."

Additionally, consistent with this Basin-level Sustainability Goal, each South of Kern River (SOKR) GSA has defined a local, complementary Sustainability Goal for their respective Management Areas, as detailed below:

- The Sustainability Goal for the **Arvin-Edison Management Area** is to maintain an economically-viable groundwater resource that supports the current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental) by utilizing the area's groundwater resources within the local sustainable yield. Long-term groundwater sustainability will be evaluated and maintained in compliance with locally-defined sustainability criteria. The Management Area will remain in compliance through the continued importation of surface water as well as implementation of projects and management actions to both increase water supplies and reduce demands within the Management Area. The District's historical efforts to achieve a balanced and sustainable water supply for all lands, including to both the Surface Water Service Area and the Groundwater Service Area, and in an equitable manner, will continue under SGMA.

- The sustainability goal for the **Wheeler Ridge-Maricopa Management Area** is to maintain an economically-viable groundwater resource for the beneficial use of the Management Area's landowners and water users by utilizing the area's groundwater resources within the local sustainable yield. Long-term groundwater sustainability, i.e., the absence of undesirable results within 20 years of the applicable statutory deadline, will be achieved and maintained through the implementation of projects and management actions as described herein to both increase water supplies and reduce demands within the Management Area.

- The Sustainability Goal for the **Tejon-Castac Management Area** is to maintain an economically-viable groundwater resource that supports the current and future beneficial uses of groundwater by utilizing the area's groundwater resources within the local sustainable yield. Long-term groundwater sustainability will be evaluated relative to locally-defined sustainability criteria and maintained through increased groundwater monitoring and the implementation of projects and management actions within the Management Area. This Management Area Plan has been developed and will be implemented consistent with the natural resource values of the Tejon Ranch Conservation and Land Use Agreement.

In addition to the Sustainability Goal statements above, the Tejon-Castac Management Area is covered almost entirely by lands that are owned by Tejon Ranch Company (TRC) and subject to the conservation regime described in the Ranch-Wide Management Plan (RWMP), as discussed above in **Section 5.3.4 *Tejon Ranch Conservation and Land Use Agreement***. The very first recital in the Tejon Ranch Conservation and Land Use (C&LU) Agreement states:

> "The Parties to this Agreement desire to protect in perpetuity substantial and significant natural resource values of the 270,000-acre Tejon Ranch. These natural resource values include an extraordinary diversity of native species and vegetation communities, numerous special status plant and animal species, intact watersheds and landscapes supporting natural ecosystem functions and regionally significant habitat connectivity. These important natural resource values exist on Tejon Ranch because historic ranch uses, tracing back to 1843, have largely sustained a natural landscape. The objective of this Agreement is to maintain the bulk of Tejon Ranch in this unaltered condition and, as appropriate, enhance and restore natural resource values."

# 3. AGENCY INFORMATION

## 3.1. Name and Mailing Address of the Agency

☑ 23 CCR § 354.6(a)

This South of Kern River Groundwater Sustainability Plan (SOKR GSP) has been prepared by the Arvin Groundwater Sustainability Agency (GSA), the Wheeler Ridge-Maricopa GSA, the Tejon-Castac Water District (TCWD) GSA, and Arvin Community Services District (ACSD). The Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA are the exclusive GSAs for the portions of the Arvin-Edison Water Storage District (AEWSD), Wheeler Ridge-Maricopa Water Storage District (WRMWSD) and TCWD service areas that are located within the Kern County Subbasin (Basin).

The mailing address for the Arvin GSA is:
Arvin-Edison Water Storage District
P.O. Box 175
Arvin, California 93203-0175

The mailing address for the Wheeler Ridge-Maricopa GSA is:
Wheeler Ridge-Maricopa Water Storage District
12109 Highway 166
Bakersfield, California 93313-9630

The mailing address for the TCWD GSA is:
Tejon-Castac Water District
P.O. Box 478
Lebec, CA 93243

The mailing address for ACSD is:
Arvin Community Services District
309 Campus Drive
Arvin, CA 93203

## 3.2. Organization and Management Structure of the Agency

☑ 23 CCR § 354.6(b)

The Arvin GSA, Wheeler Ridge-Maricopa GSA, TCWD GSA, and ACSD have entered into a Memorandum of Agreement (MOA) that establishes a governance structure for how the GSAs will cooperate and coordinate in exercising their authorities under the Sustainable Groundwater Management Act (SGMA) to jointly develop and implement the SOKR GSP within their collective GSA boundaries, and in other matters related to sustainable groundwater management. Pursuant to the SOKR MOA, each agency has designated representatives to participate in the SOKR GSP Executive Committee which, with the support of the agencies' respective staff and consultants, is responsible for guiding the joint development and implementation of the SOKR GSP in a manner that is coordinated with the other Basin GSAs/GSPs to achieve sustainable groundwater management as required by SGMA and implementing regulations Basin wide. The Executive Committee responsibilities also include guiding public outreach and stakeholder engagement efforts, and keeping the Governing Bodies of each agency informed and prepared to take any and all actions necessary to satisfy the requirements of SGMA. The MOA commits each agency to ongoing cooperation and cost-sharing in undertaking activities related to the SOKR GSP and sustainable groundwater management.

To facilitate the implementation of the SOKR GSP, the South of Kern River MOA jurisdictional area is divided into management areas that are coincident with the portion of the Basin that underlies each SOKR GSA.

In addition to their cooperation and work on this SOKR GSP, AEWSD, WRMWSD, and TCWD have jointly developed, adopted, and are implementing the White Wolf GSP as the White Wolf GSA.

### 3.2.1. Arvin GSA

AEWSD encompasses approximately 132,000 acres of prime agricultural land located in the southeasterly portion of the San Joaquin Valley of California and lies entirely within Kern County. AEWSD is governed by a nine-person board of directors, who are responsible for AEWSD's policies and for setting the direction of the agency. A current list of AEWSD Directors can be found on the AEWSD website at http://www.aewsd.org. The Directors participate in monthly board and committee meetings and in meetings of other organizations with whom the district is a member.

The Arvin GSA was formed in March 2022 and covers 105,630 acres within the Basin (i.e., the Arvin-Edison Management Area). The AEWSD Board of Directors is also the governing body for the Arvin GSA.

### 3.2.2. Wheeler Ridge-Maricopa GSA

WRMWSD encompasses about 147,000 acres of land south of Bakersfield in Kern County, California, at the southern end of the San Joaquin Valley. Except for a few locations along Interstate 5, WRMWSD is exclusively rural. There are no cities or towns within the WRMWSD's boundaries. WRMWSD is governed by nine-person board of directors from nine Divisions, who are responsible for WRMWSD's policies and for setting the direction of the agency. A current list of WRMWSD Directors can be found on the WRMWSD website at https://wrmwsd.com. The Directors participate in monthly board meetings.

The Wheeler Ridge-Maricopa GSA was formed in March 2022 and covers 91,430 acres within the Basin (i.e., the Wheeler Ridge-Maricopa Management Area). The WRMWSD Board of Directors also represents the Wheeler Ridge-Maricopa GSA.

### 3.2.3. TCWD GSA

TCWD encompasses approximately 142,000 acres of land at the southeastern end of Kern County. TCWD provides water services to approximately 50 customers, all of them in the Industrial and Commercial category. TCWD is governed by a five-person board of directors, who are responsible for TCWD's policies and for setting the direction of the agency. A current list of TCWD Directors can be found on the TCWD website at https://www.tejoncastacwd.com. The Directors participate in bimonthly (every two months) board meetings.

The TCWD GSA was formed in March 2022 and covers 19,280 acres within the Basin (i.e., the Tejon-Castac Management Area). The TCWD Board of Directors is also the governing body for the TCWD GSA.

### 3.2.4. ACSD

ACSD provides water for about 20,850 residents living in the AEWSD area within Kern County. ACSD is governed by five-person board of directors elected by the residents, who are responsible for ACSD's policies and for setting the direction of the organization (https://www.arvincsd.com). ACSD is fully within the Arvin-Edison Management Area/Arvin GSA. The Directors participate in Board Meetings twice a month.

## 3.3. GSP Manager

☑ **23 CCR § 354.6(c)**

The Plan Manager for the SOKR GSP is Jeevan Muhar, Engineer Manager of AEWSD. The contact information for Mr. Muhar is provided below.

Jeevan Muhar, PE
Engineer-Manager
Arvin-Edison Water Storage District
P.O. Box 175
Arvin, CA 93203
Office phone: 661-854-5573
Office fax: 661-854-5213
email: jmuhar@aewsd.org

## 3.4. Legal Authority of the GSA

☑ **23 CCR § 354.6(d)**

The Arvin GSA, Wheeler-Ridge Maricopa GSA, and TCWD GSA applied for and were granted exclusive GSA status under SGMA Section 10723(c).

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

☑ **23 CCR § 354.6(e)**

Information on estimated costs to implement the SOKR GSP and the plan to meet those costs is provided in **Section 18.2 *Plan Implementation Costs***.

# 4. GSP ORGANIZATION

This South of Kern River (SOKR) Groundwater Sustainability Plan (GSP) has been jointly prepared by the Arvin Groundwater Sustainability Agency (GSA), the Wheeler Ridge-Maricopa GSA, the Tejon-Castac Water District (TCWD) GSA, and Arvin Community Services District (ACSD) as an amended GSP (i.e., as a synthesis of three of the Management Area Plans that were originally included in the Kern Groundwater Authority GSP) for submission to the California Department of Water Resources (DWR) in response to their 28 January 2022 letter entitled *Incomplete Determination of the 2020 Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Kern County Subbasin*. The SOKR GSP has been developed to meet Sustainable Groundwater Management Act (SGMA) regulatory requirements while reflecting local needs and preserving local control over water resources. The SOKR GSP is coordinated with the other GSPs for the Kern County Subbasin (Basin) to collectively comply with SGMA. Together, these documents (i.e., constituting the "Kern Subbasin Plan") provide a path to maintain the long-term sustainability of the Basin's groundwater resources now and into the future. The SOKR GSP is organized as follows:

- Sections 1 through 4 comprise the **Introduction**, including the following sections:
    - Section 1. Purpose of the Groundwater Sustainability Plan
    - Section 2. Sustainability Goal
    - Section 3. Agency Information
    - Section 4. GSP Organization
- Section 5 provides a **Description of the Plan Area**.
- Sections 6 through 10 present the **Basin Setting**, including the following sections:
    - Section 6. Introduction to Basin Setting
    - Section 7. Hydrogeologic Conceptual Model
    - Section 8. Current and Historical Groundwater Conditions
    - Section 9. Water Budget Information
    - Section 10. Management Areas
- Sections 11 through 15 present the **Sustainable Management Criteria**, including the following sections:
    - Section 11. Introduction to Sustainable Management Criteria
    - Section 12. Sustainability Goal
    - Section 13. Undesirable Results
    - Section 14. Minimum Thresholds
    - Section 15. Measurable Objectives and Interim Milestones
- Section 16 presents the **Monitoring Network**.
- Section 17 presents the **Projects and Management Actions**.

- Section 18 presents the **Plan Implementation**.
- **References and Technical Studies** are included at the end of this document.
- Supporting information is provided in appendices as follows:
  - Appendix A. GSP Submittal Checklist
  - Appendix B. Power & Water Resources Pooling Authority Description
  - Appendix C. White Lands Addendum
  - ACSD 2018 Water Use Summary
  - Appendix E. Summary of Stakeholder Communications and Engagement
  - Appendix F. Detailed Responses to Selected Comments Received Regarding the MA Plan
  - Appendix G. SWRCB Concurrence Letters Re: Edison Oil Field
  - Appendix H. Analysis of Temporal Characteristics of Available Groundwater Quality Data
  - Appendix I. Potential Additional Water Quality Data Sources
  - Appendix J. Methods and Data Used in the Water Budget Spreadsheet Model Approach
  - Appendix K. AEWSD CASGEM Monitoring Plan
  - Appendix L. AEWSD Long-term Access Agreement
  - Appendix M. Project and Management Action Information Forms
  - Appendix N. Board Resolution

[The Appendix list will be updated upon completion of the GSP.]

# PLAN AREA

# 5. DESCRIPTION OF THE PLAN AREA

☑ 23 CCR § 354.8

This section presents a description of the Plan Area covered by the South of Kern River Groundwater Sustainability Plan (SOKR GSP) and a summary of the relevant jurisdictional boundaries and other key land use features potentially relevant to the sustainable management of groundwater in the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas. This section also describes the water monitoring programs, water and power management programs, and general plans relevant to the Management Areas and their influence on the development and execution of this SOKR GSP. This SOKR GSP was developed as an amended GSP for submission to the California Department of Water Resources (DWR) in response to their 28 January 2022 letter entitled *Incomplete Determination of the 2020 Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Kern County Subbasin*, and has been closely coordinated with the amendments of the other GSPs in the Kern County Subbasin (DWR Basin 5-022.14, referred to herein as the Kern Subbasin or Basin) (i.e., collectively the Kern Subbasin Plan).

It is recognized that additional, more recent data (i.e., through 2022) are available at the time of preparation of this amended SOKR GSP. However, as the SOKR GSP does not constitute a five-year update to a GSP (per Article 7 of the GSP Regulations), but rather a response to the DWR determination letter, those additional data are not incorporated herein, with minor exceptions.

## 5.1. Summary of Jurisdictional Areas and Other Features

### 5.1.1. Area Covered by the Plan

☑ 23 CCR § 354.8(a)(1)
☑ 23 CCR § 354.8(b)

As shown on ***Figure PA-1, Figure PA-2*** and ***Figure PA-3***, the SOKR GSP covers a portion of the Basin, specifically the portion underlying the Arvin Groundwater Sustainability Agency (GSA), Wheeler Ridge-Maricopa GSA, and Tejon-Castac Water District (TCWD) GSA which are collectively referred to as the "SOKR GSAs". The Basin is bounded on the north by the Tulare Lake Subbasin (DWR Basin 5-022.12), the Tule Subbasin (DWR Basin 5-022.13) and the Kettleman Plain Subbasin (DWR Basin 5-022.17), on the south by the White Wolf Subbasin (DWR Basin 5-022.18) on the west side by the Coastal Range, and on the east side by the Tehachapi Range.

The areas covered by the SOKR GSP are referred to herein as the Arvin-Edison Management Area, Wheeler Ridge-Maricopa Management Area, and Tejon-Castac Management Area, the boundaries of which are coincident with the respective SOKR GSA boundaries. Lands within the Arvin-Edison Water Storage District (AEWSD), Wheeler Ridge-Maricopa Water Storage District (WRMWSD) and TCWD service areas that are located in the White Wolf Subbasin are managed under the White Wolf GSP developed and adopted by the White Wolf GSA.

The Arvin-Edison Management Area is located in the southeastern portion of the Kern Subbasin and encompasses 105,630 acres of the AEWSD service area. The Arvin-Edison Management Area includes all AEWSD lands within the Kern Subbasin that are not overlapped by the East Niles Community Services District (ENCSD); the area of overlap between AEWSD and ENCSD is managed under a separate GSP prepared by the Kern River GSA. The Arvin Community Services District (ACSD) urban area consists of approximately 2,450 acres, wholly within the Arvin-Edison Management Area. Additional water agencies whose jurisdictional boundaries overlap the Arvin-Edison Management Area and who are represented by the SOKR GSP include the ACSD and Mettler County Water District (MCWD).

The Wheeler Ridge-Maricopa Management Area is in the southern-southeastern portion of the Kern Subbasin and encompasses 91,430 acres of the WRMWSD service area. The Wheeler Ridge-Maricopa Management Area includes all WRMWSD lands within the Basin excepting 2,809 acres that occur within the West Kern Water District (WKWD), and lands that occur within AEWSD. For purposes of Sustainable Groundwater Management Act (SGMA) monitoring and management, WRMWSD and AEWSD have agreed that the Arvin GSA will cover the overlap areas between the two districts.

The Tejon-Castac Management Area is located in the southeastern portion of the Kern Subbasin and encompasses approximately 19,280 acres of the TCWD service area. The Tejon-Castac Management Area is bounded to the west and north by the TCWD administrative/jurisdictional boundary and to the east and south by the boundaries of the Kern Subbasin and the White Wolf Subbasin, respectively. The Tejon-Castac Management Area is located directly to the east of the Arvin-Edison Management Area.

Other than the SOKR GSAs (i.e., the Arvin, Wheeler Ridge-Maricopa, and TCWD GSAs), there are 11 other GSAs that are located within the Kern Subbasin[9]: Buena Vista Water Storage District (BVWSD) GSA, Cawelo Water District GSA, Greenfield County Water District GSA, Henry Miller Water District (HMWD) GSA, Kern River GSA, City of McFarland GSA, Olcese Water District GSA, Pioneer GSA, Semitropic Water Storage District GSA, WKWD GSA, Kern Groundwater Authority (KGA) GSA. These GSAs were formed by several other GSA-eligible public agencies in the Basin and are preparing separate, amended GSP documents. The rest of the Basin is comprised of un-districted lands (also known as “white lands”), some of which have executed management agreements with nearby water districts or other public agencies.

### 5.1.2. Adjudicated Areas

☑ **23 CCR § 354.8(a)(2)**
☑ **23 CCR § 354.8(b)**

The Basin is not adjudicated and no portion is being managed pursuant to an alternative.

### 5.1.3. Jurisdictional Boundaries

☑ **23 CCR § 354.8(a)(3)**
☑ **23 CCR § 354.8(b)**

#### 5.1.3.1. Arvin-Edison Management Area

The Arvin-Edison Management Area falls entirely within Kern County and contains the City of Arvin and Mettler, a census designated place. As shown on ***Figure PA-2***, water agencies and public water systems that at least partially overlie the Arvin-Edison Management Area include: WRMWSD, TCWD, ACSD, MCWD, ENCSD, Kern County Water Agency (KCWA) #ID4, Orange Grove RV Park, Grimmway Enterprises Malaga Water System, Heck Cellars Water System, and Grimmway Farms Frozen Foods. Additional water

[9] SGMA Portal: https://sgma.water.ca.gov/portal/gsa/all, retrieved on 4/20/2022.

agencies in the vicinity of the Management Area include California Water Service Company-Bakersfield and Kern Delta Water District (KDWD).

Another public agency with jurisdiction within the Arvin-Edison Management Area is the Power & Water Resources Pooling Authority (PWRPA), formed by several irrigation and water districts through a Joint Power Authority (JPA). The PWRPA, of which AEWSD is a participant, has the authority to develop and implement projects and programs related to water and energy (see **Appendix B**). AEWSD plans to expand this program in the future upon further development of groundwater banking facilities and in-lieu projects (see **Section 5.2 *Water Resources Monitoring and Management Programs*** and **Section 17 *Projects and Management Actions*** for further details).

According to the information made available by DWR[10] in support of the development of GSPs, there are currently no designated tribal or federal lands within or in the vicinity of the Arvin-Edison Management Area.[11] State lands within the Arvin-Edison Management Area include the 226-acre Bakersfield Cactus Ecological Reserve that is located near Caliente Creek in the northeastern portion of AEWSD (***Figure PA-4***) and maintained by the California Department of Fish and Wildlife. Additional protected lands include a small (<100 acre) dedicated Conservation Easement Area[12] in the TCWD-AEWSD overlap area close to the eastern boundary of AEWSD (***Figure PA-4***).

DWR further presents information regarding United States Census Blocks, Tracts and Places that are defined as disadvantaged communities (DAC) or severely disadvantaged communities (SDAC). ***Figure PA-5*** shows the DAC/SDAC designations within the Arvin-Edison Management Area. A majority of the Management Area is considered a DAC based on the Census Block Group and Census Tract characterizations. Additionally, Mettler is defined as a DAC and the City of Arvin is defined as a SDAC based on the Census Place characterization.

The Arvin-Edison Management Area is located entirely within the Kern County General Plan area, and a portion is also within the Metropolitan Bakersfield General Plan area (***Figure PA-6*** and ***Figure PA-7***). The Management Area also encompasses the entire ACSD urban area, which is covered by the City of Arvin General Plan. Each of these plans are described further in **Section 5.3 *Land Use Elements or Topic Categories of Applicable General Plans.***

#### 5.1.3.2. Wheeler Ridge-Maricopa Management Area

The Wheeler Ridge-Maricopa Management Area is entirely within Kern County and the KCWA. As shown on ***Figure PA-3***, water agencies that partially overlie the Wheeler Ridge-Maricopa Management Area are AEWSD and the WKWD.[13] Additional water agencies and public water systems in the vicinity of the Management Area include: BVWSD, HMWD, KDWD, Opal Fry and Son Water System, and MCWD.

According to the information made available by DWR[14] in support of the development of GSPs, there are no tribal lands nor state lands within or in the vicinity of the Wheeler Ridge-Maricopa Management Area. Federal lands include approximately 500 acres of national public lands managed by the U.S. Bureau of

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

[11] The Tejon Tribe is a federally recognized tribe that is in the process of securing Tribal Land Trust status for 305 acres in the AEWSD service area, *see* https://www.tejonindiantribe.com/federal-recognition/.

[12] Per the *Tejon Ranch Conservation & Land Use Agreement (Tejon Ranch Company, 2008)*

[13] WKWD overlaps a portion of WRMWSD, however, the GSA formed by this district (WKWD GSA) does not include such area.

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

Land Management, located in the northern portion of the Wheeler Ridge-Maricopa Management Area (***Figure PA-4***).

DWR further presents information regarding U.S. Census Blocks, Tracts and Places that are defined as DAC or SDAC. ***Figure PA-5*** shows DAC/SDAC areas within the Wheeler Ridge-Maricopa Management Area. As shown on ***Figure PA-5***, a majority of the Wheeler Ridge-Maricopa Management Area is considered either a SDAC or a DAC based on the Census Block Group and Census Tract characterizations.

The Wheeler Ridge-Maricopa Management Area is located entirely within the Kern County General Plan area (see ***Figure PA-8***). This plan is described in further detail below in **Section 5.3.1 *Kern County General Plan***.

#### 5.1.3.3. Tejon-Castac Management Area

The Tejon-Castac Management Area is located entirely within Kern County. As shown on ***Figure PA-3***, nearby water districts and agencies include: AEWSD and ACSD to the west, and Tehachapi-Cummings County Water District (TCCWD) and the Bear Valley Community Services District (BVCSD) to the southeast. Nearby cities include Arvin to the west, Bakersfield to the northwest, and Tehachapi to the southeast.

According to the information made available by the DWR[15] in support of the development of GSPs, there are no tribal, state, or federal lands within the Tejon-Castac Management Area. The Bakersfield National Cemetery is directly adjacent to the Tejon-Castac Management Area boundary along Highway 223, but this facility is not within the Tejon-Castac Management Area boundaries.

According to U.S. Census Bureau data, a portion of Tract 60.04, which is identified as a DAC tract, overlies the northern portion of the Tejon-Castac Management Area north of Highway 58 (***Figure PA-5***). However, based on TCWD knowledge, there are no residents living within this DAC area, as the few residences within the Tejon-Castac Management Area are south of this tract.

### 5.1.4. Existing Land Use and Water Use

☑ **23 CCR § 354.8(a)(4)**
☑ **23 CCR § 354.8(b)**

#### 5.1.4.1. Arvin-Edison Management Area

As shown on ***Figure PA-9***, intensive agriculture is the primary land use within the Arvin-Edison Management Area, followed by undeveloped/non-irrigated areas and urban/industrial areas, including solar developments.[16] As of Spring 2015,[17] approximately 89,800 acres were classified as irrigated agricultural lands within the Arvin-Edison Management Area, 5,000 acres were classified as non-irrigated agricultural, 4,600 acres were classified as urban lands, 4,200 acres were classified as native lands, and an

[15] SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer; Water Management Planning Tool: https://gis.water.ca.gov/app/boundaries/

[16] Reported urban area currently includes approximately 1,700 acres of solar facilities within the Management Area. Continued expansion of solar facilities is expected to occur in the future.

[17] Spring 2015 was selected as the representative period for which to describe existing land and water use as this is the closest season to the SGMA baseline date (1 January 2015, per CWC § 10727.2(b)(4)) and is also consistent with how "current conditions" are being defined within the Groundwater Conditions and Water Budget sections of the KGA GSP (see Sections 8 and **9.1.3**).

additional 2,300 acres were covered by AEWSD's canal and spreading basin facilities. **Table PA-1** includes a more detailed breakdown of the land use in the Arvin-Edison Management Area.

**Table PA-1. Land Use Classification – Spring 2015, Arvin-Edison Management Area**

| DWR Land Use Classification | Acreage[18] | Percent of Total Acreage | Percent of Irrigated Ag. Lands |
|---|---|---|---|
| Truck, nursery, and berry crops | 26,417 | 25% | 29% |
| Vineyards | 19,631 | 19% | 22% |
| Citrus | 14,901 | 14% | 17% |
| Field crops | 12,995 | 12% | 14% |
| Deciduous fruits and nuts | 11,128 | 11% | 12% |
| Grain and hay crops | 3,773 | 4% | 4% |
| Pasture | 686 | 1% | 1% |
| Semi-agricultural | 293 | 0% | 0% |
| Ag Non-Irrigated | 4,981 | 5% | NA |
| Urban (including solar, *see footnote 8)* | 4,592 | 4% | NA |
| Native vegetation | 4,163 | 4% | NA |
| Canals, spreading basins, and other surface water features | 2,343 | 2% | NA |
| **Total** | **105,902** | | |

Urban potable water demands within the Arvin-Edison Management Area (i.e., City of Arvin and Mettler) are entirely met by ACSD and MCWD with groundwater. The ACSD serves a population of 20,850 through 3,885 service connections and MCWD serves a population of 157 through 17 service connections.[19] The potable consumption of groundwater in the Management Area also includes limited use by domestic well owners and public water systems.

[18] The slight mismatch in total acreage in ***Table PA-1.*** versus the value provided in ***Section 5.1.1*** is likely due to minor inconsistencies in the land use shapefile used for this analysis.
[19] Information retrieved from the California Environmental Health Tracking Program Water Boundary Tool on 02/21/2019. The ACSD data was last updated on 08/13/2018 and MCWD on 09/23/2016.

Agricultural water demands are met by conjunctive use of imported surface water and/or groundwater depending on location within the Arvin-Edison Management Area.[20] AEWSD has a contract with the United States Bureau of Reclamation (USBR) for 40,000 acre-feet per year (AFY) of Class 1 water and 311,675 AFY of Class 2 water from the Friant Division of the Central Valley Project (CVP), delivered through the Friant-Kern Canal (AEWSD, 2015). AEWSD also has access to water from the following associated sources: Recovered Water Account (RWA), Unreleased Restoration Flows (URF), Recapture & Recirculation (R/R), and Section 215 water. Pursuant to transfer agreements with partner agencies, AEWSD has also obtained imported water from other sources such as the State Water Project (SWP), Westside CVP, and the Kern, Kings, Kaweah and St. John's Rivers. ***Figure PA-10*** shows the parcels that are located within the AEWSD Surface Water Service Area (SWSA). The remainder of the Arvin-Edison Management Area relies on groundwater to meet demands, although in recent years AEWSD has expanded its Temporary Water Service and In-Lieu programs to extend surface water delivery to some limited additional parcels (details of the Temporary Water Service Program and In-Lieu Program are discussed in **Section 5.2.3 *Conjunctive Use in the Management Areas***). AEWSD customers with surface water contracts are not precluded from pumping underlying groundwater for beneficial use.

*ACSD Land and Water Use*

Lands contained within ACSD's boundary are both urban and agricultural. The total acreage within ACSD's boundary is 2,450 acres. This includes about 450 acres of open land and 450 acres of farmed lands. It is anticipated that the open lands will eventually be developed to urban uses as in-fill projects. The acreage that is developed to urban uses (residential, commercial/industrial, public parks, schools, public buildings) is about 1,508 acres. This area estimate reflects the latest Local Agency Formation Commission (LAFCo) mapping. ACSD lands are generally located south of Sunset Boulevard, north of Burkett Boulevard, east of Comanche Drive, and west of Tejon Highway. However, there are lands that are a part of ACSD that are external to the main boundary. These are designated "islands" and are included in the acreage tabulation below. Acreage values are approximate and are not to be considered the product of an ACSD boundary survey conducted by a licensed land surveyor; rather they are included in ***Table PA-2*** below for preparation of SGMA land and water use calculations.

[20] A small portion of agricultural water demands are met by recycled wastewater from agricultural processing facilities within AEWSD.

**Table PA-2. ACSD Land Use Summary**

| Land Use Description | Area (acres) |
|---|---|
| Lands within ACSD Boundaries[1] | 2,447 |
| Urban areas within ACSD Boundaries, 5 acres or greater, that are not developed[2] | 455 |
| Areas that are intensively farmed[3] | 447 |
| Special Use Lands (Ski Lakes)[4] | 37 |
| Total Urban Developed Lands within the ACSD Boundary[5] | 1,508 |

Notes:
(1) Lands within ACSD Boundaries include the contiguous area served by ACSD together with the individual parcels ("islands") served external to the main body of ACSD lands.
(2) As of January 1, 2019, there are 13 vacant tracts of land within the ACSD boundary. The size of these tracts varies from 5 acres to 125 acres.
(3) There are 447 acres of farm lands within the ACSD boundary. These lands are intensively farmed and supplied with water from private non-ACSD wells, and with wastewater from the City of Arvin Wastewater Treatment Plant.
(4) Water to fill and maintain the Ski Lakes is pumped by a private, non-ACSD well installed for that specific purpose. Domestic water to the households is provided by ACSD.

ACSD relies on groundwater as its only source of water. ACSD's Arsenic Mitigation Project, begun in 2010, is nearing completion with the last well, Well #18. The Arsenic Mitigation Project consists of replacing six old wells that had a history of contamination, with six new wells that meet current municipal water quality standards. The old wells - Wells #1, 5, 6, 7, 8, and 9 - were contaminated with a mixture of arsenic, nitrates, and volatile organics. These wells have been destroyed and abandoned in accordance with State and County standards. They were replaced by Wells #12, 13, 14, 16, and 17, with Well #18 projected to be completed by the end of 2022.

ACSD was operating under a United States Environmental Protection Agency (USEPA) Compliance Order for arsenic that required compliance with the new arsenic standards (adopted in 2006) by Spring 2019. This schedule has been adjusted several times to accommodate construction timing and availability of equipment. The USEPA released its Arsenic Compliance Order in July 2021 because ACSD had met all the requirements of the Order.

ACSD developed its Arsenic Mitigation Project in 2010 to deal with the arsenic problem and obtained financing from the State of California to drill two new wells in 2015 as the first phase ("Phase 1") in its Arsenic Mitigation Project. These two new wells (Wells #13 and #14) were placed online in 2017 and comply with the new arsenic standards, however one of these wells (Well #13) was affected by the contaminant 1,2,3-Tricholoropropane (1,2,3-TCP). A new maximum contaminant level (MCL) was established for 1,2,3-TCP, effective January 1, 2018. This well was taken out of service while a treatment system could be designed and installed. Treatment for this well was installed in late 2018/early 2019 and the well was returned to service in the Spring of 2019.

Additionally, the USEPA released financing for construction of a new well (ACSD Well #12) to replace one of its wells that was in the path of a contaminant plume from the now-abandoned Brown and Bryant Superfund Site. The plume did not reach this well but was moving in its direction, and the USEPA determined that it was in the best interest of ACSD to drill a new well to replace it. The new well (the fourth replacement well to be drilled in 2019) was placed in service in 2021. The well that was in the path of the plume (Well #1) was destroyed by ACSD in 2018.

As a part of Phase 2 of the Arsenic Mitigation Project, ACSD constructed a new one-million-gallon water storage tank with booster pumping plant, new connective piping for the wells, and a new SCADA system to monitor and control the new system.

After completion of Well #18, ACSD will have six new production wells and retain two of the older wells that have arsenic contaminant levels near the MCL. These two wells are part of an arsenic blending program that was made possible by the installation of the new one-million-gallon storage tank. The objective of the Arsenic Mitigation Project was to drill new wells with arsenic below the MCL. To date all new wells, meet State water quality standards (with the exception of Well #13 for which 1,2,3-TCP treatment is ongoing). Initial testing of Well #18 during drilling (it is drilled but not yet equipped), indicates that it also will meet arsenic standards.

#### 5.1.4.2. Wheeler Ridge-Maricopa Management Area

As shown on ***Figure PA-11***, agriculture is the primary land use within the Wheeler Ridge-Maricopa Management Area, followed by idle/non-irrigated lands. As of Spring 2017, approximately 63,620 acres (71%) were classified as irrigated agricultural lands within the Wheeler Ridge-Maricopa Management Area, ~23,950 acres (27%) were classified as non-irrigated agricultural/native lands, and ~2,260 acres (3%) were classified as urban areas and artificial channels.

Agricultural water demands are met with surface water and/or groundwater depending on location within the Wheeler Ridge-Maricopa Management Area. WRMWSD has a contract for 197,088 AFY of Table A water from the SWP through the KCWA (WRMWSD, 2015). ***Figure PA-12*** shows the parcels within WRMWSD's SWSA. The remainder of the Wheeler Ridge-Maricopa Management Area relies solely on groundwater to meet demands; surface water customers are not precluded from pumping underlying groundwater for beneficial use.

Imported surface water is served only to agricultural water users for irrigation. All municipal/industrial (M&I) and domestic demands are met by groundwater pumping. The potable consumption of groundwater in the Wheeler Ridge-Maricopa Management Area is limited to domestic well owners.

Land use designations under the Kern County General Plan are discussed in **Section 5.3.1 *Kern County General Plan*** and shown on ***Figure PA-8***.

#### 5.1.4.3. Tejon-Castac Management Area

According to the National Land Cover Database (2011), land cover is predominantly grassland/herbaceous with lesser amounts of shrub/scrub (***Figure PA-13***), and the predominant land use within the Tejon-Castac Management Area is livestock grazing. There are several residential buildings in the northeastern portion of the Tejon-Castac Management Area along Bena Road between Highway 223 and Bealville Road, and an active quarry (the Granite Construction, Inc. Arvin Facility; "Granite Quarry") located in the south-central portion of the Tejon-Castac Management Area.

The Tejon-Castac Management Area relies solely on groundwater to meet demands. Agricultural pumping within the Tejon-Castac Management Area is used on lands in AEWSD. Other pumping includes domestic pumping, which is likely negligible, and industrial pumping.

### 5.1.5. Well Density per Square Mile

☑ **23 CCR § 354.8(a)(5)**
☑ **23 CCR § 354.8(b)**

#### 5.1.5.1. Arvin-Edison Management Area

***Figure PA-14*** shows the density of wells per square mile within the Arvin-Edison Management Area, based on Well Completion Report (WCR) records compiled by DWR.[21] According to these records, approximately 486 production wells, 140 domestic wells, and 22 public supply wells have been installed within the Public Land Survey System (PLSS) sections[22] that fall partially or entirely within the Arvin-Edison Management Area. Communities dependent on groundwater within the Arvin-Edison Management Area are the City of Arvin and Mettler, which are served by ACSD and MCWD as previously stated. According to ACSD records, ACSD has six active wells (ACSD Wells #10, 12, 13, 14, 16, and 17) and one new well that is projected to be completed by the end of 2022 (ACSD Well #18). ACSD wells are located within a 6.4 square mile radius and are all located within the ACSD jurisdictional area. The MCWD produces groundwater from two wells.

AEWSD's internal Data Management System (DMS) identifies 819 wells within the Arvin-Edison Management Area (i.e., 444 production wells, 48 domestic/M&I wells, and 149 of unknown classification). As part of GSP preparation efforts, AEWSD is conducting an expansive investigation to reconcile the information in its DMS with the DWR records (e.g., to locate and identify the status of the 140 domestic wells and to validate DWR Well Completion Report records). These data reconciliation efforts are expected to continue as part of GSP implementation.

#### 5.1.5.2. Wheeler Ridge-Maricopa Management Area

***Figure PA-15*** shows the density of wells per square mile within the Wheeler Ridge-Maricopa Management Area, based on WCR records compiled by DWR[23] and refined information on active domestic wells obtained from the Community Water Center.[24] According to these records, approximately 121 production wells, 27 active domestic wells, and one public supply well have been installed within the PLSS sections[25] that fall partially or entirely within the Wheeler Ridge-Maricopa Management Area.

The WRMWSD DMS identifies 595 wells within the Wheeler Ridge-Maricopa Management Area; 205 of these wells are known to be active, 105 inactive or abandoned, and the status of 285 wells is unknown.

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[21] DWR Well Completion Report Map Application website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37, accessed 08/17/2018.
[22] Each PLSS section represents approximately 1 square mile of area (i.e., 640 acres).
[23] DWR Well Completion Report Map Application website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37, accessed 08/17/2018.
[24] Community Water Center Drinking Water Vulnerability Tool, obtained 24 May 2019.
[25] Each PLSS section represents approximately 1 square mile of area (i.e., 640 acres).

Of the active wells, 142 are production wells, 32 are domestic/ M&I wells, and 31 are monitoring wells. As part of GSP preparation efforts, WRMWSD is attempting to reconcile the information in its DMS with the DWR records. These data reconciliation efforts are expected to continue as part of GSP implementation.

The closest urban communities to the Wheeler Ridge-Maricopa Management Area are Maricopa and Mettler but there are no communities dependent on groundwater within the Wheeler Ridge-Maricopa Management Area. The only potable groundwater consumption comes from the domestic wells.

#### 5.1.5.3. Tejon-Castac Management Area

***Figure PA-16*** shows the density of wells per square mile within the Tejon-Castac Management Area, based on WCR records compiled by DWR.[26] ***Table PA-3*** shows a summary of all WCRs in PLSS sections[27] that are overlain, in whole or in part, by the Tejon-Castac Management Area. According to these records a total of 20 wells, including 11 domestic wells, three irrigation wells, two industrial wells and four wells of "unknown" type have been completed within sections that fall partially or entirely within the Tejon-Castac Management Area. However, closer inspection of WCR location descriptions indicates that nine of these wells are definitively outside of the lateral boundaries of the Tejon-Castac Management Area.

Of the remaining 11 wells that may be located within the Tejon-Castac Management Area lateral boundaries, six wells (all domestic according to the WCRs, including two wells owned by Tejon Ranch Company [TRC] – the White Wolf Well and the Eleven Mile Well) have penetrated and draw water from granite or fractured granite, rather than alluvial materials, and are thus considered to be outside of the Basin defined by the alluvial sedimentary materials (see **Section 7.1.3 *Bottom of the Basin)***. One industrial production well (DWR WCR No. 97142) in the far northwestern corner of the Tejon-Castac Management Area was constructed in the early 1960s and, according to a recent environmental study in the area, no longer exists (Amec Foster-Wheeler, 2017).

After eliminating the above wells, there may exist a total of four wells within the Tejon-Castac Management Area, including one industrial well used by the Granite Quarry (well T31SR30E28; DWR WCR No. 74572; the "Caratan" well),[28] and three domestic wells in PLSS section 31S31E03. Of these four wells, the only one with known non-de minimis use in the Tejon-Castac Management Area is the Caratan well. On ***Figure PA-16***, the Caratan well is shown along with the two TRC-owned wells (as they are known to be located geographically within the Tejon-Castac Management Area, even though they are screened below the bottom of the Basin; i.e., screened in bedrock).

### 5.1.6. Lands Outside of Districts Covered by the SOKR GSP

Under SGMA (California Water Code [CWC] § 10724), counties are presumed to be the GSA for areas that are not otherwise covered by another GSA, unless the county specifically opts out of this GSA role. In the Kern Subbasin, the County of Kern opted out of this role in early 2019 which resulted in lands outside of the other GSA boundaries being "uncovered". To address the gap in coverage, the SOKR GSAs sent notices to these "un-districted" landowners offering an opportunity to sign an agreement for coverage under the

[26] DWR Well Completion Report Map Application website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37, accessed 08/17/2018.

[27] Each PLSS section represents approximately 1 square mile of area (i.e., 640 acres).

[28] The Granite Quarry does not use the Caratan well for potable supply even though it is shown on the DWR Well Completion Report Map Application as a "public supply" well.

SOKR GSP. Eight landowners with a total of 26 parcels outside of the AEWSD service area totaling approximately 1,860 acres (1,079 irrigated acres, 781 non-irrigated acres) and three landowners with a total of three parcels outside of the WRMWSD service area totaling approximately 1,042 acres (all non-irrigated acres) accepted the offer to gain coverage under the SOKR GSP. Given the late time at which these offers were made and accepted following the County's withdrawal, the SOKR GSAs determined that it would not be possible to cover these un-districted lands in the SOKR GSP to the same degree of detail as lands that were covered by AEWSD, WRMWSD, and TCWD from the start; instead, it was determined that it would be appropriate to include the lands in an appendix to the SOKR GSP, providing basic information about each parcel including the owner, Assessor's Parcel Number (APN), area, land/water use, and well information. As such, **Appendix C** presents information on these lands, including a table with the above information as well as a figure showing their locations. In addition, for the subset of un-districted lands that are currently irrigated, a projected water budget has been developed and is included in **Appendix C**. It is the intention to include additional information for these lands (if they still need GSP coverage) in the 2025 GSP updates.

## 5.2. Water Resources Monitoring and Management Programs

### 5.2.1. Existing Monitoring and Management Programs

☑ **23 CCR § 354.8(c)**

*Existing Monitoring Programs*

Existing groundwater elevation and water quality monitoring programs within the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas include:

- The California Statewide Groundwater Elevation Monitoring (CASGEM) Program which tracks long-term groundwater elevation trends in groundwater basins throughout California. The program's mission is to establish a permanent, locally-managed program of regular and systematic monitoring in all of California's alluvial groundwater basins. AEWSD has been a Monitoring Entity under the CASGEM Program since 2011. In 2011, WRMWSD submitted to DWR an application to be the CASGEM Monitoring Entity for the WRMWSD service area (except the overlap areas with AEWSD and WKWD), but a full CASGEM monitoring plan has not been completed. Therefore, all wells monitored within WRMWSD are designated as "voluntary wells" under the CASGEM program.
- The Groundwater Ambient Monitoring and Assessment (GAMA) Program, which is California's comprehensive groundwater quality monitoring program that was created by the State Water Resources Control Board (SWRCB) in 2000, monitors groundwater quality trends throughout California, including within the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas.[29]
- The Monitoring and Reporting Program (MRP) from the Irrigated Lands Regulatory Program (ILRP), establishes the specific surface and groundwater monitoring, reporting, and electronic data deliverable requirements for irrigated lands used for commercial purposes within the Tulare Lake

[29] GAMA Website: https://www.waterboards.ca.gov/water_issues/programs/gama/about.html.

Basin Area (The ILRP is further described in the section below "Existing Management Programs"). The purpose of this MRP is to determine the effects of irrigated lands waste discharges on water quality and assess the effectiveness of ILRP management actions. Data and reports are available in the GAMA database (CVRWQCB, 2013).

- Central Valley-Salinity Alternatives for Long-term Sustainability (CV-SALTS) is a collaborative stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley. The Kern Subbasin is a Priority 2 basin for nitrate management. Consequently, the nitrate control program schedule is set to begin in 2021.
- AEWSD and WRMWSD conduct regular groundwater level monitoring and groundwater quality sampling in selected wells throughout the Management Areas as part of their on-going water resources management efforts. WRMWSD conducts periodic groundwater level monitoring and groundwater quality sampling in selected wells within the AEWSD-WRMWSD overlap portion of the Management Areas.
- The SWRCB's Division of Drinking Water monitors groundwater quality from public water system wells. Public water systems included within the Arvin-Edison Management Area are described in **Section 5.1.3 *Jurisdictional Boundaries*** of this document.
- AEWSD monitors flowrates on all of its wells using propeller flowmeters, and also measures pumping in some private agricultural wells as part of a voluntary grant funded program.
- AEWSD measures all imported surface water and deliveries to its customers and spreading works. All water banking and water transfer programs in which AEWSD participates include monitoring and reporting programs as well. Both ACSD and MCWD conduct regular groundwater quality sampling of their public supply wells for compliance with California Code of Regulations Title 22 Drinking Water Standards. For example, ACSD monitors wells on a quarterly basis for contaminants of concern such as arsenic and 1,2,3-TCP, and conducts Unregulated Contaminant Monitoring Rule (UCMR) testing required by the federal government every three years.

The CASGEM groundwater elevations (and groundwater elevations from wells in the AEWSD and WRMWSD monitoring networks) have been used to characterize groundwater level conditions (see **Section 8.2 *Groundwater Elevations and Flow Direction***). Water quality data from the above sources have been used to identify groundwater quality conditions (see **Section 8.5 *Groundwater Quality***).

Various surface water monitoring programs are also active within the Kern Subbasin (e.g., California Data Exchange Center [CDEC], United States Geological Survey [USGS] National Water Information System [NWIS], etc.). However, there are no active monitoring points within or proximate to the Arvin-Edison Management Area as natural surface water resources are limited to a small number of ephemeral creeks draining into the area from surrounding watersheds to the east[30] (see **Section 7.3.5 *Surface Water Bodies***). AEWSD is developing a monitoring network to better understand this phenomenon locally. There are no active monitoring points within or proximate to the Tejon-Castac Management Area. Existing surface water monitoring in the Wheeler Ridge-Maricopa Management Area includes the following:

[30] The USGS NWIS reports a historical gauge in Caliente Creek (USGS 11196400) with monthly streamflow data between Oct 1964 to Feb 1983.

- The WRMWSD is establishing a network of five stream gauges in the San Emigdio mountains, three of which are on streams that flow into the Wheeler Ridge-Maricopa Management Area and two of which flow into the White Wolf Subbasin.
- The CDEC provides a centralized database to store, process, and exchange real-time hydrologic information gathered by various cooperators throughout the State.[31] The CDEC has three monitoring points within or in the vicinity of the Wheeler Ridge-Maricopa Management Area.

Land subsidence data within and in the vicinity of Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas is available through the following sources:

- University Navstar[32] Consortium (UNAVCO) Plate Boundary Observatory's continuous and conventional Global Positioning System (GPS) network.
- Remote sensing studies by National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL).
- AEWSD's internal ground-surface elevation monitoring network.
- USGS San Joaquin Valley Land Subsidence Network. A subsidence monitoring network in the San Joaquin Valley was implemented in the 1960s to help quantify the extent and magnitude of the subsidence that was first discovered in the 1950s. To identify existing and future subsidence, a new monitoring network is currently being developed.[33]
- The DWR's San Luis Field Division and the San Joaquin Field Division conducted a land subsidence study along the California Aqueduct (DWR, 2017a; DWR, 2019) to understand the magnitude, location and effects of past and present land subsidence. For this study, data from 940 survey benchmarks along the California Aqueduct that have been monitored at 1-year and 7-year intervals by the San Luis Field Division, and 1,009 benchmarks monitored at 3-year and 7-year intervals by the San Joaquin Field Division was used.
- Vertical displacement estimates derived from Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE ALTAMIRA Inc. (TRE).

From the above-mentioned monitoring programs, the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas will incorporate the existing Monitoring Plans into the monitoring networks, as applicable. The Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas SGMA Monitoring Network is further described in **Section 16 *Monitoring Network.***

*Existing Management Programs*

Existing groundwater management programs within the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas include:

[31] CDEC Website: http://cdec.water.ca.gov/cdecstation2/
[32] Navstar is a network of U.S. satellites that provide GPS services.
[33] From USGS California Water Science Center website: https://ca.water.usgs.gov/projects/central-valley/land-subsidence-san-joaquin-valley.html

- The Arvin-Edison and Wheeler Ridge-Maricopa Management Areas fall within the South County Subregion of the Kern County Integrated Regional Water Management Region (Kern Region) and is therefore included in the November 2011 Kern Integrated Regional Water Management Plan (Kern IRWMP; Kennedy/Jenks Consultants, 2011 and updated by Provost & Pritchard). The Kern Region covers approximately 5,690 square miles of Kern County and a small portion of southern Kings County. The Kern Region is separated into nine subregions, in acknowledgement of the variation in geography, agency boundaries, and water management strategies. These subregions are: (1) Greater Bakersfield, (2) Kern Fan, (3) Mountains/Foothills, (4) Kern River Valley, (5) North County, (6) South County, (7) West Side, (8) KCWA and (9) the County of Kern.

  The vast majority of the Tejon-Castac Management Area is within the Mountains/Foothills Subregion (Kern County, 2011). However, a small portion of the Wheeler Ridge-Maricopa appears to lie within the adjacent South County Subregion.

  The key issues, needs, challenges, and priorities for the South County subregion, according to the Kern IRWMP (2011), include the following:

  - Decreased Imported Water Supply;
  - Water Quality/Groundwater Contamination;
  - Urban Growth Encroachment on Key Recharge Areas; and
  - Water Rights.

  The key issues, needs, challenges, and priorities for the Mountains/Foothills subregion, according to the Kern IRWMP (2011), include the following:

  - Groundwater Overdraft;
  - Watershed Protection;
  - Aging and/or Duplicative Infrastructure;
  - Urban Growth and Water Demand (South Mountains); and
  - Climate Change.

  A 2019 Kern IRWMP update that is consistent with the 2016 IRWM Guideline requirements was adopted in 2020; information from that update will be incorporated in the 2025 GSP update.

- The AEWSD Groundwater Management Plan (GWMP) was developed in 2003 (pursuant to CWC § 10750 et seq., § 10753.7, and § 10753.8) and has completed annual reports that collect all groundwater related items into a single report aimed to implement groundwater management strategies that would maintain high quality and dependable water resources while minimizing negative impacts within the AEWSD service area. This GSP extends and supersedes the groundwater management efforts outlined in the GWMP, but a brief summary is included below for completeness. Specifically, the AEWSD GWMP (2003) set forth the following groundwater management objectives to guide its water management activities, programs, and projects:

  - Water supply reliability;
  - Water supply affordability;

- Groundwater overdraft;
- Groundwater quality;
- Compliance with contracts, agreements, laws, and cooperation with other agencies;
- Inelastic land surface subsidence; and
- Groundwater monitoring.

- The WRMWSD GWMP was developed in 2007 and aimed to increase reliability and sustainability of water supply by conjunctively integrating groundwater with imported surface water supply. Specifically, the WRMWSD GWMP (2007) set forth the following groundwater management objectives to guide future water management actions:
    - Prevent a return to historical overdraft conditions;
    - Maintain groundwater quality;
    - Monitor water levels, water quality, and groundwater storage; and
    - Estimate groundwater use and future groundwater demands on the basin.

- AEWSD's USBR Water Management Plan (WMP) was first developed in 1996 (then referred to as a USBR "Water Conservation Plan"), was revised in 2013 to comply with new requirements of Senate Bill (SB) x7 of 2009 and was last updated in October 2018 pursuant to the Central Valley Improvement Act of 1992 and Section 210(b) of the Reclamation Reform Act of 1982. This WMP describes water use within AEWSD, provides an inventory of water resources, contains a Drought Management Plan, and establishes Best Management Practices (BMPs) for agricultural contractors to improve water use efficiency. Some examples of these practices include: metering delivered water, supporting the local Resource Conservation District's Mobile Lab Program's conduct of on-farm evaluations, supporting more precise irrigation and delivery scheduling, etc.

- The Irrigated Lands Regulatory Program, initiated in 2003 for surface water and last modified in 2013 to include groundwater provisions, is a program whose objective is to protect both groundwater and surface water from irrigated agricultural waste dischargers throughout the Central Valley. The ILRP is implemented through Central Valley Regional Water Quality Control Board (CVRWQCB) Orders, also called Waste Discharge Requirements (WDRs). Order R5-2013-0120 (Order) regulates discharges in the Tulare Lake Basin. The ILRP makes third parties responsible for fulfilling regional requirements and conditions (e.g. surface and groundwater monitoring) and certain management actions. AEWSD and WRMWSD are members of the Kern River Watershed Coalition Authority (KRWCA) which is a third-party coalition that formed in 2014 to respond to the Order and amendments thereof. Key management elements of the ILRP are: Sediment and Erosion Control Plan, Nitrogen Management Plan and Mitigation Monitoring. The overall goals of the ILRP for the Tulare Lake Basin Area are:
    - To restore and/or maintain the highest reasonable quality of state waters;
    - Minimize waste discharge from irrigated agricultural lands that could degrade state waters quality;
    - Maintain the economic viability of agriculture in California's Central Valley (CV); and
    - Ensure that irrigated agricultural discharges do not impair access by CV communities and residents to safe and reliable drinking water.

In accordance with these goals, the objectives are the following:

  - Restore and/or maintain appropriate beneficial uses established in CVRWQCB plans by ensuring that all state waters meet applicable water quality objectives; and
  - Encourage implementation of management practices that improve water quality in keeping with the first objective, without jeopardizing the economic viability for all sizes of irrigated agricultural operations.

- The 2015 ACSD Urban Water Management Plan (UWMP), compliant with the CWC § 10610-10656 and § 10608, provides an assessment of the existing and planned water demands and water resources within the ACSD service area through 2040. The ACSD UWMP includes a description of the reliability of the local groundwater supply and its vulnerability to seasonal or climatic shortage, anticipated water projects, the water demand management measures implemented by ACSD, and ACSD's water shortage contingency plan (ACSD, 2016). ACSD completed an update to its UWMP in 2020; that update will be incorporated in the 2025 GSP update.
- WRMWSD prepared an Agricultural Water Management Plan (AWMP) in accordance with the requirements of SB X7-7 and Governor's Executive Order B-29-15 and it was last modified in December 2015. The purpose of this AWMP is to describe and document WRMWSD's existing and proposed agricultural water management programs and activities aimed to provide reliable agricultural water supply for its landowners. The document provides a description and quantification of water supply sources for agricultural users (surface and groundwater), a water reliability assessment, and efficient water management practices (WRMWSD, 2015). WRMWSDD completed an update to its AWMP in 2020; that update will be incorporated in the 2025 GSP update.
- Tejon Ranch Conservancy prepared a Ranch-Wide Management Plan (RWMP). Under the RWMP, the Conservancy conducts ecological monitoring as part of its adaptive management program. Initial monitoring is conducted to develop baseline information, and subsequent monitoring is intended to identify and track progress towards land management goals under the RWMP. One aspect of the RWMP monitoring that relates to groundwater management under SGMA is the assessment and monitoring of riparian systems at selected study sites throughout TRC lands. Although none of the 15 selected study sites were within the Tejon-Castac Management Area, results from the study helped to define ecological conceptual models that include a hydrologic component, knowledge that likely has a broader applicability to systems within the Tejon-Castac Management Area.

### 5.2.2. Operational Flexibility Limitations

**☑ 23 CCR § 354.8(d)**

The above water resource monitoring and management programs are not expected to limit operational flexibility in the Basin or the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas. In fact, some of these monitoring networks will be integral to the on-going monitoring and reporting that will be conducted pursuant to this SOKR GSP (see **Section 16 *Monitoring Network***).

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

ACSD water wells and water system are controlled by the ACSD. Water restrictions in the ACSD urban area will be controlled by the ACSD. The ACSD UWMP contains provisions consistent with water use as contemplated by the SOKR GSP. The ACSD needs to meet certain guidelines under Title 22 to provide water to its customers and will do so while being consistent with the objectives set forth in the SOKR GSP.

The ACSD UWMP reports a 2015 water demand of close to 2,000 AFY and projects a future demand of up to 6,400 AFY in 2040. A more detailed breakdown of ACSD Water Use estimates as of 2018 is provided in **Appendix D**. Currently, AEWSD and ACSD have executed a Memorandum of Understanding (MOU) that, among other things, provides ACSD with a "…right of first refusal to purchase any pumping allocations offered for sale through such approved market mechanism up to the quantity actually needed by ACSD to serve its customers, not to exceed 1.8 AF per acre of developed urban lands".[34] Beyond the cooperative relationship established in the MOU, and the need to establish Sustainability Criteria that are protective in the ACSD urban area, it is not expected that the water use by ACSD will limit operational flexibility of the Arvin-Edison Management Area.

Most of the groundwater management objectives identified in the GWMPs and AWMPs are consistent with the issues and objectives identified in the following sections of this GSP. The implementation of this SOKR GSP will contribute to the sustainable groundwater use within the Management Areas. Therefore, this SOKR GSP complements and supersedes the GWMPs.

### 5.2.3. Conjunctive Use in the Management Areas

☑ **23 CCR § 354.8(e)**

#### 5.2.3.1. Arvin-Edison Management Area

Since the mid-1960s, AEWSD has supported the conjunctive use of surface water (CVP, SWP, Kern River, and other surface water/river systems) and groundwater resources within the Arvin-Edison Management Area, which has been the primary cause of the recovery and stability of groundwater levels observed in the area (see **Section 8 *Current and Historical Groundwater Conditions***). Since the availability of most of AEWSD's imported surface water supply varies depending on hydrology and other factors (see **Section 9.1.2.1 *Surface Water Inflows and Outflows***), AEWSD actively develops and implements conjunctive use programs wherein the underlying groundwater basin is utilized directly for seasonal and long-term carry-over storage. Because of this, AEWSD's distribution system, from the beginning, has incorporated recharge basins and AEWSD-owned deep wells to capture, store, and recover wet period water for later use during dry periods. AEWSD's historical operations to import, manage, and store water within its service area have resulted in benefits to both the SWSA and the Groundwater-only Service Area (GWSA).

[34] Additional relevant terms of the MOU include: Sewage effluent resulting from ACSD extractions of groundwater and delivery of water to its customers is collected, treated, and disposed of by the City of Arvin and the Parties wish to ensure that any return flow from the ultimate disposition of the treated effluent is considered when accounting for net groundwater use in the area.

As part of Plan Implementation, AEWSD will continue to refine and update its policies as appropriate regarding General Project and General Administration Service Charges (see **Section 18 *Plan Implementation***).

AEWSD operates a large-scale groundwater storage and recovery program within the Arvin-Edison Management Area that includes three spreading basin facilities (totaling approximately 1,850 acres) and 86 recovery wells (see **Section 7.3.4 *Recharge and Discharge Areas***). Between July 1966 and December 2018, a total of over 2.3 million acre-feet (AF) of water has been delivered to these facilities, an average of approximately 43,300 AFY. Net percolation[35] for the same period was approximately 2.22 million AF, averaging approximately 42,400 AFY.

The Metropolitan Water District (MWD) first entered into a banking agreement with AEWSD in 1997, which was then amended in 2007.[36] Since the program inception through 2018, MWD has stored approximately 580,000 AF of water in AEWSD banking facilities, and AEWSD has returned about 400,000 AF of recovered banked supplies. The MWD banking agreement establishes a maximum regulation capacity (i.e., maximum storage of MWD water) of 350,000 AF and a return volume between 40,000 AF and 75,000 AF in any given year. Available MWD water is the volume of delivered water minus a fixed 10% loss factor that is assessed to address losses incurred due to transportation, evaporation, metering discrepancies, etc. The 10% loss factor was set conservatively to assure that more water is stored than recovered, ensuring a net gain to the Basin from the Program. As of 23 May 2019, the current MWD balance in AEWSD's spreading facilities is approximately 153,200 AF.

AEWSD currently maintains active partnerships with several agencies on an annual basis to support the transfer and exchange of surface water within and outside of the Kern Subbasin.[37] AEWSD also participates in several out-of-district groundwater storage and recovery programs both within and outside the Kern Subbasin. As an example, and as of February 2019, AEWSD has 77,590 AF of imported water supplies banked and available to withdraw in various locations outside the Arvin-Edison Management Area, including:

- 58,886 AF in the Rosedale Rio-Bravo Water Storage District (RRBWSD) water bank;
- 10,704 AF in the Westside Mutual Water Company water bank; and
- 8,000 AF in the Kaweah Delta Water Conservation District water bank.

Recently, AEWSD has increased its conjunctive use efforts through the development of the North In-Lieu Project (NILP), also referred to as the DiGiorgio Unit In-Lieu Project. This project involves expanding the SWSA by approximately 3,900 acres and incorporating groundwater wells within this area into the AEWSD distribution system for increased extraction capability when necessary. Additional conjunctive use projects are considered in **Section 17 *Projects and Management Actions***.

The NILP is planned to be developed over several phases: Phase I, completed in 2018, consisted of the expansion of AEWSD's network (2.7 miles of bi-directional pipelines) to serve two purposes: (1) provide

[35] Net percolation is defined as the net amount of water infiltrated into basin from the recharge facilities. This is calculated as the delivered water minus losses due to evaporation and other factors.

[36] From the First Amended and Restated *Agreement Between Arvin-Edison Water Storage District and Metropolitan Water District of Southern California for a Water Management Program*, dated 9 October 2007. This agreement currently extends through 2034.

[37] AEWSD has had over 72 partners since 1995.

surface water supply to 743 acres that were previously located outside of the SWSA, and (2) connect five pumping facilities located within the Phase I area such that they can pump water back to the North Canal, thereby fully integrating landowner pumping facilities to AEWSD's water and power distribution systems. The remaining phases will be initiated once funding is secured and are included in the Projects and Management Actions described in **Section 17 *Projects and Management Actions.*** The Groundwater Service Program (GWSP), approved in February 2019 by AEWSD's board, provides for an agreement between AEWSD and NILP participants so that together NILP and the GWSP meet AEWSD's goal to increase conjunctive use planning procedures to improve overall supply reliability while minimizing total water supply costs. Under the GWSP, AEWSD can also provide PWRPA electrical service to any landowner well pumping facilities within AEWSD as a means to minimize costs associated with groundwater recovery operations and further integrate them into its comprehensive water and power distribution systems.

The NILP incorporates five new connected electrical loads consisting of 1,000 horsepower. The GWSP meets the Western Areas Power Administration (WAPA) wholesale distribution tariff with Pacific Gas & Electric (PG&E) and consequently requests that PWRPA approve the additional loads. Development of future phases of the NILP are included as a Project and Management Action to this GSP (see "DiGiorgio Unit In-Lieu Project" description in **Section 17 *Projects and Management Actions***). With this GSP, the GWSP may also be expanded to all landowner well pumping facilities provided agreements are executed with AEWSD to transfer groundwater pumping facilities.

AEWSD further plans to extend the in-lieu SWSA by an additional 2,500 acres through its proposed Frick Unit In-Lieu Project. This project will involve the development of a pressure pipeline system that connects to AEWSD's Forest-Frick Pumping Plant facility and/or the Eastside Canal (maintained by KDWD) to provide surface water service to customers along the northwestern AEWSD boundary. The AEWSD Board recently approved Task Orders of over $300,000 for its engineering consultant (Provost & Pritchard) to continue with 30% design and complete environmental documentation for the NILP and additional in-lieu areas, as well as the Forest-Frick Pumping Plant facility and Eastside Canal intertie. This project will be initiated once funding is secured. There is no current estimated timeframe of completion.

AEWSD also operates a Temporary Water Service Program to contracted landowners within its jurisdictional boundaries, both for agricultural uses as well as other special purposes defined by AEWSD. Temporary Water Service for Agricultural Uses is water service made available for agricultural use on an interruptible and non-dependable basis to lands outside the SWSA, and at times AEWSD would otherwise be spreading and recharging water. As the delivery of temporary water offsets groundwater extraction this program serves as an "in-lieu" recharge program. In the event that the AEWSD Board determines that temporary water service for a given period or water year is in the best interest of AEWSD, the AEWSD Board may authorize such service and set charges. Such temporary water service shall be made available only to lands having an independent alternative source of water and no crop is to be planted which will be dependent upon the continued delivery of the temporary water. In order that land located outside the SWSA is to be eligible for temporary water service, the landowner shall have executed an agreement establishing a covenant running with the land, in a form provided by AEWSD, wherein the landowner expressly acknowledged that the affected lands have no right to Contract Water Service from AEWSD. Such temporary water service may be made available to eligible land through an existing farm turnout or through a temporary farm turnout to be installed by AEWSD at landowner's expense and used to serve temporary water or directly from AEWSD's Distribution Facilities canals through pumps and metering devices installed to AEWSD's specifications and at landowner's expense, which facilities shall be operated solely by AEWSD personnel; provided that AEWSD facilities are able to deliver the extra water and the delivery of such water does not interfere with water service deliveries to Water Users within the SWSA.

Temporary Water Service for Special Purposes is water service made available on an interruptible and non-dependable basis for uses not directed to agricultural uses, within or outside of the Surface Water Service Area. Such water may be made available at the discretion of the Engineer-Manager on a short-term basis only, and AEWSD reserves the right to discontinue such service at any time. Persons wishing such service must either make arrangements with a Water User for use of turnout facilities or with AEWSD if water is to be taken directly from AEWSD's canal or other facility; file with AEWSD a form of contract entitled "Arvin-Edison Water Storage District Contract for Temporary Water Service for Special Purposes"; and make such payments or deposit such funds as are set forth in said form of contract pursuant to policy established by the Board from time to time.

##### 5.2.3.2. Wheeler Ridge-Maricopa Management Area

Since 1971, WRMWSD has imported SWP surface water, supporting the conjunctive use of surface water and groundwater resources within the Wheeler Ridge-Maricopa Management Area, which has been the primary cause of the recovery and stability of groundwater levels observed in the area (see **Section 8 *Current and Historical Groundwater Conditions***). WRMWSD banks water in and returns it from out-of-district water banks (e.g., the Pioneer Water Bank; see **Section 9.2.2.1 *Surface Water Inflows and Outflows***) through its own conveyance network and the California Aqueduct. As of December 2018, WRMWSD has a combined 200,700 AF stored in its banking projects. The California Aqueduct is also used for intra-district conveyance, wherein delivered water supplies are blended with groundwater, the proportion of which varies depending on the season and the water year type.

##### 5.2.3.3. Tejon-Castac Management Area

There is no significant use of surface water or conjunctive use within the Tejon-Castac Management Area. No permitted Points of Diversion exist within the Tejon-Castac Management Area.[38]

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

☑ **23 CCR § 354.8(f)**

The following sections describe topic categories of general plans and other planning documents with specific relevance to this SOKR GSP. This section also introduces Watch Areas, a concept developed to promote sustainable management of groundwater in largely undeveloped areas.

### 5.3.1. Kern County General Plan

☑ **23 CCR § 354.8(f)(1)**

The Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas are located within the Kern County General Plan area (Kern County, 2009). The current Kern County General Plan was first

[38] Point of Diversion (POD) No. 44642 shows up within the Tejon-Castac Management Area in the State Water Resources Control Board Electronic Water Rights Information Management System (eWRIMS) mapping tool; however, this POD appears to be plotting incorrectly as it is associated with the Beaumont-Cherry Valley Water District which is several hundred miles away.

adopted in 2004 and has undergone several amendments; the most recent amendment was approved in 2009 (General Plan). The County is currently working to update its General Plan through 2040, with completion of the "2040 General Plan" expected in 2019. This section identifies relevant policies in the current General Plan that could: (1) affect water demands in the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas (e.g., due to population growth and development of the built environment), (2) influence the GSP's ability to achieve sustainable groundwater use, and (3) affect implementation of General Plan land use policies.

***Figure PA-6, Figure PA-8,*** and ***Figure PA-17*** shows the current General Plan land use designations within the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas. The land use designations include primarily intensive and extensive agriculture, residential, mineral and petroleum, industrial, incorporated cities (City of Arvin), and other designations. These designations are generally consistent with the predominantly agricultural land use within the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas as shown in **Figure PA-9*, Figure PA-11,*** and ***Figure PA-13.***

The Land Use, Open Space, and Conservation Element (Chapter 1) of the General Plan includes the following goals, policies, and implementation measures that are related to groundwater or land use management, and that could potentially influence the implementation of this SOKR GSP.

*Physical and Environmental Constraints*

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

*Public Facilities and Services*

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

*Residential*

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

*Industrial*

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

*Energy*

- **Goal:** Encourage safe and orderly commercial solar development.
- **Policy 4.** The County should encourage solar development in the desert and valley regions previously disturbed and discourage development of energy projects on undisturbed land supporting State or federally protected plant and wildlife species.
- **Implementation Measure A.** The County shall continue to maintain, and update as necessary, provisions in the Kern County Zoning Ordinance to provide adequate development standards for commercial solar energy development.
- **Implementation Measure B.** The County should work with affected State and federal agencies and interest groups to establish consistent policies for solar energy development.

*Resource*

- **Goal 6.** Encourage alternative sources of energy, such as solar and wind energy, while protecting the environment.
- **Policy 7.** Areas designated for agricultural use, which include Class I and II land classifications and other enhanced agricultural soils with surface delivery water systems, should be protected from incompatible residential, commercial, and industrial subdivision and development activities.
- **Policy 10.** To encourage effective groundwater resource management for the long-term economic benefit of the County the following shall be considered:
- **Policy 10.a.** Promote groundwater recharge activities in various zone districts.
- **Policy 10.c.** Support the development of groundwater management plans.
- **Policy 10.d.** Support the development of future sources of additional surface water and groundwater, including conjunctive use, recycled water, conservation, additional storage of surface water and groundwater and desalination.

*General Provisions*

- **Goal 1.** Ensure that the County can accommodate anticipated future growth and development while maintaining a safe and healthful environment and a prosperous economy by preserving valuable natural resources, guiding development away from hazardous areas, and assuring the provision of adequate public services.
- **Policy 40.** Encourage utilization of community water systems rather than the reliance on individual wells.
- **Policy 41.** Review development proposals to ensure adequate water is available to accommodate projected growth.
- **Policy 45.** New high consumptive water uses, such as lakes and golf courses, should require evidence of additional verified sources of water other than local groundwater. Other sources may include recycled stormwater or wastewater.

- **Implementation Measure U.** The Kern County Environmental Health Services Department will develop guidelines for the protection of groundwater quality which will include comprehensive well construction standards and the promotion of groundwater protection for identified degraded watersheds.

☑ **23 CCR § 354.8(f)(2)**
☑ **23 CCR § 354.8(f)(3)**

The above goals, policies and implementation measures established by the General Plan are complementary to sustainable groundwater management of the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas relative to future land use development and conservation (i.e., the General Plan encourages development of the County's groundwater supply to ensure that existing users have access to high quality water, and states that future growth should be accommodated only while ensuring that adequate high-quality water supplies are available to existing and future users). Successful implementation of this SOKR GSP will help to ensure that the Management Areas' groundwater supply is managed in a sustainable manner, and will provide routine reporting of groundwater conditions that Kern County and others can use to inform local decisions on growth and development. Therefore, implementation of General Plan policies is not expected to affect the ability of the Management Areas to achieve groundwater sustainability.

Likewise, implementation of this SOKR GSP is not anticipated to significantly affect the water supply assumptions or land use plans within the General Plan over the planning horizon. Given that the General Plan is being updated concurrently with the development of this SOKR GSP, and the County has been engaged in the process of SGMA implementation, it is anticipated that the 2040 General Plan would consider the Kern Subbasin Plan and utilize consistent water supply assumptions over the 2040 planning horizon. As required by California Government Code § 65352.5(d), the SOKR GSAs will coordinate with and provide the necessary information to land use planning agencies that are adopting or amending their general plans.

### 5.3.2. Metropolitan Bakersfield General Plan

☑ **23 CCR § 354.8(f)(1)**

The northeastern portion of the Arvin-Edison Management Area overlies the City of Bakersfield General Plan Area; therefore, it is subject to the Metropolitan Bakersfield General Plan (City of Bakersfield, 2016). The current City General Plan was first adopted in 2002 updated in January 2016 (City General Plan). This section identifies relevant policies in the City General Plan that could affect water management in the Arvin-Edison Management Area.

The City General Plan land use designations include primarily residential - low density, residential - rural, residential - suburban, resource - extensive, open space - slopes (areas with greater than equal to thirty percent slope), open space (floodplains and resource management areas and agriculture uses). As seen in ***Figure PA-7***, primary land use designations within the portion of the City General Plan overlain by the Arvin-Edison Management Area include intensive agriculture and mineral and petroleum. These designations are generally consistent with the predominantly agricultural land use within the

Management Area shown in ***Figure PA-9*** and the Kern County General Plan land use designations shown in ***Figure PA-6*** .

The Land Use Element (Chapter II) of the City General Plan includes the following goals, policies, and implementation measures that are related to groundwater or land use management, that could potentially influence the implementation of this SOKR GSP.

- **Goal 6.** Accommodate new development that is sensitive to the natural environment, and accounts for environmental hazards.
- **Policy 77.** Allow for the continuance of agricultural uses in areas designated for future urban growth.
- **Policy 79.** Provide for an orderly outward expansion of new "urban" development (any commercial, industrial, and residential development having a density greater than one unit per acre) so that it maintains continuity of existing development, allows for the incremental expansion of infrastructure and public services, minimizes impacts on natural environmental resources, and provides a high-quality environment for living and business.
- **Policy 80.** Assure that General Plan Amendment proposals for the conversion of designated agricultural lands to urban development occur in an orderly and logical manner giving full consideration to the effect on existing agricultural areas.
- **Implementation 7.** Environmental Review. Local guidelines for project processing shall reflect California Environmental Quality Act (CEQA) Guidelines which state that the environmental effects of a project must be taken into account as part of project consideration.

The Conservation Element (Chapter V) of the City General Plan includes the following goals, policies, and implementation measures that are related to groundwater or land use management, that could potentially influence the implementation of this SOKR GSP.

*Mineral Resources*

- **Goal 4.** Protect land, water, air quality and visual resources from environmental damage resulting from mineral and energy resource development.

*Soils and Agriculture*

- **Goal 2.** Promote soil conservation and minimize development of prime agricultural land.
- **Goal 3.** Establish urban development patterns and practices that promote soil conservation and that protect areas of agricultural production of food and fiber crops, and nursery products.
- **Policy 4.** Monitor the amount of prime agricultural land taken out of production for urban uses or added within the plan area.
- **Policy 10**. Encourage landowners to retain their lands in agricultural production.
- **Policy 14.** When considering proposals to convert designated agricultural lands to nonagricultural use, the decision-making body of the City and County shall evaluate the following factors to determine the appropriateness of the proposal: Ability to be provided with urban services (sewer, water, roads, etc.).

*Water Resources*

- **Goal 1.** Conserve and augment the available water resources of the planning area.
- **Goal 2.** Assure that adequate groundwater resources remain available to the planning area.
- **Goal 3.** Continue cooperative planning for and implementation of programs and projects which will resolve water resource deficiencies and water quality problems.
- **Goal 5.** Achieve a continuing balance between competing demands for water resource usage.
- **Goal 6.** Maintain effective cooperative planning programs for water resource conservation and utilization in the planning area by involving all responsible water agencies in the planning process.
- **Policy 1.** Develop and maintain facilities for groundwater recharge in the planning area.
- **Policy 2.** Minimize the loss of water which could otherwise be utilized for groundwater recharge purposes and benefit planning area groundwater aquifers from diversion to locations outside the area.
- **Policy 3.** Support programs to convey water from other than San Joaquin Valley basin sources to the planning area.
- **Policy 4.** Support programs and policies which assure continuance or augmentation of Kern River surface water supplies.
- **Policy 5.** Work towards resolving the problem of groundwater resource deficiencies in the upland portions of the planning area.
- **Policy 6.** Protect planning area groundwater resources from further quality degradation.
- **Policy 7.** Provide substitute or supplemental water resources to areas already impacted by groundwater quality degradation by supporting facilities construction for surface water diversions.
- **Policy 8.** Consider each proposal for water resource usage within the context of total planning area needs and priorities-major incremental water transport, groundwater recharge, flood control, recreational needs, riparian habitat preservation and conservation.
- **Policy 9.** Encourage and implement water conservation measures and programs.
- **Implementation measure 2.** Support all financially feasible and practical groundwater projects, for the augmentation of groundwater recharge for the south San Joaquin Valley basin by the construction and operation of additional recharge facilities or the importation of additional water for basin recharge.
- **Implementation measure 5.** Initiate and/or support planning, financing, construction and implementation programs for supplying upland portions of the planning area having groundwater deficiencies with an adequate water supply.
- **Implementation measure 10.** Support additional water conservation measures and programs of benefit to the planning area.

☑ 23 CCR § 354.8(f)(2)
☑ 23 CCR § 354.8(f)(3)

The above goals, policies and implementation measures established by the City General Plan are complementary to sustainable groundwater management of the Arvin-Edison Management Area relative to future land use development and conservation. The City General Plan establishes as a general goal for groundwater management to reach a condition of "safe yield" for the groundwater basin. Furthermore, it acknowledges the need to provide a stable water supply and considers water resources as a major factor for development decisions. Successful implementation of this SOKR GSP will help to ensure that the Arvin-Edison Management Area's groundwater supply is managed in a sustainable manner and will provide routine reporting of groundwater conditions that the City of Bakersfield and others can use to inform local decisions on growth and development. Therefore, implementation of City General Plan policies is not expected to affect the ability of the Arvin-Edison Management Area to achieve groundwater sustainability. Likewise, implementation of this SOKR GSP is not anticipated to affect the City's water supply assumptions or land use plans. As required by California Government Code § 65352.5(d), the Arvin GSA will coordinate with and provide the necessary information to land use planning agencies that are adopting or amending their general plan.

### 5.3.3. City of Arvin General Plan

☑ 23 CCR § 354.8(f)(1)

The City of Arvin falls entirely within the Arvin-Edison Management Area and therefore the City of Arvin General Plan (City of Arvin, 2012) is relevant to the Arvin-Edison Management Area. The current City of Arvin General Plan was updated in August 2012. This section identifies relevant policies in the Arvin General Plan that could affect water management in the Arvin-Edison Management Area.

The Arvin General Plan land use designations are listed in the following table (***Table PA-4***). These designations are consistent with AEWSD's land use designations shown in ***Figure PA-9***, Kern County General Plan land use designations shown in ***Figure PA-6***, and the City of Bakersfield General Plan land use designations shown in ***Figure PA-7***.

**Table PA-4. City of Arvin - Land Use Designations**

| Land Use Designation | Acres | Percent of Total |
|---|---|---|
| Estate Residential | 294.8 | 9.6% |
| Residential Reserve | 179.1 | 5.8% |
| Low Density Residential | 950.7 | 30.9% |
| Medium Density Residential | 18.0 | 0.6% |
| High Density Residential | 158.3 | 5.1% |
| General Commercial | 151.4 | 4.9% |
| Light Industrial | 291.9 | 9.5% |
| Heavy Industrial | 512.5 | 16.7% |
| Parks | 45.2 | 1.5% |
| Public Facilities | 19.7 | 0.6% |
| Schools | 129.9 | 4.2% |
| Agricultural | 1.0 | <0.1% |
| Streets/ROW | 325.0 | 10.6% |
| **Total** | **3,077.5** | |

*Source: City of Arvin General Plan*

The Conservation and Open Space Element of the City of Arvin General Plan includes the following goals and policies that are related to groundwater or land use management, that could potentially influence the implementation of this SOKR GSP.

- **Goal 3** Maintain and enhance groundwater levels in order to assure an adequate supply for future City water needs.
    - Policy CO-3.1 Encourage continued groundwater recharge efforts of the Arvin-Edison Water Storage District.
    - Policy CO-3.2 Embark on a public education program regarding water conservation practices in residential, commercial, industrial and public facility development.
    - Policy CO-3.3 Encourage the use of reclaimed wastewater for appropriate uses such as agricultural irrigation or frost protection.

- Policy CO-3.4 Require thorough information in all environmental assessments for projects which may have a substantial effect on groundwater levels.

- **Goal 4** Continue to provide high quality water for domestic use within the City of Arvin.
  - Policy CO-4.1 Monitor water quality regularly in all wells in the Arvin Community Services District.
  - Policy CO-4.2 Investigate means of protecting the groundwater supply from contamination by agricultural chemicals.
  - Policy CO-4.3 Ensure that all components of the City's infrastructure related to water delivery and consumption, including those on private property, are functioning properly to protect water quality.

☑ **23 CCR § 354.8(f)(2)**
☑ **23 CCR § 354.8(f)(3)**

The above goals and policies established by the City of Arvin General Plan are complementary to sustainable groundwater management of the Arvin-Edison Management Area relative to future land use development and conservation. The City of Arvin General Plan establishes as a purpose for the Conservation and Open Space Element: "…to promote the protection, stewardship, and use of the City's natural resources and to prevent wastefulness, unsustainable usage, and neglect. Furthermore, all of the Elements of the General Plan reflect the principles of integration of SB 375, the Sustainable Communities Planning Act of 2008". Considering ACSD's active involvement in the development of this GSP, the implementation of City of Arvin General Plan policies is not expected to affect the ability of the Arvin-Edison Management Area to achieve groundwater sustainability. Likewise, implementation of this SOKR GSP is not anticipated to affect the City of Arvin's water supply assumptions or land use plans. The goals and objectives of the ACSD UWMP are consistent with and complement this SOKR GSP. As required by California Government Code § 65352.5(d), the Arvin GSA will coordinate with and provide the necessary information to land use planning agencies that are adopting or amending their general plan.

#### 5.3.4. Tejon Ranch Conservation and Land Use Agreement

Lands within the Tejon-Castac Management Area are owned almost exclusively by a single entity, the TRC, and are protected and managed under the Tejon Ranch Conservation and Land Use Agreement (C&LU Agreement; dated 17 June 2008). The sole exception to TRC's ownership of lands within the Tejon-Castac Management Area is a miniscule (10 feet [ft] by 10 ft) piece of land that contains the Caratan Well (see ***Figure PA-16***); this land was included in a transfer/sale by TRC of several hundred acres of other agricultural lands outside of the Tejon-Castac Management Area in 1971.[39] The Bakersfield National Cemetery is directly adjacent to the Tejon-Castac Management Area boundary along Highway 223, but this facility is not within the Tejon-Castac Management Area boundaries.

The C&LU Agreement was entered into by TRC and a collection of Resource Organizations[40] in 2008 for the purposes of protecting the natural resource values of the 270,000-acre Tejon Ranch. The C&LU

[39] This transaction was recorded by the Kern County Recorder in Book 4616 page 496.
[40] Resources Organizations party to the C&LU Agreement include the Sierra Club, the National Audubon Society d.b.a. Audubon California, the Natural Resources Defense Council, the Endangered Habitats League, and the Planning and Conservation League.

Agreement dedicates the majority of Tejon Ranch lands (approximately 90%) to conservation while reserving to TRC the right to pursue development in certain defined areas of Tejon Ranch. The C&LU Agreement included the establishment of a new independent non-profit entity, the Tejon Ranch Conservancy (Conservancy),[41] whose purpose is to develop and implement a RWMP[42] that includes BMPs for land management. Under the C&LU Agreement and subsequent exercise of easement acquisition options contained therein, approximately 54% of land area within the Tejon-Castac Management Area is now designated as Conservation Easement (CE) area (covered by the RWMP), and it will be entirely designated as a CE area once certain development milestones for the Grapevine Project[43] are reached. Approximately 277 acres of land in the west-central portion of the Tejon-Castac Management Area are designated as Designated Mining Area (190 acres of which are currently developed for mining), and approximately 2,500 additional acres on the northwest side of the Tejon-Castac Management Area are designated as a "Future Mining Envelope" of which a maximum of 800 acres may be designated in the future as Designated Mining Area.

### 5.3.5. Watch Areas

☑ **23 CCR § 354.8(f)(1)**

"Watch Areas" is a groundwater management tool concept developed by the KGA GSA and its members to fulfill the requirements of SGMA in areas of the Kern Subbasin with no significant groundwater use and no planned groundwater use as documented in the SOKR GSP. Watch Areas will be monitored for land use changes and groundwater conditions.

The concept of Watch Areas recognizes the need for monitoring and management of these areas under SGMA, while also acknowledging the lack of infrastructure for groundwater use and monitoring. These areas, which are typically on the fringes of the main valley floor area, are markedly different in their water use patterns than the agriculturally dominated (and urbanized) areas in the main valley floor area. In these areas, the occurrence and condition of groundwater is controlled by natural hydrologic factors (e.g., climatic variability, relatively undisturbed land use, etc.) rather than human activity. In Watch Areas, groundwater use is de minimis and the prevailing water use pattern is similar to that of native vegetation.

Due to their lack of groundwater use (and typically a lack of groundwater extraction and monitoring infrastructure), Watch Areas are not required to establish specific sustainability criteria or monitoring networks. Instead, to achieve sustainable management in the Watch Areas, land and water use is planned to be monitored using remote sensing technology (e.g., the Irrigation Training and Research Center [ITRC] Mapping of EvapoTranspiration with Internal Calibration [METRIC™] method), and the primary metric being monitored is the consumptive use of water. This consumptive use of water use is compared to that of native vegetation, and as long as the measured consumptive use is no greater than the consumptive use by native vegetation, the area meets the definition of Watch Area. If the measured consumptive use of water exceeds that of native vegetation for a specified period of time, the land is considered to no

[41] http://www.tejonconservancy.org/index.htm
[42] http://www.tejonconservancy.org/rwmp.htm
[43] The Grapevine Project is a mixed-use development project on other TRC lands outside of the Tejon-Castac Management Area and the Kern Subbasin.

longer meet the definition of Watch Areas and is then subject to the full suite of comprehensive management actions and requirements prescribed within the GSP.

With the exception of approximately 190 acres of developed area within the Designated Mining Envelope (i.e., the Granite Quarry facility), the Tejon-Castac Management Area consists entirely of the types of land use considered for inclusion under the Watch Area definition. As discussed further below, based on available data, groundwater conditions within the Tejon-Castac Management Area are not significantly affected by human activity, supporting the notion that the Tejon-Castac Management Area is consistent with the definition of Watch Areas.

### 5.3.6. Well Permitting Process

☑ **23 CCR § 354.8(f)(4)**

Well permits within the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas are issued by the Kern County Public Health Services Department (KCPHSD) Water Well Program. The Water Well Program issues permits to construct, reconstruct and destroy water wells. All wells must be constructed in accordance with Kern County Ordinance Code Section 14.08, and the Department of Water Resources' Bulletin 74-81 and Bulletin 74-90, except as modified by subsequent revisions. The ordinance requires, among other things, that domestic and agricultural wells be installed a minimum distance from potential pollution and contaminant sources, water quality be tested for new and reconstructed wells, an NSF 61 approved flowmeter be installed, and the final well construction be inspected by County staff. Recently, the KCPHSD released a supplemental well application for wells intended to be installed in overdrafted basins. This new form additionally requires water district and GSA information, and grants GSAs review power. Starting in 2019, it is AEWSD's and WRMWSD's policies to provide a written response to KCPHSD and the well applicant when supplemental well application forms are received.

#### 5.3.6.1. Well Permitting Urban Process

ACSD has the authority to construct water wells without obtaining permits through the County of Kern. The ACSD operates under a water supply permit issued by the State of California. ACSD must obtain authorization to discharge new wells into the distribution system after a review of water quality by the SWRCB. This review considers the construction of the well and wellsite, discharge piping and chlorination equipment, a review of the risk of contamination of the new well from external sources of contamination, and the sanitary and security measures put in place to protect the well from accidental/unintended contamination (such as flooding) as well as terrorism and vandalism.

#### 5.3.6.2. Executive Order N-7-22

Executive Order (EO) N-7-22 was signed by Governor Newsom on 28 March 2022 and amends prior proclamations for states of emergency due to California's ongoing drought conditions. The SOKR GSAs, in coordination with other Basin GSAs, are working with the County of Kern to implement the EO's new well-permitting requirements.

## 5.4. Additional GSP Elements

☑ **23 CCR § 354.8(g)**

Per CWC § 10727.4, a GSP shall include, where appropriate and in collaboration with the appropriate agencies, all of the following:

*Control of saline water intrusion*

Because the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas are located far from coastal areas, seawater intrusion is not considered to be an issue. Waste discharges containing saline water are a concern, but they are regulated by the CVRWQCB. Oil field produced water (water brought up with oil) has high salinity in some areas. AEWSD, WRMWSD, and TCWD support the CVRWQCB and California Geologic Energy Management Division (CalGEM) regulations that protect groundwater from being contaminated by oil field produced water and has been investigating water treatment programs to turn it into a new resource.

*Wellhead protection*

The Kern County Public Health Services Department Water Well Program issues permits to construct, reconstruct and destroy water wells (see **Section 5.3.6 *Well Permitting Process)***. AEWSD, WRMWSD, and TCWD actively assists its landowners to comply with County wellhead protection and well destruction policies.

*Migration of contaminated groundwater*

AEWSD has been active in monitoring where contaminated groundwater is and gets involved as an interested party to support migration control and groundwater cleanup projects. A USEPA Superfund site in Arvin is an example of this.

There are no known active contaminated groundwater sites within the Wheeler Ridge-Maricopa Management Area. The CVRWQCB GeoTracker and California Department of Toxic Substances Control (DTSC) EnviroStor databases show two closed Cleanup Program sites, one closed Leaking Underground Storage Tank (LUST) site, and four sites listed as "inactive – Needs Evaluation". These sites are discussed further in **Section 8.5 *Groundwater Quality*** below.

There are no known contaminated groundwater sites within the Tejon-Castac Management Area. The CVRWQCB GeoTracker website shows one active site located outside of the Tejon-Castac Management Area to the north, which is discussed further in **Section 8.5 *Groundwater Quality*** below.

*Well abandonment and well destruction program*

The KCPHSD Water Well Program issues permits to construct, reconstruct and destroy water wells with written verification from the managing GSA per EO N-7-22 (see **Section 5.3.6 *Well Permitting Process***). AEWSD, WRMWSD, and TCWD has been active to assist landowners in converting wells into monitoring wells. This has included obtaining grants from DWR that included funds to assist landowners with well conversion costs. AEWSD will continue to support the County's Program.

*Replenishment of groundwater extractions*

AEWSD and WRMWSD actively manage the Basin within its boundaries through conjunctive use, groundwater banking and recovery using its system of spreading basins, and other programs (see **Section 5.2.3 *Conjunctive Use in the Management Areas***). Projects and programs to replenish extracted groundwater, such as the Temporary Water Service Contracts and North In-Lieu Project developed by AEWSD will be pursued as funding permits and as required to maintain sustainable groundwater conditions as defined in this SOKR GSP.

In 2017, an approximately 75.5-acre parcel of land located outside of Tejon-Castac Management Area near its southwestern edge was made subject to use restrictions by TRC such that it became known as the "Water Recharge Site".[44] Land use for this parcel was thereby restricted to commercial grazing and "water reuse", meaning the receipt and irrigation and/or discharge to infiltration basins of water suitable for groundwater recharge for the purposes of groundwater recharge and reuse on Tejon Ranch. In an accompanying Memorandum of Amendment to Ranch Agreement, this land was released and no longer encumbered by the C&LU Agreement. This amendment to the C&LU Agreement benefitted certain lands previously within the CE Areas, including some lands in the southern portion of the Tejon-Castac Management Area. It is anticipated that this reuse activity, including potentially moving water between areas within and outside of the Tejon-Castac Management Area owned by TRC, will continue in the future.

*Conjunctive use and underground storage*

AEWSD and WRMWSD actively manage the Basin within its boundaries through conjunctive use and other programs (see **Section 5.2.3 *Conjunctive Use in the Management Areas***). Conjunctive use will continue to be a fundamental principle for AEWSD. Expanding Temporary Water Service Contracts for landowners in the GWSA, and the North and Eastside In-Lieu Projects are examples of opportunities AEWSD will employ, as funding and landowner interest allows, to maintain sustainable underground storage in AEWSD.

There are no active conjunctive use or groundwater storage programs within the Tejon-Castac Management Area. See above for a description of water recharge actions being implemented by TRC in an area outside of the Tejon-Castac Management Area near its southwestern edge. A potential future project involves conversion of the Granite Quarry site from an active mine to a groundwater recharge and recovery facility which could involve new wells. Such activity would not be inconsistent with the C&LU Agreement.

*Well construction policies*

The KCPHSD Water Well Program issues permits to construct, reconstruct and destroy water wells with written verification from the managing GSA per EO N-7-22 (see **Section 5.3.6 *Well Permitting Process***).

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

AEWSD and WRMWSD will continue to be active interested parties in groundwater contamination cleanup. Their involvement in the ILRP through the Kern River Watershed Coalition on behalf of AEWSD's and WRMWSD's landowners will continue for water quality protection.

[44] The Declaration of Use Restrictions was recorded at the Kern County Recorder as document #0217047475.

Expansion of recharge projects such as the North In-Lieu Project and Temporary Water Service Contracts will continue to be pursued by AEWSD as funding and landowner interest permit.

AEWSD is a participant in water storage projects that have the potential to improve surface water supplies (and groundwater conditions as a result) such as the Temperance Flat Reservoir Authority through the Friant Water Authority as funding and regulatory permitting processes allow. Groundwater storage projects such as the Metropolitan Water District banking program will continue to be supported and is in favor of AEWSD's long term groundwater sustainability.

Water recycling programs with the City of Bakersfield and ACSD are being investigated and will be pursued if deemed to be feasible, economical, and superior to other options for groundwater sustainability. Similarly, potential treatment and beneficial use of produced water from oil fields is being investigated.

AEWSD will continue to facilitate groundwater conveyance within its distribution systems to assist growers with drought protection.

AEWSD's work on its masterplan for groundwater extraction facilities will continue to support sustainable groundwater supplies.

WRMWSD constantly pursues water conservation through its water management practices. Currently its efficient water management practices for agricultural users are described in the WRMWSD Agricultural Water Management Plan (WRMWSD, 2015). This plan is summarized in **Section 5.2.1 *Existing Monitoring and Management Programs.***

WRMWSD also operates a “User Input pump-in program” to facilitate conveyance of groundwater pumped by landowners through its distribution system to other lands within the WRMWSD service area owned by that same landowner.

There are no groundwater contamination cleanup sites within the Tejon-Castac Management Area. Activities related to recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction are all governed by the principles within the C&LU Agreement (particularly Exhibit M thereto) and the RWMP.

*Efficient water management practices*

AEWSD and WRMWSD constantly pursue gaining efficiency through their water management practices, currently its water management practices for agricultural and urban contractors are described in the USBR AEWSD Water Management Plan (AEWSD, 2018), the ACSD UWMP (ACSD, 2016) that describes ACSD’s plan to reduce urban per capita potable water demand, and the WRMWSD Agricultural Water Management Plan (WRMWSD, 2015). These plans are summarized in **Section 5.2.1 *Existing Monitoring and Management Programs***.

The RWMP prepared by Tejon Ranch Conservancy includes Water Resources BMPs, as part of the Ranching and Livestock Management land use measures, designed to ensure efficient water resource management. These BMPs relate to maintenance of livestock water systems (i.e., to support existing and allowed grazing land uses), prevention of leakage and water loss from water systems to maximize efficiency, and prohibition of transferring water off of the Tejon Ranch.

*Relationships with State and federal regulatory agencies*

As described above, AEWSD maintains a federal water supply contract with the USBR for its Friant Division surface water supply. AEWSD also maintains a power supply contract with the Western Areas Power Administration (WAPA). AEWSD also has multiple agreements in place with DWR relating to its system of connections to California Aqueduct. ACSD reports to the SWRCB for Title 22 drinking water compliance and also receives state funding for various drinking water projects (see **Section 8.5 *Groundwater Quality***). As part of its 2012 annual update to the GWMP, AEWSD listed the following proposed management actions to continue relationships with Federal, State, and Local Agencies:

- Continue coordination of Project operations and monitoring programs with USBR;
- Monitor DWR and USBR Grant Funding Programs to seek funding for projects to improve groundwater conditions;
- Continue participation in the Friant Water Authority;
- Continue participation in KCWA's IRWMP, and other programs;
- Continue participation in Cross Valley Canal Advisory Committee;
- Continue participation in San Joaquin River Restoration Project (SJRRP) implementation meetings to minimize loss of Friant-Kern Canal Water Supplies and maximize the importation of Recapture/Recirculation water;
- Participate in studies and meeting with other agencies with an overall goal of maintaining highest incoming surface water quality possible;
- Continue operating water management programs with other agencies to increase supplies and reduce water costs;
- Continue participation in Kern River Watershed Coalition Authority to assist growers to comply with the ILRP;
- Continue participation in the Kern Basin, including agencies South of Kern River with the goal of improved local management of the Kern Basin; and
- Continue as a CASGEM reporting agency.

WRMWSD also maintains a water supply contract with KCWA for its SWP surface water supply that remains in effect until 2035. Currently, the Contractors and DWR are in the validation process of approving a contract extension to 2085. TCWD also maintains a water supply contract with KCWA for its SWP surface water supply; however, this SWP supply is not used within the Tejon-Castac Management Area.

The U.S. Fish and Wildlife Service has an interest in the Tejon-Castac Management Area under the Tehachapi Uplands Multiple Species Habitat Conservation Plan (TUMSHCP) which contemplates extension of incidental take authority to TCWD under a certificate of inclusion.

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

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

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

*Impacts on Groundwater Dependent Ecosystems*

Groundwater Dependent Ecosystems (GDEs) are ecosystems that depend on near-surface groundwater for their existence. GDEs can form where groundwater discharges to the surface as springs or seeps, or where groundwater exists at shallow depths (but without discharging), such that plants can access it with their roots. Impacts on Groundwater Dependent Ecosystems are discussed in **Section 8.8 *Groundwater Dependent Ecosystems***.

## 5.5. Notice and Communication

☑ **23 CCR § 354.10**

To fulfil notice and communication requirements, the Arvin-Edison Management Area adopted its Stakeholder Communication and Engagement Plan (SCEP) in June 2018, the Wheeler Ridge-Maricopa Management Area adopted its SCEP in August 2018, and the Tejon-Castac Management Area adopted its SCEP in December 2018. The SCEPs are living documents with frequent updates and are included herein in **Appendix E**. The SCEPs include sections on goals and desired outcomes of the GSP development process, stakeholder identification and mapping, messaging, venues for engagement, implementation schedule, and a stakeholder survey.

Following the public process described herein, the original Management Area Plans were approved by the AEWSD Board on 10 December 2019, by the WRMWSD Board on 11 December 2019, and by the TCWD Board on 10 December 2019, as documented in **Appendix N**. These Management Area Plans have now been amended and synthesized into the SOKR GSP, which was re-adopted and submitted in July 2022 (see **Section 4**).

### 5.5.1. Beneficial Uses and Users of Groundwater

☑ **23 CCR § 354.10(a)**

As part of the SCEPs, beneficial uses and users of groundwater in the Basin were identified, including various holders of overlying groundwater rights (agricultural users, domestic users, commercial/industrial users, etc.), municipal well operators, public water systems, local land use planning agencies, environmental users of groundwater, surface water users, the federal government, Native American tribes, and DACs/SDACs. Additionally, a Stakeholder Constituency “Lay of the Land” exercise was developed which identified stakeholders in the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas respectively, key interests and issues, and the level of engagement expected with each stakeholder. This exercise will be updated during GSP implementation.

### 5.5.2. Public Meetings Summary

☑ 23 CCR § 354.10(b)

The list below identifies public meetings, workshops, and direct outreach specific to SGMA and GSP development. Detailed meeting minutes and materials are available by request to Arvin, Wheeler Ridge-Maricopa, and TCWD GSAs.

*Board Meetings*

The AEWSD Board, WRMWSD Board, and TCWD Board have monthly Board Meetings at their offices. Regular SGMA updates are provided by Staff and/or their consultants, and stakeholders are provided the opportunity to provide input on the SOKR GSP development and implementation process. **Appendix E** includes a list of meeting dates where SGMA topics have been discussed at the Board Meetings. This information will be updated throughout SGMA implementation.

*Stakeholder Workshops*

AEWSD has hosted multiple workshops to educate its customers and other stakeholders within the Arvin-Edison Management Area regarding SGMA, including:

- AEWSD SGMA Landowner Workshop #1 – 17 November 2016
- AEWSD SGMA Landowner Workshop #2 – 8 December 2016
- AEWSD SGMA Landowner Workshop #3 – 2 October 2018; multiple workshops hosted in coordination with ACSD and Self-Help Enterprises
- Kern Subbasin Open House – 14 May 2019
- AEWSD SGMA Landowner Workshop #4 – 30 May 2019; multiple workshops hosted in coordination with ACSD, MCWD and Self-Help Enterprises
- Kern Subbasin GSP Public Review Open House – 26 September 2019
- SOKR GSP Stakeholder Workshop – 7 June 2022

As mentioned above, AEWSD and ACSD worked with the local community groups and Self-Help Enterprises, hosted several of the stakeholder workshops, and provided Spanish language translation. This list will be populated throughout GSP implementation. Stakeholder questions were answered during the workshop and a record of key questions and responses is provided in **Appendix E**. A detailed Implementation Plan has been developed (see ***Section 18***) in response to stakeholder interest in what SGMA implementation would look like locally.

WRMWSD has hosted and/or participated in workshops intended to educate local landowners and other stakeholders within the Wheeler Ridge-Maricopa Management Area regarding SGMA, including:

- WRMWSD SGMA Landowner Workshop #1 – 05/24/2018;
- Kern Subbasin Open House – 14 May 2019;
- WRMWSD SGMA Landowner Workshop #2 – 12 June 2019;
- Kern Subbasin GSP Public Review Open House – 26 September 2019; and

- SOKR GSP Stakeholder Workshop – 7 June 2022

This list will be populated throughout GSP implementation. While stakeholders were very engaged during the workshops, no direct feedback was provided for input into the GSP.

TCWD has hosted and/or participated in the following workshop intended to educate local landowners and other stakeholders within and around the Tejon-Castac Management Area regarding SGMA, including:

- Kern Subbasin Open House – 14 May 2019;
- Kern Subbasin GSP Public Review Open House – 26 September 2019; and
- SOKR GSP Stakeholder Workshop – 7 June 2022

*Miscellaneous Meetings*

AEWSD staff have conducted and/or attended numerous meetings where SGMA and related issues have been discussed. **Appendix E** includes a list of meeting dates where SGMA topics have been discussed with various entities and stakeholders in the Basin. This list will be updated throughout SGMA implementation.

*Direct Outreach*

Through the distribution of letters and surveys, the Arvin, Wheeler Ridge-Maricopa, and TCWD GSAs have made numerous efforts to secure local stakeholder input during the SGMA process (see **Appendix E**):

- Stakeholder survey distribution and respondence (2018 – 2019);
- Agricultural stakeholder survey distribution and respondence (2018 – 2019);
- Public water system data requests (2018 – 2022);
- Landowner letters (2019 – 2022); and
- White lands landowner letters (2019 – 2022)

Results from these outreach efforts have been compiled and reviewed. Data and information received from respondents has been incorporated into the AEWSD and WRMWSD DMSs and into this GSP, as appropriate.

The vast majority of land within the Tejon-Castac Management Area is owned by one entity, TRC, and they have been kept informed throughout the process. TCWD has also outreached directly to the owner of the Caratan Well regarding the GSP development process. The list above will be updated throughout GSP development and/or implementation.

### 5.5.3. Comments Received

☑ **23 CCR § 354.10(c)**

#### 5.5.3.1. Arvin-Edison Management Area

As described in the above sections and in the remainder of this section, AEWSD and ACSD have conducted extensive engagement of stakeholders through the GSP development process. During this time, input and feedback from the public has been encouraged. ***Table PA-5*** below summarizes the comments and input received by AEWSD and ACSD on the original submitted Management Area Plan and how that input was incorporated into the SOKR GSP. In some cases, more detailed responses can be found in **Appendix F**.

**Table PA-5. Comments and Input Received from Public During GSP Development, Arvin-Edison Management Area**

| Source | Date | Type of Input | How Input was Incorporated |
|---|---|---|---|
| Landowners | various | Responses to Stakeholder Survey (34) | Incorporated relevant information into Plan Area (see **Section 5.5.4**). |
| Agricultural stakeholders | various | Responses to Agricultural Stakeholder Survey (11) | Incorporated relevant information into Groundwater Conditions and Water Budget; incorporated data into the DMS. |
| The Nature Conservancy (TNC) | 27 October 2018 | Letter to KGA regarding consideration of GDEs in GSPs | As recommended by TNC, reviewed the *GDE Guidance Document for GSPs* and the *Groundwater Resource Hub* and conducted analysis of the presence of GDEs (see **Section 8.8**, ***Figure GWC-37*** and ***Figure GWC-38****)*. |
| Leadership Counsel for Justice and Accountability (LCJA) | 19 December 2018 | Letter to KGA regarding the KGA adoption of the Undesirable Results definitions | AEWSD has worked closely with ACSD, neighboring GSAs and KGA members and other stakeholders within its service area to develop its local definitions of Undesirable Results that are protective of beneficial users (see **Section 14**). |
| LCJA | 25 June 2019 | Letter to KGA entitled *Concerns and Recommendations to Ensure that Kern Groundwater Authority GSA GSP Protects Vulnerable Drinking Water Users* | AEWSD has worked closely with ACSD and other Public Water Systems in its service area to understand water quality conditions (**Section 8.5**) and to ensure that the Sustainability Criteria are protective of water quality and beneficial users (see **Sections 13.4, 14.4, 15.4**). |

| Source | Date | Type of Input | How Input was Incorporated |
|---|---|---|---|
| LCJA | 10 July 2019 | Letter to AEWSD entitled *Concerns and Recommendations to Ensure that all Water Districts Protect Vulnerable Drinking Water Users during GSP Development* | AEWSD has worked closely with ACSD and other Public Water Systems in its service area to understand water quality conditions (**Section 8.5**) and to ensure that the Sustainability Criteria are protective of water quality and beneficial users (see **Sections 13.4, 14.4, 15.4**). |
| LCJA | 8 October 2019 | Email to AEWSD with questions regarding MA Plan | Responded to questions in email dated 7 November 2019 (see **Appendix F**). |
| Chevron | 20 November 2019 | Email to KGA with comments on KGA Umbrella GSP | No changes to MA Plan were requested or made. KGA incorporated suggested changes into the KGA Umbrella GSP. |
| California Department of Fish and Wildlife | 25 November 2019 | Letter to KGA and SWSD with comments on the KGA Public Draft GSP and SWSD Public Draft Management Area Plan | Clarifying text added to **Section 8.8**. See **Appendix F** for additional information. |
| LCJA | 26 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Detailed responses to portions of the LCJA letter specific the Arvin-Edison MA Plan are included in **Appendix F**. Revisions were made to **Sections 5.5** and **18.1.6**. |
| Shafter-Wasco Irrigation District | 26 November 2019 | Letter to KGA entitled *Water budget guidance inside individual Groundwater Sustainability Plans* | Comments noted. No changes to MA Plan requested or made. |
| Farmland Reserve | 27 November 2019 | Letter to AEWSD with comments on AEWSD Public Draft MA Plan | Clarifying text added to the **Executive Summary** and **Section 9.1.1.3**. Detailed responses are included in **Appendix F.** |

| Source | Date | Type of Input | How Input was Incorporated |
|---|---|---|---|
| Hancock Farmland Services | 27 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Clarifying text added to the **Executive Summary** and **Sections 9.1.1.3** and **18.1.4**. Detailed responses are included in **Appendix F.** |
| TNC | 27 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Clarifying text added to **Sections 7.3.5** and **8.8**. See **Appendix F** for additional information. |
| Westchester Group Investment Management | 27 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Clarifying text added to the **Executive Summary** and **Sections 8.1, 9.1.1.3, ▯** and **18.1.4.** Detailed responses are included in **Appendix F.** |
| Wonderful Orchards / Wonderful Citrus | 27 November 2019 | Letter to AEWSD with comments on KGA Public Draft GSP and AEWSD Public Draft MA Plan | Clarifying text added to the **Executive Summary** and **Sections 8.1**, **9.1.1.3**, **▯** and **18.1.4**. Detailed responses are included in **Appendix F.** |
| Eastside Water Management Agency | 27 November 2019 | Letter to KGA entitled *Re: Implementation of the GSP* | Comments noted. No changes to MA Plan requested or made. |
| Committee for a Better Arvin | 3 December 2019 | Letter in support of AEWSD and ACSD MA Plan development efforts | Feedback is noted. No changes to MA Plan were requested or made. |
| Community Water Center | 17 December 2019 | Letter in support of AEWSD and ACSD MA Plan development efforts | Feedback is noted. No changes to MA Plan were requested or made. |

The Arvin GSA and ACSD welcome further comments during GSP implementation. In addition to **Table PA-5** above and **Appendix F** a detailed list of questions from the public and answers during the public meetings and stakeholder outreach activities described above can be found in **Appendix E**. ***Table PA-5*** will be updated as part of the 2025 GSP Update as more comments are received during GSP implementation.

5.5.3.2. <u>Wheeler Ridge-Maricopa Management Area</u>

As described in the above sections and in the remainder of this section, WRMWSD has conducted extensive engagement of stakeholders through the GSP development process. During this time, input and feedback from the public has been encouraged. ***Table PA-6*** below summarizes the comments and input received by WRMWSD on its Management Area Plan and how that input was incorporated into the SOKR GSP.

**Table PA-6. Comments and Input Received from Public During GSP Development, Wheeler Ridge-Maricopa Management Area**

| Source | Date | Type of Input | How Input was Incorporated |
|---|---|---|---|
| Chevron | 19 November 2019 | Email to WRMWSD with comments on Public Draft MA Plan | WRMWSD has taken the comments of Chevron into consideration in defining the bottom of the basin (**Section 7.1.3.2**). See **Appendix D** for additional information. |
| Farmland Reserve | 27 November 2019 | Letter to WRMWSD with comments on WRMWSD Public Draft MA Plan | Clarifying text added to the **Executive Summary** and **Section 9.2.1.3**. Detailed responses are included in **Appendix D.** |
| Wonderful Orchards / Wonderful Citrus | 27 November 2019 | Letter to WRMWSD with comments on KGA Public Draft GSP and WRMWSD Public Draft MA Plan | Clarifying text added to the **Executive Summary** and **Sections 8.1, 9.2.1.3,** and **18.1.4**. Detailed responses are included in **Appendix D.** |

The Wheeler Ridge-Maricopa GSA welcomes further comments during GSP implementation. ***Table PA-6*** will be updated as part of the 2025 GSP Update as more comments are received during GSP implementation.

5.5.3.3. Tejon-Castac Management Area

As described in the above sections and in the remainder of this section, TCWD has conducted engagement of stakeholders through the GSP development process. During this time, input and feedback from the public has been encouraged. **Table PA-7** below summarizes the comments and input received by TCWD on its Management Area Plan and how that input was incorporated into the SOKR GSP.

**Table PA-7. Comments and Input Received from Public During GSP Development, Tejon-Castac Management Area**

| Source | Date | Type of Input | How Input was Incorporated |
|---|---|---|---|
| Landowners | 4 March 2019 | Responses to Stakeholder Survey (1) | Incorporated relevant information into Plan Area (see **Section 5.1.4.3**). |

| Source | Date | Type of Input | How Input was Incorporated |
|---|---|---|---|
| The Nature Conservancy (TNC) | 27 October 2018 | Letter to KGA regarding consideration of GDEs in GSPs | As recommended by TNC, reviewed the GDE Guidance Document for GSPs and the Groundwater Resource Hub and conducted analysis of the presence of GDEs (see **Section 8.7** and ***Figure GWC-40***). |
| Leadership Counsel for Justice and Accountability (LCJA) | 19 December 2018 | Letter to KGA regarding the KGA adoption of the Undesirable Results definitions | TCWD has worked closely with neighboring GSAs and KGA members and other stakeholders within its service area to develop its local definitions of Undesirable Results that are protective of beneficial users (see **Section 13**). |
| LCJA | 25 June 2019 | Letter to KGA entitled *Concerns and Recommendations to Ensure that Kern Groundwater Authority GSA GSP Protects Vulnerable Drinking Water Users* | Comments noted and considered during MA Plan development. |
| Chevron | 20 November 2019 | Email to KGA with comments on KGA Umbrella GSP | Comments noted. No changes to MA Plan were requested or made. |
| California Department of Fish and Wildlife | 25 November 2019 | Letter to KGA and SWSD with comments on the KGA Public Draft GSP and SWSD Public Draft Management Area Plan | Clarifying text added to **Section 8.8.3**. See **Appendix C** for additional information. |
| LCJA | 26 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Comments noted. No changes to MA Plan were requested or made. |

| Source | Date | Type of Input | How Input was Incorporated |
|---|---|---|---|
| Shafter-Wasco Irrigation District | 26 November 2019 | Letter to KGA entitled *Water budget guidance inside individual Groundwater Sustainability Plans* | Comments noted. No changes to MA Plan requested or made. |
| Farmland Reserve | 27 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Comments noted. Clarifying text added to **Section 9.3.10**. |
| Hancock Farmland Services | 27 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Comments noted. Clarifying text added to **Section 9.3.10**. |
| TNC | 27 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Clarifying text added to **Sections 7.3.5** and **8.8.3**. See **Appendix C** for additional information. |
| Westchester Group Investment Management | 27 November 2019 | Letter to KGA with comments on KGA Public Draft GSP | Comments noted. Clarifying text added to **Section 9.3.10**. |
| Wonderful Orchards / Wonderful Citrus | 27 November 2019 | Letter to KGA with comments on Public Draft GSP | Comments noted. Clarifying text added to **Section 9.3.10**. |
| Eastside Water Management Agency | 27 November 2019 | Letter to KGA entitled *Re: Implementation of the GSP* | Comments noted. No changes to MA Plan requested or made. |

The TCWD GSA welcomes further comments during GSP implementation. **Table PA-7** will be updated as part of the 2025 GSP Update as more comments are received during GSP implementation.

### 5.5.4. Communication

☑ **23 CCR § 354.10(d)**

The SCEPs outline the Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA communication goals.

*Decision-Making Process*

☑ **23 CCR § 354.10(d)(1)**

The SCEPs outline the Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA's decision-making process. Briefly, the process involves decision making by the Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA Board of Directors during Board meetings which are open to the public.

*Public Engagement Opportunities*

☑ **23 CCR § 354.10(d)(2)**

The SCEPs discuss public engagement opportunities and how public input and responses will be handled. These opportunities include Board meetings, stakeholder workshops, planned public hearings at which the Draft SOKR GSP will be available for public comments, and the various stakeholder surveys, discussed below.

*Stakeholder Involvement*

☑ **23 CCR § 354.10(d)(3)**

The SCEPs outline the Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA goals, including open and transparent engagement with diverse stakeholders. Additionally, the SCEPs describe the Stakeholder Survey which the Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA used to gain additional knowledge of stakeholders within the Management Areas. Specifically for the Arvin-Edison Management Area:

- Results from 34 Stakeholder Survey responses received indicate that:
  - 63% of respondents are ag users; 30% are Public Water Systems users; 66% use both surface water and groundwater; and 9% use groundwater only.
- Results from 11 Agriculture Stakeholder Survey responses received indicate that:
  - 90% of respondents irrigate through a mixture of surface water and groundwater; and 10% irrigate with groundwater only.
  - 10% use drip irrigation only; 50% use a combination of drip and micro-sprinkler irrigation; and 30% use a combination of sprinklers and drip irrigation.

Specifically for the Wheeler Ridge-Maricopa Management Area:

- Three entities have responded to the survey to date.

As a result of the Stakeholder Survey, several stakeholders provided data on their wells to the Arvin GSA for consideration and inclusion in the SOKR GSP. Data included well locations, well construction information, depth to water measurements, estimated pumping rates, lithologic and geophysical logs, water quality data, and pump tests. These data were added to the DMS for the Arvin-Edison Management Area and considered during assessment of groundwater conditions (**Section 8 *Current and Historical Groundwater Conditions***).

As a result of the Stakeholder Survey, and follow up interactions by the TCWD GSA, the only two landowners/stakeholders within the Tejon-Castac Management Area (i.e., TRC and the owner of the Caratan Well) expressed willingness to share information about their wells and water use for consideration and inclusion in the SOKR GSP. Data included well location, well construction information, depth to water measurements, and estimated pumping rates. These data were added to the DMS for the Tejon-Castac Management Area and considered during assessment of groundwater conditions (**Section 8 *Current and Historical Groundwater Conditions***).

Staff have also made numerous outreach efforts to landowners within AEWSD, WRMWSD, and TCWD regarding well status information and access for monitoring. This effort has represented a constructive effort to improve local knowledge of well conditions and to engage landowners in SGMA implementation efforts.

*Public Notification*

☑ **23 CCR § 354.10(d)(4)**

The SCEPs detail the methodology that is being followed to inform the public on SOKR GSP updates, status, and actions.

### 5.5.5. Interagency Coordination

The Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA have actively engaged in both intrabasin and interbasin coordination efforts through multiple avenues during the GSP development process, including:

*KGA Board/Coordination Committee Meetings*

Prior to enactment of the SGMA, the KGA was established to provide a framework for the active, comprehensive management of the groundwater basin underlying the valley portion of Kern County, to preserve and maintain local control of groundwater resources and provide long term surety for all basin users. With passage of the SGMA, the KGA seeks to coordinate local groundwater management efforts and is working with its members to determine the most cost effective and efficient way of meeting the new requirements of the SGMA. During 2016-2018 the KGA Board of Directors met monthly at the Kern County office in Bakersfield. These monthly meetings have continued. Meeting agendas and other information can be found at http://www.kerngwa.com.

*Kern Managers Meetings*

Representatives from Kern Subbasin GSAs meet regularly to discuss Basin-wide SGMA topics ranging from monitoring network coordination to Basin-wide modeling efforts and sustainable management criteria development.

*South of Kern River Coordination Meetings*

The Arvin GSA, Wheeler Ridge-Maricopa GSA, TCWD GSA and neighboring agencies in the south of Kern River portion of the Basin have periodically convened to coordinate on major GSP development topics, including methodologies and data sources used to develop the Basin Setting, Water Budget, and Sustainability Criteria sections of their respective GSPs and the development of projects and management actions.

*White Wolf Basin GSA*

The White Wolf GSA was formed in 2017 by three water districts: AEWSD, TCWD, and WRMWSD, as well as Kern County (as a non-voting member). Prior to that, the GSA parties coordinated in an effort to subdivide the Kern Subbasin into two separate subbasins and remove the critical-overdraft status from the newly formed White Wolf Subbasin. By December of 2016, both goals were accomplished, and the White Wolf GSA has now developed and submitted a GSP. The White Wolf GSA meets quarterly at WRMWSD’s offices.

*City of Arvin and ACSD*

AEWSD staff have met multiple times with the City of Arvin and ACSD to discuss issues related to recycled water, SGMA, and other matters. Significant joint effort and coordination supported development and amendment of this SOKR GSP.

**Appendix E** includes a detailed record of the above inter-agency and inter- and intra-basin coordination efforts that AEWSD, WRMWSD, and TCWD have been active in. This list will be populated throughout SGMA implementation.

### 5.5.6. Interbasin Coordination

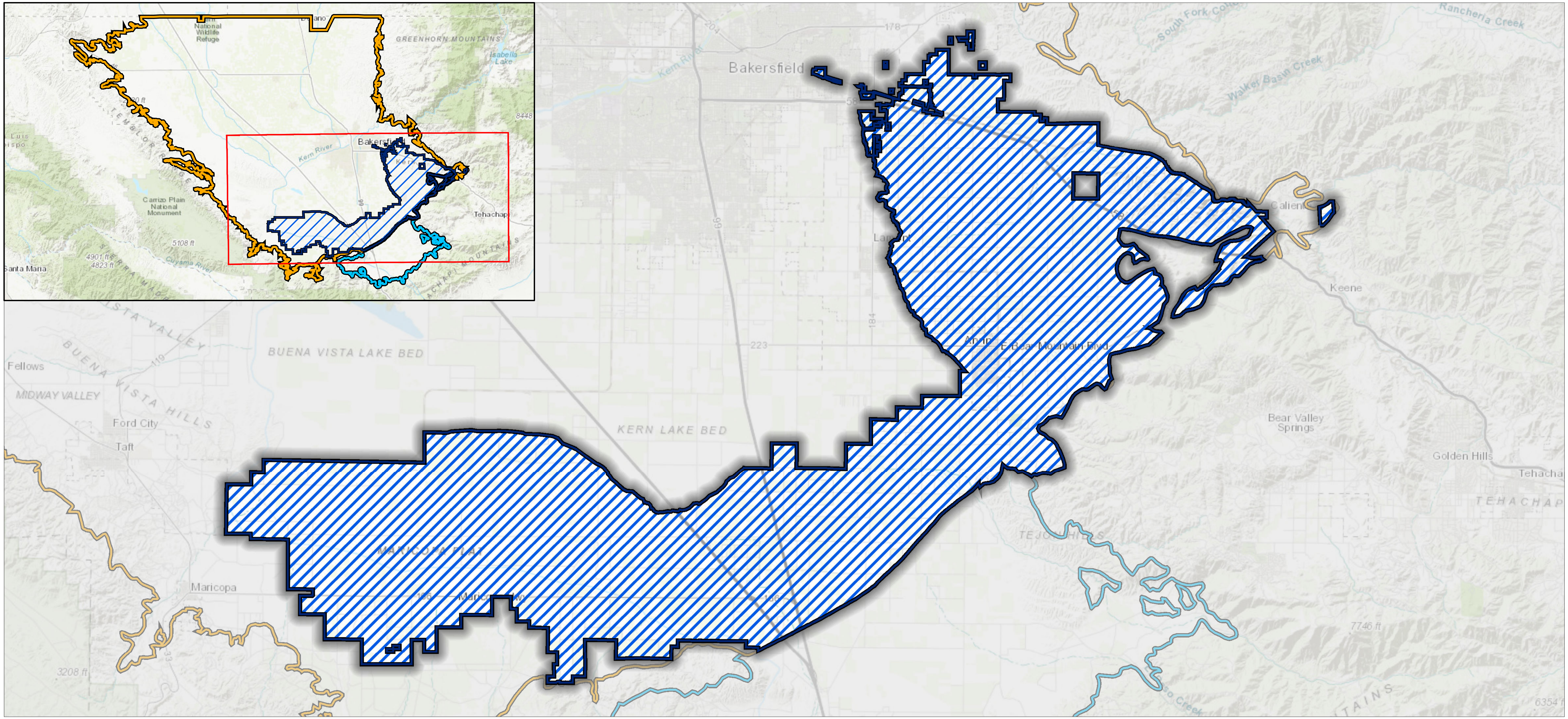
The Arvin GSA, Wheeler Ridge-Maricopa GSA, and TCWD GSA have actively participated in interbasin coordination with the neighboring White Wolf Subbasin (DWR 5-022.18), Tule Subbasin (DWR 5-022.13), and Tulare Lake Subbasin (DWR 5-022.12) throughout the GSP development process. Coordination topics have included subsidence concerns along the Friant-Kern Canal, delineation of the White Wolf Fault, and cross-boundary flows between subbasins. The Arvin GSA has also actively reviewed and provided comments on Draft GSP documents from neighboring basins (e.g., Tule Subbasin) as well as other GSPs and Management Area Plans within the Kern Subbasin.

**Table PA-3**
**Summary of Wells within the**
**Tejon-Castac Management Area**

| DWR WCR Number | Township | Range | Section | Tract (if known) | Other Identifiers | Proposed Use, as listed in WCR | Year Constructed | Use (if known) | Status (if known) | Total Depth (ft) | Top of Screen Depth (ft bgs) | Bottom of Screen Depth (ft bgs) | Depth Water First Found (ft bgs) | Standing Water Level (ft bgs) | Lithology in Screened / Perforated Interval | Screened in Granite Bedrock | Located in TCWD MA | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 97142 | 30 | 30 | 10 | | | Industrial | 1961 | Ind | Destroyed | 1272 | 500 | 1272 | 118 | | shale/sand & gravel | No | Yes | formerly part of AFC Bena Plant |
| 40683 | 30 | 31 | 27 | | | Irrigation | 1978 | | | 400 | 80 | 400 | | 185 | clay/sand/rocks | No | No | |
| **74572** | **31** | **30** | **28** | | **Caratan Well; #93** | **Industrial** | **1964** | **Ind / Ag** | **Active** | **800** | **436** | **800** | | | **sand/clay** | **No** | **Yes** | **supplies water to Granite Quarry and 1 or 2 ag parcels in AEWSD** |
| 113858 | 31 | 31 | 3 | | | Domestic | 1964 | | | 150 | 29 | 150 | 15 | | fractured granite | Yes | Unlikely | |
| 113859 | 31 | 31 | 3 | | | Domestic | 1964 | | | 125 | 14 | 125 | 15 | | fractured granite | Yes | Unlikely | |
| 113860 | 31 | 31 | 3 | | | Domestic | 1964 | | | 200 | 12 | 200 | 30 | | fractured granite | Yes | Unlikely | |
| 242992 | 31 | 31 | 3 | | | Domestic | 1984 | | | 365 | 265 | 365 | 160 | 140 | limestone/broken limestone | No | Unlikely | |
| 377713 | 31 | 31 | 3 | | | Domestic | 1993 | | | 400 | 225 | 400 | 225 | 60 | sand/gravel | No | Unlikely | |
| 377755 | 31 | 31 | 3 | | | Domestic | 1991 | | | 310 | 195 | 310 | 195 | 195.6 | coarse sand | No | Unlikely | |
| 248036 | 31 | 31 | 4 | | White Wolf Well; #09 | Domestic | 1983 | Domestic | Active | 760 | 392 | 742 | 360 | | granite | Yes | Yes | TRC-owned; supplies water to three residences along Bena Road |
| 248037 | 31 | 31 | 4 | | Eleven Mile Well; #08 | Domestic | 1983 | Stock water | Active | 880 | 490 | 870 | 305 | | granite | Yes | Yes | TRC-owned; supplies stockwater via pipeline to lands to the south |
| 75404 | 31 | 31 | 8 | | | Domestic | 1971 | | | 300 | 55 | 300 | 165 | | fractured granite | Yes | Unlikely | |
| 113861 | 31 | 31 | 9 | | | Domestic | 1964 | | | 195 | 40 | 195 | 50 | | fractured granite | Yes | No | |
| XX001 | 32 | 29 | 14 | A | | Unknown | 1948 | | | | 296 | | | | clay/sand & gravel/rock | No | No | WCR mostly illegible |
| XX002 | 32 | 29 | 14 | | | Unknown | 1939 | | | 1010 | | | 113 | 113 | clay/sand & gravel | No | No | |
| AXX001 | 32 | 29 | 14 | A | | Unknown | 1937 | | | 1000 | | | | 79 | sand/boulders | No | No | |
| 10199 | 32 | 29 | 14 | F | | Irrigation | 1955 | | | 972 | 498 | 960 | | | sand/sandy clay | No | No | |
| XX | 32 | 29 | 14 | H | | Unknown | | | | | | | | | Unknown | Unknown | No | WCR mostly illegible |
| 40547 | 32 | 30 | 7 | | | Irrigation | 1978 | | | 1075 | 457 | 1075 | | | Sand/clay/gravel | No | No | |
| 190232 | 32 | 30 | 8 | | | Domestic | 1987 | | | 605 | 400 | 605 | 385 | 80 | fractured granite | Yes | No | |

**Abbreviations**

AEWSD = Arvin-Edison Water Storage District
Ag = agricultural
DWR = California Department of Water Resources
ft = feet
ft bgs = feet below ground surface
Ind = industrial
TCWD MA = Tejon-Castac Water District Management Area
WCR = Well Completion Report




## Legend

South of Kern River Plan Area

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

## Abbreviations

DWR = California Department of Water Resources
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act

## Notes

1. All locations are approximate.
2. The "South of the Kern River" Plan Area encompasses the Arvin-Edison, Tejon-Castac, and Wheeler Ridge-Maricopa Management Areas.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Managementa area boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

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**South of Kern River GSP Plan Area**

South of Kern River GSP
Kern County, CA
July 2022
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**Figure PA-1**

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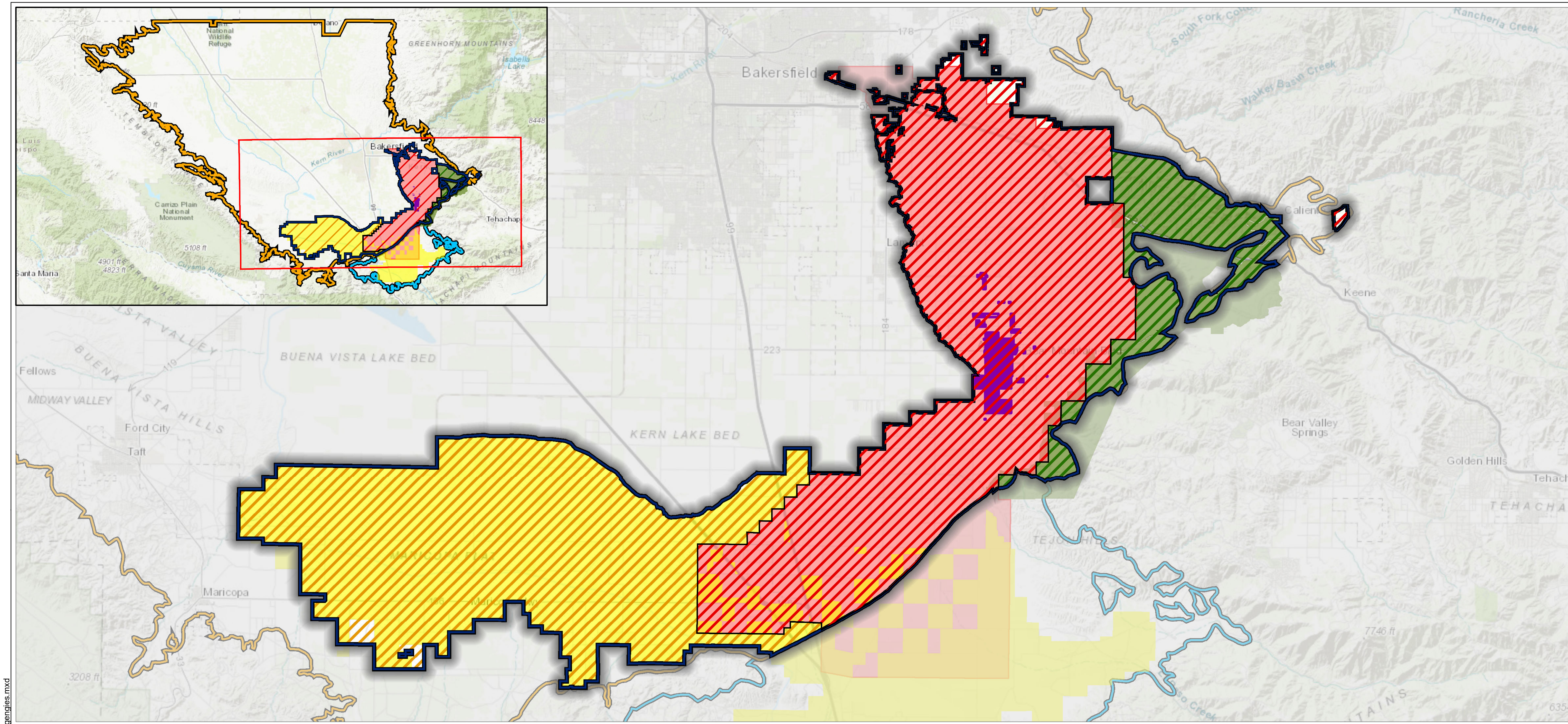


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## Legend

- South of Kern River Plan Area
- AEWSD GSA
- WRMWSD GSA
- TCWD GSA
- AEWSD Service Area
- ACSD Service Area
- WRMWSD Service Area
- TCWD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

## Abbreviations

ACSD = Arvin Community Services District
AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act
TCWD = Tejon-Castac Water District
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. The "South of the Kern River" Plan Area encompasses the Arvin-Edison, Tejon-Castac, and Wheeler Ridge-Maricopa Management Areas.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. GSA boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

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**South of Kern River GSP Member Agencies**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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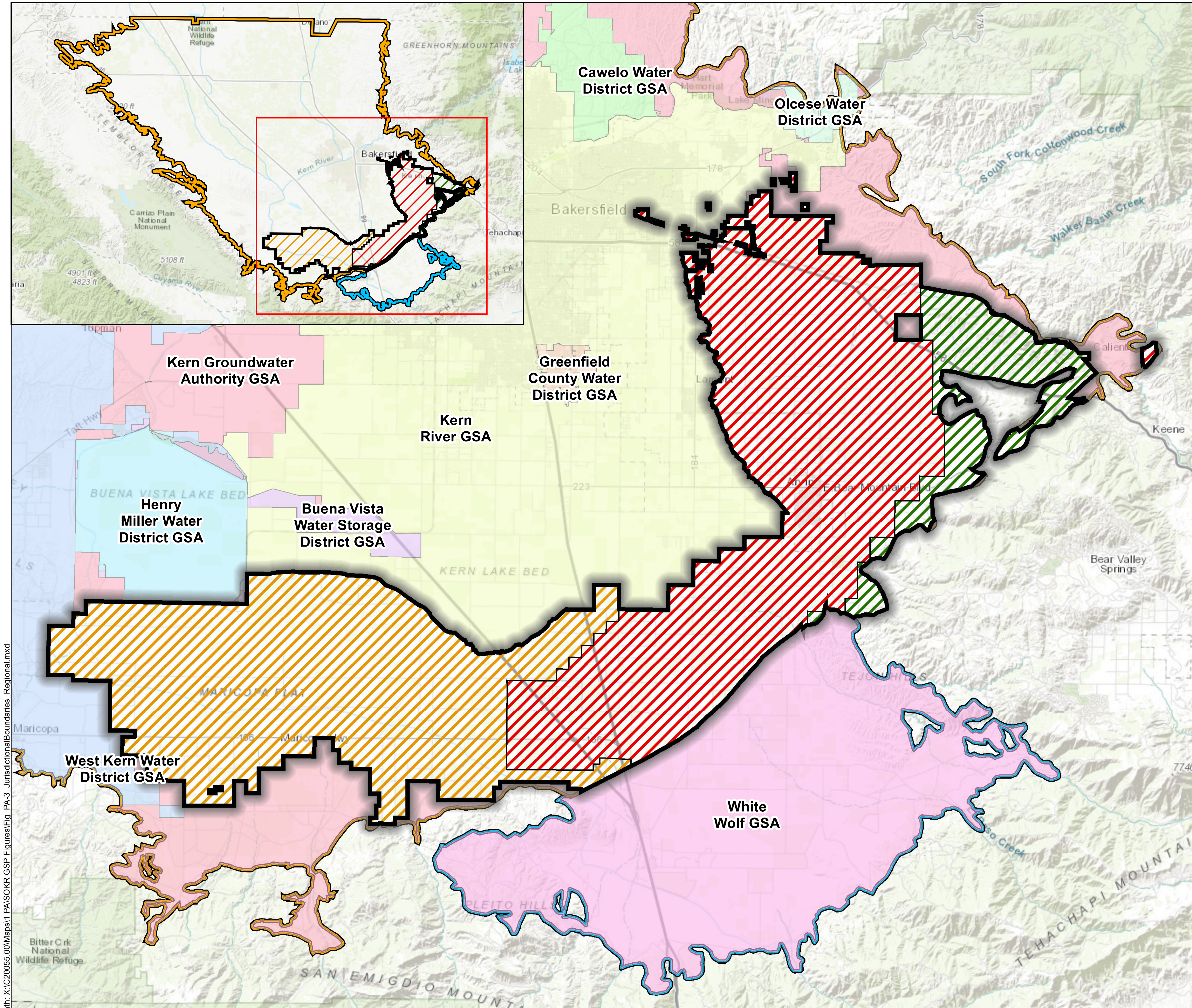
**Figure PA-2**




Legend
- South of Kern River Plan Area
- AEWSD GSA
- WRMWSD GSA
- TCWD GSA

**Groundwater Subbasin**
- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**GSA Name**
- Buena Vista Water Storage District GSA
- Cawelo Water District GSA
- Greenfield County Water District GSA
- Henry Miller Water District GSA
- Kern Groundwater Authority GSA
- Kern River GSA
- Olcese Water District GSA
- West Kern Water District GSA
- White Wolf GSA

Abbreviations
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act
SOKR = South of Kern River

Notes
1. All locations are approximate.
2. The Plan Area encompasses the Arvin-Edison, Tejon-Castac, and Wheeler Ridge-Maricopa Management Areas.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. GSA boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

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**Plan Area and Neighboring GSAs**

South of Kern River GSP
Kern County, CA
July 2022
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**Figure PA-3**

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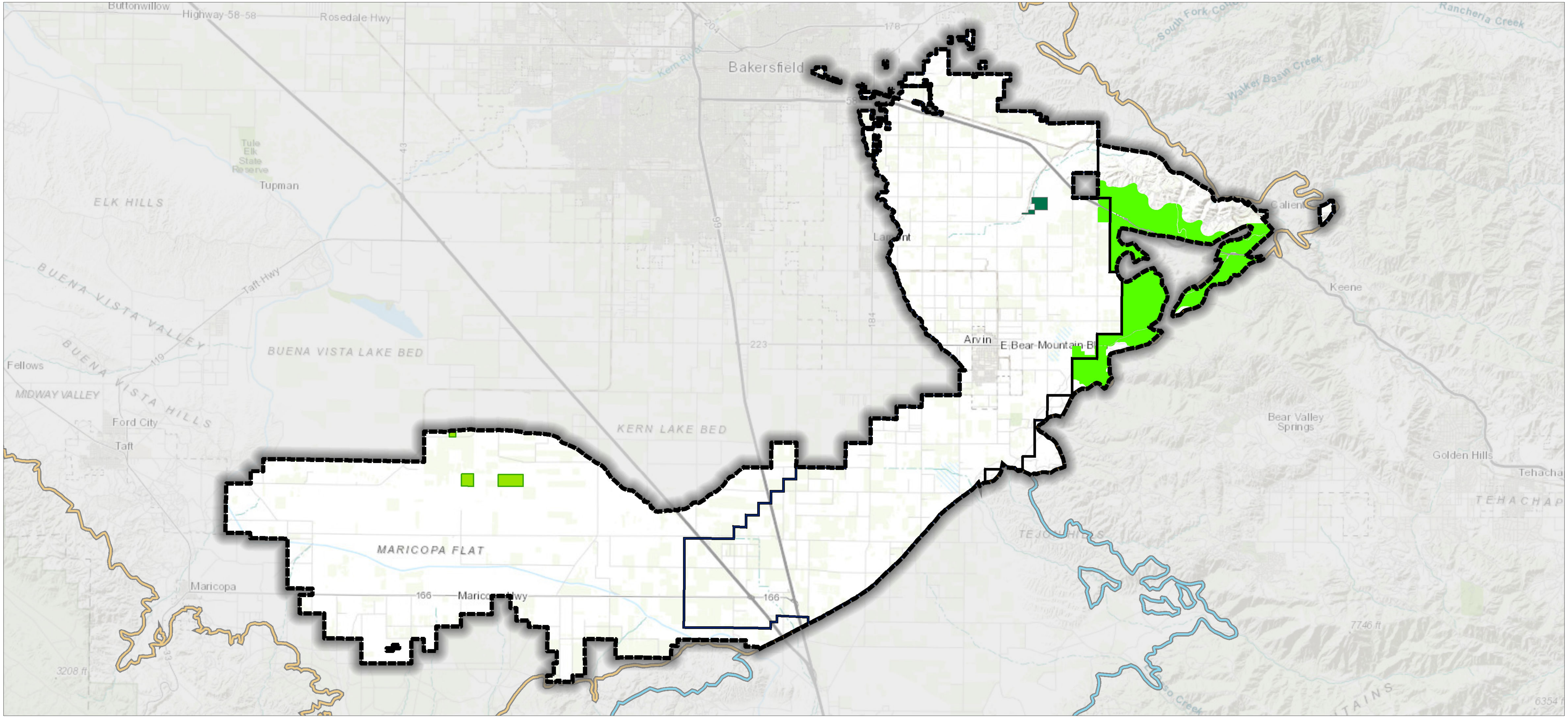


## Legend

- South of Kern River Plan Area
- GSA Boundary
- California Conservation Easement Area
- Bakersfield Cactus Ecological Preserve
- Federal Lands - BLM

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

## Abbreviations

BLM = United States Bureau of Land Management
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act

## Notes

1. All locations are approximate.
2. Ecological Reserves from California Protected Areas Database downloaded on 20 December 2018 from https://data.cnra.ca.gov/dataset/california-protected-areas-database-2018a
3. Federal lands information downloaded on 04 October 2018 from the SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer. Last updated 2016.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. GSA boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

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**Federal and State Lands, and Protected Areas**

South of Kern River GSP
Kern County, CA
July 2022
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**Figure PA-4**

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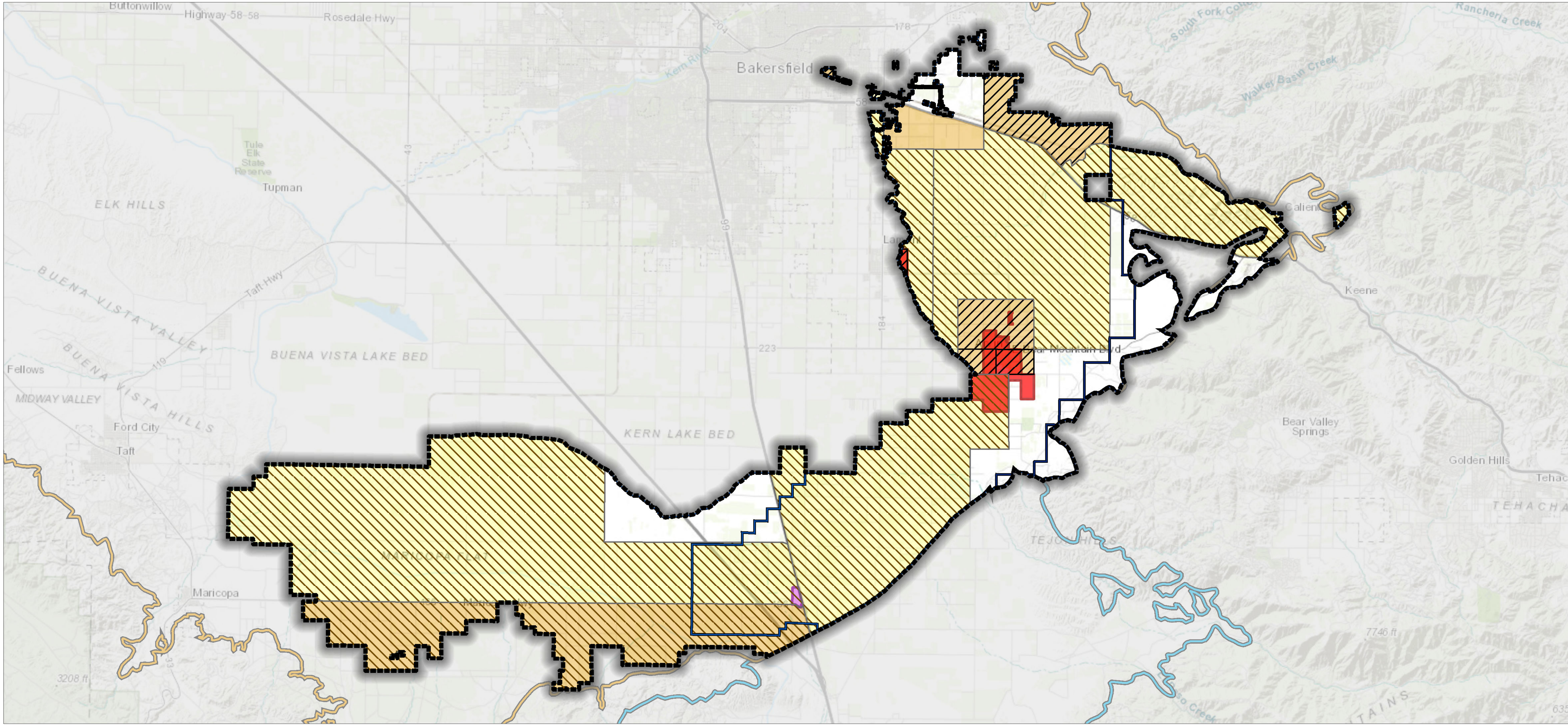


## Legend

- South of Kern River Plan Area
- GSA Boundary

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Disadvantaged Community Census Tract**

- Severely Disadvantaged Community
- Disadvantaged Community

**Disadvantaged Community Census Place**

- Severely Disadvantaged Community
- Disadvantaged Community

**Disadvantaged Community Census Block Group**

- Severely Disadvantaged Community
- Disadvantaged Community

## Abbreviations

BLM = United States Bureau of Land Management
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act

## Notes

1. All locations are approximate.
2. Disadvantaged communities information downloaded on 04 October 2018 from the SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer. Last updated 2016.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. GSA boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

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**Disadvantaged Community Tracts**

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South of Kern River GSP
Kern County, CA
July 2022
C20055.00

**Figure PA-5**

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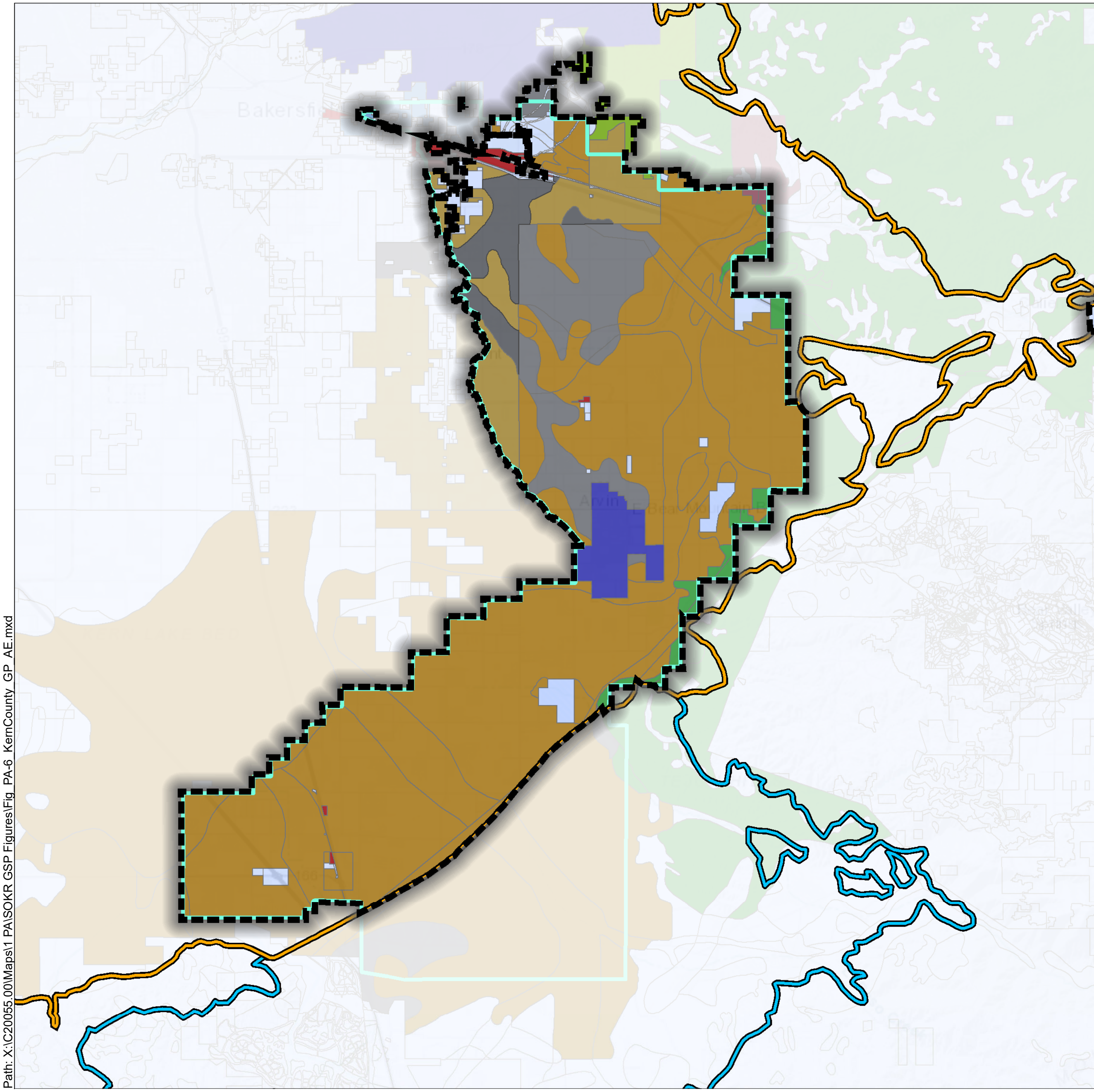

## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Land Use Designation**

- Extensive
- Extensive Agriculture (Min. 20 Acre Parcel Size)
- Incorporated Cities
- Intensive
- Intensive Agriculture (Min. 20 Acre Parcel Size)
- Low Medium Density Residential
- Mineral and Petroleum
- Mineral and Petroleum (Min. 5 Acre Parcel Size)
- Residential/ Other
- Service Industrial
- Solid Waste Facilities

## Abbreviations

DWR = California Department of Water Resources

GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.

## Sources

1. Kern County General Plan information obtained on 16 August 2018 from: http://esps.kerndsa.com/gis/gis-download-data

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**Kern County Geneal Plan -**
**Land Use Designation**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
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**Figure PA-6**

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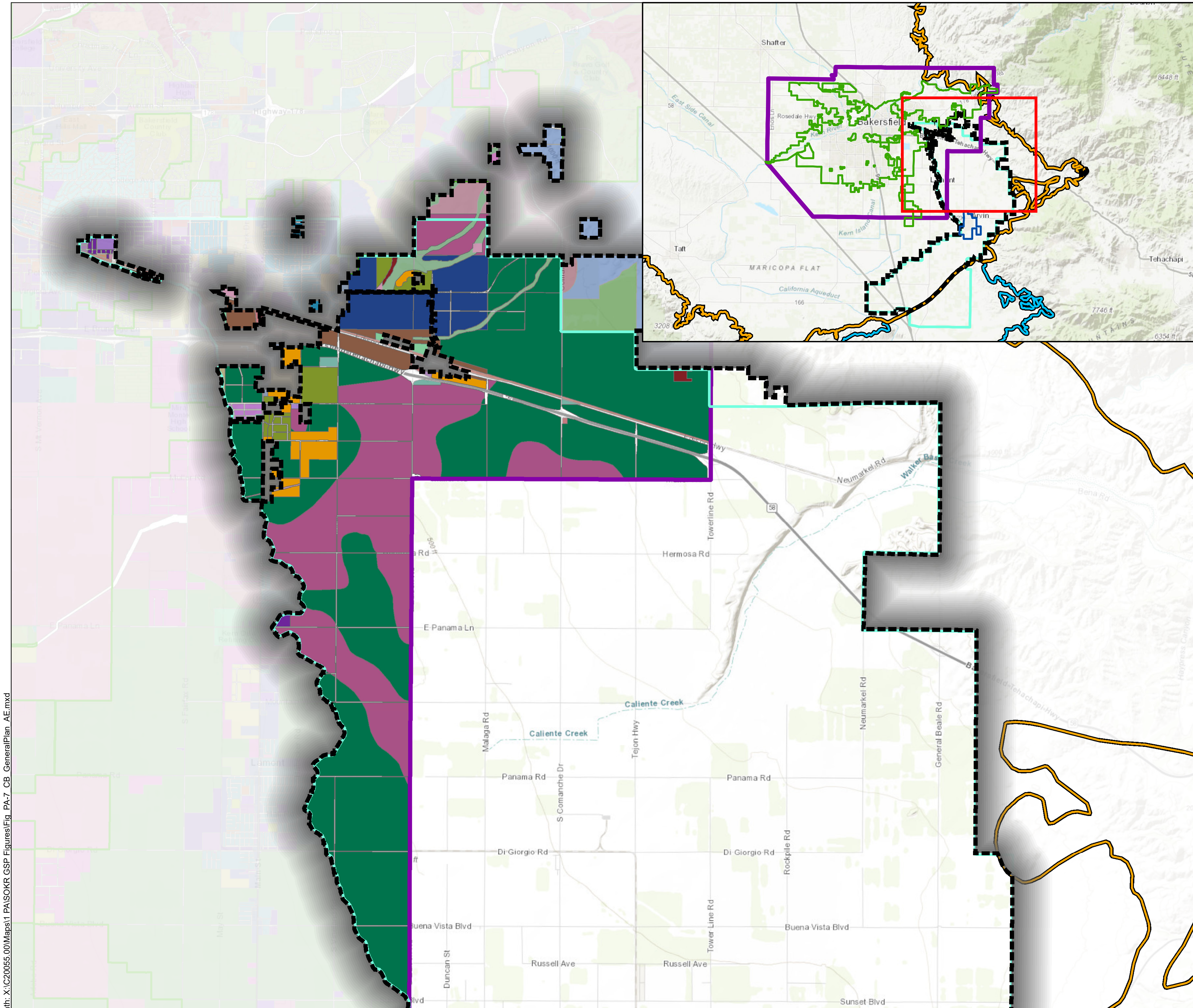


Legend

- Arvin GSA
- Arvin-Edison Water Storage District
- City of Arvin
- City of Bakersfield
- Metropolitan Bakersfield General Plan

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Land Use Designation**

- Residential-Estate
- Residential-Low Medium Density
- Residential-Low /Low Medium Density
- Extensive Agriculture
- Intensive Agriculture
- Mineral and Petroleum
- Residential-Rural
- Industrial-Service
- Residential-Suburban

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. City of Bakersfield boundary and Land Use Designations downloaded on 8/22/18 from City of Bakersfield website: https://bakersfieldcity.us/gov/depts/geographic_information_services/data_download.htm,

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**Metropolitan Bakersfield General Plan - Land Use Designation Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
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**Figure PA-7**

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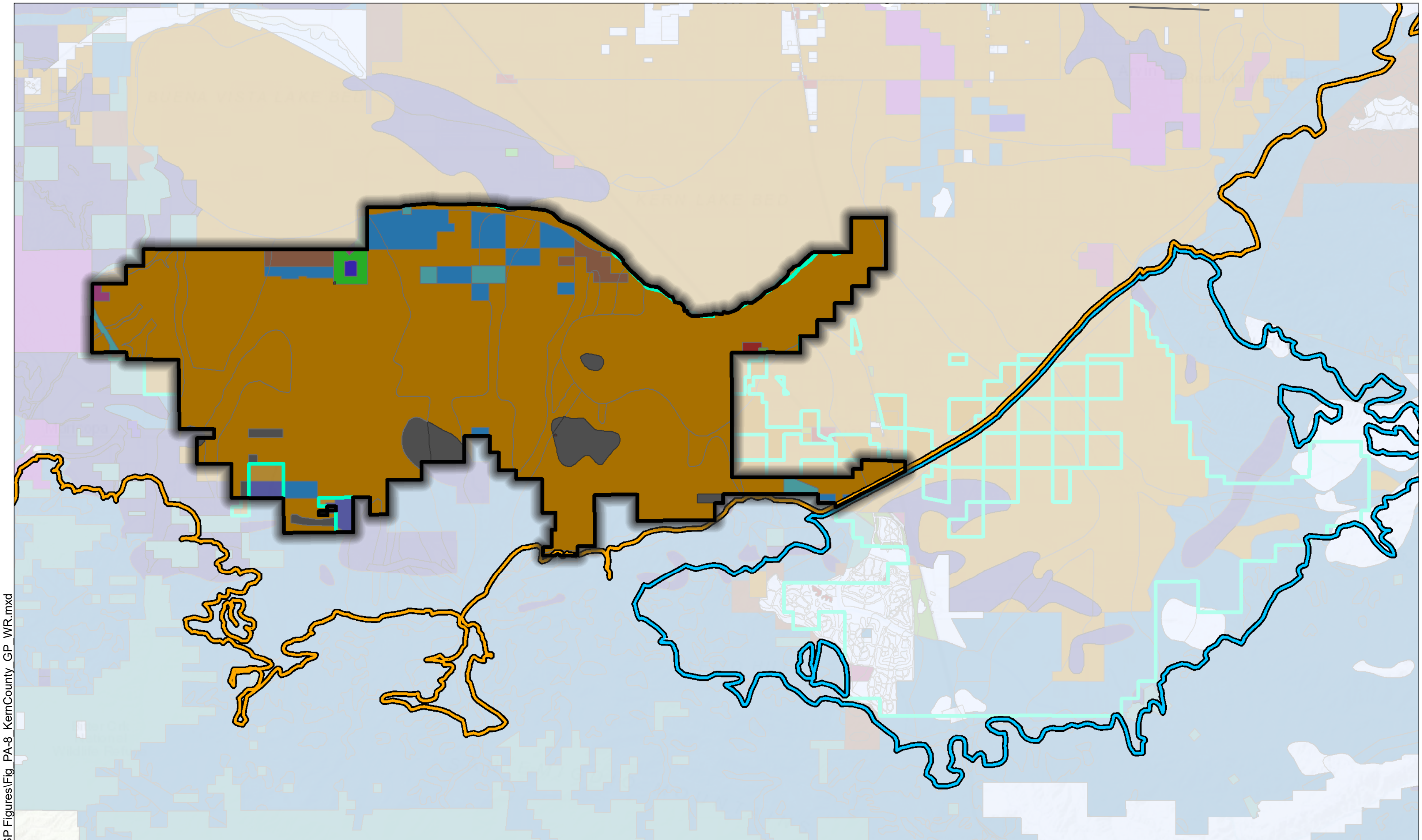

Legend

- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Land Use Designation**

- Extensive Agriculture; Extensive Agriculture (Min. 20 Acre Parcel Size)
- Heavy Industrial
- Highway Commercial
- Intensive Agriculture; Intensive Agriculture (Min. 20 Acre Parcel Size)
- Light Industrial
- Low Medium Density Residential
- Mineral and Petroleum; Mineral and Petroleum (Min. 5 Acre Parcel Size)
- Residential/ Other
- Resource Management
- Service Industrial
- Solid Waste Facilities
- State or Federal Land

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Notes

1. All locations are approximate.
2. The legend shows land use designations only within the Management Area.

Sources

1. Kern County General Plan information obtained on 16 August 2018 from the Kern County website.

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(Scale in Miles)

**Kern County General Plan - Land Use Designation**

**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP

Kern County, CA

July 2022

C20055.00

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**Figure PA-8**

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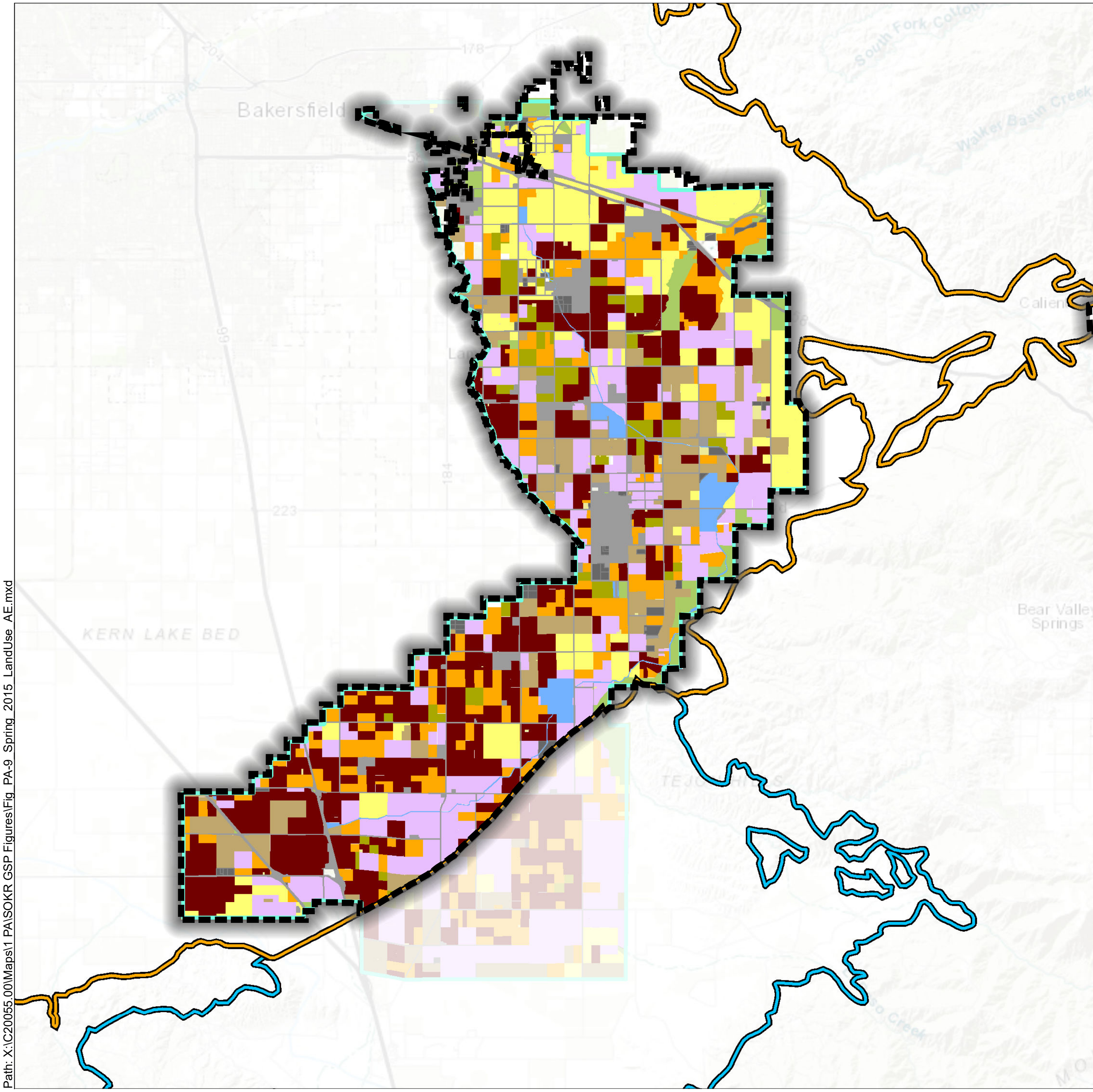


## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**DWR 2015 Land Use Designations**

- Citrus
- Deciduous Fruits and Nuts
- Field Crops
- Grain And Hay Crops
- Native Vegetation
- Pasture
- Semiagricultural
- Truck, Nursery And Berry Crops
- Vineyards
- Canals and Spreading Basins
- Idle / Non-Irrigated
- Urban

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.

## Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, obtained 1 June 2022.
2. Land use data provided by AEWSD on 3 March 2017.

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**Spring 2015 Land Use**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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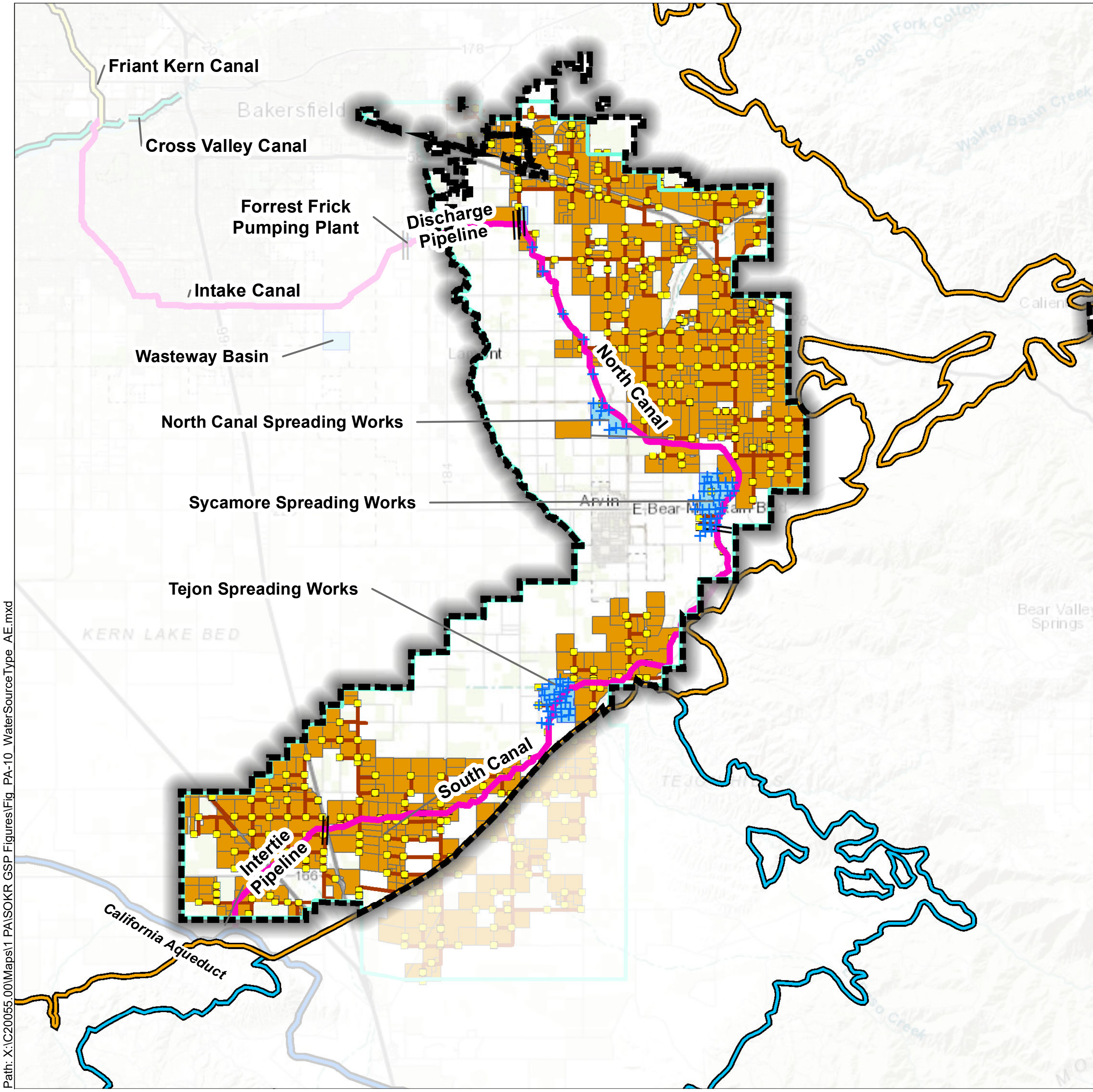
**Figure PA-9**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-9_Spring_2015_LandUse_AE.mxd




Legend
- Arvin GSA
- Arvin-Edison Water Storage District
- SWSA

**Groundwater Subbasin**
- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- AEWSD Recovery Well
- Turnout
- AEWSD Distribution Pipeline
- AEWSD Canal

**Major Canals**
- California Aqueduct
- Cross Valley Canal
- Friant-Kern Canal
- Spreading Basin

Abbreviations

AEWSD = Arvin-Edison Water Storage District
GSA = Groundwater Sustainability Agency
SWSA = Surface Water Service Area

Notes
1. All locations are approximate.
2. Users outside the SWSA rely exclusively on groundwater, however, users on the SWSA are not precluded of using groundwater.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. AEWSD units and facility locations provided to EKI by AEWSD on 3 March 2017.

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**AEWSD Facilities and Surface Water Service Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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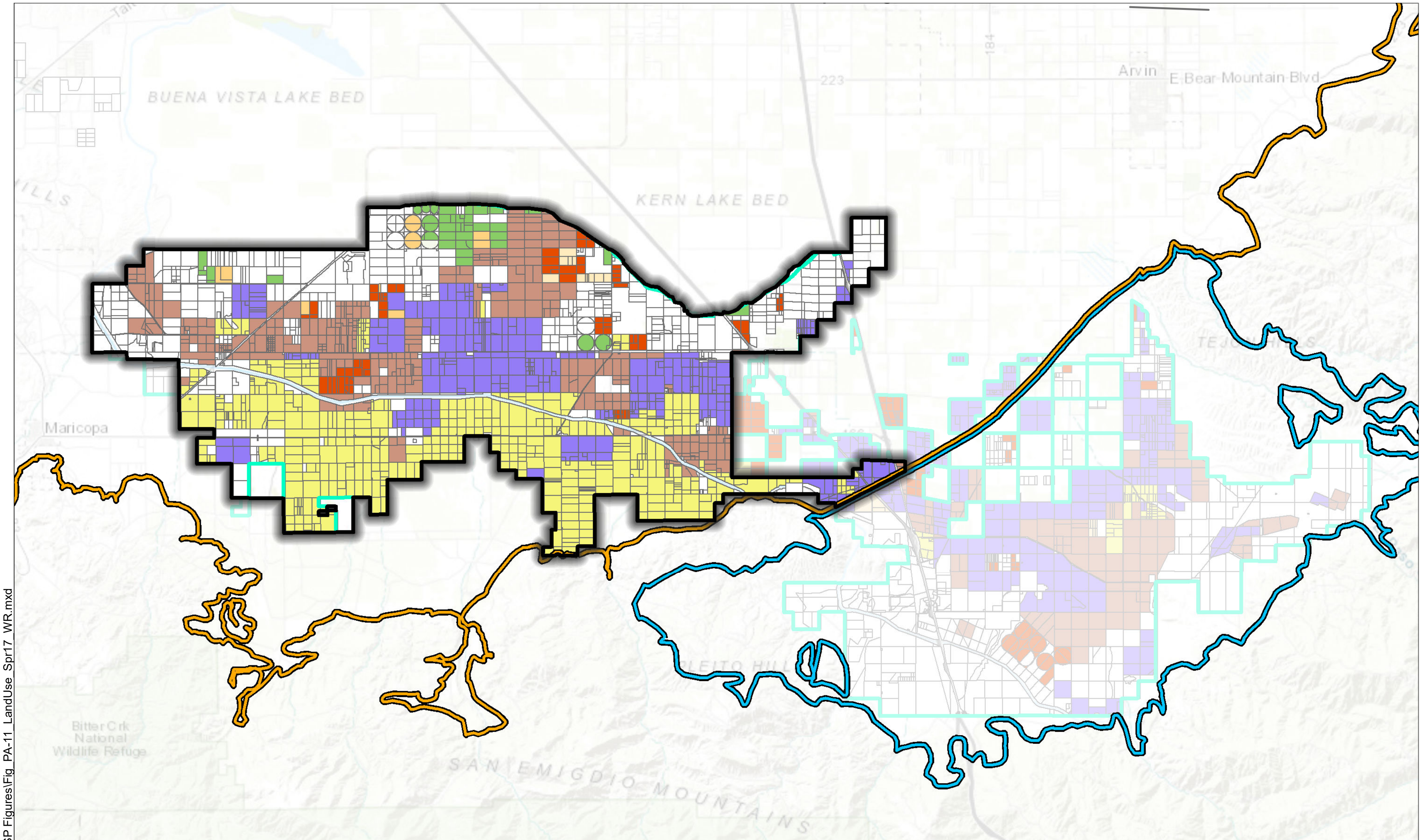
**Figure PA-10**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-10_WaterSourceType_AE.mxd




Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-11_LandUse_Spr17_WR.mxd

## Legend

- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Spring 2017 Land Use**

- Pasture
- Deciduous Fruits and Nuts
- Truck, Nursery, and Berry Crops
- Citrus and Subtropical
- Field Crops
- Grain and Hay Crops
- Vineyards
- Idle

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world aerial map, obtained 1 June 2022.
2. Spring 2017 land use data received from WRMWSD staff on 21 November 2017.

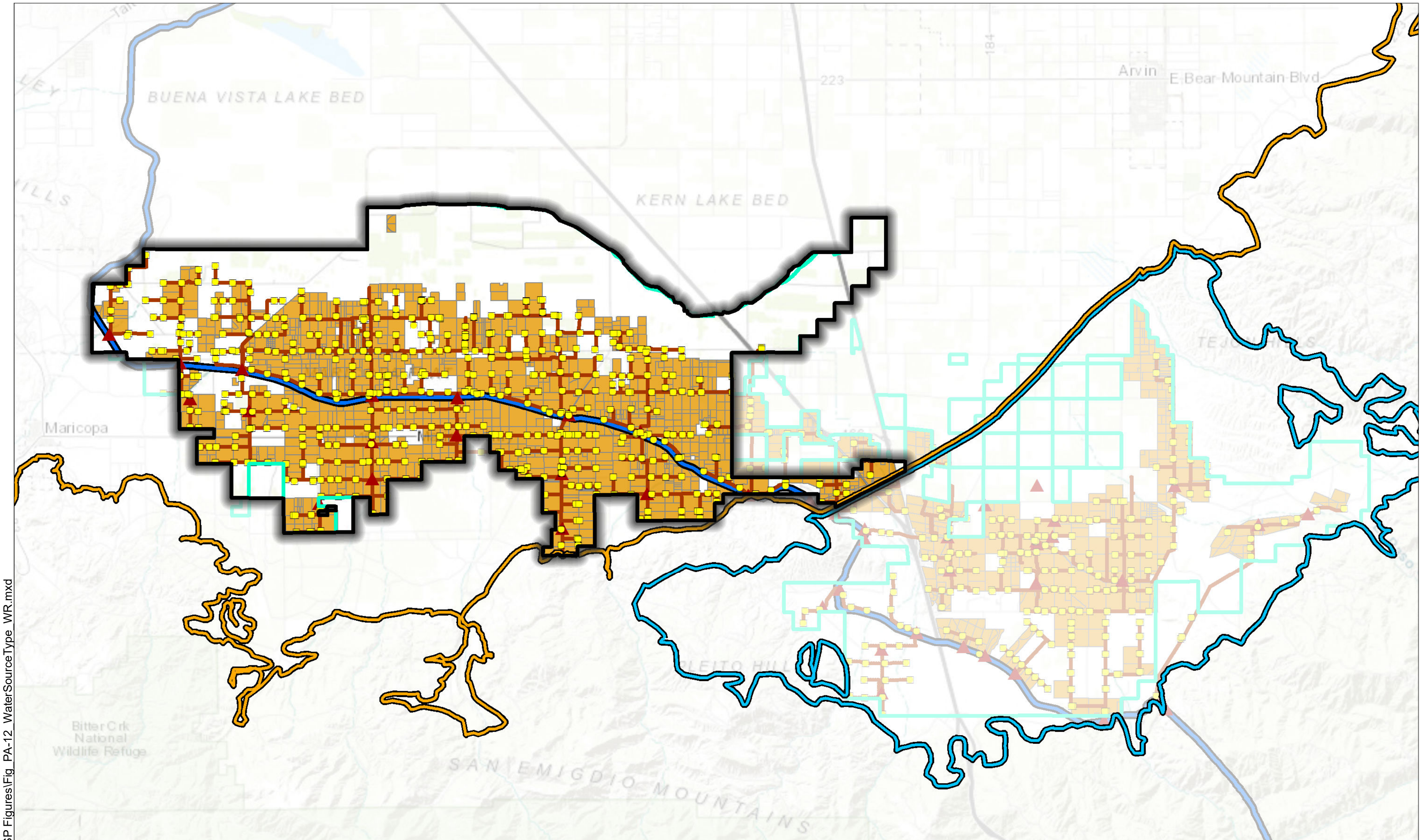
N 0 5 10 (Scale in Miles)

**Spring 2017 Land Use**
**Wheeler Ridge-Maricopa Management Area**

eki environment & water

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

**Figure PA-11**




**Legend**

- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**WRMWSD Infrastructure**

- Turnout
- Pumping Plant
- Pipeline

**Surface Water Feature**

- California Aqueduct
- WRMWSD Surface Water Service Area

**Abbreviations**

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
NHD = National Hydrography Dataset
SWSA = surface water service area
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

**Notes**

1. All locations are approximate.
2. Users outside the SWSA rely exclusively on groundwater, however, users on the SWSA are not precluded of using groundwater.

**Sources**

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. Surface water features and California Aqueduct location from NHD.
3. District infrastructure data and Surface Water Service Area acquired from WRMWSD staff on 21 November 2017.

N

0 5 10

(Scale in Miles)

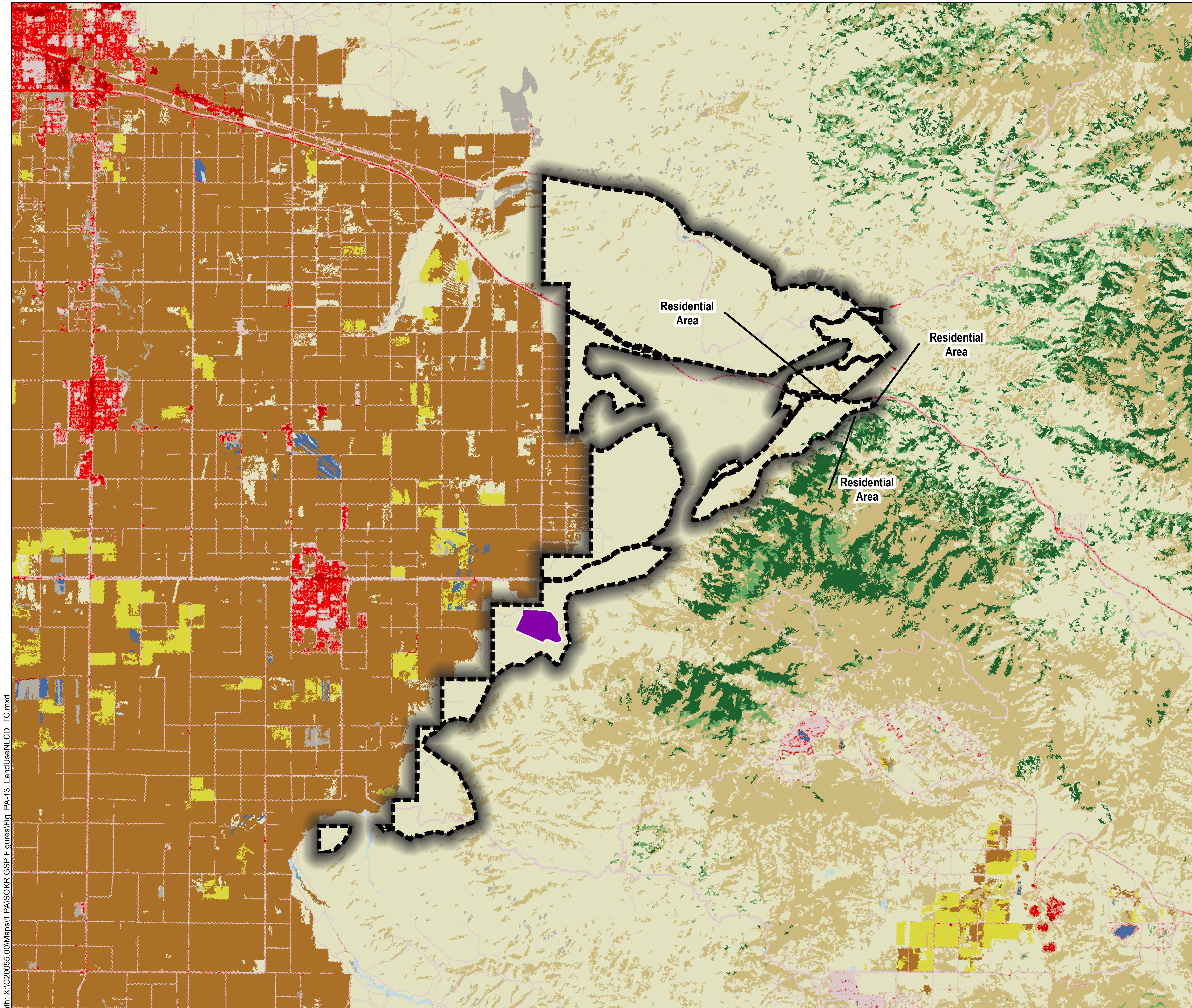
**WRMWSD Facilities and Surface Water Service Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure PA-12**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-12_WaterSourceType_WR.mxd




Legend

- Tejon-Castac Water District GSA
- Active Granite Quarry

**NLCD Land Cover Classification**

- 0 Unclassified
- 11 Open Water
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
NLCD = National Land Cover Database

Notes

1. All locations are approximate.
2. NLCD data is for 2011.

Sources

1. NLCD land use data obtained from Multi-Resolution Land Characteristics Consortium NLCD viewer (https://www.mrlc.gov/viewer/).

N
0 2 4
Miles

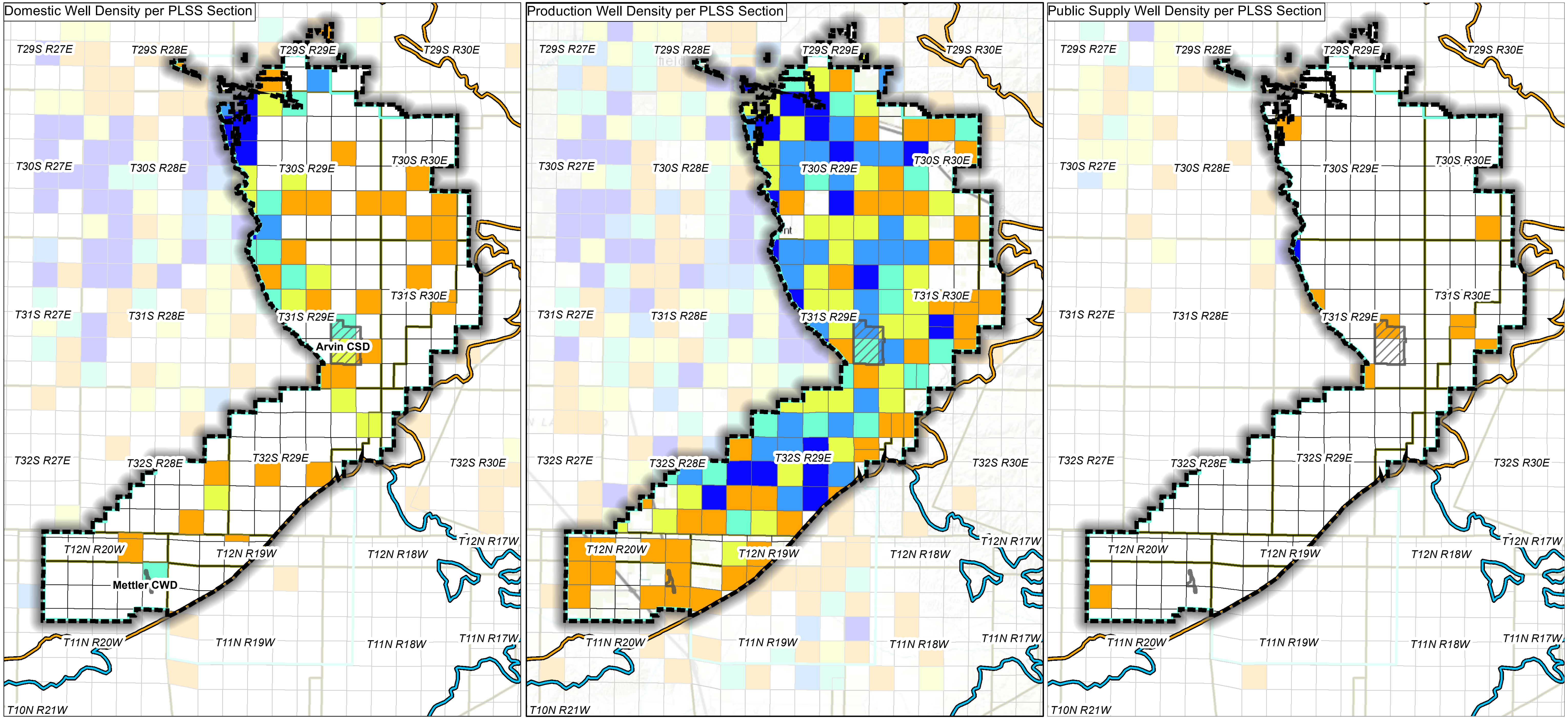
**Land Use (NLCD)**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure PA-13**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-13_LandUseNLCD_TC.mxd




Legend

- Arvin GSA
- Arvin-Edison Water Storage District
- Communities Dependent on Groundwater

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Well Density by PLSS Section**

- 0
- 1
- 2
- 3
- 4
- >4

Abbreviations

| | |
|---|---|
| CSD | = Community Services District |
| CWD | = County Water District |
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| PLSS | = Public Land Survey System |

Notes

1. All locations are approximate.
2. Mettler and the City of Arvin and are the only communities dependent on groundwater within the Arvin-Edison Management Area.

Sources

1. Well Count per square mile (PLSS section) from Well Completion Report Map Application, obtained on 19 October 2018, website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

N

0 4 8

Miles

**Well Density by PLSS Section from DWR Well Completion Reports Arvin-Edison Management Area**

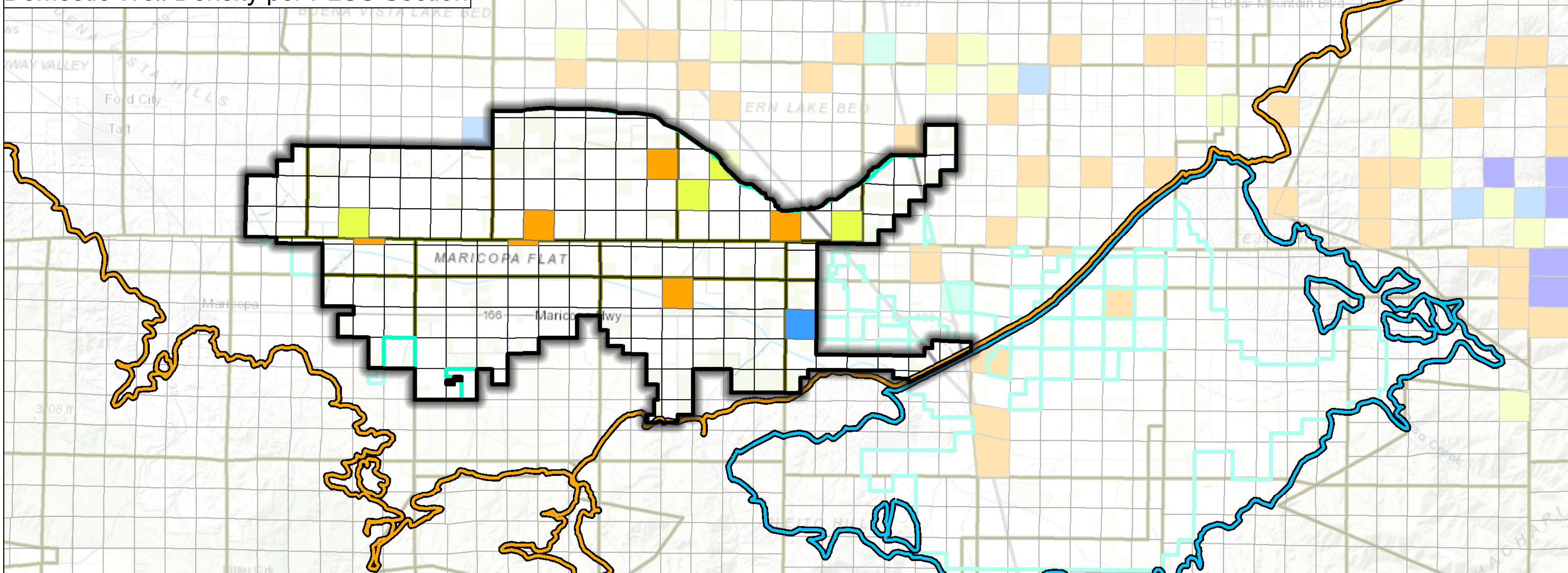
South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

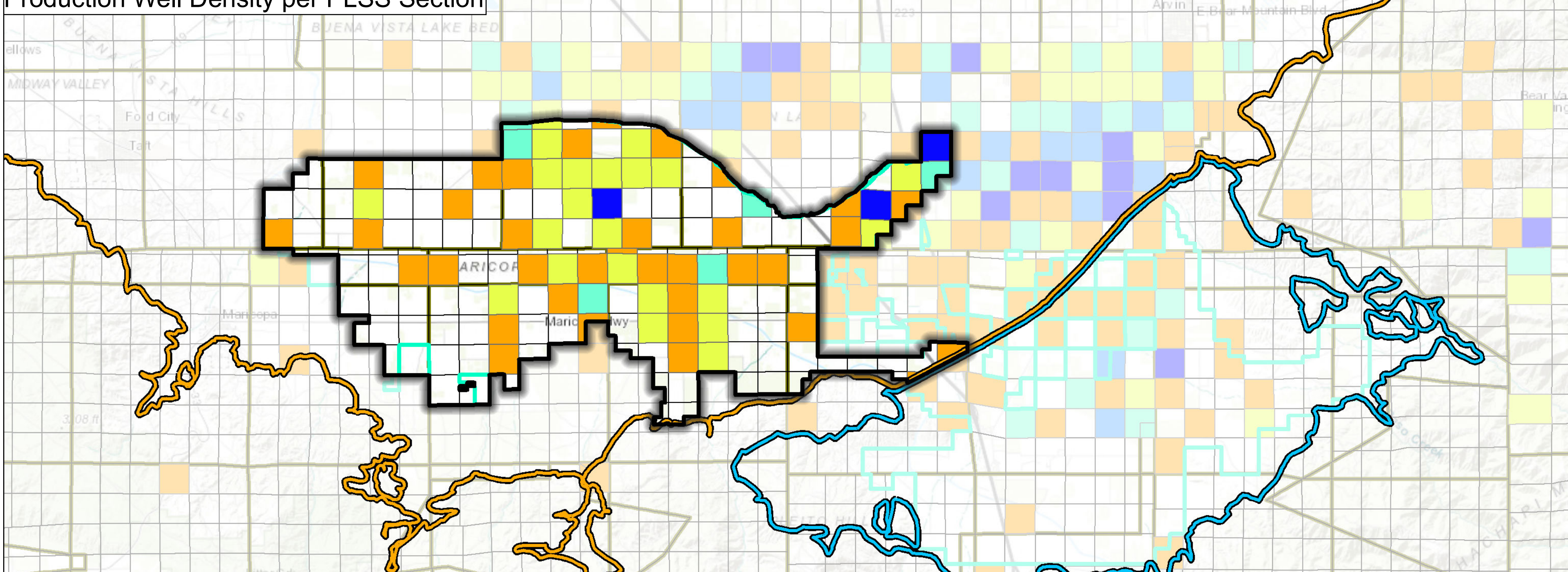
**Figure PA-14**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-14_WellDensity_AE.mxd

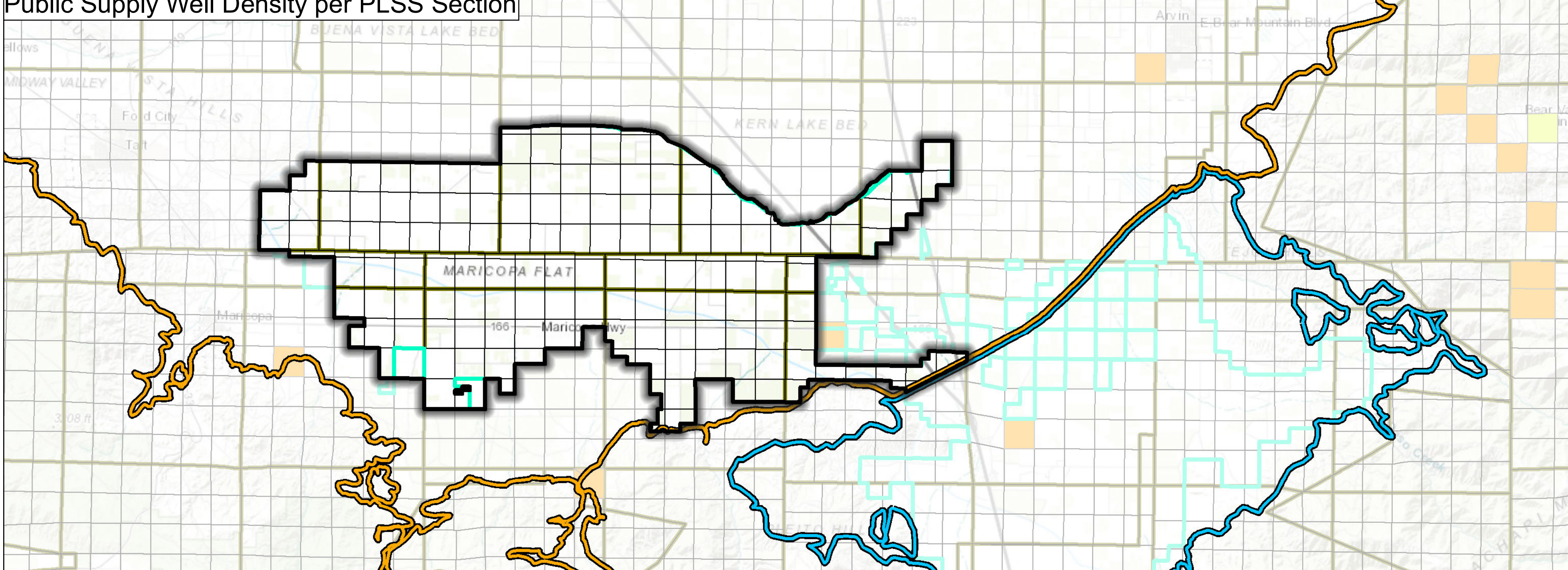
Domestic Well Density per PLSS Section




Production Well Density per PLSS Section




Public Supply Well Density per PLSS Section




Legend

- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area
- PLSS Sections
- PLSS Township

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Well Density per PLSS Section**

- 0
- 1
- 2
- 3
- 4
- >4

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| MA | = management area |
| PLSS | = Public Land Survey System |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Notes

1. All locations are approximate.
2. Potable water is supplied in the WRMWSD MA by private domestic wells, there is no public water supply, therefore, it is considered that there are not communities dependent on groundwater.

N

0 5 10

(Scale in Miles)

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. WRMWSD boundary is from DWR's water agencies shapefile and updated based on input from WRMWSD staff on 12 April 2017.
3. Well Count per square mile (PLSS section) from Well Completion Report Map Application, obtained on 8 October 2018, website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

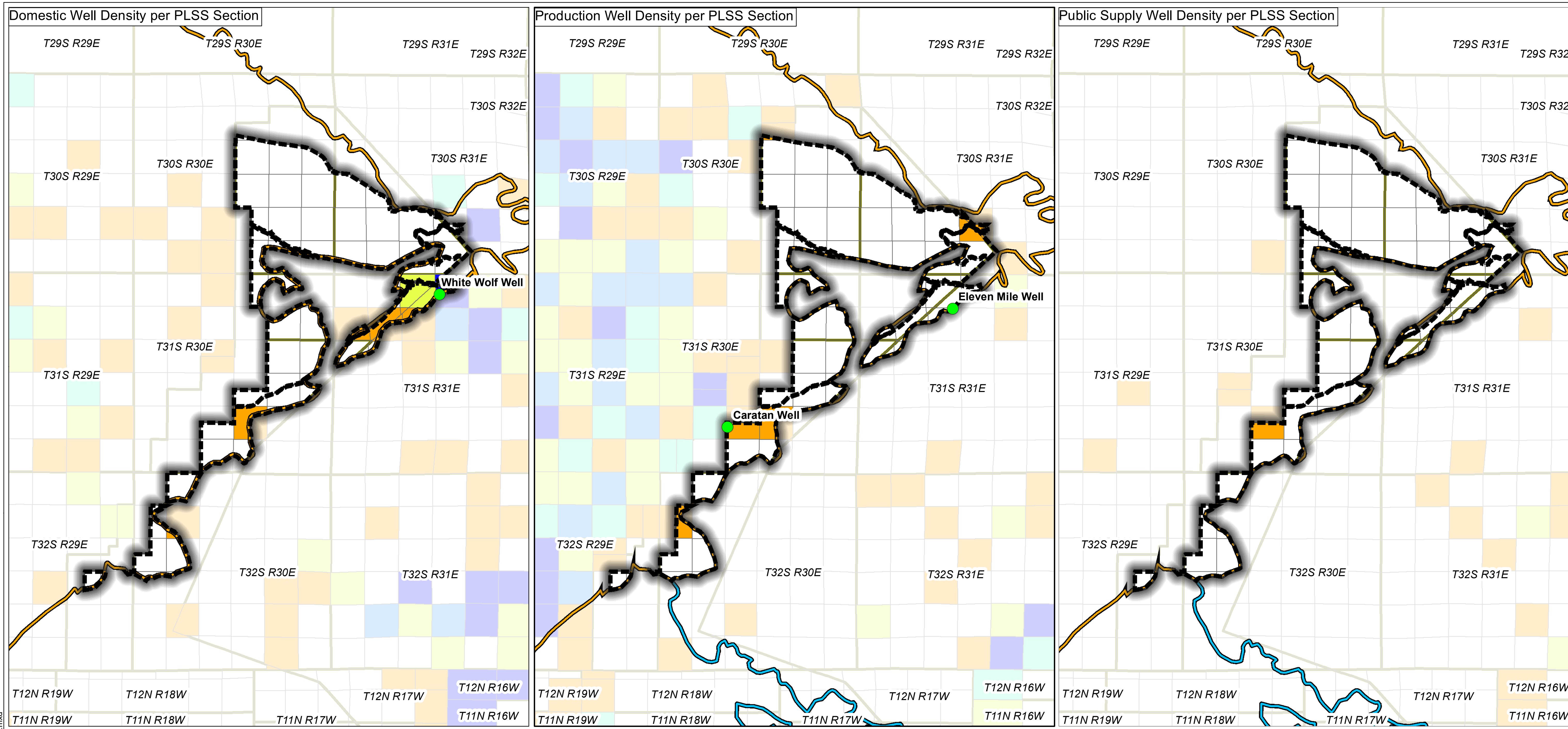
**Well Density by PLSS Section from DWR Well Completion Reports Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure PA-15**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-15_Well_Density_WR.mxd




**Legend**

Tejon-Castac Water District GSA

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

TCWD Well

**Well Density per PLSS Section**

0

1

2

3

4

>4

**Abbreviations**

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
PLSS = Public Land Survey System
TCWD = Tejon-Castac Water District

**Notes**

1. All locations are approximate.
2. Despite the DWR Well Completion Report Map Application shows that there are two wells (domestic, and production) within section 31S30E22 and one domestic well within section 31S31E07, the DWR does not have well construction records for these sections.

**Sources**

1. Well count per square mile (PLSS section) from DWR Well Completion Report Map Application, obtained on 8 October 2018, website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

N

0 3 6

Miles

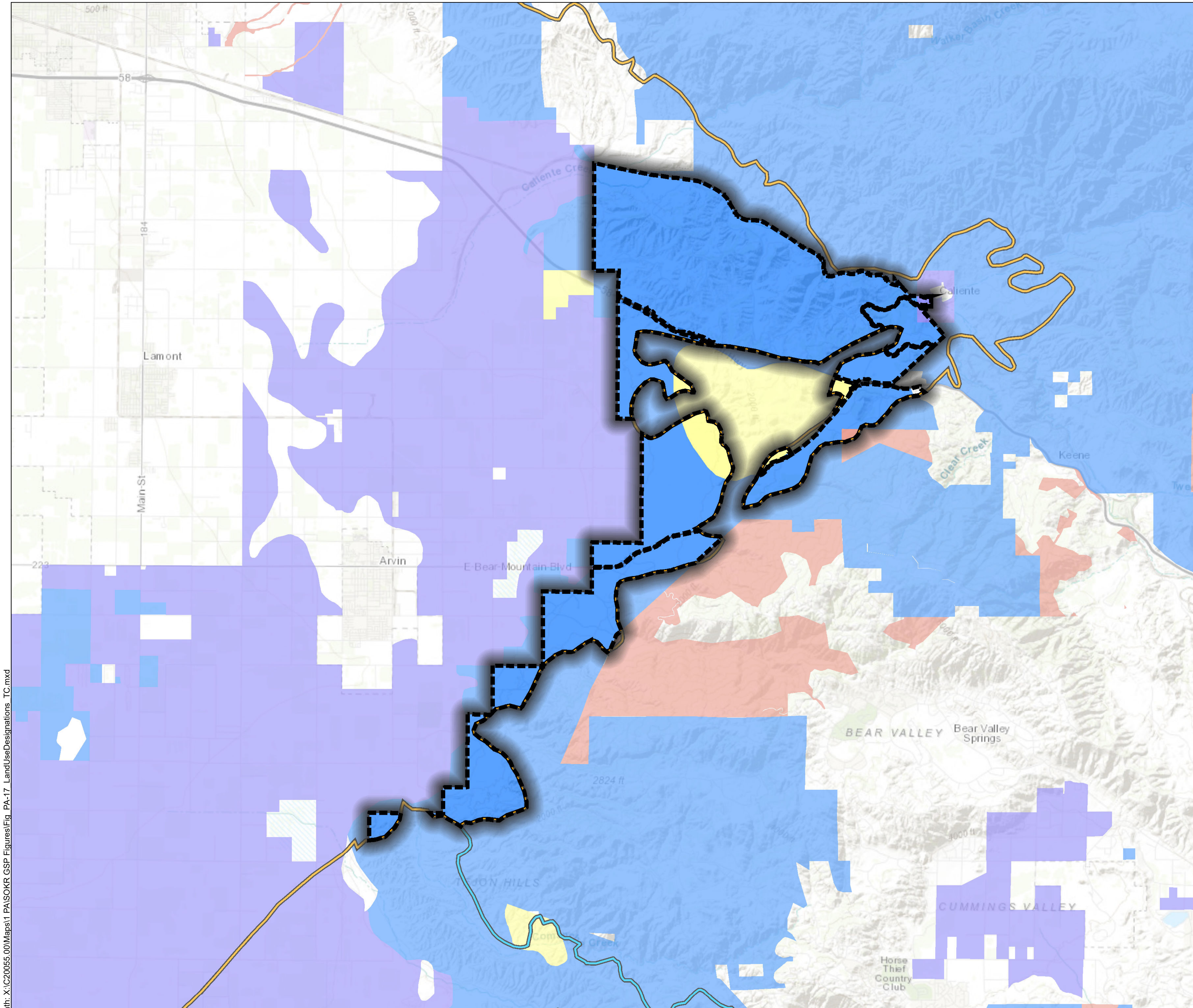
**Well Density by PLSS Section from DWR Well Completion Reports Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure PA-16**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-16_WellDensity_TC.mxd




Legend

Tejon-Castac Water District GSA

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Kern County General Plan Land Use Designation**

Extensive Agriculture (Min. 20 Acre Parcel Size)

Intensive Agriculture (Min. 20 Acre Parcel Size)

Resource Management (Min. 20 Acre Parcel Size)

Specific Plan Required (see Note 2)

Abbreviations

| | |
|---|---|
| C+LU | = Conservation and Land Use |
| CE | = Conservation Easement |
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| TRC | = Tejon Ranch Company |

Notes

1. All locations are approximate.
2. The area designated as "Specific Plan Required" within the TCWD MA corresponds to the White Wolf Specific Plan.
3. The rest of the TCWD MA is considered "Future" CE Areas that will become CE Areas once certain development benchmarks in other TRC lands are achieved per the Tejon Rnach C+LU Agreement.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. Kern County General Plan information obtained on 16 August 2018 from http://esps.kerndsa.com/gis/gis-download-data

N

0 2 4

Miles

**Land Use Designations within the Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure PA-17**

Path: X:\C20055.00\Maps\1 PA\SOKR GSP Figures\Fig_PA-17_LandUseDesignations_TC.mxd

# BASIN SETTING

## 6. INTRODUCTION TO BASIN SETTING

☑ **23 CCR § 354.12**

This section presents Basin Setting information for the South of Kern River Groundwater Sustainability Plan (SOKR GSP). As discussed previously in **Section 5 *Description of the Plan Area***, this SOKR GSP covers a portion of the Kern County Subbasin (California Department of Water Resources [DWR] Basin 5-022.14, referred to herein as the Kern Subbasin or Basin), specifically the portion underlying the Arvin Groundwater Sustainability Agency (GSA),[45] Wheeler Ridge-Maricopa GSA, and Tejon-Castac Water District (TCWD) GSA, which are collectively referred to as the "SOKR GSAs". As described in **Section 5 *Description of the Plan Area*** and **Section 10 *Management Areas***, and shown on ***Figure PA-1*** and ***Figure PA-2***, the SOKR GSP includes three Management Areas (i.e., the Arvin-Edison Management Area including Arvin Community Services District (ACSD), the Wheeler Ridge-Maricopa Management Area, and the Tejon-Castac Management Area) which are coincident with the respective SOKR GSA boundaries. In some cases, Basin Setting information for areas proximal to, but outside of, the SOKR GSP Area (e.g., within the neighboring White Wolf Subbasin) is provided for context. Basin Setting information includes the Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget.

It is recognized that additional, more recent data (i.e., through 2022) are available at the time of preparation of this amended SOKR GSP. However, as the SOKR GSP does not constitute a five-year update to a GSP (per Article 7 of the GSP Regulations), but rather a response to the DWR determination letter, those additional data are not incorporated herein, with minor exceptions.

[45] Arvin Community Services District is within the Arvin GSA and the Arvin-Edison Management Area.

# 7. HYDROGEOLOGIC CONCEPTUAL MODEL

☑ 23 CCR § 354.14(a)

This section presents the hydrogeologic conceptual model (HCM) for the South of Kern River Groundwater Sustainability Plan (SOKR GSP). As described in the Hydrogeological Conceptual Model Best Management Practices (BMP) document (DWR, 2016), an HCM provides, through descriptive and graphical means, an understanding of the physical characteristics of an area that affect the occurrence and movement of groundwater, including geology, hydrology, land use, aquifers and aquitards, and water quality. This HCM serves as a foundation for subsequent Basin Setting analysis including water budgets (**Section 9 *Water Budget Information***) and numerical models, monitoring network development (**Section 16 *Monitoring Network***), and the development of sustainable management criteria (**Sections 11** through **15**).

## 7.1. General Description

☑ 23 CCR § 354.14(b)

### 7.1.1. Geological and Structural Setting

☑ 23 CCR § 354.14(b)(1)

The SOKR GSP Area is located at the southern end of the San Joaquin Valley which is the portion of California's Central Valley that is south of the San Joaquin/Sacramento River Delta. The San Joaquin Valley is a structural trough filled with tens of thousands of feet of Cenezoic continental and shallow marine sedimentary deposits shed from the surrounding mountains which include the Sierra Nevada Mountains to the east, the Coast Range Mountains to the west, and the San Emigdio and Tehachapi Mountains to the south (Davis et al., 1959). The structural trough is asymmetric, with its axis located west of the valley's centerline at land surface (Scheirer, 2013). Locally, to the immediate west of the Arvin-Edison Management Area and north of the Wheeler Ridge-Maricopa Management Area, the Maricopa Depocenter is a structural depression which has accumulated thicker deposits than the surrounding areas. The "E"-Clay, a significant Pleistocene-aged regional aquitard (Croft, 1972) deposited in the west-central portion of the southern San Joaquin Valley, underlies portions of the Arvin-Edison Management Area and Wheeler Ridge-Maricopa Management Area. The "E"-Clay is several tens of feet thick in this area and becomes thinner and shallower towards the east, pinching out in the vicinity of the City of Arvin.

Due to its location near the North American and Pacific plate boundary, the southern San Joaquin Valley underwent complex patterns of tectonic evolution during the Cenezoic era, including phases of extension, uplift, subsidence, faulting, and flexure (Goodman and Malin, 1992). The White Wolf Fault cuts through the southern portions of the service areas of Arvin-Edison Water Storage District (AEWSD) and Wheeler Ridge-Maricopa Water Storage District (WRMWSD), passes through the southern portion of the Tejon-Castac Management Area, and forms the boundary between the Kern County Subbasin (referred to herein as the Kern Subbasin or Basin) to the north and the White Wolf Subbasin to the south. The White Wolf Fault is a recently active southward-dipping high-angle reverse fault that has resulted in significant displacement of stratigraphic units on either side (California Division of Mines, 1955; Hagan, 2001). The total vertical displacement is estimated to be over 10,000 feet and is greatest at the southwestern end and less to the northeast (California Division of Mines, 1955). As evidenced by surface rupture during the major earthquake of 21 July 1952, the White Wolf Fault is active, and its displacement plane extends to the ground surface, affecting the youngest sedimentary deposits. Based on multiple lines of evidence, the White Wolf Fault acts as a significant barrier to groundwater flow, which is the basis for the subbasin boundary (Erler & Kalinowski, Inc., 2016). These lines of evidence include substantial groundwater elevation differences across the fault (based on analysis of available water level data and reports prepared by others), aquifer testing data from wells close to the fault that showed boundary effects, and groundwater modeling studies.

Hydrogeologic cross-sections through each Management Area that further illustrate the complex subsurface structural relationships are discussed further in **Section 7.2 *Cross-Sections*** below.

#### 7.1.1.1. Arvin-Edison Management Area

In addition to the regional geologic and structural setting of the SOKR GSP Area described above, the Arvin-Edison Management Area's geologic setting includes the Edison Fault and the Bakersfield Arch. The Edison Fault is an inactive north-dipping normal fault located near the eastern side of the Arvin-Edison Management Area, with units on the south side uplifted relative to units on the north side (Ross, 1986). The exact spatial relationship between the Edison and White Wolf faults in this area is uncertain and the subject of some debate (Ross, 1986). The Edison Fault has uplifted pre-Tertiary basement rocks on the south side to be adjacent to Tertiary sediments on the north side. The Edison Fault was most recently active during Oligocene, Miocene, and perhaps Pliocene times (Dibblee, Jr., and Chesterman, 1953). The Bakersfield Arch is a broad east-west trending structural dome in the vicinity of the Kern River, north of the Management Area. On the south side of the arch, sedimentary strata thin in a northward direction.

#### 7.1.1.2. Wheeler Ridge-Maricopa Management Area

In addition to the regional geologic and structural setting of the SOKR GSP Area described above, the general geologic setting of the Wheeler Ridge-Maricopa Management Area consists of multiple alluvial fans derived from sediments washed into the Basin from the surrounding highlands, coarser near their source and finer towards the basin interior. These fan deposits wash up against Quaternary lake and basin deposits that border the Wheeler Ridge-Maricopa Management Area to the north. These basin deposits, including those beneath the Buena Vista Lake Bed, Kern Lake Bed, and the slough that connects them, are generally fine-grained due to the low energy depositional environment in which they were formed. On the northern edge of the Wheeler Ridge-Maricopa Management Area, shallow clay layers and fine-grained soils create areas of perched groundwater that are separate from the main groundwater system. The Buena Vista Hills are located to the northwest of the Wheeler Ridge-Maricopa Management Area.

#### 7.1.1.3. Tejon-Castac Management Area

Within the broader regional geologic context, the Tejon-Castac Management Area is located adjacent to the southeastern boundary of the Kern Subbasin where the Cenozoic sedimentary deposits overlie Paleozoic igneous and metamorphic rocks. The point at which surficial geologic units transition from Cenozoic sedimentary rocks to older igneous and metamorphic rocks constitutes the eastern boundary of the Tejon-Castac Management Area (and the Kern Subbasin), whereas the northern Tejon-Castac Management Area boundary is a political boundary defined by the extent of the Tejon-Castac Water District (TCWD) jurisdictional area. The White Wolf Fault cuts through the Tejon-Castac Management Area from southwest to northeast but does not coincide with the Tejon-Castac Management Area boundary. The Edison Fault cuts through the entire northern portion of the Tejon-Castac Management Area in a roughly east-west direction, as mapped by the California Division of Mines and Geology (CDMG, 1964). The Bakersfield Arch is located north of the Tejon-Castac Management Area.

### 7.1.2. Lateral Basin Boundaries

☑ **23 CCR § 354.14(b)(2)**

This SOKR GSP covers the Arvin-Edison Management Area, Wheeler Ridge-Maricopa Management Area, and Tejon-Castac Management Area, which are located in the southern part of the larger Kern Subbasin (***Figure HCM-1***). The Basin's lateral boundaries on the east, west and south sides are geologically-based, whereas the northern boundary is generally jurisdictionally-based. On the east and west sides, the Basin boundary is generally defined as the contact between Pliocene or younger (Quaternary) units and Miocene or older units, based on the surficial geologic map published by the California Division of Mines and Geology (CDMG, 1964). A 2018 basin boundary modification modified the boundary for certain segments on the western side based on the contact between the Quaternary alluvium and Pliocene or older rocks, as mapped by Jennings (2010). For a portion of the southeastern side, the Basin boundary is defined by the White Wolf Fault which separates the Basin from the adjacent White Wolf Subbasin. On the north side, the Basin boundary is defined primarily by the Kern County line, with the exception of two jurisdictionally-based cutouts where portions of certain Groundwater Sustainability Agencies' (GSA) areas in the basins north of the county line (i.e., a portion of the Delano-Earlimart Irrigation District GSA and El Rico GSA) extend southward into Kern County. On the northwest edge of the Basin the boundary with the Kettleman Plain Subbasin is based on the jurisdictional extent of the Devils Den Water District.

The SOKR GSP Area boundary coincides with the Basin boundary and is geologically-based along the White Wolf Fault and the portion of the Basin boundary directly northeast of the White Wolf Fault (***Figure PA-1***); all other portions of the SOKR GSP Area boundary are jurisdictionally-based and within the interior of the Basin. The northeastern SOKR GSP Area boundary coincides with TCWD's administrative boundary which is roughly aligned with portions of the Caliente Creek channel, Bena Road, and the Union Pacific Railroad. The north/northwestern boundary SOKR GSP Area boundary is defined by the extent of the Arvin-Edison Management Area, based on a combination of AEWSD's service area boundary, with addition of certain out-of-District lands ("White Lands"), and the exclusion of lands overlapped by East Niles Community Services District. The central western boundary of the SOKR GSP Area is based on jurisdictional boundaries between AEWSD and Kern Delta Water District (KDWD) and between WRMWSD and KDWD. The western and southwestern boundaries of the SOKR GSP Area are based on the WRMWSD service area boundary, with the addition of certain White Lands on the southern side.

### 7.1.3. Bottom of the Basin

☑ **23 CCR § 354.14(b)(3)**

As discussed above, the southern San Joaquin Valley is a deep structural trough filled with a thick sequence of Tertiary sediments including sandstone, siltstone, shale, and conglomerate. As described below, multiple sources of information can be relied on to define the "bottom of the basin" for purposes of Sustainable Groundwater Management Act (SGMA), including elevation maps of the basement bedrock surface, information on the base of fresh water, the presence, location and depth of oil and gas fields, "exempted" aquifers under the Safe Drinking Water Act (SDWA), and depth of groundwater extraction. Available information regarding the vertical position of the bottom of the Basin for each other three management areas comprising the SOKR GSP Area is discussed below, with vertical location information presented in terms of depth (i.e., as feet below ground surface [ft bgs]) or elevation (i.e., feet above mean sea level [ft msl]), based on the original source information. A summary comparison, including a unit normalization, is included in ***Table HCM-1***.

#### 7.1.3.1. Arvin-Edison Management Area

*Depth to Basement Bedrock*

The depth of pre-Tertiary basement rocks which form the impermeable floor of the San Joaquin Valley groundwater basin generally increases from east to west within the southern end of the San Joaquin Valley. Within the Arvin-Edison Management Area the elevation of the top of the basement rock surface ranges from between -2,000 and -8,000 ft msl in the northern area, 0 to -6,000 ft msl in the eastern/central area, and approximately -10,000 to -20,000 ft msl in the far southwestern area (Scheirer, 2013). Given the land surface elevations, discussed further in **Section 7.3 *Physical Characteristics*** below, the depth to bedrock ranges from less than 1,000 ft bgs in the eastern area to over 20,000 ft bgs in the far southwestern area.

*Base of Fresh Water*

Despite the substantial thickness of sedimentary strata overlying impermeable basement rock within this structural basin, in the case of the Central Valley it is more appropriate to consider geochemical properties (i.e., water quality) in determining the definable bottom of the basin (California Department of Water Resources [DWR], 2016). Documentation of the DWR's California Central Valley Surface Water-Groundwater Simulation (C2VSim) model states that "although the Central Valley sedimentary basins are very thick, the fresh water aquifer in each basin is very thin" (Brush et al., 2016).

Page (1973) mapped the elevation of the base of fresh water in the Kern Subbasin using a criterion for fresh water of specific conductance (also known as electrical conductivity or EC) of less than 3,000 micromhos per centimeter (umhos/cm). This EC is equivalent to a total dissolved solids (TDS) concentration of approximately 2,000 milligrams per liter (mg/L). The Page (1973) base of fresh water map does not cover the northeastern portion of the Arvin-Edison Management Area, but for the area that is covered, the base of fresh water elevation ranges from approximately -2,000 ft msl in the north-central portion of the Management Area to approximately -4,000 ft msl in the southwestern portion (***Figure HCM-2***). These elevations translate to a range of depths of approximately 2,500 ft bgs to 4,400 ft bgs.

*Base of Fresh Water from Oil Field Information*

For over a century, oil and gas exploration and development has taken place throughout the Kern Subbasin, tapping various Tertiary sedimentary deposits. Such activity continues to this day and has resulted in the accumulation of a substantial body of knowledge concerning the regional geology, including stratigraphy, structural features, hydrocarbon occurrence, and the geochemical character of groundwater.

***Figure HCM-3*** shows the locations of oil and gas fields in the vicinity of the Arvin-Edison Management Area, as mapped by the California Division of Energy Management (CalGEM; formerly the Division of Oil, Gas, and Geothermal Resources [DOGGR]). The Edison Oil Field, located in the northern portion of the Management Area, contains several "pools" (subareas with distinct production characteristics and rules), including the Main Area, West Area, Jeppi Area, Portals-Fairfax Area, Race Track Hills Area, and (outside of the Arvin-Edison Management Area) the Edison Groves Area. The base of fresh water indicated on the field data sheets for these pools ranges from 1,700 ft bgs in the Main Area to 4,000 ft bgs in the West Area (DOGGR, 1998). The DOGGR (1998) base of fresh water determination is based primarily on salinity derived from borehole electric log ("e-log") data, but in some cases is based on Boron content. The Mountain View Oil Field, located along the western edge of the Management Area, is comprised of five pools, including the Main Area, Arvin Area, West Arvin Area, Vaccaro Area, and Di Giorgio Area. The base of fresh water for all Mountain View field pools except the Main Area is between 2,000 and 2,900 ft bgs; for the Main Area the base of fresh water ranges from 1,150 to 4,800 ft bgs.

*Exempted Aquifers*

Under the Safe Drinking Water Act, the United States Environmental Protection Agency (and through a primacy agreement, the State Water Resources Control Board [SWRCB]) regulate injections into Underground Sources of Drinking Water. One such type of injection, known as "Class II injections", involve either enhanced oil recovery or for disposal of fluids associated with oil and gas production. In general, Class II injections are prohibited under the SDWA, except in "exempted aquifers". CalGEM and SWRCB consider proposals for aquifer exemptions on a case-by-case basis. Within the Arvin-Edison Management Area, aquifer exemptions for several deeper formations within the Edison Oil field were proposed by CalGEM (formerly DOGGR) and approved by the SWRCB in two "final concurrence" letters dated 19 October 2018 and 4 February 2019 (see **Appendix G**). The 19 October 2018 letter approves the aquifer exemption proposal for formations including the Vedder Formation, Pyramid Hills Sands, and Main Wicker Sands, and the Transition/Santa Margarita Formation, and the 4 February 2019 letter approves the aquifer exemption proposal for the Chanac Formation (along the northern edge of the Management Area). Both approvals include the condition that fluids injected in the proposed exempted formations must be "of similar or better quality than the existing groundwater" in the area, as determined by Water Boards staff. Based on the CalGEM field data sheet for the Edison field, the Vedder, Pyramid Hills Sands, Main Wicker Sands, Transition/Santa Margarita, and Chanac formations occur at depths of 4,730 to 6,040 ft bgs, 4,620 to 5,950, 2,500 to 4,200 ft bgs, 1,700 to 4,100 ft bgs, and 1,150 to 3,300 ft bgs, respectively (DOGGR, 1998). AEWSD correspondence with local landowners suggests the depth to base of fresh water can be found as shallow as 1,200 ft bgs in parts of the Edison Oil Field.

*Deepest Groundwater Extractions*

The HCM BMP states that "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions" (DWR, 2016). Based on well construction information from 196 wells within the Arvin-Edison Management Area, all wells have depths less than 1,400 ft bgs.[46]

Another indication of the "bottom" of the basin in the Arvin-Edison Management Area comes from the basin representation within groundwater flow models, specifically the DWR's C2VSim basin model (Brush et al., 2016).[47] The depth of groundwater extraction is further characterized in regional groundwater flow models. The C2VSim model (C2VSim-CG, version R374) divides the Central Valley alluvial basin vertically into three layers, the top two of which are pumped (i.e., could be considered to define the vertical extent

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[46] The depth of wells is determined from well construction information using the following data, in order of preference (if data are available): bottom of screen depth, completed depth, or total depth.
[47] GAMA Website: https://www.waterboards.ca.gov/water_issues/programs/gama/about.html.
[47] http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm

of the Basin). The updated version of C2VSim which utilizes a finer grid (C2VSim-FG, Beta version) uses the same layering scheme, but adjusts the thickness of Layers 1 through 3 and adds an additional Layer 4 below Layer 3.[48] C2VSim-CG layer thickness data for 18 model nodes within and near the Management Area show that the combined thickness of Layers 1 and 2 (i.e., the unconfined and confined pumped layers) ranges from 1,438 feet (ft) to 2,146 ft, averaging 1,595 ft. C2VSim-FG layer thickness data for 145 model nodes within the Management Area show a combined thickness of Layers 1 and 2 ranging from 1,157 ft to 1,646 ft, averaging 1,488 ft (***Figure HCM-4***). These combined Layer 1 and 2 thicknesses correspond to the total depth of the pumped zone in this model.

Given the above information, the controlling factor for the definable "bottom of the basin" within the Arvin-Edison Management Area is determined to be the depth of the base of fresh water. Within the Management Area, the bottom of the basin ranges in elevation from -2,000 to -3,200 ft msl in the northern portion to approximately -3,200 to 4,000 ft msl in the southern portion, corresponding to depths of approximately 2,500 ft bgs in the north to 4,400 ft bgs in the south. In certain areas where pools within the Edison and Mountain View oil fields are shallower than the previously mentioned depths, the bottom of the basin is defined as the (shallower) depth of fresh water from the CalGEM oil field data. It is recognized, however, that the maximum depth of wells is only about 1,400 feet, and therefore a substantial volume of groundwater above the "bottom of the basin" has not been tapped by water wells.

#### 7.1.3.2. Wheeler Ridge-Maricopa Management Area

*Depth to Basement Bedrock*

Within the Wheeler Ridge-Maricopa- Management Area the elevation of the top of the basement rock surface ranges from between -21,000 to -22,000 ft msl in the western area and -16,000 to -20,000 ft msl in the eastern area (Scheirer, 2013). Given the land surface elevations, discussed further in **Section 7.3 *Physical Characteristics*** below, the depth to bedrock ranges from less than 16,500 ft bgs in the eastern area to approximately 23,000 ft bgs in the far western area.

*Base of Fresh Water*

The Page (1973) base of fresh water map only characterizes the northernmost portion of the Wheeler Ridge-Maricopa- Management Area and is therefore less informative in this case. O'Bryan (1992) used the same criteria as Page (1973) to map the base of fresh water in areas farther south in the San Joaquin Valley, including most of the Management Area. O'Bryan (1992) shows that the base of fresh water ranges from -1,000 ft msl in the western portion of the Management Area to below -5,000 ft msl near the Rio Viejo oil field in the east-central portion of the Management Area (***Figure HCM-5***). These elevations translate to a range of depths of approximately 1,300 ft bgs to 5,600 ft bgs.

*Base of Fresh Water from Oil Field Information*

***Figure HCM-6*** shows the locations of oil fields in and around the Wheeler Ridge-Maricopa- Management Area, as mapped by DOGGR. The San Emidio Nose oil field, located in the central portion of the Management Area, contains two "pools" (subareas with distinct production characteristics and rules) –

[48] C2VSim-FG, Beta version is currently uncalibrated, and various potential concerns have been identified regarding this model's parameterization of the Kern and White Wolf Subbasins, including representation of the White Wolf Fault (location and hydraulic properties), hydraulic properties of the aquifers, etc. as discussed in detail in the letter to DWR from the White Wolf GSA, of which AEWSD is a member, on 9 July 2018.

the Main Area and the Northwest Area. The base of fresh water indicated on the field data sheets for these pools ranges from 4,500 ft bgs to 5,000 ft bgs in the Main Area to 3,800 ft bgs to 5,000 ft bgs in the Northwest Area (DOGGR, 1998). The DOGGR (1998) base of fresh water determinations are based primarily on salinity derived from borehole e-log data. The Rio Viejo oil field, located just north of the San Emigdio Nose oil field, has a base of fresh water of 5,500 ft bgs. The Yowlumne oil field, located in the western portion of the Management Area, has a base of fresh water between 1,600 ft bgs and 4,000 ft bgs. The Los Lobos oil field overlies a small portion of the southwestern corner of the Management Area and has a base of fresh water between 500 and 3,000 ft bgs. The Midway-Sunset oil field overlies portions of the far western edge of the Management Area, and is largely in an area without fresh water, except in the far southeastern tip of the oil field near Santiago Creek where fresh water is found down to approximately 500 ft bgs.

*Deepest Groundwater Extractions*

Based on well construction information from 191 wells within the Wheeler Ridge-Maricopa Management Area, all wells have depths less than 2,600 ft bgs and approximately 90% of wells have depths less than 1,800 ft bgs.

Another indication of the "bottom" of the basin in the Wheeler Ridge-Maricopa- Management Area comes from the DWR's C2VSim basin model (Brush et al., 2016).[49] C2VSim-CG layer thickness data for 33 model nodes within and near the Management Area show that the combined thickness of Layers 1 and 2 (i.e., the unconfined and confined pumped layers) ranges from 1,252 ft to 3,910 ft, averaging 1,834 ft. The updated version of C2VSim which utilizes a finer grid (C2VSim-FG, Beta version) uses the same layering scheme, but has a refined grid/mesh, adjusts the thickness of Layers 1 through 3 and adds an additional deeper Layer 4.[50] C2VSim-FG layer thickness data for 103 model nodes within the Management Area show a combined thickness of Layers 1 and 2 ranging from 597 ft to 1,807 ft, averaging 1,446 ft (***Figure HCM-7***). These combined Layer 1 and 2 thicknesses correspond to the total depth of the pumped zone in this model.

Within the Wheeler Ridge-Maricopa Management Area, the bottom of the basin (as determined by the depth of the base of fresh water) ranges in elevation from -1,000 ft msl in the western portion to below -5,000 ft msl near the Rio Viejo oil field in the east-central portion, corresponding to depths of approximately 1,300 ft bgs to 5,600 ft bgs. In the certain areas where pools within the Yowlumne, San Emigdio Nose, and Rio Viejo oil fields are shallower than the previously mentioned depths, the bottom of the basin is defined as the (shallower) depth of fresh water from the CalGEM oil field data. The maximum depth of wells is only about 2,600 feet, with 90% of wells screened to depths of 1,800 feet or less, and therefore a substantial volume of groundwater above the "bottom of the basin" has not been tapped by water wells.

[49] http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm
[50] C2VSim-FG, Beta version is currently uncalibrated, and various potential concerns have been identified regarding this model's parameterization of the Kern and White Wolf Subbasins, including representation of the White Wolf Fault (location and hydraulic properties), hydraulic properties of the aquifers, etc. as discussed in detail in the letter to DWR from the White Wolf GSA, of which WRMWSD is a member, on 9 July 2018.

#### 7.1.3.3. Tejon-Castac Management Area

The Tejon-Castac Management Area is located on the margins of the Kern Subbasin largely away from the main valley floor area and consists of largely undeveloped land; groundwater wells and information upon which to base a bottom of the basin determination on water quality grounds are generally scarce. With little available subsurface information to determine things such as the base of fresh water, for the purpose of this GSP, the bottom of the basin within the Tejon-Castac Management Area is defined as the granitic bedrock surface.[51]

The elevation and depth of bedrock can be determined through examination of drillers logs, when available. Based on the cross-section of Bartow (1984) (***Figure HCM-8***) and on the limited available drillers log information, the depth to bedrock varies significantly throughout the Tejon-Castac Management Area. In the portion of the Management Area south of the Edison Fault, the depth of granitic bedrock generally increases from northeast to southwest. North of the Edison Fault, due to the relative down-drop of the northern block, the depth to granitic bedrock is much greater, ranging from approximately 2,500 ft bgs at the northern Management Area boundary to about 5,500 ft bgs along the Edison Fault. Bedrock elevations range from about 0 to -1,000 ft msl in the portion of the Management Area south of the Edison Fault, and from about -1,000 to -4,500 ft msl north of the Edison Fault. In the narrow alluvial valley on the far southeastern side of the Management Area, the depth to bedrock is much shallower, only a few hundred feet. As mentioned above in **Section 5.1.5 *Well Density per Square Mile***, some wells in the Management Area actually draw water from the granitic bedrock and are thus considered to be outside of the Basin.

[51] In other parts of the Kern Subbasin, the "bottom of the basin" is defined with consideration of the depth of oil fields. For example, in the adjacent Arvin-Edison Management Area to the west of the Tejon-Castac Management Area, the "bottom of the basin" is based in part on the depth of the Edison and Mountain View oil fields. There are no oil fields underlying the Tejon-Castac Management Area, and so this consideration is not relevant to defining the bottom of the basin in the Tejon-Castac Management Area.

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

| Type of Information | Source(s) | Parameter Range within Arvin-Edison Management Area | | Parameter Range within Wheeler Ridge-Maricopa Management Area | |
|---|---|---|---|---|---|
| | | Elevation Range (ft msl) | Depth Range (ft bgs) | Elevation Range (ft msl) | Depth Range (ft bgs) |
| Bedrock Basement Composite Surface (2) | Scheirer, 2013 | Northern area: -2,000 to -8,000<br>Eastern/central area: 0 to -6,000<br>Southwestern area: -10,000 to -20,000 | Northern area: 2,500 to 8,500<br>Eastern/central area: 1,000 to 6,500<br>Southwestern area: 10,500 to -20,500 | Western Area: -22,000 to -21,000<br>Eastern area: -20,000 to -16,000 | Western Area: 21,500 to 23,000<br>Eastern area: 16,500 to 20,500 |
| Base of Fresh Water | Page, 1973; O'Bryan, 1992 | Northern Area: -2,000 to -3,200<br>Southern area: -3,200 to -4,000 | Northern Area: 2,500 +<br>Southern area: Up to 4,400 | Western Area: -3,000 to -1,000<br>Eastern area: -5,000 | Western Area: 1,300 to 4,000<br>Eastern area: 5,300 to 5,600 |
| Oil Field Base of Fresh Water Information | DOGGR, 1998 | Edison oil field area: -1,000 to -3,300<br>Mountain View oil field area: -700 to -4,300 | Edison oil field area: 1,700 to 4,000<br>Mountain View oil field area: 1,150 to 4,800 | Yowlumne oil field: -3,400 to -1,000<br>San Emigdio Nose oil field: -4,400 to -3,200<br>Rio Viejo oil field: -5,100 | Yowlumne oil field: 1,600 to 4,000<br>San Emigdio Nose oil field: 3,800 to 5,000<br>Rio Viejo oil field: 5,500 |

| Type of Information | Source(s) | Parameter Range within Arvin-Edison Management Area | | Parameter Range within Wheeler Ridge-Maricopa Management Area | |
|---|---|---|---|---|---|
| | | Elevation Range (ft msl) | Depth Range (ft bgs) | Elevation Range (ft msl) | Depth Range (ft bgs) |
| Exempted Aquifers | SWRCB; CalGEM | Edison oil field area: -800 to -3,300 | Edison oil field area: 1,500 to 6,040 | N/A | N/A |
| Deepest GW Extractions from Well Construction Information | WRMWSD Well Database | N/A | N/A | 90% of wells BOS elevation > -1,400<br>100% of wells BOS elevation > -2,000 | 90% of wells less than 1,800 feet deep<br>100% of wells less than 2,600 feet deep |
| Deepest Groundwater Extractions from Regional Groundwater Model | Brush et al., 2016; DWR, 2018 | C2VSim-CG (R374): -734 to -1,244<br>C2VSim-FG (Beta): -340 to -1,151 | C2VSim-CG (R374): 1,458 to 2,146<br>C2VSim-FG (Beta): 1,157 to 1,646 | C2VSim-CG (R374): -357 to -1,447<br>C2VSim-FG (Beta): -129 to -1,342 | C2VSim-CG (R374): 1,252 to 3,910<br>C2VSim-FG (Beta): 597 to 1,807 |

Notes:

(1) Shaded cells indicate estimated values based on approximate ground surface elevation.

