GREENFIELD COUNTY WATER DISTRICT

2025 URBAN WATER MANAGEMENT PLAN

JUNE 2026

2025 URBAN WATER MANAGEMENT PLAN

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Table of Contents

Acronyms and Abbreviations *1*

SECTION 1 - Introduction and Lay Description *2*

1.1 - Overview 2
1.2 - Background and Purpose 2
1.3 - Lay Description 3
1.4 - Document Organization and Contents 3

SECTION 2 - Plan Preparation *5*

2.1 - Basis for Preparing a Plan 5
2.1.1 - Overview 5
2.1.2 - Public Water Systems 5
2.2 - Regional Planning 6
2.3 - Individual Planning and Compliance 6
2.4 - Calendar Year and Units of Measure 6
2.5 - Coordination and Outreach 7
2.5.1 - Coordination Within the District 8
2.5.2 - Wholesale and Retail Coordination 8
2.5.3 - Coordination with Other Agencies and the Community 8
2.5.4 - Notice to Cities and Counties 9

SECTION 3 - System Description *10*

3.1 - General Description 10
3.2 - Service Area Boundary Maps 10
3.3 - Service Area Climate 14
3.4 - Service Area Population and Demographics 15
3.4.1 - Service Area Population 15
3.4.2 - Other Social, Economic, and Demographic Factors 15
3.5 - Land Uses Within the Service Area 16

SECTION 4 - Water Use Characterization *18*

4.1 - Non-Potable Versus Water Use 18
4.1.1 - Potable and Raw Water 18
4.1.2 - Recycled Water 18
4.2 - Past, Current, and Projected Water Use by Sector 18
4.2.1 - Water-Use Sectors Listed in Water Code 18
4.2.2 - Optional Water-Use Sectors in Addition to Those Listed in Water Code 19
4.2.3 - Current Water Use 19
4.2.4 - Projected Water Use 20
4.2.5 - Estimating Future Water Savings 20
4.3 - Distribution System Water Losses 22

4.3.1 - Previous Five Years Distribution System Losses 22
4.3.2 - Progress Toward Meeting the Water Loss Performance Standard 22

SECTION 5 - SB X7-7 Baselines, 2020 Targets, and 2025 Reporting 24

SECTION 6 - Normal-Year Water Supply Characterization 25

6.1 - Water Supply Analysis Overview 25
6.2 - Water Supply Characterization - Groundwater 26
6.2.1 - Basin Description 27
6.2.2 - Basin Management Information 29
6.2.3 - Overdraft Conditions 29
6.2.4 - Groundwater Pumping 29
6.3 - Surface Water 30
6.4 - Stormwater 30
6.5 - Wastewater and Recycled Water 30
6.6 - Desalinated Water Opportunities 33
6.7 - Water Exchanges and Transfers 33
6.8 - Future Water Projects 33
6.9 - Groundwater Supplies Coordination 34
6.10 - Energy Use 40
6.11 - Summary of Existing and Planned Sources of Water 41

SECTION 7 - Water Service Reliability and Drought Risk Assessment 43

7.1 - Constraints on Water Sources Considerations 43
7.2 - Water Service Reliability Assessment 44
7.2.1 - Supply and Demand Comparison 46
7.3 - Drought Risk Assessment 49

SECTION 8 - Water Shortage Contingency Plan 51

8.1 - Water Supply Reliability Analysis 53
8.2 - Annual Water Supply and Demand Assessment Procedures 53
8.3 - Six Standard Water Shortage Levels 53
8.4 - Supply Augmentation 54
8.5 - Demand Reduction Actions 56
8.6 - Shortage Response Actions Penalties, Charges, Other Enforcement of Prohibitions 57
8.7 - Determining Water Shortage Reductions 57
8.8 - Revenue and Expenditure Impacts 58
8.9 - Resolution or Ordinance 58
8.10 - Catastrophic Supply Interruption 58
8.11 - Emergency Response Plan 58
8.12 - Seismic Risk Assessment and Mitigation Plan 58

SECTION 9 - Demand Management Measures 60

9.1 - Water Waste Prevention Ordinances 60
9.2 - Metering 61
9.3 - Public Education and Outreach 61
9.4 - Programs to Assess and Manage Distribution System Real Loss 61
9.5 - Water Conservation Program and Staffing Support 62
9.6 - Other Demand Management Measures That Impact GPCD 62
9.7 - Planned Implementation to Achieve Water Use Targets 62
9.8 - Members of the California Urban Water Conservation Council 63

SECTION 10 - UWMP Adoption, Submittal, and Implementation 64

Bibliography 67

Appendices

Appendix A – Urban Water Management Planning Act
Appendix B – 60-Day Notice
Appendix C – Adopted Resolution
Appendix D – Letter of Transmittal
Appendix E – Checklist Arranged by Subject
Appendix F – County of Kern Multi-Jurisdiction Hazard Mitigation Plan
Appendix G – Final Groundwater Sustainability Plan – Kern River Groundwater Sustainability Agency
Appendix H - Water Loss Audit Reports

List of Figures

Figure 3-1 Regional Location 11
Figure 3-2 Service Area 12
Figure 3-3 Well Locations 13
Figure 3-4 Land Uses Within Service Area 17
Figure 6-1 Tulare Lake Hydrologic Region 28

List of Tables

Table 2-1 Retail Only: Public Water Systems 6
Table 2-2: Plan Identification 6
Table 2-3: Agency Identification 7
Table 2-4 Retail: Water Supplier Information Exchange 8
Table 3-1 Retail: Population – Current and Projected 15
Table 4-1 Retail: Demands for Potable and Raw Water – Actual 20
Table 4-2 Retail: Demand for Potable and Raw Water – Projected (MG) 21
Table 4-3 Retail: Inclusion in Water Use Projections 21
Table 4-5 Retail: Water Loss Audit Reporting 22

Table 4-6 Retail: Progress Toward 2028 Water Loss Standard 23
Table 5-1 Retail: SB X7-7 2020 Target Progress..... 24
Table 6-1 Retail: Groundwater Volume Pumped..... 30
Table 6-2 Retail: Wastewater Collected Within Service Area..... 32
Table 6-3 Retail: Wastewater Treatment and Outcomes Within UWMP Service Area..... 32
Table 6-4 Retail: Recycled Water Direct Beneficial Uses Within Service Area 32
Table 6-5 Retail: 2020 Recycled Water Use Projection Compared to 2025 Actual..... 33
Table 6-5 Retail: 2020 Recycled Water Use Projection Compared to 2025 Actual..... 33
Table 6-7 Retail: Expected Future Water Supply Projects or Programs 34
Table O-1A Recommended Energy Reporting..... 41
Table 6-8 Retail: Water Supplies – Actual 42
Table 6-9 Retail: Water Supplies – Projected..... 42
Table 7-1 Retail: Basis of Water Year Data 45
Table 7-2 Retail: Normal Year Supply and Use Comparison..... 46
Table 7-3 Retail: Single Dry Year Supply and Demand Comparison..... 47
Table 7-4 Retail: Five Consecutive Dry Years Supply and Demand Comparison..... 48
Table 7-5 Five-Year Drought Risk Assessment Tables to Address..... 50
Table 8-1 Retail: Cross-reference for Standard vs Supplier Storage Levels 54
Table 8-2 Retail: Supply Augmentation and Other Actions..... 55
Table 8-3 Retail: Demand Reduction Actions 56
Table 10-1 Retail: Notification to Cities and Counties..... 65

ACRONYMS AND ABBREVIATIONS

Act	Urban Water Management Planning Act of 1983
AF	acre-feet
District	Greenfield County Water District
cf	cubic feet
CII	Commercial, Industrial, and Institutional
CWC	California Water Code
DMMs	Demand Management Measures
GCWD	Greenfield County Water District
GPCD	Gallons per Capita per Day
GSA	Groundwater Sustainability Agency
Guidebook	*2025 Guidebook for Urban Water Suppliers*
KDWD	Kern-Delta Water District
MCL	maximum contaminant level
MG	million gallons
MGD	million gallons per day
mg/L	milligrams per liter
mph	miles per hour
PWS	Public Water System
QK	Quad Knopf, Inc.
SB	Senate Bill
SGMA	Sustainable Groundwater Management Act
SR	State Route
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
UWMP	Urban Water Management Plan
WDR	Waste Discharge Requirements
WSCP	water shortage contingency plan
WSIHIST	DWR's Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices 1995 to 2026
WWTP	wastewater treatment plant
^{0}F	degrees Fahrenheit

SECTION 1 - INTRODUCTION AND LAY DESCRIPTION

1.1 - Overview

This document presents the 2025 Urban Water Management Plan (UWMP) for the Greenfield County Water District (GCWD or District) as required by the Urban Water Management Planning Act of 1983 (Act). It was prepared in cooperation with GCWD staff to address the requirements in California Water Code Division 6, Part 2.6, sections 10610 through 10656. Throughout this 2025 UWMP is italicized text quoting specific requirements of the Act. The quoted text precedes sections relevant to a specific portion of the Act to serve as an aid to the reader. A copy of the Act is included as Appendix A. Section 1 describes the general background and purpose of an UWMP, previous GCWD plans, as well as this 2025 UWMP's organization and contents.

The threshold that is required to prepare and submit an UWMP is 3,000 customers (or service connections). GCWD surpassed 3,000 customers in 2017 and in 2025, the GCWD had 3,541 service connections.

1.2 - Background and Purpose

Water Code section 10617 defines an "urban water supplier" as a public or private supplier, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet (AF) of water annually. If qualified as an urban water supplier, a public or private supplier is required to create or update an UWMP every five years and submit it to the Department of Water Resources (DWR) for review and approval. The purpose of the Act is to ensure that urban water suppliers are adequately planning.

An UWMP is a planning tool that was created to help generally guide the actions of urban water suppliers in successfully preparing for potential water supply disruptions and issues. It provides a framework for long-term water planning and informs the public of a supplier's long-term resource planning to ensure adequate water supplies for existing and future demands. An UWMP is not a substitute for project-specific planning documents, nor was it intended to be so mandated by the State Legislature.

The Act requires that an UWMP include historic, current, and future supplies and demands for water; address conservation measures, describe potential supply deficiencies during drought conditions and the ability to mitigate these conditions; compare total projected water use and supply sources over 20 years in 5-year increments for a single-dry water year and for dry water years; and include provisions for recycled water use, demand management measures, and a water shortage contingency plan.

To assist urban water suppliers in preparing UWMP's DWR developed the *2025 Guidebook for Urban Water Suppliers* (Guidebook). The Guidebook is updated every five years to address any changes in State legislation (such as SB X7-7) and all requirements of the Act. The 2025 Guidebook reflects new legislation, provides information to the public regarding

water suppliers and water management programs, and provides a framework for minimizing the negative effects of potential water shortages. Additionally, the Guidebook provides a general layout for how UWMPs could be organized. This 2025 UWMP largely utilizes the Guidebook's layout.

1.3 - Lay Description

Based on the results of this UWMP, the District has a reliable water supply and is not vulnerable to seasonal and climatic shortages. There is no current need to supplement or replace the existing groundwater source available to the District with alternative sources or water demand management measures.

As shown in the table below from Section 7 of this UWMP, future water supplies are anticipated to not only meet but exceed demands in normal year conditions through year 2050.

Submittal Table 7-2 Retail: Normal Year Supply and Use Comparison
Water Code Section 10635 (a)

	2030 (MG)	2035 (MG)	2040 (MG)	2045 (MG)	2050 (MG)
Supply totals (autofill from Submittal Table 6-9 R)	3,010	3,010	3,010	3,010	3,010
Use totals (autofill from Submittal Table 4-2 R)	912	949	987	1,026	1,067
Surplus/(shortfall)	2,098	2,061	2,023	1,984	1,943

1.4 - Document Organization and Contents

The content and format of this 2025 UWMP is designed to meet the requirements of the Guidebook dated January 2026 and contains the following sections:

Section 1 – Introduction and Lay Description: This section provides an overview of the Act and CWC requirements, document organization, and a discussion of the importance and extent of the District's water management planning efforts.

Section 2 – Plan Preparation: This section provides information on the UWMP development process, including coordination and outreach efforts.

Section 3 – System Description: This section provides a detailed description of the District's current water system.

Section 4 – Water Use Characterization: This section describes and quantifies the current and projected water uses within the District's service area.

Section 5 – SB X7-7 Baselines, 2020 Targets, and 2025 Reporting: This section describes the methods used for calculating the District's baseline and target water consumption. It will describe whether the District has met the 20-percent conservation mandate by 2025.

Section 6 – Normal-Year Water Supply Characterization: This section describes and quantifies the current and projected sources of water available to the District.

Section 7 – Water Supply Reliability and Drought Risk Assessment: This section describes the reliability of the District's water supply and projects that reliability for 20 years. Such reliability is projected for normal, single-dry, and multiple-dry years.

Section 8 – Water Shortage Contingency Plan: This section provides the District's staged plan for dealing with water shortages, including a catastrophic supply interruption.

Section 9 – Demand Management Measures: This section describes the District's efforts to promote conservation and to reduce demand on its water supply and specifically addresses several demand management measures.

Section 10 – UWMP Adoption, Submittal, and Implementation: This section describes the steps to be taken to adopt and submit the 2025 UWMP and to make it publicly available. It also includes a discussion of the District's plan for implementation of the 2025 UWMP.

SECTION 2 - PLAN PREPARATION

2.1 - Basis for Preparing a Plan

2.1.1 - OVERVIEW

CWC 10617. "Urban water supplier" means a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. An urban water supplier includes a supplier or contractor for water, regardless of the basis of right, which distributes or sells for ultimate resale to customers. This part applies only to water supplied from public water systems subject to Chapter 4 (commencing with Section 116275) of Part 12 of Division 104 of the Health and Safety Code.

CWC 10620(b). Every person that becomes an urban water supplier shall adopt an urban water management plan within one year after it has become an urban water supplier.

CWC 10621(a). Each urban water supplier shall update its plan at least once every five years on or before July 1, in years ending in six and one, incorporating updated and new information from the five years preceding each update.

The District currently supplies approximately 726 million gallons (MG) (2,230 AF) of water per year and maintains 3,541 service connections, which is above the 3,000-connection threshold identified in CWC Section 10617.

This 2025 UWMP has been prepared by Quad Knopf, Inc. a California corporation, dba QK, as an independent contractor to the District. Accordingly, and as set forth herein, this 2025 UWMP has been prepared in accordance with the Act, SB X7-7, and the technical guidance documentation prepared and published by DWR.

2.1.2 - PUBLIC WATER SYSTEMS

California Health and Safety Code section 116275(h) defines a "Public Water System" (PWS) as a system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. PWS's are regulated by the State Water Resources Control Board (SWRCB), Division of Drinking Water.

PWS data reported to the SWRCB is used to determine whether a retail supplier has reached the UWMP reporting threshold of 3,000 or more connections or 3,000 AF of water supplied DWR. Table 2-1 describes the District's PWS information and, as noted above, the District currently supplies water to over 3,541 connections. The District is not a wholesale water supplier.

Table 2-1 Retail Only: Public Water Systems

Submittal Table 2-1 Retail: Public Water Systems			
Public Water System Number	Public Water System Name	Number of Municipal Connections 2025	Volume of Water Supplied 2025 (MG)
Add additional rows as needed			
CA1510024	Greenfield County WD	3,541	877
	Total	3,541	877

2.2 - Regional Planning

The District is not involved in any regional water planning efforts nor will it be involved in developing a cooperative 2025 UWMP or Regional UWMP or Regional Plan.

2.3 - Individual Planning and Compliance

This 2025 UWMP is intended to address those aspects of the Act and SB X7-7, which are under the control of the District, specifically water supply and water use. The District is undertaking individual reporting to address all requirements for applicable uses served within the District's service area (see Table 2-2).

Table 2-2: Plan Identification

Submittal Table 2-2: Plan Identification		
Select One	**Type of Plan**	**Name of Regional Alliance or RUWMP** (Drop Down List)
☑	**Individual UWMP**	
	If Water Supplier is also a member of a SB X7-7 Regional Alliance, select name from the drop-down.	
☐	**Regional Urban Water Management Plan (RUWMP)**	
	If Supplier selected RUWMP, select name from the drop-down.	

2.4 - Calendar Year and Units of Measure

As shown in Table 2-3, the District is a retailer that reports on a calendar year basis and uses million gallons MG as the unit of measure when reporting water volumes. This 2025 UWMP includes water use and planning data for calendar years.

Table 2-3: Agency Identification

Submittal Table 2-3: Supplier Identification	
Type of Supplier (select one or both)	
☐	Supplier is a wholesale supplier
☑	Supplier is a retail supplier
Fiscal or Calendar Year (select one)	
☑	UWMP Tables are in calendar years
☐	UWMP Tables are in fiscal years
If using fiscal years provide month and date that the fiscal year begins (mm/dd)	
Units of measure used in UWMP (Select from the drop down list).	
Unit	MG

2.5 - Coordination and Outreach

CWC 10620(d)(2). Coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.

CWC 10642. Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan. Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. The urban water supplier shall provide notice of the time and place of hearing to any District or county within which the supplier provides water supplies. A privately owned water supplier shall provide an equivalent notice within its service area. After the hearing, the plan shall be adopted as prepared or as modified after the hearing.

While preparing this 2025 UWMP, the District coordinated its efforts with relevant local agencies to ensure that the data and issues are presented accurately and encouraged public involvement in full compliance with CWC 10642.

2.5.1 - Coordination Within the District

The preparation of this 2025 UWMP was coordinated with all appropriate District staff. Copies of the 2025 UWMP were made available to District staff for comment and revision prior to adoption.

2.5.2 - Wholesale and Retail Coordination

Prior to and during the development of this 2025 UWMP, the District worked with Kern-Delta Water District (KDWD) on several future water projects. The District and KDWD draw their water supply from the same groundwater basin. The District's water supply is produced solely from District-owned groundwater wells within the Kern County Subbasin (Groundwater Basin 5-22.14) as defined in DWR Bulletin 118 (Update 2003) (DWR, 2003) (see *Section 6.2 – Groundwater* for more information). Thus, the continued coordination with KDWD was important while preparing this UWMP. As shown in Table 2-4, the District purchases raw-seepage water from the Kern Delta Water District through that portion of the Kern Delta's unlined canal systems lying within the District's Sphere of Influence via the Kern Island Main and Central Canals from the Arvin-Edison Canal on the north and DiGiorgio Road on the South. On average over the last five years, 3,600 AF from KDWD per year of such water is purchased from KDWD, and this water is then pumped from the ground using GCWD-owned wells or "banked" for future use.

Table 2-4 Retail: Water Supplier Information Exchange

Submittal Table 2-4 Retail: Water Supplier Information Exchange Water Code Section 10631(h)
The retail Supplier has informed the following wholesale supplier(s) of projected water use.
Wholesale Water Supplier Name
Add additional rows as needed
Kern-Delta Water District
NOTES: GCWD purchases seepage water from KDWD from the Kern Island and Central Canals.

2.5.3 - Coordination with Other Agencies and the Community

Since a portion of the District's sphere of influence is within the Bakersfield City limits, this UWMP was developed in coordination with the City of Bakersfield. Also, GCWD coordinated with the County of Kern in the preparation of this 2025 UWMP. GCWD has met the 60-day local agency notification requirement of CWC Section 10621(b).

2.5.4 - NOTICE TO CITIES AND COUNTIES

CWC 10620 (d)(3) Each urban water supplier shall coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.

Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan...

The District's 2025 UWMP will be available for the public, KDWD, City of Bakersfield, and Kern County for a 60-day review prior to the UWMP public hearing from March 9, 2026 through May 7, 2026. Written comments on the draft 2025 UWMP must be postmarked by June 1, 2026. Submit written comments to:

Greenfield County Water District
551 Taft Highway
Bakersfield, CA 93307

Copies of the 2025 UWMP are available for review at the District's main office. See *Section 10 – UWMP Adoption, Submittal, and Implementation* for more information on notifications to the public, cities, and counties.

SECTION 3 - SYSTEM DESCRIPTION

3.1 - General Description

The District currently has a service population of approximately 12,039 people (see *Section 3.4 – Service Area Population and Demographics*). In 2025, approximately 2,230 AF of water was delivered to an estimated 3,541 water service connections of which approximately 3,435 (97%) are residential services. The remainder are for commercial and industrial uses.

The District currently utilizes local groundwater as its sole source of water supply. Groundwater is extracted by seven wells located within the District's sphere of influence. The seven wells include the Bannock, Dublin, McKee, Taft, Panama, Berkshire and East Berkshire sites (see Figure 3-3). The Panama well is a standby well. The Taft and Panama well sites are in the southern portion of the service area, the McKee and Dublin well sites are located roughly in the middle of the District, and the Berkshire, East Berkshire and Bannock groundwater wells are located at the northern border of the service area. All seven wells are crucial to meet the demands of District customers. In addition to production wells, the District has six storage tanks: the Panama and Taft sites contain one storage tank each, while the Dublin and Berkshire sites each contain two storage tanks each.

Recently, the District has been undergoing issues that require immediate attention, including dry, outdated wells and elevated levels of arsenic in the water supply.

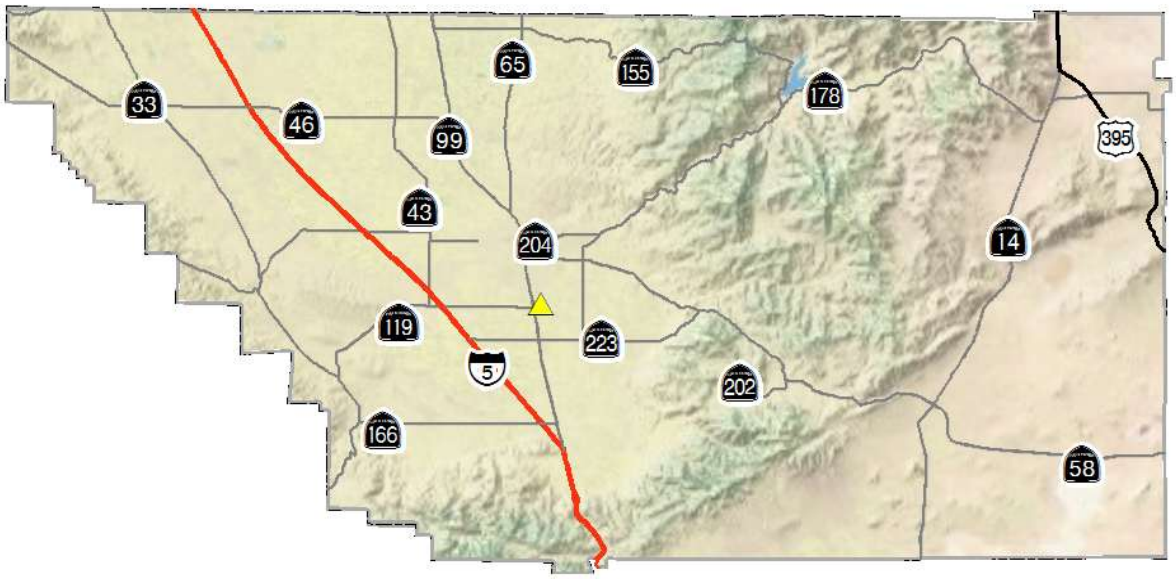
3.2 - Service Area Boundary Maps

10631(a). Describe the service area of the supplier.

Established in 1955 by the Kern County Board of Supervisors, GCWD is located within the census-designated place of Greenfield, which is located approximately 7 miles south of Metropolitan Bakersfield (see Figure 3-1). The District is classified as a special district within Kern County. A special district is one which is self-governing and has the authority to provide services to a specific area. Therefore, the District operates under its own Board of Directors and sets its own budget. Like most of the Bakersfield area, the District supplies water from the subterranean reserve of groundwater within the Kern County Subbasin (see *Section 6 – Normal-Year Water Supply Characterization*). The District does not produce or supply raw or recycled water and solely supplies potable groundwater.

The District service area is approximately 3.61 square miles of which 1.82 square miles is developed with urban land uses such as residential, commercial, and schools (see Figure 3-2). The remaining undeveloped area is primarily farmland; however, the District has no agricultural customers and does not supply water to the undeveloped area.

The District's sphere of influence is bound by the Arvin-Edison Intake Canal (north), Cottonwood Road (east), Di Giorgio Road (south), and State Route (SR) 99 (west) (see Figure 3-2). Total land within the District's sphere of influence is 6.12 square miles.



KERN COUNTY



Greenfield CWD

Document Path: ArcGIS Server Generated

N

NOT TO SCALE

QK Sources: ESRI, State of California, Kern CountyUS Census
ESRI Source: US National Park Service

Figure 3-1
Regional Location

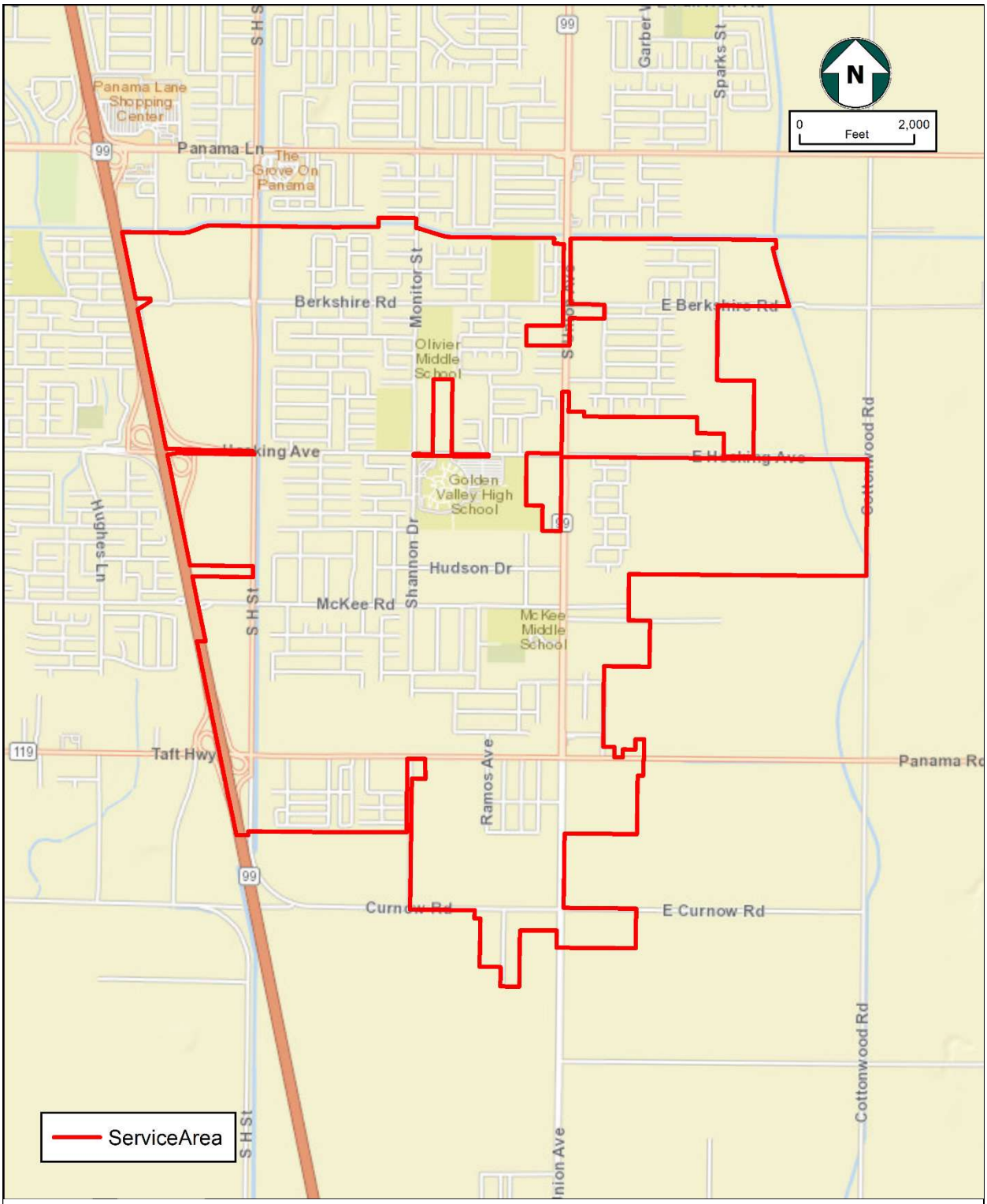


Figure 3-2
Service Area

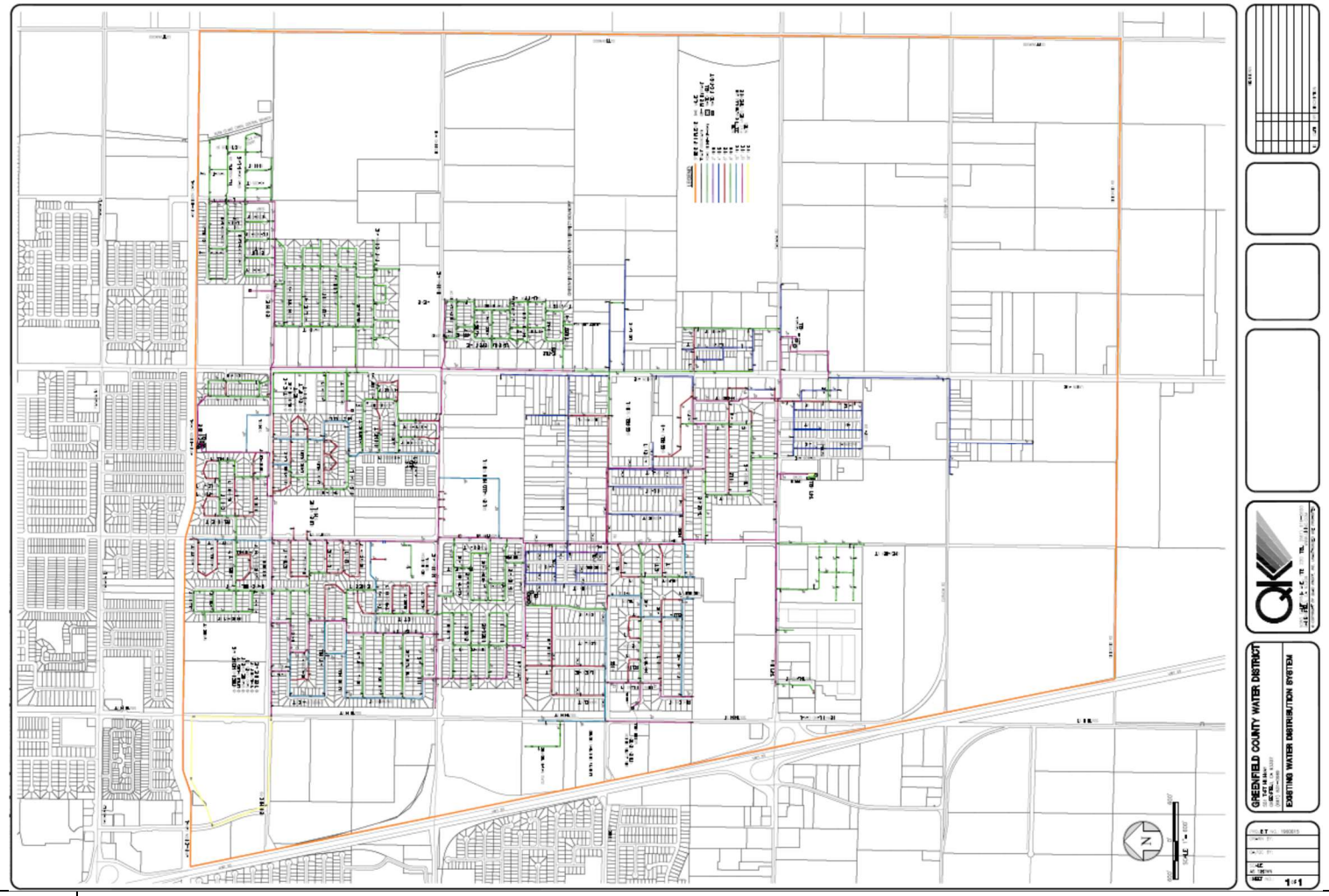


Figure 3-3
Well Locations

3.3 - Service Area Climate

10631(a). Describe the climate of the service area of the supplier.

The climate within the service area is characteristic of that of the Southern San Joaquin Valley. The summer climate is hot and dry, while winters are cool and periodically humid. Mean daily maximum temperatures range from a low of approximately 40 degrees Fahrenheit (^{0}F) in February to a high of about 98^{0}F in July. Rainfall is concentrated during the six months from October to May. December and January typically experience heavy fog, mostly nocturnal, caused when moist cool air is trapped in the valley by high pressure systems. In extreme cases, this fog may last continuously for two or three weeks. Its depth is usually less than 3,000 feet.

The Valley area is subject to characteristic seasonal air flows. During the summer, air currents from the Pacific Ocean enter the Valley through the San Francisco Bay and Delta region and are forced down the valley. These air movements are primarily to the southeast at velocities of 6 to 10 miles per hour (mph). During the winter, cold air flowing off the surrounding mountains results in currents toward the northwest and velocities ranging from 0 to 5 mph. These airflows result in extensive horizontal mixing of air masses in the Valley. However, vertical dispersion is constrained by temperature inversions, an increase in air temperature in a stable atmospheric layer, which may occur throughout the year.

Climatic data within the service area is summarized as follows:

Bakersfield Airport Climate Summary (1991 to 2026)

Month	Average Maximum Temperature (degree Fahrenheit)	Average Minimum Temperature (degrees Fahrenheit)	Average Total Precipitation (inches)
January	58	40	1.19
February	64	43	1.18
March	70	47	1.15
April	76	51	0.60
May	84	58	0.25
June	92	65	0.05
July	98	71	0.00
August	97	70	0.00
September	91	65	0.05
October	80	55	0.28
November	67	45	0.51
December	59	40	1.10
Annual	**78**	**54**	**6.36**

Source: (US Climate Data, 2026).

3.4 - Service Area Population and Demographics

3.4.1 - Service Area Population

16031(a). Indicate the current population of the service area.

16031(a). Provide population projections for in five-year increments to 20 years or as far as data is available.

The population projections for the service area are based on the current number of residential connections using an average of 3.40 people per household from most current 2020 Census data of the City of Bakersfield (United States Census, 2022). It is estimated based on 3,541 residential connections that 12,039 people currently live in the service area.

Using the number of connections provided by the District, current and projected population for the service area was calculated through 2050 using the City of Bakersfield's 3.40 people per household. The results are presented in Table 3-1.

Table 3-1 Retail: Population – Current and Projected

Submittal Table 3-1 Retail: Population - Current and Projected Water Code Section 10631(a)						
Population Served	2025	2030	2035	2040	2045	2050(opt)
	12,039	12,521	13,021	13,542	14,084	14,647

3.4.2 - Other Social, Economic, and Demographic Factors

16031(a). Describe other demographic factors affecting the supplier's water management planning.

There are no unique or pertinent community demographic characteristics which will influence future population growth or water usage.

3.5 - Land Uses Within the Service Area

10631 (a). The description shall include the current and projected land uses within the existing or anticipated service area affecting the supplier's water management planning. Urban water suppliers shall coordinate with local or regional land use authorities to determine the most appropriate land use information, including, where appropriate, land use information obtained from local or regional land use authorities.

Figure 3-4 describes the current (2025) land use and delineates the service area.

The District provides water service to residents, businesses, and other institutions within its limits. Future land use includes the development of vacant or underdeveloped areas not defined as known development. It is assumed that development and redevelopment will occur according to the land use designations as depicted in Figure 3-4. At build-out, the service area will encompass approximately 2.14 square miles (excluding agriculture).

A breakdown of the District's existing Land Use by *Land Use Category,* and acreage for the same, is shown below:

- Residential Single Family - 736.26 acres
- Multifamily Residential - 80.96 acres
- Commercial - 273.73 acres
- Industrial - 72.27 acres
- Agricultural - 534.86 acres
- Vacant - 204.05 acres

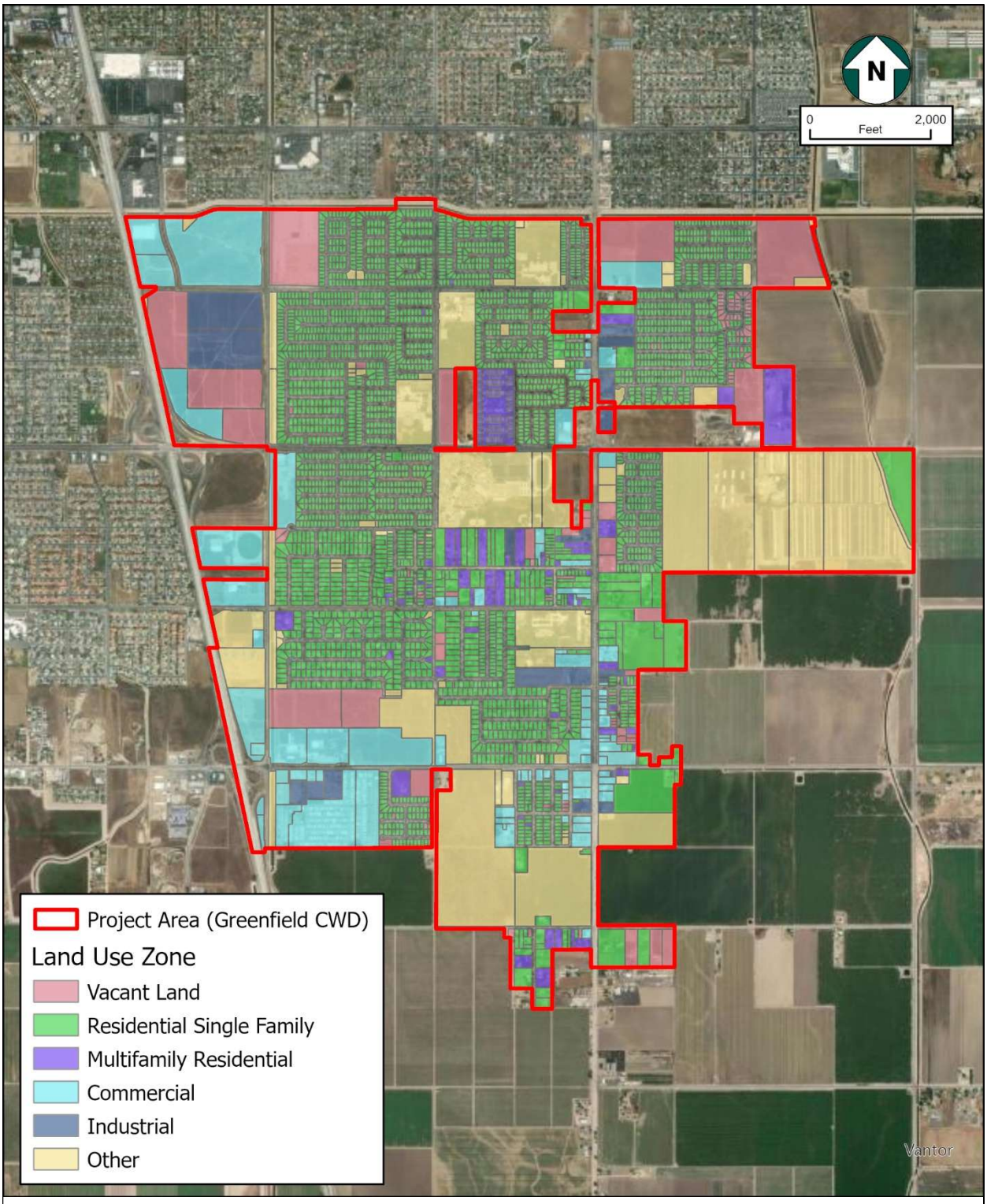


Figure 3-4
Land Uses Within Service Area

SECTION 4 - WATER USE CHARACTERIZATION

A system's water use is determined by the amount of water conveyed by a distribution system, that is used by a water agency and its customers for any purpose, including non-potable water uses, water losses, and other nonrevenue water. This section describes and quantifies the District's current water use and water use projections by individual land use sector through the year 2050.

4.1 - Non-Potable Versus Water Use

4.1.1 - POTABLE AND RAW WATER

Potable water is water intended for human consumption, which is delivered through a public water system, and regulated by a State or local health agency. Raw water is untreated water that is used in its natural state. The District supplies potable water to residences, commercial, industrial businesses, and institutions and does not supply raw water. *Section 6 – Normal-Year Water Supply Characterization* provides a full description of the District's potable supply including the source, quality, and groundwater levels.

4.1.2 - RECYCLED WATER

Recycled water is municipal wastewater that has been treated to a specified quality to enable it to be used again. Wastewater from the District is discharged to and treated by the City of Bakersfield. The District currently has no plans to utilize recycled water to offset potable water demand.

4.2 - Past, Current, and Projected Water Use by Sector

4.2.1 - WATER-USE SECTORS LISTED IN WATER CODE

16031(c)(1). Quantify past, current, and projected water use, identifying the uses.

The quantifications of past, current, and projected water use include the following land use sectors in five-year increments:

- Single-family residential – lot with a free-standing building containing one dwelling unit;
- Multi-family residential – multiple dwelling units contained within one building or several buildings within one complex;
- Commercial – water users that provide or distribute a product or service;
- Industrial – water users that are primarily the manufacturer or processor of materials as defined by North American Industry Classification System code sectors 31 to 33, or entities that are water users and primarily engage in research and development;
- Institutional and government – water users dedicated to public service, including education, courts, churches, hospitals, government facilities, and nonprofit research institutions; and

- Landscape – water connections that supply water solely for landscape irrigation.

The following sectors are not included in this UWMP because they are not applicable to the District:

- Conjunctive use – the District does not apply a management strategy where surface water is managed in conjunction with an underground aquifer;
- Groundwater recharge – the District does not manage or intentionally replenish natural groundwater supplies using manmade conveyance;
- Saline water intrusion barriers – the District does not inject water into a freshwater aquifer to prevent intrusion of salt water;
- Agricultural – the District does not supply water for commercial agricultural irrigation;
- Surface water augmentation – the District does not place recycled water in a surface water reservoir as a source of domestic drinking water supply. The District purchases seepage water that recharges groundwater in the area that is used as a source of domestic drinking water; and
- Wetlands or wildlife habitat – the District does not use water for a managed environmental use to improve any environmental conditions.
- Past, current, and projected losses within the system were tabulated.
- The following sectors are not included in this UWMP because they are exclusively associated with wholesale demand and, because the District is exclusively a retailer (see Table 2-3), these sectors are not applicable:
    - Sales to other agencies – the District does not make water sales to other agencies;
    - Exchanges – the District does not exchange water with other agencies; and
    - Transfers – the District does not transfer water to other agencies as defined by the CWC as a temporary or long-term change in the point of diversion, place of use, or purpose of use.

4.2.2 - Optional Water-Use Sectors in Addition to Those Listed in Water Code

Not applicable.

4.2.3 - Current Water Use

This section describes the different types of land use sectors and their 2025 individual water demand within the District service area. Pursuant to the UWMP Standardized Tables provided by DWR, the District has provided, in Table 4-1, the 2025 water demand volume by land use sector.

As shown in Table 4-1, the District experienced a water demand of 2,627 ac-ft (856 MG) in year 2025. All water distributed through the District service area is potable drinking water. The District produces all its water supply through pumping groundwater using District facilities. There are no current plans to purchase wholesale water. The District does

purchase seepage water that recharges groundwater in the area that is used as a source of domestic drinking water.

Table 4-1 Retail: Demands for Potable and Raw Water – Actual

Submittal Table 4-1 Retail: Total Uses for Potable and Non-Potable Water — Actual Water Code Section 10631(d)(1)			
Use Type	Additional Description (as needed)	2025 Actual Water Use	
Drop down list May select each use multiple times These are the only use types that will be recognized by the WUEdata online submittal tool		**Potable or Non-Potable** (OPTIONAL) Drop down list	Volume (MG)
Add additional rows as needed			
Single Family		Potable	552
Multi-Family		Potable	61
Commercial		Potable	108
Industrial		Potable	
Other (optional)	Construction Water	Non-Potable	3
Landscape		Non-Potable	13
Distribution System Water Loss		Potable	140
		Subtotal Potable	861.156
		Subtotal Non-Potable	16.07
		Total	877

4.2.4 - PROJECTED WATER USE

Pursuant to the UWMP Standardized Tables provided by DWR, the District has provided, in Table 4-2, the projected demands for water by land use. Total projected demands for the District do not include the use of any raw or recycled water and only include potable water.

4.2.5 - ESTIMATING FUTURE WATER SAVINGS

CWC 10631(e)(4)(A). If available and applicable to an urban water supplier, water use projections may display and account for the water savings estimated to result from adopted codes, standards, ordinances, or transportation and land use plans identified by the urban water supplier, as applicable to the service area.

CWC 10631(e)(4)(B). To the extent that an urban water supplier reports the information described in subparagraph (A), an urban water supplier shall do both of the following: (i) Provide citations of the various codes, standards, ordinances, or transportation and land use plans utilized in making the projections. (ii) Indicate the extent that the water use projections consider savings from codes, standards, ordinances, or transportation and land use plans. Water use projections that do not account for these water savings shall be noted of that fact.

Water savings from codes, standards, ordinances, or transportation and land use plans are also known as "passive savings." These various factors generally decrease the water use for new and future customers compared to historical customers.

As shown in Table 4-3, this 2025 UWMP does not display or account for future water savings estimated to result from adopted codes, standards, ordinances, or transportation and land use plans. This does not preclude the District from adopting codes, standards, ordinances, or transportation and land use plans in the future that would result in water savings. If such adoptions occur, they would be reflected in future UWMPs for the District.

Table 4-2 Retail: Demand for Potable and Raw Water – Projected (MG)

Submittal Table 4-2 Retail: Total Uses for Potable, and Non-Potable Water — Projected Water Code Section 10631(d)(1)							
Use Type	Additional Description (as needed)	**Projected Water Use** (Report To the Extent that Records are Available)					
Drop down list May select each use multiple times These are the only Use Types that will be recognized by the WUEdata online submittal tool		**Potable or Non-Potable** (OPTIONAL) Drop down list	**2030 (MG)**	**2035 (MG)**	**2040 (MG)**	**2045 (MG)**	**2050 opt (MG)**
Add additional rows as needed.							
Single Family		Potable	574	597	621	646	672
Multi-Family		Potable	63	66	69	71	74
Commercial		Potable	112	117	121	126	131
Industrial		Potable					
Other (optional)	Construction Water	Non-Potable	3	3	4	4	4
Landscape		Non-Potable	13	14	14	15	16
Distribution System Water Loss		Potable	146	151	157	164	170
		Subtotal Potable	896	931	969	1,007	1,048
		Subtotal Non-Potable	17	17	18	19	20
		Total	912	949	987	1,026	1,067

Table 4-3 Retail: Inclusion in Water Use Projections

Submittal Table 4-3 Retail: Inclusion in Water Use Projections Water Code Section 10631 (a), 10631 (d)(4)(A), and 10631 (d)(4)(B)	
Are Future Water Savings Included in Projections? **Drop down list (y/n)**	No
If "Yes" to above, **state the section or page number**, in the cell to the right, where citations of the codes, ordinances, or otherwise are utilized in demand projections are found. ***Optional*** Suppliers may complete Optional Submittal Table 4-4 R to quantify the expected savings.	
Are Lower Income Residential Demands Included In Projections? **Drop down list (y/n)**	Yes
Optional If the method for accounting Lower Income Residential Demands has been included, provide page number where this accounting can be found.	

4.3 - Distribution System Water Losses

4.3.1 - Previous Five Years Distribution System Losses

Submittal Table 4-5 is used by Retail Suppliers to indicate that they submitted their Water Loss Aduit to DWR's Water Loss Audit Program. The District is providing a copy of these Water Loss Audit Reports in this UWMP document in Appendix H.

Table 4-5 Retail: Water Loss Audit Reporting

Submittal Table 4-5 Retail: Water Loss Audit Reporting Water Code Section 10631(d)(3)(A)		
Public Water System ID # Reported in Table 2-1 R	Reporting Period	Submitted to DWR Water Loss Audit Program (yes/no)
Report submittal status for all five years for each Public Water System as available. Add rows as needed		
CA1510024	**2020**	Yes
	2021	Yes
	2022	Yes
	2023	Yes
	2024	Yes
DWR NOTES: Suppliers will provide a link to the WUEdata submittals of their Water Loss Audit Reports.		

4.3.2 - Progress Toward Meeting the Water Loss Performance Standard

Retail Suppliers need to report data to show whether the Water Loss Performance Standard has been met. The associated standards must be listed in the table, along with relevant information for converting between the performance standard and water loss volumes to determine progress toward meeting the water loss standard.

Submittal of this table (Table 4-6) and relevant data is for UWMP Act purposes only and does not constitute compliance or non-compliance with the Water Loss Control Regulation which is under the authority of the State Water Board.

Table 4-6 Retail: Progress Toward 2028 Water Loss Standard

Submittal Table 4-6 Retail: Progress Towards 2028 Water Loss Standard Water Code Section 10631(d)(3)(C)											
Public Water System ID # Reported in Submittal Table 2-1 R	Did the Water Board Calculate a Water Loss Standard for this Public Water System? (y/n) If no, Supplier will not complete this row.	Real Water Loss					Apparent Water Loss				
		State Water Board Standard		Most Recent AWWA Water Loss Audit			State Water Board Standard		Most Recent AWWA Water Loss Audit		
		2028 Real Water Loss Standard per Unit per day	Units for Real Water Loss Drop down list	Number of Units (Connections or Miles corresponding with units selected)	Volume of Total Real Loss (from AWWA Water Loss Audit) (MG)	Real Water Loss Per Unit per Day	2028 Apparent Water Loss Standard per Unit per Day	Units for Apparent Water Loss	Number of Connections	Volume of Total Apparent Loss (from AWWA Water Loss Audit) (MG)	Apparent Water Loss Per Unit per Day
Add additional rows as needed.											
CA1510024	Yes	14.4	Gallons per Service Connection per Day (GPSCD)	3464	64.565	51.1	24.3	Gallons per Service Connection per Day (GPSCD)	3464	54.014	42.7

SECTION 5 - SB X7-7 BASELINES, 2020 TARGETS, AND 2025 REPORTING

The Water Conservation Act of 2009, also known as Senate Bill (SB) X7-7 (Steinberg), mandated a 20% reduction in urban per-capita water use across California by 2020. To achieve this goal, SB X7-7 required each Retail Supplier to establish an urban water-use target, contributing to the State's collective efforts. The Legislature stated that the combined reductions from all Retail Supplier's would fulfill the statewide legislative mandate.

The Water Code requires that Retail Suppliers report their progress in meeting the 2020 Target. The Water Code does not set an end date for reporting on this progress.

Suppliers' reporting requirements will vary depending on whether the Supplier:

- Was considered an urban retail water supplier in 2020,
- Met its 2020 target in 2020,
- Was part of a merger or consolidation since 2020.

The District did meet its 2020 target in 2020 as shown in Table 5-1 and is in compliance with the Water Conservation Act of 2009. Additionally, because the District did achieve its 2020 Target, the District is eligible to receive a water grant or loan from the State of California.

Table 5-1 Retail: SB X7-7 2020 Target Progress

Submittal Table 5-1 Retail: SB X7-7 2020 Target Progress **Water Code Section 10608.40**						
☐	**Check the box if the Supplier was not an Urban Water Supplier during or before the 2020 UWMP reporting cycle. Proceed to the next table.**					
Was Supplier part of a merger or consolidation since 2020?	Regional Alliance Target or Individual Target? Drop down list	2020 Target	Actual 2020 GPCD	Did Supplier Achieve Targeted Reduction for 2020?	**Only for suppliers that did not meet the Target in 2020** **See DWR NOTES below.** Actual 2025 GPCD (From SB X7-7 Compliance Form)	 Did Supplier meet the 2020 Target in 2025?
No	Individual Target	206	206	Yes		NA
DWR NOTES: **Suppliers calculating a 2025 GPCD** will need to complete and submit SB X 7-7 Compliance Tables to verify the use of SB X7-7 Methodologies. **Suppliers that were part of a merger or consolidation since 2020** see Chapter 5 and Appendix P for guidance.						

SECTION 6 - NORMAL-YEAR WATER SUPPLY CHARACTERIZATION

CWC 10631(b). Identify and quantify, to the extent practicable, the existing and planned sources of water available to the supplier over the same five-year increments described in subdivision (a).

This section describes and quantifies sources of water available to the District. As discussed in *Section 4 – Water Use Characterization*, the District produces all its water supply through pumping groundwater using District facilities. The District does not purchase water from any other source. There are no current plans to purchase wholesale water in the near future. Thus, the District does not:

- Purchase or import water (with caveat; see *Section 6.1 – Water Supply Analysis Overview*);
- Use surface water;
- Reuse stormwater, wastewater, or recycled water;
- Desalinate water; or
- Enter into water exchanges or transfers.

Therefore, the following discussion focuses on groundwater as the District's only existing water supply. This section also discusses future water projects and provides a summary of existing and planned sources of water.

6.1 - Water Supply Analysis Overview

The District does not purchase or import surface water from other water suppliers or other entities for direct use. There are no plans for the District to purchase or import surface water for direct use as part of its water supply.

The District does purchase Kern Island Canal "seepage" water from the KDWD (Kern Delta Water District) through that portion of the Kern Delta's unlined canal systems lying within the District's Sphere of Influence via the Kern Island Main and Central Canals from the Arvin-Edison Canal on the north and DiGiorgio Road on the South. Within this unlined canal, a certain amount of conveyed surface water "seeps" into the ground as it passes through the GCWD's service area and becomes groundwater. The District purchases this seepage water to "bank" groundwater for future use. This water will ultimately be used by the District when it is pumped via their groundwater wells for retail treatment and delivery (see *Section 6 – Normal-Year Water Supply Characterization*). Therefore, the District considers this seepage water as groundwater, which is discussed further below.

The following table provides a history of the amount of seepage water GCWD has purchased for groundwater banking purposes since 2008.

Seepage Water Purchases from KTWD (2008 to 2025)

Year	Acre-Feet Purchased	Million Gallons Purchased
2008	2,915	950
2009	3,039	990
2010	3,032	988
2011	3,344	1,090
2012	3,855	1,256
2013	1,890	616
2014	2,760	899
2015	3,322	1,082
2016	3,894	1,269
2017	3,775	1,230
2018	3,582	1,167
2019	3,754	1,223
2020	3,573	1,164
2021	3,284	1,070
2022	3,518	1,146
2023	3,844	1,253
2024	3,676	1,198
2025	3,722	1,213

6.2 - Water Supply Characterization - Groundwater

CWC 10631(b). If groundwater is identified as an existing or planned source of water available to the supplier, all of the following information shall be included in the plan:

(1) A copy of any groundwater management plan adopted by the urban water supplier, including plans adopted pursuant to Part 2.75 (commencing with Section 10750), or any other specific authorization for groundwater management.

(2) A description of any groundwater basin or basins from which the urban water supplier pumps groundwater. For basins that a court or the board has adjudicated the rights to pump groundwater, a copy of the order or decree adopted by the court or the board and a description of the amount of groundwater the urban water supplier has the legal right to pump under the order or decree. For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.

(3) A detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years. The description

and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(4) A detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the urban water supplier. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

6.2.1 - BASIN DESCRIPTION

The groundwater subbasin underlying the District's service area is the Kern Subbasin (Groundwater Basin No. 5-22.14). The Kern Subbasin is one of eight subbasins within the Tulare Lake Hydrologic Region that transport, filter, and store water (see Figure 6-1). The major watercourses in the Subbasin that provide much of the surface water runoff for the region are the Kern River and Poso Creek.

The Kern Subbasin has a surface area of about 1.95 million acres (3,040 square miles). The Kern Subbasin is bounded on the north by the County line, the base of the Sierra Nevada Mountains on the east, the base of the San Emigdio and Tehachapi Mountains on the south, and the base of the Coast Ranges on the west. (Department of Water Resources, 2006).

Basin Levels and Storage

Per Bulletin 118, the estimated total useable groundwater in storage in the Kern Subbasin is estimated to be 40 million AF and detwatered storage[1] is 10 million AF. The average Subbasin water level is essentially unchanged from 1970 to 2000 (DWR, 2006). However, the Subbasin water level is overdrafted in areas. As a result, the State has listed the Kern Subbasin as critically overdrafted.

Basin Water Quality

The eastern portion of the Subbasin contains primarily calcium bicarbonate waters in the shallow zones, increasing in sodium with depth. Bicarbonate is replaced by sulfate and lesser chloride in an east to west trend across the Subbasin. West side waters are primarily sodium sulfate to calcium-sodium sulfate type. The average total dissolved solids (TDS) of groundwater is 450 milligrams per liter (mg/L) with a range of 150 to 5,000 mg/L. (DWR, 2006)

[1] "Dewatered storage" refers to a phenomenon when a well is pumped and the water drawn into the well leaves behind a dewatered area or the cone of depression or influence. Water is stored and can still be pumped from this dewatered area. The pumped well is always located at the apex of this cone. The shape of the cone and the rate at which it expands across the top depend on the coefficients of transmissivity and storage of the aquifer and on the rate of pumping. The first water to be pumped by the well is derived from the pores in the immediate area of the well. However, as pumping continues, the cone enlarges and continues to do so until it intercepts a source of recharge (replenishment) that will produce all the water demanded by the pump. In unconfined or water table aquifers, the cone of influence expands initially at rates ranging from less than 100 meters to, in some cases, more than 1,000 meters per day.



Source: Department of Water Resources, CWP 2013

Figure 6-1
Tulare Lake Hydrologic Region

Shallow groundwater presents problems for agriculture in the western portion of the basin. High TDS, sodium chloride, and sulfate are associated with the axial trough of the Subbasin. Elevated arsenic concentrations exist in some areas associated with lakebed deposits. Nitrate, dibromo-chloropropane (DBCP), and dibromoethane (DBE) concentrations exceed maximum contaminate level (MCLs) in various areas of the basin. (DWR, 2006)

6.2.2 - BASIN MANAGEMENT INFORMATION

An adjudicated groundwater basin exists where, because of a lawsuit, the court decides who extracts from the basin, how much they extract, and who will manage the basin. The Kern Subbasin is not adjudicated, as defined by DWR. Therefore, there are no limitations placed on groundwater pumping volumes due to adjudication.

The District is an exclusive Groundwater Sustainability Agency (GSA) within its service area and located within the Kern River Groundwater Sustainability Agency (KRGSA). The KRGSA's Plan Area, which includes the District, covers 363 square miles (232,499 acres), about 12.7 percent of the 2,384 square mile Kern Subbasin. The District coordinates with the KRGSA through a memorandum of understanding to ensure local compliance with the Sustainable Groundwater Management Act. The District is one of 20 GSAs cooperatively managing groundwater within the Kern County Subbasin. The Kern Subbasin published its GSP final in August 2025, which includes the District's GSA area. This UWMP is in compliance with the goals set forth in the GSP.

6.2.3 - OVERDRAFT CONDITIONS

As required by CWC section 10631(b)(2), for basins that have not been adjudicated, information as to whether DWR has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted, an UWMP must include a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.

According to DWR, the Kern Subbasin is listed as a critically overdrafted basin (California Department of Water Resources, 2015). According to DWR Bulletin 118-80, "critical conditions of overdraft" in a basin exist "when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (DWR, 2015).

6.2.4 - GROUNDWATER PUMPING

The District currently uses groundwater as its sole source of municipal water supply. The District's municipal water system extracts its water supply from underground aquifers via seven active groundwater wells within the District's limits (see Figure 3-3). The Panama Well is currently a stand-by well. The District maintains six water storage tanks.

The amount of groundwater pumped by the District over the last 5 years is shown in Table 6-1. The amount of groundwater projected to be pumped in 5-year increments over the next 20 years is shown in Table 4-2 in *Section 4 – Water-Use Characterization*. The projected retail demands for potable and raw water shown in the table are supplied solely by groundwater pumping.

Table 6-1 Retail: Groundwater Volume Pumped

Submittal Table 6-1 Retail: Groundwater Volume Pumped **Water Code Section 10631(4) and 10631(4)(c)**							
☐	Check the box if the Supplier does not pump groundwater. Proceed to the next table.						
☐	Check the box if all or part of the groundwater described below is desalinated. (OPTIONAL)						
Groundwater Type **Drop Down List** May use each category multiple times	Potable or Non-Potable (OPTIONAL) **Drop down list**	Location or Basin Name	2021 (MG)	2022 (MG)	2023 (MG)	2024 (MG)	2025 (MG)
Add additional rows as needed							
Alluvial Basin	Potable	Kern County Subbasin (GW Basin No. 5-22.14)	895.673	859.742	824.107	863.949	877.497
		Total	896	860	824	864	877

6.3 - Surface Water

The District does not draw water from streams, lakes or reservoirs for use in its potable water distribution system. There are no plans for the District to use surface water as part of its water supply.

6.4 - Stormwater

The District does not intentionally divert stormwater for beneficial use within its potable water distribution system. There are no plans for the District to use stormwater to offset water supply.

6.5 - Wastewater and Recycled Water

CWC 10633. The plan shall provide, to the extent available, information on recycled water and its potential for use as a water source in the service area of the urban water supplier. The preparation of the plan shall be coordinated with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area, and shall include all of the following:

(a) A description of the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal.

(b) A description of the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.

(f) A description of actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.

(g) A plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use.

Sewer treatment and disposal within the GCWD service area is performed either 1) at the City of Bakersfield's Wastewater Treatment Plant (WWTP) No. 3 located at 8101 Ashe Road, Bakersfield, CA 93307 or 2) using individual septic systems in compliance with applicable regulations. The following discussion is specific to wastewater treated at WWTP No. 3. Please also note that the 5,000 MG volume of wastewater collected (see Table 6-2) at the City of Bakersfield WWTP No. 3 is for all the water collected at the plant, which includes the GCWD service area and other areas outside the service area.

WWTP No. 3 is an advanced (activated sludge) secondary treatment facility with disinfection system that can handle a design flow of 32 million gallons per day (MGD) daily. The plant includes two improved bar screens, a wet well, grit removal system, eight primary clarifiers, four secondary clarifiers, four trickling filters, eight effluent storage ponds (total capacity 2,280 acre-feet), eight anaerobic digesters, 10 covered aeration basins, an equalization lagoon, and about 20 acres of unlined sludge beds (Central Valley Regional Water Quality Control Board, 2009).

Wastewater effluent from WWTP No. 3 is discharged into the Interstate 5 (I-5) Reclamation Site, property owned by the City of Los Angeles and bound by Taft Highway on the north, I-5 on the east, Enos Lane on the west, and adjacent to the plant site on the south (Central Valley Regional Water Quality Control Board, 2009). The City of Bakersfield discharge up to 16 MGD of effluent to the I-5 Reclamation Site and 16 MGD to the onsite effluent storage ponds, and the effluent percolates to ground in compliance with the Waste Discharge Order (WDR) No. R5-2009-0122 (Central Valley Regional Water Quality Control Board, 2009).

The District is not using and does not plan to use wastewater or recycled water within the planning horizon of the 2025 UWMP as shown in Tables 6-2 through 6-6 need to be completed.

Table 6-2 Retail: Wastewater Collected Within Service Area

Submittal Table 6-2 Retail: Wastewater Collected Within Service Area Water Code Section 10633(a)				
☐	Check the box if there is no wastewater collection system. Proceed to the next table.			
	Percentage of 2025 service area served by wastewater collection system (OPTIONAL)			
	Percentage of 2025 service area population served by wastewater collection system (OPTIONAL)			
Wastewater Collection			**Recipient of Collected Wastewater**	
Name of Wastewater Collection Agency	Wastewater Volume Metered or Estimated? OPTIONAL **Drop Down List**	Volume of Wastewater Collected from UWMP Service Area 2025 (MG)	Name of Wastewater Treatment Plant (WWTP) and Place ID Number **Drop down list**	Is WWTP Located Within UWMP Area? **Drop Down List**
Add additional rows as needed				
City of Bakersfield Public Works	Estimated	5,000	Bakersfield WWTP #3, Place ID 273209	No
Total Wastewater Received from UWMP Service Area in 2025:		5,000		

Table 6-3 Retail: Wastewater Treatment and Outcomes Within UWMP Service Area

Submittal Table 6-3 Retail: Wastewater Treatment and Outcomes Within UWMP Service Area Water Code Section 10633(b)	
☑	**Check the box if no wastewater is treated or disposed of within the UWMP service area.** Proceed to the next table.

Table 6-4 Retail: Recycled Water Direct Beneficial Uses Within Service Area

Submittal Table 6-4 Retail: Recycled Water Direct Beneficial Uses Within Service Area Water Code Section 10633 (c),(d),(e)	
☑	Check box if recycled water is not used and is not planned for use within the service area of the supplier. The supplier will only complete the column on "Potential Recycled Water Use" and submit an accompanying narrative on the feasibility of that potential recycled water use.

Table 6-5 Retail: 2020 Recycled Water Use Projection Compared to 2025 Actual

Submittal Table 6-5 Retail: 2020 UWMP Recycled Water Use Projection Compared to 2025 Actual Water Code Section 10633(e)	
☑	Check the box if recycled water was not used in 2025 nor previously projected for use in 2020. Proceed to the next table.

Table 6-6 Retail: Methods to Encourage Future Recycled Water Use

Submittal Table 6-6 Retail: Methods to Encourage Future Recycled Water Use Water Code Section 10633(f)	
☑	Check the box if the Supplier does not plan to expand recycled water use in the future. Supplier will not complete the table below but will provide narrative explanation.

6.6 - Desalinated Water Opportunities

CWC 16031(h). Describe desalinated water project opportunities for long-term supply.

The District has no feasible opportunity for the development of a water desalination system as a long-term supply. With no nearby or convenient sources of saline water to desalinate, the cost of providing the water and then treating would outweigh the benefits.

6.7 - Water Exchanges and Transfers

CWC 10631(d). Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.

The District does not have any planned or potential future water exchanges or transfers.

6.8 - Future Water Projects

CWC 10631(g). Include a description of all water supply projects and water supply programs that may be undertaken by the urban water supplier to meet the total projected water use, as established pursuant to subdivision (a) of Section 10635. The urban water supplier shall include a detailed description of expected future projects and programs that the urban water supplier may implement to increase the amount of the water supply available to the urban water supplier in average, single-dry, and multiple-dry water years. The description shall identify specific projects and include a description of the increase in water supply that is expected to be available from each project. The description shall include an estimate with regard to the implementation timeline for each project or program.

Since the last UWMP, the District re-drilled the McKee Well, and provides treatment at the Berkshire and Taft well sites. None of these projects will increase the Districts water supply, only improve water quality and reliability. As shown in Table 6-7 below, the District is not expecting future water supply projects or programs to increase supply in the future.

Table 6-7 Retail: Expected Future Water Supply Projects or Programs

Submittal Table 6-7 Retail: Expected Future Water Supply Projects or Programs Water Code Section 10631(f)	
☑	Check the box if there are no expected future water supply projects or programs that provide a quantifiable increase to the agency's water supply. Proceed to the next table.

6.9 - Groundwater Supplies Coordination

In 2014, the Legislature enacted the Sustainable Groundwater Management Act to address groundwater conditions throughout California. The CWC now requires 2025 UWMPs to be consistent with GSPs in areas where those plans have been completed by GSAs.

The District formed its own GSA and is coordinating with the KRGSA through a memorandum of understanding to prepare a GSP. The KRGSA's planned area as part of the Kern Subbasin GSP was published on August 2025, which includes the District's GSA area. The table below is from the August 2025 KRGSA GSP and it shows the GSP implementation items and the projected timeline.

This 2025 UWMP is consistent with the GSP and the proposed projects and management actions.

Table 14-10. Kern River GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Feasibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional		In-Process			As-Needed					
KRGSA-1	Water Allocation Plan	KDWD plans to use its full Kern River entitlement as prioritized in its Water Allocation Plan (WAP) for the Agricultural MA.	✓	✓	✓	Exercise of Rights	Complete	KDWD, Board Meetings & Website	CEQA (completed)	Implemented	Complete	2018	2018-	20,797	0			✓			Kern River Supplies	None	$0	$0	KDWD, Operating Budget
KRGSA-2	Kern River Optimized Conjunctive Use	The City plans to use its full Kern River entitlement, less current obligations, to mitigate undesirable results for water levels and water quality in the Urban MA.	✓	✓	✓	Exercise of Rights	Complete	COB, City Council Meetings & Website	CEQA (As Needed)	Implemented	Complete	2018	2018-	67,930	0			✓			Kern River Supplies	None	$0	$0	COB, Operating Budget
KRGSA-3	Lining of Pool 4B	The Kern County Water Agency's (Agency) - Improvement District No. 4 (ID4) Cross Valley Canal (CVC) Extension Lining Project – Pool No. 8 (Project) includes installation of approximately 5,280 lineal feet of fiber-reinforced concrete lining on an existing earthen canal to reduce seepage and improve water delivery reliability. The lining will reduce seepage, increase water delivery reliability, reduce maintenance efforts and reduce the potential for canal breaches.	✓				Already being implemented	KCWA, UBAC, Board Meetings & Website	CEQA & NEPA (completed)	Implemented	2023	2024	2024-	0	0			✓			Surface Supplies	KCWA, ID4	$7,000,000	$0	ID4 Grants Received
KRGSA-4	Urban Conservation	Future urban demand will be reduced from current modeled levels. The average urban demand for Metropolitan Bakersfield is reported by local UWMPs is 211 gallons per capita per day (gpcpd). Previous estimates for future demand were estimated at 248 gpcpd and basin wide GSP modelling included this estimate in all future model scenarios.	✓	✓	✓	Water Conservation-Efficiency	Already being implemented	COB, City Council Meetings & Website	None	Implemented	Ongoing (expected savings from 2020)	2040	2020-2040	0	21,299			✓			Demand Reduction	COB/Retail Urban Providers	NA	$0	COB, ENCSD, Lamont, Cal Water, Vaughn - Operating Budgets
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	Feasibility Study	NA	2030	2030-	0	0			✓	✓	✓	NA	None	Unknown	Unknown	KRGSA
KRGSA-5	ENCSD North Weedpatch Highway Water System Consolidation	Up to six small water systems in the northeast KRGSA will be consolidated into the ENCSD system for benefits to drinking water quality, including to disadvantaged communities (DACs). The project includes new water distribution systems, a new well (1,400 gpm capacity) with arsenic treatment, a storage tank, hydropneumatics tank, and a booster pump station. If TCP is detected in the new well, the grant will also fund a TCP treatment system. All wells with water quality violations will be properly abandoned according to Kern County Environmental Health regulations.		✓			In Progress	ENCSD, Board Meetings & Website	DDW	In-Process	2019	2024	2024-	0	0	✓		✓				COB/Retail Urban Providers	$0	$0	ENCSD and potential SAFER 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	Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits: Primary (AFY): Water Supply Augmentation	Expected Benefits: Primary (AFY): Demand Reduction	Expected Benefits: Secondary: Water Quality Improvement	Expected Benefits: Secondary: Flood Control	Expected Benefits: Secondary: Water Management Flexibility / Efficiency	Expected Benefits: Secondary: Mitigation Programs	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)
KRGSA-6	South Kern and Old River Mutual Water System Consolidation	Two small mutual water systems in the southern KRGSA will be consolidated into the City of Bakersfield's domestic water system for benefits to drinking water quality, including to disadvantaged communities (DACs). The Project will include new water distribution systems connecting the mutual water systems with the City's water system, which improve drinking water quality for the DAC.		✓			In Progress	COB, City Council Meetings & Website	DDW	In-Process	2022	2025	2025	0	0	✓		✓				COB, DDW	$7,500,000	$78,000	COB and potential SAFER Grants
KRGSA-7	Expand Recycled Water Use in the KRGSA	The City will increase recycled water use inside of the KRGSA from its WWTP No. 3 in 2026 when a contract for use outside of the KRGSA expires (about 72% is currently used outside of the KRGSA).	✓	✓	✓	New Local Supply	Already being implemented - Reallocates water	COB, City Council Meetings & Website	None	In-Process	Current	2026	2026	13,407	0			✓			Recycled Water	None	NA	$0	COB Operating Budget
KRGSA-8	Conversion of Agricultural Lands in Urban Use	Approximately 10,000 acres of current KRGSA agricultural lands is expected to be urbanized; this future urban demand is already included in the projected water budget, so 100% of this agricultural water use represents a demand reduction.	✓	✓	✓	Ag to Urban Conversion	Land use changes	COB/Planning Commission, Board Meetings & Website	CEQA (As Needed)	In-Process	2020 (total expected by 2028)	2038	Total by 2038	0	27,000							None	NA	NA	NA
Management Actions		Implemented / Functional / In-Process			As-Needed								Implemented		Functional		In-Process			As-Needed					
Phase 1																									
KRGSA-9	Implement Action Plan if Water Levels Fall Below Minimum Thresholds	A five-step action plan for addressing exceedance of GSP thresholds, including KRGSA Plan Manager coordination: 1. Identify the Well(s) and investigate the Area 2. Coordinate with KRGSA Plan Managers 3. Select Appropriate Management Actions or Projects for Mitigation 4. Consider Institutional Changes for Future Mitigation 5. Consider the Need for Improved Monitoring	✓			Supplemental Water Use	MT exceedance	KRGSA, Board Meetings & Website	None	Ongoing	NA	NA	2020 -	0	0	✓		✓				None	$0	$0	KRGSA
KRGSA-10	Optimize Conjunctive Use in the KRGSA	Surface water sources available to the KRGSA will be prioritized for use when available, retaining the shared groundwater resources for periods when surface water is scarce. This balance of water use and higher reliance of groundwater during drought provides for increased reliability, higher groundwater levels to avoid undesirable results, and preservation of groundwater resources for other supplies are less available. Conjunctive management also encourages recharge of any excess surface water for storage and subsequent recovery to assist with drought management.	✓			Supplemental Water Use		KRGSA, Board Meetings & Website	None	Ongoing	NA	NA	2020 -	0	0	✓		✓				None	$0	$0	KRGSA
KRGSA-11	Support California Delta Conveyance Project to Preserve Imported Water Supplies	In its UWMP, ID4 emphasizes the need for state-wide support in improving the availability and reliability of SWP supplies. On April 29, 2019, Governor Newsom announced that his administration will develop a water resiliency portfolio (Portfolio) intended to address a range of water-related challenges facing the state. The Portfolio will address unsafe drinking water, major flood risks, severely depleted groundwater aquifers, communities with uncertain water supplies and native fish populations.	✓	✓		Supplemental Water Use		KRGSA, Board Meetings & Website	None	Ongoing	NA	NA	2020 -	0	0	✓						None	$0	$0	KRGSA

KRGSA-12	Incorporate Climate Change Adaptation Strategies	As noted in its 2015 UWMP (P&P, 2016), ID4 has identified strategies that can be adapted to fit within ID4 operations to address potential uncertainties associated with the reliability of imported water supplies. In brief, climate change may result in reduced surface water that will be even more unpredictable on a year-to-year basis. As listed in the UWMP, ID4 has identified the following measures for consideration: • Work with retail purveyors to identify impacts of demand management measures to improve the accuracy of overall ID4 future demands. New developments are incorporating the latest water conversation features and policies that may alter the current ID4 demand projections. • Continue water recharge activities to the extent practicable to increase reliability of supplies during dry-year conditions.	✓					KRGSA, Board Meetings & Website	None	Ongoing	NA	NA	2020 -	0	0	✓						None	$0	$0	KRGSA
KRGSA-13	Support Sustainable Groundwater Supplies for KRGSA Disadvantaged Communities	The three founding KRGSA member agencies have established lines of communication and coordination with other agencies in the GSP Plan Area, many of whom provide water to DACs in the KRGSA Plan Area. In this manner, representation of these communities is considered in KRGSA actions and policies.	✓	✓				KRGSA, Board Meetings & Website	None	Ongoing	NA	NA	2020 -	0	0				✓			None	$0	$0	KRGSA
KRGSA-14	Improve Groundwater Monitoring in the KRGSA Plan Area	It is the policy of the KRGSA to monitor groundwater for GSP compliance and to provide the understanding necessary for sustainable groundwater management. These actions will consist of: improving documentation of well construction in the KRGSA Plan Area, coordinating water quality analysis through existing monitoring programs, securing inactive wells/dedicated monitoring wells, and obtaining access agreements for GSP monitoring network wells.	✓	✓				KRGSA, Board Meetings & Website	None	Ongoing	NA	NA	2020 -	0	0				✓			None	$0	$0	KRGSA
KRGSA-15	Avoid Widespread Impacts to Domestic and Small Water System Wells in the Plan Area	This management action has been developed to provide clarity and more focused information on the issue of potential impacts to domestic and small water system wells. The new management action is based on an updated analysis of potential impacts to domestic and small water system wells throughout the entire Plan Area. It will consist of: Documenting Active Domestic and Small Water System Wells, Tracking the Potential for Impacts to Active Domestic and Small Water System Wells, Investigating Issues and Assisting Active Domestic and Small Water System Wells, Adjusting KRGSA Management Activities, (If Needed) and Updating Management Actions.	✓	✓				KRGSA, Board Meetings & Website	None	Ongoing	2022	NA	2020 -	0	0				✓			None	$0	$0	KRGSA
KRGSA-16	Establish Well Metering Policy in the KRGSA	This policy will assist with monitoring groundwater extractions for ongoing water budget analyses and compliance with SGMA reporting requirements. (Add specific member updates)	✓			Water Conservation-Efficiency		KRGSA, Board Meetings & Website	None	Ongoing	NA	2025	2020 -	0	0				✓			None	$0	$0	KRGSA
KRGSA-17	Implement Groundwater Extraction Reporting Program	As required by SGMA, the KRGSA will begin reporting extractions to DWR on an annual basis. In order to improve the accuracy of its reporting and to support the ongoing water budget analysis, KRGSA Plan Managers will implement a program for all well owners to report groundwater production to the GSA.	✓			Water Conservation-Efficiency		KRGSA, Board Meetings & Website	None	Ongoing	NA	NA	2020 -	0	0				✓			None	$0	$0	KRGSA

Phase 2																								
KSB-2	Coordination with Groundwater Regulatory Programs	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	Implemented	NA	2020	2020-	0	0	✓				✓	NA	NA	$0	$25,000	KRGSA
KSB-3	Exceedance Policy	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	Implemented	NA	2024	2024-	0	0				✓	✓	NA		$0	$25,000	KRGSA
KSB-5	Well Mitigation Program	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.	NA	2025	2025-	0	0				✓		NA	NA	$0	$45,000	KRGSA
KRGSA-18	Additional Urban Conservation Measures	To reduce urban demand, additional conservation measures could be considered by the City and other urban retail water purveyors. Such actions are documented in the UWMPs and strict adherence to permanent reductions in urban demand by 2020 are underway. A decrease in the long-term per capita water use is provided in UWMPs and embedded in the projected water budgets for the KRGSA.	✓			Water Conservation-Efficiency	New Legislation	KRGSA, Board Meetings & Website	None	Ongoing	NA	2040	2020 -	0	0				✓			None	$0	TBD	KRGSA
KSB-4	Coordination with Basin Study	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	Ongoing	NA	2025	2025-	0	0					✓	NA	NA	$25,000	$0	KRGSA
KSB-6 (IDH4 only) (KDWD & Bakersfield not participating)	White Land Demand Management	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	Initiating Development	NA	2030	2030-	0	20,410	✓				✓	NA	None	$0	$10,000	KRGSA
KSB-7	Well Registry	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	Ongoing	NA	2024-	2024-	0	0				✓	✓	NA	NA	$0	$25,000	KRGSA
KSB-8	Consumptive-Use Study	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	Ongoing	NA	2020-	2020-	0	0				✓	✓	NA	NA	$0	$25,000	KRGSA
KSB-9	California Aqueduct Subsidence Action Plan	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	Ongoing	In-process	Ongoing												

KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
KRGSA-19	**Conversion of Agricultural Lands**	Changes in land use may also result in a decrease in agricultural demand through urbanization. Some land conversion from agriculture to urban is anticipated in Phase One associated with growth projections for Metropolitan Bakersfield. Additional changes in land use to reduce water demand could be developed in Phase Two as needed.	✓			Ag to Urban Conversion	Urbanization	KRGSA, Board Meetings & Website	CEQA (As Needed)	**Ongoing**	2020	2040	As needed	**0**	**0**				✓			None	$0	As needed	KRGSA
KRGSA-20	**Additional Considerations for Adaptive Management**	It is recognized that demand reduction projects could have a detrimental impact on the local economy, livelihood of residents and business owners, and the well-being of Metropolitan Bakersfield and Kern County. Therefore, large-scale reductions are not proposed in Phase One and may be unnecessary for achieving the sustainability goal. At a minimum, such actions are delayed until later in the implementation period to allow water supply projects the opportunity to sustainably support current and projected growth in the beneficial uses of groundwater.	✓	✓	✓	Supplemental Water Use	As needed	KRGSA, Board Meetings & Website	None	**As Needed**	NA	NA	As needed	**0**	**0**				✓			None	$0	As needed	KRGSA
KRGSA-21	**Possible Water Exchange**	KRGSA member agencies can perform exchanges of surface water and groundwater for benefits to water quality, including to DACs.		✓		Supplemental Water Use	As needed	KRGSA, Board Meetings & Website	None	**As Needed**	NA	NA	As needed	**0**	**0**							None	$0	As needed	KRGSA
KRGSA-22	**Pumping Reductions and Allocation of Agricultural Groundwater Supply**	If sustainable management cannot readily be achieved through increased and optimized supplies, then pumping allocations may a helpful management tool. If needed, KDWD will explore options and opportunities for equitable allocation scenarios and engage landowners to develop workable allocations. Adjacent water districts are already developing such programs and KDWD may benefit from lessons learned and strategies incorporated by others. Agricultural demand could also be achieved if needed by growing different crop types, fallowing portions of fields, district purchase and retirement of land (and possibly used for recharge if suitable), and other strategies.	✓			Demand Reduction	Continued MT exceedance	KRGSA, Board Meetings & Website	TBD	**As needed**	NA	NA	As needed	**0**	**0**				✓			None	$0	As needed	KRGSA

6.10 - Energy Use

Water Code Section 10631.2. (a) In addition to the requirements of Section 10631, an urban water management plan shall include any of the following information that the urban water supplier can readily obtain:

A. An estimate of the amount of energy used to extract or divert water supplies.

B. An estimate of the amount of energy used to convey water supplies to the water treatment plants or distribution systems.

C. An estimate of the amount of energy used to treat water supplies.

D. An estimate of the amount of energy used to distribute water supplies through its distribution systems.

E. An estimate of the amount of energy used for treated water supplies in comparison to the amount used for

nontreated water supplies.

F. An estimate of the amount of energy used to place water into or withdraw from storage.

G. Any other energy-related information the urban water supplier deems appropriate.

Readily-available energy use information from the District includes a summary of energy use per month and for an average year, indicated in the table below and Table O1-A. The tabulated data includes the summed energy usage from individual well sites and the District's water distribution system.

District - Available Energy Use Information

Month	Kilowatt-hours (kWh)
January	100,517
February	107,057
March	97,758
April	118,878
May	168,000
June	205,070
July	214,243
August	198,699
September	191,445
October	168,451
November	133,347
December	96,683
Total Annual	**1,800,148**

Table O-1A Recommended Energy Reporting

Optional Submittal Table O-1A: Recommended Energy Reporting - SINGLE DELIVERY PRODUCT - WATER SUPPLY PROCESS APPROACH										
Water Delivery Product drop down list (If delivering more than one type of product recommend using Table O-1C)	Retail Non-Potable Deliveries	Only for Water Delivery Products Under the Urban Water Supplier's Operational Control								
Start Date of Reporting Period	1/1/2025	Water Management Process							Non-Consequential Hydropower (if applicable)	
End Date of Reporting Period	12/31/2025									
Is upstream embedded energy included in the values reported?	No									
		Units for Water Volume	Extract and Divert	Place into Storage	Conveyance	Treatment	Distribution	**Total Utility** See DWR NOTES	Hydropower	Net Utility
Volume of Water Entering Process		MG	877.4969							0
Energy Consumed (kWh)		N/A	1800148					1800148		1800148
Energy Intensity (kWh/vol. converted to MG)		N/A	2051.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00
DWR NOTES: Total Utility: The volume of water entered in the "Total Utility" column should equal the volume of water entering the distribution system (excluding recycled water); in most cases, this is the total volume calculated in UWMP Table 4-1: 2025 Actual Total Uses for Potable and Non-Potable Water. Note if recycled water is included in your Submittal Table 4-1, you must exclude it from your volume in this table.										
Quantity of Self-Generated Renewable Energy										
0 kWh										
Data Quality (Estimate, Metered Data, Combination of Estimates and Metered Data)										
Metered Data										

6.11 - Summary of Existing and Planned Sources of Water

As discussed above, the sole source of water for the District is through groundwater pumping. Continued groundwater pumping is also the only planned source of water in the future. Since the Kern Subbasin is a non-adjudicated basin, there are currently no restrictions on groundwater pumping.

Because there is no current restriction on groundwater pumping, the limit of available water is the pump capacity of the six existing wells to pump groundwater. The pump capacity of the five wells to pump groundwater is shown in the following table.

Pump Capacity at the Six Well Sites

Well Site	Pump Capacity (gallons per minute)	Pump Capacity (million gallons per year)[1]
Dublin	1,151	530
McKee	904	416
Taft	1,022	470
Berkshire	1,337	615
Bannock	1,060	488
East Berkshire	1,067	491
Total	**6,541**	**3,010**

[1] (Gallons per minute X 60 minutes/hour X 21 hours/day X 365.2425 days/year)/1,000,000

Source: (Greenfield County Water District, 2025).

Based on the above table, the District has the pumping capacity to produce 3,010 MG per year if the pumps were to run 21 hours a day. The assumption of 21 hours of use per day was determined to allow for the pumps to remain idle a portion of the day to extend their useful life and to account for times in the year when pumps will be down for repair or replacement as needed. Therefore, the retail water supply available to the District in 2025 is 3,010 MG (9,237 AF) per year as shown in Table 6-8.

Table 6-8 Retail: Water Supplies – Actual

Submittal Table 6-8 Retail: Water Supplies — Actual Water Code Section 10631(b)				
Water Supply		**2025**		
Drop down list May use each category multiple times. These are the only water supply categories that will be recognized by the WUEdata online submittal tool	Additional Description (as needed)	**Potable or Non-Potable** (after treatment if treated) (OPTIONAL) Drop Down list	Actual Volume (MG)	Total Entitlement (OPTIONAL) See 'DWR Notes' below (MG)
Add additional rows as needed				
Groundwater (not desalinated)		Potable	3,010	
		Subtotal Potable	3,010	0
		Subtotal Non-Potable	0	0
		Total	3,010	0

For the same reasons discussed above, it is assumed that the projected groundwater supply available to the District is also 3,168 MG (9,722 AF) for each of the projected years (see Table 6-9). Actual projected groundwater supply may change during the next UWMP cycle in response to the results of GSPs developed in the Kern Subbasin to comply with SGMA.

Table 6-9 Retail: Water Supplies – Projected

Submittal Table 6-9 Retail: Water Supplies — Projected Water Code Section 10631 (b)												
Water Supply			**Projected Water Supply (Report to the Extent Practicable)**									
			2030		**2035**		**2040**		**2045**		**2050 (opt)**	
Drop down list May use each category multiple times. These are the only water supply categories that will be recognized by the WUEdata online submittal tool	Additional Detail on Water Supply	**Potable or Non-Potable** (after treatment if treated) (OPTIONAL) Drop Down list	Reasonably Available Volume (MG)	Total Entitlement (OPTIONAL) See 'DWR Notes' below (MG)	Reasonably Available Volume (MG)	Total Entitlement (OPTIONAL) See 'DWR Notes' below (MG)	Reasonably Available Volume (MG)	Total Entitlement (OPTIONAL) See 'DWR Notes' below (MG)	Reasonably Available Volume (MG)	Total Entitlement (OPTIONAL) See 'DWR Notes' below (MG)	Reasonably Available Volume (MG)	Total Entitlement (OPTIONAL) See 'DWR Notes' below (MG)
Add additional rows as needed												
Groundwater (not desalinated)	87.5% of well pump capacity (pumping 21 hours/day) of all groundwater wells	Potable	3,010		3,010		3,010		3,010		3,010	
		Subtotal Potable	3,010	0	3,010	0	3,010	0	3,010	0	3,010	0
		Subtotal Non-Potable	0	0	0	0	0	0	0	0	0	0
		Total	3,010	0	3,010	0	3,010	0	3,010	0	3,010	0

SECTION 7 - WATER SERVICE RELIABILITY AND DROUGHT RISK ASSESSMENT

CWC 10634. The plan shall include information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments as described in subdivision (a) of Section 10631, and the manner in which water quality affects water management strategies and supply reliability.

All UWMPs must include an assessment of the reliability of their water supplies. The water supply and demand assessment must compare the total projected water use with the projected water supply, in 5-year increments, through the next 20 years. This section presents a comparison of the water demands and supplies within the District's service area, and assesses supply versus demand during normal years, single dry water years, and multiple dry water years. This section describes the long-term reliability of the District's water supply while *Section 8 – Water Shortage Contingency Planning* provides short-term reliability planning that may require immediate action, such as a drought or a catastrophic supply interruption.

7.1 - Constraints on Water Sources Considerations

CWC 10631(c)(2). For any water source that may not be available at a consistent level of use, given specific legal, environmental, water quality, or climatic factors, describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.

The District obtains 100% of its potable water supply from groundwater pumping. Regardless of climatic conditions, there is approximately 40 million AF of water in storage within the Kern Subbasin. Using the existing pump capacity at the six wells running at 21 hours per day, it was calculated that the existing groundwater water supply available to the District is 3,010 MG (9,237 AF) per year (see Tables 6-8 and 6-9). This water supply is available to the District regardless of the climatic conditions related to average, single-dry, and multiple-dry years.

However, because the District relies entirely on groundwater wells, the drawdown will be more severe in drought years and high mean temperature years. Since the entire southern San Joaquin Valley experienced severe drought conditions over the period of 2012-2016, the groundwater drawdown may eventually reach a critical point particularly in depth of wells. Groundwater would still be available to the District over the UWMP planning horizon, but the need to deepen wells may become necessary in the future in the event of prolonged drought. The District has watering regulations in place to ensure water conservation and provide education to all customers. These regulations can be found on the District's website. Additionally, future SGMA regulations will mandate safe yields within the Kern Subbasin, which will further alleviate the possibility of requiring the deepening of wells in the future. Compliance with SGMA may require the District to come up with alternative sources of water in the future based on the GSP, but now the District can pump as much water as is required to supply the needs of the District.

The District's water system includes seven wells located within the District's sphere of influence. The seven wells include the Dublin, McKee, Taft, Panama, Berkshire, Bannock and East Berkshire sites (see Figure 3-3). That Panama well is on standby. The District produces an annual water quality report required by the California State Water Resources Control Board – Division of Drinking Water. The report summarizes the water quality sampling results for 2024 for all water customers.

Based on the *Consumer Confidence Report For Calendar Year 2024* (Greenfield County Water District, 2025), the GCWD system is in compliance with the primary and secondary drinking water MCLs.

7.2 - Water Service Reliability Assessment

CWC 10620(f). An urban water supplier shall describe in the plan water management tools and options used by that entity that will maximize resources and minimize the need to import water from other regions.

CWC 10631(c)(1). Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for each of the following:

(A) An average water year.

(B) A single-dry water year.

(C) Multiple-dry water years.

There are two aspects of supply reliability that can be considered. The first relates to immediate service needs and is primarily a function of the availability and adequacy of the supply facilities. The second aspect is climate related and involves the availability of water during mild or severe drought periods. This section compares water supplies and demands during three water scenarios: average or normal water year, single-dry water year, and multiple-dry water years. These scenarios are defined as follows:

- Average year – a year, or an averaged range of years, that most closely represents the median runoff levels and patterns. The supply quantities for this condition are derived from historical average yields. Within this document the terms "normal" and "average" are used interchangeably.
- Single-dry year – the year with the lowest water supply availability. Generally considered to be the lowest annual runoff for a watershed since the water-year beginning in 1903.
- Multiple-dry years – the lowest average water supply availability to the agency for a consecutive multiple year period (three years or more). Generally considered to be the lowest average runoff for a consecutive multiple year period (three years or more) for a watershed since 1903.

Drought years for the hydrologic region can be determined by referencing DWR's Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices 1995 to 2015 (WSIHIST) (California Department of Water Resources, 2016). The District experienced a multiple dry year cycle, which started in 2012 and continued through 2015. Within this multiple dry year period, the District still could meet all its water demands without the need to implement water management tools. Also, the impact of an extreme single dry year such as 2015 did not impact the ability of the District to meet all its water demands. Supply reliability for average water years such as 2010 and multiple and single dry years is shown in Table 7-1. The reliability of water service, which is subject to proper operation and maintenance of the District's water distribution system and its ability to deliver the water, is discussed in *Section 6 – Normal-Year Water Supply Characterization*.

Table 7-1 Retail: Basis of Water Year Data

Optional Submittal Table 7-1 Retail: Basis of Water Year Data (Reliability Assessment)			
Year Type	**Base Year** If not using a calendar year, type in the last year of the fiscal, water year, or range of years, for example, water year 2024-2025, use 2025	**Available Supplies if Year Type Repeats**	
		☐ Check the box if quantification of available supplies is not compatible with this table and is provided elsewhere in the UWMP. **Location:** [insert location from UWMP]	
		Quantification of available supplies is provided in this table as either volume only, percent only, or both.	
		Volume Available (MG)	**% of Average Supply**
Average Year	2008-2015	3020	100%
Single-Dry Year	2015	4845	160%
Consecutive Dry Years 1st Year	2012	3990	132%
Consecutive Dry Years 2nd Year	2013	3130	104%
Consecutive Dry Years 3rd Year	2014	3522	117%
Consecutive Dry Years 4th Year			
Consecutive Dry Years 5th Year			

Therefore, the District has a reliable water supply and is not vulnerable to seasonal and climatic shortages. There is no current need for plans to supplement or replace the existing groundwater source available to the District with alternative sources or water demand management measures.

7.2.1 - Supply and Demand Comparison

10635(a). Every urban water supplier shall include, as part of its urban water management plan, an assessment of the reliability of its water service to its customers during normal, dry, and multiple dry water years. This water supply and demand assessment shall compare the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. The water service reliability assessment shall be based upon the information compiled pursuant to Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.

Average (or Normal) Year

Normal year supply and demand projections and differences are presented in Table 7-2.

Table 7-2 Retail: Normal Year Supply and Use Comparison

Submittal Table 7-2 Retail: Normal Year Supply and Use Comparison Water Code Section 10635 (a)					
	2030 (MG)	2035 (MG)	2040 (MG)	2045 (MG)	2050 (MG)
Supply totals (autofill from Submittal Table 6-9 R)	3,010	3,010	3,010	3,010	3,010
Use totals (autofill from Submittal Table 4-2 R)	912	949	987	1,026	1,067
Surplus/(shortfall)	2,098	2,061	2,023	1,984	1,943

As shown in Table 7-2, future water supplies are anticipated to be meet.

Single Dry Year

Projected supplies were compared to the increased demands for a single-dry year and are presented in Table 7-3.

Table 7-3 Retail: Single Dry Year Supply and Demand Comparison

Submittal Table 7-3 Retail: Single Dry Year Supply and Use Comparison Water Code Section 10635(a)					
	2030 (MG)	2035 (MG)	2040 (MG)	2045 (MG)	2050 (MG)
Supply totals	4,845	4,845	4,845	4,845	4,845
Use totals	890	926	963	1,001	1,041
Surplus/(shortfall)	3,955	3,919	3,882	3,844	3,804

As shown in Table 7-3, anticipated groundwater supplies are sufficient to meet all demands through the year 2050 even under single-year drought conditions.

Five Consecutive Dry-Year Reliability Assessment

Projected supplies were compared to the increased demands for a five consecutive dry-year scenarios and are presented in Table 7-4.

Table 7-4 Retail: Five Consecutive Dry Years Supply and Demand Comparison

Submittal Table 7-4 Retail: Multiple Dry Years Supply and Use Comparison Water Code Section 10635(a)						
		2030 (MG)	2035 (MG)	2040 (MG)	2045 (MG)	2050 (MG)
First year	Supply totals	3,010	3,010	3,010	3,010	3,010
	Use totals	890	926	963	1,001	1,041
	Surplus/(shortfall)	2,120	2,084	2,047	2,009	1,969
	OPTIONAL Planned WSCP Actions					
	WSCP - supply augmentation benefit					
	WSCP - use reduction savings benefit					
	Revised Surplus/(shortfall)					
Second year	Supply totals	3,010	3,010	3,010	3,010	3,010
	Use totals	890	926	963	1,001	1,041
	Surplus/(shortfall)	2,120	2,084	2,047	2,009	1,969
	OPTIONAL WSCP Actions					
	WSCP - supply augmentation benefit					
	WSCP - use reduction savings benefit					
	Revised Surplus/(shortfall)					
Third year	Supply totals	3,010	3,010	3,010	3,010	3,010
	Use totals	890	926	963	1,001	1,041
	Surplus/(shortfall)	2,120	2,084	2,047	2,009	1,969
	OPTIONAL Planned WSCP Actions					
	WSCP - supply augmentation benefit					
	WSCP - use reduction savings benefit					
	Revised Surplus/(shortfall)					
Fourth year	Supply totals	3,010	3,010	3,010	3,010	3,010
	Use totals	890	926	963	1,001	1,041
	Surplus/(shortfall)	2,120	2,084	2,047	2,009	1,969
	OPTIONAL Planned WSCP Actions					
	WSCP - supply augmentation benefit					
	WSCP - use reduction savings benefit					
	Revised Surplus/(shortfall)					
Fifth year	Supply totals	3,010	3,010	3,010	3,010	3,010
	Use totals	890	926	963	1,001	1,041
	Surplus/(shortfall)	2,120	2,084	2,047	2,009	1,969
	OPTIONAL Planned WSCP Actions					
	WSCP - supply augmentation benefit					
	WSCP - use reduction savings benefit					
	Revised Surplus/(shortfall)					

As shown in Table 7-4, anticipated groundwater supplies are sufficient to meet all demands through the year 2050 even under multiple-dry year drought conditions.

7.3 - Drought Risk Assessment

Water Code Section 10635(b)
Every urban water supplier shall include, as part of its urban water management plan, a drought risk assessment for its water service to its customers as part of information considered in developing the demand management measures and water supply projects and programs to be included in the urban water management plan. The urban water supplier may conduct an interim update or updates to this drought risk assessment within the five-year cycle of its urban water management plan update. The drought risk assessment shall include each of the following:

(1) A description of the data, methodology, and basis for one or more supply shortage conditions that are necessary to conduct a drought risk assessment for a drought period that lasts five consecutive water years, starting from the year following when the assessment is conducted.

(2) A determination of the reliability of each source of supply under a variety of water shortage conditions. This may include a determination that a particular source of water supply is fully reliable under most, if not all, conditions.

(3) A comparison of the total water supply sources available to the water supplier with the total projected water use for the drought period.

(4) Considerations of the historical drought hydrology, plausible changes on projected supplies and demands under climate change conditions, anticipated regulatory changes, and other locally applicable criteria.

Projected total supplies and projected water use for the next five years (2021 to 2025) were compared and are presented in Table 7-5. The information in the table shows a significant surplus of water available each year. Based on this, on supply augmentation or use reduction savings are included. However, the District is always pursuing ways to decrease water usage and increase water savings. These items are described in Section 8 and Section 9 of this UWMP.

Table 7-5 Five-Year Drought Risk Assessment Tables to Address Water Code Section 10635(b)

Submittal Table 7-5 Retail: Five-Year Drought Risk Assessment Water Code Section 10635(b)(3)	
2026	**Total**
Total Water Use (MG)	863
Total Supplies (MG)	3,010
Surplus/Shortfall w/o WSCP Action	2,147
OPTIONAL Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit (MG)	
WSCP - use reduction savings benefit (MG)	
Revised Surplus/(shortfall)	
2027	**Total**
Total Water Use (MG)	870
Total Supplies (MG)	3,010
Surplus/Shortfall w/o WSCP Action	2,140
OPTIONAL Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit (MG)	
WSCP - use reduction savings benefit (MG)	
Revised Surplus/(shortfall)	
2028	**Total**
Total Water Use (MG)	876
Total Supplies (MG)	3,010
Surplus/Shortfall w/o WSCP Action	2,134
OPTIONAL Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit (MG)	
WSCP - use reduction savings benefit (MG)	
Revised Surplus/(shortfall)	
2029	**Total**
Total Water Use (MG)	883
Total Supplies (MG)	3,010
Surplus/Shortfall w/o WSCP Action	2,127
OPTIONAL Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit (MG)	
WSCP - use reduction savings benefit (MG)	
Revised Surplus/(shortfall)	
2030	**Total**
Total Water Use (MG)	890
Total Supplies (MG)	3,010
Surplus/Shortfall w/o WSCP Action	2,120
OPTIONAL Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit (MG)	
WSCP - use reduction savings benefit (MG)	
Revised Surplus/(shortfall)	

SECTION 8 - WATER SHORTAGE CONTINGENCY PLAN

CWC 10632 (a) Every urban water supplier required to prepare a plan pursuant to this part shall prepare its plan pursuant to Article 2 (commencing with Section 10630). The supplier shall likewise periodically review the plan as required by Section 10621, and any amendments or changes required as a result of that review shall be adopted pursuant to this article.

(b) Every urban water supplier required to prepare a water shortage contingency plan shall prepare a water shortage contingency plan pursuant to Section 10632. The supplier shall likewise periodically review the water shortage contingency plan as required by paragraph (10) of subdivision (a) of Section 10632 and any amendments or changes required as a result of that review shall be adopted pursuant to this article.

The Act requires water suppliers to incorporate a water shortage contingency plan (WSCP) focusing on the allocation of water supplies and the management of water consumption during periods of shortage due to extended drought or a water emergency. This Section describes the District's policies and ordinances to address water shortages. The District's water supply comes solely from groundwater pumping. As discussed in *Section 7 – Water Supply and Drought Risk Reliability Assessment*, the District has a reliable water supply and is not vulnerable to seasonal and climatic shortages for the normal, dry-year, and multiple dry-year scenarios through year 2050. This reliability conclusion is caveated by the fact that future compliance with SGMA may require the District to come up with alternative sources of water in the future based on the result of the final August 2025 GSP. Based on the GSP, the District can pump as much water as is required to supply its needs. To help offset water pumped, the District yearly purchases seepage water from KDWD to replenish the Districts groundwater supply.

The District's WSCP illustrates specific water supply conditions that trigger voluntary and mandatory rationing efforts. It explains the District's ability to meet projected short-term demands during extended dry periods and emphasizes some of the significant proactive measures that enhance the District's ability to respond to interruptions in water supply should a natural or manmade disaster occur. The contingency plan outlines the planned response to failures in the infrastructure of the water system in the event of an earthquake, extensive power outage, or another catastrophic event. Finally, this section provides details about prohibitions and penalties against specific water uses during water shortages, and evaluates potential impacts to the water funds should water sales decrease because of supply shortages.

The District has enacted several actions related to water conservation.

On August 11, 2014, the District's Board approved the Mandatory Water Conservation Plan. This Plan is as follows:

> The Greenfield County Water District approved these mandatory water conservation practices; as mandated by the State of California:

Authority: Section 1058.5, Water Code.

Reference: Sections 102, 104 and 105, Water Code.

Section 864. Prohibited Activities in Promotion of Water Conservation.

(a) To promote water conservation, each of the following actions is prohibited, except where necessary to address an immediate health and safety need or to comply with a condition in a permit issued by a state or federal agency;

(1) The application of potable water to outdoor landscapes in a manner that causes runoff such that water flows onto adjacent property, non-irrigated areas, private and public walkways, roadways, parking lots, or structures;

(2) The use of a hose that dispenses potable water to wash motor vehicle, except where the hose is fitted with a shut-off nozzle or device attached to it that causes it to cease dispensing water immediately when not in use;

(3) The application of potable water to driveways and sidewalks; and

(4) The use of potable water in a fountain or decorative water feature, except where the water is part of a recirculating system.

On May 11, 2015, the District Board approved additional and reaffirmed existing rules and regulations for the District's Mandatory Water Conservation Plan to meet the State's 25% conservation mandate, and the Board asked that they be posted at the District office. These rules and regulations are as follows:

[T]he Board has adopted the following <u>mandatory</u> water restrictions:

- Outdoor irrigation is limited to 3 days per week.
- Even Numbered Property Address: Outdoor irrigation is allowed on Sunday, Wednesday and Saturday only.
- Odd Numbered Property Address: Outdoor irrigation is allowed on Tuesday, Thursday and Saturday only.
- All outside irrigation is prohibited on Mondays.
- Outdoor irrigation should occur from Sundown to Sun-up.
- Outdoor irrigation that results in water flowing onto adjacent property, non-irrigated areas, private and public walkways, roadways, parking lots, or structures is prohibited.

- The use of a hose without shut-off nozzle or device to wash a vehicle is prohibited.

The District Board adopted the 2026 Water Shortage Contingency Plan (WSCP) adopted on June 8, 2026.

8.1 - Water Supply Reliability Analysis

In compliance with CWC section 10632(a)(1), all water suppliers are required to administer a strategy – an adopted ordinance or terms of service – to outline "stages of action" in response to water supply shortages. The District currently has only one stage of action, which requires compliance with all Board adopted Mandatory Water Conservation Plan rules and the 2026 WSCP adopted on June 8, 2026.

8.2 - Annual Water Supply and Demand Assessment Procedures

In compliance with CWC section 10632(a)(1), all water suppliers are required to administer a strategy – an adopted ordinance or terms of service – to outline "stages of action" in response to water supply shortages. The District currently has only one stage of action, which requires compliance with all Board adopted Mandatory Water Conservation Plan rules and the 2026 WSCP adopted on June 8, 2026.

8.3 - Six Standard Water Shortage Levels

In compliance with CWC section 10632(a)(1), all water suppliers are required to administer a strategy – an adopted ordinance or terms of service – to outline "stages of action" in response to water supply shortages. The District currently uses all the standard shortage levels with only one stage of action, which requires compliance with all Board adopted Mandatory Water Conservation Plan rules and the 2026 WSCP adopted on June 8, 2026.

Table 8-1 provides a summary of the one stage of action that has been enacted by the District's Board.

Table 8-1 Retail: Cross-reference for Standard vs Supplier Storage Levels

Submittal Table 8-1: Cross-reference for Standard vs Supplier Shortage Levels Water Code Section 10632(a)(3)(B)			
☑	Check the box if the Supplier uses the Standard six levels of water shortage. Proceed to the next table.		
Standard Shortage Levels	**Percent Shortage Range**	**Suppliers Shortage Levels**	**Percent Shortage Range**
1	Up to 10%		
2	Up to 20%		
3	Up to 30%		
4	Up to 40%		
5	Up to 50%		
6	>50%		

8.4 - Supply Augmentation

In compliance with CWC section 10632(b)(2) and described in Chapters 6 and 7, the water supplier may want to indicate that a particular supply augmentation response included in the WSCP has already been integrated into normal water management planning for shortage conditions.

To constantly address all potential shortage levels, the District purchases Kern Island Canal "seepage" water from the KDWD (Kern Delta Water District) through that portion of the Kern Delta's unlined canal systems lying within the District's Sphere of Influence. Within this unlined canal system, a certain amount of conveyed surface water "seeps" into the ground as it passes through the GCWD's service area and becomes groundwater. The District purchases this seepage water to "bank" groundwater for future use. This water will ultimately be used

by the District when it is pumped via their groundwater wells for retail treatment and delivery (see *Section 6 – Normal-Year Water Supply Characterization*).

Table 8-2 summarizes the supply augmentation methods utilized by the District.

Table 8-2 Retail: Supply Augmentation and Other Actions

Submittal Table 8-2 Retail: Supply Augmentation and Other Actions **Water Code Section 10632(a)(4)(A),(C) and (E)**				
Yes	Is the Supplier completing this table using the standard six levels? (yes/no)			
Shortage Level	Supply Augmentation Methods and Other Actions by Water Supplier **Drop down list** These are the only categories that will be accepted by the WUEdata online submittal tool	How much is this going to reduce the shortage gap?		Additional Explanation or Reference (OPTIONAL)
		Volume or Percentage Drop down	Shortage Gap Reduction Value (May be a range) (MG)	
Add additional rows as needed				
1	Other Purchases	Volume	1,200	Purchasing KDWD seepage water for recharge
2	Other Purchases	Volume	1,200	Purchasing KDWD seepage water for recharge
3	Other Purchases	Volume	1,200	Purchasing KDWD seepage water for recharge
4	Other Purchases	Volume	1,200	Purchasing KDWD seepage water for recharge
5	Other Purchases	Volume	1,200	Purchasing KDWD seepage water for recharge
6	Other Purchases	Volume	1,200	Purchasing KDWD seepage water for recharge

8.5 - Demand Reduction Actions

In compliance with CWC section 10632(a)(4) and CWC section 10632(a)(5), prohibitions on end users are defined in the Board-adopted Mandatory Water Conservation Plan rules and regulations adopted both on August 11, 2014 and May 11, 2015 as shown above. Table 8-3 summarizes the mandatory restrictions and prohibitions placed on end users.

Table 8-3 Retail: Demand Reduction Actions

Submittal Table 8-3 Retail: Demand Reduction Actions Water Code Section 10632(a)(4)(B),(D), and (E)					
Yes	Is the Supplier completing this table using the standard six levels? (yes/no)				
Shortage Level	Demand Reduction Actions **Drop down list** These are the only categories that will be accepted by the WUEdata online submittal tool. Select those that apply.	How much is this going to reduce the shortage gap?		Additional Explanation or Reference (OPTIONAL)	Penalty, Charge, or Other Enforcement? **For Retail Suppliers Only** Drop Down List
		Volume or Percentage Drop down	Shortage Gap Reduction Value (May be a range) (MG)		
Add additional rows as needed					
6	Expand Public Information	Percentage	2	Water Conservation-Website and Notice Board at office	No
6	Improve Customer Billing	Percentage	2	Add Water Conservation Note on every bill	No
6	Increase Frequency of Meter	Percentage	2	Read meters monthly	No
6	Decrease Line Flushing	Percentage	2	Flush twice a year at a minimum	No
6	Reduce System Water Loss	Percentage	2	Replacing old meters	No
6	Increase Water Waste Patrols	Percentage	2	Operators are always monitoring as they drive around	Yes

Expanded Public Information Campaign

The District distributes water conservation pamphlets and the office staff are tasked with providing water conservation education when customers pay their bills at the District office. Per the Mandatory Water Conservation Plan dated August 11, 2014, the District's Board has directed District staff to include water conservation suggestions in the monthly billings and water conservation signs be placed in District office. Additionally, during preconstruction meetings with new development, developers, management, and contractors are encouraged and monitored to use water wisely.

The District has plans to expand its existing public information campaign by providing a greater variety of pamphlets and contacting schools and other public venues.

Increase Water Waste Patrols

The District has a Water Waste Patrol program in place and plans to expand this program in the future. Currently, the Water Waste patrol assists customers with leak detection, sprinkler timers, etc. and is encouraged to educate customers whenever possible. The District also includes a large area of farmland that does not receive water, but the servicemen include this area in their patrols to discourage theft or illegal connection to the District's system.

8.6 - Shortage Response Actions Penalties, Charges, Other Enforcement of Prohibitions

On August 11, 2014, the District's Board approved the Mandatory Water Conservation Plan. Penalties found within this Plan are as follows:

> (b) The taking of any action prohibited in subdivision (a) of this section [e.g., landscape runoff, using hoses without nozzles, applying water to driveways, etc.], in addition to any other applicable civil or criminal penalties, is an infraction, punishable by a fine of up to five hundred dollars ($500) for each day in which the violation occurs.

On May 11, 2015, the District's Board further defined penalties under the Mandatory Water Conservation Plan by defining violation tiers based on the number of violations and specifically defining the monetary penalty for each tier. These penalties are as follows:

> First Violation
>
> A Notice of Violation and a Fee Schedule for all violations.
>
> Second Violation
>
> A $50.00 fee for 2nd violation, send written notice to violator with Violation Fee Schedule.
>
> Third Violation
>
> A $100.00 fee for 3rd violation, send written notice to violator with Violation Fee Schedule.
>
> Fourth Violation
>
> A $250.00 fee for 4th violation, send written notice to violator with Violation Fee Schedule.

The District continues to assess a $250.00 fee and send written notice to violators with the Violation Fee Schedule for every violation after the fourth violation.

8.7 - Determining Water Shortage Reductions

The following discussion is provided to comply with CWC section 10632(a)(9). The District's water system is supplied by groundwater wells. Each well has a flow meter that records the amount of water entering the District's distribution system. The District use these meters to monitor actual reductions in water use within the service area. Any changes in water production of the wells would prompt the District to evaluate if a water shortage level, defined in the WSCP, is necessary to implement.

8.8 - Revenue and Expenditure Impacts

The following discussion is provided to comply with CWC section 10632(a)(7). Most operating costs for most water agencies are fixed rather than a function of the amount of water sold. Thus, when conservation programs are undertaken, it is frequently necessary to raise water rates because the revenue generated is based on lower total consumption while the costs, and resulting revenue required, are basically fixed. However, reductions in water demands, especially peak demands, can delay the need to develop costly new water sources in growing communities. The District currently charges water customers a fixed service charge (stand-by rate) based on meter size plus a volumetric charge for water use.

The District does have an emergency fund for system upkeep. The District's water rates increase every year per a Proposition 218 hearing in 2023. The increase was approved at the June 19, 2023 Board meeting. The District also reviews the water connection fees yearly for new developments. A portion of the fee is put in the capital improvements account and the other portion is placed in a separate account to help pay for the KDWD seepage water.

8.9 - Resolution or Ordinance

In compliance with CWC section 10632(a)(8), the District's Board approved the Mandatory Water Conservation Plan on August 11, 2014 and approved additional and reaffirmed existing rules and regulations for the Plan on May 11, 2015. The Board adopted the 2026 WSCP adopted on June 8, 2026. Please see above for more information about the specifics of the Plan.

8.10 - Catastrophic Supply Interruption

The following discussion is provided to comply with CWC section 10632(a)(3). The Act refers to catastrophic interruptions as regional power outages, natural disasters, and other disasters that stop the water supply. The District has developed the *Emergency Disaster Response Plan* (Greenfield County Water District, 2020) that outlines the District's response to emergencies and/or disasters to continue minimum service levels and mitigate the public health risk from drinking water contamination. The Plan designates responsible personnel, provides the location to obtain an inventory of resources, designates an emergency operations center, outlines other agency coordination, and provides response procedures.

8.11 - Emergency Response Plan

8.12 - Seismic Risk Assessment and Mitigation Plan

Water Code Section 10632.5.
(a) In addition to the requirements of paragraph (3) of subdivision (a) of Section 10632, beginning January 1, 2025, the plan shall include a seismic risk assessment and mitigation plan to assess the vulnerability of each of the various facilities of a water system and mitigate those vulnerabilities.

(b) An urban water supplier shall update the seismic risk assessment and mitigation plan when updating its urban water management plan as required by Section 10621.

(c) An urban water supplier may comply with this section by submitting, pursuant to Section 10644, a copy of the most recent adopted local hazard mitigation plan or multi-hazard mitigation plan under the federal Disaster Mitigation Act of 2000 (Public Law 106-390) if the local hazard mitigation plan or multi-hazard mitigation plan addresses seismic risk.

In lieu of conducting their own seismic risk assessment, which can be a lengthy process, suppliers can comply with the CWC requirement by submitting the relevant local hazard mitigation plan or multi-hazard mitigation plan, if available. The District was one of the agencies that is included in the Kern County Hazard Mitigation Plan. The current Plan was completed in 2020 and approved by the Federal Emergency Management Plan (FEMA) in October 2021. The Kern County Hazard Mitigation Plan is included in this Plan as an attachment. An updated Kern County Hazard Mitigation Plan is scheduled to be completed by February 20271.

SECTION 9 - DEMAND MANAGEMENT MEASURES

CWC 10631(f). Provide a description of the supplier's water demand management measures. This description shall include all of the following:

CWC 10631(f)(1)(A). For an urban retail water supplier, as defined in Section 10608.12, a narrative description that addresses the nature and extent of each water demand management measure implemented over the past five years. The narrative shall describe the water demand management measures that the supplier plans to implement to achieve its water use targets pursuant to Section 10608.20.

CWC 10631(f)(1)(B). The narrative pursuant to this paragraph shall include descriptions of the following water demand management measures:

(i) Water waste prevention ordinances.

(ii) Metering.

(iii) Conservation pricing.

(iv) Public education and outreach.

(v) Programs to assess and manage distribution system real loss.

(vi) Water conservation program coordination and staffing support.

(vii) Other demand management measures that have a significant impact on water use as measured in gallons per capita per day, including innovative measures, if implemented.

This section provides a comprehensive description of the water conservation programs that the District has implemented, is currently implementing, and plans to implement to meet urban water reduction targets. The District is not a signatory to the Memorandum of Understanding regarding Urban Water Conservation in California and therefore, is not a member of the California Urban Water Conservation Council. For responding to the Act, the District will address the six Demand Management Measures (DMMs) described in CWC section 10631(f)(1)(B). Descriptions of the District's DMMs are provided below.

9.1 - Water Waste Prevention Ordinances

In compliance with CWC section 10632(a)(8), the District's Board approved the Mandatory Water Conservation Plan on August 11, 2014 and approved additional and reaffirmed existing rules and regulations for the Plan on May 11, 2015. Please see *Section 8 – Water Shortage Contingency Planning* for more information about the specifics of the Plan.

9.2 - Metering

As of 2025, one-hundred percent of the District's service connections are metered. The District is in compliance with the Urban Water Management Planning Act, CWC section 325, which requires water meters and billings based thereon for all service connections by 2025.

The District uses radio read technology on all metered connections. And the GCWD has a metered testing program and replaces inaccurate meters, as needed.

9.3 - Public Education and Outreach

The following describes the public education and outreach efforts by the District to promote water conservation and other water-related topics.

The annual Consumer Confidence Report is mailed each year and posted on the District website: https://greenfieldwater.specialdistrict.org/. The District uses these mailings and its website when necessary to provide customers additional information on water conservation and other demand management measures. Display cases and bulletin boards at District facilities augment the mailings by providing a permanent posting of the most current District mailings.

The District monthly water bill distributed to all water service customers is another vehicle used by the District for public education purposes. The bill presents information regarding comparable previous year water usage so that the public can self-monitor their water demand. The bill also contains a space for public service announcements that are used to remind citizens of conservation and demand management measures.

9.4 - Programs to Assess and Manage Distribution System Real Loss

The GCWD has several programs to manage distribution system loss.

1. Electronic water meter read

    - After all water meters are read, a report card is created and reviewed for meters reading low and high.

    - A list is created of meters reading low and high and these meters are visually inspected, which includes current read, checking using flow meter, and noting possible equipment failure.

    - Failed meter-reading equipment are replaced at time of inspection.

2. Leak detection program

    - Daily water patrol helps to detect visible leaks.

- Customer calls on possible water leaks, when received, are inspected the same day.
- All leaks are repaired as soon as possible.
- When repairing a leak, 1) underground dig alert is notified to let other utilities know of underground excavations and 2) the water leak is repaired.

3. Regular meter testing
   - Several meters are flow tested regularly throughout the District for accuracy.
   - Meters are also flow tested by request of a customer.
   - Meters are replaced, if needed.

9.5 - Water Conservation Program and Staffing Support

The following provides a description of the District's water conservation program and staffing support.

On August 11, 2014, the District's Board approved the Mandatory Water Conservation Plan. This Plan states:

> The Greenfield County Water District Board of Directors requested that field personnel increase their daily water patrol and discuss with customers the severity of the present drought. The Board also requested that conservation suggestions be placed on the monthly bills, signs be placed in the office and that office personnel encourage customers to conserve water.

The contact information for District-related water conservation program is provided below:

Nick Cooper, District Manager
(661) 831-0989

9.6 - Other Demand Management Measures That Impact GPCD

The District does not currently employ any other DMMs that affect GPCD.

9.7 - Planned Implementation to Achieve Water Use Targets

As required by CWC Section 10631(f)(1)(A), the District must describe the DMMs that it plans to implement to achieve its water use targets (see Table 5-1). The District plans to use all DMMs described above, if needed, to achieve its water use targets.

9.8 - Members of the California Urban Water Conservation Council

CWC 10631(i). For purposes of this part, urban water suppliers that are members of the California Urban Water Conservation Council shall be deemed in compliance with the requirements of subdivision (f) by complying with all the provisions of the "Memorandum of Understanding Regarding Urban Water Conservation in California," dated December 10, 2008, as it may be amended, and by submitting the annual reports required by Section 6.2 of that memorandum.

The District is not a member of the California Urban Water Conservation Council and therefore, need not comply with this section of the CWC.

SECTION 10 - UWMP ADOPTION, SUBMITTAL, AND IMPLEMENTATION

CWC 10621(b). Every urban water supplier required to prepare a plan pursuant to this part shall, at least 60 days before the public hearing on the plan required by Section 10642, notify any District or county within which the supplier provides water supplies that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan. The urban water supplier may consult with, and obtain comments from, any District or county that receives notice pursuant to this subdivision.

CWC 10621(d). Each urban water supplier shall update and submit its 2025 plan to the department by June 30, 2021.

CWC 10608.26(a). In complying with this part, an urban retail water supplier shall conduct at least one public hearing to accomplish all of the following:

(1) Allow community input regarding the urban retail water supplier's implementation plan for complying with this part.

(2) Consider the economic impacts of the urban retail water supplier's implementation plan for complying with this part.

(3) Adopt a method, pursuant to subdivision (b) of Section 10608.20, for determining its urban water use target.

CWC 10635(b). The urban water supplier shall provide that portion of its urban water management plan prepared pursuant to this article to any District or county within which it provides water supplies no later than 60 days after the submission of its urban water management plan.

CWC 10642. Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan. Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. The urban water supplier shall provide notice of the time and place of hearing to any District or county within which the supplier provides water supplies. A privately owned water supplier shall provide an equivalent notice within its service area. After the hearing, the plan shall be adopted as prepared or as modified after the hearing.

CWC 10644(a)(1). An urban water supplier shall submit to the department, the California State Library, and any District or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be submitted to the department, the California State Library, and any District or county within which the supplier provides water supplies within 30 days after adoption.

CWC 10644(a)(2). The plan, or amendments to the plan, submitted to the department pursuant to paragraph (1) shall be submitted electronically and shall include any standardized forms, tables, or displays specified by the department.

CWC 10645. Not later than 30 days after filing a copy of its plan with the department, the urban water supplier and the department shall make the plan available for public review during normal business hours.

The District has notified all entities that have land use jurisdiction within its service area that it is reviewing and considering amendments to its 2025 UWMP. The District has served 60-day notice to these agencies on March 9, 2026 that its 2025 UWMP is under review and may be revised in concurrence with updated land use information, demand projections and new legislations. This 60-day notice also stated that a public hearing would be held on June 8, 2026 at 6:00pm at the District office to receive comments, questions, and suggestions regarding District's 2025 UWMP, and to address water supply reliability and management by the District for at least the next 20 years. Copies of the 60-day notices are included in Appendix B. A notice of public hearing was published in the local newspaper, notifying interested parties that the 2025 UWMP was available at the District for review; at the same time copies of the 2025 UWMP were forwarded to the DWR for review. Upon the completion of that review, and corrections based thereon, the District Board of Directors will adopt the UWMP.

Table 10-1 provides the cities and counties that received notice.

Table 10-1 Retail: Notification to Cities and Counties

Submittal Table 10-1 Retail: Notification to Cities and Counties Water Code Section 10621(b) and 10642		
City Name	60 Day Notice **Drop Down (yes/no)**	Notice of Public Hearing **Drop Down (yes/no)**
Add additional rows as needed		
Bakersfield	Yes	Yes
Bakersfield - Water Resources Dept	Yes	Yes
County Name **Drop Down List**	60 Day Notice **Drop Down (yes/no)**	Notice of Public Hearing **Drop Down (yes/no)**
Add additional rows as needed		
Kern County	Yes	Yes
NOTES: Also notified Kern River SGA		

In accordance with CWC section 10635(b), a urban water supplier shall provide that portion of its urban water management plan prepared pursuant to this article to any city or county within which it provides water supplies no later than 60 days after the submission of its urban water management plan. Since the District is the urban water supplier for itself, this requirement does not apply.

The District held the public hearing at its regularly scheduled District Council meeting on June 8, 2026 in which the following was accomplished:

- Community input was taken regarding the 2025 UWMP.
- The economic impacts of the 2025 UWMP were considered.
- Community input was taken regarding the 2026 WSCP.

A copy of the signed resolution by the District Council adopting the 2025 UWMP is included in Appendix C. This UWMP includes all information necessary to meet the requirements of California Water Code Division 6, Part 2.6 (Urban Water Management Planning).

The District's 2025 UWMP will be provided to DWR per CWC section 10621 both in hardcopy and electronically. In addition, the District's 2025 UWMP will be provided to the California State Library and the agencies listed in Table 10-1 that have land use jurisdiction within its service area per CWC section 10644 no later than 30 days following its adoption. Copies of these letters of transmittal are included in Appendix D.

No later than 30 days after filing a copy of the 2025 UWMP with DWR, the District will make a hardcopy of its 2025 UWMP available for public review at the District during normal business hours.

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APPENDIX A
URBAN WATER MANAGEMENT PLANNING ACT OF 1983

APPENDIX A
URBAN WATER MANAGEMENT PLANNING ACT OF 1983

Assembly Bill No. 797

CHAPTER 1009

An act to add and repeal Part 2.6 (commencing with Section 10610) to Division 6 of the Water Code, relating to water conservation.

[Approved by Governor September 21, 1983. Filed with Secretary of State September 22, 1983.]

LEGISLATIVE COUNSEL'S DIGEST

AB 797, Klehs. Water: management planning.

(1) Under existing law, local water suppliers may, but are not required to, adopt and enforce water conservation plans.

This bill would require every urban water supplier providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually to prepare and adopt, in accordance with prescribed requirements, an urban water management plan containing prescribed elements. The bill would require the plan to be filed with the Department of Water Resources, and would require the department to annually prepare and submit to the Legislature a report summarizing the status of the plans. The bill would require each supplier to periodically review its plan in accordance with prescribed requirements, would specify requirements for actions or proceedings arising under the bill, and would specify related matters.

The bill would make legislative findings and declarations in this connection.

The provisions of the bill would remain in effect only until January 1, 1991.

(2) Article XIII B of the California Constitution and Sections 2231 and 2234 of the Revenue and Taxation Code require the state to reimburse local agencies and school districts for certain costs mandated by the state. Other provisions require the Department of Finance to review statutes disclaiming these costs and provide, in certain cases, for making claims to the State Board of Control for reimbursement.

This bill would impose a state-mandated local program as its requirements would be applicable to local public agencies.

However, the bill would provide that no appropriation is made and no reimbursement is required by this act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. Part 2.6 (commencing with Section 10610) is added to Division 6 of the Water Code, to read:

REPRINT

PART 2.6. URBAN WATER MANAGEMENT PLANNING

CHAPTER 1. GENERAL DECLARATION AND POLICY

10610. This part shall be known and may be cited as the "Urban Water Management Planning Act."

10610.2. The Legislature finds and declares as follows:

(a) The waters of the state are a limited and renewable resource subject to ever increasing demands.

(b) The conservation and efficient use of urban water supplies are of statewide concern; however, the planning for that use and the implementation of those plans can best be accomplished at the local level.

10610.4. The Legislature finds and declares that it is the policy of the state as follows:

(a) The conservation and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.

(b) The conservation and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to achieve conservation and efficient use.

CHAPTER 2. DEFINITIONS

10611. Unless the context otherwise requires, the definitions of this chapter govern the construction of this part.

10611.5. "Conservation" means those measures that limit the amount of water used only to that which is reasonably necessary for the beneficial use to be served.

10612. "Customer" means a purchaser of water from a water supplier who uses the water for municipal purposes, including residential, commercial, governmental, and industrial uses.

10613. "Efficient use" means those management measures that result in the most effective use of water so as to prevent its waste or unreasonable use or unreasonable method of use.

10614. "Person" means any individual, firm, association, organization, partnership, business, trust, corporation, company, public agency, or any agency of such an entity.

10615. "Plan" means an urban water management plan prepared pursuant to this part. A plan shall describe and evaluate reasonable and practical efficient uses and conservation activities. The components of the plan may vary according to an individual community or area's characteristics and its capabilities to efficiently use and conserve water. The plan shall address measures for residential, commercial, governmental, and industrial water management as set forth in Article 2 (commencing with Section 10630) of Chapter 3. In addition, a strategy and time schedule for implementation shall be included in the plan.

10616. "Public agency" means any board, commission, county, city and county, city, regional agency, district, or other public entity.

10617. "Urban water supplier" means a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. An urban water supplier includes a supplier or contractor for water, regardless of the basis of right, which distributes or sells for ultimate resale to customers. This part applies only to water supplied from public water systems subject to Chapter 7 (commencing with Section 4010) of Part 1 of Division 5 of the Health and Safety Code.

CHAPTER 3. URBAN WATER MANAGEMENT PLANS

Article 1. General Provisions

10620. (a) Every urban water supplier serving water directly to customers shall, not later than December 31, 1985, prepare and adopt an urban water management plan in the manner set forth in Article 3 (commencing with Section 10640).

(b) Every person that becomes an urban water supplier after December 31, 1984, shall adopt an urban water management plan within one year after it has become an urban water supplier.

(c) An urban water supplier indirectly providing water to customers may adopt an urban water management plan or participate in areawide, regional, watershed, or basinwide urban water management planning; provided, however, an urban water supplier indirectly providing water shall not include planning elements in its water management plan as provided in Article 2 (commencing with Section 10630) that would be applicable to urban water suppliers or public agencies directly providing water, or to their customers, without the consent of those suppliers or public agencies.

(d) An urban water supplier may satisfy the requirements of this part by participation in areawide, regional, watershed, or basinwide urban water management planning where those plans will reduce preparation costs and contribute to the achievement of conservation and efficient water use.

(e) The urban water supplier may prepare the plan with its own staff, by contract, or in cooperation with other governmental agencies.

10621. Each urban water supplier shall periodically review its plan at least once every five years. After the review, it shall make any amendments or changes to its plan which are indicated by the review. Amendments or changes in its plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).

Article 2. Contents of Plans

10630. It is the intention of the Legislature, in enacting this part, to permit levels of water management planning commensurate with the numbers of customers served and the volume of water supplied.

10631. A plan shall include all of the following elements:

(a) Contain an estimate of past, current, and projected water use and, to the extent records are available, segregate those uses between residential, industrial, commercial, and governmental uses.

(b) Identify conservation measures currently adopted and being practiced.

(c) Describe alternative conservation measures, if any, which would improve the efficiency of water use with an evaluation of their costs and their environmental and other significant impacts.

(d) Provide a schedule of implementation for proposed actions as indicated by the plan.

(e) Describe the frequency and magnitude of supply deficiencies, including conditions of drought and emergency, and the ability to meet short-term deficiencies.

10632. In addition to the elements required pursuant to Section 10631, a plan projecting a future use which indicates a need for expanded or additional water supplies shall contain an evaluation of the following:

(a) Waste water reclamation.

(b) Exchanges or transfer of water on a short-term or long-term basis.

(c) Management of water system pressures and peak demands.

(d) Incentives to alter water use practices, including fixture and appliance retrofit programs.

(e) Public information and educational programs to promote wise use and eliminate waste.

(f) Changes in pricing, rate structures, and regulations.

10633. The plan shall contain an evaluation of the alternative water management practices identified in Sections 10631 and 10632, taking into account economic and noneconomic factors, including environmental, social, health, customer impact, and technological factors.

Evaluation of the elements in Section 10632 shall include a comparison of the estimated cost of alternative water management practices with the incremental costs of expanded or additional water supplies, and in the course of the evaluation first consideration shall be given to water management practices, or combination of practices, which offer lower incremental costs than expanded or additional water supplies, considering all the preceding evaluation factors.

Article 3. Adoption and Implementation of Plans

10640. Every urban water supplier required to prepare a plan pursuant to this part shall prepare its plan pursuant to Article 2 (commencing with Section 10630).

The supplier shall likewise periodically review the plan as required by Section 10621, and any amendments or changes required as a result of that review shall be adopted pursuant to this article.

10641. (a) An urban water supplier required to prepare a plan may consult with, and obtain comments from, any public agency or state agency or any person who has special expertise with respect to water conservation and management methods and techniques.

(b) In order to assist urban water suppliers in obtaining needed expertise as provided for in subdivision (a), the department, upon request of an urban water supplier, shall provide the supplier with a list of persons or agencies having expertise or experience in the development of water management plans.

10642. Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. A privately owned water supplier shall provide an equivalent notice within its service area. After the hearing, the plan shall be adopted as prepared or as modified after the hearing.

10643. An urban water supplier shall implement its plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan.

10644. An urban water supplier shall file with the department a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be filed with the department within 30 days after adoption.

The department shall annually prepare and submit to the Legislature a report summarizing the status of the plans adopted pursuant to this part.

CHAPTER 4. MISCELLANEOUS PROVISIONS

10650. Any actions or proceedings to attack, review, set aside, void, or annul the acts or decisions of an urban water supplier on the grounds of noncompliance with this part shall be commenced as follows:

(a) An action or proceeding alleging failure to adopt a plan shall be commenced within 18 months after that adoption is required by this part, or within 18 months after commencement of urban water service by a supplier commencing that service after January 1, 1984.

(b) Any action or proceeding alleging that a plan, or action taken pursuant to the plan, does not comply with this part shall be

commenced within 90 days after filing of the plan or amendment thereto pursuant to Section 10644 or the taking of that action.

10651. In any action or proceeding to attack, review, set aside, void, or annul a plan, or an action taken pursuant to the plan by an urban water supplier on the grounds of noncompliance with this part, the inquiry shall extend only to whether there was a prejudicial abuse of discretion. Abuse of discretion is established if the supplier has not proceeded in a manner required by law or if the action by the water supplier is not supported by substantial evidence.

10652. The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) does not apply to the preparation and adoption of plans prepared and adopted under this part. Nothing in this part shall be interpreted as exempting projects for implementation of the plan or for expanded or additional water supplies from the provisions of the California Environmental Quality Act.

10653. The adoption of a plan shall satisfy any requirements of state law, regulation, or order, including those of the State Water Resources Control Board, for the preparation of water management plans or conservation plans; provided, that if the State Water Resources Control Board requires additional information concerning water conservation to implement its existing authority, nothing in this part shall be deemed to limit the board in obtaining that information. The requirements of this part shall be satisfied by any water conservation plan prepared to meet federal laws or regulations after the effective date of this part, and which substantially meets the requirements of this part, or by any existing water management or conservation plan which includes the contents of a plan required under this part.

10654. All costs incurred by an urban water supplier in developing or implementing its plan shall be borne by it unless otherwise provided for by statute.

10655. If any provision of this part or the application thereof to any person or circumstances is held invalid, that invalidity shall not affect other provisions or applications of this part which can be given effect without the invalid provision or application thereof, and to this end the provisions of this part are severable.

10656. This part shall remain in effect only until January 1, 1991, and as of that date is repealed, unless a later enacted statute, which is chaptered before January 1, 1991, deletes or extends that date.

SEC. 2. No appropriation is made and no reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution or Section 2231 or 2234 of the Revenue and Taxation Code because the local agency or school district has the authority to levy service charges, fees, or assessments sufficient to pay for the program or level of service mandated by this act.

O

APPENDIX B
60-DAY NOTICE

551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989

March 9, 2026

City of Bakersfield
1600 Truxtun Ave.
Bakersfield, CA 93301

RE: 2025 Urban Water Management Plan & Water Shortage Contingency Plan Update

60-Day Notice of Preparation

The Urban Water Management Planning Act (Water Code sections 10610 through 10657) (**Act**) requires every urban water supplier to prepare and adopt an Urban Water Management Plan (**UWMP**) and Water Shortage Contingency Plan **(WSCP)** at least once every five years in years ending in six and one. Under section 10621 of the Act, each urban water supplier must update and submit its 2025 UWMP by July 1, 2026 to the California Department of Water Resources. The UWMP is a planning document to direct urban water suppliers to evaluate their water supply and reliability and compare that to their water conservation efforts.

In accordance with the Act, this letter provides the required 60-day notice that Greenfield County Water District (**District**) has begun its 2025 UWMP and WSCP process. A draft copy of the 2025 UWMP and WSCP will be available on the District website: http://www.greenfieldwater.specialdistrict.org. The Public Hearing and Adoption Meeting for the 2025 UWMP and WSCP is planned for June 8, 2026. The public hearing will allow community input on the District's water supply reliability, the economic effects of complying with the Act, and the District's Water Shortage Contingency Plan. Information regarding the public meeting will be published at least twice in the Bakersfield Californian and available on the agenda located on the District's website prior to the meeting.

If you have any comments regarding the District's UWMP and WSCP, please provide them to the District prior to the planned public hearing. Written comments can be emailed to ncooper@greenfieldcwd.org or mailed to Greenfield County Water District.

Sincerely,

Nick Cooper

General Manager

551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989

March 9, 2026

City of Bakersfield Water Resources Department
1000 Buena Vista Rd.
Bakersfield, CA 93311

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60-Day Notice of Preparation

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If you have any comments regarding the District's UWMP and WSCP, please provide them to the District prior to the planned public hearing. Written comments can be emailed to ncooper@greenfieldcwd.org or mailed to Greenfield County Water District.

Sincerely,

Nick Cooper

General Manager

551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989

March 9, 2026

Attn: County Clerk
County of Kern
1115 Truxtun Ave.
Bakersfield, CA 93301

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60-Day Notice of Preparation

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If you have any comments regarding the District's UWMP and WSCP, please provide them to the District prior to the planned public hearing. Written comments can be emailed to ncooper@greenfieldcwd.org or mailed to Greenfield County Water District.

Sincerely,

Nick Cooper

General Manager

551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989

March 9, 2026

Kern County Planning and Natural Resources
2700 M St., Suite 100
Bakersfield, CA 93301

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60-Day Notice of Preparation

The Urban Water Management Planning Act (Water Code sections 10610 through 10657) (**Act**) requires every urban water supplier to prepare and adopt an Urban Water Management Plan (**UWMP**) and Water Shortage Contingency Plan **(WSCP)** at least once every five years in years ending in six and one. Under section 10621 of the Act, each urban water supplier must update and submit its 2025 UWMP by July 1, 2026 to the California Department of Water Resources. The UWMP is a planning document to direct urban water suppliers to evaluate their water supply and reliability and compare that to their water conservation efforts.

In accordance with the Act, this letter provides the required 60-day notice that Greenfield County Water District (**District**) has begun its 2025 UWMP and WSCP process. A draft copy of the 2025 UWMP and WSCP will be available on the District website: http://www.greenfieldwater.specialdistrict.org. The Public Hearing and Adoption Meeting for the 2025 UWMP and WSCP is planned for June 8, 2026. The public hearing will allow community input on the District's water supply reliability, the economic effects of complying with the Act, and the District's Water Shortage Contingency Plan. Information regarding the public meeting will be published at least twice in the Bakersfield Californian and available on the agenda located on the District's website prior to the meeting.

If you have any comments regarding the District's UWMP and WSCP, please provide them to the District prior to the planned public hearing. Written comments can be emailed to ncooper@greenfieldcwd.org or mailed to Greenfield County Water District.

Sincerely,

Nick Cooper

General Manager

551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989

March 9, 2026

Kern Delta Water District
501 Taft Hwy.
Bakersfield, CA 93307

RE: 2025 Urban Water Management Plan & Water Shortage Contingency Plan Update

60-Day Notice of Preparation

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Sincerely,

Nick Cooper

General Manager

551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989

March 9, 2026

Attn: Kern River Groundwater Sustainability Agency
City of Bakersfield
1600 Truxtun Ave.
Bakersfield, CA 93301

RE: 2025 Urban Water Management Plan & Water Shortage Contingency Plan Update

60-Day Notice of Preparation

The Urban Water Management Planning Act (Water Code sections 10610 through 10657) (**Act**) requires every urban water supplier to prepare and adopt an Urban Water Management Plan (**UWMP**) and Water Shortage Contingency Plan **(WSCP)** at least once every five years in years ending in six and one. Under section 10621 of the Act, each urban water supplier must update and submit its 2025 UWMP by July 1, 2026 to the California Department of Water Resources. The UWMP is a planning document to direct urban water suppliers to evaluate their water supply and reliability and compare that to their water conservation efforts.

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If you have any comments regarding the District's UWMP and WSCP, please provide them to the District prior to the planned public hearing. Written comments can be emailed to ncooper@greenfieldcwd.org or mailed to Greenfield County Water District.

Sincerely,

Nick Cooper

General Manager

APPENDIX C
ADOPTED RESOLUTION

GREENFIELD COUNTY WATER DISTRICT

RESOLUTION NO. 2026-03

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE GREENFIELD COUNTY WATER DISTRICT ADOPTING THE 2025 URBAN WATER MANAGEMENT PLAN FOR THE DISTRICT

A. The Urban Water Management Planning Act (Water code, §§ 10610-10656) requires every urban water supplier providing more than 3,000 acre-feet of water annually or serving more than 3,000 customers to prepare and adopt an urban water management plan at least once every five years.

B. Greenfield County Water District (**District**) is an urban water management supplier providing water for municipal purposes to more than 3,000 customers.

C. The District has prepared its 2025 Urban Water Management Plan (**2025 UWMP**) in compliance with the Urban Water Planning Act.

D. The District made the 2025 UWMP available for public review, and notice of the public hearing (Exhibit A) was published on May 22, 2026 and May 29, 2026 in the *Bakersfield Californian* in accordance with Government Code section 6066 and Water Code section 10642.

E. The Board has duly reviewed, discussed, and considered the 2025 UWMP at the public hearing held on June 8, 2026.

NOW, THEREFORE, IT IS RESOLVED by the Board of the GREENFIELD COUNTY WATER DISTRICT as follows:

1. The above recitals are true and correct, and the Board so finds and determines.

2. The District hereby adopts the 2025 UWMP attached to this Resolution as Exhibit B as the urban water management plan for the District under Water Code section 10642.

3. The District shall submit a copy of the adopted 2025 UWMP to the California Department of Water Resources, the California State Library, the City of Bakersfield, The County of Kern, and any other agency required by law, no later than 30 days after adoption under Water Code section 10644.

4. District staff is hereby directed to make a copy of the adopted 2025 UWMP available for public review at the District's office no later than 30 days after submittal to the California Department of Water Resources section 10645.

5. The District secretary shall certify to the adoption of the Resolution, which shall be affective upon its adoption.

Alex Alvarado
President of the Board of Directors

ATTEST:

Nick Cooper, Secretary

STATE OF CALIFORNIA)
COUNTY OF KERN)

I, Nick Cooper, Secretary of the Board of Directors, GREENFIELD COUNTY WATER DISTRICT, Bakersfield, California, hereby certify the foregoing and annexed to be a full, true, and correct copy of the original Resolution No. 2026-03 on file in this office and that I compared the same with the original.

WITNESS my hand and seal this 8th day of June 2026.

ATTEST:

Nick Cooper, Secretary

SECRETARY'S CERTIFICATE

I HEREBY CERTIFY that the foregoing Resolution No. 2026-03 was duly passed and adopted by the Board of Directors of Greenfield County Water District at a regular meeting thereof held on June 8th, 2026, on the following roll call vote:

AYES:	Alex Alvarado
	Dennis Costa
	Angelo Zunino
	Daniel Ibarra
	Jeremy Keeling
NOES:	None
ABSTAIN:	None
ABSENT:	None

Nick Cooper, Secretary,

APPENDIX D
LETTER OF TRANSMITTAL

GREENFIELD COUNTY WATER DISTRICT

NOTICE OF PUBLIC HEARING CONCERNING

ADOPTION OF 2025 URBAN WATER MANAGEMENT PLAN AND 2025 WATER SHORTAGE CONTINGENCY PLAN

PLEASE TAKE NOTICE that on June 8, 2026, at 6:00 p.m., the Greenfield County Water District's (District) Board of Directors will hold a public hearing concerning the adoption of the 2025 Urban Water Management Plan (UWMP). The public hearing will allow community input on the District's water supply reliability, the economic effects of complying with the Act, and the District's 2025 Water Shortage Contingency Plan (WSCP). A copy of proposed UWMP & WSCP is available on the District website: http://www.greenfieldwater.specialdistrict.org.

All persons wishing to comment in writing may deliver or mail comments to the District office at 551 Taft Highway, Bakersfield, California, 93307 in advance of the hearing. All persons wishing to comment orally are invited to attend the hearing.

Dated: May 15, 2026

GREENFIELD COUNTY WATER DISTRICT

BY _____/s/_____

Nick Cooper, General Manager and Secretary

RECEIVED

JUN 01 2026

GREENFIELD WATER

Proof of Publication

THE BAKERSFIELD CALIFORNIAN
4900 CALIFORNIA AVE STE 100A
BAKERSFIELD, CA 93309

Ad Number:	593080	PO #:	
Edition:	CALC	Run Times	2
Class Code	LEGAL NOTICES		
Start Date	05/22/2026	Stop Date	05/29/2026

GREENFIELD COUNTY WATER DISTRICT
551 TAFT HIGHWAY
BAKERSFIELD CA 93307
US

Billing Lines	27.00	Inches	2.7140266
Total Cost	$ 484.72	Account	89963
Billing Address	GREENFIELD COUNTY WATER DISTRICT 551 TAFT HIGHWAY BAKERSFIELD CA 93307 US		

STATE OF CALIFORNIA
COUNTY OF KERN

I AM A CITIZEN OF THE UNITED STATES AND A RESIDENT OF THE COUNTY AFORESAID: I AM OVER THE AGE OF EIGHTEEN YEARS, AND NOT A PARTY OR INTERESTED IN THE ABOVE ENTITLED MATTER. I AM THE ASSISTANT PRINCIPAL CLERK OF THE PRINTER OF THE BAKERSFIELD CALIFORNIAN, A NEWSPAPER OF GENERAL CIRCULATION, PRINTED AND PUBLISHED DAILY IN THE CITY OF BAKERSFIELD COUNTY OF KERN,

AND WHICH NEWSPAPER HAS BEEN ADJUDGED A NEWSPAPER OF GENERAL CIRCULATION BY THE SUPERIOR COURT OF THE COUNTY OF KERN, STATE OF CALIFORNIA, UNDER DATE OF FEBRUARY 5, 1952, CASE NUMBER 57610; THAT THE NOTICE, OF WHICH THE ANNEXED IS A PRINTED COPY, HAS BEEN PUBLISHED IN EACH REGULAR AND ENTIRE ISSUE OF SAID NEWSPAPER
AND NOT IN ANY SUPPLEMENT THEREOF ON THE FOLLOWING DATES, TO WIT:

05/22/2026 05/29/2026

ALL IN YEAR 2026

I CERTIFY (OR DECLARE) UNDER PENALTY OF PERJURY THAT THE FOREGOING IS TRUE AND CORRECT.