(2) In the Tejon-Castac Management Area, the elevation and depth of bedrock was determined through available drillers log information and cross-sections (Bartow, 1984). North of the Edison Fault, the depth to granitic bedrock ranges from 2,500 ft bgs to 5,500 ft bgs and the elevation ranges from -1,000 to -4,500 ft msl. South of the Edison Fault, the depth to granitic bedrock generally increases from northeast to southwest and bedrock elevations range from about 0 to -1,000 ft msl.

### 7.1.4. Principal Aquifers and Aquitards

☑ 23 CCR § 354.14(b)(4)

Principal aquifers are defined in the GSP Emergency Regulations as "aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems" (23 CCR § 351(aa)).

#### 7.1.4.1. Arvin-Edison Management Area

Given the above definition, in areas with significant groundwater development, such as the Arvin-Edison Management Area, it is reasonable to equate the principal aquifers with the aquifers from which wells pump water for water supply. This in turn can be deduced through examination of the depths of water supply production wells.

Based on well construction information from 196 wells within the Arvin-Edison Management Area, all wells have depths less than 1,400 ft bgs,[52] and approximately 90 percent of wells have depths between 400 and 1,200 ft bgs (***Figure HCM-9***). This indicates that the principal aquifer(s) are those that are encountered within the top 1,400 ft bgs. The following discussion, therefore, focuses on the aquifer materials encountered in this depth zone. The surficial geology within the Arvin-Edison Management Area is discussed further below in **Section 7.3 *Physical Characteristics***, and the stratigraphic relations and well log information along the lines of section are presented on cross-sections A-A', B-B', and C-C', discussed further below in **Section 7.2 *Cross-Sections***.

*Formation Names and Occurrence*

☑ 23 CCR § 354.14(b)(4)(A)

The stratigraphy in the depth zone of the principal aquifer within the Arvin-Edison Management Area includes (from shallowest to deepest; youngest to oldest), the Quaternary (Recent and Pleistocene) Alluvium deposits and the late Tertiary (Miocene and Pliocene) Kern River Formation (KRF). The Alluvium deposits, sometimes divided into Younger (Recent) and Older (Pleistocene) units (e.g., Wood and Dale, 1964), are composed generally of unconsolidated sands and gravels, coarser towards its base, and is somewhat coarser than the underlying deposits (Croft, 1972). However, the Older Alluvium and late Tertiary KRF are similar in depositional/lithologic character and are difficult to distinguish from one another.

The KRF is analogous to (and sometimes considered part of) the Tulare Formation (Croft, 1972). The name "Kern River Formation" was originally used by Diepenbrock (1933) and subsequently formalized by Bartow and Pittman (1983). The KRF consists of unconsolidated beds of sand and conglomerate with interbeds of siltstone and mudstone, is generally poorly-sorted with medium- to large-scale cross-bedding, and was deposited in fluvial, braided-channel environments (Bartow and Pittman, 1983). The fluvial origin of the KRF results in channel-like bodies of coarse-grained materials which can provide anisotropic hydraulic connections. These channels are largely unmapped but have occasionally been deduced through detailed local-scale hydrogeologic inference (e.g., Central Valley Regional Water Quality Control Board [CVRWQCB], 2009). Near the base of the formation, the KRF includes intervals containing hydrocarbon-

[52] The depth of wells is determined from well construction information using the following data, in order of preference (if data are available): bottom of screen depth, completed depth, or total depth.

bearing sands, lenticular in shape and separated by lower permeability silt and clay interbeds. Most of the oil contained within these oil sands migrated upwards from older marine units.

Underlying the KRF (generally beneath the principal aquifer) are the Miocene Chanac Formation (and in some areas, generally westward, the Etchegoin Formation). The contact between the KRF and the Chanac Formation is possibly unconformable (Bartow and Pittman, 1983). Below the Chanac Formation is the Miocene marine Santa Margarita Formation (Bartow and Pittman, 1983).

A significant regional aquitard within the principal aquifer, the Pleistocene "E"-Clay (Croft, 1972), underlies the western portion of the northern half of the Arvin-Edison Management Area and the northern portion of the southern half of the Arvin-Edison Management Area (***Figure HCM-10***). The “E”-Clay or “Corcoran Clay” is one of several flood-basin, lacustrine and marsh deposits that exist within the southern San Joaquin Valley and is often referred to as “blue clay” in well driller logs (Croft, 1972). The “E”-Clay dips generally southwestward, and beneath the Management Area the base of the "E"-Clay ranges in elevation from approximately 200 ft msl in the east to -200 feet ft msl in the southwest (Croft, 1972). The depth to top of the Corcoran Clay (“E”-Clay) ranges from approximately 400 ft bgs in its most northeastern extent beneath the Management Area to approximately 250 ft bgs in the southwestern portion (DWR, 2008). The “E”-Clay, where present, acts as a confining unit for the underlying groundwater; above the “E”-Clay (and where the “E”-Clay does not exist) groundwater occurs under unconfined conditions (Croft, 1972). Another similar regional aquitard unit, the “A”-Clay, exists at shallower depths to the west of the Arvin-Edison Management Area but does not underlie it (***Figure HCM-10***). The “A”-Clay is likely the cause of perched groundwater conditions observed in this area (Croft, 1972).

It should be noted that despite the variably confined conditions in this area, it is not deemed appropriate to define separate unconfined and confined principal aquifers because (1) the regional aquitards do not extend throughout the Arvin-Edison Management Area; and (2) many wells are screened over large vertical intervals including above and below the regional aquitard (where it is present), thus creating a vertical hydraulic connection.

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

**☑ 23 CCR § 354.14(b)(4)(B)**

Given the range of lithologies and grain sizes within the formations that comprise the principal aquifer (i.e., ranging from gravels and sands, to silts and clays, generally poorly-sorted and interbedded), the physical properties of the aquifer vary widely both laterally and with depth. In general, wells drilled into the principal aquifer tap into sufficient coarse-grained material to be productive enough to support overlying agricultural demands. AEWSD periodically measures the specific capacity of its wells and the most recent available data indicates specific capacity ranging from 3 to 145 gallons per minute per foot of drawdown (gpm/ft) with an average of 29.6 gpm/ft and a median of 23 gpm/ft. Wood and Dale (1964) developed a map of “yield factors” for the Edison-Maricopa area. The yield factor is defined as the specific capacity per 100 feet of aquifer screened by a well (i.e., units of gpm/100ft$^2$). The Wood and Dale (1964) map (***Figure HCM-11***) shows that most of the northern portion of the Arvin-Edison Management Area has yield factors of between 11 and 50 gpm/100ft$^2$, with a small area of yield factor greater than 50 gpm/100ft$^2$. The southern portion of the Management Area has lower yield factors in the range of 6 to 10 gpm/100ft$^2$.

While the yield factors of Wood and Dale (1964) provide insight into the relative productivity of wells, they do not directly translate into aquifer hydraulic properties. Multiple-well aquifer pumping test data which is necessary to accurately determine hydraulic conductivity and storage parameters is generally not available. Another potential source of information regarding hydraulic properties is extraction of parameters from calibrated numerical groundwater models, although this information must be used with caution, particularly in areas such as Arvin-Edison Management Area where the model parameters are not based on local calibration.[53] The DWR's C2VSim model is one such source of hydraulic property information.

As mentioned above, C2VSim-CG has three model layers: Layer 1 (top) represents the unconfined unit, Layer 2 (middle) represents the pumped portion of the confined unit, and Layer 3 (bottom) represents the unpumped portion of the confined unit (Brush et al., 2016). C2VSim-FG adds an additional fourth layer below the bottom of the three existing layers. ***Table HCM-2***, below, shows a summary of hydraulic property information for C2VSim nodes in Layers 1 and 2 within the Arvin-Edison Management Area, based on the R374 version of the coarse model and the "beta" version of the fine grid model. ***Figure HCM-12*** shows selected hydraulic property values for the 145 C2VSim-FG nodes within the Arvin-Edison Management Area, including hydraulic conductivity for Layers 1 and 2, specific yield for Layer 1, and specific storage for Layer 2.

**Table HCM-2. Hydraulic Properties Extracted from C2VSim Models, Arvin-Edison Management Area**

| **Parameter** | **C2VSim-CG (R374)** | **C2VSim-FG (Beta version)** |
|---|---|---|
| Number of Nodes within Arvin-Edison Management Area | 18 | 145 |
| *Layer 1 Node Properties:* Average (Minimum to Maximum) | | |
| Hydraulic Conductivity (ft/day) | 48.1 (34.3 to 69.2) | 29.2 (8.2 to 49.2) |
| Specific Yield (-) | 0.292 (0.114 to 0.400) | 0.085 (0.074 to 0.094) |
| Specific Storage (-) | NA | NA |
| *Layer 2 Node Properties:* Average (Minimum to Maximum) | | |
| Hydraulic Conductivity (ft/day) | 46.2 (20.7 to 98.6) | 15.2 (2.6 to 38.6) |
| Specific Yield (-) | 0.122 (0.122 to 0.124) | 0.081 (0.071 to 0.097) |
| Specific Storage (-) | 2.5E-05 (8.8E-06 to 4.6E-05) | 0.0014 (0.0002 to 0.0021) |

Abbreviations:
ft/day = feet per day
NA = not applicable

[53] Numerical models that are regional (i.e., large scale) in extent should be assumed to possess a high degree of uncertainty with respect to local parameter values. Nonetheless, where local measurements are not available, such model parameters can serve as an approximation for unknown values.

As shown in the table above, the upper unconfined zone, represented by Layer 1 in both the coarse-grid and (uncalibrated) fine-grid versions of C2VSim, is somewhat more permeable than the confined zone represented by Layer 2. Both the specific yield of Layer 1 and the specific storage of Layer 2 are much greater in the Arvin-Edison Management Area in C2VSim-CG than in C2VSim-FG; however, these values may change in C2VSim-FG upon completion of updated model calibration.

Another numerical groundwater model that covers the entire Central Valley is the U.S. Geological Survey's (USGS) Central Valley Hydrologic Model (CVHM) (Faunt, ed., 2009). The CVHM model is based on the USGS' MODFLOW software package and simulates integrated subsurface and surface water flow processes, including agricultural water demand based on climate and land use information, for the period from October 1961 through September 2003. Hydraulic properties for each 1-square mile model grid cell were assigned based on the kriged distribution of coarse-grained deposits which was ascertained through review and lithologic coding of thousands of well logs. ***Figure HCM-13*** shows the distribution of coarse-grained (i.e., more permeable) deposits in the CVHM model layers 3, 4, 6, and 8 which correspond, respectively and approximately, to (Layer 3) the upper unconfined, saturated portion of the principal aquifer, (Layer 4) the Corcoran Clay, and (Layers 6 and 8), the confined portion of the principal aquifer. As shown on ***Figure HCM-13***, this distribution shows a relatively coarse area in the north-central portion of the Arvin-Edison Management Area, finer materials to the northeast of the Edison Fault, and moderate to fine materials in the southern portion (Faunt, ed., 2009). This pattern is generally consistent with the "yield factor" map of Wood and Dale (1964), shown on ***Figure HCM-11***. Although the Layer 4 (Corcoran Clay) appears to have a high percent coarse in ***Figure HCM-13***, in the model the texture-based estimated hydraulic conductivity for this layer is reduced by a factor of 100 in the horizontal direction and 500 in the vertical direction to simulate impedance to flow (Faunt, ed., 2009)

From the information discussed above, it is clear that considerable uncertainty exists in the values for aquifer properties including hydraulic conductivity and specific yield. This is not unexpected, given the heterogeneous nature of the KRF. As a further indication of the variability in these parameters, Dale et al. (1966) provided estimates of permeability (analogous to hydraulic conductivity) of the various types of continental deposits in the Kern River alluvial fan area, and they range over several orders of magnitude. Permeability for gravel and clay is stated in Dale et al. (1966) to range between 10 and 100 gallons per day per foot squared (gpd/ft$^2$),[54] for fine sand and silt from 0.001 to 10 gpd/ft$^2$, for medium and coarse sand from 100 to 1,000 gpd/ft$^2$, and for the gravel (dominated) lentil from 1,000 to 10,000 gpd/ft$^2$. As such, an accurate spatial distribution of hydraulic properties remains a significant data gap, although one that may be filled via further local investigation and/or model calibration.

*Structural Properties of the Basin that Restrict Groundwater Flow Within the Principal Aquifer(s)*

**☑ 23 CCR § 354.14(b)(4)(C)**

The White Wolf Fault that forms the southern border of the Arvin-Edison Management Area and the Kern Subbasin is known to act as a significant barrier to lateral groundwater flow from the White Wolf Subbasin northwards into the Kern Subbasin, especially at lower groundwater levels (Erler & Kalinowski, Inc., 2016). Groundwater level information (discussed further below in **Section 8.2 *Groundwater Elevations and Flow Direction***) suggests that the Edison Fault in the northeastern portion of the Arvin-Edison Management Area may also create a "barrier" effect on flow in the deeper portions of the principal aquifer, even though

[54] One gpd/ft$^2$ is equal to 0.133 ft/day.

the fault, which was active during the Miocene and possibly Pliocene era, likely does not extend vertically up through the entire KRF. As discussed above, the “E”-Clay acts as a regional aquitard that limits vertical flow to some extent between the unconfined and confined portions of the aquifer in the western portion of the Arvin-Edison Management Area. It should be noted, however, that many wells are screened through this aquitard and therefore serve as a hydraulic connection between the two zones.

*General Water Quality of the Principal Aquifer(s)*

**☑ 23 CCR § 354.14(b)(4)(D)**

General groundwater quality within most of the Arvin-Edison Management Area was categorized by Wood and Dale (1964) as "transition" waters (**Figure HCM-14**). A small area on the far eastern side is categorized as “waters of the older rocks”. The Wood and Dale (1964) groundwater quality categories reflect differences in the chemical characteristics of streams that recharge groundwater and differences in the rock types through which groundwater moves. The “transition” waters represent the transition from water emanating chiefly from the Sierra Nevada Mountains to the east and “axial” and “west-side” waters whose chemical composition reflects geochemical processes occurring in the central and western San Joaquin Valley, respectively. The “transition” waters have bicarbonate as the predominant anion and an intermediate cation composition. The “waters of the older rocks” are of a sodium or sodium calcium bicarbonate type (Wood and Dale, 1964). Further discussion of specific constituents of particular relevance to the beneficial uses within the Arvin-Edison Management Area, including maps of the distribution of these constituents, is provided in **Section 8.5 *Groundwater Quality*** below.

*Primary Uses of Each Aquifer*

**☑ 23 CCR § 354.14(b)(4)(E)**

The predominant use of groundwater from the principal aquifer in the Arvin-Edison Management Area is for irrigated agriculture. This includes groundwater pumped by individual landowners for use on their crops, as well as groundwater banked by AEWSD and subsequently recovered for distribution to AEWSD customers and others on a second priority basis (i.e., water management programs with third parties). Groundwater is also used by Arvin Community Services District (ACSD) and Mettler County Water District (MCWD) as a source municipal & industrial (M&I) water supply, by a small number of private commercial entities for industrial use (i.e., food processing), and to supply an unknown number of private domestic wells. ***Figure HCM-15*** shows the distribution of wells within the Arvin-Edison Management Area by well type (i.e., irrigation, domestic/M&I, monitoring, recovery, and unknown).

#### 7.1.4.2. Wheeler Ridge-Maricopa Management Area

As discussed previously and shown on ***Figure HCM-16***, well construction information from 191 wells within the Wheeler Ridge-Maricopa Management Area indicates that all wells have depths less than 2,600 ft bgs,[55] and approximately 90% of wells have depths less than 1,800 ft bgs. Therefore, the principal aquifer is considered to be the aquifer materials encountered within the top 2,600 ft bgs. The surficial geology within the Wheeler Ridge-Maricopa Management Area is discussed further below in **Section 7.3**

[55] The depth of wells is determined from well construction information using the following data, in order of preference (if data are available): bottom of screen depth, completed depth, or total depth.

***Physical Characteristics***, and the stratigraphic relations and well log information along the lines of section are presented on cross-sections D-D’ and E-E’, discussed further below in **Section 7.2 *Cross-Sections***.

<u>*Formation Names and Occurrence*</u>

**☑ 23 CCR § 354.14(b)(4)(A)**

The stratigraphy within the depth zone of the principal aquifer in the Wheeler Ridge-Maricopa Management Area includes (from shallowest to deepest; youngest to oldest): Quaternary (Recent to Pleistocene) Alluvium deposits and the late Tertiary (Pliocene/Pleistocene) Tulare Formation. Underlying the Tulare Formation (and generally well below the depth of the principal aquifer) are Miocene and Pliocene marine sedimentary rocks of the San Joaquin and Etchegoin Formations. Owing to their similar continental origin and fluvial mode of deposition, the Quaternary Alluvium and Plio/Pleistocene Tulare Formation can be difficult to distinguish from one another. The Alluvium and Tulare Formations are generally unconsolidated, although consolidation increases with age and depth.

The Alluvium unit, sometimes divided into Younger (Recent) and Older (Pleistocene) units (e.g., Wood and Dale, 1964), is composed generally of unconsolidated sands and gravels of fluvial origin, coarser towards its base, and is somewhat coarser than the underlying deposits (Croft, 1972). The Tulare Formation is correlative to and interfingers with the KRF which underlies the Quaternary Alluvium on much of the eastern side of the Kern Subbasin. In the vicinity of the southwestern border of the San Joaquin Valley, the Tulare Formation is exposed in the foothills and is folded or tilted. It consists of poorly sorted lenticular beds of sand and conglomerate with interbeds of siltstone and mudstone. The fluvial origin of the Tulare Formation results in channel-like bodies of coarse-grained materials which can provide anisotropic hydraulic connections, although these channels are largely unmapped. Underlying the Tulare Formation (generally well below the depth of the principal aquifer) are the Etchegoin Formation and, towards the east, the Miocene Chanac Formation to the east of the Management Area.

The Pleistocene “E”-Clay (Croft, 1972), underlies the northern portion of the center of the Wheeler Ridge-Maricopa Management Area (***Figure HCM-17***). Beneath the Wheeler Ridge-Maricopa Management Area the base of the “E”-Clay ranges in elevation from approximately -200 ft msl in the northeastern portion to -400 ft msl in the north-central portion. The depth to top of the “E”-Clay is approximately 250 ft bgs in its most southwestern extent beneath the Wheeler Ridge-Maricopa Management Area (DWR, 2008). As shown on ***Figure HCM-17***, the “E”-Clay is not known to extend all the way underneath the Wheeler Ridge-Maricopa Management Area to the western or southern extents, and thus is not known to consistently confine the underlying aquifer. The “A”-Clay exists at shallower depths to the north of the Wheeler Ridge-Maricopa Management Area but does not underlie it. The “A”-Clay may be the cause of perched groundwater conditions observed in this area (Croft, 1972).

It should be noted that despite the variably confined conditions in this area, it is not deemed appropriate to define separate unconfined and confined principal aquifers because (1) the regional aquitards are not extensive throughout the Wheeler Ridge-Maricopa Management Area; and (2) many wells are screened over large vertical intervals including above and below the regional aquitard (where it is present), thus creating a vertical hydraulic connection.

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

**☑ 23 CCR § 354.14(b)(4)(B)**

The Wood and Dale (1964) yield factor map (***Figure HCM-18***) shows that most of the central portion of the Wheeler Ridge-Maricopa Management Area has yield factors between 1 and 5 gpm/100ft$^2$, with some areas to the west having lower yield factors, and some areas to the east having higher yield factors of 6 to 10 gpm/100ft$^2$. Well testing data collected in 2017 from 19 wells located in the north-central portion of the Management Area indicates specific capacity ranging from 10.8 gpm/ft to 61.4 gpm/ft, averaging 28.1 gpm/ft.

As mentioned previously, the DWR's C2VSim model covers the Wheeler Ridge-Maricopa Management Area and is another source of hydraulic property information. ***Table HCM-3***, below, shows a summary of hydraulic property information for C2VSim nodes in Layers 1 and 2 within the Wheeler Ridge-Maricopa Management Area, based on the R374 version of the coarse grid (CG) model and the "beta" version of the fine grid (FG) model. ***Figure HCM-19*** shows selected hydraulic property values for the 103 C2VSim-FG nodes within the Wheeler Ridge-Maricopa Management Area, including hydraulic conductivity for Layers 1 and 2, specific yield for Layer 1, and specific storage for Layer 2.

**Table HCM-3. Hydraulic Properties Extracted from C2VSim Models, Wheeler Ridge-Maricopa Management Area**

| Parameter | C2VSim-CG (R374) | C2VSim-FG (Beta version) |
|---|---|---|
| Number of Nodes within Wheeler Ridge-Maricopa Management Area | 9 | 103 |
| *Layer 1 Node Properties:* Average (Minimum to Maximum) | | |
| Hydraulic Conductivity (ft/day) | 33.6 (30.0 to 41.4) | 20.8 (8.7 to 37.3) |
| Specific Yield (-) | 0.27 (0.11 to 0.40) | 0.082 (0.075 to 0.087) |
| Specific Storage (-) | N/A | N/A |
| *Layer 2 Node Properties:* Average (Minimum to Maximum) | | |
| Hydraulic Conductivity (ft/day) | 20.7 (8.7 to 49.9) | 15.6 (2.2 to 71.2) |
| Specific Yield (-) | 0.122 (0.122 to 0.123) | 0.080 (0.071 to 0.097) |
| Specific Storage (-) | 1.8E-05 (9E-06 to 4.6E-05) | 0.0014 (0.0002 to 0.0021) |

Abbreviations:
ft/day = feet per day
NA = not applicable

As shown in the table above, the upper unconfined zone, represented by Layer 1 in both the coarse-grid and (uncalibrated) fine-grid versions of C2VSim, is somewhat more permeable than the confined zone represented by Layer 2. The specific yield of Layer 1 is much greater in the Wheeler Ridge-Maricopa

Management Area in C2VSim-CG than in C2VSim-FG; however, these values may change in C2VSim-FG upon completion of updated model calibration.

As discussed above, another numerical groundwater model that covers the Central Valley is the USGS CVHM model. ***Figure HCM-20*** shows the horizontal hydraulic conductivity of active cells of CVHM model layers 3, 4, 6, and 8 which correspond, respectively and approximately, to (Layer 3) the upper unconfined, saturated portion of the principal aquifer, (Layer 4) the Corcoran Clay, and (Layers 6 and 8), the confined portion of the principal aquifer. As shown on ***Figure HCM-20***, the hydraulic conductivity of Layer 3 is high (generally in the 250 feet per day [ft/day] to 500 ft/day range), which is much higher than in C2VSim. For the confined aquifer represented in CVHM by Layers 6 and 8, hydraulic conductivity ranges from 5 ft/day to 50 ft/day.

As discussed above, considerable uncertainty exists in the values for aquifer properties including hydraulic conductivity and specific yield. An accurate spatial distribution of hydraulic properties remains a significant data gap, although one that may be filled via further local investigation and/or model calibration.

*Structural Properties of the Basin that Restrict Groundwater Flow Within the Principal Aquifer(s)*

**☑ 23 CCR § 354.14(b)(4)(C)**

As discussed above, the White Wolf Fault is known to act as a significant barrier to lateral groundwater flow from the White Wolf Subbasin northwards into the Kern Subbasin, especially at lower groundwater levels (Erler & Kalinowski, Inc., 2016). Additionally, the “E”-Clay acts as a regional aquitard that limits vertical flow to some extent between the unconfined and confined portions of the aquifer in the northern portion of the Wheeler Ridge-Maricopa Management Area. It should be noted, however, that many wells are screened through this aquitard and therefore serve as a hydraulic connection between the two zones. The Plieto Fault is a southward dipping thrust fault located roughly two to six miles south of the Wheeler Ridge-Maricopa Management Area that separates Miocene and older rocks on the south from Pliocene and Quaternary rocks on the north. The fault is active in Recent times and is roughly coincident with the southern boundary of the Kern Subbasin (as defined in 2016).

*General Water Quality of the Principal Aquifer(s)*

**☑ 23 CCR § 354.14(b)(4)(D)**

General groundwater quality within most of the Wheeler Ridge-Maricopa- Management Area is categorized by Wood and Dale (1964) as “west-side waters” (***Figure HCM-21***). Small areas on the far eastern side are categorized as “transition waters” and “axial waters”. The Wood and Dale (1964) groundwater quality categories reflect differences in the chemical characteristics of streams that recharge groundwater and differences in the rock types through which groundwater moves. The “west-side waters” have sulfate as the predominant anion and with intermediate cation composition. Total ionic concentrations, indicated by the size of the pie charts on ***Figure HCM-21***, are highest in the west, which reflects that the source of water is marine rocks of the Coast Range Mountains. The “transition” waters represent the transition from water emanating chiefly from the Sierra Nevada Mountains to the east and “axial” and “west-side” waters whose chemical composition reflects geochemical processes occurring in the central and western San Joaquin Valley, respectively. The “transition” waters have bicarbonate as the predominant anion and an intermediate cation composition. Further discussion of specific constituents of particular relevance to the beneficial uses within the Wheeler Ridge-Maricopa Management Area, including maps of the distribution of these constituents, is provided in **Section 8.5 *Groundwater Quality***.

<u>*Primary Uses of Each Aquifer*</u>

☑ **23 CCR § 354.14(b)(4)(E)**

The predominant use of groundwater from the principal aquifer in the Wheeler Ridge-Maricopa Management Area is for irrigated agriculture. This includes groundwater pumped by individual landowners for use on their crops, as well as groundwater pumped by WRMWSD and subsequently distributed to WRMWSD customers. There are also several domestic wells in the Wheeler Ridge-Maricopa Management Area, mostly in the east-central portion. WRMWSD also supplies small quantities of water (approximately 1% of total water deliveries) to several industrial entities. ***Figure HCM-22*** shows the distribution of wells within the Wheeler Ridge-Maricopa Management Area by well type (i.e., agricultural, domestic, industrial, monitoring, and unknown). As shown on ***Figure HCM-22***, the density of wells is much lower in the western half of the Wheeler Ridge-Maricopa Management Area, presumably due to the relatively lower yields and poorer water quality in that area.

#### 7.1.4.3. <u>Tejon-Castac Management Area</u>

The Tejon-Castac Management Area can be conceptualized as having two distinct areas, separated approximately by the Edison Fault (***Figure HCM-8***). The area south of the Edison Fault includes those lands directly adjacent to the Arvin GSA along the margins of the main valley floor area of the Basin which are connected to the main groundwater system of the Kern Subbasin, and also includes the lands confined within a narrow valley along Highway 223 on the eastern side of the Tejon-Castac Management Area. The principal aquifer in these areas consists of the saturated portions of the Quaternary and late Tertiary alluvial/continental materials. All of the known existing wells within the Tejon-Castac Management Area are within this area south of the fault, with one combination industrial/agricultural well (i.e., the Caratan Well), and possibly one irrigation well, in the valley floor area and several domestic wells in the narrow eastern valley area (***Figure PA-16***).

The area north of the Edison Fault consists of highly dissected hilly terrain and a small floodplain valley on the far northern side. In this area north of the fault, groundwater availability is thought to be limited and development has not occurred and is unlikely to occur in the future for the following reasons: (1) the rugged topography likely precludes groundwater development for irrigated agriculture; (2) the shallow Quaternary alluvium along Caliente Creek has limited water storage capacity to support groundwater development (see further discussion in **Section 8.2 *Groundwater Elevations and Flow Direction*** below); (3) the area is covered by Conservation Easements under the Tejon Ranch Conservation and Land Use (C&LU) Agreement, either currently or in the future once development milestones of the Grapevine Project are reached; and (4) the land use designation under the Kern County General Plan is Extensive Agriculture for which land uses are typically livestock grazing, dry farming, and woodlands (***Figure PA-17*** and discussion above in **Section 5.1.4 *Existing Land Use and Water Use***). Because of the lack of development in this area, insufficient information exists to determine whether this area contains a principal aquifer as defined under SGMA.[56]

[56] Principal aquifers are defined in the GSP Emergency Regulations (23 CCR § 351(aa)) as "aquifers or aquifer systems that storage, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems."

*Formation Names and Occurrence*

☑ **23 CCR § 354.14(b)(4)(A)**

Based on the California Division of Mines and Geology (CDMG) (1964) surficial geologic map, the surficial geologic unit in the portion of the Tejon-Castac Management Area south of the Edison Fault is predominantly Recent fan deposits ("Qf") in the valley floor area and Recent alluvium ("Qal") in the narrow eastern valley area (***Figure HCM-8***). The Qf unit is described in CDMG (1964) as "sediments deposited from streams emerging from high lands surrounding the Great Valley" and the Qal unit is described as "alluvium, unconsolidated valley and stream deposits; locally includes dissected fans; lake and marsh deposits in the Sierra Nevada probably Pleistocene age in part; coarse granitic fanglomerate along eastern base of Sierra Nevada". This same area is generally mapped by Bartow (1984) as Younger Alluvium (Holocene and Upper Pleistocene) ("Qya"), and described as "Sand, gravel, silt, and clay in modern channels and underlying modern flood plains, abandoned channels, lowest terraces along streams, and undissected alluvial fans". Below these surficial units lie lithologically similar units including or correlative to the KRF, which constitutes the principal aquifer in the Arvin-Edison Management Area. Because of their position close to the granitic bedrock basin margin, the saturated thickness of these units is likely small (i.e., up to only about 1,000 feet).[57] Boundary effects from the adjacent and underlying bedrock may affect water-bearing behavior of these units.

In the area north of the Edison Fault, geologic units above the granitic bedrock are older including (after CDMG, 1964) Tertiary non-marine sedimentary rocks ("Tc") and Undivided Miocene nonmarine sedimentary rocks ("Mc"). Bartow (1984) maps these units specifically as the Bealville Fanglomerate and Walker Formation (ranging from Upper Eocene to Lower Miocene) and the Bena Gravel (Miocene). These older units have greater thicknesses than the units in the area south of the Edison Fault, filling the structural basin created by displacement along the fault.

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

☑ **23 CCR § 354.14(b)(4)(B)**

Given the location of the Tejon-Castac Management Area (i.e., very proximate to the Kern Subbasin boundary) and the low groundwater production of the area, there is very limited information about the physical properties of the principal aquifer within the Tejon-Castac Management Area. Multiple-well aquifer pumping test data which are necessary to accurately determine hydraulic conductivity and storage parameters are not available. Therefore, evaluation of physical and hydraulic properties of the units must rely on more general regional studies.

While most areas of the Tejon-Castac Management Area lie outside of the area mapped by Wood and Dale (1964), areas to the west have yield factors of between 6 and 10 gpm/100ft$^2$ and between 11 and 50 gpm/100ft$^2$ (***Figure HCM-23***), and it may be presumed that similar values would hold for saturated alluvial materials within the Tejon-Castac Management Area.

As previously mentioned, another potential source of information regarding hydraulic properties is extraction of parameters from DWR's C2VSim groundwater model. ***Figure HCM-24*** shows selected hydraulic property values for the C2VSim-FG nodes within the Tejon-Castac Management Area, including

[57] The depth of the only known active production well in the Tejon-Castac Management Area, the Caratan Well, is 800 feet.

hydraulic conductivity for Layers 1 and 2, specific yield for Layer 1, and specific storage for Layer 2. As shown on ***Figure HCM-24***, C2VSim-FG nodes in the area of the principal aquifer (i.e., south of the Edison Fault) have hydraulic conductivity values between 20 and 30 ft/day in Layer 1 and between 3 and 20 ft/day in Layer 2. Specific yield in C2VSim-FG Layer 1 is between 0.08 and 0.09, and specific storage in C2VSim-FG Layer 2 is between 0.001 and 0.0021.[58] These parameter values suggest that, on average, the shallower portion of the aquifer systems is more permeable than the deeper portion. However, these values might change after updated model calibration.

*Structural Properties of the Basin that Restrict Groundwater Flow Within the Principal Aquifer(s)*

**☑ 23 CCR § 354.14(b)(4)(C)**

The White Wolf Fault that cuts through the southern portion of the Tejon-Castac Management Area is known to act as a significant barrier to lateral groundwater flow from the White Wolf Subbasin northwards into the Kern Subbasin (Erler & Kalinowski, Inc., 2016). As such, the White Wolf Fault may also act as a barrier to flow within the narrow band of alluvial materials in the southern portion of the Tejon-Castac Management Area, although such a barrier effect has not been observed or documented.

The Edison Fault appears to create a significant impediment to groundwater flow in the area to the west of the Tejon-Castac Management Area, as evidenced by steep groundwater level gradients in that part of the Arvin-Edison Management Area. Within the Tejon-Castac Management Area, the Edison Fault juxtaposes the granitic bedrock on the south side against the Tertiary sedimentary units (i.e., Bena Gravel and Bealville Fanglomerate) on the north side (***Figure HCM-8***). Because the granitic bedrock is relatively impermeable and flow into or out of the bedrock is likely negligible, the Edison Fault likely serves as an impediment to groundwater flow in the Tejon-Castac Management Area as well.

*General Water Quality of the Principal Aquifer(s)*

**☑ 23 CCR § 354.14(b)(4)(D)**

General groundwater quality within the Tejon-Castac Management Area remains uncertain due to a lack of wells with water quality data. However, Wood and Dale (1964) categorized water quality for a portion of the southern Kern Subbasin that partially covers the Management Area (***Figure HCM-25***). The area adjacent to the center of the Management Area is categorized as "waters of the older rocks", the southern portion as "transition waters". The Wood and Dale (1964) groundwater quality categories reflect differences in the chemical characteristics of streams that recharge groundwater and differences in the rock types through which groundwater moves. The "transition" waters represent the transition from water emanating chiefly from the Sierra Nevada Mountains to the east and "axial" and "west-side" waters whose chemical composition reflects geochemical processes occurring in the central and western San Joaquin Valley, respectively. The "transition" waters have bicarbonate as the predominant anion and an

[58] Values for specific storage appear high and may be in fact representative of storativity (i.e., specific storage multiplied by aquifer thickness).

intermediate cation composition. The “waters of the older rocks” are of a sodium or sodium calcium bicarbonate type (Wood and Dale, 1964).

*Primary Uses of Each Aquifer*

☑ **23 CCR § 354.14(b)(4)(E)**

The only significant use of groundwater within the Tejon-Castac Management Area is at the Caratan Well (***Figure PA-16***). Water from this well is used for industrial purposes at the Granite Quarry, as well as for agricultural irrigation of certain lands within the adjacent Arvin-Edison Management Area. Pumping for use at the Granite Quarry was metered for a time historically, but not recently; historic production rates were approximately 400 acre-feet per year (AFY). Return flows from the quarry were estimated by the quarry operator, based on data from a similar operation in the nearby adjudicated Antelope Valley Basin, at approximately 37 percent of total pumping. Therefore, net consumptive use of groundwater by the Granite Quarry is estimated to be approximately 250 AFY.

Water pumped from the Caratan Well is also used for irrigation of certain lands outside of Tejon-Castac Management Area.[59] Those lands comprise two parcels, a northern parcel with an area of approximately 137 acres and a southern parcel with an area of approximately 126 acres. As of 2014, both parcels were planted with grapes. The northern parcel is also within the AEWSD Surface Water Service Area (SWSA) and therefore may receive some or all of its irrigation water from AEWSD. The actual pumping volume for agricultural purposes from the Caratan Well is unknown but is estimated to be up to approximately 950 AFY (if the full area of both parcels were irrigated by groundwater pumped from the well, assuming non-deficit irrigation rates).

As discussed above, several domestic wells may exist in the eastern narrow valley area of the Tejon-Castac Management Area. Total production from these wells is likely de minimis (i.e., less than 2 AFY each). Pumping records from one well in the area (the “White Wolf Well”, located within the lateral boundaries of the Tejon-Castac Management Area but screened in granite bedrock and therefore outside of the Basin) show a total of approximately 19.8 acre-feet (AF) pumped over a period of 11 years, amounting to about 1.8 AFY.

### 7.1.5. Data Gaps and Uncertainty

☑ **23 CCR § 354.14(b)(5)**

Key data gaps and uncertainties identified during development of this HCM for the Arvin-Edison Management Area include:

- Uncertainty in hydraulic properties (hydraulic conductivity, specific yield) of the principal aquifer;
- Uncertainty in the degree of hydraulic connection between the unconfined and confined zones of the principal aquifer where the “E”-Clay is present; and

[59] As part of Plan Implementation (**Section 18.1**), TCWD will also pursue development of an agreement with AEWSD regarding groundwater pumping of the Caratan well pumping and subsequent use of pumped groundwater on agricultural lands within AEWSD.

- Uncertainty about well construction details for many in-district wells (i.e., many available well logs are old and no longer legible, or the well logs cannot be accurately mapped to the correct well location).

Key data gaps and uncertainties identified during development of this HCM for the Wheeler Ridge-Maricopa Management Area include:

- Uncertainty in hydraulic properties of the principal aquifer;
- Uncertainty in the degree of hydraulic connection between the unconfined and confined zones of the principal aquifer where the "E"-Clay is present;
- Uncertainty about well construction details, including well screen intervals, for many in-district wells; and
- Uncertainty about well status (i.e., whether or not certain wells are active).

Key data gaps and uncertainties identified during development of this HCM for the Tejon-Castac Management Area, and the Basin Setting elements, include:

- Uncertainty regarding hydraulic properties of the principal aquifer;
- Uncertainty as to whether the area north of the Edison Fault contains a principal aquifer, despite being undeveloped and protected by Conservation Easements under the C&LU Agreement;
- Uncertainty regarding the depth to bedrock and thickness of the principal aquifer; and
- Uncertainty regarding groundwater conditions, including groundwater levels and quality throughout the Management Area (discussed further below in **Section 8** ***Current and Historical Groundwater Conditions***); and
- Uncertainty regarding the pumping rate for irrigation of lands outside of Tejon-Castac Management Area from the only non-de minimis production well (i.e., the Caratan Well).

## 7.2. Cross-Sections

☑ **23 CCR § 354.14(c)**

### 7.2.1. <u>Arvin-Edison Management Area</u>

Three hydrogeologic cross-sections (A-A', B-B' and C-C') were developed for the Arvin-Edison Management Area HCM (***Figure HCM-27***, ***Figure HCM-28***, and ***Figure HCM-29***, respectively). The locations of the cross-sections with respect to the surficial geology are shown on ***Figure HCM-26***. The cross-sections extend laterally slightly beyond the boundaries of the Arvin-Edison Management Area and extend vertically down to an elevation of -3,600 ft msl. As such, the cross-sections include the entire thickness of aquifer materials that are or could reasonably be tapped for groundwater supply purposes (i.e., down through the Pliocene and younger continental/alluvial deposits of the KRF and ending at the base of the Mio-Pliocene Chanac Formation) and includes the entire zone above the Page (1973) base of fresh water surface. The cross-sections include the following:

- Land surface elevation extracted from the USGS 10-meter digital elevation model (DEM);
- Surficial geologic units after CDMG (1964), discussed further below;

- Water supply wells proximal to the cross-section lines,[60] showing the perforated/screened interval and generalized lithologic information (i.e., fine, medium or coarse intervals) derived from inspection of well logs. The locations of water supply wells included on the cross-sections are shown on inset maps in the cross-section figures;
- Oil wells, based on CalGEM datasets, proximal to the cross-section lines from which the elevations of various stratigraphic markers were extracted from well records. The locations of oil wells used in the development of the cross-sections are shown on inset maps in the cross-section figures;
- Subsurface geologic units, informed by Bartow (1984) and Croft (1972), and CalGEM oil well information;
- Groundwater levels from Fall 2016;
- Approximate depths of C2VSim-CG model layers; and
- Base of fresh water, after Page (1973).

As shown on the cross-sections and discussed previously, most groundwater supply wells within the Arvin-Edison Management Area are screened in the top 1,400 feet, whereas the base of fresh groundwater (after Page, 1973) and the KRF extend significantly deeper. Wells are typically not drilled deeper than needed to obtain the desired quantity of water. Therefore, while usable groundwater may be present below the depths currently tapped by groundwater wells, it may not currently be economical to do so, especially given that water quality tends to be poorer at greater depths, even above the nominal base of fresh water.

*Cross-Section A-A’*

Cross-section A-A’ extends for approximately 20 miles in a northwest-southeast direction along the axis of the northern portion of the Arvin-Edison Management Area. The cross-section starts at the Kern River (outside of the Management Area) and crosses into AEWSD about five miles south. In this far northern portion outside of AEWSD, the cross-section cuts through the topographically elevated area where the surficial geologic unit is Plio-Pleistocene non-marine (“Qp”). Further south, the surficial geologic unit is Pleistocene non-marine (“Qc”), and then transitions into the Recent Alluvium (“Qf”) near where the cross-section crosses Caliente Creek. Towards the southern end the land surface begins to rise again. The subsurface geologic units include primarily the KRF, underlain by the Chanac and Santa Margarita Formations in the northern portion and the Chanac and basement granite in the southern portion. On the northern end of the section line, the southern limb of the Bakersfield Arch causes the Miocene and older beds to dip southward. In the area around Caliente Creek, the Edison Fault causes a large offset of these deeper units, bringing them closer to the land surface on the southern/eastern side of the fault. The “E”-Clay is intersected for about two miles just south of Caliente Creek. Water well screen and lithologic data show that along the section line well depths vary from less than 200 ft bgs to about 1,000 ft bgs. The fall 2016 groundwater elevation surface is higher in the north and gradually decreases towards the south. The Page (1973) base of fresh ranges from about -2,000 ft msl to -2,700 ft msl in this area, although data is limited to the northern portion of the cross-section.

[60] Data were included within a 0.5-mile distance from the section line for cross-sections A-A’ and C-C’ and within a 1-mile distance for cross-section B-B’.

*Cross-Section B-B'*

Cross-section B-B' extends roughly 22 miles along the axis of the southern portion of the Arvin-Edison Management Area. The land surface is elevated at both ends – on the west by Wheeler Ridge and on the east by the Tehachapi Mountain foothills. Elevations are lowest, around 400 ft msl, in the middle of the section. The predominant surficial geologic unit is the Recent Alluvium ("Qf"). Underlying this alluvium and extending to depths of at least 4,000 ft bgs in this area, is the KRF, undifferentiated with the Tulare Formation. The "E"-Clay is intersected for approximately 10 miles and dips to the west. On the far northeast side of the cross-section line, the Chanac Formation and underlying granite dip steeply to the southwest. Water wells along this section line range from roughly 500 to 1,200 ft bgs, with some screened below the "E"-Clay and others screened across it. CalGEM oil well logs in this area extend to depths well over 15,000 ft bgs. The fall 2016 groundwater elevation surface is higher in the southwest and decreases to the northeast, reaching below 0 ft msl. The Page (1973) base of fresh water is at approximately -3,600 ft msl in this area.

*Cross-Section C-C'*

Cross-section C-C' is perpendicular to cross-section A-A' and extends roughly 16 miles through the northern portion of the Arvin-Edison Management Area in a direction roughly parallel to the stratigraphic dip direction. The western five miles are outside of the Arvin-Edison Management Area. Land surface slopes to the west from a high point of approximately 1,100 ft msl in the east to approximately 400 ft msl at the AEWSD boundary. The surficial geologic units include the Pleistocene non-marine deposits ("Qc"), overlain to the west by Recent Alluvium ("Qf") and Basin deposits ("Qb") in the far western portion of the section. Similar to cross-section A-A', subsurface geologic units include predominantly the KRF which is underlain by the Chanac and Santa Margarita Formations. The "E"-Clay is present beneath the western eight miles of the section and dips to the west. The Edison Fault offsets the Miocene Chanac and Santa Margarita Formations and extends possibly into the KRF to some degree. CalGEM well logs help define the depth at which the basement bedrock (mostly schist in this area) is encountered. Groundwater elevation contours show a substantial steepening in the area overlying the Edison Fault which suggests a barrier effect is occurring. Water wells along this section line range in depth from approximately 300 to 700 ft bgs. The Page (1973) base of fresh water is deeper in the southwest at about -4,000 ft msl elevation and rises along the section line to the northeast.

### 7.2.2. Wheeler Ridge-Maricopa Management Area

Two hydrogeologic cross-sections (D-D' and E-E') were developed for the Wheeler Ridge-Maricopa Management Area HCM (***Figure HCM-31*** and ***Figure HCM-32***, respectively). The locations of the cross-sections with respect to the surficial geology are shown on ***Figure HCM-30***. The cross-sections extend laterally slightly beyond the boundaries of the Wheeler Ridge-Maricopa Management Area and extend vertically down to an elevation of -15,000 ft msl. As such, the cross-sections include the entire thickness of aquifer materials that are or could reasonably be tapped for groundwater supply purposes (i.e., down through the Pliocene and younger continental/alluvial deposits of the Tulare Formation) and include the entire zone above the Page (1973) and O'Bryan (1992) base of fresh water surfaces. The cross-sections include the following:

- Land surface elevation extracted from the USGS 10-meter DEM;

- Surficial geologic units after Chapman and Saleeby (2012), Bartow and McDougall (1984), and Wood and Dale (1964), and other geologic references, discussed further below;
- The locations and State Well IDs of water wells proximal to the cross-section lines, that were used to infer lithology based on inspection of well logs. The locations of water supply wells included on the cross-sections are also shown on ***Figure HCM-30***;
- The locations an American Petroleum Institute (API) ID numbers of oil wells, from CalGEM datasets, proximal to the cross-section lines from which the elevations of various stratigraphic markers were extracted from well records;
- Subsurface geologic units, after Chapman and Saleeby (2012), Bartow and McDougall (1984), Wood and Dale (1964), and other geologic references (i.e., lithologic information from water well and CalGEM oil well records);
- Base of fresh water, after O'Bryan (1992);
- Locations of relevant boundaries and landmarks, including the WRMWSD jurisdictional boundary, the Kern Subbasin boundary, the centerlines of various roadways, etc.; and
- The Spring and Fall 2015 groundwater elevations as measured in wells screened in the principal aquifer.

As shown on the cross-sections and discussed previously, all groundwater supply wells with known construction information within the Wheeler Ridge-Maricopa Management Area are less than 2,800 feet in total depth, whereas the Tulare Formation extends significantly deeper. The base of fresh groundwater (after O'Bryan, 1992) is generally deeper than groundwater supply wells in the Wheeler Ridge-Maricopa Management Area. Wells are typically not drilled deeper than needed to obtain the desired quantity of water. Therefore, while usable groundwater may be present below the depths currently tapped by groundwater wells, it may not currently be economical to do so, especially given that water quality tends to be poorer at greater depths, even above the nominal base of fresh water.

*Cross-Section D-D'*

Cross-section D-D' extends for approximately 37 miles in a west-east direction through the center and extending out of the Wheeler Ridge-Maricopa Management Area. The cross-section starts between the bases of the Little Signal Hills and Buena Vista Hills to the west of the Wheeler Ridge-Maricopa Management Area, where the ground surface is highest in elevation (approximately 1,000 ft msl). The cross-section then crosses through Maricopa Flat in the center of the Wheeler Ridge-Maricopa Management Area, passes through the south-central portion of the Arvin-Edison Management Area, and ends near the southeastern boundary of the Kern Subbasin and the northeastern corner of the White Wolf Subbasin. After declining in elevation from the hills in the west, the ground surface along the cross-section remains approximately constant near 400 to 500 ft msl.

The surficial geologic unit traversed by the cross-section is "Qa", Undifferentiated Surficial Deposits (Pleistocene/Holocene). This deposit is approximately 500 to 700 feet in thickness within the Wheeler Ridge-Maricopa Management Area. Underlying the Qa unit is the Plio-Pleistocene Tulare Formation, which thickens from west to east and extends down to approximately 5,000 feet in the eastern portion of the Wheeler Ridge-Maricopa Management Area. The contact with the KRF on the east is approximate and gradational. Underlying the Tulare Formation are the Pliocene San Joaquin Formation, the Miocene/Pliocene Etchegoin Formation, and the Miocene Monterey Formation.

The groundwater elevation in Spring and Fall 2015 is shown to be several hundred feet below the land surface which is within the Pleistocene/Holocene surficial deposits. The base of fresh water is shown to increase in depth from west to east, roughly in line with the base of the Tulare Formation.

*Cross-Section E-E'*

Cross-section E-E' extends for approximately 26 miles in a north-south direction through the center of the Wheeler Ridge-Maricopa Management Area. The northern end of the cross-section is roughly seven miles north of the Wheeler Ridge-Maricopa Management Area within the KDWD service area at an elevation of approximately 300 ft msl. Moving southward the land surface elevation rises through the Management Area and then more steeply as it nears the Plieto Fault Zone and the southern boundary of the Kern Subbasin. Further south, the cross-section extends up into the San Emigdio Mountains, reaching an elevation at its southern end of approximately 5,000 ft msl. The portion of the cross-section within the Wheeler Ridge-Maricopa Management Area has similar stratigraphy as in cross-section D-D', including the Undifferentiated Surficial Deposits, underlain by the Tulare, San Joaquin, Etchegoin, and the Monterey Formations. The groundwater levels in Spring and Fall 2015 are relatively flat, showing a slight decrease to the south. The base of fresh water is found at elevations between -4,000 and -5,000 ft msl. On the southern end of the cross-section, outside of the Management Area and Subbasin, the structural regime is dominated by the Plieto Fault which has raised older (Miocene and older) marine sedimentary units upwards on the south relative to the younger continental rocks on the north side. Another prominent feature in this area is the Devil's Kitchen Syncline.

### 7.2.3. Tejon-Castac Management Area

*Cross-Section F-F'*

One hydrogeologic cross-section, based on cross-section F-F' of Bartow (1984), was considered for the Tejon-Castac Management Area HCM. There is insufficient information to allow creation of a second cross-section; however, as discussed above this GSP contains three cross-sections for the adjacent Arvin-Edison Management Area. ***Figure HCM-33*** shows the cross-section as well as its location with respect to the surficial geology. The cross-section extends horizontally for approximately eight miles in a northeast-southwest direction through the northern portion of the Tejon-Castac Management Area and extends vertically down to an elevation of approximately -5,000 ft msl. As such, the cross-section includes the entire thickness of Tertiary sedimentary deposits in the northern portion of the Management Area (i.e., down through the Lower Miocene/Upper Oligocene Bealville Fanglomerate to the top of the Cretaceous granitic basement). The southwestern end of the cross-section extends into the main valley floor portion of the Basin, and likely depicts similar structural and geologic conditions as are found further south in the southern portion of the Tejon-Castac Management Area. The cross-section and inset map figure show the following:

- Land surface elevation;
- Surficial geologic units after Bartow (1984);
- The locations and depths of several oil wells used in the development of the cross-sections; and
- Subsurface geologic units after Bartow (1984).

The cross-section starts at its western end in the valley floor area about three miles west of the Tejon-Castac Management Area boundary. In this location, the surficial geology is Quaternary Alluvium with a thickness of approximately 200 feet which is underlain by the Plio-Pleistocene KRF with a thickness of approximately 1,000 feet. These units thicken and dip gently to the west. Further east, near the boundary of the Tejon-Castac Management Area, the cross-section crosses the Edison Fault. At this location, the depth to granitic basement rock is only about 400 feet. On the northeast side of the Edison Fault, the depth to granitic bedrock increases, and the Quaternary Alluvium pinches out. The Bena Gravel rests against the Edison Fault, dipping to the southwest. Further to the northeast, near the topographic high point, the surficial geologic unit transitions to the Bealville Fanglomerate and then the Walker Sand in the vicinity of Caliente Creek.

## 7.3. Physical Characteristics

☑ 23 CCR § 354.14(d)

### 7.3.1. Topographic Information

☑ 23 CCR § 354.14(d)(1)

#### 7.3.1.1. Arvin-Edison Management Area

***Figure HCM-34*** shows the topography within the Arvin-Edison Management Area. Topography generally slopes to the southwest in the northern half of the Management Area and to the north and northwest in the southern half. Elevations within the Arvin-Edison Management Area range from approximately 330 ft msl in the central low spot to 1,100 ft msl in the northeastern highlands. Where Caliente Creek enters the Arvin-Edison Management Area from the northeast it has formed a broad entrenched floodplain area approximately 1- to 2-miles wide which is lower than the surrounding lands to the south and north by approximately 20 to 80 feet. Aeolian processes have also formed a linear ridge of dune sand deposits on the north side of the Caliente Creek channel which is up to 100 feet higher than the lands to the north and up to approximately 180 feet higher than the entrenched Caliente Creek floodplain to the south.

#### 7.3.1.2. Wheeler Ridge-Maricopa Management Area

***Figure HCM-35*** shows the topography within the Wheeler Ridge-Maricopa Management Area. Topography generally slopes to the north in the western and central portions of the Wheeler Ridge-Maricopa Management Area and to the northwest in the eastern portion. Elevations range from approximately 300 ft msl in the central low spot to 1,000 ft msl in the southern highlands of the San Emigdio Mountains.

#### 7.3.1.3. Tejon-Castac Management Area

***Figure HCM-36*** shows the topography within the Tejon-Castac Management Area. Elevations within the Tejon-Castac Management Area range from approximately 450 ft msl in the lowest part of the valley floor portion to approximately 2,400 ft msl in the highest part in the east. The hilly area north of the Edison Fault has peak elevations around 1,800 to 2,000 ft msl. The Caliente Creek channel and floodplain along the northern boundary of the Tejon-Castac Management Area are at an elevation of approximately 900 to 1,000 ft msl.

### 7.3.2. Surficial Geology

☑ 23 CCR § 354.14(d)(2)

#### 7.3.2.1. Arvin-Edison Management Area

***Figure HCM-26*** shows the surficial geology within the Arvin-Edison Management Area, based on the Geologic Map of California, Bakersfield Sheet (CDMG, 1964) and associated map explanation. The predominant surficial geologic unit covering approximately three-quarters of the Arvin-Edison Management Area is "Qf" (i.e., Recent alluvial fan deposits in the Great Valley). These deposits were deposited by streams entering the San Joaquin Valley from the uplands to the east. In the northern quarter of the Arvin-Edison Management Area, the predominant surficial geologic unit is "Qc", Quaternary (Pleistocene) non-marine deposits. These deposits consist of older alluvium, including slightly consolidated and dissected fan deposits. Other minor units in the area include "Qs", Recent Dune sand, in a thin strip along the north side of Caliente Creek (as discussed above) and southwest of the City of Arvin; and "QP", Quaternary (Pliocene-Pleistocene) non-marine deposits that include the KRF. These deposits outcrop in several small areas including on the far northeastern boundary, along the western boundary north of Lamont, and along the eastern boundary south of Caliente Creek. As shown on cross-sections A-A', B-B', and C-C', these Pliocene-Pleistocene KRF deposits underlie the Recent Alluvium throughout the Arvin-Edison Management Area.

Further to the west outside of the Arvin-Edison Management Area is an area of Recent "basin" deposits ("Qb"), which are relatively less permeable, were deposited under lower-energy floodplain or marsh environments, and which may contribute to local perched water conditions in that area in the very shallow subsurface (i.e., approximately the top 20 feet). These perched zones, however, are often poor quality (CVRWQCB, 2009) and do not yield significant or economic quantities of water to wells, springs, or surface water systems, and therefore are not considered part of the principal aquifer.

#### 7.3.2.2. Wheeler Ridge-Maricopa Management Area

***Figure HCM-30*** shows the surficial geology within the Wheeler Ridge-Maricopa Management Area, based on the Geologic Map of California, Bakersfield Sheet (CDMG, 1964) and associated map explanation. The predominant surficial geologic unit- of Wheeler Ridge-Maricopa Management Area is "Qf" (i.e., Recent alluvial fan deposits in the Great Valley). These deposits were deposited by streams entering the San Joaquin Valley from the uplands to the south and west. A small portion of cross-section D-D' cuts through "Qs" (Recent dune sand) in the northeastern extent of the Wheeler Ridge-Maricopa Management Area and just south of the Kern Lake Bed.

Along the northern boundary of the Wheeler Ridge-Maricopa Management Area, "Qf" alluvial fan deposits transition to fine-grained "Qb" Quaternary basin deposits that connect two areas of "Ql" Quaternary lake deposits associated with the Buena Vista Lake Bed and Kern Lake Bed. These recent "basin" deposits ("Qb") are relatively less permeable and were deposited under lower-energy floodplain or marsh environments. The basin and lake deposits may contribute to local perched water conditions in that area in the very shallow subsurface (i.e., approximately the top 20 feet). These perched zones are often composed of poor-quality water (CVRWQCB, 2009) and do not yield significant or economic quantities of water to wells, springs, or surface water systems, and therefore are not considered part of the principal aquifer.

Just south of the Wheeler Ridge-Maricopa Management Area and along the boundary of the Kern Subbasin, “Qc”, Quaternary (Pleistocene) non-marine deposits, and “QP”, Quaternary (Pliocene Pleistocene) non-marine deposits are prevalent. The “Qc” deposits consist of older alluvium, including slightly consolidated and dissected fan deposits. The “QP” deposits underlie the Recent Alluvium throughout the Wheeler Ridge-Maricopa Management Area.

#### 7.3.2.3. Tejon-Castac Management Area

***Figure HCM-8*** shows the surficial geology within the Tejon-Castac Management Area, based on the Geologic Map of California, Bakersfield Sheet (CDMG, 1964) and associated map explanation. The predominant surficial geologic unit covering the southern portion of the Tejon-Castac Management Area is “Qf” (i.e., Recent alluvial fan deposits in the Great Valley). These deposits were deposited by streams entering the San Joaquin Valley from the uplands to the east. In the northern half of the Tejon-Castac Management Area, the predominant surficial geologic unit is “QP”, Quaternary (Pliocene-Pleistocene) non-marine deposits that include the Kern River Formation. These deposits outcrop along the eastern boundary south of Caliente Creek. Additional discussion on the surficial geology is provided in **Section 7.1.4 *Principal Aquifers and Aquitards*** above.

### 7.3.3. Soil Characteristics

☑ **23 CCR § 354.14(d)(3)**

#### 7.3.3.1. Arvin-Edison Management Area

Soils within the Arvin-Edison Management Area are shown on ***Figure HCM-37***, based on the U.S Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Soil Survey Geographic Database (SSURGO) for western Kern County. Soils are generally coarse-textured, with the predominant types being sandy loam and loamy sand with lesser amounts of loam, sandy clay loam, fine sandy loam, and other. Textures are generally coarser to the east near the foothills and finer to the west. As shown on ***Figure HCM-38***, soils are predominantly in the A and B Hydrologic Soil Groups, indicating high and above average infiltration rates, respectively, and low and moderately low runoff potential, respectively. The northernmost portion of the Arvin-Edison Management Area, underlain by "Qc" (Pleistocene non-marine deposits) has soils belonging to the C Hydrologic Soil Group, with below average infiltration rate and moderately high runoff potential. Saturated vertical hydraulic conductivity of soils is generally in the range of 0 to 30 inches per hour (0 to 60 ft/day), with some areas near the foothills and along the channels of Caliente Creek and the Tejon Creek fan with higher values.

#### 7.3.3.2. Wheeler Ridge-Maricopa Management Area

Soils within the Wheeler Ridge-Maricopa Management Area are shown on ***Figure HCM-39***, based on the USDA-NRCS SSURGO database for western Kern County. Soils are generally of intermediate texture, with the predominant type being loam with lesser amounts of fine sandy loam, sandy loam, loamy sand, and other. As shown on ***Figure HCM-39***, saturated hydraulic conductivity of soils is generally in the range of 2 to 4 inches per hour (4 to 8 ft/day) in the southern area, decreasing towards the north. As shown on ***Figure HCM-40***, soils are predominantly in the B Hydrologic Soil Group in the south and the C Hydrologic Soil Group in the north. These B and C Hydrologic Soil Groups indicate moderate and slow infiltration rates, respectively, and moderately low and moderately high runoff potential, respectively. The northernmost portion of the Wheeler Ridge-Maricopa Management Area, where the “Qf” alluvial fan deposits transition to fine-grained "Qb" Quaternary basin deposits, has soils belonging to the D Hydrologic Soil Group, with very slow infiltration rates and high runoff potential.

#### 7.3.3.3. Tejon-Castac Management Area

Soils map units within the Tejon-Castac Management Area, grouped by texture and based on the USDA-NRCS SSURGO database for western Kern County, are shown on ***Figure HCM-41***. Soils are generally coarse-textured in the area south of the Edison Fault with the predominant type being sandy loam. In the area north of the Edison Fault soil complexes and associations are predominant. As shown on ***Figure HCM-42***, soils south of the Edison Fault are predominantly in Hydrologic Soil Group A, indicating high infiltration rates and low runoff potential, whereas soils north of the Edison Fault are predominantly of Hydrologic Soil Groups C and D, indicating below average infiltration rate and moderately high to high runoff potential. As shown on ***Figure HCM-43***, saturated hydraulic conductivity of soils is generally in the range of 20 to 30 inches per hour in the area south of the Edison Fault and 0 to 20 inches per hour in the area north of the Edison Fault, with some areas near the Caliente Creek with higher values (> 40 inches per hour).

### 7.3.4. Recharge and Discharge Areas

☑ **23 CCR § 354.14(d)(4)**

#### 7.3.4.1. Arvin-Edison Management Area

***Figure HCM-44*** shows the existing and potential recharge and discharge areas within the Arvin-Edison Management Area. The groundwater system underlying the Arvin-Edison Management Area is recharged from several sources, including spreading grounds, deep percolation of excess irrigation water applied to agricultural lands (i.e., due to inherent irrigation inefficiency and leaching of salts from the root zone), and seepage from natural surface water channels entering the Arvin-Edison Management Area from the uplands. It should be noted that irrigation evaluations performed by the North Kern Resource Conservation District's mobile lab have regularly shown very high irrigation efficiencies in AEWSD. Recharge of precipitation via deep percolation likely occurs primarily during particularly wet time periods and less so during normal and dry periods. Treated wastewater effluent is disposed of by ACSD via application to approximately 240 acres of agricultural lands at agronomic rates south of the City of Arvin (CVRWQCB, 2000); due to irrigation inefficiency a portion of this treated effluent likely percolates below the root zone of crops and becomes recharge to groundwater. Discharge of groundwater is predominantly through groundwater pumping from wells. Because water levels are far below the land surface, no significant springs, seeps, or wetlands exist within AEWSD.

AEWSD operates three spreading grounds including the North Canal Spreading Works, Sycamore Spreading Works, and Tejon Spreading Works. The North Canal Balancing Reservoir, used to balance imported water inflows prior to distribution to AEWSD customers, is also operated for spreading (recharge) in wetter periods. The first AEWSD recharge facilities, the Sycamore Spreading Works, were constructed starting in 1964 and received water for the first time in 1966 (AEWSD, 2015). The Sycamore Spreading Works was expanded twice, and now consists of 75 ponds with a combined area of 551 acres; the Tejon Spreading Works was constructed in 1972, consists of 72 ponds with a combined area of 447 acres; the North Canal Spreading Works was constructed in 1999 and consists of 12 ponds with a combined area of 300 acres; and the North Canal Balancing Reservoir was constructed in 2000 and consists of 2 ponds with an area of 54 acres (AEWSD, 2015). The Spillway Basin at the end of the South Canal, used as a regulation basin, is un-lined and some recharge occurs there as well.

Between July 1966 and September 2015, a total of over 2.2 million acre-feet (AF) of water has been delivered to these facilities, an average of approximately 44,200 AFY. Net percolation for the same time period was approximately 2.13 million AF, averaging approximately 42,700 AFY. All canals have concrete lining, but some canal seepage occurs. In addition to these existing spreading grounds, a new parcel in the west-central portion of the Arvin-Edison Management Area was acquired by AEWSD in 2019, in partnership with KDWD, and is being developed into a new spreading grounds facility (see further discussion in **Section 17** ***Projects and Management Actions***). AEWSD operates a total of 82 recovery wells to recover the groundwater previously stored via spreading.

*SAGBI Soil Recharge Potential*

***Figure HCM-45*** shows groundwater recharge suitability on agricultural lands within the Arvin-Edison Management Area based on the UC Davis California Soil Resource Lab's Soil Agricultural Groundwater Banking Index (SAGBI) dataset. This dataset ranks agricultural lands for groundwater recharge suitability based on soil types and five key factors: deep percolation potential, root zone residence time, topography, chemical limitations, and soil surface conditions. The SAGBI dataset ranks a majority of lands within the Arvin-Edison Management Area as having "Excellent" to "Very Good" suitability for groundwater recharge, including nearly all the central and southwestern portions of the Management Area. As mentioned above and further discussed in **Section 17** ***Projects and Management Actions***, AEWSD has initiated development of a new spreading grounds facility (the "Sunset Spreading Works") in the west central portion of the Management Area, which is ranked as having "Excellent" to "Very Good" suitability for groundwater recharge. Soils ranked as having "Moderately Good", "Moderately Poor", or "Poor" groundwater recharge suitability are located primarily in the northern portion of the Management Area as well as in a small section in the south-central portion. Any additional future groundwater recharge facilities proposed within the Management Area will be screened against the SAGBI dataset along with other local sources of information to determine their potential suitability for groundwater recharge operations.

#### 7.3.4.2. Wheeler Ridge-Maricopa Management Area

***Figure HCM-46*** shows the existing and potential recharge and discharge areas within the Wheeler Ridge-Maricopa Management Area. The groundwater system underlying the Wheeler Ridge-Maricopa Management Area is recharged from several sources, including deep percolation of excess irrigation water applied to agricultural lands (i.e., due to inherent irrigation inefficiency), and seepage/shallow subsurface inflow from natural surface water channels entering the Wheeler Ridge-Maricopa Management Area from the uplands. Recharge of precipitation via deep percolation likely occurs primarily during particularly wet time periods and rarely if ever during normal and dry periods. Discharge of groundwater is predominantly through groundwater pumping from wells. Because water levels are far below the land surface, no significant springs, seeps, or wetlands exist within the Wheeler Ridge-Maricopa Management Area. Outside of the Wheeler Ridge-Maricopa Management Area, recharge areas include spreading grounds associated with other water banking operations and agricultural lands, and discharge areas are primarily to groundwater supply and recovery wells.

*SAGBI Soil Recharge Potential*

***Figure HCM-47*** shows groundwater recharge suitability on agricultural lands within the Wheeler Ridge-Maricopa Management Area based on the SAGBI dataset. The SAGBI dataset ranks a majority of lands within the southern two thirds of the Management Area as having "Good" suitability for groundwater recharge, whereas areas in the northern third are classified as "Moderately Good" or "Very Poor". As discussed in **Section 17 *Projects and Management Actions***, WRMWSD plans to study and pursue in-district banking and recharge efforts as part of its portfolio approach to supply augmentation projects. Any additional future groundwater recharge facilities proposed within the Wheeler Ridge-Maricopa Management Area will be screened against the SAGBI dataset along with other local sources of information to determine their potential suitability for groundwater recharge operations.

#### 7.3.4.3. Tejon-Castac Management Area

***Figure HCM-48*** shows the existing and potential recharge and discharge areas within the Tejon-Castac Management Area. The groundwater system underlying the Tejon-Castac Management Area is recharged mainly from rainfall infiltration and seepage from natural surface water channels entering the Tejon-Castac Management Area from the uplands. Discharge of groundwater is predominantly through subsurface outflow towards the main valley floor area of the Kern Subbasin and groundwater pumping from one well. According to the National Hydrography Dataset (NHD), there are many mapped springs or seeps in the area to the north, east, and southeast of the Tejon-Castac Management Area, indicating that groundwater discharge contributes to surface water flow in many of the small ephemeral/intermittent streams in those areas. Within the Tejon-Castac Management Area, the NHD dataset shows a single spring/seep very close to the southeastern boundary within the "Upper Lake Paulina" NHD-defined watershed.

There is also a 75.5-acre parcel located just outside of the Tejon-Castac Management Area (Township 32S Range 30E Section 6) that is used by Tejon Ranch Company (TRC) as a groundwater recharge site. The site, which has been in operation since 2016, receives carrot wash water from a nearby carrot processing facility which is discharged to a set of recharge ponds. A total of over 1,000 AF has been recharged at these ponds between 2016 and early 2019.

### 7.3.5. Surface Water Bodies

☑ **23 CCR § 354.14(d)(5)**

#### 7.3.5.1. Arvin-Edison Management Area

Surface water bodies significant to the management of the Arvin-Edison Management Area include both natural surface water features as well as man-made features. ***Figure HCM-49*** shows the natural surface water features in the vicinity of the Arvin-Edison Management Area. To the east of the Arvin-Edison Management Area approximately 707 square miles of upland watershed area drains into the area, providing occasional surface water inflows and likely some shallow subsurface inflow. The primary named creeks include Walker Basin Creek and Tehachapi Creek which join Caliente Creek before entering AEWSD; Sycamore Creek, Comanche Creek, and Tejon Creek. Several smaller unnamed watersheds along the eastern valley margin also drain into the Arvin-Edison Management Area. In addition, several other watersheds and creeks, including El Paso Creek, Pastoria Creek, Grapevine Creek, and Tecuya Creek drain into the White Wolf Subbasin which ultimately drains into the Kern Subbasin.

Based on observations of ungauged flows and limited historical stream gauging data from Caliente Creek outside of the Arvin-Edison Management Area,[61] surface water inflows to the area occur seasonally with some frequency. Storm-related flooding along the larger streams (i.e., Caliente Creek and Tejon Creek) is common in some areas such as Lamont and Arvin, as well as near AEWSD's spreading works and the David Road and Sebastian Road areas. Due to the intermittent nature of streamflows in the creeks draining into the Arvin-Edison Management Area, only two of these streams have reported water applications and permits issued from the SWRCB (i.e., Tejon Creek, Grapevine Creek) with no action taken from the remainder. There are no instream flow requirements established for any of the creeks draining into the Arvin-Edison Management Area.

As discussed above, AEWSD operates three main spreading works as part of its in-district water banking program. AEWSD's Balancing Reservoir is also a full-fledged banking facility capable of recharge and extraction operations. In addition to these spreading basin facilities, AEWSD moves water throughout its service area via a network of conveyance canals and pipelines, discussed below. AEWSD also has recharge partners outside its service area, both within and outside of the Kern Subbasin.

#### 7.3.5.2. Wheeler Ridge-Maricopa Management Area

Surface water bodies significant to the management of the Wheeler Ridge-Maricopa Management Area include both natural surface water features as well as man-made features. ***Figure HCM-50*** shows the natural surface water features in the vicinity of the Wheeler Ridge-Maricopa Management Area.

To the south of the Wheeler Ridge-Maricopa Management Area, approximately 309 square miles of upland watershed area drains into the area, providing occasional surface water inflows and likely some shallow subsurface inflow. Several creeks whose headwaters are in the Tehachapi and San Emigdio mountains drain northward into the Management Area, including (from west to east) Bitterwater Creek, Cienega Creek, Bitter Creek, Santiago Creek, Muddy Creek, Los Lobos Creek, San Emigdio, and Pleito Creeks. Several smaller unnamed watersheds along the southern valley margin also drain into the Management Area. In addition, several other watersheds and creeks, including El Paso Creek, Pastoria Creek, Grapevine Creek, and Tecuya Creek drain into the White Wolf Subbasin which ultimately drains into the Kern Subbasin. The mapped extents of these creeks mostly terminate along the southern edge of the Management Area, implying that channelized flow does not continue further into the basin, but rather seeps out into the subsurface. The mountain watersheds that drain into the Management Area receive substantially greater precipitation than the Wheeler Ridge-Maricopa Management Area itself and therefore surface/shallow subsurface inflows from these watersheds are likely a considerable source of recharge.

The USGS historically operated a stream gauge on San Emigdio Creek,[62] south of the Wheeler Ridge-Maricopa Management Area but the gauge has not been in operation since 1981. WRMWSD has recently established a network of five stream gauges in the San Emigdio mountains, three of which are on

[61] https://waterdata.usgs.gov/nwis/inventory/?site_no=11196400
[62] https://waterdata.usgs.gov/nwis/inventory/?site_no=11195500

streams that flow into the Wheeler Ridge-Maricopa Management Area and two of which flow into the White Wolf Subbasin. No streamflow data are yet available from these gauges.

7.3.5.3. Tejon-Castac Management Area

***Figure HCM-51*** shows the natural surface water features in the vicinity of the Tejon-Castac Management Area including contributing watersheds and streams. Approximately 456 square miles of watersheds to the east and southeast drain into and through the Tejon-Castac Management Area. The primary surface water stream is Caliente Creek which is fed by Indian Creek, Weaver Creek and Tehachapi Creek before entering the Tejon-Castac Management Area. A number of smaller watersheds drain into the southern portion of the Tejon-Castac Management Area including Sycamore Creek (Canyon), and Comanche Creek.

The USGS operated a stream gauge on Caliente Creek near the confluence of Tehachapi Creek from October 1961 through February 1983 (USGS gauge 11196400). The gauge had a contributing area of 165 square miles. Data from that gauge show that monthly average streamflow ranged from a minimum of 0.39 cubic feet per second (cfs) in July and September to a maximum of 16 cfs in February. Average annual streamflow ranged from 0.224 cfs in 1977 to 13.3 cfs in 1969. Annual peak streamflow ranged from a minimum of 2.2 cfs in 1966 to 3,060 cfs in 1978, until a large storm event in 1983, with a peak flow of 15,500 cfs, washed out the gauge permanently.

Due to the intermittent nature of streamflows in the creeks draining into the Tejon-Castac Management Area, there are no surface water diversion rights registered with the SWRCB[63] and there are no instream flow requirements established for any of the creeks draining into the Tejon-Castac Management Area.

### 7.3.6. Source and Point of Delivery for Imported Water Supplies

☑ **23 CCR § 354.14(d)(6)**

7.3.6.1. Arvin-Edison Management Area

AEWSD conjunctively manages its surface water and groundwater supplies. AEWSD has a contract for 40,000 AFY of Class 1 water and 311,675 AFY of Class 2 water from the Friant Division of the Central Valley Project (CVP) (AEWSD, 2015) plus various other water supplies from the San Joaquin River. Pursuant to transfer agreements with partner agencies, AEWSD has also obtained imported water from other sources such as the State Water Project (SWP), the Kern River, and the westside CVP including Cross Valley contractors. ***Figure HCM-52*** shows AEWSD's facilities and infrastructure used for the conveyance and distribution of imported water supplies. Most of AEWSD's imported water supply is brought in through AEWSD's Intake Canal which starts near the terminus of the CVP Friant-Kern Canal in Bakersfield and runs south and then east through the Forrest Frick Pumping Plant, then entering the AEWSD service area at a point along the northwest boundary. Through this gravity canal and associated pumping infrastructure, AEWSD has the flexibility to access supplies from the Cross-Valley Canal (SWP, CVP and groundwater) and to exchange water with the neighboring Kern Delta Water District. Once in AEWSD, the imported water generally flows southward through AEWSD's North Canal and South Canal, feeding into branches of AEWSD's distribution system and also into the three main spreading grounds and the Balancing Reservoir

[63] One Point of Diversion (POD # 44642) is shown by the SWRCB's electronic Water Rights Information System (eWRIMS) mapping application within the northern portion of the Tejon-Castac Management Area; however, the POD's water right is listed as being for Little San Gorgonio Creek and held by the Beaumont-Cherry Valley Water District, which is located some 140 miles away to the southeast, and therefore must be mapped incorrectly.

discussed above. AEWSD also has a bi-directional turnout connection at its southern end to the California Aqueduct at Milepost 277.20 through which it can either deliver water to or receive water from the California Aqueduct.

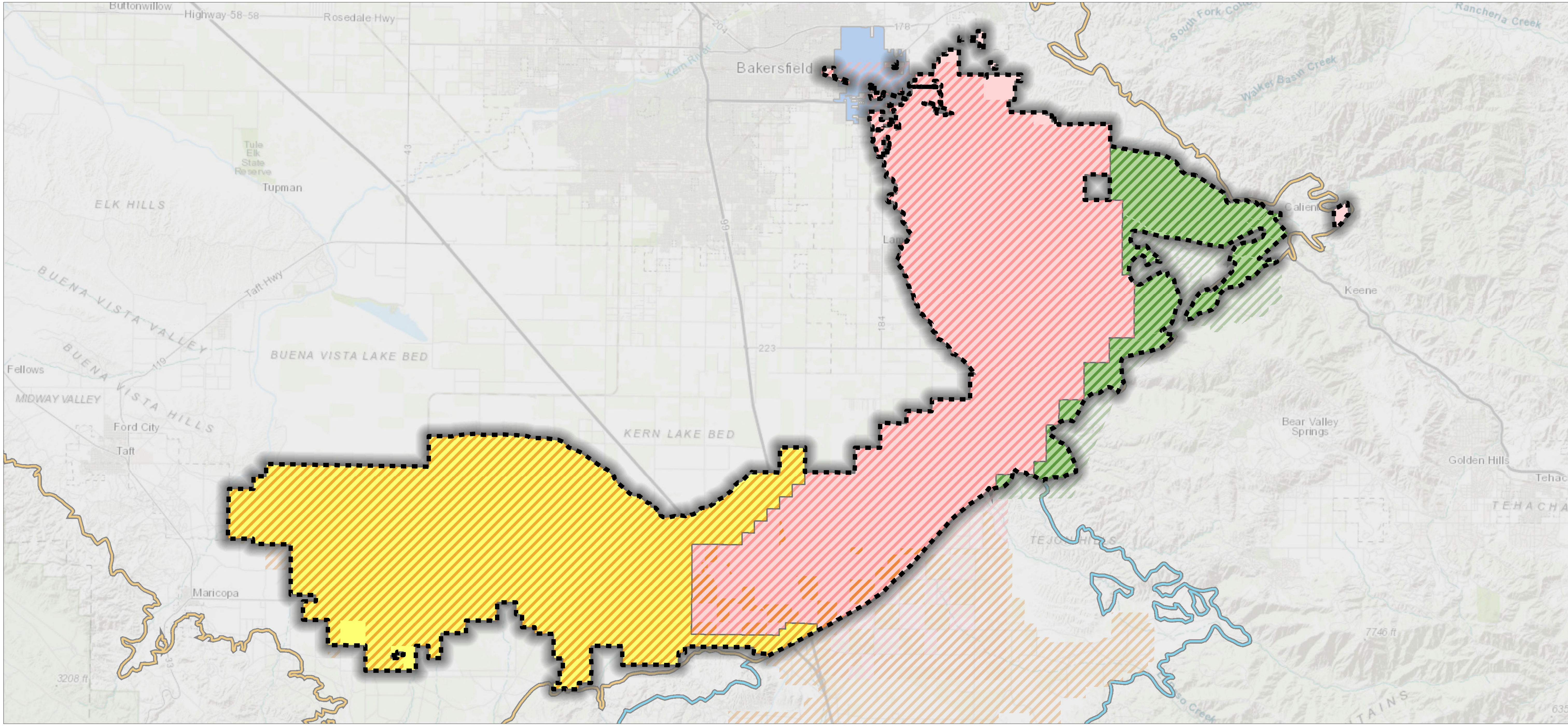
7.3.6.2. Wheeler Ridge-Maricopa Management Area

WRMWSD conjunctively manages its surface water and groundwater supplies and imports SWP water through a contract with Kern County Water Agency (KCWA) for 197,088 AFY of Table A Allocation (WRMWSD, 2015). During wet years, WRMWSD also receives "Article 21" wet period, surplus water from the SWP. Pursuant to transfer agreements with partner agencies (e.g., Buena Vista Water Storage District, Tehachapi-Cummings Community Water District, etc.), WRMWSD has also obtained additional imported water from the SWP, the CVP, and other sources. Additionally, WRMWSD banks water with the Kern Water Bank, Pioneer Project, and Mesa Project in wet years and recovers banked water during dry years.[64] ***Figure PA-12*** shows WRMWSD's facilities and infrastructure used for the conveyance and distribution of imported water supplies. The California Aqueduct runs through WRMWSD from west to southeast, and WRMWSD has thirteen turnouts along the Aqueduct that feed SWP water into WRMWSD pipelines, distributing water to WRMWSD's Surface Water Service Area.

7.3.6.3. Tejon-Castac Management Area

No water is imported into the Tejon-Castac Management Area. As mentioned above, TRC facilitates groundwater recharge at a 75.5-acre parcel just outside of the Tejon-Castac Management Area by allowing carrot wash water to be discharged into recharge ponds.

[64] Table 28 of the WRMWSD Agricultural Water Management Plan provides a complete listing of water transfer and exchange partners.




## Legend

South of Kern River Plan Area

Arvin-Edison Management Area

Tejon-Castac Management Area

Wheeler Ridge-Maricopa Management Area

East Niles CSD

AEWSD Service Area

TCWD Service Area

WRMWSD Service Area

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
CSD = Community Services District
DWR = California Department of Water Resources
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act
TCWD = Tejon-Castac Water District
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. Managementa area boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

## Notes

1. All locations are approximate.
2. The "South of the Kern River" Plan Area encompasses the Arvin-Edison, Tejon-Castac, and Wheeler Ridge-Maricopa Management Areas.

N

0 4 8
Miles

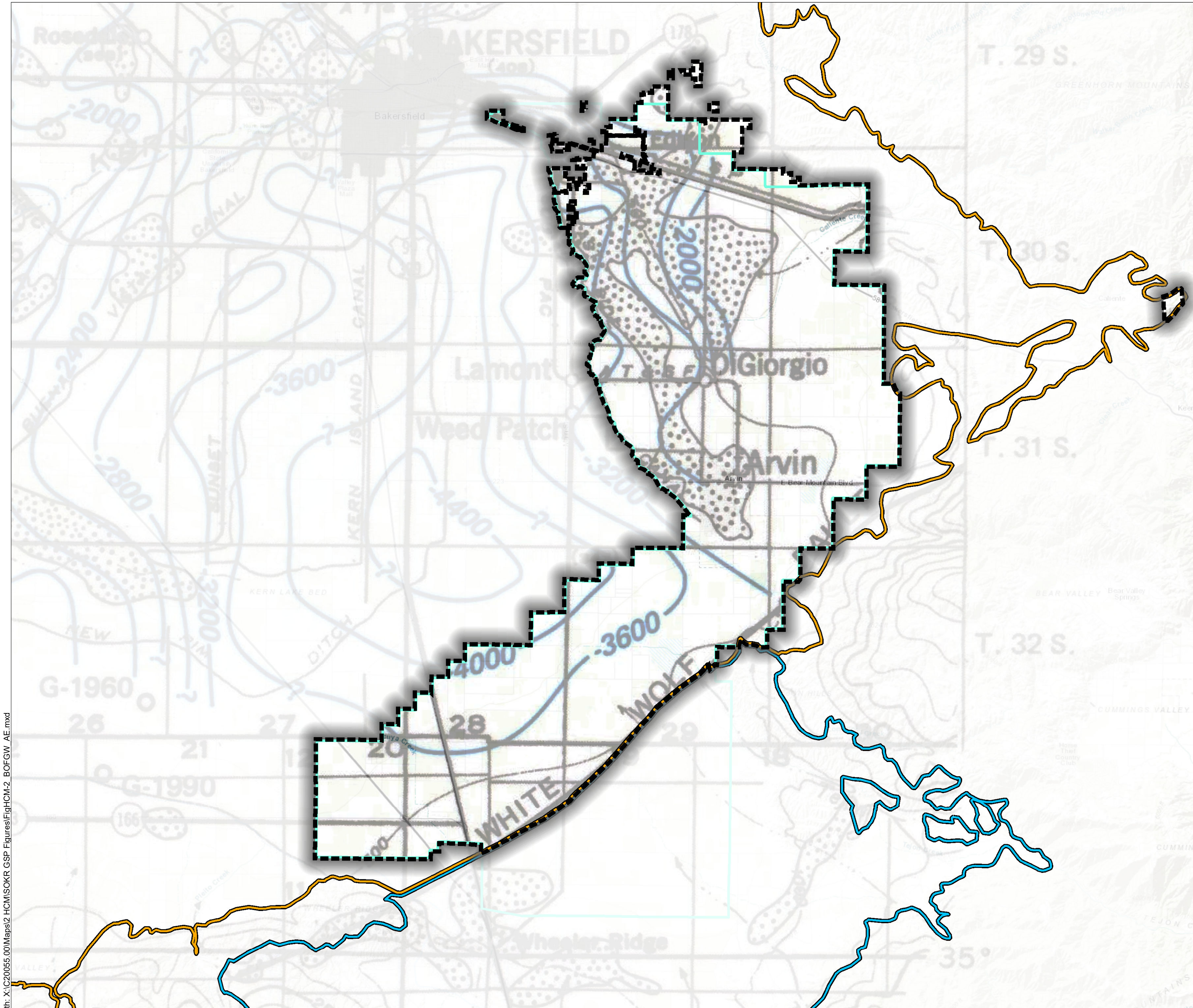
**Districts and Management Areas**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure HCM-1**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-1_Districts_Management_Areas.mxd




Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft msl | = feet above mean sea level |
| GSA | = Groundwater Sustainability Agency |
| USGS | = United States Geological Survey |

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Page R.W., 1973. Base of Fresh Ground Water (approximately 3,000 micromhos) in the San Joaquin Valley, California. USGS Hydrologic Investigations Atlas HA-489.

N

0 3 6

(Scale in Miles)

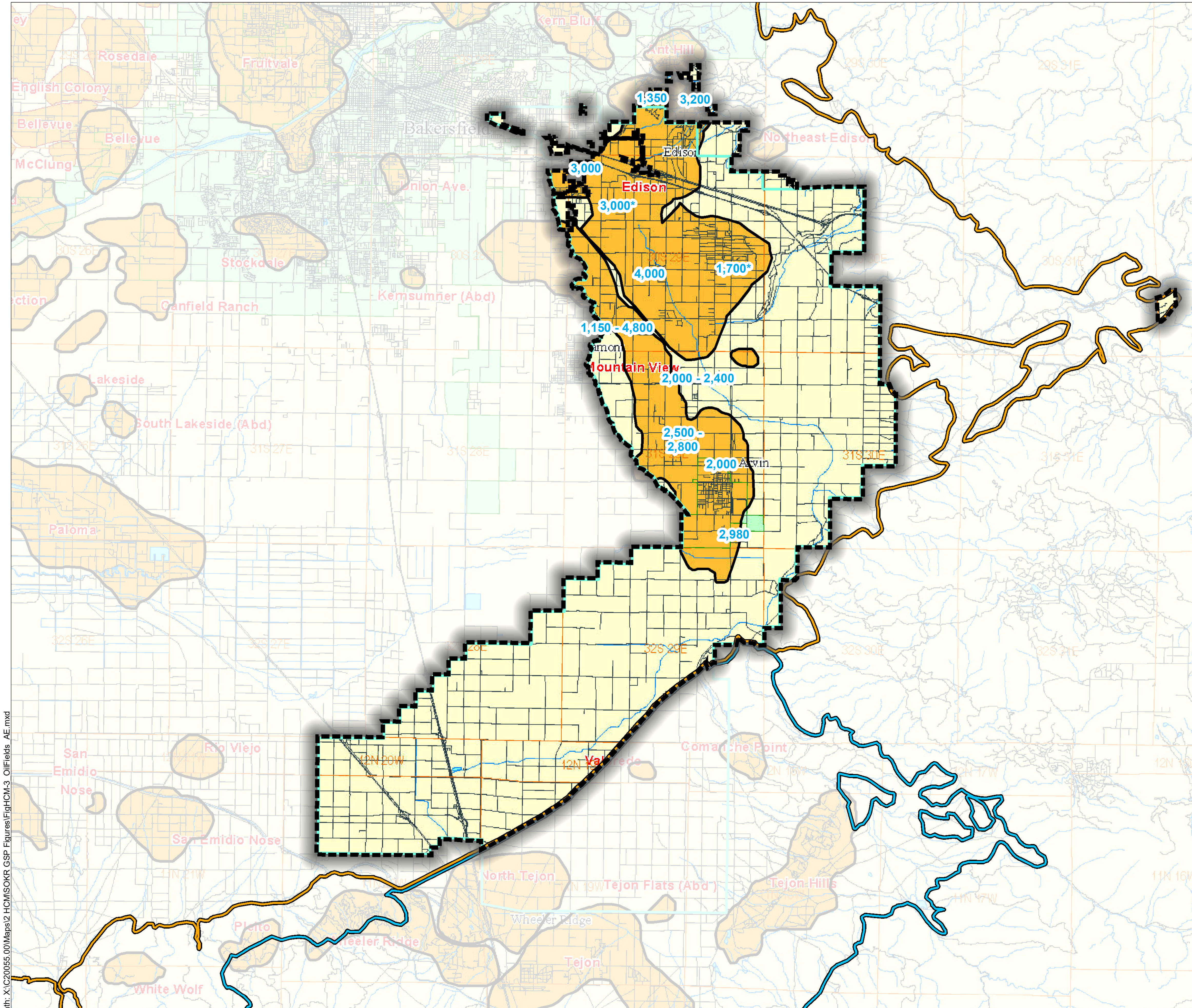
**Base of Fresh Groundwater**
**Based on Page, 1973 (USGS)**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-2**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-2_BOFGW_AE.mxd




Legend

Arvin GSA

Arvin-Edison Water Storage District

DOGGR Oil Field

XX Base of Fresh Groundwater (ft bgs)

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

Abbreviations

DWR = California Department of Water Resources
DOGGR = California Division of Oil, Gas, and Geothermal Resources
ft bgs = feet below ground surface
GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.
2. Base of Fresh Groundwater according to DOGGR field data sheets (* when based on high Boron concentrations).

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Oil fields map obtained from DOGGR website (ftp://ftp.consrv.ca.gov/pub/oil/maps/dist4/Dist4_fields.pdf)

N

0 3 6

(Scale in Miles)

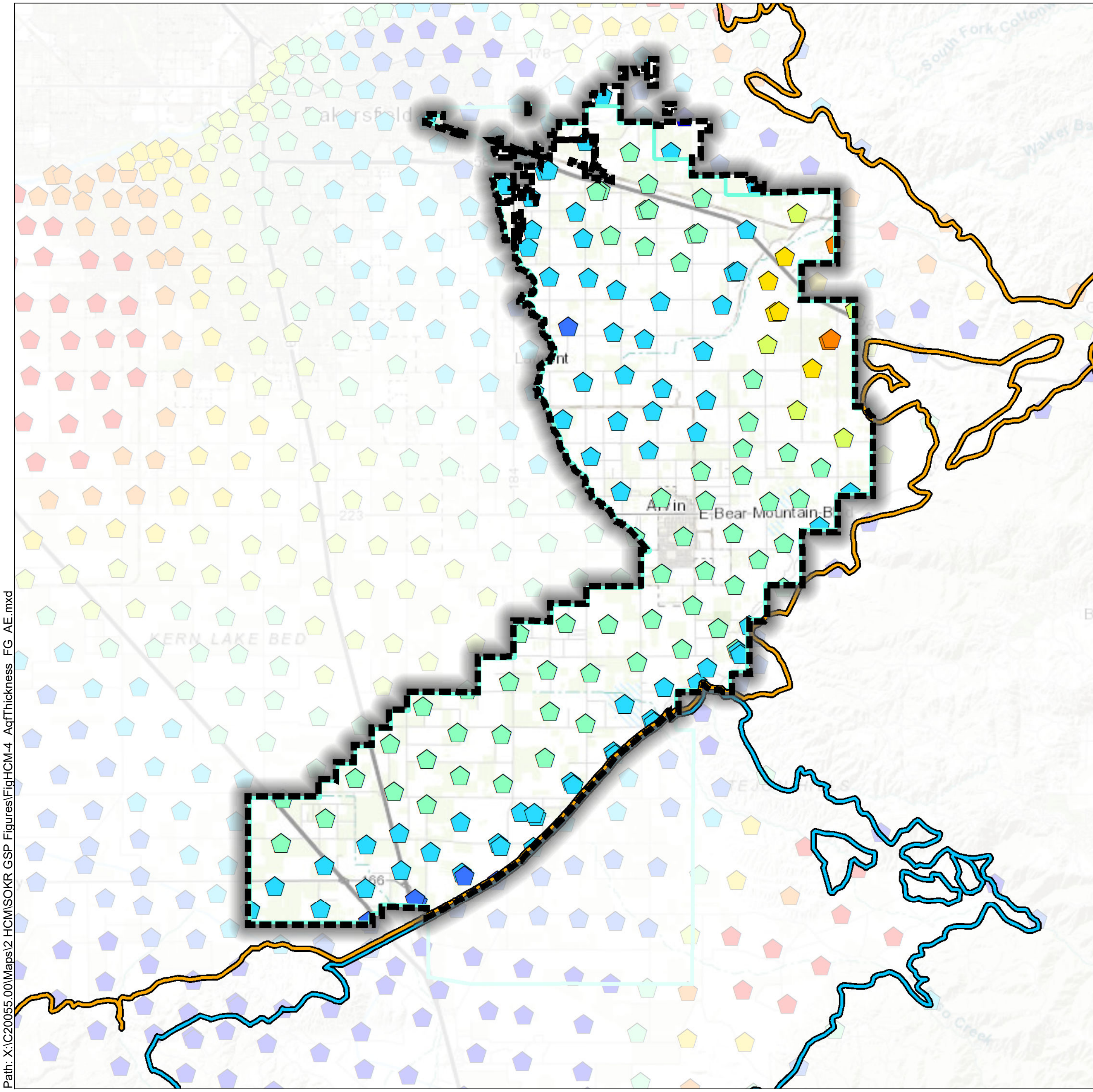
**Kern County Oil Fields**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-3**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-3_OilFields_AE.mxd




## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Depth to Bottom of Layer 2 (feet bgs)**

- <1,100
- 1,100 - 1,200
- 1,200 - 1,300
- 1,300 - 1,400
- 1,400 - 1,500
- 1,500 - 1,600
- 1,600 - 1,700
- >1,700

## Abbreviations

C2VSim-FG = California Central Valley Groundwater-Surface Water Simulation Model - Fine Grid
CNRA = California Natural Resources Agency
DWR = California Department of Water Resources
ft bgs = feet below ground surface
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.
2. Total thicknes of Layers 1 and 2 of C2VSim-FG Model are shown.
3. Layer 1 and 2 total depths range from 1,150 to 1,650 ft bgs in C2VSim-FG Model within AEWSD Management Area.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. C2VSim-FG Model data obtained from CNRA website: https://data.cnra.ca.gov/dataset/c2vsimfg-beta-model

N 0 5 10
Miles

**Thickness of Layers 1 and 2 in C2VSim-FG Model (Beta Version) Arvin-Edison Management Area**

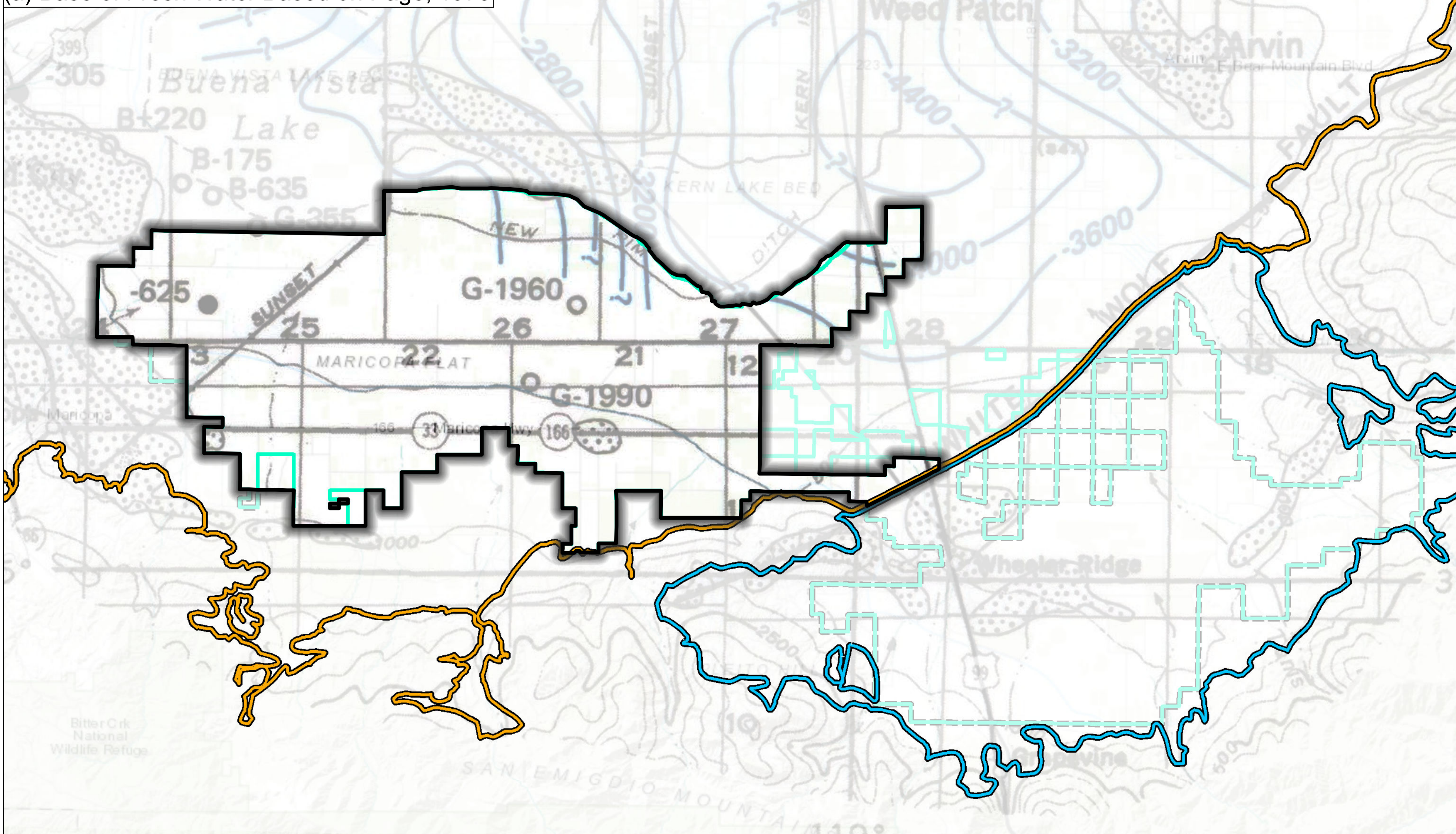
South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

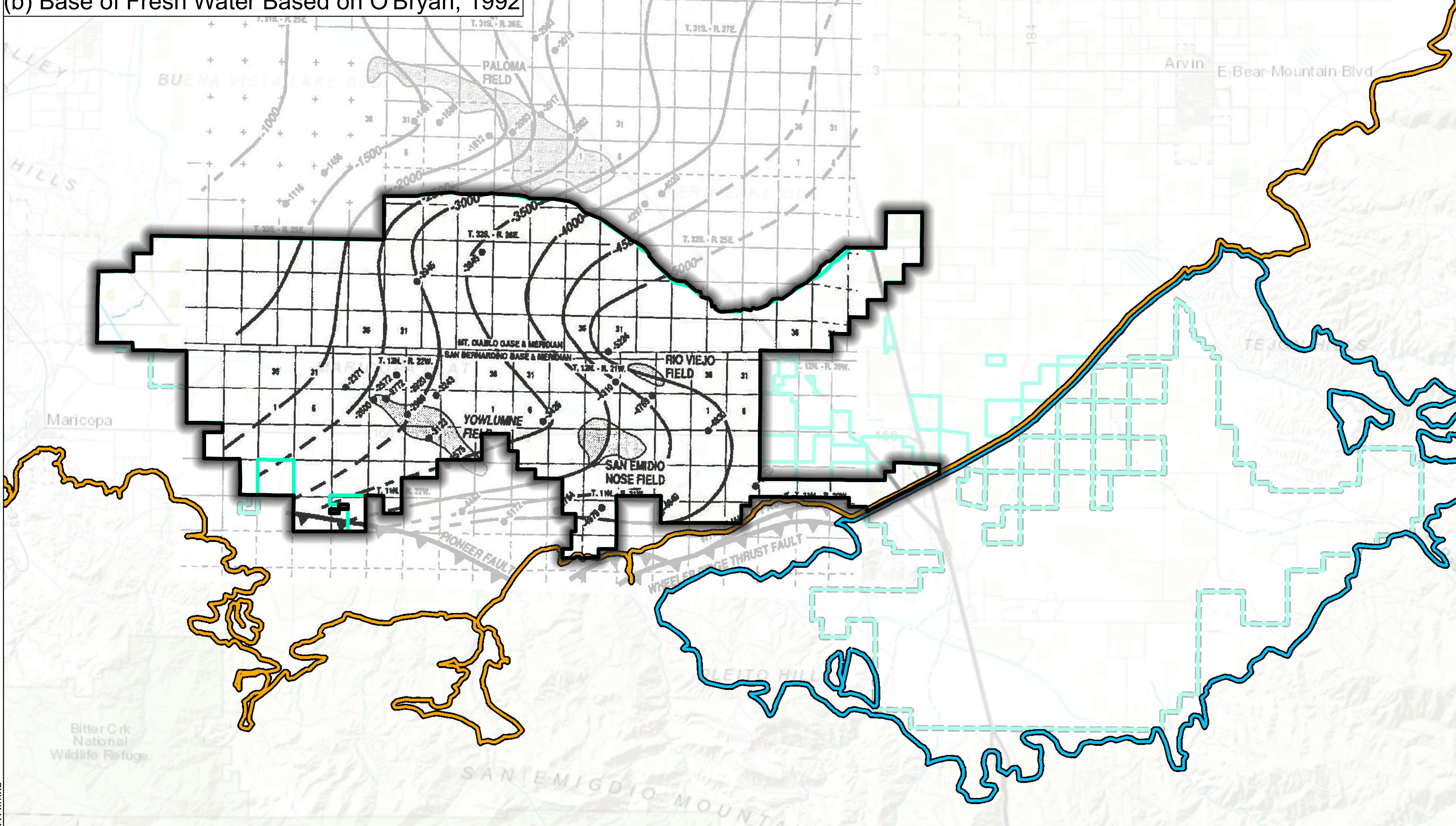
**Figure HCM-4**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-4_AqfThickness_FG_AE.mxd

(a) Base of Fresh Water Based on Page, 1973




(b) Base of Fresh Water Based on O'Bryan, 1992




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Base of Fresh Water Based on Page (ft msl)
- Base of Fresh Water Based on O'Bryan (ft msl)

## Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
USGS = United States Geological Survey
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.

N

0 4 8
(Scale in Miles)

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. Page RW, 1973. Base of Fresh Ground Water (approximately 3,000 micromhos) in the San Joaquin Valley, California. USGS Hydrologic Investigations Atlas HA-489.
3. O'Bryan, 1992. A Study of the Base of Fresh Water in the Southern San Joaquin Basin, California. Society of Petroleum Engineers.

**Base of Fresh Groundwater, Based on Page, 1973 (USGS) and O'Bryan, 1992 Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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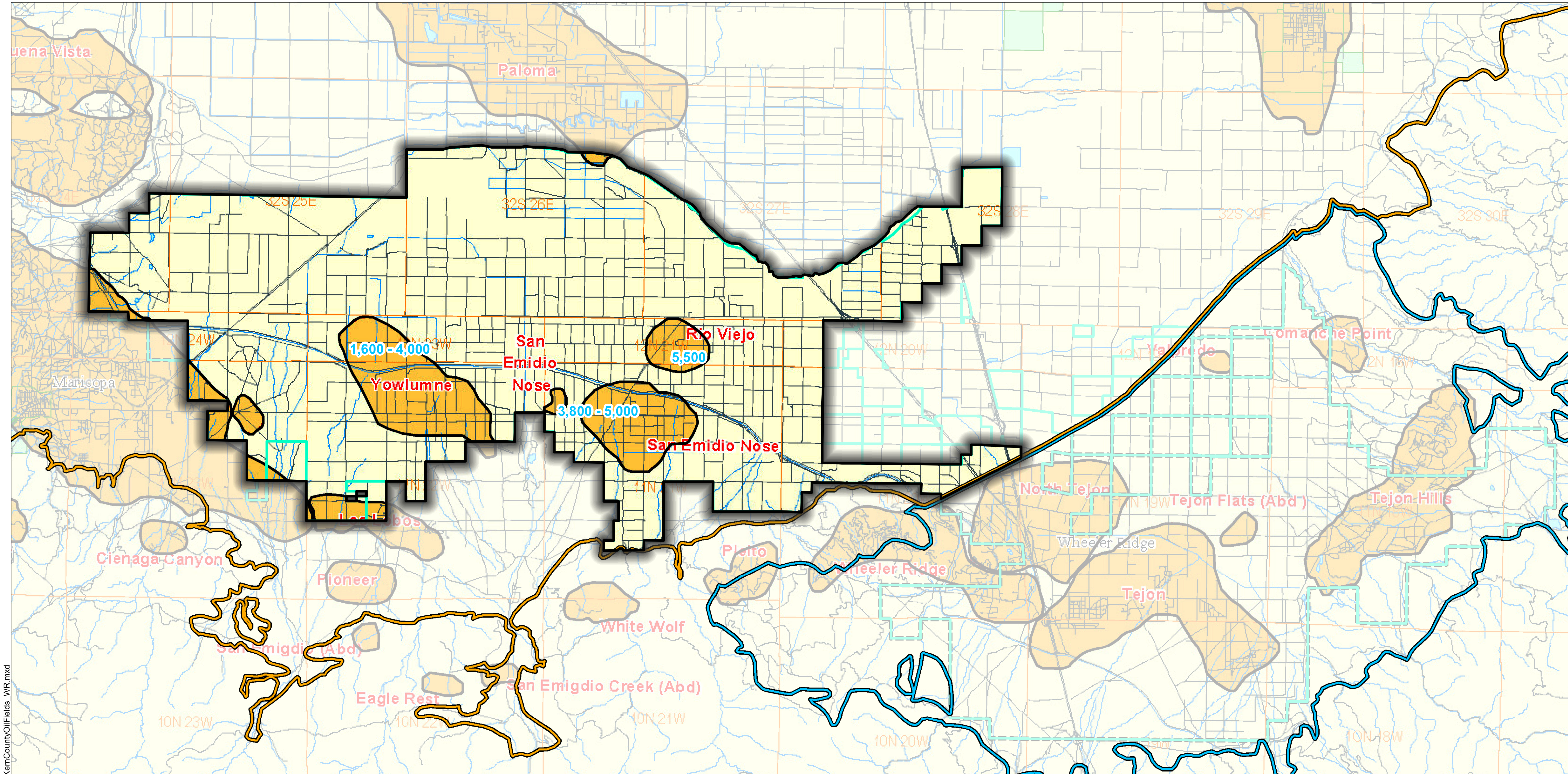
**Figure HCM-5**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\Fig HCM-5_BaseFreshGroundwater_Page_OBryan_WR.mxd




Legend
- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**
- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- DOGGR Oil Field
- xx Base of Fresh Groundwater (ft bgs)

Abbreviations
- DOGGR = California Division of Oil, Gas, and Geothermal Resources
- DWR = California Department of Water Resources
- ft bgs = feet below ground surface
- GSA = Groundwater Sustainability Agency
- WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes
1. All locations are approximate.
2. Base of Fresh Groundwater according to DOGGR field data sheets.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. Oil fields map obtained from DOGGR website (ftp://ftp.consrv.ca.gov/pub/oil/maps/dist4/Dist4_fields.pdf)

N
0 2.5 5
(Scale in Miles)

**Kern County Oil Fields**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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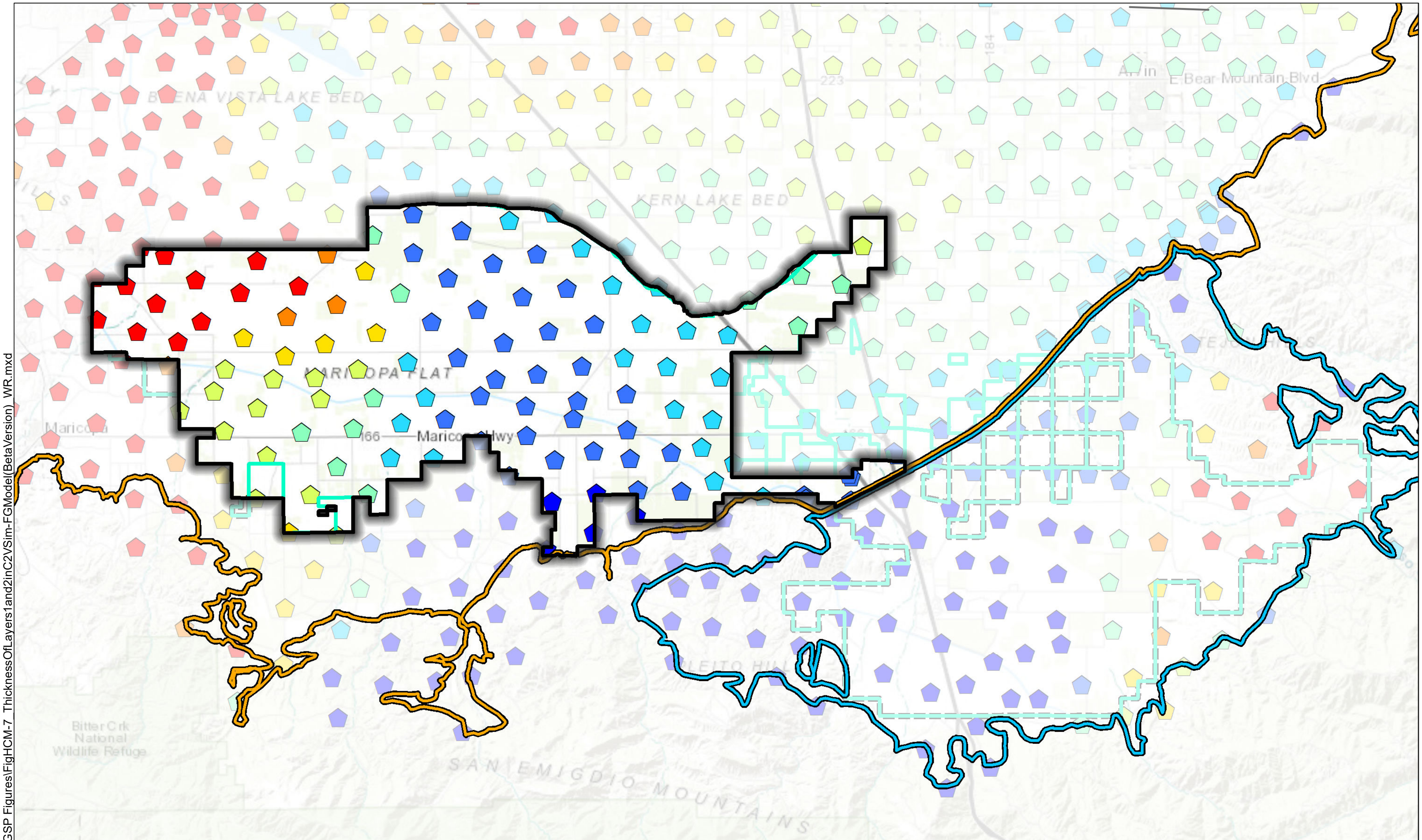
**Figure HCM-6**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-6_KernCountyOilFields_WR.mxd




Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-7_ThicknessOfLayers1and2inC2VSim-FGModel(BetaVersion)_WR.mxd

## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Depth to Bottom of Layer 2 (ft bgs)**

- <1,100
- 1,100 - 1,200
- 1,200 - 1,300
- 1,300 - 1,400
- 1,400 - 1,500
- 1,500 - 1,600
- 1,600 - 1,700
- >1,700

## Abbreviations

C2VSim-FG = California Central Valley Groundwater-Surface Water Simulation Model-Fine Grid
CNRA = California Natural Resources Agency
DWR = California Department of Water Resources
ft bgs = feet below ground surface
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. Total thickness of Layers 1 and 2 of C2VSim-FG Beta Model are shown.
3. Layer 1 and 2 total depths range from 597 to 1,807 ft bgs in C2VSim-FG Model within WRMWSD Management Area.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. C2VSim-FG Model data obtained from CNRA website: https://data.cnra.ca.gov/dataset/c2vsimfg-beta-model

N
0 5 10
(Scale in Miles)

**Thickness of Layers 1 and 2 in C2VSim-FG Model (Beta Version)**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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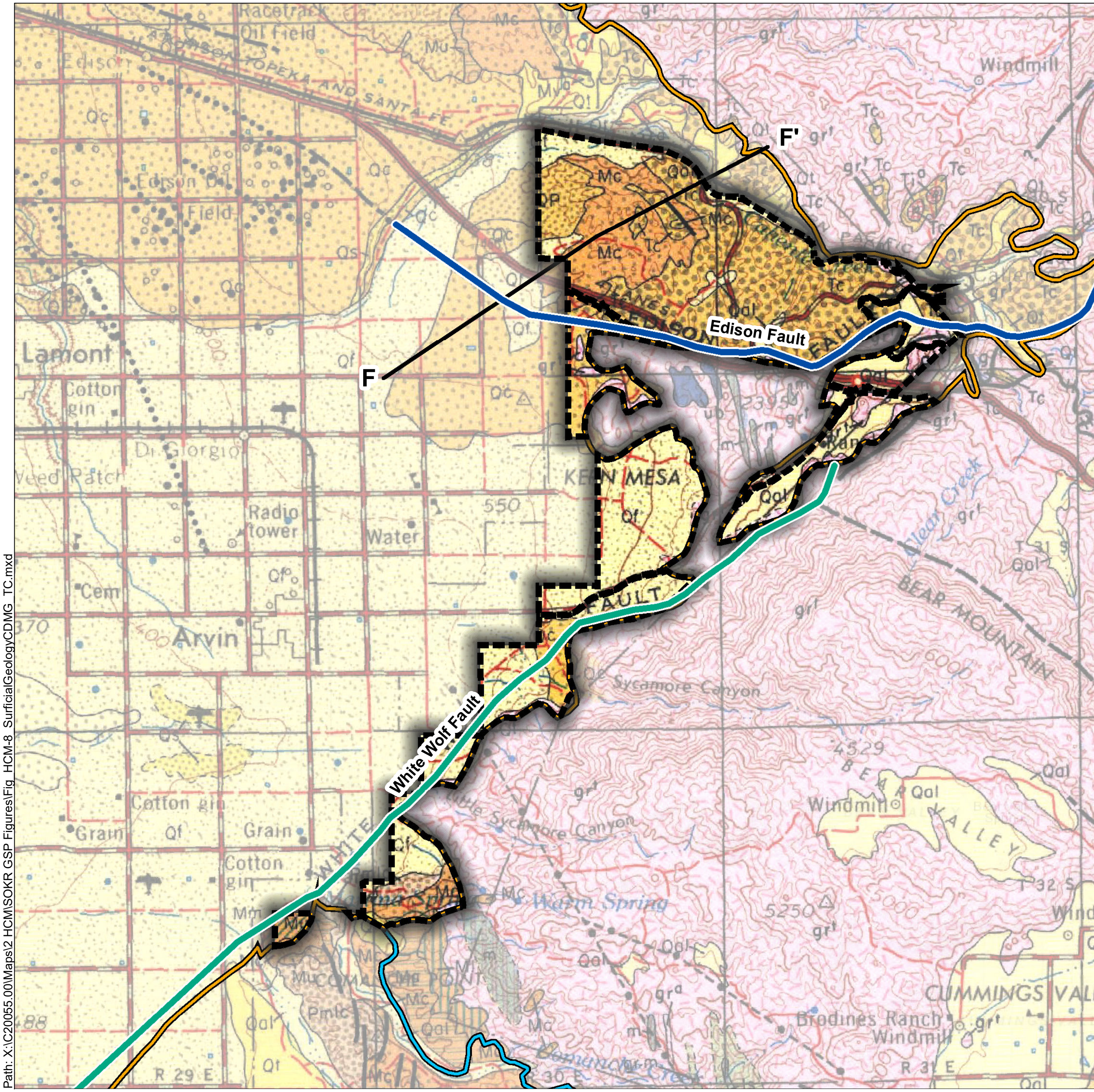
**Figure HCM-7**




## Legend

Tejon-Castac Water District GSA

Cross-Section Location (see Figure HCM-2)

Edison Fault

White Wolf Fault

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Geologic Units**

| | |
|---|---|
| Qal | Recent alluvium |
| Qs | Recent dune sand |
| Ql | Quaternary lake deposits |
| Qc | Pleistocene nonmarine |
| Qf | Recent fan deposits |
| QP | Plio-Pleistocene nonmarine |
| Qt | Pleistocene nonmarine terrace deposits |
| Pmlc | Middle and/or lower Pliocene nonmarine |
| Mc | Undivided Miocene nonmarine |
| Ml | Lower Miocene marine |
| gr | Mesozoic granitic rocks |
| m ls | Pre-Cretaceous metamorphic rocks<br>(ls= limestone or dolomite) |

## Abbreviations

CDMG = California Division of Mines and Geology
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.

## Sources

1. Surficial geology from CDMG Geologic Map of California, Olaf P. Jenkins Edition, Bakersfield Sheet (1964) and Los Angeles Sheet (1969).

N 0 3 6 Miles

**Surficial Geology (after CDMG)**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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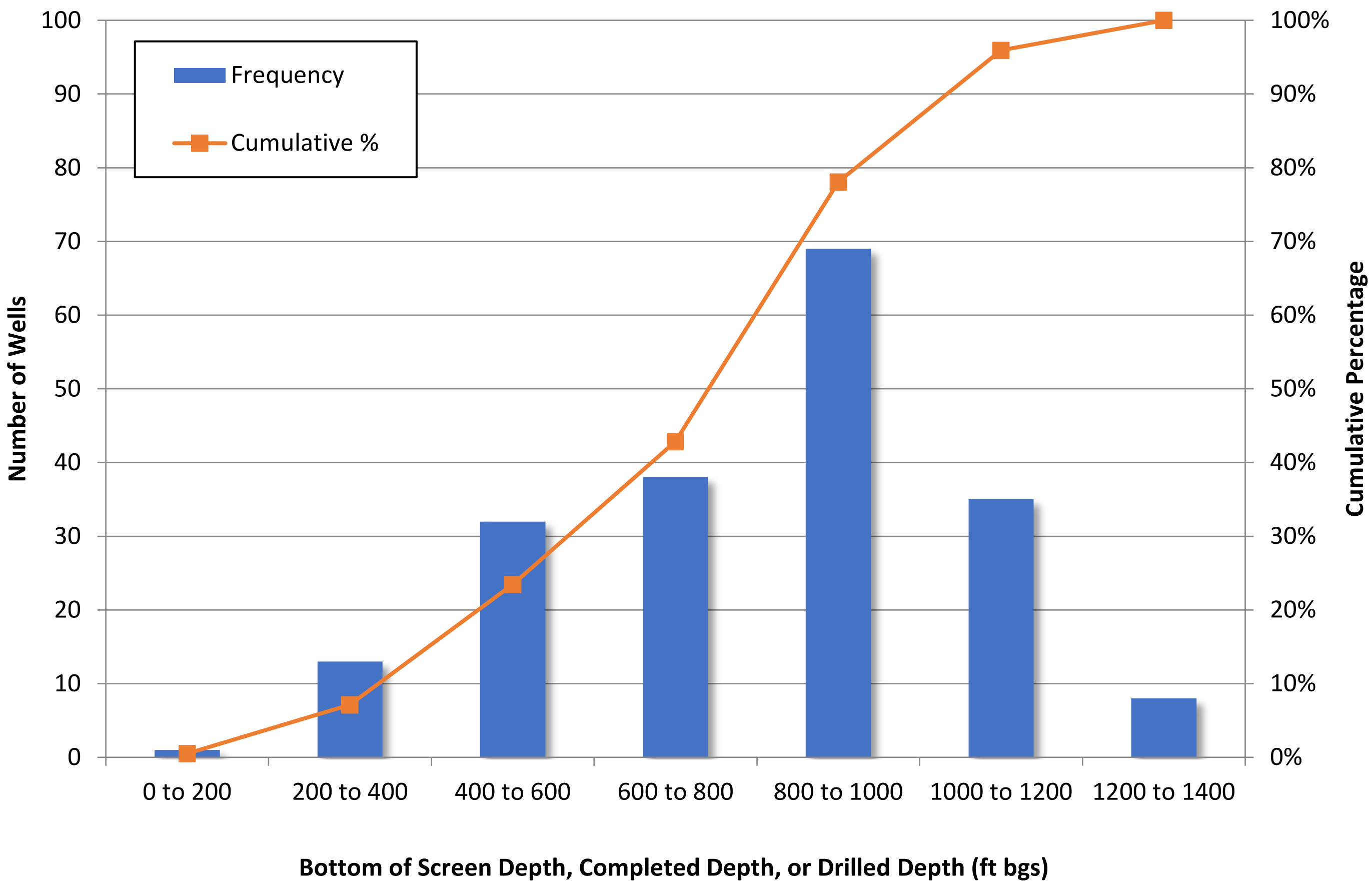
**Figure HCM-8**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\Fig_HCM-8_SurficialGeologyCDMG_TC.mxd




Abbreviations

BOS = bottom of screen
ft bgs = feet below ground surface
GSP = Groundwater Sustainability Plan

Notes

1. Well screen data is based on digitized well records of 196 wells in the Arvin-Edison Management Area.
2. When BOS depth was not available, completed depth or drilled depth were used, in that order of priority.

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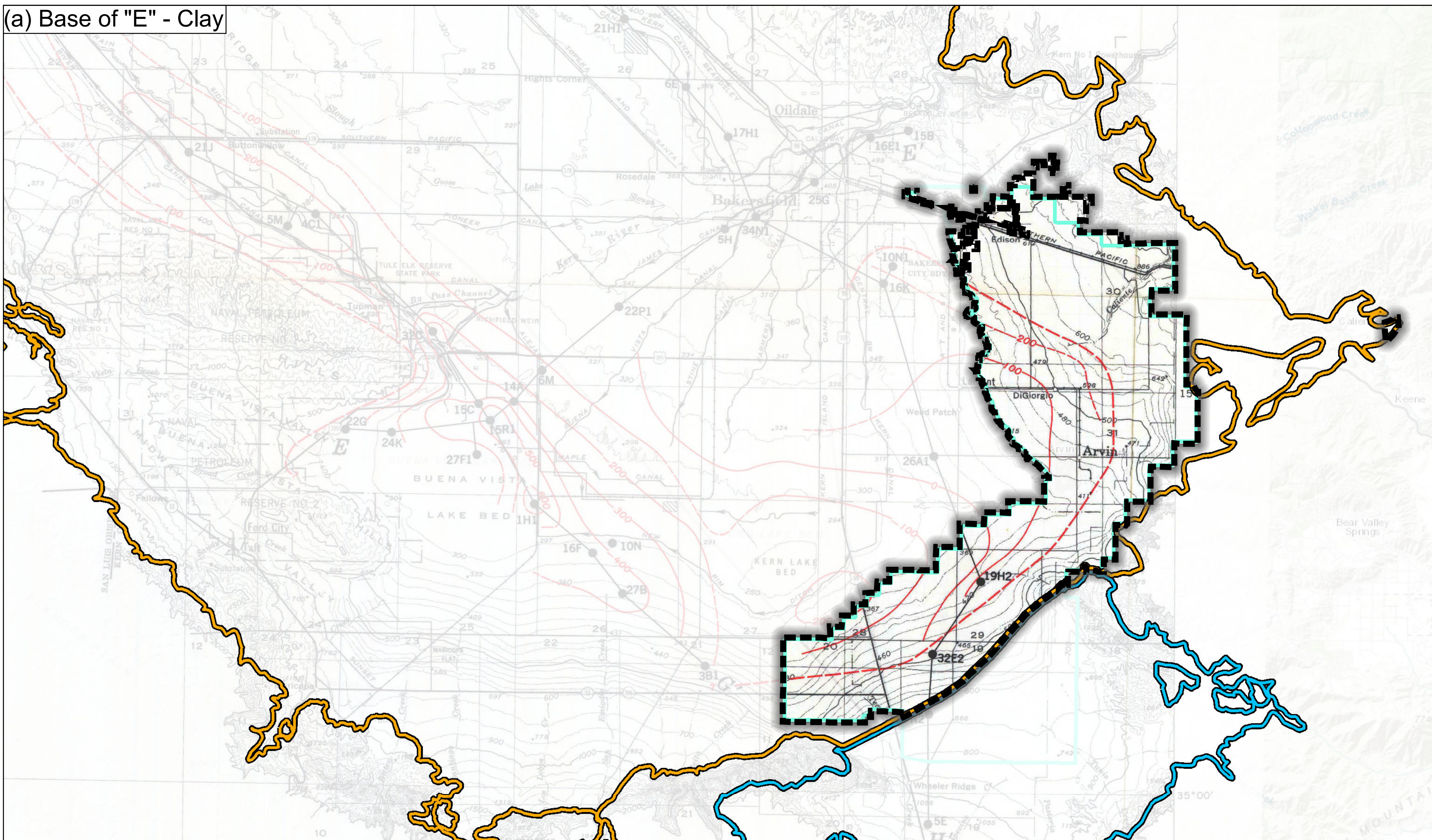
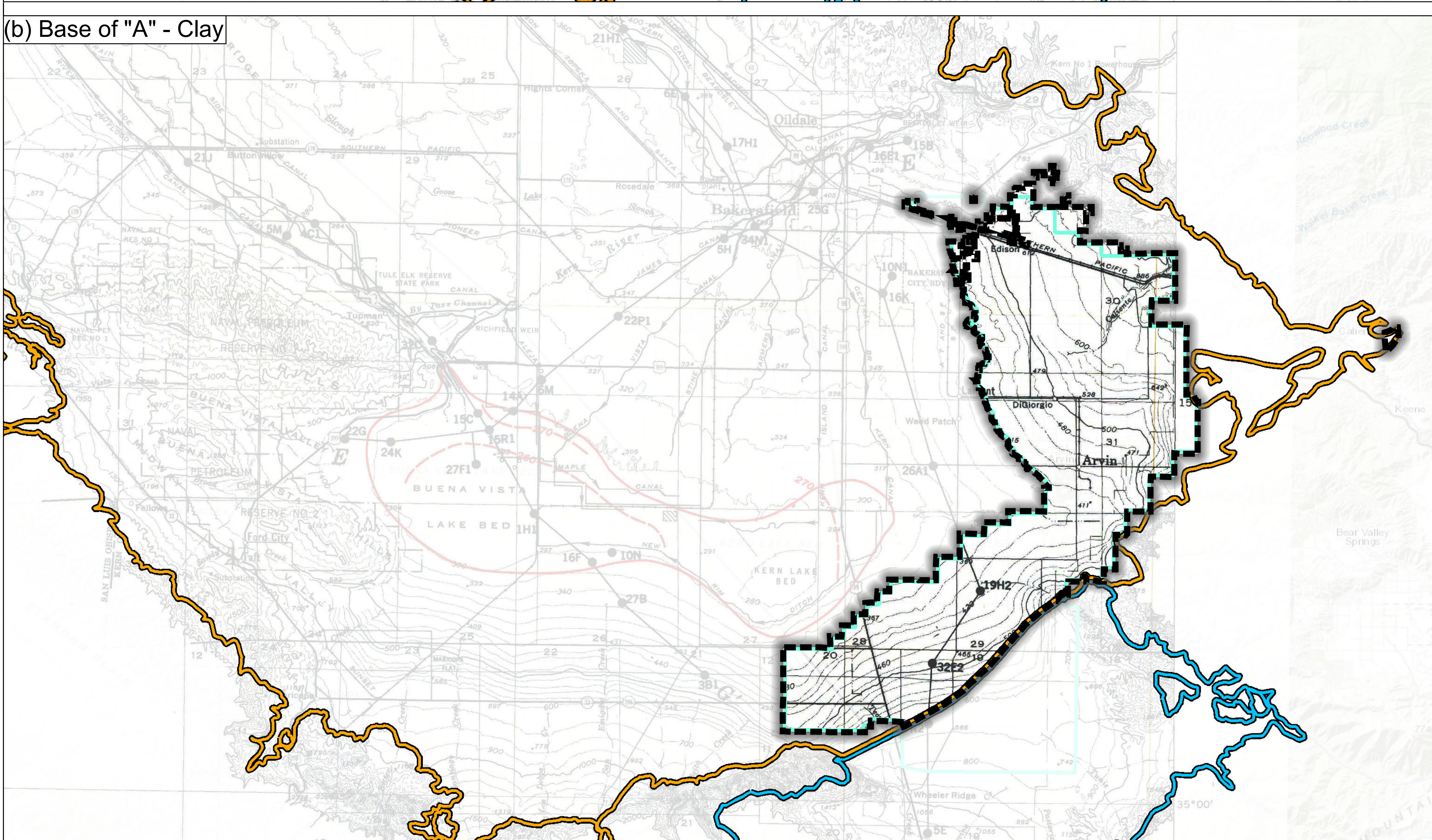
**Summary of Well Screen Depth Data**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00
**Figure HCM-9**




## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**"E" - Clay Overlay Map Attributes**

300

Structure contour
*Shows altitude of base of E clay. Dashed where approximately located. Contour interval 100 feet; datum is mean sea level*

Boundary of upper clay stratum of the E clay

Boundary of lower clay stratum of the E clay

Boundary of the E clay; stratum not determined

6F3
Well, core hole, or auger hole and number

Alinement of geologic section

**"A" - Clay Overlay Map Attributes**

120

Structure contour
*Shows altitude of base of A clay. Dashed where approximately located. Contour interval 20 feet; datum is mean sea level*

270

Structure contour
*Shows altitude of base of upper stratum of A clay. Contour interval 10 feet; datum is mean sea level*

Boundary of the A clay

6F3
Well, core hole, or auger hole and number

Alinement of geologic section

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Croft, M.G., 1972, Sub surface geology of the late Tertiary and Quaternary water-bearing deposits of the southern part of the San Joaquin Valley, California, USGS Water Supply Paper 199 H, 29 pp.

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.
2. Overlay map shows elevation contours (red lines) of the base of the "E" - Clay and "A" - Clay. The contour interval is 100 feet and the datum is mean sea level.

N

0 6 12
(Scale in Miles)

**Contour Map of Base Elevation of "E" - Clay and "A" - Clay Layers Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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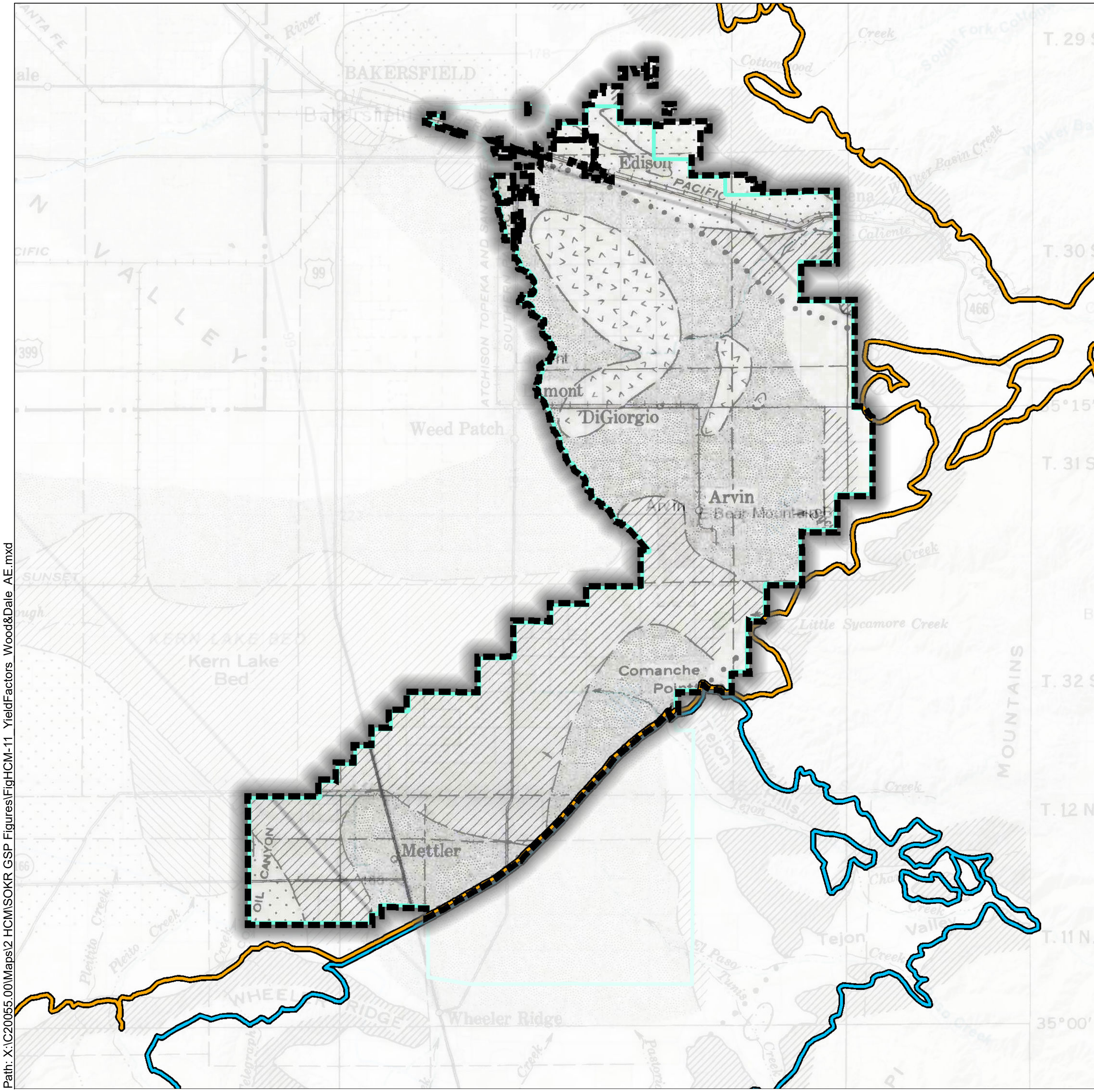
**Figure HCM-10**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-10_EandA_Clay_BaseElevation_AE.mxd




## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Yield Factor (gpm/ft per 100 feet of aquifer)**

< 1

1 - 5

6 - 10

11 - 50

> 50

## Abbreviations

DWR = California Department of Water Resources
gpm/ft = gallons per minute per foot
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.
2. Yield factor is in gallons per minute per foot of drawdown per 100 feet of saturated materials penetrated by irrigation wells.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. P. R. Wood and R. H. Dale, 1964, Geology and Ground-Water Features of the Edison-Maricopa Area, Geological Survey Water-Supply Paper 1656.

N 0 5 10 Miles

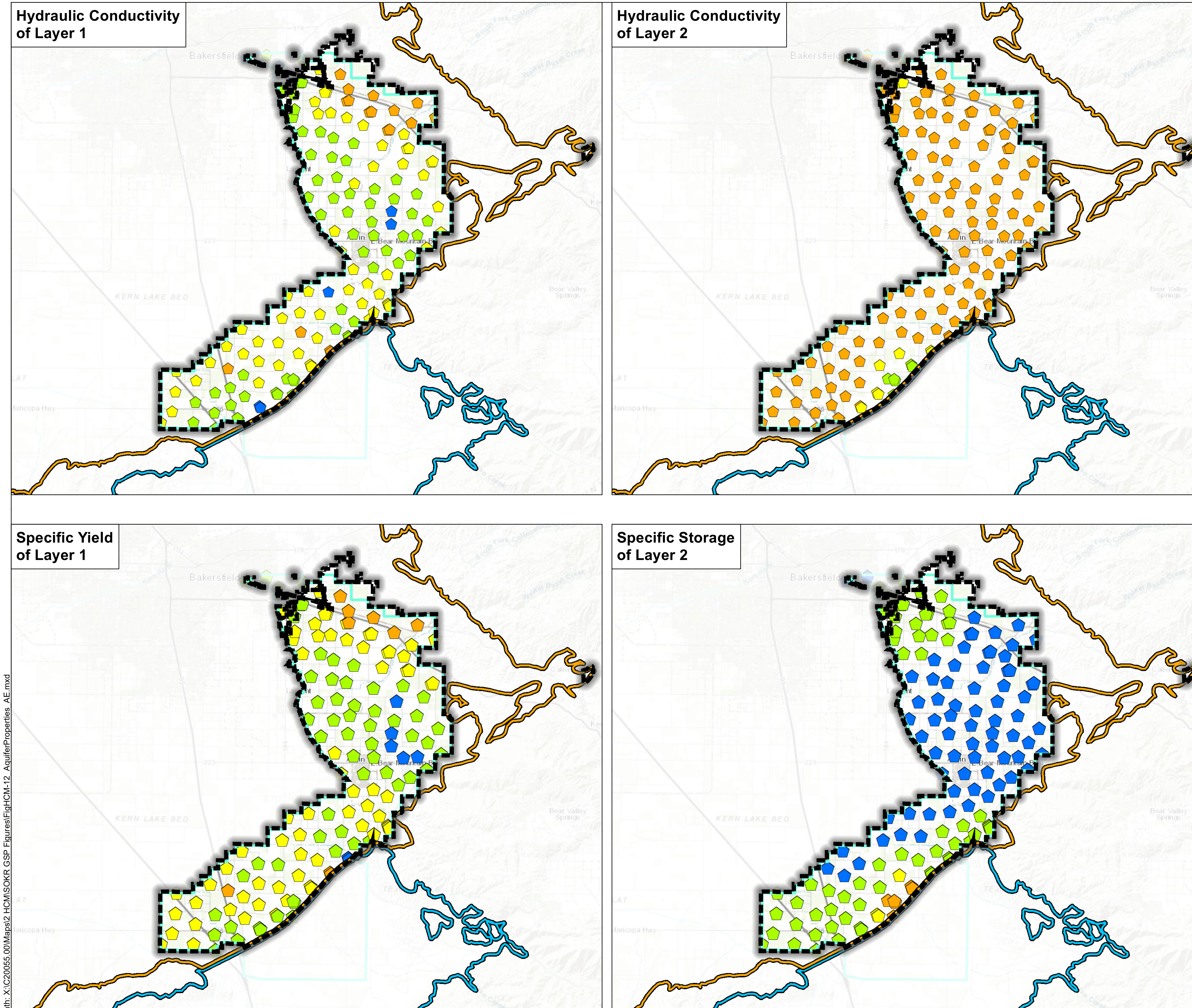
**Yield Factors Based on Wood & Dale, 1964 (USGS)**
**Arvin-Edison Management Area**

eki environment & water

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure HCM-11**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-11_YieldFactors_Wood&Dale_AE.mxd




## Legend

- Arvin GSA
- Arvin-Edison Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Hydraulic Conductivity (ft/day)**

- 3 - 20
- 20 - 30
- 30 - 40
- 40 - 50

**Specific Yield [-]**

- 0.075 - 0.080
- 0.080 - 0.085
- 0.085 - 0.090
- 0.090 - 0.095

**Specific Storage (1/ft)**

- < 0.0005
- 0.0005 - 0.001
- 0.001 - 0.0015
- 0.00150 - 0.0021

## Abbreviations

| | |
|---|---|
| AEWSD | = Arvin-Edison Water Storage District |
| C2VSim-FG | = California Central Valley Groundwater-Surface Water Simulation Model - Fine Grid |
| CNRA | = California Natural Resources Agency |
| DWR | = California Department of Water Resources |
| ft | = feet |
| ft/day | = feet per day |
| GSA | = Groundwater Sustainability Agency |

## Notes

1. All locations are approximate.
2. Layers 1 and 2 are the representative "pumped layers" of C2VSim-FG Model.
3. Layer 1 and 2 total depths range from 1,150 to 1,650 ft bgs in C2VSim-FG Model within AEWSD Management Area.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. C2VSim-FG Model data obtained from CNRA website: https://data.cnra.ca.gov/dataset/c2vsimfg-beta-model

N

0 6 12

(Scale in Miles)

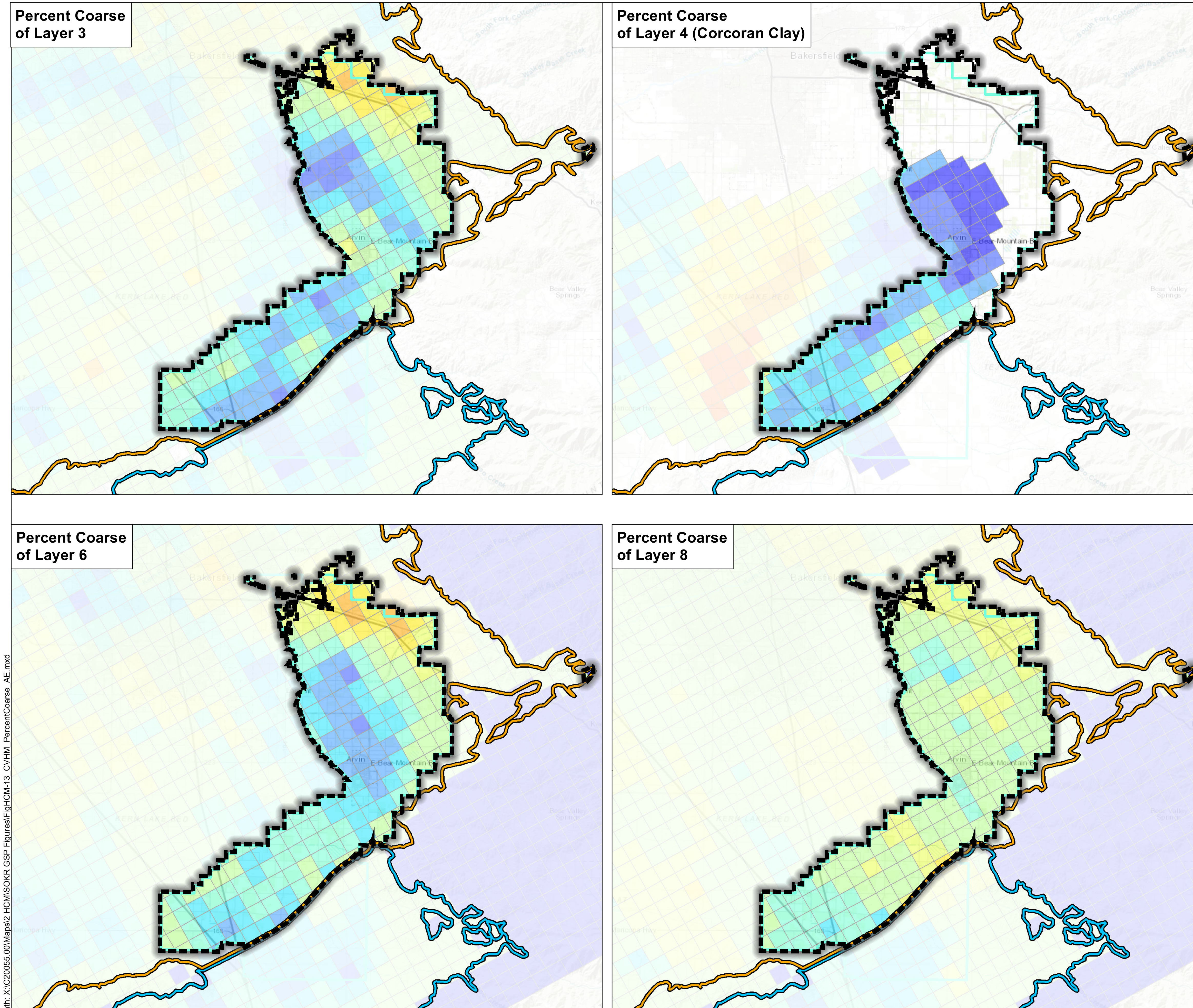
**Hydraulic Properties in C2VSim-FG Model (Beta Version)**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-12**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-12_AquiferProperties_AE.mxd




Legend

- Arvin GSA
- Arvin-Edison Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Percent Coarse**

- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100

Abbreviations

CVHM = Central Valley Hydrologic Model
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. Percent coarse is used to approximate hydrogeologic properties of each layer in the CVHM model.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. CVHM percent coarse data were acquired from Faunt, C.C., ed., 2009, Groundwater Availability of the Central Valley Aquifer, California: USGS Professional Paper 1766, 225 p.

N 0 6 12 (Scale in Miles)

**CVHM Percent Coarse Layers 3, 4, 6 and 8**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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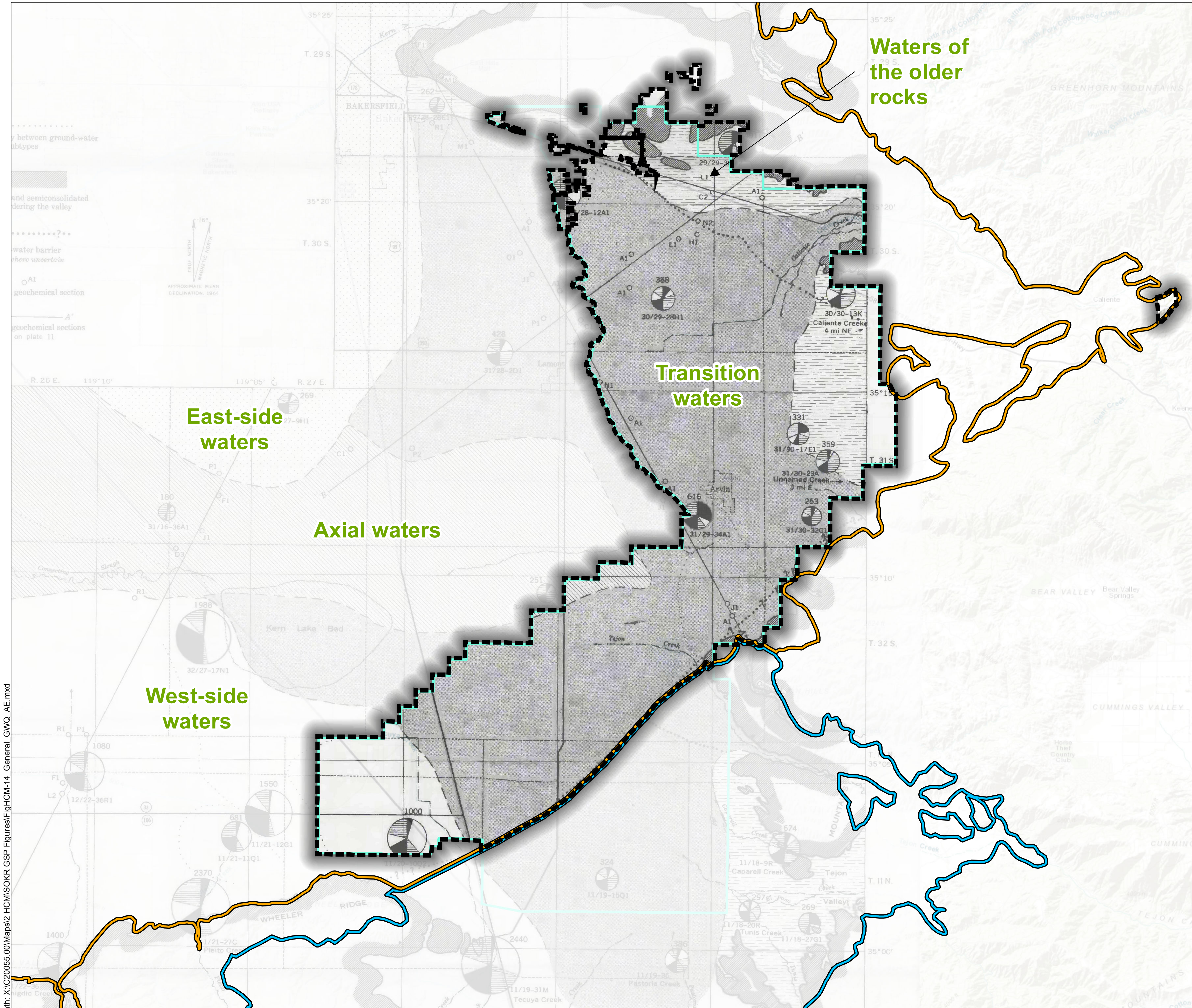
**Figure HCM-13**




Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

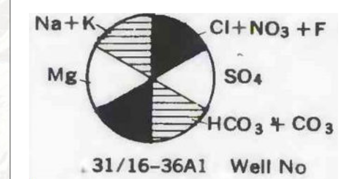
White Wolf (DWR 5-022.18)

**General Water Quality**

Probable boundary between groundwater subtypes

Consolidated rocks bordering the valley

Groundwater barrier (querried where uncertain)




Area of circle indicates mineral concentration (excluding silica), in parts per million

Abbreviations

DWR = California Department of Water Resources

GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.
2. Map shows areas of different water quality (shading, hatching, and stippling), as shown by labels, and chemical composition of major ions (pie charts) the sizes of which are scaled by the total mineral concentration (excluding silica).

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. Wood P.R. and R. H. Dale, 1964, Geology and Ground-Water Features of the Edison-Maricopa Area, Kern County, California, USGS Water Supply Paper 1656.

N

0 3 6

(Scale in Miles)

**General Groundwater Quality**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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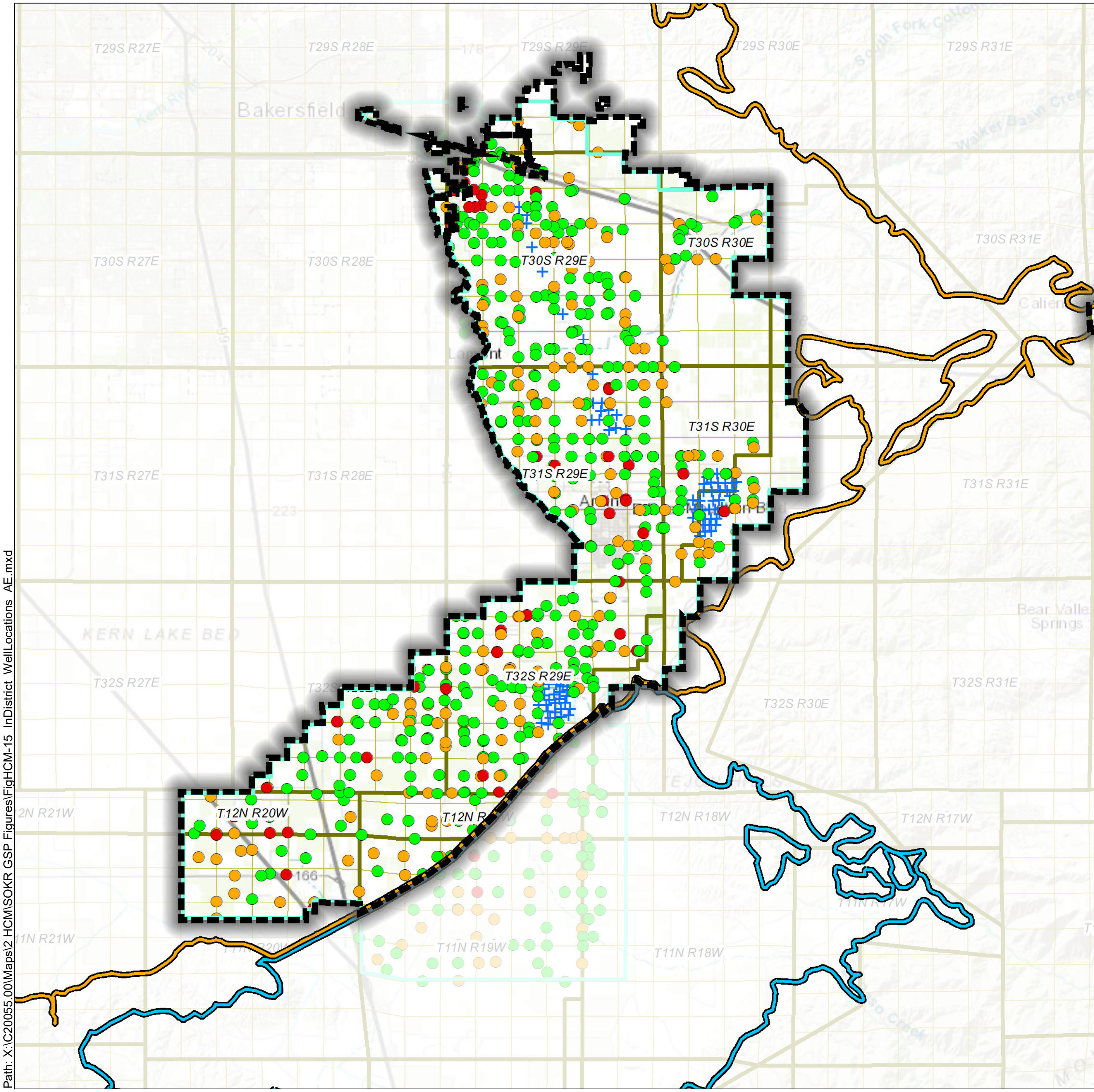
**Figure HCM-14**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-14_General_GWQ_AE.mxd




## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
M&I = Municipal and Industrial

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. Well information received from AEWSD on 17 November 2017.

**In-District Well Locations**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure HCM-15**

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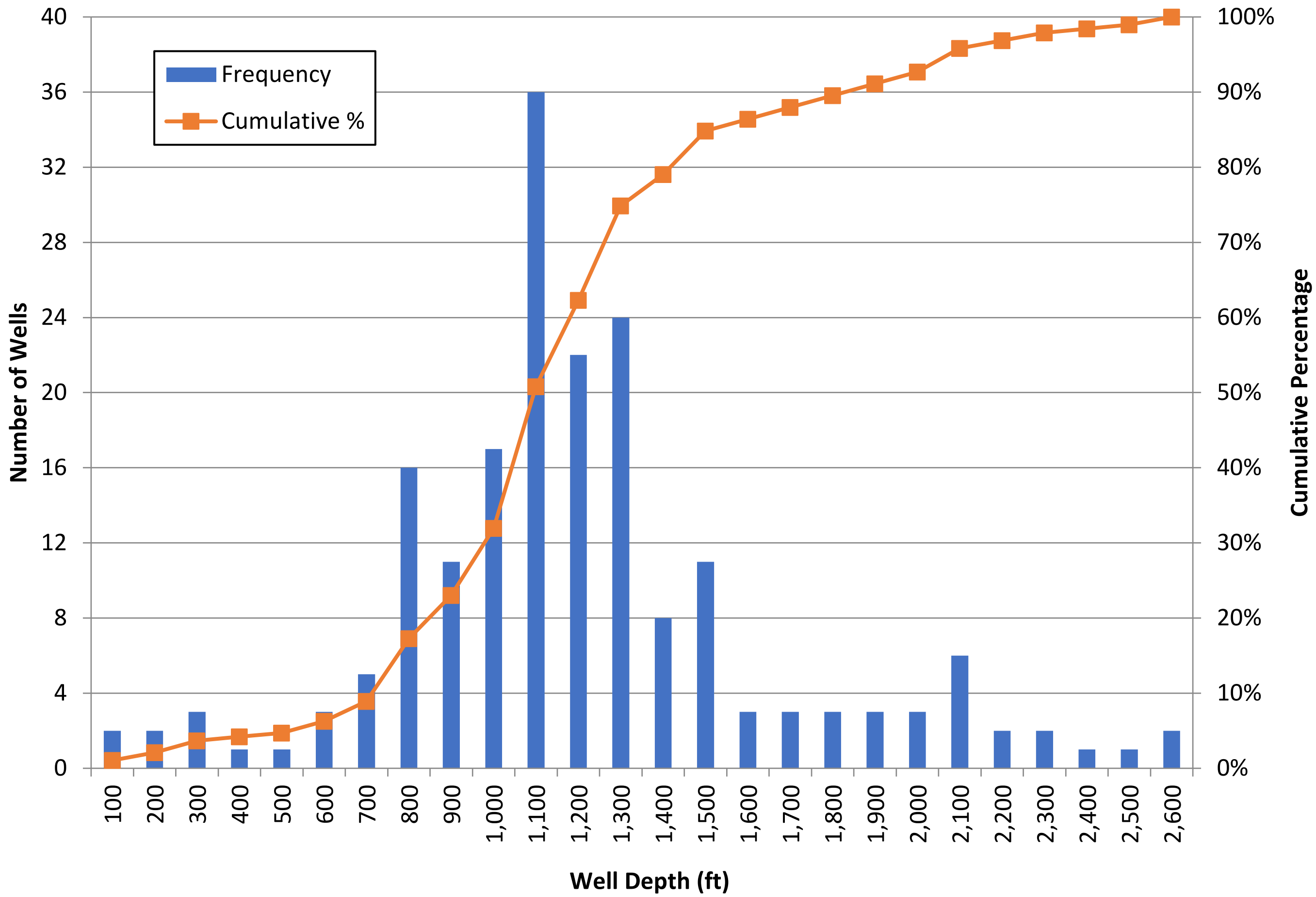
Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-15_InDistrict_WellLocations_AE.mxd




Abbreviations

| | | |
|---|---|---|
| BOS | = | bottom of screen |
| ft | = | feet |
| GSP | = | Groundwater Sustainability Plan |

Notes

1. Well screen data is based on digitized well records of 191 wells in the Wheeler Ridge-Maricopa Management Area.
2. When BOS depth was not available, completed depth was used.

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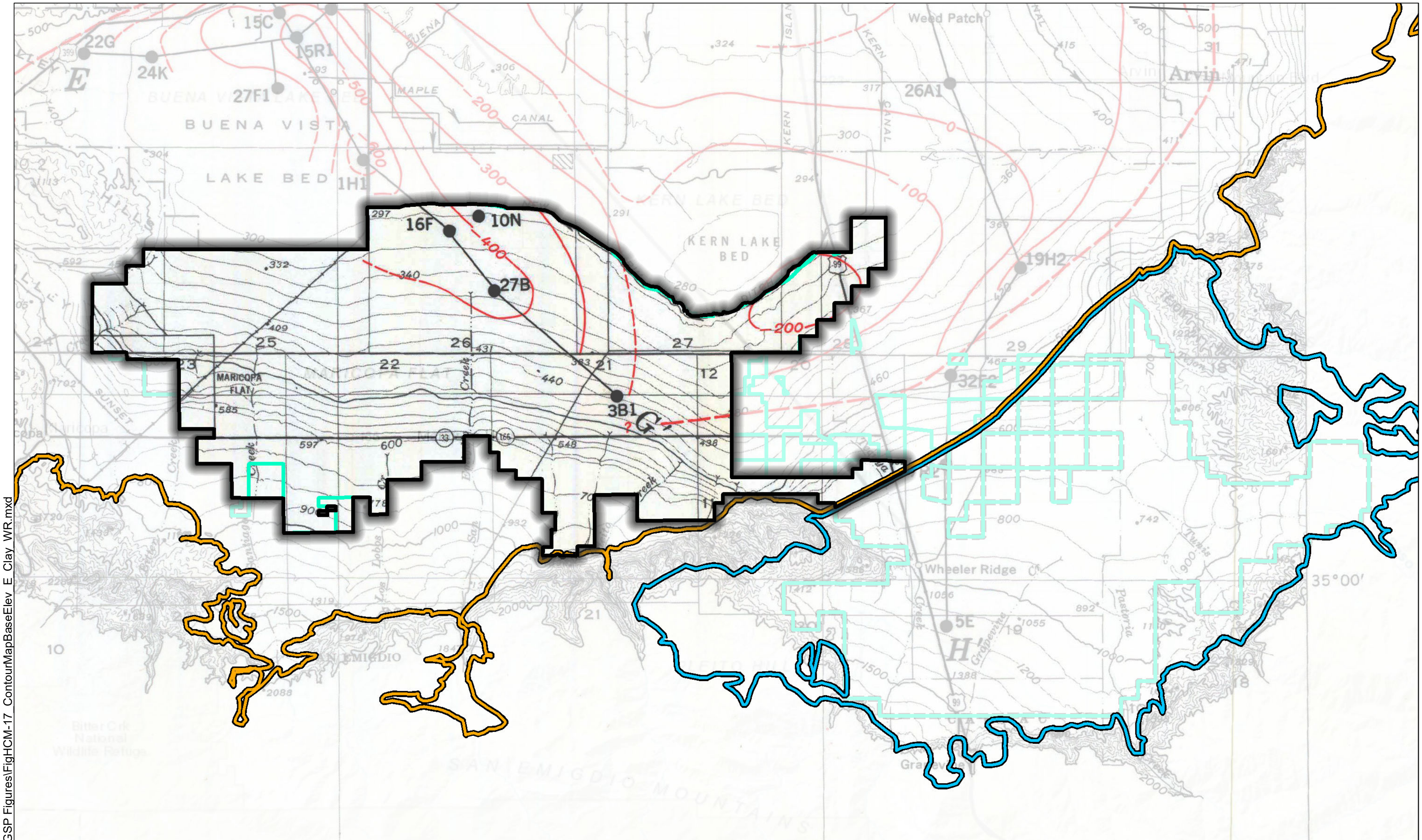
**Summary of Well Screen Depth Datab.**
**Wheeler Ridge-Maricopa**
**Management Area**

South of Kern River GSP
Kern County, California
July 20222
EKI C20055.00

**Figure HCM-16**




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**"E Clay" Overlay Map Attributes**

300 — Structure contour. Shows altitude of base of E clay. Dashed where approximately located. Contour interval 100 feet; datum is mean sea level

Boundary of upper clay stratum of the E clay

Boundary of lower clay stratum of the E clay

Boundary of the E clay; stratum not determined

6F3 — Well, core hole, or auger hole and number

Alinement of geologic section

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. Overlay map shows elevation contours (red lines) of the base of the "E Clay". The contour interval is 100 feet and the datum is mean sea level.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. Croft, M.G., 1972, Sub surface geology of the late Tertiary and Quaternary water-bearing deposits of the southern part of the San Joaquin Valley, California, USGS Water Supply Paper 199 H, 29 pp.

N

0 5 10 (Scale in Miles)

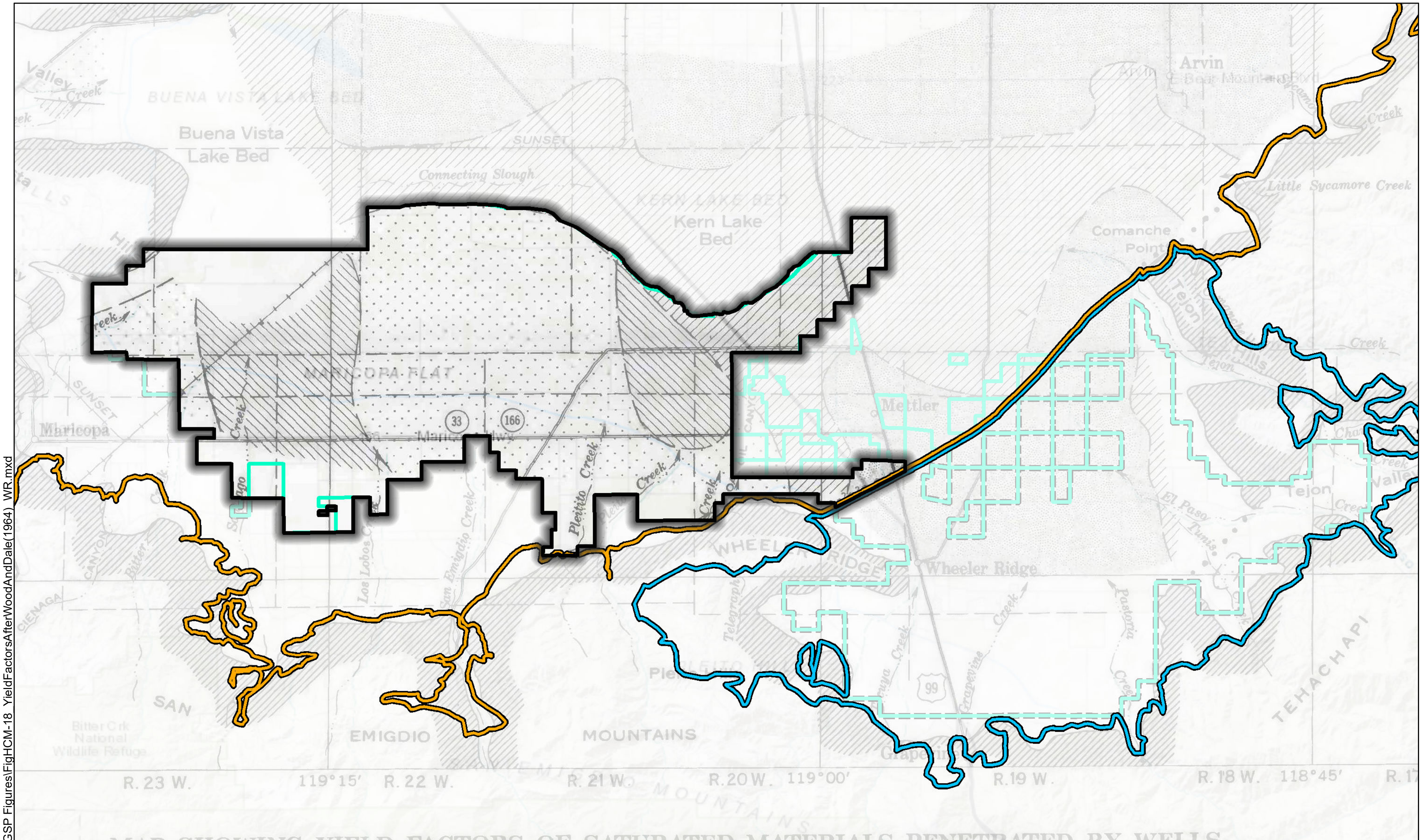
**Contour Map of Base Elevation of "E Clay" Layer**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-17**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-17_ContourMapBaseElev_E_Clay_WR.mxd




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Yield Factor (gpm/ft per 100 feet of aquifer)**

- < 1
- 1 - 5
- 6 - 10
- 11 - 50
- > 50

## Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| gpm/ft | = gallons per minute per foot |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

## Notes

1. All locations are approximate.
2. Yield factor is in gallons per minute per foot of drawdown per 100 feet of saturated materials penetrated by irrigation wells.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. P. R. Wood and R. H. Dale, 1964, Geology and Ground-Water Features of the Edison-Maricopa Area, Geological Survey Water-Supply Paper 1656.

N 0 5 10 (Scale in Miles)

**Yield Factors after Wood and Dale (1964)**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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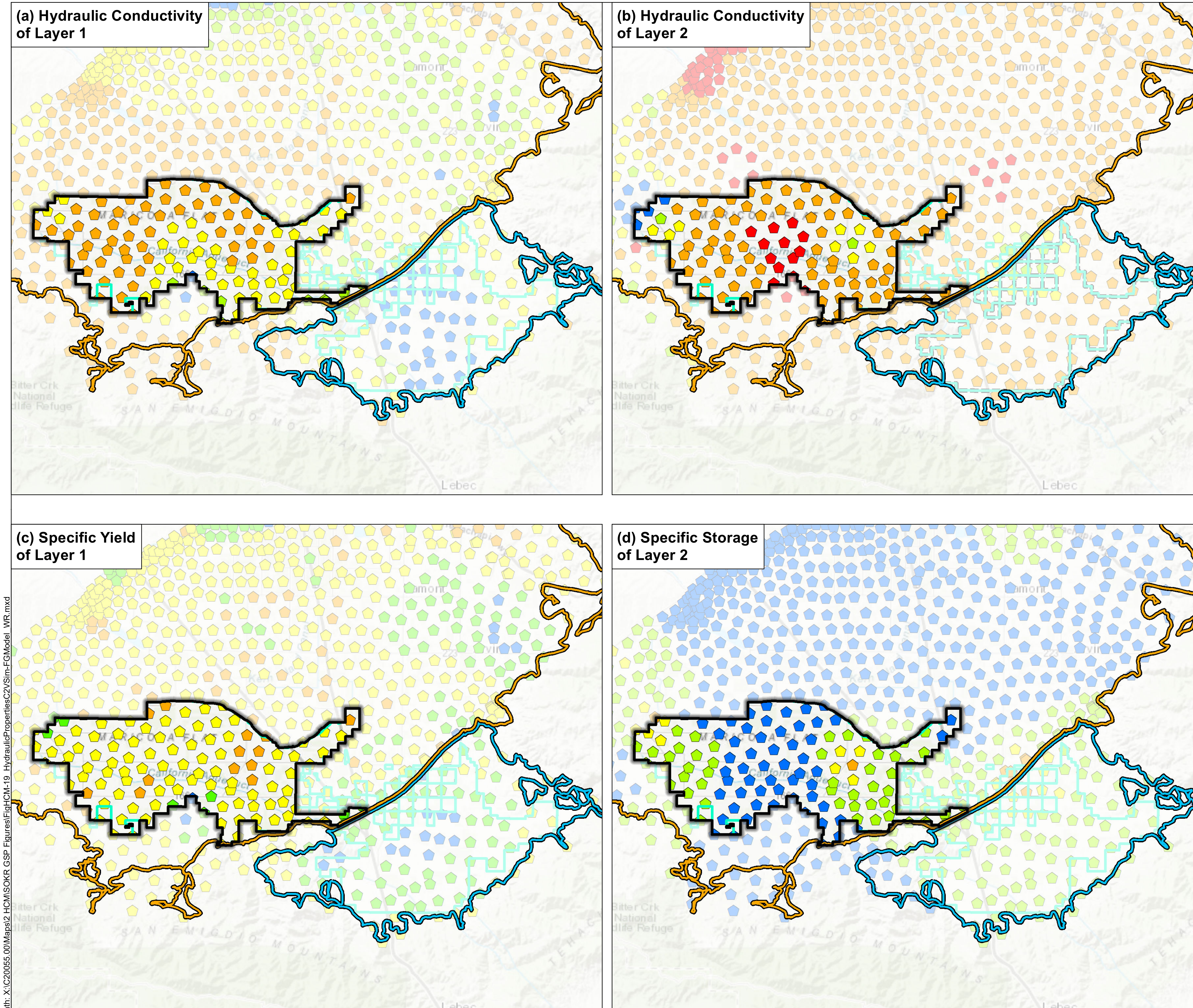
**Figure HCM-18**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-18_YieldFactorsAfterWoodAndDale(1964)_WR.mxd

er Ridge-Maricopa GSA

WSD_FeatheredBuffer




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Hydraulic Conductivity (ft/day)**

- 2 - 8
- 8 - 20
- 20 - 30
- 30 - 40
- > 40

**Specific Yield [-]**

- 0.070 - 0.080
- 0.080 - 0.085
- 0.085 - 0.090
- 0.090 - 0.100

**Specific Storage**

- < 0.0005
- 0.0005 - 0.001
- 0.001 - 0.0015
- 0.0015 - 0.0021

## Abbreviations

C2VSim-FG = California Central Valley Groundwater-Surface Water Simulation Model - Fine Grid
CNRA = California Natural Resources Agency
ft bgs = feet below ground surface
ft/day = feet per day
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. Layers 1 and 2 are the representative "pumped layers" of C2VSim-FG Beta Model.
3. Layer 1 and 2 total depths range from 600 to 1,810 ft bgs in C2VSim-FG Beta Model within WRMWSD Management Area.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. C2VSim-FG Model data obtained from CNRA website: https://data.cnra.ca.gov/dataset/c2vsimfg-beta-model

N

0 7 14

(Scale in Miles)

**Hydraulic Properties in C2VSim-FG Model (Beta Version) Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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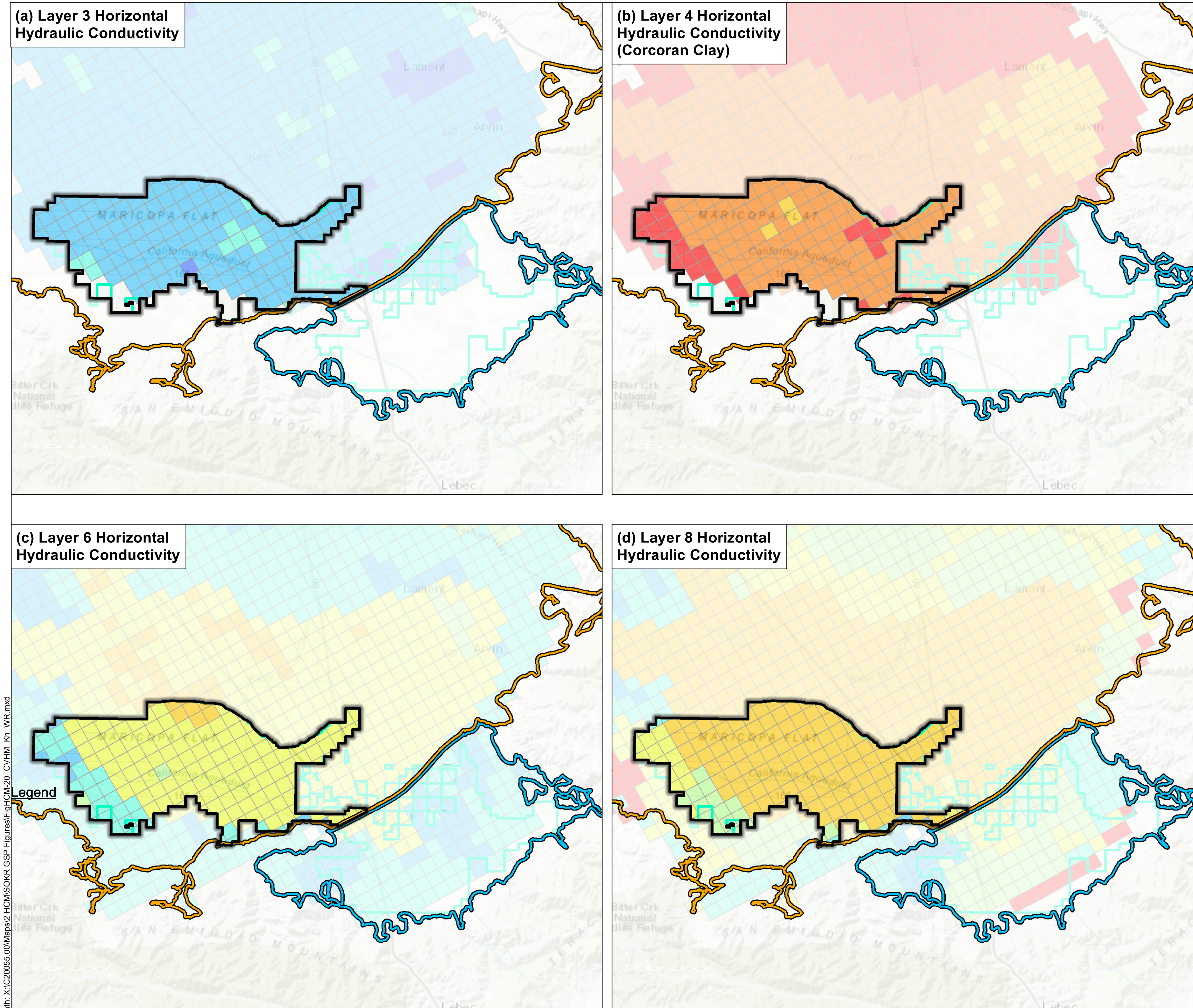
**Figure HCM-19**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-19_HydraulicProperties\C2VSim-FGModel_WR.mxd




**Legend**

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Horizontal Hydraulic Conductivity (ft/d)**

- < 0.5
- 0.5 - 5.0
- 5.0 - 25
- 25 - 50
- 50 - 100
- 100 - 250
- 250 - 500
- 500 - 1,000
- > 1,000

**Abbreviations**

| | |
|---|---|
| CVHM | = Central Valley Hydrologic Model |
| DWR | = California Department of Water Resources |
| ft/d | = feet per day |
| GSA | = Groundwater Sustainability Agency |
| USGS | = United States Geological Survey |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

**Notes**

1. All locations are approximate.
2. Percent coarse is used to approximate hydrogeologic properties of each layer in the CVHM model.

**Sources**

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. CVHM aquifer properties were acquired from Faunt, C.C., ed., 2009, Groundwater Availability of the Central Valley Aquifer, California: USGS Professional Paper 1766, 225 p.

N

0 7 14

(Scale in Miles)

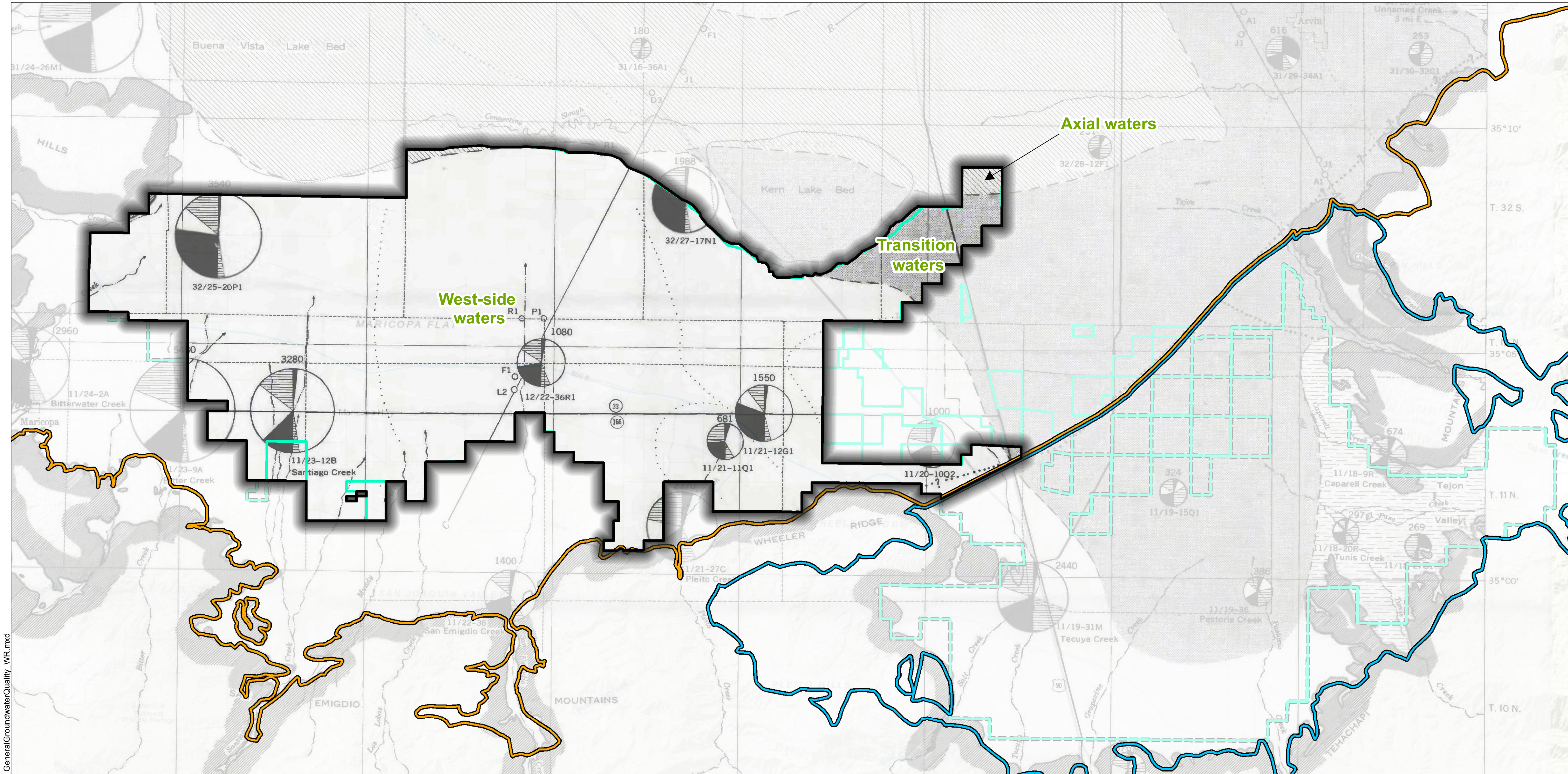
**CVHM Horizontal Hydraulic Conductivity, Layers 3, 4, 6, 8**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-20**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-20_CVHM_Kh_WR.mxd




Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-21_GeneralGroundwaterQuality_WR.mxd

## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**General Water Quality**

- Probable boundary between groundwater subtypes
- Consolidated rocks bordering the valley
- Groundwater barrier (querried where uncertain)

Na+K, Cl+NO3+F, Mg, SO4, HCO3 + CO3, 31/16-36A1, Well No

Area of circle indicates mineral concentration (excluding silica), in parts per million

SCALE OF RADII

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
USGS = The United States Geological Survey
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. Map shows areas of different water quality (shading, hatching, and stippling), as shown by labels, and chemical composition of major ions (pie charts) the sizes of which are scaled by the total mineral concentration (excluding silica).

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. Wood P.R. and R. H. Dale, 1964, Geology and Ground-Water Features of the Edison-Maricopa Area, Kern County, California. USGS Water Supply Paper 1656.

N

0 2.5 5

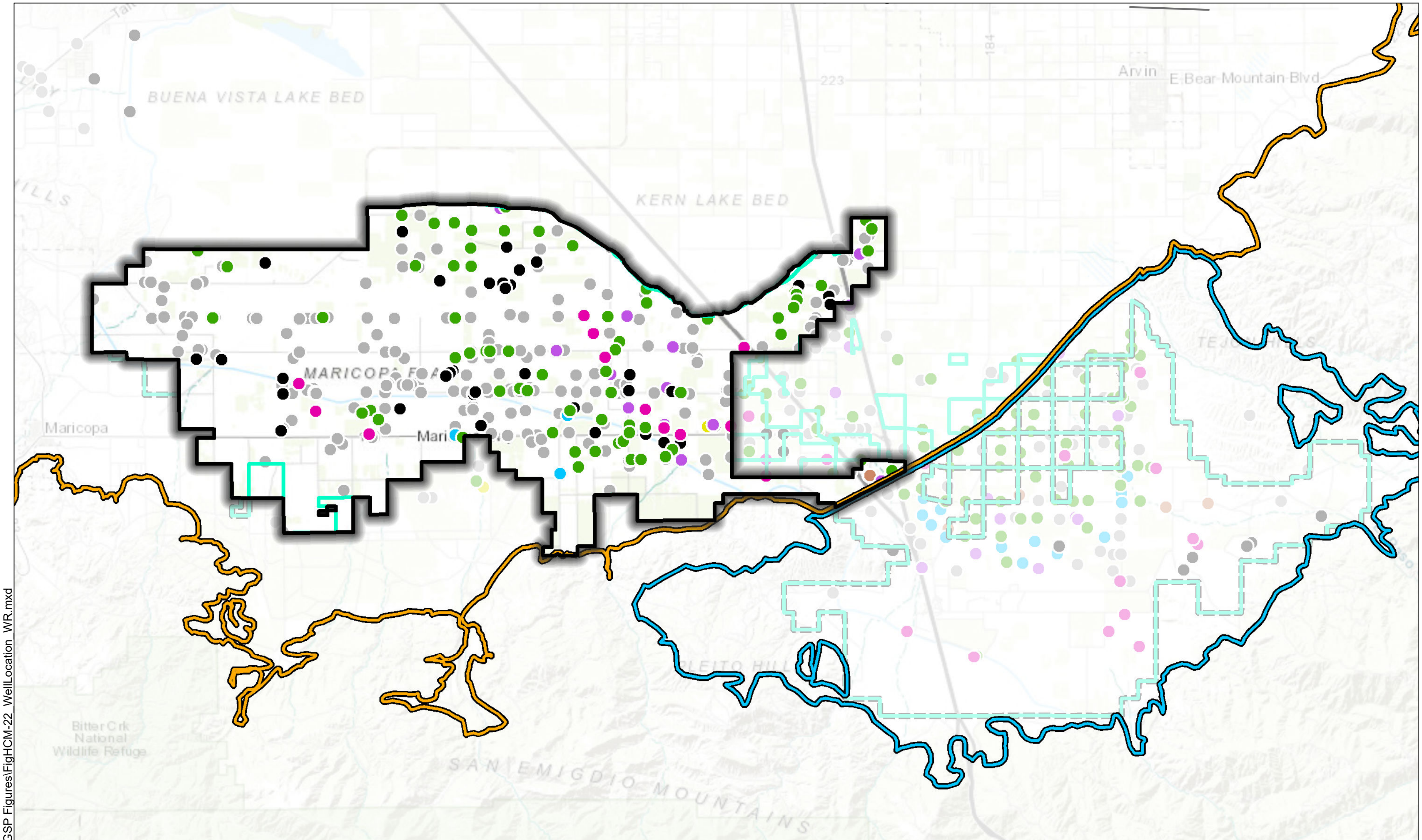
(Scale in Miles)

**General Groundwater Quality**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure HCM-21**




Legend

Wheeler Ridge-Maricopa GSA
Wheeler Ridge-Maricopa Water Storage District
WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

Kern County (DWR 5-022.14)
White Wolf (DWR 5-022.18)

**Well Type/Status**

- Active Agricultural
- Active Domestic
- Active Industrial
- Active WRMWSD Production Well
- Monitoring Well
- Abandoned
- Dry Well
- Other

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 June 2022.
2. Well type data received from WRMWSD on 20 November 2017.

N 0 5 10 (Scale in Miles)

**In-District Well Locations, Type, and Status**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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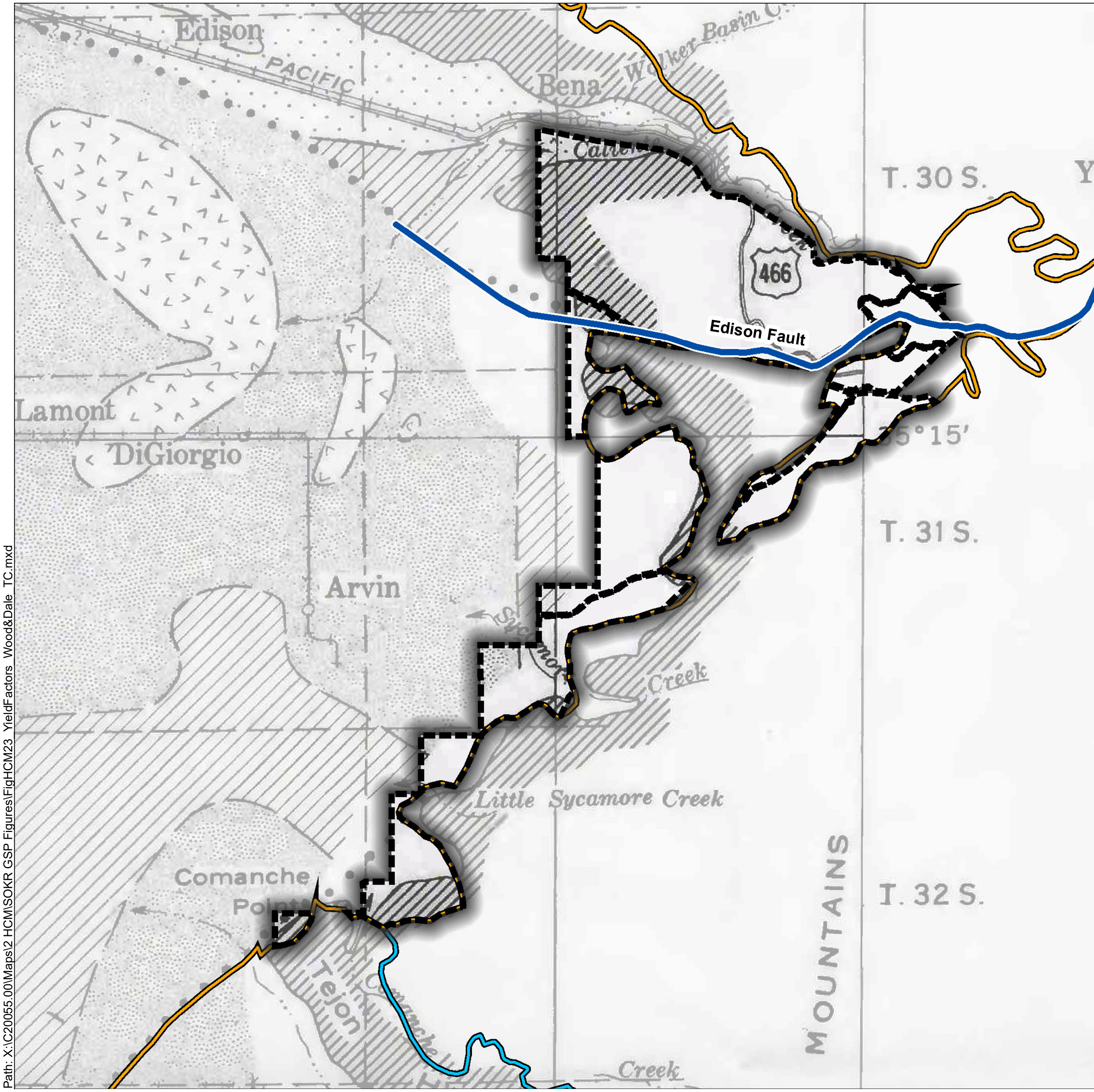
**Figure HCM-22**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-22_WellLocation_WR.mxd




## Legend

Tejon-Castac Water District GSA

Edison Fault

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Yield Factor (gpm/ft per 100 feet of aquifer)**

< 1

1 - 5

6 - 10

11 - 50

> 50

## Abbreviations

DWR = California Department of Water Resources

gpm/ft = gallons per minute per foot

GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.
2. Yield factor is defined as the pumping rate (in gallons per minute) per foot of drawdown per 100 feet of saturated materials penetrated by irrigation wells.

## Sources

1. P. R. Wood and R. H. Dale, 1964, Geology and Ground-Water Features of the Edison-Maricopa Area, Geological Survey Water-Supply Paper 1656.

N 0 3 6

Miles

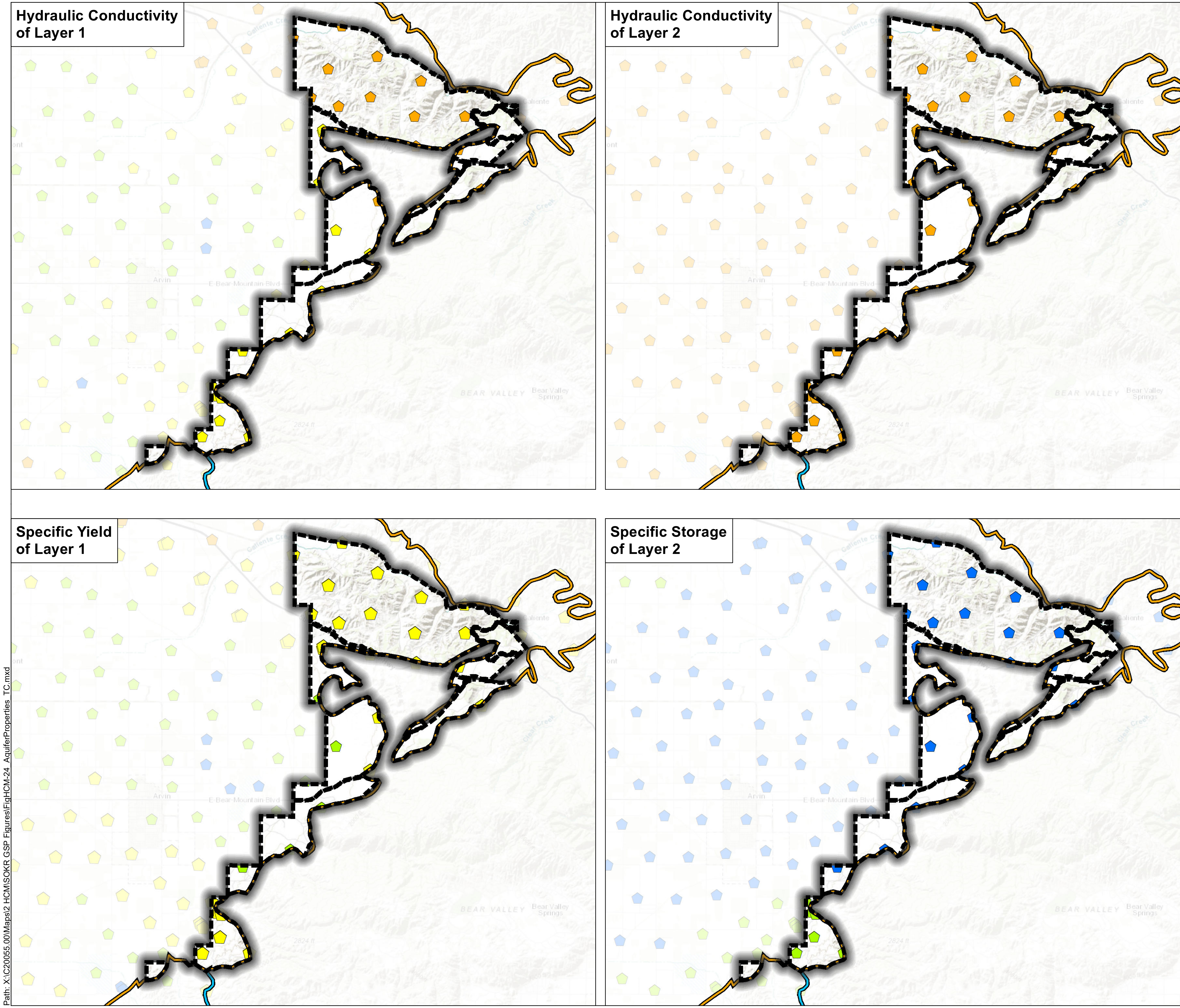
**Yield Factors (after Wood & Dale, 1964)**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-23**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM23_YieldFactors_Wood&Dale_TC.mxd




Legend

Tejon-Castac Water District GSA

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Hydraulic Conductivity (ft/day)**

- 3 - 20
- 20 - 30
- 30 - 40
- 40 - 50

**Specific Yield [-]**

- 0.075 - 0.080
- 0.080 - 0.085
- 0.085 - 0.090
- 0.090 - 0.095

**Specific Storage (1/ft)**

- < 0.0005
- 0.0005 - 0.001
- 0.001 - 0.0015
- 0.00150 - 0.0021

Abbreviations

C2VSim-FG = California Central Valley Groundwater-Surface Water Simulation Model - Fine Grid
CNRA = California Natural Resources Agency
DWR = California Department of Water Resources
ft = feet
ft/day = feet per day
GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.
2. Layers 1 and 2 are the representative C2VSim-FG Model layers of the defined principal aquifer.
3. Layer 1 and 2 total depths range from 1,100 to 2,150 ft bgs in C2VSim-FG Model within theTejon-Castac Water District Management Area.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. C2VSim-FG Model data obtained from CNRA website: https://data.cnra.ca.gov/dataset/c2vsimfg-beta-model

N

0 3 6

(Scale in Miles)

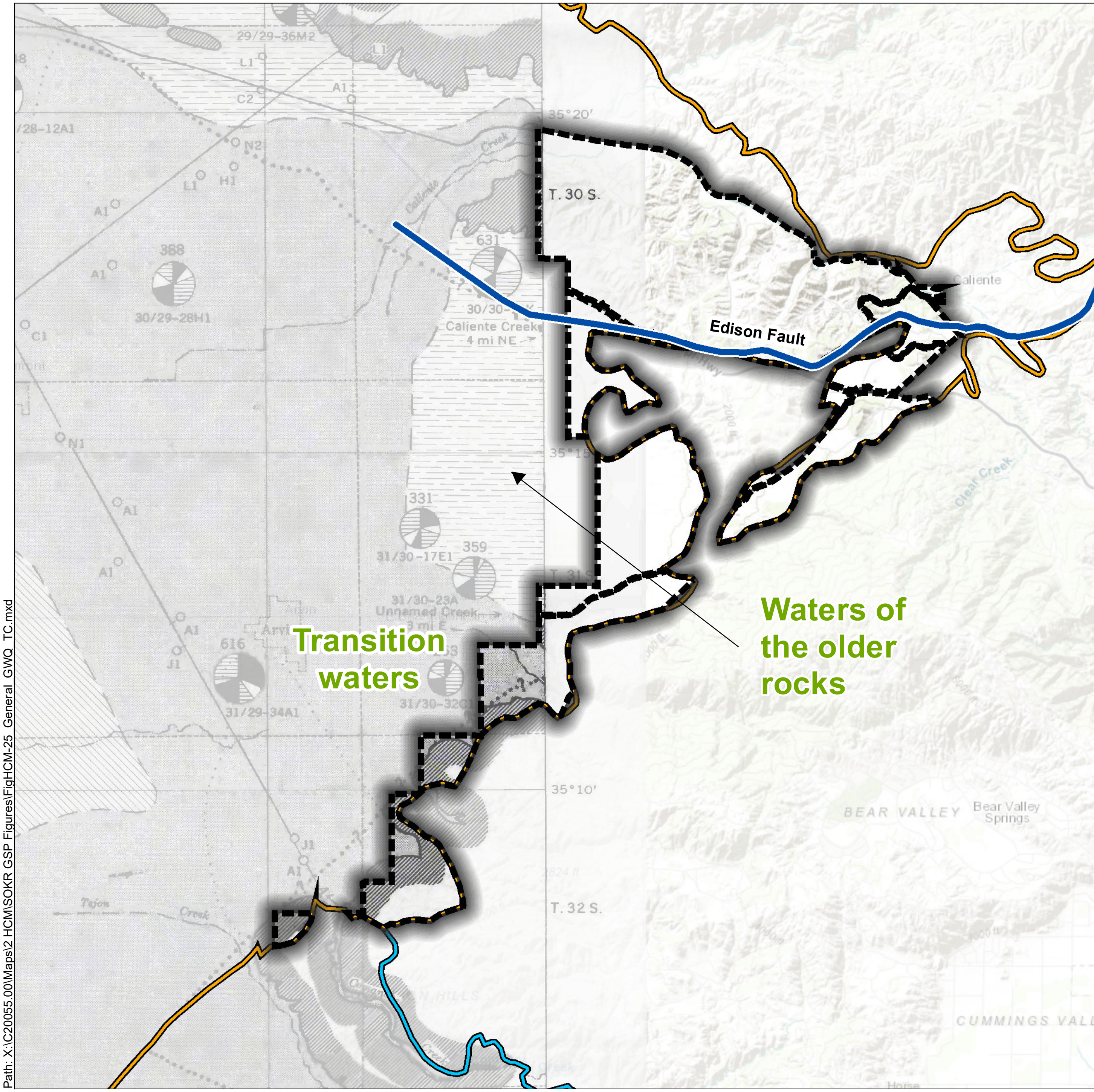
**Hydraulic Properties in C2VSim-FG Model (Beta Version) Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-24**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-24_AquiferProperties_TC.mxd




## Legend

Tejon-Castac Water District GSA

Edison Fault

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**General Water Quality**

Consolidated rocks bordering the valley

Groundwater barrier (queried where uncertain)

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.
2. Map shows areas of different water quality (shading, hatching, and stippling), as shown by labels, and chemical composition of major ions (pie charts) the sizes of which are scaled by the total mineral concentration (excluding silica).

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. Wood P.R. and R. H. Dale, 1964, Geology and Ground-Water Features of the Edison-Maricopa Area, Kern County, California, USGS Water Supply Paper 1656.

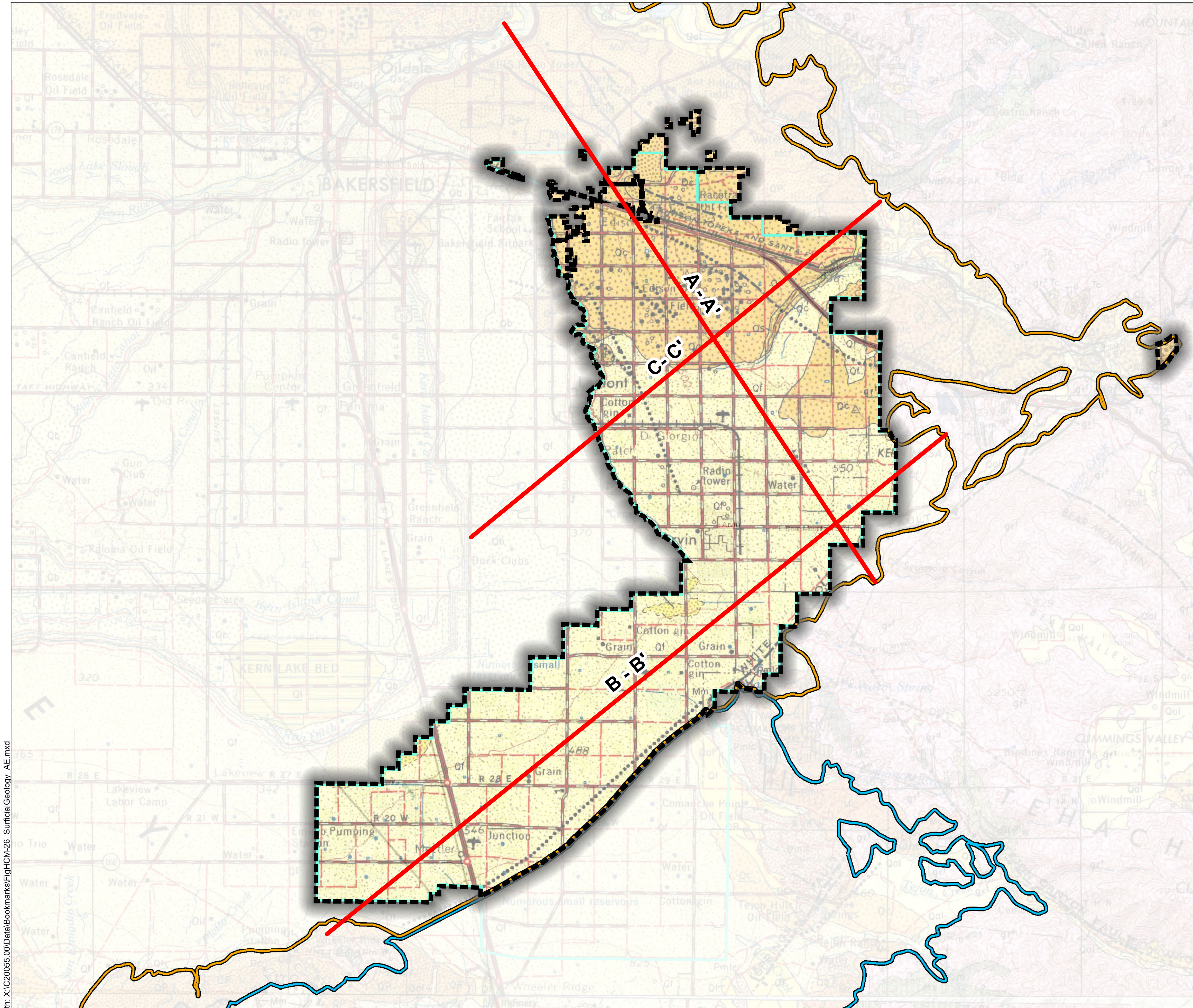
N 0 3 6
Miles

**General Groundwater Quality**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-25**




## Legend

- Arvin GSA
- Arvin-Edison Water Storage District
- Cross-Section Location

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Geologic Units**

- Qal Recent alluvium
- Qs Recent dune sand
- Ql Quaternary lake deposits
- Qc Pleistocene nonmarine
- Qf Recent fan deposits
- QP Plio-Pleistocene nonmarine
- Qt Pleistocene nonmarine terrace deposits
- Pmlc Middle and/or lower Pliocene nonmarine
- Mc Undivided Miocene nonmarine
- Ml Lower Miocene marine
- gr Mesozoic granitic rocks
- ls Pre-Cretaceous metamorphic rocks

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. Surficial geology from California Division of Mines and Geology, Geologic Map of California, Olaf P. Jenkins Edition, Bakersfield Sheet (1964) and Los Angeles Sheet (1969).

N

0 3 6
(Scale in Miles)

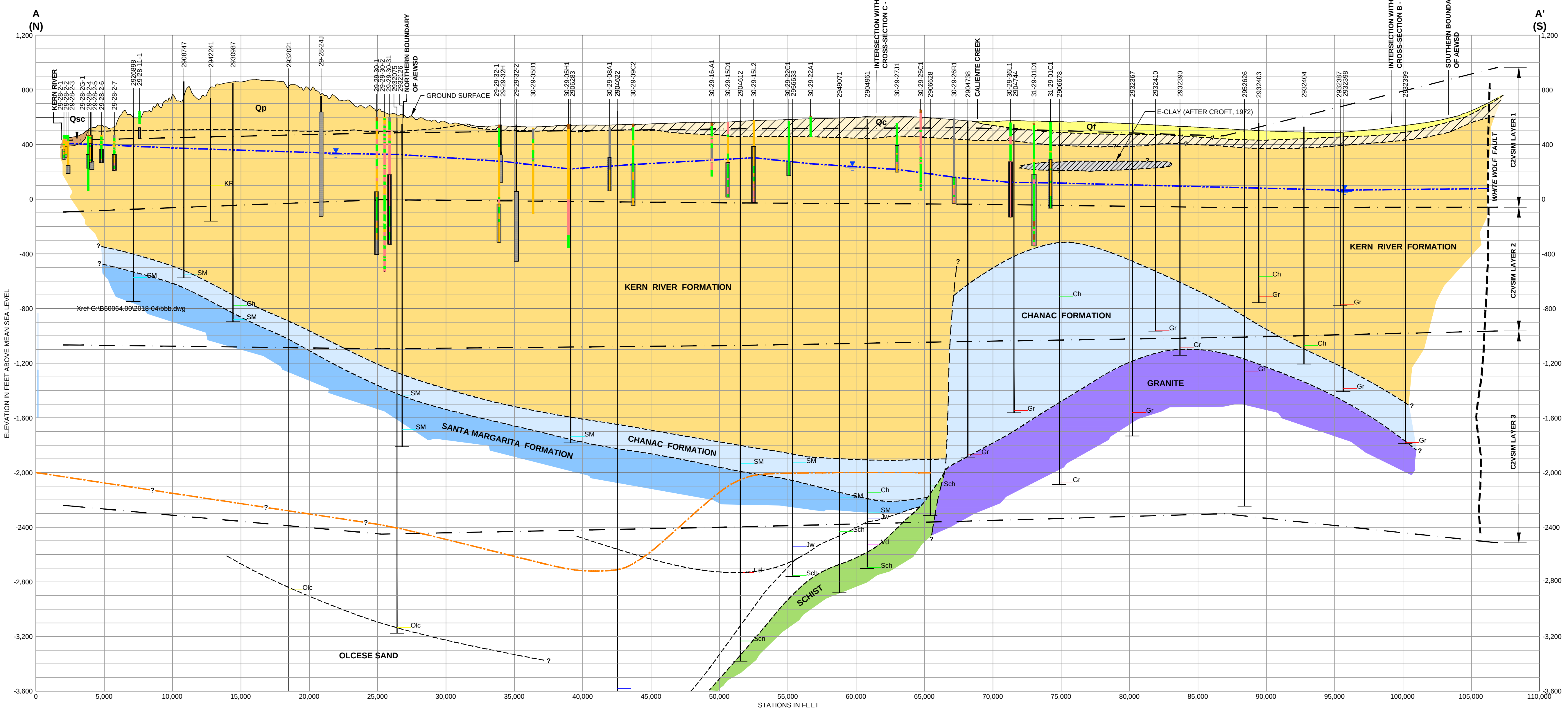
**Surficial Geology and Cross-Section Locations**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

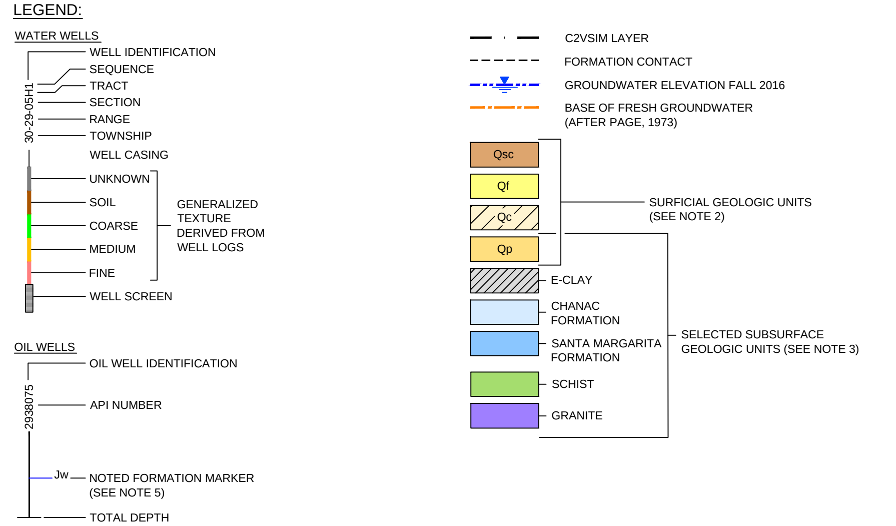
**Figure HCM-26**

Path: X:\C20055.00\Data\Bookmarks\FigHCM-26_SurficialGeology_AE.mxd




## GEOLOGIC CROSS-SECTION A - A'

LEGEND:




ABBREVIATIONS:

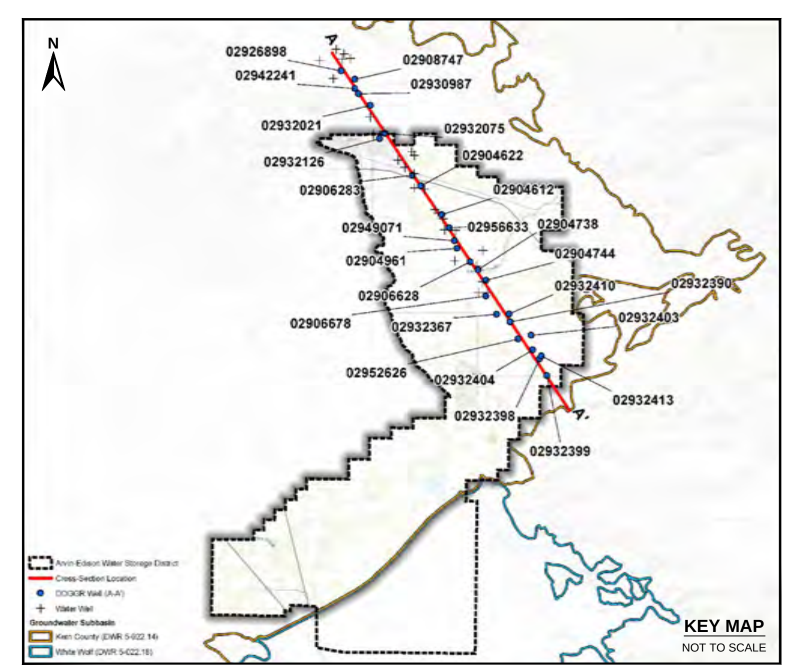
| | |
|---|---|
| AEWSD | = ARVIN-EDISON WATER STORAGE DISTRICT |
| API | = AMERICAN PETROLEUM INSTITUTE |
| C2VSIM | = CALIFORNIA CENTRAL VALLEY GROUNDWATER-SURFACE WATER SIMULATION MODEL |
| CDMG | = CALIFORNIA DIVISION OF MINES AND GEOLOGY |
| DOGGR | = DIVISION OF OIL, GAS & GEOTHERMAL RESOURCES |

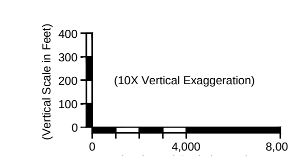
SOURCES:


1. CDMG, 1964, CALIFORNIA DIVISION OF MINES AND GEOLOGY, GEOLOGIC MAP, OLAF P. JENKINS EDITION, BAKERSFIELD SHEET.
2. CROFT, 1972. CROFT, M.G., 1972, 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, 29 PP.
3. BARTOW, 1984. BARTOW, J.A. TERTIARY STRATIGRAPHY OF THE SOUTHEASTERN SAN JOAQUIN VALLEY, CALIFORNIA, USGS BULLETIN 1529-J, 1984.
4. DOGGR OIL WELL RECORDS.
5. PAGE R.W., 1973. BASE OF FRESH GROUNDWATER (APPROXIMATELY 3,000 MICROMHOS) IN THE SAN JOAQUIN VALLEY, CALIFORNIA. USGS HYDROLOGIC INVESTIGATIONS ATLAS HA-489.


NOTES:

1. WELL IDENTIFICATION BASED ON PUBLIC LAND SURVEY SYSTEM.
2. SURFICIAL GEOLOGY AS SHOWN ON CDMG (1964). SURFICIAL GEOLOGY MAP UNIT SYMBOLS ARE:
   Qsc - RECENT STREAM CHANNEL DEPOSITS
   Qf - RECENT FAN DEPOSITS
   Qc - PLEISTOCENE NON-MARINE
   Qp - PLIO-PLEISTOCENE NON-MARINE
3. SUBSURFACE GEOLOGIC UNITS BASED ON BARTOW (1984) & CROFT (1972) AND DOGGR OIL WELL RECORDS.
4. SEE FIGURE 8a FOR CROSS-SECTION LOCATION. WELLS SHOWN ON CROSS-SECTION ARE LOCATED WITHIN 1/2 MILE OF CROSS-SECTION LINE.
5. FORMATION MARKERS FROM DOGGR OIL WELL RECORDS INCLUDE: Ch (CHANNAC), SM (SANTA MARGARITA), Olc (OLCESE), Ed (EDISON), Jw ( JEWETT), Vd (VEDDER), Sch (SCHIST) AND Gr (GRANITE).



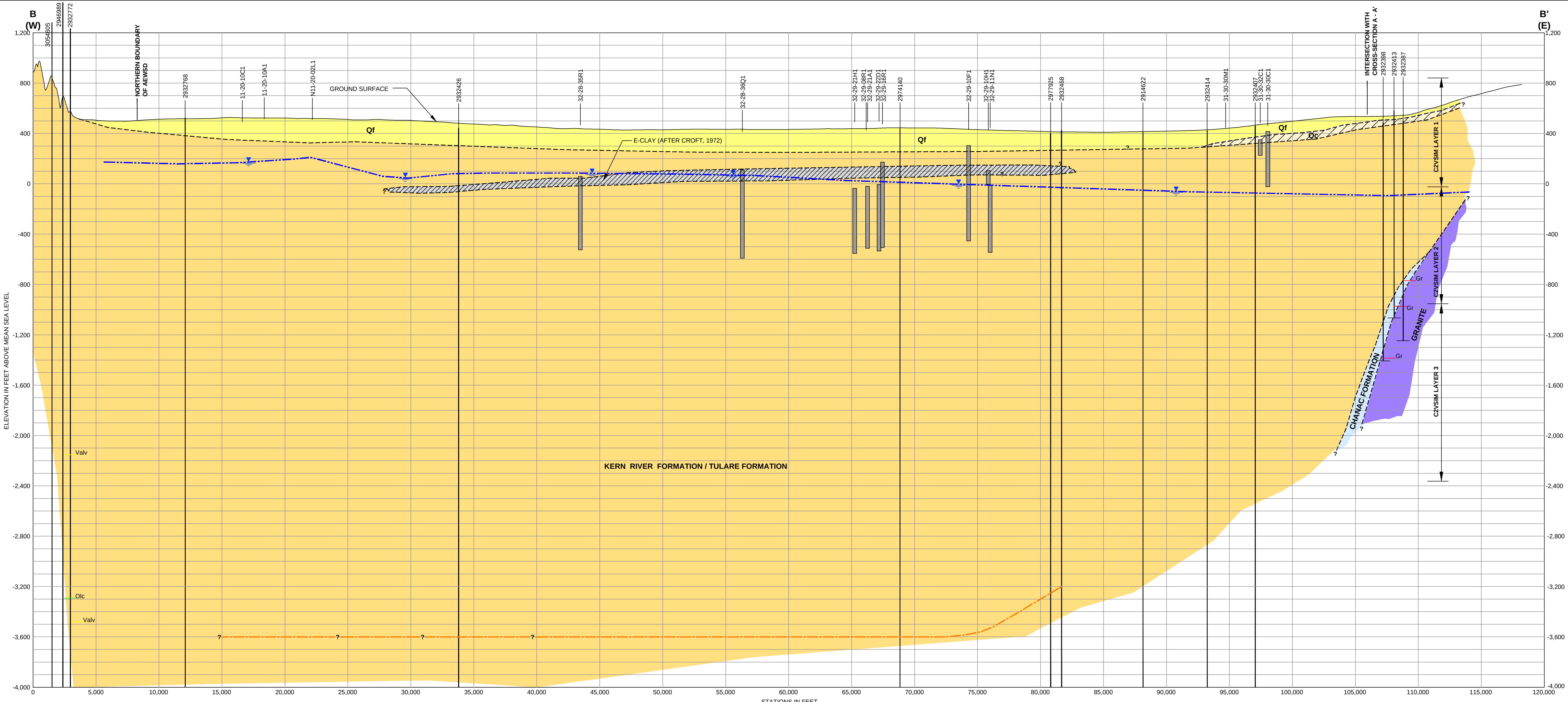




**Geologic Cross-Section A - A'**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, CA
July 2022
EKI C20055.00

eki environment & water

**Figure HCM-27**




## GEOLOGIC CROSS-SECTION B - B'

### LEGEND:

WATER WELLS

- 30-29-05H1
  - WELL IDENTIFICATION
  - SEQUENCE
  - TRACT
  - SECTION
  - RANGE
  - TOWNSHIP
- WELL CASING
  - UNKNOWN
  - SOIL
  - COARSE
  - MEDIUM
  - FINE
  - (GENERALIZED TEXTURE DERIVED FROM WELL LOGS)
- WELL SCREEN

OIL WELLS

- 29380075
  - OIL WELL IDENTIFICATION
  - API NUMBER
- Jw — NOTED FORMATION MARKER (SEE NOTE 5)
- TOTAL DEPTH

- C2VSIM LAYER
- FORMATION CONTACT
- GROUNDWATER ELEVATION FALL 2016
- BASE OF FRESH GROUNDWATER (AFTER PAGE, 1973)

SURFICIAL GEOLOGIC UNITS (SEE NOTE 2):

- Qsc
- Qf
- Qc
- Qp

SELECTED SUBSURFACE GEOLOGIC UNITS (SEE NOTE 3):

- E-CLAY
- CHANAC FORMATION
- SANTA MARGARITA FORMATION
- GRANITE

### ABBREVIATIONS:

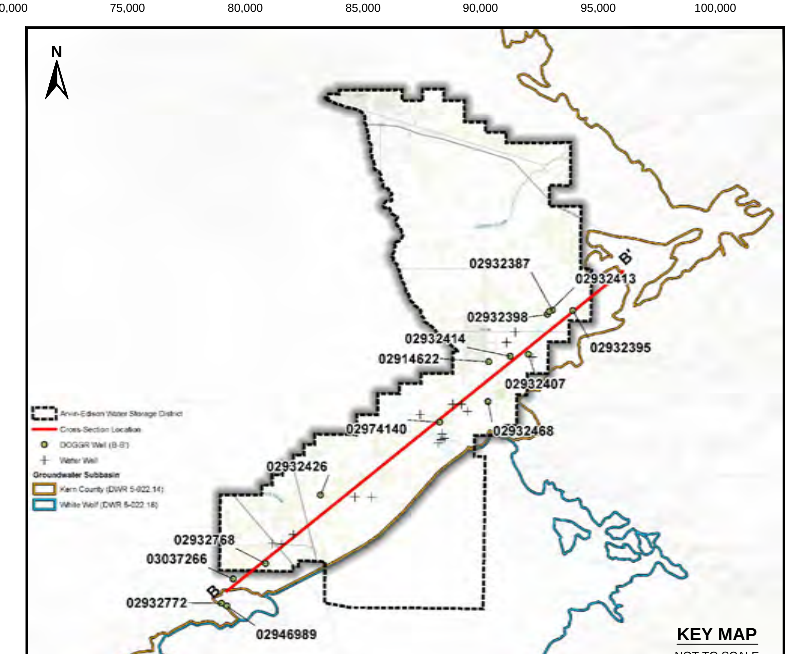
| | |
|---|---|
| AEWSD | = ARVIN-EDISON WATER STORAGE DISTRICT |
| API | = AMERICAN PETROLEUM INSTITUTE |
| C2VSIM | = CALIFORNIA CENTRAL VALLEY GROUNDWATER-SURFACE WATER SIMULATION MODEL |
| CDMG | = CALIFORNIA DIVISION OF MINES AND GEOLOGY |
| DOGGR | = DIVISION OF OIL, GAS & GEOTHERMAL RESOURCES |

### SOURCES:

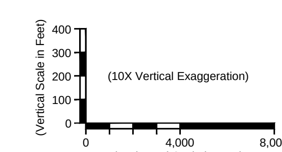

1. CDMG, 1964, CALIFORNIA DIVISION OF MINES AND GEOLOGY, GEOLOGIC MAP, OLAF P. JENKINS EDITION, BAKERSFIELD SHEET.
2. CROFT, 1972. CROFT, M.G., 1972, SUBSURFACE GEOLOGY OF THE LATE TERTIARY AND QUATERNARY WATER-BEARING DEPOSITS OF THE SOUTHERN PART OF THE SAN JOAQUIN VALLEY, CALIFORNIA, USGS WATER SUPPLY PAPER 1999-H, 29 PP.
3. BARTOW, 1984. BARTOW, J.A. TERTIARY STRATIGRAPHY OF THE SOUTHEASTERN SAN JOAQUIN VALLEY, CALIFORNIA, USGS BULLETIN 1529-J, 1984.
4. DOGGR OIL WELL RECORDS.
5. PAGE R.W., 1973. BASE OF FRESH GROUNDWATER (APPROXIMATELY 3,000 MICROMHOS) IN THE SAN JOAQUIN VALLEY, CALIFORNIA. USGS HYDROLOGIC INVESTIGATIONS ATLAS HA-489.


### NOTES:

1. WELL IDENTIFICATION BASED ON PUBLIC LAND SURVEY SYSTEM.
2. SURFICIAL GEOLOGY AS SHOWN ON CDMG (1964). SURFICIAL GEOLOGY MAP UNIT SYMBOLS ARE:
   - Qsc - RECENT STREAM CHANNEL DEPOSITS
   - Qf - RECENT FAN DEPOSITS
   - Qc - PLEISTOCENE NON-MARINE
   - Qp - PLIO-PLEISTOCENE NON-MARINE
3. SUBSURFACE GEOLOGIC UNITS BASED ON BARTOW (1984) & CROFT (1972) AND DOGGR OIL WELL RECORDS.
4. SEE FIGURE 8a FOR CROSS-SECTION LOCATION. WELLS SHOWN ON CROSS-SECTION ARE LOCATED WITHIN 1/2 MILE OF CROSS-SECTION LINE.
5. FORMATION MARKERS FROM DOGGR OIL WELL RECORDS INCLUDE: Ch (CHANNAC), SM (SANTA MARGARITA), Olc (OLCESE), Ed (EDISON), Jw ( JEWETT), Vd (VEDDER), Sch (SCHIST) AND Gr (GRANITE).




KEY MAP
NOT TO SCALE

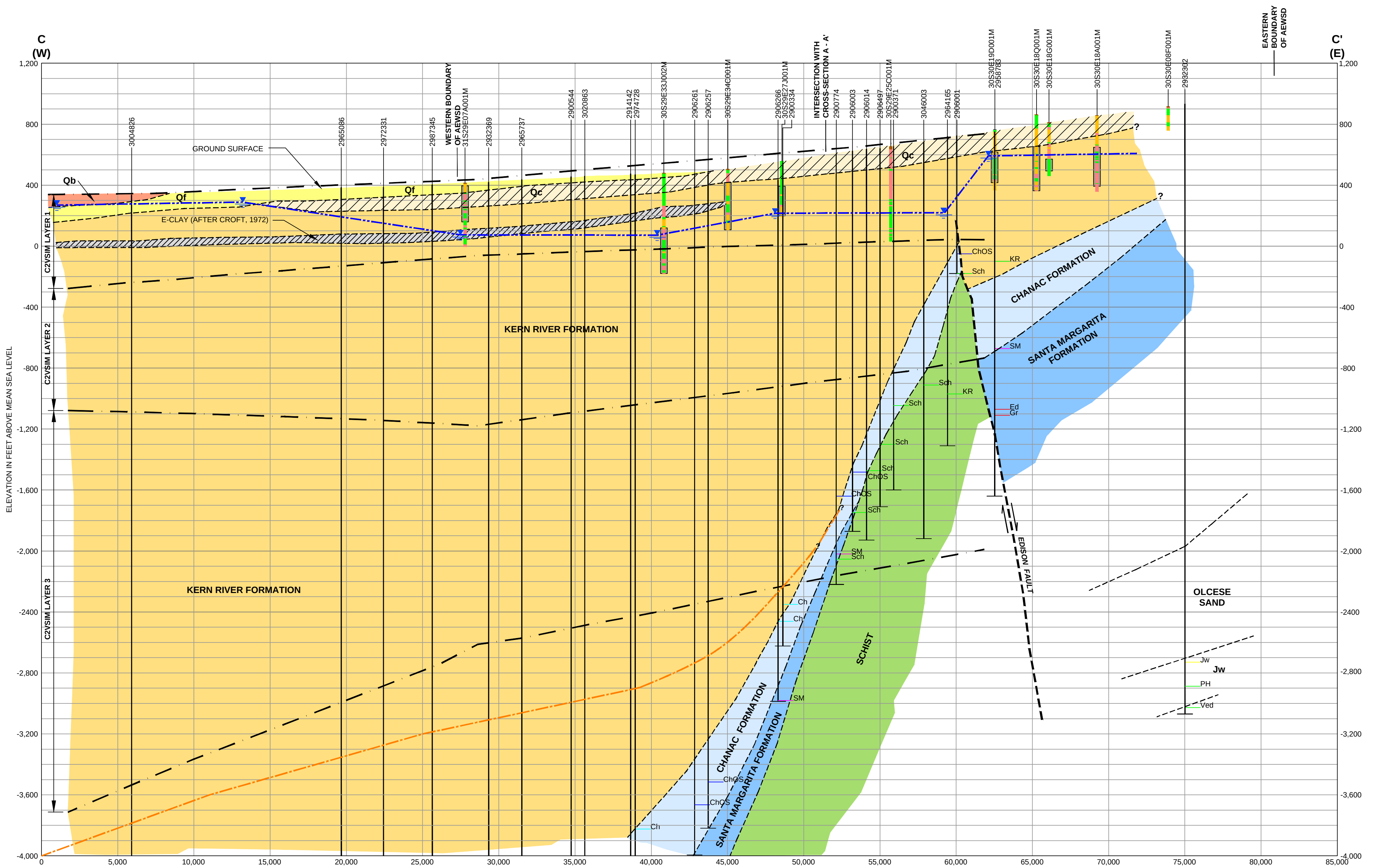



**Geologic Cross-Section B - B'**
**Arvin-Edison Management Area**

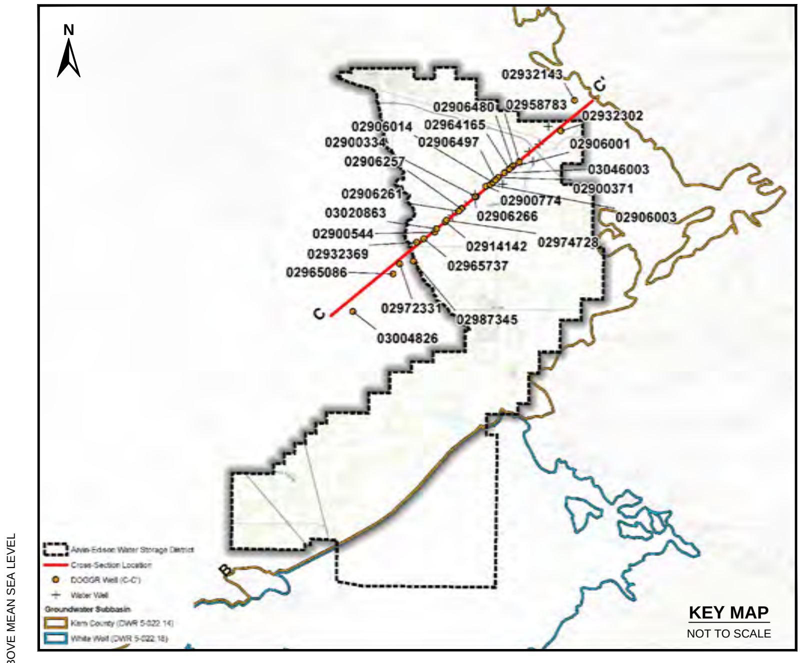
South of Kern River GSP
Kern County, CA
July 2022
EKI C20055.00

eki environment & water

**Figure HCM-28**




## GEOLOGIC CROSS-SECTION C - C'




### LEGEND:

WATER WELLS

- 30-29-05H1: WELL IDENTIFICATION, SEQUENCE, TRACT, SECTION, RANGE, TOWNSHIP
- WELL CASING
- UNKNOWN, SOIL, COARSE, MEDIUM, FINE: GENERALIZED TEXTURE DERIVED FROM WELL LOGS
- WELL SCREEN

OIL WELLS

- OIL WELL IDENTIFICATION
- 2938075: API NUMBER
- Jw: NOTED FORMATION MARKER (SEE NOTE 5)
- TOTAL DEPTH

- C2VSIM LAYER
- FORMATION CONTACT
- GROUNDWATER ELEVATION FALL 2016
- BASE OF FRESH GROUNDWATER (AFTER PAGE, 1973)

- Qsc, Qf, Qc, Qp, Qb: SURFICIAL GEOLOGIC UNITS (SEE NOTE 2)
- E-CLAY, CHANAC FORMATION, SANTA MARGARITA FORMATION, SCHIST: SELECTED SUBSURFACE GEOLOGIC UNITS (SEE NOTE 3)

### ABBREVIATIONS:

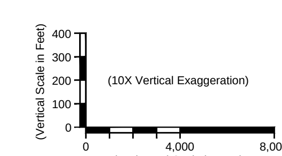
| | |
|---|---|
| AEWSD | = ARVIN-EDISON WATER STORAGE DISTRICT |
| API | = AMERICAN PETROLEUM INSTITUTE |
| C2VSIM | = CALIFORNIA CENTRAL VALLEY GROUNDWATER-SURFACE WATER SIMULATION MODEL |
| CDMG | = CALIFORNIA DIVISION OF MINES AND GEOLOGY |
| DOGGR | = DIVISION OF OIL, GAS & GEOTHERMAL RESOURCES |

### SOURCES:


1. CDMG, 1964, CALIFORNIA DIVISION OF MINES AND GEOLOGY, GEOLOGIC MAP, OLAF P. JENKINS EDITION, BAKERSFIELD SHEET.
2. CROFT, 1972. CROFT, M.G., 1972, 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, 29 PP.
3. BARTOW, 1984. BARTOW, J.A. TERTIARY STRATIGRAPHY OF THE SOUTHEASTERN SAN JOAQUIN VALLEY, CALIFORNIA, USGS BULLETIN 1529-J, 1984.
4. DOGGR OIL WELL RECORDS.
5. PAGE R.W., 1973. BASE OF FRESH GROUNDWATER (APPROXIMATELY 3,000 MICROMHOS) IN THE SAN JOAQUIN VALLEY, CALIFORNIA. USGS HYDROLOGIC INVESTIGATIONS ATLAS HA-489.