Teri Brandy

DATED AT BAKERSFIELD CALIFORNIA

5-29-26

Solicitor I.D.: 0

First Text
GREENFIELD COUNTY WATER D

Ad Number 593080

GREENFIELD COUNTY WATER DISTRICT

NOTICE OF PUBLIC HEARING CONCERNING

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Dated: May 15, 2026 GREENFIELD COUNTY WATER DISTRICT

BY /s/
Nick Cooper, General Manager and Secretary

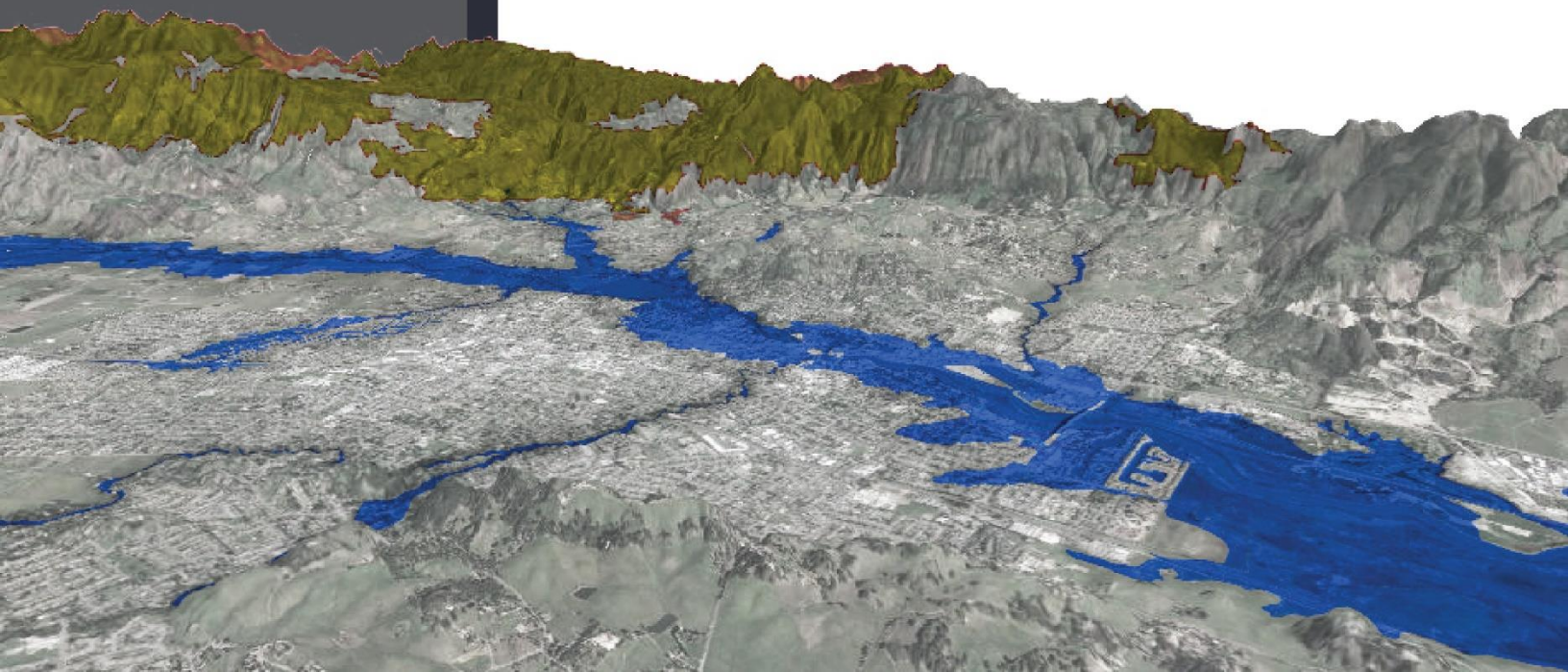
May 22, 29, 2026
593080

APPENDIX E
HAZARD MITIGATION

COUNTY OF KERN

MULTI-JURISDICTION
HAZARD MITIGATION PLAN

KERN COUNTY FIRE DEPARTMENT
OFFICE OF EMERGENCY SERVICES
2601 PANORAMA DR. BUILDING B
BAKERSFIELD, CA 93306



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Kern County

Multi-Jurisdiction Hazard Mitigation Plan

Volume 1

Planning-Area-Wide Elements

Executive Summary ..... **xi**
What is a hazard mitigation plan? xii
Why have a hazard mitigation plan? xii
Why is the plan updated so often? xiii
Participating Jurisdictions xiii
Plan Development and Update Methods xiv
Risk Assessment xv
Hazard Exposure and Damage Estimation xvi
Population and Asset Exposure ..... *xvi*
Damage Assessments ..... *xvii*
Summary of Vulnerable Assets: People, Property Value, and Infrastructure xviii
Mitigation Goals xxiii
Mitigation Strategy xxiii
County Wide Priority Mitigation Actions xxiv
Mitigation Action Implementation xxiv
Adoption Records (To be included) ..... **xxviii**
Volume 1 ..... **1-1**
Section 1. Introduction **1-2**
1.1 Purpose 1-2
1.2 Background and Scope 1-2
1.3 Participating Jurisdictions 1-3
1.4 Why Update This Plan? 1-3
1.4.1 Purposes for Planning *1-4*
1.5 Who Will Benefit from This Plan? 1-5
1.6 How to Use This Plan 1-5
Section 2. What's New **2-1**

2.1 Participating Jurisdictions in the 2014 HMP vs MJHMP Update 2-1
2.2 Mitigation Actions 2-3
2.3 New Analysis and Risk Assessment Methodology 2-4
2.4 Successful Mitigation Activities 2-5
2.5 Incorporation into other Planning Mechanisms 2-9
Section 3. Planning Process 3-1
STEP 1: Organize Resources 3-3
Building the Planning Team 3-3
Steering Committee 3-3
Planning Committee 3-4
Planning Committee Meetings 3-16
Public Involvement and Outreach 3-17
STEP 2: Assess the Risk 3-19
Identify/Profile Hazards 3-19
Assess Vulnerabilities 3-19
Web Based Risk Assessment Mapping and Analysis 3-19
STEP 3: Develop a Mitigation Strategy 3-21
Identify Goals 3-21
Develop Capabilities Assessment 3-21
Identify Hazard Problem Statements 3-22
Identify Mitigation Actions 3-22
Mitigation Action Support Tool (MAST) 3-22
County Planning Processes Library 3-23
Multi-Jurisdiction Planning Process 3-23
STEP 4: Adopt and Implement the Plan 3-24
Plan Review and Revision 3-24
Plan Adoption and Submittal 3-24
Implement, Evaluate, and Revise the Plan 3-24
Plan Maintenance 3-25
Section 4. Risk Assessment 4-1
4.1 Hazard Identification and Screening 4-1
4.1.1 Hazard Screening 4-2

4.1.2 Past Major Hazard Events *4-5*
4.2 Hazard Prioritization 4-7
4.3 Kern County Geographic and Demographic Profile 4-9
4.3.1 Geography *4-9*
4.3.2 Climate *4-10*
4.3.3 Demographics and Vulnerable Populations *4-10*
4.3.4 Economy *4-19*
4.3.5 Past and Future Trends in Development *4-20*
4.4 Vulnerability Assessment Methods 4-23
4.4.1 Population and Asset Inventory *4-23*
4.4.2 Hazard Exposure and Damage Estimation *4-27*
4.5 Vulnerability to Specific Hazards 4-29
4.5.1 Severe Weather Hazard Profile *4-30*
4.5.2 Flood Hazard Profile *4-45*
4.5.3 Dam Failure Hazard Profile *4-78*
4.5.4 Earthquake Hazard Profile *4-95*
4.5.5 Wildfire Hazard Profile *4-127*
4.5.6 Drought Hazard Profile *4-147*
4.5.7 Slope Failure Hazard Profile *4-157*
4.5.8 Soil Stability Hazard Profile *4-169*
Section 5. Mitigation Strategy 5-1
5.1 Mitigation Alternatives 5-1
5.2 Identifying the Problem 5-6
5.3 Capabilities Assessment 5-6
5.3.1 Planning and Regulatory Mitigation Capabilities *5-7*
5.3.2 Financial Capabilities *5-9*
5.3.3 Education and Outreach *5-10*
5.3.4 Administrative and Technical Capabilities *5-11*
5.3.5 Federal and State Funding Opportunities *5-12*
5.4 Mitigation Goals 5-16
5.5 County Wide Mitigation Actions 5-17
5.5.1 Prioritization of Mitigation Actions *5-18*

5.5.2 Mitigation Action Plan 5-20

Section 6. Plan Implementation and Maintenance 6-1

6.1 Plan Adoption 6-1

6.2 Plan Implementation 6-1

6.2.1 Steering Committee 6-1

6.3 Monitoring, Evaluating and Updating the MJHMP 6-2

6.3.1 Schedule 6-2

6.3.2 Mitigation Action Support Tool (MAST) Updates 6-2

6.3.3 Process 6-3

6.3.4 Continuing Public Involvement 6-4

6.3.5 HMA Monitoring 6-5

6.3.6 Incorporation into Other Planning Mechanisms 6-7

6.3.7 Planning Integration Processes 6-8

Section 7. Works Cited 7-1

Appendix A. Analysis Methodology A-1

A.1. Natural Hazard Exposure A-2

A.1.1. Damage Estimation with Hazus A-2

A.1.2. Distinguishing Results – Natural Hazard Exposure Analysis vs Hazus Results A-4

A.2. Analysis Data A-4

A.2.1. Assets, Value, and Population A-4

A.2.2. Natural Hazard Data A-5

A.2.3. Methodology Overview A-7

A.2.4. Data Dictionary A-8

A.2.5. Insured Assets Roll A-10

Appendix B. Process Documentation B-1

List of Figures

Figure ES 1 Risk Assessment Methodology Summary xvi
Figure ES 2 Exposure explanation graphic xvii
Figure ES 3 Hazus Damage Estimation Example xvii
Figure ES 4 Wildfire and Flood Snapshots xix
Figure ES 5 Dam Inundation and Earthquake Snapshot xx

Figure ES 6 Awareness Zone and Landslide Snapshot xxi
Figure ES 7 Subsidence and Earthquake Snapshot xxii

Figure 1-1: Participating Jurisdictions Map 1-4
Figure 2-1: Caliente Creek Feasibility Study Area 2-6
Figure 2-2: U.S. Forest Service Worker Removing Branches from Dead Tree 2-7
Figure 2-3: Bena Bridges During Construction 2-8
Figure 3-1: Kern County MHJHMP Planning Process 3-2
Figure 3-2 Snapshot of community survey results from English-speaking survey. Results are captured fully in Appendix B. 3-18
Figure 3-3: RAMP Facilities Map Access at mitigatehazards.com 3-20
Figure 3-4: RAMP showing the population of Bakersfield overlaid with FEMA Flood Hazard 3-21
Figure 3-5. Categories of issues addressed in problem statements 3-22
Figure 3-6 MAST elements and Cal OES Grant Applications 3-25
Figure 4-1 Prioritized Hazard Assessment Matrix for Kern County 4-8
Figure 4-2 Kern County Geographic Overview 4-10
Figure 4-3: Median Household Income Distribution 4-14
Figure 4-4: Population Under Age 18 4-15
Figure 4-5: Population Over Age 65 4-16
Figure 4-6: Kern County Race Distribution in 2017 4-17
Figure 4-7: Data Source and Method 4-23
Figure 4-8: Critical Facilities in Kern County 4-26
Figure 4-9: Hazard Exposure Explanation Graphic 4-27
Figure 4-10: Hazus Damage Estimation Example 4-28
Figure 4-11 Historical & Projected Annual Average Maximum Temp Increase 4-33
Figure 4-12 Kern County - Average Annual Precipitation 4-36
Figure 4-13: 30-YR Normal Maximum Temperature for July 4-37
Figure 4-14: 30-YR Normal Minimum Temperature for January 4-38
Figure 4-15: Annual Average Wind Speed (Power Class) 4-39
Figure 4-16 Watershed Map 4-54
Figure 4-17: FEMA Flood Zone Exposure Map 4-55
Figure 4-18 DWR Awareness Zones 4-57
Figure 4-19 Population Exposure to Flood (Unincorporated County) 4-62
Figure 4-20: FEMA Flood Zone Exposure and Snapshot Map 4-63
Figure 4-21 100-YR Flood Damage Estimation by Occupancy 4-69
Figure 4-22 500 YR Flood Damage Estimation by Occupancy Type 4-71
Figure 4-23. Oroville Dam Spillway after 2017 failure. 4-81
Figure 4-24: Dam Inundation Exposure 4-84
Figure 4-25 Kern County Levee System 4-85
Figure 4-26: Dam Failure Vulnerability Snapshot Map 4-89
Figure 4-27 Population Exposure to Dam Inundation by Zone 4-90
Figure 4-28: Earthquake Faulting 4-95

Figure 4-29: Zones of Required Investigation 4-99
Figure 4-30 Fault Probability Map for Kern County 4-103
Figure 4-31: Earthquake Shaking Potential 4-105
Figure 4-32. Earthquake Scenario, S. San Andreas Mojave N. 4-106
Figure 4-33 S. San Andreas Mojave N. Exposure and Snapshot Map 4-109
Figure 4-34: Population Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County) 4-110
Figure 4-35: 2016 Erskine Fire 4-131
Figure 4-36: Historic Fire Occurrence Map (Fires Greater than 2,000 acres, 2000-2018) 4-132
Figure 4-37: Wildfire Return Intervals 4-136
Figure 4-38: Wildfire Severity Zones 4-137
Figure 4-39 Population Exposed to Wildfire Risk 4-139
Figure 4-40: Exposure Wildfire Vulnerability and Snapshot Map 4-140
Figure 4-41. Drought-lowered Lake Isabella in 2015. Photo by Don Barrett, USC News 4-149
Figure 4-42 Kern County Drought Severity Timeline 2000-2021 4-151
Figure 4-43. Mudflow near Tehachapi Mountains 4-159
Figure 4-44: Landslide Susceptibility 4-161
Figure 4-45: Landslide Vulnerability Snapshot 4-164
Figure 4-46. Illustration of various stages of erosion. 4-170
Figure 4-47 Subsidence Areas 4-174
Figure 4-48. Subsidence example in San Joaquin Valley 4-175
Figure 5-1: Mitigation Action Application 5-17
Figure 5-2: Mitigation Action Number Key 5-20
Figure 6-1 Diagram of MAST viewing details 6-3
Figure 6-2: MAST and Cal OES Grant Applications 6-6
Figure 6-3: HMGP Timeline 6-7
Figure 7-1: Hazard Exposure 2
Figure 7-2: Flood Depth and Damage Curves 3
Figure 7-3: Hazus Damage Estimations 3
Figure 7-4: Data Analysis Methodology 7

List of Tables

Table 2-1: Participating Jurisdiction Tracker 2-1
Table 2-2. Cancelled Mitigation Actions from 2014 2-4
Table 2-3. Completed Mitigation Actions Since 2014 MJHMP 2-5
Table 3-1: MJHMP Steering Committee 3-3
Table 3-2: MJHMP Planning Committee 3-5
Table 3-3: MJHMP Update Consultant Team 3-16
Table 3-4: Meeting Summary 3-16
Table 3-5 Kern County Links to HMP Resources 3-23
Table 4-1: Document Review Crosswalk 4-2
Table 4-2. Hazard prioritization 4-3
Table 4-3: Disaster Declarations in Kern County 1995- present 4-6

Table 4-4: Disability Status of Non-Institutionalized Population in Kern County in 2017 4-19
Table 4-5: Top 10 Jobs by Occupation in Kern County[1] in May 2018 4-20
Table 4-6: Parcel Counts and Value 4-25
Table 4-7: Severe Weather Damage Summary by Year 2000-2019 4-34
Table 4-8: Classes of Wind Power Density at 10 m and 50 m[a] 4-40
Table 4-9 Severe Weather Problem Statements 4-44
Table 4-10: Flood Insurance Statistics for Kern County 4-49
Table 4-11: Kern County Flood Events Since 2000 4-50
Table 4-12: Summary of Discharges in Kern County 4-58
Table 4-13: Summary Population Exposure to Flood (Unincorporated County) 4-62
Table 4-14: Parcels Exposed to NFIP Flood Zones (Unincorporated County) 4-64
Table 4-15: Critical Facility Points in the Floodplain 4-64
Table 4-16: Lifelines in the Floodplain (Unincorporated County) 4-66
Table 4-17: 100 YR Flood Damage Estimation by Occupancy Type 4-68
Table 4-18 100 YR Flood Damage Estimation of County Insured Assets 4-69
Table 4-19: Damage Estimation Summary for 500 yr. Floodplain 4-70
Table 4-20 500-YR Flood Damage Estimation of County Facilities 4-72
Table 4-21 Flood Problem Statements 4-73
Table 4-22: FEMA & DSOD Hazard Potential Classification 4-82
Table 4-23: Dams in Kern County 4-82
Table 4-24: Population Exposure to Dam Failure (Unincorporated County) 4-90
Table 4-25: Parcel Values at Risk from Dam Inundation (Unincorporated County) 4-91
Table 4-26: Critical Infrastructure Points in Dam Inundation Zones (Unincorporated County) 4-91
Table 4-27: Miles of Critical Infrastructure (Linear) in Dam Inundation Zones (Unincorporated County) 4-93
Table 4-28 Dam Failure Problem Statements 4-94
Table 4-29: Moment Magnitude Scale 4-96
Table 4-30: Modified Mercalli intensity level descriptions 4-97
Table 4-31: Modified Mercalli Scale and Peak Ground Acceleration 4-98
Table 4-32: Earthquakes in Kern County 4.5 Magnitude or Greater Since 2000 4-101
Table 4-33: Population Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County) 4-110
Table 4-34: Seismic Benchmark Years 4-111
Table 4-35: Definitions of FEMA Building Types 4-112
Table 4-36: Age of Structures in Kern County 4-113
Table 4-37: Parcel Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County) 4-114
Table 4-38: Critical Facility Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County) 4-115
Table 4-39: Lifeline Exposure S. San Andreas Mojave N. Scenario (Unincorporated County) 4-116
Table 4-40: Hazus Building Damage Descriptions 4-121
Table 4-41: Loss Estimations for S. San Andreas Mojave N. Scenario 4-122
Table 4-42: Loss Estimations for S. San Andreas Mojave N. Scenario 4-123
Table 4-43 Earthquake Problem Statements 4-125
Table 4-44: Wildfire Events in Kern County 2000 Acres or Greater 2000-2018 4-130
Table 4-45 Populations Exposed to Wildfire Risk (Unincorporated County) 4-139

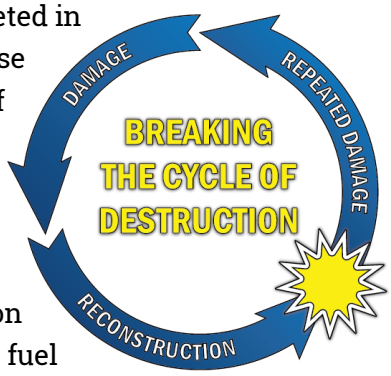
Table 4-46: Residential Buildings and Content within Wildfire Severity Zones (Unincorporated County) 4-141
Table 4-47: Critical Facility Exposure to Wildfire Severity Zones (Unincorporated County) 4-142
Table 4-48: Lifelines in Wildfire Severity Zones (Unincorporated County) 4-143
Table 4-49 Wildfire Problem Statements 4-144
Table 4-50. Drought Classifications and Impacts for California 4-150
Table 4-51 Drought Problem Statements 4-156
Table 4-52: Slope Failure Events in Kern County Since 2000 4-159
Table 4-53: Population Exposure to Landslide Susceptibility 4-163
Table 4-54: Property Value Exposed to Landslides 4-165
Table 4-55: Critical Facility Points with Slope Failure Hazard Risk (Unincorporated County) 4-165
Table 4-56: Critical Facilities (Linear) with Slope Failure Hazard Risk (Unincorporated County) 4-166
Table 4-57 Slope Failure Problem Statements 4-168
Table 4-58 Dust Storm Events 2000-2019 4-172
Table 4-59 Soil Stability Hazard Problem Statements 4-179
Table 5-1: Kern County Planning and Regulatory Mitigation Capabilities 5-7
Table 5-2: Kern County Fiscal Capabilities Summary 5-9
Table 5-3: Kern County Education/ Outreach Capabilities Summary 5-10
Table 5-4: Kern County Administrative and Technical Capabilities 5-11
Table 5-5: Federal and State Funding Opportunities 5-12
Table 5-6: County Wide Mitigation Action Tracker 5-21
Table 7-1 Wildfire Hazard Severity Classification 6
Table 7-2: Data Dictionary 8
Table 7-3 Insured Assets Roll 10

Executive Summary

KERN COUNTY
MULTI-JURISDICTION
HAZARD MITIGATION PLAN

Kern County prepared this Hazard Mitigation Plan to guide County and City Officials, Special District Managers, School District Administrators, and Water and Wastewater District Managers in protecting the people and property within the County from the effects of natural disasters and hazard events. This plan demonstrates Kern County's commitment to reducing risk from natural hazards through mitigation and serves as a tool to direct County resources to achieve optimum results with available administrative, technical, and financial resources.

The term **"hazard mitigation"** refers to actions or strategies that can reduce or eliminate long-term risks caused by natural disasters. Mitigation activities can be developed, planned, and implemented before or after a disaster occurs. After disasters, repairs and reconstruction often are completed in such a way as to simply restore damaged property to pre-disaster conditions. These efforts may return property and infrastructure to "the norm", but the replication of pre-disaster conditions may result in a repetitive cycle of damage and reconstruction. Hazard mitigation planning in Kern County can break this repetitive cycle by reducing vulnerability to hazards through smart construction and proper planning of future development and critical infrastructure. Hazard mitigation activities can be conducted through a wide variety of mitigation strategies, such as construction of regional flood control projects or implementing fuel reduction activities around buildings within high wildfire risk areas.



What is a hazard mitigation plan?

This Hazard Mitigation Plan provides an explanation of prevalent hazards within the County and how hazards may affect the County and participating cities and special districts differently based upon proximities to natural hazards. This plan also identifies risks to vulnerable assets, both people and property. Most importantly, the mitigation strategy presented in this plan responds to the identified vulnerabilities within each community and provides prescriptions or actions to achieve the greatest risk reduction based upon available resources. The County and participating jurisdictions intend to save lives, reduce injuries, reduce property damage, and protect natural resources for future generations through mitigation activities.

Why have a hazard mitigation plan?

The passage of the Disaster Mitigation Act in 2000 (DMA 2000) requires proactive pre-disaster planning as a condition of receiving certain federal financial assistance under the Robert T. Stafford Act. DMA 2000 encourages state and local authorities to work together on pre-disaster planning to assist local governments to accurately assess mitigation needs, resulting in faster allocation of funding and more cost-effective risk reduction projects under FEMA's Hazard Mitigation Assistance program. The purpose of this Multi-jurisdiction Hazard Mitigation Plan (MJHMP) is twofold. First, it provides the County and participating jurisdictions continued access to grant funding from FEMA to conduct hazard mitigation activities for participating jurisdictions. Secondly, it provides resources for residents wishing to conduct

hazard mitigation efforts by identifying areas of extreme risk and providing financial and technical mitigation resources based upon current gaps.

Why is the plan updated so often?

As a DMA 2000 requirement, the plan must be updated every five years to remain in compliance with federal mitigation grant conditions. Federal regulations require hazard mitigation plans to include a plan for monitoring, evaluating, and updating the hazard mitigation plan. An update process provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies over time. Grant compliance is contingent on meeting the plan update requirements that are contained in the Code of Federal Regulations (CFRs). Jurisdictions that allow a plan to expire are not able to pursue funding under the Robert T. Stafford Act.



Participating Jurisdictions

The Kern County MJHMP has multiple participating jurisdictions and geographically covers the entire area within Kern County (hereinafter referred to as the "planning area"). A planning partnership was formed to develop and steer content in this Plan. This partnership consists of Kern County stakeholders and participating jurisdictions who have worked together to create the goals, objectives, mitigation strategies, and implementation methods to reduce risk. Any local government or non-profit agency with the ability to regulate building or infrastructure development or maintenance may participate in the planning process. However, to obtain FEMA approval, each of the local jurisdictions must meet all FEMA planning requirements outlined in federal regulations at 44 CFR § 201.6 *et seq*. A list of jurisdictions that have elected to participate in this MJHMP can be found in Table 2-1.

Plan Development and Update Methods

Hazard mitigation planning is the process through which hazards are identified, likely impacts determined, mitigation goals set, and appropriate mitigation strategies identified. This plan documents the hazard mitigation planning process the County and participating jurisdictions used to increase natural hazard resiliency in the community. Kern County and all participating jurisdictions followed the recommended FEMA four-step process to develop this 2020 updated Plan. This update included a reorganization of planning partners to provide clear delineation of jurisdiction information, development of a new risk assessment, revaluation of goals and objectives, development of new mitigation actions, new enhancements for implementing mitigation actions, updates to all sections of the 2014 plan, and a new website for stakeholder involvement and public information.



Risk Assessment

The risk assessment measures the potential loss of life, personal injury, economic injury, and property or infrastructure damage resulting from natural hazards in order to determine vulnerability. For this update, the risk assessment utilized new data and technologies that have become available since 2014. The County and participating jurisdictions used risk assessment information to rank risks and to gauge the potential impacts of each hazard of concern in the Operational Area. The risk assessment included:

- Hazard identification and profiling,
- Assessment of the impact of hazards on physical, social, and economic assets,
- Identification of particular areas of vulnerability,
- Additional impacts of each hazard due to climate change, and
- Estimates of the cost of potential damage.

The following natural hazard threats were identified and profiled as County priority hazards:

Severe Weather
SECTION 4.5.1



Flood
SECTION 4.5.2



Dam Failure
SECTION 4.5.3



Earthquake
SECTION 0



Wildfire
SECTION 4.5.5



Drought
SECTION 4.5.6



Slope Failure
SECTION 4.5.7



Soil Stability
SECTION 4.5.8



Participating jurisdictions also individually assessed risks applicable to their jurisdiction. Many participating jurisdictions identified fewer than the County-identified hazards. Those jurisdiction-specific profiles are included in Volume 2 of this MJHMP.

Hazard Exposure and Damage Estimation

In Kern County, earthquakes, flooding, slope failure, dam failure, and wildfire have known geographic extents and corresponding spatial information, which make exposure and damage estimation possible. In order to describe vulnerability for each hazard, it is important to understand the total population and total assets at risk. This provides the estimated damage and losses expected during a "worst case scenario" event for each hazard.

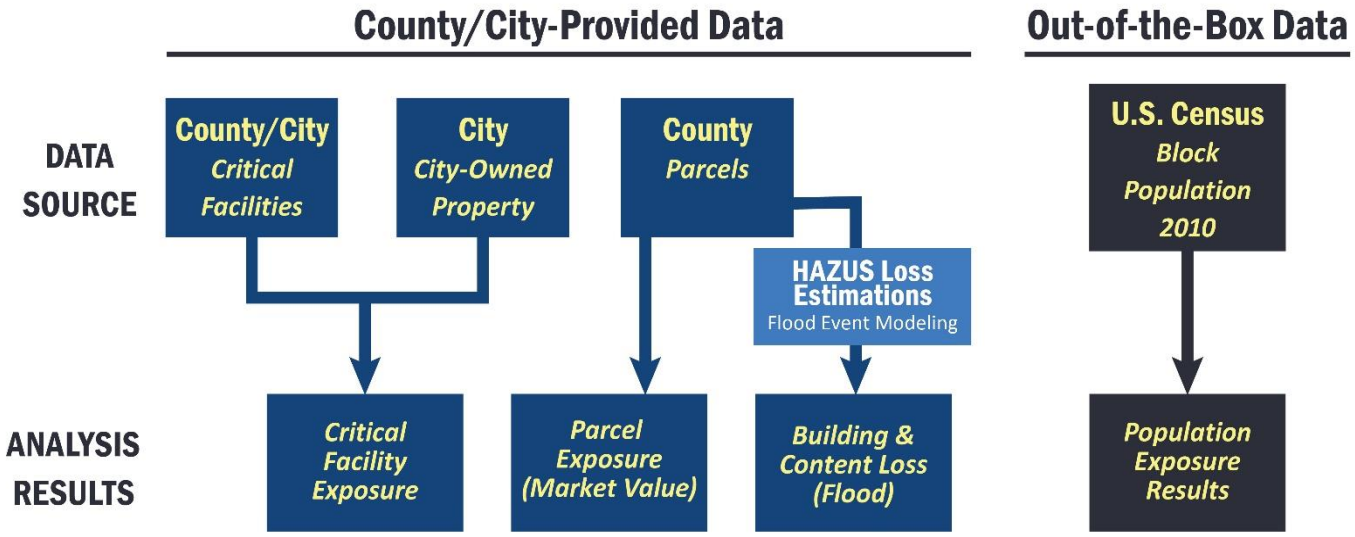


Figure ES 1 Risk Assessment Methodology Summary

Population and Asset Exposure

The total counts of parcels, people, facilities, assets and the sum of values within the planning area which could be exposed to a hazard event is referred to as the "exposure" in this plan. A natural hazards overlay was developed to reflect the combination of many known natural hazard spatial footprints. The spatial overlay method enables summarization of building values, parcel counts, population exposure, and critical facility exposure within a hazard's geographic extents (see Figure ES 2 exposure example). This method has been used to evaluate exposure for earthquakes, landslides, flooding, dam inundation, and wildfire. For a more detailed explanation on Risk Assessment Methods, see Section 4.4 and Appendix A at A 1-2.



Figure ES 2 Exposure explanation graphic

Damage Assessments

FEMA's Hazus software was used to conduct a detailed loss estimation for flood and earthquake. Hazus is a nationally-applicable, standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. For this planning effort, Hazus was used to generate damage estimations due to possible earthquakes and flooding. The estimated damage and losses provided by the Hazus Software is a "worst case scenario" event and provides the ability to understand possible widescale damage to buildings and facilities.

In the hypothetical map in Figure ES 3, even though both structures are exposed to flooding, it is predicted that the structure with a first floor height below the depth of flooding will receive significantly more damage than the structure with a first floor height above the expected water depth. For a more detailed explanation on Risk Assessment Methods, see Section 4.4 and Appendix A at A 1-2.



Figure ES 3 Hazus Damage Estimation Example

Summary of Vulnerable Assets: People, Property Value, and Infrastructure

Hazards with spatial boundaries can be evaluated to demonstrate the amount of population, critical infrastructure, and parcels within each hazard's footprint. At-risk populations, critical infrastructure, improved parcels, and loss results for each hazard category are provided in bar chart summary tables throughout this plan to evaluate the percentage of assets exposed to different types of hazards. The side-by-side comparison allows officials to evaluate the impacts of potential hazards to determine what hazards to direct energy and financial resources for mitigation activities. For detailed vulnerabilities assessment information, see the individual hazard-specific sections presented in Section 4.5. This Executive Summary provides map summaries for the profiled hazards in Figure ES 4 through Figure ES 7.

KERN COUNTY - WILDFIRE VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
23,615 26%

POPULATION
COUNT OF PERSONS
31,356 10%

LEGEND
MODERATE
HIGH
VERY HIGH

PARCEL VALUE
SUM OF IMPROVEMENT
$3,108,015,208 28%
SUM OF CONTENT
$1,554,381,104 28%

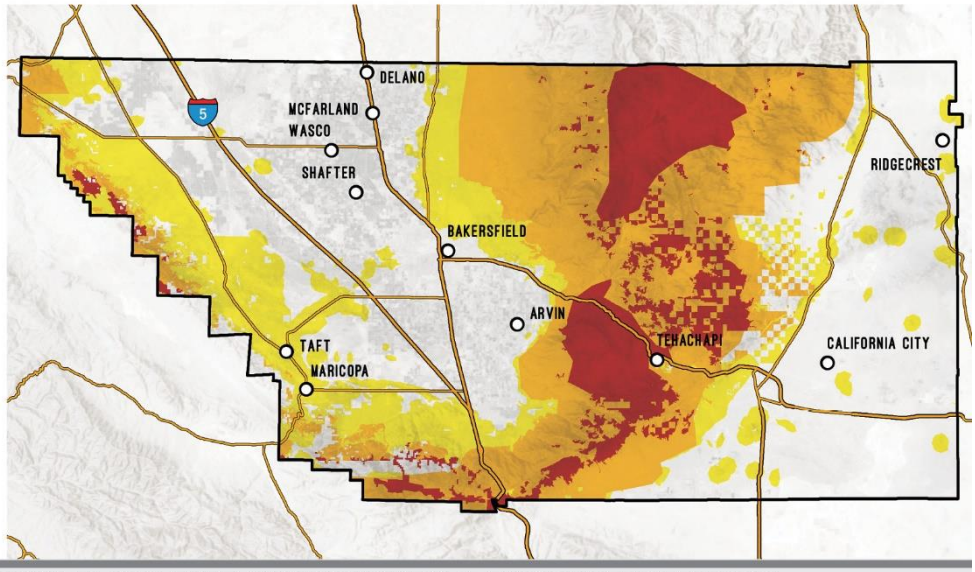
CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	18	37%
High Potential Loss	148	21%
Transportation & Lifeline	1,223	22%

LINEAR MILEAGE

Transportation & Lifeline	3,074	20%

*Exposure summaries include high and very high LRA and SRA zones. Hazard data sources: Cal Fire, CPUC.



KERN COUNTY - FEMA FLOOD ZONE VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
14,968 16%

POPULATION
COUNT OF PERSONS
51,220 17%

LEGEND
100-YR
100-YR FLOODWAY
500-YR
PROTECTED BY LEVEE

PARCEL VALUE
SUM OF IMPROVEMENT
$1,497,380,907 14%
SUM OF CONTENT
$748,831,453 14%

CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	11	22%
High Potential Loss	139	19%
Transportation & Lifeline	1,104	20%

LINEAR MILEAGE

Transportation & Lifeline	2,962	20%

*Exposure summaries include 100-year and 500-year flood zone areas. Hazard data sources: FEMA.

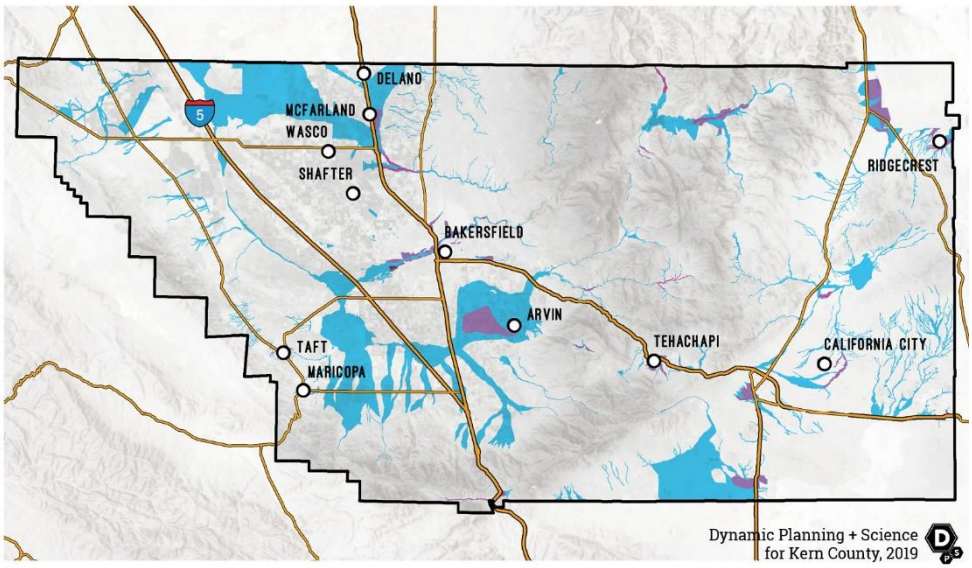


Figure ES 4 Wildfire and Flood Snapshots

KERN COUNTY – DAM INUNDATION VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
24,411 27%

POPULATION
COUNT OF PERSONS
100,612 34%

LEGEND — INUNDATION ZONE

PARCEL VALUE
SUM OF IMPROVEMENT
$3,356,526,800 31%
SUM OF CONTENT
$1,678,343,900 31%

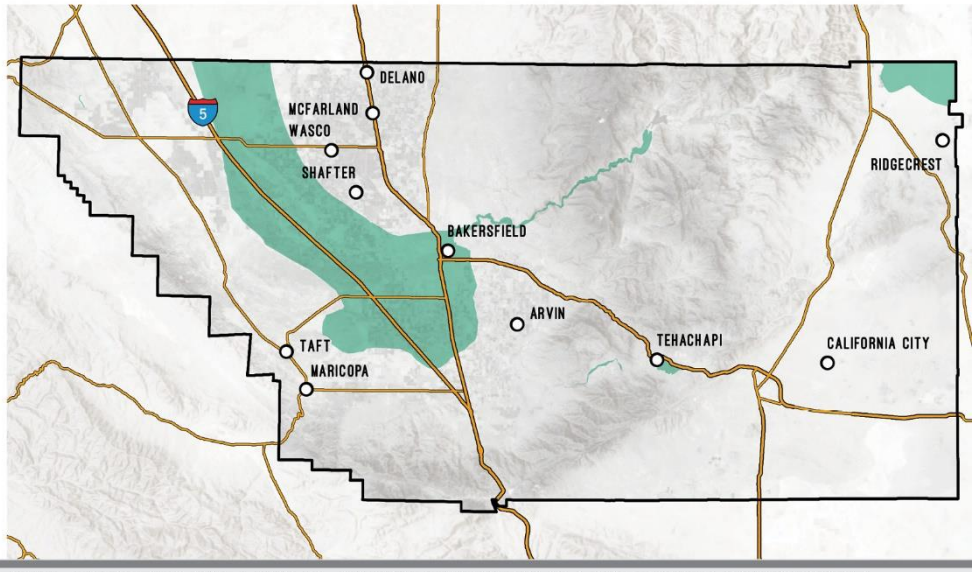
CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	10	20%
High Potential Loss	207	29%
Transportation & Lifeline	1,258	22%

LINEAR MILEAGE

Transportation & Lifeline	2,605	17%

*Exposure summaries include all dam inundation areas. Hazard data sources: Cal OES.



KERN COUNTY – EQ – S. SAN ANDREAS MOJAVE N. VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
77,923 85%

POPULATION
COUNT OF PERSONS
254,106 85%

LEGEND — MMI: III WEAK, IV LIGHT, V MODERATE, VI STRONG, VII VERY STRONG, VIII SEVERE, IX VIOLENT, X EXTREME

PARCEL VALUE
SUM OF IMPROVEMENT
$9,672,907,618 89%
SUM OF CONTENT
$4,837,003,809 89%

CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	34	69%
High Potential Loss	556	77%
Transportation & Lifeline	3,868	68%

LINEAR MILEAGE

Transportation & Lifeline	9,425	62%

*Exposure summaries include strong, very strong, and severe MMI classes. Hazard data sources: USGS.

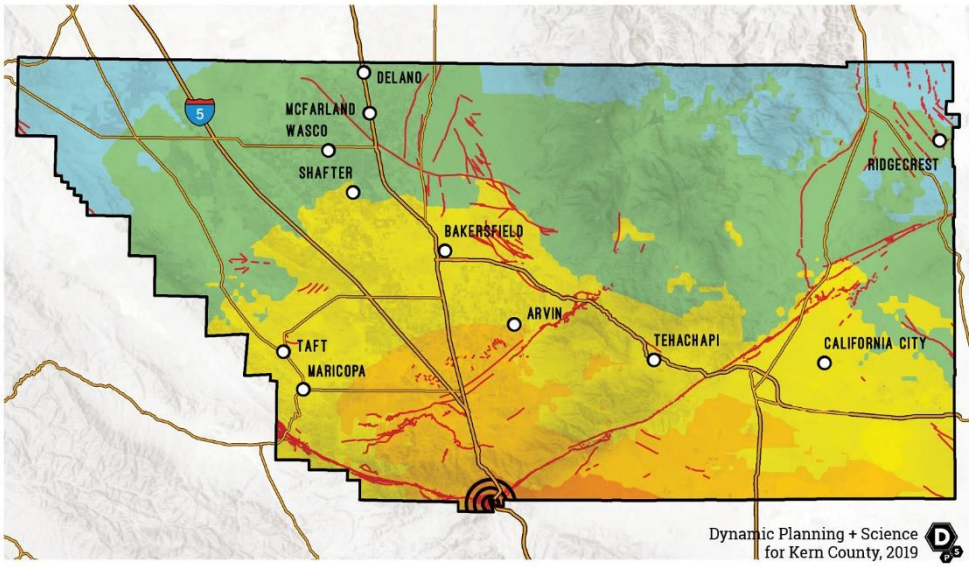


Figure ES 5 Dam Inundation and Earthquake Snapshot

KERN COUNTY - DWR AWARENESS ZONE VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
178 0%

POPULATION
COUNT OF PERSONS
349 0%

LEGEND: AWARENESS ZONE

PARCEL VALUE
SUM OF IMPROVEMENT
$28,464,953 0%
SUM OF CONTENT
$14,233,976 0%

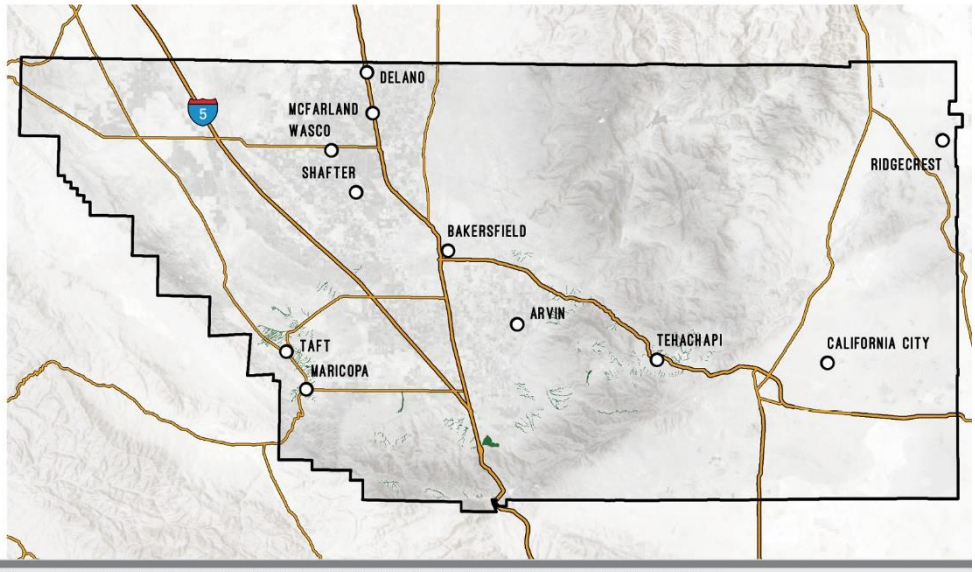
CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	0	0%
High Potential Loss	0	0%
Transportation & Lifeline	8	0%

LINEAR MILEAGE

Transportation & Lifeline	37	0%

*Exposure summaries include all awareness zones. Hazard data sources: DWR.



KERN COUNTY - LANDSLIDE VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
1,942 2%

POPULATION
COUNT OF PERSONS
5,769 2%

LEGEND: HIGH LANDSLIDE RISK

PARCEL VALUE
SUM OF IMPROVEMENT
$276,015,865 3%
SUM OF CONTENT
$138,039,432 3%

CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	0	0%
High Potential Loss	4	1%
Transportation & Lifeline	342	6%

LINEAR MILEAGE

Transportation & Lifeline	331	2%

*Exposure summaries include high susceptibility only (class 9+). Hazard data sources: CGS.

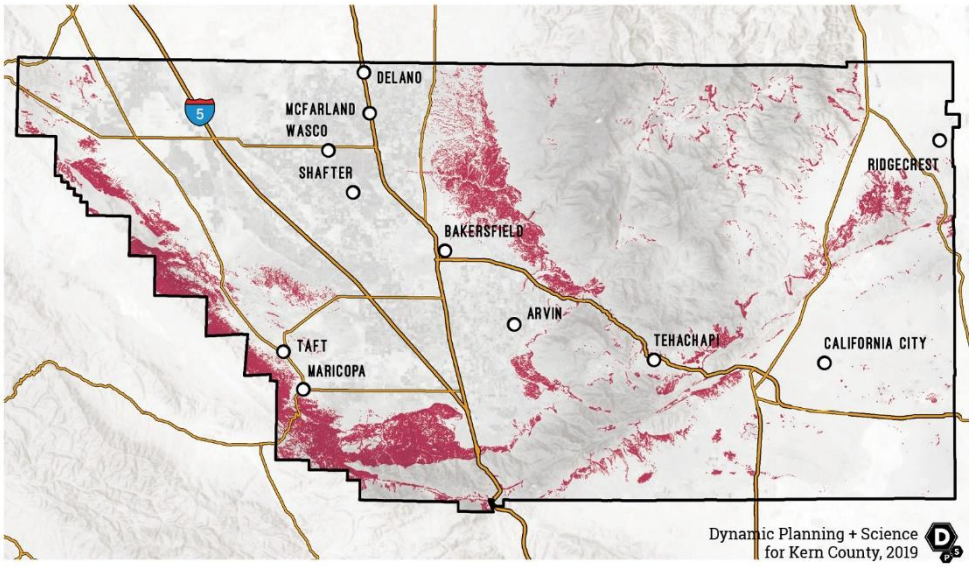


Figure ES 6 Awareness Zone and Landslide Snapshot

KERN COUNTY - SUBSIDENCE VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
76,994 84%

POPULATION
COUNT OF PERSONS
265,101 88%

LEGEND
LOW LIFT
LOW SUBSIDENCE
MEDIUM SUBSIDENCE
HIGH SUBSIDENCE
EARTH MOVEMENT

PARCEL VALUE
SUM OF IMPROVEMENT
$8,989,026,902 82%
SUM OF CONTENT
$4,495,077,951 82%

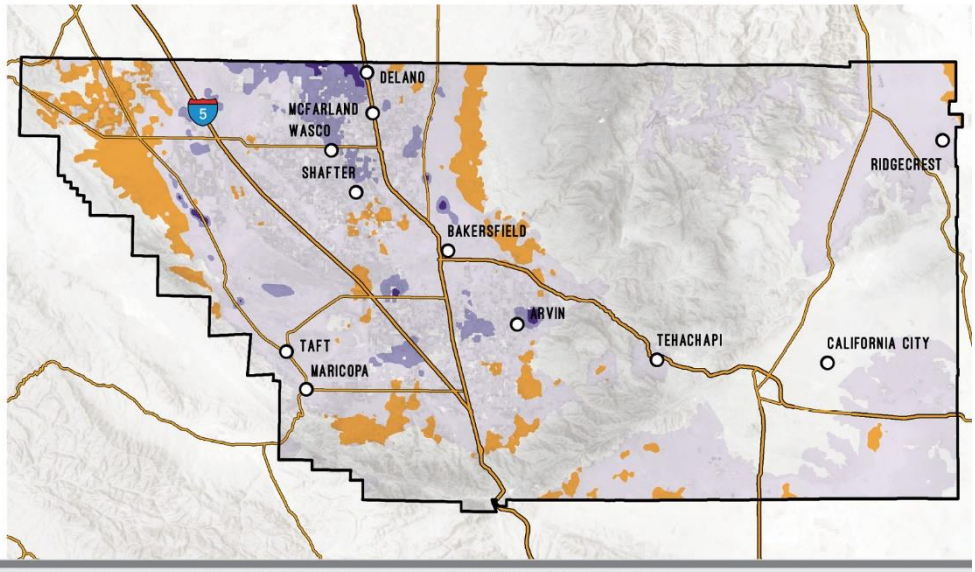
CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	35	71%
High Potential Loss	632	88%
Transportation & Lifeline	4,133	73%

LINEAR MILEAGE

Transportation & Lifeline	10,707	71%

*Exposure summaries include all classes of earth movement. Hazard data sources: DWR.



KERN COUNTY - EQ2 VULNERABILITY & EXPOSURE SNAPSHOT

PARCEL COUNT
COUNT
86,520 95%

POPULATION
COUNT OF PERSONS
264,002 88%

LEGEND
III IV V VI VII VIII IX X
WEAK LIGHT MODERATE STRONG VERY STRONG SEVERE VIOLENT EXTREME
MMI

PARCEL VALUE
SUM OF IMPROVEMENT
$10,405,778,755 95%
SUM OF CONTENT
$5,203,625,878 95%

CRITICAL INFRASTRUCTURE
POINT COUNT

Essential Facilities	41	84%
High Potential Loss	649	90%
Transportation & Lifeline	4,480	79%

LINEAR MILEAGE

Transportation & Lifeline	10,834	72%

*Exposure summaries include strong, very strong, and severe MMI classes. Hazard data sources: USGS.

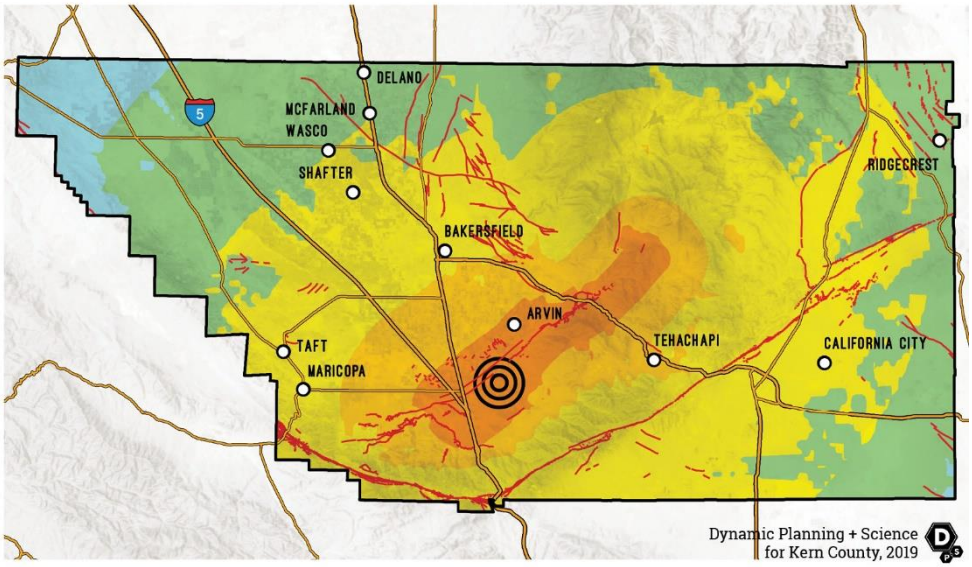


Figure ES 7 Subsidence and Earthquake Snapshot

Mitigation Goals

The Steering Committee reviewed and updated the goals from the 2014 Kern County Hazard Mitigation Plan and confirmed a set of objectives. The following guiding principles aided the Steering Committee and planning partners in selecting actions contained in this plan Update:

Goal 1: Enable residents to mitigate the impacts of hazards and disasters.

Goal 2: Reduce hazard impacts to existing and future development and the natural environment.

Goal 3: Reduce hazard impacts to existing and future critical facilities, infrastructure, and high potential loss facilities.

Goal 4: Improve multi-jurisdiction coordination to reduce risk through mitigation planning and hazard analysis on a continual basis.

Mitigation Strategy

The mitigation strategies and activities designed to reduce or eliminate losses resulting from natural hazards are the centerpiece of the mitigation planning process. Through the mitigation actions, participating jurisdictions will become more resilient to disasters. Actions identified in this plan may or may not be geared toward grant funding under HMA. Rather, the focus was the initiatives' effectiveness in achieving the goals of the plan within each jurisdiction's capabilities.

Participating jurisdictions individually selected a range of appropriate mitigation actions to work toward achieving the MJHMP's goals, compiled in Volume 2 and the jurisdiction Annex HMPs. In addition, the Steering Committee and participating jurisdictions identified countywide actions benefiting the whole partnership, as listed in Volume 1. These initiatives also are summarized in the following tables.

County Wide Priority Mitigation Actions

Mitigation No.	Hazard Type	Year	Title/Description
ma-AH-KC-201	All Hazard	2005	Hazard Public Education
ma-AH-KC-104	All Hazard	2005	Remote Automated Weather Station System
ma-DF-KC-384	Dam Failure	2020	Design and implement County-wide warning system program, with all other HMP participating jurisdictions as secondary participants, to warn everyone within a dam inundation zone of impending dam failure
ma-DR-KC-290	Drought	2020	Develop a public education campaign to encourage water conservation during drought.
ma-DR-KC-291	Drought	2020	Install remote monitoring devices on well flow meters on County owned wells
ma-DR-KC-293	Drought	2020	Amend land use codes to incorporate regulations that encourage and incentive water savings for development
ma-DR-KC-294	Drought	2020	Replace existing turf grass and water intensive landscaping with drought resistant landscaping
ma-DR-KC-384	Drought	2020	Expand Willow Springs Water Bank to reduce drought and increase water supply flexibility and sustainability
ma-EQ-KC-297	Earthquake	2020	Encourage privately owned critical facilities (e.g. churches, hotels, other gathering facilities) to evaluate the ability of the buildings to withstand earthquakes and to address any deficiencies identified.
ma-AH-KC-111	Earthquake	2005	Mobile Home Foundation Earthquake Retrofitting
ma-EQ-KC-102	Earthquake	2005	Formation of Kern County Unreinforced Masonry Task Force
ma-EQ-KC-305	Earthquake	2020	Participate in seismic studies and needed seismic retrofits on County bridges that are located in high risk areas for earthquake scenarios included in this HMP
ma-EQ-KC-306	Earthquake	2020	Evaluate soil liquefaction potential around County assets in areas with shallow groundwater
ma-EQ-KC-307	Earthquake	2020	Install seismic gas shut-off valves on County buildings to prevent the flow of gas into buildings during a seismic event
ma-EQ-KC-295	Earthquake	2020	Retrofit / Harden County-owned critical facilities and buildings and their ability to withstand earthquakes.
ma-EQ-KC-296	Earthquake	2020	Retrofit non-compliant suspended ceilings in County buildings. This includes Non-Structural Suspended Gypsum Dry-Wall & Cement Plaster Ceilings built 1950-1974.
ma-EW-KC-301	Extreme Weather	2020	Outreach and Education to developers before and during the development process about best management practices to mitigate the effects of the urban heat island effect and stormwater runoff resulting from increased impervious surface

Mitigation No.	Hazard Type	Year	Title/Description
ma-EW-KC-435	Extreme Weather	2020	Develop outreach to educate the public, via County communication channels, on preparedness for driving in winter weather including preparing your vehicle, driving techniques, and what to do if caught in a winter weather event while driving.
ma-FL-KC-202	Flood	2005	Kern Lake CRMP Master Plan Mitigation Projects
ma-FL-KC-283	Flood	2020	Adopt higher regulatory standards (including but not limited to freeboard, comp storage, lower substantial damage thresholds, setback and fill restrictions) as means to reduce future flood risk and support a no-adverse-impact (NAI) philosophy to floodplain management
ma-FL-KC-284	Flood	2020	Routinely inspect storm water channels for vegetation build up or encroachment, trash and debris, silt and gravel build up, and erosion or bank failure
ma-FL-KC-285	Flood	2020	Elevate and retrofit bridges and culverts to allow proper stormwater / 100-YR flows
ma-AH-KC-153	Flood	2005	Caliente Creek Habitat Mitigation Project
ma-AH-KC-158	Flood	2005	Cuddy Creek Restoration Project
ma-FL-KC-110	Flood	2005	Flood Mitigation Plan
ma-FL-KC-99	Flood	2014	Streambed Mitigation in Kern River South Fork at Sierra Hwy (north of SR 178)
ma-FL-KC-70	Flood	2014	Continue to Implement Sound Floodplain Management Practices through Participation in the National Flood Insurance Program
ma-FL-KC-97	Flood	2014	Lake Isabella Blvd Box Culvert at Erskine Creek (near Elizabeth Norris Rd)
ma-FL-KC-82	Flood	2014	Bridge on Famoso Road at Poso Creek (approx 1/3 mile east of State Hwy 99)
ma-FL-KC-98	Flood	2014	Construct a Box Culvert across Redrock Randsburg Road at Redrock Canyon Wash (just east of Hwy 14)
ma-FL-KC-302	Flood	2020	Kern Storm Water Resource Plan Mitigation Projects
ma-FL-KC-303	Flood	2020	Kern County Flood Hazard Mitigation Plan - Projects
ma-FL-KC-304	Flood	2020	County of Kern Caliente Creek - Conceptual Plan for Mitigation
ma-SF-KC-292	Slope Failure	2020	Establish a priority list of slope failure locations and implement slope stabilization projects in the highest risk areas.
ma-AH-KC-245	Soil Stability	2005	Lebec Landfill and Transfer Station Drainage Improvements and Erosion Control
ma-AH-KC-63	Soil Stability	2014	Kern Valley Landfill and Transfer Station Drainage Improvements and Erosion Control
ma-SS-KC-299	Soil Stability	2020	Implement wind breaks to prevent wind erosion leading to buildup of soil on County roads and bridges. Wind break erosion mitigation examples include solid fences, porous fences, straw bales, soil surface modification, berms, and landscaping
ma-SS-KC-300	Soil Stability	2020	Conduct subsidence investigations on County bridges located in high subsidence areas

Mitigation No.	Hazard Type	Year	Title/Description
ma-SH-KC-298	Soil Stability	2020	Outreach and educational programming to property owners and agricultural growers about wind erosion and mitigation techniques such as introducing cover crops, eliminating tillage, and avoiding over grazing
ma-AH-KC-179	Wildfire	2005	Hazard Tree Removal, County Park Lands
ma-WF-KC-231	Wildfire	2005	Roadside Disc Breaks
ma-WF-KC-183	Wildfire	2005	Defensible Space, Public Education
ma-WF-KC-184	Wildfire	2005	Education, Fire Department Personnel
ma-WF-KC-180	Wildfire	2005	Greater Tehachapi Area Community Wildfire Protection Plan (was Hazardous Wildland Fuels Mitigation, Greater Tehachapi Area)
ma-WF-KC-181	Wildfire	2005	Mount Pinos Community Wildfire Protection Plan (was Hazardous Wildland Fuels Mitigation, Frazier Mtn Area)
ma-WF-KC-182	Wildfire	2005	Kern River Valley Community Wildfire Protection Plan (formerly Hazardous Wildland Fuels Mitigation, Kern River Valley)
ma-WF-KC-286	Wildfire	2020	Retrofit care facilities (adult care, child care, schools) with fire-resistant materials and or create defensible space around structures.
ma-WF-KC-287	Wildfire	2020	The Alta Sierra CWPP details mitigation needed to protect 7 structure protection groups throughout the WUI in Alta Sierra Community.
ma-WF-KC-288	Wildfire	2020	Myers Canyon CWPP Mitigation Projects
ma-WF-KC-289	Wildfire	2020	Make high visibility address markers available to all residents within the WUI

Mitigation Action Implementation

Despite County efforts, no amount of planning or mitigation can prevent disasters from occurring or eliminate the risk and impacts of such events. Hazard events will continue to occur, and the County and participating jurisdictions will take actions to reduce the risks these hazards pose to life, property, and the economy. While this MJHMP identifies opportunities for reasonable mitigation actions, each individual has a responsibility to be aware of the potential hazards where they live and to minimize their own household's vulnerability.

The County's ability to carry out mitigation is limited to those facilities over which it has authority. The County does not have direct authority over schools, water and sanitation districts, private gas, electric and communication utilities, state and federal highways and facilities, private hospitals, or neighboring cities and tribes. The County will focus on actions within its authority to do while seeking to cooperatively work with other entities to address mutual areas of vulnerability and interdependence.

Full implementation of the Plan's recommendations will take time and resources. The measure of the Plan's success will be the coordination and pooling of resources within the participating jurisdictions and maintaining these successes over time. Teaming together to seek financial assistance at the state and federal level will be a priority to initiate projects that are dependent on alternative funding sources. This plan was built upon the effective leadership of a multi-disciplined steering committee and a process that relied heavily on public input and support. The plan will succeed for the same reasons.

Adoption Records (To be included)

To comply with DMA 2000, the County Board of Supervisors officially adopt this Kern County Multi-Jurisdiction Hazard Mitigation Plan Volume 1 and Volume 2 upon plan approval from Cal OES and FEMA. The adoption of the MJHMP in its entirety recognizes the County's commitment to reducing the impacts of natural hazards within the Cities and County. See below record of Adoption.

FEMA Approval 4/9/2021

Volume 1

KERN COUNTY
MULTI-JURISDICTION
HAZARD MITIGATION PLAN

FEMA Approval 4/9/2021

Section 1. Introduction

1.1 Purpose

Kern County and many other participating jurisdictions prepared this Multi-Jurisdiction Hazard Mitigation Plan (MJHMP), originally approved by the Federal Emergency Management Agency (FEMA) in 2006. The plan in its current form reflects a comprehensive update in 2019-2020. The purpose of this plan is to guide hazard mitigation planning to better protect the people and property of the County from the effects of hazard events. This plan demonstrates the commitment of each participating jurisdiction to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed to ensure Kern County and participating jurisdictions' continued eligibility for certain federal disaster assistance, specifically the FEMA Hazard Mitigation Assistance (HMA) grants, including the Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC), and Flood Mitigation Assistance Program (FMA). The plan is also important for maintaining and improving the standing of the County in the National Flood Insurance Program's Community Rating System (CRS) which provides for lower flood insurance premiums to the residents in the unincorporated areas.

The **Master Goal/Mission Statement of the Kern County Multi-Jurisdiction Hazard Mitigation Plan** is "to develop sustainable communities to preserve life, protect property, the environment, and the economy from natural hazards."

1.2 Background and Scope

Each year in the United States, natural disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters, because additional expenses incurred by insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many natural disasters are predictable, and much of the damage caused by these events can be reduced or even eliminated. Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event." The results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities demonstrates that mitigation activities are highly cost-effective. On average, each dollar spent on mitigation saves society an average of $6 in avoided future losses in addition to saving lives and preventing injuries. (National Institute of Building Sciences, 2017)

1.3 Participating Jurisdictions

The Kern County Hazard Mitigation Plan is a multi-jurisdiction plan that geographically covers the entire area within Kern County's jurisdictional boundaries (hereinafter referred to as the "planning area"). A planning partnership was formed to develop and steer content in this plan. This partnership consists of Kern County and local government planning partners who worked together to create the goals, objectives, mitigation strategies, and implementation methods to reduce natural hazard risk within the planning area. Any jurisdiction or organization may participate in the planning process. However, to obtain Federal Emergency Management Agency (FEMA) approval, each local jurisdiction must meet all requirements of hazard mitigation planning outlined in 44 C.F.R. § 201.6. Participating jurisdictions are listed in Table 2-1, and municipal participating jurisdictions are shown in Figure 1-1 along with Kern County boundaries.

1.4 Why Update This Plan?

Hazard mitigation is a way to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster through long and short-term strategies. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners, business and industry, and local, state and federal government.

The Federal Disaster Mitigation Act of 2000 (DMA 2000) required state and local governments to develop hazard mitigation plans as a condition of federal disaster grant assistance. (Pub. L. No. 106-390; 42 U.S.C. § 5121 *et seq.*) Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. DMA 2000 increased the emphasis on planning for disasters before they occur.

DMA 2000 encourages state and local authorities to work together on pre-disaster planning and promotes sustainability. Sustainable hazard mitigation includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the broadest possible social and economic context. The enhanced planning network called for by DMA 2000 helps local governments articulate accurate mitigation needs, resulting in faster allocation of funding and more cost-effective risk reduction projects.

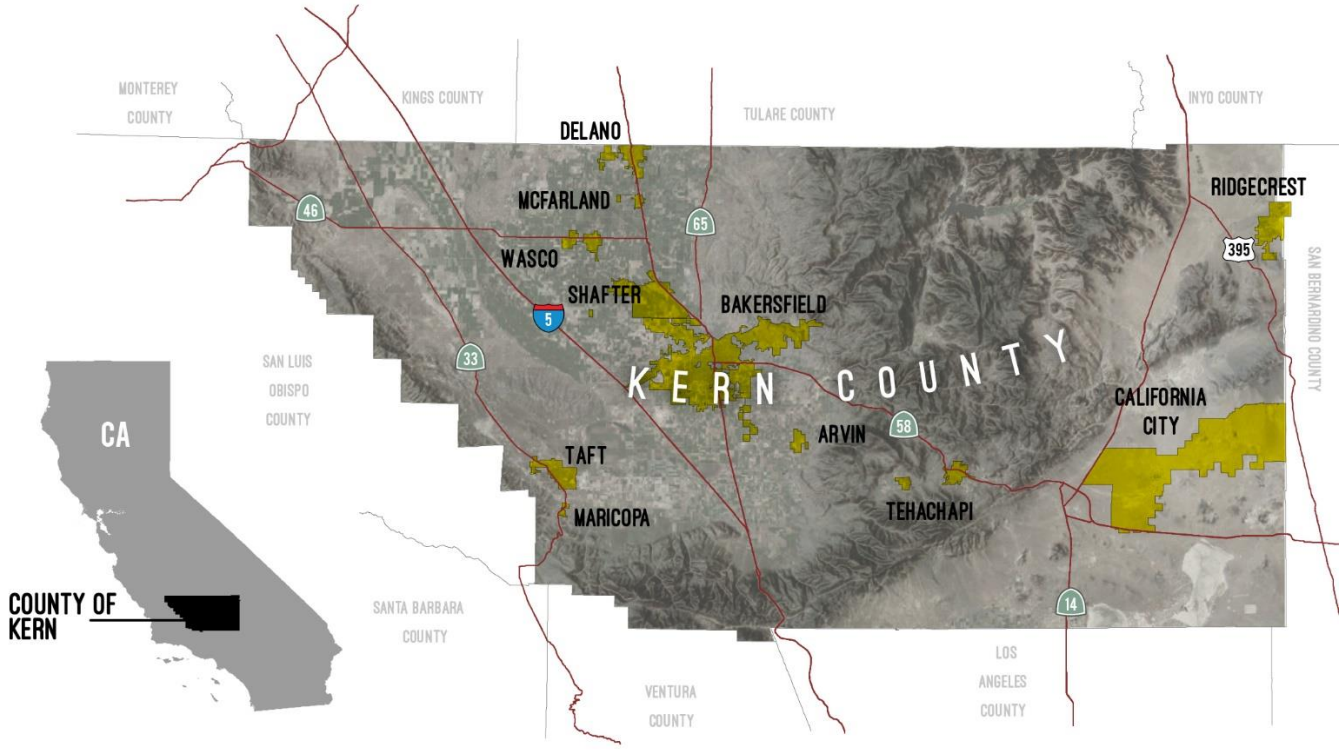


Figure 1-1: Municipal and County Participating Jurisdiction Map

1.4.1 Purposes for Planning

This Hazard Mitigation Plan identifies resources, information, and strategies for reducing risk from natural hazards. Kern County and the local jurisdictions that participated as planning partners (collectively "the planning partners") initiated this planning effort in part because:

- the Kern County area has significant exposure to numerous natural hazards that have caused millions of dollars in past damage;
- the planning partners want to be proactive in preparing for the probable impacts of natural hazards; and
- limited local resources make it difficult to implement proactive risk-reduction measures. Federal and State financial assistance is paramount to successful hazard mitigation in the area.

Elements and strategies in the plan were selected because they best meet the needs of the planning partners and their citizens. The plan was developed to meet the following objectives:

- Meet or exceed requirements of the DMA 2000 and the 2015 California legislation requiring the incorporation of climate adaptation strategies into hazard mitigation planning (SB 379).
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.

- Create a risk assessment that focuses on Kern County hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the County and puts all partners on the same planning cycle for future updates.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.

1.5 Who Will Benefit from This Plan?

One benefit of multi-jurisdiction planning is the ability to pool resources and eliminate redundant activities within a planning area with fairly uniform risk exposure and vulnerabilities. FEMA encourages multi-jurisdiction planning under its guidance for the DMA 2000. The plan will help guide and coordinate mitigation activities throughout Kern County.

All citizens and businesses of Kern County are the ultimate beneficiaries of this MJHMP. The plan reduces risk for those who live in, work in, and visit the County. It provides a viable planning framework for all foreseeable natural hazards that may impact the County. County stakeholder participation helped ensure that plan outcomes will be mutually beneficial. The resources and background information in the plan are applicable countywide, and the Plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.6 How to Use This Plan

This plan has been set up in two volumes to separate jurisdiction-specific elements (Volume 2) from those that apply to the whole planning area (Volume 1):

- **Volume 1**—Volume 1 includes all federally-required elements of a hazard mitigation plan that apply to the entire planning area. This includes the description of the planning process, public involvement strategy, goals and objectives, countywide hazard risk assessment, countywide mitigation initiatives, and a plan maintenance strategy. Vol. 1 includes the following appendices:
  - Appendix A—Annex Methodology
  - Appendix B—Planning Process Documentation
- **Volume 2**—Volume 2 includes a crosswalk that directs readers to all federally-required, jurisdiction-specific elements for each participating jurisdiction, which are in turn available as standalone Annex HMPs. Vol. 2 describes the categorization of jurisdictions into municipalities, special districts, school districts, and water and wastewater districts. All planning partners have adopted Volume 1 in its entirety and each partner's jurisdiction-specific Annex HMP.

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Section 2. What's New

This section of the plan includes background information on the 2014 MJHMP and this MJHMP Update. The 2014 Mitigation Actions were reviewed and have been changed, updated, and revised to reflect new priorities in this MJHMP. Only the information and data still valid from the 2014 Plan was carried forward as applicable into this MJHMP update. The sections below describe the planning process for this update.

2.1 Participating Jurisdictions in the 2014 HMP vs MJHMP Update

In September of 2014, the County met all approval requirements from the DMA and officially adopted an update to the 2006 HMP. Eligibility status of the planning partnership was monitored by the Kern County Point of Contact (POC) over the five-year update process. A partner was deemed to be meeting participation requirements based on:

- Progress reports being submitted annually by the specified time frames,
- Partners notifying the POC of changes in designated points of contact,
- Partners supporting the Steering Committee by attending designated meetings or responding to needs identified by the Committee, and
- Partners continuing to be supportive as specified in the planning partner expectations package provided to them at the beginning of the process.

Table 2-1 tracks 2014 and 2020 Participating Jurisdictions.

Table 2-1: Participating Jurisdiction Tracker

Jurisdiction Name	2014 Participating Jurisdiction	2020 Participating Jurisdiction
Airport Districts		
Indian Wells Valley Airport District	Y	N
Mojave Air and Space Port	Y	Y
Community Service Districts		
Arvin CSD	Y	Y
Bear Valley CSD	Y	Y
East Niles CSD	Y	Y
Golden Hills CSD	Y	Y
Rosamond CSD	Y	Y
Stallion Springs CSD	Y	Y
Mosquito Abatement Districts		
South Fork Mosquito Abatement District	Y	N

Jurisdiction Name	2014 Participating Jurisdiction	2020 Participating Jurisdiction
Municipalities		
City of Arvin	Y	Y
City of Bakersfield	Y	Y
City of California City	Y	Y
City of Delano	Y	Y
City of Maricopa	Y	Y
City of McFarland	Y	N**
City of Ridgecrest	Y	Y
City of Shafter	Y	Y
City of Taft	Y	Y
City of Tehachapi	Y	Y
City of Wasco	Y	Y
Recreation and Park Districts		
Buttonwillow RPD	Y	N*
North of River RPD	Y	Y
Shafter RPD	Y	Y
Tehachapi Valley RPD	Y	Y
Wasco RPD	Y	N
West Side RPD	Y	N*
School Districts		
Bakersfield City School District	Y	Y
Buttonwillow Union School District	Y	Y
Delano Joint Union High School District	Y	N*
Edison Elementary School District	Y	N*
Elk Hills School District	Y	N*
Fairfax School District	Y	N*
Kern Community College District	Y	Y
Kern High School District	Y	Y
Kernville Union School District	Y	N*
Lost Hills Union School District	Y	Y
Mojave Unified School District	Y	Y
Panama-Buena Vista School District	Y	N
Pond Union School District	Y	N*
Richland School District	Y	Y
Sierra Sands Unified School District	Y	Y
Taft City School District	Y	Y

Jurisdiction Name	2014 Participating Jurisdiction	2020 Participating Jurisdiction
Tehachapi Unified School District	Y	Y
Vineland School District	Y	N*
Sanitation Districts		
Ford City-Taft Heights Sanitation District	Y	Y
Kern Sanitation Authority	Y	Y
North of the River Sanitary District	Y	Y
Water Districts		
Arvin-Edison Water Storage District	Y	Y
Berrenda Mesa Water District	Y	Y
Buena Vista Water Storage District	Y	N
Buttonwillow County Water District	Y	Y
Cawelo Water District	Y	Y
Greenfield County Water District	Y	Y
Kern County Water Agency	Y	Y
Kern Delta Water District	Y	Y
Kern-Tulare Water District	Y	Y
Lost Hills Water District	Y	Y
North of the River Municipal Water District	Y	Y
Semitropic Water Storage District	Y	Y
Tehachapi-Cummings County Water District	Y	Y
West Kern Water District	Y	Y
Wheeler Ridge-Maricopa Water Storage District	Y	Y

** Indicates a jurisdiction that did not participate in the HMP formulation process, although never formally withdrew participation.*
*** The City of McFarland has its own active Hazard Mitigation Plan that explores vulnerabilities and mitigation separate from this MJHMP.*

2.2 Mitigation Actions

During this MJHMP update process, each of the 2014 County-wide mitigation actions were examined for relevancy and the potential for future implementation and then evaluated for potential follow-up. Some mitigation actions developed during the 2014 HMP effort are an inherent part of the HMP update process or were not detailed enough for implementation at a local jurisdiction level, and thus were not included in this update. The County has made significant changes to other 2014 Mitigation Actions because of the updated risk assessment and implementation strategy, to include more detail, or to update based on current mitigation practices.

Fema Approval 4/9/2021

Table 2-2 provides a record of cancelled County-wide Mitigation Actions and an explanation for why the mitigation action was cancelled. Ongoing or pending mitigations actions from previous HMPs are included within the Mitigation Action Plan in Table 5-6. Completed previous Mitigation Actions for the County are detailed in Table 2-3.

Table 2-2. Cancelled Mitigation Actions from 2014

Mitigation No.	Hazard Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Reason Cancelled
ma-AH-KC-64	All Hazard	Cancelled	2014	County of Kern	Mosquito Vector Control in Kern County for Communities without Mosquito Control Districts	Kern County Department of Public Health	Some progress has been made over the years; marked as deleted in 2014.
ma-FL-KC-62	Flood	Cancelled	2014	County of Kern	Bridge on Redrock Randsburg Road at Redrock Canyon Wash	Kern County Roads Department	This project has been replaced with an alternative project to construct a box culvert.

2.3 New Analysis and Risk Assessment Methodology

The County strengthened this plan by using new research methods and information systems. Geographic Information Systems (GIS) mapping provided the County with the tools to develop more comprehensive data sets than those in the 2014 MJHMP.

This MJHMP focuses on natural hazards. New MJHMP mitigation actions focus on four different classifications, including:

- Local Plans and Regulations – intended to reduce the County's vulnerability to future hazard events through the implementation of codes and regulations.
- Structure and Infrastructure Projects – intended to protect existing structures by retrofitting, relocating, or modifying the structure to withstand a hazard event.
- Natural Systems – to reduce the effects of hazards on the natural resources within a region by preserving and/or restoring natural areas along with their mitigation functions.
- Public Information and Awareness – to advise residents, potential buyers, and visitors about hazards, potentially hazardous areas, and mitigation techniques.

2.4 Successful Mitigation Activities

The 2014 Kern County HMP guiding principles, goals, objectives, and mitigation actions have been implemented through various on-going projects, plans and programs. With respect to the mitigation actions and strategies developed in 2014, Kern County has made improvements toward reducing natural hazard risks to life and property within the County. Significant risk reduction efforts have been made for floodplain management, flood damage prevention, and fire hazard abatement. Table 2-3 summarizes the completed mitigation actions since 2014. These and many other successful policies, programs, and projects are summarized below.

Table 2-3. Completed Mitigation Actions Since 2014 MJHMP

Mitigation No.	Hazard Type	Status	Year	Primary Agency	Title/Description	Responsible Party
ma-AH-KC-39	Soil Stability	Completed	2014	County of Kern	Bena Landfill Drainage Improvements and Erosion Control	County of Kern Waste Management Department
ma-FL-KC-100	Flood	Completed	2014	County of Kern	Replace Tehachapi Blvd Bridge at Cache Creek with Reinforced Concrete Box Culvert	Kern County Roads Department
ma-FL-KC-69	Flood	Completed	2014	County of Kern	Bena Road Bridge Replacements at Caliente Creek and Walker Basin Creek	Kern County Roads Department
ma-FL-KC-94	Flood	Completed	2014	County of Kern	Emergency Bridge on Pasadena Lane (across Borel Canal)	Kern County Roads Department
ma-FL-KC-95	Flood	Completed	2014	County of Kern	Cuddy Creek Streambed Restoration at Frazier Mtn Park Rd Bridge	Kern County Roads Department
ma-WF-KC-3	Wildfire	Completed	2014	County of Kern	Fire Safe Council Development	Kern County FD
ma-HM-KC-109	Hazmat	Completed	2005	County of Kern	Pesticide Accident Response Gap Alleviation	Kern County Office of Emergency Services

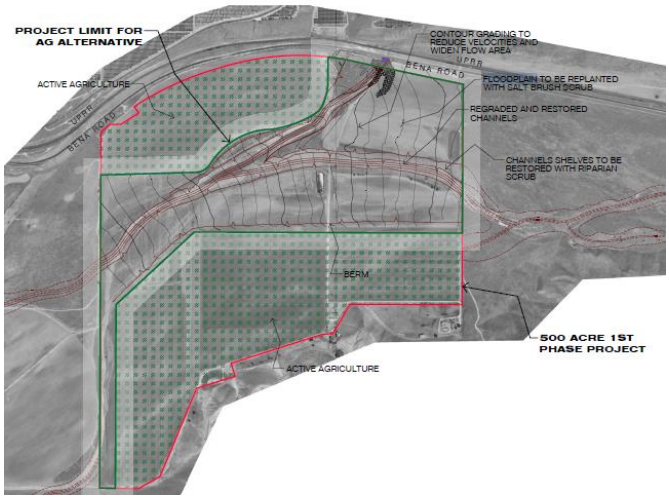

Figure 2-1: Caliente Creek Feasibility Study Area

Photo: AECOM (Patch, May 2019)

Caliente Creek Flood Mitigation Study

Kern County Public Works published the Caliente Creek Habitat Mitigation and Groundwater Recharge Feasibility Study (Feasibility Study) in June 2017, and a counterpart, the Caliente Creek Conceptual Plan in May 2019, as initial steps in flood mitigation for Caliente Creek. The Feasibility Study includes two alternative scenarios for floodplain management. In the first scenario, 267 acres would remain in farming production while the remaining 233 acres would be restored to native vegetation. In the second scenario the entire 500-acre floodplain would be restored to native vegetation with no farming. The Caliente Creek Conceptual Plan includes permitting requirements and estimated costs for each alternative scenario.

Backup Emergency Generators Installed in the City of Bakersfield

The City of Bakersfield received funding from FEMA's Hazard Mitigation Grant Program (HMGP) to purchase and install emergency backup generators at Beach Park Storm Lift Station and Pistol Range Storm Lift Station. During rain events, storm runoff drains to the two pump stations, where it is pumped over levees into the river channel. Installing two new backup generators will aid in ensuring that the lift stations remain functional during any storms which might impair access to power, vital to flood protection for the City. The City utilized (HMGP) funds for 75% of the associated costs, matched by local funding.

Removal of Wildfire Prone Dead and Dying Trees throughout Kern County

The combined effects of drought and insect infestation have caused massive tree die-offs both regionally and in Kern County in recent years. Approximately 150 million trees have died from the California drought, which began in 2011. (Smithsonian Magazine, 2019) These trees pose a fire hazard to public facilities owned and operated by the County. The Kern County Fire Department conducted a series of tree removal projects during 2019. Two projects on Sawmill Road and Poso Creek involved the selection and removal of 2,223 dead or dying trees to reduce wildfire hazard in those areas. The County also completed removal projects for Tehachapi Mountain Park, Rancheria Road, Breckenridge Road, the Piute Mountains, Icehouse Road, and Old State Road.

The County has also taken administrative steps to mitigate the fire risk of tree die-offs. The County established a Kern County Tree Mortality Task Force which was assembled in order to create a response plan for removing dead and dying hazard trees in addition to serving as a forum for information sharing between local, state, federal, private, and non-profit agencies. One of the principal goals of the Task Force is to collaborate with local, private, and public partners to identify and remove these trees. The Task Force meets on a monthly basis. It has so far been associated with a number of ongoing efforts to remove fire prone trees around Kern County. These include securing state responsibility area fire prevention fund grants, and working with Cal Trans, private landowners, and utility companies to remove trees. (Kern County Fire Department, n.d.)



Figure 2-2: U.S. Forest Service Worker Removing Branches from Dead Tree

Photo: U.S. Forest Service (Patch, April 2016)

Kern County Fire Department's Maintenance of Fire Roads and Fuel Breaks

Kern County Fire Department Road Crews have maintained more than 1,000 miles of fire roads and fuel breaks between 2019 and 2020. Maintaining routes for firefighting is an indispensable mitigation measure to prepare for and lessen the risk of wildland fires on both public and private lands. Maintaining defensible space around key structures or infrastructure is also one of the most cost-effective ways of protecting property from highly combustible material such as grass, brush, and timber.

Walker Basin Creek, Caliente Creek, and Tehachapi Boulevard Bridge Replacements

Two bridges were constructed in 1933 to cross Walker Basin Creek and Caliente Creek. The original construction of these bridges used wood pile and frame with concrete decking. The wooden supports of the construction were severely damaged from flooding activity in 2011, which effectively undermined the supporting framework of the construction. County Engineers inspected the bridge and determined that it was not practical to retrofit or rehabilitate the bridges. They also determined that the bridges were no longer safe for motorists and could collapse under heavy weight. After deciding on an emergency replacement, the County selected a protected box culvert conveyance design. Additionally, the roadway surroundings were modified to provide extensive erosion mitigation in order to protect the roadway and downstream properties from any damage resulting from the culvert capacity being exceeded.

The Tehachapi bridge replacement resulted from the need to construct an emergency replacement bridge due to the Piute Fire which burned the structural supports of the bridge on July 17, 2012. A new bridge was constructed in 2012 which featured a design of triple box culverts.



Figure 2-3: Bena Bridges During Construction

Photo: Kern County California (Patch, October 2012)

Cuddy Creek Bridge and Channel Protection

The Cuddy Creek bridge project consisted of placing concreted-rock channel protection downstream from the bridge in order to prevent further degradation to the bridge, to prevent the channel from an immediate danger of being washed out from potential flooding, and to provide for the general safety of travelers using the bridge. Construction of the project began in October of 2008 and it was completed on November of the same year. There were an additional number of protective measures that were taken during and after construction. These included a Water Diversion Plan, biological monitoring, and post-construction surveys. The County was careful to protect fish and wildlife resources in and around Cuddy Creek. Vehicle access corridors and staging areas were marked with highly visible flags to ensure that environmentally sensitive areas were not disturbed. Excess construction materials were also removed from the project site in order to restore the channel bed and banks to their condition prior to construction.

County-Wide Community Wildfire Protection Plan Update In-Development

Since the 2014 HMP, the County took proactive role in developing Community Wildfire Protection Plans (CWPPs) for the Mount Pinos, Greater Tehachapi, and Kern River Valley areas. The purpose of CWPPs is to reduce wildfire risk through a collaborative process of planning, prioritizing, and implementing hazardous fuels reduction projects. CWPPs are community plans and thus require the involvement of various stakeholders from throughout the County. These were in addition to the development of Fire Safe Councils. Fire Safe Councils are grassroots community-based organizations which share the objective of making California's communities less vulnerable to catastrophic wildfire.

The County is currently developing its first county-wide CWPP which encompasses over two million acres and could potentially affect over 70,000 habitable structures. The work is being done by a consultant and is being funded by a Calfire Greenhouse Gas Reduction Fund (GGRF) grant for $93,333. The CWPP will be completed by September 2021.

The CWPP will be broken into three geographic regions:

- The Kern River Valley area, which includes the communities of Kernville, Lake Isabella, Bodfish, Alta Sierra, and Glenville.
- The Frazier Park area, which includes the communities of Pine Mt. Club, Pinion Pines, and Lake of the Woods.
- The greater Tehachapi area, which includes the communities of Keene, Hart Flat, and Bear Valley Springs.

Along with providing important regional wildfire data, it is hoped that involving community members in the CWPP planning process will bring out a new group of potential fire planning leaders.

2.5 Incorporation into other Planning Mechanisms

Over the past 5 years, the 2014 HMP was incorporated into other planning mechanisms as a demonstration of progress in local hazard mitigation effort. This newly-updated HMP will be referenced in the 2020-2021 Kern County Emergency Operations Plan and the 2021 County-Wide CWPP. This update also will be incorporated into planning documents such as the County Flood Mitigation Plan, Groundwater Management Plan, Groundwater Sustainability Plan, General Plan, Wildfire Protection Plan and the Kern County Integrated Regional Water Management (IRWM) Plan in the future.

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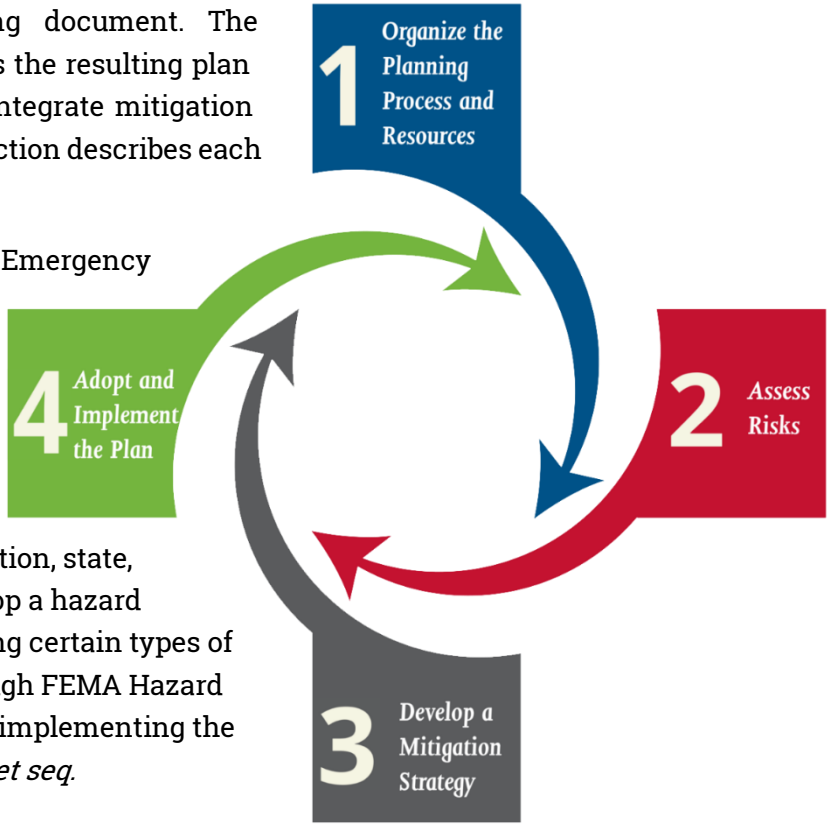
Section 3. Planning Process

This section describes each stage of the planning process used to develop the MJHMP. The planning process provides a framework for document development and follows the FEMA recommended steps as enumerated in federal regulation and outlined herein. This MJHMP is a community-driven, living document. The planning process itself is as important as the resulting plan because it encourages communities to integrate mitigation with day-to-day decision making. This section describes each stage of the planning process.



The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by the Disaster Mitigation Act of 2000 (DMA 2000, 42 U.S.C. § 5165), is intended to "reduce the loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters." Under this legislation, state, tribal, and local governments must develop a hazard mitigation plan as a condition for receiving certain types of non-emergency disaster assistance through FEMA Hazard Mitigation Assistance. FEMA regulations implementing the DMA 2000 are located at 44 C.F.R. § 201.6 *et seq.*

FEMA prescribes four major planning steps:

- **Step 1: Organize Resources**
- **Step 2: Assess Risk**
- **Step 3: Develop a Mitigation Strategy**
- **Step 4: Adopt and Implement the plan**

Each jurisdiction that participated in the MJHMP independently followed the FEMA four step process. Figure 3-1 provides a detailed, phased breakdown of the planning process that each participating jurisdiction completed. These four steps are integrated with a ten step planning process which FEMA's Community Rating System uses to establish floodplain management credit in addition to Flood Mitigation Assistance programs.

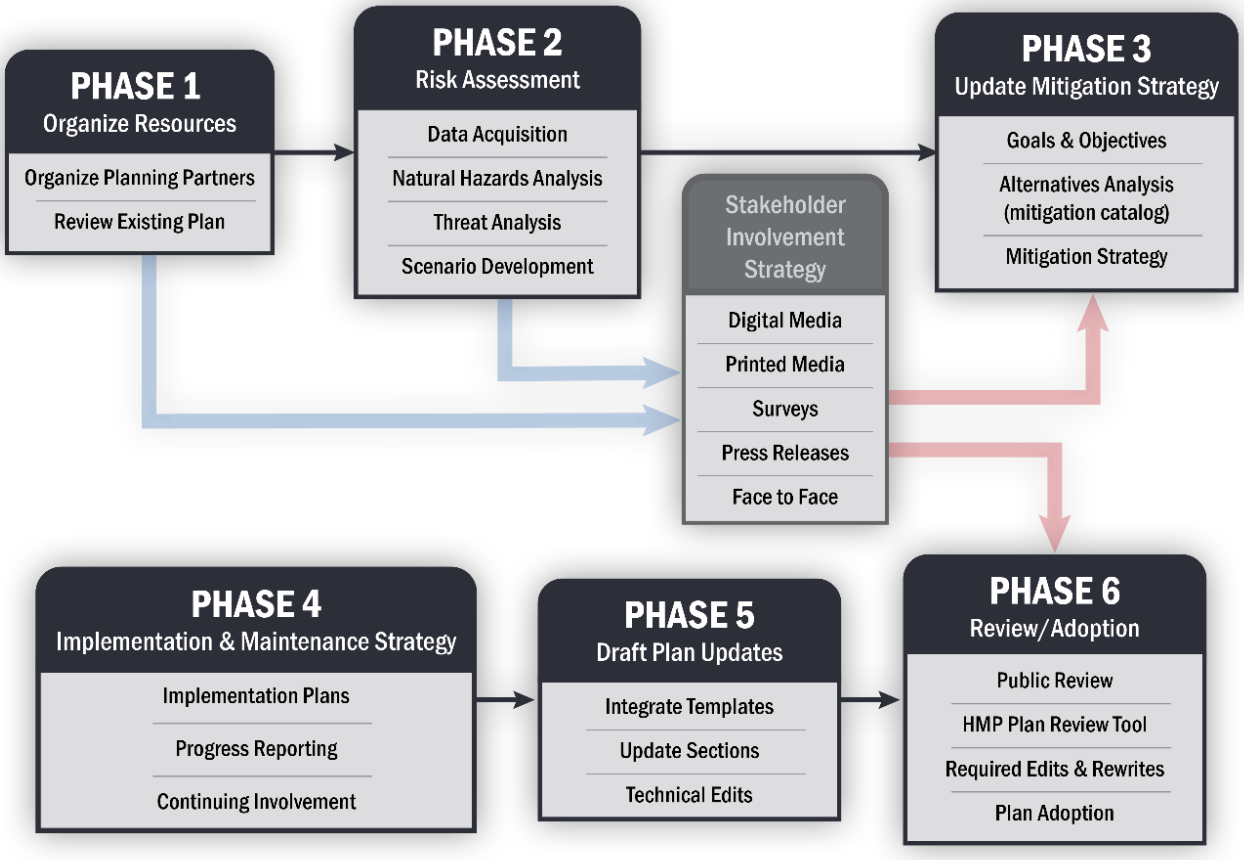


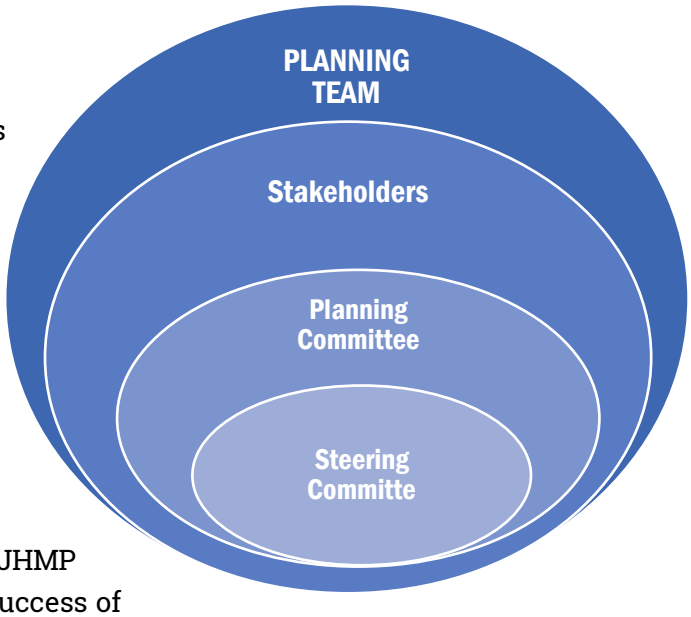
Figure 3-1: Kern County MHJHMP Planning Process

STEP 1: Organize Resources

The first step of the MJHMP planning process was organizing resources, consisting of developing the planning team and reviewing relevant existing documents.

Building the Planning Team

The Planning Team was comprised of participants from all participating jurisdictions who worked together to develop the MJHMP. The Planning Team consisted of a Steering Committee, Planning Committee, a broader group of residents and regional stakeholders, and an HMP consultant used for plan development and facilitation.



Steering Committee

The Steering Committee was at the core of the MJHMP planning process and was integral to ensuring the success of the planning process, its implementation, and future maintenance. Members of the Steering Committee, listed in Table 3-1 below, represented each participating jurisdiction and were also a part of the MJHMP Planning Committee, discussed below and in the individual annexes in Volume 2.

Table 3-1: MJHMP Steering Committee

Name	Title	Department
County of Kern		
Alexa Kolosky	Planner III	Public Works Department
Andrew Freeborn	Public Information Officer	Fire Department
Brad Aragon	Loss Prevention Specialist	Kern County Counsel/Risk Management
Brandon Smith	Battalion Chief	Fire Department
Chris Huot	Assistant City Manager	City of Bakersfield
David Witt	Fire Chief/Director of Emergency Services	Fire Department
Dennis McNamara	Division Chief	Planning and Natural Resources Department
Greg Van Mullem	Systems Analyst II	Assessor-Recorder
Jeff Fariss	EMS Program Manager	Public Health Services Department

Name	Title	Department
Jeffrey Utter	GIS Manager	Information and Technology Services
Jon Lifquist	Assessor-Recorder	Assessor-Recorder
Jose De Leon	GIS Specialist	Fire Department
Kevin Hamilton	Floodplain Manager	Public Works Department
Lorelei Oviatt	Director	Planning and Natural Resources Department
Megan Person	Director of Countywide Communications	Board of Trade/KGOV
Michael Dillenbeck	Public Works Manager	Public Works Department
Nik Turner	GIS Specialist	Public Works Department
Robert Voyles	Public Works Operations Manager	City of Bakersfield
Wendy Benson	Administrative Coordinator	Fire Department
Zachary Wells	Battalion Chief	Fire Department

Planning Committee

The MJHMP Planning Committee consisted of multiple key decisionmakers with specific expertise to contribute to the planning process from each participating jurisdiction. The Planning Committee served as liaisons to the greater community. Each Planning Committee member was responsible for communicating the direction and status of the planning effort to respective departments and constituents of each jurisdiction and were expected to represent the perspectives of the participating jurisdiction to the Committee.

The Planning Committee was involved in various planning processes, including:

- Structured coordination and meetings
- Collection of valuable local information and other requested data
- Decision making on plan process and content
- Development of mitigation actions
- Review and comment on plan drafts
- Coordination of the public input process

All Planning Committee members did not necessarily attend stakeholder group meetings. Some participated by reviewing draft documents, assisting in individual jurisdictional vulnerability assessments, with public outreach, or at other stages of the process. Table 3-2 provides a list of the Planning Committee Members. Documentation of Planning Committee invitations are provided in Appendix B.

FEMA Approval 4/9/2021

Table 3-2: MJHMP Planning Committee

Name	Title	Department
County of Kern		
Adrianna Kessler	Senior Human Resources Manager	Department of Human Services
Alexa Kolosky	Planner II	Public Works Department
Andrew Freeborn	Public Information Officer	Fire Department
Brandon Smith	Battalion Chief	Fire Department
Brian Marsh	County Director/Farm Advisor	Farm and Home Advisor
Carl Brewer	Senior CAO Manager, Construction Services	County Administrative Office/General Services Division
Carlos Rojas	Planner III	Planning and Natural Resources Department
Darin Heard	Deputy Agricultural Commissioner/Sealer	Agricultural and Measurement Standards Department
David Witt	Interim Fire Chief/Director of Emergency Services	Fire Department
Dennis McNamara	Division Chief	Planning and Natural Resources Department
Ed Greynolds		Department of Agriculture
Greg Van Mullem	Systems Analyst II	Assessor-Recorder
Jared Bradford	Planner I	Planning and Natural Resources Department
Jeff Fariss	EMS Program Manager	Public Health Services Department
Jeffrey Utter	GIS Manager	Information and Technology Services
Jeremy Oliver	Program Director	Aging & Adult Services Department
John George	Supervising Planner	Planning and Natural Resources Department
Jose De Leon	GIS Specialist	Fire Department
Kaler Ayala	Fiscal and Policy Analyst III	County Administrative Office
Kevin Hamilton	Floodplain Manager	Public Works Department
Kevin Kimmel		Sheriff's Department
Kimberly Fleming, B.S., M.P.A.	Special Projects Manager	County Administrative Office/General Services Division
Mark Lewis	Business Manager	Library
Michael Dillenbeck	Waste Management Supervisor	Public Works Department
Michael Mata	Assistant Probation Division Director	Probation Department
Nick Cullen	Director	Animal Services Department
Nik Turner	GIS Specialist	Public Works Department
Shane Denton	Supervising Park Ranger	Kern County Administrative Office/General Services Division
Steve Williams	Lieutenant	Sheriff's Department

Fema Approval 4/9/2021

Name	Title	Department
Zachary Wells	Battalion Chief	Fire Department
Zack Bittle	Sergeant	Sheriff's Department
Municipalities		
City of Arvin		
Cecilia Vela	City Clerk	City of Arvin
Christine Viterelli	Grant Writer	City of Arvin
Jerry Breckinridge	City Manager	City of Arvin
Olan Armstrong	Lieutenant	Arvin Police Department
Pawan Gill	Director of HR and Administrative Services	City of Arvin
City of Bakersfield		
Brianna Carrier	Administrative Analyst III	City Manager's Office
Chris Huot	Assistant City Manager	City of Bakersfield
John Frando	Deputy Fire Chief	Bakersfield Fire
Kevin Albertson	Fire Marshal/Training Officer	Bakersfield Fire Department
Robert Voyles	Operations Manager	City of Bakersfield Public Works Department
Stuart Patteson, P.E.	Assistant Public Works Director	City of Bakersfield Public Works Department
William Ballard	Deputy Fire Chief	Bakersfield Fire Department
City of California City		
Anna Linn	Acting City Manager	City of California City
David Orr	Firefighter/Paramedic	California City Fire Department
Jeremy Kosick	Fire Chief / Fire Marshal	California City Fire Department
Riuss Jensma	Administrator/EOC Coordinator	California City Fire Department
City of Delano		
Joe Rojas	Associate Engineer/Water Coordinator	City of Delano
Pattie Castellanos	Department Assistant	City of Delano Engineering Department
Roman Dowling, P.E.	City Engineer / Public Works Director	City of Delano Public Works Department
City of Maricopa		
Eric Ziegler	City Administrator	City of Maricopa
Laura Robison	Deputy City Clerk	City of Maricopa
City of Ridgecrest		
Bard Lower	Public Works Director	City of Ridgecrest Public Works Department
Heather Spurlock	Administrative Secretary	City of Ridgecrest Planning Department
Joshua Villa	Code Enforcement Officer	Ridgecrest Police Department
Ronald Strand	City Manager	City of Ridgecrest

Fema Approval 4/9/2021

Name	Title	Department
City of Shafter		
Diana Burnett	Captain	Shafter Police Department
Jeff Bell	Captain	Shafter Police Department
Kevin Zimmermann	Chief	Shafter Police Department
Suzanne Forrest	Senior Planner	City of Shafter Planning Department
Wayne Clausen	Planning Director	City of Shafter Planning Department
City of Taft		
Craig Jones	City Manager	City of Taft
Damon McMinn	Chief	Taft Police Department
Lonn Boyer	Director of Human Resources/Assistant City Manager	City of Taft
Mark Staples	Director of Planning and Development Services	Planning and Development Services
Michelle Kincaid	Administrative Assistant to the City Manager	City of Taft
City of Tehachapi		
Ashley Whitmore	Administrative Manager/Deputy City Clerk	City of Tehachapi
Corey Costelloe	Assistant to the City Manager	City of Tehachapi
Greg Garrett	City Manager	City of Tehachapi
Kent Kroeger	Chief	Tehachapi Police Department
Key Budge	Community Relations Specialist	City of Tehachapi
City of Wasco		
Biridiana Bishop	Public Works Director	City of Wasco Public Works Department
Daniel Ortiz-Hernandez	City Manager	City of Wasco
Jeff Tackett	Water Superintendent	City of Wasco
Keri Cobb	Senior Planner	City of Wasco
Maria Martinez	Executive Assistant	City of Wasco
Wayne Jackson	Facilities Supervisor	City of Wasco
School Districts		
Bakersfield City School District		
Kristabel Garcia-Diaz	Office Manager	Bakersfield City School District
Marcos Rodriguez	Director, Facilities	Bakersfield City School District
Buttonwillow Union School District		
Dana Baugh	Administrative Assistant	Buttonwillow Union School District
Steven Santillan	Lead Bus Driver/Custodian	Buttonwillow Union School District
Stuart Packard	Superintendent	Buttonwillow Union School District
Kern Community College District		
Christopher Counts	Director, Public Safety	Bakersfield College

Fema Approval 4/9/2021

Name	Title	Department
Joseph Grubbs	Executive Director, Risk Assessment and Management	Kern Community College District
Sheila Shearer	Coordinator, Risk Management and Safety	Kern Community College District
Kern High School District		
Benny Wofford	Emergency Preparedness & Safety Manager	Kern High School District
Brian Mendiburu	Director of Student Behavior & Supports	Kern High School District
Jenny Hannah	Director of Facilities	Kern High School District
Kenny Seals, Ed.D.	Director of Business Administration	Kern High School District
Patrick Blake	Emergency Preparedness & Safety Administrator	Kern High School District
Dr. Kenny Seals	Director of Business Administration	Kern High School District
Ed Komin	Chief of Police	Kern High School District
Lost Hills Union School District		
Harrison Favereaux	Chief Administrative Officer	Lost Hills Union School District
Jackie Villa		Lost Hills Union School District
Mojave Unified School District		
Aaron Haughton, Ed.D.	Superintendent	Mojave Unified School District
Cassie Hogan	Supervisor of Accounting & Categorical Programs	Mojave Unified School District
Keith Gainey	Assistant Superintendent - Business Services	Mojave Unified School District
Paula Dickerson	Administrative Assistant to the Superintendent	Mojave Unified School District
Richland School District		
Martin Rodriguez	Chief Business Officer	Richland School District
Yuriana Torres	Facilities Planning & Operations Secretary	Richland School District
Sierra Sands Unified School District		
Bryan Auld	Assistant Superintendent, Human Resources	Sierra Sands Unified School District
Carol Brewster	Human Resource Technician, Human Resources	Sierra Sands Unified School District
Dave Ostash	Superintendent	Sierra Sands Unified School District
Diane Naslund	Administrative Secretary to the Superintendent	Sierra Sands Unified School District
Taft City School District		
Janice Dillingham	Executive Assistant	Taft City School District
Tommy Aguilera	MOT Director	Taft City School District
Tehachapi Unified School District		
Julianna Schill	Secretary to the Business Services Chief Administrator	Tehachapi Unified School District
Kelly Patterson	Secretary to the Director of Maintenance and Operations	Tehachapi Unified School District

Fema Approval 4/9/2021

Name	Title	Department
Kirk Gilbert	Director of Maintenance and Operations	Tehachapi Unified School District
Hojat Entezari	Business Services Chief Administrator	Tehachapi Unified School District
Stacey Larson-Everson	Superintendent	Tehachapi Unified School District
Special Districts		
Arvin CSD		
Alexis Gaona	Chief Operator	Arvin Community Services District
Raul Barraza, Jr.	General Manager	Arvin Community Services District
Bear Valley CSD		
Kristy McEwen	Secretary of the Board	Bear Valley Community Services District
Tim Melanson	Chief of Police	Bear Valley Community Services District
William Malinen	General Manager	Bear Valley Community Services District
East Niles CSD		
Larry White	Senior Treatment Operator	East Niles Community Services District
Timothy Ruiz, P.E.	General Manager	East Niles Community Services District
Tony Johnson	Superintendent	East Niles Community Services District
Mojave Air and Space Port		
Floyd VanWey	Facilities Manager	Mojave Air and Space Port
Joe Hughes	Fire Chief Assistant	Mojave Air and Space Port
John Himes	Director of Operations	Mojave Air and Space Port
North of the River RPD		
Joe West	CTSA Transportation Supervisor	North of the River Recreation and Park District
Monya Jameson	General Manager	North of the River Recreation and Park District
Paul Anderson	Superintendent of Parks	North of the River Recreation and Park District
Rosamond CSD		
Brach Smith	Director of Public Works	Rosamond Community Services District
John Houghton	Assistant General Manager/Superintendent	Rosamond Community Services District
Lizette Guerrero	Director of Administration/Board Secretary	Rosamond Community Services District
Shafter RPD		
Armando Gonzalez		Shafter Recreation and Park District
Phillip Jimenez	District Manager	Shafter Recreation and Park District

Fema Approval 4/9/2021

Name	Title	Department
Stallion Springs CSD		
Brad Burris		Stallion Springs Community Services District
Vanessa Stevens	General Manager	Stallion Springs Community Services District
David Aranda	General Manager (Retired)	Stallion Springs Community Services District
Ed Gordon	President, Board of Directors	Stallion Springs Community Services District
Tehachapi Valley RPD		
Carrie Champlin	Business Manager/Clerk of the Board	Tehachapi Valley Recreation and Parks District
Corey Torres	Interim District Manager	Tehachapi Valley Recreation and Park District
Water/Wastewater Districts		
Arvin-Edison Water Storage District		
Chris Krauter	General Superintendent	Arvin-Edison Water Storage District
Fernando Ceja	Engineering Technician	Arvin-Edison Water Storage District
Jeevan Muhar	Engineer-Manager	Arvin-Edison Water Storage District
Mark Dawson, P.E.	Engineer	Arvin-Edison Water Storage District
Micah Clark	Engineering Technician	Arvin-Edison Water Storage District
Sherry Jauch	Executive Secretary	Arvin-Edison Water Storage District
Berrenda Mesa Water District		
Kris Lawrence	Regulatory Coordinator	Berrenda Mesa Water District / Lost Hills Water District
Phillip Nixon	Co-Manager	Berrenda Mesa Water District
Steve Bottoms	Operations and Maintenance Superintendent	Berrenda Mesa Water District
Buttonwillow County Water District		
Regina Houchin	Board Secretary	Buttonwillow County Water District
Cawelo Water District		
David Ansolabehere	General Manager	Cawelo Water District
Ford City-Taft Heights Sanitation District		
Adrian Nava	Engineer III-C	Ford City-Taft Heights Sanitation District
Jason Nordine	Wastewater Specialist II	Ford City-Taft Heights Sanitation District
Kyle Perez	Engineer II	Ford City-Taft Heights Sanitation District and Kern Sanitation Authority

Fema Approval 4/9/2021

Name	Title	Department
Leslie Edwards	Engineer III-C	Ford City-Taft Heights Sanitation District and Kern Sanitation Authority
Rositza Lopez	Administrative Coordinator	Ford City-Taft Heights Sanitation District
Golden Hills CSD		
Debbie Lee	Administrative Assistant	Golden Hills Community Services District
Susan Wells	General Manager	Golden Hills Community Services District
Greenfield County Water District		
Mel Johnson	General Manager	Greenfield County Water District
Nick Cooper	Operations Manager	Greenfield County Water District
Windy Rojas	Office Manager	Greenfield County Water District
Kern County Water Agency		
Monica Tennant	Water Resources Planner	Kern County Water Agency
Kern Delta Water District		
Jana Marquez	Groundwater Manager	Kern Delta Water District
Steven Teglia	General Manager	Kern Delta Water District
Kern Sanitation Authority		
Adrian Nava	Engineer III-C	Kern Sanitation Authority
Jason Nordine	Wastewater Specialist II	Kern Sanitation Authority
Leslie Edwards	Engineer III-C	Ford City-Taft Heights Sanitation District and Kern Sanitation Authority
Rositza Lopez	Administrative Coordinator	Kern Sanitation Authority
Kern-Tulare Water District		
Skye Grass	Resources Manager	Kern-Tulare Water District
Steven Dalke	General Manager	Kern-Tulare Water District
Vanessa Yap	Staff Engineer	Kern-Tulare Water District
Lost Hills Water District		
Kris Lawrence	Regulatory Coordinator	Berrenda Mesa Water District/Lost Hills Water District
North of River Sanitary District No. 1		
Megan Lee	Office Administrator	North of River Sanitary District No. 1
Patrick Ostly	District Manager	North of River Sanitary District No. 1
North of the River Municipal Water District		
Carol Havens	Office Manager / Controller	North of the River Municipal Water District
Doug Nunneley	General Manager/Secretary-Treasurer	North of the River Municipal Water District

Fema Approval 4/9/2021

Name	Title	Department
Ryan Nunneley		North of the River Municipal Water District
Semitropic Water Storage District		
Isela Medina	Staff Engineer, Water Resources	Semitropic Water Storage District
John Luna	Engineering Technician	Semitropic Water Storage District
Marsha Payne	Executive Secretary	Semitropic Water Storage District
Tehachapi-Cummings County Water District		
Cat Adams	Executive Assistant and Board Secretary	Tehachapi-Cummings County Water District
Curtis Hilliker	Operations Assistant	Tehachapi-Cummings County Water District
Tom Neisler	General Manager	Tehachapi-Cummings County Water District
Troy DePriest	Operations Manager	Tehachapi-Cummings County Water District
West Kern Water District		
Andrea Crabb	Technical Analyst	West Kern Water District
Deann Crabtree	General Manager	West Kern Water District
Greg Hammett	General Manager	West Kern Water District
Tami Sivils	Human Resource Administrator	West Kern Water District
Wheeler Ridge-Maricopa Water Storage District		
Eric McDaris	Contract Administrator	Wheeler Ridge-Maricopa Water Storage District
Thomas Suggs, P.E., P.G., H.G.	Staff Engineer	Wheeler Ridge-Maricopa Water Storage District
Stakeholders		
Aaron Bock	Chief Planner	Tulare County RMA - Planning
Amanda Verhaege	Emergency Services Coordinator	Kings County Fire Department
Amy Rocha	District Conservationist	Natural Resources Conservation Service
Andrew Lockman	Emergency Services Manager	Tulare County Office of Emergency Services
		Antelope Valley Conservancy
Ariana Joven	Executive Director	Kern County Farm Bureau
Ben Raymond	Regional Planner	Kern Council of Governments
Bernice Romo	Assistant Team Manager, Sand Canyon	Greater Tehachapi Valley CERT
Bob Belcher	Assistant Coordinator	Bakersfield CERT
Brad Aragon	Loss Prevention Specialist	Kern County Counsel/Risk Management
Brandon Bates	Acting Area Conservationist, New Mexico - South Area	Natural Resources Conservation Service
Brenda Dawson	Coordinator	Indian Wells Valley CERT

Fema Approval 4/9/2021

Name	Title	Department
Brian Hockett	District Manager	North West Kern Resource Conservation District
Brian Thoburn	Governmental Relations Manager	Southern California Edison
Brian Uhl	Emergency Services Manager	Santa Barbara County Office of Emergency Management
Cal Rossi	Government Relations Manager	Southern California Edison
Cathreen Richards	Director	Inyo County Planning Department
Chris Hickernell	General Superintendent	Friant Water Authority
Christian Buenrostro	Mechanical Engineer, Operations Division, South-Central California Area Office	U. S. Bureau of Reclamation
Colt Esenwein	Director	County of San Luis Obispo Public Works Department
David Brinsfield	CenCal ADFMO	Bureau of Land Management
David Burt	Assistant Coordinator	Stallion Springs CERT
David Davis	Emergency Services Officer	San Bernardino County Office of Emergency Services
David Reiner	Assistant Coordinator	Mountain Communities CERT
David Romo	Team Manager, Sand Canyon	Greater Tehachapi Valley CERT
David Shaw	Coordinator / Team Manager, Golden Hills/Tehachapi	Greater Tehachapi Valley CERT
Dayne Yancey		Pine Mountain Club CERT
Dean Ott	Assistant Coordinator	Kern River Valley CERT
Douglas DeFitch	Chief Operating Officer	Friant Water Authority
Dylan Van Dyne	Project Manager	U. S. Army Corps of Engineers
Ed Rieth		Pine Mountain Club POA
Emily Montanez	Senior Program Manager, Chief Executive Office	Los Angeles County Office of Emergency Management
Emmanuel Gonzalez Hinojosa	Soil Conservationist	Natural Resources Conservation Service
Frank Trotta	Superintendent, Kern River Valley	California Water Service Company
Gary Crowell	Interim Chief	Stallion Springs Police Department
Gary Darcy	Coordinator	Rosamond CERT
Geoff Fulks	District Manager, Bakersfield District	California Water Service Company
Gerald Simon	VP, Chief Safety, Sec & EPO	California Water Service Company
Gina Darcy	Assistant Coordinator	Rosamond CERT
Greg Gatzka	Community Development Director	Kings County Community Development Agency
Helen Chavez	Assistant Director	Los Angeles County Office of Emergency Management
Hunter Merritt	Water Resources Planner, Public Involvement Specialist	U.S. Army Corps of Engineers, Sacramento District

Fema Approval 4/9/2021

Name	Title	Department
J. D. Saucedo	Emergency Manager	Santa Barbara County Office of Emergency Management
James Nelson	Team Manager, Bear Valley Springs	Greater Tehachapi Valley CERT
Jeannie Taylor	Kern County CERT Coordinator	Kern County Fire Department
Jeannine Giuffre	President	Tehachapi Resource Conservation District
Jeffrey Kestly	Senior Public Safety Specialist	PG&E
Jim Mason	Coordinator	Mountain Communities CERT
Joe Guzzardi	Emergency Services Manager	San Luis Obispo County Office of Emergency Services
Jon Yasin	Local Manager, Kern River Valley District	California Water Service Company
Jose Pena	Superintendent	California Water Service Company
Justin Gagnon		Los Padres National Forest
Karin Shulman	General Manager	Pine Mountain Club POA
Kathy Gibson	Emergency Manager	Ventura County Office of Emergency Services
Katie Allen	Marketing and Communications	PG&E
Kelley Williams	Emergency Services Manager	County of Inyo
		Kern River Valley Heritage Foundation
Kim Lary	District Conservationist	Natural Resources Conservation Service
Kristen Doud	Government Relations Representative, Corporate Affairs	PG&E
Leif Mathiesen	Bakersfield Zone Fire Management Officer	Bureau of Land Management
Lynn Greer	Outreach Program Specialist / Public Involvement	U. S. Army Corps of Engineers
Marty Pepito	Superintendent	California Water Service Company
Matt Gutierrez	Risk Manager	Risk Management Division
Michael Dyer	Technical Specialist	Santa Barbara County Office of Emergency Management
Michael Heimer	Regional Planner III	Kern Council of Governments
Michael Washam	Associate Director	Tulare County Resource Management Agency
Mike Martinez	Assistant DFMO Suppression	United States Forest Service
Miles Wagner	Emergency Services Officer	San Bernardino County OES
Monica Williams	Hazard Mitigation Grants Specialist	Governor's Office of Emergency Services
Nancy Gooch	Administrative Assistant	Eastern Kern County Resource Conservation District
Nick Lesourd	Natural Disaster Program Manager	EOC

Name	Title	Department
Pat Wood	Senior Civil Engineer	Los Angeles County Public Works Department
Peggy Hoyt-Voelker		Pine Mountain Club POA
Phillip Dixon	District Conservationist	Natural Resources Conservation Service
Phyllis Throckmorton		Pine Mountain Club POA
Rafael Molina		California Water Service Company
Reed Schenke	Director	Tulare County Resource Management Agency
Rob Dixon	Team Manager, Old West Ranch	Greater Tehachapi Valley CERT
Ross Miller	Chief Engineer	Tulare County Resource Management Agency
Sally Thoun	Team Manager, Alpine Forest	Greater Tehachapi Valley CERT
Sandy Young	Coordinator	Stallion Springs CERT
Sarah Rose	Assistant Team Manager, Golden Hills/Tehachapi	Greater Tehachapi Valley CERT
Scott Milner	Emergency Services Coordinator	San Luis Obispo County Office of Emergency Services
Sergio Vargas	Deputy Director, Watershed Planning & Permits Division	Ventura County Watershed Protection District
Seth Mitchell	District Fire Management Officer (Detailed)	United States Forest Service
Shane Santos	Assistant District Fire Manager	United States Forest Service
Stephanie Stephens	Hazard Mitigation Grants Specialist	Governor's Office of Emergency Services
Steve Doe, Ph.D., P.E.	Chief, Special Investigations Branch, South Central Region Office	California Department of Water Resources
Steven Larson	Chief, Pre-Disaster and Flood Mitigation Division	Governor's Office of Emergency Services
Terri Mejorado	Emergency Services Coordinator	Governor's Office of Emergency Services
Terry Butler	Assistant Coordinator	Pine Mountain Club CERT
Thomas Klein	Coordinator	Kern River Valley CERT
Thomas Yancey	Coordinator	Pine Mountain Club CERT
Wendy Wang	Water Resources Engineer, Central Valley Flood Planning Office	California Department of Water Resources

Fema Approval 4/9/2021

The County enlisted Dynamic Planning + Science (DP+S or Planning Consultant Team) due to its expertise in assisting public sector entities with developing hazard mitigation plans. DP+S staff facilitated the planning process, collected, and analyzed data, produced meeting materials, and produced drafts of the MJHMP for review. The MJHMP Consultant Team, as shown in Table 3-3, consisted of a variety of hazard mitigation and certified urban planning professionals.

Table 3-3: MJHMP Update Consultant Team

HMP Update Project Team	HMP Update Project Team Role
Ethan Mobley, AICP	Project Manager / Hazard Mitigation Planner
Brian Greer	GIS Specialist/Spatial Analyst
Torie Jarvis	Assistant Project Manager
Bob Lagomarsino	Lagomarsino Planning + Management, subconsultant to municipalities
Ty Johnson	Hazard Mitigation Planner
Daniel Spivak	Hazard Mitigation Planner
Alex Krebs	GIS Associate

Planning Committee Meetings

The Planning Committee met throughout the development of the updated MJHMP. Table 3-4 charts those meetings, including date, type, and topics discussed. Meeting documentation, including agendas, hazard maps, PowerPoint presentations, minutes, sign-in sheets, and other relevant handouts, are provided in Appendix B.

Table 3-4: Meeting Summary

Date	Meeting Type	Topics
April 12th, 2019	Planning Committee Kickoff Meeting	▪ *Welcome and Introductions* ▪ *Statement of Work Review* ▪ *Expectations from Participating Jurisdictions* ▪ *DMA 2000 Requirements* ▪ *Project Schedule* ▪ *Data Calls/Data Review* ▪ *Next Steps*
May 23rd, 2019	Planning Committee Meeting #1	▪ *Welcome and Introductions* ▪ *Mitigation Planning Defined* ▪ *Expectations from Participating Jurisdictions* ▪ *Planning Process Review* ▪ *Project Schedule* ▪ *Website Review* ▪ *FEMA Hazard Mitigation Program* ▪ *2012 Mitigation plan Review* ▪ *What has Changed?* ▪ *Outreach*



Date	Meeting Type	Topics
		▪ *Next Steps*
July 18th, 2019	Planning Committee Meeting #2	▪ *Welcome and Introductions* ▪ *Meeting #1 Recap* ▪ *Planning Team Development* ▪ *Risk Assessment Data Review* ▪ *RAMP Tool Review* ▪ *RAMP Tool Exercises* ▪ *Next Steps*
September 19th, 2019	Planning Committee Meeting #3	▪ *Welcome and Introductions* ▪ *Planning Process Recap* ▪ *Pinpointing Your Vulnerabilities* ▪ *Developing a Nexus to HMA Funding* ▪ *Closeout*
November 14th, 2019	Planning Committee Meeting #4	▪ *Welcome and Introductions* ▪ *Planning Process Recap* ▪ *Mitigation Alternatives* ▪ *Hazard Areas of Concern* ▪ *Goals & Objectives Review (previous plan)* ▪ *Updating the Mitigation Strategy*

Public Involvement and Outreach

Public involvement is an important and requisite component of any HMP update. The public outreach strategy for this update maximized public involvement throughout the planning process and utilized websites, local media, and community face-to-face efforts.

As required by FEMA, the general public was given an opportunity to be involved in the planning process while developing the HMP Update through surveys, a project website, and public review periods. Each is described below.

Surveys

An 8-question community survey was distributed via the County Nixle Account and website, Facebook page, and e-mail blasts. A total of 1,173survey responses were collected, including 4 Spanish-speaking survey responses. The results of the survey were used to ensure that the priorities of the County and participating jurisdictions match those of the residents/community members. For example, community members were asked if they believe their property was at risk from a natural hazard disaster; 77.9% said "yes." An example result is displayed in Figure 3-2, while full survey results are discussed in Section 5.5.1.2. The full survey results can be found in Appendix B.

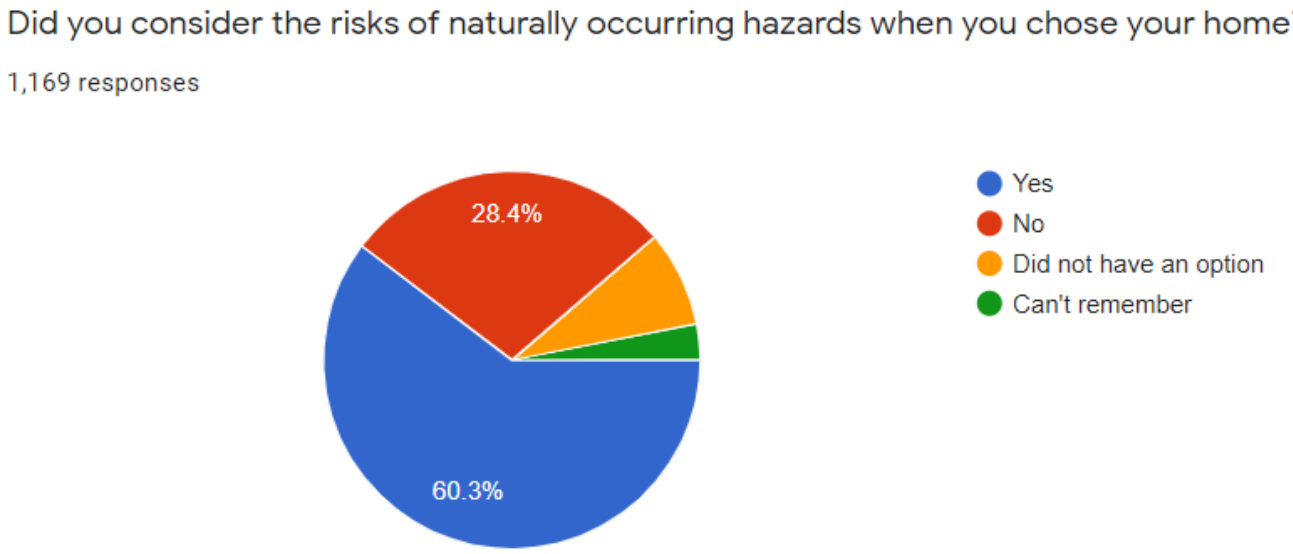


Figure 3-2 Snapshot of community survey results from English-speaking survey. Results are captured fully in Appendix B.

HMP Update Website

For this MJHMP, a project portal at http://mitigatehazards.com/county-of-kern/ served and will continue to serve as a centralized project information and file-sharing platform. This website provides a tool for project management, collaborative content, and one-stop-shop for mitigation planning resources.

In addition to internal coordination, the project portal played a critical role in public involvement throughout the planning process and documenting public involvement including the community survey, meetings, and working sessions. Resources such as the Risk Assessment Mapping Platform (RAMP) and links to all meeting summaries are available to the public via the website. Project participants and stakeholders used the website as a project resource for the duration of the planning process and will continue to have access during the 5-year update cycle and beyond.

Public Review of Draft HMP

The public reviewed the draft HMP during July of 2020. The County and several other jurisdictions announced the available public draft via their websites, and the drafts were available at http://mitigatehazards.com/county-of-kern/. The public was able to provide comment via a collaborative PDF, an online submission form, or an email. The notice and response to comments received are available in Appendix B.

STEP 2: Assess the Risk

In accordance with FEMA requirements, the Planning Committee identified and prioritized the natural hazards affecting both Kern County as a whole and each participating jurisdiction individually. It also assessed the vulnerability from those identified hazards. Results from this risk assessment aided subsequent identification of appropriate mitigation actions. While the process is described below, the substance of this risk assessment is detailed in Section 4.

Identify/Profile Hazards

Based on a review of past hazard events, existing plans, reports, and other technical studies, data, and information, the Planning Committee determined if regional hazards could affect the planning area. The Planning Committee completed screening and prioritization processes to determine priority hazards to be assessed. A risk assessment finalized the prioritization process by ranking hazards according to the impact and threat to the County in Vol. 1 and to each participating jurisdiction in Annex HMPs.

Assess Vulnerabilities

Assessing vulnerabilities exposes the unique characteristics of individual hazards and begins the process of narrowing down which areas within Kern County are vulnerable to specific hazard events. The vulnerability assessment included field visits and a GIS overlaying method for examining such vulnerabilities more in depth. Participating jurisdictions completed this exercise both singly and jointly with the County, and the identified hazards varied widely depending on the geographic make-up of, priorities of, and services provided by the participating jurisdiction. Using these methods, participating jurisdictions estimated vulnerable populations, infrastructure, and potential losses from hazards.

> ***Updated content for each hazard profile for the County, including vulnerability, is provided in Section 4.5. Participating jurisdictions are profiled individually in Volume 2 of this plan as Annex HMPs.***

Web Based Risk Assessment Mapping and Analysis

The web based and interactive Risk Assessment Mapping Platform (RAMP), accessed via the project website at www.mitigatehazards.com, allows interactive discovery of robust risk, vulnerability, and

exposure data developed especially for Kern County. RAMP is a mapping platform built specifically for mitigation planning. It displays County facilities and buildings overlaid with natural hazards layers to bring interactivity and individual discovery to the GIS analysis performed for the MJHMP. Figure 3-3 shows the location of RAMP on the project website.

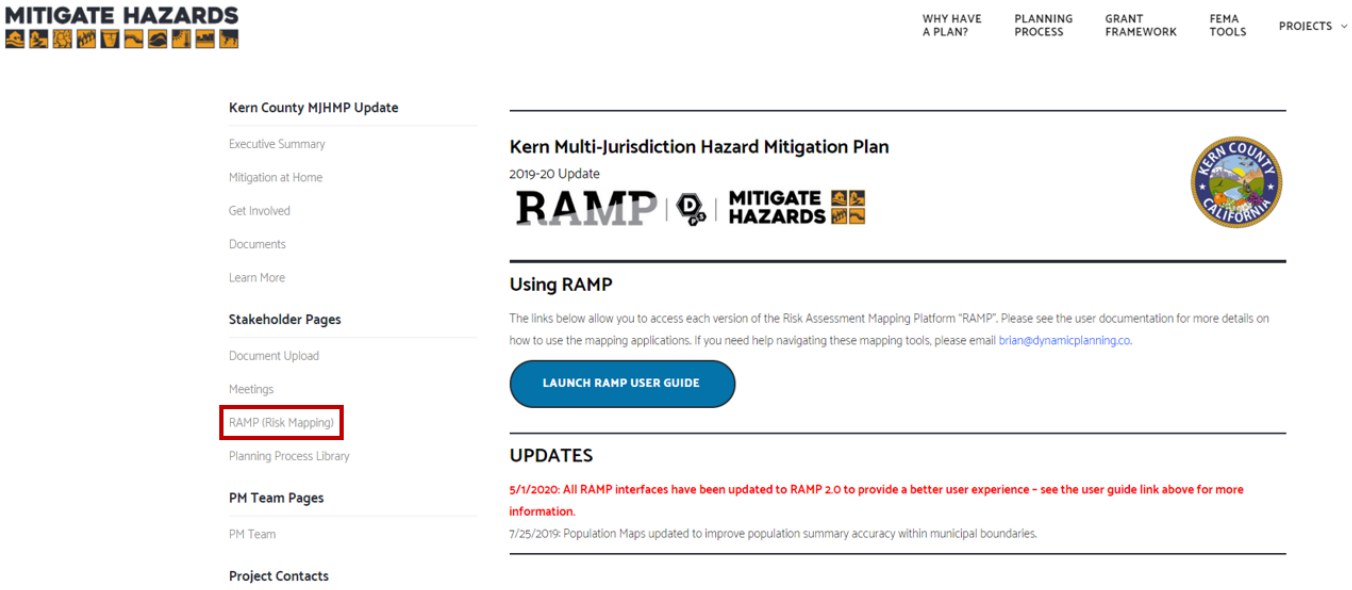


Figure 3-3: RAMP Facilities Map Access at mitigatehazards.com

The Planning Team used RAMP in meetings and as needed to understand vulnerabilities to the County and participating jurisdiction facilities. Users interactively filter facilities and buildings by natural hazard zones and/or construction characteristics.

RAMP's robust data filtering and summation calculations allow the user to understand and visualize vulnerabilities at the facility level with detailed information on the number of structures exposed to various natural hazards. RAMP enables Kern County to pinpoint vulnerabilities and reinforces problem statements in the mitigation strategy. Figure 3-4 demonstrates the RAMP web-based interface.

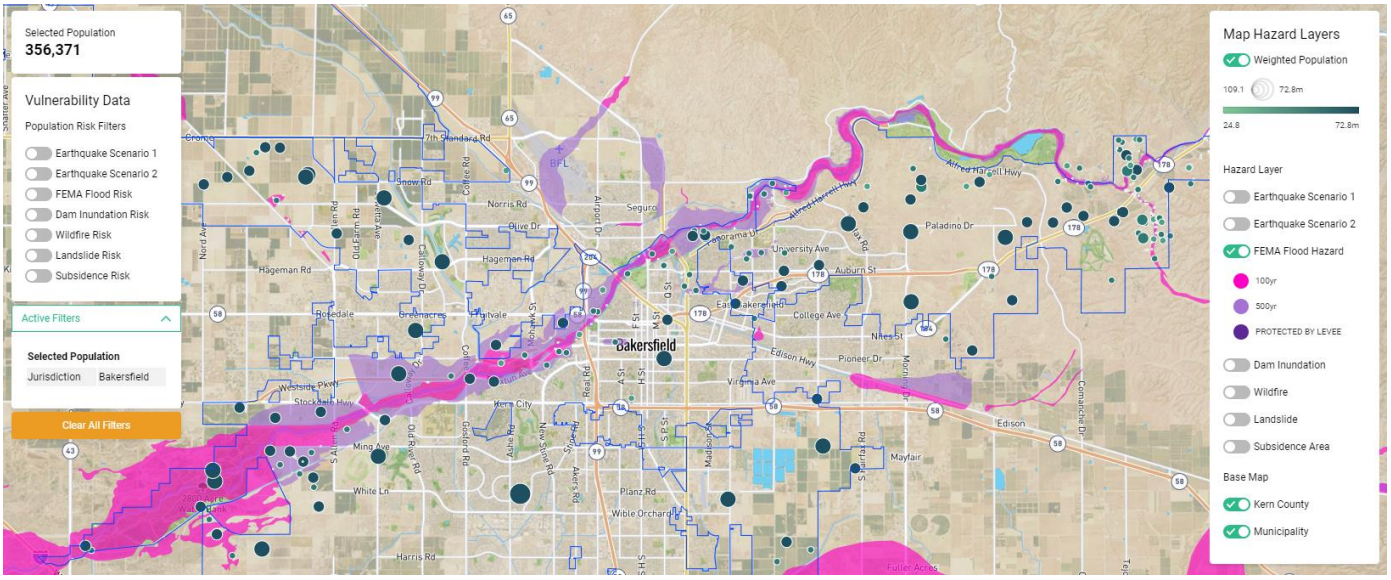


Figure 3-4: RAMP showing the population of Bakersfield overlaid with FEMA Flood Hazard

STEP 3: Develop a Mitigation Strategy

The MJHMP was prepared in accordance with requirements from DMA 2000 and the California Office of Planning and Research (OPR) and FEMA's HMP guidance. This document provides an explicit strategy and blueprint for reducing potential losses identified in the risk assessment based on existing authorities, policies, programs and resources, and participating jurisdictions' abilities to expand on and improve these existing tools. MJHMP development included identifying goals, assessing existing capabilities, reviewing the 2013 HMP goals, and identifying new mitigation actions. The process is described below; the substance of the mitigation strategy is detailed in Section 5 for the County and within Annex HMPs for other participating jurisdictions.

Identify Goals

The Planning Committee reviewed the 2014 HMP goals and determined their current validity, consistent with FEMA requirements. The goals and objectives were updated to meet the current hazard environments and to be consistent with the changing policies and goals of participating organizations. The Goals and Objectives are presented in Section 5.3.4.1.

Develop Capabilities Assessment

A capabilities assessment is a comprehensive review of participating jurisdictions' capabilities and tools to implement the mitigation actions in the MJHMP. The Planning Committee identified technical, financial, and administrative capabilities to implement mitigation actions, as detailed in Section 5.3 and in Annex HMPs.

Identify Hazard Problem Statements

The Planning Committee developed mitigation actions, as both planning activities and projects, to address problems that could originate from hazards identified in the risk assessment, in line with identified capability of each jurisdiction. Mitigation actions were created first by developing problem statements for prioritized hazards. As a rule of thumb, each hazard problem statement should be mitigated with a combination of short-term and long-range planning activities, either through operational and or physical projects. Hazard Problem Statements are located at the conclusion of each hazard profile in table format and are also uploaded in an interactive web-based Mitigation Action Support Tool (MAST), described below. Hazard problem statements for the County and other participating jurisdictions are categorized as impact-related, victim-related, or threat-related, as described in Figure 3-5.



IMPACT

- Casualties
- Property Damage
- Business Interruption
- Financial Loss
- Environmental Contamination



VICTIM

- School Children in Hazard High Hazard Areas
- Care Facilities in High Hazard Area
- Vulnerable Population Exposed to hazards



THREAT

- Increased Fuels due to drought
- Hotter, drier climates
- More Intense Storms
- Impervious surfaces = greater runoff
- Increases of Invasive Species

Figure 3-5. Categories of issues addressed in problem statements

Identify Mitigation Actions

As part of the MJHMP planning process, the Planning Committee reviewed and analyzed the status of the mitigation actions identified in the 2014 HMP. The Consultant Team and Planning Committee then worked together to identify and develop new mitigation actions with implementation elements. The Planning Committee prioritized and further detailed the implementation strategies during Planning Committee Meeting #3. Additional detail on these mitigation actions is provided in Section 5.3.

Mitigation Action Support Tool (MAST)

Hazard problem statements and mitigation activities are presented and will be updated through a web interface application developed specifically for participating jurisdictions, truly creating a living document

that can continue to be a valuable resource into the future. The Mitigation Action Support Tool (MAST) is accessible through www.mitigatehazards.com

MAST is a web-based interactive tool that enables multiple users to search, view, enter, and update mitigation actions, ideas or projects, and other information. MAST provides participating jurisdictions and plan reviewers (California Office of Emergency Services (Cal OES) and FEMA) access to valuable mitigation information that can be leveraged by future planning or other risk reduction efforts within the County. Participating jurisdictions can update the status of their mitigation projects throughout the planning lifecycle, and this web-based tool will improve participating jurisdiction's ability to apply for FEMA's Hazard Mitigation Assistance (HMA) grant programs including initial grant application processes through Cal OES.

County Planning Processes Library

Kern County assessed hazards, explored hazard vulnerability, developed mitigation strategies, and followed the planning process as described in this section. Table 3-5 provides planning library links for Kern County to each individual vulnerability task that was completed throughout the planning process. Volume 2 includes planning process links for other participating jurisdictions.

Table 3-5 Kern County Links to HMP Resources

Jurisdiction	Planning Library Links
Kern County	Risk Assessment – View Maps / Download maps Hazard Prioritization – View Risk Matrix Areas of Concern – View Problem Statements Capability Assessments – View Capability Assessment

Multi-Jurisdiction Planning Process

Multi-jurisdiction hazard mitigation planning offers many benefits, such as increased coordination and efficiency in planning and implementation efforts. At the same time, each jurisdiction has specific hazards and specific mitigation actions that must be addressed individually. The MJHMP balances the benefits of a comprehensive, coordinated approach to hazard mitigation with the specific realities of individual participating jurisdictions. Multi-jurisdiction plans are contemplated under FEMA regulations at 44 C.F.R. § 201.6(4).

Volume 2 of this MJHMP documents each jurisdiction's HMP resources. Each participating jurisdiction individually assessed hazards, explored hazard vulnerability, developed mitigation strategies, and followed the same planning process as Kern County to create the annexes. Volume 2 provides links to each participating jurisdiction's stand-alone annex and its vulnerability assessment tasks completed. This ensures each jurisdiction can quickly and easily access its annex, making it a more usable document than a large, unwieldly combined document.

STEP 4: Adopt and Implement the Plan

Once the risk assessment and mitigation strategy were completed, information, data, and associated narratives were compiled into the MJHMP. Section 2 provides detailed information on new and updated elements of the MJHMP.

Plan Review and Revision

Once the *Draft* MJHMP Update was completed, a public and government review period was established for official review and revision. Public comments were accepted, reviewed, and incorporated into this update. Applicable comments from the public have been received and addressed prior to the *"authorization to submit"* to FEMA and Cal OES. Notice of the public comment period is included in Appendix B.

Plan Adoption and Submittal

This plan has been submitted and approved by FEMA and adopted by the County. Copies of the resolutions are provided in forward of this document***. NOTE: adoption proceedings will be completed after approval by Cal OES and FEMA.***

Implement, Evaluate, and Revise the Plan

The true worth of any mitigation plan is its implementation and success under FEMA's grant programs. This MJHMP has been assembled to reduce the risk of natural hazards, and also to meet the requirements of the DMA 2000 and maintain eligibility under FEMA's Hazard Mitigation Assistance (HMA) grant programs.

FEMA administers three programs that provide funding for local agencies with approved mitigation plans:

- **Hazard Mitigation Grant Program (HMGP),** which assists in implementing long-term hazard mitigation planning and projects following a Presidential major disaster declaration.
- **Building Resilient Infrastructure and Communities (BRIC),** which provides funds for hazard mitigation planning and projects on an annual basis.
- **Flood Mitigation Assistance (FMA),** which provides funds for planning and projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis.

For more information about FEMA HMA, visit: https://www.fema.gov/hazard-mitigation-assistance.

Plan Maintenance

The County will update and monitor this plan in accordance with all FEMA requirements in order maintain eligibility for FEMA HMA. Evaluation and revision procedures for this plan are detailed in Section 6.

Section 6 includes the measures Kern County and participating jurisdictions will take to ensure the MJHMP's continuous long-term implementation, including MJHMP monitoring, reporting, evaluation, maintenance, and updating. Most of this implementation and maintenance will be done through MAST. Figure 3-6 demonstrates how MAST information will translate into Cal OES NOIs and grant sub application requests. Section 6 also contains specifics on integrating mitigation with day-to-day decision making.

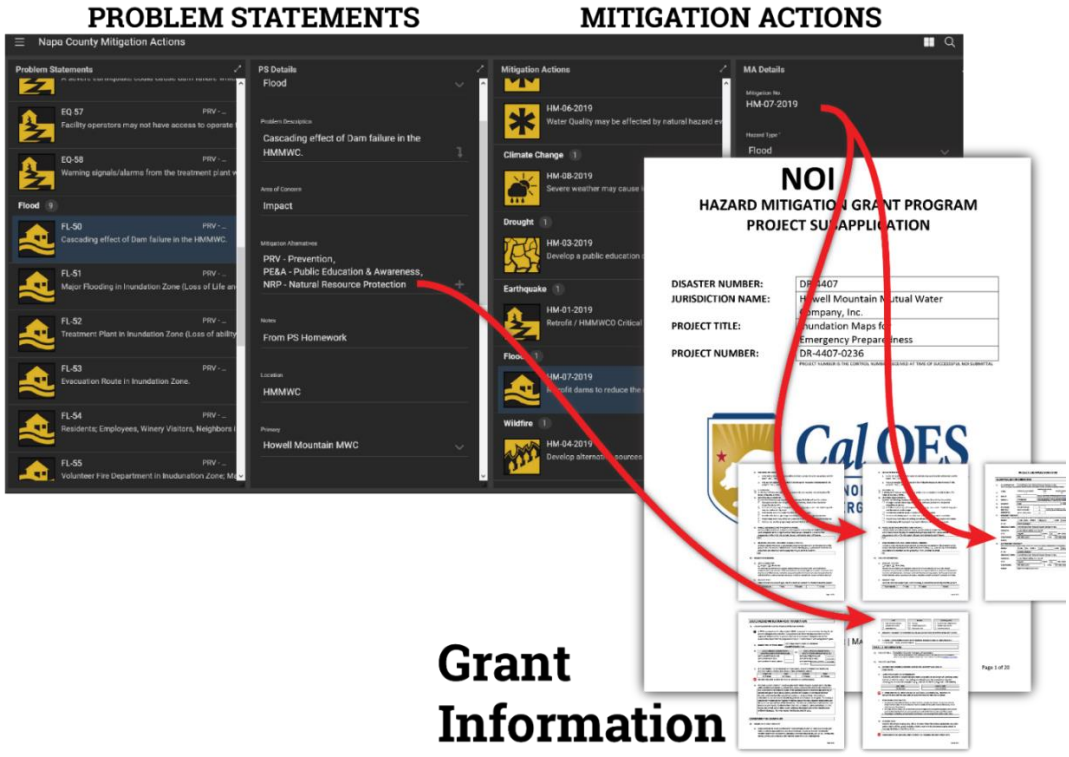


Figure 3-6 MAST elements and Cal OES Grant Applications

Section 4. Risk Assessment

The risk assessment measures the potential impact to life, property, and the economy resulting from natural hazards. The intent of the Risk Assessment is to identify the qualitative and quantitative vulnerabilities of a community to the greatest extent possible given available data. The risk assessment increases understanding of natural hazard impacts to the community and provides a foundation to develop and prioritize mitigation actions. In turn, mitigation actions reduce damage from natural disasters through increased preparedness and focus resources to areas of greatest vulnerability.

This risk assessment section evaluates potential loss from a hazard event by assessing the vulnerability of buildings, infrastructure, and people. It identifies the characteristics and potential consequences of hazards, explores how much of the County could be affected by a hazard, and assesses the impact on County assets. The risk assessment approach consists of three (3) components:

- **HAZARD IDENTIFICATION AND SCREENING**
  Identification and screening of hazards (Section 4.1)
- **HAZARD PRIORITIZATION**
  Identifying "priority hazards" for each participating jurisdiction to be profiled in more detail (Section 4.2)
- **VULNERABILITY ASSESSMENT**
  Determination of potential losses or impacts to buildings, infrastructure and population
  This section contains HAZARD PROFILES for individual priority hazards (Section 4.5)

4.1 Hazard Identification and Screening

Per FEMA Guidance, the first step in developing the Risk Assessment is identifying the hazards. This step includes two parts. First, the MJHMP Planning Team considered and screened a broad set of hazards presented in relevant local, regional, and statewide hazard planning documents. The crosswalk of documents reviewed and the results of screening the relevant hazards to be reviewed are outlined in Section 4.1.1. Second, the MJHMP considered past hazard events in Kern County to help prioritize hazards to be evaluated in this document, as outlined in Section 0.

4.1.1 Hazard Screening

The County's MJHMP Planning Team first reviewed previously-prepared hazard mitigation plans and other relevant documents to determine the realm of natural hazards that have the potential to affect the County and the nearby region. Table 4-1 provides a crosswalk of hazards identified in the 2014 Kern County MJHMP, 2009 Kern County General Plan, and the 2018 California State Hazard Mitigation Plan. Eighteen different hazards were identified based on a thorough document review. The crosswalk was used to develop a preliminary hazards list, providing a framework for MJHMP Planning Team members to evaluate which hazards were truly relevant to participating jurisdictions and which ones were not. For example, volcanoes were considered to have no relevance to the County, while earthquake, flood, dam failure, landslide, and wildfire were indicated in every hazard document.

Table 4-1: Document Review Crosswalk

Hazards	2014 Kern County MJHMP	2009 Kern County General Plan	2018 California State HMP
Agricultural Pests			■
Climate Change	■		■
Dam Failure	■	■	■
Drought	■		■
Earthquake	■	■	■
Flood	■	■	■
Insect Hazards	■		
Landslide	■	■	■
Levee Failure	■		■
Manmade Hazards		■	■
Pandemic Disease	■		■
Sea Level Rise			■
Severe Weather	■		■
Soil Hazards	■	■	
Terrorism & Tech Hazards			■
Tsunami			■
Volcano	■		■
Wildfire	■	■	■

The crosswalk provided the basis for prioritizing hazards to be profiled, displayed in Table 4-2. The prioritized hazards have detailed hazard profiles in Section 4.5, the Vulnerability Assessment.

Table 4-2. Hazard prioritization

Hazard Type	Explanation
Climate Change	**High priority county-wide, profiled as part of Flood, Wildfire, and Severe Weather hazard.**
Dam failure	**High priority county-wide, profiled hazard.**
Drought	**High priority county-wide, profiled hazard**
Dust Storms	**High priority county-wide; profiled as part of Severe Weather**
Earthquake/ Geologic Hazards	**High priority county-wide, profiled hazard**
Extreme Heat	**Profiled as part of Severe Weather hazard**
Extreme Cold	Extreme cold is rare in Kern County and not profiled in this plan
Flood	**High priority county-wide, profiled hazard**
Hail	Hail events are rare in Kern County and not profiled in this plan
Fog	While fog events do occur within Kern County, they are rare and are not considered a priority
Hazardous Material	While hazardous materials can release and impact the County, there are better avenues to address this hazard outside this plan.
High Winds/ Straight Line Winds	**High priority county-wide, profiled as part of Severe Weather**
Insect Hazards	While insects including Africanized honeybee and pine bark beetle exist in Kern County, this was not considered a priority and pests are not profiled in this plan
Levee Failure	**High priority county-wide, profiled as part of Dam Failure**
Lightning	Lightning was not identified as a priority for this plan.
Pandemic Disease	While pandemic disease can impact the County, there are better avenues to address this hazard outside this plan. *See Note after table for additional info.*
Radon	This hazard was not identified as a priority
Severe Thunderstorm	Severe thunderstorms are rare in Kern County and not profiled in this plan.
Slope Failure	**High priority county-wide, profiled hazard**
Soil Hazards	**High priority county-wide, profiled hazard**
Terrorism/Human Caused Threats	While terrorism is certainly a threat to the County and participating jurisdictions, it is best addressed in other plans as this HMP does not address human caused threats.
Tornado	Impacts to the County from tornados are extremely unlikely, if any.
Volcanic Activity	Due to distance from volcanoes and the limited chance of an eruption, this hazard was not identified as a priority.
Wildfire	**High priority county-wide, profiled hazard**
Winter Storm / Freeze Events	**Profiled as part of Severe Weather hazard**

Note regarding pandemic: The County's pandemic planning efforts go back to at least 2006, when a working group prepared a pandemic influenza continuity of operations report that was presented to the Kern Operational Area Emergency Council. At the time, the Emergency Council approved moving forward with the working group's recommendations. Several months later, the report was distributed to the managers of the incorporated cities so they could work on their own pandemic response planning.

The region has continued to move forward implementing recommendations, including the Kern County Board of Supervisors approving labor relations guidelines that would be activated in the event of a pandemic disaster or other disaster that affected employees' availability at their worksites. The guidelines were put into practice during the COVID-19 pandemic in Spring 2020.

In 2012, the need to plan continuity of operations from a perspective broader than solely pandemic influenza was identified. Subsequently, pandemic influenza continuity of operations planning evolved into all-hazards continuity of operations planning.

All-hazards continuity of operations planning continued as an in-County effort until late 2012, when efforts began to hire a consultant to review the County-produced documents, identify inconsistencies, and deliver a Countywide Continuity of Operations Plan (COOP). In 2014, the Board of Supervisors hired a consultant.

COOP development continues. Staff from the responsible County department continues to work with departments to reconcile any conflicting information included in the COOP, such as multiple departments that inadvertently plan to use the same continuity facility. The COOP will eventually be integrated into the overall County EOP, which is in the process of being updated.

FEMA Approval 4/9/2021

4.1.2 Past Major Hazard Events

One important consideration in identifying and prioritizing hazards is past major hazard events, especially those that triggered federal or state disaster declarations. The MJHMP Planning Team reviewed and considered past major hazard events in Kern County as part of the screening and identification process. During this Plan update process, the Planning Team concluded its review of past major hazard events and identified the hazards that would be profiled in the updated MJHMP in July 2019, approximately six months before the COVID-19 pandemic began.

Most available information on major past hazard events comes from federal or state disaster declarations. These declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Additional federal or state disaster funding (or both) is generally available in response to a disaster declaration. State funding assistance is provided when a local government's capacity to respond to the disaster is exceeded. Should the disaster be so severe that both the local and state governments' capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs that accompany major disaster declarations. Quantity and types of damage are the determining factors.

Kern County has received 32 federal disaster declarations[1] since 1953, some of which were statewide, including:



9 Wildfires



2 Earthquakes



11 Severe Weather



1 Drought



5 Floods

Severe weather and flooding events are most likely to occur in the winter months, with twenty-five of the 54 federally-declared disasters occurring in January and February. Wildfires have typically occurred in the late summer and fall, with 170 wildfire declarations from July through October. Table 4-3 lists federal disaster declarations in Kern County since 1995.

[1] Officially, 33 disasters have been declared, as California was declared as part of Hurricane Katrina evacuation; however, no disaster occurred in California.

FEMA Approval 4/9/2021

Table 4-3: Disaster Declarations in Kern County 1995- present

Year	Date Declared	Incident Description	Disaster Number
2019	*07/19*	Earthquake	*EM-3415*
2017	*03/17*	Severe Winter Storms, Flooding, & Mudslides	*DR-4305*
2016	*08/16*	California Cedar Fire	*FM-5150*
2016	*06/16*	California Erskine Fire	*FM-5131*
2011	*09/11*	California Canyon Fire	*FM-2961*
2011	*09/11*	California Comanche Fire Complex	*FM-2971*
2011	*09/11*	California Keene Fire Complex	*FM-2970*
2011	*01/11*	Winter Storms, Flooding, & Debris & Mudflow	*DR-1952*
2010	*07/10*	California Bull Fire	*FM-2849*
2010	*09/10*	California Canyon Fire	*FM-2858*
2010	*08/10*	California Post Fire	*FM-2852*
2010	*07/10*	California West Fire	*FM-2850*
2008	*06/08*	California Wildfires	*EM-3287*
2007	*03/07*	Severe Freeze	*DR-1689*
2005	*09/05*	Hurricane Katrina Evacuation	*EM-3248*
2005	*02/05*	Severe Storms, Flooding, Debris Flow, & Mudslides	*DR-1577*
2005	*04/05*	Severe Storms, Flooding, Landslides, & Mud/Debris Flow	*DR-1585*
2003	*06/03*	California Sawmill Fire	*FM-2473*
2003	*06/03*	California Tejon Fire	*FM-2474*
2002	*07/02*	California Deer Fire	*FSA-2450*
1999	*02/99*	Severe Storms, Tornadoes, High Winds, and Flooding	*DR1267*
1998	*02/98*	Severe Winter Storms and Flooding	*DR-1203*
1995	*03/95*	Severe Winter Storms, Flooding, Landslides, Mud Flows	*DR-1046*
1995	*01/95*	Severe Winter Storms, Flooding, Landslides, Mud Flows	*DR-1044*

Source: FEMA Disaster Database via http://mitigatehazards.com/hazard-mapping/ , accessed 03/04/2020.

Drought declarations may also occur through the United States Department of Agriculture (USDA), as agricultural areas such as Kern County can be particularly impacted from drought. A USDA disaster declaration certifies that the affected county has suffered at least a 30-percent loss in one or more crop or livestock areas and provides affected producers with access to low-interest loans and other programs to help mitigate the impact of the drought. Importantly, all counties neighboring those receiving disaster declarations are eligible for the same assistance. Since 1995, Kern County qualified for USDA drought assistance in 2006 and 2009.

It is important to be aware that hazard events occurring outside County boundaries also directly and indirectly impact Kern County. For instance, dam failures and wildfires may occur outside Kern County but affect watersheds that drain into the County and result in flooding and other impacts related to watershed health. Power supply also could be interrupted by hazards outside of the County.

4.2 Hazard Prioritization

The Planning Committee's hazard prioritization process combines historical data, local knowledge, and consensus opinions to produce a matrix that illustrates whether each profiled hazard is an extreme, high, or medium priority. The criteria below were used to evaluate hazards and identify the highest risk hazard in Kern County. The results of the prioritization process for Kern County are shown in Figure 4-1.

Each participating jurisdiction also completed the hazard prioritization process specifically for the jurisdiction, and this important initial stage informed the rest of the planning process for each jurisdiction. Individual prioritization matrices are available in Volume 2 of this MJHMP.

The following questions and guidance shaped the ranking on the matrices:

Probability

What is the likelihood of a hazard event occurring in a given year?

- **Unlikely-** less than 1% annual probability or occurs rarely in the region or community
- **Possible-** 1%-10% annual probability or could occur. Uncommon in the region or community
- **Likely-** 10%- 100% annual probability or recurrent. Not frequent in the region or community
- **Highly likely-** 100% annual probability or occurs frequently in the region or community

Impact

In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?

- **Minor-** very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.
- **Limited-** minor injuries only. 10%-25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.
- **Critical-** multiple deaths or injuries possible. 25%-50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.
- **Catastrophic-** high number of deaths or injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.

Risk Assessment Matrix Definitions

PROBABILITY RATING

The likelihood of a hazard event occurring within a time period?

PROBABILITY

- **Highly Likely** - **Highly likely** - 100% annual probability. Or Likely to occur every year in your lifetime.
- **Likely** - **Likely** - between 10 & 100% annual probability. Or will occur several times in your lifetime.
- **Possible** - **Possible** - between 1 & 10% annual probability. Or Likely to occur some time in your lifetime.
- **Unlikely** - **Unlikely** - less than 1% annual probability. Or unlikely but possible to occur in your lifetime.

IMPACT RATING

In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs? The impact could be in terms of one hazard event (flooding from a culvert failure) or a large-scale event (multiple rivers flooding) in the same jurisdictional boundary.

IMPACT

Minor	Limited	Critical	Catastrophic

Minor - very few injuries, if any. Only minor property damage & minimal disruption on quality of life. Temporary shutdown of critical facilities.

Limited - minor injuries only. Approx. 10% or less of property in disaster footprint damaged or destroyed. Complete shutdown of critical facilities for more than one day.

Critical - multiple deaths/injuries possible. Between 25% and 50% of property in disaster footprint is damaged or destroyed. Complete shutdown of critical facilities for more than one week.

Catastrophic - high number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.

To concentrate resources, the jurisdictional planning team will focus on "High" and "Extreme" risk hazards. These hazards have the higher probability and greater impact as it relates to the jurisdictions planning area.

Hazard definitions are included in **Vol. 1** of this plan. Some hazards are discussed as subset hazards— e.g., "Dam Failure" within the "Flood" hazard profile. If a hazard is not present on the risk matrix or are grey in color, the jurisdictional planning team felt the hazard had a minimal footprint within their planning area and was not ranked.

Kern County Risk Matrix

PROBABILITY \ IMPACT	Minor	Limited	Critical	Catastrophic
Highly Likely	Medium	SOIL STABILITY, DROUGHT	WILDFIRE	Extreme
Likely	Medium	EXTREME WEATHER, SLOPE FAILURE	EARTHQUAKE, FLOOD	Extreme
Possible	Low	Medium	High	High
Unlikely	Low	Low	Medium	DAM FAILURE

Hazard Information / Legend:

- CLIMATE CHANGE — Climate change may change the frequency, duration and intensity of hazards within each planning area. If applicable Climate Change impacts are described at the end of each section.
- ALLUVIAL FANS — Alluvial Fan deposits and issues in Kern County. This hazard is profiled and defined under "Slope Failure" in Vol. 1 of this plan.
- SOIL STABILITY — Soil Stability in Kern County includes Land Subsidence and Wind Erosion. Definitions for each are described in Vol. 1. of this plan.
- SOIL STABILITY — If hazard symbol is grey or not present, the jurisdictional planning team did not develop hazard vulnerability information related to the planning areas due to perceived probability and impact described above.

Figure 4-1 Prioritized Hazard Assessment Matrix for Kern County

4.3 Kern County Geographic and Demographic Profile

The geographic and demographic profile for Kern County and participating jurisdictions sets the stage for the vulnerability assessment. Paired with the vulnerability assessment, the regional profile can help guide jurisdictions' resources to key populations and geographic areas.

4.3.1 Geography

Kern County is located in southern California, at the southern end of California's San Joaquin Valley. Kern County is California's third-largest county in land area, and at 8,172 square miles, is larger than the land area of Massachusetts, New Jersey, or Hawaii. It is also larger than the areas of Delaware, Rhode Island, and Connecticut combined (California State Association of Counties, 2014). Elevations range from a low of 206' above sea level along the northern border of the county to a high of 8824' in southwest Kern County, just north of the summit of Mt. Pinos (the summit is in Ventura County). The County is bordered by Los Angeles and Ventura Counties on the south, San Bernardino County on the east, Inyo, Tulare and Kings Counties on the north, and San Luis Obispo and Santa Barbara Counties on the west.

Kern County is as diverse as it is large. Terrain varies dramatically within the County, from the fertile lowlands of the San Joaquin Valley, rugged mountain peaks of the southern Sierra Nevada and Tehachapi mountains, to the sweeping panoramas of the Mojave Desert. The County contains the San Joaquin Valley, the Mojave Desert, and interspersed mountain regions. The San Joaquin Valley floor comprises most of the western third of the County and is the population and agricultural center. Mountain ranges include the Sierra Nevada Range, the Tehachapi Range, Temblor Range, El Tejon Mountains, and Tecuya Ridge. The Mojave Desert covers roughly the eastern quarter of the County. Many of the hazards experienced throughout Kern County are more prevalent in one region or another. For example, the mountain region is more susceptible to wildfires while the valley region may be more impacted by drought.

Kern's main water sources are snowmelt from the Sierras that feed into the Kern River from other tributaries and groundwater resources of the San Joaquin Valley and Mojave Desert. The Lake Isabella Dam on the Kern River is the major surface water impoundment in the County. Another important man-made body of water is the Gov. Edmund Brown Aqueduct (also called the California Aqueduct), which carries up to 2 million gallons of water per minute south from the Sacramento River Delta, through Kern County, and into metropolitan Los Angeles. The single largest water user is the Kern County Water Agency, who receives as much as 1 million acre-feet per year for its member districts who hold agricultural and municipal and industrial water supply contracts with the Agency. The aqueduct is visible along portions of Interstate 5, as are powerful pumping stations that help carry its flow over the Tehachapi Mountains towards Los Angeles. (Water Education Foundation, 2020)

Figure 4-2 displays a geographic overview of Kern County.

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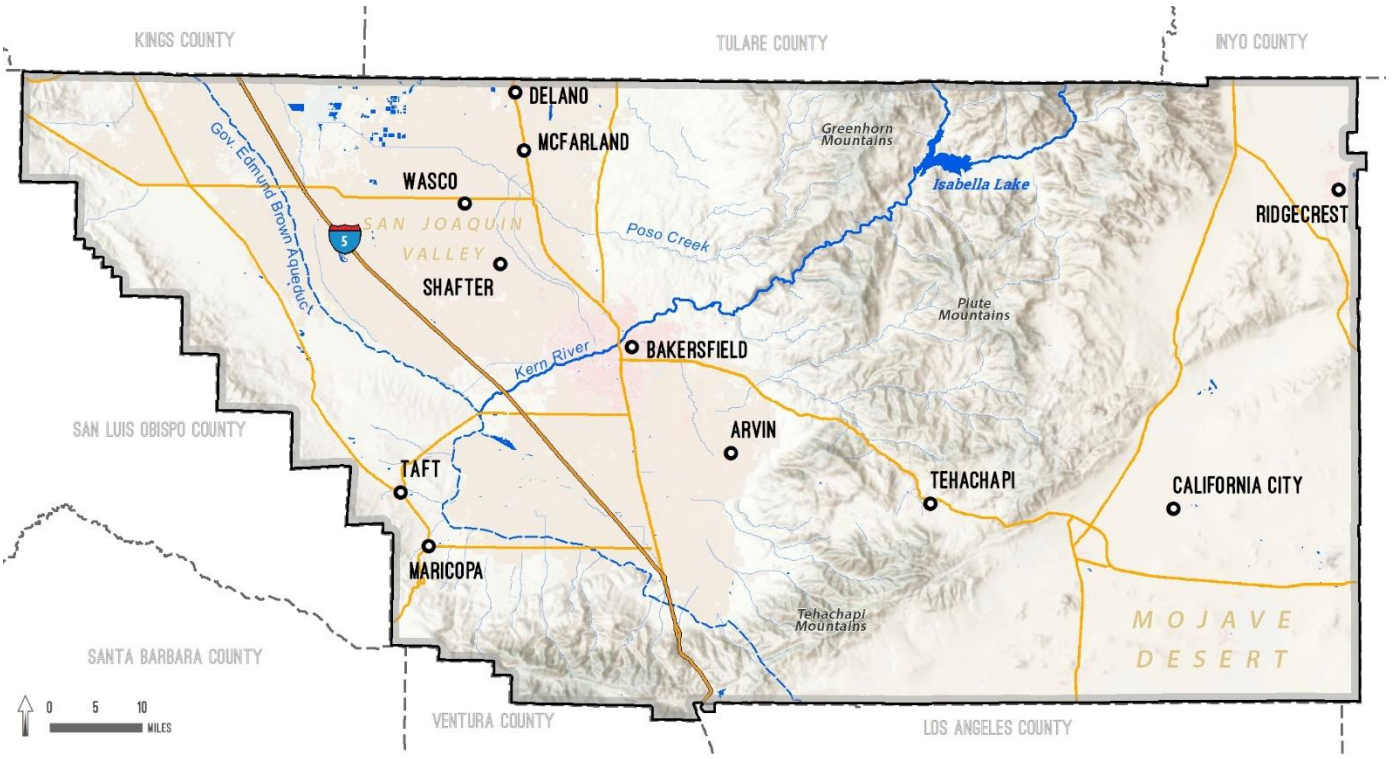


Figure 4-2 Kern County Geographic Overview

4.3.2 Climate

Due to a highly varied geography, Kern County has a diverse range of climates, determined largely by elevation and precipitation. Temperatures are marked by extremes, with summertime highs topping 100 degrees in the San Joaquin Valley and Mojave Desert, while winter temperatures dip into the teens during snowfalls in the higher mountains. Generally, the County is classified as desert or semi-arid, with hot, dry summers and mild, humid winters. In most areas, 90 percent of the precipitation occurs between November and April. The Valley averages 3 to 7 inches of precipitation annually. The western side of the Tehachapi and Sierra Nevada Ranges receive as much as 40 inches of precipitation a year. The desert averages 3 to 6 inches of precipitation a year but is extremely variable. Snowfall is rare in the desert and valley regions but may range from 1 to 4 inches. (Kern County Flood Insurance Study, 2008)

4.3.3 Demographics and Vulnerable Populations

Population information directly relates to the impact of hazards and to other community needs such as housing, industry, stores, public facilities and services, and transportation. Knowledge of the composition of the population, how it has changed, and how it may change in the future helps with future decision making. The United States Census Bureau estimated Kern County's population to be 896,764 in 2018, an estimated 7% increase since 2010. (United States Census Bureau, 2018) This is in contrast to an estimated 6% population increase in California in the same period. (*Id.*)

Importantly, demographics help identify which populations may be particularly vulnerable to hazard events. Some populations are at greater risk because of age, resources, physical abilities, or other factors. Vulnerability in the face of a hazard event is not a fixed characteristic; the same person may be at risk for some hazards but not at risk for others. For example, a low-income family without a car may be at risk for a wildfire or flood if a quick evaluation is necessary but prepared in the event of an earthquake. Some individuals are highly and permanently vulnerable to many hazards, such as the frail elderly; people living with chronic sensory, mobility, or cognitive impairments; and individuals dependent upon assistive devices or complex medical regimens in order to survive. (National Center for Disaster Preparedness, 2020) Vulnerable populations also may be living in hazard-prone areas, compounding their risk.