### NOTES:

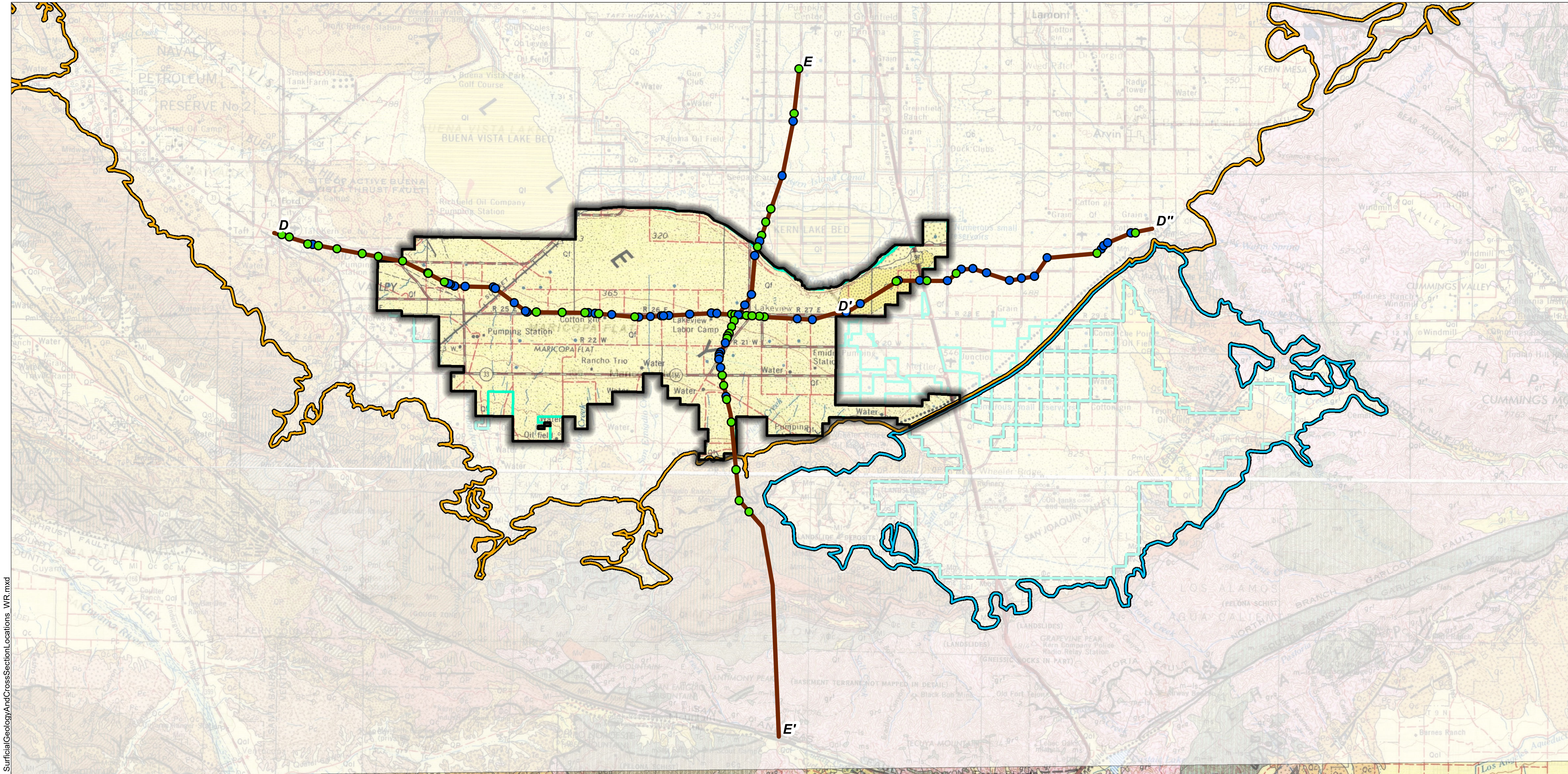
1. WELL IDENTIFICATION BASED ON PUBLIC LAND SURVEY SYSTEM.
2. SURFICIAL GEOLOGY AS SHOWN ON CDMG (1964). SURFICIAL GEOLOGY MAP UNIT SYMBOLS ARE:
   - Qsc - RECENT STREAM CHANNEL DEPOSITS
   - Qf - RECENT FAN DEPOSITS
   - Qc - PLEISTOCENE NON-MARINE
   - Qp - PLIO-PLEISTOCENE NON-MARINE
   - Qb - RECENT BASIN DEPOSITS
3. SUBSURFACE GEOLOGIC UNITS BASED ON BARTOW (1984) & CROFT (1972) AND DOGGR OIL WELL RECORDS.
4. SEE FIGURE 8a FOR CROSS-SECTION LOCATION. WELLS SHOWN ON CROSS-SECTION ARE LOCATED WITHIN 1/2 MILE OF CROSS-SECTION LINE.
5. FORMATION MARKERS FROM DOGGR OIL WELL RECORDS INCLUDE: Ch (CHANNAC), SM (SANTA MARGARITA), Olc (OLCESE), Ed (EDISON), Jw ( JEWETT), Vd (VEDDER), Sch (SCHIST) AND Gr (GRANITE).




**Geologic Cross-Section C - C'**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, CA
July 2022
EKI C20055.00

**Figure HCM-29**




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Cross Section Location

**Cross Section Data Point**

- Water Well (Completion Report or Electric Log)
- Oil Well Electric Log

## Geologic Units

| Symbol | Unit | Symbol | Unit | Symbol | Unit |
|---|---|---|---|---|---|
| Qs | Dune sand | Qal | Recent alluvium | Qsc | Quaternary Stream channel deposits |
| Qf | Quaternary fan deposits | Qb | Quaternary basin deposits | Ql | Quaternary lake deposits |
| Qt | Quaternary nonmarine terrace deposits | Qc | Pleistocene nonmarine | QP | Plio-Pleistocene nonmarine |
| Pc | Undivided Pliocene nonmarine | Pmlc | Middle and/or lower Pliocene nonmarine | Pml | Middle and/or lower Pliocene marine |
| Mc | Undivided Miocene nonmarine | Mu | Upper Miocene marine | Mv | Miocene volcanic |
| Mm | Middle Miocene marine | Ml | Lower Miocene marine | Φc | Oligocene nonmarine |
| Φ | Oligocene marine | E | Eocene marine | Ep | Paleocene marine |
| Tc | Tertiary nonmarine | bi | Mesozoic basic intrusive rocks | Ku | Upper Cretaceous marine |
| m ls | Pre-Cretaceous metamorphic rocks | ms | Pre-Cretaceous metasedimentary rocks | gr | Mesozoic granitic rocks |

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.

## Sources

1. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
2. WRMWSD cross section locations and data type provided by WRMWSD staff on 25 January 2018 (D-D'-D'') and 9 March 2018 (E-E').
3. Surface geology from California Division of Mines and Geology, Geologic Map of California, Olaf P. Jenkins Edition, Bakersfield Sheet (1964) and Los Angeles Sheet (1969).

N

0 4 8

(Scale in Miles)

**Surficial Geology and Cross Section Locations**
**Wheeler Ridge-Maricopa Management Area**

eki environment & water

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

**Figure HCM-30**

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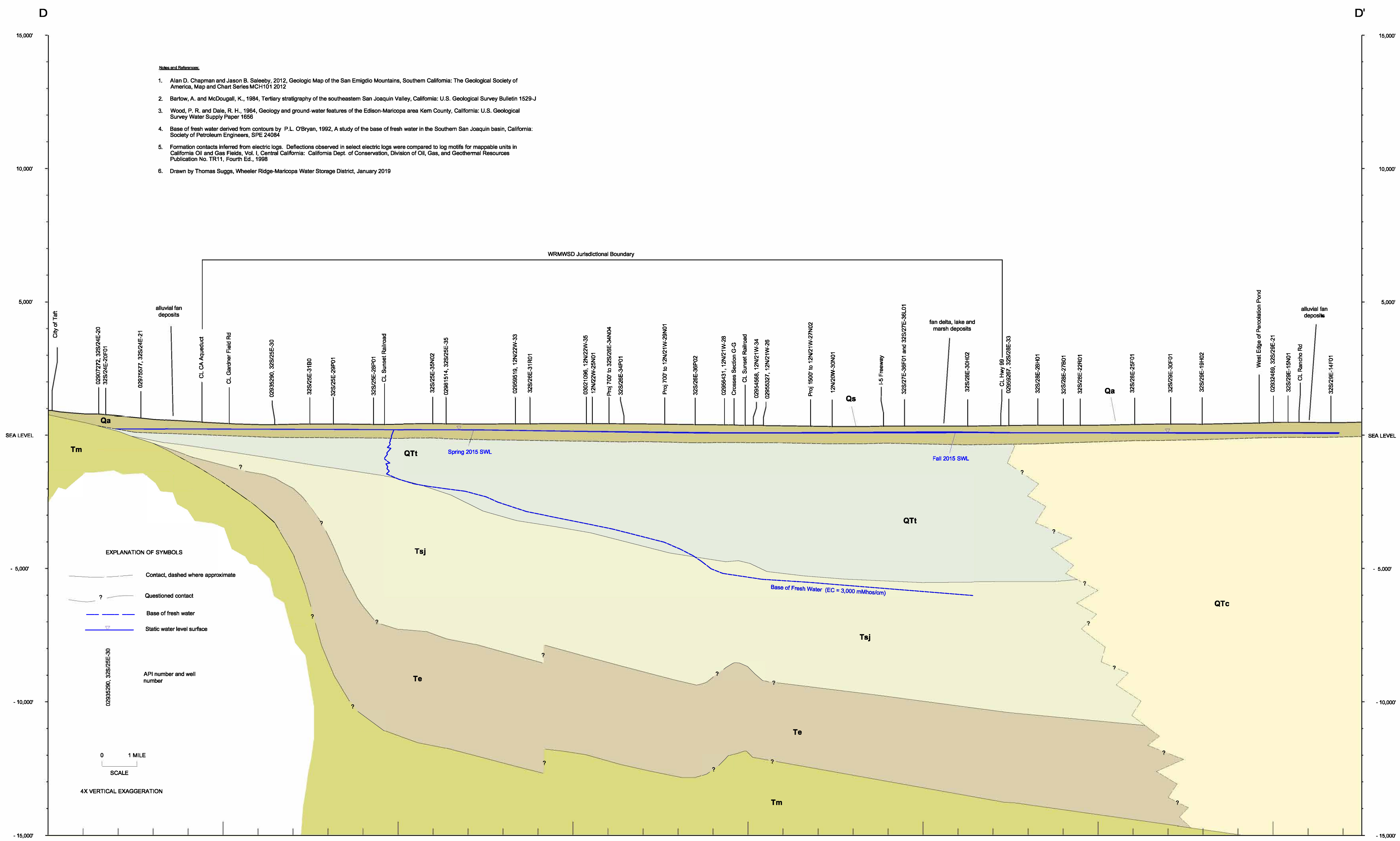
# Figure HCM-31 Geologic Cross-Section D-D’

**July 2022**




Notes and References:

1. Alan D. Chapman and Jason B. Saleeby, 2012, Geologic Map of the San Emigdio Mountains, Southern California: The Geological Society of America, Map and Chart Serles MCH101 2012
2. Bartow, A. and McDougall, K., 1984, Tertiary stratigraphy of the southeastern San Joaquin Valley, California: U.S. Geological Survey Bulletin 1529-J
3. Wood, P. R. and Dale, R. H., 1964, Geology and ground-water features of the Edison-Maricopa area Kern County, Callfornla: U.S. Geological Survey Water Supply Paper 1656
4. Base of fresh water derived from contours by P.L. O'Bryan, 1992, A study of the base of fresh water in the Southern San Joaquin basin, California: Society of Petroleum Engineers, SPE 24084
5. Formation contacts inferred from electric logs. Deflections observed in select electric logs were compared to log motifs for mappable units in California Oil and Gas Fieids, Vol. I, Central California: California Dept. of Conservation, Division of Oil, Gas, and Geothermal Resources Publication No. TR11, Fourth Ed., 1998
6. Drawn by Thomas Suggs, Wheeler Ridge-Maricopa Water Storage District, January 2019

GEOLOGIC CROSS SECTION D-D', SAN JOAQUIN VALLEY, CALIFORNIA

**Qs** — **Sand dunes** (Holocene) Windblown sand and dune sand

**Qa** — **Undifferentiated Surficial Deposits** (Pleistocene - Holocene) Unconsolidated to cemented, oxidized silt, sand, and gravel, cobbles, boulders, and minor clay; equivalent to the older alluvial fan, tilted alluvial fan, younger alluvium, flood basin deposits, and terrace deposits of Wood and Dale (1964)

**QTt** — **Tulare Formation** (Pliocene - Pleistocene) Mostly unconsolidated clay, sand, pebble gravel with some beds of sandstone and conglomerate derived from both west-side and east-side sources; alluvial fan, flood plain, deltalc, lacustrlne, and marsh deposits; Includes Corcoran clay member

**Tsj** — **San Joaquin Formation** (Pliocene) Silt and clay beds alternating with beds of sandstone and conglomerate; contains marine, brackish water and nonmarine fossils

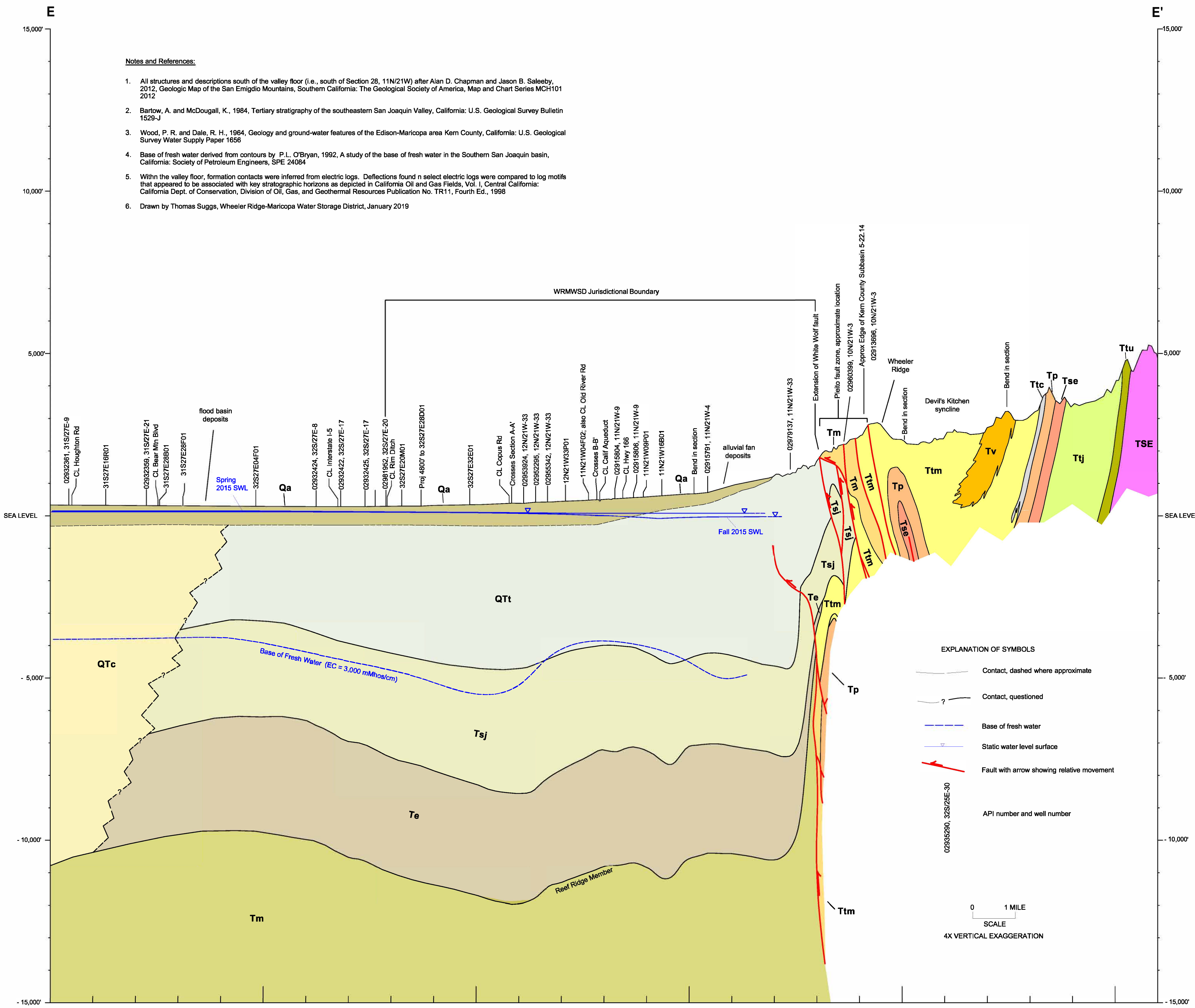
**Te** — **Etchegoin Formation** (Miocene - Pliocene) Marine and terrestrial sandstone, conglomerate, and claystone, tan to greenish gray, friable, fossiliferous

**QTc** — **Kern River Formation / Chanac Formation** (Miocene - Pleistocene) Unconsolidated to semiconsolidated, generally poorly sorted clay, silt, sand, and gravel derived from the Sierra Nevada and Tehachapi Mountains; flluvial and alluvial deposits; grades westward into continental and marine deposits of Tulare, San Joaquin and Etchegoin formations

**Tm** — **Monterey Formation** (Miocene) Marine biogenic shale, lithified, siliceous to semi-siliceous, gray to white, platy to fissile

# Figure HCM-32 Geologic Cross-Section E-E’

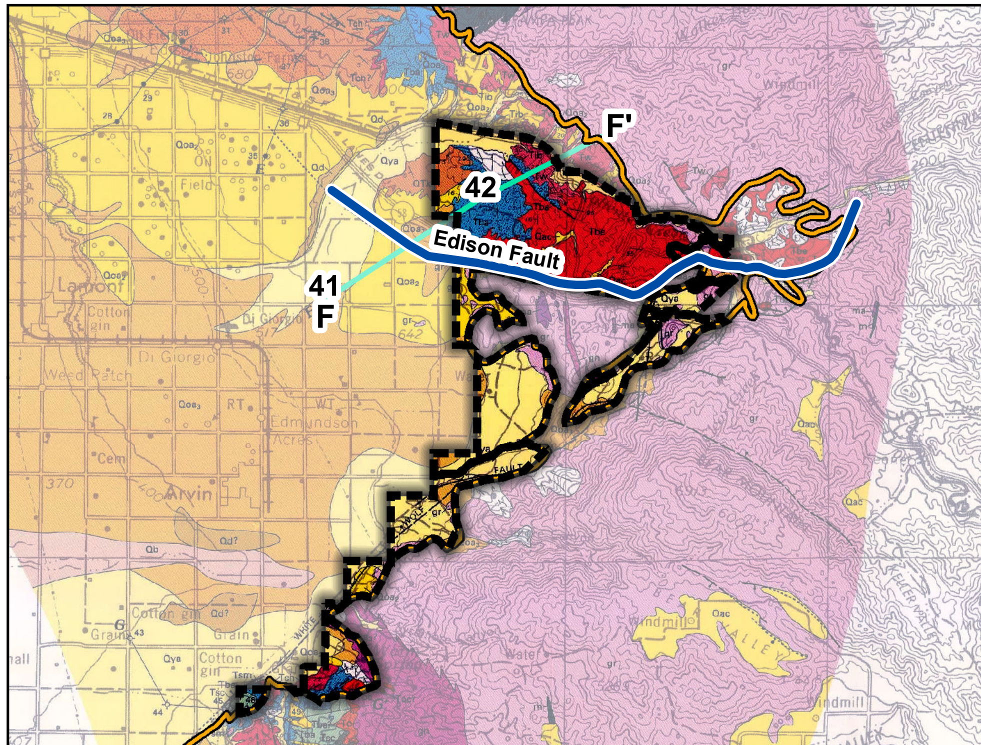
**July 2022**

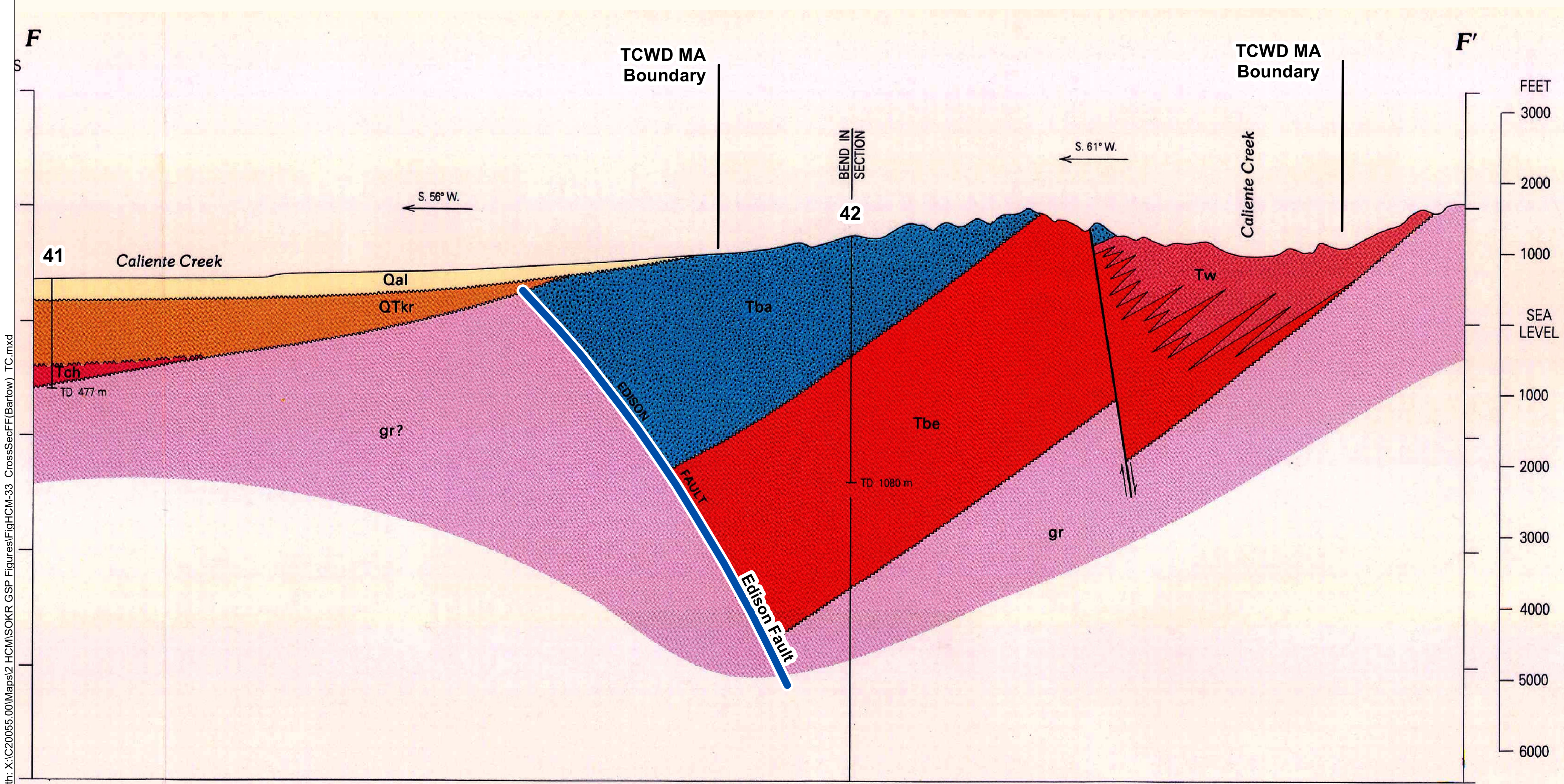



GEOLOGIC CROSS SECTION E-E', SAN JOAQUIN VALLEY, CALIFORNIA

| | |
|---|---|
| Qa | **Undifferentiated Surficial Deposits** (Pleistocene - Holocene) Unconsolidated to cemented, oxidized silt, sand, and gravel, cobbles, boulders, and minor clay; equivalent to the older alluvial fan, tilted alluvial fan, younger alluvium, flood basin deposits, and terrace deposits of Wood and Dale (1964) |
| QTc | **Kern River Formation / Chanac Formation** (Miocene - Pleistocene) Unconsolidated to semiconsolidated, generally poorly sorted clay, silt, sand, and gravel derived from the Sierra Nevada and Tehachapi Mountains; flluvial and alluvial deposits; grades westward into continental and marine deposits of Tulare, San Joaquin and Etchegoin formations |
| QTt | **Tulare Formation** (Pliocene - Pleistocene) Mostly unconsolidated clay, sand, pebble gravel with some beds of sandstone and conglomerate derived from both west-side and east-side sources; alluvial fan, flood plain, deltaic, lacustrine, and marsh deposits; includes Corcoran clay member |
| Tsj | **San Joaquin Formation** (Pliocene) Silt and clay beds alternating with beds of sandstone and conglomerate; contains marine, brackish water and nonmarine fossils |
| Te | **Etchegoin Formation** (Miocene - Pliocene) Marine and terrestrial sandstone, conglomerate, and claystone, tan to greenish gray, friable, fossiliferous |
| Tm | **Monterey Formation** (Miocene) Marine biogenic shale, lithified, siliceous to semi-siliceous, gray to white, platy to fissile |
| Ttm | **Temblor Formation** (Lower Miocene) Marine shale to sandstone |
| Tv | **Volcanic Rocks** (Lower Miocene) Extrusive basalt, olivine basalt, diabase, andesite, and dacite with fine feldspar phenocrysts, black to tan and light gray, massive |
| Ttc | **Tecuya Formation** (Lower Miocene - Oligocene) Marine variegated red, green, and gray sandstone, clay and conglomerate of granite, quartzite, and marble detritus |
| Tp | **Pleito Formation** (Lower Miocene - Oligocene) Marine claystone to sandstone, similar in composition to Ttm |
| Tse | **San Emlgdlo Formation** (Upper Eocene?) Marine claystone to siltstone |
| Ttj Ttu | **Tejon Formation** (Eocene - Paleocene?) Ttj (Metralla Sandstone and Liveoak Shale Members) Tts (Uvas Member) |
| TSE | **Undiffentiated Tehachapi - San Emigdio Complex** |

# Cross Section F - F'




## Legend

- Tejon-Castac Water District GSA
- Kern County Subbasin (DWR 5-022.14)
- Cross-Section Location
- Edison Fault

**Geologic Units**

- Qal — Alluvium Undivided (Holocene & Pleistocene)
- Qya — Younger Alluvium (Holocene & Upper Pleistocene)
- Qoa — Older Alluvium (Pleistocene) - Low Terraces
- Qoa — Older Alluvium (Pleistocene) - High Terraces
- Qoa — Older Alluvium (Pleistocene) - Dissected Fans
- QTkr — Kern River Formation
- Tch — Chanac Formation
- Tsm — Santa Margarita Formation
- Tba — Bena Gravel - Alluvial Fan Facies
- Tbp — Bena Gravel - Paralic Facies
- Tes — Edison Shale
- Trm — Round Mountain Silt
- To — Olcese Sand
- Tf — Freeman Silt
- Tj — Jewett Sand
- Tbe — Bealville Fanglomerate
- Tv — Vedder Sand
- Tw — Walker Sand
- gr — Granitic Rocks (Pre-Upper Cretaceous)
- br — Basement Rocks (Pre-Upper Cretaceous)

**Abbreviations**

DWR = California Department of Water Resources

**Notes**

1. All locations are approximate.

**Sources**

1. Bartow, J. Alan, 1984. Geologic Map and Cross Sections of the Southeastern Margin of the San Joaquin Valley, California, U.S. Geological Survey, Miscellaneous Investigation Series, Map I-1496.

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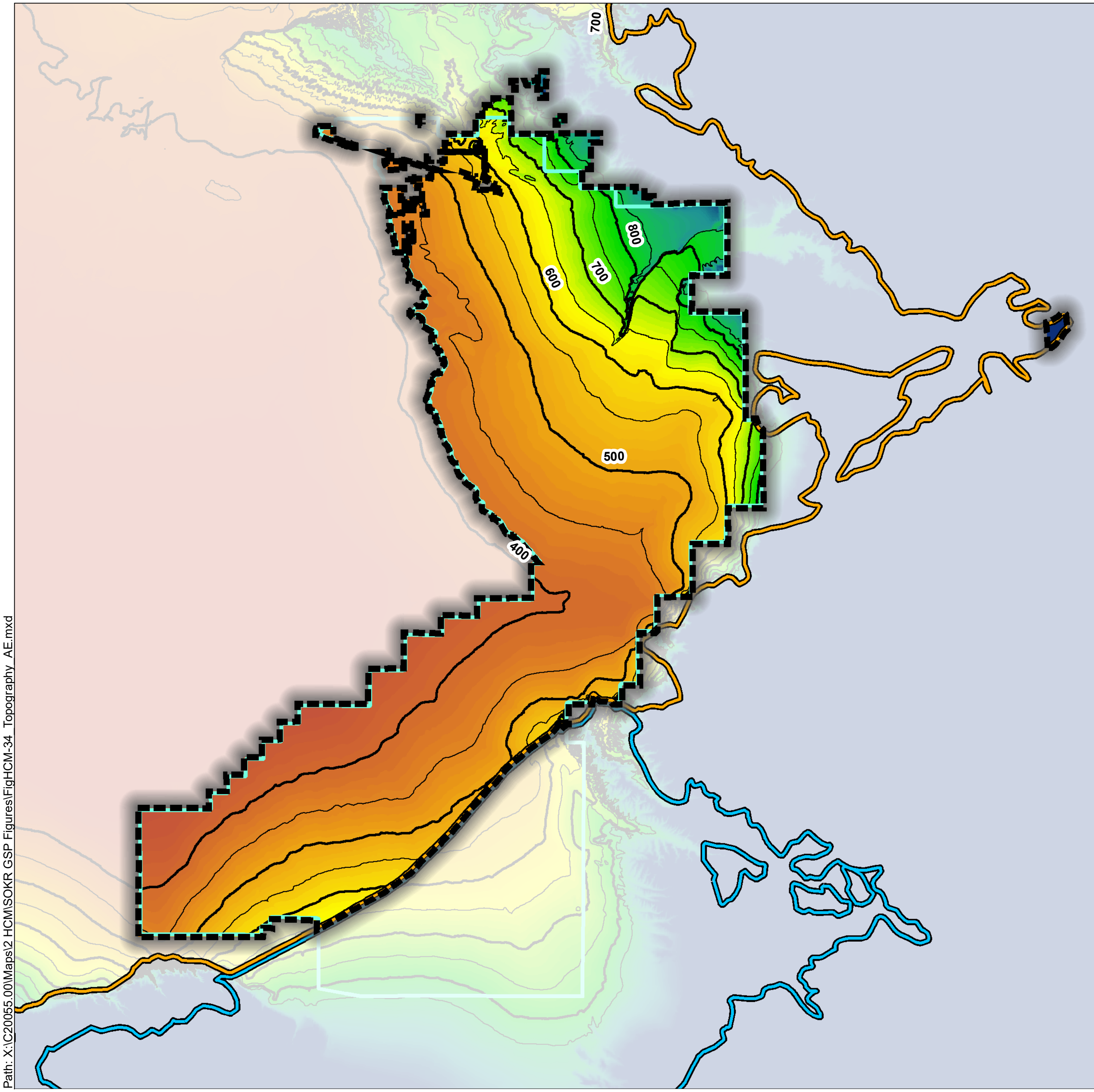
**Geologic Cross-Section (after Bartow, 1984)**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-33**




## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

Elevation Contour

**Land Surface Elevation (ft msl)**

High : 1100

Low : 330

## Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
NED = National Elevation Dataset
USGS = United States Geological Survey

## Notes

1. All locations are approximate.
2. Color scale is based on maximum and minimum elevations within the Arvin-Edison Management Area.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. Surface elevation data obtained from USGS NED (https://viewer.nationalmap.gov/basic/).

N 0 5 10

Miles

**Topography**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-34**

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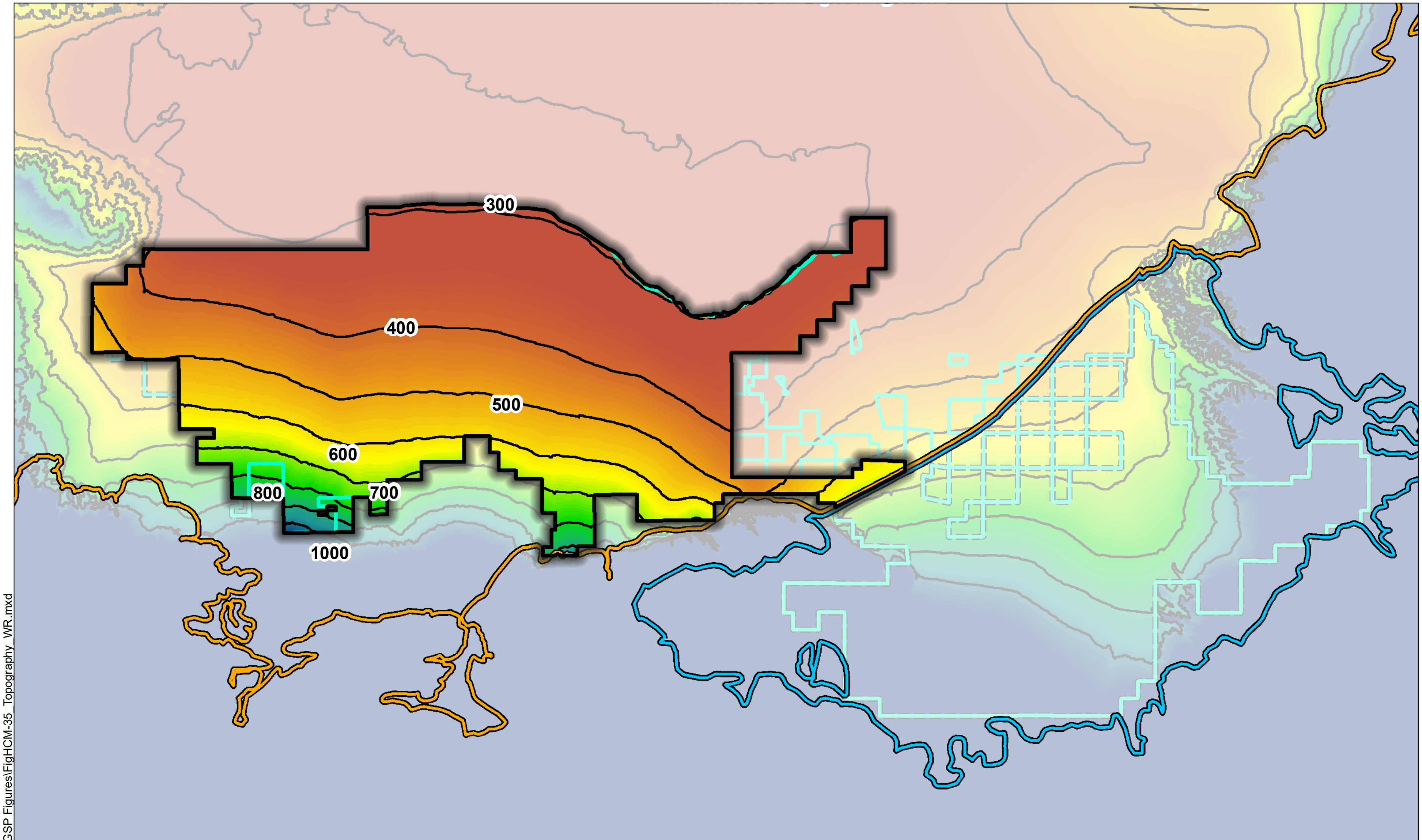


Legend
- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- Elevation Contour (100-ft interval)

**Groundwater Subbasin**
- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Land Surface Elevation (ft msl)**
High : 1100
Low : 330

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft msl | = feet above mean sea level |
| GSA | = Groundwater Sustainability Agency |
| NED | = National Elevation Dataset |
| USGS | = United States Geological Survey |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Notes
1. All locations are approximate.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 2 June 2022.
2. Surface elevation data obtained from USGS NED (https://viewer.nationalmap.gov/basic/).

N 0 5 10 (Scale in Miles)

**Topography**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-35**

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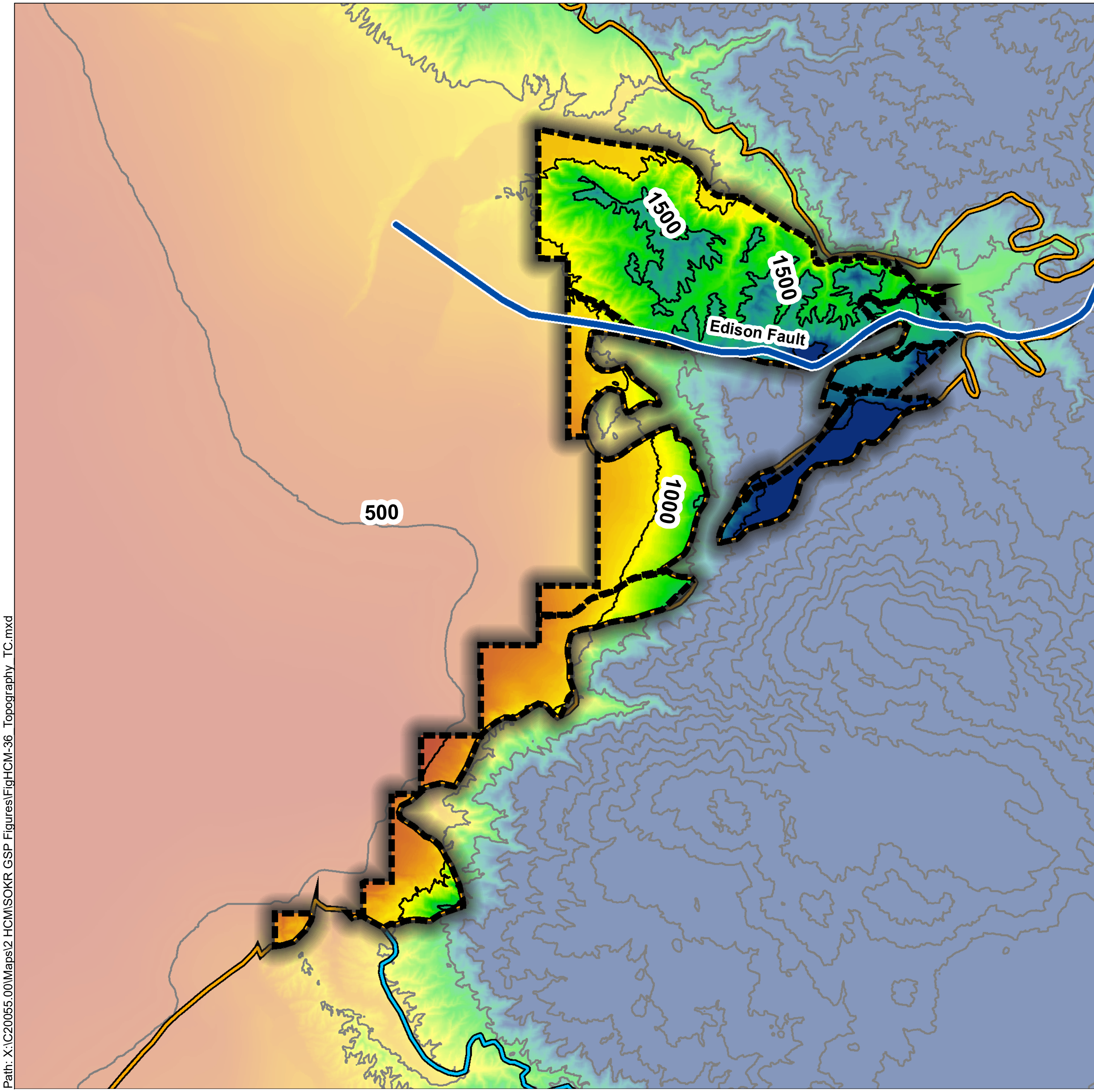


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Legend

Tejon-Castac Water District GSA

Elevation Contour (ft msl)

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Land Surface Elevation (ft msl)**

>2,000

400

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
NED = National Elevation Dataset
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. Color scale is based on maximum and minimum elevations within the Tejon-Castac Water District Management Area.

Sources

1. Surface elevation data obtained from USGS NED (https://viewer.nationalmap.gov/basic/).

N 0 3 6

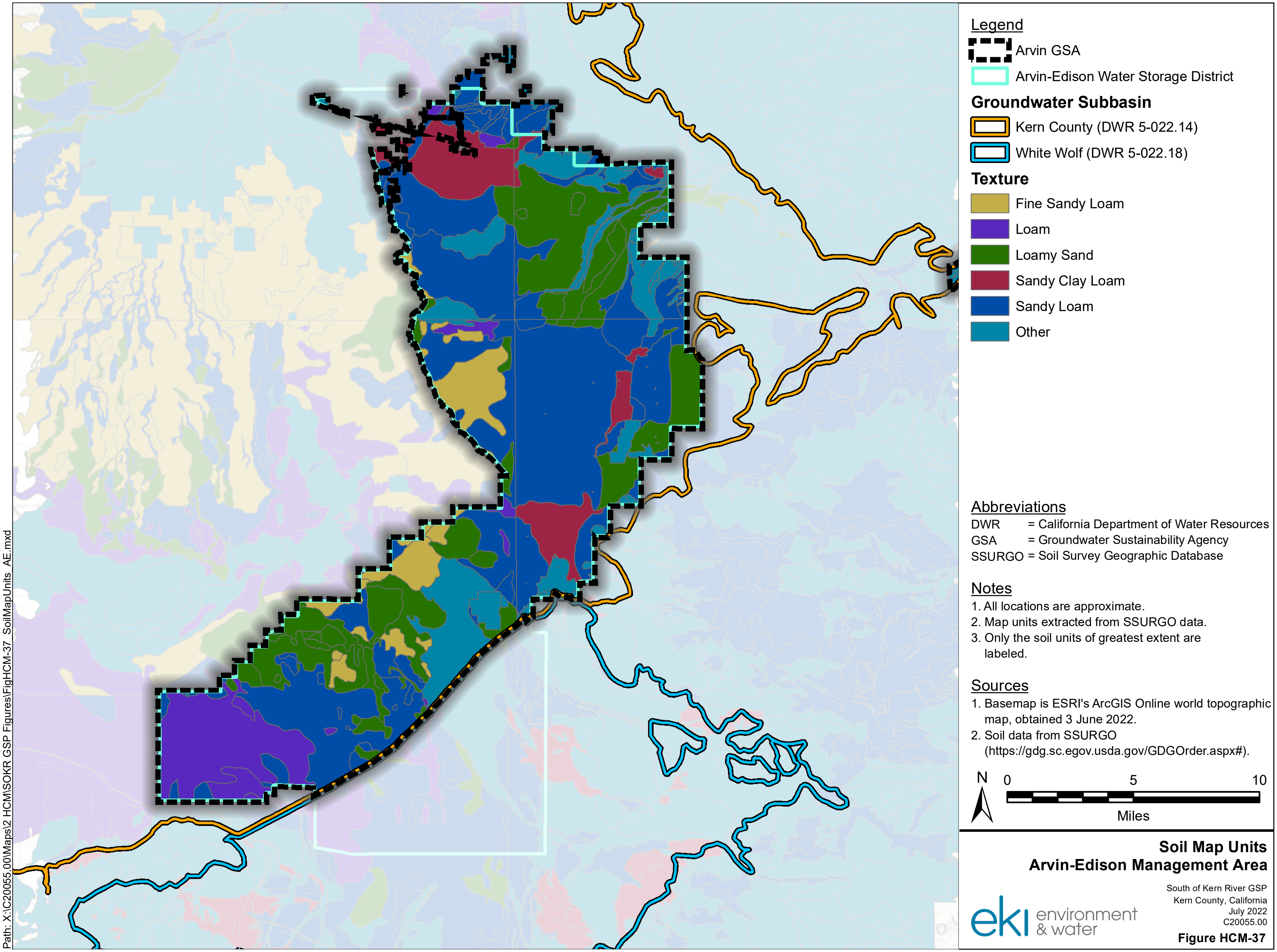
Miles

**Topography**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

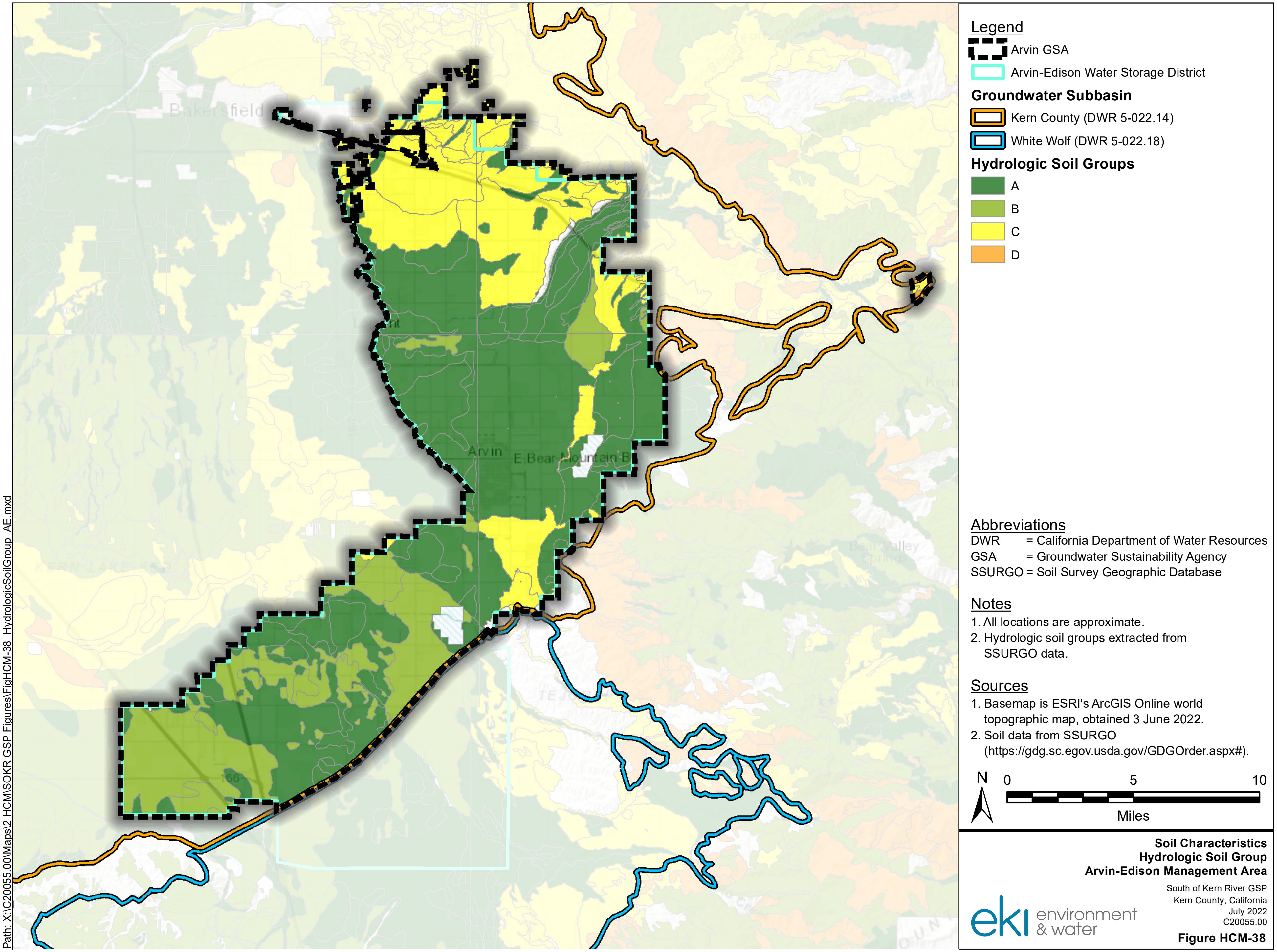
eki environment & water

**Figure HCM-36**

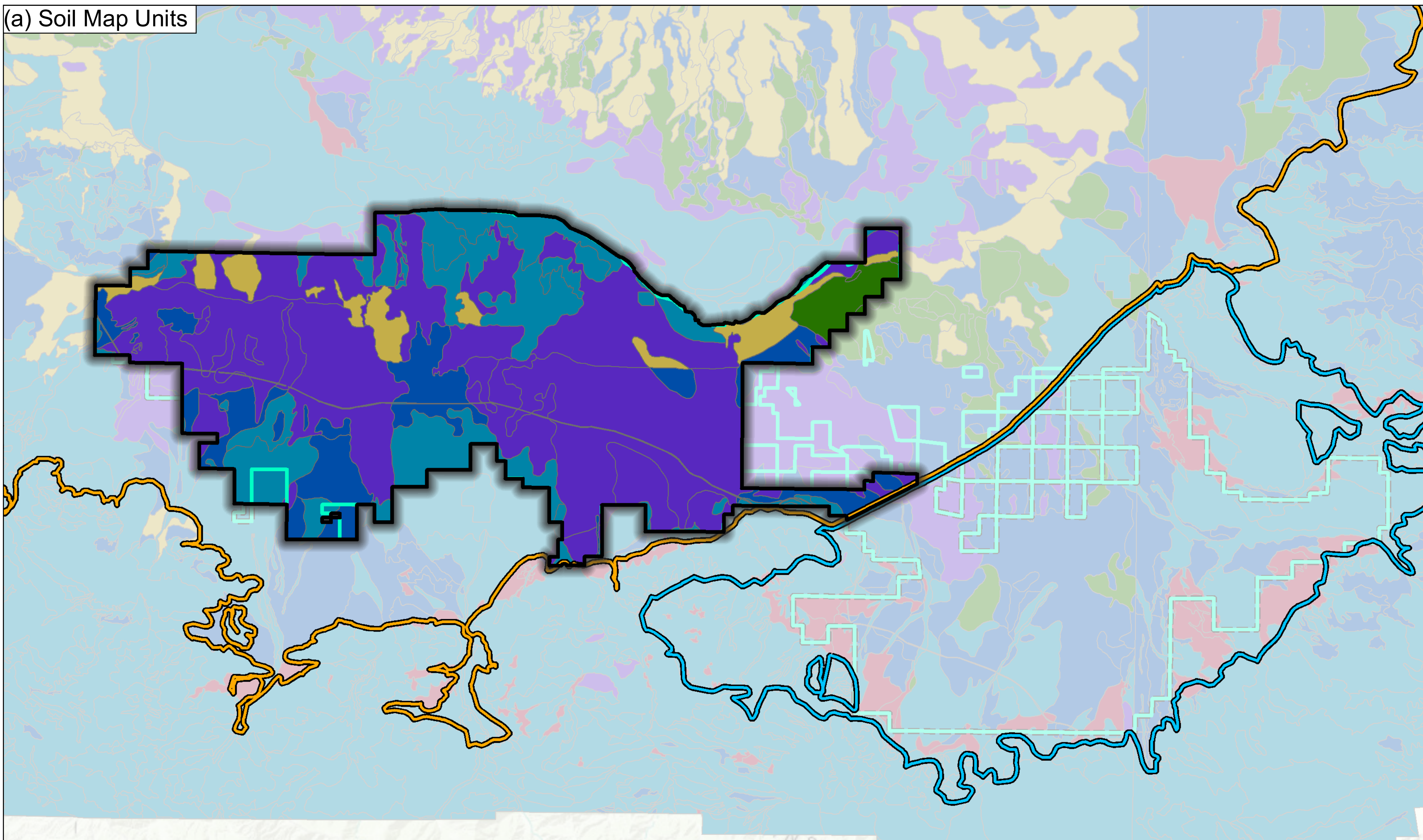


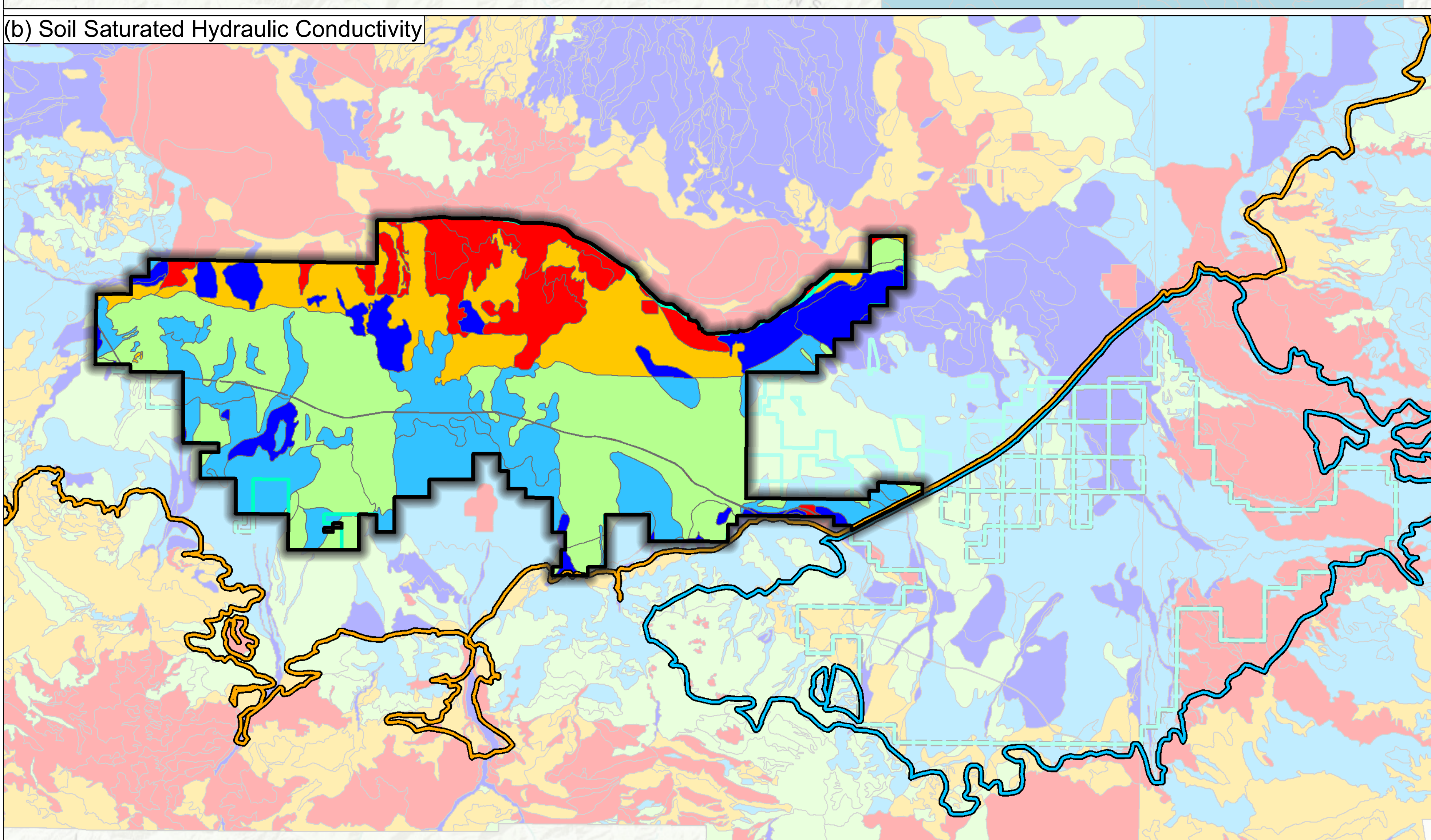

**Soil Map Units**
**Arvin-Edison Management Area**

**Figure HCM-37**




Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-38_HydrologicSoilGroup_AE.mxd




Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Texture**

- Fine Sandy Loam
- Loam
- Loamy Sand
- Sandy Clay Loam
- Sandy Loam
- Other

**Soil Saturated Hydraulic Conductivity (in/hr)**

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

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| in/hr | = inches/hour |
| NRCS | = Natural Resources Conservation Service |
| SSURGO | = Soil Survey Geographic Database |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Notes

1. All locations are approximate.
2. Map units extracted from SSURGO data.
3. Only the soil units of greatest extent are included in their own category. Additonal soil units grouped as "Other".

N 0 4 8 (Scale in Miles)

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Soil data from SSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

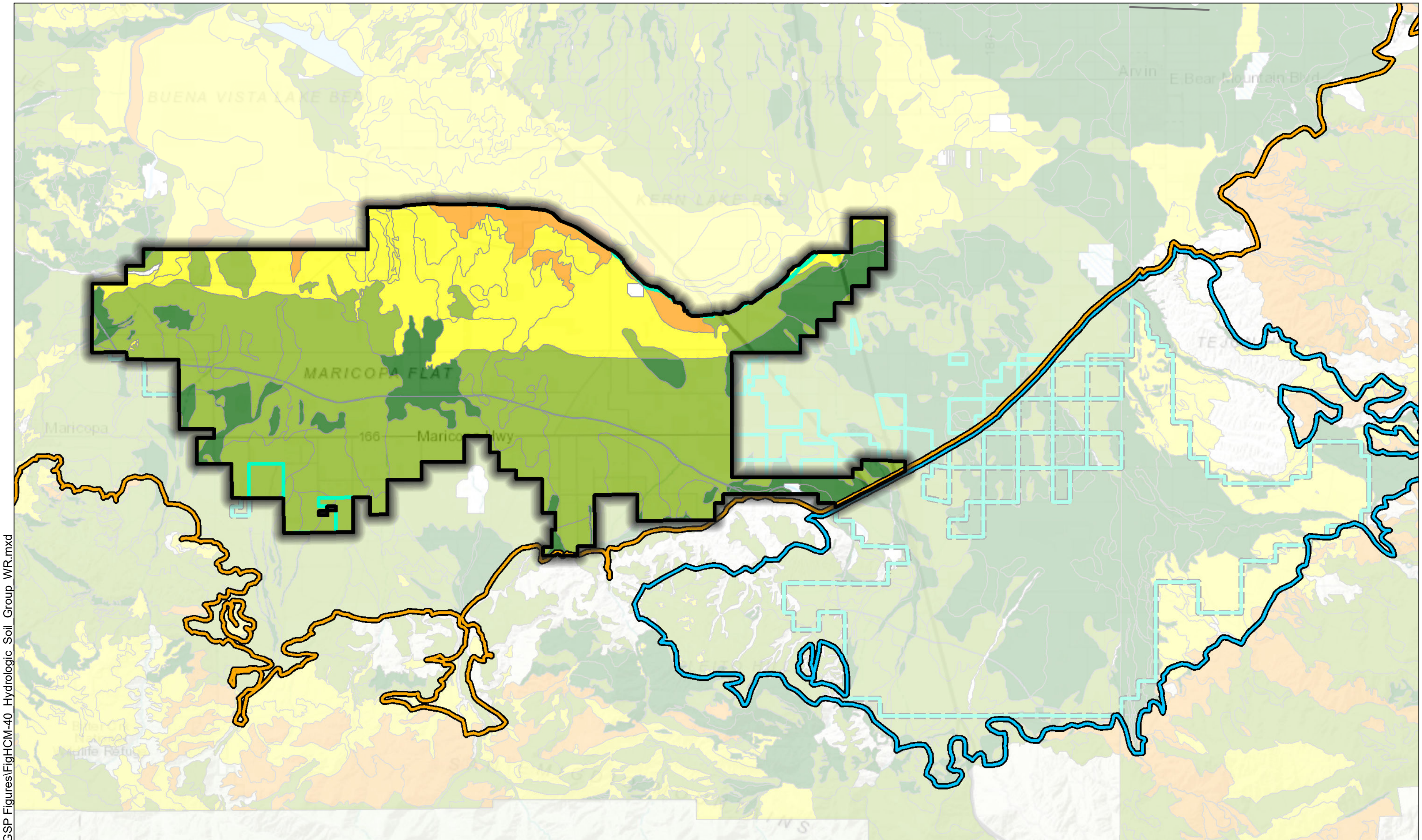
**Soil Map Units and Saturated Hydraulic Conductivity**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure HCM-39**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\Fig HCM-39_SoilMapUnits_Ksat_WR.mxd




Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-40 Hydrologic Soil Group WR.mxd

## Legend

Wheeler Ridge-Maricopa GSA

Wheeler Ridge-Maricopa Water Storage District

WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Hydrologic Soil Groups**

A

B

C

D

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
SSURGO = Soil Survey Geographic Database
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. Hydrologic soil groups extracted from SSURGO data.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Soil data from SSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

N

0 5 10

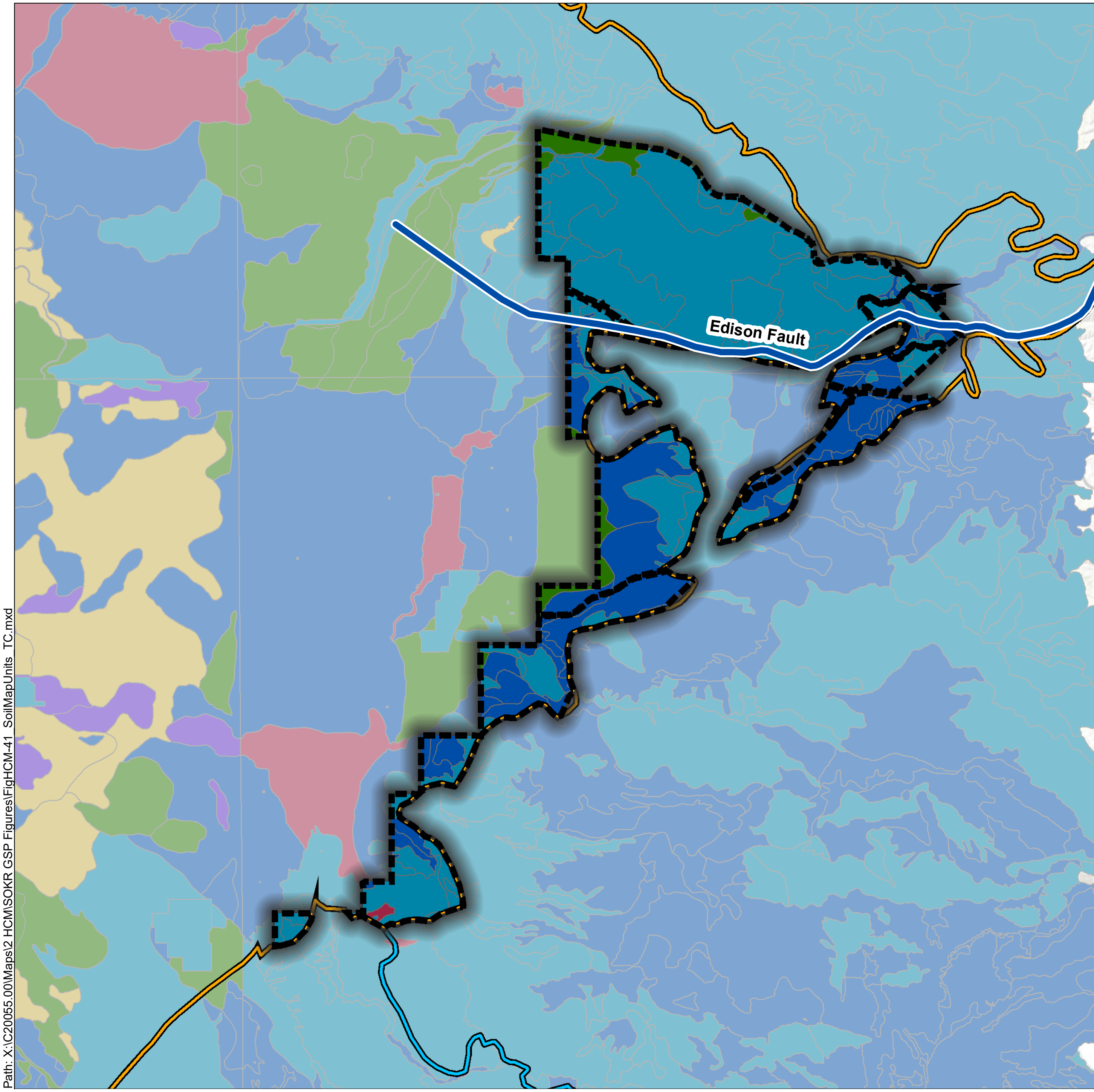
(Scale in Miles)

**Hydrologic Soil Group**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-40**




## Legend

Tejon-Castac Water District GSA

Edison Fault

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Texture**

Fine Sandy Loam

Loam

Loamy Sand

Sandy Clay Loam

Sandy Loam

Other (Complex, Association)

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
SSURGO = Soil Survey Geographic Database

## Notes

1. All locations are approximate.
2. Map unit textures extracted from SSURGO data.

## Sources

1. SSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

N 0 3 6 Miles

**Soil Map Units - Texture**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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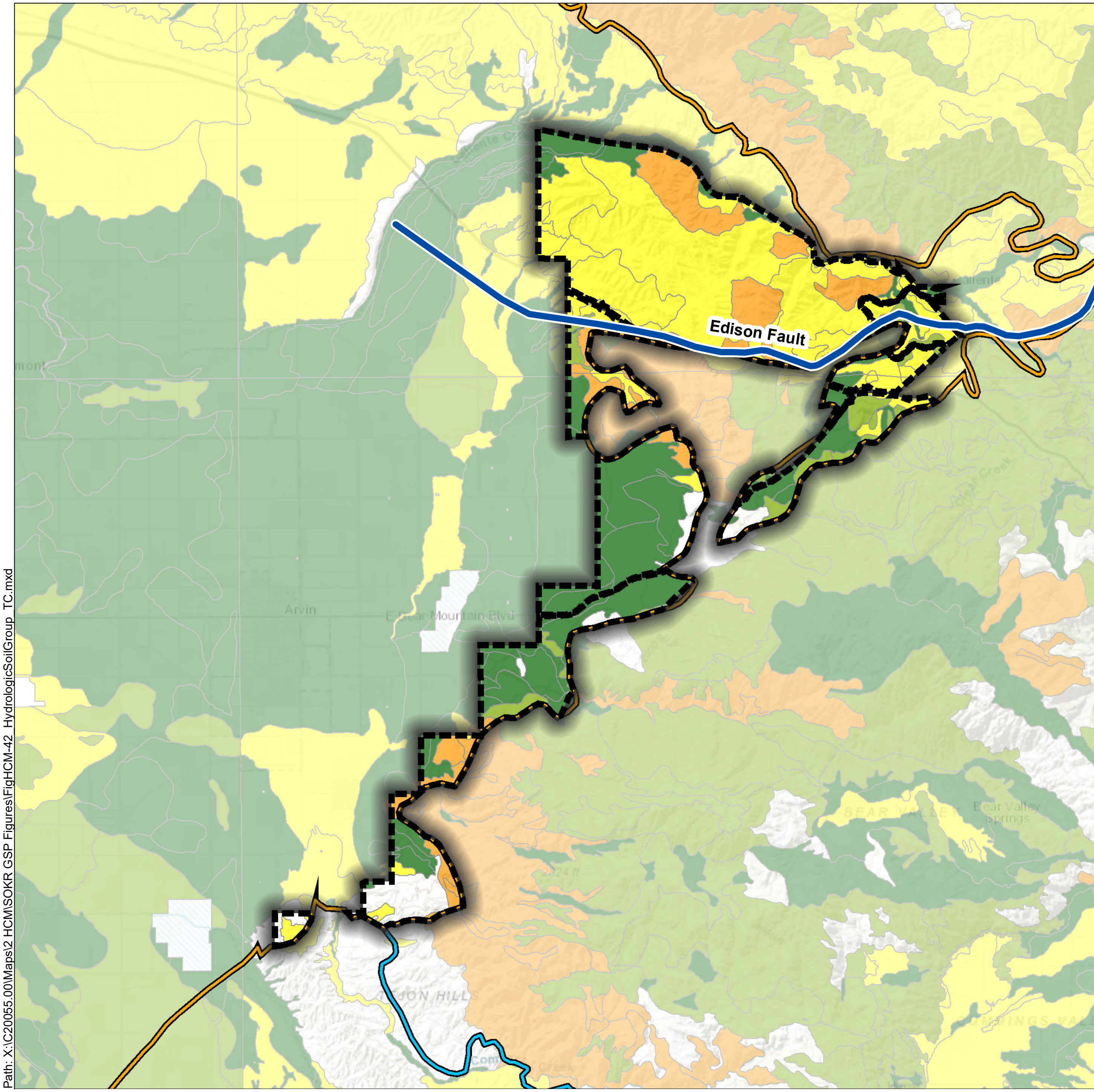
**Figure HCM-41**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-41_SoilMapUnits_TC.mxd




## Legend

Tejon-Castac Water District GSA

Edison Fault

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Hydrologic Soil Groups**

A

B

C

D

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
SSURGO = Soil Survey Geographic Database

## Notes

1. All locations are approximate.
2. Hydrologic soil groups extracted from SSURGO data.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. SSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

N 0 3 6 Miles

**Soil Characteristics-Hydrologic Soil Group**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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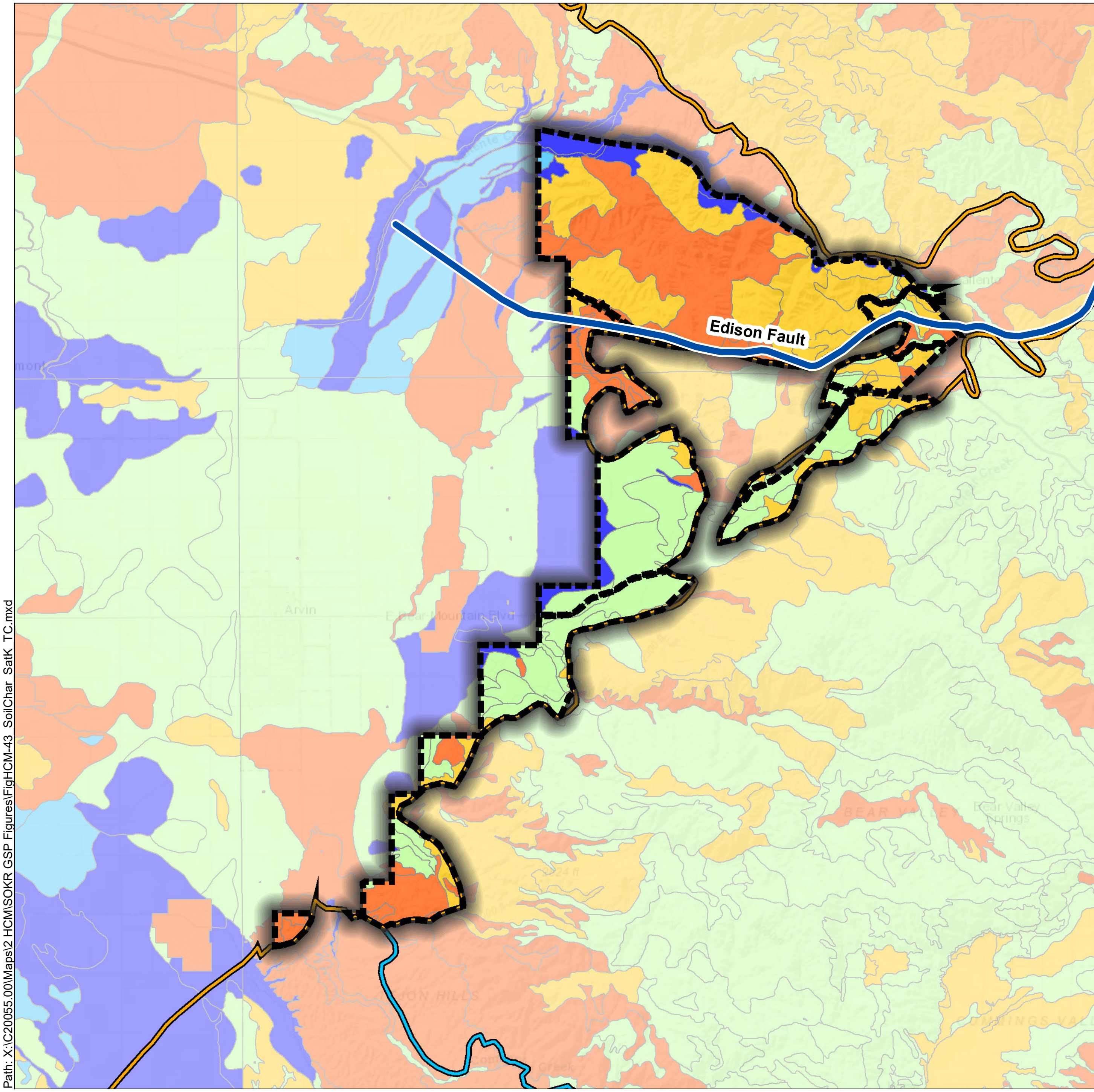
**Figure HCM-42**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-42_HydrologicSoilGroup_TC.mxd




## Legend

Tejon-Castac Water District GSA

Edison Fault

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Soil Saturated Hydraulic Conductivity (in/hr)**

0 - 10

> 10 and ≤ 20

> 20 and ≤ 30

> 30 and ≤ 40

> 40

## Abbreviations

GSA = Groundwater Sustainability Agency
in/hr = inches per hour
SSURGO = Soil Survey Geographic Database

## Notes

1. All locations are approximate.
2. Saturated hydraulic conductivity extracted from SSURGO data.

## Sources

1. SSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

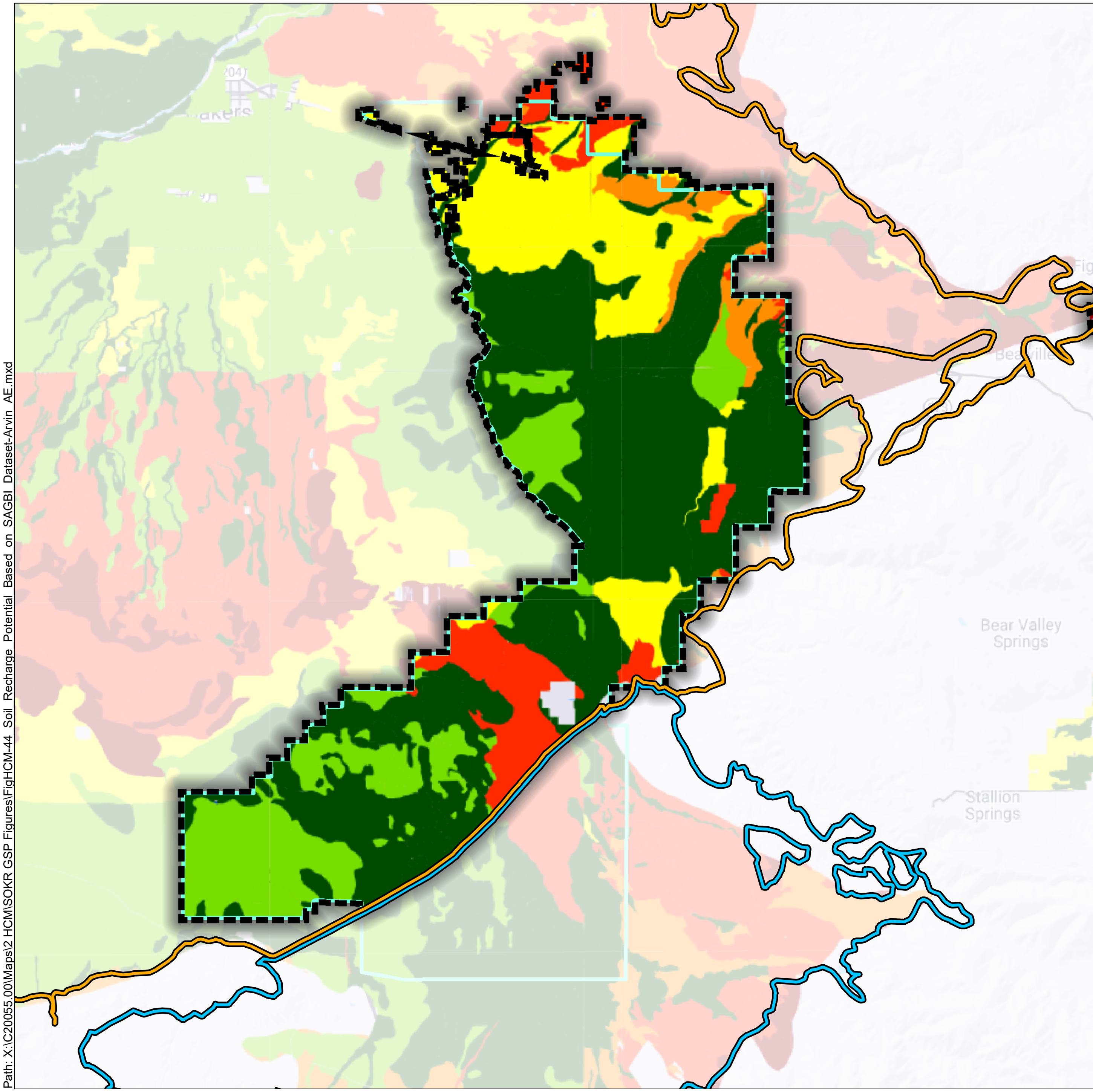
N 0 3 6
Miles

**Soil Characteristics-**
**Saturated Hydraulic Conductivity**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure HCM-43**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-43_SoilChar_SatK_TC.mxd




Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-44 Soil Recharge Potential Based on SAGBI Dataset-Arvin AE.mxd

**Legend**

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**SAGBI Rating**

Excellent

Good

Moderately Good

Moderately Poor

Poor

Very Poor

**Abbreviations**

DWR = California Department of Water Resources

GSA = Groundwater Sustainability Agency

SAGBI = Soil Agricultural Groundwater Banking Index

**Notes**

1. All locations are approximate.
2. The SAGBI dataset is a spatial mapping of a suitability index for groundwater recharge on agricultural land, based on five key factors: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

**Sources**

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. SAGBI data from https://casoilresource.lawr.ucdavis.edu/sagbi/.

N 0 5 10

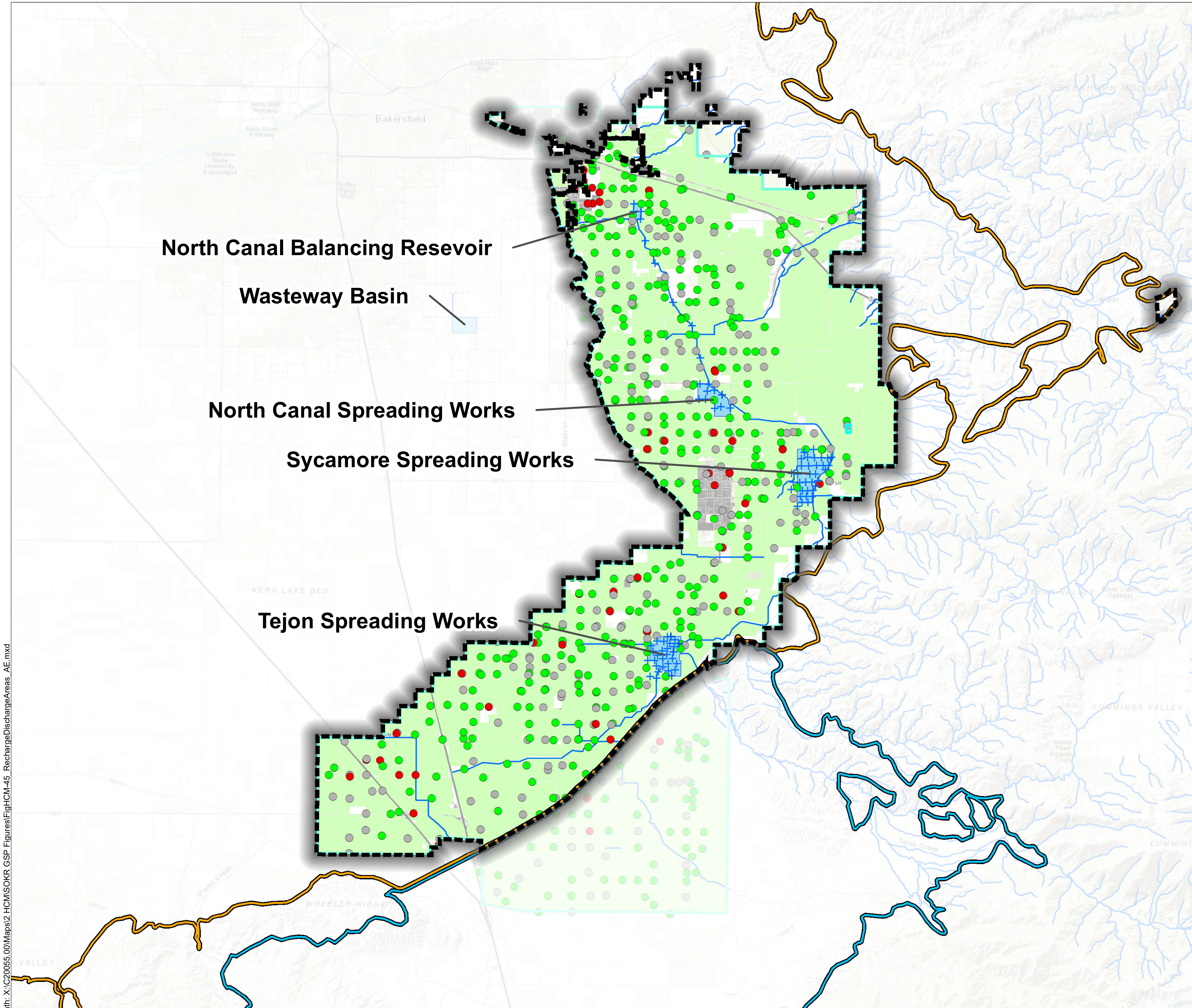
Miles

**Soil Recharge Potential Based on SAGBI Dataset**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-44**




Legend

- Arvin GSA

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Arvin-Edison Water Storage District
- AEWSD Recovery Well

**Well Type**

- Agricultural
- Domestic / M&I
- Other / Unknown
- Spreading Basin
- Urban Lands
- Irrigated Lands
- Stream/River

Abbreviations

AEWSD = Arvin-Edison Water Storage District
GSA = Groundwater Sustainability Agency
M&I = Municipal and Industrial
NHD = National Hydrography Dataset

Notes

1. All locations are approximate.
2. Existing recharge areas include irrigated lands (light green), AEWSD spreading basins, and natural surface water channels entering AEWSD area. Existing discharge areas include groundwater wells (shown by type).
3. Potential recharge areas are the same as existing recharge areas.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Surface water features from NHD (https://viewer.nationalmap.gov/basic/).

N

0 3 6

(Scale in Miles)

**Recharge and Discharge Areas**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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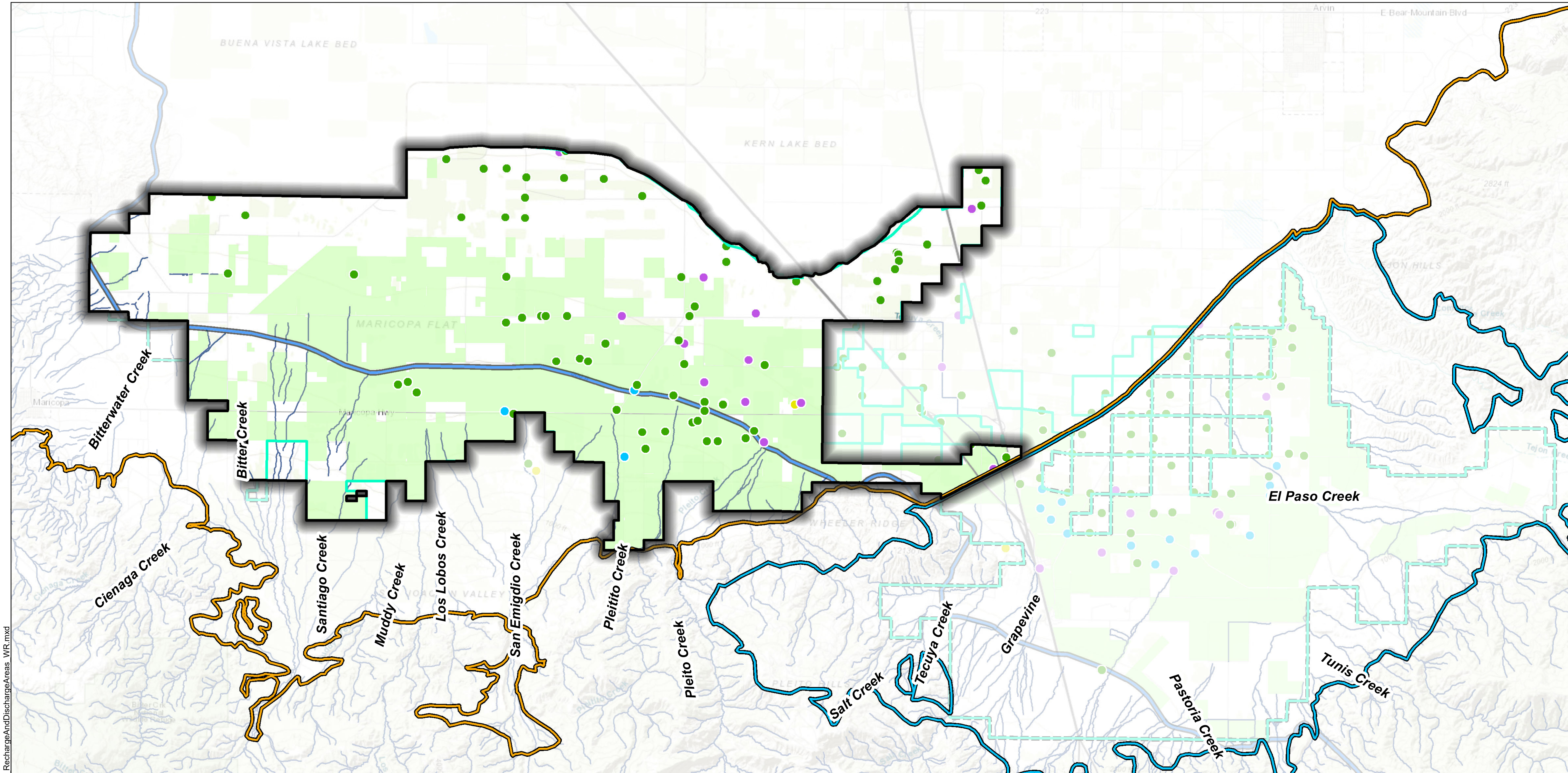
**Figure HCM-45**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-45_RechargeDischargeAreas_AE.mxd




## Legend

Wheeler Ridge-Maricopa GSA

Wheeler Ridge-Maricopa Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Surface Water Feature**

California Aqueduct

WRMWSD Surface Water Service Area

Streams into WRMWSD

**Well Type**

Active Agricultural

Active Domestic

Active Industrial

Active WRMWSD Production

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
NHD = National Hydrography Dataset
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Surface water features and California Aqueduct location from NHD (https://viewer.nationalmap.gov/basic/).
3. Surface Water Service Area and well type and status data acquired from WRMWSD staff on 21 November 2017.

**Recharge and Discharge Areas**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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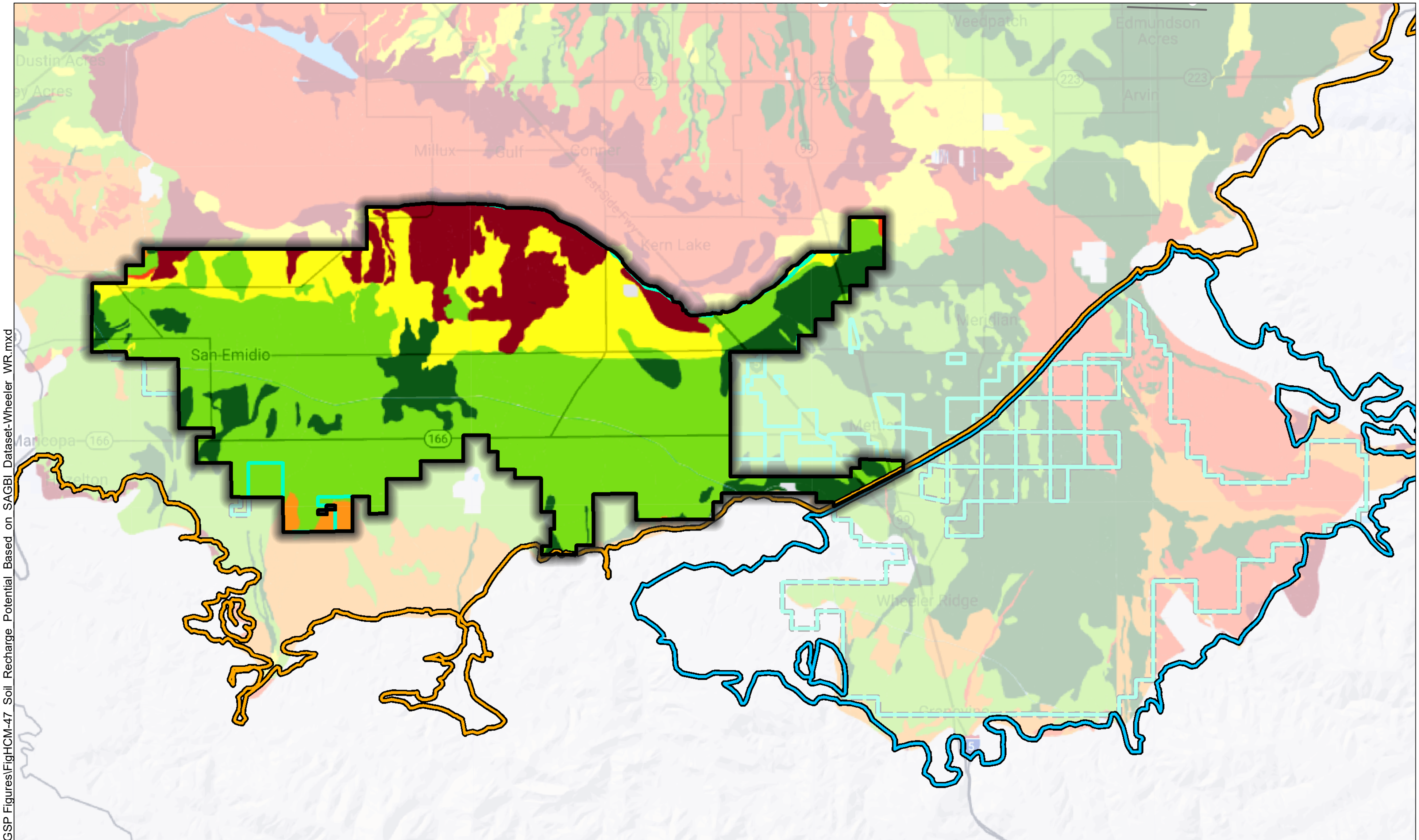
**Figure HCM-46**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-46_RechargeAndDischargeAreas_WR.mxd




Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-47_Soil_Recharge_Potential_Based_on_SAGBI_Dataset-Wheeler_WR.mxd

## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**SAGBI Rating**

- Excellent
- Good
- Moderately Good
- Moderately Poor
- Poor
- Very Poor

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
SAGBI = Soil Agricultural Groundwater Banking Index
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. The SAGBI dataset is a spatial mapping of a suitability index for groundwater recharge on agricultural land, based on five key factors: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. SAGBI data from https://casoilresource.lawr.ucdavis.edu/sagbi/.

N

0 5 10

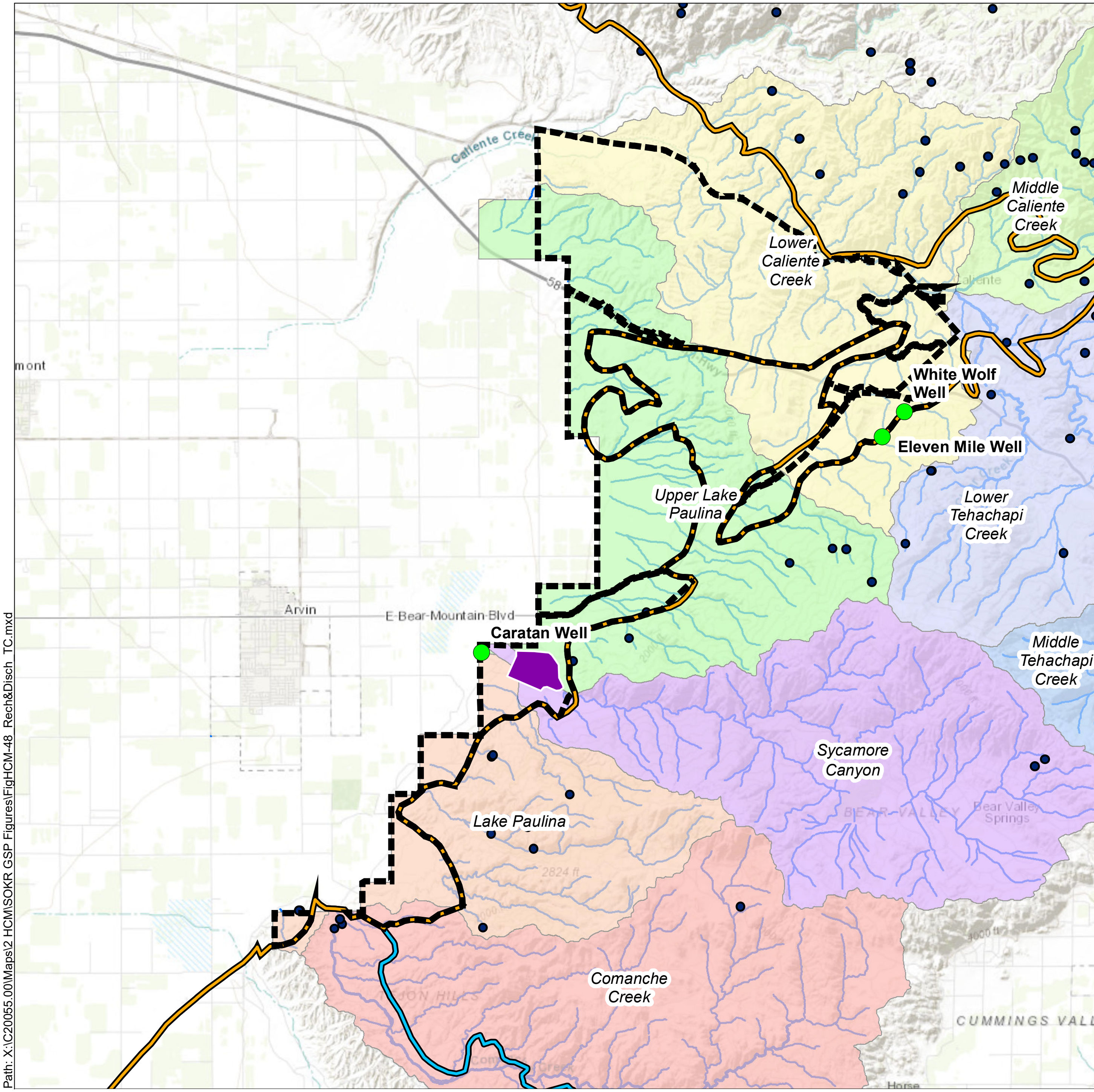
(Scale in Miles)

**Soil Recharge Potential Based on SAGBI Dataset**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-47**




Legend

Tejon-Castac Water District GSA

Granite Quarry (see Note 3)

Spring/Seep

TCWD MA Wells

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

Abbreviations

| | | |
|---|---|---|
| DWR | = | California Department of Water Resources |
| GSA | = | Groundwater Sustainability Agency |
| NHD | = | National Hydrography Dataset |
| TCWD MA | = | Tejon-Castac Water District Management Area |

Notes

1. All locations are approximate.
2. Pastel filled areas are watersheds draining into the Tejon-Castac Management Area.
3. Granite Quarry may be converted to a groundwater recharge and recovery facility.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Well location information obtained on 10/19/2018 from the Distrct.
3. Surface water features and watersheds from NHD website: (https://viewer.nationalmap.gov/basic/).

N 0 3 6

Miles

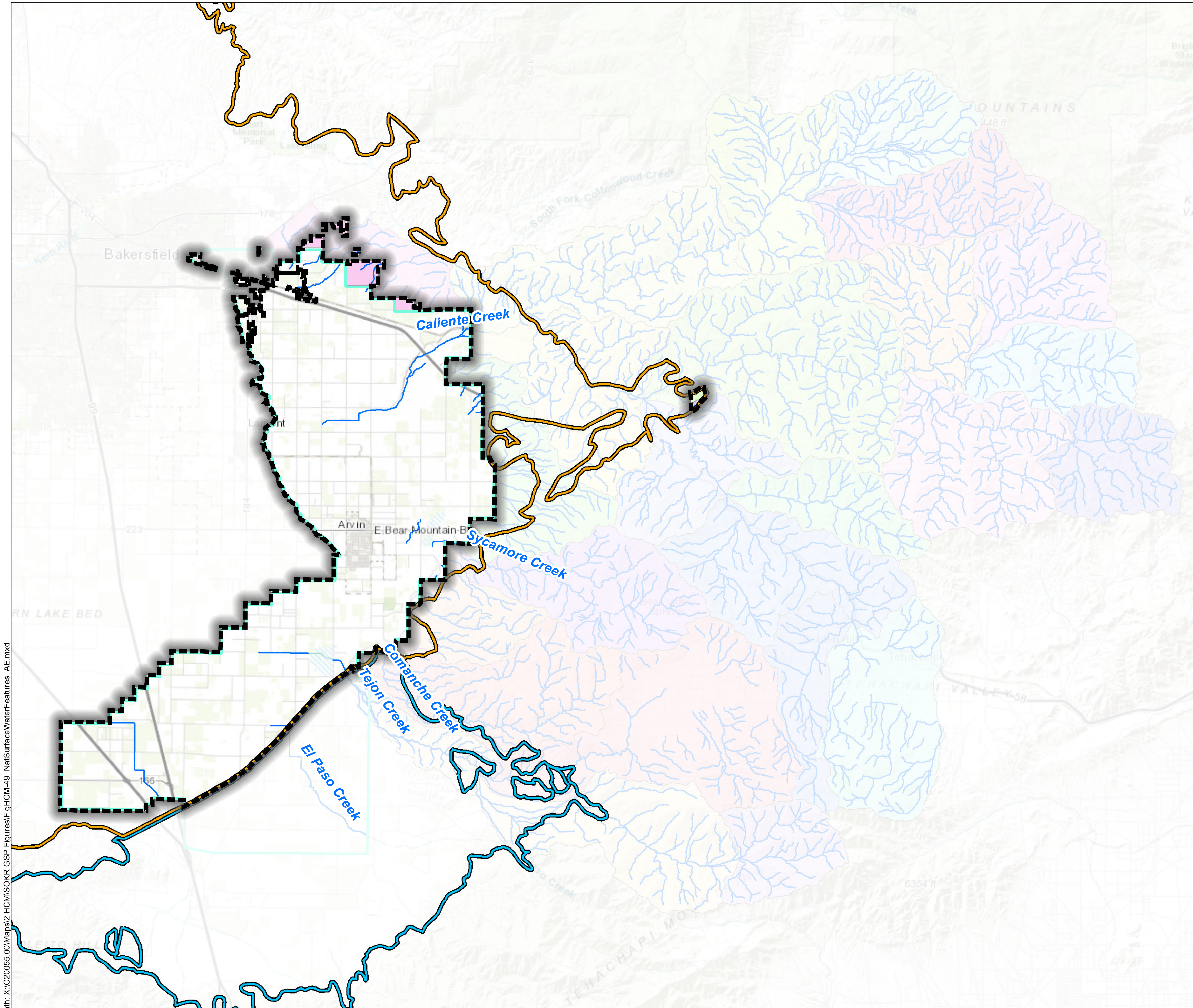
**Recharge and Discharge Areas**
**Tejon-Castac Management Area**

eki environment & water

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure HCM-48**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-48_Rech&Disch_TC.mxd




Legend

Arvin GSA

Arvin-Edison Water Storage District

Stream/River

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
NHD = National Hydrography Dataset

Notes

1. All locations are approximate.
2. Pastel filled areas are watersheds draining into the Arvin-Edison Management Area.
3. Labels are shown for named surface water streams entering the Arvin-Edison Management Area.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Surface water features and watersheds from NHD website: (https://viewer.nationalmap.gov/basic/).

N

0 4 8

(Scale in Miles)

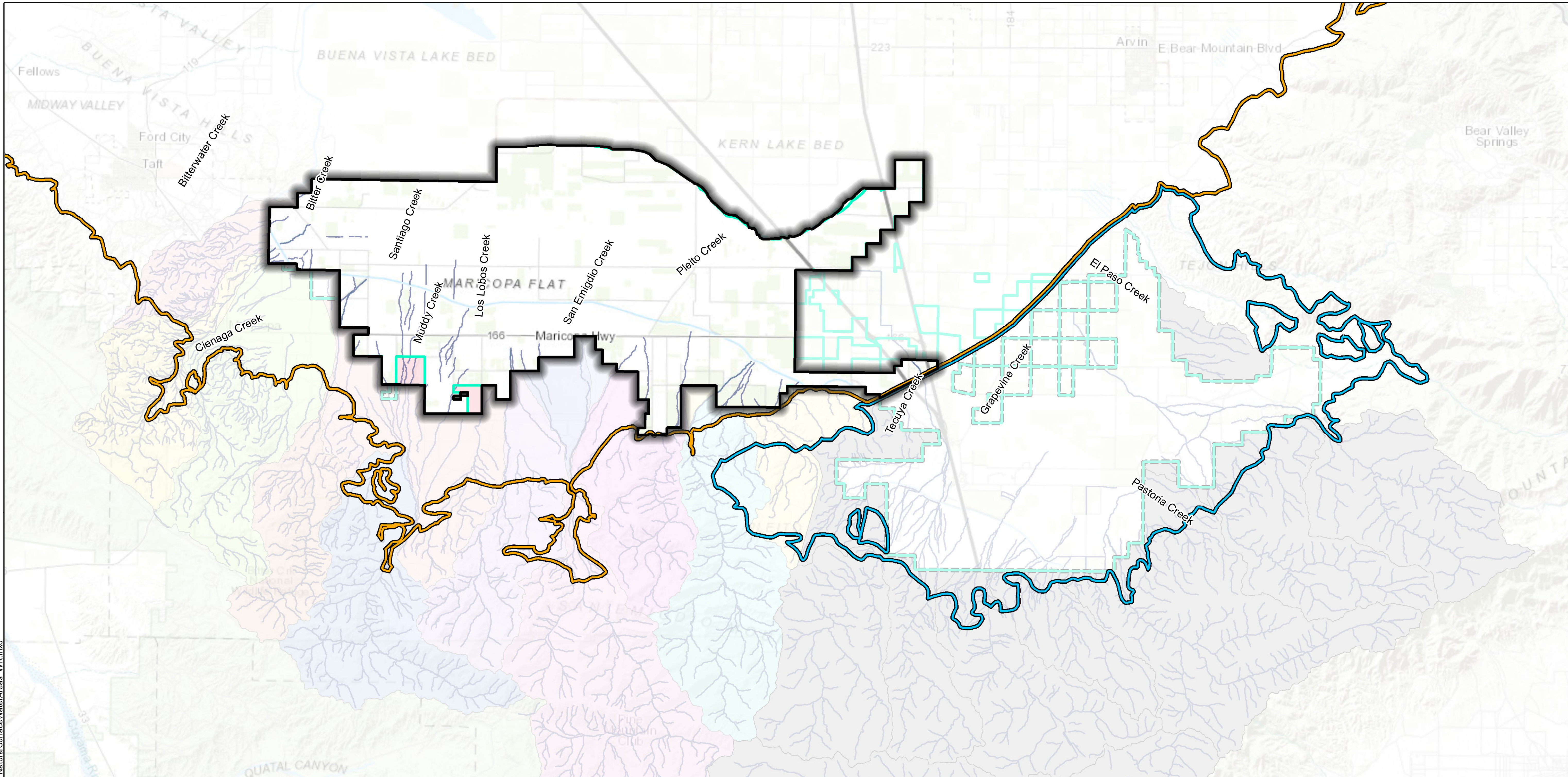
**Natural Surface Water Features**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-49**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-49_NatSurfaceWaterFeatures_AE.mxd




Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Stream into WRMWSD

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
NHD = National Hydrography Dataset
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

1. All locations are approximate.
2. Pastel filled areas are watersheds draining into the Wheeler Ridge-Maricopa Management Area, and gray filled areas are watersheds draining into WRMWSD's area in the White Wolf Subbasin.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Surface water features and watersheds from NHD (https://viewer.nationalmap.gov/basic/).

N

0 3.5 7

(Scale in Miles)

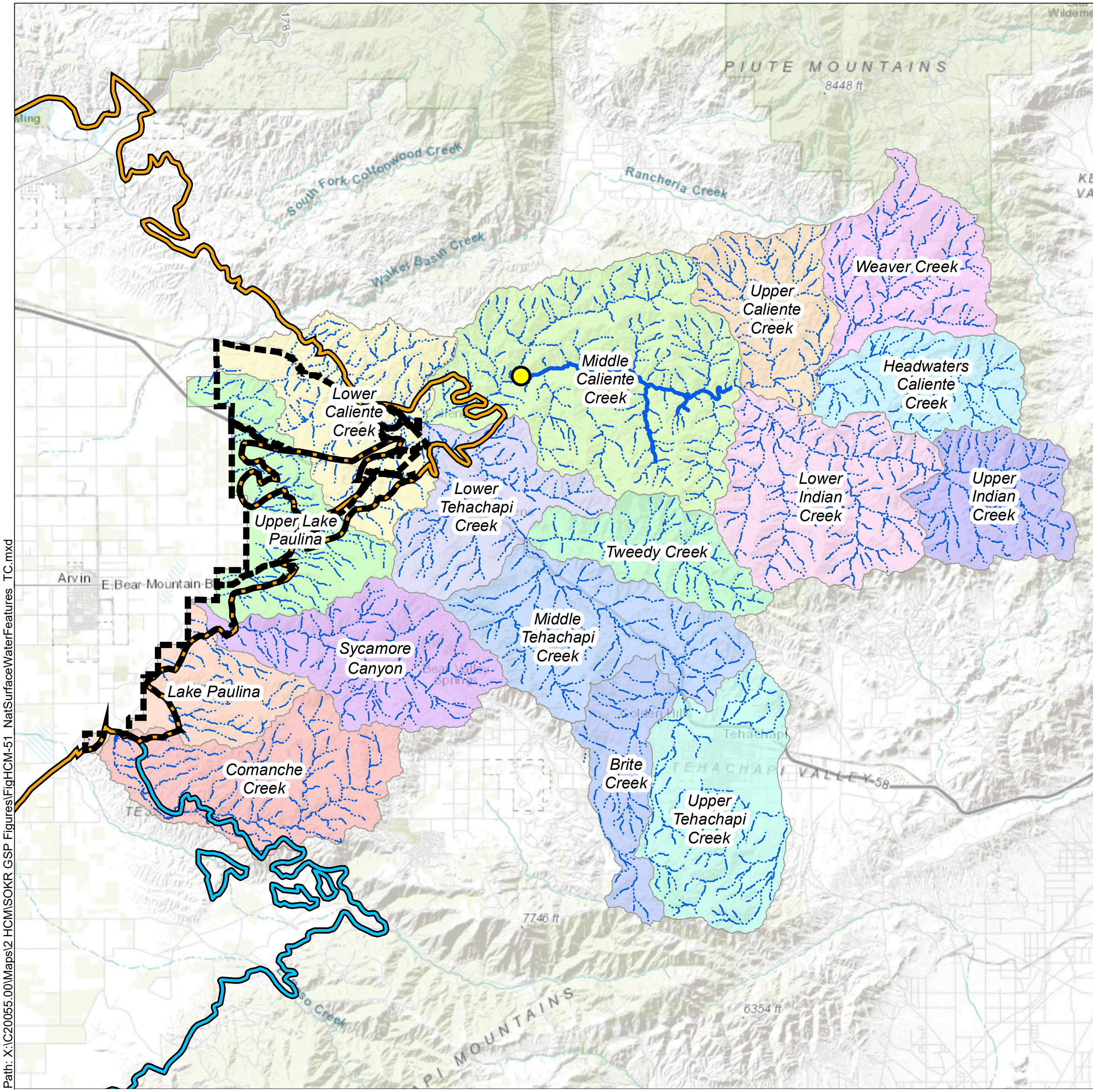
**Natural Surface Water Features**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure HCM-50**

Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-50_NaturalSurfaceWaterAreas_WR.mxd




## Legend

- Tejon-Castac Water District GSA
- USGS Caliente Creek Gauge Station (11196400)

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Stream/River**

- Perennial
- Intermittent

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
NHD = National Hydrography Dataset
USGS = United States Geological Survey

## Notes

1. All locations are approximate.
2. Pastel filled areas are watersheds draining into the Tejon-Castac Management Area.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 June 2022.
2. Surface water features and watersheds from NHD website: (https://viewer.nationalmap.gov/basic/).

N 0 6 12 Miles

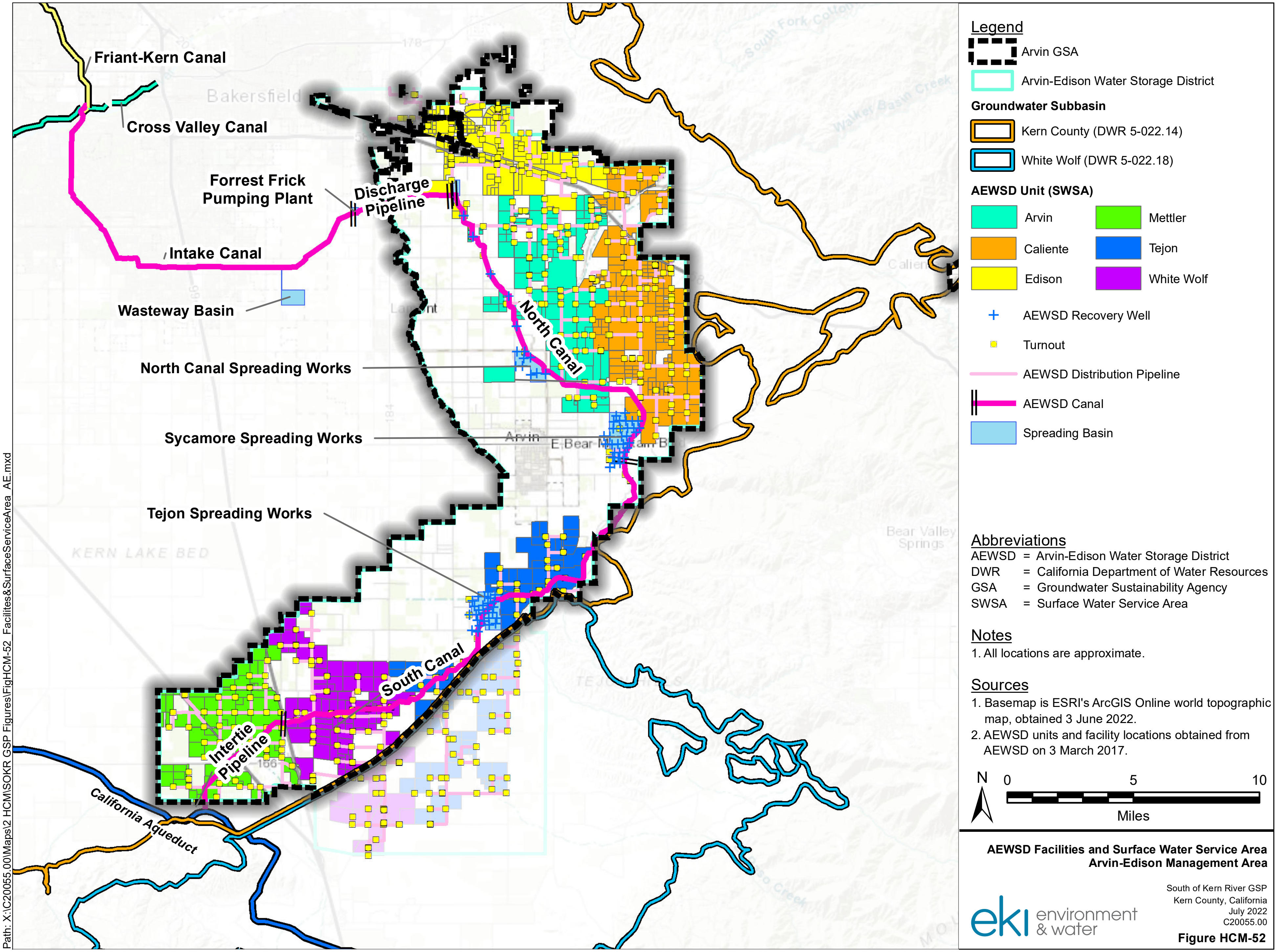
**Natural Surface Water Features**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure HCM-51**

Path: X:\C20055.00\Maps\2 HCMs\SOKR GSP Figures\FigHCM-51_NatSurfaceWaterFeatures_TC.mxd




Path: X:\C20055.00\Maps\2 HCM\SOKR GSP Figures\FigHCM-52_Facilities&SurfaceServiceArea_AE.mxd

# 8. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

☑ 23 CCR § 354.16

This section presents information on historical and current groundwater conditions within the South of Kern River Groundwater Sustainability Plan (SOKR GSP) Area based on available data. Sources of data used to inform the current conditions assessment are described within each data topic section and include data from district records, various state and federal databases, and other reports.

For the purposes of this assessment, "current conditions" refers to conditions in calendar year 2015 (i.e., the effective date of the Sustainable Groundwater Management Act; SGMA). For historical conditions, two periods are relevant. The first is California Department of Water Resources (DWR) Water Years (WY) 1995 through 2015 (i.e., October 1994 through September 2015), which is the period being used by the SOKR Groundwater Sustainability Agencies (GSAs) for historical water budget development. As discussed further below, this period is climatically close to normal/average, but includes a significantly dry (drought) period between 2012 and 2015, as well as other drier and wetter than normal years. The second historical period discussed herein is the period since the start of water importation operations up to "current". As Arvin-Edison Water Storage District (AEWSD) began importing water in 1966, for the Arvin-Edison Management Area, this historical period is from 1966 through 2015. For the Wheeler Ridge-Maricopa Management Area, this historical period is from 1971 through 2017/2018, as Wheeler Ridge-Maricopa Water Storage District (WRMWSD) began importing water in 1971. Historical data for the Tejon-Castac Management Area is very limited, as discussed below. Consideration of the longer historical periods allows assessment of the long-term effects of each district's operations and various sustainability indicators (i.e., groundwater levels, storage, and water quality). In some cases, certain other historical periods are also discussed in this section when either (a) the discussion is constrained by the time periods of available datasets (e.g., for land subsidence), or (b) the groundwater conditions characterization is improved by incorporation of data from other representative time periods. It is recognized that additional more recent data for certain groundwater conditions are available at the time of preparation of this amended SOKR GSP in 2022. However, as the SOKR GSP does not constitute an updated GSP, those additional data are not incorporated herein; rather, they will be incorporated in the next five-year update in 2025. One exception to this is for land subsidence data, the discussion of which is updated herein as part of the SOKR GSAs' response to DWR's comments on the GSPs in the Kern County Subbasin (DWR Basin 5-022.14, referred to herein as the Kern Subbasin or Basin) (i.e., collectively the Kern Subbasin Plan).

As discussed previously, there are very few wells in the Tejon-Castac Management Area, and those that do exist have not been historically monitored in any consistent way. Therefore, very limited information is available to characterize current and historical conditions. On the other hand, the lack of wells and non-de minimis pumping, with the exception of a single well (i.e., the Caratan Well) that serves non-potable water for industrial uses at the Granite Quarry and agricultural use on certain parcels within AEWSD, indicates that the Tejon-Castac Management Area currently and historically functions largely in an undeveloped state, fitting the description of a Watch Area (see **Section 5.3.5 *Watch Areas***).

## 8.1. Data Sources and Compilation

☑ 23 CCR § 352.6

Per the GSP Emergency Regulations (23 CCR § 352.6), each GSA "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 support of GSP development (i.e., hydrogeologic conceptual model [HCM] development, analysis of groundwater conditions, water budget development, and Plan Area information) a substantial number of data sources were compiled, organized, and processed, and stored within district-specific data management systems (DMS). The data compiled, which are described in greater detail in the sections that follow, include:

*Arvin-Edison Management Area*

- Seasonal water level measurements for in-district wells, 2004-2016
- Historical spring and fall water level measurements for in-district wells, 1994-2003[65]
- Survey of in-district wells and associated Geographic Information System (GIS) shapefiles
- GIS shapefiles of AEWSD facilities, surface-water infrastructure and service areas
- AEWSD operations records, including surface water imports, deliveries to spreading basins, and wellfield extractions on an annual basis, 1966-2016
- 2015 district-wide land use survey and associated GIS shapefiles
- Historic rainfall data at the AEWSD office station, 1974-2016
- Climate data at the AEWSD office station, 2013-2015
- Groundwater quality data from AEWSD's 2016 well sampling effort
- Kern County Water Agency (KCWA) Water Supply Reports, 2002-2011
- Kern River Watershed Coalition Authority (KRWCA) 2017 Groundwater Trend Report and Monitoring Network Plan
- AEWSD 2016 Water Balance, maintained by Provost & Pritchard (P&P)
- List and map of in-district land subsidence monitoring points, maintained by P&P
- Well log records from DWR (well and lithology information were subsequently digitized by AEWSD, to the extent possible given the legibility of the records)
- Topographic data from U.S. Geological Survey's (USGS) National Elevation Dataset (NED)
- Surficial geology maps from the California Geological Survey (CGS; previously known as the California Division of Mines and Geology)

[65] The 1994-2003 data was provided as either "spring" or "fall", without exact dates. For the purposes of hydrograph preparation, the water levels for spring and fall were assumed to be collected on April 1 and October 1 of each year, respectively.

- Soils data from National Resources Conservation Service's (NRCS) Soil Survey Geographic Database (SSURGO)
- Historical water level data for Kern County from DWR's Water Data Library and California Statewide Groundwater Elevation Monitoring (CASGEM) databases, 1960-2017
- GIS shapefiles of watershed boundaries and surface water features from National Hydrography Dataset (NHD)
- Aquifer parameter information from California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) (for model nodes within district boundaries)
- Locations of known contamination sites and plumes from the State Water Resources Control Board (SWRCB) GeoTracker database
- Water quality data for monitoring wells within GeoTracker's Groundwater Ambient Monitoring and Assessment (GAMA) database
- Crop evapotranspiration (ETc) data by year type from Cal-Poly Irrigation Training and Research Center (ITRC)
- Climate data from California Irrigation Management Information System (CIMIS) Arvin climate station
- Oil field reports for the Arvin-Edison area from California Geologic Energy Management Division (CalGEM; formerly known as Division of Oil, Gas, and Geothermal Resources [DOGGR])
- California water agency administrative boundary shapefiles from DWR
- GSA administrative boundary shapefiles from DWR[66]
- Various regional geologic surveys, cross-sections, and reports covering the Arvin-Edison Management Area
- Various land subsidence studies
- Natural Communities Commonly Associated with Groundwater (NCCAG) datasets from DWR

*Wheeler Ridge-Maricopa Management Area*

- Groundwater level measurements for in-District and nearby wells compiled by WRMWSD from its own records and state data sources such as the CASGEM Program, 1924-2017
- WRMWSD records of in-District wells and associated GIS shapefiles
- Well construction information compiled by WRMWSD
- GIS shapefiles of the WRMWSD service area and surface water conveyance and distribution infrastructure
- Annual district-wide land use survey and associated GIS shapefile, 2000-2017
- Groundwater quality data, 1951-2016

[66] GSA boundaries are subject to change, and are changing frequently.

- WRMWSD data for evapotranspiration (ET) as provided to the Kern Groundwater Authority (KGA) by the ITRC at monthly intervals, 1993-2015 (excluding 2012)
- Surficial geology maps from the CGS
- GIS shapefiles of watershed boundaries and surface water features from NHD
- Locations of known contamination sites from the SWRCB GeoTracker database
- Aquifer parameter information from C2VSim for model nodes within WRMWSD
- Percent coarse information from the Central Valley Hydrologic Model (CVHM) for model elements within WRMWSD
- CalGEM oil field reports for the WRMWSD area
- Soils data from the NRCS SSURGO database
- California water agency administrative boundary shapefiles from DWR
- Various regional geologic reports, maps and cross-sections
- Various land subsidence studies encompassing WRMWSD
- Base of fresh water studies
- NCCAG datasets from DWR

*Tejon-Castac Management Area*

- Historic rainfall data at the AEWSD office station, 1974-2016
- Climate data at the AEWSD office station, 2013-2015
- Well log records from DWR
- Topographic data from USGS NED
- Surficial geology maps from the California Geological Survey (CGS; previously known as the California Division of Mines and Geology)
- Soils data from NRCS SSURGO
- GIS shapefiles of watershed boundaries and surface water features from NHD
- Aquifer parameter information from C2VSim (for model nodes within district boundaries)
- Locations of known contamination sites and plumes from the SWRCB GeoTracker database
- Water quality data for monitoring wells within GeoTracker's GAMA database
- Crop ETc data by year type from Cal-Poly ITRC
- Climate data from CIMIS Arvin climate station
- California water agency administrative boundary shapefiles from DWR

- GSA administrative boundary shapefiles from DWR[67]
- Various regional geologic surveys, cross-sections, and reports covering the Arvin-Edison Management Area
- Various land subsidence studies
- NCCAG datasets from DWR

All geospatial data were integrated into the ArcGIS software platform as a “geodatabase”, a composite file structure (.gdb) which packages attribute data with associated geospatial information in a user-defined coordinate system.

Much of the data compiled for GSP development and analyses needed at least some pre-processing before the data could be integrated into ArcGIS. These pre-processing tasks included digitization, georeferencing, filtering, and linking georeferenced datasets to associated attribute data from other sources. For example, water level information in some instances did not have any coordinate or elevation information attributed to individual wells. To bring water level information into ArcGIS and create groundwater elevation maps, unique well identifiers based on the Public Land Survey System (PLSS) township information were assigned and then used to link water level records with their associated well coordinates derived from the well survey.

The result of these processing steps is a series of compiled spreadsheets containing, to the extent the information was available: (1) Well IDs, coordinates, and elevation information; (2) well construction information; (3) lithology information provided in the DWR well log records; (4) seasonal water level measurements for the period of collection (AEWSD water levels dataset [1994-2016]; WRMWSD water levels dataset [1924-2017]); and (5) water quality information provided from each SOKR GSA (2016 well sampling effort conducted by AEWSD; water quality data compiled by WRMWSD [1951-2016]). These data were subsequently brought into ArcGIS and stored in a geodatabase created for each SOKR GSA along with other geospatial data sources used for HCM development and further assessment of groundwater conditions. Last, selected data types (i.e., water level and water quality data at wells) were brought into a Microsoft Access database. Together these spreadsheets, geodatabase files, and Microsoft Access databases comprise the working DMS for each Management area. A coordinated Kern Subbasin DMS has been developed as part of Plan Implementation (see **Section 18.1 *Plan Implementation Activities***).

## 8.2. Groundwater Elevations and Flow Direction

☑ 23 CCR § 354.16(a)

Groundwater elevation data have been collected and compiled from AEWSD and WRMWSD monitoring records, datasets from other neighboring entities (i.e., Kern Delta Water District and Kern County Water Agency), and the DWR’s CASGEM database. The multiple datasets were reconciled and processed for quality assurance/quality control prior to analysis for groundwater conditions. These “data cleaning” efforts included removal of erroneous data points identified through examination of hydrographs and removal of very shallow depth-to-water data points (less than 20 feet below ground surface [ft bgs]) suspected of being affected by perched conditions to the west of the Arvin-Edison Management Area and

[67] GSA boundaries are subject to change, and are changing frequently.

along the northern boundary and to the north of the Wheeler Ridge-Maricopa Management Area. The resulting datasets used to inform this discussion of groundwater elevation conditions consists of a total of:

- Arvin-Edison Management Area: 24,102 groundwater elevation data points from 890 wells over the period from 1945 to Spring 2018.
- Wheeler Ridge-Maricopa Management Area: Over 100,000 groundwater elevation data points from over 1,600 wells over the period from 1936 to Spring 2018 throughout the Kern Subbasin.[68]
- Tejon-Castac Management Area: very limited groundwater elevation data, as discussed below.

For the purposes of this analysis the periods of Spring and Fall 2015 are used to represent seasonal high and low conditions under current land and water use, which is consistent with the other GSPs within the Kern Subbasin.

### 8.2.1. Arvin-Edison Management Area

*Lateral Gradients*

Lateral gradients are discussed below in the context of groundwater elevation contour maps.

*Vertical Gradients*

Vertical gradients between the different zones within the principal aquifer (i.e., the unconfined zone above the "E"-Clay versus the confined zone below the "E"-Clay, where it exists) may develop due to variability in proximity to recharge sources and the intensity of groundwater pumping. Vertical gradients may also vary in time as the factors affecting water levels are also temporally variable. Evaluation of vertical gradients can be accomplished by examination of water levels in well pairs where one well is representative of the upper, unconfined zone and the other well is representative of the lower, confined zone. This approach requires water level information from wells that: (a) have known well construction information, (b) are screened in different depth zones, (c) have contemporaneous measurements (i.e., water levels measured at least in the same year and season), and (d) are in close spatial proximity to each other (i.e., to minimize the influence of lateral gradients in water level). At this time, data that meets all of the above criteria has not been identified, and thus this issue represents a data gap in the groundwater conditions assessment. Compiling additional well screen interval information for associated groundwater elevation data would help fill to better define vertical gradients between different zones of the principal aquifer.

[68] Within the Wheeler Ridge-Maricopa Management Area, the dataset consists of roughly 11,000 groundwater elevation data points from 381 wells over the period from 1943 to 2018.

## *Groundwater Elevation Contour Maps*

☑ **23 CCR § 354.16(a)(1)**

Groundwater elevation contour maps for "current conditions" – Spring 2015 and Fall 2015 – are presented on ***Figure GWC-1*** and ***Figure GWC-2***, respectively. The following generalities can be made based on groundwater elevation data compiled for wells within the Arvin-Edison Management Area.

- Groundwater levels are consistently highest in the northeast area near the foothills and east of the Edison Fault and lowest in the south-central portion of the Arvin-Edison Management Area, to the south and east of the City of Arvin.
- Assuming groundwater flow is perpendicular to groundwater elevation contours, flow directions are generally to the southwest in the northeastern portion, and northwest across the White Wolf Fault. Groundwater flows into the Arvin-Edison Management Area from the west across both the northwestern and southwestern boundaries.
- Average lateral groundwater gradients across the northwestern and southwestern Arvin-Edison Management Area boundaries were extracted using GIS analysis. The estimated lateral gradients across the northwestern boundary were 0.00065 feet per foot (ft/ft) and 0.0015 ft/ft for spring and fall 2015, respectively, in an into-District direction. Across the southwestern boundary, the estimated lateral gradient in spring and fall 2015 were greater – 0.006 ft/ft and 0.0027 ft/ft, respectively – also in an into-district direction.
- An area of relatively high groundwater levels exists to the west of the Arvin-Edison Management Area, which may be due to a combination of factors including disposal of treated wastewater effluent to irrigated lands in this area, less groundwater pumping due to the availability of recycled water, and potentially the impact of finer-grained "basin" deposits. The "A"-Clay and its equivalent under the old Kern Lake Bed and the sloughs and swamp and over-flowed land connected to it are another factor.

The relative highs and lows within the Arvin-Edison Management Area appear to be controlled, at least in part, by the distribution of groundwater pumping versus surface water deliveries; areas within AEWSD's Surface Water Service Area (SWSA) (***Figure GWC-3***) tend to exhibit higher groundwater elevations than areas outside of the SWSA that rely exclusively on groundwater. As discussed above, the "barrier" effects of White Wolf Fault and Edison Fault also tend to cause higher groundwater levels on the upgradient sides, due to "backing up" of water. Groundwater gradients are steepest in the vicinity of the Edison Fault, although spatial water level data coverage in that area is limited.

## *Depth to Groundwater*

As shown on ***Figure GWC-4***, depth to groundwater for "current conditions" in Spring 2015 within the Arvin-Edison Management Area varies from 149 to 535 ft bgs.[69] Most of the Arvin-Edison Management Area had depths to water of between 300 and 400 ft bgs, with relatively greater depths in the east-central area where the land surface rises, and lesser depths in the far southwest and far northeast. The shallowest depth to water, 149 ft bgs, was measured in a well near Caliente Creek, which may be indicative of

[69] It should be noted that 2015 was the fourth year of a significant drought which led to zero surface water allocations on the Friant Kern system, thereby putting greater than normal demands on the groundwater system.

recharge occurring in this area but may also be influenced by barrier effects of the Edison Fault. Even for this shallowest measurement, the relatively deep depths to water in the principal aquifer system indicate that interconnected surface water and groundwater-dependent ecosystems are unlikely to occur in the Arvin-Edison Management Area. These topics are discussed further below in **Section 8.7 *Interconnected Surface Water Systems*** and **Section 8.8 *Groundwater Dependent Ecosystems***, respectively.

*Long-Term Groundwater Elevation Trends*

**☑ 23 CCR § 354.16(a)(2)**

Long-term trends in groundwater levels were evaluated based on examination of hydrographs for 14 wells throughout the Arvin-Edison Management Area. Wells were selected for hydrograph analysis based on the length of record, their distribution throughout the Arvin-Edison Management Area, and their representativeness of conditions in their area. Hydrographs were developed for two periods: a long-term period from 1945 through spring 2018 which captures the entire operational history of AEWSD through the most recent available data (***Figure GWC-5***), and the more recent period from 1994 through 2015 which is consistent with the  period of interest for water budget development (***Figure GWC-6***).[70] As shown on ***Figure GWC-5***, for most wells in the northern, eastern, and southern portions the Arvin-Edison Management Area, groundwater levels have increased over the long-term, reflecting the increased storage resulting from the AEWSD's importation of surface water starting in 1966. This trend is in contrast to the large rates of groundwater level decline (approximately 8 to 10 feet per year [ft/yr]) that were occurring prior to the surface water importation. Wells within the central and western areas show either long-term stability or a long-term decline (i.e., well 31S29E34A001M located near the City of Arvin). Wells located in close proximity to AEWSD's spreading basins show larger fluctuations than other wells as a result of focused recharge and recovery pumping. The effects of drought cycles are also apparent, with greater declines during dry periods and recovery during wet periods. As shown on ***Figure GWC-6***, over the more recent period from 1994 to spring 2018, the same general behavior and spatial patterns are apparent, except that the long-term increase in water levels due to surface water importation is largely obscured.

To evaluate long-term water level trends, linear regression of the water level data was used (recognizing that this method can be slightly biased by the data's temporal frequency and distribution). Based on hydrographs for 14 wells, over the period from 1966 (i.e., the start of surface water imports) through spring 2018, long-term water level trends range from increasing at up to 3.9 ft/yr to decreasing at up to 2.5 ft/yr. Of the 14 wells, six showed a decreasing trend over this time period and eight had an increasing trend. Over the period from 1994 through 2015, trends ranged from increases of 1.0 ft/yr to decreases of 4.1 ft/yr, with 12 wells decreasing and two wells increasing.

***Table GWC-1*** below shows the DWR Water Year Hydrologic Classification Index for the San Joaquin Valley (i.e., water year type).[71,72] Based on the DWR San Joaquin Valley Water Year Index for the 21 Water Years from 1995 through 2015, the period included five "critical" (dry) years (24%), four dry years (19%), two

[70] ***Figure GWC-6*** shows data from 1994 through the most recent available data which is either fall 2017 or spring 2018. For the purposes of water level trend calculation, only the data from 1994 through 2015 (i.e., the water budget period of interest) were used.

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

[72] DWR defines a Water Year as extending from October 1 of the previous year to September 30 of the year in question. For example, Water Year 2005 extends from 1 October 2004 through 30 September 2005.

below normal years (10%), three above normal year (14%), and seven wet years (33%). The first third of this period was relatively wet, the middle third was a mix of wet and dry years, and the last third of the period was extremely dry. This climatic factor is reflected in the hydrographs which tend to exhibit water level increases in the 1990s, relative stability in the early 2000s, and then greater decreases starting in the late 2000s.

**Table GWC-1. Summary of DWR Water Year Types, 1995 - 2015**

| Water Year | WY Index | Water Year | WY Index | Water Year | WY Index |
|---|---|---|---|---|---|
| 1995 | Wet | 2002 | Dry | 2009 | Below Normal |
| 1996 | Wet | 2003 | Below Normal | 2010 | Above Normal |
| 1997 | Wet | 2004 | Dry | 2011 | Wet |
| 1998 | Wet | 2005 | Wet | 2012 | Dry |
| 1999 | Above Normal | 2006 | Wet | 2013 | Critical |
| 2000 | Above Normal | 2007 | Critical | 2014 | Critical |
| 2001 | Dry | 2008 | Critical | 2015 | Critical |

### 8.2.2. Wheeler Ridge-Maricopa Management Area

*Lateral Gradients*

Lateral gradients are discussed below in the context of groundwater elevation contour maps.

*Vertical Gradients*

Vertical gradients between the different zones within the principal aquifer (i.e., the unconfined zone above the “E”-Clay versus the confined zone below the “E”-Clay, where it exists) may develop due to variability in proximity to recharge sources and the intensity of pumping. Vertical gradients may also vary in time as the stresses affecting water levels are also temporally variable. Evaluation of vertical gradients can be accomplished by examination of water levels in well pairs where one well is representative of the upper, unconfined zone and the other well is representative of the lower, confined zone. This approach requires water level information from wells that: (a) have known well construction information, (b) are screened in different depth zones, (c) have contemporaneous measurements (i.e., water levels measured at least in the same year and season), and (d) are in close spatial proximity to each other (i.e., to minimize the influence of lateral gradients in water level). At this time, data that meets all of the above criteria are limited. Available data indicate that vertical gradients within the Wheeler Ridge-Maricopa Management Area are generally downwards but vary between years and seasons. Compiling additional well screen interval information for associated groundwater elevation data would help fill to better define vertical gradients between different zones of the principal aquifer.

*Groundwater Elevation Contour Maps*

☑ **23 CCR § 354.16(a)(1)**

Groundwater elevation contour maps for "current conditions" – Spring 2015 and Fall 2015 – are presented on ***Figure GWC-7*** and ***Figure GWC-8***, respectively. The following generalities can be made based on groundwater elevation data compiled for wells within the Wheeler Ridge-Maricopa Management Area.

- Groundwater levels are consistently lowest in the southern central portion of the Wheeler Ridge-Maricopa Management Area near the California Aqueduct, in the northernmost portion between the Buena Vista Lake Bed and Kern Lake Bed, and in the far eastern portion just north of the White Wolf Fault.
- Groundwater levels are highest in the western portion of the Wheeler Ridge-Maricopa Management Area and just south of the Kern Lake Bed.
- The barrier effects of White Wolf Fault tend to cause higher groundwater levels on the upgradient (South) side just outside of the Wheeler Ridge-Maricopa Management Area, due to "backing up" of water.
- Assuming groundwater flow is perpendicular to groundwater elevation contours, flow directions are highly variable throughout the Wheeler Ridge-Maricopa Management Area. Generally, groundwater flows into the Wheeler Ridge-Maricopa Management Area across the White Wolf Fault at a relatively low rate due to low transmissivity. Flow across the northern boundary is variable and may result in net inflow or outflow from season to season.
- Average lateral groundwater gradients across the northern boundary of the Wheeler Ridge-Maricopa Management Area under current conditions were extracted from the Spring and Fall 2015 groundwater elevation contour maps (***Figure GWC-7*** and ***Figure GWC-8***) using GIS analysis. This boundary was divided into three sections – northwest (where data are very limited and gradients therefore uncertain), north-central, and northeast. The estimated lateral gradients across these three northern boundary sections in Spring 2015 were 0.005 ft/ft, 0.0016 ft/ft, and 0.0022 ft/ft, all in a northerly (outflow) direction. In Fall 2015, the gradients for these sections were 0.0049 ft/ft, 0.0033 ft/ft, and 0.0039 ft/ft, respectively, also all in an outflow direction. Average lateral gradients across the White Wolf Fault in Spring and Fall 2015 were approximately 0.01 ft/ft.
- An area of relatively high groundwater levels exists to the northeast of the Wheeler Ridge-Maricopa Management Area, which may potentially be due to the impact of finer-grained "basin" deposits.

The relative highs and lows within the Wheeler Ridge-Maricopa Management Area appear to be controlled, at least in part, by the distribution of groundwater pumping versus surface water deliveries; with the notable exception of the south-central area with low groundwater elevations mentioned in the first bullet above, areas within the WRMWSD SWSA (***Figure GWC-9***) tend to exhibit higher groundwater elevations than areas outside of the SWSA that rely exclusively on groundwater.

*Depth to Groundwater*

As shown on ***Figure GWC-10***, depth to groundwater for "current conditions" in Spring 2015 within the Wheeler Ridge-Maricopa Management Area varies from about 23 ft bgs to 559 ft bgs within the principal aquifer. Most of the Wheeler Ridge-Maricopa Management Area had depths to water of between 100 and 350 ft bgs, with shallower depths interspersed in the northern portion and deeper depths concentrated in the south-central portion. The shallowest depths to water (i.e., less than 50 ft bgs), were measured in wells along the far northern portion of the Wheeler Ridge-Maricopa Management Area near the Kern Lake Bed and Buena Vista Lake Bed and may be indicative of perched groundwater atop the fine-grained "basin" deposits in that area. It appears that these shallow measurements are representative of perched water that is not connected to the principal aquifer system. The fact that depth to water in the principal aquifer system is in most cases more than 100 ft bgs indicates that interconnected surface water and groundwater-dependent ecosystems are unlikely to occur with respect to the principal aquifer in the Wheeler Ridge-Maricopa Management Area.

*Long-Term Groundwater Elevation Trends*

**☑ 23 CCR § 354.16(a)(2)**

Long-term trends in groundwater levels were evaluated based on examination of hydrographs for 16 wells throughout the Wheeler Ridge-Maricopa Management Area. Wells were selected for hydrograph analysis based on the length of record, their distribution throughout the Management Area, and their representativeness of conditions in their area. Hydrographs were developed for two periods: a long-term period from 1955 through February 2018 which captures the entire operational history of WRMWSD through the most recent available data (***Figure GWC-11***), and the more recent period from October 1994 through September 2015 (i.e., the period of interest for water budget development) (***Figure GWC-12)***. As shown on ***Figure GWC-11***, a majority of the wells with long-term records in the Management Area have shown increased groundwater levels over the long-term, reflecting the increased storage resulting from the WRMWSD's importation of surface water starting in 1971. Prior to 1971, groundwater levels in many wells were experiencing steep declines. Wells in the far eastern and northwestern portions of the Management Area show more moderate long-term increases or slight declines in groundwater level. The effects of drought cycles (e.g., late 1980s/early 1990s) are apparent in some but not all wells, with greater declines during dry periods and recovery during wet periods. As shown on ***Figure GWC-12***, over the more recent period from October 1994 to September 2015, the same general behavior and spatial patterns are apparent, except that the long-term increase in water levels due to surface water importation is tempered by recent declines due to drought, especially in the central portion of the Wheeler Ridge-Maricopa Management Area.

As in the Arvin-Edison Management Area, linear regression of the water level data was used to evaluate long-term water level trends. Over the period from 1971 (i.e., the start of surface water imports) through February 2018, trends ranged from -1.38 ft/yr to +4.06 ft/yr, with 12 out of 16 wells showing positive trends greater than 0.5 ft/yr, and only two wells with negative trends. Over the period from Fall 1994 through Fall 2015, trends ranged from -2.06 ft/yr to +3.86 ft/yr, with 9 out of 16 wells showing positive trends greater than 0.5 ft/yr, and six wells with negative trends. See ***Table GWC-1*** above for the DWR water year types for the San Joaquin Valley.

### 8.2.3. Tejon-Castac Management Area

Groundwater elevation data is very limited in the Tejon-Castac Management Area due to the lack of production or monitoring wells. The information used to inform this discussion includes:

- Static groundwater levels in wells at the time of well construction;

- Groundwater elevation data from wells outside of the Tejon-Castac Management Area to the west and northwest, in AEWSD;
- Monitoring data for a limited time period in one well located within the Tejon-Castac Management Area but screened in the granitic bedrock;
- Monitoring data for several shallow wells outside of the Tejon-Castac Management Area in the vicinity of Caliente Creek; and
- Inference of maximum groundwater elevation based on Granite Quarry operations.

*Static Groundwater Levels from Well Completion Reports*

Shown on ***Table PA-3*** are the standing water levels that were measured at the time of well completion for wells in the vicinity of the Tejon-Castac Management Area; it should be noted that these data are for wells that are either definitively or probably not within the Tejon-Castac Management Area, and in one case for a well screened within the granite bedrock. As shown on ***Table PA-3***, the depth to water ranged from 60 ft bgs to about 196 ft bgs in the three domestic wells in T31SR31ES03 in between 1984 and 1993. Depth to water in the far northeastern area was 185 ft bgs in 1978. In the far southwestern area, depth to water in two wells in the main valley floor area was between about 79 and 113 ft bgs in the late 1930s, and in the granitic bedrock foothills was 80 ft bgs in 1987.

*Data from Wells Outside of the Tejon-Castac Management Area to the West and Northwest*

**☑ 23 CCR § 354.16(a)(2)**

***Figure GWC-13*** shows hydrographs for three wells located to the west of Tejon-Castac Management Area in AEWSD for the period from 1994 through 2015 and one well to the northwest for the period from 1959 through 2002. These wells were chosen because they have some of the longest water level records and were considered representative of conditions in the area. The three hydrographs in T31S R30E show a relatively consistent pattern of rising in the first five years, staying flat or stable in the next six to eight years, and then declining back towards their original (1994) levels by the end of the period. The total range of fluctuation of water levels in these wells is about 150 feet, except for one well which has a range of about 75 feet. The most recent data available for these wells shows water levels between about 80 and 140 feet above mean sea level (ft msl). The ground surface elevation in this area is approximately 450 to 475 ft msl, which indicates the depth to groundwater is on the order of 310 to 400 ft bgs. It should be noted that the fluctuations are likely affected by AEWSD's banking operations (recharge and recovery) at the nearby Sycamore Spreading Basins. These hydrographs suggest that groundwater levels in this area were relatively balanced and stable during this period (i.e., not in a condition of long-term decline). The hydrograph for well T30SR30E09Q shows much higher groundwater elevations, ranging from approximately 550 ft msl to 790 ft msl (i.e., approximately 50 to 290 ft bgs, based on a ground surface elevation of approximately 840 ft bgs). This illustrates the effect of the Edison Fault which causes groundwater levels to back up on the upgradient (northeastern) side of the fault.

*Monitoring Data from the White Wolf Well*

Groundwater levels were measured in the White Wolf Well (***Figure PA-16***) for a period between March 2011 and May 2013. During this period, groundwater levels vary between approximately 152 and 199 ft bgs, with most readings around 170 to 175 ft bgs. No apparent seasonal trend was observed in the groundwater levels.

*Data from Shallow Wells Near Caliente Creek*

Groundwater level data from five shallow monitoring wells from 1984 and 1987 are presented in a groundwater monitoring work plan report for the former Bean Fertilizer Facility north of the Tejon-Castac Management Area along Bena Road (Amec Foster Wheeler [AFW], 2017) (***Figure GWC-14***). The monitoring wells are between 30 and 70 feet deep, and thus are not screened within the principal aquifer from which most wells in the main valley floor area (outside of Tejon-Castac Management Area) pump. These data indicate that groundwater levels in the shallow alluvium underlying Caliente Creek fluctuated significantly between 1984 and 1987 between approximately 10 and 58 ft bgs in response to climatic cycles (AFW, 2017); however, no additional water level data since 1987 is available to determine if groundwater exists currently at shallow depths. The data from 1984 were also used to estimate a horizontal gradient of approximately 0.008 feet per foot in a westerly direction, roughly parallel to the direction of Caliente Creek surface flow.

*Inference of Maximum Groundwater Elevations from Granite Quarry Operations*

Although there are no actual groundwater elevation monitoring points at the Granite Quarry, it can be inferred by the fact that the quarry floor has not intersected the groundwater table that the maximum groundwater elevation in this area is approximately 550 ft msl (Google Earth). It should be noted that this elevation is well below the land surface of the surrounding non-excavated area which ranges from approximately 600 ft msl at the western edge of the facility to 850 ft msl at the eastern edge of the facility. This suggests that any shallow groundwater that may be present within the narrow canyons draining into the main valley floor area, which occasionally discharges to the surface as springs or seeps, likely percolates downwards quickly into the alluvial sediments at the point where they abut the underlying bedrock. This process is known as mountain front recharge.

*Summary*

The following general conclusions can be made based on the limited available groundwater level from within and around the Tejon-Castac Management Area:

- Groundwater levels in the portion of the Tejon-Castac Management Area south of the Edison Fault and connected to the main valley floor area of the Basin are likely similar to levels measured in wells in the adjacent AEWSD area. Wells closer to the AEWSD spreading basins likely fluctuate in response to AEWSD recharge and recovery operations. Levels in these areas are on the order of 50 to 200 ft msl. Groundwater flow directions are likely predominantly from east to west, from the uplands towards the interior of the Basin. The lack of water in the bottom of the Granite Quarry excavation indicates that depth to groundwater is at least 50 to 300 ft bgs in this area.

- Groundwater levels in the far eastern area portion of the Tejon-Castac Management Area are likely much higher due to the higher ground surface elevation. Groundwater flow directions and gradients cannot be determined with confidence due to the complex topography and uncertainty in the location of focused recharge and discharge areas. Negligible groundwater pumping results in a groundwater system that is largely controlled by natural hydrologic variability.

- Groundwater levels in the portion of the Tejon-Castac Management Area north of the Edison Fault are likely higher than on the south side of the fault due to backing up of water on the upgradient side. Fluctuations in both the deeper wells and shallow wells located outside of the Tejon-Castac Management Area in response to climate cycles suggests a regime dominated by natural hydrologic conditions, including occasional recharge from the major creeks in the area. However, no data exists within this portion of the Tejon-Castac Management Area to evaluate long-term trends.

## 8.3. Change in Groundwater Storage

☑ **23 CCR § 354.16(b)**

Change in groundwater storage for the Arvin-Edison Management Area and the Wheeler Ridge-Maricopa Management Area was estimated based on data for selected periods of interest. The method used to estimate storage change for these periods used water level data collected at the start and end of each period, spatially-variable specific yield information, and the following relationship, applied in a distributed manner:

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

Specifically, this approach was implemented by: (1) interpolating groundwater elevations for both years onto a 100-ft grid of pixels using the geostatistical spatial interpolation method known as kriging, (2) similarly interpolating the specific yield values from C2VSim-FG node data,[73] (3) calculating the water level difference at each pixel, (4) multiplying the water level difference from (3) by the specific yield at each pixel, (5) multiplying the result from (4) by the area of each pixel (i.e., 100 ft x 100 ft = 10,000 ft$^2$), and (5) summing all calculated values. To avoid errors caused by comparison of interpolated data that is based on different well points, a paired-well approach was used, wherein wells were selected for inclusion only if they were present in both datasets or if they were in close proximity (less than 1 mile) to a well in both datasets.

### 8.3.1. Arvin-Edison Management Area

***Table GWC-2***, below, presents the results of this storage change estimation for selected time periods of interest for the Arvin-Edison Management Area. As shown in ***Table GWC-2***, the total change in storage from 1966 through 2017 (i.e., since the start of AEWSD water imports through the latest available data) was -20,420 acre-feet (AF) or approximately -400 acre-feet per year (AFY). The total change in storage from 1994 through 2015 was -161,749 AF or approximately -7,702 AFY. To put this annual change in storage value into context, it represents approximately 5.7 percent of the average annual rate of groundwater pumping within the Management Area over that same period (approximately 144,000 AFY; discussed further below in **Section 9.1.3.2 *Historical Water Budget***).

[73] As discussed previously, specific yield values in the C2VSim-FG model used in this calculation may change upon completion of the model calibration by DWR.

**Table GWC-2. Change in Storage for Selected Time Periods, Arvin-Edison Management Area**

| Period | Relevance of Time Period | Total Change in Storage (AF) | Annual Rate of Change in Storage (AFY) |
|---|---|---|---|
| Fall 1966 – Fall 2017[74] | Entire period of AEWSD Operations | -20,420 | -400 |
| Spring 1994 – Spring 2015 | Water budget period of interest | -161,749 | -7,702 |
| Spring 1994 – Spring 2007 | Longer normal/wet period | 359,216 | 27,632 |
| Spring 2009 – Spring 2011 | Shorter wet period | 39,744 | 19,872 |
| Spring 2007 – Spring 2015 | Longer dry period | -560,197 | -70,025 |
| Spring 2014 – Spring 2015 | Short dry period | -144,219 | -142,219 |

***Figure GWC-15*** shows the distribution of storage change throughout the Arvin-Edison Management Area for the periods from Fall 1966 through Fall 2016 and Spring 1994 through Spring 2015. As shown on ***Figure GWC-15***, since 1966 AEWSD's importation of water has resulted in increases in groundwater storage since 1966 in the SWSA, but a loss in storage occurred outside of the SWSA (i.e., in the west-central portion of the Management Area). Over the recent period from 1994 through 2015, changes in groundwater storage have been variable, with increases in storage in the vicinity of AEWSD's spreading basins, near zero storage change in the southwestern portion of the Management Area, and slight decreases in the remaining portion.

Determination of the change in storage on a yearly basis using the method described above is more difficult due to a lack of consistent water level monitoring data. To address this issue, annual change in storage estimates were extracted from the output of the water budget model, described further in **Section 9 *Water Budget Information*** below. A graph of estimated annual change in storage between seasonal water level highs (i.e., from March of each year to March of the following year), is presented on ***Figure GWC-16***. Also shown on ***Figure GWC-16*** is the Water Year type based on DWR's San Joaquin Valley Water Year Index.[75] As shown on ***Figure GWC-16***, annual change in storage within the Arvin-Edison Management Area ranged from an increase of 155,000 AF for the period from March 2010 – February 2011 to a decrease of 185,000 AF for the period between March 2013 and February 2014. Change in

[74] The period from Fall 2017 through early 2019 was wetter than normal, and AEWSD was able to add a total (net) of 13,000 AF to banked storage in 2018.

[75] The seasonal high groundwater condition occurs typically in late winter or spring and for the purposes of ***Figure GWC-15 and Figure GWC-16*** is assumed to occur in March. March groundwater levels are affected by both the amount of pumping during the prior summer (i.e., previous DWR Water Year) as well as the amount of precipitation during the winter months of the current DWR Water Year. In ***Figure GWC-15 and Figure GWC-16***, the color of each bar is based on the Water Year type for the year the begins in the October between the March and February represented by the bar.

storage tends to be more negative during dry Water Years and more positive during wet Water Years. Change in groundwater storage is discussed further below in **Section 9.1.3.2 *Historical Water Budget***.

### 8.3.2. Wheeler Ridge-Maricopa Management Area

***Table GWC-3***, below, presents the results of the storage change estimation for selected time periods of interest for the Wheeler Ridge-Maricopa Management Area. As shown in ***Table GWC-3***, the total change in storage from 1971 through 2016 (i.e., since the start of WRMWSD water imports through the latest available data) was 77,180 AF or approximately 1,715 AFY. The total change in storage from Fall 1994 through Fall 2015 was 27,180 AF or approximately 1,294 AFY. To put this annual change in storage value into context, it represents approximately 2.3% of the average annual rate of groundwater pumping within the Management Area over that same period (approximately 57,000 AFY; discussed further below in **Section 9.1.3.2 *Historical Water Budget***). This indicates that groundwater storage over the Management Area has shown long-term stability over the WY 1994 – 2015 period.[76]

[76] Results from the basin-wide numerical modeling indicated a negative average annual storage change of approximately 7,900 AFY between Fall 1994 and Fall 2014. However, that estimate is considered less accurate than the locally-derived storage change estimates presented here because the basin-wide model has not undergone calibration of subsurface parameters on a local scale against actual local water level data.

**Table GWC-3. Change in Storage for Selected Time Periods, Wheeler Ridge-Maricopa Management Area**

| Period | Relevance of Time Period | Total Change in Storage (AF) | Annual Rate of Change in Storage (AFY) |
|---|---|---|---|
| Spring 1971 – Spring 2016 | Entire period of WRMWSD Operations | 77,180 | 1,715 |
| Fall 1971 – Fall 1990 | Entire Bookman-Edmonston Water Budget Period | 358,993 | 18,894 |
| Fall 1994 – Fall 2015 | Water budget period of interest | 27,180 | 1,294 |
| Spring 2003 – Spring 2015 | Longer normal/dry period | -80,939 | -6,745 |
| Spring 2003 – Spring 2012 | Longer normal/wet period | 81,839 | 9,093 |
| Fall 2014 – Fall 2015 | Short dry period | -76,197 | -76,197 |

***Figure GWC-17*** shows the distribution of groundwater elevation change throughout the Wheeler Ridge-Maricopa Management Area for the periods from Spring 1971 through Spring 2016, Fall 1994 through Fall 2015, and Fall 2014 through Fall 2015 (groundwater elevation change is directly related to storage change). As shown on ***Figure GWC-17***, from Spring 1971 through Spring 2016 groundwater levels increased throughout most of the Management Area, with the exception of the south-central portion and a small area along the west/central portion of the northern border. The area in the south-central portion appears to have been influenced by several low water level measurements that may be indicate short-term pumping-related levels rather than static levels, but because they were observed in several wells, they were not considered outliers. Over the recent period from Fall 1994 through Fall 2015, changes in groundwater elevation were variable, with slight increases in the west, north-central, and east portions of the Management Area, and slight decreases along the southern central and northeastern areas. Over the period from Fall 2014 to Fall 2015, groundwater elevation changes were slightly positive in most areas, but negative in the south-central area.

A graph of estimated annual change in storage between seasonal water level highs (i.e., from March of each year to March of the following year), is presented on ***Figure GWC-18***. Also shown on ***Figure GWC-18*** is the Water Year type based on DWR's San Joaquin Valley Water Year Index. As shown on ***Figure GWC-18***, annual change in storage within the Wheeler Ridge-Maricopa Management Area ranged from an increase of 83,000 AF for the period from March 1998 – February 1999 to a decrease of 46,000 AF for the period between March 2013 and February 2014.

#### 8.3.3. Tejon-Castac Management Area

As discussed above, there is very little groundwater level data upon which to base an analysis of changes in groundwater storage. However, as a first order approximation, the volume of groundwater in storage can be calculated as the product of the area and the average thickness of alluvial deposits and a storage coefficient. Assuming an area of 19,280 acres (known), an average saturated thickness of 1,000 feet (recognizing a much thicker section in the northern area and small thickness in the southern area), and a storage coefficient of 0.04 (assuming half of the thickness has an unconfined specific yield of about 0.08 and the other half has a confined storage coefficient of about 0.0015; ***Figure HCM-24***), the volume is estimate at approximately 800,000 AF.

For a perspective on the magnitude of groundwater use within the Tejon-Castac Management Area, as stated above, the only non-de minimis use of groundwater in the Management Area is from the Caratan Well which serves the Granite Quarry as well as certain agricultural lands outside of the Management Area. Total consumptive use from the Caratan Well is estimated to be between approximately 250 and 1,200 AFY. This amount represents between 0.03 percent and 0.15 percent of the estimated volume in storage within the Management Area. Clearly, any changes in storage within the Tejon-Castac Management Area due to groundwater pumping within the Management Area are small relative to the total volume of water in storage and are likely outweighed by changes due to natural hydrologic variability, or due to recharge/recovery operations at water banking facilities outside of the Tejon-Castac Management Area.

### 8.4. Seawater Intrusion

☑ **23 CCR § 354.16(c)**

Because the Kern County Subbasin is located far from coastal areas, seawater intrusion is not considered to be an issue.

### 8.5. Groundwater Quality

☑ **23 CCR § 354.16(d)**

#### 8.5.1. Arvin-Edison Management Area

*Groundwater Quality Constituents of Concern*

Groundwater quality constituents that may affect the supply and beneficial uses of groundwater in the Arvin-Edison Management Area were identified by comparing measured concentrations detected during a 2016 district-wide sampling event to applicable screening levels for the various beneficial uses (i.e., Maximum Contaminant Levels [MCLs] for domestic/municipal & industrial (M&I) use and various thresholds for irrigated agricultural use). Constituents for which at least 20 percent of samples exceeded the applicable screening level include nitrate, arsenic, total dissolved solids (TDS), boron, iron, and manganese, as discussed below.

- Nitrate was detected above the primary MCL[77] of 10 milligrams per liter (mg/L) (as N) in 160 (32%) of 497 samples collected in 2016. Higher concentrations were measured in locations along the western edge of the northern half of the Arvin-Edison Management Area, as well as in the southern portion both north and south of the White Wolf Fault (***Figure GWC-19***). Relative to 1966, nitrate concentrations have increased in most portions of the Management Area except in the vicinity of the spreading basins and in the northern part of the SWSA. The southern half of the Management Area had some of the most significant increases. Increasing nitrate concentrations are likely a legacy of historical intensive use of fertilizers on overlying agricultural lands. Addressing impacts from nitrate is one of the focuses of the Irrigated Lands Regulatory Program, with which AEWSD is directly involved as part of the Kern River Watershed Coalition Authority.
- Arsenic was detected above the primary MCL of 10 micrograms per liter (ug/L) in 152 (31%) of 497 samples collected in 2016, with most MCL exceedances in the northern half of the Arvin-Edison Management Area (***Figure GWC-20***). Arsenic concentration varies over short distances, with values above the MCL in close proximity to "non-detect" values. Arsenic is naturally-occurring in this area, derived from the granitic source rocks whose eroded sediments comprise the alluvial KRF (Thiros, 2010). The highest concentrations, ranging from 100 to 1,200 ug/L occur in the far northern portion of AEWSD (Township 30S Range 29E). The Central Valley Regional Water Quality Control Board (CVRWQCB) has issued a compliance order to Arvin Community Services District (ACSD) requiring the municipal water supplier to address arsenic contamination in its older wells above the MCL. ACSD is implementing an Arsenic Mitigation Program to replace the older wells with new wells that are to be drilled in areas believed to be less impacted by arsenic. Other ACSD efforts to address arsenic include providing customers access to arsenic-free water from filling stations at selected locations, funded by a grant from DWR. The Community Water Center has also helped install 50 at-the-tap arsenic treatment systems using funds from a separate SWRCB grant (ACSD, 2016).
- TDS was detected above the recommended secondary MCL[78] of 500 mg/L in 253 (51%) of 497 samples collected in 2016 and was present in most areas of the Arvin-Edison Management Area except the central portion (***Figure GWC-21***). TDS exceeded the upper secondary MCL of 1,000 mg/L in 55 (11%) of 2016 samples, primarily in the far northwest and far southwest of the Management Area. ***Figure GWC-22*** shows the change in TDS concentrations from 1966 through 2016. This water quality constituent is one of the more commonly measured parameters, and thus has a relatively complete dataset that enables evaluation of changes in water quality over time. As shown on ***Figure GWC-22***, TDS concentrations between 1966 and 2016 showed variable amounts of change in both direction (i.e., increase or decrease) and magnitude. TDS concentrations showed relatively consistent pattern of significant increase in the northwestern portion of the Management Area and in some parts of the southern half of the area, whereas in much of AEWSD the changes were small and variable in direction. Decreases in TDS concentrations occurred in the vicinity of AEWSD's spreading basin facilities and in the SWSA, especially in the northern half of the Management Area.

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[77] Primary MCLs are drinking water standards set by the USEPA and California Environmental Protection and Agency (CalEPA) based on human health considerations.

[78] Secondary MCLs are non-health related standards set by the SWRCB based on aesthetic characteristics of drinking water such as taste, odor, and color. For four common constituents – TDS, specific conductance, chloride and sulfate – the SWRCB sets three levels of secondary MCLs for consumer acceptance, referred to as (lowest to highest concentration): "recommended", "upper", and "short term".

- Boron was detected at levels that may restrict a water's use for irrigation (i.e., above 700 ug/L; Ayers and Westcot, 1985) in small areas in the central part of the northern half of the Arvin-Edison Management Area (***Figure GWC-23***). Boron was also cited as the cause of a base of fresh water determination for certain pools (Jeppi, Main Area) within the Edison oil field (DOGGR, 1988).
- Both iron and manganese exceeded their respective secondary MCLs (300 ug/L and 50 ug/L, respectively) in some locations. Iron exceeded its secondary MCL in 95 (19%) of 496 samples in 2016, and manganese exceeded its secondary MCL in 64 (13%) of 496 samples. Though these naturally-occurring constituents can impair the aesthetic quality of drinking water, and at high enough concentrations can result in staining of fixtures or clothes washed therein, they are not likely to significantly affect beneficial uses of groundwater.

The AEWSD-wide 2016 sampling event, and other less comprehensive sampling events conducted by or for AEWSD in earlier years, included primarily inorganic constituents such as major ions and metals, but did not include volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs). These constituents are typically not a concern for agricultural beneficial uses, but some are harmful to humans if consumed at high enough concentrations (often at parts per million or parts per billion concentrations) and are thus regulated by CalEPA (specifically by the SWRCB) in drinking water sources. Some of these compounds are, or have been historically, used in agriculture as pesticides, herbicides, and/or fungicides, and can be transported to groundwater by deep percolation of excess applied water, although this is more of a concern for the older "legacy" chemicals and less so for the current generation of chemicals that are designed to avoid deep percolation. One compound in particular, 1,2,3-trichloropropane (1,2,3-TCP), which is an industrial solvent that was also historically a component in a soil fumigant, was recognized in 2006 as a "constituent of special interest" in Kern County (Shelton et al., 2006), and was recently assigned a (primary) MCL of 0.005 ug/L (five parts per trillion) by CalEPA,[79] effective 14 December 2017. Data from the USGS GAMA program (Shelton et al., 2006) indicates that 1,2,3-TCP was detected in 2006 in one location in the Arvin-Edison Management Area at a concentration of 0.40 ug/L, 80 times the MCL.

Historical water quality sampling data are limited both in spatial extent and temporal frequency within the Arvin-Edison Management Area, thus making any statistical analysis of water quality trends and their potential nexus to groundwater elevations difficult. The most regularly monitored constituents of concern within AEWSD include TDS, arsenic, and nitrate. For these constituents, time-series water quality data were plotted relative to groundwater level measurements for wells with at least ten historical water quality (for TDS and nitrate) and groundwater level records and for the five ACSD wells with available arsenic data (see **Appendix H**).[80] For each constituent, there was no discernable relationship between groundwater levels and groundwater quality trends that could be consistently identified. Thus, additional data collection and analysis will be needed to further evaluate this potential relationship.

More generally, additional efforts to compile and characterize water quality data from additional data sources will continue as part of Plan Implementation. **Appendix I** includes a list and description of potential water quality datasets that may be analyzed to further assess groundwater quality conditions in the Arvin-Edison Management Area, including, for example, the CalEPA's Regulated Site Portal, Cortese List, GeoTracker, Drinking Water Watch, GAMA-Priority Basin Project (PBP), California Pesticide

[79] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/123-tcp/2017_1115_01S_app.pdf
[80] Arsenic data for ACSD wells obtained from https://sdwis.waterboards.ca.gov/PDWW/, accessed 17 July 2019.

Information Portal, United States Environmental Protection Agency's (USEPA) National Priorities List, and CalGEM's CalStim'D and WellFinder datasets.

*Point-Source Contamination Sites*

In addition to the relatively widespread non-point source groundwater quality constituents of concern, there are a small number of point-source contamination sites that historically affected or currently affect shallow (possibly perched) groundwater within the Arvin-Edison Management Area. These sites, shown in ***Figure GWC-24***, are typically associated with certain industrial or commercial land uses (e.g., gas stations).

As shown on ***Figure GWC-24***, there are a total of four active Cleanup Program sites and one active Leaking Underground Storage Tank (LUST) Cleanup sites within the Arvin-Edison Management Area. The LUST Cleanup site and two of the Cleanup Program sites are being managed under the oversight of the CVRWQCB. One Cleanup Program site is under the oversight of the California Department of Toxic Substances Control (DTSC) and another Cleanup Program site is a Superfund site under the oversight of the USEPA. Both LUST Cleanup sites and one of the Cleanup Program sites have gasoline, diesel, or Benzene/Toluene/Ethylbenzene/Xylenes listed as potential contaminants of concern. The other three Cleanup Program sites have agricultural chemicals (i.e., insecticides, herbicides, pesticides, and/or fumigants) listed as potential contaminants of concern. Three of the Cleanup Program sites and one of the LUST Cleanup sites are under remediation, the other Cleanup Program site is listed as being in the site assessment phase, and the other LUST Cleanup site is listed as open, eligible for closure. In addition to the active/open sites discussed above, there are approximately 25 closed LUST Cleanup sites and three closed Cleanup Program sites within the Arvin-Edison Management Area, most of which are located in the more urbanized areas near the cities of Bakersfield and Arvin, and in or around the Interstate 5/Highway 99 corridor. ***Table GWC-4*** below summarizes these four active sites within the Arvin-Edison Management Area.

**Table GWC-4. Summary of Active Point-Source Contamination Sites, Arvin-Edison Management Area**

| Site ID (see *Figure GWC-24*) | Site Name | Site Type | Regulatory Oversight Agency | Potential Contaminants of Concern | Status |
|---|---|---|---|---|---|
| 1 | J. R. Simplot - Edison | Cleanup Program Site | DTSC | DBCP, fertilizer, pesticides, herbicides | Open, remediation |
| 2 | Ribier Market | LUST Cleanup Site | CVRWQCB | gasoline | Open, remediation |
| 3 | Brown & Bryant - Arvin | Cleanup Program Site | USEPA | Pesticides, herbicides | Open, remediation |
| 4 | J & J Crop Dusters | Cleanup Program Site | CVRWQCB | Toxaphene, other insecticides, pesticides, fumigants, herbicides | Open, site assessment |

*Oil Field Injection Wells and Produced Water Ponds*

As described in **Section 7.1.3** ***Bottom of the Basin***, there are two oil fields in the vicinity of the Arvin-Edison Management Area – the Edison Oil Field and the Mountain View Oil Field. ***Figure GWC-25*** shows the locations of active underground injection wells and produced water ponds used for oil field operations in these areas. A large majority of the injection wells within these oil fields are located outside the Arvin-Edison Management Area boundaries in the northernmost portion of the Edison Oil Field. Produced water ponds are scattered throughout both oil fields, most of which are inactive. In total there are 35 active injection wells and 9 active produced water ponds within the Arvin-Edison Management Area boundaries.

Underground injection wells used to dispose of wastewater from oil and gas development are regulated in California by the USEPA, CalGEM, and SWRCB (see California Health and Safety Code § 25159.10 et seq). As described in **Section 7.1.3** ***Bottom of the Basin,*** injection wells within the Edison Oil Field inject wastewater into the deeper Vedder, Pyramid Hills Sands, Main Wicker Sands, Transition/Santa Margarita, and Chanac formations which are classified as "Exempted Aquifers" per the SWRCB "final concurrence" letters dated 19 October 2018 and 4 February 2019. Produced water discharges to ponds within the Arvin-Edison Management Area are under the purview of SWRCB and CVRWQCB regulatory oversight and are subject to regulation under individual and general Waste Discharge Requirements (WDRs) among other requirements to ensure adequate protection against impacts to underlying groundwater resources. Pursuant to SB 4 (2013), the SWRCB established a Regional Groundwater Monitoring Program to assess the potential effects on groundwater resources of well stimulation activities in oil and gas producing areas.[81] The Regional Groundwater Monitoring Program has been implemented through cooperative

[81] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/regional_monitoring/

efforts between the SWRCB and the USGS, including collection of groundwater quality samples in selected wells in proximity to oil fields within the Kern Subbasin (Dillon et al., 2017).

8.5.1.1. Groundwater Quality within the ACSD Well Network

The ACSD experience with water quality in the area to the south of the City of Arvin has shown that water quality for domestic purposes varies from wellsite to wellsite. Water quality sampling data from municipal supply wells in ACSD show that there are contaminants that exist in the upper level of the aquifer (e.g., nematicides), as well as state-regulated contaminants that exist primarily at deeper levels in the aquifer (e.g., arsenic), although there exist traces of both of these contaminants at mid-levels as well. In general, arsenic levels increase with depth, and nitrates and VOCs are present in the upper levels of the aquifer. Generally, domestic water quality improves with depth until arsenic is encountered. This is not a hard-and-fast rule, as exceptions occur where a contaminant normally found at depth (around 1,000 ft bgs) may be detected at higher elevations. Presently, water meeting state-mandated water quality standards can be produced only after test wells have been drilled to identify strata that contain these contaminants.

It has also been observed that water levels can influence produced water quality, offering a mix of upper and lower waters that varies with the water levels and thereby influencing the blend that is produced by the well. ACSD's experience indicates that lowering water levels will generally reduce water quality within their well network, and it is suspected that there is a threshold below which certain contaminants will dominate the water quality. However, this threshold is likely to vary from well-to-well, and no direct correlation can be discerned between water levels and trends in Arsenic concentrations within the ACSD well network or elsewhere within the Arvin-Edison Management Area at this time (see **Appendix H**). Water quality in ACSD's two new wells indicates that greater production from the deeper zones increases arsenic levels. It has been observed that drawing water from both the shallower and deeper production zones creates a mixture that will meet water quality standards. This can go both ways, improving the blend of deeper contaminants by introduction of shallower water, but risking the introduction of the shallower contaminants that can increase the levels of these contaminants in the blend to unacceptable levels for domestic uses. For example, even a trace of certain contaminants such as 1,2,3-TCP will cause a violation of water quality standards and require treatment.[82] Therefore, great care is taken in the preliminary wellsite evaluation process to determine the aquifer water quality at each prospective site.

### 8.5.2. Wheeler Ridge-Maricopa Management Area

*Groundwater Quality Constituents of Concern*

Groundwater quality constituents that may affect the supply and beneficial uses of groundwater in the Wheeler Ridge-Maricopa Management Area were identified by comparing the highest measured concentrations detected at an individual well for each constituent between 2012 and 2016 to applicable screening levels for the various beneficial uses (i.e., MCLs for domestic/M&I use and various thresholds for irrigated agricultural use). Constituents for which at least 15% of samples exceeded the applicable screening level include TDS, nitrate, arsenic, boron, iron, manganese, and sulfate, as discussed below. Of the seven constituents mentioned above, only nitrate and arsenic are regulated with a primary (i.e., health risk-based) MCL, while TDS, iron, manganese, and sulfate have secondary (i.e., aesthetically-based) MCLs. Boron does not have a primary nor secondary MCL, but levels exceeding 0.50 mg/L can be harmful to

[82] ACSD has installed Emergency 1,2,3-TCP treatment at one of its production wells (Well 13). See **Section 17.2.3 *Projects to Improve Drinking Water Quality in ACSD Service Area*** for further details.

sensitive crops (including oranges and grapes) and thus may cause a slight to moderate restriction of use to prevalent crops in the Wheeler Ridge-Maricopa Management Area (United Nations Food and Agriculture Organization, 1985).

- Nitrate was detected above the primary MCL of 10 mg/L (as N) or 45 mg/L (as $NO_3$) in zero of 37 wells sampled between 2012 and 2016. Higher concentrations were measured in locations along the southeastern edge of the Wheeler Ridge-Maricopa Management Area, near the White Wolf Fault, and several wells just southeast of the Management Area across the White Wolf Fault show nitrate MCL exceedances (***Figure GWC-26***).
- Arsenic was detected above the primary MCL of 10 ug/L in six (38%) of 16 wells sampled between 2012 and 2016, with most MCL exceedances in the northern and central portions of the Wheeler Ridge-Maricopa Management Area (***Figure GWC-26***). Arsenic concentration varies over short distances, with relatively high values in close proximity to "non-detect" values. Arsenic is naturally-occurring in this area, derived from the granitic source rocks whose eroded sediments are present within the alluvial Tulare Formation (Thiros, 2010).
- Boron was detected at levels that may restrict a water's use for irrigation for common crops (i.e., above 0.5 mg/L; Ayers and Westcot, 1985) in 13 (87%) of 15 wells sampled between 2012 and 2016. Boron is commonly detected throughout the central portion of the Wheeler Ridge-Maricopa Management Area (***Figure GWC-27***). Boron was also cited as the cause of a base of fresh water determination for nearby oil field pools (Jeppi, Main Area of the Edison oil field) (DOGGR, 1988).
- Sulfate was detected above the recommended secondary MCL of 250 mg/L throughout the Wheeler Ridge-Maricopa Management Area; 34 (92%) of 37 wells sampled between 2012 and 2016 show sulfate concentrations above 250 mg/L. In many cases (41%, or 15 of 37 wells), the sulfate concentration exceeds the upper secondary MCL of 500 mg/L.
- TDS was detected above the recommended secondary MCL of 500 mg/L in 35 (95%) of 37 wells sampled between 2012 and 2016 and was present throughout the Wheeler Ridge-Maricopa Management Area (***Figure GWC-28***). TDS exceeded the upper secondary MCL of 1,000 mg/L in 10 (27%) of 37 wells sampled between 2012 and 2016, primarily in the northern central portion of the Management Area. As shown on ***Figure GWC-28***, recent water quality sampling has not occurred in the western portion of the Management Area, as groundwater use and monitoring have mostly ceased in this area due to a combination of poor water quality and relatively low yield. Historical water quality sampling from the 1960s shows high concentrations of TDS in the western portion of the Management Area, with TDS detected in most wells above the upper secondary MCL.
- Both iron and manganese exceeded their respective secondary MCLs (300 ug/L and 50 ug/L, respectively) in some locations within the Wheeler Ridge-Maricopa Management Area. Iron exceeded its secondary MCL in eight (33%) of 24 wells sampled between 2012 and 2016, and manganese exceeded its secondary MCL in six (25%) of 24 wells sampled between 2012 and 2016. Though these naturally-occurring constituents can impair the aesthetic quality of drinking water and at high enough concentrations can result in staining of fixtures or clothes washed therein, they are not likely to significantly affect beneficial uses of groundwater in the Management Area.

- WRMWSD has indicated that chloride and Uranium may be of concern; groundwater sample data collected between 2012 to 2016 showed no exceedances of MCLs (primary for Uranium and secondary for chloride) for either constituent. Because chloride can negatively affect crop health, recent (2012-2016) groundwater quality sample data were screened against a lower concentration threshold associated with sensitive rootstocks and cultivars for major tree and berry crops (Ayers and Westcot, 1985). Only one of 43 samples exceeded the lowest (most conservative) threshold concentration of 117 mg/L (3.3 milliequivalents per liter of chloride).

Recent WRMWSD sampling has included primarily inorganic constituents such as major ions and metals, as well as VOCs and SVOCs. VOCs and SVOCs are typically not a concern for agricultural beneficial uses, but some are harmful to humans if consumed at high enough concentrations (often at parts per million or parts per billion concentrations) and are thus regulated by the USEPA and CalEPA (specifically by SWRCB) in drinking water sources. Some of these compounds are, or have been historically, used in agriculture as pesticides, herbicides, and/or fungicides, and can be transported to groundwater by deep percolation of excess applied water, although this is more of a concern for the older "legacy" chemicals and less so for the current generation of chemicals that are designed to avoid deep percolation. One compound in particular, 1,2,3-TCP, which is an industrial solvent that was also historically a component in a soil fumigant, was recognized in 2006 as a "constituent of special interest" in Kern County (Shelton et al., 2006), and was recently assigned a (primary) MCL of 0.005 ug/L (five parts per trillion) by CalEPA,[83] effective 14 December 2017. Limited data from WRMWSD's water quality sampling (43 samples since 2000) indicate that 1,2,3-TCP has not been detected in the Wheeler Ridge-Maricopa Management Area. Additionally, limited data from the USGS GAMA program (Shelton et al., 2006) showed that 1,2,3-TCP was not detected in wells within the Wheeler Ridge-Maricopa Management Area but was detected in 2006 in one location in the adjacent Arvin-Edison Management Area at a concentration of 0.40 ug/L, 80 times the MCL.

More generally, additional efforts to compile and characterize water quality data from additional data sources will continue as part of Plan Implementation. **Appendix I** includes a list and description of potential water quality datasets that may be analyzed to further assess groundwater quality conditions in the Wheeler Ridge-Maricopa Management Area, including, for example, the CalEPA's Regulated Site Portal, Cortese List, GeoTracker, Drinking Water Watch, GAMA-PBP, California Pesticide Information Portal, USEPA's National Priorities List, and CalGEM's CalStim'D and WellFinder datatsets.

*Temporal Characteristics of Groundwater Quality*

Historical water quality sampling data are limited both in spatial extent and temporal frequency within the Wheeler Ridge-Maricopa Management Area, thus making analysis of water quality trends and their potential nexus to groundwater elevations difficult. The most regularly monitored constituents of concern within WRMWSD include TDS, Arsenic, and Nitrate. For these constituents, time-series water quality data were plotted relative to groundwater level measurements for all wells with at least five historical water quality and groundwater level records (see **Appendix I**). For each constituent, there was no discernable relationship between groundwater levels and groundwater quality trends that could be consistently identified. Thus, additional data collection and analysis will be needed to further evaluate this potential relationship.

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[83] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/123-tcp/2017_1115_01S_app.pdf

*Point-Source Contamination Sites*

In addition to the relatively widespread non-point source groundwater quality constituents of concern, there are a small number of point-source contamination sites that historically or currently affect shallow (possibly perched) groundwater within the Wheeler Ridge-Maricopa Management Area. These sites, shown in ***Figure GWC-29***, are typically associated with certain industrial or commercial land uses (e.g., gas stations).

As shown on ***Figure GWC-29***, there are a total of two closed Cleanup Program sites and one closed LUST Cleanup site. The LUST Cleanup site was managed by Kern County and the two of the Cleanup Program sites were managed under the oversight of the CVRWQCB. There are no active cleanup sites within the Wheeler Ridge-Maricopa Management Area. The LUST Cleanup site has gasoline listed as a potential contaminant of concern and one of the Cleanup Program sites has crude oil listed as a contaminant of concern. ***Table GWC-5*** below summarizes these three closed sites within the Wheeler Ridge-Maricopa Management Area.

As shown on ***Figure GWC-29***, there are five inactive sites that need evaluation listed in the Department of Toxic Substances Control EnviroStor database within the Wheeler Ridge-Maricopa Management Area. Four of these are military sites, and one is a firing range that has been identified for State Response. In addition to the closed and inactive sites discussed above, there are several open and closed Cleanup Program Sites, several closed LUST Cleanup sites, a few active Corrective Action and State Response Sites, and Certified Voluntary Cleanup Sites just outside of the Wheeler Ridge-Maricopa Management Area. Given the lack of open sites and the fact that groundwater is generally hundreds of feet below the surface and separated from near-surface contamination by numerous thin low permeability layers, the threat to groundwater from the closed sites is likely minor.

**Table GWC-5. Summary of Active Point-Source Contamination Sites, Wheeler Ridge-Maricopa Management Area**

| Site ID (see ***Figure GWC-29***) | Site Name | Site Type | Regulatory Oversight Agency | Potential Contaminants of Concern | Status |
|---|---|---|---|---|---|
| 1 | Tenneco - Rancho Loma Farm | Cleanup Program Site | CVRWQCB | None Listed | Completed - Case Closed |
| 2 | Robert Andrews Farms | LUST Cleanup Site | Kern County | Gasoline | Completed - Case Closed |
| 3 | Four Corners Pipeline Company | Cleanup Program Site | CVRWQCB | Crude Oil | Completed - Case Closed |

*Oil Field Injection Wells and Produced Water Ponds*

As described in **Section 7.1.3 *Bottom of the Basin***, there are five oil fields that overlap the Wheeler Ridge-Maricopa Management Area – the San Emidio Nose, Yowlumne, Rio Viejo, Los Lobos, and Midway-Sunset oil fields. ***Figure GWC-30*** shows the locations of active underground injection wells (based on CalGEM data) and produced water ponds (based on data from the SWRCB's GeoTracker website) used for oil field operations in these areas. Within the Wheeler Ridge-Maricopa Management Area there are 12 active injection wells, all but one of which are in the Yowlumne oil field (the other being in the Rio Viejo oil field). There are also a large number of injection wells in the Midway-Sunset oil field to the west of the Wheeler Ridge-Maricopa Management Area. There are no produced water ponds within the Management Area, but there are many in the Midway-Sunset oil field.

Underground injection wells used to dispose of wastewater from oil and gas development are regulated in California by the USEPA, CalGEM, and SWRCB (see California Health and Safety Code § 25159.10 et seq). Produced water discharges to ponds are under the purview of SWRCB and CVRWQCB regulatory oversight and are subject to regulation under individual and general WDRs among other requirements to ensure adequate protection against impacts to underlying groundwater resources. Pursuant to Senate Bill (SB) 4 (2013), the SWRCB established a Regional Groundwater Monitoring Program[84] to assess the potential effects on groundwater resources of well stimulation activities in oil and gas producing areas. The Regional Groundwater Monitoring Program has been implemented through cooperative efforts between the SWRCB and the USGS, including collection of groundwater quality samples in selected wells in proximity to oil fields within the Kern Subbasin (Dillon et al., 2017).

#### 8.5.3. Tejon-Castac Management Area

There are no known groundwater quality issues that may affect the supply and beneficial use of groundwater within the Tejon-Castac Management Area. The only significant use of groundwater is from the Caratan Well for operations at the Granite Quarry (i.e., gravel washing), a use for which quality is not critical, and irrigation of certain agricultural lands outside of the Tejon-Castac Management Area in AEWSD.

As mentioned above, the Former Bena Fertilizer Facility site (GeoTracker Site SLT5FS304448) is located north of (and outside of) the Tejon-Castac Management Area near Caliente Creek (***Figure GWC-14***). The site's status is listed as "open – site assessment as of 10/1/2016" and the potential contaminants of concern are listed as "nitrate, other insecticides / pesticides / fumigants/ herbicides". Data from shallow monitoring wells at this site showed that in 1984 one of the five wells had slightly elevated electrical conductance (EC) and elevated sulfate, relative to secondary MCLs. Elevated phosphate levels were also observed but were not considered reliable due to laboratory analytical issues (AFW, 2017). A follow-up sampling work plan was submitted to and approved by the CVRWQCB in 2017 (AFW, 2017), but results from sampling pursuant to the approved work plan at the site have not been uploaded to GeoTracker as of 1 March 2019.

### 8.6. Land Subsidence

☑ **23 CCR § 354.16(e)**

The Kern Subbasin has a documented history of subsidence, including historical and recent subsidence in the southern portion of the subbasin, south of the Kern River, covered by the SOKR GSP (Lofgren, 1975; DWR, 2014). Subsidence in this area can be caused by withdrawal of groundwater, with some areas in the Wheeler Ridge-Maricopa Management Area also affected by hydro-compaction (Lofgren, 1975). Subsidence due to oil and gas production has also occurred in some areas. ***Figure GWC-31, Figure GWC-***

[84] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/regional_monitoring/

***32,*** and ***Figure GWC-33*** depict maps of historical (1949-2005) and recent (2015-2016) subsidence for each of the three management areas individually, and ***Figure GWC-34*** shows an updated subsidence map covering the period from June 2015 – January 2022 for the entirety of the SOKR GSP Area. The above-mentioned regional maps of subsidence have been developed based on leveling surveys and synthetic aperture radar (SAR) techniques, and there are few continuous subsidence monitoring sites in the area.[85]

### 8.6.1. Arvin-Edison Management Area

*Historical Subsidence*

During the mid-20th century, when groundwater levels were declining rapidly before the importation of surface water supplies by AEWSD and others began, subsidence was widespread throughout the area, with the greatest amounts – over nine feet between 1926 and 1970 – occurring just south of Kern Lake Bed northwest of Mettler (Lofgren, 1975). Subsidence amounts tended to decrease in all directions from this central "hot spot". The area just to the east of the City of Arvin also experienced somewhat greater subsidence than surrounding areas. This area of historical subsidence generally coincides with the presence of the regional "E"-Clay aquitard, which is also presumably an area that includes a greater proportion of other unnamed fine-grained compactible materials.

Between 1957 and 1965, the estimated rate of subsidence as a function of groundwater level decline ranged from approximately 0.01 to 0.03 feet of subsidence per foot of head decline in the Arvin-Edison Management Area (Lofgren, 1975).

Extending the historical record further into recent times, DWR has mapped subsidence in this portion of the Kern Subbasin between 1949 and 2005. Most areas within the Arvin-Edison Management Area are shown in this dataset as having subsidence over that period of between 0 and five feet and some areas in the western and southern portions having subsidence between five and 10 feet (***Figure GWC-31***).

*Recent Subsidence*

Subsidence due to water level decline has continued in recent times of groundwater level decline associated with dry climatic conditions; between May 2015 and September 2016 most areas within the Arvin-Edison Management Area experienced between one and four inches of subsidence, with some areas between four and eight inches (***Figure GWC-31***; based on Farr et al., 2016). Subsidence over the period from June 2015 – January 2022 was between 0 and 0.5 ft over most of the Arvin-Edison Management Area, with lesser amounts in the far northern portion of the Arvin-Edison Management Area and greater amounts (up to approximately 1.1 ft) in the east-central area (***Figure GWC-34***). The continued recent subsidence, occurring at a time when groundwater levels are not necessarily below their historic minima, demonstrates that subsidence can continue to occur even after water levels are partially recovered through a lag mechanism resulting from the continued slow depressurization of compactible fine-grained materials (Lofgren, 1975). Also, as discussed further in **Section 13 *Undesirable Results***, the localized areas of increased subsidence in the near-vicinity of AEWSD's groundwater recharge and extraction facilities

[85] It should be noted that subsidence estimates based on interferometric synthetic aperture radar (InSAR) methods can be subject to errors when the period of time between measurements is short and when the land is subject to surface disturbance, as is typical in agricultural areas (personal communication, Michelle Sneed, USGS, 27 June 2018).

(and the well-documented impacts of subsidence on the Friant-Kern Canal in the Tule Subbasin) highlights the potential impacts of subsidence on Management Area Critical Infrastructure.[86]

One continuous subsidence monitoring site [ARM1 (Arvin_Main1SCIGN) NAM08] is located approximately four miles west of the City of Arvin in the Arvin Maintenance Yard, which is outside the Arvin-Edison Management Area (***Figure GWC-35***). Data from this continuous GPS monitoring station show a decline in ground surface elevation of approximately 16 inches from 2000 through early 2018.

### 8.6.2. <u>Wheeler Ridge-Maricopa Management Area</u>

*<u>Historical Subsidence</u>*

As previously mentioned, groundwater levels were declining rapidly before the importation of surface water supplies by WRMWSD and others began in the mid-20th century, and subsidence was widespread throughout the area. The greatest amounts of subsidence – over nine feet between 1926 and 1970 – occurred just south of Kern Lake Bed northwest of Mettler (Lofgren, 1975). Subsidence amounts tended to decrease in all directions from this central “hot spot”. This area of historical subsidence generally coincides with the presence of the regional “E”-Clay aquitard and other shallower regional aquitards, which is also presumably an area that includes a greater proportion of other unnamed fine-grained compactible materials.

Between 1957 and 1965, the estimated rate of subsidence as a function of groundwater level decline varied widely from approximately 0.01 to 0.4 feet of subsidence per foot of head decline in the Wheeler Ridge-Maricopa Management Area (Lofgren, 1975).

Extending the historical record further into recent times, DWR has mapped subsidence in this portion of the Kern Subbasin between 1949 and 2005. The southern and northwestern areas of the Wheeler Ridge-Maricopa Management Area are shown in this dataset as having subsidence over that period of between zero and five feet and the northern central areas having subsidence between five and 15 feet (***Figure GWC-32***). DWR has noted that between 7.5 and 9 feet of land subsidence was observed within the Management Area between 1965 and 1968 as a result of hydro-compaction upon the development of pre-construction ponds along the proposed alignment of the California Aqueduct Mileposts 255.7 – 274.3 (DWR, 2017a).

*<u>Recent Subsidence</u>*

Subsidence due to water level decline has continued in recent times of groundwater level decline associated with dry climatic conditions; between May 2015 and September 2016 most areas within the Wheeler Ridge-Maricopa Management Area experienced between one and eight inches of subsidence, with some small areas between eight and twelve inches (***Figure GWC-32***; based on Farr et al., 2016). The continued recent subsidence, occurring at a time when groundwater levels are not necessarily below their historic minima, demonstrates that subsidence can continue to occur even after water levels are partially recovered. This continued subsidence could be elastic or could be inelastic subsidence resulting from the temporally-lagged, continued slow depressurization of compactible fine-grained materials (Lofgren, 1975).

[86] AEWSD relies heavily on the Friant-Kern Canal for its imported surface water supplies (see **Section 9.2.1 *Surface Water Inflows and Outflows***).

As discussed further in **Section 13 *Undesirable Results***, the localized areas of increased subsidence in the near-vicinity of the alignment of the California Aqueduct within the Wheeler Ridge-Maricopa Management Area highlights the potential impacts of subsidence on Regional Critical Infrastructure. Approximately 22 miles of the California Aqueduct runs through the Management Area, from approximately Milepost 256.14 (Check No. 31) to Milepost 278.13 (Teerink Pumping Plant). This portion of the California Aqueduct includes pools 32 through 35. DWR has documented subsidence by milepost of the California Aqueduct with a baseline of 1967 or 1969 ground surface elevation and estimated hydraulic impacts of differential settling (DWR, 2017a). Within this section of the Aqueduct, measured values for survey benchmark locations within the Management Area show up to approximately 1.7 feet of settlement from the 1967/1969 baseline through 2013 (DWR, 2017a), and up to approximately 14 inches of additional settlement between 2013 and 2017 (DWR, 2019). Subsidence measurements based on Interferometric Synthetic Aperture Radar (InSAR) data between April 2014 and June 2016 indicate a localized area of subsidence in the south-central portion of the Management Area in close proximity to the California Aqueduct (***Figure GWC-36***). Subsidence over the period from June 2015 – January 2022 was between 0 and 0.5 ft over most of the Wheeler Ridge-Maricopa Management Area, with greater amounts (up to approximately 1.1 ft) in the north-central portion of the Wheeler Ridge-Maricopa Management Area and up to approximately 0.65 ft in the south-central area in the vicinity of the California Aqueduct (***Figure GWC-34***).

#### 8.6.3. Tejon-Castac Management Area

Based on available data, the Tejon-Castac Management Area, which consists of largely undeveloped lands and is located on the edge of the Kern Subbasin, has not undergone any significant land subsidence. ***Figure GWC-33*** shows maps of historical (1949-2005; after DWR, 2017b) and recent (2015-2016, after Farr et al., 2016) ground surface elevation change. Both maps have incomplete coverage of the Tejon-Castac Management Area, cutting off some distance west of the eastern Tejon-Castac Management Area boundary. Nevertheless, the maps show generally 0 to 5 ft of land surface change over the historical period (i.e., 0 to 1.07 inch per year) and -1 to 1 inch change over the recent period (2015-2016) except in the far north which shows -1 to -4 inches change. Subsidence over the period from June 2015 – January 2022 was between 0 and 0.1 ft over the entire Tejon-Castac Management Area (***Figure GWC-34***). Given the lack of non de minimis groundwater development and use, except the Caratan Well for use at the Granite Quarry and irrigation of certain agricultural lands outside of the Tejon-Castac Management Area in AEWSD, these maps confirm that subsidence in the Tejon-Castac Management Area is not a significant concern.

### 8.7. Interconnected Surface Water Systems

☑ **23 CCR § 354.16(f)**

Groundwater levels in the principal aquifer are far below the ground surface within the SOKR GSP Area, as described below.

- *Arvin-Edison Management Area*: Depths to groundwater generally exceed 150 ft bgs, including at wells in close proximity to the natural surface water features within the Management Area (***Figure GWC-4***). Therefore, with respect to the principal aquifer, it is determined there is no interconnected surface water.

- *Wheeler Ridge-Maricopa Management Area*: Depths to groundwater are generally 100 or more ft bgs, and even deeper (greater than 350 ft bgs) in the southern areas where surface water streams enter the Management Area from the south (***Figure GWC-10***). The few water level data that show shallower groundwater in the northern portion of the Management Area are from wells that are not screened in the principal aquifer, but rather shallow monitoring wells monitoring perched conditions. Therefore, with respect to the principal aquifer, it is determined there is no interconnected surface water.
- *Tejon-Castac Management Area*: Groundwater levels in the principal aquifer in the southern portion of the Management Area are estimated to be approximately 310 to 400 ft bgs, based on data from nearby wells located outside of the Management Area to the west. To the northwest of (and outside of) the Management Area, available data from a well screened in the principal aquifer show that groundwater levels ranged between approximately 50 and 290 ft bgs (***Figure GWC-13***). Therefore, with respect to the principal aquifer, it is determined there is no interconnected surface water.

Based on the available data on depth to groundwater in the principal aquifer, it is determined there are no interconnected surface water systems within the SOKR GSP Area. As such depletion of interconnected surface water is not considered to be an issue.

## 8.8. Groundwater Dependent Ecosystems

**☑ 23 CCR § 354.16(g)**

Groundwater dependent ecosystems (GDEs) are those natural communities that depend on near-surface groundwater as a source of water. Guidance for identification of GDEs developed by The Nature Conservancy (TNC) states that groundwater depths less than 30 feet below ground surface are "generally accepted as being a proxy" for confirming that potential GDEs are actually supported by groundwater (TNC, 2019).[87] As discussed above, depths to groundwater in the principal aquifer are several hundred feet below ground surface, and it is therefore highly unlikely that any ecosystems depend on groundwater from this aquifer system.

DWR has developed a map of "Natural Communities Commonly Associated with Groundwater" for use by GSAs in identifying potential GDEs. The process for using the NCCAG dataset to identify and eliminate potential GDEs is described below for each Management Area, and is consistent with the guidance developed by The Nature Conservancy (TNC, 2019).

### 8.8.1. Arvin-Edison Management Area

***Figure GWC-37*** and ***Figure GWC-38*** show the distribution of NCCAG within the Arvin-Edison Management Area. As shown on ***Figure GWC-37*** and ***Figure GWC-38***, the primary area where NCCAG were identified is along Caliente Creek where it enters AEWSD from the east. Depth to groundwater at the nearest monitoring well (30S30E20D001M, located ~1,000 ft from the creek bed) is measured at 150 ft bgs as of Spring 2015. This serves to indicate that the vegetation communities surrounding Caliente Creek (i.e., mostly areas of scalebroom, with much smaller areas of quailbush and tamarisk) are likely not dependent

[87] https://groundwaterresourcehub.org/public/uploads/pdfs/TNC_NCdataset_BestPracticesGuide_2019.pdf

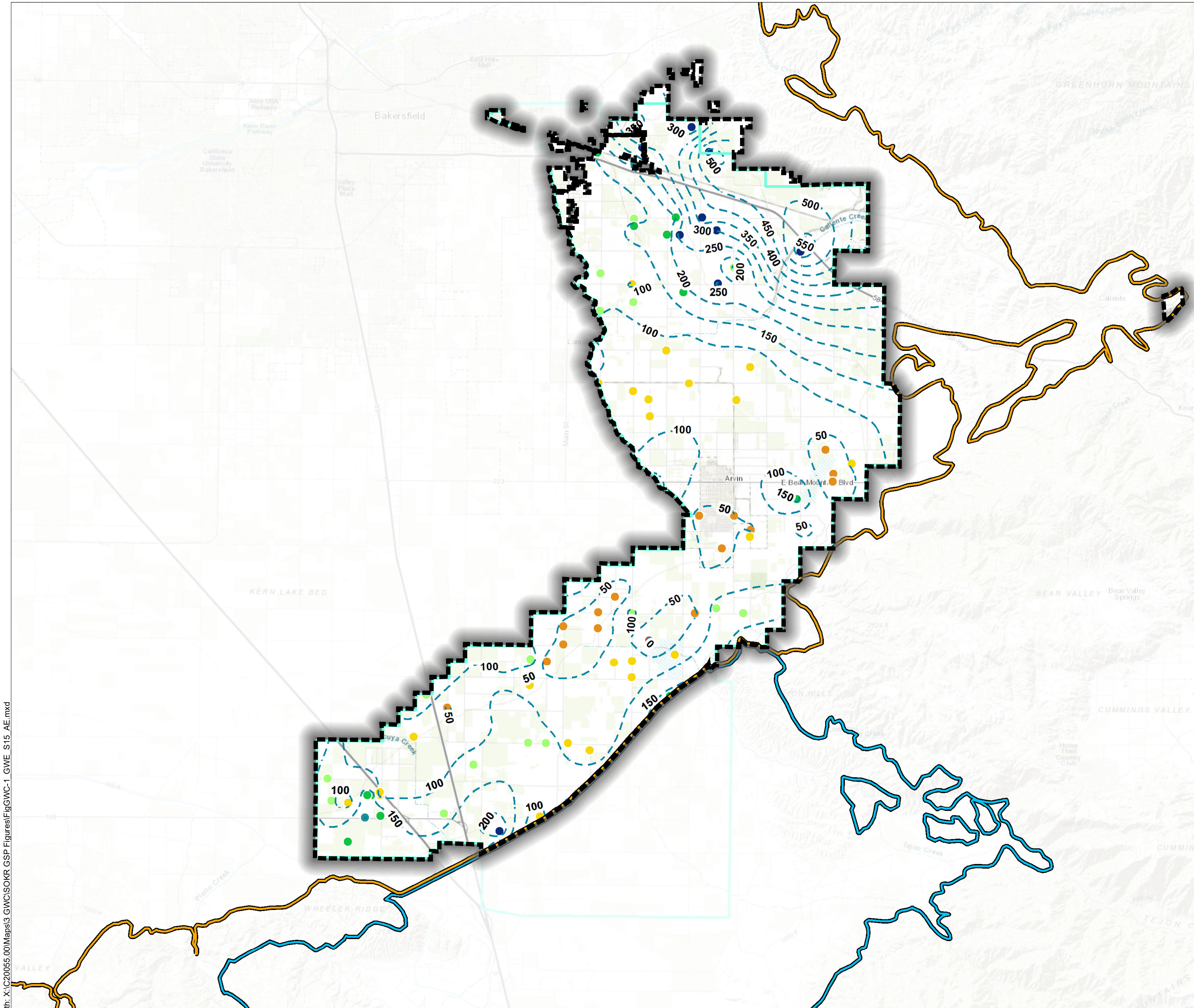
on groundwater from the principal aquifer system, but rather may derive necessary moisture from relatively shallow, wet, water-retentive soils disconnected from and far above the principal aquifer. Other potential GDE features identified by the NCCAG within the central portions of the Arvin-Edison Management Area are vegetation communities that generally line AEWSD's canal and spreading basin infrastructure, artificial reservoirs, ditches, or other small open water bodies. Based on groundwater level data collected from surrounding monitoring wells, depth to water is generally encountered below 300 ft bgs in these areas, indicating that these vegetation communities are not connected to the principal aquifer system and are therefore not considered to be GDEs.

### 8.8.2. Wheeler Ridge-Maricopa Management Area

As shown on ***Figure GWC-39***, the primary area within the Wheeler Ridge-Maricopa Management Area where NCCAG were identified is along the northern boundary of the Wheeler Ridge-Maricopa Management Area near the Kern Lake bed. These wetlands and vegetation may be connected to perched groundwater atop the fine-grained "basin" deposits in that area, where depth to groundwater is generally encountered at less than 20 ft bgs. This perched zone is not used for groundwater production within the Wheeler Ridge-Maricopa Management Area. Water level data collected from monitoring wells screening the principal aquifer in the area indicate depth to water of approximately 120-200 ft bgs in the area as of Spring 2015, suggesting that the perched zone is fully disconnected from the underlying principal aquifer. Due to the great depth of the principal aquifer, these vegetation communities (i.e., mostly areas of iodine bush, quailbush, and tamarisk) are likely not dependent on groundwater from the principal aquifer system. Other potential GDE features identified by the NCCAG within the north-central portions of the Wheeler Ridge-Maricopa Management Area are vegetation communities that generally line artificial reservoirs, ditches, or other small open water bodies within WRMWSD. Based on groundwater level data collected from surrounding monitoring wells, depth to water is generally encountered at 140-300 ft bgs in these areas, indicating that these vegetation communities are not connected to the principal aquifer system and are therefore not considered to be GDEs.

### 8.8.3. Tejon-Castac Management Area

***Figure GWC-40*** shows the distribution of NCCAG within the Tejon-Castac Management Area. As shown in this figure, the primary area where NCCAG were identified is along Caliente Creek where it enters the Tejon-Castac Management Area from the east and flows along the northern Tejon-Castac Management Area boundary. These vegetation communities (i.e., mostly areas of scalebroom, with much smaller areas of quailbush and tamarisk) are likely not dependent on groundwater from the principal aquifer system given the large depth to groundwater in the principal aquifer measured in this area (i.e., greater than 150 ft bgs, ***Figure GWC-13***), but rather may rely on near-surface moisture within the thin strip of streambed sediments adjacent to the creek which, based on groundwater level data discussed above, is likely disconnected from and far above the principal aquifer. As demonstrated in ***Figure GWC-13***, other potential GDE features identified by the NCCAG dataset in the southwest portion of the Tejon-Castac Management Area exist where depth to groundwater is generally encountered below 300 ft bgs, indicating that these vegetative communities are not connected to the principal aquifer system and are therefore not considered to be GDEs.




Legend

Arvin GSA

Arvin-Edison Water Storage District

Spring 2015 Groundwater Elevation (50 ft interval)

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Spring 2015 Groundwater Elevation (ft msl)**

<0

0 - 50

50 - 100

100 - 150

150 - 200

200 - 250

>250

Abbreviations

DWR = California Department of Water Resources
ft = feet
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.
2. Groundwater elevation contours are based on kriged data and are less certain in areas with sparse data.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Water level data provided by Arvin-Edison Water Storage District, Kern Delta Water District, and Wheeler Ridge-Maricopa Water Storage District.

N

0 3 6

(Scale in Miles)

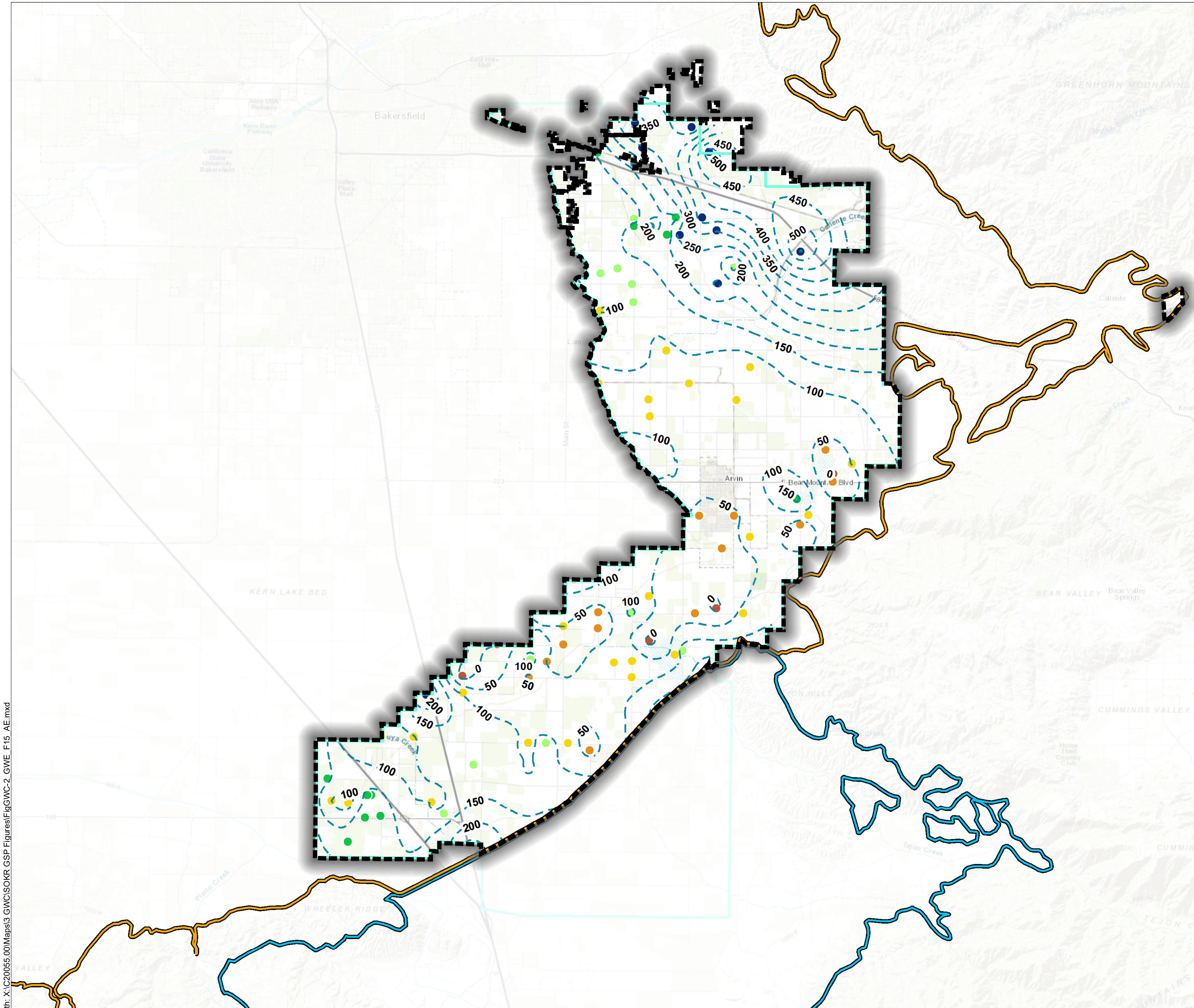
**Groundwater Elevations - Spring 2015**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-1**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-1_GWE_S15_AE.mxd




Legend

- Arvin GSA
- Arvin-Edison Water Storage District
- Fall 2015 Groundwater Elevation (50 ft interval)

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Fall 2015 Groundwater Elevation (ft msl)**

- <0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- >250

Abbreviations

DWR = California Department of Water Resources
ft = feet
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.
2. Groundwater elevation contours are based on kriged data and are less certain in areas with sparse data.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Water level data provided by Arvin-Edison Water Storage District, Kern Delta Water District, and Wheeler Ridge-Maricopa Water Storage District.

N

0 3 6

(Scale in Miles)

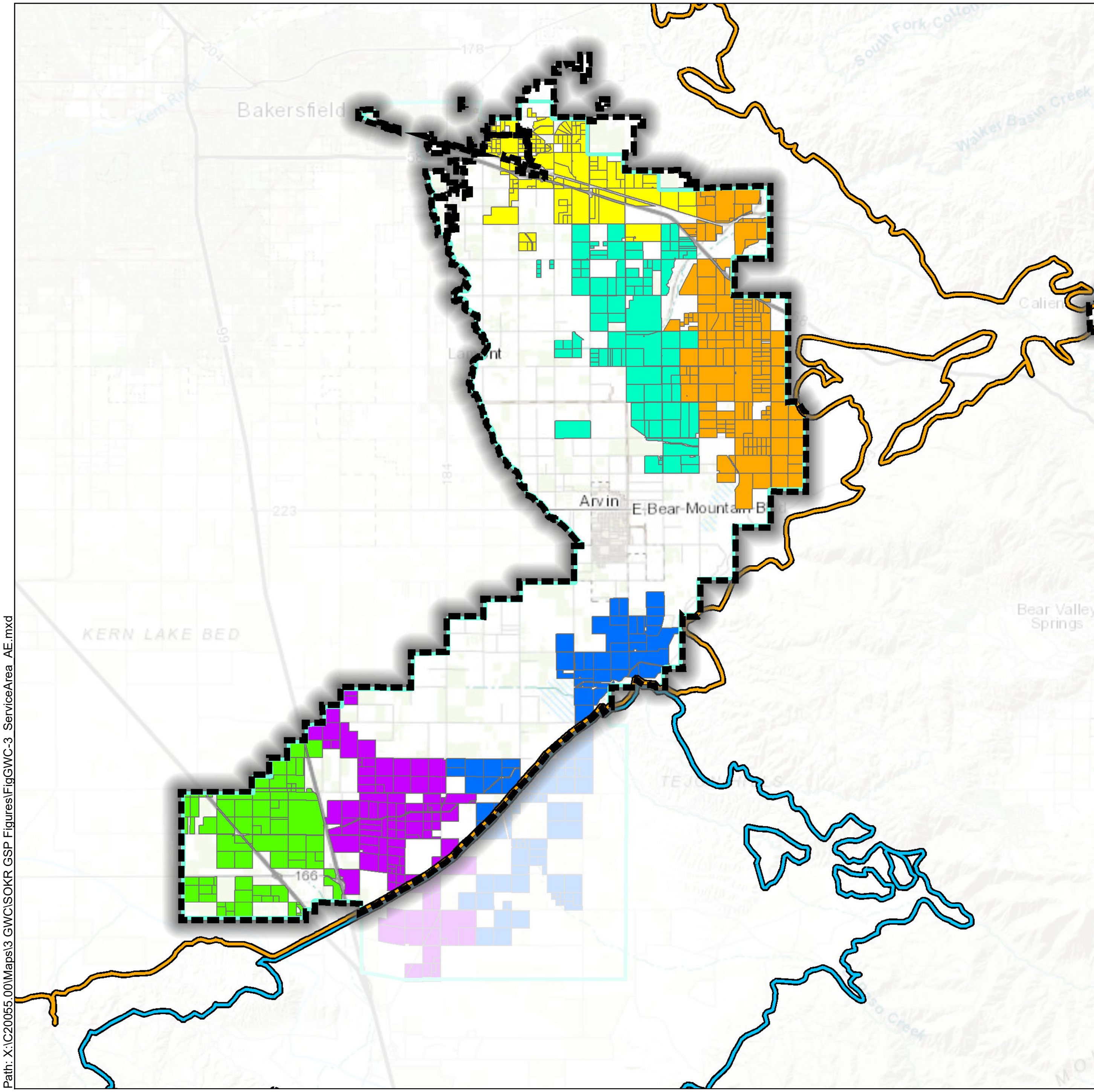
**Groundwater Elevations - Fall 2015**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure GWC-2**

eki environment & water

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-2_GWE_F15_AE.mxd




## Legend

- Arvin GSA
- Arvin-Edison Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**AEWSD Unit (SWSA)**

- Arvin
- Caliente
- Edison
- Mettler
- Tejon
- White Wolf

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
GSA = Groundwater Sustainability Agency
SWSA = Surface Water Service Area

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. AEWSD units and facility locations obtained from AEWSD on 3 March 2017.

N 0 5 10
Miles

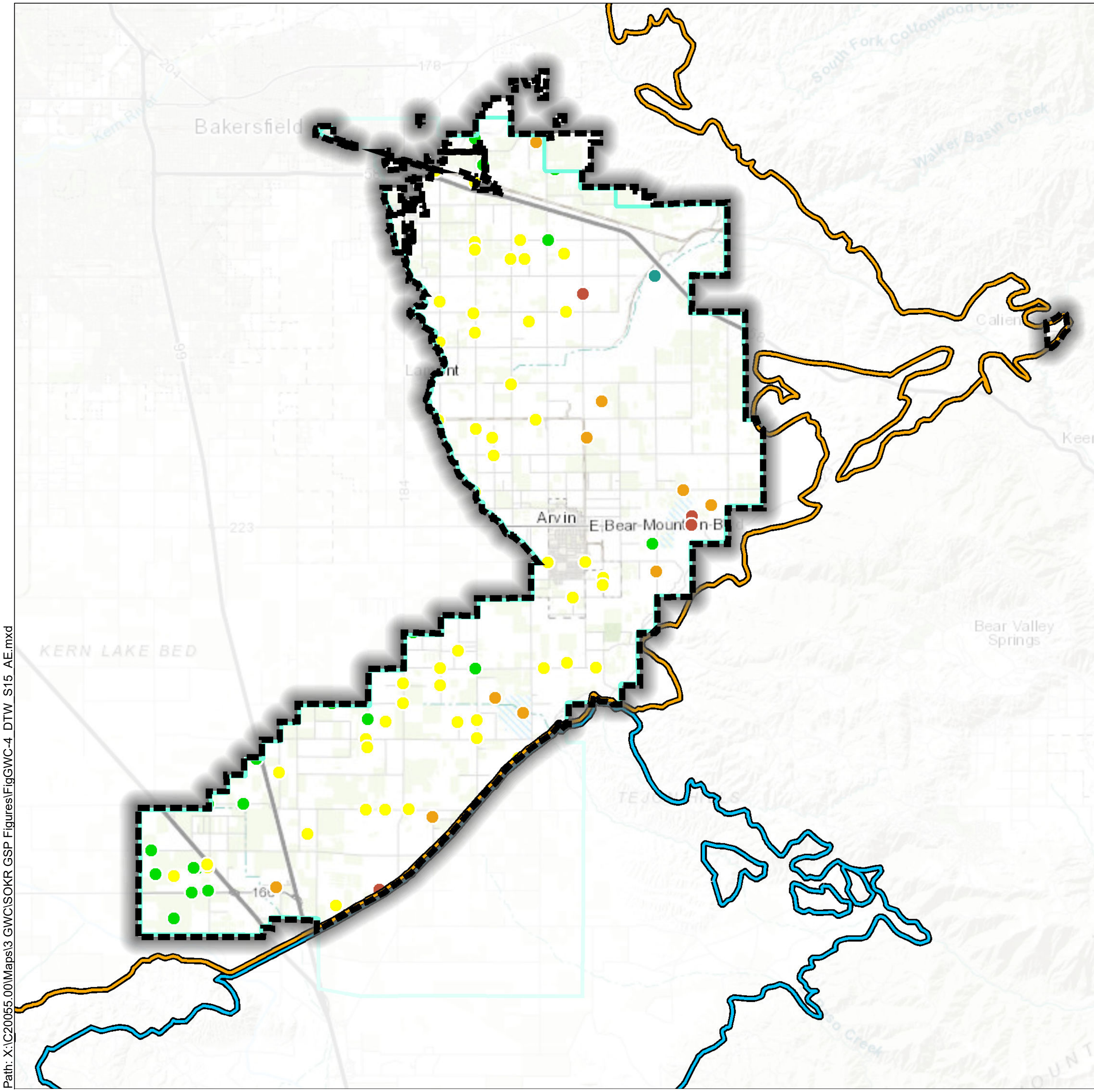
**Water Service Areas**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-3**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-3_ServiceArea_AE.mxd




## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Spring 2015 Depth to Groundwater (feet)**

- <100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- >500

## Abbreviations

DWR = California Department of Water Resources

GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Water level data provided by Arvin-Edison Water Storage District,Kern Delta Water District, and Wheeler Ridge-Maricopa Water Storage District.

N

0 5 10

Miles

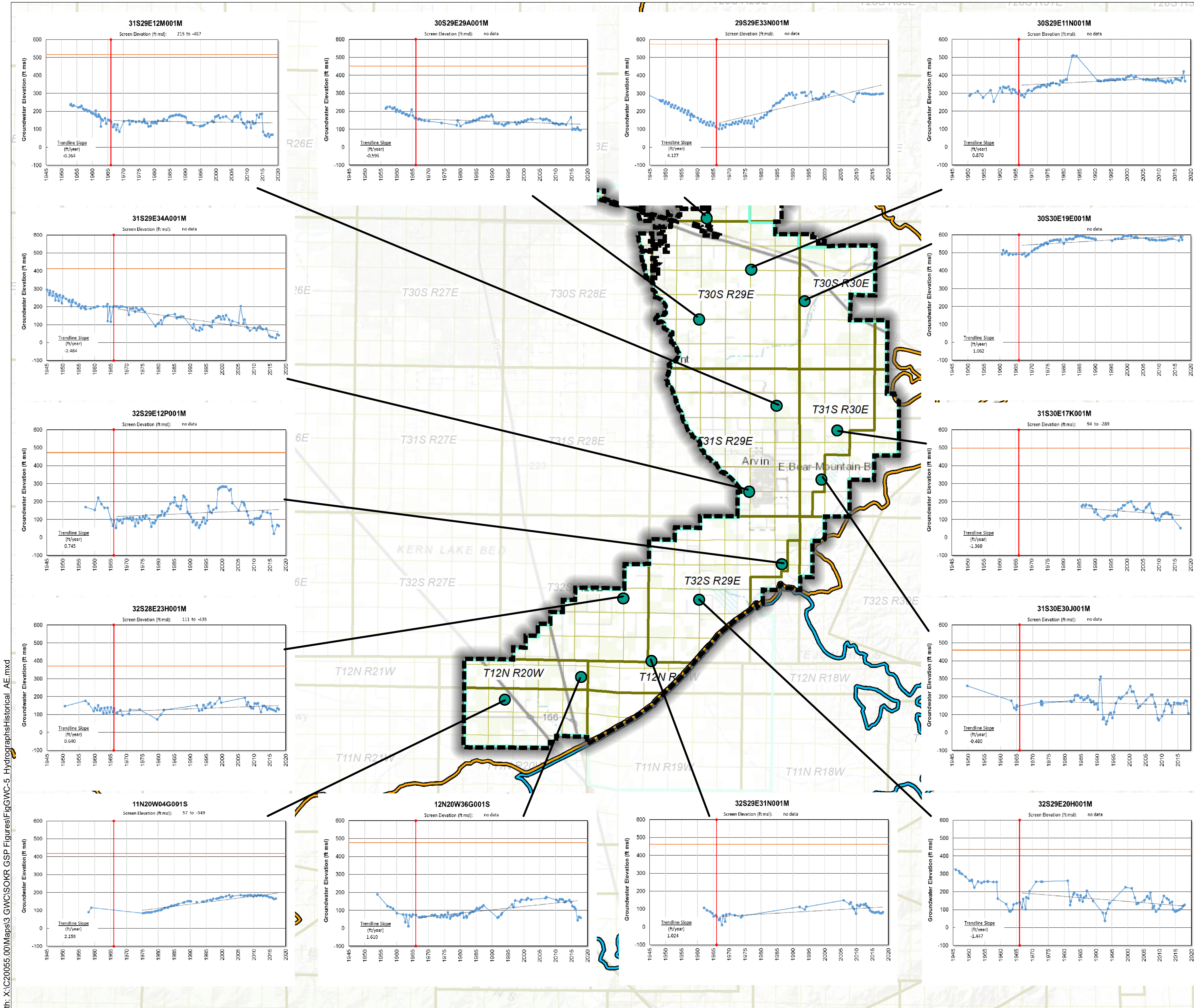
**Depth to Groundwater - Spring 2015**
**Arvin-Edison Management Area**

eki environment & water

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure GWC-4**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-4_DTW_S15_AE.mxd




## Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
ft bgs = feet below ground surface
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.
2. Hydrographs show the reference point elevation in solid orange line. Water levels from 1994 through 2004 are based on "spring" and "fall" measurements, assumed to occur on April 1 and October 1 of each year, respectively.
3. Water levels that showed a rate of change between consecutive measurements greater than 50 ft in 60 days, or a significant change without a reasonable hydrological explanation, were removed from the hydrographs.
4. Hydrograph trendlines are based on linear regression and only consider data since 1966 (i.e., since AEWSD began importing surface water) .

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Water level information obtained from AEWSD on 30 November 2017.

N

0 4 8

(Scale in Miles)

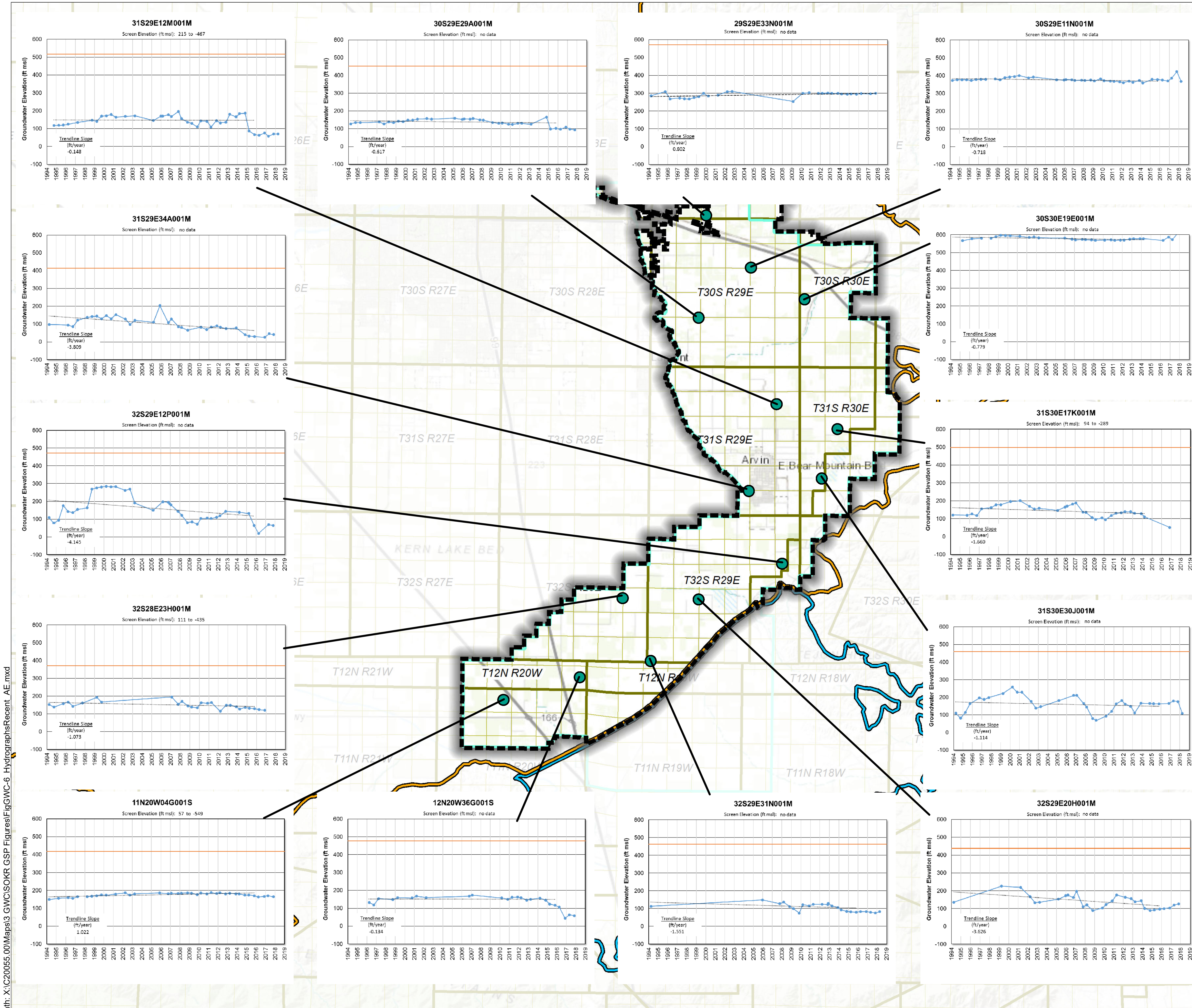
**Historical (1945-2018) Groundwater Elevation Hydrographs**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-5**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-5_HydrographsHistorical_AE.mxd




## Legend

- Arvin GSA
- Arvin-Edison Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
ft bgs = feet below ground surface
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
KGA = Kern Groundwater Authority

## Notes

1. All locations are approximate.
2. Hydrographs show the reference point elevation in solid orange line. Water levels from 1994 through 2004 are based on "spring" and "fall" measurements, assumed to occur on April 1 and October 1 of each year, respectively.
3. Water levels that showed a rate of change, between consecutive measurements points, greater than 50 ft in 60 days, or a significant change without a reasonable hydrological explanation, were removed.
4. Trendlines were based on linear regression and were calculated for the period 1994-2015, (i.e., the KGA period of interest).

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Water level information obtained from AEWSD on 30 November 2017.

N

0 4 8
(Scale in Miles)

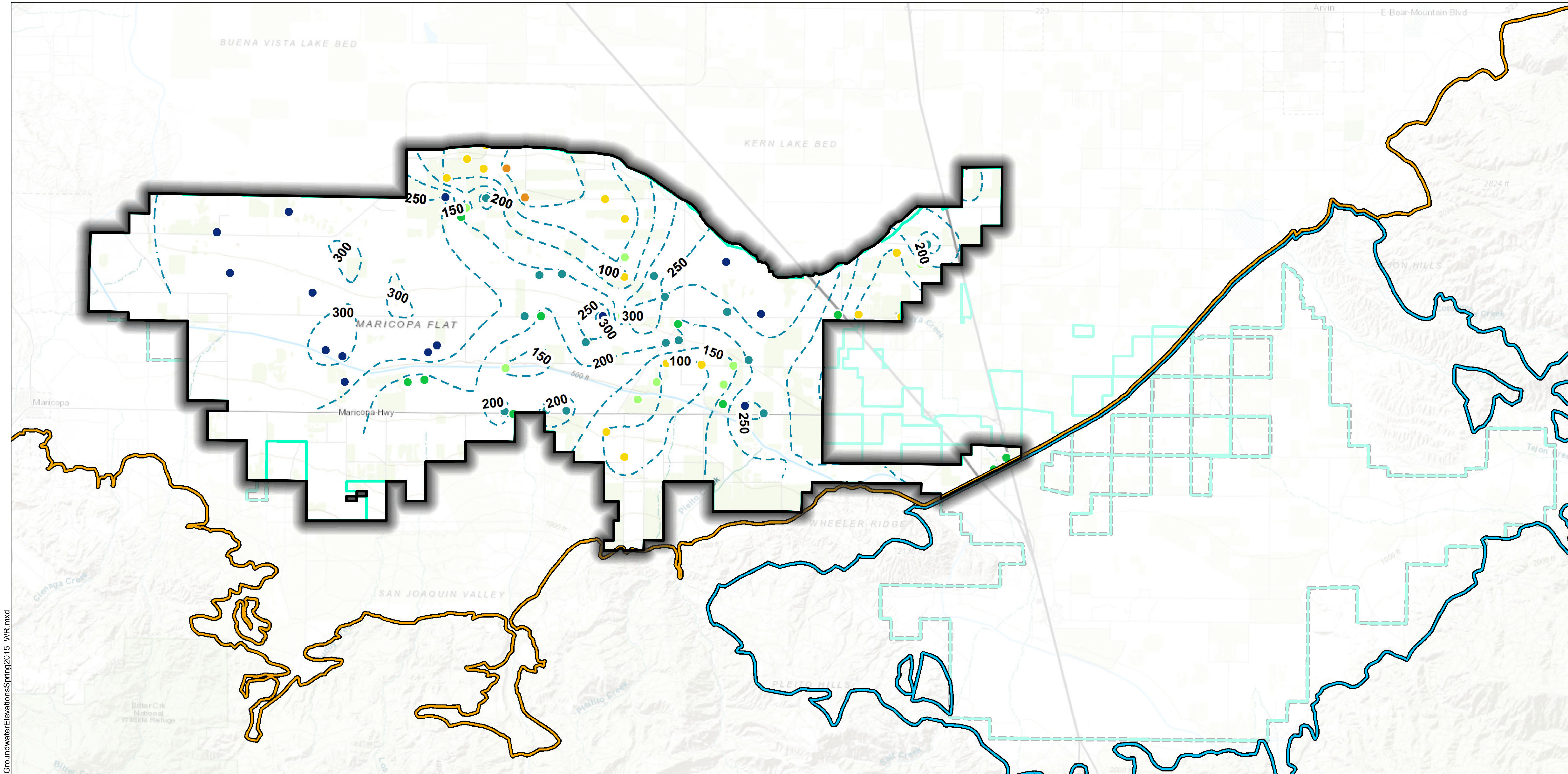
**Recent (1994-2017) Groundwater Elevation Hydrographs**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-6**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-6_HydrographsRecent_AE.mxd




Legend

Wheeler Ridge-Maricopa GSA
Wheeler Ridge-Maricopa Water Storage District
WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

Kern County (DWR 5-022.14)
White Wolf (DWR 5-022.18)
Spring 2015 Groundwater Elevation (50 ft interval)

**Spring 2015 Groundwater Elevation (ft msl)**

- <0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- >250

Abbreviations

DWR = California Department of Water Resources
ft = feet
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

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

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Water level data provided by Arvin-Edison Water Storage District, Kern Delta Water District, and WRMWSD.

N

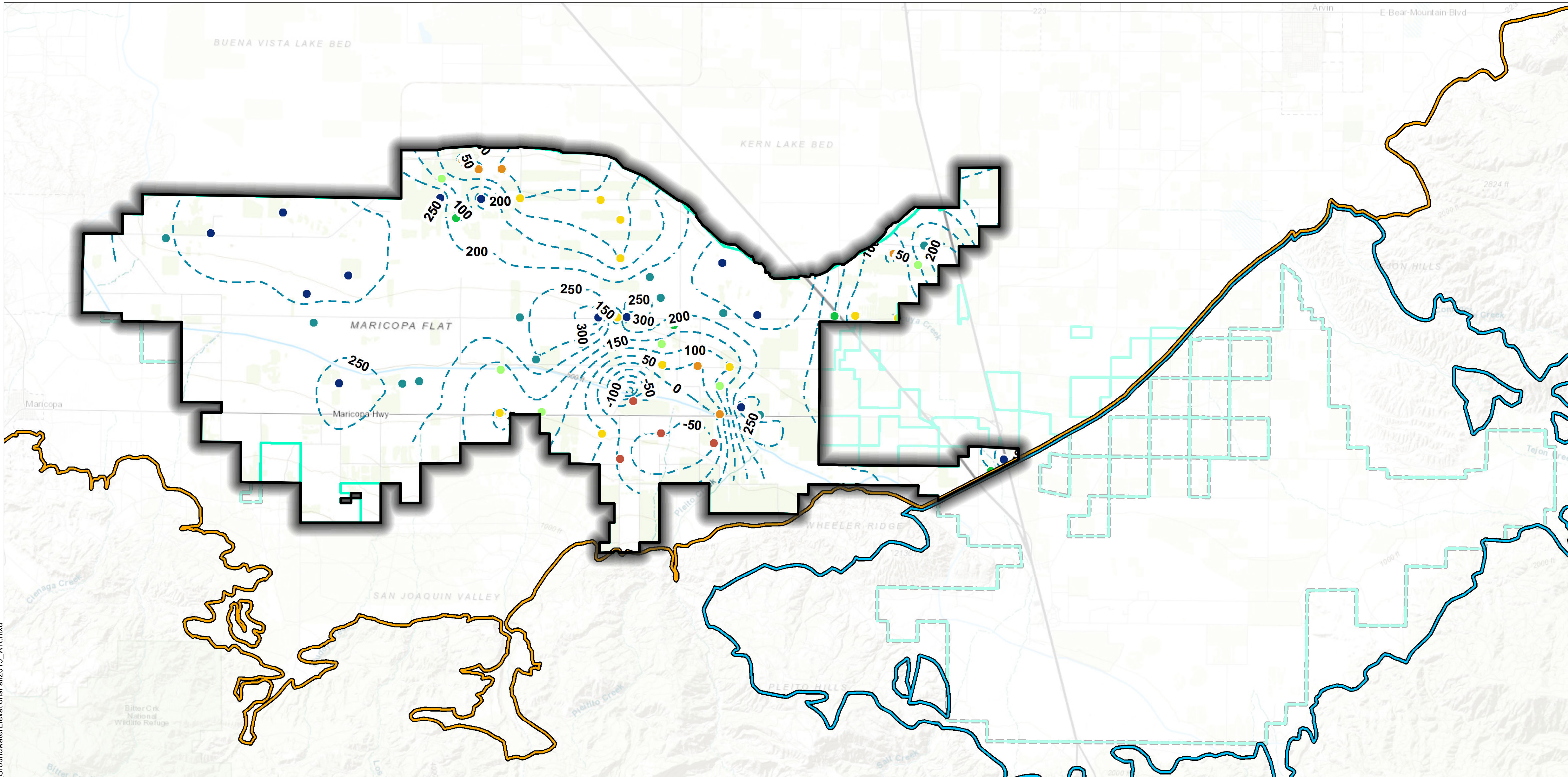
0 2.5 5
(Scale in Miles)

**Groundwater Elevations Spring 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

**Figure GWC-7**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-7_GroundwaterElevationsSpring2015_WR.mxd




## Legend

Wheeler Ridge-Maricopa GSA
Wheeler Ridge-Maricopa Water Storage District
WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

Kern County (DWR 5-022.14)
White Wolf (DWR 5-022.18)

**Fall 2015 Groundwater Elevation (ft msl)**

- <0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- >250

## Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft | = feet |
| ft msl | = feet above mean sea level |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

## Notes

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

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Water level data provided by Arvin-Edison Water Storage District, Kern Delta Water District, and WRMWSD.