In the context of all-hazards preparedness and response planning, **at-risk individuals** (often used interchangeably with "**vulnerable populations**") are defined federally as "children, pregnant women, senior citizens, and other individuals who have access or functional needs in the event of a public health emergency." (42 U.S.C. § 2802(b)(4)(B)(2019)) Examples of these populations may include, but are not limited to, individuals with disabilities, individuals who live in institutional settings, individuals from diverse cultures, individuals who have limited English proficiency or are non-English speaking, individuals who are transportation-disadvantaged, individuals experiencing homelessness, individuals who have chronic medical disorders, and individuals who have pharmacological dependency.

Natural resource managers may be able to reduce vulnerability of certain populations by increasing the adaptive capacity of affected communities. Examples include cost-sharing to reduce fuels, stabilize structures, or implement flood-reducing measures or educational programs offered in English and Spanish and targeted to specific populations. Specifically planning for vulnerable populations in hazard mitigation can help prioritize resources where they will be the most effective.

This section explores the various demographic and economic circumstances surrounding common vulnerable populations.

4.3.3.1 Income & Housing

Income or wealth is one of the most important factors in natural hazard vulnerability. First, lower income populations are less able to afford housing and other infrastructure that can withstand extreme events. The poor typically occupy more poorly-built and inadequately-maintained housing. For example, mobile or modular homes are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes.

Second, low income populations are less able to purchase resources needed for disaster response. In the United States, individual households are expected to use private resources to prepare for, respond to, and recover from disasters, to a large extent. This means that households living in poverty and minorities are disadvantaged when confronting hazards. The more affluent are able to relocate to safer areas or rebuild following a hazard event. Moreover, individuals who do not own cars or who cannot afford gas for their cars will likely decide not to evacuate. (Krause & Reeves, 2017)

Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. Hurricane events such as Harvey, Irma, and Katrina demonstrate that low-income and minority communities are more vulnerable to hazard events, and they struggle to recover the most. (Id.)

Figure 4-3 shows the median household income distribution for Kern County. The "median" is the value that divides the distribution of household income into two equal parts (e.g., the middle). The median household income in Kern County in 2015 (in 2015 dollars) was estimated to be $55,775, compared to $56,516 across the U.S. (United States Census Bureau, 2015)

4.3.3.2 Age

Children and the elderly may be more vulnerable during an extreme hazard event.

Specific planning attention for the elderly is an important consideration, especially given the current aging of the American population. Elderly vulnerability can vary significantly based on health, age, and economic security. However, as a group, the elderly more often lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences that make recovery slower. They are more likely to be vision, hearing, or mobility impaired and more likely to experience mental impairment or dementia.

Additionally, elderly persons are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations.

Lower-income elderly populations are less likely to have access to medical care due to financial hardship and are more likely to need special medical attention which may not be readily available during natural disasters.

In many cases, both children and the elderly depend on others to care for them during day-to-day life. Very young children and the elderly may be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards. They also may be weaker and less able to survive a hazard event.

Finally, both children and the elderly have fewer financial resources and are frequently dependent on others for survival. For these populations to remain resilient before and after a natural hazard event, it may be necessary to assist residents with resources provided by the County, Cities, State and Federal emergency management agencies and organizations.

Based on the 2015 American Community Survey, 14% of Kern County's population is 65 or older. The overall age distribution for Kern County is illustrated in Figure 4-4 for population under 18 and Figure 4-5 for population over 65. Figure 4-5 shows that the highest concentrations of people over the age of 65 are east of Arvin. (United States Census Bureau, 2015)

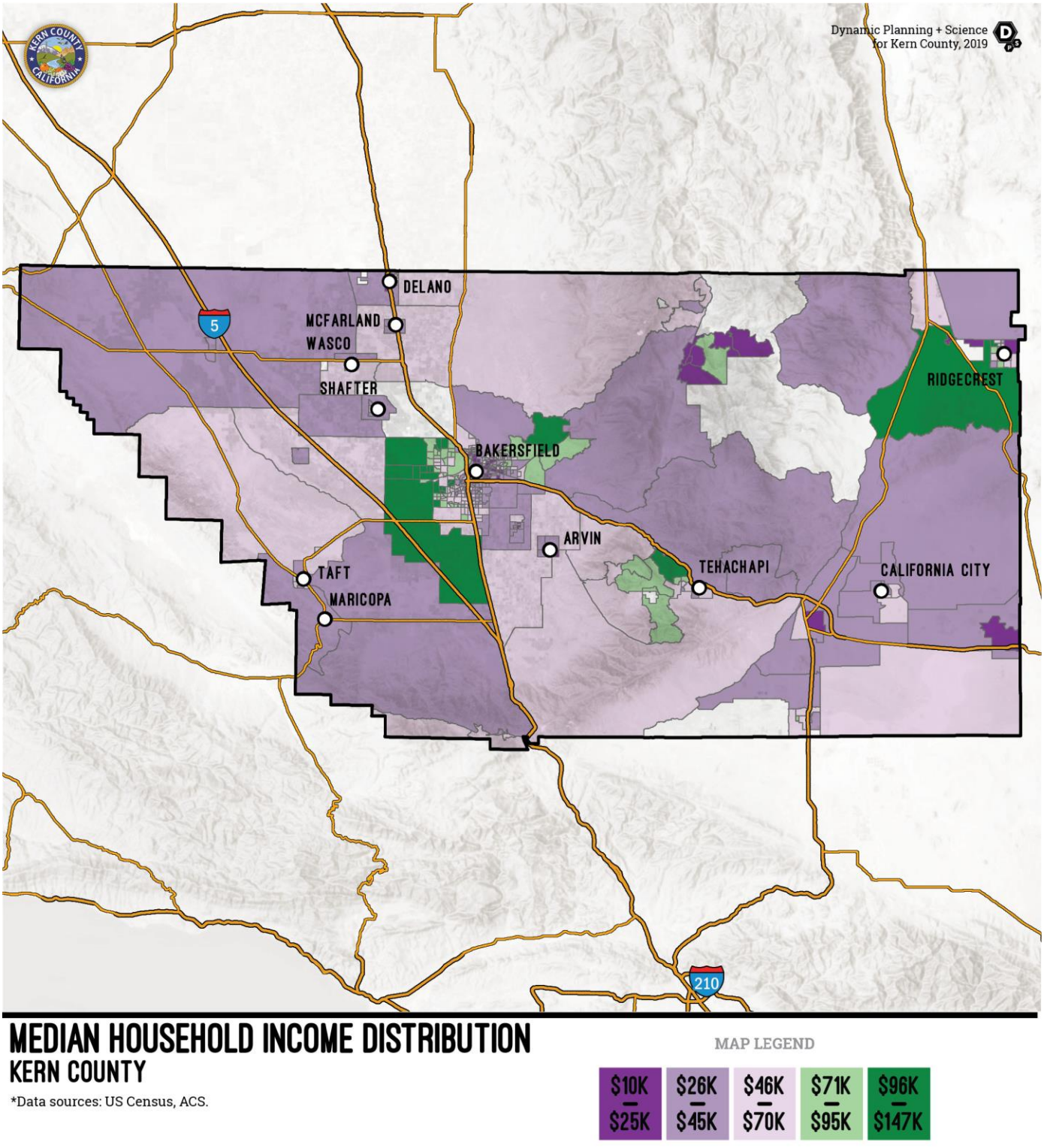


Figure 4-3: Median Household Income Distribution

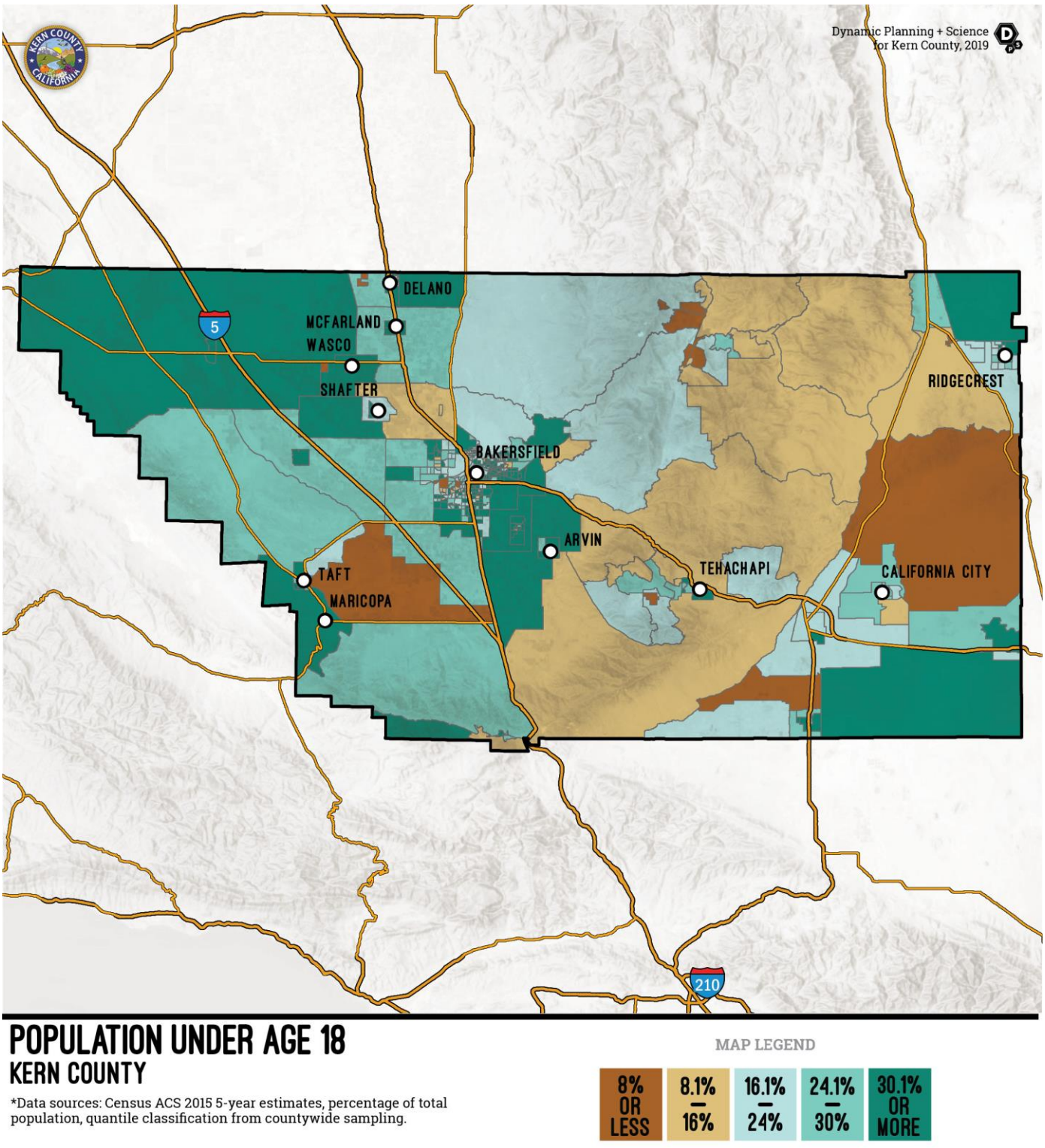


Figure 4-4: Population Under Age 18

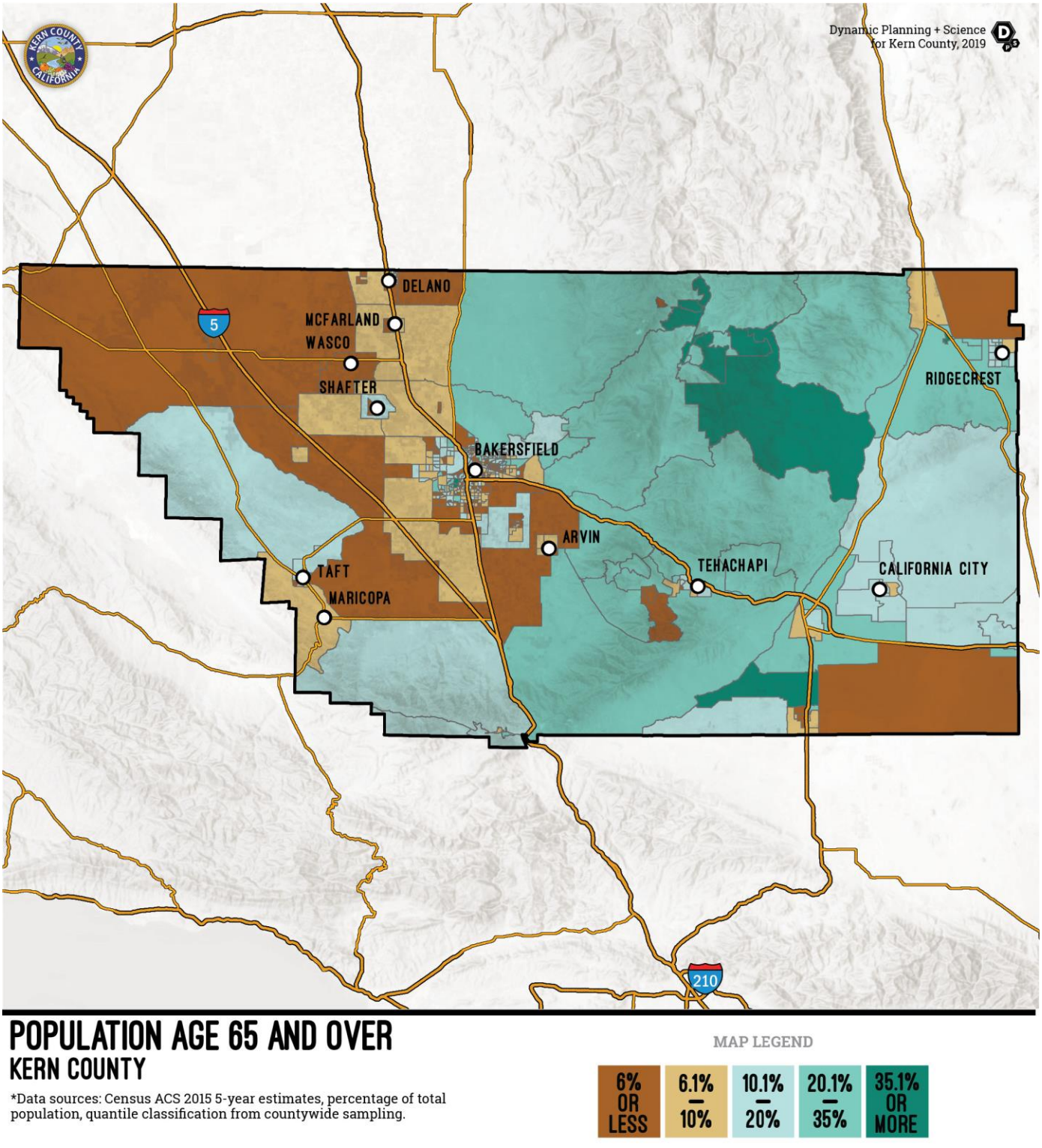


Figure 4-5: Population Over Age 65

4.3.3.3 Race, Ethnicity and Language

Non-English or limited-English speakers may have difficulty understanding emergency information as a result of language and literacy barriers. Non-white communities in fire-prone areas appear from research to be less able to adapt to a wildfire event. (Levin, Phil; Davies, Ian, 2019) Another study found that communities of color lose up to $29,000 on average in personal wealth following events like hurricanes and wildfires. (Mandel, How Natural Disasters Widen the Wealth Gap Between Mintority and White Communities, 2018) Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. Farm workers may be particularly vulnerable during a hazard event, especially those non-English speaking and those living in temporary worker housing. (California Employment Development Department, 2019) . (U.S. Dep't of Ag, 2017)

According to the 2017 American Community Survey estimates, Kern County is predominately white, at 75.1% of the total population. The largest minority population is Hispanic or Latino, at 52% of the total county population. This percentage includes other applicable race categories. See Figure 4-6 for the racial distribution within Kern County and a source note explaining the percentage estimates.

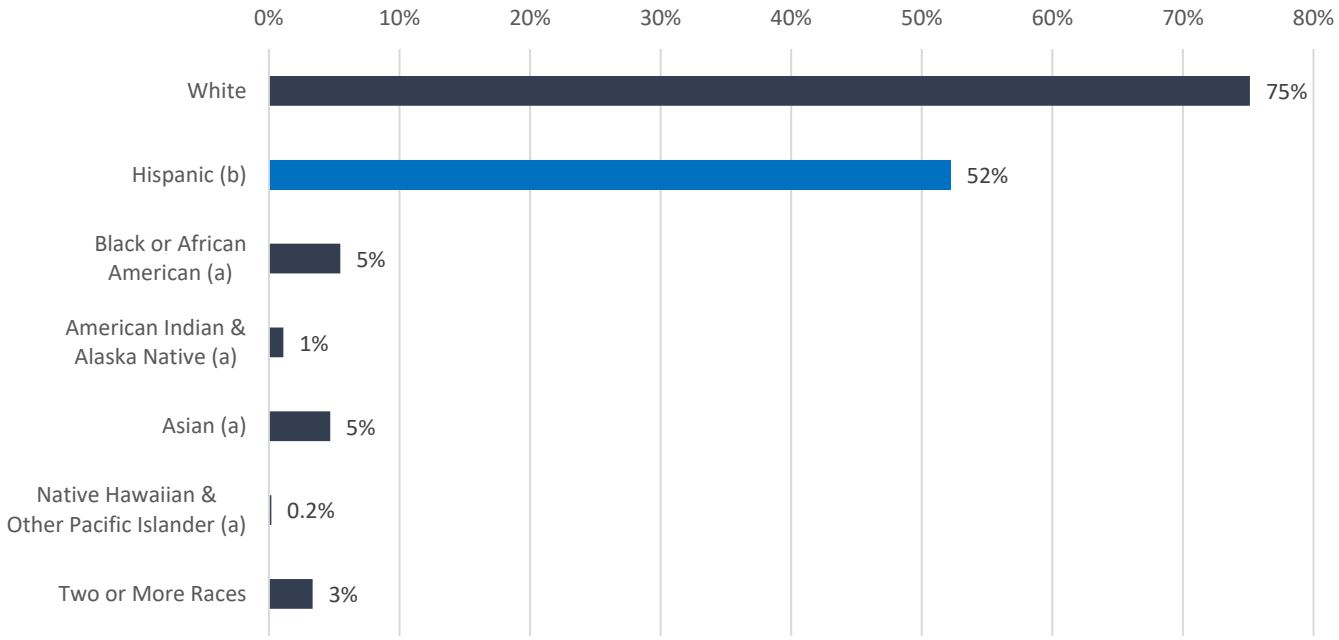


Figure 4-6: Kern County Race Distribution in 2017

Source: 2017 American Community Survey
Note: Hispanics may be of any race, so are included in applicable race categories. This has the effect of influencing total population percentage. (a) Includes persons reporting only one race. (b) Hispanics may be of any race, so also are included in applicable race categories

4.3.3.4 At-risk Individuals with Access and Functional Needs

Another vulnerable population is individuals with access and functional needs that may interfere with their ability to access or receive medical care before, during, or after a disaster or emergency. Irrespective of specific diagnosis, status, or label, the term "access and functional needs" refers to a broad set of cross-cutting access and function-based needs, generally distinguished into **access-based** or **function-based** needs according to the following:

- **Access-based needs** require that resources are accessible to all individuals, such as social services, accommodations, information, transportation, and medications to maintain health.
- **Function-based needs** refer to restrictions or limitations an individual may have that requires assistance before, during, and after a disaster or public health emergency.

At-risk individuals may have additional needs that must be considered in planning for, responding to, and recovering from a disaster or emergency. A recommended approach for integrating the access and functional needs of these individuals is to consider elements based on the CMIST (defined below) Framework:

- Communication – Individuals who may have limitations that interfere with the receipt of and response to information require information be provided in an appropriate and accessible format. This can include individuals who are deaf or hard of hearing, individuals who speak American Sign Language, individuals who have limited or no English proficiency, individuals who are blind or have low vision, and individuals who have cognitive or physiological limitations.
- Maintaining Health – Individuals who may require Personal Assistance Services (or personal care assistance) in maintaining their activities of daily living such as eating, dressing, grooming, transferring, and toileting.
  Independence – Includes individuals who function independently if they have their assistive devices, such as consumable medical supplies (diapers, formula, bandages, ostomy supplies, etc.), durable medical equipment (wheelchairs, walkers, scooters, etc.), and/or service animals.
- Services and Support – Includes support for individuals with behavioral health needs, those who have psychiatric conditions (such as dementia, Alzheimer's disease, Schizophrenia, severe mental illness), pregnant women, nursing mothers, infants, and children.
- Transportation – Includes individuals with transportation needs because of age, disability, temporary injury, poverty, addiction, legal restriction, or those who do not have access to a vehicle. This requires coordination to ensure access to mass transit and accessible vehicles such as para-transit. (Services, 2016)

While most individuals with access and functional needs do not have acute medical needs requiring the support of trained medical professionals, many will require assistance to maintain health and minimize preventable medical conditions. These individuals may require more time and assistance during an evacuation. It is estimated that over 38% of people over age 65 have some form of disability, as shown in

Table 4-4. (United States Census Bureau, 2018) These numbers warrant special attention from planners and emergency managers.

Table 4-4: Disability Status of Non-Institutionalized Population in Kern County in 2017

Age	Persons with a Disability	Percent of Age Group
Under 18 years	9,279	4
18 to 64 years	52,065	10
Age 65 years and over	34,097	40

Source: 2017 American Community Survey

4.3.4 Economy

Agriculture has been Kern County's number one industry for many years. Kern County ranks in the top four California counties in agricultural production. Kern County became the leading county with an agricultural production value of $7.19 billion in 2016. (California Department of Food and Agriculture, 2017) Leading export commodities include almonds, apples, carrots, cotton, garlic, grapes, onions, oranges, pistachios, plums, and roses. These commodities are exported to over 85 foreign countries. The Pacific Rim, including China, Hong Kong, Japan, Republic of Korea, Australia, Canada, India, Vietnam, and the Philippines, receive most of the exported commodities. (2017 Kern County Agricultural Crop Report, 2017)

Kern County had the most farm workers in California in 2016, totaling 150,300, defined by an individual having at least one farm job. In Kern County, the number of farmworkers rose 25% in 2015. (University of California, 2019) The leading sectors of farm employment in Kern County include farm labor contractors (97,900), tree nut farming (11,800), grape vineyards (11,300), other vegetables and melon farming (3,100), and other non-citrus fruit farming (3,000).

A high percentage of farmworkers in Kern County are estimated to be migrant workers. Some of these farm workers may not have proper documentation to be working in the U.S. and may be more hesitant to seek aid or ask questions to properly prepare for a hazard event because of their immigration status. Farmworkers in Kern County are paid an average wage significantly below the national average. In 2014, the average annual wage in the Kern County food system was $24,182, compared to $43,737 for all industries. (Sustainable Agriculture Research and Education Program, 2017)

Kern ranks as the largest oil-producing county in the state, with most of the 30,000 working oil wells studding the hills along the western edge of the County. In the desert to the east, the military plays an important role as the home to Edwards Air Force Base and the China Lake Naval Weapons Center. Edwards Air Force Base ranks among the best-known military installations in the country, being the site of many space shuttle landings, and the place where Air Force test pilots push the limits of aircraft under development.

The population centers of Kern County generally correlate with the economic bases for the regions.

Bakersfield, the county seat, is home to over one-third of the County's residents and has seen continued economic growth. Ridgecrest, Tehachapi, and Mojave in the east are aligned with military installations that provide employment. Eastern Kern County is known as a space industry employer. Rosamond provides reasonably priced homes to Los Angeles commuters. Taft and other smaller communities in the southern area of Kern are contiguous to large petroleum fields that have been in operation since the early 1900's. Lamont, Arvin, Delano, Shafter, and Lost Hills provide services and homes to the workers who labor in the fields of the large farms and ranches in the county.

The Kern economy can fluctuate more than other counties because of the cyclical nature of the agricultural, military support, and petroleum industries that comprise the largest segments of the Kern economy. Kern County, CA, had the largest percentage decrease in GDP (-0.7 percent). The mining, quarrying, and oil and gas extraction industry (primarily oil and gas extraction) was the leading contributor to the decrease. (United States Bureau of Economic Analysis, 2018) 2017 unemployment in the County was at 11%. (US Census Bureau, 2017) According to the Bureau of Labor Statistics, in Dec 2019 there were 357,700 jobs in all industries in Kern County. Table 4-5 shows the number of jobs by sector in the County of the top ten occupations in 2018. The top sectors farming, fishing, and forestry related, office and administrative support occupations related, and sales and related occupations.

Table 4-5: Top 10 Jobs by Occupation in Kern County[1] in May 2018

Occupation	Percent of total employment (in %)	Mean hourly wage (in $)
Farming, Fishing, and Forestry	13.3	11.77
Office and Administrative Support Occupations	11.7	18.43
Sales and Related Occupations	8.1	17.96
Food Preparation and Serving Related	7.8	12.95
Education, Training, and Library Occupations	7.5	31.65
Transportation and Material Moving	7.0	18.69
Construction and Extraction	5.4	25.72
Healthcare Practitioners and Technical Occupations	4.8	40.66
Installation, Maintenance, and Repair	4.3	24.75
Production Occupations	3.8	18.84
Management Occupations	3.7	54.56

1 The Bureau of Labor Statistics refers to Kern County as the "Bakersfield, California Metropolitan Statistical Area."

Source: Bureau of Labor Statistics, May 2018, https://www.bls.gov/regions/west/news-release/occupationalemploymentandwages_bakersfield.htm.

4.3.5 Past and Future Trends in Development

Kern County has long been on the forefront of planning for the preservation of agricultural lands and intends to remain leaders in planning for a sustainable future. Kern County has retained its prime agricultural lands in production, even while vast tracts of farmland in other parts of the state have been

urbanized. Looking to the future, there are a number of demographic and land use trends relating to housing, population, and employment issues.

Past development that most increased the risk of hazards in the County happened many decades and even more than a century ago. The County and other participating jurisdictions are well aware of areas of increased hazard risk through older development.

More recently, development in the last few decades has occurred with minimized hazard risk because of existing overlay of federal, state, and local regulation. First, the County and its municipal planning partners all adopt general plans (GPs) which serve as blueprints for establishing long-range development policies, as directed with California's General Planning Law. A GP provides a basis for private development proposals and public projects to remain consistent with existing city, regional and state policies. The GP is designed to help the County and participating jurisdictions address issues related to land use, circulation (traffic), housing, open space, conservation, noise, and safety. The Land Use portion of the plan helps guide the County and participating jurisdictions in determining the location of future development(s), to include possible future annexations for municipal jurisdictions. The Safety Element of the GP serves to decrease risk of impact from natural hazards through multiple required elements and subsection most importunately through the health and safety as required by the California Sate Law.

All planning partners reviewed their general plans under the capability assessments undertaken for this hazard mitigation plan. Deficiencies revealed by these reviews are identified as mitigation actions to decrease risks to move beyond past trends.

Moreover, while past development has occurred in hazard areas to some degree, increasing hazard risks, development standards and performance measures, often times incorporated into specific plans, policy plans, and master plans, are employed to reduce risk. These development standards are continually improving and will continue to strengthen into the future.

The total housing units forecast for Kern County includes occupied and vacant housing units. Current methodologies utilized for estimating housing trend predictions include projections based on jobs-to-housing ratios. These models indicate that the region's housing stock will increase by about 1.2 percent per year, but multifamily housing will grow faster, by about 2.3 percent per year, compared to 0.9 percent per year for single family housing. Population forecasts indicate that the County's household population (those living in households) will increase annually by about 1.8% whereas its group quarters population (those living in institutional settings, primarily correctional facilities, college dormitories, and nursing homes) will increase by about 1.1% annually between 2015 and 2050. (Kern Council of Governments, 2015)

Current employment forecasts predict a lower level of growth in the farming sector over the next 35 years. This reflects the potential impact of water supply constraints and the potential conversion of farmland to other uses such as habitat conservation, water recharge, solar, and urban development. The forecast does show an increase in the mining, logging, and oil and gas exploration and extraction sector. Employment in this sector is almost exclusively in oil and gas. Employment in this sector could vary based on the

consistency of oil prices. Total employment forecasts predict an upward trend in growth. (Kern Council of Governments, 2015)

General trends in development indicate a growth pattern which began in 2010 and was reaffirmed in 2013 by a more robust housing market. Wise public policies and social trends explain the healthier trend. For instance, there was federal intervention in the mortgage market and rising incomes. The federal government changed housing finance patterns which consequently influenced how housing was built, bought, and sold in the United States. Additionally, migration patterns help to explain demographic forecasts in the San Joaquin Valley. These trends explain development patterns among many of the Counties in the Valley, including Kern County. (Kern Council of Governments, 2015)

Participating jurisdictions have gone to great lengths to ensure future development within hazard areas is minimized and mitigated to the greatest extent possible. Section 5.3 (Capabilities Assessment) of Volume 1 for the County and each jurisdiction's capabilities assessment of Volume 2 of this MJHMP explain those proactive steps in greater detail. Buildings are increasingly more resilient to hazards through California's building codes, some of the strongest in the country. Nationally, building codes have continually improved disaster resilience, and since 1990 those great improvements have only added about 1% to construction costs. (National Institute of Building Sciences, 2019)

4.4 Vulnerability Assessment Methods

This section provides an overview of the methods used in the vulnerability assessments in Section 4.5. Vulnerabilities to each hazard are assessed in a two-step process, as outlined in this section. First, population, critical facilities, and county parcels are inventoried to develop a "lay of the land." Second, the inventories are used to calculate estimated exposure and damage from hazards at various levels of severity. A more detailed explanation of the methodology is included in Appendix A.

The vulnerability assessment utilizes geospatial data along with local knowledge of past events. Geospatial data is essential in determining population and assets exposed to hazards identified in this plan. Geospatial analysis can be conducted if a natural hazard has a spatial footprint that can be analyzed against the locations of people and assets. In Kern County, dam failure, earthquake, flooding, landslide, soil subsidence, and wildfire have identifiable geographic extents and corresponding spatial information about each hazard.

Figure 4-7 illustrates the data inputs and outputs used to create the vulnerability analyses for each hazard in Section 4.5.

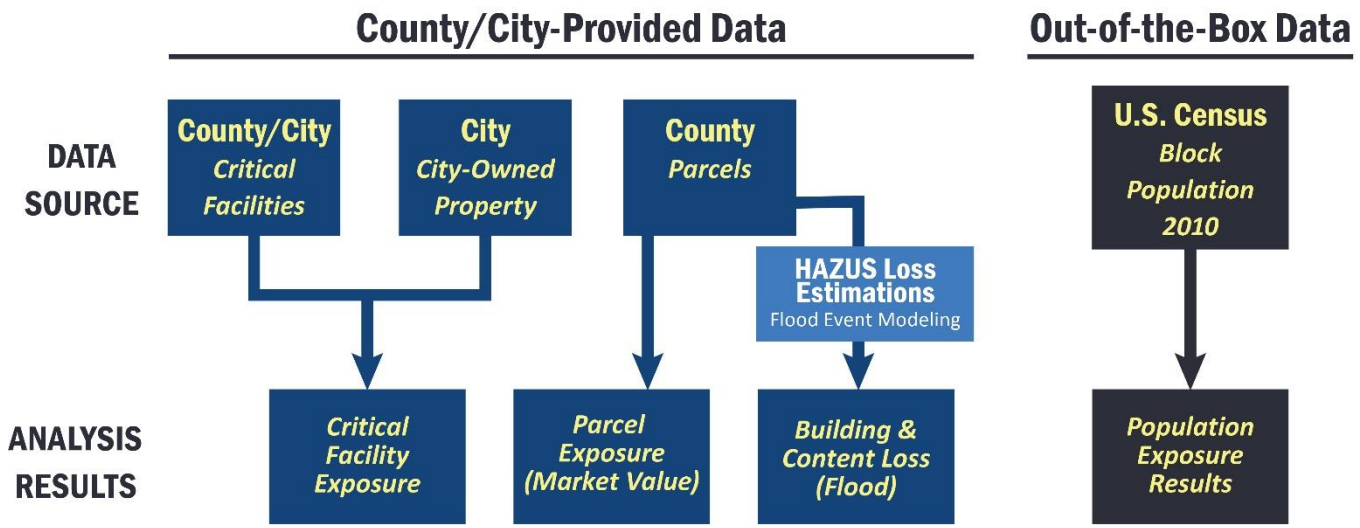


Figure 4-7: Data Source and Method

4.4.1 Population and Asset Inventory

In order to describe vulnerability for each hazard, it is important to first understand the total population and total assets at risk. The population and asset inventories provide a baseline to measure the significance or vulnerability to people and assets for natural hazard events. The asset inventories can also be used to estimate damages and losses expected during a "worst case scenario" event for each hazard. The following sections provide a description of the total population, critical facilities, and parcel inventory inputs.

4.4.1.1 Population

An initial step in producing the hazard-specific vulnerability assessments is to determine the population near each natural hazard. Each natural hazard scenario affects the County residents differently depending on the location of the hazard and the population density of where the hazard event could occur. For hazards that potentially affect the whole county such as earthquake or drought, the vulnerability assessment assumes 896,764 persons or 100% of the County's population is exposed.[2] Vulnerability assessments presented in Section 4.5 summarize the population exposure for each natural hazard if available.

4.4.1.2 Critical Facilities Inventory

Critical facilities are of particular concern when planning to mitigate hazards. A critical facility is a structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to cause disruption of vital socioeconomic activities if it is destroyed, damaged, or functionally impaired.

Critical facilities inventory data was developed from a variety of sources, including County, City, District, State, Federal, and private industry datasets. A critical infrastructure spatial database was developed to translate critical facilities information into georeferenced[3] points and lifelines.

Critical facility points include police stations, fire stations, hospitals, elder care facilities, day care facilities, buildings containing hazardous materials (HAZMAT), schools, transportation infrastructure, utilities, and government buildings. **Lifelines** include communication, electric power, liquid fuel, natural gas, and transportation routes. A current representation of the critical facility points and lifelines are provided in Figure 4-8. Some critical facility information has been omitted from this document due to national security purposes.

Critical facilities and transportation and lifeline data came from a collection of sources, including but not limited to Kern County GIS, Kern County and local jurisdiction insurance data, California Department of Social Services (CDSS), California Energy Commission (CEC), Federal Communications Commission (FCC), Hazus, U.S. Army Corps of Engineers (USACE), FEMA, and National Park Service (NPS). All data sources have a level of accuracy acceptable for planning purposes. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

[2] Population estimates were derived from 2018 Census American Community Survey (ACS) information.
[3] To georeference something means to define its existence in physical space. That is, establishing its location in terms of map projections or coordinate systems. The term is used both when establishing the relation between raster or vector images and coordinates, and when determining the spatial location of other geographical features.

FEMA Approval 4/9/2021

4.4.1.3 Parcel Value Inventory

The Kern County Assessor's data is essential to developing parcel values exposed to each hazard and includes current fair market value of at-risk assets. Kern County Parcel Value Inventory is summarized in Table 4-6. This table only includes parcels that are located in unincorporated Kern County. The Parcel Value Inventory includes market value,[4] content replacement value, and total assessed value ("total value"), and each hazard profile outlines predicted impacts to this inventory for each hazard's geographic extent. These elements are called out in the table because, in the event of a disaster, the value of the infrastructure or improvements to the land is usually the focus of concern. Generally, the land is not a total loss, and structures can be rebuilt or contents replaced.

"Total market value" as presented in this plan reflect Kern County Assessor data including fair market value where available. If no fair market value was available for a given property, the value reflects the assessed improvement value.

"Total content value" was calculated based on assessor's use codes, translated to occupancy-based multipliers. Each occupancy class prescribes a specific content cost multiplier used to calculate the content cost values shown in the summary and in the hazard profiles in Section 4.5. Occupancy-based content cost multipliers used in this plan reflect those found in the FEMA Hazus 4.2 technical manuals.

Table 4-6: Parcel Counts and Value

	Total Parcels	Total Market Value ($)	Total Content Value ($)	Total Value ($)
Unincorporated County	91,455	$ 10,906,675	$ 5,453,338	$16,360,013

Currency in Thousands. Total market value as provided by County Assessor's Office. Content value calculated using content multipliers per Hazus occupancy classes per county land use designation. Total value is the sum of total market value and total content value.

[4] Market Value Includes a long-term asset which indicates the cost of the constructed improvements to land, such as buildings, driveways, walkways, lighting, and parking lots.

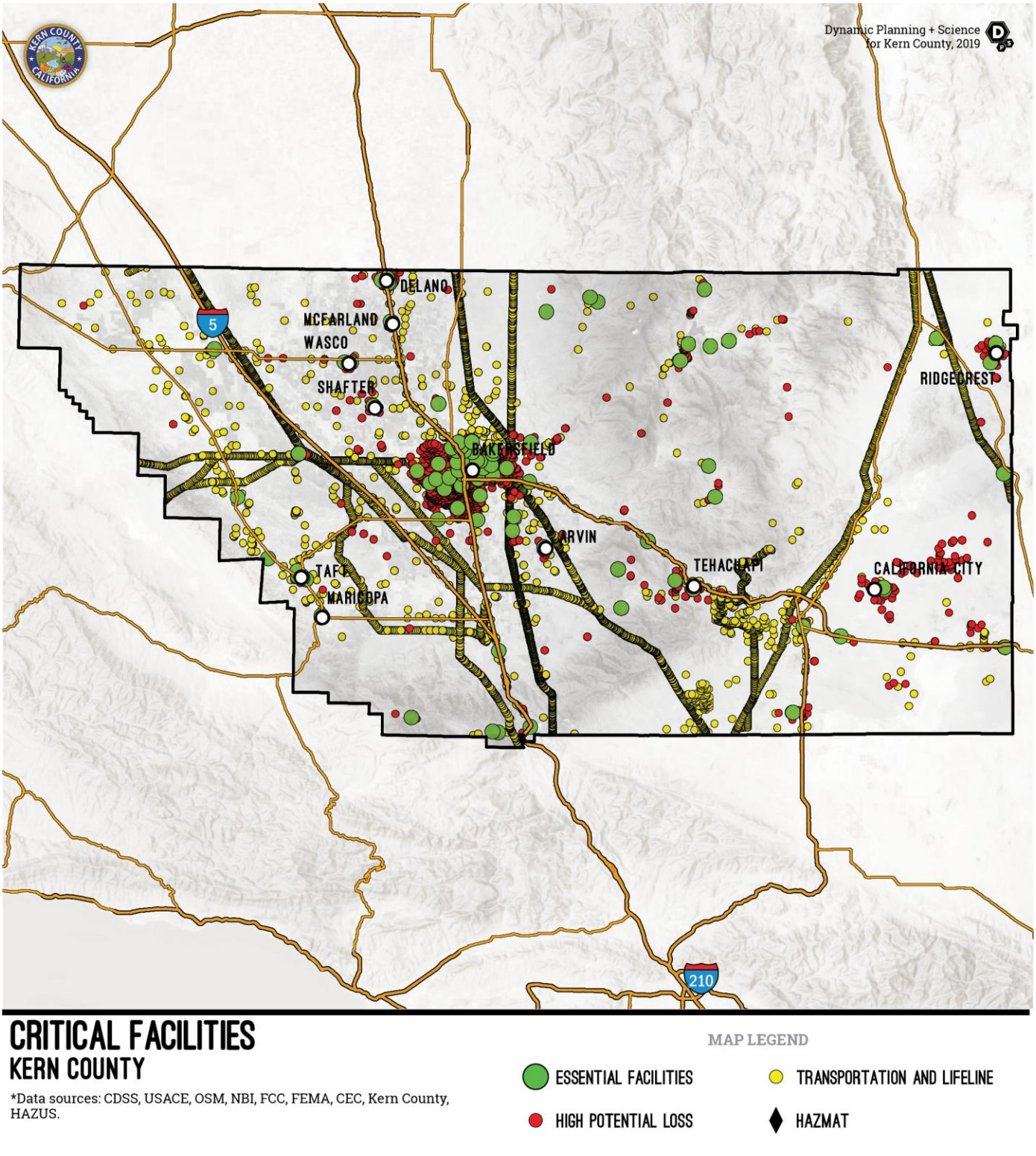


Figure 4-8: Critical Facilities in Kern County

4.4.2 Hazard Exposure and Damage Estimation

The population and inventory information are used to generate specific exposure and damage estimations based on the severity of specific hazard events. The hazards in Kern County which have known geographic extents and corresponding spatial information, and thus have exposure and damage estimations, are:

- earthquake,
- flooding,
- slope failure,
- soil subsidence,
- dam failure, and
- wildfire.

Population and Asset Exposure

"Exposure" of assets and population refers to the total counts of parcels, people, facilities, and assets within the planning area in which a hazard event may occur. A natural hazards overlay was developed to reflect the combination of many known natural hazard spatial footprints. The spatial overlay method enables summarization of building values, parcel counts, population exposure, and critical facility exposure within a hazard's geographic extents. Figure 4-9 illustrates hypothetical flooding exposure. Exposure numbers were generated using Kern County Assessor, address point, and parcel data for replacement and content cost estimates.



Figure 4-9: Hazard Exposure Explanation Graphic

Damage Estimation

For flood and earthquake, detailed damage estimations were conducted through FEMA's Hazus software. Hazus is a nationally applicable, standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. The estimated damage and losses provided by the Hazus Software is a based upon chosen severity of events and provides the ability to understand possible widescale damage to buildings and facilities.

In the hypothetical geography shown in Figure 4-10, even though both structures are exposed to flooding, it is expected that the structure with a first floor height below the depth of flooding will receive significantly more damage than the structure with a first floor height above the expected water depth. For a more detailed explanation on risk assessment methods, see Appendix A.

At-risk populations, critical infrastructure, improved parcels, and loss results for each hazard category are provided in bar chart summary tables in Section 4.5 to evaluate the percentage of assets exposed to different types of hazards. The side-by-side comparison allows participating jurisdictions to evaluate impacts of potential hazards to prioritize hazard mitigation energy and resources.



Figure 4-10: Hazus Damage Estimation Example

4.5 Vulnerability to Specific Hazards

This section introduces prevalent hazards within the unincorporated portions of Kern County and analyzes how each may affect populations, property, and critical facilities within the County's jurisdiction. Importantly, the hazard mitigation strategy presented in Section 5 is informed by, and responds to, the particular vulnerabilities outlined in this section. The mitigation strategy provides prescriptions or actions to achieve the greatest reduction of vulnerability based on this section, which results in saved lives, reduced injuries, reduced property damage, and protection for the environment in the event of a natural hazard. Methods for calculating exposure and loss estimates are described in Section 4.4 and Appendix A.

This section provides quantifiable exposures to people and property and also contains damage and loss estimates for the unincorporated portions of the County. Participating Jurisdiction Annexes in Vol. 2 of this plan contain specific vulnerabilities to hazards. This section provides information for the following hazards that were prioritized by the MJHMP Planning Committee:

Severe Weather
SECTION 4.5.1



Flood
SECTION 4.5.2



Dam Failure
SECTION 4.5.3



Earthquake
SECTION 4.5.4



Wildfire
SECTION 4.5.5



Drought
SECTION 4.5.6



Slope Failure
SECTION 4.5.7



Soil Stability
SECTION 4.5.8



4.5.1 Severe Weather Hazard Profile



Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life.

Severe weather events can be categorized into two groups: those that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Severe weather, technically, is not the same as extreme weather, which refers to unusual weather events at the extremes of the historical distribution for a given area. (Crop Insurance Solutions, n.d.)

The MJHMP Planning Committee identified three types of severe weather events that typically impact Kern County: high wind, winter weather, and high heat. Thunderstorms are not highlighted as a severe weather hazard on their own, as the primary impact of thunderstorms is the potential spread of wildfire, which is described in detail in Section 4.5.5.

The following are characteristics of severe weather events that can occur in Kern County.

High Wind

Damaging winds are classified as those exceeding 60 mph. Damage from such wind accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds—**Any thunderstorm wind that is not associated with rotation; this term is used primarily to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts—**A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts—**A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts—**A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are both wet and dry microbursts. A wet microburst is accompanied by heavy precipitation. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.

- **Gust front**—A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho**—A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of the boundary formed by horizontal spreading of thunderstorm-cooled air. The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo**—A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground. (The National Severe Storms Laboratory, n.d.)

Extreme Cold / Freeze Events

Extreme cold and freeze events are most likely to occur in Kern County during the months of November-February. Prolonged exposure to the cold can cause frostbite or hypothermia, with infants and the elderly being the most susceptible. Extreme cold can freeze and burst pipes and impair communication facilities. Late or early freeze events can have a devastating effect on agriculture and the economy of the region. Freeze events in Kern County usually occur in the Central Valley and are becoming less exceptional as extreme weather conditions become more common due to climate change.

Hail

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Super-cooled water may accumulate on frozen particles near the backside of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry-growth hailstones grow when the air temperature is well below freezing, and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are "frozen" in place, leaving cloudy ice.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are "balanced" in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting its layers. Hailstones can begin to melt and then re-freeze together, forming large, irregularly-shaped, damaging hail.

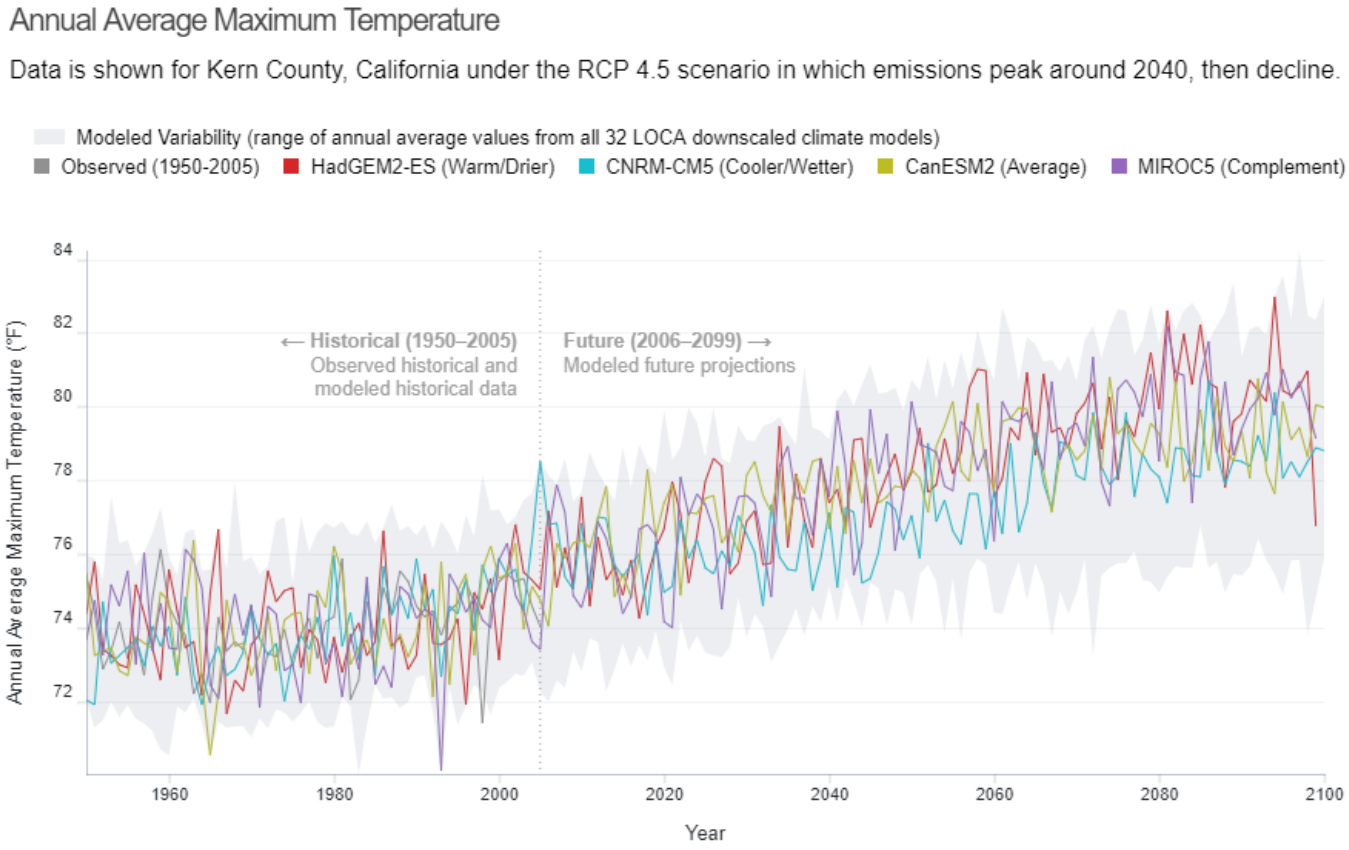
High Heat / Heat Waves

Heat waves are periods of abnormally hot weather lasting days to weeks. The number of heat waves has been increasing in recent years across the Country and locally. Figure 4-11 displays historical and projected annual average maximum temperature increase in California from 1950 to 2099. Climate change will continue to cause extreme heat events more often. Studies show that by the end of this century, the number of days with temperatures reaching 100°F or more is projected to increase dramatically across the United States as a result of climate change. What the public now considers to be an exceptional event could become routine across much of the country. As temperatures rise and extreme heat events become longer, more severe, and more frequent, experts expect to see more health problems and deaths caused by heat (Center for Disease Control).

According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the National Weather Service (NWS), among natural hazards, only the cold of winter—not lightning, hurricanes, tornados, floods, or earthquakes—takes a greater toll. (National Weather Service, 2020) In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the heat wave of 1980, more than 1,250 people died. (Disasters Are Us, n.d.)

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Elderly persons, small children, chronic invalids, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves in areas where moderate climate usually prevails. (Canadian Centre for Occupational Health and Safety, 2020)

Heat emergencies are often slower to develop, taking several days of continuous, oppressive heat before a significant or quantifiable impact is seen. Heat waves do not strike victims immediately, but rather their cumulative effects slowly take the lives of vulnerable populations. Heat waves do not cause damage or elicit the immediate response of floods, fires, earthquakes, or other more "typical" disaster scenarios. While heat waves are obviously less dramatic, they are potentially more deadly. The worst single heat wave event in California occurred in Southern California in 1955, when an eight-day heat wave resulted in 946 deaths. (California Office of Emergency Services, 2008)



- Source: Cal-Adapt. Data: LOCA Downscaled Climate Projections (Scripps Institution of Oceanography), Gridded Historical Observed Meteorological Data (University of Colorado, Boulder).
- Four models have been selected by California's Climate Action Team as priority models for research contributing to California's Fourth Climate Change Assessment (Pierce et al., 2018). Projected future climate from these four models can be described as producing:
  - A *warm/dry* simulation (HadGEM2-ES)
  - A *cooler/wetter* simulation (CNRM-CM5)
  - An *average* simulation (CanESM2)
  - The model simulation that is most unlike the first three for the best coverage of different possibilities (MIROC5)

Figure 4-11 Historical & Projected Annual Average Maximum Temp Increase
Source: Cal-Adapt

Climate Change

The effects of climate change are varied and include warmer and more varied weather patterns, such as melting ice caps and poor air quality. As a result, climate change will likely worsen a number of natural hazards including severe weather. The effects of climate change on severe weather are most likely to create more frequent and prolonged periods of extreme heat. However, climate change will result in unpredictable temperature fluctuations that could lead to freeze events during the warmer months of the year which could have a devastating effect on agriculture. (United States Environmental Protection Agency, 2016)

4.5.1.1 Plans, Policies, and Regulatory Environment

There are very few formal regulations that pertain directly to severe weather events. The California Building Code,[5] adopted by Kern County and the participating jurisdictions, is generally adequate to properly address development impacts from severe weather events.

Faulty Weather Protection in Kern County Code, § 1001.7

Kern County Code includes provision for severe weather preparedness having to do with substandard building conditions. Defective housing materials and general conditions demonstrating a lack of weather protection and requiring maintenance or repair include crumbling or loose plaster, ineffective waterproofing of exterior walls, roof or floors, and broken windows.

4.5.1.2 Past Events

Strong wind events and frost or freeze events have been the only type of severe weather events to occur in Kern County since the year 2000 (not high heat). Table 4-7 summarizes extreme weather events in Kern County since 2000, as recorded by the National Oceanic and Atmospheric Administration (NOAA). Strong wind events are most common, resulting in property damage every year since 2000.

Table 4-7: Severe Weather Damage Summary by Year 2000-2019

Year	Total Property Damage Value ($)	Total Crop Damage Value ($)
Strong Wind Events		
2002	12,000	0
2003	277,000	0
2004	218,000	0
2005	137,000	0
2006	376,000	112,500
2007	113,500	0
2008	106,900	9,000

[5] Available at https://www.dgs.ca.gov/BSC/Codes.

Year	Total Property Damage Value ($)	Total Crop Damage Value ($)
2009	12,800	0
2010	708,000	0
2011	9,000	0
2012	147,000	0
2013	61,000	0
2014	31,000	0
2017	100,000	0
2018	6,000	0
2019	381,000	0
Total	**2,696,200**	**121,500**
Frost/Freeze Events		
2001	0	1,100,000
2006	0	5,420,000
2007	150,000	568,600,000
Total	**150,000**	**575,120,000**

Source: NOAA Storm Events Database

4.5.1.3 Location

Severe weather events have the potential to happen anywhere in the planning area. Communities in the Central Valley are more susceptible to extreme weather and freeze events. Wind events are most damaging to areas that are heavily wooded. The following figures show average weather conditions for Kern County, including:

- Figure 4-12: Average Annual Precipitation,
- Figure 4-13: Normal Maximum Temperatures for July,
- Figure 4-14: Normal Minimum Temperatures for January, and
- Figure 4-15: Annual Average Wind Speed.

Table 4-8 explains further the classes of wind power density shown in Figure 4-15.

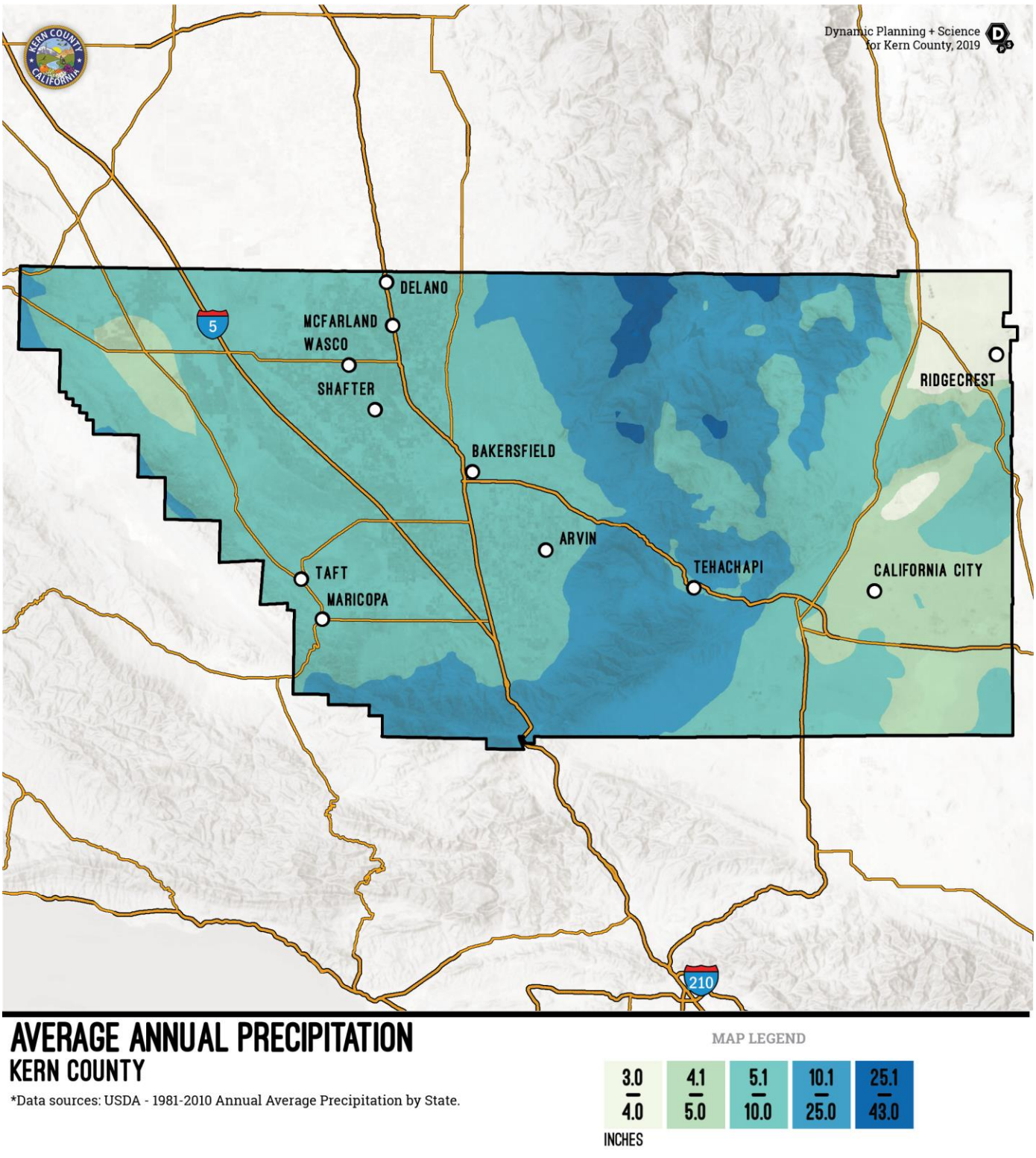


Figure 4-12 Kern County - Average Annual Precipitation

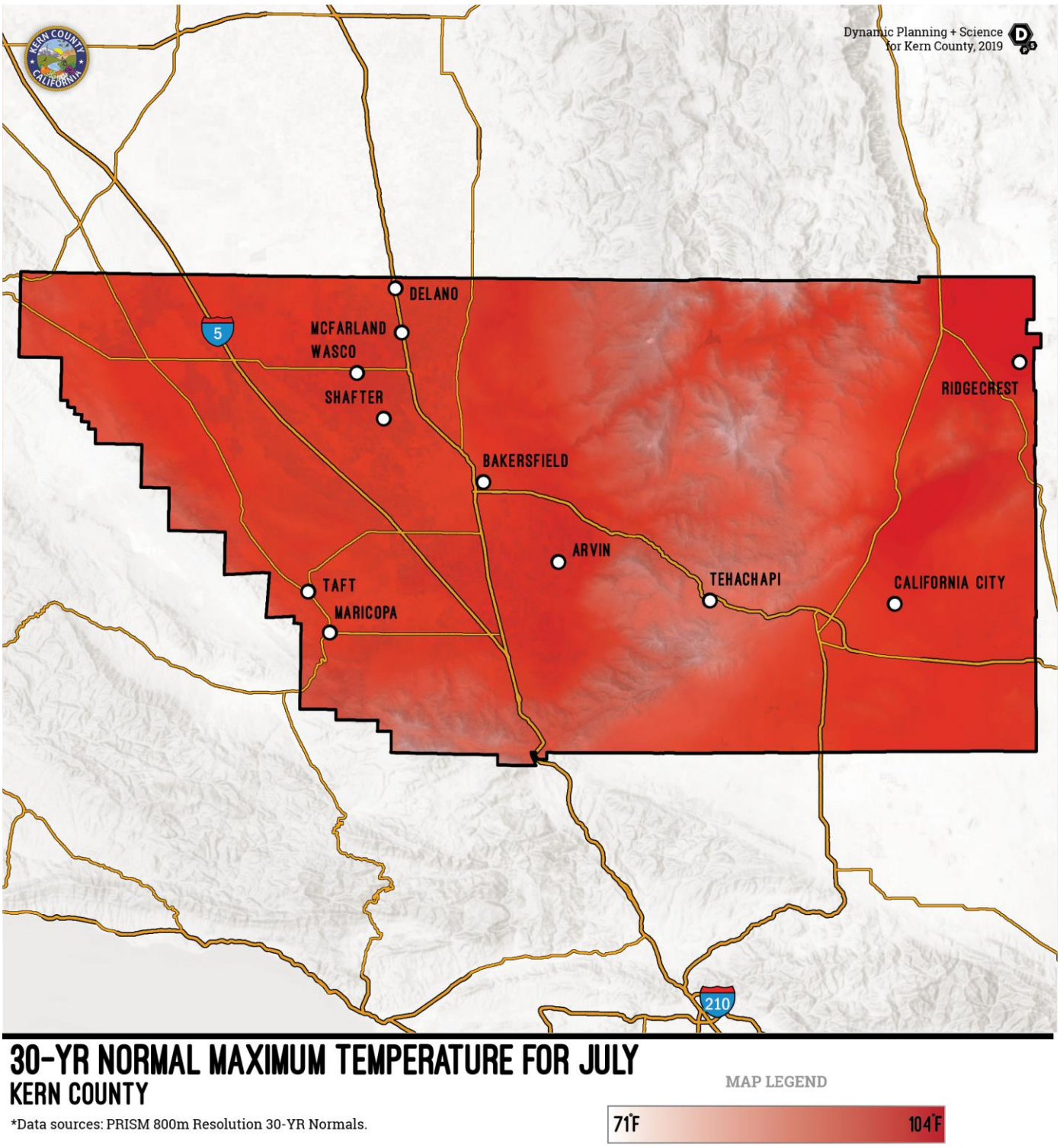


Figure 4-13: 30-YR Normal Maximum Temperature for July

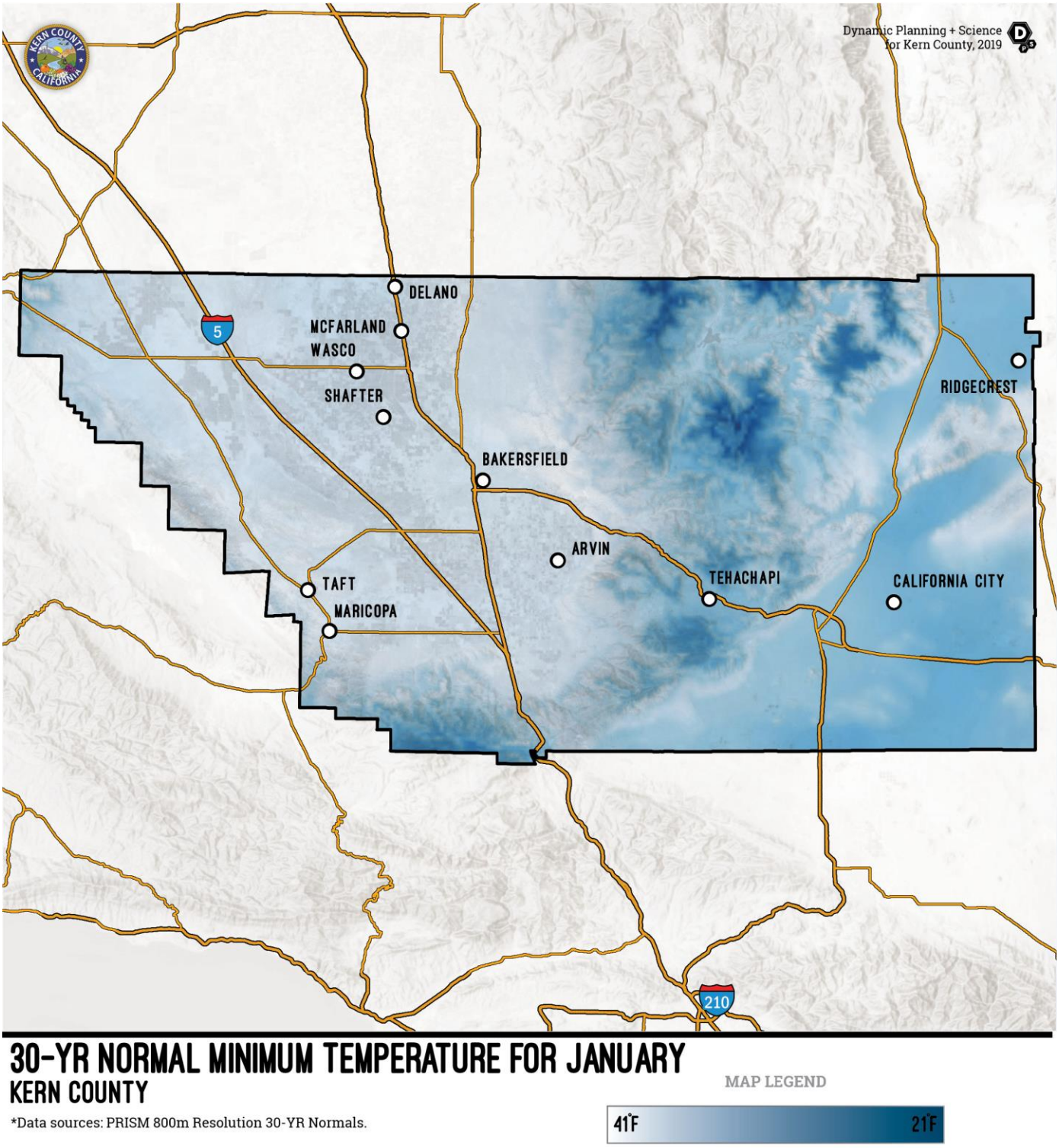


Figure 4-14: 30-YR Normal Minimum Temperature for January

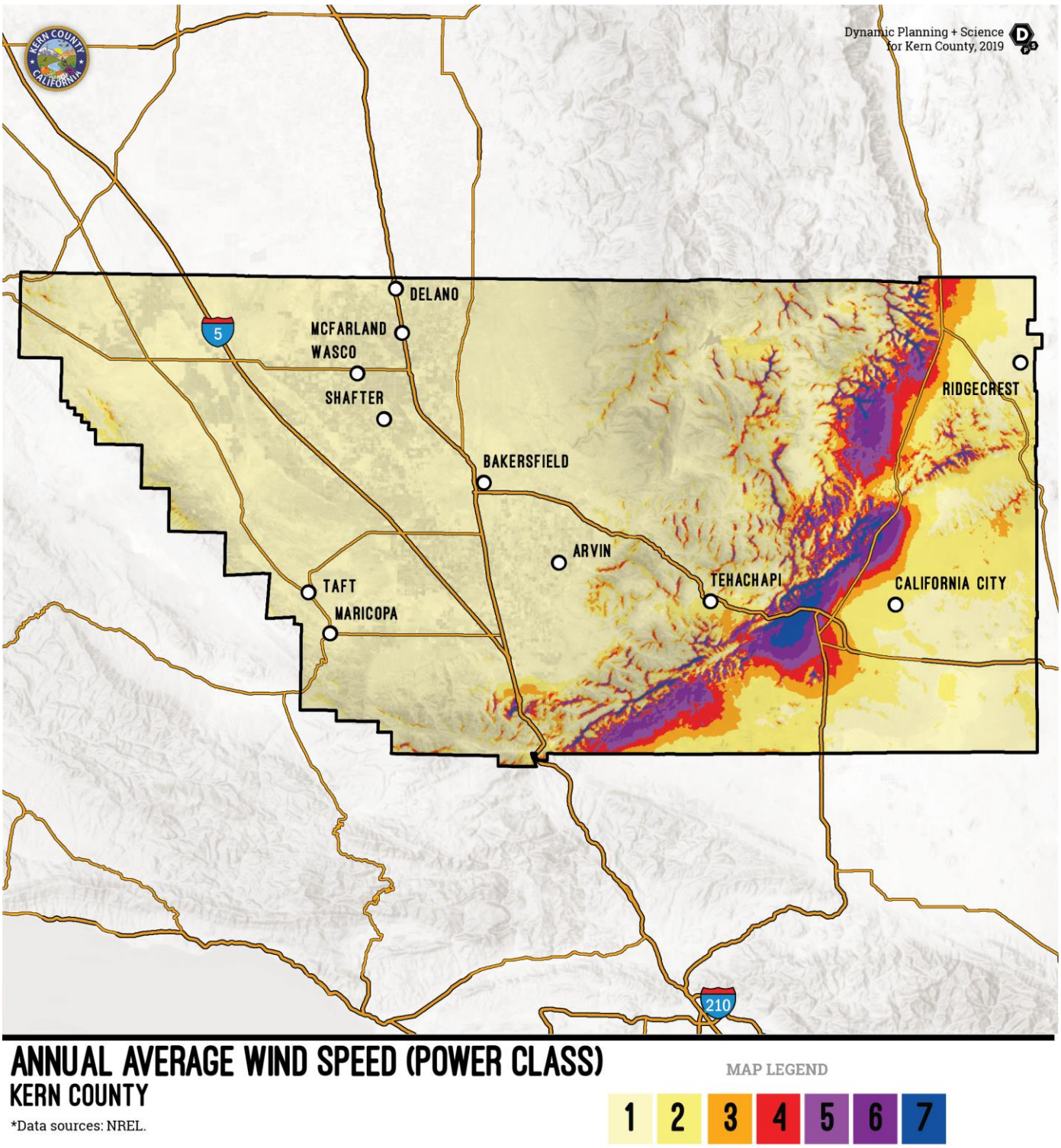


Figure 4-15: Annual Average Wind Speed (Power Class)

Table 4-8: Classes of Wind Power Density at 10 m and 50 m[a]

Wind Power Class	10 m (33 ft) Wind Power Density (W/m2)	Speed[b] m/s (mph)	50 m (164 ft) Wind Power Density (W/m2)	Speed[b] m/s (mph)
1	0	0	0	
	100	4.4 (9.8)	200	5.6 (12.5)
2	150	5.1 (11.5)	300	6.4 (14.3)
3	200	5.6 (12.5)	400	7.0 (15.7)
4	250	6.0 (13.4)	500	7.5 (16.8)
5	300	6.4 (14.3)	600	8.0 (17.9)
6	400	7.0 (15.7)	800	8.8 (19.7)
7	1000	9.4 (21.1)	2000	11.9 (26.6)

[a] Vertical extrapolation of wind speed based on the 1/7 power law.
[b] Mean wind speed is based on Rayleigh speed distribution of equivalent mean wind power density. Wind speed is for standard sea-level conditions. To maintain the same power density, speed increases 3%/1000 m (5%/5000 ft) elevation.

NOTE: Each wind power class should span two power densities. For example, Wind Power Class = 3 represents the Wind Power Density range between 150 W/m2 and 200 W/m2. The offset cells in the first column attempt to illustrate this concept.

4.5.1.4 Frequency/ Probability of Future Events

Severe weather events for Kern County since the year 2000, as shown in Table 4-7, have all been related to either wind or freeze events. Strong wind events since the year 2000 have caused a total of $2.6 million worth of property damage in Kern County. Figure 4-15 displays average annual wind speeds by power class in Kern County and Table 4-8 describes wind power classes.

4.5.1.5 Severity and Extent

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon but can occur. Roads may become impassable due to flooding, downed trees, ice or snow, or a landslide. Crops can be damaged by below-freezing temperatures. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Utility companies will shutoff power (also known as, Public Safety Power Shutoffs) as a fire prevention measure in hot and dry periods.

Windstorms can be a problem in the planning area and could cause damage to utilities. It is important to note that the predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher.

Hail events can occur in Kern County. Events have occurred in the greater County and in the City of Taft with hail size ranging from .25 to .75 inches.

High heat events can occur throughout Kern County, and are projected to worsen with climate change. In 2018, the southern portion of California's central valley, and, in particular, the region including Los Angeles broke an all-time record of 111 degrees, surpassing the previous record of 109 degrees, set in 1939. (Washington Post, 2018)

4.5.1.6 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time.

4.5.1.7 Secondary Hazards

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides, downed power lines, and wildfire. Heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails. Landslides are further outlined as slope failure in Section 4.5.7, while flooding is analyzed in Section 4.5.2.

4.5.1.8 Severe Weather Vulnerability Analysis

4.5.1.8.1 Population

It can be assumed that the entire planning area is exposed to some extent to severe weather events. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out.

Vulnerable populations such as the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas may become isolated from major roads in severe weather events. Power outages can be life threatening to those dependent on electricity for life support. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard, and therefore vulnerable populations are of particular concern.

4.5.1.8.2 Property

All property is vulnerable during severe weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse. Crops may be damaged by frost, especially if a frost event occurs after the growing season has already begun.

4.5.1.8.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding are also likely exposed to severe weather. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to ice or snow or from secondary hazards such as landslides.

4.5.1.8.4 Lifelines

Loss of roads or power and communication lines are the primary lifeline failures resulting from severe weather and are mostly due to secondary hazards such as floods, falling and downed trees, landslides, and wildfire. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Snowstorms in higher elevations can significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and vulnerable populations.

Prolonged obstruction of major routes due to landslides, snow, debris, or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

FEMA Approval 4/9/2021

4.5.1.8.5 Future Trends in Development

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. Participating jurisdictions have adopted the California Building Code, which corresponds to the International Building Code, to meet California mandates. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in general plans within the planning area also address many of the secondary impacts, such as flood and landslide, of the severe weather hazard. With these tools, the participating jurisdictions are well equipped to deal with future growth and the associated impacts of severe weather.

4.5.1.8.6 Severe Weather Hazard Problem Statements

As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities based on the risk assessment and vulnerability analysis, utilizing the RAMP mapping tool and flood data. Severe weather problem statements for Kern County are listed in Table 4-9; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understanding the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. See Table 5-6 for a full list of mitigation actions and the corresponding problem statements that they address. Each problem statement is coded with a problem number for cross-referencing between Table 4-9 and Table 5-6.

Table 4-9 Severe Weather Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-EW-KC-227	Extreme Weather	Impact	PPRO - Property Protection , NRP - Natural Resource Protection , ES - Emergency Services , SP - Structural Projects	**County of Kern**	Heavy rains could create localized flooding issues around County infrastructure including buildings and roads, posing a threat to buildings and creating hazardous travel conditions The following culverts have been identified as undersized by Kern County and frequently create flooding issues after heavy rain events: LAKE ISABELLA BLVD, 200' S OF ELIZABETH NORRIS RD, LAKE ISABELLA ; FRAZIER MTN PARK RD, 2,200' E OF MT PINOS WY E, FRAZIER PARK; CALIENTE CREEK RD, BETWEEN MILLERSVILLE AND TWIN OAKS; COPUS RD, 3,000' W OF I-5 FWY	ma-FL-KC-98
ps-EW-KC-228	Extreme Weather	Threat	PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	Strong winds can blow over trees and utility lines, posing a hazard to traffic and pedestrians	ma-AH-KC-179
ps-EW-KC-229	Extreme Weather	Threat	PRV - Prevention	**County of Kern**	Increased impervious surfaces can lead to the urban heat island effect and increased runoff during heavy rains events that may overwhelm storm drain facilities that have received insufficient storm water maintenance	ma-EW-KC-301
ps-EW-KC-338	Extreme Weather	Threat	PE&A - Public Education & Awareness	**County of Kern**	Winter weather events can interrupt travel on County roads leading to hazardous driving conditions and road closures	ma-EW-KC-435

4.5.2 Flood Hazard Profile



Flooding is one of the three primary hazards in California, along with earthquake and wildfire, and represents the second most destructive source of hazard, vulnerability, and risk statewide. (California Office of Emergency Services, 2018) Flooding is a priority hazard for Kern County as well.

Connections between a river and its floodplain are most apparent during and after major flood events. A **floodplain** is the area adjacent to a river, creek, or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon. These areas form a complex physical and biological system that supports a variety of natural resources and provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, its natural, built-in benefits can be lost, altered, or significantly reduced. (Federal Emergency Management Agency)

There are four types of flood events in the Kern County area: riverine, flash, urban stormwater, alluvial fan, and dam failure. Regardless of the type, the cause is primarily the result of severe weather and excessive rainfall, either in the flood area or upstream reach. (The National Severe Storms Laboratory, n.d.)

Riverine flooding occurs when a watercourse exceeds its 'bank-full' capacity and is the most common type of flood event. Riverine flooding occurs as a result of prolonged rainfall that is combined with saturated soils from previous rain events, or combined with snowmelt, and is characterized by high peak flows of moderate duration and by a large volume of runoff. Riverine flooding occurs in river systems whose tributaries drain large geographic areas and can include many watersheds and sub-watersheds. The duration of riverine floods varies from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, soil moisture content, channel capacity, seasonal variation in vegetation, snow depth, and water-resistance of the surface due to urbanization. *(Id)*

In Kern County, riverine flooding can occur anytime during the period from November through April. Flooding is more severe when antecedent rainfall has resulted in saturated ground conditions

The term "flash flood" describes localized floods of great volume and short duration, generally in less than four hours. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall in a relatively small drainage area. Precipitation of this sort usually occurs in the spring and summer. (Kern County MJHMP, 2014)

Urbanization may increase peak flow runoff as well as the total volume of stormwater runoff from a site. The increase is dependent upon the type of soil and its topography in relation to the proposed development. Comparison of the peak flow and volume impacts to the watershed should be analyzed whenever development is proposed to ensure that any increases are accommodated. (United States Geological Survey, 2016)

FEMA Approval 4/9/2021

Flooding may result as a secondary impact from an earthquake, and may cause failure of dams, canal banks, or areas where landslides block drainage channels, streams, and/or rivers. *See Section 0 for the Earthquake Hazard Profile.*

Dam failures also often result in flash flooding. However, dam failures are discussed separately in this plan. *See Section 4.5.3.*

Floodplain Definitions

100-YR Floodplain

The boundaries of the 100 year (100-YR) floodplain coincide with an annual risk of 1% and are a FEMA study product consisting of both floodway and flood fringe.

500-YR Floodplain

The boundaries of the floodplain coincide with an annual risk of 0.2% and are a FEMA study product. The 500-YR floodplain includes the 100-YR.

Floodway

This includes the channel of the tributary and the land adjacent to it. This zone needs to remain free from obstruction so the 100-YR floodplain can be conveyed downstream.

Flood Fringe

This is the remaining portion of the 100-YR floodplain, excluding the floodway. This zone can be obstructed or developed if criteria are met.

Special Flood Hazard Area (SFHA)

An area having special flood, mudflow, or flood-related erosion hazards and shown on a Flood Insurance Rate Map (FIRM). The SFHA is the area where the National Flood Insurance Program's (NFIP) floodplain management regulations must be enforced.

Floodplain Ecosystems

Floodplains can support ecosystems that are rich in quantity and diversity of plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients left over from the last flood and resulting from the rapid decomposition of organic matter that had accumulated. Microscopic organisms thrive, and larger species enter a rapid breeding cycle. Opportunistic feeders, particularly birds, move in to take advantage. The production of nutrients peaks and falls away quickly; however, the surge of new growth endures for some time. This makes floodplains particularly valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, trees in floodplains and riparian areas tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

Floodplains that are undisturbed or have been restored to a natural state provide many benefits to both human and natural systems. In their natural vegetative state, undisturbed floodplains provide the following benefits:

- Slow the rate at which incoming surface runoff reaches the main body of water, slowing down the impact of flood events.
- Maintain water quality by allowing surface runoff to drop sediment into the natural soil, preventing it from depositing in streams and rivers.
- Recharge groundwater. The slowing of runoff allows additional time for the runoff to recharge existing groundwater aquifers.
- Provide habitat for large and diverse populations of plants and animals.

Floodplains are often compromised by human development. Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains because water is readily available, land is fertile and suitable for farming, transportation by water is easily accessible, and land is flatter and easier to develop.

But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

4.5.2.1 Plans, Policies, and Regulatory Environment

National Flood Insurance Program (NFIP)

The NFIP makes federally-backed flood insurance available to homeowners, renters, and business owners in participating communities. Kern County and the cities of Arvin, Bakersfield, California City, Delano, Maricopa, McFarland, Shafter, Taft, Tehachapi, and Wasco all participate in NFIP.

For most participating communities, FEMA has prepared a detailed Flood Insurance Study (FIS). The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood (the 100-year flood) and the 0.2-percent annual chance flood (the 500-year flood).

Base-flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principal tool for identifying the extent and location of the flood hazard. FIRMs also designate and display the floodway which is the channel of the river or stream and adjacent land that must remain free from obstruction so that the 100-year flood can be conveyed downstream. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program. The most recent countywide FIRM was completed September 26th, 2008 and is a digital flood insurance rate map (DFIRM).

FEMA Approval 4/9/2021

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-YR flood;
- New floodplain development must not aggravate existing flood problems or increase damage to other properties; and
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

Structures permitted or built in the County before December 31, 1974, are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." Post-FIRM properties are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Pre-FIRM properties are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The insurance rate is different for the two types of structures.

Compliance is monitored by FEMA regional staff and by the California Department of Water Resources under a contract with FEMA. Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified initiatives to maintain their compliance and good standing.

Community Rating System (CRS)

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions that meet the three goals of the CRS: 1) reduce flood losses, 2) facilitate accurate insurance rating, and 3) promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent according to the community's classification. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. Class 10 communities are those that do not participate in the CRS; they receive no discount. The CRS classes for local communities are based on 18 creditable activities related to public information, mapping and regulations, flood damage reduction, and flood preparedness.

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base are communities in the CRS. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks. Table 4-10 lists NFIP and CRS statistics for the County.

FEMA Approval 4/9/2021

Table 4-10: Flood Insurance Statistics for Kern County

NFIP and CRS Status & Information	
County of Kern	
NFIP Status	Participating since 09/29/86
CRS Class	9
Policies in Force	3,168
Policies in SFHA	2,678
Policies in non-SFHA	490
Total Claims Paid	128
Paid Losses	$791,697
Repetitive Loss Properties	0
Severe Repetitive Loss Properties	0
Repetitive Loss Payment by NFIP on Building	N/A
Repetitive Loss Payment by NFIP on Contents	N/A

Note: The Privacy Act of 1974 (5 U.S.C. 522a) restricts the release of certain types of data to the public. Flood insurance policy and claims data are included in the list of restricted information. FEMA can only release such data to state and local governments, and only if the data are used for floodplain management, mitigation, or research purposes. Therefore, this plan does not identify the repetitive loss properties or include claims data for any individual property.

Cobey-Alquist Floodplain Management Act

The Cobey-Alquist Floodplain Management Act of 1965 provided state-level guidance and review of floodplain management, including the review of floodplain management plans, establishment of floodplain management regulations, and the use of designated floodways. The California Department of Water Resources (DWR) adopts regulations, maintains a statewide flood management data collection and planning program, manages a statewide grant program, and helps coordinate emergency flood response operations.

State Plan of Flood Control (SPFC) in the Central Valley

The SPFC describes authorized project levees and related facilities for which the State of California has accepted responsibility for maintenance. The Plan further describes the existing flood control works of the State-federal flood protection system in California's central valley, in addition to the lands, modes of operations and maintenance necessary for the system to function, conditions, and programs and plans for the system. (Department of Water Resources, 2010) (Legislative Analyst's Office, 2019)

Kern County General Plan

The 2004 Kern County General Plan includes many policies, implementation measures, and goals in the Land Use and Safety Elements that limit development occurring in floodplains and mitigate impacts from such development.

Policies around flooding include limited development in floodplains, generally forbidding structures that impede flow in floodplains, and preserving important flood channels and water courses from development more broadly. The Kern County General Plan is currently being updated and will consider this MJHMP Update as it continues to shape policies around flood mitigation and protection.

Floodplain Management Ordinance in Kern County Code, § 17.48

The Kern County Code addresses mitigation options for reducing flood losses through restricting or prohibiting development that may be dangerous due to flooding and erosion. These methods and provisions additionally stipulate that vulnerable uses be protected against flood damage during construction; the management of natural floodplains and stream channels in order to accommodate flood waters; the management of any development which might increase flood damage; and the management of flood barrier construction, which might increase flood hazards in other areas.

The County's regulations also prohibit the encroachment of new development that would increase any flood levels within the severe flood hazard area. Contingent on this first provision being satisfied, all new construction and other proposed development shall comply with all other applicable flood hazard reduction provisions of this chapter.

4.5.2.2 Major Flood Events

Table 4-11 shows the flood events that took place in Kern County since the year 2000 that caused either property or crop damage. (NOAA, 2019)

Table 4-11: Kern County Flood Events Since 2000

Date	Flood Type	Property Damage Value ($)	Crop Damage Value ($)
1/8/2002	Flood	25,000	0
11/8/2002	Flood	23,000	0
2/12/2003	Flood	50,000	0
7/31/2003	Flash Flood	5,000	0
12/25/2003	Flood	30,000	0
2/22/2004	Flood	5,000	0
10/26/2004	Flood	5,000	0
10/26/2004	Flood	5,000	0
1/9/2005	Flood	2,000,000	0
1/10/2005	Flood	500,000	0
1/10/2005	Flood	250,000	0

Date	Flood Type	Property Damage Value ($)	Crop Damage Value ($)
2/21/2005	Flood	0	300,000
2/22/2005	Flood	5,000	0
8/15/2005	Flash Flood	198,500	0
10/17/2005	Flash Flood	75,000	0
10/17/2005	Flash Flood	25,000	0
10/29/2007	Flash Flood	10,000	0
1/27/2008	Flash Flood	25,000	0
1/27/2008	Flood	5,000	0
1/27/2008	Flood	1,000	0
7/12/2008	Flash Flood	1,500,000	0
7/13/2008	Flash Flood	50,000	0
7/13/2008	Flash Flood	25,000	0
7/14/2008	Flash Flood	100,000	0
7/15/2008	Flash Flood	20,000	0
7/16/2008	Flash Flood	1,000	0
7/20/2008	Flash Flood	30,000	0
12/10/2009	Flood	25,000	0
1/18/2010	Flood	100,000	0
1/18/2010	Flash Flood	10,000	0
1/19/2010	Flood	35,000	0
10/1/2010	Flood	5,000	0
10/2/2010	Flash Flood	10,000	0
10/2/2010	Flood	5,000	0
10/6/2010	Flash Flood	100,000	0
10/6/2010	Flood	10,000	0
10/17/2010	Flood	5,000	0
12/19/2010	Flood	5,000,000	0
12/19/2010	Flood	50,000	0
12/20/2010	Flash Flood	5,000	0
12/22/2010	Flood	350,000	0
12/29/2010	Flood	1,000,000	0
1/2/2011	Flood	12,700,000	0
1/2/2011	Flood	800,000	0
2/26/2011	Flood	5,000	0
2/26/2011	Flood	2,500	0
3/20/2011	Flood	5,000	0
3/23/2011	Flood	2,000	0
3/23/2011	Flood	2,000	0
7/4/2011	Flash Flood	5,000	0
7/5/2011	Flash Flood	2,500	0
7/30/2011	Flash Flood	5,000	0

Date	Flood Type	Property Damage Value ($)	Crop Damage Value ($)
8/1/2011	Flash Flood	25,000	0
8/27/2011	Flash Flood	25,000	0
9/11/2011	Flood	25,000	0
3/17/2012	Flood	12,000	0
3/17/2012	Flood	6,000	0
4/13/2012	Flood	15,000	0
8/22/2012	Flash Flood	60,000	0
10/11/2012	Flood	25,000	0
3/8/2013	Flood	5,000	0
7/22/2013	Flash Flood	50,000	0
8/18/2013	Flash Flood	50,000	0
8/19/2013	Flash Flood	100,000	0
8/19/2013	Flash Flood	100,000	0
2/28/2014	Flood	20,000	0
12/31/2016	Flash Flood	10,000	0
1/5/2017	Flood	36,000	0
1/5/2017	Flood	15,000	0
1/5/2017	Flood	6,000	0
1/22/2017	Flood	150,000	0
3/6/2019	Flash Flood	50,000	0
3/6/2019	Flash Flood	20,000	0
3/6/2019	Flash Flood	10,000	0

Source: NOAA Storm Events Database

4.5.2.3 Location

Kern County, due to its large extent and varied geography, has several hundred potential flood sources. Figure 4-17 displays FEMA flood zones within Kern County. More detailed views of FEMA flood zones are available for participating jurisdictions through the Risk Assessment Mapping Platform (RAMP) on mitigatehazards.com. The types of floodplains within the County are diverse and include riverine floodplains (fast moving channelized flow), distributary flow floodplains (broad, slow moving, shallow flow), and alluvial fan floodplains (heavily sediment-laden, broad, shifting, and rapid moving flow).

Kern County's watersheds are effectively a closed basin system, with all drainage discharging to one of the following lake basins in the County: Tulare Lake, Kern Lake, Lake Isabella (manmade), Koehn Lake, Rogers Lake, Buena Vista Lake, Castac (Tejon) Lake, China Lake, and Rosamond Lake. These lakes temporarily enlarge during flood events. Rogers Lake, China Lake, and Rosamond Lake are "dry lakes," meaning that only under certain conditions do they fill with water. Figure 4-16 displays the watersheds in Kern County.

Most of the major streams are fed by melting snow from high in the Sierra Nevada. The Kern River is the major river in the County and has an average annual runoff of 700,000 acre feet. The Kern River flows from the Sierras northeast of Bakersfield, is dammed at Lake Isabella, and continues approximately 30 miles through the steep Kern River Canyon to the Valley, where it flows through Bakersfield. The river enters the Buena Vista lakebed twenty-one miles downstream of Bakersfield or flows to Tulare Lake via the Kern River Flood Canal. Flows can also be diverted into the California Aqueduct via the Kern River-California Aqueduct Intertie, built in 1977. (Kern County MJHMP, 2014)

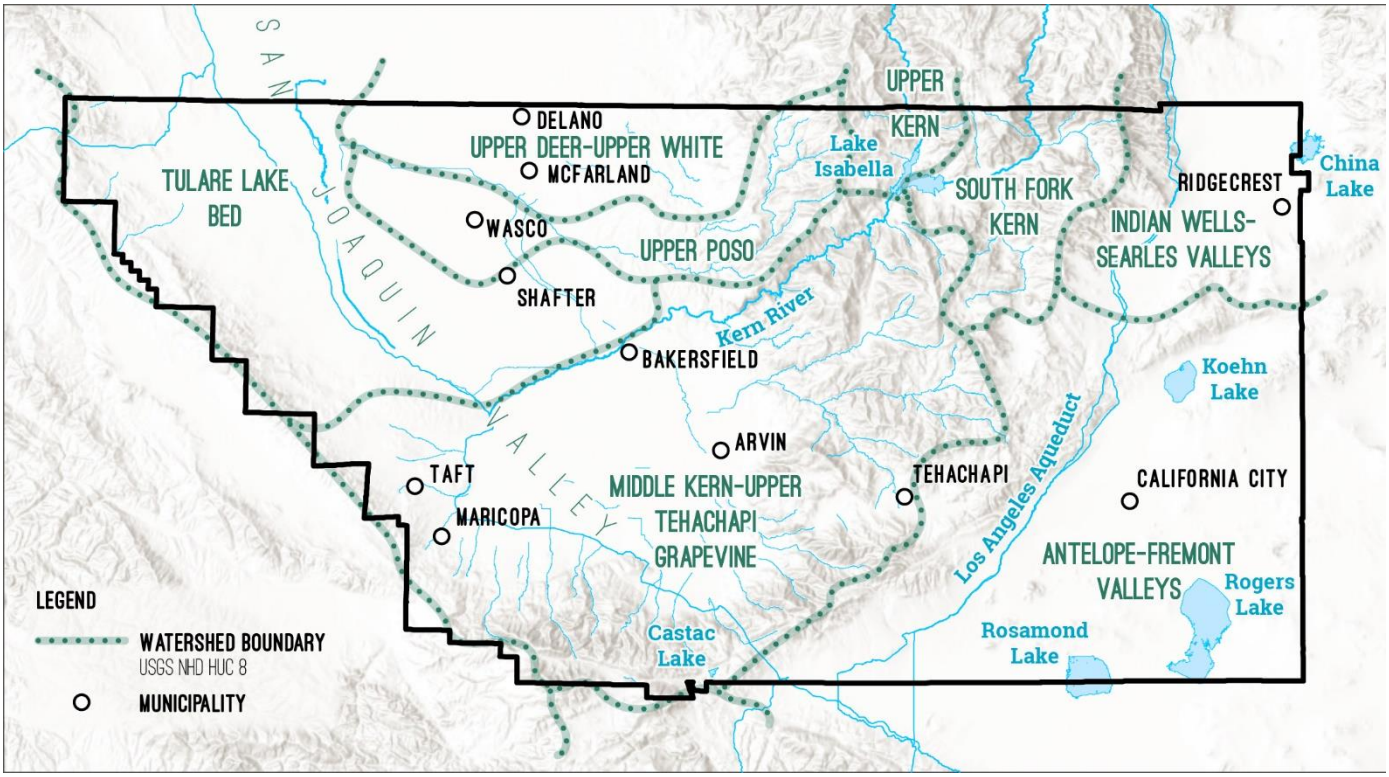


Figure 4-16 Watershed Map

Valley Flood Sources

The Kern River is the source of flooding for the Central Valley in Kern County. Many small streams also cause flooding in the Valley where they discharge from steep canyons. While confined in the upland areas, the streams tend to spread onto alluvial fans with poorly defined drainages on the valley floor. Flow is further disrupted by cultivation and urbanization. This type of flooding occurs at the Little Poso Creek, Caliente Creek, Walker Basin Creek, Sycamore Canyon, Little Sycamore Canyon, Comanche Creek, Tejon Creek, El Paso Creek, Grapevine and Tecuya Creek, and in the vicinity of Taft.

Flooding is typically broad and shallow, two feet deep or less. All surface water originating in or passing through Central and Western Kern County infiltrates into the San Joaquin Valley aquifer or drains into Tulare and Buena Vista Lakes. Man-made drainages that could potentially lead to flooding include several diversion canals that siphon water from the Kern River that flow through the City of Bakersfield, as well as the California Aqueduct and Kern Water Bank Canal. Some of these canals have above-grade sections that can result in local flooding when the canals fail, much like a levee failure flood.

Poso Creek is a major water course that flows north westerly through Kern County. The watershed covers more than 250,000 acres. Precipitation on this watershed ranges from six to thirty inches annually. In years of high rainfall extensive flooding occurs along a 25 mile reach from Zerker Road to the Kern National Wildlife Refuge. For the flood years of 1969 and 1978 flood waters broke out of the Poso Creek Channel and inundated an area of 17,280 acres. Improvements were made under the Emergency Watershed Protection Act for repairs implemented in 1978 and 1979. The channel now is designed to carry 1,050 cfs. More flooding occurred in 1997 and 1998. A major project was undertaken to repair the levees with assistance from the NRCS through an Emergency Watershed Protection grant in 1997. However, the 1998 flooding was curtailed with assistance from two of the local water districts. (FEMA, 2008, p. 21)

Desert Flood Sources

The desert zone lies in the eastern portion of Kern County and has flood problems similar to the Valley, where intermittent streams shift across alluvial fans. Streets, roads, and railroads often divert flows and may increase flood problems. Most flood sources that affect the desert areas originate in local drainages in the eastern portion of Kern County; only Jawbone Canyon Wash originates in the Sierra Nevada range. (FEMA, 2008, p. 21)

Mountain Flood Sources

Floods in the Mountain region typically have flood flows that peak quickly and have high velocities. Floods can occur on streams that include Cuddy Creek, Upper Sycamore Creek, Antelope Creek, Blackburn Creek, Caliente Creek, Erskine and Kelso Creeks. Flows typically are more confined to narrow valleys, but alluvial fan flooding can occur in the vicinity of Lake Isabella. Life safety is a concern in this region due to the flash floods that could potentially impact travelers and those participating in outdoor recreation in the mountain valleys. (FEMA, 2008, p. 21)

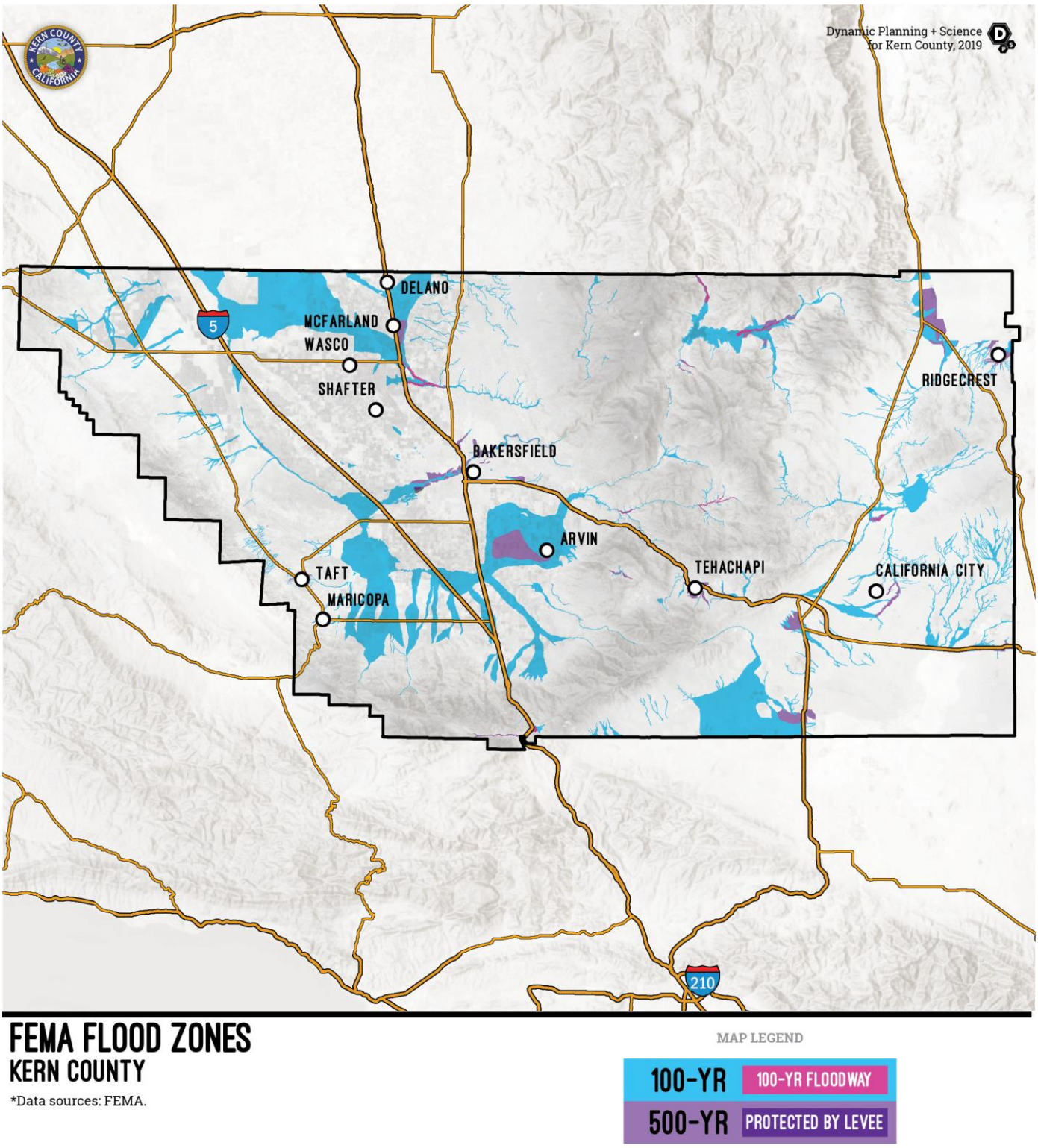


Figure 4-17: FEMA Flood Zone Exposure Map

4.5.2.3.1 Flood Awareness Zones

Flood Awareness Zones have been developed by California DWR to map areas of additional flood threat throughout the state. The intent of the Awareness Floodplain Mapping project is to identify all pertinent flood hazard areas for areas that are not mapped under the Federal Agency Management Agency's (FEMA) National Flood Insurance Program (NFIP) and to provide the community and residents an additional tool in understanding potential flood hazards currently not mapped as a regulated floodplain. The awareness maps identify the 100-YR flood hazard areas using approximate assessment procedures. These floodplains are shown simply as flood prone areas without specific depths and other flood hazard data. Flood awareness zones for Kern County are shown in Figure 4-18.

4.5.2.4 Measuring Frequency and Severity

The frequency and severity of flooding are measured using a discharge probability, a statistical tool which defines the probability that a certain river discharge or flow level will be equaled or exceeded within a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-YR discharge has a 1-percent chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-YR or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-YR flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

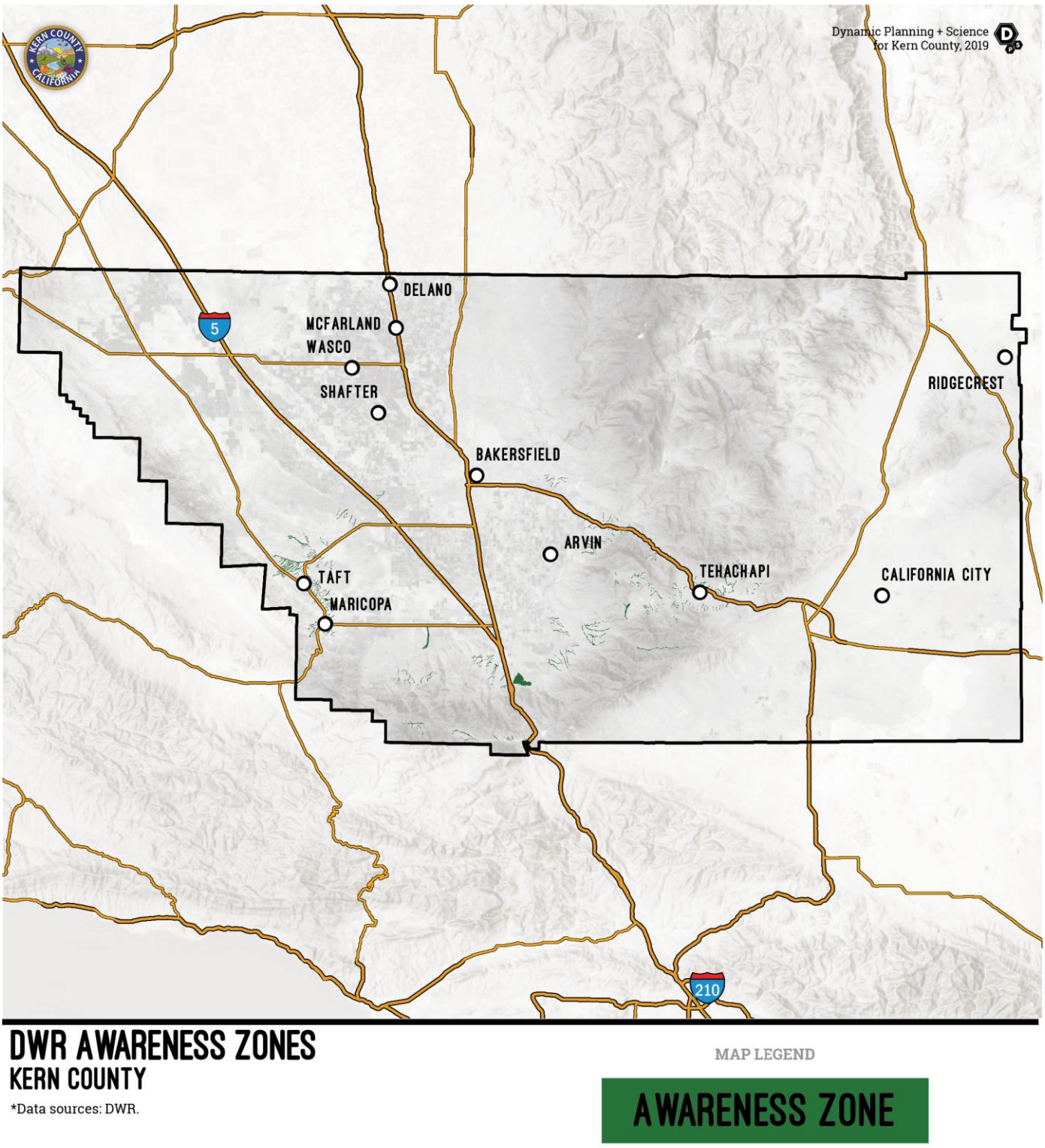


Figure 4-18 DWR Awareness Zones

4.5.2.5 Frequency/ Probability of Future Occurrences

Kern County will experience flooding in the future, with the probability of flooding in Kern County between 10 and 100% annually. The majority of the floods in Kern County have occurred from winter-through-spring rainfall, but several have been the result of heavy rain events during the months of July, August, and September. Flooding in Southern California is often associated with the El Nino weather phenomenon. El Nino is a term originally used to describe the appearance of warm (surface) water from time to time in the eastern equatorial Pacific region along the coasts of Peru and Ecuador. This ocean warming can strongly affect weather patterns all over the world. El Nino events are often associated with above normal precipitation in the southwestern United States. El Niños often occur during the Christmas season. La Niña is the opposite or "cold phase" of the El Niño cycle. It was once suggested that minor El Niño events occurred about every two to three years and major ones about every 8 to 11 years. Today, scientists note that El Niño has a return period of four to five years. When an El Niño event occurs, it often lasts from 12 to 18 months. (National Oceanic and Atmospheric Administration , 2020)

4.5.2.6 Severity and Extent

The main factors affecting flood damage are water depth and velocity. Deeper and faster flood flows can cause more damage. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges; Table 4-12 lists peak flows used by FEMA to map Kern County floodplains.

Table 4-12: Summary of Discharges in Kern County

	Drainage sq. Miles	Peak Discharge (cubic feet/second)			
Flooding Source/Location		10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Antelope Creek					
At Tehachapi Western Corporate Limit	25.4	2,730	6,970	9,090	18,000
At Western Corporate Limits	4.8	650	1,150	1,380	1,900
Blackburn Creek					
At Tehachapi Boulevard and Dennison Road	10.1	2,410	5,780	7,450	11,850
At Western Corporate Limits	16.2	2,730	6,970	9,090	18,000
Downstream of Tehachapi Boulevard	28.2	3,310	8,250	12,030	23,000
Near Highline Road	4.5	*	*	5,290	*
Caliente Creek					
Above Bealville Road Bridge	186.1	1,800	7,550	19,800	56,000
At State Highway 58	467.8	3,600	16,000	27,000	87,500
Caliente Creek Near Loraine					
Upstream of Confluence of Weaver Creek	20.0	325	1,800	3,350	12,300

Flooding Source/Location	Drainage sq. Miles	Peak Discharge (cubic feet/second)			
		10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Downstream of Indian Creek Confluence	124.0	1,650	9,050	16,900	61,000
Upstream of Sand Canyon Confluence	51.0	800	4,000	7,650	26,000
Upstream of Unnamed Tributary Confluence	47.0	770	3,800	7,100	24,000
Cuddy Creek					
At Lebec Road	46.4	850	3,900	7,750	25,000
El Paso Wash					
At North Downs St. & Ridgecrest-Inyoken Rd.	12.7	240	1,670	3,000	7,050
Erskine Creek					
At State Highway 178	37.7	850	2,300	7,700	25,000
Grapevine Canyon Creek	11.0	520	4,330	9,200	42,000
Grapevine Canyon Creek	11.0	520	4,330	9,200	42,000
Kelso Creek					
At State Highway 178	159.5	2,850	11,000	22,700	68,000
Kern River					
At Gaging Station 5.8 Miles NE of Bakersfield Post Office	2,407.0	2,800	7,000	10,200	28,700
At Kernville Gaging Stations	2,407.0	2,800	7,000	10,200	28,700
At Stockdale Highway	*	2,800	7,000	10,200	28,700
Poso Creek					
At State Highway 58	368.0	2,900	11,500	19,000	52,000
Upper Sycamore					
At Lower End of Valley Rd.	14.9	260	990	2,900	10,000

** Data not available*

Source: Table 5 Summary of Discharges from FEMA FIS Text, 2008

4.5.2.7 Warning Time

The type and rate of flooding experienced in Kern County varies. In general, warning times for floods can be between 24 and 48 hours to prepare communities to reduce flood damages Seasonal notification for flooding can enhance awareness for citizens at risk, and, when communicated effectively, advance notification can reach target audiences on a large scale.

4.5.2.7.1 DWR Awareness Zones Notification

The Flood Risk Notification Program (FRN Program) is part of DWR's FloodSAFE California Initiative. The program's key goal is to increase flood risk awareness by effectively communicating that risk to individual property owners, the public, and local, state, and federal agencies. This includes encouraging people to understand the levee system that protects them; be prepared and aware of their flood risk; and take appropriate actions before, during, and after flooding to protect themselves, minimize damage to their property or personal possessions, and facilitate recovery.

To achieve this goal, the FRN Program:

- sends out an annual notice to property owners whose property is at risk of flooding,
- maintains accurate Levee Flood Protection Zone (LFPZ) maps [6] and an associated parcel information database,
- provides people with useful ways to assess risk and reduce flood loss,
- establishes outreach and educational projects with public involvement,
- expands its interactive Flood Risk Notification website, and
- collaborates with federal agencies, local agencies, and communities.

In September of 2010, DWR provided the first annual written notice of flood risks to each landowner whose property is protected by State Plan of Flood Control (SPFC) levees and is within an LFPZ. The notice informs recipients of their property's potential flood risks and potential sources of flooding and offers flood emergency planning and preparedness tips. It encourages recipients to take preventative actions such as purchasing flood insurance, elevating or "floodproofing" their buildings, and preventing blockage of channels, drains, and ditches.

4.5.2.8 Secondary Hazards

The most problematic secondary hazard for flooding is bank erosion, which in some cases can be more harmful than actual flooding. Flooding is also responsible for landslides when high flows over-saturate soils on steep slopes and cause them to fail. Hazardous materials spills are a secondary hazard of flooding if storage tanks rupture and spill into streams or storm sewers. (Department of Environmental Conservation, 2020)

Wildland fires within a watershed can exacerbate the flood hazard by virtue of increased rate and volume of runoff and attendant erosion and sediment discharge. (United States Geological Survey, 2020)

4.5.2.9 Climate Change Impacts

The effects of climate change are varied and include warmer and more varied weather patterns, melting ice caps, and poor air quality, for example. As a result, climate change will likely worsen a number of natural hazards including flooding. Climate change will shift rainfall patterns, making heavy rains more

[6] These maps are different from Federal Emergency Management Agency regulatory maps.

frequent in many areas. An increase in heavy rain events will lead to more flooding including flash floods that happen suddenly as a result of heavy rain and localized flooding which involves pooling of water in low-lying areas. Heavy rain events can inundate and overwhelm stormwater drainage systems resulting in localized flooding where pooling of water can cause significant damage to buildings. Overwhelmed stormwater drainage facilities also create hazardous conditions on roadways where water pools in low lying areas creating dangerous driving conditions. (United States Environmental Protection Agency, 2020)

4.5.2.10 Flood Vulnerability Analysis

Both an exposure analysis and Hazus loss estimation analysis were conducted to develop the flood vulnerability analysis for Kern County. Flood exposure numbers were generated using the inventories outlined in 4.5.2.10.1 County inventories were overlaid with FEMA delineated flood plains to determine exposure. These risk assessment exposure analysis values do not include Hazus-generated results.

Hazus flood vulnerability data was generated using a Level 2 Hazus-MH 4.2 analysis. Hazus is a FEMA software product that uses a GIS to analyze 100-year depth grids derived from FEMA 100-year "A" zones with Base Flood Elevations (BFE) to estimate loss. Parcel data defined in 4.5.2.10.1 was imported into Hazus as User Defined Facilities (UDF) and serves as the basis for replacement and content cost estimations as well as associated loss. Where flood vulnerability is mentioned absent of Hazus, exposure analysis figures are used. Figure 4-20 displays a snapshot of flood exposure and damage estimation in Unincorporated Kern County.

4.5.2.10.1 Flood Exposure

The tables and graphs in this section detail population, property, and infrastructure that are exposed to flooding in Unincorporated Kern County. Flood exposure is categorized by exposure to different flood hazard zones including the floodway, flood fringe, 100-year floodplain, and 500-year floodplain. The tables and graphs also include a category of 100-year total which is a combined total of floodway, flood fringe, and 100-year floodplain categories. The 500-year sans 100-year category includes only the 500-year floodplain, and the 500-year total includes all of the categories combined. Refer to section 4.5.2 for floodplain definitions to better understand these flood hazard areas.

Population

Population counts of those living in the floodplain were generated by analyzing County assessor and parcel data that intersect with the 100-YR and 500-year floodplains identified on FIRMs. Using GIS, U.S. Census Bureau information was used to intersect the floodplain and an estimate of population was calculated by weighting the population within each census block and track with the percentage of flood risk area. Using this approach, Table 4-13 and displays the results of this analysis showing how much of the population of Unincorporated Kern County is exposed to flood hazard zones.

Population Exposure

Population Count in the 100-Year and 500-YR Floodplains

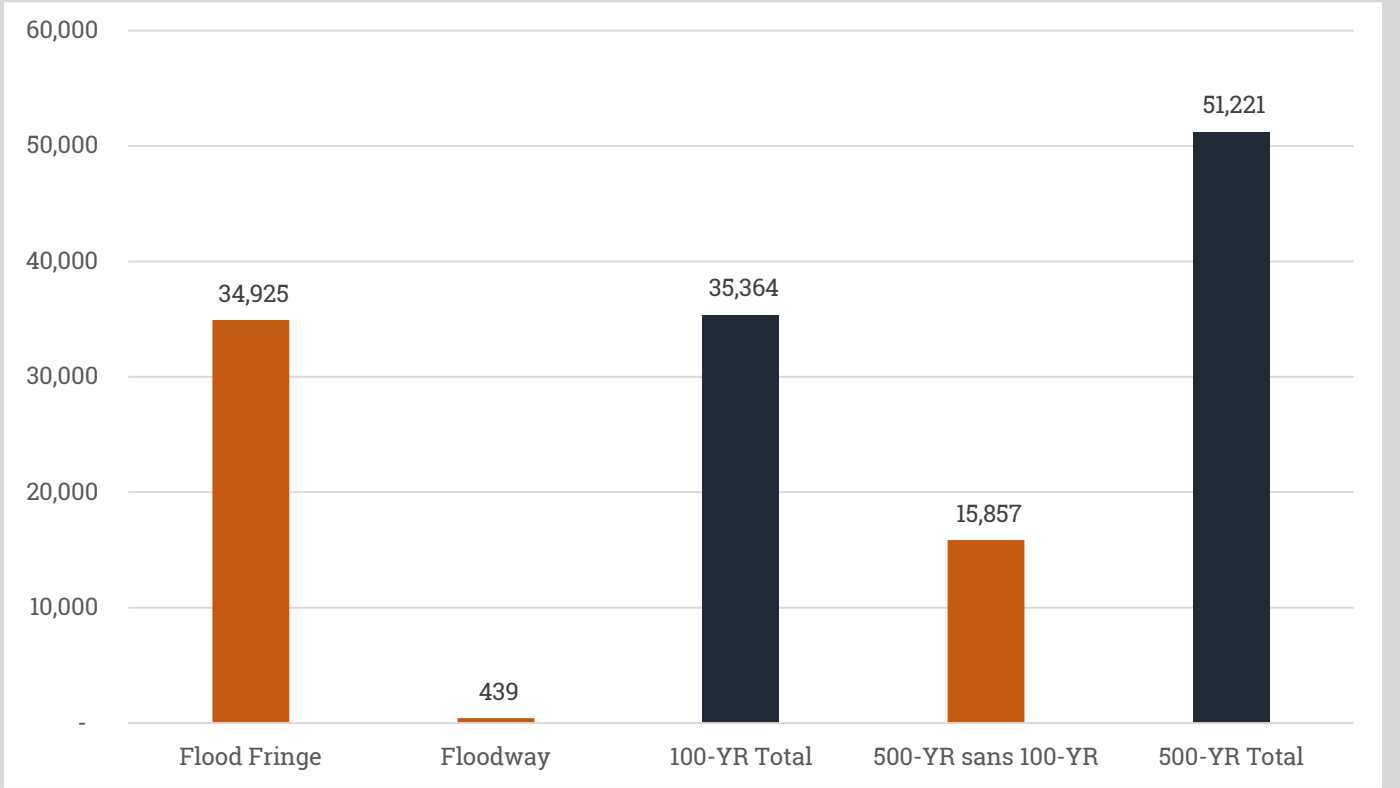


Figure 4-19 Population Exposure to Flood (Unincorporated County)

Table 4-13: Summary Population Exposure to Flood (Unincorporated County)

	Total Population
Unincorporated County	299,935

Flood Hazard Zone	Population Count	% of Total
Flood Fringe	34,925	*11.64%*
Floodway	439	*0.15%*
100-YR Total	35,364	*11.79%*
500-YR sans 100-YR	15,857	*5.29%*
500-YR Total	51,221	*17.08%*

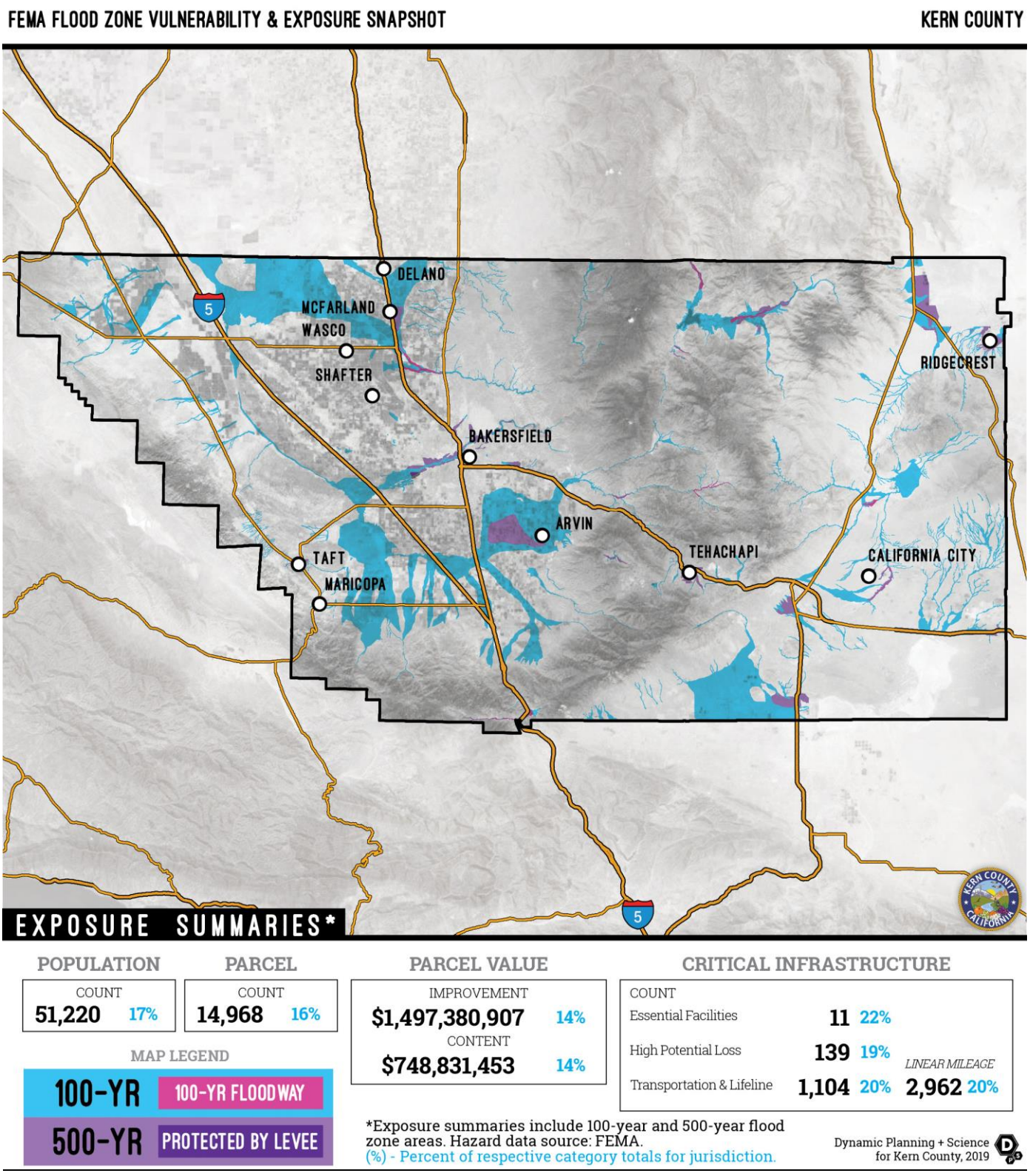


Figure 4-20: FEMA Flood Zone Exposure and Snapshot Map

Structures and Parcel Value

Table 4-14 summarizes parcels in Unincorporated Kern County that are exposed to flood hazard areas. The beginning of Section 4.5.2 includes definitions of the various flood hazard areas.

Table 4-14: Parcels Exposed to NFIP Flood Zones (Unincorporated County)

	Total Parcels	Total Market Value ($)	Total Content Value ($)	Total Value ($)
Unincorporated County	91,455	$10,906,675	$ 5,453,338	$ 16,360,013

Flood Hazard Zone	Parcel Count	% of Total	Market Value Exposure ($)	Content Value Exposure ($)	Total Exposure ($)	% of Total
Flood Fringe	7,823	*8.6%*	$678,412	$ 339,206	$ 1,017,618	*6.2%*
Floodway	143	*0.2%*	$ 11,380	$ 5,690	$ 17,070	*0.1%*
100-YR Total	**7,966**	**8.7%**	**$ 689,792**	**$ 344,896**	**$ 1,034,688**	**6.3%**
500-YR sans 100-YR	7,002	*7.7%*	$ 807,307	$ 403,653	$ 1,210,960	*7.4%*
500-YR Total	**14,968**	**16.4%**	**$ 1,497,099**	**$ 748,549**	**$2,245,648**	**13.7%**

Currency in Thousands

Note: The table above does not display loss estimation results; the table exhibits total value at risk based upon the hazard overlay and Kern County Assessor data.

Critical Facilities and Infrastructure

Table 4-15 summarizes the critical facilities and infrastructure located in the flood fringe, floodway, and 100-year and 500-year floodplains of Kern County.

Table 4-15: Critical Facility Points in the Floodplain

Infrastructure Type	Flood Fringe	Floodway	100-YR Total	500-YR sans 100-YR	500-YR Total
Essential Facility	6	-	6	5	11
EOC	-	-	-	-	-
Fire Station	6	-	6	2	8
Hospital	-	-	-	-	-
Police Station	-	-	-	-	-
Sheriff Station	-	-	-	3	3
High Potential Loss	79	-	79	60	139
Adult Residential facility	2	-	2	1	3
Child Care Center	11	-	11	9	20
Dam	5	-	5	-	5
Family Child Care Home	9	-	9	9	18
Foster Family Agency	-	-	-	-	-
Historic Building	-	-	-	1	1
Home Care Organization	-	-	-	-	-

Infrastructure Type	Flood Fringe	Floodway	100-YR Total	500-YR sans 100-YR	500-YR Total
Library	6	-	6	2	8
Residential Child Care	1	-	1	-	1
Residential Elder Care	-	-	-	1	1
School	14	-	14	14	28
County Insured Asset*	20	-	20	13	33
Cooling Center	-	-	-	1	1
Healthcare Facility	2	-	2	2	4
Special Needs Facility	9	-	9	7	16
City Hall	-	-	-	-	-
Historic Site	-	-	-	-	-
Transportation and Lifeline	968	14	982	122	1,104
Airport	-	-	-	2	2
Bridge	129	12	141	12	153
Power Plant	22	1	23	1	24
Substation	17	1	18	7	25
Transmission Line Tower	741	-	741	98	839
NG Facility	13	-	13	2	15
Wind Turbine	42	-	42	-	42
Bus Facility	1	-	1	-	1
Potable Water Facility	1	-	1	-	1
Waste Water Facility	1	-	1	-	1
Oil Facility	1	-	1	-	1
Railroad Facility	-	-	-	-	-
Grand Total	**1,053**	**14**	**1,067**	**187**	**1,254**

**These insured assets may include critical infrastructure already represented in other Infrastructure Types. For more information on these insured assets, see the Damage Estimation at Section 4.5.2.10.2.*

Linear Utilities

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the county, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Levees can fail or be overtopped, inundating the land that they protect. Table 4-16 shows critical facilities (linear) in the floodplain.

Table 4-16: Lifelines in the Floodplain (Unincorporated County)

Lifelines (miles) - Flood Risk Exposure					
Infrastructure Type (linear)	Flood Fringe	Floodway	100-YR Total	500-YR sans 100-YR	500-YR Total
Levee	304.90	-	304.90	4.01	308.91
NG Pipeline	158.28	0.39	158.67	11.30	169.97
Railroad	79.34	0.89	80.23	15.34	95.57
Street	1600.74	22.18	1622.92	334.39	1957.31
4WD trail	7.58	-	7.58	0.14	7.72
4WD trail, major	-	-	-	0.08	0.08
Alley	0.94	-	0.94	0.55	1.49
Cul-de-sac	0.46	-	0.46	0.13	0.59
Driveway	17.62	0.35	17.97	3.10	21.06
Interstate	43.27	2.02	45.29	10.24	55.53
Local road	636.93	11.63	648.57	124.06	772.63
Local road, major	574.65	3.12	577.77	124.84	702.60
Primary highway	41.93	0.04	41.97	8.84	50.81
Ramp	8.11	0.59	8.70	3.60	12.30
Road, parking area	3.37	-	3.37	-	3.37
Service road	0.53	-	0.53	2.17	2.70
State/county highway	231.44	4.30	235.74	54.57	290.31
State/county highway, major	-	-	-	-	-
Thoroughfare, major	33.83	0.13	33.96	1.82	35.79
Walkway	0.08	-	0.08	0.23	0.31
Transmission Line	387.13	5.78	392.91	37.08	429.99
Grand Total	**2530.39**	**29.25**	**2559.64**	**402.12**	**2961.76**

Roads

Kern County Public Works (KCPW) maintains a list of roads throughout the County to avoid during a flood event. That list can be viewed by contacting the Kern County Public Works directly. It is also available on the Kern County Public Works website. KCPW also has real-time closure notifications provided at https://kernpublicworks.com/transportation/road-status-closures

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

4.5.2.10.2 Flood Damage Estimation

This section provides estimations of damages to County insured assets and residential buildings in the 100-year and 500-year flood zones. This section first looks at overall damages for County insured assets and residential buildings in the 100-year flood zone, then looks specifically at potential damage to various County insured assets according to type (e.g., administrative buildings, equipment and services, or recreation). This section then repeats this information for the 500-year flood zone.

Damage estimations, as calculated by Hazus, estimate losses to structures from flooding by analyzing the depth of flooding and type of structure. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, all non-vacant parcels with current market values were used instead of the default inventory data provided with Hazus. Table 4-17 and Figure 4-21 show the 100-year flood loss estimation (based on depth) in NFIP flood zones by occupancy type. Figure 4-22 and Table 4-19 shows the 500-year flood loss estimation (based on depth) in NFIP flood zones by occupancy type.

The County's insurance data was obtained and formatted for use in Hazus for a detailed damage estimation of County-owned insured assets. This combined government dataset has additional information including number of floors, building value, content value, and construction type that greatly enhances Hazus results. Table 4-18 displays damage estimation for County insured assets located in the 100-year flood zone, and Table 4-20 displays the same in the 500-year flood zone.

Damage Estimation for 100 yr. Floodplain

Table 4-17 and Figure 4-21 display damage estimation summaries for the 100-year floodplain in Unincorporated Kern County by occupancy type.

Table 4-17: 100 YR Flood Damage Estimation by Occupancy Type

Building Type	Building Damage ($)	Building Damage (% of total loss)	Content Damage ($)	Content Damage (% of total loss)	Total Damage ($)	Proportion of Loss (%)
County Insured Assets						
Government Service†	$ 117,332	0.1%	$ 69,557	0.0%	$ 186,888	0.1%
Emergency Response††	$ -	0.0%	$ -	0.0%	$ -	0.0%
Residential						
Single Family	$ 138,281,371	72.2%	$ 41,169,002	21.5%	$179,450,373	93.7%
Mobile Home	$ 2,659,571	1.4%	$ 876,594	0.5%	$3,536,165	1.8%
Multi Family Duplex	$ 4,249,036	2.2%	$ 2,584,794	1.3%	$ 6,833,830	3.6%
Multi Family 3-4 Units	$ 901,543	0.5%	$ 550,297	0.3%	$ 1,451,840	0.8%
Multi Family 5-9 Units	$ 33,282	0.0%	$13,313	0.0%	$ 46,595	0.0%
Multi Family 10-19 Units	$ -	0.0%	$ -	0.0%	$ -	0.0%
Multi Family 20-49 Units	$ -	0.0%	$ -	0.0%	$ -	0.0%
Total	**$ 146,242,134**	**76.4%**	**$ 45,263,557**	**23.6%**	**$191,505,691**	

†Government Services includes: admin, airport, animal, building, bus, correctional, equipment, golf course, health, leased, library, misc, museum, office, park, recreation, relay, shop, storage, vacant, veterans, warehouse, water, yard
†† Emergency Response includes Sherriff Offices and Fire Departments

Note: Total Inventory Values
1 - Building Replacement Costs = $11,868,231,028.60
2 - Content Replacement Costs = $5,673,439,613.70
3 - Total Value = $17,541,670,642.30

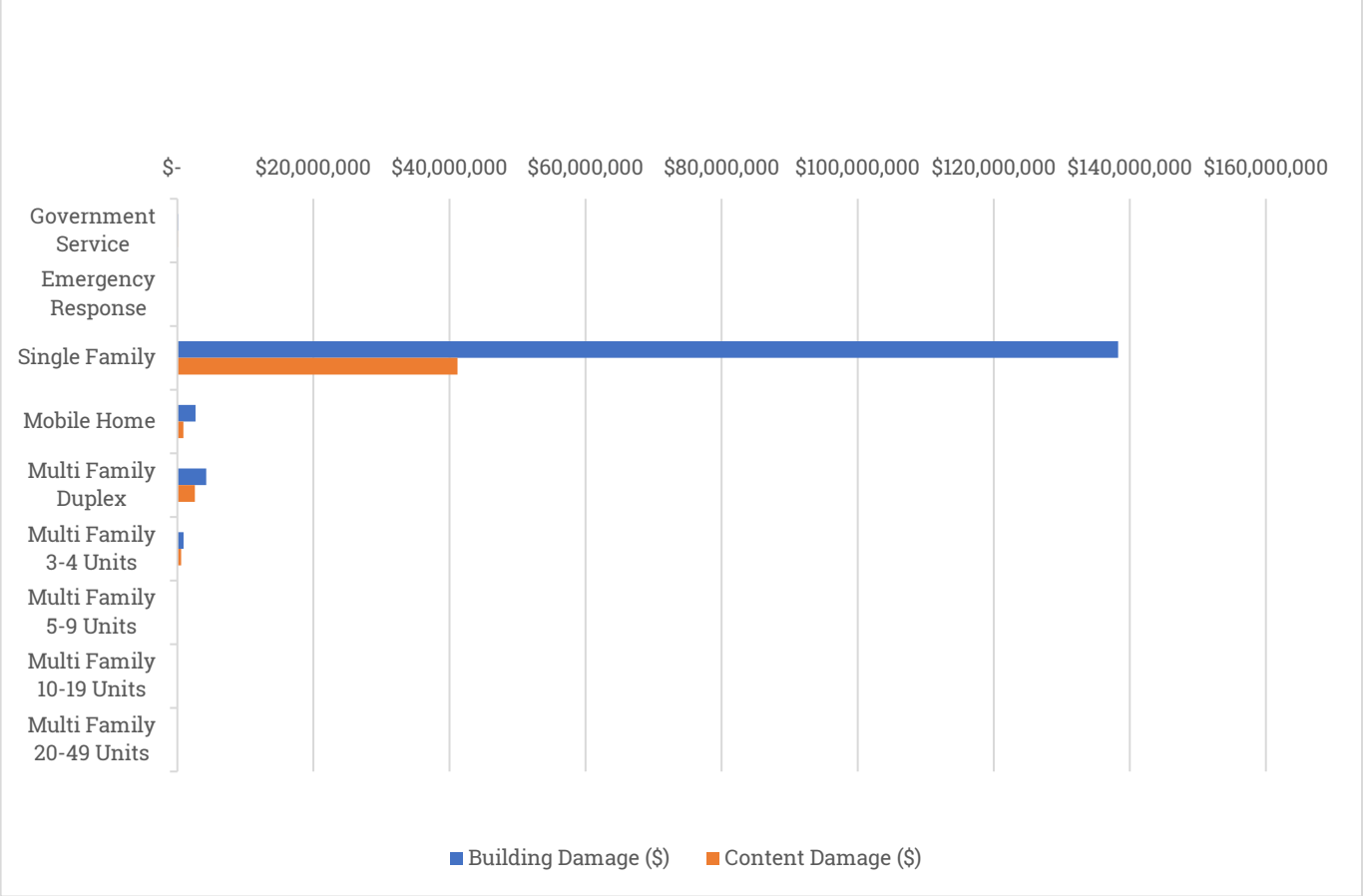


Figure 4-21 100-YR Flood Damage Estimation by Occupancy

Table 4-18 displays damage estimation for County insured assets located in the 100-year flood zone.

Table 4-18 100 YR Flood Damage Estimation of County Insured Assets

Asset Type	Bldg. Count	Bldg. Cost USD	Content Cost USD	Bldg. Dmg. %.	Content Dmg. %	Bldg. Loss %	Content Loss %	Total Value Loss USD	Total Loss as % of Values
Administrative & Office	**2**	**$2,265,678**	**$2,000**	**0.0%**	**0.0%**	**$0**	**$0**	**$0**	**0.0%**
Admin	2	$2,265,678	$2,000	0.0%	0.0%	$0	$0	$0	0.0%
Equipment & Storage	**2**	**$796,212**	**$12,274**	**0.0%**	**0.0%**	**$0**	**$0**	**$0**	**0.0%**
Yard	2	$796,212	$12,274	0.0%	0.0%	$0	$0	$0	0.0%
Other Assets	**3**	**$1,396,511**	**$620,194**	**2.8%**	**20.1%**	**$117,332**	**$69,557**	**$186,888**	**9.3%**
Leased	3	$1,396,511	$620,194	2.8%	20.1%	$117,332	$69,557	$186,888	9.3%
Recreation	**3**	**$1,227,733**	**$18,257**	**0.0%**	**0.0%**	**$0**	**$0**	**$0**	**0.0%**
Park	1	$135,359	$1,000	0.0%	0.0%	$0	$0	$0	0.0%
Recreation	2	$1,092,374	$17,257	0.0%	0.0%	$0	$0	$0	0.0%
Services	**8**	**$5,612,671**	**$418,183**	**0.0%**	**0.0%**	**$0**	**$0**	**$0**	**0.0%**

Asset Type	Bldg. Count	Bldg. Cost USD	Content Cost USD	Bldg. Dmg. %.	Content Dmg. %	Bldg. Loss %	Content Loss %	Total Value Loss USD	Total Loss as % of Values
Fire	4	$2,893,100	$306,260	0.0%	0.0%	$0	$0	$0	0.0%
Library	2	$2,620,412	$2,000	0.0%	0.0%	$0	$0	$0	0.0%
Sheriff	2	$99,159	$109,923	0.0%	0.0%	$0	$0	$0	0.0%
Grand Total	**18**	**$11,298,805**	**$1,070,908**	**0.5%**	**3.3%**	**$117,332**	**$69,557**	**$186,888**	**1.5%**

Damage Estimation for 500 yr. Floodplain

Table 4-19 and Figure 4-22 display the damage estimation summaries for the 500 yr. floodplain in Unincorporated Kern County by occupancy type.

Table 4-19: Damage Estimation Summary for 500 yr. Floodplain

Building Type	Building Damage ($)	Building Damage (% of total lossl)	Content Damage ($)	Content Damage (% of total loss)	Total Damage ($)	Proportion of Loss (%)
County Insured Assets						
Government Service†	$ 460,297	0.1%	$ 56,267	0.0%	$ 516,563	0.3%
Emergency Response††	$ 33,985	0.0%	$8,682	0.0%	$ 42,667	0.0%
Residential						
Single Family	$251,352,817	75.7%	$ 68,051,451	35.5%	$ 319,404,268	166.8%
Mobile Home	$ 2,613,035	0.8%	$1,116,376	0.6%	$ 3,729,412	1.9%
Multi Family Duplex	$ 3,570,518	1.1%	$ 2,041,086	1.1%	$ 5,611,604	2.9%
Multi Family 3-4 Units	$ 1,825,942	0.5%	$ 1,037,288	0.5%	$ 2,863,229	1.5%
Multi Family 5-9 Units	$ 822	0.0%	$ 329	0.0%	$ 1,151	0.0%
Multi Family 10-19 Units	$ 38,416	0.0%	$ 26,380	0.0%	$ 64,796	0.0%
Multi Family 20-49 Units	$ -	0.0%	$ -	0.0%	$ -	0.0%
Total	**$ 259,895,832**	**78.2%**	**$ 72,337,858**	**21.8%**	**$ 332,233,690**	

†Government Services includes: admin, airport, animal, building, bus, correctional, equipment, golf course, health, leased, library, misc, museum, office, park, recreation, relay, shop, storage, vacant, veterans, warehouse, water, yard

†† Emergency Response includes Sherriff Offices and Fire Departments

Note: Total Inventory Values
1 - Building Replacement Costs = $11,868,231,028.60
2 - Content Replacement Costs = $5,673,439,613.70
3 - Total Value = $17,541,670,642.30

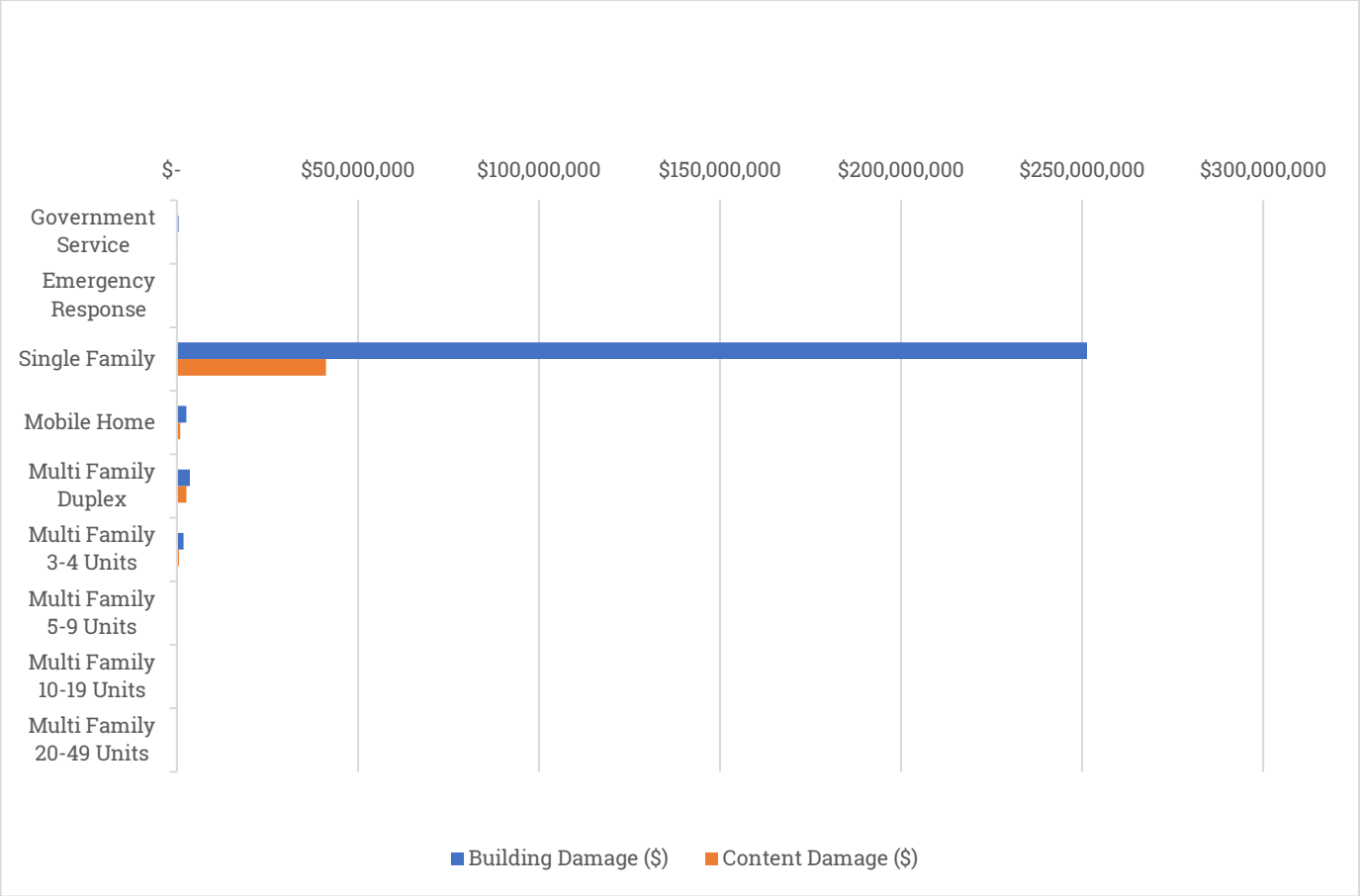


Figure 4-22 500 YR Flood Damage Estimation by Occupancy Type

Table 4-20 displays damage estimation for County facilities located in the 500-year flood zone.

Table 4-20 500-YR Flood Damage Estimation of County Facilities

Row Labels	Bldg. Count	Bldg. Cost USD	Content Cost USD	Bldg. Dmg. %	Content Dmg. %	Bldg. Loss %	Content Loss %	Total Value Loss USD	Total Loss as % of Values
Equipment & Storage	**1**	**$579,319**	**$36,616**	**4.9%**	**29.3%**	**$28,285**	**$10,726**	**$39,011**	**6.3%**
Storage	1	$579,319	$36,616	4.9%	29.3%	$28,285	$10,726	$39,011	6.3%
Other Assets	**2**	**$2,000**	**$480,268**	**0.0%**	**0.0%**	**$0**	**$0**	**$0**	**0.0%**
Leased	2	$2,000	$480,268	0.0%	0.0%	$0	$0	$0	0.0%
Recreation	**3**	**$3,414,586**	**$49,963**	**8.7%**	**58.3%**	**$289,837**	**$45,333**	**$335,170**	**9.7%**
Recreation	3	$3,414,586	$49,963	8.7%	58.3%	$289,837	$45,333	$335,170	9.7%
Services	**4**	**$5,634,901**	**$207,245**	**3.1%**	**8.9%**	**$176,160**	**$8,889**	**$185,049**	**3.2%**
Fire	3	$1,513,954	$206,245	2.9%	5.0%	$33,985	$8,682	$42,667	2.5%
Library	1	$4,120,947	$1,000	3.5%	20.7%	$142,175	$207	$142,382	3.5%
Grand Total	**10**	**$9,630,806**	**$774,092**	**4.3%**	**24.0%**	**$494,281**	**$64,949**	**$559,230**	**5.4%**

4.5.2.11 Future Trends in Development

Levees in Kern County provide the community with some degree of protection from flooding. Kern County has a comprehensive floodplain management ordinance (Kern County Code § 17.48) to restrict and mitigate impacts from future development occurring within floodplains and floodways. The County has also undertaken several studies on reducing flood risk and converted those follow up projects into mitigation actions. For example, see Caliente Creek Feasibility Study and Conceptual Plan.

The Kern County Water Agency (KCWA) has limited flood control responsibilities through Improvement District No. 1 in the Rosedale area of Bakersfield and Improvement District No. 3 to provide flood protection to Weldon Valley residents east of Isabella Reservoir. (KCWA, 2018)

The County and its planning partners are equipped to handle future growth within flood hazard areas. The County and all other municipal planning partners have General Plans that address frequently flooded areas in their Safety Elements. All partners have committed to linking their General Plans to this MJHMP. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas.

4.5.2.12 Flood Hazard Problem Statements

As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities based on the risk assessment and vulnerability analysis, utilizing the RAMP mapping tool and flood data. Flood problem statements for the County are listed in Table 4-21; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understanding the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. See Table 5-6 for a full list of mitigation actions and the corresponding problem statements that they address. Each problem statement is coded with a problem number for cross-referencing between Table 4-21 and Table 5-6.

Table 4-21 Flood Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-FL-KC-173	Flood	Impact	PRV - Prevention , PPRO - Property Protection , PE&A - Public Education & Awareness	**County of Kern**	Floods and their impacts will vary by community, and will likely only affect certain areas of the County during specific timeframes.	ma-FL-KC-110, ma-FL-KC-70, ma-FL-KC-202, ma-FL-KC-302
ps-FL-KC-174	Flood	Impact	PPRO - Property Protection , NRP - Natural Resource Protection	**County of Kern**	While many of the floods are shallow sheet flow events, they have resulted in property damage, road washouts, and transportation disruptions.	ma-FL-KC-284, ma-FL-KC-202, ma-FL-KC-97, ma-FL-KC-302
ps-FL-KC-175	Flood	Impact	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	County bridges are affected by scouring during flooding. Reference the County Poor Health Bridges Report for bridges of poor quality that require attention- https://www.dropbox.com/s/kkb4c685iwlefsd/Poor%20Health%20Bridges%20Report.pdf?dl=1	ma-FL-KC-285, ma-FL-KC-202, ma-FL-KC-97
ps-FL-KC-176	Flood	Victim	PRV - Prevention	**County of Kern**	Problems still occur in areas that have no mapped floodplain or where floodplain maps are inaccurate.	ma-FL-KC-110, ma-FL-KC-70, ma-FL-KC-202, ma-FL-KC-302

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-FL-KC-177	Flood	Victim	PRV - Prevention , PE&A - Public Education & Awareness , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Approx . 35k residents live within or near the 100 YR Floodplain. Approx. 400 live within proximity to floodway.	ma-FL-KC-70, ma-FL-KC-110, ma-FL-KC-283, ma-FL-KC-202
ps-FL-KC-178	Flood	Victim	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	High Potential Loss Facilities within 100-YR Flood Zone: 11 - Child Care Centers 9 – In-Home Child Care Facilities 9 – Special Needs Facilities	ma-FL-KC-110, ma-FL-KC-70
ps-FL-KC-179	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Based on input from the Golden Hills Community Service District, 2,100-7,500 persons could be impacted by floods in this area. Certain areas of the District's water system and roads in two road maintenance districts could be affected. Areas could be isolated from emergency services and experience loss of power service, power and natural gas.	ma-FL-KC-110, ma-FL-KC-70, ma-FL-KC-284
ps-FL-KC-180	Flood	Threat	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	South Lake – The area along the southeast shore of Lake Isabella has several residential developments constructed on active alluvial fans.	ma-FL-KC-70, ma-FL-KC-283, ma-FL-KC-110
ps-FL-KC-181	Flood	Threat	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	Lynch Canyon/Mountain Mesa – This residential and commercial area, along the south shore of Lake Isabella, is constructed on an active alluvial fan.	ma-FL-KC-283, ma-FL-KC-70, ma-FL-KC-110
ps-FL-KC-182	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Cache Creek – Pg. 4 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-303

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-FL-KC-183	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Little Dixie Wash – Pg. 4 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-303
ps-FL-KC-184	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Ridgecrest Washes – Pg. 4 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-303
ps-FL-KC-185	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	According to the Wheeler Ridge-Maricopa Water Storage District and Kern County Roads Department the following public roads have flood problems, some of which could use improvements to prevent recurrent damage: David Rd at Grapevine Creek and El Paso Creek Sebastion Rd at Grapevine Creek and El Paso Creek Laval Rd at Grapevine Creek Randsburg Red Rock Rd near Red Rock Canyon State Park Copus and Valpredo Rds near the junction of Highway 99 and Interstate 5 Wheeler Ridge Road and Rancho Road near El Paso and Tejon Creek Frazier Mtn Park Rd and bridges along Cuddy Creek has erosion concerns	ma-FL-KC-99
ps-FL-KC-204	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Sandy Creek (Taft/Ford City area) –Pg. 3 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-284, ma-FL-KC-285

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-FL-KC-206	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	The Southern Stream Group – Pg. 3 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	
ps-FL-KC-207	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Poso Creek – Pg. 3 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1 Also has potential to break across HWY 99 and create backwater flooding issues as a result of debris and flow impediment.	ma-FL-KC-82, ma-FL-KC-244
ps-FL-KC-208	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Caliente Creek – Pg. 3 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-304
ps-FL-KC-209	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Upper Caliente Creek – Pg. 3 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-AH-KC-153, ma-FL-KC-304
ps-FL-KC-210	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	North Fork of the Kern River (Kernville) – Pg. 3 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-303
ps-FL-KC-211	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Lower Kern River/Buena Vista Lake – Pg. 3 of Kern Co. Flood Hazard Mitigation Plan details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-303

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-FL-KC-212	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Onyx – Pg. 4 of Kern Co. Flood Hazard Mitigation Plan, details issues w/ this waterway. Kelso Creek also has a role in this problem area. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-303
ps-FL-KC-213	Flood	Threat	PPRO - Property Protection , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Kelso Creek – Pg. 4 of the Kern Co. Flood Hazard Mitigation Plan, details issues w/ this waterway. https://www.dropbox.com/s/544jltdk9vf6sy4/Kern%20County%20Flood%20Hazard%20Mitigation%20Plan%20%281998%29.pdf?dl=1	ma-FL-KC-303
ps-FL-KC-214	Flood	Impact	PRV - Prevention , PE&A - Public Education & Awareness , NRP - Natural Resource Protection , SP - Structural Projects	**County of Kern**	Properties in the area of Kelso Creek have a total value of approx. $7.5 million, and many properties are not floodproofed to the County's standards. Flooding could affect more than 200 residents in the area. Portions of Kelso Creek Road are at risk with an average cost of repairs of approximately $80,000 each time it floods.	ma-FL-KC-70, ma-FL-KC-283

4.5.3 Dam Failure Hazard Profile



Dam failures in the United States typically occur in one of four ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures. (Federal Emergency Management Agency, 2019)

Many dam failures in the United States have been secondary results of other disasters, such as earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies. (*Id.*) Dam inundation zones are shown in Figure 4-24.

Levees

Levees are a common form of flood protection throughout the Kern County. Figure 4-25 displays the levee system in Kern County. A levee is built parallel to a body of water in order to protect life and property on the other side by channeling the water away during flooding.

Levees do not provide full protection from flooding. They are designed to provide a specific level of flood protection and large flood events can cause levees to be overtopped or fail. Levee failure is most likely during large flood events where a large surge of water leads to erosion of the soil that constitutes the levee itself.

4.5.3.1 Plans, Policies, and Regulatory Environment

1972 National Dam Safety Act

The potential for catastrophic flooding due to dam failures led to passage of the 1972 National Dam Safety Act, Pub. Law No. 92-367. The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the public lives and property.

FERC Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. There are 3,036 dams that are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. (Federal Energy Regulatory Commission, 2011) As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC staff inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent consulting engineer, approved by the FERC, must inspect and evaluate projects with dams higher than 10 meters (32.8 feet), or with a total storage capacity of more than 2,000 acre-feet. (*Id.*)

FERC staff monitors and evaluates seismic research in geographic areas where there are concerns about seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects in these areas. FERC staff also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC staff visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

The FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations. (*Id.*)

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers ("Corps") is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried such dams and surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. The Corps develops guidelines for inspection and evaluation of dam safety.

California Division of Safety of Dams

California's Division of Safety of Dams, a division of the Department of Water Resources, monitors the dam safety program at the state level. When a new dam is proposed, Division staff inspects the site. The Division reviews dam applications and building plans to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for known geologic conditions. It also inspects construction to ensure that the work is done in accordance with the approved plans. The Division inspects constructed dams on an annual basis to ensure that it is performing as intended and is not developing problems. Roughly a third of these inspections include in-depth instrumentation reviews. The Division periodically reviews the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California. (Cal. Dep't of Water Resources, 2019)

Senate Bill 92: Dam Safety

Senate Bill 92 was signed into law on June 27th, 2017 and it provides new requirements focused on dam safety. Specifically, it requires dam owners to submit inundation maps to the Department of Water Resources. After they have been approved, the dam owner must then submit an emergency action plan (EAP) to Cal OES. These need to be approved by Cal OES, and resubmitted every 10 years. (California Office of Emergency Services, 2020)

Kern County General Plan

The 2004 Kern County General Plan includes many policies, implementation measures, and goals in the Land Use and Safety Elements that limit development occurring in inundation zones and mitigate impacts from such development.

Policies around dam failure include limited development in inundation zones, generally forbidding structures to be built without emergency response and evacuation plans or without inundation mitigation capabilities. The Kern County General Plan is currently being updated and will consider this MJHMP Update as it continues to shape policies around dam failure mitigation and protection.

FEMA Approval 4/9/2021

4.5.3.2 Past Events

No dams have failed in Kern County to date. As the risk assessment for Kern County illustrates, the chances of a dam failure area low, but the consequences of such are quite severe.

The most recent concerning dam failure in California was the 2017 collapse of a spillway on the Oroville Dam in Butte County, California. Oroville Dam is the largest facility within the State Water Project in California; the dam stores 3.5 million acre-feet of water, and serves as important flood control for the Feather River. In 2017, after substantial runoff from the Sierra Nevadas, Lake Oroville was full, and the spillway was opened to release extra water downstream.



Figure 4-23. Oroville Dam Spillway after 2017 failure.

Source: https://www.watereducation.org/aquapedia/oroville-dam

"Spillways" are dam safety features that allow water to overtop the dam if the reservoir fills too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential.

The force of the release gouged a large crater in the concrete spillway and required the California Department of Water Resources (DWR) to halt water releases via that conduit. The high lake level then created fear that erosion would compromise the integrity of the auxiliary spillway and flood the city of Oroville and surrounding communities. Thousands were evacuated, and eventually runoff receded without further issue. Ultimately, an independent analysis concluded that poor design and construction and inadequate state oversight contributed to the collapse of the concrete spillway. (Water Education Foundation, 2020)

The Oroville Dam spillway failure triggered inspection of 93 dam spillways across California through the new Spillway Re-evaluation Program. (Cal. Dep't of Water Resources, 2019)

4.5.3.3 Location

According to California Department of Water Resources Division of Dam Safety and USACE National Inventory of Dams (NID), there are 25 dams in Kern County, shown in Table 4-23. These dams are rated for hazard potential according to the descriptors in Table 4-22. FEMA developed the classification system shown in for potential dam failures. California DWR Division of Safety of Dams (DSOD) includes a fourth category "Extremely High". This hazard potential classification system categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. Improbable loss of life exists where persons are only temporarily in the potential inundation area.

Figure 4-24 shows inundation zones for select dams in Kern County. Areas of the County most threatened by dam inundation are those within the Central Valley.

Figure 4-25 displays the levee system in Kern County. During large flood events, a levee failure could impact populations, properties, and infrastructure within levee inundation zones.