N

0 2.5 5

(Scale in Miles)

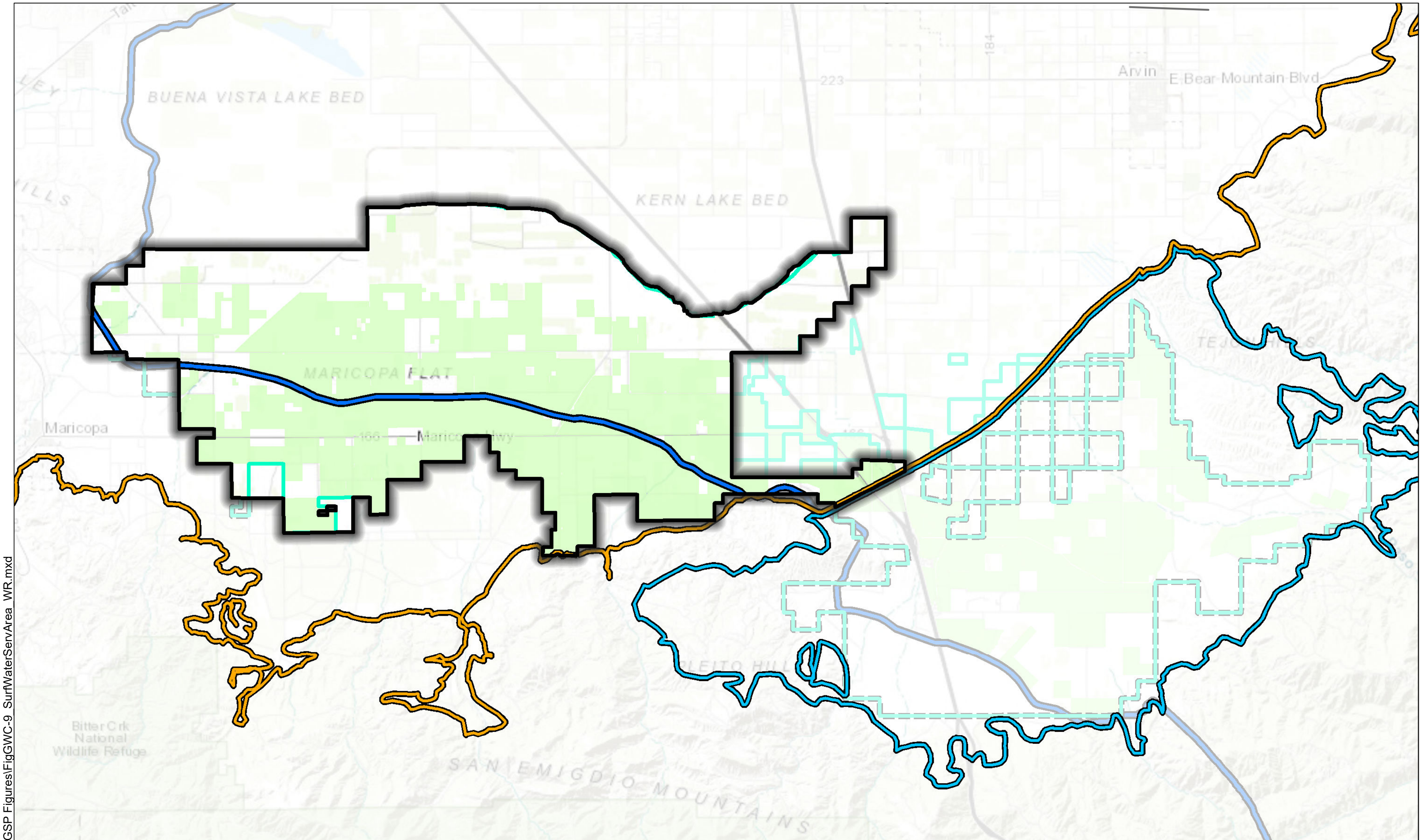
**Groundwater Elevations Fall 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-8**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-8_GroundwaterElevationsFall2015_WR.mxd




Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Surface Water Feature**

- California Aqueduct
- WRMWSD Surface Water Service Area

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
NHD = National Hydrography Dataset
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Surface water features and California Aqueduct location from NHD (https://viewer.nationalmap.gov/basic/).
3. Surface Water Service Area acquired from WRMWSD staff on 21 November 2017.

N 0 5 10 (Scale in Miles)

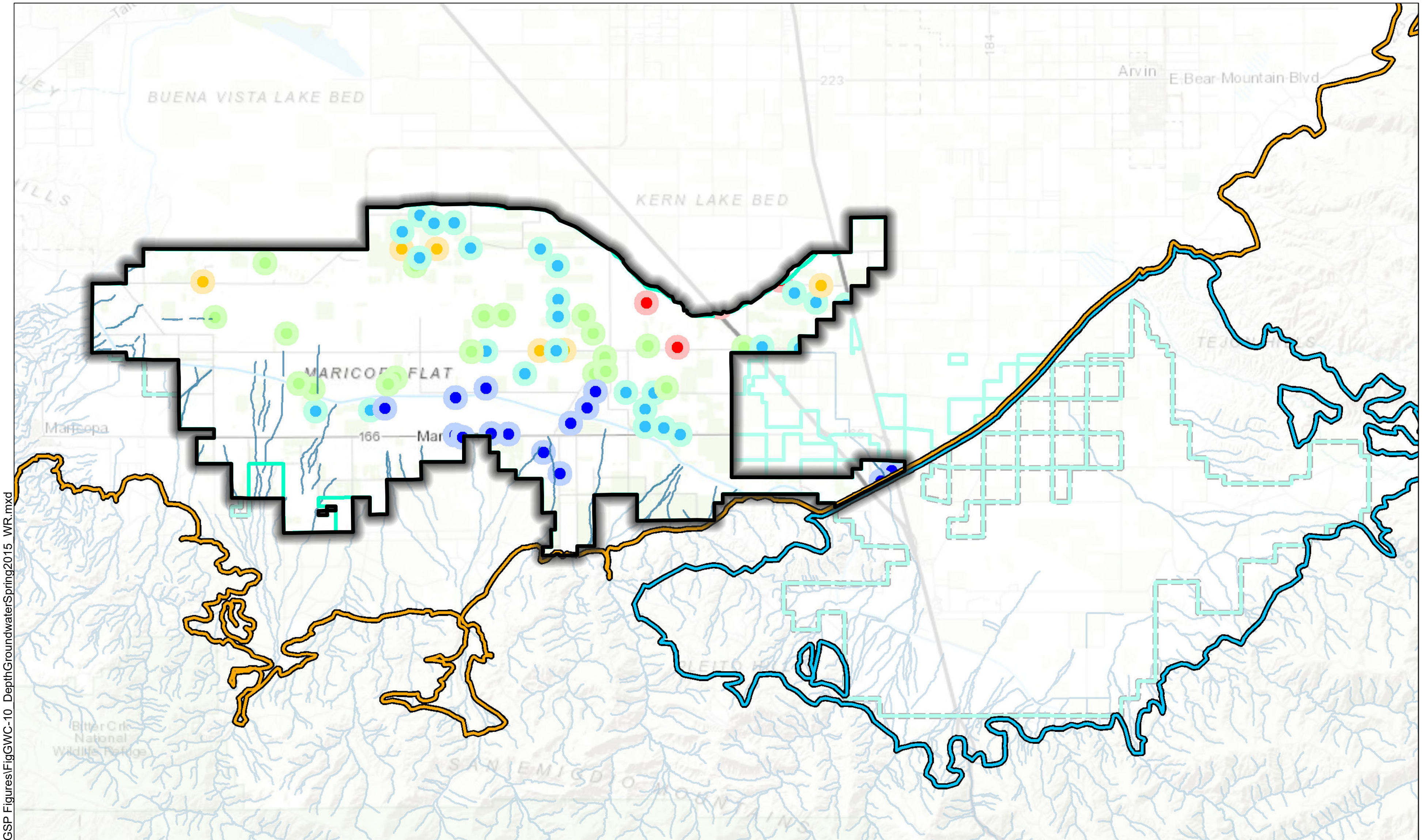
**Surface Water Service Area**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-9**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-9_SurfWaterServArea_WR.mxd




Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Stream into WRMWSD

**Spring 2015 Depth to Groundwater (ft bgs)**

- 0 - 50
- 50 - 100
- 100 - 200
- 200 - 350
- > 350

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft bgs | = ft below ground surface |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Depth to groundwater data provided by WRMWSD on 8 December 2017.

N

0 5 10

(Scale in Miles)

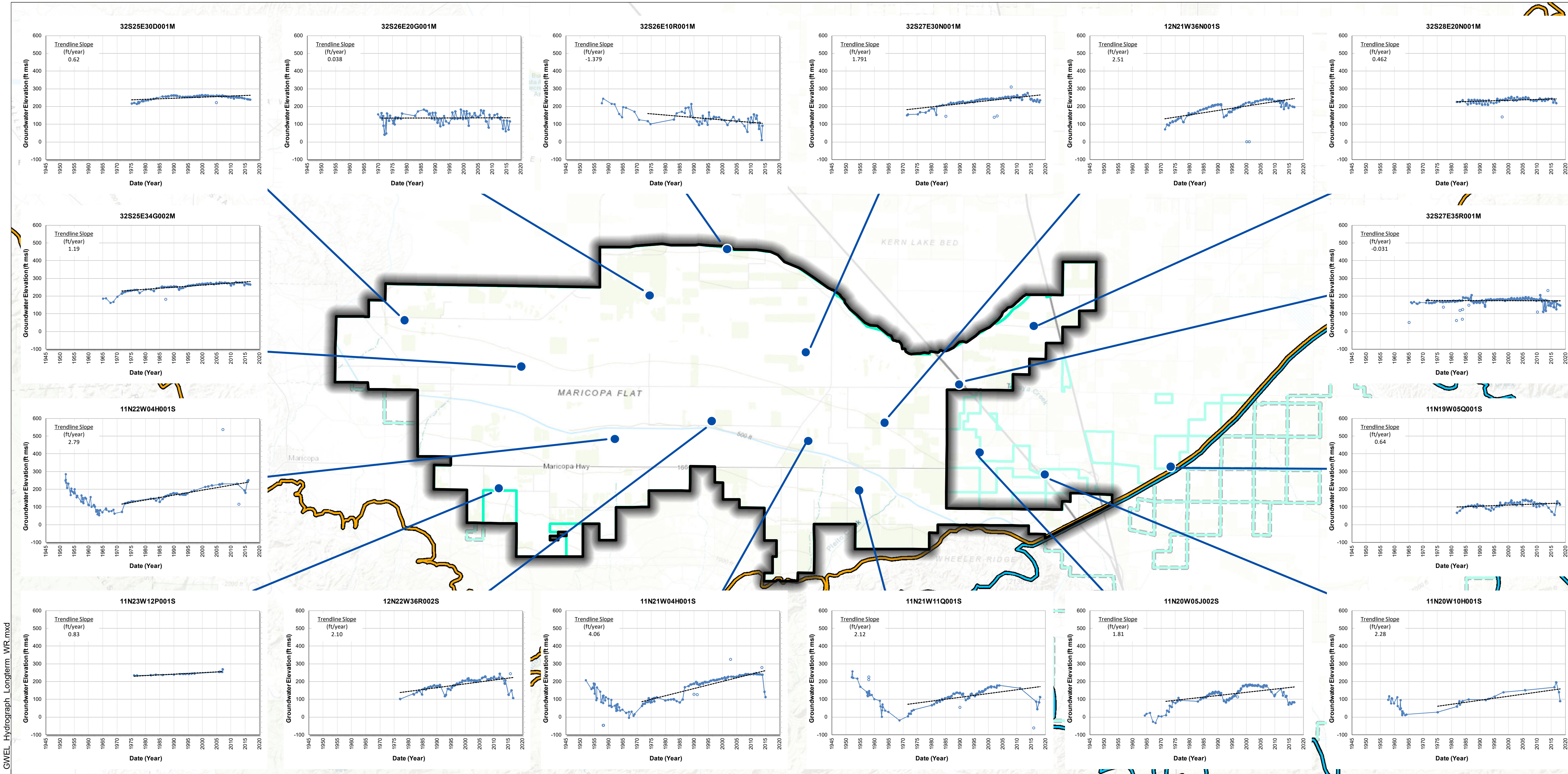
**Depth to Groundwater Spring 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-10**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-10_DepthGroundwaterSpring2015_WR.mxd




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Groundwater Monitoring Well
- Groundwater Elevation Measurement
- Groundwater Elevation Measurement, Apparent Outlier

## Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. The water level trend was calculating using linear regression on all non-outlier data between 1 January 1971 and 1 August 2018.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Groundwater elevation data provided by WRMWSD on 8 December 2017.

N
0 3 6
(Scale in Miles)

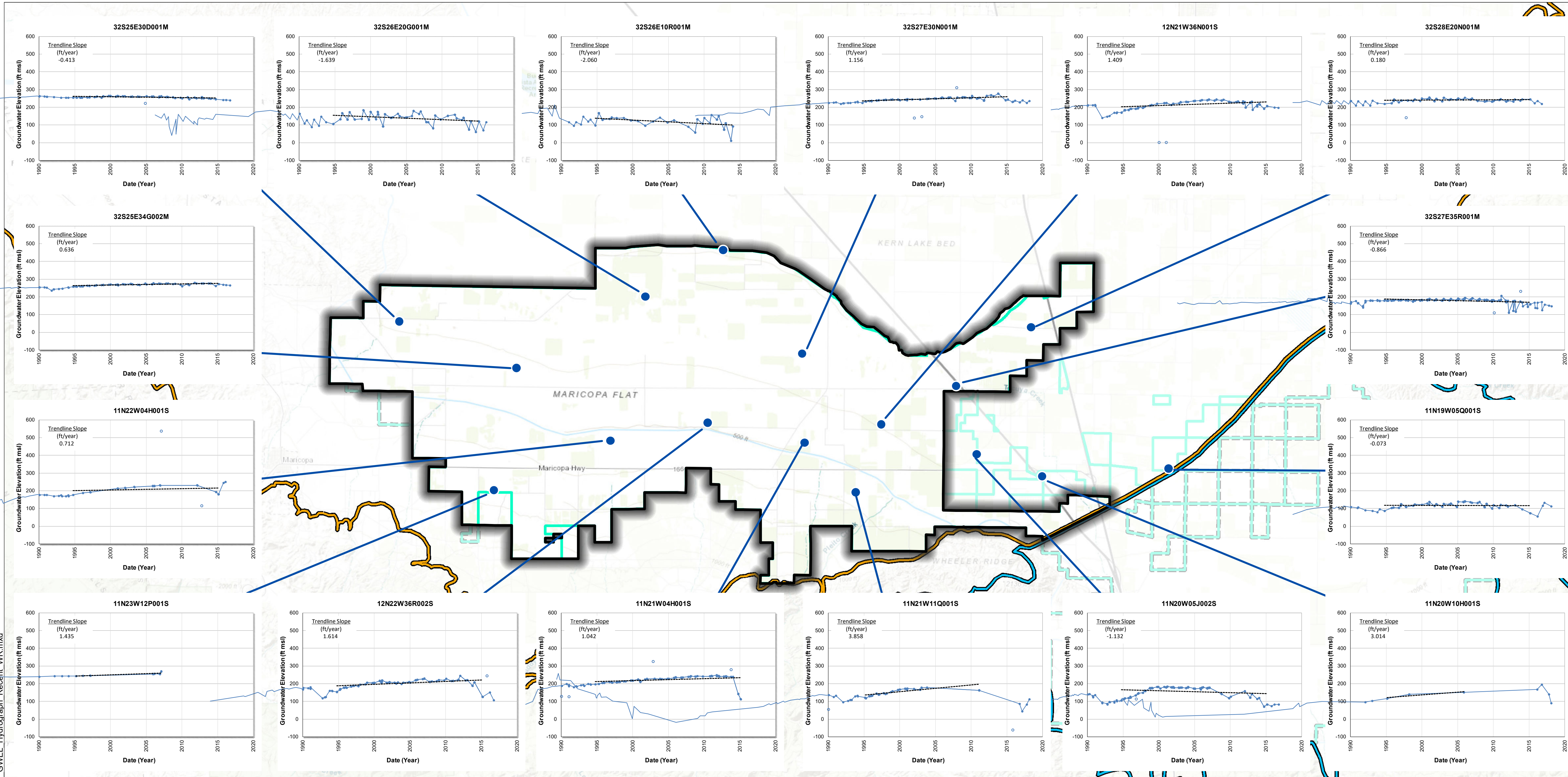
**Historical (1955-2018) Groundwater Elevation Hydrographs**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-11**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-11_GWEL_Hydrograph_Longterm_WR.mxd




Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-12_GWEL_Hydrograph_Recent_WR.mxd

## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Groundwater Monitoring Well
- Groundwater Elevation Measurement
- Groundwater Elevation Measurement, Apparent Outlier

## Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft msl | = feet above mean sea level |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

## Notes

1. All locations are approximate.
2. The water level trend was calculating using linear regression on all non-outlier data between 1 October 1994 and 30 September 2015.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Groundwater elevation data provided by WRMWSD on 8 December 2017.

N

0 3 6

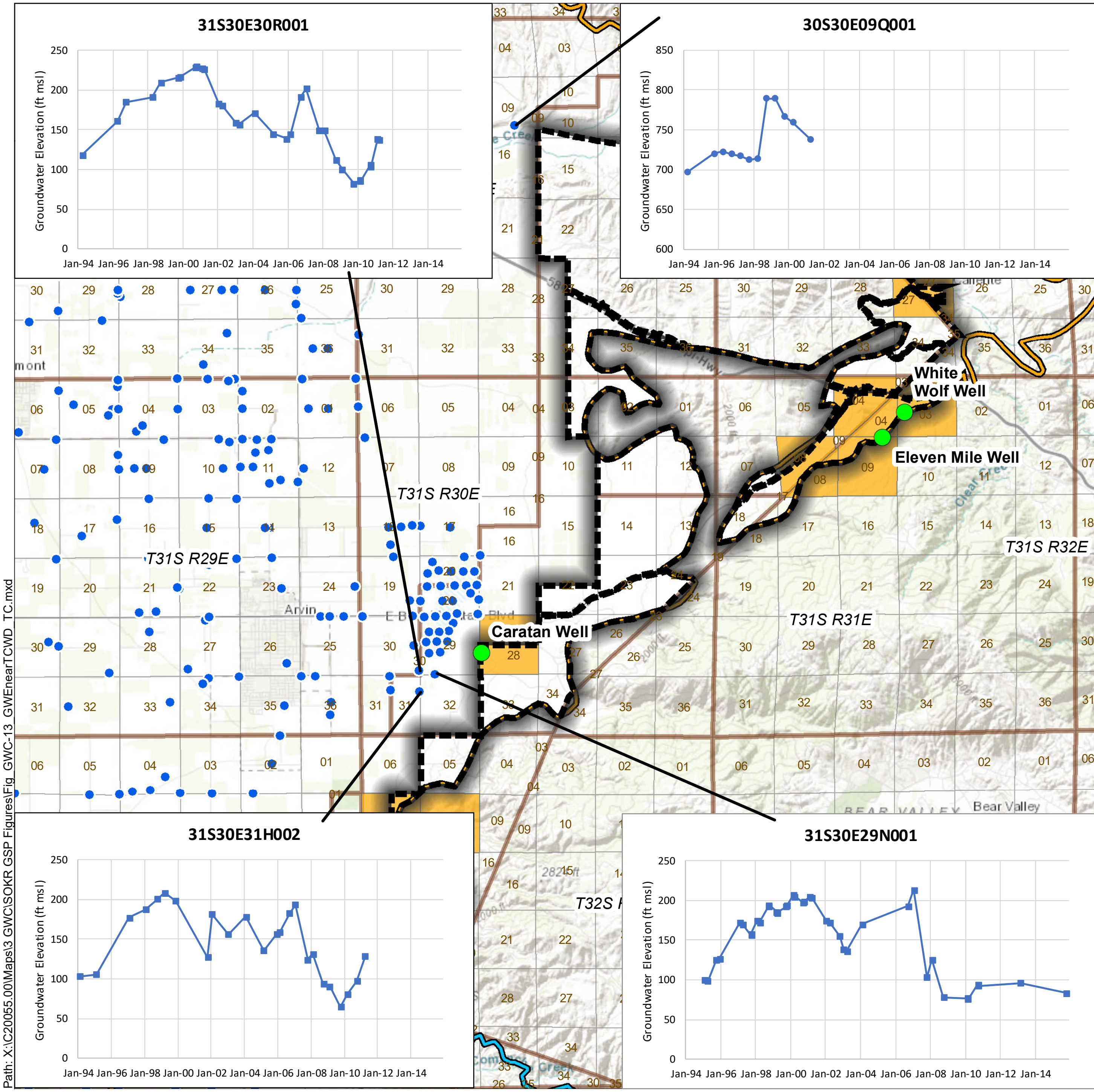
(Scale in Miles)

**Recent (1994-2015) Groundwater Elevation Hydrographs**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-12**




## Legend

Tejon-Castac Water District GSA

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

AEWSD MA Well

TCWD MA Well

PLSS Section with DWR WCRs (see Note 2)

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MA = Management Area
PLSS = The Public Land Survey System
TCWD = Tejon-Castac Water District
WCR = well completion report

## Notes

1. All locations are approximate.
2. According to DWR's WCRs, 15 wells have been constructed in PLSS sections that at least partially overlie the TCWD MA, however, these wells might not be within the TCWD MA.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Groundwater elevation data from AEWSD.

N 0 3 6
Miles

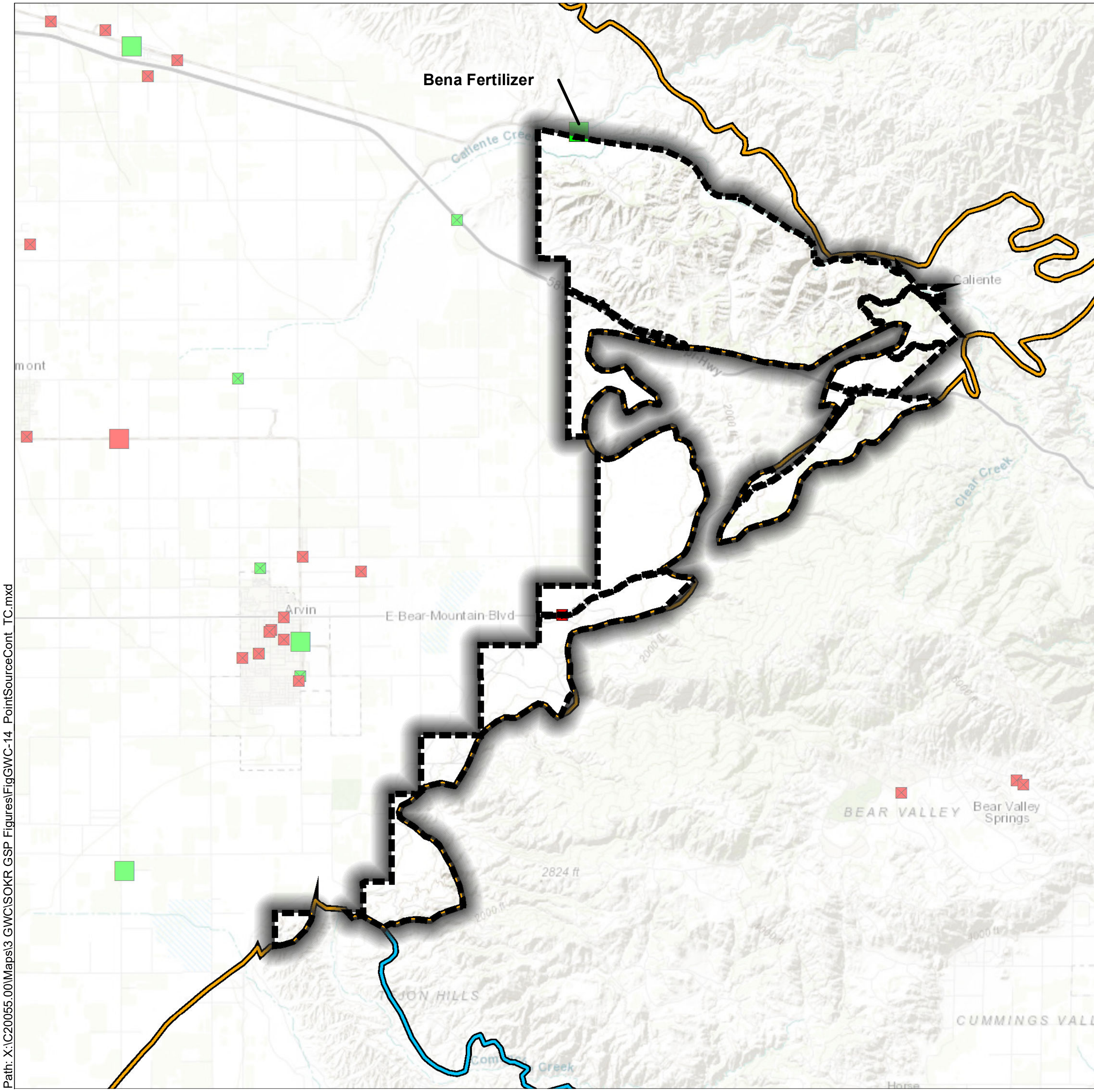
**Groundwater Elevations in the Vicinity of TCWD MA**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-13**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\Fig_GWC-13_GWEnearTCWD_TC.mxd




## Legend

Tejon-Castac Water District GSA

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**GeoTracker Sites**

Cleanup Program Site, Open

Cleanup Program Site, Closed

LUST Cleanup Site, Open

LUST Cleanup Site, Closed

## Abbreviations

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

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Locations of contamination sites from SWRCB GeoTracker website (http://geotracker.waterboards.ca.gov/datadownload), accessed 10 March 2017.

N 0 3 6 Miles

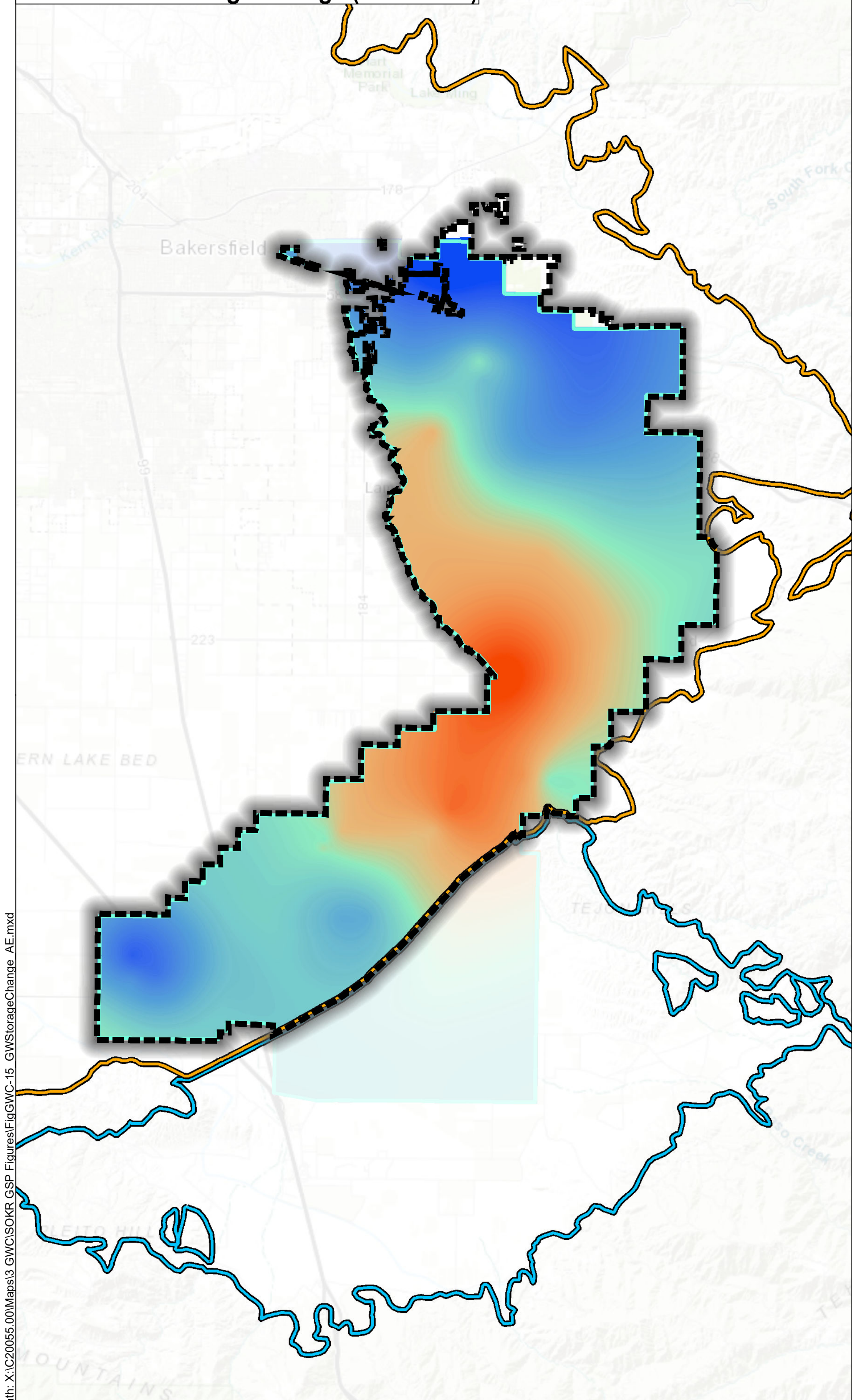
**Point Source Contamination Sites**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

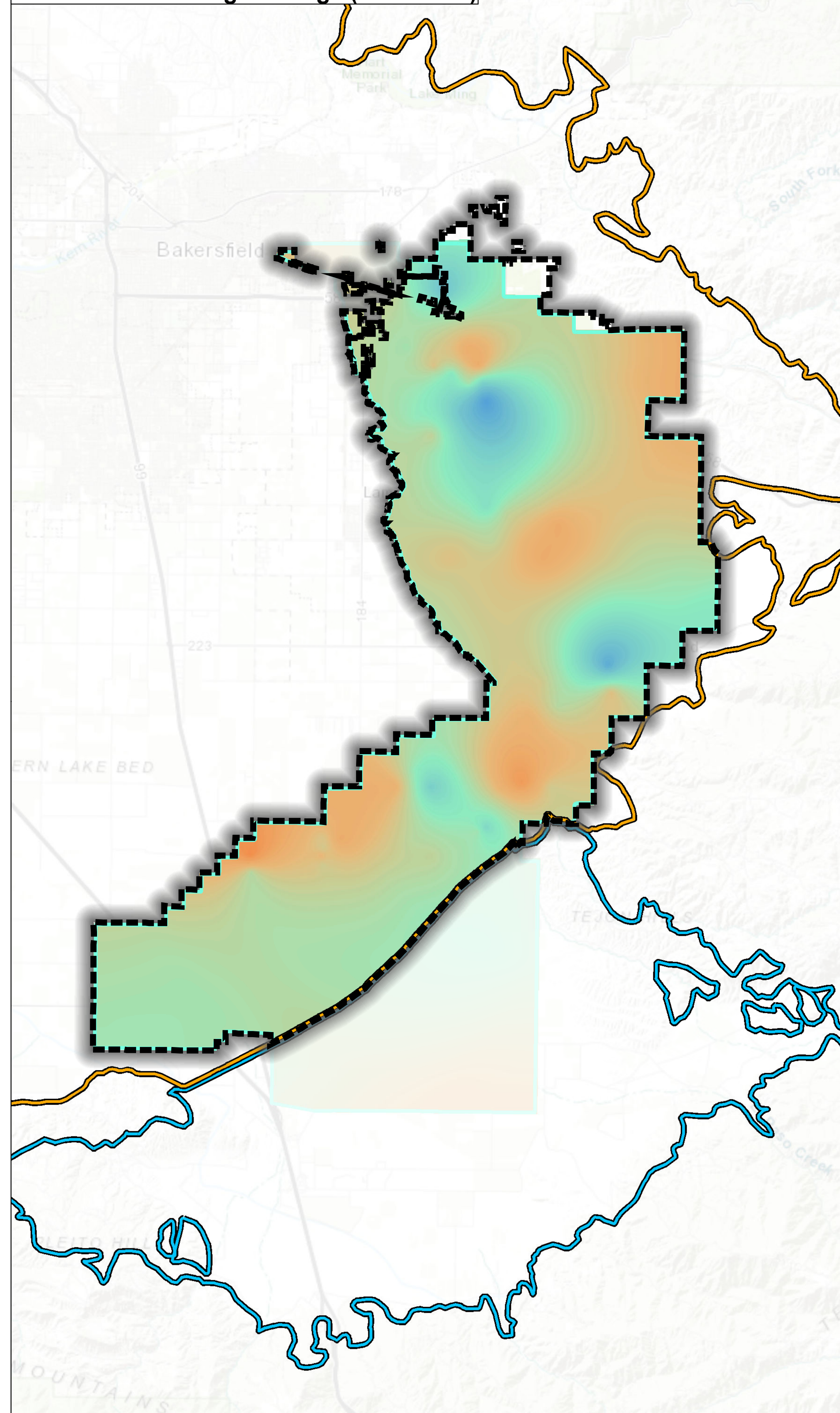
eki environment & water

**Figure GWC-14**

Groundwater Storage Change (1966-2016)




Groundwater Storage Change (1994-2015)




Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Groundwater Storage Change (acre-feet/acre)**

High : 15

Low : -12

Abbreviations

| | |
|---|---|
| AEWSD | = Arvin-Edison Water Storage District |
| C2VSim-FG | = California Central Valley Groundwater-Surface Water Simulation Model-Fine Grid |
| DWR | = California Department of Water Resources |
| ft | = feet |
| GSA | = Groundwater Sustainability Agency |

Notes

1. All locations are approximate.
2. Groundwater storage change shown as feet change in each 100 ft by 100 ft cell. Groundwater elevation data and C2VSim-FG Layer-1 specific yield data were interpolated using kriging, and the difference in groundwater elevation was multiplied by specific yield to calculate groundwater storage change.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Groundwater elevation data provided by AEWSD staff.
3. C2VSim Model data obtained from DWR website: https://www.water.ca.gov/Library/Modeling-and-Analysis/Central-Valley-models-and-tools/C2VSim

N

0 4 8

(Scale in Miles)

**Groundwater Storage Change - 1966-2016 and 1994-2015**

**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure GWC-15**

eki environment & water

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\Fig\GWC-15_GWStorageChange_AE.mxd


Legend

***DWR Water Year Type***

= Wet

= Above Normal

= Below Normal

= Dry

= Critical

Abbreviations

AFY = acre-feet per year

Notes

1. "Seasonal high" condition is defined as March – February of the following year.
2. Annual groundwater change between "seasonal highs" of 2015 – 2016 only includes March – December 2015.
3. The color of each bar is based on the Water Year type for the Water Year the begins in the October between the March and February represented by the bar.

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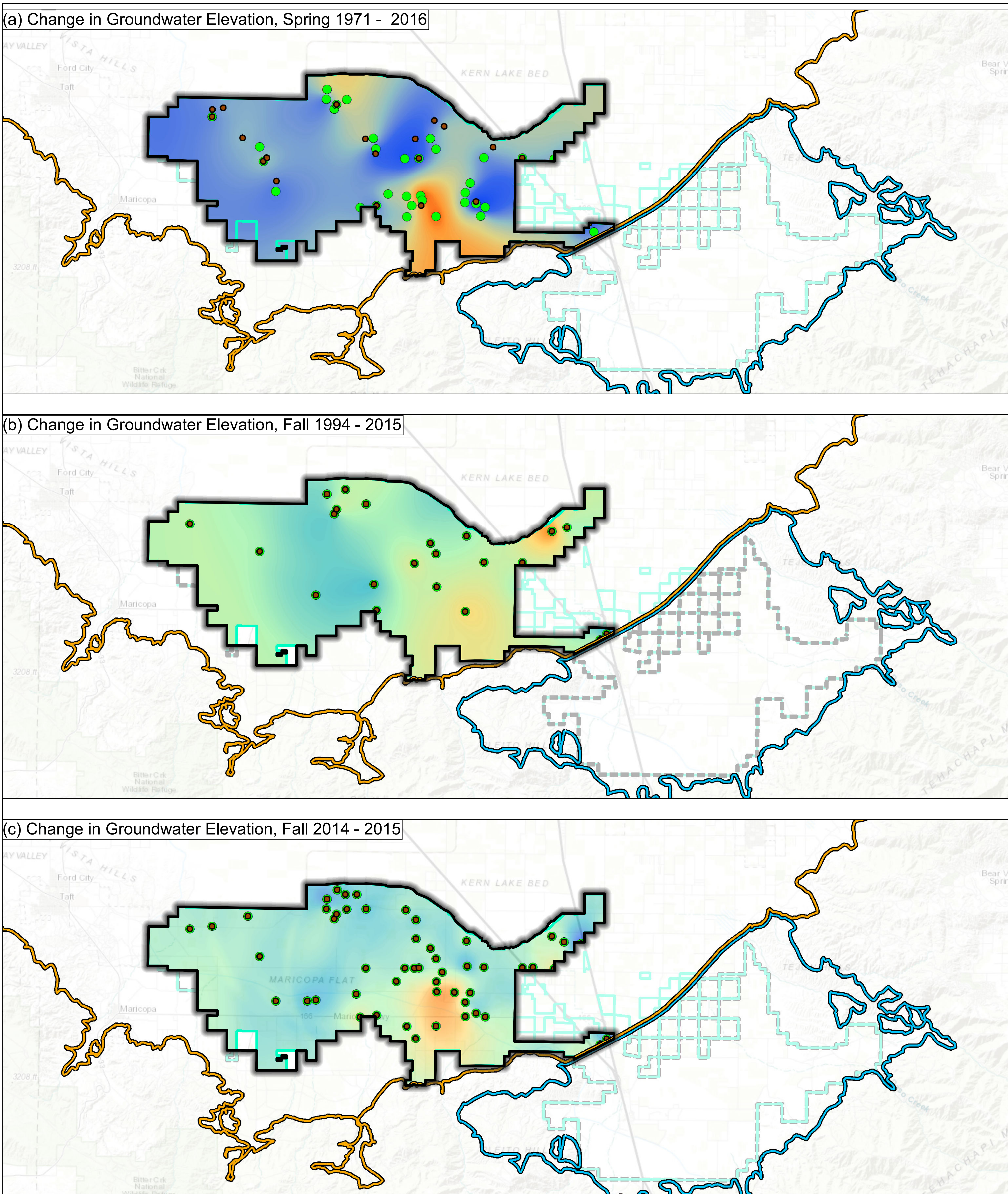
**Annual Change in Storage Between Seasonal Highs vs. DWR Water Year Type**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure GWC-16**




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Starting Groundwater Elevation
- Ending Groundwater Elevation

**Groundwater Elevation Change (ft)**

220
100
0
-100
-200
-270

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
USGS = United States Geological Survey
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. Groundwater elevation change shown as feet change in each 100 ft by 100 ft call. Groundwater elevation data were interpolated using kriging for each year, and the difference was calculated using GIS tools.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Groundwater elevaiton data provided by WRMWSD staff on 8 December 2017.

N
0 5 10
(Scale in Miles)

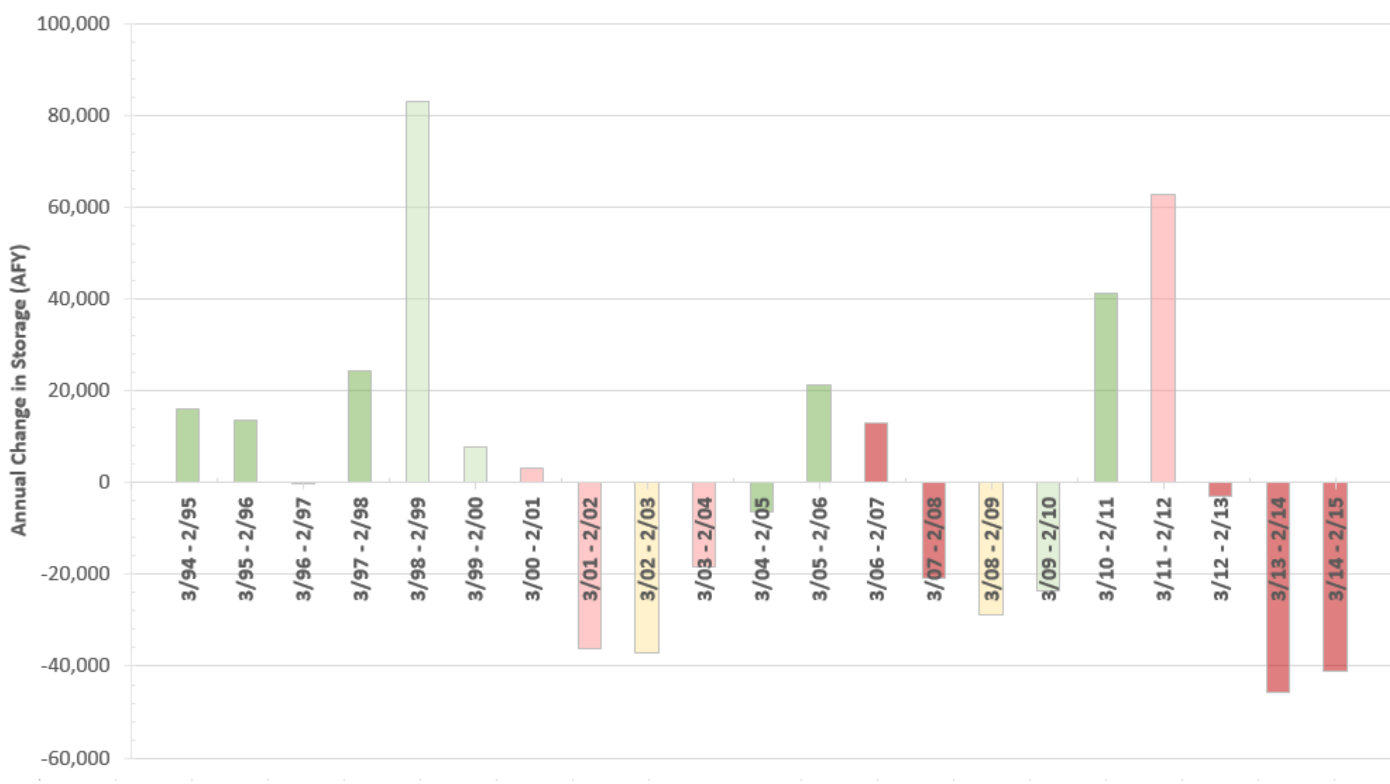
**Groundwater Elevation Change 1971 - 2016, 1994 - 2015, and 2014 - 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-17**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-17_GW_ChangeinStorage_WR.mxd




Legend

***DWR Water Year Type***

= Wet

= Above Normal

= Below Normal

= Dry

= Critical

Abbreviations

AFY = acre-feet per year

Notes

1. "Seasonal high" condition is defined as March – February of the following year.
2. The color of each bar is based on the Water Year type for the Water Year the begins in the October between the March and February represented by the bar.

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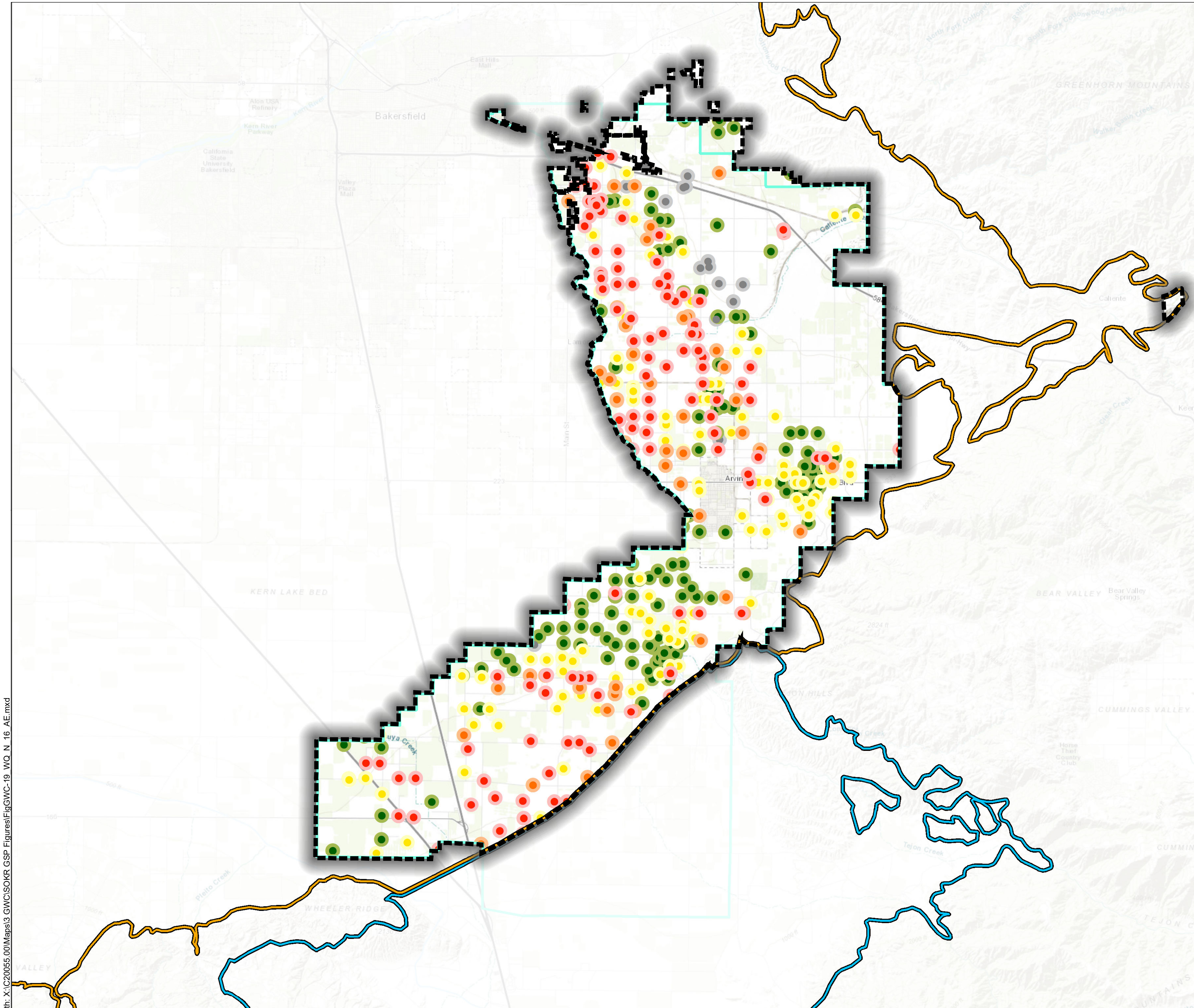
**Annual Change in Storage Between Seasonal Highs vs. DWR Water Year Type Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure GWC-18**




Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Nitrate (as NO3) Concentration (mg/L)**

ND (< 0.1)

0.1 - 10

10 - 30

30 - 45

> 45

Abbreviations

AEWSD = Arvin-Edison Water Storage District
CCR = California Code of Regulations
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
MCL = Maximum Contaminant Level
mg/L = milligrams per Liter
ND = Not Detected
NO3 = Nitrate

Notes

1. All locations are approximate.
2. CCR 22-4 Table 64431-A lists the Primary MCL for Nitrate (as NO3) as 45 mg/L.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. In-District water quality data obtained from AEWSD on 30 September 2017.

N

0 3 6

(Scale in Miles)

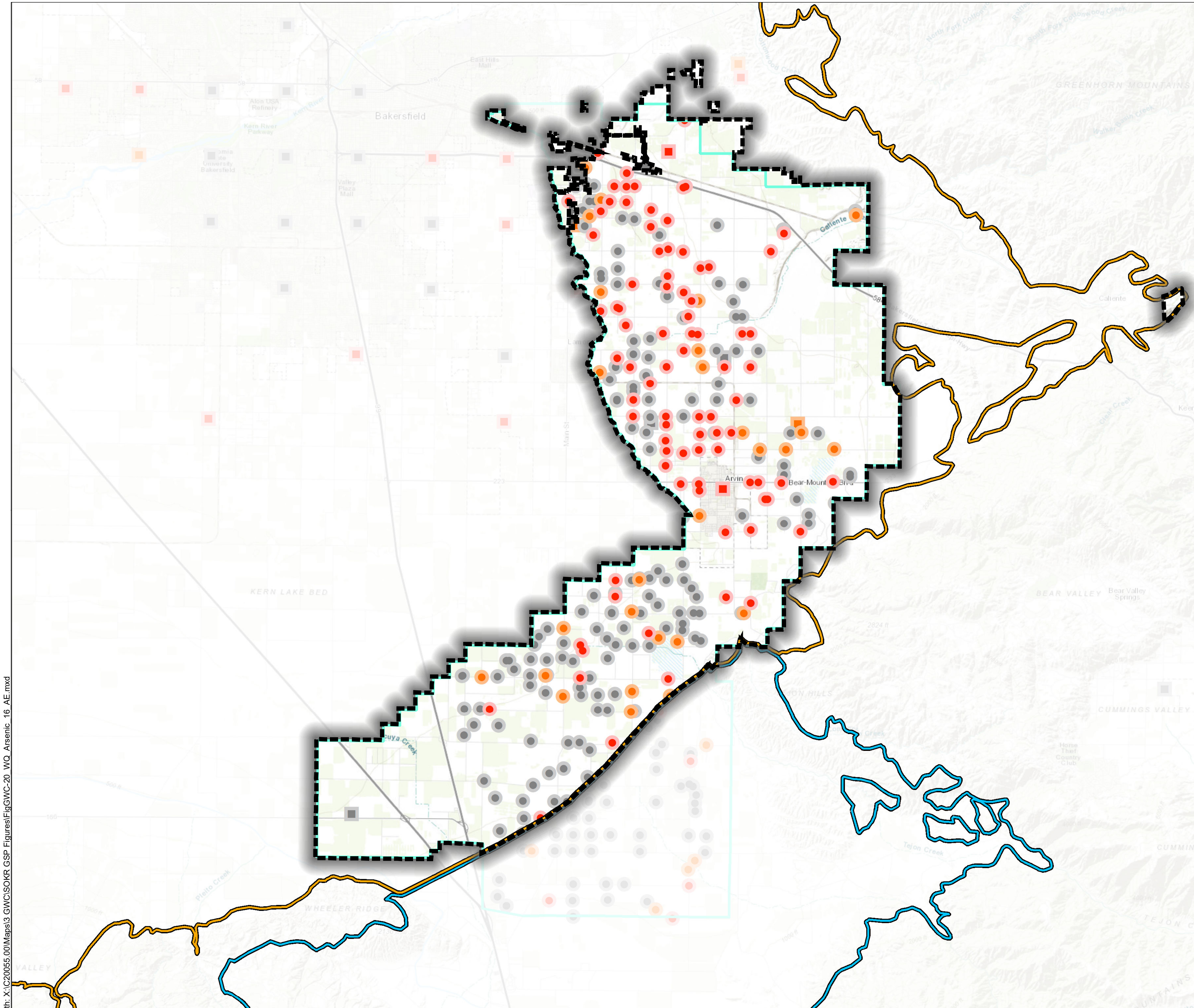
**Groundwater Quality - Nitrate (as NO3) Concentrations (2016)**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-19**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-19_WQ_N_16_AE.mxd




**Legend**

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Total Recoverable Arsenic Concentration (ug/L)**

ND (< 7.8)

7.8 - 10

> 10

**Abbreviations**

AEWSD = Arvin-Edison Water Storage District
CCR = California Code of Regulations
DWR = California Department of Water Resources
GAMA = Groundwater Ambient Monitoring Program
GSA = Groundwater Sustainability Agency
MCL = Maximum Contaminant Level
PLSS = Public Land Survey System
ug/L = micrograms per liter
ND = Not Detected

**Notes**

1. All locations are approximate.
2. For a given well, reported water quality values represent the latest sample collected during the 2016 calendar year.
3. Circular wells indicate water quality data provided by AEWSD. Square wells indicate water quality data retrieved from GAMA.
4. GAMA data lack actual coordinates and are therefore plotted according to PLSS section, resulting in overlap of symbols. In these cases, the symbol shown represents the maximum concentration of all co-located points.
5. Arsenic measurements obtained using EPA-200.7 method, with a detection limit of 7.8 ug/L.
6. CCR 22-4 Table 64431-A lists the Primary MCL for Arsenic as 10 ug/L.

**Sources**

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. In-District water quality data obtained from AEWSD on 3 April 2017; out-of-District water quality data obtained from GAMA database on 14 April 2017.

N

0 3 6
(Scale in Miles)

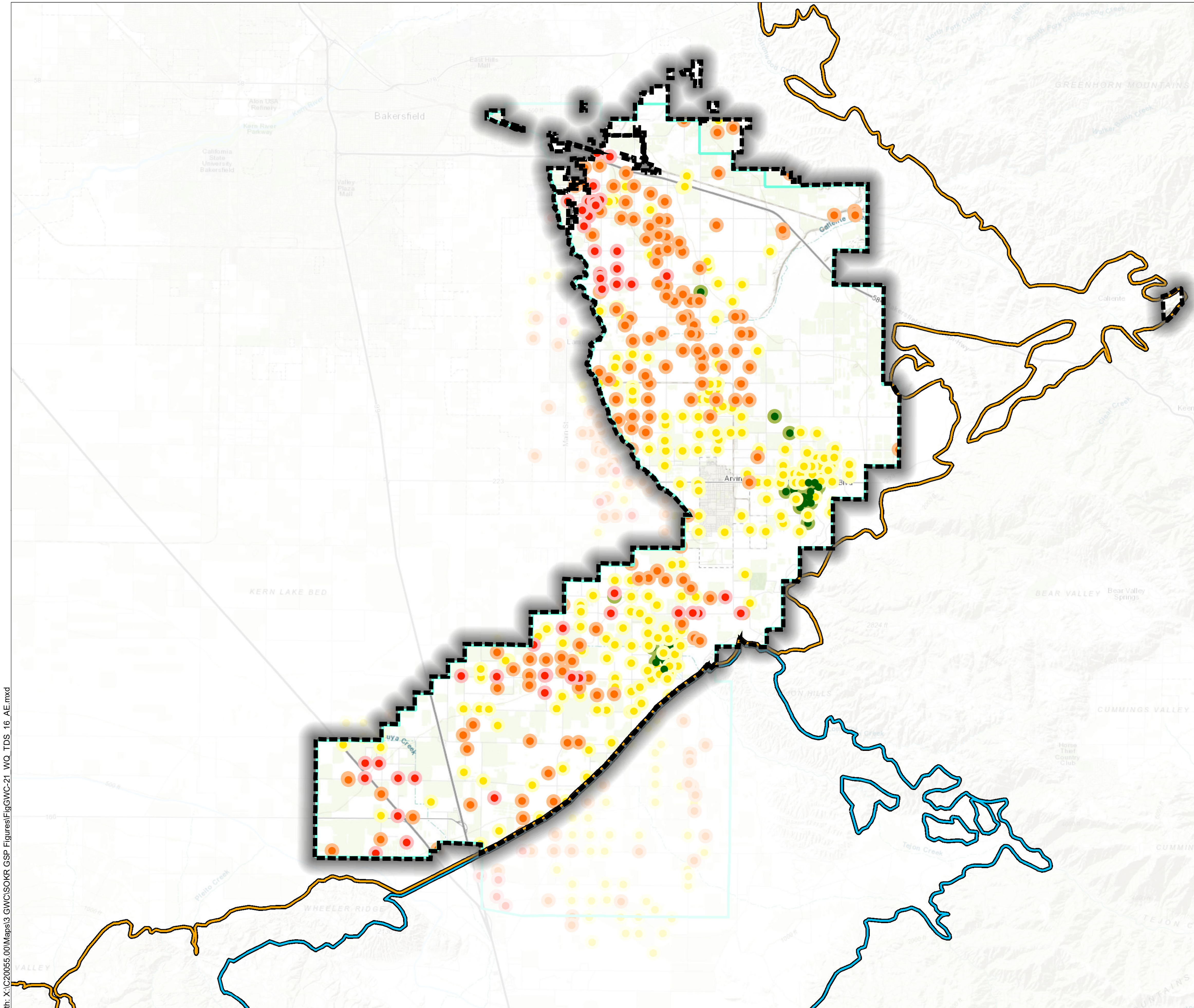
**Groundwater Quality - Arsenic Concentrations (2016)**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-20**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-20_WQ_Arsenic_16_AE.mxd




Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Total Dissolved Solids Concentration (mg/L)**

0 - 200

200 - 500

500 - 1,000

> 1,000

Abbreviations

| | | |
|---|---|---|
| AEWSD | = | Arvin-Edison Water Storage District |
| CCR | = | California Code of Regulations |
| DWR | = | California Department of Water Resources |
| GSA | = | Groundwater Sustainability Agency |
| MCL | = | Maximum Contaminant Level |
| mg/L | = | milligrams per liter |
| TDS | = | Total Dissolved Solids |

Notes

1. All locations are approximate.
2. For a given well, reported water quality values represent the latest sample collected during the calendar year.
3. TDS measurements obtained using EPA-160.1 method, with a detection limit of 33 mg/L.
4. CCR 22-4 Table 64449-B lists the "Upper" Secondary MCL for TDS as 1,000 mg/L.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. In-District water quality data obtained from AEWSD on 3 April 2017.

N

0 3 6

(Scale in Miles)

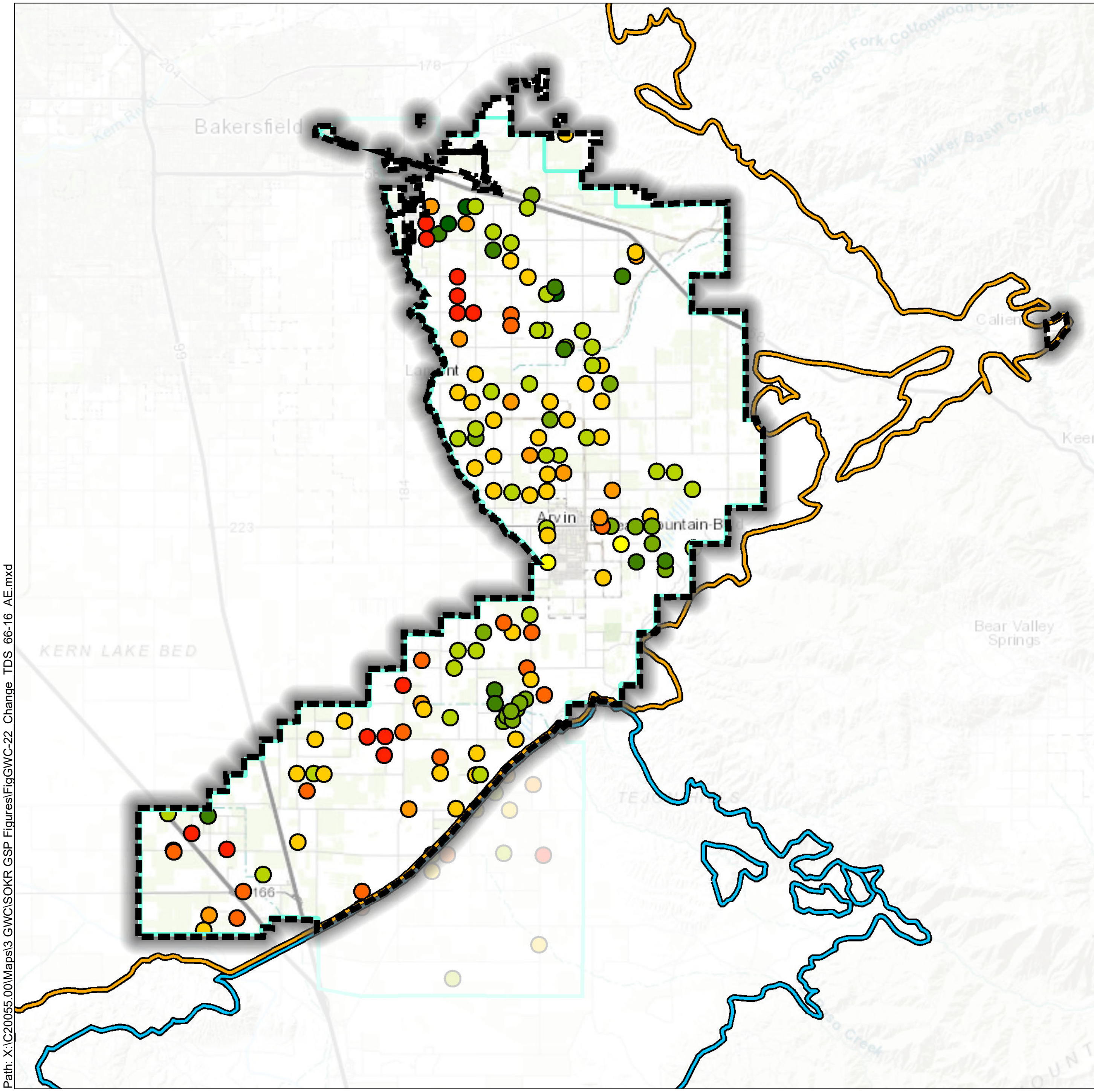
**Groundwater Quality -**
**Total Dissolved Solids Concentrations (2016)**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-21**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-21_WQ_TDS_16_AE.mxd




## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
mg/L = miligrams per liter
TDS = Total Dissolved Solids

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. In-District water quality data obtained from AEWSD on 30 September 2017.

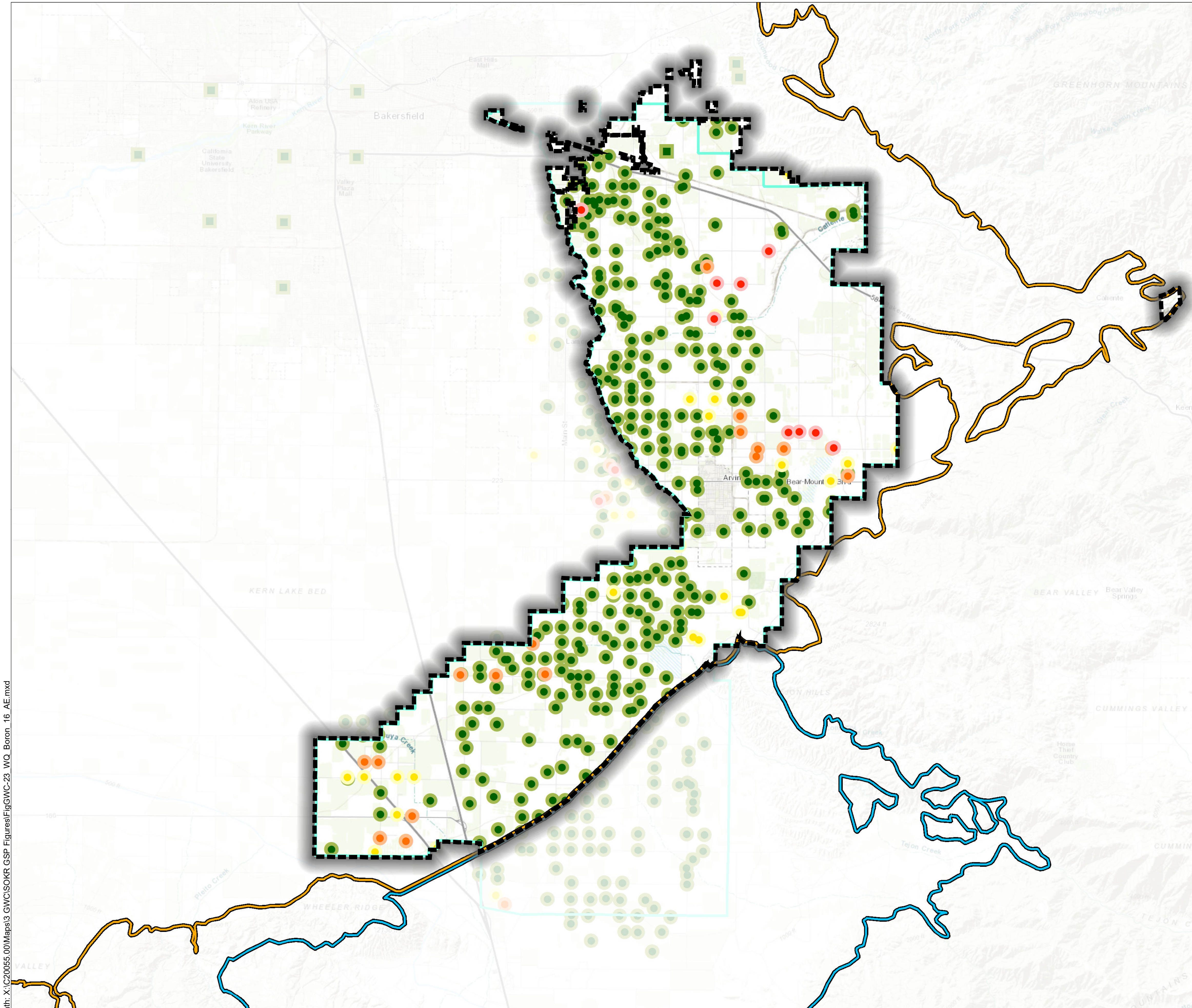
**Groundwater Quality - Change in Total Dissolved Solids (1966 - 2016)**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-22**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-22_Change_TDS_66-16_AE.mxd




Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Total Recoverable Boron Concentration (ug/L)**

- 10 - 700
- 700 - 1,000
- 1,000 - 2,000
- > 2,000

Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GAMA = Groundwater Ambient Monitoring Program
GSA = Groundwater Sustainability Agency
PLSS = Public Land Survey System
ug/L = micrograms per liter

Notes

1. All locations are approximate.
2. For a given well, reported water quality values represent the latest sample collected during the 2016 calendar year.
3. Circular wells indicate water quality data provided by AEWSD. Square wells indicate water quality data retrieved from GAMA.
4. GAMA data lack actual coordinates and are therefore plotted according to PLSS section, resulting in overlap of symbols. In these cases, the symbol shown represents the maximum concentration of all co-located points.
5. Boron measurements obtained using EPA-200.7 method, with a detection limit of 10 ug/L.
6. Boron levels >700-2000 ug/L can exhibit slight to moderate restrictions on agricultural productivity, depending on crop type.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. In-District water quality data obtained from AEWSD on 3 April 2017; out-of-District water quality data obtained from GAMA database on 14 April 2017.

N

0 3 6
(Scale in Miles)

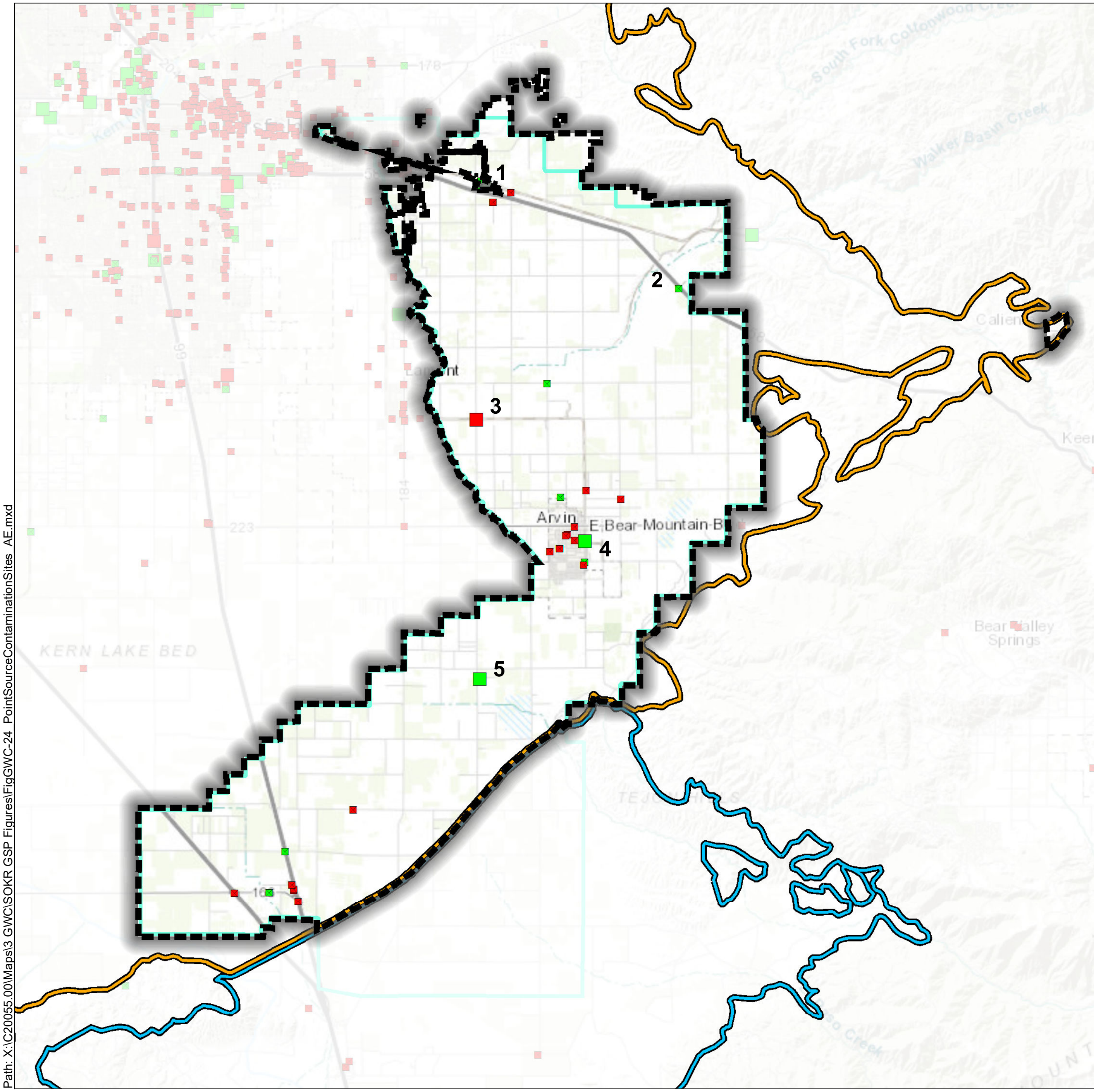
**Groundwater Quality - Boron Concentrations (2016) Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-23**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-23_WQ_Boron_16_AE.mxd




Legend

- Arvin GSA
- Arvin-Edison Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**GeoTracker Sites**

- Cleanup Program Site, Open
- Cleanup Program Site, Closed
- LUST Cleanup Site, Open
- LUST Cleanup Site, Closed

Abbreviations

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

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Locations of contamination sites from SWRCB GeoTracker website (http://geotracker.waterboards.ca.gov/datadownload), accessed 10 March 2017.
3, Active sites denoted with a number (1-5) are further described in Table GWC-3 of the GSP chapter text.

N 0 5 10 Miles

**Point Source Contamination Sites**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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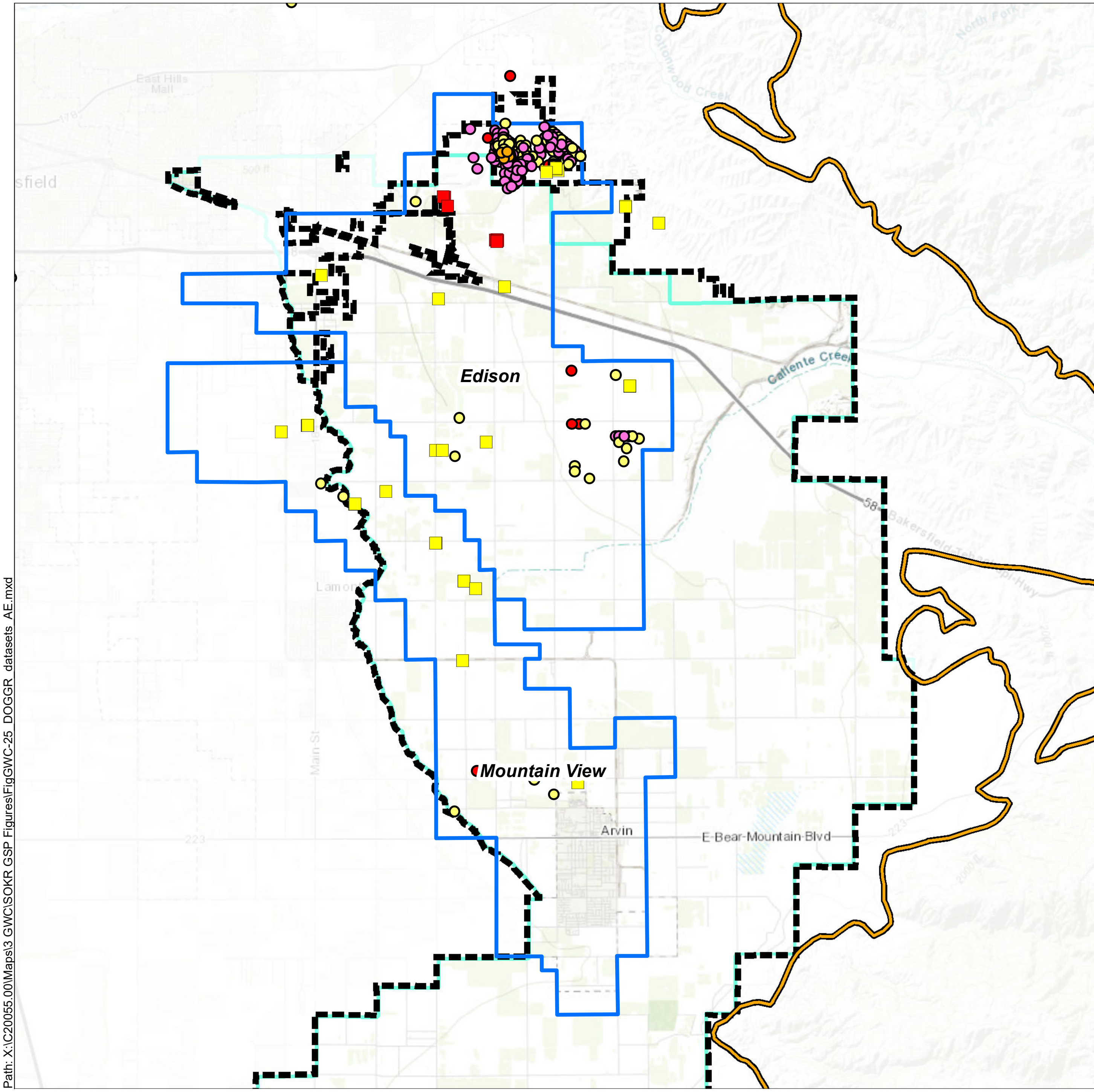
**Figure GWC-24**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-24_PointSourceContaminationSites_AE.mxd




## Legend

Arvin GSA
Arvin-Edison Water Storage District
DOGGR Oil & Gas Fields

**Groundwater Subbasin**

Kern County (DWR 5-022.14)
White Wolf (DWR 5-022.18)

**Produced Water Ponds**

Active
Inactive

**Injection Well Type (see Note 2)**

INJ
Multi
SC
SF

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DOGGR = Division of Oil, Gas, and Geothermal Resources
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

## Notes

1. All locations are approximate.
2. Wells shown are listed as "Active" and include injection (INJ), Cyclic Steam (SC), Steam Flood (SF), and Multi (injection and production).

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. DOGGR well data obtained 4 June 2019.
3. Produced water ponds data obtained 4 June 2019.

N
0 3 6
Miles

**Locations of Oil Fields, Active Injection Wells, and Produced Water Ponds**
**Arvin-Edison Management Area**

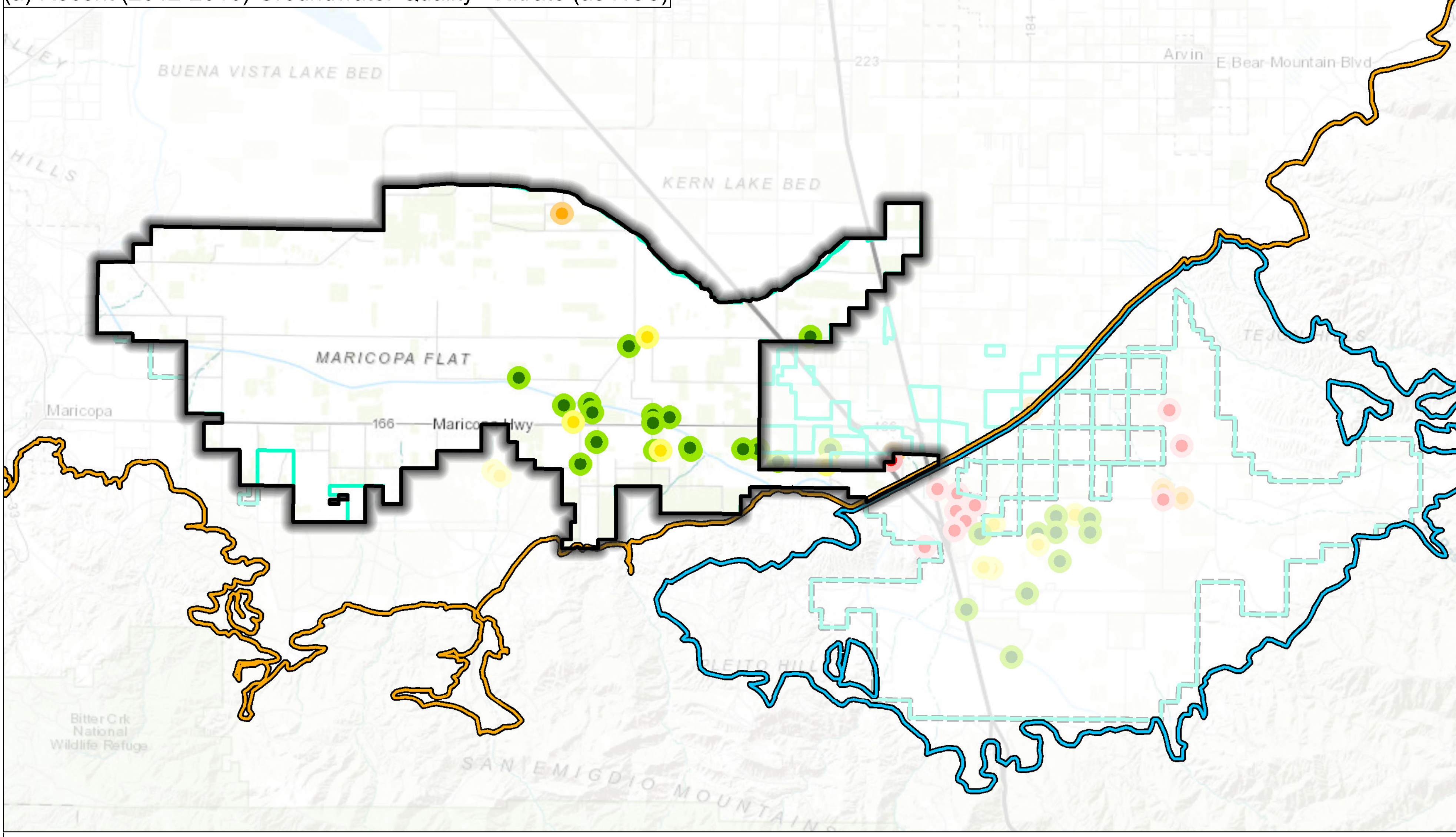
eki environment & water

South of Kern River GSP
Kern County, California
July 2022
C20055.00

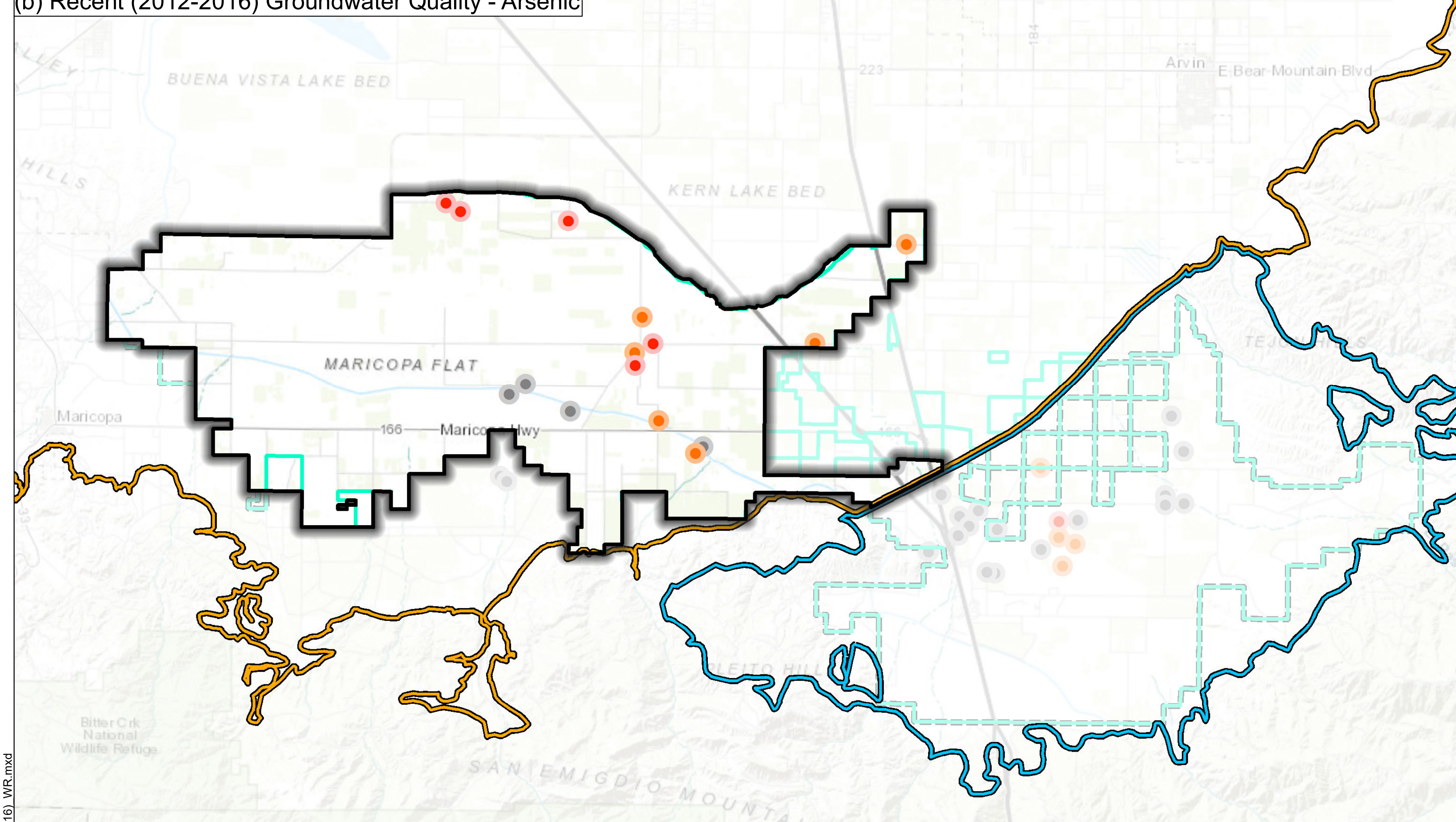
**Figure GWC-25**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-25_DOGGR_datasets_AE.mxd

(a) Recent (2012-2016) Groundwater Quality - Nitrate (as NO3)




(b) Recent (2012-2016) Groundwater Quality - Arsenic




Legend
- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**
- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Nitrate (as NO3) Concentration (mg/L)**
- ND
- 0.1- 9
- 9 - 22.5
- 22.5 - 45
- > 45

**Dissolved Arsenic Concentration (ug/L)**
- ND (< 7.8)
- 7.8 - 10
- > 10

Abbreviations

| | |
|---|---|
| CCR | = California Code of Regulations |
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| MCL | = Maximum Concentration Level |
| mg/L | = miligrams per liter |
| ug/L | = micrograms per liter |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

N

0 4 8

(Scale in Miles)

Notes
1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 2012 and 2016.
3. CCR 22-4 Table 64431-A lists primary MCL for nitrate as nitrogen at 10 mg/L, equivalent to 45 mg/L nitrate as NO3.
4. CCR 22-4 Table 64431-A lists Primary MCL for Arsenic at 10 ug/L.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Groundwater quality data was provided by WRMWSD staff on 20 November 2017.

**Groundwater Quality – Nitrate and Arsenic Concentrations (2012 - 2016)**
**Wheeler Ridge-Maricopa Management Area**

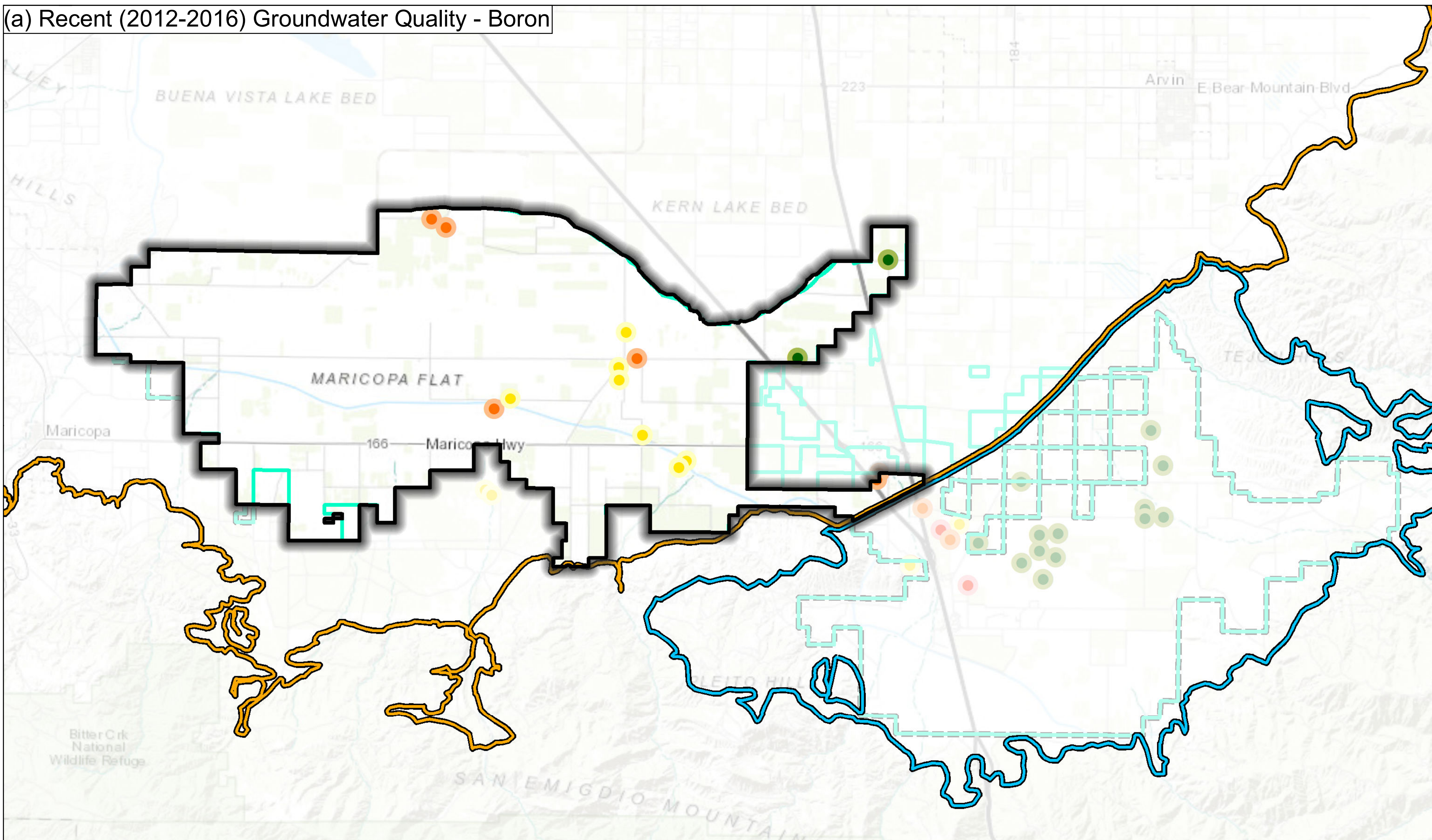
South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

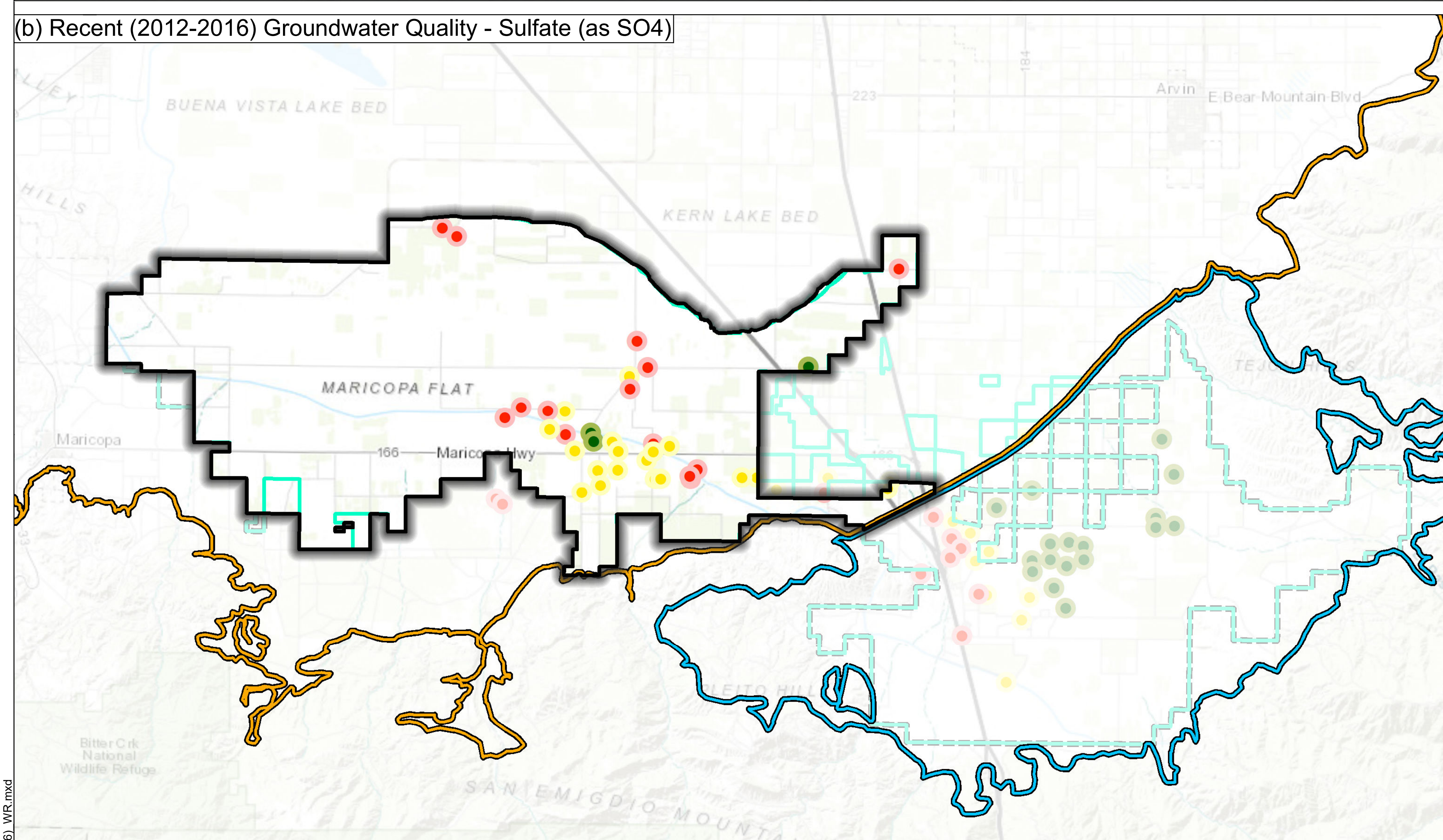
**Figure GWC-26**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\Fig\GWC-26_NitrateArsenicConcentrations(2012-2016)_WR.mxd

(a) Recent (2012-2016) Groundwater Quality - Boron




(b) Recent (2012-2016) Groundwater Quality - Sulfate (as SO4)




**Legend**

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Dissolved Boron Concentration (mg/L)**

- < 0.50
- 0.50 - 0.69
- 0.70 - 0.99
- > 1.0

**Sulfate (as $SO_4$) Concentration (mg/L)**

- < 250
- 250 - 499
- > 500

**Abbreviations**

CCR = California Code of Regulations
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
MCL = Maximum Concentration Level
mg/L = miligrams per liter
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

N

0 4 8

(Scale in Miles)

**Notes**

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 2012 and 2016.
3. Boron levels >0.5 mg/L can exhibit slight to moderate restrictions on agricultural productivity, depending on crop type.
4. CCR 22-4 Table 64449-B lists "Upper" Secondary MCL for sulfate at 500 mg/L.

**Sources**

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Groundwater quality data was provided by WRMWSD staff on 20 November 2017.

**Groundwater Quality – Boron and Sulfate Concentrations (2012 - 2016)**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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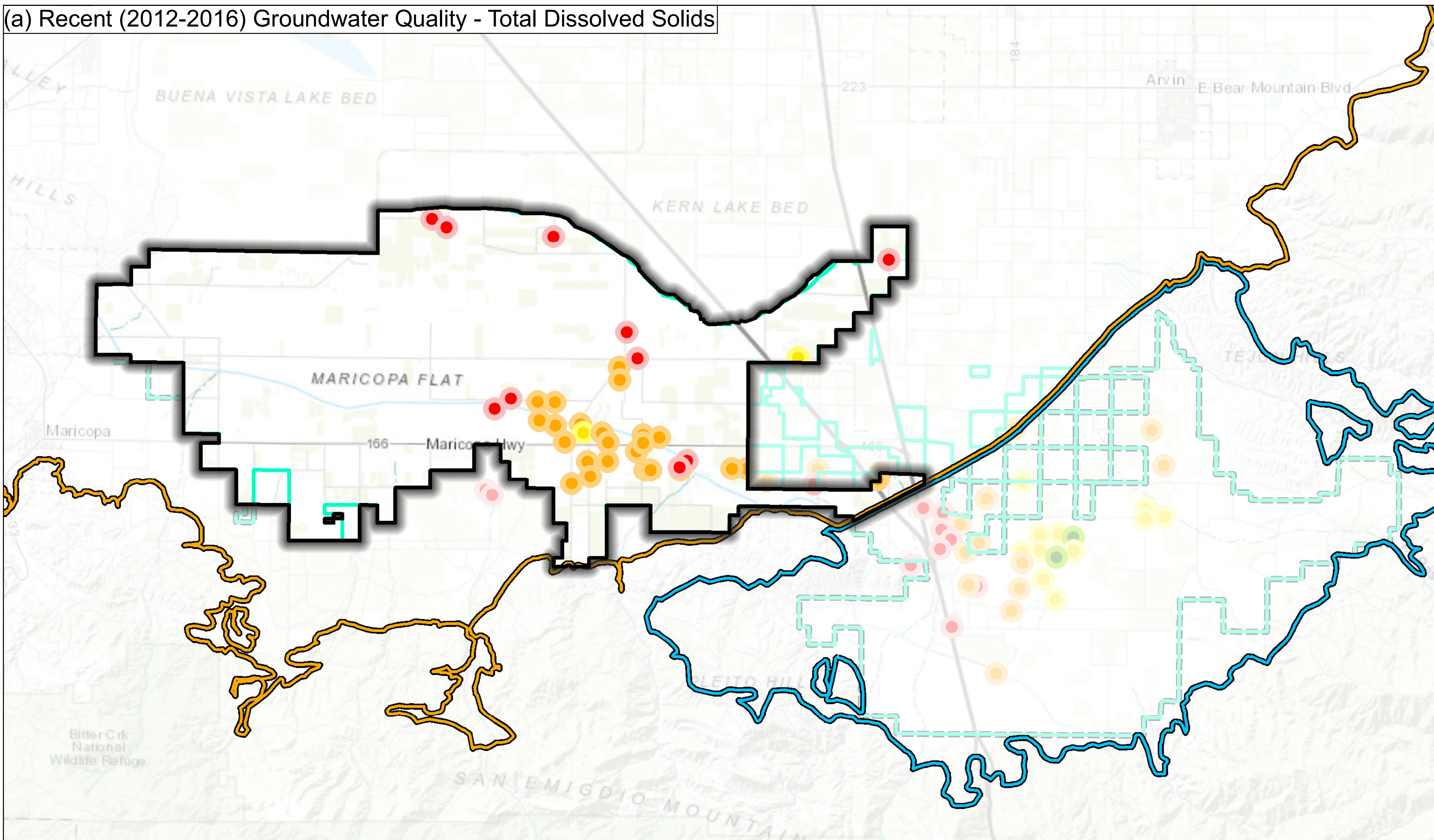
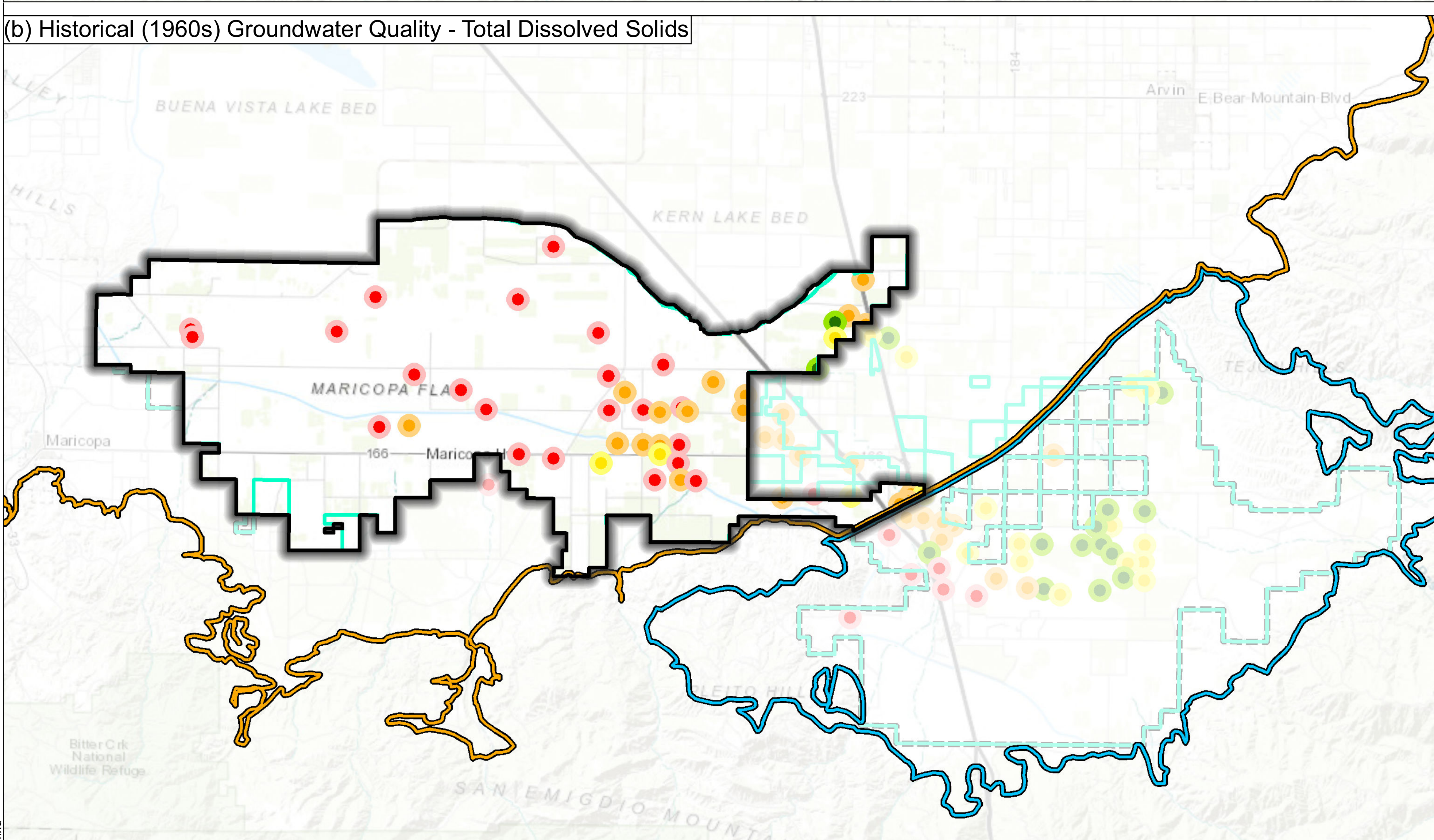
**Figure GWC-27**

Path: X:\C20055\00\Maps\3 GWC\SOKR GSP Figures\Fig\GWC-27_BoronSulfateConcentrations(2012-2016)_WR.mxd

(a) Recent (2012-2016) Groundwater Quality - Total Dissolved Solids




(b) Historical (1960s) Groundwater Quality - Total Dissolved Solids




Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-28_RecentHistoricTDSconcentration_WR.mxd

## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Total Dissolved Solids Concentration (mg/L)**

- <300
- 300 - 500
- 500 - 1,000
- >1,000

## Abbreviations

| | |
|---|---|
| CCR | = California Code of Regulations |
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| MCL | = Maximum Contaminant Level |
| mg/L | = miligrams per liter |
| TDS | = Total Dissolved Solids |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

## Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 2012 and 2016 (Figure GWC-13(a)) and between 1960 and 1969 (Figure GWC-13(b)).
3. CCR 22-4 Table 64449-B lists "upper" Secondary MCL for TDS at 1,000 mg/L and "lower". Secondary MCL for TDS at 500 mg/L.

N 0 4 8 (Scale in Miles)

## Sources

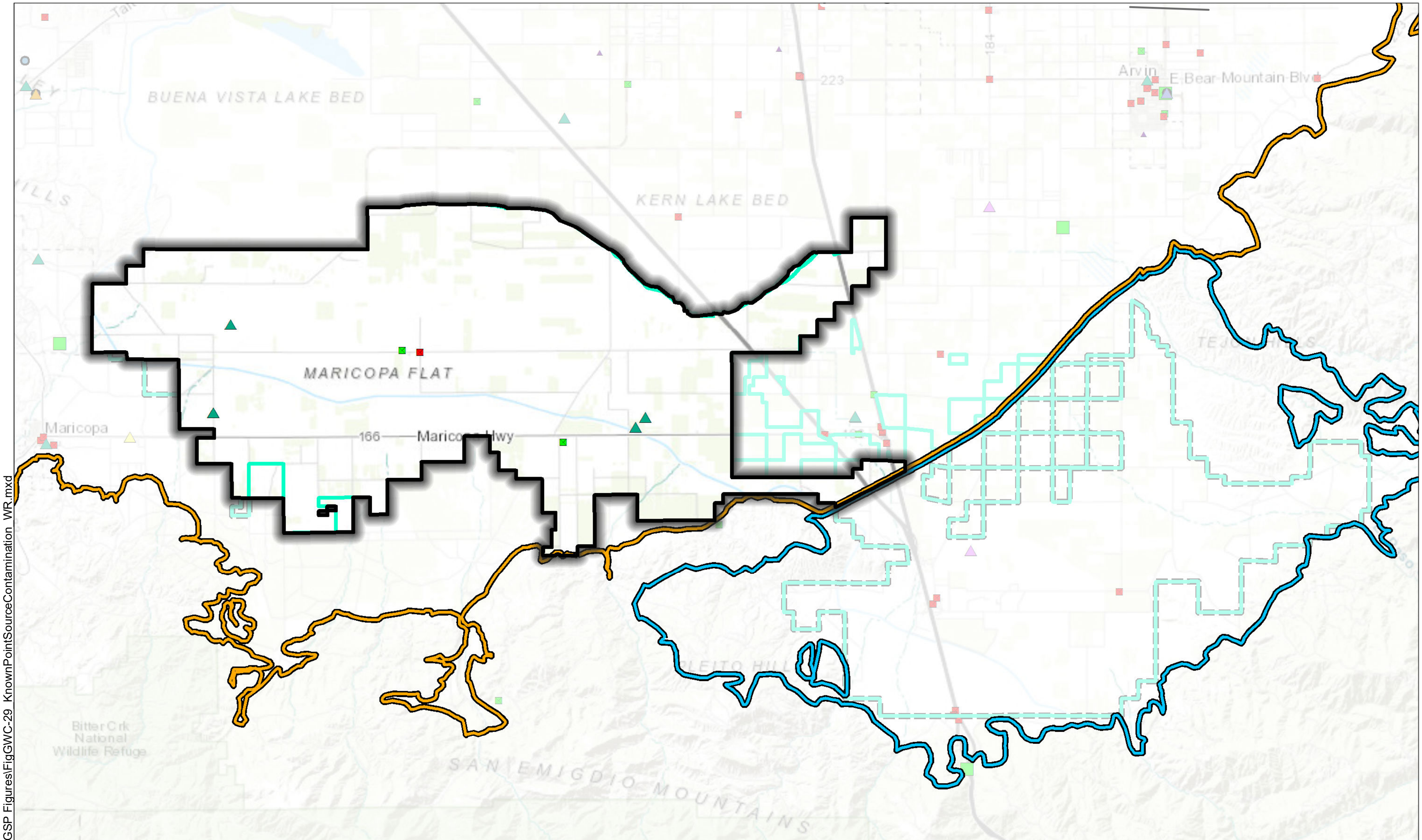
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Groundwater quality data was provided by WRMWSD staff on 20 November 2017.

**Groundwater Quality – Recent (2012 - 2016) and Historical (1960s) TDS Concentrations Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-28**




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**GeoTracker Sites**

- Cleanup Program Site, Open
- Cleanup Program Site, Closed
- LUST Cleanup Site, Closed

**EnviroStor Sites**

- Active Corrective Action
- Active Federal Superfund
- Active State Response
- Corrective Action, Refer: EPA
- Inactive - Needs Evaluation
- Certified Voluntary Cleanup
- School Investigation, No Action or No Further Action
- Closed Hazardous Waste Site
- Hazardous Waste Site Undergoing Closure

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
LUST = Leaking Underground Storage Tank
SWRCB = State Water Resources Control Board
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Locations of contamination sites from SWRCB GeoTracker website (http://geotracker.waterboards.ca.gov/datadownload) accessed 27 February 2018 and Department of Toxic Substances Control EnviroStor website (https://www.envirostor.dtsc.ca.gov/public/) accessed 11 May 2018.

N
0 5 10
(Scale in Miles)

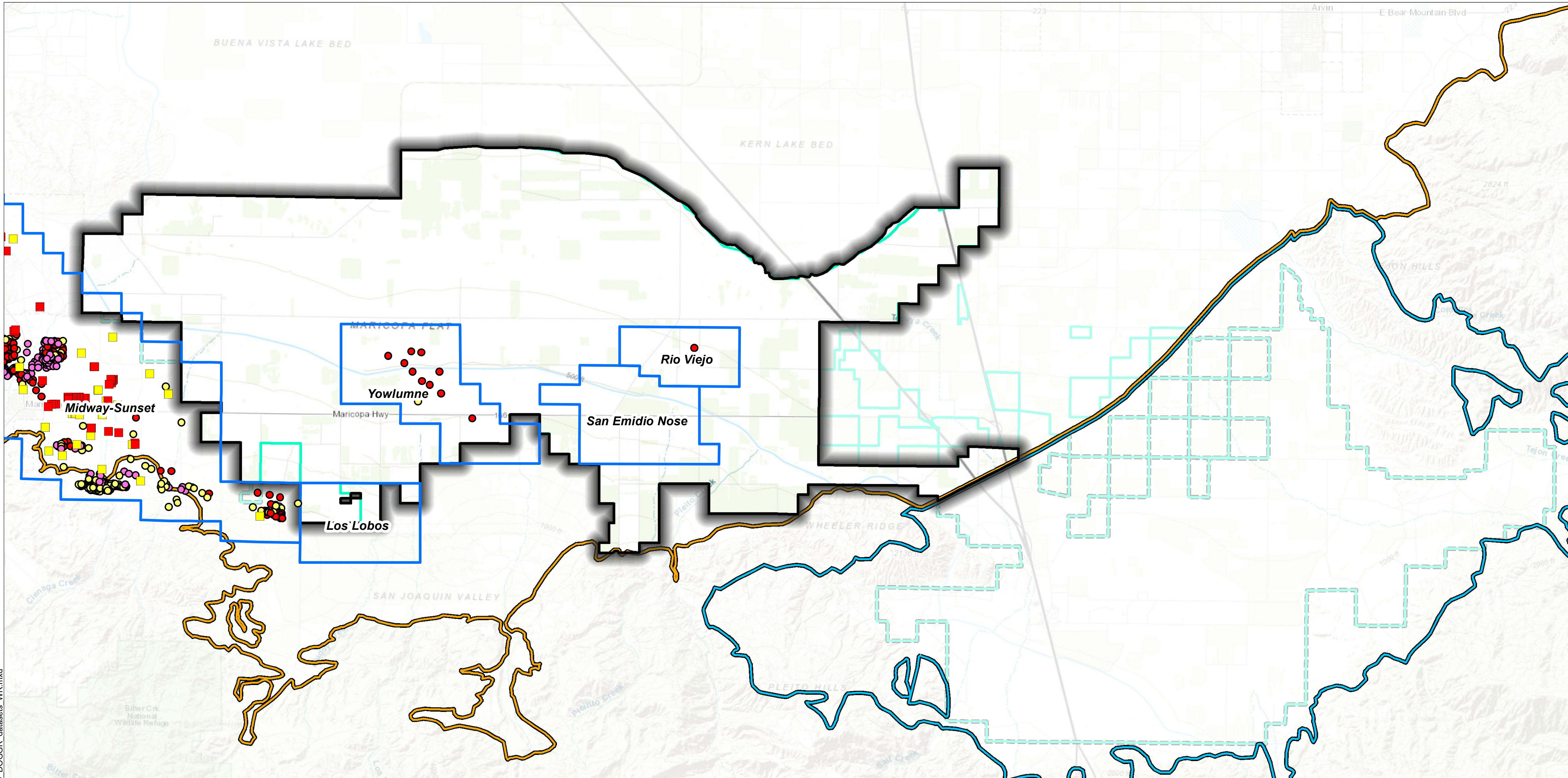
**Known Point Source Contamination Sites**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-29**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-29_KnownPointSourceContamination_WR.mxd




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- DOGGR Oil & Gas Fields
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Produced Water Ponds**

- Active
- Inactive

**Injection Well Type (see Note 2)**

- INJ
- Multi
- SC
- SF

## Abbreviations

DWR = California Department of Water Resources
DOGGR = Division of Oil, Gas, and Geothermal Resources
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. Wells shown are listed as "Active" and include injection (INJ), Cyclic Steam (SC), Steam Flood (SF), and Multi (injection and production).

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. DOGGR well data obtained 4 June 2019.
3. Produced water ponds data obtained 4 June 2019.

N

0 2.5 5

(Scale in Miles)

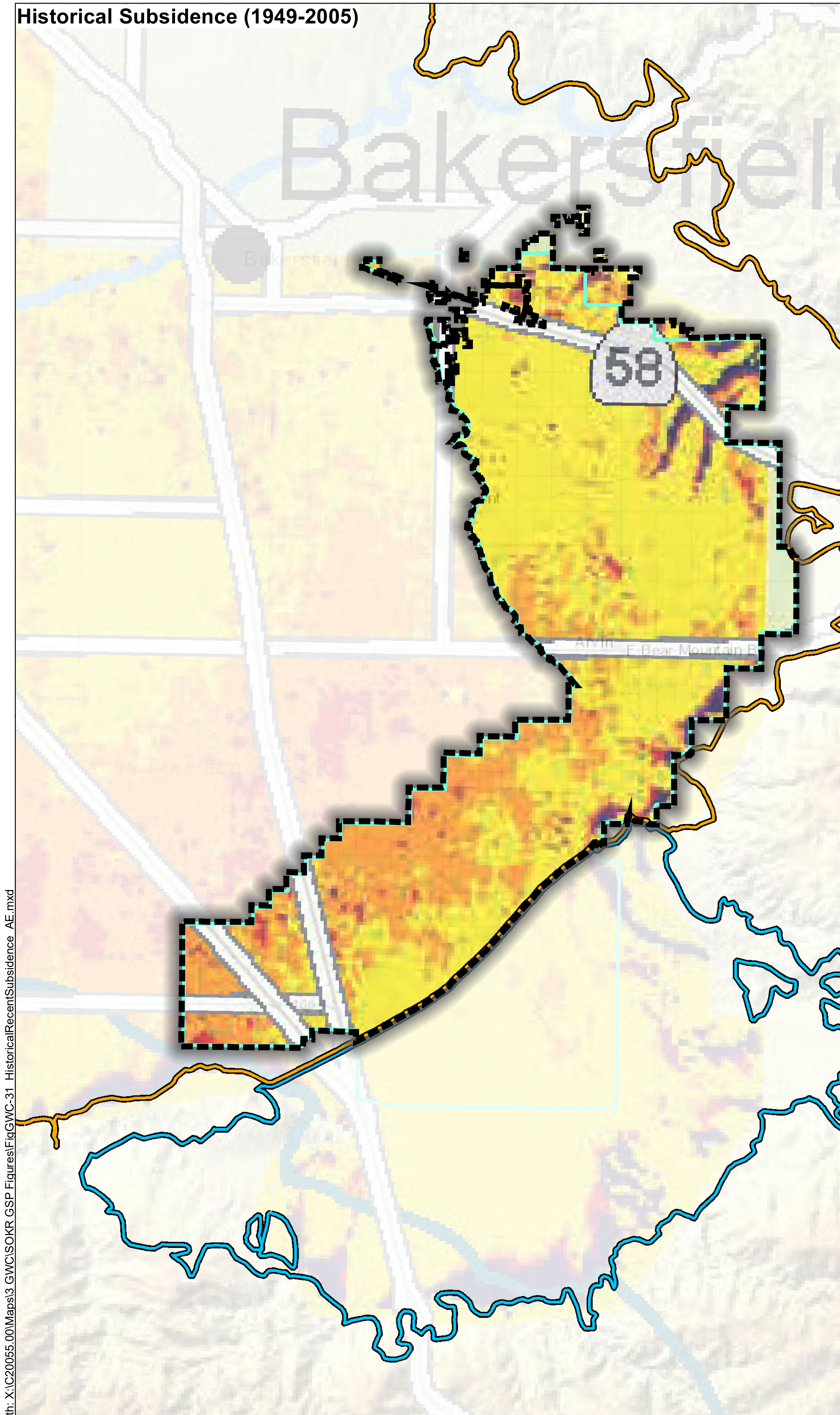
**Locations of Oil Fields, Active Injection Wells, and Produced Water Ponds**
**Wheeler Ridge-Maricopa Management Area**

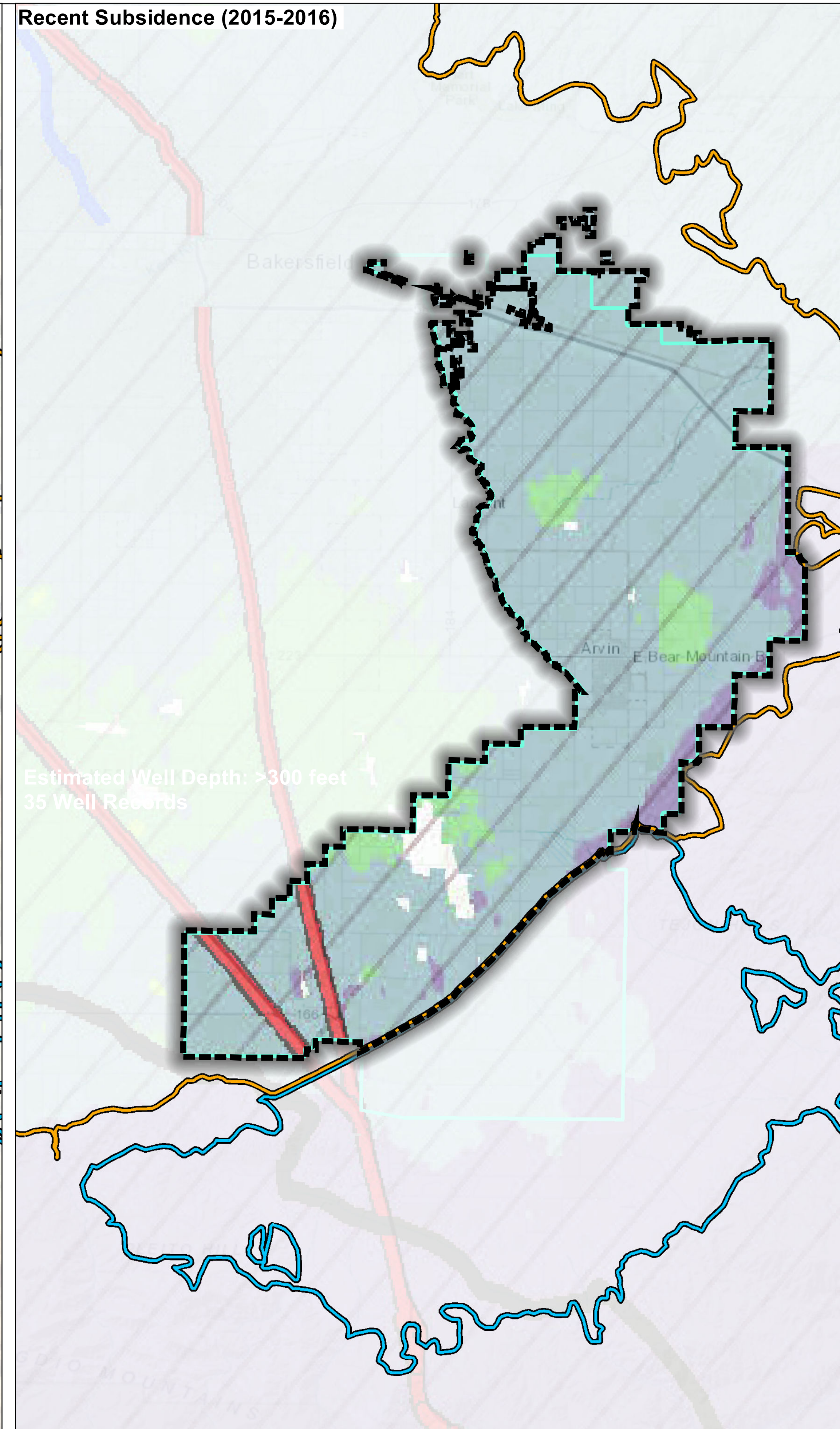
South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-30**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-30_DOGGR_datasets_WR.mxd




Legend

- Arvin GSA
- Arvin-Edison Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Change in Ground Surface Elevation (inches) (May 2015 - September 2016)**

- No data
- -12 to -8
- -8 to -4
- -4 to -1
- -1 to 1
- California Aqueduct
- Highway

**Change in Ground Surface Elevation (feet) (1949 - 2005)**

- -30 to -25
- -25 to -20
- -20 to -15
- -15 to -10
- -10 to -5
- -5 to 0
- California Aqueduct
- Highway

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Recent subsidence data is from the California Institute of Technology Jet Propulsion Laboratory Progress Report: Subsidence in California, March 2015 - September 2016.
4. Historical subsidence data is from DWR's Estimated Subsidence in the San Joaquin Valley between 1949-2005.

N

0 4 8

(Scale in Miles)

**Historical (1949 - 2005) and Recent (2015 - 2016) Land Subsidence**
**Arvin-Edison Management Area**

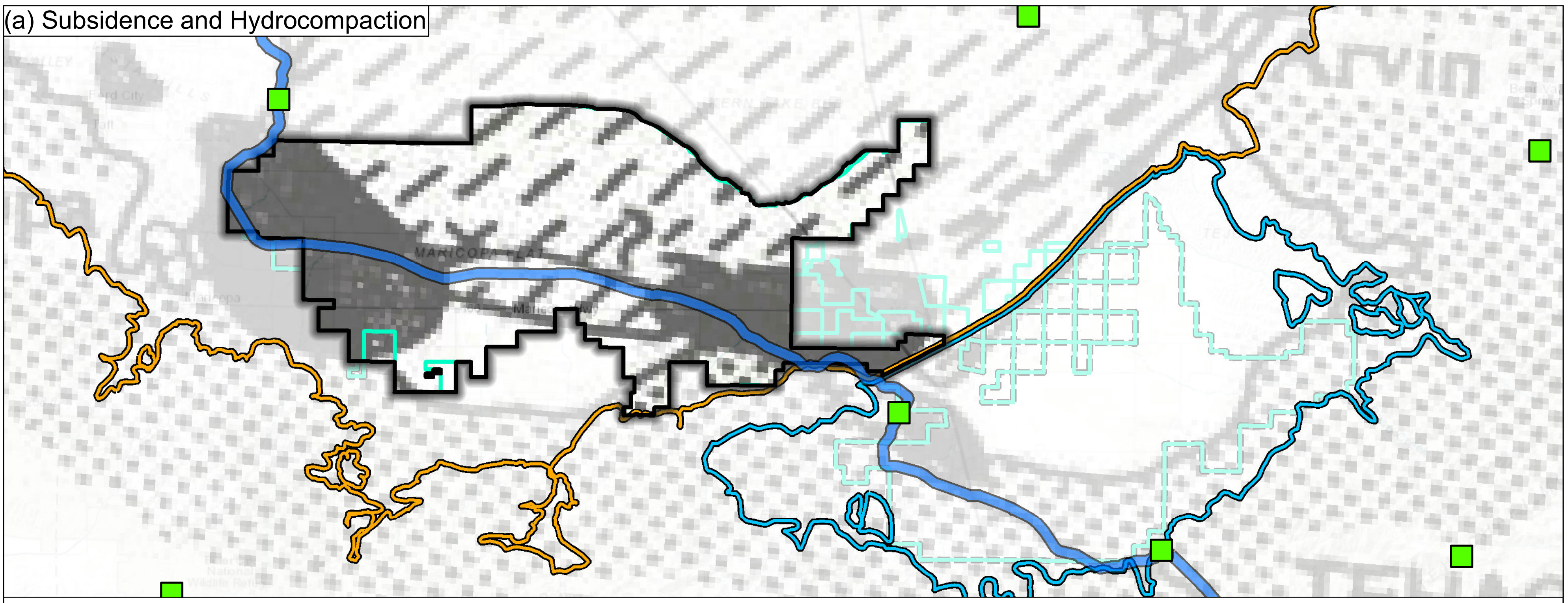
South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

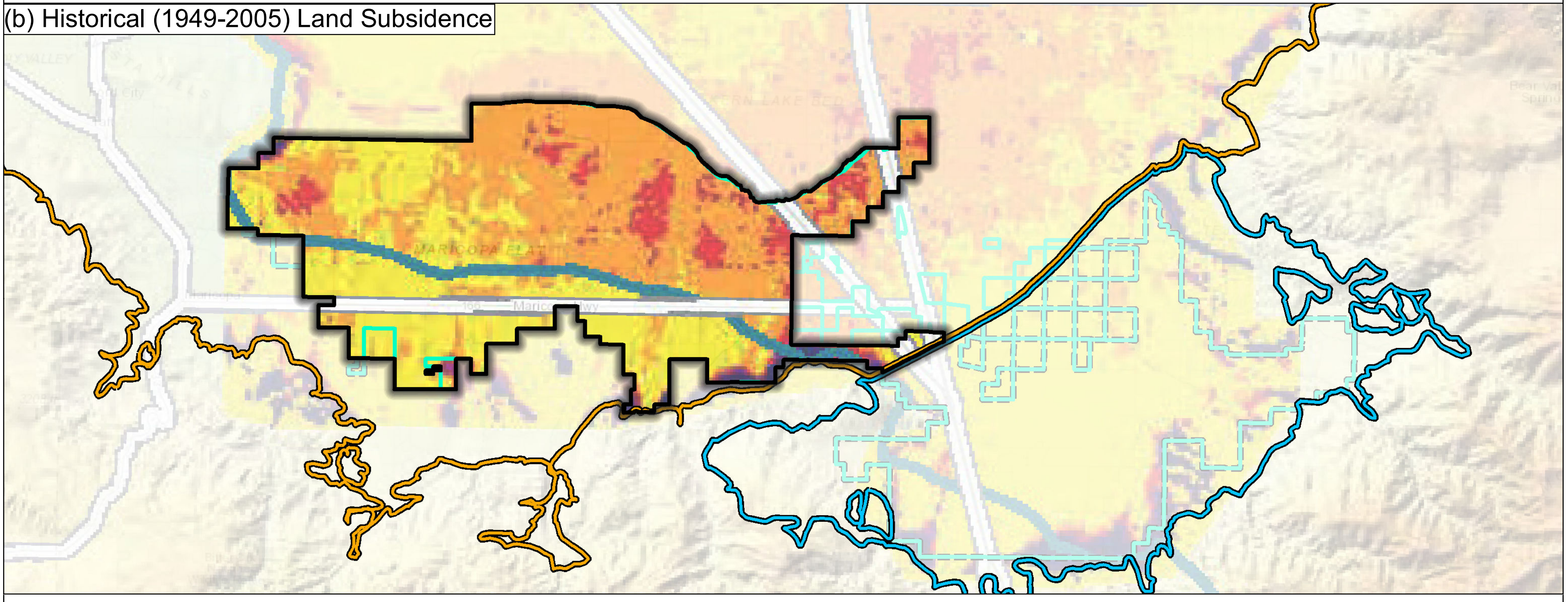
**Figure GWC-31**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-31_HistoricalRecentSubsidence_AE.mxd

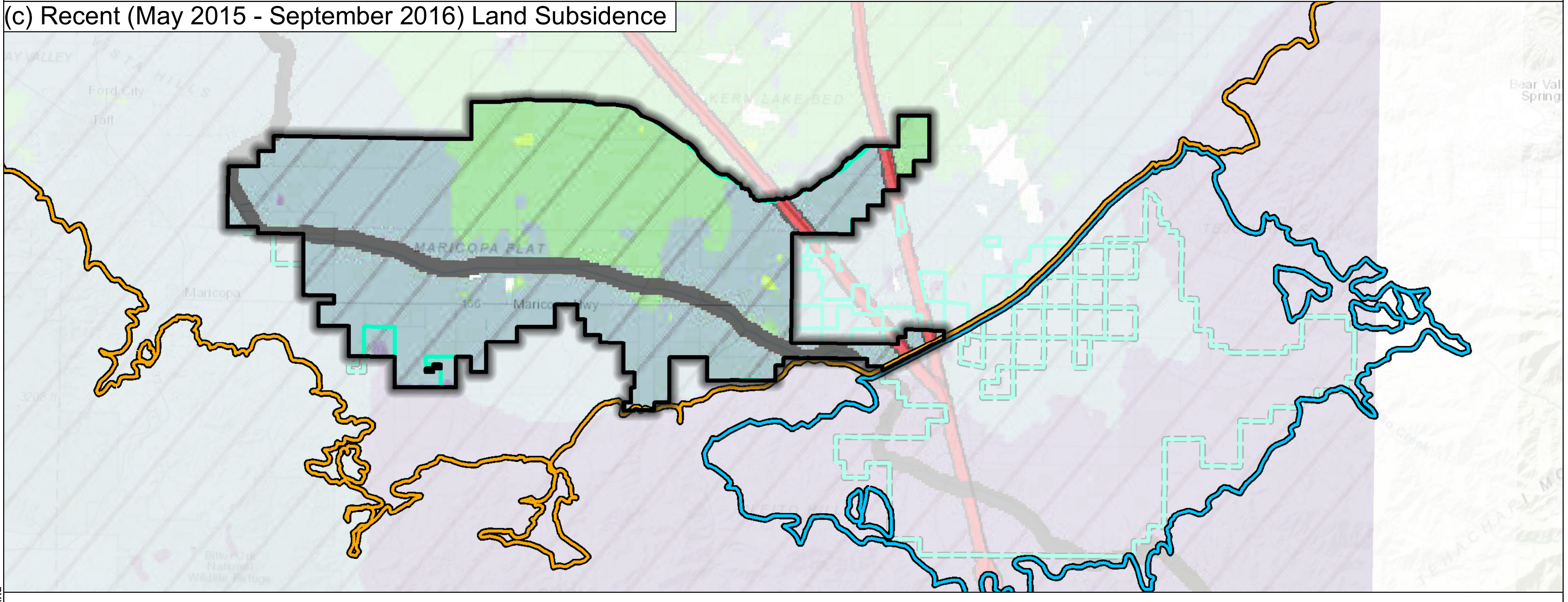
(a) Subsidence and Hydrocompaction




(b) Historical (1949-2005) Land Subsidence




(c) Recent (May 2015 - September 2016) Land Subsidence




Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Subsidence Type (after Ireland et al., 1984)**

- Subsidence Monitoring Station
- Area of subsidence due to hydrocompaction
- Area with subsidence due to water level decline of >1 foot
- Outline of valley

**Subsidence (1949 - 2005)**

- -30 to -25 feet
- -25 to -20 feet
- -20 to -15 feet
- -15 to -10 feet
- -10 to -5 feet
- -5 to 0 feet
- Highway
- California Aqueduct

**Subsidence (May 2015 - Sept. 2016)**

- No data
- -12 to -8 inches
- -8 to -4 inches
- -4 to -1 inches
- -1 to 1 inches
- California Aqueduct
- Highway

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
USGS = United States Geological Survey
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.
2. Ireland et al., 1984. Land Subsidence in the San Joaquin Valley, California, as of 1980. USGS Professional Paper 437-1.
3. California Aqueduct location is from the National Hydrography Dataset.
4. Subsidence monitoring locations are from UNAVCO's Plate Boundary Observatory database.
5. Subsidence data is from DWR's Estimated Subsidence in the San Joaquin Valley between 1949-2005.
6. Subsidence data is from the California Institute of Technology Jet Propulsion Laboratory Progress Report: Subsidence in California, March 2015 - September 2016.

N

0 5 10
(Scale in Miles)

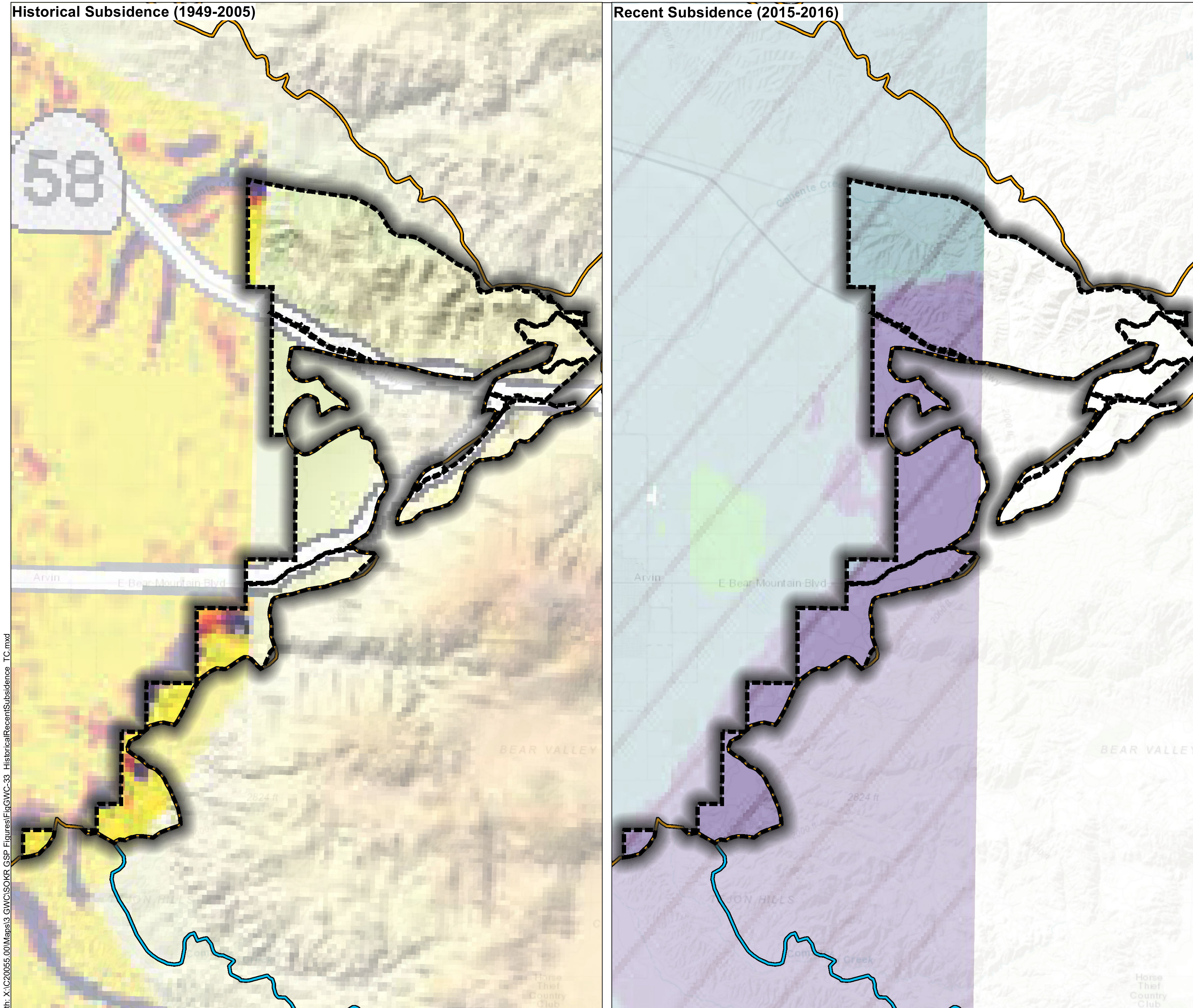
**Historical (1949-2005) and Recent (2015-2016) Land Subsidence, and Hydrocompaction Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

**Figure GWC-32**

eki environment & water

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-32_HistoricRecentSubsidence_WR.mxd




Legend

Tejon-Castac Water District GSA

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Change in Ground Surface Elevation (inches) (May 2015 - September 2016)**

No data

-12 to -8

-8 to -4

-4 to -1

-1 to 1

California Aqueduct

Highway

**Change in Ground Surface Elevation (feet) (1949 - 2005)**

-30 to -25

-25 to -20

-20 to -15

-15 to -10

-10 to -5

-5 to 0

California Aqueduct

Highway

Abbreviations

DWR = California Department of Water Resources

GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Recent subsidence data is from the California Institute of Technology Jet Propulsion Laboratory Progress Report: Subsidence in California, March 2015 - September 2016.
4. Historical subsidence data is from DWR's Estimated Subsidence in the San Joaquin Valley between 1949-2005.

N

0 2 4

(Scale in Miles)

**Historical (1949 - 2005) and Recent (2015 - 2016) Land Subsidence Tejon-Castac Management Area**

South of Kern River GSP

Kern County, California

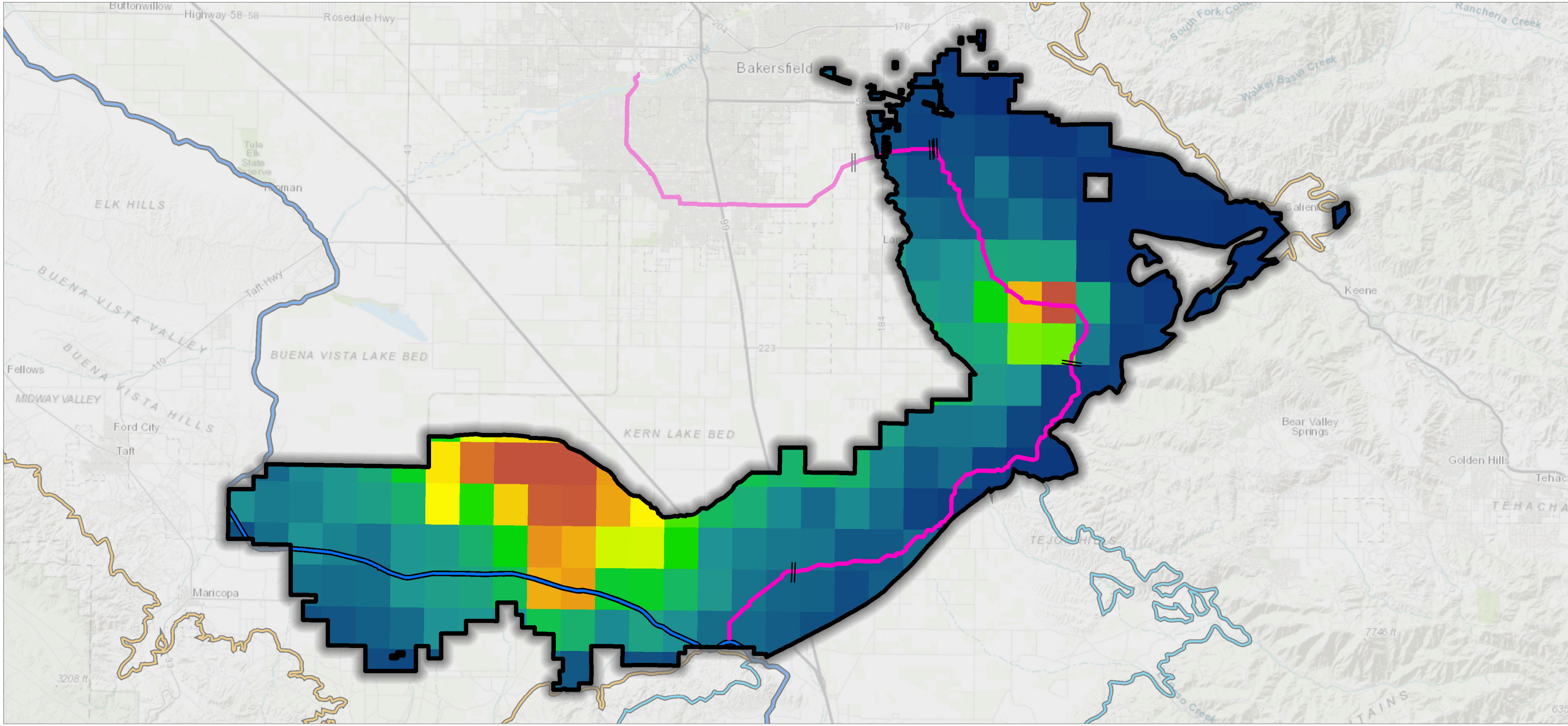
July 2022

C20055.00

eki environment & water

**Figure GWC-33**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-33_HistoricalRecentSubsidence_TC.mxd




## Legend

- South of Kern River Plan Area
- AEWSD Canal
- California Aqueduct

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**InSAR Subsidence**

**Average Vertical Ground Surface Displacement in Feet (Jun 2015 - Oct 2021)**

0.0213

-0.258

## Abbreviations

| | |
|---|---|
| AEWSD | = Arvin-Edison Water Storage District |
| DWR | = California Department of Water Resources |
| GSP | = Groundwater Sustainability Plan |
| InSAR | = Interferometric Synthetic Aperture Radar |
| SGMA | = Sustainable Groundwater Management Act |
| SOKR | = South of Kern River |

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.
2. InSAR subsidence dataset obtained from SGMA Data Viewer.

N

0 4 8
Miles

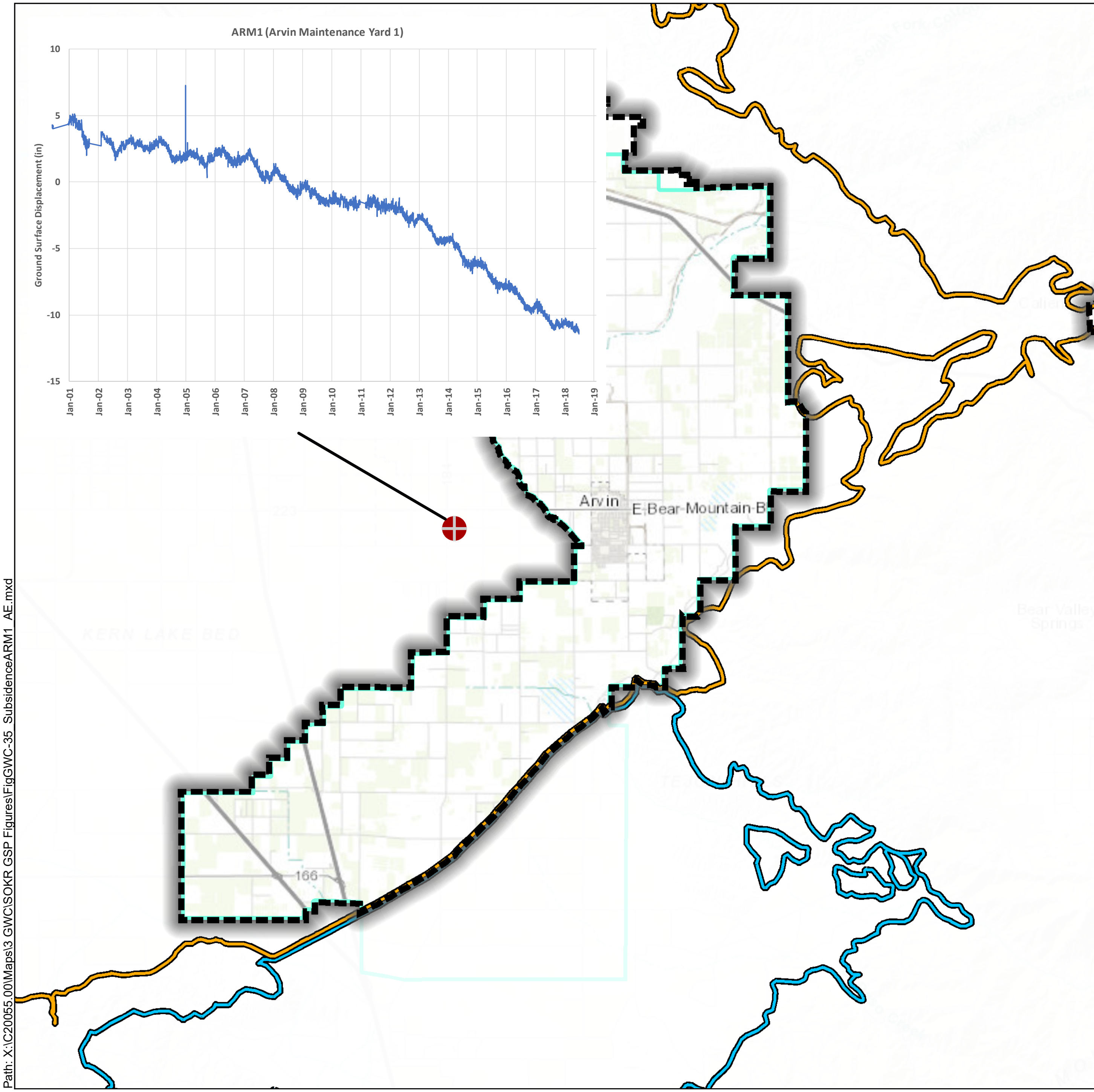
**Recent (2015-2021) Land Subsidence within the SOKR Plan Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-34**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-34_RecentLandSubsidenceSOKR.mxd




## Legend

Arvin GSA

Arvin-Edison Water Storage District

Benchmark ARM 1

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

## Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
SGMA = Sustainable Groundwater Management Act

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.
2. Data downloaded from SGMA Data Viewer on 6/28/2018

N 0 5 10
Miles

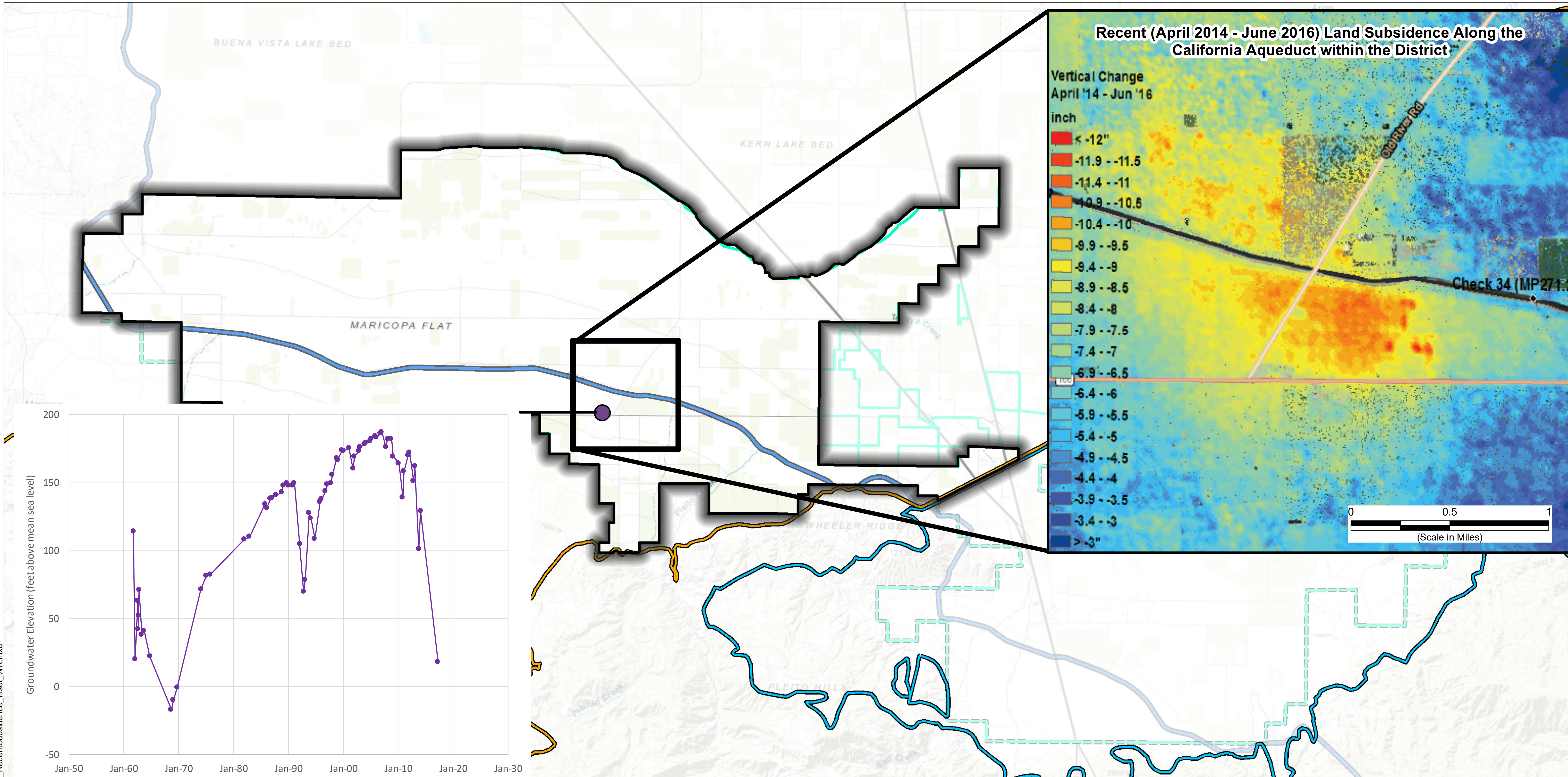
**Subsidence at Continuous GPS Benchmark ARM1 (2001-2017)**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-35**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-35_SubsidenceARM1_AE.mxd




Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area
- California Aqueduct

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- State Well 11N21W08A001S

Abbreviations

CASGEM = California Statewide Groundwater Elevation Monitoring Program
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

1. All locations are approximate.
2. Inset map shows the area of highest widespread subsidence observed along the southern portion of the California Aqueduct from April 2014 to June 2016. See Source 4.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.
2. Subsidence data is from the California Institute of Technology Jet Propulsion Laboratory Progress Report: Subsidence in California, March 2015 - September 2016.
3. Groundwater elevation data for acquired from CASGEM for State Well 11N21W08A001S on 19 December 2017.

N

0 2.5 5
(Scale in Miles)

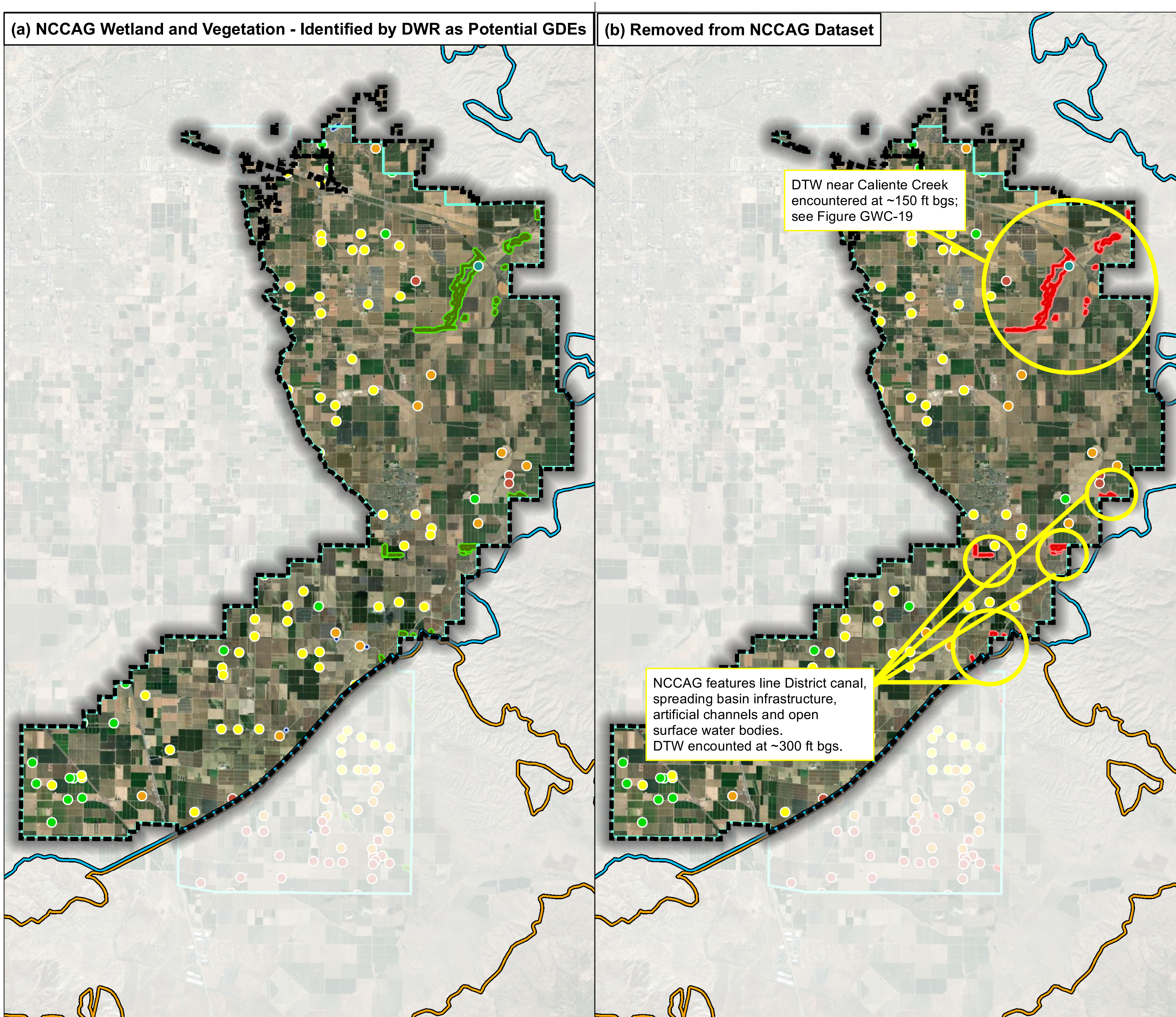
**Recent Land Subsidence Along the California Aqueduct With Groundwater Elevation Hydrograph Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-36**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-36_RecentSubsidence_Inset_WR.mxd




Legend

Arvin GSA

Arvin-Edison Water Storage District

**Groundwater Subbasin**

Kern County (DWR 5-022.14); 5-022.18

White Wolf (DWR 5-022.18); 5-022.14

NCCAG Vegetation

NCCAG Wetland

Removed NCCAG Vegetation or Wetland

Natural Stream/ River

**Spring 2015 Depth to Groundwater (ft bgs)**

- <100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- >500

Abbreviations

| | |
|---|---|
| DTW | = Depth to water |
| DWR | = California Department of Water Resources |
| ft bgs | = feet below ground surface |
| GDE | = Groundwater Dependent Ecosystem |
| GSA | = Groundwater Sustainability Agency |
| NCCAG | = Natural Communities Commonly Associated with Groundwater |

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.
2. DWR NCCAG dataset was obtained from NC Dataset Viewer (https://gis.water.ca.gov/app/NCDatasetViewer/)

N

0 4 8

(Scale in Miles)

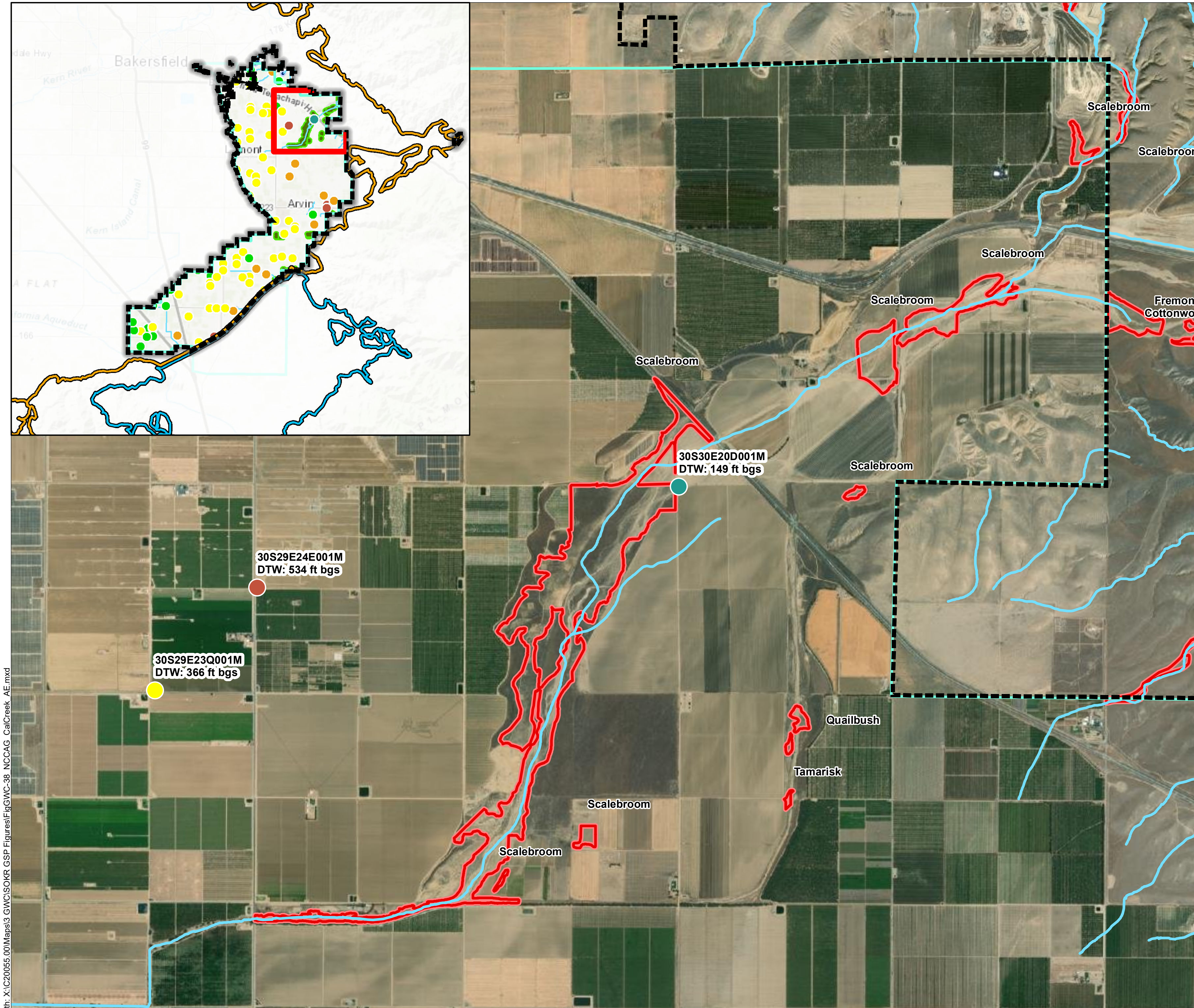
**Natural Communities Commonly Associated with Groundwater (DWR) Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-37**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-37_NCCAG_v2_AE.mxd




Legend

Arvin GSA

Arvin-Edison Water Storage District

Removed NCCAG Vegetation or Wetland

Natural Stream/ River

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Spring 2015 Depth to Groundwater (feet)**

<100

100 - 200

200 - 300

300 - 400

400 - 500

>500

Abbreviations

DWR = California Department of Water Resources

GSA = Groundwater Sustainability Agency

NCCAG = Natural Communities Commonly Associated with Groundwater

Notes

1. All locations are approximate.

Sources

1. DWR NCCAG dataset was obtained from NC Dataset Viewer (https://gis.water.ca.gov/app/NCDatasetViewer/)
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.

N

0 2,500 5,000

Feet

**Natural Communities Commonly Associated with Groundwater (DWR) - Caliente Creek Arvin-Edison Management Area**

South of Kern River GSP

Kern County, California

July 2022

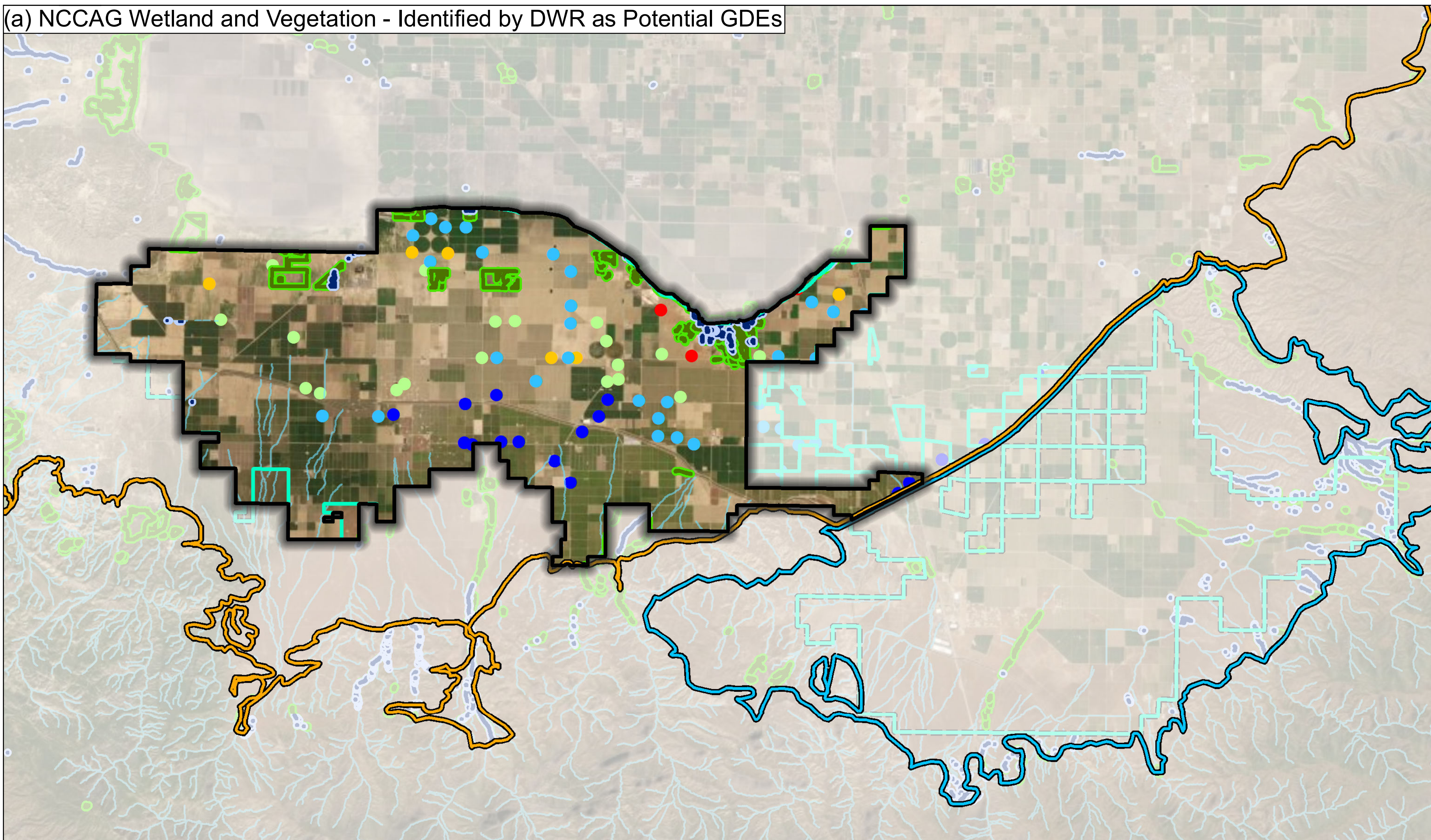
C20055.00

eki environment & water

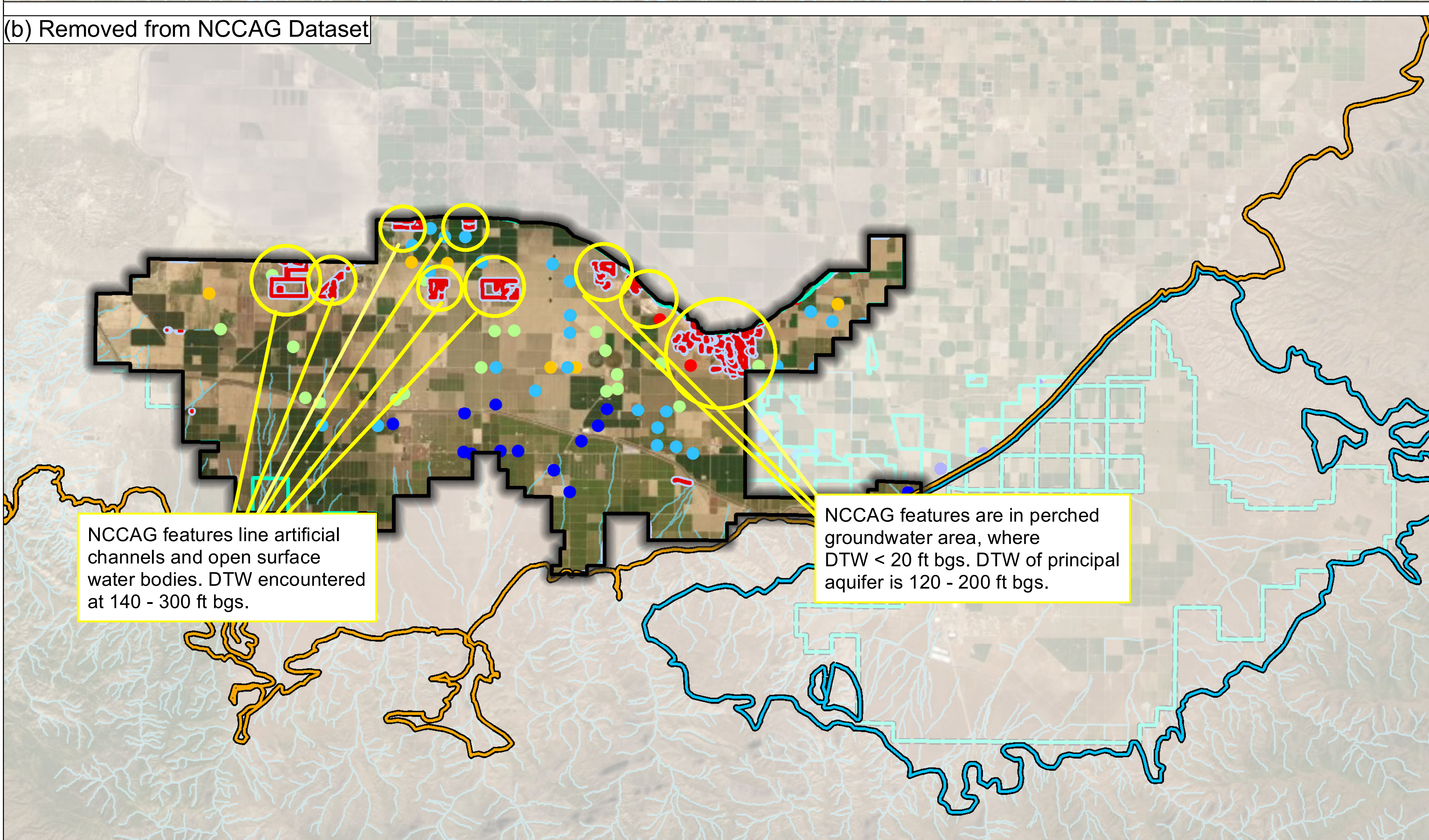
**Figure GWC-38**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-38_NCCAG_CalCreek_AE.mxd

(a) NCCAG Wetland and Vegetation - Identified by DWR as Potential GDEs



(b) Removed from NCCAG Dataset




Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- NCCAG Wetland
- NCCAG Vegetation
- Removed NCCAG Vegetation or Wetland
- Stream into WRMWSD

**Spring 2015 Depth to Groundwater (ft bgs)**

- 0 - 50
- 50 - 100
- 100 - 200
- 200 - 350
- > 350

Abbreviations

| | |
|---|---|
| DTW | = Depth to Water |
| DWR | = California Department of Water Resources |
| ft bgs | = feet below ground surface |
| GSA | = Groundwater Sustainability Agency |
| NCCAG | = Natural Communities Commonly Associated with Groundwater |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

N

0 4 8

(Scale in Miles)

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 June 2022.
2. DWR NCCAG dataset was obtained from NC Dataset Viewer (https://gis.water.ca.gov/app/NCDatasetViewer/)

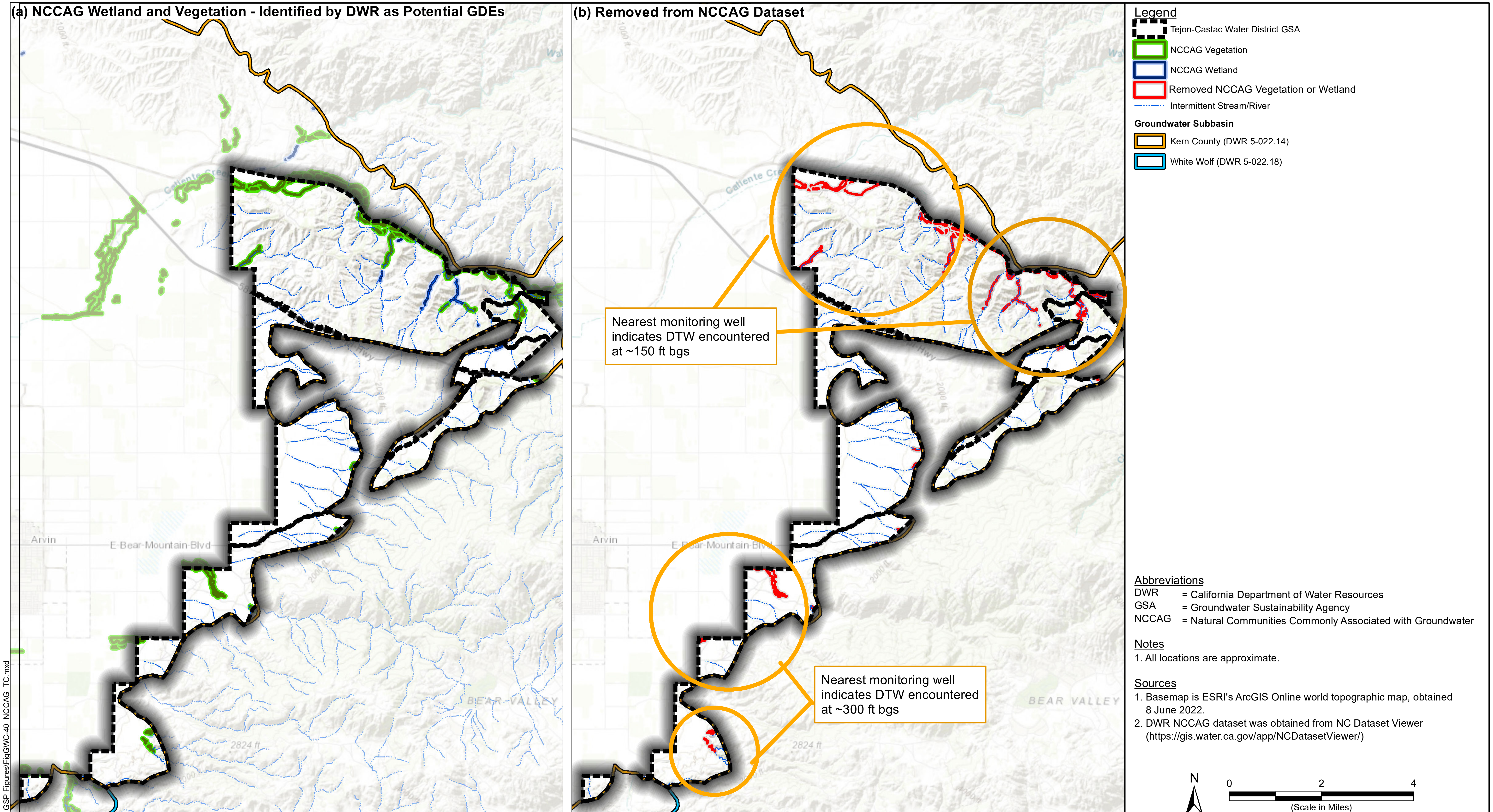
**Natural Communities Commonly Associated with Groundwater (DWR) Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure GWC-39**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-39_NCCAG(DWR)_v2_WR.mxd




**Natural Communities Commonly Associated with Groundwater (DWR)**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure GWC-40**

Path: X:\C20055.00\Maps\3 GWC\SOKR GSP Figures\FigGWC-40_NCCAG_TC.mxd

## 9. WATER BUDGET INFORMATION

☑ 23 CCR § 354.18(a)
☑ 23 CCR § 354.18(f)

All Groundwater Sustainability Agencies (GSAs) in the Kern County Subbasin (referred to herein as the Kern Subbasin or Basin) coordinated and collaborated on the development of a groundwater model (Model)[88] to evaluate historical, baseline and projected groundwater conditions. The GSAs entered into a Cost Share Agreement with the Kern River GSA who took the lead and contracted with Todd Groundwater to develop the Model on behalf of the Subbasin. The contract required that Todd Groundwater use the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) model provided by the California Department of Water Resources (DWR). Considerable effort and resources were expended to update the C2VSim model with local data to better represent Subbasin conditions. Basin-wide water budget results from the Model are provided in the Coordination Agreement. These results show that the Basin, as a whole, has a total storage deficit of approximately -324,326 acre-feet per year (AFY) over the baseline period.

The Kern Subbasin's dynamic conjunctive use programs, water banking operations, and water transfers/exchanges made it necessary to coordinate a GSA-level water accounting system (Checkbook) using Subbasin specific values for supply, demand and net results. The Model results reflect Subbasin-wide conditions and does not allocate water shortages/surpluses, nor do the results allocate the "ownership" of water. As a result, the GSAs, through a coordinated effort, developed the Checkbook that estimates current conditions for each GSA that are generally consistent with the Model results under baseline condition. The Checkbook and Model budgets are based upon best available information, recognizing however that each estimate includes data gaps and has varying degrees of accuracy and/or reliability in the interest of developing a Subbasin coordinated approach.

To ensure the individual water budgets reflected actual conditions, members of the Kern Groundwater Authority (KGA), along with the other GSAs preparing Groundwater Sustainability Plans (GSPs) in the Basin, developed the Checkbook budget and coordinated water accounting methodology. The result of that effort indicated a current baseline shortage/deficit for KGA members of approximately -256,281 AFY as reported in Appendix B of the original (2020) Coordination Agreement. Of that KGA total amount, the South of Kern River (SOKR) GSAs (including associated un-districted "white" lands) collectively amounted to a deficit of -30,748 AFY.

As part of the resubmittal of the SOKR GSP, the SOKR GSAs have reconstructed the Basin-wide Checkbook by removing their respective supply, demand, and deficit values from the KGA term and relisting them under a new SOKR term (see **Appendix XX**). The result of this is a new KGA deficit of -225,533 AFY. Together, the SOKR Checkbook values and the revised KGA Checkbook values equate to the original KGA Checkbook values reported in the (2020) KGA Umbrella GSP and Coordination Agreement, and the Basin-wide Checkbook balance remains unchanged.

As mentioned above, each estimate includes data gaps and has varying degrees of accuracy and/or reliability. The Checkbook is complementary to the Model and reflects the allocation of water supply benefits and obligations independent of geographic constraints within the Subbasin. This was important

[88] The "Model" is referred to elsewhere in this water budget discussion as the "numerical model".

to recognize and ensure the coordination of the various groundwater banking projects and water management programs amongst the various GSAs within the Basin.

These two Basin-level water budgeting efforts (i.e., the Model and the Checkbook) are described in the Coordination Agreement and Appendices thereto. These two Basin-level efforts are supplemented by the local water budget information presented in this section for the SOKR Management Areas. Consistent with DWR's GSP Emergency Regulations and DWR's Water Budget Best Management Practices (BMP) (DWR, 2016b), these Management Area-specific water budget information provide an accounting of the total annual volume of water entering and leaving the Management Areas, for historical, current, and projected future conditions.

The Model, Checkbook and the local water budget assessments discussed in detail in this section provide a range of results. ***Table WB-1*** below shows a comparison of results for change in groundwater storage from the three water budget approaches for several time periods within each Management Area, and for the entire SOKR GSP Area. Change in groundwater storage is considered an appropriate term for comparison, as it amounts to an integration of all of the other inflow and outflow terms and represents the overall quantitative balance of the system.

The range of change in groundwater storage results shown in ***Table WB-1*** is due to several reasons. These include:

- Slight differences in the spatial area considered by each method (i.e., due to the fact that the model's grid cells/elements do not exactly align with the boundaries of the SOKR Management Areas);
- Slight differences in the way that project and management actions are implemented over time;
- Inherently different levels of spatial resolution between methods, affecting the parameterization and subsequent calculation of subsurface flow across boundaries;
- Slight differences in the way in which land surface processes are treated (i.e., evapotranspiration demand, precipitation);
- Differences in the apportionment of native/natural water supplies stemming from the different perspectives and objectives of the multiple methods (i.e., the Model and local [analytical spreadsheet] model consider water supplies from a purely physical perspective whereas the Checkbook utilized a water accounting approach that assumes for management purposes a uniform Basin distribution).[89]

Despite these differences, each approach provides valuable information that can support effective groundwater management within the Basin and the SOKR Plan Area. As part of Plan Implementation, the SOKR GSAs will continue to refine the water budget parameters based on additional data and modeling (see **Section 18.1** ***Plan Implementation Activities***.

It is recognized that additional, more recent data (i.e., through 2022) are available at the time of preparation of this amended SOKR GSP. However, as the SOKR GSP does not constitute an updated GSP, but rather a response to the DWR determination letter, those additional data are not incorporated herein, with minor exceptions.

[89] Nothing in this water budget information presented herein results or is intended to be a determination of water rights.

**Table WB-1. Comparison of Change in Groundwater Storage Estimates from Three Water Budget Estimation Methods (all values in AFY)**

| | Arvin-Edison Management Area | | | | Wheeler Ridge-Maricopa Management Area | | | Tejon-Castac Management Area | | | Entire SOKR GSP Area | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period / Scenario | Basin-wide Numerical Model | Local Analytical Spreadsheet Model | Basin-wide "Checkbook" Water Accounting Approach – within AEWSD | Basin-wide "Checkbook" Water Accounting Approach – "White Lands" | Basin-wide Numerical Model | Local Analytical Spreadsheet Model | Basin-wide "Checkbook" Water Accounting Approach | Basin-wide Numerical Model | Local Analytical Spreadsheet Model | Basin-wide "Checkbook" Water Accounting Approach [3] | Basin-wide Numerical Model | Local Analytical Spreadsheet Model [5] | Basin-wide "Checkbook" Water Accounting Approach |
| Historical Period (WY 1995 – 2014) | 18,208 (a) | 1,364 (b) | NA | NA | -8,654 (k) | 3,286 (l) | NA | 40 (u) | 350 to 5,000 (v) | NA | 9,594 | 7,325 | NA |
| Current Period (WY 2015) | -112,364 (a) | -164,385 (b) | NA | NA | -45,191 (k) | -42,898 (l) | NA | -17,428 (u) | -150 to 5,800 (v) | NA | -174,983 | -204,458 | NA |
| Projected Period (50 years; 2021 – 2070)<br>Baseline w/o Projects | 2,750 (c) | 1,660 (d) | -8,418 (e) | -850 (e) | -5,423 (m) | -14,665 (n) | -14,665 (o) | -74 | 600 to 5,250 (v) | -6,815 (w) | -2,747 | -10,080 | -30,748 |
| Projected Period (50 years; 2021 – 2070)<br>2030 Climate Change w/o Projects [2] | -782 (f) | -31,586 (d) | NA | NA | -9,712 (p) | -21,429 (n) | NA | -376 | -1,570 to 3,340 (v) | NA | -10,870 | -52,130 | NA |
| Projected Period (50 years; 2021 – 2070)<br>2030 Climate Change w/ Projects [2] | 26,503 (g) | 343 (h) | NA | NA | 9,780 (q) | 53 (r) | NA | 2,481 | -1,570 to 3,340 (v)(4) | NA | 38,764 | 1,281 | NA |
| Projected Period (50 years; 2021 – 2070)<br>2070 Climate Change w/o Projects [2] | -8,695 (i) | -56,333 (d) | NA | NA | -17,952 (s) | -33,326 (n) | NA | -1,400 | -3,520 to 1,510 (v) | NA | -28,047 | -90,664 | NA |
| Projected Period (50 years; 2021 – 2070)<br>2070 Climate Change w/ Projects [2] | 17,855 (j) | 28 (h) | NA | NA | 1,571 (t) | 47 (r) | NA | NA | -1,570 to 3,340 (v)(4) | NA | NA | -930 | NA |

<u>Abbreviations</u>
NA = not applicable

<u>Notes:</u>

(1) All values are in AFY.
(2) The Projected Period is 50 years in length. For the 2030 Climate Change scenarios, the Basin-wide numerical model approach includes a 20-year (2021-2040) "implementation period" and a 30-year (2041-2070) "sustainability period". The Analytical Spreadsheet Model results assumes projects and management actions are fully implemented for the entire 50-year projected period.
(3) In the "Checkbook" water accounting approach, demands within the Tejon-Castac Management Area are specified as the evapotranspiration demand of the native vegetation, as measured by the ITRC METRIC method, and the additional estimated consumptive use for the agricultural lands outside of the TCWDGSA supplies by groundwater pumped from the Caratan well during drier years. Supplies include precipitation and "native yield", which is specified as 0.15 AFY/ac. Because the Tejon-Castac Management Area functions in a largely natural state, evapotranspiration demands will adjust to match available natural supplies.
(4) No P/MAs were explicitly considered in the TCWD Local Analytical Spreadsheet Model; thus, the reported change in storage is equivalent to that under the "no projects" scenario.
(5) Reported change in groundwater storage for the entire SOKR GSP Area reflects an average of the ranges in storage change estimated for the Tejon-Castac Management Area.

<u>Sources:</u>

(a) Table 1A of "FINAL_AEWSD-Hist-WB.xlsx", received from Todd, 7 May 2019.
(b) ***Table WB-6***
(c) Table 1 of "AEWSD-Baseline-Nov14-FINAL.xlsx", received from Todd, 18 November 2019.
(d) ***Table WB-7***
(e) "SKM_C25819111413180.pdf", received from KGA on 14 November 2019.
(f) Table 1 of "AEWSD-2030-Nov14-FINAL.xlsx", received from Todd, 18 November 2019.
(g) Table 1 of "AEWSD-2030_Projects-Nov14-FINAL.xlsx", received from Todd, 18 November 2019.
(h) ***Table WB-8***
(i) Table 1 of "AEWSD-2070-Nov14-FINAL.xlsx", received from Todd, 18 November 2019.
(j) Table 1 of "AEWSD-2070_Projects-Nov14-FINAL.xlsx", received from Todd, 18 November 2019
(k) Table 1 of "FINAL_WRMWSD-Hist-WB.xlsx", received from Todd, 7 May 2019.
(l) ***Table WB-13***
(m) Table 1 of "WRMWSD-Baseline-Nov14-FINAL.xlsx", received from Todd, 18 November 2019.
(n) ***Table WB-14***
(o) "SKM_C25819111413180.pdf", received from KGA on 14 November 2019.
(p) Table 1 of "WRMWSD-2030-Nov14-FINAL.xlsx", received from Todd, 18 November 2019.
(q) Table 1 of "WRMWSD-2030_Projects-Nov14-FINAL.xlsx", received from Todd, 18 November 2019.
(r) ***Table WB-15***
(s) Table 1 of "WRMWSD-2070-Nov14-FINAL.xlsx", received from Todd, 18 November 2019
(t) Table 1 of "WRMWSD-2070_Projects-Nov14-FINAL.xlsx", received from Todd, 18 November 2019
(u) Table 1 of "FINAL_Tejon-Hist-WB.xlsx", received from Todd, 7 May 2019.
(v) ***Table WB-16***
(w) "SKM_C25819111413180.pdf", received from KGA on 14 November 2019.

## 9.1. Arvin-Edison Management Area

### 9.1.1. Water Budget Methods and Data Sources

☑ 23 CCR § 354.18(d)
☑ 23 CCR § 354.18(e)

This Arvin GSA-level water budget uses a spreadsheet model approach that quantifies each flow component and enforces mass balance principles for each "subdomain" that collectively comprise the water budget domain (Arvin-Edison Management Area). Details of this approach and the corresponding data sources employed within the water budget model are described further below.

#### 9.1.1.1. Spreadsheet Model Approach

The spreadsheet model approach was developed for AEWSD to serve as an independent estimate of local historical, current, and projected water budget conditions within the Arvin-Edison Management Area. The spreadsheet model approach uses a variety of data and analytical methods to quantify each water budget flow component. Processes and groups of processes are grouped into "subdomains" and "flow components". These water budget flow components are quantified on a monthly timestep for the period from January 1994 through December 2015.

*Water Budget Subdomains*

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

- Artificial Channels;
- Spreading Grounds;
- Agricultural Lands;
- Urban Lands;
- Natural Channels; and
- Groundwater System.

In addition to the six internal subdomains, several external subdomains are incorporated into the spreadsheet model. These include the watersheds that contribute streamflow to streams entering the Arvin-Edison Management Area, the atmosphere which is a source of precipitation and sink for evapotranspiration, the adjacent and connected portions of the groundwater basin, and the external surface water sources including out-of-basin and in-basin (but outside of AEWSD) storage "accounts". The spreadsheet model does not explicitly account for the vadose (unsaturated) zone between the land surface and the (saturated) groundwater system, but instead incorporates temporal lag factors to account for the movement of water through this zone. An implicit assumption in this approach, therefore, is that the vadose zone does not experience any change in storage over time.

*Water Budget Flow Components*

Within and between each subdomain are 36 water budget flow components that route water through the Arvin-Edison Water Management Area. ***Figure WB-2*** shows a conceptual diagram of the individual water budget flow components between subdomains as well as flow components that are external to the overall water budget domain (i.e., serve only as an inflow or outflow to the entire system, rather than a flow between subdomains).

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

*Arvin-Edison / Wheeler Ridge-Maricopa Overlap Lands*

WRMWSD supplies surface water to certain lands within the portion of its service area that overlaps with the AEWSD service area. The total acreage of overlap lands within the Kern Subbasin is approximately 5,318 acres, and WRMWSD serves surface water to approximately 3,186 acres in this area. Although the overlap lands are being covered by the Arvin GSA for Sustainable Groundwater Management Act (SGMA) monitoring and management purposes, WRMWSD will continue in the future to serve surface water to those lands within the overlap area that have historically received WRMWSD supplies in accordance with WRMWSD's water delivery contracts with landowners. The Checkbook accounting exercise appropriately considered the supply and demands within the overlap lands included in the Arvin-Edison Management Area.

#### 9.1.1.2. Data Sources

☑ **23 CCR § 354.18(d)**
☑ **23 CCR § 354.18(e)**

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

- Precipitation Records from the various local climate stations including:
  - California Irrigation Management Information System (CIMIS) station #125 – Arvin, *Monthly [March 1996 – December 2015]*
  - AEWSD's own climate stations ("Office", "Sycamore", and "Tejon"), *Monthly [July 1967 – December 2015]*

- Four additional climate stations maintained by the National Oceanic and Atmospheric Administration (NOAA);[90] *Monthly resolution, January 1971 – December 2015 (data availability varies by station)*

- Satellite Evapotranspiration (ET) Data from the Cal Poly Irrigation Training and Research Center's "Mapping Evapotranspiration at High Resolution with Internalized Calibration" (ITRC-METRIC) Study, funded by the KGA[91]; *Monthly, January 1993 -December 2015* [92]
- AEWSD Land Use Surveys from AEWSD's internal land use records and agricultural consulting reports; *Seasonal, Spring 1994 – Fall 2015 (data availability varies by season)*
- AEWSD Surface Water Imports Records from AEWSD's internal operations records; *Monthly [January 1966 – December 2015]*
- AEWSD Spreading Records from AEWSD's internal operations records, *Monthly [January 1966 – December 2015]*
- AEWSD Recovery Well Pumping Records from AEWSD's internal operations records, *Monthly [January 1966 – December 2015]*
- Historical Groundwater Level Records from selected wells within AEWSD; *Seasonal resolution, Spring 1940 – Fall 2015 (data availability varies by well)*
- Streamflow Records for Caliente Creek (U.S. Geological Survey [USGS] stream gauge 11196400), *Monthly, October 1961 – February 1983*

#### 9.1.1.3. Intended Purpose of Water Budget

The local water budget spreadsheet model described herein (as well as the basin-wide Model approach to water budget estimation described in the Coordination Agreement and Appendices thereto) was designed to assess the water budget from a purely quantitative, physical perspective, which is consistent with SGMA and the GSP Emergency Regulations (i.e., California Water Code [CWC] § 10720.5 and 23 § CCR 354.18(a)). With the exception of explicit accounting for AEWSD's water banking operations, the local spreadsheet model does not consider water rights. As discussed above, the Checkbook "water accounting" approach attempts to evaluate the water budget using certain management assumptions (e.g., a uniform "native yield" component to all lands within the Basin). However, nothing in this water budget information results in or is intended to be a determination of water rights within the Arvin-Edison Management Area.

[90] See **Appendix J** for a detailed description of how climate stations are used to estimate precipitation on AEWSD lands and surrounding watersheds.
[91] Howes, D. 2017. 1993-2015 ITRC-METRIC ETc for Kern County. prepared for the Kern Groundwater Authority on behalf of the Cal Poly Irrigation Training and Research Center.
[92] There is no ITRC satellite ET data for calendar year 2012, as the LANDSAT satellite system employed in the ITRC-METRIC analysis was non-operational during this period. See **Appendix J** for further details.

### 9.1.2. Water Budget Results

Results are presented below in terms of both annual values during the historical water budget period (DWR Water Years [WY] 1995 – 2014),[93] as well as long-term averages over that period. As such, some information presented here aligns with the requirements of the historical water budget described under **Section 9.1.3 *Current and Historical Water Budget*** below and is not repeated there.

#### 9.1.2.1. Surface Water Inflows and Outflows

**☑ 23 CCR § 354.18(b)(1)**

***Table WB-1*** presents an annual summary of the total surface water inflows to and outflows from the Arvin-Edison Management Area between WY 1995 – 2015. These inflows include imported surface water, natural streamflow into the area, and precipitation. ***Figure WB-3*** shows the total surface water inflows by type. Total surface water inflows to the Management Area average approximately 253,000 AFY over WY 1995 – 2014 but have varied widely from year to year. On average, 69% of surface water inflows are from imported water supplies, 29% are from direct precipitation, and 2% are from intermittent streamflow from surrounding watersheds.

*Imported Water Supplies*

AEWSD has been importing water into the Arvin-Edison Management Area since 1966. Annual surface water imports (district-wide) during that time have ranged from 31,000 to over 305,000 AFY, and cumulatively a total of 7.89 million AF have been imported through February 2018 (***Figure WB-4***). AEWSD's primary source of imported water is the Friant Division of the United States Bureau of Reclamation's (USBR) Central Valley Project (CVP). AEWSD has contracts for 40,000 AFY of Class 1 water and 311,675 AFY of Class 2 water from the Friant Division.[94] Over the historical period (WY 1995 – 2014), imports of Friant Division water have averaged approximately 102,400 AFY.

In addition to its CVP contracts, AEWSD actively and regularly pursues additional water supplies through transfers, purchases, exchanges, and banking programs. Over the past 21 years, AEWSD has obtained roughly 1.50 million AF of additional water supplies through agreements with over 70 entities. Furthermore, AEWSD has invested in surface water infrastructure that gives it great flexibility to move water into (and out of) its service area to facilitate water exchanges (***Figure HCM-52***). AEWSD categorizes its imported surface water by source type according to the specific conveyance facility through which the water passes, as follows:

- Friant-Kern Canal;
- Cross Valley Canal;
- California (CA) Aqueduct (through its Intertie Pipeline);
- Kern River;

[93] DWR Water Years run from October of the previous year to September of the current year (e.g. DWR Water Year 2015 is October 2014 – September 2015.

[94] https://www.usbr.gov/mp/cvp-water/docs/latest-water-contractors.pdf

- Deliveries from Wheeler Ridge-Maricopa Water District (originating from the CA Aqueduct) to WRMWSD lands that overlap lands within the Arvin GSA; and
- "Other" infrequent supply sources, including wheeled surface water and groundwater from the adjacent Kern Delta Water District.

***Figure WB-5*** and ***Figure WB-6*** present an annual summary and long-term average breakdown of surface water imports by source from WY 1995 – 2014. Imported surface water supplies have averaged approximately 174,000 AFY over WY 1995 – 2014 but vary substantially from year to year.[95] As discussed below, a portion of these surface water imports is exported to customers in the White Wolf Subbasin.

<u>*Natural Streamflow*</u>

As discussed in **Section 7.3.5 *Surface Water Bodies***, several creeks drain into the Arvin-Edison Management area from watersheds to the east and south (***Figure HCM-49***). There are no currently active stream gauges on these creeks; however, one stream gauge on Caliente Creek above Tehachapi Creek (USGS stream gauge 11196400),[96] located approximately 10 miles east of the AEWSD boundary, has a period or record from October 1961 through February 1983, and data from this gauge was used as a proxy for all contributing watersheds. During this gauge's period of record, average monthly discharge at this location ranged from 0.39 cubic feet per second (cfs) in July and September to 16 cfs in February. Annual average discharge ranged from 0.263 cfs in 1966 to 33.5 cfs in 1978 (no data for 1983). Annual peak flows ranged from a minimum of 2.2 cfs in 1966 to a maximum of 15,500 cfs in 1983 (the stream gauge was apparently rendered inoperable by the 1983 peak flow and has not been repaired). These data indicate a highly seasonal pattern in streamflow at this location as well as substantial variability from year to year. It is expected that most creeks in this area exhibit this same behavior. As noted in **Section 7.3.5 *Surface Water Bodies***, Caliente Creek occasionally discharges into the Arvin-Edison Management Area during storm events and has caused flooding in the downstream town of Lamont. Similar flooding has also occurred on Tejon Creek. While Tejon Creek flooding does not affect any downstream communities, it has on occasion caused damage to AEWSD's Tejon Spreading Works facility.

<u>*Precipitation*</u>

Precipitation on lands within the Arvin-Edison Management contributes some water to the overall water budget and is grouped herein with "surface water inflows". Precipitation and other climate variables are measured at the CIMIS station #125 located in the City of Arvin. AEWSD also operates three rainfall measurement stations. Data from AEWSD's rain gauges are similar in magnitude and temporal pattern. Annual rainfall at the CIMIS station #125 over the period of WY 1995 – 2014 ranged from approximately 4.3 inches in WY 2008 to over 20 inches in WY 1998, with an average of 8.2 inches per year. Overall, an average of approximately 72,400 AFY of precipitation fell on lands within the Arvin-Edison Management Area during this period. This water serves to wet the near surface soil and then either evaporates, contributes to crop water demand, or (when a rainfall event is intense enough or long enough) percolates through the root zone to eventually recharge groundwater. "Effective precipitation", i.e. the volume of precipitation that ultimately contributes to meeting evapotranspirative demands within the root zone, is

[95] Imported surface water supplies are affected not only by hydrology (i.e., water year type) but also by non-hydrological factors in the decisions of those running the state and federal water projects
[96] https://waterdata.usgs.gov/ca/nwis/inventory/?site_no=11196400

estimated to be approximately 37,000 AFY (or 51% of total precipitation) within the Arvin-Edison Management Area.[97]

*Surface Water Outflows*

As shown in **Table WB-1** and **Figure WB-7**, natural surface water outflows from the Arvin-Edison Management Area are essentially zero.[98] Total surface water outflows averaged approximately 39,800 AFY between WY 1995 – 2014, 65% of which were in the form of deliveries to Arvin-Edison's service area in the White Wolf Subbasin and the remaining 35% as exports to the Metropolitan Water District (MWD) through the CA Aqueduct (via the Intertie Pipeline; see **Figure HCM-52**).

It should be noted that AEWSD uses its canal and pipeline delivery network to convey recovered groundwater from banking operations in addition to delivering imported surface water supplies. Therefore, all surface water outflows leaving the Arvin-Edison Management Area via AEWSD's pipeline and canal network have been blended upstream and may include a variable percentage of recovered groundwater depending on the given season and Water Year type.

*Out-of-District Groundwater Storage*

As described in **Section 5.2.3 *Conjunctive Use in the Management Areas*,** AEWSD also participates in several out-of-district groundwater storage and recovery programs both within and outside the Kern Subbasin. As an example, and as of February 2019, AEWSD has 77,590 AF of imported water supplies banked and available to withdraw in various locations outside the Arvin-Edison Management Area, including:

- 58,886 AF in the Rosedale Rio-Bravo Water Storage District (RRBWSD) water bank;
- 10,704 AF in the Westside Mutual Water Company water bank; and
- 8,000 AF in the Kaweah Delta WCD water bank.

These banked imported water supplies are not included in the quantification of total surface water inflows into the Arvin-Edison Management Area or in the subsequent determination of change in groundwater storage, as they are currently being physically stored outside the Management Area boundaries. However, these banked supplies contribute to the overall storage within the Kern Subbasin. AEWSD maintains rights to recover these banked supplies in the future per the contract terms specified in the individual agreements with the entities mentioned above.

#### 9.1.2.2. Groundwater Inflows and Outflows

☑ **23 CCR § 354.18(b)(2)**
☑ **23 CCR § 354.18(b)(3)**

***Table WB-3*** and ***Figure WB-8*** provide an annual summary of inflows to and outflows from the groundwater system by water source type for Water Years 1995 – 2014. As evident from these two exhibits (as well as the groundwater hydrographs shown in ***Figure GWC-5*** and ***Figure GWC-6***), the groundwater system is highly sensitive to climatic conditions and AEWSD operations. As such, annual

[97] Based off the U.S. Department of Agriculture-Soil Conservation Service method (USDA-SCS, 1970); see **Appendix J**.
[98] Ungauged flood flows originating from Caliente Creek have been observed during large storm events in Lamont, west of the Arvin-Edison Management Area.

inflows and outflows vary widely depending on availability of surface water supplies to meet irrigation demands and to sustain groundwater banking operations. Sources of inflow to the groundwater system include:

- Recharge from groundwater banking operations;
- Subsurface inflows across AEWSD's western boundary (from west to east) and across the White Wolf Fault (from south to north);
- Infiltration of applied water;
- Infiltration of precipitation; and
- Infiltration from surface water systems (e.g., seepage from streams and channels).

***Figure WB-9*** provides a summary of long-term (WY 1995 – 2014) annual average inflows to and outflows from the groundwater system. Total inflows to the groundwater system averaged approximately 145,500 AFY. Approximately 40% of total inflows to the groundwater system were supplied by infiltration of applied water, 35% by recharge from spreading basins, 13% from subsurface groundwater inflows, 9% from infiltration from surface water systems, and 3% from infiltration of precipitation.

Due to AEWSD's position at the southwestern edge of the Kern Subbasin (near pre-development discharge areas) and the resulting low hydraulic heads which are further drawn down by pumping, there are virtually no subsurface outflows, losses to surface water systems, or evapotranspirative losses occurring from the groundwater system (see ***Figure GWC-1***). As shown on ***Figure WB-9***, total outflows from the groundwater system averaged approximately 143,800 AFY over WY 1995 – 2014 and were entirely related to groundwater extraction. Of this value, approximately 61% of groundwater extraction can be attributed to private agricultural pumpage, 37% to pumpage from AEWSD wells related to its groundwater banking and recovery operations, and the remaining 2% to pumpage from municipal and industrial customers, including ACSD.

#### 9.1.2.3. <u>Change in Groundwater Storage</u>

**☑ 23 CCR § 354.18(b)(4)**

***Figure WB-10***, ***Figure WB-11***, and ***Table WB-4*** present the annual and cumulative change in groundwater storage between seasonal high conditions, which are defined in this chapter to be March through February of the following year. Note that this time window is distinct from DWR's definition of the "Water Year", which runs from October of the previous year to September of the current year (e.g. DWR Water Year 2014 is October 2013 – September 2014); thus the values presented in ***Table WB-4*** are slightly different than the annual and cumulative change in storage estimates provided for DWR Water Years 1995 – 2014 in ***Table WB-3***, ***Table WB-5***, and ***Table WB-6***.

Annual change in groundwater storage under the Arvin-Edison Management Area averaged approximately -2,700 AFY between seasonal high conditions for the period of March 1994 – February 2015, with a cumulative change in storage equating to -57,000 AF over the same period of record. However, as seen in ***Figure WB-10*** and ***Figure WB-11***, change in storage varied widely between years, from a -185,000 AF decrease in storage to a 155,000 AF increase in storage.

9.1.2.4. Overdraft Conditions

☑ **23 CCR § 354.18(b)(5)**

The Kern Subbasin is designated by DWR in its latest version of *Bulletin 118 – California's Groundwater* as being in a condition of critical overdraft (DWR, 2016c). With respect to overdraft conditions and basins subject to those conditions, DWR has made the following statements:

- "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts." (DWR, 1980)
- Groundwater overdraft is "... the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts." (DWR, 2003)
- "Overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of water to the basin. Effects of overdraft result can include seawater intrusion, land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels".[99]

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

The historical water budget information discussed herein covers the period from WY 1995 - 2014[100] (i.e., it does not cover the entire period used in DWR's evaluation). However, within the period covered by this water budget, the timeframe between WY 1997 - 2009 (October 1996 through September 2009) meets all of the same criteria. During this 13-year period, the cumulative departure in statewide average precipitation increased by approximately 9% (DWR, 2016c Figure 1), indicating that, on average, each year was less than 1% wetter than the long-term average. Over this time period, the cumulative change in storage within the Arvin-Edison Management Area increased by approximately 32,500 AF, averaging 2,500 AFY. Therefore, based on local historical water budget information, the Management Area as a whole does not show a deficit.[101] According to the results of the "Checkbook" water accounting approach

[99] https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins, accessed 1 July 2018.

[100] This timeframe is consistent with the water budgeting timeframes incorporated into basin-level modeling efforts for the Kern Subbasin.

[101] It should be noted that groundwater conditions vary spatially through the Kern Subbasin and even within the Arvin-Edison Management Area, and broad generalizations over large areas can lead to mischaracterization of conditions on a local scale. For this reason, its imperative (and SGMA requires) that conditions be evaluated locally on a management area or Representative Monitoring Site basis.

for the projected baseline condition, the Management Area has a projected annual deficit of -8,418 AFY. The Arvin GSA has developed a suite of Projects and Management Actions (see **Section 17 *Projects and Management Actions***) whose intended benefit is to prevent or eliminate any future overdraft condition by the statutory deadline. As discussed in **Section 9** above, however, significant uncertainty exists regarding the actual magnitude of projected water budgets, and the water budget will be refined over time as additional data is collected. In the meantime, the planned P/MAs will be implemented according to the implementation plan outlined **Section 18 *Plan Implementation***.

9.1.2.5. Water Year Types

**☑ 23 CCR § 354.18(b)(6)**

***Table WB-5*** presents the annual total supplies, total demands, and change in groundwater storage in the Arvin-Edison Management Area along with the DWR Water Year type (October – September) for the period from WY 1995 through 2015. Also shown on ***Table WB-5*** are the averages for total supplies, total demands and change in groundwater storage for each of the five Water Year types. ***Figure WB-12*** and ***Figure WB-13*** present the change in groundwater storage versus Water Year type on an annual and cumulative basis, respectively. The Water Year type is based on DWR's San Joaquin Valley Water Year Index. These exhibits depict a clear relationship between Water Year type and change in groundwater storage, whereby change in storage is more positive during wet and above normal Water Years and more negative during below normal, dry and critical Water Years. This variability can be traced largely to differences in supplies during different Water Year types, as the total demands are relatively constant. The net benefit of a "wet" period on groundwater conditions is especially evident in Water Years 1995 – 2000, whereas the impact of a severe multi-year drought becomes increasingly evident in WYs 2012 – 2015.

**Section 8.3 *Change in Groundwater Storage***, in the Groundwater Conditions section of this GSP, reports values for change in storage based on interpolated groundwater levels and specific yield values (***Table GWC-2***). Those water level-based change in storage values were used in the calibration of the water budget spreadsheet model.[102] ***Figure WB-14*** shows a comparison of the spreadsheet model-based transient change in storage against the water level-based change in storage values for the entire AEWSD service area as well as for the Arvin-Edison Management Area. As shown on ***Figure WB-14***, the spreadsheet model matches the water level-based estimates well; the root-mean squared error (RMSE) for the annual rate of change for the three long-term periods (1994 – 2007, 2007 – 2015, 1994 – 2015) is 5,800 AFY, which is a small fraction (<2%) of the overall groundwater subdomain water budget magnitude (e.g., average annual groundwater inflows and outflows of approximately 145,500 AFY and 143,800 AFY, respectively).

9.1.2.6. Sustainable Yield

**☑ 23 CCR § 354.18(b)(7)**

SGMA defines sustainable yield as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be

[102] The water budget spreadsheet model calibration was completed for the entire AEWSD service area, inclusive of the area within the White Wolf Subbasin.

withdrawn annually from a groundwater supply without causing an undesirable result" (CWC § 10721(w)). DWR's Water Budget BMP (DWR, 2016b), further states that "Water budget accounting information should directly support the estimate of sustainable yield for the basin and include an explanation of how the estimate of sustainable yield will allow the basin to be operated to avoid locally defined undesirable results. The explanation should include a discussion of the relationship or linkage between the estimated sustainable yield for the basin and local determination of the sustainable management criteria (sustainability goal, undesirable results, minimum thresholds, and measurable objectives)."

A key part of the codified definition and the BMP statement is the avoidance of Undesirable Results, defined as "significant and unreasonable" effects for any of the six SGMA sustainability indicators. For example, with regard to groundwater levels, declining levels during a drought do not constitute and Undesirable Result for Chronic Lowering of Groundwater Levels if extractions and groundwater recharge are managed as necessary to ensure that reduction in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods (CWC § 10721(x)(1)). Therefore, while the water budget should provide support for sustainable yield, determination of the sustainable yield for the Arvin-Edison Management Area ultimately depends upon whether Undesirable Results are avoided within the timeframes required by SGMA.

A conservative estimate of the sustainable yield of the groundwater system underlying the Arvin-Edison Management Area can be made by adding the average annual change in storage, minus any temporary groundwater surplus resulting from out-of-District entitlements (e.g., the MWD groundwater banking "return obligation" described in **Section 9.1.4.3 *Additional Surface Water Supply Adjustments***), to the average annual private and municipal & industrial (M&I) groundwater extraction (i.e., excluding all AEWSD groundwater banking recovery pumping). This simplified approach provides a sustainable yield number corresponding to the volume of groundwater that, if pumped over the water budget period of interest, would have resulted in zero change in storage – a reasonable metric for sustainability. Based on the average annual change in groundwater storage over the water budget period from WY 1995 – 2014 (i.e., +1,400 AFY), the average annual private and M&I groundwater extraction rate (i.e., 90,500 AFY), and the average annual MWD surplus (7,700 AFY), using this simple method the sustainable yield is conservatively estimated to be at a minimum approximately 84,200 AFY under current supply and demand conditions. This equates to an acreage-normalized sustainable yield of approximately 0.80 AFY/acre over the (105,630 acre) Arvin-Edison Management Area.[103]

This number is conservative because SGMA itself does not require that the basin or any particular management area to be balanced at any particular point in time, as discussed above. As mentioned above, this number does not include the additional 53,200 AFY of AEWSD pumping occurring from its groundwater banking and recovery operations. The sustainable yield estimate also does not factor in the additional 77,600 AF (~3,900 AFY) of imported AEWSD supplies currently stored within other groundwater banking facilities outside the district but within the Kern Subbasin (**Section 9.1.2.1 *Surface Water Inflows and Outflows***).

This sustainable yield number is also inherently conservative in that it is based on a pumping rate that, under similar hydrologic conditions as the historical period, would result in no decrease in storage. As

[103] The acreage-normalized sustainable yield values presented herein should not be viewed as an "allocation" but rather is presented herein to facilitate comparisons to commonly used agronomic quantities (e.g., crop water demands in AFY/ac).

discussed in **Section 13.1** ***Undesirable Results for Chronic Lowering of Groundwater Levels*** and **Section 13.2** ***Undesirable Results for Reduction of Groundwater Storage***, the locally defined criteria for what constitutes an Undesirable Result for groundwater levels and change in storage is not strictly limited to a zero net decrease; rather, those criteria allow for some operation of the basin at groundwater levels and storage levels below current conditions. For the other relevant sustainability indicators (i.e., water quality degradation and land subsidence), a sustainable yield value that amounts to a zero change in storage would also be expected to avoid Undesirable Results. Therefore, this sustainable yield estimate takes into account Undesirable Results, as required by CWC § 10721(w).

Moreover, as described earlier in this section, AEWSD has also participated in a Basin-wide numerical modeling effort in addition to developing a more refined local water budget for their Management Area. Results of the C2VSim-FG historical water budget model extracted from the model elements most closely corresponding to the Arvin-Edison Management Area jurisdictional boundaries indicate an average annual groundwater extraction rate of approximately 150,600 AFY for the historical period of WY 1995 – 2014, and an average annual change in storage of +18,200 AFY during that same period. Under the same approach as described above, the C2VSim-FG historical water budget results indicate a sustainable yield estimate of 107,900 AFY within the Management Area, or 1.02 AFY/acre. It is important to note that this model is intended to be a Basin-wide assessment of groundwater conditions and, unlike the local water budget described above, is not specifically calibrated to the AEWSD service area. Additional reconciliation of basin water budgeting efforts is a high priority for basin GSAs as part of GSP implementation.

### 9.1.3. Current and Historical Water Budget

#### 9.1.3.1. Current Water Budget

☑ **23 CCR § 354.18(c)(1)**

This section presents results for the "current" water budget, based on values extracted from the spreadsheet model for WY 2015. This is consistent with how "current" is being defined in the Kern Subbasin Plan.

WY 2015 was classified as the third consecutive "Critical" (dry) Water Year and fourth consecutive "Dry" or "Critical" Water Year within the San Joaquin Valley and is thus representative of perhaps the worst drought condition in recent history within the region.

***Table WB-6*** and ***Figure WB-15*** provide a summary of total inflows and outflows to the Arvin-Edison Management Area for WY 2015, while ***Table WB-3*** and ***Figure WB-16*** provide a summary of groundwater inflows and outflows.

Total inflows to the Arvin-Edison Management Area amounted to 142,000 AF in WY 2015, comprised of 46% precipitation, 35% surface water imports, 16% subsurface inflows, and 2% natural surface water inflows. This resulted in a total inflow to the groundwater system of approximately 85,200 AF, comprised of 60% infiltration of applied water, 27% subsurface inflow, 8% infiltration from surface water systems, 4% infiltration of precipitation, and 2% from recharge from spreading basins.

Total outflows from the Arvin-Edison Management Area amounted to 311,400 AF in WY 2015, comprised of 70% evapotranspiration (consumptive use by vegetation), 27% surface water exports and deliveries to the White Wolf Subbasin, and 3% municipal and industrial (M&I) consumptive use. This resulted in a net outflow from the groundwater system of approximately 251,500 AF, 100% of which is due to groundwater extraction.

As evident from these water budget values, the Arvin-Edison Management Area (like nearly all areas in the Kern Subbasin and San Joaquin Valley as a whole) was impacted significantly by the extreme drought condition and allocation decisions made by the USBR in WY 2015, resulting in a net loss of approximately -164,400 AF of groundwater storage during this timeframe. However, as evidenced by the recovery of water levels and storage following previous dry periods, the groundwater system is resilient, and the "current" (WY 2015) conditions are not indicative of a normal condition but rather represent the late stages of a major drought period from which the groundwater system has already started to recover (see ***Figure GWC-6***).

#### 9.1.3.2. Historical Water Budget

☑ **23 CCR § 354.18(c)(2)**

Water budget results are presented for the historical water budget period in **Section 9.1.4.5 *Projected Water Budget Results*** including associated figures and tables, and are not repeated here. Rather, this section focuses on providing: (a) a quantitative evaluation of historical surface water availability and reliability (23 CCR § 354.18(d)(2)(A)), (b) a quantitative assessment of the historical water budget (23 CCR § 354.18(d)(2)(B)), and (c) a description of how historical conditions have impacted the ability of the Arvin-Edison Management Area to be operated within its sustainable yield (23 CCR § 354.18(d)(2)(C)).

*Historical Surface Water Availability and Reliability*

☑ **23 CCR § 354.18(c)(2)(A)**

As described above, AEWSD's only contracted source of surface water supply is its Class 1 and Class 2 contracts for CVP (Friant Division) water, at 40,000 AFY and 311,675 AFY respectively. AEWSD has been granted its full Friant Class 1 allocation a total of 38 times in the 54 years since deliveries began in 1966, and in 16 out of 20 years over the historical water budget period of record (WY 1995 – 2014). The average annual volume of Class 1 Friant water allocated to AEWSD over WY 1995 – 2014 is 35,700 AFY, and the total average volume of Friant water delivered (including Class 2 and other supplies) is 98,000 AFY. ***Figure WB-17*** presents an annual breakdown of total imported Friant-Kern supplies relative to AEWSD's existing Class 1 and Class 2 contract volumes.

This large inter-annual variability in supply indicates that, while Friant water remains the primary and most important source to AEWSD, its reliability is variable, and has been impacted significantly in recent years due to: (1) the 2006 San Joaquin River Restoration Settlement and subsequent federal legislation, which has reduced deliveries from the Friant Division, and (2) subsidence, which has significantly impacted conveyance capacity of the Friant-Kern Canal to AEWSD. For this reason, AEWSD actively and regularly pursues additional water supplies through transfers, purchases, exchanges, and banking programs (e.g., its long-standing banking programs with MWD and RRBWSD, among others), as well as supporting efforts to increase yields from, and the conveyance capacity of, the Friant Division of the CVP.

*Quantitative Assessment of Historical Water Budget*

☑ **23 CCR § 354.18(c)(2)(B)**

Based on the DWR San Joaquin Valley Water Year Index for the 20-year period from WY 1995 - 2014, this period included four "critical" (dry) years, four dry years, two below normal years, three above normal year, and seven wet years. The first third of this period was relatively wet, the middle third was a mix of wet and dry years, and the last third of the period was extremely dry. This climatic factor is clearly reflected in the water budget for the Arvin-Edison Management Area, whereby the groundwater system shows consistent increases in storage with "wetter" conditions and decreases in storage under "drier" conditions (see ***Figure WB-12***, ***Figure WB-13***, and ***Table WB-5***).

***Table WB-6*** and ***Figure WB-18*** provide a tabular and graphical breakdown of total inflows and outflows to the Arvin-Edison Management Area for WY 1995 – 2014, with a summary of average annual total inflows and outflows provided in ***Figure WB-19***. ***Table WB-3*** and ***Figure WB-8*** provide a tabular breakdown of inflows and outflows to the groundwater system underlying Arvin-Edison Management Area for WY 1995 – 2014, with a summary of average annual groundwater inflows and outflows provided in ***Figure WB-9***.

Total inflows to the Arvin-Edison Management Area amounted to an average of 271,600 AFY for WY 1995 – 2014, comprised of 64% surface water imports, 27% precipitation, 7% subsurface inflows, and 2% natural surface water inflows. This resulted in an average net inflow to the groundwater system of approximately 145,500 AFY, comprised of 40% groundwater recharge from spreading basins, 35% infiltration of applied water, 13% subsurface inflow, 9% infiltration from surface water systems, and 3% infiltration of precipitation.

Total annual outflows from the Arvin-Edison Management Area amounted to 269,800 AFY for WY 1995 – 2014, comprised of 83% evapotranspiration (consumptive use by vegetation), 15% surface water exports and deliveries to the White Wolf Subbasin, and 2% municipal and industrial consumptive use. This resulted in a net outflow from the groundwater system of approximately 143,800 AF, 100% of which caused by groundwater extraction.

*Operation Within Sustainable Yield*

☑ **23 CCR § 354.18(c)(2)(C)**

The average annual change in groundwater storage within the Arvin-Edison Management Area amounted to +1,400 AFY between WY 1995 – 2014 (i.e., a cumulative change in groundwater storage of +27,300 AF within this period). This small cumulative storage change over a 20-year historical record, that includes the recent severe drought, indicates that the groundwater system is in a state of relative balance, and not a state of significant overdraft. Although the overall net change during this period is slightly negative, the calculated transient change in storage and water levels measured in wells within the Arvin-Edison Management Area (see ***Figure WB-21***, ***Figure GWC-5***, and ***Figure GWC-6***) demonstrate that the groundwater system is sensitive to climatic variability and AEWSD operations, with decreases in storage during drought and/or regulatory restrictions followed by increases in storage during wet periods.

As discussed previously and shown on ***Figure WB-4***, AEWSD has imported over 7.89 million AF of water into the Arvin-Edison Management Area since it began operations in 1966. Since that time, the groundwater system has experienced a long-term change in storage of approximately -20,400 AF, or -400 AFY (***Table GWC-2***) and groundwater elevations have increased in areas where imported surface water is delivered (***Figure GWC-5***). This shows how AEWSD operations have resulted in a net balance to the groundwater supply beneath the Arvin-Edison Management Area, demonstrating successful groundwater management.

### 9.1.4. Projected Water Budget

☑ **23 CCR § 354.18(c)(3)**

Projected water budgets are required as a way to estimate future conditions of water supply and demand within a basin, as well as the aquifer response to implementation of the Plan over the planning and implementation horizon. To develop the projected water budget, the same tools and methodologies that were used for the historical and current water budget were used, with updated inputs for climate variables (i.e., precipitation and ET) and water supply assumptions (i.e., imported water supplies). The chief purpose of this projected water budget analysis is to assess the magnitude of the net water supply deficit that would need to be addressed through Projects and Management Actions to prevent Undesirable Results (discussed further in **Section 13 *Undesirable Results*** and **Section 17 *Projects and Management Actions***) and achieve the Sustainability Goal. This section describes the development and results of the projected water budget for the Arvin-Edison Management Area.

#### 9.1.4.1. Development of 50-Year Analog Period

☑ **23 CCR § 354.18(c)(3)(A)**
☑ **23 CCR § 354.18(c)(3)(B)**
☑ **23 CCR § 354.18(c)(3)(C)**

Per 23 CCR § 354.18(c)(3)(A), the projected water budgets must use 50 years of historical precipitation, evapotranspiration, and streamflow information as the basis for evaluating future conditions under baseline and climate-modified scenarios. The process by which a 50-year period of precipitation, evapotranspiration and streamflow information was developed is based on the process adopted by all GSAs within the Basin, as described in the Coordination Agreement and Appendices thereto. That process is briefly summarized here.

To develop the required 50 years-worth of hydrologic input information, first an "analog period" was created from the 20 years-worth of historical information (WY 1995-2014) by combining the years in a specific way that, on average, maintained the long-term average hydrologic conditions. This approach, which was used for both the spreadsheet water budget model approach and the basin-wide C2VSim-FG modeling approach, allowed for the creation of a complete 50-year period to inform the projected water budget analysis, even when certain component datasets were not available for that length of time. The sequence of actual years that were combined to create the 50-year analog period is as follows:

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

The above mapping of actual years to analog years within the required 50-year projected water budget period applies to precipitation and ET datasets. It also applies to datasets of imported surface water and exports to MWD with some additional modifications as described in the following section.

#### 9.1.4.2. Development of Projected Water Budget Scenarios

☑ **23 CCR § 354.18(c)(3)(A)**
☑ **23 CCR § 354.18(c)(3)(B)**
☑ **23 CCR § 354.18(c)(3)(C)**

Using the 50-year analog period, three projected water budget scenarios were developed for this analysis: a baseline scenario, and 2030 climate change scenario, and a 2070 climate change scenario. Development of the three scenarios was done consistent with the agreed-upon process being used basin-wide. Details of the scenario development are contained within the Coordination Agreement and Appendices thereto, and are briefly summarized here.

*Baseline Scenario*

Per 23 CCR § 354.18(c)(3)(C), the projected water budgets must use "the most recent water supply information as the baseline condition for estimating future surface water supply". Consistent with the process applied basin-wide, the information used to inform the baseline conditions for CVP supplies is from the Friant Water Authority (FWA) modeling projections (FWA, 2018), specifically the "2015.c projection". Similarly, the latest available information used to inform the baseline conditions for State Water Project (SWP) supplies is based on information published by and/or obtained from DWR, including data from DWR's California Water Resources Simulation Model (CalSim) water resources planning model, historical SWP operations data, and impacts from new operations regulations pursuant to the 2008/2009 Long-Term Operations Criteria and Plan (OCAP) Biological Opinion (BO).[104] As part of the basin-wide approach to Baseline Scenario development, certain substitutions and/or adjustments to years were made to the 50-year analog period for certain water supplies because the available datasets did not cover the entire historical water budget time period (WY 1995-2014). These substitutions included the following:

- Replacing years 2004-2014 with years 1951-1961 for Friant Division (CVP) supplies;
- Adjusting years 2004-2007 for SWP supplies to account for the recent regulatory changes to SWP operations made effective in 2008 and 2009 (i.e., the OCAP BO);[105]
- Replacing years 1995-2003 for SWP supplies with values from DWR's 2030-level CalSim study,[106] increased by 3.03%, again to account for the OCAP BO; and

[104] CalSim deliveries data from: https://data.cnra.ca.gov/dataset/sgma-climate-change-resources; SWP operational data from: https://water.ca.gov/Programs/State-Water-Project/Operations-and-Maintenance/Monthly-and-Annual-Operations-Reports; new operations regulations pursuant to the 2008-2009 OCAP BOs used as basis for calculation of SWP impacts by KGA's consultant.

[105] https://www.fws.gov/sfbaydelta/Documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf
https://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/nmfs_biological_and_conference_opinion_on_the_long-term_operations_of_the_cvp_and_swp.pdf

[106] Consistent set of CalSim operations studies at current, 2030 and 2070 climate levels for Bay Delta Conservation Plan evaluation provided by DWR Bay Delta Office staff.

- Replacing years 2011-2014 with years 1986, 1991, 1990, and 1961, respectively, for Kern River flows.

The above substitutions and adjustments were made by KGA GSA consultants based upon their analysis of the FWA and DWR (CalSim) studies and were provided to all districts as a basis for development of projected water budgets. As such, the information used for this analysis is consistent with the basin-wide approach.

*2030 Climate Change Scenario*

☑ **23 CCR § 354.18(d)(3)**

In order to estimate the potential effects on the projected water budget of climate change during the GSP implementation period (i.e., between 2020 and 2040), a water budget scenario based on 2030 climate change factors published by DWR was developed. For this scenario, precipitation and ET were both adjusted based on the change factors published by DWR. CVP water supplies were taken from the FWA projections under the "2030.c scenario." (FWA, 2018). SWP supply projections were taken from the DWR 2030-Level CalSim studies, except for years 2004-2007 which were taken as the actual SWP data, adjusted for the OCAP BO and reduced by 3.03%, and years 2008-2014 which were taken as the actual SWP data, reduced by 3.03%. Again, the assumptions upon which this scenario was based are from the KGA consultant's analysis of FWA and DWR information and are therefore consistent with the basin-wide approach.

*2070 Climate Change Scenario*

☑ **23 CCR § 354.18(d)(3)**

In order to estimate the potential effects on the projected water budget of climate change towards the end of the planning and implementation horizon (i.e., 50 years out into the future), a water budget scenario based on 2070 "central tendency" climate change factors published by DWR was developed. It should be noted that estimates of climate change impacts on water supplies this far into the future have significant uncertainty.[107] For this scenario, precipitation and ET were both adjusted based on the 2070 "central tendency" change factors published by DWR. CVP water supplies were taken from the FWA projections under the "2070.c scenario". SWP supply projections were taken from the DWR 2070-Level CalSim studies, except for years 2004-2007 which were taken as the actual SWP data, adjusted for the OCAP BO and reduced by 8.09%, and years 2008-2014 which were taken as the actual SWP data, reduced by 8.09%. Again, the assumptions upon which this scenario was based are from the KGA consultant's analysis for FWA and DWR (CalSim) information and are therefore consistent with the basin-wide approach.

#### 9.1.4.3. Additional Surface Water Supply Adjustments

☑ **23 CCR § 354.18(c)(3)(C)**

As described in **Section 9.1.2.1** ***Surface Water Inflows and Outflows***, in addition to its CVP contracts, AEWSD actively and regularly pursues additional surface water supplies through transfers, purchases,

[107] Alternative perspective on climate change impacts: https://townhall.com/columnists/pauldriessen/2019/01/19/climate-hysterics-skyrocket-n2539295

exchanges, and banking programs as a means of increasing supply reliability during extended periods of drought and/or regulatory restrictions. From DWR Water Years 1995 - 2015, AEWSD has obtained roughly 1.50 million AF of additional water supplies through agreements with over 70 entities, comprising approximately 41% of total surface water imports to AEWSD during that period (***Figure WB-6***).

Given the considerable uncertainty surrounding the future availability of non-CVP water supplies to AEWSD, AEWSD has taken a conservative approach by applying a <u>50% reduction to the initial estimates of projected SWP and Kern River imports through the Cross-Valley Canal, Intertie Pipeline, and Kern River conveyance systems entering the district under the Baseline, 2030, and 2070 scenarios described above.</u> This adjustment was made to reflect the possibility that under SGMA implementation, AEWSD may not be able to fully secure additional, non-CVP water supplies via transfers, exchanges, and/or purchases to the extent that they have been able to achieve historically. This approach therefore provides a more conservative estimate of the potential future impacts of reduced surface water supply reliability to AEWSD, and is subsequently used to inform the development of Projects & Management Actions within the Arvin-Edison Management Area (see **Section 17 *Projects and Management Actions***). In all cases AEWSD will continue to implement its policy of aggressively pursuing additional, non-CVP water supplies in order to maintain maximum availability and reliability of surface water imports going forward.

9.1.4.4. <u>Groundwater Banking Return Obligation</u>

As described in **Section 5.2.3 *Conjunctive Use in the Management Areas***, AEWSD conducts banking and recovery operations within the Arvin-Edison Management Area for out-of-district entities including the MWD. As of May 2019, the "balance" in MWD's water bank account within the Management Area is approximately 153,000 AF. Because the MWD water banking agreement expires in 2034, and assuming that MWD would opt to have its entire balance recovered/returned by that time, the return obligation over the next 15 years to MWD is approximately 10,200 AFY. MWD/AEWSD could also mutually agree to extend the agreement. This return obligation can be met through delivery to MWD of groundwater or an equivalent volume of surface water supplies. This return obligation of banked water to MWD will be fulfilled, if possible, with wet period supplies, transfers/exchanges of surface waters, and otherwise with normal year supplies.

9.1.4.5. <u>Projected Water Budget Results</u>

Results of the projected water budget analysis are summarized in ***Table WB-7*** for both the entire water budget domain and for the groundwater subdomain, as well as in ***Figure WB-22***. As shown in ***Table WB-7***, water budget components are presented as averages over the 20-year historical period and averages over the 50-year analog period for the Baseline, 2030 Climate Change, and 2070 Climate Change scenarios. Water budget components are grouped into inflows and outflows, relative to the domain or subdomain they pertain to (also see ***Figure WB-2***). Also shown in ***Table WB-7*** is the average annual change in groundwater storage for the historical period and each projected scenario. Results from ***Table WB-7*** were subsequently used to inform the development of Projects and Management Actions (P/MAs) as further described in **Section 17 *Projects and Management Actions***. Implementation of the P/MAs described in **Section 17** were then input into the 2030 and 2070 projected water budget model scenarios to assess their estimated impacts to the groundwater balance within the Arvin-Edison Management Area. Results of this exercise are presented in ***Table WB-8*** and briefly mentioned below.

*<u>Baseline Scenario</u>*

In the Baseline Scenario, the water budget components that are not dependent on surface water imports differ only slightly from the historical period. The percent difference from the historical average period to the Baseline Scenario ranges from approximately -1.2% for natural surface water inflows to +3.5% for M&I consumptive use. This demonstrates that the 50-year analog period is a good representation of the historical conditions.

The water budget components that are dependent on surface water imports differ more significantly from the historical averages, due to the different assumptions about imported surface water availability under the Baseline Scenario, as discussed above. Though the total surface water imports component is only 1.2% lower under the Baseline Scenario than it is under the historical period, the supply source portfolio changes considerably relative to historical conditions within AEWSD. In particular, CVP supplies increase by approximately 35.3%, largely stemming from the assumptions incorporated by FWA (2018) to reflect the San Joaquin River Restoration Program (SJRRP) implementation, in particular the estimate of SJRRP Paragraph 16(b) "Recovered Water Account" supplies. This estimated increase in CVP deliveries is fully offset by a projected decrease in SWP and Kern River supplies, which are assumed to decrease by 57.7% and 56%, respectively, after applying the adjustments described in **Sections 9.1.4.2** and **9.1.4.3** above.

<u>Overall, the Baseline Scenario indicates a net "surplus" (i.e., inflows greater than outflows) of approximately +1,700 AFY.</u> If imported surface water supplies are assumed to be limited only to the CVP source for which AEWSD has a contract (i.e., removing all future SWP and Kern River imports), the projected water budget for the Baseline Scenario indicates a net deficit (i.e., outflows greater than inflows) of approximately -13,900 AFY. Conversely, if imported SWP and Kern River supplies are assumed to occur in proportions similar to the historical period (i.e., only incorporating the Baseline change factors described in **Section 9.1.4.2 *Development of Projected Water Budget Scenarios***), then the Baseline Scenario indicates a net surplus of +16,800 AFY.

<u>*2030 Climate Change Scenario*</u>

Under the 2030 Climate Change Scenario, changes in precipitation, natural surface water inflows, and M&I consumptive use relative to the Baseline Scenario are all relatively small (i.e., relative changes of 0.8% to 2.9% and absolute changes of approximately 100 AFY to 600 AFY). The most significant changes relative to the Baseline Scenario is a reduction in surface water imports of approximately -32,000 AFY (-18.6%). Associated surface water exports and deliveries to the White Wolf Subbasin are also reduced on a proportional basis by approximately -4,100 AFY (-10.7%). Evapotranspiration is greater by approximately 6,000 AFY (+2.7%).

<u>Overall, the 2030 Climate Change Scenario indicates a net deficit of approximately -31,600 AFY.</u> Consistent with the approach being used by all the GSAs in the Basin, this estimated net deficit under the 2030 Climate Change Scenario is the amount that the Projects and Management Actions are targeted to address by the GSP implementation deadline (i.e., January 2040). It should be noted that, in addition to this net deficit, AEWSD will need to fulfill the groundwater banking return obligation to MWD discussed in **Section 9.1.4.4 *Groundwater Banking Return Obligation*** above. If imported surface water supplies are limited only to the CVP source, the projected water budget for the 2030 Climate Change Scenario indicates a net deficit of approximately 46,500 AFY. Conversely, if imported surface water supplies are to include full (climate-adjusted) SWP and Kern River supplies, the projected water budget for the 2030 Climate Change Scenario indicates- a net deficit of approximately -17,500 AFY.

As shown on ***Table WB-8*** and further described in **Section 17.1.4 *Implementation Glide Path*** and in ***Table PMA-3,*** AEWSD has proposed to address approximately 70% of the projected deficit of -31,600 AFY by the GSP implementation deadline (i.e., January 2040) through adoption of supply augmentation projects (i.e., ~22,400 AFY), and may address the remaining 30% of the projected deficit (i.e., ~9,600 AFY) through adoption of demand reduction management actions as necessary in order to achieve and maintain the sustainability goal within the Management Area.

It should be noted that the results from the numerical model show that, upon implementation of the planned Projects and Management Actions, the Arvin-Edison Management Area is projected to achieve its sustainability goal (i.e., avoids Minimum Thresholds and Undesirable Results and achieve Measurable Objectives for Chronic Lowering of Groundwater Levels) (see **Section 17.8.2 *Evaluation Relative to Water Level Sustainability Criteria***).

<u>*2070 Climate Change Scenario*</u>

Under the 2070 Climate Change Scenario, changes in precipitation, natural surface water inflows, and M&I consumptive use relative to the Baseline Scenario are somewhat greater than in the 2030 Climate Change Scenario, but still not significant (i.e., relative changes of -2.1% to 6.9% and absolute changes of approximately 500 AFY to -1,500 AFY). Surface water imports are lower by approximately -58,400 AFY (-33.9%). Surface water exports and deliveries to the White Wolf Subbasin are also lower by approximately -15,500 AFY (-40.9%). Evapotranspiration is greater by approximately +13,300 AFY (+6.0%).

<u>Overall, the 2070 Climate Change Scenario indicates a net deficit of approximately -56,300 AFY.</u> If imported surface water supplies are limited only to the CVP source (i.e., removing all future SWP and Kern River Imports), the projected water budget for the 2070 Climate Change Scenario indicates a net deficit of approximately -68,800 AFY. Conversely, if imported surface water supplies are to include full (climate-adjusted) SWP and Kern River supplies, the projected water budget for the 2070 Climate Change Scenario indicates a net deficit of approximately -44,000 AFY.

As shown on ***Table WB-8*** and further described in **Section 17.1.4 *Implementation Glide Path*** and in ***Table PMA-4***, AEWSD has proposed to address approximately 72% of the projected deficit of -56,300 AFY by the end of the 50-year GSP planning and implementation horizon (i.e., January 2070) through adoption of supply augmentation projects (i.e., ~40,800 AFY), and may address the remaining 28% of the projected deficit (i.e., ~15,700 AFY) through adoption of demand reduction management actions as necessary in order to achieve and maintain the sustainability goal within the Management Area.