Table 4-22: FEMA & DSOD Hazard Potential Classification

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable. One or more expected	Yes (but not necessary for this classification)
Extremely High	One or more and inundating an area of 1,000+ population	Inundation of facilities/infrastructure, posing significant threat to public safety determined case-by-case by DSOD

Source: Federal Guidelines for Dam Safety- Hazard Potential Classification Systems for Dams, April 2004, DSOD Jurisdictional Dams

Table 4-23: Dams in Kern County

DWR ID	NID ID	Dam Name	Owner	Year Built	Hazard
No. 1083-2	CA01213	Antelope	Tehachapi Cummings County Water District	1987	H+
No. 738-6	CA01498	Bap Pond 5	Rio Tinto	2008	L
No. 738-7	CA01552	Bap Pond 6	Rio Tinto	2012	L
No. 738-8	CA10410	Bap Pond 7	Rio Tinto	Unknown	L
No. 738-5	CA01430	Bap Ponds 1, 2, 3, 4	Rio Tinto	2003	L
No. 1051-0	CA00884	Berrenda Mesa	Berrenda Mesa Water District	1967	S
No. 737-0	CA00722	Big Four Ranch	Kern-Tulare Water District	1970	S
No. 1083-3	CA01310	Blackburn	Tehachapi Cummings County Water District	1991	H
No. 738-4	CA01190	Borax Solar Evaporation Ponds	Rio Tinto	1984	L

DWR ID	NID ID	Dam Name	Owner	Year Built	Hazard
No. 738-0	CA01099	Boron Tails Pond	Rio Tinto	1975	L
No. 738-3	CA01178	Boron Tails Pond 6	Rio Tinto	1980	L
No. 732-0	CA00717	Buena Vista	J.G. Boswell Company & Tenneco West	1890	S
No. 735-2	CA00721	Buena Vista	Kern County Parks and Recreation	1973	S
No. 104-2	CA00429	Diversion No. 1	Southern California Edison	1906	H
	CA01558	Fresh Water Impoundment	Oil-Dri Corporation of America	Unknown	H
	CA01559	Fresh Water Pond	CALMAT	Unknown	H
No. 2011-2	CA01181	Irrigation Reservoir	City of Bakersfield	1980	H
	CA10106	Isabella Dam	CESPK	1953	H
No. 1083-0	CA00587	J.C. Jacobsen	Tehachapi Cummings County Water District	1973	H
No. 735-0	CA00720	Kern River County Park	Kern County Parks and Recreation	1959	H
	CA01614	Kern River No. 1 Forebay	Southern California Edison	Unknown	S
	CA01595	Rio Bravo Canal	Olcese Water District	1988	S
	CA01595	Rio Bravo Diversion	Olcese Water District	1989	L
No. 734-0	CA00718	Tejon Storage 1	Tejon Ranch Company	1946	L
No. 734-2	CA00729	Tejon Storage 2	Tejon Ranch Company	1956	L

Note: Hazard Definitions: L – Low; S – Significant; H – High; H+ – Extremely High

Source: *DWR Jurisdictional Dams & USACE National Inventory of Dams*

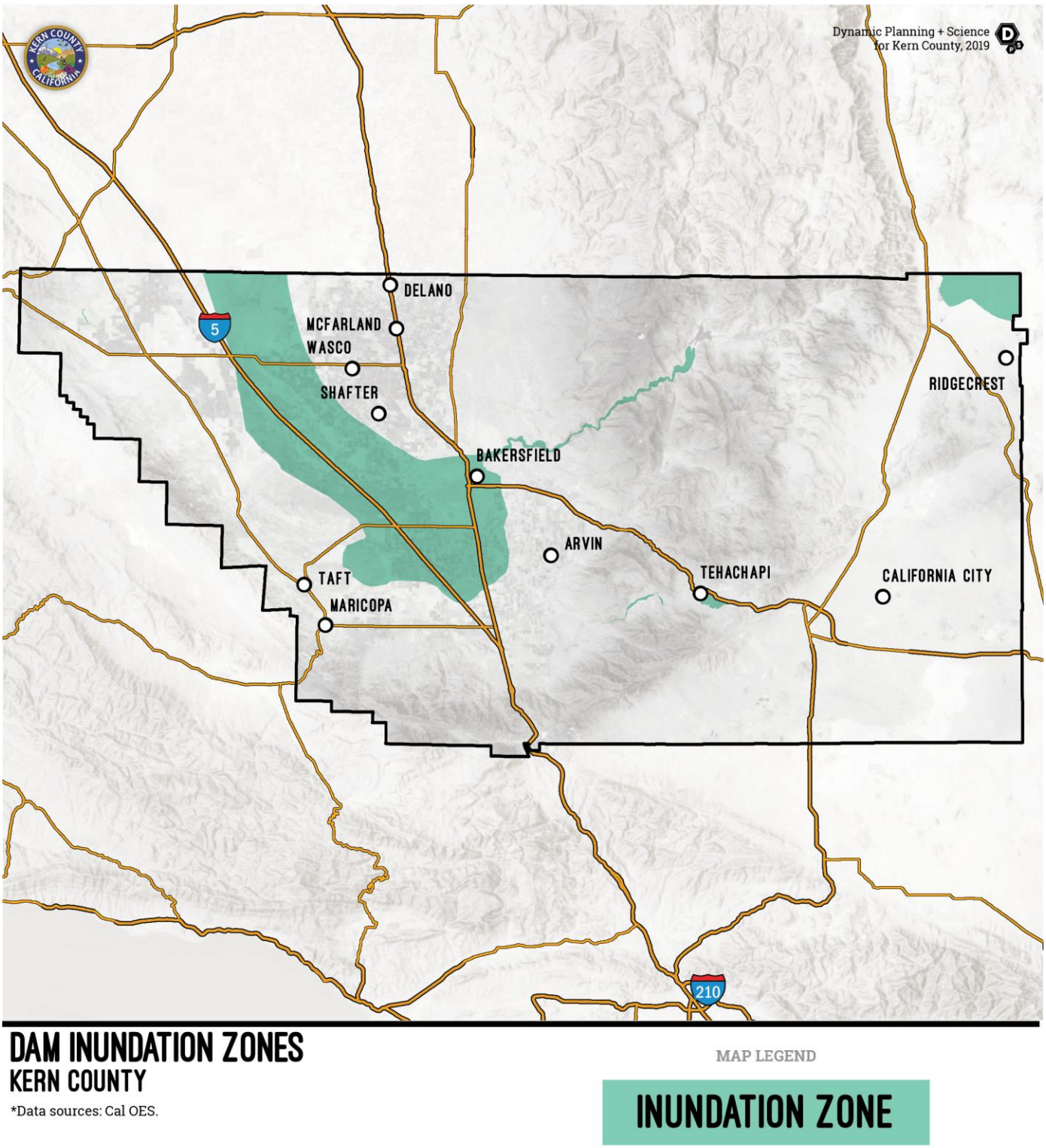


Figure 4-24: Dam Inundation Exposure

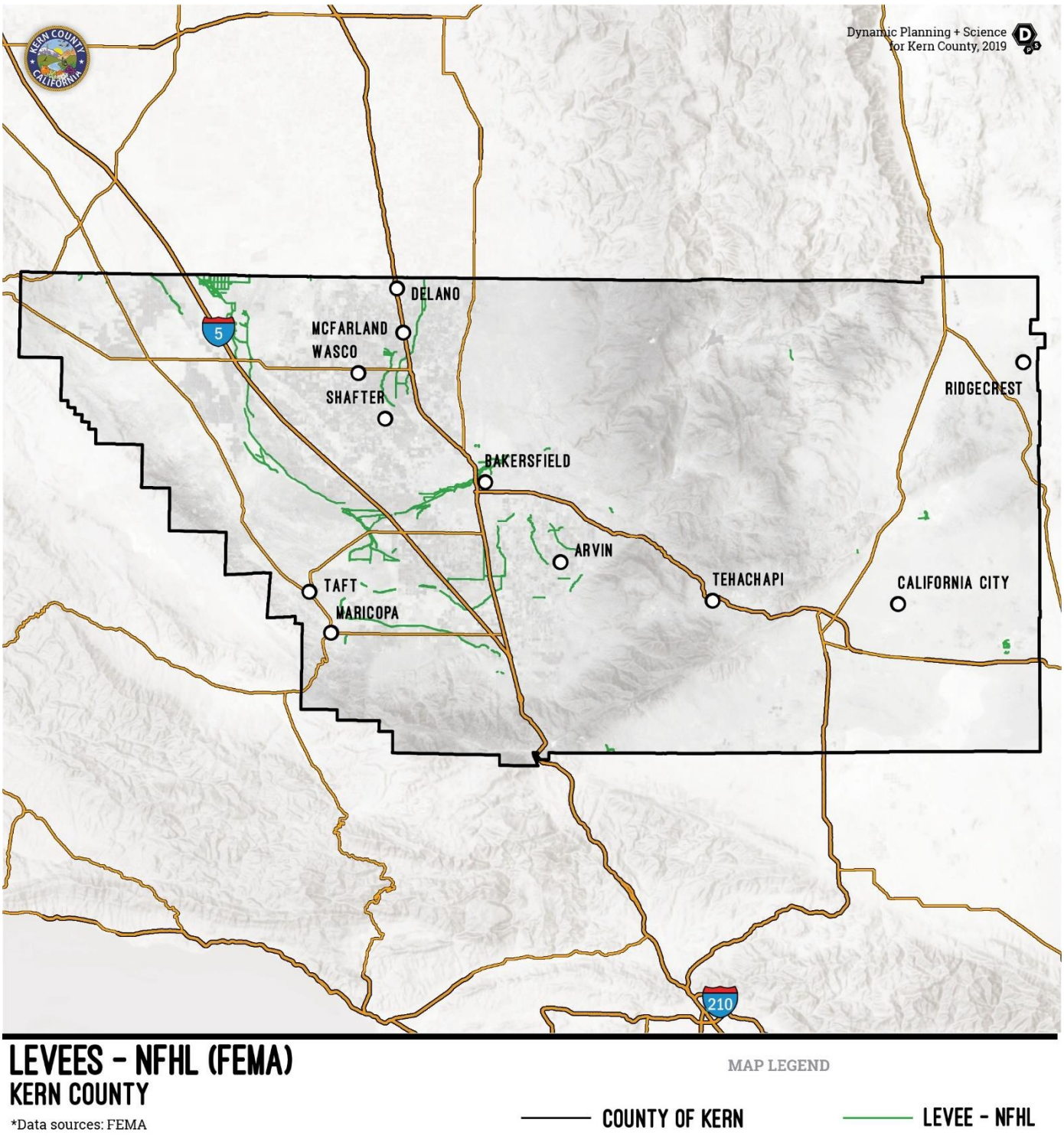


Figure 4-25 Kern County Levee System

4.5.3.4 Severity and Extent

Dam failure can be catastrophic to all life and property downstream. The potential loss of life and property is difficult to qualtify. For example, the FEMA hazard potential classification system in Table 4-22 does not contemplate the improbable loss of life of the occasional recreational user of the river and downstream lands, passer-by, or non-overnight outdoor user of downstream lands. In any classification system, all possibilities cannot be defined. High usage areas of any type should be considered appropriately. Judgment and common sense must ultimately be a part of any decision on classification. Further, no allowances for evacuation or other emergency actions by the population should be considered because emergency procedures should not be a substitute for appropriate design, construction, and maintenance of dam structures.

4.5.3.5 Frequency/ Probability of Future Occurrences

The probability of any type of dam failure is low in today's regulatory and dam safety oversight environment. Dam failure events usually coincide with events such as earthquakes, landslides, and excessive rainfall and snowmelt.

4.5.3.6 Warning Time

Warning time for dam failure depends on the cause of failure. In an event of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail instantaneously. Once a breach is initiated, discharging water erodes the breach until the reservoir water is depleted, or the breach resists further erosion. Concrete gravity dams also tend to have an initial partial breach. The time of breach formation ranges from a few minutes to a few hours. Several participating jurisdictions have established protocols in their emergency operations plans for warning and response to imminent dam failure within the flood warning. These protocols are tied to emergency action plans created by the dam owner.

Developing Emergency Action Plans (EAPs) for all high and significant hazard potential dams for Kern County is critical to reducing the risks of loss of life and property damage from dam failures. The EAP contains procedures and information to assist the dam owner in issuing early warning and notification messages to emergency management authorities. The EAP also contains inundation maps to identify the areas subject to flooding in the unlikely event of dam failure.

EAPs are critical in identifying areas downstream from dams requiring warning and evacuation in the event of dam failure. Documented cases have demonstrated that warning and evacuation time for EAPs can dramatically influence the loss of life. Loss of life can vary from 0.02 percent of the persons-at-risk when the warning time is 90 minutes to 50 percent when less than 15 minutes, (Graham, Assessing the Threat to Life from Dam Failure, 1988) One USGS report states that the average number of fatalities per dam failure is 19 times greater when there is little to no warning. (U.S. Geological Survey, 1985) Dam breach inundation studies usually assume one of two failure scenarios:

- Flows from a dam failure during "fair weather" or "sunny day" conditions with the reservoir at the normal pool level and receiving normal inflow (usually insignificant). A fair weather failure is generally considered to have the most potential for loss of human life, primarily due to the element of surprise.
- Flows from a dam failure during flood conditions or the inflow design flood. Failure during flood conditions is considered to show the upper limit of inundation and to have less potential for loss of human life because the downstream population is "on alert." The flood conditions scenario is more expensive to analyze due to the additional cost for the necessary watershed and spillway studies.

Inundation mapping shows a continuous "line of inundation" identifying the area potentially at risk in event of dam failure. It starts at the dam and continues downstream to a point where the breach flood no longer poses a risk to life and property damage, such as a large river or reservoir with the capacity of storing the flood waters. The need to consider the "domino effect" should be made on a case-by-case basis if the assumed failure of a dam would cause the failure of any downstream dams.

4.5.3.7 Secondary Hazards

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

4.5.3.8 Dam Failure Vulnerability Assessment

The primary danger associated with dam failure is high velocity flooding downstream of the dam and limited warning times for evacuation. Vulnerability varies by community and depends on the particular dam profile and the nature and extent of the failure. Vulnerable populations are present directly below the dam and may include those who are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to self-evacuate from the inundation area. Vulnerable populations also include those who would not have adequate warning from a television or radio emergency warning system. Dam inundation zones created by Cal OES were used in conjunction with the inventory listed in Table 4-23 to develop at risk populations and loss estimations for dam failure.

4.5.3.8.1 Exposure Analysis

4.5.3.8.2 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television, radio emergency warning system, have not registered with reverse 911, or do not have cell phones that can receive amber alerts. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The entire population in a dam failure inundation zone is exposed to the risk of a dam failure. The estimated population exposed to dam inundation is summarized in Figure 4-26 and Table 4-24.

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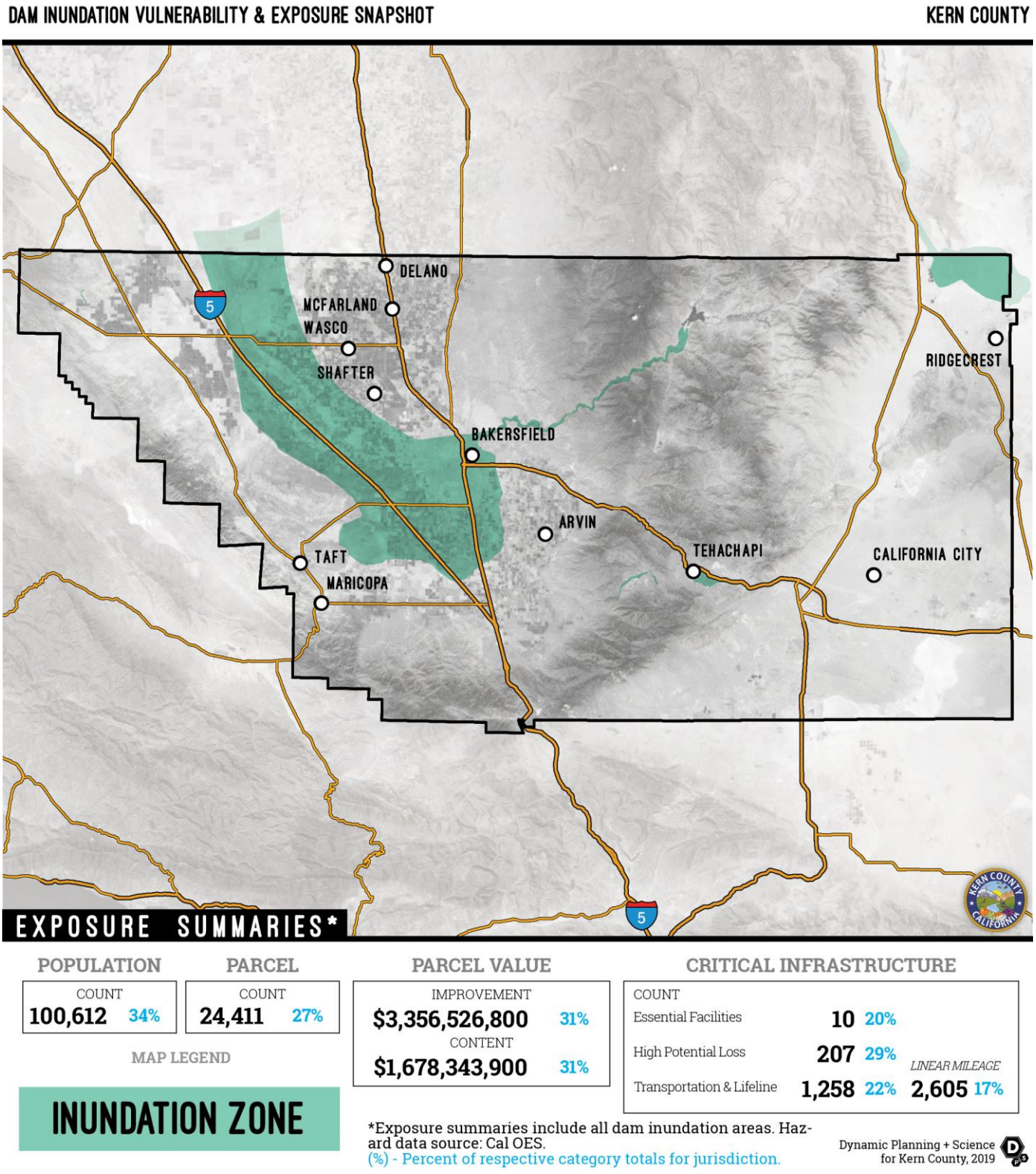

Figure 4-26: Dam Failure Vulnerability Snapshot Map

Table 4-24: Population Exposure to Dam Failure (Unincorporated County)

	Total Population
Unincorporated County	299,935

Dam Inundation Zone	Population Count	% of Total
Antelope Kern	1,101	*0.37%*
Berrenda Mesa	-	*0.00%*
Blackburn	1,393	*0.46%*
South Haiwee	184	*0.06%*
Isabella	98,408	*32.81%*
JC Jacobsen	62	*0.02%*
Total*	**100,621**	**33.55%**

*Total population is not equal to sum of all dam inundation zones due to dissolved overlapping inundation areas.

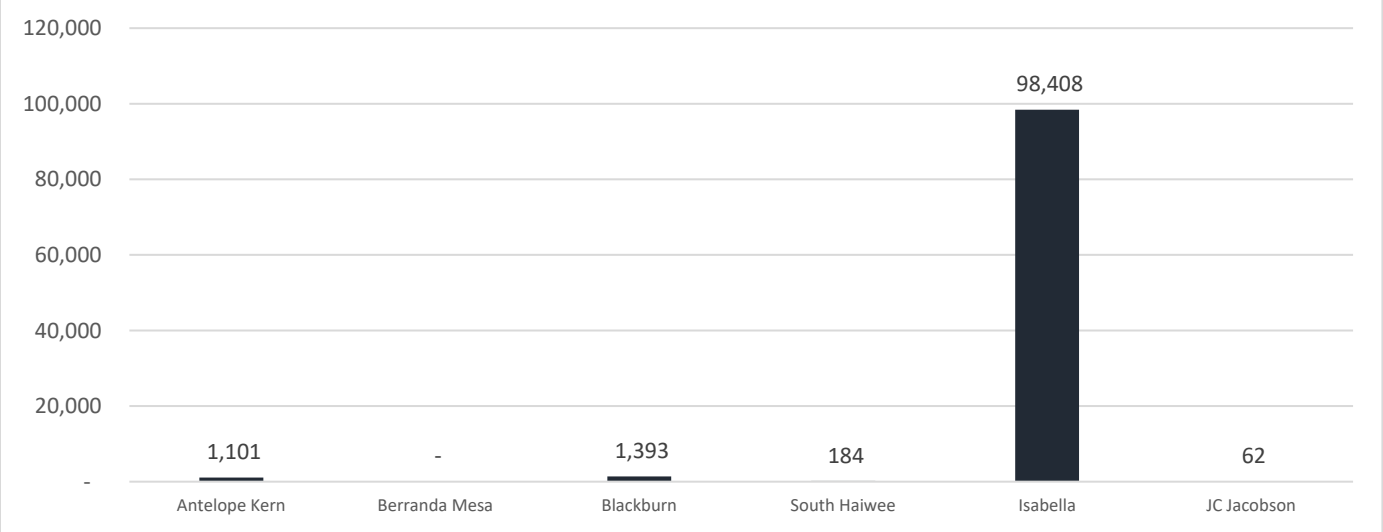

Figure 4-27 Population Exposure to Dam Inundation by Zone

4.5.3.8.3 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas where water would collect are also vulnerable. Transportation routes, discussed below, are also vulnerable to dam inundation and have the potential to be eliminated or compromised, creating isolation issues. Vulnerable populations may not be able to withstand a large water surge. Utilities such as overhead power, cable, and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas. Table 4-25 below displays parcel values exposed to dam inundation.

Table 4-25: Parcel Values at Risk from Dam Inundation (Unincorporated County)

	Total Parcels	Total Market Value ($)	Total Content Value ($)	Total Value ($)
Unincorporated County	91,455	$ 10,906,675	$ 5,453,338	$ 16,360,013

Dam Inundation Zone	Parcel Count	% of Total	Market Value Exposure ($)	Content Value Exposure ($)	Total Exposure ($)	% of Total
Antelope Kern	22	0.0%	$5,407.08	$ 2,703.54	$ 8,110.61	0.05%
Berrenda Mesa	1	0.0%	$ -	$-	$ -	0.00%
Blackburn	19	0.0%	$ 2,173.95	$ 1,086.97	$ 3,260.92	0.02%
South Haiwee	-	0.0%	$ -	$-	$ -	0.00%
Isabella	24,363	26.6%	$ 3,347,387.22	$ 1,673,693.61	$5,021,080.83	30.69%
JC Jacobsen	9	0.0%	$ 1,547.71	$ 773.85	$ 2,321.56	0.01%
Dam Inundation Area*	**24,411**	**26.7%**	**$ 3,356,366**	**$ 1,678,183**	**$ 5,034,549**	**30.8%**

Currency in Thousands
**Totals are not equal to sum of all dam inundation zones due to dissolved overlapping inundation areas.*

4.5.3.8.4 Critical Facilities & Lifelines

Low-lying areas are vulnerable to dam inundation, especially transportation routes. This includes all roads, railroads, and bridges in the flow path of water, which could be eliminated or compromised in a dam inundation event. The most vulnerable critical facilities are those in poor condition that would have difficulty withstanding a large surge of water. Utilities such as overhead power lines and communication lines could also be vulnerable. Loss of these utilities could create additional compounding issues for emergency management officials attempting to conduct evacuation and response actions. Table 4-26 and Table 4-27 summarizes critical infrastructure exposed to dam failure in Kern County.

Table 4-26: Critical Infrastructure Points in Dam Inundation Zones (Unincorporated County)

Infrastructure Type	TOTAL FEATURE COUNT	Antelope Kern	Berrenda Mesa	Blackburn	South Haiwee	Isabella	JC Jacobsen
Essential Facility	10	-	-	-	-	10	-
EOC	-	-	-	-	-	-	-
Fire Station	8	-	-	-	-	8	-
Hospital	1	-	-	-	-	1	-
Police Station	-	-	-	-	-	-	-
Sheriff Station	1	-	-	-	-	1	-
High Potential Loss	1	-	-	-	-	1	-
Adult Residential facility	21	-	-	-	-	21	-
Child Care Center	33	-	-	-	-	33	-

Infrastructure Type	TOTAL FEATURE COUNT	Antelope Kern	Berrenda Mesa	Blackburn	South Haiwee	Isabella	JC Jacobsen
Dam	5	-	-	-	-	5	-
Family Child Care Home	-	-	-	-	-	-	-
Foster Family Agency	-	-	-	-	-	-	-
Historic Building	-	-	-	-	-	-	-
Home Care Organization	-	-	-	-	-	-	-
Library	3	-	-	-	-	3	-
Residential Child Care	-	-	-	-	-	-	-
Residential Elder Care	12	-	-	-	-	12	-
School	40	-	-	-	-	40	-
County Insured Asset*	28	-	-	-	-	28	-
Cooling Center	2	-	-	-	-	2	-
Healthcare Facility	11	-	-	-	-	11	-
Special Needs Facility	52	-	-	-	-	52	-
City Hall	-	-	-	-	-	-	-
Historic Site	-	-	-	-	-	-	-
Transportation and Lifeline	-	-	-	-	-	-	-
Airport	-	-	-	-	-	-	-
Bridge	107	-	-	4	-	103	-
Power Plant	19	-	-	-	-	19	-
Substation	23	-	-	-	-	23	-
Transmission Line Tower	1070	-	-	-	13	1055	2
NG Facility	29	-	-	-	-	29	-
Wind Turbine	-	-	-	-	-	-	-
Bus Facility	-	-	-	-	-	-	-
Potable Water Facility	-	-	-	-	-	-	-
Waste Water Facility	-	-	-	-	-	-	-
Oil Facility	9	-	-	-	-	9	-
Railroad Facility	1	-	-	-	-	1	-
Grand Total	**1475**	**-**	**-**	**4**	**13**	**1456**	**2**

** These insured assets may include critical infrastructure already represented in other Infrastructure Types.*

Table 4-27: Miles of Critical Infrastructure (Linear) in Dam Inundation Zones (Unincorporated County)

Infrastructure Type (linear)	TOTAL DAM EXPOSURE	Antelope Kern	Berranda Mesa	Blackburn	South Haiwee	Isabella	JC Jacobson
Levee	267.96	-	-	-	-	268.0	-
NG Pipeline	242.46	-	-	-	-	241.1	1.4
Railroad	54.22	2.6	-	0.0	-	51.6	-
Street	1613.76	6.9	-	17.8	127.9	1457.6	5.0
4WD trail	2.39	-	-	-	2.3	0.0	-
4WD trail, major	-	-	-	-	-	-	-
Alley	0.64	-	-	-	-	0.6	-
Cul-de-sac	1.15	-	-	-	0.4	0.8	-
Driveway	21.97	-	-	-	-	22.0	-
Interstate	123.44	3.0	-	4.5	-	115.9	-
Local road	513.79	1.3	-	5.3	26.5	479.2	2.0
Local road, major	424.38	1.3	-	5.1	18.2	397.8	2.8
Primary highway	12.07	-	-	-	-	12.1	-
Ramp	21.66	-	-	-	0.0	21.6	-
Road, parking area	0.35	-	-	-	-	0.3	-
Service road	1.41	-	-	-	-	1.4	-
State/county highway	311.81	1.3	-	2.8	-	307.6	0.2
State/county highway, major	0.02	-	-	-	-	0.0	-
Thoroughfare, major	177.96	-	-	-	80.5	97.5	-
Walkway	0.69	-	-	-	-	0.7	-
Transmission Line	426.55	0.9	-	4.4	5.2	415.8	0.5
Grand Total	**3792.15**	**10.3**	**-**	**22.1**	**133.1**	**2434.0**	**6.8**

4.5.3.8.5 Future Trends in Development

Flooding due to a dam failure event is likely to exceed the special flood hazard areas regulated through local floodplain ordinances. The County and participating jurisdictions should consider the dam failure hazard when permitting development in mapped dam inundation zones and downstream of high hazard and significant hazard dams in the County. Low hazard dams could become significant or high hazard dams if development occurs below them.

4.5.3.9 Dam Failure Hazard Problem Statements

As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities based on the risk assessment and vulnerability analysis, utilizing the RAMP mapping tool and flood data. Dam failure hazard problem statements are listed in Table 4-28; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understanding the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. Projects or actions have been developed to mitigate each problem identified. See Table 5-6 for a full list of mitigation actions and corresponding problem statements that they address. Each problem statement is coded with a problem number for cross-referencing between Table 4-28 and Table 5-6.

Table 4-28 Dam Failure Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-DF-KC-252	Dam Failure	Victim	PRV - Prevention , PPRO - Property Protection , PE&A - Public Education & Awareness , ES - Emergency Services , SP - Structural Projects	**County of Kern**	There are approx. 100,000 people and 24,000 parcels within the dam inundation zone in the unincorporated county	ma-DF-KC-384
ps-DF-KC-253	Dam Failure	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , ES - Emergency Services , SP - Structural Projects	**County of Kern**	There are approx. 213 critical infrastructure facilities and 2.5 miles of transportation and lifelines within the dam inundation zone in the unincorporated county	ma-DF-KC-384
ps-DF-KC-254	Dam Failure	Victim	PPRO - Property Protection , PE&A - Public Education & Awareness , ES - Emergency Services , SP - Structural Projects	**County of Kern**	Cascading effects of dam inundation could include loss of power and blocked access for evacuation routes	ma-DF-KC-384

4.5.4 Earthquake Hazard Profile

Earthquake is the sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks. Seismic waves are produced when some form of energy stored in Earth's crust is suddenly released, usually when masses of rock straining against one another suddenly fracture and "slip." Earthquakes associated with this type of energy release are called tectonic earthquakes. The energy also can be released by elastic strain, gravity, chemical reactions, or even the motion of massive bodies. Earthquakes occur most often along geologic *faults*, narrow zones where rock masses move in relation to one another. (United States Geological Survey, n.d.)

Earthquakes have different properties depending on the type of fault that causes them. See Figure 4-28. The usual fault model has a "strike" (that is, the direction from north taken by a horizontal line in the fault plane) and a "dip" (the angle from the horizontal shown by the steepest slope in the fault). The lower wall of an inclined fault is called the footwall. Lying over the footwall is the hanging wall. When rock masses slip past each other parallel to the strike, the movement is known as strike-slip faulting. Movement parallel to the dip is called dip-slip faulting. In dip-slip faults, if the hanging-wall block moves downward relative to the footwall block, it is called "normal" faulting; the opposite motion, with the hanging wall moving upward relative to the footwall, produces reverse or thrust faulting. *(Id)*

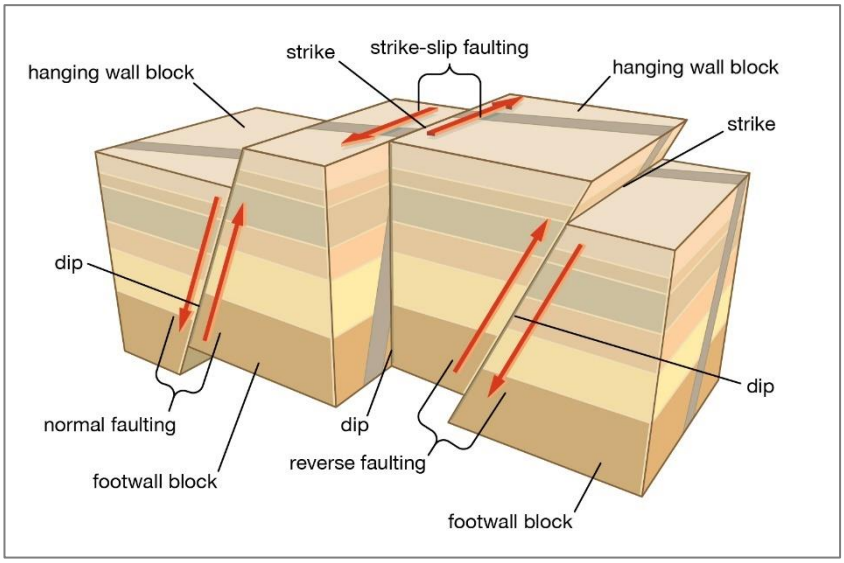

Figure 4-28: Earthquake Faulting

As a fault rupture progresses along or up the fault, rock masses are flung in opposite directions and thus spring back to a position where there is less strain. *(Id)*

Soil Liquefaction

Soil liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Soil liquefaction and related phenomena have been responsible for tremendous amounts of damage in historical earthquakes around the world. Soil liquefaction occurs when material that is ordinarily a solid behaves like a liquid. Saturated or partially-saturated soil substantially loses strength and stiffness in response to an applied stress such as shaking during an earthquake or other sudden change in stress condition. The phenomenon is most often observed in saturated, loose, low-density or uncompacted, sandy soils. Loose sand tends to compress when a load is applied. Dense sands, by contrast, tend to expand in volume or 'dilate'. If the soil is saturated by water, which often occurs when

soil is below the water table or sea level, then water fills the pore spaces between soil grains. (United States Geological Survey, n.d.)

Artificial Induction

Earthquakes are sometimes caused by human activities, including the injection of fluids into deep wells, pumping of ground water, the excavation of mines, and the filling of large reservoirs. In fluid injection, the slip is thought to be induced by premature release of elastic strain, as in the case of tectonic earthquakes, after fault surfaces are lubricated by the liquid. (Encyclopedia Britannica, 2020)

Earthquake Classifications

Earthquakes are typically classified in one of two ways: by the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity. (United States Geological Survey, n.d.)

Magnitude

The most common method for measuring earthquakes is magnitude, which measures the strength of earthquakes. While majority of scientists currently use either the Mw Scale or Modified Mercalli Intensity (MMI) Scale to measure an earthquake, the Richter scale is the most well-known measurement for earthquake magnitude. The magnitude of an earthquake is related to the total area of the fault that ruptured, as well as the amount of offset (displacement) across the fault. As shown in Table 4-29, there are seven earthquake magnitude classes, ranging from great to micro. A magnitude class of great can cause tremendous damage to infrastructure, compared to a micro class, which results in minor damage to infrastructure. *(Id)*

Earthquake Magnitude Classes		
Magnitude Class	**Magnitude Range (M = Magnitude)**	**Description**
Great	M > 8	Tremendous damage
Major	7 <= M < 7.9	Widespread heavy damage
Strong	6 <= M < 6.9	Severe damage
Moderate	5 <= M < 5.9	Considerable damage
Light	4 <= M < 4.9	Moderate damage
Minor	3 <= M < 3.9	Rarely causes damage.
Micro	M < 3	Minor damage

Table 4-29: Moment Magnitude Scale

Intensity

The effects of an earthquake in a particular location are measured by intensity. Earthquake intensity decreases with increasing distance from the epicenter of the earthquake. The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects experienced at that place. (United States Geological Survey)

The **lower** numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The **higher** numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above. Table 4-30 is an abbreviated description of the levels of Modified Mercalli intensity. *(Id)*

Table 4-30: Modified Mercalli intensity level descriptions

Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Source: USGS, Abridged from The Severity of an Earthquake, USGS General Interest Publication 1989-288-913

Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly-mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity. (Pacific Northwest Seismic Network)

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" such as single-family dwellings. Longer-period response components determine the lateral forces that damage larger structures with longer natural periods such as apartment buildings, factories, high-rises, bridges. Table 4-31 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale. (USGS)

Table 4-31: Modified Mercalli Scale and Peak Ground Acceleration

		Potential Structure Damage		Estimated PGA
Modified Mercalli Scale	Perceived Shaking	Resistant Buildings	Vulnerable Buildings	(%g)
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X - XII	Extreme	Very Heavy	Very Heavy	>124%

Note: PGA measured in percent of g, where g is the acceleration of gravity

Sources: USGS, 2008; USGS, 2010

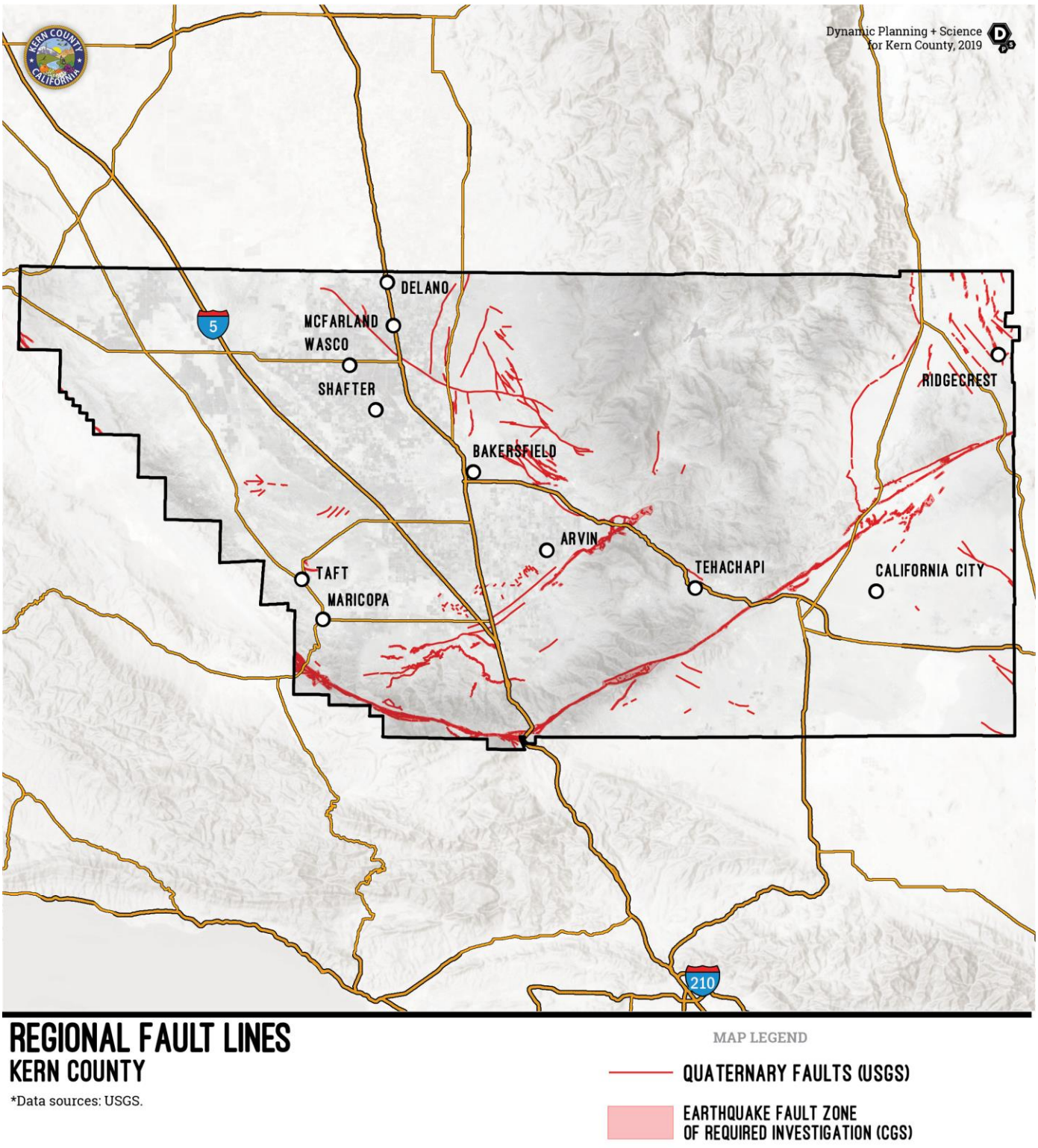

Figure 4-29: Zones of Required Investigation

Quaternary faults are those active faults that have been recognized at the surface and which have evidence of movement in the past 1.6 million years - the duration of the Quaternary Period.

4.5.4.1 Plans, Policies, and Regulatory Environment

Alquist-Priolo Earthquake Fault Zoning Act and Seismic Hazards Mapping Act (1972)

The 1971 San Fernando Earthquake resulted in the destruction of numerous structures built across its path. This led to passage of the Alquist-Priolo Earthquake Fault Zoning Act in 1972. This Act prohibits the construction of buildings for human occupancy across active faults in the State of California. Similarly, extensive damage caused by ground failures during the 1989 Loma Prieta Earthquake focused attention on decreasing the impacts of landslides and liquefaction. This led to the creation of the Seismic Hazards Mapping Act, which increases construction standards at locations where ground failures are probable during earthquakes. Figure 4-29 displays these zones of required investigation in Kern County.

2019 California Building Standards Code

The 2019 California Building Code, adopted by Kern County in January 2020, includes materials requirements, construction methods, and maintenance standards for earthquake protection and resiliency.

Kern County General Plan

The 2004 Kern County General Plan includes many policies, implementation measures, and goals in the Safety Element that limit development occurring in earthquake fault lines and mitigate impacts from such development.

Policies around earthquakes include limited development near earthquake fault lines, generally forbidding structures for human occupancy that are located near active fault lines and determining the liquefaction potential of different sites more broadly. The Kern County General Plan is currently being updated and will consider this MJHMP Update as it continues to shape policies around earthquake mitigation and protection.

4.5.4.2 Past Events

Numerous earthquakes have occurred in and near Kern County over the last twenty years. *See* Table 4-32 for earthquake events 4.5 magnitude or greater since 2000. Ridgecrest experienced 6.4 and 7.1 magnitude earthquakes on July 4th and 5th of 2019 which was the largest earthquake in southern California since 1999 The July 2019 earthquake resulted in significant damage to homes in the Ridgecrest area where some homes were ripped off foundations. No deaths or major building damage resulted from the July 2019 earthquake. (KSBY News, 2019)

Table 4-32: Earthquakes in Kern County 4.5 Magnitude or Greater Since 2000

Date	Location	Magnitude
1/25/2003	20km NE of Arvin	4.9
9/29/2004	25km SSW of Bodfish	5.0
4/16/2005	20km ESE of Maricopa	4.6
9/22/2005	14km NW of Grapevine	4.7
2/24/2016	6km SSW of Wasco	4.9
7/4/2019	200km NE of Los Angeles near Ridgecrest	6.4
7/5/2019	11 km from 7/4/2019 earthquake (in San Bernardino County)	7.1

Source: USGS

4.5.4.3 Location

The Alquist-Priolo Act established earthquake fault zones in California. These Alquist-Priolo Earthquake Fault Zones encompass surface traces of active faults that have a potential for future surface fault rupture and are mapped across California. These zones have been established by the State Geologist and indicate an active fault within the zone. The fault may pose a risk to existing or future structures from a surface fault rupture. The major faults include the San Andreas fault system running north and south on the western portion of the County, several smaller faults of the Sierra Nevadas to the west of the San Andreas fault, and the Garlock and Ridgecrest faults to the east. Figure 4-29 shows the location of fault zones as well as the underlying quaternary faults near the County.

4.5.4.4 Frequency/ Probability of Future Occurrences

This plan utilizes two mapping tools for understanding the frequency and probability of an earthquake occurring at different faults in and around Kern County: 1) the Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3)(see Figure 4-30) and 2) the Earthquake Shaking Potential based on the USGS National Seismic Hazard Model (see Figure 4-31). Both mapping tools are described in more detail below.

Importantly, these probabilistic maps were used to determine the earthquake scenario used for the vulnerability analysis. While the Risk Assessment Mapping Platform (RAMP) contains exposure and damage estimations around the 7.2 M White Wolf scenario, this plan focuses on the South San Andreas Mojave North scenario, because it is the scenario with the highest likelihood of severe shaking and of producing a magnitude 6.7 earthquake within 30 years. See Figure 4-32 for an overview map of the scenario and Section 4.5.4.4.3 for further explanation on why this scenario was chosen.

According the California State Hazard Mitigation Plan, earthquakes large enough to cause moderate damage to structures—those of 5.5 Magnitude (M.) or larger—occur three to four times a year statewide. Strong earthquakes of 6 to 6.9 M. strike on an average of once every two to three years. Major earthquakes of 7 to 7.9 M. occur in California about once every 10 years.

4.5.4.4.1 30-Year Earthquake Probability (UCERF3)

Probability of earthquake events is based on the approximate location of earthquake faults within and outside the Kern County region. The Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3)[7] is a comprehensive model of earthquake occurrence for California. It represents the best available science for authoritative estimates of the magnitude, location, and likelihood of potentially damaging earthquakes in California. According to UCERF3 and as shown in Figure 4-30, the San Andreas fault as a 10% to 100% probability of occurrence within 30 years, the highest probability affecting the County. A study by the USGS indicates that the Big Bend section of the San Andreas fault near Tejon Pass is overdue for a strong or major earthquake. (Scharer, 2017) On average, an earthquake occurs in this area every 100 years, with the most recent 7.9 Fort Tejon earthquake occurring in 1857. (Id.) The Garlock Central and West faults have close to a 5% chance of an occurrence within thirty years, with many other faults having less than a 1% chance of annual occurrence.

[7] Quaternary faults are those active faults that have been recognized at the surface and which have evidence of movement in the past 1.6 million years - the duration of the Quaternary Period.

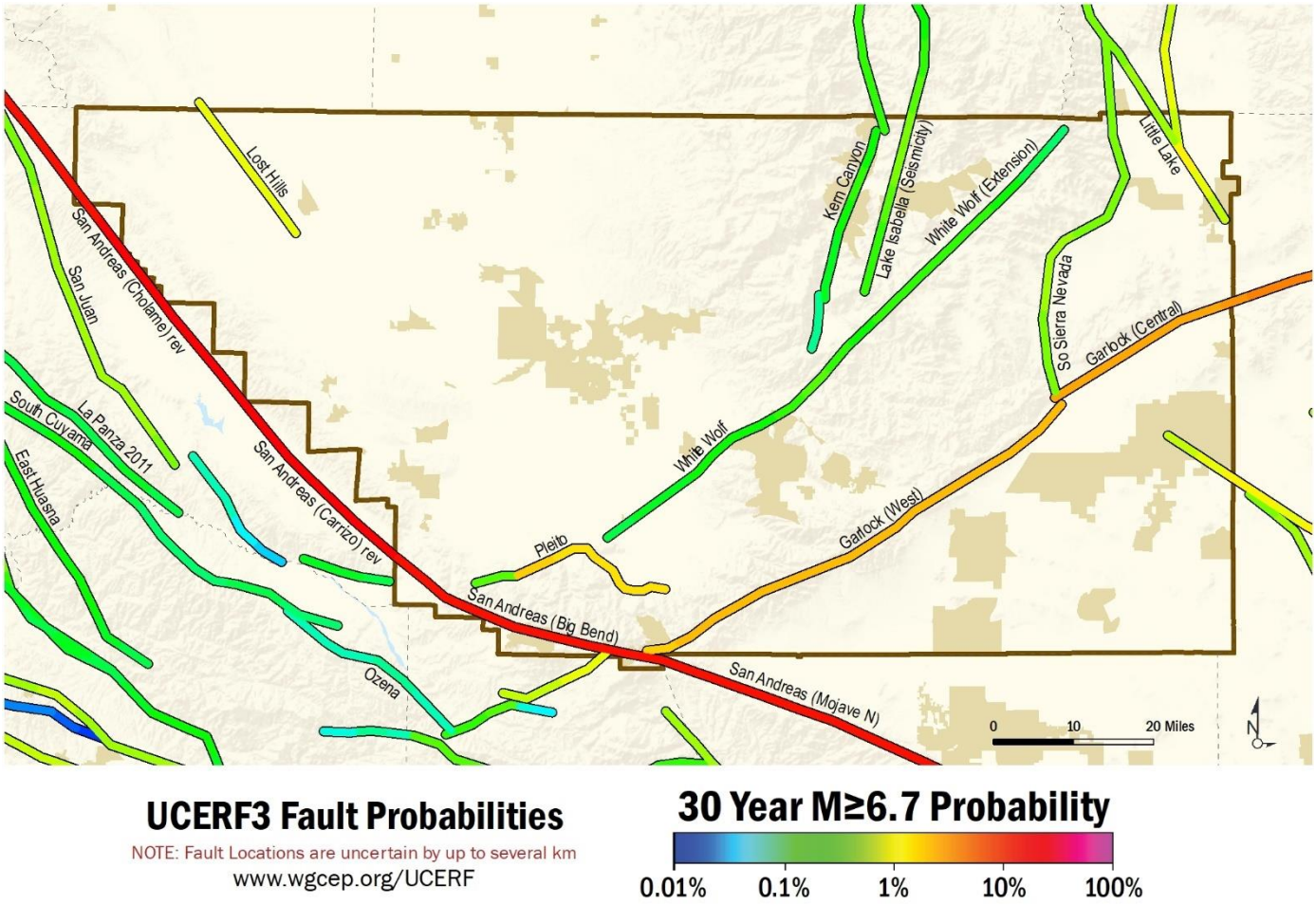

Figure 4-30 Fault Probability Map for Kern County

4.5.4.4.2 Earthquake Shaking Potential

The Earthquake Shaking Potential Map, Figure 4-31, shows potential seismic shaking from anticipated future earthquakes. It is probabilistic in the sense that the analysis takes into consideration the uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site. (CGS, 2020) It is also useful in understanding the probability of severe shaking in different locations throughout the County, as discussed in Section 4.5.4.5.

The map is expressed in terms of probability of exceeding a certain ground motion. The map shows a 2% probability of exceeding one second of ground motion in 50 years. Earthquake shaking potential in California is calculated based on the USGS National Seismic Hazard Model and in partnership with California Geological Survey (CGS). Earthquake shaking potential also considers historic earthquakes, slip rates on major faults, deformation throughout the region, and the potential for amplification of seismic waves by near-surface geologic materials. (CGS, 2020)

The map depicts a range of lower hazard to higher hazard probability, where higher hazard areas are those regions near major, active faults that will on average experience stronger earthquake shaking more frequently. This intense shaking can damage even strong, modern buildings. Lower hazard areas are those regions that are distant from known, active faults that will experience lower levels of shaking less frequently. In most earthquakes, only weaker, masonry buildings would be damaged. However, very infrequent earthquakes could still cause strong shaking in those locations. (D. Branum, 2016)

The shaking potential is calculated as the level of ground motion that has a 2% chance of being exceeded in 50 years, which is the same as the level of ground-shaking with about a 2500-year average repeat time. Relatively long-period (1.0 second) earthquake shaking is shown. Long-period shaking affects tall, relatively flexible buildings, but also correlates well with overall earthquake damage. Although the greatest hazard is in areas of highest intensity as shown in Figure 4-31, no region is immune from potential earthquake damage. (*Id.*)

The potential for earthquake ground shaking, as defined by the U.S. National Seismic Hazard Model, is used by engineers to design buildings for larger ground motions than what we think will occur during a 50-year interval, which will make buildings safer than if they were only designed for the ground motions that we expect to occur in the next 50 years. (USGS, 2018 United States (Lower 48) Seismic Hazard Long-term Model, 2020)

4.5.4.4.3 S. San Andreas Mojave N. Earthquake Scenario

The South San Andreas Mojave North earthquake scenario was chosen from a range of regional, scenario-based shakemaps available from USGS for the vulnerability analysis. The shakemap data consist of peak ground velocity, peak ground acceleration, peak spectral accelerations in an earthquake scenario. The San Andreas fault has the highest probability of an earthquake greater than 6.7 M. within Kern County, with a greater than 10% annual probability. See Figure 4-30. Likewise, the most significant shaking potential depicted in the ShakeMap in Figure 4-31 centers around the San Andreas fault system

The RAMP mapping tool also displays the 7.2 M White Wolf scenario which would occur along the white wolf fault line, displayed in Figure 4-30. The White Wolf scenario was one of the scenarios included in the 2014 MJHMP and also matches the 7.7 M Bakersfield earthquake of 1952. (United States Geological Survey, 1984) This plan chose to highlight the South San Andreas Mojave scenario in the vulnerability analysis over the White Wolf scenario because it has a higher probability of occurring and has a higher shaking potential, as displayed in Figure 4-30 and Figure 4-31.

Section 4.5.4.8.1 analyzes the County's exposure to this scenario and Section 4.5.4.8.2 details damage estimation to residential properties and County facilities for this scenario.

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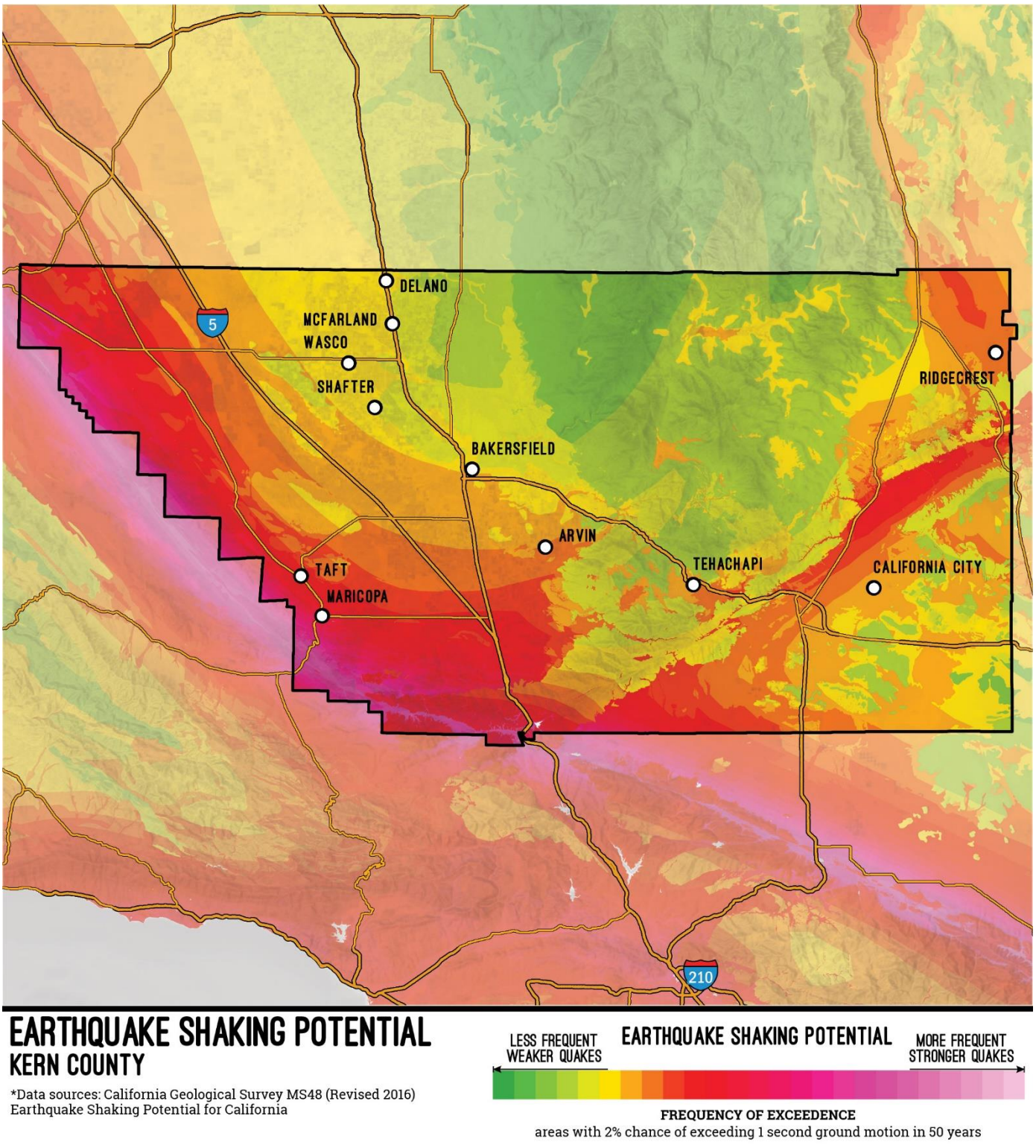

Figure 4-31: Earthquake Shaking Potential

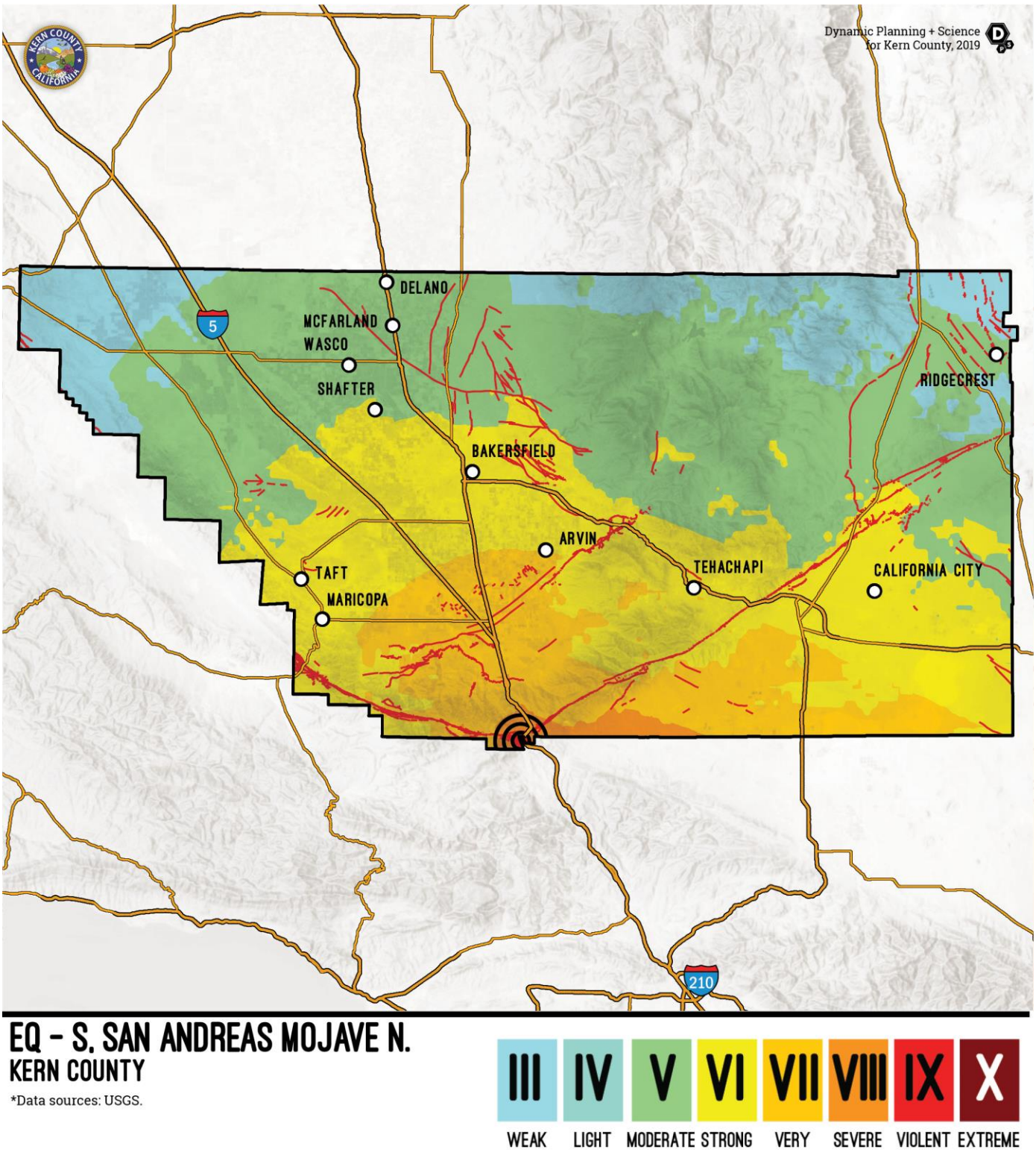

Figure 4-32. Earthquake Scenario, S. San Andreas Mojave N.

4.5.4.5 Severity and Extent

As we know from past events, even a "moderate" earthquake occurring in or near the Kern County region could result in deaths, casualties, property and environmental damage, and disruption of normal services and activities. The severity of the event could be aggravated by collateral emergencies such as fires, hazardous material spills, utility disruptions, landslides, transportation emergencies, and the possible failure of the Kern County dams.

Neither the occurrence of an earthquake nor the severity can be predicted. Instead, scientists can only calculate the probability that a significant earthquake will occur in a specific area within a certain number of years.

The probabilistic Earthquake Shake Potential Map, Figure 4-31, illustrates the areas of the County most likely to experience an earthquake exceeding one second of ground motion in 50 years, which aids in understanding locations in Kern County with the greatest probability of experiencing a severe earthquake. The greatest probability of a severe earthquake focuses around the San Andreas fault. This is merely a probability, as the same map also illustrates that most of the County is susceptible to moderate-to-severe earthquakes depending on the location, intensity, and magnitude of the earthquake.

4.5.4.6 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. Seconds and minutes of advance warning can allow people and systems to take actions to protect life and property from destructive shaking. Even a few seconds of warning can enable protective actions specific to various sectors of the population, such as:

- **Public:** Citizens, including schoolchildren, drop, cover, and hold on; turn off stoves, safely stop vehicles.
- **Businesses:** Personnel move to safe locations, automated systems ensure elevator doors open, production lines are shut down, sensitive equipment is placed in a safe mode.
- **Medical services:** Surgeons, dentists, and others stop delicate procedures.
- **Emergency responders:** Open firehouse doors, personnel prepare and prioritize response decisions.
- **Power infrastructure:** Protect power stations and grid facilities from strong shaking.

4.5.4.7 Secondary Hazards

Earthquakes can create the secondary hazards of soil liquefaction and tsunamis. Tsunamis are not applicable to Kern County. Other hazards can also occur from earthquakes and are profiled in other parts of this plan, such as dam failure or wildfires.

Soil Liquefaction

Soil liquefaction occurs when seismic waves pass through saturated granular soil, distorting its granular structure, and causing some of the pore spaces between granules to collapse. Pore-water pressure may also increase sufficiently to cause the soil to behave like a fluid for a brief period and cause deformations.

Soil liquefaction can cause severe damage to property, including damaging pipes, compromising building foundations, and bucking roads and airport runways. Soil liquefaction problems could be present in areas built on unconsolidated river soils.

4.5.4.8 Earthquake Vulnerability Analysis

Earthquakes are a considerable threat to life and property in Kern County. A moderate to severe seismic incident on any fault zones in close proximity to the County is expected to cause:

- Extensive property damage, particularly to pre-1930's unreinforced masonry structures,
- Possible fatalities and injuries,
- Damage to water and sewage systems,
- Disruption of communications systems,
- Broken gas mains and petroleum pipelines,
- Disruption of transportation arteries, and
- Competing requests for regional aid resources.

Community needs would quickly exceed the response capability of the County's emergency management organization, requiring mutual assistance from volunteer and private agencies, the Governor's Office of Emergency Services, and the Federal Emergency Support Functions.

In any earthquake, the primary consideration is saving lives. Time and effort must also be given to providing for people's mental health by reuniting families, providing shelter to the displaced persons, and restoring basic needs and services. A major effort will be needed to remove debris and clear roadways, demolish unsafe structures, assist in reestablishing public services and utilities, and provide continuing care and temporary housing for affected citizens.

After any earthquake there will be a loss of income both in private and public sectors. Individuals can lose wages due to businesses inability to function because of damaged goods or facilities. Due to business losses, Kern County and the cities in the planning area will lose revenue. Economic recovery from even a minor earthquake is critical.

4.5.4.8.1 Earthquake Exposure

The exposure analysis for Kern County centers on an earthquake scenario produced from the South San Andreas Mojave North Faultline. As discussed in Section 4.5.4.4, this scenario is the highest probability for a severe earthquake and severe shaking in Kern County.

An exposure analysis was conducted to develop earthquake vulnerability data throughout Kern County using the methods outlined in Section 4.4. To develop earthquake exposure data for the County, asset inventories for people, property, and critical facilities were superimposed with earthquake shaking intensity data from the USGS.

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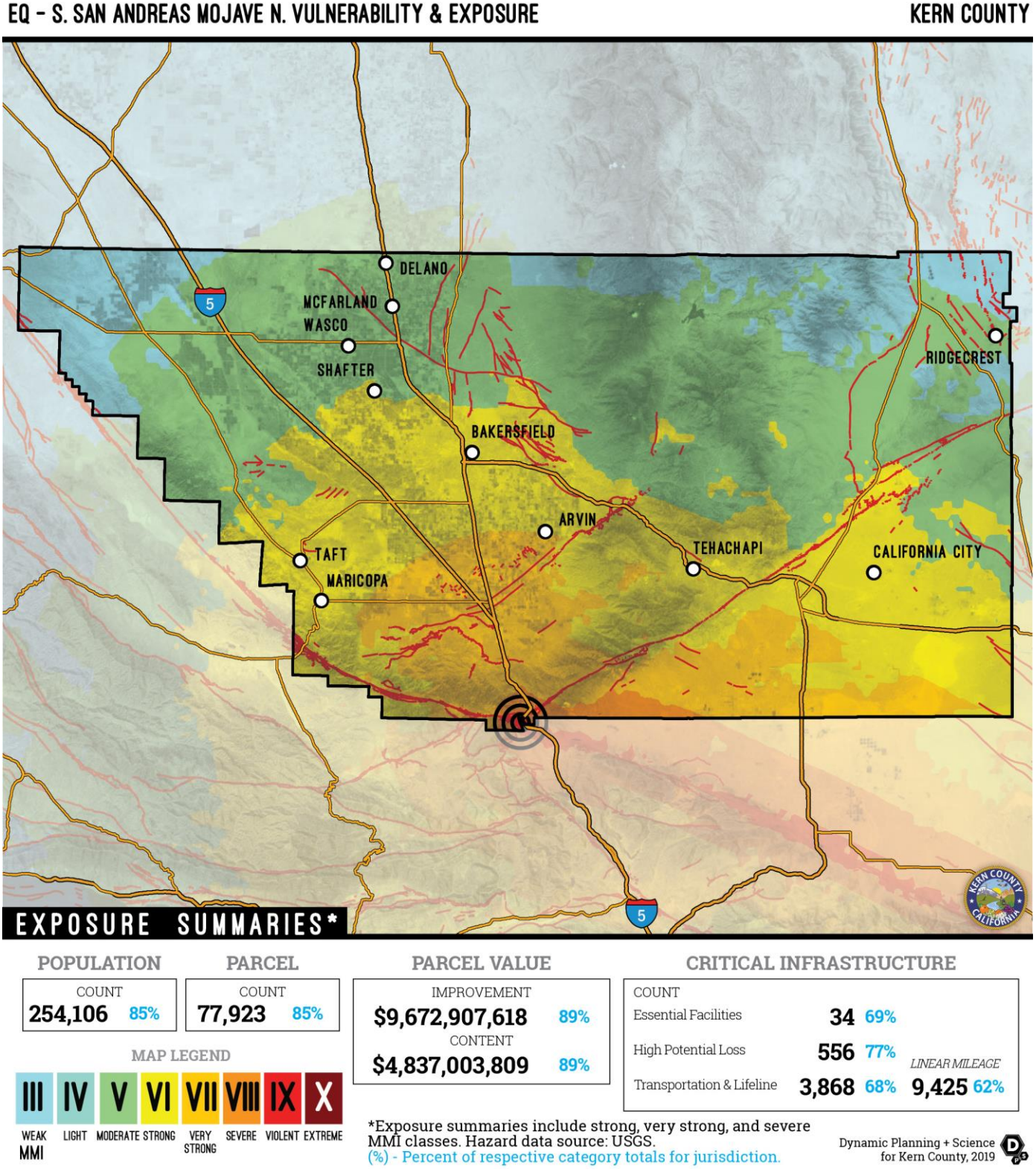


Figure 4-33 S. San Andreas Mojave N. Exposure and Snapshot Map

Population

Figure 4-34 and Table 4-33 summarize population exposure results for the S. San Andreas Mojave N. scenario. The entire population of Kern County is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure depends on many factors, including the age and construction type of dwellings, the soil types on which their homes are constructed, and proximity to fault location. Whether directly or indirectly impacted, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself. (United States Geological Survey, 1981)

Figure 4-34: Population Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County)

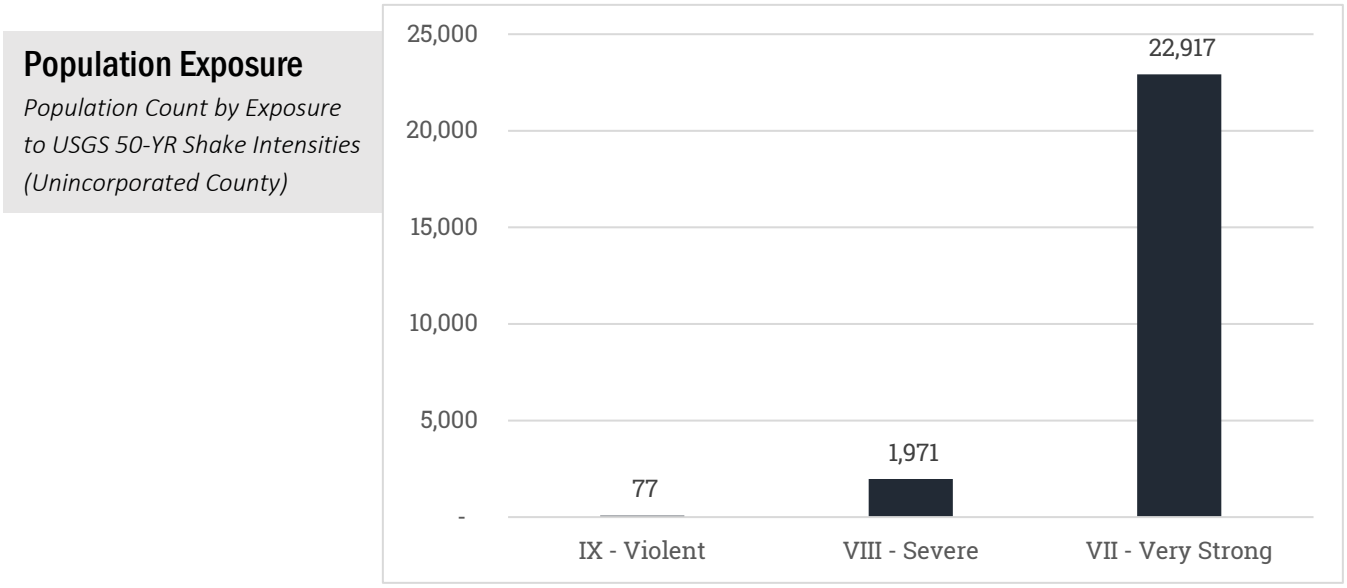


Table 4-33: Population Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County)

	Total Population
Unincorporated County	299,935

Shake Severity Zone	Population Count	% of Total
IX - Violent	77	0.03%
VIII - Severe	1,971	0.66%
VII - Very Strong	22,917	7.64%
Total	**24,965**	**8.32%**

Property

An earthquake vulnerability assessment depends on determining two important factors:

(1) the year in which seismic codes were initially adopted and enforced by the jurisdiction having authority, and
(2) the year in which seismic codes were improved and enforced.

These are known as benchmark years. (Federal Emergency Management Agency, 2020) The County adheres to the 2019 California Building Code. Table 4-34 provides a listing of code improvements. Benchmark years are indicated in bold. For reference, Table 4-35 provides the definitions of building types.

Table 4-34: Seismic Benchmark Years

Code Edition	Effective Date	Building Type
(2019 CBC)	January 1, 2020	
(2016 CBC)	January 1, 2017	
(2013 CBC)	January 1, 2014	N/A
(2012 IBC)		
(2010 CBC)	January 1, 2011	N/A
(2009 IBC)		
(2007 CBC)	January 1, 2008	N/A
(2006 IBC)		
(2001 CBC)	November 1, 2002	N/A
(1997 UBC)		
(1998 CBC)	**July 1, 1999**	**W1a, S2, S2a, RM1, PC1, PC1a**
(1997 UBC)		
(1994 UBC)	**January 7, 1996**	**S1, S1a, C1, C2, C2a, RM2**
(1991 UBC)	**November 29, 1992**	**URM**
(1988 UBC)	**April 29, 1990**	**S2 & S2a**
(1985 UBC)	November 8, 1987	N/A
(1982 UBC)	December 9, 1984	N/A
(1979 UBC)	June 21, 1981	N/A
(1976 UBC)	**November 1, 1977**	**W1 and W2**
(1973 UBC)	April 13, 1975	N/A
(1970 UBC)	August 29, 1971	N/A
(1967 UBC)	July 12, 1968	N/A
(1964 UBC)	July 1, 1965	N/A
(1961 UBC)	August 17, 1962	N/A
(1958 UBC)	October 1, 1958	N/A
(1955 UBC)	January 1, 1956	N/A
(1955 UBC)	January 1, 1956	N/A
(1946 UBC)	June 18, 1948	N/A
(1943 UBC)	July 13, 1944	N/A

Code Edition	Effective Date	Building Type
(1940 UBC)	April 4, 1941	N/A
(1937 UBC)	September 10, 1937	N/A
(1930 UBC)	March 20, 1933	N/A

Source: ASCE 41-13. County Building Dept.

Table 4-35: Definitions of FEMA Building Types

FEMA Building Type	Definition
W1	Wood Light Frame
W1A	Wood Light Frame (multi-unit residence)
W2	Wood Frame (commercial and industrial)
S1	Steel Moment Frames
S2	Steel-braced Frames
S3	Steel Light Frames
S4	Steel Frames with concrete shear walls
S5	Steel Frames with infill masonry walls
C1	Concrete Moment Frames
C3	Concrete Frames with infill masonry shear walls
C2	Concrete Shear Walls
PC1	Tilt-Up Concrete shear walls
PC2	Precast Concrete Frames with shear walls
RM1	Reinforced Masonry Walls with flexible diaphragms
RM2	Reinforced Masonry Walls with stiff diaphragms
URM	Unreinforced Masonry Bearing Walls

Building Ages

The California State Building Code Council incorporates significant milestones in building and seismic code requirements that directly affect the structural integrity of development in California. Using these seismic benchmark years, the Steering Committee used county-provided assessor's data to identify the number of parcels by date of construction or improvement. Table 4-36 shows the results of this analysis. The number of parcels does not reflect the number of total housing units, as many multi-family units and attached housing units are reported on one parcel.

Table 4-36: Age of Structures in Kern County

Time Period	No. of County Parcels with Improvements in Period	Significance of Time Frame
Pre-1933	3,915	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	5,869	Before the first strong motion recording was made in 1940.
1941-1960	22,488	Prior to when the Structural Engineers Association of California published guidelines on earthquake construction in 1960.
1961-1975	12,790	Prior significant improvements to lateral force requirements in 1975.
1976-1994	27,043	Prior to the Uniform Building Code being amended to include provisions for seismic safety in 1994.
1995 - present	18,058	Seismic code is currently enforced.

Source: Kern County Assessor

Soft-Story Buildings

A soft-story building is a multi-story building with one or more floors that are "soft" due to structural design. If a building has a floor that is 70-percent less stiff than the floor above it, it is considered a soft-story building. These floors can be especially dangerous in earthquakes, because they cannot cope with the lateral forces caused by the swaying of the building during a quake. As a result, the soft story may fail, causing what is known as a *soft story collapse*. Soft stories are typically associated with retail spaces and parking garages, often on the lower stories of a building. A soft story collapse can cause the rest of the building to collapse as well, causing serious structural damage that may render the structure totally unusable.

Soft-story collapse is one of the leading causes of earthquake damage to private residences. The level of vulnerability due to this type of construction within the planning area is not currently known. This type of data should be generated to support future earthquake risk assessments.

Property Value Exposure

An inventory of current market values and content value was completed using County Assessor's parcel data. GIS was used to create centroids, or points, to represent the center of each parcel polygon, assumed to be the location of the structure for analysis purposes. The centroids were then superimposed with the USGS probabilistic shaking severity zones to determine the at-risk structures. Table 4-37 shows the count of at-risk parcels and their associated building and content exposure values to the S. San Andreas Mojave N. earthquake scenario.

Table 4-37: Parcel Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County)

	Total Parcels	Total Market Value ($) (000)	Total Content Value ($) (000)	Total Value ($) (000)
Unincorporated County	91,455	$ 10,906,675	$ 5,453,338	$ 16,360,013

Shake Severity Zone	Improved Res. Parcel Count	% of Total	Market Value Exposure ($) (000)	Content Value Exposure ($) (000)	Total Exposure ($) (100)	% of Total
IX - Violent	84	0.1%	$ 12,206	$ 6,103	$ 18,309	0.1%
VIII - Severe	1,884	2.1%	$ 177,763	$ 88,881	$266,644	1.6%
VII - Very Strong	9,144	10.0%	$ 1,305,581	$ 652,790	$ 1,958,371	12.0%
Total	**11,112**	**12.2%**	**$1,495,549**	**$ 747,775**	**$ 2,243,324**	**13.7%**

**Currency in Thousands*

Critical Facilities and Infrastructure

Earthquakes pose numerous risks to critical facilities and infrastructure. Seismic risks, or losses, that are likely to result from exposure to seismic hazards include:

- Utility outages.
- Economic losses for repair and replacement of critical facilities, roads, buildings, etc.
- Indirect economic losses such as income lost during downtime resulting from damaged public infrastructure.
- Roads or railroads that are blocked or damaged can prevent access throughout the area and can isolate residents and emergency service providers needing to reach vulnerable populations or to make repairs.

Linear utilities and transportation routes are vulnerable to rupture and damage during and after a significant earthquake event. The cascading impact of a single failure can have affects across multiple systems and utility sectors. Degrading infrastructure systems and future large earthquakes with epicenters near critical regional infrastructure could result in system outages that last weeks for the most reliable systems, and multiple months for others.

All critical facilities in Kern County are exposed to the earthquake hazard. Table 4-38 lists the number of each type of facility in the Violent, Severe, and Very Severe MMI severity zones within the County, described in Table 4-30.

Table 4-38: Critical Facility Exposure to S. San Andreas Mojave N. Scenario (Unincorporated County)

Critical Infrastructure - S. San Andreas Mojave N. Scenario			
Infrastructure Type	IX - Violent	VIII - Severe	VII - Very Strong
Essential Facility	-	2	5
EOC	-	-	-
Fire Station	-	1	4
Hospital	-	-	-
Police	-	-	-
Sheriff	-	1	1
High Potential Loss	1	15	42
Adult Residential facility	-	-	2
Child Care Center	-	2	4
Dam	-	-	4
Family Child Care Home	-	-	10
Foster Family Agency	-	-	-
Historic Building	-	-	-
Home Care Organization	-	-	-
Library	-	1	1
Residential Child Care	-	-	-
Residential Elder Care	-	-	-
School	-	6	8
County Insured Asset*	-	4	8
Cooling Center	-	1	1
Healthcare Facility	1	-	-
Special Needs Facility	-	1	4
City Hall	-	-	-
Historic Site	-	-	-
Transportation and Lifeline	16	89	1536
Airport	-	-	1
Bridge	2	9	44
Power Plant	-	5	31
Substation	-	3	30
Transmission Line Tower	14	70	1342
NG Facility	-	2	18
Wind Turbine	-	-	70
Bus Facility	-	-	-
Potable Water Facility	-	-	-
Waste Water Facility	-	-	-
Oil Facility	-	-	-
Railroad Facility	-	-	-
Grand Total	**17**	**106**	**1583**

** These insured assets may include critical infrastructure already represented in other Infrastructure Types. For more information on these insured assets, see the Damage Estimation at Section 4.5.4.8.2.*

HazMat Fixed Facilities

Earthquakes can produce hazardous materials (HazMat) threats at very high levels. Depending on the year of build and construction of each facility containing HazMat, the earthquake-initiated hazardous material release (EIHR) potential will vary. HazMat contained within masonry or concrete structures built before certain benchmark years may be particularly vulnerability.

Utilities

Linear utilities and transportation infrastructure would likely suffer considerable damage in the event of an earthquake. Due to the amount of infrastructure and sensitivity of utility data, linear utilities are difficult to analyze without further investigating individual system components. Table 4-39 provides best available linear utility data; it should be assumed that these systems are exposed to breakage and failure.

Table 4-39: Lifeline Exposure S. San Andreas Mojave N. Scenario (Unincorporated County)

Lifelines (miles) – S. San Andreas Mojave N. Scenario			
Infrastructure Type (Linear)	IX - Violent	VIII - Severe	VII - Very Strong
Levee	-	5.09	92.39
NG Pipeline	0.79	5.73	217.67
Railroad	-	-	19.77
Street	21.12	207.60	1846.22
4WD trail	1.84	5.25	20.78
4WD trail, major	-	0.18	-
Alley	-	2.64	0.59
Cul-de-sac	-	0.54	0.20
Driveway	0.62	1.03	5.24
Interstate	1.75	11.04	92.67
Local road	10.97	121.03	791.37
Local road, major	2.42	53.98	594.14
Primary highway	-	-	-
Ramp	0.75	1.87	15.63
Road, parking area	-	-	2.73
Service road	-	2.42	1.15
State/county highway	2.07	7.46	200.12
State/county highway, major	-	-	-
Thoroughfare, major	0.70	0.15	121.61
Walkway	-	-	-
Transmission Line	5.70	25.85	515.63
Grand Total	**27.62**	**244.28**	**2691.67**

Water Supply Utilities

Kern County's water supply is mostly dependent on snowmelt runoff in the mountains, some of which is captured in reservoirs, and groundwater resources in the Valley and Desert regions. Kern County receives water from external sources that include the State Water Project and Central Valley Project. (Kern County MJHMP, 2014)

The Kern River provides most of the water to Kern County via Lake Isabella. Lake Isabella is on solid ground and expected to be usable after a major earthquake, but any disruption to water deliver infrastructure from an earthquake will affect the ability of Lake Isabella to supply water to populations of Kern County.

Natural Gas Utilities

Several common characteristics of earthquakes and their impacts on natural gas safety are:

- Earthquake ground shaking will generally lead to substantially more instances of building damage than fire ignitions.
- Ground motions that are sufficient enough to damage buildings are the most likely to impact utility and customer gas systems and create a potential for gas-related fire ignitions.
- The number of post-earthquake fire ignitions related to natural gas can be expected to be 20% to 50% of the total post-earthquake fire ignitions.
- The consequences of post-earthquake fire ignitions for residential gas customers are largely financial. A fire ignition only becomes a life safety concern when inhabitants are unable to exit the building following earthquakes. Experience in past earthquakes indicates that egress from earthquake damaged single-family homes is generally possible because of the limited structure height, low numbers of occupants, and multiple direct escape paths through doors and windows. (Earthquake Country Alliance, 2020)
- The potential life safety dangers from post-earthquake fires are considerably more serious in seismically vulnerable apartment or condominium buildings since they provide a greater chance for damaging the structure and trapping the occupants. (United States Geological Survey, 2020)

SoCal Gas and Pacific Gas & Electric, Kern County's natural gas utility providers, are responsible for designing, constructing, maintaining, and operating the natural gas system safely and efficiently. This includes all the facilities used in the delivery of gas to any customer up to and including the point of delivery to the customers' gas piping system. (SoCalGas, 2020) (City of Taft, n.d.)

Gas customers and Kern County residents are responsible for using gas safely on their property and within their buildings and other facilities. Customers meet this responsibility by maintaining their gas appliances in good working condition, assuring that only qualified individuals are engaged to modify or

maintain their gas service and facility piping, and knowing what to do before and after earthquakes to maintain the safe operation of their natural gas service.

The following conditions, when combined, pose the greatest risk for post-earthquake fire damage:

1. Buildings are unoccupied and individuals are not present to mitigate damage to gas systems or control small fires.
2. High building density or dense, fire-prone vegetation.
3. High wind and low humidity weather conditions.
4. Damage to water systems that severely limits firefighting capabilities.
5. Reduced responsiveness of firefighting resulting from impaired communications, numerous requests for assistance, direct damage to fire stations, restricted access because of traffic congestion and damaged roadways, and delays in mutual aid from neighboring fire districts. (Science Daily, 2013)

Telecommunication

Telecommunication systems will be affected by system failure, overloads, loss of electrical power and possible failure of some alternate power systems. Immediately following an event, numerous failures will occur, compounded by system use overloads. This will likely disable up to 80% of the telephone system for one day. County UHF/VHF and microwave radio systems are expected to operate at 40% effectiveness the first 12 hours following an earthquake, increase to 50% for the second 12 hours then begin to slowly decline to approximately 40% within 36 hours.

Microwaves systems will likely be 30% or less effective following a major earthquake. Damage to natural gas facilities serving the Kern County communities will consist primarily of isolated breaks in major transmission lines. Breaks in mains and individual service connections within the distribution system will be significant, particularly near the fault zones. These many leaks pose a fire threat in these susceptible areas of intense ground shaking and/or poor ground near the shoreline. Breaks in the system will affect large portions of the County and restoration of natural gas service could be significantly delayed. (International Telecommunication Union, 2013)

Public Schools

The Field Act was enacted on April 10, 1933, one month after the Long Beach Earthquake in which many schools were destroyed or suffered major damage. Public school construction has been governed by the Field Act since 1933 and enforced by the Division of the State Architect. In any community, public schools constructed under the Field Act after 1978 are likely to be among the safest buildings in which to experience a major earthquake. The Field Act requires:

FEMA Approval 4/9/2021

- School building construction plans to be prepared by qualified California licensed structural engineers and architects.
- Designs and plans to be checked by the Division of the State Architect (DSA) for compliance with the Field Act before a contract for construction can be awarded.
- Qualified inspectors, independent of the contractors and hired by the school districts, to continuously inspect construction and verify full compliance with plans.
- The responsible architects and/or structural engineers to observe the construction periodically and prepare changes to plans (if needed) subject to approval by DSA.
- Architects, engineers, inspectors and contractors to file reports, under penalty of perjury, to verify compliance of the construction with the approved plans emphasizing the importance of testing and inspections to achieve seismically safe construction. Any person who violates the provisions or makes any false statement in any verification report or affidavit required pursuant to the Act, is guilty of a felony.

Private schools are not subject to the Field Act and fall solely under the jurisdiction of the local building departments and their requirements. Private schools are covered under the Private Schools Building Act of 1986, with the legislative intent that children attending private schools be afforded life safety protection similar to that of children attending public schools.

In the late 1960s regulations were put in place to have pre-Field Act (1933) buildings retrofitted, removed from school use or demolished. (Cal. Edu. Code § 15516, Appendix X, 1968) The Field Act also prohibits use of unreinforced masonry buildings as school buildings. Seismic building standards in general were greatly strengthened after significant damage to buildings was observed, especially in the 1971 San Fernando earthquake. The Field Act regulations in place since 1978 are considered adequate for most public school buildings in most cases. (GeoScienceWorld, 2003)

Transportation

Earthquake events can significantly impact bridges and overpasses which often provide the only access to some neighborhoods. Since soft soil regions generally follow floodplain boundaries, bridges that cross water courses are considered vulnerable.

Interstate 5 (I-5) is a major north–south route of the Interstate Highway System in the U.S. state of California. It begins at the Mexico–United States border at the San Ysidro crossing, goes north across the length of California and crosses into Oregon south of the Medford-Ashland metropolitan area. It is the more important and most used of the two major north south routes on the Pacific Coast. I-5 provides vital connectivity for Kern County to other cities and supply hubs in California. I-5 could become impassable after an earthquake event which could isolate the County until road crews are able to complete road restoration. Table 4-39 shows transportation infrastructure exposed to shake severity zones in the event of the S San Andreas Mojave N. earthquake scenario.

4.5.4.8.2 Earthquake Damage Estimation

This section provides estimations of damages to County insured assets and residential buildings in S San Andreas Mojave N. earthquake scenario. This section first looks at overall damages for County insured assets and residential buildings, then looks specifically at potential damage to various County insured assets according to type (e.g., administrative buildings, equipment and services, or recreation).

Hazus Earthquake damage data was generated using a Level 2 Hazus 4.2 analysis. Hazus is a FEMA software product that uses a GIS to analyze multiple factors influencing earthquake damage estimates including peak ground velocity (PGV), peak ground acceleration (PGA) and soil of a given scenario and geographic area. Once the location and size of a hypothetical earthquake is identified, Hazus software estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

The parcel data defined in Section 4.4.2 was imported into Hazus as User Defined Facilities (UDF) serving as the basis for replacement and content cost as well as associated damage estimation and loss. The scenarios used for the Kern County Hazus analysis was the S. San Andreas Mojave North.

To understand building damage, damage outputs from Hazus are categorized into slight, moderate, and extensive damage. Ranges of damage are used to provide the user with an understanding of the building's physical condition. Table 4-40 provides a physical description of each damage state.

County assessor data does not include detailed information for tax exempt structures, such as federal and local government buildings. These data were added through the development of GIS data by utilizing insurance schedule tables for each municipality's insured assets.

While there are several limitations to the FEMA Hazus earthquake models, it does allow for potential loss estimation for each building construction category. County wide loss estimation results are summarized by building category type in Table 4-42 for the S San Andreas Mojave North 7.7 magnitude earthquake scenario. It is important to understand that the Hazus loss estimation values for earthquake are categorized in exceedance values. From reviewing Table 4-42, one can infer the probability of structures exceeding extensive damage is relatively low. However, if damage were to occur, the economic loss is averaged and summarized for each building type defined in the software.

Important to note: Loss estimation is worst case scenario. Loss estimation does not include damage to transportation routes, infrastructure, and other public and private utilities located throughout the County. An important concept in loss data is the "probability" of damage to exceed a certain degree. It is unlikely that buildings in County would receive "extensive" damage from earthquake shaking.

Table 4-40: Hazus Building Damage Descriptions

Damage State	Damage Description
Slight	Small plaster cracks at corners of door and window openings and wall/ceiling intersections; small cracks in masonry chimneys and masonry veneers. Small cracks are assumed to be visible with a maximum width of less than 1/8 inch (cracks wider than 1/8 inch are referred to as "large" cracks).
Moderate	Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
Extensive	Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations.
Complete	Structure may have large permanent lateral displacement or be in imminent danger of collapse due to cripple wall failure or failure of the lateral load resisting system; some structures may slip and fall off the foundation; large foundation cracks. Three percent of the total area of buildings with Complete damage is expected to be collapsed, on average.

FEMA Approval 4/9/2021

Damage Estimation

Hazus 4.2 was used to estimate the loss potential to residential properties and Government service facilities exposed to S San Andreas Mojave N. earthquake scenario. Hazus reports the damage potential and loss potential from a given earthquake scenario in four categories: slight damage, moderate damage, extensive damage, and economic loss. Economic loss consists of estimations on the cost of repair and replacement to damaged or destroyed buildings and contents, relocation expenses, capital-related income, wage losses, and rental income losses. The results shown in Table 4-41 summarizes residential property loss with county insurance holding data.

Table 4-41: Loss Estimations for S. San Andreas Mojave N. Scenario

Building Type	Average of Potential Damage to Exceed "Slight"	Average of Potential Damage to Exceed "Moderate"	Average of Potential Damage to Exceed "Extensive"	Average Economic Loss for Each Building Category	Sum of Economic Loss	Proportion of Loss (%)
County Insured Assets						
Government Service†	12.6%	4.7%	1.0%	$ 59,161	$ 19,700,776	14.1%
Emergency Response††	10.5%	4.2%	1.3%	$ 10,058	$ 663,816	0.5%
Residential						
Single Family	9.0%	1.3%	0.1%	$ 1,394	$ 108,691,550	77.8%
Mobile Home	9.5%	1.1%	0.1%	$ 898	$ 1,705,888	1.2%
Multi Family Duplex	9.9%	1.7%	0.2%	$ 872	$ 7,034,332	5.0%
Multi Family 3-4 Units	9.4%	1.5%	0.1%	$ 1,033	$ 1,840,423	1.3%
Multi Family 5-9 Units	11.9%	2.8%	0.2%	$ 610	$ 14,638	0.0%
Multi Family 10-19 Units	4.1%	0.3%	0.0%	$ 826	$ 1,652	0.0%
Multi Family 20-49 Units	3.5%	0.3%	0.0%	$ 5,658	$ 28,291	0.0%
Total					**$ 139,681,366**	

†Government Services includes: admin, airport, animal, building, bus, correctional, equipment, golf course, health, leased, library, misc, museum, office, park, recreation, relay, shop, storage, vacant, veterans, warehouse, water, yard
†† Emergency Response includes Sherriff Offices and Fire Departments

Note: Total Inventory Values
1 - Building Replacement Costs = $11,868,231,028.60
2 - Content Replacement Costs = $5,673,439,613.70
3 - Total Value = $17,541,670,642.30

Damage Estimation for County Owned Property

Hazus 4.2 was used to estimate the loss potential to county facilities exposed to the S. San Andreas Mojave N. earthquake scenario. Hazus reports the damage potential and loss potential from a given earthquake scenario in four categories: slight damage, moderate damage, extensive damage, and economic loss. Economic loss consists of estimations on the cost of repair and replacement to damaged or destroyed buildings and contents, relocation expenses, capital-related income, wage losses, and rental income losses.

County insurance data was obtained and formatted for use in Hazus for a detailed damage estimation. This dataset has additional information including number of floors, building value, content value, and construction type that greatly enhances results from default Hazus database.

The results shown in Table 4-42 summarizes essential facility and high potential loss facilities with county insurance holding data.

Table 4-42: Loss Estimations for S. San Andreas Mojave N. Scenario

Row Labels	Bldg Count	Bldg Cost	Content Cost	Total Value	PD Ex. Slight	PD Ex. Moderate	PD Ex. Extensive	Economic Loss	Loss %
Administrative & Office	**68**	**$359,226,983**	**$118,496,490**	**$477,723,473**	**11.6%**	**4.0%**	**0.6%**	**$10,931,124**	**2.3%**
Admin	26	$281,036,365	$2,180,986	$283,217,351	9.2%	2.2%	0.2%	$9,318,203	3.3%
Building	12	$22,885,686	$1,192,850	$24,078,536	10.7%	4.5%	0.9%	$632,278	2.6%
Office	30	$55,304,932	$115,122,654	$170,427,586	14.1%	5.4%	0.9%	$980,644	0.6%
Equipment & Storage	**51**	**$57,237,326**	**$5,149,231**	**$62,386,557**	**19.0%**	**9.7%**	**2.9%**	**$3,617,495**	**5.8%**
Equipment	5	$127,977	$3,302,171	$3,430,148	52.1%	30.2%	7.1%	$3,389	0.1%
Shop	11	$41,016,235	$837,660	$41,853,895	14.2%	7.6%	2.0%	$2,515,277	6.0%
Storage	20	$6,039,390	$446,971	$6,486,361	12.1%	4.8%	0.9%	$663,345	10.2%
Warehouse	6	$6,387,091	$526,728	$6,913,819	15.6%	4.1%	0.3%	$195,036	2.8%
Yard	9	$3,666,633	$35,701	$3,702,334	23.7%	15.4%	7.8%	$240,448	6.5%
Other Assets	**42**	**$6,182,000**	**$26,036,768**	**$32,218,768**	**8.4%**	**2.5%**	**0.5%**	**$175,017**	**0.5%**
Leased	31	$2,397,883	$20,982,229	$23,380,112	7.1%	1.2%	0.1%	$45,609	0.2%
Misc	3	$203,622	$4,770,874	$4,974,496	27.5%	16.2%	5.5%	$1,427	0.0%
Relay	4	$154,576	$21,384	$175,960	1.1%	0.1%	0.0%	$207	0.1%
Vacant	4	$3,425,919	$262,281	$3,688,200	11.1%	4.7%	0.5%	$127,775	3.5%

Row Labels	Bldg Count	Bldg Cost	Content Cost	Total Value	PD Ex. Slight	PD Ex. Moderate	PD Ex. Extensive	Economic Loss	Loss %
Recreation	**107**	**$48,550,442**	**$8,536,674**	**$57,087,116**	**14.6%**	**4.9%**	**0.8%**	**$1,056,087**	**1.8%**
Golf Course	3	$2,927,248	$3,000	$2,930,248	8.7%	0.8%	0.0%	$32,601	1.1%
Museum	76	$19,615,343	$6,634,355	$26,249,698	16.7%	5.8%	1.0%	$521,824	2.0%
Park	9	$10,016,887	$1,409,407	$11,426,294	5.6%	1.0%	0.1%	$116,025	1.0%
Recreation	19	$15,990,964	$489,912	$16,480,876	11.8%	3.5%	0.4%	$385,637	2.3%
Services	**121**	**$438,023,808**	**$56,317,933**	**$494,341,741**	**8.7%**	**3.1%**	**0.8%**	**$3,582,045**	**0.7%**
Animal	1	$528,591	$1,000	$529,591	16.3%	7.7%	1.2%	$23,216	4.4%
Correctional	27	$288,265,742	$193,074	$288,458,816	3.7%	1.0%	0.1%	$1,191,262	0.4%
Fire	47	$40,345,749	$4,818,942	$45,164,691	11.6%	4.6%	1.5%	$577,059	1.3%
Health	5	$23,063,560	$3,690,348	$26,753,908	10.4%	2.1%	0.1%	$627,690	2.3%
Library	18	$57,750,901	$46,750,699	$104,501,600	8.5%	2.0%	0.2%	$680,012	0.7%
Sheriff	19	$14,114,343	$351,792	$14,466,135	7.7%	3.3%	0.9%	$86,757	0.6%
Veterans	1	$672,868	$184,792	$857,660	4.5%	0.7%	0.0%	$4,495	0.5%
Warehouse	1	$1,038,472	$50,193	$1,088,665	17.7%	4.1%	0.3%	$32,328	3.0%
Water	2	$12,243,582	$277,093	$12,520,675	11.6%	5.0%	0.7%	$359,227	2.9%
Transportation	**10**	**$52,335,358**	**$5,564,962**	**$57,900,320**	**15.5%**	**7.4%**	**2.0%**	**$1,002,824**	**1.7%**
Airport	9	$52,334,358	$5,563,962	$57,898,320	10.3%	3.2%	0.4%	$1,002,561	1.7%
Bus	1	$1,000	$1,000	$2,000	62.4%	44.7%	16.2%	$263	13.2%
Grand Total	**399**	**$961,555,917**	**$220,102,058**	**$1,181,657,975**	**12.2%**	**4.6%**	**1.0%**	**$20,364,592**	**1.7%**

4.5.4.9 Future Trends in Development

Land use in the planning area will be directed by general plans adopted under California's General Planning Law. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. The information in this plan provides the participating partners a tool to ensure that there is no increase in exposure in areas of high seismic risk. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The geologic hazard portions of the planning area are heavily regulated under California's General Planning Law. The International Building Code establishes provisions to address seismic risk.

4.5.4.10 Earthquake Hazard Problem Statements:

As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities based on the risk assessment and vulnerability analysis, utilizing the RAMP mapping tool and flood data. Earthquake problem statements for all participating jurisdictions are listed in Table 4-43; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understanding the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. See Table 5-6 for a full list of mitigation actions and the corresponding problem statements that they address. Each problem statement is coded with a problem number for cross-referencing between Table 4-43 and Table 5-6.

Table 4-43 Earthquake Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-EQ-KC-242	Earthquake	Impact	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	Older construction and particularly unreinforced masonry (URM) buildings within the County will pose hazards during earthquakes.	**ma-EQ-KC-102, ma-EQ-KC-295, ma-AH-KC-111**
ps-EQ-KC-243	Earthquake	Impact	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	Historic buildings can be more susceptible to ground shaking since many of these buildings have weakened with age and were built before the use of building codes.	**ma-EQ-KC-295, ma-EQ-KC-296, ma-EQ-KC-297, ma-EQ-KC-307**
ps-EQ-KC-244	Earthquake	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , SP - Structural Projects	**County of Kern**	The following County assets are located in severe or violent shakes zone for the S. San Andreas Mojave N. EQ scenario: Pine Mtn Fire Station, Kern Co. Fire Station 55, Frazier Park Branch Kern Co. Library, Frazier Park Rec Bldg, Frazier Park Fire Station, Wanda Kirk Branch Kern Co. Library, Hummel Hall Community Center, Rosamond Fire Station, Rosamond Rec Center, Search and Rescue Desert Unit, and Lebec Maintenance Yard. Table 4-42 in Vol. 1 also lists damage estimation of County facilities for this EQ scenario	**ma-EQ-KC-295, ma-EQ-KC-296, ma-EQ-KC-307**

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-EQ-KC-245	Earthquake	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , SP - Structural Projects	**County of Kern**	The following County assets are located in severe shake zones for the 7.2 white wolf EQ scenario: Kern Co. Fire Station 55, Tejon Fire Station, Park Home (KCAC) special needs facility, DAI Break residential facility, Bear Valley Fire Station, Kern Co. Fire Station 16, Keene Fire Station, Kern Co. Fire Station 11, Book Mobile 1 Library.	**ma-EQ-KC-295, ma-EQ-KC-296, ma-EQ-KC-307**
ps-EQ-KC-246	Earthquake	Impact	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	The following County bridges have been identified as poor quality by the County and could be severely damaged by an earthquake: East of Harbor Rd. (#50C0261) .5 Mi N/O Rnd Mtn Rd. (#50C0085) 2.9 Mi E State HWY 43 (#50C0118) .6 Mi N of RTE 178 (#50C0195) E of Buena Vista Dr. (#50C0018)	**ma-EQ-KC-305**
ps-EQ-KC-247	Earthquake	Victim	PPRO - Property Protection , PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	Shallow ground water near planned development areas in south Bakersfield should be evaluated for liquefaction potential.	**ma-EQ-KC-306**
ps-EQ-KC-248	Earthquake	Impact	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	Tenant improvements and building remodels, including non-structural retrofits, may not have included seismic upgrades	**ma-EQ-KC-296**

4.5.5 Wildfire Hazard Profile

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson. The 2018 California State Hazard Mitigation Plan provides the following definition of wildfires:

> *any free-burning vegetative fire that initiates from an unplanned ignition, whether natural (e.g., lightning) or human-caused (e.g., powerlines, mechanical equipment, escaped prescribed fires), where the management objective is full suppression.* (CalOES, 2018, p. 507)

Wildfires are costly, putting lives and property at risk and compromising rivers and watersheds, open space, timber, range, recreational opportunities, wildlife habitats, endangered species, historic and cultural assets, scenic assets, and local economies. Vulnerability to flooding increases due to the destruction of forest and ground cover within watersheds. The potential for significant damage to life and property increases in areas where development is adjacent to densely vegetated areas, known as wildland urban interface (WUI) areas. (Federal Emergency Management Agency, 2020)

While some fires are allowed to burn naturally in order to maintain or restore the health of forest lands, out of control wildfires need to be prevented through cooperative, community, and land management planning. (United States Forest Service, n.d.)

4.5.5.1 Local Conditions Relating to Wildfire

Kern County spans the southern extent of the Central Valley floor. The County is flanked by the southern slope of the coastal mountain ranges to the west and the southern slope of the eastern Sierra Nevada to the east, both mountain ranges are surrounded by and intermingled with steep, hilly, grassy, wooded terrain—areas highly susceptible to wildfires. Such fires expose residential and other development within the County to an increased risk of conflagration, or extensive fire which destroys a great deal of land or property. The hilly/mountainous terrain on the east and west side of the Central Valley strongly influences both wildland fire behavior and fire suppression capabilities.

Wind is also a significant factor in the spread of fire, as fires spread faster, and burning embers are carried with the wind to adjacent exposed areas. In densely-populated areas, flying ember production is the principal driver of wildfire. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread to adjacent structures.

4.5.5.2 Plans, Policies, and Regulatory Environment

Wildfire Protection Responsibility in California

Local, state, tribal, and federal organizations all have legal and financial responsibility for wildfire protection. In many instances, two fire organizations have dual primary responsibility on the same parcel of land—one for wildfire protection and the other for structural fire protection. To address wildfire jurisdiction responsibilities, in 1981 the California State Legislature outlined various wildfire responsibilities, described below, in Cal. Pub. Res. Code § 4291.5 and Cal. Health & Safety Code § 13108.5:

- **Federal Responsibility Areas (FRAs)**—FRAs are fire-prone wildland areas that are owned or managed by a federal agency such as the U.S. Forest Service, National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, or U.S. Department of Defense. Primary financial and rule-making jurisdiction authority rests with the federal land agency. In many instances, FRAs are interspersed with private land ownership or leases. Fire protection for developed private property is usually the responsibility of the relevant local government agency, not the federal land management agency.
- **State Responsibility Areas (SRAs)**—SRAs are lands in California where the California Department of Forestry and Fire Protection (CAL FIRE) has legal and financial responsibility for wildfire protection. CAL FIRE administers fire hazard classifications and building standard regulations in these areas. SRAs are defined as lands that:

    - are in the unincorporated county areas,
    - are not federally-owned,
    - have wildland vegetation cover rather than agricultural or ornamental plants,
    - have row crops or seasonal crops, or
    - have watershed, range, or forage values.

    CAL FIRE adopts SRA boundaries and updates them every 5 years. Where SRAs contain structures or development, the relevant local government agencies have fire protection responsibility for those improvements.

- **Local Responsibility Areas (LRAs)**—LRAs include land in cities, cultivated agriculture lands, unincorporated non-flammable areas, and lands that do not meet the criteria for SRA or FRA. LRA fire protection is typically provided by city or county fire departments, fire protection districts, or by CAL FIRE under contract to local governments. LRAs may still include areas of flammable vegetation and WUI.

In 2012, as part of local General Plan requirements, California began requiring local governments in State Responsibility Areas (SRAs) and Very High Fire Hazard Severity Zones (VHFHSZ) to:

- Update their general plan safety elements to recognize specific wildfire risks in such areas,
- Adopt special findings when approving subdivisions in such areas, and

- Use wildfire safety guidelines and California Environmental Quality Act (CEQA) initial study wildfire hazards checklist updates issued by the Governor's Office of Planning and Research (OPR) when those become available. Cal. Gov. Code § 65040.20 and § 65302.5.

For further information on the details and implications of these Safety Element requirements, see Progress Summaries 3.F and 8.A of the 2018 California State Hazard Mitigation Plan.

Healthy Forests Restoration Act (2003)

The federal Healthy Forests Restoration Act (HFRA) appropriates funding to address five main sub-categories of the National Fire Plan (NFP): preparedness, suppression, reduction of hazardous fuels, burned-area rehabilitation, and state and local assistance to firefighters. Kern County Community CWPPs have integrated these sub-categories through the following four best practices:

1. identifying and prioritizing fuels reduction opportunities across the landscape,
2. addressing structural ignitability,
3. assessing community fire suppression capabilities, and
4. collaborating with stakeholders.

California Fire Code (2016)

Kern County has adopted the 2016 Edition of the California Fire Code to safeguard the public health, safety, and general welfare from the hazards of fire, explosion, or dangerous conditions in new and existing buildings, structures, and premises, and to provide safety and assistance to fire fighters and emergency responders during emergency operations. Section (§17.32) of the Kern County Fire Code applies the 2016 California Fire Code which describes what is required for a Fire Protection Plan, applicable to all new development within the Wildland-Urban Interface Fire Area. It stipulates that such a plan address water supply, access, fire resistance of buildings, fire protection systems and equipment, defensible space and vegetation management.

California Building Standards Code (2019)

The 2019 California Building Code, adopted by the County in 2020, includes materials and construction methods for exterior wildfire exposure and standards of quality for fire-resistant buildings. See Cal. Building Codes, Chapter 7a (2019).

Hazardous Environmental Conditions in Kern County Code, §17.32

The Kern County Code aids in enforcing wildfire prevention strategies via its regulation of potentially hazardous environmental conditions (§17.32). When the Fire Chief determines that hazardous environmental conditions necessitate restricted use of open flame or other ignition sources, the Fire Chief is authorized to prohibit the use or ignition of any such materials.

Required Operational Permits in Kern County Code, §17.32

An operational permit is required to ignite or cause to be ignited tumbleweeds, agricultural waste, or other combustible material. This is stipulated in the Rules and Regulations of the Air Pollution Control District with jurisdiction.

4.5.5.3 Past Events

There are four major factors that contribute to historic wildfire events:

1. Extreme vegetation diversity
2. Diverse fire weather and fire behavior
3. Dynamic fire history
4. Complex land use patterns

From 2010-2018 there were 22 wildfires burning over 2,000 acres in Kern County. These events are listed in Table 4-44 and displayed in Figure 4-36.

Table 4-44: Wildfire Events in Kern County 2000 Acres or Greater 2000-2018

Date	Name	Size in Acres	Cause
8/3/2018	Tarina Fire	3,516	Tarina Fire
7/7/2017	Hawk Fire	2,940	Hawk Fire
8/16/2016	Cedar Fire	29,101	Cedar Fire
6/23/2016	Erskine Fire	48,008	Erskine Fire
8/18/2014	Way Fire	3,882	Way Fire
6/13/2014	Shirley Fire	2,546	Shirley Fire
5/16/2013	Grand Fire	4,345	Grand Fire
8/10/2012	Jawbone Complex Fire	12,015	Jawbone Complex Fire
9/23/2011	65 Fire	2,003	65 Fire
9/11/2011	Cattle Fire	2,130	Cattle Fire
9/10/2011	Black Fire	2,578	Black Fire
9/10/2011	Knob Fire	2,710	Knob Fire
9/10/2011	Indian Fire	3,069	Indian Fire
9/10/2011	North Fire	3,439	North Fire
9/10/2011	Reed Fire	5,900	Reed Fire
9/10/2011	Breckenridge Complex Fire	25,223	Breckenridge Complex Fire
9/10/2011	Comanche Fire	25,939	Comanche Fire
9/4/2011	Canyon Fire	14,585	Canyon Fire
6/21/2011	Quinn Fire	3,139	Quinn Fire
6/19/2011	Antelope Fire	5,069	Antelope Fire
9/12/2010	Canyon Fire	9,336	Canyon Fire
7/25/2010	Bull Fire	16,448	Bull Fire
6/28/2008	Piute Fire	37,346	Piute Fire

FEMA Approval 4/9/2021

Date	Name	Size in Acres	Cause
6/24/2007	White Fire	12,432	White Fire
12/7/2006	Westside Fire	4,025	Westside Fire
8/13/2006	Quail Fire Fire	4,770	Quail Fire Fire
8/7/2006	Cottonwood Fire	2,344	Cottonwood Fire
7/22/2006	Ridge Fire	2,417	Ridge Fire
9/3/2005	Gorman Fire	2,516	Gorman Fire
6/15/2002	Borel Fire	3,418	Borel Fire
8/1/2000	King Fire	5,106	King Fire

Recent Large Wildfire Events

Erskine Fire (2016)

The Erskine fire occurred near Lake Isabella in 2016. An investigation revealed that the fire began as a result of a private power line that wore down as it repeatedly rubbed against a tree. Ultimately, the Erskine Fire consumed approximately 48,008 acres and destroyed more than 280 residences. It was the most devastating fire in Kern County history and was California's second largest wildfire in 2016. (Kotowski, 2016)

Comanche Fire Complex (2011)

The Comanche Fire Complex consisted of four fires that burned in the Tehachapi Mountains just five miles southeast of Arvin in September, 2011. The fires started from lightning strikes and grew to 29,000 acres as wind fueled the growth. Evacuations were ordered for nearby residents while crews worked to control the fire.

Bull Fire (2010)

The Bull Fire was a human caused fire that occurred in a remote area at the bottom of Bull Run Creek Canyon in July, 2010. The Bull Fire threatened the communities of Riverkern and Kernville as the fire spread down the Bull Run Creek drainage and across the Kern River Canyon. The fire grew to over 16,000 acres, destroyed 16 structures, and was the largest wildfire of the 2010 California wildfire season. (CalFire, 2010)



Figure 4-35: 2016 Erskine Fire

Photo: Michael Cuffe (Patch, June, 2016)

See Figure 4-36 for locations of these historic fires.

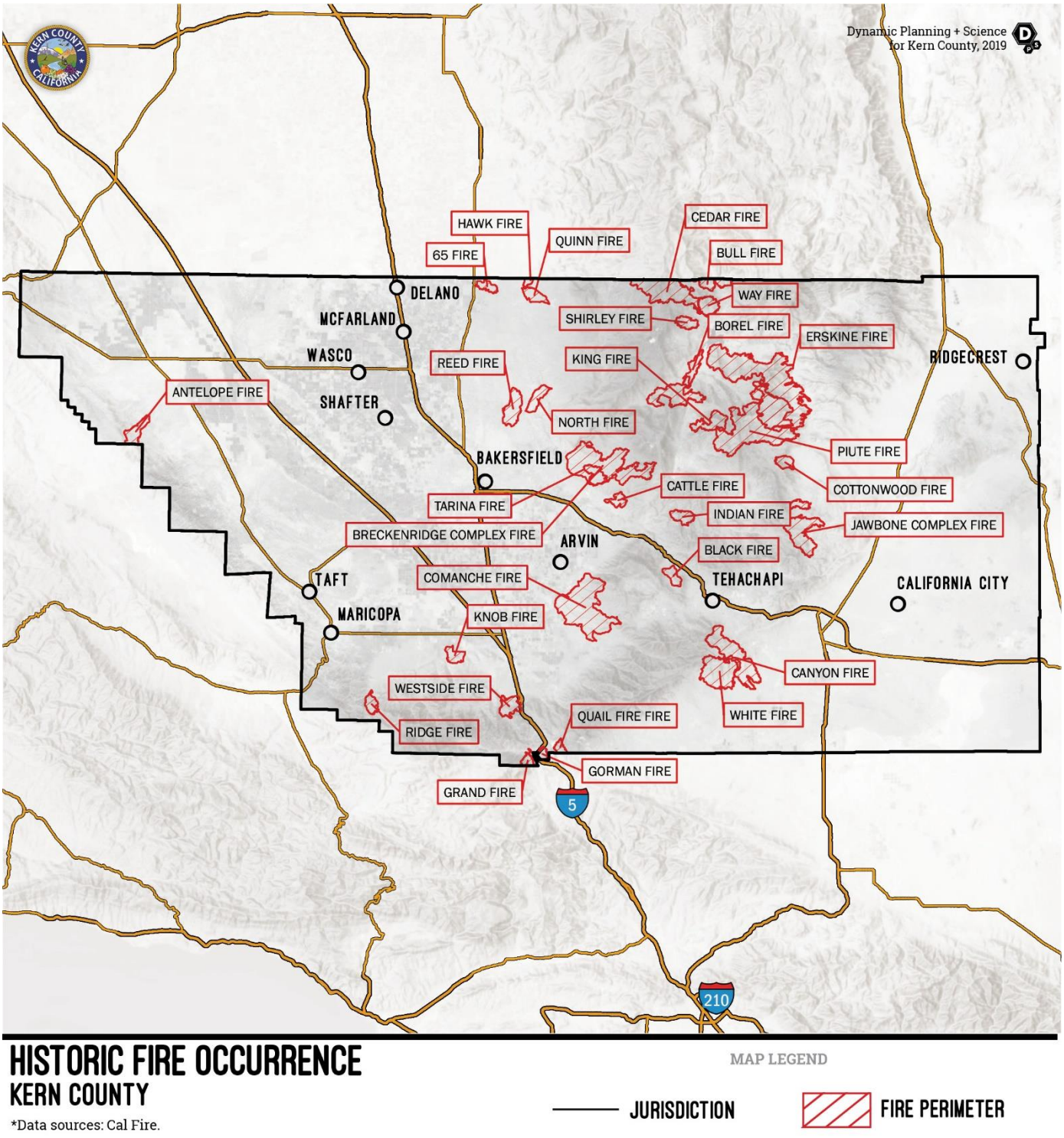


Figure 4-36: Historic Fire Occurrence Map (Fires Greater than 2,000 acres, 2000-2018)

4.5.5.4 Fire Hazard Severity Zones (FHSZs)

The County's hilly areas contain the major wildland fire hazard risks for residential structures and other development, characterized by steep slopes, poor fire suppression delivery access, inadequate water supply and highly flammable vegetation.

To help better refine areas of wildfire concern, CAL FIRE establishes and maps **Fire Hazard Severity Zones (FHSZ),** or areas of significant fire hazards based on factors such as fuel, weather, terrain, and the number of days of moderate, high and extreme fire hazard. These zones define the application of various mitigation strategies to reduce risk associated with wildfires.

The FHSV model inputs frequency of fire weather, ignition patterns, expected rate-of-spread, and past fire history. It also accounts for flying ember production based on the area of influence where embers are likely to land and cause ignitions. The FHSZ model also is built from existing data and hazard constructs, and thus does not necessarily take into consideration significant land use and structural resiliency. The geography, weather patterns and vegetation in the planning area provide ideal conditions for recurring wildfires. See Figure 4-37 and Figure 4-38 for wildfire return intervals and fire severity zones. These maps are the basis for this wildfire risk assessment.

4.5.5.5 Frequency/ Probability of Future Occurrences

Generally, Kern County faces a wildland fire threat each and every year. Fire conditions arise from a combination of hot weather, an accumulation of vegetation, and low moisture content in the air. These conditions, when combined with high winds and years of drought, increase the potential for a wildfire to occur. Urban wildfires often occur in those areas where development has expanded into the rural areas. A fire along this **wildland urban interface (WUI)** can result in major losses of property and structures. Generally, there are three major factors that sustain wildfires and allow for predictions of a given area's potential to burn: fuel, topography, and weather.

Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and volume. Fuel sources are diverse and include everything from dead tree needles and leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Man-made structures and other associated combustibles may be considered fuel sources. The type of prevalent fuel directly influences the behavior of wildfire. Light fuels such as grasses burn quickly and serve as a catalyst for fire spread. The volume of available fuel is described in terms of Fuel Loading. Certain areas in and surrounding Kern County are extremely vulnerable to fires as a result of dense grassy vegetation combined with a growing number of structures being built near and within wildland areas.

An area's topography affects its susceptibility to wildfire spread. Fire intensities and rates of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The natural arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes.

Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out the fuels that feed the wildfire creating a situation where fuel will more readily ignite and burn more intensely.

Wind is the most treacherous weather factor. The greater a wind, the faster a fire will spread, and the more intense it will be. Winds can be significant in Kern County. However, it should be noted that the winds generally occur during the winter storm season, not during the summer fire season. In addition to high winds, wind shifts can occur suddenly due to temperature changes or the interaction of wind with topographical features such as slopes or steep hillsides.

Recent drought conditions also have increased the threat of wildfire. (Kern County MJHMP, 2014) The majority of past wildfire events in Kern County were in the late summer months (typically July through September). Frequency of wildfire events may increase because of increasingly drier conditions caused by climate change. Fire risk will also continue to grow as more people build in WUI areas, which increases fuel loads and the risk of human-caused fires.

As seen in Figure 4-36, fire occurrences are the most common in mountainous areas in the central and eastern portion of Kern County. The probability of a wildfire occurring in Kern County is highly likely (100% annual chance).

4.5.5.6 Severity and Extent

The severity of the wildland fire hazard is determined by the relationship between three factors: fuel classification, topographic slope, and critical fire weather frequency. Critical fire weather conditions occur in periods of relative low humidity, high heat and high winds. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.

4.5.5.7 Warning Time

Regardless of the circumstances around the start of a wildfire, response time can be rapid and warning time short. Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out.

The Fourth of July can be a time of heightened concern and outreach around wildfires, since fireworks can cause fires and usage is high. Dry seasons and droughts greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning or wind events. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm. (California Fire, 2019)

FEMA Approval 4/9/2021

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has contributed to a significant improvement in warning time. (*Id*)

4.5.5.8 Secondary Hazards

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism and commerce. Wildfires cause the contamination of reservoirs, destroy transmission lines, and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff, weakening soils, and causing slope failures. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus creating hydrophobic soils that repel water. When it rains in burned areas, more soil washes off the hills and into roads, ditches, and streams and increases flooding. (*Id*)

4.5.5.9 Climate Change Impacts

Fire in western ecosystems is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot, dry spells create the highest fire risk. Drought and increased temperatures intensify wildfire danger by warming and drying out vegetation. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

A changing climate is expected to subject forests to increased stress due to drought, disease, invasive species, and insect pests. These stressors are likely to make forests more vulnerable to catastrophic fire. While periodic fires are natural processes and fulfill an important ecological function, catastrophic fire events that cannot be contained or managed can cause serious threats to homes and infrastructure, especially for properties located at the wildland-urban interface. Moreover, rain events are predicted to become more severe in our changing climate, and post-fire flooding could worsen as well.

It is predicted that Kern County will see higher daily temperatures, more heatwaves, increased wildfires, and a diminished snowpack within this century, as a result of climate change. The eastern edge of Kern County is projected to experience an increase in wildfire risk of 4 to 6 times current fire season averages by the year 2050. (Advancement Project California, 2019)

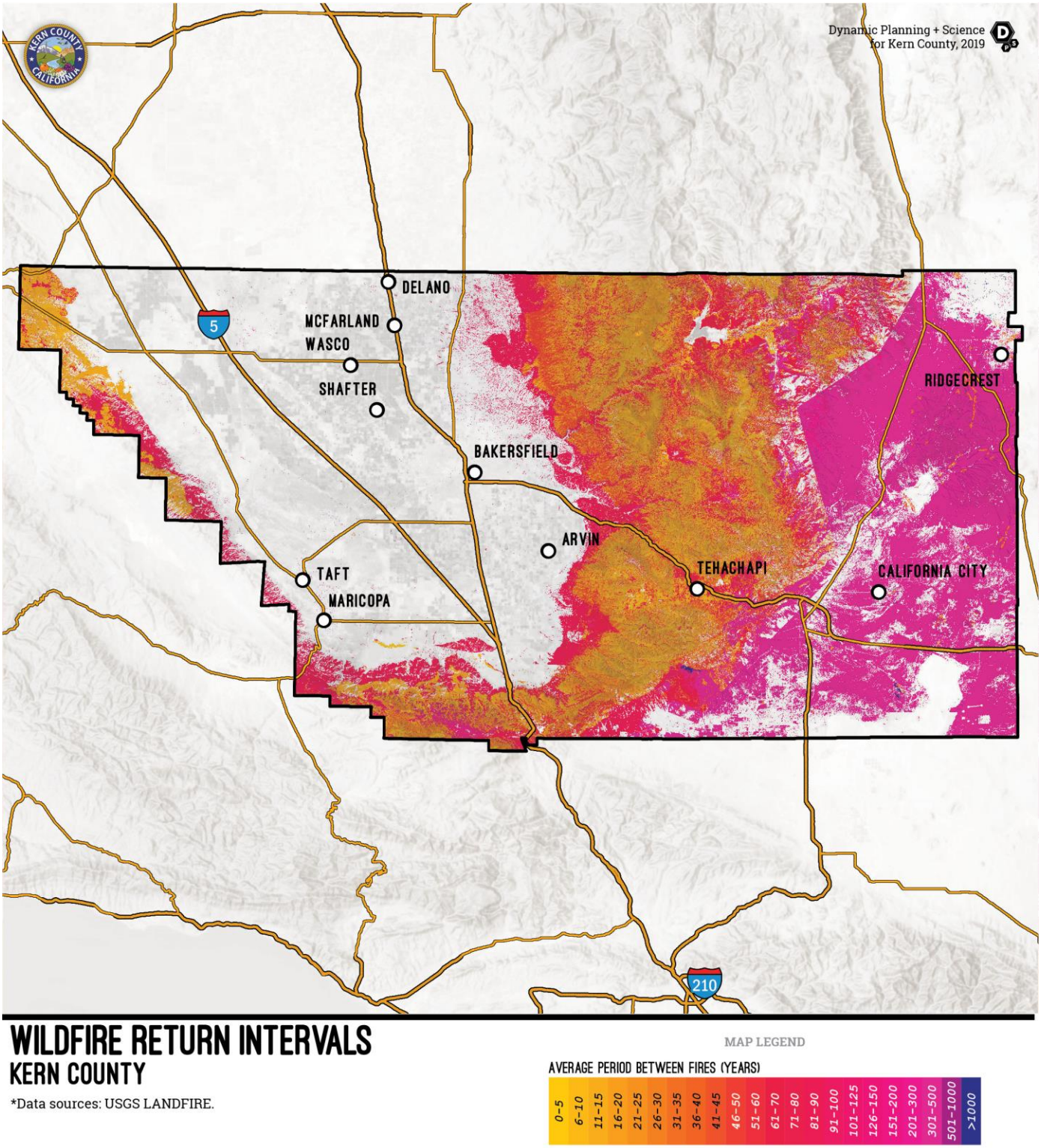


Figure 4-37: Wildfire Return Intervals

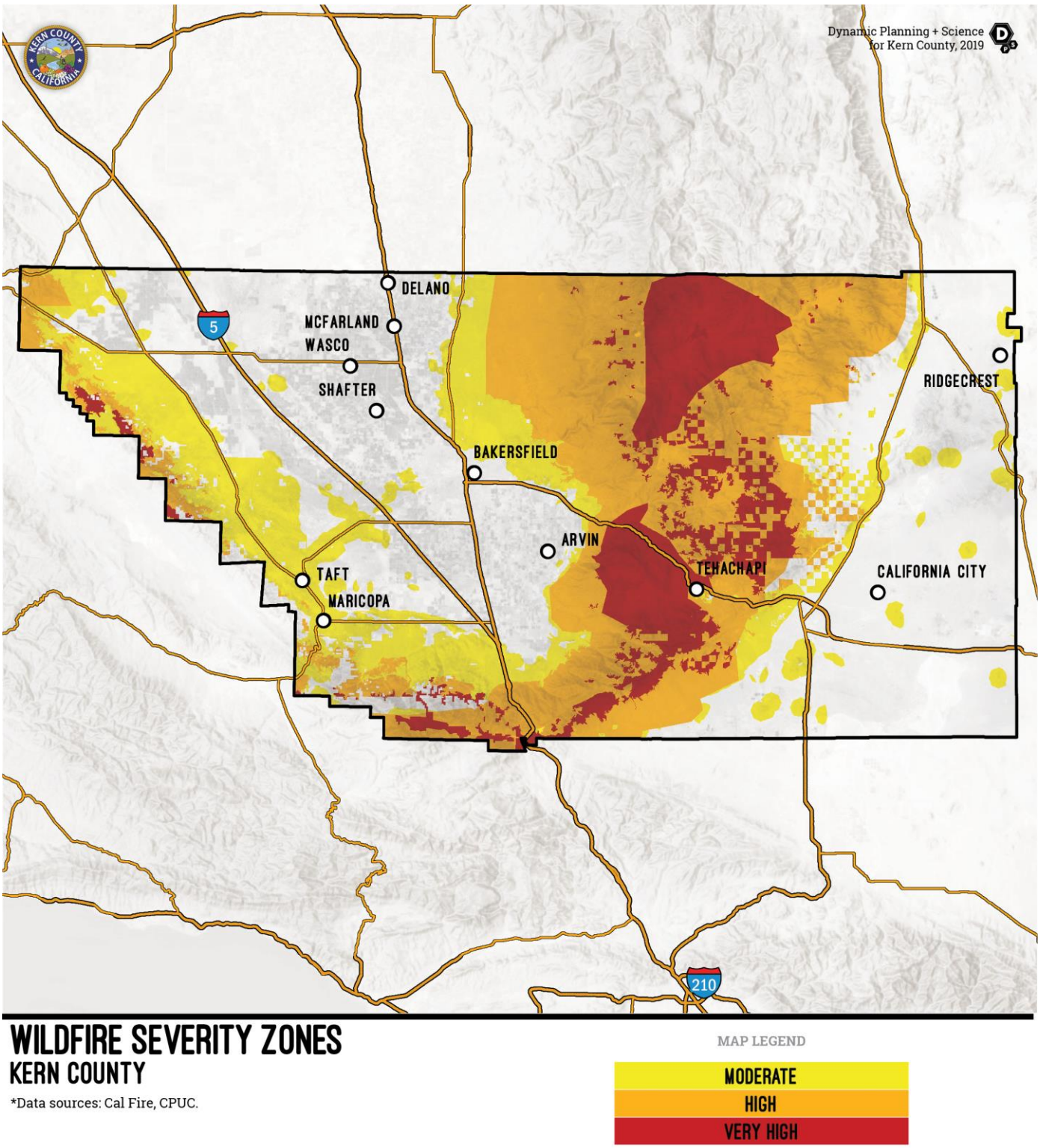


Figure 4-38: Wildfire Severity Zones

4.5.5.10 Wildfire Vulnerability Analysis

This section describes vulnerabilities to wildfire in terms of population, property, and infrastructure. Wildfire population, parcel value, critical facilities and lifeline exposure numbers were generated by overlaying the inventory outlined in Section 4.4 with CalFire Wildfire Hazard Severity Zones. Figure 4-40 shows a snapshot of wildfire vulnerability in Kern County. All data sources have a level of accuracy acceptable for planning purposes. Details for each snapshot can be found in this section.

4.5.5.10.1 Population

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. Smoke generated by wildfire contain visible and invisible emissions that contain particulate matter such as soot, tar, water vapor, and minerals; gases such as carbon monoxide, carbon dioxide, and nitrogen oxides; and toxics such as formaldehyde, benzene. Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency or temperature of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. First responders likewise are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. (EPA)

Wildfire is of greatest concern to populations residing in the moderate, high and very high fire hazard severity zones. U.S. Census Bureau block data was used to estimate populations within the CAL FIRE identified hazard zones. See Figure 4-40, Figure 4-39, and Table 4-45 for detail on populations residing in wildfire risk areas.

Table 4-45 Populations Exposed to Wildfire Risk (Unincorporated County)

	Total Population
Unincorporated County	299,935

Wildfire Severity Zone	Population Count	% of Total
Very High Intensity	19,903	*6.64%*
High Intensity	11,453	*3.82%*
Moderate Intensity	40,614	*13.54%*
Total	**71,970**	**24.00%**

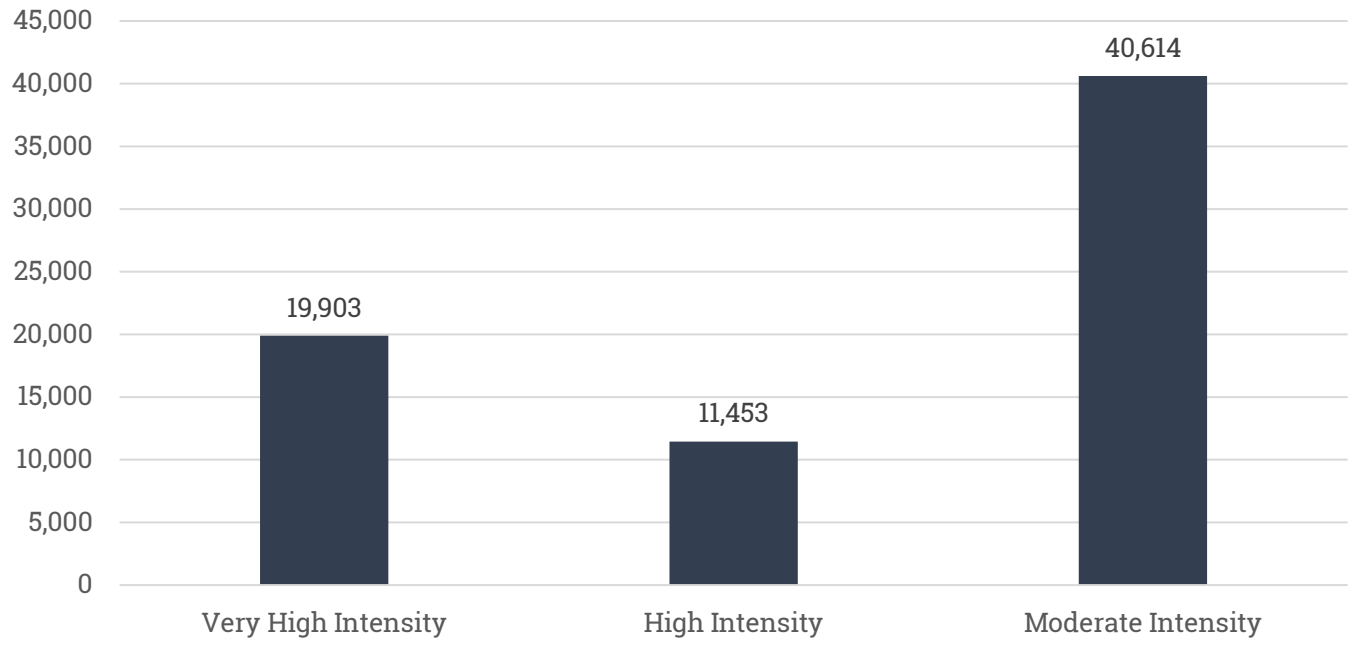


Figure 4-39 Population Exposed to Wildfire Risk

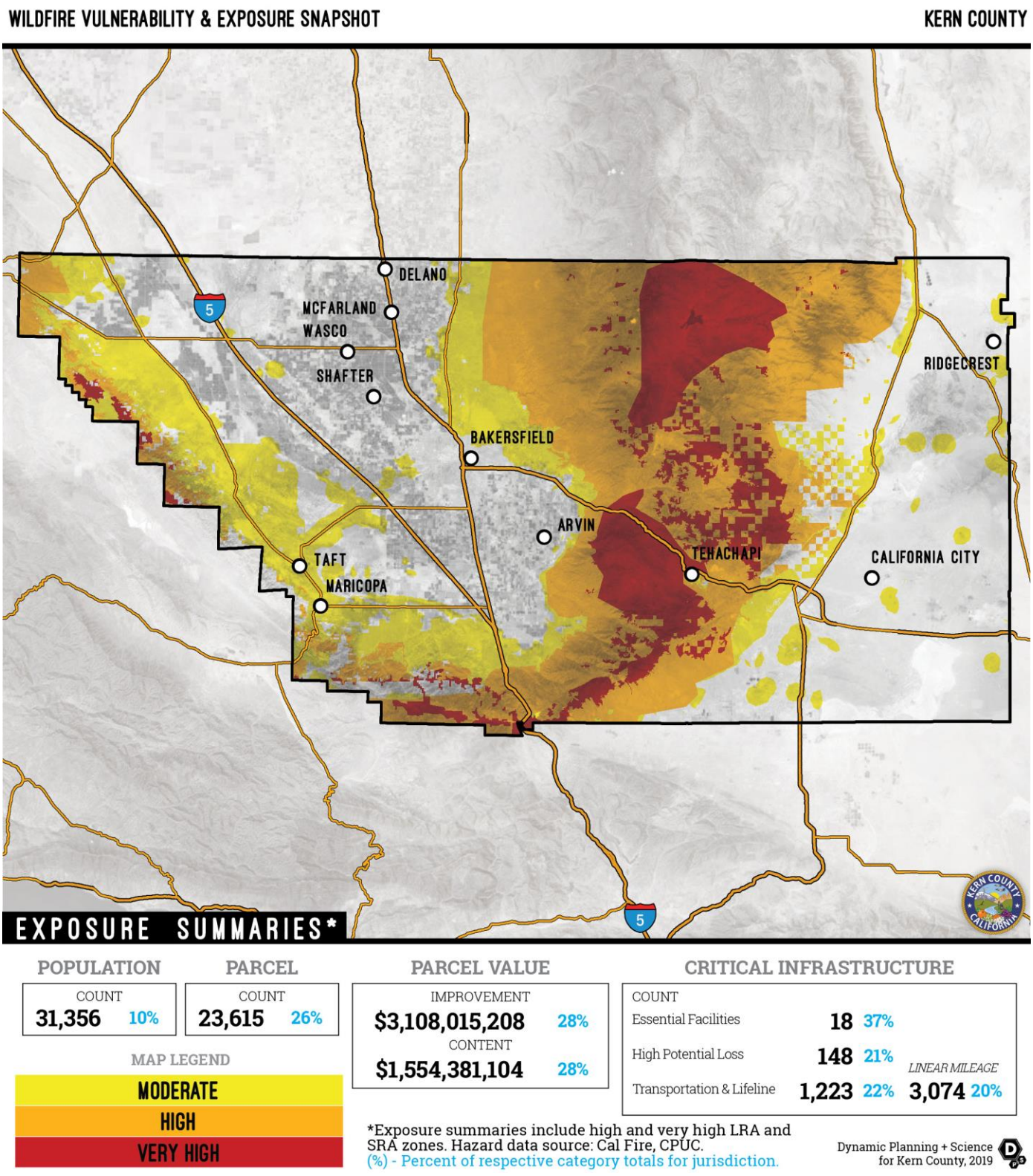


Figure 4-40: Exposure Wildfire Vulnerability and Snapshot Map

4.5.5.10.2 Property

This Section calculates the considerable assets at risk of wildfire in those severity zones. See Table 4-46, which utilizes County parcel information to calculate exposure. In some cases, a parcel will be within in multiple fire threat zones, and for this exercise every parcel with a square footage value greater than zero was developed in some way. Only improved parcels were analyzed.

Table 4-46: Residential Buildings and Content within Wildfire Severity Zones (Unincorporated County)

	Total Parcels	Total Market Value ($)	Total Content Value ($)	Total Value ($)
Unincorporated County	91,455	$ 10,906,675	$5,453,338	$ 16,360,013

Fire Hazard Severity Zone	Parcel Count	% of Total	Market Value Exposure ($)	Content Value Exposure ($)	Total Exposure ($)	% of Total
Very High	21,750	*23.8%*	$ 1,459,089	$21,750	$1,480,839	*9.1%*
High	1,865	*2.0%*	$ 94,545	$ 1,865	$96,410	*0.6%*
Moderate	14,434	*15.8%*	$874,469	$14,434	$ 888,903	*5.4%*
Total	**38,049**	**42%**	**$ 2,428,103**	**$ 38,049**	**$ 2,466,152**	**15.1%**

Currency in Thousands

4.5.5.10.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events; power lines are also at risk from wildfire because some poles are made of wood and are susceptible to burning.

In most cases, roads and railroads are not susceptible to damage from wildfire but create response issues if affected. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

Critical facilities data were overlaid with fire hazard severity zone data to determine the type and number of facilities within each risk classification. Table 4-47 lists the critical facilities in wildfire hazard severity zones for Kern County, and Table 4-48 similarly lists critical infrastructure.

Table 4-47: Critical Facility Exposure to Wildfire Severity Zones (Unincorporated County)

Critical Infrastructure - Wildfire Severity Zone			
Infrastructure Type	Very High	High	Moderate
Essential Facility	12	6	10
EOC	-	-	-
Fire Station	8	4	7
Hospital	1	-	-
Police Station	1	-	1
Sheriff Station	2	2	2
High Potential Loss	119	29	121
Adult Residential facility	3	-	7
Child Care Center	14	-	7
Dam	2	5	6
Family Child Care Home	2	-	-
Foster Family Agency	1	-	-
Historic Building	-	-	-
Home Care Organization	-	-	-
Library	9	3	2
Residential Child Care	-	-	-
Residential Elder Care	8	-	5
School	14	13	17
County Insured Asset*	42	7	57
Cooling Center	2	-	-
Healthcare Facility	7	-	4
Special Needs Facility	15	1	16
City Hall	-	-	-
Historic Site	-	-	-
Transportation and Lifeline	163	1060	1474
Airport	-	-	1
Bridge	45	36	85
Power Plant	4	37	67
Substation	11	29	83
Transmission Line Tower	99	914	1163
NG Facility	2	8	57
Wind Turbine	-	34	15
Bus Facility	-	-	-
Potable Water Facility	1	1	-
Waste Water Facility	1	1	-
Oil Facility	-	-	3
Railroad Facility	-	-	-
Grand Total	**294**	**1095**	**1605**

** These insured assets may include critical infrastructure already represented in other Infrastructure Types.*

Table 4-48: Lifelines in Wildfire Severity Zones (Unincorporated County)

Lifelines (miles) - Wildfire Severity Zone			
Infrastructure Type (Linear)	Very High	High	Moderate
Levee	1.50	4.23	123.97
NG Pipeline	55.01	90.02	420.74
Railroad	28.64	16.77	47.12
Street	1262.59	1172.69	1720.92
4WD trail	16.87	66.15	29.75
4WD trail, major	0.18	0.03	0.04
Alley	1.08	2.68	0.50
Cul-de-sac	0.38	0.51	0.88
Driveway	6.36	2.37	14.52
Interstate	32.04	41.76	69.46
Local road	701.45	456.30	528.57
Local road, major	290.16	359.01	568.40
Primary highway	2.88	6.81	135.59
Ramp	6.09	3.99	15.00
Road, parking area	0.52	-	0.60
Service road	0.35	2.10	1.88
State/county highway	196.69	220.79	240.02
State/county highway, major	-	-	0.42
Thoroughfare, major	6.95	6.93	114.60
Walkway	0.57	3.26	0.69
Transmission Line	127.12	315.15	643.23
Grand Total	**1474.87**	**1598.86**	**2955.97**

4.5.5.11 Changes in Development and Future Trends

Fuel reduction projects are ongoing on federal, state, and private lands in Kern County. Such projects include vegetation management, broadcast burning, pre-commercial thinning, and the removal of dead, dying, and diseased trees. The Kern County Fire Hazard Reduction Program (FHRP) is a joint effort between the Kern County Fire Department, Cal Fire, Kern County Code Enforcement, and property owners to ensure fire safe communities within the County. The goal of the program is to provide sufficient defensible space around homes and other structures to improve the safety of the public and emergency personnel, as well as increase the chance of a home's survival in the event of fires. Having heavy accumulations of fuel, and/or dry fuel poses a significant risk to a specific property, neighboring properties, and fire personnel. While inspections are typically done once a year, after June 1 in preparation for fire season, a property can receive an inspection at any time if it is deemed to be a hazard. (Kern County Fire Department, n.d.)

4.5.5.12 Wildfire Problem Statements

As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities. The problem statements were based on the risk assessment and vulnerability analysis which utilizes the RAMP mapping tool and flood data. Wildfire problem statements for all participating jurisdictions are listed in Table 4-49; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understanding the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. See Table 5-6 for a full list of mitigation actions and the corresponding problem statements that they address. Each problem statement is coded with a problem number for cross-referencing between Table 4-49 and Table 5-6.

Table 4-49 Wildfire Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-WF-KC-232	Wildfire	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	The Alta Sierra CWPP (link below) details fire hazards requiring mitigation for the continued protection of the WUI throughout the area: https://www.dropbox.com/s/nfk6320d3j5vg2l/Alta%20Sierra%20CWPP%201204.pdf?dl=1	**ma-WF-KC-183, ma-WF-KC-184, ma-WF-KC-287**
ps-WF-KC-233	Wildfire	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	The Kern Valley CWPP (link below) details fire hazards requiring mitigation for the continued protection of the WUI throughout the area: https://www.dropbox.com/s/5ia29n0nt0by10e/Community%20Wildfire%20Protection%20Plan-February%202012%20Update1.pdf?dl=1	**ma-WF-KC-182, ma-WF-KC-183, ma-WF-KC-184**
ps-WF-KC-234	Wildfire	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	The Mt. Pinos CWPP (link below) details fire hazards requiring mitigation for the continued protection of the WUI throughout the area: https://www.dropbox.com/s/3vel3cdnk791acm/107658_FSPLT3_4276170.pdf?dl=1	**ma-WF-KC-181, ma-WF-KC-183, ma-WF-KC-184**

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-WF-KC-235	Wildfire	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	The Myers Canyon CWPP (link below) details fire hazards requiring mitigation for the continued protection of the WUI throughout the area: https://www.dropbox.com/s/l93a92wpj5om8sx/Myers%20CWPP%20081605.pdf?dl=1	**ma-WF-KC-288, ma-WF-KC-183, ma-WF-KC-184**
ps-WF-KC-236	Wildfire	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	The Greater Tehachapi Area CWPP (link below) details fire hazards requiring mitigation for the continued protection of the WUI throughout the area: https://www.wildfirelessons.net/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=48eaad9b-b2ab-4abc-841e-79dd5320d8dd&forceDialog=1	**ma-WF-KC-180, ma-WF-KC-183, ma-WF-KC-184**
ps-WF-KC-237	Wildfire	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness , ES - Emergency Services	**County of Kern**	Not all address markers are compliant. Reflective number signs are needed on all homes and at the road.	**ma-WF-KC-289**
ps-WF-KC-238	Wildfire	Victim	PRV - Prevention , PPRO - Property Protection , PE&A - Public Education & Awareness	**County of Kern**	There are approx. 11 Adult Care Facilities, 15 special needs facilities, and 11 Health Care facilities in Very High Wildfire Severity Zones in mountain communities.	**ma-WF-KC-286, ma-AH-KC-104**
ps-WF-KC-239	Wildfire	Victim	PRV - Prevention , PPRO - Property Protection , PE&A - Public Education & Awareness	**County of Kern**	There are approx. 10 Schools in Very High Wildfire Severity Zones in mountain communities.	**ma-WF-KC-286, ma-AH-KC-104**
ps-WF-KC-240	Wildfire	Victim	PRV - Prevention , PPRO - Property Protection , PE&A - Public Education & Awareness	**County of Kern**	There are approx. 20,000 people living in the very high wildfire intensity zone. Approx. 10,000 in Tehachapi Area. Approx. 7,000 in Lake Isabella Area.	**ma-WF-KC-184, ma-WF-KC-183, ma-AH-KC-201**

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-WF-KC-241	Wildfire	Threat	PPRO - Property Protection , NRP - Natural Resource Protection	**County of Kern**	Ongoing fuel mitigation is needed throughout the County. The County has identified the following fuel project priorities: Battalion 1: Bear Valley (Skyline), Water Canyon, Old West Ranch, Alpine, Golden Hills Battalion 5: Pinion Pines, South Frazier, Lake of the Woods, Camp Condor with emphasis on Peak to Peak Charter School, PMC Green Belts Battalion 7: Alta Sierra, Kernville (includes Frontier, Grandview and Burma fuel breaks), Bodfish Phase 1,2, and 3, Pala Ranches, Squirrel Valley	**ma-AH-KC-179, ma-WF-KC-231**

4.5.6 Drought Hazard Profile



California's water resources have been stressed by periodic drought cycles and, in some places, overuse, creating the need for unprecedented restrictions in water diversions from the Sacramento-San Joaquin Delta in recent years. Climate change is expected to increase drought and extreme weather. While the duration of drought is always in question, it is certain that California and Kern County will continue to be impacted by drought. (California Drought Contingency Plan, 2010)

4.5.6.1 Drought in California

Drought has impacted almost every county in California at one time or another, causing more than $2.6 million in damage. Droughts exceeding three years are relatively rare in northern California, the source of much of the state's water supply. The 1929-1934 drought established the criteria commonly used in designing storage capacity and yield for large northern California reservoirs. The driest single year in California's measured hydrologic history was 1977. (California Department of Water Resources, 2015)

Past experience shows that drought impacts in California are felt first by those most dependent on annual rainfall: agencies fighting wildfires, ranchers engaged in dryland grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source. *(Id)*

Most of California's precipitation comes from storms moving across the Pacific Ocean. The path followed by the storms is determined by the position of an atmospheric high-pressure belt that normally shifts southward during the winter, allowing low pressure systems to move into the state. On average, 75 percent of California's annual precipitation occurs between November and March, with 50 percent occurring between December and February. If a persistent Pacific high-pressure zone takes hold over California mid-winter, the water year tends to be dry. (Western Reginoal Climate Center, 2020)

A typical water year produces about 100 inches of rainfall over the North Coast, 50 inches of precipitation (combination of rain and snow) over the Northern Sierra, 18 inches in the Sacramento area, and 15 inches in the Los Angeles area. In extremely dry years, these annual totals can fall to as little as one half, or even one third of these amounts. *(Id)*

Kern County's water supply is mostly dependent on snowmelt runoff in the mountains, some of which is captured in reservoirs, and groundwater resources in the Valley and Desert regions. Kern County receives water from external sources that include the State Water Project and Central Valley Project.

4.5.6.2 Plans, Policies, and Regulatory Environment

California Sustainable Groundwater Management Act

On September 16, 2014, Governor Brown signed into law a package of bills (SB1168, AB1739 and SB1319) collectively called the Sustainable Groundwater Management Act (SGMA). SGMA requires governments and water agencies of high and medium priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge. Kern County currently has one basin, the Kern River Valley Basin, which is categorized as high-medium priority. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, that date will be 2040. For the remaining high and medium priority basins, 2042 is the deadline.

Statewide Emergency Water Conservation Regulations

In 2016, the State Water Resources Control Board (Water Board) adjusted emergency water conservation regulations in recognition of the differing water supply conditions and ongoing drought across the state to comply with an Executive Order from the California Governor declaring a drought emergency. Executive Order B-37-16 Making Water Conservation a California Way of Life updates temporary emergency water restrictions and transitions to permanent, long-term improvements in water use by:

- providing for wiser water use
- Eliminating water waste
- Strengthening local drought resilience
- Improving agricultural water use efficiency and drought planning

In April of 2017, a new Executive Order lifted the drought emergency but retained many of the conservation requirements. Most regulations are still in effect with the exception of water supply "stress test" requirements and conservation standards for urban water suppliers. The temporary restrictions established a baseline of the types of benefits that are possible from water conservation requirements. The Executive Orders are found at:
https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/executive_orders.html

California Water Plan

The California Water Plan presents strategic plan elements including a vision, mission, goals, guiding principles, and recommendations for current water conditions, challenges, and activities. The plan includes future uncertainties and climate change impacts, scenarios for 2050, and a roadmap for improving data and analytical tools needed for integrated water management and sustainability. The California Water Plan was updated most recently in 2018. See: https://water.ca.gov/Programs/California-Water-Plan.

4.5.6.3 Past Events

California experienced massive changes over the course of the twentieth century as evidenced by dramatic population increases and land use conversion. (Cal. Dep't of Water Resources, 2015) The California Department of Water Resources has state hydrologic data back to the early 1900s. The hydrologic data show multi-year droughts from 1912 to 1913, 1918 to 1920, 1922 to 1924, 2007-2009, and 2014 to 2017.

The most recent major drought in California spanned 2014-2017. With California facing water shortfalls in the driest year in recorded state history, California State Governor Jerry Brown declared a drought state of emergency on January 17, 2014. In the State of Emergency declaration, Governor Brown directed state officials to assist farmers and communities that are economically impacted by dry conditions and to ensure the state can respond if Californians face drinking water shortages. The Governor also directed state agencies to use less water and hire more firefighters and initiated a greatly expanded water conservation public awareness campaign. Figure 4-41 shows drought-impacted Lake Isabella in 2015. On April 17, 2017, Brown issued Executive Order B-40-17, officially ending the drought state of emergency in all California counties except Fresno, Kings, Tulare, and Tuolumne.



Figure 4-41. Drought-lowered Lake Isabella in 2015. Photo by Don Barrett, USC News

The National Drought Monitor provides drought data and maps nationally and on a localized, watershed scale. The National Drought Monitor is the product of eleven agencies, from the NDMC, NOAA and USDA, and is available at http://droughtmonitor.unl.edu/. The National Drought Monitor categorizes the level of drought from D0 through D4, with D4 being the highest "exceptional drought." Table 4-50 depicts drought classifications and impacts from the level of drought occurrence in California.

Figure 4-42 shows a time series of the level of drought in Kern County from 2000 to 2020 according to the National Drought Monitor as well as the watersheds in Kern County. The National Drought Monitor also classifies drought on a watershed scale (according to hydrologic units established by the US Geological Survey). The participating jurisdiction annexes for those jurisdictions that prioritized drought hazards depict the past twenty years of droughts within applicable watersheds.

Table 4-50. Drought Classifications and Impacts for California

Category	Description	Possible Impacts
D0	Abnormally Dry	▪ Soil is dry; irrigation deliver begins early ▪ Dryland crop germination is stunted ▪ Active fire season begins ▪ Winter resort visitation is low; snowpack is minimal
D1	Moderate Drought	▪ Dryland pasture growth is stunted; producers give supplemental feed to cattle ▪ Landscaping and gardens need irrigation earlier; wildlife patters begin to change ▪ Stock ponds and creeks are lower than usual
D2	Severe Drought	▪ Producers increase water efficiency methods and drought-resistant crops; ▪ Grazing land inadequate ▪ Fire season is longer, with high burn intensity, dry fuels, and large fire spatial extent; more fire crews on staff ▪ Lake- and river-based tourism declines; boat ramps close ▪ Trees are stressed; plants increase reproductive mechanisms; wildlife diseases increase ▪ Water temperatures increase; programs to divert water to protect fish begin ▪ River flows decrease; reservoir levels are low and banks are exposed
D3	Extreme Drought	▪ Livestock need expensive supplemental feed, cattle and horses are sold; little pasture remains ▪ Fruit trees bud early; producers begin irrigating in winter ▪ Federal water not adequate to meet irrigation contracts, extracting supplemental groundwater is expensive ▪ Dairy operations close ▪ Fire season lasts year-round; fires occur in typically wet parts of the state; burn bans are implemented ▪ Ski and rafting business is low, mountain communities suffer ▪ Orchard removal and will drilling company business increase; panning for gold increases ▪ Low water levels impede fish migration and cause lower survival rates ▪ Wildlife encroach on developed areas; little native food and water is available for bears, which hibernate less ▪ Water sanitation is a concern, reservoir levels drop significantly, surface water is nearly dry, flows are very low; water theft occurs ▪ Well and aquifer levels decrease; homeowners drill new wells
D4	Exceptional Drought	▪ Fields are left fallow; orchards are removed; vegetable yields are low; honey harvest is small; agricultural unemployment is high, food aid is needed ▪ Fire season is very costly; number of fires and areas burned are extensive ▪ Many recreational activities are affected ▪ Fish rescue and relocation begins; pine beetle infestation occurs; forest mortality is high; wetlands dry up; survival of native plants and animals is low; fewer wildflowers bloom; wildlife death is widespread; algae blooms appear ▪ Poor air quality affects health; greenhouse gas emissions increase as hydropower production decreases; West Nile outbreaks rise ▪ Water shortages are widespread; surface water is depleted; federal irrigation water deliveries are curtailed; water prices are extremely high; wells are dry, more and deeper wells are drilled; water quality is poor

Adapted from U.S. Drought Monitor Drought Classifications and Impacts.
https://droughtmonitor.unl.edu/Data/StateImpacts.aspx

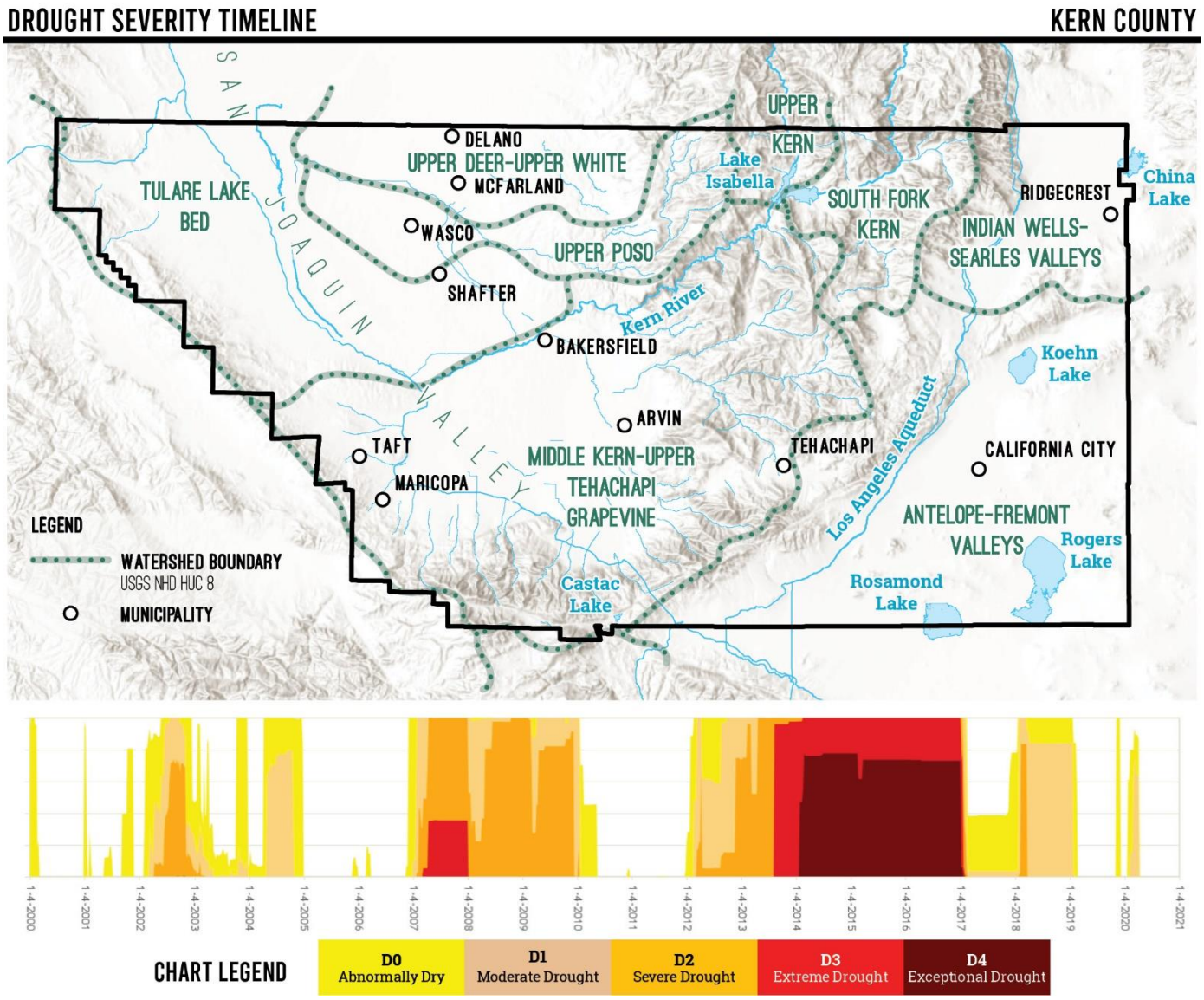


Figure 4-42 Kern County Drought Severity Timeline 2000-2021

Drought is one of the few hazards with the potential to impact the entire population of Kern County directly or indirectly, be it from water restrictions, higher water and food prices, reduced air or water quality, or restricted access to recreational areas. No portion of the County is immune from drought conditions. Lack of winter snowfall in the mountains can eventually lead to agricultural impacts due to decreased stream flows. Droughts of just a few weeks during critical periods of plant development can have disastrous effects on agriculture production. Reduced reservoir storage from decreased runoff in the mountains can lead to water shortages. Droughts that occur in populated areas may not have direct effects to the residents but may increase the threat of wildfire in the wildland urban interface areas.