It should be noted that the results from the numerical model show that, upon implementation of the planned Projects and Management Actions, the Arvin-Edison Management Area is projected to achieve its sustainability goal (i.e., avoids Minimum Thresholds and Undesirable Results and achieve Measurable Objectives for Chronic Lowering of Groundwater Levels) (see **Section 17.8.2 *Evaluation Relative to Water Level Sustainability Criteria***).

## 9.2. Wheeler Ridge-Maricopa Management Area

### 9.2.1. Water Budget Methods and Data Sources

☑ 23 CCR § 354.18(d)
☑ 23 CCR § 354.18(e)

This Wheeler Ridge-Maricopa GSA-level water budget uses a **spreadsheet model approach** that quantifies each flow component and enforces mass balance principles for each "subdomain" that collectively comprise the water budget domain (i.e., the Wheeler Ridge-Maricopa Management Area). Details of this approach and the corresponding data sources employed within the water budget model are described further below.

#### 9.2.1.1. Spreadsheet Model Approach

The spreadsheet model approach was developed for WRMWSD to serve as an independent estimate of the local historical, current, and projected water budget conditions within the Wheeler Ridge-Maricopa Management Area. The spreadsheet model approach uses a variety of data and analytical methods to quantify each water budget flow component. Processes and groups of processes are grouped into "subdomains" and "flow components". These water budget flow components are quantified on a monthly timestep for the period from January 1994 through December 2015.

*Water Budget Subdomains*

The water budget is divided into five internal subdomains, each influenced by a number of flow components and within which mass-balance is enforced (i.e., the sum of inflow components is balanced by the sum of outflow components and/or a change in storage component). ***Figure WB-23*** shows the water budget domain, and the following internal subdomains:

1. Artificial Channels and Pipelines;
2. Agricultural Lands;
3. Urban Lands;
4. Natural Channels; and
5. Groundwater System

In addition to the five internal subdomains, several external subdomains are incorporated into the spreadsheet model. These include the watersheds that contribute streamflow to streams entering the Wheeler Ridge-Maricopa Management Area, the atmosphere which is a source of precipitation and sink for evapotranspiration, the adjacent and connected portions of the groundwater basin, and the external surface water sources including out-of-basin and in-basin (but outside of the district) storage "accounts". The spreadsheet model does not explicitly account for the vadose (unsaturated) zone between the land surface and the (saturated) groundwater system, but instead incorporates temporal lag factors to account for the movement of water through this zone. An implicit assumption in this approach, therefore, is that the vadose zone does not experience any change in storage over time.

*Water Budget Flow Components*

Within and between each subdomain are 31 water budget flow components that route water through the Wheeler Ridge-Maricopa Management Area. ***Figure WB-24*** shows a conceptual diagram of the individual water budget flow components between subdomains as well as flow components that are external to the overall water budget domain (i.e., serve only as an inflow or outflow to the entire system, rather than a flow between subdomains).

Certain components are based on “raw” data which are directly measured and based on historical records. These “raw” components are considered to have a relatively high degree of certainty. Other components are estimated using a variety of analytical methods (e.g., Darcy’s Law to calculated subsurface flows across the domain’s external boundaries) and are thus subject to uncertainty based on the parameters used in their estimation. Some components (i.e., groundwater pumping for agricultural use) constitute major proportions of the overall water budget and have thus been given significant attention. Others are relatively minor in magnitude (e.g., seepage from artificial channels) and are, to some degree, less significant to the overall water budget and less well defined. Details of the methods and data used in the spreadsheet model approach are provided in **Appendix J.**

*Wheeler Ridge-Maricopa / Arvin-Edison Overlap Lands*

WRMWSD also supplies surface water to certain lands within the portion of its service area that overlaps with the AEWSD service area. The total acreage of overlap lands within the Kern Subbasin is approximately 5,318 acres, and WRMWSD serves surface water to approximately 3,186 acres in this area. Although the overlap lands are being covered by AEWSD for SGMA monitoring and management purposes, WRMWSD will continue in the future to serve surface water to those lands within the overlap area that have historically received district supplies in accordance with WRMWSD’s water delivery contracts with landowners. The water budget presented herein is quantified for the entire Wheeler Ridge-Maricopa Management Area, but also specifically identifies inflow and outflow quantities associated with these overlap lands. For the projected water budget “Checkbook” accounting exercise conducted by all entities within the Kern Subbasin, the demands for the overlap lands are only included in the Arvin-Edison Management Area “Checkbook” and the supplies for those lands include WRMWSD-provided surface water (included as an import to the Arvin-Edison “Checkbook”) and groundwater.

#### 9.2.1.2. Data Sources

☑ **23 CCR § 354.18(d)**
☑ **23 CCR § 354.18(e)**

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

- Precipitation Records from the various local climate stations including:
  - WRMWSD’s own climate stations (WRM-2 Pumping Plant, SP-P2 Pumping Plant, Greenlee’s Pasture, District Headquarters, PA-2 Pumping Plant, and Spillway Basin), *Monthly, January 1971 – December 2017*

- Two additional climate stations (Lebec and Tejon Rancho) maintained by the NOAA;[108] *Monthly resolution, January 1971 – December 2015 (data availability varies by station)*

- Satellite ET Data from the California Polytechnic Institute's ITRC-METRIC Study, funded by the KGA;[109] *Monthly, January 1993 -December 2015* [110]
- WRMWSD Land Use Surveys from the district's internal land use records; *Seasonal*, *Spring 2001 – Spring 2017 (data availability varies by season)*
- WRMWSD Surface Water Delivery Records from the district's internal operations records; *Monthly resolution, January 1999 – December 2016*
- Historical Groundwater Level Records from selected wells within the district; *Seasonal resolution, Spring 1936 – Fall 2017 (data availability varies by well)*
- Streamflow Records for San Emigdio Creek (USGS stream gauge 11195500), *Monthly, April 1959 – September 1981*

#### 9.2.1.3. Intended Purpose of Water Budget

The water budget spreadsheet model described herein (as well as the basin-wide numerical modelling approach to water budget estimation described in the Coordination Agreement and Appendices thereto) aims to assess the water budget from a purely quantitative, physical perspective, which is consistent with SGMA and the GSP Emergency Regulations (i.e., CWC § 10720.5 and 23 § CCR 354.18(a)). The spreadsheet model does not aim to evaluate the water budget from the perspective of water rights. As discussed above, the Checkbook "water accounting" approach described in the Coordination Agreement and Appendices thereto attempts to evaluate the water budget using certain management assumptions (e.g., a uniform "native yield" component to all lands within the Basin). However, nothing in this water budget information results in or is intended to be a determination of water rights within the Wheeler Ridge-Maricopa Management Area.

### 9.2.2. Water Budget Results

Results are presented below in terms of both annual values during the historical water budget period (DWR Water Years [WY] 1995 – 2014),[111] as well as long-term averages over that period. As such, some information presented here aligns with the requirements of the historical water budget described under **Section 9.2.3 *Current and Historical Water Budget***. below, and is not repeated there.

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[108] See **Appendix G** for a detailed description of how climate stations are used to estimate precipitation on District lands and surrounding watersheds.

[109] Howes, D. 2017. 1993-2015 ITRC-METRIC ETc for Kern County. prepared for the Kern Groundwater Authority on behalf of the Cal Poly Irrigation Training and Research Center.

[110] There is no ITRC satellite ET data for calendar year 2012, as the LANDSAT satellite system employed in the ITRC-METRIC analysis was non-operational during this period. See **Appendix G** for further details.

[111] DWR Water Years run from October of the previous year to September of the current year (e.g., DWR Water Year 2015 is October 2014 – September 2015.

#### 9.2.2.1. Surface Water Inflows and Outflows

☑ **23 CCR § 354.18(b)(1)**

***Table WB-9*** presents an annual summary of the total surface water inflows to and outflows from the Wheeler Ridge-Maricopa Management Area between WY 1995 – 2015. These inflows include imported surface water, natural streamflow into the area, and precipitation. ***Figure WB-25*** shows the total surface water inflows by type. Total surface water inflows to the Management Area average approximately 166,000 AFY over WY 1995 – 2014 but have varied widely from year to year. On average, 68% of surface water inflows are from imported water supplies, and 30% are from direct precipitation, and 2% are from intermittent streamflow from surrounding watersheds.

*Imported Water Supplies*

WRMWSD has been importing surface water into its service area since 1971. Annual surface water imports (district-wide) from 1971 through WY 2015 have ranged from approximately 41,000 AFY to over 250,0000 AFY, and cumulatively a total of 7.49 million AF have been imported through September 2015 (see ***Figure WB-26***).[112] WRMWSD's primary source of imported water is the SWP, delivered via the California Aqueduct which runs through the district. WRMWSD has a contract with the Kern County Water Agency for 197,088 AFY of Table A water from the SWP. In addition to its Table A water allocation, in the district has access to Article 21 water when it is available (primarily during wet years). When surplus supplies are available, the district banks water in several out-of-District water banks.[113] Recovery of banked water during dry years is used to supplement SWP allocations. The district also actively and regularly pursues additional water supplies through banking programs, water transfers, and purchases. Imported surface water supplies have averaged approximately 113,000 AFY over WY 1995 – 2014 but vary substantially from year to year.

*Natural Streamflow*

As discussed in **Section 7.3.5 *Surface Water Bodies***, several creeks drain into the Wheeler Ridge-Maricopa Management Area from watersheds to the south and west (see ***Figure HCM-50***). There are no stream gauges on these creeks that have data during the historical water budget period (WY 1995 – 2014). However, in 2018 the district installed gauges on five streams and will be establishing rating curves for these gauges over the next few years. Between April 1959 and September 1981, the USGS operated a stream gauge on San Emigdio Creek (USGS stream gauge 11195500),[114] located approximately four miles south of the district boundary. Data from this gauge were used as a proxy for all contributing watersheds (i.e., runoff as a function of precipitation was upscaled for the remaining watersheds by proportional area). During this gauge's period of record, average monthly discharge at this location ranged from 2.2 cfs in October to 3.5 cfs in May. Annual average discharge ranged from 0.71 cfs in 1966 to 9.87 cfs in 1978. Annual peak flows ranged from a minimum of 16.0 cfs in 1968 to a maximum of 6,690 cfs in 1961. These

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[112] Through 11 July 2019, WRMWSD has imported and delivered a total of 7,974,462 AF.

[113] WRMWSD has participated in the following groundwater banking and recovery projects: Kern Water Bank, 2800 Acres, Pioneer Project, and Berrenda Mesa Project (WRMWSD, 2015).

[114] https://waterdata.usgs.gov/ca/nwis/inventory/?site_no=11195500; upstream catchment area = 48.8 square miles.

data indicate a mildly seasonal pattern in streamflow at this location with substantial variability from year to year.

*Precipitation*

Precipitation on lands within the Wheeler Ridge-Maricopa Management Area contributes some water to the overall water budget and is grouped herein with “surface water inflows”. WRMWSD operates six rainfall measurement stations, four of them are within the Management Area. Data from the district’s rain gauges are similar in magnitude and temporal pattern. Annual rainfall over the period of WY 1995 – 2014 ranged from approximately 1.5 inches in WY 2014 to over 16 inches in WY 1998, with an average of 6.5 inches per year. Overall, an average of approximately 49,700 AFY of precipitation fell on lands within the Management Area during this period. This water serves to wet the near surface soil and then either evaporates, contributes to crop water demand, or (when a rainfall event is intense enough or long enough) percolates through the root zone to eventually recharge groundwater. “Effective precipitation”, i.e. the volume of precipitation that ultimately contributes to meeting evapotranspiration demands within the root zone, is estimated to be approximately 24,100 AFY (or 49% of total precipitation) within the Management Area.[115]

*Surface Water Outflows*

As shown in ***Table WB-9***, natural surface water outflows from the Wheeler Ridge-Maricopa Management Area are essentially zero. This is because there are no natural stream channels that flow through the Wheeler Ridge-Maricopa Management Area to the north; any natural stream inflows percolate into the ground before reaching the northern Wheeler Ridge-Maricopa Management Area boundary.

WRMWSD uses its network of canals and pipelines to convey and deliver not only imported surface water, but also groundwater pumped by the district, and by district customers participating in its “User Input” groundwater pump-in program. These deliveries are made to customers throughout the WRMWSD service area, including some customers in the White Wolf Subbasin. At times, the WRMWSD also uses the California Aqueduct for intra-district conveyance. Some of these conveyance facilities, including the California Aqueduct, cross the basin boundary between the Kern Subbasin and the White Wolf Subbasin. Therefore, outflows leaving the Wheeler Ridge-Maricopa Management Area through these conveyance facilities have been blended upstream and may include a variable percentage of groundwater depending on the given season and Water Year type.

*Out-of-District Groundwater Storage*

As described in **Section 5.2.3 *Conjunctive Use in the Management Areas*,** WRMWSD also participates in several out-of-district groundwater storage and recovery programs both within and outside the Kern Subbasin. As of December 2018, WRMWSD has a combined 200,774 AF stored and available to withdraw in its various banking projects outside the Wheeler Ridge-Maricopa Management Area, including:

- 160,564 AF in the Kern Water Bank;
- 29,288 AF in the Pioneer Project; and
- 10,922 AF in the Berrenda Mesa water bank.

[115] Based on application of the U.S. Department of Agriculture-Soil Conservation Service method (USDA-SCS, 1970); see **Appendix G**.

These banked imported water supplies are not included in the quantification of total surface water inflows into the Wheeler Ridge-Maricopa Management Area or in the subsequent determination of change in groundwater storage, as they are currently being physically stored outside the Wheeler Ridge-Maricopa Management Area boundaries. However, these banked supplies contribute to the overall storage within the Kern Subbasin. WRMWSD maintains rights to recover these banked supplies in the future per the contract terms specified in the individual agreements with the entities mentioned above.

#### 9.2.2.2. Groundwater Inflows and Outflows

☑ **23 CCR § 354.18(b)(2)**
☑ **23 CCR § 354.18(b)(3)**

***Table WB-10*** and ***Figure WB-27*** provide an annual summary of inflows to and outflows from the groundwater system by water source type for WY 1995 – 2014. As evident from these two exhibits (as well as the groundwater hydrographs shown in ***Figure GWC-11*** and ***Figure GWC-12***), the groundwater system is highly sensitive to climatic conditions and WRMWSD operations. As such, annual inflows and outflows vary widely depending on availability of surface water supplies to meet irrigation demands. Sources of inflow to the groundwater system include:

- Subsurface inflows across the Wheeler Ridge-Maricopa Management Area northern boundary (from north to south), across its southern boundary (from southern foothills to north), and across the White Wolf Fault (from southeast to northwest);
- Infiltration of a portion of applied irrigation water;
- Infiltration of precipitation; and

***Figure WB-28*** provides a summary of long-term (WY 1995 – 2014) annual average inflows to and outflows from the groundwater system. Total inflows to the groundwater system averaged approximately 60,300 AFY. Approximately 20% of total inflows to the groundwater system came from subsurface groundwater inflows, 66% from infiltration of applied water, 6% from infiltration from surface water systems, and 9% from infiltration of precipitation.

Due to the Wheeler Ridge-Maricopa Management Area's position at the southern edge of the Kern Subbasin (near pre-development discharge areas) and the resulting low hydraulic heads which are further drawn down by pumping, there are virtually no subsurface outflows, losses to surface water systems, or evapotranspiration losses occurring from the groundwater system (***Figure GWC-7***). As shown on ***Figure WB-28***, total outflows from the groundwater system averaged approximately 57,000 AFY over WY 1995 – 2014 and were entirely related to groundwater extraction. Of this value, approximately 94% of groundwater extraction can be attributed to private agricultural pumpage, 5% to pumpage from private wells related to its "User Input" pump-in program, and the remaining 1% to pumpage from district wells.

#### 9.2.2.3. Change in Groundwater Storage

☑ **23 CCR § 354.18(b)(4)**

***Figure WB-29,*** and ***Figure WB-30,*** and ***Table WB-11*** present the annual and cumulative change in groundwater storage between seasonal high conditions, which are defined in this chapter to be March through February of the following year. Note that this time window is distinct from DWR's definition of the Water Year, which runs from October of the previous year to September of the current year (e.g. DWR WY 2014 is October 2013 – September 2014); thus the values presented in ***Table WB-11*** are slightly different than the annual and cumulative change in storage estimates provided for DWR WY 1995 – 2014 in ***Table WB-10, Table WB-12***, and ***Table WB-13***.

Annual change in groundwater storage under the Wheeler Ridge-Maricopa Management Area averaged approximately +2,300 AFY between seasonal high conditions for the period of March 1994 – February 2015, with a cumulative change in storage of +47,700 AF over the same period. However, as seen in ***Figure WB-29*** and ***Figure WB-30***, change in storage varied widely between years, from a -29,400 AF decrease in storage to a +51,000 AF increase in storage.

***Figure WB-31***, ***Figure WB-32***, and ***Table WB-12*** compare the annual and cumulative change in storage in the Wheeler Ridge-Maricopa Management Area associated with each DWR Water Year from WY 1995 – 2014 to the water year type based on DWR's San Joaquin Valley Water Year Index. Annual change in groundwater storage under the Management Area averaged approximately +3,300 AFY from DWR WY 1995 – 2014, with a cumulative change in storage amounting to +65,700 AF over this period. These exhibits depict a clear relationship between change in groundwater storage to WY type, whereby change in storage becomes more positive with an increasing "wet" condition and more negative with an increasing "dry" condition. The net benefit of a "wet" period on groundwater conditions is especially evident in WYs 1995 – 2000, whereas the impact of a severe multi-year drought becomes increasingly evident in WYs 2012 – 2015.

#### 9.2.2.4. <u>Overdraft Conditions</u>

**☑ 23 CCR § 354.18(b)(5)**

The Kern Subbasin is designated by DWR in its latest version of *Bulletin 118 – California's Groundwater* as being in a condition of critical overdraft (DWR, 2016c). With respect to overdraft conditions and basins subject to those conditions, DWR has made the following statements:

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

intrusion, land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels".[116]

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

The historical water budget information discussed herein covers the period from WY 1995 through 2014[117] (i.e., it does not cover the entire period used in DWR's evaluation). However, within the period covered by this water budget, the timeframe between WYs 1997 and 2009 (October 1996 through September 2009) meets all of the same criteria. During this 13-year period, the cumulative departure in statewide average precipitation increased by approximately 9% (DWR, 2016c Figure 1), indicating that, on average, each year was less than 1% wetter than the long-term average. Over this time period, the cumulative change in storage within the Wheeler Ridge-Maricopa Management Area increased by approximately 48,100 AF, averaging 3,700 AFY. Therefore, based on local historical water budget information, the Management Area as a whole does not show a deficit. According to the results of the "Checkbook" water accounting approach for the projected baseline condition, the Management Area has a projected annual deficit of -14,665 AFY. The Wheeler Ridge-Maricopa GSA has developed a suite of Projects and Management Actions (see **Section 17 *Projects and Management Actions***) whose intended benefit is to prevent or eliminate any future net water budget deficit condition by the statutory deadline. As discussed in **Section 9** above, however, significant uncertainty exists regarding the actual magnitude of projected water budgets, and the water budget will be refined over time as additional data is collected. In the meantime, the planned P/MAs will be implemented according to the implementation plan outlined **Section 18 *Plan Implementation***.

#### **9.2.2.5.** Water Year Types

☑ **23 CCR § 354.18(b)(6)**

***Table WB-12*** presents the annual total supplies, total demands, and change in groundwater storage in the Wheeler Ridge-Maricopa Management Area along with the DWR Water Year type (October – September) for the period from WY 1995 through 2015. Also shown on ***Table WB-12*** are the averages for total supplies, total demands and change in groundwater storage for each of the five Water Year types. ***Figure WB-31*** and ***Figure WB-32*** present the change in groundwater storage versus Water Year type on an annual and cumulative basis, respectively. The Water Year type is based on DWR's San Joaquin Valley Water Year Index. These exhibits depict a clear relationship between Water Year type and change in groundwater storage, whereby change in storage is more positive during wet and above normal Water Years and more negative during below normal, dry and critical Water Years. This variability can be traced largely to differences in supplies during different Water Year types, as the total demands are relatively constant. The net benefit of a "wet" period on groundwater conditions is especially evident in Water Years 1995 –

[116] https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins, accessed 1 July 2018.
[117] This timeframe is consistent with the water budgeting timeframes incorporated into basin-level modeling efforts for the Kern Subbasin.

2000, whereas the impact of a severe multi-year drought becomes increasingly evident in WYs 2012 – 2015.

**Section 8.3 *Change in Groundwater Storage***, of the Groundwater Conditions section of this GSP, reported values for change in storage based on interpolated groundwater levels and specific yield values (***Table GWC-3***). Some of those water level-based change in storage values were used in the calibration of the water budget spreadsheet model.[118] ***Figure WB-33*** shows a comparison of the spreadsheet model-based transient change in storage against the water level-based change in storage values for the entire WRMWSD service area as well as for the Wheeler Ridge-Maricopa Management Area. As shown on ***Figure WB-33***, the spreadsheet model matches the water level-based estimates well; the RMSE for the annual rate of change for the three long-term periods (Fall 1994 – Fall 2015, Spring 2003 – Spring 2012, and Spring 2003 – Spring 2015) over the Management Area is approximately 4,300 AFY, which is a relatively small fraction (<4%) of the overall groundwater subdomain water budget magnitude (e.g., average annual groundwater inflows and outflows of approximately 60,300 AFY and 57,000 AFY, respectively).

#### 9.2.2.6. Sustainable Yield

**☑ 23 CCR § 354.18(b)(7)**

SGMA defines sustainable yield as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result" (CWC § 10721(w)). DWR's Water Budget BMP (DWR, 2016b), further states that "Water budget accounting information should directly support the estimate of sustainable yield for the basin and include an explanation of how the estimate of sustainable yield will allow the basin to be operated to avoid locally defined undesirable results. The explanation should include a discussion of the relationship or linkage between the estimated sustainable yield for the basin and local determination of the sustainable management criteria (sustainability goal, undesirable results, minimum thresholds, and measurable objectives)."

A key part of the codified definition and the BMP statement is the avoidance of Undesirable Results, defined as "significant and unreasonable" effects for any of the six SGMA sustainability indicators. For example, in regard to groundwater levels, declining levels during a drought do not constitute and Undesirable Result for Chronic Lowering of Groundwater Levels if extractions and groundwater recharge are managed as necessary to ensure that reduction in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods (CWC § 10721(x)(1)). Therefore, while the water budget should provide support for sustainable yield, determination of the sustainable yield for the Wheeler Ridge-Maricopa Management Area ultimately depends upon whether Undesirable Results are avoided within the time-frames required by SGMA.

A conservative estimate of the sustainable yield of the groundwater system underlying the Wheeler Ridge-Maricopa Management Area can be made by adding the average annual change in storage to the average annual groundwater extraction. This simplified approach provides a sustainable yield number corresponding to the volume of groundwater that, if pumped over the water budget period of interest,

[118] The water budget spreadsheet model calibration was completed for the entire WRMWSD service area, inclusive of the area within the White Wolf Subbasin.

would have resulted in zero change in storage – a reasonable metric for sustainability. Based on the average annual change in groundwater storage over the water budget period from WY 1995 – 2014 (i.e., +3,300 AFY) and the average annual groundwater extraction (i.e., 57,000 AFY), using this simple method the sustainable yield is conservatively estimated to be at a minimum approximately 60,300 AFY under current supply and demand conditions. This equates to an acreage-normalized sustainable yield of approximately 0.65 AFY/acre over the (92,343 acre) Wheeler Ridge-Maricopa Management Area.[119]

This number is conservative because SGMA itself does not require that the basin or any particular management area to be balanced at any particular point in time, as discussed above. As mentioned above, the sustainable yield estimate does not factor in the additional ~200,700 AF of imported WRMWSD supplies currently stored within other groundwater banking facilities outside the sistrict but within the Kern Subbasin (see **Section 9.2.2.1**).

This sustainable yield number is also inherently conservative in that it is based on a pumping rate that, under similar hydrologic conditions as the historical period, would result in no decrease in storage. As discussed in **Section 13.1 *Undesirable Results for Chronic Lowering of Groundwater Levels*** and **Section 13.2 *Undesirable Results for Reduction of Groundwater Storage*** the locally defined criteria for what constitutes an Undesirable Result for groundwater levels and change in storage is not strictly limited to a zero net decrease; rather, those criteria allow for some operation of the basin at groundwater levels and storage levels below current conditions. For the other relevant sustainability indicators (i.e., water quality degradation and land subsidence), a sustainable yield value that amounts to a zero change in storage would also be expected to avoid Undesirable Results. Therefore, this sustainable yield estimate takes into account Undesirable Results, as required by CWC § 10721(w).

Moreover, as described earlier in this section, WRMWSD has also participated in a Basin-wide numerical modeling effort in addition to developing a more refined local water budget for their Management Area. Results from the C2VSim-FG historical water budget model, extracted for model elements corresponding approximately to the Management Area, indicate an average annual groundwater extraction rate of approximately 107,200 AFY for the historical period of WY 1995 – 2014, and an average annual change in storage of -7,900 AFY during that same period. Under the same approach as described above, the C2VSim-FG historical water budget results indicate a sustainable yield estimate of 99,300 AFY within the Management Area, or 1.08 AFY/acre. It is important to note that this model is intended to be a Basin-wide assessment of groundwater conditions and, unlike the local water budget described above, is not specifically calibrated to the WRMWSD service area. Additional reconciliation of basin water budgeting efforts is a high priority for basin GSAs as part of GSP implementation.

[119] The acreage-normalized sustainable yield values presented herein should not be viewed as an "allocation" but rather is presented herein to facilitate comparisons to commonly-used agronomic quantities (e.g., crop water demands in AFY/ac).

### 9.2.3. Current and Historical Water Budget

#### 9.2.3.1. Current Water Budget

☑ 23 CCR § 354.18(c)(1)

This section presents results for the "current" water budget, based on values extracted from the spreadsheet model for WY 2015. This is consistent with how "current" is being defined in the Kern Subbasin Plan.

WY 2015 was classified as the third consecutive "Critical" (dry) Water Year and fourth consecutive "Dry" or "Critical" Water Year within the San Joaquin Valley and is thus representative of perhaps the worst drought condition in recent history within the region.

***Table WB-13*** and ***Figure WB-34*** provide a summary of total inflows and outflows to the Wheeler Ridge-Maricopa Management Area for WY 2015, while ***Table WB-10*** and ***Figure WB-35*** provide a summary of groundwater inflows and outflows.

Total inflows to the Wheeler Ridge-Maricopa Management Area amounted to approximately 150,000 AF in WY 2015, comprised of 36% precipitation, 56% surface water imports, 6% subsurface inflows, and 2% natural surface water inflows. This resulted in a total inflow to the groundwater system of approximately 57,600 AF, comprised of 15% subsurface inflow, 70% infiltration of applied water, 6% infiltration from surface water systems, and 9% infiltration of precipitation.

Total outflows from the Wheeler Ridge-Maricopa Management Area amounted to approximately 187,000 AF in WY 2015, comprised entirely (100%) of evapotranspiration (consumptive use by vegetation). This resulted in a total outflow from the groundwater system of approximately 103,000 AF, 100% of which is due to groundwater extraction.

As evident from these water budget values, the Wheeler Ridge-Maricopa Management Area (like nearly all areas in the Kern Subbasin and San Joaquin Valley as a whole) was impacted significantly by the extreme drought condition of WY 2015, resulting in a net loss of approximately -42,900 AF of groundwater storage during this timeframe. However, as evidenced by the recovery of water levels and storage following previous dry periods, the groundwater system is resilient, and the "current" (WY 2015) conditions are not indicative of a normal condition but rather represent the late stages of a major drought period from which the groundwater system has already started to recover (***Figure GWC-12***).

#### 9.2.3.2. Historical Water Budget

☑ 23 CCR § 354.18(c)(2)

Water budget results are presented for the historical water budget period in **Section 9.2.2 *Water Budget Results***, including associated figures and tables, and are not repeated here. Rather, this section focuses on providing: (a) a quantitative evaluation of historical surface water availability and reliability (23 CCR § 354.18(d)(2)(A)), (b) a quantitative assessment of the historical water budget (23 CCR § 354.18(d)(2)(B)), and (c) a description of how historical conditions have impacted the ability of the Wheeler Ridge-Maricopa Management Area to be operated within its sustainable yield (23 CCR § 354.18(d)(2)(C)).

*Historical Surface Water Availability and Reliability*

☑ **23 CCR § 354.18(c)(2)(A)**

As described above, WRMWSD's only contracted source of surface water supply is its SWP supply contract with KCWA for 197,088 AFY of Table 1 water. Between WY 1995 – 2014, WRMWSD received an average allocation (entitlement) of approximately 73% of this contractual amount. ***Figure WB-36*** presents an annual breakdown of total imported SWP supplies relative to the WRMWSD's existing SWP contract volumes.

This large inter-annual variability in supply indicates that, while SWP water remains the primary and most important source to the Wheeler Ridge-Maricopa Management Area, its reliability is not iron-clad, and has been impacted significantly in recent years due to natural drought, and by federal court rulings and other regulatory measures which have served to limit pumping of northern California supplies through the Delta to the southern part of the state. For this reason, the WRMWSD actively and regularly pursues additional water supplies through transfers, purchases, exchanges, and banking programs.

*Quantitative Assessment of Historical Water Budget*

☑ **23 CCR § 354.18(c)(2)(B)**

Based on the DWR San Joaquin Valley Water Year Index for the 20-year period from WY 1995 through 2014, this period included four "critical" (dry) years, four dry years, two below normal years, three above normal year, and seven wet years. The first third of this period was relatively wet, the middle third was a mix of wet and dry years, and the last third of the period was extremely dry. This climatic factor is clearly reflected in the water budget for the Wheeler Ridge-Maricopa Management Area, whereby the groundwater system shows consistent increases in storage with wetter conditions and decreases in storage under "drier" conditions (see ***Figure WB-31, Figure WB-32***, and ***Table WB-12***.

***Table WB-13*** and ***Figure WB-37*** provide a tabular and graphical breakdown of total inflows and outflows to the Wheeler Ridge-Maricopa Management Area for WY 1995 – 2014, with a summary of average annual total inflows and outflows provided in ***Figure WB-38***. ***Table WB-10*** and ***Figure WB-25*** provide a tabular breakdown of inflows and outflows to the groundwater system underlying the Management Area for WY 1995–2014, with a summary of average annual groundwater inflows and outflows provided in ***Figure WB-26***.

Total inflows to the Wheeler Ridge-Maricopa Management Area amounted to an average of 178,000 AFY for WY 1995 – 2014, including 64% from surface water imports, 28% from precipitation, 7% from subsurface inflows, and 2% from natural surface water inflows. This resulted in an average net inflow to the groundwater system of approximately 60,300 AFY, comprised of 66% of infiltration of applied water, 20% of subsurface inflow, 6% of infiltration from surface water systems, and 9% of infiltration of precipitation.

Total annual outflows from the Wheeler Ridge-Maricopa Management Area amounted to 175,000 AFY for WY 1995 – 2014, comprised nearly entirely (99.99%) of evapotranspiration (consumptive use by vegetation). This resulted in a net outflow from the groundwater system of approximately 57,000 AF, 100% of which comes from groundwater extraction.

*Operation Within Sustainable Yield*

☑ **23 CCR § 354.18(c)(2)(C)**

Average annual change in groundwater storage under the Wheeler Ridge-Maricopa Management Area amounted to approximately +3,300 AFY between WY 1995 – 2014, resulting in a cumulative change in groundwater storage of 65,700 AF during this period. This cumulative storage change over a 20-year historical record, that includes the recent severe drought, indicates that the groundwater system is in a state of relative balance. Although some years in this period showed negative changes in storage as much as -34,000 AF, the calculated transient change in storage and water levels measured in wells within the Management Area (see ***Figure WB-37***, ***Figure GWC-11***), and ***Figure GWC-12***) demonstrate that the groundwater system is sensitive to climatic variability and WRMWSD operations, with decreases in storage during drought followed by increases in storage during wet periods.

As discussed previously, through September 2015 WRMWSD has imported nearly 7.5 million AF of water into its service area since it began imports in 1971. Since that time, the groundwater system has experienced a long-term increase in storage of approximately 77,100 AF (***Table GWC-3***) and groundwater elevations have increased in areas where imported surface water is delivered (***Figure GWC-11***). Clearly WRMWSD operations have resulted in a net benefit to the groundwater supply beneath the Wheeler Ridge-Maricopa Management Area, demonstrating successful groundwater management.

### 9.2.4. Projected Water Budget

☑ **23 CCR § 354.18(c)(3)**

Projected water budgets are required as a way to estimate future conditions of water supply and demand within a basin, as well as the aquifer response to implementation of the Plan over the planning and implementation horizon. To develop the projected water budget, the same tools and methodologies that were used for the historical and current water budget were used, with updated inputs for climate variables (i.e., precipitation and ET) and water supply assumptions (i.e., imported water supplies). The chief purpose of this projected water budget analysis is to assess the magnitude of the net water supply deficit that would need to be addressed through Projects and Management Actions to prevent Undesirable Results (discussed further in **Section 13 *Undesirable Results*** and **Section 17 *Projects and Management Actions***) and achieve the Sustainability Goal. This section describes the development and results of the projected water budget for the Wheeler Ridge-Maricopa Management Area.

#### 9.2.4.1. Development of 50-Year Analog Period

☑ **23 CCR § 354.18(c)(3)(A)**
☑ **23 CCR § 354.18(c)(3)(B)**
☑ **23 CCR § 354.18(c)(3)(C)**

Per 23 CCR § 354.18(c)(3)(A), the projected water budgets must use 50 years of historical precipitation, evapotranspiration, and streamflow information as the basis for evaluating future conditions under baseline and climate-modified scenarios. The process by which a 50-year period of precipitation, evapotranspiration and streamflow information was developed is based on the process adopted by all

GSAs within the Basin, as described in the Coordination Agreement and Appendices thereto. That process is briefly summarized here.

To develop the required 50 years-worth of hydrologic input information, first an "analog period" was created from the 20 years-worth of historical information (WY 1995-2014) by combining the years in a specific way that, on average, maintained the long-term average hydrologic conditions. This approach, which was used for both the spreadsheet water budget model approach and the basin-wide C2VSim-FG modeling approach, allowed for the creation of a complete 50-year period to inform the projected water budget analysis, even when certain component datasets were not available for that length of time. The sequence of actual years that were combined to create the 50-year analog period is as follows:

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

The above mapping of actual years to analog years within the required 50-year projected water budget period applies to precipitation and ET datasets. It also applies to imported surface water datasets with some additional modifications as described in the following section.

#### 9.2.4.2. Development of Projected Water Budget Scenarios

☑ **23 CCR § 354.18(c)(3)(A)**
☑ **23 CCR § 354.18(c)(3)(B)**
☑ **23 CCR § 354.18(c)(3)(C)**

Using the 50-year analog period, three projected water budget scenarios were developed for this analysis: a baseline scenario, and 2030 climate change scenario, and a 2070 climate change scenario. Development of the three scenarios was done consistent with the agreed-upon process being used basin-wide. Details of the scenario development are contained within in the Coordination Agreement and Appendices thereto and are briefly summarized here.

*Baseline Scenario*

Per 23 CCR § 354.18(c)(3)(C), the projected water budgets must use "the most recent water supply information as the baseline condition for estimating future surface water supply". Consistent with the process applied basin-wide, the information used to inform the baseline conditions for SWP supplies is based on information published by and/or obtained from DWR, including data from DWR's CalSim water resources planning model, historical SWP operations data, and impacts from new operations regulations pursuant to the 2008/2009 Long-Term OCAP BO.[120,121]

[120] CalSim deliveries data from: https://data.cnra.ca.gov/dataset/sgma-climate-change-resources; SWP operational data from: https://water.ca.gov/Programs/State-Water-Project/Operations-and-Maintenance/Monthly-and-Annual-Operations-Reports; new operations regulations pursuant to the 2008-2009 OCAP BOs used as basis for calculation of SWP impacts by KGA's consultant.

[121] The District has a long history of actively striving to achieve sustainable groundwater use within the District. In fact, the District was specifically formed to contract for a substantial surface water supply because of declining groundwater levels. Since that time, groundwater levels within the District have stabilized, and in many areas have risen. In the 1990s, with regulatory

As part of the basin-wide approach to Baseline Scenario development, certain substitutions and/or adjustments to years were made to the 50-year analog period for certain water supplies because the available datasets did not cover the entire historical water budget time period (WY 1995-2014). These substitutions included the following:

- Adjusting years 2004-2007 for SWP supplies to account for the recent regulatory changes to SWP operations made effective in 2008 and 2009 (i.e., the OCAP BO);[122] and
- Replacing years 1995-2003 for SWP supplies with values from DWR's 2030-level CalSim study,[123] increased by 3.03%, again to account for the OCAP BO.

The above substitutions and adjustments were made by KGA GSA consultants based upon their analysis of the DWR studies and were provided to all districts as a basis for development of projected water budgets. As such, the information used for this analysis is consistent with the basin-wide approach.

*2030 Climate Change Scenario*

☑ **23 CCR § 354.18(d)(3)**

In order to estimate the potential effects on the projected water budget of climate change during the GSP implementation period (i.e., between 2020 and 2040), a water budget scenario based on 2030 climate change factors published by DWR was developed. For this scenario, precipitation and ET were both adjusted based on the change factors published by DWR. SWP supply projections were taken from the DWR 2030-Level CalSim studies, except for years 2004-2007 which were taken as the actual SWP data, adjusted for the OCAP BO and reduced by 3.03%, and years 2008-2014 which were taken as the actual SWP data, reduced by 3.03%. Again, the assumptions upon which this scenario was based are from the KGA consultant's analysis of DWR information and are therefore consistent with the basin-wide approach.

*2070 Climate Change Scenario*

☑ **23 CCR § 354.18(d)(3)**

In order to estimate the potential effects on the projected water budget of climate change towards the end of the planning and implementation horizon (i.e., 50 years out into the future), a water budget scenario based on 2070 "central tendency" climate change factors for the published by DWR was developed. It should be noted that estimates of climate change impacts on water supplies this far into the future have significant uncertainty. For this scenario, precipitation and ET were both adjusted based on the 2070 "central tendency" change factors published by DWR. SWP supply projections were taken from the DWR 2070-Level CalSim studies, except for years 2004-2007 which were taken as the actual SWP data,

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shifts in the State Water Project, the District invested in groundwater storage facilities in order to capture and recharge wet year supplies to augment the District's contractual supplies. The Wenger decision in 2008, and the subsequent Biological Opinions, had a dramatic negative impact on the availability of the District's contractual supplies. Although the District does not agree with the decision nor the subsequent Biological Opinions, it has been forced to adapt to those negative impacts.

[122] https://www.fws.gov/sfbaydelta/Documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf
https://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/nmfs_biological_and_conference_opinion_on_the_long-term_operations_of_the_cvp_and_swp.pdf

[123] Consistent set of CALSIM operations studies at current, 2030 and 2070 climate levels for Bay Delta Conservation Plan evaluation provided by DWR Bay Delta Office staff.

adjusted for the OCAP BO and reduced by 8.09%, and years 2008-2014 which were taken as the actual SWP data, reduced by 8.09%. Again, the assumptions upon which this scenario was based are from the KGA consultant's analysis of DWR (CalSim) information and are therefore consistent with the basin-wide approach.

#### 9.2.4.3. Projected Water Budget Results

Results of the projected water budget analysis are summarized in ***Table WB-14*** for both the entire water budget domain and for the groundwater subdomain, as well as in ***Figure WB-38***. As shown in ***Table WB-14***, water budget components are presented as averages over the 20-year historical period and averages over the 50-year analog period for the Baseline, 2030 Climate Change, and 2070 Climate Change scenarios. Water budget components are grouped into inflows and outflows, relative to the domain or subdomain they pertain to (also see ***Figure WB-24***). Also shown in ***Table WB-14*** is the average annual change in groundwater storage for the historical period and each projected scenario. Results from ***Table WB-14*** were subsequently used to inform the development of P/MAs as further described in **Section 17 *Projects and Management Actions***. Implementation of the P/MAs described in **Section 17** were then input into the 2030 and 2070 projected water budget model scenarios to assess their estimated impacts to the groundwater balance within the Wheeler Ridge-Maricopa Management Area. Results of this exercise are presented in ***Table WB-15*** and briefly mentioned below.

*Baseline Scenario*

In the Baseline Scenario, the water budget components that are not dependent on surface water imports differ only slightly from the historical period. The percent difference from the historical average period to the Baseline Scenario ranges from approximately -4.0% for M&I consumptive use (including evapotranspiration from urban lands) to natural surface water inflows to -1.2% for precipitation. This demonstrates that the 50-year analog period is a good representation of the historical conditions.

The water budget components that are dependent on surface water imports differ more significantly from the historical averages, due to the different assumptions about imported surface water availability under the Baseline Scenario, as discussed above. In particular, the surface water imports component is approximately 17.7% lower under the Baseline Scenario than it is under the historical period, due a projected decrease in SWP supplies due to factors including the OCAP BO.

Overall, the Baseline Scenario indicates a net "deficit" (i.e., outflows greater than inflows) of approximately -14,700 AFY.

*2030 Climate Change Scenario*

Under the 2030 Climate Change Scenario, changes in precipitation, natural surface water inflows, and M&I consumptive use relative to the Baseline Scenario are all relatively small (i.e., relative changes of 1.1% to 2.9% and absolute changes of approximately 0 AFY to 550 AFY). The most significant changes relative to the Baseline Scenario are a reduction in surface water imports of approximately -2,800 AFY (-3.0%) and an increase in evapotranspiration of approximately 4,700 AFY (+2.8%).

Overall, the 2030 Climate Change Scenario indicates a net deficit of approximately -21,400 AFY. Consistent with the approach being used by all the GSAs in the Basin, this estimated net deficit under the 2030 Climate Change Scenario is the amount that the Projects and Management Actions are targeted to address by the GSP implementation deadline (i.e., January 2040).[124] As shown on ***Table WB-15*** and further described in **Section 17.1.4 *Implementation Glide Path*** and in ***Table PMA-4***, WRMWSD has proposed to address approximately 60% of the projected deficit of -21,400 AFY by the GSP implementation deadline (i.e. January 2040) through adoption of supply augmentation projects (i.e., ~12,900 AFY), and may address the remaining 40% of the projected deficit (i.e., ~8,600 AFY) through adoption of demand reduction management actions as necessary in order to achieve and maintain the sustainability goal within the Management Area.

It should be noted that the results from the numerical model show that, upon implementation of the planned Projects and Management Actions, the Wheeler Ridge-Maricopa Management Area achieves its sustainability goal (i.e., avoids Minimum Thresholds and Undesirable Results and achieves Measurable Objectives for Chronic Lowering of Groundwater Levels) (see **Section 17.8.2 *Evaluation Relative to Water Level Sustainability Criteria***).

*2070 Climate Change Scenario*

Under the 2070 Climate Change Scenario, changes in precipitation, natural surface water inflows, and M&I consumptive use relative to the Baseline Scenario are somewhat greater than in the 2030 Climate Change Scenario, but still not significant (i.e., relative changes of -1.3% to 6.8% and absolute changes of approximately 0 AFY to -700 AFY). Surface water imports are lower by approximately -7,200 AFY (-7.7%) and evapotranspiration is greater by approximately +10,700 AFY (+6.2%).

Overall, the 2070 Climate Change Scenario indicates a net deficit of approximately -33,300 AFY. As shown on ***Table WB-15*** and further described in **Section 17.1.4 *Implementation Glide Path*** and in ***Table PMA-4***, WRMWSD has proposed to address approximately 56% of the projected deficit of -33,300 AFY by the end of the 50-year GSP planning and implementation horizon (i.e. January 2070) through adoption of supply augmentation projects (i.e., ~18,800 AFY), and may address the remaining 44% of the projected deficit (i.e., ~14,600 AFY) through adoption of demand reduction management actions as necessary in order to achieve and maintain the sustainability goal within the Management Area..

It should be noted that the results from the numerical model show that, upon implementation of the planned Projects and Management Actions, the Wheeler Ridge-Maricopa Management Area achieves its sustainability goal (i.e., avoids Minimum Thresholds and Undesirable Results and achieves Measurable Objectives for Chronic Lowering of Groundwater Levels) (see **Section 17.8.2 *Evaluation Relative to Water Level Sustainability Criteria***).

## 9.3. Tejon-Castac Management Area

### 9.3.1. Water Budget Components

☑ **23 CCR § 354.18(d)**
☑ **23 CCR § 354.18(e)**

[124] The District, as required by law, is planning on implementing Projects and Management Actions to address the potential impacts due to climate change. The District does note that making planning decisions based on models has real and substantial economic impacts on District landowners and residents and does not agree with this exercise.

***Figure WB-42*** shows a schematic diagram of the water budget for the Tejon-Castac Management Area. The conceptual water budget domain is considered to be the entire Tejon-Castac Management Area and is comprised of two water budget "subdomains" (i.e., the land surface subdomain and the groundwater subdomain). Various flow components move water into and out of the Tejon-Castac Management Area and between the two subdomains. Each of these flow components is described and discussed below.

***Table WB-16*** presents a summary of the various water budget components during historical (i.e., DWR WY 1995 – 2014), current (DWR WY 2015), and projected (future) conditions. It should be noted, however, that most of the components are not described herein quantitatively or in terms of historical temporal variability, as there is insufficient local data to do so. Furthermore, the quantitative requirements for a basin-wide water budget are satisfied within the Umbrella GSP.

Because the vast majority of the Tejon-Castac Management Area meets the definition of Watch Area discussed in **Section 5.3.5 *Watch Areas***, the level of detail in the water budget information that is necessary for sustainable management of the Tejon-Castac Management Area is less than in other more developed areas. Per that definition, if data collected upon implementation of this GSP indicates consumptive use greater than that of native vegetation in the future, the lands will be re-classified as actively managed lands, and more detailed water budget information will be developed.

#### 9.3.1.1. Precipitation

**☑ 23 CCR § 354.18(b)(2)**

Precipitation, occurring primarily as rainfall, is one of the primary sources of water into the water budget domain. As is typical for the region, precipitation occurs on a highly seasonal basis, with most occurring in the months of November through March. Based on precipitation data from the CIMIS Arvin station,[125] average annual rainfall over the historical period from WY 1995 – 2014 was approximately 8.2 inches. Average annual rainfall from the NOAA Tehachapi climate station[126] located at higher elevations in the contributing watersheds to the Tejon-Castac Management Area over the same period is approximately 10.6 inches. Precipitation within the Tejon-Castac Management Area is therefore likely between about 8 and 10 inches per year. Over the entire Tejon-Castac Management Area, this amounts to total historical precipitation of approximately 13,200 to 17,100 AFY. During WY 2015 (i.e., "current" conditions), the rainfall was approximately 9,100 to 14,600 AFY.

#### 9.3.1.2. Surface Water Inflows

**☑ 23 CCR § 354.18(b)(1)**

Streams and creeks entering the Tejon-Castac Management Area are shown on ***Figure HCM-51*** and discussed above in **Section 7.3.5 *Surface Water Bodies***. Based on gauge data from the historical Caliente Creek stream gauge (USGS gauge 11196400), the average annual flow during the 1961 – 1983 period of record was approximately 2,960 AFY. Given that the contributing watershed area for this gauge is about one third of the contributing area of all watersheds draining into and through the Tejon-Castac Water District (TCWD), the total historical surface water inflows into the TCWD are estimated to be

[125] https://cimis.water.ca.gov/
[126] https://www.ncdc.noaa.gov/cdo-web/)

approximately 7,600 AFY, based on a proportional scaling up by watersheds area of the average Caliente Creek flows. Current surface water inflows were estimated by scaling the historical estimated inflows by the ratio of current to historical precipitation, for a value of approximately 6,300 AFY.

### 9.3.2. Surface Water Outflows

☑ 23 CCR § 354.18(b)(1)

As stated above, there are no active stream gauges within the Tejon-Castac Management Area that could be used to quantify streamflow out of the Tejon-Castac Management Area. For this reason, this component is grouped together in ***Table WB-16*** with other unquantifiable outflow terms. The mapped extents of most of the ephemeral/intermittent streams that enter the Tejon-Castac Management Area from the southeast do not extend to the west beyond the western boundary of the Tejon-Castac Management Area, suggesting that surface flow ceases, presumably due to infiltration (mountain front recharge). It is therefore likely that surface water outflows are somewhat less than surface water inflows, the difference being recharge (and minor runoff contribution from lands within the Tejon-Castac Management Area).

### 9.3.3. Evapotranspiration

☑ 23 CCR § 354.18(b)(3)

ET is a primary outflow from the Tejon-Castac Management Area, removing the majority of precipitation before it has a chance to percolate to become groundwater recharge. Based on the ITRC data, which covers approximately 88 percent of the Tejon-Castac Management Area, average ET over the period Water Year 1995 through 2014 was approximately 16,900 AFY. Scaled up to the area of the entire Tejon-Castac Management Area, the ET over the historical period is estimated to be 19,200 AFY .[127] Over the current period, the ET is estimated using the same methodology to be 14,600 AFY.

### 9.3.4. Percolation/Recharge

☑ 23 CCR § 354.18(b)(2)

Water added to the land surface subdomain within the Tejon-Castac Management Area, either by precipitation, surface water inflow, or groundwater pumping for industrial and (de minimis) domestic use, can either be lost to the atmosphere through ET, exit via surface water outflow in streams, or infiltrate below the root zone to become recharge. Given the semi-arid climate in this area, where potential ET exceeds precipitation by several fold, precipitation recharge likely only occurs during exceptionally wet months. There is insufficient data to quantify this component of the water budget. Operators of the Granite Quarry estimate that approximately 37 percent of the water used at the quarry percolates back to groundwater (Granite Quarry staff; personal communication 28 February 2019). Rates of percolation of streamflow cannot be quantified based on available data.

[127] The fact that the ITRC ET data are higher than the range of estimated precipitation (12,800 to 16,000 AFY) may be due to error or uncertainty in the data or may indicate some additional ET of water that enters from the upstream watersheds, most likely along the riparian corridor. It should be noted that such riparian ET, and the ecosystem responsible for it, being supported by surface water inflows from the upstream watershed would not be considered groundwater dependent.

### 9.3.5. Groundwater Discharge to Land Surface

☑ 23 CCR § 354.18(b)(3)

Groundwater discharge to the land surface in the form of seeps and springs is likely a very small component of the overall Tejon-Castac Management Area water budget, as evidenced by the lack of mapped seeps and springs within the Tejon-Castac Management Area. However, outside of the Tejon-Castac Management Area to the southeast (outside of the Basin), there are many mapped springs. These likely occur due to the thin soils overlying shallow granitic bedrock in those areas which prevents deep percolation of precipitation, forcing shallow groundwater back to the land surface in topographic low spots.

### 9.3.6. Subsurface Groundwater Inflows

☑ 23 CCR § 354.18(b)(2)

Subsurface groundwater inflows to the Tejon-Castac Management Area are likely small due to the fact that the Tejon-Castac Management Area is located at the edge of the Basin and is underlain by relatively low permeability granitic bedrock. Some inflows from the granitic bedrock may occur where the rock is fractured.

### 9.3.7. Subsurface Groundwater Outflows

☑ 23 CCR § 354.18(b)(3)

Subsurface groundwater outflows from the Tejon-Castac Management Area likely come from a combination of percolated surface water from ephemeral/intermittent and perennial streams, and to a lesser degree from percolated precipitation. Although information on groundwater levels and gradients within the Tejon-Castac Management Area is generally lacking, and the actual magnitudes of the gradients are not known with confidence, it is presumed that gradients along the western boundary of the Tejon-Castac Management Area, both north and south of the Edison Fault, point to the west and that some subsurface outflow occurs. There is insufficient data to quantify this water budget component specifically, and it is therefore grouped together in ***Table WB-16*** with other unquantifiable outflow terms.

### 9.3.8. Groundwater Pumping

☑ 23 CCR § 354.18(b)(3)

As described above in **Section 5.1.5 *Well Density per Square Mile*** and **Section 7.1.4 *Principal Aquifers and Aquitards***, the only well with significant (non de minimis) pumping within the Tejon-Castac Management Area is the Caratan Well, located in the main valley floor area near the western boundary of the Tejon-Castac Management Area. Water pumped from this well is used for industrial purposes (i.e., gravel washing) at the Granite Quarry. Operators at the quarry have estimated the volume pumped for use at the quarry is approximately 400 AFY, approximately 37 percent of which returns to groundwater, for a net consumptive use of approximately 250 AFY (Granite Quarry staff; personal communication 28 February 2019). In addition, the owners of the Caratan Well use the well to supply irrigation water to agricultural parcels located in the adjacent AEWSD, although one parcel is within the AEWSD SWSA and therefore is not solely dependent on groundwater for irrigation. Based on the DWR 2014 crop records, these parcels are planted in grapes. Total pumping for the parcel that is not connected to the AEWSD SWSA is estimated at approximately 457 AFY. For the parcel that is connected to the AEWSD SWSA, total applied water demand is estimated at approximately 497 AFY although this amount is not likely supplied entirely by groundwater.

### 9.3.9. Change in Storage

☑ **23 CCR § 354.18(b)(4)**

There is insufficient data to characterize the change in storage in the groundwater system. As discussed above, with the exception of the pumping of the Caratan Well for industrial uses at the Granite Quarry and some agricultural uses outside of the Tejon-Castac Management Area, the system functions largely in a natural condition. Even at the upper end estimate of consumptive use of groundwater, the annual use is likely small compared to total estimated storage capacity of about 800,000 AF, and largely controlled by natural hydrologic variability. This term is therefore grouped together in ***Table WB-16*** with other unquantifiable outflow terms.

### 9.3.10. Intended Purpose of Water Budget

The water budget spreadsheet model described herein (as well as the basin-wide numerical modelling approach to water budget estimation described in the Coordination Agreement and Appendices thereto) aims to assess the water budget from a purely quantitative, physical perspective, which is consistent with SGMA and the GSP Emergency Regulations (i.e., CWC § 10720.5 and 23 § CCR 354.18(a)). The spreadsheet model does not aim to evaluate the water budget from the perspective of water rights. As discussed above, the "Checkbook" water accounting approach described in the Coordination Agreement and Appendices thereto attempts to evaluate the water budget using certain management assumptions (e.g., a uniform "native yield" component to all lands within the Basin). However, nothing in this water budget information results in or is intended to be a determination of water rights within the Tejon-Castac Management Area.

### 9.3.11. Overdraft Conditions

☑ **23 CCR § 354.18(b)(5)**

The Kern Subbasin is designated by DWR in its latest version of *Bulletin 118 – California's Groundwater* as being in a condition of critical overdraft (DWR, 2016c). With respect to overdraft conditions and basins subject to those conditions, DWR has made the following statements:

- "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts." (DWR, 1980)
- Groundwater overdraft is "... the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never

fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts." (DWR, 2003)

- "Overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of water to the basin. Effects of overdraft result can include seawater intrusion, land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels".[128]

Given the relative lack of groundwater development within the Tejon-Castac Management Area, as well as the size and associated storage volume of the Tejon-Castac Management Area relative to the small amount of pumping, the Management Area as a whole is not considered to be in a deficit. According to the results of the "Checkbook" water accounting approach for the projected baseline condition, the Management Area has a projected annual deficit of -6,815 AFY. The TCWD GSA has developed a suite of Projects and Management Actions (see **Section 17 *Projects and Management Actions***) whose intended benefit is to prevent or eliminate any future overdraft condition by the statutory deadline. As discussed in **Section 9** above, however, significant uncertainty exists regarding the actual magnitude of projected water budgets, and the water budget will be refined over time as additional data is collected. In the meantime, the planned P/MAs will be implemented according to the implementation plan outlined **Section 18 *Plan Implementation***.

### 9.3.12. Water Year Types

☑ 23 CCR § 354.18(b)(6)

The Water Year type is based on DWR's San Joaquin Valley Water Year Index. There is insufficient information on groundwater levels to determine the change in groundwater storage within the Tejon-Castac Management Area relative to Water Year type. As described above, supplies consist of natural inflows including precipitation and surface water inflow. As would be expected, these supply sources vary according to Water Year type, with greater amounts during Wet and Above Normal Water Years and lesser amounts during Below Normal, Dry and Critical Water Years (e.g., the greatest precipitation during the historical water budget period [WY 1995-2014] occurred during WY 1998, a "wet" Water Year, and the lowest precipitation occurred during WY 2013, a "critical" water year). Demands include ET from the native rangeland vegetation and a small amount of groundwater pumping at the Caratan well for use on lands outside of the Tejon-Castac Management Area. ET from native vegetation has varied from approximately 4,200 AFY to 32,900 AFY, but does not appear to be strongly correlated with Water Year type.

### 9.3.13. Sustainable Yield

☑ 23 CCR § 354.18(b)(7)

SGMA defines sustainable yield as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be

[128] https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins, accessed 1 July 2018.

withdrawn annually from a groundwater supply without causing an undesirable result" (CWC, §10721(w)). DWR's Water Budget BMP (DWR, 2016b), further states that "Water budget accounting information should directly support the estimate of sustainable yield for the basin and include an explanation of how the estimate of sustainable yield will allow the basin to be operated to avoid locally defined undesirable results." Inherent to the codified definition and the BMP statement is the avoidance of Undesirable Results, which include significant and unreasonable effects for any of the six SGMA sustainability indicators. Therefore, determination of the sustainable yield depends upon how the Undesirable Results are defined.

While no exact method for defining the sustainable yield is required by SGMA or promoted by DWR in its Water Budget BMP, the BMP does emphasize that water budget accounting information should be used. In an area such as the Tejon-Castac Management Area, which is largely undeveloped and consists primarily of native range land vegetation used for grazing (***Figure PA-13***), the sustainable yield is essentially equivalent to the sum of the natural inflow components to groundwater, a quantity sometimes referred to as the "native yield". This quantity is being used at the GSA level as a starting point for identifying the sustainable yield, although it is recognized that in areas where return flows from applied imported water contributed to groundwater storage, the sustainable yield can be substantially greater than the "native yield".

Because quantification of the "native yield" is inherently uncertain, even with a basin-wide numerical model such as the C2VSim-based model being employed by the Basin GSAs for the basin-wide water budget, the Basin GSAs have agreed to a value for the normalized (i.e., per acre) "native yield" of 0.15 AFY/acre. Based on this assumption, <u>the "native yield" of the 19,280-acre Tejon-Castac Management Area is 2,892 AFY</u>. It should be noted that current groundwater use is well below this range of estimated "native yield". Furthermore, the use of acreage-normalized "native yield" values in the "Checkbook" water accounting approach should not be viewed as an "allocation" of groundwater pumping to lands in the Kern Subbasin, but rather are used to facilitate comparisons to commonly-used agronomic quantities (e.g., crop water demands in AFY/ac).

This sustainable yield number is inherently conservative because it only counts the "native yield" value of 0.15 AFY/ac, even though precipitation on the Tejon-Castac Management Area lands is much higher. Because the Tejon-Castac Management Area functions in a largely natural condition, the actual evapotranspiration of native vegetative will be dictated largely by the available precipitation. Thus, this sustainable yield estimate is protective of beneficial uses and users of groundwater and considers Undesirable Results, as required by CWC § 10721(w).

### 9.3.14. <u>Projected Water Budget</u>

**☑ 23 CCR § 354.18(c)(3)**

As discussed above in **Section 5.3.4 *Tejon Ranch Conservation and Land Use Agreement,*** lands within the Tejon-Castac Management Area are almost entirely subject to protections under the Conservation and Land Use (C&LU) Agreement and related Ranch-Wide Management Plan (RWMP) and Conservation Easements. The existing Granite Quarry facility is expected to cease operations at some point within the next one to four years (TCWD staff; personal communication, 6 March 2019), and there are no plans to develop any other mining facilities in the "future mining envelope". Therefore, in terms of projected future land use changes, the Tejon-Castac Management Area is only expected to become less developed on the whole. Therefore, impacts on the projected water budget from human development are negligible.[129]

It is recognized that climate change will likely change the timing and possibly the magnitude of certain natural hydrologic fluxes (e.g., precipitation, ET, streamflow), and that such changes may, on balance, result in drier conditions and a lower actual value of native safe yield. However, given the lack of development currently and anticipated in the future, such changes will have no bearing one way or the other on achievement of sustainability within the Tejon-Castac Management Area; the area will simply continue to function in an essentially natural state. Estimates of the change in precipitation, streamflow, and ET under two future climate change conditions (2030 and 2070) are presented in ***Table WB-16***, based on the climate change factors provided by DWR, in accordance with the *Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development* (DWR, 2018). In general, precipitation is estimated to stay roughly the same or increase by roughly 6 percent, ET/consumptive use is estimated to increase by about 12 to 18 percent, and surface water inflows are estimated to decrease by about 4 to 8 percent.

[129] TCWD and TRC reserve the right to pump groundwater and/or develop surface water resources within the Tejon-Castac Management Area in the future, subject to the terms of the C&LU Agreement.

## TABLE WB-2
## Annual Surface Water Inflows and Outflows by Source Type
Arvin-Edison Management Area

| DWR Water Year (Oct - Sept) | INFLOWS [AFY] | | | | | | | | | | | OUTFLOWS [AFY] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Surface Water Imports* | | | | | | | *Natural Inflows* | | | | *Surface Water Exports (c)* | | | *Natural Outflows* | | | |
| | Friant-Kern Canal | Cross Valley Canal | California Aqueduct (via Intertie Pipeline) | Kern River | WRMWSD Deliveries to Overlap Areas | Other (b) | *Total Imported Surface Water* | Direct Precipitation | Streamflow into District | *Total Natural Surface Water Inflows* | **TOTAL SURFACE WATER INFLOWS** | Deliveries to White Wolf Subbasin Customers | Exports to Metro-politan Water District | *Total Surface Water Exports* | Streamflow Out of District (d) | Runoff of Excess Precip. | *Total Natural Outflows* | **TOTAL SURFACE WATER OUTFLOWS** |
| **Historical Water Budget (DWR WY 1995 - 2014)** | | | | | | | | | | | | | | | | | | |
| **1995** | 203,813 | 16,435 | 0 | 8,241 | 7,102 | 0 | *235,591* | 103,801 | 13,332 | *117,133* | **352,724** | 27,297 | 2,816 | 30,113 | 0 | 0 | 0 | **30,113** |
| **1996** | 207,698 | 19,460 | 0 | 30,548 | 8,842 | 0 | *266,548* | 71,124 | 5,660 | *76,784* | **343,332** | 32,646 | 0 | 32,646 | 0 | 0 | 0 | **32,646** |
| **1997** | 155,854 | 1,768 | 0 | 79,127 | 10,282 | 0 | *247,031* | 78,694 | 6,165 | *84,860* | **331,891** | 24,574 | 0 | 24,574 | 0 | 0 | 0 | **24,574** |
| **1998** | 149,995 | 13,389 | 0 | 65,326 | 6,446 | 0 | *235,156* | 176,666 | 16,283 | *192,949* | **428,106** | 21,937 | 2,308 | 24,245 | 0 | 0 | 0 | **24,245** |
| **1999** | 77,790 | 101,359 | 0 | 58,243 | 7,849 | 0 | *245,241* | 69,364 | 5,818 | *75,182* | **320,422** | 24,103 | 30 | 24,133 | 0 | 0 | 0 | **24,133** |
| **2000** | 104,806 | 150,957 | 0 | 3,663 | 8,406 | 0 | *267,832* | 42,956 | 4,650 | *47,606* | **315,438** | 29,253 | 0 | 29,253 | 0 | 0 | 0 | **29,253** |
| **2001** | 40,650 | 57,624 | 0 | 2,520 | 6,315 | 0 | *107,109* | 60,737 | 7,273 | *68,010* | **175,119** | 25,294 | 0 | 25,294 | 0 | 0 | 0 | **25,294** |
| **2002** | 34,716 | 41,008 | 2,772 | 1,693 | 6,639 | 0 | *86,828* | 37,499 | 3,290 | *40,788* | **127,616** | 27,380 | 0 | 27,380 | 0 | 0 | 0 | **27,380** |
| **2003** | 92,993 | 62,810 | 12,894 | 1,154 | 6,101 | 0 | *175,952* | 77,638 | 8,364 | *86,002* | **261,954** | 26,626 | 12,380 | 39,006 | 0 | 0 | 0 | **39,006** |
| **2004** | 39,878 | 50,736 | 9,092 | 0 | 6,965 | 0 | *106,671* | 63,554 | 5,241 | *68,795* | **175,466** | 28,043 | 11,573 | 39,616 | 0 | 0 | 0 | **39,616** |
| **2005** | 208,155 | 5,870 | 4,467 | 8,846 | 6,097 | 397 | *233,832* | 81,071 | 11,431 | *92,502* | **326,333** | 23,227 | 13,939 | 37,166 | 0 | 0 | 0 | **37,166** |
| **2006** | 182,882 | 35,185 | 5,719 | 16,367 | 6,518 | 103 | *246,774* | 69,012 | 5,716 | *74,727* | **321,501** | 25,102 | 0 | 25,102 | 0 | 0 | 0 | **25,102** |
| **2007** | 22,132 | 57,535 | 4,122 | 300 | 7,702 | 0 | *91,791* | 67,339 | 3,702 | *71,041* | **162,832** | 25,774 | 7,609 | 33,383 | 0 | 0 | 0 | **33,383** |
| **2008** | 31,039 | 21,795 | 156 | 14,955 | 6,114 | 0 | *74,059* | 37,411 | 4,568 | *41,979* | **116,037** | 27,268 | 42,615 | 69,883 | 0 | 0 | 0 | **69,883** |
| **2009** | 73,088 | 2,811 | 1,280 | 18,209 | 6,195 | 0 | *101,583* | 60,385 | 2,203 | *62,588* | **164,171** | 25,007 | 43,080 | 68,087 | 0 | 0 | 0 | **68,087** |
| **2010** | 163,675 | 69,725 | 19,419 | 1,547 | 5,742 | 0 | *260,108* | 95,947 | 4,161 | *100,109* | **360,217** | 23,822 | 56,229 | 80,051 | 0 | 0 | 0 | **80,051** |
| **2011** | 194,718 | 26,521 | 25,427 | 0 | 5,698 | 0 | *252,364* | 104,662 | 8,011 | *112,673* | **365,037** | 22,627 | 16,065 | 38,692 | 0 | 0 | 0 | **38,692** |
| **2012** | 32,013 | 75,534 | 38,430 | 0 | 6,669 | 0 | *152,646* | 48,150 | 5,542 | *53,692* | **206,338** | 25,399 | 10,010 | 35,409 | 0 | 0 | 0 | **35,409** |
| **2013** | 19,925 | 16,048 | 12,499 | 868 | 6,629 | 0 | *55,969* | 59,329 | 3,206 | *62,535* | **118,503** | 26,593 | 15,111 | 41,704 | 0 | 0 | 0 | **41,704** |
| **2014** | 11,918 | 16,668 | 0 | 0 | 4,920 | 11,666 | *45,172* | 43,570 | 919 | *44,490* | **89,662** | 24,568 | 45,195 | 69,763 | 0 | 0 | 0 | **69,763** |
| **TOTAL** | 2,047,738 | 843,238 | 136,277 | 311,607 | 137,229 | 12,166 | *3,488,255* | 1,448,909 | 125,535 | *1,574,444* | **5,062,699** | 516,542 | 278,960 | 795,502 | 0 | 0 | 0 | **795,502** |
| ***AVERAGE*** | *102,387* | *42,162* | *6,814* | *15,580* | *6,861* | *608* | *174,413* | *72,445* | *6,277* | *78,722* | ***253,135*** | *25,827* | *13,948* | *39,775* | *0* | *0* | *0* | ***39,775*** |
| ***%*** | *40%* | *17%* | *3%* | *6%* | *3%* | *0%* | *69%* | *29%* | *2%* | *31%* | - | *65%* | *35%* | *100%* | *0%* | *0%* | *0%* | - |
| **Current Water Budget (DWR WY 2015)** | | | | | | | | | | | | | | | | | | |
| **2015** | 2,001 | 12,489 | 0 | 0 | 4,478 | 31,002 | *49,970* | 65,315 | 4,269 | *69,583* | **119,553** | 17,202 | 67,142 | 84,344 | 0 | 0 | 0 | **84,344** |
| ***%*** | *2%* | *10%* | *0%* | *0%* | *4%* | *26%* | *42%* | *55%* | *4%* | *58%* | - | *20%* | *80%* | *100%* | *0%* | *0%* | *0%* | - |

**Abbreviations**

AEWSD = Arvin-Edison Water Storage District
AFY = acre-feet per year
DWR = California Department of Water Resources
Precip. = precipitation
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

**Notes**

(a) All values reported in acre-feet per year (AFY).
(b) "Other" import sources include wheeled surface water and groundwater from Ken Delta Water District.
(c) Surface water exports are blended in AEWSD's delivery network within the Kern Subbasin and thus cannot be distinguished by source type. On certain years, a proportion of deliveries to White Wolf Subbasin customers and/or exports to Metropolitan Water District may come from groundwater inputs from recovery banking operations into AEWSD's delivery network within the Kern Subbasin.
(d) On exceptionally wet years there is anecdotal knowledge of the City of Lamont (west of the AEWSD boundary) being briefly flooded by runoff waters from Caliente Creek. These surface water "outflows" from the AEWSD Management Area are difficult to quantify and have thus been noted as existing data gap within the currrent water budget.

# TABLE WB-3
## Annual Inflows to and Outflows from the Groundwater System, and Change in Groundwater Storage
Arvin-Edison Management Area

| DWR Water Year (Oct - Sept) | INFLOWS [AFY] | | | | | | OUTFLOWS [AFY] | | | | | | | CHANGE IN STORAGE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | *Groundwater Extraction* | | | | | | | | |
| | Subsurface Groudwater Inflow | Infiltration of Precipitation | Infiltration of Applied Water | Infiltration from Surface Water Systems | Recharge from Spreading Basins | **TOTAL INFLOWS TO GROUND-WATER SYSTEM** | Pumpage from District Wells (b) | Pumpage from Private Wells | M&I Pumpage | Discharge to Surface Water Sources | Evapo-transpiration (c) | Subsurface Groundwater Outflow | **TOTAL OUTFLOWS FROM GROUND-WATER SYSTEM** | **Annual Change in Groundwater Storage [AFY]** | *Cumulative Change in Groundwater Storage Since WY 1995 [AF]* |
| **Historical Water Budget (DWR WY 1995 - 2014)** | | | | | | | | | | | | | | | |
| **1995** | 18,158 | 5,410 | 56,754 | 31,092 | 70,233 | **181,647** | 14,191 | 85,494 | 1,547 | 0 | 0 | 0 | **101,232** | **69,322** | *69,322* |
| **1996** | 18,373 | 4,249 | 63,649 | 31,104 | 78,246 | **195,621** | 1,095 | 109,613 | 2,200 | 0 | 0 | 0 | **112,908** | **77,044** | *146,366* |
| **1997** | 18,451 | 4,648 | 68,321 | 7,744 | 50,013 | **149,177** | 0 | 46,401 | 2,307 | 0 | 0 | 0 | **48,708** | **100,450** | *246,817* |
| **1998** | 16,964 | 9,302 | 56,370 | 26,177 | 91,857 | **200,670** | 245 | 45,441 | 2,126 | 0 | 0 | 0 | **47,812** | **142,140** | *388,957* |
| **1999** | 16,344 | 3,150 | 66,154 | 13,311 | 76,794 | **175,751** | 915 | 70,801 | 2,540 | 0 | 0 | 0 | **74,256** | **104,357** | *493,314* |
| **2000** | 17,783 | 2,512 | 60,822 | 17,132 | 78,378 | **176,627** | 2,119 | 92,954 | 2,740 | 0 | 0 | 0 | **97,813** | **75,242** | *568,557* |
| **2001** | 17,400 | 3,310 | 60,830 | 15,018 | 63,496 | **160,054** | 100,648 | 83,063 | 2,573 | 0 | 0 | 0 | **186,285** | **-19,684** | *548,873* |
| **2002** | 17,448 | 2,074 | 58,899 | 11,932 | 3,818 | **94,171** | 86,879 | 116,542 | 2,696 | 0 | 0 | 0 | **206,117** | **-107,490** | *441,383* |
| **2003** | 17,751 | 3,146 | 58,190 | 15,904 | 42,552 | **137,544** | 30,906 | 96,780 | 2,772 | 0 | 0 | 0 | **130,458** | **4,925** | *446,307* |
| **2004** | 16,441 | 3,599 | 62,518 | 10,677 | 7,215 | **100,450** | 75,399 | 121,478 | 2,948 | 0 | 0 | 0 | **199,825** | **-100,046** | *346,262* |
| **2005** | 17,078 | 3,847 | 46,785 | 15,986 | 96,703 | **180,399** | 25,104 | 62,064 | 2,731 | 0 | 0 | 0 | **89,899** | **91,449** | *437,711* |
| **2006** | 17,608 | 3,633 | 56,864 | 17,841 | 85,581 | **181,526** | 174 | 82,702 | 2,925 | 0 | 0 | 0 | **85,801** | **90,534** | *528,245* |
| **2007** | 17,283 | 3,297 | 54,396 | 9,044 | 22,037 | **106,056** | 101,517 | 93,406 | 3,178 | 0 | 0 | 0 | **198,101** | **-95,972** | *432,273* |
| **2008** | 19,116 | 2,138 | 52,632 | 12,518 | 4,109 | **90,512** | 141,081 | 92,396 | 2,958 | 0 | 0 | 0 | **236,435** | **-150,702** | *281,570* |
| **2009** | 20,615 | 3,117 | 53,854 | 8,013 | 32,789 | **118,387** | 128,043 | 88,842 | 3,147 | 0 | 0 | 0 | **220,032** | **-102,677** | *178,893* |
| **2010** | 19,644 | 4,754 | 51,532 | 9,096 | 70,011 | **155,037** | 37,081 | 53,987 | 2,969 | 0 | 0 | 0 | **94,037** | **64,333** | *243,226* |
| **2011** | 19,987 | 5,976 | 56,193 | 8,308 | 113,373 | **203,837** | 445 | 55,598 | 2,911 | 0 | 0 | 0 | **58,954** | **155,838** | *399,065* |
| **2012** | 21,069 | 2,183 | 57,859 | 8,505 | 35,316 | **124,932** | 43,589 | 136,345 | 2,781 | 0 | 0 | 0 | **182,715** | **-53,645** | *345,420* |
| **2013** | 20,365 | 3,149 | 60,678 | 3,506 | 3,176 | **90,874** | 123,971 | 115,329 | 2,992 | 0 | 0 | 0 | **242,293** | **-150,593** | *194,827* |
| **2014** | 21,798 | 2,177 | 55,443 | 3,469 | 3,919 | **86,806** | 151,371 | 107,228 | 2,865 | 0 | 0 | 0 | **261,463** | **-167,556** | *27,270* |
| **TOTAL** | 369,676 | 75,669 | 1,158,742 | 276,377 | 1,029,615 | **2,910,079** | 1,064,773 | 1,756,463 | 53,907 | 0 | 0 | 0 | **2,875,144** | **27,270** | *27,270* |
| ***AVERAGE*** | *18,484* | *3,783* | *57,937* | *13,819* | *51,481* | ***145,504*** | *53,239* | *87,823* | *2,695* | *0* | *0* | *0* | ***143,757*** | **1,364** | - |
| *%* | *13%* | *3%* | *40%* | *9%* | *35%* | - | *37%* | *61%* | *2%* | *0%* | *0%* | *0%* | - | - | - |
| **Current Water Budget (DWR WY 2015)** | | | | | | | | | | | | | | | |
| **2015** | 22,676 | 3,153 | 51,042 | 6,932 | 1,397 | **85,200** | 136,187 | 113,001 | 2,333 | 0 | 0 | 0 | **251,521** | **-164,385** | - |
| *%* | *27%* | *4%* | *60%* | *8%* | *2%* | - | *54%* | *45%* | *1%* | *0%* | *0%* | *0%* | - | - | - |

**Abbreviations**

AF = acre-feet
AFY = acre-feet per year
DWR = California Department of Water Resources
ITRC = Cal Poly Irrigation Training & Research Center
WY = Water Year

**Notes**

(a) All values reported in acre-feet per year (AFY), except cumulative change in storage (reported in acre-feet).
(b) This value includes all groundwater extractions from AEWSD wells for its long-term groundwater banking and recovery program. On certain years, this value also includes minor groundwater inputs to the District delivery system from private wells that have elected to participate in the District's groundwater "pump-in" program to augment delivery supplies in times of drought.
(c) There are years for which ITRC-measured evapotranspiration from non-irrigated lands exceeds the total measured rainfall to these lands. In these cases, residual water demands on non-irrigated lands are accounted for as a reduction in total infiltration ("inflows") rather than an explicit groundwater "outflow" due to evapotranspiration. This is based on the understanding that the groundwater table is fully disconnected from the root zone under the District. ITRC-measured residual water demands on non-irrigated lands are likely caused in part by evaporation from local surface water bodies (e.g., storage ponds) and/or are met by a reduction of root zone soil moisture, which is not explicitly accounted for in the water budget spreadsheet model.

**TABLE WB-4**

**Annual and Cumulative Change in Groundwater Storage between Seasonal Highs (Mar - Feb)**

Arvin-Edison Management Area

| Period of Reference [m/yy] | Annual Change in Groundwater Storage [AFY] | Cumulative Change in Groundwater Storage [AF] |
|---|---|---|
| 3/94 - 2/95 | -45,655 | -45,655 |
| 3/95 - 2/96 | 125,796 | 80,141 |
| 3/96 - 2/97 | 53,388 | 133,529 |
| 3/97 - 2/98 | 114,017 | 247,547 |
| 3/98 - 2/99 | 144,020 | 391,566 |
| 3/99 - 2/00 | 96,004 | 487,570 |
| 3/00 - 2/01 | 108,878 | 596,448 |
| 3/01 - 2/02 | -103,469 | 492,979 |
| 3/02 - 2/03 | -99,893 | 393,086 |
| 3/03 - 2/04 | 13,779 | 406,865 |
| 3/04 - 2/05 | -114,825 | 292,040 |
| 3/05 - 2/06 | 123,293 | 415,334 |
| 3/06 - 2/07 | 83,037 | 498,371 |
| 3/07 - 2/08 | -164,012 | 334,359 |
| 3/08 - 2/09 | -143,666 | 190,693 |
| 3/09 - 2/10 | -75,062 | 115,631 |
| 3/10 - 2/11 | 155,063 | 270,694 |
| 3/11 - 2/12 | 126,733 | 397,428 |
| 3/12 - 2/13 | -120,764 | 276,664 |
| 3/13 - 2/14 | -185,285 | 91,379 |
| 3/14 - 2/15 | -148,324 | -56,945 |
| **TOTAL** | -56,945 | -56,945 |
| ***AVERAGE*** | -2,712 | - |

**Abbreviations**

AF = acre-feet

AFY = acre-feet per year

DWR = California Department of Water Resources

# TABLE WB-5

## Supplies, Demands, and Change in Groundwater Storage vs. DWR Water Year Type

Arvin-Edison Management Area

| DWR Water Year (Oct - Sept) | DWR Water Year Type (a) | Total Supplies [AFY] (b) | Total Demands [AFY] (c) | Annual Change in Groundwater Storage [AFY] |
|---|---|---|---|---|
| 1995 | W | 370,882 | 278,693 | 69,322 |
| 1996 | W | 361,705 | 291,434 | 77,044 |
| 1997 | W | 350,342 | 255,873 | 100,450 |
| 1998 | W | 445,070 | 287,270 | 142,140 |
| 1999 | AN | 336,766 | 236,134 | 104,357 |
| 2000 | AN | 333,220 | 239,617 | 75,242 |
| 2001 | D | 192,519 | 236,118 | -19,684 |
| 2002 | D | 145,064 | 263,118 | -107,490 |
| 2003 | BN | 279,705 | 265,938 | 4,925 |
| 2004 | D | 191,907 | 299,968 | -100,046 |
| 2005 | W | 343,412 | 252,967 | 91,449 |
| 2006 | W | 339,109 | 244,496 | 90,534 |
| 2007 | C | 180,115 | 281,537 | -95,972 |
| 2008 | C | 135,153 | 285,796 | -150,702 |
| 2009 | BN | 184,786 | 286,081 | -102,677 |
| 2010 | AN | 379,861 | 280,999 | 64,333 |
| 2011 | W | 385,024 | 243,176 | 155,838 |
| 2012 | D | 227,407 | 297,455 | -53,645 |
| 2013 | C | 138,868 | 286,311 | -150,593 |
| 2014 | C | 111,460 | 283,614 | -167,556 |
| 2015 | C | 142,229 | 311,403 | -164,385 |

| Water Year Type (a) | Number of Years During WY 1995 - 2015 Period | Average Total Supplies [AFY] (b) | Average Total Demands [AFY] (c) | Average Annual Change in Groundwater Storage [AFY] |
|---|---|---|---|---|
| C | 5 | 141,565 | 289,732 | -145,842 |
| D | 4 | 189,224 | 274,165 | -70,216 |
| BN | 2 | 232,246 | 276,009 | -48,876 |
| AN | 3 | 349,949 | 252,250 | 81,311 |
| W | 7 | 370,792 | 264,844 | 103,825 |

**Abbreviations**

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

**Notes:**

(a) DWR Water Year Types are as follows: W = wet, AN = above normal, BN = below normal, D = dry, C = critical
(b) Total supplies equal the sum of inflow terms (see Table WB-6 for individual inflow components).
(c) Total demands equal the sum of outflow terms (see Table WB-6 for individual outflow components).
(d) The apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix E - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**Sources:**

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

# TABLE WB-6
## Annual Total Inflows, Outflows, and Change in Groundwater Storage
Arvin-Edison Management Area

| DWR Water Year (Oct - Sept) | INFLOWS [AFY] | | | | | OUTFLOWS [AFY] | | | | | | CHANGE IN STORAGE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subsurface Groudwater Inflow | Precipitation | Surface Water Imports | Natural Surface Water Inflows | **TOTAL INFLOWS** | Evapo-transpiration (b) | M&I Consumptive Use (c) | Surface Water Exports & Deliveries to White Wolf Subbasin | Natural Surface Water Outflows | Subsurface Groundwater Outflow | **TOTAL OUTFLOWS** | **Annual Change in Groundwater Storage [AFY]** (d) | *Cumulative Change in Groundwater Storage Since WY 1995 [AF]* |
| **Historical Water Budget (DWR WY 1995 - 2014)** | | | | | | | | | | | | | |
| **1995** | 18,158 | 103,801 | 235,591 | 13,332 | **370,882** | 242,615 | 5,965 | 30,113 | 0 | 0 | **278,693** | **69,322** | *69,322* |
| **1996** | 18,373 | 71,124 | 266,548 | 5,660 | **361,705** | 254,080 | 4,708 | 32,646 | 0 | 0 | **291,434** | **77,044** | *146,366* |
| **1997** | 18,451 | 78,694 | 247,031 | 6,165 | **350,342** | 228,516 | 2,784 | 24,574 | 0 | 0 | **255,873** | **100,450** | *246,817* |
| **1998** | 16,964 | 176,666 | 235,156 | 16,283 | **445,070** | 260,334 | 2,690 | 24,245 | 0 | 0 | **287,270** | **142,140** | *388,957* |
| **1999** | 16,344 | 69,364 | 245,241 | 5,818 | **336,766** | 208,195 | 3,806 | 24,133 | 0 | 0 | **236,134** | **104,357** | *493,314* |
| **2000** | 17,783 | 42,956 | 267,832 | 4,650 | **333,220** | 203,887 | 6,476 | 29,253 | 0 | 0 | **239,617** | **75,242** | *568,557* |
| **2001** | 17,400 | 60,737 | 107,109 | 7,273 | **192,519** | 204,486 | 6,338 | 25,294 | 0 | 0 | **236,118** | **-19,684** | *548,873* |
| **2002** | 17,448 | 37,499 | 86,828 | 3,290 | **145,064** | 227,585 | 8,154 | 27,380 | 0 | 0 | **263,118** | **-107,490** | *441,383* |
| **2003** | 17,751 | 77,638 | 175,952 | 8,364 | **279,705** | 219,819 | 7,112 | 39,006 | 0 | 0 | **265,938** | **4,925** | *446,307* |
| **2004** | 16,441 | 63,554 | 106,671 | 5,241 | **191,907** | 249,666 | 10,686 | 39,616 | 0 | 0 | **299,968** | **-100,046** | *346,262* |
| **2005** | 17,078 | 81,071 | 233,832 | 11,431 | **343,412** | 207,960 | 7,841 | 37,166 | 0 | 0 | **252,967** | **91,449** | *437,711* |
| **2006** | 17,608 | 69,012 | 246,774 | 5,716 | **339,109** | 210,729 | 8,664 | 25,102 | 0 | 0 | **244,496** | **90,534** | *528,245* |
| **2007** | 17,283 | 67,339 | 91,791 | 3,702 | **180,115** | 237,695 | 10,460 | 33,383 | 0 | 0 | **281,537** | **-95,972** | *432,273* |
| **2008** | 19,116 | 37,411 | 74,059 | 4,568 | **135,153** | 207,278 | 8,635 | 69,883 | 0 | 0 | **285,796** | **-150,702** | *281,570* |
| **2009** | 20,615 | 60,385 | 101,583 | 2,203 | **184,786** | 210,223 | 7,771 | 68,087 | 0 | 0 | **286,081** | **-102,677** | *178,893* |
| **2010** | 19,644 | 95,947 | 260,108 | 4,161 | **379,861** | 195,024 | 5,924 | 80,051 | 0 | 0 | **280,999** | **64,333** | *243,226* |
| **2011** | 19,987 | 104,662 | 252,364 | 8,011 | **385,024** | 199,748 | 4,735 | 38,692 | 0 | 0 | **243,176** | **155,838** | *399,065* |
| **2012** | 21,069 | 48,150 | 152,646 | 5,542 | **227,407** | 254,898 | 7,147 | 35,409 | 0 | 0 | **297,455** | **-53,645** | *345,420* |
| **2013** | 20,365 | 59,329 | 55,969 | 3,206 | **138,868** | 237,600 | 7,007 | 41,704 | 0 | 0 | **286,311** | **-150,593** | *194,827* |
| **2014** | 21,798 | 43,570 | 45,172 | 919 | **111,460** | 206,458 | 7,393 | 69,763 | 0 | 0 | **283,614** | **-167,556** | *27,270* |
| **TOTAL** | 369,676 | 1,448,909 | 3,488,255 | 125,535 | **5,432,376** | 4,466,795 | 134,297 | 795,502 | 0 | 0 | **5,396,594** | **27,270** | *27,270* |
| ***AVERAGE*** | *18,484* | *72,445* | *174,413* | *6,277* | ***271,619*** | *223,340* | *6,715* | *39,775* | *0* | *0* | ***269,830*** | **1,364** | - |
| ***%*** | *7%* | *27%* | *64%* | *2%* | - | *83%* | *2%* | *15%* | *0%* | *0%* | **-** | - | - |
| **Current Water Budget (DWR WY 2015)** | | | | | | | | | | | | | |
| **2015** | 22,676 | 65,315 | 49,970 | 4,269 | **142,229** | 217,977 | 9,082 | 84,344 | 0 | 0 | **311,403** | **-164,385** | - |
| ***%*** | *16%* | *46%* | *35%* | *3%* | - | *70%* | *3%* | *27%* | *0%* | *0%* | **-** | - | - |

**Abbreviations**

AF = acre-feet
AFY = acre-feet per year
DWR = California Department of Water Resources
M&I = municipal & industrial
WY = Water Year

**Notes**

(a) All values reported in acre-feet per year (AFY), except cumulative change in storage (reported in acre-feet).
(b) "Evapotranspiration" includes all estimated crop and vegetative evapotranspirative demands as well as evaporation of excess rainfall and from open water bodies within the District.
(c) M&I Consumptive Use includes evapotranspiration on Urban Lands (no other consumptive uses specified within the District), which is in part met by precipitation
(d) Apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix E - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**TABLE WB-7**
**Summary of Projected Water Budget Results without Project & Management Action Implementation**
Arvin-Edison Management Area

**Total Water Budget Domain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| Inflows | (Net) Subsurface Inflow [b] | 18,484 | 18,519 | 18,519 | 18,519 |
| | Precipitation | 72,445 | 72,060 | 72,653 | 70,549 |
| | Surface Water Imports | 174,413 | 172,134 | 140,188 | 113,784 |
| | Natural Surface Water Inflows | 6,277 | 6,200 | 6,327 | 6,183 |
| | **TOTAL INFLOWS** | **271,619** | **268,913** | **237,688** | **209,035** |
| Outflows | Evapotranspiration [c] | 223,340 | 222,533 | 228,532 | 235,809 |
| | M&I Consumptive Use [d] | 6,715 | 6,951 | 7,153 | 7,429 |
| | Surface Water Exports & Deliveries to White Wolf Subbasin | 39,775 | 37,996 | 33,912 | 22,453 |
| | Natural Surface Water Outflows | 0 | 0 | 0 | 0 |
| | Subsurface Groundwater Outflow | 0 | 0 | 0 | 0 |
| | **TOTAL OUTFLOWS** | **269,830** | **267,480** | **269,597** | **265,691** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **1,364** | **1,660** | **-31,586** | **-56,333** |

**Groundwater Subdomain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| Groundwater Inflows | (Net) Subsurface Inflow[b] | 18,484 | 18,519 | 18,519 | 18,519 |
| | Infiltration of Precipitation | 3,783 | 3,857 | 3,853 | 3,704 |
| | Infiltration of Applied Water | 57,937 | 70,660 | 69,173 | 68,198 |
| | Infiltration from Surface Water Systems | 13,819 | 17,375 | 14,237 | 16,101 |
| | Recharge from Spreading Basins | 51,481 | 42,192 | 36,381 | 31,931 |
| | **TOTAL GW INFLOWS** | **145,504** | **152,603** | **142,163** | **138,452** |
| Groundwater Outflows | Pumpage from District Wells[e] | 53,239 | 54,258 | 54,258 | 54,258 |
| | Pumpage from Private Wells | 87,823 | 94,145 | 117,046 | 138,076 |
| | M&I Pumpage | 2,695 | 2,743 | 2,743 | 2,743 |
| | **TOTAL GW OUTFLOWS** | **143,757** | **151,145** | **174,047** | **195,076** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **1,364** | **1,660** | **-31,586** | **-56,333** |

**Notes**

(a) All values reported in acre-feet per year (AFY).
(b) Projected GW Inflow terms based on Estimated Net Groundwater Inflows from Calibrated Historical Water Budget
(c) "Evapotranspiration" includes all estimated crop and vegetative evapotranspirative demands as well as evaporation of excess rainfall and from open water bodies within the District.
(d) M&I Consumptive Use includes evapotranspiration on Urban Lands (no other consumptive uses specified within the District), which is in part met by precipitation.
(e) This value includes all groundwater extractions from AEWSD wells for its long-term groundwater banking and recovery program. On certain years, this value also includes minor groundwater inputs to the District delivery system from private wells that have elected to participate in the District's groundwater "pump-in" program.
(f) Apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix E - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**TABLE WB-8**
**Summary of Projected Water Budget Results with Project & Management Action Implementation**
Arvin-Edison Management Area

**Total Water Budget Domain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| Inflows | (Net) Subsurface Inflow [b] | 18,484 | 18,519 | 18,519 | 18,519 |
| | Precipitation | 72,445 | 72,060 | 72,653 | 70,549 |
| | Surface Water Imports | 174,413 | 172,134 | 140,188 | 113,784 |
| | **P&MA Augmented Supplies** | **-** | **0** | **22,400** | **40,775** |
| | Natural Surface Water Inflows | 6,277 | 6,200 | 6,327 | 6,183 |
| | **TOTAL INFLOWS** | **271,619** | **268,913** | **260,088** | **249,810** |
| Outflows | Evapotranspiration [c] | 223,340 | 222,533 | 228,532 | 235,809 |
| | **P&MA Demand Reduction** | **-** | **0** | **-9,600** | **-15,725** |
| | M&I Consumptive Use [d] | 6,715 | 6,951 | 7,153 | 7,429 |
| | Surface Water Exports & Deliveries to White Wolf Subbasin | 39,775 | 37,996 | 33,912 | 22,453 |
| | Natural Surface Water Outflows | 0 | 0 | 0 | 0 |
| | Subsurface Groundwater Outflow | 0 | 0 | 0 | 0 |
| | **TOTAL OUTFLOWS** | **269,830** | **267,480** | **259,997** | **249,966** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **1,364** | **1,660** | **343** | **28** |

**Groundwater Subdomain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| **Groundwater Inflows** | (Net) Subsurface Inflow[b] | 18,484 | 18,519 | 18,519 | 18,519 |
| | Infiltration of Precipitation | 3,783 | 3,857 | 3,879 | 3,752 |
| | Infiltration of Applied Water | 57,937 | 70,660 | 72,727 | 74,610 |
| | Infiltration from Surface Water Systems | 13,819 | 17,375 | 14,273 | 16,169 |
| | Recharge from Spreading Basins | 51,481 | 42,192 | 36,381 | 31,931 |
| | **TOTAL GW INFLOWS** | **145,504** | **152,603** | **145,780** | **144,981** |
| **Groundwater Outflows** | Pumpage from District Wells[e] | 53,239 | 54,258 | 54,258 | 54,258 |
| | Pumpage from Private Wells | 87,823 | 94,145 | 88,663 | 88,105 |
| | M&I Pumpage | 2,695 | 2,743 | 2,743 | 2,743 |
| | **TOTAL GW OUTFLOWS** | **143,757** | **151,145** | **145,663** | **145,105** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **1,364** | **1,660** | **343** | **28** |

**Notes**
(a) All values reported in acre-feet per year (AFY).
(b) Projected GW Inflow terms based on Estimated Net Groundwater Inflows from Calibrated Historical Water Budget
(c) "Evapotranspiration" includes all estimated crop and vegetative evapotranspirative demands as well as evaporation of excess rainfall and from open water bodies within the District.
(d) M&I Consumptive Use includes evapotranspiration on Urban Lands (no other consumptive uses specified within the District), which is in part met by precipitation.
(e) This value includes all groundwater extractions from AEWSD wells for its long-term groundwater banking and recovery program. On certain years, this value also includes minor groundwater inputs to the District delivery system from private wells that have elected to participate in the District's groundwater "pump-in" program.
(f) Apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix E - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**TABLE WB-9**
**Annual Surface Water Inflows and Outflows by Source Type**
Wheeler Ridge-Maricopa Management Area

| DWR Water Year (Oct - Sept) | INFLOWS [AFY] | | | | | | OUTFLOWS [AFY] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Total Imported Surface Water (b)* | *Natural Inflows* | | | | **TOTAL SURFACE WATER INFLOWS** | *Surface Water Exports* | *Surface Water Deliveries to Overlap Lands* | *Natural Outflows* | | **TOTAL SURFACE WATER OUTFLOWS** |
| | | Direct Precipitation | | | Streamflow into District | | | | Streamflow out of District | Runoff of Excess Precip. | |
| | | Non-Overlap Lands | Overlap Lands | TOTAL | | | | | | | |
| **Historical Water Budget Period (DWR WY 1995 - 2014)** | | | | | | | | | | | |
| **1995** | 120,977 | 67,393 | 4,118 | 71,511 | 6,625 | **199,113** | 0 | 7,102 | 0 | 0 | **0** |
| **1996** | 150,040 | 61,041 | 3,730 | 64,771 | 2,279 | **217,090** | 0 | 8,842 | 0 | 0 | **0** |
| **1997** | 147,817 | 46,179 | 2,822 | 49,001 | 2,562 | **199,380** | 0 | 10,282 | 0 | 0 | **0** |
| **1998** | 108,888 | 118,987 | 7,271 | 126,258 | 8,904 | **244,049** | 0 | 6,446 | 0 | 0 | **0** |
| **1999** | 126,098 | 50,787 | 3,103 | 53,890 | 3,701 | **183,689** | 0 | 7,849 | 0 | 0 | **0** |
| **2000** | 132,736 | 34,843 | 2,129 | 36,972 | 2,451 | **172,159** | 0 | 8,406 | 0 | 0 | **0** |
| **2001** | 95,287 | 49,374 | 3,017 | 52,391 | 3,228 | **150,907** | 0 | 6,315 | 0 | 0 | **0** |
| **2002** | 93,727 | 27,223 | 1,664 | 28,887 | 1,252 | **123,866** | 0 | 6,639 | 0 | 0 | **0** |
| **2003** | 86,002 | 57,801 | 3,532 | 61,333 | 4,165 | **151,500** | 0 | 6,101 | 0 | 0 | **0** |
| **2004** | 97,212 | 34,477 | 2,107 | 36,583 | 2,298 | **136,094** | 0 | 6,965 | 0 | 0 | **0** |
| **2005** | 92,378 | 61,076 | 3,732 | 64,808 | 7,402 | **164,588** | 0 | 6,097 | 0 | 0 | **0** |
| **2006** | 104,769 | 43,555 | 2,662 | 46,216 | 2,608 | **153,594** | 0 | 6,518 | 0 | 0 | **0** |
| **2007** | 120,260 | 30,176 | 1,844 | 32,020 | 1,870 | **154,149** | 0 | 7,702 | 0 | 0 | **0** |
| **2008** | 121,328 | 16,782 | 1,026 | 17,808 | 1,555 | **140,691** | 0 | 6,114 | 0 | 0 | **0** |
| **2009** | 109,427 | 35,367 | 2,161 | 37,529 | 1,762 | **148,718** | 0 | 6,195 | 0 | 0 | **0** |
| **2010** | 110,195 | 49,311 | 3,013 | 52,324 | 1,113 | **163,632** | 0 | 5,742 | 0 | 0 | **0** |
| **2011** | 111,698 | 77,100 | 4,711 | 81,811 | 3,178 | **196,687** | 0 | 5,698 | 0 | 0 | **0** |
| **2012** | 123,256 | 35,585 | 2,175 | 37,760 | 2,073 | **163,089** | 0 | 6,669 | 0 | 0 | **0** |
| **2013** | 120,138 | 29,627 | 1,810 | 31,438 | 1,848 | **153,424** | 0 | 6,629 | 0 | 0 | **0** |
| **2014** | 96,394 | 10,560 | 645 | 11,205 | 1,211 | **108,810** | 0 | 4,920 | 0 | 0 | **0** |
| **TOTAL [AF]** | 2,268,628 | 937,243 | 57,272 | 994,516 | 62,087 | 3,325,230 | 0 | 137,229 | 0 | 0 | **0** |
| ***AVERAGE*** | *113,431* | *46,862* | *2,864* | *49,726* | *3,104* | *166,262* | *0* | *6,861* | *0* | *0* | *0* |
| ***%*** | *68.2%* | *28.2%* | *1.7%* | *29.9%* | *1.9%* | - | - | - | - | - | - |
| **Current Water Budget Period (DWR WY 2015** | | | | | | | | | | | |
| **2015** | 83,710 | 51,321 | 3,136 | 54,457 | 2,676 | **140,842** | 0 | 4,478 | 0 | 0 | **0** |
| ***%*** | *59.4%* | *36.4%* | *2.2%* | *38.7%* | *1.9%* | - | - | - | - | - | - |

**Abbreviations**
AFY = acre-feet per year
DWR = California Department of Water Resources
Precip. = precipitation
WRMWSD = Wheeler Ridge-Maricopa Water Storage District
WY = Water Year

**Notes**
(a) All values reported in acre-feet per year (AFY).
(b) Surface water import sources include State Water Project water, as well as recovered groundwater from out-of-district banking operations, including (1) Kern Water Bank, (2) Pioneer Project, (3) Berrenda Mesa Project, and (4) 2800 Acres. These sources are blended into the California Aqueduct prior to delivery to WRMWSD customers and thus cannot be independently quantified.

# TABLE WB-10
## Annual Inflows to and Outflows from the Groundwater System, and Change in Groundwater Storage
Wheeler Ridge-Maricopa Management Area

| DWR Water Year (Oct - Sept) | INFLOWS [AFY] | | | | | | | | | OUTFLOWS [AFY] | | | | | | | | | CHANGE IN STORAGE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subsurface Groundwater Inflow | Infiltration of Precipitation | | | Infiltration from Surface Water Systems | Infiltration of Applied Water | | | **TOTAL INFLOWS TO GROUND WATER SYSTEM** | *Groundwater Extraction* | | | | | Discharge to Surface Water Sources | Evapo-transpiration (c) | Subsurface Groundwater Outflow | **TOTAL OUTFLOWS FROM GROUND-WATER SYSTEM** | **Annual Change in Groundwater Storage [AFY]** | *Cumulative Change in Groundwater Storage Since WY 1995 [AF]* |
| | | | | | | | | | | Pumpage from District Wells | Pumpage from Private Wells - for User Input Program | Pumpage from Private Wells - for Private Use | | | | | | | | |
| | | Non-Overlap Lands | Overlap Lands | TOTAL | | Non-Overlap Lands | Overlap Lands | TOTAL | | | | Non-Overlap Lands | Overlap Lands | TOTAL | | | | | | |
| **Historical Water Budget (DWR WY 1995 - 2014)** | | | | | | | | | | | | | | | | | | | | |
| **1995** | 22,957 | 7,720 | 472 | 8,192 | 6,307 | 44,921 | 2,745 | 47,666 | **85,122** | 139 | 0 | 60,375 | 3,689 | 64,065 | 0 | 0 | 0 | **64,204** | **15,125** | *15,125* |
| **1996** | 10,578 | 7,392 | 452 | 7,844 | 2,907 | 50,284 | 3,073 | 53,357 | **74,685** | 0 | 0 | 65,039 | 3,974 | 69,013 | 0 | 0 | 0 | **69,013** | **-4,020** | *11,105* |
| **1997** | 11,897 | 5,296 | 324 | 5,619 | 3,128 | 45,736 | 2,795 | 48,531 | **69,175** | 0 | 0 | 58,247 | 3,559 | 61,806 | 0 | 0 | 0 | **61,806** | **4,946** | *16,051* |
| **1998** | 30,923 | 14,826 | 906 | 15,732 | 8,090 | 54,583 | 3,335 | 57,918 | **112,663** | 63 | 0 | 54,550 | 3,333 | 57,883 | 0 | 0 | 0 | **57,947** | **49,878** | *65,929* |
| **1999** | 15,316 | 6,131 | 375 | 6,505 | 4,020 | 49,369 | 3,017 | 52,386 | **78,227** | 13 | 0 | 64,941 | 3,968 | 68,910 | 0 | 0 | 0 | **68,922** | **22,381** | *88,310* |
| **2000** | 11,239 | 4,059 | 248 | 4,307 | 3,041 | 41,460 | 2,533 | 43,993 | **62,581** | 0 | 0 | 58,444 | 3,571 | 62,016 | 0 | 0 | 0 | **62,016** | **51** | *88,361* |
| **2001** | 9,982 | 5,738 | 351 | 6,088 | 3,649 | 34,311 | 2,097 | 36,408 | **56,128** | 1,270 | 943 | 50,887 | 3,110 | 53,997 | 0 | 0 | 0 | **56,210** | **862** | *89,223* |
| **2002** | 4,055 | 2,345 | 143 | 2,489 | 2,104 | 28,855 | 1,763 | 30,618 | **39,265** | 0 | 191 | 66,780 | 4,081 | 70,860 | 0 | 0 | 0 | **71,051** | **-31,814** | *57,409* |
| **2003** | 12,794 | 4,630 | 283 | 4,913 | 4,383 | 28,581 | 1,746 | 30,327 | **52,416** | 0 | 0 | 50,809 | 3,105 | 53,913 | 0 | 0 | 0 | **53,913** | **-6,413** | *50,997* |
| **2004** | 7,565 | 2,793 | 171 | 2,963 | 2,922 | 30,847 | 1,885 | 32,732 | **46,181** | 0 | 0 | 54,865 | 3,353 | 58,217 | 0 | 0 | 0 | **58,217** | **-21,726** | *29,271* |
| **2005** | 23,988 | 4,976 | 304 | 5,280 | 6,915 | 28,923 | 1,767 | 30,690 | **66,873** | 8 | 0 | 32,635 | 1,994 | 34,629 | 0 | 0 | 0 | **34,637** | **27,419** | *56,690* |
| **2006** | 10,409 | 4,544 | 278 | 4,821 | 3,165 | 33,739 | 2,062 | 35,801 | **54,196** | 0 | 0 | 34,710 | 2,121 | 36,831 | 0 | 0 | 0 | **36,831** | **18,718** | *75,408* |
| **2007** | 10,819 | 3,367 | 206 | 3,573 | 2,587 | 32,411 | 1,981 | 34,392 | **51,370** | 0 | 0 | 45,592 | 2,786 | 48,378 | 0 | 0 | 0 | **48,378** | **446** | *75,854* |
| **2008** | 7,952 | 1,940 | 119 | 2,058 | 2,340 | 30,597 | 1,870 | 32,466 | **44,817** | 1,388 | 1,051 | 41,813 | 2,555 | 44,368 | 0 | 0 | 0 | **46,807** | **-14,703** | *61,152* |
| **2009** | 7,708 | 3,646 | 223 | 3,869 | 2,503 | 30,251 | 1,849 | 32,099 | **46,179** | 0 | 7,906 | 38,005 | 2,322 | 40,327 | 0 | 0 | 0 | **48,233** | **-1,949** | *59,203* |
| **2010** | 5,353 | 4,683 | 286 | 4,969 | 1,995 | 35,684 | 2,181 | 37,865 | **50,181** | 1,631 | 7,719 | 34,207 | 2,090 | 36,297 | 0 | 0 | 0 | **45,648** | **6,846** | *66,049* |
| **2011** | 12,006 | 7,792 | 476 | 8,268 | 3,610 | 37,448 | 2,288 | 39,736 | **63,620** | 236 | 1,398 | 25,539 | 1,561 | 27,100 | 0 | 0 | 0 | **28,734** | **53,698** | *119,747* |
| **2012** | 7,788 | 3,435 | 210 | 3,645 | 2,746 | 37,381 | 2,284 | 39,665 | **53,844** | 960 | 1,900 | 56,210 | 3,435 | 59,645 | 0 | 0 | 0 | **62,505** | **3,863** | *123,611* |
| **2013** | 7,143 | 3,340 | 204 | 3,544 | 2,570 | 38,071 | 2,326 | 40,397 | **53,654** | 1,131 | 8,260 | 65,658 | 4,012 | 69,670 | 0 | 0 | 0 | **79,061** | **-24,061** | *99,550* |
| **2014** | 5,110 | 1,373 | 84 | 1,457 | 2,071 | 33,098 | 2,023 | 35,121 | **43,759** | 2,636 | 24,728 | 54,289 | 3,317 | 57,607 | 0 | 0 | 0 | **84,971** | **-33,839** | *65,711* |
| **TOTAL** | 235,582 | 100,024 | 6,112 | 106,137 | 71,050 | 746,549 | 45,620 | 792,169 | **1,204,937** | 9,475 | 54,095 | 1,013,595 | 61,938 | 1,075,533 | 0 | 0 | 0 | **1,139,104** | **65,711** | *65,711* |
| ***AVERAGE*** | *11,779* | *5,001* | *306* | *5,307* | *3,552* | *37,327* | *2,281* | *39,608* | **60,247** | *474* | *2,705* | *50,680* | *3,097* | *53,777* | *0* | *0* | *0* | **56,955** | **3,286** | - |
| ***%*** | *20%* | *8%* | *1%* | *9%* | *6%* | *62%* | *4%* | *66%* | - | *0.8%* | *5%* | *89%* | *5%* | *94%* | *0%* | *0%* | *0%* | - | - | - |
| **Current Water Budget (DWR WY 2015)** | | | | | | | | | | | | | | | | | | | | |
| **2015** | 8,640 | 5,044 | 308 | 5,352 | 3,217 | 38,081 | 2,327 | 40,408 | **57,618** | 2,410 | 31,253 | 65,327 | 3,992 | 69,319 | 0 | 0 | 102 | **103,084** | **-42,898** | - |
| ***%*** | *15%* | *8.8%* | *0.5%* | *9%* | *6%* | *66%* | *4%* | *70%* | - | *2.3%* | *30%* | *63%* | *4%* | *67%* | *0%* | *0%* | *0%* | - | - | - |

**Abbreviations**

AF = acre-feet
AFY = acre-feet per year
DWR = California Department of Water Resources
ITRC = Cal Poly Irrigation Training & Research Center
WY = Water Year

**Notes**

(a) All values reported in acre-feet per year (AFY), except cumulative change in storage (reported in acre-feet).

(b) This value includes all groundwater extractions from WRMWSD wells for its long-term groundwater banking and recovery program. On certain years, this value also includes minor groundwater inputs to the District delivery system from private wells that have elected to participate in the District's groundwater "pump-in" program to augment delivery supplies in times of drought.

(c) There are years for which ITRC-measured evapotranspiration from non-irrigated lands exceeds the total measured rainfall to these lands. In these cases, residual water demands on non-irrigated lands are accounted for as a reduction in total infiltration ("inflows") rather than an explicit groundwater "outflow" due to evapotranspiration. This is based on the understanding that the groundwater table is fully disconnected from the root zone under the District. ITRC-measured residual water demands on non-irrigated lands are likely caused in part by evaporation from local surface water bodies (e.g., storage ponds) and/or are met by a reduction of root zone soil moisture, which is not explicitly accounted for in the water budget spreadsheet model.

**TABLE WB-11**

**Annual and Cumulative Change in Groundwater Storage between Seasonal Highs (Mar - Feb)**

Wheeler Ridge-Maricopa Management Area

| Period of Reference [m/yy] | Annual Change in Groundwater Storage [AFY] | Cumulative Change in Groundwater Storage [AF] |
|---|---|---|
| 3/94 - 2/95 | 676 | 676 |
| 3/95 - 2/96 | 2,314 | 2,989 |
| 3/96 - 2/97 | 4,749 | 7,738 |
| 3/97 - 2/98 | 12,156 | 19,894 |
| 3/98 - 2/99 | 49,356 | 69,251 |
| 3/99 - 2/00 | 4,753 | 74,004 |
| 3/00 - 2/01 | 5,654 | 79,658 |
| 3/01 - 2/02 | -12,446 | 67,212 |
| 3/02 - 2/03 | -27,481 | 39,732 |
| 3/03 - 2/04 | -10,773 | 28,959 |
| 3/04 - 2/05 | -8,647 | 20,312 |
| 3/05 - 2/06 | 19,552 | 39,864 |
| 3/06 - 2/07 | 21,652 | 61,517 |
| 3/07 - 2/08 | -11,478 | 50,038 |
| 3/08 - 2/09 | -12,299 | 37,740 |
| 3/09 - 2/10 | -2,415 | 35,325 |
| 3/10 - 2/11 | 26,890 | 62,215 |
| 3/11 - 2/12 | 50,964 | 113,180 |
| 3/12 - 2/13 | -8,233 | 104,946 |
| 3/13 - 2/14 | -29,420 | 75,526 |
| 3/14 - 2/15 | -27,863 | 47,664 |
| **TOTAL** | 47,664 | 47,664 |
| ***AVERAGE*** | 2,270 | - |

# TABLE WB-12

## Supplies, Demands, and Change in Groundwater Storage vs. DWR Water Year Type

Wheeler Ridge-Maricopa Management Area

| DWR Water Year (Oct - Sept) | DWR Water Year Type (a) | Total Supplies [AFY] (b) | Total Demands [AFY] (c) | Annual Change in Groundwater Storage [AFY] |
|---|---|---|---|---|
| 1995 | W | 222,070 | 210,575 | 15,125 |
| 1996 | W | 227,668 | 229,141 | -4,020 |
| 1997 | W | 211,276 | 202,384 | 4,946 |
| 1998 | W | 274,972 | 210,421 | 49,878 |
| 1999 | AN | 199,005 | 191,299 | 22,381 |
| 2000 | AN | 183,398 | 186,354 | 51 |
| 2001 | D | 160,889 | 163,299 | 862 |
| 2002 | D | 127,921 | 165,102 | -31,814 |
| 2003 | BN | 164,294 | 172,178 | -6,413 |
| 2004 | D | 143,658 | 166,256 | -21,726 |
| 2005 | W | 188,576 | 152,979 | 27,419 |
| 2006 | W | 164,003 | 142,920 | 18,718 |
| 2007 | C | 164,968 | 175,259 | 446 |
| 2008 | C | 148,643 | 158,517 | -14,703 |
| 2009 | BN | 156,426 | 156,802 | -1,949 |
| 2010 | AN | 168,985 | 150,323 | 6,846 |
| 2011 | W | 208,694 | 151,074 | 53,698 |
| 2012 | D | 170,877 | 178,157 | 3,863 |
| 2013 | C | 160,567 | 180,823 | -24,061 |
| 2014 | C | 113,920 | 151,114 | -33,839 |
| 2015 | C | 149,483 | 187,327 | -42,898 |

| Water Year Type (a) | Number of Years During WY 1995 - 2015 Period | Average Total Supplies [AFY] (b) | Average Total Demands [AFY] (c) | Average Annual Change in Groundwater Storage [AFY] |
|---|---|---|---|---|
| C | 5 | 147,516 | 170,608 | -23,011 |
| D | 4 | 150,837 | 168,204 | -12,204 |
| BN | 2 | 160,360 | 164,490 | -4,181 |
| AN | 3 | 183,796 | 175,992 | 9,760 |
| W | 7 | 213,894 | 185,642 | 23,681 |

**Abbreviations**

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

**Notes:**

(a) DWR Water Year Types are as follows: W = wet, AN = above normal, BN = below normal, D = dry, C = critical
(b) Total supplies equal the sum of inflow terms (see Table WB-6 for individual inflow components).
(c) Total demands equal the sum of outflow terms (see Table WB-6 for individual outflow components).
(d) The apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix E - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**Sources:**

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

# TABLE WB-13
## Annual Total Inflows, Outflows, and Change in Groundwater Storage
Wheeler Ridge-Maricopa Management Area

| DWR Water Year (Oct - Sept) | INFLOWS [AFY] | | | | | | | OUTFLOWS [AFY] | | | | | | | | | CHANGE IN STORAGE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subsurface Groudwater Inflow | Precipitation | | | Surface Water Imports | Natural Surface Water Inflows | **TOTAL INFLOWS** | Evapotranspiration (b) | | | M&I Consumptive Use | Surface Water Exports | *Surface Water Deliveries to Overlap Lands* | Natural Surface Water Outflow | Subsurface Groundwater Outflow | **TOTAL OUTFLOWS** | **Annual Change in Groundwater Storage [AFY]** (c) | *Cumulative Change in Groundwater Storage Since WY 1995 [AF]* |
| | | Non-Overlap Lands | Overlap Lands | TOTAL | | | | Non-Overlap Lands | Overlap Lands | TOTAL | | | | | | | | |
| **Historical Water Budget (DWR WY 1995 - 2014)** | | | | | | | | | | | | | | | | | | |
| **1995** | 22,957 | 67,393 | 4,118 | 71,511 | 120,977 | 6,625 | **222,070** | 197,340 | 12,059 | 209,399 | 1,176 | 0 | 7,102 | 0 | 0 | **210,575** | **15,125** | *15,125* |
| **1996** | 10,578 | 61,041 | 3,730 | 64,771 | 150,040 | 2,279 | **227,668** | 214,732 | 13,122 | 227,854 | 1,287 | 0 | 8,842 | 0 | 0 | **229,141** | **-4,020** | *11,105* |
| **1997** | 11,897 | 46,179 | 2,822 | 49,001 | 147,817 | 2,562 | **211,276** | 189,352 | 11,571 | 200,923 | 1,461 | 0 | 10,282 | 0 | 0 | **202,384** | **4,946** | *16,051* |
| **1998** | 30,923 | 118,987 | 7,271 | 126,258 | 108,888 | 8,904 | **274,972** | 196,980 | 12,037 | 209,017 | 1,405 | 0 | 6,446 | 0 | 0 | **210,421** | **49,878** | *65,929* |
| **1999** | 15,316 | 50,787 | 3,103 | 53,890 | 126,098 | 3,701 | **199,005** | 178,895 | 10,932 | 189,826 | 1,472 | 0 | 7,849 | 0 | 0 | **191,299** | **22,381** | *88,310* |
| **2000** | 11,239 | 34,843 | 2,129 | 36,972 | 132,736 | 2,451 | **183,398** | 174,416 | 10,658 | 185,074 | 1,280 | 0 | 8,406 | 0 | 0 | **186,354** | **51** | *88,361* |
| **2001** | 9,982 | 49,374 | 3,017 | 52,391 | 95,287 | 3,228 | **160,889** | 153,149 | 9,359 | 162,508 | 791 | 0 | 6,315 | 0 | 0 | **163,299** | **862** | *89,223* |
| **2002** | 4,055 | 27,223 | 1,664 | 28,887 | 93,727 | 1,252 | **127,921** | 154,768 | 9,457 | 164,225 | 877 | 0 | 6,639 | 0 | 0 | **165,102** | **-31,814** | *57,409* |
| **2003** | 12,794 | 57,801 | 3,532 | 61,333 | 86,002 | 4,165 | **164,294** | 161,512 | 9,870 | 171,382 | 797 | 0 | 6,101 | 0 | 0 | **172,178** | **-6,413** | *50,997* |
| **2004** | 7,565 | 34,477 | 2,107 | 36,583 | 97,212 | 2,298 | **143,658** | 155,848 | 9,523 | 165,371 | 885 | 0 | 6,965 | 0 | 0 | **166,256** | **-21,726** | *29,271* |
| **2005** | 23,988 | 61,076 | 3,732 | 64,808 | 92,378 | 7,402 | **188,576** | 143,465 | 8,767 | 152,231 | 747 | 0 | 6,097 | 0 | 0 | **152,979** | **27,419** | *56,690* |
| **2006** | 10,409 | 43,555 | 2,662 | 46,216 | 104,769 | 2,608 | **164,003** | 133,980 | 8,187 | 142,168 | 753 | 0 | 6,518 | 0 | 0 | **142,920** | **18,718** | *75,408* |
| **2007** | 10,819 | 30,176 | 1,844 | 32,020 | 120,260 | 1,870 | **164,968** | 164,208 | 10,034 | 174,242 | 1,016 | 0 | 7,702 | 0 | 0 | **175,259** | **446** | *75,854* |
| **2008** | 7,952 | 16,782 | 1,026 | 17,808 | 121,328 | 1,555 | **148,643** | 148,695 | 9,086 | 157,782 | 735 | 0 | 6,114 | 0 | 0 | **158,517** | **-14,703** | *61,152* |
| **2009** | 7,708 | 35,367 | 2,161 | 37,529 | 109,427 | 1,762 | **156,426** | 147,070 | 8,987 | 156,057 | 745 | 0 | 6,195 | 0 | 0 | **156,802** | **-1,949** | *59,203* |
| **2010** | 5,353 | 49,311 | 3,013 | 52,324 | 110,195 | 1,113 | **168,985** | 141,206 | 8,629 | 149,835 | 488 | 0 | 5,742 | 0 | 0 | **150,323** | **6,846** | *66,049* |
| **2011** | 12,006 | 77,100 | 4,711 | 81,811 | 111,698 | 3,178 | **208,694** | 142,031 | 8,679 | 150,710 | 364 | 0 | 5,698 | 0 | 0 | **151,074** | **53,698** | *119,747* |
| **2012** | 7,788 | 35,585 | 2,175 | 37,760 | 123,256 | 2,073 | **170,877** | 167,257 | 10,221 | 177,478 | 679 | 0 | 6,669 | 0 | 0 | **178,157** | **3,863** | *123,611* |
| **2013** | 7,143 | 29,627 | 1,810 | 31,438 | 120,138 | 1,848 | **160,567** | 169,857 | 10,379 | 180,237 | 586 | 0 | 6,629 | 0 | 0 | **180,823** | **-24,061** | *99,550* |
| **2014** | 5,110 | 10,560 | 645 | 11,205 | 96,394 | 1,211 | **113,920** | 141,951 | 8,674 | 150,625 | 488 | 0 | 4,920 | 0 | 0 | **151,114** | **-33,839** | *65,711* |
| **TOTAL** | 235,582 | 937,243 | 57,272 | 994,516 | 2,268,628 | 62,087 | 3,560,812 | 3,276,714 | 200,231 | 3,476,945 | 18,033 | 0 | 137,229 | 0 | 0 | **3,494,978** | **65,711** | *65,711* |
| ***AVERAGE*** | *11,779* | *46,862* | *2,864* | *49,726* | *113,431* | *3,104* | ***178,041*** | *163,836* | *10,012* | *173,847* | *902* | *0* | *6,861* | *0* | *0* | ***174,749*** | **3,286** | - |
| ***%*** | *7%* | *26%* | *2%* | *28%* | *64%* | *2%* | - | *94%* | *6%* | *99.5%* | *0.5%* | *0%* | - | *0%* | *0%* | **-** | - | - |
| **Current Water Budget (DWR WY 2015)** | | | | | | | | | | | | | | | | | | |
| **2015** | 8,640 | 51,321 | 3,136 | 54,457 | 83,710 | 2,676 | **149,483** | 175,651 | 10,734 | 186,384 | 840 | 0 | 4,478 | 0 | 102 | **187,327** | **-42,898** | - |
| ***%*** | *6%* | *34%* | *2%* | *36%* | *56%* | *2%* | - | *94%* | *6%* | *99.5%* | *0.4%* | *0%* | - | *0%* | *0%* | **-** | - | - |

**Abbreviations**

AF = acre-feet
AFY = acre-feet per year
DWR = California Department of Water Resources
M&I = municipal & industrial
WY = Water Year

**Notes**

(a) All values reported in acre-feet per year (AFY), except cumulative change in storage (reported in acre-feet).
(b) "Evapotranspiration" includes all estimated crop and vegetative evapotranspirative demands as well as evaporation of excess rainfall and from open water bodies within the District.
(c) Apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix A - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**TABLE WB-14**
**Summary of Projected Water Budget Results without Project & Management Action Implementation**
Wheeler Ridge-Maricopa Management Area

**Total Water Budget Domain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| Inflows | (Net) Subsurface Inflow [b] | 11,779 | 11,551 | 11,704 | 11,485 |
| | Precipitation | 49,726 | 49,144 | 49,707 | 48,485 |
| | Surface Water Imports | 113,431 | 93,328 | 90,541 | 86,119 |
| | Natural Surface Water Inflows | 3,104 | 3,044 | 3,095 | 3,022 |
| | **TOTAL INFLOWS** | **178,041** | **157,067** | **155,046** | **149,111** |
| Outflows | Evapotranspiration [c] | 173,847 | 171,023 | 175,767 | 181,702 |
| | M&I Consumptive Use [d] | 902 | 866 | 891 | 925 |
| | Surface Water Exports | 0 | 0 | 0 | 0 |
| | Natural Surface Water Outflows | 0 | 0 | 0 | 0 |
| | Subsurface Groundwater Outflow | 0 | 0 | 0 | 0 |
| | **TOTAL OUTFLOWS** | **174,749** | **171,888** | **176,658** | **182,627** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **3,286** | **-14,665** | **-21,429** | **-33,326** |

**Groundwater Subdomain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| Inflows | (Net) Subsurface Inflow [b] | 11,779 | 11,551 | 11,704 | 11,485 |
| | Infiltration of Precipitation | 5,307 | 4,997 | 4,974 | 4,678 |
| | Infiltration from Surface Water Systems | 3,552 | 3,443 | 3,450 | 3,308 |
| | Infiltration of Applied Water | 39,608 | 33,132 | 32,618 | 30,935 |
| | **TOTAL GW INFLOWS** | **60,247** | **53,123** | **52,745** | **50,406** |
| Outflows | Pumpage from District Wells | 474 | 463 | 463 | 463 |
| | Pumpage from Private Wells - User Input Program | 2,705 | 2,563 | 2,563 | 2,563 |
| | Pumpage from Private Wells - Private Use | 53,777 | 64,918 | 71,330 | 80,894 |
| | **TOTAL GW OUTFLOWS** | **56,955** | **67,944** | **74,357** | **83,921** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **3,286** | **-14,665** | **-21,429** | **-33,326** |

**Notes**
(a) All values reported in acre-feet per year (AFY).
(b) Projected GW Inflow terms based on Estimated Net Groundwater Inflows from Calibrated Historical Water Budget
(c) Evapotranspiration includes all estimated crop and vegetative evapotranspirative demands as well as evaporation of excess rainfall and from open water bodies within the District.
(d) M&I Consumptive Use includes evapotranspiration on Urban Lands (no other consumptive uses specified within the District), which is in part met by precipitation.
(e) Apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix E - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**TABLE WB-15**
**Summary of Projected Water Budget Results with Project & Management Action Implementation**
Wheeler Ridge-Maricopa Management Area

**Total Water Budget Domain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| Inflows | (Net) Subsurface Inflow [b] | 11,779 | 11,551 | 11,704 | 11,485 |
| | Precipitation | 49,726 | 49,144 | 49,707 | 48,485 |
| | Surface Water Imports | 113,431 | 93,328 | 90,541 | 86,119 |
| | **P&MA Augmented Supplies** | - | **0** | **12,900** | **18,800** |
| | Natural Surface Water Inflows | 3,104 | 3,044 | 3,095 | 3,022 |
| | **TOTAL INFLOWS** | **178,041** | **157,067** | **167,946** | **167,911** |
| Outflows | Evapotranspiration [c] | 173,847 | 171,023 | 175,767 | 181,702 |
| | **P&MA Demand Reduction** | **-** | **0** | **-8,600** | **-14,600** |
| | M&I Consumptive Use [d] | 902 | 866 | 891 | 925 |
| | Surface Water Exports | 0 | 0 | 0 | 0 |
| | Natural Surface Water Outflows | 0 | 0 | 0 | 0 |
| | Subsurface Groundwater Outflow | 0 | 0 | 0 | 0 |
| | **TOTAL OUTFLOWS** | **174,749** | **171,888** | **168,058** | **168,027** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **3,286** | **-14,665** | **53** | **47** |

**Groundwater Subdomain**

| Water Budget Category | Water Budget Component | Historical Period (WY 1995-2014) | Projected: Baseline (50-year Synthetic Hydrologic Period) | Projected: 2030 Climate (scaled from Baseline Period) | Projected: 2070 Climate (scaled from Baseline Period) |
|---|---|---|---|---|---|
| Inflows | (Net) Subsurface Inflow[b] | 11,779 | 11,551 | 11,704 | 11,485 |
| | Infiltration of Precipitation | 5,307 | 4,997 | 5,031 | 4,757 |
| | Infiltration from Surface Water Systems | 3,552 | 3,443 | 3,477 | 3,345 |
| | Infiltration of Applied Water | 39,608 | 33,132 | 34,470 | 33,222 |
| | **TOTAL GW INFLOWS** | **60,247** | **53,123** | **54,682** | **52,808** |
| Outflows | Pumpage from District Wells | 474 | 463 | 463 | 463 |
| | Pumpage from Private Wells - User Input Program | 2,705 | 2,563 | 2,563 | 2,563 |
| | Pumpage from Private Wells - Private Use | 53,777 | 64,918 | 51,767 | 49,897 |
| | **TOTAL GW OUTFLOWS** | **56,955** | **67,944** | **54,794** | **52,923** |
| **Change in Groundwater Storage** | **Equivalent to "Deficit"** | **3,286** | **-14,665** | **53** | **47** |

**Notes**
(a) All values reported in acre-feet per year (AFY).
(b) Projected GW Inflow terms based on Estimated Net Groundwater Inflows from Calibrated Historical Water Budget
(c) Evapotranspiration includes all estimated crop and vegetative evapotranspirative demands as well as evaporation of excess rainfall and from open water bodies within the District.
(d) M&I Consumptive Use includes evapotranspiration on Urban Lands (no other consumptive uses specified within the District), which is in part met by precipitation.
(e) Apparent residual of water-budget calculated change in groundwater storage to [Total Inflows - Total Outflows] can be attributed to the deep percolation lag effect in the water budget spreadsheet model, which serves to delay infiltration from reaching the groundwater system. See "Appendix E - Methods & Data Used in the Water Budget Spreadsheet Model Approach" for further details on how monthly storage change is calculated within the water budget spreadsheet model.

**Table WB-16**
**Summary of Historical, Current, and Projected Water Budget Components**
Tejon-Castac Management Area

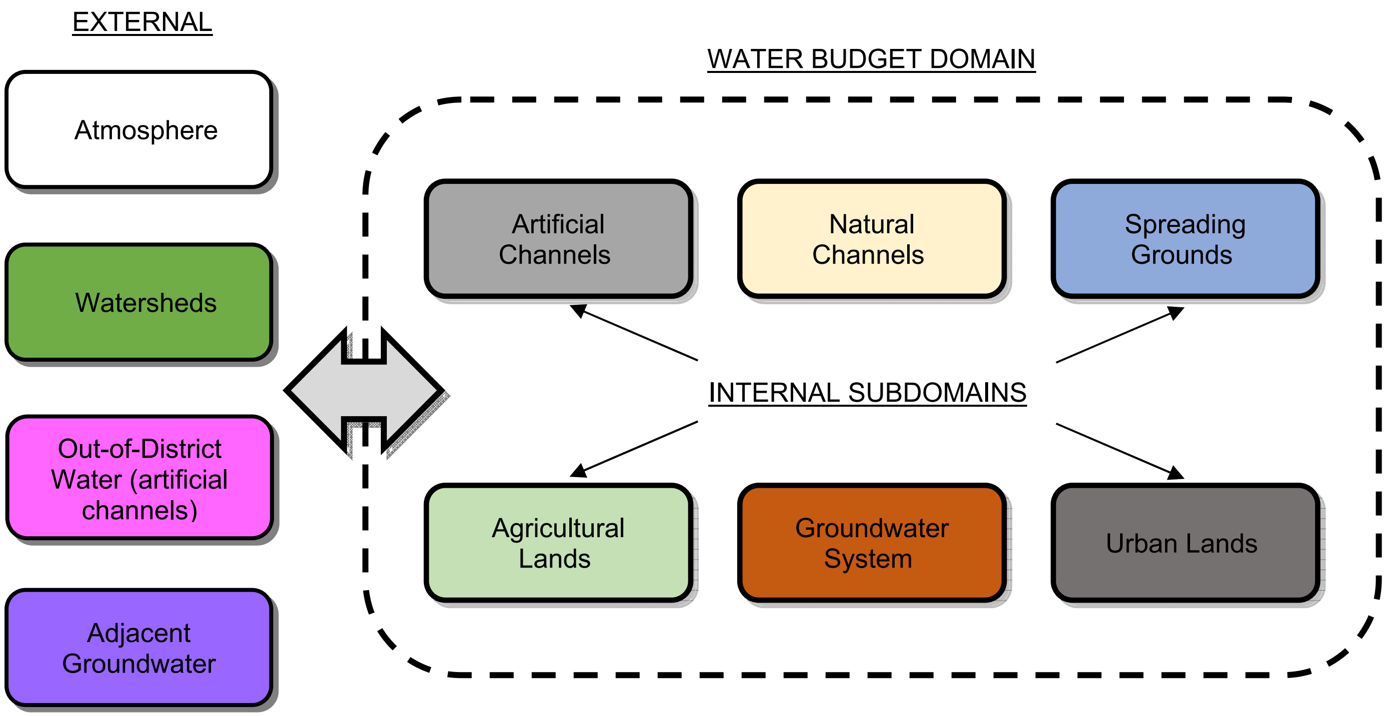
| Component | Type | Historical (WY 1995 - 2014) | Current (WY 2015) | Projected (Future) Baseline | Projected (Future) 2030 | Projected (Future) 2070 |
|---|---|---|---|---|---|---|
| *KNOWN/QUANTIFIED INFLOWS* | | | | | | |
| Precipitation | Inflow to Land Surface Subdomain | 13,200 to 17,100 (a) | 9,100 to 14,600 (a) | 13,200 to 17,100 (b) | 13,800 to 18,200 (c) | 13,200 to 17,700 (c) |
| Surface Water Inflows | Inflow to Land Surface Subdomain | 7,600 (d) | 6,300 (e) | 7,600 (b) | 7,300 (f) | 7,000 (f) |
| Subsurface Inflows | Inflow to Groundwater Subdomain | likely negligible | likely negligible | likely negligible | likely negligible | likely negligible |
| | *SUM OF KNOWN/QUANTIFIED INFLOWS* | 20,800 to 24,700 | 15,400 to 20,900 | 20,800 to 24,700 | 21,100 to 25,500 | 20,200 to 24,700 |
| *KNOWN/QUANTIFIED OUTFLOWS* | | | | | | |
| ET / Consumptive Use | Outflow from Land Surface Subdomain | 19,200 (g) | 14,600 (h) | 19,200 (b) | 21,600 (c) | 22,600 (c) |
| Agricultural Pumping to Lands Outside of TCWD MA | Outflow from Groundwater Subdomain | 500 to 950 (i) | 500 to 950 (i) | 500 to 950 (b) | 560 to 1,070 (j) | 590 to 1,120 (j) |
| | *SUM OF KNOWN/QUANTIFIED OUTFLOWS* | 19,700 to 20,150 | 15,100 to 15,550 | 19,700 to 20,150 | 22,160 to 22,670 | 23,190 to 23,720 |
| *INTERNAL EXCHANGE FLOWS* | | | | | | |
| Industrial Pumping (Net) | Exchange Flow from Groundwater to Land Surface Subdomain | 250 (k) | 250 (k) | 0 (l) | 0 (l) | 0 (l) |
| Domestic Pumping | Exchange Flow from Groundwater to Land Surface Subdomain | de minimus | de minimus | de minimus | de minimus | de minimus |
| Seepage to Springs | Exchange Flow from Groundwater to Land Surface Subdomain | likely negligible | likely negligible | likely negligible | likely negligible | likely negligible |
| Percolation/Recharge | Exchange Flow from Land Surface to Groundwater Subdomain | not quantified | not quantified | not quantified | not quantified | not quantified |
| *UNKNOWN/UNQUANTIFIED OUTFLOWS* | | | | | | |
| Surface Water Outflows | Outflow from Land Surface Subdomain | not quantified | not quantified | not quantified | not quantified | not quantified |
| Subsurface Outflows | Outflow from Groundwater Subdomain | not quantified | not quantified | not quantified | not quantified | not quantified |
| Change in Storage | Inflow/Outflow to Groundwater Subdomain | not quantified | not quantified | not quantified | not quantified | not quantified |
| | SUM OF UNKNOWN/UNQUANTIFIED OUTFLOWS (calculated as residual) | 350 to 5,000 | -150 to 5,800 | 600 to 5,250 | -1,570 to 3,340 | -3,520 to 1,510 |

**Abbreviations**

AFY = acre-feet per year
CIMIS = California Irrigaiton Management and Information System
DWR = California Department of Water Resources
ET = evapotranspiration
ITRC = Irrigation Training and Research Center
NOAA = National Oceanic and Atmospheric Administration
SIMETAW = Simulation of Evapotranspiration of Applied Water
USGS = United States Geological Survey
TCWD = Tejon-Castac Water District
TCWD MA = Tejon-Castac Water District Management Area
TRC = Tejon Ranchcorp
WY = water year

**Notes**

(a) Precipitation range is based on measured rainfall at the Arvin CIMIS Station, the Tejon Rancho NOAA climate station and the Tehachapi NOAA climate station.
(b) Baseline Projected values for Precipitation, Surface Water Inflows, ET / Consumptive Use and Agricultural Pumping to Lands Outside of TCWD MA area assumed to be the same as Historical values.
(c) 2030 and 2070 Projected values for Precipitation and ET / Consumptive Use are based on Historical values multiplied by the climate change factors derived from the VIC model.
(d) Surface Water Inflows for the Historical period are based on long-term average flow data from the Caliente Creek stream gauge (USGS gauge 11196400; period of record 1961 - 1983), scaled up by the ratio of the entire TCWD MA contributing watershed area to the Caliente Creek stream gauge contributing area.
(e) Surface Water Inflows for the Current period are based on the value for the historical period, scaled by the relative precipitation during the Current versus Historical Period
(f) 2030 and 2070 Projected Values for Surface Water Inflows are based on the historical values multiplied by the climate change factors derived from the VIC Model.
(g) ET/Consumptive Use for the Historical period is based on averages of ITRC ET data from WY 1995 - 2014, scaled up to cover the entire TCWD MA area.
(h) ET/Consumptive Use for the Current period is based on ITRC ET data from WY 2015, scaled up to cover the entire TCWD MA area.
(i) Historical and Current Agricultural Pumping to Lands Outside of TCWD MA is estimated based on the current crop type (grapes), the parcel acreages, and the unit applied water rates derived from the DWR SIMETAW model.
(j) 2030 and 2070 Projected Values for Agricultural Pumping to Lands Outside of TCWD MA are based on Historical values, scaled by the relative percent change in ET / Consumptive use.
(k) Current and Historical Industrial Pumping (Net) is based on approximately 400 AFY of total pumping and approximately 37 percent return flow (Granite Quarry staff, personal communication 28 February 2019).
(l) Projected Industrial Pumping (Net) is zero because the Granite Quarry facility is anticipated to cease operations within the next four years (TCWD staff, personal communication 6 March 2019).
(m) TCWD and TRC reserve the right to pump groundwater and/or develop surface water resources within the TCWD MA in the future, subject to the terms of the Tejon Ranch Conservation & Land Use Agreement.

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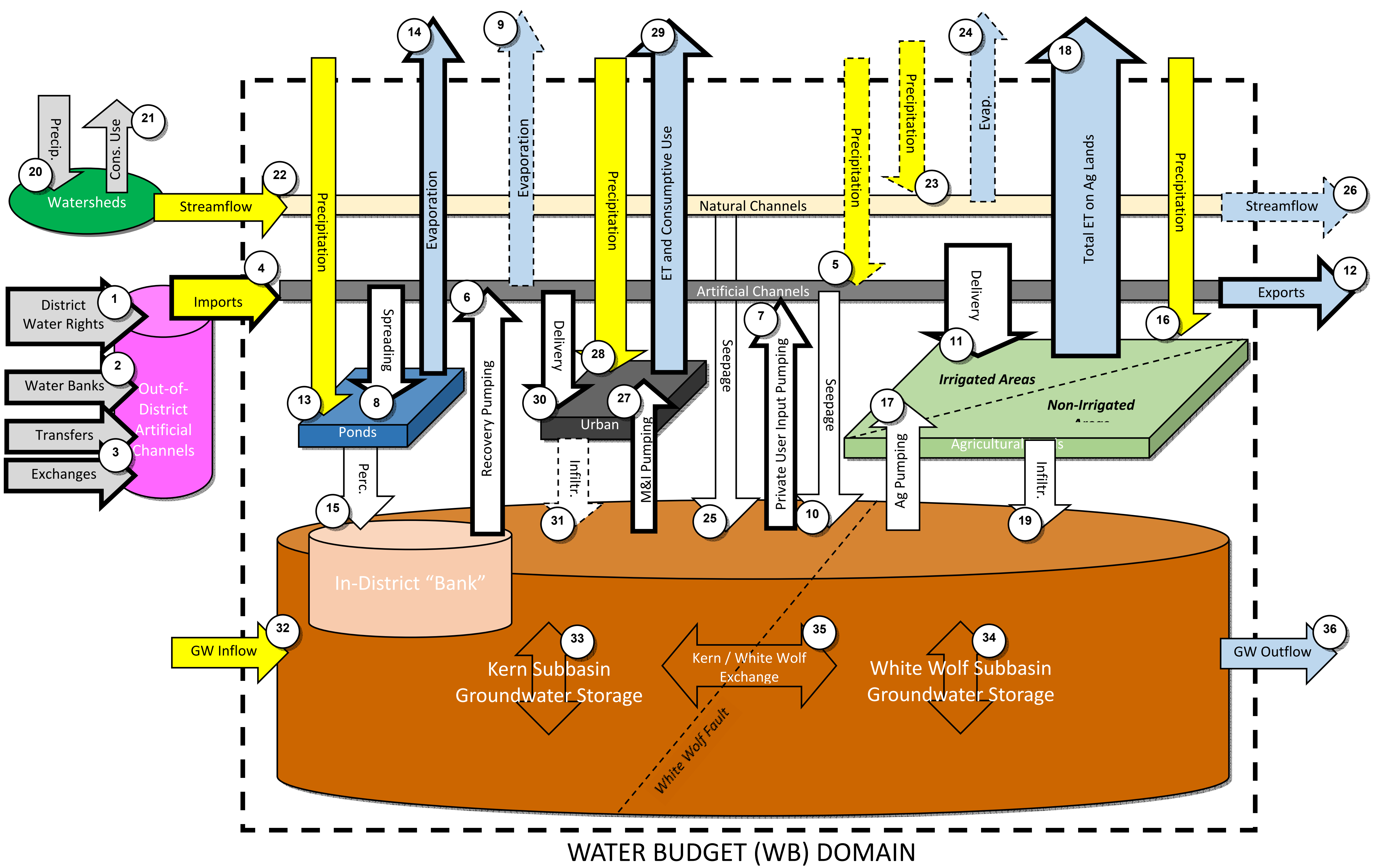
**Water Budget Domains and Subdomains**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-1**




Legend

- "Raw"
- Likely Negligible
- External
- Inflow to WB Domain
- Internal
- Outflow from WB Domain

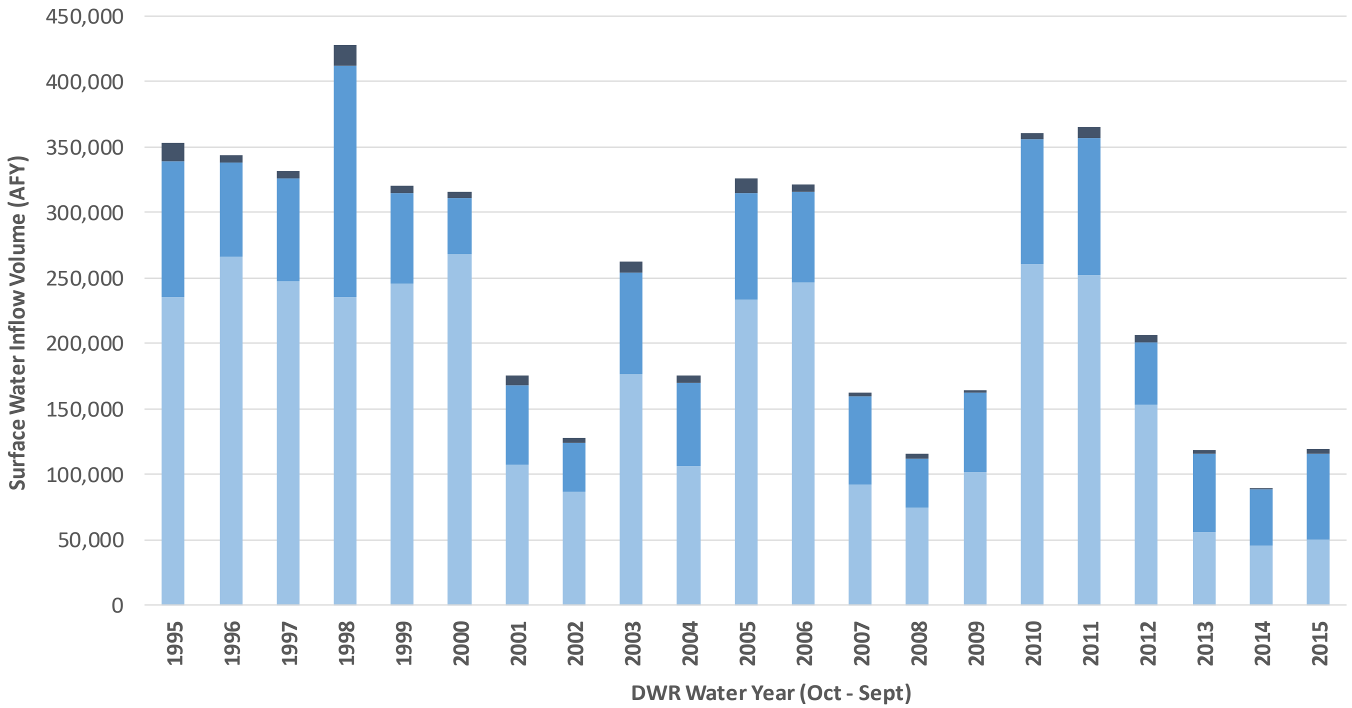
**Abbreviations:**

| | | |
|---|---|---|
| Ag | = | agricultural |
| Cons. | = | consumptive |
| Evap. | = | evaporation |
| ET | = | evapotranspiration |
| GW | = | groundwater |
| Infiltr. | = | infiltration |
| M&I | = | municipal & industrial |
| Perc. | = | percolation |
| Precip. | = | precipitation |
| WB | = | water budget |

**Conceptual Water Budget Components and Linkages**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-2**




Legend

= Surface Water Imports

= Direct Precipitation

= Streamflow into District

Abbreviations

AFY = acre-feet per year

DWR = California Department of Water Resources

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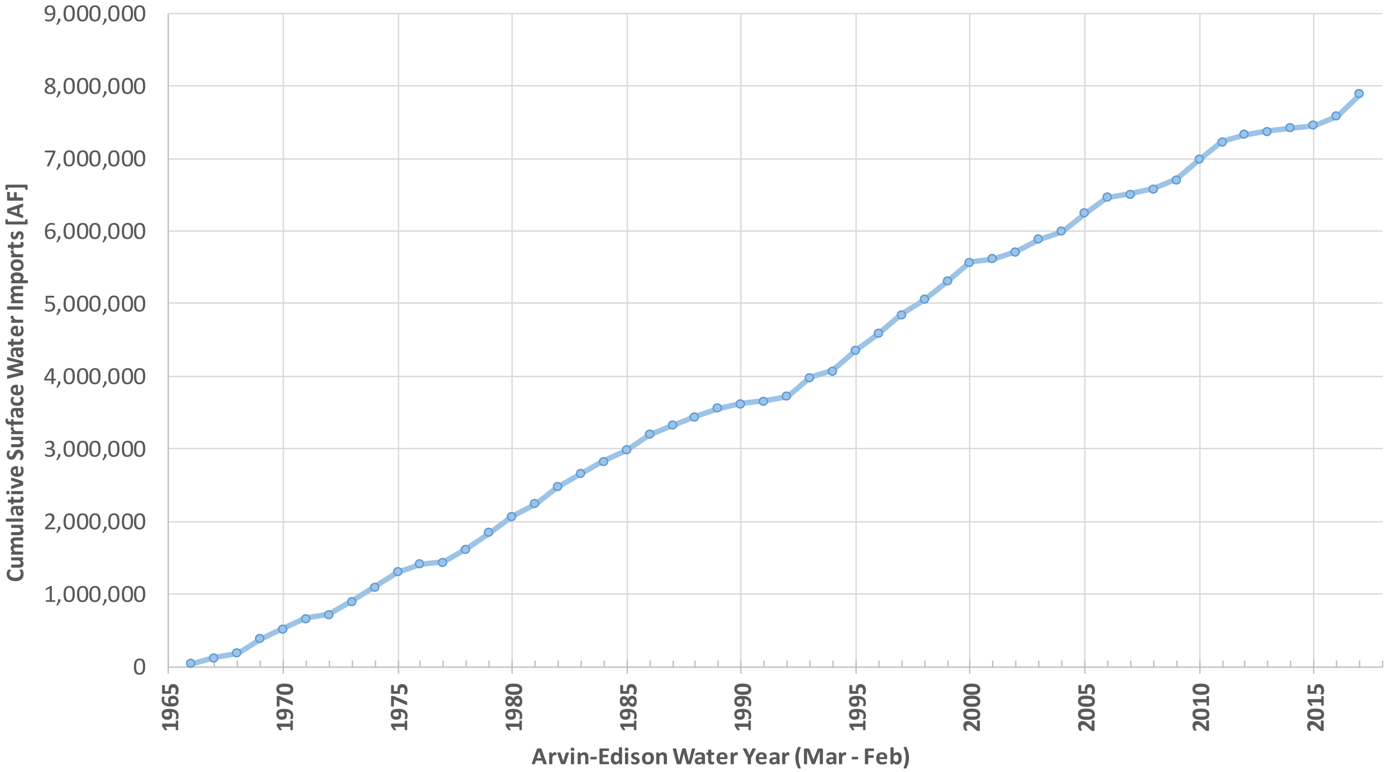
**Annual Surface Water Inflows by Source**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-3**



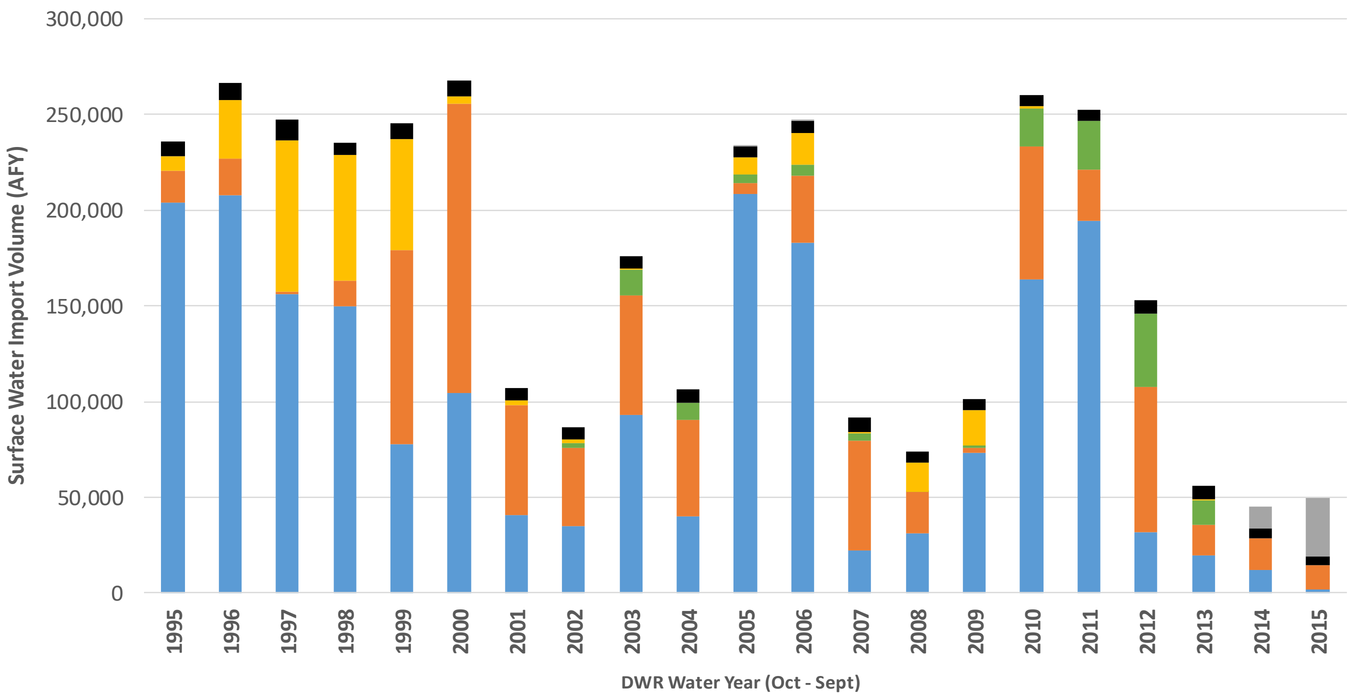

Abbreviations
AF = acre-feet

Notes
1. Annual volumes reported by Arvin-Edison Water Year, which extends March – February of the following year.

**Cumulative Surface Water Imports, 1996 - 2017**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-4**




Legend

= Friant-Kern Canal

= Cross Valley Canal

= California Aqueduct

= Kern River

= WRMWSD Deliveries to Overlap Areas

= Other

Abbreviations

AFY = acre-feet per year

WRMWSD = Wheeler Ridge-Maricopa Water Storage District

DWR = California Department of Water Resources

Notes

1. "Other" sources include wheeled surface water & groundwater from Kern Delta Water District.

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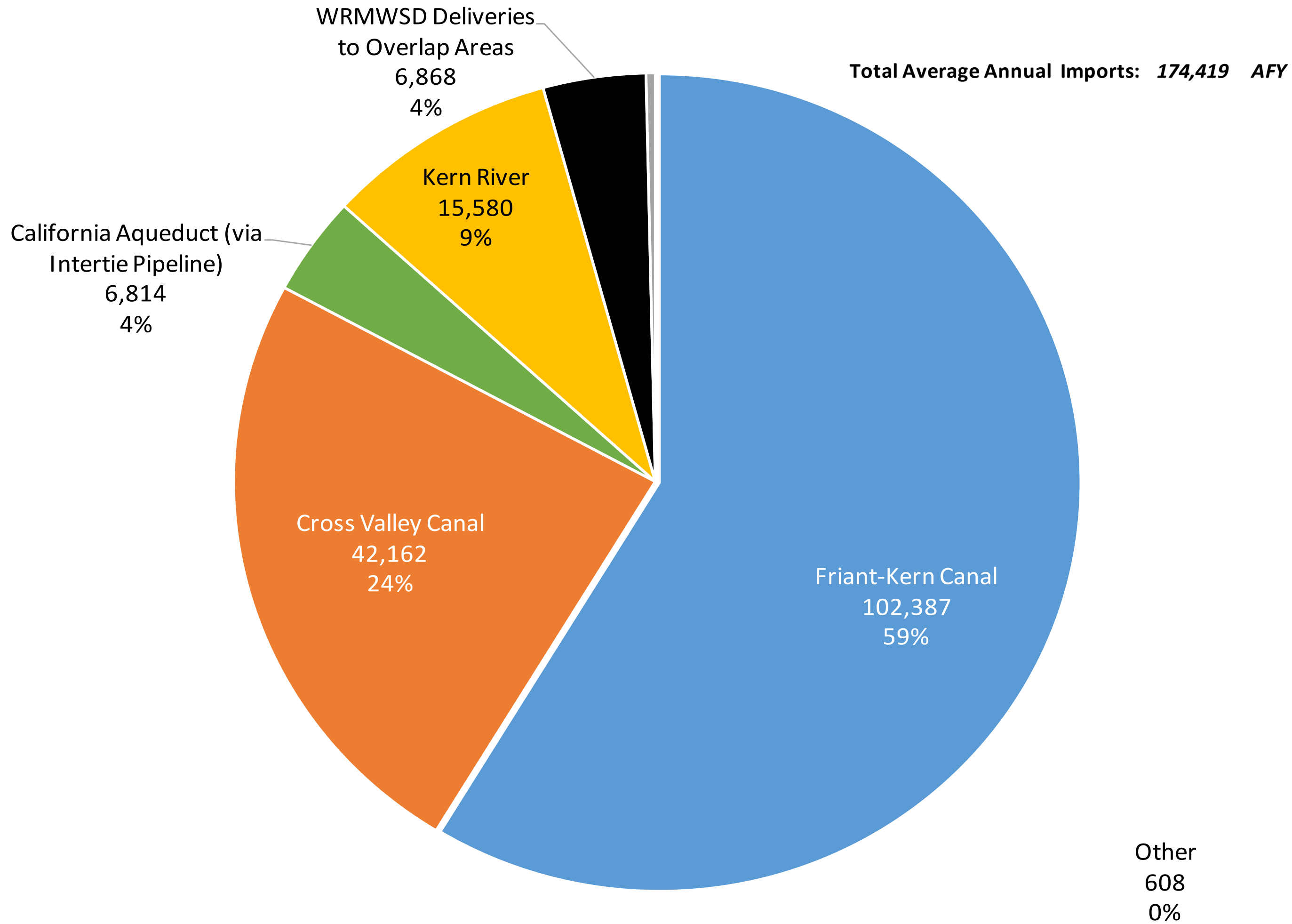
**Annual Surface Water Imports by Source**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-5**




Legend

- = Friant-Kern Canal
- = Cross Valley Canal
- = California Aqueduct
- = Kern River
- = WRMWSD Deliveries to Overlap Areas
- = Other

Abbreviations

AFY = acre-feet per year
WRMWSD = Wheeler Ridge-Maricopa Water Storage District
WY = Water Year

Notes

1. All values reported in acre-feet per year (AFY).

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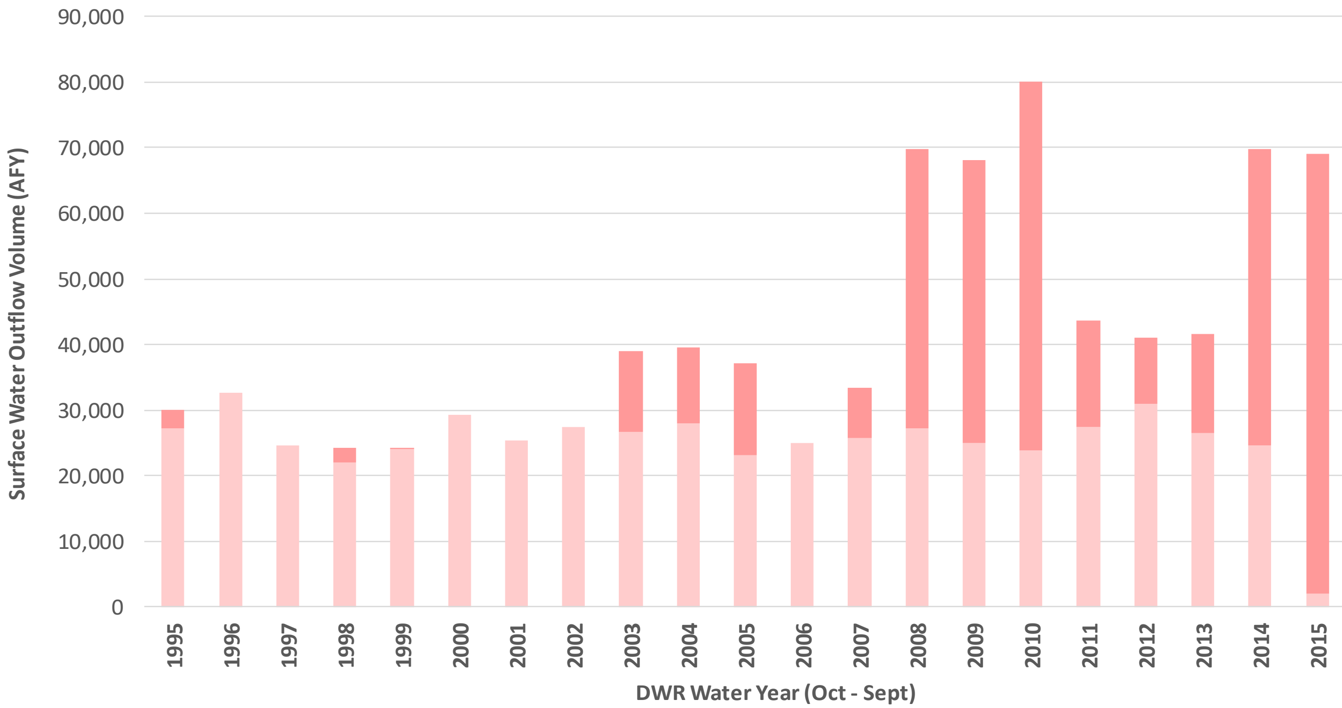
**Summary of Surface Water Import Sources, WY 1995 - 2014**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-6**




Legend

- = Deliveries to White Wolf Subbasin Customers
- = Exports to Metropolitan Water District

Abbreviations

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

Notes

1. Surface water outflows are blended in Arvin-Edison's delivery network before leaving the Kern Subbasin and on certain years may include a proportion of groundwater inputs from recovery banking operations.

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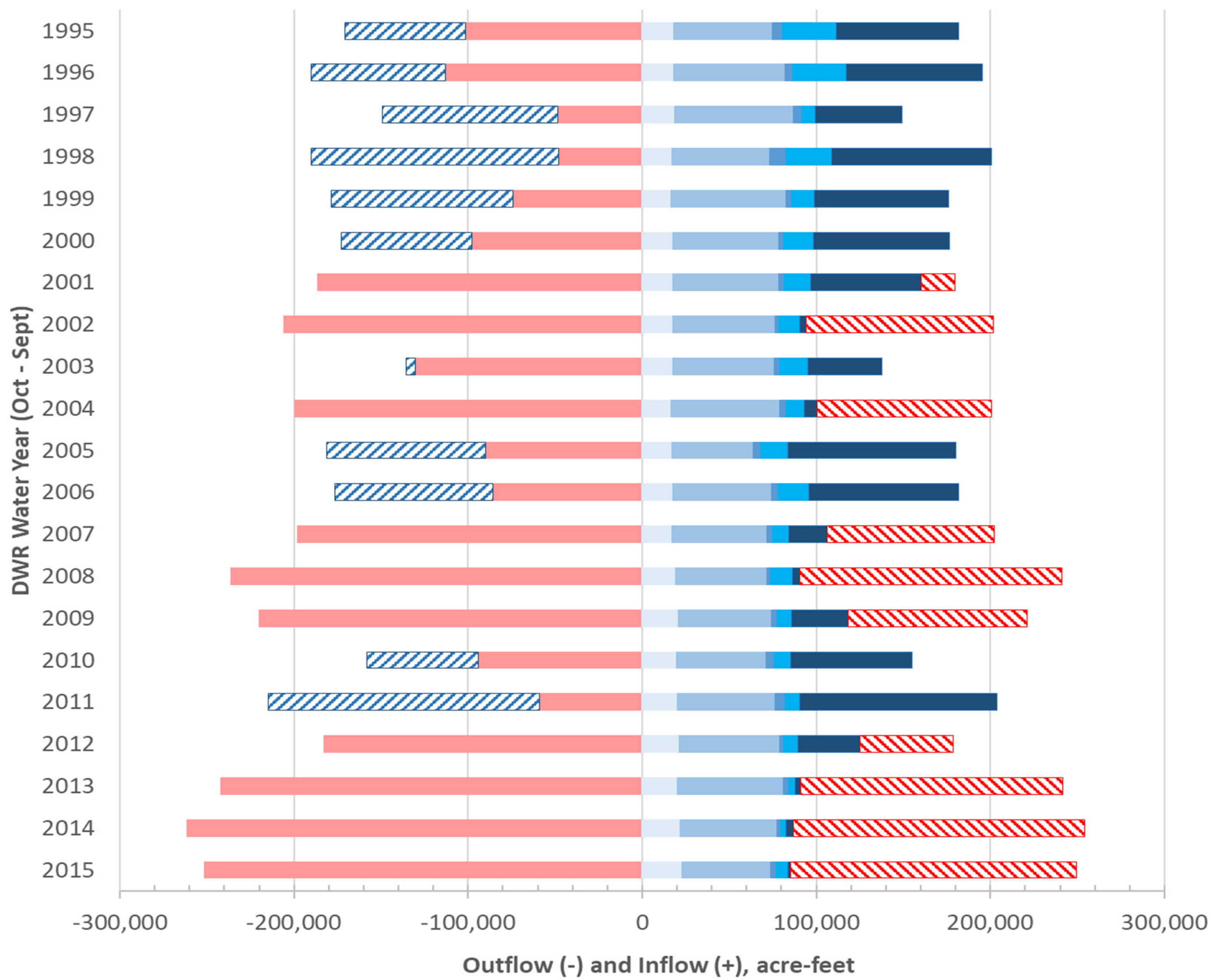
**Annual Surface Water Outflows by Source**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-7**




Legend

***Groundwater Inflows***

= Subsurface GW Inflow

= Infiltration of Applied Water

= Infiltration of Precipitation

= Infiltration from Surface Water Systems

= Recharge from Spreading Basins

***Groundwater Outflows***

= Groundwater Extraction

***Change in Groundwater Storage***

= Gain in GW Storage

= Reduction in GW Storage

Abbreviations

DWR = California Department of Water Resources

GW = groundwater

Notes

1. "Groundwater Extraction" includes all District, private, and municipal & industrial groundwater pumping.

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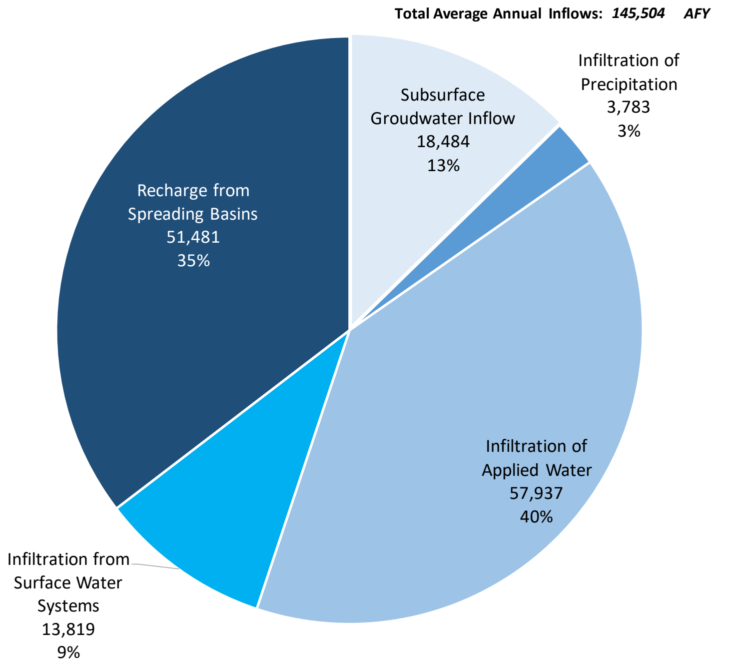
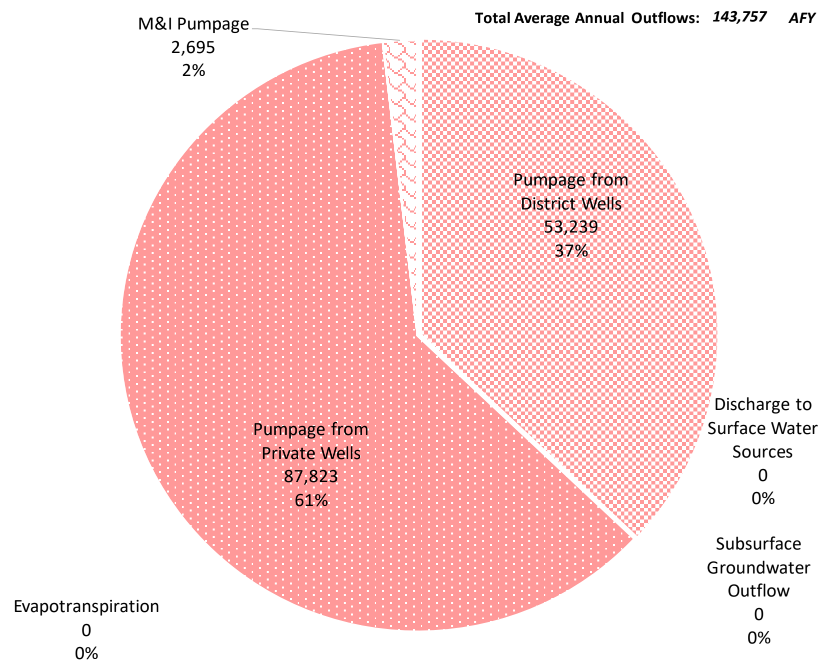
**Annual Groundwater Inflows and Outflows**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-8**




Legend

***Groundwater Inflows***

= Subsurface GW Inflow
= Infiltration of Applied Water
= Infiltration of Precipitation
= Infiltration from Surface Water Systems
= Recharge from Spreading Basins

***Groundwater Outflows***

= Groundwater Extraction

Abbreviations

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

Notes

1. All values reported in acre-feet per year (AFY).
2. “Groundwater Extraction” includes all District, private, and municipal & industrial groundwater pumping.

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**Summary of Groundwater Inflows & Outflows, WY 1995 - 2014**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-9**


Abbreviations

AFY = acre-feet per year

Notes

1. "Seasonal high" condition is defined as March – February of the following year.
2. Annual groundwater change between "seasonal highs" of 2015 – 2016 only includes March – December 2015.

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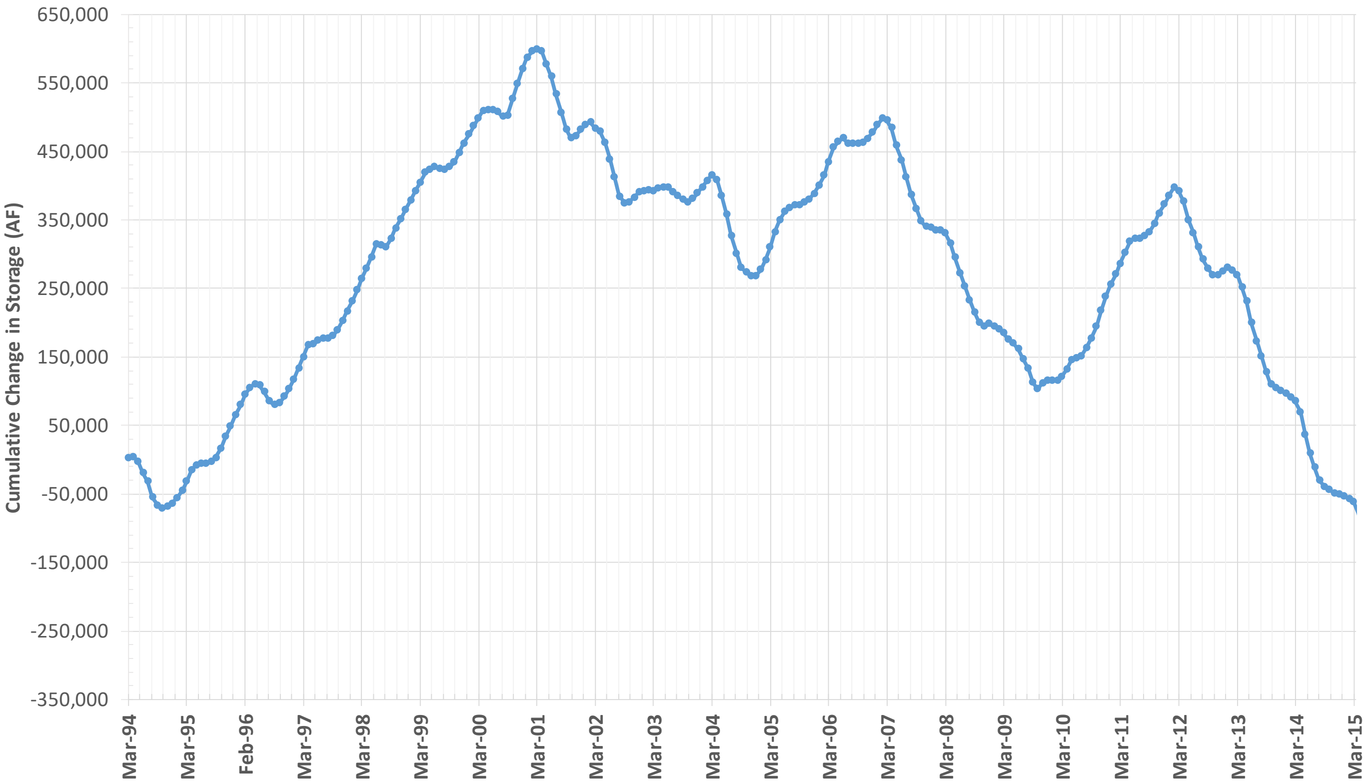
**Annual Change in Storage**
**Between Seasonal Highs**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-10**




Abbreviations

AF = acre-feet

Notes

1. Values represent cumulative change in storage since the “seasonal high” condition of March 1994.

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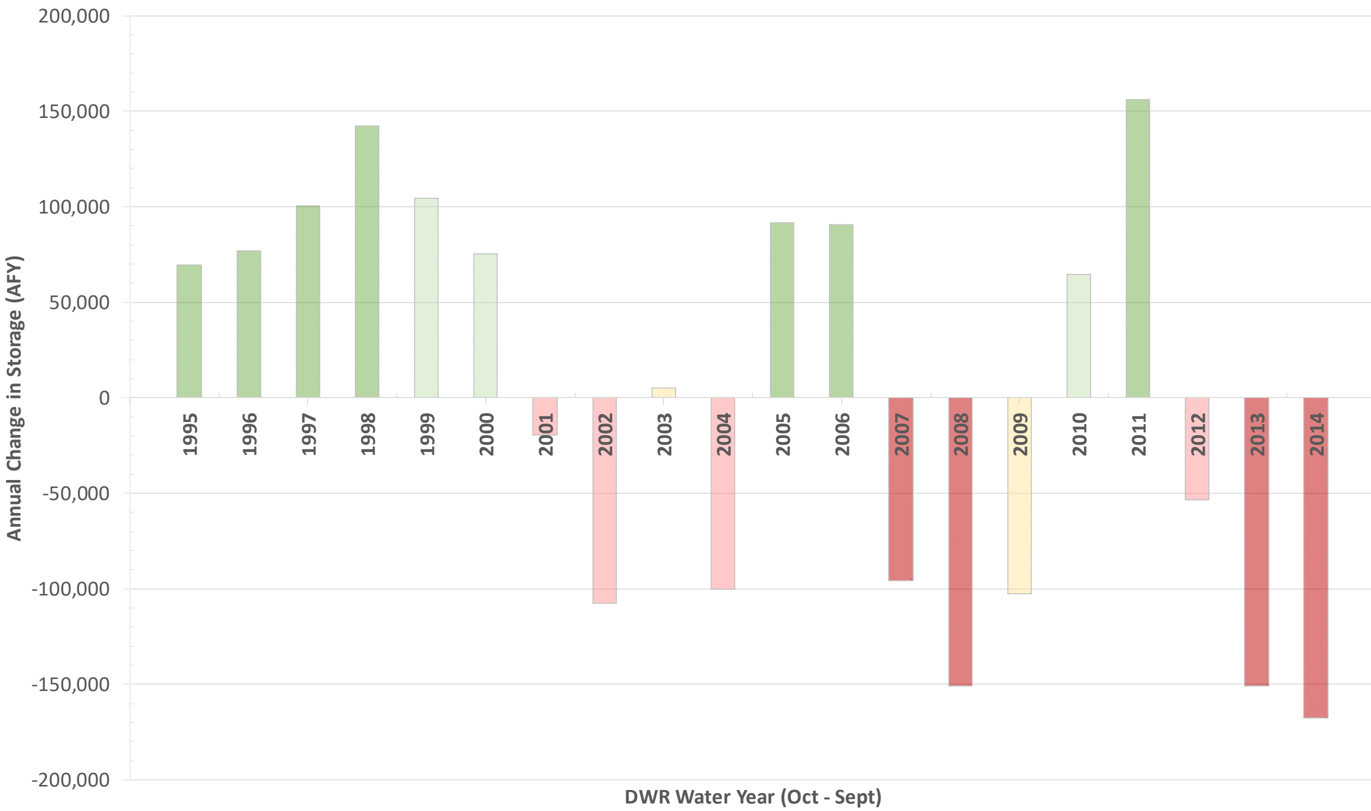
**Cumulative Change in Storage, March 1994 - February 2015**

**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-11**




Legend

***DWR Water Year Type***

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

Abbreviations

AFY = acre-feet per year

Sources

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

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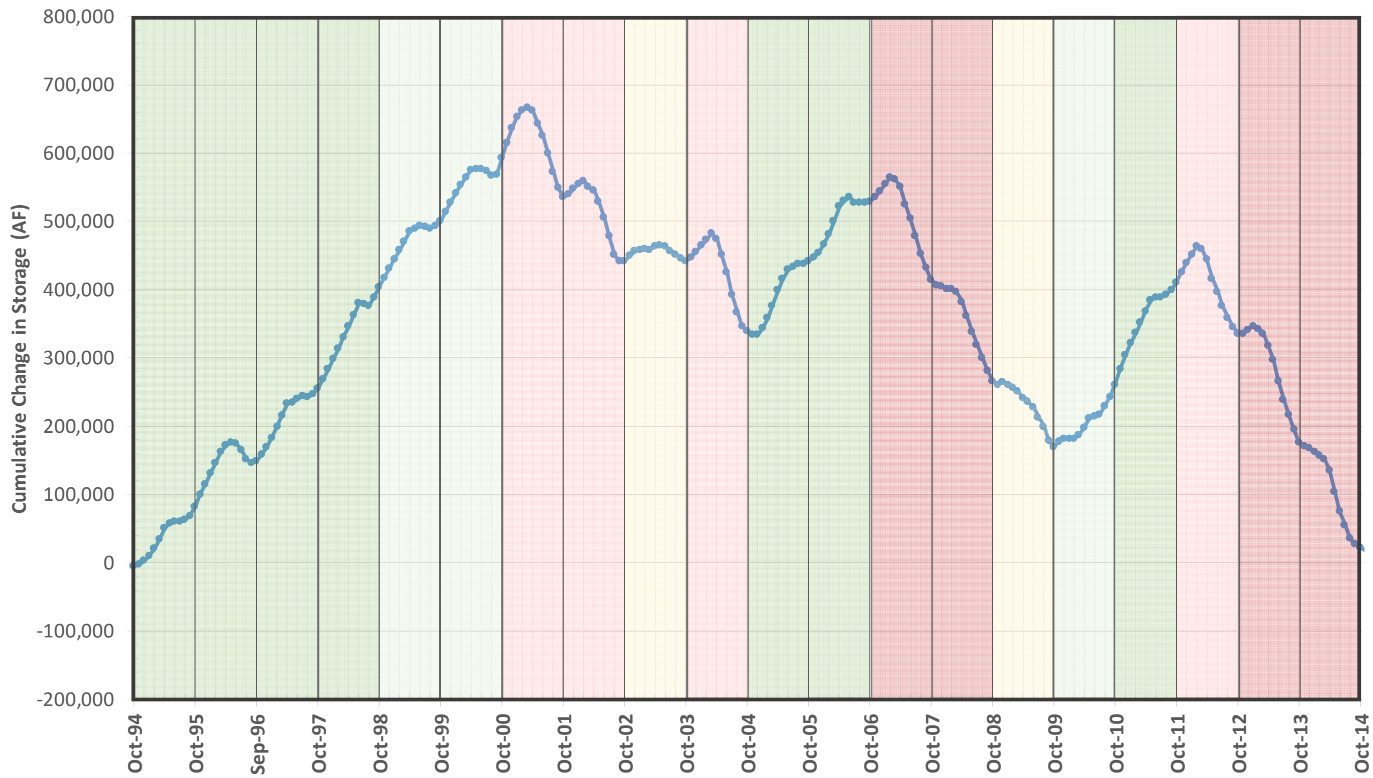
**Annual Change in Storage vs. DWR Water Year Type Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-12**




Legend

***DWR Water Year Type***

= Wet

= Above Normal

= Below Normal

= Dry

= Critical

Abbreviations

AF = acre-feet

Sources

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

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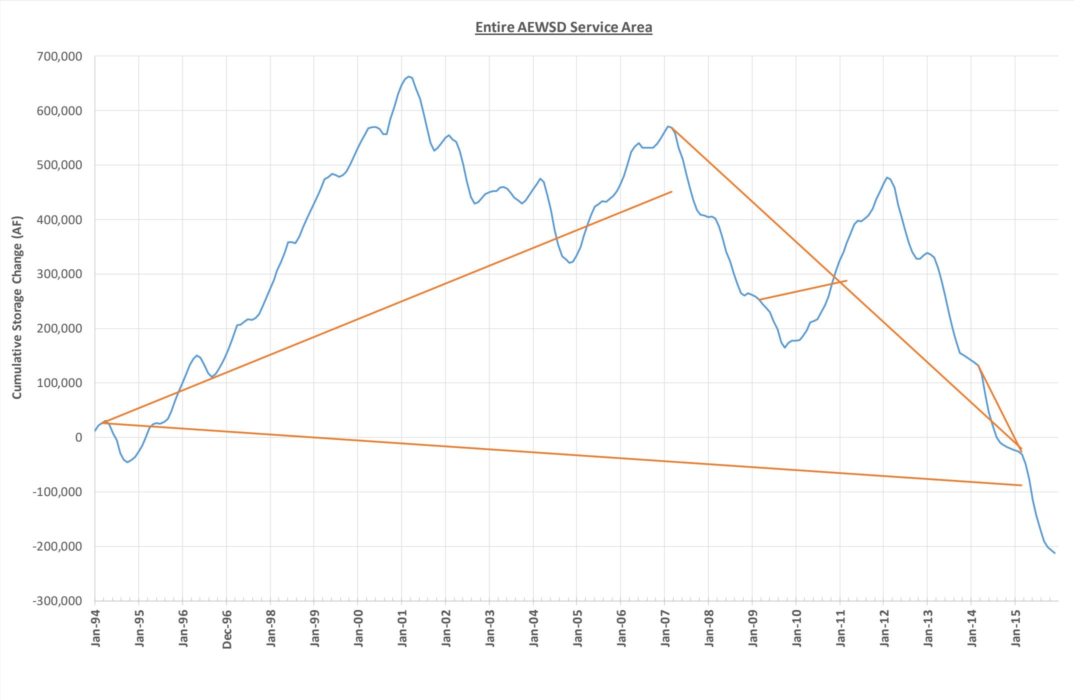
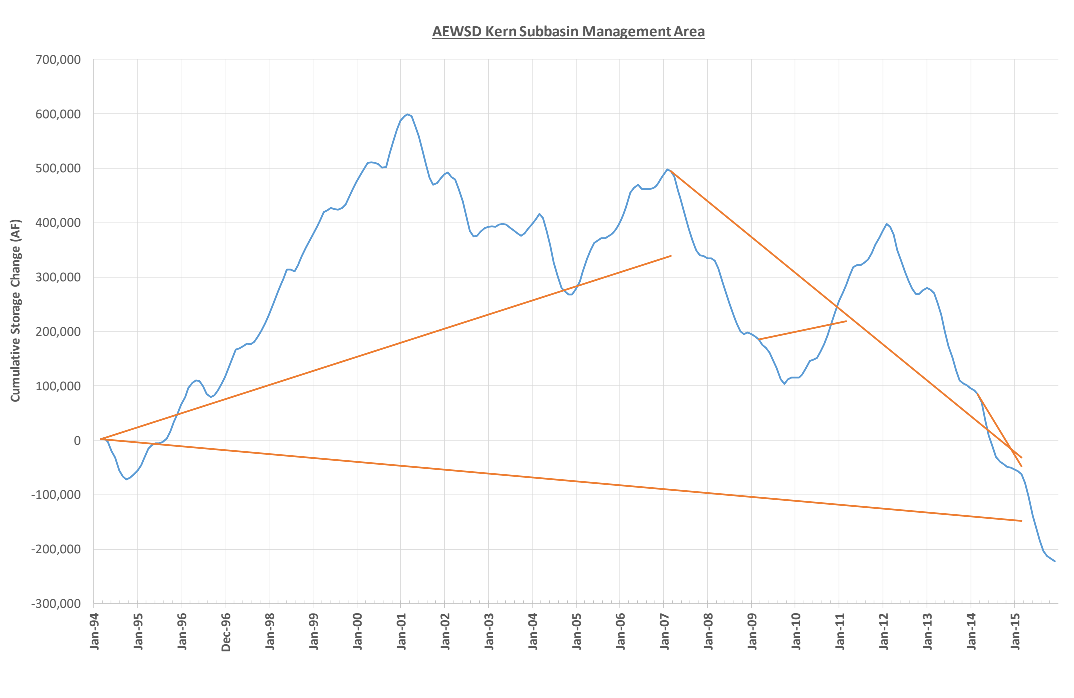
**Cumulative Change in Storage vs. DWR Water Year Type**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-13**




Legend

= Raster-Based Estimated Change In Storage (AF)

= Water Budget Spreadsheet Model-Calculated Change In Storage (AF)

Abbreviations

AF = acre-feet

Notes

1. Calibration of the water budget spreadsheet model was performed for the District's entire service area, including the portion within the White Wolf Subbasin.

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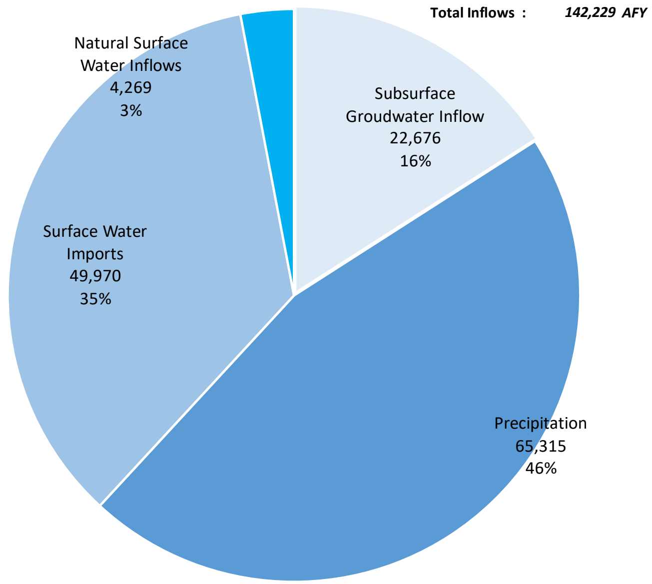
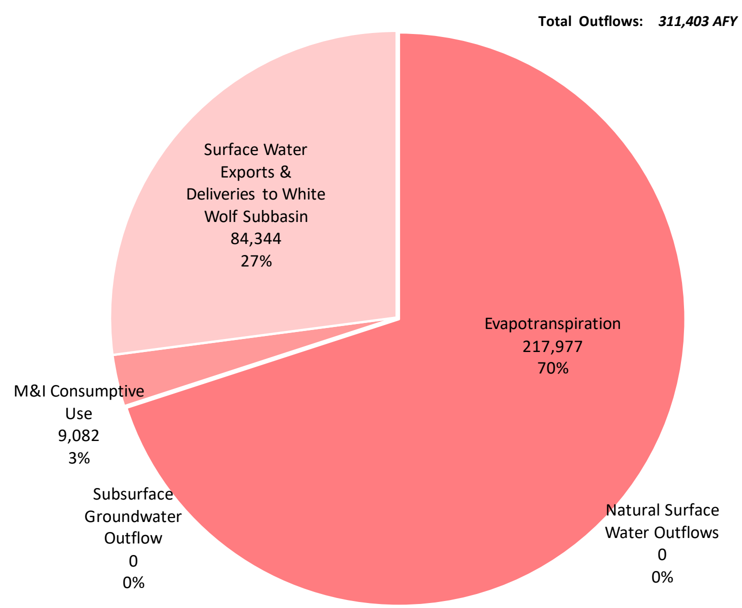
**Comparison of Modeled & Water Level-Based Estimated Change in Storage Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-14**




Legend

***Inflows***

= Subsurface GW Inflow

= Surface Water Imports

= Precipitation

= Natural Surface Water Inflows

***Outflows***

= Surface Water Exports & Deliveries to WWB

= M&I Consumptive Use

= Evapotranspiration

Abbreviations

AFY = acre-feet per year
GW = groundwater
M&I = municipal & industrial
WWB = White Wolf Subbasin
WY = Water Year

Notes

1. All values reported in acre-feet per year (AFY).

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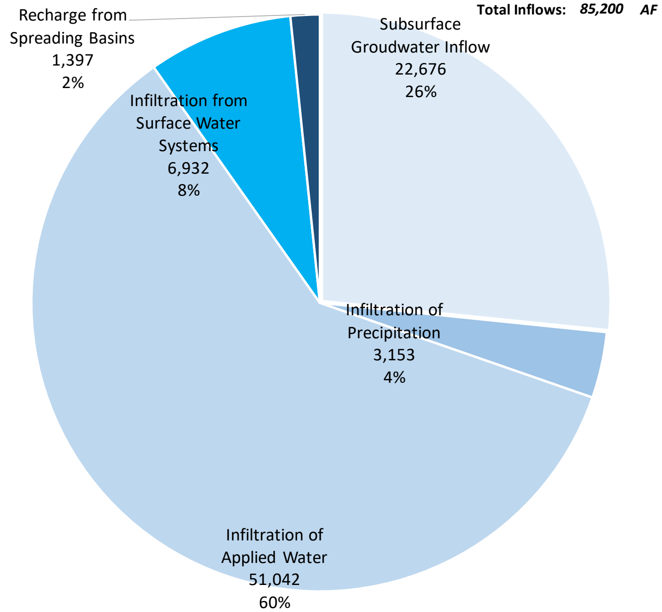
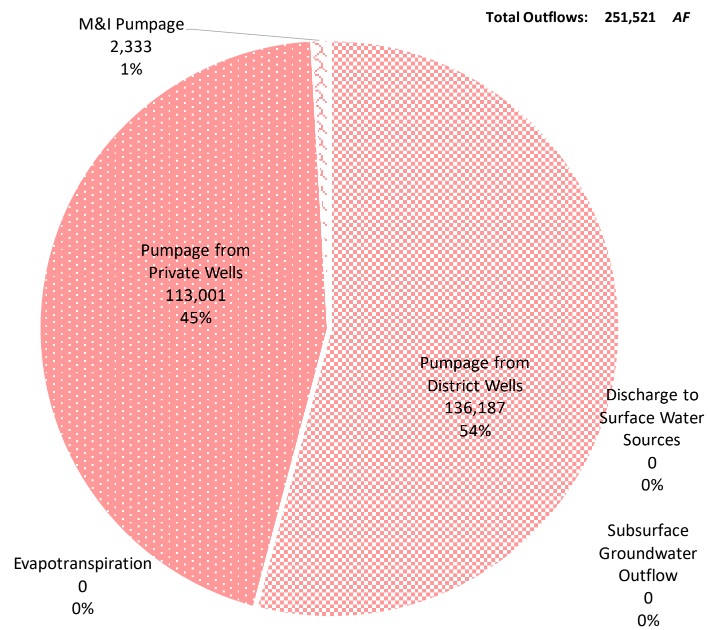
**Summary of Total Inflows & Outflows, WY 2015**
**Arvin-Edison Management Area**
South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-15**




Legend

***Groundwater Inflows***

= Subsurface GW Inflow

= Infiltration of Applied Water

= Infiltration of Precipitation

= Infiltration from Surface Water Systems

= Recharge from Spreading Basins

***Groundwater Outflows***

= Groundwater Extraction

Abbreviations

AF = acre-feet

GW = groundwater

WY = Water Year

Notes

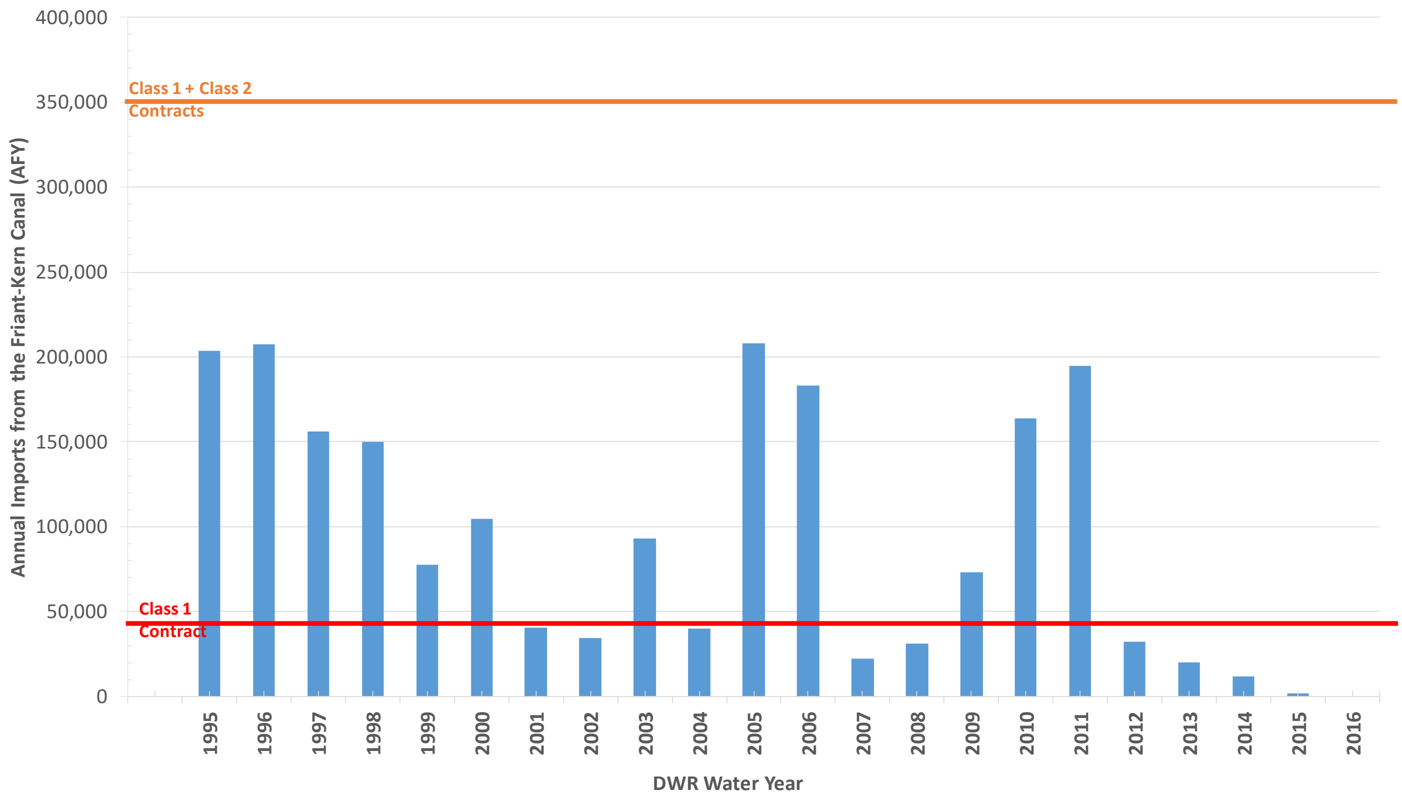
1. All values reported in acre-feet (AF).
2. “Groundwater Extraction” includes all District, private, and municipal & industrial groundwater pumping.

eki environment & water

**Summary of Groundwater Inflows & Outflows, WY 2015**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-16**




Legend

= Friant-Kern Annual Imports

= Class 1 Contract

= Class 1 + Class 2 Contract

Abbreviations

AFY = acre-feet per year

DWR = California Department of Water Resources

Notes

1. AEWSD's Class 1 Contract is 40,000 AFY.
2. AEWSD's Class 2 Contract is 311,675 AFY.

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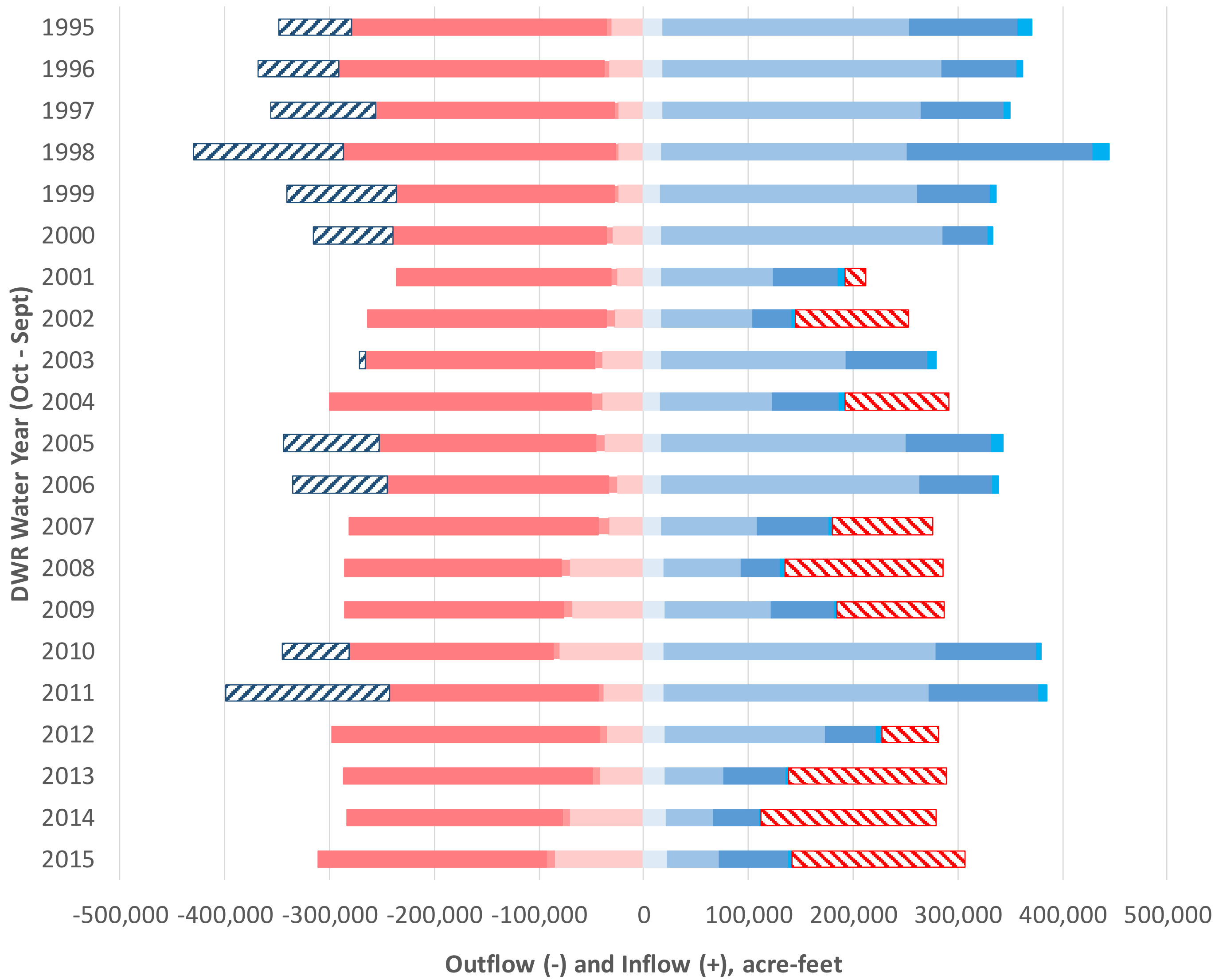
**Annual Friant-Kern Imports vs. Contracted Supplies**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-17**




<u>Legend</u>

***Inflows***

= Subsurface GW Inflow

= Surface Water Imports

= Precipitation

= Natural Surface Water Inflows

***Outflows***

= Surface Water Exports & Deliveries to WWB

= M&I Consumptive Use

= Evapotranspiration

***Change in Groundwater Storage***

= Gain in GW Storage

= Reduction in GW Storage

<u>Abbreviations</u>

DWR = California Department of Water Resources
GW = groundwater
M&I = municipal & industrial
WWB = White Wolf Subbasin

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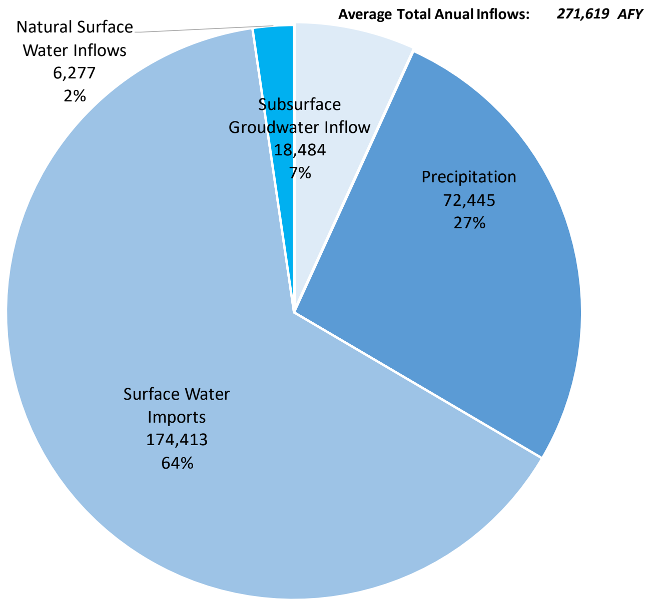
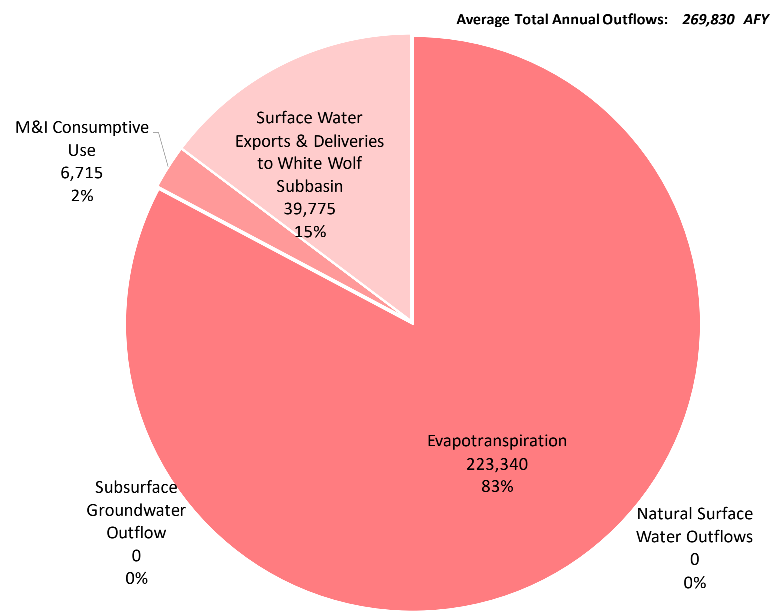
**Annual Inflows & Outflows**
**Arvin-Edison Management Area**
South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-18**




Legend

***Inflows***

- = Subsurface GW Inflow
- = Surface Water Imports
- = Precipitation
- = Natural Surface Water Inflows

***Outflows***

- = Surface Water Exports & Deliveries to WWB
- = M&I Consumptive Use
- = Evapotranspiration

Abbreviations

AFY = acre-feet per year
GW = groundwater
M&I = municipal & industrial
WWB = White Wolf Subbasin
WY = Water Year

Notes

1. All values reported in acre-feet per year (AFY).

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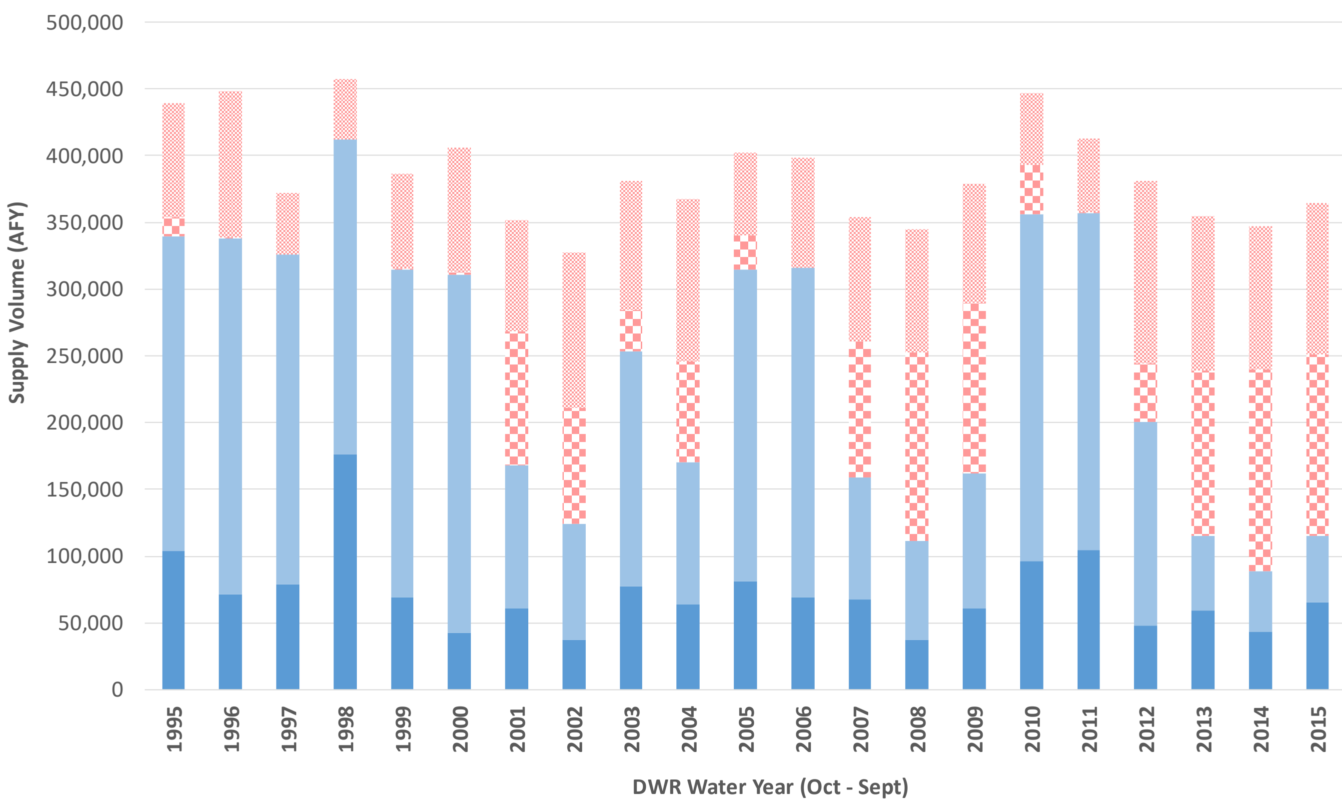
**Summary of Total Inflows & Outflows, WY 1995 - 2014**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-19**




Legend

= Precipitation

= Surface Water Imports

= District Pumpage

= Private Pumpage

Abbreviations

AFY = acre-feet per year

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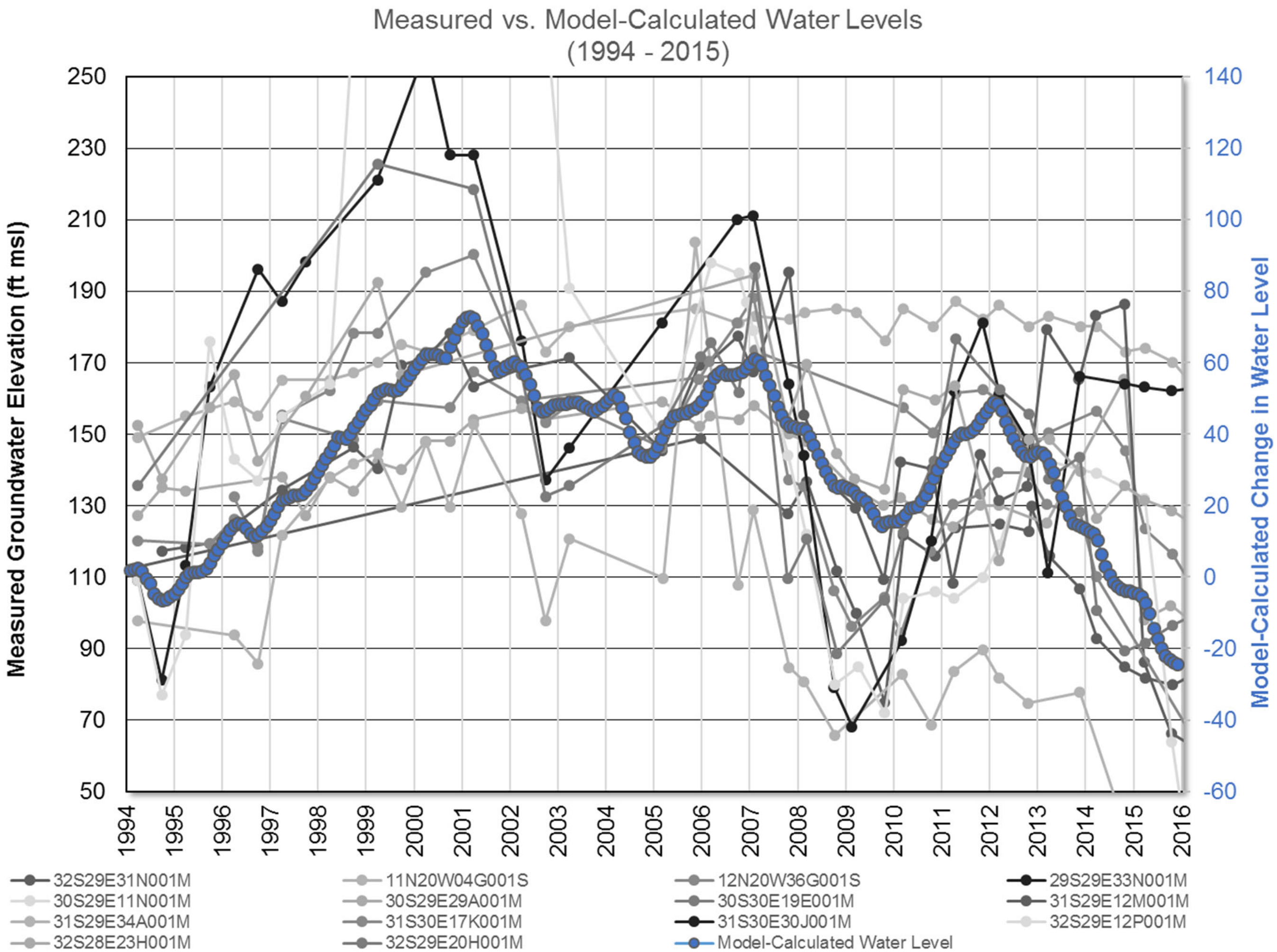
**Water Supply Portfolio and Annual Precipitation, WY 1995 - 2015**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-20**




Legend

= Measured Water Level

= Water Budget Spreadsheet Model-Calculated Change In Water Level (ft)

Abbreviations

| | |
|---|---|
| ft | = feet |
| ft msl | = feet above mean sea level |
| WY | = Water Year |

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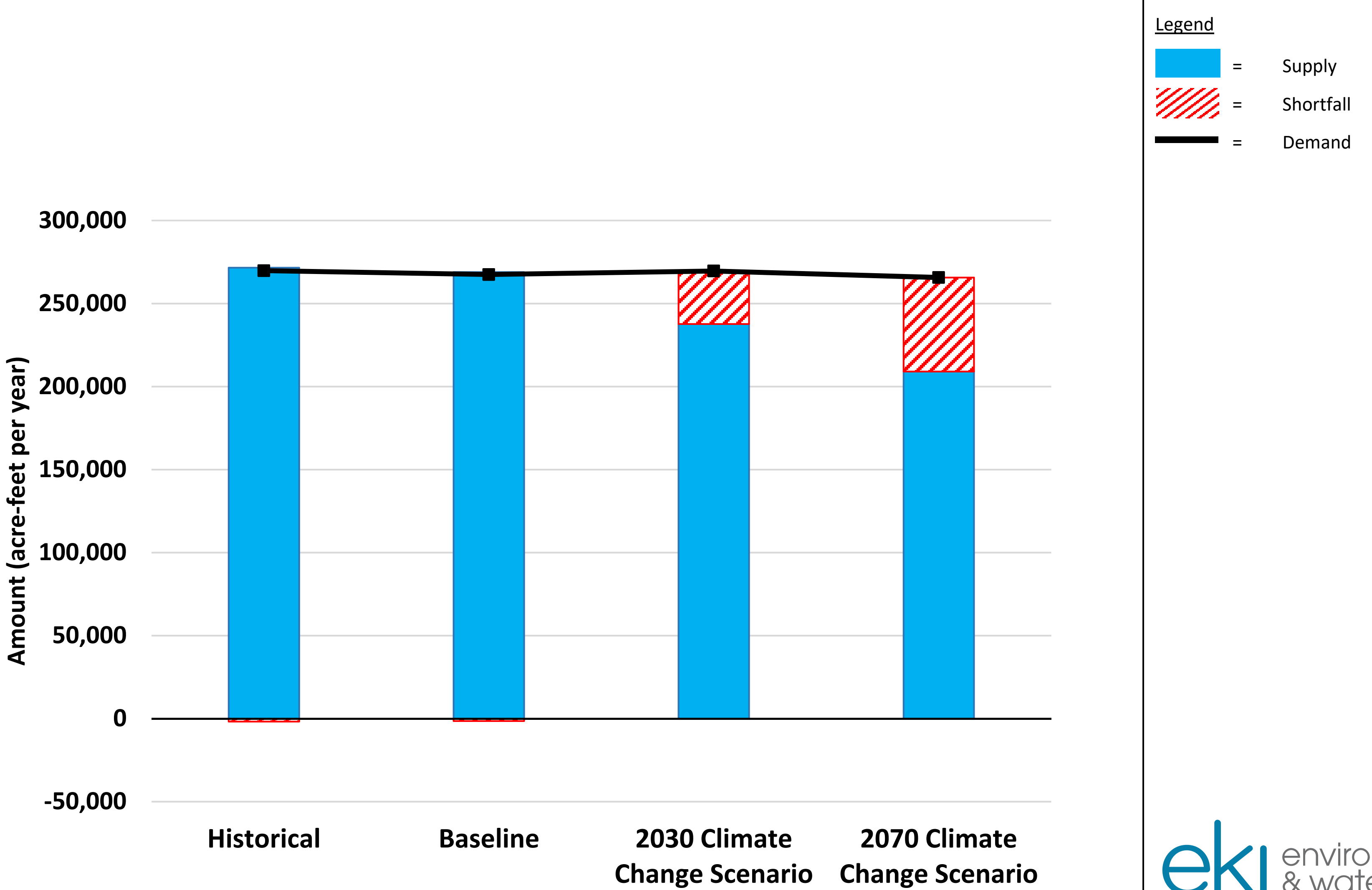
**Observed vs. Modeled Change in Water Levels, WY 1995 - 2015**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

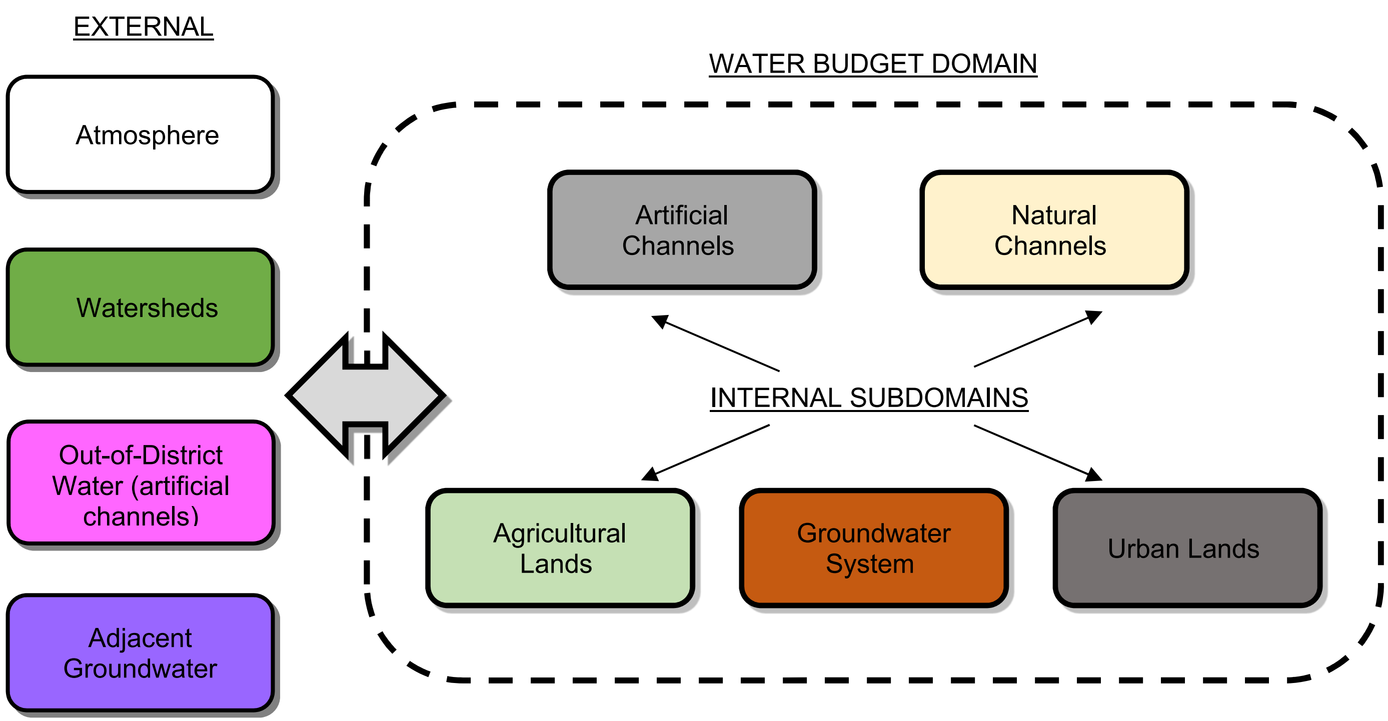
**Figure WB-21**




**Projected Water Budget Supplies, Demands, and Shortfall Before Project & Management Action Implementation Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-22**

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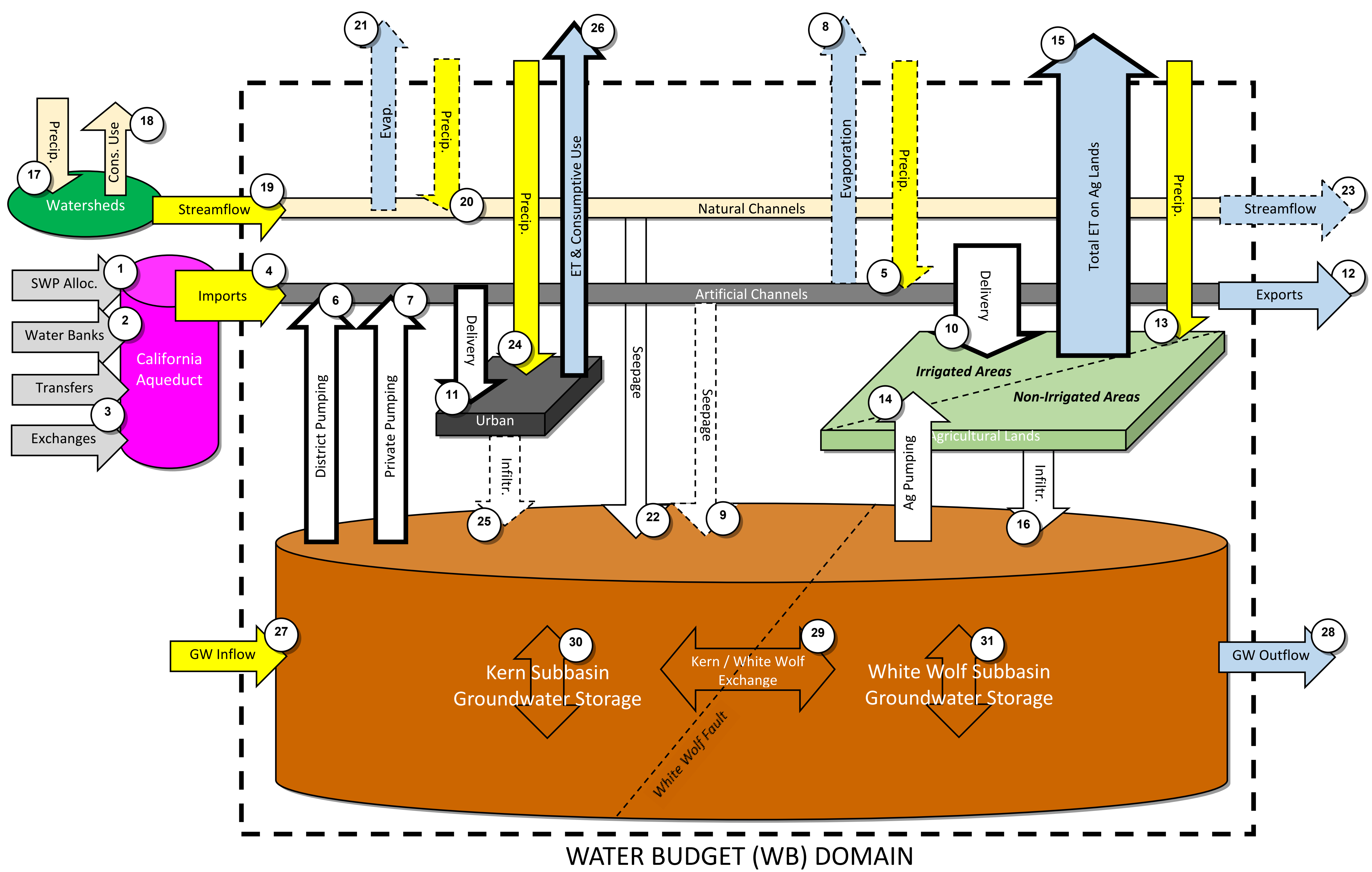
**Water Budget Domains and Subdomains**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-23**




Legend

- "Raw"
- Likely Negligible
- External
- Inflow to WB Domain
- Internal
- Outflow from WB Domain
- Currently Not Estimated in WB

**Abbreviations:**

| | | |
|---|---|---|
| Ag | = | agricultural |
| Cons. | = | consumptive |
| Evap. | = | evaporation |
| ET | = | evapotranspiration |
| GW | = | groundwater |
| Infiltr. | = | infiltration |
| M&I | = | municipal & industrial |
| Perc. | = | percolation |
| Precip. | = | precipitation |
| WB | = | water budget |

**Notes:**

1. Components 4-28 are further parsed into their respective contributions to the Kern and White Wolf Subbasins within the water budget.

**Water Budget Flow Components**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

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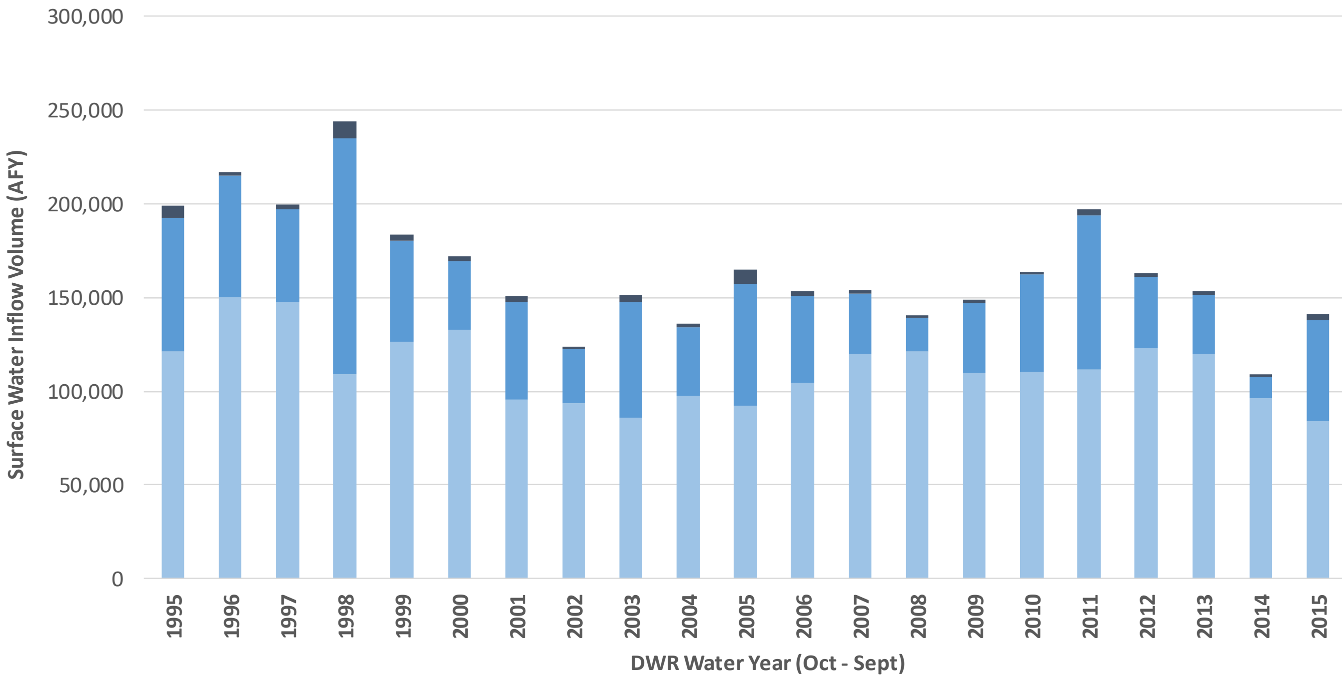
**Figure WB-24**




Legend

= Surface Water Imports

= Direct Precipitation

= Streamflow into District

Abbreviations

AFY = acre-feet per year

DWR = California Department of Water Resources

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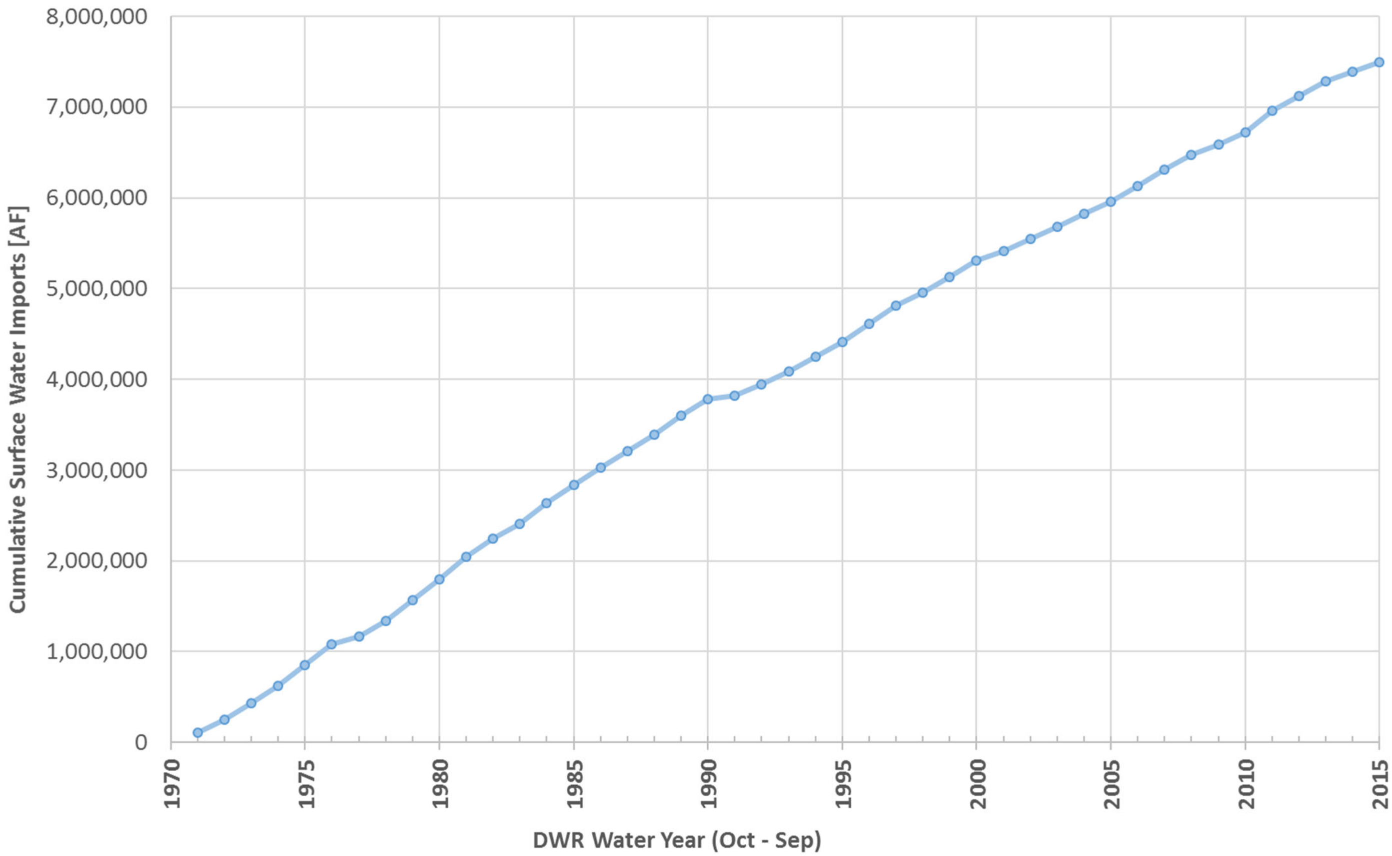
**Annual Surface Water Inflows by Source**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-25**




Abbreviations

AF = acre-feet

DWR = California Department of Water Resources

Notes

1. Annual volumes reported by DWR Water Year, which extends October (of the previous year) – September.

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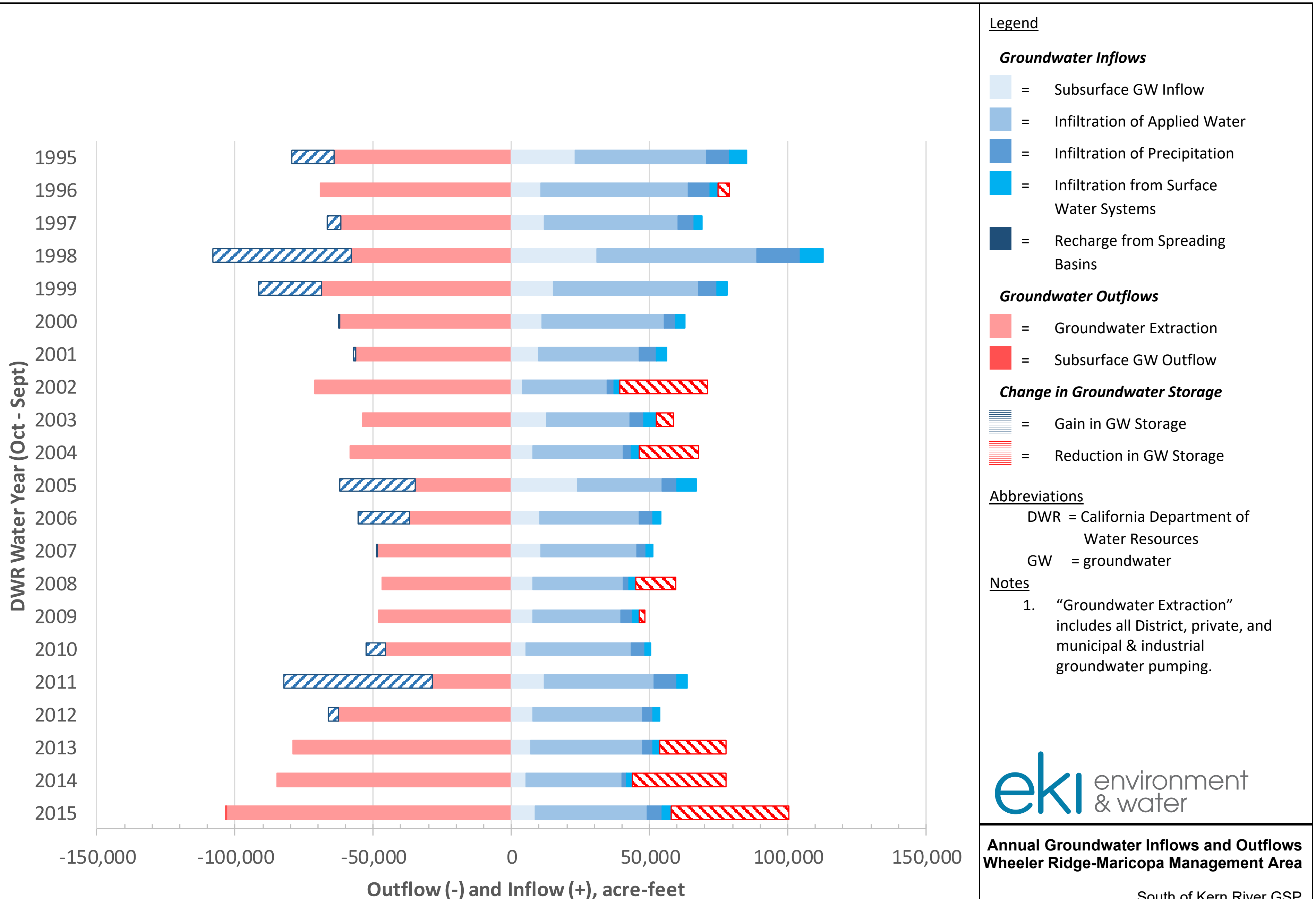
**Cumulative Surface Water Imports, 1971 - 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-26**

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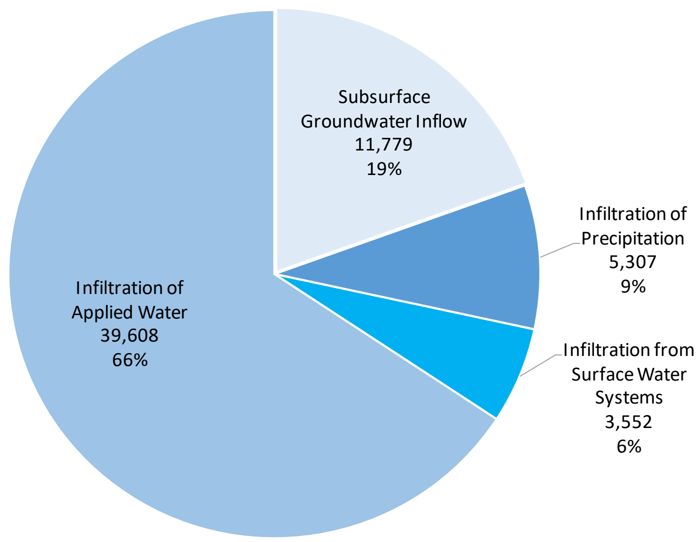
**Annual Groundwater Inflows and Outflows**
**Wheeler Ridge-Maricopa Management Area**

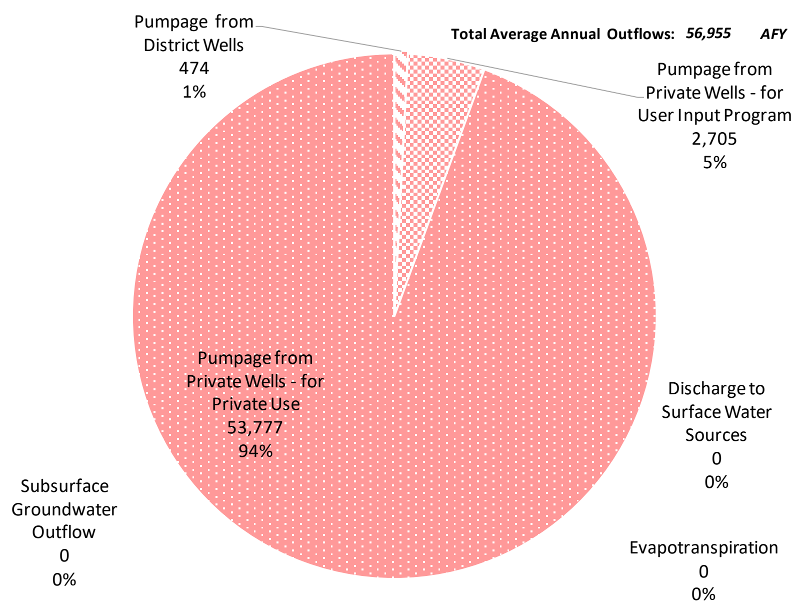
South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-27**

Total Average Annual Inflows: *60,247* *AFY*




Total Average Annual Outflows: *56,955* *AFY*




Legend

***Groundwater Inflows***

= Subsurface GW Inflow

= Infiltration of Applied Water

= Infiltration of Precipitation

= Infiltration from Surface Water Systems

= Recharge from Spreading Basins

***Groundwater Outflows***

= Groundwater Extraction

= Subsurface GW Outflow

***Change in Groundwater Storage***

= Gain in GW Storage

= Reduction in GW Storage

Abbreviations

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

Notes

1. All values reported in acre-feet per year (AFY).
2. "Groundwater Extraction" includes all District and private groundwater pumping.

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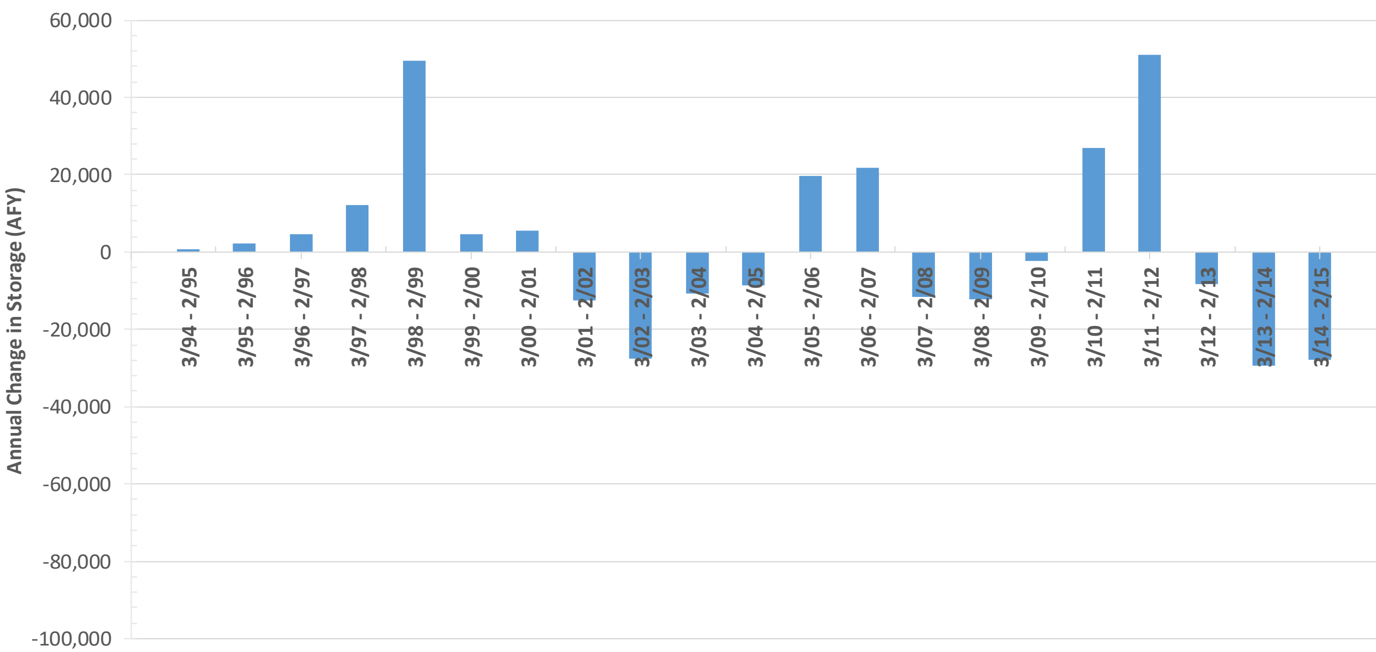
**Summary of Groundwater Inflows & Outflows, WY 1995 - 2014**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-28**




Abbreviations

AFY = acre-feet per year

Notes

1. "Seasonal high" condition is defined as March – February of the following year.

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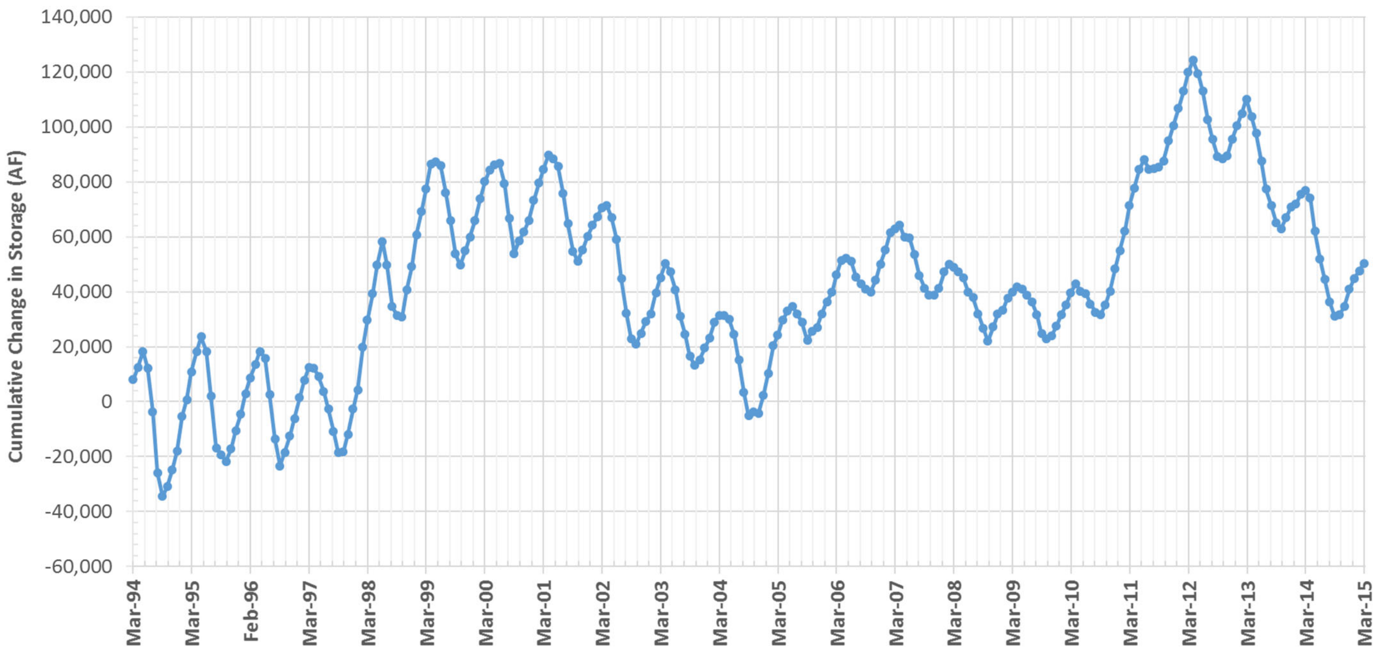
**Annual Change in Storage Between Seasonal Highs**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-29**




Abbreviations

AF = acre-feet

Notes

1. Values represent cumulative change in storage since the "seasonal high" condition of March 1994.

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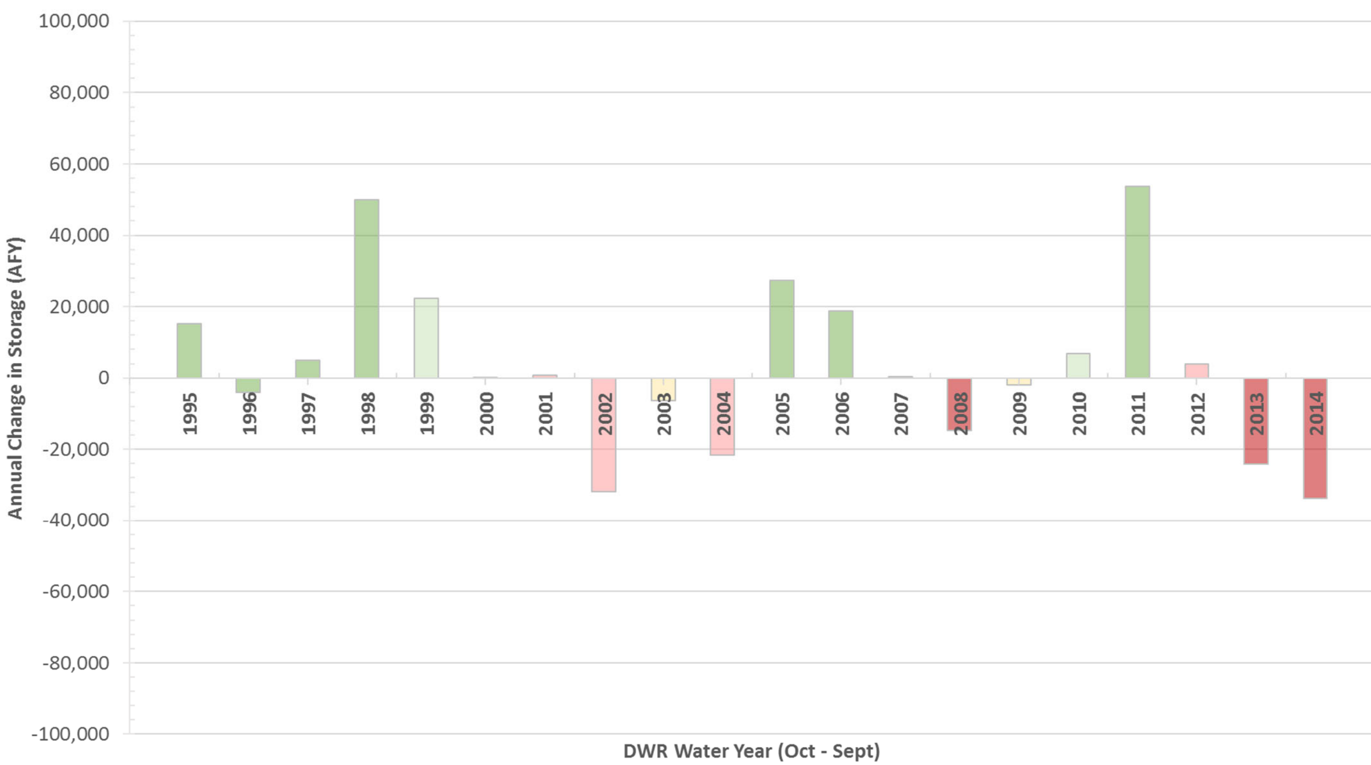
**Cumulative Change in Storage, March 1994 - February 2015**

**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-30**




Legend

***DWR Water Year Type***

= Wet

= Above Normal

= Below Normal

= Dry

= Critical

Abbreviations

AFY = acre-feet per year

Sources

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

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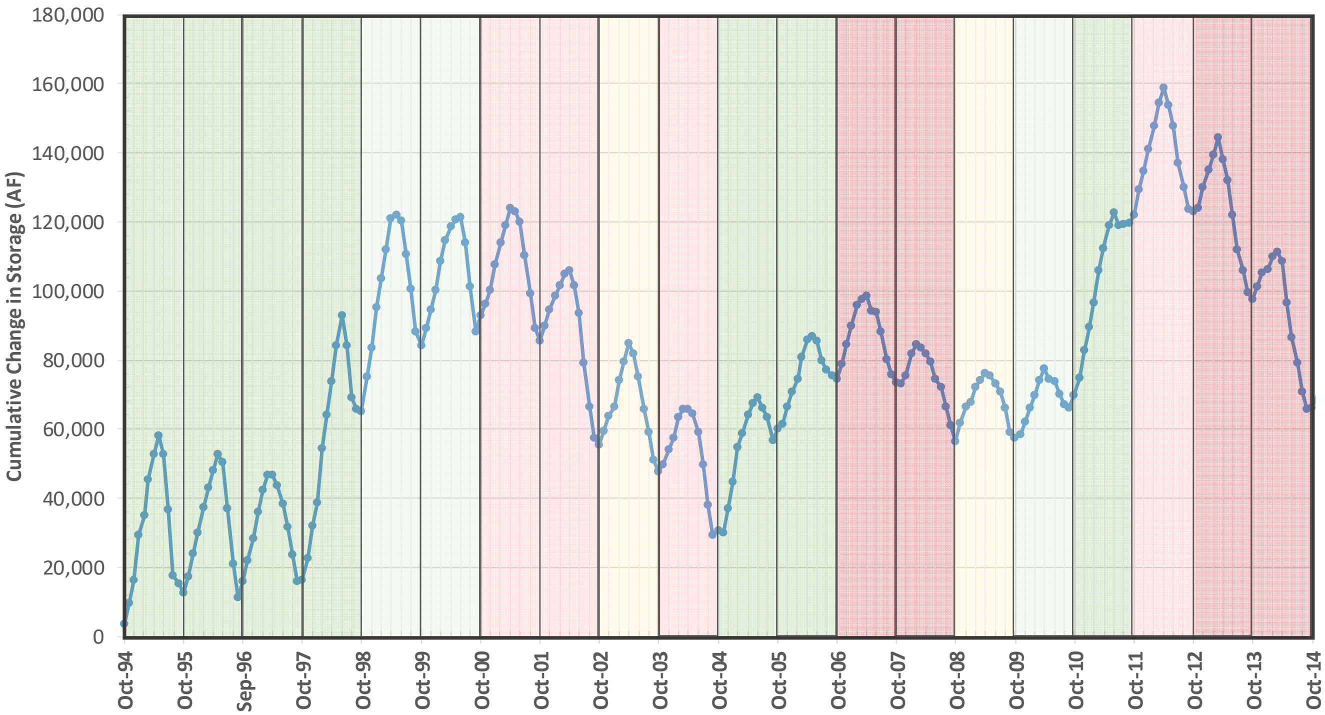
**Annual Change in Storage vs.**
**DWR Water Year Type**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-31**




Legend

***DWR Water Year Type***

= Wet

= Above Normal

= Below Normal

= Dry

= Critical

Abbreviations

AF = acre-feet

Sources

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

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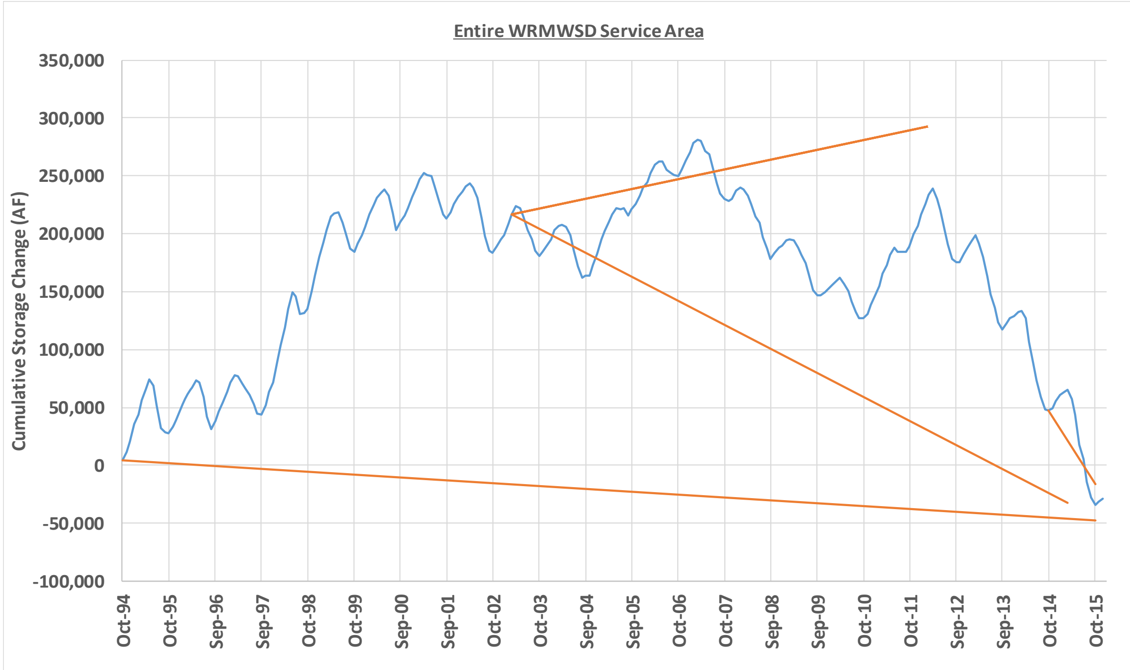
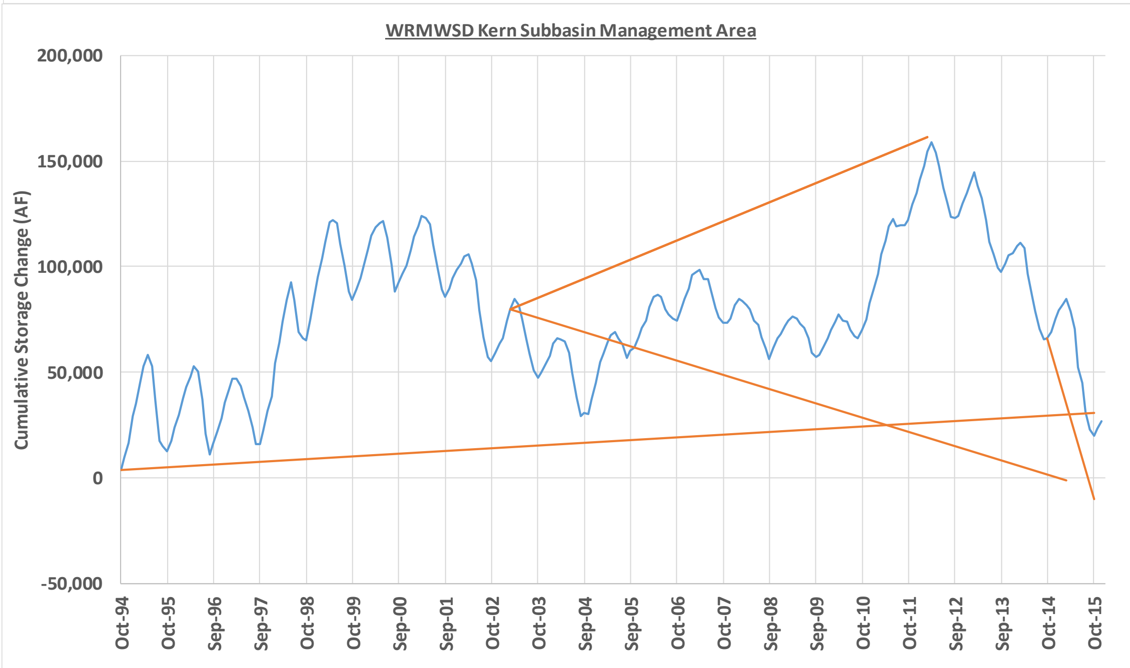
**Cumulative Change in Storage vs. DWR Water Year Type**

**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-32**




Legend

= Raster-Based Estimated Change In Storage (AF)

= Water Budget Spreadsheet Model-Calculated Change In Storage (AF)

Abbreviations

AF = acre-feet

Notes

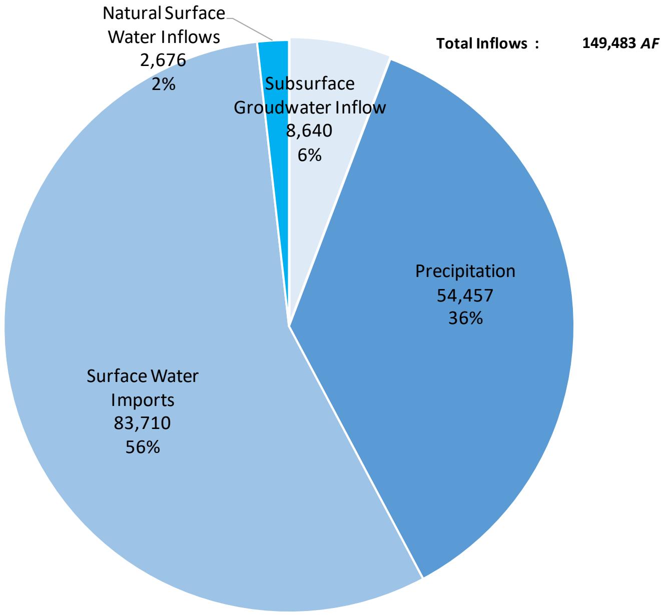
1. Calibration of the water budget spreadsheet model was performed for the District's entire service area, including the portion within the White Wolf Subbasin.

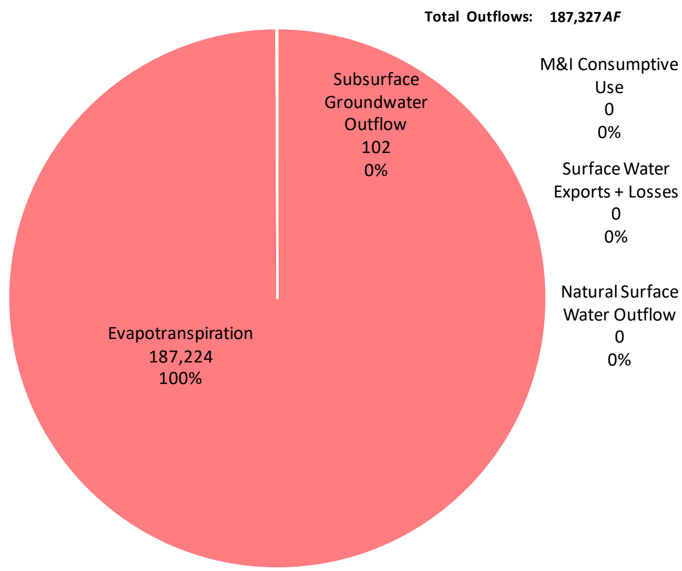
eki environment & water

**Comparison of Modeled & Water Level-Based Estimated Change in Storage Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-33**




Legend

***Inflows***

= Subsurface GW Inflows

= Surface Water Imports

= Precipitation

= Natural Surface Water Inflows

***Outflows***

= Subsurface GW Outflows

= Evapotranspiration

Abbreviations

AFY = acre-feet per year
GW = groundwater
M&I = municipal & industrial
WY = Water Year

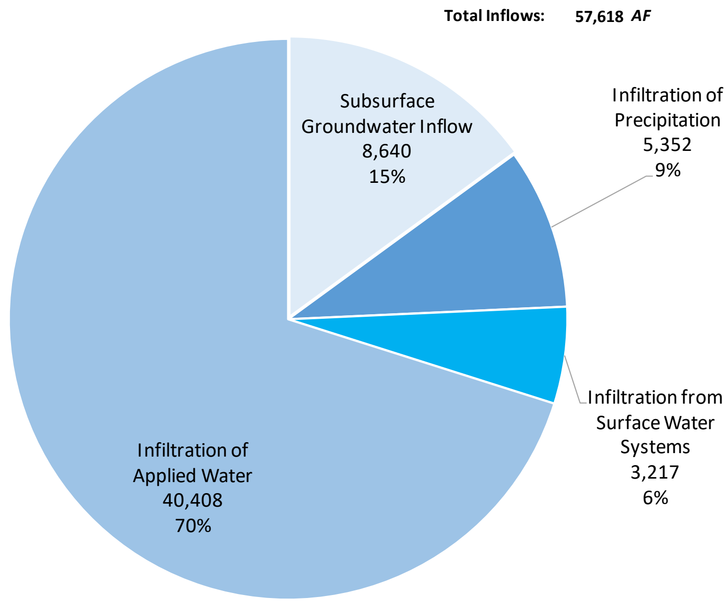
Notes

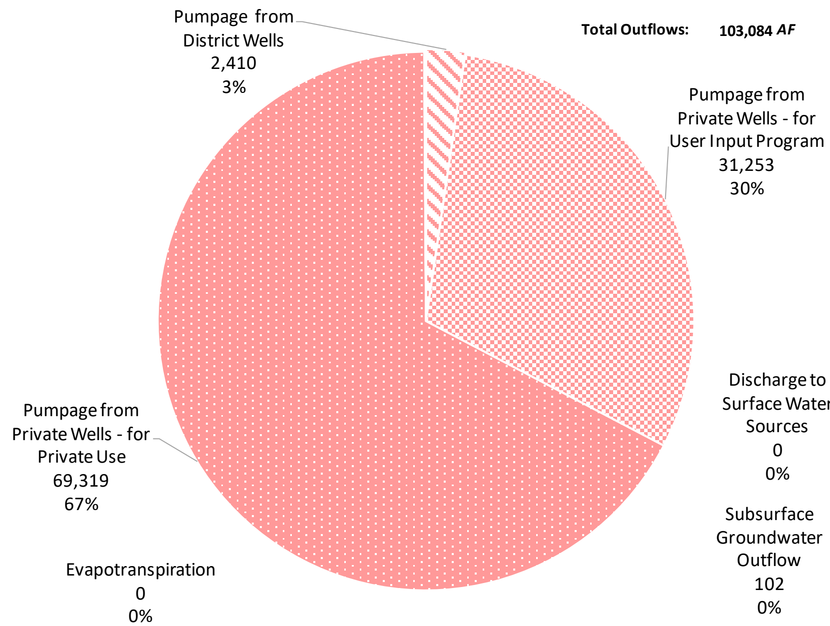
1. All values reported in acre-feet per year (AFY).

eki environment & water

**Summary of Total Inflows & Outflows, WY 2015**
**Wheeler Ridge-Maricopa Mangement Area**
South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-34**




Legend

***Groundwater Inflows***

= Subsurface GW Inflow

= Infiltration of Applied Water

= Infiltration of Precipitation

= Infiltration from Surface Water Systems

= Recharge from Spreading Basins

***Groundwater Outflows***

= Groundwater Extraction

= Subsurface GW Outflow

***Change in Groundwater Storage***

= Gain in GW Storage

= Reduction in GW Storage

Abbreviations

AF = acre-feet

GW = groundwater

WY = Water Year

Notes

1. All values reported in acre-feet (AF).
2. "Groundwater Extraction" includes all District and private groundwater pumping.

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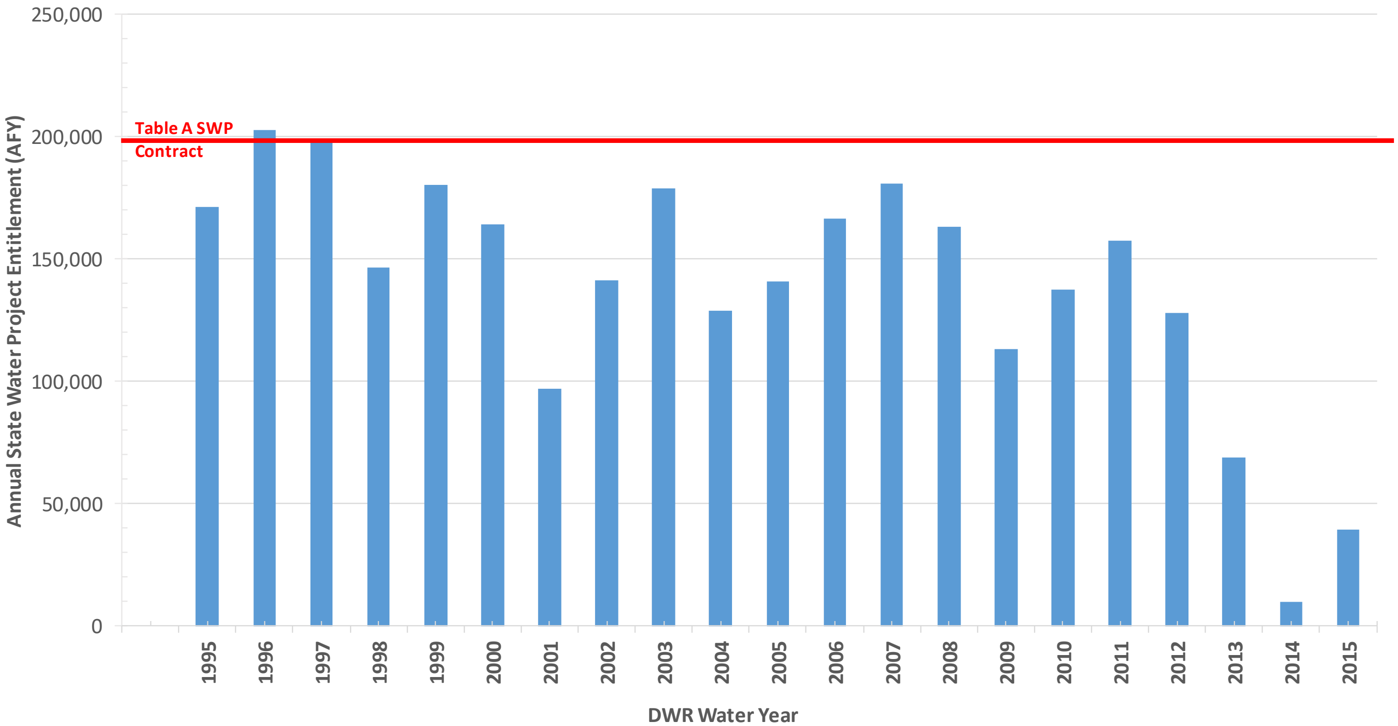
**Summary of Groundwater Inflows & Outflows, WY 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-35**




Legend

= SWP Annual Entitlement

= SWP Table A Contract

Abbreviations

AFY = acre-feet per year

SWP = State Water Project

Notes

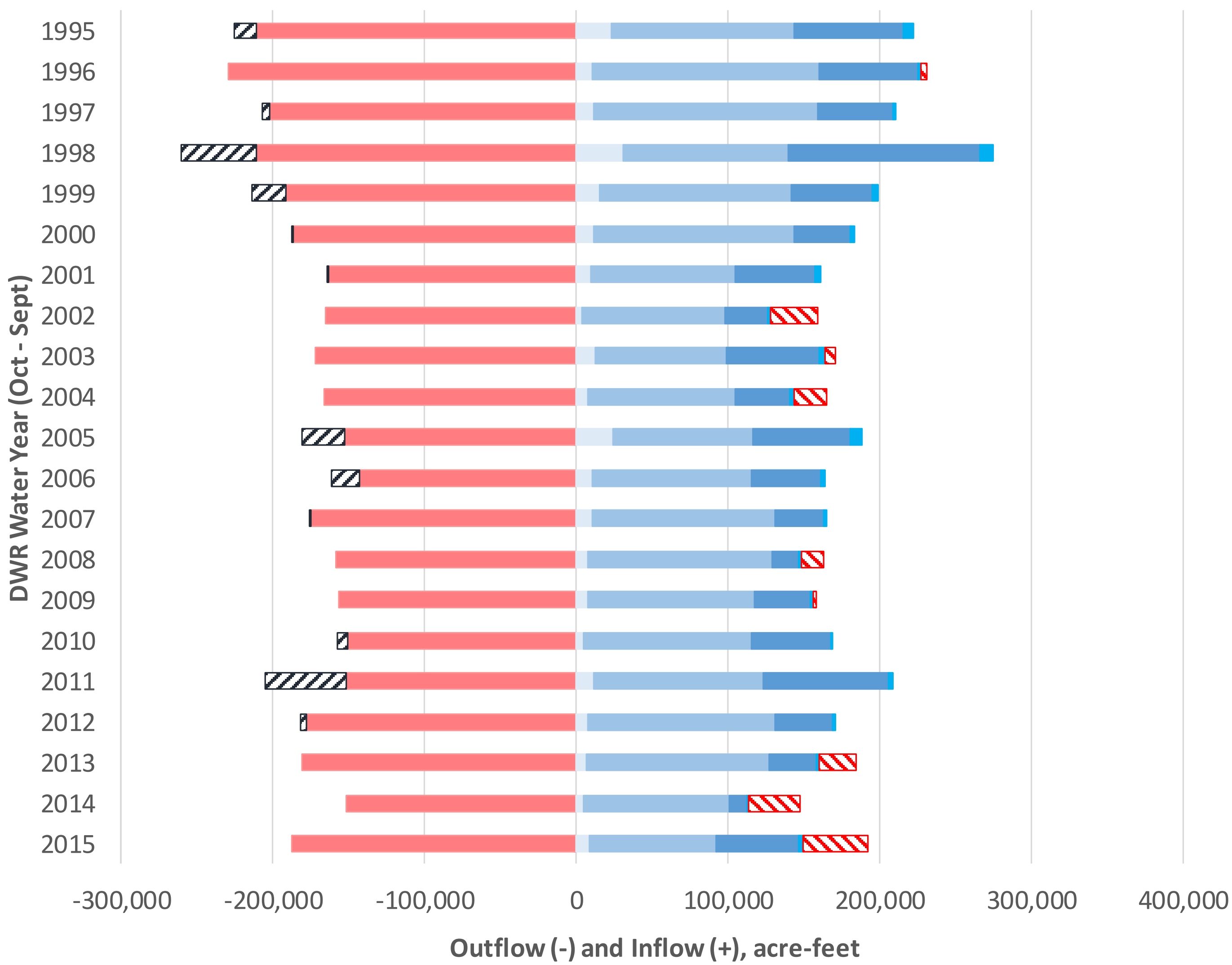
1. WRMWSD's Table A SWP Contract is 197,088 AFY

eki environment & water

**Annual State Water Project Entitlement vs. Table A Contract Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-36**




Legend

***Inflows***

= Subsurface GW Inflow

= Surface Water Imports

= Precipitation

= Natural Surface Water Inflows

***Outflows***

= Subsurface Outflows

= Evapotranspiration

***Change in Groundwater Storage***

= Gain in GW Storage

= Reduction in GW Storage

Abbreviations

DWR = California Department of Water Resources

GW = groundwater

eki environment & water

**Annual Inflows & Outflows**

**Wheeler Ridge-Maricopa Management Area**

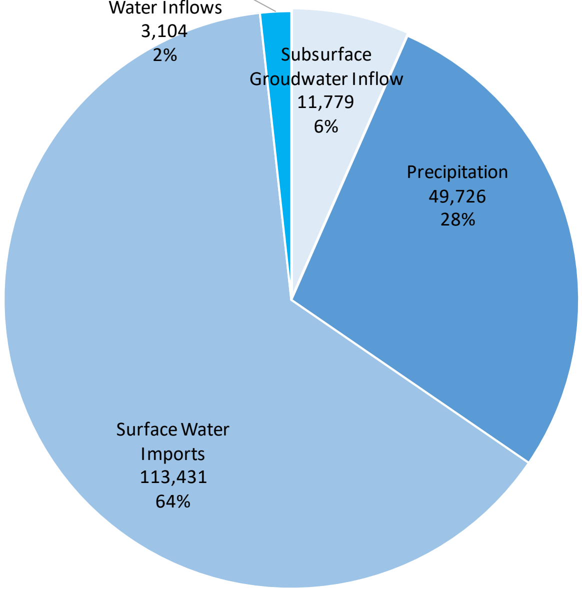
South of Kern River GSP

Kern County, California

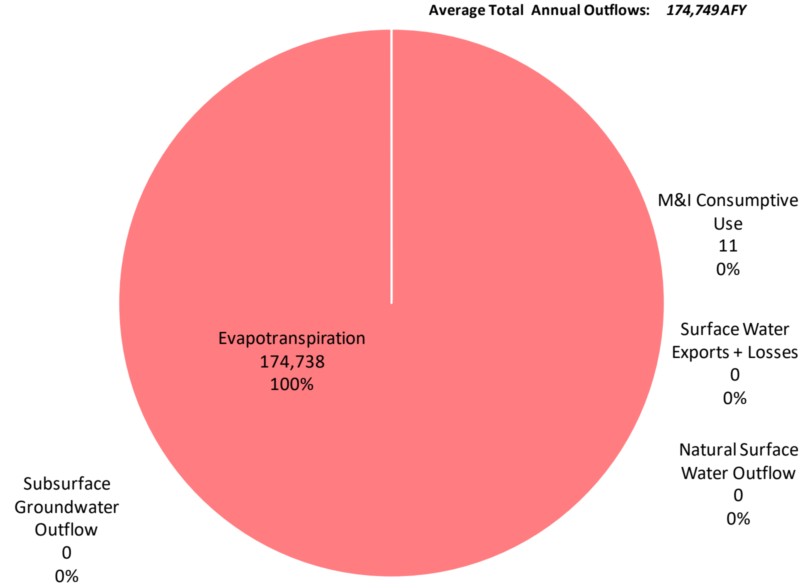
July 2022

EKI C20055.00

**Figure WB-37**






Legend

***Inflows***

= Subsurface GW Inflows

= Surface Water Imports

= Precipitation

= Natural Surface Water Inflows

***Outflows***

= Subsurface GW Outflows

= Evapotranspiration

Abbreviations

AFY = acre-feet per year

GW = groundwater

M&I = municipal & industrial

WY = Water Year

Notes

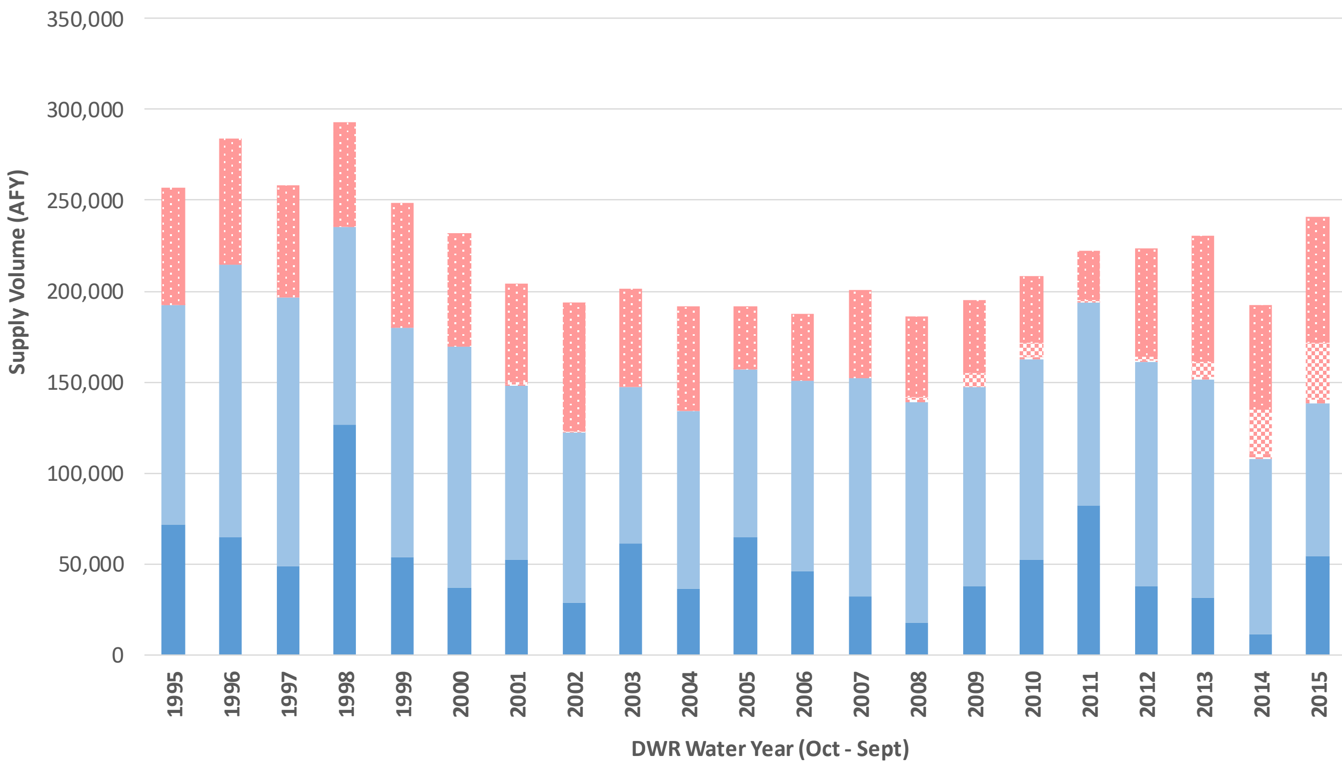
1. All values reported in acre-feet per year (AFY).

eki environment & water

**Summary of Total Inflows & Outflows, WY 1995 - 2014**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-38**




Legend

= Precipitation
= Surface Water Imports
= District Pumpage
= Private Pumpage - User Input Program
= Private Pumpage - Private Use

Abbreviations

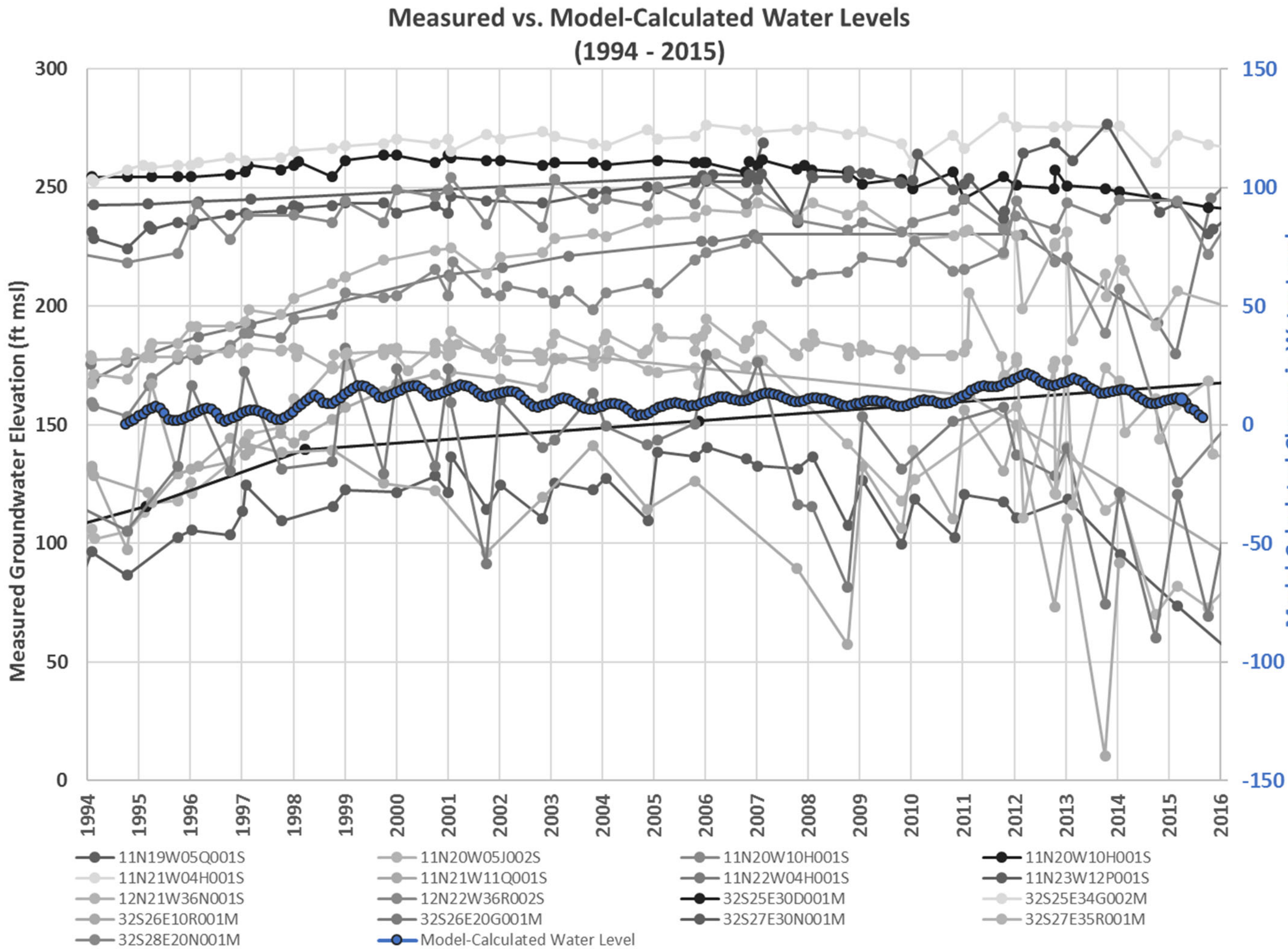
AFY = acre-feet per year
WY = Water Year

eki environment & water

**Water Supply Portfolio and Annual Precipitation, WY 1995 - 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-39**




Legend

= Measured Water Level (ft msl)

= Water Budget Spreadsheet Model-Calculated Change In Water Level (ft)

Abbreviations

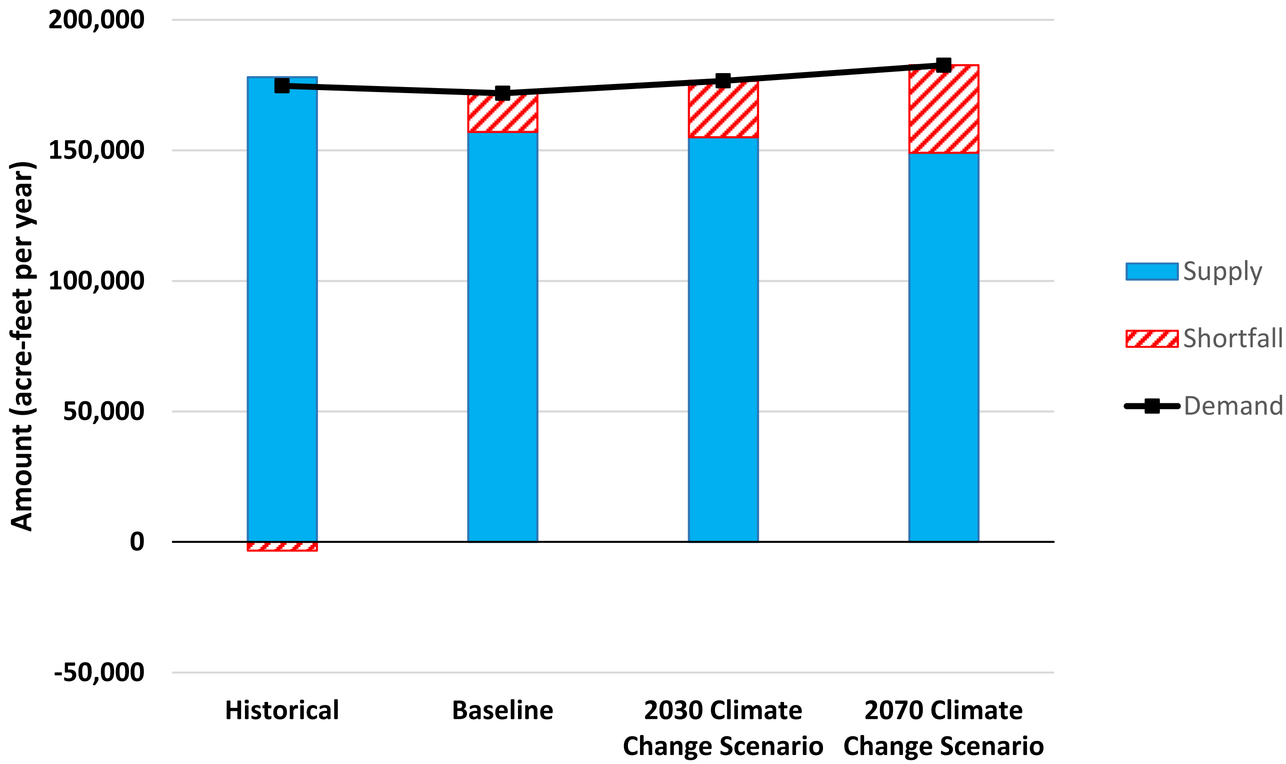
| | |
|---|---|
| ft | = feet |
| ft msl | = feet above mean sea level |
| WY | = Water Year |

eki environment & water

**Observed vs. Modeled Change in Water Levels, WY 1995 - 2015**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-40**

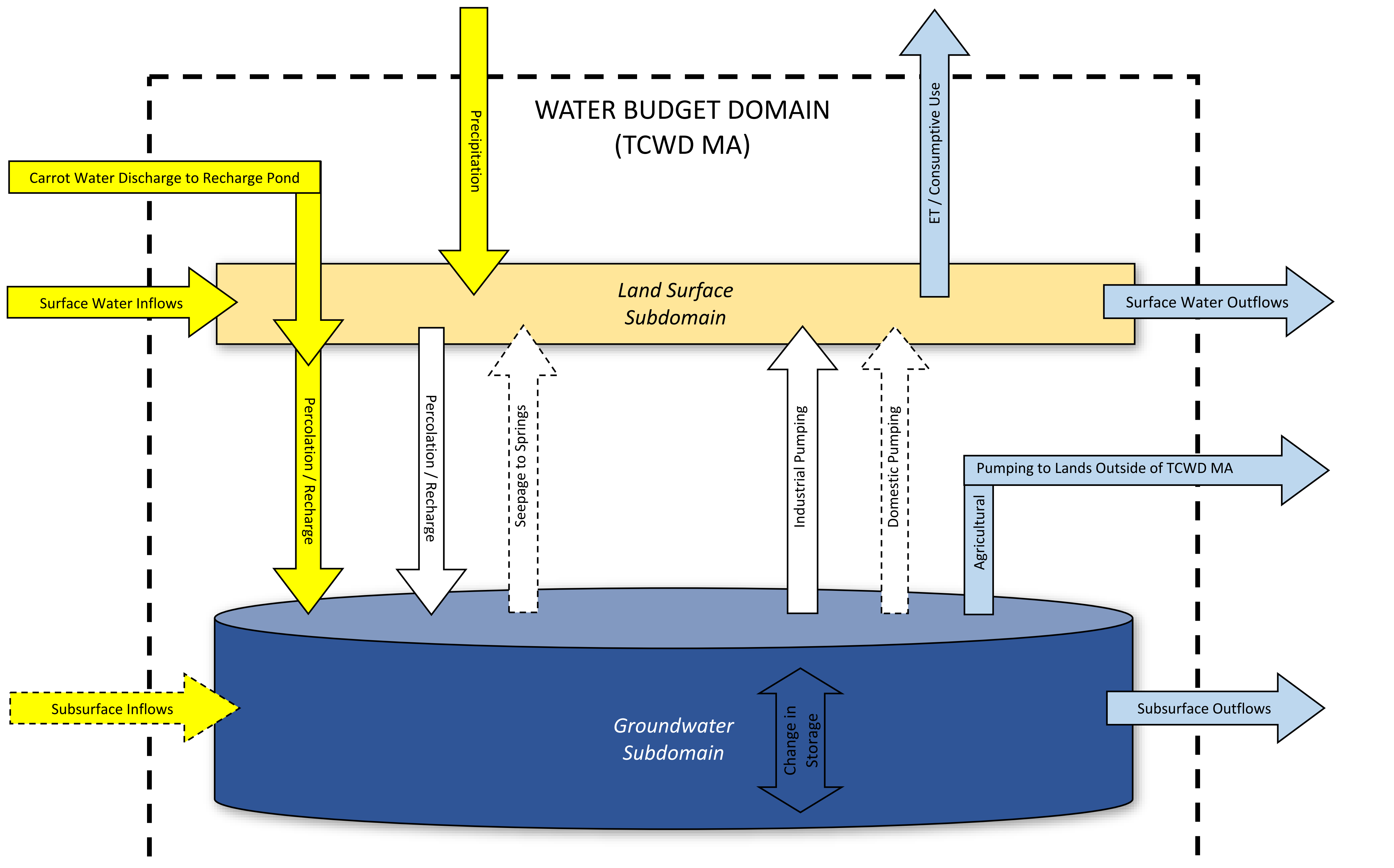



eki environment & water

**Projected Water Budget Supplies, Demands, and Shortfall Before Project & Management Action Implementation**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure WB-41**




Abbreviations

ET = Evapotranspiration
MA = Management Area
TCWD = Tejon-Castac Water District

Notes

1. ET / Consumptive Use includes ET from native vegetation and consumptive use from the Granite Quarry and de minimus domestic use.
2. Percolation / Recharge includes infiltration of excess precipitation and infiltration from surface water streams.
3. Industrial Pumping is from the Caratan Well for non-potable use at the Granite Quarry.
4. Agricultural Pumping to Lands Outside of the TCWD MA is from the Caratan Well to approximately 264 acres in the adjacent Arvin-Edison Water Storage District.

**Conceptual Water Budget Components/ Linkages**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

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**Figure WB-42**

# 10. MANAGEMENT AREAS

☑ 23 CCR § 354.20(a)

The information presented in the Basin Setting sections of this South of Kern River Groundwater Sustainability Plan (SOKR GSP) (i.e., **Section 7 *Hydrogeologic Conceptual Model,*** **Section 8 *Current and Historical Groundwater Conditions*** and **Section 9 *Water Budget Information***) is specific to and describes conditions within the SOKR GSP Area, including the Arvin-Edison Management Area, Wheeler Ridge-Maricopa Management Area, and the Tejon-Castac Management Area (***Figure HCM-1***). As discussed in **Section 5.1.6 *Lands Outside of Districts Covered by the SOKR GSP*** information regarding the un-districted lands (i.e., "white lands") covered by this SOKR GSP is presented in **Appendix C**.

## 10.1. Description and Justification

☑ 23 CCR § 354.20(b)(1)
☑ 23 CCR § 354.20(c)

As discussed previously in **Section 5 *Description of the Plan Area***, the Kern County Subbasin (Kern Subbasin or Basin) is under the jurisdiction of a large number of entities with water and/or land use management authority, a subset of which have formed Groundwater Sustainability Agencies (GSAs). In the SOKR GSP Area, the three GSAs that have formed (effective March 2022) include the Arvin GSA, the Wheeler Ridge-Maricopa GSA, and the Tejon-Castac Water District (TCWD) GSA. Each GSA is responsible for Sustainable Groundwater Management Act (SGMA) compliance within its specific Management Area of the overall SOKR GSP Area.

These Management Areas were created within the SOKR GSP Area based on jurisdictional boundaries to ensure that each GSA has the flexibility and control needed to implement the coordinated program for sustainable groundwater management established in the GSP in a manner that is responsive to local needs and interests. The SOKR GSAs have entered into a Memorandum of Agreement, to which Arvin Community Services District (ACSD) is also a party, that describes and formalizes each GSA's commitment to implement the GSP within its Management Area in full coordination and cooperation with the other SOKR GSAs to satisfy the requirements of SGMA (**Appendix X**).

### 10.1.1. Arvin-Edison Management Area

The Arvin-Edison Management Area is coincident with the Arvin GSA boundary, which includes all of Arvin-Edison Water Storage District's (AEWSD) service area within the Basin excepting those acres that overlap with the East Niles Community Services District and the Kern River GSA (***Figure HCM-1***). The Arvin-Edison Management Area also includes 1,860 acres of un-districted "white lands" in the vicinity of AEWSD (see **Appendix C**). The remainder of the AEWSD service area is located within the adjacent White Wolf Subbasin.

Water use in the both Arvin-Edison and Wheeler Ridge-Maricopa Management Areas water is predominantly agricultural, and there is a strong nexus between Arvin GSA / Wheeler Ridge-Maricopa GSA management decisions and groundwater conditions.

The Arvin-Edison Management Area also encompasses the entire boundaries of ACSD, an urban water supplier to the severely disadvantaged community of Arvin. ACSD is required to manage its groundwater wells and water system in compliance with all applicable Federal and State regulations. ACSD, as a component of the Arvin-Edison Management Area, recognizes and acknowledges that the operation of its water wells and water system should be consistent with the SOKR GSP based on the needs of an urban water supplier. The AEWSD and ACSD have entered into the Memorandum of Understanding (MOU) dated 1 January 2019, and updated June 2022, stating that ACSD will fully cooperate with Arvin GSA regarding the implementation of the SOKR GSP.

### 10.1.2. Wheeler Ridge-Maricopa Management Area

The Wheeler Ridge-Maricopa Management Area is coincident with the Wheeler Ridge-Maricopa GSA boundary, which includes all of Wheeler Ridge-Maricopa Water Storage District's (WRMWSD) lands within the Basin excepting 2,809 acres that occur within the West Kern Water District (WKWD), and lands that overlap with the AEWSD service area (***Figure HCM-1***). For purposes of SGMA monitoring and management, WRMWSD and AEWSD have agreed that the Arvin GSA will cover the overlap areas between the two districts. The Wheeler Ridge-Maricopa Management Area also includes 1,122 acres of un-districted "white lands" in the vicinity of WRMWSD (see **Appendix C**). The remainder of the WRMWSD service area is located within the adjacent White Wolf Subbasin.

As above, water use in both the Arvin-Edison and Wheeler Ridge-Maricopa Management Areas water is predominantly agricultural, and there is a strong nexus between Arvin GSA / Wheeler Ridge-Maricopa GSA management decisions and groundwater conditions.

### 10.1.3. Tejon-Castac Management Area

The Tejon-Castac Management Area is located in the southeastern portion of the Basin and encompasses approximately 19,280 acres of the TCWD service area (***Figure HCM-1***). The Tejon-Castac Management Area is bounded to the west and north by the TCWD administrative/jurisdictional boundary and to the east and south by the boundaries of the Kern Subbasin and the White Wolf Subbasin, respectively. The Tejon-Castac Management Area is located directly to the east of the Arvin-Edison Management Area. A portion of the TCWD service area is located within the adjacent White Wolf Subbasin.

As discussed previously in **Section 7.1.4 *Principal Aquifers and Aquitards***, in a hydrogeological sense the Tejon-Castac Management Area can be thought of as consisting of two relatively distinct areas, separated by the Edison Fault. Each area (i.e., north and south of the Edison Fault) has characteristic geology, topography, hydrology, and surrounding land uses. With few exceptions (i.e., the Granite Quarry and the Caratan Well), the entire Tejon-Castac Management Area, both north and south of the Edison Fault, is undeveloped land that is destined to remain undeveloped under the Conservation and Land Use (C&LU) Agreement. Limited water use occurs in the Tejon-Castac Management Area as it primarily encompasses undeveloped lands that are present in their natural state, making this area unique within the Basin.

## 10.2. Minimum Thresholds and Measurable Objectives

☑ 23 CCR § 354.20(b)(2)
☑ 23 CCR § 354.20(b)(4)

The Sustainable Management Criteria developed for the three Management Areas, including the rationale for their selection, are described in detail in **Section 14 *Minimum Thresholds*** and **Section 15 *Measurable Objectives and Interim Milestones.***

## 10.3. Monitoring

☑ 23 CCR § 354.20(b)(3)

Monitoring networks for each applicable Sustainability Indicator within the three Management Areas, including a discussion of the level of monitoring and analysis appropriate for each Management Area, are described in detail in **Section 16 *Monitoring Network***.

# SUSTAINABLE MANAGEMENT CRITERIA

## 11. INTRODUCTION TO SUSTAINABLE MANAGEMENT CRITERIA

☑ 23 CCR § 354.22

The Sustainable Groundwater Management Act (SGMA) legislation defines "Sustainability Goal" as "the existence and implementation of one or more groundwater sustainability plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield" (California Water Code [CWC] § 10721(u)). SGMA requires Groundwater Sustainability Plans (GSPs) to develop and implement plans to meet the Sustainability Goal (CWC § 10727(a)) and requires that the plans include Measurable Objectives as well as Interim Milestones in increments of five years to achieve the Sustainability Goal within 20 years of the implementation of the plan (CWC § 10727.2(b)(1)).

The SGMA legislation and California Code of Regulations Title 23 (23 CCR) Division 2 Chapter 1.5 Subchapter 2 define terms related to achievement of the Sustainability Goal, including:

- Undesirable Result (UR) – "one or more of the following effects caused by groundwater conditions occurring throughout the basin:
    (1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.
    (2) Significant and unreasonable reduction of groundwater storage.
    (3) Significant and unreasonable seawater intrusion.
    (4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
    (5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.
    (6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water." (CWC § 10721(x));
- Minimum Threshold (MT) – "a numeric value for each sustainability indicator used to define undesirable results" (23 CCR § 351(t)).
- Measurable Objective (MO) – "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" (23 CCR § 351(s)); and

- Interim Milestone (IM) – “a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan” (23 CCR § 351(q))

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

The GSP Emergency Regulations specify how Groundwater Sustainability Agencies (GSAs) must establish SMCs for each applicable Sustainability Indicator. **Sections 12**, **13**, **14**, and **15** of this South of Kern River (SOKR) GSP describe the **Sustainability Goal, Undesirable Results, Minimum Thresholds,** and **Measurable Objectives and Interim Milestones**, respectively, developed as part of this SOKR GSP, in coordination with the other GSPs for the Kern County Subbasin (i.e., collectively the Kern Subbasin Plan).

***Table SMC-1*** below presents as summary of the current status (i.e., as of the end of Water Year [WY] 2021) of groundwater conditions relative to the criteria used to identify URs within the SOKR GSP and describes any actions taken to address the potential occurrence of URs, demonstrating how the SOKR GSAs have continued to sustainably manage their respective portions of the Basin to avoid URs throughout the SGMA implementation period to date. ***Table SMC-2***, ***Table SMC-3***, and ***Table SMC-4,*** present a detailed summary of the SMCs defined for each Management Area of the SOKR GSP.

**Table SMC-1. Current Status of Relevant Sustainability Indicators**

| Sustainability Indicator | Local Undesirable Results Criteria | Current Status (WY 2021) | Action Taken |
|---|---|---|---|
| Chronic Lowering of Groundwater Levels | It is considered a local UR for Chronic Lowering of Groundwater Levels when groundwater levels decline below established MTs in 40% or more of any water level representative monitoring sites (RMS) within the management area over four consecutive bi-annual SGMA required monitoring events. The number of exceedances that equates to at least 40% of RMS for each Management Area is as follows:<br>• **Arvin-Edison Management Area:** 7 of 16 RMS<br>• **Wheeler Ridge-Maricopa Management Area:** 6 of 14 RMS<br>• **Tejon-Castac Management Area:** 1 of 1 RMS | • **Arvin-Edison Management Area**: MTs were not exceeded at any of the 16 RMS during either the Fall 2020 or Spring 2021 monitoring events (***Figure SMC-1***).<br>• **Wheeler Ridge-Maricopa Management Area**: MTs were exceeded at one RMS (Well # 11N21W16E001S) during the Fall 2020 monitoring event; the remaining 13 RMS were measured above their MTs during both the Fall 2020 and Spring 2021 monitoring events (***Figure SMC-2***).<br>• **Tejon-Castac Management Area**: MT was not exceeded at the one RMS during either the Fall 2020 or Spring 2021 monitoring events (***Figure SMC-3***). | Continue to monitor and implement the SOKR GSP. |
| Reduction of Groundwater Storage | It is considered a local UR for Reduction of Groundwater Storage when groundwater levels decline below established MTs in 40% or more of any water level RMS within the management area over four | • Groundwater levels are used as a proxy for monitoring Reduction of Groundwater Storage; see above for description of current status of RMS within each Management | Continue to monitor and implement the SOKR GSP. |

| Sustainability Indicator | Local Undesirable Results Criteria | Current Status (WY 2021) | Action Taken |
|---|---|---|---|
| | consecutive bi-annual SGMA required monitoring events.<br><br>Due to the great depth of fresh water and wells able to access it, there is significant usable groundwater storage within the SOKR GSP Area even below the elevation of the MTs. As such, on a local level it is not necessary to define unique SMCs for Reduction of Groundwater Storage; **the criteria set for Chronic Lowering of Groundwater Levels are "protective" and a reasonable proxy.** | Area. | |
| Seawater Intrusion | Groundwater conditions in the basin show that Seawater Intrusion is not present within the Basin and is not anticipated to be present in the future, and therefore the Sustainability Indicator is not applicable to the Basin. | | |
| Degraded Water Quality | It is considered a local UR for Degraded Water Quality within the **Arvin-Edison Management Area** and the **Wheeler Ridge-Maricopa Management Area** if the MT is exceeded in 40% or more of any water quality RMS within the Management Area over two consecutive annual SGMA required measurements as a result of groundwater recharge or extraction, such that it cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable). The number of exceedances that equates to at least 40% of RMS for each Management Area is as follows:<br>• **Arvin-Edison Management Area:** 4 of 10 RMS<br>• **Wheeler Ridge-Maricopa Management Area:** 4 of 9 RMS<br><br>Given the lack of groundwater use and development within the **Tejon-Castac Management Area**, there are no degraded water quality conditions that would fall under the purview of the SOKR GSAs. Further, there are no beneficial uses that are expected to be significantly and unreasonably affected by groundwater quality. Therefore, no URs for Degraded Water Quality are defined for the Tejon-Castac Management Area. | • Within the **Arvin-Edison Management Area**, arsenic concentrations exceeded the MT at Arvin Community Services District (ACSD) Well #14 during the Spring 2021 monitoring event, but have since remained below the MT during the Fall 2020, Spring 2021, Fall 2021, and Spring 2022 monitoring events.<br>• Additional SMCs for arsenic were assigned at water quality RMS within the **Arvin-Edison Management Area** and **Wheeler Ridge-Maricopa Management Area** as part of the resubmittal of the SOKR GSP in response to comments from the California Department of Water Resources (DWR) in their 2022 *Kern Subbasin Determination* letter. These SMCs will be implemented going forward, and may be revisited as part of future Five Year Updates to the SOKR GSP based on newly collected data and information. | ACSD conducted significant well rehabilitation efforts in 2021 and 2022, which resulted in a significant decrease in arsenic concentrations.<br><br>Continue to monitor and implement the SOKR GSP. |

| Sustainability Indicator | Local Undesirable Results Criteria | Current Status (WY 2021) | Action Taken |
|---|---|---|---|
| Land Subsidence | Within the **Arvin-Edison Management Area**, it is considered a local UR if the Minimum Threshold extent of subsidence is exceeded in at least 40% (i.e., 2 of 5) of the local survey benchmark locations along the canal system within the Arvin-Edison Management Area.<br><br>Within the **Wheeler Ridge-Maricopa Management Area**, it is considered a local UR if the Minimum Threshold extent of subsidence is exceeded in any one (1) of four (4) Aqueduct pools located within the Wheeler Ridge-Maricopa Management Area.<br><br>Because subsidence has not been an issue historically within the **Tejon-Castac Management Area** and there is no significant groundwater development other than the industrial and agricultural uses of the Caratan Well, land subsidence is unlikely to occur within the Tejon-Castac Management Area. Furthermore, the MT value for Chronic Lowering of Groundwater Levels is defined so as to be protective against possible land subsidence by being limited to levels that are generally no lower than historical lows. | • Land surface elevation data collected within the Arvin GSA during Water Year 2021 showed that cumulative subsidence since June 2018 has occurred in amounts less than the MT extent at all five local survey benchmark locations along the canal system within the **Arvin-Edison Management Area**.<br>• Land surface elevation data collected at the DWR survey benchmark locations along the Aqueduct during Water Year 2021 and in early 2022 showed that cumulative subsidence has occurred in amounts less than the MT extent defined for each Aqueduct pool within the **Wheeler Ridge-Maricopa Management Area**. | Continue to monitor and implement the SOKR GSP. |
| Depletions of Interconnected Surface Waters | Groundwater conditions in the Basin show that Depletion of Interconnected Surface Waters is not present within the Basin and is not anticipated to be present in the future, and therefore the Sustainability Indicator is not applicable to the Basin. | | |

## 12. SUSTAINABILITY GOAL

☑ 23 CCR § 354.24

The Sustainable Groundwater Management Act (SGMA) requires that a Sustainability Goal be defined for each basin (California Water Code [CWC] § 10727(a)). The Sustainability Goal adopted by all of the Groundwater Sustainability Agencies (GSAs) in the Kern County Subbasin is defined below:

> "The sustainability goal of the Kern County Subbasin is to:
>
> - Achieve sustainable groundwater management in the Kern County Subbasin through the implementation of projects and management actions at the member agency level of each GSA
> - Maintain its groundwater use within the sustainable yield of the basin.
> - Operate within the established sustainable management criteria, which are based on the collective technical information presented in the GSPs in the Subbasin.
> - Implement projects and management actions that include a variety of water supply development and demand management actions.
> - Collectively bring the Subbasin into sustainability and to maintain sustainability over the implementation and planning horizon.
>
> Further, the Subbasin sustainability goal includes a commitment to monitor and report groundwater conditions, as required by SGMA, and to continue coordination among all GSAs in the Subbasin to identify the potential for, or presence of, undesirable results and actions to prevent undesirable results. The coordination process established in the development of this GSP and memorialized in the Coordination Agreement will ensure that the Subbasin is managed as a shared groundwater resource and that the districts within the Subbasin work collaboratively towards achieving and maintaining sustainable groundwater use."

Additionally, consistent with this Basin-level Sustainability Goal, each South of Kern River (SOKR) GSA has defined a local, complementary Sustainability Goal for their respective Management Areas, as detailed below:

- The Sustainability Goal for the **Arvin-Edison Management Area** is to maintain an economically-viable groundwater resource that supports the current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental) by utilizing the area's groundwater resources within the local sustainable yield. Long-term groundwater sustainability will be evaluated and maintained in compliance with locally-defined sustainability criteria. The Management Area will remain in compliance through the continued importation of surface water as well as implementation of projects and management actions to both increase water supplies and reduce demands within the Management Area. The District's historical efforts to achieve a balanced and sustainable water supply for all lands, including to both the Surface Water Service Area and the Groundwater Service Area, and in an equitable manner, will continue under SGMA.

- The sustainability goal for the **Wheeler Ridge-Maricopa Management Area** is to maintain an economically-viable groundwater resource for the beneficial use of the Management Area's landowners and water users by utilizing the area's groundwater resources within the local sustainable yield. Long-term groundwater sustainability, i.e., the absence of undesirable results within 20 years of the applicable statutory deadline, will be achieved and maintained through the implementation of projects and management actions as described herein to both increase water supplies and reduce demands within the Management Area.
- The Sustainability Goal for the **Tejon-Castac Management Area** is to maintain an economically-viable groundwater resource that supports the current and future beneficial uses of groundwater by utilizing the area's groundwater resources within the local sustainable yield. Long-term groundwater sustainability will be evaluated relative to locally-defined sustainability criteria and maintained through increased groundwater monitoring and the implementation of projects and management actions within the Management Area. This Management Area Plan has been developed and will be implemented consistent with the natural resource values of the Tejon Ranch Conservation and Land Use Agreement.

In addition to the Sustainability Goal statements above, the Tejon-Castac Management Area is covered almost entirely by lands that are owned by Tejon Ranch Company (TRC) and subject to the conservation regime described in the Ranch-Wide Management Plan (RWMP), as discussed above in **Section 5.3.4 *Tejon Ranch Conservation and Land Use Agreement***. The very first recital in the Tejon Ranch Conservation and Land Use (C&LU) Agreement states:

> "The Parties to this Agreement desire to protect in perpetuity substantial and significant natural resource values of the 270,000-acre Tejon Ranch. These natural resource values include an extraordinary diversity of native species and vegetation communities, numerous special status plant and animal species, intact watersheds and landscapes supporting natural ecosystem functions and regionally significant habitat connectivity. These important natural resource values exist on Tejon Ranch because historic ranch uses, tracing back to 1843, have largely sustained a natural landscape. The objective of this Agreement is to maintain the bulk of Tejon Ranch in this unaltered condition and, as appropriate, enhance and restore natural resource values."

# 13. UNDESIRABLE RESULTS

☑ 23 CCR § 354.26(a)

This section describes the Undesirable Results defined for the South of Kern River Groundwater Sustainability Plan (SOKR GSP) Area. Pursuant to the GSP Emergency Regulations, which state that Undesirable Results are to be defined consistently throughout a basin (23 California Code of Regulations [CCR] § 354.20), definitions of Undesirable Results have been developed through a coordinated effort of the Kern County Subbasin (Kern Subbasin or Basin) Groundwater Sustainability Agencies (GSAs).

As discussed below for each Sustainability Indicator, the Undesirable Results (UR) definitions for the Basin refer to and rely on Minimum Thresholds (MT) established at the local management area/GSP level. Specifically, URs for the Basin occur when local URs are triggered by MT exceedances for a certain percentage (by acreage) of management areas. Each management area determines what the local MT values are, but uses a consistent trigger to assess whether a local UR is occurring. If a local UR manifests in a management area, that area begins to count towards the Basin-wide UR definition.

In the following sections, the UR definitions adopted by the SOKR GSAs and other Basin GSAs for each Sustainability Indicator are presented (i.e., what combination of MT exceedances, if any, constitutes a local UR). Each entity in the SOKR GSP portion of the Basin has further coordinated on the methodologies for developing the associated Sustainable Management Criteria (SMCs) within their respective management areas and confirmed that they are consistent with the intent of the Sustainable Groundwater Management Act (SGMA).

## 13.1. Undesirable Results for Chronic Lowering of Groundwater Levels

The Basin-wide definition of URs for Chronic Lowering of Groundwater Levels is as follows:

> "The point at which significant and unreasonable impacts over the planning and implementation horizon, as determined by depth/elevation of water, affect the reasonable and beneficial use of, and access to, groundwater by overlying users.
>
> This is determined when the minimum threshold for groundwater levels are exceeded in at least three (3) adjacent management areas that represent at least 15% of the Subbasin or greater than 30% of the Subbasin (as measured by each management area). Minimum thresholds shall be set by each of the management areas through their respective management area plans or Groundwater Sustainability Plans."

The above Basin-wide definition requires local definition within each management area of the MTs and combination of exceedances that constitute a significant and unreasonable impact to the reasonable and beneficial use of, and access to, groundwater by overlying users. As such, it is necessary to consider local conditions and beneficial uses and users within each management area.

### 13.1.1. Identification of Beneficial Users

*Arvin-Edison Management Area*

Beneficial users that could be impacted by Chronic Lowering of Groundwater Levels in the Arvin-Edison Management Area include:

1) Agricultural and Industrial Users: The primary use of groundwater from the principal aquifer in the Arvin-Edison Management Area is for agricultural purposes, including pumping from private wells and pumping from Arvin-Edison Water Storage District (AEWSD) wells for recovery and delivery of previously banked groundwater. Groundwater is pumped for municipal and industrial (M&I) use in the City of Arvin and for industrial use at several crop processing facilities within the Management Area. There are approximately 402 agricultural and industrial wells.
2) Domestic and Small Community Users: There are approximately 134 domestic wells.
3) Municipal Users: There are 19 public supply wells.

Regional Critical Infrastructure is not defined as a beneficial user in California Water Code (CWC) §10723.2, but is still considered as a land use and property interest in the development of SMCs for Chronic Lowering of Groundwater Levels.

Per CWC §106.3(a), all drinking water users of groundwater within the Management Area are considered beneficial users with a human "right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

*Wheeler Ridge-Maricopa Management Area*

Beneficial users that could be impacted by Chronic Lowering of Groundwater Levels in the Wheeler Ridge-Maricopa Management Area include:

1) Agricultural and Industrial Users: The primary use of groundwater in the Wheeler Ridge-Maricopa Management Area is for agricultural purposes. There are approximately 130 agricultural and industrial wells.
2) Domestic and Small Community Users: There are approximately 27 domestic wells.
3) Municipal Users: There is one public supply well.

Regional Critical Infrastructure is not defined as a beneficial user in CWC §10723.2, but is still considered as a land use and property interest in the development of SMCs for Chronic Lowering of Groundwater Levels.

Per CWC §106.3(a), all drinking water users of groundwater within the Management Area are considered beneficial users with a human "right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

*Tejon-Castac Management Area*

The only significant use of groundwater within the Tejon-Castac Management Area is from the Caratan Well for operations at Granite Quarry. Groundwater may also be pumped for domestic use at three domestic wells at de minimis rates (i.e., less than 2 acre-feet per year [AFY]), although the status of pumping at these wells is uncertain. Furthermore, the Tejon Ranch Conservation and Land Use (C&LU) Agreement provides robust land use protections to limit further commercial/agricultural groundwater development within the Management Area. No Regional Critical Infrastructure has been identified within the Tejon-Castac Management Area.

Per CWC §106.3(a), all drinking water users of groundwater within the Management Area are considered beneficial users with a human "right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

#### 13.1.2. Potential Effects of Undesirable Results on Beneficial Users

☑ 23 CCR § 354.26(b)(3)

*Arvin-Edison Management Area*

The primary potential effects of URs caused by Chronic Lowering of Groundwater Levels on beneficial uses and users of groundwater in the Arvin-Edison Management Area include groundwater well dewatering, increased pumping lift, and potential land subsidence. Excessive well dewatering is detrimental to wells as it can lead to increased maintenance costs (i.e., well rehabilitation/redevelopment, pump lowering) and reduced well lifespan due to corrosion of well casing and screen, and in some cases the need to replace wells with deeper wells.[130] Increased pumping lift results in more energy use per unit volume of groundwater pumped and greater pumping costs and can cause increased wear and tear on well pumps/motors. Land subsidence can affect critical infrastructure as discussed further below in **Section 13.5 *Undesirable Results for Land Subsidence***.

*Wheeler Ridge-Maricopa Management Area*

The primary potential effects of URs caused by Chronic Lowering of Groundwater Levels on beneficial uses and users of groundwater in the Wheeler Ridge-Maricopa Management Area are the same as those in the Arvin-Edison Management Area listed above.

*Tejon-Castac Management Area*

The primary potential effects of URs caused by Chronic Lowering of Groundwater Levels on beneficial uses and users of groundwater in the Tejon-Castac Management Area are the same as those in the Arvin-Edison Management Area listed above.

#### 13.1.3. Potential Causes of Undesirable Results

☑ 23 CCR § 354.26(b)(1)

*Arvin-Edison Management Area*

Potential causes of URs due to Chronic Lowering of Groundwater Levels in the Arvin-Edison Management Area include increased pumping and/or reduced recharge. Increased pumping from the principal aquifer could occur if new land is put into production or if water use per acre on existing irrigated land increases. Pumping from the principal aquifer for potable domestic use is relatively small and unlikely to substantially increase. Reduced recharge could occur due to increased agricultural irrigation efficiency, reduced surface water imports and banking, reduced groundwater inflows from adjacent areas, or due

[130] AEWSD has proposed a Well Dewatering Mitigation Program to address these potential impacts to beneficial users (see **Sections 14.1** and **18.1.6**).

to climate change that results in decreased precipitation and increased evapotranspiration (ET), as discussed in **Section 9.1.4 *Projected Water Budget***.

*Wheeler Ridge-Maricopa Management Area*

Potential causes of URs due to Chronic Lowering of Groundwater Levels in the Wheeler Ridge-Maricopa Management Area are the same as those in the Arvin-Edison Management Area.

*Tejon-Castac Management Area*

A potential cause of URs due to Chronic Lowering of Groundwater Levels in the Tejon-Castac Management Area is increased pumping. However, it should be noted that other than de minimis pumping at three potentially active domestic wells in the far eastern upland portion of the Management Area, pumping within the Management Area is limited to the single known active industrial/agricultural well (i.e., the Caratan Well).

#### 13.1.4. Criteria Used to Define Local Undesirable Results

☑ **23 CCR § 354.26(b)(2)**
☑ **23 CCR § 354.26(c)**

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the description of URs must include a quantitative description of the number of MT exceedances that constitute an UR. In a similar manner to how URs are defined at the Basin level, it is considered a local UR for Chronic Lowering of Groundwater Levels when groundwater levels decline below established MTs in 40% or more of any water level representative monitoring sites (RMS) within the management area over four consecutive bi-annual SGMA required monitoring events. The number of exceedances that equates to at least 40% of RMS for each Management Area is as follows:

- Arvin-Edison Management Area: 7 of 16 sites
- Wheeler Ridge-Maricopa Management Area: 6 of 14 sites
- Tejon-Castac Management Area: 1 of 1 site

### 13.2. Undesirable Results for Reduction of Groundwater Storage

The Basin-wide definition of URs for Reduction of Groundwater Storage is as follows*:*

> "The point at which significant and unreasonable impacts, as determined by the amount of groundwater in the basin, affect the reasonable and beneficial use of, and access to, groundwater by overlying users over an extended drought period.
>
> This is determined when the volume of storage (above the groundwater level minimum thresholds) is depleted to an elevation lower than the groundwater level minimum threshold in at least three (3) adjacent management areas that represent at least 15% of the subbasin or greater than 30% of the subbasin (as measured by the acreage of each Management Area).
>
> Minimum thresholds shall be set by each of the management areas through their respective Groundwater Sustainability Plans."

The above Basin-wide definition ties the UR for Reduction of Groundwater Storage directly to the Minimum Thresholds for Chronic Lowering of Groundwater Levels which, as stated above, are defined locally within each management area.

### 13.2.1. Identification of Beneficial Users

Reduction of Groundwater Storage is directly correlated to Chronic Lowering of Groundwater Levels. Therefore, the beneficial users for each Management Area are the same as those defined in **Section 13.1.1** above.

### 13.2.2. Potential Effects of Undesirable Results on Beneficial Users

☑ **23 CCR § 354.26(b)(3)**

The primary potential effect of URs caused by Reduction of Groundwater Storage on beneficial uses and users of groundwater in the SOKR GSP Area is reduced groundwater supply reliability. The effect of reduced groundwater supply reliability would be most significant during periods of reduced surface water supply availability due to, for example, natural drought conditions, regulatory restrictions, natural disasters, or other causes. However, as discussed in **Section 14.2.1** below, there is significant groundwater storage within the SOKR GSP Area, and so these effects are unlikely to occur.

### 13.2.3. Potential Causes of Undesirable Results

☑ **23 CCR § 354.26(b)(1)**

Reduction of Groundwater Storage is directly, if not linearly, correlated to Chronic Lowering of Groundwater Levels. Therefore, the potential causes of URs due to Reduction in Groundwater Storage are generally the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels within the SOKR GSP Area.

### 13.2.4. Criteria Used to Define Local Undesirable Results

☑ **23 CCR § 354.26(b)(2)**
☑ **23 CCR § 354.26(c)**

The criteria used to define URs for Reduction of Groundwater Storage in the Basin-wide definition above are the MTs established at a local management area level for Chronic Lowering of Groundwater Levels. Furthermore, MTs set related to Subsidence protect against excessive loss of aquifer storage (and resulting Reduction of Groundwater Storage). Extending this definition to the local management area level, it is considered a local UR for Reduction of Groundwater Storage when groundwater levels decline below established MTs in 40% or more of any water level RMS within the management area over four consecutive bi-annual SGMA required monitoring events. As discussed below in **Section 14.2 *Minimum Threshold for Reduction of Groundwater Storage***, due to the great depth of fresh water and wells able to access it, there is significant usable groundwater storage within the SOKR GSP Area even below the elevation of the MTs. As such, on a local level it is not necessary to define unique SMCs for Reduction of Groundwater Storage; the criteria set for Chronic Lowering of Groundwater Levels are “protective” and a reasonable proxy.

## 13.3. Undesirable Results for Seawater Intrusion

☑ 23 CCR § 354.26(d)

The GSP Emergency Regulations state that "An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators" (23 CCR § 354.26(d)). Because the Kern Subbasin is not located near any saline water bodies, seawater intrusion is not present and not likely to occur, and the Seawater Intrusion Sustainability Indicator is not applicable. Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.

## 13.4. Undesirable Results for Degraded Water Quality

The Basin-wide definition of URs for Degraded Water Quality is as follows:

> "The point at which significant and unreasonable impacts over the planning and implementation horizon, as caused by water management actions, that affect the reasonable and beneficial use of, and access to, groundwater by overlying users.
>
> This is determined when the minimum threshold for a groundwater quality constituent of concern is exceeded in at least three (3) adjacent management areas which represent at least 15% of the subbasin or greater than 30% of the designated monitoring points within the basin. Minimum thresholds shall be set by each of the management areas through their respective Groundwater Sustainability Plans."

As with Chronic Lowering of Groundwater Levels, the above Basin-wide definition allows for local definition, within each management area, of the MTs that constitute a significant and unreasonable impact to the reasonable and beneficial use of, and access to, groundwater by overlying users. Key to the Basin-wide definition is the phrase "as caused by water management actions". This phrase rightfully distinguishes between water quality impacts that are due to GSA-related water management activities (recharge and extraction) and those that are the result of natural conditions or that pre-date SGMA. Because impacts that were present prior to 2015 or that are due to natural conditions are not caused by (and in some cases, cannot be remedied by) GSA action, those impacts are not considered to be URs subject to SGMA compliance.[131,132]

The definition also draws a distinction between localized or isolated (e.g., well specific) effects, that are not necessarily under the purview of GSAs to manage (especially if related to well location and design relative to naturally-occurring or anthropogenically-caused impacts that pre-date SGMA), and broader,

[131] "SGMA and the GSP Regulations do not require a GSP to address undesirable results associated with degraded water quality that occurred before, and have not been corrected by, January 1, 2015." (DWR Consultation Letter, Cuyama Valley 2020 Groundwater Sustainability Plan, 3 June 2021).

[132] "Department staff recognize that GSAs are not responsible for improving existing degraded water quality conditions. GSAs are required; however, to manage future groundwater extraction to ensure that groundwater use subject to its jurisdiction does not significantly and unreasonably exacerbate existing degraded water quality conditions." (DWR Determination Letter, 180/400 Foot Aquifer Subbasin GSP, 3 June 2021).

groundwater management-related regional effects which can fall under a GSA's purview. This approach is both consistent with the SGMA's definition of URs meaning "…effects caused by groundwater conditions occurring throughout the basin" (emphasis added) (CWC § 10721(x)) and reflects the fact that SGMA does not require GSPs to address URs that occurred before, and have not been corrected by, January 1, 2015.

### 13.4.1. Identification of Beneficial Users

*Arvin-Edison Management Area*

As described in **Section 8.5 *Groundwater Quality***, agricultural use is the dominant beneficial use of groundwater within the Arvin-Edison Management Area, and groundwater quality is generally suitable for agricultural uses; therefore, agriculture is not considered a beneficial user for purposes of this analysis. Further, water quality issues related to deep percolation of agricultural chemicals such as nitrate are regulated separately under the Irrigated Lands Regulatory Program (ILRP) and Central Valley-Salinity Alternatives for Long-term Sustainability (CV-SALTS).

The most sensitive beneficial use of groundwater is for potable supply. Groundwater served by public water systems must meet water quality regulatory standards (i.e., Maximum Contaminant Levels; MCLs) and these systems are regulated by the State Water Resources Control Board (SWRCB). Domestic wells are not directly regulated, however. Per CWC §106.3(a), all drinking water users of groundwater within the Management Area are considered beneficial users with a human "right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

As such, beneficial users that could be impacted by Degraded Water Quality in the Arvin-Edison Management Area include:

1) Domestic and Small Community Users: Groundwater is pumped for domestic use by approximately 134 domestic wells.
2) Municipal Users: There are 19 public supply wells.

*Wheeler Ridge-Maricopa Management Area*

As described in **Section 5.1.4.2**, agricultural use is the dominant beneficial user of groundwater identified within the Wheeler Ridge-Maricopa Management Area, and groundwater quality is generally suitable for agricultural uses, with the exception of groundwater on the western side of the management area which has higher total dissolved solids (TDS) and sulfate concentrations due to natural geologic conditions. Therefore, agriculture is not considered a beneficial user for purposes of this analysis. Further, water quality issues related to deep percolation of agricultural chemicals such as nitrate are regulated separately under the ILRP and CV-SALTS.

The most sensitive beneficial use of groundwater is for potable supply. Groundwater served by public water systems must meet water quality regulatory standards (i.e., MCLs) and these systems are regulated by the SWRCB. Domestic wells are not directly regulated, however. Per CWC §106.3(a), all drinking water users of groundwater within the Management Area are considered beneficial users with a human "right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

As such, beneficial users that could be impacted by Degraded Water Quality in the Wheeler Ridge-Maricopa Management Area include:

1) Domestic and Small Community Users: Groundwater is pumped for domestic use by approximately 27 domestic wells.
2) Municipal Users: There is one public supply well.

*Tejon-Castac Management Area*

Beneficial users affected by Degraded Water Quality in the Tejon-Castac Management Area theoretically include the domestic users. However, the three potentially active domestic wells are located in the far eastern upland area, far from the valley floor area where the only non-de minimis pumping occurs. Therefore, it is unlikely that water management actions by the Tejon-Castac Water District (TCWD) GSA could affect groundwater quality conditions at the domestic wells.

### 13.4.2. Potential Effects of Undesirable Results on Beneficial Users

☑ **23 CCR § 354.26(b)(3)**

*Arvin-Edison Management Area*

As discussed above, water quality is generally suitable for the dominant beneficial use within the Arvin-Edison Management Area (i.e., agriculture). Nevertheless, potential effects of Degraded Water Quality could include increased costs to blend relatively poor-quality groundwater with higher quality sources for agricultural use, and limitations on viable crop types or crop yield depending on crop sensitivity and tolerance to Constituents of Concern (COCs) in groundwater used for irrigation. That is why, among other things, AEWSD is actively working to protect and maintain the quality of its surface and groundwater supplies, with a focus on reducing salt loading to the aquifer system by maintaining the quality of its surface water supplies.

Potable use of groundwater has the potential to be affected by Degraded Water Quality. The potential effects of URs caused by Degraded Water Quality on the potable beneficial use may include increased costs to treat or blend groundwater to drinking water standards and/or to procure and provide alternative water supplies to potable users.

*Wheeler Ridge-Maricopa Management Area*

Although water quality is generally suitable for agricultural uses within the Wheeler Ridge-Maricopa Management Area, potential effects of URs caused by Degraded Water Quality on beneficial uses and users of groundwater may include increased costs to treat groundwater to drinking water standards if it is to be used as a potable supply source, increased costs to blend relatively poor-quality groundwater with higher quality sources for agricultural and non-agricultural uses, limitations on viable crop types or crop yield depending on crop sensitivity and tolerance to COCs in groundwater used for irrigation, and potential reduction in “usable storage” volume of groundwater in the basin if large areas of aquifer are impacted to the point that they cannot be used to support beneficial uses and users.

Potable use of groundwater has the potential to be affected by Degraded Water Quality. The potential effects of URs caused by Degraded Water Quality on the potable beneficial use may include increased costs to treat or blend groundwater to drinking water standards and/or to procure and provide alternative water supplies to potable users.

*Tejon-Castac Management Area*

As discussed above, the only significant pumping in the Tejon-Castac Management Area is at the Caratan Well. Degraded Water Quality is not a concern for agricultural and industrial use at this well.

### 13.4.3. Potential Causes of Undesirable Results

☑ **23 CCR § 354.26(b)(1)**

*Arvin-Edison Management Area*

Potential causes of URs due to Degraded Water Quality within the Arvin-Edison Management Area include the continued movement of 'legacy' COCs from soil and vadose zone as well as within the groundwater into wells and excessive addition of COCs to groundwater in the principal aquifer through processes that are causatively related to water management or land use activities. These potential processes include:

- Deep percolation of precipitation, seepage from various natural and man-made channels, and recharge from reservoirs and spreading basins;
- Irrigation system backflow into wells and flow through well gravel pack and screens from one formation to another;[133]
- Deep percolation of excess applied irrigation water[134] and other water applied for cultural practices (e.g., for soil leaching). Potential COCs include salinity, nitrate, and agricultural chemicals;
- Lateral migration from adjacent areas with poorer quality groundwater. Potential COCs include both anthropogenic and natural constituents;
- Leaching from internal sources such as fine-grained, clay-rich interbeds. Potential COCs include arsenic and other constituents associated with fine-grained depositional environments (Smith et al., 2018); and
- Upwards vertical flow from deeper zones below the bottom of the basin. Potential COCs include salinity, petroleum hydrocarbons, and other naturally-occurring constituents.

In the case of deep percolation of precipitation and excess applied irrigation and leaching water, such activities are regulated separately under the ILRP and CV-SALTS. For the last three items listed above, the underlying cause has to do with hydraulic gradients and heads (groundwater levels), and thus the causes are the same as those associated with the URs of Chronic Lowering of Groundwater Levels, discussed above. As discussed in **Section 8.5 *Groundwater Quality*** and shown by the groundwater level and quality graphs included in **Appendix H**, there is no discernable relationship between groundwater levels and groundwater quality trends that is consistent across the Arvin-Edison Management Area. Thus, additional data collection and analysis will be needed to further evaluate this potential relationship and to assess if the water quality issues are something that the Arvin GSA can reasonably address by managing future

[133] Kern County's existing well destruction programs are designed to help minimize cross-connection between aquifer zones and prevent groundwater quality impairments that can result from cross-contamination of aquifer zones.

[134] AEWSD is actively engaged in various local and Basin-level coordination efforts to help protect the quality of its imported surface water supplies (see **Section 5.4 *Additional GSP Elements***).

groundwater extractions to ensure that groundwater use subject to its jurisdiction does not significantly and unreasonably exacerbate existing degraded water quality conditions.[135]

*Wheeler Ridge-Maricopa Management Area*

Potential causes of URs due to Degraded Water Quality in the Wheeler Ridge-Maricopa Management Area are the same as those listed above for the Arvin-Edison Management Area.

Similarly, as discussed in **Section 8.5 *Groundwater Quality*** and shown by the groundwater level and quality graphs included in **Appendix H**, there is no discernable relationship between groundwater levels and groundwater quality trends that is consistent across the Wheeler Ridge-Maricopa Management Area. Thus, additional data collection and analysis will be needed to further evaluate this potential relationship and to assess if the water quality issues are something that the Wheeler Ridge-Maricopa GSA can reasonably address by managing future groundwater extractions to ensure that groundwater use subject to its jurisdiction does not significantly and unreasonably exacerbate existing degraded water quality conditions.

*Tejon-Castac Management Area*

Potential causes of URs due to Degraded Water Quality in the Tejon-Castac Management Area are conditions potentially influenced by extraction and/or recharge, including:

- Lateral migration from adjacent areas with poorer quality groundwater;
- Leaching from internal sources such as fine-grained, clay-rich interbeds; and
- Upwards vertical flow from deeper zones below the bottom of the Basin.

### 13.4.4. Criteria Used to Define Local Undesirable Results

☑ **23 CCR § 354.26(b)(2)**

The Basin-wide definition of URs for Degraded Water Quality provides for local definition of the combination of MT exceedances that constitute and UR in a management area.

Under SGMA, the regulatory authority granted to GSAs includes the management of the quantity, location, and timing of groundwater pumping to prevent URs, namely the "significant and unreasonable" impacts to beneficial users. Water quality within the SOKR GSP Area is generally suitable for agricultural uses; therefore, in order to be considered a "significant and unreasonable" impact, water quality would need to negatively impact potable supply (the most sensitive beneficial user; see above) in a significant portion of the management areas (i.e., not a well-specific issue).

Additionally, per CWC § 10727.2(b)(4), "The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015." Therefore, addressing Degraded Water Quality conditions that existed before 2015 is not under the purview of the GSAs. Further, GSAs are responsible for "management of groundwater quality, groundwater quality degradation, inelastic land

[135] "Department staff recognize that GSAs are not responsible for improving existing degraded water quality conditions. GSAs are required; however, to manage future groundwater extraction to ensure that groundwater use subject to its jurisdiction does not significantly and unreasonably exacerbate existing degraded water quality conditions." (DWR Determination Letter, 180/400 Foot Aquifer Subbasin GSP, 3 June 2021).

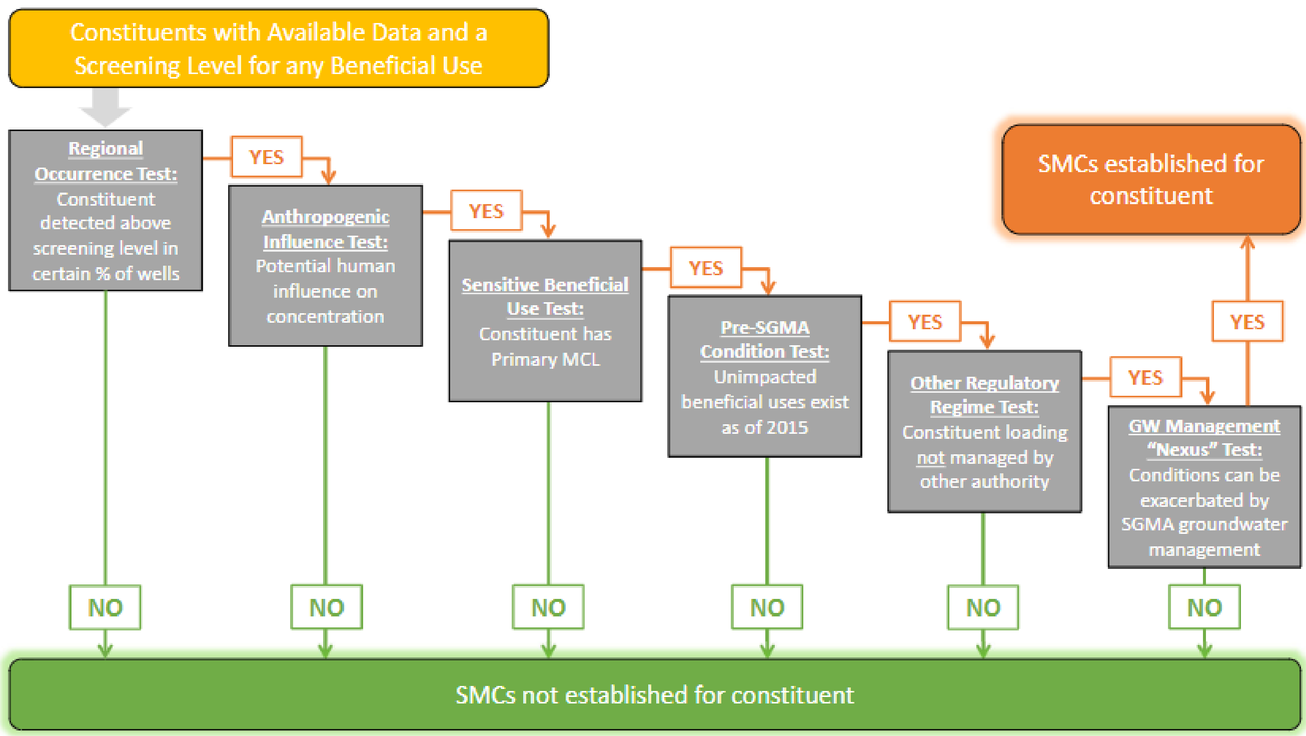
surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin" (CWC § 10727.2(d)(2).

As depicted on ***Figure SMC-4*** and described below, several criteria, or "tests", were utilized by the SOKR GSAs to systematically and transparently assess which COCs warranted the development of SMCs for to be consistent based on the understanding of groundwater conditions, the relationship between groundwater management (i.e., extraction and recharge to water quality), the regulatory landscape, and the above-listed regulations. The SOKR GSAs then only developed SMCs for those COCs that passed all of the following tests. This process notwithstanding, the GSAs are committed to continue to monitor and otherwise evaluate water quality and the COCs as part of on-going SGMA implementation, in coordination with all other Basin GSAs.

- *Regional Occurrence Test:* A COC passes this test if it is detected in at least 15% of wells within a Management Area. The test draws a distinction between localized or isolated (e.g., well specific) effects, that are not necessarily under the purview of GSAs to manage (especially if related to well location and design relative to naturally-occurring or anthropogenically-caused impacts that pre-date SGMA) and is consistent with the SGMA's definition of URs meaning "…effects caused by groundwater conditions occurring throughout the basin" (CWC § 10721(x)).
- *Anthropogenic Influence Test:* This test further draws a distinction between human-influenced versus naturally-occurring effects, that are not necessarily under the purview of GSAs to manage (e.g., as implied by the use of the terms "contamination", "degradation", and "pollution" in the discussion of Degraded Water Quality sustainability indicator in the California Department of Water Resources (DWR) Sustainable Management Criteria Best Management Practices document, all of which relate to human-influenced effects).
- *Sensitive Beneficial Use Test:* A COC passes this test if it has a primary MCL set by the SWRCB, and therefore could have an impact on drinking water users, assuming the COC passes the other "tests".
- *Pre-SGMA Condition Test:* A COC passes this test if unimpacted beneficial users still exist as of 2015 (i.e., impacts are not significant as of the SGMA effective date). Per CWC § 10727.2(b)(4), "The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015." Therefore, addressing Degraded Water Quality conditions that existed before 2015 is not under the purview of the GSAs. However, if beneficial users could be impacted then this COC is still relevant, assuming the COC passes the other "tests".
- *Other Regulatory Regime Test:* A COC passes this test if the constituent loading is not already being managed by another regulatory authority (e.g., ILRP or CV-SALTS), and assuming the COC passes the other "tests".
- *Groundwater Management "Nexus" Test:* A COC passes this test if concentrations are or have the potential to be exacerbated by groundwater management actions taken by the GSAs (i.e., management of groundwater extractions or recharge). GSAs are responsible for "management of groundwater quality, groundwater quality degradation, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin" (CWC § 10727.2(d)(2).

Detailed analysis of the available water quality information in the SOKR GSP Area is presented in **Section 8.5 *Groundwater Quality***; however, per the rationale described and employed herein (see ***Figure SMC-4***, ***Table SMC-5,*** and ***Table SMC-6***), because the focus of SGMA rightfully emphasizes those constituents that may be degraded to groundwater management activities (i.e., extraction and recharge), the only COC applicable for the development of Degraded Water Quality Sustainable Management Criteria within the SOKR GSP Area is arsenic, as discussed further below.

**Figure SMC-4. Considerations for Development of Sustainable Management Criteria for Degraded Water Quality**




The above notwithstanding, extensive and regular monitoring for water quality will be conducted at a set of RMS locations within the SOKR GSP Area, as discussed further in **Section 16.1.4 *Monitoring Network for Degraded Water Quality***.

*<u>Arvin-Edison Management Area</u>*

As discussed in **Section 8.5 *Groundwater Quality***, a detailed analysis of available data was conducted and a correlation between groundwater quality and groundwater levels was not established in the Arvin-Edison Management Area, with the exception of a suspected correlation between groundwater levels and arsenic in the Arvin Community Services District (ACSD) wells(s). Therefore, the available data indicate that groundwater extractions or recharge (i.e., actions that can be managed by Arvin GSA) will not exacerbate degraded water quality conditions for the COCs evaluated in detail in **Section 8.5.1** or increase risks to drinking water beneficial users. Further rationale and considerations related to the setting of SMCs for the identified COCs within the Arvin-Edison Management Area is provided in ***Table SMC-5*** below using the process outlined in ***Figure SMC-4***. It is critically important to note that the COCs identified within the Arvin-Edison Management Area are largely not risks to drinking water beneficial users that have been or are expected to be exacerbated by groundwater management actions under the purview of the Arvin GSA.

**Table SMC-5. Considerations for Development of Degraded Water Quality Sustainable Management Criteria, Arvin-Edison Management Area**

| Constituent of Concern | Regional Occurrence Test | Anthro-pogenic Influence Test | Sensitive Beneficial Use Test | Pre-SGMA Condition Test | Other Regulatory Regime Test | GW Management "Nexus" Test | SMC Developed |
|---|---|---|---|---|---|---|---|
| Arsenic | X | X | X | X | X | X | Yes |
| Boron | X | | | X | X | | No |
| Iron | X | | | X | X | | No |
| Manganese | X | | | X | X | | No |
| Nitrate | X | X | X | X | ILRP | | No |
| TDS | X | X | | X | CV-SALTS | | No |

Abbreviations:
CV-SALTS = Central Valley Salinity Alternative for Long-Term Sustainability
GW = Groundwater
ILRP = Irrigated Lands Regulatory Program
SMC = Sustainable Management Criteria
SGMA = Sustainable Groundwater Management Act
TDS = Total Dissolved Solids

As discussed previously in **Section 8.5 *Groundwater Quality***, in recent years ACSD, which provides M&I supplies to the City of Arvin, has faced issues with arsenic in its groundwater wells for years (i.e., prior to 2015 and SGMA). ACSD's experience indicates that well location and construction, and potentially lowering groundwater levels, impacts water quality, and it is suspected that there is a water level threshold below which certain contaminants will dominate the water quality. However, that water level cannot be identified at this time, and it varies well-to-well and over time. ACSD has recently installed new production wells (see **Section 17 *Projects and Management Actions***) following a process wherein test wells are drilled to identify strata containing arsenic and other naturally-occurring constituents at elevated levels. One new well, Well #14, currently meets drinking water standards for arsenic, but also appears to potentially be affected by lowering groundwater levels although the correlation has not been directly established.

Until additional groundwater level and groundwater quality information is available to refine this definition, it is considered a local UR for Degraded Water Quality within the Arvin-Edison Management Area if the MT is exceeded in 40% or more (i.e., at least 4 of 10) of any water quality RMS within the

Management Area over two consecutive annual SGMA required measurements as a result of groundwater recharge or extraction, such that it cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable). If URs do occur, the Arvin GSA and/or ACSD will take appropriate action to ensure a continued safe water supply for customers (e.g., re-drilling, treatment, and/or investigating additional supply sources).

It is further noted that regulatory oversight authority for ACSD's drinking water quality rests with the SWRCB and the County, not necessarily with the Arvin GSA. Those regulatory oversight and enforcement actions have and will occur on their own mandated timelines. The additional data collection and analysis planned by ACSD will be necessary to further evaluate the potential relationship between local water levels and water quality and to assess if the water quality issues are something that the Arvin GSA can reasonably address by managing future groundwater extractions to ensure that groundwater use subject to its jurisdiction does not significantly and unreasonably exacerbate existing degraded water quality conditions.[136] Similarly, Arvin GSA will continue to monitor the SGMA Monitoring Network to assess the relationship between arsenic (and other COC concentrations) to groundwater extraction and recharge for purposes of SGMA implementation and compliance.

*Wheeler Ridge-Maricopa Management Area*

As discussed in **Section 8.5 *Groundwater Quality***, a detailed analysis of available data was conducted and a correlation between groundwater quality and groundwater levels was not established in the Wheeler Ridge-Maricopa Management Area, indicating that groundwater extractions or recharge will not exacerbate degraded water quality conditions for the COCs evaluated in detail in **Section 8.5.1** or increase risks to drinking water beneficial users. Nevertheless, given the potential correlation between groundwater levels and arsenic concentrations observed elsewhere within the Basin, the Wheeler Ridge-Maricopa GSA has elected to establish SMCs for arsenic within its Management Area. Further rationale and considerations related to the setting of SMCs for the identified COCs within the Wheeler Ridge-Maricopa Management Area is provided in ***Table SMC-6*** below using the process outlined in ***Figure SMC-4***. It is critically important to note that the COCs identified within the Wheeler Ridge-Maricopa Management Area are largely not risks to drinking water beneficial users that have been or are expected to be exacerbated by groundwater management actions under the purview of the Wheeler Ridge-Maricopa GSA.

[136] "Department staff recognize that GSAs are not responsible for improving existing degraded water quality conditions. GSAs are required; however, to manage future groundwater extraction to ensure that groundwater use subject to its jurisdiction does not significantly and unreasonably exacerbate existing degraded water quality conditions." (DWR Determination Letter, 180/400 Foot Aquifer Subbasin GSP, 3 June 2021).

**Table SMC-6. Considerations for Development of Degraded Water Quality Sustainable Management Criteria, Wheeler Ridge-Maricopa Management Area**

| Constituent of Concern | Regional Occurrence Test | Anthro-pogenic Influence Test | Sensitive Beneficial Use Test | Pre-SGMA Condition Test | Other Regulatory Regime Test | GW Management "Nexus" Test | SMC Developed |
|---|---|---|---|---|---|---|---|
| Arsenic | X | X | X | X | X | X | Yes |
| Boron | X | | | X | X | | No |
| Iron | X | | | X | X | | No |
| Manganese | X | | | X | X | | No |
| Nitrate | X | X | X | X | ILRP | | No |
| Sulfate | X | X | | X | X | | No |
| TDS | X | X | | X | CV-SALTS | | No |

Abbreviations:
CV-SALTS = Central Valley Salinity Alternative for Long-Term Sustainability
GW = Groundwater
ILRP = Irrigated Lands Regulatory Program
SMC = Sustainable Management Criteria
SGMA = Sustainable Groundwater Management Act
TDS = Total Dissolved Solids

Until additional groundwater level and groundwater quality information is available to refine this definition, it is considered a local UR for Degraded Water Quality within the Wheeler Ridge-Maricopa Management Area if the MT is exceeded in 40% or more (i.e., at least 4 of 9) of any water quality RMS within the Management Area over two consecutive annual SGMA required measurements as a result of groundwater recharge or extraction, such that it cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable). If URs do occur, the Wheeler Ridge-Maricopa GSA will take appropriate action to ensure a continued safe drinking water supply for customers (e.g., re-drilling, treatment, and/or investigating additional supply sources).

The Wheeler Ridge-Maricopa GSA will continue to monitor the SGMA Monitoring Network to assess the relationship between arsenic (and other COC concentrations) to groundwater extraction and recharge for purposes of SGMA implementation and compliance.

*Tejon-Castac Management Area*

Given the lack of groundwater use and development, there are no degraded water quality conditions that would fall under the purview of the SOKR GSAs. Further, there are no beneficial uses that are expected to be significantly and unreasonably affected by groundwater quality. Therefore, no URs for Degraded Water Quality are defined for the Tejon-Castac Management Area.

## 13.5. Undesirable Results for Land Subsidence

The Basin-wide definition of Undesirable Results for Land Subsidence is as follows:

Section 1: CA Aqueduct

"The California Aqueduct (Aqueduct) has been identified as critical infrastructure on the West side of the Subbasin. The Subbasin definition of an undesirable result for land subsidence is the point at which the amount of inelastic subsidence, if caused by Subbasin groundwater extractions, creates a significant and unreasonable impact to surface land uses or critical infrastructure.

A variety of subsurface conditions and mechanisms, not all completely understood, can cause subsidence. A relatively minor amount of subsidence over a wide area can be insignificant and/or imperceptible, whereas a significant amount of localized subsidence can create an unreasonable impact to overlying infrastructure. Although groundwater extractions for agricultural or other uses have potential under limited conditions to cause subsidence, recent studies conducted by Management Areas on the West side and the KGA have identified soluble soils, natural differential compaction and oil and gas production activities as potential contributors to subsidence along the Aqueduct. None of the subsidence modes besides groundwater extraction for agricultural and other Management Area uses are within the control of Subbasin GSAs. Identifying the subsurface conditions and mechanisms causing subsidence in the Subbasin will be a critical first step to managing current and future impacts and identifying appropriate management actions.

Based on the findings of the 2019 DWR California Aqueduct Subsidence Program Report (CASP) (DWR, 2019), subsidence has reduced freeboard and impacted conveyance capacity in several Aqueduct pools in the Subbasin. Maintaining operating freeboard and conveyance capacity is critical to long-term sustainability of the Aqueduct."

Section 2: Friant-Kern Canal:

"An undesirable result for land subsidence is defined as the point at which the amount of inelastic subsidence, if caused by Subbasin groundwater extractions, creates a significant and unreasonable impact to surface land uses or critical infrastructure. A significant and unreasonable impact to the Friant-Kern Canal (FKC) is determined when the flow capacity through the Lower Reach is reduced to capacities below historical operational flow capacities over the previous 10 years, impacting surface land uses of available water supplies, as a result of groundwater extractions from agricultural, domestic, municipal, or urban beneficial users within the Kern County Subbasin.

The cause of subsidence is attributable to the compaction of underground materials as a result of the lowering of groundwater levels or oil and gas production activities. Other contributing factors can be natural events such as seismic activity, other soil compaction, and residual subsidence. As seen throughout the San Joaquin Valley, subsidence can occur over large regional areas or in smaller localized zones. It can be challenging to determine the cause of subsidence and requires a thorough understanding of all the beneficial uses and user activities occurring in the region and local areas along with the physical geologic structure and character of the aquifer layers.

> Identifying all of the potential factors (local, regional, out of region) contributing to subsidence will be a critical first step to managing current and future impacts and identifying appropriate management actions."

The above Basin-wide definition for Undesirable Results for Land Subsidence refers to significant and unreasonable impacts to Regional Critical Infrastructure. The Kern Subbasin has adopted two classifications for critical infrastructure: Regional Critical Infrastructure and Management Area Critical Infrastructure:

> "Regional Critical Infrastructure is defined as infrastructure located within the Subbasin that serves multiple areas of the Subbasin and whose loss of significant functionality due to inelastic subsidence, if caused by Subbasin groundwater extractions, would have significant impacts to beneficial users. The Subbasin has collectively determined that the only infrastructure that meets the definition for Regional Critical Infrastructure are the California Aqueduct and the Friant-Kern Canal.
>
> Management Area Critical Infrastructure is defined as infrastructure located within a particular Subbasin Management Area whose loss of significant functionality due to inelastic subsidence if caused by Subbasin groundwater extractions would have significant impacts to beneficial users within that Subbasin Management Area. Each Subbasin Management Area has identified their respective Management Area Critical Infrastructure in their Management Area Plan or individual GSP."

### 13.5.1. Identification of Beneficial Users

*Arvin-Edison Management Area*

Within the Arvin-Edison Management Area, AEWSD's surface water conveyance system is considered Management Area Critical Infrastructure because it serves as an integral component of the water supply delivery system for not only local in-district customers, but also for other out-of-district entities that participate in AEWSD's groundwater banking program (e.g., Metropolitan Water District; MWD). There is no Regional Critical Infrastructure within the management area.

*Wheeler Ridge-Maricopa Management Area*

Within the Wheeler Ridge-Maricopa Management Area, the California Aqueduct is considered Regional Critical Infrastructure. The California Aqueduct is the backbone of the State Water Project and is vital to the movement of water from northern California to the south. As such, the Aqueduct is subject to ongoing subsidence monitoring by the DWR, which is anticipated to continue during the SGMA implementation period.

*Tejon-Castac Management Area*

There is no Regional Critical Infrastructure or Management Area Critical Infrastructure within the Tejon-Castac Management Area that could be significantly and unreasonably affected by land subsidence.

### 13.5.2. Potential Effects of Undesirable Results on Beneficial Users

☑ **23 CCR § 354.26(b)(3)**

*Arvin-Edison Management Area*

Potential effects of URs caused by Land Subsidence on beneficial uses and users of groundwater and overlying land uses within the Arvin-Edison Management Area could include damage to gravity-driven water conveyance infrastructure (i.e., AEWSD's canal system) which could impair its ability to move water into, out of, and throughout AEWSD. Land subsidence could also affect non-critical infrastructure such as local water conveyance systems (e.g., AEWSD's pressure pipeline distribution system) and groundwater well heads, discharges, and casings, but those land uses are not considered Regional Critical Infrastructure per the Basin-wide definition which emphasizes regional impacts.

*Wheeler Ridge-Maricopa Management Area*

Potential effects of URs caused by land subsidence on beneficial uses and users of groundwater and overlying land uses within the Wheeler Ridge-Maricopa Management Area could include damage to gravity-driven water conveyance infrastructure (i.e., the California Aqueduct) which could impair its ability to move water to points further south. Land subsidence could also affect non-critical infrastructure such as local water conveyance systems (e.g., the district's pressure pipeline distribution system) and groundwater well casings, but those land uses are not considered Regional Critical Infrastructure per the Basin-wide definition which emphasizes regional impacts.

*Tejon-Castac Management Area*

Because there is no Regional Critical Infrastructure or Management Area Critical Infrastructure within the Tejon-Castac Management Area, there are no potential effects of URs caused by Land Subsidence.

### 13.5.3. Potential Causes of Undesirable Results

☑ **23 CCR § 354.26(b)(1)**

Land Subsidence can be caused by several mechanisms, but the only mechanism relevant to sustainable groundwater management is the depressurization of aquifers and aquitards due to lowering of groundwater levels caused by groundwater extraction, which can lead to compaction of compressible strata and lowering of the ground surface. Therefore, the potential causes of URs due to Land Subsidence are generally the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels.

### 13.5.4. Criteria Used to Define Undesirable Results

☑ 23 CCR § 354.26(b)(2)

The Basin-wide definition of URs refers to significant and unreasonable impacts to Regional Critical Infrastructure which, as noted above, is defined with a regional emphasis.

*Arvin-Edison Management Area*

Recent monitoring has shown some land subsidence impacts to a section of AEWSD's North Canal in the vicinity of the Sycamore Spreading Works. Recognizing the importance of AEWSD's canals to local and regional water supplies, it is considered an UR to continue substantially degrading canal capacity, level management, or in-canal balancing volume. That being said, it is also recognized that due to the inherent time lag of the aquitard depressurization process, there may still be some "built-in" subsidence potential that has yet to manifest. It is therefore unrealistic to define the UR as "any further land subsidence", as such an outcome would almost certainly be unavoidable, and would prevent achievement of the Sustainability Goal. Therefore, it is considered significant and unreasonable if land subsidence were to occur at rates in excess of those rates observed during the 2014-2018 period.[137]

Given the variability in subsidence throughout the Arvin-Edison Management Area, it is appropriate to incorporate a fraction of monitoring sites in the definition of URs, similar to how URs are defined for Chronic Lowering of Groundwater Levels. For Land Subsidence, it is considered a local UR if the Minimum Threshold extent of subsidence is exceeded in at least 40% (i.e., 2 of 5) of the local survey benchmark locations along the canal system within the Arvin-Edison Management Area. The Minimum Threshold is described in **Section 14.5 *Minimum Threshold for Land Subsidence*.**

*Wheeler Ridge-Maricopa Management Area*

Recent monitoring has shown some land subsidence impacts to the section of the Aqueduct within the Wheeler Ridge-Maricopa Management Area. It is considered significant and unreasonable for land subsidence to continue indefinitely in the vicinity of the Aqueduct. For the same reasons mentioned above, it is unrealistic to define the UR as "any further land subsidence", as such an outcome would almost certainly be unavoidable. Therefore, the UR for land subsidence is defined based on exceedance of a Minimum Threshold subsidence extent which is based on historical observations of subsidence rates along the California Aqueduct.

For Land Subsidence, it is considered a local UR if the Minimum Threshold extent of subsidence is exceeded in any one (1) of the four (4) Aqueduct pools located within the Wheeler Ridge-Maricopa Management Area (i.e., Pools 32 through 35, between Mileposts 256.14 [Check No. 31] and 278.13 [Teerink Pumping Plant]).[138] The Minimum Threshold is described in **14.5 *Minimum Threshold for Land Subsidence.***

[137] Sections of the North Canal impacted by localized land subsidence were raised in 2018 and designed for future raising, if necessary, in an effort to reduce cost. These sections could be raised again as part of land subsidence mitigation and thus the future subsidence along these reaches is not considered to be an "Undesirable Result" unless subsidence rates exceed those observed through the 2014-2018 period.

[138] As shown in Table 6-7 of DWR (2017).

*Tejon-Castac Management Area*

Because subsidence has not been an issue historically and there is no significant groundwater development other than the industrial and agricultural uses of the Caratan Well, land subsidence is unlikely to occur within the Tejon-Castac Management Area. Furthermore, the MT value for Chronic Lowering of Groundwater Levels is defined so as to be protective against possible land subsidence by being limited to levels that are generally no lower than historical lows.

## 13.6. Undesirable Results for Depletions of Interconnected Surface Water

The GSP Emergency Regulations state that "An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators" (23 CCR § 354.26(d)). To-date no Basin-wide definition of URs for Depletions of Interconnected Surface Water has been developed by the Kern Subbasin GSAs. Based on available data and information, groundwater conditions in the Subbasin show that Interconnected Surface Water is not present within the Basin and is not anticipated to be present in the future. Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.

## 13.7. Undesirable Results Summary

***Table SMC-7*** provides a summary of the local definitions of URs for each Sustainability Indicator for the SOKR GSP.

**Table SMC-7. Summary of Undesirable Results Definitions**

| Sustainability Indicator | Undesirable Results Definitions within the Arvin-Edison Management Area | Undesirable Results Definitions within the Wheeler Ridge-Maricopa Management Area | Undesirable Results Definitions within the Tejon-Castac Management Area |
|---|---|---|---|
| Chronic Lowering of Groundwater Levels | Minimum Threshold exceedance in 40% (i.e., 7 of 16) or more of RMS over four consecutive bi-annual SGMA required monitoring events. | Minimum Threshold exceedance in 40% (i.e., 6 of 14) or more of RMS over four consecutive bi-annual SGMA required monitoring events. | Minimum Threshold exceedance in 40% (i.e., 1 of 1) or more of RMS over four consecutive bi-annual SGMA required monitoring events. |
| Reduction of Groundwater Storage | UR definition based on use of Chronic Lowering of Groundwater Levels used as a proxy. | UR definition based on use of Chronic Lowering of Groundwater Levels used as a proxy. | UR definition based on use of Chronic Lowering of Groundwater Levels used as a proxy. |
| Seawater Intrusion | No Basin-wide or local UR definition. | | |
| Degraded Water Quality | Minimum Threshold exceedance in 40% or more (i.e., 4 of 10) RMS over two consecutive annual SGMA required monitoring events. | Minimum Threshold exceedance in 40% or more (i.e., 4 of 9) RMS over two consecutive annual SGMA required monitoring events. | No local UR definition. |
| Land Subsidence | Minimum Threshold exceedance in at least 40% (i.e., 2 of 5) of the local survey benchmark locations along the canal system within the Arvin-Edison Management Area. | Minimum Threshold exceedance at any one (1) of the four (4) Aqueduct pools located within the Wheeler Ridge-Maricopa Management Area. | No local UR definition. |
| Depletions of Interconnected Surface Water | No Basin-wide or local UR definition. | | |

## 14. MINIMUM THRESHOLDS

☑ 23 CCR § 354.28(a)

Minimum Thresholds (MTs) are the numerical criteria for each Sustainability Indicator that, if exceeded, may cause Undesirable Results (URs). This section describes the MTs that have been developed to avoid URs for each applicable Sustainability Indicator in the South of Kern River Groundwater Sustainability Plan (SOKR GSP) Area. The SOKR Groundwater Sustainability Agencies (GSAs) have developed these MTs in coordination with each other and the other Kern County Subbasin (Kern Subbasin or Basin) GSAs.

As shown in ***Table SMC-8***, MTs within the SOKR GSP Area are defined at different spatial scales and locations, or not at all, depending on the Sustainability Indicator. Where appropriate, MTs for certain Sustainability Indicators have been set using groundwater levels as a proxy, based on demonstration "that there is a significant correlation between groundwater levels and the other metrics" (California Department of Water Resources [DWR], 2017c).

Summaries of all Sustainable Management Criteria (SMCs), including URs, MTs, and Measurable Objectives (MOs), for each management area can be found in ***Table SMC-2***, ***Table SMC-3***, and ***Table SMC-4.***

**Table SMC-8. Spatial Scale of Minimum Threshold Definition**

| Sustainability Indicator | Spatial Scale of Minimum Threshold Definition | Notes |
|---|---|---|
| **Arvin-Edison Management Area** | | |
| Chronic Lowering of Groundwater Levels | Sustainability Criteria Zones | Four Sustainability Criteria Zones are defined; Groundwater levels will be measured at 16 Representative Monitoring Sites (RMS, i.e., wells). |
| Reduction of Groundwater Storage | No MT defined | Chronic Lowering of Groundwater Levels will be used as a proxy. |
| Seawater Intrusion | No MT defined | Sustainability Indicator not applicable within the Kern Subbasin. |
| Degraded Water Quality | Representative Monitoring Sites | Groundwater quality for Sustainable Groundwater Management Act (SGMA) compliance will be monitored at ten RMS, including three RMS in Arvin Community Services District [ACSD] (Well #14) and seven additional RMS spatially distributed throughout the Management Area. |

| Sustainability Indicator | Spatial Scale of Minimum Threshold Definition | Notes |
|---|---|---|
| Land Subsidence | Representative Monitoring Sites (1) | Land surface elevation will be monitored at a network of five benchmarks distributed along Arvin-Edison Water Storage District's (AEWSD) water conveyance facilities. |
| Depletion of Interconnected Surface Water | No MT defined | Sustainability Indicator not applicable within the Basin. |
| **Wheeler Ridge-Maricopa Management Area** | | |
| Chronic Lowering of Groundwater Levels | Sustainability Criteria Zones | Three Sustainability Criteria Zones are defined; Groundwater levels will be measured at 14 RMS (i.e., wells). |
| Reduction of Groundwater Storage | No MT defined | Chronic Lowering of Groundwater Levels will be used as a proxy. |
| Seawater Intrusion | No MT defined | Sustainability Indicator not applicable within the Kern Subbasin. |
| Degraded Water Quality | Representative Monitoring Sites | Groundwater quality for SGMA compliance will be monitored at nine RMS spatially distributed throughout the Management Area. |
| Land Subsidence | California Aqueduct pools | Ground surface elevations will be monitored by DWR at a network of 40 benchmark locations along the California Aqueduct. The MT is defined and monitored based on an average of measurements collected within each Aqueduct pool. |
| Depletion of Interconnected Surface Water | No MT defined | Sustainability Indicator not applicable within the Kern Subbasin. |

| Sustainability Indicator | Spatial Scale of Minimum Threshold Definition | Notes |
|---|---|---|
| **Tejon-Castac Management Area** | | |
| Chronic Lowering of Groundwater Levels | Representative Monitoring Sites | Groundwater levels will be measured at one Representative Monitoring Site (i.e., well). |
| Reduction of Groundwater Storage | No MT defined | Chronic Lowering of Groundwater Levels will be used as a proxy. |
| Seawater Intrusion | No MT defined | Sustainability Indicator not applicable within the Kern Subbasin. |
| Degraded Water Quality | No MT defined | Sustainability Indicator not applicable within the Tejon-Castac Management Area. |
| Land Subsidence | No MT defined | No critical infrastructure within the Tejon-Castac Management Area; Groundwater level MTs are set to be protective of potential subsidence. |
| Depletion of Interconnected Surface Water | No MT defined | Sustainability Indicator not applicable within the Kern Subbasin. |

Note:

(1) The local land subsidence RMS are supplemental to the basin-wide subsidence monitoring network being implemented, as discussed in as discussed in the Coordination Agreement and appendices thereto.

## 14.1. Minimum Threshold for Chronic Lowering of Groundwater Levels

☑ **23 CCR § 354.28(c)(1)**

Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator, as it influences several other key Sustainability Indicators, including Reduction of Groundwater Storage, Land Subsidence, and in certain ways, Degraded Water Quality. Groundwater levels are also the most readily available and measurable metrics of groundwater conditions, which allows for a systematic, data-driven approach to development of MTs to be applied.

### 14.1.1. Minimum Threshold Development

☑ **23 CCR § 354.28(c)(1)(A)**
☑ **23 CCR § 354.28(c)(1)(B)**

The SOKR GSAs developed MTs using common data and methodologies. Consistent with the GSP Emergency Regulations (23 California Code of Regulations [CCR] § 354.28(c)), the definition of MTs for Chronic Lowering of Groundwater Levels in the SOKR GSP is based on consideration of trends in historical groundwater levels, water year types, projected water use in the SOKR GSP Area, impacts to beneficial users, and the relationship to other Sustainability Indicators and other considerations. Specifically, the information and criteria relied on to establish the MTs for Chronic Lowering of Groundwater Levels includes:

- Historical water level data from the selected RMS (or nearby wells), each of which has a long-term historical record of water levels;[139]
- The proximity to critical infrastructure (i.e., for consideration of potential land subsidence impacts);
- Well construction information (i.e., for consideration of impacts to beneficial users); and
- Coordination with and consideration of adjacent GSAs, basins, and the other applicable Sustainability Indicators.

This information was used to develop initial MT estimates using a quantitative algorithm that accounted for trends, historical lows, and water level variability. Then, these initial MT estimates were mapped and generalized spatially to create "Sustainability Criteria Zones". This approach allowed for the most complete and representative historical water level information to inform the MTs, while also allowing for the possibility that different wells (i.e., other than those with the best historical records) could be used as RMS (which did occur in multiple locations in the Wheeler Ridge-Maricopa Management Area).

As discussed below in **Section 14.1.2.3**, due to limited historical water level data, Tejon-Castac Management Area did not directly use the methods described in this section but rather set the MT at its single Representative Monitoring Site equal to that used in the Arvin-Edison Management Area for the nearest RMS. Therefore, the single MT set in the Tejon-Castac Management Area is directly coordinated with those set in the rest of the SOKR GSP Area.

*Minimum Threshold Algorithm*

☑ **23 CCR § 354.28(b)(1)**

The initial MT estimates for Chronic Lowering of Groundwater Levels were developed for each long-term hydrograph well location through development and application of an algorithm that considers the above information, as follows:

- Historical low water levels over a relevant time period are used as a starting point for MTs based

[139] The representativeness of the wells with long-term hydrograph records is illustrated on ***Figure SMC-5*** and ***Figure SMC-6***, which shows the Fall 2015 groundwater level at each well compared to the average Fall 2015 groundwater elevation by Public Land Survey System (PLSS) section for all sections "associated with" (i.e., closest to) each long-term hydrograph location. The figure shows that the percent difference in water level in the local area around each well is small in most cases, indicating that the well is representative of that local area.

on the fact that significant and unreasonable impacts to beneficial uses and users of groundwater due to groundwater levels are not known to have occurred since the time when water levels were at their historical low. The relevant time period for historical low determination is defined as Water Year (WY) 1966 – 2018 for the following reasons:

  - The assumed upper-end usable lifespan of groundwater wells is approximately 50 years, and therefore most wells would likely not have experienced conditions prior to about 50 years ago;
  - AEWSD and Wheeler Ridge-Maricopa Water Storage District (WRMWSD) began importing water in 1966 and 1971, respectively, an action that represented a significant change to water management in this part of the Kern Subbasin; and
  - The relevant time period includes conditions observed up to "present" (Fall 2018).

- Variability in groundwater levels is accounted for by calculating a "Variability Correction Factor" as the product of the observed water level range over a relevant time period and a "Range Fraction". This Variability Correction Factor is applied to the historical low (as discussed below) and acknowledges the fact that different locations have experienced different amounts of water level variability.
  - The time period for water level range determination is defined as WY 1995 – 2015 for the following reasons:
    - The 21-year length of this period is roughly the same as the 20-year SGMA implementation period, and therefore the SGMA implementation period is expected to include a similar range of variability as the groundwater level range period;
    - The period includes a mix of wet and dry years and so variability in groundwater levels during this time should be reflective of variable climate;
    - The period is climatically close to the long-term average for precipitation and Kern River Flow (Todd Groundwater, 2016); and
    - This period is the same as the historical and current water budget period of interest defined by the other Kern Subbasin GSAs, and therefore water budget and model results are available for this period.
  - The Range Fraction is set at 25% as a conservative allowance for water level fluctuation within a well.
- Recent trends in groundwater levels and projected water use are accounted for by extending the trend for a certain amount of time (the "Trend Extension Period") to determine a "Trend Continuation Factor". This factor is also applied to historical low water levels (as discussed below) in order to avoid rapid disruption to land uses and allow time for implementation of any Projects and/or Management Actions (P/MAs) needed to eliminate declining trends.
  - The time period for water level trend calculation is defined as WY 2009 – 2018 for the following reasons:
    - This period reflects the effects of changes to State Water Project (SWP) and Central Valley Project (CVP) deliveries resulting from Delta-related federal District Court rulings and initial implementation of the San Joaquin River Restoration Program; and

        - The period includes the recent significant drought, and therefore allows the Trend Continuation Factor to incorporate the possibility of another long-term drought in the future (e.g., potentially exacerbated by climate change), consistent with the basin-level UR definition for Reduction in Groundwater Storage.
    - The Trend Extension Period was set to ten years for the following reasons:
        - This length of time is considered reasonable and necessary to implement the various P/MAs that may be required to reverse declining groundwater level trends, in consideration of the potential regulatory, environmental, logistical, engineering, socioeconomic and other challenges that the various P/MAs may entail, as well as the time that such measures would likely take to manifest in observed groundwater level conditions; and
        - This length of time is half the duration of the SGMA implementation period, suggesting that by the halfway point, the SOKR GSP Area should be on a trajectory towards achieving the Sustainability Goal.
- Using the above values (i.e., the Historical Low, the Variability Correction Factor, and the Trend Continuation Factor), the initial MT estimates for Chronic Lowering of Groundwater Levels at each long-term hydrograph location were calculated as the lower of: (a) the historic low groundwater level minus the Variability Correction Factor), and (b) the recent (Fall 2015) groundwater level minus the greater of either the Variability Correction Factor or the Trend Continuation Factor. In mathematical terms, the algorithm for defining the initial MT estimates for Chronic Lowering of Groundwater Levels at each long-term hydrograph location is as follows:

$$MT = min\begin{cases} HL - VCF \\ Recent - max\begin{cases} VCF \\ TCF \end{cases} \end{cases}$$

$$VCF = Range * 25\%$$

$$TCF = Trend * 10\ yrs$$

where:

$MT$ is the initial Minimum Threshold estimate (feet above mean sea level [ft msl]);

$HL$ is the historical low groundwater level over the WY 1965 – 2018 period (ft msl);

$VCF$ *is* the Variability Correction Factor (ft);

$TCF$ is the Trend Continuation Factor (ft);

$Recent$ is the Fall 2015 groundwater level (ft msl);

$Range$ is the water level range over the WY 1995 – 2015 period; and

$Trend$ is the groundwater level trend over the 2009 – 2015 period (ft/yr).

*Adjustment in Areas Proximal to Critical Infrastructure*

☑ **23 CCR § 354.28(b)(2)**
☑ **23 CCR § 354.28(b)(4)**

In areas proximal to critical infrastructure, as defined in **Section 13.5**, that may be particularly sensitive to significant and unreasonable effects from land subsidence (discussed further below), an adjustment to the initial MT estimates was applied in the algorithm to keep the values at historical low groundwater levels. Specifically, for long-term hydrograph locations that were within one mile of critical infrastructure, the initial MT estimates were set to their historical low groundwater levels, as this theoretically prevents any further subsidence from occurring. Results from the initial MT estimation exercise described above are shown on ***Figure SMC-7*** and ***Figure SMC-8***.

*Spatial Generalization into Sustainability Criteria Zones*

Once the initial MT estimates for the long-term hydrograph locations were calculated using the algorithm described above, they were plotted on a map and examined for spatial patterns that could be used to generalize the values into zones. The purpose of this step was to allow flexibility in the selection of RMS for this Sustainability Indicator, recognizing the possibility that not all wells with long-term hydrograph data would be available for use in the SGMA Monitoring Network. It was determined that the Arvin-Edison Management Area could be divided into four zones, referred to as the North Canal, Edison, ACSD, and South Canal zones, as shown on ***Figure SMC-7***. The Wheeler Ridge-Maricopa Management Area was divided into three zones, referred to as the Western, Northeastern, and Southeastern zones, as shown on ***Figure SMC-8***.

*Well Impacts Analysis*

After defining sustainability criteria zones, a well impacts analysis was performed to evaluate the potential risk of well dewatering under the MTs proposed for each Management Area. Specifically, well construction information was compiled from DWR's Well Completion Report (WCR) database[140] for all known domestic, production (agricultural), and public supply wells within each Management Area. Well depths were subsequently compared to MT groundwater elevations proposed for each sustainability criteria zone to quantify how many wells would likely be dewatered if groundwater levels dropped to the MT within that zone. For this analysis, a well was considered to be "dewatered" if the total depth of the well was less than the MT groundwater elevation specified within its corresponding sustainability criteria zone.[141] Dewatered well counts were summarized by well type and zone, and were compared to total well counts from the WCR database to calculate the dewatered well fraction (%) within each sustainability criteria zone.

A coupled well age analysis was also performed to help assess if the dewatered well fractions under MT groundwater conditions could be considered a significant and unreasonable impact affecting the reasonable and beneficial use of, and access, to groundwater, per the Basin-wide UR definition and consistent with the human right to water specified under CWC §106.3(a)[142]. Specifically, well completion dates were compiled from the WCR database and used to estimate a "natural well replacement rate" within each Management Area. Here, the "natural well replacement rate" was defined as the total fraction of wells that would reach the end of their usable lifespan (i.e., will be at least 50 years old) by the SGMA implementation deadline (i.e., 1 January 2040) and would thus likely need to be replaced due to their age, irrespective of future groundwater conditions. It was then considered significant and unreasonable if the

[140] https://water.ca.gov/Programs/Groundwater-Management/Wells/Well-Completion-Reports
[141] Wells that were already "dewatered" under Fall 2015 groundwater conditions were excluded from the analysis.
[142] CWC §106.3(a) specifies that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

dewatered well fraction under MT groundwater conditions exceeded the natural well replacement rate within each Management Area over the 20-year SGMA implementation period.

Results from the well impact analysis are discussed by Management Area below in **Section 14.1.2** and shown on ***Figure SMC-9***, ***Figure SMC-10***, ***Figure SMC-11***, and ***Figure SMC-12***. Through this analysis it was determined that although the proposed groundwater elevation MTs would potentially result in some wells being dewatered within each Management Area, the impacts would not be considered significant and unreasonable per the definition above. Furthermore, the SOKR GSAs have committed to mitigating potential impacts of dewatering on domestic wells that may occur as a result of SGMA implementation by establishing an *Impacted Well Mitigation Program*, to be developed as part of GSP Implementation (see **Section 18.1 *Plan Implementation Activities***). Collectively, the well impacts analysis and the commitment by the SOKR GSAs to establish a Impacted Well Mitigation Program demonstrate how the interests of beneficial uses and users of groundwater were considered during development of the MTs for Chronic Lowering of Groundwater Levels.

### 14.1.2. Final Minimum Thresholds

The final MTs for Chronic Lowering of Groundwater Levels for the entire SOKR GSP Area are shown in ***Table SMC-9*** and ***Figure SMC-13*** and a discussion of how these MTs will avoid significant and unreasonable impacts is provided below.

#### 14.1.2.1. Arvin-Edison Management Area

The final MTs for Chronic Lowering of Groundwater Levels in each Sustainability Criteria Zone and at each Representative Monitoring Site in the Arvin-Edison Management Area are shown in ***Table SMC-9*** and on ***Figure SMC-14.***

*Relationship with Other Sustainability Indicators*

**☑ 23 CCR § 354.28(b)(2)**

As previously discussed, Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage are directly, if not linearly, related. Therefore, groundwater levels are used as a proxy for the Reduction of Groundwater Storage Sustainability Indicator. As described in detail in **Section 14.2**, the MTs will not result in a significant and unreasonable loss of groundwater storage.

Based on available data, no direct correlation can be discerned between Chronic Lowering of Groundwater Levels and Degraded Water Quality within the Arvin-Edison Management Area at this time (discussed further in **Section 14.4**).

As previously discussed, the initial MT estimates for Chronic Lowering of Groundwater Levels were set to historical low groundwater levels in the six RMS within one mile of critical infrastructure, in consideration of the relationship between groundwater levels and land subsidence.

As discussed above, both Seawater Intrusion and Interconnected Surface Water are not applicable Sustainability Indicators within the Arvin-Edison Management Area.

*Consideration of Adjacent Basins*

☑ **23 CCR § 354.28(b)(3)**

The MTs for Chronic Lowering of Groundwater Levels have been developed in consideration of and in coordination with neighboring water agencies within the Kern Subbasin (see **Section 5.5.5 *Interagency Coordination***) and in neighboring basins (see **Section 5.5.6 *Interbasin Coordination*).** Through its membership in the White Wolf GSA (along with WRMWSD and Tejon-Castac Water District [TCWD]), AEWSD has and will continue to coordinate the development of SMCs within in the Arvin-Edison Management Area with the White Wolf GSA in order to minimize any impacts on the adjacent White Wolf Basin's ability to achieve its Sustainability Goal.

*Impact to Beneficial Users*

☑ **23 CCR § 354.28(b)(4)**

One factor to consider when setting MTs for Chronic Lowering of Groundwater Levels is the potential for dewatering of wells or well screens (DWR, 2017c). As described in **Section 14.1.1** and shown on ***Figure SMC-12***, using available well construction information for domestic, production (agricultural), and public supply wells, an assessment was made of the number of wells that could be dewatered at the MT. This well impact analysis shows that the proposed MTs could potentially result in dewatering of 9% of domestic wells, 5% of production wells, and 5% of public supply wells.

In order to determine whether these rates of well dewatering would cause significant and unreasonable effects on beneficial users, the Arvin GSA conducted a well age analysis (see **Section 14.1.1** and ***Figure SMC-15***) to compare the rates of potential dewatering to the natural replacement rate of wells within the Arvin-Edison Management Area. The well age analysis showed that 67% of domestic wells, 72% of production wells, and 61% of public supply wells would be older than 50 years by 2040 and would likely have to be replaced, irrespective of SGMA.

As such, effects to beneficial users would not be significant and unreasonable as long as the rate of well dewatering does not exceed natural replacement rates. Given that the estimated rate of well impacts at the proposed MT levels (i.e., a maximum of 9%) is significantly lower than the estimated natural replacement rate (~60-70%), the Arvin GSA determined that the proposed MTs would not cause significant and unreasonable impacts. Further, the Arvin GSA plans to mitigate impacts to domestic and public supply wells through implementation of an Impacted Well Mitigation Program (discussed further in **Section 18.1.6**).

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

There are no state, federal, or local standards pertaining to groundwater levels in the Arvin-Edison Management Area.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

Groundwater levels will be measured in each of the 16 RMS semiannually using the monitoring protocols outlined in **Section 16.2**.

14.1.2.2. Wheeler Ridge-Maricopa Management Area

The final MTs for Chronic Lowering of Groundwater Levels in each Sustainability Criteria Zone and at each Representative Monitoring Site in the Wheeler Ridge-Maricopa Management Area are shown in ***Table SMC-9*** and on ***Figure SMC-16***.

*Relationship with Other Sustainability Indicators*

☑ **23 CCR § 354.28(b)(2)**

As previously discussed, Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage are directly, if not linearly, related. Therefore, groundwater levels are used as a proxy for the Reduction of Groundwater Storage Sustainability Indicator. As described in detail in **Section 14.2**, the MTs will not result in a significant and unreasonable loss of groundwater storage.

Historical monitoring data show no discernible and consistent correlation between Chronic Lowering of Groundwater Levels and Degraded Water Quality in the Wheeler Ridge-Maricopa Management Area.

As previously discussed, the initial MT estimates for Chronic Lowering of Groundwater Levels were set to historical low groundwater levels in the three RMS within one mile of critical infrastructure, in consideration of the relationship between groundwater levels and land subsidence.

As discussed above, both Seawater Intrusion and Interconnected Surface Water are not applicable Sustainability Indicators within the Wheeler Ridge-Maricopa Management Area.

*Consideration of Adjacent Basins*

☑ **23 CCR § 354.28(b)(3)**

The MTs for Chronic Lowering of Groundwater Levels have been developed in consideration of and in coordination with neighboring water agencies within the Kern Subbasin (see **Section 5.5.5 *Interagency Coordination***) and in neighboring basins (see **Section 5.5.6 *Interbasin Coordination***). Through its membership in the White Wolf GSA (along with AEWSD and TCWD), WRMWSD has and will continue to consider the effects of Sustainability Criteria in the Wheeler Ridge-Maricopa Management Area on the adjacent White Wolf Basin's ability to achieve its Sustainability Goal.

*Impact to Beneficial Users*

☑ **23 CCR § 354.28(b)(4)**

As detailed in **Section 14.1.1**, based on the best available information, historical low groundwater levels are not known to have caused significant and unreasonable impacts the beneficial uses and users of groundwater Wheeler Ridge-Maricopa Management Area. Specifically, under the assumption that historical low water levels occurred in Fall 1971, just prior to the start of surface water imports by WRMWSD (which is generally supported by the long-term hydrographs shown on ***Figure GWC-11***), historic groundwater elevation lows from Fall 1971 were compared to well top of screen (TOS) data (***Figure SMC-***

***17*** and ***Figure SMC-18(a)***).[143] Wells in the western and northern portions of the Wheeler Ridge-Maricopa Management Area tended to be less impacted than wells in the central portion, due to variability in well construction.

To assess potential vulnerability due to drought under the current water supply regime (i.e., since surface water imports have been in effect), groundwater levels from Fall 2016 were compared to the TOS data (***Figure SMC-18*** (b)).[144] As this analysis was focused on assessing recent and future potential impact, only wells known to be active are shown.

Of the four active domestic wells for which WRMWSD has well screen data, one showed groundwater elevations more than 100 ft below the TOS elevation, two showed groundwater elevations between 50 and 100 feet below the TOS, and one showed groundwater elevations between 100 and 200 feet above the TOS. Of the 30 active agricultural production wells (including 28 private wells and two WRMWSD wells) for which WRMWSD has well screen data, groundwater levels were below the TOS for 10 wells and were within 50 ft of the TOS for four other wells. None of the wells was dewatered.

One factor to consider when setting MTs for Chronic Lowering of Groundwater Levels is the potential for dewatering of wells or well screens (DWR, 2017c). The well impact analysis described above in **Section 14.1.1** and shown on ***Figure SMC-12*** shows that the proposed MTs could potentially result in 22% of domestic wells, 2% of production wells, and 0% of public supply wells being dewatered. As described in **Section 14.1.1** and shown on ***Figure SMC-19***, the Wheeler Ridge-Maricopa GSA also conducted a well age analysis to compare the rates of dewatering to the natural replacement rate of wells within the Wheeler Ridge-Maricopa Management Area. The well age analysis showed that 42% of domestic wells, 58% of production wells, and 0% of public supply wells would be older than 50 years by 2040 and would likely have to be replaced, irrespective of SGMA. As such, effects to beneficial users would not be significant and unreasonable as long as the rate of well dewatering of domestic wells would not exceed natural replacement rates. Further, impacts could be prevented and/or mitigated through an Impacted Well Mitigation Program (discussed further in **Section 18.1.6**).

The above notwithstanding, the lack of complete well screen data currently prevents a comprehensive analysis of impacts of lowering groundwater levels on wells in the Wheeler Ridge- Maricopa Management Area.[145] To better understand the potential impacts of groundwater level changes on active wells, it would be necessary to acquire and compile data on well screen interval information for additional domestic, agricultural, and industrial wells. Additionally, it would be necessary to update data on well status (i.e., whether or not the well is active) to determine potential impacts to existing wells, as district data show that the status of some wells was most recently assessed in January 1991.

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[143] Groundwater elevation data used are interpolated values in order to include all wells for which the District has well screen data in the analysis, as opposed to only those with both well screen and Fall 1971 groundwater elevation records.

[144] Data from Fall 2016, near the end of the recent historic drought, were used to understand the extent of drought impacts.

[145] WRMWSD records indicate that there are thirteen active domestic wells in the Wheeler Ridge-Maricopa Management Area; WRMWSD has well screen data compiled for four of these wells. There are 74 active agricultural production wells within the Management Area, not including WRMWSD's own production wells, and WRMWSD has well screen data for 28 of these and is lacking well screen data for 46. There are three active WRMWSD production wells in the Management Area (WRMWSD has thirteen additional active production wells in its area within the White Wolf Basin), and WRMWSD has well screen information for two of these wells. WRMWSD also lacks well screen information for the one active industrial well in the Management Area.

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

There are no state, federal, or local standards pertaining to groundwater levels in the Wheeler Ridge-Maricopa Management Area.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

Groundwater levels will be measured in each of the 14 RMS within the Wheeler Ridge-Maricopa Management area semiannually using the monitoring protocols outlined in **Section 16.2**.

#### 14.1.2.3. Tejon-Castac Management Area

The MT for Chronic Lowering of Groundwater Levels in the single Representative Monitoring Site in the Tejon-Castac Management Area is set at 50 ft msl (***Figure SMC-20***). This value is based on the approximate average historical low groundwater level for wells within the Arvin-Edison Management Area to the west of the Tejon-Castac Management Area that are nearest to the Representative Monitoring Site, the reason being that no historical water level data otherwise exist in this portion of the Tejon-Castac Management Area. As described above, in the Arvin-Edison Management Area, the method used to set MTs for water levels is informed by historical water level data, including trends and the size of the historical range, as well as consideration of historical lows in the areas near certain critical infrastructure at risk of significant and unreasonable effects from subsidence and of other beneficial uses and users of groundwater.

*Relationship with Other Sustainability Indicators*

☑ **23 CCR § 354.28(b)(2)**

As previously discussed, Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage are directly, if not linearly, related. Therefore, groundwater levels are used as a proxy for the Reduction of Groundwater Storage sustainability indicator. Groundwater levels are also used as a proxy for Land Subsidence, as there is no critical infrastructure within the Tejon-Castac Management Area, and MT groundwater levels are set to be protective of potential subsidence impacts.

As discussed above, the Degraded Water Quality, Seawater Intrusion, and Interconnected Surface Water Sustainability Indicators are not applicable to the Tejon-Castac Management Area.

*Consideration of Adjacent Basins*

☑ **23 CCR § 354.28(b)(3)**

MTs have been developed in consideration of and in coordination with neighboring water agencies within the Kern Subbasin (see **Section 5.5.5 *Interagency Coordination***) and in neighboring basins (see **Section 5.5.6 *Interbasin Coordination***). Through its membership in the White Wolf GSA (along with AEWSD and WRMWSD), TCWD has and will continue to consider the effects of Sustainability Criteria in the Tejon-Castac Management Area on the adjacent White Wolf Basin's ability to achieve its Sustainability Goal.

*Impact to Beneficial Users*

☑ **23 CCR § 354.28(b)(4)**

A well impact analysis was conducted that showed that the proposed MT would entail partial dewatering of the single active industrial/agricultural well's 364-ft screen. However, there would still be more than 300 feet of saturated thickness remaining. Based on the response of the well's owner to the Stakeholder Survey, historical low groundwater levels are not known to have caused significant and unreasonable impacts to beneficial uses and users of groundwater. No non-de minimis groundwater extraction occurs or is likely to occur in the vicinity of the three potentially active domestic wells in the far eastern upland portion of the Tejon-Castac Management Area due to the robust land use protections under the Tejon Ranch Conservation and Land Use (C&LU) Agreement. Furthermore, land subsidence typically does not occur unless groundwater levels fall below historical lows for a sufficient period of time, the length of which depends on the thickness of compressible clay beds. As such, this MT is presumed to be protective of known beneficial uses and users of groundwater in the Management Area.

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

There are no state, federal, or local standards pertaining to groundwater levels in the Tejon-Castac Management Area.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

Groundwater levels will be measured in the single Representative Monitoring Site in the Tejon-Castac Management Area semiannually using the monitoring protocols outlined in **Section 16.2**.

## 14.2. Minimum Threshold for Reduction of Groundwater Storage

☑ **23 CCR § 354.28(c)(2)**

As discussed above, the URs definition for Reduction of Groundwater Storage at the Basin level refers to a decrease in storage that would cause water levels to decline below the MTs established for Chronic Lowering of Groundwater Levels. It is logical to tie these two Sustainability Indicators together, as the amount of groundwater in storage is directly, if not linearly, related to groundwater levels. Because of the close relationship between these two Sustainability Indicators, and because the MTs for Chronic Lowering of Groundwater Levels are protective of the beneficial uses and users of groundwater, it is not necessary to set a unique MT for Reduction of Groundwater Storage. Rather, MTs for Chronic Lowering of Groundwater Levels will be used as a proxy for the Reduction of Groundwater Storage Sustainability Indicator.

### 14.2.1. Use of Groundwater Levels as Proxy

☑ **23 CCR § 354.28(d)**

Pursuant to the GSP Emergency Regulations (23 CCR § 354.28(d)) and as further described in the DWR

Sustainable Management Criteria Best Management Practices (BMP) (DWR, 2017c), MTs for Reduction of Groundwater Storage may be set by using groundwater levels as a proxy if it is demonstrated that a correlation exists between the two metrics. One approach to using groundwater levels as a proxy, described in the DWR Sustainable Management Criteria BMP (DWR, 2017c), is to demonstrate that MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable occurrences of the Sustainability Indicator in question.

To demonstrate that the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective against Reduction of Groundwater Storage, a calculation was performed to determine the volume of groundwater that would be removed from storage in the primary aquifer if groundwater levels were to decline from current (Fall 2015) levels to their respective MTs for Chronic Lowering of Groundwater Level. This volume is then compared to the volume of usable storage, and it is shown that the usable storage is greater, and therefore the MTs for Chronic Lowering of Groundwater Levels are protective for the Reduction of Groundwater Storage Sustainability Indicator.

*Storage Reduction at Minimum Threshold Levels*

The volume of groundwater that would be removed from storage if groundwater levels were to decline to MT levels is calculated for each Public Land Survey System (PLSS) section by subtracting the MT of the associated Sustainability Criteria Zone from the "current" (Fall 2015) gridded groundwater elevation data, multiplying the difference by the storage coefficient, and then summing the values for each PLSS section to arrive at a total volume for the entire management area. This calculation is shown in the equation below:

$$MT\_Stor = \sum_{k=1}^{n} (GWL_i - MT\_GWL_i) * A_k * S_k$$

where:

$MT\_Stor$ is the storage reduction if groundwater levels were lowered to Minimum Threshold for Chronic Lowering of Groundwater Levels (acre-feet [AF]),

$GWL$ is the current (Fall 2015) groundwater elevation (ft msl),

$MT\_GWL$ is the Minimum Threshold for Chronic Lowering of Groundwater Levels within the Sustainability Criteria Zone (subscript *i*) (ft msl),

$A$ is the area (acres), and

$S$ is the storage coefficient (dimensionless). The subscript *k* refers to each PLSS section (a total of *n* sections within the management area).

#### 14.2.1.1. Arvin-Edison Management Area

*Usable Storage*

To support the use of MTs for Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage, it is informative to define an actual volume of "usable storage" above the median bottom depth of wells. For the Arvin-Edison Management Area, this volume is calculated based on the following data and assumptions:

- Area of Arvin-Edison Management Area (105,630 acres)
- Storage coefficient (0.08)[146]
- Average depth to groundwater in Fall 2015 (approximately 381 ft)
- Depth corresponding to the median bottom depth of wells (approximately 815 ft)

The volume of usable storage is approximately 3.7 million AF. This volume corresponds to the volume that would be pumped from private wells in roughly 42 years of pumping at the average historical rate pumped from WY 1995 – 2014 (i.e., 87,823 acre-feet per year; AFY).

*Storage Reduction at Minimum Threshold Levels*

Using the method described above, the resulting volume that would be removed from storage is approximately 1.08 million AF, which represents 29% of total usable groundwater storage. This volume corresponds to the volume that would be removed in approximately seven years of pumping at the average historical rate. Further, given that the UR definition is based on only 40% of RMS exceeding their MTs, the actual reduction in storage that would occur when URs are triggered would be much less than 29% of the usable storage. Therefore, the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable occurrences of Reduction of Groundwater Storage. Therefore, no separate MT for Reduction of Groundwater Storage is set within the Arvin-Edison Management Area.

#### 14.2.1.2. Wheeler Ridge-Maricopa Management Area

*Usable Storage*

To support the use of MTs for Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage, it is informative to define an actual volume of "usable storage" above the median bottom depth of wells. This volume is calculated based on the following data and assumptions:

- Area of Wheeler Ridge-Maricopa Management Area (92,343 acres)
- Storage coefficient (0.08)[147]
- Average depth to groundwater in Fall 2015 (approximately 303 ft)
- Depth corresponding to the median bottom depth of wells (approximately 1,100 ft)

The volume of usable storage is approximately 5.9 million AF. This volume corresponds to the volume that would be pumped in roughly 100 years of pumping at the average rate pumped from WY 1995 through 2015 (i.e., 59,152 AFY).

*Storage Reduction at Minimum Threshold Levels*

Using the method described above, the resulting volume that would be removed from storage is approximately 1.08 million AF, which represents 18% of the total usable groundwater storage. This volume corresponds to the volumed that would be pumped in approximately 19 years of pumping at the average historical rate. As mentioned above, the UR definition is based on only 40% of RMS exceeding their MTs, so the actual reduction in storage that would occur when URs are triggered would be much less than 18%

[146] There is uncertainty in the value for the storage coefficient used in the above calculations, as discussed in **Section 7.1.4 *Principal Aquifers and Aquitards***. However, the value of 0.08 is considered conservative.

[147] There is uncertainty in the value for the storage coefficient used in the above calculations, as discussed in Section **Section 7.1.4 *Principal Aquifers and Aquitards***. However, the value of 0.08 is considered conservative.

of the usable storage. Therefore, the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable occurrences of Reduction of Groundwater Storage. Therefore, no separate MT for Reduction of Groundwater Storage is set within the Wheeler Ridge-Maricopa Management Area.

14.2.1.3. Tejon-Castac Management Area

As there is only a single Representative Monitoring Site in the Tejon-Castac Management Area, and significant and unreasonable effects of Chronic Lowering of Groundwater Levels are directly related to those caused by Reduction of Groundwater Storage, the use of groundwater levels as a proxy for storage is both appropriate and protective.

## 14.3. Minimum Threshold for Seawater Intrusion

☑ **23 CCR § 354.28(c)(3)**
☑ **23 CCR § 354.28(e)**

The GSP Emergency Regulations state that "An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in 23 CCR § 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators" (23 CCR § 354.28(e)). Because the Kern Subbasin is not located near any saline water bodies, seawater intrusion is not present and not likely to occur, and the Seawater Intrusion Sustainability Indicator is not applicable. Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.

## 14.4. Minimum Threshold for Degraded Water Quality

☑ **23 CCR § 354.28(c)(4)**

The GSP Emergency Regulations (23 CCR § 354.28(c)) state that the MT for Degraded Water Quality shall be the "degradation of water, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results". The GSP Emergency Regulations further state that the MT "shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin", and that "the Agency shall consider local, state, and federal water quality standards applicable to the basin." This language indicates that MTs for Degraded Water Quality can reasonably be based on concentrations of water quality constituents of concern, as quantified by sampling measurements at RMS.

The GSP Emergency Regulations also state that "An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators" (23 CCR § 354.28(e)).

### 14.4.1. Minimum Threshold Development

As discussed above in **Section 13.4.4**, the process for developing SMC for the COCs identified within the SOKR GSP area considers the role the regulatory authority granted to GSAs to effect sustainable groundwater management under SGMA, which includes the management of the quantity, location, and timing of groundwater pumping and recharge. The SMC development process, outlined on ***Figure SMC-4***, considers whether COCs are risks to drinking water beneficial users or are expected to be exacerbated by groundwater management actions (i.e., extractions or recharge), among other things. Available data indicate that groundwater extractions or recharge will not worsen degraded water quality conditions for the COCs evaluated in **Section 8.5.1**, with the potential exception of arsenic, because no correlation was able to be established between water levels and water quality based on the available data. Therefore, because of the limited purview of GSAs with respect to water quality, and the rightful emphasis on those constituents that may be related to groundwater quantity management activities, the only constituent of concern currently applicable within the SOKR GSP Area is arsenic.

As described in **Section 8.5 *Groundwater Quality***, high arsenic concentrations are known to occur within the Arvin-Edison Management Area and Wheeler Ridge-Maricopa Management Area; however, no clear correlation has been established between groundwater levels and arsenic concentrations at this time. As discussed further below in **Section 17 *Projects and Management Actions***, the SOKR GSAs implementing projects to address drinking water quality issues within their respective Management Areas.

### 14.4.2. Final Minimum Thresholds

#### 14.4.2.1. Arvin-Edison Management Area

A MT for Degraded Water Quality is set at ten (10) RMS within the Arvin-Edison Management Area, including three (3) RMS in the ACSD well network (ACSD Wells #14, #16, and #17) and seven (7) RMS spatially distributed throughout the Management Area (***Figure SMC-21***). The SMCs are tied to regulatory water quality standards – namely, the CCR Title 22 Drinking Water Standards.

The MT for Degraded Water Quality is set either at the California Maximum Contaminant Level (MCL) for arsenic of 10 micrograms per liter (ug/L) arsenic, or for wells already in exceedance of the MCL at the SGMA-effective date, at the pre-SGMA baseline arsenic concentration plus 5 ug/L. Final MTs for Degraded Water Quality are shown by RMS in ***Table SMC-10*** and ***Figure SMC-21***.

*Relationship with Other Sustainability Indicators*

☑ **23 CCR § 354.28(b)(2)**

As described above, there is no known correlation between Chronic Lowering of Groundwater Levels (and Reduction of Groundwater Storage, by proxy) and Degraded Water Quality in the Arvin-Edison Management Area. There is also no known correlation between Degraded Water Quality and Land Subsidence.

As discussed above, both the Seawater Intrusion and Depletion of Interconnected Surface Water Sustainability Indicators are not applicable to the Arvin-Edison Management Area.

*Consideration of Adjacent Basins*

☑ **23 CCR § 354.28(b)(3)**

The MT for Degraded Water Quality is not expected to impact adjacent management areas' or basins' ability to achieve their sustainability goals, as it is set to the primary MCL, a regulatory threshold set by the United States Environmental Protection Agency (USEPA) and State Water Resources Control Board

(SWRCB) Division of Drinking Water, or pre-SGMA concentrations plus a reasonable buffer (5 ug/L) generally reflective of the variability observed in historical arsenic sampling data. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water from the Arvin-Edison Management Area.

*Impact to Beneficial Users*

☑ **23 CCR § 354.28(b)(4)**

Primary MCLs are regulatory thresholds based on criteria for drinking water quality, which is the most sensitive beneficial use. As such, the MT for Degraded Water Quality considers the most sensitive beneficial uses and users of groundwater. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water within the Arvin-Edison Management Area.

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

State, federal, and local entities have greater authority to enforce water quality standards, especially for anthropogenic-derived pollutant constituents. For example, drinking water supplies from public water systems are regulated to primary MCLs set by the USEPA and SWRCB Division of Drinking Water. Water quality issues related to deep percolation of agriculture chemicals (e.g., nitrates) are regulated separately under the Irrigated Lands Regulatory Program (ILRP) and Central Valley Salinity Alternative for Long-Term Sustainability (CV-SALTS). As described above, the MT for Degraded Water Quality in the Arvin-Edison Management Area is set with direct consideration of the applicable state, federal, and local standards. Should any state, federal, or local standards change in the future, MTs for Degraded Water Quality will be revisited accordingly.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

Compliance with the Degraded Water Quality MT will be based on monitoring data collected annually in the ten (10) water quality RMS currently specified for the Arvin-Edison Management Area in accordance with the monitoring protocols described in **Section 16.2** and in the Coordination Agreement.

#### 14.4.2.2. Wheeler Ridge-Maricopa Management Area

A MT for Degraded Water Quality is set at nine (9) RMS within spatially distributed throughout the Wheeler Ridge-Maricopa Management Area (***Figure SMC-22***). The SMCs are tied to regulatory water quality standards – namely, the CCR Title 22 Drinking Water Standards.

The MT for Degraded Water Quality is set either at the California MCL for arsenic of 10 ug/L arsenic, or for wells already in exceedance of the MCL at the SGMA-effective date, at the pre-SGMA baseline arsenic concentration plus 5 ug/L. Final MTs for Degraded Water Quality are shown by RMS in ***Table SMC-10*** and ***Figure SMC-22***.

*Relationship with Other Sustainability Indicators*

☑ **23 CCR § 354.28(b)(2)**

As described above, there is no known correlation between Chronic Lowering of Groundwater Levels (and Reduction of Groundwater Storage, by proxy) and Degraded Water Quality in the Wheeler Ridge-Maricopa Management Area. There is also no known correlation between Degraded Water Quality and Land Subsidence.

As discussed above, both the Seawater Intrusion and Depletion of Interconnected Surface Water Sustainability Indicators are not applicable to the Wheeler Ridge-Maricopa Management Area.

*Consideration of Adjacent Basins*

☑ **23 CCR § 354.28(b)(3)**

The MT for Degraded Water Quality is not expected to impact adjacent management areas' or basins' ability to achieve their sustainability goals, as it is set to the primary MCL, a regulatory threshold set by the US EPA and SWRCB Division of Drinking Water, or pre-SGMA concentrations plus a reasonable buffer (5 ug/L) generally reflective of the variability observed in historical arsenic sampling data. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water from the Wheeler Ridge-Maricopa Management Area.

*Impact to Beneficial Users*

☑ **23 CCR § 354.28(b)(4)**

Primary MCLs are regulatory thresholds based on criteria for drinking water quality, which is the most sensitive beneficial use. As such, the MT for Degraded Water Quality considers the most sensitive beneficial uses and users of groundwater. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water within the Wheeler Ridge-Maricopa Management Area.

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

State, federal, and local entities have greater authority to enforce water quality standards, especially for anthropogenic-derived pollutant constituents. For example, drinking water supplies from public water systems are regulated to primary MCLs set by the USEPA and SWRCB Division of Drinking Water. Water quality issues related to deep percolation of agriculture chemicals (e.g., nitrates) are regulated separately under the ILRP and CV-SALTS. As described above, the MT for Degraded Water Quality in the Wheeler Ridge-Maricopa Management Area is set with direct consideration of the applicable state, federal, and local standards. Should any state, federal, or local standards change in the future, MTs for Degraded Water Quality will be revisited accordingly.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

Compliance with the Degraded Water Quality MT will be based on monitoring data collected annually in the nine (9) water quality RMS currently specified for the Wheeler Ridge-Maricopa Management Area in accordance with the monitoring protocols described in **Section 16.2** and in the Coordination Agreement.

#### 14.4.2.3. Tejon-Castac Water Management Area

Given the lack of groundwater use and development, there are no beneficial uses that are expected to be significantly and unreasonably affected by groundwater quality. Therefore, no MTs for Degraded Water Quality are set for the Tejon-Castac Management Area.

*Relationship with Other Sustainability Indicators*

☑ **23 CCR § 354.28(b)(2)**

Groundwater level and quality time-series data are not available in the Tejon-Castac Management Area, but no discernible and consistent relationship between groundwater levels (and by proxy, groundwater storage) and water quality is expected in the Tejon-Castac Management Area, based on data from nearby/adjacent portions of the Basin.

There is also no known correlation between Degraded Water Quality and Land Subsidence. As discussed previously, both the Seawater Intrusion and Depletion of Interconnected Surface Water Sustainability Indicators are not applicable to the Tejon-Castac Management Area.

*Consideration of Adjacent Basins*

☑ **23 CCR § 354.28(b)(3)**

MTs for Chronic Lowering of Groundwater Level are anticipated to be protective in terms of preventing migrations of poor-quality water into or from adjacent management areas and basins.

*Impact to Beneficial Users*

☑ **23 CCR § 354.28(b)(4)**

As described previously, beneficial uses identified within the Tejon-Castac Management Area included one active industrial/agricultural well for which groundwater quality is generally suitable for major beneficial uses, and one active domestic well located in the far eastern upland portion of the Tejon-Castac Management Area, where existing limitations on land use are expected to be protective.

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

State, federal, and local entities have greater authority to enforce water quality standards, especially for anthropogenic-derived pollutant constituents. For example, drinking water supplies from public water systems are regulated to primary MCLs set by the USEPA and SWRCB Division of Drinking Water. Water quality issues related to deep percolation of agriculture chemicals (e.g., nitrates) are regulated separately under the ILRP and CV-SALTS. Based on the largely undeveloped land uses within the Tejon-Castac Management Area and the limited beneficial uses and users, no state, federal, or local water quality standards are relevant to the Tejon-Castac Management Area.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

No MTs for Degraded Water Quality are set in the Tejon-Castac Management Area, and thus no monitoring specific to MTs will be conducted.

## 14.5. Minimum Threshold for Land Subsidence

☑ **23 CCR § 354.28(c)(5)**

MTs for Land Subsidence are defined herein as levels of land subsidence that, if they occurred, would result in significant and unreasonable impacts to critical infrastructure and surface land uses. The Kern Subbasin has defined two categories of critical infrastructure: Regional Critical Infrastructure and Management Area Critical Infrastructure (see **Section 13.5 *Undesirable Results for Land Subsidence***). While certain other land uses exist within the SOKR GSP Area that are potentially affected by land subsidence, those land uses are not of regional significance and are not considered to be critical infrastructure. The MTs defined below are in terms of total vertical extent of inelastic land subsidence (in inches [in]). These MTs also inform the Measurable Objectives and Interim Milestones defined in **Section 15.5**.

Within the Arvin-Edison Management Area, there is no Regional Critical Infrastructure. However, the Management Area Critical Infrastructure that has the potential to be significantly and unreasonably impacted by land subsidence includes AEWSD's canal system.

Within the Wheeler Ridge-Maricopa Management Area, the Regional Critical Infrastructure that has the potential to be significantly and unreasonably impacted by land subsidence includes the California Aqueduct.

There is no Regional Critical Infrastructure or Management Area Critical Infrastructure within the Tejon-Castac Management Area.

### 14.5.1. Minimum Threshold Development

☑ **23 CCR § 354.28(b)(1)**
☑ **23 CCR § 354.28(b)(4)**

*Arvin-Edison Management Area*

Historical and recent rates of subsidence measured within the Arvin-Edison Management Area in proximity to the sensitive land uses listed above are discussed in **Section 8.6 *Land Subsidence***. The MT for Land Subsidence is defined within the Arvin-Edison Management Area as the cumulative extent of inelastic subsidence that would occur if the maximum rate of subsidence observed through ground-based surveys between 2014 and 2018 at the "Sycamore Check", a monitoring point near the Sycamore Spreading

Works, were to continue through the end of the SGMA implementation timeline, i.e., to 2040. Specifically, the MT for Land Subsidence is calculated as follows:

$$MT\_Sub = Max\_rate\_Sycamore * \ t\_impl$$

where:

$MT\_Sub$ is the Minimum Threshold for Land Subsidence as a cumulative amount (in),

$Max\_rate\_Sycamore$ is the maximum rate of subsidence observed between 2014 and 2018 at the Sycamore Check, equal to 1.5 in/yr, and

$t\_impl$ is the time from 2018 until the end of the SGMA GSP implementation timeframe (2040), equal to 22 years.

*Wheeler Ridge-Maricopa Management Area*

Historical and recent rates of subsidence measured within the Wheeler Ridge-Maricopa Management Area in proximity to the sensitive land uses listed above are discussed in **Section 8.6 *Land Subsidence***. The MT for Land Subsidence is defined within the Wheeler Ridge-Maricopa Management Area for each Aqueduct pool as the cumulative extent of inelastic subsidence that would result in a 75 percent (%) reduction in average available freeboard height (as of 2017) above DWR's design criterion for lined freeboard height in the San Joaquin Field Division of 30 inches (DWR, 2017a). Specifically, the MT for Land Subsidence is calculated for each Aqueduct pool as follows:

$$MT\_Sub_i = 0.75 * (Freeboard_{i,2017} - 30)$$

where:

$MT\_Sub_i$ is the Minimum Threshold for Land Subsidence as a cumulative amount (in) defined at Aqueduct pool *I*,

$Freeboard_{i,2017}$ is the average freeboard height (in) measured in 2017 at all DWR survey benchmark locations within Aqueduct pool *I, and*

$30$ reflects DWR's design criterion for lined freeboard height (in).

As mentioned above, the MT for each Aqueduct pool is based on average of the freeboard measured at all DWR survey benchmark locations within the pool as of 2017 based on DWR's California Aqueduct Subsidence Program Report (DWR, 2019). These benchmark locations are shown by pool on the profiles included in the DWR (2019) report plates included in **Appendix X** and are described in greater detail in **Section 16.1.5 *Monitoring Network for Land Subsidence***.

*Tejon-Castac Management Area*

In the Tejon-Castac Management Area, the MT value for Chronic Lowering of Groundwater Levels is defined so as to be protective against possible land subsidence by being limited to levels that are generally no lower than historical lows. Therefore, no specific MT for Land Subsidence is established in the Tejon-Castac Management Area.

### 14.5.2. Final Minimum Thresholds

☑ 23 CCR § 354.28(b)(2)
☑ 23 CCR § 354.28(b)(6)

#### 14.5.2.1. Arvin-Edison Management Area

Per **Section 14.5.1**, the resulting MT extent of subsidence is 33 inches, relative to ground surface elevations measured in June 2018. The MT applies to all five RMS along AEWSD's canal system within the Arvin-Edison Management Area. The final MTs for Land Subsidence at each RMS are shown in ***Table SMC-11*** below***.*** Additional information about the RMS is provided in **Section 16.1.5.**

**Table SMC-11. Minimum Thresholds for Land Subsidence, Arvin-Edison Management Area**

| Representative Monitoring Site [RMS] | Minimum Threshold [MT] Extent(1) (in) | 2018 Ground Surface Elevation (ft msl) | MT Ground Surface Elevation (ft msl) |
|---|---|---|---|
| 3-CP-1 | 33 | 518.80 | 516.05 |
| 15-N CANAL PP CORNERS | 33 | 511.37 | 508.62 |
| 30C-WELL 11 | 33 | 482.38 | 479.63 |
| 39-TEJON CREEK SIPHON | 33 | 493.65 | 490.90 |
| 48-TOP 883 CS | 33 | 486.88 | 484.13 |

Note:
(1) Relative to ground surface elevations measured in June 2018.

*Relationship with Other Sustainability Indicators*

☑ 23 CCR § 354.28(b)(2)

The MTs for Chronic Lowering of Groundwater Levels include consideration of land subsidence by limiting the initial MT estimates to the historical low groundwater levels in those RMS that are within one mile of critical infrastructure (see **Section 14.1** ***Minimum Threshold for Chronic Lowering of Groundwater Levels***). While groundwater level measurements are not being used as a proxy for land subsidence measurements in these areas (i.e., the land subsidence monitoring network will consist of survey benchmark locations maintained and measured by the Arvin GSA), these MTs for Chronic Lowering of Groundwater Levels are set conservatively to avoid further land subsidence.

No direct correlation has been discerned between water quality and land subsidence.

As discussed above, both the Seawater Intrusion and Interconnected Surface Water Sustainability Indicators are not applicable to the Arvin-Edison Management Area.

*Consideration of Adjacent Basins*

☑ **23 CCR § 354.28(b)(3)**

The MTs for Land Subsidence have been developed in consideration of and in coordination with the other GSAs within the Kern Subbasin and in neighboring basins. The methods used to develop MTs for Land Subsidence are generally consistent with the adjoining basins.

*Impact to Beneficial Users*

☑ **23 CCR § 354.28(b)(4)**

As discussed above, the MT extent of subsidence defined herein is based on subsidence rates that have been historically managed by AEWSD through ongoing maintenance and improvements to its facilities (e.g., adding additional freeboard to its canals, as necessary), and AEWSD could likely continue to manage/mitigate further subsidence if it were to occur at similar or lower rates.

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

There are no state, federal, or local standards pertaining to land subsidence in the Arvin-Edison Management Area.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

Five RMS at locations along AEWSD's critical infrastructure facilities (i.e., conveyance canal system) will be monitored annually in accordance with the monitoring protocols outlined in **Section 16.2**.

#### 14.5.2.2. Wheeler Ridge-Maricopa Management Area

Per **Section 14.5.1**, the resulting MT extent of subsidence is defined for each pool in ***Table SMC-12*** below. Additional information about the RMS for each pool is provided in **Section 16.1.5.**

**Table SMC-12. Minimum Thresholds for Land Subsidence, Wheeler Ridge-Maricopa Management Area**

| Aqueduct Pool | Minimum Threshold [MT] Extent(1) (in) | Average Available Freeboard Height, 2017 (in) | Freeboard Height at MT (in) |
|---|---|---|---|
| Pool 32 | 18.1 | 54.1 | 36.0 |
| Pool 33 | 38.2 | 81.0 | 42.7 |
| Pool 34 | 36.4 | 78.5 | 42.1 |
| Pool 35 | 42.8 | 87.1 | 44.3 |

Note:
(1) The MT extent is relative to the average elevation of all DWR survey benchmark locations within the pool in 2017 (DWR, 2019).

*Relationship with Other Sustainability Indicators*

☑ 23 CCR § 354.28(b)(2)

As stated for the Arvin-Edison Management Area above, it should be noted that the MTs for Chronic Lowering of Groundwater Levels include consideration of land subsidence by limiting the initial MT estimates to the historical low groundwater levels for the long-term hydrograph locations used in developing the MTs that are within one mile of critical infrastructure.

Historical monitoring data show no correlation between land subsidence and water quality in the Wheeler Ridge-Maricopa Management Area.

As discussed above, the Seawater Intrusion and Interconnected Surface Water Sustainability Indicators are not applicable to the Wheeler Ridge-Maricopa Management Area.

*Consideration of Adjacent Basins*

☑ 23 CCR § 354.28(b)(3)

The MTs for Land Subsidence have been developed in consideration of and in coordination with the other GSAs within the Kern Subbasin and in neighboring basins. The methods used to develop MTs for Land Subsidence are generally consistent with the adjoining basins.

*Impact to Beneficial Users*

☑ 23 CCR § 354.28(b)(4)

As discussed above, the MT extent of subsidence defined herein is designed to maintain Aqueduct freeboard heights within each pool well above DWR's design criterion for lined freeboard height of 30 inches for the San Joaquin Field Division. As shown in ***Table SMC-12*** above, the freeboard height that would result from additional subsidence to the MT extent within the Management Area ranges from 36 inches in Aqueduct Pool 32 to 44.3 inches in Aqueduct Pool 35.

*State, Federal, and Local Standards*

☑ **23 CCR § 354.28(b)(5)**

There are no state, federal, or local standards pertaining to land subsidence in the Wheeler Ridge-Maricopa Management Area.

*Measurement of Minimum Thresholds*

☑ **23 CCR § 354.28(b)(6)**

The 40 DWR survey benchmark locations between Mileposts 256.14 (Check No. 31) and 278.13 (Teerink Pumping Plant) of the California Aqueduct are monitored annually by DWR, and those data will be used for purposes of SGMA monitoring of land subsidence within the Wheeler Ridge-Maricopa Management Area. The monitoring conducted by DWR is consistent with the land subsidence monitoring principles outlined in **Section 16.2**.

#### 14.5.2.3. Tejon-Castac Management Area

Because subsidence has not been an issue historically and there is no significant groundwater development other than the industrial and agricultural uses of the Caratan Well, land subsidence is unlikely to occur within the Tejon-Castac Management Area and therefore no SMCs are defined for Land Subsidence within the Management Area. Furthermore, the MT value for Chronic Lowering of Groundwater Levels is defined so as to be protective against possible land subsidence by being limited to levels that are generally no lower than historical lows.

## 14.6. Minimum Threshold for Depletions of Interconnected Surface Water

☑ **23 CCR § 354.28(c)(6)**
☑ **23 CCR § 354.28(e)**

The GSP Emergency Regulations state that "An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in 23 CCR § 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators" (23 CCR § 354.28(e)). As discussed above, based on available data and information, Depletion of Interconnected Surface Water has not been observed within the SOKR GSP Area. Depths to groundwater are so deep as the preclude the possibility of occurrence of interconnected surface water in the Arvin-Edison and Wheeler Ridge-Maricopa Management Areas, and the Tejon-Castac Management Area functions in a largely natural state and under the conservation protections of the Tejon C&LU Agreement, with any groundwater/surface water interactions occurring independent of human influence. Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.

# 15. MEASURABLE OBJECTIVES AND INTERIM MILESTONES

☑ 23 CCR § 354.30(a)
☑ 23 CCR § 354.30(b)

This section discusses the development of Measurable Objectives (MOs) and Interim Milestones (IMs) for all relevant Sustainability Indicators in the South of Kern River Groundwater Sustainability Plan (SOKR GSP) Area.

## 15.1. Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels

### 15.1.1. Measurable Objectives for Chronic Lowering of Groundwater Levels

☑ 23 CCR § 354.30(c)

For the Arvin-Edison Management Area and the Wheeler Ridge-Maricopa Management Area, initial estimates for MOs for Chronic Lowering of Groundwater Levels were developed based on the groundwater levels that were observed in the long-term hydrograph locations in or around Fall 2015. As with the Minimum Thresholds (MTs), the initial MO estimates were then adjusted and generalized into values for each Sustainability Criteria Zone. The adjustments and generalizations generally entailed decreasing the MO for the zone relative to the Fall 2015 levels. The downward adjustments were made in recognition of the fact that in most cases groundwater levels in 2015 were not near their historical low, and therefore an ample Margin of Operational Flexibility could be achieved even with levels lower than they were in 2015. Also, considering the potential for reduced surface water imports in the future and potentially increased groundwater use, it was considered appropriate to set the MOs to allow for some decrease from 2015 levels.

MOs for Chronic Lowering of Groundwater Levels for each Sustainability Criteria Zone and at each Representative Monitoring Site are shown on ***Figure SMC-23*** and ***Table SMC-9*** for the Arvin-Edison Management Area and on ***Figure SMC-24*** and ***Table SMC-9*** for the Wheeler Ridge-Maricopa Management Area.

The MO for the single Representative Monitoring Site in the Tejon-Castac Management Area is set at 100 feet mean sea level (ft msl). This value is based on the approximate average Fall 2015 water level for wells within the Arvin-Edison Management Area to the west of the Tejon-Castac Management Area that are nearest to the Representative Monitoring Site, the reason being that no historical water level data otherwise exist in this portion of the Tejon-Castac Management Area. The 50-foot difference between the MT and MO at this well is considered to be the Margin of Operational Flexibility and is consistent with observed water level fluctuations in wells directly adjacent to the Tejon-Castac Management Area (***Figure SMC-20***).

### 15.1.2. Interim Milestones for Chronic Lowering of Groundwater Levels

☑ 23 CCR § 354.30(e)

IMs for Chronic Lowering of Groundwater Levels in the Arvin-Edison Management Area and the Wheeler Ridge-Maricopa Management Area are defined herein based on a trajectory for groundwater levels informed by the current (Fall 2018) levels, the MT, and the MOs. This trajectory allows for and assumes a continuation of current groundwater level trends for the first 5-year period, a deviation from that trend over the second 5-year period, a recovery to the 5-year Interim Milestone in the third 5-year period, and recovery towards the MOs over the fourth (last) 5-year period. Specifically, the trajectory for groundwater levels prescribed in the IMs is as follows:

**Table SMC-13. Interim Milestone Trajectory for Chronic Lowering of Groundwater Levels**

| Calendar Year | Interim Milestone for Chronic Lowering of Groundwater Levels | Basis for Interim Milestone |
|---|---|---|
| 2020 | Not applicable | Not applicable |
| 2025 | $IM\text{-}5_{GWL}$ | ½ * $(GWL_{Fall2018} + MT\_GWL)$ |
| 2030 | $IM\text{-}10_{GWL}$ | ½ * $(IM\text{-}5_{GWL} + MT\_GWL)$ |
| 2035 | $IM\text{-}15_{GWL}$ | ½ * $(IM\text{-}10_{GWL} + MO\_GWL)$ |
| 2040 | Not applicable (Measurable Objective) | Not applicable (Measurable Objective) |

where:

$IM\text{-}5_{GWL}$, $IM\text{-}10_{GWL}$, and $IM\text{-}15_{GWL}$ are the Interim Milestones for Chronic Lowering of Groundwater Levels after 5 years, 10 years and 15 years, respectively;

$GWL_{Fall2018}$ is the measured groundwater elevations in Fall 2018;

$MT\_GWL$ is the Minimum Threshold for Chronic Lowering of Groundwater Levels (defined previously); and

$MO\_GWL$ is the Minimum Threshold for Chronic Lowering of Groundwater Levels (defined previously).

IMs and MOs for Chronic Lowering of Groundwater Levels in the Arvin-Edison Management Area are presented in ***Table SMC-9***, and are displayed relative to historical water levels at each Representative Monitoring Site on ***Figure SMC-25***.

IMs and MOs for Chronic Lowering of Groundwater Levels in the Wheeler Ridge-Maricopa Management Area are presented in ***Table SMC-9***, and are displayed relative to historical water levels at each Representative Monitoring Site on ***Figure SMC-26***.

Setting the IMs for Chronic Lowering of Groundwater Levels at the single Representative Monitoring Site within the Tejon-Castac Management Area will have to be deferred as there is no current groundwater level data upon which to base a sustainability trajectory to achieve the MO. Once sufficient data from the Representative Monitoring Site have been collected (i.e., at least by the time of the first periodic evaluation [“5-year update”] of the SOKR GSP), IMs will be established.

## 15.2. Measurable Objective for Reduction of Groundwater Storage

☑ 23 CCR § 354.30(c)
☑ 23 CCR § 354.30(d)

As discussed above, the Undesirable Results (URs) definition for Reduction of Groundwater Storage at the Basin level refers to a decrease in storage that would cause water levels to decline below MTs established in each management area for Chronic Lowering of Groundwater Levels. It is logical to tie these two Sustainability Indicators together, as the amount of groundwater in storage is directly, if not linearly, related to groundwater levels. Because of the close relationship between these two Sustainability Indicators, the MO for Chronic Lowering of Groundwater Levels serves as a proxy for Reduction of Groundwater Storage, and it is not necessary to set a unique MO for Reduction of Groundwater Storage. As stated above, the MOs for Chronic Lowering of Groundwater Levels provide an adequate Margin of Operational Flexibility.

## 15.3. Measurable Objective for Seawater Intrusion

The GSP Emergency Regulations state that "An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in 23 California Code of Regulations (CCR) § 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators" (23 CCR § 354.28(e)). Because the Kern County Subbasin (Kern Subbasin or Basin) is not located near any saline water bodies, seawater intrusion is not present and not likely to occur, and the Seawater Intrusion Sustainability Indicator is not applicable. Therefore, no Sustainable Management Criteria (SMCs) for this Sustainability Indicator are defined in the Kern Subbasin.

## 15.4. Measurable Objective and Interim Milestones for Degraded Water Quality

☑ 23 CCR § 354.30(c)

### 15.4.1. <u>Arvin-Edison Management Area</u>

As with the Minimum Threshold, the MO for Degraded Water Quality is defined for a single Constituent of Concern (COC, arsenic) at the ten (10) water quality Representative Monitoring Sites (RMS) currently specified for the Management Area. Within the Arvin Community Services District (ACSD) RMS (i.e., ACSD Wells #14, #16, and #17), the MO is set at 7.5 micrograms per liter (ug/L) arsenic, corresponding to 75% of the California Maximum Contaminant Level (MCL). Within the remaining RMS, the MO is set at either the California MCL for arsenic (10 ug/L) or the pre- Sustainable Groundwater Management Act (SGMA) baseline arsenic concentration, whichever is greater. It is an appropriate goal to try to maintain concentrations of this COC at or below MCL, or for wells that were already impacted before the SGMA effective date, to try and maintain arsenic concentrations at their pre-SGMA baseline levels.

IMs for Degraded Water Quality are set at the same value as the MT for each RMS, in line with the Arvin Groundwater Sustainability Agency's (GSA) commitment to not allow further degradation of water quality beyond existing regulatory thresholds or, in areas that were already impacted before the SGMA effective date, beyond their pre-SGMA baseline levels. Final IMs and MOs for Degraded Water Quality are shown by RMS in ***Table SMC-10***.

#### 15.4.2. Wheeler Ridge-Maricopa Management Area

As with the Minimum Threshold, the MO for Degraded Water Quality is defined for a single Constituent of Concern (arsenic) at the nine (9) water quality RMS currently specified for the Management Area. The MO is set at each RMS at either the California MCL for arsenic (10 ug/L) or the pre-SGMA baseline arsenic concentration, whichever is greater. It is an appropriate goal to try to maintain concentrations of this COC at or below MCL, or for wells that were already impacted before the SGMA effective date, to try and maintain arsenic concentrations at their pre-SGMA baseline levels.

IMs for Degraded Water Quality are set at the same value as the MT for each RMS, in line with the Wheeler Ridge-Maricopa GSA's commitment to not allow further degradation of water quality beyond existing regulatory thresholds or, in areas that were already impacted before the SGMA effective date, beyond their pre-SGMA baseline levels. Final IMs and MOs for Degraded Water Quality are shown by RMS in ***Table SMC-10***.

#### 15.4.3. Tejon-Castac Management Area

As discussed above, there are not URs for Degraded Water Quality occurring in the Tejon-Castac Management Area and the MTs for Chronic Lowering of Groundwater Level are anticipated to be protective. Therefore, no unique MTs, MOs, or IMs are set for this Sustainability Indicator in the Tejon-Castac Management Area.

### 15.5. Measurable Objectives and Interim Milestones for Land Subsidence

☑ **23 CCR § 354.30(c)**
☑ **23 CCR § 354.30(e)**

#### 15.5.1. Arvin-Edison Management Area

The MO for Land Subsidence is defined within the Arvin-Edison Management Area as the extent of land subsidence that would be observed if the MT subsidence rates were to continue from 2018 through 2030 and then cease, which amounts to approximately half of the MT extent. While ideally there would be no further land subsidence along Management Area Critical Infrastructure (i.e., Arvin-Edison Water Storage District's [AEWSD] canal system), as stated above, due to the inherent time lag of the aquitard depressurization process, there may still be some "built-in" subsidence potential that has yet to manifest. Therefore, it is not considered reasonable to expect an immediate and complete cessation to the historic subsidence rates. Rather, it is considered a reasonable and potentially achievable goal to reduce the observed historical rate by half over the SGMA implementation period (i.e., by 2040).

The MOs and IMs for Land Subsidence are set with the management goal that no additional subsidence will occur beyond 2030. IMs for Land Subsidence are specified within the Arvin-Edison Management Area as follows:

**Table SMC-14. Interim Milestone Trajectory for Land Subsidence, Arvin-Edison Management Area**

| Calendar Year | Interim Milestone [IM] for Land Subsidence | Basis for IM |
|---|---|---|
| 2025 | $IM\text{-}5_{Subs}$ | $GS\_Elev_{2018} - 7 * MT\_Rate$ |
| 2030 | $IM\text{-}10_{Subs}$ | $GS\_Elev_{2018} - 12 * MT\_Rate$ |
| 2035 | $IM\text{-}15_{Subs}$ | $GS\_Elev_{2018} - 12 * MT\_Rate$ |
| 2040 | Measurable Objective | $GS\_Elev_{2018} - 12 * MT\_Rate$ |

where:

$IM\text{-}5_{Subs}$, $IM\text{-}10_{Subs}$, and $IM\text{-}15_{Subs}$ are the Interim Milestones for Land Subsidence (ft msl) after 5 years, 10 years and 15 years, respectively;

$GE\_Elev_{2018}$ is the measured ground surface elevations in June 2018; and

$MT\_Rate$ is the Minimum Threshold rate for Land Subsidence in the Arvin-Edison Management Area (1.5 in/yr; defined previously).

The final MOs and IMs for Land Subsidence at each RMS are shown in ***Table SMC-15*** below and depicted in ***Figure SMC-27***. Additional information about the RMS is provided in **Section 16.1.5.**

**Table SMC-15. Measurable Objective and Interim Milestones for Land Subsidence, Arvin-Edison Management Area**

| Representative Monitoring Site [RMS] | Measurable Objective [MO] Extent(1) (in) | MO Ground Surface Elevation (ft msl) | Interim Milestone Ground Surface Elevations (ft msl) | | |
|---|---|---|---|---|---|
| | | | 2025 | 2030 | 2035 |
| 3-CP-1 | 18 | 517.30 | 517.93 | 517.30 | 517.30 |
| 15-N CANAL PP CORNERS | 18 | 509.87 | 510.50 | 509.87 | 509.87 |
| 30C-WELL 11 | 18 | 480.88 | 481.51 | 480.88 | 480.88 |
| 39-TEJON CREEK SIPHON | 18 | 492.15 | 492.78 | 492.15 | 492.15 |
| 48-TOP 883 CS | 18 | 485.38 | 486.01 | 485.38 | 485.38 |

Note:
(1) Relative to ground surface elevations measured in June 2018.

### 15.5.2. Wheeler Ridge-Maricopa Management Area

The MO for Land Subsidence is defined within the Wheeler Ridge-Maricopa Management Area as half of the MT extent of land subsidence defined for each Aqueduct pool. While ideally there would be no further land subsidence along Regional Critical Infrastructure (i.e., the California Aqueduct), as stated above, due to the inherent time lag of the aquitard depressurization process, there may still be some "built-in" subsidence potential that has yet to manifest. Therefore, it is not considered reasonable to expect an immediate and complete cessation to the historic subsidence rates. Rather, it is considered a reasonable and potentially achievable goal to reduce the observed historical rate by half over the SGMA implementation period (i.e., by 2040).

The MOs and IMs for Land Subsidence are set with the management goal that land subsidence rates will decelerate throughout the SGMA implementation period and that no additional subsidence will occur beyond 2040. IMs for Land Subsidence are specified within the Wheeler Ridge-Maricopa Management Area as follows:

**Table SMC-16. Interim Milestone Trajectory for Land Subsidence, Wheeler Ridge-Maricopa Management Area**

| Calendar Year | Interim Milestone [IM] for Land Subsidence | Basis for IM |
|---|---|---|
| 2025 | $IM\text{-}5_{Sub,i}$ | $0.25^{*}\, MT\_Sub_i$ |
| 2030 | $IM\text{-}10_{Sub,i}$ | $0.40^{*}\, MT\_Sub_i$ |
| 2035 | $IM\text{-}15_{Sub,i}$ | $0.45^{*}\, MT\_Sub_i$ |
| 2040 | Measurable Objective | $0.50^{*}\, MT\_Sub_i$ |

where:

$IM\text{-}5_{Sub,i}$, $IM\text{-}10_{Sub,i}$, and $IM\text{-}15_{Sub,i}$ are the Interim Milestones (in) for Land Subsidence defined at Aqueduct pool *i* after 5 years, 10 years and 15 years, respectively; and

$MT\_Sub_i$ is the Minimum Threshold extent for Land Subsidence defined at Aqueduct pool *i*

The final MOs and IMs for Land Subsidence at each Aqueduct pool are shown in ***Table SMC-17*** below and depicted in ***Figure SMC-28***. Additional information about the RMS for each pool is provided in **Section 16.1.5.**

**Table SMC-17. Measurable Objective and Interim for Land Subsidence, Wheeler Ridge-Maricopa Management Area**

| Aqueduct Pool | Measurable Objective [MO] Extent(1) (in) | MO Freeboard Height (in) | Interim Milestone Freeboard Heights (in) | | |
|---|---|---|---|---|---|
| | | | 2025 | 2030 | 2035 |
| Pool 32 | 9.1 | 45.1 | 49.6 | 46.9 | 46.0 |
| Pool 33 | 19.1 | 61.9 | 71.4 | 65.7 | 63.8 |
| Pool 34 | 18.2 | 60.3 | 69.4 | 64.0 | 62.2 |
| Pool 35 | 21.4 | 65.7 | 76.4 | 70.0 | 67.8 |

Note:
(1) The MT extent is relative to the average elevation of all DWR survey benchmark locations within the pool in 2017 (DWR, 2019).

### 15.5.3. Tejon-Castac Management Area

Because subsidence has not been an issue historically and there is no significant groundwater development other than the industrial and agricultural uses of the Caratan Well, land subsidence is unlikely to occur within the Tejon-Castac Management Area and therefore no SMCs are defined for Land Subsidence within the Management Area.

## 15.6. Measurable Objective for Depletions of Interconnected Surface Water

The GSP Emergency Regulations state that "An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in 23 CCR § 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators" (23 CCR § 354.28(e)). As discussed above, based on available data and information, Depletion of Interconnected Surface Water has not been observed within the SOKR GSP Area. Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.

**TABLE SMC-2**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Arvin-Edison Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| **Sustainability Indicator** | **Identification of Beneficial Users** | **Potential Effects on Beneficial Users** | **Undesirable Result (UR) Causes** | **Local Undesirable Results Criteria (i.e., Trigger)** | **Local Undesirable Results Criteria Justification** | **Minimum Threshold (MT) Definition** | **Minimum Threshold Justification** | **Measurable Objective (MO) Definition** |
|---|---|---|---|---|---|---|---|---|
| Chronic Lowering of Groundwater Levels | Beneficial Users impacted by Chronic Lowering of Groundwater Levels include:<br>- Agricultural and Industrial Water Users (402 wells);<br>- Domestic and Small Community Water Users (134 wells); and,<br>- Municipal Water Users (19 wells).<br><br>Critical Surface Infrastructure is not defined as a Beneficial User in California Water Code (CWC) §10723.2, but is still considered as a land use and property interest in the development of Sustainable Management Criteria (SMC) for Groundwater Levels. | Groundwater well dewatering and associated effects (e.g., increased maintenance costs, possible well deepening/replacement, and reduced well lifespan).<br><br>Increased pumping lift and associated effects (i.e., greater energy use, higher pumping costs, increased wear and tear on well pump motors, reduced well efficiency, and lower well yield). | Increased Pumping due to:<br>- increase in water use per acre on irrigated land; and/or,<br>- new land put into production.<br><br>Reduced Recharge due to:<br>- increased agricultural irrigation efficiency;<br>- reduced surface water imports and banking;<br>- climate change resulting in decreased precipitation and increased ET; and/or,<br>- decreased groundwater inflows from adjacent areas. | It is considered a local UR for Chronic Lowering of Groundwater Levels **when groundwater levels decline below established MTs in 40% or more of any water level Representative Monitoring Sites (RMS) within the MA over four consecutive bi-annual Sustainable Groundwater Management Act (SGMA) required monitoring events.** | **A well age analysis** was conducted that showed that **67%** of domestic wells will be older than 50 years by 2040 and would likely have to be replaced, irrespective of SGMA. As such, effects to beneficial users would not be significant and unreasonable as long as the rate of well dewatering of domestic wells would not exceed natural replacement rates. This analysis shows that it is not significant or unreasonable to replace **67%** of wells.<br><br>A well impact analysis was conducted that showed that the proposed MTs could potentially dewater 9% of domestic wells and 5% of production and public supply wells.<br><br>Additionally, the Arvin-Edison Water Storage District Groundwater Sustainability Agency (AEWSD GSA) has developed a Well Dewatering Mitigation Program to address potential dewatering of domestic wells at MT water levels. The effective impact is therefore 0%. | Initial MT estimates are set at the 16 designated RMS using an algorithm taking into consideration:<br><br><u>Historical Trends, Water Year Type, and Projected Water Use:</u><br>- Historical water level data, by basing the algorithm on historical hydrograph data;<br>- Well construction information, for the consideration of impacts to beneficial users;<br>- Variability in the amount of groundwater level fluctuation in different wells, by applying a 25% Range Fraction as a conservative allowance for water level fluctuations within a given well; and<br>- Recent trends in groundwater levels, by incorporation of a Trend Extension Period.<br><br><u>Effects on Other Sustainability Indicators</u><br>- Proximity to critical infrastructure for consideration of land subsidence impacts, by setting the initial MT estimates to their historical low groundwater levels in | MTs are set at levels to avoid a depletion of supply that may lead to URs.<br><br>Use of a 10-year Trend Extension Period allows sufficient time for implementation of Projects and Management Actions (P/MAs) needed to reverse declining trends. This period is half the duration of the SGMA implementation period, and thus by this point the Basin should be on a trajectory towards achieving the Sustainability Goal.<br><br><u>Relationship with Other Sustainability Indicators:</u><br>Groundwater levels are used as a proxy for groundwater storage.<br><br>Based on available data, no direct correlation can be discerned between water levels and trends in water quality within the Arvin-Edison MA at this time.<br><br>Groundwater Level MTs consider land subsidence impacts by setting the initial MT estimates to their historical low groundwater levels in the 6 RMS within one mile of critical infrastructure.<br><br>Seawater intrusion and interconnected surface water are not applicable to the Arvin-Edison MA.<br><br><u>Impact to Adjacent Management Areas and Basins:</u><br>The MTs have been developed in consideration of and in coordination with the neighboring water agencies within the Kern Subbasin and in neighboring basins. The MT methods are generally consistent with the adjoining basins.<br><br><u>Impact to Beneficial Users:</u><br>Historical low groundwater levels are not known to have caused significant and unreasonable impacts to beneficial uses and users of groundwater, based on the best available information. | MOs were initially based on groundwater levels observed in Fall 2015 and adjusted so that RMS within a Sustainability Zone have the same MO value. These adjustments generally entail decreasing the MO for the sustainability zone relative to Fall 2015.<br><br><u>Margin of Operational Flexibility:</u><br>Generally, groundwater levels in 2015 were not near the historical lows. Therefore, an ample Margin of Operational Flexibility exists. |

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | | | | | | the 6 RMS within one mile of critical infrastructure (i.e., AEWSD's surface water conveyance system).<br><br>Initial MT estimates were generalized spatially to create four "Sustainability Criteria Zones" to allow for flexibility in the selection of RMS. All RMS within a Sustainability Zone have the same MT value. | Furthermore, a well impact analysis shows that although the proposed MTs could potentially result in 9% of domestic wells and 5% of production and public supply wells being dewatered, the impacts would not be unreasonable and would be prevented and/or mitigated through a Well Dewatering Mitigation Program.<br><br><u>State, Federal, and Local Standards:</u> There are no state, federal, or local standards pertaining to groundwater levels in the Arvin-Edison MA.<br><br><u>Measurement of Minimum Thresholds:</u> Groundwater levels will be measured in each of the 16 RMS semiannually using the monitoring protocols outlined in the South of Kern River Groundwater Sustainability Plan (SOKR GSP). | |
| Reduction of Groundwater Storage | Same Beneficial Users as the Chronic Lowering of Groundwater Levels sustainability indicator. | Reduced groundwater supply reliability due to reduced quantity of water available. | Same causes as the Chronic Lowering of Groundwater Levels sustainability indicator (i.e., increased groundwater pumping and reduced recharge; see above). | It is considered a local UR for Reduction of Groundwater Storage **when groundwater levels decline below established MTs in 40% or more of any water level RMS within the MA over four consecutive bi-annual SGMA required monitoring events.** | The use of MTs for the Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage has been demonstrated to be appropriate and protective. The amount by which groundwater storage would be reduced if groundwater levels at <u>all</u> RMS declined to their respective MTs represents 29% of total usable groundwater storage. This volume (1.08 million acre-feet [MAF]) corresponds to the volume that would be pumped in roughly seven years of pumping at the average historical rate.<br><br>Given that the UR definition is based on only 40% of RMS exceeding their MTs, the actual reduction in storage that would occur if URs for chronic groundwater levels were triggered would be much less, and therefore the UR definition avoids significant and unreasonable effects for the | MTs for Chronic Lowering of Groundwater Levels are used as a proxy for Reduction of Groundwater Storage. See above for definitions of those MTs. | <u>Use of Groundwater Levels as a Proxy:</u> MTs for Reduction in Groundwater Storage may be set by using MTs for Chronic Decline in Groundwater Levels as a proxy if it is demonstrated that a correlation exists between the two metrics. The following calculation demonstrates this correlation:<br><br>The volume of "usable storage" theoretically accessible to existing wells was estimated as the storage between the average Fall 2015 groundwater levels (381 feet [ft]) and the median depth of production wells (815 ft). The usable storage volume is about 3.7 MAF within the Arvin-Edison MA.<br><br>The volume of groundwater above the Chronic Lowering of Groundwater Levels MTs and the Fall 2015 groundwater elevations is estimated at 1.08 MAF, which is approximately 29% of the estimated volume of usable storage. Because estimated usable storage is much greater than the volume of water | MOs for Chronic Lowering of Groundwater Levels are used as a proxy for Reduction of Groundwater Storage. See above for definitions of those MOs. |

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
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| | | | | | Reduction of Groundwater Storage Sustainability Indicator. | | above the MTs, the MTs for Chronic Lowering of Groundwater Levels are considered protective for the Reduction of Groundwater Storage Sustainability Indicator. | |
| Seawater Intrusion | Because the Kern Subbasin is not located near any saline water bodies, seawater intrusion is not present and not likely to occur, and the Seawater Intrusion Sustainability Indicator is not applicable. **Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.** | | | | | | | |
| Degraded Water Quality | Beneficial Users impacted by Degraded Water Quality include:<br>- Domestic and Small Community Water Users (134 wells); and,<br>- Municipal Water Users (19 wells). | Increased costs to treat groundwater to drinking water standards for municipal and industrial (M&I) customers.<br><br>Increased costs to blend relatively poor-quality groundwater with higher quality sources for agricultural use. | Causes related to the continued movement of 'legacy' constituents of concern from soil and vadose zone, as well as conditions potentially influenced by extraction and recharge, including:<br>- Deep percolation of precipitation and seepage from natural and man-made channels;<br>- Irrigation system backflow into wells;<br>- Deep percolation of excess applied irrigation water;<br>- Lateral migration from adjacent areas with poorer groundwater quality;<br>- Leaching from internal sources such as fine-grained, clay-rich interbeds;<br>- Upwards vertical flow from deeper zones below the bottom of the Basin; and<br>- Recharge from managed recharge projects. | It is considered a local UR for Degraded Water Quality **if the MT is exceeded in 40% or more (i.e., at least 4 of 10) of any water quality RMS within the MA over two consecutive annual SGMA required measurements as a result of groundwater recharge or extraction, such that it cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable).** | Several criteria, or "tests," were utilized by the SOKR GSAs to systematically and transparently assess which Constituents of Concern (COCs) warranted the development of SMCs for to be consistent based on the understanding of groundwater conditions, the relationship between groundwater management (i.e., extraction and recharge to water quality), the regulatory landscape, and the above-listed regulations. The SOKR GSAs then only developed SMCs for those COCs that passed all of the following tests. These "tests" include:<br>- Regional Occurrence Test: A COC passes this test if it is detected in at least 15% of wells within a MA<br>- Anthropogenic Influence Test: This test further draws a distinction between human-influenced versus naturally-occurring effects, that are not necessarily under the purview of GSAs to manage.<br>- Sensitive Beneficial Use Test: A COC passes this test if it has a Primary MCL set by the SWRCB, and therefore could have an impact on drinking water users, assuming the COC passes the other "tests".<br>- Pre-SGMA Condition Test: A COC passes this test if unimpacted beneficial users | The MT is set for arsenic based on regulatory thresholds for drinking water beneficial use set by United States Environmental Protection Agency (USEPA) and State of California. Specifically, the MT is set either at the California Maximum Contaminant Level (MCL) for arsenic of 10 micrograms per liter (ug/L) arsenic, or for wells already in exceedance of the MCL at the SGMA-effective date, at the pre-SGMA baseline arsenic concentration plus 5 ug/L. | Per CWC § 10727.2, GSAs only need to address degradation of water quality caused by groundwater management (i.e., extraction and recharge) in the basin, and are not required to address URs that occurred before January 1, 2015. As such, it is not under the purview of the GSA to regulate several "legacy" constituents of concern.<br><br>The criteria acknowledge that URs only occur if the groundwater cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable) and that the groundwater is generally suitable for the dominant beneficial use in the Arvin-Edison MA (i.e., agriculture).<br><br>Relationship with Other Sustainability Indicators:<br>As described above, there is no known correlation between groundwater levels (and by proxy, groundwater storage) and water quality in the Arvin-Edison MA.<br><br>There is no known direct correlation between land subsidence and water quality in the Arvin-Edison MA.<br><br>Seawater intrusion and interconnected surface water are not applicable to the Arvin-Edison MA.<br><br>Impact to Adjacent Management Areas and Basins:<br>The MT for Degraded Water Quality is not expected to impact adjacent MAs' or basins' ability to achieve their sustainability goals, as it is set to either | Within the ACSD RMS (i.e., ACSD Wells #14, #16, and #17), the MO is set at 7.5 ug/L arsenic, corresponding to 75% of the California MCL. Within the remaining RMS, the MO is set at either the California MCL for arsenic (10 ug/L) or the pre-SGMA baseline arsenic concentration, whichever is greater. |

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | | | | | still exist as of 2015 (i.e., impacts are not significant as of the SGMA effective date).<br>- Other Regulatory Regime Test: A COC passes this test if the constituent loading is not already being managed by another regulatory authority (e.g., ILRP or CV-SALTS), and assuming the COC passes the other “tests”.<br>- Groundwater Management “Nexus” Test: A COC passes this test if concentrations are or have the potential to be exacerbated by groundwater management actions taken by the GSAs (i.e., management of groundwater extractions or recharge).<br><br>Per the rationale described and employed herein, because the focus of SGMA rightfully emphasizes those constituents that may be degraded to groundwater management activities (i.e., extraction and recharge), the only COC applicable for the development of Degraded Water Quality SMCs within the Arvin-Edison MA is arsenic.<br><br>This process notwithstanding, the GSAs are committed to continue to monitor and otherwise evaluate water quality and the COCs as part of on-going SGMA implementation, in coordination with all other Basin GSAs. | | the Primary MCL, a regulatory threshold set by the US EPA and SWRCB Division of Drinking Water, or pre-SGMA concentrations plus a reasonable buffer (5 ug/L) generally reflective of the variability observed in historical arsenic sampling data. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water from the Arvin-Edison MA.<br><br>Impact to Beneficial Users:<br>Primary MCLs are regulatory thresholds based on criteria for drinking water quality, which is the most sensitive beneficial use. As such, the MT for Degraded Water Quality considers the most sensitive beneficial uses and users of groundwater. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water within the Arvin-Edison MA.<br><br>State, Federal, and Local Standards:<br>State, federal, and local entities have greater authority to enforce water quality standards, especially for anthropogenic-derived pollutant constituents, and regulation of those constituents is not under the purview of a GSA.<br><br>Measurement of Minimum Thresholds:<br>Compliance with the Degraded Water Quality MT will be based on monitoring data collected annually in the ten water quality RMS currently specified for the MA in accordance with the monitoring protocols described in Section 16.2 and in the Coordination Agreement. | |

**TABLE SMC-2**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Arvin-Edison Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| Land Subsidence | Critical Surface Infrastructure is not defined as a Beneficial User in CWC §10723.2, but is considered as a land use and property interest in the development of SMC for Land Subsidence. | Damage to critical infrastructure, including gravity-driven water conveyance infrastructure (i.e., AEWSD's canal system).<br><br>Damage to non-critical infrastructure such as local water conveyance systems (i.e., AEWSD's pressure pipeline distribution system), groundwater well heads, discharge lines, and casings. | Depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of compressible strata and lowering of the ground surface. Therefore, the causes of URs due to Land Subsidence are the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels. | URs would occur in the Arvin-Edison MA if recent subsidence rates (i.e., the rates of subsidence observed from 2014-2018) were to continue through the SGMA implementation period (i.e., through 2040).<br><br>It is considered a local UR **if the MT extent of subsidence is exceeded in at least 40% (i.e., 20 of 5) of the local survey benchmark locations along the canal system within the Arvin-Edison MA.** | An UR is defined as land subsidence that substantially degrades canal capacity, level management, or in-canal balancing volume. It is therefore unrealistic to define URs as "any further land subsidence," as such an outcome would almost certainly be unavoidable.<br><br>AEWSD has historically been able to manage effects from subsidence continuing at historical rates and will continue to do so throughout the SGMA implementation period. | The MT for Land Subsidence is defined within the Arvin-Edison MA as the cumulative extent of inelastic subsidence that would occur if the maximum rate of subsidence observed through ground-based surveys between 2014 and 2018 (i.e., 1.5 in/yr) were to continue through the end of the SGMA implementation timeline, i.e., to 2040.<br><br>Over the 22-year implementation timeframe (i.e., from 2018 to 2040), this equates to a cumulative amount of subsidence of 33 inches, relative to ground surface elevations measured in June 2018. | Relationship with Other Sustainability Indicators:<br>MTs for groundwater levels (and by proxy, groundwater storage) avoid further land subsidence by setting MTs to the historical low groundwater levels at RMS within one mile of critical infrastructure.<br><br>There is no known direct correlation between land subsidence and water quality in the Arvin-Edison MA.<br><br>Seawater intrusion and interconnected surface water are not applicable to the Arvin-Edison MA.<br><br>Impact to Adjacent Management Areas and Basins:<br>The MTs have been developed in consideration of and in coordination with the neighboring water agencies within the Kern Subbasin and in neighboring basins. The MT methods are generally consistent with the adjoining basins.<br><br>Impact to Beneficial Users:<br>The rate of subsidence defined by the MT has been historically managed by AEWSD through maintenance and improvements to its facilities, and AEWSD could likely continue to manage and mitigate further subsidence and impacts to Beneficial Users if it were to occur at similar or lower rates.<br><br>State, Federal, and Local Standards:<br>There are no state, federal, or local standards pertaining to land subsidence in the Arvin-Edison MA.<br><br>Measurement of Minimum Thresholds:<br>Five RMS located at AEWSD's main critical infrastructure facilities will be monitored annually in accordance with the monitoring protocol outlined in the SOKR GSP. | The MO for Land Subsidence is defined within the Arvin-Edison MA as the extent of land subsidence that would be observed if the MT subsidence rated were to continue from 2018 to 2030, and then cease, which amounts to approximately half of the MT extent.<br><br>The MOs and Interim Milestones for Land Subsidence are set with the management goal that no additional subsidence will occur beyond 2030. |

**TABLE SMC-2**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Arvin-Edison Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| Depletions of Interconnected Surface Water | Based on available data and information, groundwater conditions in the Subbasin show that Interconnected Surface Water is not present within the Basin and is not anticipated to be present in the future. Therefore, **no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.** | | | | | | | |

**Abbreviations:**

ACSD = Arvin Community Service District
AEWSD = Arvin-Edison Water Storage District
CWC = California Water Code
CV-SALTS = Central Valley Salinity Alternative for Long-Term Sustainability
DWR = California Department of Water Resources
ET = evapotranspiration
ft = feet
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
in/yr = inches per year
M&I = municipal and industrial
MA = Management Area
MAF = million acre-feet
MCL = Maximum Contaminant Level
MO = Measurable Objective
MT = Minimum Threshold
P/MAs = Projects and Management Actions
RMS = Representative Monitoring Site
SGMA = Sustainable Groundwater Management Act
SMC = Sustainable Management Criteria
SOKR = South of Kern River
ug/L = micrograms per liter
UR = Undesirable Result
USEPA = United States Environmental Protection Agency

**TABLE SMC-3**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Wheeler Ridge-Maricopa Management Area (MA)**

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| **LEGEND**<br>Blue text reflects substantive additions relative to 2020 Plan |

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| Chronic Lowering of Groundwater Levels | Beneficial Users impacted by Chronic Lowering of Groundwater Levels include:<br>- Agricultural and Industrial Water Users (approximately 130 wells);<br>- Domestic and Small Community Water Users (approximately 27 wells); and,<br>- Municipal Water Users (1 well).<br><br>Critical Surface Infrastructure is not defined as a Beneficial User in California Water Code (CWC) §10723.2, but is still considered as a land use and property interest in the development of Sustainable Management Criteria (SMC) for Groundwater Levels. | Groundwater well dewatering and associated effects (e.g., increased maintenance costs, possible well deepening/replacement, and reduced well lifespan).<br><br>Increased pumping lift and associated effects (i.e., greater energy use, higher pumping costs, increased wear and tear on well pump motors, reduced well efficiency, and lower well yield). | **Increased pumping** due to:<br>- increase in water use per acre on irrigated land; and/or<br>- new land put into production.<br><br>**Reduced recharge** due to:<br>- increased agricultural irrigation efficiency;<br>- reduced surface water imports;<br>- climate change resulting in decreased precipitation and increased ET; and/or<br>- reduced groundwater inflows from adjacent areas. | It is considered a local UR for Chronic Lowering of Groundwater Levels **when groundwater levels decline below established MTs in 40% or more of any water level Representative Monitoring Sites (RMS) within the MA over four consecutive bi-annual Sustainable Groundwater Management Act (SGMA) required monitoring events.** | A well age analysis was conducted that showed that 42% of domestic wells, 58% of agricultural/industrial wells, and 0% of municipal wells will be older than 50 years by 2040 and would likely have to be replaced, irrespective of SGMA. As such, effects to beneficial users would not be significant and unreasonable so long as the rate of well dewatering would not exceed the assumed natural replacement rates for each beneficial user category.<br><br>A well impact analysis was conducted that showed that the proposed MTs could potentially dewater 22% of domestic wells, 2% of agricultural/industrial wells, and 0% of municipal wells.<br><br>Additionally, Wheeler Ridge-Maricopa Water Storage District (WRMWSD) has outlined a Well Dewatering Mitigation Program to address potential dewatering of domestic wells at MT water levels. Upon implementation of this program, effectively 0% of domestic wells will be impacted (i.e., dewatered) at the MT. | **Initial MT estimates are set at the 14 designated water level Representative Monitoring Sites (RMS-WLs)**, using an algorithm taking into consideration:<br><br><u>Historical Trends, Water Year Type, and Projected Water Use:</u><br>- Historical water level data, by basing the algorithm on historical hydrograph data;<br>- Well construction information, for the consideration of impacts to beneficial users;<br>- Variability in the amount of groundwater level fluctuation in different wells, by applying a 25% Range Fraction as a conservative allowance for water level fluctuations within a given well; and<br>- Recent trends in groundwater levels, by incorporation of a Trend Extension Period.<br><br><u>Effects on Other Sustainability Indicators</u><br>- Proximity to critical infrastructure for consideration of land subsidence impacts, by setting the initial MT estimates to their historical low groundwater levels in the 3 RMS-WLs within one mile of critical | MTs are set at levels to **avoid a depletion of supply** that may lead to URs.<br><br>Use of a **10-year Trend Extension Period** allows the Groundwater Sustainability Agencies (GSAs) sufficient time for implementation of Projects and Management Actions (P/MAs) needed to reverse declining trends. This period is half the duration of the SGMA Implementation Period, and thus by this point the Basin should be on a trajectory towards achieving the Sustainability Goal.<br><br><u>Relationship with Other Sustainability Indicators:</u><br>Groundwater levels are used as a proxy for groundwater storage.<br><br>Historical monitoring data show no discernible and consistent correlation between groundwater levels and water quality in the Wheeler Ridge-Maricopa MA.<br><br>Groundwater Level MTs consider land subsidence impacts by setting the initial MT estimates to their historical low groundwater levels in the 3 RMS-WLs within one mile of critical infrastructure.<br><br>Seawater intrusion and interconnected surface water are not applicable to the Wheeler Ridge-Maricopa MA.<br><br><u>Impact to Adjacent Management Areas and Basins:</u><br>The MTs have been developed in consideration of and in coordination with the neighboring water agencies within the Kern Subbasin and in neighboring basins. The MT methods are generally consistent with the adjoining basins.<br><br><u>Impact to Beneficial Users:</u><br>Historical low groundwater levels are not known to have caused significant and unreasonable impacts to beneficial uses and users of groundwater, based on the best | MOs were initially based on groundwater levels observed in or around Fall 2015 and adjusted so that RMS-WLs within a Sustainability Zone have the same MO value. These adjustments generally entail decreasing the MO for the sustainability zone relative to Fall 2015.<br><br><u>Margin of Operational Flexibility:</u><br>Generally, groundwater levels in 2015 were not near the historical lows. Therefore, an ample Margin of Operational Flexibility exists. |

**TABLE SMC-3**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Wheeler Ridge-Maricopa Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | | | | | | infrastructure (i.e., the CA Aqueduct);<br><br>Initial MT estimates were generalized spatially to create three "Sustainability Criteria Zones" to allow for flexibility in the selection of RMS-WLs. All RMS-WLs within a Sustainability Zone have the same MT value. | available information.<br><br>Well Impact analysis shows that although the proposed MTs could potentially result in 22% of domestic wells, 2% of agricultural/industrial wells, and 0% of municipal wells being dewatered, the impacts would not be unreasonable and would be prevented and/or mitigated through a Well Dewatering Mitigation Program.<br><br><u>State, Federal, and Local Standards:</u><br>There are no state, federal, or local standards pertaining to groundwater levels in the Wheeler Ridge-Maricopa MA.<br><br><u>Measurement of Minimum Thresholds:</u><br>Groundwater levels will be measured in each of the 14 RMS-WLs semiannually using the monitoring protocols outlined in the South of Kern River Groundwater Sustainability Plan (SOKR GSP). | |
| Reduction of Groundwater Storage | Same Beneficial Users as the Chronic Lowering of Groundwater Levels sustainability indicator. | Reduced groundwater supply reliability due to reduced quantity of water available. | Same causes as the Chronic Lowering of Groundwater Levels Sustainability Indicator (i.e., increased groundwater pumping and reduced recharge; see above). | It is considered a local UR for Reduction of Groundwater Storage **when groundwater levels decline below established MTs in 40% or more of any water level RMS within the MA over four consecutive bi-annual SGMA required monitoring events.** | The use of MTs for the Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage has been demonstrated to be appropriate and protective. The amount by which groundwater storage would be reduced if groundwater levels at <u>all</u> RMS-WLs declined to their respective MTs represents 18% of total usable groundwater storage. This volume (1.08 million acre-feet [MAF]) corresponds to the volume that would be pumped in roughly 19 years of pumping at the average historical rate (57,000 AFY).<br><br>Given that the UR definition is based on only 40% of RMS-WLs exceeding their MTs, the actual reduction in storage that would occur if URs for Chronic Lowering of Groundwater Levels were triggered would be | MTs for Chronic Lowering of Groundwater Levels are used as a proxy for Reduction of Groundwater Storage. See above for definitions of those MTs. | <u>Use of Groundwater Levels as a Proxy:</u><br>MTs for Reduction in Groundwater Storage may be set by using MTs for Chronic Decline in Groundwater Levels as a proxy if it is demonstrated that a correlation exists between the two metrics. The following calculation demonstrates this correlation:<br><br>The volume of "usable storage" theoretically accessible to existing wells was estimated as the storage between the average Fall 2015 depth to groundwater (303 feet below ground surface [ft bgs]) and the median depth of agricultural/industrial wells (1,100 feet [ft]). The usable storage volume is about 5.9 MAF within the Wheeler Ridge-Maricopa MA.<br><br>The volume of groundwater above the Chronic Lowering of Groundwater Levels MTs and the Fall 2015 groundwater elevations is estimated at 1.08 MAF, which is approximately 18% of the estimated volume | MOs for Chronic Lowering of Groundwater Levels are used as a proxy for Reduction of Groundwater Storage. See above for definitions of those MOs. |

# TABLE SMC-3
## Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives
## Wheeler Ridge-Maricopa Management Area (MA)

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | | | | | much less, and therefore the UR definition avoids significant and unreasonable effects for the Reduction of Groundwater Storage Sustainability Indicator. | | of usable storage. **Because estimated usable storage is much greater than the volume of water above the MTs, the MTs for Chronic Lowering of Groundwater Levels are considered protective for the Reduction of Groundwater Storage Sustainability Indicator**. | |
| Seawater Intrusion | Because the Kern Subbasin is not located near any saline water bodies, seawater intrusion is not present and not likely to occur, and the Seawater Intrusion Sustainability Indicator is not applicable. **Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.** | | | | | | | |
| Degraded Water Quality | Beneficial Users impacted by Degraded Water Quality include:<br>- Domestic and Small Community Water Users (approximately 27 wells); and,<br>- Municipal Water Users (1 well).<br>Agricultural use is the dominant beneficial user of groundwater identified within the Wheeler Ridge-Maricopa MA, and groundwater quality is generally suitable for agricultural uses, with the exception of groundwater on the western side of the Wheeler Ridge-Maricopa MA which has higher total dissolved solids (TDS) and sulfate concentrations due to natural geologic conditions. | Increased costs to treat groundwater to drinking water standards if it is to be used as a potable supply source.<br>Increased costs to blend relatively poor-quality groundwater with higher quality sources for agricultural and non-agricultural uses.<br>Potential reduction in "usable storage" volume of groundwater if large areas are further impaired to the point that they cannot be used to support beneficial uses and users. | Causes related to the continued movement of 'legacy' constituents of concern from soil and vadose zone, as well conditions potentially influenced by extraction and recharge, including:<br>- Deep percolation of precipitation and seepage from natural and man-made channels, and recharge from reservoirs and spreading basins;<br>- Irrigation system backflow into wells;<br>- Deep percolation of excess applied irrigation water and other water applied for cultural practices;<br>- Lateral migration from adjacent areas with poorer quality groundwater;<br>- Leaching from internal sources such as fine-grained, clay-rich interbeds; and<br>- Upwards vertical flow from deeper zones below the bottom of the Basin. | It is considered a local UR for Degraded Water Quality **if the MT is exceeded in 40% or more (i.e., at least 4 of 9) of any water quality RMS within the MA over two consecutive annual SGMA required measurements as a result of groundwater recharge or extraction, such that it cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable).** | Several criteria, or "tests," were utilized by the SOKR GSAs to systematically and transparently assess which Constituents of Concern (COCs) warranted the development of SMCs for to be consistent based on the understanding of groundwater conditions, the relationship between groundwater management (i.e., extraction and recharge to water quality), the regulatory landscape, and the above-listed regulations. The SOKR GSAs then only developed SMCs for those COCs that passed all of the following tests. These "tests" include:<br>- <u>Regional Occurrence Test:</u> A COC passes this test if it is detected in at least 15% of wells within a MA<br>- <u>Anthropogenic Influence Test</u>: This test further draws a distinction between human-influenced versus naturally-occurring effects, that are not necessarily under the purview of GSAs to manage.<br>- <u>Sensitive Beneficial Use Test:</u> A COC passes this test if it has a Primary MCL set by the SWRCB, and therefore could have an impact on drinking water users, assuming the COC passes the other "tests". | The MT is set for arsenic based on regulatory thresholds for drinking water beneficial use set by United States Environmental Protection Agency (USEPA) and State of California. Specifically, the MT is set either at the California Maximum Contaminant Level (MCL) for arsenic of 10 micrograms per liter (ug/L) arsenic, or for wells already in exceedance of the MCL at the SGMA-effective date, at the pre-SGMA baseline arsenic concentration plus 5 ug/L. | Per CWC § 10727.2, GSAs only need to address degradation of water quality caused by groundwater management (i.e., extraction and recharge) in the basin, and are not required to address URs that occurred before January 1, 2015. As such, it is not under the purview of the GSA to regulate several "legacy" constituents of concern.<br>The criteria acknowledge that URs only occur if the groundwater cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable) and that the groundwater is generally suitable for the dominant beneficial use in the Wheeler Ridge-Maricopa MA (i.e., agriculture).<br><u>Relationship with Other Sustainability Indicators:</u><br>there is no known correlation between groundwater levels (and by proxy, groundwater storage) and water quality in the Wheeler Ridge-Maricopa MA.<br>Historical monitoring data show no correlation between land subsidence and water quality in the Wheeler Ridge-Maricopa MA.<br>Seawater intrusion and interconnected surface water are not applicable to the Wheeler Ridge-Maricopa MA.<br><u>Impact to Adjacent Management Areas and Basins:</u><br>The MT for Degraded Water Quality is not | The MO is set at either the California MCL for arsenic (10 ug/L) or the pre-SGMA baseline arsenic concentration, whichever is greater. |

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | | | | | - Pre-SGMA Condition Test: A COC passes this test if unimpacted beneficial users still exist as of 2015 (i.e., impacts are not significant as of the SGMA effective date).<br>- Other Regulatory Regime Test: A COC passes this test if the constituent loading is not already being managed by another regulatory authority (e.g., ILRP or CV-SALTS), and assuming the COC passes the other "tests".<br>- Groundwater Management "Nexus" Test: A COC passes this test if concentrations are or have the potential to be exacerbated by groundwater management actions taken by the GSAs (i.e., management of groundwater extractions or recharge).<br><br>Per the rationale described and employed herein, because the focus of SGMA rightfully emphasizes those constituents that may be degraded to groundwater management activities (i.e., extraction and recharge), the only COC applicable for the development of Degraded Water Quality SMCs within the Wheeler Ridge-Maricopa MA is arsenic.<br><br>This process notwithstanding, the GSAs are committed to continue to monitor and otherwise evaluate water quality and the COCs as part of on-going SGMA implementation, in coordination with all other Basin GSAs. | | expected to impact adjacent MAs' or basins' ability to achieve their sustainability goals, as it is set to either the Primary MCL, a regulatory threshold set by the US EPA and SWRCB Division of Drinking Water, or pre-SGMA concentrations plus a reasonable buffer (5 ug/L) generally reflective of the variability observed in historical arsenic sampling data. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water from the Wheeler Ridge-Maricopa MA.<br><br>Impact to Beneficial Users:<br>Primary MCLs are regulatory thresholds based on criteria for drinking water quality, which is the most sensitive beneficial use. As such, the MT for Degraded Water Quality considers the most sensitive beneficial uses and users of groundwater. Also, the water level MTs are not expected to cause significant changes to existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water within the Wheeler Ridge-Maricopa MA.<br><br>State, Federal, and Local Standards:<br>State, federal, and local entities have greater authority to enforce water quality standards, especially for anthropogenic-derived pollutant constituents, and regulation of those constituents is not under the purview of a GSA.<br><br>Measurement of Minimum Thresholds:<br>Compliance with the Degraded Water Quality MT will be based on monitoring data collected annually in the nine (9) water quality RMS currently specified for the MA in accordance with the monitoring protocols described in Section 16.2 and in the Coordination Agreement. | |

**TABLE SMC-3**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Wheeler Ridge-Maricopa Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| Land Subsidence | Critical Surface Infrastructure is not defined as a Beneficial User in CWC §10723.2, but is considered as a land use and property interest in the development of SMC for Land Subsidence.<br><br>Within the Wheeler Ridge-Maricopa MA, the California Aqueduct is considered Regional Critical Infrastructure. The California Aqueduct is the backbone of the State Water Project and is vital to the movement of water from northern California to the south. As such, the Aqueduct is subject to ongoing subsidence monitoring by the DWR, which is anticipated to continue during the SGMA implementation period. | Damage to critical infrastructure, including gravity-driven water conveyance infrastructure (i.e., the California [CA] Aqueduct), which could impair its ability to move water to points further south.<br><br>Damage to non-critical infrastructure such as local water conveyance systems (i.e., WRMWSD's pressure pipeline distribution system), groundwater well heads, discharge lines, and casings. | Depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of compressible strata and lowering of the ground surface. Therefore, the causes of URs due to Land Subsidence are the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels. | URs would occur **if the MT extent of subsidence is exceeded in any one (1) of four (4) Aqueduct pools located within the Wheeler Ridge-Maricopa MA.** | Within the Wheeler Ridge-Maricopa MA, the only critical infrastructure is the CA Aqueduct. Recent monitoring has shown some land subsidence impacts to the section of the CA Aqueduct within the District. It is recognized that due to the inherent time lag of the aquitard depressurization process, there may still be some "built-in" subsidence potential that has yet to manifest. It is therefore unrealistic to define the UR as "any further land subsidence", as such an outcome would almost certainly be unavoidable.<br><br>Within the Wheeler Ridge-Maricopa MA, as of 2013 there are no reaches of the CA Aqueduct that have less than the 2.5 ft minimum recommended freeboard defined by the California Department of Water Resources (DWR); the minimum freeboard is approximately 3.9 ft in one location around milepost 256.56, and along most other portions of these reaches the freeboard is between 6 and 8 feet (DWR, 2017). | The MT for Land Subsidence is defined within the Wheeler Ridge-Maricopa MA for each Aqueduct pool as the cumulative extent of inelastic subsidence that would result in a 75 percent (%) reduction in average available freeboard height (as of 2017) above DWR's design criterion for lined freeboard height in the San Joaquin Field Division of 30 inches (i.e., 2.5 feet). | Relationship with Other Sustainability Indicators:<br>MTs for Chronic Lowering of Groundwater Levels (and by proxy, Reduction of Groundwater Storage) avoid further land subsidence by setting MTs to the historical low groundwater levels at RMS within one mile of the CA Aqueduct.<br><br>Historical monitoring data show no correlation between land subsidence and water quality in the Wheeler Ridge-Maricopa MA.<br><br>Seawater intrusion and interconnected surface water are not applicable to the Wheeler Ridge-Maricopa MA.<br><br>Impact to Adjacent Management Areas and Basins:<br>The MTs have been developed in consideration of and in coordination with the neighboring water agencies within the Kern Subbasin and in neighboring basins**.** The MT methods are generally consistent with the adjoining basins.<br><br>Impact to Beneficial Users:<br>The MT extent of subsidence defined herein is designed to maintain Aqueduct freeboard heights within each pool well above DWR's design criterion for lined freeboard height of 30 inches for the San Joaquin Field Division. The freeboard height that would result from additional subsidence to the MT extent within the MA ranges from 36 inches in Aqueduct Pool 32 to 44.3 inches in Aqueduct Pool 35.<br><br>State, Federal, and Local Standards:<br>There are no state, federal, or local standards pertaining to land subsidence in the Wheeler Ridge-Maricopa MA.<br><br>Measurement of Minimum Thresholds:<br>The 40 DWR survey benchmark locations between Mileposts 256.14 (Check No. 31) | The MO for Land Subsidence is defined within the Wheeler Ridge-Maricopa MA as half of the MT extent of land subsidence defined for each Aqueduct pool.<br><br>The MOs and Interim Milestones for Land Subsidence are set with the management goal that land subsidence rates will decelerate throughout the SGMA implementation period and that no additional subsidence will occur beyond 2040. |

**TABLE SMC-3**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Wheeler Ridge-Maricopa Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result (UR) Causes | Local Undesirable Results Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | and 278.13 (Teerink Pumping Plant) of the California Aqueduct are monitored annually by DWR, and those data will be used for purposes of SGMA monitoring of land subsidence within the Wheeler Ridge-Maricopa MA. The monitoring conducted by DWR is consistent with the land subsidence monitoring principles outlined in the SOKR GSP. | |
| Depletions of Interconnected Surface Water | Based on available data and information, groundwater conditions in the Subbasin show that Interconnected Surface Water is not present within the Basin and is not anticipated to be present in the future. Therefore, **no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.** | | | | | | | |

**Abbreviations:**

CA = California
CV-SALTS = Central Valley Salinity Alternative for Long-Term Sustainability
CWS = California Water Code
DWR = California Department of Water Resources
ET = Evapotranspiration
ft = feet
ft bgs = feet below ground surface
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
ILRP = Irrigated Lands Regulatory Program
MA = Management Area
MAF = million acre-feet
MCL = Maximum Contaminant Level
MO = Measurable Objective
MT = Minimum Threshold
No. = Number
P/MAs = Projects and Management Actions
RMS = Representative Monitoring Site
RMS-WL = Water Level Representative Monitoring Site
SGMA = Sustainable Groundwater Management Act
SOKR = South of Kern River
TDS = Total Dissolved Solids
UR = Undesirable Results
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

**TABLE SMC-4**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Tejon-Castac Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result Causes | Local Undesirable Result Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| Chronic Lowering of Groundwater Levels | Beneficial Users impacted by Chronic Lowering of Groundwater Levels include:<br>- Agricultural and Industrial Water Users (1 active industrial/ agricultural well); and<br>- Domestic and Small Community Water Users (3 potentially active domestic wells)<br><br>Critical Surface Infrastructure is not defined as a Beneficial User in California Water Code (CWC) §10723.2, but is still considered as a land use and property interest in the development of Sustainable Management Criteria (SMC) for Groundwater Levels. There is no Regional Critical Infrastructure within the Tejon-Castac MA. | Groundwater well dewatering and associated effects (e.g., increased maintenance costs, possible well deepening/replacement, and reduced well lifespan).<br><br>It should be noted that the potential causes (see right) and potential effects would be occurring at the same well, i.e., the single known active industrial/ agricultural well. | Increased pumping. It should be noted that, besides de minimis pumping at a single known active domestic well in the far eastern upland area, pumping within the Tejon-Castac MA is limited to pumping from the single known active industrial/ agricultural well for limited purposes (i.e., at the Granite quarry, and selected irrigated lands located outside of the Tejon-Castac MA), and this well is the representative monitoring well at which SMCs are defined. | It is considered a local UR for Chronic Lowering of Groundwater Levels **when groundwater levels decline below established MTs in 40% or more of any RMS (Representative Monitoring Sites) within the MA over four consecutive bi-annual Sustainable Groundwater Management Act (SGMA) required monitoring events.**<br><br>Because there is only one representative monitoring well in the Tejon-Castac MA, this definition effectively means local Undesirable Results are triggered when groundwater levels decline below the established MT in the one representative monitoring well over four consecutive bi-annual SGMA required monitoring events. | A well impact analysis was conducted that showed that the proposed MT would entail partial dewatering of the single active industrial/ agricultural well's 364-ft screen. However, there would still be more than 300 feet of saturated thickness remaining. No significant and unreasonable effects from low groundwater levels are known to have occurred at this well (based on stakeholder survey response from the well owner) and so the minimum threshold and undesirable results criteria are considered to be protective against significant and unreasonable effects. | The MT for Chronic Lowering of Groundwater Levels is set at 50 feet above mean sea level (ft msl).<br><br><u>Historical Trends, Water Year Type, and Projected Water Use:</u><br>- No historical data are available for wells within the Tejon-Castac MA; instead, historical water level data from nearby wells within the Arvin-Edison MA were used.<br><br><u>Effects on Other Sustainability Indicators</u><br>- Proximity to critical infrastructure for consideration of land subsidence impacts, by setting the initial MT estimates to their estimated historical low groundwater levels<br><br><u>Effects on Adjacent Areas</u><br>- This MT is set at the same value as the MTs for the two nearest Representative Monitoring Sites in the adjacent Arvin-Edison MA. | The MT is set at a level to avoid a depletion of supply that may lead to URs.<br><br>The MT is based on the approximate average historical low value for wells within Arvin-Edison Water Storage District (AEWSD) to the west of the Tejon-Castac MA that are nearest to the Representative Monitoring Site, the reason being that no historical water level data otherwise exists in this portion of the Tejon-Castac MA.<br><br>The approximate historical low water level as the MT avoids Undesirable Results because such lows are not known to have ever caused problems with respect to groundwater production (based on the response of the Caratan Well owner to the Stakeholder Survey).<br><br><u>Relationship with Other Sustainability Indicators:</u><br>Groundwater levels are used as a proxy for the Reduction of Groundwater Storage.<br><br>Groundwater levels are also used as a proxy for Land Subsidence, as there is no critical infrastructure within the Tejon-Castac MA, and the groundwater level MTs are set to be protective of potential subsidence impacts.<br><br>Degraded Water Quality, Seawater Intrusion, and Interconnected Surface Water are not applicable to the Tejon-Castac MA.<br><br><u>Consideration of Adjacent Basins:</u><br>MTs have been developed in consideration of and in coordination with neighboring water agencies within the Kern Subbasin and in neighboring basins. Through its membership in the White Wolf Groundwater Sustainability Agency (GSA), Tejon-Castac Water District (TCWD) has and will continue to consider the effects of Sustainability Criteria in the Tejon-Castac MA on the adjacent White Wolf Basin's ability to achieve its Sustainability Goal.<br><br>**<u>Impact to Beneficial Users:</u>**<br>As previously mentioned, the well impact analysis showed that the proposed MT would entail partial dewatering of the single active industrial/agricultural well's 364-ft screen. | The MO was set at 100 ft msl, the same value as the MO for representative monitoring wells in the adjacent Arvin-Edison MA<br><br>**<u>Margin of Operational Flexibility:</u>**<br>The Margin of Operational Flexibility is 50 ft. |

**TABLE SMC-4**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Tejon-Castac Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result Causes | Local Undesirable Result Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | However, there would still be more than 300 feet of saturated thickness remaining. Based on the response of the well's owner to the Stakeholder Survey, historical low groundwater levels are not known to have caused significant and unreasonable impacts to beneficial uses and users of groundwater. As such, this MT is presumed to be protective of known beneficial uses and users of groundwater in the Tejon-Castac MA.<br><br>**State, Federal, and Local Standards:**<br>There are no state, federal, or local standards pertaining to groundwater levels in the Tejon-Castac MA.<br><br>**Measurement of Minimum Thresholds:**<br>Groundwater levels will be measured in the single RMS semiannually using the monitoring protocols outlined in the South of Kern River Groundwater Sustainability Plan (SOKR GSP). | |
| Reduction of Groundwater Storage | Same Beneficial Users as the Chronic Lowering of Groundwater Levels sustainability indicator. | Reduced groundwater supply reliability due to reduced quantity of water available. | Same causes as the Chronic Lowering of Groundwater Levels Sustainability Indicator. | It is considered a local UR for Reduction of Groundwater Storage **when groundwater levels decline below established MTs in 40% or more of any RMS within the MA over four consecutive bi-annual SGMA required monitoring events.** | The use of MTs for the Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage is appropriate and protective because the significant and unreasonable effects of groundwater levels and storage are directly related in this case because there is only a single well. | The MT for Chronic Lowering of Groundwater Levels is used as a proxy for Reduction of Groundwater Storage. See above for definitions of the MT. | The MT for Chronic Lowering of Groundwater Levels is used as a proxy for Reduction of Groundwater Storage. See above for justification of the MT. | MOs for Chronic Lowering of Groundwater Levels are used as a proxy for Reduction of Groundwater Storage. See above for definitions of those MOs. |
| Seawater Intrusion | Because the Kern Subbasin is not located near any saline water bodies, seawater intrusion is not present and not likely to occur, and the Seawater Intrusion Sustainability Indicator is not applicable. **Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.** | | | | | | | |
| Degraded Water Quality | Beneficial Users impacted by Degraded Water Quality include:<br><br>- Domestic and Small Community Water Users (3 potentially active domestic wells) | Increased costs to treat groundwater to drinking water standards if it is to be used as a potable supply source. | Conditions potentially influenced by extraction and recharge, including:<br><br>- Lateral migration from adjacent areas with poorer quality groundwater; | **No local URs for Degraded Water Quality are defined for the Tejon-Castac MA.** | Given the lack of groundwater use and development, there are no degraded water quality conditions that would fall under the purview of the SOKR GSAs. Further, there are no beneficial uses that are expected to be significantly and | No MTs have been established for Degraded Water Quality within the Tejon-Castac MA. | <u>Relationship with Other Sustainability Indicators:</u><br>Groundwater level and quality time-series data are not available in the Tejon-Castac MA, but no discernible and consistent relationship between groundwater levels (and by proxy, groundwater storage) and water quality is expected in the Tejon-Castac MA, based on data from other portions of the Basin. | No MOs have been established for Degraded Water Quality within the Tejon-Castac MA. |

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| **Sustainability Indicator** | **Identification of Beneficial Users** | **Potential Effects on Beneficial Users** | **Undesirable Result Causes** | **Local Undesirable Result Criteria (i.e., Trigger)** | **Local Undesirable Results Criteria Justification** | **Minimum Threshold (MT) Definition** | **Minimum Threshold Justification** | **Measurable Objective (MO) Definition** |
|---|---|---|---|---|---|---|---|---|
| | It should be noted that the potentially active domestic wells within the Tejon-Castac MA are located in the far eastern upland area, far from the valley floor area where the only non-de minimis pumping occurs. It is therefore unlikely that water management actions by the TCWD GSA could affect groundwater quality conditions at the single active domestic well. | | - Leaching from internal sources such as fine-grained, clay-rich interbeds; and<br>Upwards vertical flow from deeper zones below the bottom of the Basin. | | unreasonably affected by groundwater quality. | | There is no known direct correlation between land subsidence and water quality in the Tejon-Castac MA.<br><br>Seawater intrusion and interconnected surface water are not applicable to the Tejon-Castac MA.<br><br>Impact to Adjacent Management Areas and Basins:<br>MTs for Chronic Lowering of Groundwater Level are anticipated to be protective in terms of preventing migrations of poor-quality water into or from adjacent MAs and basins.<br><br>Impact to Beneficial Users:<br>As described previously, beneficial uses identified within the Tejon-Castac MA included one active industrial/agricultural well for which groundwater quality is generally suitable for major beneficial uses, and one active domestic well located in the far eastern upland portion of the Tejon-Castac MA, where existing limitations on land use are expected to be protective.<br><br>State, Federal, and Local Standards:<br>State, federal, and local entities have greater authority to enforce water quality standards, especially for anthropogenic-derived pollutant constituents. For example, drinking water supplies from public water systems are regulated to primary maximum contaminant level (MCL) thresholds set by the United States Environmental Protection Agency (USEPA) and State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) as specified in Title 22 of the California Code of Regulations (CCR). Water quality issues related to deep percolation of agriculture chemicals (e.g., nitrates) are regulated separately under the Irrigated Lands Regulatory Program (ILRP) and Central Valley Salinity Alternative for Long-Term Sustainability (CV-SALTS). | |
| Land Subsidence | Regional Critical Infrastructure is not defined as a Beneficial User in CWC §10723.2, but is considered as a land use and property | Damage to critical infrastructure. However, there is no Regional Critical Infrastructure within the Tejon-Castac MA that could be significantly and | Depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of | **No local URs for Land Subsidence are defined for the Tejon-Castac MA.** | Because subsidence has not been an issue historically within the Tejon-Castac MA, and there is no non de-minimis groundwater use other | The MT for Chronic Lowering of Groundwater Levels is used as a proxy for Land Subsidence. See above for definitions of those MTs. | Relationship with Other Sustainability Indicators:<br>The MT value for Chronic Lowering of Groundwater Levels is defined so as to be protective against possible land subsidence by being limited to levels that are generally no | MOs for Chronic Lowering of Groundwater Levels are used as a proxy for Reduction of Groundwater Storage. |

**TABLE SMC-4**
**Summary of Undesirable Results, Minimum Thresholds, and Measurable Objectives**
**Tejon-Castac Management Area (MA)**

**LEGEND**
Blue text reflects substantive additions relative to 2020 Plan

| Sustainability Indicator | Identification of Beneficial Users | Potential Effects on Beneficial Users | Undesirable Result Causes | Local Undesirable Result Criteria (i.e., Trigger) | Local Undesirable Results Criteria Justification | Minimum Threshold (MT) Definition | Minimum Threshold Justification | Measurable Objective (MO) Definition |
|---|---|---|---|---|---|---|---|---|
| | interest in the development of SMC for Land Subsidence.<br><br>There is no Regional Critical infrastructure within the Tejon-Castac MA that could be significantly and unreasonably affected by land subsidence. | unreasonably affected by land subsidence. | compressible strata and lowering of the ground surface. Therefore, the causes of URs due to Land Subsidence are the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels. | | than at the single active industrial/ agricultural well (i.e., the Caratan Well), land subsidence is unlikely to occur within the Tejon-Castac MA. | | lower than historical lows.<br><br>Use of the approximate historical low water level as the MT avoids URs for land subsidence because land subsidence typically does not occur unless groundwater levels fall below historical lows for a sufficient period of time, the length of which depends on the thickness of compressible clay beds.<br><br>There is no known direct correlation between land subsidence and water quality in the Tejon-Castac MA.<br><br>Seawater intrusion and interconnected surface water are not applicable to the Tejon-Castac MA.<br><br>Impact to Beneficial Users<br>Because subsidence has not been an issue historically and there is no significant groundwater development other than the industrial and agricultural uses of the Caratan Well, land subsidence is unlikely to occur within the Tejon-Castac MA.<br><br>Impact to Adjacent Management Areas and Basins:<br>The MTs for Chronic Lowering of Groundwater Levels have been developed in consideration of and in coordination with the neighboring water agencies within the Kern Subbasin and in neighboring basins. The MT methods are generally consistent with the adjoining basins.<br><br>State, Federal, and Local Standards:<br>There are no state, federal, or local standards pertaining to land subsidence in the Tejon-Castac MA. | See above for definitions of those MOs. |
| Depletions of Interconnected Surface Water | Based on available data and information, groundwater conditions in the Subbasin show that Interconnected Surface Water is not present within the Basin and is not anticipated to be present in the future. Therefore, **no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.** | | | | | | | |

**Abbreviations:**

AEWSD = Arvin-Edison Water Storage District
ft msl = feet relative to mean sea level
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
MA = Management Area
MT = Minimum Threshold
RMS = Representative Monitoring Site
SGMA = Sustainable Groundwater Management Act
SMC = Sustainable Management Criteria
SOKR = South of Kern River
TCWD = Tejon-Castac Water District
UR = Undesirable Result

**TABLE SMC-9**

**Summary of Minimum Thresholds, Interim Milestones, and Measurable Objectives for Chronic Lowering of Groundwater Levels**

| Representative Monitoring Site ID | Sustainability Criteria Zone | Minimum Threshold | Interim Milestones | | | Measurable Objective (ft) | Margin of Operational Flexibility (ft) |
|---|---|---|---|---|---|---|---|
| | | | 2025 | 2030 | 2035 | | |
| **Arvin-Edison Management Area** | | | | | | | |
| 29S29E33N001M | North Canal | **50** | 174 | 112 | 106 | **100** | 50 |
| 30S29E29A001M | North Canal | **50** | 71 | 61 | 80 | **100** | 50 |
| 31S29E05E001M | North Canal | **50** | 74 | 62 | 81 | **100** | 50 |
| 31S29E12M001M | North Canal | **50** | 66 | 58 | 79 | **100** | 50 |
| 31S30E17K001M | North Canal | **50** | 51 | 50 | 75 | **100** | 50 |
| 31S30E30J001M | North Canal | **50** | 83 | 66 | 83 | **100** | 50 |
| 30S29E11N001M | Edison | **250** | 309 | 279 | 290 | **300** | 50 |
| 30S30E19E001M | Edison | **250** | 414 | 332 | 316 | **300** | 50 |
| 31S29E34A001M | ACSD | **-70** | -16 | -43 | -6 | **30** | 100 |
| ACSD Well No. 14 | ACSD | **-70** | -16 | -43 | -6 | **30** | 100 |
| 11N20W05J001S | South Canal | **0** | 53 | 26 | 38 | **50** | 50 |
| 12N20W36G001S | South Canal | **0** | 28 | 14 | 32 | **50** | 50 |
| 32S28E23H001M | South Canal | **0** | 68 | 34 | 42 | **50** | 50 |
| 32S29E12P001M | South Canal | **0** | 32 | 16 | 33 | **50** | 50 |
| 32S29E20H001M | South Canal | **0** | 68 | 34 | 42 | **50** | 50 |
| 32S29E31N001M | South Canal | **0** | 36 | 18 | 34 | **50** | 50 |
| **Wheeler Ridge-Maricopa Management Area** | | | | | | | |
| 11N22W06H001S | Western | **100** | 184 | 142 | 171 | **200** | 100 |
| 32S25E29Q001M | Western | **100** | 195 | 147 | 174 | **200** | 100 |
| 32S26E20G001M | Northeastern | **-50** | 33 | -8 | -4 | **0** | 50 |

**TABLE SMC-9**

**Summary of Minimum Thresholds, Interim Milestones, and Measurable Objectives for Chronic Lowering of Groundwater Levels**

| Representative Monitoring Site ID | Sustainability Criteria Zone | Minimum Threshold | Interim Milestones | | | Measurable Objective (ft) | Margin of Operational Flexibility (ft) |
|---|---|---|---|---|---|---|---|
| | | | 2025 | 2030 | 2035 | | |
| **Wheeler Ridge-Maricopa Management Area** | | | | | | | |
| 32S26E24K001M | Northeastern | **-50** | 33 | -8 | -4 | **0** | 50 |
| 32S27E30N001M | Northeastern | **-50** | 93 | 21 | 11 | **0** | 50 |
| 32S27E35R001M | Northeastern | **-50** | 49 | -1 | 0 | **0** | 50 |
| 32S26E34P001M | Northeastern | **-50** | 68 | 9 | 4 | **0** | 50 |
| 32S26E36P002M | Northeastern | **-50** | 63 | 6 | 3 | **0** | 50 |
| 32S28E16P001M | Northeastern | **-50** | 111 | 30 | 15 | **0** | 50 |
| 11N22W01D001S | Southeastern | **0** | 93 | 47 | 61 | **75** | 75 |
| 11N21W16E001S | Southeastern | **0** | 3 | 2 | 38 | **75** | 75 |
| 12N21W35Q001S | Southeastern | **0** | 100 | 50 | 62 | **75** | 75 |
| 12N21W34N001S | Southeastern | **0** | 62 | 31 | 53 | **75** | 75 |
| 11N21W09C001S | Southeastern | **0** | 80 | 40 | 58 | **75** | 75 |
| **Tejon-Castac Management Area** | | | | | | | |
| RMS-1 (Caratan Well) | N/A | **50** | TBD(2) | TBD(2) | TBD(2) | **100** | 50 |

**Abbreviations:**

ft msl = feet above mean sea level

N/A = Not Appplicable

TBD = To Be Determined

**Notes:**

(1) All values are in ft msl.