4.5.6.4 Frequency/Probability of Future Occurrences

Currently there is no data on the probability of drought akin to data for predicting earthquakes or flood probability. Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

According to the results of the risk factor exercises for the participating jurisdictions, the probability of drought occurring in Kern County is highly likely (100% annual probability). Figure 4-42 provides a time series from the National Drought Monitor that shows Kern County has been in some form of drought for well over half of the period from 2000 to 2020.

4.5.6.5 Severity and Extent

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly.

The agricultural sector clearly demonstrates the site-specific nature of drought impacts. Agricultural drought impacts are normally felt earliest by those relying on unmanaged water supplies: entities carrying out dryland grazing and non-irrigated crop production, usually grain crops. Impacts to irrigated agriculture depend on the source and nature of the irrigation water supply, whether it be local groundwater, local surface water, or imported surface water, and any water rights or contractual provisions that may be associated with the source. The extent to which producers may mitigate water shortage impacts depends on multiple factors but is heavily influenced by economic considerations. Factors involved in making decisions about mitigating irrigation water shortages include availability and costs of pumping groundwater, price of alternative surface water sources, capital investments associated with maintaining permanent plantings, and status of international crop markets. (California Drought Contingency Plan, 2010)

Unlike most disasters, droughts normally occur slowly but last a long time. On average, the nationwide annual impacts of drought are greater than the impacts of any other natural hazard. They are estimated to be between $6 billion and $8 billion annually in the United States and occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts.

Drought eventually affects groundwater sources but generally not as quickly as surface water supplies; groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in

FEMA Approval 4/9/2021

streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

A drought directly or indirectly impacts all people in affected areas. A drought can result in farmers not being able to plant crops or the failure of planted crops. This results in loss of work for farm workers and those in food processing and wine making jobs. Other water-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them.

Table 4-50 described impacts of the various severity levels of drought in California according to the National Drought Monitor classifications.

4.5.6.6 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions .Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale. (National Institute of Water and Atmospheric Research, 2016)

4.5.6.7 Secondary Hazards

The secondary hazard most associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends.

4.5.6.8 Drought Vulnerability Analysis

All people, property, and environments in the County planning area would be exposed to the impacts of moderate to extreme drought conditions to some degree.

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought vulnerability of an activity usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand. California's 2018 Water Plan indicates that water demand in the state will continue to increase.

4.5.6.8.1 Population

The residents of the county rely on healthy watersheds to provide adequate water for domestic and agricultural purposes. Kern County has experienced population growth and is projected to continue grow, with Bakersfield being one of the fastest growing cities in the state. No significant life or health impacts are anticipated as a result of drought within the planning area.

4.5.6.8.2 Property

During drought years, property owners with shallow wells can be impacted by drought with increased demand on groundwater resources. Surface water supplies are often lower, which can reduce available supplies and increase cost. This sometimes encourages growers who historically used surface water to switch to groundwater, which has a permanent impact on the amount of users using groundwater.

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

4.5.6.8.3 Critical Facilities

Critical facilities, as defined for this plan, will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

4.5.6.9 Future Trends in Development

The County will face challenges in providing sufficient water supplies in the future due to climate change effects, coupled with an increasing population (i.e., mostly in the incorporated areas) and increasing water demand. While the County has already taken steps towards achieving long-term groundwater sustainability, there is still a possibility that water supply availability may change in the future and will need to be further addressed.

A new program is being developed to address drought and future development. It involves Kern County and the expansion of the Willow Springs Water Bank (WSWB). Kern County is the lead for a 2018 FEMA grant of $15 M. The grant is part of the Hazard Grant Mitigation Program funds allocated to California. It will pay for facilities to pre-deliver water owned by Kern County from Lake Isabella to WSWB. Pre-delivery creates empty space in the reservoir. The empty volume created in Isabella can (1) provide new yield that can be used to mitigate drought, and (2) reduce the water level in Lake Isabella, reducing dam failure risk. WSWB can provide county-wide benefits to address future droughts.

FEMA Approval 4/9/2021

Education is also important to ensure sustainable future trends in development. The Water Association of Kern County exists to inform and educate the public and water community about water issues in Kern County. They are a resource for information on water issues in Kern County and provide tips for water conservation.

Finally, each participating municipality has an established General Plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. These plans provide the capability at the local level to protect future development from the impacts of drought. All participating municipalities reviewed their general plans as part of their hazard mitigation capability assessments. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

4.5.6.10 Climate Change Impacts

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure

With a warmer climate, droughts could increase in severity, frequency, and duration. According to the UC Davis Center for Watershed Sciences, water shortages in 2016 were projected to cost the agricultural industry a total of $550 million in direct costs and 1,815 in lost jobs. More frequent extreme events such as droughts could end up being more cause for concern than the long-term change in temperature and precipitation averages. (University of California, Davis Center for Watershed Sciences, 2020)

4.5.6.11 Drought Hazard Problem Statements

As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities based on the risk assessment and vulnerability analysis, utilizing the RAMP mapping tool and flood data. Drought hazard problem statements for the County are listed in Table 4-51; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understand the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. Projects or actions have been developed to mitigate each problem identified. See Table 5-6 for a full list of mitigation actions and corresponding problem statements that they address.

Each problem statement is coded with a problem number for cross-referencing between Table 4-51 and Table 5-6.

Table 4-51 Drought Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-DR-KC-215	Drought	Impact	PE&A - Public Education & Awareness	**County of Kern**	Public education and programming is needed to support the water conservation efforts by WAKC and GSA's	**ma-DR-KC-290**
ps-DR-KC-216	Drought	Victim	PRV - Prevention , PE&A - Public Education & Awareness , SP - Structural Projects	**County of Kern**	Groundwater pumping for private wells during drought years has created water quality issues in existing aquifers	**ma-DR-KC-291**
ps-DR-KC-217	Drought	Victim	PRV - Prevention , PE&A - Public Education & Awareness , SP - Structural Projects	**County of Kern**	Private wells are at risk of going dry during drought years	**ma-DR-KC-291**
ps-DR-KC-218	Drought	Threat	PRV - Prevention , NRP - Natural Resource Protection	**County of Kern**	County buildings and facilities have irrigated landscaping including turf grass	**ma-DR-KC-294**
ps-DR-KC-219	Drought	Threat	PRV - Prevention , PE&A - Public Education & Awareness	**County of Kern**	Existing land use/building code does not require or incentivize water conservation measures including requiring the use of low-flow toilets and showerheads	**ma-DR-KC-293**
ps-DR-KC-220	Drought	Threat	PRV - Prevention	**County of Kern**	There is an opportunity for the County land use code to include more incentives for developers to implement drought-tolerant landscaping that provides shade and lowers the urban heat island effect	**ma-DR-KC-293**

4.5.7 Slope Failure Hazard Profile



Landslides, mudflow, debris flow, and rockfall, collectively known as slope failure, may cause damage across the County. They rarely present a threat to human life, but often result in a disruption of everyday services, including emergency response capabilities. Landslides can block transportation routes, dam creeks and drainages, and contaminate water supplies. When these hazards affect transportation routes, they are frequently expensive to clean-up and can have significant economic impacts to the County. (United States Geological Survey, 2004)

For this MJHMP update, three types of slope failure (Landslide, Debris Flow, and Rockfall) were identified as concerns to the County and are briefly described below.

Landslide

The many types of landslides are categorized based on form and type of movement. They range from slow moving rotational slumps and earth flows, which can slowly distress structures but are less threatening to personal safety, to fast-moving rock avalanches and debris flows that are a serious threat to structures and have been responsible for most fatalities during landslide events. Many large landslides are complex and a combination of more than one landslide type. (Bakersfield.com, 2008, p. 341)

Mudflow/Debris Flow

When slope material becomes saturated with water, a debris flow may develop. According to NOAA, debris flow is the most common type of slope failure in Kern County. From a geologic perspective, there are generally two types of debris flows: debris flows related to shallow landslides and post-wildfire debris flows. (United States Geological Survey, 2005)

Debris flows related to shallow landslides occur on hillslope due to soil failure in which soil liquefies and runs downhill. This type of debris flow generally results from a shallow landslide (less than 10 to 15 feet deep) and has a discrete initiation zone depositional area. Shallow landslides tend to occur in winter but are most likely after prolonged periods of heavy rainfall when soil materials are saturated. Debris flows are typically more dangerous because they are fast moving, causing both property damage and loss of life. *(Id)*

Post-wildfire debris flows are a result of post-fire conditions, where burned soil surfaces enhance rainfall runoff that concentrates in a channel and picks up debris as it moves. The post-fire debris flow has a less discrete initiation zone but is similar to a debris flow derived from hillslopes in that it may result in inundation and a detrimental impact on lives and property within its zone of runout and deposition. It can result in downstream flooding. *(Id)*

An example of a catastrophic post-fire debris flow is the event that occurred in Kern County on July 12, 2008, when, significant thunderstorm activity in the mountains above Lake Isabella, tons of water were deposited through the Erskine Creek watershed. See Figure 4-43 for debris flow in the Tehachapi area. (Bakersfield.com, 2008)

Rockfall

Rockfall is the falling of a newly detached mass of rock from a cliff or rock outcrop or a loose rock that erodes out of unconsolidated debris on a hillside and rolls or falls down a very steep slope. Over-steepened slopes such as at roadcuts or in glaciated terrain are susceptible to rockfall due to the steep slopes that are not highly vegetated or benched, which can help attenuate rockfall. Rock outcrops that are highly fractured and/or undercut by weaker rock layers are also susceptible to rockfall. (Colorado Geological Survey, 2020)

Alluvial Fan

Alluvial fans consist of sediment deposits leftover from a flood event. The sediment is carried by a flood and distributed in a fan-like shape. Alluvial fans represent a high risk of natural hazards in the form of debris flow as the deposited soil remains unstable after the flood event.

4.5.7.1 Plans, Policies, and Regulatory Environment

Kern County General Plan

The 2004 Kern County General Plan includes policies and implementation measures in the Land Use and Safety Elements that ensure adequate slope stability for development in areas prone to slope failure and impacts from the potential of slope failure are mitigated.

Policies and implantation measures around slope failure include ensuring effective slope stability for development and developing spatial referents for geologic hazards more generally. The Kern County General Plan is currently being updated and will consider this MJHMP Update as it continues to shape policies around slope failure mitigation and protection.

Regulation of Cut Surfaces in Kern County Code, § 17.28

The Kern County Code discusses the regulation of slope via its Grading Code, § 17.28. It stipulates that the slope of cut surfaces shall be no steeper than is safe for the intended use and shall be no steeper than two (2) units horizontal to one (1) unit vertical, the exception being if the applicant furnishes a soils engineering or an engineering geology report, or both, stating that the site has been investigated and giving an opinion that a cut at a steeper slope will be stable and not create a hazard to public or private property.

4.5.7.2 Past Events

According to NOAA, the most common type of slope failure in Kern County is debris flow, which typically occurs during winter months. Table 4-52 lists the slope failure events that took place in the County since the year 2000.

Table 4-52: Slope Failure Events in Kern County Since 2000

Date	Type of Event	Property Damage Value ($)	Crop Damage
12/7/2003	Debris Flow	5,000	None reported
2/21/2005	Debris Flow	3,000	None reported
4/24/2005	Debris Flow	3,000	None reported
12/16/2016	Debris Flow	1,000	None reported
9/3/2017	Debris Flow	50,000	None reported
10/3/2018	Debris Flow	1,000	None reported
12/26/2019	Debris Flow	100,000	None reported

Source: NOAA Storm Events Database



Figure 4-43. Mudflow near Tehachapi Mountains

Photo by The Watchers, https://watchers.news/2015/10/19/massive-mudslide-engulfs-highway-58-near-the-tehachapi-mountains-california/

4.5.7.3 Location

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

Recognizing ancient dormant mass movement sites is important to identify current areas susceptible to flows and slides, because they can be reactivated by earthquakes or by exceptionally wet weather. Those ancient scars also consist of broken materials, frequently involve disruption of groundwater flow, and are vulnerable to construction-triggered sliding.

Kern County does have a history of landslide events that have impacted transportation, access to more remote residences in the unincorporated county, and caused property damage. Figure 4-43 shows a 2015 mudflow adjacent to the Tehachapi Mountains that caused traffic backups on Highway 58.

Figure 4-44 shows low, moderate, and high landslide susceptibility in Kern County. Most of the high susceptibility areas are in the hilly regions bordering the Central Valley. This map should be used with caution, however, as site-specific conditions can make some locations in low to moderate instability areas highly unstable and some high instability locations more stable.

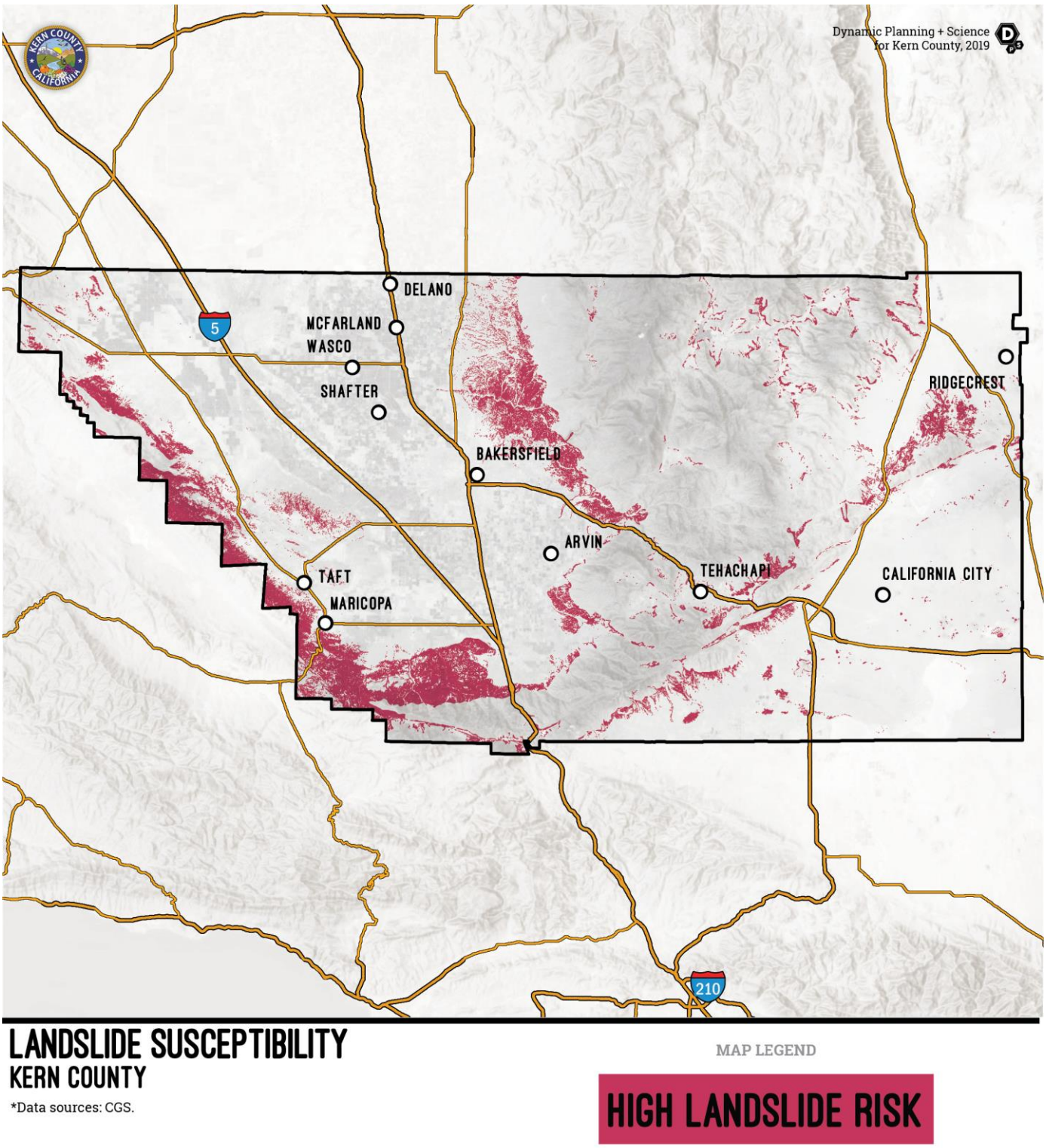


Figure 4-44: Landslide Susceptibility

4.5.7.4 Frequency/ Probability of Future Occurrences

Slope failures are most frequently triggered in periods of high rainfall. The hazard is greatest in steeply-sloped areas, although slides may occur on slopes of 15 percent or less if the conditions are right. Slope steepness and underlying soils are the most important factors affecting the landslide hazard. However, surface and subsurface drainage patterns also affect the landslide hazard, and vegetation removal can increase the likelihood of a landslide. (United States Geological Survey, 2004)

Slope failures are often triggered by other natural hazards such as earthquakes, heavy rain, floods, or wildfires, so landslide frequency is often related to the frequency of these other hazards. The probability of slope failure occurring in Kern County is likely (between 10 and 100% annual probability).

4.5.7.5 Severity and Extent

The severity of landslide problems depends upon the local bedrock and soil conditions, including moisture content, slope, and vegetation. Small landslides are common in the County's mountain areas as loose material moves naturally down slope or fires have caused loss of soil-stabilizing vegetative cover. In addition, many human activities tend to make the earth materials less stable and, thus, increase the chance of ground failure. Some of the natural nonseismic causes of ground instability are steam and lakeshore erosion, heavy rainfall, and poor quality natural materials. Human activities contribute to soil instability through grading of steep slopes or overloading them with artificial fill, by extensive irrigation, construction of impermeable surfaces, excessive groundwater withdrawal, and removal of stabilizing vegetation (Kern County General Plan, 2009)

4.5.7.6 Warning Time

Some geologic hazards occur slowly but can have significant property or health consequences, like erosion and some forms of slope movement or land sliding. The identification of those hazards generally takes site-specific analysis to determine if the site soils and geology are susceptible to these hazards and what mitigation is most relevant and prudent for a site. For these types of hazards, warning time is long.

For other hazards, such as debris flows, rockfall, and landslides, warning time is often very short and may not occur at all. Identifying areas where these events are known have occurred, or which have ideal characteristics for these hazards to occur, could help with hazard preparedness when triggering-type events like intense rainfall occur. This identification won't reduce the warning time, but it will make proactive response to potential triggering events more effective. (AGU Publications, 2016)

4.5.7.7 Secondary Hazards

There are some hazards that can trigger or exacerbate slope failure. Flooding, for example, can undercut the toe of a slope which can remove the support for the slope and cause a landslide or rockfall. Wildfires create an immediate hazard of their own and create long-term impacts by altering the soil structure, impeding its ability to absorb moisture, and destroying vegetation that binds the soil with roots and absorbs rainfall and runoff with foliage. Post-wildfire, even small rainfall events can create devastating mudflows, debris flows, and landslides. Areas that are mapped currently as low to moderate risk of these hazards may have high risk after a wildfire.

4.5.7.8 Slope Failure Vulnerability Assessment

Figure 4-45 displays landslide susceptibility for population and infrastructure in Kern County. This section discusses exposure to this vulnerability.

4.5.7.8.1 Population

An estimated 5,769 persons, or 1.92% of the County population, are exposed to slope failure areas, as shown in Table 4-53 below. Population estimates within slope failure areas were generated by analyzing County assessor and parcel data that intersect with landslide hazard areas identified by California Geological Survey. Using GIS, U.S. Census Bureau information was used to intersect slope failure hazards an estimate of population was calculated by weighting the population within each census block and track with the percentage of slope hazard areas.

Table 4-53: Population Exposure to Landslide Susceptibility

	Total Population
Unincorporated County	299,935

Landslide Susceptibility	Population Count	% of Total
High	5,769	*1.92%*
Total	**5,769**	**1.92%**

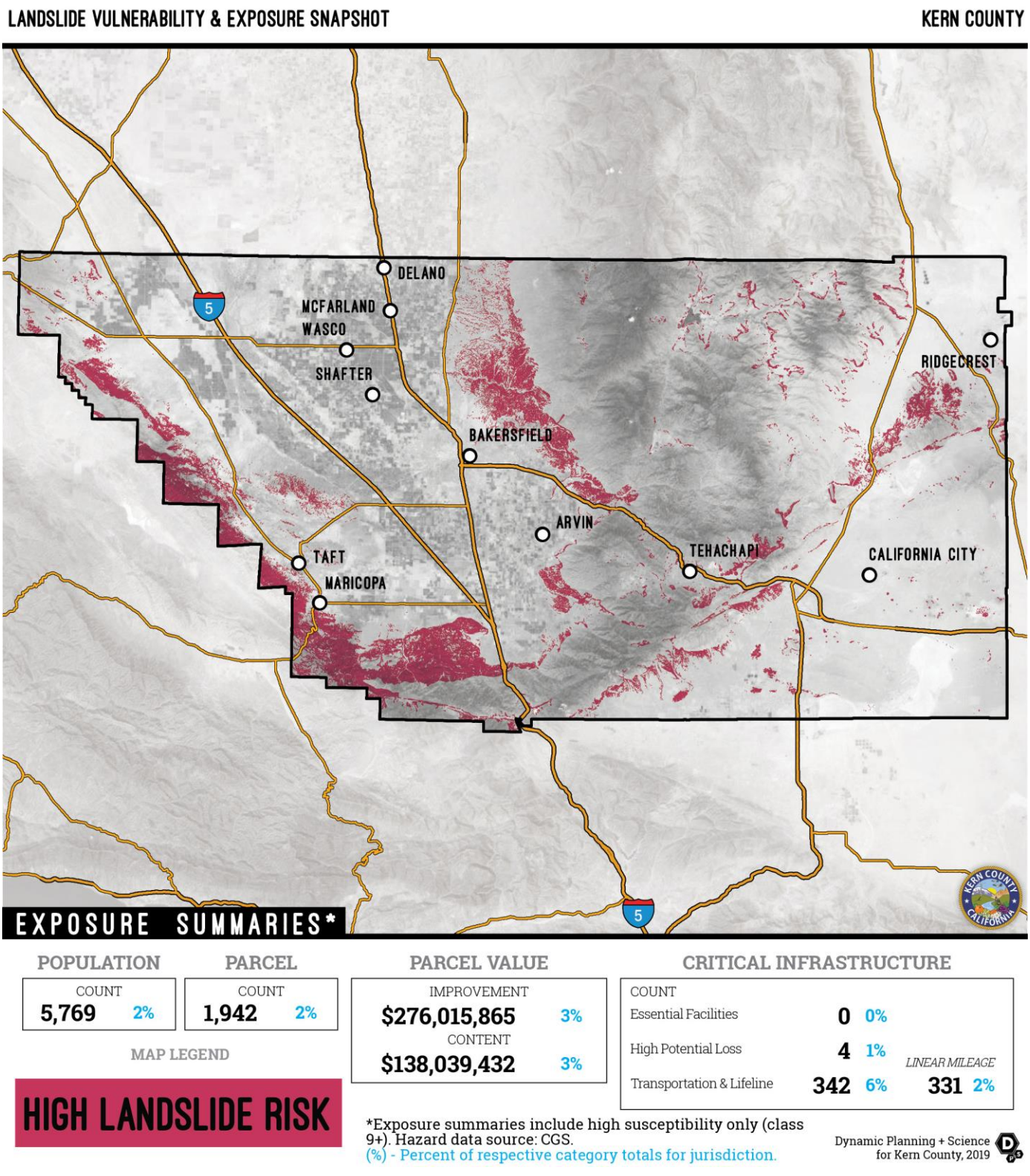


Figure 4-45: Landslide Vulnerability Snapshot

4.5.7.8.2 Property

Table 4-54 shows the number of parcels, market value exposure and content value exposure in the steep-slope risk areas. The predominant zoning classes in cities are single-family, vacant and manufactured homes.

Table 4-54: Property Value Exposed to Landslides.

	Total Parcels	Total Market Value ($)	Total Content Value ($)	Total Value ($)
Unincorporated County	91,455	$ 10,906,675	$ 5,453,338	$ 16,360,013

Landslide Susceptibility	Parcel Count	% of Total	Market Value Exposure ($)	Content Value Exposure ($)	Total Exposure ($)	% of Total
High	1,942	*2.1%*	$ 275,953	$ 137,976	$ 413,929	*2.5%*
Total	**1,942**	**2%**	**$ 275,953**	**$ 137,976**	**$ 413,929**	**2.5%**

Currency in Thousands

4.5.7.8.3 Critical Facilities and Infrastructure

Several types of infrastructure are exposed to mass movements, including transportation, water, sewer, and power infrastructure. At this time, all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available. Table 4-55 and Table 4-56 summarize the critical facilities exposed to the slope failure hazard.

Table 4-55: Critical Facility Points with Slope Failure Hazard Risk (Unincorporated County)

Critical Infrastructure - Landslide Susceptibility	
Infrastructure Type	High
Essential Facility	-
EOC	-
Fire Station	-
Hospital	-
Police Station	-
Sheriff Station	-
High Potential Loss	4
Adult Residential facility	-
Child Care Center	-
Dam	2
Family Child Care Home	1
Foster Family Agency	-
Historic Building	-
Home Care Organization	-

Critical Infrastructure - Landslide Susceptibility	
Infrastructure Type	High
Library	-
Residential Child Care	-
Residential Elder Care	-
School	-
County Insured Asset*	1
Cooling Center	-
Healthcare Facility	-
Special Needs Facility	-
City Hall	-
Historic Site	-
Transportation and Lifeline	342
Airport	-
Bridge	9
Power Plant	8
Substation	6
Transmission Line Tower	318
NG Facility	1
Wind Turbine	-
Bus Facility	-
Potable Water Facility	-
Waste Water Facility	-
Oil Facility	-
Railroad Facility	-
Grand Total	**346**

** These insured assets may include critical infrastructure already represented in other Infrastructure Types.*

Table 4-56: Critical Facilities (Linear) with Slope Failure Hazard Risk (Unincorporated County)

Lifelines (miles) - Landslide Susceptibility	
Infrastructure Type (Linear)	High
Levee	0.85
NG Pipeline	28.49
Railroad	7.26
Street	172.44
4WD trail	12.54
4WD trail, major	-
Alley	0.05

Lifelines (miles) - Landslide Susceptibility	
Infrastructure Type (Linear)	High
Cul-de-sac	-
Driveway	0.98
Interstate	4.79
Local road	69.07
Local road, major	41.92
Primary highway	3.10
Ramp	0.45
Road, parking area	-
Service road	-
State/county highway	35.82
State/county highway, major	-
Thoroughfare, major	3.74
Walkway	-
Transmission Line	122.05
Grand Total	**331.09**

4.5.7.8.4 Lifelines

A significant amount of linear infrastructure (or lifelines) can be exposed to mass movements:

- **Roads**—Access to major roads is crucial to life-safety, response, and recovery operations after a disaster event. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems, and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact bridges, by knocking out bridge abutments or significantly weaken the soil supporting them.
- **Power Lines**—Power lines are generally elevated above steep slopes, but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and rip down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

4.5.7.9 Future Trends in Development

Kern County is equipped to handle future growth within landslide hazard areas. The 2009 Kern County General Plan addresses development in areas susceptible to slope failure.

4.5.7.10 Slope Failure Hazard Problem Statements

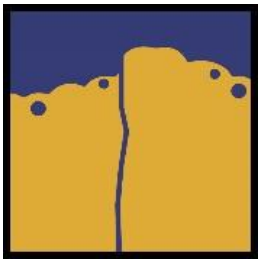
As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities based on the risk assessment and vulnerability analysis, utilizing the RAMP mapping tool and flood data. Slope failure hazard problem statements are listed in Table 4-57; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understand the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. Projects or actions have been developed to mitigate each problem identified. See Table 5-6 for a full list of mitigation actions and corresponding problem statements that they address. Each problem statement is coded with a problem number for cross-referencing between Table 4-57 and Table 5-6.

Table 4-57 Slope Failure Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-SF-KC-230	Slope Failure	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness	**County of Kern**	County transportation routes may be located near high danger landslide areas, which could result in blocked roads and dangerous driving conditions in the event of a landslide. The following County roads pass through high landslide risk areas: Bakersfield-Glennville Rd.; Round Mountain Rd.; Granite Rd.; and Caliente Bodfish Rd	**ma-SF-KC-292**
ps-SF-KC-231	Slope Failure	Impact	PPRO - Property Protection , PE&A - Public Education & Awareness	**County of Kern**	The following County bridges are located in high landslide risk areas: Cottonwood Creek (50 0047); Hillside (50 0137); Hillside (50 0140); Hillside (50 0182)	**ma-SF-KC-292**

4.5.8 Soil Stability Hazard Profile



Hazards associated with soils in Kern County include land subsidence and wind erosion.

Land Subsidence

Land subsidence is a gradual settling or sudden sinking of the Earth's surface due to subsurface movement of earth materials. The main cause of subsidence in California is groundwater pumping. The effects of subsidence include damage to buildings and infrastructure, increased flood risk in low-lying areas, and lasting damage to groundwater aquifers and aquatic ecosystems. Subsidence in Kern County is most often caused by the withdrawal of large volumes of fluids from underground reservoirs, but it can also occur by the addition of surface water to certain types of soils, called hydrocompaction. Subsidence from any cause accelerates maintenance problems on roads, lined and unlined canals, and underground utilities. Subsidence has and will continue to cause gradient changes in canals, causing the need for canal banks to be raised and bridges elevated at significant expense. (USGS, Land Subsidence in California, n.d.)

There are four types of subsidence occurring in Kern County.

- **Tectonic subsidence**, a long-term, very slow sinking of the valley, which is significant only over a geologic time period.
- **Subsidence caused by the extraction of oil and gas**. This type of subsidence is still too small to be of serious concern. The State Division of Oil, Gas, and Geothermal Resources monitors subsidence in oil and gas fields and regulates oil and gas withdrawal and repressurizing of the fields.
- **Subsidence caused by withdrawal of groundwater** in quantities much larger than replacement can occur, causing a decline of the water level. This type of subsidence is of major concern and should be regulated and reduced, especially in urbanizing areas. This practice has lowered the ground level over a large area south of Bakersfield and in other areas of the County.
- **Subsidence caused by hydrocompaction of moisture – deficient alluvial deposits**. This is a one time densification from collapse of the soil structure in near-surface strata where the rainfall or other moisture has not penetrated during a long period of time. Parts of the California Aqueduct were constructed through and over hydrocompaction deposit after compaction has occurred through ponding. The areas where hydrocompaction exists and suspect areas should be mapped, studied, and evaluated. Any development on these areas of damaging subsidence requires corrective measures. (Kern County General Plan, 2009)

Wind Erosion

Erosion is the general process whereby the materials of the earth's crust are worn down, removed by weathering, and deposited in other places by water or air. Lakeshore erosion is a special problem involving wave action and can be practically eliminated by proper engineering, construction, and soil stabilization through vegetative cover. Alluvial fans that form at the base of mountain foothills are a product of erosion in the watershed above depositing debris on the gentler valley floors, often associated with debris flows. Development in these areas can be subject to inundation from mud to boulder sized particles. Within

urbanized areas, the major problem of erosion is from the continued need to remove sediment from drainage systems and basins. Sedimentation within these systems decreases the volume of flood flows that the system can handle. (Kern County MJHMP, 2014)

Agricultural areas are particularly susceptible to wind erosion between crops, during periods of fallow, when grazed by sheep, or when taken completely out of production. Any process that reduces vegetative cover creates dust control issues. For growers, blowing dust comes from two sources, land you own or lease and the land upwind of it. Sand blowing from upwind may cause your previously stable ground to begin to erode, as high winds pick up loose sand particles and bounce them along the ground. This saltation of sand and other coarse particles sandblasts the soil surface, eroding the stable crust, dislodging additional particles, and causing further erosion. Saltating particles can kill vegetation, scour stable land, and cause dust to be lofted into the air. See Figure 4-46. Wind rarely lifts sand higher than about 3 feet above ground. However, fine dust rises much higher, which eliminates any practical means of capture.

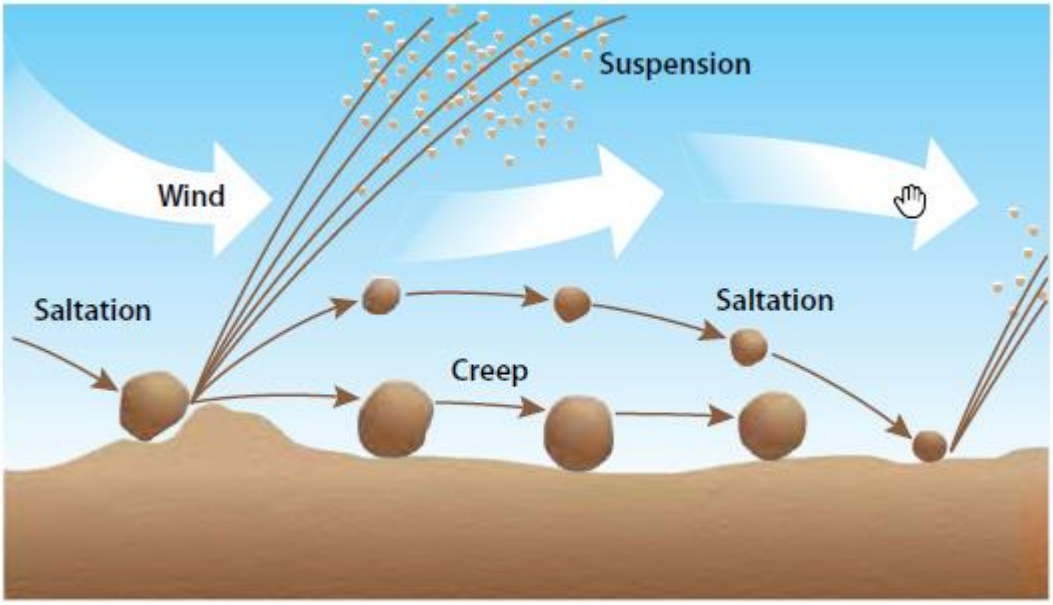


Figure 4-46. Illustration of various stages of erosion.

From Antelope Valley Dustbuster's Agricultural Guide to Controlling Windblown Sand and Dust, 2010, http://www.kernair.org/Documents/Dust_Buster/Dustbusters%20Agricultural%20Guide%2010-25-10.pdf

Growers may choose to implement procedures that control dust, in order to improve visibility, reduce wind erosion and loss of topsoil, minimize damage to roads and structures, and limit health impacts due to poor air quality. Effective dust control methods conserve your topsoil, protect your downwind cropped acreage, and support compliance with air quality regulations. Soils remain viable for production only when soil loss is held below about 5 tons per acre per year. Dust regulations require submittal of a Best Management Practice Plan that includes selection of Practices for Agricultural Operations specifically developed for control of fugitive dust in the Mojave Desert. (Antelope Valley Dustbusters, 2010)

High winds can create hazardous dust storms in Kern County. Dust storms can damage agricultural crops, property, and create hazardous driving conditions. Dust storms are also a health hazard to residents that are forced to breathe particulates in the air. Dust storms in Kern County are most likely to occur in valley and desert areas.

4.5.8.1 Plans, Policies, and Regulatory Environment

Healthy Soils Action Plan

The California Healthy Soils Action Plan was created by a collaboration of state agencies and departments which are referred to as the Healthy Soils Initiative. They are headed by the California Department of Food and Agriculture. The California Healthy Soils Action Plan is meant to promote the development of healthy soils on California's farm and ranchlands. The benefits of healthy soil include increased plant health and yields, water retention, greenhouse gas sequestration, and reduced sediment erosion and dust. There are five primary actions which the Healthy Soils Initiative promotes:

- the protection and restoration of soil organic matter in California's soils.
- the identification of sustainable and integrated financing opportunities to facilitate healthy soils.
- the provision for research, education, and technical support to facilitate healthy soils.
- increased governmental efficiencies to enhance soil health on public and private lands.
- the promotion of interagency coordination and collaboration to support soils and related state goals.

Kern County General Plan

The 2004 Kern County General Plan includes several policies and implementation measures in the Land Use and Safety Elements that maintain soil stability in development areas and mitigate impacts from such development.

Policies around soil stability include minimizing alteration of the landscape in order maintain soil stability. The Kern County General Plan is currently being updated and will consider this MJHMP Update as it continues to shape policies around soil stability mitigation and protection.

Soil Stabilization: Maintenance of Disturbed Lands in Kern County Code, § 19.80

The Kern County Code includes a provision for the Eastern Kern Desert Region, which regulates any development that results in any surface disturbance. Best management practices are to be used for the minimization of soil erosion by onsite activities, rainfall, flowing water, or wind.

4.5.8.2 Past Events

Land subsidence in the San Joaquin Valley was first noted in 1935 near Delano. Accelerated ground water pumping of the deep aquifer system during the 1950's and 1960's caused about 75 percent of the total volume of land subsidence. The southern end of the Valley has seen the most subsidence, up to 4 to 8 feet in some areas. Some of the direct damages associated with subsidence in the Valley have included

decreased aquifer storage, partial or complete submergence of canals and associated bridges and pipe crossings, collapse of well casings, and disruption of collector drains and irrigation ditches.

Land subsidence in the vicinity of Edwards Air Force Base has been associated with declining ground water levels and the presence of subsurface fine-grained material that is subject to compaction. Groundwater pumping in this area has been extensive to satisfy water demands at the base as well as agricultural needs. Subsidence in this area was first reported in 1926 and by 1992 about 200 square miles of the Antelope Valley, which includes the Base, were affected by as much as 4 feet of subsidence. The average rate of subsidence between 1961 and 1989 has been about a tenth of a foot a year.

Land-use problems at Edwards AFB due to subsidence have included:

- Failure of well casings during compaction of the aquifer,
- Damage to fluid transport systems such as underground water, sewer, and petroleum lines,
- Erosion of drainage channels and formation of new drainage channels on the lakebed,
- Increase in areas subject to flooding as a result of subsidence,
- Development of cracks, fissures, soft spots and depressions that affect the use of runways,
- Rapid drainage of water on the lakebed into fissures and sink-like depressions. (Kern County MJHMP, 2014)

Erosion over time can be difficult to track as a past "event." This HMP examines dust storms as past events that can be a catalyst for more rapid erosion in the County. Dust storms in Kern County have caused property damage, injuries, and deaths. Table 4-58 summarizes dust storm events in Kern County since 2000, as recorded by the National Oceanic and Atmospheric Administration (NOAA).

Table 4-58 Dust Storm Events 2000-2019

Dust Storm Events			
Date	**Deaths**	**Injuries**	**Property Damage Value ($)**
10/16/2007	0	0	500,000
10/13/2009	3	0	100,000
6/4/2012	0	0	25,000
6/4/2012	0	0	25,000
7/31/2012	0	0	5,000
1/23/2014	0	1	100,000
1/23/2014	0	0	3,000
3/26/2014	0	0	100,000
6/15/2014	0	0	60,000
11/2/2015	0	15	0
4/13/2017	0	0	100,000
9/3/2017	0	0	10,000
9/3/2017	0	0	10,000
9/3/2017	0	0	10,000

Dust Storm Events			
Date	**Deaths**	**Injuries**	**Property Damage Value ($)**
9/3/2017	0	0	10,000
9/3/2017	0	0	1,000
9/3/2017	0	0	1,000
9/3/2017	0	0	1,000
9/3/2017	0	0	1,000
9/3/2017	0	0	1,000
Total	**3**	**16**	**1,062,000**

4.5.8.3 Location

Subsidence from groundwater withdrawal affects the San Joaquin Valley, particularly the southwest end of the Valley in the vicinity of the Buena Vista Lakebed. Edwards Air Force Base in the Desert Region has also experienced subsidence problems in the vicinity of the Rogers Dry Lakebed. (Kern County MJHMP, 2014) Figure 4-47 shows subsidence areas in Kern County.

Erosion can occur throughout the County. The San Juaquin Valley and the Mojave Desert region have more rapid erosion events such as dust storms more often.

4.5.8.4 Frequency/ Probability of Future Occurrences

Subsidence is occurring in the Valley and Desert regions of Kern County. Now that the hazard is recognized and understood, subsidence from ground water withdrawal has generally slowed since the 1970's in the San Joaquin Valley due to reductions in ground water pumping. Long term subsidence is expected to continue, but at a slower rate than before. Studies indicate that subsidence in the Edwards AFB area will be between 0.5-1.7 feet in the next 25 years, depending on groundwater levels. Even though water levels have stabilized in the past 20 years, subsidence continues due to past stresses on the aquifer system. Continued population growth, water demands, and uncertain water supplies will likely continue the trend of groundwater withdrawal and continued subsidence. (Kern County MJHMP, 2014)

Erosion occurs slowly over time and is expected to continue occurring throughout the County to varying degrees. As drought intensifies and continues intensifying due to climate change, additional dust in the air will increase the probability and frequency of erosion. Dust storms are projected to increase as well.

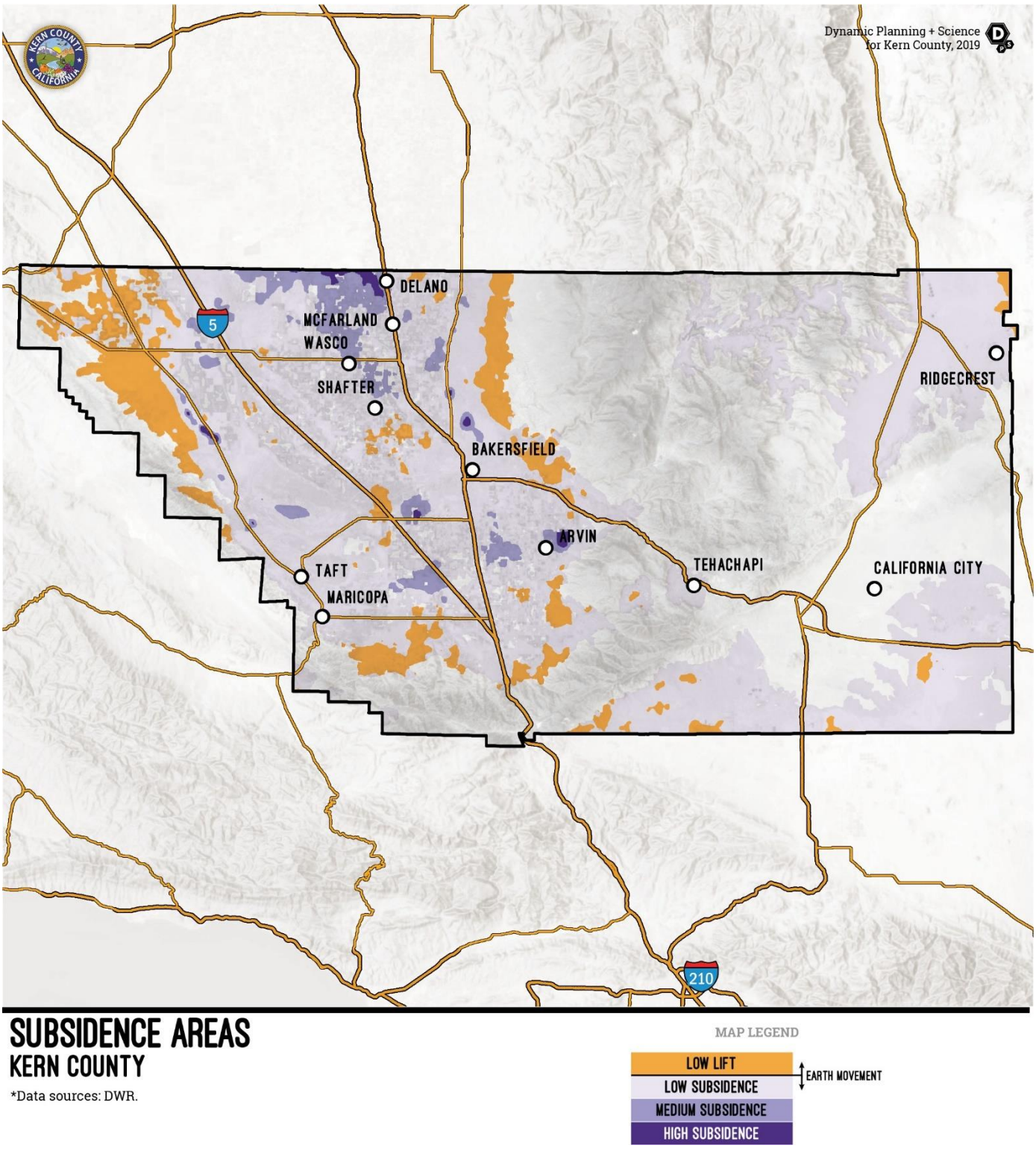


Figure 4-47 Subsidence Areas

4.5.8.5 Severity

Subsidence from any cause accelerates maintenance problems on roads, lined and unlined canals, and underground utilities. All new installations in areas suspected of subsidence should be engineered to withstand such subsidence. The usual remedial action is that of raising the water table by injecting water or by reducing groundwater pumping. This increases the fluid pressure in the aquifer and, in most instances, subsidence decreases or stops after a period of time. Figure 4-48 displays exposure of property and population in Kern County to land subsidence.



Figure 4-48. Subsidence example in San Joaquin Valley.

Source: Matt Ball, Nov. 19, 2013 in Informed Infrastructure Magazine, https://informedinfrastructure.com/6816/land-subsidence-poses-risk-to-water-infrastructure-in-californias-san-joaquin-valley/

Erosion occurs slowly over time and is expected to continue occurring throughout the County to varying degrees. As drought intensifies and continues intensifying due to climate change, additional dust in the air will increase the severity of erosion and dust storms.

4.5.8.6 Warning Time

Subsidence is a long-term hazard with a slow onset. Subsidence can occur years after groundwater pumping has stopped due to the long-term effects it has on the aquifer. Detailed studies and modeling can predict future subsidence based on past groundwater pumping. **Erosion** likewise occurs slowly over time with the exception of dust storms, which can accelerate erosion and cause damage as an extreme weather event.

4.5.8.7 Secondary Hazards

There are no significant secondary hazards associated with land **subsidence**. However, land subsidence has the possibility to alter floodplains makings some areas more prone to flooding. **Erosion** can create secondary slope failure hazards such as landslides and mudflows. See Section 4.5.7 for more information on these secondary hazards.

4.5.8.8 Soil Stability Vulnerability Assessment

4.5.8.8.1 Population

Land subsidence poses a threat to the population of Kern County. Subsidence occurring near residential areas threatens homes and the populations that live in those areas. Figure 4-49 displays the number and percentage of the population which are in areas of the County that are vulnerable to land subsidence.

Wind erosion effects the population of Kern County because it can cause dust clouds. Dust clouds are a source of poor air quality. They have the effect of causing respiratory health problems. Wind erosion can also damage crop production and it can limit visibility, triggering roadway accidents. (Antelope Valley Dustbusters, 2010)

4.5.8.8.2 Critical Facilities

Critical facilities can be affected by land subsidence. Land subsidence creates maintenance problems on roads, lined and unlined canals, and underground utilities that can impact the County as a whole. Figure 4-49 displays the number and percentage of critical infrastructure which is in areas of the County which are vulnerable to land subsidence.

Wind erosion can negatively impact drainage infrastructure, especially in urban and agricultural areas. Erosion causes a continued need to remove sediment from drainage systems and basins. Sedimentation within these systems decreases the volume of flood flows that the system can handle. (Kern County MJHMP, 2014)

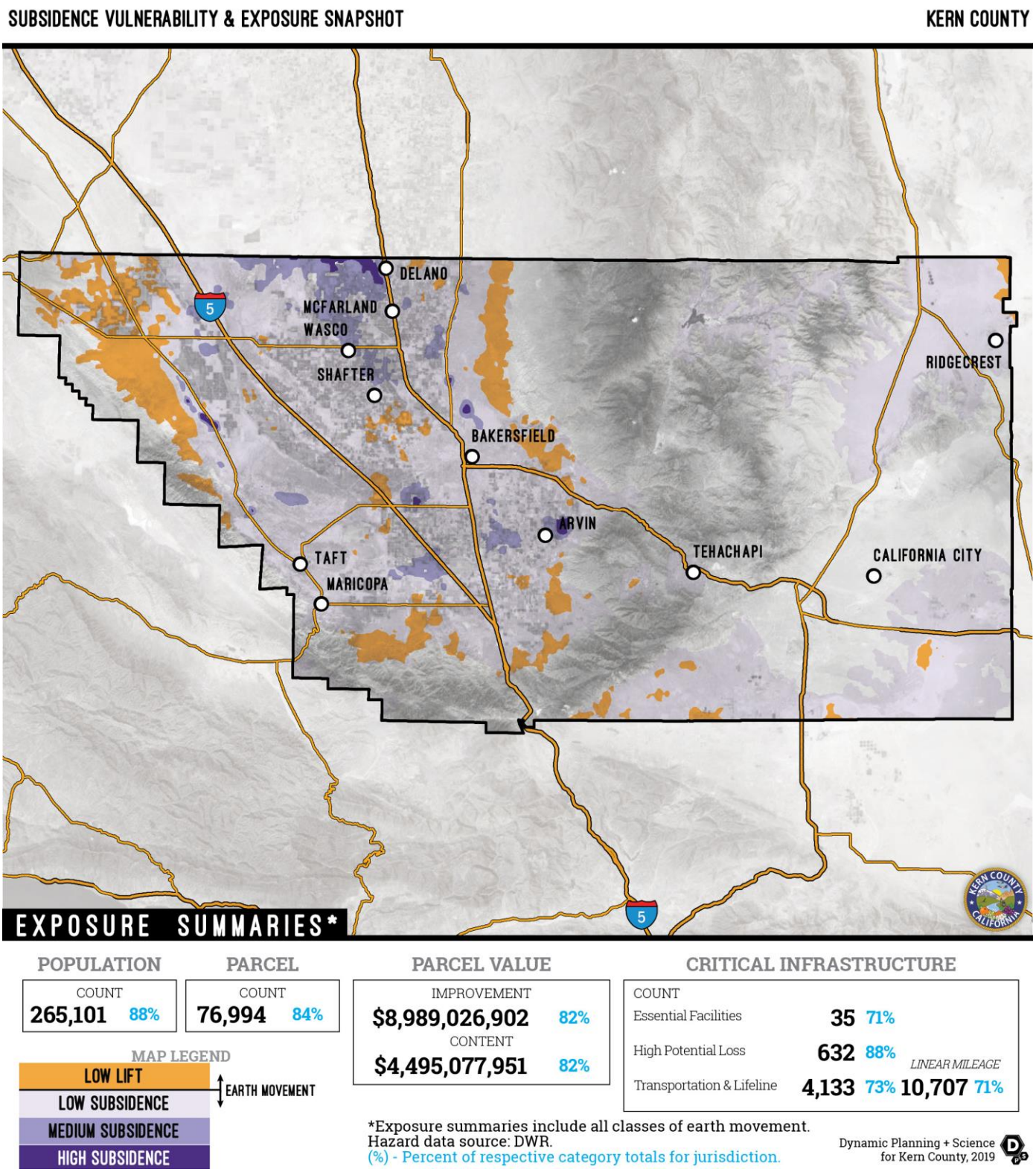


Figure 4-49 Subsidence Vulnerability & Exposure Snapshot

4.5.8.9 Future Trends in Development

Future development has the potential to increase subsidence issues in Kern County. Private water well drilling during drought years can contribute to subsidence issues as it depletes the aquifer, increasing the amount of areas that are susceptible to subsidence. Kern County Department of Public Health issues permits to construct, reconstruct, and destroy water wells and evaluates the construction and water quality of existing wells. The Kern County General Plan acknowledges subsidence issues throughout Kern County and the County is capable of managing growth and development to avoid high risk subsidence areas. Geologic studies and mapping will enhance the County's understanding of high-risk subsidence areas and trends and help the County manage growth and development to avoid high risk areas.

Increased development in arid areas creates additional dust that can exacerbate erosion. (Robbins, 2017) As farming and other development spreads into arid regions, vegetation is destroyed and the soil is exposed to wind erosion. Expected future increase in droughts compound this issue. (*Id.*) This could affect Kern County in some key areas that may experience growth in already-arid exurban areas.

4.5.8.10 Soil Stability Hazard Problem Statements

As part of the mitigation action identification process, the Planning Committee for the County and for each jurisdiction identified issues and weaknesses, also called problem statements, for their respective facilities based on the risk assessment and vulnerability analysis, utilizing the RAMP mapping tool and flood data. Agricultural disaster hazard problem statements are listed in Table 4-59; problem statements for all other participating jurisdictions are accessed in Volume 2 of this plan.

Identifying these common issues and weaknesses assists the Planning Committee in understanding the realm of resources needed for mitigation. The goal is to have at least one mitigation action for every problem statement. Projects or actions have been developed to mitigate each problem identified. See Table 5-6 for a full list of mitigation actions and corresponding problem statements that they address. Each problem statement is coded with a problem number for cross-referencing between Table 4-59 and Table 5-6.

Table 4-59 Soil Stability Hazard Problem Statements

Problem No.	Hazard	Area of Concern	Mitigation Alternatives	Primary Agency	Problem Description	Related MA
ps-SS-KC-221	Soil Stability	Impact	PRV - Prevention , PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	Increased groundwater pumping for private wells can contribute to land subsidence problems.	**ma-DR-KC-291**
ps-SS-KC-222	Soil Stability	Impact	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	Bridge at Rock Pile Rd. and Arvin Edison Canal is located in a high risk subsidence area and may need further investigation	**ma-SS-KC-300**
ps-SS-KC-223	Soil Stability	Impact	PPRO - Property Protection , SP - Structural Projects	**County of Kern**	There are 13 bridges in Unincorporated Kern County located in medium subsidence area which may require further investigation	**ma-SS-KC-300**
ps-SS-KC-224	Soil Stability	Impact	PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	Wind erosion could lead to soil accumulation on county roadways, creating hazardous driving conditions	**ma-SH-KC-298, ma-SS-KC-299**
ps-SS-KC-225	Soil Stability	Threat	PE&A - Public Education & Awareness , NRP - Natural Resource Protection	**County of Kern**	The presence of fallow agricultural fields and ag fields without cover crops contribute to wind erosion	**ma-SH-KC-298**
ps-SS-KC-226	Soil Stability	Threat	NRP - Natural Resource Protection	**County of Kern**	A lack of erosion control in areas around steep hillsides will increase the risk of landslide/mudflow/rockslide	**ma-AH-KC-158**
ps-SF-KC-249	Soil Stability	Impact	PPRO - Property Protection	**County of Kern**	The Lebec Landfill and Transfer Station site is located at the bottom of a canyon which is surrounded by high steep hills. Runoff from adjacent properties is eroding deep gullies into the hillsides.	**Ma-AH-KC-245**
ps-SS-KC-250	Soil Stability	Impact	PPRO - Property Protection	**County of Kern**	Bena Landfill could see future damage caused by precipitation. The following requires mitigation: high water velocity flows in earth ditches, steep grades and limited vegetation on surface slopes.	**Ma-AH-KC-39**
ps-SS-KC-251	Soil Stability	Impact	PPRO - Property Protection	**County of Kern**	Kern Valley Landfill and Transfer Station is at risk of erosion from high precipitation	**Ma-AH-KC-63**

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Section 5. Mitigation Strategy

The mitigation strategy is the guidebook to future hazard mitigation administration for the County and all other participating jurisdictions, capturing the key outcomes of the MJHMP planning process. The mitigation strategy is intended to reduce vulnerabilities outlined in the previous section with a prescription of policies and physical projects. These mitigation actions should be compatible with existing planning mechanisms and should outline specific roles and resources for implementation success. The Planning Committee conducted the hazard mitigation planning process through typical problem-solving, as did the Steering Committees for each participating jurisdiction. Those steps included:

- Estimate the impacts (*See* Vulnerability Assessment);
- Describe the problem (*See* Problem Statements);
- Assess what resources exist to lessen impacts and problem (*See* Capability Assessment,);
- Develop Goals and Objectives to address the problems (*See* Goals and Objectives); and
- Determine what can be done and develop actions that are appropriate for the community (*See* Mitigation Action Matrix).

5.1 Mitigation Alternatives

During Planning Committee Meeting #4 on November 14th, 2019 the MJHMP Planning Committee developed and reviewed mitigation actions with a wide range of alternatives, using FEMA's six broad categories of mitigation alternatives described below. The MJHMP Planning Committee considered many mitigation alternatives for implementation under each mitigation category, both county-wide and for individual participating jurisdictions.

PREVENTION (PRV):

Preventative activities keep hazard problems from getting worse and typically are administered through government programs or regulations addressing building and land development. Preventative actions are particularly effective in reducing a community's future vulnerability in areas where development has not occurred, or capital improvements have not yet been substantial. Examples of preventative activities include:

- Planning and zoning ordinances;
- Building codes;
- Open space preservation;
- Floodplain regulations;
- Stormwater management regulations;
- Drainage system maintenance;
- Capital improvements programming; and
- Riverine or fault zone setbacks.

PRV ALTERNATIVES:

- Establish ingress/ egress standards for future development.
- Enhance the County's GIS database and capabilities related to hazards information.
- Assist dam owners in updating their Emergency Action Plans.
- Maintain detention basins.
- Conduct detailed study and mapping of floodplains for Kern River and its tributaries, targeting problematic floodplains.
- Update and distribute wildfire risk mapping for Kern County.
- Restrict new development in dam inundation zones.
- Amend or revise water conservation regulations for landscape design for commercial and residential development with the goal of limiting outdoor watering.

PROPERTY PROTECTION (PPRO):

Property protection measures involve the modification of existing buildings and structures to help them better withstand the forces of a hazard, or removal of the structures from hazardous locations. Examples include:

- Building elevation;
- Critical facilities protection;
- Retrofitting (e.g., seismic design techniques, etc.);
- Safe rooms, shutters, shatter resistant glass; and
- Insurance.

PPRO ALTERNATIVES:

1. Continue to work with the County of Kern local Fire Safe Councils to conduct mitigation projects with homeowners. Provide homeowners easily accessible resources for mitigating the risk of wildfire around their homes.
2. Implement additional fuel reduction projects.
3. Remove existing structures from flood areas whenever and to the greatest extent possible; Relocate farm work centers from flood risk areas.
4. Encourage privately owned critical facilities (e.g. Churches, Hotels, other gathering facilities) to evaluate the ability of the buildings to withstand earthquakes and to address any deficiencies identified.
5. Identify and harden critical lifeline systems (i.e., critical public services such as utilities and roads) to meet "Seismic Design Guidelines and Standards for Lifelines" or equivalent standards such as American Lifelines Alliance (ALA) guidance.
6. Increase participation in NFIP.
7. Review construction plans for all bridges to determine their susceptibility to collapse and retrofitting problem bridges.
8. Use flexible piping when extending water, sewer, or natural gas service.

9. Strengthening and retrofitting non-reinforced masonry buildings and non-ductile concrete facilities that are particularly vulnerable to ground shaking
10. Install shutoff valves and emergency connector hoses where water mains cross fault lines.
11. Continue to incentivize drought-tolerant landscape design.

PUBLIC EDUCATION AND AWARENESS (PE&A):

Public education and awareness activities advise students, staff, parents, nearby residents, and elected officials about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Measures to educate and inform the public include:

- Outreach projects including neighborhood and community outreach;
- Speaker series / demonstration events;
- Hazard mapping;
- Real estate disclosures;
- Materials library;
- School children educational programs; and
- Hazard expositions.

PE&A ALTERNATIVES:

1. Continue to work with the County of Kern local Fire Safe Councils educating homeowners on reducing the risk of wildfire on their property, including understanding their wildfire risk, and free site visits.
2. Distribute public education materials relating to natural hazards as well as emergency notifications in both English and Spanish.
3. Partner with Water Association of Kern County, Eastern Kern County Resource Conservation District, Kern Valley Resource Conservation District, North West Kern Resource Conservation District, and/or Tehachapi Resource Conservation District, and the Kern Valley River Council in their public education and conservation campaigns (in English and Spanish).
4. Encourage businesses to build financial reserves as part of economic development.
5. Improve floodplain management, earthquake preparedness, wildfire mitigation and preparedness, and other information on participating jurisdiction's websites.
6. Distribute National Flood Insurance Program and floodplain development information in County libraries for access by the public
7. Focus a public education program around neighborhoods with egress/ingress issues and narrow roads.
8. Improve interactive hazard mapping resources available to public.
9. Develop a public information campaign on 72-hour kits.
10. Develop a "Natural Hazard Awareness Week" campaign and conduct corresponding outreach to the community and all interested parties.

11. Conduct outreach to builders, architects, engineers, and inspectors about building susceptibility to earthquakes and proper design and building requirements.
12. Educate on the importance of drought-tolerant landscaping, low flow indoor fixtures, and other water savings techniques to better withstand periods of drought.
13. Partner with local organizations such as the Kern River Watershed Coalition Authority and Water Association of Kern County to educate farmers on soil and water conservation practices.
14. Offer agricultural disaster training and networking opportunities for farmers and ag regulatory agencies.

NATURAL RESOURCE PROTECTION (NRP):

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, or conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection
- Watershed management;
- Vegetation management (e.g., fire resistant landscaping, fuel breaks, etc.);
- Erosion and sediment control;
- Wetland and habitat preservation and restoration;

NRP ALTERNATIVES:

1. Continue to implement the Kern County Flood Hazard Mitigation Plan.
2. Protect and restore wetlands, riparian areas, and natural buffers to sea level rise, in particular continuing to implement restoration of Kern County rivers.
3. Continue to implement the County of Kern Storm Water Management Plan.
4. Complete vegetation management projects as prescribed in Community Wildfire Protection Plans.
5. Encourage and incentivize drought-tolerant landscape design.
6. Establish a priority list of slope failure locations and implement slope stabilization projects in the highest risk areas.

EMERGENCY SERVICES (ES):

Although not typically considered a "mitigation" technique, emergency service measures do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems;
- Construction of evacuation routes;
- Sandbag staging for flood protection; and

- Installing temporary shutters on buildings for wind protection.

ES ALTERNATIVES:

1. Construct/Install back up power generators for fire stations, pump houses, emergency shelters and cooling centers.
2. Utilize website "Smart911," for vulnerable populations to register information such as where the individual in question lives, medications, restrictions, etc. Also, map registrants or tie information to Nixle alert system
3. Focus capital improvements on evacuation or emergency access routes needing attention.
4. Increase the capacity of existing hospitals through retrofits or upgrades such as isolation wings.
5. Construct or improve egress for wildfire emergencies in wilderness-urban interface (WUI) areas.

STRUCTURAL PROJECTS (SP):

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event through construction. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Stormwater diversions / detention / retention infrastructure;
- Utility Upgrades
- Seismic Retrofits

SP ALTERNATIVES:

1. Continue Kern River restoration projects.
2. Improve water supply and delivery systems to be more resilient during times of drought.
3. Construct and develop alternative water supplies to augment single sources of water delivery.
4. Construct rainwater catchment systems to recharge groundwater in government ROWs.
5. Install water monitoring devices and drought-tolerant landscaping on government-owned facilities.
6. Improve stormwater drainage capacity; construct / improve stormwater basins County-wide to accomplish 100-YR protection.
7. Conduct regular maintenance for drainage systems and flood control structures.
8. Construct, install and maintain warning gauges on local dams as the opportunity or need arises.
9. Create an inventory and establish a priority list for culvert replacement that takes into account fish passage, flood depth reduction and future losses avoided.
10. Retrofit critical care facilities with enhanced HVAC and isolation areas.

5.2 Identifying the Problem

As part of the mitigation action identification process, the MJHMP Planning Committee identified the areas of concern and potential impacts of each of the identified hazards on the community. Developing these "problem statements" for areas of concern, which describe the nature of the consequences or effects of a hazard occurrence on the community and its assets, ensures the identified mitigation actions are tailored to the specific problems created by various hazard scenarios and are specific to each participating jurisdiction. Each jurisdiction's problem statements are available as part of the Mitigation Action Support Tool (MAST), which is summarized in Section 3, Step STEP 3: Develop a Mitigation Strategy, available on mitigatehazards.com, and summarized in individual participating jurisdictions in Volume 2 of this plan.

See Section 5.5 for related Countywide mitigation actions, or related mitigation actions for each participating jurisdiction in Volume 2 of this plan.

5.3 Capabilities Assessment

This section examines the County's planning and regulatory, administrative, technical, financial, educational, and outreach capabilities to augment known issues and weaknesses from identified natural hazards. Volume 2 of this HMP includes a capabilities assessment for each participating jurisdiction as part of their annexes.

The tables in this section explore various local planning mechanisms, administrative capacity, financial capabilities, and education and outreach initiatives. The columns in each table represent deeper dives into the following questions:

- Is the existing planning or regulatory mechanism used currently? (*Column 1, Status*)
- Has the HMP been integrated into the planning mechanism currently so that the named mechanism is currently used in HMP planning? (*Column 2, Current Mitigation Use*)
- Is there a future opportunity to expand, improve upon, and incorporate this 2020 HMP Update into the planning or regulatory mechanism? (*Column 3, Future Opportunity*)

The capabilities and evaluation is easily-digestible and based on color coding to indicate which policies and plans are adequate, need improvement or in which the HMP could be integrated. Each table includes a legend that explain how each one of these questions are being answered according to the color indicated: green, yellow, and orange.

5.3.1 Planning and Regulatory Mitigation Capabilities

The information in Table 5-1 is used to align mitigation actions with existing planning and regulatory capabilities of the County. Planning and regulatory tools typically used by local jurisdictions to implement hazard mitigation activities are building codes, zoning regulations, floodplain management policies, and other municipal planning documents.

Table 5-1: Kern County Planning and Regulatory Mitigation Capabilities

CAPABILITY ASSESSMENT LEGEND

Status	Current Mitigation Use	Future Opportunity
Currently in use or present.	Used widely for mitigation.	Opportunity to expand and integrate.
(Sort of) Seldomly used or limited presence.	Limited use in mitigation planning.	Limited opportunity to expand and integrate.
(No) Not present or available.	Not used in mitigation planning.	No opportunity to expand or integrate.

Resource	HMP Integration: Status	HMP Integration: Current Mitigation Use	HMP Integration: Future Opportunity	Notes / Additional Detail
Planning and Regulatory Capabilities				
Construction and Future Development Regulations				
Building Codes				
BCEGS Rating				
Public Protection (ISO Class)				
Hazard Related Development Standards				
Zoning Ordinance				Title 17, Buildings and Construction.
Hazard-Specific Ordinance				
Growth Management Ordinance				
Hazard Reduction Programs (Annually Conducted)				
Capital Improvements Program (CIP) or Plan				
Erosion/Sediment Control Program				
Hazard-Related Public Outreach Program				See Education and Outreach Resource Capabilities.
Stormwater Management Program (Annual Inspections)				
Seismic Safety Program (Non-structural)				
Earthquake Modernization Plan (Building Safety)				

Resource	HMP Integration: Status	HMP Integration: Current Mitigation Use	HMP Integration: Future Opportunity	Notes / Additional Detail
Planning and Regulatory Capabilities				
Hazard Plans				
General Plan Safety Element				
Community Wildfire Protection Plan (CWPP)				Countywide CWPP expected 2021.
Floodplain Management Plan				
Stormwater Management Plan				
Emergency Operations Plan				
Climate Action Plan				
Ground Water Management Planning / Plans				Groundwater authorities with plans in Kern include the Kern Groundwater Authority for valley region and Mojave Water Agency
National Flood Protection Program (NFIP)				
Floodplain Management Regulations				
Flood Insurance Education and Technical Assist.				
Flood Hazard Mapping / Re-Mapping				
Community Rating System (CRS)				CRS Class 7

5.3.2 Financial Capabilities

Table 5-2 identifies the financial tools or resources that the County has used to fund mitigation activities.

Table 5-2: Kern County Fiscal Capabilities Summary

CAPABILITY ASSESSMENT LEGEND

Status	Current Mitigation Use	Future Opportunity
Currently in use or present.	Used widely for mitigation.	Opportunity to expand and integrate.
(Sort of) Seldomly used or limited presence.	Limited use in mitigation planning.	Limited opportunity to expand and integrate.
(No) Not present or available.	Not used in mitigation planning.	No opportunity to expand or integrate.

Resource	HMP Integration: Status	HMP Integration: Current Mitigation Use	HMP Integration: Future Opportunity	Notes / Additional Detail
Fiscal Capabilities				
Financial Resources for Hazard Mitigation				
Levy for Specific Purposes with Voter Approval				
Utilities Fees				
Benefit assessments				
System Development Fee				
General Obligation Bonds to Incur Debt				
Special Tax Bonds to Incur Debt				
Withheld Spending in Hazard-Prone Areas				
Stormwater Service Fees				
Capital Improvement Project Funding				

5.3.3 Education and Outreach

Table 5-3 lists the local citizen groups that communicate hazard risks.

Table 5-3: Kern County Education/ Outreach Capabilities Summary

CAPABILITY ASSESSMENT LEGEND

Status	Current Mitigation Use	Future Opportunity
Currently in use or present.	Used widely for mitigation.	Opportunity to expand and integrate.
(Sort of) Seldomly used or limited presence.	Limited use in mitigation planning.	Limited opportunity to expand and integrate.
(No) Not present or available.	Not used in mitigation planning.	No opportunity to expand or integrate.

Resource	HMP Integration: Status	HMP Integration: Current Mitigation Use	HMP Integration: Future Opportunity	Notes / Additional Detail
Education / Outreach Capabilities				
Education/Outreach Resources				
Website Dedicated to Hazard Topics				https://www.kerncountyfire.org/en/emergency-preparedness-info/emergency-preparedness-links.html
Dedicated Social Media				
Hazard Info. Avail. at Library/ Planning Desk				
Annual Public Safety Events				Law enforcement "National Night Out", Emergency Preparedness Fair, and September National Preparedness Month
Ability to Field Public Tech. Assistance Requests				
Public Safety Newsletters or Printed Outreach				
Fire Safe Councils				The umbrella organization is the Kern Fire Safe Council.
Resource Conservation Districts				
Other	N/A	N/A	N/A	

5.3.4 Administrative and Technical Capabilities

Table 5-4 shows the administrative and technical capabilities of Kern County.

Table 5-4: Kern County Administrative and Technical Capabilities

CAPABILITY ASSESSMENT LEGEND

Status	Current Mitigation Use	Future Opportunity
Currently in use or present.	Used widely for mitigation.	Opportunity to expand and integrate.
(Sort of) Seldomly used or limited presence.	Limited use in mitigation planning.	Limited opportunity to expand and integrate.
(No) Not present or available.	Not used in mitigation planning.	No opportunity to expand or integrate.

	HMP Integration			
Resource	Status	Current Mitigation Use	Future Opportunity	**Notes / Additional Detail**
Administrative and Technical				
Community Planning and Development Services				
Community Planner				
Civil Engineer				
Building Code Official (Full time or Augmented)				
Floodplain Administrator				
Fire Marshal				
Dedicated Public Outreach Personnel				
GIS Specialist and Capability				
Emergency Manager				
Full-Time Building Official				
Grant Manager, Writer, or Specialist				
Other	N/A	N/A	N/A	
Warning Systems/Services				
General				
Flood				
Wildfire				
Geological Hazards				

5.3.4.1 Expanding and Improving Existing Policies and Programs

The capabilities assessment presents an opportunity for the County to examine what capabilities it does not currently have and where it makes the most sense to expand and improve upon those capabilities in the future. This assessment effort shaped mitigation actions for all hazards and for specific hazards that focus on expanding and improving existing policies and programs. See mitigation actions in Table 5-6 that relate to policy and program improvements identified by the County.

5.3.5 Federal and State Funding Opportunities

Table 5-5 is a list of available funding sources from state and federal agencies. This includes the FEMA Hazard Mitigation Assistance grant program, which is described in more detail in Section 6.3.5. This list serves as a resource and is not exclusive.

Table 5-5: Federal and State Funding Opportunities

Agency / Grant Name	Potential Programs/Grants
FEMA Hazard Mitigation Assistance Grants	See Section 6 for FEMA/ HMA grant details. For more information on current grants visit https://www.fema.gov/hazard-mitigation-assistance ▪ Hazard Mitigation Grant Program (HMGP): https://www.fema.gov/hazard-mitigation-grant-program ▪ Building Resilient Infrastructure and Communities (BRIC): https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities ▪ Flood Mitigation Assistance Grant Program (FMA): https://www.fema.gov/flood-mitigation-assistance-grant-program
FEMA other grant programs	Including: ▪ Assistance to Firefighters Grant Program. Assistance to Firefighters Grants, Fire Prevention & Safety, and Staffing for Adequate Fire and Emergency Response. https://www.fema.gov/welcome-assistance-firefighters-grant-program ▪ Emergency Management Performance Grants (EMPG). Good for Equipment, Back Up Generators, Etc. https://www.fema.gov/emergency-management-performance-grant-program ▪ Regional Catastrophic Preparedness Grant Program (RCPGP). Housing and Logistics and Supply Chain Management, encouraging innovative regional solutions to issues related to catastrophic incidents, and building on existing regional efforts. https://www.fema.gov/regional-catastrophic-preparedness-grant-program
U.S. Dept. of Energy / Energy Efficiency and Conservation Block Grant Program	***Provides funding for weatherization of structures and development of building codes/ordinances to ensure energy efficiency and restoration of older homes.*** https://www.energy.gov/eere/wipo/energy-efficiency-and-conservation-block-grant-program

Agency / Grant Name	Potential Programs/Grants
State and County Community Development Dept. Block Grants (CDBG)	Through Cal. Dept. of Housing and Community Development Dept. (HCD) Programs Include: ▪ Community Development (CD) ▪ Economic Development (ED) ▪ Disaster Recovery Initiative (DRI) ▪ Neighborhood Stabilization Program (NSP) https://www.hcd.ca.gov/grants-funding/active-funding/cdbg.shtml
Cal OES **Proposition 1B Grants Programs**	The Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006, approved by the voters as Proposition 1B at the November 7, 2006 general election, authorizes the issuance of nineteen billion nine hundred twenty five million dollars ($19,925,000,000) in general obligation bonds for specified purposes, including grants for transit system safety, security, and disaster response projects. http://www.caloes.ca.gov/cal-oes-divisions/grants-management/homeland-security-prop-1b-grant-programs/proposition-1b-grant
California Proposition 1: the Water Bond (AB 1471)	Authorize $7.545 billion in general obligation bonds for state water supply infrastructure projects, such as public water system improvements, surface and groundwater storage, drinking water protection, water recycling and advanced water treatment technology, water supply management and conveyance, wastewater treatment, drought relief, emergency water supplies, and ecosystem and watershed protection and restoration. The State Water Resources Control Board (State Water Board) will administer Proposition 1 funds for five programs. The estimated implementation schedule for each is outlined in Five Categories: ▪ Small Community Wastewater ▪ Water Recycling ▪ Drinking Water ▪ Stormwater ▪ Groundwater Sustainability http://www.waterboards.ca.gov/water_issues/programs/grants_loans/proposition1.shtml
Assistance to Firefighters Grant Program (AFG); Fire Prevention and Safety (FP&S)	The primary goal of the FP&S Grants is to enhance the safety of the public and firefighters with respect to fire and fire-related hazards. The Grant Programs Directorate administers the FP&S Grants as part of the AFG Program. FP&S Grants are offered to support projects in two activity areas: 1). Fire Prevention and Safety (FP&S) Activity Activities designed to reach high-risk target groups and mitigate the incidence of death and injuries caused by fire and fire-related hazards. 2). Research and Development (R&D) Activity To learn more about how to prepare to apply for a project under this activity, please see the FP&S Research and Development Grant Application Get Ready Guide.

Agency / Grant Name	Potential Programs/Grants
	https://www.fema.gov/fire-prevention-safety-grants
California Housing and Community Development (HCD) Emergency Solutions Grant (ESG) Program	***To fund projects that serve homeless individuals and families with supportive services, emergency shelter/transitional housing, assisting persons at risk of becoming homeless with homelessness prevention assistance, and providing permanent housing to the homeless population. The Homeless Emergency Assistance and Rapid Transition to Housing (HEARTH) Act of 2009 places new emphasis on assisting people to quickly regain stability in permanent housing after experiencing a housing crisis and/or homelessness.*** http://www.hcd.ca.gov/fa/esg/index.html
CalTrans Division of Local Assistance / Safe Routes to School Program	California Dept. of Transportation. Federal funding administered via Caltrans. Local 10% match is the minimum requirement. http://www.dot.ca.gov/hq/LocalPrograms/saferoutes/saferoutes.htm Active transportation grant program. Creating mobility and connectivity. Prioritize projects, and preparation of PED for active transportation projects.
Property Assessed Clean Energy (PACE) Programs	PACE financing allows property owners to fund energy efficiency, water efficiency and renewable energy projects with little or no up-front costs. With PACE, residential and commercial property owners living within a participating district can finance up to 100% of their project and pay it back over time as a voluntary property tax assessment through their existing property tax bill.
HazMat Emergency Preparedness Grant	The purpose of this grant program is to increase effectiveness in safely and efficiently handling hazardous materials accidents and incidents; enhance implementation of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA); and encourage a comprehensive approach to emergency training and planning by incorporating the unique challenges of responses to transportation situations. http://www.caloes.ca.gov/cal-oes-divisions/fire-rescue/hazardous-materials/hazmat-emergency-preparedness-grant
CERT Program Manager Course	The purpose of this Community Emergency Response Team (CERT) Program Manager course is to prepare CERT Program Managers for the tasks required to establish and sustain an active local CERT program. http://www.californiavolunteers.org/index.php/CERT/PM/
California Residential Mitigation Program	The California Residential Mitigation Program (CRMP) was established to carry out mitigation programs to assist California homeowners who wish to seismically retrofit their houses. http://www.californiaresidentialmitigationprogram.com/

Agency / Grant Name	Potential Programs/Grants
Earthquake Brace + Bolt (EBB)	EBB, part of the California Residential Mitigation Program, was developed to help homeowners lessen the potential for damage to their houses during an earthquake by offering eligible homeowners up to a $3,000 incentive to seismically retrofit their homes. https://www.earthquakebracebolt.com/
California Air Resources Board Air Pollution Incentives, Grants and Credit Programs	These programs have hundreds of millions of dollars in grants available over the next several years to reduce emissions from on- and off-road vehicles and equipment. https://www.arb.ca.gov/ba/fininfo.htm
California Department of Water Resources Grants and Loans	https://water.ca.gov/Work-With-Us/Grants-And-Loans Agency offers a variety of grants and loans related to integrated regional water management, flood mitigation, water conservation and efficiency, environmental restoration, groundwater, water quality, and water supply.
US Bureau of Reclamation WaterSMART Grants	Annual funding available for: ▪ Water Reclamation and Reuse funding ▪ Drought Resiliency Project funding ▪ Water and Energy Efficiency Grant funding https://www.usbr.gov/watersmart/

5.4 Mitigation Goals

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 C.F.R. § 201.6(c)(3)(i)). The Steering Committee established a set of goals for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy.

Goals discussed in this section describe what actions should occur. Specific, measurable mitigation actions explain how to accomplish the goals. The goals and actions form the basis for the development of the Mitigation Action Strategy and specific mitigation projects. The process consists of 1) setting goals, 2) considering mitigation alternatives, 3) identifying strategies or "actions", and 4) developing a prioritized action plan resulting in a mitigation strategy.

The goals, objectives, and mitigation actions in this plan all support each other. Objectives were selected that met multiple goals. Actions were prioritized based on their ability to achieve multiple objectives. A mitigation strategy is considered effective based on how well the goals of the strategy are achieved. The following are the goals for this plan:

Goal 1: Enable residents to mitigate the impacts of hazards and disasters.

Goal 2: Reduce hazard impacts to existing and future development and the natural environment.

Goal 3: Reduce hazard impacts to existing and future critical facilities, infrastructure, and high potential loss facilities.

Goal 4: Improve multi-jurisdiction coordination to reduce risk through mitigation planning and hazard analysis on a continual basis.

5.5 County Wide Mitigation Actions

Mitigation actions were developed based upon planning committee priorities, risk assessment results, and mitigation alternatives. Most importantly, the newly-developed mitigation actions acknowledge updated risk assessment information outlined in the Executive Summary under Risk Assessment.

Mitigation actions are available on MAST linked through mitigatehazards.com; the format allows for regular updating and easy sorting by jurisdiction and hazard. Figure 5-1 illustrates the mitigation actions entered through MAST.

Table 5-6 establishes mitigation actions for the County and Participating Jurisdictions. Each participating jurisdiction developed mitigation actions specifically tailored to their vulnerabilities and capabilities. Those mitigation actions are available as part of the planning process library, which is summarized for Kern County in Table 3-5, available on the Mitigation Action Application, and available for each individual participating jurisdiction in Volume 2 of this plan.

Some mitigation actions support ongoing activities of participating jurisdictions, while other actions are intended to be completed when funding is available. All mitigation actions will be reviewed annually.

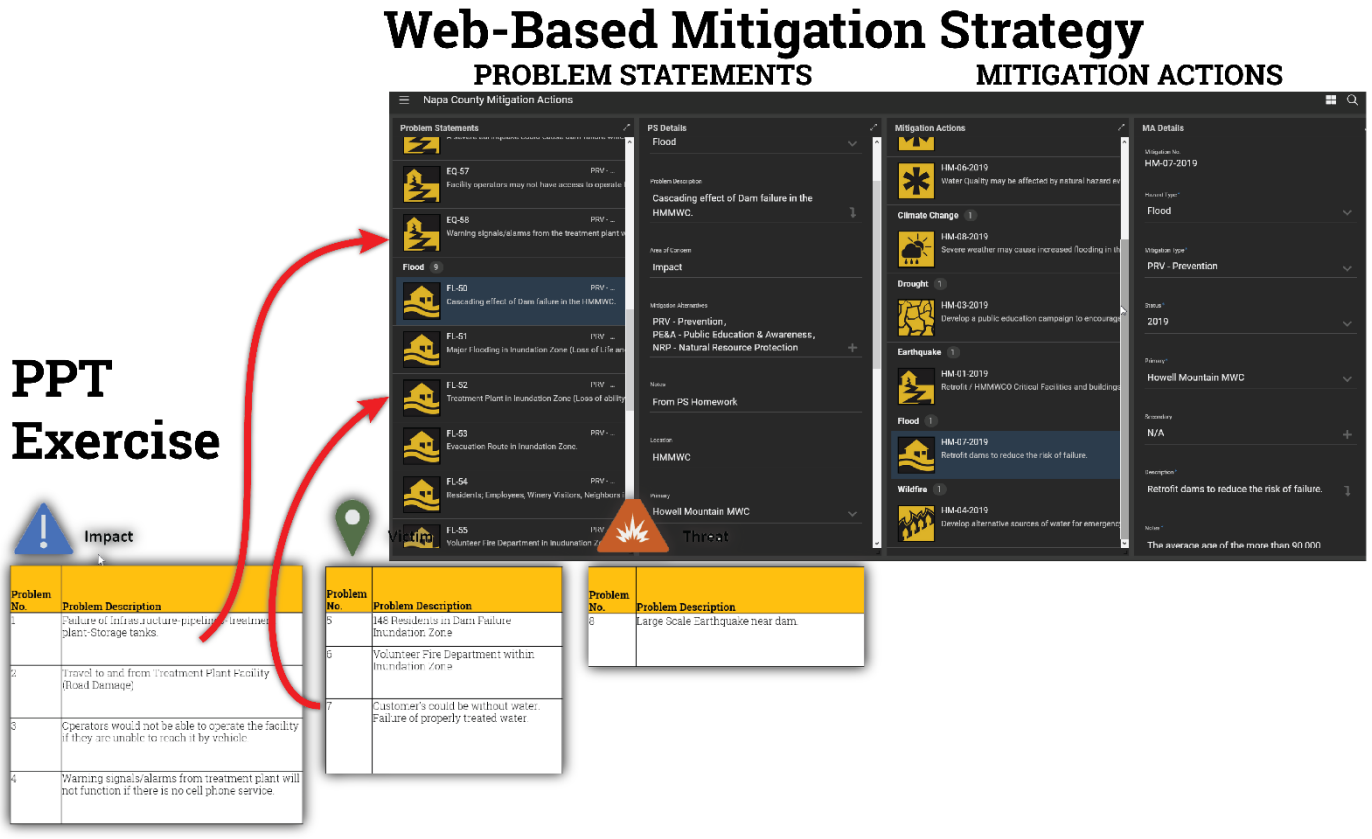

Figure 5-1: Mitigation Action Application

5.5.1 Prioritization of Mitigation Actions

Implementing the identified mitigation can be overwhelming for any local jurisdiction or district, especially with limited staffing and fiscal resources; prioritizing the identified mitigation actions can help greatly with this. To ensure this MJHMP realistically reflects available resources, mitigation actions are prioritized by considering benefit cost review, public input, and MJHMP Planning Committee agreement.

5.5.1.1 Cost/ Benefit Review

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 C.F.R. §201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. This review does not meet FEMA Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC) grant program requirements. A less formal, less costly approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects. Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low**—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High**—Project will provide an immediate reduction of risk exposure for life and property.
- **Medium**—Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.
- **Low**—Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly. For many of the strategies identified in this action plan, the partners may seek financial assistance under the HMGP or BRIC programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, the partners reserve the right to define "benefits" according to parameters that meet the goals and objectives of this HMP.

5.5.1.2 Public Input

An 8-question community survey was distributed to the public, yielding 1,156 survey responses and useful insight into the community's perception of natural hazards affecting Kern County. Specific question responses heavily influenced the prioritization of mitigation actions, including:

- 77.9% of participants believe their property is at risk from a natural hazard disaster.
- 66.8% of respondents have experienced earthquakes, 24.9% experienced wildfire, and 38.4% experienced drought. Only 12.9% of respondents (or someone in their household) had not experienced a natural hazard.
- 60.2% of participants considered the risk of naturally occurring hazards when choosing their home.
- 59.6% of respondents felt they were well-informed about the dangers of natural hazards, while 31.1% felt somewhat informed and 9.4% felt not informed.
- When asked what incentives would encourage additional home protection from possible natural hazards, the top responses were insurance premium discounts (67.4%), rebate programs or reimbursement of upfront costs (66.8%), and home improvement cost-share grants (40%).
- Respondents indicated top mitigation projects that local government agencies should focus on:
    - Retrofit and strengthen essential facilities (59.7%)
    - Replace inadequate or vulnerable bridges and roadways (55.8%)
    - Retrofit or upgrade drainage systems (45.9%)
    - Work on improving damage resistance of utilities (68.2%)
    - Ensure emergency shelters, the Emergency Operations Center, and communication towers have backup power generators (57.5%)

The complete survey results can be found in Appendix B.

5.5.2 Mitigation Action Plan

Table 5-6 lists each mitigation action for the unincorporated County. Each participating jurisdiction developed unique mitigation actions as well, targeted at their own unique priorities and vulnerabilities; these are available on MAST and in Vol. 2 of this MJHMP. Each mitigation action identifies the responsible party, time frame, potential funding source, implementation steps and resources needed to implement these priority mitigation actions. As a living document, hazard problem statements and mitigation activities will be updated through MAST.

The detail provided in MAST and captured in Table 5-6 meets the regulatory requirements of FEMA and DMA 2000.

The actions detailed in Table 5-6 and MAST contain both new action items developed for this plan Update as well as old actions that were yet to be completed from the 2012 Plan. The action numbers indicate whether the action is new or from the 2012 plan. A sample of the action number nomenclature is presented in Figure 5-2.

Section 2, What's New, illustrates progress towards new and previous mitigation action and indicates how many actions have been completed, deleted, or are ongoing or pending.

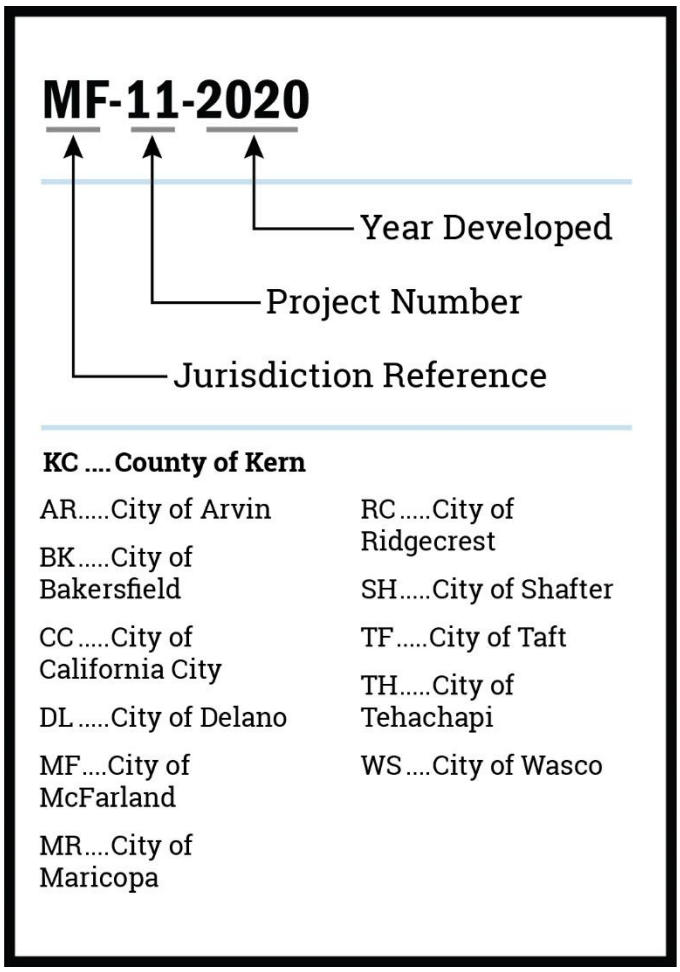

Figure 5-2: Mitigation Action Number Key

Important to note: The Planning Committee realizes that new needs and priorities may arise as a result of a disaster or other circumstances and reserves the right to support new actions and edit existing actions as necessary as long as they conform to the overall goals of the plan

Table 5-6: County Wide Mitigation Action Tracker

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-AH-KC-201	All Hazard	PE&A - Public Education & Awareness	Ongoing	2005	County of Kern	Hazard Public Education	Kern County Office of Emergency Services	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Low - Long-term benefits of the project are difficult to quantify in the short term.	Ongoing	5%	EMPG	Low	ps-WF-KC-240
ma-AH-KC-104	All Hazard	ES - Emergency Services	Pending	2005	County of Kern	Remote Automated Weather Station System	Kern FD	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Project	HMGP / BRIC	Medium	ps-WF-KC-238, ps-WF-KC-239
ma-DF-KC-384	Dam Failure	ES - Emergency Services	Pending	2020	County of Kern	Design and implement County-wide warning system program, with all other HMP participating jurisdictions as secondary participants, to warn everyone within a dam inundation zone of impending dam failure	Kern County	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	FMA	Medium	ps-DF-KC-252, ps-DF-KC-253, ps-DF-KC-254
ma-DR-KC-290	Drought	PE&A - Public Education & Awareness	Ongoing	2020	County of Kern	Develop a public education campaign to encourage water conservation during drought.	Public Works, Planning, Building	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	5%	HMGP / BRIC	Medium	ps-DR-KC-215
ma-DR-KC-291	Drought	NRP - Natural Resource Protection	Pending	2020	County of Kern	Install remote monitoring devices on well flow meters on County owned wells	Public Health Services	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	HMGP / BRIC	High	ps-SS-KC-221, ps-DR-KC-216, ps-DR-KC-217
ma-DR-KC-293	Drought	NRP - Natural Resource Protection	Pending	2020	County of Kern	Amend land use codes to incorporate regulations that encourage and incentive water savings for development	Planning and Natural Resources	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	1-3 Years	Planning	HMGP / BRIC	Medium	ps-DR-KC-219, ps-DR-KC-220
ma-DR-KC-294	Drought	NRP - Natural Resource Protection	Pending	2020	County of Kern	Replace existing turf grass and water intensive landscaping with drought resistant landscaping	General Services	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Planning	HMGP / BRIC	Medium	ps-DR-KC-218

FEMA Approval 4/9/2021

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-DR-KC-384	Drought	NRP - Natural Resource Protection	Pending	2020	County of Kern	Expand Willow Springs Water Bank to reduce drought and increase water supply flexibility and sustainability	Executive Office	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	HMGP / BRIC	High	ps-DR-KC-216, ps-DR-KC-217
ma-EQ-KC-297	Earthquake	PE&A - Public Education & Awareness	Ongoing	2020	County of Kern	Encourage privately owned critical facilities (e.g. churches, hotels, other gathering facilities) to evaluate the ability of the buildings to withstand earthquakes and to address any deficiencies identified.	Kern County	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	5%	HMGP / BRIC	High	ps-EQ-KC-243
ma-AH-KC-111	Earthquake	PPRO - Property Protection	Pending	2005	County of Kern	Mobile Home Foundation Earthquake Retrofitting	Kern County Office of Emergency Services	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	Funding Dependent	Project	HMGP / BRIC	Medium	ps-EQ-KC-242
ma-EQ-KC-102	Earthquake	PPRO - Property Protection	Pending	2005	County of Kern	Formation of Kern County Unreinforced Masonry Task Force	Since 10 communities will be potentially involved, the topic of who facilitates and coordinates the work will have to be decided. Initially options include a committee representing all of the candidate jurisdictions, County OES, or the Kern County Council of Governments.	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	Ongoing	Planning	HMGP / BRIC , CDBG DRI	High	ps-EQ-KC-242

FEMA Approval 4/9/2021

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-EQ-KC-305	Earthquake	PPRO - Property Protection	Pending	2020	County of Kern	Participate in seismic studies and needed seismic retrofits on County bridges that are located in high risk areas for earthquake scenarios included in this HMP	Public Works	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	5-10 Years	Project	HMGP / BRIC	High	ps-EQ-KC-246, ps-AH-ENCSD-10
ma-EQ-KC-306	Earthquake	PPRO - Property Protection	Pending	2020	County of Kern	Evaluate soil liquefaction potential around County assets in areas with shallow groundwater	Public Works	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	HMGP / BRIC	Medium	ps-EQ-KC-247
ma-EQ-KC-307	Earthquake	PPRO - Property Protection	Pending	2020	County of Kern	Install seismic gas shut-off valves on County buildings to prevent the flow of gas into buildings during a seismic event	General Services	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	1-3 Years	Project	HMGP / BRIC	High	ps-EQ-KC-243, ps-EQ-KC-244, ps-EQ-KC-245
ma-EQ-KC-295	Earthquake	SP - Structural Projects	Pending	2020	County of Kern	Retrofit / Harden County-owned critical facilities and buildings and their ability to withstand earthquakes.	General Services	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	5-10 Years	Project	HMGP / BRIC	High	ps-EQ-KC-242, ps-EQ-KC-243, ps-EQ-KC-244, ps-EQ-KC-245
ma-EQ-KC-296	Earthquake	SP - Structural Projects	Pending	2020	County of Kern	Retrofit non-compliant suspended ceilings in County buildings. This includes Non-Structural Suspended Gypsum Dry-Wall & Cement Plaster Ceilings built 1950-1974.	Public Works - Building	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	HMGP / BRIC	High	ps-EQ-KC-243, ps-EQ-KC-244, ps-EQ-KC-245, ps-EQ-KC-248
ma-EW-KC-301	Extreme Weather	PE&A - Public Education & Awareness	Ongoing	2020	County of Kern	Outreach and Education to developers before and during the development process about best management practices to mitigate the effects of the urban heat island effect and stormwater runoff resulting from increased impervious surface	Planning and Natural Resources	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	5%	HMGP / BRIC	Medium	ps-EW-KC-229

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-EW-KC-435	Extreme Weather	PE&A - Public Education & Awareness	Pending	2020	County of Kern	Develop outreach to educate the public, via County communication channels, on preparedness for driving in winter weather including preparing your vehicle, driving techniques, and what to do if caught in a winter weather event while driving.	Kern County	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	Ongoing	5%	HMGP / BRIC	Medium	ps-EW-KC-338
ma-FL-KC-202	Flood	NRP - Natural Resource Protection	Ongoing	2005	County of Kern	Implement Kern Lake CRMP Master Plan Mitigation Projects	Building and Development	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	Funding Dependent	Project	FMA	Low	ps-FL-KC-173, ps-FL-KC-174, ps-FL-KC-175, ps-FL-KC-176, ps-FL-KC-177
ma-FL-KC-283	Flood	PRV - Prevention	Ongoing	2020	County of Kern	Adopt higher regulatory standards (including but not limited to freeboard, comp storage, lower substantial damage thresholds, setback and fill restrictions) as means to reduce future flood risk and support a no-adverse-impact (NAI) philosophy to floodplain management	Public Works - Building and Development	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	1-3 Years	Planning	FMA	Medium	ps-FL-KC-214, ps-FL-KC-177, ps-FL-KC-180, ps-FL-KC-181
ma-FL-KC-284	Flood	PRV - Prevention	Ongoing	2020	County of Kern	Routinely inspect storm water channels for vegetation build up or encroachment, trash and debris, silt and gravel build up, and erosion or bank failure	Public Works - Building and Development	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	Ongoing	Project	HMGP / BRIC	High	ps-FL-KC-174, ps-FL-KC-179, ps-FL-KC-204
ma-FL-KC-285	Flood	SP - Structural Projects	Ongoing	2020	County of Kern	Elevate and retrofit bridges and culverts to allow proper stormwater / 100-YR flows	Public Works - Building and Development	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	5-10 Years	Project	FMA	Medium	ps-FL-KC-175, ps-FL-KC-204
ma-AH-KC-153	Flood	PPRO - Property Protection	Pending	2005	County of Kern	Caliente Creek Habitat Mitigation Project	Kern County Engineering and Survey Services	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	FMA	High	ps-FL-KC-209

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-AH-KC-158	Flood	PPRO - Property Protection	Pending	2005	County of Kern	Cuddy Creek Restoration Project	Kern County Engineering and Survey Services	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	1-3 Years	Project	FMA	High	ps-SS-KC-226
ma-FL-KC-110	Flood	PPRO - Property Protection	Pending	2005	County of Kern	Flood Mitigation Plan	Public Works - Building and Development	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	Funding Dependent	Planning	FMA	High	ps-FL-KC-173, ps-FL-KC-176, ps-FL-KC-177, ps-FL-KC-178, ps-FL-KC-179, ps-FL-KC-180, ps-FL-KC-181
ma-FL-KC-99	Flood	NRP - Natural Resource Protection	Pending	2014	County of Kern	Streambed Mitigation in Kern River South Fork at Sierra Hwy (north of SR 178)	Kern County Engineering & Surveying Services (Flood Plain Management) and Kern County Roads Department	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	FMA	Medium	ps-FL-KC-185
ma-FL-KC-70	Flood	PPRO - Property Protection	Pending	2014	County of Kern	Continue to Implement Sound Floodplain Management Practices through Participation in the National Flood Insurance Program	Engineering, Surveying and Permit Services Department	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Planning	HMGP / BRIC	Medium	ps-FL-KC-214, ps-FL-KC-173, ps-FL-KC-176, ps-FL-KC-177, ps-FL-KC-178, ps-FL-KC-179, ps-FL-KC-180, ps-FL-KC-181
ma-FL-KC-97	Flood	PPRO - Property Protection	Pending	2014	County of Kern	Lake Isabella Blvd Box Culvert at Erskine Creek (near Elizabeth Norris Rd)	Kern County Roads Department	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	5-10 Years	Project	HMGP / BRIC	Medium	ps-FL-KC-174, ps-FL-KC-175
ma-FL-KC-82	Flood	SP - Structural Projects	Pending	2014	County of Kern	Bridge on Famoso Road at Poso Creek (approx 1/3 mile east of State Hwy 99)	Kern County Roads Department	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	Funding Dependent	Project	FMA	Medium	ps-FL-KC-207

FEMA Approval 4/9/2021

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-FL-KC-98	Flood	SP - Structural Projects	Pending	2014	County of Kern	Construct a Box Culvert across Redrock Randsburg Road at Redrock Canyon Wash (just east of Hwy 14)	Public Works-Building and Development	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	5-10 Years	Project	FMA	High	ps-EW-KC-227
ma-FL-KC-302	Flood	PPRO - Property Protection	Pending	2020	County of Kern	Implement Kern Storm Water Resource Plan Mitigation Projects	Public Works	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Project	FMA	High	ps-FL-KC-173, ps-FL-KC-174, ps-FL-KC-176
ma-FL-KC-303	Flood	PPRO - Property Protection	Pending	2020	County of Kern	Kern County Flood Hazard Mitigation Plan - Projects	Public Works	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	5-10 Years	Project	FMA	High	ps-FL-KC-210, ps-FL-KC-211, ps-FL-KC-212, ps-FL-KC-213, ps-FL-KC-182, ps-FL-KC-183, ps-FL-KC-184
ma-FL-KC-304	Flood	PPRO - Property Protection	Pending	2020	County of Kern	County of Kern Caliente Creek - Conceptual Plan for Mitigation	Public Works	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	FMA	High	ps-FL-KC-208, ps-FL-KC-209
ma-SF-KC-292	Slope Failure	PPRO - Property Protection	Pending	2020	County of Kern	Establish a priority list of slope failure locations and implement slope stabilization projects in the highest risk areas.	Public Works	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	Low - Long-term benefits of the project are difficult to quantify in the short term.	5-10 Years	Project	HMGP / BRIC	Low	ps-SF-KC-230, ps-SF-KC-231
ma-AH-KC-245	Soil Stability	PPRO - Property Protection	Ongoing	2005	County of Kern	Lebec Landfill and Transfer Station Drainage Improvements and Erosion Control	Kern County Waste Management Department	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	1-3 Years	Project	HMGP / BRIC	High	ps-SF-KC-249

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-AH-KC-63	Soil Stability	PPRO - Property Protection	Pending	2014	County of Kern	Kern Valley Landfill and Transfer Station Drainage Improvements and Erosion Control	County of Kern Waste Management Department	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	1-3 Years	Project	HMGP / BRIC	High	ps-SS-KC-251
ma-SS-KC-299	Soil Stability	NRP - Natural Resource Protection	Pending	2020	County of Kern	Implement wind breaks to prevent wind erosion leading to buildup of soil on County roads and bridges. Wind break erosion mitigation examples include solid fences, porous fences, straw bales, soil surface modification, berms, and landscaping	Public Works	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	1-3 Years	Project	HMGP / BRIC	Medium	ps-SS-KC-224
ma-SS-KC-300	Soil Stability	NRP - Natural Resource Protection	Pending	2020	County of Kern	Conduct subsidence investigations on County bridges located in high subsidence areas	Public Works and Engineering	High - Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).	High - Project will provide an immediate reduction of risk exposure for life and property.	5-10 Years	Project	HMGP / BRIC	Medium	ps-SS-KC-222, ps-SS-KC-223
ma-SH-KC-298	Soil Stability	PE&A - Public Education & Awareness	Pending	2020	County of Kern	Outreach and educational programming to property owners and agricultural growers about wind erosion and mitigation techniques such as introducing cover crops, eliminating tillage, and avoiding over grazing	Agriculture & Administration	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	Ongoing	Project	HMGP / BRIC	Medium	ps-SS-KC-224, ps-SS-KC-225
ma-AH-KC-179	Wildfire	NRP - Natural Resource Protection	Ongoing	2005	County of Kern	Hazard Tree Removal, County Park Lands	Kern County FD, KC Parks	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	Ongoing	Project	HMGP / BRIC	High	ps-WF-KC-241, ps-EW-KC-228
ma-WF-KC-231	Wildfire	NRP - Natural Resource Protection	Ongoing	2005	County of Kern	Roadside Disc Breaks	KCFD	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	Annually	Project	HMGP / BRIC	High	ps-WF-KC-241

FEMA Approval 4/9/2021

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-WF-KC-183	Wildfire	PE&A - Public Education & Awareness	Ongoing	2005	County of Kern	Defensible Space, Public Education	Kern County FD	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	5%	HMGP / BRIC , FP&S	High	ps-WF-KC-232, ps-WF-KC-233, ps-WF-KC-234, ps-WF-KC-235, ps-WF-KC-236, ps-WF-KC-240
ma-WF-KC-184	Wildfire	PE&A - Public Education & Awareness	Ongoing	2005	County of Kern	Education, Fire Department Personnel	KCFD	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	Medium - Project will have a long-term impact on the reduction of risk exposure for life and property, or project will not provide an immediate reduction in the risk exposure for property.	Ongoing	5%	FP&S	Medium	ps-WF-KC-232, ps-WF-KC-233, ps-WF-KC-234, ps-WF-KC-235, ps-WF-KC-236, ps-WF-KC-240
ma-WF-KC-180	Wildfire	PPRO - Property Protection	Ongoing	2005	County of Kern	Greater Tehachapi Area Community Wildfire Protection Plan (was Hazardous Wildland Fuels Mitigation, Greater Tehachapi Area)	KCFD	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Project	HMGP / BRIC	High	ps-WF-KC-236
ma-WF-KC-181	Wildfire	PPRO - Property Protection	Ongoing	2005	County of Kern	Mount Pinos Community Wildfire Protection Plan (was Hazardous Wildland Fuels Mitigation, Frazier Mtn Area)	KCFD	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Project	HMGP / BRIC , FMA	High	ps-WF-KC-234
ma-WF-KC-182	Wildfire	PPRO - Property Protection	Ongoing	2005	County of Kern	Kern River Valley Community Wildfire Protection Plan (formerly Hazardous Wildland Fuels Mitigation, Kern River Valley)	KCFD	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Project	FP&S	High	ps-WF-KC-233
ma-WF-KC-286	Wildfire	PPRO - Property Protection	Ongoing	2020	County of Kern	Retrofit care facilities (adult care, child care, schools) with fire-resistant materials and or create defensible space around structures.	Kern County Fire	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	3-5 Years	Project	FP&S	High	ps-WF-KC-238, ps-WF-KC-239

Mitigation No.	Hazard Type	Mitigation Type	Status	Year	Primary Agency	Title/Description	Responsible Party	Estimated Cost	Estimated Benefit	Time Frame	HMA Activity Type	Potential Grant Source	Priority	Related Problem Statements
ma-WF-KC-287	Wildfire	PPRO - Property Protection	Ongoing	2020	County of Kern	The Alta Sierra CWPP details mitigation needed to protect 7 structure protection groups throughout the WUI in Alta Sierra Community.	Kern County Fire	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Project	FP&S	High	ps-WF-KC-232
ma-WF-KC-288	Wildfire	PPRO - Property Protection	Ongoing	2020	County of Kern	Myers Canyon CWPP Mitigation Projects	Kern County Fire	Medium - The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.	High - Project will provide an immediate reduction of risk exposure for life and property.	Ongoing	Project	FP&S	High	ps-WF-KC-235
ma-WF-KC-289	Wildfire	PPRO - Property Protection	Ongoing	2020	County of Kern	Make high visibility address markers available to all residents within the WUI	Kern County Fire	Low - The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.	High - Project will provide an immediate reduction of risk exposure for life and property.	1-3 Years	Project	FP&S	High	ps-WF-KC-237

Note: As a living document, project descriptions and actions in the tables above will be modified to reflect current conditions over time in MAST.

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Section 6. Plan Implementation and Maintenance

It is important that this plan becomes a usable, used tool for all participating jurisdictions to ensure reductions in possible damage from a natural hazard event. This section discusses adopting, implementing, monitoring, evaluating, and updating the MJHMP, which should help ensure that the MJHMP remains relevant. This section describes incorporation of the MJHMP into existing planning mechanisms, and how the jurisdictions will continue to engage the public.

6.1 Plan Adoption

To comply with DMA 2000, the Kern County Board of Supervisors has officially adopted the Kern County Multi-Jurisdiction Hazard Mitigation Plan. The adoption of the MJHMP recognizes the County's commitment to reducing the impacts of natural hazards within the County. A copy of the MJHMP adoption resolution is included immediately following the Executive Summary.

6.2 Plan Implementation

Over time, implementation strategies for mitigation actions will become more detailed. MAST will be extremely useful to plan for updates to this MJHMP and to update individual mitigation actions as implemented or revised. In conjunction with the progress report processes, implementation strategy worksheets will be extremely useful as a plan of record tool for updates. Each implementation strategy worksheet provides individual steps and resources need to complete each priority mitigation action. The following are considerations for developing future implementation strategies:

- **Use processes that already exist.** Take advantage of tools and procedures identified in the capability assessment in Section 5.3. Using planning mechanisms already in use and familiar to participating jurisdictions will give the planning implementation phase a strong initial boost.
- **Updated work plans, policies, or procedure.** Incorporating hazard mitigation concepts and activities can help integrate the HMP into daily operations. These changes can include how major development projects and subdivision reviews are addressed in hazard prone areas or ensure that hazard mitigation concerns are considered in the approval of major capital improvement projects.
- **Job descriptions.** Working with department or agency heads to revise job descriptions of government staff to include mitigation-related duties, including designating a "mitigation lead" within a department, can further institutionalize hazard mitigation with little financial expenditure or programmatic overhaul.

6.2.1 Steering Committee

The Steering Committee oversaw the development of the plan and made recommendations on key elements of the plan, including the maintenance strategy. The Steering Committee recommended that an

oversight committee, referred to herein as the MJHMP Steering Committee, should have an active role in the plan maintenance strategy. Therefore, it is recommended that the MJHMP Steering Committee become involved in key elements of the plan maintenance strategy. The new MJHMP Steering Committee should strive to include representation from the planning partners, as well as other stakeholders in the planning area.

The new MJHMP Steering Committee will review the annual progress report and provide input to Kern County on possible improvements or action steps to be considered at the next update. Keeping this new MJHMP Steering Committee intact will also jump start future updates. Completion of a progress report is the responsibility of each participating jurisdiction, not the responsibility of the steering committee. It will simply be the MJHMP Steering Committee's role to review the progress report in an effort to identify issues needing to be addressed by future plans.

6.3 Monitoring, Evaluating and Updating the MJHMP

This section describes the schedule and process for monitoring, evaluating, and updating the MJHMP.

6.3.1 Schedule

Monitoring the progress of the mitigation actions will be ongoing throughout the five-year period between the adoption of the MJHMP and the next update effort. The newly-formed MJHMP Steering Committee will meet biannually to monitor the implementation of mitigation actions and develop updates as necessary.

The MJHMP will be updated every five years, as required by DMA 2000. The update process will begin at least one year prior to the expiration of the MJHMP. However, should a significant disaster occur within the County, the MJHMP Steering Committee will reconvene within 30 days of the disaster to review and update the MJHMP as appropriate. The Board of Supervisors will adopt written updates to the MJHMP as a DMA 2000 requirement.

6.3.2 Mitigation Action Support Tool (MAST) Updates

Hazard problem statements and mitigation activities will be updated through a web interface application developed specifically for Kern County, available on project website, (http://mitigatehazards.com/county-of-kern/), to ensure this MJHMP stays a living document.

MAST is a web-based interactive tool that enables multiple users to search, view, enter, and update mitigation actions, ideas or projects, and other information. MAST provides participating jurisdiction staff and plan reviewers (Cal OES/FEMA) access to valuable mitigation information that can be leveraged by future planning or other risk reduction efforts. Users can update the status of their mitigation projects throughout the planning lifecycle and this web-based tool will improve participating jurisdiction's ability to apply for FEMA's Hazard Mitigation Assistance (HMA) grant programs including the initial grant application processes through Cal OES.

6.3.3 Process

The MJHMP Steering Committee will coordinate with responsible agencies/organizations identified for each mitigation action. These responsible agencies/organizations will monitor and evaluate the progress made on the implementation of mitigation actions and report to the MJHMP Steering Committee on an annual basis. These responsible departments will assess the effectiveness of the mitigation actions and modify them as appropriate. MAST will assist mitigation project managers in reporting on the status and assessing the effectiveness of the mitigation actions. Most updates to the HMP will occur easily through MAST. Figure 6-1 displays MAST viewing details for problem statements and mitigation actions.



Figure 6-1 Diagram of MAST viewing details

Information from the mitigation leads within responsible departments will be used to monitor mitigation actions and annual evaluation of the MJHMP. The following questions will be considered in evaluating MJHMP effectiveness:

- Has the nature or magnitude of hazards affecting the County and other jurisdictions changed?
- Are there new hazards that have the potential to impact the County and other jurisdictions?
- Do the identified goals and actions address current and expected conditions?
- Have mitigation actions been implemented or completed?
- Has the implementation of identified mitigation actions resulted in expected outcomes?
- Are current resources adequate to implement the MJHMP?
- Should additional local resources be committed to address identified hazards?

Future updates to the MJHMP will account for any new hazard vulnerabilities, special circumstances, or new information that becomes available. Issues that arise or updates made during monitoring and evaluating the MJHMP will be incorporated into the next update of the MJHMP in 2024. The questions identified above would remain valid during the preparation of the 2025 update.

6.3.4 Continuing Public Involvement

During the five-year update cycle, County staff will involve the public through public workshops and meetings. Information on upcoming public events related to the MJHMP or solicitation for comments will be announced via newspapers, mailings, and on the County MJHMP website (http://mitigatehazards.com/county-of-kern/). An electronic copy of the current MJHMP document will be accessible through the County website. Hard copies will be placed in each of the open Kern County branch libraries. The MJHMP Planning Committee will, as much as practicable, incorporate the following concepts into its public outreach strategy to ensure continued public involvement in the MJHMP planning process:

- Work with public service clubs, i.e., the Bakersfield Breakfast Lions.
- Collaborate with faith-based organizations, i.e., Kern River Valley Christian Church, Discovery Church, Unitarian Universalist Fellowship of Kern County, Temple Beth El, etc.
- Create story ideas for media outlets, such as newspapers, local radio, and TV
- Distribute emails and postcards/mailers to County/ City/ Town residents about hazard mitigation updates
- Post meeting announcements at City Halls, community centers, coffee houses, grocery stores, etc.
- Educate and collaborate with insurance companies.
- Participate in other existing local community meeting places, i.e., Haggin Oaks Farmers' Market, Valley Farmers' Market, Brimhall Farmers' Market, etc.
- Distribute information through K-12 schools
- Continue to use the County website as a distribution point of hazard mitigation information

6.3.5 HMA Monitoring

FEMA's Hazard Mitigation Assistance (HMA) Program is the catalyst that drives increased understanding and supports proactive community action to reduce losses from natural hazards. To support this vision, FEMA funds three grant programs under HMA. The three programs are the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance (FMA) Program, and Building Resilient Infrastructure and Communities (BRIC) Program.[8]

- **HMGP** assists in implementing long-term hazard mitigation planning and projects following a Presidential major disaster declaration
- **BRIC** provides funds for hazard mitigation planning and projects on an annual basis
- **FMA** provides funds for planning and projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis.

HMGP funding is generally 15% of the total amount of Federal assistance provided to a State, Territory, or federally-recognized tribe following a major disaster declaration. BRIC and FMA funding depends on the amount congress appropriates each year for those programs. The HMGP supports cost-effective post-disaster projects and is the longest running mitigation program among FEMA's three grant programs. A 2017 study by the National Institute of Building Sciences' (NIBS) Multihazard Mitigation Council have shown that every federal dollar spent on mitigation saves six dollars in response and recovery costs.

MAST will be extremely useful in applying for Cal OES funding. Plan maintenance will be primarily done through MAST. Figure 6-2 demonstrates how MAST information will translate into Cal OES NOIs and grant Sub application requests.

[8] In August of 2020, the BRIC program replaced Pre-Disaster Mitigation (PDM) grant program.

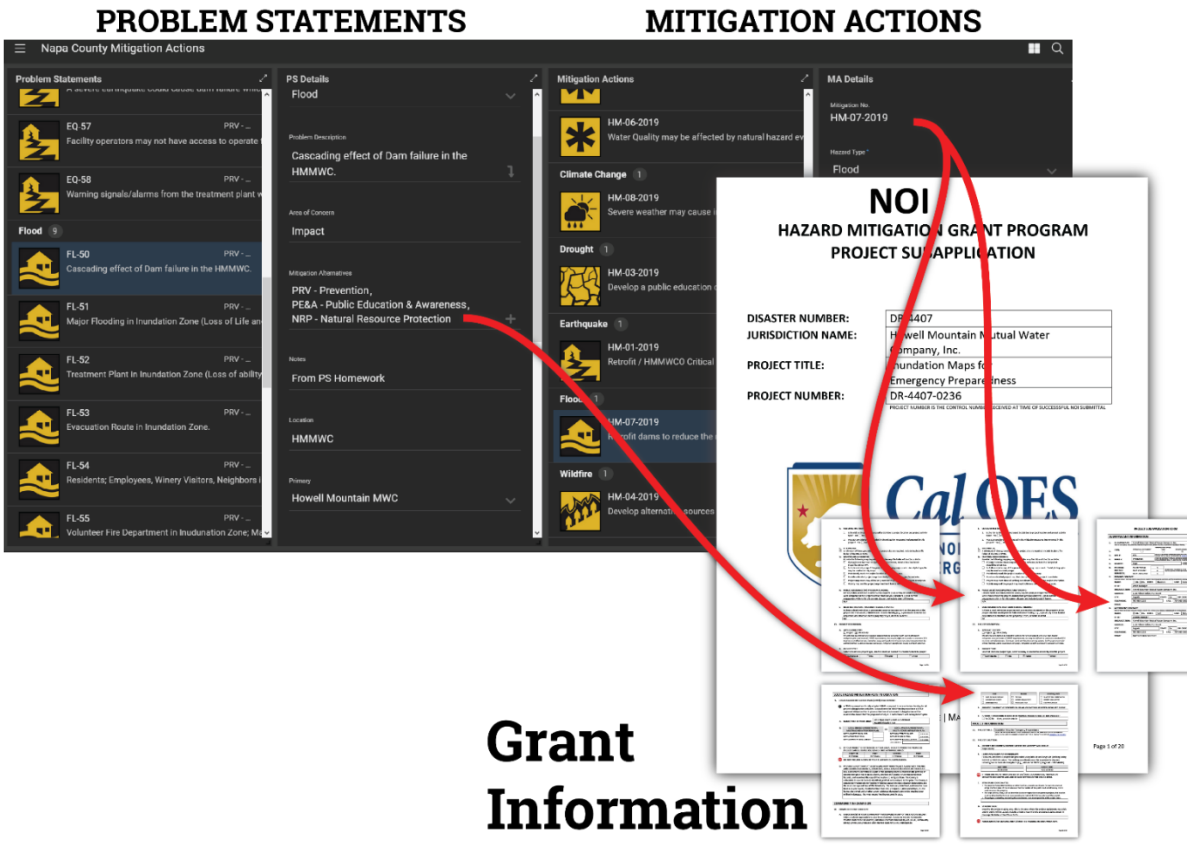

Figure 6-2: MAST and Cal OES Grant Applications

Following a disaster, California Office of Emergency Services (Cal OES) and local Kern County officials, in a joint effort with FEMA, will perform Preliminary Damage Assessments (PDA) of the areas that sustained damage. Cal OES submits, through the FEMA Regional Office, the information collected along with a damage estimate to request a declaration from the President. A Presidential Major Disaster Declaration provides for the availability of HMGP funds at the request of a state's Governor in eligible communities within a state, tribe, or territory. Figure 6-3 depicts this.

Figure 6-3 shows a timeline of how projects should be developed and administered by local government and FEMA under the HMGP program. HMGP grant recipients will have 36 months from the close of the application period to complete projects.



Figure 6-3: HMGP Timeline

For More information on HMGP project development process visit:
www.fema.gov/hazard-mitigation-grant-program-guide-state/local-governments

6.3.6 Incorporation into Other Planning Mechanisms

For the HMP to be successful, the recommendations and underlying principles of the MJHMP should be incorporated into community planning and development such as capital improvement budgeting, building and zoning codes, general plans and regional plans. Integration into a variety of departments at the County and participating jurisdiction level provides an opportunity to network, identify, and highlight mitigation activities and opportunities at all levels of government. It is also important to monitor funding opportunities which can be leveraged to implement the mitigation actions.

The Capabilities Assessment in Section 5.3 includes an evaluation of which planning processes might incorporate the HMP in the future. For example, the information from this MJHMP can be incorporated into:

- **Kern County and Municipal General Plans:** The MJHMP will provide information that can be incorporated into the Safety, Land Use, and Conservation Elements of General Plans for municipalities and the County as they are updated. Many jurisdictions will update the Safety Element of the General Plan to incorporate the MJHMP in compliance with AB 2140. Specific risk and vulnerability information from the Kern County MJHMP will assist to identify areas where development may be at risk to potential hazards, which in turn can be incorporated into General Plans. For example, jurisdictions may consider instituting a hazard overlay zone that requires additional scrutiny because of close proximity to certain hazards..
- **Building / Development Codes and Zoning Ordinances:** The MJHMP provides information to enable the County and municipalities to make decisions on appropriate building/development codes and ordinances. Appropriate building codes and ordinances can increase resilience against natural disasters. Some County and municipal mitigation actions directly recommend updates or new regulations as mitigation for hazard risks; those mitigation actions indicate priorities for regulatory updates in participating jurisdictions.

- **Community Wildfire Protection Plans (CWPP):** The MJHMP will provide information that can be incorporated into CWPPs and Strategic Fire Plan updates for areas within the County. The MJHMP likewise captured mitigation actions derived from CWPPs.
- **Water/ Flood Management Plans:** The MJHMP will provide information that can be included in updates of the Kern County Groundwater Monitoring Plan, Stormwater Management Plan, the Kern River Flood Management Plan, and other water/ flood management plans. While the process for updating these types of plans will vary by jurisdiction, the flood data developed for the MJHMP can be used in other mechanisms along with exposure and damage estimation information.
- **Planning Mechanisms for Special Districts.** Special districts and other participating jurisdictions likely have specific planning documents that will incorporate elements of the MJHMP as well. These will vary by jurisdiction and are explored more specifically in each Annex Capability Assessment. These include capital improvement plans, maintenance plans, emergency response or operations plans, and other relevant planning documents. Mitigation actions prioritize what plans may need to be updated to reflect this MJHMP information. Valuable information includes exposure and damage estimation and granular spatial footprint information from RAMP.

6.3.7 Planning Integration Processes

With adoption of this plan, Kern County and participating jurisdictions will be responsible for the plan implementation and maintenance. The County and the MJHMP Steering Committee will continue to:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to Kern County communities;
- Ensure hazard mitigation risk assessments and maps remain a consideration for safety decisionmakers;
- Report on plan progress and recommended changes; and
- Inform and solicit input from the public.

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Appendix A. Analysis Methodology

KERN COUNTY
MULTI-JURISDICTION
HAZARD MITIGATION PLAN

A GIS-based vulnerability assessment was conducted for each of the priority hazards identified by the Planning Committee. Several sources of data are necessary to conduct a vulnerability analysis. This appendix presents an outline of the data inputs, processing steps, and outputs used to create the vulnerability analysis results presented in the Hazard Mitigation Plan. The analysis methodology is presented first, followed by an overview of the analysis data.

A.1. Natural Hazard Exposure

The natural hazard exposure analysis (see C. Natural Hazard Exposure in Figure 7-4) is an inventory of population, parcels, critical facilities, and other assets within each natural hazard area. As shown in Figure 7-1, the presence of a structure inside a natural hazard area (the flood zone in this example) qualifies that structure as exposed to the natural hazard.



Figure 7-1: Hazard Exposure

The total counts of parcels, people, facilities, assets and the sum of values within the planning area which could be exposed to a hazard event is referred to as the "exposure" in this plan. A natural hazards overlay was developed to reflect the combination of many known natural hazard spatial footprints. The spatial overlay method enables summarization of building values, parcel counts, population exposure, and critical facility exposure within a hazard's geographic extents (see C. Natural Hazard Exposure in Figure 7-4). The input data is used to evaluate exposure for earthquakes, landslides, flooding, dam inundation, wildfire, and subsidence.

A.1.1. Damage Estimation with Hazus

FEMA's Hazus software was implemented to conduct a detailed loss estimation for flood and earthquake. Hazus is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. For purposes of this planning effort, Hazus was used to generate damage estimations due to possible earthquakes and flooding. The

estimated damage and losses provided by the Hazus Software provides the ability to understand possible widescale damage to buildings and facilities (see D. Hazus Damage Estimations in Figure 7-4).

In the hypothetical geography shown in Figure 7-3, even though both structures are exposed to flooding, it is expected that the structure with a first floor height below the depth of flooding will receive significantly more damage than the structure with a first floor height above the expected water depth. Note that not all building data contains first floor height and first floor height is an example of the type of field utilized by Hazus in calculating damage estimates.

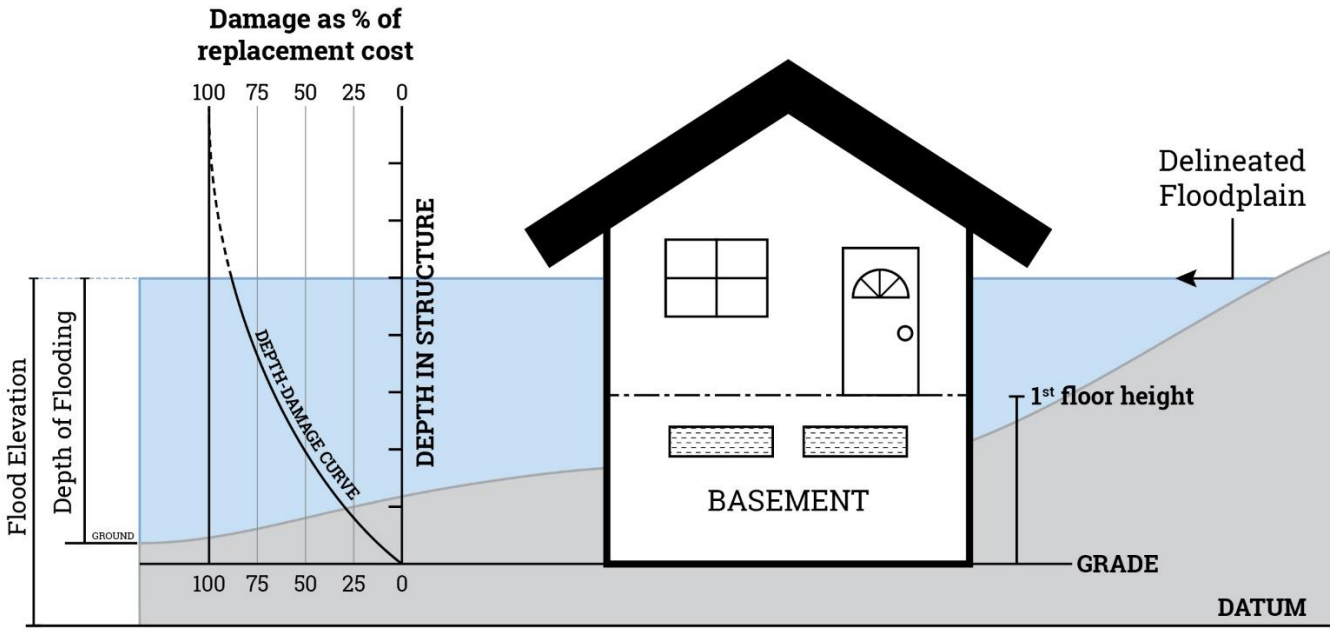

Figure 7-2: Flood Depth and Damage Curves



Figure 7-3: Hazus Damage Estimations

Hazus is a FEMA product with highly detailed documentation provided on the analysis steps and algorithms performed against the input data and associated scenarios in the process of obtaining loss estimates. The explanation in this appendix section is simplified. Refer to the full documentation and technical manuals from FEMA for greater explanation on Hazus specifics.

A.1.2. Distinguishing Results – Natural Hazard Exposure Analysis vs Hazus Results

Table and chart references throughout the hazard mitigation plan are explicitly called out for Hazus results as "Damage Estimates". There are expected differences in the results between estimations of Natural Hazard overlays and detailed Hazus results. Snapshot tables and Natural Hazard Exposure sections do not contain Hazus estimates.

A.2. Analysis Data

A.2.1. Assets, Value, and Population

A.2.1.1. Parcels

County provided parcel geometry was joined with county assessor data. In some cases, there were multiple building attributed to a single parcel. Centroids were created to represent parcels at a single location. Where multiple building values were represented in the parcel roll, multiple overlapping centroids were created. In situations where building values were duplicated among overlapping points, the points were weighted for equal and accurate representation of the parcel totals. Building type, year built, number of stories, use code, area, and valuation data were all fields that were input into the analyses. Earthquake building design level attribution was based on year built and building code adaptation chronology. Improved residential parcels were chosen for the parcels dataset by a query of improvement value presence and residential construction type codes. The parcel inputs were supplemented with point geometries from the Asset Insurance Schedule.

A.2.1.2. Asset Insurance Schedules

County assessor data does not include detailed information for tax exempt structures, such as federal and local government buildings. This data was added to the GIS utilizing insurance schedule tables for the county. The Insurance Schedule data was consolidated with the county parcel dataset.

A.2.1.3. Population

Population estimates were derived from 2015 5-year Census American Community Survey (ACS) numbers as applied to census block groups and then processed through GIS modeling to break down the proportional population for smaller units of area.

A.2.1.4. Critical Infrastructure

Critical facilities and transportation/lifeline typically include hospitals, fire stations, police stations, storage of critical records, and similar facilities. These data came from a collection of sources including but not limited to: County GIS, County and local jurisdiction insurance data, CDSS, CEC, FCC, Hazus, USACE,

FEMA Approval 4/9/2021

FEMA, and NPS. All data sources have a level of accuracy acceptable for planning purposes. See Table 7-2 for a list of Critical Infrastructure data used in the analysis.

A.2.1.5. Hazus Inputs

Hazus data inputs can be customized in several different ways including hazard scenario data and detailed building data. The GIS team conducted a Level 2 analysis utilizing user-defined buildings with refined building characteristic parameters as inputs for the damage estimation calculations (See A.2.1.1 andA.2.1.2). Both countywide building data and government assets were used as inputs in this level 2 analysis. The customized user defined building dataset allows for more accurate results for damage estimation based upon detailed building characteristics.

Note: FEMA's Hazus software utilizes different user defined building information inputs to develop loss estimates depending on the hazard module. The Hazus flood and earthquake modules use fragility curves based upon the user's definition of building characteristics including but not limited to:

- ***Area***
- ***Year Built***
- ***Construction Type***
- ***Number of Stories***
- ***EQ Design Level***
- ***Occupancy Type (Residential, Government, etc)***
- ***Building Values***

A default set of field values is utilized in leu of missing values where required by Hazus.

A.2.2. Natural Hazard Data

A.2.2.1. Dam Inundation Zones

Dam inundation zone GIS data were provided by the County. These represent the estimated flood extent in the event of dam failure for individual dams.

A.2.2.2. Earthquake Shaking

The CGS 2 percent chance – 50-yr probability map was used as a qualitative guide in selecting an earthquake epicenter based shakemap scenario for analyses. The South San Andreas Mojave North M7.7 Scenario was chosen for use in Hazus for damage estimations.

A.2.2.3. Subsidence

Obtained from DWR vertical movement subsidence dataset. Classified from low-lift to high-subsidence.

A.2.2.4. Flood Zones

The input parameters for Hazus analysis of Flood exposure included depth grids created with the FEMA Flood Zone data mentioned in section A.2.2.4. 100-YR, 500-YR, and Areas Protected by Levee were all scenarios that were used to analyze the exposure to Hazus inputs as depicted in Figure 7-4.

A.2.2.5. Landslide Susceptibility

GIS layer with geographic boundaries defining the likelihood of deep-seated landslides. Underlying geology and slope angle are used in the creation of this layer by the California Geological Society. High landslide classes were chosen as summary classes for this plan.

A.2.2.6. Wildfire Hazard Severity

A proprietary DP+S composite layer derived from Wildland Urban Interfaces, California Public Utilities Commission fire threat areas and Fire Hazard Severity Zones. See Table 7-1.

Table 7-1 Wildfire Hazard Severity Classification

Hazard	Native Class	Description
Moderate	Tier 1	HHZs are zones in direct proximity to communities, roads, and utility lines, and are a direct threat to public safety.
	1	WUI is the potential treatment zone in which projects could be conducted to reduce wildland fire threats to people.
	1 / Moderate	See Cal Fire FHSZ (State Responsibility Area [SRA] & Local Responsibility Area [LRA])
High	Tier 2	Tier 2 fire-threat areas depict areas where there is an elevated risk (including likelihood and potential impacts on people and property) from utility associated wildfires.
	High	See Cal Fire FHSZ (State Responsibility Area [SRA] & Local Responsibility Area [LRA])
Very High	Tier 3	Tier 3 fire-threat areas depict areas where there is an extreme risk (including likelihood and potential impacts on people and property) from utility associated wildfires.
	Very High	Classification of a zone as moderate, high or very high fire hazard is based on a combination of how a fire will behave and the probability of flames and embers threatening buildings. Each area of the map gets a score for flame length, embers, and the likelihood of the area burning. Scores are then averaged over the zone areas. Final zone class (moderate, high and very high) is based on the averaged scores for the zone.

Source: Moderate - Cal Fire Tree Mortality, WUI, FHSZ; High - CPUC Utility Threat, Cal Fire FHSZ; Very High - High - CPUC Utility Threat, Cal Fire FHSZ (SRA & LRA)

A.2.3. Methodology Overview

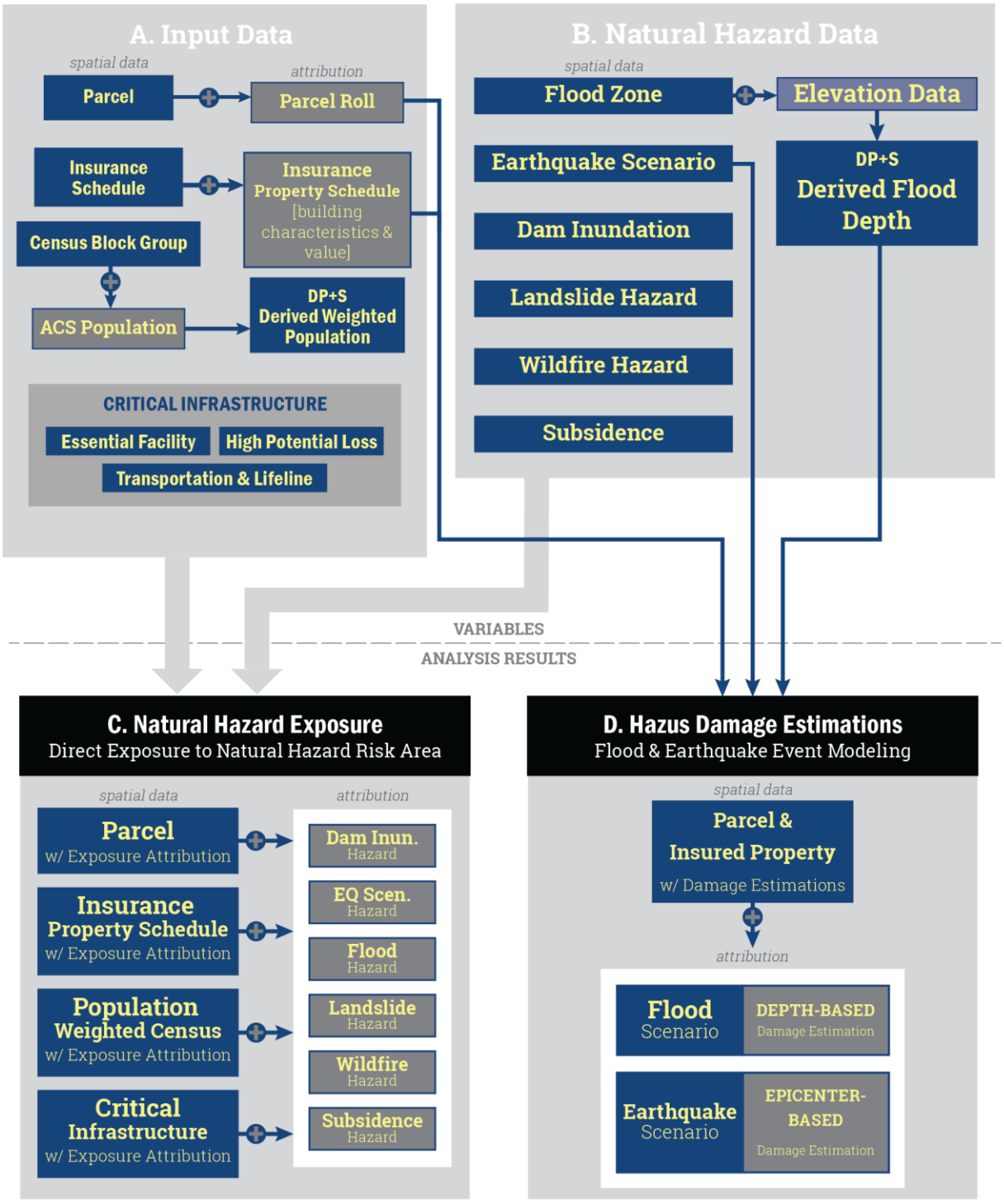

Figure 7-4: Data Analysis Methodology

A.2.4. Data Dictionary

Table 7-2: Data Dictionary

Dataset	Data Steward	Notes
Airport Districts	Local Jurisdiction	Received from local jurisdiction
Community Service Districts	Local Jurisdiction	Received from local jurisdiction
County	Census, Esri	County boundary and planning area extent
Incorporated Cities	Census, Local Jurisdiction	Received from local jurisdiction
Mosquito Abatement District	Local Jurisdiction	Received from local jurisdiction
Recreation And Park Districts	Local Jurisdiction	Received from local jurisdiction
Sanitation Districts	Local Jurisdiction	Received from local jurisdiction
School Districts	Local Jurisdiction	Received from local jurisdiction, consolidated with CDE School Ownership
Water Districts	USBR, Local Jurisdiction	Received from local jurisdiction
DEM	NED	1/3 Arc Second
Place	Census	TIGER dataset
Stream	Esri, NHD	Multiple stream basemap layers for various cartographic products
Water	Esri	Downloaded from Esri dataset
GNIS	USGS	Downloaded from USGS
Parcel Geometry	Local Assessors	Received from local jurisdiction
Parcel Roll	Local Assessors	Received from local assessor office
Building Roll	Local Assessors	Received from local assessor office
Emergency Operations Center	Local Jurisdiction	Geocoded from notes
Fire	Local Jurisdiction	Received from local jurisdiction
Hospital	Local Jurisdiction	Received from local jurisdiction
Police	Hazus, Local Jurisdiction	Reconciled police and sheriff with Hazus and Local data
Sheriff	Local Jurisdiction	Reconciled police and sheriff with Hazus and Local data
Adult Res Facility	CA Department of Social Services	Geocoded with ESRI streetfile
Child Care Center	CA Department of Social Services	Geocoded with ESRI streetfile
Family Child Care Home	CA Department of Social Services	Geocoded with ESRI streetfile
Foster Family Agency	CA Department of Social Services	Geocoded with ESRI streetfile
Home Care Organization	CA Department of Social Services	Geocoded with ESRI streetfile
Res Child Care	CA Department of Social Services	Geocoded with ESRI streetfile
Res Elder Care Facility	CA Department of Social Services	Geocoded with ESRI streetfile
Library	Local Jurisdiction	Received from local jurisdiction
Healthcare Facility	Local Jurisdiction	Received from local jurisdiction
Cooling Center	Local Jurisdiction	Received from local jurisdiction

Dataset	Data Steward	Notes
City Hall	Local Jurisdiction	Received from local jurisdiction
Dam	USACE NID	Have dam locations as provided in NID
Historic Building	NPS	National Park Service Data
Historic Site	NPS	National Park Service Data
Special Needs Facility	Local Jurisdiction	Received from local jurisdiction
School	Local Jurisdiction, CDE	Received from local jurisdiction, reconciled with CDE data
Potable Water Facility	Hazus	Hazus data is limited
Waste Water Facility	Hazus	Hazus data is limited
Airport	Hazus	Hazus data compared to other sources
Bridge	NBI	National Bridge Inventory data
Bus Facility	HAZUS	Hazus data was most complete for this asset
Levee	FEMA	From NFHL
Levee Flood Wall	USACE NLD	From NLD WFS
Levee Levee Centerline	USACE NLD	Do not appear to be any (Also the new WFS does not contain centerlines)
NG Facility	Local Jurisdiction	Open Data
NG Pipeline	Local Jurisdiction	Open Data
Oil Facility	Hazus	Hazus limited
Power Plant	Local Jurisdiction	Open Data
Railroad	Esri	From Esri dataset
Railroad Facility	Hazus	Hauz limited
Street	Esri	Esri for classifications
Substation	Local Jurisdiction	Open Data
Transmission Line	Local Jurisdiction	Open Data
Transmission Line Tower	CEC	have statewide dataset
Wind Turbine	Local Jurisdiction	Open Data
County Insured Assets (Insurance Schedule)	Insurance Provider	Reconcile with CI
Census Block	US Census Bureau	TIGER dataset
Census Block Group	US Census Bureau	TIGER dataset - appended pops
Census Tract	US Census Bureau	TIGER dataset
Awareness Zones	DWR	have statewide dataset
Dam Inundation	Cal OES	Dam inundation from Cal OES zones
EQ Probabilistic MI	USGS, CISN	Used to determine scenarios
EQ Scenarios 1-2	USGS, CISN	Scenarios as determined by Probabilistic composition
Flood Hazard	FEMA	NFHL
Subsidence	DWR	Classified from Low-Lift to High - Subsidence
Landslide Susceptibility	CGS	High class 8-10 from raw data
Wildfire Hazard Severity Zone	Cal Fire / CPUC	Proprietary composite layer for DPS including Cal Fire / CPUC data
200 Year Usace	USACE NLD	From National levee Dataset

Dataset	Data Steward	Notes
EQ Fault Zones	CGS	Used for overview, global source
Fire Perimeter Calfire	Cal Fire	Used for overview, global source
Fire Regime MFRI	USGS	Used for overview, global source
Qfaults	USGS	Used for overview, global source

A.2.5. Insured Assets Roll

Table 7-3 Insured Assets Roll

Asset	Building Count	Building Cost	Content Cost	Total Value
Administrative & Office	**68**	**$359,226,983**	**$118,496,490**	**$477,723,473**
Admin	26	$281,036,365	$2,180,986	$283,217,351
Building	12	$22,885,686	$1,192,850	$24,078,536
Office	30	$55,304,932	$115,122,654	$170,427,586
Equipment & Storage	**51**	**$57,237,326**	**$5,149,231**	**$62,386,557**
Equipment	5	$127,977	$3,302,171	$3,430,148
Shop	11	$41,016,235	$837,660	$41,853,895
Storage	20	$6,039,390	$446,971	$6,486,361
Warehouse	6	$6,387,091	$526,728	$6,913,819
Yard	9	$3,666,633	$35,701	$3,702,334
Other Assets	**42**	**$6,182,000**	**$26,036,768**	**$32,218,768**
Leased	31	$2,397,883	$20,982,229	$23,380,112
Misc	3	$203,622	$4,770,874	$4,974,496
Relay	4	$154,576	$21,384	$175,960
Vacant	4	$3,425,919	$262,281	$3,688,200
Recreation	**107**	**$48,550,442**	**$8,536,674**	**$57,087,116**
Golf Course	3	$2,927,248	$3,000	$2,930,248
Museum	76	$19,615,343	$6,634,355	$26,249,698
Park	9	$10,016,887	$1,409,407	$11,426,294
Recreation	19	$15,990,964	$489,912	$16,480,876
Services	**121**	**$438,023,808**	**$56,317,933**	**$494,341,741**
Animal	1	$528,591	$1,000	$529,591
Correctional	27	$288,265,742	$193,074	$288,458,816
Fire	47	$40,345,749	$4,818,942	$45,164,691
Health	5	$23,063,560	$3,690,348	$26,753,908
Library	18	$57,750,901	$46,750,699	$104,501,600
Sheriff	19	$14,114,343	$351,792	$14,466,135
Veterans	1	$672,868	$184,792	$857,660
Warehouse	1	$1,038,472	$50,193	$1,088,665

Asset	Building Count	Building Cost	Content Cost	Total Value
Water	2	$12,243,582	$277,093	$12,520,675
Transportation	**10**	**$52,335,358**	**$5,564,962**	**$57,900,320**
Airport	9	$52,334,358	$5,563,962	$57,898,320
Bus	1	$1,000	$1,000	$2,000
Grand Total	**399**	**$961,555,917**	**$220,102,058**	**$1,181,657,975**

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Appendix B. Process Documentation

KERN COUNTY
MULTI-JURISDICTION
HAZARD MITIGATION PLAN

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Appendix B

Table of Contents

Planning Committee Meeting Documentation.....B1

Public Notice & Press Release Documentation B2

Survey & Results Documentation..... B3

Mitigation Strategy Prioritization Process Documentation B4

Website Documentation B5

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Planning Committee Meeting Documentation

Appendix B.1

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COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Meeting Agenda

Kern Multi-Jurisdiction 2019-20 MJHMP Update

Internal Kick-Off Meeting

Friday, April 12, 2019, 10:00 a.m. – 12:00 p.m.

- **Meeting Objectives**
  - SOW Review
  - Project Management
    - Communication Protocols
    - Website Review
    - Schedule
  - Expectations from Participating Jurisdictions
    - Requirements (DMA2000)
    - Cal OES / FEMA Review Tool Grey Areas
    - Tracking Participation
  - Anticipated Public Outreach (I.e. Canvassing, notices, review times)
  - Data Calls / Data Review

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Kick-Off Meeting

Kern County/Operational Area Emergency Operations Center — April 12, 2019

2601 Panorama Drive, Building B Bakersfield — 10:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Jeri West	NOR/CTSA	jwest@nrarecreation.org	392-2000	
Paul Anderson	North of the River Rec & Park	panderson@norrecreation.org	661 392-2000	

PAGE _____ OF _____

Kick-Off Sign-In Sheets 1

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Kick-Off Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

April 12, 2019
10:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Lorelei Oviatt	KC PLANNING	Loreleio@kerncounty.com	66-862-8866	
Jon Lifquist	Assessor/Recorder	lifquistj@kerncounty.com	868-3315	
Erica Bain	KCFD	ebainc kerncountyfire.org	391-7068	
Kenny Seals	Kern High SD	Kenny_seals@kernhigh.org	827-3145	
Brianna Carrier	City of Bakersfield	bcarrier@bakersfieldcity.us	326-3745	

Kick-Off Sign-In Sheets 2

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Kick-Off Meeting

Kern County/Operational Area Emergency Operations Center — April 12, 2019

2601 Panorama Drive, Building B Bakersfield — 10:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
~~[illegible]~~	~~KERN COUNTY~~ RISK MGMT.			
BRAD ARAGON	RISK MGMT.	baragon@kerncounty.com	661 703-0385	
Nick Cooper	Greenfield county water District	greenfield county water@gmail.com	661-301-3823	
Kevin Hamilton	Kern County public works	kevinh@kerncounty.com	661 862 5071	
BRANDEN SMITH	KERN CO. FIRE	BSSMITH@KERNCOUNTYFIRE.ORG	661 330-0181	
Megan Person	CAO	Personm@kerncounty.com	661-868-3173 Cell - 203.1770	
Michael Heimer	Kern COG	mheimer@kerncog.org	635-2909	
Jeffrey Utter	Kern County ITS	UtterJ@KERNCOUNTY.COM	868-0041	
Troy DePriest	TCCWD	tdepriest@tccwd.com	7603153349.	
Chris Huot	City of Bakersfield	CHuot@BakersfieldCity.us	661 326 3751	
Alexa Kolosky	Kern County Public Works	akolosky@kerncounty.com	862-5002	

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Kick-Off Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

April 12, 2019
10:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Ben Raymond	Kern COG	BRAYMOND@KERNLAC.ORG	635-2911	
Robert Voyles	City of Bakersfield	rvoyles@bakersfieldcity.us	661-326-3105	
Michael Dillenbeck	Public Works County of Kern	dillenbeckm@kerncounty.com	661-8628913	
David Witt	Fire Dep	dwitt@kerncountyfire.org		



Kick-Off Photo

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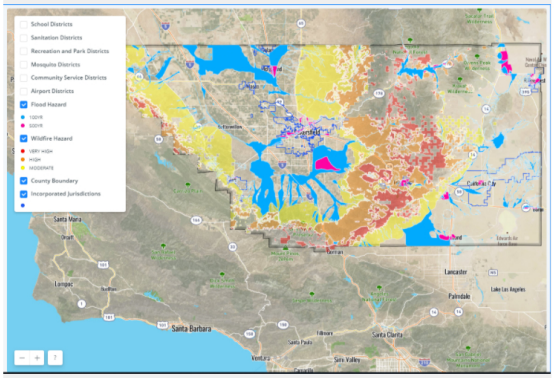
KERN MULTI-JURISDICTION HAZARD MITIGATION PLAN UPDATE

Planning Committee Meeting #1 Reminder

Thursday, May 23rd, 2019
9:00 a.m. to 12:00 p.m.
Kern County/Operational Area Emergency Operations Center (EOC)
2601 Panorama Drive, Building B
Bakersfield



May 2019
23

You are cordially invited to attend the first meeting in the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan!

We are beginning the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan (MJHMP). The purpose of the Kern MJHMP is to reduce property losses and avoid injury and/or casualties resulting from natural disasters. Hazard mitigation is the use of sustained, long-term actions to reduce loss of life, personal injury, and property damage that can result from a disaster. The Plan is multi-jurisdictional in that 63 different Kern County jurisdictions participate in it. As we develop this plan a stakeholder group is necessary and **Your insight is needed (and, for those representing participating jurisdictions, required)** to meet FEMA's strict guidelines for active participation. Under FEMA's guidelines, active participation is a prerequisite for Plan approval.

This is the first in a series of four meetings, over the course of six months, to review and develop information for the updated MJHMP. During the series of meetings, you will learn about FEMA's hazard mitigation program, prevalent hazards throughout the County, and mitigation techniques to reduce damage and injury in the event of wildfire, flood, earthquake, and other natural hazards.

At this first meeting, you will meet the team from our new Plan update consultant, Dynamic Planning + Science (DP+S). We will review project scope and schedule, internal project management protocol, and Cal OES/FEMA plan review requirements. Meeting participants will discuss required multi-jurisdictional planning processes and documentation of such and begin planning a public outreach strategy. DP+S staff will demonstrate new Plan

Meeting 1 MailChimp Notification

Meeting Agenda:

Kern County Multi-Jurisdiction Hazard Mitigation Plan 2019-20 Update

Planning Committee Meeting #1

Thursday, May 23rd, 2019, 9:00 a.m. – 12:00 p.m.

Meeting Objectives

- **Welcome and Introductions**
- **Mitigation Planning Defined**
- **Expectations from Participating Jurisdictions**
- **Planning Process Review**
  - Project Schedule
  - Website Review
- **FEMA Hazard Mitigation Program**
- **2012 Mitigation Plan Review**
- **What has Changed?**
- **Outreach**
- **Next Steps**

Project Website: mitigatehazards.com

Project Webpage: http://mitigatehazards.com/county-of-kern/

Website Password: Kern2020

Polling Website for Smartphone: www.pollev.com/dynamicplanning

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
SHANE DENTON	KERN COUNTY RANGERS	Dentons@kern county.com	(661) 381-3189	18 mI
Biridiana Bishop	City of Wasco	bibishop@ci.wasco.ca.us	(661) 390-2601	60 miles
Regina Houchin	Buttonwillow Co. Water Co.	agcenter@bak.rr.com	661-764-5223	60 miles
Justin Gagnon	Los Padres National Forest	justin.gagnon@usda.gov	661-289-0042	
Jana Marquez	KDWD	jana@kerndelta.org	661 834 6656	30
John Frando	Bakersfield Fire	jfrando@bakersfieldfire.us	661 326 3652	
JEFF FARISS	Kern County Public Health	FARISSJ@kerncounty.com	661-868-5216	3
Rafael Molina	Cal Water	rmolina@calwater.com	661-827 7686	
Monica Tennant	KCWA	mtennant@kcwa.com	661-634-1419	
David Goodell	Cal City Fire	dgoodell@calcityfire.us	760 643 8981	
JOE ROJAS	CITY OF DELAN	jrojas@cityofdelan.org	661 720.2281 56	
Heather Spurlock	City of Ridgecrest	hspurlock@ridgecrest-ca.gov	760 499 5063	

PAGE _____ OF _____

PC Meeting1 Sign In 1

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Brianna Carrier	City of Bakersfield City Managers office	bcarrier@bakersfieldcity.us	661-326-3745	
JoeWest	NOR REC & Park Dist	JWest@NorRecreation.org	661-392-2000	
Paul Anderson	NOR Rec & Park Dist	panderson@norrecreation.org	661-392-2000	
Phillip Jimenez	Shafter Recreation & Park District	pjimenez@shafterrec.com	661 746-3303	

PAGE _____ OF _____

PC Meeting1 Sign In 10

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COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Terri Mejorado	CalOES	terri.mejorado@caloes.ca.gov	5592599890	230
BRACH SMITH	ROSAMOND CSD	BSMITH@ROSAMONDCSD.COM	661-256-3411	140
MARY PEPITO	CALWATER	mpepito@calwater.com	661-979-7341	
Kenny Seals	KHSD Kern High	kenny_seals@kernhigh.org	661-827-3100	

PAGE _____ OF _____

PC Meeting1 Sign In 11

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COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Marcos A. Rodriguez	Bakersfield City School District	mrodriguez@bcsd.com	661-631-5883	12.42

PAGE _____ OF _____

PC Meeting1 Sign In 12

Name	Agency	Email	Phone	Miles
Skye Grass	Kern-Tulare Water Distr.	Skyg@kern-tulare.com	661-327-3132	25

PC Meeting1 Sign In 13

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Kevin Hamilton	Kern County Public Works	kwinh@kerncounty.com	661 862 5071	7 miles
Fernando Ceja	Arvin-Edison Water Storage District	fceja@aewsd.org	661-444-3290	48 ~~20~~ miles
TODD Noble	Edison School District	tnoble@edison.k12.ca.us	661-340-1150	
Susan Wells	Golden Hills CSD	gm@ghcsd.com	661-822-3064	
Jackie Villa	Lost Hills USD	javilla@losthills.k12.ca.us	661 797 3003	90
STEVEN SANTILLAN	Buttonwillow union school District	ssantillan@buttonwillowschool.com	661-770-7180	64
Brandon Welton	Mojave Air & Space Port FIRE	brandon@mojaveairport.com	(661) 221-1138	101
Jeremy Kosick	California City Fire	~~Jero~~ JKosick@calcityfire.us	760 803 7546	
Dayne Yancey	PMC CERT	kaydly@calneva.org	661-242-1094	130
TOM YANCEY	PMC CERT	Tom1YANCEY@GMAIL.com	242.1094	130
Kirk Gilbert	Tehachapi unified School Dist.	kgilbert@teh.kk.ca.us	661-822-2120	70

PAGE _____ OF _____

PC Meeting1 Sign In 2

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
JEFF JACKETT	CITY OF WASCO	JETACKETT@CI.WASCO.CA.US	661-758-7273	40
Wayne Jackson	City of Wasco	Wajackson@ci.wasco.ca.us	661-779 0341	40
Brian Thoburn	So. Cal. Edison	brian.thoburn@sce.com	559-685-3240	160
MARK LEWIS	K.C. LIBRARY	LEWISMA@KERNCOUNTY.COM	661-868-0710	12
Nick Cullen	KCAS	cullenn@kern county.com	661-229-7453	~~16~~
Troy DePriest	TCCWD	tdepriest@tccwd.com	7603153349	60
JOE GRUBBS	KCCD	joseph.grubbs@kccd.edu	(661)336-5019	12
Vargas Humberto	Pond School	hvargas@Pond.k12.ca.us	661 778 9764	78
Alexander Lee	CITY of McFarland	[redacted]@McFarlandCity.org	661-792-3091	~~50~~

PAGE _____ OF _____

PC Meeting1 Sign In 3

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PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Isela Medina	semitropic WSD	imedina@semitropic.com	661-758-5113	60mi
Kaler Ayala	Kern CAO	ayalak@kerncounty.com	661-868-3164	10 mi
David Aranda	Stallion Springs CSD	duranda300@gmail.com	661-300-1231	75mi
Kristen Dowd	PG&E	kfd5@pge.com	661-398-5989	60 mi.
Brad Write	WSRPD	Brad@wsrpd.com	661 577-2094	80 miles
PAT OSTLY	North of River SD	postly@norsd.com	661. 399. 6411	15 m.
Ed Greynolds	KC Dept of Agriculture & Measurement Stnd	agcomm@kerncounty.com greynoldse@kerncounty.com	661-868-6300	10 mi
Katie Allen	P G&E	kmad@pge.com	661-8658637	60mi.