(2) Due to lack of existing data, Interim Milestones for the Tejon-Castac Management Area will be determined once sufficient data from the Representative Monitoring Site have been collected.

**TABLE SMC-10**
**Summary of Minimum Thresholds, Interim Milestones, and Measurable Objectives for Degraded Water Quality**

| Representative Monitoring Site ID | Recent/Historical Arsenic Concentration Data (ug/L) | Minimum Threshold (2) | Interim Milestones | | | Measurable Objective (3) | Margin of Operational Flexibility |
|---|---|---|---|---|---|---|---|
| | | | 2025 | 2030 | 2035 | | |
| **Arvin-Edison Management Area** | | | | | | | |
| ACSD Well #14 | **5.2 – 9.7 (4)** | **10** | 10 | 10 | 10 | **7.5** | 2.5 |
| ACSD Well #16 | **3.5 – 6.8 (5)** | **10** | 10 | 10 | 10 | **7.5** | 2.5 |
| ACSD Well #17 | **3.1 – 5.9 (5)** | **10** | 10 | 10 | 10 | **7.5** | 2.5 |
| 30S29E29A001M | **11 (6)** | **16** | 16 | 16 | 16 | **11** | 5.0 |
| 32S29E04R001M | **<7.8 (6)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 32S28E33R002M | **<7.8 (6)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 32S28E22R001M | **<7.8 (6)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 31S29E25J001M | **15 (6)** | **20** | 20 | 20 | 20 | **15** | 5.0 |
| 31S29E10K001M | **<7.8 (6)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 30S30E18G001M | **15 (6)** | **20** | 20 | 20 | 20 | **15** | 5.0 |
| **Wheeler Ridge-Maricopa Management Area** | | | | | | | |
| 32S25E29Q001M | **5.4 (7)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 32S28E16P001M | **ND (<2.0) – 5.2 (8)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 32S26E17H001M | **12 – 16 (9)** | **21** | 21 | 21 | 21 | **16** | 5.0 |
| 11N21W12N002S | **2.6 – 7 (9)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 11N22W09A001S | **no data** | **10 (12)** | 10 | 10 | 10 | **10** | 2.5 |
| 12N21W31P001S | **no data** | **10 (12)** | 10 | 10 | 10 | **10** | 2.5 |
| 12N21W34N001S | **4.1 – 7 (10)** | **10** | 10 | 10 | 10 | **10** | 0.0 |
| 32S26E14J001M | **2.8 – 47 (9)** | **52** | 52 | 52 | 52 | **47** | 5.0 |
| 32S27E36R001M | **2.3 – 3.5 (11)** | **10** | 10 | 10 | 10 | **10** | 0.0 |

**Abbreviations:**

MCL = Maximum Contaminant Level
RMS = Representative Monitoring Site(s)
ug/L = micrograms per liter

## TABLE SMC-10
## Summary of Minimum Thresholds, Interim Milestones, and Measurable Objectives for Degraded Water Quality

**Notes:**

(1) All values shown are arsenic concentrations in micrograms per liter (ug/L).

(2) Minimum Thresholds are set at the MCL for RMS where recent/historical arsenic concentrations are less than the MCL, and are set at the historical high value plus 5 ug/L for RMS where recent/historical arsenic concentrations are greater than the MCL.

(3) Measurable Objectives are set at 75% of the MCL for RMS where recent/historical arsenic concentrations are less than the MCL, and are set at the recent/historical high value for RMS where recent/historical arsenic concentrations are greater than the MCL.

(4) Recent arsenic concentration values for ACSD Well #14 are based on samples collected between October 2016 and October 2019.

(5) Recent arsenic concentration values for ACSD Wells #16 and #17 are based on samples collected between July 2020 and December 2021.

(6) Recent arsenic concentration values for other RMS in the Arvin-Edison Management Area besides ACSD Well #14 are based on samples collected in 2016.

(7) Recent/historical data is from 2008.

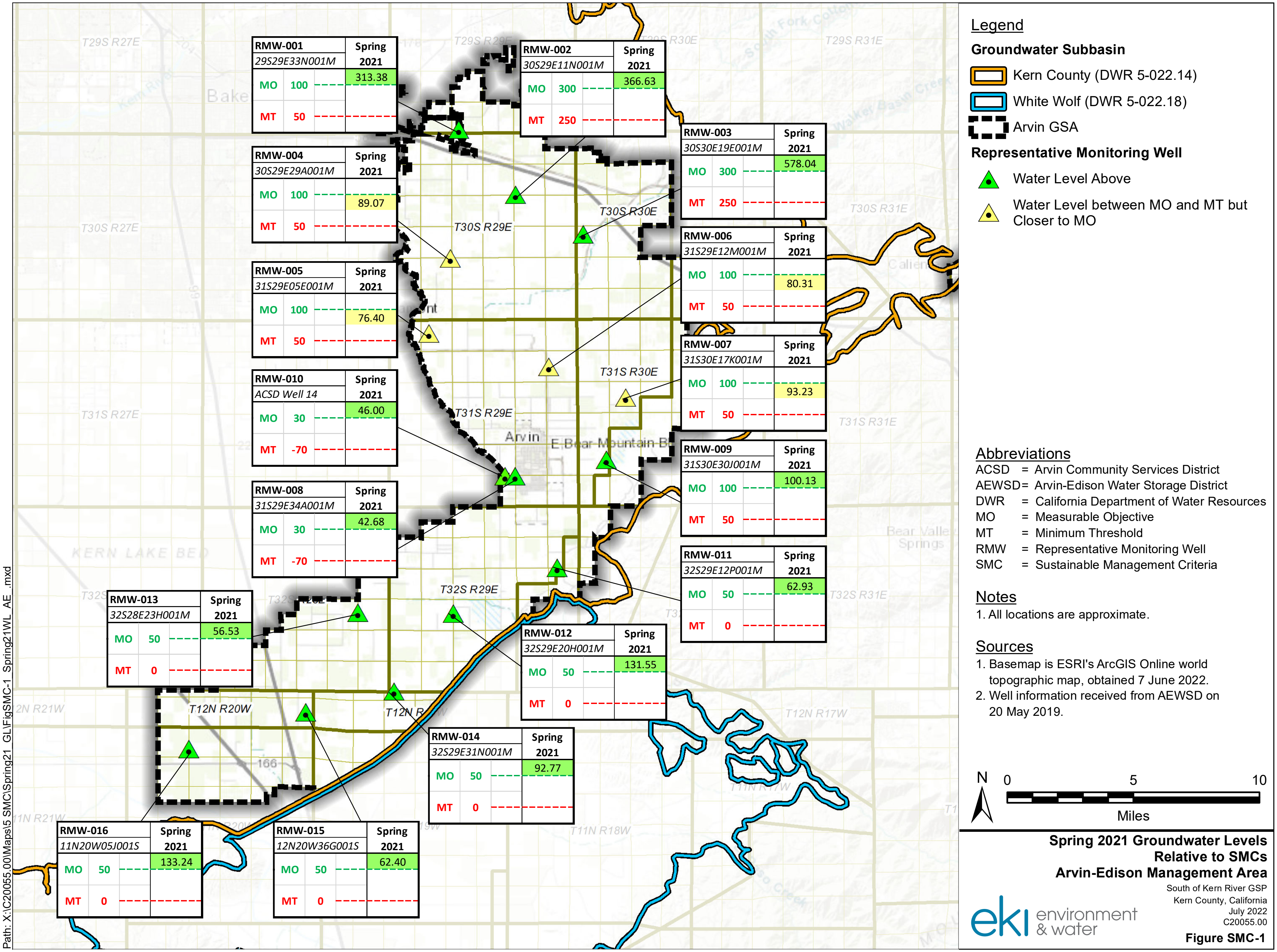
(8) Recent/historical data is from 2008 to 2014, and is from nearby well 32S28E16P002M.

(9) Recent/historical data is from 2008 to 2014.

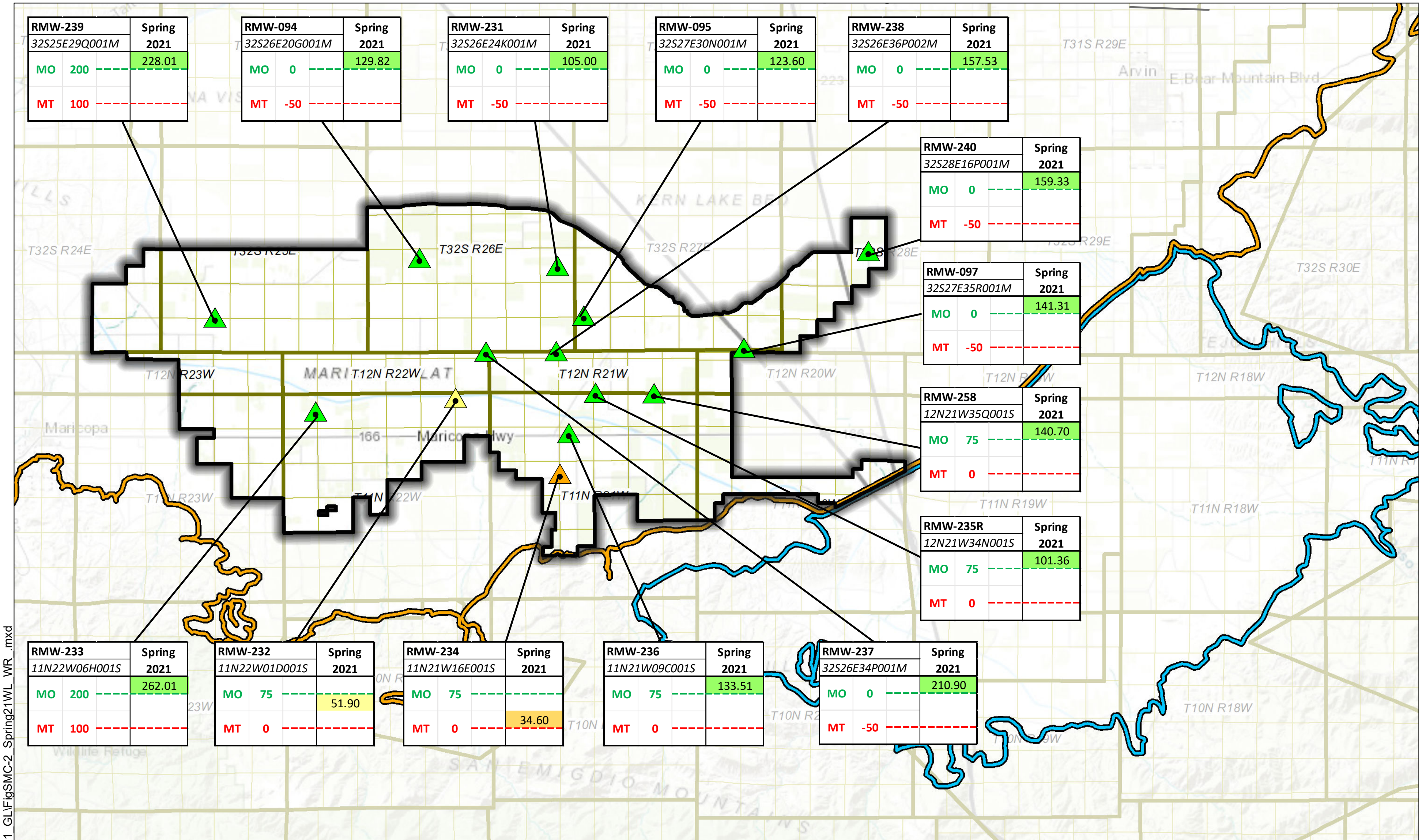
(10) Historical data is from 1991; no more recent data are available.

(11) Recent/historical data is from 2008 to 2012.

(12) For RMS where recent/historical data are not available, the Minimum Thresholds and Measurable Objectives are set at 10 ug/L and 7.5 ug/L, respectively, but are considered interim values which may be revised upon collection of monitoring data.




Path: X:\C20055.00\Maps\5 SMC\Spring21 GLIFigSMC-1 Spring21WL AE .mxd

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Legend

Wheeler Ridge-Maricopa GSA

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Representative Monitoring Site**

Water Level Above MO

Water Level between MO and MT but Closer to MO

Water Level between MO and MT but Closer to MT

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MO = Measurable Objective
MT = Minimum Threshold
SMC = Sustainable Management Criteria
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

**Spring 2021 Groundwater Levels Relative to SMCs**
**Wheeler Ridge-Maricopa Management Area**
South of Kern River GSP
Kern County, California
July 2022
C20055.00

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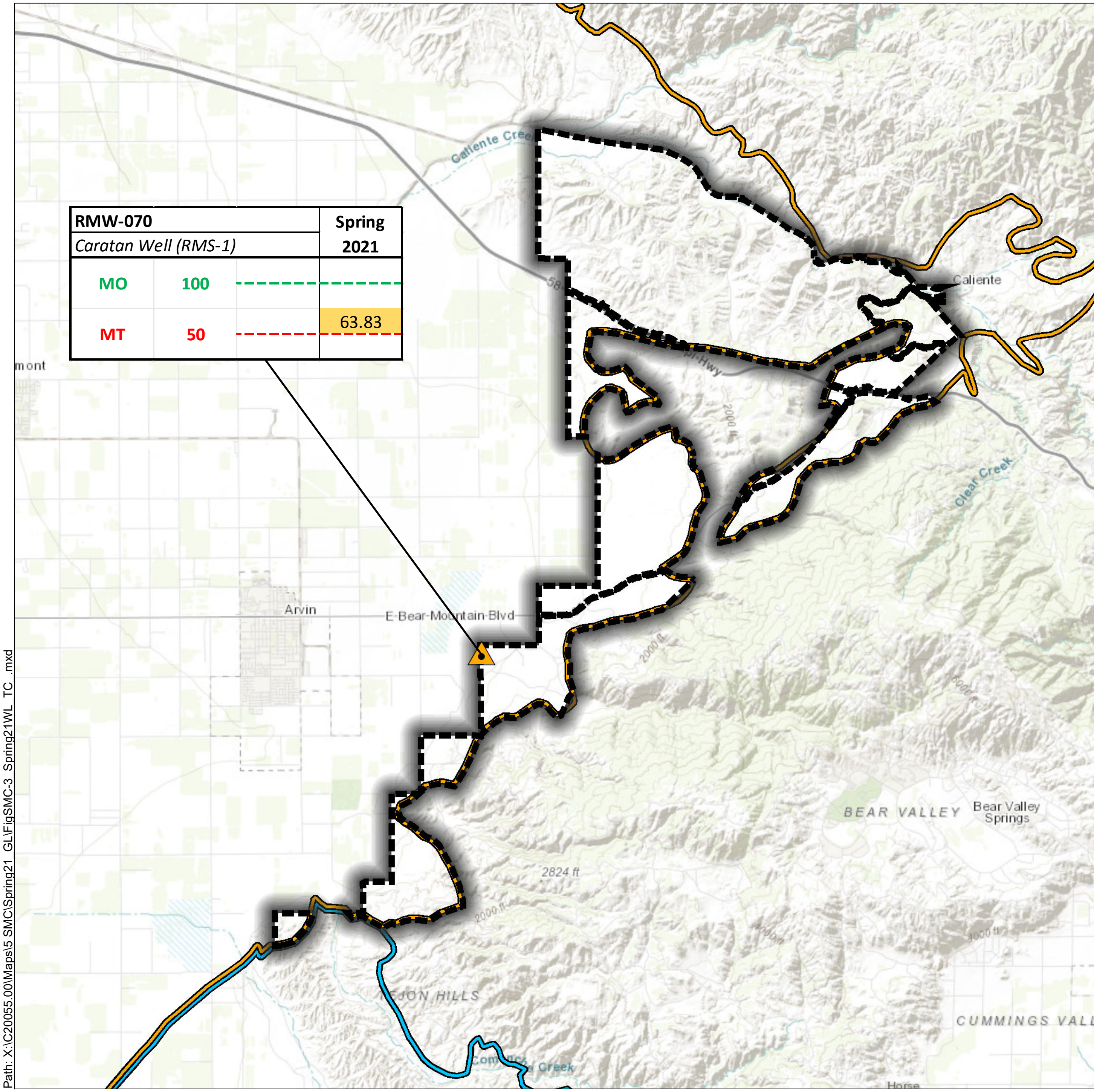
**Figure SMC-2**




## Abbreviations
DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MO = Measurable Objective
MT = Minimum Threshold
RMS = Representative Monitoring Site
RMW = Representative Monitoring Well
SMC = Sustainable Management Criteria

## Notes
1. All locations are approximate.

## Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

**Spring 2021 Groundwater Levels Relative to SMCs**
**Tejon-Castac Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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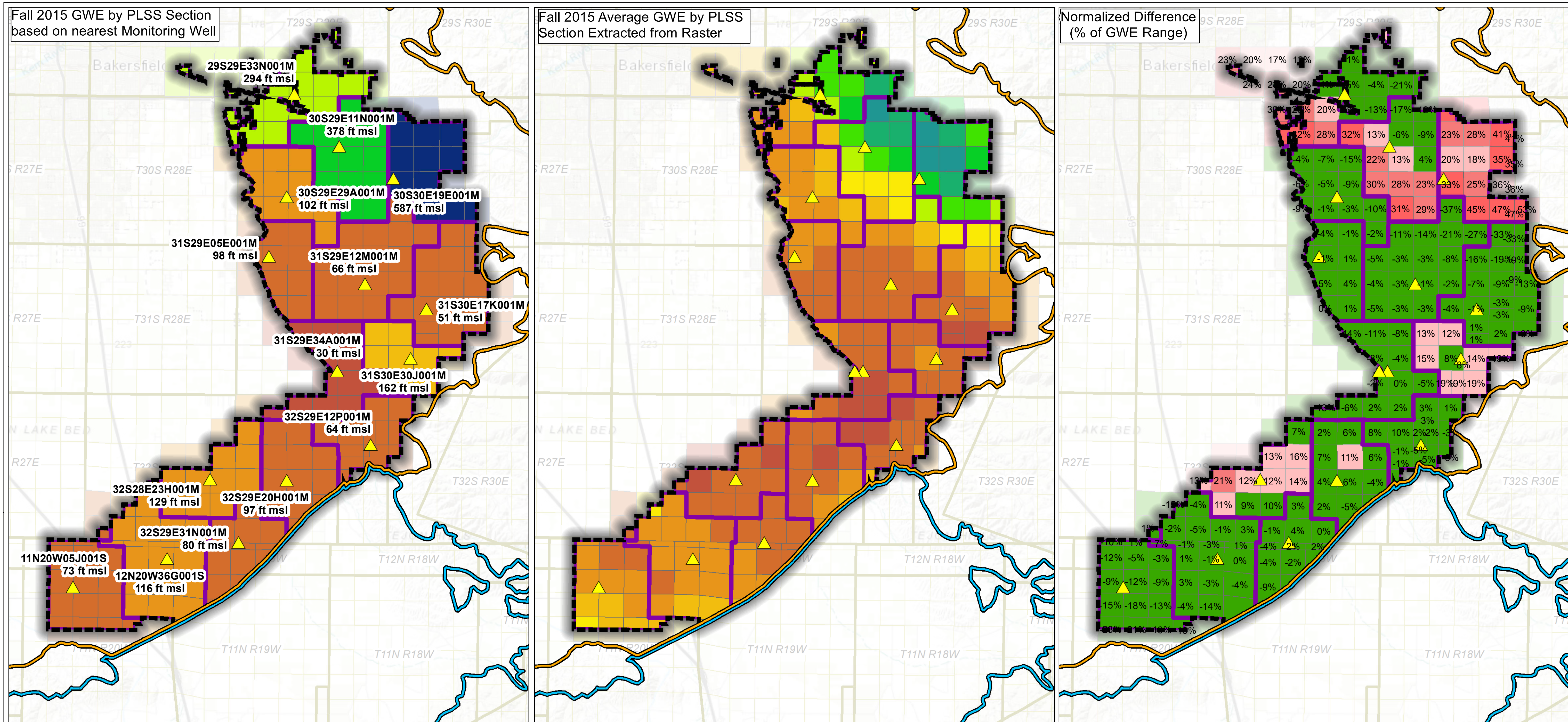
**Figure SMC-3**

Path: X:\C20055.00\Maps\5 SMC\Spring21_GL\FigSMC-3_Spring21WL_TC_.mxd




Legend

- Representative Monitoring Location
- Arvin GSA
- Representative Monitoring Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Normalized Difference (RML - Actual)**

- < 10%
- 10% to 20%
- 20% to 30%
- >30%

**Fall 2015 Groundwater Elevation (ft msl)**

- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- 500 - 550
- 550 - 600

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
GWE = Groundwater Elevation
PLSS = Public Land Survey System
RML = Representative Monitoring Location

Notes

1. All locations are approximate.
2. "Normalized Difference" is defined herein as the difference between the Fall 2015 GWE at the RML and the average Fall 2015 GWE within each section, divided by the total range of Fall 2015 GWE within the Arvin-Edison Kern Management Area.
2. Negative normalized differences (i.e. where the GWE at RML is less than the average Fall 2015 GWE within the section), are represented in green as these sections have an RML that is considered "overprotective" of local water level conditions.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

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Miles

**Representativeness of Monitoring Locations Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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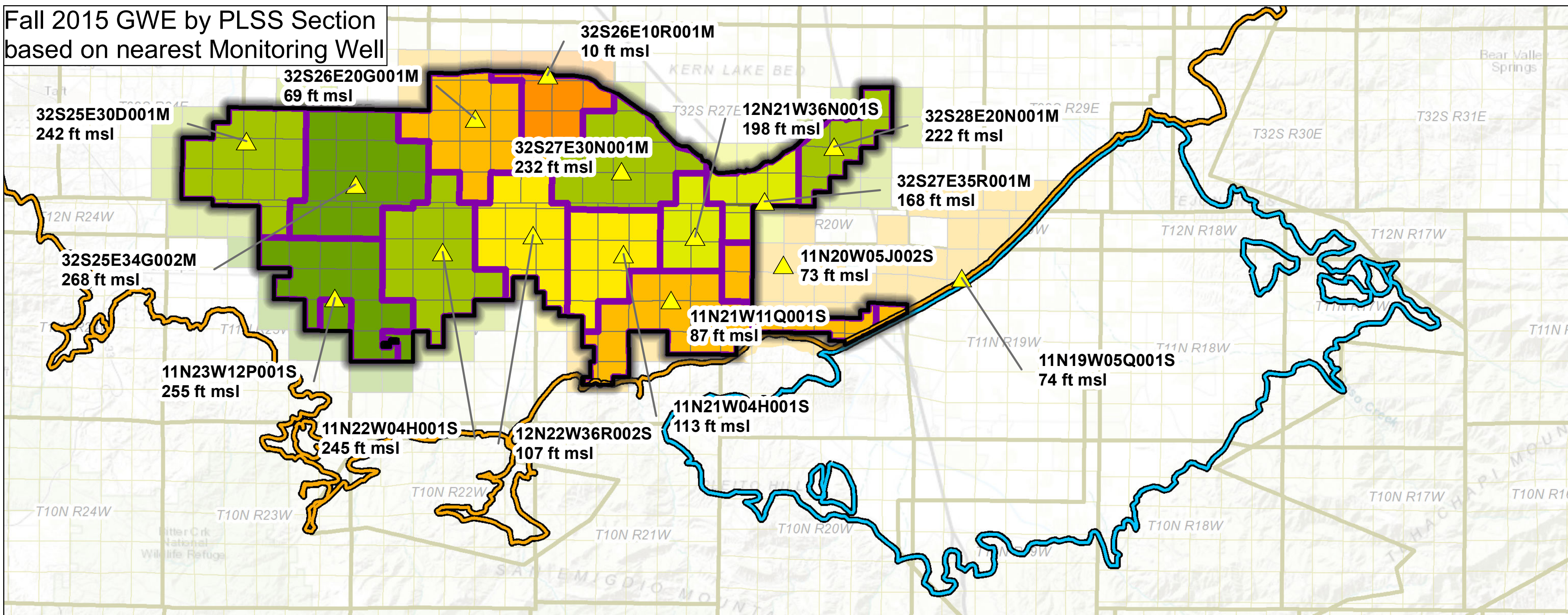
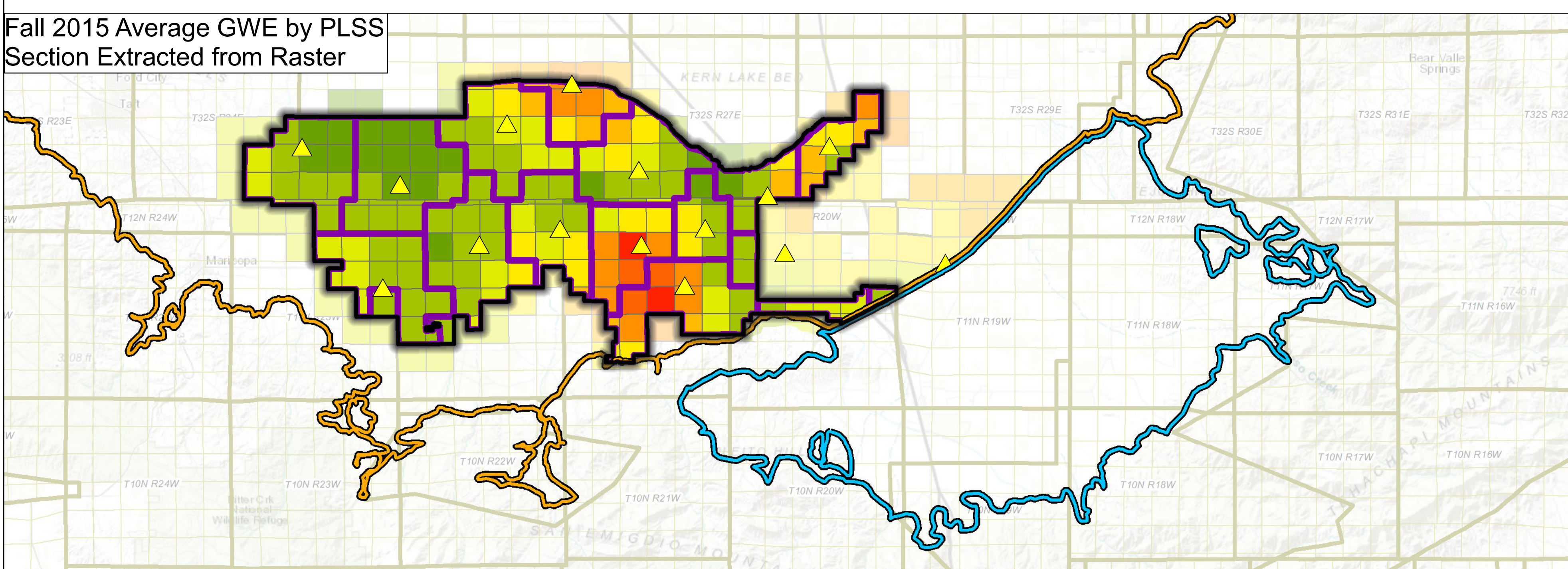
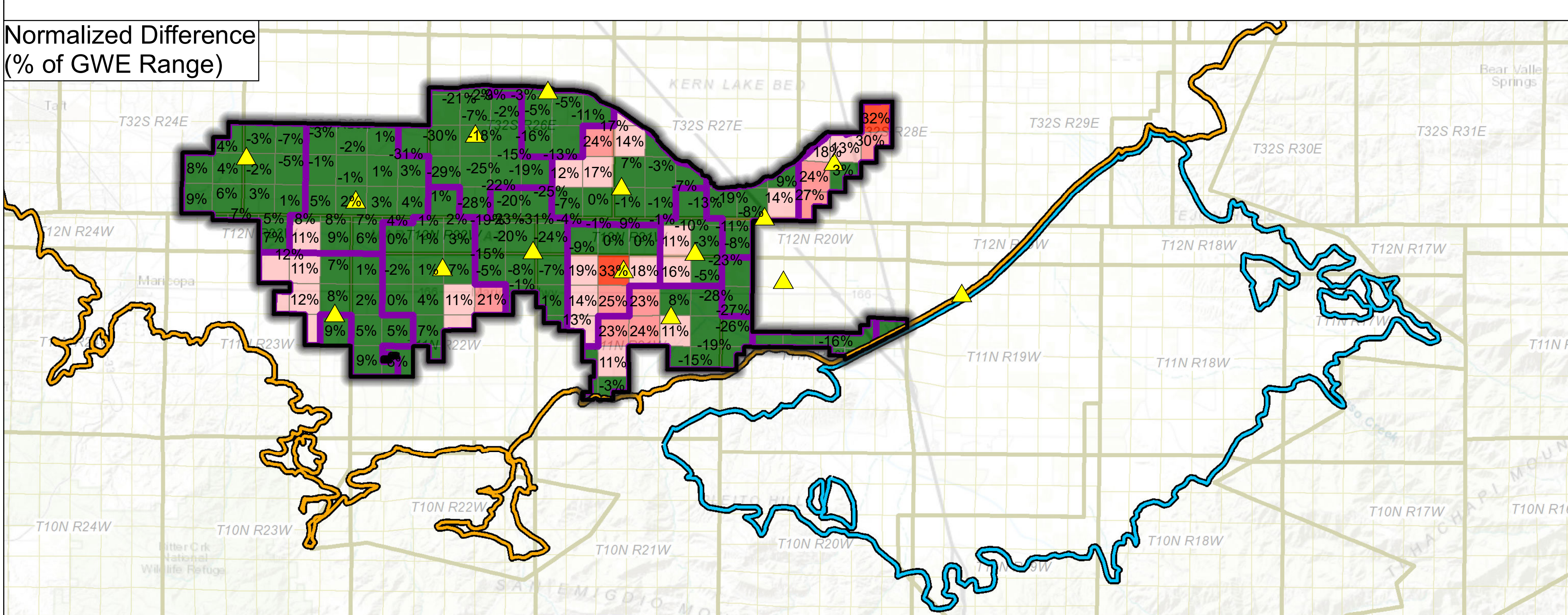
**Figure SMC-5**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-5_SMC_RepTest_AE.mxd




**Legend**

- Long-Term Hydrograph Well
- Wheeler Ridge-Maricopa GSA
- Representative Coverage Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Normalized Difference (RML - Actual)**

- < 10%
- 10% to 20%
- 20% to 30%
- > 30%

**Fall 2015 Groundwater Elevation (ft msl)**

- < - 50
- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- 150 to 200
- 200 to 250
- 250 to 300
- 300 to 350
- > 350

**Abbreviations**

| | |
|---|---|
| GWE | = Groundwater Elevation |
| DWR | = California Department of Water Resources |
| ft msl | = feet above mean sea level |
| GSA | = Groundwater Sustainability Agency |
| PLSS | = Public Land Survey System |
| RML | = Representative Monitoring Location |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

**Sources**

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

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**Notes**

1. All locations are approximate.
2. "Normalized Difference" is defined herein as the difference between the Fall 2015 GWE at the RML and the average Fall 2015 GWE within each section, divided by the total range of Fall 2015 GWE within the WRMWSD Kern Management Area.
2. Negative normalized differences (i.e. where the GWE at RML is less than the average Fall 2015 GWE within the section), are represented in green as these sections have an RML that is considered "overprotective" of local water level conditions.

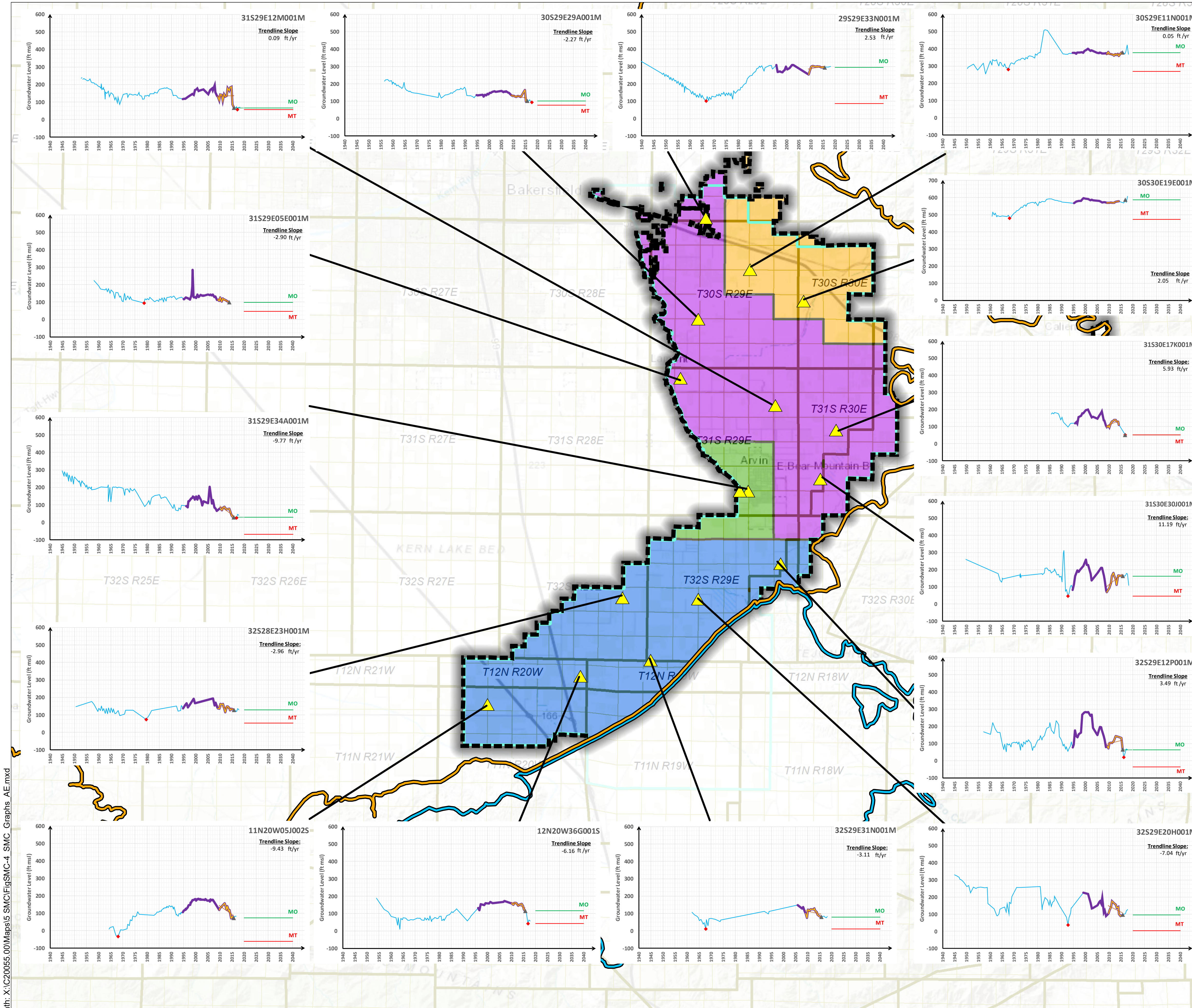
**Representativeness of Long-Term Hydrograph Locations**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure SMC-6**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-3_SMC_RepTest_WR.mxd




## Legend

- Arvin GSA
- Arvin-Edison Water Storage District
- Representative Monitoring Location

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- ACSD
- Edison
- North Canal
- South Canal

- Hydrograph
- Range Period (10/94 - 9/15)
- Trend Period (1/09 - 11/15)
- Initial Measurable Objective (MO) Estimate
- Initial Minimum Threshold (MT) Estimate
- Historical Low
- Fall 2015
- Linear Regression (Trend Period)

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
ft bgs = feet below ground surface
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MO = Measurable Objective
MT = Minimum Threshold
SGMA = Sustainable Groundwater Management Act

## Notes

1. All locations are approximate.
2. Water levels that showed a rate of change between consecutive measurements greater than 50 ft in 60 days, or a significant change without a reasonable hydrological explanation, were removed from the hydrographs.
3. Representative monitoring location 12N20W05J001S does not have a complete historical water level data record, and is thus represented by nearby well 12N20W05J002S for the purposes of this analysis.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Water level information obtained from AEWSD on 30 November 2017.

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(Scale in Miles)

**Water Level Sustainability Criteria - Hydrograph Analysis Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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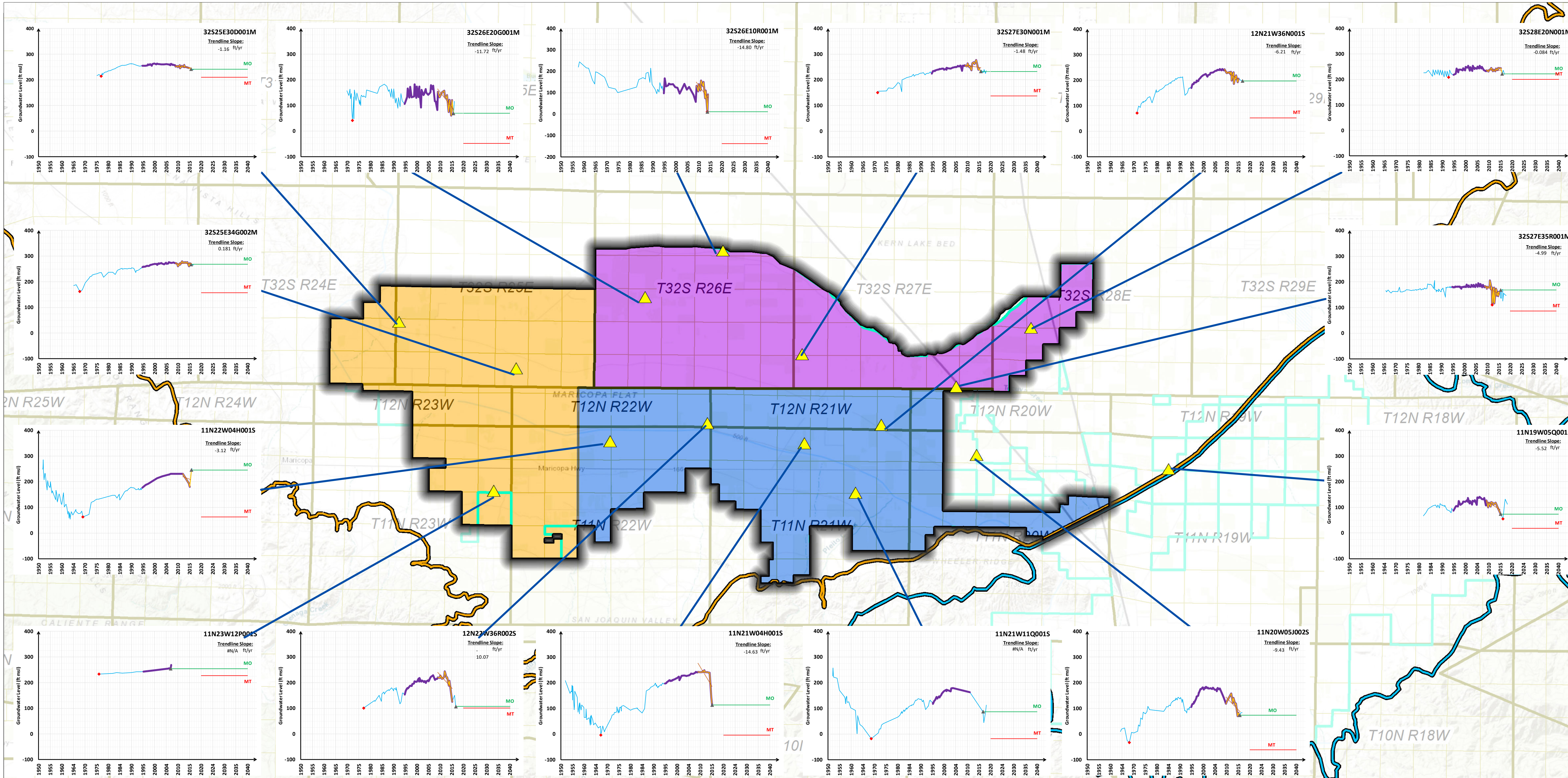
**Figure SMC-7**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-4_SMC_Graphs_AE.mxd




<u>Legend</u>

- Long-Term Hydrograph Well
- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- Northeastern Zone
- Southeastern Zone
- Western Zone

- Hydrograph
- Range Period (10/94 - 9/15)
- Trend Period (1/09 - 11/15)
- Initial Measurable Objective (MO) Estimate
- Initial Minimum Threshold (MT) Estimate
- Historical Low
- Fall 2015
- Linear Regression (Trend Period)

<u>Abbreviations</u>

DWR = California Department of Water Resources
ft bgs = feet below ground surface
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MO = Measurable Objective
MT = Minimum Threshold
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

<u>Notes</u>

1. All locations are approximate.
2. Water levels that showed a rate of change between consecutive measurements greater than 50 ft in 60 days, or a significant change without a reasonable hydrological explanation, were removed from the hydrographs.

<u>Sources</u>

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Groundwater elevation data provided by WRMWSD on 8 December 2017.

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0 3 6

(Scale in Miles)

**Water Level Sustainability Criteria - Hydrograph Analysis**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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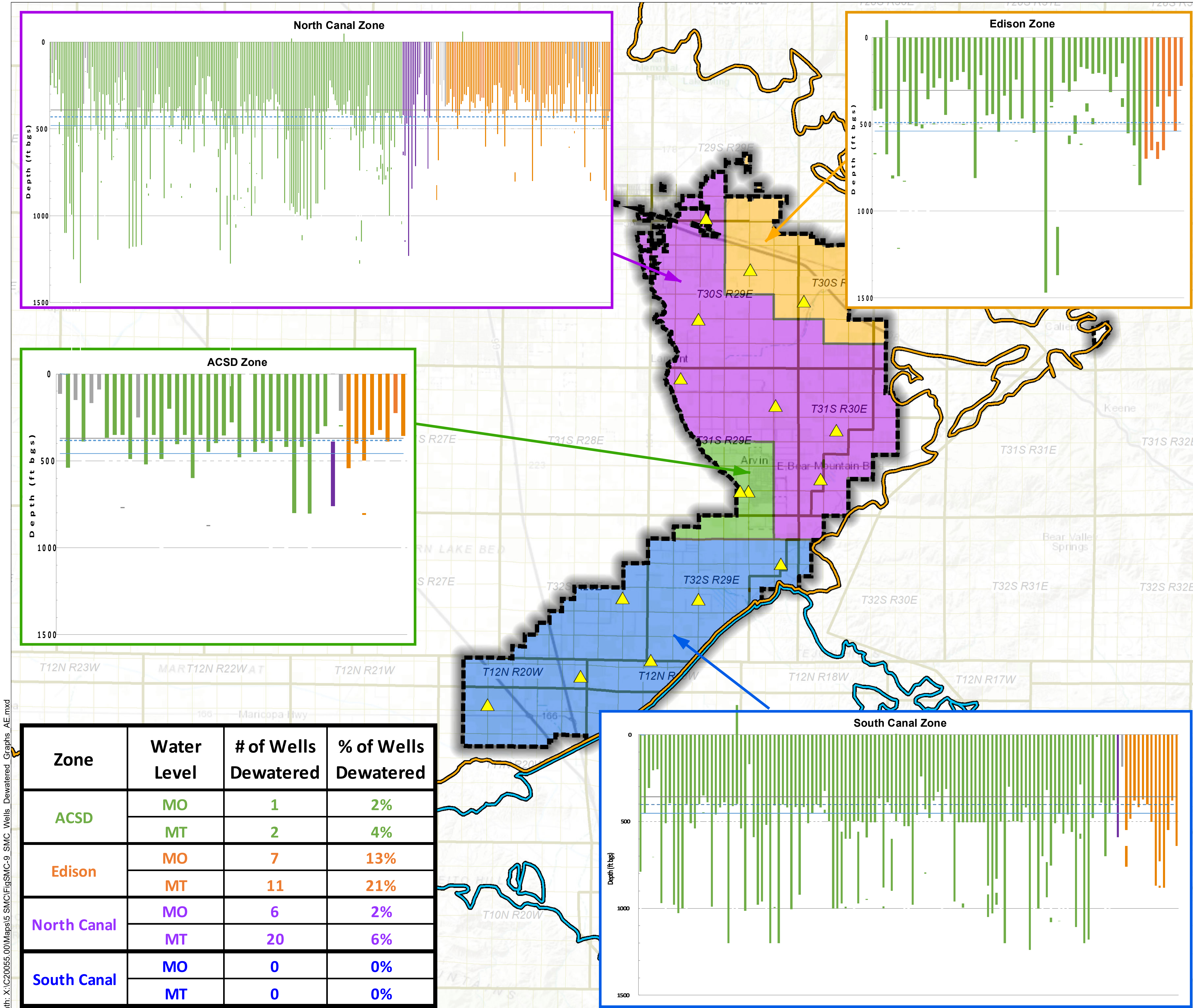
**Figure SMC-8**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-8_SMC_Graphs_WR.mxd




| Zone | Water Level | # of Wells Dewatered | % of Wells Dewatered |
|---|---|---|---|
| ACSD | MO | 1 | 2% |
| | MT | 2 | 4% |
| Edison | MO | 7 | 13% |
| | MT | 11 | 21% |
| North Canal | MO | 6 | 2% |
| | MT | 20 | 6% |
| South Canal | MO | 0 | 0% |
| | MT | 0 | 0% |

Legend

- Arvin GSA
- Representative Monitoring Location

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zone**

- ACSD
- Edison
- North Canal
- South Canal

- Production Well
- Public Supply Well
- Domestic Well
- Well Screen Interval
- Fall 2015 Water Level
- Measurable Objective
- Minimum Threshold

Abbreviations

AEWSD= Arvin-Edison Water Storage District
DWR = California Department of Water Resources
ft bgs = feet below ground surface
GSA = Groundwater Sustainability Agency
KGA = Kern Groundwater Authority
MO = Measurable Objective
MT = Minimum Threshold

Notes

1. All locations are approximate.
2. MTs and MOs are defined as elevations, and are displayed on the bar graphs as their average depth (ft bgs) within all representative sections
3. A "dewatered well" is considered to be a well whose total depth is less than the MT specified for the given sustainability criteria zone.
3. Wells displayed in grey were already dewatered relative to Fall 2015 groundwater conditions and are thus not included in the count of dewatered wells.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Well info obtained from KGA on 21 November 2018.

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0 4 8

(Scale in Miles)

**Preliminary Well Impact Analysis by Sustainability Criteria Zone Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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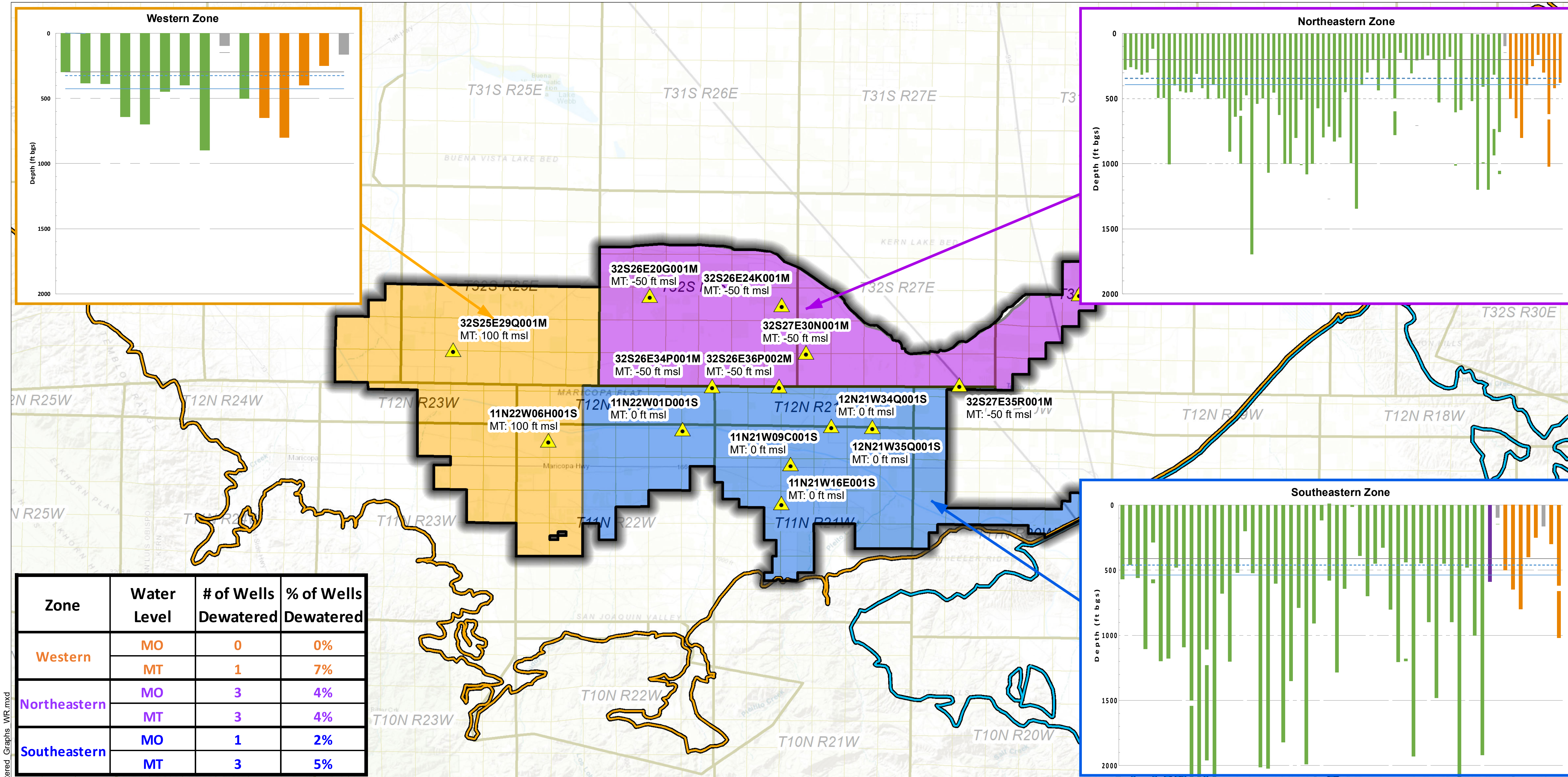
**Figure SMC-9**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-9_SMC_Wells_Dewatered_Graphs_AE.mxd




| Zone | Water Level | # of Wells Dewatered | % of Wells Dewatered |
|---|---|---|---|
| Western | MO | 0 | 0% |
| | MT | 1 | 7% |
| Northeastern | MO | 3 | 4% |
| | MT | 3 | 4% |
| Southeastern | MO | 1 | 2% |
| | MT | 3 | 5% |

Legend

- Representative Monitoring Site
- Wheeler Ridge-Maricopa GSA

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- Northeastern Zone
- Southeastern Zone
- Western Zone

- Production Well
- Public Supply Well
- Domestic Well
- Well Screen Interval
- Fall 2015 Water Level
- Measurable Objective
- Minimum Threshold

Abbreviations

DWR = California Department of Water Resources
ft bgs = feet below ground surface
GSA = Groundwater Sustainability Agency
KGA = Kern Groundwater Authority
MO = Measurable Objective
MT = Minimum Threshold
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

1. All locations are approximate.
2. MTs and MOs are defined as elevations, and are displayed on the bar graphs as their average depth (ft bgs) within all representative sections.
3. A "dewatered well" is considered to be a well whose total depth is less than the MT specified for the given sustainability criteria zone.
4. Wells displayed in grey were already dewatered relative to Fall 2015 groundwater conditions and are thus not included in the count of dewatered wells.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Well info obtained from KGA on 21 November 2018.

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0 3 6

(Scale in Miles)

**Preliminary Well Impact Analysis by Sustainability Criteria Zone**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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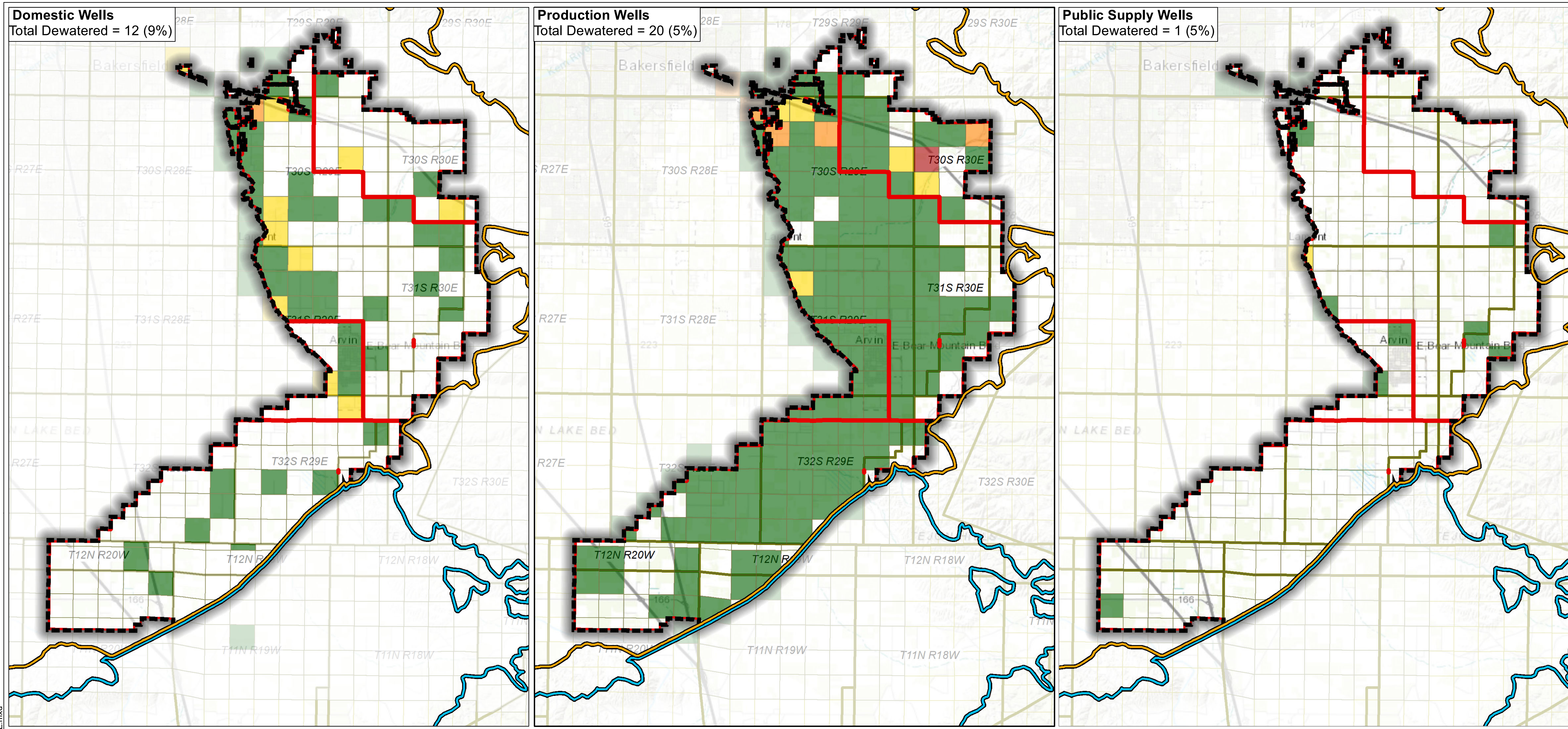
**Figure SMC-10**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-10_SMC_Wells_Dewatered_Graphs_WR.mxd




Legend

Arvin GSA

Sustainability Criteria Zones

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

**Count of Wells Dewatered at Minimum Threshold**

- N/A
- 0
- 1
- 2
- 3
- 4 or more

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
MT = Minimum Threshold
N/A = Not Applicable
PLSS = Public Land Survey System

Notes

1. All locations are approximate.
2. A "dewatered" well is considered to be a well whose total depth is less than the MT specified for the given sustainability criteria zone.
3. Wells that were already dewatered relative to Fall 2015 groundwater conditions are not included in the count of dewatered wells.

Sources

1. Well count and depth statistics from Well Completion Report Map Application, obtained on 19 October 2018, website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

N

0 4 8
Miles

**Preliminary Well Impact Analysis by PLSS Section Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

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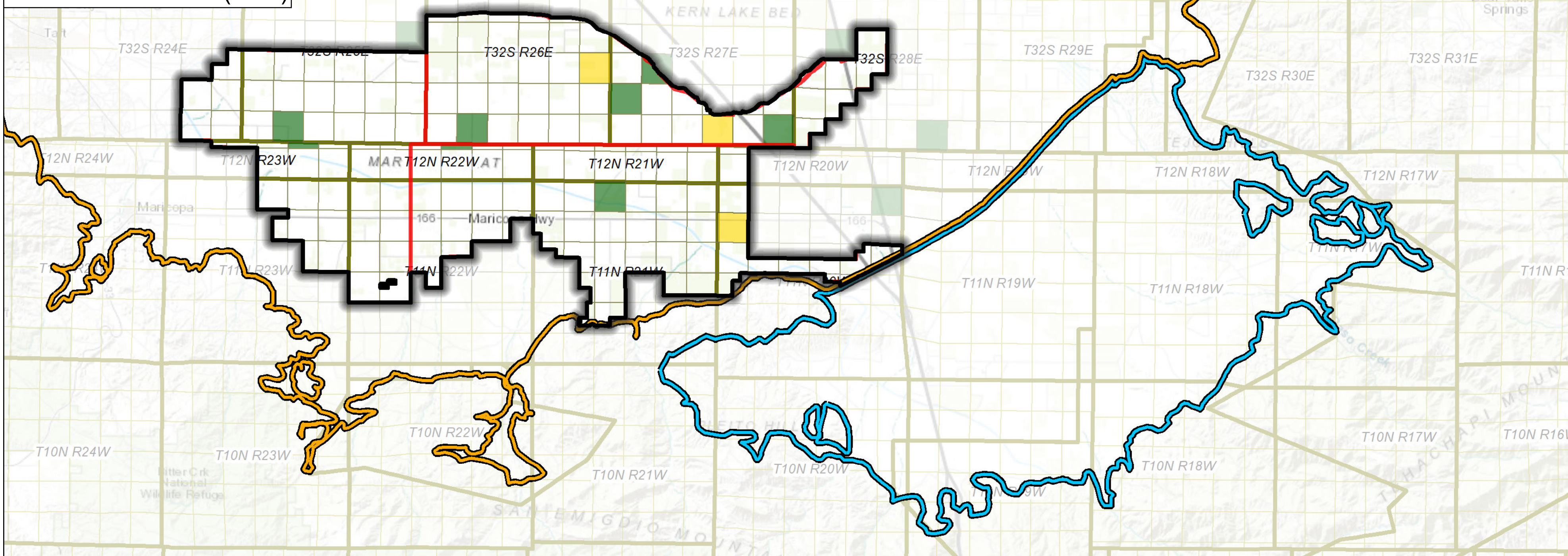
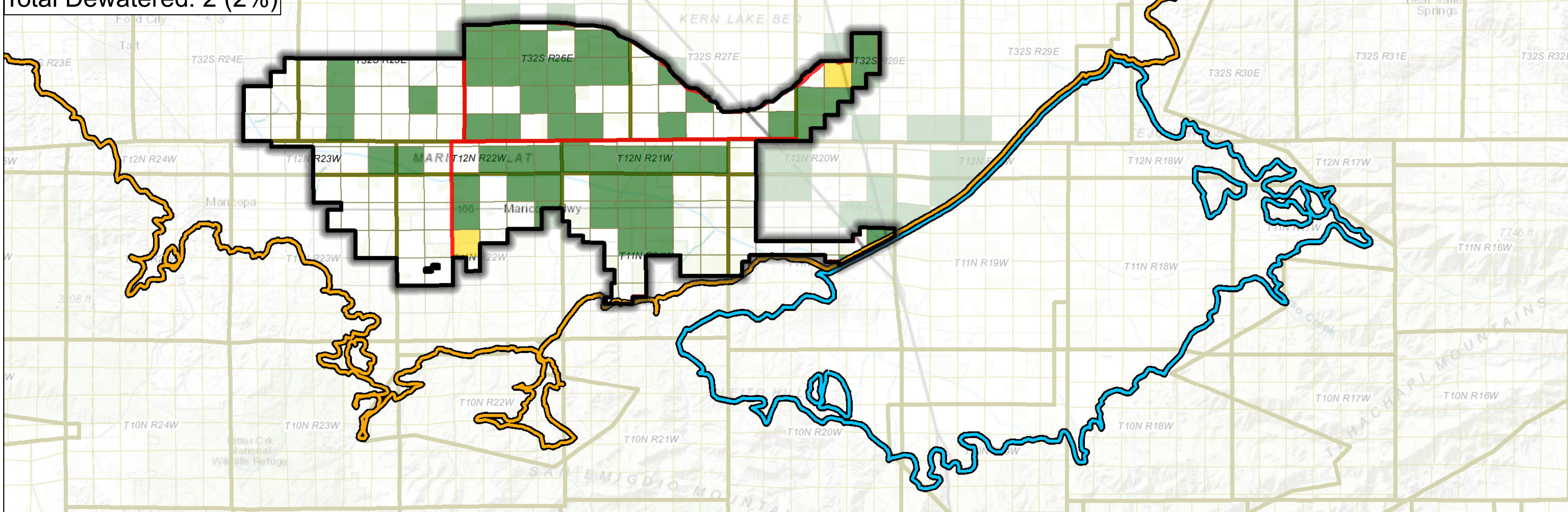
**Figure SMC-11**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-11_SMC_Wells_Dewatered_PLSS_AE.mxd

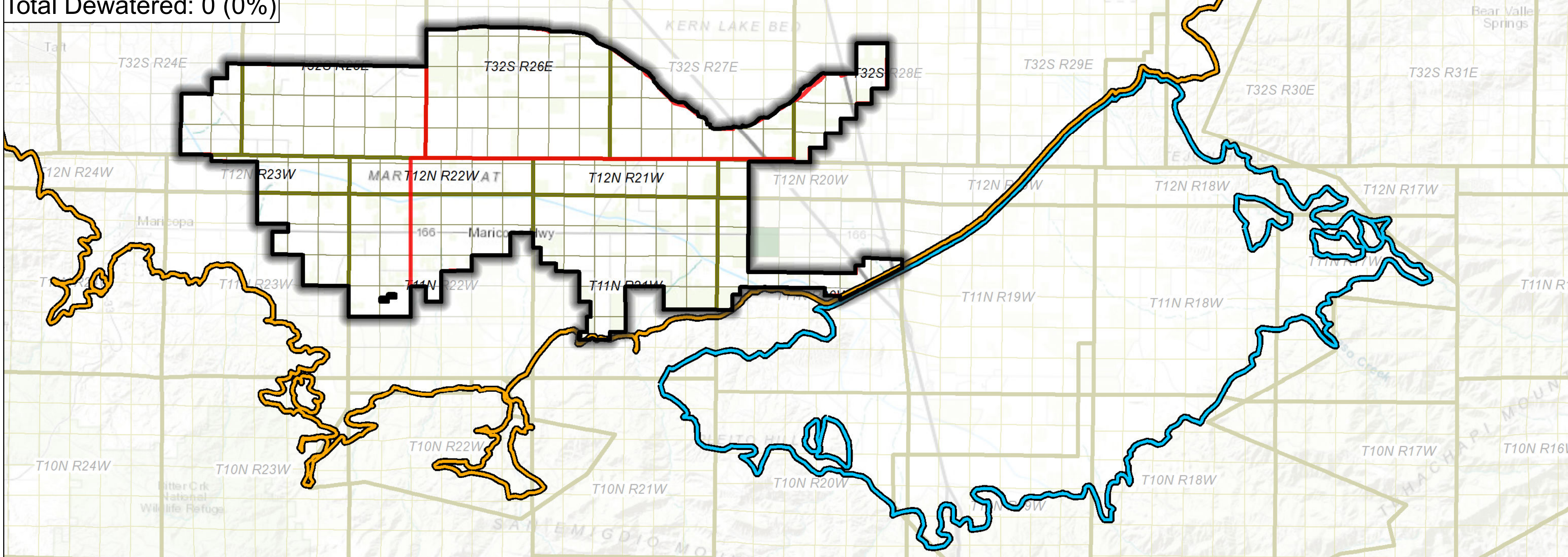
**Domestic Wells**
Total Dewatered: 3 (11%)




**Production Wells**
Total Dewatered: 2 (2%)




**Public Supply Wells**
Total Dewatered: 0 (0%)




Legend

- Wheeler Ridge-Maricopa GSA
- Sustainability Criteria Zones

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Count of Wells Dewatered at Minimum Threshold**

- N/A
- 0
- 1
- 2
- 3

Notes
1. All locations are approximate.
2. A "dewatered well" is considered to be a well whose total depth is less than the MT specified for the given sustainability criteria zone.
3. Wells that were already dewatered relative to Fall 2015 groundwater conditions are not included in the count of dewatered wells.

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| MT | = Minimum Threshold |
| N/A | = Not Applicable |
| PLSS | = Public Land Survey System |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Sources
1. Well count and depth statistics from Well Completion Report Map Application, obtained on 19 October 2018, website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

N 0 5 10
(Scale in Miles)

**Preliminary Well Impact Analysis by PLSS Section**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

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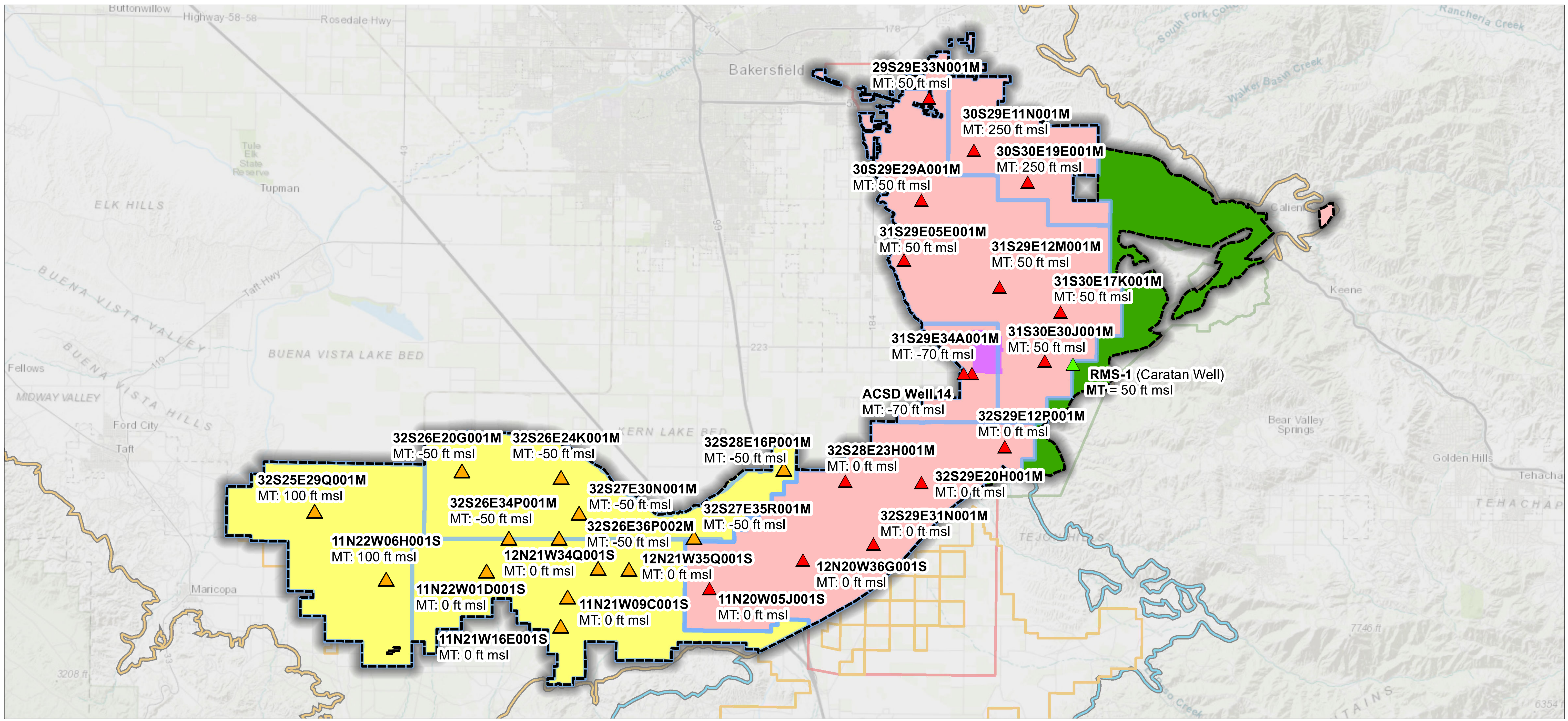
**Figure SMC-12**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-12_SMC_Dewatered_PLSS_WR.mxd




## Legend

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- South of Kern River Plan Area
- Sustainability Zones
- Tejon-Castac Management Area RMS
- Arvin-Edison Management Area RMS
- Wheeler Ridge-Maricopa Management Area RMS
- ACSD Service Area
- Arvin GSA
- Wheeler Ridge-Maricopa GSA
- Tejon-Castac Water District GSA
- WRMWSD Service Area
- AEWSD Service Area
- TCWD Service Area

## Abbreviations

ACSD = Arvin Community Services District
AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
RMS = Representative Monitoring Site
SGMA = Sustainable Groundwater Management Act
TCWD = Tejon-Castac Water District
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.
2. The "South of the Kern River" Plan Area encompasses the Arvin-Edison, Tejon-Castac, and Wheeler Ridge-Maricopa Management Areas.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. GSA boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

N

0 4 8

Miles

**Final Minimum Thresholds for Chronic Lowering of Groundwater Levels**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00
**Figure SMC-13**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-13_SOKR_MTs.mxd

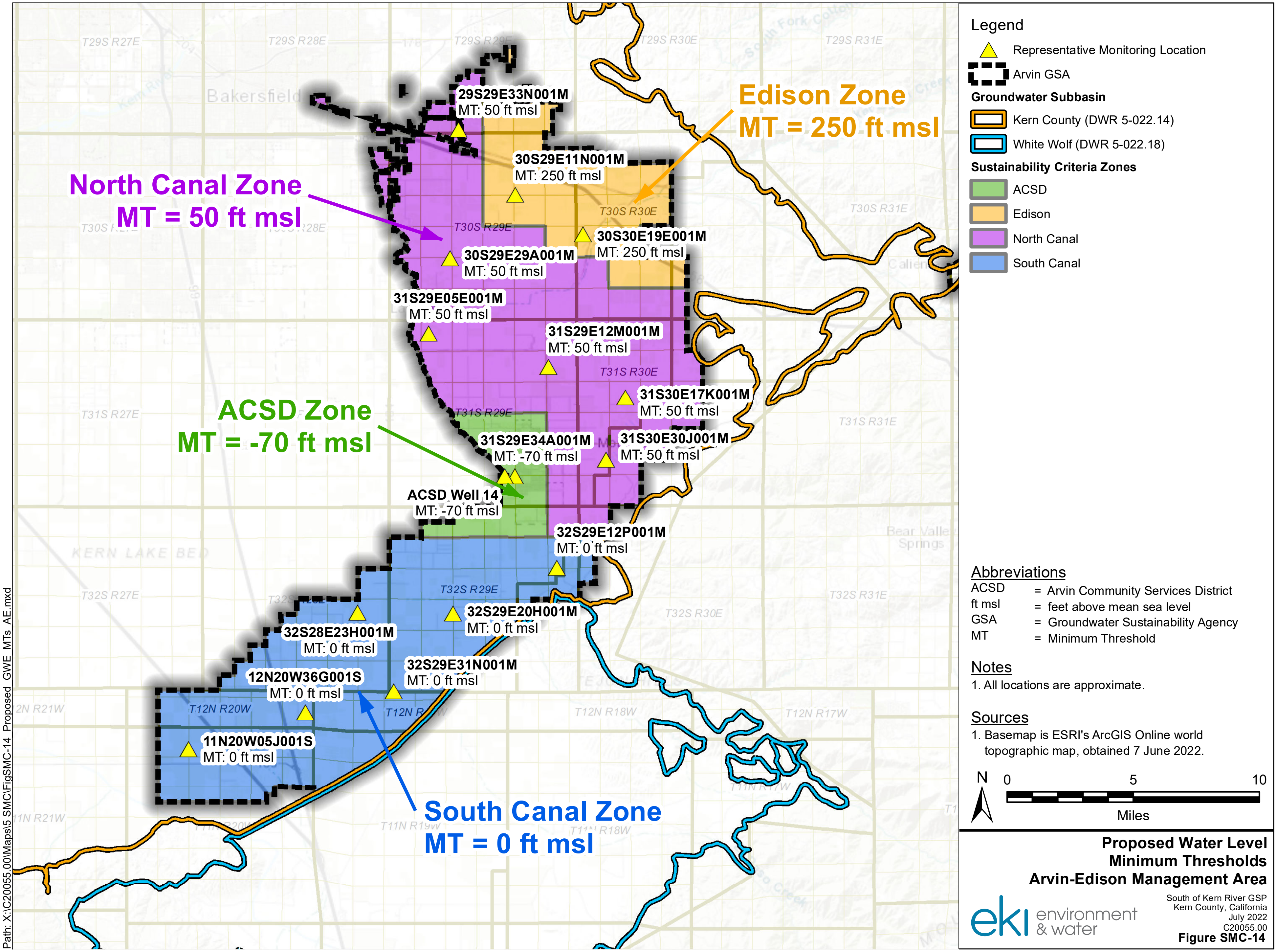

Edison Zone
MT = 250 ft msl
North Canal Zone
MT = 50 ft msl
ACSD Zone
MT = -70 ft msl
South Canal Zone
MT = 0 ft msl
29S29E33N001M
MT: 50 ft msl
30S29E11N001M
MT: 250 ft msl
30S30E19E001M
MT: 250 ft msl
30S29E29A001M
MT: 50 ft msl
31S29E05E001M
MT: 50 ft msl
31S29E12M001M
MT: 50 ft msl
31S30E17K001M
MT: 50 ft msl
31S29E34A001M
MT: -70 ft msl
31S30E30J001M
MT: 50 ft msl
ACSD Well 14
MT: -70 ft msl
32S29E12P001M
MT: 0 ft msl
32S29E20H001M
MT: 0 ft msl
32S28E23H001M
MT: 0 ft msl
32S29E31N001M
MT: 0 ft msl
12N20W36G001S
MT: 0 ft msl
11N20W05J001S
MT: 0 ft msl
Bakersfield
KERN LAKE BED
T29S R27E
T29S R28E
T29S R30E
T29S R31E
T30S R28E
T30S R29E
T30S R30E
T30S R31E
T31S R27E
T31S R29E
T31S R30E
T31S R31E
T32S R27E
T32S R29E
T32S R30E
T32S R31E
T12N R20W
T12N R18W
T12N R17W
T11N R19W
T11N R18W
T11N R17W
Legend
Representative Monitoring Location
Arvin GSA
Groundwater Subbasin
Kern County (DWR 5-022.14)
White Wolf (DWR 5-022.18)
Sustainability Criteria Zones
ACSD
Edison
North Canal
South Canal
Abbreviations
ACSD = Arvin Community Services District
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MT = Minimum Threshold
Notes
1. All locations are approximate.
Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
N
0
5
10
Miles
Proposed Water Level
Minimum Thresholds
Arvin-Edison Management Area
eki environment & water
South of Kern River GSP
Kern County, California
July 2022
C20055.00
Figure SMC-14
Path: X:\C20055.00\Maps\5 SMC\FigSMC-14_Proposed_GWE_MTs_AE.mxd

**Figure SMC-15**

Distribution of Projected Well Ages

Arvin-Edison Management Area

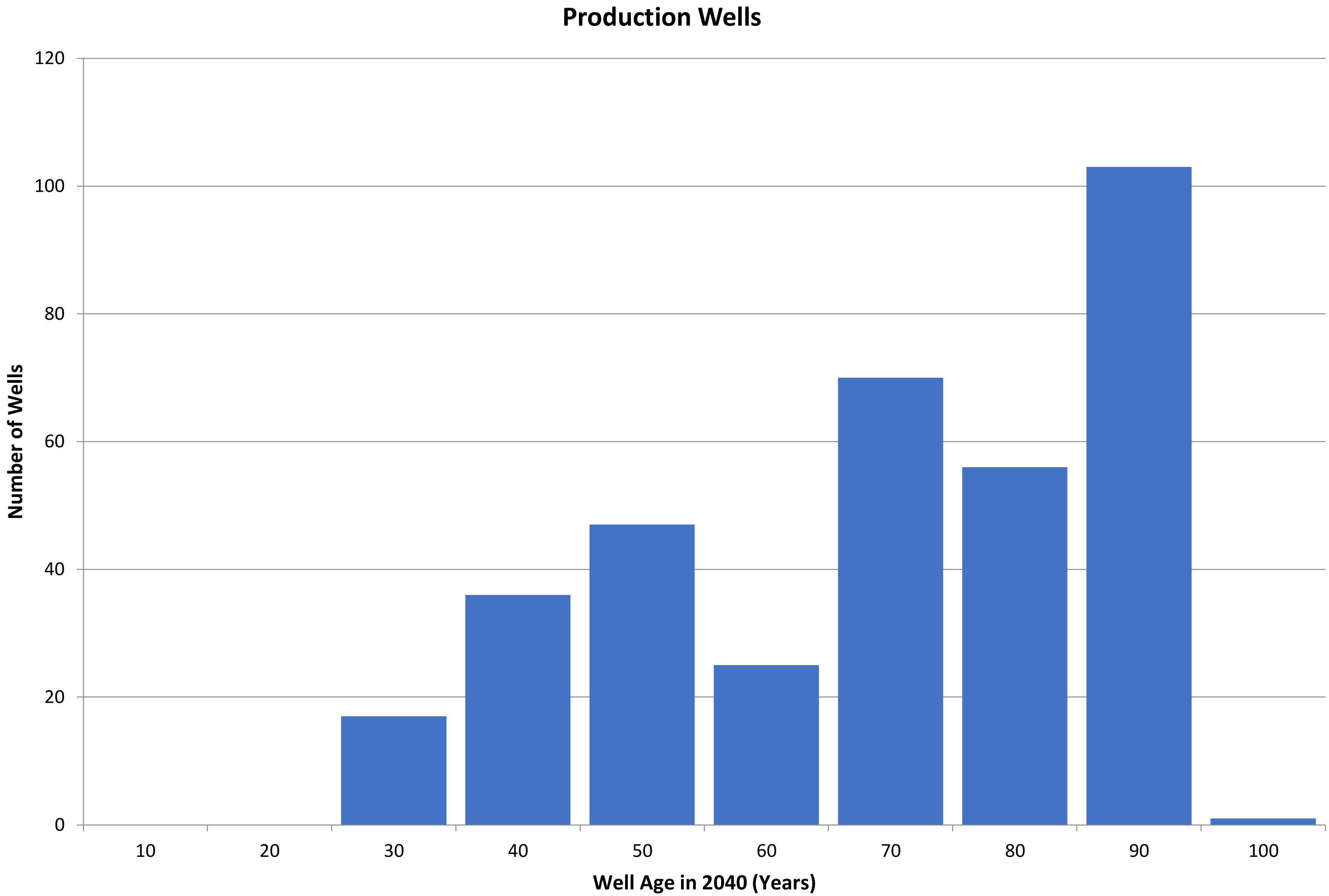


**Figure SMC-15**

Distribution of Projected Well Ages

Arvin-Edison Management Area

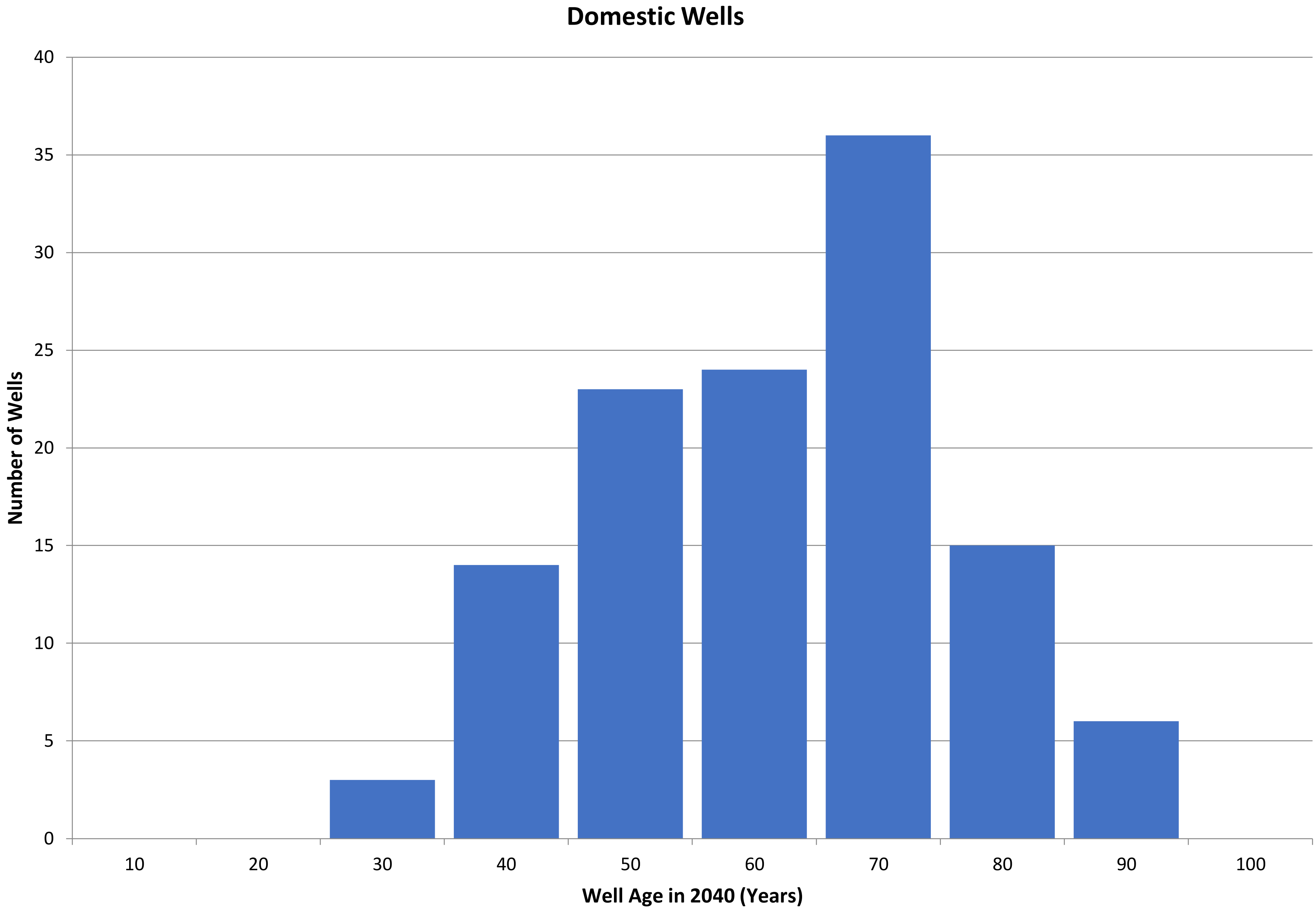
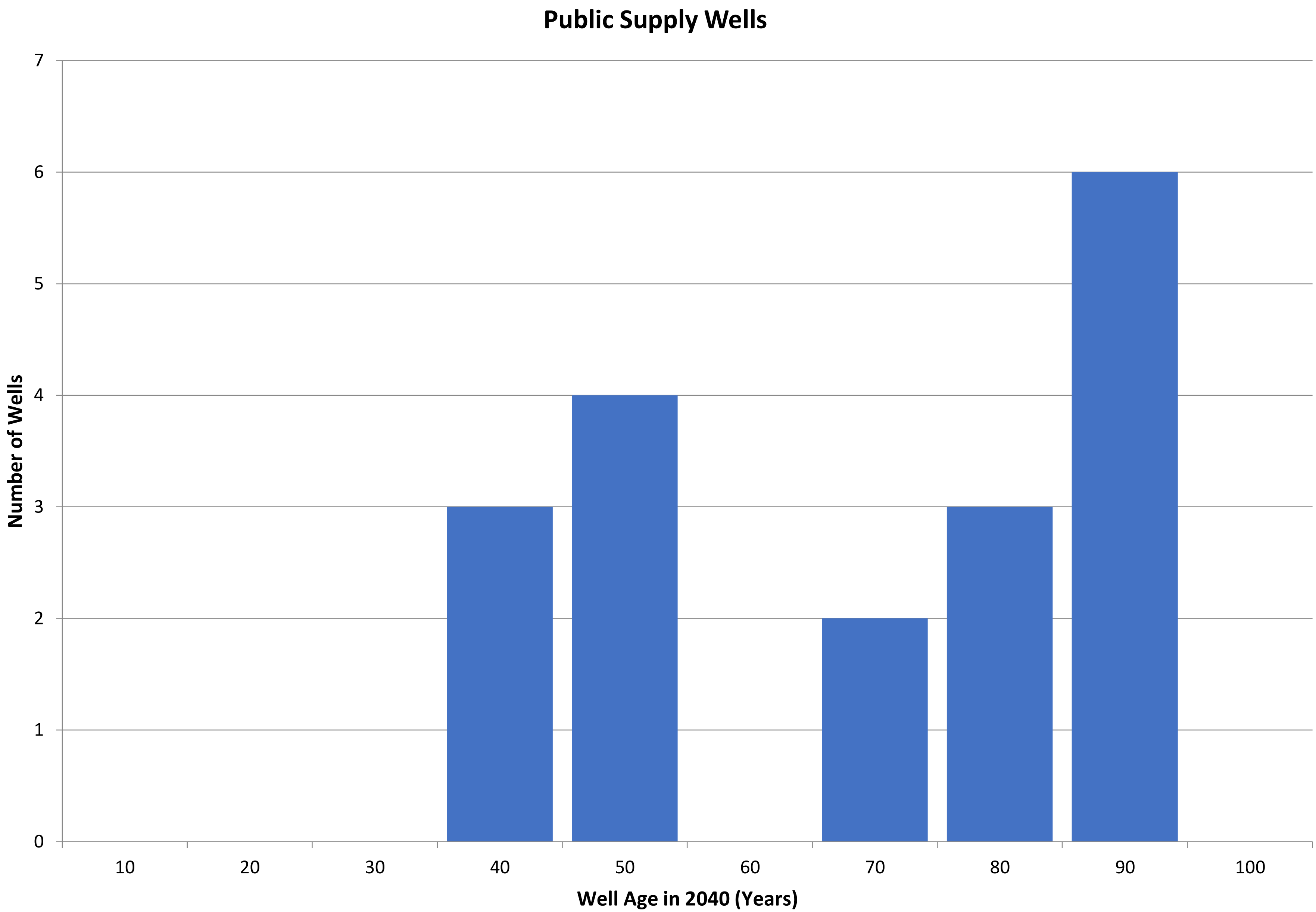
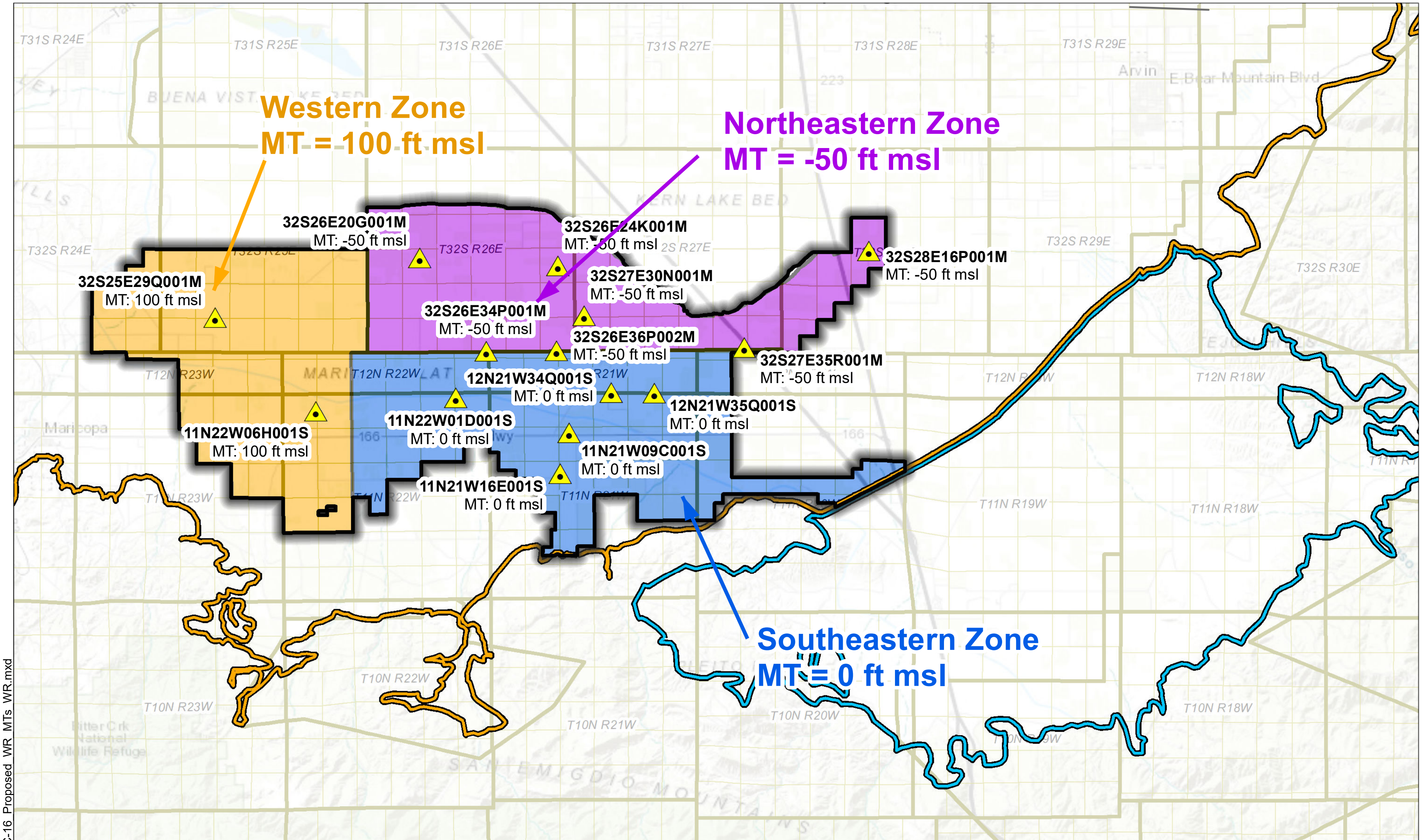


**Figure SMC-15**

Distribution of Projected Well Ages

Arvin-Edison Management Area






Legend

- Representative Monitoring Site
- Wheeler Ridge-Maricopa GSA

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- Northeastern Zone
- Southeastern Zone
- Western Zone

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft msl | = feet above mean sea level |
| GSA | = Groundwater Sustainability Agency |
| MT | = Minimum Threshold |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

N

0 5 10

(Scale in Miles)

**Proposed Water Level Minimum Thresholds**

**Wheeler Ridge-Maricopa Management Area**

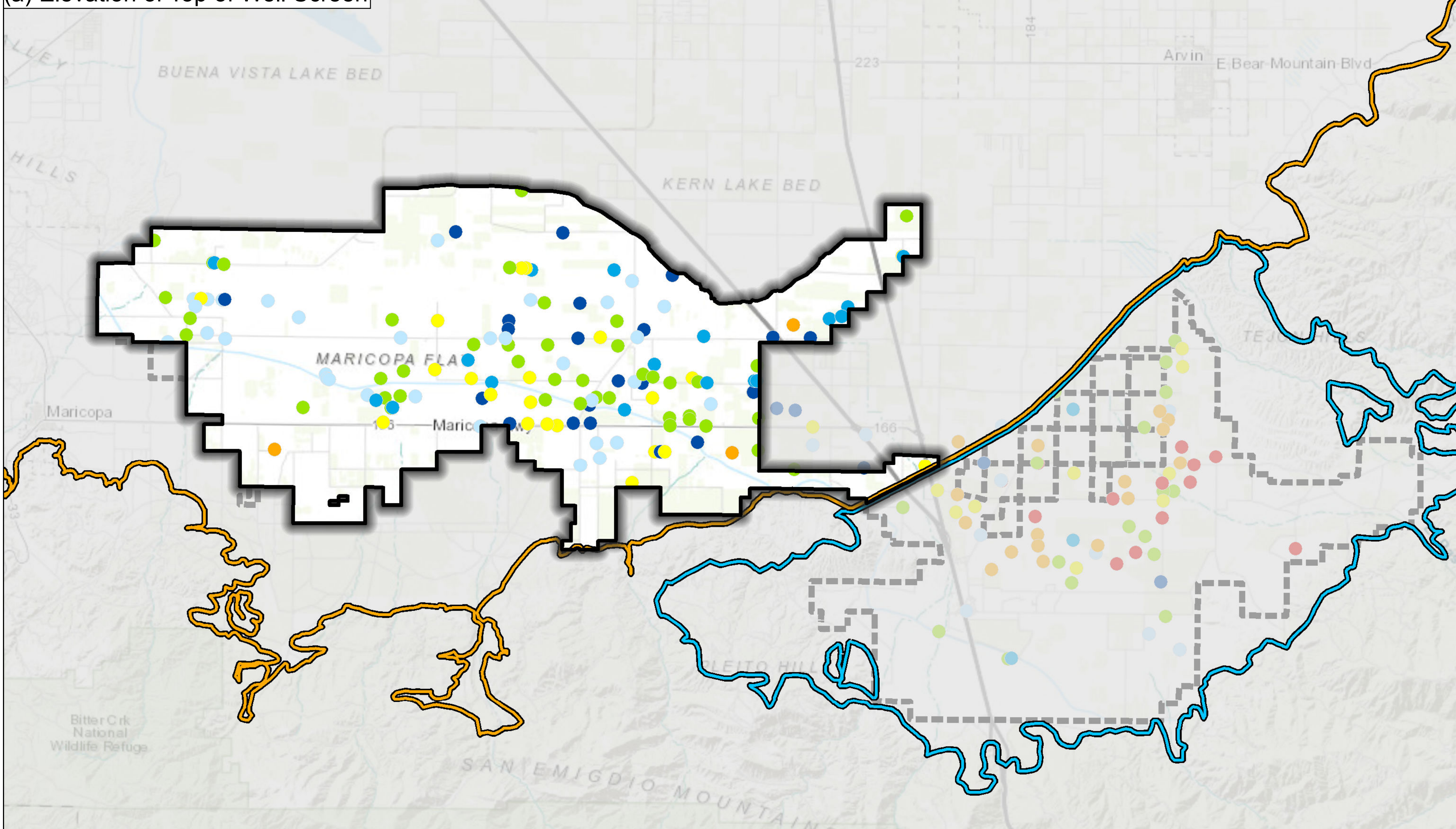
South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

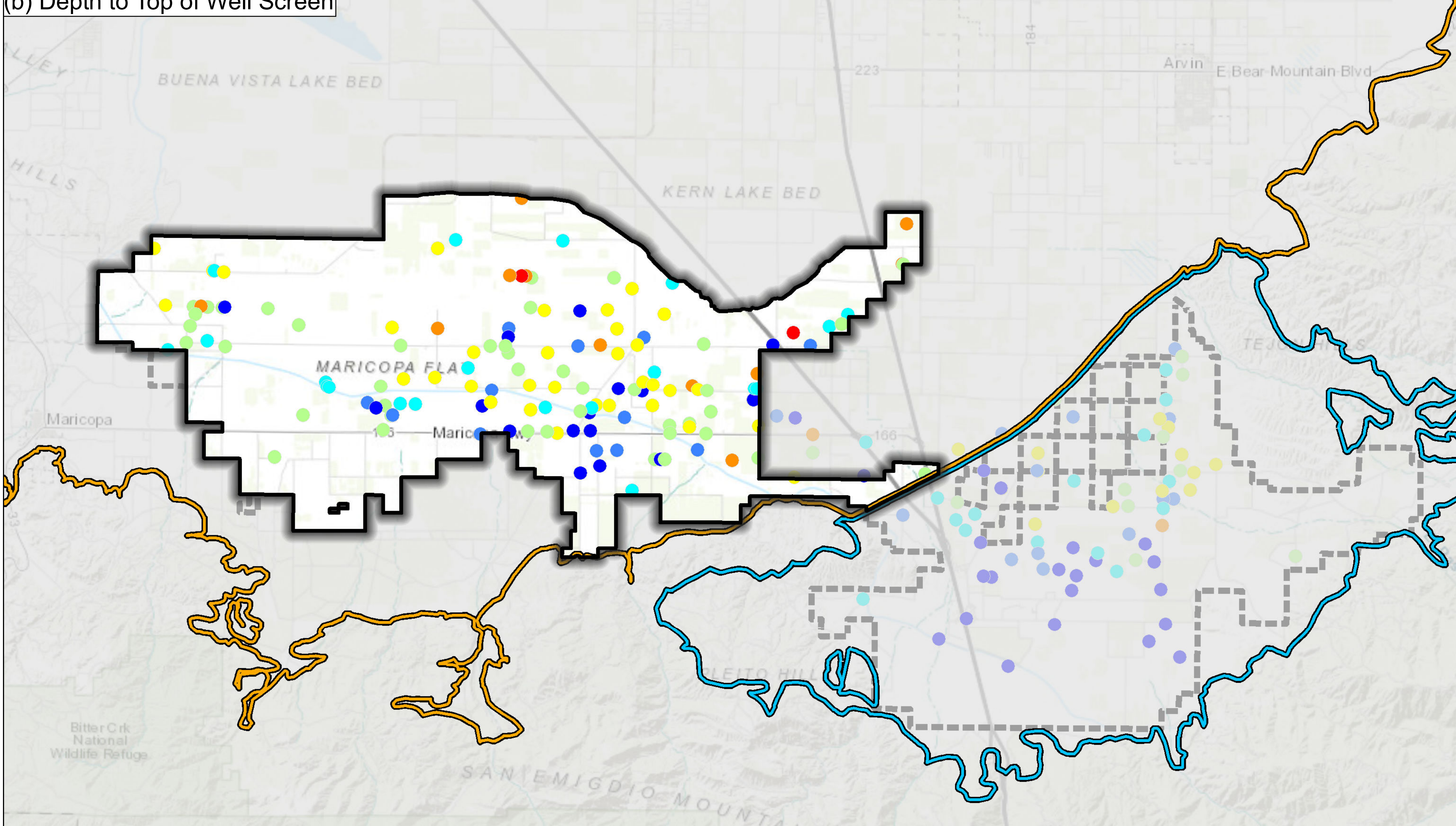
**Figure SMC-16**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-16_Proposed_WR_MTs_WR.mxd

(a) Elevation of Top of Well Screen




(b) Depth to Top of Well Screen




**Legend**

- Wheeler Ridge-Maricopa GSA

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- WRMWSD Service Area Outside of Management Area

**Elevation of Top of Well Screen (ft msl)**

- <-100
- -100 - 0
- 1 - 100
- 101 - 200
- 201 - 300
- 301 - 400
- >400

**Depth of Top of Well Screen (ft bgs)**

- <100
- 100 - 200
- 201 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- >600

**Abbreviations**

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft bgs | = feet below ground surface |
| ft msl | = feet above mean sea level |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

**Notes**

1. All locations are approximate.

**Sources**

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Well screen data provided by WRMWSD staff on 20 November 2017.

N

0 4 8

(Scale in Miles)

**Elevation and Depth to Top of Well Screen**
**Wheeler Ridge-Maricopa Management Area**

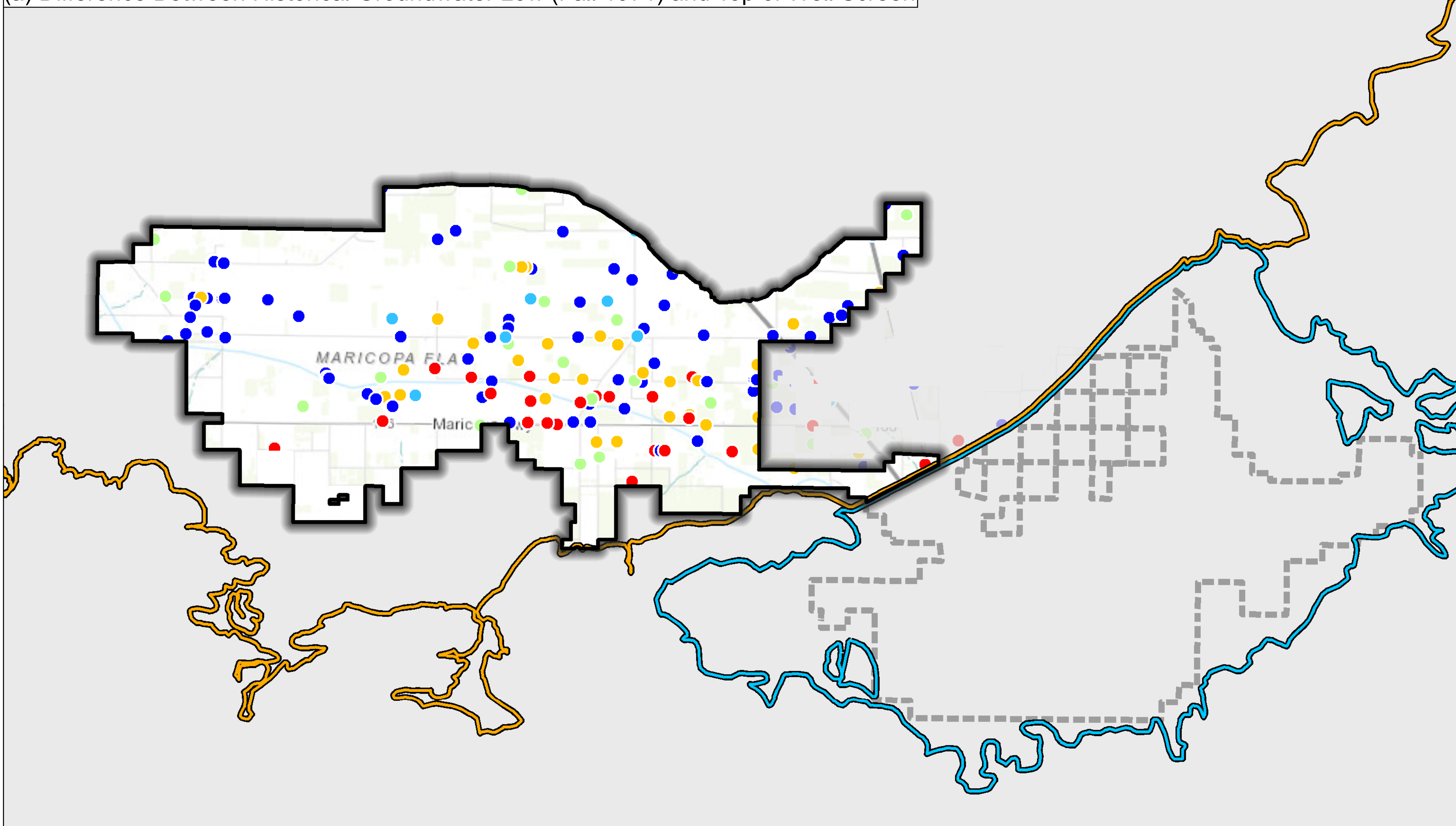
South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

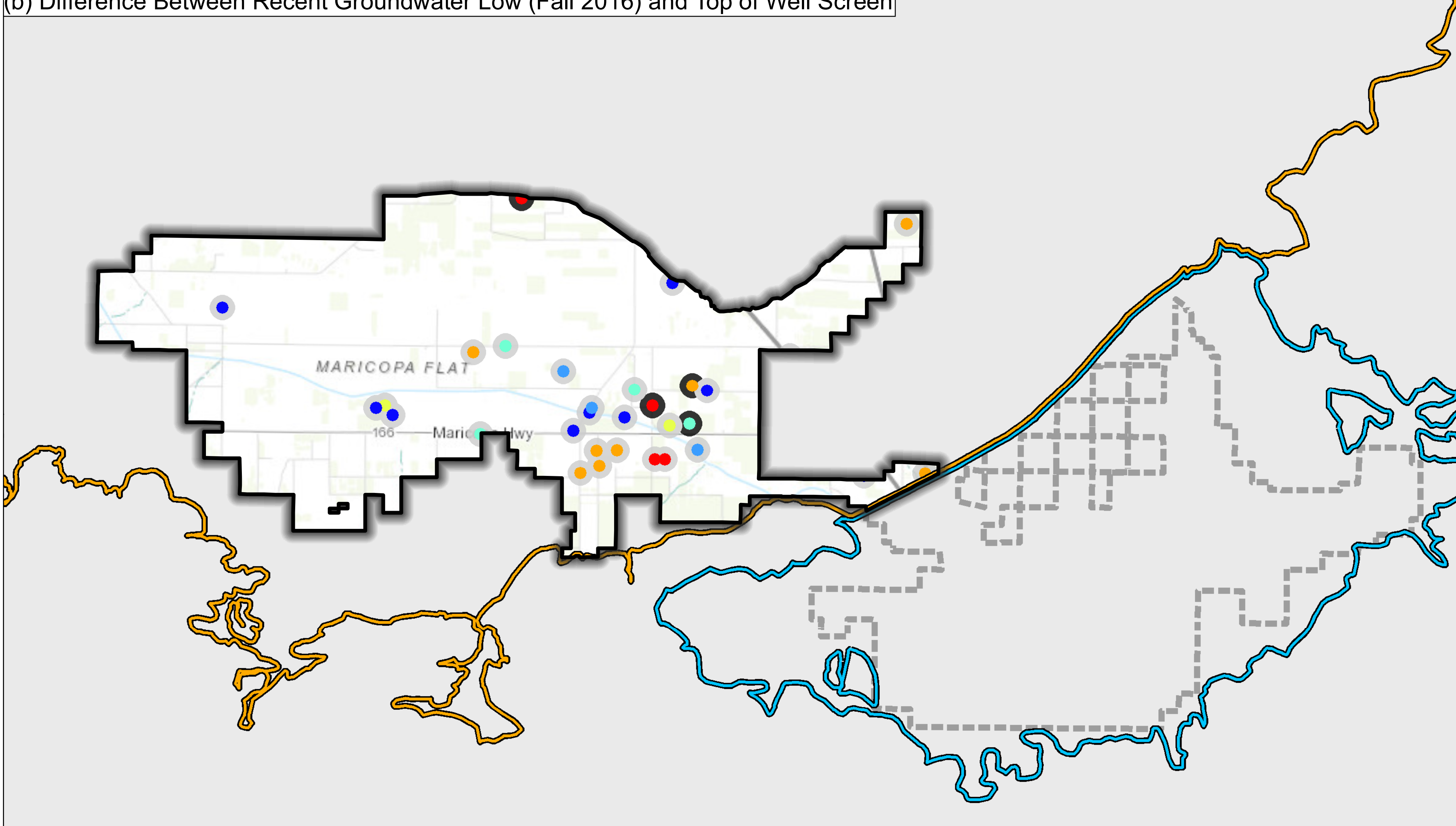
**Figure SMC-17**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-17_Elevation_Depth_TOS_WR.mxd

(a) Difference Between Historical Groundwater Low (Fall 1971) and Top of Well Screen




(b) Difference Between Recent Groundwater Low (Fall 2016) and Top of Well Screen




Legend

- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area Outside of Management Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Difference between Groundwater Elevation and Top of Well Screen (ft)**

- <-100
- -100 - 0
- 0 - 50
- 50 - 100
- 100 - 200
- >200

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft | = feet |
| GSA | = Groundwater Sustainability Agency |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

N

0 4 8

(Scale in Miles)

**Difference between Historical (Fall 1971) or Recent (Fall 2016) Groundwater Elevation and Top of Well Screen Wheeler-Ridge Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure SMC-18**

Notes

1. All locations are approximate.
2. Only active wells with available Fall 2016 groundwater elevation data are displayed for panel (b).

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.
2. Groundwater elevation and well screen data provided by WRMWSD staff on 20 November 2017.

Path: X:\C20055.00\Maps\5 SMC\FigSMC-18_Historical_Recent_GWlow_TOS_WR.mxd

**Figure SMC-19**

Distribution of Well Ages

Wheeler Ridge-Maricopa Management Area

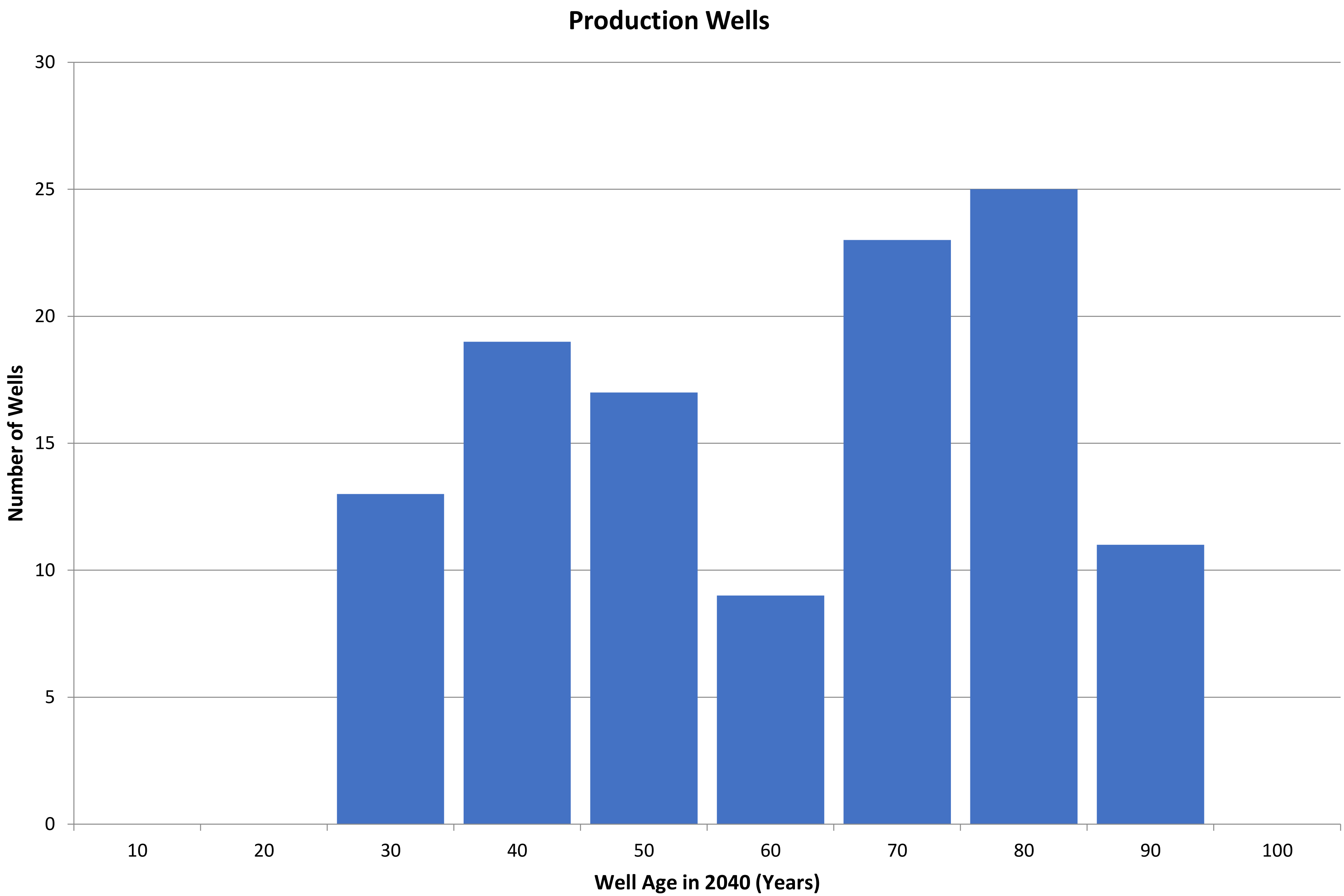


**Figure SMC-19**

Distribution of Well Ages

Wheeler Ridge-Maricopa Management Area

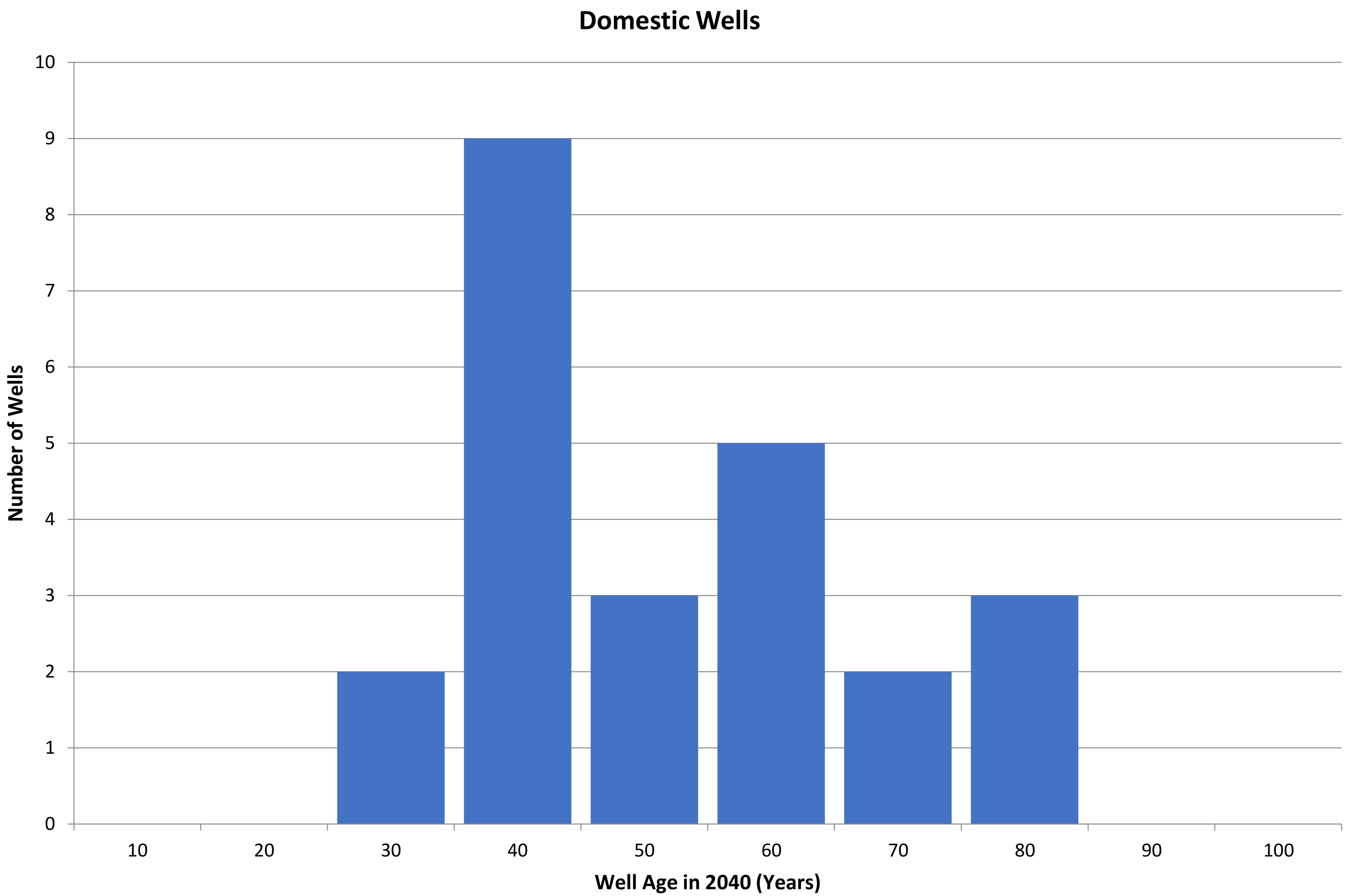
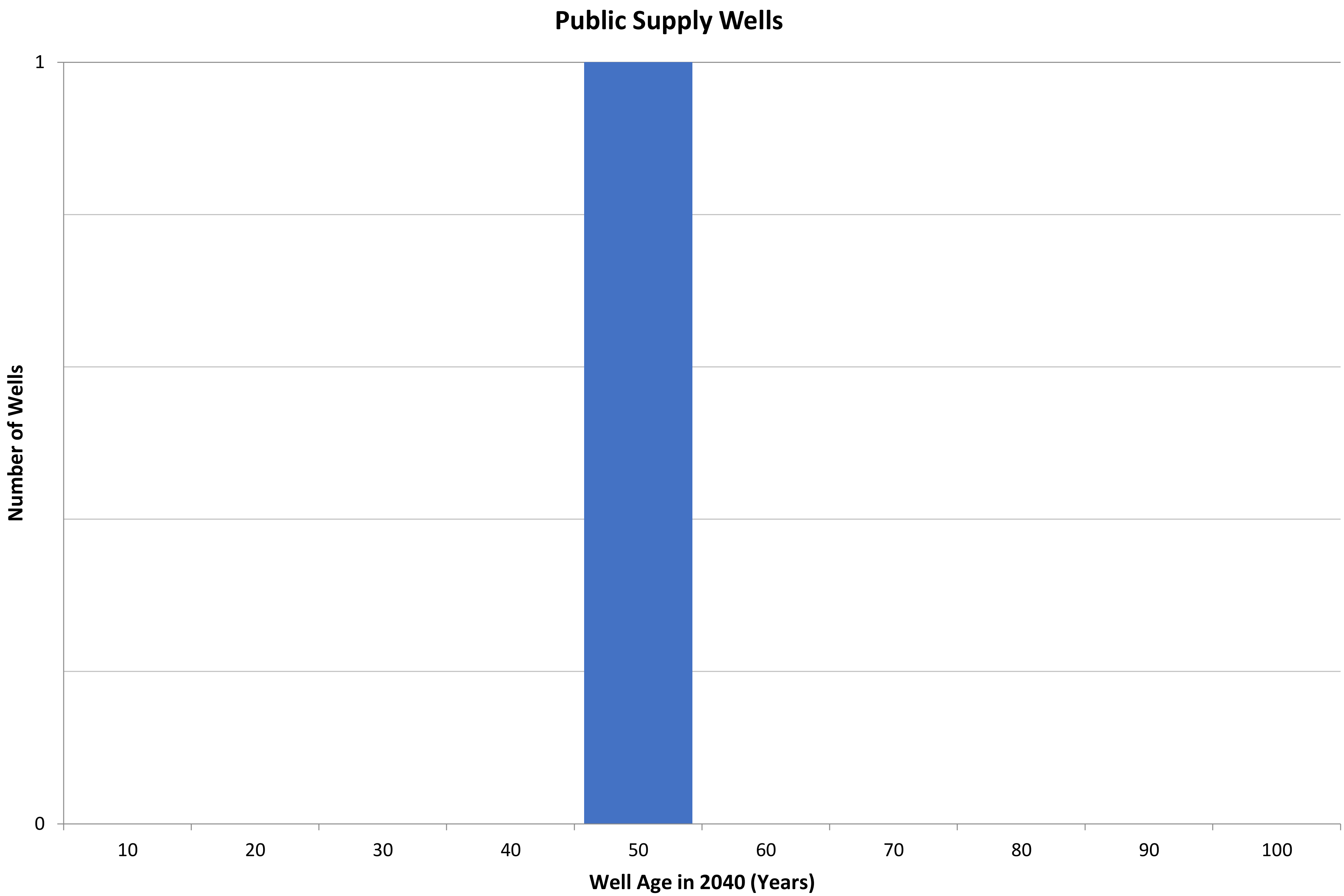
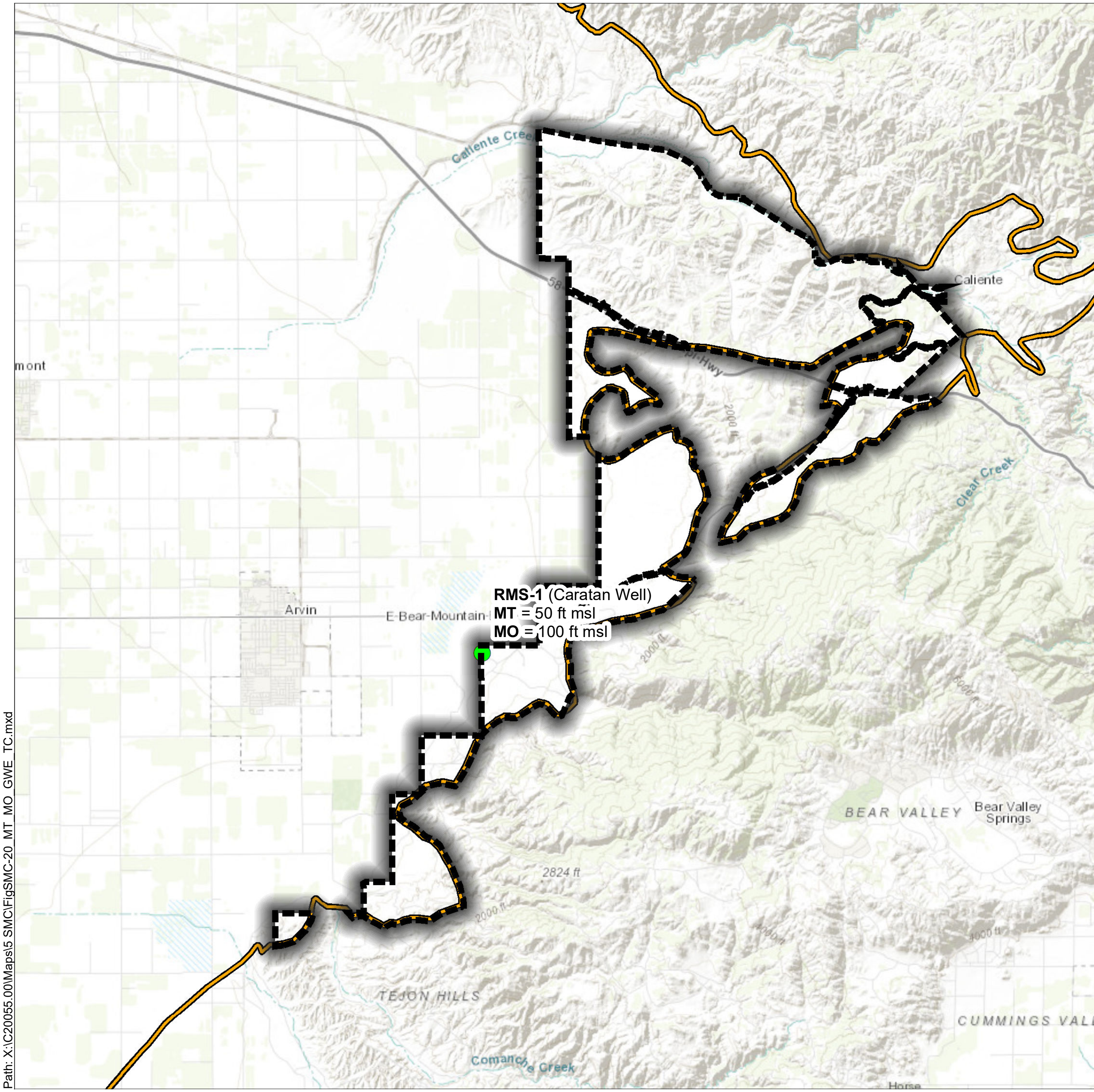


**Figure SMC-19**
Distribution of Well Ages
Wheeler Ridge-Maricopa Management Area






Path: X:\C20055.00\Maps\5 SMC\FigSMC-20_MT_MO_GWE_TC.mxd

## Legend

Tejon-Castac Water District GSA

Kern County Subbasin (DWR 5-022.14)

Representative Monitoring Site

## Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MO = Measurable Objective
MT = Minimum Threshold
RMS = Representative Monitoring Site

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 June 2022.

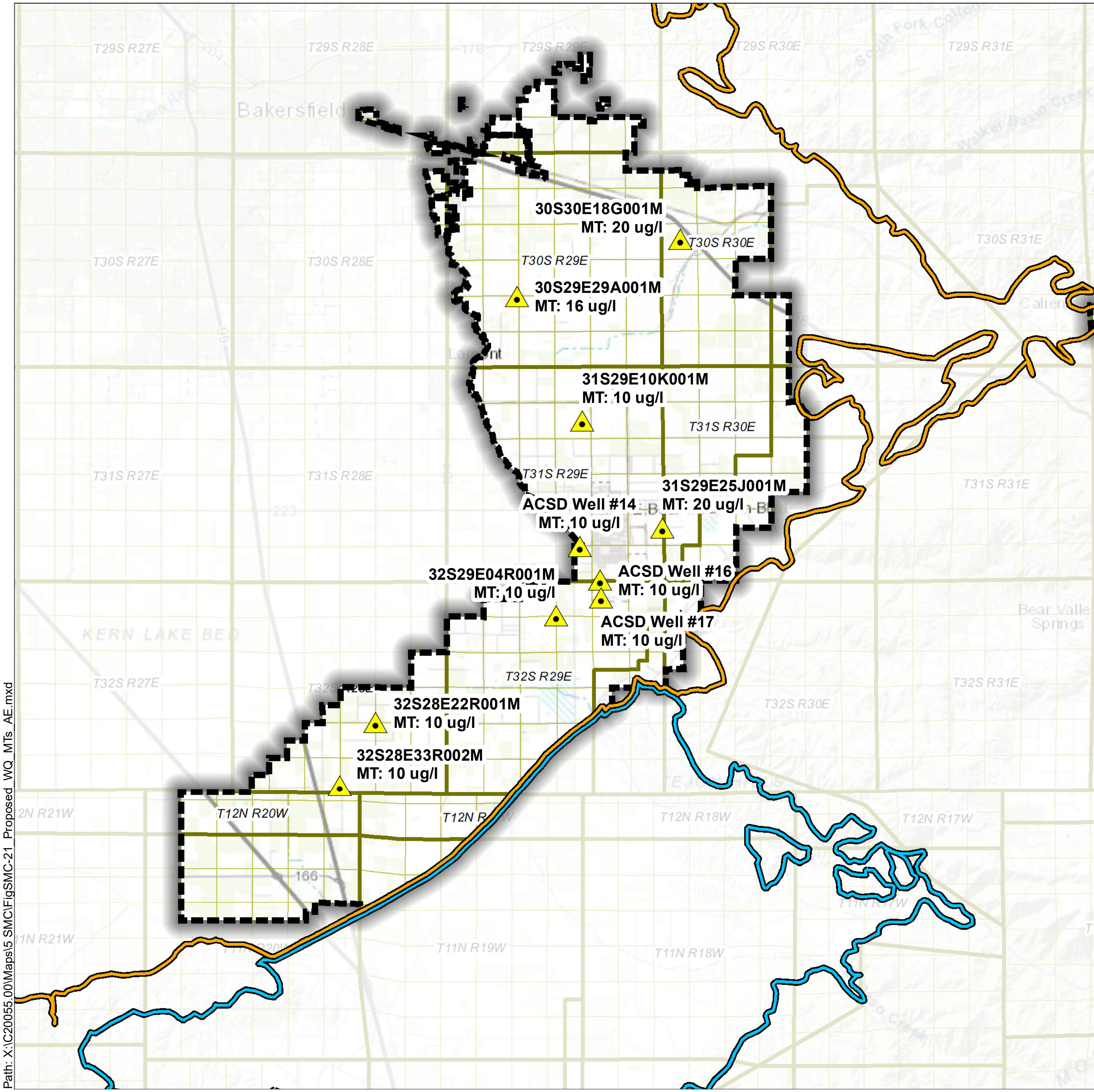
N 0 3 6 Miles

**Water Level Minimum Threshold and Measurable Objective Tejon-Castac Management Area**

eki environment & water

South of Kern River GSP
Kern County, California
July 2022
C20055.00

**Figure SMC-20**




Legend

Arvin GSA

Arvin-Edison Management Area RMS

**Groundwater Subbasin**

Kern County (DWR 5-022.14)

White Wolf (DWR 5-022.18)

Abbreviations

| | | |
|---|---|---|
| ACSD | = | Arvin Community Services District |
| GSA | = | Groundwater Sustainability Agency |
| MT | = | Minimum Threshold |
| RMS | = | Representative Monitoring Site |
| ug/l | = | micrograms per liter |

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 13 June 2022.

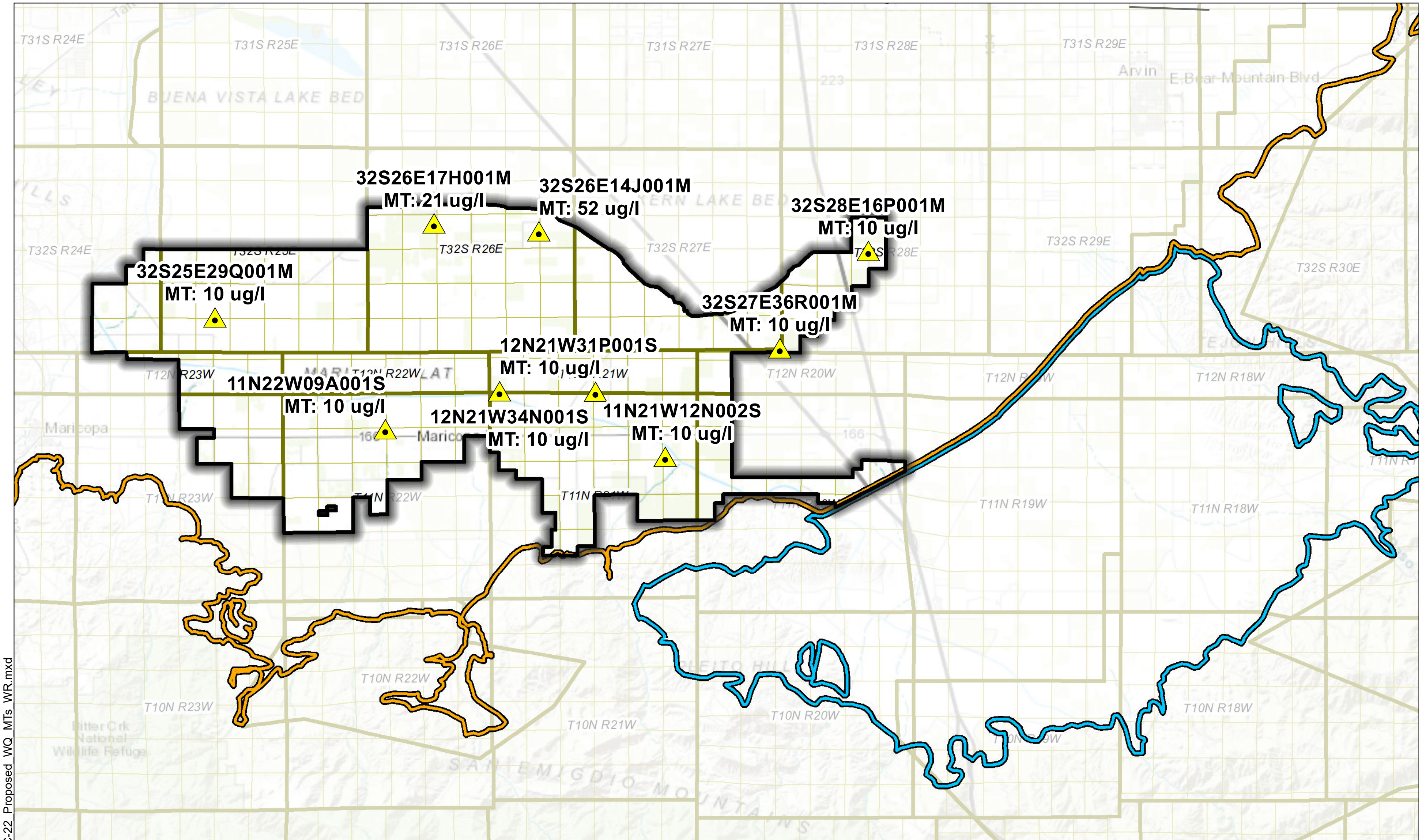
N 0 5 10 Miles

**Proposed Water Quality Minimum Thresholds - Arsenic Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00
**Figure SMC-21**

eki environment & water

Path: X:\C20055.00\Maps\5 SMC\FigSMC-21_Proposed_WQ_MTs_AE.mxd




Legend
- Representative Monitoring Site
- Wheeler Ridge-Maricopa GSA

**Groundwater Subbasin**
- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| GSA | = Groundwater Sustainability Agency |
| MT | = Minimum Threshold |
| ug/l | = microgram per liter |

Notes
1. All locations are approximate.

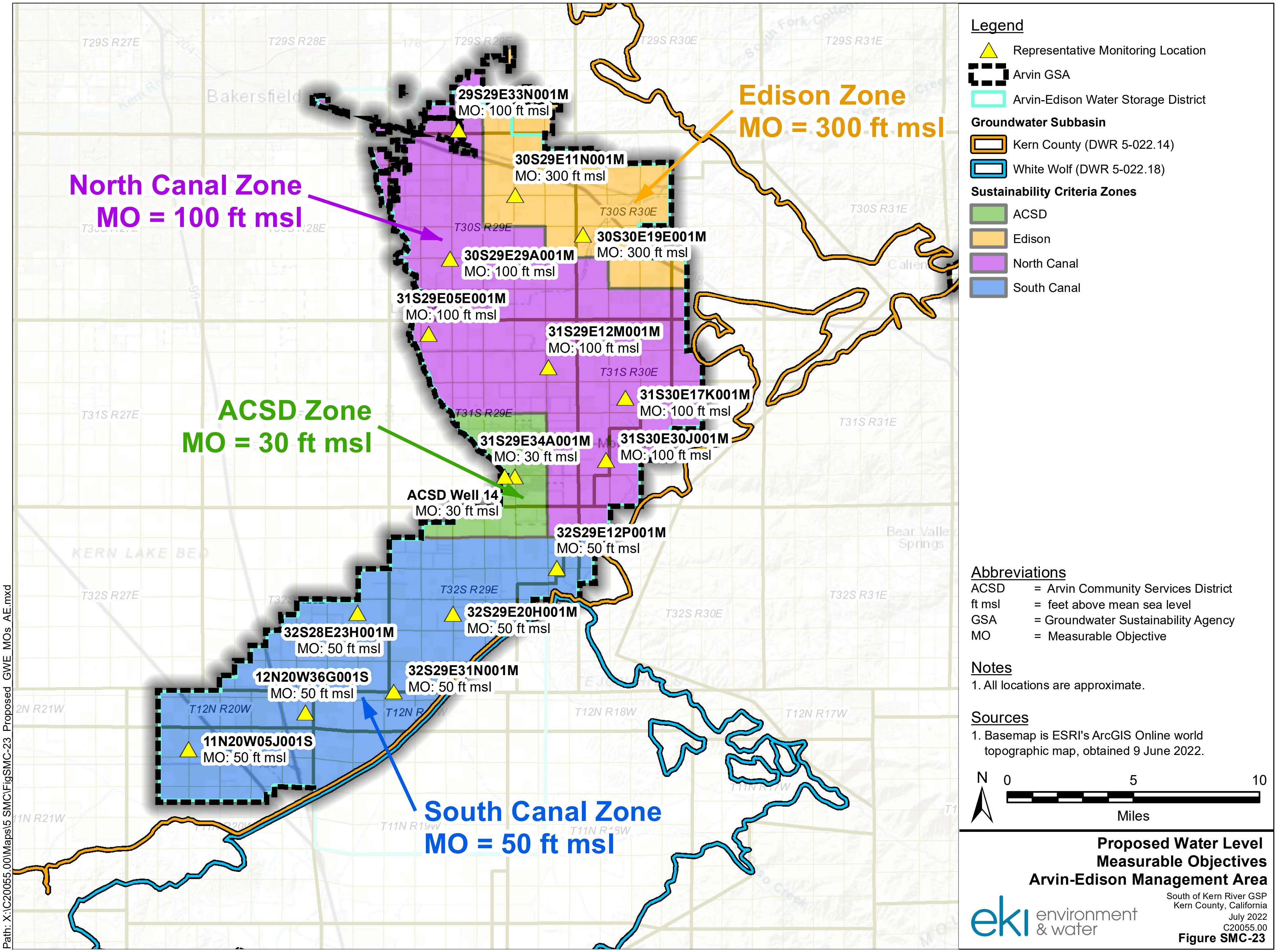
Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.

N
0 5 10
(Scale in Miles)

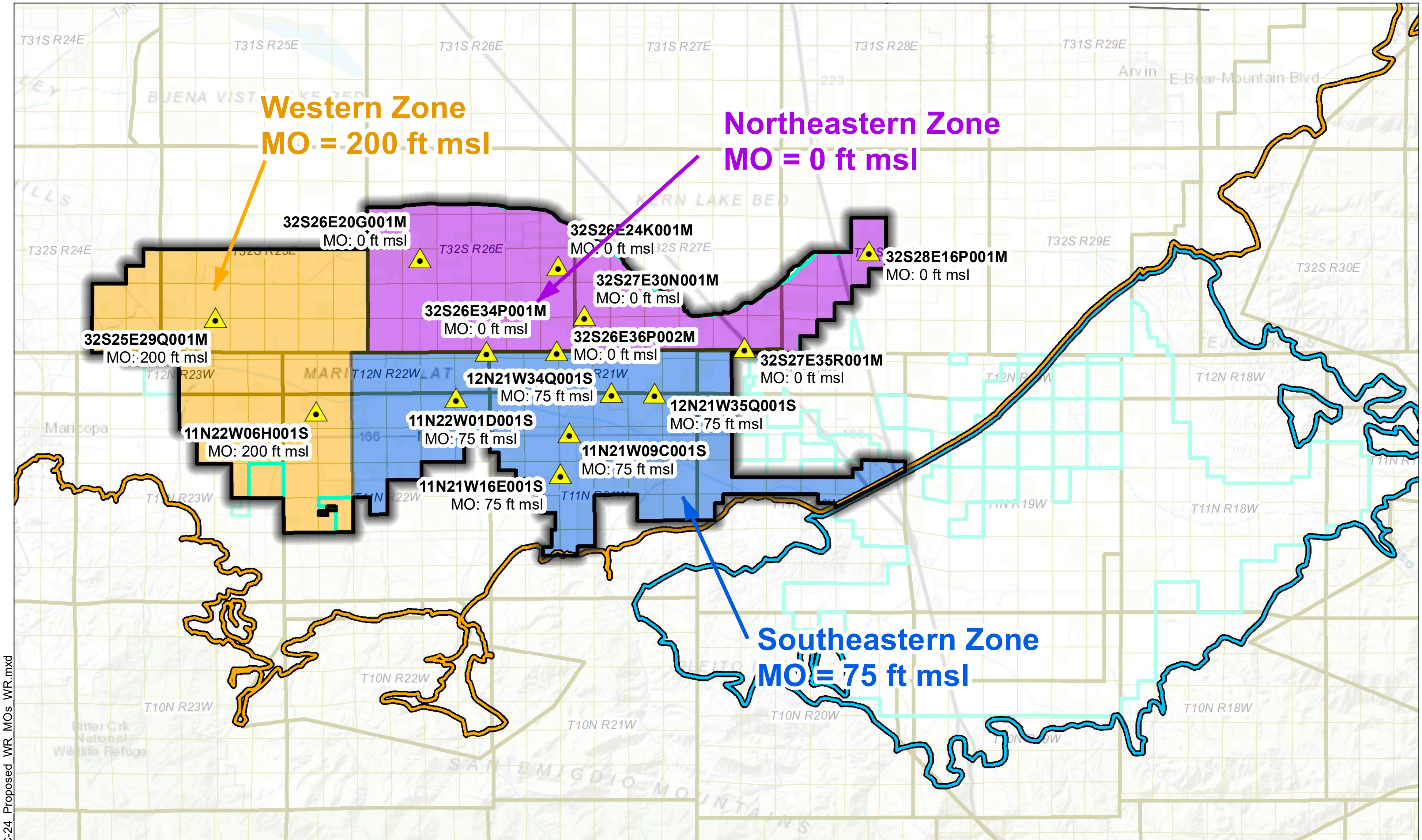
**Proposed Water Quality**
**Minimum Thresholds - Arsenic**
**Wheeler Ridge-Maricopa Management Area**
South of Kern River GSP
Kern County, California
July 2022
C20055.00
**Figure SMC-22**

eki environment & water

Path: X:\C20055.00\Maps\5 SMC\FigSMC-22_Proposed_WQ_MTs_WR.mxd



Edison Zone
MO = 300 ft msl
North Canal Zone
MO = 100 ft msl
ACSD Zone
MO = 30 ft msl
South Canal Zone
MO = 50 ft msl
29S29E33N001M
MO: 100 ft msl
30S29E11N001M
MO: 300 ft msl
30S30E19E001M
MO: 300 ft msl
30S29E29A001M
MO: 100 ft msl
31S29E05E001M
MO: 100 ft msl
31S29E12M001M
MO: 100 ft msl
31S30E17K001M
MO: 100 ft msl
31S29E34A001M
MO: 30 ft msl
31S30E30J001M
MO: 100 ft msl
ACSD Well 14
MO: 30 ft msl
32S29E12P001M
MO: 50 ft msl
32S29E20H001M
MO: 50 ft msl
32S28E23H001M
MO: 50 ft msl
12N20W36G001S
MO: 50 ft msl
32S29E31N001M
MO: 50 ft msl
11N20W05J001S
MO: 50 ft msl
Bakersfield
KERN LAKE BED
Bear Valley Springs
T29S R27E
T29S R28E
T29S R29E
T29S R30E
T29S R31E
T30S R29E
T30S R30E
T30S R31E
T31S R27E
T31S R29E
T31S R30E
T31S R31E
T32S R27E
T32S R29E
T32S R30E
T32S R31E
T12N R20W
T12N R18W
T12N R17W
T11N R19W
T11N R18W
Legend
Representative Monitoring Location
Arvin GSA
Arvin-Edison Water Storage District
Groundwater Subbasin
Kern County (DWR 5-022.14)
White Wolf (DWR 5-022.18)
Sustainability Criteria Zones
ACSD
Edison
North Canal
South Canal
Abbreviations
ACSD = Arvin Community Services District
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MO = Measurable Objective
Notes
1. All locations are approximate.
Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.
N
0 5 10
Miles
Proposed Water Level Measurable Objectives
Arvin-Edison Management Area
South of Kern River GSP
Kern County, California
July 2022
C20055.00
Figure SMC-23
eki environment & water
Path: X:\C20055.00\Maps\5 SMC\FigSMC-23_Proposed_GWE_MOs_AE.mxd




Legend

- Representative Monitoring Site
- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- Northeastern Zone
- Southeastern Zone
- Western Zone

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
MO = Measurable Objective
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.

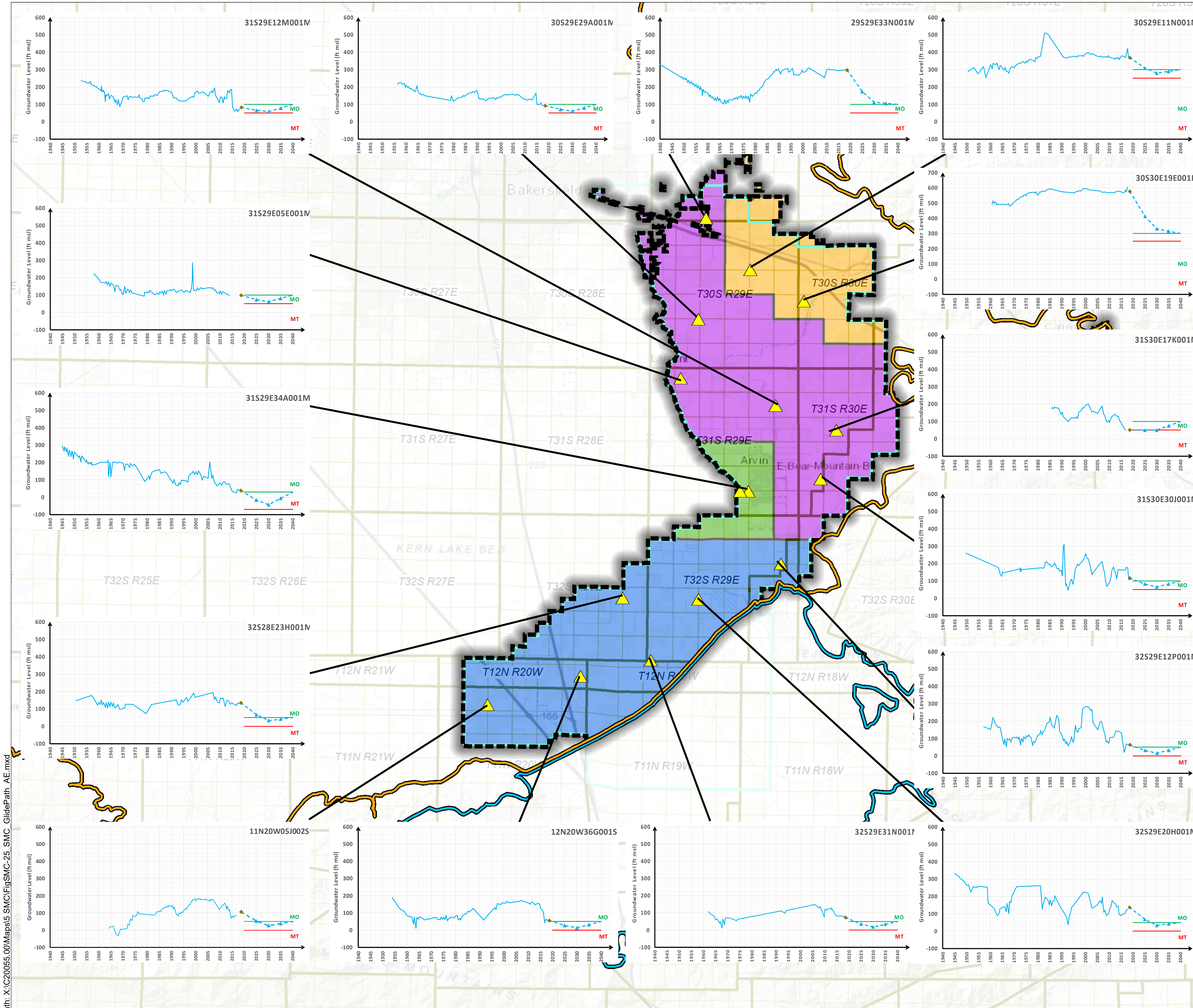
N 0 5 10 (Scale in Miles)

**Proposed Water Level Measurable Objectives**
**Wheeler Ridge-Maricopa Management Area**
South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure SMC-24**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-24 Proposed WR MOs WR.mxd




## Legend

- Representative Monitoring Location
- Arvin GSA
- Arvin-Edison Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- ACSD
- Edison
- North Canal
- South Canal

- Hydrograph
- Measurable Objective (MO)
- Minimum Threshold (MT)
- Interim Milestone (IM)
- Glide Path
- Fall 2018

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
ft = feet
GSA = Groundwater Sustainability Agency
IM = Interim Milestone
MO = Measurable Objective
MT = Minimum Threshold
SGMA = Sustainable Groundwater Management Act

## Notes

1. All locations are approximate.
2. Water levels that showed a rate of change between consecutive measurements greater than 50 ft in 60 days, or a significant change without a reasonable hydrological explanation, were removed from the hydrographs.
3. Representative monitoring location 12N20W05J001S does not have a complete historical water level data record, and is thus represented by nearby well 12N20W05J002S for the purposes of this analysis.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.
2. Water level information obtained from AEWSD on 30 November 2017.

N
0 4 8
(Scale in Miles)

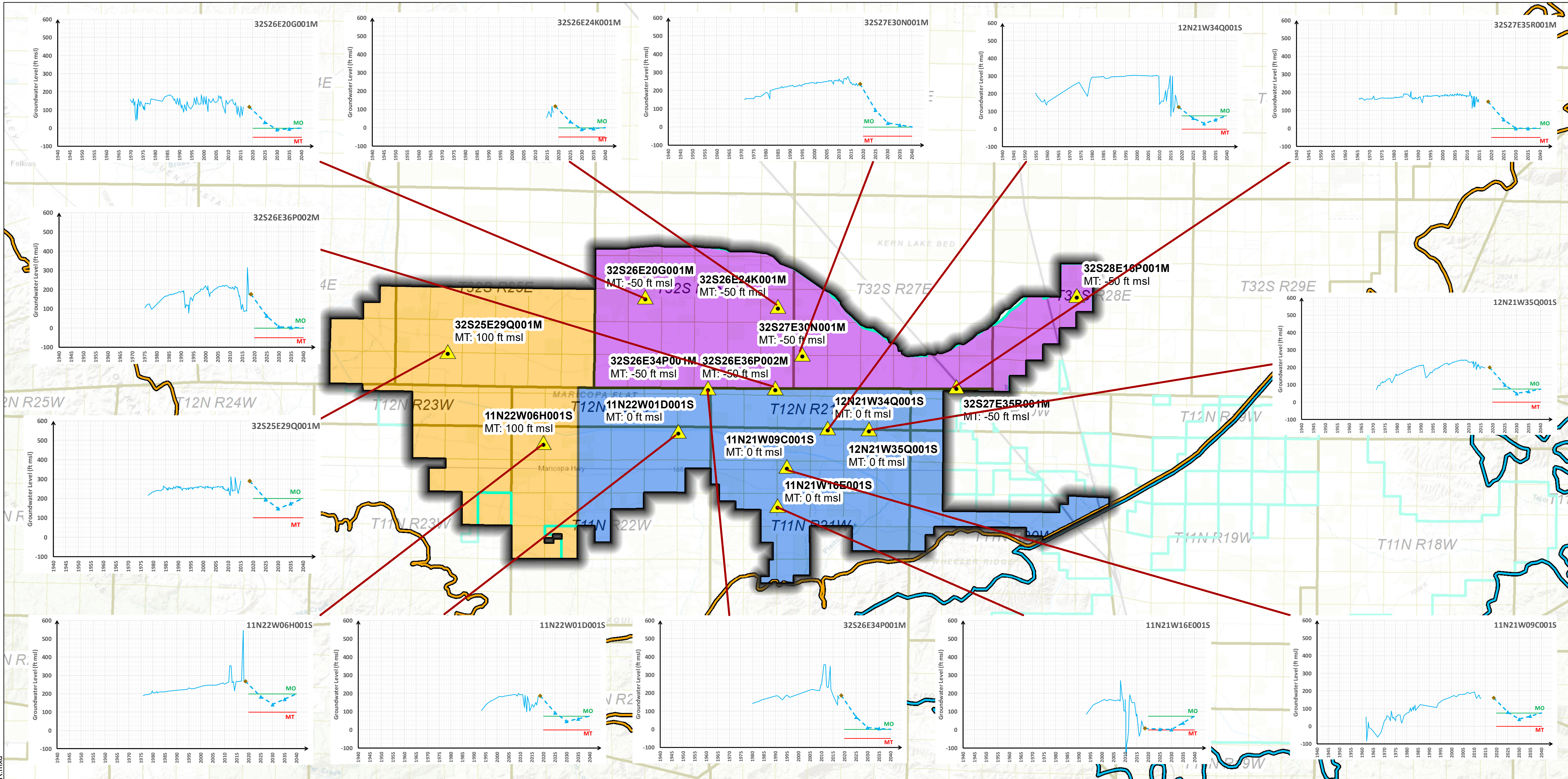
**Water Level Sustainability Criteria - Interim Milestones Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure SMC-25**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-25_SMC_GlidePath_AE.mxd




## Legend

- Representative Monitoring Site
- Wheeler Ridge-Maricopa GSA
- WRMWSD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- Northeastern Zone
- Southeastern Zone
- Western Zone

- Hydrograph
- Measurable Objective (MO)
- Minimum Threshold (MT)
- Interim Milestone (IM)
- Glide Path
- Fall 2018

## Abbreviations

| | |
|---|---|
| DWR | = California Department of Water Resources |
| ft | = feet |
| GSA | = Groundwater Sustainability Agency |
| IM | = Interim Milestone |
| MO | = Measurable Objective |
| MT | = Minimum Threshold |
| WRMWSD | = Wheeler Ridge-Maricopa Water Storage District |

## Notes

1. All locations are approximate.
2. Representative Monitoring Well 32S28E16P001M does not have a historical water level record and is thus not displayed on the map

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.
2. Groundwater elevation data provided by WRMWSD on 26 September 2018.

N

0 3 6 (Scale in Miles)

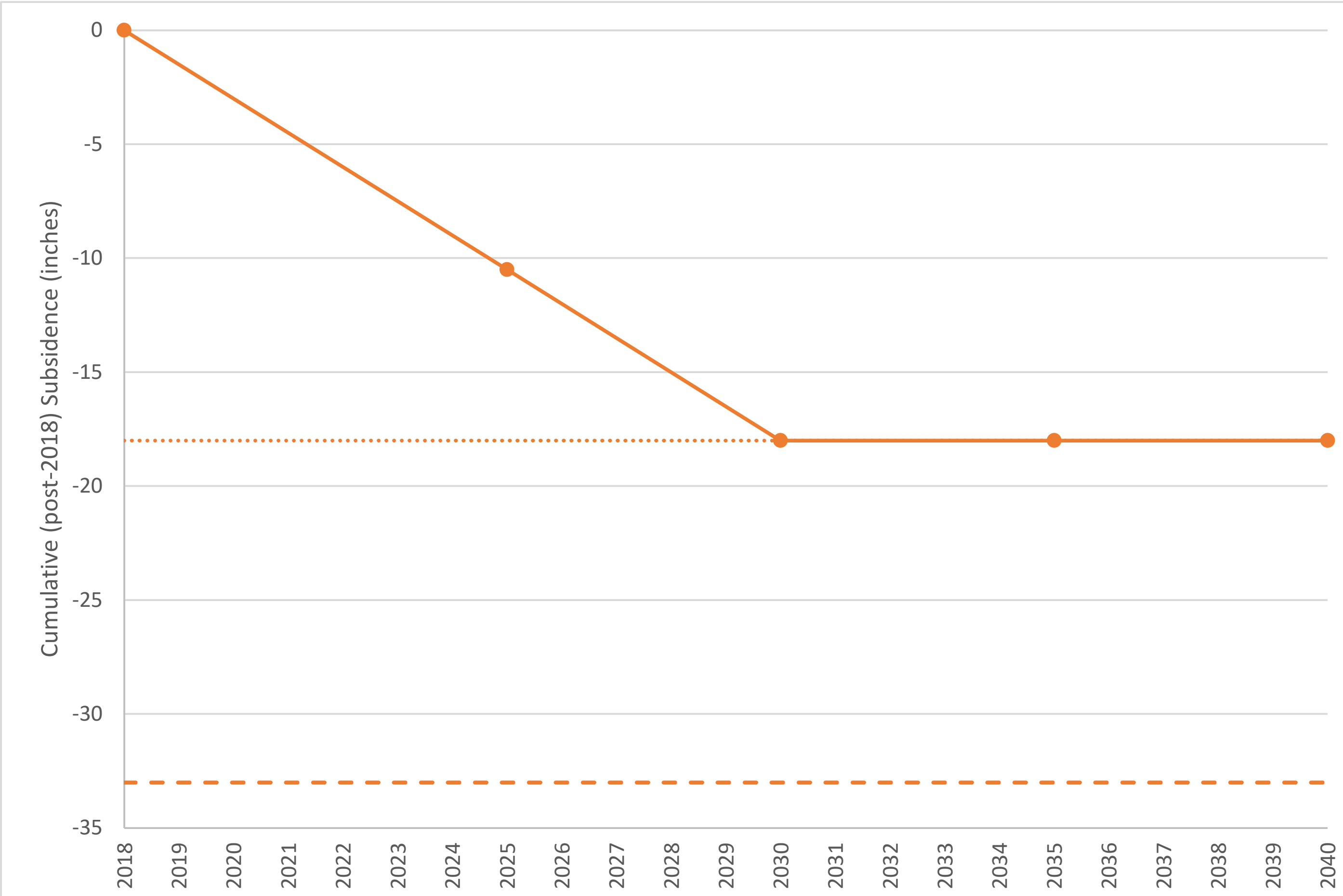
**Water Level Sustainability Criteria - Interim Milestones**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00

eki environment & water

**Figure SMC-26**

Path: X:\C20055.00\Maps\5 SMC\FigSMC-26_SMC_GlidePath_WR.mxd




Legend

- Glide path
- MT
- MO

Abbreviations

GSP = Groundwater Sustainability Plan
MO = Measurable Objective
MT = Minimum Threshold

eki environment & water

**Land Subsidence Sustainability Criteria**
**Interim Milestones**
**Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure SMC-27**


Legend

- Glide path
- MT
- MO
- Subsidence 2022

Abbreviations

ft = feet
GSP = Groundwater Sustainability Plan
MO = Measurable Objective
MT = Minimum Threshold

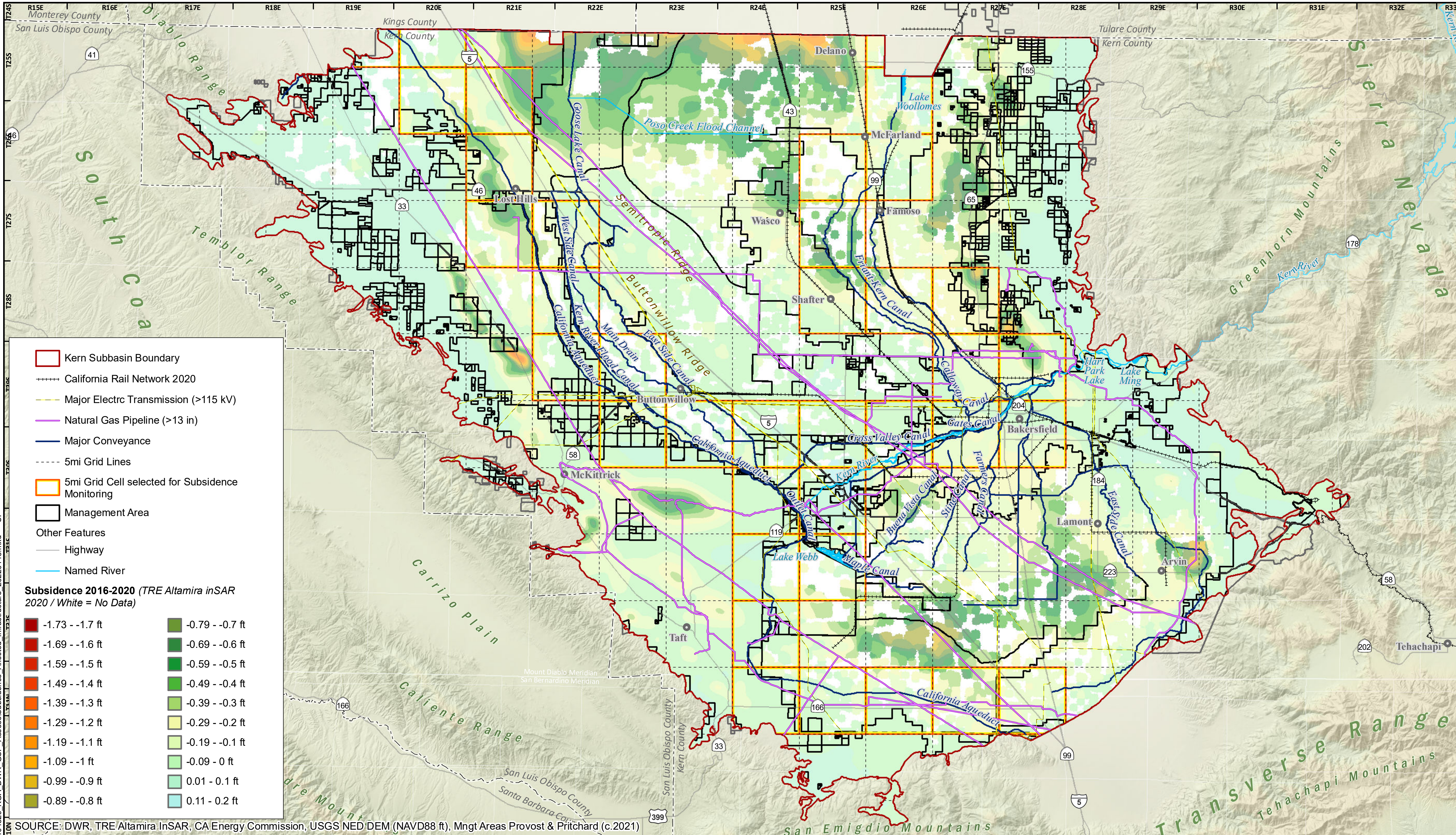
**Land Subsidence Sustainability Criteria**
**Interim Milestones**
**Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
EKI C20055.00

**Figure SMC-28**

## Figure SMC-29 Kern County Subbasin Regional Critical Infrastructure

**From GEI, 2022 *"Subsidence and Potentially Impacted Major Infrastructure"***




0 2.5 5 10 15 20

Miles

Kern Groundwater Authority
Basin Setting

Kern County, California

GEI Consultants

SUBSIDENCE AND POTENTIALLY IMPACTED MAJOR INFRASTRUCTURE

APR 2022

DRAFT

# MONITORING NETWORK

# 16. MONITORING NETWORK

☑ 23 CCR § 354.32

This section describes the Sustainable Groundwater Management Act (SGMA) monitoring network designed for the South of Kern River Groundwater Sustainability Plan (SOKR GSP), subsequently referred to as the "SGMA Monitoring Network". Pursuant to the GSP Emergency Regulations, the objective of the SGMA Monitoring Network is to collect sufficient data for the correct assessment of the Sustainability Indicators relevant to the SOKR GSP (see **Section 13 *Undesirable Results***), and the impacts to the beneficial users of groundwater within the SOKR GSP Area of the Kern County Subbasin (Basin or Kern Subbasin).

## 16.1. Description of Monitoring Network

☑ 23 CCR § 354.34(a)
☑ 23 CCR § 354.34(b)
☑ 23 CCR § 354.34(d)
☑ 23 CCR § 354.34(f)

The SGMA Monitoring Network is designed to collect data with sufficient temporal frequency and spatial density necessary to evaluate Plan implementation as it relates to:

- Monitoring short-term, seasonal, and long-term trends in groundwater and related surface water conditions (see **Section 8 *Current and Historical Groundwater Conditions***);
- Demonstrating progress toward achieving measurable objectives described in the Plan (see **Section 15 *Measurable Objectives and Interim Milestones***);
- Monitoring impacts to the beneficial uses and users of groundwater (see **Section 5.5.1 *Beneficial Uses and Users of Groundwater***);
- Monitoring changes in groundwater conditions relative to Measurable Objectives (see **Section 15 *Measurable Objectives and Interim Milestones***) and Minimum Thresholds (see **Section 14 *Minimum Thresholds***); and
- Quantifying annual changes in water budget components (see **Section 9 *Water Budget Information***).

*Arvin-Edison Management Area*

The SGMA Monitoring Network within the Arvin-Edison Management Area consists of a series of Representative Monitoring Sites (RMS) that: (1) were selected from the existing monitoring programs that are active within the Arvin-Edison Management Area (see **Section 5.2.1 *Existing Monitoring and Management Programs***), (2) have been demonstrated to be representative of groundwater conditions within the Arvin-Edison Management Area (see ***Figure SMC-5***, for example), and (3) where Sustainability Criteria (Minimum Thresholds [MT], Measurable Objectives [MO], and Interim Milestones [IM]) have been defined for at least one of the relevant Sustainability Indicators (see **Section 13 *Undesirable Results***):

- Chronic Lowering of Groundwater Levels;

- Reduction of Groundwater Storage;
- Degraded Water Quality; and
- Land Subsidence.

Per 23 California Code of Regulations (CCR) § 354.32(e), the selection of Representative Monitoring Sites was informed by the existing local monitoring programs and California Statewide Groundwater Elevation Monitoring (CASGEM) network (see **Section 5.2.1** ***Existing Monitoring and Management Programs***) and leverages historical data wherever possible to help assess and quantify Basin response to Plan implementation relative to historical groundwater conditions (see **Section 8** ***Current and Historical Groundwater Conditions***). Pursuant to 23 CCR § 354.32(f), the spatial distribution, spatial density, and temporal frequency of measurements collected from Representative Monitoring Sites is determined for each Sustainability Indicator based on considerations of:

- Amount of current and projected groundwater use;
- Aquifer characteristics, including any vertical and/or lateral barriers to groundwater flow;
- Potential impacts to beneficial uses and users of groundwater, land uses and property interests affected by groundwater production, and other adjacent basins (and Groundwater Sustainability Agencies [GSAs] within the Basin); and
- Availability of historical data to evaluate long-term trends in groundwater conditions associated with the above factors.

Per 23 CCR § 354.32(g), other factors considered in the selection of Representative Monitoring Sites include:

- Availability of existing technical information about the Representative Monitoring Site (e.g., well location, construction information, condition, status, etc.);
- Quality and reliability of historical data at the Representative Monitoring Site;
- "Representativeness" to local groundwater conditions and nearby well populations (per 23 CCR § 354.36); and
- Projected availability of long-term access to the Representative Monitoring Site.

***Table MN-1*** summarizes the site type, site count, measured constituent(s), measurement frequency, and spatial density of the SGMA Monitoring Network for each of the relevant Sustainability Indicators mentioned above. Further details about the SGMA Monitoring Network for each Sustainability Indicator can be found in **Sections 16.1.1** through **16.1.6**.

**Table MN-1. Summary of SGMA Monitoring Network, Arvin-Edison Management Area**

| Sustainability Indicator | Site Type | Site Count | Measured Constituent(s) | Measurement Frequency | Spatial Density (# sites / 100 mi$^2$) |
|---|---|---|---|---|---|
| Chronic Lowering of Groundwater Levels | Well | 16 | Water Level | Semiannually | 9.7 |
| Reduction of Groundwater Storage | Well | 16 | Water Level | Semiannually | 9.7 |
| Degraded Water Quality[148] | Well | 10 | see list in **Section 16.1.4** | Annually | 6.05 |
| Land Subsidence (1) | Stationary Global Positioning System (GPS) | 5 | Ground Surface Elevation | Annually | 3.03 |

Note:

(2) The local land subsidence monitoring network described herein is supplemental to the basin-wide subsidence monitoring network being implemented, as discussed in the KGA Umbrella GSP and Appendices thereto.

Pursuant to 23 CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols specified for the Basin as described in **Section 16.2 *Monitoring Protocols for Data Collection and Monitoring*** and in the Coordination Agreement and Appendices thereto.

*Wheeler Ridge-Maricopa Management Area*

The SGMA Monitoring Network consists of a series of Representative Monitoring Sites that: (1) were selected from the existing monitoring programs that are active within the Wheeler Ridge-Maricopa Management Area (see **Section 5.2.1 *Existing Monitoring and Management Programs***), (2) have been demonstrated to be representative of groundwater conditions within the Wheeler Ridge-Maricopa Management Area (see ***Figure SMC-6***, for example), and (3) where Sustainability Criteria (Minimum Thresholds, Measurable Objectives, and Interim Milestones) have been defined for at least one of the relevant Sustainability Indicators (see **Section 13 *Undesirable Results***):

- Chronic Lowering of Groundwater Levels;
- Reduction of Groundwater Storage;
- Degraded Water Quality; and

[148] The SGMA Monitoring Network for Degraded Water Quality includes additional Representative Monitoring Sites for which Sustainability Criteria have not been defined; these sites will be used to collect supplemental data to allow for continued evaluation of groundwater quality trends within the Arvin-Edison Management Area (see **Section 16.1.4 *Monitoring Network for Degraded Water Quality***).

- Land Subsidence.[149]

Per 23 CCR § 354.32(e), the selection of Representative Monitoring Sites was informed by the existing local monitoring programs (see **Section 5.2.1 *Existing Monitoring and Management Programs***) and leverages historical data wherever possible to help assess and quantify Basin response to Plan implementation relative to historical groundwater conditions (see **Section 8 *Current and Historical Groundwater Conditions***). Pursuant to 23 CCR § 354.32(f), the spatial distribution, spatial density, and temporal frequency of measurements collected from Representative Monitoring Sites is determined for each Sustainability Indicator based on considerations of:

- Amount of current and projected groundwater use;
- Aquifer characteristics, including any vertical and/or lateral barriers to groundwater flow;
- Potential impacts to beneficial uses and users of groundwater, land uses, and property interests affected by groundwater production, and other adjacent basins (and GSAs within the Basin); and
- Availability of historical data to evaluate long-term trends in groundwater conditions associated with the above factors.

Per 23 CCR § 354.32(g), other factors considered in the selection of Representative Monitoring Sites include:

- Availability of existing technical information about the Representative Monitoring Site (e.g., well location, construction information, condition, status, etc.);
- Quality and reliability of historical data at the Representative Monitoring Site;
- "Representativeness" to local groundwater conditions and nearby well populations (per 23 CCR § 354.36); and
- Projected availability of long-term access to the Representative Monitoring Site.

***Table MN-2*** summarizes the site type, site count, measured constituent(s), measurement frequency, and spatial density of the Monitoring Network for each of the relevant Sustainability Indicators mentioned above. Further details about the SGMA Monitoring Network for each Sustainability Indicator can be found in **Sections 16.1.1** through **16.1.6**.

[149] WRMWSD will leverage DWR's existing regional subsidence monitoring program along the California Aqueduct for use in evaluating land subsidence conditions within the Management Area (see **Section 16.1.5**).

**Table MN-2. Summary of SGMA Monitoring Network, Wheeler Ridge-Maricopa Management Area**

| Sustainability Indicator | Site Type | Site Count | Measured Constituent(s) | Measurement Frequency | Spatial Density (# sites / 100 mi$^2$) |
|---|---|---|---|---|---|
| Chronic Lowering of Groundwater Levels | Well | 14 | Water Level | Semiannually | 10.4 |
| Reduction of Groundwater Storage | Well | 14 | Water Level | Semiannually | 10.4 |
| Degraded Water Quality | Well | 9 | see list in **Section 16.1.4** | Annually | 6.7 |
| Land Subsidence (2) | Stationary GPS | 40 | Ground Surface Elevation | Annually, or per California Department of Water Resources (DWR) schedule | 27.7 |

Note:

(1) Spatial density of monitoring sites is calculated based on only the area of the Wheeler Ridge-Maricopa Management Area that is not overlapped by AEWSD (86,112 acres), as WRMWSD and AEWSD have agreed that AEWSD will cover the overlap lands for SGMA monitoring purposes.

(2) The land subsidence monitoring network described herein is supplemental to the basin-wide subsidence monitoring network being implemented, as discussed in the KGA Umbrella GSP and Appendices thereto.

Pursuant to 23 CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols specified for the Basin as described in **Section 16.2 *Monitoring Protocols for Data Collection and Monitoring*** and in the Coordination Agreement and Appendices thereto.

*Tejon-Castac Management Area*

Due to the lack of development within the Tejon-Castac Management Area, the SGMA Monitoring Network consists of only a single well. As discussed further below in **Section 17.2.4 Additional Data-Gap Filling Efforts**, the Tejon-Castac Water District (TCWD) GSA is evaluating options to add one or more additional wells to the SGMA Monitoring Network within the Tejon-Castac Management Area.

Pursuant to 23 CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols specified for the Basin as described in **Section 16.2 *Monitoring Protocols for Data Collection and Monitoring*** and in the Coordination Agreement and Appendices thereto.

### 16.1.1. Monitoring Network for Chronic Lowering of Groundwater Levels

☑ 23 CCR § 354.34(c)(1)

***Figure MN-1*** shows the SGMA Monitoring Network for Chronic Lowering of Groundwater Levels within the SOKR GSP Area. Additional details on the SGMA Monitoring Network for the three Management Areas are described in the sections below.

*Arvin-Edison Management Area*

The SGMA Monitoring Network for Chronic Lowering of Groundwater Levels consists of 16 wells distributed across the Arvin-Edison Management Area (spatial density of 9.7 wells / 100 $mi^2$.) for which water level Sustainability Criteria have been defined (see **Section 14.1** ***Minimum Threshold for Chronic Lowering of Groundwater Levels*** and **Section 15.1** ***Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels***). Specific details regarding each of the Representative Monitoring Sites are listed in ***Table MN-3*****.** The site locations and their spatial distribution are displayed on ***Figure MN-1****.* These Representative Monitoring Sites were selected based on the following considerations:

- **Current and projected groundwater use** – The SGMA Monitoring Network includes eight wells located within or immediately adjacent to AEWSD's surface water service area and eight wells located in the "groundwater only" portion of the Arvin-Edison Management Area.
- **Aquifer characteristics** – All 16 wells included in the SGMA Monitoring Network screen the Kern River Formation, which is the only principal aquifer defined within this portion of the Basin. Additionally, the SGMA Monitoring Network includes a well near the White Wolf Fault (32S29E31N001M), a known lateral barrier to groundwater flow and the defined boundary between the Kern Subbasin (DWR 4-022.14) and the White Wolf Subbasin (DWR 5-022.18). As such, this network is sufficient to delineate groundwater occurrence, flow directions and hydraulic gradients.
- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent Basins (or GSAs)** – The SGMA Monitoring Network includes six wells situated within one mile of AEWSD's canal and/or spreading basin facilities (31S29E12M001M, 31S30E17K001M, 31S30E30J001M, 32S29E12P001M, 32S29E31N001M, and 12N20W36G001S), which are defined as Management Area Critical Infrastructure (see **Section 13.5** ***Undesirable Results for Land Subsidence***). The SGMA Monitoring Network also includes two wells within Arvin Community Services District (ACSD) and the City of Arvin (ACSD Well #14 and 31S2934A001M), where a majority of municipal and industrial groundwater production occurs within the Arvin-Edison Management Area. The Monitoring Network also includes one well situated within half a mile of Caliente Creek (30S20E19E001M), which will be used to monitor hydraulic gradients between the creek and underlying principal aquifer.[150] Finally, the SGMA Monitoring Network includes three wells proximate to the AEWSD-Kern Delta Water District (KDWD) boundary (31S29E05E001M,

[150] There are no interconnected surface water features presumed to occur within the Management Area as the water table is encountered well below the ground surface (i.e., depth to water greater than 150 ft. bgs) throughout AEWSD (see **Section 8.7 Interconnected Surface Water Systems**).

ACSD Well #14, and 32S28E23H001M), which will be used to assess hydraulic gradients between the Arvin-Edison Management Area and the KDWD portion of the Kern River GSA.

- **Availability of historical data** – All 16 Representative Monitoring Sites have associated water level records spanning back through at least 1966, the year that AEWSD began importing surface water and coincident to the general period of historical low groundwater elevations within the Arvin-Edison Management Area (see **Section 8** ***Current and Historical Groundwater Conditions***).
- **Availability of site-specific technical information** – As shown in ***Table MN-3***, each of the 16 Representative Monitoring Sites have known geographic coordinates, ground surface elevations, and reference point elevations. Seven of the 16 sites contain known well depths, and six of the 16 sites contain known well screen intervals. Seven of the 16 wells are presumed to still be active and in use for irrigation or municipal and industrial purposes, while the other nine are inactive wells which will be used for dedicated monitoring purposes only. All 16 wells are confirmed to be in suitable condition for recording water level measurements. For the sites where well construction information is incomplete or currently unavailable, the Arvin GSA has developed a plan to fill these data gaps in accordance with 23 CCR § 354.38 (see **Section 16.4** ***Assessment and Improvement of Monitoring Network***).
- **Quality and reliability of historical data** – Each of the Representative Monitoring Sites contains at least 45 water level records, including at least one record in the last five years (i.e., since January 2014). Each site is included in AEWSD's voluntary CASGEM network, and most sites have been monitored biannually for at least the past ten years as part of AEWSD's routine water level monitoring program.
- **"Representativeness" to local groundwater conditions** – The 16 wells' "representativeness" to local groundwater conditions is illustrated on ***Figure SMC-5***, which shows the Fall 2015 groundwater level at each well compared to the average groundwater elevation by PLSS section for all sections "associated with" (i.e., closest to) each long-term hydrograph location. The figure shows that the percent difference in water level in the local area around each well is small in most cases, indicating that the well is representative of that local area.
- **Long-term access –** For each of the 16 Representative Monitoring Sites, a fully executed long-term access agreement has been reached with associated landowners/well owners allowing the Arvin GSA long-term access to the site to conduct monitoring for SGMA compliance purposes. A copy of the long-term access agreement template can be found in **Appendix L**.

All Representative Monitoring Sites will be monitored semiannually in accordance with the monitoring protocol described in **Section 16.2** ***Monitoring Protocols for Data Collection and Monitoring***. All data will be reported to DWR per the requirements specified under **Section 16.5** ***Reporting Monitoring Data to the Department***.

*Wheeler Ridge-Maricopa Management Area*

The SGMA Monitoring Network for Chronic Lowering of Groundwater Levels consists of 14 wells distributed across the Wheeler Ridge-Maricopa Management Area (spatial density of 10.4 wells / 100 $mi^2$.) for which water level Sustainability Criteria have been defined (see **Section 14.1** ***Minimum Threshold for Chronic Lowering of Groundwater Levels*** and **Section 15.1** ***Measurable Objective and Interim Milestones***

***for Chronic Lowering of Groundwater Levels***). As described in **Section 14.1 *Minimum Threshold for Chronic Lowering of Groundwater Levels***, a series of 15 wells with long-term groundwater level records were initially selected to analyze historical and current groundwater conditions across the Wheeler Ridge-Maricopa Management Area and to inform the development of Sustainability Criteria for Chronic Lowering of Groundwater Levels (see **Sections 14.1** and **15.1**). These wells were included in the selection of Representative Monitoring Sites wherever possible; however, in Wheeler Ridge-Maricopa Water Storage District's (WRMWSD) stakeholder outreach efforts, it became clear that there were several instances in which the "long-term hydrograph" wells would not be available for continued monitoring. In these cases, alternative Representative Monitoring Sites were identified in areas proximate to the long-term hydrograph well locations such that the SGMA Monitoring Network achieves a comparable spatial density, distribution, and "representativeness" to local groundwater conditions. Specific details regarding each of the Representative Monitoring Sites are listed in ***Table MN-4*.** The site locations and their spatial distribution are displayed on ***Figure MN-1*.** These Representative Monitoring Sites were selected based on the following considerations:

- **Current and projected groundwater use** – The SGMA Monitoring Network includes ten wells located within or immediately adjacent to WRMWSD's surface water service area and four wells located in the "groundwater only" portion of the Wheeler Ridge-Maricopa Management Area.
- **Aquifer characteristics** – All 14 wells included in the Monitoring Network screen the Tulare Formation, which is the only principal aquifer defined within this portion of the Basin.
- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent Basins (or GSAs) –** The SGMA Monitoring Network includes three wells situated within one mile of the California Aqueduct (11N22W06H001S, 11N22W01D001S, and 11N21W09C001S), which is defined as "critical infrastructure" to the Wheeler Ridge-Maricopa Management Area (see **Section 13.5 *Undesirable Results for Land Subsidence***). The SGMA Monitoring Network also includes one well situated within half a mile of San Emigdio Creek (11N21W16E001S), which will be used to monitor hydraulic gradients between the creek and underlying principal aquifer.[151] Finally, the SGMA Monitoring Network includes three wells near the WRMWSD-KDWD boundary (32S26E20G001M, 32S26E24K001M, and 32S29E16P001M) and two wells near the WRMWSD-AEWSD boundary (32S28E16P001M and 32S27E35R001M), which will be used to assess hydraulic gradients between the Wheeler Ridge-Maricopa Management Area, the KDWD portion of the Kern River GSA, and the Arvin GSA.
- **Availability of historical data –** Eight of the 14 Representative Monitoring Sites have associated water level records spanning back through at least 1971, the year that WRMWSD began importing surface water and coincident to the general period of historical low groundwater elevations within the Wheeler Ridge-Maricopa Management Area (see **Section 8 *Current and Historical Groundwater Conditions***). 13 out of 14 Representative Monitoring Sites have associated water level records spanning back through at least October 1994, coincident with the start of the historical water budget period (see **Section 9.1.3.2 *Historical Water Budget***).

[151] There are no interconnected surface water features presumed to occur within the Management Area as the water table is encountered well below the ground surface (i.e., depth to water greater than 100 ft. bgs) throughout WRMWSD (see **Section 8.7 *Interconnected Surface Water Systems***).

- **Availability of site-specific technical information –** As shown in ***Table MN-4***, each of the 14 Representative Monitoring Sites have known geographic coordinates, ground surface elevations, and reference point elevations. Nine of the 14 sites contain known well depths, and 11 of the 14 sites contain known well screen intervals. Four of the 14 wells are presumed to still be active and in use for irrigation or production purposes, while the other 10 are inactive wells which will be used for dedicated monitoring purposes only. All 14 wells are confirmed to be in suitable condition for recording water level measurements. For the sites where well construction information is incomplete or currently unavailable, the Wheeler Ridge-Maricopa GSA has developed a plan to fill these data gaps in accordance with 23 CCR § 354.38 (see **Section 16.4** ***Assessment and Improvement of Monitoring Network***).
- **Quality and reliability of historical data –** Twelve of the 14 Representative Monitoring Sites contain at least 35 water level records, and 13 of 14 have at least one record in the last five years (i.e., since January 2014). Nine of the 14 sites are included in WRMWSD's voluntary CASGEM network, and most sites have been monitored biannually for at least the past 10 years as part of WRMWSD's routine water level monitoring program.
- **"Representativeness" to local groundwater conditions –** As described above, Representative Monitoring Sites were selected from the list of "long-term hydrograph" wells demonstrated to be representative of local groundwater conditions (***Figure SMC-6***) wherever possible; however, there were several cases where the long-term hydrograph wells would not be available for continued monitoring going forward. In these cases, alternative Representative Monitoring Sites were identified in areas proximate to the long-term hydrograph well locations such that the SGMA Monitoring Network achieves a comparable spatial density, distribution, and "representativeness" to local groundwater conditions.
- **Long-term access –** For each of the 14 Representative Monitoring Sites, a preliminary agreement has been reached with associated landowners/well owners allowing the Wheeler Ridge-Maricopa GSA long-term access to the site to conduct monitoring for SGMA compliance purposes. A copy of the long-term access agreement can be found in **Appendix L**.

All Representative Monitoring Sites will be monitored semiannually in accordance with the monitoring protocol described in **Section 16.2** ***Monitoring Protocols for Data Collection and Monitoring***. All data will be reported to DWR per the requirements specified under **Section 16.5** ***Reporting Monitoring Data to the Department***.

<u>*Tejon-Castac Management Area*</u>

The SGMA Monitoring Network in the Tejon-Castac Management Area consists of a single well: the Caratan Well which is designated as RMS-1 (see ***Figure MN-1***). Details of this well are presented in ***Table MN-5***.

According to the DWR "Best Management Practices #2 – Monitoring Network and Identification of Data Gaps" (DWR, 2016), monitoring well density should be between 0.2 and ten wells per 100 square miles. The SGMA Monitoring Network in the Tejon-Castac Management Area is compliant with these criteria, having one well in approximately 30 square miles of area currently provides adequate coverage of relevant Sustainability Indicators, especially in combination with other monitoring networks in the adjacent Arvin-

Edison Management Area. That being said, the TCWD GSA will consider development of additional monitoring wells in the future to further improve the SGMA Monitoring Network as needed.

The Representative Monitoring Site will be monitored semiannually in accordance with the monitoring protocol described in **Section 16.2 *Monitoring Protocols for Data Collection and Monitoring***. All data will be reported to DWR per the requirements specified under **Section 16.5 *Reporting Monitoring Data to the Department***.

### 16.1.2. Monitoring Network for Reduction of Groundwater Storage

☑ **23 CCR § 354.34(c)(2)**

As described in **Section 13.2.4 *Criteria Used to Define Local Undesirable* Results** and in **Section 14.2.1 *Use of Groundwater Levels as Proxy***, the criteria used to define Undesirable Results for Reduction of Groundwater Storage are the Minimum Thresholds established at the Management Area level for Chronic Lowering of Groundwater Levels. As such, the SGMA Monitoring Network for Reduction of Groundwater Storage will be comprised of the same Representative Monitoring Sites described in **Section 16.1.1 *Monitoring Network for Chronic Lowering of Groundwater Levels***. The information collected from this SGMA Monitoring Network will be sufficient to estimate the change in annual groundwater in storage.

### 16.1.3. Monitoring Network for Seawater Intrusion

☑ **23 CCR § 354.34(c)(3)**
☑ **23 CCR § 354.34(j)**

As described in **Section 13.3 *Undesirable Results for Seawater Intrusion***, seawater intrusion is not present and not likely to occur within the Kern Subbasin, the Seawater Intrusion Sustainability Indicator is not applicable to the Basin, and therefore no Undesirable Results for this Sustainability Indicator are defined. As such, per the stipulations defined under 23 CCR § 354.32(j), a monitoring network has not been defined for the Seawater Intrusion Sustainability Indicator as it is demonstrated to not be applicable to the Basin.

### 16.1.4. Monitoring Network for Degraded Water Quality

☑ **23 CCR § 354.34(c)(4)**

***Figure MN-2*** shows the SGMA Monitoring Network for Degraded Water Quality within the SOKR GSP Area. Additional details on the SGMA Monitoring Network for the three Management Areas are described in the sections below.

*Arvin-Edison Management Area*

The SGMA Monitoring Network for Degraded Water Quality consists of ten RMS, including three RMS situated within ACSD and seven RMS selected from AEWSD's existing water quality sampling program, for which Sustainable Management Criteria (SMCs) for arsenic have been defined (see **Section 14.4 *Minimum Threshold for Degraded Water Quality*** and **Section 15.4 *Measurable Objective and Interim Milestones for Degraded Water Quality***). Specific details regarding each RMS are listed in ***Table MN-3.*** The site locations are displayed on ***Figure MN-2.***

As described by ACSD, Well #14, Well #16, and Well #17 were selected as a water quality RMS based on the following considerations:

- **Current and projected groundwater use** – ACSD Wells #14, #16, and #17 are municipal production wells used to serve customers within the City of Arvin, which is entirely dependent on groundwater. Sampling data from these wells are considered representative of local groundwater quality within ACSD and the greater City of Arvin.
- **Aquifer characteristics** – ACSD Wells #14, #16, and #17 are screened within the primary aquifer defined for the Basin (i.e., Kern River Formation).
- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent Basins (or GSAs)** – ACSD Wells #14, #16, and #17 are used to provide drinking water supplies to domestic users within the City of Arvin as well as other industrial users within the Arvin-Edison Management Area. As such, compliance with Title 22 CCR drinking water regulations for Maximum Contaminant Levels (MCLs) is the governing regulatory criteria for this well due to the nature of its beneficial use.
- **Availability of historical data** – The ACSD water quality RMS were drilled in 2015 (#14) and 2019 (#16 and #17), and thus do not have a long period of historical record; however, since the wells were put into service, they have been sampled for primary and secondary MCL constituents at monthly frequency in accordance with Title 22 CCR drinking water regulations.
- **Availability of site-specific technical information** – As shown in ***Table MN-3***, ACSD Wells #14, #16, and #17 have known coordinates, well construction information (including total depth and perforated intervals), and verified Well Completion Reports.
- **Quality and reliability of historical data** – As described above, ACSD Wells #14, #16, and #17 have been sampled monthly for Title 22 constituents since they were put into service in October 2016 and November 2019 (#16, #17), respectively.
- **"Representativeness" to local groundwater conditions** – As mentioned above, the water quality and water levels within ACSD Well #14, Well #16, and Well #17 are considered representative of local conditions within the ACSD service area and the greater City of Arvin, whereby a large majority of human consumption of groundwater occurs within the Management Area.
- **Long-term access** – ACSD Wells #14, #16, and #17 are owned and operated by ACSD, and thus there are no anticipated access constraints to the Representative Monitoring Site.

The additional seven water quality RMS were selected from AEWSD's sampling program based on the following considerations:

- **Current and projected groundwater use** – The SGMA Monitoring Network includes two wells located within AEWSD's surface water service area and five wells located in the "groundwater only" portion of the Arvin-Edison Management Area.
- **Aquifer characteristics** – All seven wells included in the Monitoring Network screen the Kern River Formation, which is the only principal aquifer defined within this portion of the Basin.
- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent Basins (or GSAs)** – The SGMA Monitoring Network is spread generally evenly across the Arvin-Edison Management Area and includes Representative Monitoring Sites in the areas of groundwater quality concern identified in **Section 8.5 *Groundwater Quality***.

- **Availability of historical data** – Each of the seven Representative Monitoring Sites have been sampled for groundwater quality constituents (including the constituents of concern [COCs] identified in **Section 8.5 *Groundwater Quality***) at least nine times, including at least four times since the year 2000. Four of the seven wells have sampling records extending back through 1966.
- **Availability of site-specific technical information** – As shown in ***Table MN-3***, each of the seven Representative Monitoring Sites have known geographic coordinates, ground surface elevations, and reference point elevations. Only one of the seven sites contains known well depths and well screen intervals. Six of the seven wells are presumed to still be active and in use for irrigation purposes, while one is currently dedicated for monitoring purposes only. All seven wells are confirmed to be in suitable condition for collecting water quality samples. For the sites where well construction information is incomplete or currently unavailable, the Arvin GSA has developed a plan to fill these data gaps in accordance with 23 CCR § 354.38 (see **Section 16.4 *Assessment and Improvement of Monitoring Network***).
- **Quality and reliability of historical data** – Each of the seven Representative Monitoring Sites contains at least nine water quality sampling records, including at least four records since 2000 and at least two records in the last five years (i.e., since January 2014). Most sites have been monitored regularly for at least the past ten years as part of AEWSD's routine water quality sampling program.
- **"Representativeness" to local groundwater conditions** – As described above, the seven sites are spread generally evenly across the Arvin-Edison Management Area, including some wells in the areas of groundwater quality concern identified in **Section 8.5 *Groundwater Quality***.
- **Long-term access** – For each of the seven Representative Monitoring Sites, a preliminary agreement has been reached with associated landowners/well owners allowing the Arvin GSA long-term access to the site to conduct monitoring for SGMA compliance purposes. A copy of the long-term access agreement template can be found in **Appendix L.**

All RMSs will be sampled at least annually in accordance with the monitoring protocol described in **Section 16.2 *Monitoring Protocols for Data Collection and Monitoring***. RMSs will be sampled for the COCs identified in **Section 8.5 *Groundwater Quality***, namely:

- Arsenic
- Total Dissolved Solids
- Nitrate
- Arsenic
- Boron
- Iron
- Manganese

In addition, the RMSs will be monitored for other relevant groundwater quality constituents[152] which may include constituents within some or all of the following categories:

- Descriptive parameters (temperature, pH, etc.)
- Major ions
- Heavy metals
- Organic substances
- Pesticides
- Microbes

All Representative Monitoring Sites will be monitored annually in accordance with the monitoring protocol described in **Section 16.2 *Monitoring Protocols for Data Collection and Monitoring***. All data will be reported to DWR per the requirements specified under **Section 16.5 *Reporting Monitoring Data to the Department***.

*Wheeler Ridge-Maricopa Management Area*

The SGMA Monitoring Network for Degraded Water Quality includes nine Representative Monitoring Sites selected from WRMWSD's existing water quality sampling program, for which SMC for arsenic have been defined. Specific details regarding each of the Representative Monitoring Sites are listed in ***Table MN-4***. The site locations are displayed on ***Figure MN-2***. These Representative Monitoring Sites were selected based on the following considerations:

- **Current and projected groundwater use** – The SGMA Monitoring Network includes five wells located within WRMWSD's surface water service area and four wells located in the "groundwater only" portion of the Wheeler Ridge-Maricopa Management Area.
- **Aquifer characteristics** – All nine wells included in the SGMA Monitoring Network screen the Tulare Formation, which is the only principal aquifer defined within this portion of the Basin.
- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent Basins (or GSAs) –** The SGMA Monitoring Network is spread generally evenly across the Wheeler Ridge-Maricopa Management Area and includes Representative Monitoring Sites in the areas of groundwater quality concern identified in **Section 8.5 *Groundwater Quality***.
- **Availability of historical data –** All nine Representative Monitoring Sites have been sampled for groundwater quality constituents (including the COCs identified in **Section 8.5 *Groundwater Quality***) at least three times, and six of nine at least 15 times. Eight of the nine sites have been sampled at least once since the year 2000, and seven sites have sampling records extending back through at least 1981.
- **Availability of site-specific technical information –** As shown in ***Table MN-4***, each of the nine Representative Monitoring Sites have known geographic coordinates, ground surface elevations, and reference point elevations. Three of the nine sites contain known well depths, and five of the

[152] As identified in Stanford University's "A Guide to Water Quality Requirements under the Sustainable Groundwater Management Act" (Moran & Belin, 2019).

nine sites contain known well screen intervals. Four of the nine wells are presumed to still be active and in use for irrigation purposes, while the other five will be used for dedicated monitoring purposes only. All nine wells are confirmed to be in suitable condition for collecting water quality samples. For the sites where well construction information is incomplete or currently unavailable, the Wheeler Ridge-Maricopa GSA has developed a plan to fill these data gaps in accordance with 23 CCR § 354.38 (see **Section 16.4** ***Assessment and Improvement of Monitoring Network***).

- **Quality and reliability of historical data –** Each of the nine Representative Monitoring Sites contains at least three water quality sampling records, and eight of nine contain at least one record since 2000, and four of nine contain at least one record in the last five years (i.e., since January 2014). Most sites have been monitored regularly for at least the past ten years as part of WRMWSD's routine water quality sampling program.
- **"Representativeness" to local groundwater conditions –** As described above, the nine sites are spread generally evenly across the Wheeler Ridge-Maricopa Management Area, including some wells in the areas of groundwater quality concern identified in **Section 8.5** ***Groundwater Quality***.
- **Long-term access –** For each of the nine Representative Monitoring Sites, a preliminary agreement has been reached with associated landowners/well owners allowing the Wheeler Ridge-Maricopa GSA long-term access to the site to conduct monitoring for SGMA compliance purposes. A copy of the long-term access agreement can be found in **Appendix L.**

All Representative Monitoring Sites will be sampled annually in accordance with the monitoring protocol described in **Section 16.2** ***Monitoring Protocols for Data Collection and Monitoring***. Representative Monitoring Sites will be sampled for the COCs identified in **Section 8.5** ***Groundwater Quality***, namely:

- Total Dissolved Solids
- Nitrate
- Arsenic
- Boron
- Iron
- Manganese
- Sulfate

In addition, Representative Monitoring Sites will be monitored for other relevant groundwater quality constituents[153] which may include constituents within some or all of the following categories:

- Descriptive parameters (temperature, pH, etc.)
- Major ions
- Heavy metals

[153] As identified in Stanford University's "A Guide to Water Quality Requirements under the Sustainable Groundwater Management Act" (Moran & Belin, 2019).

- Organic substances
- Pesticides
- Microbes

All Representative Monitoring Sites will be monitored annually in accordance with the monitoring protocol described in **Section 16.2** ***Monitoring Protocols for Data Collection and Monitoring***. All data will be reported to DWR per the requirements specified under **Section 16.5** ***Reporting Monitoring Data to the Department***.

*Tejon-Castac Management Area*

Due to the lack of development within the Tejon-Castac Management Area, a SGMA Monitoring Network for Degraded Water Quality is currently not in place, and as discussed in **Section 17.2.4 Additional Data-Gap Filling Efforts**, the TCWD GSA is evaluating options to add one or more additional wells to the SGMA Monitoring Network.

### 16.1.5. Monitoring Network for Land Subsidence

☑ 23 CCR § 354.34(c)(5)

*Arvin-Edison Management Area*

The SGMA Monitoring Network for Land Subsidence consists of five ground surface elevation survey locations distributed across the Arvin-Edison Management Area (spatial density of 3.03 sites / 100 mi$^2$.) for which land subsidence Sustainability Criteria have been defined (see **Section 14.5** ***Minimum Threshold for Land Subsidence*** and **Section 15.5** ***Measurable Objectives and Interim Milestones for Land Subsidence***). Specific details regarding each of the Representative Monitoring Sites are listed in ***Table MN-3***. The site locations and their spatial distribution are displayed *on* ***Figure MN-3***. These Representative Monitoring Sites are located at AEWSD's Management Area Critical Infrastructure facilities (see **Section 13.5** ***Undesirable Results for Land Subsidence***), including:

- AEWSD North Canal Balancing Reservoir
- AEWSD North Canal Spreading Works
- AEWSD Sycamore Spreading Works
- AEWSD Tejon Spreading Works
- AEWSD Spillway Basin

These sites were selected as the most representative locations for which to monitor ground surface elevations within the Arvin-Edison Management Area as they are each situated directly within or proximate to these Management Area Critical Infrastructure facilities. The Representative Monitoring Sites have been surveyed three times for ground surface elevations since 2012, including recent surveys completed in 2018 and 2019. AEWSD plans to complete surveys on an annual, or more frequent basis, basis.

All Representative Monitoring Sites will be monitored annually in accordance with the monitoring protocol described in **Section 16.2** ***Monitoring Protocols for Data Collection and Monitoring***. All data will be reported to DWR per the requirements specified under **Section 16.5** ***Reporting Monitoring Data to the Department***.

*Wheeler Ridge-Maricopa Management Area*

As described in **Section 14.5** ***Minimum Threshold for Land Subsidence****,* the California Aqueduct is considered Regional Critical Infrastructure in the definition of Undesirable Results from Land Subsidence in the Basin and the Wheeler Ridge-Maricopa Management Area. As such, the Wheeler Ridge-Maricopa GSA intends to utilize DWR's existing land subsidence monitoring program along the California Aqueduct for its local SGMA Monitoring Network for Land Subsidence (see **Appendix I**).

DWR maintains 40 ground surface elevation survey benchmark locations within the Wheeler Ridge-Maricopa Management Area, between Mileposts 256.56 (Check No. 31) and 278.13 (Teerink Pumping Plant) of the California Aqueduct. These benchmarks have been surveyed intermittently since 1967, including the most recent surveys completed in 2019.[154] The Wheeler Ridge-Maricopa GSA will coordinate with DWR to obtain access to future survey data collected between Pools 32 – 35 (i.e., Mileposts 256.56 – 278.13) from this regional monitoring program, and will use these publicly-available data to evaluate changes in ground surface elevation along the local reaches of the California Aqueduct within the Wheeler Ridge-Maricopa Management Area, and to assess Plan Implementation relative to the Sustainability Criteria for Land Subsidence defined under **Section 14.5** ***Minimum Threshold for Land Subsidence*** and **Section 15.5** ***Measurable Objectives and Interim Milestones for Land Subsidence*** of this GSP.

All Representative Monitoring Sites will be monitored annually in accordance with the monitoring protocol described in **Section 16.2** ***Monitoring Protocols for Data Collection and Monitoring***. All data will be reported to DWR per the requirements specified under **Section 16.5** ***Reporting Monitoring Data to the Department***.

*Tejon-Castac Management Area*

Due to the lack of observed subsidence and critical infrastructure within the Tejon-Castac Management Area, a SGMA Monitoring Network for Land Subsidence is currently not in place.

### 16.1.6. Monitoring Network for Depletions of Interconnected Surface Water

☑ **23 CCR § 354.34(c)(6)**
☑ **23 CCR § 354.34(j)**

As described in **Section 13.6** ***Undesirable Results for Depletions of Interconnected Surface Water***, as of 19 December 2018 no Basin-wide definition of Undesirable Results for Depletions of Interconnected Surface Water has been developed by the Kern Subbasin GSAs, and, based on available data and information, depletion of interconnected surface water has not been observed within the three SOKR GSP Management Areas. As such, per the stipulations defined under 23 CCR § 354.32(j), a SGMA Monitoring

[154] DWR survey information along the California Aqueduct through 2013 are presented in DWR (2017), several plates of which are included as **Appendix I**. Additional benchmark survey data provided by DWR on 22 July 2019 is also included in **Appendix I**.

Network has not been defined for the Depletion of Interconnected Surface Water Sustainability Indicator as it is demonstrated to not be applicable to the Basin.

## 16.2. Monitoring Protocols for Data Collection and Monitoring

☑ **23 CCR § 352.2**

Pursuant to 23 CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols developed by the Kern Subbasin GSAs and contained within the Coordination Agreement and Appendices thereto. Monitoring is needed to track changes in Basin conditions, Sustainability Indicators, and the effectiveness of GSP implementation to achieve groundwater sustainability. Data collection protocols for groundwater levels, groundwater quality, land subsidence, and surface water are detailed below and are designed for compatibility with the 23 CCR and DWR's "Best Management Practices (BMP) #1 for Groundwater Monitoring Protocols, Standards, and Sites" (DWR, 2016e).

The Basin's monitoring protocols are designed to ensure the following:

- Data are collected from the correct location with proper site identification;
- Data are accurate and reproducible;
- Data represent conditions in the Basin;
- All salient information is recorded to check and correct data; and
- Data are handled in a way that ensures data integrity.

### 16.2.1. Protocols for Groundwater Level Measurements

Groundwater level measurements will be collected, at a minimum, semiannually (Spring and Fall) to document seasonal fluctuations in groundwater levels. Specifically, Spring levels will be measured between January and March to represent the seasonal high prior to summer irrigation demands and Fall levels will be measured between August and November to represent the seasonal low after the increased summer irrigation demands. The groundwater level data will be the basis for the development of Basin-wide groundwater elevation maps. The following data collection protocols will be followed by the field technician:

- Measurements will be taken in wells that are not influenced by recent pumping. Measurements should be taken at least two hours, and preferably longer, after the well was last pumped. Multiple measurements can be collected from the well to verify that equilibrium has been reached.
- Depth to groundwater will be measured by an electronic sounder, chalked steel tape, or datalogging pressure transducer. As required by 23-CCR § 352.4(a)(3), depth to groundwater will be recorded to at least the nearest 0.1 foot and preferably to the nearest 0.01 foot. Other measurement methods such as airlines and acoustic sounders may not provide the required accuracy of 0.1 foot but may be used in instances by which sounding equipment cannot fit inside the well casing.
- Depth to groundwater will be measured from a specific, easily identifiable, and clearly marked Reference Point (RP) on the well casing. As required by 23-CCR § 352.4(a)(4), the reference point

elevation (RPE) will be surveyed relative to the North American Vertical Datum of 1988 (NAVD 88) to an accuracy of 0.5 foot and preferably to an accuracy of 0.1 foot or less.

- For measuring wells that are under pressure or artesian, allow a period of time for the water level to stabilize and take multiple measurements take multiple measurements to confirm the water level has reached equilibrium. For artesian wells, site-specific procedures will be developed to collect accurate water level data.

- Groundwater elevation will be calculated as:

$$GWE = RPE - DTW$$

where:

GWE = Groundwater Elevation;
RPE = Reference Point Elevation; and
DTW = Depth to Water

- Consistent units of feet, tenths of feet, and hundredths of feet will be used, and measurements will not be recorded in units of feet and inches.

- Record the site identifier, date, time (24-hour format), method of measurement, height of RPE above or below the ground surface, depth to water, groundwater elevation, and any factors that may influence the depth to water measurements such as weather, nearby irrigation or pumping, flooding, or well condition. If a measurement cannot be obtained, record the reason the measurement was not collected.

- Any well caps, plugs, or locks will be replaced and access points such as doors or gates returned to the condition found upon arrival at the site.

- The measurement devices will be decontaminated after measuring each well and routinely maintained and tested in accordance with manufacturer's instructions to ensure measurement accuracy.

Where and when deemed appropriate, data loggers may be implemented to record water levels more frequently (e.g., hourly, daily, weekly, and so forth). Groundwater levels may be recorded using pressure transducers equipped with data loggers installed in monitoring wells. The following general protocols must be followed when installing a pressure transducer in a monitoring well or for recording stream stage:

- Utilize protocols above to determine the water levels in the monitoring well and properly program and reference the installation.

- Record the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.

- Employ transducers able to record groundwater levels with an accuracy of at least 0.1 foot, and confirm the instrument has sufficient battery life, and data storage capacity, and can accommodate a range of groundwater level fluctuations and natural pressure drift.

- If employing non-vented units, consistent logging of barometric pressures that coincide with the water level measurement intervals is required.

- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that data quality objectives are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Monitor against potential future cable slippage by marking cable at the same elevation of the RP.
- The transducer data will periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This will happen during routine site visits, at least annually, or as necessary to maintain data integrity.

The data will be downloaded as necessary to ensure no data is lost, undergo Quality Assurance/Quality Control (QA/QC) checks, and be entered into the Basin's Data Management System (DMS). Data collected with non-vented data logger cables will be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data will be deleted from the data logger to ensure adequate memory storage remains

### 16.2.2. Protocols for Water Quality Sampling

Water quality samples will be collected annually. General steps for water quality sampling include depth to groundwater measurement prior to purging, multi-meter calibration, installation of sampling pump (if required), purging of the well casing, water quality sample collection in lab-specified bottles, and following standard chain-of-custody guidelines for sample preservation and transport. All analyses will be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program. The following data collection protocols will be followed by the field technician in addition to protocols identified in the United States Geological Survey (USGS) National Manual for the Collection of Water-Quality Data:

- Record the site identifier, date, time, condition of the well, depth to groundwater measurement, meter calibration information,[155] purge volumes, meter readings during purging, and water quality samples that were collected and preservation methods used.
- Production wells will be sampled while the well pump is running, with well-water collected from a spigot near the wellhead. Samples will not be collected from storage tanks, at a long distance from the wellhead, or after any water treatment. Sample ports and sampling equipment must be cleaned prior to sample collection.
- Monitoring wells without a permanent pump installation will be purged and sampled using a submersible pump or bailer. Submersible pump, tubing, and sampling equipment will be cleaned and decontaminated between sample sites.
- If possible, a minimum of three casing volumes will be purged from the well prior to sample collection. For larger wells and wells with permanent pump installations, purging of three casing volumes may not be necessary or practical depending on the well's operational history and operational constraints. If a well is pumped dry, the well will be allowed to recover within 90% of original water level prior to sampling. Professional judgment will be used to determine well

[155] Ideally, a multi-meter shall be used to collect field parameters prior to sample collection. As applicable, multi-meter probes shall be calibrated per manufacturer specifications using standards closest to that of the anticipated well-water.

purging required to achieve a representative sample from the well.

- If applicable, field parameters (e.g., pH, specific conductance, temperature, and dissolved oxygen) will be monitored using a multi-meter and flow cell during purging. Field parameters will be allowed to stabilize during purging so that variation of each parameter is within appropriate pre-defined limits for three casing volumes. In cases where purging of three casing volumes is not practical, field parameters will be stable for three successive measurements collected at least three minutes apart. All field instruments will be calibrated daily and evaluated for drift throughout the day.

- Prior to collection, new sample bottles appropriate to each analysis will be obtained from the analytical lab contracted for chemical analysis. Each sample bottle will be clearly labeled after sampling with the site identifier, sample personnel, date, time of sample collection, preservative used, and required analysis. Samples will be collected according to appropriate standards such as those listed in the Standard Methods for the Examination of Water and Wastewater, the USGS *National Field Manual for the Collection of Water-Quality Data* (USGS, variously dated) or other appropriate guidance. The specific sample collection procedure will reflect the type of analysis to be performed. Samples will be collected under laminar flow conditions which may require reducing the flow rate prior to sample collection. Samples will be filtered as recommended for the specific analytes.

- After collection, all sample bottles will immediately be preserved as required, dried, sealed in zip-closure polyethylene bags, and placed on ice in an insulated cooler for temporary storage and transport to the analytical lab. All samples will be delivered to the laboratory following standard chain-of-custody control guidelines within their prescribed holding times.

- Field duplicates and field blank samples will be collected and analyzed for QA/QC purposes. Duplicate samples will be collected, processed, and analyzed in the field using the same methodology as the primary sample, with an assigned dummy site identifier. Field blanks will be collected for quality assurance purposes. Field blanks will be collected using deionized water, processed in the field, and then submitted to the laboratory with a dummy site identifier.

### 16.2.3. Protocols for Land Subsidence Measurements

Basin-wide land subsidence monitoring protocols are currently in development, and will be adhered to in accordance with the Coordination Agreement. Pursuant to DWR's BMP#1 (DWR, 2016e), evaluating and monitoring land subsidence can utilize multiple data sources and numerous techniques to evaluate the specific conditions and associated causes. The following guidelines will be followed:

- The use of existing subsidence monitoring sites will be incorporated to the greatest extent possible. Publicly available data will be downloaded and stored in the Basin's DMS following QA/QC.

- Leveling and GPS surveys conducted by the GSA will follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual (Caltrans, variously dated).

- Measurements will be in the same vertical datum, preferably NAVD88.

#### 16.2.4. Protocols for Data Management and Reporting

Records of all data collected will be maintained in the Basin DMS. Prior to importation, standard QA/QC checks will be undertaken to help ensure the validity and accuracy of data.

- Depth to groundwater measurements will be converted to groundwater elevation by subtracting the depth to groundwater from the reference point elevation following the protocols for groundwater level measurements described above.
- Groundwater elevation will be plotted on individual well hydrographs. Groundwater elevations which vary significantly from previous measurements will be evaluated to determine if the measurement is questionable due to a substantial change relative to historical conditions. If determined that the measurement is anomalous, the measurement will be flagged as questionable in the Basin DMS.
- Laboratory reports will be checked to ensure all samples were analyzed within the prescribed holding times.
- Laboratory reports will be checked to ensure all laboratory blank analyses were determined acceptable by the laboratory.
- Constituent detections in the field blank will be tabulated and compared to their respective practical quantitation limit.
- Field duplicate results will be compared to the primary sample results. Ideally, concentrations will agree within 10% or have differences within their respective practical quantitation limit. If concentrations from duplicate samples vary by more than 25%, the GSA may ask the laboratory to reanalyze the constituent to confirm the result is reasonable.
- Major cations and anions represent a positive and negative charge respectively, and therefore the sum of cations will equal the sum of anions in neutral groundwater. An anion-cation charge balance will be calculated for each sample collected using concentrations of the major anions and cations in milliequivalents per liter (meq/L), with the difference between the two sums reported as a percentage where:

  $$\frac{Anions - Cations}{Anions + Cations} * 100$$

  In general, an up to 5% difference is acceptable. Deviations can be greater if other constituents in the groundwater are not accounted for within the major anions and cations categories. If the anion/cation charge balance difference exceeds 15%, the GSA may ask the laboratory to reanalyze certain constituents or the entire sample to confirm the result is accurate.
- Concentrations will be plotted on individual well chemographs to monitor trends and ensure concentrations are reasonable.

After QA/QC, all data collected will be imported into the Basin DMS. Data for the RMSs will also be integrated into Annual Reports, as required by DWR, and will be uploaded to the SGMA data portal. Per the 23 CCR § 352.4, the following reporting standards apply to all categories of information, unless otherwise indicated:

- Water volumes will be reported in acre-feet (AF).
- Surface water flow will be reported in cubic feet per second (cfs) and groundwater flow will be reported in acre-feet per year (AFY).
- Field measurements of elevations of groundwater, surface water, and land surface will be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Reference point elevations will be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Geographic locations will be reported in GPS coordinates by latitude and longitude in decimal degree to seven decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

## 16.3. Representative Monitoring

☑ **23 CCR § 354.36**

*Arvin-Edison Management Area*

As described in **Section 16.1** ***Description of Monitoring Network***, the Arvin GSA has defined a SGMA Monitoring Network for each relevant Sustainability Indicator that will be used for SGMA reporting purposes to evaluate Plan implementation with respect to meeting the Sustainability Goal defined for the Basin through compliance with the Minimum Thresholds and Measurable Objectives described in the SOKR GSP. The rationale for selecting Representative Monitoring Sites is described for each Sustainability Indicator in **Sections 16.1.1** through **16.1.6**.

As described in **Section 16.1.2** ***Monitoring Network for Reduction of Groundwater Storage***, the SGMA Monitoring Network for Chronic Lowering of Groundwater Levels will be used as a proxy to monitor Reduction in Groundwater Storage. As described in **Section 14.2** ***Minimum Threshold for Reduction of Groundwater Storage***, groundwater levels are considered sufficiently protective of Reduction in Groundwater Storage, and thus no unique Sustainability Criteria have been defined for this Sustainability Indicator. There are no other Sustainability Indicators for which groundwater levels will be used as a proxy for representative monitoring.

*Wheeler Ridge-Maricopa Management Area*

As described in **Section 16.1** ***Description of Monitoring Network***, the Wheeler Ridge-Maricopa GSA has defined a SGMA Monitoring Network for each relevant Sustainability Indicator that will be used for SGMA reporting purposes to evaluate Plan implementation with respect to meeting the Sustainability Goal defined for the Basin through compliance with the Minimum Thresholds and Measurable Objectives described in the SOKR GSP. The rationale for selecting Representative Monitoring Sites is described for each Sustainability Indicator in **Sections 16.1.1** through **16.1.6**.

As described in **Section 16.1.2** ***Monitoring Network for Reduction of Groundwater Storage***, the SGMA Monitoring Network for Chronic Lowering of Groundwater Levels will be used as a proxy to monitor Reduction in Groundwater Storage. As described in **14.2** ***Minimum Threshold for Reduction of***

***Groundwater Storage***, groundwater levels are considered sufficiently protective of Reduction in Groundwater Storage, and thus no unique Sustainability Criteria have been defined for this Sustainability Indicator. There are no other Sustainability Indicators for which groundwater levels will be used as a proxy for representative monitoring.

*Tejon-Castac Management Area*

As described in **Section 16.1 *Description of Monitoring Network***, the TCWD GSA has defined a SGMA Monitoring Network for each relevant Sustainability Indicator that will be used for SGMA reporting purposes to evaluate Plan implementation with respect to meeting the Sustainability Goal defined for the Basin through compliance with the Minimum Thresholds and Measurable Objectives described in the SOKR GSP. The rationale for selecting Representative Monitoring Sites is described for each Sustainability Indicator in **Sections 16.1.1** through **16.1.6**.

As described in **14.2 *Minimum Threshold for Reduction of Groundwater Storage***, groundwater levels are considered sufficiently protective of Reduction in Groundwater Storage, and thus no unique Sustainability Criteria have been defined for this Sustainability Indicator. There are no other Sustainability Indicators for which groundwater levels will be used as a proxy for representative monitoring.

## 16.4. Assessment and Improvement of Monitoring Network

☑ **23 CCR § 354.38**

*Arvin-Edison Management Area*

As described above and in the Basin-wide Monitoring Protocols, the SGMA Monitoring Network in the Arvin-Edison Management Area will be reevaluated in each five-year GSP update, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the Sustainability Goal for the Basin.

In all cases, the SGMA Monitoring Network developed for each Sustainability Indicator includes a sufficient density and spatial distribution of monitoring sites to meet the monitoring objectives outlined in **Section 16.1 *Description of Monitoring Network***. In most cases, the existing Representative Monitoring Sites selected for each Sustainability Indicator conform to the best management practices for monitoring networks outlined in DWR's *Monitoring Networks and Identification of Data Gaps* BMP (DWR, 2016d). As identified in **Sections 16.1.1** through **16.1.6**, there are a few notable exceptions:

Regarding the Monitoring Network for Chronic Lowering of Groundwater Levels:

- Nine of the 16 sites are missing well depth information (wells 12N20W36G001S, 29S29E33N001M, 30S29E11N001M, 30S29E29A001M, 30S30E19E001M, 31S29E05E001M, 31S30E30J001M, 32S29E20H001M, and 32S29E31N001M);
- Ten of the 16 sites are missing perforation interval information (wells 12N20W36G001S, 29S29E33N001M, 30S29E11N001M, 30S29E29A001M, 30S30E19E001M, 31S29E05E001M, 31S30E30J001M, 32S29E20H001M, 32S29E31N001M, and 31S29E34A001M); and

- Seven of the 16 wells are presumed to still be active and in use for irrigation or municipal and industrial purposes (wells 30S29E29A001M, 31S29E12M001M, 31S29E34A001M, 31S30E17K001M, 31S30E30J001M, 32S29E31N001M, and ACSD Well #14).

Regarding the Monitoring Network for Degraded Water Quality:

- Five of the seven sites are missing well depth information (wells 32S29E04R001M, 32S28E33R002M, 31S29E25J001M, and 31S29E10K001M);
- Six of the seven sites are missing perforation interval information (wells 32S29E04R001M, 32S28E33R002M, 31S29E25J001M, 31S29E10K001M, and 32S28E22R001M); and
- All seven wells are presumed to still be active and in use for irrigation or municipal and industrial purposes.

For the Representative Monitoring Sites currently missing well information and well screen information, the Arvin GSA has proposed a plan to fill these data gaps by conducting video-logging on the identified wells (see **Section 18.1 *Plan Implementation Activities***). In the event these data gaps cannot be readily filled, the Arvin GSA will identify alternative sites or develop plans to construct new Representative Monitoring Sites for Chronic Lowering of Groundwater Levels as deemed necessary by the Arvin GSA.

For the Representative Monitoring Sites still under active use, the Arvin GSA will work to convert these sites to dedicated monitoring sites or will otherwise identify or develop alternative sites by the SOKR GSP implementation deadline (i.e., by January 2040).

*Wheeler Ridge-Maricopa Management Area*

As described above and in the Basin-wide Monitoring Protocols, the SGMA Monitoring Network in the Wheeler Ridge-Maricopa Management Area will be reevaluated in each five-year GSP update, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the Sustainability Goal for the Basin.

In all cases, the SGMA Monitoring Network developed for each Sustainability Indicator includes a sufficient density and spatial distribution of monitoring sites to meet the monitoring objectives outlined in **Section 16.1 *Description of Monitoring Network***. In most cases, the existing Representative Monitoring Sites selected for each Sustainability Indicator conform to the best management practices for monitoring networks outlined in DWR's BMP 2 – *Monitoring Networks and Identification of Data Gaps.* As identified in **Sections 16.1.1** through **16.1.6***,* there are a few notable exceptions:

Regarding the Monitoring Network for Chronic Lowering of Groundwater Levels:

- Five of the 14 sites are missing well depth information (wells 32S26E24K001M, 11N22W01D001S, 11N22W06H001S, 12N21W35G001S, and 32S28E16P001M));
- Three of the 14 sites are missing perforation interval information (wells 32S26E24K001M, 12N21W35G001S, and 11N22W06H001S); and
- Four of the 14 wells are presumed to still be active and in use for irrigation or production purposes (wells 11N21W16E001S, 32S27E35R001M, 32S26E34P001M, and 32S25E29Q001M).

Regarding the Monitoring Network for Degraded Water Quality:

- Six of the nine sites are missing well depth information (wells 32S28E16P001M, 32S26E17H001M, 11N21W12N002S, 11N22W09A001S, 12N21W31P001S, and 32S26E14J001M);
- Four of the nine sites are missing perforation interval information (wells 11N21W12N002S, 11N22W09A001S, 12N21W31P001S, and 32S26E14J001M); and
- Four of the nine wells are presumed to still be active and in use for irrigation or municipal and industrial purposes (wells 32S25E29Q001M, 11N21W12N002S, 12N21W31P001S, and 32S26E14J001M).

For the Representative Monitoring Sites currently missing well information and well screen information, the Wheeler Ridge-Maricopa GSA has developed a plan to fill these data gaps by conducting video-logging on the identified wells (see **Section 18**

***Plan Implementation***

☑ **23 CCR § 351(y)**

). In the event these data gaps cannot be readily filled, the Wheeler Ridge-Maricopa GSA will identify alternative sites or develop plans to construct new Representative Monitoring Sites for Chronic Lowering of Groundwater Levels and Degraded Water Quality as deemed necessary by the Wheeler Ridge-Maricopa GSA.

For the Representative Monitoring Sites still under active use, the Wheeler Ridge-Maricopa GSA will work to convert these sites to dedicated monitoring sites or will otherwise identify or develop alternative sites by the SOKR GSP implementation deadline (i.e., by January 2040).

*<u>Tejon-Castac Management Area</u>*

As described above, the monitoring network in the Tejon-Castac Management Area will be evaluated at least every five years, in relation the circumstances described in 23 CCR § 354.38(e), and will be adjusted, as necessary, by the TCWD GSA in coordination with the other SOKR GSAs.

Because of the lack of development within the Tejon-Castac Management Area and the conservation framework imposed upon the lands by the Tejon Ranch Conservation and Land Use (C&LU) Agreement, it is appropriate for the Tejon-Castac Management Area monitoring network to consist of just one well (i.e., the only well in the Tejon-Castac Management Area that is pumped in non-de minimis amounts). Therefore, no data gaps exist with respect to Monitoring Network coverage. However, vertical and horizontal survey data for the well will need to be collected for the well to comply with SGMA standards.

That being said, the existing monitoring infrastructure is not sufficient to determine hydraulic gradients and other requirements of 23 CCR § 354.34. Therefore, should it become necessary in the future, SOKR GSP implementation may include efforts by the TCWD GSA to improve the monitoring infrastructure in order to refine the understanding of groundwater conditions within the Tejon-Castac Management Area, particularly with respect to areas where there has not been any historical monitoring and the nature and occurrence of Groundwater Dependent Ecosystems (GDEs).

## 16.5. Reporting Monitoring Data to the Department

☑ **23 CCR § 354.40**

Data collected from the SGMA Monitoring Network will be uploaded to the Basin DMS and reported to the DWR in accordance with the Monitoring Protocols developed for the Basin as described in **Section 16.2** ***Monitoring Protocols for Data Collection and Monitoring*** . Additional data collected as part of AEWSD's, WRMWSD's, and TCWD's other regular monitoring programs (see **Section 5.2.1** ***Existing Monitoring and Management Programs***) may be used in conjunction with data collected from the SGMA Monitoring Network to meet compliance with GSP Emergency Regulations regarding Annual Reporting (23 CCR § 356.2) or as otherwise deemed necessary by the SOKR GSAs.

**TABLE MN-3**
**Summary of Representative Monitoring Sites**
Arvin-Edison Management Area

| Monitoring Site ID | Representative Monitoring Well (RMW) ID | Monitoring Site Type | Type of Measurement Taken | Frequency of Measurement | Sustainability Indicator(s) *(1,2)* | | | | | | CASGEM Details | | | Monitoring Site Location | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Groundwater Level | Groundwater Storage | Seawater Intrusion | Groundwater Quality | Land Subsidence | Interconnected Surface Water | Station ID | Well ID | CASGEM Well Type | Latitude (° NAD83) | Longitude (° NAD83) | APN | Landowner / Well Owner | Contact # | Description of Site Location | GeoJot+ ID | Long-term Access Agreement in Place? |
| 11N20W05J001S | RMW-016 | Well | Groundwater Level | Semiannually | x | x | | | | | 350669N1190295W001 | 11446 | Voluntary | 35.06617 | -119.02941 | 238-211-48 | FOSTER TYLER FAMILY TRUST | Colby Fry 661-619-5592 | NE CORNER OF SE 1/4 | 6524 | Executed Agreement |
| 12N20W36G001S | RMW-015 | Well | Groundwater Level | Semiannually | x | x | | | | | 350833N1189632W001 | 15226 | Voluntary | 35.08341 | -118.96255 | 445-080-28 | VIGNOLO FARM T 1 LLC | Office 661-746-2148 | SW CORNER OF NE 1/4 | 6497 | Executed Agreement |
| 29S29E33N001M | RMW-001 | Well | Groundwater Level | Semiannually | x | x | | | | | 353577N1188771W001 | 23853 | Voluntary | 35.35626 | -118.87488 | 388-290-11 388-290-10 | LEHR RONALD R -or- LEHR FAMILY LIMITED PTN | Shae Lehr 661-204-8085 | SW CORNER OF SW 1/4 | N/A | Executed Agreement |
| 30S29E11N001M | RMW-002 | Well | Groundwater Level | Semiannually | x | x | | | | | 353269N1188418W001 | 36361 | Voluntary | 35.32573 | -118.84235 | 177-220-27 | STULL FAMILY TRUST | Matt Fisher 661-792-3715 | SW CORNER OF SW 1/4 | N/A | Executed Agreement |
| 30S30E19E001M | RMW-003 | Well | Groundwater Level | Semiannually | x | x | | | | | 353072N1188037W001 | 22486 | Voluntary | 35.30730 | -118.80349 | 179-062-30 | DJGJ FAMILY LP | Denis Johnston 661-979-1214 | SW CORNER OF NW 1/4 | N/A | Executed Agreement |
| 31S29E05E001M | RMW-005 | Well | Groundwater Level | Semiannually | x | x | | | | | 352605N1188932W001 | 36729 | Voluntary | 35.26088 | -118.89198 | 189-030-32 | CARREON VINEYARDS INC | Rene Carreon 661-343-0464 | SW CORNER OF NW 1/4 | 6298 | Executed Agreement |
| 31S29E12M001M | RMW-006 | Well | Groundwater Level | Semiannually | x | x | | | | | 352452N1188243W001 | 23691 | Voluntary | 35.24530 | -118.82316 | 189-060-33 189-060-23 | C A K FARMS INC | Brian Kirschenmann 661-747-7901 | NW CORNER OF SW 1/4 | 6129 | Executed Agreement |
| 31S29E34A001M | RMW-008 | Well | Groundwater Level | Semiannually | x | x | | | | | 351944N1188423W001 | 36401 | Voluntary | 35.19423 | -118.84251 | 189-340-51 | KOONER GURMIT S & BALJEET | Nazar Kooner 661-303-1313 | NE CORNER OF NE 1/4 | 6522 | Executed Agreement |
| 31S30E17K001M | RMW-007 | Well | Groundwater Level | Semiannually | x | x | | | | | 352311N1187790W001 | 23916 | Voluntary | 35.23089 | -118.77915 | 503-041-20 | MOORE JOHN & KRISTIN FAMILY TR | John Moore 661-332-6097 | NW CORNER OF SE 1/4 | 6218 | Executed Agreement |
| 31S30E30J001M | RMW-009 | Well | Groundwater Level | Semiannually | x | x | | | | | 352017N1187987W001 | 36913 | Voluntary | 35.20188 | -118.79020 | 503-060-02 | ANTHONY VINEYARDS INC | John Kovacevich 661-304-5483 | NE CORNER OF SE 1/4 | 6606 | Executed Agreement |
| 32S28E23H001M | RMW-013 | Well | Groundwater Level | Semiannually | x | x | | | | | 351300N1189357W001 | 36491 | Voluntary | 35.13015 | -118.93255 | 445-042-41 | ANTHONY VINEYARDS INC | John Kovacevich 661-304-5483 | SE CORNER OF NE 1/4 | 6063 | Executed Agreement |
| 32S29E12P001M | RMW-011 | Well | Groundwater Level | Semiannually | x | x | | | | | 351522N1188199W001 | 22592 | Voluntary | 35.15131 | -118.81840 | 446-010-51 | PANDOL MATT JR & LINDA FAMILY | Matt Pandol 661-747-5218 | 80' N/O Comanche Point Rd. & 2,000' E/O Tejon Hwy | 6070 | Executed Agreement |
| 32S29E20H001M | RMW-012 | Well | Groundwater Level | Semiannually | x | x | | | | | 351300N1188781W001 | 23007 | Voluntary | 35.12984 | -118.87796 | 446-042-20 | GRIMMWAY ENTERPRISES INC | Carl Voss 661-477-9405 | SE CORNER OF NE 1/4 | N/A | Executed Agreement |
| 32S29E31N001M | RMW-014 | Well | Groundwater Level | Semiannually | x | x | | | | | 350931N1189123W001 | 23019 | Voluntary | 35.09337 | -118.91189 | 446-062-07 | WEST COAST FOREST & CINDER | Office 661-858-2081 | SW CORNER OF SW 1/4 | 6358 | Executed Agreement |
| ACSD Well #14 | RMW-010 | Well | Groundwater Level & Groundwater Quality | Semiannually | x | x | | x | | | - | - | - | 35.19419 | -118.84839 | 189-340-52 | ARVIN COMMUNITY SERVICES DISTRICT | Raul Barraza 661-854-2127 | 2000' W/O Commanche Dr. & 60' S/O Sycamore Rd. | N/A | Owner (ACSD) |
| 30S29E29A001M | RMW-004 | Well | Groundwater Level & Groundwater Quality | Semiannually | x | x | | x | | | 352958N1188807W001 | 22463 | Voluntary | 35.29607 | -118.87971 | 178-220-04 | SUNRIDGE VINEYARDS LP | Tom Bracken 661-363-8463 | NE CORNER OF NE 1/4 | 6457, 6652, 6758 | Executed Agreement |
| 32S29E04R001M | RMW-220 | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.16570 | -118.86008 | 446-023-16 | ASHLEY LANE L P | Henry "Skip" Foppiano 209-401-7481 | SE CORNER OF SE 1/4 | 6430 | Verbal Agreement |
| 32S28E33R002M | RMW-221 | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.09635 | -118.96795 | 445-062-28 | BAG KATU LLC | Charles Fanucchi 661-858-2264 | SE CORNER OF SE 1/4 | 6498, 6644, 6724 | Verbal Agreement |
| 32S28E22R001M | RMW-222 | Well | Groundwater Quality | Annually | | | | x | | | 351225N1189520W001 | 21946 | Voluntary | 35.12235 | -118.95017 | 445-042-33 | GEORGE NOROIAN FAMILY FARMS LLC | Carl Voss 661-477-9405 | SE CORNER OF SE 1/4 | 6552 | Verbal Agreement |
| 31S29E25J001M | RMW-223 | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.20169 | -118.80719 | 193-120-04 | HRONIS LAND CO | Pete Hronis 661-725-2503 | NE CORNER OF SE 1/4 | 6289, 6702, 6714 | Verbal Agreement |
| 31S29E10K001M | RMW-224 | Well | Groundwater Quality | Annually | | | | x | | | 352453N1188473W001 | 36735 | Voluntary | 35.24526 | -118.84718 | 189-050-65 | WAY GIN LP | Wayne Kirschenman 661-201-6202 | NE CORNER OF NW 1/4 OF SE 1/4 | 6287 | Verbal Agreement |
| 30S30E18G001M | RMW-225 | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.31925 | -118.79823 | 179-070-07 | KEPLER KAREN J FAMILY TRUST | Kevin Johnston 661-979-4476 | SW 1/4 OF SW 1/4 OF NE 1/4 | 6076, 6700 | Verbal Agreement |
| ACSD Well #16 | | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.18031 | -118.83809 | 189-351-71 | ARVIN COMMUNITY SERVICES DISTRICT | Raul Barraza 661-854-2127 | | N/A | Owner (ACSD) |
| ACSD Well #17 | | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.17308 | -118.83764 | 446-010-58 | ARVIN COMMUNITY SERVICES DISTRICT | Raul Barraza 661-854-2127 | | N/A | Owner (ACSD) |
| 3-CP-1 | | Survey Location | Ground Surface Elevation | Annually | | | | | x | | - | - | - | 35.32597 | -118.87666 | 177-210-33 | ARVIN_EDISON WATER STORAGE DISTRICT | AEWSD Office 661-854-5573 | North Canal Balancing Reservoir | N/A | Owner (AEWSD) |
| 15-N CANAL PP CORNERS | | Survey Location | Ground Surface Elevation | Annually | | | | | x | | - | - | - | 35.24429 | -118.82605 | 189-400-16 | ARVIN_EDISON WATER STORAGE DISTRICT | AEWSD Office 661-854-5573 | North Canal Spreading Works | N/A | Owner (AEWSD) |
| 30C-WELL 11 | | Survey Location | Ground Surface Elevation | Annually | | | | | x | | - | - | - | 35.20906 | -118.78362 | 503-060-10 | ARVIN_EDISON WATER STORAGE DISTRICT | AEWSD Office 661-854-5573 | Sycamore Spreading Works | N/A | Owner (AEWSD) |
| 39-TEJON CREEK SIPHON | | Survey Location | Ground Surface Elevation | Annually | | | | | x | | - | - | - | 35.13378 | -118.85615 | 446-031-20 | ARVIN_EDISON WATER STORAGE DISTRICT | AEWSD Office 661-854-5573 | Tejon Spreading Works | N/A | Owner (AEWSD) |
| 48-TOP 883 CS | | Survey Location | Ground Surface Elevation | Annually | | | | | x | | - | - | - | 35.07966 | -118.96813 | 445-080-38 | ARVIN_EDISON WATER STORAGE DISTRICT | AEWSD Office 661-854-5573 | Spillway Basin | N/A | Owner (AEWSD) |

**TABLE MN-3**
**Summary of Representative Monitoring Sites**
Arvin-Edison Management Area

| Monitoring Site ID | Reference Point | | | Pump Type | Well Type | Well Status | Well Completion Type | Well Construction Details | | | | | | | | | DWR Well Completion Report No. *(3)* | Principal Aquifer(s) Monitored *(4)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ground Surface Elevation (ft amsl) | Reference Point Elevation (ft amsl) | Reference Point Description | | | | | Year Drilled | Total Completed Depth (ft bgs) | Borehole Depth (ft bgs) | Top of Perforations Depth (ft bgs) | Bottom of Perforations Depth (ft bgs) | Casing Diameter (in) | Nameplate - Horsepower | Well Capacity (gpm) | Well Discharge (in) | | |
| 11N20W05J001S | 394.24 | 395.24 | UNKNOWN | DIESEL - NO DRIVER - AG | CONVERTED MONITOR | INACTIVE | Single | | 1009.14 | 1025 | 432.03 | 1009.14 | | 300 | | 10 | | Principal Aquifer (KRF) |
| 12N20W36G001S | 477.40 | 477.40 | UNKNOWN | CAP | CONVERTED MONITOR | INACTIVE | Single | | | | | | | N/A | | N/A | | Principal Aquifer (KRF) |
| 29S29E33N001M | 571.38 | 573.38 | TOP OF CASING | CAP | CONVERTED MONITOR | INACTIVE | Single | | | | | | 8 | N/A | | N/A | | Principal Aquifer (KRF) |
| 30S29E11N001M | 636.63 | 636.63 | UNKNOWN | ELECTRIC - AG | CONVERTED MONITOR | INACTIVE | Single | 1950 | | | | | | N/A | | 8 | 40521783_redacted | Principal Aquifer (KRF) |
| 30S30E19E001M | 759.24 | 760.04 | TOP OF CASING | CONVERTED MONITOR | CONVERTED MONITOR | INACTIVE | Single | | | | | | 10 | N/A | | N/A | | Principal Aquifer (KRF) |
| 31S29E05E001M | 429.75 | 430.40 | TOP OF SOUNDING TUBE | CAP | CONVERTED MONITOR | INACTIVE | Single | | | | | | | N/A | | N/A | | Principal Aquifer (KRF) |
| 31S29E12M001M | 515.11 | 516.31 | UNKNOWN | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | 1952 | 982 | 982 | 380 | 982 | | 250 | | 12 | 40520710_redacted | Principal Aquifer (KRF) |
| 31S29E34A001M | 412.38 | 412.68 | UNKNOWN | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | | 800 | 800 | | | | 200 | | 10 | 40520810-40520811_redacted | Principal Aquifer (KRF) |
| 31S30E17K001M | 497.13 | 497.23 | UNKNOWN | SUBMERISBLE - AG | IRRIGATION | ACTIVE | Single | 1952 | 786 | 786 | 403 | 786 | | N/A | | 3 | 40520860_redacted | Principal Aquifer (KRF) |
| 31S30E30J001M | 460.03 | 460.13 | TOP OF SOUNDING TUBE | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | | | | | | | N/A | | 10 | | Principal Aquifer (KRF) |
| 32S28E23H001M | 370.53 | 370.53 | TOP OF CASING | CONVERTED MONITOR | CONVERTED MONITOR | INACTIVE | Single | 1945 | 806 | 806 | 260 | 806 | | N/A | | N/A | 40520357_redacted | Principal Aquifer (KRF) |
| 32S29E12P001M | 470.03 | 471.93 | TOP OF SOUNDING TUBE | NO DRIVER | CONVERTED MONITOR | INACTIVE | Single | 1989 | 520 | 520 | 420 | 520 | 8-5/8 | N/A | | N/A | No. 286911 | Principal Aquifer (KRF) |
| 32S29E20H001M | 436.55 | 437.55 | TOP OF SOUNDING TUBE | CONVERTED MONITOR | CONVERTED MONITOR | INACTIVE | Single | | | | | | | N/A | | N/A | | Principal Aquifer (KRF) |
| 32S29E31N001M | 462.47 | 462.77 | TOP OF CASING | SUBMERISBLE - DOM | IRRIGATION | ACTIVE | Single | | | | | | 14 | N/A | | 4 | | Principal Aquifer (KRF) |
| ACSD Well #14 | 402.00 | 402.00 | UNKNOWN | ELECTRIC - M&I | MUNICIPAL / INDUSTRIAL | ACTIVE | Single | 2015 | 920 | 950 | 600 | 900 | 16-5/16 | | 1000 | | No. e0295346 | Principal Aquifer (KRF) |
| 30S29E29A001M | 450.47 | 451.07 | TOP OF SOUNDING TUBE | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | 1946 | | | | | | 300 | | 10 | 40521867_redacted | Principal Aquifer (KRF) |
| 32S29E04R001M | 403.00 | 403.30 | TOP OF SOUNDING TUBE | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | | | | | | | | | | | Principal Aquifer (KRF) |
| 32S28E33R002M | 427.46 | 428.56 | TOP OF SOUNDING TUBE | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | | | | | | | | | | | Principal Aquifer (KRF) |
| 32S28E22R001M | 365.23 | 366.03 | TOP OF SOUNDING TUBE | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | | | 1000 | | | | | | | | Principal Aquifer (KRF) |
| 31S29E25J001M | 435.17 | 436.07 | TOP OF SOUNDING TUBE | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | | | | | | | | | | | Principal Aquifer (KRF) |
| 31S29E10K001M | 486.20 | 487.10 | UNKNOWN | DIESEL - AG | IRRIGATION | ACTIVE | Single | | | | | | | | | | | Principal Aquifer (KRF) |
| 30S30E18G001M | 811.09 | 811.39 | UNKNOWN | ELECTRIC - AG | IRRIGATION | ACTIVE | Single | | 318 | 350 | 240 | 318 | | | | | | Principal Aquifer (KRF) |
| ACSD Well #16 | | | | | MUNICIPAL / INDUSTRIAL | ACTIVE | Single | 2019 | 910 | 930 | 620 | 900 | 16-5/8 | | 1000 | | | Principal Aquifer (KRF) |
| ACSD Well #17 | | | | | MUNICIPAL / INDUSTRIAL | ACTIVE | Single | 2019 | 935 | 955 | 710 | 925 | 16-5/8 | | 2000 | | | Principal Aquifer (KRF) |
| 3-CP-1 | 518.80 | 518.80 | 2" Benchmark on Water Outlet Structure | | | | | | | | | | | | | | | |
| 15-N CANAL PP CORNERS | 511.37 | 511.37 | Pumping Plant -Top of Structure NW Corner | | | | | | | | | | | | | | | |
| 30C-WELL 11 | 482.38 | 482.38 | Well 11 Pad | | | | | | | | | | | | | | | |
| 39-TEJON CREEK SIPHON | 493.65 | 493.65 | Tejon Crk Siphon East Upstream Top Liner | | | | | | | | | | | | | | | |
| 48-TOP 883 CS | 486.88 | 486.88 | 883 Check Structure Top of Structure | | | | | | | | | | | | | | | |

**Abbreviations**
ACSD = Arvin Community Services Agreement
AEWSD = Arvin Edison Water Storage District
amsl = above mean sea level
bgs = below ground surface
CASGEM = California Statewide Groundwater Elevation Monirtoring
DWR = California Department of Water Resources
ft = feet
gpm = gallons per minute
in = inches
KRF = Kern River Formation
N/A = not applicable
NAD = North American Datum

**Notes**
(1) Seawater intrusion is not considered to be a sustainability indicator of concern to the Arvin-Edison Management Area and is thus not monitored for SGMA compliance.
(2) Depletion of Interconnected Surface Water is not considered to be a sustainability indicator of concern to the Arvin-Edison Management Area and is thus not monitored for SGMA compliance.
(3) The filename of the well log is given in cases where such a log is available but does not contain a DWR Well Completion Report number.
(4) Only one Principal Aquifer is defined for the Arvin-Edison Management Area - the "Kern River Formation Principal Aquifer".

**TABLE MN-4**
**Summary of Representative Monitoring Sites**
Wheeler Ridge-Maricopa Management Area

| | | | | | Sustainability Indicator(s) *(1,2)* | | | | | | CASGEM Details | | | Monitoring Site Location | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Monitoring Site ID** | **Representative Monitoring Well (RMW) ID** | **Monitoring Site Type** | **Type of Measurement Taken** | **Frequency of Measurement** | Groundwater Level | Groundwater Storage | Seawater Intrusion | Groundwater Quality | Land Subsidence | Interconnected Surface Water | **Station ID** | **Well ID** | **CASGEM Well Type** | **Latitude (° NAD 83)** | **Longitude (° NAD 83)** | **APN** | **Landowner / Well Owner** | **Contact Name/#** | **Description of Site Location** | **Long-term Access Agreement in Place?** |
| 32S26E20G001M | RMW-094 | Well | Groundwater Level | Semiannually | x | x | | | | | 351303N1192078W001 | 23790 | Voluntary | 35.13376 | -119.20768 | 295-040-25 | MOC | Michael Blaine | 1.5 mi N/o t/o 5G85 | Verbal Agreement |
| 32S27E30N001M | RMW-095 | Well | Groundwater Level | Semiannually | x | x | | | | | 351092N1191270W001 | 21426 | Voluntary | 35.10948 | -119.12320 | 295-130-02 | C & A FARMS LLC | Michael Blaine | Located near t/o 7G46 N/o center pivots | Verbal Agreement |
| 32S27E35R001M | RMW-097 | Well | Groundwater Level | Semiannually | x | x | | | | | 350961N1190435W001 | 21811 | Voluntary | 35.09602 | -119.04069 | 295-120-55 | DIAMOND FARMING | Carl Voss | Located at ISO Copus Rd and I-5; consistently high WL | Verbal Agreement |
| 32S26E24K001M | RMW-231 | Well | Groundwater Level | Semiannually | x | x | | | | | - | - | - | 35.13044 | -119.13660 | 295-030-39 | MFC | Alex Shafer | Bonanza 701 | Verbal Agreement |
| 11N22W01D001S | RMW-232 | Well | Groundwater Level | Semiannually | x | x | | | | | - | - | - | 35.07496 | -119.18920 | State of California | WHEELER RDG MARICOPA WTR DIST | Sheridan Nicholas | | Executed Agreement |
| 11N22W06H001S | RMW-233 | Well | Groundwater Level | Semiannually | x | x | | | | | 350686N1192609W001 | 30197 | Voluntary | 35.06924 | -119.26117 | 239-080-54 | SUN PAC | Jose Marin | | Verbal Agreement |
| 11N21W16E001S | RMW-234 | Well | Groundwater Level | Semiannually | x | x | | | | | - | - | - | 35.04283 | -119.13554 | 239-041-07 | WHEELER RDG MARICOPA WTR DIST | Sheridan Nicholas | | Executed Agreement |
| 11N21W09C001S | RMW-236 | Well | Groundwater Level | Semiannually | x | x | | | | | 350592N1191328W001 | 12159 | Voluntary | 35.06010 | -119.13088 | 239-320-26 | MILLWOOD RANCH CO LTD | Jose Marin | No completion report; located between t/o 7P8 and 7P39; could be infl. by San Emigdio Ck; typ 30' higher | Verbal Agreement |
| 32S26E34P001M | RMW-237 | Well | Groundwater Level | Semiannually | x | x | | | | | - | - | - | 35.09430 | -119.17355 | 295-050-57 | P & N PTP | Peter Dulcich | Located near t/o 7G26 on Copus Rd; could be composite based on screen, but WLs look right | Verbal Agreement |
| 32S26E36P002M | RMW-238 | Well | Groundwater Level | Semiannually | x | x | | | | | 350947N1191370W001 | 21294 | Voluntary | 35.09466 | -119.13748 | 259-050-58 | P & N L P | Peter Dulcich | Located near t/o 7G32 | Verbal Agreement |
| 32S25E29Q001M | RMW-239 | Well | Groundwater Level & Groundwater Quality | Semiannually | x | x | | x | | | 351083N1193140W001 | 23744 | Voluntary | 35.10876 | -119.31313 | 220-170-10 | MOC | Michael Blaine | Behind locked fence; located at t/o 4G27 | Verbal Agreement |
| 32S28E16P001M | RMW-240 | Well | Groundwater Level & Groundwater Quality | Semiannually | x | x | | x | | | 351397N1189767W001 | 21937 | Voluntary | 35.13668 | -118.97678 | 445-030-16 | BIDART | Leonard Bidart | | Executed Agreement |
| 32S26E17H001M | RMW-241 | Well | Groundwater Quality | Annually | | | | x | | | 351450N1191992W001 | 37161 | Voluntary | 35.14836 | -119.20019 | 295-040-36 | HALL | Paula Hall | | Verbal Agreement |
| 11N21W12N002S | RMW-242 | Well | Groundwater Quality | Annually | | | | x | | | 350489N1190806W001 | 12300 | Voluntary | 35.05004 | -119.08134 | 239-012-25 | CENTRAL ALMONDS LLC | | | Verbal Agreement |
| 11N22W09A001S | RMW-243 | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.06164 | -119.22530 | 239-080-74 | WONDERFUL CITRUS LLC | | | Verbal Agreement |
| 12N21W31P001S | RMW-244 | Well | Groundwater Quality | Annually | | | | x | | | - | - | - | 35.07771 | -119.16659 | 295-200-13 | P&N LP | Peter Dulcich | | Verbal Agreement |
| 12N21W34N001S | RMW-245 | Well | Groundwater Level & Groundwater Quality | Semiannually | x | x | | x | | | 350772N1191178W001 | 15237 | Voluntary | 35.07743 | -119.11721 | 295-270-14 | CENTRAL ALMONDS LLC | | | Verbal Agreement |
| 32S26E14J001M | RMW-246 | Well | Groundwater Quality | Annually | | | | x | | | 351450N1191459W001 | 36997 | Voluntary | 35.14505 | -119.14618 | 295-030-04 | MFC | Alex Shafer | | Verbal Agreement |
| 32S27E36R001M | RMW-247 | Well | Groundwater Quality | Annually | | | | x | | | 350953N1190215W001 | 21813 | Voluntary | 35.09582 | -119.02226 | 295-120-48 | DIAMOND FARMING | Carl Voss | | Verbal Agreement |
| 12N21W35Q001S | RMW-258 | Well | Groundwater Level | Semiannually | x | x | | | | | - | - | - | 35.07685 | -119.08714 | 295-220-10 | WEST COAST GRAPE FARMS | Frank Canela | Located near t/o 8G18 | Verbal Agreement |

## TABLE MN-4
## Summary of Representative Monitoring Sites
Wheeler Ridge-Maricopa Management Area

| | Reference Point | | | | | | | Well Construction Details | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring Site ID | Ground Surface Elevation (ft amsl) | Reference Point Elevation (ft amsl) | Reference Point Description | Status_Code | Well Type | Well Status | Well Completion Type | Year Drilled | Total Completed Depth (ft bgs) | Borehole Depth (ft bgs) | Top of Perforations Depth (ft bgs) | Bottom of Perforations Depth (ft bgs) | Casing Diameter (in) | Pump Type | Nameplate - Horsepower | Well Capacity (gpm) | Well Discharge (in) | DWR Well Completion Report No. | Principal Aquifer(s) Monitored *(3)* |
| 32S26E20G001M | 335.42 | 335.42 | | OY | Irrigation | Inactive | Single | 1969 | 1201 | | 295 | 1201 | | | | | | | Principal Aquifer (KRF) |
| 32S27E30N001M | 352.39 | 352.39 | | OB | Monitoring | Inactive | Single | 1953 | 1002 | | 252 | 1002 | | | | | | | Principal Aquifer (KRF) |
| 32S27E35R001M | 346.41 | 348.41 | | OB | Monitoring | Active | Single | 1958 | 1314 | | 647 | 1314 | | | | | | | Principal Aquifer (KRF) |
| 32S26E24K001M | 317.00 | 317.00 | | Unknown | Unknown | Unknown | Single | | | | | | | | | | | | Principal Aquifer (KRF) |
| 11N22W01D001S | 501.00 | 500.00 | | IWRM | Monitoring | Inactive | Single | | | | 820 | 1858 | | | | | | | Principal Aquifer (KRF) |
| 11N22W06H001S | 542.51 | 544.51 | | OB | Monitoring | Inactive | Single | | | | | | | | | | | | Principal Aquifer (KRF) |
| 11N21W16E001S | 644.00 | 644.00 | | AWRM | Production | Active | Single | 1992 | 1500 | | 619 | 2280 | | | | | | | Principal Aquifer (KRF) |
| 11N21W09C001S | 545.51 | 546.01 | | OY | Irrigation | Inactive | Single | | 2100 | | 800 | 2100 | | | | | | | Principal Aquifer (KRF) |
| 32S26E34P001M | 427.00 | 425.00 | | AA | Irrigation | Active | Single | 1951 | 700 | | 350 | 700 | | | | | | | Principal Aquifer (KRF) |
| 32S26E36P002M | 402.43 | 402.43 | *Data Gap - will be filled as part of GSP implementation* | OY | Irrigation | Inactive | Single | 1958 | 1802 | | 552 | 1802 | *Data Gap - will be filled as part of GSP implementation* | | | | | | Principal Aquifer (KRF) |
| 32S25E29Q001M | 422.51 | 424.51 | | AA | Irrigation | Active | Single | 1977 | 1002 | | 642 | 1002 | | | | | | | Principal Aquifer (KRF) |
| 32S28E16P001M | 316.23 | 316.23 | | OY | Irrigation | Inactive | Single | | | | 350 | 700 | | | | | | | Principal Aquifer (KRF) |
| 32S26E17H001M | 312.40 | 312.40 | | OY | Irrigation | Inactive | Single | | | | 444 | 836 | | | | | | | Principal Aquifer (KRF) |
| 11N21W12N002S | 530.54 | 530.54 | | Unknown | Irrigation | Active | Single | | | | | | | | | | | | Principal Aquifer (KRF) |
| 11N22W09A001S | 565.00 | 565.00 | | Unknown | Unknown | Unknown | Single | | | | | | | | | | | | Principal Aquifer (KRF) |
| 12N21W31P001S | 487.00 | 489.00 | | Unknown | Irrigation | Active | Single | | | | | | | | | | | | Principal Aquifer (KRF) |
| 12N21W34N001S | 447.46 | 448.96 | | OB | Monitoring | Active | Single | 1964 | 2050 | 2050 | 647 | 2002 | | | | | | | Principal Aquifer (KRF) |
| 32S26E14J001M | 306.35 | 306.35 | | Unknown | Irrigation | Active | Single | | | | | | | | | | | | Principal Aquifer (KRF) |
| 32S27E36R001M | 354.44 | 356.44 | | Unknown | Unknown | Unknown | Single | | 1800 | | 600 | 1800 | | | | | | | Principal Aquifer (KRF) |
| 12N21W35Q001S | 415.00 | 417.00 | | OB | Monitoring | Active | Single | 1937 | | | | | | | | | | | Principal Aquifer (KRF) |

**Abbreviations**

AA = active agricultural well
AD = active domestic well
AWRM = active WRM production well
amsl = above mean sea level
bgs = below ground surface
CASGEM = California Statewide Groundwater Elevation Monirtoring
DWR = California Department of Water Resources
ft = feet
gpm = gallons per minute
in = inches
IWRM = inactive WRM production well
KRF = Kern River Formation
N/A = not applicable
NAD = North American Datum
OB = observation well
OY = open hole
t/o = turnout
WRM = Wheeler Ridge-Maricopa

**Notes**

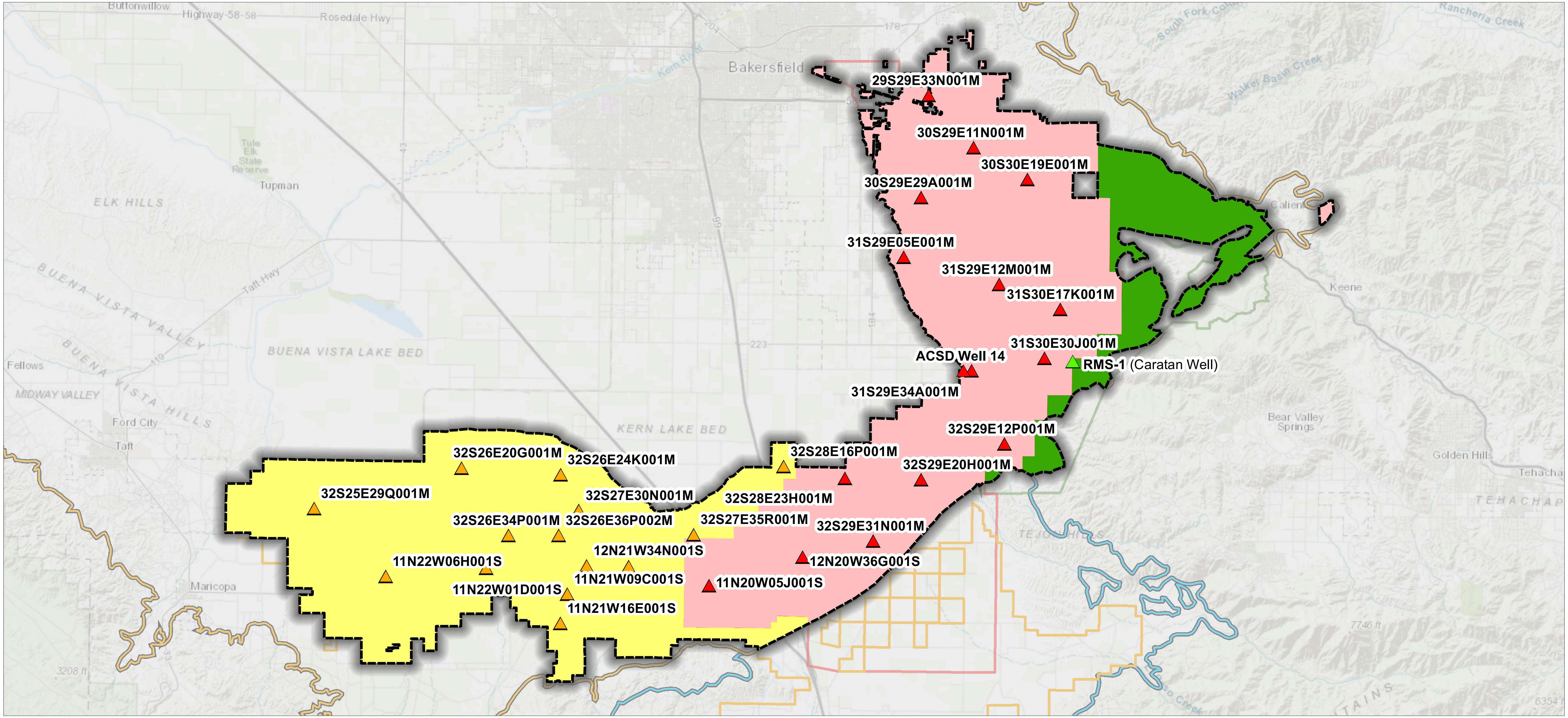
(1) Seawater intrusion is not considered to be a sustainability indicator of concern to the Wheeler Ridge-Maricopa Management Area and is thus not monitored for SGMA compliance.
(2) Depletion of Interconnected Surface Water is not considered to be a sustainability indicator of concern to the Wheeler Ridge-Maricopa Management Area and is thus not monitored for SGMA compliance.
(3) Only one Principal Aquifer is defined for the Wheeler Ridge-Maricopa Management Area - the "Kern River Formation Principal Aquifer".

**TABLE MN-5**
**Summary of Representative Monitoring Sites**
Tejon-Castac Management Area

| | | |
|---|---|---|
| **Monitoring Site ID** | | RMS-1 |
| **Monitoring Site Type** | | Well |
| **Type of Measurement Taken** | | Groundwater Level |
| **Frequency of Measurement** | | Semi-annually |
| **Sustainability Indicator(s)** | Groundwater Level | Yes |
| | Groundwater Storage | Proxy |
| | Seawater Intrusion | Not applicable |
| | Groundwater Quality | No |
| | Land Subsidence | No |
| | Interconnected Surface Water | No |
| **CASGEM Details** | **Station ID** | Not applicable |
| | **Well ID** | Not applicable |
| | **Well Type (CASGEM / Voluntary)** | Not applicable |
| **Monitoring Site Location** | **Latitude (° WGS 84)** | 35.20019 |
| | **Longitude (° WGS 84)** | -118.76977 |
| | **Description of Site Location** | 3,340 ft south of E. Bear Mountain Blvd (Hwy 223), 180 ft east of section line between 31S30E28 and 31S30E29 |
| | **Long-term Access Agreement in Place?** | Not Yet |
| **Reference Point** | **Ground Surface Elevation (ft msl)** | 546 |
| | **Reference Point Elevation (ft msl)** | To be determined |
| | **Reference Point Description** | To be determined |
| **Well Use** | | Industrial, Irrigation |
| **Well Status** | | Active |
| **Well Completion Type** | | Single |
| **Well Construction Details** | **Total Completed Depth (ft bgs)** | 800 |
| | **Borehole Depth (ft bgs)** | 800 |
| | **Top of Perforations Depth (ft bgs)** | 436 |
| | **Bottom of Perforations Depth (ft bgs)** | 800 |
| | **Casing Diameter (in)** | 14 |
| | **Well Capacity (gpm)** | unknown |
| **DWR Well Completion Report No.** | | 74572 |
| **Principal Aquifer(s) Monitored** | | Plio-Pliestocene Alluvium |
| **Other Relevant Information** | | also known as the Caratan Well |

**Abbreviations**

CASGEM = California Statewide Groundwater Elevation Monitoring Network
DWR = California Department of Water Resources
ft bgs = feet below ground surface
ft msl = feet above mean sea level
gpm = gallons per minute
ID = identification
in = inches
TBD = to be determined
WGS = World Geodetic System




## Legend

- South of Kern River Plan Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)
- Tejon-Castac Management Area RMS
- Arvin-Edison Management Area RMS
- Wheeler Ridge-Maricopa Management Area RMS
- Arvin GSA
- Wheeler Ridge-Maricopa GSA
- Tejon-Castac Water District GSA
- WRMWSD Service Area
- AEWSD Service Area
- TCWD Service Area

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
RMS = Representative Monitoring Site
SGMA = Sustainable Groundwater Management Act
TCWD = Tejon-Castac Water District
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.
2. GSA boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

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**SGMA Water Level Monitoring Network**

eki environment & water

South of Kern River GSP
Kern County, CA
July 2022
C20055.00
**Figure MN-1**

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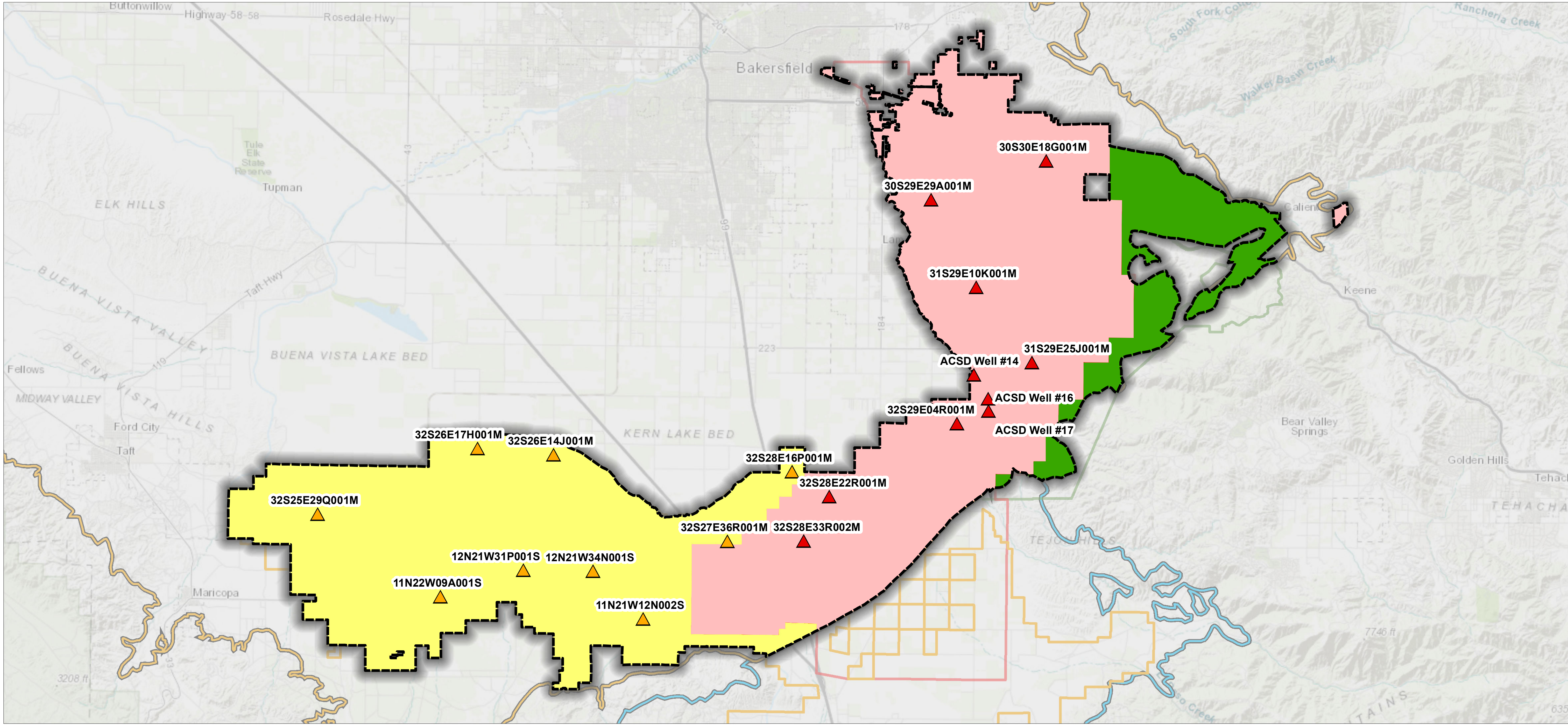


## Legend

- Wheeler Ridge-Maricopa RMS
- Arvin-Edison Management Area RMS
- South of Kern River Plan Area
- Arvin GSA
- Wheeler Ridge-Maricopa GSA
- Tejon-Castac Water District GSA
- WRMWSD Service Area
- AEWSD Service Area
- TCWD Service Area

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
RMS = Representative Monitoring Site
SGMA = Sustainable Groundwater Management Act
TCWD = Tejon-Castac Water District
WRMWSD = Wheeler Ridge-Maricopa Water Storage District

## Notes

1. All locations are approximate.

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 13 June 2022.
2. GSA boundaries obtained from SGMA GSA Map Viewer portal, accessed 6 May 2022.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

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**SGMA Water Quality Monitoring Network**

South of Kern River GSP
Kern County, CA
July 2022
C20055.00
**Figure MN-2**

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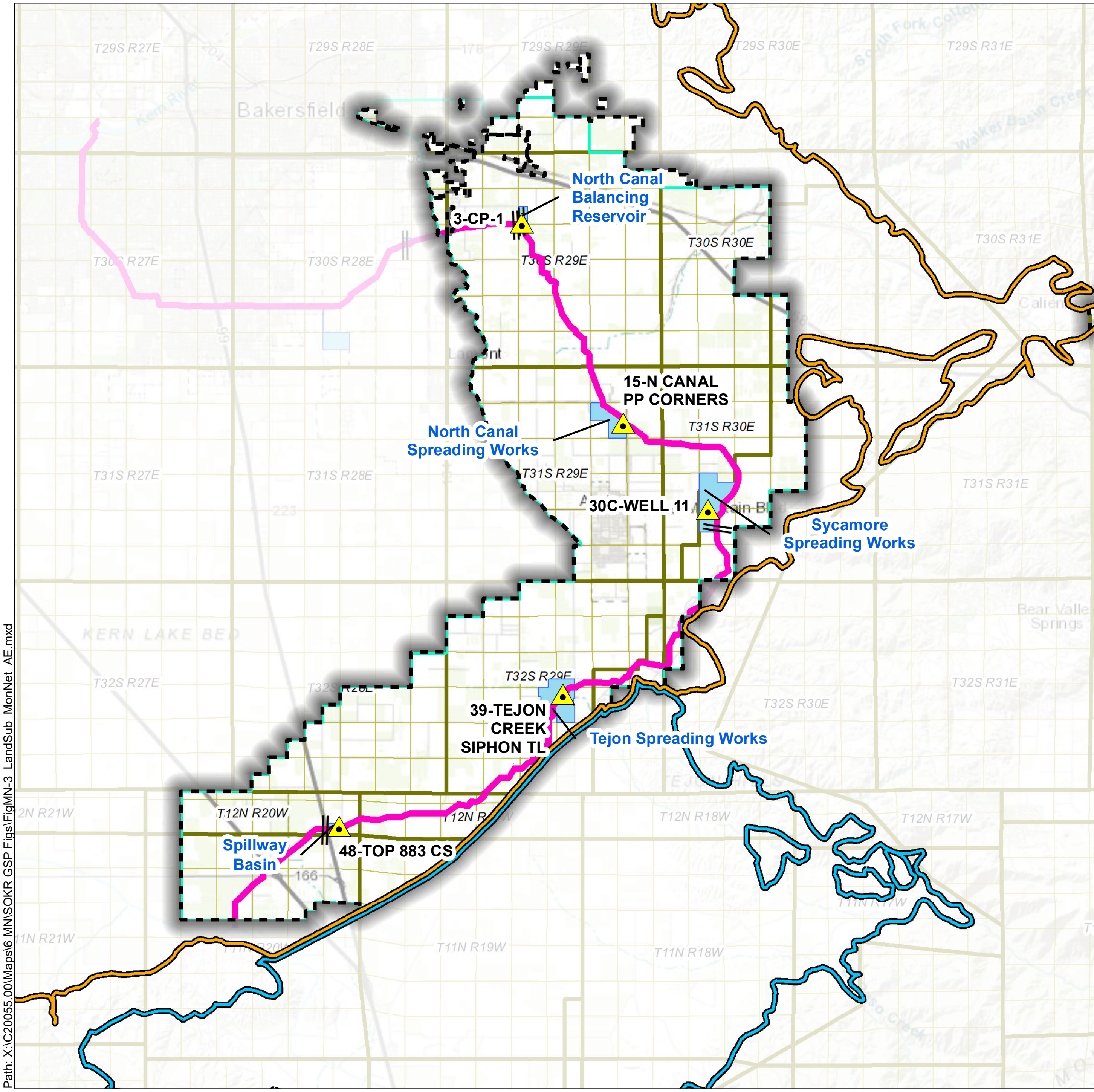


Legend

- Arvin GSA
- AEWSD Service Area
- Representative Monitoring Site
- AEWSD Spreading Basin
- AEWSD Canal

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

Abbreviations

ACSD = Arvin Community Services District
AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 June 2022.
2. Land subsidence survey point information received from AEWSD on 20 May 2019.

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**SGMA Land Subsidence Monitoring Network Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
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**Figure MN-3**

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# PROJECTS AND MANAGEMENT ACTIONS

## 17. PROJECTS AND MANAGEMENT ACTIONS

☑ 23 CCR § 354.42

Pursuant to the Groundwater Sustainability Plan (GSP) Emergency Regulations, this section presents the Projects and Management Actions (P/MAs) proposed to support achievement of the Sustainability Goal within the South of Kern River (SOKR) GSP Area. The P/MAs were developed using a portfolio approach whereby individual P/MAs were identified and grouped into categories based on their expected benefits. Implementation of P/MAs within those benefit categories is estimated to occur along a "glide path" that will result in closing of the currently identified "deficit" under the 2030 Climate Change Scenario by the January 2040 GSP implementation deadline (see **Section 9.1.4.5 *Projected Water Budget Results***), as well as in response to observed groundwater conditions relative to the associated Sustainability Indicators. The proposed P/MAs thus represent a path to achieve the sustainability goal for the SOKR GSP Area, as further demonstrated by results from the Basin-wide numerical groundwater flow model that show groundwater levels exceeding Measurable Objectives when P/MAs are implemented. This approach allows for flexible implementation of P/MAs as needed to address future conditions throughout the 50-year GSP planning and implementation horizon (i.e., out to 2070). The P/MAs presented herein were developed with consideration of costs and benefits and preliminary feasibility analysis; however, each P/MA will require significant further evaluation (i.e., engineering, economic, environmental, legal, etc.) prior to implementation. In addition to the P/MAs presented herein, the SOKR Groundwater Sustainability Agencies (GSAs) and Arvin Community Services District (ACSD) will continue to conduct data gap filling activities as part of Plan Implementation that may include, but are not limited to, validating the status of existing wells, refining the water budget parameters based on additional data and modeling, collecting additional data related to aquifer conditions and properties, and conducting additional data compilation and analysis of groundwater conditions information (see **Section 18.1 *Plan Implementation Activities***).

This section first presents the goals and objectives of the P/MAs, including the relevant Sustainability Indicators, the spatial "focus areas" within the SOKR GSP Area, and the categories of expected benefits and the implementation glide path. Next, a list of specific P/MAs grouped by benefit category, Management Area (MA), and type is presented, information which is also provided in ***Table PMA-1*** and ***Table PMA-2*** (detailed P/MA Information Forms are included in **Appendix M**). Following this list is a discussion of how the P/MAs address overdraft conditions or other Undesirable Results (i.e., water quality); a description of the various potentially applicable permitting and regulatory requirements; a discussion of the P/MA status and implementation timeline; a discussion of how the expected benefits will be evaluated; a description of sources of outside water that are relied upon; a discussion of the legal authority required to implement the P/MAs; a summary of estimated costs and how the SOKR GSP plans to meet those costs; and a discussion of how recharge and extraction will be managed to avoid depletion of groundwater levels and storage.

## 17.1. Goals and Objectives of Projects and Management Actions

### 17.1.1. Relevant Sustainability Indicators

Per the GSP Emergency Regulations, GSPs must include P/MAs to address any existing or potential future Undesirable Results for the identified relevant Sustainability Indicators.

*Arvin-Edison Management Area*

As discussed in **Section 13 *Undesirable Results*** the relevant Sustainability Indicators in the Arvin-Edison Management Area for which Sustainable Management Criteria (SMCs) have been defined include: (1) Chronic Lowering of Groundwater Levels, (2) Reduction of Groundwater Storage, (3) Degraded Water Quality, and (4) Land Subsidence. Because groundwater levels and storage area directly correlated, P/MAs that address groundwater levels also address groundwater storage, and the two Sustainability Indicators are considered together in this discussion of P/MAs. Each of these relevant Sustainability Indicators is further associated with specific areas within the Arvin-Edison Management Area. Therefore, the goal of the P/MAs discussed herein is to address significant and unreasonable effects related to the relevant Sustainability Indicators in the relevant areas.

*Wheeler Ride-Maricopa Management Area*

As discussed in **Section 13 *Undesirable Results***, the relevant Sustainability Indicators in the Wheeler Ridge-Maricopa Management Area for which SMCs have been defined include: (1) Chronic Lowering of Groundwater Levels, (2) Reduction of Groundwater Storage, and (3) Land Subsidence. Because groundwater levels and storage area directly correlated, P/MAs that address groundwater levels also address groundwater storage, and the two Sustainability Indicators are considered together in this discussion of P/MAs. Each of these relevant Sustainability Indicators is further associated with specific areas within the Wheeler Ridge-Maricopa Management Area. Therefore, the goal of the P/MAs discussed herein is to address significant and unreasonable effects related to the relevant Sustainability Indicators in the relevant areas.

*Tejon-Castac Management Area*

As discussed in **Section 13 *Undesirable Results***, the only relevant Sustainability Indicator in the Tejon-Castac Management Area for which SMCs are defined is Chronic Lowering of Groundwater Levels. Because groundwater levels and storage area directly correlated, P/MAs that address groundwater levels also address groundwater storage, and the two Sustainability Indicators are considered together in this discussion of P/MAs.

### 17.1.2. Focus Areas

*Arvin-Edison Management Area*

As discussed in **Section 8.2 *Groundwater Elevations and Flow Direction*,** groundwater levels are generally lowest and tend to show decreasing trends in the west/central portions of the Arvin-Edison Management Area that rely exclusively on groundwater (i.e., outside of the Surface Water Service Area [SWSA]) (see ***Figure GWC-1***, ***Figure GWC-2***, and ***Figure GWC-5***). For that reason, the proposed P/MAs that address groundwater levels and storage are focused on those areas. Land Subsidence is also closely tied to groundwater levels but is only relevant where there is critical infrastructure (defined as "facilities which are utilized to provide public services such as water, utilities, and or transportation service for a region", as discussed in **Section 13.5 *Undesirable Results for Land Subsidence*** above). Therefore, the area relevant to the Land Subsidence Sustainability Indicator is along the Arvin-Edison Water Storage District (AEWSD) canals. Groundwater quality is generally suitable for agricultural uses in the Arvin-Edison Management Area, and therefore water quality concerns are most relevant in the ACSD area where groundwater is used as a drinking water supply. As discussed in **Section 13.4 *Undesirable Results for Degraded Water Quality***, there may be a link between groundwater levels and arsenic concentrations in ACSD wells, and therefore P/MAs to address groundwater levels in this area are expected to have positive impacts on groundwater quality in ACSD wells. In addition, ACSD has identified and is implementing projects to address drinking water quality issues.

*Wheeler Ridge-Maricopa Management Area*

As discussed in **Section 8.2 *Groundwater Elevations and Flow Direction***, groundwater levels in 2015 were lowest in the southern central portion and the far northernmost portion of the Wheeler Ridge-Maricopa Management Area, and the patterns likely reflect, in part, the distribution of groundwater pumping (the latter of these two areas is outside of the SWSA and therefore relies exclusively on groundwater) (see *Figure GWC-7**, Figure GWC-8,*** and ***Figure GWC-11***). For that reason, the proposed P/MAs that address groundwater levels and storage are focused on those areas. Land Subsidence is also closely tied to groundwater levels but is only relevant where there is critical infrastructure (defined as "facilities which are utilized to provide public services such as water, utilities, and or transportation service for a region", as discussed in **Section 13.5 *Undesirable Results for Land Subsidence*** above). The area most relevant to the Land Subsidence Sustainability Indicator is along the California Aqueduct, which is also within the SWSA. As discussed in **Section 13.4 *Undesirable Results for Degraded Water Quality***, Groundwater quality is generally suitable for agricultural uses within the Management Area, except for the far western portion of the Management Area where naturally occurring salinity affects groundwater quality, and therefore no SMCs are defined, and no P/MAs are proposed to address effects related to this Sustainability Indicator.

*Tejon-Castac Management Area*

In the Tejon-Castac Management Area, the vast majority of the land is covered by land use policies and restrictions under the Tejon Ranch Conservation and Land Use (C&LU) Agreement (see discussion in **Section 5.3.4 *Tejon Ranch Conservation and Land Use Agreement*).** Nevertheless, a few additional P/MAs have been proposed beyond those already in place under the C&LU Agreement and associated Ranch Wide Management Plan (RWMP) to ensure sustainability within the Tejon-Castac Management Area.

### 17.1.3. Benefit Categories

**☑ 23 CCR § 354.42(b)(5)**

The primary water management "tools" (i.e., authorities) by which GSAs can address conditions that may lead to Undesirable Results associated with water quantity (i.e., Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage) pertain to management of inflows (supplies) and outflows (demands). Therefore, the primary categories of expected benefits for these water quantity-related P/MAs are:

- Water supply augmentation, including

- Wet year supplies
- Other (i.e. all year) new supplies; and

- Water demand reduction.

All of the P/MAs that have water quantity-related benefits belong to at least one of those two primary categories. In addition, some of these quantity-related P/MAs also have secondary benefits, including:

- Water quality improvement;
- Flood control;
- Water management flexibility/efficiency; and
- Improved data to better understand the Basin Setting components.

Two projects being led by ACSD address drinking water quality as their primary benefit.

### 17.1.4. <u>Implementation Glide Path</u>

☑ **23 CCR § 354.42(d)**

As stated above, the goals and objectives of the P/MAs presented herein are to address any existing or potential Undesirable Results by the GSP implementation deadline for the Kern County Subbasin (Basin or Kern Subbasin) (i.e., by January 2040). As such, P/MAs could be implemented incrementally on an as-needed basis to achieve this goal and after significant data gaps across the basin and a multitude of questions about any GSP-mandated reductions in light of current and future uncertainties (i.e., climate change, hydrologic time periods used for evaluation purposes, lack of basin-wide modeling calibration/validation, etc.) are addressed. While the exact schedule and timetable for implementation of individual P/MAs is not known at this time, general implementation schedules, also known as a "glide path", have been developed for the Arvin-Edison and Wheeler Ridge-Maricopa Management Areas and are summarized in ***Table PMA-3*** and ***Table PMA-4*** below.[156] These preliminary "glide paths" aim to address a certain percentage of the projected deficit during each five-year period through 2040, which in turn will affect conditions of the relevant Sustainability Indicators based on the assumption that those conditions are directly related to the balance of supplies and demands within the SOKR GSP Area. The "glide paths" also include a preliminary estimate of the supply augmentation and/or demand reduction measures necessary to address the projected deficit specified under the 2070 Climate Change Scenario by the end of the 50-year GSP planning and implementation horizon (i.e., January 2070).

[156] Due to the relatively undeveloped condition in most of the Tejon-Castac Management Area, and the fact that future development beyond current land uses (i.e., grazing) is not permitted under the Tejon Ranch C&LU Agreement, no glide path is established for implementation of P/MAs in the Tejon-Castac Management Area.

**Table PMA-3. General Project and Management Actions Implementation Schedule ("Glide Path"), Arvin-Edison Management Area**

| | | P/MA Implementation Schedule (2) | | | | |
|---|---|---|---|---|---|---|
| | | **By 2025** | **By 2030** | **By 2035(3)** | **By 2040** | **By 2070** |
| Projected Deficit (1) (AFY) | | 31,600 | | | | 56,500 |
| Target Deficit Reduction (%) | | 25% | 50% | 75% | 100% | 100% |
| Target Deficit Reduction (AFY) | | 8,000 | 16,000 | 24,000 | 32,000 | 56,500 |
| **P/MA Benefits, by Type (AFY)** | | | | | | |
| Water Supply Augmentation | Wet Year Supplies (4) | 6,400 | 12,000 | 16,800 | 20,800 | 33,050 |
| | Other New Supplies | 0 | 0 | 0 | 1,600 | 7,725 |
| Demand Reduction | | 1,600 | 4,000 | 7,200 | 9,600 | 15,725 |
| **Total P/MA Benefits** | | **8,000** | **16,000** | **24,000** | **32,000** | **56,500** |

Abbreviations:
AFY = acre-feet per year
P/MA = Projects and Management Actions

Notes:
(1) Projected Deficit to be addressed by implementation of P/MAs up to 2040 is the net water supply shortfall based on the 2030 Climate Change Scenario. Projected Deficit to be addressed by future P/MA implementation beyond 2040 (i.e., up to 2070) is the net water supply shortfall based on the 2070 Climate Change Scenario.
(2) In the 2025 through 2040 periods, 70% of the target deficit reduction is met by Water Supply Augmentation P/MAs and the remaining 30% may be met by Demand Reduction P/MAs as necessary. In the period from 2040 through 2070, at least 75% of the additional target deficit reduction is met with Water Supply Augmentation P/MAs and the remaining 25% may met with Demand Reduction P/MAs as necessary.
(3) AEWSD will presumably need to meet an additional 153,000 AF banked water return obligation to MWD by the 2034 termination date of its existing water management program agreement.
(4) Specific "wet-year supply augmentation" projects that are currently underway within AEWSD include the Sunset Spreading Works Project (P/MA #1), DiGiorgio Unit In-Lieu Project (P/MA #16), and On-Farm Recharge Project (P/MA #6).

**Table PMA-4. General Project and Management Actions Implementation Schedule ("Glide Path"), Wheeler Ridge-Maricopa Management Area**

| | | P/MA Implementation Schedule | | | | |
|---|---|---|---|---|---|---|
| | | **By 2025** | **By 2030** | **By 2035** | **By 2040** | **By 2070** |
| Projected Deficit [1] (AFY) | | 21,400 | | | | 33,300 |
| Target Deficit Reduction (%) | | 15% | 45% | 75% | 100% | 100% |
| Target Deficit Reduction (AFY) | | 3,200 | 9,600 | 16,100 | 21,400 | 33,300 |
| **P/MA Benefits, by Type (AFY)** | | | | | | |
| Water Supply Augmentation | Wet Year Supplies | 896 | 2,688 | 4,508 | 5,992 | 5,992 |
| | Other New Supplies | 1,024 | 3,072 | 5,152 | 6,848 | 12,798 |
| Demand Reduction | | 1,280 | 3,840 | 6,440 | 8,560 | 14,510 |
| **Total P/MA Benefits** | | **3,200** | **9,600** | **16,100** | **21,400** | **33,300** |

Abbreviations:
AFY = acre-feet per year
P/MA = Project and Management Actions

Notes:
1. Projected Deficit to be addressed by implementation of P/MAs up to 2040 is the net water supply shortfall based on the 2030 Climate Change Scenario. Projected Deficit to be addressed by future P/MA implementation beyond 2040 (i.e., up to 2070) is the net water supply shortfall based on the 2070 Climate Change Scenario.
2. In the 2025 through 2040 periods, 60% of the target deficit reduction is met by Water Supply Augmentation P/MAs and the remaining 40% may be met by Demand Reduction P/MAs as necessary. In the period from 2040 through 2070, 50% of the additional target deficit reduction is met with Water Supply Augmentation P/MAs, and the remaining 50% with Demand Reduction P/MAs as necessary.

## 17.2. List of Projects and Management Actions

☑ 23 CCR § 354.44(b)(1)

This section provides a list of the P/MAs identified for each Management Area of the SOKR GSP, divided into the two primary benefit categories discussed above, both of which address the Chronic Lowering of Groundwater and Reduction of Groundwater Storage Sustainability Indicators.

Within the two benefit categories identified for the Arvin-Edison Management Area, the P/MAs are further classified into seven types based on the mechanism by which the primary benefit is achieved. In addition, the list includes two projects that address drinking water quality in the ACSD service area. Details of the P/MAs are provided in ***Table PMA-1*** and in the P/MA forms included in **Appendix M**. ***Figure PMA-1*** shows the approximate locations of these P/MAs in the Arvin-Edison Management Area.

Within the two benefit categories identified for the Wheeler Ridge-Maricopa Management Area, the P/MAs are further classified into five types based on the mechanism by which the primary benefit is achieved. Details of the P/MAs are provided in ***Table PMA-2*****.**

The two P/MAs identified for the Tejon-Castac Management Area generally apply to and address the Chronic Lowering of Groundwater Levels Sustainability Indicator. Both of these P/MAs address this through augmentation of water supplies and/or recharge. It should be noted that due to the relatively undeveloped condition in most of the Tejon-Castac Management Area, and the fact that future development beyond current land uses (i.e., grazing) is not permitted under the C&LU Agreement,[157] neither of these P/MAs is necessary for the Tejon-Castac Management Area to achieve and maintain sustainability. These P/MAs are, however, planned for implementation to further support sustainability in the region and Tejon-Castac Water District (TCWD) operations.

### 17.2.1. Water Supply Augmentation Projects

*Arvin-Edison Management Area*

The Projects listed below have supply augmentation as their primary expected benefit, and include Projects to Enhance Recharge, Projects to Manage and/or Capture Floodwater,[158] Projects to Increase Surface Storage Capacity / Delivery Flexibility, In-Lieu Projects, and Projects to Develop New Supplies in the Arvin-Edison Management Area.

**Projects to Enhance Recharge**

- AE-1. AEWSD Sunset Spreading Works
- AE-2. Private and Caltrans Basin Connections

**Projects to Manage and/or Capture Floodwater**

- AE-3. Sycamore Creek Detention and Sedimentation Basin
- AE-4. AEWSD South Canal Flood Study / Improvements
- AE-5. Stormwater Management and Flood Control Improvements
- AE-6. On-Farm Recharge
- AE-7. Caliente Creek Habitat Mitigation and Groundwater Recharge

**Projects to Increase Surface Storage Capacity / Delivery Flexibility**

- AE-8. AEWSD Intake Canal / Kern Delta Water District (KDWD) Buena Vista Canal Intertie
- AE-9. AEWSD Intake Canal / KDWD Farmer's Canal Intertie
- AE-10. AEWSD Wasteway Basin Improvements
- AE-11. Forrest Frick Pipeline / KDWD Eastside Canal Intertie
- AE-12. AEWSD North Canal Balancing Reservoir Expansion and Discharge Pipelines

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[157] TCWD and TRC reserve the right to pump groundwater and/or develop surface water resources within the Tejon-Castac Management Area in the future, subject to the terms of the C&LU Agreement.

[158] From a water supply augmentation perspective, projects to manage and/or capture floodwaters may have limited new benefit, as typically those floodwaters already contribute to the recharge and supplies within the Arvin-Edison Management Area. However, this group of projects aims to better manage and secure such floodwaters, both physically and in terms of associated water rights issues.

AE-13. AEWSD Lateral Capacity Improvement Projects
AE-14. Conversion of Granite Quarry to Sycamore Reservoir
AE-15. AEWSD South Canal Balancing Reservoir
AE-31. Construction of New Groundwater Recovery Wells[159]

**In-Lieu Projects**

AE-16. Frick Unit In-Lieu Project
AE-17. DiGiorgio Unit In-Lieu Project
AE-18. General In-Lieu Banking Program

**Projects to Develop New Supplies**

AE-19. Reclamation of Oilfield Produced Water
AE-20. Wastewater Reclamation with Cities of Arvin and Bakersfield

*Wheeler Ridge-Maricopa Management Area*

The Projects listed below have supply augmentation as their primary expected benefit, and include Projects to Enhance Recharge/Banking, Projects to Increase Water Management Flexibility, and Projects to Develop New Supplies in the Wheeler Ridge-Maricopa Management Area.

**Projects to Enhance Recharge/Banking**

WRM-1. On-Farm Recharge[160]
WRM-2. In-District Banking Facilities
WRM-3. Increase Out-of-District Banking Operations

**Projects to Increase Water Management Flexibility**

WRM-4. Expand District Distribution System

**Projects to Develop New Supplies**

WRM-5. Purchase Additional Supplies
WRM-6. Desalination Facilities
WRM-7. "Thru Delta" Facility
WRM-13. Facility Interconnections with AEWSD[161]
WRM-14. Facility Interconnections with KDWD[163]

*Tejon-Castac Management Area*

This section lists the two P/MAs identified by TCWD that, in a general sense, apply to and address the Chronic Lowering of Groundwater Levels Sustainability Indicator. Both of these P/MAs address this through augmentation of water supplies and/or recharge. It should be noted that due to the relatively undeveloped condition in most of the Tejon-Castac Management Area, and the fact that future development beyond current land uses (i.e., grazing) is not permitted under the C&LU Agreement,[162]

[159] Project AE-31 is new as of 2022, and is therefore not included in ***Table PMA-1***.
[160] As discussed in **Section 7.3.4 Recharge and Discharge Areas,** much of the District, especially the southern portion, has surface conditions deemed suitable for recharge (***Figure HCM-46***).
[161] Projects WRM-13 and WRM-14 are new as of 2022, and therefore are not included in ***Table PMA-1***.
[162] TCWD and TRC reserve the right to pump groundwater and/or develop surface water resources within the Tejon-Castac Management Area in the future, subject to the terms of the C&LU Agreement.

neither of these P/MAs is necessary for the Tejon-Castac Management Area to achieve and maintain sustainability. These P/MAs are, however, planned for implementation to further support sustainability in the region and TCWD operations.

### TC-1. Conversion of Granite Quarry to Sycamore Reservoir

This P/MA entails repurposing of the Granite Quarry excavation into a storage reservoir upon cessation of mining operations at the facility which is expected in the next one to four years. The P/MA is being considered and developed in conjunction with AEWSD, and the source of water to fill the new reservoir would likely be surplus imported surface water, brought to the reservoir by AEWSD during wet years, with possible additional contribution from local stormflow runoff. In addition, TCWD may choose to store some of its State Water Project water supplies in the facility at times, supplies which would be wheeled through the AEWSD canal system. The facility is anticipated to serve as a storage basin for water added to it, as well as a location for recharge. Either benefit (i.e., increased storage capacity or increased recharge) would serve to augment the supplies available to the local area, thereby benefiting the Chronic Lowering of Groundwater Levels Sustainability Indicator.

AEWSD has estimated the net benefit of this P/MA to be approximately 2,500 acre-feet (AF) of increased storage capacity (which aids in delivery flexibility for AEWSD), and between 3,000 and 6,000 acre-feet per year (AFY) of increased recharge. As a secondary benefit, recharge of imported surface water would likely have a positive effect on local groundwater quality.

In order to implement this P/MA, TCWD and AEWSD would need to prepare environmental documents (e.g., California Environmental Quality Act [CEQA] documentation), as well as seek approvals from a variety of permitting authorities including possibly the California Division of Dam Safety, State Water Resources Control Board (SWRCB) if a water right is to be established, the Central Valley Regional Water Quality Control Board (CVRWQCB) in relation to groundwater replenishment and recharge project regulations, and others,

Costs for this P/MA are estimated at $10 to 20 million for feasibility study and one-time (i.e., capital, construction) costs, and annual operations and maintenance (O&M) costs to-be-determined. The sources of these funds may include AEWSD and/or TCWD general funds or project-specific funds, and grants.

The timeframe for initiation and completion of this P/MA are not certain, but presumably would begin once the Granite Quarry facility ceases operations, which is anticipated in one to four years. Construction duration is to-be-determined, and the accrual of benefits is estimated to occur within one to three years after the first wet year (i.e., with surplus water available to bring into the new reservoir) after construction is complete.

### TC-2. Recharge of Carrot Wash Water

As discussed previously in **Section 7.3.4 Recharge and Discharge Areas,** Tejon Ranch Company (TRC) recharges carrot wash water generated at a nearby carrot processing facility to a 75.5-acre parcel located just outside of the Tejon-Castac Management Area (Township 32S Range 30E Section 6). The site, which has been in operation since 2016, receives carrot wash water from a nearby carrot processing facility which is discharged to a set of recharge ponds. A total of over 1,000 AF has been recharged at these ponds between 2016 and early 2019. This project is anticipated to continue in the future, and results in a local recharge benefit. A production well may be installed in the future at the site to allow for recovery of recharged groundwater.

Based on the amount of water recharged since operations began in 2016, the annual benefit from this P/MA is estimated at approximately 300 AFY.

All required permissions to recharge this carrot wash water have been obtained, including a Waste Discharge Requirements (WDR) No. 5-01-22 from the Regional Water Quality Control Board. Permissions required to install a new well will include a Well Construction Permit from Kern County.

Costs to date for this P/MA are estimated at approximately $4,500 one-time/capital costs spent on site work. Capital costs for installation of a new well are to-be-determined (likely on the order of $100,000 to $300,000). Annual O&M costs for recharge operations are borne by the owner of the carrot processing facility. Costs associated with O&M of a future well for recovery of recharged water are to-be-determined.

The status of this P/MA currently underway, and the timeframe to accrual of benefits is likely on the order of one year.

### 17.2.2. Water Demand Reduction Management Actions

*Arvin-Edison Management Area*

The Management Actions listed below have water demand reduction as their primary expected benefit and include Management Actions / Policies to Reduce Overall Water Demand and Management Actions / Policies to Reduce Groundwater Pumping in the Arvin-Edison Management Area.

**Management Actions / Policies to Reduce Overall Water Demand**

- AE-21. Subsidies for Land Conversion
- AE-22. On-Farm Water Conservation

**Management Actions / Policies to Reduce Groundwater Pumping**

- AE-23. Groundwater Fee Increase
- AE-24. Groundwater Extraction Quantification Method
- AE-25. Groundwater Allocation Per Acre
- AE-26. Groundwater Marketing and Trading
- AE-27. Education of Groundwater Use per Acre
- AE-32. Development of a Groundwater Model and Decision Support Tool[163]

*Wheeler Ridge-Maricopa Management Area*

The Management Actions listed below have water demand reduction as their primary expected benefit and include Management Actions / Policies to Raise Funds to Support Sustainable Groundwater Management Act (SGMA) Compliance and Management Actions / Policies to Reduce Groundwater Pumping in the Wheeler Ridge-Maricopa Management Area.

**Management Actions to Raise Funds to Support SGMA Compliance**

- WRM-8. Acreage Assessment

[163] Management Action AE-32 is new as of 2022, and is therefore not included in ***Table PMA-1***.

**Management Actions / Policies to Reduce Groundwater Pumping**

WRM-9. Groundwater Allocation and Market
WRM-10. Voluntary Pumping Limitations
WRM-11. Mandatory Pumping Limitations
WRM-12. Land Retirement

### 17.2.3. Projects to Improve Drinking Water Quality in ACSD Service Area

The two projects listed below are being implemented by ACSD to improve the quality of drinking water served by ACSD.

AE-28. ACSD Emergency 1,2,3-trichloropropane (1,2,3-TCP) Treatment at Well No. 13
AE-29. ACSD Arsenic Mitigation Project – Phase II
AE-30. ACSD Well #12 Construction

### 17.2.4. Additional Data-Gap Filling Efforts

In addition to the P/MAs described above, additional efforts to fill data gaps in the understanding of groundwater conditions will be undertaken. The exact scope of these efforts is not yet defined, but may include:

- Validating the status of existing wells;
- Installation of new, dedicated monitoring well(s) to improve understanding of groundwater conditions;
- Refining historical, current, and projected water budget parameters based on additional data and numerical modeling (e.g., through development of a numerical groundwater flow model and decision support tool);
- Collecting additional data related to aquifer conditions and properties;
- Collecting additional data related to agricultural and industrial water use and demand trends;
- Conducting additional data compilation and analysis of groundwater conditions information using sources identified in **Appendix I** and other public datasets as they become available (e.g., California Department of Fish and Wildlife's new "Critical Species Lookbook" dataset[164]).

Status updates regarding ongoing data-gap filling activities conducted by each of the SOKR GSAs throughout SGMA implementation are provided in **Section 18.1.1 Monitoring and Data Collection**.

## 17.3. Circumstances for Implementation

☑ **23 CCR § 354.44(b)(1)(A)**

Using the portfolio/menu approach, P/MAs will be selected for implementation based on further consideration of the magnitude of expected benefit, the relative cost and ease of implementation, and other factors. Some P/MAs will be implemented immediately upon adoption of the SOKR GSP. Others will be implemented when grant funds are obtained or upon completion of feasibility studies, economic

[164] https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/

evaluations, and/or other necessary planning studies. A key precursor to implementing some of the P/MAs will be renegotiation and modification to the contracts between the Districts and their landowners to allow for certain funding and assessment provisions, and to allow greater flexibility in the types of water supplies that the Districts can purchase. Renegotiation of the contracts will be pursued by the Districts' Boards of Directors immediately upon adoption of the GSP.

As discussed above, an overall P/MA implementation schedule, or preliminary "glide path" has been developed for the Arvin-Edison and Wheeler Ridge-Maricopa Management Areas that serves as a framework to guide the level of benefits that are planned to be achieved over the GSP implementation period (i.e., until 2040), and further through the SGMA planning and implementation horizon (i.e., through 2070).

Accelerated implementation of P/MAs (i.e., at expected benefit accrual rates faster than those shown in ***Table PMA-3*** and ***Table PMA-4*** above) could be triggered if Minimum Thresholds for Chronic Lowering of Groundwater Levels are exceeded in more than 20% of Representative Monitoring Sites defined within the Arvin-Edison and Wheeler-Ridge Management Areas or at the one Representative Monitoring Site defined within the Tejon-Castac Management Area.

## 17.4. Public Notice Process

**☑ 23 CCR § 354.44(b)(1)(B)**

Public notice requirements vary for the different P/MAs listed above. Some projects that involve infrastructure improvements only may not require specific public noticing (other than that related to construction), whereas certain other management actions that involve, for example, imposition of fees by the SOKR GSAs, may require public noticing pursuant to Proposition 218 or Proposition 26. In general, P/MAs being considered for implementation will be discussed during regular Board Meetings of the SOKR GSAs (and/or ACSD) which are open to the public. Additional stakeholder outreach efforts will be conducted prior to and during P/MA implementation, as required by law.

## 17.5. Addressing Overdraft Conditions

**☑ 23 CCR § 354.44(b)(2)**

*Arvin-Edison Management Area*

As discussed in **Section 9.1.2.4 *Overdraft Conditions***, the Arvin-Edison Management Area as a whole does not have a net water budget deficit over the historical period based on the Management Area-specific spreadsheet water budget model.[165] However, groundwater levels in some areas (i.e., outside of the SWSA) have shown persistent decreasing trends, suggesting a local imbalance of supplies versus groundwater pumping. Furthermore, the projected water budget indicates that under the 2030 Climate Change Scenario, imported water supplies to the Arvin-Edison Management Area may be reduced, resulting in a net deficit of approximately -31,600 AFY. The P/MAs presented herein are expected to result

[165] Prior to the start of water importation into the AEWSD area in 1966, groundwater levels were in a state of chronic decline.

in benefits (discussed below) that will address the projected deficit so as to avoid Undesirable Results and maintain sustainability.

*Wheeler Ridge-Maricopa Management Area*

As discussed in **Section 9.2.2.4 *Overdraft Conditions***, the Wheeler Ridge-Maricopa Management Area as a whole does not have a net water budget deficit over the historical period based on the Management Area-specific spreadsheet water budget model.[166] However, groundwater levels in some areas, both inside and outside of the SWSA, have shown decreasing trends in recent years, suggesting a local imbalance of supplies versus pumping over this period (which includes a significant drought period). Furthermore, the projected water budget indicates that under the 2030 Climate Change Scenario, imported water supplies to the Management Area may be reduced, resulting in a net deficit of approximately -21,400 AFY. The P/MAs presented herein are expected to result in benefits (discussed below) that will address the projected deficit so as to avoid Undesirable Results and maintain sustainability.

*Tejon-Castac Management Area*

As discussed in **Section 9.3.11 *Overdraft Conditions***, the Tejon-Castac Management Area as a whole does not have a net water budget deficit over the historical period based on the Management Area-specific spreadsheet water budget model. The P/MAs presented herein are expected to result in benefits to support the avoidance of Undesirable Results and achieve sustainability.

## 17.6. Permitting and Regulatory Process

☑ **23 CCR § 354.44(b)(3)**

Permitting and regulatory requirements vary for the different P/MAs depending on whether they are infrastructure projects, recharge projects, demand reduction management actions, and so forth. The various types of permitting and regulatory requirements (not all applicable to every P/MA) include the following, if applicable:

- Federal
    - National Environmental Policy Act (NEPA) documentation, if federal grant funds are used;
    - National Pollution Discharge Elimination System (NPDES) stormwater program permit (administered by the California State Water Resources Control Board);
- State
    - CEQA documentation, including one or more of the following: Initial Study (IS), Categorical Exemption (CE), Negative Declaration (ND), Mitigated Negative Declaration (MND), Environmental Impact Report (EIR);
    - California State Water Resources Control Board permits and regulations regarding recycled water use, waste discharge, and stormwater capture for recharge;
    - California Surface Mining and Reclamation Act (SMARA) regulations;
    - California Division of Safety of Dams regulations;

[166] Prior to the start of water importation into the WRMWSD area in 1971, groundwater levels were in a state of chronic decline.

- Regional
  - San Joaquin Valley Air Pollution Control District (SJVAPCD) permit and regulations;
  - Power and Water Resources Pooling Authority (PWRPA);
- County/Local
  - Encroachment permits – Kern County, KDWD, CalTrans, and others;
  - Kern County grading permit;
  - Kern County well construction permit.

Specific currently-identified permitting and regulatory requirements for each P/MA are listed in ***Table PMA-1*** and ***Table PMA-2*** and described in **Section 17.2.1 *Water Supply Augmentation Projects*.** Upon implementation of any P/MA, the regulatory and permitting requirements of the P/MA will be re-examined.

## 17.7. Status and Implementation Timetable

☑ 23 CCR § 354.44(b)(4)

As discussed above in **Section 17.3 *Circumstances for Implementation***, P/MAs related to water quantity will be initiated in a manner and sequence that achieves the "glide path" level of expected benefits shown in ***Table PMA-3*** and ***Table PMA-4***, with accelerated implementation if Minimum Thresholds for Chronic Lowering of Groundwater Levels are exceeded at the Representative Monitoring Sites. ***Table PMA-1, Table PMA-2,*** and **Section 17.2.1 *Water Supply Augmentation Projects*** present preliminary estimates of the time required to complete/implement each P/MA and a timetable for accrual of expected benefits for the SOKR GSP Area. These estimates will be refined, as necessary, upon further evaluation of the P/MAs.

## 17.8. Expected Benefits

☑ 23 CCR § 354.44(b)(5)

The different categories of expected benefits are presented above in **Section 17.1.3 Benefit Categories**, and the specific expected benefits of each P/MA are presented in ***Table PMA-1*** and ***Table PMA-2***. Below is a discussion of how the expected benefits will be evaluated.

### 17.8.1. Evaluation of Benefits

Each of the AEWSD, Wheeler Ridge-Maricopa Water Storage District (WRMWSD), and TCWD-led P/MAs has expected benefits related to water quantity, and the two ACSD-led projects have expected benefits related to drinking water quality. Once a P/MA is implemented, it is important for there to be a way to evaluate, ideally to quantify, the benefits resulting from that P/MA. The way in which P/MA benefits are evaluated/quantified depends on the P/MA type. For those P/MAs that involve direct supply augmentation, the benefit is quantified directly through measurement of those flows and corresponding response in water levels. For P/MAs that involve indirect supply augmentation through, for example, increased surface water storage capacity and delivery flexibility, quantification of the benefit will require a comparison of the observed water supply condition (e.g., total imported water) against a hypothetical condition where the P/MA was not in place. For P/MAs that involve water demand reduction the benefit will be evaluated by comparison of the observed water demand condition (e.g., irrigated acreage) against a hypothetical condition where the P/MA was not in place. Because it is not possible to determine with certainty what the condition without the P/MA would be like, quantification of the benefits is inherently uncertain. For the two ACSD-led projects associated with water quality, evaluation of benefits will be done through regular water quality monitoring of ACSD wells, pursuant to its public water system permit.

As discussed above, although the P/MAs described herein are laid out along a general timetable defined by incremental elimination of water budget deficits (i.e., the "glide path"), the goals and objectives of P/MA implementation are not necessarily to achieve a certain water budget outcome, but rather to ensure that Undesirable Results for relevant Sustainability Indicators are avoided by the end of the SGMA implementation period (i.e., by 2040). For this reason, ultimately the success of the collective implementation of P/MAs will be determined by whether the Sustainability Goal is achieved.

### 17.8.2. Evaluation Relative to Water Level Sustainability Criteria

As mentioned in **Section 9 *Water Budget Information***, as part of its Basin coordination efforts, the SOKR GSAs participated in the development of a numerical groundwater water flow model for the Kern Subbasin based on DWR's California Central Valley Groundwater-Surface Water Simulation beta fine-grid model (C2VSim-FG). As part of this process, all Basin GSAs were asked to input their proposed P/MAs into the Baseline and 2030 Climate Change C2VSim-FG projected model scenarios to assess water level responses to SOKR GSP implementation relative to proposed Water Level Sustainability Criteria defined for each GSA/Management Area (see **Sections 14.1** and **15.1**). As demonstrated in ***Figure PMA-2***, for each of the 16 water level Representative Monitoring Sites within the Arvin-Edison Management Area, groundwater elevations are expected to meet their Minimum Thresholds under P/MA implementation in both the Baseline and 2030 Climate Change Scenarios. As demonstrated **in *Figure PMA-3***, for each of the 15 water level Representative Monitoring Sites within the Wheeler Ridge-Maricopa Management Area, groundwater elevations are expected to meet their Minimum Thresholds under P/MA implementation in both the Baseline and 2030 Climate Change Scenarios. For the single Representative monitoring Site within the Tejon-Castac Management Area, no model-based hydrograph is provided herein because the P/MAs in that Management Area are not expected to significantly affect groundwater level conditions. Water levels are also maintained at or above the Measurable Objectives upon full P/MA implementation for all three Management Areas. The results of this Basin-wide projected modeling exercise thus further support the notion that the proposed P/MA implementation strategy is expected to result in sustainable management of groundwater levels within the SOKR GSP Area**.**

## 17.9. Source and Reliability of Water from Outside South of Kern River GSP Area

☑ **23 CCR § 354.44(b)(6)**

*Arvin-Edison Management Area*

Several of the P/MAs discussed above and shown in ***Table PMA-1*** rely on additional water supplies from outside of the Arvin-Edison Management Area. Specifically, certain P/MAs rely on the availability of water during wet years to fill surface storage, conduct managed recharge, and offset groundwater pumping. As discussed in **Section 9.1.4 *Projected Water Budget***, the volume of CVP supplies is anticipated to decrease under the 2030 Climate Change Scenario relative to the Baseline Scenario, and that decrease is the main cause of the projected deficit. However, the Friant Water Authority (FWA) projections of Friant-Kern deliveries to AEWSD (FWA, 2018) assume a certain level of demand for Paragraph 16(b) wet year supplies, as described in the following excerpts:

> "This analysis simulates 16(b) delivery via the Friant Kern and Madera canals with an anticipated level of future groundwater infiltration facilities throughout the Friant Division. These facilities were contemplated as a result of SJRRS implementation, and are described by analysis in the SJRRS PEIS/R.
>
> The future management of 16(b) supplies cannot be fully anticipated at this time. Policy for the allocation of supplies has been in a constant state of evolution. For the purposes of this TM, a suggested allocation of 16(b) supplies among Friant Contractors is presented, based on the relative expected reduction in delivery of SJRRS on Class 1 and 2 contract supplies, by contractor."

The FWA (2018) further states:

> "The second SJRRS water category, Paragraph 16(b) supplies, are quantified in the CalSim II model by assuming a demand for this potential supply and meeting this demand, limited by availability of flood water and channel capacity for delivery."

The level of demand within the Arvin-Edison Management Area that is assumed in the CalSim II modeling for the FWA analysis is almost certainly less than the level of demand under the proposed P/MAs discussed herein. Therefore, with additional demand for wet year (Paragraph 16(b)) supplies created by implementation of various P/MAs within the Arvin-Edison Management Area, this analysis assumes that additional Paragraph 16(b) water will be available.

In addition to the apparent underestimation of Friant Kern supplies available to AEWSD described above, the Arvin GSA will continue its efforts to refine modeling results but also continue to secure additional water supplies for importation into the Arvin-Edison Management Area through transfers, exchanges, and purchases, as necessary and possible given pricing and timing constraints.

*Wheeler Ridge-Maricopa Management Area*

Several of the P/MAs discussed above and shown in ***Table PMA-2*** rely on additional water supplies from outside of the Wheeler Ridge-Maricopa Management Area. Specifically, certain P/MAs rely on the availability of water during wet years to conduct managed recharge, banking inside and outside of the Wheeler Ridge-Maricopa Management Area, and offset groundwater pumping. As discussed in **Section 9.2.4 *Projected Water Budget***, the volume of SWP supplies is anticipated to decrease under the 2030 Climate Change Scenario relative to the historical water budget period (Water Year [WY] 1995 – 2014) and the Baseline Scenario, and that decrease is the main cause of the projected deficit. However, the Wheeler Ridge-Maricopa GSA understands that additional wet year supplies may be available, if sufficient infrastructure is developed to take it in (within or outside of the District). Furthermore, WRMWSD is an active participant in the various surface water transfer, exchange and purchase markets in the Central Valley and will continue those efforts.

The WRMWSD is also participating in efforts to develop several new surface water supplies that would provide a more regular (i.e., year to year) source of supply, to be conveyed through the California Aqueduct. These potential additional sources of supply include the following:

- Sites Reservoir Project; and

- Water Fix and Eco Restore (formerly known as the Bay Delta Conservation Plan, referred to in ***Table PMA-3*** as the “Thru Delta” Facility).

## 17.10. Legal Authority Required

☑ 23 CCR § 354.44(b)(7)

The Arvin GSA, Wheeler Ridge-Maricopa GSA, TCWD GSA and ACSD are Participating Members of the development and implementation of the SOKR GSP, which is formalized in a Memorandum of Agreement (MOA). Each Participating Member, as water storage district or water district, possesses the legal authority to implement the supply augmentation P/MAs discussed herein. ACSD, as a public water system, has the legal authority to implement the drinking water quality projects discussed herein. As GSAs, per California Water Code (CWC) § 10725 through 10726.8, the SOKR GSAs possess the legal authority necessary to implement the demand management P/MAs described herein, and will either act upon Participating Members’ behalf to enforce these P/MAs as necessary or will delegate authority to Participating Members themselves to enforce the SOKR GSP within each Management Area.

## 17.11. Estimated Costs and Plans to Meet Them

☑ 23 CCR § 354.44(b)(8)

Estimated costs for each P/MA are presented in ***Table PMA-1*** and ***Table PMA-2***. Given the uncertainty in the scope and timing of these P/MAs, the costs are presented as ranges, and in all cases are considered approximate subject to refinement. These costs include “one-time” costs and ongoing costs. The one-time costs may include capital costs associated with construction, feasibility studies, permitting, environmental (CEQA) compliance, or any other costs required to initiate a given P/MA. The ongoing costs are associated with O&M and/or costs to otherwise continue implementing a given P/MA. It should be noted that depending on the source and nature of funding for the P/MAs, the one-time costs may or may not be incurred entirely at the beginning of the P/MA; in some instances, loans or other financing options may allow for spreading out of “one-time” costs over time.

*Arvin-Edison Management Area*

Potential sources of funding for the various P/MAs within the Arvin-Edison Management Area are also presented in ***Table PMA-1***, and include the following:

- AEWSD funds, generally supported by fees charged to landowners within AEWSD, including potentially the following:
  - General fund
  - SGMA compliance subaccount (to be created)
- Partnering agencies for certain P/MAs (e.g., KDWD, TCWD, Cities of Bakersfield and Arvin, oil field producers)
- Grant funding from sources including DWR, United States Bureau of Reclamation (USBR), and the Federal Emergency Management Agency (FEMA)
- ACSD funds, generally supported by local rate payers
- Other

*Wheeler Ridge-Maricopa Management Area*

Potential sources of funding for the various P/MAs within the Wheeler Ridge-Maricopa Management are also presented in ***Table PMA-2***, and include the following:

- WRMWSD funds, generally supported by fees charged to landowners within WRMWSD, including potentially the following:
    - General fund
    - SGMA compliance subaccount (to be created)
- Partnering agencies for certain P/MAs
- Grant funding from sources including DWR and others
- Other

*Tejon-Castac Management Area*

Potential sources of funding for the two proposed P/MAs within the Tejon-Castac Management Area may include the following:

- TCWD funds, generally supported by fees charged to landowners within TCWD (i.e., TRC), including potentially the following:
    - General fund
    - SGMA compliance subaccount (to be created)
- Partnering agencies for certain P/MAs (e.g., AEWSD)
- Grant funding from sources including DWR and others
- Other

Upon implementation of any given P/MA, the available funding sources for that P/MA will be re-examined.

## 17.12. Management of Recharge and Groundwater Extractions

**☑ 23 CCR § 354.44(b)(9)**

As stated previously in **Section 9 *Water Budget Information***, under historical conditions (WY 1995 – 2014) the SOKR GSP area as a whole is in a state of approximate water supply/demand balance (i.e., a small net surplus of approximately 5,000 AFY, based on the Management Area-specific spreadsheet water budget models). Under the projected Baseline and 2030 (and 2070) Climate Change Scenarios, however, a net water supply deficit is projected to occur within the SOKR GSP area. That projected deficit is due, in large part, to a projected reduction in imported water supplies.[167,168] However, as discussed above, one of the primary means by which the deficit will be addressed is through the implementation of P/MAs that obtain additional outside sources of water, in particular during normal to wet years. Many of the projects discussed herein and shown on ***Table PMA-1*** and ***Table PMA-2*** take advantage of additional wet year supplies that are assumed to be available once demands increase. These P/MAs include various direct recharge projects and projects that increase storage capacity and delivery flexibility.

In addition to these supply augmentation projects, the portfolio also includes policy-based management actions aimed at demand reduction. Some of these management actions aim to reduce overall water demand, and others are more specifically focused on reducing groundwater pumping. These management actions will rely initially on financial incentives (e.g., tiered pricing and/or fees) to drive voluntary demand reduction, but also include setting of mandatory groundwater pumping allocations, if necessary. A groundwater allocation program would likely include mechanisms to allow for trading or exchange of pumping allocations within designated areas, subject to constraints dictated by groundwater conditions observed within the Monitoring Network and policies developed by the respective Board of Directors for each of the SOKR GSAs. Through this combination of increased recharge during wet years and as-needed demand reduction, the SOKR GSAs' P/MA efforts will ensure that chronic lowering of groundwater levels and reduction in storage during drought will be offset by increases in groundwater levels and storage during other periods.

[167] For TCWD, a net water supply deficit is only projected to occur under the 2030 (and 2070) Climate Change Scenarios when using the lower end of assumptions for future precipitation and upper end for future evapotranspiration (ET). However, because land use within the Tejon-Castac Management Area is limited to natural vegetation (i.e., native rangelands), it is unlikely that a net deficit would actually occur; rather, ET demands of the native vegetation would adjust to changes in the available precipitation.

[168] As mentioned in **Section 17.9 *Source and Reliability of Water from Outside South of Kern River GSP Area***, the assumptions used in the FWA modeling analysis (FWA, 2018) regarding demand for Paragraph 16(b) water likely underestimate the demand for such wet year water within AEWSD, and therefore also underestimate Friant-Kern deliveries to AEWSD under the 2030 and 2070 conditions.

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Groundwater Quality | Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Projects to Enhance Recharge*** | | | | | | | | | | |
| AE-1 | **AEWSD Sunset Spreading Works** | The Sunset Spreading Works, approximately 150 acres, is located on the boundary between AEWSD and KDWD, adjacent to KDWD's Eastside Canal. The Project will take surface water (Federal CVP, State Water Project, or local supplies) diverted through KDWD's Eastside Canal and recharge the surface supplies as part of AEWSD's and KDWD's joint water management programs. The Project will include the construction of exterior and interior dikes for a direct recharge facility, a new turnout and pump station from the KDWD Eastside Canal, and interbasin structures. | x | x | | To be implemented upon completion of design and construction | Infrastructure improvement; no public noticing necessary | KDWD encroachment permit; CEQA; NEPA if federal funds are used | Completed land acquisition, operations and maintenance agreement approved, earthworks and structures contracts awarded; pump station and pipeline design and consutrction are anticipated to be compelted by the end of 2022. | To be initiated upon grant funding and completion of design and construction. |
| AE-2 | **Private & Caltrans Basin Connections** | This project involves the construction of pipelines to connect several on-farm private basins and Caltrans sumps near AEWSD to utilize for groundwater recharge. | x | | | Grant funding | Infrastructure improvement; no public noticing necessary | Caltrans permitting; CEQA if longer pipeline connections are required | Not yet initiated | Upon grant funding |
| ***Projects to Manage and/or Capture Floodwater*** | | | | | | | | | | |
| AE-3 | **Sycamore Creek Detention & Sedimentation Basin** | The proposed basin would serve to intercept sediment from Sycamore creek flows to prevent constriction where sediment deposits downstream, reduce the peak outflow, and prevent the likelihood of a canal and spreading basing breach. Detained water could be recirculated for irrigation demands or recharged for groundwater supply augmentation. | x | x | | Grant funding | Infrastructure improvement; no public noticing necessary | County grading permit; NEPA if federal grant funds used; SMARA (potentially) | Not yet initiated | Upon grant funding |
| AE-4 | **AEWSD South Canal Flood Study / Improvements** | The South Canal Flood Study would review and possibly revise the FEMA floodplain in this area in order to increase the height of the canal bank to provide additional operational freeboard and accordingly reduce the potential for canal spills and subsequent flooding.The additional canal storage could allow for the caputure and use of additional floodwater in-lieu of groundwater pumping. | x | | | Grant funding | Infrastructure improvement; no public noticing necessary | Not applicable for study | Initiated the South Canal Flood Study, including idetnification of potential grant funding sources | Study initiated upon GSP adoption |
| AE-5 | **Stormwater Management and Flood Control Improvements** | Potential construction of new sedimentation/detention basins, flood ditch erosion protection, Spillway Basin expansion, lengthening the South Canal's siphon under David Road or extension of the South Canal liner through designated floodplain reaches. | x | x | | Grant funding/Completion of feasibility study | Infrastructure improvement; no public noticing necessary | Permits: TBD; NEPA requirements if funds are granted | Not yet initiated | TBD upon available funding; excessive flooding or further damages may expedite initiation |
| AE-6 | **On-Farm Recharge** | The program will encourage individual growers to perform on-farm recharge for individual and aggregated benefits. Water may be recharged on-farm in private basins and/or distributed through irrigation systems across irrigated acreage in excess of current crop ET. | x | | | Underway | No public notice required for implementation; outreach and education will expand program. | Not applicable | Underway | Underway |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| | | | | Expected Benefits | | | | | | | | Estimated Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | | Secondary | | | | | | | | |
| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Water Supply Augmentation | Water Demand Reduction | Water Quality Improvement | Flood Control | Water Management Flexibility / Efficiency | Data Gap Filling/ Monitoring | Source(s) of Water, if applicable | Legal Authority Required | One-time Costs | Ongoing Costs (per year) | Potential Funding Source(s) |
| ***Projects to Enhance Recharge*** | | | | | | | | | | | | | | |
| AE-1 | **AEWSD Sunset Spreading Works** | Construction duration: approx. 1~~2~~ years | 1 year after construction | 2,000 - 3,000 AFY recharge | 410 AFY | x | | x | | Additional wet-year imported water supplies | Existing Authority as a Water Storage District | $7,330,000 (including property purchase; scalable) | TBD | AEWSD (50%), KDWD (50%) |
| AE-2 | **Private & Caltrans Basin Connections** | Construction duration: within 5 years | 1-3 years after construction | 50 - 500 AFY recharge | | | | | | Additional wet-year imported water supplies;<br>Local stormwater | None | $100K - $500K | Not applicable | AEWSD, Grants |
| ***Projects to Manage and/or Capture Floodwater*** | | | | | | | | | | | | | | |
| AE-3 | **Sycamore Creek Detention & Sedimentation Basin** | Construction duration: approx. 2 years | 1-3 years after construction | 200 - 300 AFY stormwater capture | | | x | | | Local stormwater | None | $2M - $3M | $10K - $30K | AEWSD, Grants |
| AE-4 | **AEWSD South Canal Flood Study / Improvements** | Study approx. 1 year; construction approx. 1 year | 1-3 years after construction | 100 - 200 AF increased storage capacity / stormwater capture | | | x | x | | Local stormwater | None | $200K - $300K for study plus construction costs estimated at $2M | Not applicable | AEWSD, FEMA Grants |
| AE-5 | **Stormwater Management and Flood Control Improvements** | Construction duration: approx. 1 year | 1-3 years after construction | TBD | | x | x | | | Local stormwater | None | $1M - $10M | TBD | AEWSD and partering agencies |
| AE-6 | **On-Farm Recharge** | Ongoing | Immediately | TBD | | | | | | Local stormwater | None | None | None | Private, if required |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Groundwater Quality | Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| AE-7 | **Caliente Creek Habitat Mitigation and Groundwater Recharge** | Restoration of agricultural lands to native vegetation to provide flood mitigation. Two alternatives arebeing considered, of which Alternative 1 is partial agricultural and 2 is non-agricultural. | x | | | Grant funding | | CEQA; NEPA (if federal funds used); SWRCB Waste Discharge Requirements; CDFW Agreement; Determination of consistency with VFHCP | Not yet initiated | TBD, upon grant funding |

| | | | | Expected Benefits | | | | | | | | Estimated Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | | Secondary | | | | | | | | |
| **P/MA Number** | **P/MA Name** | **Timetable for Completion** | **Timetable for Accrual of Expected Benefits** | **Water Supply Augmentation** | **Water Demand Reduction** | **Water Quality Improvement** | **Flood Control** | **Water Management Flexibility / Efficiency** | **Data Gap Filling/ Monitoring** | **Source(s) of Water, if applicable** | **Legal Authority Required** | **One-time Costs** | **Ongoing Costs (per year)** | **Potential Funding Source(s)** |
| AE-7 | **Caliente Creek Habitat Mitigation and Groundwater Recharge** | Construction duration TBD | flood control benefits immediately | TBD | | | x | | | Local stormwater | None | $1.6 M for Alternative 1; $3.8 M for Alternative 2 | TBD | AEWSD, Grants |

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Relevant Sustainability Indicators Affected: Groundwater Quality | Relevant Sustainability Indicators Affected: Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Projects to Increase Surface Storage Capacity / Delivery Flexibility*** | | | | | | | | | | |
| AE-8 | **AEWSD Intake Canal / KDWD Buena Vista Canal Intertie** | Improvement of existing and/or construction of new interties between AEWSD Intake Canal and KDWD's Buena Vista Canal to facilitate water exchanges between the two districts and Kern County partners. | x | | | Completion of feasibility study | Infrastructure improvement; no public noticing necessary | None (CEQA exempt under 15301 and 15303) | Not yet initiated | TBD |
| AE-9 | **AEWSD Intake Canal / KDWD Farmer's Canal Intertie** | Improvement of existing and/or construction of new interties between AEWSD Intake Canal and KDWD's Farmer's Canal to facilitate water exchanges between the two districts and Kern County partners. | | | | | Infrastructure improvement; no public noticing necessary | None (CEQA exempt under 15301 and 15303) | Not yet initiated | TBD |
| AE-10 | **AEWSD Wasteway Basin Improvements** | The primary use of the existing AEWSD Wasteway Basin is to provide emergency water storage in the event of power failure. Additionally, it works as a detention facility for the City of Bakersfield stormwater. This project would include construction of a HDPE liner along the levees, installation of recirculation pumps, and basin grading. These improvements would allow the basin to serve as a location to divert and clarify sediment. | x | | | Project to be implemented upon FEMA grant approval. | Infrastructure improvement; no public noticing necessary | SJVAPCD Dust Control & SWPPP;<br>NEPA Cultural Resources | Not yet initiated; AEWSD submitted a Notice of Intent application in 2021 for the CalOES Building Resilient Infrastructure and Communities (BRIC) funding opportunity | Initiation upon FEMA grant approval |
| AE-11 | **Forrest Frick Pipeline / KDWD Eastside Canal Intertie** | This project would connect the Forrest Frick Pipeline to the KDWD Eastside Canal to send AEWSD SW supplies through KDWD to serve portions of the AEWSD GWSA with temporary water contracts, utilizing existing infrastructure (turnouts, pipelines that are both District and landowner owned). With the District's new 9(d) contract, certain provisions of Reclamation law are no longer applicable and all lands within the service area can now be served with federal water supplies. | x | x | | To be implemented upon adoption of SOKR GSP and Grant funding | Infrastructure improvement; no public noticing necessary | CEQA;<br>NEPA requirements if grant funds are used; possible County encroachment permits | $500,000 in federal grant funding awarded; CEQA completed; NEPA initiated | TBD |
| AE-12 | **AEWSD North Canal Balancing Reservoir Expansion & Discharge Pipelines** | The proposed project will consist of the installation of a pipeline system that will convey flows from the four (4) wells within the AEWSD Balancing Reservoir directly to the basin discharge structure and no longer through the basin low flow channels. Infiltration and evaporation losses on well discharge flows will be eliminated and power efficiency for the wells (kwh/af) will be significantly enhanced since all water pumped will be discharged into the North Canal. | x | | | Completion of feasibility study | Infrastructure improvement; no public noticing necessary | None | Not yet initiated | Upon grant funding |
| AE-13 | **AEWSD Lateral Capacity Improvement Projects** | Increase delivery capacity of the AEWSD N-55 lateral system. Some examples of the actions considered for this project are: replacement of lateral system and landowner pipelines, renovation of storage tanks, construction of pump stations, etc. | x | | | Grant funding/Completion of feasibility study | Infrastructure improvement; no public noticing necessary | Permits: TBD;<br>NEPA requirements if funds are granted | Not yet initiated | TBD |
| AE-14 | **Conversion of Granite Quarry to Sycamore Reservoir** | The Granite Co. quarry, located upstream of the Sycamore Spreading Basins, is approaching the end of its operational life and could be converted into a balancing / detention / spreading reservoir. Excess flows in the North Canal could be pumped into the quarry reservoir, so the detained water could be recirculated for irrigation demands in-lieu of groundwater pumping and/or recharged. | x | x | | To be implemented upon adoption of SOKR GSP / Grant funding | Infrastructure improvement; no public noticing necessary | CEQA; DMR SMARA permit closure;<br>NEPA requirements if grant funds are used | Not yet initiated; AEWSD has participated in several meetings to discuss the permitting process for this project | TBD |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| | | | | Expected Benefits | | | | | | | | Estimated Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | | Secondary | | | | | | | | |
| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Water Supply Augmentation | Water Demand Reduction | Water Quality Improvement | Flood Control | Water Management Flexibility / Efficiency | Data Gap Filling/ Monitoring | Source(s) of Water, if applicable | Legal Authority Required | One-time Costs | Ongoing Costs (per year) | Potential Funding Source(s) |
| ***Projects to Increase Surface Storage Capacity / Delivery Flexibility*** | | | | | | | | | | | | | | |
| AE-8 | **AEWSD Intake Canal / KDWD Buena Vista Canal Intertie** | Construction duration: approx. 1 year | 1 year after construction | 8,000 AFY increased transfer/ exchange potential | | | | x | | Additional wet-year imported water supplies | None | $2M - $5M | ~$20,000 | AEWSD, KDWD |
| AE-9 | **AEWSD Intake Canal / KDWD Farmer's Canal Intertie** | Construction duration: approx. 1 year | 1 year after construction | 4,000 AFY increased transfer/ exchange potential | | | | x | | Additional wet-year imported water supplies | None | $1M - $2.5M | ~$20,000 | AEWSD, KDWD |
| AE-10 | **AEWSD Wasteway Basin Improvements** | Construction duration: 3 years | Upon completion of construction | 1,550 AFY stormwater capture | | | x | x | | Stormwater from Bakersfield storm sewer system | None | $2.5M | ~$32,000 | FEMA 75% - AEWSD 25% |
| AE-11 | **Forrest Frick Pipeline / KDWD Eastside Canal Intertie** | Construction duration TBD | 1-3 years after construction | 10 AFY recharge; 3 AFY/ac of land served | | x | | x | | Additional wet-year imported water supplies | None | $0.5M - $1.5M | TBD | AEWSD, USBR |
| AE-12 | **AEWSD North Canal Balancing Reservoir Expansion & Discharge Pipelines** | Construction duration TBD | 1-3 years after construction | 16 AF increased storage capacity; 100 AFY recharge | 50 AFY reduced evaporative losses | | | x | | Additional wet-year imported water supplies | None | $300K | TBD | AEWSD, Grants |
| AE-13 | **AEWSD Lateral Capacity Improvement Projects** | Construction duration TBD | TBD | 1,000 AFY increased delivery capacity | | | | x | | Additional wet-year imported water supplies | None | $10M - $20M | TBD | AEWSD |
| AE-14 | **Conversion of Granite Quarry to Sycamore Reservoir** | Construction duration TBD | 1-3 years after construction | 3,000 - 6,000 AFY recharge; 2,500 AF increased storage capacity | | x | | x | | Additional wet-year imported water supplies | Will require property acquisition or land use agreement with quarry owner | $10M - $20M | TBD | AEWSD, TCWD, Grants |

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Relevant Sustainability Indicators Affected: Groundwater Quality | Relevant Sustainability Indicators Affected: Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| AE-15 | **AEWSD South Canal Balancing Reservoir** | Creation of a reservoir to allow water storage for flow mismatches in the AEWSD canal system during operation or emergencies. Depending on the location, this reservoir would increase storage capacity by ~500 AF. | x | | | Grant funding, South County flooding response | Infrastructure improvement; no public noticing necessary | Not available | Not yet initiated | TBD |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Expected Benefits: Primary: Water Supply Augmentation | Expected Benefits: Primary: Water Demand Reduction | Expected Benefits: Secondary: Water Quality Improvement | Expected Benefits: Secondary: Flood Control | Expected Benefits: Secondary: Water Management Flexibility / Efficiency | Expected Benefits: Secondary: Data Gap Filling/ Monitoring | Source(s) of Water, if applicable | Legal Authority Required | Estimated Costs: One-time Costs | Estimated Costs: Ongoing Costs (per year) | Estimated Costs: Potential Funding Source(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AE-15 | **AEWSD South Canal Balancing Reservoir** | Construction duration TBD | TBD | 500 AF increased storage capacity | 190 AFY | | | x | | Additional wet-year imported water supplies | None | $1M - $10M | ~$5,000 | AEWSD |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected | | | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Groundwater Levels & Storage | Groundwater Quality | Land Subsidence | | | | | |
| ***In-Lieu Projects*** | | | | | | | | | | |
| AE-16 | **Frick Unit In-Lieu Project** | This project would increase the ability of the District to provide surface water supplies to the Groundwater Service Area (GWSA) to help meet crop irrigation requirements. With the Project, the District will supply surface water when available through new facilities to the GWSA to meet crop irrigation requirements with the intent of reducing District wide groundwater use. | | | | | Infrastructure improvement; no public noticing necessary | CEQA; NEPA requirements if grant funds are used; PWRPA; possible Kern County encroachment permits | Not yet initiated | Upon grant funding |
| AE-17 | **DiGiorgio Unit In-Lieu Project** | The District will supply SW when available through new facilities to the GWSA to meet its water requirements with the intent of reducing District-wide GW use. However, when SW is in short supply and under agreement, the landowners could recover and return GW from their own wells to the District canal system through new pipelines once they have satisfied their own water needs. | x | x | | Grant funding/ project completion | Infrastructure improvement; no public noticing necessary | CEQA; NEPA requirements if grant funds are used; PWRPA; possible Kern County encroachment permits | Completed Phase I; $2M in federal grant funding awarded for Phase II. | Future Phases initiated upon grant funding |
| AE-18 | **General In-Lieu Banking Program** | The In-Lieu Banking Program consists of suppling surface water to landowners that previously relied only on groundwater (GWSA). New infrastructure would have to be built to facilitate the implementation of this program. | x | x | | Grant funding | Infrastructure improvement; no public noticing necessary | CEQA; NEPA requirements if grant funds are used; PWRPA; possible Kern County encroachment permits | Imported and delivered surface water in WY 2020 to contracted and non-contracted lands; completed preliminary designs for two additional in-lieu units; CEQA underway. | Upon grant funding |
| ***Projects to Develop New Supplies*** | | | | | | | | | | |
| AE-19 | **Reclamation of Oilfield Produced Water** | Reclaiming water from oil production facilities for irrigation purposes is currently an untapped water source in AEWSD. After treatment and cooling, produced water could be pumped into AEWSD facilities to serve irrigation demands in-lieu of groundwater pumping. | x | x | | To be implemented upon adoption of AEWSD GSP Chapter/ agreement with partnering oil field | Public meetings | TBD | Not yet initiated | Upon agreement with oil field producers |
| AE-20 | **Wastewater Reclamation with City of Arvin & Bakersfield** | Reclaiming water from Cities of Arvin and Bakersfield wastewater treatment facilities for irrigation purposes is currently an untapped water source in AEWSD. After wastewater treatment, the effluent could be pumped into AEWSD facilities to serve irrigation demands in-lieu of groundwater pumping. | x | | | To be implemented upon adoption of AEWSD GSP Chapter / agreement with City of Arvin and City of Bakersfield | Public meetings | City encroachment permits; SWRCB Waste Discharge Requirements | Not yet initiated | Upon agreement with cities |
| ***Management Actions / Policies to Reduce Overall Water Demand*** | | | | | | | | | | |
| AE-21 | **Incentives for Land Conversion** | The District would provide subsidies to incentivize groundwater users to convert land to alternative land uses (e.g. solar farms) and reduce groundwater extractions. The District may consider a subsidy structure study to determine which subsidies would result in the greatest expected annual benefit in acre-feet per year. | x | | x | To be implemented upon adoption of AEWSD GSP Chapter | District flyers, direct mail, public meetings | None | Not yet initiated | Upon adoption of GSP |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| | | | | Expected Benefits | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | | Secondary | | | | | | Estimated Costs | | |
| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Water Supply Augmentation | Water Demand Reduction | Water Quality Improvement | Flood Control | Water Management Flexibility / Efficiency | Data Gap Filling/ Monitoring | Source(s) of Water, if applicable | Legal Authority Required | One-time Costs | Ongoing Costs (per year) | Potential Funding Source(s) |
| ***In-Lieu Projects*** | | | | | | | | | | | | | | |
| AE-16 | **Frick Unit In-Lieu Project** | TBD | 1-3 years after completion | 3,500 AFY increased surface water deliveries | | x | | | | Additional wet-year imported water supplies | None | TBD | TBD | AEWSD |
| AE-17 | **DiGiorgio Unit In-Lieu Project** | TBD | 1-3 years after completion | 4,250 AFY increased surface water deliveries | | x | | | | Additional wet-year imported water supplies | None | Phases II-V: $17M | TBD | AEWSD, federal funds |
| AE-18 | **General In-Lieu Banking Program** | TBD | 1-3 years after completion | 2.75 AFY/ac increased surface water deliveries every 2.5 years | | x | | | | Additional wet-year imported water supplies | None | $1M - $10M | TBD | AEWSD |
| ***Projects to Develop New Supplies*** | | | | | | | | | | | | | | |
| AE-19 | **Reclamation of Oilfield Produced Water** | TBD | 1 year after agreement | 1,000 AF/yr | | | | | | oil field produced water | None | TBD | TBD | AEWSD and partnering oilfield |
| AE-20 | **Wastewater Reclamation with City of Arvin & Bakersfield** | TBD | 1 year after agreement | 10,000 AFY | | | | | | wastewater from Cities or Arvin and Bakersfield | None | TBD | TBD | AEWSD and partnering cities |
| ***Management Actions / Policies to Reduce Overall Water Demand*** | | | | | | | | | | | | | | |
| AE-21 | **Incentives for Land Conversion** | TBD | 3-5 years after implementation | | 2.75 AFY/ac of land converted | | | | | reduced irrigated area resulting in decreased ET | Authority of GSA under SGMA to develop and implement GSP | $15K - $30K | ~$10,000 - $1M | AEWSD |

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Relevant Sustainability Indicators Affected: Groundwater Quality | Relevant Sustainability Indicators Affected: Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| AE-22 | **On-farm Water Conservation** | The NRCS is offering landowner incentive programs to assist in implementing various conservation activities, including but not limited to: irrigation system improvements, water/nutrient/pest management, and pump engine replacement. Interested landowners can call (661) 336-0967 or visit the website (www.ca.nrcs.usda.gov) for more information. | x | | | Grant funding | District flyers, direct mail, public meetings | None | Not yet initiated | Upon stakeholder interest |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| | | | | Expected Benefits | | | | | | | | | Estimated Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | | Secondary | | | | | | | | | |
| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Water Supply Augmentation | Water Demand Reduction | Water Quality Improvement | Flood Control | Water Management Flexibility / Efficiency | Data Gap Filling/ Monitoring | Source(s) of Water, if applicable | Legal Authority Required | One-time Costs | Ongoing Costs (per year) | Potential Funding Source(s) |
| AE-22 | **On-farm Water Conservation** | TBD | 1-3 years after initiation | | 50 - 500 AFY | | | | | conservation practices resulting in decreased applied water and crop consumptive use | None | $10K-100K | Not applicable | NRCS |

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Groundwater Quality | Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Management Actions / Policies to Reduce Groundwater Pumping*** | | | | | | | | | | |
| AE-23 | **Groundwater Fee Increase** | Increase GWSA costs to incentivize groundwater users to reduce groundwater extractions and take surface water when available. The District may consider modifying its fee structure study to determine the best strategy for curbing groundwater overdraft without causing inequitable economic impact. | x | | x | Contingent on P/MAs 15, 16, and 17. | District flyers, direct mail, public meetings | Prop 218 or through District rate setting | Not yet initiated | As-needed to meet milestones, depending on participation in P/MA 17 |
| AE-24 | **Groundwater Extraction Quantification Method** | Application of a new policy to specify an approved method to quantify the individual and aggregated groundwater extractions for the required SGMA annual reporting. Some methods to consider (or a combination of them) are the following: (1) Irrigated Acreage determined by aerial imagery; (2) Irrigated area hybrid determined by annual crop survey alongside aerial imagery; (3) Calibrated energy records; (4) Volumetric flow measurement; (5) Remote sensing of evapotranspiration; (6) Other. | x | | x | To be implemented upon adoption of AEWSD GSP Chapter | District flyers, direct mail, public meetings | None | Conducted analysis using DWR Cal-SIMETAW model in WY 2020; 50 groundwater pumping meters installed | Upon adoption of GSP and discretion of GSA Board |
| AE-25 | **Groundwater Allocation per Acre** | This program would provide a finite groundwater allocation on a per acre basis. The policy would identify and forecast the demands associated with existing water rights, domestic and environmental uses. The sustainable yield and ultimate groundwater allocation would take into consideration the applicable beneficial uses and users of groundwater. Once an individual groundwater allocation is determined, the District may adopt a policy which provides a gradual “ramp-down” wherein an allocation would decrease over time to arrive at the actual groundwater allocation to allow growers time to adjust to the concept of an allocation and, for some growers, a reduction in groundwater use. The policy would detail the number of years and amount of reduction each year. | x | | x | To be implemented upon adoption of AEWSD GSP Chapter | District flyers, direct mail, public meetings | GSA adoption of resolution; potentially CEQA | Not yet initiated | As-needed to meet milestones, if other new supplies are not developed as anticipated |
| AE-26 | **Groundwater Marketing & Trading** | Contingent on the GW extraction quantification and allocation programs, the District would pursue a groundwater market and trading program to provide uses and beneficial users more flexibility in utilizing a groundwater allocation. The District may adopt a policy to define a groundwater trading program, acknowledging that many complexities and considerations required to successfully initiate and manage a trading program may arise. Therefore the District should discuss any other water bank/credit systems in existence. The District may adopt a groundwater trading structure and consider a variety of structures including: (1) Bilateral contracts or "coffee shop" markets; (2) Brokerage; (3) Bulletin boards; (4) Auctions and reverse auctions; (5) Electronic clearing-houses or "smart markets" ; (6) Other trade structures. | x | | x | Contingent on Management Actions 23 and 24 | District flyers, direct mail, public meetings | GSA adoption of resolution; potentially CEQA | Not yet initiated | As-needed to meet milestones, if other new supplies are not developed as anticipated |
| AE-27 | **Education of Groundwater Use per Acre** | This program would provide groundwater users an expected groundwater volume, as an education tool, prior to enforcement actions on groundwater allocations, with the goal of providing awarness of overdraft conditions. This information would be provided in an annual letter, along with average crop demand, GSA average extraction, GW overdraft, and reminders of GSA powers and authorities. | x | | | To be implemented upon adoption of AEWSD GSP Chapter | District flyers, direct mail, public meetings | None | Not yet initiated | upon GSP adoption |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| | | | | Expected Benefits | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | | Secondary | | | | | | Estimated Costs | | |
| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Water Supply Augmentation | Water Demand Reduction | Water Quality Improvement | Flood Control | Water Management Flexibility / Efficiency | Data Gap Filling/ Monitoring | Source(s) of Water, if applicable | Legal Authority Required | One-time Costs | Ongoing Costs (per year) | Potential Funding Source(s) |
| ***Management Actions / Policies to Reduce Groundwater Pumping*** | | | | | | | | | | | | | | |
| AE-23 | **Groundwater Fee Increase** | TBD | 1-3 years after implementation | | quantity TBD | | | | | reduced irrigated area resulting in decreased ET | Authority of GSA under SGMA to develop and implement GSP | NA | NA | NA |
| AE-24 | **Groundwater Extraction Quantification Method** | Dependent on methodology; approx. 2-3 years | 1 year after implementation | | | | | x | x | NA | Authority of GSA under SGMA to develop and implement GSP | $25K - $1M | ~$25,000 | AEWSD |
| AE-25 | **Groundwater Allocation per Acre** | TBD | 1-3 years after implementation | | quantity TBD | | | | | mandatory reduction in District-wide groundwater pumping | Authority of GSA under SGMA to develop and implement GSP | $25K - $100K | NA | AEWSD |
| AE-26 | **Groundwater Marketing & Trading** | 1-2 years after initiation by GSA Board | 1-3 years after implementation | | | | | x | | NA | Authority of GSA under SGMA to develop and implement GSP | $25K - $100K | $25,000 - $50,000 | AEWSD |
| AE-27 | **Education of Groundwater Use per Acre** | TBD | 1 year after initiation | | 100 AFY | | | | | conservation practices resulting in decreased applied water and crop consumptive use | None | $10K - $20K | $5K | AEWSD |

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Groundwater Quality | Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Projects to Improve Drinking Water Quality in ACSD Service Area*** | | | | | | | | | | |
| AE-28 | **ACSD Emergency 1,2,3-TCP Treatment at Well No. 13** | The project involves the installation of emergency 1,2,3-TCP treatment at the well head. The work will include installation of a skid mounted treatment system with two granular activated carbon media vessels for removal of 1,2,3-TCP, connection to the existing well discharge piping, installation of below ground and above ground influent and effluent piping and appurtenances, electrical and controls, and modifications to the existing well site PLC programming. | | x | | Implementation underway | Public meetings, direct mail | Title 22 Drinking Water Regulations | Emergency treatment at Well #13 completed | Completed |
| AE-29 | **ACSD Arsenic Mitigation Project - Phase II** | The purpose of the project is to bring the ACSD water system into compliance for Arsenic. All five of the ACSD active wells exceed the maximum contaminant level (MCL) of 10 ppb for Arsenic. The project was separated into two phases. Phase II involves drilling three new wells, constructing a 1.0 MG storage tank and booster pumping plant, and connecting the facilities to the existing distribution system. The original five (5) water wells will then be abandoned and destroyed in accordance with Kern County Standards. | | x | | Implementation underway | Public meetings, direct mail | Title 22 Drinking Water Regulations | All project components completed, excluding one new well | Underway |
| AE-30 | **ACSD Well #12 Construction** | This project would drill a new well to replace a well that is considered at risk of contamination due to its proximity to the Brown and Bryant Superfund Site. The new well (No. 12) is being drilled concurrently with the Arsenic Mitigation Project Phase II and will allow ACSD to bring four new wells online in addition to Well No. 13 and 14 brought online in July of 2016. | | x | | Implementation underway | Public meetings, direct mail | Title 22 Drinking Water Regulations | Well constructed | Completed |

**TABLE PMA-1**
**Details of Projects and Management Actions**
Arvin-Edison Management Area

| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Expected Benefits: Primary: Water Supply Augmentation | Expected Benefits: Primary: Water Demand Reduction | Expected Benefits: Secondary: Water Quality Improvement | Expected Benefits: Secondary: Flood Control | Expected Benefits: Secondary: Water Management Flexibility / Efficiency | Expected Benefits: Secondary: Data Gap Filling/ Monitoring | Source(s) of Water, if applicable | Legal Authority Required | Estimated Costs: One-time Costs | Estimated Costs: Ongoing Costs (per year) | Estimated Costs: Potential Funding Source(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Projects to Improve Drinking Water Quality in ACSD Service Area*** | | | | | | | | | | | | | | |
| AE-28 | **Emergency 1,2,3-TCP Treatment at Well No. 13** | Completed | Upon completion | | | x | | | | NA | None | $1.6 million | TBD | ACSD |
| AE-29 | **Arsenic Mitigation Project - Phase II** | Final well expected to be complete by July 2022 | Upon completion | | | x | | | | NA | None | $14.2 million | TBD | ACSD |
| AE-30 | **ACSD Well #12 Construction** | Completed | Upon completion | | | x | | | | NA | None | $2,250,000 | NA | ACSD |

**Abbreviations:**

AEWSD = Arvin-Edison Water Storage District
AFY = acre-feet per year
CDFW = California Department of Fish and Game
CEQA = Califronia Environmental Quality Act
DMR = California Division of Mine Reclamation
FEMA = Federal Emergency Management Agency
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
GWSA = Groundwater Only Service Area
KDWD = Kern Delta Water District
NA = Not Applicable
NEPA = National Environmental Protection Act
NRCS = Natural Resources Conservation Service
P/MA = Project/Management Action
SMARA = Surface Mining and Reclamation Act
SWRCB = State Water Resources Control Board
TBD = to be determined
TCWD = Tejon-Castac Water District
USBR = United States Bureau of Reclamation

**Notes:**

(a) Summary table developed based off information provided by AEWSD and its engineering consultant, Provost & Pritchard, on 10 February 2019, 18 March 2019 and 25 April 2019.

# TABLE PMA-2
## Details of Projects and Management Actions
Wheeler Ridge-Maricopa Management Area

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Groundwater Quality | Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Projects to Enhance Recharge / Banking*** | | | | | | | | | | |
| WRM-1 | **On-Farm Recharge** | Study and implement on-farm recharge where viable. | x | x | | To be implemented upon adoption of WRMWSD GSP Chapter | Regular District Board meetings | CEQA | Not yet initiated | TBD |
| WRM-2 | **In-District Banking Facilities** | Program to promote private and/or District-owned banking facilities within the District. | x | x | | To be implemented upon adoption of WRMWSD GSP Chapter | Regular District Board meetings | CEQA | Not yet initiated | TBD |
| WRM-3 | **Increase Out-of-District Banking Operations** | Increase size/participation in out-of-District banking facilities (i.e., Kern Water Bank and Pioneer Project). Increased banking of wet year supplies outside of the District would support deliveries of imported water into the District in normal/dry years. | x | x | | To be implemented upon adoption of WRMWSD GSP Chapter | Regular District Board meetings | CEQA | Completed expansion of Kern Water Bank by 1,025 acres | Ongoing |
| ***Projects to Increase Water Management Flexibility*** | | | | | | | | | | |
| WRM-4 | **Expand District Distribution System** | Project to expand District distribution system into area currently using only private groundwater. | x | x | x | upon modification of water service contracts | Regular District Board meetings | CEQA | Not yet initiated | TBD |
| ***Projects to Develop New Supplies*** | | | | | | | | | | |
| WRM-5 | **Purchase Additional Supplies** | Continue purchase of additional supplies, as available, for banking outside of the District or direct delivery within the District. | x | x | x | Ongoing | Regular District Board meetings | CEQA | Ongoing | Ongoing |
| WRM-6 | **Desalination Facilities** | Desalination facilities to allow for use of additional poor quality groundwater for agricultural use, easing demand on principal aquifer. | x | x | x | Localized pumping lowering GW levels near MT | Regular District Board meetings | CEQA | Not yet initiated | TBD |
| WRM-7 | **"Thru Delta" Facility** | Particpation of some sort of "Thru Delta" Facility to increase access to contracted (SWP) supplies. | x | x | x | State-led effort underway | Prop 218 | CEQA | State-led effort underway | Underway |
| ***Management Actions to Raise Funds to Support SGMA Compliance*** | | | | | | | | | | |
| WRM-8 | **Acreage Assessment** | Set policy to implement an acreage assessment to fund purchase of additional supplies, purchase of land for fallowing, and other investments to support SGMA compliance. | x | | x | To be implemented upon adoption of WRMWSD GSP Chapter | Prop 218 | CEQA | Ongoing | 2022 |

# TABLE PMA-2
## Details of Projects and Management Actions
### Wheeler Ridge-Maricopa Management Area

| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Expected Benefits: Primary: Water Supply Augmentation | Expected Benefits: Primary: Water Demand Reduction | Expected Benefits: Secondary: Water Quality Improvement | Expected Benefits: Secondary: Water Management Flexibility / Efficiency | Source(s) of Water, if applicable | Legal Authority Required | Estimated Costs: One-time Costs | Estimated Costs: Ongoing Costs (per year) | Estimated Costs: Potential Funding Source(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Projects to Enhance Recharge*** | | | | | | | | | | | | |
| WRM-1 | **On-Farm Recharge** | TBD; depending on grower interest | First wet year after construction | approx. 2,000 AFY (10,000 AF every five years) | | x | x | Additional wet-year imported water supplies | None | CEQA Costs <$50K | Costs tied to water purchases plus pumping costs (~ $50/AF) | WRMWSD |
| WRM-2 | **In-District Banking Facilities** | construction duration: TBD | First wet year after construction | approx. 2,000 AFY (10,000 AF every five years) | approx. 2.75 AFY per acre of land converted to basins | x | x | Additional wet-year imported water supplies | None | Approx. $40K per acre for land purchase and recharge basin construction | Costs tied to water purchases plus pumping costs (~ $50/AF) | WRMWSD |
| WRM-3 | **Increase Out-of-District Banking Operations** | -Recharge area expanded in 2020 and 2021, "getaway" capacity increased by 150 cfs | First wet year after construction | 9,225 AF per month | | x | x | Additional wet-year supplies | None | Approx. $40K per acre for land purchase and recharge basin construction | Costs tied to water purchases plus pumping costs (~ $50/AF) | WRMWSD |
| ***Projects to Increase Water Management Flexibility*** | | | | | | | | | | | | |
| WRM-4 | **Expand District Distribution System** | construction duration: TBD | First wet year after construction | approx. 2,000 AFY | | x | x | Additional wet-year imported water supplies | District authority as a Water Storage District | approx. $18M for 2,000 acre SWSA expansion | Costs tied to water purchases plus pumping costs (~ $50/AF) | WRMWSD; grants |
| ***Projects to Develop New Supplies*** | | | | | | | | | | | | |
| WRM-5 | **Purchase Additional Supplies** | Ongoing | Immediately | Increased purchases by 18,350 AFY in WY 2020 and 11,695 in WY 2021 | | x | | Additional imported water supplies | District authority as a Water Storage District | NA | District has been an active purchaser of additional supplies for some time. Average costs are approx. $500/AF. | WRMWSD |
| WRM-6 | **Desalination Facilities** | construction duration: 1-3 years | Immediately upon completion of construction | No net supply augmentation, but minimizes local GW pumping impacts | | x | | poor-quality (currently unused) groundwater | None | NA | Annual costs approximately $600/AF | WRMWSD; grants |
| WRM-7 | **"Thru Delta" Facility** | 2035 | 1 year after completion | up to 25,000 AFY | | x | | State Water Project | None | NA; as this Project would be bonded through SWP, costs would occur on annual bills | TBD; estimates of Cal WaterFix Project were >$600/AF | WRMWSD |
| ***Management Actions / Policies to Reduce Overall Water Demand*** | | | | | | | | | | | | |
| WRM-8 | **Acreage Assessment** | upon modification of water service contracts | 1-3 years after completion | | x | | | NA | District authority as a Water Storage District | approx. $50,000 to set up program | This management action would be used to fund other P/MA | WRMWSD; grants |

**TABLE PMA-2**
**Details of Projects and Management Actions**
Wheeler Ridge-Maricopa Management Area

| P/MA Number | P/MA Name | Summary Description | Relevant Sustainability Indicators Affected: Groundwater Levels & Storage | Groundwater Quality | Land Subsidence | Circumstances for Implementation | Public Noticing Process | Permitting and Regulatory Process Requirements | Status | Timetable / Circumstances for Initiation |
|---|---|---|---|---|---|---|---|---|---|---|
| *Management Actions / Policies to Reduce Groundwater Pumping* | | | | | | | | | | |
| WRM-9 | **Groundwater Allocation and Market** | Develop a groundwater pumping allocation methodology, including a market system for trading and/or transfering of allocations. | x | | x | To be implemented upon adoption of WRMWSD GSP Chapter | Regular District Board meetings | CEQA | Not yet initiated | TBD |
| WRM-10 | **Voluntary Pumping Limitations** | Set non-binding pumping limitations in conjunction with a fee for pumping above limits. | x | | x | To be implemented upon adoption of WRMWSD GSP Chapter | Prop 218 | CEQA | Not yet initiated | TBD |
| WRM-11 | **Mandatory Pumping Limitations** | Set binding pumping limitations in conjunction with a fee for pumping above limits. | x | | x | if other PMAs are insufficient | Prop 218 | CEQA | Not yet initiated | 2030 |
| WRM-12 | **Land Retirement** | Purchase and permanently fallow previously irrigated acreage within District to reduce overall water demand and groundwater extractions. | x | | x | if other PMAs are insufficient | Prop 218 | CEQA | Not yet initiated | 2035 |

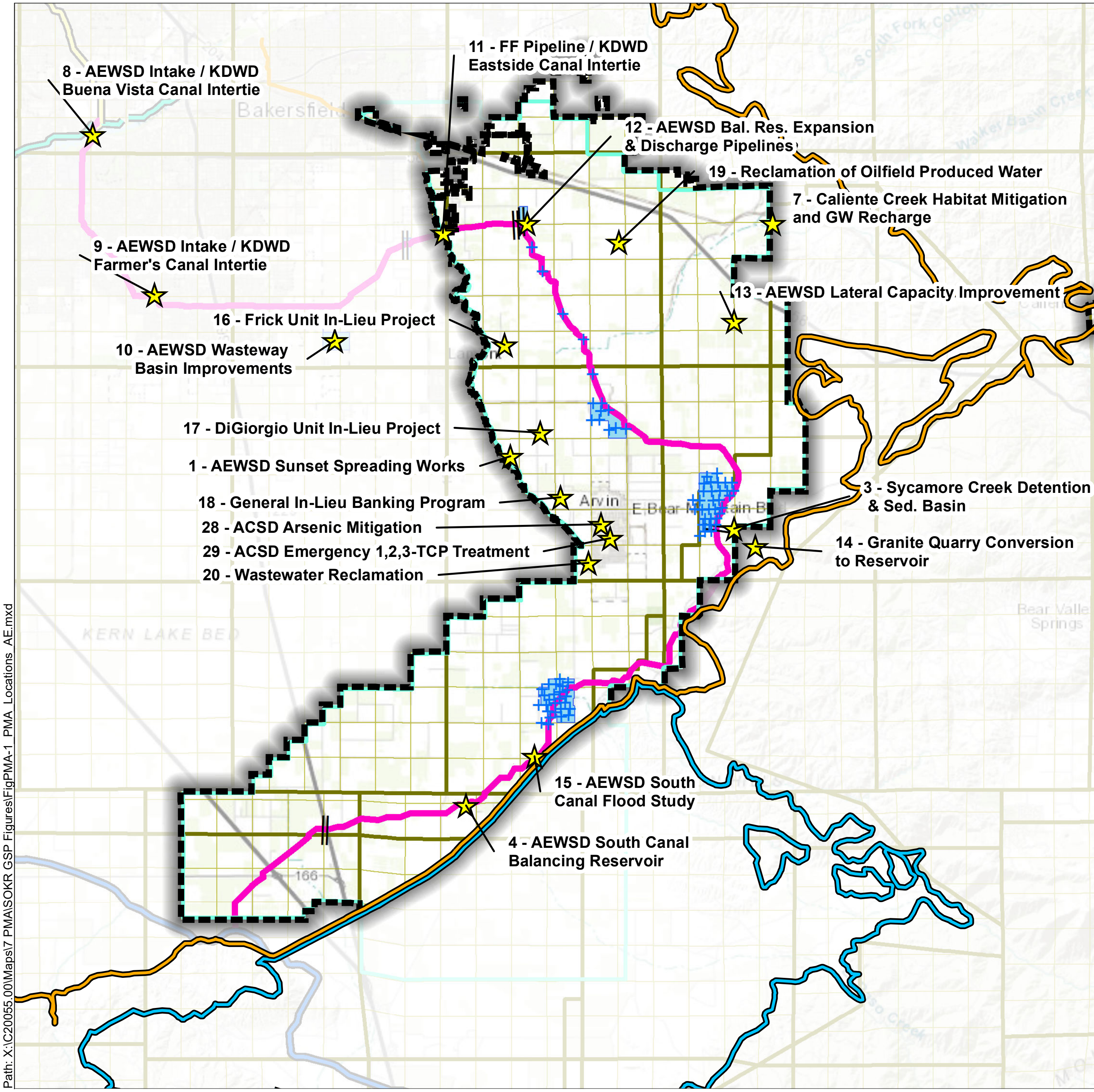
# TABLE PMA-2
## Details of Projects and Management Actions
Wheeler Ridge-Maricopa Management Area

| P/MA Number | P/MA Name | Timetable for Completion | Timetable for Accrual of Expected Benefits | Expected Benefits: Primary: Water Supply Augmentation | Expected Benefits: Primary: Water Demand Reduction | Expected Benefits: Secondary: Water Quality Improvement | Expected Benefits: Secondary: Water Management Flexibility / Efficiency | Source(s) of Water, if applicable | Legal Authority Required | Estimated Costs: One-time Costs | Estimated Costs: Ongoing Costs (per year) | Estimated Costs: Potential Funding Source(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Management Actions / Policies to Reduce Groundwater Pumping*** | | | | | | | | | | | | |
| WRM-9 | **Groundwater Allocation and Market** | upon modification of water service contracts | 1 year after completion | | | | x | NA | District authority as a GSA (KGA Member) | approx. $50,000 to set up program | Minimal | WRMWSD; grants |
| WRM-10 | **Voluntary Pumping Limitations** | upon modification of water service contracts | 1-3 years after completion | | up to 21,000 AFY | | | NA | District authority as a Water Storage District | approx. $100,000 to set up program | approx. $100,000/yr for monitoring costs; this management action would be used to fund other P/MAs | WRMWSD; grants |
| WRM-11 | **Mandatory Pumping Limitations** | 2030 | 1-3 years after completion | | up to 21,000 AFY | | | NA | District authority as a GSA (KGA Member) | Minimal additional cost beyond Voluntary Pumping Limitations P/MA | Minimal additional cost beyond Voluntary Pumping Limitations P/MA | WRMWSD; grants |
| WRM-12 | **Land Retirement** | TBD; depending on landowner interest | 1 year after completion | | up to 21,000 AFY | | | NA | District authority as a GSA (KGA Member) | approx. $40,000 per acre for land purchase (incl. interest); 30 yrs of water savings at 2.75 AFY/ac gives net cost of ~$500 per AF | $250/yr per acre for maintenance | WRMWSD; grants |

**Abbreviations:**

AFY = acre-feet per year
CEQA = Califronia Environmental Quality Act
CFS = cubic feet per second
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
KGA = Kern Groundwater Authority
NA = Not Applicable
P/MA = Project/Management Action
SGMA = Sustainable Groundwater Management Act
TBD = to be determined
WRMWSD = Wheeler Ridge-Maricopa Water Storage District
SWP = State Water Project
GW = groundwater

**Notes:**




## Legend

- Proposed P/MA Location
- Arvin GSA
- Arvin-Edison Water Storage District
- AEWSD Spreading Basin
- AEWSD Canal
- AEWSD Recovery Well

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Major Canals**

- California Aqueduct
- Cross Valley Canal
- Friant-Kern Canal
- Eastside Canal

## Abbreviations

AEWSD = Arvin-Edison Water Storage District
DWR = California Department of Water Resources
FF = Forrest Frick
GSA = Groundwater Sustainability Agency
KDWD = Kern Delta Water District
P/MA = Project / Management Action
GW = groundwater

## Notes

1. All locations are approximate.
2. Additional P/MAs not displayed on the map include:
   **2 - Private / Caltrans Basin Connections**
   **5 - Stormwater Mgmt. / Flood Control**
   **6 - On-Farm Recharge**
   **Projects 21-27 are water demand reduction management actions.**

## Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.

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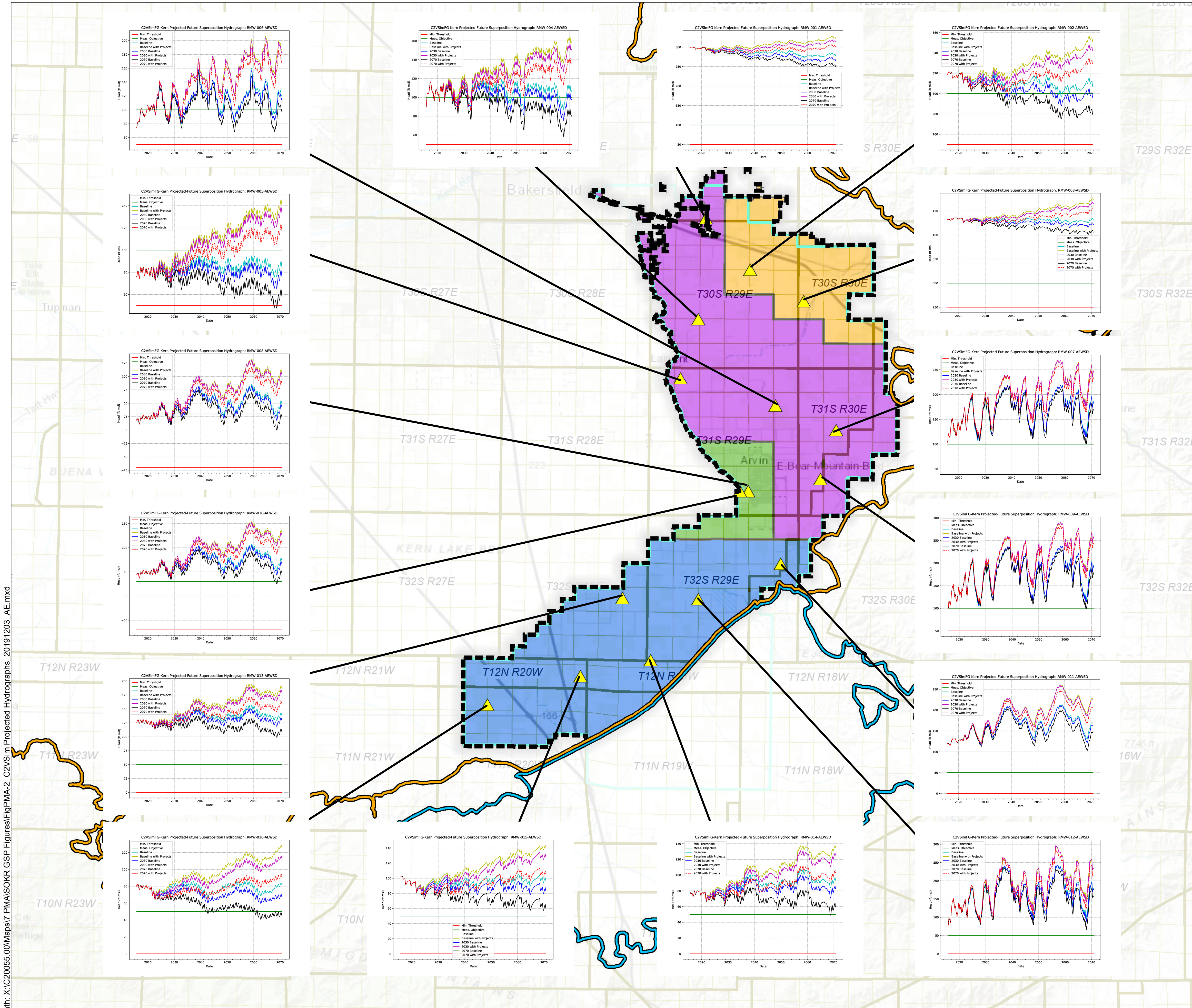
Miles

**Locations of Proposed Projects & Management Actions Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00
**Figure PMA-1**

eki environment & water

Path: X:\C20055.00\Maps\7 PMA\SOKR GSP Figures\FigPMA-1 PMA Locations AE.mxd




Legend

- Arvin GSA
- Arvin-Edison Water Storage District
- Representative Monitoring Location

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

**Sustainability Criteria Zones**

- ACSD
- Edison
- North Canal
- South Canal

- Minimum Threshold
- Measurable Objective
- Baseline
- Baseline with Projects
- 2030 Baseline
- 2030 with Projects
- 2070 Baseline
- 2070 with Projects

Abbreviations

| | | |
|---|---|---|
| ACSD | = | Arvin Community Service District |
| AEWSD | = | Arvin-Edison Water Storage District |
| C2VSim-FG | = | California Central Valley Groundwater-Surface Water Simulation Model, beta fine-grid version |
| DWR | = | California Department of Water Resources |
| ft | = | feet |
| GSA | = | Groundwater Sustainability Agency |
| P/MA | = | Project/Management Action |

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 June 2022.
2. Model-projected hydrographs were provided by Todd Groundwater on 1 December 2019.

N

0 4 8

(Scale in Miles)

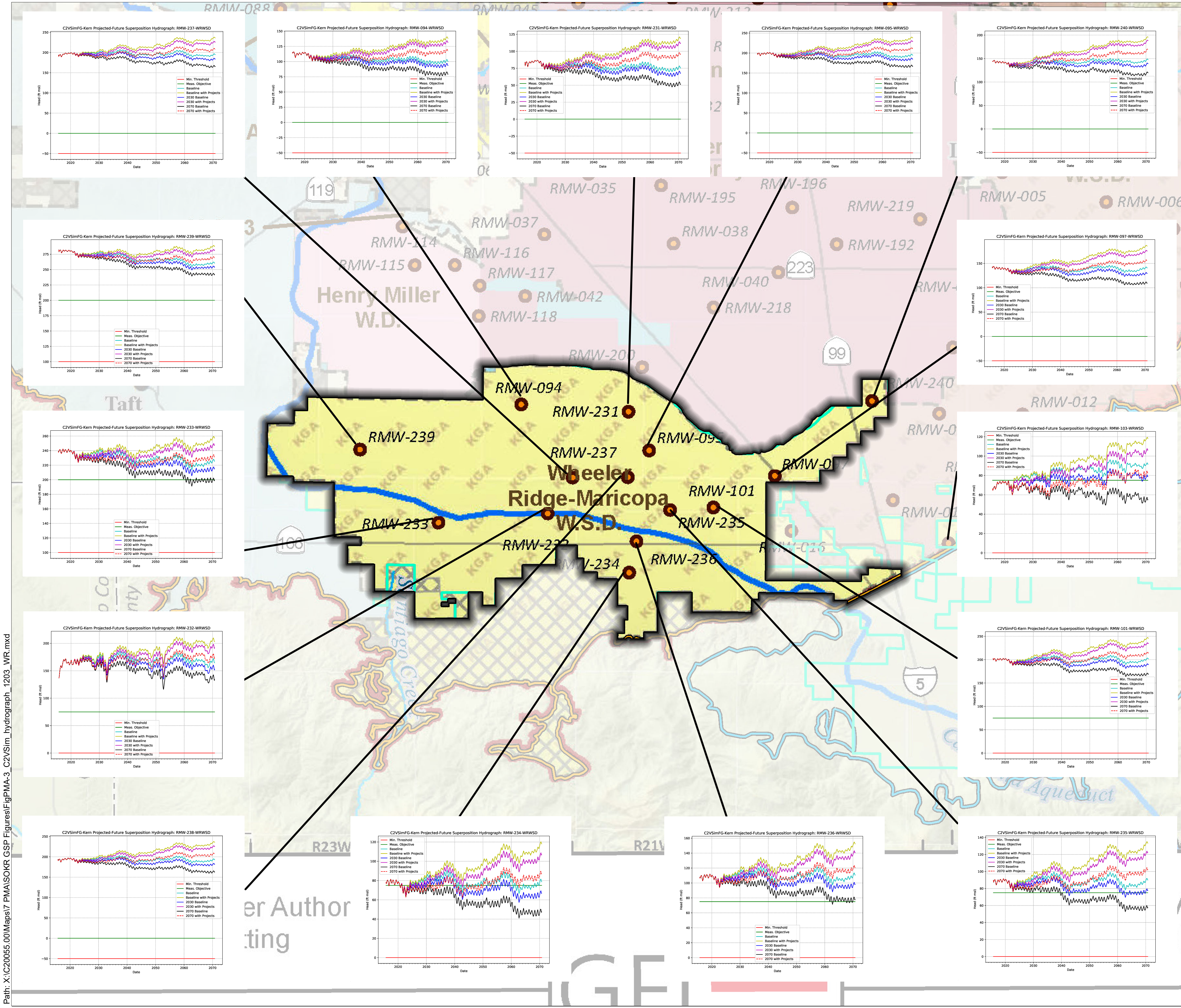
**C2VSim-FG Projected Hydrographs with and without P/MA Implementation Arvin-Edison Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure PMA-2**

Path: X:\C20055.00\Maps\7 PMA\SOKR GSP Figures\FigPMA-2_C2VSim Projected Hydrographs_20191203_AE.mxd




## Legend

- Wheeler Ridge-Maricopa GSA
- Wheeler Ridge-Maricopa Water Storage District

**Groundwater Subbasin**

- Kern County (DWR 5-022.14)
- White Wolf (DWR 5-022.18)

- Minimum Threshold
- Measurable Obejective
- Baseline
- Baseline with Projects
- 2030 Baseline
- 2030 with Projects
- 2070 Baseline
- 2070 with Projects

## Abbreviations

C2VSim-FG = California Central Valley Groundwater-Surface Water Simulation Model, beta fine-grid version
DWR = California Department of Water Resources
ft = feet
GSA = Groundwater Sustainability Agency
P/MA = Project / Management Action
RMW = Representative Monitoring Well
SGMA = Sustainable Groundwater Management Act
WRMWSD = Wheeler Ridge-Maricopa Water Stroage District

## Notes

1. All locations are approximate.

## Sources

1. Model-projected hydrographs were provided by Todd Groundwater on 1 December 2019.
2. Basemap of RMW locations were provided by GEI on 27 November 2019.

N

0 4 8
(Scale in Miles)

**C2VSim-FG Projected Hydrographs with and without P/MA Implementation Wheeler Ridge-Maricopa Management Area**

South of Kern River GSP
Kern County, California
July 2022
C20055.00

eki environment & water

**Figure PMA-3**

Path: X:\C20055.00\Maps\7 PMA\SOKR GSP Figures\FigPMA-3_C2VSim_hydrograph_1203_WR.mxd

# PLAN IMPLEMENTATION

## 18. PLAN IMPLEMENTATION

☑ **23 CCR § 351(y)**

Per the Groundwater Sustainability Plan (GSP) Emergency Regulations, "plan implementation" refers to "an [Groundwater Sustainability] Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities" (23 California Code of Regulations [CCR] § 351(y)). This section describes the ongoing and planned activities that have and will be performed by the South of Kern River (SOKR) Groundwater Sustainability Agencies (GSAs) as part of implementation of the SOKR GSP, with a focus on the first five years (i.e., through 2025).

Key ongoing and planned implementation activities to be undertaken by each SOKR GSA include:

- Monitoring and data collection;
- Data gap filling efforts;
- Projects & Management Action (P/MA) implementation, including policy development to support SOKR GSP implementation;
- Technical and non-technical coordination with other water management entities within the Kern County Subbasin (Kern Subbasin or Basin);
- Continued outreach and engagement with stakeholders;
- Annual reporting;
- Enforcement and response actions, as necessary; and
- Evaluation and updates, as necessary, of the SOKR GSP as part of the required periodic evaluations (i.e., "five-year updates").

These activities are discussed in more detail below. Also provided below are status updates on select Plan Implementation activities within each of the SOKR Management Areas as of the date of resubmittal of the SOKR GSP (i.e., through Water Year [WY] 2021).

Collectively, the Plan Implementation Activities described herein and current groundwater conditions presented in ***Table SMC-1, Figure SMC-1, Figure SMC-2,*** and ***Figure SMC-3*** demonstrate the SOKR GSAs have been actively implementing specific P/MAs, policies, and programs to sustainably manage groundwater resources for all beneficial uses and users of groundwater and continue to meet the Sustainability Goal defined for their respective Management Areas within the Basin.

### 18.1. Plan Implementation Activities

#### 18.1.1. Monitoring and Data Collection

As discussed in **Section 16 *Monitoring Network***, successful sustainable groundwater management relies on a foundation of data to support decision making. As such, collection of data within the SOKR GSP Area will be a key part of SOKR GSP implementation. These data collection efforts include data on applicable sustainability indicators to be collected from the networks of Representative Monitoring Sites (RMS), as well as other data and information required for management and reporting under the Sustainable Groundwater Management Act (SGMA), as described below.

*Monitoring of Applicable Sustainability Indicators*

**Section 16 *Monitoring Network*** discusses the monitoring networks (i.e., RMS) and protocols that will be used for the applicable sustainability indicators within the SOKR GSP Area, including Chronic Lowering of Groundwater Levels, Reduction of Groundwater Storage (using groundwater levels as a proxy), Degradation of Water Quality, and Land Subsidence. Those protocols will be followed in the defined networks as part of SOKR GSP implementation. Data collected will be incorporated into each agency's respective Data Management System (DMS) for subsequent inclusion in the Basin-wide DMS. These data will be used to support coordination efforts between the SOKR GSAs and all other GSAs within the Kern Subbasin (e.g., as part of Annual Reports; see **Section 18.1.5 *Annual Reporting***).

Monitoring results will be routinely evaluated against applicable Sustainable Management Criteria (SMCs; i.e., Undesirable Results, Minimum Thresholds, and Measurable Objectives) to support local management efforts. In addition to the single RMS for water quality established in the Arvin Community Services District (ACSD) service area (i.e., ACSD Well #14), The Arvin GSA and Wheeler Ridge-Maricopa GSAs have established a network of voluntary water quality monitoring sites and sampling protocols within the other parts of the Arvin-Edison and Wheeler Ridge-Maricopa Management Areas. Those data collection activities will also be conducted to support improved local understanding and groundwater management decisions. If it is determined in the future that SMCs are warranted outside of ACSD for this Sustainability Indicator, the SOKR GSP will be amended as such. ACSD, as a public water system, is also required to monitor and report water production and water quality to State Water Resources Control Boards (SWRCB) Division of Drinking Water on an annual basis, and to report any water quality violations immediately.

The SOKR GSAs anticipate that within the first five years of SGMA implementation (i.e., in the 2020 – 2025 timeframe), the following efforts related to monitoring will be performed:

- Refinement of the local DMS to better conform to the structure of the Basin-wide DMS;
- Refinement of the SGMA Monitoring Network, including potentially adding, replacing or drilling new wells and/or video-logging to collect missing screen/depth info of Representative Monitoring Sites with data existing data gaps (see **Section 16.4 *Assessment and Improvement of Monitoring Network***);
- Semi-annual monitoring for water levels at the RMS, with the potential for more frequent (i.e., monthly) monitoring and/or monitoring of additional well sites;
- Semi-annual monitoring for water quality at the RMS, with the potential for more frequent monitoring at the other voluntary water quality monitoring sites and/or monitoring additional well sites; and
- Compilation and review of publicly available subsidence data.

*Collection of Other Required Information*

Besides the data on Sustainability Indicators described above, collection and reporting of other types of information is required under SGMA (see further discussion below in **Section 18.1.5 *Annual Reporting***). These other types of information include:

- Groundwater extraction information; and
- Surface water supply data

Groundwater extraction information will be quantified for inclusion in the Annual Reports through methods described in the Coordination Agreement and Appendices thereto.

Within the Arvin-Edison Management Area, surface water supply data will be based on metered imports through the Arvin-Edison Water Storage District (AEWSD) canal system (i.e., at the head of the North Canal at the Forrest Frick Pumping Plant and at the California Aqueduct Intertie). All surface water delivered into the Arvin-Edison Management Area will have a source/type (e.g., Central Valley Project [CVP], State Water Project [SWP], Kern River, or other) assigned to it to facilitate local and Basin-wide accounting of these supply sources.

Within the Wheeler Ridge-Maricopa Management Area, surface water supply data will be based on metered diversions at each of the turnouts off the California Aqueduct. All surface water delivered into the Wheeler Ridge-Maricopa Management Area will have a source/type (e.g., SWP, Kern River, CVP, or other) assigned to it to facilitate local and Basin-wide accounting of these supply sources.[169]

Within the Tejon-Castac Management Area, groundwater extraction information will be measured or otherwise estimated at the Caratan well for inclusion in the Annual Reports. In addition, consumptive use of water will be monitored through methods described in the Coordination Agreement and Appendices thereto to ensure that it does not exceed that of native vegetation. No imported surface water is used within the Tejon-Castac Management Area and therefore that reporting requirement is not applicable.

*Data Gap Filling*

The SOKR GSAs will prioritize and begin to fill the key data gaps identified in the SOKR GSP related to the hydrogeologic conceptual model, groundwater conditions, and water budgets, among other things (see **Section 17.2.4 Additional Data-Gap Filling Efforts**). As of the date of resubmittal of the SOKR GSP (i.e., through WY 2021), completed and/or ongoing data-gap filling efforts have included:

Arvin-Edison Management Area

- Development of a numerical groundwater flow model and decision support tool for the AEWSD service area;
- Installation of groundwater pumping meters at 50 sites within the AEWSD service area to refine estimates of agricultural groundwater pumping from satellite evapotranspiration data; and
- Conducting additional outreach to public water systems to refine estimates of industrial groundwater demands within the AEWSD service area.

[169] The District's sole contractual source for imported water supplies is for SWP supplies through the Kern County Water Agency (KCWA). However, the District also obtains water through various exchanges, transfers and sales of water from other sources from time to time.

Wheeler Ridge-Maricopa Management Area

- Established a contract with LandIQ to provide ongoing estimates of water use rates within WRMWSD service area;
- Performing a detailed analysis of WRMWSD's Private User Pump-In Program to better quantify ongoing groundwater pumping trends and to identify potential improvements to program policies under SGMA implementation; and
- Installation of four (4) stream gauging dataloggers to quantify intermittent surface water inflows from contributing creeks to the Wheeler Ridge-Maricopa Management Area.

Tejon-Castac Management Area

- Surveying of horizontal and vertical coordinates of the Caratan Well, which serves as Representative Monitoring Site RMS-1; and
- Planned installation of dedicated monitoring well(s) in the South of Edison Fault/Valley Floor Management Subarea.

### 18.1.2. Project and Management Action Implementation

A main part of SOKR GSP implementation will be the implementation of P/MAs to address and prevent potential Undesirable Results. As described in **Section 17 *Projects and Management Actions***, a portfolio of P/MAs has been developed by each SOKR GSA with the goal of addressing the relevant Sustainability Indicators in the specific areas of concern within the Arvin-Edison, Wheeler Ridge-Maricopa, and Tejon-Castac Management Areas, and each P/MA in the portfolio has certain expected benefits. ***Table PMA-1, Table PMA-2*** and **Section 17.2.1 *Water Supply Augmentation Projects*** provide the required details about each P/MA, including the circumstances under which they will be implemented.

For many of the P/MAs shown in ***Table PMA-1*** and ***Table PMA-2*** or otherwise described in **Section 17**, initial steps in P/MA implementation will include performing various studies or analyses to refine the concepts into actionable projects and/or policies.[170] Studies and work efforts may include, but are not limited to, the following:

- Drafting white papers exploring policy options;
- Initiating California Environmental Quality Act (CEQA) and/or National Environmental Protection Act (NEPA) studies and documentation;
- Initiating engineering feasibility studies and preliminary design reports;
- Performing financial and/or economic analysis such as Proposition 218 studies; and
- Performing legal analyses.

Once the necessary initial studies are completed, P/MAs will undergo, as necessary, final engineering design (in the case of infrastructure projects) and final drafting (in the case of policy-based actions). At that point, construction of projects and/or adoption of policies will occur, followed by ongoing operations and maintenance (O&M), as necessary. It is anticipated that each implemented P/MA will have its own set of monitoring or data collection components to allow for P/MA assessment and, if necessary, modification.

[170] Studies conducted in support of P/MA implementation will be based on the best available data and science.

As of the date of resubmittal of the SOKR GSP (i.e., WY 2022), several of the P/MAs proposed for each Management Area have already been initiated. Ongoing P/MA implementation activities through end of WY 2021 are further described for each Management Area below.

_Arvin-Edison Management Area_

As of the end of WY 2021, AEWSD and ACSD have initiated or completed implementation of several of the P/MAs included in ***Table PMA-1***. This progress has included an effort to further evaluate and rank all of its P/MAs for purposes of prioritization, but more specifically includes the following updates:

- **P/MA #AE-1 - Sunset Groundwater Recharge Facility:** Purchased 150 acres with neighboring Kern Delta Water District (KDWD) in January 2019; approved an Operations and Maintenance agreement in February 2021; awarded an earthworks and structures contract in September 2021 with completion in February 2022; pump station and pipeline design and construction are anticipated to be completed by the end of 2022;
- **P/MA #AE-4 – AEWSD South Canal Flood Study/Improvements:** Initiated the South Canal Flood Study, including identification of potential grant funding sources;
- **P/MA #AE-6 – On-Farm Recharge:** New On-Farm Landowner Recharge Program approved by AEWSD Board of Directors in 2019, which resulted in the delivery of approximately 4,500 acre-feet of additional water into the Arvin-Edison Management Area; AEWSD staff continue to conduct outreach and investigations to develop and expand on-farm recharge, including drafting policies involving on-farm banking opportunities that capture surface water;
- **P/MA #AE-10 AEWSD Wasteway Basin Improvements**: AEWSD submitted a Notice of Intent application in 2021 for the CalOES Building Resilient Infrastructure and Communities (BRIC) funding opportunity.
- **P/MA #AE-11 – Forrest Frick Pipeline/KDWD Eastside Canal Intertie:** AEWSD was awarded a $500,000 United States Bureau of Reclamation Water SMART Grant in 2021 to support construction of the Forrest Frick Pipeline / KDWD Eastside Canal Intertie. CEQA has been completed and the NEPA process is nearly completed. Construction is anticipated to begin in late 2022;
- **P/MA #AE-14 – Conversion of Granite Quarry to Sycamore Reservoir:** AEWSD has participated in several meetings with Granite Construction, Tejon-Castac Water District (TCWD), Tejon Ranch Company (TRC), and the County of Kern to discuss the permitting process of this project;
- **P/MA #AE-17 DiGiorgio Unit In-Lieu Banking Program:** AEWSD submitted a United States Bureau of Reclamation (USBR) WaterSMART Drought Resiliency Project grant application for Phase 2 (of 5) of the DiGiorgio Unit at $2,000,000 (with a $2,600,00 local cost share). The project would cover an additional 1,025 acres and incorporate six wells into the AEWSD distribution system.
- **P/MA #AE-18 – General In-Lieu Banking Program**: Imported and delivered surface water in WY 2020 to contracted and non-contracted lands under the General In-Lieu Banking Program. Completed preliminary designs for two additional in-lieu units on the north side of the AEWSD service area (Frick and Panama Units). Development of a potential hybrid in-lieu and temporary water service contract is underway for the two areas. The AEWSD Board of Directors approved the

CEQA Negative Declaration for its groundwater service area distribution pipeline expansion project in 2021 and has completed a 30% design of pipe alignments and sizes;

- **P/MA #AE-24 Groundwater Extraction Quantification Method:** AEWSD continues to refine its methods to estimate the water budget within its service area. In WY 2020, these efforts included an analysis using the Department of Water Resources (DWR) Cal-SIMETAW model among other methods. In WY 2020, AEWSD completed installation of groundwater pumping meters at 50 sites in 2021 under its existing Groundwater Metering grant program.
- **P/MA #AE-28 – ACSD Emergency 1,2,3-trichloropropane (1,2,3-TCP) Treatment at Well #13:** Emergency treatment at Well #13 was completed in April 2019. A new emergency well (Well #12 or EPA Replacement CW-1) was completed and commissioned in May 2021 as part of work done at the Brown and Bryan Superfund Site. All samples so far have shown no sign of 1,2,3-TCP and Arsenic levels are below the Maximum Contaminant Level (MCL).
- **P/MA #AE-29 – ACSD Arsenic Mitigation Project- Phase II**: A new 1.0 million-gallon storage tank was constructed at the Well #11 site in July 2020. This tank provides much-needed above ground storage and also provides the opportunity to blend water from Wells #10 and #11 so as to reduce the levels of arsenic in these two wells, which are just above the MCL. Two of the three wells (#16 and #17) were completed in WY 2021. Well #18 is waiting on PG&E and its completion has been delayed due to easement issues and COVID-19. Well #18 is expected to be completed by July 2022. All other components of the project have been completed including a 1.0 million-gallon storage tank with a 6-motor booster station, 15,000 feet of new conveyance pipe, the abandonment of six old well sites, and SCADA implementation for system automation.
- **Multiple P/MAs:** Authorization of approximately $300,000 in Task Orders for consultants to complete preliminary and 30% design documents for P/MA #AE-11 and P/MA #AE-17, and environmental documentation for P/MA #AE-11 and all potential in-lieu projects and interconnection facilities (i.e., P/MA #AE-16, P/MA #AE-17, and P/MA #18);

In addition to the above activities related to P/MAs specifically included in ***Table PMA-1***, the following SGMA-related studies and activities have been conducted by the Arvin GSA since January 2020:

- Successful completion of a Proposition 218 Election raising General Administrative and General Project Service Charges including commitment to P/MAs;
- Submitted notification materials to DWR regarding AEWSD's decision to become a GSA within the Kern Subbasin and working with neighbors to address potential overlap and/or SGMA implementation agreements;
- Continued analysis of critical water budget components, including agricultural (evapotranspirative) water demands and return flow estimates;
- Initiated development of a numerical groundwater flow model and decision support tool for the AEWSD service area;
- Coordination with Cal Water Bakersfield District regarding SGMA implementation;

- Continued involvement in review and comment of various water banking CEQA documents potentially affecting AEWSD's CVP / Friant-Kern Canal surface water supplies from both quantity and quality concerns;
- Continued participation in water quality studies related to Friant-Kern Canal Reverse Flow/Pump-Back Program;
- Continued participation in Basin-wide initiatives including the Basin Study, DMS development and implementation, and the DWR airborne electromagnetic (AEM) data collection effort;
- Developed an operations planning tool to help optimize conjunctive use operations;
- Respond to County of Kern well permit applications;
- Reviewed statewide well mitigation policies for development of a local policy;
- Conducted an analysis of well ages to support SMC impacts analysis;
- Developed materials to respond to "Proof of Water" requests in line with Kern County initiative;
- Participated in public awareness initiatives regarding the social benefits of maintaining agricultural economy;
- Assisted the Friant Division to effect an exchange of supplies between Millerton Lake and San Luis Reservoir to minimize water supply impact to Friant districts;
- Provided several water supply notification letters to water users to conserve supplies during an extreme drought year;
- Continue to engage in statewide lawsuits that threaten AEWSD's water supplies;
- Completed an interconnection with neighboring Wheeler Ridge-Maricopa Water Storage District (WRMWSD) for transfer/exchanges of water supplies; and
- Continued to follow and review DWR and SWRCB responses, comments, and decisions regarding SGMA in other basins throughout the state.

Additional, ongoing SGMA-related efforts and programs within ACSD include:

- ACSD has state-mandated water shortage supply programs that are described in ACSD's 2020 Urban Water Management Plan. These programs address water shortages caused by drought and events that create a loss of water supplies, such as well failures, and system-wide power outages;
- ACSD is mandated to reduce water consumption on a per-capita basis by 20% relative to its "baseline" by the end of Year 2020. SB X7-7 required urban water suppliers to reduce per-capita water consumption by 10% by the end of Year 2015 and by 20% by the end of Year 2020, both goals that ACSD achieved; and
- Assembly Bill (AB) 1668: This bill requires the SWRCB, in coordination with DWR, to adopt long-term standards for the efficient use of water, as provided, and performance measures for commercial, industrial, and institutional water use on or before June 30, 2022.
    - The bill requires the department, in coordination with the board, to conduct necessary studies and investigations and make recommendations, no later than October 1, 2021, for purposes of these standards and performance measures. The bill would authorize the

department and the board to jointly recommend to the Legislature a standard for indoor residential water use;

- The bill, until January 1, 2025, would establish 55 gallons per capita daily as the standard for indoor residential water use, beginning January 1, 2025, would establish the greater of 52.5 gallons per capita daily or a standard recommended by the department and the board as the standard for indoor residential water use, and beginning January 1, 2030, would establish the greater of 50 gallons per capita daily or a standard recommended by the department and the board as the standard for indoor residential water use. The bill would impose civil liability for a violation of an order or regulation issued pursuant to these provisions, as specified.

- ACSD is protecting the human right to water consistent with the provisions of CWC §106.3(a), which specifies that all drinking water users of groundwater have a human "right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."
- Consistent with the human right to water act (CWC §106.3(a)), ACSD is pursuing consolidation of previously defunct, nearby small public water system in the vicinity of its existing service area to improve drinking water quality and access for existing domestic users of groundwater. This potential annexation is currently awaiting LAFCO approval

The Arvin GSA further anticipates that the following efforts will be performed within the first five years of SOKR GSP implementation (i.e., in the 2020 – 2025 timeframe) for the following P/MAs:

- **P/MA #AE-19 – Reclamation of Oilfield Produced Water:** Initiate feasibility study of Reclamation of Oilfield Produced Water project;
- **P/MA #AE-20 – Wastewater Reclamation with City of Arvin and Bakersfield:** Initiate study of Wastewater Reclamation with City of Arvin and Bakersfield project;
- **P/MA #AE-21 – Incentives for Land Conversion:** Initiate policy study for Incentives for Land Conversion;
- **P/MA #AE-25 – Groundwater Allocation per Acre:** Initiate policy study on Groundwater Allocation per Acre; and
- **P/MA #AE-27 – Education of Groundwater Use per Acre:** Initiate outreach for Education of Groundwater Use per Acre.

In addition to the above specific P/MA activities, AEWSD and ACSD will continue to actively participate in the local, regional and state-wide water market(s) to secure additional short- and long-term surface water supplies through exchanges, trades, and sales. AEWSD and ACSD will also actively explore and pursue grant funding source to support other P/MAs listed in ***Table PMA-1***.

The Arvin GSA also anticipates that part of P/MA implementation will involve review and potential modification of AEWSD's landowner contracts to provide, among other things, greater flexibility in terms of water purchase and delivery and revenue to support other P/MAs. The Arvin GSA will also work with owners of irrigated parcels within the un-districted areas that are covered by this SOKR GSP (see **Appendix C**) to develop approaches to address the imbalance in projected water budgets for those lands.

*Wheeler Ridge-Maricopa Management Area*

As of the end of WY 2021, the Wheeler Ridge-Maricopa GSA has initiated or completed implementation of several P/MAs included in ***Table PMA-2***. as summarized below:

- **P/MA #WRM-3 – Increase Out-of-District Banking Operations:** Expansions of the Kern Water Bank by 1,025 acres (which WRMWSD is a 24.03% participant) have been completed, increasing the Kern Water Bank recharge capabilities, under conservative assumptions, by approximately 9,225 acre-feet (AF)/month. Recharge operations are assumed to occur, on average, approximately four months per year. The "getaway" capacity from the California Aqueduct has been increased by 150 cubic feet per second, allowing the Kern Water Bank to more fully utilize its recharge capabilities when excess supplies on the California Aqueduct are available;
- **P/MA #WRM-5 – Purchase Additional Supplies:** As has historically been done, WRMWSD is continually investigating, pursuing, and purchasing supplies for delivery into its service area, and into WRMWSD's banking projects. WRMWSD has purchased supplies above its normal State Water Project entitlement in the following amounts in the following years:
    - 2015 – 4,481 AF
    - 2016 – 16,794 AF
    - 2017 – 90,866 AF
    - 2018 – 43,734 AF
    - 2019 – 57,819 AF
    - 2020 – 18,350 AF
    - 2021 – 11,695 AF
- **P/MA #6 Desalination Facilities:** WRMWSD is currently in discussions with various vendors on possible desalination opportunities.
- **P/MA #WRM-7 – "Thru Delta" Facility:** The WRMWSD Board of Directors elected to participate at 32% of its SWP entitlement (63,100 acre-feet) in 2020 and 2021 during the planning phase of the Delta Conveyance Project ("Thru-Delta" facility).
- **P/MA #WRM-8 – Acreage Assessment:** WRMWSD continues to study and analyze possible acreage assessments or groundwater pumping charges that could both fund future P/MAs and provide financial incentives to limit pumping from the groundwater basin. It is anticipated that these analyses will be completed by mid-2022.
- **P/MA #WRM-12 Land Retirement**: Facilitated approximately 4,000 acres of land repurposing, i.e., retirement of agricultural land for private solar projects, within the Wheeler Ridge-Maricopa GSA in efforts to reduce the GSA's long-term groundwater demand.
- **P/MA #WRM-13 Facility Interconnections with AEWSD**: Completed an interconnection with neighboring AEWSD conveyance system in WY 2021 to allow for transfer/exchanges of water supplies between the Districts.

- **P/MA #WRM-14 Facility Interconnections with KDWD**: Initiated discussions with KDWD staff to explore options for building an interconnection between KDWD Rim Ditch and WRMWSD conveyance system to allow for transfer/exchanges of water supplies between the Districts.

In addition to the above activities related to P/MAs specifically included in ***Table PMA-2***, the following SGMA-related studies and activities have been conducted by the Wheeler Ridge-Maricopa GSA since January 2020:

- Successful completion of a Proposition 218 Election raising General Administrative and General Project Service Charges including commitment to P/MAs;
- Submitted notification materials to DWR regarding WRMWSD's decision to become a GSA within the Kern Subbasin and working with neighbors to address potential overlap and/or SGMA implementation agreements;
- Continued participation in Basin-wide initiatives including the Basin Study, DMS development and implementation, and the DWR AEM data collection effort;
- Respond to County of Kern well permit applications;
- Reviewed statewide well mitigation policies for development of a local policy; and
- Conducted an analysis of well ages to support SMC impacts analysis.

In addition, the Wheeler Ridge-Maricopa GSA anticipates that the following efforts will be performed within the first five years of SOKR GSP implementation (i.e., in the 2020 – 2025 timeframe) for the following P/MAs:

- **P/MA #WRM-1 – On-Farm Recharge**: Initiate study, permitting (i.e., CEQA), and implementation of on-farm recharge;
- **P/MA #WRM-2 – In-District Banking Facilities:** Initiate program to promote private and/or district-owned banking facilities within the district;
- **P/MA #WRM-4 – Expand District Distribution System:** Initiate feasibility and engineering studies to expand the WRMWSD distribution system to areas currently using only private groundwater;
- **P/MA #WRM-9 – Groundwater Allocation and Market:** Initiate study of potential groundwater allocation and market system; and/or
- **P/MA #WRM-10 – Voluntary Pumping Limitations:** Develop policies to implement voluntary pumping limitations.

<u>*Tejon-Castac Management Area*</u>

The TCWD GSA anticipates that the following efforts will be performed within the first five years of SOKR GSP implementation (i.e., in the 2020 – 2025 timeframe) for the following P/MAs:

- **P/MA #TC-1 – Conversion of Granite Quarry to Sycamore Reservoir:** Steps towards implementation of this P/MA will include working in conjunction with AEWSD to perform appropriate preliminary studies which may include engineering studies, hydrology studies, permitting and legal analysis, funding studies, CEQA studies, and others. TCWD has participated in several meetings with Granite Construction, Tejon Ranch Company, ACSD, and the County of Kern to discuss the permitting process of this project;

- **P/MA #TC-2 – Recharge of Carrot Wash Water:** This project has been implemented by TRC since 2016 and will continue through the GSP implementation phase. Activities include receipt of carrot wash water to the site, disposal of the water to the recharge ponds, and monitoring pursuant to the Waste Discharge Requirements order. TRC may at some point install a production well at the site to allow for recovery of recharged water. The following volumes of carrot wash water were recharged to the basin in recent water years:
    - 2019 – 527 AF
    - 2020 – 334 AF
    - 2021 – 79 AF

The TCWD GSA will also pursue development of an agreement with AEWSD regarding groundwater pumping of the Caratan well pumping and subsequent use of pumped groundwater on agricultural lands within AEWSD.

In addition to the above specific P/MA activities, the TCWD GSA will continue to foster sustainable land and water management within the Tejon-Castac Management Area through its implementation of the Conservation and Land Use (C&LU) Agreement and Ranch Wide Management Plan (RWMP).

In addition to the above activities related to P/MAs specifically included in **Section 17.2.1 *Water Supply Augmentation Projects***, the following SGMA-related studies and activities have been conducted by the TCWD GSA since January 2020:

- Submitted notification materials to DWR regarding TCWD's decision to become a GSA within the Kern Subbasin and working with neighbors to address potential overlap and/or SGMA implementation agreements; and
- Continued participation in Basin-wide initiatives including the Basin Study, DMS development and implementation, and the DWR AEM data collection effort.

### 18.1.3. <u>Intrabasin Coordination</u>

Just as this SOKR GSP has been developed as part of a coordinated process in the Kern Subbasin, coordination amongst all water management entities involved in SGMA in the Kern Subbasin will continue during implementation. This coordination will include both technical and non-technical matters, as discussed below.

*<u>Technical Coordination</u>*

Continued technical coordination will be critical to ensure that all entities in the Kern Subbasin as a whole approach local groundwater management using a robust shared framework of data, information, and technical assumptions. SOKR GSP members will coordinate with other water management entities on technical matters including, but not limited to, the following:

- DMS development and maintenance;
- Groundwater model refinement including subsidence modules and updates;
- Water budget refinement and collection of supporting data including evapotranspiration (ET) estimates; and
- Basin-wide monitoring and reporting efforts.

*Non-Technical Coordination*

Non-technical coordination will involve matters related to policy, advocacy, governance, and the like. The SOKR GSAs will continue to actively participate in coordination meetings with other Kern Subbasin GSAs. Other non-technical coordination activities will be pursued, as necessary.

### 18.1.4. Stakeholder Engagement

Each SOKR GSA's Stakeholder Communication and Engagement Plan (SCEP; see **Appendix E**) is a key part of the SOKR GSP, and will continue to be refined, updated and executed during implementation. Anticipated stakeholder engagement activities include, but are not limited to:

- Regular SGMA updates during Arvin GSA, Wheeler Ridge-Maricopa GSA and TCWD GSA Board meetings;
- Hosting stakeholder workshops, as needed;
- Posting of relevant announcements and information on the South of Kern River GSA websites; and
- Conducting informational discussions and meetings, as necessary, with interested stakeholders.

Any implementation actions that relate to establishment of allocations of groundwater pumping or "native yield" on a landowner level will be conducted through a robust stakeholder engagement process.

### 18.1.5. Annual Reporting

☑ **23 CCR § 356.2(b)(1)(2)(3)**

Per the GSP Emergency Regulations, an annual report on Basin conditions and SGMA implementation status is required to be submitted to DWR by April 1 of each year following GSP adoption. These annual reports will be prepared on the basin-level but will require input from each local entity. Activities required at the GSA level and the Basin level are described below.

*GSA-Level Activities*

In support of the annual reporting requirements, the SOKR GSAs will provide to the Basin-level entity preparing the reports all monitoring data from the RMS in the SGMA Monitoring Networks, as well as the other required information discussed above. The SOKR GSAs will also provide review and comment on the draft reports to ensure that local information is properly incorporated into the basin-level reports.

*Basin-Level Activities*

An entity will be designated at the Basin level to compile and consolidate all of the local information into annual reports that meet the requirements of the GSP Emergency Regulations (23 CCR § 356.2).

### 18.1.6. Enforcement and Response Actions

Part of successful management involves the ability to adapt and respond to unforeseen or uncertain circumstances. To the extent possible, methods to address foreseeable problems should be developed before those problems arise. It is anticipated that there may need to be actions taken to enforce compliance with the SOKR GSP and any policies adopted thereunder. Such actions, if necessary, will be taken in accordance with applicable laws and authorities.

18.1.6.1. Minimum Threshold Exceedance Policy

Consistent with the process developed by member agencies of the Kern Groundwater Authority (KGA) in the Kern Subbasin and the White Wolf GSA in the White Wolf Subbasin, the following action plan has been developed to address Minimum Thresholds (MT) exceedances as they may occur at single RMS within the SOKR GSP area.

The SOKR GSP defines sustainability under the SGMA as the avoidance of Undesirable Results (URs). URs occur when there is an impact to the Principal Aquifer that negatively affects the reasonable and beneficial use of, and access to, groundwater for beneficial uses and users within the Basin. The unique criteria for monitoring whether URs are being experienced in the Basin is when a certain percentage of RMSs exceed their respective MTs. While a single or isolated MT exceedance will not, by itself, cause an UR, such an exceedance may be indicative of future or trending exceedances which could result in URs.

The SOKR GSAs are responsible for monitoring groundwater conditions, complying with GSP / SGMA requirements and coordinating with other agencies and entities (e.g., public water systems, etc.) within the Basin. However, the SOKR GSAs also rely upon their member districts to facilitate SGMA implementation. For example, each GSA member district collects and compiles necessary data within their service areas in order to support preparation of an annual report (see **Section 18.1.5 *Annual Reporting***) which is submitted to the DWR each year on April 1. The annual reports include progress towards achieving interim milestones and identifies whether any MT exceedances have occurred.

It is important to monitor compliance with MTs and Measurable Objectives (MOs) over time to understand the Basin's likelihood of achieving sustainability and avoiding URs. The following six-step action plan is proposed to proactively address MT exceedances if they occur.

**1. Identify Exceedance and Investigate the RMS Area:**

After each annual report, the SOKR GSAs will review data, identify any MT exceedance(s) at RMS(s), and will compile a summary of MT exceedances for review by the Board of Directors for the GSA(s) where an MT exceedance occurred. This summary will evaluate whether the MT exceedance is associated with a single RMS or indicates a potential regional issue. Various conditions surrounding the RMS will be considered. For example: Are water levels declining in nearby wells? If so, how large of an area is affected? Has a new well been installed nearby or localized groundwater extraction increased? Is the problem related to area-wide drought conditions? Has local demand increased?

**2. Evaluate Outside Contributing Factors:**

Declining water levels, degraded water quality, or depletions of interconnected surface water in a portion of the Basin may be the result of natural factors or due to operations within the service area of a GSA member district or in the adjacent White Wolf Subbasin. In the latter case, a coordinated effort by the GSA member districts (as directed by the SOKR GSAs' Boards) could include discussions with the White Wolf Subbasin GSA, the evaluation of modifying operations, adjusting MTs to account for aforementioned outside contributing factors, and/or adding or moving a RMS if the existing RMS is found to no longer be representative of the area or an alternate RMS is determined to be a better measure of sustainability. Updates or proposals for how to address any observed issues shall be reported back to and approved by the SOKR GSAs' Boards.

**3. Consider the Need for Increased or Expanded Monitoring:**

The SOKR GSAs shall evaluate the efficacy of increasing the monitoring frequency, expanding the monitoring area, adding or re-assigning RMS(s), or other monitoring-related actions necessary to identify the cause of declining water levels. Updates or results from this effort shall be reported back to and approved by the SOKR GSAs' Boards. In the case of MT exceedances for Degraded Water Quality, the GSAs will coordinate with Public Water Systems to increase water sampling frequency as needed to further assess water quality trends.

**4. Consider Initiating Projects and/or Management Actions:**

If there are repeated MT exceedances observed, the SOKR GSAs Boards' will consider initiating one of the proposed P/MAs (see **Section 17.2 *List of Projects and Management Actions***). This will require coordination with each GSA member district, as most P/MAs are district specific and details pertaining to initiation, projected benefits, payments, and cost allocations will need to be negotiated. Examples of P/MAs that could be initiated in response to MT exceedances include, but are not limited to, purchasing or obtaining new and/or wet year supplies via water transfers/exchanges, development of new water supplies, recapturing cross-boundary flows, increasing recharge in select areas, in-lieu banking, or management actions/policies to reduce overall groundwater demand.

**5. Evaluate Whether GSP Implementation Is Causing or Exacerbating MT Exceedance for Water Quality**

MT exceedances in a water quality RMS are assumed to be correlated with SGMA-related groundwater management activities and thus contribute to a UR if all of the following criteria are met:

a. The constituent concentrations in the water quality RMS exceed the established MT over a period of two (2) consecutive years.

b. The constituent concentrations in the water quality RMS show a statistically significant deviation or increasing trend after the implementation of any P/MAs. The GSP will determine baseline values for groundwater levels and water quality conditions for the RMSs in the annual reporting and GSP updates. Once the baseline values are determined, a deviation will be determined through calculation of the t-test using pre- and post-P/MA datasets, and trend will determined using the Mann-Kendall trend test, similar to the analysis conducted on existing 1995 – 2018 data as described in **Section 8.5 *Groundwater Quality.*** Both statistical tests will use a p-value of 0.05. As stated above, the GSAs will coordinate with the Public Water Systems to increase monitoring frequency to at least twice a year if any constituent exceeds its MT in a water quality RMS. This will generate at least four water quality measurements over the next two years, which will provide a sufficient dataset to conduct the Mann-Kendall trend test.

c. The affected water quality RMS is located within an area of influence of any P/MAs. The area of influence is conservatively assumed to be that area within a one-mile radius of a local P/MA that has been implemented, in the down gradient direction from the P/MA based on pre-P/MA groundwater flow gradients.

d. There is a statistically significant correlation between groundwater elevation and constituent concentrations in the water quality RMS where MTs are exceeded when the measurements and sampling events are taken over the course of at least two consecutive years, and constituent detections exceed MTs over those consecutive years. The correlation will be determined through calculation of the cross-correlation coefficient (p-value = 0.05), similar to the analysis conducted on existing data as described in **Section 8.5 *Groundwater Quality***.

**6. Consider Enforcement Action:**

MT exceedances that result in UR(s) as defined in the GSP (see **Section 13 *Undesirable Results***) will require the SOKR GSAs to establish an enforcement plan. The enforcement plan will outline specific P/MAs that must be initiated to eliminate the UR and will demonstrate how these P/MAs will be sufficient to avoid URs.

#### 18.1.6.2. Impacted Well Mitigation Program

As described in **Section 14.1 *Minimum Threshold for Chronic Lowering of Groundwater Levels***, the SOKR GSAs have committed to mitigating potential impacts of dewatering on domestic wells that may occur as a result of SGMA implementation by establishing an Impacted Well Mitigation Program, to be developed as part of GSP Implementation. Further details regarding the potential elements covered by such a program and its current status of development are provided below.

*Arvin-Edison Management Area Impacted Well Mitigation Program*

In other cases, a response action may be needed that is driven not by a non-compliance concern (e.g., an Undesirable Result), but rather by a physical, social or economic condition that falls outside of the six Sustainability Indicators defined under SGMA. One such condition that may arise is that of wells being impacted by declining groundwater levels. Impacts could include dewatering of pumps or dewatering of well screens to the point of significant reduction in production. To address this potential occurrence, an Impacted Well Mitigation Program will be developed whereby a potential remedy will be provided to owners of wells that are demonstrably unreasonably impacted by groundwater conditions, as defined within the policy. Funding for such a program may be sourced from the AEWSD general fund or from a dedicated fund supported by a fee on owners of commercial (i.e., agricultural or industrial) supply wells. The program may be modeled after similar programs developed elsewhere in the basin or around the state (e.g., the Kern Water Bank's program [Kern Water Bank, 2017]), and may include, but not be limited to, remedies such as lowering of pumps, deepening of wells, drilling new wells, and support for access to alternative water sources. The program will be developed in coordination with and in consideration of the interests of local stakeholders within the SOKR GSP area.

*Wheeler Ridge-Maricopa Management Area Impacted Well Mitigation Program*

Similarly, an Impacted Well Mitigation Program is currently being developed for the Wheeler Ridge-Maricopa Management Area whereby a potential remedy will be provided to owners of wells that are demonstrably unreasonably impacted by groundwater conditions, as defined within the policy. The scope of the program will be similar to the Joint Operations Plan on the Kern Fan area [Kern Water Bank, 2017]. In that program impacted well owners submit claims to the Joint Operations group, and the group then reviews the claim taking into account a number of factors to determine the mitigation method. In the case of domestic wells, emergency water supplies were made available until such time as the domestic well mitigation could occur. The program may be modeled after similar programs developed elsewhere in the basin or around the state and may include, but not be limited to, remedies such as lowering of pumps, deepening of wells, drilling new wells, and support for access to alternative water sources.

It is anticipated that the draft policy will be reviewed by the public and submitted to the WRM Board of Directors by June 2023, and if approved will be implemented soon thereafter. Funding for such a program may be sourced from the WRMWSD general fund or from a dedicated fund supported by a fee on owners of commercial (i.e., agricultural or industrial) supply wells. The program will be developed in coordination with and in consideration of the interests of local stakeholders within the SOKR GSP area.

#### 18.1.7. Periodic Evaluations of GSP

☑ **23 CCR § 356.4**

Per the GSP Emergency Regulations (23 CCR § 356.4), the SOKR GSAs will conduct a periodic evaluation of the SOKR GSP, at least every five years, and will modify the SOKR GSP as necessary to ensure that the Sustainability Goal defined for the Kern Subbasin (see **Section 12 *Sustainability Goal***) is achieved. The GSP elements that will be covered in the periodic evaluation are described below. It is anticipated that the 2025 plan will require substantial revision, especially on matters related to the water budget, P/MAs and sustainability criteria.

*Sustainability Evaluation*

This section will evaluate the current groundwater conditions for each applicable Sustainability Indicator within the SOKR GSP Area, including progress toward achieving Interim Milestones and Measurable Objectives.

*Plan Implementation Progress*

This section will evaluate the current implementation status of P/MAs, along with an updated project implementation schedules and any new projects that are not included to date.

*Reconsideration of GSP Elements*

Per 23 CCR § 356.4(c), elements of the SOKR GSP, including the Basin Setting, Management Areas, Undesirable Results, Minimum Thresholds, and Measurable Objective, will be reviewed and revised if necessary.

*Monitoring Network Description*

This section will provide a description of the SGMA Monitoring Network, including identification of data gaps, assessment of monitoring network function with an analysis of data collected to date, identification of actions that are necessary to improve the monitoring network, and development of plans or programs to fill data gaps.

*New Information*

This section will provide a description of significant new information that has been made available since the adoption or amendment of the SOKR GSP, or the last five-year assessment, including data obtained to fill identified data gaps. As discussed above under *Reconsideration of GSP Elements*, if evaluation of the Basin Setting, Measurable Objective, Minimum Threshold, or Undesirable Results definition warrant changes to any aspect of the SOKR GSP, this new information would also be included.

*Regulations or Ordinances*

Each SOKR GSA possesses the legal authority to implement regulations or ordinances related to the SOKR GSP. This section will provide a description of relevant actions taken by each SOKR GSA, including a summary of related regulations or ordinances.

*Legal or Enforcement Actions*

This section will summarize legal or enforcement actions taken by each SOKR GSA in relation to the SOKR GSP, along with how such actions support sustainability in the SOKR GSP Area and the Basin.

*Plan Amendments*

This section will provide a description of proposed or complete amendments to the SOKR GSP.

*Coordination*

This section will describe coordination activities relevant to the SOKR GSP Area.

## 18.2. Plan Implementation Costs

☑ 23 CCR § 354.6(e)

Per the GSP Emergency Regulations (23 CCR § 354.6(e) and 354.44(b)(8)), this section provides estimates of the costs to each SOKR GSA to implement this SOKR GSP and potential sources of funding to meet those costs.

### 18.2.1. Estimated Costs

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

- Costs of local groundwater management activities;
- AEWSD's, WRMWSD's, TCWD's, and ACSD's proportional share of costs for Basin-wide groundwater management activities; and
- Costs to implement P/MAs, including capital/one-time costs and ongoing costs.

***Table PI-1, Table PI-2,*** and ***Table PI-3*** provide an estimate of the costs for each of the above groups by Management Area. The P/MA implementation costs are estimated by main category as described in **Section 17.2 *List of Projects and Management Actions***; more detailed cost estimates for individual P/MAs are provided in ***Table PMA-1, Table PMA-2,*** and **Section 17.2.1 *Water Supply Augmentation Projects***.

### 18.2.2. Sources of Funding to Meet Costs

*Arvin-Edison Management Area*

As shown in ***Table PI-1***, The Arvin GSA anticipates costs to implement the SOKR GSP within the Arvin-Edison Management Area will be significant – i.e., approximately $2.93 million per year on average over the next 20 years. To meet these costs, the Arvin GSA will need to establish new funding sources or increase existing funding sources. SGMA grants GSAs certain financial authorities (California Water Code [CWC] § 10725.4 and 10730 through 10731), including to raise revenue through use of fees, assessments, pump taxes, and other methods to pay for the costs incurred by the GSA for SGMA compliance. The Arvin GSA will likely meet the estimated costs through a combination of the following:

- AEWSD revenue from assessments/fees;
- Special assessments/fees for specific projects;
- Grant funding or other financing options; and/or
- Penalties levied on prohibited activities.

*Arvin Community Service District*

ACSD is a Severely Disadvantaged Community with an annual household income of less than $40,000 per year. The cost shared by ACSD for the implementation of the SOKR GSP has not yet been determined, however, ACSD has budgeted $50,000 annually for SGMA-related expenses.

The sole source of ACSD operating revenue is from water tolls. The cost of implementation will be borne by the water users. A Proposition 218 election must be held and approved by ACSD residents prior to implementation of a rate increase. The last Prop 218 rate increase was approved in 2016 and implemented in 2017. The rate increase was 16% for the first year and 15.5% per year for the next four years. 2022 will be the last year of the raises approved in 2016.

Grant/loan funding may be available for projects. The Arsenic Mitigation Project is being financed by a Proposition 1 Grant/Loan. The USEPA Replacement Well is being partially financed by a grant from the USEPA.

Funding Sources Available to ACSD include:

- ACSD revenue from fees and assessments;
- Special assessments;
- Grant / Loan funding; and/or
- Penalties levied on prohibited activities.

*Wheeler Ridge-Maricopa Management Area*

As shown in ***Table PI-2***, the Wheeler Ridge-Maricopa GSA anticipates costs to implement the SOKR GSP within the Wheeler Ridge-Maricopa Management Area will be significant – i.e., ranging from approximately $3.8 million to $7.5 million per year on average over the next 20 years. To meet these costs, the Wheeler Ridge-Maricopa GSA will need to establish new funding sources or increase existing funding sources. SGMA grants GSAs certain financial authorities (CWC § 10725.4 and 10730 through 10731), including to raise revenue through use of fees, assessments, pump taxes, and other methods to pay for the costs incurred by the GSA for SGMA compliance. The Wheeler Ridge-Maricopa GSA will likely meet the estimated costs through a combination of the following:

- District revenue from assessments/fees;
- Special assessments/fees for specific projects;
- Grant funding or other financing options; and/or
- Penalties levied on prohibited activities.

*Tejon-Castac Management Area*

As shown in ***Table PI-3*,** the TCWD GSA anticipates costs to implement the SOKR GSP within the Tejon-Castac Management Area will be significant – i.e., approximately $110,000 per year on average over the next five years, and potentially increasing if the monitoring network is expanded or if P/MA No. 1 is fully implemented. The TCWD GSA will likely meet the estimated costs through a combination of contributions from its main landowner, TRC, and grant funding, if available.

## 18.3. Plan Implementation Schedule

This section discusses a general estimated schedule for SOKR GSP implementation. The GSP Emergency Regulations do not specifically require that a schedule for GSP implementation over the 20-year implementation period (i.e., 2020 through 2040) be provided, and any such schedule would be subject to considerable uncertainty. However, the following factors and constraints inherent to the GSP process guide the schedule for GSP implementation:

- The GSP Emergency Regulations require achievement of the Sustainability Goal (i.e., avoidance of Undesirable Results) within 20 years of GSP adoption, which in the case of the Kern Subbasin means by 2040.
- The P/MA implementation glide path discussed in **Section 17.1.4 *Implementation Glide Path*** above spells out the general schedule for when expected benefits from P/MAs will accrue between 2020 and 2040 within the SOKR GSP Area.
- Annual reports are due on April 1 of the following year.
- Periodic evaluations are required at least every five years, meaning the SOKR GSP will be updated no later than 31 January 2025.

# TABLE PI-1
## Estimated Costs for Plan Implementation
Arvin-Edison Management Area

**Part 1. Costs of Local Groundwater Management Activities**

| Local Groundwater Management Activity | 2020 - 2025 Average Annual Costs | 2025 - 2030 Average Annual Costs | 2030 - 2035 Average Annual Costs | 2035 - 2040 Average Annual Costs |
|---|---|---|---|---|
| Monitoring and Data Collection | (no incremental cost) | (no incremental cost) | (no incremental cost) | (no incremental cost) |
| Monitoring of Applicable Sustainability Indicators | - | - | - | - |
| Voluntary Monitoring of Groundwater Quality at Selected Sites | - | - | - | - |
| Collection of Other Required Information | - | - | - | - |
| Enforcement and Response Actions | $70,300 | $70,300 | $70,300 | $70,300 |
| Enforcement Actions | $10,000 | $10,000 | $10,000 | $10,000 |
| Impacted Well Mitigation Program | $60,300 | $60,300 | $60,300 | $60,300 |
| Data Gap Filling | $50,000 | $50,000 | $50,000 | $50,000 |
| Local Stakeholder Engagement | $40,000 | $40,000 | $40,000 | $40,000 |
| Annual Reporting - District-Level Activities | $12,500 | $12,500 | $12,500 | $12,500 |
| Periodic Evaluation of GSP - District-Level Activities | $100,000 | $100,000 | $100,000 | $100,000 |
| **TOTAL Annual Costs of Local Groundwater Management Activities** | **$272,800** | **$272,800** | **$272,800** | **$272,800** |

**Part 2. Costs for Basin-Wide Groundwater Management Activities**

| Local Groundwater Management Activity | 2020 - 2025 Average Annual Costs | 2025 - 2030 Average Annual Costs | 2030 - 2035 Average Annual Costs | 2035 - 2040 Average Annual Costs |
|---|---|---|---|---|
| Intrabasin Coordination | $105,000 | $105,000 | $105,000 | $105,000 |
| Technical Coordination | $49,000 | $49,000 | $49,000 | $49,000 |
| DMS Maintenance | $4,000 | $4,000 | $4,000 | $4,000 |
| Groundwater Model Updates | $16,000 | $16,000 | $16,000 | $16,000 |
| Water Budget Refinement | $16,000 | $16,000 | $16,000 | $16,000 |
| Collection of Supporting Data (e.g., METRIC ET) | $13,000 | $13,000 | $13,000 | $13,000 |
| Non-Technical Coordination | $56,000 | $56,000 | $56,000 | $56,000 |
| Annual Reporting - Basin-Level Activities | $3,000 | $3,000 | $3,000 | $3,000 |
| Periodic Evaluation of GSP - Basin-Level Activities | $12,000 | $12,000 | $12,000 | $12,000 |
| **TOTAL Costs for Basin-Wide Groundwater Management Activities** | **$120,000** | **$120,000** | **$120,000** | **$120,000** |

# TABLE PI-1
## Estimated Costs for Plan Implementation
Arvin-Edison Management Area

**Part 3. Costs to Implement Projects and Management Actions**

| | 2020 - 2025 | | | 2025 - 2030 | | | 2030 - 2035 | | | 2035 - 2040 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Projects and Management Actions Category** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** |
| Projects to Enhance Recharge | $7,505,000 | $50,000 | $1,551,000 | $0 | $50,000 | $50,000 | $0 | $50,000 | $50,000 | $0 | $50,000 | $50,000 |
| Projects to Manage and/or Capture Floodwater | $250,000 | $0 | $50,000 | $0 | $0 | $0 | $2,500,000 | $0 | $500,000 | $0 | $0 | $0 |
| Projects to Increase Surface Storage Capacity / Delivery Flexibility | $2,800,000 | $50,000 | $610,000 | $3,250,000 | $70,000 | $720,000 | $3,250,000 | $70,000 | $720,000 | $1,750,000 | $90,000 | $440,000 |
| In-Lieu Projects | $6,111,515 | $200,000 | $1,422,303 | $3,055,757 | $200,000 | $811,151 | $1,222,303 | $200,000 | $444,461 | $0 | $200,000 | $200,000 |
| Projects to Develop New Supplies | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,120,000 | $50,000 | $274,000 |
| Management Actions / Policies to Reduce Overall Water Demand | $55,870 | $505,000 | $516,174 | $1,305 | $505,000 | $505,261 | $1,755 | $505,000 | $505,351 | $1,305 | $505,000 | $505,261 |
| Management Actions / Policies to Reduce Groundwater Pumping | $590,000 | $30,000 | $148,000 | $0 | $30,000 | $30,000 | $0 | $30,000 | $30,000 | $0 | $30,000 | $30,000 |
| **TOTAL Costs to Implement P/MAs** | **$17,312,385** | **$835,000** | **$4,297,477** | **$6,307,062** | **$855,000** | **$2,116,412** | **$6,974,058** | **$855,000** | **$2,249,812** | **$2,871,305** | **$925,000** | **$1,499,261** |

**Grant Total Costs of GSP Implementation**

| **Cost Category** | **2020 - 2025** | **2025 - 2030** | **2030 - 2035** | **2035 - 2040** |
|---|---|---|---|---|
| Part 1. Costs of Local Groundwater Management Activities | $272,800 | $272,800 | $272,800 | $272,800 |
| Part 2. Costs for Basin-Wide Groundwater Management Activities | $120,000 | $120,000 | $120,000 | $120,000 |
| Part 3. Costs to Implement Projects and Management Actions | $4,297,477 | $2,116,412 | $2,249,812 | $1,499,261 |
| **TOTAL Annual Costs of GSP Implementation** | **$4,690,277** | **$2,509,212** | **$2,642,612** | **$1,892,061** |

# TABLE PI-2
## Estimated Costs for Plan Implementation
### Wheeler Ridge-Maricopa Management Area

**Part 1. Costs of Local Groundwater Management Activities**

| | 2020 - 2025 | 2025 - 2030 | 2030 - 2035 | 2035 - 2040 |
|---|---|---|---|---|
| **Local Groundwater Management Activity** | **Average Annual Costs** | **Average Annual Costs** | **Average Annual Costs** | **Average Annual Costs** |
| Monitoring and Data Collection | $38,150 | $38,150 | $38,150 | $38,150 |
| Monitoring of Applicable Sustainability Indicators | $12,400 | $12,400 | $12,400 | $12,400 |
| Voluntary Monitoring of Groundwater Quality at Selected Sites | $19,000 | $19,000 | $19,000 | $19,000 |
| Collection of Other Required Information | $6,750 | $6,750 | $6,750 | $6,750 |
| Enforcement and Response Actions | $20,100 | $20,100 | $20,100 | $20,100 |
| Enforcement Actions | $0 | $0 | $0 | $0 |
| Impacted Well Mitigation Program | $20,100 | $20,100 | $20,100 | $20,100 |
| Local Stakeholder Engagement | $40,000 | $40,000 | $40,000 | $40,000 |
| Data Gap Filling | $50,000 | $50,000 | $50,000 | $50,000 |
| Annual Reporting - District-Level Activities | $12,500 | $12,500 | $12,500 | $12,500 |
| Periodic Evaluation of GSP - District-Level Activities | $100,000 | $100,000 | $100,000 | $100,000 |
| **TOTAL Annual Costs of Local Groundwater Management Activities** | **$260,750** | **$260,750** | **$260,750** | **$260,750** |

**Part 2. Costs for Basin-Wide Groundwater Management Activities**

| | 2020 - 2025 | 2025 - 2030 | 2030 - 2035 | 2035 - 2040 |
|---|---|---|---|---|
| **Local Groundwater Management Activity** | **Average Annual Costs** | **Average Annual Costs** | **Average Annual Costs** | **Average Annual Costs** |
| Intrabasin Coordination | $105,000 | $105,000 | $105,000 | $105,000 |
| Technical Coordination | $49,000 | $49,000 | $49,000 | $49,000 |
| DMS Maintenance | $4,000 | $4,000 | $4,000 | $4,000 |
| Groundwater Model Updates | $16,000 | $16,000 | $16,000 | $16,000 |
| Water Budget Refinement | $16,000 | $16,000 | $16,000 | $16,000 |
| Collection of Supporting Data (e.g., METRIC ET) | $13,000 | $13,000 | $13,000 | $13,000 |
| Non-Technical Coordination | $56,000 | $56,000 | $56,000 | $56,000 |
| Annual Reporting - Basin-Level Activities | $3,000 | $3,000 | $3,000 | $3,000 |
| Periodic Evaluation of GSP - Basin-Level Activities | $12,000 | $12,000 | $12,000 | $12,000 |
| **TOTAL Costs for Basin-Wide Groundwater Management Activities** | **$120,000** | **$120,000** | **$120,000** | **$120,000** |

# TABLE PI-2
## Estimated Costs for Plan Implementation
Wheeler Ridge-Maricopa Management Area

**Part 3. Costs to Implement Projects and Management Actions**

| | 2020 - 2025 | | | 2025 - 2030 | | | 2030 - 2035 | | | 2035 - 2040 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Projects and Management Actions Category** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** | **Capital Costs** | **Annual O&M Costs** | **Total Average Annual Costs** |
| Projects to Enhance Recharge/Banking | $2,050,000 | $26,964 | $436,964 | $2,000,000 | $98,868 | $498,868 | $2,000,000 | $188,748 | $588,748 | $2,000,000 | $269,640 | $669,640 |
| On-Farm Recharge | $50,000 | $8,988 | $18,988 | $0 | $32,956 | $32,956 | $0 | $62,916 | $62,916 | $0 | $89,880 | $89,880 |
| In-District Banking Facilities | $0 | $8,988 | $8,988 | $0 | $32,956 | $32,956 | $0 | $62,916 | $62,916 | $0 | $89,880 | $89,880 |
| Increase Out-of-District Banking Operations | $2,000,000 | $8,988 | $408,988 | $2,000,000 | $32,956 | $432,956 | $2,000,000 | $62,916 | $462,916 | $2,000,000 | $89,880 | $489,880 |
| Projects to Increase Water Management Flexibility | $4,500,000 | $0 | $900,000 | $4,500,000 | $0 | $900,000 | $4,500,000 | $0 | $900,000 | $4,500,000 | $0 | $900,000 |
| Expand District Distribution System | $4,500,000 | $0 | $900,000 | $4,500,000 | $0 | $900,000 | $4,500,000 | $0 | $900,000 | $4,500,000 | $0 | $900,000 |
| Projects to Develop New Supplies | $0 | $338,976 | $338,976 | $0 | $1,242,912 | $1,242,912 | $0 | $2,372,832 | $2,372,832 | $0 | $3,389,760 | $3,389,760 |
| Purchase Additional Supplies | $0 | $154,080 | $154,080 | $0 | $564,960 | $564,960 | $0 | $1,078,560 | $1,078,560 | $0 | $1,540,800 | $1,540,800 |
| Desalination Facilities | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| "Thru Delta" Facility | $0 | $184,896 | $184,896 | $0 | $677,952 | $677,952 | $0 | $1,294,272 | $1,294,272 | $0 | $1,848,960 | $1,848,960 |
| Management Actions to Raise Funds to Support SGMA Compliance | $50,000 | $0 | $10,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Acreage Assessment | $50,000 | $0 | $10,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Management Actions / Policies to Reduce Groundwater Pumping | $7,981,818 | $168,150 | $1,764,514 | $7,781,818 | $296,550 | $1,852,914 | $7,781,818 | $457,050 | $2,013,414 | $7,781,818 | $601,500 | $2,157,864 |
| Groundwater Allocation and Market | $50,000 | $10,000 | $20,000 | $0 | $10,000 | $10,000 | $0 | $10,000 | $10,000 | $0 | $10,000 | $10,000 |
| Voluntary Pumping Limitations | $100,000 | $100,000 | $120,000 | $0 | $100,000 | $100,000 | $0 | $100,000 | $100,000 | $0 | $100,000 | $100,000 |
| Mandatory Pumping Limitations | $50,000 | $10,000 | $20,000 | $0 | $10,000 | $10,000 | $0 | $10,000 | $10,000 | $0 | $10,000 | $10,000 |
| Land Retirement | $7,781,818 | $48,150 | $1,604,514 | $7,781,818 | $176,550 | $1,732,914 | $7,781,818 | $337,050 | $1,893,414 | $7,781,818 | $481,500 | $2,037,864 |
| **TOTAL Costs to Implement P/MAs** | **$14,581,818** | **$534,090** | **$3,450,454** | **$14,281,818** | **$1,638,330** | **$4,494,694** | **$14,281,818** | **$3,018,630** | **$5,874,994** | **$14,281,818** | **$4,260,900** | **$7,117,264** |

**Grant Total Costs of GSP Implementation**

| **Cost Category** | **2020 - 2025** | **2025 - 2030** | **2030 - 2035** | **2035 - 2040** |
|---|---|---|---|---|
| Part 1. Costs of Local Groundwater Management Activities | $260,750 | $260,750 | $260,750 | $260,750 |
| Part 2. Costs for Basin-Wide Groundwater Management Activities | $120,000 | $120,000 | $120,000 | $120,000 |
| Part 3. Costs to Implement Projects and Management Actions | $3,450,454 | $4,494,694 | $5,874,994 | $7,117,264 |
| **TOTAL Annual Costs of GSP Implementation** | **$3,831,204** | **$4,875,444** | **$6,255,744** | **$7,498,014** |

**TABLE PI-3**

**Estimated Costs for Plan Implementation**

Tejon-Castac Management Area

**Part 1. Costs for Local Groundwater Management Activities**

| | 2020-2025 |
|---|---|
| **Local Groundwater Management Activity** | **Average Annual Costs** |
| Monitoring and Data Collection | $5,000 |
| Stakeholder Engagement | $5,000 |
| Annual Report (review and comment of basin-wide reports) | $10,000 |
| Periodic Evaluations of GSP - District-level Activities | $40,000 |
| **TOTAL Annual Costs of Local Groundwater Management Activities** | **$60,000** |

**Part 2. Costs for Basin-Wide Groundwater Management Activities**

| | 2020-2025 |
|---|---|
| **Local Groundwater Management Activity** | **Average Annual Costs** |
| Techincal Coordination | $15,000 |
| Non-Technical Coordination | $15,000 |
| **TOTAL Annual Costs for Basin-Wide Groundwater Management Activities** | **$30,000** |

**Part 3. Costs to Implement Projects and Management Actions**

| | 2020-2025 |
|---|---|
| **Project and Management Actions Category** | **Average Annual Costs** |
| P/MA TC-1: Conversion of Granite Quarry to Sycamore Reservoir | $20,000 |
| P/MA TC-2: Recharge of Carrot Wash Water | $10,000 |
| **TOTAL Annual Costs to Implement P/MAs** | **$30,000** |

| | |
|---|---|
| **Total Cost of GSP Implementation** | **$120,000** |

# REFERENCES AND TECHNICAL STUDIES

☑ 23 CCR § 354.4(b)

Amec Foster Wheeler (AFW), 2017, Groundwater Sampling Work Plan, Former Bena Fertilizer Plant, Kern County, California, prepared for J.R. Simplot Company, dated 28 April 2017.

Arvin Community Services District (ACSD) and Dee Jasper & Associates, Inc., 2016, Arvin Community Services District 2015 Urban Water Management Plan

Arvin-Edison Water Storage District (AEWSD), 2015, Water Management Plan Update, dated September 2013, amended October 2015, 423 pp.

Ayers, R.S., and Westcot, D.W., 1985, Water Quality for Agriculture, FAO Irrigation and Drainage Paper 29,

Bartow, A., and McDougall, K., 1984, Tertiary stratigraphy of the southeastern San Joaquin Valley, California, U.S. Geological Survey Bulletin 1529-J.

Bartow, J.A., 1984, Tertiary Stratigraphy of the Southeastern San Joaquin Valley, California, U.S. Geological Survey Bulletin 1529-J.

Bartow, J.A., and Pittman, G.M., 1983, The Kern River Formation, Southeastern San Joaquin Valley, California, U.S. Geological Survey Bulletin 1529-D, 17 pp.

Brush, C.F., E.C. Dogrul, and T.N. Kadir, 2016, Development and Calibration of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim), Version 3.02-CG, DWR Technical Memorandum, 193 pp.

California Department of Water Resources (DWR), 2008, Depth to the Top of Corcoran Clay – 1981, San Joaquin Valley, 1 plt.

California Department of Water Resources (DWR), 2015, A Guidebook to Assist Agricultural Water Suppliers to Prepare a 2015 Agricultural Water Management Plan, dated June 2015, 169 pp.

California Department of Water Resources (DWR), 2016, Hydrogeologic Conceptual Model Best Management Practice, dated December 2016, 23 pp.

California Department of Water Resources (DWR), 2016b, Water Budget Best Management Practice, dated December 2016, 51 pp.

California Department of Water Resources (DWR), 2016c, Bulletin 118 – Interim Update 2016, California's Groundwater, Working Towards Sustainability, 58 pp.

California Department of Water Resources (DWR), 2016d, Monitoring Networks and Identification of Data Gaps Best Management Practice, dated December 2016, 34 pp.

California Department of Water Resources (DWR), 2017a, California Aqueduct Subsidence Study, San Luis Field Division, San Joaquin Field Division, 206 pp.

California Department of Water Resources (DWR), 2017b, NASA REPORT: San Joaquin Valley Land Continues to Sink – Excessive Groundwater Pumping Damages Water Infrastructure, DWR news report, dated 8 February 2017, 5 pp.

California Department of Water Resources (DWR), 2017c, Sustainable Management Criteria Best Management Practice, dated November 2017, 38 pp.

California Department of Water Resources (DWR), 2019, California Aqueduct Subsidence Study: Supplemental Report, 219 pp.

California Division of Mines (CDM), 1955, Earthquakes in Kern County California During 1952, Bulletin 171, 283 pp.

California Division of Mines and Geology (CDMG), 1964, Geologic Map, Olaf P. Jenkins Edition, Bakersfield Sheet.

California Division of Oil, Cas, and Geothermal Resources (DOGGR), 1998, California Oil & Gas Fields, Volume 1 – Central California, 507 pp.

Central Valley Regional Water Quality Control Board (CVRWQCB), 2000, Order No. R5-00-093, Waste Discharge Requirements for City of Arvin and United States Filter Corporation Arvin Wastewater Treatment Facility, Kern County.

Central Valley Regional Water Quality Control Board (CVRWQCB), 2009, Order No. R5-2009-0122, Waste Discharge Requirements for City of Bakersfield Wastewater Treatment Plant No. 2, Kern County.

Central Valley Regional Water Quality Control Board (CVRWQCB), 2013, Order No. R5-2013-0120, Waste Discharge Requirements General Order for Growers within the Tulare Lake Basin Area that are Members of a Third-Party Group, Kern County.

Chapman, A.D., and Saleeby, J.B., 2012, Geologic Map of the San Emigdio Mountains, Southern California, Geological Society of America, Map and Chart Series MCH101 2012.

Croft, M.G., 1972, Subsurface Geology of the Late Tertiary and Quaternary Water-Bearing Deposits of the Southern Part of the San Joaquin Valley, California, U.S Geological Survey Water-Supply Paper 1999-H, prepared in cooperation with the California Department of Water Resources, 29 pp.

Dale, R.H., J.J. French, and G.V. Gordon, 1966, Ground-water Geology and Hydrology of the Kern River Alluvial-Fan Area, California, U.S. Geological Survey Open-File Report 66-21, prepared in cooperation with the California Department of Water Resources, 91 pp.

Davis, G.H., J.H. Green, F.H. Olmsted, and D.W. Brown, 1959, Groundwater Conditions and Storage Capacity in the San Joaquin Valley California, U.S. Geological Survey Water-Supply Paper 1469, prepared in cooperation with the California Department of Water Resources, 287 pp.

Dibblee, Jr., T.W., and C.W. Chesterman, 1953, Geology of the Breckenridge Mountain Quadrangle, California, California Division of Mines, Bulletin 168, 56 pp.

Diepenbrock, A., 1933, Mount Poso oil field: California Division of Oil and Gas Summary of Operations – California Oil Fields, v. 19, no. 2.

Dillon, D.B., Davis, T.A., Landon, M.K., Land, M.T., Wright, M.T., and Kulongoski, J.T., 2016, Data from exploratory sampling of groundwater in selected oil and gas areas of coastal Los Angeles County and Kern and Kings Counties in southern San Joaquin Valley, 2014–15: California Oil, Gas, and

Groundwater Project (ver. 1.1, November 2017): U.S. Geological Survey Open-File Report 2016–1181, 24 p.

Erler & Kalinowski, Inc., 2016, White Wolf Subbasin Technical Report, prepared for: Wheeler Ridge-Maricopa Water Storage District, Arvin-Edison Water Storage District, Tejon-Castac Water District, 68 pp.

Farr, T.G., C.E. Jones, and Z. Lui, 2016, Progress Report: Subsidence in California, March 2015 – September 2016, California Institute of Technology, Jet Propulsion Laboratory, 37 pp.

Faunt, C.C, ed., 2009, Groundwater Availability of the Central Valley Aquifer, California, U.S. Geological Survey Professional Paper 1766, 225 pp.

Friant Water Authority (FWA), 2018, Technical Memorandum: Estimate of Future Friant Division Supplies for use in Groundwater Sustainability Plans, California, dated December 2018.

Goodman, E.D., and P.E. Malin, 1992, Evolution of the Southern San Joaquin Basin and Mid-Tertiary "Transitional" Tectonics, Central California, Tectonics, Vol. 11, No. 3, pages 478-498.

Hagan, K., 2001, The effects of the White Wolf fault on groundwater hydrology in the southern San Joaquin Valley, California, M.S. thesis in partial fulfillment of the degree of Master of Science in Geology at California State University – Bakersfield, CA.

Kern Water Bank, 2017. Project Recovery Operations Plan Regarding Pioneer Project, Rosedale-Rio Bravo Water Storage District, and Kern Water Bank Authority Projects. Joint Operating Plan. 6 p.

Lofgren, B.E., 1975, Land Subsidence Due to Ground-Water Withdrawal, Arvin-Maricopa Area, California, U.S. Geological Survey Professional Paper 437-D, prepared in cooperation with the California Department of Water Resources, 55 pp.

O'Bryan, P.L., 1992, A Study of the Base of Fresh Water in the Southern San Joaquin Basin, California, Society of Petroleum Engineers.

Page, R.W., 1973, Base of Fresh Ground Water (Approximately 3,000 Micromhos) in the San Joaquin Valley, California, U.S. Geological Survey Hydrologic Investigations Atlas HA-489, prepared in cooperation with the California Department of Water Resources.

Scheirer, A.H., 2013, The three-dimensional geologic model used for the 2003 National Oil and Gas Assessment of the San Joaquin Basin Province, California: Chapter 7 in Petroleum systems and geologic assessment of oil and gas in the San Joaquin Basin Province, California, U.S. Geological Survey Professional Paper 1713-7, 81 pp.

Shelton, J.L., Pimentel, I., Fram, M.S., and Belitz, K., 2008, Ground-water quality data in the Kern County subbasin study unit, 2006—Results from the California GAMA Program, U.S. Geological Survey Data Series 337, 75 pp.

Smith, R., Knight, R., and Fendorf, S., 2018, Overpumping leads to California groundwater arsenic threat, Nature Communications, DOI: 10.1038/s41467-018-04475-3

State Water Resources Control Board (SWRCB), 2018, Electronic Water Rights Information Management System (eWRIMS), https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/ accessed 26 July 2018.

Tejon Ranch Company, 2008, Tejon Ranch Conservation & Land Use Agreement., 280 pp. https://www.sec.gov/Archives/edgar/data/96869/000119312508138009/dex1028.htm

Thiros, S.A., 2010, Section 13 - Conceptual Understanding and Groundwater Quality of the Basin-Fill Aquifer in the Central Valley, California, in: Thiros, S.A., L.M. Bexfield, D.W. Anning, and J.M. Huntington, eds., 2010, Conceptual Understanding and Groundwater Quality of Selected Basin-Fill Aquifers in the Southwestern United States, U.S. Geological Survey Professional Paper 1781, 288 pp.

Todd Groundwater, 2016, Modeling Approach for GSP-Required Water Budgets, Kern County Groundwater Subbasin (presentation).

Walker, D., 2017, California Aqueduct Subsidence Study: Report Overview and Project Status, California Department of Water Resources presentation dated 15 November 2017. (https://cwc.ca.gov/-/media/CWC-Website/Files/Documents/2017/11_November/November2017_Agenda_Item_9_Attach_2_SubsidencePowerpoint.pdf)

Wheeler Ridge-Maricopa Water Storage District (WRMWSD), 2015, Agricultural Water Management Plan (AWMP), dated December 2015, 127 pp.

Wood, P.R., and R.H. Dale, 1964, Geology and ground-water features of the Edison-Maricopa area, Kern County, California, U.S. Geological Survey Water-Supply Paper 1656, 108 pp.

# APPENDICES

ARVIN - EDISON WATER STORAGE DISTRICT

WHEELER RIDGE - MARICOPA WATER STORAGE DISTRICT

TEJON-CASTAC WATER DISTRICT

ARVIN CSD