PAGE _____ OF _____

PC Meeting1 Sign In 4

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Dennis McNamara	KC Planning	mcnamarad@	(661) 862-8624	
Taylor Schoene	KC planning	schoenet@kerncounty.com	(661) 862-5017	
Jeannie Taylor	KCFD CERT / BVCSO DPAC	Jetaylor@kerncountyfire.org / JeannieMTaylor@gmail.com	805-603-7424	~100
Brian Marsh	Univ of CA Cooperative Extension KC Farm & Home	bhmarsh@ucanr.edu	661-868-6210	
Alexa Kolosky	Kern County Public Works	akolosky@kerncounty.com	661-862-5002	

PAGE _____ OF _____

PC Meeting1 Sign In 5

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Tim Ruiz	East Niles CSD	truiz@eastnilescsd.org	661-871-2011	8
Jason Nordine	Kern Sanitation Authority & Ford City Taft Heights	nordinej@kerncounty.com	cell - 868-8287	14
Jon Yasin	CAL WATER	JYasin@calwater.com	760-549-3032	90
Frank Trotta	CAL Water	FTrotta@calwater.com	(760)549-3268	90
Wayne Clausen	Shafter	wclausen@shafter.com	(661)746-5002	20

PAGE _____ OF _____

PC Meeting1 Sign In 6

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
ZACK BITTLE	KCSO SHERIFF	BITTLEZ@KERNSHERIFF.ORG	661 392 6092 328 5014	7
Megan Person	Kern CAO	PersonM@kerncounty.com	661. 868-3173	
KEVIN KIMMEL	KERN SHERIFF	KIMMELK@KERNSHERIFF.ORG	661-369-0564 245-3440	
Stuart Patteson	City of Bakersfield	spatteso@bakersfieldcity.us	661-326-3575	
STEVE WILLIAMS	KCSO	WILLIAMSSC@KERNSHERIFF.ORG	661-204-3390	

PAGE _____ OF _____

PC Meeting1 Sign In 7

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COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Yuriana Torres	Richland SD	ytorres@rsdshafter.org	746-8621	46
STEVE DOE	DWR	STEVE.DOE@WATER.CA.GOV	559 230-3348	230
Craig Jones	TAFT	CJones@CityofTaft.org	661 763-1228	81
Damon McMinn	TAFT PD	dmcminn@CityofTaft.org	661-763 3101	81
CRIS LAWRENCE	Westside District water authority	klawrence@lhwd.org	661-666-1095	10.

PAGE _____ OF _____

PC Meeting1 Sign In 8

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COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #1 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

May 23rd, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
K. Stulman	PMC POA	gm@pmcpoa.com	cell 7333597	
Christian Buenrostro	USBR	cbuenrostro@usbr.gov	559-262-0361	
Greg VanMullem	Assessor	vanmullem@kerncounty.com	x83390	
Ed Rieth	Retired fire PARadise, CA	edeBeyond the Call of Duti.com	(530) 864-5595	

PAGE _____ OF _____

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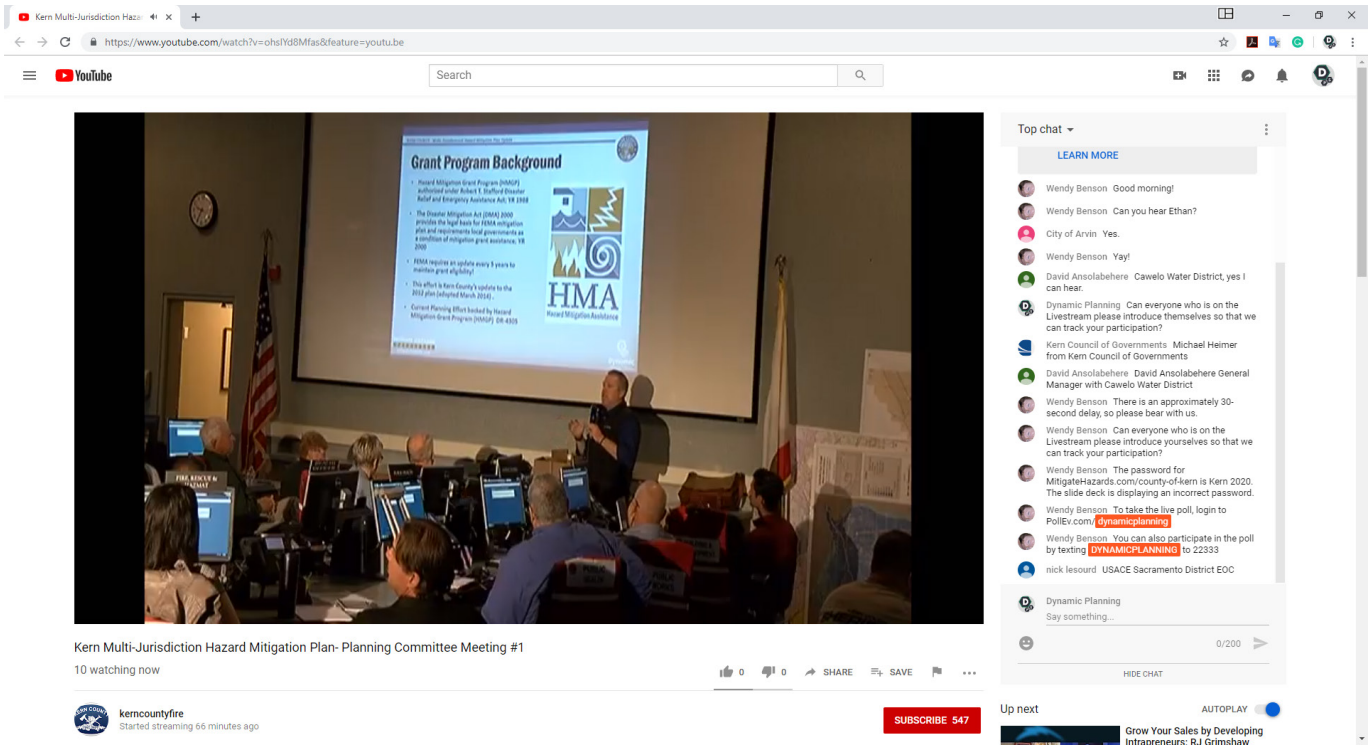
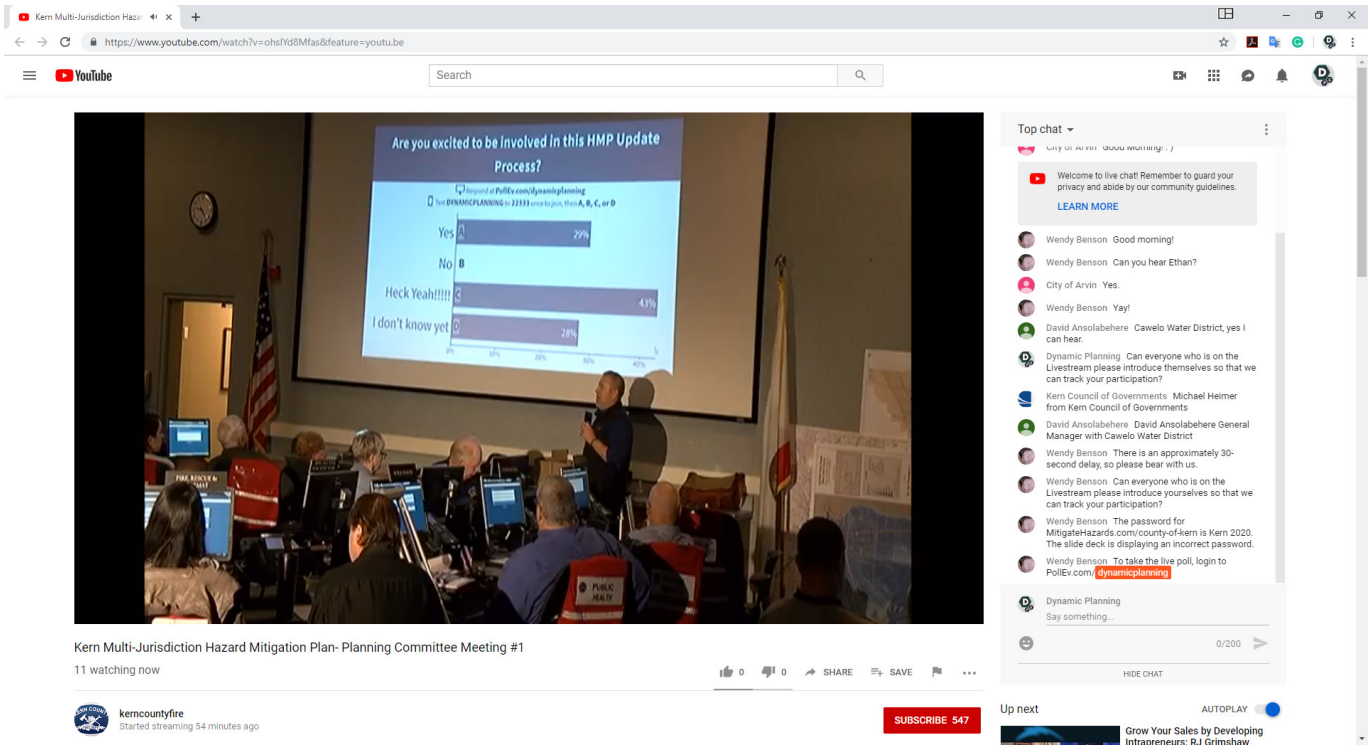
PC Meeting 1 Photo 1



PC Meeting 1 Photo 2



PC Meeting 1 Photo 3



PC Meeting 1 Photo 4 zoom attendance

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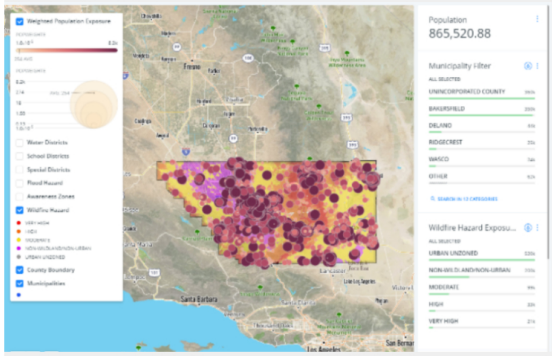
KERN MULTI-JURISDICTION HAZARD MITIGATION PLAN UPDATE

Planning Committee Meeting #2 Reminder

Thursday, July 18th, 2019
9:00 a.m. to 12:00 p.m.
Kern County/Operational Area Emergency Operations Center (EOC)
2601 Panorama Drive, Building B
Bakersfield



July 2019

18

You are cordially invited to attend the second meeting in the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan!

We are continuing the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan (MJHMP). The purpose of the Kern MJHMP is to reduce property losses and avoid injury and/or casualties resulting from natural disasters. Hazard mitigation is the use of sustained, long-term actions to reduce the loss of life, personal injury, and property damage that can result from a disaster. The Plan is multi-jurisdictional in that 63 different Kern County jurisdictions participate in it. As we develop this plan a stakeholder group is necessary and **your insight is needed (and, for those representing participating jurisdictions, required)** to meet FEMA's strict guidelines for active participation. Under FEMA's guidelines, active participation is a prerequisite for Plan approval.

During the series of meetings, you will learn about FEMA's hazard mitigation program, prevalent hazards throughout the County, and mitigation techniques to reduce damage and injury in the event of a wildfire, flood, earthquake, and other natural hazards. This is the **second** in a series of four meetings to review and develop information for the County's Multi-Jurisdiction Hazard Mitigation Plan Update.

During this second meeting, we will assess vulnerability by examining the populations and assets (such as buildings, roads, and other critical infrastructure) within hazard areas. The vulnerability data will be used to identify problem statements for each jurisdiction, which will be an essential building block for creating specific mitigation actions during our third meeting. **We**

Meeting 2 MailChimp Notification

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Meeting Agenda

Kern County Multi-Jurisdiction Hazard Mitigation Plan 2019-20 Update

Planning Committee Meeting #2

Thursday, July 18th, 2019, 9:00 a.m. – 12:00 p.m.

Meeting Objectives

- Welcome and Introductions
- Meeting #1 Recap
- Planning Team Development
- Risk Assessment Data Review
- IRAMP Tool Review
- IRAMP Exercises
- Next Steps

Project Website: mitigatehazards.com

Project Webpage: http://mitigatehazards.com/county-of-kern/

Website Password: Kern2020

Polling Website for Smartphone: www.pollev.com/dynamicplanning

NOTES:

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Kern County Hazard Risk Assessment Criteria

Planning Committee Meeting #2, July 18th, 2019

Probability

What is the likelihood of a hazard event occurring in a given year?

Unlikely - less than 1% annual probability

Possible - between 1 & 10% annual probability

Likely - between 10 &100% annual probability

Highly likely - 100% annual probability

Impact

In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?

Minor - very few injuries, if any. Only minor property damage & minimal disruption on quality of life. Temporary shutdown of critical facilities.

Limited - minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.

Critical - multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.

Catastrophic - high number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Joe Rojas	City of Delano	jrojas@cityofdelano.org	661.720.2281	60
Jana Marquez	KDWD	Jana@Kerndelta.org	661 834 4655	

PAGE 1 OF 13

PC Meeting 2 Sign In 1

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Chris Hickernell	Friant Water Authority	chickernell@friantwater.org	559-562-6305 559-631-3628 cell	
Harrison Faverreaux	Lost Hills Union Sch.	hafaver@losthills.k12.ca.us	661 797-3008 cell 661 496-2167	
Micah Clark	Arvin-Edison WSD	mclark@aewsd.org	661-854-5573	42
Leif Mathiesen	Bureau of Land Management	lmathies@blm.gov	661-391-6055	22

PAGE 10 OF 13

PC Meeting 2 Sign In 10

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Nick Cooper	GCWD	Greenfield county water @ gmail.com	661 301-3823	
Jeff Utter	ITS	UTTERJ @ KERN-COUNTY.COM	661-868-0041	
Brandon Smith	KCFD	BSmith @ KERNCOUNTYFIRE.ORG	661-330-0189	0
Isela Medina	SWSD	imedina@semitropic.com	661-758-5113	60
Kevin Albertson	BFD	kalberts @ Bakersfieldfire.us	661 496-0410	
PAT OSTLY	NORSD	postly @ norsd.com	661.399.6411	
Brian Marsh	UCCE	bhmarsh@ucanr.edu	661 868 6210	

PAGE 11 OF 13

PC Meeting 2 Sign In 11

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Jenny Hannah	Kern High	Jenny_hannah@kernhigh.org		
Megan Person	CAO			
Genel Hodges	JFMAD			
Vanessa Yap	KTWD			
Glenn Imke	Panama - Buena Vista USD			
Kimberly Fleming	KC CAO-GS	FLEMINK	661-868-3049	
Dennis McNamara	KC Planning			

PAGE 12 OF 13

PC Meeting 2 Sign In 12

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
David Goodell	Cal City Fire	dgoodell@calcityfire.us	760-463-8981	

PAGE 13 OF 13

PC Meeting 2 Sign In 13

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
KARIN Shulman	PMC POA	gm@pmcpoa.com	242 3788	
Phyllis Throckmorton	PMC POA	phyllis.throckmorton@gmail.com	805-509-5542	
PEGGY HOYT-VOECKER	PMCPOA	PEGGYHV1@gmail.com	818-383-7928	

PAGE 2 OF 13

PC Meeting 2 Sign In 2

FEMA Approval 4/9/2021

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
BRADY SMITH	ROSAMOND C.S.D.	BSMITH@ ROSAMONDCSD.com	661 256 3411	140
Zachary Wells	Kern County Fire	zwells@kerncounty fire.org	661-330-0498	300

PC Meeting 2 Sign In 3

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Wayne Clausen	City of Shafter	wclausen@shafter.com	661-746-5002	24
Monica Tennant	Kern Co. Water Agency	mtennant@kcwa.com	(Local) 634-1419	~10
DAMON MCMINN	CITY OF TAFT	dmcminn@cityoftaft.org	(661) 763-3105	90
Lowe Boyer	City of Taft	lboyer@cityoftaft.org	(661) 763-1222	90
Tim Ruiz	East Niles CSD	truiz@eastnilescsd.org	661-871-2011	5
JOSE DE LEON	KCFD	JDELEON@KERNCOUNTYFIRE.ORG	661 330 0502	10

PAGE 4 OF 13

PC Meeting 2 Sign In 4

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Brandon Welton	Mojave Air & SpacePort Fire	brandon@mojaveairport.com	(661) 824-5240 (661) 221-1130	196
Amando Gonzalez	Shafter Rec & Park District	mando.gonco97@gmail.com	(661)-746-3303 (661)-900-2386	22 miles
Susan Wells	GHCSD	gm@ghcsd.com	661-822-3064	
Eric Zieglen	City of Maricopa	lrobison-com@bak.rr.com	(661) 769-8219	?
Ryan Nunneley	NOIR Municipal Water District	rnunneley@oildalewater.com	(661)399-5516	—

PC Meeting 2 Sign In 5

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center — July 18th, 2019

2601 Panorama Drive, Building B Bakersfield — 9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Curtis Hilliker	Tehachapi Cummings County Water District	chilliker@TCCWD.com	661 565 8224	80 miles
Tim Ashlock	BVWSD	tima@bvh20.com	661-746-2901	—
JEFF KRISS	PUBLIC Health		661-301-9965	2 miles
Rob Voyles	City of Bakersfield	rvoyles@bakersfieldcity.us	661-304-2939	5
Regina Hanchin	Buttonwillow			25
Taylor Schoene	KC Planning/ Nat. Resources	~~taylorschoene~~ ag.	661-862-5017	5
Jeannie Taylor	KCFD CERT	JEtaylor@KernCountyFire.org	661-301 7111	
Carl Brewer	KC GS	brewerc@kerncounty	661-342-8334	
Eric McDaris	Wheeler Ridge Water District	emcdaris@wrmwsdi.com ~~emcdaris~~	661 527 6688	70
ED Komin	KERN H.S. DISTRICT POLICE	ED-Komin@KERNHIGH.ORG	661 827-3219	18
STEVEN SANTILLAN	Buttonwillow Union school District	Ssantillan@Buttonwillow School.Com	661 770-[illegible]0	25

PC Meeting 2 Sign In 6

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Kevin Hamilton	Kern County Public Works	kevinh@kerncounty.com	661 862 5071	10 miles
Adrian Nava	Kern County Public Works	NavaA@kerncounty.com	661 - 862-8688	10 miles
JEFF TACKETT	CITY OF WASCO	JETACKETT@CI.WASCO.CA.US	661-750-7273	30
BRAD ARAGON	Kern County Risk Mgmt	baragon@kerncounty.com	661/703-0385	12
Heather Spurlock	City of Ridgecrest	hspurlock@ridgecrest-ca.gov	760 499 5063	
JOSHUA VILLA	CITY OF RIDGECREST POLICE DEPT	JVILLA@RIDGECREST-CA.GOV	5094554000	
Paul ANDERSON	NOR Rec & PARK	Panderson@norrecreation.org	661-619 0481	10
Kelly Patterson	Tehachapi Unified SD	kpatterson@teh.K12.CA.US kalibert@teh.K12.CA.US	661-822-2120	60
JOE WEST	NOR REC & Parks	JWest@NORRECREATION.org	661-392-2000	10
adrianna Kessler	DHS	Kessler@kerndhs.com	633-7373	10
Lonn Boyer	CITY of TAFT	lboyer@cityoftaft.org	763-1222	90

PAGE 7 OF 13

PC Meeting 2 Sign In 7

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Biridiana Bishop	City of Wasco	bibishop@ ci.wasco.ca.us	6061-390-2601	60
Wayne Jackson	City of Wasco	Wajackson@ ci.wasco.ca.us	661 479 0341	60

PAGE 8 OF 13

PC Meeting 2 Sign In 8

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #2 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

July 18th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Ed Gordon	Stallion Springs CSD	EGordon.SSCSD@Gmail.com	818 288 0366	90
MARK LEWIS	LIBRARY	LEWISMA@KERNCOUNTY.COM	661 868-0710	15

PC Meeting 2 Sign In 9

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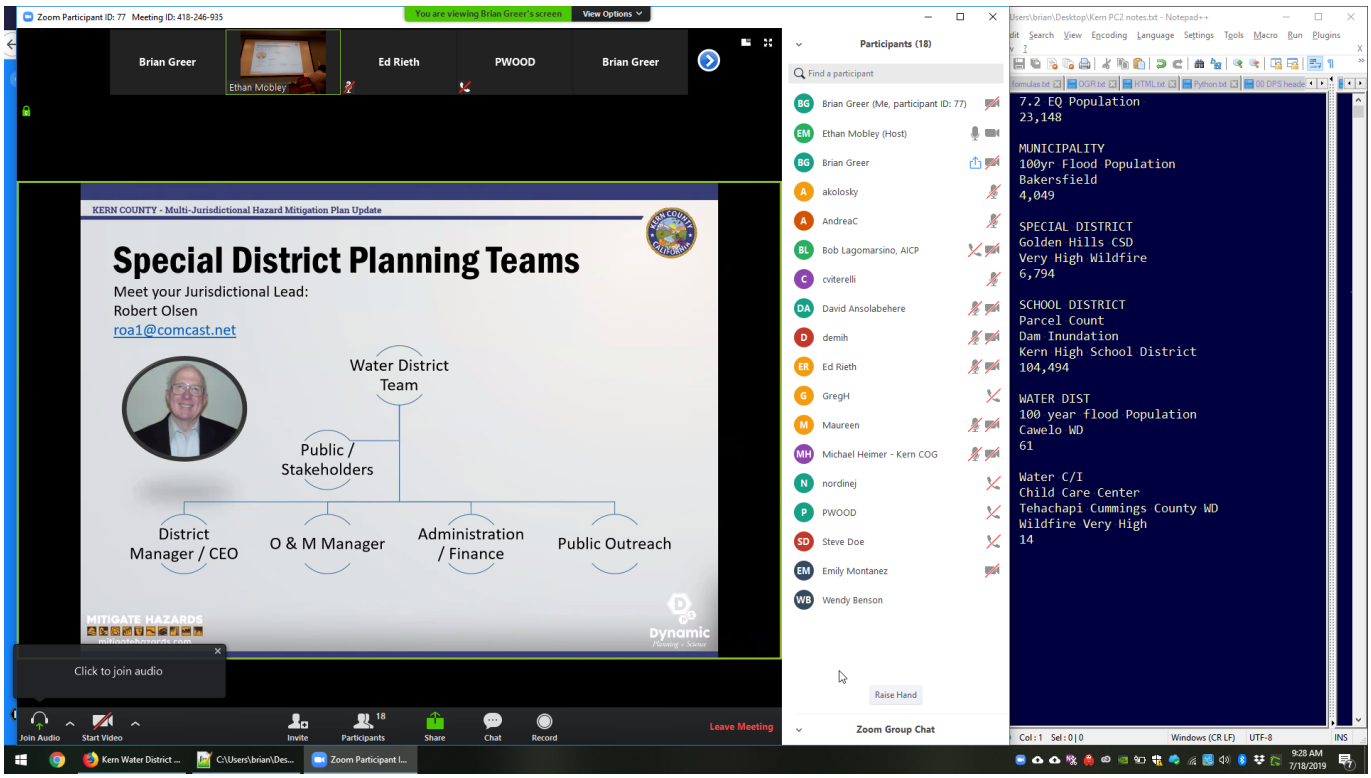
PC Meeting 2 Photo 1



PC Meeting 2 Photo 2



PC Meeting 2 Photo 2

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KERN MULTI-JURISDICTION HAZARD MITIGATION PLAN UPDATE

Planning Committee Meeting #3 Reminder

Thursday, Sept 19th, 2019
9:00 a.m. to 12:00 p.m.
Kern County/Operational Area Emergency Operations Center (EOC)
2601 Panorama Drive, Building B
Bakersfield



You are cordially invited to attend the third meeting in the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan!

Sept 2019
19

We are continuing the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan (MJHMP). The purpose of the Kern MJHMP is to reduce property losses and avoid injury and/or casualties resulting from natural disasters. Hazard mitigation is the use of sustained, long-term actions to reduce the loss of life, personal injury, and property damage that can result from a disaster. The Plan is multi-jurisdictional in that 63 different Kern County jurisdictions participate in it. As we develop this plan a stakeholder group is necessary and **your insight is needed (and, for those representing participating jurisdictions, required)** to meet FEMA's strict guidelines for active participation. Under FEMA's guidelines, active participation is a prerequisite for Plan approval.

During the series of meetings, you will learn about FEMA's hazard mitigation program, prevalent hazards throughout the County, and mitigation techniques to reduce damage and injury in the event of a wildfire, flood, earthquake, and other natural hazards. This is the **third** in a series of four meetings to review and develop information for the County's Multi-Jurisdiction Hazard Mitigation Plan Update.

During this third meeting, we will assist you to pinpoint your vulnerabilities using the tools and data that have been developed for your jurisdiction. We will review your Risk Assessment Matrix progress and see where we can assist jurisdictions with questions. **We need your feedback on what hazard information should be updated, deleted or remain in the plan!**

Project updates and meeting materials will

Meeting 3 MailChimp Notification

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Meeting Agenda

Kern County Multi-Jurisdiction Hazard Mitigation Plan 2019-20 Update

Planning Committee Meeting #3

Thursday, September 19th, 2019, 9:00 a.m. – 12:00 p.m.

Meeting Objectives:

- Welcome and Introductions
- Planning Process Recap
- Pinpointing your Vulnerabilities
- Developing a Nexus to HMA Funding
- Next Steps

Project Website: mitigatehazards.com

Project Webpage: mitigatehazards.com/county-of-kern/

Website Password: **Kern2020**

Polling Website for Smartphone:
pollev.com/dynamicplanning

NOTES:

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Taylor Schoene	KC Planning + Natural Resources Dept.	schoenet@kerncounty.com	661-862-5017	
Glenn Imke	Panama - Buena Vista	gimke@pbvusd.net	661-699-0122	
MARK LEWIS	LIBRARY	LEWISMA@KERNCOUNTY.COM	661 868-0710	
Monica Tennant	KCWA	mtennant@kcwa.com	661-634-1419	10
Ed Gordon	Stallion Springs CSD	@GORDON.SSCSD @GMAIL.COM	8182880365	75
Ivan Arambula	Vineland School District		661. 331.9610	

PC Meeting 3 Sign In 1

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
JEFF TACKETT	CITY of WASCO	JETACKETT @CI.WASCO.CA.US	661-758-7273	60 MILES
CHRIS COUNTS	K.C.C.D. B.C.	CCOUNTS@BAKERSFIELDCollege.edu	661-337-0852	.5 miles
Regina Hondin	BWCWD	Rhondin@agcenteraccounting.com	661-764-5273	30 Miles
MARCOS RODRIGUEZ	BCSD	MRODRIGUEZ@BCSD.com	661 631-5883	10 miles
Biridiana Bishop	wasco	bibishop@ci.wasco.ca.us	661-390-2601	60 miles
Vickie Hight	Wasco Recreation	Vhight@wrpd.net	661 758 3081	60 miles

PAGE 10 OF 13

PC Meeting 3 Sign In 10

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
BRAD SMITH	R.C.S.O.	BSMITH@RCSO.COM	661 256 3411	140
Suzanne Forrest	City of Shafter	SForrest@Shafter.com	(661) 746 0572	∅
Rob Voyles	City of Bakersfield	rvoyles@bakersfieldcity.us	661-304-2959	

PC Meeting 3 Sign In 11

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COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Ed Rietz	FD Retired PMC	Ed @ Beyondthe CallofDuti.com	530-864-55[illegible]	140
Ryan Nunneley	North of the River Municipal Water District	ryan@oildalewater.com	661-399-5516	
Jana Marquez	Kern Delta Water Dist.	jana@kerndelta.org	661 834 4656	

PC Meeting 3 Sign In 12

FEMA Approval 4/9/2021

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Brandon Welton	Mojave Air & Space Port	brandon@mojaveairport.com	(661) 221-1130	196
BENNY WOFFORD	KERN HIGH School Dist.	benny_wofford@kernhigh.org	(661) 827-3428	
Patrick Blake	Kern High	pblake@kernhigh.org	661-827-3427	
Zachary Wells	Kern County Fire Dept	zwells@kerncountyfire.org	661-330-0498	300
Brandon Smith	KCSD	BSSmith " "	661 330-0181	

PC Meeting 3 Sign In 13

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Alexis	ACSD Arvin community Sewer	agnova@arvin	(661) 852-1226	
Keith Gainey	Mojave USD	keithgainey@mojave.k12.ca.us	(661) 824-4001	
Paul Anderson	North of the River Rec+Park	panderson@norrecreation.org	661-619-0481	15 miles

PAGE 2 OF 13

PC Meeting 3 Sign In 2

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Susan Wells	GHCSD	gm@ghcsd.com	661-822-3064	?
Tim Ruiz	East Niles CSD	truiz@eastnilescsd.org	661-971-2041	—

PC Meeting 3 Sign In 3

FEMA Approval 4/9/2021

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Yuriana Torres	Richland School District	ytorres@rdshatter.org	746-8621	46
ZACK BITTLE	KCSO	BITTLEZ@KERNSHERIFF.ORG	378-5014	19

PC Meeting 3 Sign In 4

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Frank Trotta	Cal Water	FTrotta@calwater.com	(760)549-3268	100
Michael Mata	Kern Co Probation	michael mata@kernprobation.org	(661) 2055573	10
Kris Lawrence	WDWA	klawrence@lhwd.org	661-666-1095	10
Darin Heard	Ag-Dept	heardd@kerncounty.com		10

PC Meeting 3 Sign In 5

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Harrison Favereaux	Cost Hills Sch. Dist	hafaver@losthills.k12.ca.us	(661) 797-3008	
Curtis Hilliker	Tehachapi-Cummings County Water District	chilliker@tccwd.com	(661) 565 8224	80
Heather Spurlock	City of Ridgecrest	hspurlock@ridgecrest-ca.gov	7604995063	
David Orr	Cal-City F.D.	dorr@calcityfire.us	(661) 476-7176	
Matt Carter	Delano J.U.	mcarter@djuhsd.org	661-543-8033	60
Adrian Madueno	DJUHSD	amadueno@djuhsd.org	661-720-4104	60
PATRICK OSTLY	NORSD	postly@norsd.com	661. 399. 6411	20
AMY ROCHA	NRCS	AMY.ROCHA@USDA.GOV		
EMMANUEL GONZALEZ	NRCS	EMMANUEL.GONZALEZHINOJOSA@USDA.GOV		
JOE ROJAS	CITY OF DELANO	jrojas@cityofdelano.org 661 720 2155		60

PAGE 6 OF 13

PC Meeting 3 Sign In 6

FEMA Approval 4/9/2021

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Nick Cooper	GCWD	greenfieldcountywater@gmail.com	661-3013823	
Bill Malinen	Bear Valley CSD	bmalinen@bvcsd.org	661 821-4428	
Brianna Carrera	City of Bakersfield	bcarrera bakersfieldcity.us	661 326 3745	
John Frando	Bakersfield Fire	jfrando@bakersfieldfire.us	661 326-3652	
Melissa Kielpinski	Tehachapi Unified S.D.	mkielpinski@tehachapi.kl2.ca.us	661-822-2102	
Greg VanMullem	Assessor/ ITS	vanmullem@kerncounty.com	661-301-2259	
Rafael Molina	Cal Water	rmolina@calwater.com	661-827-7606	
Jose Pena	Cal water service	jpena@calwater.com	661-837-7273	
Tommy Aguilera	Taft City School District	taguilera@taftcity.org	661-213-6817	
Isela Medina	Semitropic WSD	imedina@semitropic.com	661-758-5113	

PC Meeting 3 Sign In 7

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Jeannie Taylor	Kern Co Fire CERT	jetaylor@KernCountyFire.org	661-391-7108	
Chris Hickernell	Friant Water Authority	chickernell@friantwater.org	559-562-6305	
Brad Aragon	Kern County Risk Mgmt	baragon@kerncounty.com	703-0385	
JEFF FARIS	EMS			
Bryan Auld	Sierra Sands USD Ridgecrest	bauld@ssusd.org	(760) 608-7174	
Laurca Robison	City of Maricopa	LRobison-Call@Bak.rr.com	661-747-3775	
Kelly Patterson	TUSD	KPatterson@tehachapi-k12.ca.us	661 822 2120	
Kirk Gilbert	TUSD	kgilbert@tehachapi-k12.ca.us	661 822 2120	
STEVEN SANTILLAN	Buttonwillow School	Ssantillan@buttonwillowschool.com	(661) 770-7180	70 miles
KIMBERLY FLEMING	COUNTY OF KERN - GS	FLEMINGK	661-868-3049	

PC Meeting 3 Sign In 8

FEMA Approval 4/9/2021

PC #3 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

September 19th, 2019
9:00 AM

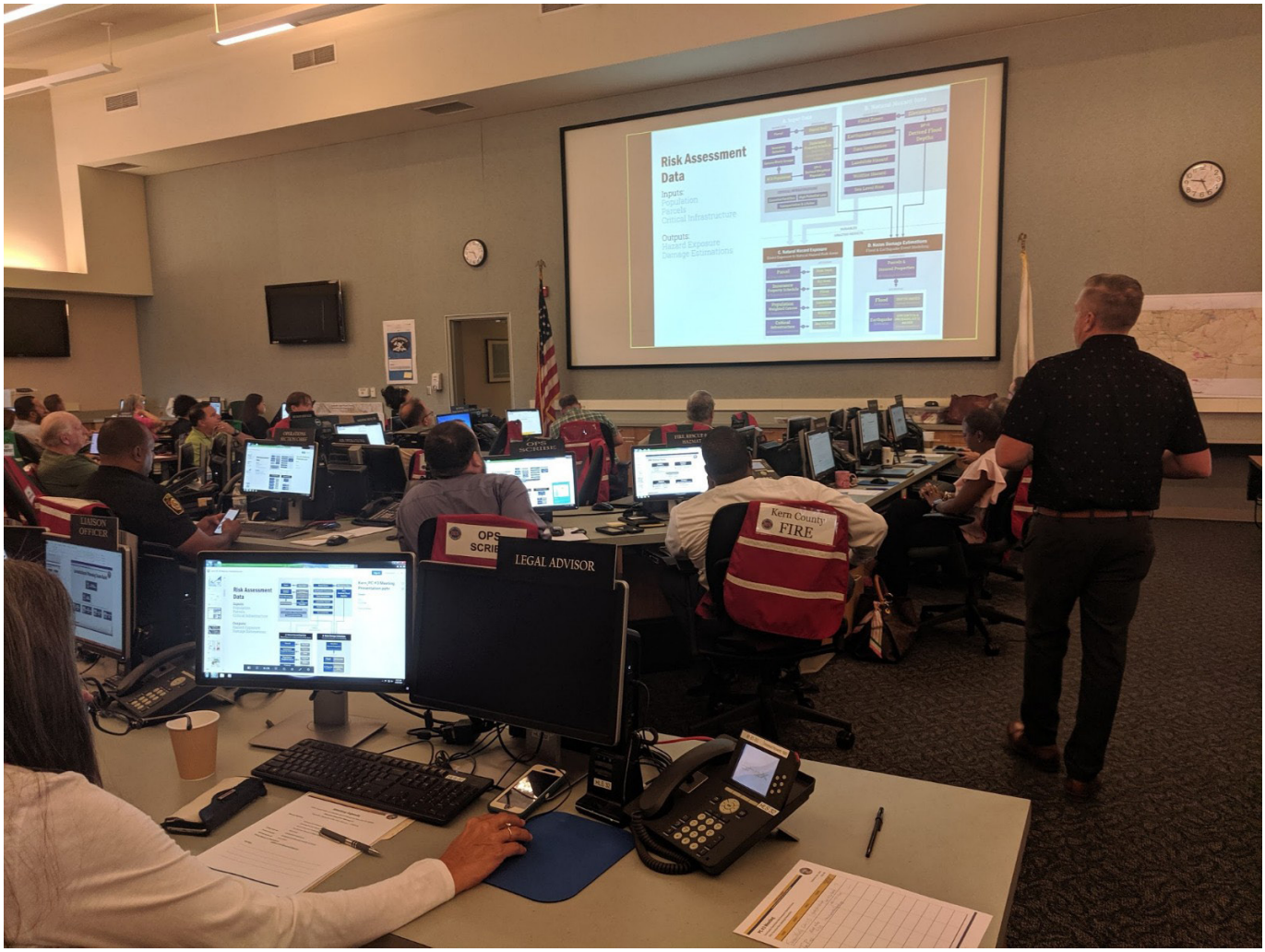
NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Fernando Ceja	Arvin-Edison Water Storage District	fceja@aewsd.org	661-444-3246	36 mi
Armando Gonzalez	Shafter Rec & Park District	mando.gonz097@gmail.com	661-900-2356	22 miles
Curtis Hilliker	Tehachapi-Cummings County Water District	chilliker@tccwd.com	661-565-8224	80 m

PC Meeting 3 Sign In 9

FEMA Approval 4/9/2021



PC Meeting 3 Photo 1



PC Meeting 3 Photo 2



PC Meeting 3 Photo 3

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KERN MULTI-JURISDICTION HAZARD MITIGATION PLAN UPDATE

Planning Committee Meeting #4 (Final Committee Meeting)

Thursday, November 14th, 2019
9:00 a.m. to 12:00 p.m.
Kern County/Operational Area Emergency Operations Center (EOC)
2601 Panorama Drive, Building B
Bakersfield



Nov 2019
14

You are cordially invited to attend the final Planning Committee meeting in the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan!

We are continuing the process to update the Kern Multi-Jurisdiction Hazard Mitigation Plan (MJHMP). As we update this plan, this stakeholder group is necessary and **your insight is needed (and, for those representing participating jurisdictions, required)** to meet FEMA's strict guidelines for active participation. Under FEMA's guidelines, active participation is a prerequisite for Plan approval.

At the last meeting, we presented the material that will assist each jurisdiction to pinpoint vulnerabilities and discussed ways to build a nexus between mitigation planning and FEMA's Hazard Mitigation Assistance (HMA) programs. During next week's meeting, we will demonstrate how to develop hazard areas of concern and mitigate them through FEMA's recommended planning process. We will also review our goals and objectives from the previous plan to see if they still apply to our current day hazard mitigation priorities. This meeting will enable us to update our mitigation strategy to solve real-world problems each community faces!

The agenda, meeting materials and handouts will be posted on the Kern County MJHMP Meetings website at least 24 hours before the meeting.

Project Password: **Kern2020**

In addition, the meeting will be transmitted live over the Internet to enable participation by those unable to travel to the meeting site. If you are unable to travel to the meeting site and want to participate this way, please let me know.

At the time of the meeting, please login at the time of the meeting with the link below:

PC4 Meeting Live Stream

If you haven't already responded to the Outlook invitation that was sent some time ago, please

Meeting 4 MailChimp Notification

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

Meeting Agenda

Kern County Multi-Jurisdiction Hazard Mitigation Plan 2019-20 Update

Planning Committee Meeting #4

Thursday, November 14th, 2019, 9:00 a.m. – 12:00 p.m.

Meeting Objectives:

- Welcome and Introductions
- Planning Process Recap
- Mitigation Alternatives
- Hazard Areas of Concern
- Goals & Objectives Review (previous plan)
- Updating the mitigation strategy

Project Website: mitigatehazards.com

Project Webpage: mitigatehazards.com/county-of-kern/

Website Password: **Kern2020**

Polling Website for Smartphone: **pollev.com/dynamicplanning**

NOTES:

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Kelly Patterson	Tehachapi Unified SD	kpatterson@tehachapik12.ca.us	661 8222120	70
Jeffrey Utter	Kern County	utterje@kerncounty.com	661-868-0041	—
Brianna Carmer	City of Bakersfield	bcarmer@bakersfieldcity.us	661-326-3745	—
Susan Wells	GHCSD	gm@ghcsd.com	661-822-3064	?
Chris Hickernell	Friant Water Authority	chickernell@friantwater.org	559-562-6305	—
JEFF BELL	SHAFTER RD	JBELL@SHAFTER.COM	661-746-8914	—
Patrick Alder	Kern High School Dist.	palder@kernhigh.org	661-827-3127	—
Dennis McNamara	Kern Co. Planning	mcnamarad@kerncounty.com	(661) 862-8624	—
JEFF FARISS	EMS PUBLIC HEALTH	FARISSJ@kerncounty.com	661-868-5214	—
Paul Anderson	North of the River Rec & Park District	panderson@norrecreation.org	661-619-0481	—
Mark Dawson	Arvin-Edison Water Storage Dist	mdawson@aewsd.org	(661)477-9405	

PC Meeting 4 Sign in 1

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Laura Robison	City of Maricopa	lrobison_law@bak.rr.com	661-769-8279	80 miles
Monica Tennant	KCWA	mtennant@kcwa.com	661-634-1419	12 miles
Ed Gordon	Stallion Springs CSD	EGordon.SSCSD@GMAIL.com	818-268-0345	76 miles
Joe Rojas	City of Delano	jrojas@cityofdelano.org	661.720.2287	60
Alexander	City of McFarland	alee@mcfarland ~~city~~ city.org	661-792-3091	60

PC Meeting 4 Sign in 10

FEMA Approval 4/9/2021

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
James Langille	KHSD	James_Langille@kernhigh.org	661-827-3174	
Peggy Hoy Walker	Pine Mt. Club	PEGGYHW1@gmail.com	818-383-7928	
Phyllis Throckmorton	Pine Mountain Club	phyllis.throckmorton@gmail.com 805-504-5542		
KARIN Shulman	PMCPOA	gm@pmcpoa.com	661-242-3988	
CHRIS COUNTS	KERN Community College District	CCounts@BakersfieldCollege.edu 661-337-0852		10
Yuriana Torres	Richland SD	Ytorres@rsdshafter.org	746-8621	
BRANDON SMITH	KCFD	BSSMITH@KERNCOUNTY.COM	330-0181	

PC Meeting 4 Sign in 2

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
MARK LEWIS	LIBRARY	LEWISMA@KERNCOUNTY.COM	661-868-0710	0
JEFF TACKETT	CITY OF WASCO		661-979 5615	60
Ryan Nunneley	NOR Municipal Water District	rnunneley@oildalewater.com	661-399-5516	10
Biridiana Bishop	City of Wasco	bibishop@ci.wasco.ca.us	(661-390-7601	60
Wayne Jackson	City of Wasco	Wejackson@ci.wasco.ca.us	661 779 0341	60
JOSE DE LEON	KCFD	JDELEON@KERNCOUNTYFIRE.ORG	661 330 0503	8

PC Meeting 4 Sign in 3

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Roger Sanchez	Kern High School Dist.	roger_sanchez@kernhigh.org	327-3119	
Jeremy Kosick	Cal City	JKosick@CalCityFire.US	760 8087546	
John Frando	Bakersfield Fire	Jfrando@bakersfieldfire.us	661 326-3652	
Jeremy Amr	Aging & Adult Services	oliverj@kerncounty.com	868-1034	
Kimberly Fleming	Kern County GS	FLEMINGK	868-3049	
Ivan Medina	Vineland S.D.		337-9610	
Tommy Aguilera	Taft City School		661-763-1521	

PAGE 4 OF 10

PC Meeting 4 Sign in 4

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Robert Voyles	City of Bakersfield	rvoyles@bakersfieldcity.us	661-326-3105	8
Adrian Nava	KSA & FCTHSD	NovaA@Kerncounty.com	661-862-8898	10
Kevin Hamilton	Kern County Public Works	kevinh@kerncounty.com	661-862-5071	10

PC Meeting 4 Sign in 5

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Curtis Hilliker	Tehachapi Cummings County Water District	chilliker@tccwd.com	661 565 8224	70m
Jeannie Taylor	KCFD	jetaylor@KernCountyFire.com	661 301-7111	15m
Michael Mata	KC Probation	michaelmata@kernprobation.org	661 . 204-3822	/

PC Meeting 4 Sign in 6

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Tim Ruiz	East Niles CSD	truize eastnilescsd.org	661-871-2011	
Pat Ostly	North of River Sanitary District	postly@norsd.com	661.399.6411	25
David Orr	Cal-City F.D.	dorr@calcityfire.us	661-476-7170	70
John Luna	Semitropic W.S.D.	MLUNA@SEMITROPIC.COM	661 809 2840	80

PAGE 7 OF 10

PC Meeting 4 Sign in 7

FEMA Approval 4/9/2021

PC#4 Meeting

Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Marcos Rodriguez	BCSD	MRODRIGUEZ@BCSD.com	631-5883	10.0
Wayne Clausen	City of Shafter	wclausen@shafter	746-5002	10
Nick Cooper	GCWD	Greenfield county water@gmail.com	301-3823	10.

PC Meeting 4 Sign in 8

FEMA Approval 4/9/2021

COUNTY OF KERN
Kern Multi-Jurisdiction 2019-20 MJHMP Update

PC#4 Meeting

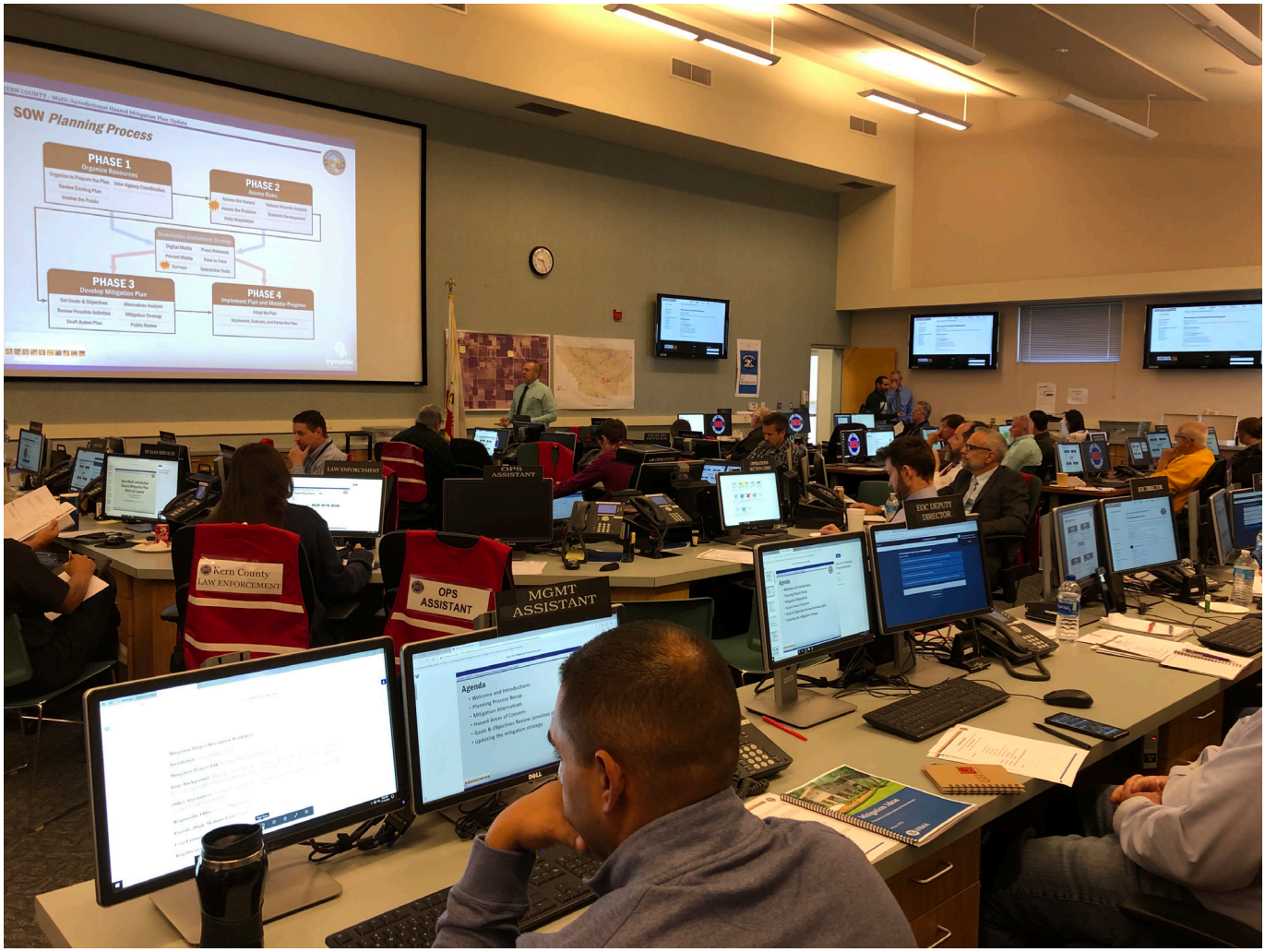
Kern County/Operational Area Emergency Operations Center
2601 Panorama Drive, Building B Bakersfield

November 14, 2019
9:00 AM

NAME	AGENCY	EMAIL	PHONE	ROUND-TRIP MILEAGE
Jared Bradford	Planning Department	BradfordJ@kerncounty.com	661-862-8653	10miles
Keith Gainey	Mojave USD	keithgainey@mojave.k12.ca.us	661-810-3251	80 miles
Raul Barraza, Jr	Arvin CSD	rbarraza@arvinsd.com	661 205-6432	40

PC Meeting 4 Sign in 9

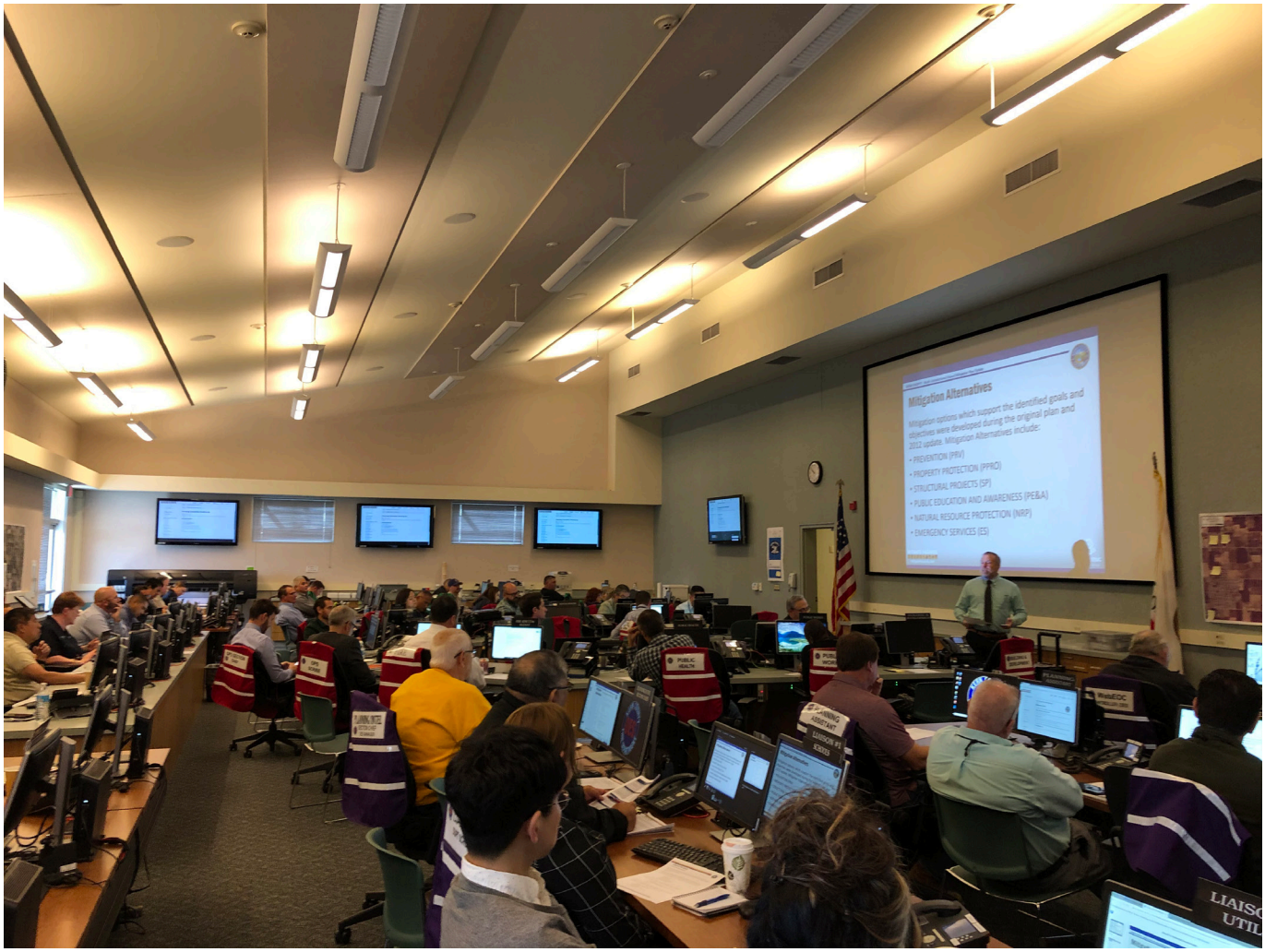
FEMA Approval 4/9/2021



PC Meeting 4 Photo 1



PC Meeting 4 Photo 2



PC Meeting 4 Photo 3

Torie Jarvis

From: Kris Lawrence <KLawrence@westsidewa.org>
Sent: Thursday, June 3, 2021 7:07 PM
To: Torie Jarvis
Cc: Morgan Mitchell
Subject: RE: Kern Batch Two Resubmittal

Hello,

On behalf of LHWD, Morgan Mitchell attended on zoom, thus there was no sign-in.
Also my email is incorrectly listed as klawrence@lkwd.org – it should be klawrence@westsidewa.org

Kris

From: Torie Jarvis <torie@dynamicplanning.co>
Sent: Thursday, May 27, 2021 11:38 AM
To: cviterelli@arvin.org; chuot@bakersfieldcity.us; jkosick@calcityfire.us; jrojas@cityofdelano.org; eziegler@bak.rr.com; hspurlock@ridgecrest-ca.gov; wclausen@shafter.com; cjones@cityoftaft.org; mrodriguez@bcsd.com; ssantillan@buttonwillowschool.com; joseph.grubbs@kccd.edu; nevans@kernvilleusd.org; keithgainey@mojave.k12.ca.us; mrodriguez@rsdshafter.org; bauld@ssusd.org; taguilera@taftcity.org; rbarraza@arvincsd.com; tmelanson@bvcsd.org; ssanders@norrecreation.org; bsmith@rosamondcsd.com; pjimenez@shafterrec.com; Kris Lawrence <KLawrence@westsidewa.org>; rhouchin@agcenteraccounting.com; dansolabehere@cawelowd.org; navaa@kerncounty.com; gm@ghcsd.com; greenfieldcountywater@gmail.com; jana@kerndelta.org; navaa@kerncounty.com; skye@kern-tulare.com; klawrence@lkwd.org; postly@norsd.com; rnunneley@oildalewater.com; imedina@semitropic.com; Greg Hammett <ghammett@wkwd.org>; emcdaris@wrmwsd.com
Cc: Wendy Benson <wbenson@kerncountyfire.org>; Ethan E. Mobley <ethan@dynamicplanning.co>
Subject: FW: Kern Batch Two Resubmittal

Hello to the "Wave Two" jurisdictional leads for the Kern Multi-Jurisdiction Hazard Mitigation Plan!

We wanted to update you that we have received and incorporated comments from Cal OES and FEMA on your annexes. You can see their comments as well as our responses in the attached Word document.

Today we resubmitted annexes to the agencies for final review. Hopefully we'll receive letters from FEMA that confirm the annexes are "approvable pending adoption" or APA shortly.

Next steps for finalizing your annexes are:

1. Receive APA letter from FEMA
2. Initiate adoptions of the HMP from each jurisdiction. **NOTE each jurisdiction must adopt the MJHMP and its annex to have an active HMP under FEMA requirements**.
    a. Wendy Benson with Kern County will coordinate adoption proceedings and collect resolutions from each jurisdiction.
    b. We hope all adoptions can be conducted within a 2-month window, after which we'll submit adoption records to FEMA.
    c. Wendy will provide you all with sample resolution language and a background memo to assist with your adoption proceedings once we have the APA.

Thanks, all! We're rounding the finish line!

Torie Jarvis

From: Wendy Benson <wbenson@kerncountyfire.org>
Sent: Wednesday, June 2, 2021 7:02 PM
To: Torie Jarvis; Ethan E. Mobley; Clare Peabody
Subject: Re: Kern Co w2 question
Attachments: Attendance x 4.xlsx; Email, Teubert-Benson 6-6-2019.pdf; HMPC.Sign.In.9.19.19.pdf; Kern MJHMP Notebook Entries.pdf; Email, Crabb-Benson 10-8-2019.pdf; Email, Hammett-Benson 10-8-2019.pdf

Hi All:

Welcome, Clare!

Attached is the additional documentation I have on the attendees Cal OES asked about previously:

- An Excel workbook I kept to document attendance at the 2019 Planning Committee meetings. I've highlighted the entries I made for Berrenda Mesa Water District/Lost Hills Water District Regulatory Coordinator Kris Lawrence and Resource Analyst Morgan Mitchell. The entries mostly came from the meeting sign-in sheets, my contemporaneous notes (more on those shortly), and my in-meeting observations.

  This is the only documentation I have that Morgan Mitchell attended Meeting #1. I'd never had any prior interaction with him and I wouldn't recognize him if I saw him today. My guess is that he sat next to Kris Lawrence at the meeting, I talked to Kris at some point during Meeting #1, and Kris introduced me to Morgan. Kris signed in, but Morgan did not.

  In a wrap-up email with then-DP+S Assistant Project Manager Maureen Teubert a couple of weeks after Meeting #1 (attached), I wrote that I knew of at least two meeting participants whom I saw at the meeting but who weren't on any of the sign-in sheets I had. Please see the box on Page 2. My guess (again, a guess) is that Morgan Mitchell was one of the two.

- I re-reviewed the sign-in sheets for Meeting #3 (attached) and discovered that Kris Lawrence signed in after all. Please see Page 5 of 13.

- Excerpts from the notes I took during the Planning Committee meetings. I noted who attended meetings via Zoom by viewing the Participants panel during each meeting:

  - Meeting #1, 5/23/2019 (Page 2 of 5)

    Christine Viterelli, City of Arvin ("Viterelli")
    David Ansolabehere, Cawelo Water District ("Ansolabehere")
    Deann Crabtree, West Kern Water District ("Crabtree")

  - Meeting #2, 7/18/2019 (Page 3 of 5)

    Andrea Crabb, West Kern Water District ("A Crabb")
    Christine Viterelli, City of Arvin ("C Viterelli")
    David Ansolabehere, Cawelo Water District ("D Ansolabehere")
    Greg Hammett, West Kern Water District ("G Hammett")

  - Meeting #3, 9/19/2019 [noted as 9/18/2019] (Page 4 of 5)

    Greg Hammett, West Kern Water District ("G Hammett")
    Andrea Crabb, West Kern Water District ("AndreaC[rabb]")

    I followed up with Andrea and Greg to verify that they were, respectively, "AndreaC" and "Greg H." Please see the attached emails.

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Public Notice & Press Release Documentation

Appendix B.2

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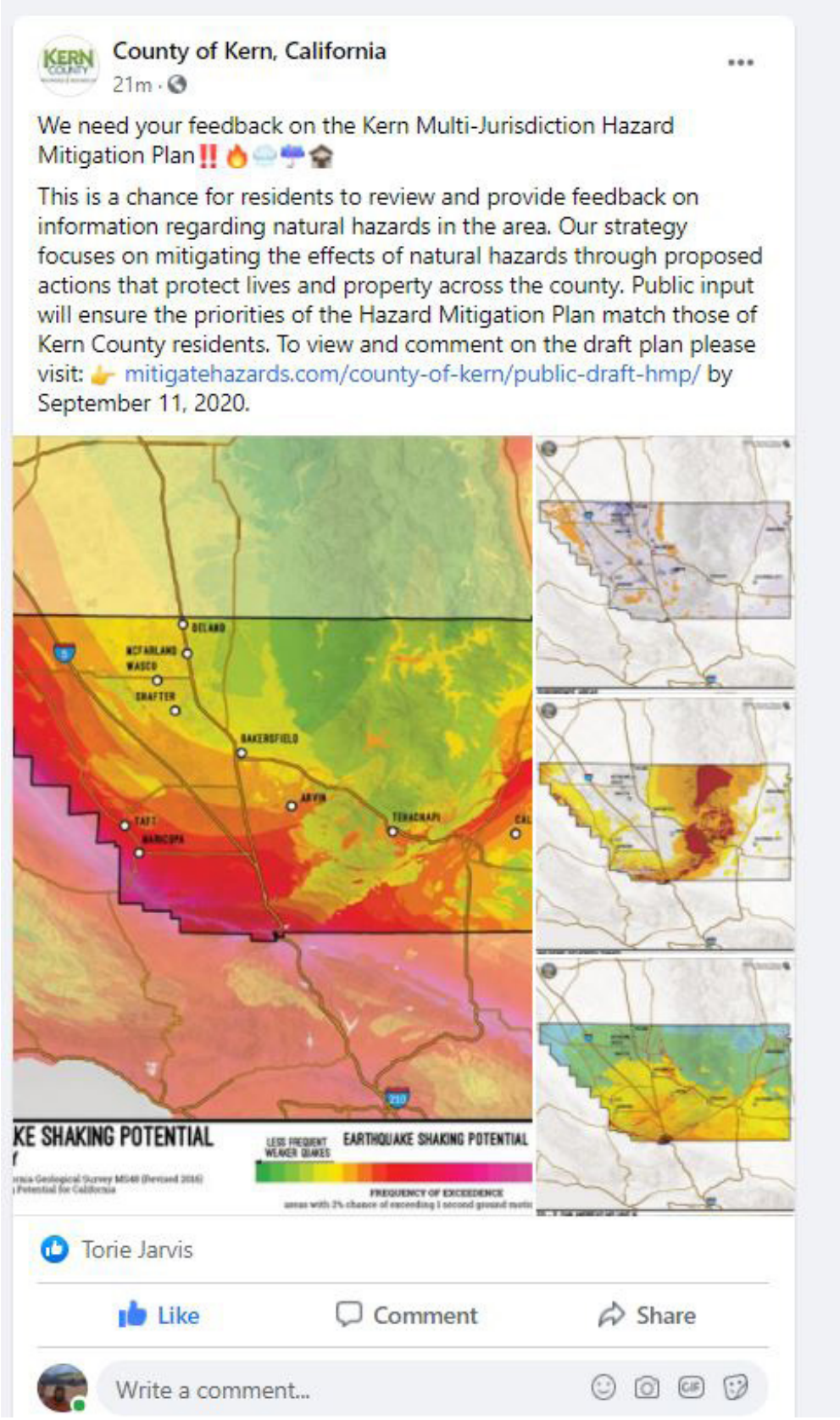
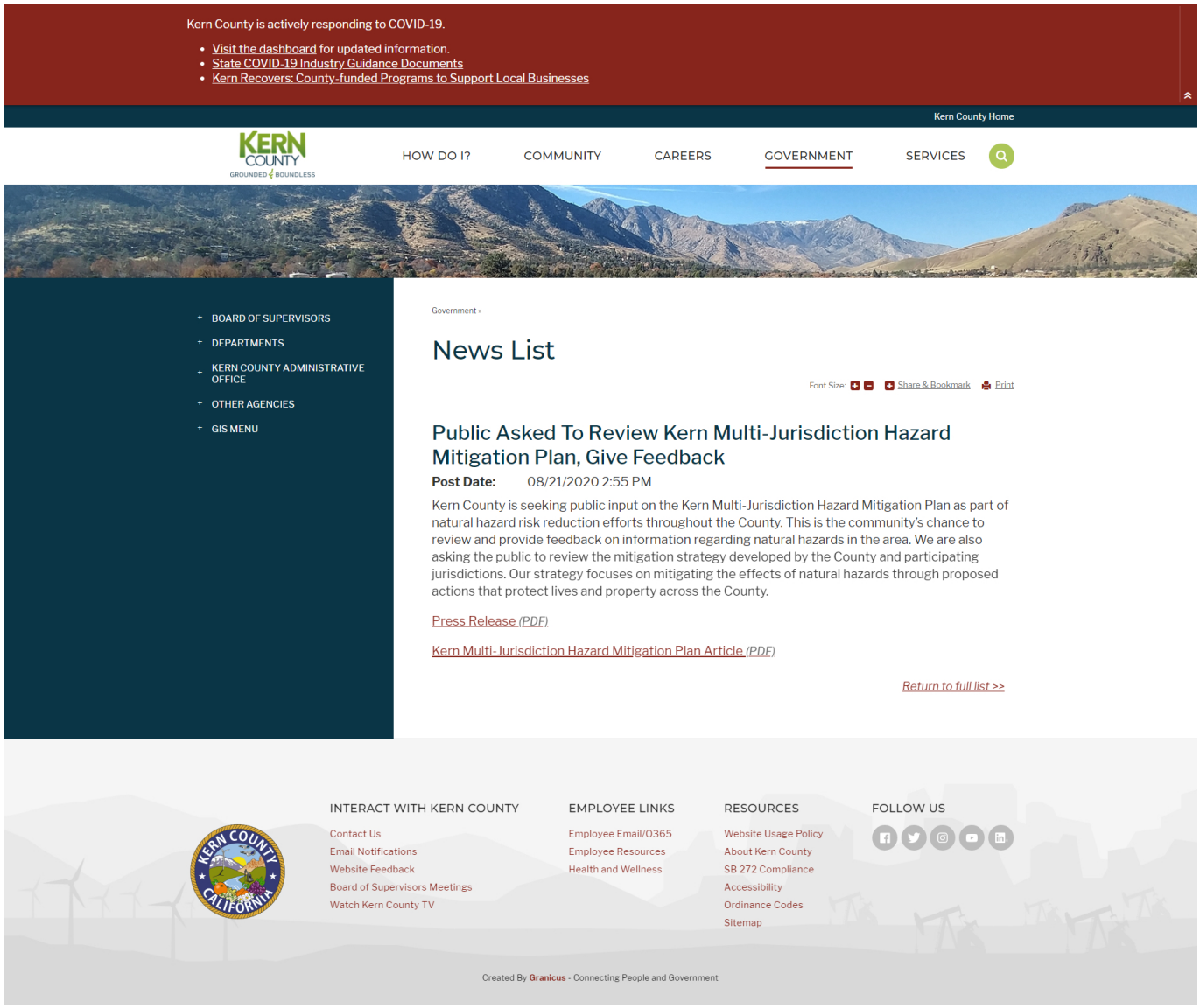
survey graphic



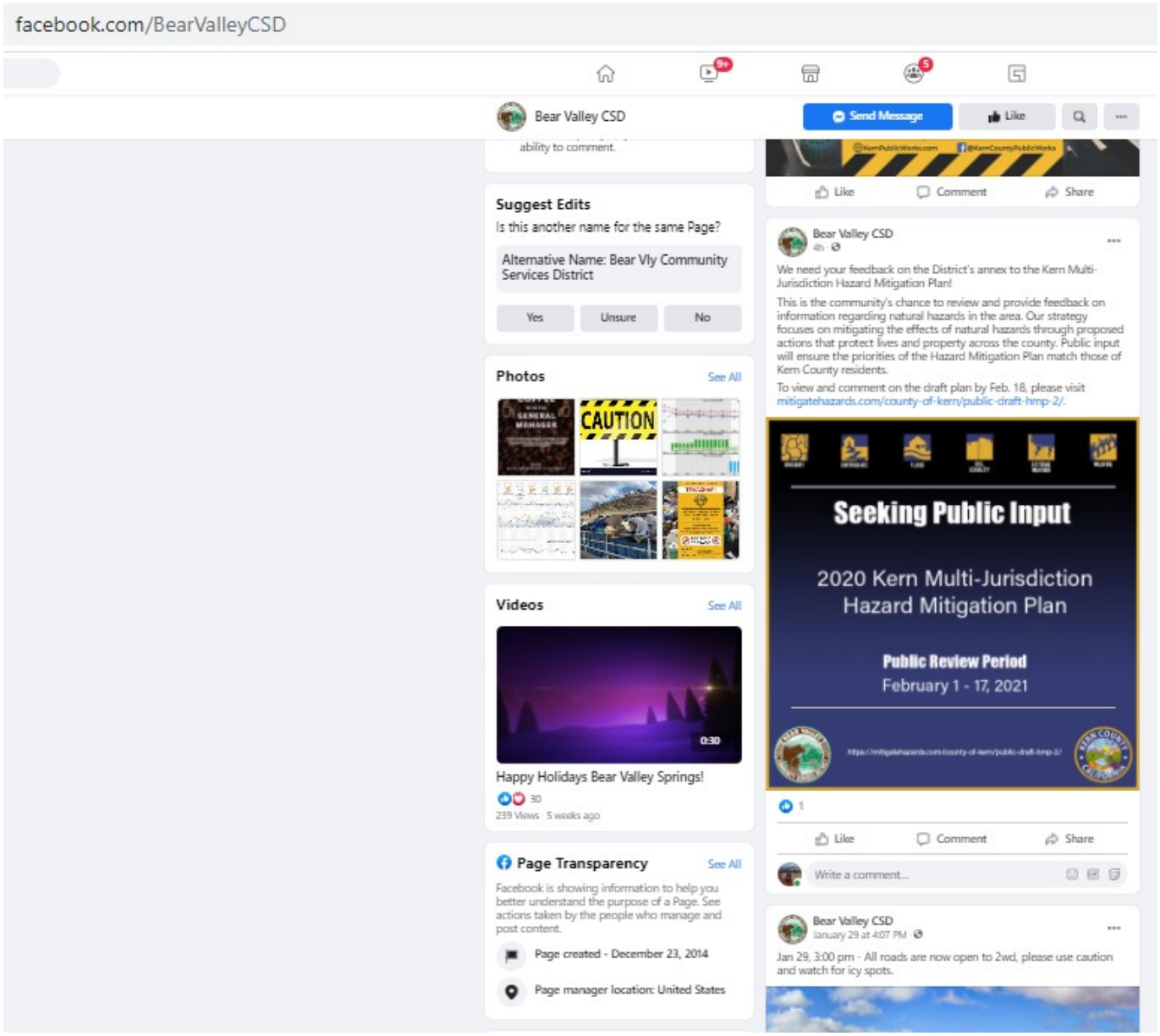
Kern County Facebook



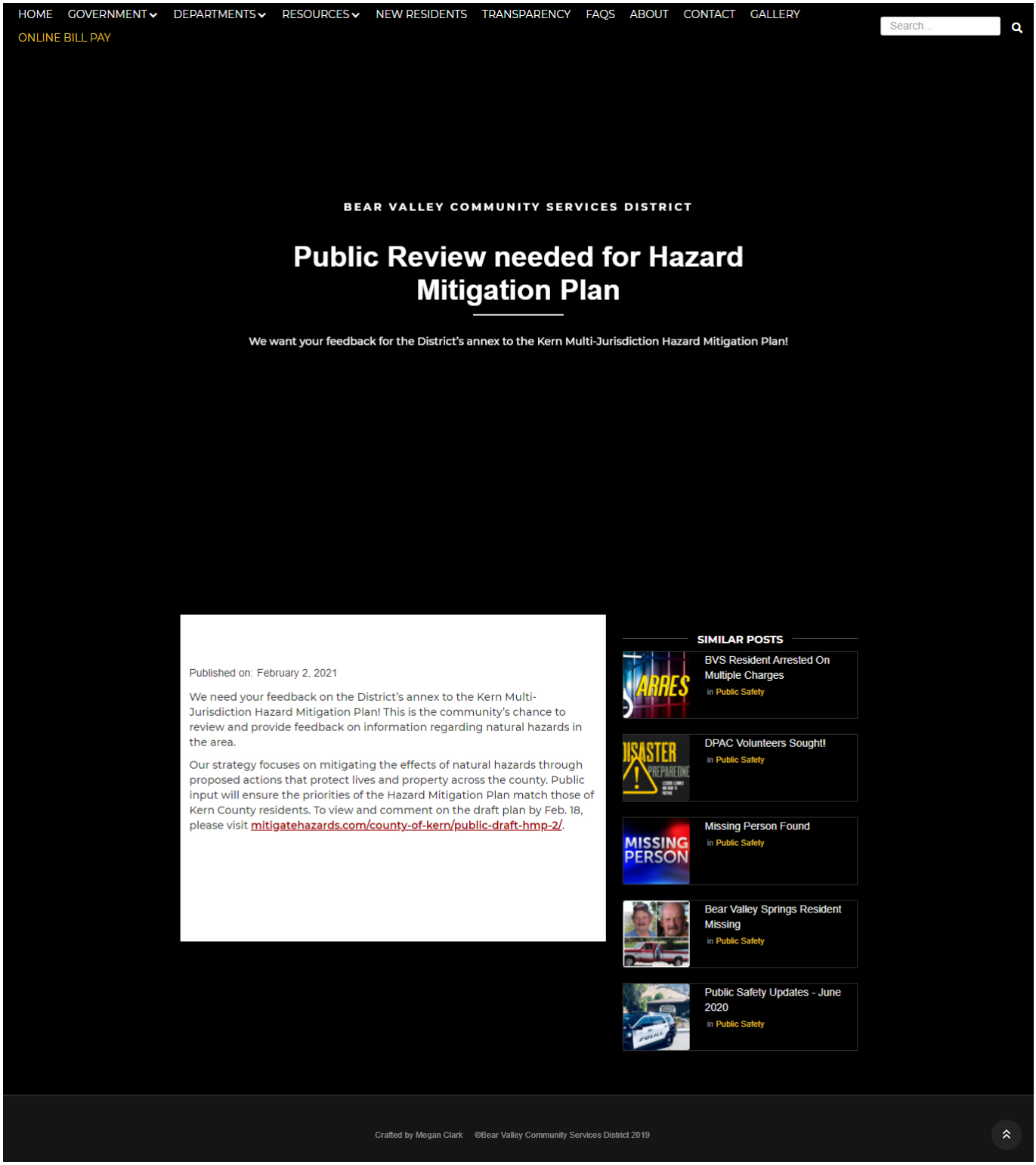
Public release web post 8-21-2020

Kern County MJHMP Response to Public Comments

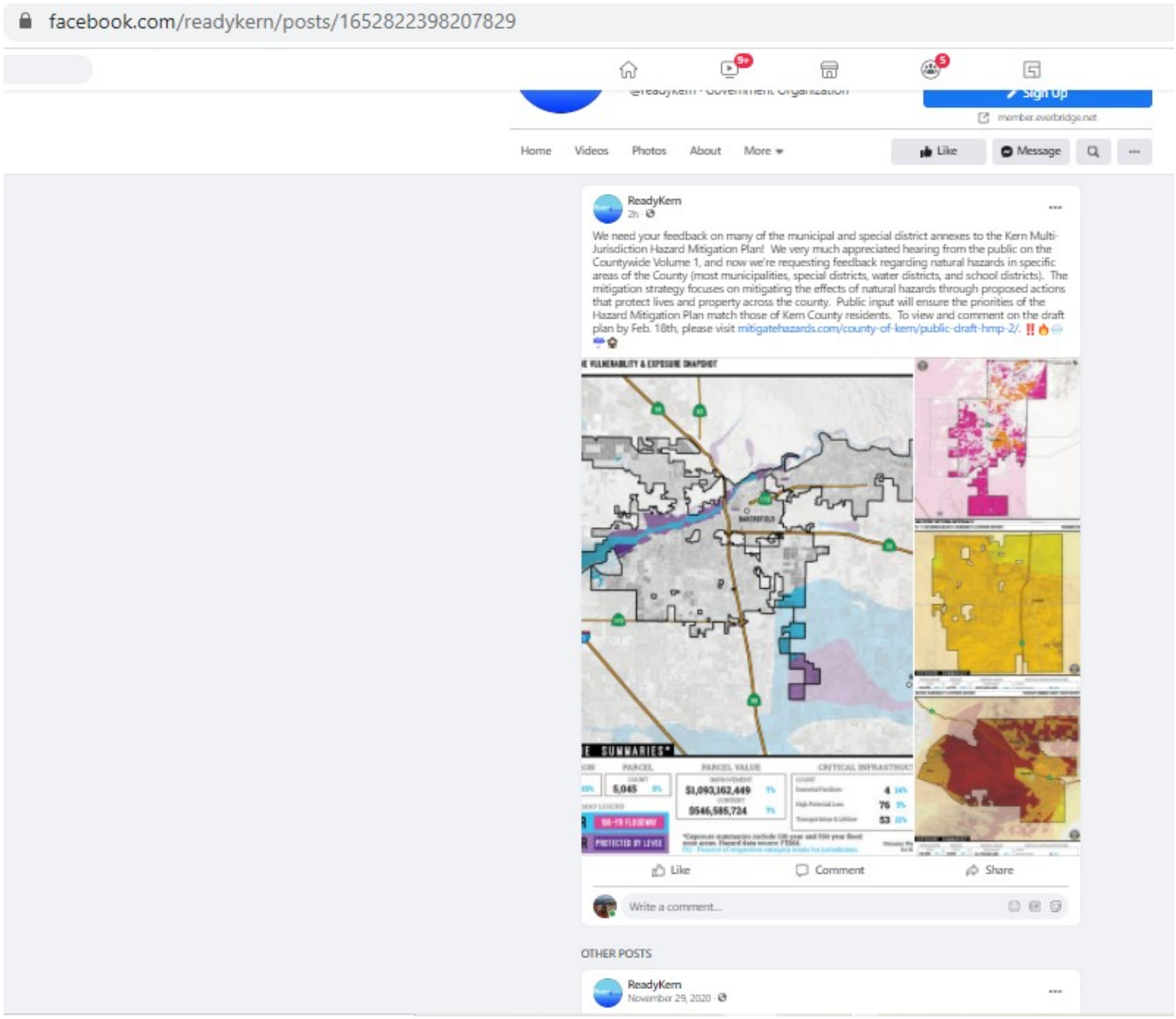
No.	Format for comment	Comment	Recommended Response
1	Via online comment form	In this new draft plan, as in the older plan as well, hospitals are listed as critical facilities on page 4-24. But the public hospitals of Kern County comprised of Kern Medical Center, Kern Valley Healthcare District, and Tehachapi Valley Healthcare District are not listed in the Participating Jurisdictions list that is on page 2-1. The Kern Valley Healthcare District, having recently submitted a grant application to CalOES/FEMA, found that because we are not listed in the mitigation plan, we had to go through a long process of approval with the Kern County Administrative Department to have the County submit the application for us. If we were listed by name in the plan, we would have been able to directly submit saving a large amount of time and effort on both the Hospital Districts part, as well as Kern County's part. Since we are a District of the County, should we not be included in the plan?	When the first version of the Kern MJHMP was being developed in 2004, the Kern Valley Healthcare District was invited to participate, along with the aforementioned scores of other jurisdictions. Ultimately, 65 jurisdictions accepted the invitation. (There are 58 participating jurisdictions now. A few have dropped off over the years.) It appears that the Kern Valley Healthcare District did not follow through on the 2004 invitation, so is not part of the Kern MJHMP now. Unfortunately, we have not been able to add any new jurisdictions to the list of participants since 2004. You accurately observed that the Kern Valley Healthcare District, as have other local government entities, requested that the County of Kern apply for Hazard Mitigation Assistance (HMA) grant funds on its behalf. The County approved the District's request last fall, resulting in Application #DR-4407-0195.
2	Via online comment form	Volume 3, Section 10 - Page 50, Tehachapi Unified School District: Please change Business Services Chief Administrator name to Hojat Entezari	This change has been made.



Bear Valley CSD Facebook post



Bear Valley CSD website re survey



ReadyKern Facebook post WaveTwo

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Survey & Results Documentation

Appendix B.3

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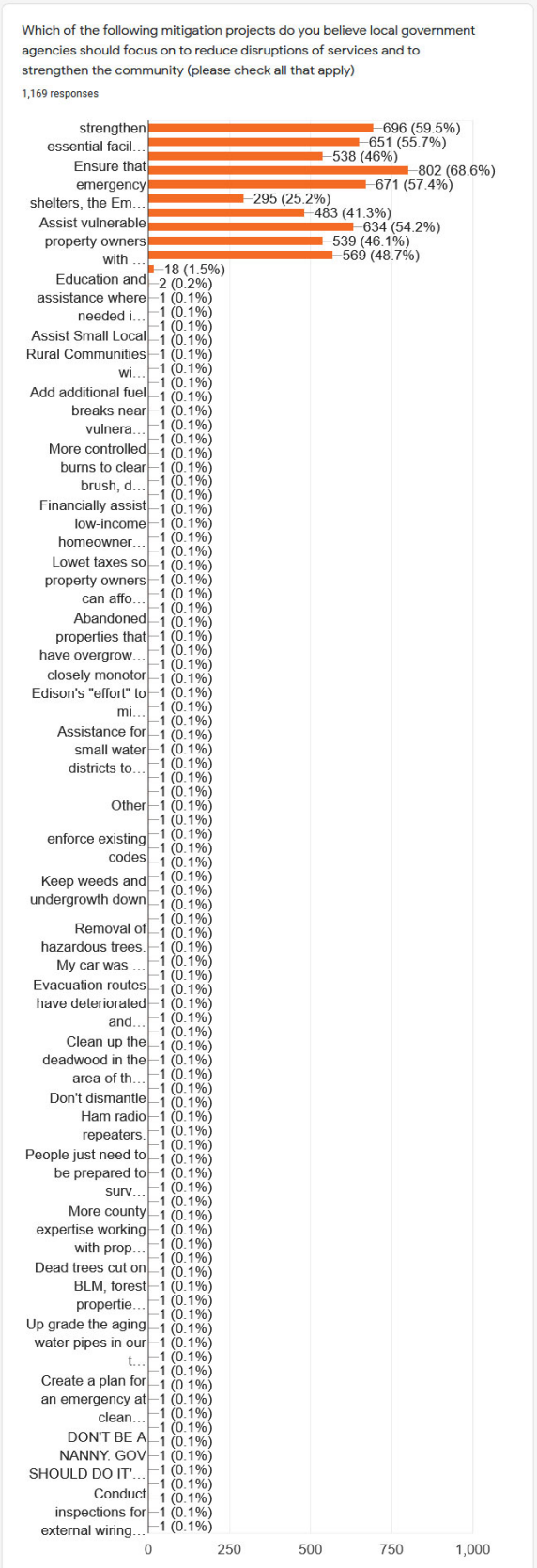


English Survey 06

Thank you again for completing the survey! Please provide any additional comments that you may have regarding hazard mitigation and community protection against natural disasters.

190 responses

None

Switching to renewable energy sources and caring for low income communities

N/A

Thanks

We have no protection that requires a sheriff and animal control to respond quickly. They come from an hour away.

Need to clear sides of freeways to prevent car fires from causing big fires.

Ensure that codes are current and practical, and that property owners are in compliance.

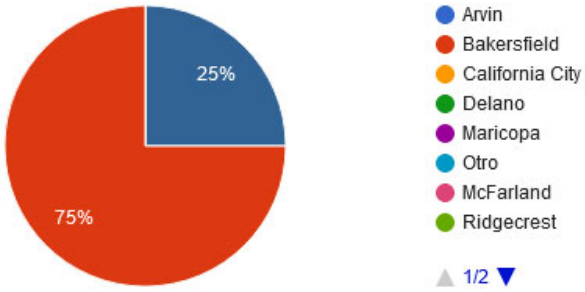
help home owners and businesses with solar systems to join together to form a small electrical grid to be used when there are power outages in area.

English Survey 08

Por favor complete todas las preguntas de la encuesta completamente. Gracias por su participación.

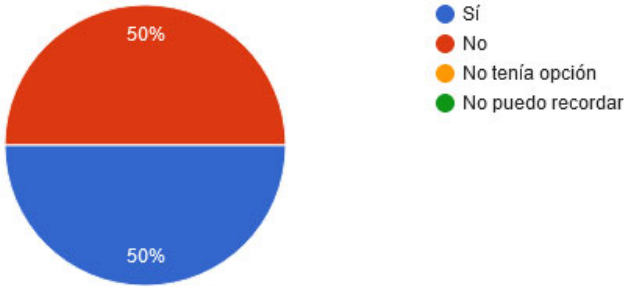
Vivo en...

4 responses



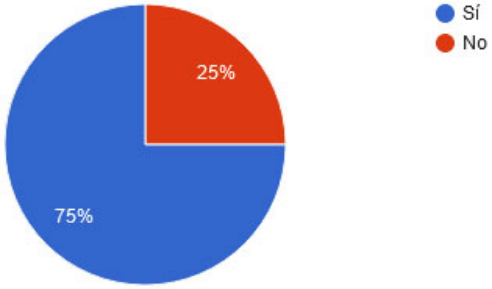
¿Consideró los riesgos de peligros naturales cuando eligió su hogar?

4 responses

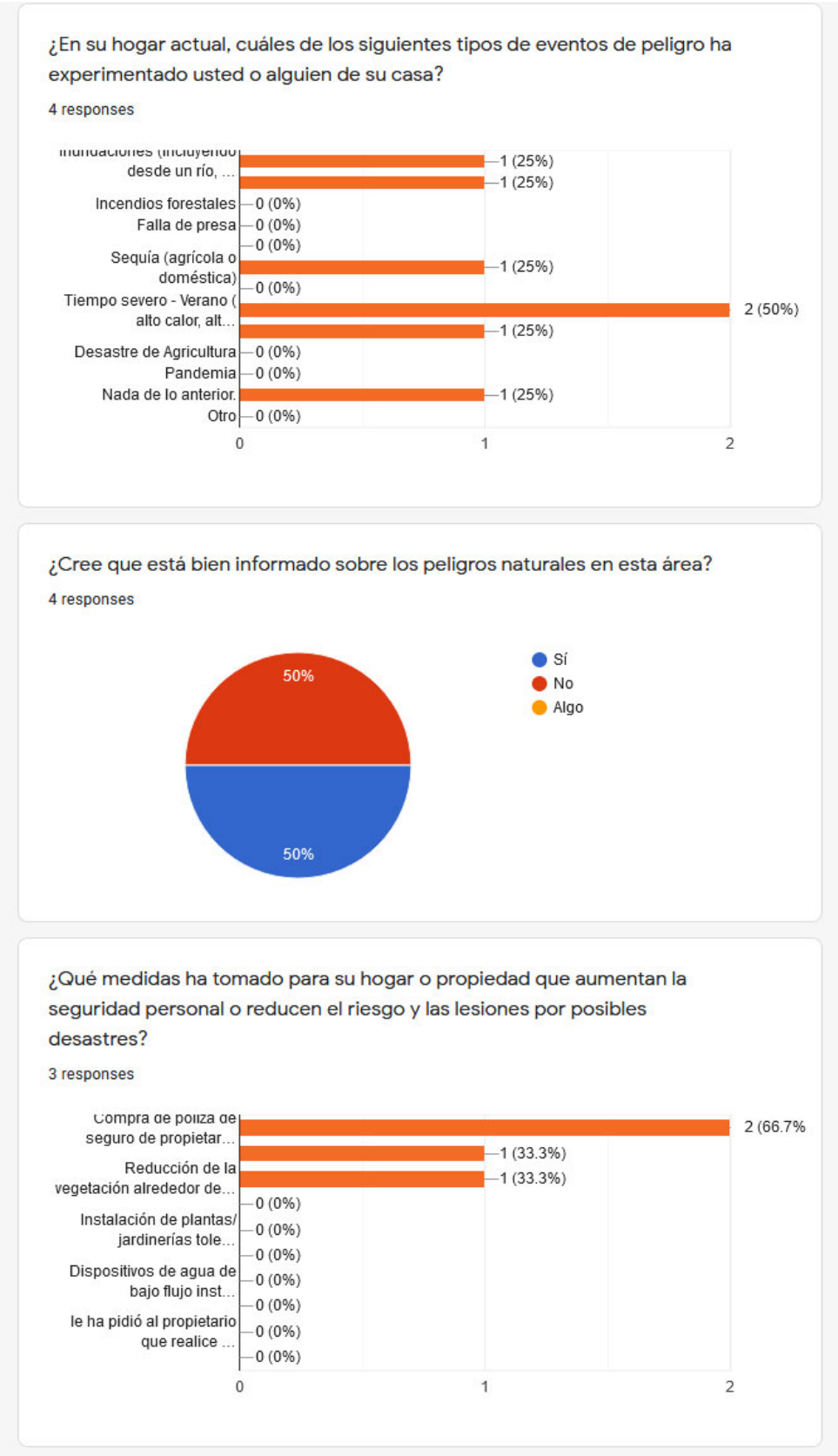


¿Cree que su propiedad está en riesgo por un desastre de peligro natural?

4 responses



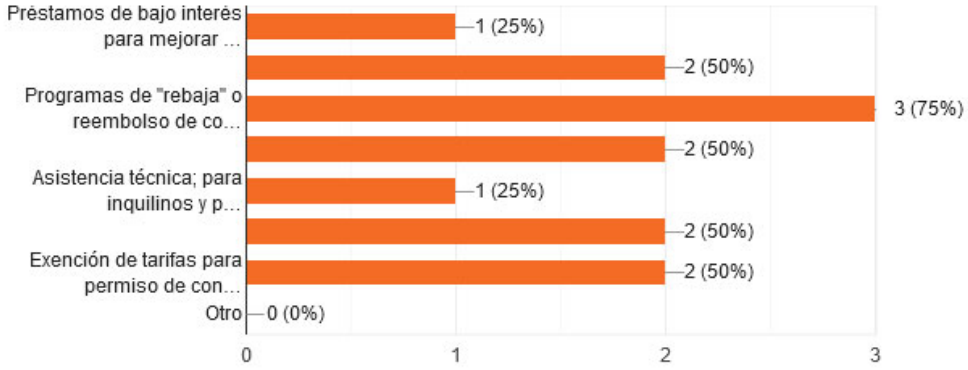
Spanish Survey 01



Spanish Survey 02

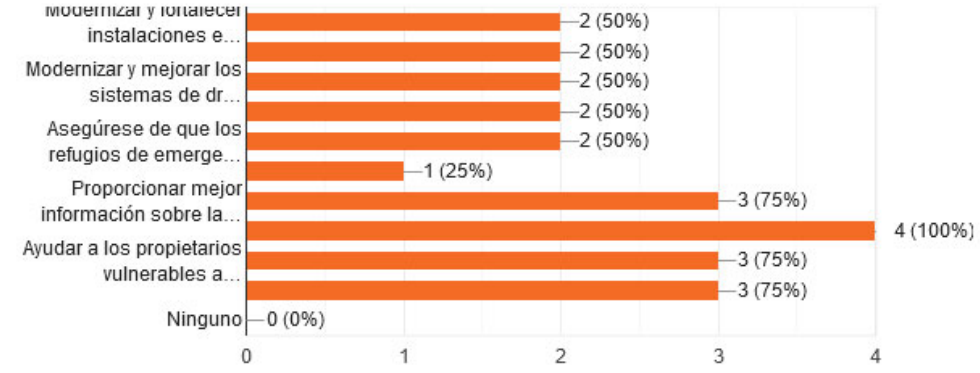
¿Cuál de los siguientes incentivos lo alentaría a proteger su hogar para resistir los impactos de posibles peligros naturales?

4 responses



¿Cuál de los siguientes proyectos de mitigación cree que las agencias gubernamentales locales deben de concentrarse en reducir las interrupciones de servicios y fortalecer la comunidad?

4 responses



¡Gracias de nuevo por completar la encuesta! Por favor proporcione cualquier comentario adicional que pueda tener con respecto a la mitigación de riesgos y la protección de la comunidad contra desastres naturales.

1 response

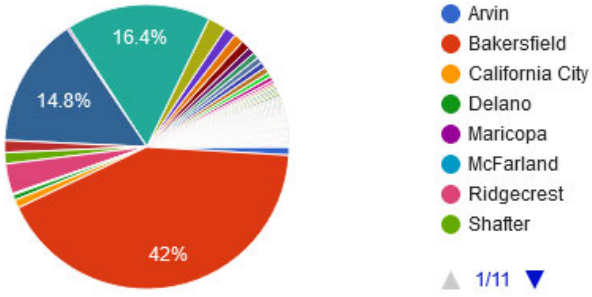
Gracias

Spanish Survey 03

Please fill out all the survey questions completely. Thanks for your participation.

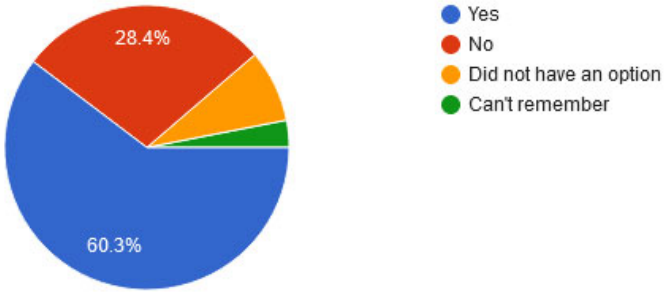
I live in...

1,169 responses



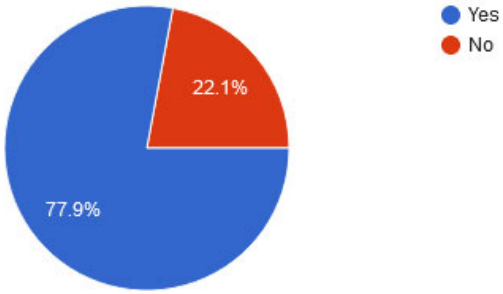
Did you consider the risks of naturally occurring hazards when you chose your home?

1,169 responses

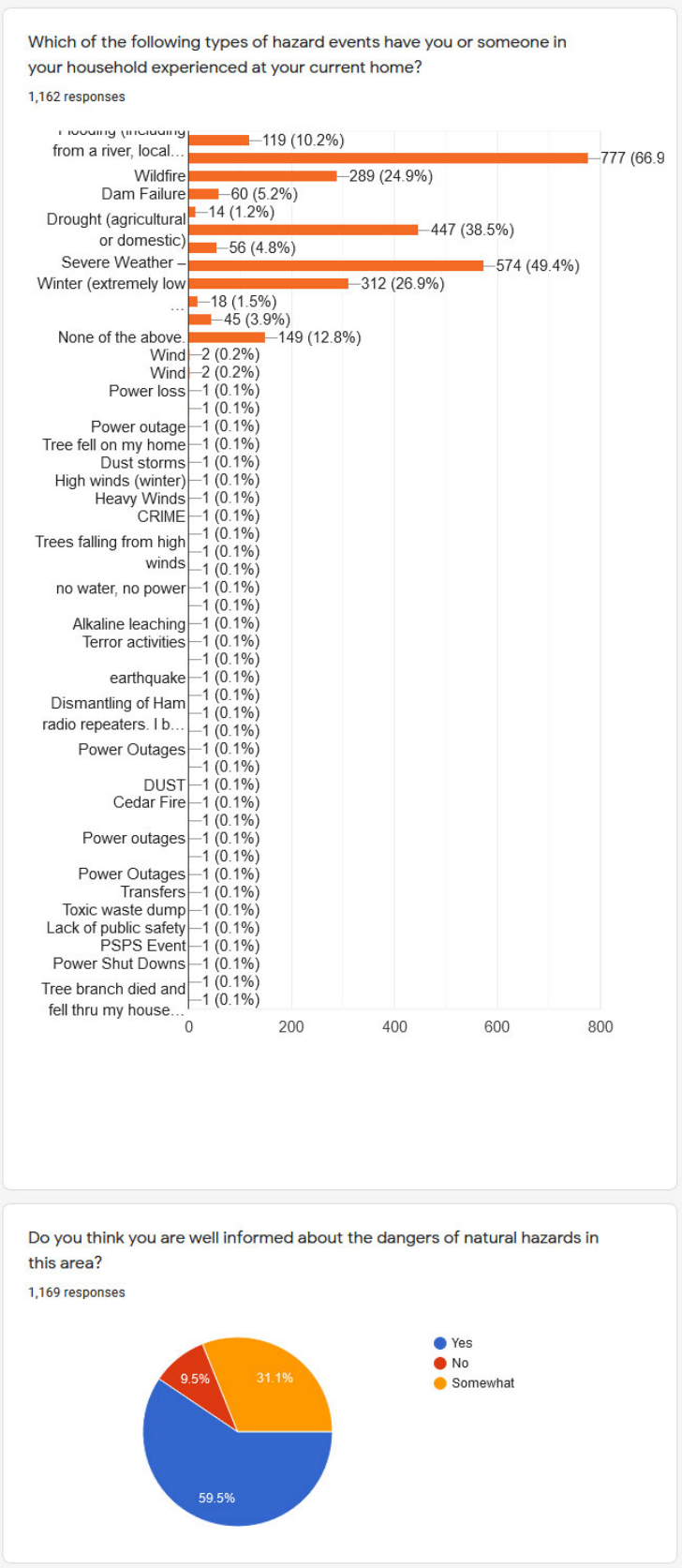


Do you believe your property is at risk from a natural hazard disaster?

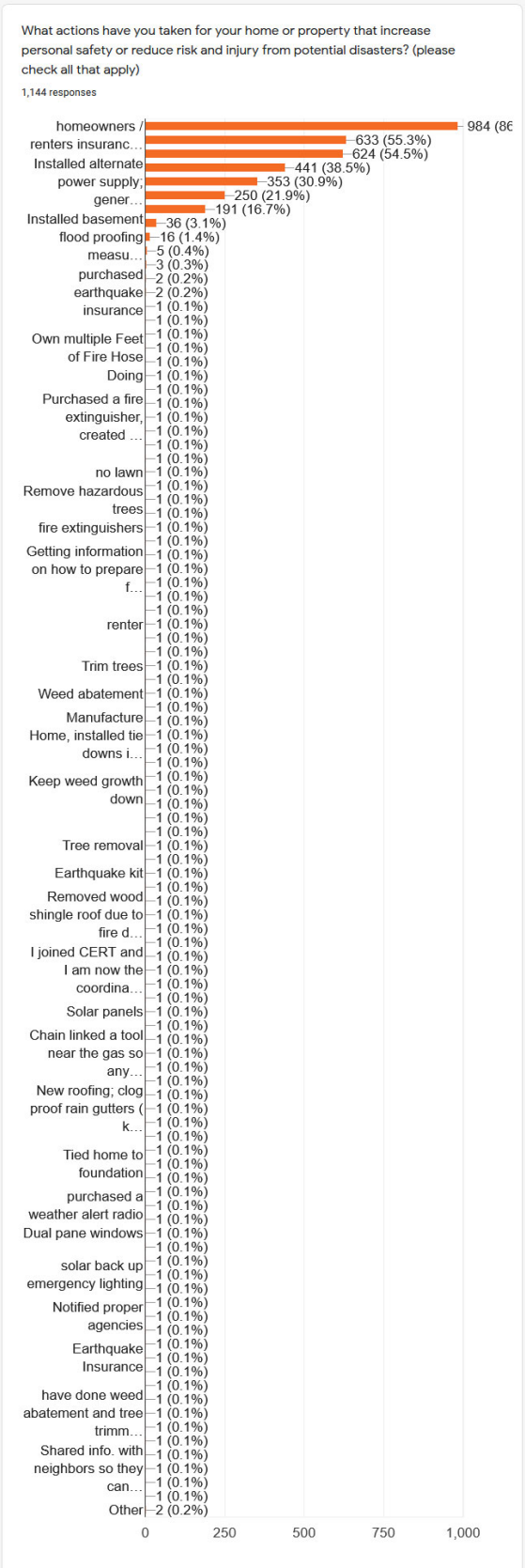
1,169 responses



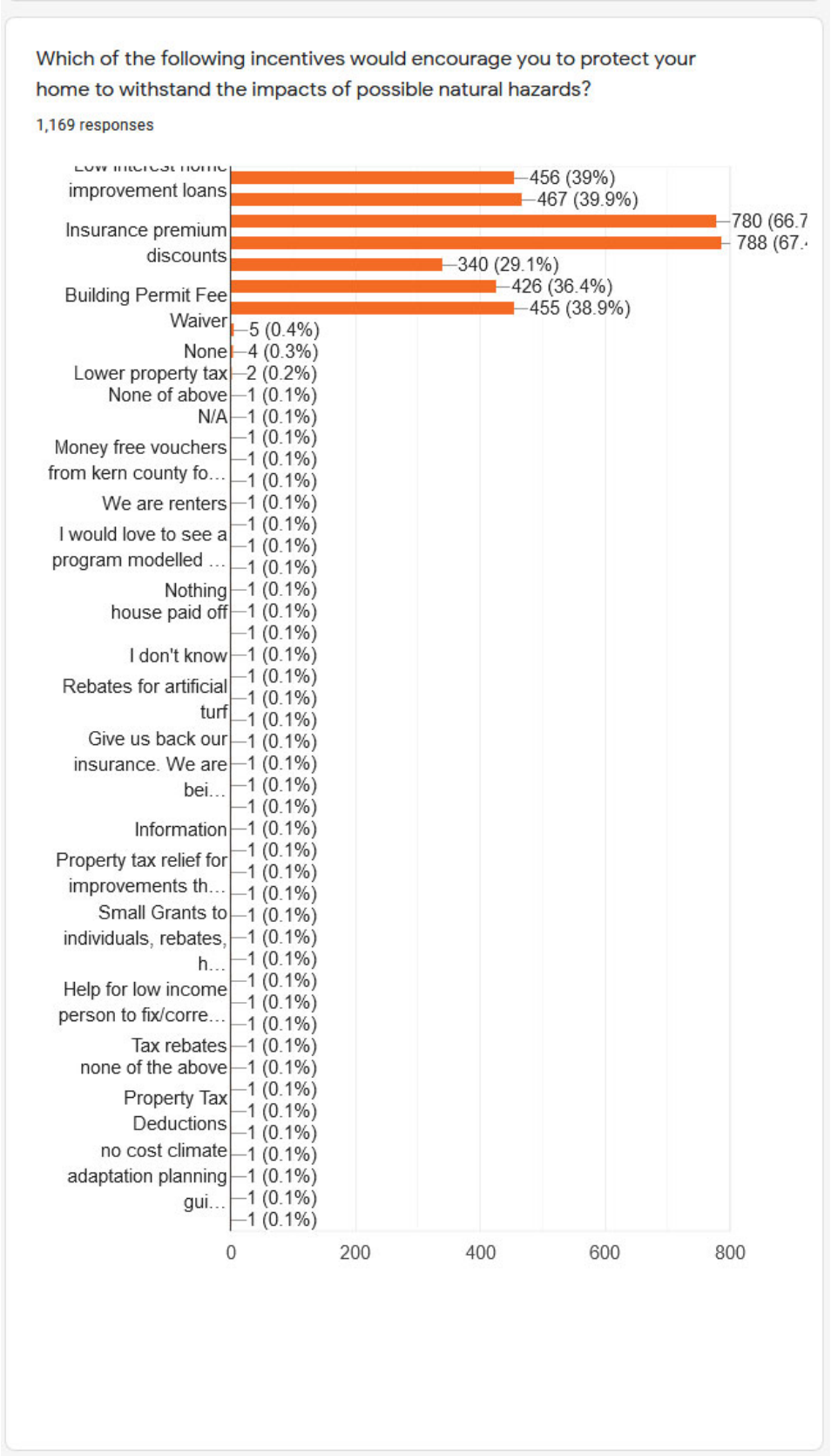
English Survey 01



English Survey 02



English Survey 03



English Survey 05

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Mitigation Strategy Prioritization Process Documentation

Appendix B.4

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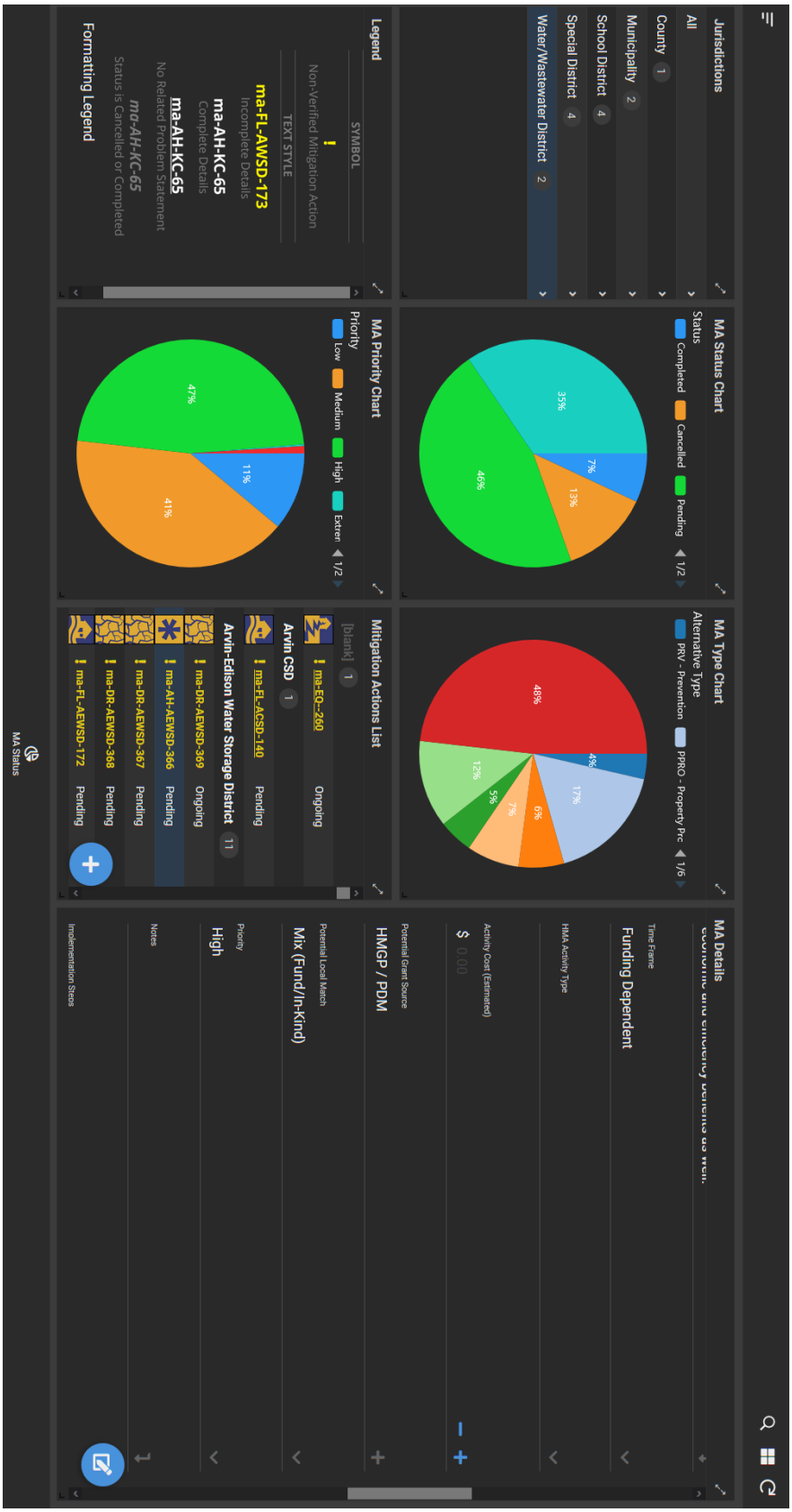

MAST Priority Field

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Website Documentation

Appendix B.5

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Kern County MJHMP Update

Executive Summary

Mitigation at Home

Other Planning Documents

Get Involved

Learn More

Stakeholder Pages

Draft HMP Documents

RAMP (Risk Mapping)

MAST (Mitigation Strategy)

Planning Process Library

Meetings

Document Upload

PM Team Pages

PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

Executive Summary

PRINT

Kern County, along with 62 other participating jurisdictions, will develop an update to the 2012-14 Kern Multi-Jurisdiction Hazard Mitigation Plan to reduce losses resulting from natural disasters. Hazard mitigation is the use of sustained, long-term actions to reduce the loss of life, personal injury, and property damage that can result from a disaster. Benefits of mitigation planning include:

- Identifying actions for risk reduction through collaboration with stakeholders and the public,
- Focusing resources on the greatest risks and vulnerabilities,
- Building partnerships by involving citizens, organizations, and businesses,
- Increasing education and awareness of threats and hazards, as well as their risks,
- Communicating priorities to State and Federal officials, and
- Aligning risk reduction with other community objectives.

Planning efforts could include capital projects and other pragmatic activities that can mitigate the impacts of hazards. The 2019-20 MJHMP Update will cover each of the major natural hazards that pose risks to County infrastructure and residents. Recognizing that successful mitigation planning efforts must be communicated and understood by the public, the County approach will include stakeholder participation and input with the use of cutting edge GIS technology to map and update the hazard information for each hazard profiled in the 2019-20 MJHMP.

Participating Jurisdictions

The 2019-20 MJHMP update will include, at a minimum, the jurisdictions listed below. It is understood that the County also encompasses areas of land controlled by Federal and State land management agencies, including the California Department of Forestry and Fire Protection, Bureau of Land Management, and Bureau of Reclamation. While other levels of government have jurisdiction in these parts of the County, the Hazard Mitigation Plan could also be used to document and coordinate mitigation efforts among Federal, State, and local jurisdictions. In addition, it will be important to invite organizations such as public and private utility companies to be stakeholders during the update process.

The following jurisdictions will meet FEMA guidelines and requirements as a formal participating agency:

Municipalities

- City of Arvin
- City of Bakersfield
- City of California City
- City of Delano
- City of Ridgecrest
- City of Shafter
- City of Taft
- City of Tehachapi

MITIGATE HAZARDS

WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

- Executive Summary
- Mitigation at Home
- Other Planning Documents
- Get Involved
- Learn More

Stakeholder Pages

- Draft HMP Documents
- RAMP (Risk Mapping)
- MAST (Mitigation Strategy)
- Planning Process Library
- Meetings
- Document Upload

PM Team Pages

- PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan
2019-20 Update

Mitigation at Home

Perform Mitigation Around Your Home!

Mitigation around your home can better prepare you and your family for an unexpected emergency or disaster incident, and help you recover more quickly. Here are some resources to get you started.

Assess Your Own Risk

Using Cal OES MyHazards, type in your address to asses your risk to natural hazards including earthquakes, flood, fire and tsunami. Learn what you should do to reduce injuries, protect your life and those of others, and reduce damage to your home and property.

Visit Ready.gov to learn about different hazards and how you can prepare your home or business for these events.

Home Mitigation Ideas

Now that you're familiar with the hazards that have the potential to affect your community, check out some of these mitigation techniques that can be performed around your home.

Wildfire Mitigation Ideas

- Kern County Fire Hazard Reduction Program: Home Inspections, Defensible Space Planning and Preparation Guide and other local mitigation resources.
- California Fire Safe Council: Information on grants/ funding programs and community events.
- CAL FIRE Why 100': Video from CAL Fire with defensible space guidelines for your home.
- CAL FIRE Ready for Wildfire: CAL Fire website for preparing your home for wildfire.
- CAL Fire Ready for Wildfire (Get Ready): CAL Fire tips on defensible space, hardening your home, and fire-resistant landscapes.
- CAL Fire Ready for Wildfire (Prevention): CAL Fire "One Less Spark" wildfire prevention tips for equipment use, debris burning, campfires and more.

Earthquake Mitigation Ideas

- FEMA Earthquake Home Hazard Hunt: FEMA recommendations for reducing earthquake hazards in your home.
- California Earthquake Brace and Bolt Program: California EBB provides $3,000 grants to be used toward a code-compliant seismic retrofit for houses that qualify. Find out more about the program and if your house qualifies.

Flood Mitigation Ideas

- FEMA Flood Mitigation: Tips for preparing your home or workplace, collecting sources of information, developing an emergency communications plan and knowing what to do when a flood is approaching your home or business.
- California Flood Preparedness Tips: Tips on how to divert water away from your home during a flood including sandbag filling and placement.

Severe Weather Mitigation Ideas

- Severe Storm Mitigation: Tips to equip your home with the accessories it will need to survive a storm from the National Association of Home Builders.

Drought Mitigation Ideas

- Water Association of Kern County: Water conservation tips for homeowners.
- Save Our Water: Tips and resources for water conservation in and around the home.

Reduce Personal Risk or Injury

Create a Plan

Every household should have a disaster plan! Meet with your family members and discuss why you need to prepare for a disaster. Discuss and explain the dangers of the various hazards that may impact your home or your community.

Build an Emergency Kit

An emergency kit is assembled so that in case of an emergency you are prepared ahead of time. It is possible that you will need to survive on your own after an emergency and this kit should have all the basic yet essential items you will need for at least 72 hours. Your kit should contain food and water, items in case there is a power shortage, and other items such as personal hygiene supplies and copies of important documents.

Mitigation at Home

Kern County MJHMP Update

Executive Summary

Mitigation at Home

Other Planning Documents

Get Involved

Learn More

Stakeholder Pages

Draft HMP Documents

RAMP (Risk Mapping)

MAST (Mitigation Strategy)

Planning Process Library

Meetings

Document Upload

PM Team Pages

PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

Other Planning Documents

Hazard Mitigation Plan:

2012 Kern Multi-Jurisdiction Hazard Mitigation Plan

- Part 1: Executive Summary, TOC, Chapters 1, 2, 3
- Part 2: Chapter 4, Part 1
- Part 3: Chapter 4, Part 2
- Part 4: Chapters 5, 6, 7
- Part 5: Appendices A through H

Other Local Planning Documents:

Kern County General Plan
2018 State of California Multi-Hazard Mitigation Plan Draft
California Drought Contingency Plan
Kern County Fire Department Unit Strategic Fire Plan
Kern County Fire Department Wildland Fire Management Plan
Kern County and Incorporated Cities Hazardous Waste Management Plan
Kern County Flood Hazard Mitigation Plan
Kern Lake Coordinated Resource Management and Planning Group Project Master Plan – Preliminary Status Report
Metropolitan Bakersfield Habitat Conservation Plan

Community Wildfire Protection Plans (CWPPs):

Alta Sierra CWPP
Kern River Valley CWPP
Mount Pinos CWPP
Meyers Canyon CWPP
Greater Tehachapi Area CWPP

Other Planning Documents

MITIGATE HAZARDS

WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

Executive Summary

Mitigation at Home

Other Planning Documents

Get Involved

Learn More

Stakeholder Pages

Draft HMP Documents

RAMP (Risk Mapping)

MAST (Mitigation Strategy)

Planning Process Library

Meetings

Document Upload

PM Team Pages

PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

Get Involved

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and their property from hazards. The County of Kern developed the Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) update to make the County, its residents and visitors less vulnerable to future hazard events.

Take a Survey!



COMMUNITY SURVEY | ENCUESTA SOBRE LA COMUNIDAD

Survey Results

Total Surveys...

1,156

Your opinion matters! The information you provide will help us identify and coordinate projects focused on reducing the risk of injury or damage to property from future hazard events (e.g. wildfires, floods, earthquakes).

The survey should take approximately 5 minutes to complete and is anonymous.

REVIEW THE HAZARD MITIGATION PLAN!

Coming soon!

Throughout the planning process, draft sections of the 2020 Kern County Multi- Jurisdictional Hazard Mitigation Plan will be made available for review and comment; documents can be found on the "Documents" page.

Discover County Planning Documents

Does your neighborhood have its own Community Wildfire Protection Plan? Do you know where the flood zones are in the County? There are a lot of great resources available to the public and they can all be found here.

Events

Come take the survey in person and get your mitigation questions answered at one of our upcoming events.

Event details coming soon!

Get Involved

MITIGATE HAZARDS

WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

- Executive Summary
- Mitigation at Home
- Other Planning Documents
- Get Involved
- Learn More

Stakeholder Pages

- Draft HMP Documents
- RAMP (Risk Mapping)
- MAST (Mitigation Strategy)
- Planning Process Library
- Meetings
- Document Upload

PM Team Pages

- PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

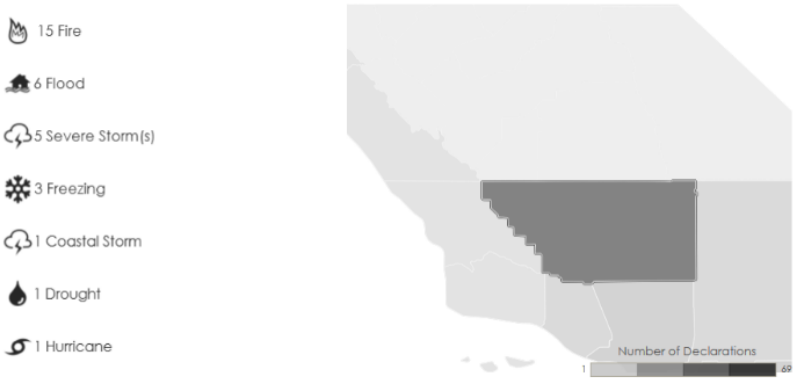
Learn More

History of the MJHMP

On behalf of the entire County, Kern County's Board of Supervisors adopted the original Multi-Jurisdictional Multi-Hazard Mitigation Plan in 2006. The 2019-20 update will be the County's "third" plan update and a demonstration of the County's continuing effort to reduce or eliminate future loss of life and property resulting from natural disasters.



Disasters in Kern County



There have been 32 declared disasters that have occurred in Kern County since 1953. Click here for more detail including the types of declared disasters and the months and years that they have occurred.

Learn More

MITIGATE HAZARDS

WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

- Executive Summary
- Mitigation at Home
- Other Planning Documents
- Get Involved
- Learn More

Stakeholder Pages

- Draft HMP Documents
- RAMP (Risk Mapping)
- MAST (Mitigation Strategy)
- Planning Process Library
- Meetings
- Document Upload

PM Team Pages

- PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

Documents

2020 Kern County Multi-Jurisdictional Hazard Mitigation Plan

This is your opportunity to be heard! Click below to open the Public Review PDF's for Volume 1 and find each volume 2 annex of the County's 2020 Hazard Mitigation Plan. For additional help on PDF commenting, use the instructions below in the "How to Comment on the PDF" section. Note the files may take a few moments to load due to the size of the documents and the interactive commenting feature.

The County's Multi-Jurisdictional Hazard Mitigation Plan is available in Volume 1 for review at the link below:

CLICK HERE - DRAFT 2020 MJHMP - VOLUME 1

You can also download the PDF and provide comments via the form linked below or by emailing our team directly: Download MJHMP VOL 1

HOW TO COMMENT!



Option 1

Click the link left to comment on the Draft Volume 1

For Volume 1

Option 2

Submit a Comment Form.

For Volume 1 or 2 Annexes

Option 3

Email your comments!

For Volume 1 or 2 Annexes

Volume 2 Draft Annexes

The Jurisdictional Annexes to Volume 1 are available in Volume 2 within the groups below:

- + MUNICIPALITIES
- + SPECIAL DISTRICTS
- + SCHOOL DISTRICTS
- + WATER/WASTEWATER DISTRICTS

+ HOW TO COMMENT

Documents

MITIGATE HAZARDS

WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

- Executive Summary
- Mitigation at Home
- Other Planning Documents
- Get Involved
- Learn More

Stakeholder Pages

- Draft HMP Documents
- RAMP (Risk Mapping)
- MAST (Mitigation Strategy)
- Planning Process Library
- Meetings
- Document Upload

PM Team Pages

- PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

RAMP | MITIGATE HAZARDS

UPDATES

5/1/2020: All RAMP interfaces have been updated to RAMP 2.0 to provide a better user experience – see the user guide link above for more information.

7/25/2019: Population Maps updated to improve population summary accuracy within municipal boundaries.

Using RAMP

The links below allow you to access each version of the Risk Assessment Mapping Platform "RAMP". Please see the user documentation for more details on how to use the mapping applications. If you need help navigating these mapping tools, please email brian@dynamicplanning.co

LAUNCH MUNICIPALITIES RAMP

LAUNCH SPECIAL DISTRICTS RAMP

LAUNCH SCHOOL DISTRICTS RAMP

LAUNCH WATER DISTRICTS RAMP

RAMP Resources

The RAMP user guide details RAMP's user interface and how to use the mapping application.

RAMP USER GUIDE

The hazards legend provides full details for each class of hazard portrayed in RAMP and provides data sources.

HAZARDS LEGEND

The GIS data dictionary itemizes the status of each GIS data layer that will be used in the project.

GIS DATA DICTIONARY

If you need additional help navigating these mapping tools or have any questions regarding data sources, analysis methodes, etc., please email brian@dynamicplanning.co.

RAMP



WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

- Executive Summary
- Mitigation at Home
- Other Planning Documents
- Get Involved
- Learn More

Stakeholder Pages

- Draft HMP Documents
- RAMP (Risk Mapping)
- MAST (Mitigation Strategy)
- Planning Process Library
- Meetings
- Document Upload

PM Team Pages

- PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

Planning Process Library

This library includes links to view map products or exercises completed by each jurisdiction to meet or exceed FEMA planning requirements outlined in 44 CFR § 201.6 – Local Mitigation Plans (44 CFR Part 201 – Mitigation Planning). Most importantly §201.6(c)(2)(iii) requires that in multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

Risk Assessment – explore or download each hazard exposure & damage estimation map
Hazard Prioritization – hazard prioritization risk matrices
Areas of Concern – identifies hazard problem statements
Capability Assessments – details specific technical, fiscal, and regulatory resources

If you need help navigating these mapping products, please email brian@dynamicplanning.co.

+ COUNTY / MUNICIPALITIES

+ SPECIAL DISTRICTS

+ SCHOOL DISTRICTS

+ WATER/WASTEWATER DISTRICTS

Planning Library

MITIGATE HAZARDS

WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

- Executive Summary
- Mitigation at Home
- Other Planning Documents
- Get Involved
- Learn More

Stakeholder Pages

- Draft HMP Documents
- RAMP (Risk Mapping)
- MAST (Mitigation Strategy)
- Planning Process Library
- Meetings
- Document Upload

PM Team Pages

- PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

Meetings

+ KICK-OFF MEETING

+ PLANNING COMMITTEE MEETING #1

+ PLANNING COMMITTEE MEETING #2

+ PLANNING COMMITTEE MEETING #3

Planning Committee Meeting #4

Date: November 14th, 2019
Time: 9:00 AM-12:00 PM
Location: Kern County/Operational Area Emergency Operations Center, 2601 Panorama Drive, Building B, Bakersfield, CA

Livestream

Meeting Materials

Live Polling with PollEV

Mitigation Action Application
username: kernmjhmp@gmail.com
password: KernHMP2020

Kern PC #4 Meeting Slide Deck View | Download
Kern County Meeting #4 Agenda View | Download
Mitigation Alternatives Handout View | Download
2012-14 Mitigation Action Worksheets View | Download

Links

Mitigation Ideas Handbook View | Download
Wildfire Hazard Mitigation Handbook for Public Facilities View

Meetings

MITIGATE HAZARDS

WHY HAVE A PLAN? | PLANNING PROCESS | GRANT FRAMEWORK | FEMA TOOLS | PROJECTS | RESOURCE LINKS

Kern County MJHMP Update

- Executive Summary
- Mitigation at Home
- Other Planning Documents
- Get Involved
- Learn More

Stakeholder Pages

- Draft HMP Documents
- RAMP (Risk Mapping)
- MAST (Mitigation Strategy)
- Planning Process Library
- Meetings
- Document Upload

PM Team Pages

- PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

Document Upload

User Document Upload

You can upload your own documents by clicking the button below and following the instructions on page.

DOCUMENT UPLOAD

See all uploaded documents here:

Participant Uploaded Documents

Documents



Kern County MJHMP Update

Executive Summary

Mitigation at Home

Other Planning Documents

Get Involved

Learn More

Stakeholder Pages

Draft HMP Documents

RAMP (Risk Mapping)

MAST (Mitigation Strategy)

Planning Process Library

Meetings

Document Upload

PM Team Pages

PM Team

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Kern Multi-Jurisdiction Hazard Mitigation Plan

2019-20 Update

PM Team



PM TRACKING APPLICATION

Project Management Team

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APPENDIX F

CHECKLIST ARRANGED BY SUBJECT

Water Code Section	Summary as Applies to UWMP	Subject	2025 Guidebook Location	2025 UWMP Location (Optional Column for Agency Review Use)
10608.20(e)	Retail suppliers shall provide baseline daily per capita water use, urban water use target, interim urban water use target, and compliance daily per capita water use, along with the bases for determining those estimates, including references to supporting data.	Baselines and Targets	Chapter 5	Section 5
10608.22	Retail suppliers' per capita daily water use reduction shall be no less than 5 percent of base daily per capita water use of the 5 year baseline. This does not apply if the suppliers base GPCD is at or below 100.	Baselines and Targets	Section 5.7.2	Section 5
10608.24(a)	Retail suppliers shall meet their water use target by December 31, 2025.	Baselines and Targets	Section 5.7	Section 5

10608.24(d)(2)	If the retail supplier adjusts its compliance GPCD using weather normalization, economic adjustment, or extraordinary events, it shall provide the basis for, and data supporting the adjustment.	Baselines and Targets	Sections 5.2 and 5.5.7	Section 5
10608.36	Wholesale suppliers shall include an assessment of present and proposed future measures, programs, and policies to help their retail water suppliers achieve targeted water use reductions.	Baselines and Targets	Section 5.1	N/A
10608.4	Retail suppliers shall report on their progress in meeting their water use targets. The data shall be reported using a standardized form.	Baselines and Targets	Section 5.8 and App E	Section 5
10631(e)(1)	Retail suppliers shall provide a description of the nature and extent of each demand management measure implemented over the past five years.	Demand Management Measures	Sections 9.2 and 9.3	Section 9.2 and 9.3

10631(e)(2)	Wholesale suppliers shall describe specific demand management measures listed in code, their distribution system asset management program, and supplier assistance program.	Demand Management Measures	Sections 9.1 and 9.3	N/A
10608.26(a)	Retail suppliers shall conduct a public hearing to discuss adoption, implementation, and economic impact of water use targets.	Plan Adoption, Submittal, and Implementation	Chapter 10	Section 10
10621(b)	Notify, at least 60 days prior to the public hearing, any city or county within which the supplier provides water that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan.	Plan Adoption, Submittal, and Implementation	Section 10.2.1	Appendix C
10621(f)	Each urban water supplier shall update and submit its 2025 plan to the department by July 1, 2021.	Plan Adoption, Submittal, and Implementation	Sections 10.3.1 and 10.4	Section 10

10635(c)	Provide supporting documentation that Water Shortage Contingency Plan has been, or will be, provided to any city or county within which it provides water, no later than 60days after the submission of the plan to DWR.	Plan Adoption, Submittal, and Implementation	Sections 8.12, 10.4	Section 10
10642	Provide supporting documentation that the urban water supplier made the plan and contingency plan available for public inspection, published notice of the public hearing, and held a public hearing about the plan and contingency plan.	Plan Adoption, Submittal, and Implementation	Sections 10.2.2, 10.3, and 10.5	Section 10
10642	The water supplier is to provide the time and place of the hearing to any city or county within which the supplier provides water.	Plan Adoption, Submittal, and Implementation	Section 10.2	Section 10
10642	Provide supporting documentation that the plan and contingency plan has been adopted as prepared or modified.	Plan Adoption, Submittal, and Implementation	Section 10.3.1	Section 10; Appendix C

10644(a)	Provide supporting documentation that the urban water supplier has submitted this UWMP to the California State Library.	Plan Adoption, Submittal, and Implementation	Section 10.5	Section 10; Appendix E
10644(a)(1)	Provide supporting documentation that the urban water supplier has submitted this UWMP to any city or county within which the supplier provides water no later than 30 days after adoption.	Plan Adoption, Submittal, and Implementation	Section 10.5	Section 10; Appendix E
10644(a)(2)	The plan, or amendments to the plan, submitted to the department shall be submitted electronically.	Plan Adoption, Submittal, and Implementation	Sections 10.4.1 and 10.4.2	Section 10
10645(a)	Provide supporting documentation that, not later than 30 days after filing a copy of its plan with the department, the supplier has or will make the plan available for public review during normal business hours.	Plan Adoption, Submittal, and Implementation	Section 10.5	Section 10

10645(b)	Provide supporting documentation that, not later than 30 days after filing a copy of its water shortage contingency plan with the department, the supplier has or will make the plan available for public review during normal business hours.	Plan Adoption, Submittal, and Implementation	Section 10.5	Section 10
10620(b)	Every person that becomes an urban water supplier shall adopt an urban water management plan within one year after it has become an urban water supplier.	Plan Preparation	Section 2.1	Section 2.1; Appendix D
10620(d)(2)	Coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.	Plan Preparation	Section 2.5.2	Section 2.5; Section 10; Appendix C

10642	Provide supporting documentation that the water supplier has encouraged active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan and contingency plan.	Plan Preparation	Section 2.6	Section 2.5; Section 10; Appendix C
10630.5	Each plan shall include a simple description of the supplier's plan including water availability, future requirements, a strategy for meeting needs, and other pertinent information.	Summary	Chapter 1	Chapter 1
10631(a)	Describe the water supplier service area.	System Description	Section 3.1	Section 3.1
10631(a)	Describe the climate of the service area of the supplier.	System Description	Section 3.3	Section 3.3
10631(a)	Provide population projections for 2025, 2030, 2035, 2040 and optionally 2045.	System Description	Section 3.4	Section 3.4

10631(a)	Describe other social, economic, and demographic factors affecting the supplier's water management planning.	System Description	Section 3.4	Section 3.5
10631(a)	Describe the land uses within the service area.	System Description	Section 3.5	Section 3
10631(a)	Indicate the current population of the service area.	System Description and Baselines and Targets	Sections 3.4 and 5.4	Section 3.4
10631(b)	Identify and quantify the existing and planned sources of water available for 2025, 2025, 2030, 2035, 2040 and optionally 2045.	System Supplies	Section 6.2.8	Section 6
10631(b)	Indicate whether groundwater is an existing or planned source of water available to the supplier.	System Supplies	Section 6.2	Section 6
10631(b)(1)	Provide a discussion of anticipated supply availability under a normal, single dry year, and a drought lasting five years, as well as more frequent and	System Supplies	Section 6.2	Section 6.2
	severe periods of drought.			

10631(b)(2)	When multiple sources of water supply are identified, describe the management of each supply in relationship to other identified supplies.	System Supplies	Section 6.1	Section 6
10631(b)(3)	Describe measures taken to acquire and develop planned sources of water.	System Supplies	Section 6.1	Section 6
10631(b)(4)(A)	Indicate whether a groundwater sustainability plan or groundwater management plan has been adopted by the water supplier or if there is any other specific authorization for groundwater management. Include a copy of	System Supplies	Section 6.2.2	Section 6.2
	the plan or authorization.			
10631(b)(4)(B)	Describe the groundwater basin.	System Supplies	Section 6.2.2	Section 6.2
10631(b)(4)(B)	Indicate if the basin has been adjudicated and include a copy of the court order or decree and a description of the amount of water the supplier has the legal right to pump.	System Supplies	Section 6.2.2	N/A

10631(b)(4)(B)	For unadjudicated basins, indicate whether or not the department has identified the basin as a high or medium priority. Describe efforts by the supplier to coordinate with sustainability or groundwater agencies to achieve sustainable groundwater conditions.	System Supplies	Section 6.2.3	Section 6.2
10631(b)(4)(C)	Provide a detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years	System Supplies	Section 6.2.4	Section 6.2
10631(b)(4)(D)	Provide a detailed description and analysis of the amount and location of groundwater that is projected to be pumped.	System Supplies	Section 6.2	Section 6.2
10631(c)	Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.	System Supplies	Section 6.7	Section 6.7

10631(f)	Describe the expected future water supply projects and programs that may be undertaken by the water supplier to address water supply reliability in average, single-dry, and for a period of drought lasting 5 consecutive water years.	System Supplies	Section 6.8	Section 6.8
10631(g)	Describe desalinated water project opportunities for long-term supply.	System Supplies	Section 6.6	Section 6.6
10631(h)	Retail suppliers will include documentation that they have provided their wholesale supplier(s) - if any - with water use projections from that source.	System Supplies	Section 2.5.1	N/A

10631(h)	Wholesale suppliers will include documentation that they have provided their urban water suppliers with identification and quantification of the existing and planned sources of water available from the wholesale to the urban supplier during various water year types.	System Supplies	Section 2.5.1	N/A
10633(b)	Describe the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.	System Supplies (Recycled Water)	Section 6.2	Section 6.5
10633(c)	Describe the recycled water currently being used in the supplier's service area.	System Supplies (Recycled Water)	Section 6.2	N/A
10633(d)	Describe and quantify the potential uses of recycled water and provide a determination of the technical and economic feasibility of those uses.	System Supplies (Recycled Water)	Section 6.2	N/A

10633(e)	Describe the projected use of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected.	System Supplies (Recycled Water)	Section 6.2	N/A
10633(f)	Describe the actions which may be taken to encourage the use of recycled water and the projected results of these actions in terms of acre-feet of recycled water used per year.	System Supplies (Recycled Water)	Section 6.2	Section 6.5
10633(g)	Provide a plan for optimizing the use of recycled water in the supplier's service area.	System Supplies (Recycled Water)	Section 6.2	Section 6.5
10631(d)(1)	Quantify past, current, and projected water use, identifying the uses among water use sectors.	System Water Use	Section 4.2	Section 4.2
10631(d)(3)(A)	Report the distribution system water loss for each of the 5 years preceding the plan update.	System Water Use	Section 4.3	Section 4.3

10631(d)(3)(C)	Retail suppliers shall provide data to show the distribution loss standards were met.	System Water Use	Section 4.2	Section 4.3
10631.1(a)	Include projected water use needed for lower income housing projected in the service area of the supplier.	System Water Use	Section 4.5	Section 4.5
10632(a)	Provide a water shortage contingency plan (WSCP) with specified elements below.	Water Shortage Contingency Planning	Chapter 8	Section 8
10632(a)(2)(A)	Provide the written decision-making process and other methods that the supplier will use each year to determine its water reliability.	Water Shortage Contingency Planning	Section 8.2	Section 8.2
10632(a)(2)(B)	Provide data and methodology to evaluate the supplier's water reliability for the current year and one dry year pursuant to factors in the code.	Water Shortage Contingency Planning	Section 8.2	Section 8

10632(a)(3)(A)	Define six standard water shortage levels of 10,20, 30, 40, 50 percent shortage and greater than 50 percent shortage. These levels shall be based on supply conditions, including percent reductions in supply, changes in groundwater levels, changes in surface elevation, or other conditions. The shortage levels shall also apply to a catastrophic interruption of supply.	Water Shortage Contingency Planning	Section 8.3	Section 8
10632(a)(3)(B)	Suppliers with an existing water shortage contingency plan that uses different water shortage levels must cross reference their categories with the six standard categories.	Water Shortage Contingency Planning	Section 8.3	N/A
10632(a)(4)(A)	Suppliers with water shortage contingency plans that align with the defined shortage levels must specify locally appropriate supply augmentation actions.	Water Shortage Contingency Planning	Section 8.4	Section 8.4

10632(a)(4)(B)	Specify locally appropriate demand reduction actions to adequately respond to shortages.	Water Shortage Contingency Planning	Section 8.4	Section 8.4
10632(a)(4)(C)	Specify locally appropriate operational changes.	Water Shortage Contingency Planning	Section 8.4	Section 8.4
10632(a)(4)(D)	Specify additional mandatory prohibitions against specific water use practices that are in addition to state-mandated prohibitions are appropriate to local conditions.	Water Shortage Contingency Planning	Section 8.4	Section 8.4
10632(a)(4)(E)	Estimate the extent to which the gap between supplies and demand will be reduced by implementation of the action.	Water Shortage Contingency Planning	Section 8.4	Section 8.4
10632(a)(5)(A)	Suppliers must describe that they will inform customers, the public and others regarding any current or predicted water shortages.	Water Shortage Contingency Planning	Section 8.5	Section 8

10632(a)(5)(B) 10632(a)(5)(C)	Suppliers must describe that they will inform customers, the public and others regarding any shortage response actions triggered or anticipated to be triggered and other relevant communications.	Water Shortage Contingency Planning	Section 8.5, 8.6	Section 8
10632(a)(7)(A)	Describe the legal authority that empowers the supplier to enforce shortage response actions.	Water Shortage Contingency Planning	Section 8.7	Section 8.7
10632(a)(7)(B)	Provide a statement that the supplier will declare a water shortage emergency Water Code Chapter 3.	Water Shortage Contingency Planning	Section 8.7	Section 8.7
10632(a)(7)(C)	Provide a statement that the supplier will coordinate with any city or county within which it provides water for the possible proclamation of a local emergency.	Water Shortage Contingency Planning	Section 8.7	Section 8
10632(a)(8)(A)	Describe the potential revenue reductions and expense increases associated with activated shortage response actions.	Water Shortage Contingency Planning	Section 8.8	Section 8

10632(a)(8)(B)	Provide a description of mitigation actions needed to address revenue reductions and expense increases associated with activated shortage response actions.	Water Shortage Contingency Planning	Section 8.8	Section 8
10632(a)(8)(C)	Describe the cost of compliance with Water Code Chapter 3.3: Excessive Residential Water Use During Drought.	Water Shortage Contingency Planning	Section 8.8	Section 8
10632(a)(9)	Retail suppliers must describe the monitoring and reporting requirements and procedures that ensure appropriate data is collected, tracked, and analyzed for purposes of monitoring customer compliance.	Water Shortage Contingency Planning	Section 8.9	Section 8.9

10632(a)(10)	Describe reevaluation and improvement procedures for monitoring and evaluation the water shortage contingency plan to ensure risk tolerance is adequate and appropriate water shortage mitigation strategies are implemented.	Water Shortage Contingency Planning	Section 8.10	Section 8.10
10632(b)	Analyze and define water features that are artificially supplied with water, including ponds, lakes, waterfalls, and fountains, separately from swimming pools and spas.	Water Shortage Contingency Planning	Section 8.11	Section 8
10620(f)	Describe water management tools and options to maximize resources and minimize the need to import water from other regions.	Water Supply Reliability Assessment	Section 7.4	Section 7

10634	Provide information on the quality of existing sources of water available to the supplier and the manner in which water quality affects water management strategies and supply reliability	Water Supply Reliability Assessment	Chapter 7	Section 7
10635(a)	Assess the water supply reliability during normal, dry, and multiple dry water years by comparing the total water supply sources available to the water supplier with the total projected water use over the next 20 years.	Water Supply Reliability Assessment	Section 7.3	Section 7.2
10635(b)	Provide a drought risk assessment as part of information considered in developing the demand management measures and water supply projects.	Water Supply Reliability Assessment	Section 7.3	Section 7.3

10635(b)(1)	Include a description of the data, methodology, and basis for one or more supply shortage conditions that are necessary to conduct a drought risk assessment for a drought period that lasts 5 consecutive years.	Water Supply Reliability Assessment	Section 7.3	Section 7.3
10635(b)(2)	Include a determination of the reliability of each source of supply under a variety of water shortage conditions.	Water Supply Reliability Assessment	Section 7.3	Section 7.3
10635(b)(3)	Include a comparison of the total water supply sources available to the water supplier with the total projected water use for the drought period.	Water Supply Reliability Assessment	Section 7.3	Section 7.3

10635(b)(4)	Include considerations of the historical drought hydrology, plausible changes on projected supplies and demands under climate change condition, anticipated regulatory changes, and other locally applicable criteria.	Water Supply Reliability Assessment	Section 7.3	Section 7.3
10631.2(a)	The UWMP must include energy intensity information as stated in the code.	System Suppliers, Energy Intensity	Section 6.4 and Appendix O	Section 6

APPENDIX G
FINAL GROUNDWATER SUSTAINABILITY PLAN – KERN RIVER GROUNDWATER SUSTAINABILITY AGENCY

KERN COUNTY SUBBASIN

GROUNDWATER SUSTAINABILITY PLAN

2025



Amended
Final Version

ADOPTED AUGUST 2025

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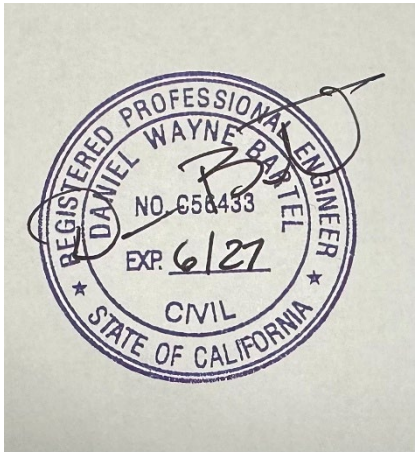

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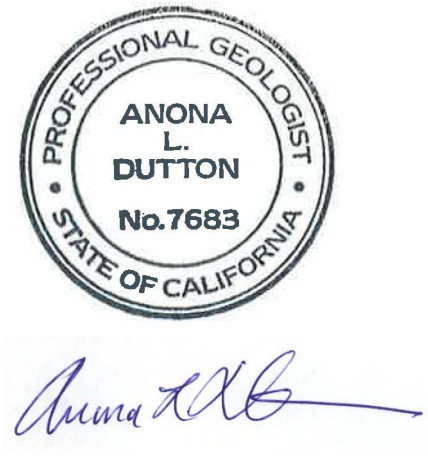

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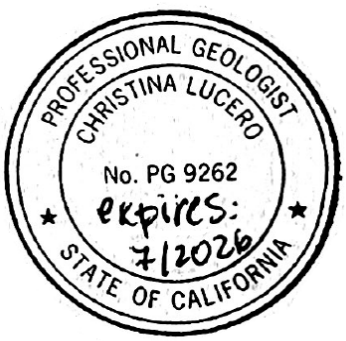

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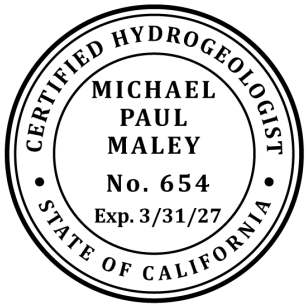

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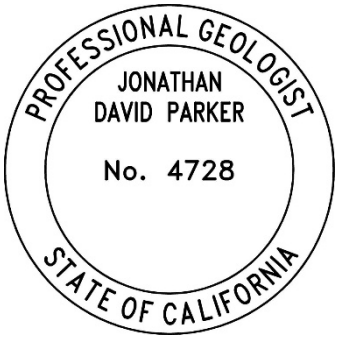

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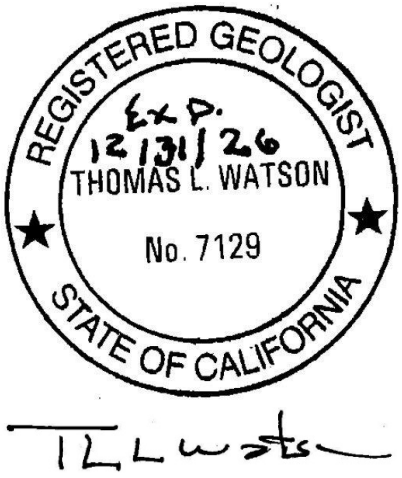

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TABLE OF CONTENTS

Executive Summary **ES-1**
ES.1 Introduction ES-3
Kern Subbasin Timeline ES-6
Summary of 2025 Plan Amendments ES-7
ES.2 Sustainability Goal ES-8
ES.3 Agency Information ES-9
ES.4 GSP Organization ES-9
ES.5 Description of the Plan Area ES-10
Adjacent Subbasins ES-10
Land Use ES-10
Incorporated Cities and Unincorporated Communities ES-11
ES.6 Introduction to Basin Setting ES-12
ES.7 Hydrogeological Conceptual Model ES-12
ES.8 Current and Historical Groundwater Conditions ES-14
Groundwater Levels ES-14
Groundwater Storage ES-15
Groundwater Quality ES-15
Land Subsidence ES-16
Seawater Intrusion ES-17
Interconnected Surface Water ES-17
ES.9 Water Budget Information ES-18
Water Budget Model ES-18
ES.10 Management Areas ES-20
ES.11 Introduction to Sustainable Management Criteria ES-20
ES.12 Sustainability Goal ES-23
ES.13 Sustainable Management Criteria ES-24
Chronic Lowering of Groundwater Levels ES-24
Impacts to Beneficial Users ES-24
Consideration of Adjacent Basins and Other Sustainability Indicators ES-25
Reduction of Groundwater Storage ES-25
Degraded Water Quality ES-25
Impacts to Beneficial Users ES-26
Consideration of Adjacent Basins ES-26
Land Subsidence ES-27
Impacts to Beneficial Users ES-27

Consideration of Adjacent Basins ES-28
Relationships Between Sustainability Indicators ES-29
ES.14 Projects and Management Actions ES-30
ES.15 Monitoring Network ES-33
ES.16 Plan Implementation ES-34
ES.17 Conclusion ES-35
1. Introduction 1-1
1.1 Purpose of the Groundwater Sustainability Plan 1-2
1.2 Background 1-6
1.2.1 DWR Process (2020 - 2023) 1-6
1.2.2 SWRCB Process (2023 - Current) 1-7
1.2.3 Coordination 1-8
1.3 Summary of Major Plan Updates 1-14
1.3.1 Beneficial Uses and Users 1-28
2. Sustainability Goal 2-1
3. Agency Information 3-1
3.1 Agency Contact Information 3-1
3.2 GSA Organization and Management Structure 3-3
3.3 Kern Subbasin Plan Manager/Point of Contact 3-6
3.4 Legal Authority of the GSAs 3-6
3.5 Estimated Cost of Implementation 3-7
4. GSP Organization 4-1
5. Description of the Plan Area 5-1
5.1 Area Covered by the Plan 5-1
5.2 Hydrogeologic Conceptual Model Areas 5-2
5.2.1 Jurisdictional Boundaries 5-5
Arvin GSA 5-5
Buena Vista GSA 5-6
Cawelo Water District GSA 5-7
Greenfield County Water District GSA 5-7
Henry Miller Water District GSA 5-8
Kern Non-Districted Land Authority 5-8
Kern River GSA 5-10
Kern-Tulare Water District GSA 5-10
Kern Water Bank GSA 5-11
North Kern Water Storage District GSA 5-11
Olcese Water District GSA 5-12
Pioneer GSA 5-12

Rosedale-Rio Bravo Water Storage District GSA 5-13
Semitropic Water Storage District GSA 5-13
Shafter-Wasco Irrigation District GSA 5-14
Southern San Joaquin Municipal Utility District GSA 5-15
Tejon-Castac Water District GSA 5-15
West Kern Water District GSA 5-16
Westside District Water Authority (WDWA) GSA 5-17
Wheeler Ridge-Maricopa GSA 5-18
Adjudicated or Areas Not Covered By a GSA 5-18
5.3 Discussion of Land Use, Water Use, and Water Sources 5-21
5.3.1 California Protected Areas, Conservation Easement Areas, and Local, State, and Federal Lands 5-22
5.3.2 Descriptions of Privately Owned Lands 5-26
5.3.3 Disadvantaged Communities 5-26
5.3.4 Native American Tribal Communities and Lands 5-27
5.4 Water Sources 5-31
5.4.1 Surface Water 5-31
5.4.2 Imported Water Deliveries 5-35
5.4.3 Wastewater Discharge and Recycled Water Delivery 5-35
5.4.4 Groundwater 5-38
5.5 Water Resources Management Programs 5-41
5.5.1 Conjunctive Use 5-42
5.5.2 Water Banking 5-43
5.6 Beneficial Uses and Users 5-46
5.6.1 Well Inventory 5-46
5.6.2 Well Density per Square Mile 5-50
5.6.3 Overview of Public Water Systems 5-53
5.6.4 Municipalities and Urban Water Purveyors 5-54
5.6.5 Disadvantaged Community Water Systems 5-57
5.6.6 Non-Public Water Systems and Domestic Wells 5-57
5.7 Existing Monitoring and Management Programs 5-63
5.7.1 Water Resources Monitoring 5-63
5.7.2 Climate 5-64
5.7.3 Groundwater Levels and Pumping 5-64
5.7.4 Land Use and Cropping 5-65
5.7.5 Water Quality 5-65
5.7.6 Land Subsidence 5-74
5.7.7 Operational Flexibility 5-75

5.8 Land Use Elements or Topic Categories of Applicable General Plans 5-76
5.8.1 Summary of General Plans and Other Land Use Plans 5-76
5.8.2 Existing Land Use Plans Effects on Groundwater Management 5-82
5.8.3 How Implementation of the Plan May Affect Water Supply Assumptions of Relevant Land Use Plans 5-82
5.8.4 Well Permitting Process 5-83
5.8.5 Implementation of Land Use Plans Outside the Basin 5-84
5.9 Additional GSP Elements 5-85
5.9.1 Control of Saline Water Intrusion 5-85
5.9.2 Wellhead Protection, Well Abandonment, and Destruction Programs 5-85
5.9.3 Groundwater Contamination Cleanup, Recharge, Diversions to Storage, Conservation, Water Recycling, Conveyance, and Extraction Projects 5-86
5.9.4 Efficient Water Management Practices 5-87
5.9.5 Relationships with State and Federal Regulatory Agencies 5-89
5.9.6 Land Use Plans and Efforts to Coordinate with Land Use Planning Agencies to Assess Activities that Potentially Create Risks to Groundwater Quality or Quantity 5-89
5.9.7 Impacts on Groundwater Dependent Ecosystems 5-89
5.10 Notice and Communication 5-90
5.10.1 Public Meetings 5-91
5.10.2 Comments Received 5-99
5.10.3 Communication 5-99
5.10.4 Interagency Coordination 5-107
5.10.5 Interbasin Coordination 5-107
6. Introduction to Basin Setting 6-1
6.1 Basin Setting Organization 6-1
6.1.1 DWR Groundwater Basin 6-1
6.2 Kern Subbasin 6-2
6.2.1 Kern Subbasin HCM Areas 6-5
6.2.2 Kern Subbasin Aquifer Types 6-6
7. Hydrogeological Conceptual Model 7-1
7.1 Physical Characteristics 7-3
7.1.1 Topography 7-3
7.1.2 Surface Water Bodies 7-6
7.1.3 Delineation of Recharge and Discharge Areas 7-12
7.1.4 Surficial Geology 7-14
7.1.5 Soils 7-17
7.2 Geologic and Structural Setting 7-20
7.2.1 Geologic Setting 7-20

7.2.2 Geologic History Summary 7-24
7.2.3 Structural Setting 7-28
7.2.4 Regional Faults 7-30
7.2.5 Structural Folds 7-32
7.2.6 Geologic Units and Their Water-Bearing Properties 7-33
7.3 Cross Sections 7-46
7.3.1 Regional Cross Sections 7-46
7.4 Hydrogeological Conceptual Model Subarea Characteristics 7-60
7.4.1 North HCM Area 7-61
7.4.2 Kern River Fan HCM Area 7-65
7.4.3 South Basin HCM Area 7-66
7.4.4 Eastern Margin HCM Area 7-67
7.4.5 Western Fold Belt HCM Area 7-69
7.5 Principal Aquifer and Aquitards 7-71
7.5.1 Primary Alluvial Principal Aquifer 7-72
7.5.2 Santa Margarita Principal Aquifer 7-83
7.5.3 Olcese Principal Aquifer 7-88
7.6 Basin Boundaries and Basin Bottom 7-91
7.6.1 Lateral Boundaries 7-91
7.6.2 Definable Basin Bottom 7-92
7.6.3 Physical Properties 7-93
7.6.4 Geochemical Properties 7-95
7.6.5 Oil Fields Aquifer Exemptions 7-99
7.6.6 Kern Subbasin Bottom Definition 7-105
8. Current and Historical Groundwater Conditions 8-1
8.1 Groundwater Elevations, Flow Directions, and Long-Term Trends for Each Principal Aquifer 8-1
8.1.1 Primary Alluvial Principal Aquifer 8-2
8.1.2 Santa Margarita Principal Aquifer 8-25
8.1.3 Olcese Principal Aquifer 8-30
8.2 Change in Groundwater in Storage 8-35
8.2.1 Subbasin Change in Groundwater in Storage 8-35
8.2.2 Estimated Subbasin Water Storage Volume 8-42
8.3 Seawater Intrusion 8-48
8.4 Groundwater Quality 8-48
8.4.1 Groundwater Quality Constituents of Concern 8-48
8.4.2 Connecting Constituents of Concern to Undesirable Results 8-51

8.4.3 Point-Source Contamination Sites 8-118
8.4.4 Oil Field Injection Wells and Produced Water Ponds 8-127
8.5 Land Subsidence 8-133
8.5.1 Historical and Recent Land Subsidence 8-133
8.5.2 Causes of Subsidence 8-156
8.5.3 Magnitude of Subsidence 8-165
8.6 Interconnected Surface Water Systems and Groundwater Dependent Ecosystems 8-183
8.6.1 North Subbasin HCM Area 8-188
8.6.2 East Margin HCM Area 8-189
8.6.3 South Basin HCM Area 8-206
8.6.4 Western Fold Belt HCM Area 8-206
8.6.5 Summary of ISWs 8-207
9. Water Budget Information 9-1
9.1 Subbasin Water Budget Methodology 9-2
9.1.1 C2VSim 9-2
9.1.2 C2VSimFG-Kern Model 9-6
9.1.3 Quality Assurance Process 9-7
9.1.4 Coordination with DWR on Future C2VSimFG Updates 9-7
9.1.5 Related Grant Studies to Improve Future Water Budget Estimates 9-8
9.2 Subbasin Water Budget Data 9-9
9.2.1 General Approach 9-9
9.2.2 Data Sources 9-10
9.2.3 Water Year Types for Base Periods 9-11
9.2.4 Surface Water 9-13
9.2.5 Water Banking and Conjunctive Use Projects 9-17
9.2.6 Urban Water Demand 9-18
9.2.7 Agricultural Crop Water Demand 9-23
9.3 Historical and Current Subbasin Water Budgets 9-26
9.3.1 Total Surface Water Inflows and Outflows 9-27
9.3.2 Historical and Current Groundwater Budgets 9-31
9.3.3 Groundwater Extraction Maps 9-43
9.3.4 Change in Groundwater in Storage Maps 9-44
9.3.5 Overdraft Conditions 9-44
9.4 Subbasin Sustainable Yield 9-48
9.4.1 Determination of Sustainable Yield 9-48
9.4.2 Native Yield 9-50
9.4.3 Application of Sustainable and Native Yield 9-51

9.5 GSA Operational Water Budgets 9-51
9.5.1 Approach 9-51
9.5.2 Water Bank Account Balances 9-52
9.5.3 Water Banking Adjustment for GSA Operational Water Budget 9-54
9.5.4 GSA Operational Water Budgets 9-55
9.6 Projected Future Subbasin Water Budget 9-64
9.6.1 Projected Water Budget Methods and Data Sources 9-65
9.6.2 Development of Projected Water Budget Scenarios 9-65
9.6.3 Additional Surface Water Supply Adjustments 9-80
9.6.4 Projected Water Budget Results 9-80
9.6.5 Change in Groundwater Storage 9-88
9.7 Subbasin Sustainability Assessment 9-91
9.7.1 Sustainability Assessment 9-91
9.7.2 GSP Implementation Progress To-Date 9-92
9.8 Conclusions 9-94
9.8.1 Findings of the C2VSimFG-Kern Application and Results 9-94
9.8.2 Limitations and Uncertainty of C2VSimFG-Kern 9-95
9.8.3 Applicability of C2VSimFG-Kern Simulation Results 9-95
9.8.4 GSA Operational Water Budgets 9-96
10. Management Areas 10-1
10.1 Description and Justification 10-1
10.2 Minimum Thresholds and Measurable Objectives 10-2
10.3 Monitoring 10-2
10.4 Hydrogeological Conceptual Model Areas 10-2
10.5 Projects and Management Actions 10-3
11. Introduction to Sustainable Management Criteria 11-1
11.1 Summary of Sustainable Management Criteria 11-2
12. Sustainability Goal 12-1
13. Sustainable Management Criteria 13-1
13.1 Chronic Lowering of Groundwater Levels 13-1
13.1.1 Undesirable Results for Chronic Lowering of Groundwater Levels 13-1
13.1.2 Minimum Threshold for Chronic Lowering of Groundwater Levels 13-7
13.1.3 Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels 13-44
13.2 Reduction of Groundwater Storage 13-49
13.2.1 Undesirable Results for Reduction of Groundwater Storage 13-49
13.2.2 Minimum Threshold for Reduction of Groundwater Storage 13-53

13.2.3 Measurable Objective and Interim Milestones for Reduction of Groundwater Storage 13-54
13.3 Degraded Water Quality 13-54
13.3.1 Undesirable Results for Degraded Water Quality 13-54
13.3.2 Minimum Threshold for Degraded Water Quality 13-61
13.3.3 Measurable Objective and Interim Milestones for Degraded Water Quality 13-71
13.4 Seawater Intrusion 13-71
13.5 Land Subsidence 13-72
13.5.1 Undesirable Results for Land Subsidence 13-72
13.5.2 Minimum Threshold for Land Subsidence 13-78
13.5.3 Measurable Objective and Interim Milestones for Land Subsidence 13-120
13.6 Interconnected Surface Water 13-122
14. Projects and Management Actions 14-1
14.1 Goals and Objectives of Projects and Management Actions 14-2
14.1.1 Implementation Glide Path Kern Subbasin 14-3
14.1.2 Uncertainty Associated with the Basin Setting 14-6
14.1.3 P/MA Planning by HCM Area 14-8
14.2 List of Projects and Management Actions 14-16
14.2.1 Demand Reduction P/MAs 14-16
14.2.2 Water Supply Augmentation P/MA's 14-17
14.2.3 Data-Gap Filling and Mitigation Efforts 14-17
14.2.4 Adaptive Management Efforts 14-22
14.3 Circumstances for Implementation 14-22
14.4 Public Notice Process 14-23
14.5 Overdraft Conditions 14-23
14.6 Permitting and Regulatory Process 14-24
14.7 Status and Implementation Timetable 14-25
14.8 Expected Benefits 14-25
14.9 Source and Reliability of Water from Outside the Basin 14-25
14.9.1 P/MA Annual Water Benefit Estimate for Groundwater Recharge/Storage Projects 14-26
14.10 Legal Authority Required 14-26
14.11 Estimated Costs and Plans to Meet Them 14-26
14.12 Management of Recharge and Groundwater Extractions 14-27
15. Monitoring Network 15-1
15.1 Monitoring Network Objectives 15-2
15.2 Description of Monitoring Network 15-4
15.2.1 Monitoring Network for Chronic Lowering of Groundwater Levels 15-7

15.2.2 Monitoring Network for Reduction in Groundwater Storage 15-19
15.2.3 Monitoring Network for Seawater Intrusion 15-19
15.2.4 Monitoring Network for Degraded Water Quality 15-20
15.2.5 Monitoring Network for Land Subsidence 15-26
15.2.6 Monitoring Network for Depletions of Interconnected Surface Water 15-29
15.3 Monitoring Protocols for Data Collection and Monitoring 15-29
15.3.1 Protocols for Groundwater Level Measurements 15-30
15.3.2 Protocols for Reduction in Groundwater Storage 15-31
15.3.3 Protocols for Water Quality Sampling 15-31
15.3.4 Protocols for Land Subsidence Measurements 15-32
15.4 Representative Monitoring 15-32
15.4.1 Designated Representative Monitoring Sites 15-32
15.5 Assessment and Improvement of Monitoring Network 15-33
15.5.1 Groundwater Levels Representative Monitoring Network Evaluation 15-33
15.5.2 Groundwater Storage Representative Monitoring Network Evaluation 15-41
15.5.3 Seawater Intrusion Representative Monitoring Network Evaluation 15-41
15.5.4 Groundwater Quality Monitoring Network Evaluation 15-41
15.5.5 Land Subsidence Representative Monitoring Network Evaluation 15-47
15.5.6 Depletion of Interconnected Surface Water Representative Monitoring Network Evaluation 15-47
15.5.7 Data Gap Filling Implementation Plan 15-47
15.6 Reporting Monitoring Data to the Department 15-48
16. Plan Implementation 16-1
16.1 Plan Implementation Activities 16-2
16.1.1 Monitoring and Data Collection 16-2
16.1.2 Project and Management Action Implementation 16-4
16.1.3 Intrabasin Coordination 16-5
16.1.4 Stakeholder Engagement 16-6
16.2 Annual Reporting 16-7
16.2.1 Enforcement and Response Actions 16-8
16.2.2 Periodic Evaluations of the Plan 16-9
16.2.3 Plan Implementation Costs 16-10
16.2.4 Estimated Costs 16-10
16.2.5 Plan Implementation Schedule 16-11

TABLES

Table ES-1. 2025 Plan GSPs ES-1
Table ES-2. Executive Summary Topics Overview ES-3
Table ES-3. Land Use and Acreage in the Plan Area ES-11
Table ES-4. Incorporated Cities and Unincorporated Communities in the Plan Area ES-11
Table ES 5. Summary of Simulated Change in Groundwater Storage Results ES-19
Table ES-6. Summary of Sustainable Management Criteria ES-21
Table 1-1. 2025 Plan GSPs 1-3
Table 1-2. Crosswalk Summary of Kern Subbasin Meetings with SWRCB Staff and 2025 Plan Additions 1-12
Table 1-3. Crosswalk Summary of Major Plan Updates in Response to SWRCB Corrective Actions 1-16
Table 1-4. Well Inventory User Category and SGMA Beneficial User Cross Reference 1-29
Table 3-1. GSA Manager Contact Information 3-1
Table 3-2. GSA Groups in the Kern Subbasin 3-4
Table 3-3 Plan Manager Contact Information 3-6
Table 3-4. Kern Subbasin Costs of Implementation 3-7
Table 5-1. Summary of Land Uses by HCM Area for 2021 5-21
Table 5-2. Recycled Water Facilities 5-36
Table 5-3. Water Sources Available to Each Water District 5-39
Table 5-4. Kern Subbasin Water Banking Programs 5-44
Table 5-5. Planned Use Definitions 5-49
Table 5-6. Summary of Beneficial Users by WCR Planned Use Category 5-50
Table 5-7. Summary of Beneficial Users and Land Uses by GSA 5-51
Table 5-8. Number of DDW regulated water systems in the Kern Subbasin 5-53
Table 5-9. Number of Domestic Wells by HCM Area 5-57
Table 5-10. Existing Groundwater Quality Monitoring Programs 5-69
Table 7-1. US EPA Oilfield Aquifer Exemptions used to modify the Definable Bottom of Kern Subbasin. 7-100
Table 8-1. Sensitivity Analysis Results of Available Usable Storage Volume in the Kern Subbasin 8-46
Table 8-2. Constituent Prevalence in Kern Subbasin (2015 to 2023) 8-49
Table 8-3. 1,2,3-TCP Range and Median Summary by HCM Area 8-57
Table 8-4. 1,2,3-TCP Well Water Quality Objective Exceedance Summary by HCM Area 8-57
Table 8-5. Median 1,2,3-TCP Summary for Wells within E-Clay or Lake Deposits Boundaries 8-57
Table 8-6. Arsenic Range and Median Summary by HCM Area 8-66
Table 8-7. Arsenic Well Water Quality Objective Exceedance Summary by HCM Area 8-66
Table 8-8. Median Arsenic Summary for Wells within E-clay or Lake Deposits Boundaries 8-67
Table 8-9. Benzene Range and Median Summary by HCM Area 8-77
Table 8-10. Benzene Well Water Quality Objective Exceedance Summary by HCM Area 8-77
Table 8-11. DBCP and EDB Range and Median Summary by HCM Area 8-81
Table 8-12. DBCP and EDB Well Water Quality Objective Exceedance Summary by HCM Area 8-81
Table 8-13. Gross Alpha and Uranium Range and Median Summary by HCM Area 8-86
Table 8-14. Gross Alpha and Uranium Well Water Quality Objective Exceedance Summary by HCM Area 8-86

Table 8-15. Median Uranium Summary for Wells Overlying E-clay or Lake Deposits 8-87
Table 8-16. Nitrate, Nitrite, and Nitrate + Nitrite Range and Median Summary by HCM Area 8-96
Table 8-17. Nitrate, Nitrite, and Nitrate + Nitrite Well Water Quality Objective Exceedance Summary by HCM Area 8-97
Table 8-18. Summary of Well Construction with Nitrate and Groundwater Level Data 8-98
Table 8-19. Summary of Kern River Fan Wells Influence by Banking Operations 8-99
Table 8-20. Summary of Public Supply Wells in the Kern Fan HCM Area 8-101
Table 8-21. 2015 to 2023 PFOA prevalence by HCM Area 8-108
Table 8-22. 2015 to 2023 PFOS prevalence by HCM Area 8-108
Table 8-23. Selenium Range and Median Summary by HCM Area 8-111
Table 8-24. Selenium Well Exceedance Summary by HCM Area 8-111
Table 8-25. Total Dissolved Solids Range and Median Summary by HCM Area 8-116
Table 8-26. Total Dissolved Solids Well Exceedance1 Summary by HCM Area 8-117
Table 8-27. Median TDS Summary for Wells within E-clay or Lakebed Deposits Boundaries 8-117
Table 8-28. Groundwater Contamination Sites Identified Within Kern Subbasin 8-121
Table 8-29. Produced Water Ponds from GeoTracker 8-130
Table 8-30. HCM Area Subsidence Data 8-143
Table 8-31. NCCAG-Mapped Natural Communities Polygons and Area by HCM Area 8-186
Table 9-1. Average Annual Surface Water Supplies in the Kern Subbasin 9-27
Table 9-2. Average Annual Surface Water Use by Sector in the Kern Subbasin 9-28
Table 9-3. Historical and Current Water Budget Summary 9-32
Table 9-4. Annual volumetric range for each water budget component from WY1995 though WY2023 in acre-feet 9-33
Table 9-5. Estimated Subbasin Sustainable Yield based on C2VSimFG-Kern – Sustainable Yield from Groundwater Pumping 9-49
Table 9-6. Estimated Subbasin Sustainable Yield based on C2VSimFG-Kern – Sustainable Yield from Basin Recharge and Outflow 9-50
Table 9-7. GSA Water Bank Operator Summary of Return Obligation Account Balances (in acre-feet) 9-59
Table 9-8. Summary of stored surface water for GSAs with accounts at Subbasin water banks (in acre-feet) 9-60
Table 9-9. Water Bank Adjustment Calculation Summary 9-61
Table 9-10. GSA Operational Water Budget for Historical Period of 1995 to 2014 (acre-feet per year) 9-62
Table 9-11. GSA Operational Water Budget for Current Period of 2015 to 2023 (acre-feet per year) 9-63
Table 9-12. Summary of Simulated Change in Groundwater Storage Results over the 2041 to 2070 Sustainability Period 9-88
Table 11-1. Current Status of Groundwater Conditions for Each Sustainability Indicator 11-2
Table 13-1. Regional Groundwater Level Trends 13-12
Table 13-2. SMCs for Chronic Lowering of Groundwater Levels by RMW-WL 13-22
Table 13-3. Projected Subsidence and Groundwater Level Minimum Thresholds 13-30
Table 13-4. Annual Well Mitigation Program Funds 13-32
Table 13-5. Kern Subbasin Drinking Water Well Impact Analysis Results 13-36
Table 13-6. Criteria for Developing Degraded Water Quality SMCs 13-58
Table 13-7. Water Quality Objectives for COCs 13-63

Table 13-8. SMCs for Degraded Water Quality 13-64
Table 13-9. California Aqueduct SMCs by Survey Benchmark 13-98
Table 13-10. Friant Kern Canal SMCs by Survey Benchmark 13-103
Table 13-11. Subsidence SMC Matrix for GSA Area/Other Infrastructure 13-109
Table 13-12. Land Subsidence SMCs by HCM Area 13-111
Table 14-1. Glide Path – Target Deficit Reduction 14-4
Table 14-2. P/MA Targets by GSA from 1995-2014 Check Book 14-7
Table 14-3. Kern Subbasin (P/MA Cost by Implementation Status) 14-27
Table 14-4. Arvin GSA P/MA 14-28
Table 14-5. BVGSA P/MA 14-36
Table 14-6. CWD GSP P/MA 14-38
Table 14-7. Eastside Water Management Area (EWMA) P/MA 14-41
Table 14-8. HMWD GSA P/MA 14-44
Table 14-9. KNDLA P/MA 14-46
Table 14-10. Kern River GSA P/MA 14-48
Table 14-11. Kern-Tulare Water District GSA P/MA 14-53
Table 14-12. Kern Water Bank GSA P/MA 14-56
Table 14-13. NKWSD GSA P/MA 14-58
Table 14-14. OWD GSA P/MA 14-61
Table 14-15. Pioneer GSA P/MA 14-63
Table 14-16. RRBWSD GSA P/MA 14-65
Table 14-17. SSJMUD GSA P/MA 14-68
Table 14-18. SWID GSA P/MA 14-71
Table 14-19. SWID 7th Standard Annex P/MA 14-74
Table 14-20. SWSD GSA P/MA 14-76
Table 14-21. TCWD GSA P/MA 14-79
Table 14-22. WDWA GSA P/MA 14-82
Table 14-23. WRM GSA P/MA 14-86
Table 14-24. WKWD GSA P/MA 14-90
Table 15-1. Summary of Representative Monitoring Sites 15-5
Table 15-2. Summary of DQO Process Implementation 15-6
Table 15-3. Monitoring Well Density Considerations 15-8
Table 15-4. Scaled Monitoring Well Density 15-8
Table 15-5. Western Fold Belt HCM Area Groundwater Beneficial Exceptions1 15-10
Table 15-6. Distribution of Minimum Number of Wells Across Pumping Groups 15-13
Table 15-7. Comparison of Existing Network to Calculated Well Density 15-16
Table 16-1. Summary of Data Collection 16-2

FIGURES

Figure ES-1. Kern Subbasin GSAs ES-5
Figure ES-2. Kern Subbasin Timeline ES-6
Figure ES-3. HCM Areas in the Plan Area ES-10
Figure ES-4. Location of the Kern Subbasin ES-12
Figure ES-5. Kern Subbasin Cross Section ES-13

Figure ES-6. Kern Subbasin Annual Change in Groundwater in Storage ES-15
Figure ES-7. Cumulative Subsidence between 2015 – 2023 (feet) based on InSAR data..... ES-16
Figure ES-8. P/MA Benefits by Category ES-31
Figure ES-9. Projected-Future Scenario Overdraft Correction Glide Path ES-32
Figure ES-10. C2VSim-FG-Kern Projected Future Superposition Hydrograph (2030 Climate Change)..... ES-33
Figure 1-1. 2025 Plan GSPs in the Kern Subbasin 1-5
Figure 1-2. Kern Subbasin Timeline 1-6
Figure 3-1. GSA Coverage in the Kern Subbasin 3-5
Figure 5-1. Kern Subbasin HCM Areas and Adjacent Subbasins 5-4
Figure 5-2. Water District Boundaries 5-19
Figure 5-3. GSA Coverage of the Kern Subbasin 5-20
Figure 5-4. Land Use in the Kern Subbasin 5-23
Figure 5-5. Land Use in Kern Non-Districted Land Authority 5-24
Figure 5-6. Federal, State, and Tribal Lands, and Protected Areas of the Kern Subbasin. 5-25
Figure 5-7. Williamson Act..... 5-28
Figure 5-8. Kern Subbasin Communities..... 5-29
Figure 5-9. Kern Subbasin Population Density (population per square mile) based on 2020 Census Block Data 5-30
Figure 5-10. Surface Water Features 5-34
Figure 5-11. Water Banks Now in Operation..... 5-45
Figure 5-12. Well Density Per Square Mile 5-52
Figure 5-13. Public Water Systems 5-58
Figure 5-14. Community and Small Community Wells 5-59
Figure 5-15. Commercial Public Water Supply Wells..... 5-60
Figure 5-16. Industrial Public Supply Wells 5-61
Figure 5-17. Non-Public and Domestic Wells 5-62
Figure 5-18. Kern County General Plan Land Use Designation..... 5-78
Figure 5-19. Trent Taylor of Rosedale RRBWSD GSA and the Community Engagement Team's Spanish Interpretors (via Linguistica Interpretting and Translation, LLC.) engaging with community members at the Shafter Community Pop-Up Event..... 5-90
Figure 5-20. Thumbnail of Instagram Post Advertising Public Workshops (English Version)..... 5-94
Figure 5-21. Vanessa Yap Escobedo, PE of Kern-Tulare Water District GSA engaging with community members at the Delano Community Pop-Up Event 5-94
Figure 5-22. Locations of Community Pop-Up Events 5-95
Figure 6-1. Regional Setting Tulare Lake Region 6-3
Figure 6-2. Outline of Kern Subbasin 6-4
Figure 6-3. Outline of Kern Subbasin Subsections HCM Areas..... 6-8
Figure 6-4. Comparison of HCM Areas to the Kern Subbasin GSA Boundaries 6-9
Figure 6-5. Comparison of HCM Areas to the Tulare Lake Basin Plan Hydrologic Areas 6-10
Figure 7-1. Schematic Diagram Regional Setting Kern Subbasin..... 7-2
Figure 7-2. Topographic Map of Kern County 7-5
Figure 7-3. Surface Water Hydrology 7-8
Figure 7-4. Imported Water Point of Delivery 7-11
Figure 7-5. Managed Recharge Areas 7-13

Figure 7-6. Surficial Geology Map 7-16
Figure 7-7. Soils Map 7-19
Figure 7-8. General Stratigraphic Column 7-22
Figure 7-9. Geologic History Panels 7-23
Figure 7-10. Structural Regions of the San Joaquin Valley 7-29
Figure 7-11. Fault Map 7-31
Figure 7-12. Geologic Folds 7-34
Figure 7-13. Stratigraphic Columns for Different Areas in Kern Subbasin 7-35
Figure 7-14. Regional Extent of the E-Clay (Corcoran Clay) based on Page, 1986 7-38
Figure 7-15. Comparison of different interpretation on the extent of the E-Clay 7-39
Figure 7-16. Cross Section Locations 7-47
Figure 7-17. Cross Section A-A' 7-51
Figure 7-18. Cross Section B-B' 7-52
Figure 7-19. Cross Section C-C' 7-53
Figure 7-20. Cross Section D-D' 7-54
Figure 7-21. Cross Section E-E' 7-55
Figure 7-22. Cross Section F-F' 7-56
Figure 7-23. Cross Section G-G' 7-57
Figure 7-24. Location of the HCM Areas relative to the geologic setting 7-62
Figure 7-25. Location of the HCM Areas relative to structural setting 7-63
Figure 7-26. Primary Alluvial Principal Aquifer 7-76
Figure 7-27. Primary Alluvial Principal Aquifer E-Clay 7-77
Figure 7-28. Extent of Localized Shallow Groundwater Conditions Above the A-Clay or Equivalent 7-78
Figure 7-29. Primary Alluvial Principal Aquifer Bottom Elevation 7-81
Figure 7-30. Santa Margarita and Olcese Principal Aquifer (Kern Subbasin View) 7-84
Figure 7-31. Santa Margarita and Olcese Principal Aquifers 7-85
Figure 7-32. Geologic Basin Bottom Elevation 7-94
Figure 7-33. Base of Fresh Water (Page 1986) 7-97
Figure 7-34. Depth to Base of Underground Source of Drinking Water 7-98
Figure 7-35. Conceptual Approach Bottom of Kern Subbasin in the Plan Area 7-106
Figure 7-36. Oil & Gas Administrative Boundaries and CALGEM Active Wells 7-107
Figure 7-37. US EPA Primacy Aquifer Exemption Areas 7-108
Figure 7-38. US EPA Post-Primacy Aquifer Exemption 7-109
Figure 7-39. Oil Field Type Schematic 7-110
Figure 8-1. Generalized Diagram of Groundwater Flow in the Primary Alluvium Principal Aquifer 8-3
Figure 8-2. Spring 2023 Groundwater Elevation Map – Primary Alluvial Principal Aquifer 8-9
Figure 8-3. Fall 2023 Groundwater Elevation Map – Primary Alluvial Principal Aquifer 8-10
Figure 8-4. Historical Groundwater Elevation Maps – Primary Alluvial Principal Aquifer 8-13
Figure 8-5. Historical Groundwater Elevation Change - Primary Alluvial Principal Aquifer 8-14
Figure 8-6. Regional Groundwater Elevation Map 8-16
Figure 8-7. Representative Hydrographs Primary Alluvial Principal Aquifer 8-17
Figure 8-8. Depth to Groundwater Map for Near-Surface Perched Area with Localized Shallow Groundwater Conditions Above the A-Clay or Equivalent 8-22
Figure 8-9. Localized Shallow Groundwater Conditions Above the E-Clay 8-23
Figure 8-10. Hydrographs from Well Clusters Used for Vertical Gradient Analysis 8-24

Figure 8-11. Santa Margarita Principal Aquifer Groundwater Elevation Maps 8-27
Figure 8-12. Santa Margarita Principal Aquifer Hydrographs 8-28
Figure 8-13. Olcese Principal Aquifer Groundwater Elevation Maps 8-33
Figure 8-14. Olcese Principal Aquifer Hydrographs 8-34
Figure 8-15. Annual Change in Groundwater Storage, WY1995 – WY2023 8-36
Figure 8-16. Simulated Change in Groundwater in Storage 2016-2021 8-40
Figure 8-17. Annual Change in Groundwater in Storage (Elevation vs. Model Analysis) 8-41
Figure 8-18. Wells Used for Groundwater Characterization 8-53
Figure 8-19. Distribution of Small Community and Domestic Wells 8-54
Figure 8-20. Median 1,2,3-TCP Concentration 8-56
Figure 8-21. 1,2,3-TCP vs. Groundwater Elevations 8-59
Figure 8-22. 1,2,3-TCP vs. Groundwater Elevations 8-60
Figure 8-23. 1,2,3-TCP vs. Well Operation 8-61
Figure 8-24. 1,2,3-TCP vs. Well Operation 8-61
Figure 8-25. Median 1,2,3-TCP Concentration of Small Community Wells 8-63
Figure 8-26. Median Arsenic Concentration in the Kern Subbasin 8-65
Figure 8-27. North Basin HCM Area Arsenic vs. Groundwater Elevations 8-69
Figure 8-28. Kern River Fan HCM Area Arsenic vs. Groundwater Elevations in Recharge Basin Areas 8-70
Figure 8-29. Kern River Fan HCM Area Arsenic vs. Groundwater Elevations outside Recharge Basin Areas 8-71
Figure 8-30. South Basin HCM Area Arsenic vs. Groundwater Elevations 8-72
Figure 8-31. Median Arsenic Concentration of Small Community Wells 8-74
Figure 8-32. Median Benzene Concentration in the Kern Subbasin 8-76
Figure 8-33. Median Dibromochloropropane (DBCP) Concentration in the Kern Subbasin 8-79
Figure 8-34. Median Ethylene Dibromide (EDB) Concentration in the Kern Subbasin 8-80
Figure 8-35. Median Gross Alpha Concentration in the Kern Subbasin 8-83
Figure 8-36. Median Uranium Concentration in the Kern Subbasin 8-84
Figure 8-37. South Basin HCM AREA Uranium vs. Groundwater Elevations 8-88
Figure 8-38. Median Uranium Concentration of Small Community Wells 8-89
Figure 8-39. Median Nitrate as N Concentration in the Kern Subbasin 8-93
Figure 8-40. Median Nitrite as N Concentration in the Kern Subbasin 8-94
Figure 8-41. Median Nitrate + Nitrite Concentration in the Kern Subbasin 8-95
Figure 8-42. North Basin HCM Area Nitrate vs. Groundwater Elevations 8-98
Figure 8-43. Kern River Fan HCM Area Recharge Basin Area Nitrate vs. Groundwater Elevations 8-100
Figure 8-44. Kern River Fan HCM Area Nitrate vs. Groundwater Elevations 8-101
Figure 8-45. South Basin HCM Area Nitrate vs. Groundwater Elevations 8-102
Figure 8-46. Median Nitrate Concentration of Small Community Wells 8-104
Figure 8-47. Median Perfluorooctanoic Acid (PFOA) Concentration in the Kern Subbasin 8-106
Figure 8-48. Median Perfluorooctane Sulfonic Acid (PFOS) Concentration in the Kern Subbasin 8-107
Figure 8-49. Selenium Concentration in the Kern Subbasin 8-110
Figure 8-50. Median Total Dissolved Solids Concentration in the Kern Subbasin 8-114
Figure 8-51. Median Total Dissolved Solids Concentration with Geologic Structures 8-115
Figure 8-52. Point Source Contaminant Sites 8-120

Figure 8-53. Permitted Discharge Locations 8-126
Figure 8-54. UIC Program Wells and GeoTracker Produced Water Ponds Sites 8-129
Figure 8-55. 1926-1970 Historical Subsidence Data from USGS (1973) 8-135
Figure 8-56. Total Subsidence from 2007 to 2011 8-137
Figure 8-57. Regional Subsidence from 2015 through 2019 from InSAR Data 8-138
Figure 8-58. 2015 to 2023 Total Vertical Displacement based on InSAR Data 8-139
Figure 8-59. Annual InSAR Total Vertical Displacement for WY2016 to WY2023 8-141
Figure 8-60. InSAR 2015-2023 Total Vertical Displacement by HCM Area 8-144
Figure 8-61. Regional Critical Infrastructure #1: California Aqueduct 8-146
Figure 8-62. EPA Aquifer Exemption Areas 8-149
Figure 8-63. Subsidence AOI-2 Soil Types 8-150
Figure 8-64. Oil Wells and Subsidence in the Northern Aqueduct MP 189 to 254 8-152
Figure 8-65. Subsidence in Southern Pools 8-154
Figure 8-66. Cumulative Subsidence Southern Pools 2016 to 2023 8-155
Figure 8-67. Kern Subbasin Cumulative Subsidence 2015 to 2023 and FKC Subsidence Profile (INTERA 2024) 8-156
Figure 8-68. Comparison of InSAR 2015 to 2023 Total Vertical Displacement with USGS 1926-1970 Historical Subsidence 8-160
Figure 8-69. Concepts of Land Subsidence 8-161
Figure 8-70. Comparison of Groundwater Pumping With InSAR 2015 to 2023 Total Vertical Displacement 8-162
Figure 8-71. Distribution of Active Oil and Gas Wells (CalGEM, 2023) Relative to InSAR 2015 to 2023 Total Vertical Displacement 8-163
Figure 8-72. Mapped Faults Compared to InSAR 2015 to 2023 Total Vertical Displacement 8-164
Figure 8-73. Subsidence Assessment Areas 8-169
Figure 8-74. Location of Time Series Tracks 8-170
Figure 8-75. Time Series for AOI-1 Track A-A' 8-171
Figure 8-76. Time Series for AOI-2 Track B-B' Aqueduct Milepost 200 8-172
Figure 8-77. Time Series for AOI-2 Track C-C' Aqueduct Milepost 204 8-173
Figure 8-78. Time Series for AOI-2 Track D-D' Aqueduct Milepost 210 8-174
Figure 8-79. Time Series for AOI-3 Track E-E' 8-175
Figure 8-80. Time Series for AOI-4 Track F-F' 8-176
Figure 8-81. Time Series for AOI-4 Track G-G' 8-177
Figure 8-82. Time Series for AOI-5 Track H-H' 8-178
Figure 8-83. Curve Comparison 8-180
Figure 8-84. Polynomial Regression Analysis 8-182
Figure 8-85. NCCAG Wetlands and Vegetation 8-185
Figure 8-86. ICONS Interconnected Surface Water 8-187
Figure 8-87. Potential ISWs with Shallow Groundwater Extent 8-191
Figure 8-88. Potential ISWs with Surficial Geology 8-192
Figure 8-89. Hydrograph – Poso Creek 8-197
Figure 8-90. Poso Creek Profile 8-198
Figure 8-91. Hydrographs – Upper Kern River 8-199
Figure 8-92. Kern River Flow with Groundwater Elevations 8-200
Figure 8-93. Kern River Profile 8-201

Figure 8-94. Hydrographs – Lower Kern River 8-204
Figure 8-95. Hydrograph – Kern Water Bank Well 8-205
Figure 9-1. C2VSimFG Kern Simulation Grid with Kern Subbasin GSAs 9-3
Figure 9-2. C2VSimFG Kern Simulation Grid for Central Valley Showing Kern Subbasin 9-4
Figure 9-3. Water Year Types for Kern River and San Josquin Valley Index, WY1995 through 2023 9-12
Figure 9-4. Surface Water Features and Recharge Facilities Used in C2VSimFG Kern 9-16
Figure 9-5. C2VSimFG-Kern Urban Zones with City Limits 9-20
Figure 9-6. 2020 Census Population Density by Census Block for Kern Subbasin 9-21
Figure 9-7. ITRC METRIC Evapotranspiration Data for WY2013 9-24
Figure 9-8. Simulated Historical Surface Water Deliveries for Kern Subbasin 9-30
Figure 9-9. C2VSimFG-Kern Historical and Current Groundwater Budget for Kern Subbasin 9-37
Figure 9-10. C2VSimFG Kern Average Annual Historical and Current Water Budget for Kern Subbasin 9-38
Figure 9-11. Simulated Historical and Current change in Groundwater Storage for Kern Subbasin 9-39
Figure 9-12. Simulated Historical Recharge Operations for Kern Subbasin 9-40
Figure 9-13. Simulated Historical and Current Groundwater Pumping for Kern Subbasin 9-41
Figure 9-14. Annual Irrigated Agricultural Land by Crop Type and Total Crop Evapotranspiration (ETc) 9-42
Figure 9-15. Annual Groundwater Extraction Maps for Dry Year (WY2022) and Wet Year (WY2023) Conditions 9-46
Figure 9-16. Annual Change in Groundwater in Storage Maps for Dry Year (WY2022) and Wet Year (WY2023) Conditions 9-47
Figure 9-17. Average Annual Benefit of Proposed SGMA Projects and Management Actions 9-69
Figure 9-18. Projected-Future Water Supplies from the Kern River 9-76
Figure 9-19. Projected-Future Water Supplies from the Friant-Kern Canal for the Federal Central Valley Project 9-77
Figure 9-20. Projected Future Water Supplies from the California Aqueduct for the State Water Project 9-78
Figure 9-21. Total Projected Future Water Supplies from Kern River, SWP, and Central Valley Project 9-79
Figure 9-22. Projected-Future Change in Groundwater Storage for Baseline Conditions 9-84
Figure 9-23. Baseline Projected Future Average Annual Groundwater Budget for WY2041 to 2070 9-85
Figure 9-24. 2030 Climate Projected Future Average Annual Groundwater Budget for WY2041 to 2070 9-86
Figure 9-25. 2070 Climate Change Projected Future Average Annual Groundwater Budget for WY2041 to 2070 9-89
Figure 9-26. Projected Future Change in Groundwater Storage for all Conditions 9-90
Figure 9-27. Comparison of Historical to Projected Future Change in Groundwater in Storage 9-93
Figure 13-1. Illustrative Example of MT Approach Steps 1 through 3 13-10
Figure 13-2. Hydrogeologic Conceptual Model Areas and Groundwater Level Trends 13-13
Figure 13-3. Groundwater Level Minimum Thresholds – Primary Alluvial Principal Aquifer 13-16
Figure 13-4. Groundwater Level Minimum Thresholds – Santa Margarita and Olcese Principal Aquifers 13-17
Figure 13-5. Water Level Transect Along Cross Section E-E' Comparing Fall 2015, MO, and MT Groundwater Elevations 13-19

Figure 13-6. Water Level Transect Along Cross Section C-C' Comparing Fall 2015, MO, and MT Groundwater Elevations 13-19
Figure 13-7. Water Level Transect Along Cross Section A-A' Comparing Fall 2015, MO, and MT Groundwater Elevations 13-20
Figure 13-8. Distribution of Groundwater Elevation Range Within a 2-mile Radius of Each RMW 13-21
Figure 13-9. Comparison of MT and 2015 Low Groundwater Elevation Contours – Primary Principal Alluvial Aquifer 13-38
Figure 13-10. Scenario #1 – Worst Case 13-39
Figure 13-11. Scenario #2 – High-End Bracketed 13-40
Figure 13-12. Scenario #3 – Low-End Bracketed 13-41
Figure 13-13. Scenario #4 - Random Stochastic Prediction Figure 13 14. Scenario #4 - Weighted Stochastic Prediction 13-42
Figure 13-15. Scenario #5 – Potential Dewatered Drinking Wells Under Modeled Projected Future 2030 Climate Conditions no P/MAs 13-43
Figure 13-16. Scenario #5 – Potential Dewatered Drinking Wells Under Modeled Projected Future 2030 Climate Conditions with P/MAs 13-43
Figure 13-17. Groundwater Level Measurable Objectives – Primary Alluvial Principal Aquifer 13-46
Figure 13-18. Groundwater Level Measurable Objectives – Santa Margarita and Olcese Principal Aquifers 13-47
Figure 13-19. Illustrative Example of IM Approach 13-49
Figure 13-20. Kern Subbasin Change in Groundwater Storage for WYs 1995-2024 13-52
Figure 13-21. Arsenic Concentrations vs. Annual Subsidence Rates 13-67
Figure 13-22. Kern Subbasin Infrastructure: Regional Critical Infrastructure 13-74
Figure 13-23. Kern Subbasin Infrastructure: GSA Area Critical Infrastructure 13-75
Figure 13-24. Kern Subbasin Infrastructure: Other Infrastructure 13-76
Figure 13-25. Approach to Develop SMCs for Land Subsidence 13-83
Figure 13-26. Characterizing Land Subsidence Potential 13-84
Figure 13-27. Historical (2015 – 2024) HCM Area Subsidence Extents 13-85
Figure 13-28. Historical (2015 – 2024) Rate, Average, and Maximum Subsidence Extents17 for each HCM Area and Protective Buffers for Regional Critical Infrastructure 13-86
Figure 13-29. Projected Future (2024 – 2040) HCM Area Subsidence Extents 13-87
Figure 13-30. Estimates of Future (2024 – 2040) Cumulative Subsidence along Regional and GSA Critical Infrastructure 13-88
Figure 13-31. Change in Slope (vertical feet per 1000 horizontal feet) along Critical Infrastructure from 2024 – 2040 based on Projected Subsidence Extent 13-89
Figure 13-32. Projected Future (2024 – 2040) Rate, Average, and Maximum Subsidence Extents for each HCM Area and Protective MTs along Regional Critical Infrastructure Mileposts18 13-90
Figure 13-33. Subsidence Along the California Aqueduct MP 180 to 280 from 1969 to 2024 13-93
Figure 13-34. Subsidence Along the California Aqueduct MP 180 to 225 from 1969 to 2024 13-93
Figure 13-35. Projected Subsidence Along the California Aqueduct MP 190 to 250 13-94
Figure 13-36. Projected Subsidence Along the California Aqueduct MP 250 to 280 (Note: When the concrete liner elevation (various color lines with markers) falls below the required freeboard elevation (red line) there is no longer sufficient operational freeboard). 13-94
Figure 13-37. Projected Liner Elevation Above Required Freeboard Along the California Aqueduct MP 190 to 250 13-95
Figure 13-38. Projected Liner Elevation Above Required Freeboard Along the California Aqueduct MP 250 to 280 13-96

Figure 13-39. FKC Mile Post 135.45 Extrapolated Subsidence to 2040 (Based on 2015 to 2024 InSAR data) 13-105
Figure 13-40. Kern Subbasin Cumulative Subsidence 2015 to 2023 and FKC Subsidence Profile Extrapolated to 2040 13-105
Figure 13-41. Estimates of MTs Based on Future (2024 – 2040) Cumulative Subsidence along GSA Critical Infrastructure 13-108
Figure 13-42. Milepost 270 Glide Path 13-122
Figure 14-1. Glide Path – P/MA Planned Deficit Reduction vs. Milestones 14-5
Figure 14-2. P/MA by Category 14-5
Figure 14-3. P/MA by Category with Implementation Glide Path 14-6
Figure 14-4. P/MA Target by GSA in the Western Fold Belt 14-9
Figure 14-5. P/MA Target by GSA in the North Basin 14-11
Figure 14-6. P/MA Target by GSA in the Eastern Margin 14-12
Figure 14-7. P/MA Target by GSA in the Kern River Fan 14-14
Figure 14-8. P/MA Target by GSA in the South Basin 14-15
Figure 15-1. Hexagonal Grid 15-9
Figure 15-2. Pumping Distribution (Average 2016-2023) 15-12
Figure 15-3. Well Density Based on Pumping Distribution 15-14
Figure 15-4. Multiple Principal Aquifers Area and Recharge Basins 15-15
Figure 15-5. Geologic Structures 15-17
Figure 15-6. Groundwater Level Monitoring Network 15-18
Figure 15-7. Domestic Wells and Small Community Systems 15-21
Figure 15-8. Recharge Basins and E-Clay Extent 15-22
Figure 15-9. ILRP Wells and Public Supply Wells 15-24
Figure 15-10. Groundwater Quality Monitoring Network 15-25
Figure 15-11. Subsidence Monitoring Network 15-28
Figure 15-12. RMN-WL Data Gap Assessment Flow Chart 15-38
Figure 15-13. Groundwater Level Monitoring Network Domestic Well Data Gaps 15-39
Figure 15-14. Groundwater Level Monitoring Network Domestic Well Potential Data Gaps 15-40
Figure 15-15. RMN-WQ Data Gap Assessment Flow Chart 15-45
Figure 15-16. Groundwater Quality Monitoring Network Domestic Well Data Gaps 15-46

APPENDICES

Appendix A – DWR Determination and Feedback

- A-1 - Incomplete Determination of the 2020 Groundwater Sustainability Plans Submitted to the San Joaquin Valley – Kern County Subbasin
- A-2 - Inadequate Determination of the Revised 2020 Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Kern Subbasin

Appendix B – SWRCB Determination and Feedback

- B-1 - State Water Resources Control Board Final Staff Report
- B-2 - SWRCB Resolution 2025-0007
- B-3 - Crosswalk Summary of Subbasin Meetings with SWRCB Staff and Plan Additions
- B-4 - Crosswalk Summary of Major Plan Updates in Response to DWR Corrective Actions

Appendix C – Coordination Agreements, MOUs, and Coordination Letters

- C-1 - Kern County Subbasin Coordination Agreement
- C-2 - Fourth Amended and Restated Joint Exercise of Powers Agreement Kern Non-Districted Lands Authority
- C-3 - County of Kern Letter to SWRCB RE: Kern Groundwater Authority and Kern County Water Agency
- C-4 - SWRCB Letter to County of Kern RE: Kern Groundwater Authority and Kern County Water Agency
- C-5 - Memorandum of Understanding between Kern Water Collaborative and Groundwater Sustainability Agencies in the Kern Subbasin

Appendix D – Kern Fan Banking Programs

Appendix E – General Plan Policies, Goals, and Implementation Measures Relevant to SGMA

Appendix F – Stakeholder Communication and Engagement

- F-1 - 2024 Stakeholder Communication and Engagement Plan
- F-2 - 2024 Summary of Public Education and Engagement Opportunities
- F-3 - 2025 Community Outreach and Engagement Strategy
- F-4 - Kern County Subbasin 2025 GSA Meeting & Event Schedule

Appendix G – Mitigation Programs

- G-1 - Kern County Subbasin Well Mitigation Program Version 2.0
- G-2 - Friant-Kern Canal Lower Reach Subsidence Mitigation Studies and Agreements
- G-3 - Friant Water Authority Letter of Support

Appendix H – Model and Water Budget Supplemental and Supporting Documentation

- H-1 - Supporting Water Budget Tables C2VSimFG-Kern Model
- H-2 - Validation and Performance Assessment C2VSimFG-Kern Model
- H-3 - Hydrographs of Groundwater Elevations Projected-Future Kern County Subbasin
- H-4 - GSA Operational Water Budgets

Appendix I – Sustainable Management Criteria Approaches, Alternatives, Thresholds, Graphs, and Associated Analyses

- I-1 - Chronic Lowering of Groundwater Levels Representative Monitoring Well Hydrographs with Sustainable Management Criteria
- I-2 - Alternatives Evaluation for Chronic Lowering of Groundwater Levels Minimum Threshold Approaches
- I-3 - Well Impact Analysis

- I-4 - Degraded Water Quality Representative Monitoring Well Chemographs with Sustainable Management Criteria

Appendix J – Individual GSA Projects and Management Actions (P/MAs)

Appendix K – Exceedance Policies and Standard Operating Procedures for Exceedances

- K-1 - Kern Subbasin Exceedance Policy and Action Plans
- K-2 - Degraded Water Quality Implementation Provisions

Appendix L – Representative Monitoring Networks

- L-1 - Representative Monitoring Networks
- L-2 - Representative Monitoring Networks Data Gap Analyses

Appendix M – Standard Operating Procedures for Regular Monitoring

- M-1 - Standard Operating Procedure for Water Level Measurements and Reporting
- M-2 - Standard Operating Procedure for Water Quality Sampling and Reporting

Appendix N – Public Comment Letters and Responses

- N-1 - 2024 Plan Public Comment Letters and Responses
- N-2 - 2025 Plan Public Comment Letters and Responses

Acronyms and Abbreviations

Acronym or Abbreviation	Definition
1,2,3-TCP	1,2,3-trichloropropane
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter
AB	Assembly Bill
ACSD	Arvin Community Services District
AEWSD	Arvin-Edison Water Storage District
AF	acre-feet
AFS	Alaskan Satellite Facility
AFY	acre-feet per year
AGR	Agricultural Supply
Al/Fe-	Aluminum- and Iron-Bearing
AOI	Area of Interest
APN	Assessor Parcel Number
Aqueduct	California Aqueduct
AWG	Attorney Working Group
AWMP	Agricultural Water Management Plans
bbls	barrels
bgs	below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practice
bmsl	Below Mean Sea Level
BMWD	Berrenda Mesa Water District
BO	biological opinion
BVARA	Buena Vista Aquatic Recreation Area
BVC	Buena Vista Coalition
BVWSD	Buena Vista Water Storage District
C2VSim	California Central Valley Groundwater-Surface Water Simulation Model
C2VSimFG-Beta	C2VSim Fine Grid Public Beta model
C2VSimFG-Kern	C2VSim Fine Grid - Kern
C&E	Communications and Engagement Plan
CA	California
CAF	Confined Animal Facility

CalGEM	California Geologic Energy Management Division
CalOES	California Office of Emergency Services
CASGEM	California Statewide Groundwater Elevation Monitoring Program
CASP	California Aqueduct Subsidence Program
CCED	California Conservation Easement Database
CCR	California Code of Regulations
CDCR	California Department of Corrections and Rehabilitation
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CDMG	California Division of Mines and Geology
CE	Categorical Exemption
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGPS	Continuous Global Positioning System
CIMIS	California Irrigation Management Information System
CIWQS	California Integrated Water Quality System
CNRA	California Natural Resources Agency
COB	City of Bakersfield
COC	Constituent of Concern
CORS	Continually Operating Reference Station
CPAD	California Protected Areas Database
CPS	Crop Production Services
Cr^{3+}	Trivalent Chromium
Cr^{6+}	Hexavalent Chromium
CSD	Community Services District
CUP	Conditional Use Permit
CVC	Cross Valley Canal
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act of 1992
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternative for Long-Term Sustainability
CWA	Clean Water Act
CWC	California Water Code
CWD	Cawelo Water District
CWDC	Cawelo Water District Coalition

DAC	Disadvantaged Community
DBCP	Dibromochloropropane
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DDW	Division of Drinking Water
DEM	Digital Evaluation Map
DMS	Data Management System
DOGGR	California Division of Oil, Gas, and Geothermal Resources
DPR	California Department of Regulation
DQO	Data Quality Objective
DRWD	Dudley Ridge Water District
DTSC	California Department of Toxic Substances Control
DTW	depth to water
DW	drinking water
DWR	California Department of Water Resources
EAP	Early Action Plan
ECI	Earth Consultants International
EDB	Ethylene Dibromide
EHS	Environmental Health Services
EIR	Environmental Impact Report
ENCSD	East Niles Community Services District
EO	Executive Order
EOR	Enhanced Oil Recovery
EP	Effective Precipitation
EPA	Environmental Protection Agency
ER	ecological reserve
ESA	European Space Agency
ET	evaportranspiration
ETc	crop evapotranspiration
ETo	reference evapotranspiration
ER	Ecological Reserve
EWMA	Eastside Water Management Area
EWMP	Efficient Water Management Practice
FKC	Friant-Kern Canal
Flood-MAR	Flood-Managed Aquifer Recharge
ft	feet

ft/day	feet per day
ft/yr	feet per year
FWA	Friant Water Authority
FWUA	Friant Water Users Authority
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information Systems
GMT	Generic Mapping Tools
GMTSAR	Generic Mapping Tool Synthetic Aperture Radar
GPM	gallons per minute
GPS	Global Positioning System
GRD Format	Gridded data format
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWE	Groundwater Elevation
GWMP	Groundwater Management Plan
GW/SW	Groundwater/Surface Water
HBSL	Health-Based Screening Level
HCM	Hydrogeologic Conceptual Model
HEC-RAS	Hydrological Engineering Center - River Analysis System
HMWD	Henry Miller Water District
HR	Hydrologic Region
HR2W	Human Right to Water
I-5	Interstate-5
ID	Irrigation District
ID4	Improvement District 4
IDC	IWFM Demand Calculator
ILRP	Irrigated Lands Regulatory Program
IM	Interim Milestone
IND	Industrial Service Supply
InSAR	Inferometric Synthetic-Aperture Radar
IPUMS	Integrated Public Use Microdata Series
IRWMP	Integrated Regional Water Management Plan
IS	Initial Study
ISW	Interconnected Surface Water
IRWM	Integrated Regional Water Management Plan
ITRC	Irrigation and Training Research Center

IWFM	Integrated Water Flow Model
JPA	Joint Powers Agreement
JPL	Jet Propulsion Laboratory
KCDEH	Kern County Department of Environmental Health
KCEHS	Kern County Environmental Health Services
KCWA	Kern County Water Agency
KDWD	Kern Delta Water District
KEDF	Kern Economic Development Foundation
Kern Fan	Kern Alluvial Fan
KFMC	Kern Fan Monitoring Committee
KGA	Kern Groundwater Authority
KGET	Kern Golden Empire Television
KNDLA	Kern Non-Districted Land Authority
KRGSA	Kern River Groundwater Sustainability Agency
KRWCA	Kern River Watershed Coalition Authority
KTWD	Kern Tulare Water District
KWB	Kern Water Bank
KWBA	Kern Water Bank Authority
KWC	Kern Water Collaborative
LANDSAT	Land Remote-Sensing Satellite
LBL	Lawrence Berkeley National Laboratory
LHWD	Lost Hills Water District
LLNL	Lawrence Livermore National Laboratory
LOHF	Lost Hills Oil Field
LSCE	Luhdorff & Scalmanini Consulting Engineers
LUST	Leaking Underground Storage Tank
M&I	Municipal and Industrial
MA	Management Area
MAF	million acre-feet
Mc	Fanglomerate
MCL	Maximum Contaminant Level
MCWD	Mettler Country Water District
MDB&M	Mount Diablo Base and Meridian
METRIC	Mapping of Evapotranspiration with Internal Calibration
mg/l	milligrams per liter
MGD	million gallons per day
MGSA	McFarland Groundwater Sustainability Agency

MHI	Median Household Income
MIT	Mechanical Integrity Test
MND	Mitigated Negative Declaration
MO	Measurable Objective
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MP	Mile Post
MWELO	Model Water Efficient Landscape Ordinance
msl	mean sea level
MT	Minimum Threshold
MTBE	Methyl Tert Butyl Ether
MUD	Municipal Utilities District
MUN	Municipal and Domestic Supply
mya	million years ago
NASA	National Aeronautics and Space Administration
NCCAG	Natural Communities Commonly Associated with Groundwater
NCK	North Central Kern
ND	Negative Declaration
NED	National Elevation Dataset
NEPA	National Environmental Policy Act
Net CDF	Network Common Data Form
NGO	Non-Governmental Organization
NH_3	ammonia
NHD	National Hydrography Dataset
NHI	Nitrate Hazard Index
NKWSD	North Kern Water Storage District
NL	Notification Levels
NO_2	Nitrite
NO_3	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NOE	Notice of Exemption
NORMWD	North of the River Municipal Water District
NORSD	North of River Sanitary District
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSF	National Sanitation Foundation
NW	northwest

NWIS	National Water Information System
NYA	Native Yield on [Developed] Area
O&G	Oil and Gas
O&M	Operations and Maintenance
OCAP	Operational Criteria and Plan
OCPS	Organochlorine Pesticides
OMWC	Oildale Mutual Water Company
OPOA	Oasis Property Owners Association
OPPS	Organophosphorus Pesticides
OSGM	Office of Sustainable Groundwater Management
OSWCR	Online System of Well Completion Reports
OWD	Olcese Water District
P&O	Prioritization & Optimization
P/MA	Projects/Management Actions
PAHs	polynuclear aromatic hydrocarbons
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PCBS	Polychlorinated Biphenyls
PCE	Tetrachloroethylene
pCi/L	Picocuries per liter
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanoic Sulfonate
ppb	parts per billion
ppt	parts per trillion
PRC	Public Resources Code
PRO	Process Supply
PUC	Public Utilities Commission
PUD	Public Utilities District
QA/QC	Quality Assurance/Quality Control
QGIS	Quantum Geographic Information System
PWRPA	Power and Water Resources Pooling Authority
R&R	Recapture & Recirculation
RRID	Rosedale Ranch Irrigation District
RRBWSD	Rosedale-Rio Bravo Water Storage District
RMN	Representative Monitoring Network
RMN-WL	Representative Monitoring Network for Chronic Lowering of Groundwater Levels
RMN-WQ	Representative Monitoring Network for Degraded Water Quality

RMS	Representative Monitoring Sites
RMS-LS	Representative Monitoring Site for Land Subsidence
RMW	Representative Monitoring Well
RMW-WL	Representative Monitoring Well for Chronic Lowering of Groundwater Levels
RMW-WQ	Representative Monitoring Well for Degraded Water Quality
ROW	Right-of-Way
RPE	Reference Point Elevation
RPW	Recycled Produced Water
RWA	Recovered Water Account
RWQCB	Regional Water Quality Control Board
SAFER	Safe and Affordable Funding for Equity and Resilience Program
SAGBI	Soil Agricultural Groundwater Banking Index
SAR	Synthetic Aperture Radar
SB	Senate Bill
SBAS	Small Baseline Subset
SCEP	Stakeholder Communication and Engagement Plan
SDAC	Severely Disadvantaged Community
SDFAR	Socially Disadvantaged Farmers and Ranchers
SDWA	Safe Drinking Water Act
SDWIS	State Drinking Water Information System
SGM	Sustainable Groundwater Management
SGMA	Sustainable Groundwater Management Act
SHE	Self-Help Enterprises
SJRRP	San Joaquin River Restoration Program
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMARA	California Surface Mining and Reclamation Act
SMCs	Sustainable Management Criteria
SMCL	Secondary Maximum Contaminant Level
SO_4	Sulfate
SOCs	Synthetic Organic Compounds
SOKR	South of Kern River
SOP	Standard Operating Procedures
SOPAC	Scripps Orbit and Permanent Array Center
SpC	Specific Conductance
SSB	Southern Sierran block
SSJMUD	Southern San Joaquin Municipal Utility District
SSURGO	Soil Survey Geographical Database

Subbasin	Kern County Subbasin
SW	Surface water
SWID	Shafter-Wasco Irrigation District
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWSD	Semitropic Water Storage District
TAF	thousand acre feet
TBA	Tert-butyl Alcohol
TCE	Trichloroethylene
TCWD	Tejon-Castac Water District
TD	total depth
TD	Total [Water] demand
TDS	Total Dissolved Solids
TNC	The Nature Conservancy
TRE	TRE Altimira Inc.
TPH	Total Petroleum Hydrocarbons
TWG	Technical Working Group
UAVSAR	Unmanned Aerial Vehicle Synthetic Aperture Radar
UC	University of California
UCANR	University of California Agriculture and Natural Resources
UIC	Federal Underground Injection Control
UNAVCO	University NAVSTAR Consortium
UR	Undesirable Result
URF	Unreleased Restoration Flows
USACE	United States Army Corp of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USDW	Underground Source of Drinking Water
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
UST	Underground Storage Tank
UWMP	Urban Water Management Plans
UWUO	Urban Water Use Objectives
VIC	Variable Infiltration Capacity Model
VOCs	Volatile Organic Compounds

W&C	Woodard and Curran
WAKC	Water Association of Kern County
WBA	Water Banking Adjustment
WCR	Well Completion Report
WD	Water District
WDL	Water Data Library
WDR	Waste Discharge Requirements
WDWA	Westside Districts Water Authority
WFB	West-Side Fold Belt
WKWD	West Kern Water District
WL	Water Level
WQ	Water Quality
WQO	Water Quality Objective
WRMWSD	Wheeler-Ridge Maricopa Water Storage District
WSD	Water Storage District
WSCP	Water Shortage Contingency Plans
WSIP	Water Supply Investment Program
WTP	Water Treatment Plant
WWA	Westside Water Authority
WWT	Wastewater Treatment
WWTP	Wastewater Treatment Plant
WY	Water Year

EXECUTIVE SUMMARY

The Kern Subbasin (Kern Subbasin) Amended Groundwater Sustainability Plan (2025 Plan)[1] consists of seven closely coordinated (and nearly identical) Groundwater Sustainability Plans (GSPs) and the Kern Subbasin Coordination Agreement. The 2025 Plan represents a critical milestone in the Kern Subbasin and all 20 Kern Subbasin Groundwater Sustainability Agencies' (GSAs) ongoing commitment to achieving long-term groundwater sustainability under California's Sustainable Groundwater Management Act (SGMA). Developed collaboratively by all 20 GSAs, the 2025 Plan responds directly to regulatory feedback from the California Department of Water Resources (DWR) and the State Water Resources Control Board (SWRCB), incorporating the latest data, technical refinements, and input from interested parties. Table ES-1 presents the overview of each of the seven GSPs that together constitute the 2025 Plan, including which GSAs are covered by each GSP and whether the GSP includes supplemental "blue pages" specific to the portion of the Kern Subbasin that the GSA manages.

Table ES-1. 2025 Plan GSPs

GSP Name	Area (acres)	Percentage of Subbasin Area (percent)	GSA	GSP Contents
Kern Subbasin GSP	1,205,482	67.6%	Arvin GSA Cawelo Water District GSA Kern Non-Districted Land Authority GSA[2] (Kern River GSA Kern Water Bank GSA Greenfield County Water Districts GSA North Kern WSD GSA Pioneer GSA Rosedale-Rio Bravo WSD GSA Shafter-Wasco ID GSA Southern San Joaquin MUD GSA Tejon-Castac Water District GSA West Kern Water District GSA Wheeler Ridge-Maricopa GSA	Kern Subbasin GSP

[1] The 2025 Plan is prepared by 20 GSAs, which collectively manage the Kern Subbasin under one Coordination Agreement. Six GSAs have prepared a version of the 2025 Plan that includes supplemental information specific to the portion of the Kern Subbasin that the GSA manages. This supplemental information is provided on blue pages so differences between the versions can be easily identified by reviewers.

[2] Formerly Kern Groundwater Authority GSA

GSP Name	Area (acres)	Percentage of Subbasin Area (percent)	GSA	GSP Contents
Buena Vista GSA GSP	51,070	2.9%	Buena Vista GSA	Kern Subbasin GSP Supplemental GSA information included on blue pages
Henry Miller Water District GSA GSP	26,063	1.5%	Henry Miller Water District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Kern-Tulare Water District GSA GSP	11,344	0.6%	Kern-Tulare Water District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Olcese Water District GSA GSP	3,199	0.2%	Olcese Water District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Semitropic Water Storage District GSA GSP	224,350	12.6%	Semitropic Water Storage District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Westside District Water Authority GSA GSP	260,061	14.6%	Westside District Water Authority GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages

The 2025 Plan outlines a coordinated, science-based approach to address DWR Deficiencies[3] and SWRCB Potential Actions to Correct the Deficiencies[4] to ensure the sustainability of groundwater resources for all beneficial uses and users.

This Executive Summary is intended to provide decision-makers, interested parties, and the public with a clear understanding of the 2025 Plan's amendments, purpose, structure, and path forward. Table ES-2 below provides an overview of the Executive Summary topics to guide readers to an overview of areas of interest in the 2025 Plan.

[3] DWR Deficiencies as identified in Appendix A-1.
[4] SWRCB Potential Actions to Correct the Deficiencies as identified in Appendix B-1.

Table ES-2. Executive Summary Topics Overview

Title	Overview of Topics Discussed in the 2025 Plan Sections
ES.1: Introduction	Introduces SGMA and the requirement for local agencies to develop GSPs to manage groundwater sustainably.
ES.2: Sustainability Goal	Defines the Kern Subbasin's shared goal to achieve groundwater sustainability by 2040 through coordinated management and monitoring.
ES.3: Agency Information	Describes the structure, roles, and coordination among the 20 GSAs managing the Kern Subbasin.
ES.4: GSP Organization	Outlines the structure and content of the GSP.
ES.5: Description of the Plan Area	Provides geographic, demographic, and land use context for the 1.78-million-acre area of the Kern Subbasin.
ES.6: Introduction to Basin Setting	Summarizes the physical and hydrologic characteristics that influence groundwater conditions in the Kern Subbasin.
ES.7: Hydrogeological Conceptual Model	Details the geologic framework and aquifer systems that define groundwater flow and storage.
ES.8: Current and Historical Groundwater Conditions	Presents data on groundwater levels, storage, quality, and land subsidence trends.
ES.9: Water Budget Information	Quantifies groundwater inflows, outflows, and storage changes using historical and projected data.
ES.10: Management Areas	Defines sub-areas within the Kern Subbasin for localized groundwater management and monitoring.
ES.11: Introduction to Sustainable Management Criteria	Introduces the framework for setting measurable thresholds to evaluate sustainability.
ES.12: Sustainability Goal	Reaffirms the Kern Subbasin's long-term goal and the metrics used to track progress.
ES.13: Sustainable Management Criteria	Specifies thresholds, objectives, and triggers for each sustainability indicator.
ES.14: Projects and Management Actions	Describes planned actions to reduce groundwater deficits and improve sustainability outcomes.
ES.15: Monitoring Network	Details the network of sites used to track groundwater conditions and compliance with sustainable management criteria.
ES.16: Plan Implementation	Outlines the timeline, responsibilities, and funding mechanisms for executing the GSP.

ES.1 Introduction

On September 16, 2014, the California legislature enacted the 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. SGMA requires local agencies to form GSAs who are tasked with managing basins sustainably through the development and implementation of GSPs.

Figure ES-1 provides an overview of the 20 GSAs within the Kern Subbasin of the San Joaquin Valley Groundwater Basin.[5] The Kern Subbasin is one of 21 basins and subbasins identified by the DWR as being critically overdrafted. This designation triggered an accelerated timeline for GSP development by 2020 and long-term sustainability by 2040.

[5] Kern Subbasin (DWR No. 5-022.14) located within San Joaquin Valley Groundwater Basin (DWR No. 5-022).

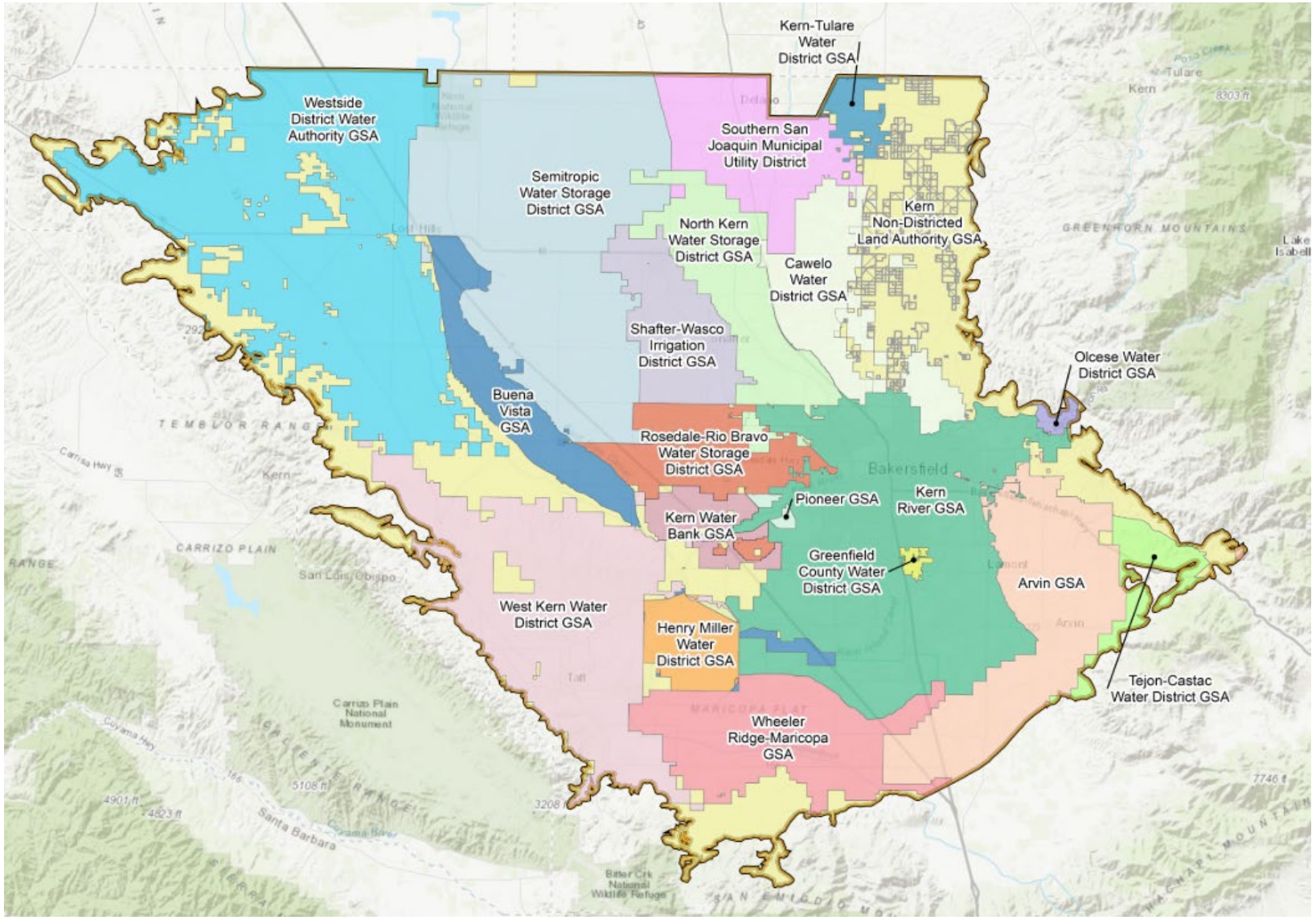


Figure ES-1. Kern Subbasin GSAs

Kern Subbasin Timeline

In response to the DWR Deficiencies and SWRCB Potential Actions to Correct Deficiencies, the Kern Subbasin has undertaken a rigorous, coordinated, and collaborative process to revise and strengthen the 2025 Plan. The Kern Subbasin worked together to address identified deficiencies and potential actions, incorporate updated data, and enhance coordination and stakeholder outreach. The timeline of SGMA implementation in the Kern Subbasin is reflected in

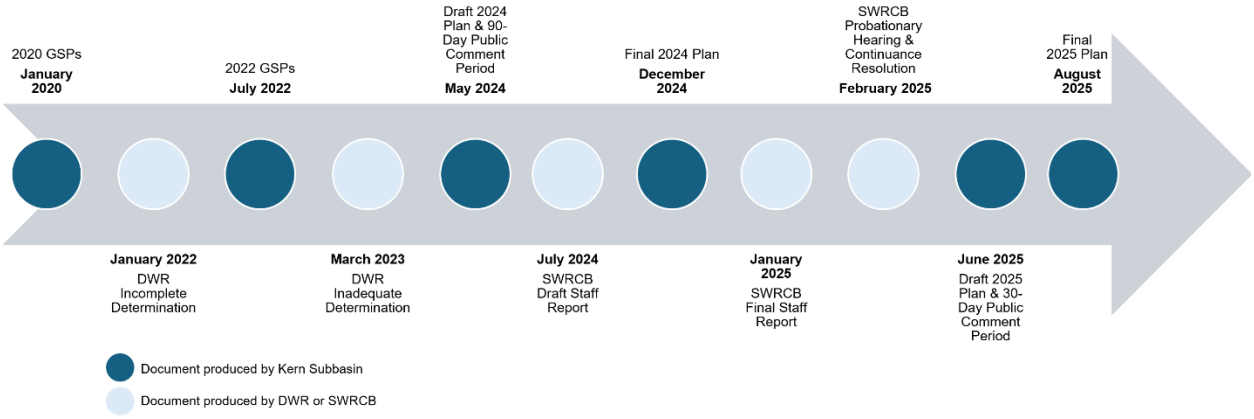


Figure ES-2 and summarized below.

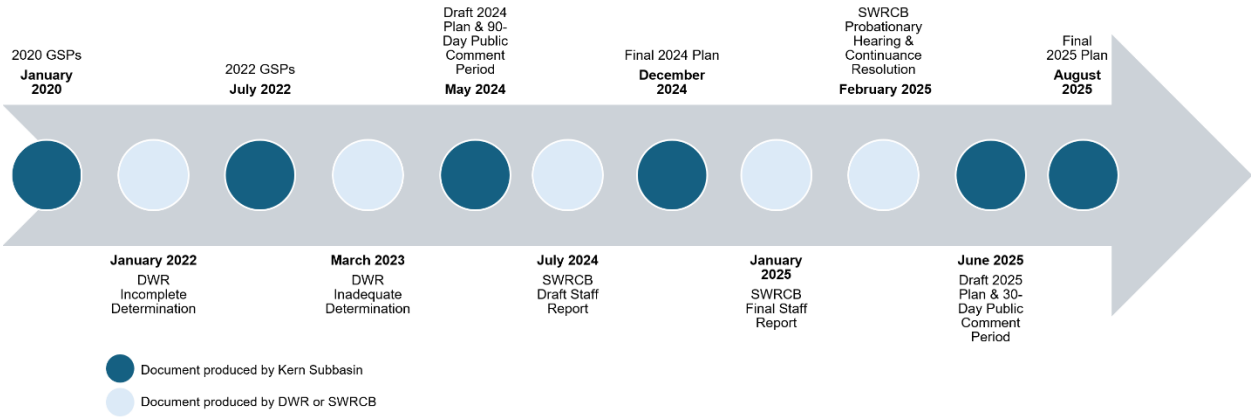


Figure ES-2. Kern Subbasin Timeline

DWR Process (2020 – 2023)

In January 2020, the Kern Subbasin GSAs executed the Kern Subbasin Coordination Agreement and subsequently submitted five GSPs to DWR (2020 GSPs). DWR designated the 2020 GSPs as “incomplete” in January 2022 and identified three deficiencies. In July 2022, the GSAs amended the Kern Subbasin Coordination Agreement and the five GSPs, plus a new independent GSA was formed, which

resulted in submitting six GSPs to DWR to address the identified deficiencies (2022 GSPs). In March 2023, DWR designated the Kern Subbasin as “inadequate” after reviewing the 2022 GSPs. As a result, the Kern Subbasin is subject to the state intervention process with the SWRCB as defined in California Water Code (CWC) §10735 et seq. The most significant deficiency was the lack of coordination among the six GSPs, which led to the next phase of work and development of a single Subbasin-wide plan.

SWRCB Process (2023 – June 2025)

In 2023 and 2024, the Kern Subbasin GSAs collaborated to amend the Kern Subbasin Coordination Agreement and integrate their plans under the SWRCB intervention process. In December 2024, the 20 GSAs adopted seven coordinated GSPs, with one subbasin-wide foundational GSP (the Kern Subbasin GSP) along with six additional GSPs (coordinated and consistent with the Kern Subbasin GSP) containing GSA-specific supplemental information included as “blue pages”. In February 2025, the SWRCB held a public hearing to consider probationary designation of the Kern Subbasin. The SWRCB resolved, through Resolution No. 2025-0007, that the hearing would be continued to allow time for the SWRCB and the GSAs to continue working collaboratively on addressing the DWR Deficiencies and SWRCB Potential Actions to Correct Deficiencies. In the Resolution, SWRCB directed the Kern Subbasin to revise and submit its draft 2025 Plan by June 2025, and to adopt the 2025 Plan prior to the September 2025 hearing.

Summary of 2025 Plan Amendments

The 2025 Plan amendments focus on addressing remaining SWRCB Corrective Actions to Address the Deficiencies. Key revisions include:

1. Reevaluation of groundwater level and groundwater quality monitoring network data gaps, and development of a Project and Management Action (P/MA) that includes a plan to fill those data gaps (Section 15.5).
2. Local refinements of Minimum Thresholds (MTs) for Chronic Lowering of Groundwater Levels targeting additional protection of beneficial uses and users (Section 13.1).
3. Revisions of Sustainable Management Criteria (SMCs) and the Undesirable Results (UR) definition for Degraded Water Quality to provide additional protection of beneficial uses and users (Section 13.3).
4. Additions to the Exceedance Policy and associated Action Plans for Groundwater Levels, Degraded Water Quality, and Land Subsidence (Appendix K-1) that elaborates on factors used to evaluate and act on groundwater level, quality, and subsidence related exceedances and expands on the GSAs’ commitment to ongoing collaboration with key critical infrastructure operators, respectively.

5. Development of a Degraded Water Quality Implementation Provisions (Appendix K-2) that includes summaries of related water quality provisions including, notification procedures for an exceedance, investigation procedures when representative monitoring well data exceed MTs (Appendix K-1), coordination efforts among existing programs, and Degraded Water Quality Mitigation (Appendix G-1).
6. Expansion of the Kern Subbasin Well Mitigation Program to include additional details (under a separate "*Degraded Water Quality Mitigation Track*") related to domestic well mitigation for Degraded Water Quality (Appendix G-1).
7. Subbasin-wide coordination among all Kern Subbasin GSAs on all GSP revisions and extensive community outreach and engagement, including initiation of the *Community Outreach and Engagement Strategy* (Appendix F-3).

Table 1-3 in Section 1 of the 2025 Plan provides a "crosswalk" between the SWRCB Deficiencies and Potential Actions to Correct the Deficiencies reflected in the SWRCB January 2025 Final Staff Report, and a summary of amendments incorporated in the 2025 Plan. The 2025 Plan provides a clear and coordinated path to achieve sustainable groundwater management in the Kern Subbasin.

ES.2 Sustainability Goal

Under SGMA, a Sustainability Goal is defined as a statement that describes the intended purpose of the GSP, including the desired conditions of the groundwater basin at the end of the 20-year planning and implementation horizon, and how the basin will achieve and maintain those conditions.

The Sustainability Goal must reflect avoidance of undesirable results, which include six conditions of groundwater known as Sustainability Indicators defined by SGMA:


Chronic lowering of groundwater levels


Reduction of groundwater storage


Seawater intrusion


Degraded water quality


Land subsidence


Depletions of interconnected surface water

The Kern Subbasin GSAs share a common Sustainability Goal, which is foundational to the development and implementation of the 2025 Plan. The Kern Subbasin GSAs'

Sustainability Goal is to achieve sustainable groundwater management within the SGMA 20-year implementation period. Achieving the Sustainability Goal will be demonstrated by eliminating chronic lowering of groundwater levels caused by overdraft conditions and avoiding undesirable results for groundwater levels, groundwater storage, land subsidence, and groundwater quality.

ES.3 Agency Information

The 2025 Plan was prepared by the 20 GSAs within the Kern Subbasin pursuant to the Kern Subbasin Coordination Agreement. Each GSA within the Kern Subbasin applied for and was granted exclusive GSA status for a portion of the Kern Subbasin under CWC §10723(c) and §10723.8. The Kern Subbasin Coordination Agreement was developed to establish the governance structure for the Kern Subbasin GSAs cooperative and coordinated exercise of authorities and responsibilities under SGMA. Each GSA has designated representative(s) to help lead or participate in coordination activities among GSAs, State agencies, local governments, local water suppliers, neighboring entities, non-governmental organizations, and other interested parties. Pursuant to Title 23 of the California Code of Regulations (CCR) §357.4(b)(1), a single point-of-contact was established for the purposes of organizing the various coordination activities and ensuring cohesion between GSA activities.

ES.4 GSP Organization

The 2025 Plan details and consolidates the Kern Subbasin GSAs' plans for achieving long-term sustainability. The organizational structure, as shown in Table ES-1, follows DWR's Annotated Outline (December 2016) with additional Sections incorporated to more thoroughly characterize the complexities of the Kern Subbasin, including its water supplies and long history of conjunctive management.

ES.5 Description of the Plan Area

The Kern Subbasin Plan Area (Plan Area) covers 1.78-million-acres and is located at the southern end of the Tulare Lake Hydrologic Region, including most of the San Joaquin Valley area within Kern County. For purposes of the 2025 Plan, the Kern Subbasin has been separated into five Hydrogeological Conceptual Model (HCM) Areas that are characterized by specific geologic and hydrogeologic attributes that dictate land and water uses in the area. The HCM Areas include the Western Fold Belt, East Margin, Kern River Fan, North Basin (North of Kern River Fan), and South Basin (South of Kern River Fan), as shown on Figure ES-3.

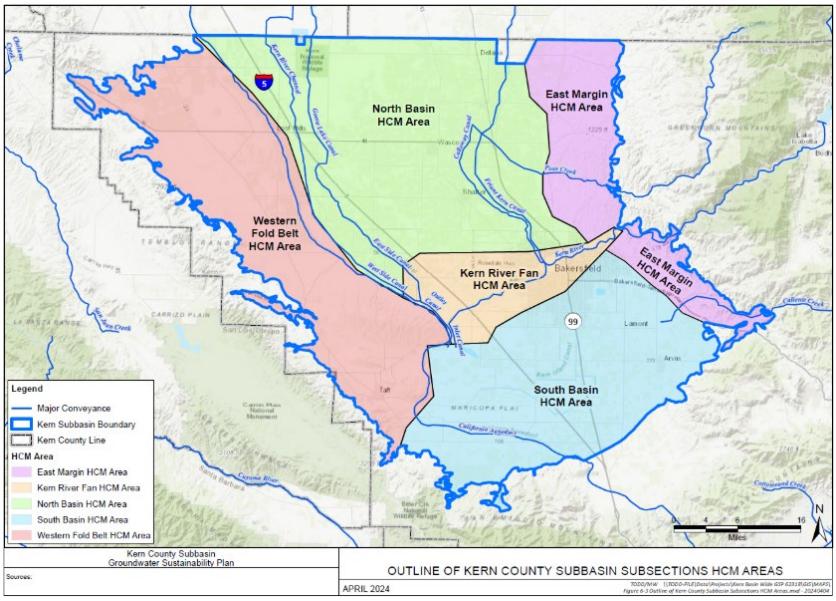


Figure ES-3. HCM Areas in the Plan Area

Adjacent Subbasins

The Kern Subbasin neighbors four separate and distinct groundwater subbasins: (1) the Tulare Lake Subbasin (DWR 5-022.12), (2) the Tule Subbasin (DWR 5-022-13), (3) the Kettleman Plain Subbasin (DWR 5-022.17), and (4) the White Wolf Subbasin (DWR 5-022.18), all also located within the San Joaquin Valley Groundwater Basin. The Tulare Lake and Tule Subbasins are designated as high priority and critically overdrafted by DWR. The adjacent Tulare Lake, Tule, and White Wolf Subbasins are each managed according to separate GSPs and SGMA-related activities. The Kern Subbasin GSAs consult with these subbasins to coordinate cross-boundary interactions (e.g., accounting for groundwater subsurface inflows and outflows and evaluating consistency of SMCs).

Land Use

The Plan Area is predominately two land use types: (1) irrigated agriculture, including a diverse array of crop types dictated largely by the economics of private farming and water supply availability, and (2) other uses. Table ES-3 breaks down land use type and acreage within the Plan Area. Water demands are met through conjunctive use programs that include diversions from the Kern River, imported surface water from the

State Water Project (SWP) and Central Valley Project (CVP), and in more recent years, recycled water.

Table ES-3. Land Use and Acreage in the Plan Area

Land Use Type	Acreage	Percentage of Total Area
Actively Cropped Agriculture Lands	644,000	36%
Idle Agriculture Lands (not actively irrigated)	256,000	15%
Urban, Suburban, and Rural Communities	81,000	8%
Industrial Oil Fields	159,000	5%
Other Uses (native/riparian vegetation, refuge, recharge basins, etc.)	~640,000	36%

Incorporated Cities and Unincorporated Communities

The Kern Subbasin is located within Kern County and includes eight incorporated cities and twenty-five unincorporated communities and census designated places as shown in Table ES-4. Areas within the Kern Subbasin identified as Disadvantaged Communities (DACs) or Severely Disadvantaged Communities (SDACs) based on the median household income (MHI) of the area compared to the Statewide MHI are identified in the table below, which reflects 1.43 million acres or 80 percent of the Plan Area.

Table ES-4. Incorporated Cities and Unincorporated Communities in the Plan Area

Incorporated Cities	
Arvin	McFarland
Bakersfield	Shafter
Delano	Taft
Maricopa	Wasco
Unincorporated Communities and Census Designated Places	
Buttonwillow	Lost Hills
Cherokee Strip	McKittrick
Derby Acres	Metter
Dustin Acres	Mexican Colony
Edison	Oildale
Unincorporated Communities and Census Designated Places	
Edmundson Acres	Rosedale
Famoso	Smith Corner
Fellows	South Taft
Ford City	Taft Heights
Fuller Acres	Tupman
Greenacres	Valley Acres
Greenfield	Weedpatch
Lamont	

Note: Cities, unincorporated communities and census designated places identified as a Disadvantaged Community or Severely Disadvantaged Community based on median household income.

ES.6 Introduction to Basin Setting

The Basin Setting provides a foundational understanding of the physical, hydrologic, and geologic characteristics of the Kern Subbasin. This introductory portion outlines the scope and purpose of the Basin Setting, which is to inform the development of SMCs and management actions by establishing a clear picture of the Kern Subbasin's structure and behavior.

ES.7 Hydrogeological Conceptual Model

The Kern Subbasin is large and geologically complex with regional faulting, folding, and three principal aquifers. The locations of the principal aquifers are shown on Figure ES-4.

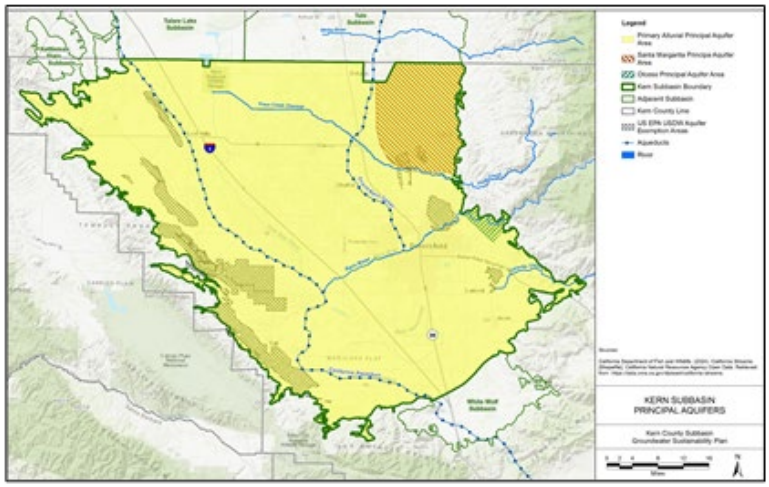


Figure ES-4. Location of the Kern Subbasin Principal Aquifers

A brief description of these principal aquifers is provided below:

1. **Primary Alluvial Principal Aquifer:** The Primary Alluvial Principal Aquifer extends over most of the Kern Subbasin and consists of the Tulare and Kern River Formations plus the overlying recent alluvium. It exhibits varying groundwater conditions and is classified as "confined" in areas with laterally extensive clay aquitards, "semiconfined" where vertical flow is impeded, and "unconfined" in various portions of the Kern Subbasin. The Primary Alluvial Principal Aquifer is the most productive freshwater aquifer, and the source of nearly all groundwater used within the Kern Subbasin.
2. **Santa Margarita Principal Aquifer:** The Santa Margarita Principal Aquifer is a confined unit located in the northeastern portion of the Kern Subbasin and is comprised of both the Santa Margarita Formation and Olcese Sand.
3. **Olcese Principal Aquifer:** The Olcese Principal Aquifer is a confined unit located in the vicinity of where the Kern River enters the eastern portion of the Kern Subbasin and consists of the Olcese Sand.

A series of hydrogeologic cross-sections have been developed to illustrate the Kern Subbasin physical characteristics and the formations present in the Plan Area. Figure ES-5 illustrates an example of the conditions parallel to the southern Plan Area. Cross sections for other portions of the Kern Subbasin are shown in Section 7. This

example shows the prevalence of Tulare and Kern River Formations, with the Santa Margarita Formation and Olcese Sand shallowing in the East Margin, and the extent of spatially discontinuous clay layers which can locally influence groundwater percolation and lateral flows. The cross sections developed improve understanding of Kern Subbasin conditions in the HCM Areas and provide the information necessary to develop water budgets from the Kern Subbasin's local numerical model, establish representative monitoring networks, develop applicable SMCs, and effectively convey hydrogeologic conditions to stakeholder groups.

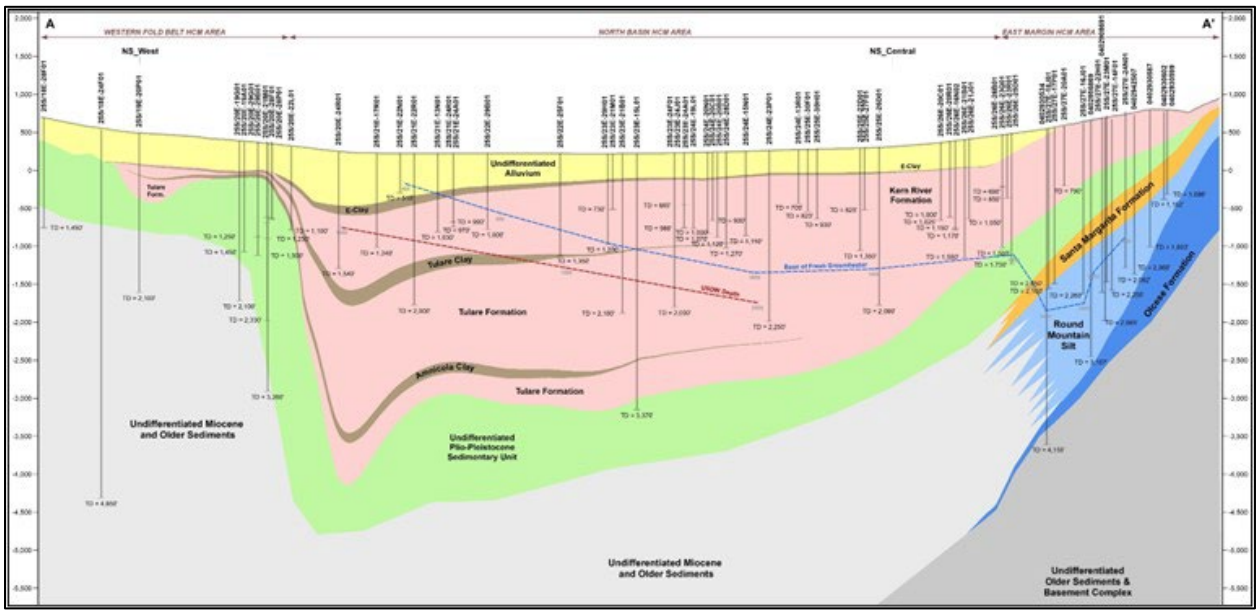


Figure ES-5. Kern Subbasin Cross Section

The Kern Subbasin contains several surface water features. The Kern River is the largest river in the Kern Subbasin and flows east to west through the center of the Plan Area. The Kern Subbasin also contains significant infrastructure that conveys imported water supplies, including the Friant-Kern Canal (FKC), California Aqueduct, and local canals.

Significant water recharge occurs in the Kern Subbasin through managed conjunctive use and water banking (surface water storage and recovery) projects along the Kern River and in other HCM Areas. The conjunctive use projects are dedicated to the management of surface water and storage of surface water within a specific portion of the Kern Subbasin for use at a later time by the overlaying lands of the Kern Subbasin, whereas water banking projects store surplus surface water supplies from the SWP, CVP, Kern River, and other flood waters for subsequent recovery for beneficial uses.[6]

[6] "The storing of water underground … constitutes a beneficial use of water if the water so stored is thereafter applied to the beneficial purposes for which the appropriation for storage was made." CWC § 1242.

ES.8 Current and Historical Groundwater Conditions

This section provides a comprehensive overview of the Kern Subbasin's physical and hydrologic characteristics, offering essential context for sustainable groundwater management. It includes an evaluation of both current and historical groundwater conditions to inform the development of sustainability goals and management actions. Key components of this section include:

1. Analysis of groundwater levels, highlighting seasonal and long-term changes in water levels.
2. Estimates of groundwater storage variations over time.
3. Assessment of seawater intrusion, where applicable, including its extent and progression.
4. Review of groundwater quality, identifying trends and areas of concern.
5. Documentation of land subsidence linked to groundwater extraction.
6. Evaluation of interconnected surface water systems and the impacts of groundwater use on surface water flows.

Groundwater Levels

Groundwater levels within the Kern Subbasin are presented using contour maps depicting the current (2023) seasonal high and seasonal low for each principal aquifer (Primary Alluvial Principal Aquifer, Santa Margarita Principal Aquifer, and Olcese Principal Aquifer) and hydrographs for various wells across the Kern Subbasin depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between and within principal aquifers. The available data indicate that the Kern River effectively bisects the Plan Area (

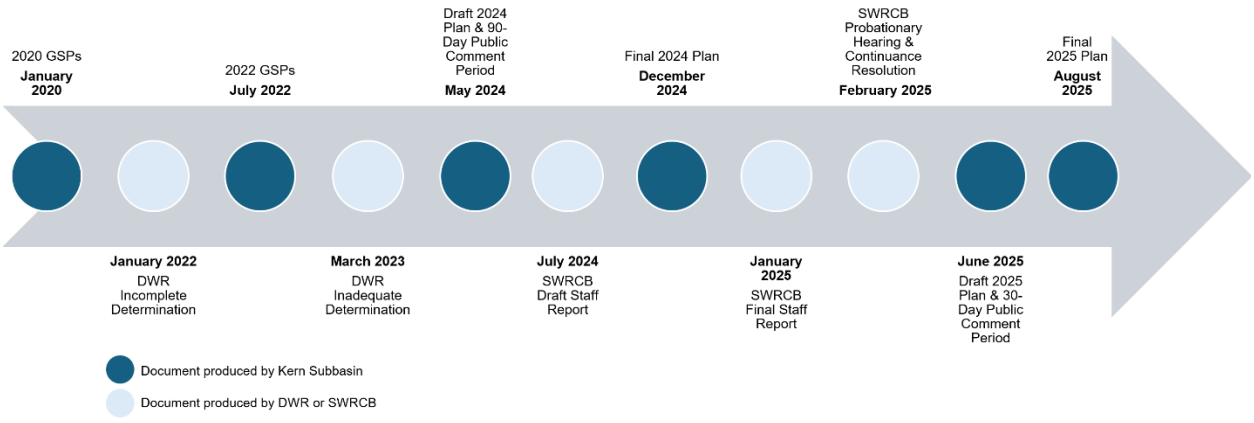


Figure ES-2). Groundwater tends to diverge from the Kern Fan HCM Area, with groundwater flowing toward extraction areas. Relative highs and lows appear to be

controlled, at least in part, by the distribution of groundwater pumping and surface water deliveries. Hydrographs show the long-term positive effects of surface water importation and corresponding conjunctive use and water banking activities in raising groundwater levels, tempered by the effects of the recent severe droughts.

Groundwater Storage

Changes in groundwater storage over selected time periods were calculated from the Kern Subbasin's local numerical model (C2VSimFG-Kern) and validated through a groundwater storage calculation that considers changes in measured groundwater elevations across the Kern Subbasin.

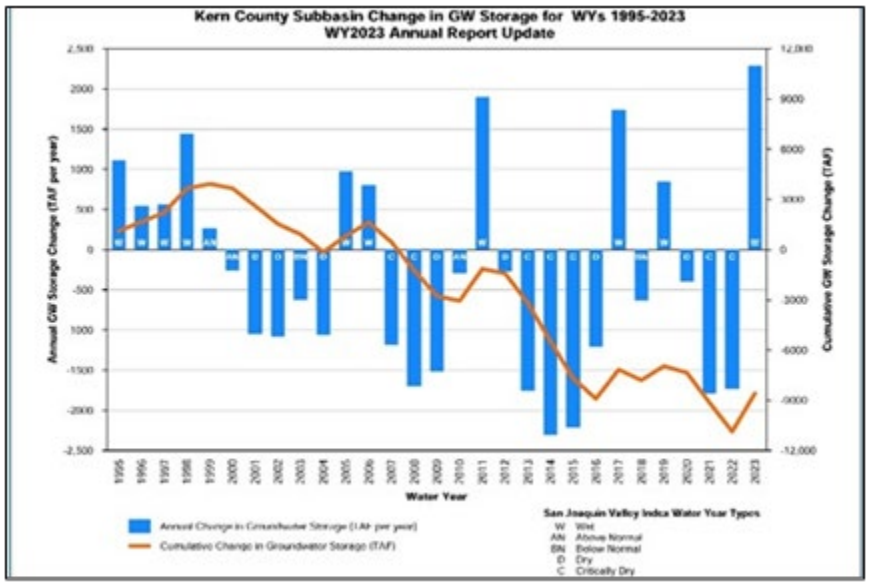


Figure ES-6. Kern Subbasin Annual Change in Groundwater in Storage

The variation in the simulated change in groundwater storage over the historical period generally corresponds with the variation in climatic conditions and surface water supply availability (Figure ES-6). The change in storage is more pronounced in the Kern Subbasin due to numerous conjunctive use and banking operations that store surface water in the aquifer typically during wet periods and then recover it for beneficial use during dry periods. As a result of these factors, the change in storage within the Kern Subbasin has had annual increases and decreases of up to 2,300,000 acre-feet per year (AFY).

Groundwater Quality

Certain constituents of concern (COCs) have been identified in the Kern Subbasin above the water quality objective, as set forth in the Water Quality Control Plan for the Tulare Lake Basin (Tulare Lake Basin Plan), which incorporates by reference maximum contaminant levels (MCLs) specified in Title 22 of the California Code of Regulations as applicable. The Kern Subbasin employed the SWRCB's methodology for identifying COCs from State and Regional Water Board datasets, and assessed the following constituents: 1,2,3-trichloropropane (1,2,3-TCP), arsenic, benzene, dibromochloropropane (DBCP), ethylene dibromide (EDB), gross alpha radiation, nitrate (as N), nitrate + nitrite (as N), nitrite (as N), perfluorooctane sulfonate (PFOS),

perfluorooctanoic acid (PFOA), selenium, total dissolved solids (TDS), and uranium. Of the 14 constituents recommended for evaluation, six were identified as COCs for SGMA monitoring across the Kern Subbasin: 1,2,3-TCP, arsenic, nitrates (including nitrite and nitrate+nitrite), TDS, and uranium.

Trend analyses were conducted on the six COCs to evaluate the relationship between groundwater management activities and degraded water quality, and to identify driving mechanisms for exacerbating constituent concentrations. No direct correlation has been observed between groundwater management activities and exacerbating concentrations of 1,2,3-TCP, TDS or uranium. While there is no clear Kern Subbasin-wide correlation for arsenic and nitrates, the driving mechanisms for degradation may require additional investigation. The GSAs have identified Representative Monitoring Wells for Degraded Water Quality (RMW-WQs) and will collect samples from these wells seasonally, coincident groundwater elevation measurements across the Kern Subbasin to monitor for potential impacts to beneficial users.

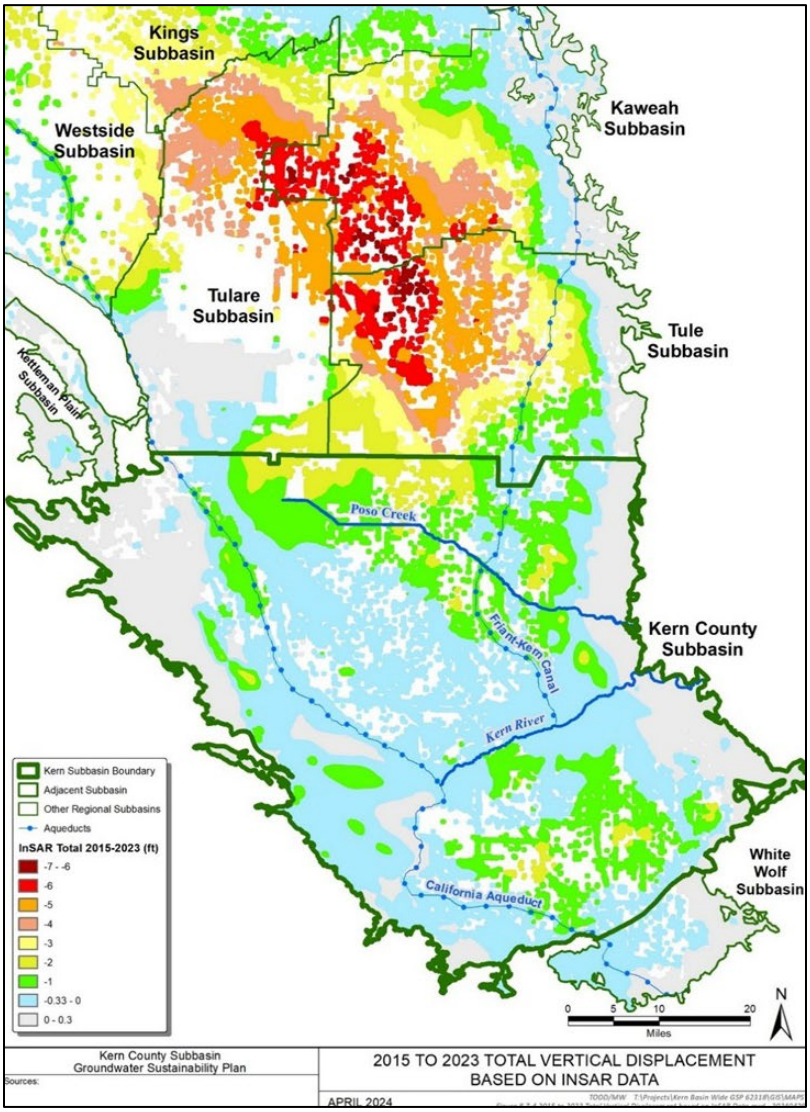


Figure ES-7. Cumulative Subsidence between 2015 – 2023 (feet) based on InSAR data

Land Subsidence

Land subsidence has been documented within the San Joaquin Valley over both historical and recent timeframes, with the greatest documented land subsidence occurring north of the Kern Subbasin (Figure ES-7). Not all land subsidence is GSA-related, nor is all land subsidence inelastic (i.e., non-recoverable). Land subsidence rates within the Kern Subbasin range from 0 to 0.3 feet per year resulting in a cumulative land subsidence of 0 to 2.41 feet since 2015. Land subsidence caused by factors within the GSAs' authority to manage is due to aquitard depressurization

following groundwater withdrawal, which tends to be greater in the areas that rely solely on groundwater for water supply (agricultural and urban pumping) and are underlain by a greater proportion of fine-grained deposits. Additional causes of land subsidence that are outside of the GSAs' control, include oil and gas extraction, potential natural processes (i.e. faulting), expansive/soluble soil types susceptible to hydro-compaction, and others (e.g., potential for deficient Aqueduct pre-construction hydro-compaction, age of infrastructure, etc.). Recent technical InSAR studies commissioned by the GSAs have been able to differentiate the land subsidence signals associated with seasonal extraction versus non-seasonal extraction..

Land subsidence has the potential to affect Kern Subbasin regional critical infrastructure (i.e., the California Aqueduct and Friant-Kern Canal) and local GSA area critical infrastructure, including gravity-driven water conveyance systems (canals). Both non-recoverable and recoverable land subsidence occurs in the area of the Kern Fan HCM Area. In some areas of the Kern Fan HCM Area, especially where significant recharge occurs at the Kern Fan banking programs, the average rate of land subsidence calculated for the Kern Fan HCM Area using the period from 2015 to 2024 likely overestimates projected land subsidence through 2040. To assess land subsidence, the Kern Subbasin has conducted a series of studies and continues on-going collaboration and communication with the California Aqueduct Subsidence Program (CASP) and the Friant Water Authority**.**

Seawater Intrusion

The Kern Subbasin is located far from coastal areas, and therefore seawater intrusion is not considered to be a relevant Sustainability Indicator.

Interconnected Surface Water

Data on depth to groundwater, geology, and other local conditions indicate that the vast majority of surface water features in the Kern Subbasin are not connected to groundwater, and in the few limited areas where a connection may occur, the connection is likely transient, short-lived, and involves shallow or perched groundwater that is not part of the principal aquifer systems. As such, the areas of vegetation mapped as Natural Communities Commonly Associated with Groundwater (NCCAG) and areas identified by the ICONS dataset are not likely groundwater dependent ecosystems (GDEs) or ISWs but instead are supported by irrigation water infiltration and agricultural return flows. In these areas, infiltration of irrigation water and agricultural return flows is impeded by clay soils and subsurface clay sediments creating shallow perched groundwater that is disconnected from groundwater in the principal aquifers that are the focus of SGMA.

ES.9 Water Budget Information

This section presents a detailed accounting of the Kern Subbasin's water inflows, outflows, and changes in storage over time. The water budget is a critical tool for understanding the Kern Subbasin's hydrologic balance and for evaluating the sustainability of current and projected groundwater use. It supports the development of measurable objectives (MOs) and SMCs by quantifying the relationship between water supply and demand under various conditions.

The water budget includes:

1. Historical Water Budget – A retrospective analysis of water conditions over a representative period, establishing baseline trends.
2. Current Water Budget – A snapshot of recent water year conditions, reflecting current management and climate influences.
3. Projected Water Budget – Future scenarios incorporating anticipated changes in land use, climate, and water demands.
4. Components of the Budget – Including natural and artificial recharge, groundwater extraction, evapotranspiration, surface water interactions, and subsurface flows.

Water Budget Model

The Kern Subbasin GSAs coordinated on the development of a single water budget using a local numerical model (C2VSimFG-Kern) that is based on the California Central Valley Groundwater/Surface Water Simulation Model (C2VSim) developed by DWR. The C2VSimFG-Kern is enhanced with additional data applied at the GSA level based on locally derived managed water supply and demand data to better represent the local water budgets. These model enhancements have been provided to DWR to help support their ongoing C2VSimFG model development. The Kern Subbasin has continued to support annual updates to the C2VSimFG-Kern model to incorporate recent conditions and estimate the current water budget.

Modeling results show that the Kern Subbasin, as a whole, had a total storage deficit of:

- Approximately 274,200 AFY over the historical period (i.e., WYs 1995-2014); and
- Approximately 344,000 AFY over the current period (i.e., WYs 2015-2023).

The Sustainable Yield has been conservatively estimated to be approximately 1.31 million AFY based on results for the historical period using model-calculated groundwater pumping and recharge to quantify the volume of water that, if pumped over the water budget period of interest, would have resulted in zero change in storage.

The projected water budget assesses the magnitude of the net water supply deficit under future conditions that would need to be addressed through P/MAs to prevent

Undesirable Results and achieve the Sustainability Goal. Three projected water budget scenarios have been developed for this analysis: (1) a Baseline Scenario, (2) a 2030 Climate Change Scenario, and (3) a 2070 Climate Change Scenario.

The projected (future) conditions were developed following the DWR guidance for developing future climate variables (i.e., adjusted precipitation and evapotranspiration) and water supply assumptions (i.e., changes to imported water supplies). This approach allows for inclusion of more complex variables, including factors influenced by climate change, resulting in more accurate projections.

Each projected (future) scenario was run twice. One version was run without P/MAs to evaluate the projected deficit, and a second version was run with a representative set of demand reduction and water augmentation P/MAs to identify the quantitative goal of planned P/MAs necessary to provide a reasonable approach to achieve sustainable groundwater management through 2040 and beyond. The results for each scenario are provided in Table ES-5**.** The Kern Subbasin GSAs used the projected deficit of 372,120 AFY from the 2030 Climate Change Scenario to define the target quantitative goal for planning purposes.

While the current C2VSimFG-Kern model provides an appropriate tool to determining the Kern Subbasin-scale water budgets, additional analysis was necessary to track GSA-level water management operations including those, such as water banking, that occur outside of the GSA boundary. The GSA operational water budgets are a spreadsheet-based accounting of surface water operations for individual GSAs. The GSA operational water budgets provide a complimentary analysis to accompany the Subbasin-wide analysis using the C2VSimFGKern model.

There are inherent limitations in using models to predict future conditions given the uncertainties surrounding input variables (e.g., uncertain future hydrologic conditions, recharge, and pumping volumes). A revised Subbasin-wide model is being developed and calibrated as part of 2025 Plan implementation and as additional information becomes available through the Basin Study (P/MA KSB-4).

Table ES-5. Summary of Simulated Change in Groundwater Storage Results

Period / Scenario	General Hydrologic Conditions of Period	Change in Groundwater Storage (acre-feet per year)
Historical Period (WYs 1995-2015)	Average	-274,200
Current Period (WYs 2015-2023)	Dry	-344,019
Projected Period (WYs 2041-2070) Baseline	Average	-324,326
Projected Period (WYs 2041-2070) Baseline with Projects	Average	85,578
Projected Period (WYs 2041-2070) 2030 Climate Change	Average with DWR climate change adjustments	-372,120
Projected Period (WYs 2041-2070) 2030 Climate Change with Projects	Average with DWR climate change adjustments	46,829

Period / Scenario	General Hydrologic Conditions of Period	Change in Groundwater Storage (acre-feet per year)
Projected Period (WYs 2041-2070) 2070 Climate Change	Average with DWR climate change adjustments	-472,336
Projected Period (WYs 2041-2070) 2070 Climate Change with Projects	Average with DWR climate change adjustments	-45,969

Note: a negative change in groundwater storage indicates a deficit and a positive change in groundwater storage indicates a surplus.

ES.10 Management Areas

For the purpose of SGMA compliance, the Kern Subbasin is divided into GSA areas which provide coverage for the entirety of Kern Subbasin including both districted lands and non-districted "white lands." There is no need to create management areas below the GSA level. The two exceptions are:

- The Eastside Water Management Area (EWMA) is a non-profit corporation governed by a seven-member Board of Directors that aims to become a public agency and function as its own GSA. Until then, it is treated as a separate management area within the Kern Non-Districted Lands Authority.
- The 7th Standard Annex, historically non-districted, was annexed into the Shafter-Wasco Irrigation District (SWID) in 2019 solely for SGMA compliance. It operates as a separate management area within SWID, as it does not share SWID's surface water supply benefits under the landowner agreement.

The 2025 Plan does divide the Kern Subbasin into five HCM Areas that each have similar geologic and aquifer characteristics distinct from those of other HCM Areas as described above in Section ES.7.

ES.11 Introduction to Sustainable Management Criteria

The SMCs are the metrics by which groundwater sustainability is evaluated under SGMA. Uniform definitions for the following SMC components were developed in the 2025 Plan through a coordinated effort of the Kern Subbasin GSAs.

1. **Undesirable Results (URs):** URs are the significant and unreasonable occurrence of conditions, for any of the six Sustainability Indicators that adversely affect beneficial uses and users and substantially interfere with surface land uses in the Kern Subbasin.
2. **Minimum Thresholds (MTs):** MTs are the numeric criteria for each Sustainability Indicator that, if exceeded in a locally defined combination of monitoring sites, may constitute an UR for that indicator.

3. **Measurable Objectives (MOs):** MOs are specific, quantifiable goals for the maintenance or improvement of groundwater conditions. MOs use the same units and metrics as the MTs allowing for direct comparison.
4. **Interim Milestones (IMs):** IMs are a set of target values representing measurable groundwater conditions in increments of five years over the 20-year statutory timeline for achieving sustainability.

Table ES-6 summarizes the SMCs for each applicable Sustainability Indicator in the Kern Subbasin.

Table ES-6. Summary of Sustainable Management Criteria

Sustainability Indicator	Undesirable Result	Minimum Threshold	Measurable Objective
Chronic Lowering of Groundwater Levels	One of the following occurs: (1) MTs exceed at least 25 percent of RMW-WLs over a single year (i.e., two consecutive seasonal measurements). (2) More than 15 drinking water wells are reported dry in any given year. If 15 drinking water wells were impacted every year, no more than 255 drinking water wells cumulatively would be impacted by 2040, or (3) Mitigation[1] backstop: a GSA is unable to meet well mitigation needs.	The lower of: (1) Groundwater level in 2030 if the regional trend is extended from the 2015 low (the MO), or (2) Groundwater level that allows for operational flexibility below the 2015 low, based on an RMW-WL-specific record of groundwater level fluctuations. MTs are then adjusted so that: (3) MTs do not exceed 61 feet below the recent historical low, (4) MTs do not newly fall below the Corcoran Clay, and/or (5) MTs are raised locally per State Water Resources Control Board staff feedback.	The 2015 low groundwater elevation.
Reduction of Groundwater Storage	The MTs for Chronic Lowering of Groundwater Levels are exceeded in at least 25 percent of the RMW-WLs over a single year (i.e., two consecutive seasonal measurements).	MTs for Chronic Lowering of Groundwater Levels used as a proxy.	MOs for Chronic Lowering of Groundwater Levels used as a proxy.
Seawater Intrusion	Groundwater conditions in the Kern Subbasin show that Seawater Intrusion is not present and is not anticipated to be present in the future, and therefore, the Sustainability Indicator is not applicable.		

Sustainability Indicator	Undesirable Result	Minimum Threshold	Measurable Objective
Degraded Water Quality	One of the following occurs: (1) Subbasin-wide, 15 percent of the Representative Monitoring Well for Degraded Water Quality (RMW-WQs) exceed the MT for the constituents of concern per water year based on confirmed sample and MT Exceedance investigation results[1]. (2) Annually, five percent of domestic wells have an assumed MT exceedance[1] based on radius of influence analysis around the RMW-WQ that exceeds the MT, with a cumulative maximum of 15 percent of domestic wells through 2040. (3) Mitigation[1] backstop: a GSA is unable to meet well mitigation needs.	(1) MT is set as close to the water quality objective as feasible. (2) If historical data exceeds the water quality objective, and at least five sample results are available, then the MT is set at the 80th Percentile value. (3) When clear trends are present, discretion should be applied a. If there is an increasing trend, set the MT at the 80th Percentile of the Pre-2015 data b. If there is a decreasing trend, MT should be set at the median value or as close to water quality objective as reasonable. If the 80th Percentile is within 10 percent of the drinking water MCL, the MT should be set at the water quality objective. (4) Proxy data are predominately used to demonstrate baseline conditions; however, data may be used when the RMW-WQ and Proxy Well are similar enough to represent the same lithology/aquifer conditions.	The water quality objective.
Land Subsidence	MT extent of land subsidence is exceeded at any RMS-LS along the Regional Critical Infrastructure at a single milepost or GSA or HCM Area MTs after six quarterly consecutive sampling events measured using InSAR data published by	MTs are established along regional critical infrastructure as a rate and extent based on either the protective level of land subsidence (the rate and extent of subsidence that would not lead to loss of conveyance capacity) or the historical rate of land	50 percent of the MT rate and MT extent.

Sustainability Indicator	Undesirable Result	Minimum Threshold	Measurable Objective
	DWR or annual survey data, if available, and can be attributed, based on a technical analysis using best available data and tools, to groundwater management activities (e.g. groundwater level changes, P/MAs). Note: The GSAs' management authority does not extend to all activities and processes that cause Kern Subbasin land subsidence.	subsidence projected to 2040 (where the projected amount of subsidence is not expected to lead to loss of conveyance capacity). Additionally, MTs are set for the Kern Subbasin as the average historical rate of land subsidence in each HCM Area from 2015-2023.	
 Interconnected Surface Water	Groundwater conditions in the Kern Subbasin show that there are a few areas with potential Interconnected Surface Waters. However, data show the connection is likely transient, short-lived, and involves shallow or perched groundwater that is not part of the principal aquifer systems. Therefore, the Sustainability Indicator is not applicable to the Kern Subbasin.		

Notes:

1. Exceedances and mitigation applications are evaluated as defined in the Exceedance Policy and Action Plans (Appendix K-1) and Mitigation Programs (Appendix G).

ES.12 Sustainability Goal

The sustainability goal for the Kern Subbasin is to implement its 2025 Plan to achieve sustainable groundwater management within the SGMA 20-year implementation period. Achieving the sustainability goal will be demonstrated by eliminating chronic lowering of groundwater levels caused by overdraft conditions and avoiding Undesirable Results for groundwater levels, groundwater storage, land subsidence, and groundwater quality. This goal will be accomplished through the following objectives:

1. Implement the Stakeholder Communication and Engagement Plan.
2. Eliminate long-term groundwater overdraft and attain sustainability through conjunctive use, water banking, and demand management programs.
3. Continuously monitor and evaluate groundwater conditions to avoid undesirable results.
4. Maintain long-term sustainability of water resources available to the Kern Subbasin.
5. Maintain a comprehensive database of beneficial uses and users to inform on the efficacy of groundwater management policies and programs.

ES.13 Sustainable Management Criteria

The Kern Subbasin GSAs identify primary beneficial uses and users of groundwater as agricultural, industrial, domestic well owners, small community wells, and municipal well operators. Additionally, infrastructure susceptible to land subsidence has been categorized based on land subsidence vulnerability and impacts to beneficial users (critical regional, GSA area, and others). The SMCs in Table ES-6 have been developed to prevent significant and unreasonable impacts to groundwater uses and users and land uses and are justified (i.e., will not result in significant and unreasonable impacts) as follows for all applicable Sustainability Indicators.

Chronic Lowering of Groundwater Levels

The Kern Subbasin GSAs' approach to developing the Chronic Lowering of Groundwater Levels SMCs applies a method that is consistent with the GSP Emergency Regulations, relies on consistent data and methodologies across the Kern Subbasin, and would not unreasonably impact beneficial uses and users of groundwater. The Kern Subbasin GSAs will strive through the implementation of P/MAs to manage groundwater levels toward the MOs, which are set at the 2015 low groundwater level. The MTs account for historical regional groundwater level trends (extended through 2030) and well-specific water level fluctuations to ensure sufficient groundwater supply and operational flexibility through variable hydrologic conditions and projected water uses. MTs are further capped to 61 feet below recent historical lows, raised to prevent groundwater levels from newly declining below the Corcoran Clay where it exists, and raised locally per SWRCB staff feedback.

Impacts to Beneficial Users

The 2025 Plan includes a well impacts analysis using the MTs and the Kern Subbasin's February 2025 well inventory to quantify potential impacts to beneficial users at the MTs as compared to the Chronic Lowering of Groundwater Levels URs definition. The (highly unlikely) worst-case scenario suggests that 184 drinking water wells may be potentially impacted if all RMW-WLs reach their MTs simultaneously, while the more likely scenario shows that under the URs definition that considers 25 percent of RMW-WLs reaching MTs, between 42 and 47 drinking water wells may be potentially impacted by 2040. Note, the groundwater level UR has an additional layer of protection by limiting the number of reported dry wells to 15 in a given year or 255 cumulatively, by 2040. The Kern Subbasin GSAs have developed and funded a Mitigation Program to address potential impacts from Chronic Lowering of Groundwater Levels to drinking water wells. A final protective "mitigation backstop" has been included, such that URs are triggered if a GSA is unable to well meet mitigation needs.

The potential "depletion of supply" for this scenario estimates the percentage of urban supply that may be impacted at MTs and the UR definition. Even under the worst-case scenario, less than two percent of the total estimated urban water supply would be

impacted by 2040. With implementation of the proposed P/MAs, the C2VSimFG-Kern model estimates that 19 drinking water wells may be potentially impacted, which corresponds to less than one percent of the Kern Subbasin's urban pumping.

Consideration of Adjacent Basins and Other Sustainability Indicators

Groundwater level SMCs have been compared to those in the neighboring Tule, Tulare Lake, and White Wolf Subbasins and are not projected to cause a change in historical gradients or prevent neighboring subbasins from achieving their Sustainability Goals. Groundwater level SMCs have also been determined to be protective of the other relevant Sustainability Indicators through quantitative analysis.

Reduction of Groundwater Storage

The Chronic Lowering of Groundwater Levels SMCs serve as a proxy for Reduction of Groundwater Storage pursuant to 23 CCR §354.28(d). Annual change in storage based on groundwater elevation change has good agreement with the simulated change in water in storage based on the C2VSimFG-Kern model, and therefore, groundwater level measurements have been demonstrated to serve as a reasonable proxy to estimate changes in groundwater storage. Furthermore, if groundwater levels decline from the MOs to the MTs, the reduction of storage would total approximately 7.2-million-acre feet (MAF). Consistent with the Chronic Lowering of Groundwater Level UR criteria, 25 percent of this volume results in a reduction of storage of approximately 1.80 MAF per year. This decline in groundwater storage is less than the storage change observed during recent multi-year droughts (i.e., 2013-2016 and 2021-2022) without an unreasonable amount of potentially impacted wells (Figure ES-6).

Degraded Water Quality

The MTs for Degraded Water Quality are set at the Kern Subbasin's RMW-WQs and are tied to regulatory water quality standards – namely, water quality objectives (WQOs) – that are considered protective of the municipal beneficial use (i.e., primary and secondary MCLs contained in CCR Title 22), as applicable for each of the six relevant COCs. Where historical data is consistently below the WQOs (as is the case for most of the RMW-WQs) or there is lack of supporting water quality data, MTs are set at WQOs. When baseline conditions (as assessed from best available historical data for pre-2015 and post-2015 water quality trends) were above WQOs, discretion was applied to set the MTs as close to the WQOs as possible, while being consistent with available water quality data trends. Where available, proxy data from nearby wells was used to augment baseline water quality data at the RMW-WQs. Water quality MOs were set at the WQOs. In general, the water quality SMCs are set to maintain concentrations of each COC at or below the applicable WQOs, or for wells that were already impacted before the SGMA effective date, to try and maintain concentrations at their pre-SGMA baseline levels.

Impacts to Beneficial Users

Approximately 93 percent of the water quality MTs are set at the WQO with the other 7 percent set at baseline conditions. MOs are set to WQOs. Hence, water quality SMCs within the Kern Subbasin are set to be protective of domestic and municipal beneficial uses. Where MTs are set above the WQOs, these represent baseline conditions based on best available data. Use of a baseline condition acknowledges that "the plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015" (CWC §10727.2(b)(4)). The GSAs continue to coordinate with other groundwater quality programs in the Kern Subbasin (Appendix K-2) that address pre-2015 or non-GSA related groundwater quality impacts.

Assuming a simple one to one ratio between RMW-WQ and domestic wells, MT exceedances at 15 percent of the RMW-WQs could result in up to 348 potentially impacted domestic wells. However, the distribution of domestic wells and RMW-WQs is not uniform across the subbasin, hence additional protective measures were incorporated into the UR. The Kern Subbasin GSAs' $3.5 million Well Mitigation Program (Appendix G-1) reserve includes a conservative estimated cost for water quality mitigation of $2,500 per mitigated domestic well, with an annual budget of $500,000 (sufficient to cover 200 wells). The second water quality UR criterion of 5 percent domestic wells equates to approximately 116 potentially impacted domestic wells annually. This translates to groundwater quality mitigation cost of approximately $300,000, which is well within the Well Mitigation Program budgeted amount of $500,000 for water quality mitigation. While highly unlikely, the third UR criterion provides yet another protective "mitigation backstop", wherein undesirable results would be declared if any GSA is unable to meet its mitigation needs.

Detailed notification and exceedance evaluations have been included (Appendix K-1) such that domestic well users impacted by Degraded Water Quality are fully informed of RMW-WQ results if WQO are exceeded, and testing and mitigation is made available for such users if MTs are exceeded due to groundwater management activities.

Additional details related to implementation of groundwater quality monitoring, SMCs, and P/MAs, including coordination with other groundwater quality programs in the Kern Subbasin are included in Appendix K-2.

Consideration of Adjacent Basins

Groundwater flow exits the Kern Subbasin across its northern boundary (Figure 8-1). The Chronic Lowering of Groundwater Levels MTs are not predicted to cause significant changes to local groundwater gradients and thus should be protective in terms of preventing migration of poor-quality water to adjacent subbasins. The adjacent subbasins similarly have SMCs established for key COCs that impact drinking water users.

Land Subsidence

The SMCs for Land Subsidence have been developed in recognition that land subsidence in the Kern Subbasin has several causative factors, some of which are within the GSAs' authorities to control ("GSA-related" land subsidence - e.g., groundwater pumping for agricultural and urban uses), and others that are outside of the GSAs' authorities to control ("non-GSA" land subsidence – e.g., oil and gas extraction,[7] potential natural processes, and expansive/soluble soil types susceptible to hydro-compaction). Consistent with the legislative intent of SGMA *"to avoid or minimize subsidence"* (CWC §10720.1(e)), the objective of the Kern Subbasin subsidence SMCs approach is to achieve zero GSA-related subsidence post-2040 and beyond. This will be accomplished through focused implementation of proactive demand reduction or other P/MAs designed to reduce land subsidence rates to meet the IM glide path (Section 13.5.3.2). The subsidence MTs are established along regional critical infrastructure as a rate and extent based on either the protective level of land subsidence (the rate and extent of subsidence that would not lead to loss of conveyance capacity) or the historical rate of land subsidence projected to 2040 (where the projected amount of subsidence is not expected to lead to loss of conveyance capacity or can be adequately mitigated by the GSAs, as is the case for certain sections of the FKC). Additionally, MTs are set for the Kern Subbasin as an average rate and extent of land subsidence in each HCM Area or adjacent to GSA area critical infrastructure. Note, that, where applicable, the subsidence MTs are based on a conservative extrapolation of the historical (2015-2024) subsidence rates through 2040. Future subsidence rates are expected to be lower as overdraft is eliminated and as groundwater levels stabilize through P/MAs implementation. As noted above, groundwater level MTs are based on extrapolating regional historical trends through 2030. The ten-year lag between groundwater level and subsidence trends are meant to capture potential future residual subsidence. Subsidence MOs are set at 50 percent of the subsidence MT rates and extents.

Impacts to Beneficial Users

MTs for regional critical infrastructure were developed in coordination with operators of the infrastructure (i.e., Friant Water Authority and CASP) and designed to avoid significant and unreasonable impacts to infrastructure functionality. MTs for the FKC are set at conservative levels with the GSAs committed to mitigating post-2020 subsidence impacts (due to groundwater management activities) on conveyance capacity (Appendix G-2). The MTs for the California Aqueduct are defined to avoid loss of conveyance capacity attributable to subsidence as limited by the remaining or required liner freeboard for specific Aqueduct mileposts (MP) 184 to 279. CASP has indicated that 2.5 feet of freeboard above the design water surface is required to maintain operations

[7] This sentence refers to United States Environmental Protection Agency (US EPA) exempt aquifer and associated oil and gas operations.

(DWR, 2017b), and is the best available metric to conduct an impacts analysis at this time. Therefore, MTs based on an extrapolation of the historical (2013-2024) subsidence rates through 2040 are adjusted to prevent available freeboard (as of 2024) falling below the 2.5 feet minimum design freeboard with a 0.1-foot margin for measurement error. Where land subsidence has already encroached on the minimum 2.5 feet of freeboard requirements, the MT is set to zero additional subsidence. The 2017 California Aqueduct Subsidence Study published by CASP does not suggest that operational impacts have occurred within the southern pools (DWR, 2017b). The MTs for the southern pools are primarily set at the future projected rates of subsidence as they do not infringe into the 2.5 feet minimum operating freeboard height, and MT rates are reduced at select MPs. The 2025 Plan defines a UR for land subsidence as a single representative monitoring site (e.g., milepost) exceeding the MT extent after 6-quarterly consecutive sampling events. Subbasin GSAs will meet with CASP quarterly to review land subsidence data trends compared to SMCs. Furthermore, the Kern Subbasin Exceedance Policy and associated Action Plan for Land Subsidence initiates an investigation proactively after an IM exceedance (Appendix K). This ensures proactive investigation responses before a MT exceedance and accounts for the complex (GSA and non-GSA related) driving mechanisms for subsidence and residual subsidence, which can continue for years after groundwater levels are stabilized.

The MTs for GSA area critical infrastructure are based on land subsidence rates that have historically occurred and have been managed by Kern Subbasin GSAs through ongoing maintenance and improvements to facilities. In addition to infrastructure-specific MTs, MTs for the entire Kern Subbasin are set based on HCM Area historical average land subsidence rates. As such, the Kern Subbasin GSAs will continue to monitor and report land subsidence throughout the entire Kern Subbasin, and coordinate with other entities that have interests in and responsibilities for land subsidence caused or influenced by activities or processes outside of the GSAs' management authorities.

The GSAs have developed a comprehensive Action Plan for Land Subsidence (Appendix K-1) that covers subsidence monitoring, reporting, exceedance evaluation, coordination with key agencies (e.g., FWA and CASP), and future updates to Subsidence protocols and P/MAs based on forthcoming documents.

Consideration of Adjacent Basins

MT extents in the Kern Subbasin are half the MT extents in the adjacent northward Tule and Tulare Lake Subbasins. Therefore, implementation of the 2025 Plan would not prevent neighboring subbasins from achieving their Land Subsidence sustainability goal(s). Although Land Subsidence MTs in the adjacent southern White Wolf Subbasin are currently set using groundwater levels as a proxy, Kern Subbasin GSAs are actively collaborating with the White Wolf GSA to ensure consistency as the White Wolf GSA develops more specific Land Subsidence SMCs.

Relationships Between Sustainability Indicators

The Kern Subbasin recognizes the interconnected nature of SGMA's Sustainability Indicators and evaluates how changes in one may influence others. Key relationships are summarized below:

1. Groundwater Levels and Groundwater Storage
    - Direct Relationship: Chronic lowering of groundwater levels is directly related to reductions in groundwater storage.
    - Proxy Use: Groundwater level MTs are used as a proxy for storage reduction.
    - Impact Estimate: If groundwater levels decline from the MOs to the MTs, the reduction of storage would total approximately 7.2 million acre feet (MAF). Consistent with the Chronic Lowering of Groundwater Level UR criteria, 25 percent of this volume results in a reduction of storage of approximately 1.80 MAF per year. The estimated total decrease in storage from the historical and current water budgets (Section 9.3.2 and Appendix H-1) during the 2013-2016 drought was 7.47 MAF, and the annual decrease in storage during the 2013-2016 and 2021-2022 droughts was on average 1.832 MAF. Hence, a reduction of storage of less of than 1.80 MAF per year and cumulative reduction in storage of 7.2 MAF is not considered significant and unreasonable, as it is similar to the storage change observed during recent multi-year droughts without unreasonable dewatering of wells.
2. Groundwater Levels and Degraded Water Quality
    - No Subbasin-Wide Correlation: Trend analysis shows no consistent correlation between declining groundwater levels and degraded water quality across the Subbasin.
    - Localized Exceptions: Some areas show localized relationships due to specific geochemical or hydrologic conditions. These will be taken into consideration along with other relevant driving mechanisms when evaluating future MT exceedances (Appendix K-1).
    - Monitoring Approach: RMW-WQs and data from 42 Department of Drinking Water (DDW) regulated small community systems with 55 active groundwater wells are used to monitor potential interactions.
3. Groundwater Levels and Land Subsidence
    - Simplified Predictive Analysis: Historical groundwater level declines and land subsidence data were used to project average HCM Area future subsidence extents at MTs.
    - Protective Thresholds: Based on regional correlation analysis, projected subsidence at groundwater level MTs is below the MTs for land subsidence, indicating that groundwater level MTs are protective. Moreover, groundwater

level MTs have been raised in areas to avoid groundwater levels falling newly below the Corcoran where they have not in the past. Groundwater level declines are projected through 2030, which is ten years before subsidence levels are projected to stabilize to account for potential residual subsidence in the future.

- Ongoing Monitoring: GSAs will compare observed subsidence with IMs and MTs annually and manage to the most protective indicator. GSAs will conduct quarterly check-ins with critical infrastructure operators to discuss land subsidence trends.
- Ongoing Modeling: The GSAs are integrating land subsidence into the C2VSimFG-Kern model as part of implementation of the 2025 Plan; the results of which will be used to ensure that MTs for chronic lowering of groundwater levels are protective of MTs set for land subsidence.

4. Land Subsidence and Groundwater Storage
    - Potential Impact: Subsidence can reduce storage capacity through compaction of fine-grained layers.
    - Conclusion: Given the correlation with groundwater level SMCs, land subsidence MTs are not expected to cause unreasonable storage loss.
5. Land Subsidence and Water Quality
    - Arsenic Mobilization: Some studies suggest clay layer compaction may release arsenic.
    - No Observed Correlation: No link has been observed between land subsidence and arsenic or other COCs in the Kern Subbasin.
    - Monitoring Strategy: RMW-WQs in historically subsiding areas are used to track potential relationships.

ES.14 Projects and Management Actions

Achieving sustainability in the Kern Subbasin will require the implementation of P/MAs to address projected water budget deficits that contribute to groundwater level and storage declines, land subsidence, and water quality impacts. The Kern Subbasin has developed a portfolio of P/MAs, each with specific projected benefits, implementation triggers, and costs. The P/MA portfolio includes 387,000 AFY in demand reduction management actions and 452,000 AFY in water supply augmentation projects. To date, the Kern Subbasin has already begun to implement 47 percent of the identified P/MAs.

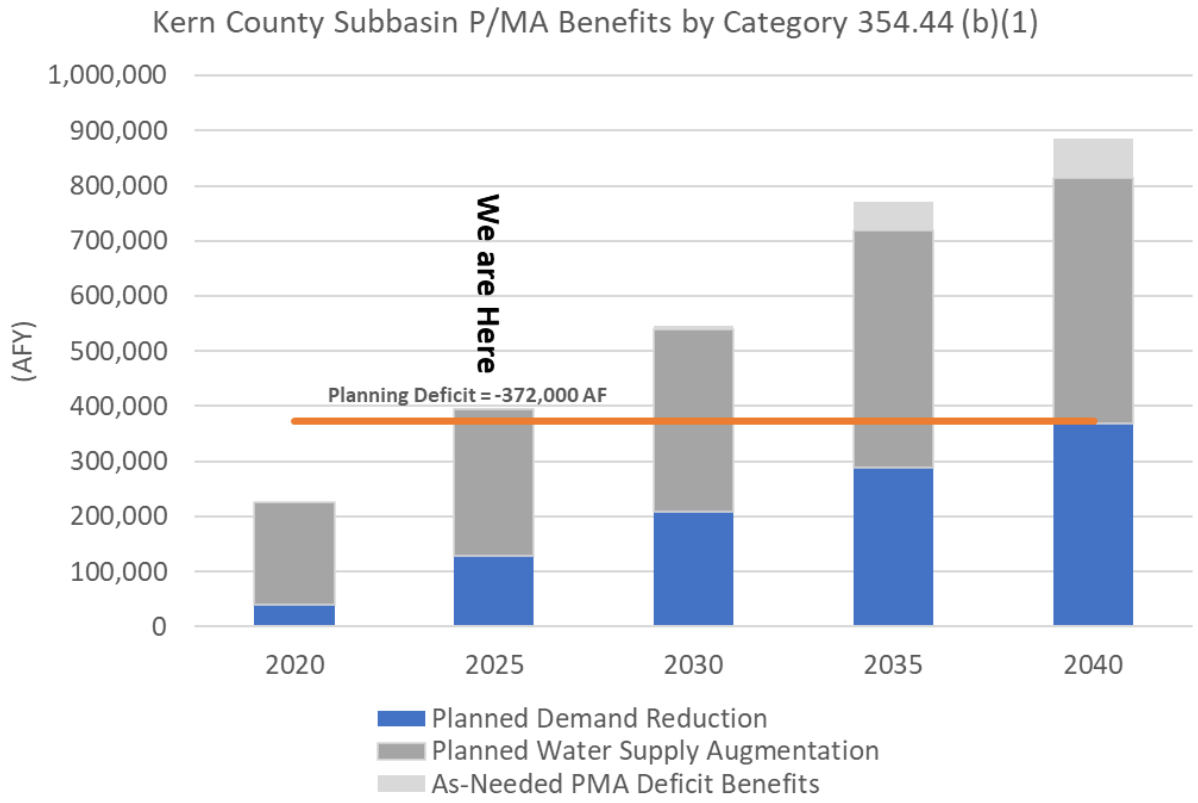


Figure ES-8. P/MA Benefits by Category

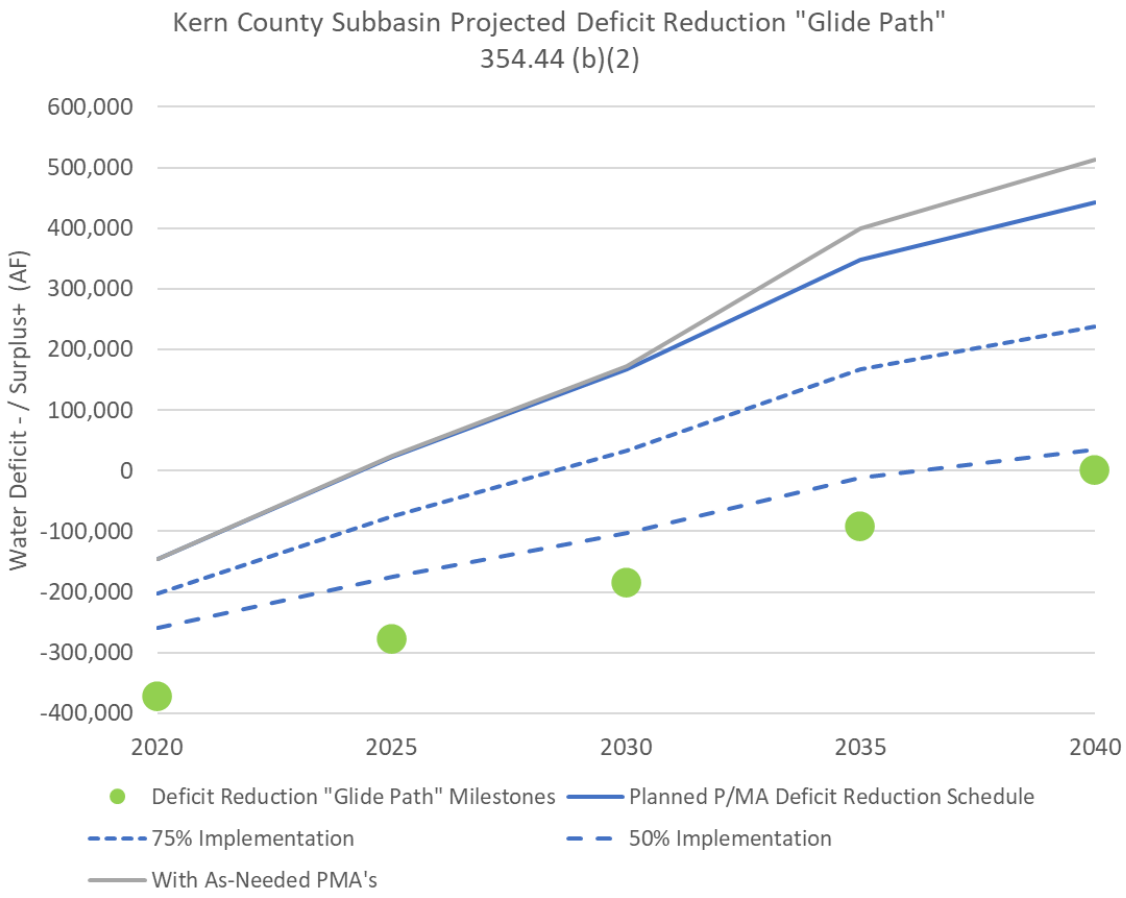


Figure ES-9. Projected-Future Scenario Overdraft Correction Glide Path

A linear "glide path" has been developed that will result in closing the projected Kern Subbasin deficit[8] of approximately 372,000 AFY by 2040, of which 99 percent is projected to be met with demand reduction P/MAs (Figure ES-8). Kern Subbasin GSAs have also included supply augmentation P/MAs. The 2025 Plan includes significantly more P/MAs than are required to address the projected deficit. In the event full estimated P/MA benefits are not ultimately realized, there is a built-in "safety factor" of nearly 2.2 and a plan to ensure that the Kern Subbasin projected deficit is reduced by 2040. Furthermore, under the Kern Subbasin Exceedance Policy, implementation of P/MAs could be triggered and/or accelerated if MT exceedances occur.

The supply augmentation and demand reduction P/MAs identified by the Kern Subbasin GSAs comprises a diverse portfolio of options that can be implemented as necessary to achieve sustainability from a comprehensive water quantity and water quality perspective. Additionally, eight Kern Subbasin P/MAs establish Subbasin-wide programs, policies, collaborations, and ongoing data gap filling.

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

The modeled simulated results for the planned P/MAs indicate that P/MA implementation along the planned glide path will successfully achieve sustainability and avoid URs for Groundwater Levels (and by proxy for the other applicable Sustainability Indicators) throughout the Kern Subbasin.

Specifically, the C2VSimFG-Kern model results have been used to compare simulated groundwater levels to the MTs and MOs for each RMW-WL. In general, across most of the Kern Subbasin, groundwater levels fall near or below MTs without P/MAs implementation but are typically above the MT for the simulations that include P/MAs (Figure ES-10).

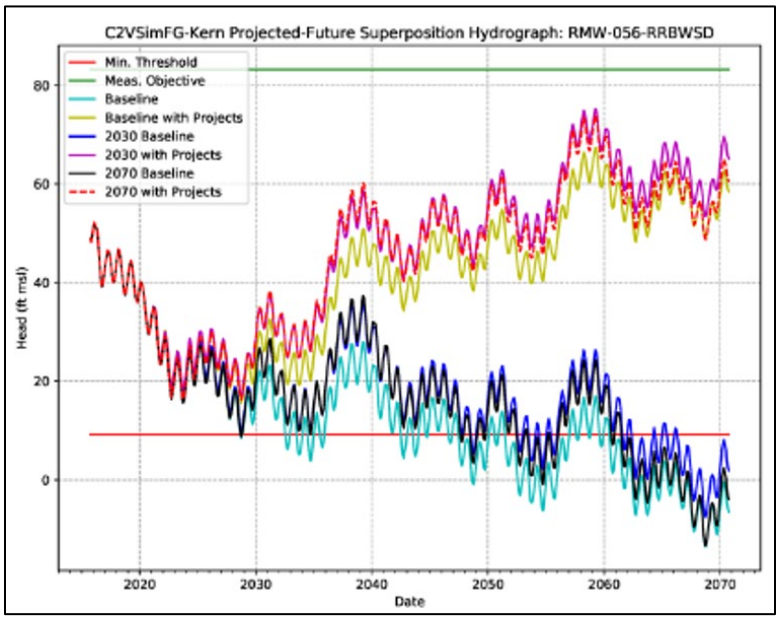


Figure ES-10. C2VSim-FG-Kern Projected Future Superposition Hydrograph (2030 Climate Change)

The implementation glide path identified by the Kern Subbasin provides a general guide to how quickly these benefits are to be realized. To date the Kern Subbasin GSAs have taken action on multiple P/MAs (e.g., development of new recharge basins). The exact schedule and order of implementation for other P/MAs, as seen in Figure ES-9, will be adaptively managed. Further analysis will be conducted to prioritize the P/MAs based on consideration of factors such as permitting, engineering feasibility, cost effectiveness, need to prevent particular URs, funding opportunities, etc. In general, P/MAs being considered for implementation will be discussed during GSA Board Meetings, 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.15 Monitoring Network

The objective of monitoring networks under SGMA is to continue to collect sufficient data to evaluate the Sustainability Indicators and assess potential impacts to the beneficial uses and users of groundwater. The Kern Subbasin representative monitoring network incorporates existing monitoring efforts conducted by local agencies and regional programs, including DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) program, the Irrigated Lands Regulatory Program (ILRP), Central Valley-Salinity Alternatives for Long-term Sustainability (CV-SALTS), among others. Within this broader network, the Representative Monitoring Network (RMN) serves as a focused subset of monitoring sites used to characterize general basin

conditions and evaluate Sustainability Indicators in accordance with SGMA requirements.

In the Kern Subbasin, the current RMN consists of:

- 187 representative monitoring wells for chronic lowering of groundwater levels (RMW-WLs) and, by proxy, groundwater storage;
- 55 representative monitoring wells for degraded water quality (RMW-WQs); and
- 123 representative monitoring sites for land subsidence (RMW-LSs), which include extensometers, benchmarks, and GPS stations. Basin-wide land subsidence is also monitored using InSAR satellite data.

To ensure the RMN is spatially and vertically representative of groundwater conditions and beneficial use and users across the Kern Subbasin, the Kern Subbasin GSAs conducted a detailed monitoring network assessment. This analysis considered the spatial and depth distribution of representative monitoring wells in relation to the distribution of wells that support various beneficial uses. Using a standardized hexagonal grid framework, the Kern Subbasin GSAs identified data gaps—particularly in monitoring of localized shallow groundwater conditions—and developed an implementation plan to address those gaps. The groundwater level monitoring network analysis identified three confirmed data gaps and seven potential data gaps related to representation of localized shallow groundwater conditions. The groundwater quality network analysis identified 30 data gaps, primarily in areas with medium to high domestic well density. The Kern Subbasin GSAs plan to fill these data gaps using existing or newly installed monitoring wells by the end of 2026. These findings and planned actions are summarized in Section 15.5.

Data collected through the RMN follows established monitoring protocols, is stored in the Kern Subbasin Data Management System (DMS), and is submitted to DWR in accordance with SGMA requirements. Quality assurance and quality control procedures are conducted by each GSA prior to data reporting. In the event of a MT exceedance for any Sustainability Indicator, all Kern Subbasin GSAs will be notified, triggering the Kern Subbasin Exceedance Policy and associated investigations and actions as outlined in Appendix K-1.

ES.16 Plan Implementation

Collectively, the SGMA implementation activities described in the 2025 Plan demonstrate the Kern Subbasin GSAs have actively implemented specific P/MAs, policies, and programs to sustainably manage groundwater resources for all beneficial uses and users and will continue to do so in order to meet the defined Sustainability Goal. Key SGMA and groundwater management implementation activities to be undertaken by the Kern Subbasin GSAs through 2040 include:

- Annual reporting

- Monitoring and data collection
- Data gap filling
- P/MA implementation, including policy development to support Plan implementation
- Technical and non-technical coordination with other water management entities within and outside the Kern Subbasin
- Continued outreach and engagement with stakeholders
- Enforcement and response actions, including:
  - Exceedance Policy
  - Well Mitigation Program
- Evaluation and updates as part of the required periodic evaluations (i.e., “five-year updates”)

Costs associated with implementation of groundwater management activities fall under two categories: (1) Subbasin-wide groundwater management activities, and (2) Individual GSAs to implement P/MAs within their jurisdictions, including capital/one-time costs and ongoing costs. Most costs for Subbasin-wide groundwater management activities are shared equally between the GSAs and are estimated as an annual cost of approximately $1.4 million. For GSA-specific P/MA implementation, the GSAs intend to meet these cost obligations through a combination of landowner contributions (within their jurisdictions), partnering agencies, grant funding (DWR, United State Bureau of Reclamation, Federal Emergency Management Agency, etc.), locally available funds, and other available sources to be determined.

ES.17 Conclusion

The passage of the SGMA has fundamentally reshaped groundwater governance in California, introducing clear concepts, actions, and timelines to achieve sustainability and prevent Undesirable Results. For high-priority and critically overdrafted basins like the Kern Subbasin, this has created a renewed urgency to enhance monitoring, planning, and response efforts. Each GSA within the Kern Subbasin is actively exercising its authority to implement the coordinated groundwater management strategy outlined in the 2025 Plan.

The Kern Subbasin GSAs remain committed to the SMCs established to prevent URs. The Kern Subbasin GSPs have multiple layers of protection: a robust groundwater level, quality, and subsidence monitoring network that is being actively expanded to fill data gaps; protective MTs while managing groundwater to MOs; a well-funded well mitigation program to address groundwater level and quality impacts (particularly on domestic well users) due to groundwater management activities; and implementation of targeted

P/MAs that correct the projected deficit (under 2030 climate-change conditions) to avoid Undesirable Results and maintain Subbasin sustainability.

With a shared vision and a science-based approach, the Kern Subbasin GSAs are confident in their ability to achieve the Sustainability Goal by SGMA's statutory deadline. The Kern Subbasin GSAs are dedicated to long-term, coordinated groundwater management, ongoing engagement, and building consensus to ensure a reliable groundwater supply for current and future generations.

1. INTRODUCTION

On September 16, 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. SGMA requires local agencies to form Groundwater Sustainability Agencies (GSAs) tasked with 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 Plan (Plan Area); a description of the Basin Setting, including the hydrogeologic conceptual model (HCM), historical and current groundwater conditions, and a water budget; locally-defined Sustainable Management Criteria (SMCs); monitoring networks and protocols for each applicable sustainability indicator; and a description of projects and/or management actions (P/MAs) that will be implemented to achieve or maintain sustainability. SGMA also requires active stakeholder outreach to ensure that all beneficial uses and users of groundwater have the opportunity to provide input into the GSP development and implementation process.

The Kern Subbasin of the San Joaquin Valley Groundwater Basin is located at the southern end of the Tulare Lake Hydrologic Region and is known for its rich soil and sunny Mediterranean-like climate, which has made Kern County one of the top producing agricultural regions in the nation. The Kern Subbasin contains 1.78 million acres and is the largest in the State. It is bounded by the Kern County line and the Tulare Lake, Tule, and Kettleman Plain Subbasins on the north; the Sierra Nevada foothills on the east; the Tehachapi Mountains and White Wolf Subbasin on the southeast; and by the San Emigdio Mountains and Coast Ranges on the southwest and west (California Department of Water Resources [DWR], 2006; DWR, 2018). The Kern Subbasin is identified by DWR as Basin No. 5-022.14 and is classified as a high priority, critically overdrafted basin (DWR, 2020).[1]

[1] https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization

1.1 Purpose of the Groundwater Sustainability Plan

The purpose of this collection of GSPs (2025 Plan) and the Kern County Subbasin Coordination Agreement (Appendix C-1) is to meet the requirements set forth in SGMA,[2] which 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" (DWR, 2017). Undesirable results (URs) are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout a 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 level 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. Depletion of interconnected surface waters that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The 2025 Plan meets the requirements of SGMA and implements regulations while reflecting local needs and preserving local control over water resources. The 2025 Plan has been coordinated among the 20 GSAs within the Kern Subbasin and provides a path to achieve and document Subbasin-wide sustainable groundwater management by 2040, and to preserve the sustainability of locally managed groundwater resources into the future.

This 2025 Plan amends the Kern Subbasin 2024 Plan that was submitted to the State Water Resources Control Board (SWRCB) in December 2024. The 2025 Plan amendments are focused on addressing the potential actions to correct the deficiencies identified in the SWRCB's "*Kern Subbasin Probationary Hearing Final Staff Report*"

[2] Nothing in this GSP 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 GSP shall be construed consistent with Section 2 of Article X of the California Constitution, and nothing provided in this GSP modifies rights or priorities to use or store groundwater except as expressly stated in CWC § 10720.5(a). The districts reserve and retain all rights to the use of water to the extent provided by law.

(Final Staff Report) (January 2025) and technical and policy meetings held between the Kern Subbasin and SWRCB staff. This coordinated, comprehensive 2025 Plan articulates how the GSAs will collectively and sustainably manage groundwater in the Kern Subbasin based on the best available data and information.

This 2025 Plan is a set of consolidated GSPs that, along with the Kern County Subbasin Coordination Agreement (Appendix C-1), cover the entirety of the Kern Subbasin and addresses the potential actions to correct the deficiencies identified in SWRCB's *Final Staff Report* and prior recommendations made by DWR. The 2025 Plan presents a coordinated, comprehensive approach to sustainably manage groundwater in the Kern Subbasin while recognizing significant variations in hydrogeology, available water supplies, groundwater usage, and the nature and distribution of beneficial users across the largest Subbasin in the state of California.

Table 1-1 and Figure 1-1 document the foundational Kern Subbasin GSP along with six supplementary GSPs that fully cover the Kern Subbasin. The six supplementary GSPs cover specific GSA areas (representing approximately 32 percent of the Kern Subbasin), providing additional GSA-specific information (inserted as blue pages at the end of each respective GSP), while staying coordinated and consistent with the overarching Kern Subbasin GSP that covers the entire Subbasin.

Table 1-1. 2025 Plan GSPs

GSP Name	Area (acres)	Percentage of Kern Subbasin Area (percent)	GSA	GSP Contents
Kern Subbasin GSP	1,205,482	67.6%	Arvin GSA Cawelo Water District GSA Kern Non-Districted Land Authority GSA (formerly Kern Groundwater Authority GSA) Kern River GSA Kern Water Bank GSA Greenfield County Water District GSA North Kern WSD GSA Pioneer GSA Rosedale-Rio Bravo WSD GSA Shafter-Wasco ID GSA Southern San Joaquin MUD GSA Tejon-Castac Water District GSA West Kern Water District GSA Wheeler Ridge-Maricopa GSA	Kern Subbasin GSP
Buena Vista GSA GSP	51,070	2.9%	Buena Vista GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages

GSP Name	Area (acres)	Percentage of Kern Subbasin Area (percent)	GSA	GSP Contents
Henry Miller Water District GSA GSP	26,063	1.5%	Henry Miller Water District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Kern-Tulare Water District GSA GSP	11,344	0.6%	Kern-Tulare Water District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Olcese Water District GSA GSP	3,199	0.2%	Olcese Water District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Semitropic Water Storage District GSA GSP	224,350	12.6%	Semitropic Water Storage District GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages
Westside District Water Authority GSA GSP	260,812	14.6%	Westside District Water Authority GSA	Kern Subbasin GSP; Supplemental GSA information on blue pages

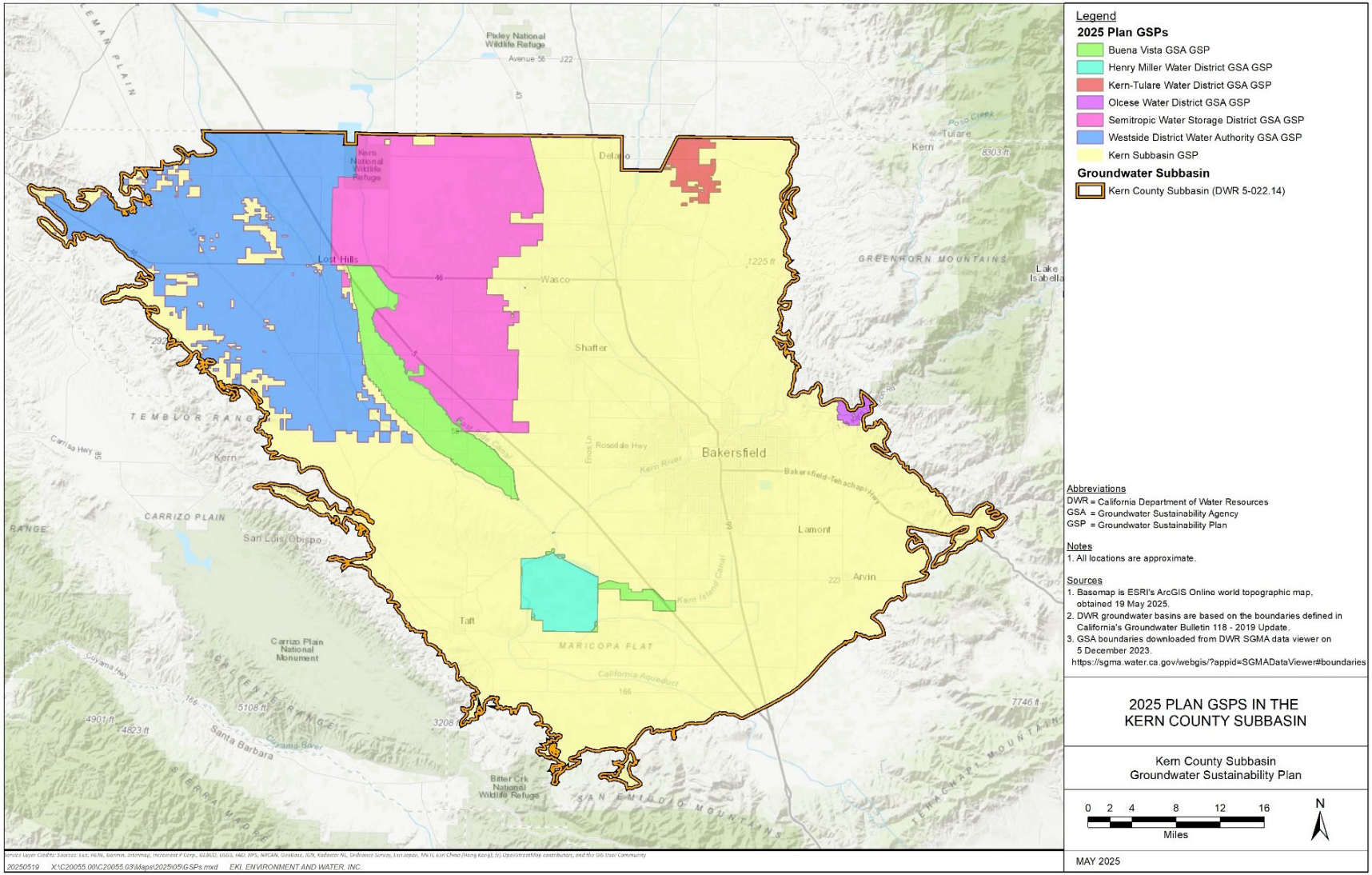


Figure 1-1. 2025 Plan GSPs in the Kern Subbasin

1.2 Background

Since the formation of GSAs in the Kern Subbasin, proactive measures have been taken to prepare and amend the GSPs to articulate Kern Subbasin management strategies, as well as address DWR and SWRCB identified deficiencies and potential actions to correct deficiencies. Figure 1-2 highlights this timeline, which reflects how the Kern Subbasin has developed GSPs and addressed DWR deficiencies and potential actions to correct deficiencies from the SWRCB through amended versions of the GSPs up to the present time. Details of the DWR and SWRCB processes are documented in the subsections below. Table 1-3 walks through the changes made in this 2025 Plan in response to January 2025 SWRCB recommended actions.

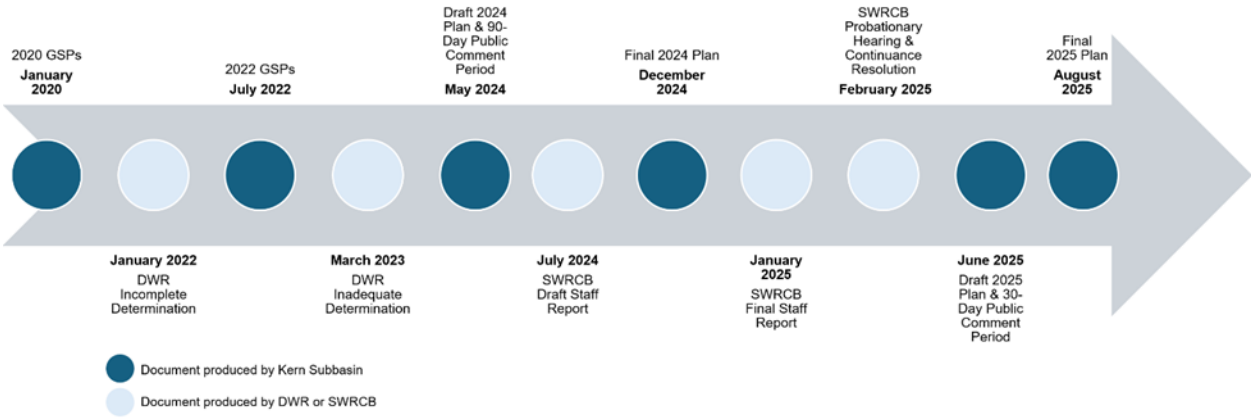


Figure 1-2. Kern Subbasin Timeline

1.2.1 DWR Process (2020 - 2023)

Pursuant to the SGMA Regulations, the Kern Subbasin GSAs submitted five GSPs (coordinated through the Kern County Subbasin Coordination Agreement dated January 20, 2020) to DWR by the January 2020 deadline (referred to herein as the "2020 GSPs").

DWR responded with an Incomplete Determination of the 2020 Groundwater Sustainability Plans submitted for the San Joaquin Valley – Kern Subbasin" (January 28, 2022) (referred to herein as "Incomplete Determination"). The Incomplete Determination of the 2020 Groundwater Sustainability Plans submitted to the San Joaquin Valley – Kern County Subbasin is provided in Appendix A-1.

As stipulated in the *Incomplete Determination* letter the Kern Subbasin GSAs amended the GSPs and Kern County Subbasin Coordination Agreement and responded with six amended GSPs (referred to herein as the "2022 GSPs") within 180 days (by July 27, 2022) of the issuance of the DWR *Incomplete Determination*. After reviewing the 2022 GSPs, DWR issued its Inadequate Determination of the Revised 2020 Groundwater Sustainability Plans submitted for the San Joaquin Valley – Kern Subbasin (March 2,

2023) (referred to as “Inadequate Determination”) in March 2023. The Inadequate Determination of the Revised 2020 Groundwater Sustainability Plans submitted for the San Joaquin Valley – Kern Subbasin is provided in Appendix A-2.

Because DWR determined that the Kern Subbasin GSAs did not take sufficient action to correct the deficiencies, primary jurisdiction shifted from DWR to the SWRCB per California Water Code (CWC) § 10735 et seq. Under this statute, the SWRCB may designate a basin as “probationary” after holding a public hearing and making certain findings (CWC § 10735.2(a)). If the SWRCB designates a basin as probationary, it must identify specific deficiencies and potential actions to address deficiencies. The GSA(s) then have one year to remedy the deficiencies that resulted in the probationary designation before the SWRCB will develop an interim plan (CWC § 10735.6).

1.2.2 SWRCB Process (2023 - Current)

In response to the *Inadequate Determination* letter, the Kern Subbasin GSAs substantially reorganized and revised their plans into one foundational Kern Subbasin GSP and six additional GSPs with supplementary GSA-specific information included as “blue pages.” The Draft 2024 Plan focused on addressing deficiencies identified in DWR’s *Inadequate Determination* letter, as well as feedback provided by the SWRCB during several meetings. The GSAs collectively submitted the Draft 2024 Plan to the SWRCB in May 2024 as draft pending public review and further consultation with SWRCB staff.

In July 2024, the SWRCB issued preliminary review of the Draft 2024 Plan in a *Kern Subbasin Probationary Hearing Draft Staff Report* (referred to as the “*Draft Staff Report*”). The *Draft Staff Report* provided a detailed review of the 2020 GSPs and the 2022 GSPs, and a preliminary review of the Draft 2024 Plan. The *Draft Staff Report* included the DWR deficiencies while identifying five additional deficiencies, and recommended designating the Kern Subbasin as probationary. The Kern Subbasin GSAs submitted a subsequent coordinated GSP in December 2024 (“Final 2024 Plan”) addressing deficiencies identified by DWR and by the SWRCB staff in its *Draft Staff Report*.

The SWRCB published the *Kern Subbasin Probationary Hearing Final Staff Report* (referred to herein as the “*Final Staff Report*”) in January 2025. The *Final Staff Report* provided a detailed review of the Draft 2024 Plan and a tentative evaluation of the Final 2024 Plan, identified certain deficiencies which were resolved, and identified four remaining deficiencies with potential corrective actions. The *Final Staff Report* is provided in Appendix B-1.

The SWRCB held a hearing to consider the Kern Subbasin’s status on February 20, 2025, at which time the SWRCB adopted Resolution 2025-0007 to continue the Kern Subbasin’s probationary hearing on September 17, 2025. As stipulated in Resolution 2025-0007, the Kern Subbasin GSAs were required to: (1) develop an enhanced

community outreach and engagement strategy within 30 days, (2) submit an amended draft Plan by June 20, 2025, and (3) adopt an amended Plan by September 17, 2025. Resolution 2025-0007 is provided in Appendix B-2.

In response to DWR's *Inadequate Determination,* SWRCB's *Final Staff Report*, and as per Resolution 2025-0007, the Kern Subbasin GSAs (through development and submission of this 2025 Plan) have addressed all the identified remaining deficiencies and implemented corrective actions outlined by both DWR and SWRCB. Appendix B-3 describes this iterative revision process and Kern Subbasin coordination required to address deficiencies and concerns brought forth by DWR and SWRCB leading up through adoption of the Final 2024 Plan. Appendix B-4 includes a summary of consultation meetings with SWRCB staff discussing the 2024 Plan development.

Following the issuance of the *Final Staff Report*, the Kern Subbasin GSAs have continued ongoing technical and policy coordination with SWRCB staff. The Kern Subbasin GSAs have incorporated revisions to the 2024 Plan and developed this 2025 Plan to address remaining SWRCB identified deficiencies (Table 1-3). Table 1-2 and Appendix B-3 includes a summary of consultation meetings with SWRCB staff discussing the 2025 Plan development. This 2025 Plan documents the Kern Subbasin's refined and coordinated approach to groundwater management and SGMA implementation.

1.2.3 Coordination

The Kern Subbasin GSAs have identified coordination as a main area of focus for ongoing successful management of groundwater resources within the Kern Subbasin. Since April 2023, the Kern Subbasin GSAs have participated in numerous and substantial Subbasin-wide coordination efforts to develop a coordinated response to the DWR and SWRCB corrective actions as incorporated into the 2025 Plan. Subbasin-wide coordination efforts have included the development of a Technical Working Group, an Attorney Working Group, intra-basin coordination efforts, Subbasin-wide outreach and engagement, and consultation with SWRCB staff. These efforts are discussed below.

1.2.3.1 Technical Working Group



In May 2023, the Kern Subbasin GSAs assembled a Technical Working Group (TWG) to produce Subbasin-wide technical solutions to address the DWR identified deficiencies. The TWG has met weekly since then to coordinate technical analysis and approach to the SWRCB corrective actions. The TWG is composed of 17 hydrogeologists and engineers representing the Kern Subbasin GSAs. The TWG's objectives include:

- Identify technical options and alternatives to address DWR and SWRCB deficiencies.
- Conduct independent analyses as needed.
- Provide technical options and recommendations for GSP revisions to the Kern Subbasin GSAs.

The TWG meets weekly to review work products and develop technical recommendations. The TWG is further subdivided into six subcommittees (see figure above) to allow for concurrent, focused technical work and evaluations to address deficiencies and develop methodologies and approaches that are applicable Subbasin-wide.

1.2.3.2 Attorney Working Group

In May 2023, the Kern Subbasin GSAs established the Attorney Working Group (AWG) to develop legal recommendations. The AWG is composed of attorneys representing the Kern Subbasin GSAs and/or Legal Counsel for GSA group(s). The AWG meets as needed.

1.2.3.3 Intra-Subbasin Coordination

Kern Subbasin GSA representatives routinely meet to collaborate and provide feedback on the technical work products produced by the TWG. These meetings include ad-hoc Managers and Kern Subbasin coordination committee members and provide a forum wherein the GSAs discuss Kern Subbasin coordination activities related to the development and implementation of the 2025 Plan. Successful intra-basin coordination efforts include the comprehensive well inventory (Section 1.3.1), coordinated SMC methodologies (Sections 11 to 13), the Kern Subbasin Exceedance Policy and Action Plans (Section 16.2.1, Appendix K-1), the Well Mitigation Program (Section 16.2.1.1 and Appendix G-1), water budgets (Section 9), coordinated P/MAs to address the projected deficit (Section 14), data management system upgrades, and a revised SGMA Monitoring Network (Section 15).

1.2.3.4 Community Outreach and Engagement

The Kern Subbasin GSAs continue to conduct community outreach and engagement activities with interested parties and members of the public throughout the coordinated 2024 Plan and adoption process, as summarized in Section 5.10 and the Stakeholder Communication and Engagement Plan (Appendix F-1). The Draft 2024 Plan was released for public review and comment on June 1, 2024, and the public comment period was open through November 4, 2024. Following continued revisions, the Kern Subbasin GSAs held three Subbasin-wide stakeholder workshops related to the 2024 Plan in October, and numerous local GSA-specific public meetings, as tabulated in Appendix F-2.

Four public comment letters were received on the Draft 2024 Plan. Appendix N-1 briefly summarizes the public comments received, response to comments, and how public comments were incorporated into the 2024 Plan.

During preparation of the 2025 Plan and in response to the SWRCB Resolution No. 2025-0007 (Appendix B-2), the Kern Subbasin GSAs implemented a robust community outreach and engagement initiative designed to build confidence, enhance public understanding of SGMA principles and GSA objectives, and promote community participation in the GSP amendment process. The initiative featured multiple outreach strategies, including the creation of new educational materials on the GSAs' website, establishment of dedicated social media channels, and development of a public engagement toolkit. To ensure inclusive participation, the GSAs conducted focus groups with community members, hosted pop-up events in five disadvantaged communities, and organized three public workshops. Additionally, monthly coordination calls were held with Community Partners[3] representing drinking water users, small growers, and underrepresented stakeholders. A comprehensive record of these 2025 community outreach and engagement efforts is available in Appendix F-3.

The Draft 2025 Plan was released for public review and comment on June 20, 2025, and the public comment period was open through July 21, 2025.

1.2.3.5 Coordination and Consultation with SWRCB Staff

The Kern Subbasin GSAs consulted regularly with SWRCB staff through both the 2024 Plan development process and 2025 Plan amendment process. As summarized in Appendix B-4, the GSAs participated in 17 technical meetings with SWRCB staff between May 2023 and November 2024 to provide updates and seek input on the Kern Subbasin's coordinated response to the DWR and SWRCB staff-identified deficiencies, including technical justifications for SMCs and GSP revisions. Following the release of the Final 2024 Plan in December 2024, the SWRCB staff published a *Final Staff Report* focused on the Draft 2024 Plan, along with tentative evaluation of the Final 2024 Plan

[3] Community Partners as defined in the 2025 Community Outreach and Engagement Strategy, Appendix F-3

(see Section 4.1, pages 21-30 of the *Final Staff Report*). On January 20, 2025, the Kern Subbasin GSAs provided SWRCB a commitment letter to continue coordination with SWRCB staff to address their remaining concerns on the 2024 Plan.

Following the SWRCB *Final Staff Report*, the Kern Subbasin GSAs participated in 14 (approximately) biweekly technical meetings with SWRCB staff from January through June 2025. In addition to technical meetings, approximately 20 additional calls with SWRCB staff occurred to address subsequent technical questions for clarification. Refer to Table 1-2 for a summary of technical meetings. Meeting goals were to provide updates on additional technical analysis and seek input and concurrence on the Kern Subbasin's coordinated response to the SWRCB staff identified deficiencies. Technical discussions focused on priority issues as outlined in the Kern Subbasin's commitment letter and recommended by SWRCB staff during subsequent communications. Priority issues discussed included:

1. Improving and expanding the representative monitoring networks data.
    - Gathering and sharing pertinent well construction information, well type, and the designated aquifer for representative monitoring wells.
    - Expanding groundwater level and quality monitoring wells to improve coverage of shallow domestic wells, especially in areas with localized shallow groundwater conditions and relatively shallow domestic wells.
2. Enhancing the groundwater level SMCs.
    - Sharing water level and other data used for technical analysis in impacts analyses for wells in the representative monitoring networks and to address local variations in Groundwater Level MTs.
    - Addressing any remaining anomalous data issues that may be locally influencing groundwater levels SMCs.
    - Refining Undesirable Results definition, as needed, for additional protections.
    - Raising Minimum Thresholds, as applicable, to address potential local impacts/risks to beneficial uses/users.
    - Ensuring groundwater level SMCs are consistent with groundwater quality and subsidence SMCs
3. Revising Water Quality SMCs to be even more protective of beneficial uses/users.
    - Sharing groundwater quality data to support establishing MTs with consideration for baseline conditions.
    - Revising the Undesirable Results definition to be even more protective of beneficial users across the Subbasin.
    - Revising groundwater quality SMCs, as needed, to be more protective of potential impacts to drinking water uses/users.

- Expanding on details related to groundwater quality implementation, including monitoring, notification, exceedance evaluation, P/MAs, and mitigation.

4. Address remaining comments provided by SWRCB staff on Subsidence.
   - Expanding on details related to mitigation of critical infrastructure.
   - Assessing potential impacts/risks from source water wells for oil and gas

Section 1.3 below summarizes the major 2025 Plan amendments as a result of the SWRCB staff consultation process, focused on addressing the remaining SWRCB potential actions to correct the deficiencies outlined in the *Final Staff Report*.

Table 1-2. Crosswalk Summary of Kern Subbasin Meetings with SWRCB Staff and 2025 Plan Additions

Meeting Date	Topic	Summary / Outcome	Plan Section and Appendix
01/23/2025	Technical Meeting – Key Remaining SWRCB potential actions to correct the Deficiencies	The technical meeting agenda summarized and prioritized key remaining SWRCB potential actions to correct the deficiencies related to data gaps, groundwater levels, groundwater quality, and subsidence identified in the Final Staff Report and discussed approaches to address these, as needed.	Appendix B-4
02/13/2025	Technical Meeting – RMS dataset Revisions and Well Inventory Updates	The technical meeting agenda covered RMN dataset revisions, well inventory updates, and GWQ UR framework.	Section 15
02/27/2025	Technical Meeting – Revised GWQ UR Definition	The TWG presented goals to resolve groundwater quality deficiencies. Key discussions included well inventory updates, defining GWQ UR, and revising the GWQ UR framework. The meeting aimed to reach a consensus on these definitions and update the Action Plan accordingly.	Section 13.3
02/28/2025	Technical Meeting – Revised GWQ UR Definitions Follow Up Call	The follow-up meeting aimed to refine discussions from the previous day's technical meeting. Key topics included revising the GWQ UR Definition, addressing threshold for domestic well impacts, and agreeing on the GWQ Monitoring Network approach. The meeting emphasized practical and manageable approaches to GWQ monitoring and mitigation, with plans to address data gaps and notification protocols.	Section 13.3 Section 13.1.2.4 Section 15 Appendix K
03/20/2025	Technical Meeting – Revised Well Impact Analysis and Data Gap Analysis	The meeting focused on the revised well impacts analysis and RMN-WL data gaps analysis. The goal was to reach a consensus on these analyses to support the Representative Monitoring Networks. Key discussions included the methodology and criteria for identifying impacted wells and data gaps, with an emphasis on using elevations versus depths and professional judgment. The meeting aimed to ensure agreement on the analyses and address any concerns or questions from the attendees.	Section 15.5 Section 13.1.2.4
04/03/2025	Technical Meeting – Approach for Revising GWL MTs, GWQ UR Definition, and RMN-WQ Data Gaps	The meeting focused on the approach for revising GWL MTs, defining GWQ UR Definition, and RMN-WQ Data Gaps. The goal was to gain consensus on concerns and approaches and establish a timeline for making GSP amendments.	Section 13.1.2 Section 15.5

Meeting Date	Topic	Summary / Outcome	Plan Section and Appendix
04/04/2025	Technical Meeting – Follow up for GWQ Monitoring and Data Gap Analysis	The 4/4 SWRCB follow-up call addressed unresolved discussions from the previous meeting, focusing on prioritizing tasks and concerns related to GWQ Monitoring and Data Gap Analysis. The call aimed to clarify these discussions and establish a collaborative approach for future tasks.	Section 15.5
04/15/2025	Technical Meeting – Revising GWQ MTs	The meeting focused on reviewing and revising GWQ MTs based on feedback from SWRCB staff. The goal was to reach consensus on a revised method for setting GWQ MTs and Management Objectives.	Section 13.3.2 Section 13.3.3
04/17/2025	Technical Meeting – GWQ Implementation and Subsidence	The TWG presented on GWL MTs, RMN-WL Data Gaps, Subsidence, and GWQ implementation. The discussions included MT data, clarified monitoring criteria, addressed subsidence concerns, and detailed the GWQ UR Definition and mitigation implementation strategies. The goal was to reach consensus on these topics and resolve outstanding concerns.	Section 15.5 Section 13.1.2 Section 13.5 Section 8.4.4
04/22/2025	Technical Meeting – Clarifying RMN-WL Data Gaps	The TWG presented clarifying questions and detailed walkthroughs of the RMN-WL Data Gaps criteria and methods. Addressed concerns from the previous meeting, discussed specific potential data gaps, and proposed adding shallow monitoring in certain areas. The goal was to reach mutual understanding and consensus on the criteria and methods used to identify RMN-WL Data Gaps.	Section 15.5
05/01/2025	Technical Meeting – Finalizing RMN-WL Data Gaps, Updating GWQ MTs, and MOs	The TWG presented on finalizing recommendations for RMN-WL Data Gaps and provided updates on GWQ MTs and MOs. Discussed criteria for identifying potential data gaps, shallow monitoring, and the process for revising GWQ MTs. The goal was to address staff concerns and confirm approaches for resolving data gaps and updating GWQ standards.	Section 15.5 Section 13.3.2 Section 13.3.3
05/07/2025	Technical Meeting – GWL MT Revisions	The meeting focused on revising GWL and GWQ MTs based on feedback from SWRCB staff. Various GSAs attended, discussing the need for operational flexibility while addressing staff's concerns about the current GWL MTs. The meeting concluded with plans for further discussions to finalize the revisions.	Section 13.1.2
05/08/2025	Technical Meeting – GWQ Implementation and RMN-WQ Data Gaps Update	The meeting focused on updates regarding GWQ MTs and addressing data gaps in the RMN-WQ. The discussions included criteria for setting GWQ MTs, the use of proxy wells, and the process for collecting high-quality, representative data. Additionally, the meeting covered the evaluation process for identifying and addressing data gaps in the monitoring network, ensuring comprehensive coverage and accurate data collection.	Section 15.5
06/05/2025	Technical Meeting – Summarize GSP Revisions to address SWRCB potential actions to correct the Deficiencies	The meeting summarized the GSP revisions to address key SWRCB potential actions to correct the deficiencies identified since January 2025. The goal was to develop consensus and/or mutual understanding of resolution to SWRCB potential actions to correct the deficiencies and answer any remaining questions from SWRCB.	Appendix B-4

1.3 Summary of Major Plan Updates

This 2025 Plan amends the Final 2024 Plan. The 2024 Plan was a completely reorganized and substantially revised GSP that addressed the Kern Subbasin's coordination deficiency and focused on addressing other deficiencies in DWR's *Inadequate Determination* letter, as well as feedback received through November 2024 from SWRCB staff. Additionally, it incorporated new information with updated data and methodologies through Water Year 2023 to use the best available data and science. A summary of major updates to the 2024 Plan is provided in Appendix B-3. The 2025 Plan builds on the Final 2024 Plan, revising specific sections to address remaining SWRCB potential actions to correct the deficiencies (Appendix B-1). Key aspects of the 2025 Plan revisions that address the SWRCB potential actions to correct the deficiencies identified by SWRCB staff in the *Final Staff Report* include:

1. Reevaluation of groundwater level and groundwater quality monitoring network data gaps, and development of a P/MA that includes a plan to fill those data gaps (Section 15.5).
2. Local refinements of MTs for Chronic Lowering of Groundwater Levels targeting additional protection of beneficial uses and users (Section 13.1).
3. Revisions of SMCs and the UR definition for Degraded Water Quality to provide additional protection of beneficial uses and users (Section 13.3).
4. Additions to the Exceedance Policy and associated Action Plans for Chronic Lowering of Groundwater Levels, Degraded Water Quality, and Land Subsidence (Appendix K-1) that elaborates on factors used to evaluate and act on groundwater level, quality, and subsidence related exceedances and expands on the GSAs' commitment to ongoing collaboration with key critical infrastructure operators, respectively.
5. Development of a Degraded Water Quality Implementation Provisions (Appendix K-2) that includes summaries of related water quality provisions including, notification procedures for an exceedance, investigation procedures when representative monitoring well data exceed MTs (Appendix K-1), coordination efforts among existing programs, and Degraded Water Quality Mitigation (Appendix G-1).
6. Expansion of the Kern Subbasin Well Mitigation Program to include additional details (under a separate Degraded Water Quality Mitigation Track) related to domestic well mitigation for Degraded Water Quality (Appendix G-1).
7. Subbasin-wide coordination among all Kern Subbasin GSAs on all GSP revisions and extensive community outreach and engagement, including initiation of the *Community Outreach and Engagement Strategy* (Appendix F-3).

Table 1-3 provides a “crosswalk” between the potential actions to correct the deficiencies identified in the *Final Staff Report* and a summary of major revisions that have been incorporated into this 2025 Plan.

Table 1-3. Crosswalk Summary of Major Plan Updates in Response to SWRCB Corrective Actions

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
Deficiency Coordination 1 (CRD)-1: Undesirable results and sustainable management criteria are not coordinated. • **Deficiency CRD-1a:** Undesirable results are poorly described, unworkably complex, and inconsistently implemented. • **Deficiency CRD-1b:** Sustainable management criteria rely on inconsistent datasets and methodologies.	**2024 Final GSPs Tentative Evaluation**: These deficiencies (CRD-1a and 1b) were addressed in the 2024 Draft GSPs based on Board staff's full review.	**Potential Action CRD-1a:** No further action is necessary. **Potential Action CRD-1b:** No further action is necessary.	**CRD-1: No further action is required; the deficiency has been resolved.**
Deficiency CRD-2: The Kern County Subbasin Coordination Agreement, GSPs, and Management Area Plans lack key details necessary for coordinated implementation. • **Deficiency CRD-2a:** The Kern County Subbasin Coordination Agreement is not sufficient to address disputes. • **Deficiency CRD-2b:** The GSAs do not explain how the multiple plans will satisfy SGMA requirements, particularly for management areas.	**2024 Final GSPs Tentative Evaluation CRD-2a:** This deficiency was addressed in the 2024 Draft GSPs. **2024 Final GSPs Tentative Evaluation CRD-2b:** This deficiency does not appear to be addressed. The GSPs continue to use HCM Areas to set SMC in a manner that may not be protective of beneficial uses and users.	**Potential Action CRD-2a:** No further action is necessary. **Potential Action CRD-2b:** Revise methodologies that result in incompatible SMC across HCM Area boundaries. Sustainability-indicator-specific technical deficiencies resulted from these methodologies are described in sections GL-1, LS-1 and GWQ-1.	**CRD-2a: No further action is required; the deficiency has been resolved.** **CRD-2b:** The SMCs were developed consistent with SGMA requirements and to address varied conditions across the Kern Subbasin. The Hydrogeologic Conceptual Model (HCM) Area approach is foundational to coordinate SMCs across the Kern Subbasin, using consistent data sets and coordinated methodologies. The SMCs are protective of significant and unreasonable effects on Kern Subbasin beneficial uses and users caused due to groundwater conditions across the basin (3 CCR §354.12 to 354.20). Based on subsequent correspondence, the Kern Subbasin has further clarified and developed a shared understanding of the importance of the coordinated HCM Area approach with SWRCB staff. Section 13.1.2.1 provides supplemental analysis that shows SMC value differences across HCM Area boundaries are consistent with historically observed groundwater conditions, and staff have communicated that SMC value differences between HCM Area boundaries are no

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
			longer a high priority concern following the local MT raises. As described in Section 13.1.2.1, the Kern Subbasin revised the water level MT determination methodology to include two targeted adjustment criteria: (step 5) adjustments for the regional Corcoran Clay confining layer, and (step 6) local MT raise per SWRCB feedback. Finally, a data screening effort was conducted, and SMCs were locally raised to ensure potentially uncertain data was not influencing SMCs. These local MT refinements resulted in MT raises at 35 RMW-WLs, with raises ranging between 10 and 112 feet, and averaging 28 feet across adjusted RMW-WLs. As described in Section 13.1.2.4, it is estimated that no more than 184 drinking water wells (7 percent of all drinking water wells in the Kern Subbasin) may be potentially impacted under a (highly unlikely) worst-case scenario where all RMW-WLs were at their MTs simultaneously.
Deficiency CRD-3: The GSAs in the Kern Subbasin have not demonstrated basin-wide management.	**2024 Final GSPs Tentative Evaluation:** This deficiency does not appear to be addressed. It is still unclear to Board staff if the Kern Non-Districted Land Authority is an official GSA that has the authority to manage groundwater in non-districted areas under the current Joint Exercise of Powers Agreement.	**Potential Action CRD-3:** The GSAs should clearly define authorities and responsibilities consistent with SGMA requirements. Ensure that the GSAs have the proper authorities to enforce SGMA within their respective management areas.	**CRD-3:** The Kern Non-Districted Lands Authority (KNDLA) is an amended and restated joint powers agreement amongst public entities. KNDLA board consists of non-districted landowners, public water agencies, and water districts with non-districted lands. The Kern County Water Agency (KCWA) is a member of the KNDLA, formerly known as the Kern Groundwater Authority, which is a GSA formed through a joint powers authority agreement, as permitted under SGMA, CA Water Code § 10723.6(a)(1). The Kern Subbasin has submitted all required documents to DWR clarifying that KNDLA has the proper authority to enforce SGMA within its management area.

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
Deficiency Groundwater Level 1 (GL-1): Groundwater level undesirable results and SMC are not defined consistent with the requirements of SGMA. • **Deficiency GL-1a:** Undesirable results are not protective of beneficial uses and users. • **Deficiency GL-1b:** Sustainable management criteria were not established consistent with the requirements of SGMA.	**2024 Final GSPs Tentative Evaluation GL- 1a:** This deficiency was addressed in the 2024 Draft GSPs. **2024 Final GSPs Tentative Evaluation GL- 1b:** This deficiency does not appear to be addressed. Although some MTs were improved, the identified issues in the deficiency remain.	**Potential Action GL-1a:** No further action is necessary. **Potential Action GL-1b:** Revise SMC consistent with requirements of SGMA. Establish MTs for representative monitoring wells in the upper and lower portions of the aquifer system separately considering spatial variations of hydrogeological conditions in the Kern Subbasin. Demonstrate MTs would not result in an undesirable result and impacts to beneficial users during prolonged periods of drought and water banking recovery operations.	**GL-1a: No further action is required; the deficiency has been resolved.** **GL-1b:** Groundwater level MTs were established consistent with SGMA requirements using the best available data and a coordinated methodology that evaluated SMCs at individual wells with consideration of local hydrogeologic conditions. Local refinements (between the 2024 and the 2025 Plan) were made to groundwater level MTs as follows: • MTs were raised between 5 and 112 feet at eight RMWs as a result of excluding potentially uncertain historical water level data or data corrections. • MTs were raised between 10 and 61 feet at six RMWs to avoid an MT exceedance newly below the regional Corcoran Clay layer. • MTs were raised between 14 and 30 feet at 21 RMWs based on SWRCB feedback. Kern Subbasin GSAs conducted a well impacts analysis using the refined MTs to determine that under a (highly unlikely) worst-case scenario with all GWL-RMWs at their MTs simultaneously, no more than 184 drinking water wells may be potentially impacted. Furthermore, the extensive data gap analysis identified three groundwater level data gaps and seven potential data gaps associated with monitoring localized shallow groundwater conditions.

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
Deficiency GL-2: The GSPs' monitoring network and mitigation plans are incomplete. • **Deficiency GL-2a:** The monitoring network was not developed consistent with the requirement of SGMA. • **Deficiency GL-2b:** The well impact mitigation plan is incomplete.	**2024 Final GSPs Tentative Evaluation GL-2a:** This deficiency does not appear to be addressed. The GSAs identified some data gaps for shallow monitoring wells to be addressed within a year, but it remains unclear if they have addressed all areas that may have separate shallow and deep groundwater users. **2024 Final GSPs Tentative Evaluation GL-2b:** This deficiency appears to be partially addressed. The GSAs have developed a mitigation plan, however, Board staff has concerns regarding potential impacts on beneficial uses and users, because it is unclear whether the impact analysis and subsequent budget are adequate.	**Potential Action GL-2a:** Develop a monitoring network consistent with SGMA requirements. Provide a summary of monitoring well information such as well depths, screened intervals, aquifer zones monitored, and well type, including public, irrigation, domestic, industrial, and monitoring wells. **Potential Action GL-2b:** Establish an appropriate well impact mitigation program. Reassess the well impact mitigation plan after updating the analysis of the impacts of MTs on domestic wells to consider the upper and lower portions of the aquifer. Confirm that the GSAs' proposed funding will cover the expected costs to mitigate impacted wells.	**GL-2a:** The Kern Subbasin conducted a thorough data gap analysis for the groundwater level monitoring network and identified three data gaps and seven potential data gaps. The GSAs have committed to adding monitoring wells to provide coverage to identified data gaps, including up to seven supplemental monitoring wells to monitor localized shallow groundwater conditions. This expansion of the network will monitor groundwater levels near 99% of domestic wells. The Kern Subbasin continues to improve the RMW network (Appendix L-1) by collecting well construction information as the RMW network is improved to address data gaps and in response to adaptive management efforts. **GL-2b:** The well impact analysis, detailed in Section 13.1.2.4, was updated based on the February 2025 well inventory using an impacted criteria of 50 feet above the well bottom. Using the locally refined MTs, under the (highly unlikely) worst-case scenario, it is estimated that a maximum of 184 drinking water wells may be potentially impacted. Localized risks were evaluated based on the percentage of potentially impacted wells by GSA. Overall, the revised well impact analysis with the updated well inventory did not show Subbasin-wide significant and unreasonable or locally disproportionate impacts across GSAs. The two GSAs with elevated risks have committed to domestic well validation efforts and monitoring for localized shallow groundwater conditions by the end of 2025. Furthermore, the Dry Well Mitigation Track program budget (Appendix G-1) is demonstrated to be sufficient to mitigate the potentially impacted wells.

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
Deficiency GL-3: The GSPs do not describe a feasible path for halting chronic lowering of groundwater levels.	**2024 Final GSPs Tentative Evaluation:** This deficiency appears to be partially addressed. The GSAs continue to rely on various proposed PMAs at various stages of implementation to reach sustainability. Board staff cannot assess the feasibility of the PMAs without representative water budgets and clarity on PMAs implementation. The GSAs included new operational water budgets derived from a mass balance analysis that is inconsistent with overlying crop types and with the Todd Groundwater Model. It remains unclear whether PMAs, if implemented, are feasible and sufficient to achieve sustainable groundwater management.	**Potential Action GL-3a:** Evaluate the feasibility of proposed supply augmentation projects. **Potential Action GL-3b:** Identify key indicator wells in each aquifer, with sufficient spatial coverage to represent beneficial uses and users in each aquifer and identify groundwater levels that will trigger specific demand management actions.	**GL-3a:** The Kern Subbasin has developed a portfolio of P/MAs, each with specific projected benefits, implementation triggers, and costs; the portfolio includes 387,000 AFY in demand reduction management actions and 452,000 AFY in water supply augmentation projects. To date, the Kern Subbasin started implementation of 47 percent of P/MAs. In addition to Subbasin-wide P/MAs, and HCM Area-specific P/MAs, each GSA was charged with developing their respective P/MAs. The current projected (future) scenarios include simulated P/MAs, a range of demand reduction and supplementary water supplies to provide a volumetric target for developing sufficient P/MAs to achieve the Kern Subbasin's sustainability goal. **GL-3b:** The 2025 Plan includes several layers of triggers that will inform the need for adaptive management. These include: • Interim milestones (IMs) which serve as monitoring triggers allowing the Kern Subbasin to assess performance against the SMCs and progress towards reaching sustainability to adaptively manage and implement P/MAs based on changing groundwater conditions in the future. • Deficit reduction goals. • Exceedance policy (Appendix K-1) under which GSA(s) will investigate conditions after a single MT exceedance, and identify potential targeted P/MAs to avoid future exceedances • A robust RMW monitoring network. After expanding the groundwater level monitoring network to fill identified data gaps, the network will cover almost 99 percent of domestic wells, including drinking water wells in localized shallow groundwater conditions.

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
Deficiency GL-4: The GSPs do not define groundwater storage sustainable management criteria consistent with SGMA requirements.	**2024 Final GSPs Tentative Evaluation:** This deficiency does not appear to be addressed. The GSAs have not revised their methodology used to calculate groundwater storage.	**Potential Action GL-4:** **Redefine the undesirable result for reduction of groundwater storage.** Quantitatively define the undesirable result as a total volume of groundwater that can be withdrawn without causing significant and unreasonable impacts. Usable storage should only include aquifers where groundwater is being extracted for beneficial uses and users. Describe the assumptions that result in a usable storage range from 90 MAF to 260 MAF. Explain how storage relates to other sustainability indicators.	**GL-4:** As described in Section 8, the total usable storage calculation was refined to exclude the thickness of three major clay layers mapped within the Primary Alluvial Principal Aquifer and to exclude 28 percent of the Kern Subbasin associated with EPA aquifer exemption areas and/or areas of poor groundwater quality. As described in Section 13.2, groundwater storage SMCs rely on groundwater level SMCs as a proxy. Therefore, the refined method used to calculate the total usable storage was utilized to calculate the groundwater storage loss between the groundwater level MO and the MT. The total potential storage loss estimate was reduced to 25 percent to represent the approximate amount of groundwater storage that may be lost at the groundwater level UR definition (MT exceedance at 25 percent of RMWs). This results in 1.80 MAF of potential groundwater storage loss, which is consistent with the estimated storage loss observed during recent drought year(s).
Deficiency Land Subsidence 1 (LS-1): Land Subsidence undesirable results and SMC are not defined consistent with the requirements of SGMA • **Deficiency LS-1a:** Undesirable results are poorly described, unworkably complex, and inconsistently implemented. • **Deficiency LS-1b:** Sustainable management criteria were not established consistent with the requirements of SGMA.	**2024 Final GSPs Tentative Evaluation LS-1a:** This deficiency appears to be partially addressed. The updated plain-language undesirable result definition no longer hinges on the economic feasibility of retrofitting or replacement of infrastructure on the part of beneficial users. The updated definition also indicates that GSAs will be responsible for mitigating losses of infrastructure functionality. Changes were made to the MT Exceedance Policy, but it is not clear if they are sufficiently protective of all beneficial uses and users. The MT exceedance language in the undesirable result criteria differs from what is in the MT Exceedance Policy.	**Potential Action LS-1a:** Develop consistent, clear undesirable results. If the undesirable result definition requires a distinction between GSA and non-GSA caused subsidence, the GSAs must be capable of quantifying their contribution to subsidence in areas where both GSA and non-GSA activities are culpable. Since the quantitative undesirable results definition relies on MT exceedances, and the MT Exceedance Policy may not be sufficiently protective of beneficial users, the MT	**LS-1a:** The Exceedance Policy and associated Action Plan related to land subsidence (Appendix K-1) was expanded to include a commitment for ongoing quarterly collaboration and data sharing with the California Aqueduct Subsidence Program (CASP). **LS-1b:** The 2024 Plan was extensively revised and updated to use consistent data and methodology to develop subsidence IMs, MOs and MTs which provide for Kern Subbasin operational flexibility and are protective of Critical Infrastructure and beneficial uses and users. The 2025 Plan provides revised Tables 13-9 and 13-10 to ensure that the MO and MT rates do not exceed their extents, and that IM rates provide a ramp-down to zero Kern Subbasin GSA-related subsidence by 2040.

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
	2024 Final GSPs Tentative Evaluation LS-1b: This deficiency appears to be partially addressed. SMC development is less complicated, and Regional Critical Infrastructure MTs appear to be protective of conveyance capacity in vulnerable areas. SMC values are now established consistently with a goal of reducing subsidence as 2040 approaches. However, Board staff is concerned that the HCM Area 2040 interim milestones (IMs) for subsidence extents exceed the MOs in three of the five HCM Areas, and 2040 IM extents for the Friant-Kern Canal and California Aqueduct exceed the MOs.	Exceedance Policy should be revised. **Potential Action LS-1b:** Use consistent data and methods to develop subsidence SMC. Redevelop subsidence MOs, MTs and IMs. MTs must provide operational flexibility below MOs. Ensure that MO and MT rates do not exceed their extents, and that IMs will enable GSAs to achieve MOs and not surpass MTs.	
Deficiency Land Subsidence 2 (LS-2): GSPs do not provide adequate implementation details • **Deficiency LS-2a:** Undesirable results are poorly described, unworkably complex, and inconsistently implemented. • **Deficiency LS-2b:** Sustainable management criteria were not established consistent with the requirements of SGMA. • **Deficiency LS-2c:** Undesirable results are poorly described, unworkably complex, and inconsistently implemented.	**2024 Final GSPs Tentative Evaluation:** This deficiency does not appear to be addressed. The Final GSPs include a subsidence exceedance "Action Plan" and a mitigation plan. A $3.5 million mitigation fund is discussed in the mitigation plan, but it is specific to mitigating impacts to wells caused by declining groundwater levels, not subsidence, and there is no mention of infrastructure mitigation. GSPs state that GSAs do not anticipate subsidence to cause significant impacts to wells. The subsidence action plan is initiated if: (1) one subsidence IM rate or extent exceedance occurs at a California Aqueduct or Friant-Kern Canal monitoring location or (2) a subsidence IM rate or extent is exceeded for a GSA or HCM Area average after six consecutive quarterly sampling events. This language conflicts with the description of the exceedance policy in Section 13.5.1.4 of the GSPs, where it states that action is triggered by exceedances of the MT rate.	**Potential Action LS-2a:** Develop and implement a plan to trigger sufficient management actions when subsidence exceeds defined thresholds, especially near critical infrastructure or facilities. **Potential Action LS-2b:** Reduce pumping and do not allow new wells in areas where subsidence threatens critical infrastructure. **Potential Action LS-2c:** Develop infrastructure mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources.	**LS-2a and LS-2b:** The Kern Subbasin has developed and refined a data driven and coordinated Subbasin-wide Action Plan for Land Subsidence (Appendix K-1) which requires GSAs to evaluate and initiate targeted P/MAs to reduce Subbasin GSA-related subsidence. For example, as part of this P/MA, GSAs located within or proximate to the CASP 5-mile-wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs. These targeted P/MAs may include: (1) well registry, (2) metered well extraction volume reporting, (3) net zero well drilling moratorium, (4) targeted pumping reductions, and (5) pumping limitations, as deemed informed by the analysis undertaken from the five-step Subsidence Action Plan. **LS-2c:** The Action Plan for Land Subsidence (Appendix K-1) establishes the framework to monitor and manage subsidence to proactively identify and assess potential undesirable subsidence results. Together, the Exceedance Policy and the Action Plan for Land Subsidence provide a logical and science-based approach to

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
	2024 Final GSPs Tentative Evaluation LS-2a: See LS-2 text, above**.** **2024 Final GSPs Tentative Evaluation LS-2b:** See LS-2 text, above. 2024 Final GSPs **Tentative Evaluation LS-2c:** See LS-2 text, above.		evaluate the causes of a subsidence MT exceedance and trigger appropriate additional P/MAs, as needed. • California Aqueduct: The CASP's goal is to develop and implement beneficial and preventive corrective actions to mitigate the adverse effects of subsidence along the California Aqueduct. The CASP is currently studying the options for long-term rehabilitation projects. As such, any future mitigation actions along the Aqueduct will need to be conducted within the framework developed by CASP. The Kern Subbasin is committed to ongoing close coordination with CASP, including data sharing and quarterly meetings to discuss and manage current and future subsidence. The Kern Subbasin has developed a five-step Action Plan for Land Subsidence to monitor, evaluate, and manage subsidence IM/MT exceedances (Appendix K-1). The Action Plan for Land Subsidence will be extended, as needed, to identify specific standardized criteria for protocols, actionable timelines, and proposed P/MA responses within six months of Kern Subbasin receipt of the final DWR subsidence BMPs that are currently in development, and expected in late 2025. Once CASP develops the framework for rehabilitation (expected to be completed in the next few years), Step 4 of the Action Plan for Land Subsidence may be expanded to include mitigation alternative(s) as a P/MA, as needed. • Friant-Kern Canal: Appendix G-2 provides a status update of the Kern Subbasin's subsidence mitigation cost analysis for the Friant-Kern Canal.

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
Deficiency Groundwater Quality 1 (GWQ-1): The GSPs do not establish undesirable results and sustainable management criteria consistent with the requirements of SGMA. • **Deficiency GWQ-1a:** Undesirable result definitions are not protective of beneficial uses and users. • **Deficiency GWQ-1b:** The GSPs are missing critical information about how GSAs will determine whether an undesirable result has occurred.	**2024 Final GSPs Tentative Evaluation GWQ-1a:** The deficiency does not appear to be addressed. The updated undesirable result definition still lacks the detail necessary to determine whether all beneficial uses and users have been considered. **2024 Final GSPs Tentative Evaluation GWQ-1b:** The deficiency does not appear to be addressed. The technical analysis process developed by the GSAs fails to consider driving mechanisms for each COC.	**Potential Action GWQ-1a:** Develop undesirable results consistent with SGMA using best available science and considering all beneficial uses and users. Develop quantitative undesirable results that clearly describe the combination of MT exceedances and represent the conditions that would cause the plain-language undesirable result. **Potential Action GWQ-1b:** The GSPs should include consistent data and methods to develop groundwater quality MTs. Evaluate more than groundwater level correlations to determine whether water quality degradation is caused by management activities. Using an inverse correlation between groundwater levels and groundwater quality may not be sufficient, especially for redox-sensitive or depth-dependent constituents.	**GWQ-1a:** The groundwater quality UR quantitative definition in Section 13.3.1.4 was refined to be even more protective of beneficial uses and users. The three-part UR definition includes a Subbasin-wide trigger based on RMW-WQ MT exceedances, an annual and cumulative trigger based on impacted domestic wells, and a mitigation backstop. **GWQ-1b**: The 2025 Plan revised and simplified the consistent methodology for establishing groundwater quality SMCs. MOs are set at the Water Quality Objective (WQO), which incorporate by reference maximum contaminant levels (MCLs). MTs are set as close as practical to the WQO with considerations for recent historical baseline conditions. There are three conditions that serve as the basis of MT: (1) limited or no historical water quality sample results, or all historical results are at or below the WQO, then the MT is set at the WQO; (2) If historical sample results exceed the WQO, the MT is set at the 80th percentile or median value of historical data, based on discretion for the most appropriate MT; (3) Discretion is applied based on trends or data from proxy wells. Results and conclusions are also provided in Section 8.4.2 to explain where each constituent is most prevalent and the relevant driving mechanisms for increasing constituent concentrations. Driving mechanisms are also highlighted in Section 13.3.2.4 where impacts to beneficial users is addressed, and in the Exceedance Policy's Action Plan for Degraded Water Quality (Appendix K) where guidance is provided to evaluate MT exceedances with consideration for the driving mechanisms.

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
Deficiency GWQ-2: Groundwater quality monitoring network is not consistent with the requirements of SGMA. • **Deficiency GWQ-2a:** The monitoring network is not protective of all beneficial uses and users in the Kern Subbasin. • **Deficiency GWQ-2b:** Water quality sampling frequencies are sometimes insufficient. • **Deficiency GWQ-2c:** It is unclear how the GSAs will assess the impacts of projects and management actions.	**2024 Final GSPs Tentative Evaluation GWQ-2a:** This deficiency does not appear to be addressed. The GSPs do not include depths or screen intervals of any representative monitoring wells. Without this information, Board staff cannot evaluate whether the monitoring network adequately represents beneficial uses and users. It is unclear whether the representative monitoring wells will be sufficient to identify impacts to domestic wells since no groundwater quality-specific impact analysis was not completed. **2024 Final GSPs Tentative Evaluation GWQ-2b:** This deficiency was addressed in the 2024 Draft GSPs. **2024 Final GSPs Tentative Evaluation GWQ-2c:** This deficiency does not appear to be addressed. It is unclear how the monitoring network is evaluating the potential impacts of PMAs.	**Potential Action GWQ-2a:** The GSAs should evaluate the existing monitoring network and add additional wells to the monitoring well network to ensure all beneficial uses and users are represented. **Potential Action GWQ-2b:** No further action is necessary. **Potential Action GWQ-2c:** The GSAs should better define how they will ensure projects and management actions do not degrade groundwater quality.	**GWQ-2a:** The Kern Subbasin conducted an extensive data gaps analysis, which identified 30 data gaps for groundwater quality monitoring. The 2025 Plan presents a plan, detailed in Section 15.5.7, to address the data gaps through the Subbasin-wide P/MAs (KSB-7 Well Inventory/Registry) and (KSB-10: RMW Data Gaps). The GSAs will prioritize completing their field verification surveys for the well inventory to verify the presence of domestic wells and establish access agreements with owners of existing domestic wells that were historically sampled under other programs or initiatives to fill the data gaps. If existing wells are not available, the GSAs plan to address data gaps by constructing new monitoring wells. The Kern Subbasin continues to improve the RMW network(Appendix L-1) by collecting well construction information as the RMW network is improved to address data gaps and in response to adaptive management efforts. **GWQ-2b: No further action is required; the deficiency has been resolved.** **GWQ-2c:** The Kern Subbasin's Representative Monitoring Network currently includes 55 wells designated for groundwater quality; of which, 36 are designated for both groundwater level and quality monitoring. The Kern Subbasin GSAs identified 30 data gaps in the RMN-WQ. The Kern Subbasin GSAs have added three wells to address two of these gaps already and anticipates adding up to an additional 28 representative monitoring wells to fill the remaining gaps. Following data gap filling, the groundwater quality monitoring network will provide coverage to approximately 95% of domestic wells. Semi-annual sampling will be used to compare baseline and current groundwater quality conditions and evaluate compliance with SMCs. As summarized in the Action Plan for Degraded

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
			Water Quality (Appendix K-1) and the Degraded Water Quality Implementation Provisions (Appendix K-2), water quality results from the monitoring network wells for groundwater will be provided to domestic well owners generally within a three-mile radius if the result exceeds a WQO based on a primary MCL. If the monitoring well from the network exceeds the minimum threshold for that well as set forth in the 2025 Plan and the cause is related to groundwater management activities, the domestic well owner will also receive notice and information with respect to the Kern Subbasin Well Mitigation Program and the process for submitting an application for potential mitigation under the Degraded Water Quality Mitigation Track. To consolidate and streamline implementation of groundwater quality monitoring, reporting, coordination, SMCs, mitigation, and P/MAs, the Kern Subbasin GSA have developed a consolidated "Degraded Groundwater Quality Implementation Provisions" document (Appendix K-2) that serves as a companion document to the GSP and accompanying Appendices pertinent to groundwater quality.
Deficiency GWQ-3: Management actions are not responsive to water quality degradation. • **Deficiency GWQ-3a:** Management actions are not protective of beneficial uses and users once a minimum threshold exceedance is triggered. • **Deficiency GWQ-3b:** Well mitigation plan does not address water quality degradation.	**2024 Final GSPs Tentative Evaluation GWQ-3a:** This deficiency appears to be partially addressed. Board staff is still concerned that beneficial uses and users may be impacted prior to an undesirable result occurring due to the Exceedance Policy's insufficient correlation procedure. **2024 Final GSPs Tentative Evaluation GWQ-3b:** This deficiency appears to be partially addressed. The GSPs still lack an appropriate method for evaluating whether groundwater quality degradation may be	**Potential Action GWQ-3a:** Develop a method to determine the impact of an exceedance to beneficial uses and users and clarify how the public will be notified should an MT exceedance occur. **Potential Action GWQ-3b:** See Potential Action GL-2b.	**GWQ-3a:** Consistent with SGMA requirements, the Kern Subbasin has done extensive work to characterize groundwater conditions, understand the driving mechanisms for degraded water quality, define baseline conditions, and quantify beneficial users. The Exceedance Investigation framework under the Action Plan for Degraded Water Quality (Appendix K-1) provides procedures to evaluate and determine the root cause of an MT exceedance and guides the initiation of corrective actions that should halt further degradation and avoid triggering an undesirable result. The notification radius was expanded to generally a three-mile buffer around the RMW-WQ with an exceedance. Clarifying language has been added

Deficiency	Deficiency Summary	Potential SWRCB Suggested Actions to Correct the Deficiency	2025 Plan Status
	due to groundwater management activities or actions. Without a clear understanding of potential impacts, Board staff cannot determine if the well mitigation plan will address the degradation of water quality.		to the Degraded Water Quality Implementation Provisions (Appendix K-2) which details how the potentially impacted residents will be notified should an MT exceedance occur and the process for submitting an application for mitigation, as applicable. **GWQ-3b:** See GWQ-3a response. Furthermore, the Kern Subbasin Well Mitigation Program has been expanded to include additional details related to domestic well mitigation for Degraded Water Quality, under a separate Degraded Water Quality Mitigation Track (Appendix G-1).
Deficiency Interconnected Surface Water 1 (ISW-1a and ISW- 1b): Interconnected Surface Water Undesirable results and SMC are not coordinated.	**2024 Final GSPs Tentative Evaluation:** This deficiency was addressed in the 2024 Final GSPs.	**Potential Action ISW-1a and ISW-1b:** Board staff does not have further concerns related to Deficiencies ISW-1a and 1b.	**ISW-1a and 1b: No action needed; deficiency has been addressed**
Deficiency ISW-2: GSAs do not adequately demonstrate that undesirable results related to the depletion of ISW are not present and are not likely to occur.	**2024 Final GSPs Tentative Evaluation:** This deficiency appears to be addressed. The 2024 Final GSPs include a more robust description of the methodology used to conclude the absence of ISW and GDE in the Kern Subbasin.	**Potential Considerations ISW-2:** Continue using the best available information to evaluate potential ISW in the Kern Subbasin.	**ISW-2: No action needed; deficiency has been addressed**

1.3.1 Beneficial Uses and Users

SGMA requires that GSAs consider the interests of all beneficial uses and users of groundwater. CWC Section 10723.2 defines beneficial users as:

(a) Holders of overlying groundwater rights, including (1) agricultural users (farmers, ranchers, and dairy professions) and (2) domestic well owners.

(b) Municipal well operators.

(c) Public water systems.

(d) Local land use planning agencies.

(e) Environmental users of groundwater.

(f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies.

(g) The federal government, including, but not limited to, the military and managers of federal lands.

(h) California Native American tribes.

(i) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems.

(j) Entities listed in Section 10927 of the California Water Code that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency.

To quantify the beneficial users in the Kern Subbasin, a well inventory that reconciles multiple datasets was conducted. While all beneficial users identified in the Water Code are acknowledged, some user categories were consolidated to align with the “type of well” options listed in Kern County Environmental Health’s Water Well Permit Application. Table 1-4 provides a cross reference to the consolidated user types and well counts for each type.

A Subbasin-wide well inventory was conducted to better understand the distribution of beneficial groundwater users in the Kern Subbasin. The inventory started with obtaining records from DWR’s Online System of Well Completion Reports (OSWCR), the Kern County Environmental Health Services (KCEHS), and United States Geological Survey (USGS). Datasets were processed to match records based on local permit numbers and well completion report number. Additionally, data were downloaded from California Open Data including well information from the Department of Drinking Water (DDW) and Irrigated Lands Regulatory Program.

The database was further reconciled through a collaboration between Kern Subbasin water agencies, particularly Kern County Water Agency who maintains an inventory of wells in Improvement District No. 4, and municipalities and GSAs who provided copies of the well completion reports in their records.

Since the OSWCR dataset provides construction information, this was maintained as the base record, but some adjustments were made to the data hierarchy to consolidate the best available information for each well. Details of the well inventory are presented in Section 5.6.1, *Well Inventory*. Prioritized data included:

- DDW data was used to identify all public supply wells, the use type (i.e., small community, municipal, or industrial), status (active, standby, inactive, destroyed), and was also found to provide the most accurate coordinates.
- For the remaining wells, where KCEHS data could be matched, well location and use type were prioritized over OSWCR data since the KCEHS dataset provided actual coordinates and an inspector validates the intended use.

Table 1-4. Well Inventory User Category and SGMA Beneficial User Cross Reference

Well Type	# of Wells	Beneficial Users per SGMA (CWC Sec. 10732.2)	Planned Use Categories
Agricultural	4,231	(a)(1) Agricultural users	Irrigation, Stock Watering, Public Irrigation
Recovery	137	No applicable definition	Banked Water Recovery
Domestic	2,322	(a)(2) Domestic well owners (h) California Native American Tribes (i) Disadvantaged communities	Domestic, Domestic/Irrigation, Non-Public, Non-Potable
Public [1]	285	(b) Municipal well operators (h) California Native American Tribes (i) Disadvantaged communities (c) Public water systems	Public/Municipal, Public/Commercial, Public/Prison
Small Community [1]	28	(c) Public water systems (h) California Native American Tribes (i) Disadvantaged communities	Public/School, Public/Small Community
Industrial [1]	189	No applicable definition	Industrial, Public/Industrial
Total	7,192		

[1] The count of "Public" wells presented in Table 1-4 represents the number of wells identified in the Kern Subbasin Well Inventory (February 2025). The GSAs are continuing their efforts to develop a comprehensive Well Inventory which will result in changes in future iterations. An accurate count of Public Supply wells, downloaded from GAMA and SDWIS, and reconciled with purveyors, municipalities, and DDW Fresno Branch is provided in Table 5-7.

Key elements of this 2025 Plan that consider potential impacts to beneficial uses and users of groundwater include:

- The process for developing SMCs related to Chronic Lowering of Groundwater Levels, Land Subsidence, Degraded Water Quality, and Groundwater Storage included the evaluation of potential impacts on local beneficial users and land surfaces. Results of impact analyses were presented at public meetings for stakeholder input including monthly GSA board meetings and GSA group meetings (e.g., South of Kern River Executive Committee), to key beneficial

users of regional critical infrastructure, and to SWRCB staff during consultation meetings.

- Kern Subbasin GSAs are working collaboratively to avoid impacts, especially to domestic and small community system wells. This 2025 Plan has addressed potential impacts to drinking water users in the Kern Subbasin through a robust well impacts analysis and establishment of an Exceedance Policy (Appendix K-1) and Well Mitigation Program (Appendix G-1). Including a numeric threshold for dewatered drinking water wells in the UR definition for Chronic Lowering of Groundwater Levels and the well impacts analyses presented in Section 13.1.2.4 demonstrates how the most sensitive beneficial users of groundwater (i.e., drinking water users) were considered during the 2025 Plan development. These potential impacts and the Well Mitigation Program were discussed at the Kern Subbasin stakeholder workshops in October and with NGOs at a focused workshop held in November 2024 and continued through the 2025 Plan development process as described in the 2025 Community Outreach and Engagement Strategy (Appendix F-3).
- The Kern Subbasin's SGMA Monitoring Network, whose purpose is to collect sufficient data to assess relevant sustainability indicators and potential impacts to beneficial uses and users, demonstrates the GSAs' commitment to collecting sufficient data to ensure the P/MAs, policies, and programs are succeeding in sustainably managing groundwater resources for all beneficial uses and users of groundwater. The data gaps analysis focused on identifying areas of the Kern Subbasin that may be lacking monitoring for shallow domestic groundwater users.

Kern Subbasin GSAs continue to implement the Stakeholder Communication and Engagement Plan (Appendix F-1) and conducted additional outreach through the 2025 Plan development process (Appendix F-3) to achieve active engagement and input of beneficial users across the Kern Subbasin.

2. SUSTAINABILITY GOAL

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

☑ 23 CCR § 354.24

The sustainability goal for the Kern Subbasin is to implement its Plan to achieve sustainable groundwater management within the Sustainable Groundwater Management Act (SGMA) 20-year implementation period. Achieving the sustainability goal will be demonstrated by eliminating chronic lowering of groundwater levels caused by overdraft conditions and avoiding Undesirable Results for groundwater levels, groundwater storage, land subsidence, and groundwater quality. This goal will be accomplished through the following objectives:

- Implement the Stakeholder Communication and Engagement Plan.
- Eliminate long-term groundwater overdraft and attain sustainability through conjunctive use, water banking, and demand management programs.
- Continuously monitor and evaluate groundwater conditions to avoid undesirable results.
- Maintain long-term sustainability of water resources available to the Kern Subbasin.
- Maintain a comprehensive database of beneficial uses and users to inform on the efficacy of groundwater management policies and programs.

3. AGENCY INFORMATION

§ 354.6. *When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:*

(a) The name and mailing address of the Agency.

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

(c) The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.

(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.

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

3.1 Agency Contact Information

☑ 23 CCR § 354.6(a)

Sustainable groundwater management for the Kern Subbasin is administered by 20 GSAs and one coordinated groundwater management area. Each agency has designated representatives to coordinate with municipalities, neighboring entities, and stakeholders within and adjacent to their management area. As described herein, managers are collectively working to achieve sustainable groundwater management within the planning horizon. Table 3-1 provides contact information for each GSA. Figure 3-1 is a map showing GSA coverage.

Table 3-1. GSA Manager Contact Information

GSA	Address	GSA Manager and E-mail	Phone
Arvin GSA www.aewsd.org	20401 E. Bear Mountain Blvd. PO Box 175 Arvin, CA 93203	Jeevan Muhar Engineer-Manager jmuhar@aewsd.org	661-854-5573
Buena Vista GSA www.bvh2o.com	525 North Main Street PO Box 756 Buttonwillow, CA 93206	Tim Ashlock Engineer-Manager tim@bvh2o.com	661-324-1101
Cawelo Water District GSA www.cawelowd.org	17207 Industrial Farm Road Bakersfield, CA 93308	David Halopoff Assistant General Manager dhalopoff@cawelowd.org	661-393-6072
Greenfield County Water District GSA	551 Taft Highway Bakersfield, CA 93307	Nick Cooper ncooper@greenfieldcwd.org	661-831-0989

GSA	Address	GSA Manager and E-mail	Phone
Henry Miller Water District GSA	101 W. Walnut Street Pasadena, CA 91103	Jeof Wyrick President / Chairman jwyrick@jgboswell.com	626-583-3000
Kern Non-Districted Land Authority GSA[4] (formerly Kern Groundwater Authority GSA) https://kndla.org/	1518 Mill Rock Way, Suite 100 Bakersfield, CA 93311	Jenny Holtermann Executive Director jenny@kndla.org	661-477-8084
Kern River GSA www.kernrivergsa.org	1000 Buena Vista Road Bakersfield, CA 93311	Daniel Maldonado Assistant Director drmaldonado@bakersfieldcity.us	661-326-3715
Kern Water Bank GSA www.kwb.org	1620 Mill Rock Way, Ste 500 Bakersfield, CA 93311	Jonathan Parker jparker@kwb.org	661-398-4900
Kern-Tulare Water District GSA www.kern-tulare.com	5001 California Ave., Ste 102 Bakersfield, CA 93309	Vanessa Yap Staff Engineer vanessa@kern-tulare.com	661-327-3132
North Kern Water Storage District GSA www.northkernwsd.com/	33380 Cawelo Ave. Bakersfield, CA 93308	David Hampton General Manager dhampton@northkernwsd.com	661-393-2696
Olcese Water District GSA	15701 Hwy 178 Bakersfield, CA 93306	Jeff Siemens jsiemens@nfllc.net	661-872-5050
Pioneer GSA www.kcwa.com/	3200 Rio Mirada Drive Bakersfield, CA 93308	Michelle Anderson Geologist manderson@kcwa.com	661-634-1479
Rosedale-Rio Bravo Water Storage District GSA www.rrbwsd.com	849 Allen Road Bakersfield, CA 93314	Dan Bartel Engineer-Manager dbartel@rrbwsd.com	661-589-6045
Semitropic Water Storage District GSA www.Semitropic.com	1101 Central Ave. Wasco, CA 93280	Jason Gianquinto General Manager jgianquinto@semitropic.com	661-758-5113
Shafter-Wasco Irrigation District GSA www.swid.org	16294 Central Valley Hwy. Wasco, CA 93280	Kris Lawrence General Manager klawrence@swid.org	661-758-5153
Southern San Joaquin Municipal Utility District GSA	11281 Garzoli Ave. Delano, CA 93215	Roland Gross General Manager/Secretary roland@ssjmud.org	661-725-0610
Tejon-Castac Water District GSA	4436 Lebec Road Lebec, CA 93243	Angelica Martin Water Resources Director amartin@tejonranch.com	661-663-4262
West Kern Water District GSA	800 Kern Street Taft, CA 93268	Greg Hammett General Manager ghammett@wkwd.org	661-763-3151

[4] Eastside Water Management Area https://kernewma.com is covered by Kern Non-Districted Land Authority GSA. Eastside Water Management Area is managed by: Taylor Blakslee TBlakslee@hgcpm.com 661-477-3385.

GSA	Address	GSA Manager and E-mail	Phone
Westside District Water Authority GSA	5555 California Avenue, Suite 209 Bakersfield, CA 93309	Morgan Campbell Director of Regulatory Affairs mcampbell@westsidewa.org	661-633-9022
Wheeler Ridge-Maricopa GSA https://wrmwsd.com/	12109 Highway 166 Bakersfield, CA 93313	Sheridan Nicholas Engineer-Manager snicholas@wrmwsd.com	661-527-6075

3.2 GSA Organization and Management Structure

☑ 23 CCR § 354.6(b)

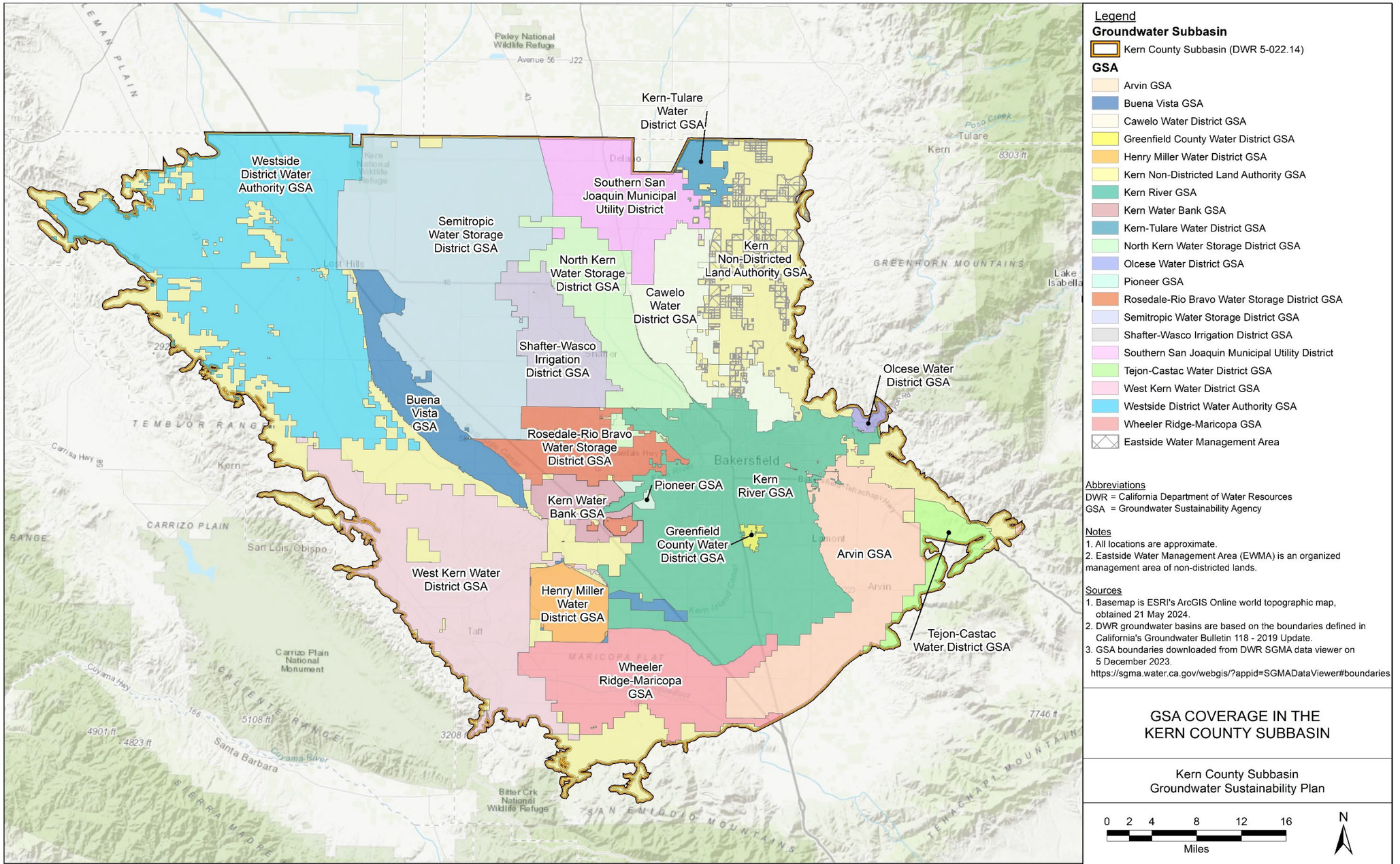
The Kern County Subbasin Coordination Agreement (Appendix C-1) establishes a governance structure for how the GSAs will cooperate and coordinate in exercising their SGMA authorities to jointly develop and implement the 2025 Plan. Pursuant to the Kern County Subbasin Coordination Agreement, each agency has designated representatives to participate in the coordination committee which, with the support of the agencies' respective staff and consultants, is responsible for providing advice and guidance on the coordinated development and implementation of the 2025 Plan to achieve sustainable groundwater management within the planning horizon. To manage the ongoing activities of SGMA implementation, Managers meet regularly to oversee SGMA-related expenses, address policy issues, and discuss implementation progress. Further, in some instances, the Kern Subbasin GSAs have formed GSA Groups for more closely coordinated local implementation, as detailed in Table 3-2.

The coordination committee's responsibilities also include encouraging public outreach and stakeholder engagement efforts of the GSAs and collaborating amongst the governing bodies of each agency so that they are informed and prepared to take all actions necessary to satisfy the requirements of SGMA. The Kern County Subbasin Coordination Agreement provides ongoing cooperation and cost-sharing in undertaking activities related to sustainable groundwater management.

The coordination committee includes a representative from each agency's Board of Directors, along with one manager from each GSA or GSA Group. The format is designed to encourage participation and facilitate communication and collaboration among all GSA representatives and other stakeholders and interested parties.

Table 3-2. GSA Groups in the Kern Subbasin

GSA Group	Member Agencies
Buena Vista GSA	Buena Vista GSA
Henry Miller GSA	Henry Miller GSA
Kern Fan Banking Group	Kern Water Bank GSA Pioneer GSA West Kern Water District GSA
Kern Non-Districted Land Authority	Full list of member agencies is provided in Appendix C-2 and is broken down by member type.
Kern River GSA	City of Bakersfield (KRGSA) Kern County Water Agency ID4 (KRGSA) Kern Delta Water District (KRGSA) Greenfield County Water District GSA California Water Service (Participating Agency) East Niles Community Service District (Participating Agency) Oildale Mutual Water Company North of the River Municipal Water District (Participating Agency) Vaughn Water Company (Participating Agency)
Kern-Tulare Water District GSA	Kern-Tulare Water District GSA
North Central Kern	Cawelo Water District GSA North Kern WSD GSA Shafter-Wasco ID GSA Shafter-Wasco 7th Standard Annex Southern San Joaquin MUD GSA
Olcese Water District GSA	Olcese Water District GSA
Rosedale-Rio Bravo WSD GSA	Rosedale-Rio Bravo WSD GSA
Semitropic Water Storage District GSA	Semitropic Water Storage District GSA
South of Kern River	Arvin GSA Tejon-Castac Water District GSA Wheeler Ridge-Maricopa GSA Arvin Community Services District
Westside District Water Authority GSA	Belridge Water Storage District Berrenda Mesa Water District Lost Hills Water District



Legend

Groundwater Subbasin

Kern County Subbasin (DWR 5-022.14)

GSA

- Arvin GSA
- Buena Vista GSA
- Cawelo Water District GSA
- Greenfield County Water District GSA
- Henry Miller Water District GSA
- Kern Non-Districted Land Authority GSA
- Kern River GSA
- Kern Water Bank GSA
- Kern-Tulare Water District GSA
- North Kern Water Storage District GSA
- Olcese Water District GSA
- Pioneer GSA
- Rosedale-Rio Bravo Water Storage District GSA
- Semitropic Water Storage District GSA
- Shafter-Wasco Irrigation District GSA
- Southern San Joaquin Municipal Utility District
- Tejon-Castac Water District GSA
- West Kern Water District GSA
- Westside District Water Authority GSA
- Wheeler Ridge-Maricopa GSA
- Eastside Water Management Area

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

Notes
1. All locations are approximate.
2. Eastside Water Management Area (EWMA) is an organized management area of non-districted lands.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 21 May 2024.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.
3. GSA boundaries downloaded from DWR SGMA data viewer on 5 December 2023. https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#boundaries

GSA COVERAGE IN THE KERN COUNTY SUBBASIN

Kern County Subbasin
Groundwater Sustainability Plan

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MAY 2024

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

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Figure 3-1. GSA Coverage in the Kern Subbasin

3.3 Kern Subbasin Plan Manager/Point of Contact

☑ 23 CCR § 354.6(c)

Pursuant to 23 CCR § 357.4(b)(1), the Kern Subbasin Coordination Committee established a “point-of-contact” for the Kern Subbasin who is appointed by unanimous agreement for a term of one calendar year, and annually thereafter, as described in the Kern County Subbasin Coordination Agreement. The Plan Manager serves as the point-of-contact between the GSAs. Additional responsibilities for this role include assisting with the submittal of GSPs, plan amendments, supporting information, monitoring data and other pertinent information, annual reports, and periodic evaluations to state agencies, when required.

Table 3-3 Plan Manager Contact Information

Plan Manager	E-mail	Phone
Kristin Pittack	kernsubbasinpoc@rinconconsultants.com	559-228-9925 (O)

3.4 Legal Authority of the GSAs

☑ 23 CCR § 354.6(d)

The Kern Subbasin includes 20 GSAs and one coordinated management area. Each GSA applied for and was granted exclusive GSA status under CWC § 10723(c) and §10723.8. As stated in CWC §10725, the GSAs have authority to determine the need for groundwater management, prepare and adopt a GSP, propose and update fees, and monitor compliance and enforcement. Further, GSAs may require registration and metering of groundwater extraction facilities, and annual reporting of groundwater extractions. Additional GSA authorities are outlined in CWC § 10726.2 and § 10726.4.

The Eastside Water Management Area (EWMA) was formed on May 7, 2018, and implements groundwater management through a Provision of Jurisdiction Agreements with the Kern Non-Districted Land Authority (KNDLA) GSA. Additional details are provided in the Kern Non-District Lands Authority Joint Powers Agreement governance document in Appendix C-2, which formally defines EWMA’s roles and responsibilities as a partner to the other Kern Subbasin GSAs.

3.5 Estimated Cost of Implementation

☑ 23 CCR § 354.6(e)

The Kern Subbasin GSAs are collectively funding the Subbasin-wide components of the 2025 Plan development, as well as ongoing monitoring and annual reporting. Individually, the groundwater management agencies are responsible for addressing local SGMA considerations and funding P/MAs. Table 3-4 summarizes actual and/or estimated costs of implementation for the Kern Subbasin with a general description of each line item. Additionally, more detailed descriptions of planned SGMA implementation and the associated costs are provided in Section 16.

Table 3-4. Kern Subbasin Costs of Implementation

Element	Description	Estimated Cost
Annual Administration	Plan manager/point-of-contact coordination and meeting facilitation, grant administration.	$250,000 per year
GSP Development	Actual cost for developing this 2025 Plan.	$2,500,000 one time
IWFM-Kern Model Development	Used to develop historical, current and future projected water budgets for the Kern Subbasin. Water budget numbers will be used to update the planning numbers to support P/MAs.	$770,000 one time
Annual Report	Ongoing costs to conduct Annual Reporting.	$100,000 per year
Data Management System	Developed to collect SGMA related data and improve efficiency and accuracy of reporting requirements.	$650,000 initial $40,000 per year
Monitoring	Coordinated InSAR, water quality sampling and water level data collection.	$75,000 per year
Mitigation Programs	Partnership with Self-Help Enterprises to administer the Dry Well Mitigation Program, and Kern Water Collaborative for general outreach and nitrate issues. Will seek to reach agreements on additional partnerships with appropriate organizations (e.g., Self-Help Enterprises) for administration of Degraded Water Quality Well Mitigation Program. Collectively, these activities are being undertaken to ensure all users have access to safe drinking water. Maintain relationships with other Kern Subbasin partners to achieve sustainability and protect water quality across the Kern Subbasin.	Up to $900,000 per year, as needed
Periodic Evaluation and 5-Year GSP Update	Review Annual Report data, current groundwater conditions, and evaluate the 2025 Plan and adjust as needed to ensure interim milestones continue to be met.	$500,000 per evaluation
Implementation of all planned P/MAs	Implementing demand reduction and supply augmentation P/MAs to achieve the Kern Subbasin sustainability goal. See Section 14 for details.	$1.3 Billion one time $45 Million per year

4. GSP ORGANIZATION

This Groundwater Sustainability Plan is organized as follows:

Executive Summary	
Introduction	*Section 1: Purpose of the Groundwater Sustainability Plan*
	Section 2: Sustainability Goal
	Section 3: Agency Information
	Section 4: GSP Organization
Description of the Plan Area	*Section 5*
Basin Setting	*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
Sustainable Management Criteria	*Section 11: Introduction to Sustainable Management Criteria*
	Section 12: Sustainability Goal
	Section 13: Sustainable Management Criteria
Projects and Management Actions	*Section 14*
Monitoring Network	*Section 15*
Plan Implementation	*Section 16*

5. DESCRIPTION OF THE PLAN AREA

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

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

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

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

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

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

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

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

This section describes the Kern Subbasin including relevant jurisdictional boundaries, key land use features, water sources and uses, and beneficial users of groundwater. Information on regulatory programs relevant to the sustainable management of groundwater and stakeholders engaged to acquire the best available information to develop this 2025 Plan are also identified. Additionally, this section introduces the Hydrogeologic Conceptual Model Areas referenced throughout this 2025 Plan to briefly describe differences in groundwater conditions across the Kern Subbasin.

5.1 Area Covered by the Plan

☑ 23 CCR § 354.8(a)(1)

The Kern Subbasin (DWR Basin No. 5-022.14) is in the southern San Joaquin Valley Groundwater Basin (5-022) and the southern portion of the Tulare Lake Hydrologic Region. Covering about 2,834 square miles (1,782,321 acres), it is the largest groundwater Subbasin in California and shares boundaries with four other groundwater subbasins (refer to Figure 5-1). To the north are Tulare Lake Subbasin (DWR Basin 5-022.12), Tule Subbasin (DWR Basin 5-022.13) and Kettleman Plain Subbasin (DWR Basin 5-022.17), and to the south is the White Wolf Subbasin (DWR Basin 5-022.18).

As discussed in Section 1.1, the 2025 Plan is a collection of GSPs and Coordination Agreement. Therefore, the area covered by the 2025 Plan (i.e., “Plan Area”) is the entire Kern Subbasin.

5.2 Hydrogeologic Conceptual Model Areas

☑ 23 CCR § 354.8(a)(1)

Because the Kern Subbasin is a large and geologically complex basin with regional faulting and folding, and three principal aquifers, this 2025 Plan divides the Kern Subbasin into five Hydrogeologic Conceptual Model Areas (HCM Areas) that each have similar geology and aquifer characteristics but have distinguishing differences from the other areas of the Kern Subbasin. Defining these HCM Areas enables readers to understand the hydrogeologic complexity of the Kern Subbasin, and for GSAs to succinctly explain why their management approach may be different from neighboring GSAs. Note that the HCM Areas (based on hydrogeology and aquifer characteristics) are distinct from Management Areas, which are described in more detail in Section 10. The following points summarize the characteristics of each HCM Area:

- **North Basin HCM Area.** (North of Kern River Fan) The large alluvial basin north of the Kern River Fan area is a major agricultural area. This area is underlain by a thick sequence of alluvial sediments that form a highly productive aquifer. The presence of clay layers, primarily the E-Clay, forms distinctive aquifer zones in some areas that influence the vertical flow of groundwater.
- **Kern River Fan HCM Area.** This area corresponds to the Kern River alluvial fan. The Kern River is a large hydrologic feature that is a major surface water supply and source of surface water storage and groundwater recharge. The coarse alluvial sediments with limited clay layers make this a prime banking area for the Kern Subbasin. The banking operations within the Kern River fan area form a distinctive water level response that is recognizable on hydrographs and is generated as banking operations cycle between periods of surface water storage and recovery.
- **South Basin HCM Area.** (South of Kern Fan) The large alluvial basin south of the Kern River Fan is the other major agricultural area underlain by a thick, highly productive alluvial aquifer.
- **East Margin HCM Area.** This area lies along the eastern Kern Subbasin margin where older geologic units taper and outcrop. The area includes large fault-bounded oil fields. In the northeast area, the Santa Margarita and Olcese Principal Aquifers provide water supply and together are designated as a local principal aquifer. In the southeast, the Edison Fault is a structural barrier to groundwater flow.

- **Western Fold Belt HCM Area.** This area corresponds to the Westside Fold Belt described in USGS Professional Paper 1501 (Bartow, 1991). Key characteristics are extensive geologic folding and it's dominated by open range lands, large oil fields and poor-quality groundwater. Due to the naturally degraded water quality and alkali soils, agriculture is limited. As such, there is only minimal groundwater pumping: all land surface uses rely on imported water supplies (i.e., State Water Project or groundwater from a neighboring HCM Area).

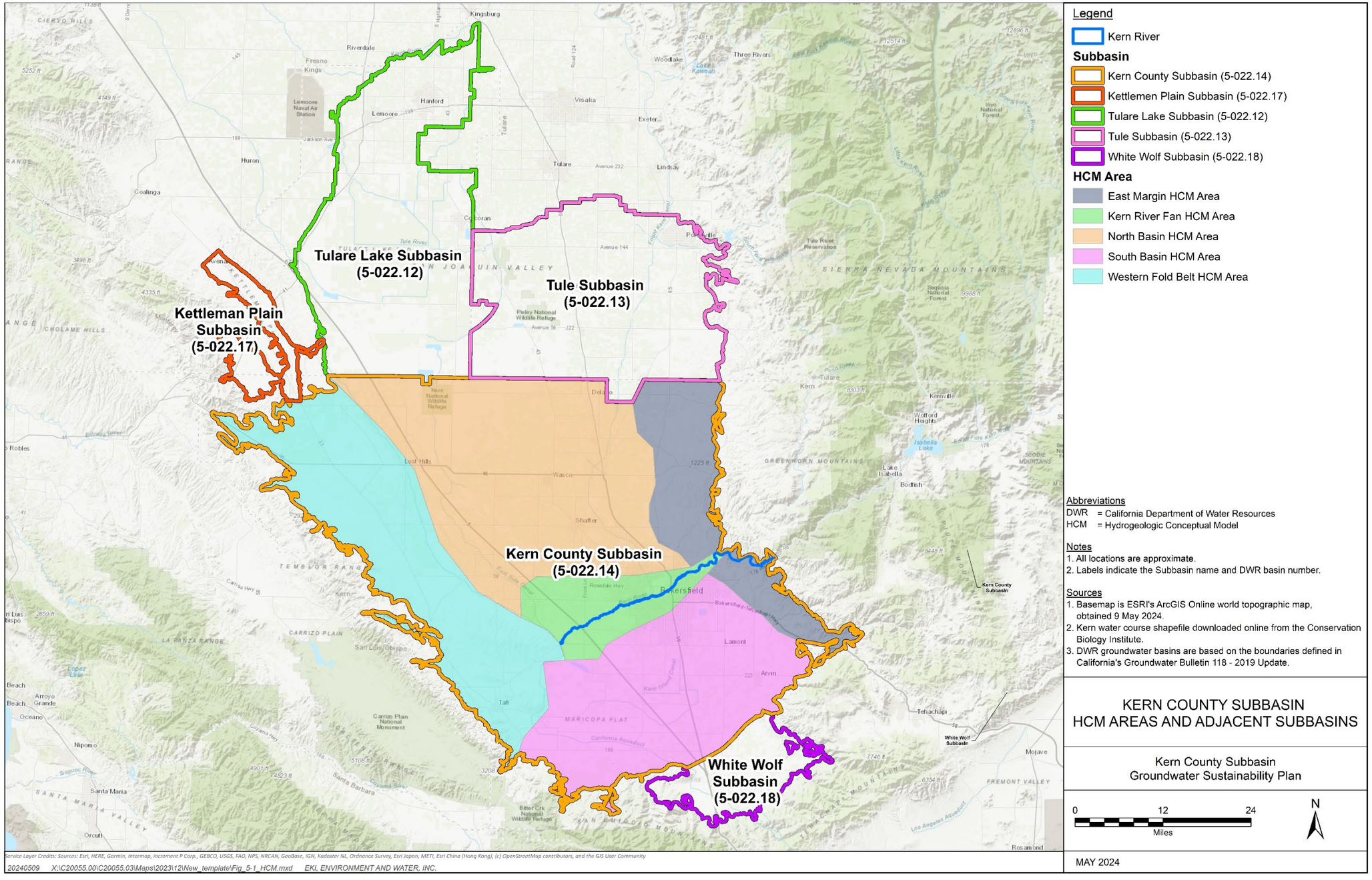


Figure 5-1. Kern Subbasin HCM Areas and Adjacent Subbasins

5.2.1 Jurisdictional Boundaries

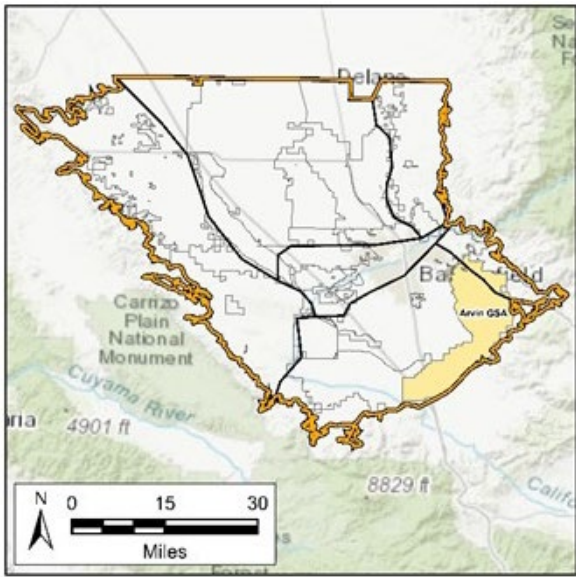
☑ 23 CCR § 354.8(a)(3)

The Kern Subbasin is entirely contained within Kern County. The majority of the agricultural areas are covered by a water district, as shown in Figure 5-2; most of which applied for and were granted exclusive Groundwater Sustainability Agency (GSA) status, as shown in Figure 5-3. However, the water district boundaries don't strictly align with GSA boundaries. Several water districts sent notices to landowners, located within or adjacent to their jurisdictional boundaries, offering an agreement for SGMA coverage when they formed their GSAs. When the County of Kern opted out of providing GSA coverage to non-districted lands, landowners who did not respond to water district agreements received coverage by the Kern Non-Districted Land Authority GSA, formerly the Kern Groundwater Authority, to ensure coverage across the entire Kern Subbasin.

In this 2025 Plan, the distinguishing difference between lands within a water district or within GSA boundaries are access to water supply benefits, such as conjunctive use programs and access to surface water banking programs that directly benefit the participating landowner. Statistical information about each GSAs management areas and jurisdictional boundaries within it are provided below in alphabetical order of GSA name.

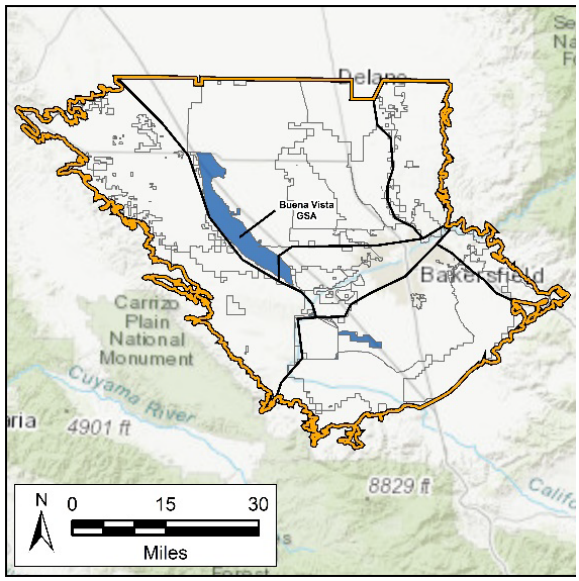
Arvin GSA

- Encompasses approximately 105,900 acres of the Arvin-Edison Water Storage District (AEWSD) service area.
- Includes all AEWSD lands within the Kern Subbasin that are not significantly overlapped by the East Niles Community Services District (ENCSD).
- Includes the Arvin Community Services District (ACSD) urban area, which is approximately 2,000 acres.
- Includes approximately 1,860 acres of parcels outside of AEWSD service area (i.e., "non-districted lands").



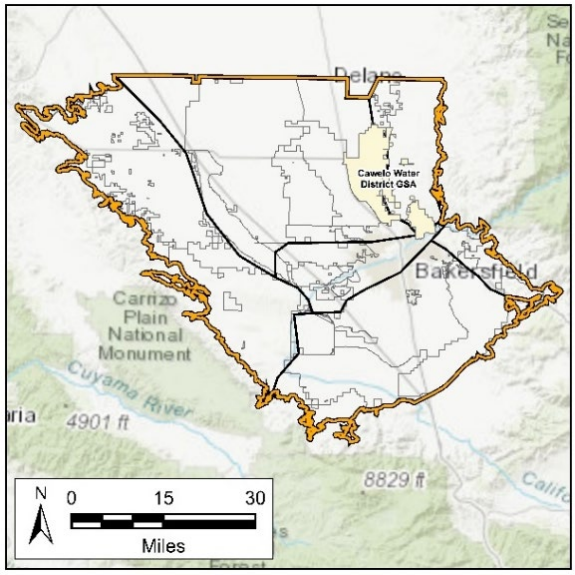
- Overlaps the jurisdictional boundary of Mettler Country Water District (MCWD) and Wheeler Ridge-Maricopa Water Storage District (WRMWSD).
- Bordered by the Wheeler Ridge-Maricopa GSA, White Wolf Subbasin and GSA, Tejon-Castac Water District GSA, Kern River GSA, and Kern Non-Districted Land Authority GSA.
- Participating entity of the South of Kern River (SOKR) GSA Group.
- Another public agency with jurisdiction within the Arvin GSA is the Power & Water Resources Pooling Authority (PWRPA), formed in 2004 by several irrigation and water districts through a Joint Powers Agreement (JPA). PWRPA, of which AEWSD is a participant, has the authority to develop and implement projects and programs related to water and energy.
- Lies mostly in the South Basin HCM Area, except where the Edison Fault transects the northeast corner of the GSA, delineating the East Margin HCM Area (Section 5.2).

Buena Vista GSA



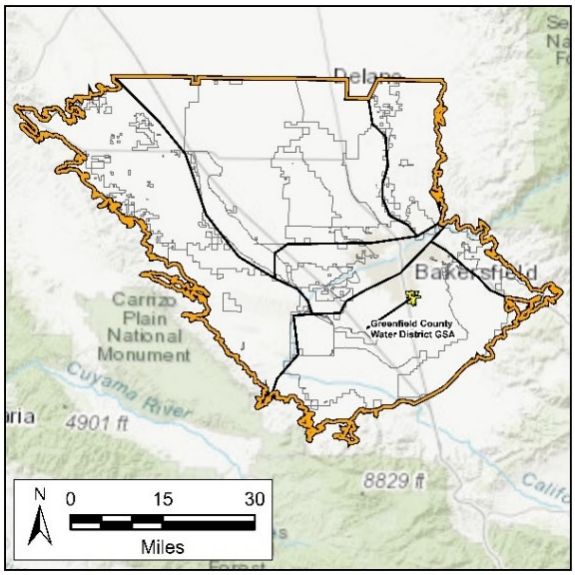
- Encompasses 50,560 acres of the Buena Vista Water Storage District (BVWSD) service area and includes all BVWSD lands.
- Bordered by the Semitropic Water Storage District GSA, the Kern Water Bank Authority GSA, the Westside District Water Authority GSA, the West Kern Water District GSA, the Kern River GSA, the Henry Miller GSA, and the Rosedale-Rio Bravo Water Storage District GSA.
- Divided into two physically separated service areas, the Buttonwillow Service Area and the Maples Service Area.
- The unincorporated community of Buttonwillow lies entirely within the GSA.
- The Buttonwillow Service Area lies within the North Basin, Western Fold Belt and Kern Fan HCM Areas while the smaller Maples Service Area lies entirely within South Basin HCM Area.

Cawelo Water District GSA



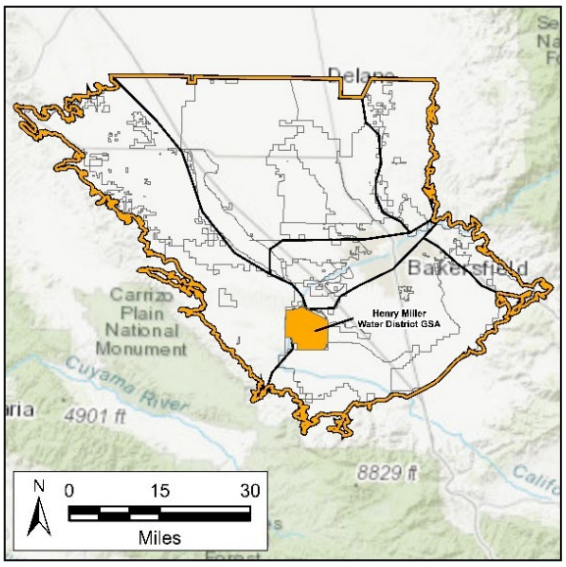
- Encompasses 62,935 acres of the Cawelo Water District (CWD) service area and includes all CWD lands except for those within the Kern River GSA.
- Includes approximately 18,521 acres of parcels outside of the CWD service area (i.e., “non-districted lands”).
- Bordered by the North Kern Water Storage District GSA, the Southern San Joaquin Municipal Utility District GSA, the Eastside Water Management Area, the Kern Non-Districted Land Authority GSA, and the Kern River GSA.
- Participating entity of the North Central Kern GSA Group.
- Another public agency with jurisdiction within the Cawelo Water District GSA is Power and Water Resources Pooling Authority (PWRPA), formed in 2004 by several irrigation and water districts through a JPA. PWRPA, of which CWD is a participant, has the authority to develop and implement projects and programs related to water and energy.
- The Cawelo Water District GSA lies mostly in the North Basin HCM Area, with some minor areas in the East Margin HCM Area and Kern Fan HCM Area.

Greenfield County Water District GSA



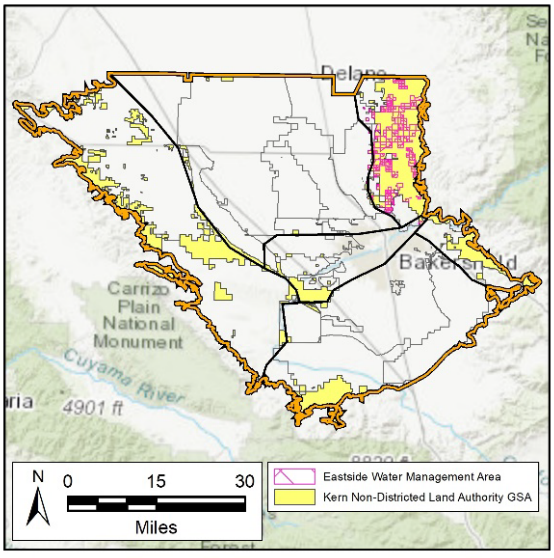
- Greenfield County Water District GSA is an exclusive GSA completely surrounded by KRGSA and coordinates with the KRGSA for SGMA implementation through a memorandum of understanding (MOU).
- Greenfield provides groundwater from six active local wells serving about 3,500 connections and delivers approximately 2,500 AFY of groundwater supply.

Henry Miller Water District GSA



- Encompasses 26,055 acres of the Henry Miller Water District GSA (HMWD) service area and includes all HMWD lands. The total area primarily consists of irrigated agricultural land, but also includes a manmade recreational lake, undeveloped land, the California Aqueduct, and land used for oil and gas production.
- Bordered by the West Kern Water District GSA, Buena Vista Water Storage District GSA, Kern River Groundwater Sustainability Agency, Kern Non-Districted Land Authority GSA, and Wheeler Ridge-Maricopa GSA.
- The majority of HMWD falls within South Basin HCM Area, with a small portion in the Western Fold Belt HCM Area.

Kern Non-Districted Land Authority



- The Kern Non-Districted Land Authority (KNDLA) is governed by public agencies responsible for water management in the Kern Subbasin who have entered into a JPA to provide regulatory authority for non-districted land, so those lands are able to be regulated under a GSP as required by SGMA (Appendix C-2).
- Encompasses 279,277 total acres, of which 39,420 acres are managed by Eastside Water Management Area (pink hash on inset map; details provided below).
- Non-Districted Lands and EWMA are treated as separate management areas with regard to water budgets and Projects and Management Actions (P/MAs). Refer to Section 10 and 14 for additional information.

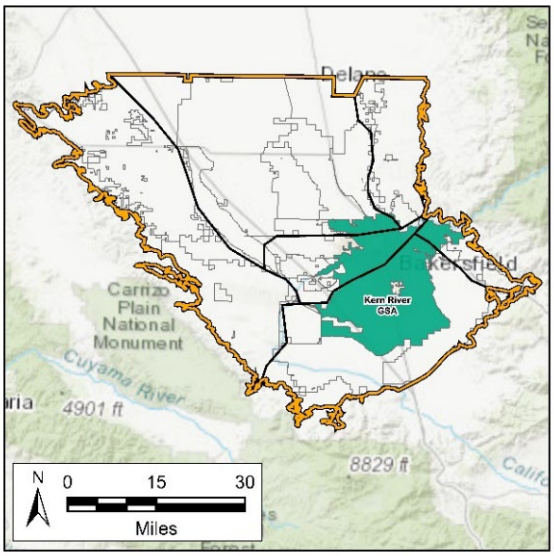
Non-Districted Lands

- The Non-Districted Lands encompass approximately 239,420 acres, just under 10,000 acres are irrigated.
- Land uses include oil/industrial (51 percent), urban and roads (27 percent), native or riparian vegetation (18 percent), trees (3 percent), and row crops (2 percent). A map of KNDLA land uses is provided in Figure 5-5.
- Urban land uses include the Western Acres Mutual Water, Enos Lane, and Stoco Mutual in the Kern River Fan HCM Area; the Tule Elk Reserve transient non-community water system in the southern Western Fold Belt HCM Area; and Choctaw Valley, Round Mountain, Uplands of the Kern, and Meadows of the Kern small community water systems in the Eastern Margin HCM Area. Additional water system information is provided in 5.6.3.
- Native vegetation includes the 93,170-acre Wind Wolves Preserve and 656-acres of the Buena Vista Aquatic Recreational Area (BVARA).

Eastside Water Management Area (EWMA)

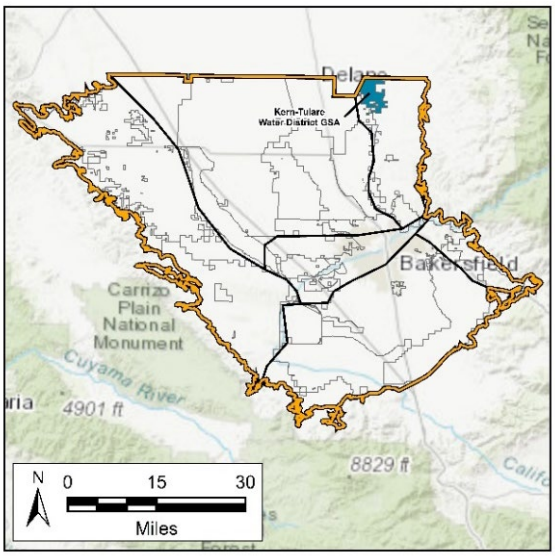
- EWMA is a non-profit corporation governed by a seven-member Board of Directors. This entity was formed to represent its members (organizations or individuals) under the GSA authority granted to the KNDLA. EWMA is working to become a public agency and serve as the GSA for land within its boundaries.
- Encompasses 39,420 acres primarily in the East Margin HCM Area with a few non-districted parcels on the eastern edge of the North Basin HCM Area.
- Most lands are adjacent to Kern-Tulare Water District GSA, Cawelo Water District GSA and the Southern San Joaquin Municipal Utility District GSA.
- Land uses include oil/industrial (81 percent), trees (16 percent), urban and roads (7 percent), and idle land (2 percent).

Kern River GSA



- Encompasses approximately 232,499 acres of the Kern Subbasin.
- Bordered by the Arvin GSA, the Henry Miller GSA, the Cawelo Water District GSA, the Kern Water Bank GSA, the Olcese GSA, Pioneer GSA, and the Rosedale – Rio Bravo GSA.
- The KRGSA lies within the South Basin and Kern Fan HCM Areas.
- KRGSA is comprised of member agencies including the City of Bakersfield, Kern Delta Water District (KDWD), Kern County Water Agency (KCWA) Improvement District No. 4 (ID4), North of the River Municipal Water District/Oildale Mutual Water Company (NORMWD/OMWC) and East Niles Community Services District (ENCSD).
- Greenfield County Water District, which is its own GSA and is cooperatively participating in the KRGSA GSP through an MOU.

Kern-Tulare Water District GSA

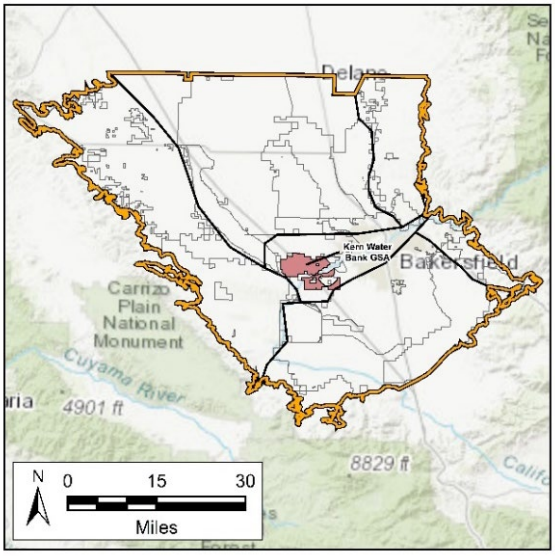


- Kern-Tulare Water District (KTWD) GSA is located on the eastern side of the Kern Subbasin, approximately 8 miles east of Delano and 27 miles north of Bakersfield. KTWD GSA encompasses all 19,700 acres of Kern-Tulare Water District service area and about 180 acres of non-districted land. KTWD GSA overlies two subbasins - the Kern Subbasin and the Tule Subbasin. The Kern Subbasin portion of the GSA is about 11,280 acres.
- Bordered by the Kern Subbasin's Kern Non-Districted Land Authority GSA to the east including the Eastside Water Management Area, the Southern San Joaquin Municipal Utility District GSA to the west and Cawelo Water District GSA to the south.

- Bordered by the Tule Subbasin's Delano-Earlimart Irrigation District GSA to the northwest and Eastern Tule GSA to the northeast.
- KTWD GSA lies entirely within the East Margin HCM Area and is exclusively comprised of agricultural lands.

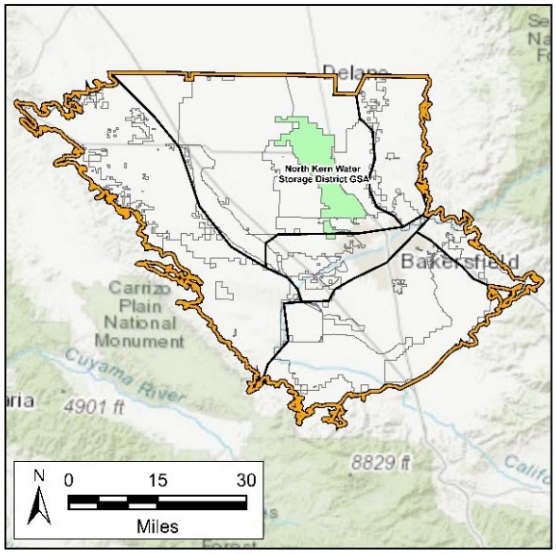
Kern Water Bank GSA

- The GSA encompasses 20,600 acres of the Kern Water Bank Authority's land. Except for local oil field activities, the land is used exclusively for the Kern Water Bank's storage and recovery operations.
- The KWB GSA is bordered by the Kern Non-Districted Land Authority GSA, the Rosedale-Rio Bravo GSA, the Pioneer GSA, the Kern River GSA, and the West Kern GSA.
- The GSA lies entirely within the Kern River Fan HCM Area.



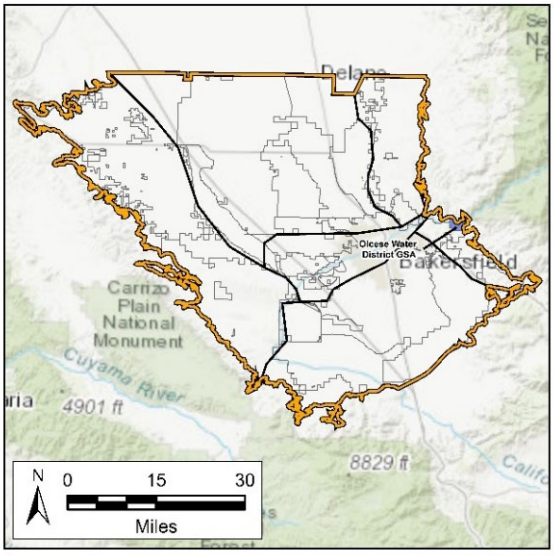
North Kern Water Storage District GSA

- Encompasses 67,543 acres of the North Kern Water Storage District (NKWSD) GSA service area and includes all NKWSD lands within the old district (61,741 acres) and portion of Rosedale Ranch Irrigation District (RRID, 5,802 acres).
- Bordered by the Shafter-Wasco Irrigation District, Semitropic Water Storage District, Southern San Joaquin Municipal Utility District, Cawelo Water District GSA, Pioneer GSA, and Rosedale-Rio Bravo GSA.
- Participating entity of the North Central Kern GSA Group.
- Lies entirely within the North Basin HCM Area.



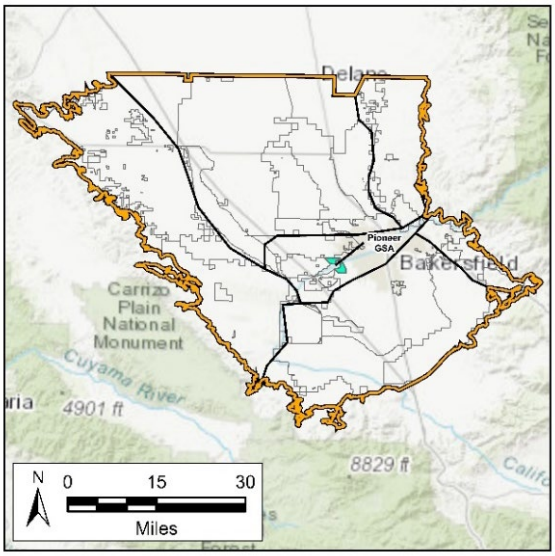
Olcese Water District GSA

- Encompasses 3,206 acres of the Olcese Water District (Olcese) service area. The Olcese Water District area extends to the north and east into areas not within any DWR groundwater basin.
- Bordered by the Kern Non-Districted Land Authority GSA and Kern River GSA.
- Lies entirely within the East Margin HCM Area.

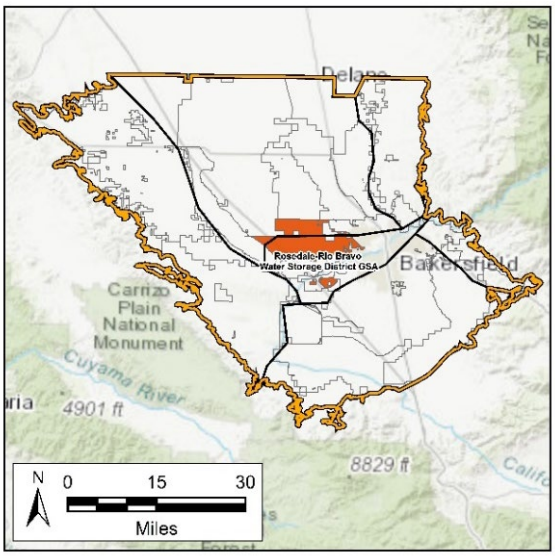


Pioneer GSA

- Encompasses 2,233 acres of the Pioneer GSA.
- Bordered by Non-Districted Lands, Kern River GSA, Kern Water Bank GSA, Rosedale-Rio Bravo Water Storage District GSA.
- The Pioneer GSA is located within the Kern River Fan HCM Area and is exclusively a banking operation. The Kern River has a large hydrologic feature that is a major surface water supply and source of surface water storage and groundwater recharge. The coarse alluvial sediments with limited clay layers make this the prime banking area for the Kern Subbasin. The banking operations form a distinctive water level response that is recognizable on hydrographs and is generated as banking operations cycle between periods of surface water storage and recovery.

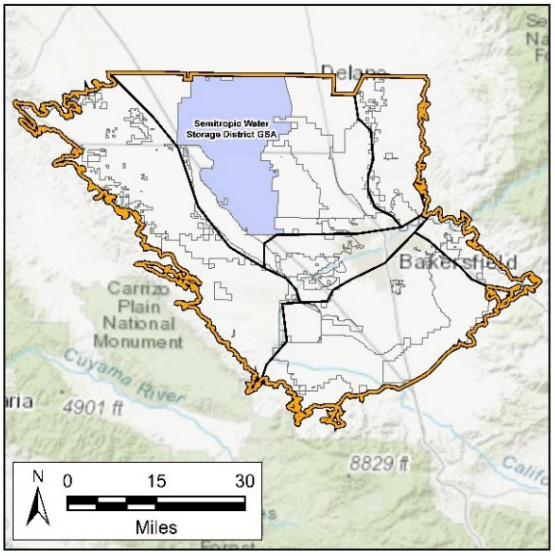


Rosedale-Rio Bravo Water Storage District GSA



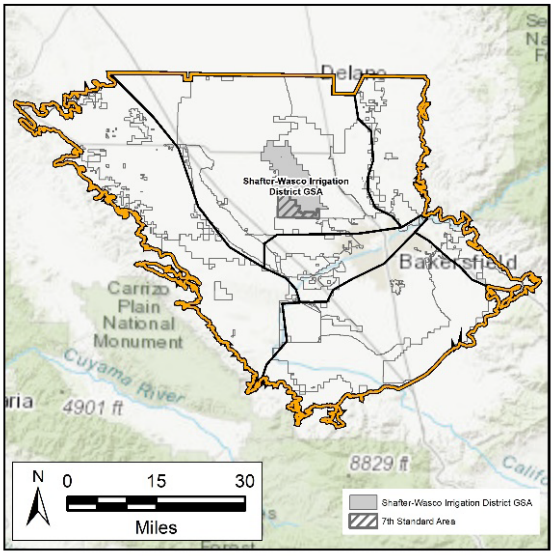
- Encompasses 40,958 acres of the Rosedale-Rio Bravo Water Storage District, plus 6,841 non-districted lands.
- Bordered by the Shafter-Wasco Irrigation District GSA, North Kern Water Storage District GSA and the Semitropic Water Storage District GSA on the north, the Buena Vista GSA on the west, the Kern Water Bank GSA, Pioneer GSA, and West Kern Water District GSA on the south, and the, the Kern River GSA on the east.
- Lies within the North Basin and Kern Fan HCM Area.

Semitropic Water Storage District GSA



- Encompasses 222,573 acres of the Semitropic Water Storage District (SWSD) GSA service area and includes all SWSD lands.
- Bordered by the Tulare Lake and Tule Subbasins to the north; San Joaquin Municipal Utility District GSA, North Kern Water Storage District GSA, and Shafter-Wasco Irrigation District GSA to the east; Rosedale-Rio Bravo Water Storage District GSA and Buena Vista GSA to the south, and Westside District Water Authority GSA to the west.
- A large area in the northern portion of the GSA is federal and California Conservation Easement Area designated for the Kern National Wildlife Refuge and 3,174-acre Semitropic Ridge Preserve. Surface water is used to support the environmental benefits of the Wildlife Refuge (Section 5.3.1).
- Lies entirely within the North Basin HCM Area.

Shafter-Wasco Irrigation District GSA



- Shafter-Wasco Irrigation District (SWID) GSA encompasses roughly 38,956 acres of SWID district lands, as well as approximately 10,000 acres of non-districted lands annexed into SWID in 2019 for the sole purpose of providing SGMA coverage and as a mechanism for collecting assessments necessary to prepare and implement a GSP.
- SWID and the 7th Standard Annex are treated as separate management areas with regard to water budgets and P/MAs. Refer to Section 10 and 14 for additional information.
- SWID GSA is bordered by Pond Poso Improvement District of Semitropic Water Storage District GSA, Rosedale-Rio Bravo Water Storage District GSA, and North Kern Water Storage District GSA.

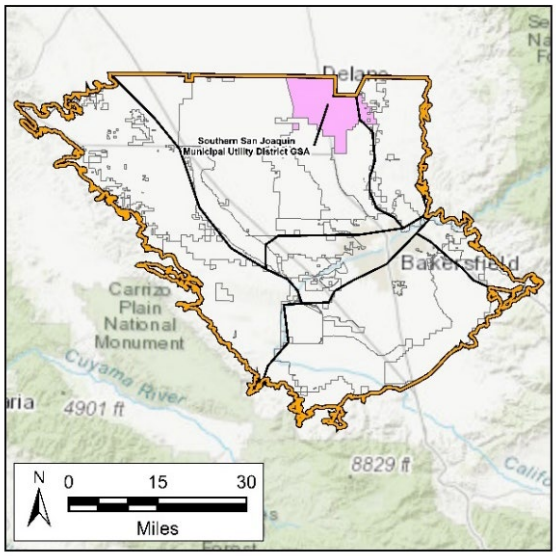
Shafter-Wasco Irrigation District

- SWID is a Central Valley Project (CVP) Friant Division contractor with 50,000 AF of Class 1 allocation and 39,600 AF of Class 2 allocation.
- Encompasses 38,956 acres. Land use is predominantly agriculture with about 28,000 acres actively farmed and the remainder (10,956) is either fallowed or the urban areas of the cities of Shafter and Wasco.
- Participating entity of the North Central Kern GSP Group.
- Lies entirely within the North Basin HCM Area.

7th Standard Annex

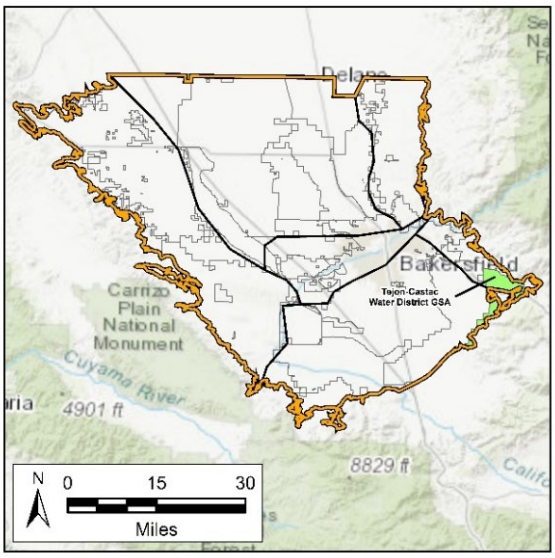
- Per the landowner agreement with SWID, 7th Standard Annex does not share benefit of SWIDs CVP allocation. However, NORSD wastewater treatment delivers recycled water that is used for crop irrigation (Table 5-2) To cover the cost of SGMA implementation, SWID began collecting assessments necessary to prepare and implement a GSP.
- Encompasses about 10,000 acres. Land use is predominantly agriculture with 7,800 acres of permanent crops, row and field crops, and dairies. Other land uses include industrial (an oil field), limited rural, residential use, and the North of River Sanitary District (NORSD) wastewater treatment plant.

Southern San Joaquin Municipal Utility District GSA



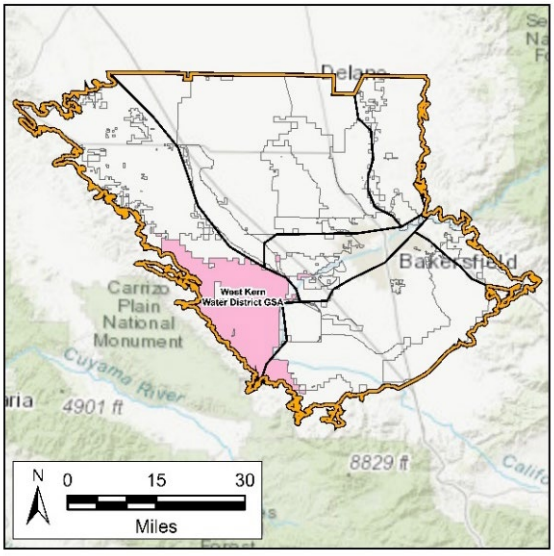
- Encompasses 66,000 acres of the Southern San Joaquin Municipal Utility District (SSJMUD) service area, plus 1,083 acres of non-districted lands. Total agricultural and irrigated acres is estimated at 54,126 acres.
- Bordered by the Tule Subbasin's Delano-Earlimart Irrigation District GSA to the north and northeast, and also shares boundaries with Kern-Tulare Water District GSA and Eastside Water Management Area to the east, Cawelo Water District GSA and North Kern Water Storage District GSA to the south, and Semitropic Water Storage District GSA to the west.
- Includes the cities of Delano and McFarland, which is 6,073 acres. Domestic and small community water users are estimated at 283 acres.
- Approximately 6,000 acres are classified as environmental which includes vacant land, native vegetation, and surface water bodies.
- Participating entity of the North Central Kern GSP Group.
- Lies entirely within the North Basin HCM Area.

Tejon-Castac Water District GSA



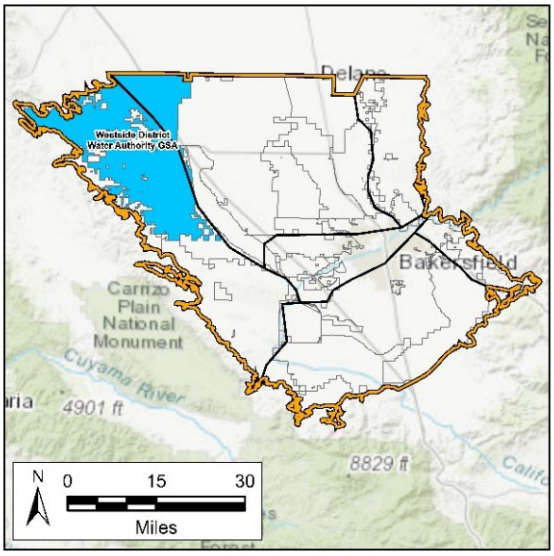
- Encompasses approximately 19,520 acres of the Tejon-Castac Water District (TCWD) annexed service area that is located within the Kern Subbasin.
- Bordered by the eastern Kern Subbasin Boundary, the White Wolf Subbasin and GSA, Arvin GSA, and Kern Non-Districted Land Authority GSA.
- Participating entity of the SOKR GSA Group.
- Lies In the South Basin and East Margin HCM Areas (Section 5.2).

West Kern Water District GSA



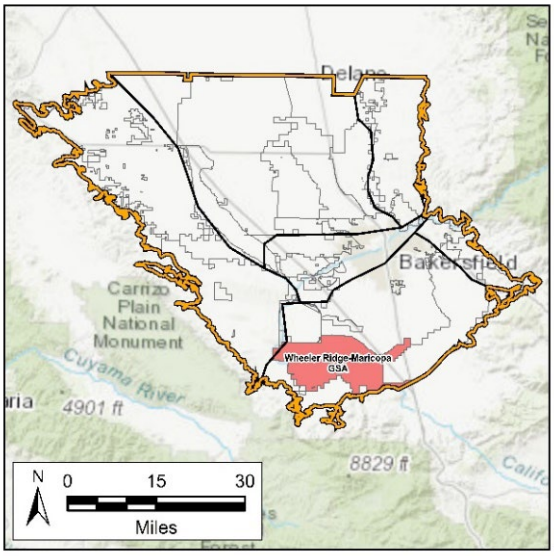
- Encompasses 203,473 acres of the West Kern Water District (WKWD) GSA service area and includes all WKWD lands as well as some adopted white areas.
- All cities and communities in the WKWD GSA service area are disadvantaged or severely disadvantaged.
- Bordered by the Westside District Water Authority GSA, the BVGSA, the KWB GSA, the Henry Miller Water District GSA, and the Wheeler Ridge-Maricopa Water Storage District GSA.
- The WKWD GSA is located predominately within the Western Fold Belt HCM Area with a small portion located within the Kern River Fan HCM Area. All groundwater wells serving beneficial uses and users of groundwater within the GSA area, including banking operations, are within the Kern River Fan HCM Area, which corresponds to the Kern River alluvial fan (Kern Fan). The Kern River has a large hydrologic feature that is a major surface water supply and source of surface water storage and groundwater recharge. The coarse alluvial sediments with limited clay layers in the Kern Fan make this the prime banking area for the Kern Subbasin. Banking operations create a distinctive water level response that is recognizable on hydrographs and is generated as banking operations cycle between periods of surface water storage and recovery.

Westside District Water Authority (WDWA) GSA



- WDWA GSA is a joint powers authority comprised of three water districts (Lost Hills Water District, Berrenda Mesa Water District, and Belridge Water Storage District) and encompasses 260,000 acres. Only 28 percent of WDWA GSA acreage is irrigated agriculture, the remaining 72 percent consists of undeveloped native range land, the community of Lost Hills, and oil field activities.
- WDWA GSA is bordered by the Semitropic GSA and Buena Vista GSA, both to the east, the West Kern GSA to the south, and the Tulare Lake Subbasin to the north.
- Approximately 98 percent of WDWA GSA's water supply is imported surface water provided by State Water Project (SWP) entitlement, supplemental surface water purchases, and banked surface water supply recovery. The community of Lost Hills imports its municipal supply water from wells located in the adjacent Semitropic GSA (North Basin HCM Area).
- Due to the poor quality of groundwater underlying WDWA GSA, groundwater use is limited. In years of low SWP allocation, landowners purchase supplemental water, conduct deficit irrigation, utilize banked surface water assets, or fallow land. Since 2015 approximately 13,000 acres have been followed.
- WDWA GSA operates sustainably and carries a significant groundwater surplus as calculated by the water budget "checkbook" approach used for Kern Subbasin planning. As such, WDWA GSA is not contributing to Kern Subbasin groundwater deficits or unsustainable loss of groundwater storage.
- WDWA GSA is predominately located within the Western Fold Belt HCM Area, an area of extensive geologic folding and historical oil field activity. These factors, along with naturally poor groundwater quality, have limited development of agricultural or other beneficial uses.

Wheeler Ridge-Maricopa GSA



- Encompasses approximately 87,350 acres of the WRMWSD service area.
- Bordered by the Arvin GSA, Kern River GSA, Henry Miller Water District GSA, Kern Non-Districted Land Authority GSA, West Kern Water District GSA, and the White Wolf Subbasin and GSA.
- Includes all WRMWSD lands within the Kern Subbasin except lands that overlap with the AEWSD service area that lie within the Arvin GSA, and 2,809 acres that lie within the West Kern Water District (WKWD).
- Includes approximately 1,042 acres of parcels outside of WRMWSD service area (i.e., “non-districted lands”).
- Participating entity of the SOKR GSA Group.
- Lies primarily in the South Basin HCM Area, with a small portion in the Western Fold Belt HCM Area.

Adjudicated or Areas Not Covered By a GSA

The Kern Subbasin is not adjudicated, and no portion is being managed pursuant to a plan approved as an Alternative GSP. Additionally, as described in the Kern Non-Districted Land Authority (Authority) statistical data, landowners who did not accept coverage by another GSA are covered by the Authority. All land within the Kern Subbasin is covered by the 2025 Plan and represented by a GSA.

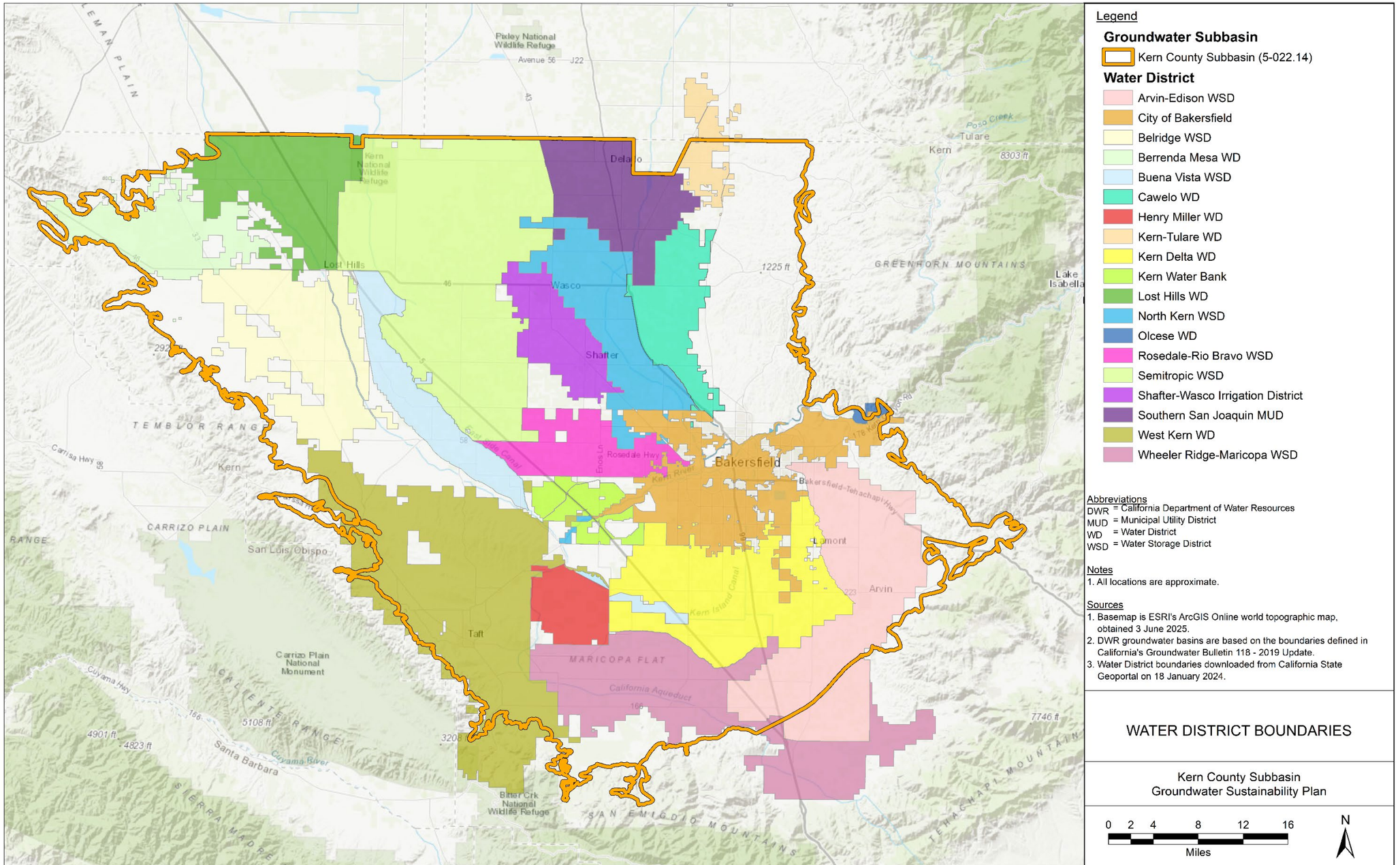


Figure 5-2. Water District Boundaries

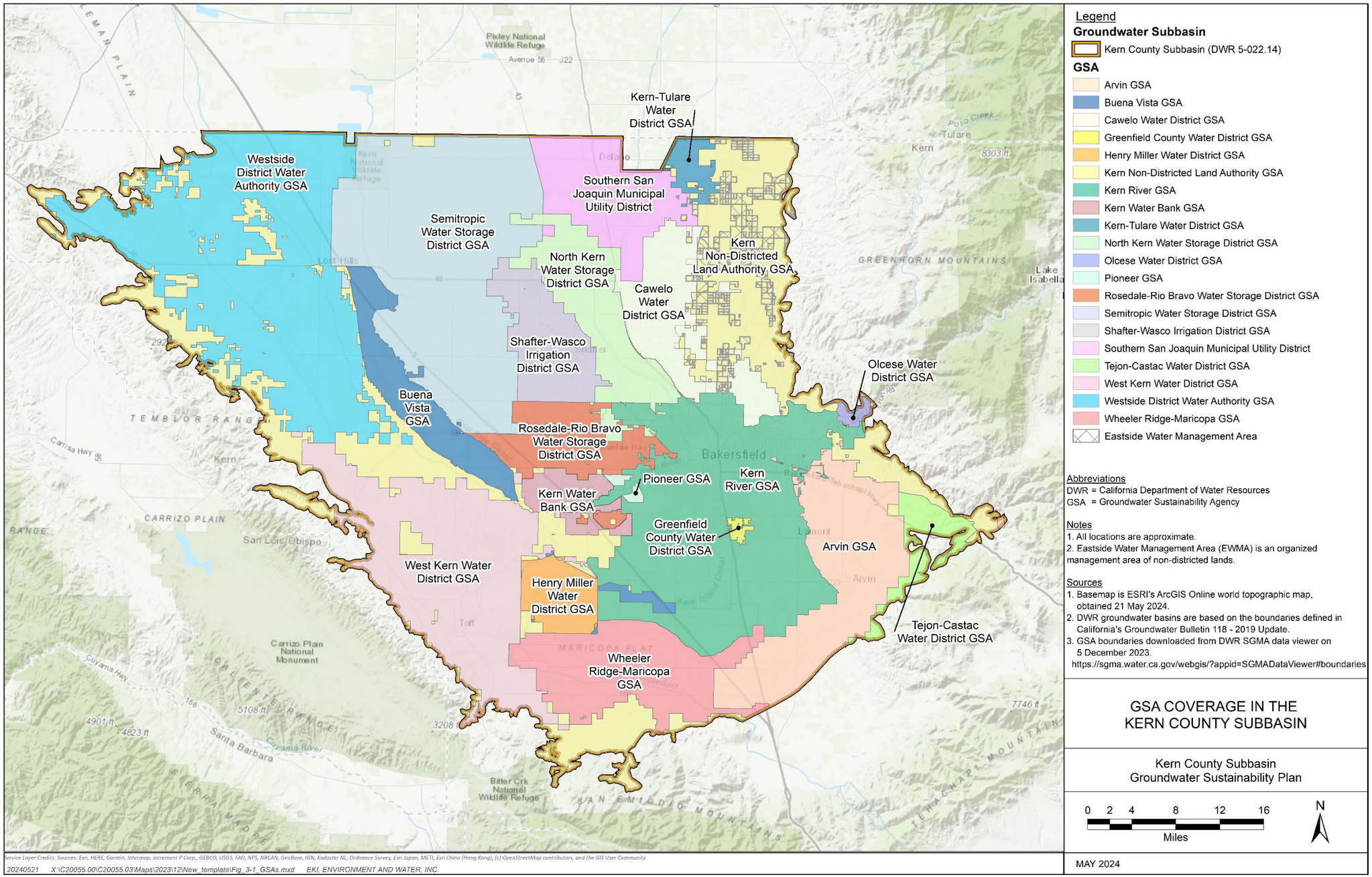


Figure 5-3. GSA Coverage of the Kern Subbasin

5.3 Discussion of Land Use, Water Use, and Water Sources

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

Land use designations are predominantly agricultural and industrial oilfields, followed by urban, suburban and rural communities. The largest metropolitan area is a medium-sized urban population in the City of Bakersfield with suburban sprawl in the unincorporated Kern County. The Kern Subbasin also has several small urban areas and rural communities (Section 5.3.1). Figure 5-4 provides geographic representation of land uses. A comprehensive, multisource dataset is maintained to tabulate land uses across the entire Kern Subbasin. The primary land uses in the Kern Subbasin are:

- 657,000 acres of active agriculture (36.2 percent of plan area)
- 600,000 acres of native land (33.1 percent of plan area)
- 256,000 acres of idle agriculture (14.1 percent of the plan area)
- 149,000 acres of urban, suburban, and rural communities (8.2 percent of the plan area)
- 91,000 acres of industrial oil fields (5.0 percent of the plan area)
- 62,000 acres of other uses (3.4 percent of the plan area)

Table 5-1 summarizes land uses by HCM Area for 2021. Detailed descriptions of each primary land use category are provided in the text following the map series. Water uses and beneficial users associated with the land uses is discussed in Section 5.3.2.

Table 5-1. Summary of Land Uses by HCM Area for 2021

Kern Subbasin Beneficial User Type	Western Fold Belt Acres and %	North Basin Acres and %	Kern River Fan Acres and %	South Basin Acres and %	East Margin Acres and %
Agricultural	63,304	325,840	23,249	216,612	27,623
	14%	56%	19%	49%	13%
Agricultural - Idle	52,993	100,832	7,269	81,740	12,798
	12%	17%	6%	19%	6%
Industrial (includes oil fields)	72,130	264	2,005	0	16,762
	16%	0%	2%	0%	8%
Urban	10,401*	38,256	42,377	50,855	6,639
	2%	7%	35%	12%	3%
Native	250,435	106,545	30,796	66,061	146,109
	55%	18%	25%	15%	70%
Other	8,902	10,602	16,599	25,581	0
	2%	2%	14%	6%	0%
Total	458,165	582,339	122,295	440,850	209,932
	100%	100%	100%	100%	100%

*The urban area in the Western Fold Belt HCM Area relies on groundwater pumped from the North Basin and South Basin HCM Areas

5.3.1 California Protected Areas, Conservation Easement Areas, and Local, State, and Federal Lands

The Kern Subbasin contains various state, federal, or locally owned public lands as shown in Figure 5-6. These lands are mostly preserved as open space areas for natural parks or monuments, managed resource protection areas, game refuge, or protected conservation easements with no associated water uses. The following sections describe each land use category and the associated water use.

Federal Lands

There are approximately 43,509 acres of federally owned land, including national public lands or lands managed by the Bureau of Land Management (BLM), the Kern National Wildlife Refuge managed by the United States Fish and Wildlife Service, and a small area managed by the United States Bureau of Reclamation (USBR).

State Lands

There are approximately 25,191 acres of state-owned land, including the California Department of Parks and Recreation Tule Elk State Reserve, land managed by the California State Lands Commission, and the following lands managed by the California Department of Fish and Wildlife: the southern portion of the Allensworth Ecological Reserve (ER), the Bakersfield Cactus ER, Buttonwillow ER, California Aqueduct, Elk Hills, a portion of the Lokern Ecological Reserve, the Semitropic Ecological Reserve, and the South Coles Levee Oilfields.

Locally Owned Lands

There are approximately 11,824 acres of locally owned land, including land owned by cities, counties, and special districts. These lands include areas such as parks, community centers, recreation centers, and golf courses.

Conservation Easement Areas

There are approximately 39,064 acres of California Conservation Easement Areas, such as the Antelope Plains and Alkali Flats managed by the Sequoia Riverlands Trust and the Coles Levee and Elk Hills Conservation Easement managed by the CDFW, amongst others, based on the CPAD/ CCED: California Protected Areas Database (calands.org).

Non-Profit Trust

Non-profit lands are located within the Kern Subbasin including 28,407 acres of Land Trust areas (Lokern Preserve, Sand Ridge Preserve, Semitropic Ridge Preserve, Tollhouse Ranch, and Wind Wolves Preserve), and other non-profit lands such as Goose Lake and Panorama Vista Nature Preserve.

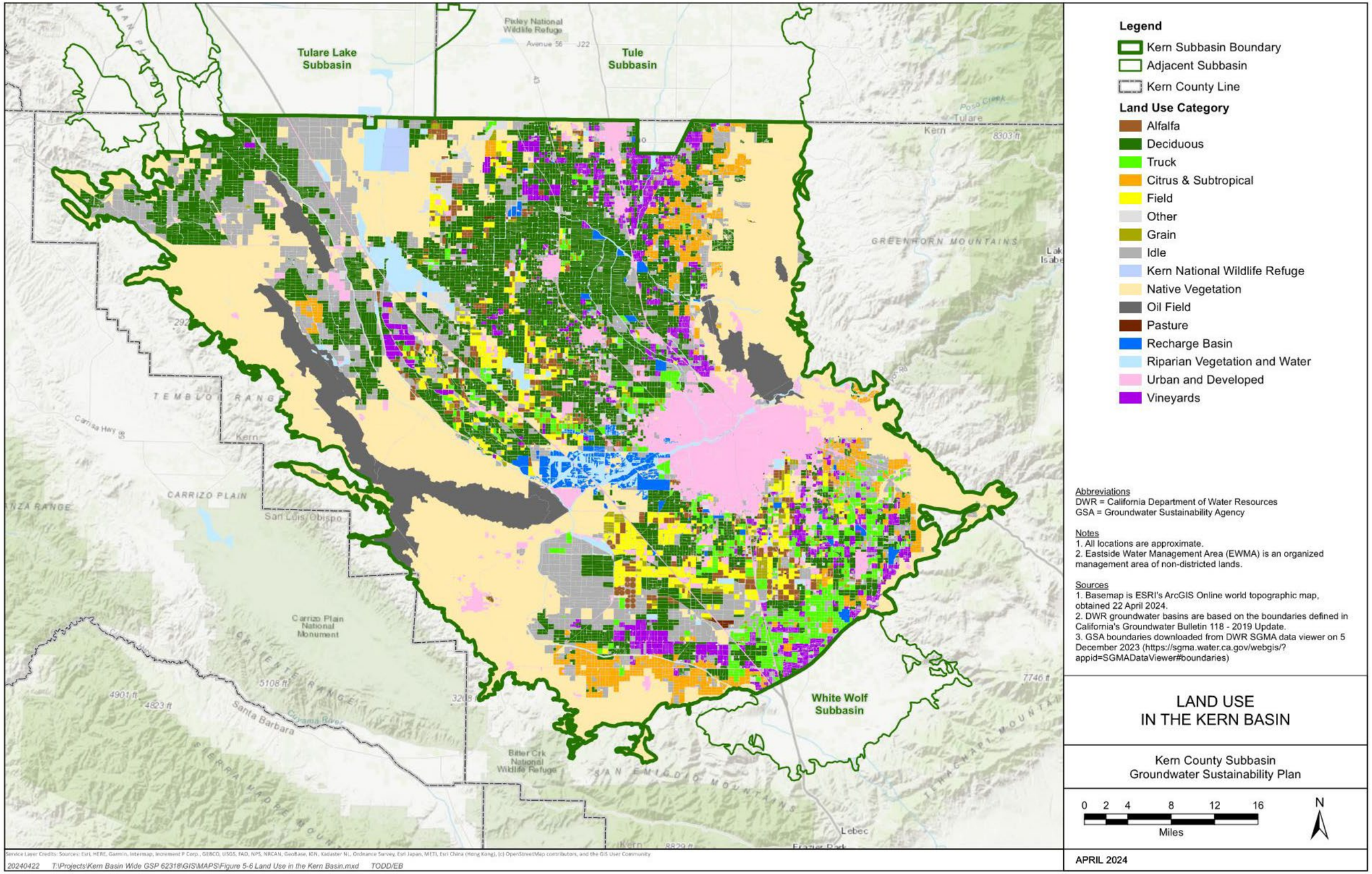


Figure 5-4. Land Use in the Kern Subbasin

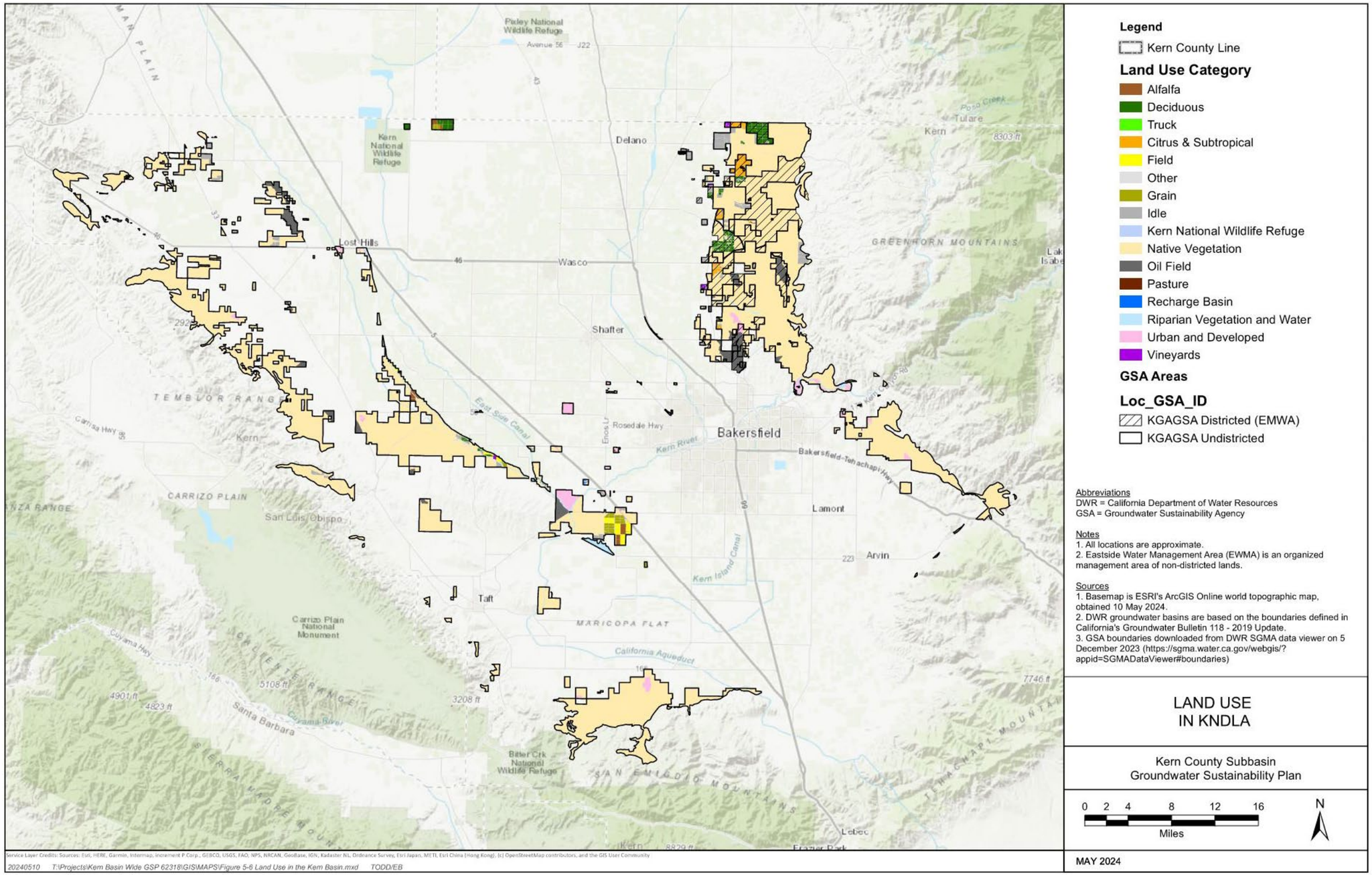


Figure 5-5. Land Use in Kern Non-Districted Land Authority

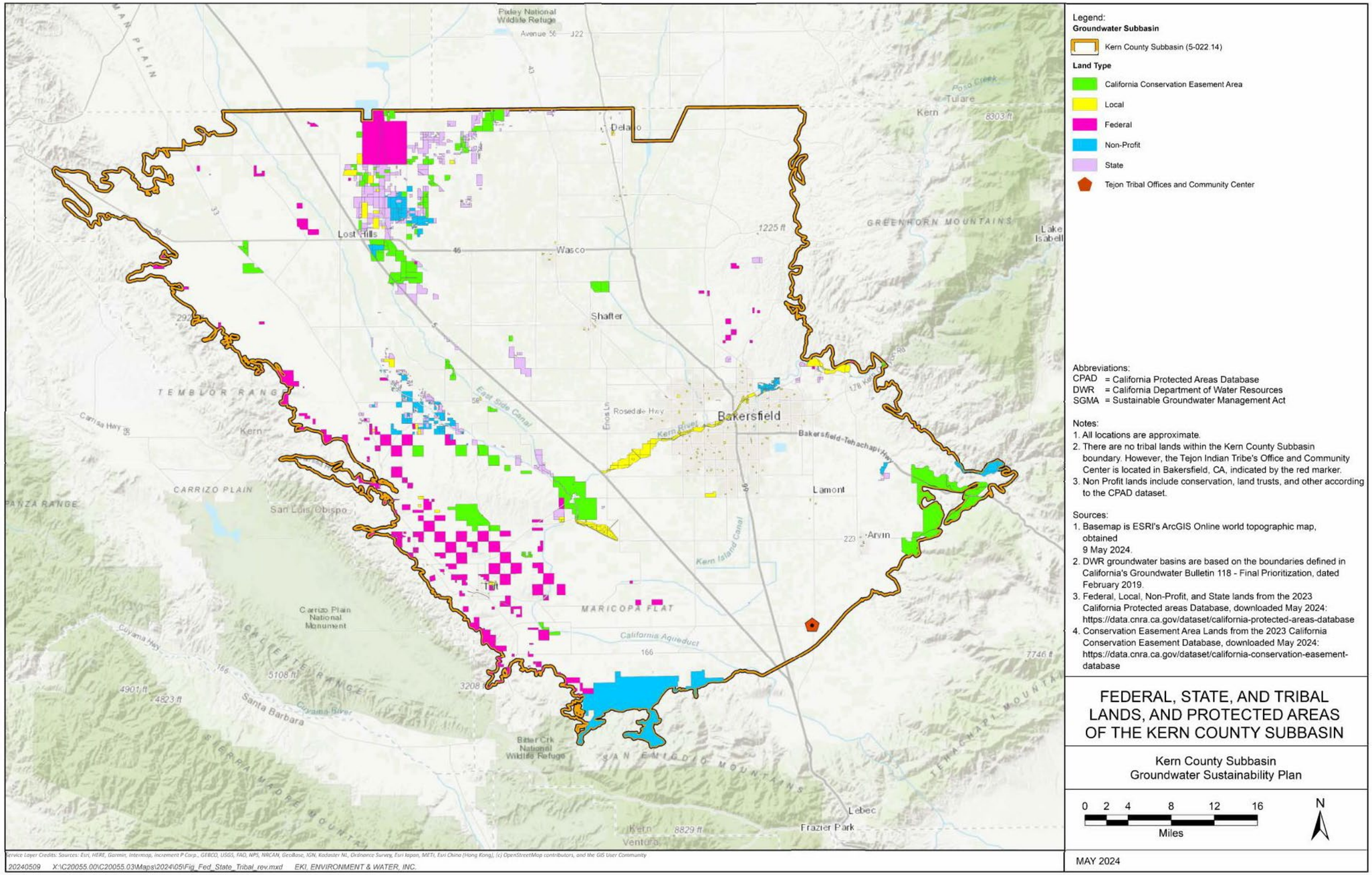


Figure 5-6. Federal, State, and Tribal Lands, and Protected Areas of the Kern Subbasin

5.3.2 Descriptions of Privately Owned Lands

Agriculture. Agriculture is the primary land use in the Kern Subbasin, representing about 51 percent of the total land area, including idle fields. There are approximately 644,000 acres of active agriculture (36 percent of Kern Subbasin) and 256,000 acres of idle agriculture (15 percent of the Kern Subbasin). The series of Figure 5-4 through Figure 5-5 show the dominance of local agriculture in the Kern Subbasin. Major crops include almonds and pistachios, grapes, carrots, potatoes, and citrus. The total acreage has remained steady over the past ten years but changes in crops include a decrease in field crops and grapes and a slight increase in almonds and pistachios. Idle agricultural land has increased from 1995 to 2021. Drought conditions in 2021 may have contributed to short term fallowing.

Agricultural preserves and agricultural lands protected under the Williamson Act encompass a significant portion of the Kern Subbasin (Figure 5-7). The Williamson Act (California Land Conservation Act of 1965, Section 51200) was adopted to encourage preservation of the state's agricultural lands and to discourage its conversion to urban uses. The other major land uses are urban and oil field operations, which account for about 8 percent and 5 percent of the Kern Subbasin, respectively. Other land uses (native, water, and unknown) account for about 36 percent of the Kern Subbasin.

Oil Field Land Use. The oil field land use occurs in the eastern and western regions of the Subbasin boundary. The areas of oil field land use shown on Figure 5-4 are areas where the oil field surface operations are the predominant land use activity. The surface operations of oil fields overlie the Kern Subbasin, but, with some exceptions on the Westside, the subsurface activity occurs in hydrocarbon reservoirs below the usable groundwater basin (more in Section 7). Oil extracted from oilfield operations contains entrained water referred to as "produced water." Produced water is used in enhanced oil recovery operations. It may also be treated for beneficial reuse as described below in Section 5.4.3. Excess produced water may be disposed of by treatment to conform with the Central Valley Regional Water Quality Control Board's (CVRWQCB) waste discharge requirements before injection into an EPA approved exempt aquifer.

5.3.3 Disadvantaged Communities

Disadvantaged communities (DACs) or severely disadvantaged communities (SDACs) are identified based on the median household income (MHI) of an area compared to the statewide MHI.[1] DACs are those with a MHI that is no more than 40 percent of the statewide MHI, and SDAC communities are those with a MHI that is no more than 20 percent of the statewide MHI (California Code, Public Resources Code § 75005(g)). Figure 5-8 tracts designated as DACs and SDACs based on the 2020 MHI from the

[1] https://gis.water.ca.gov/app/dacs

2016 to 2020 American Community Survey 5-Year Estimates, provided by DWR. More refined information is provided in the Section 5.6.5.

5.3.4 Native American Tribal Communities and Lands

The Tejon Indian Tribe is the only federally recognized tribe within Kern County.[2] The Tribe does not have communal land, however there is a parcel located near Mettler, within the Arvin GSA area, that is proposed to be developed in 2025 into the Hard Rock Hotel & Casino Tejon. The Tejon Indian Tribe has an office located in Bakersfield.

[2] https://www.tejonindiantribe.com/

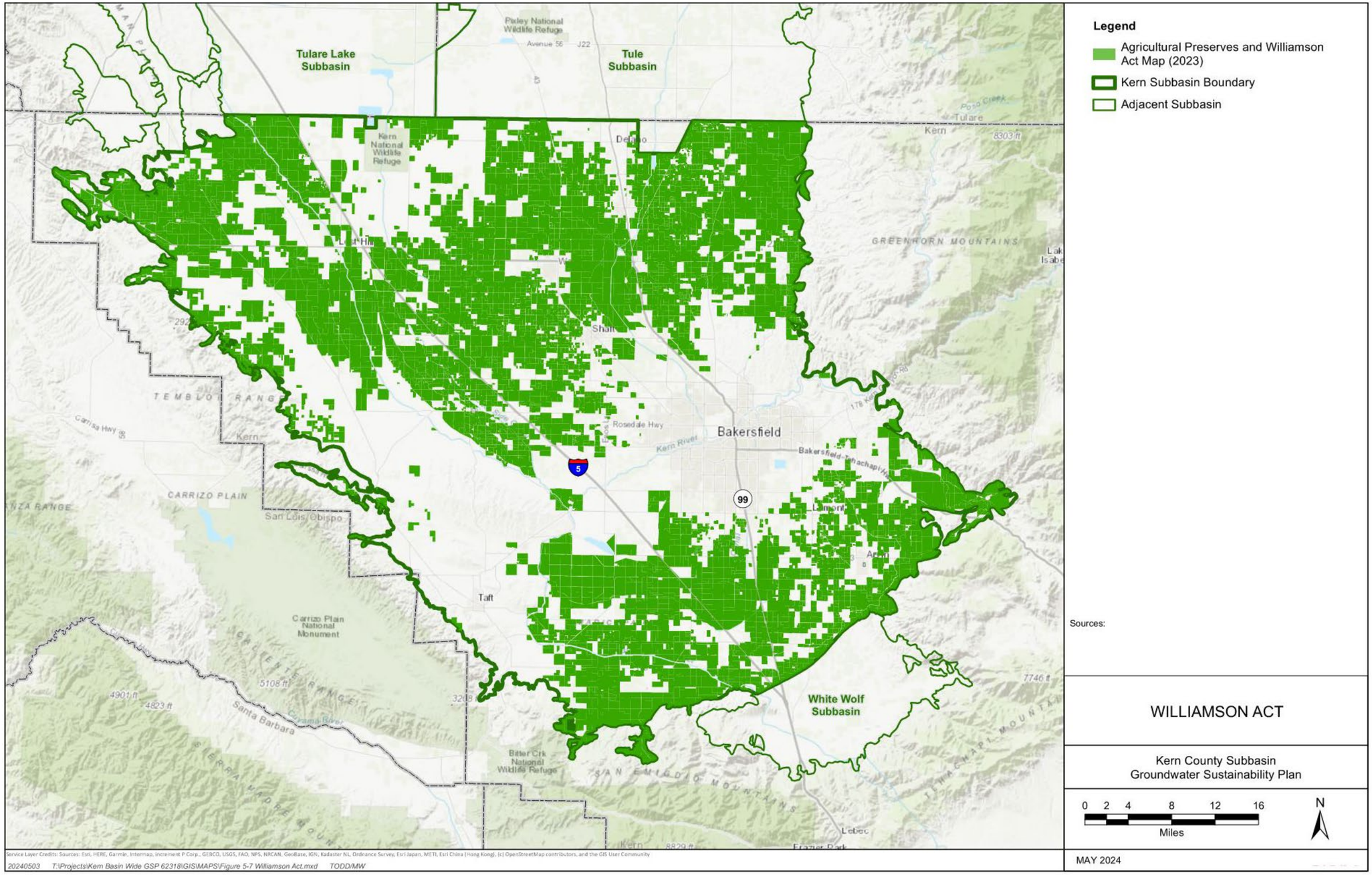


Figure 5-7. Williamson Act

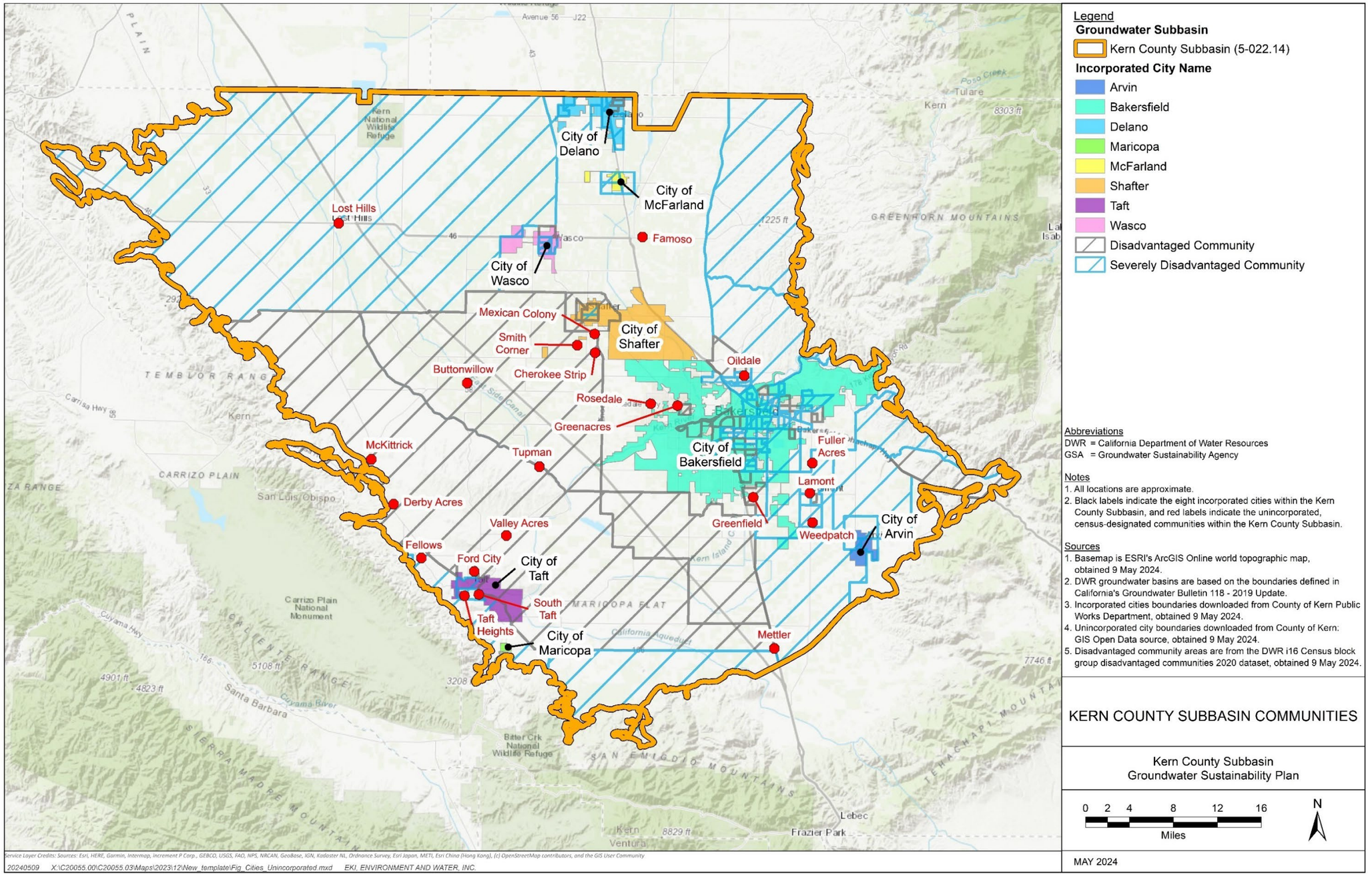


Figure 5-8. Kern Subbasin Communities

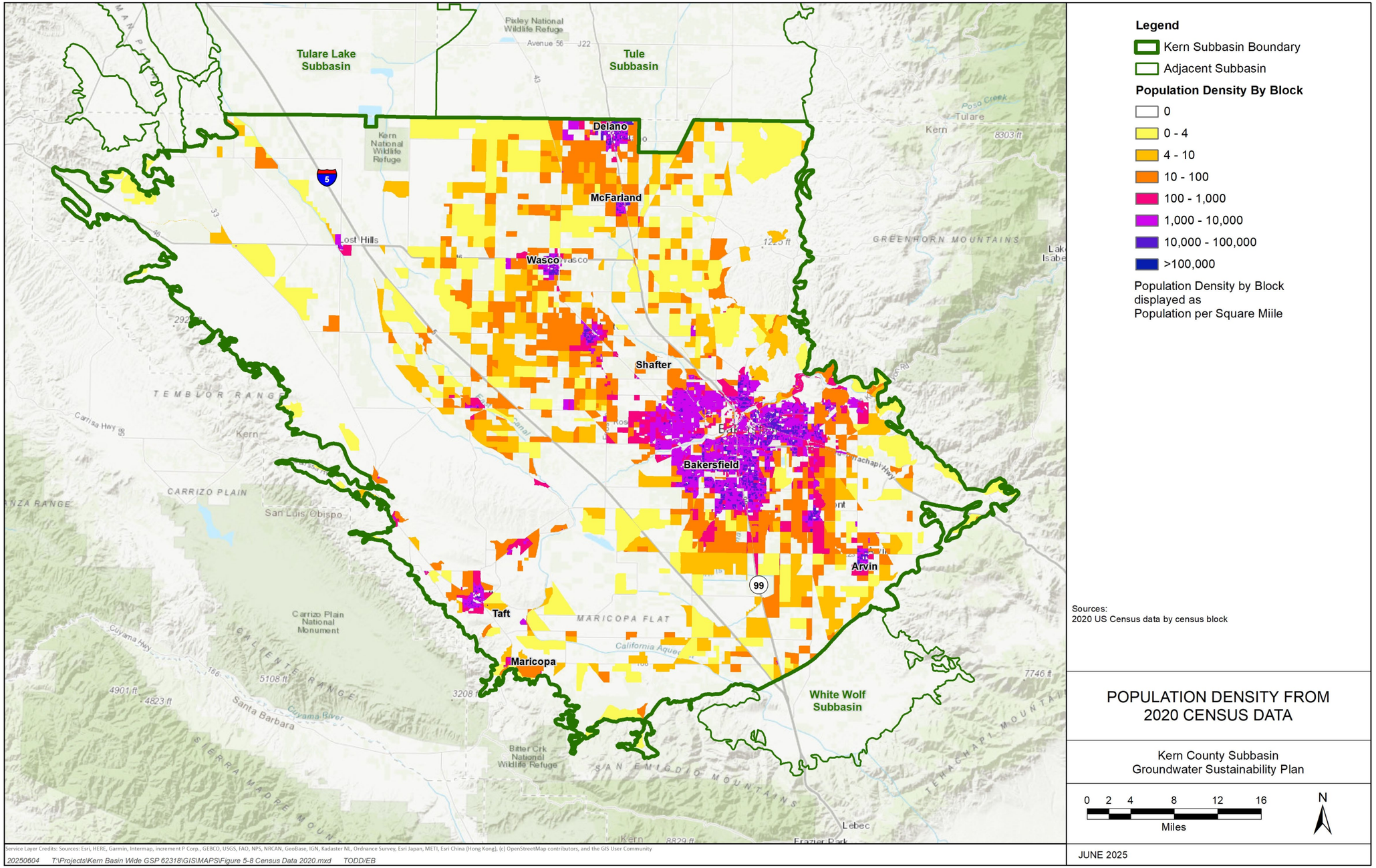


Figure 5-9. Kern Subbasin Population Density (population per square mile) based on 2020 Census Block Data

5.4 Water Sources

Hydrologic systems in the Kern Subbasin include numerous rivers, lakes, and canals, many of which are used to supply water to the entire Kern Subbasin. The prominent natural surface water body in the Kern Subbasin is the Kern River, which originates in the Sierra Nevada to the northeast of the Kern Subbasin. Canals and conveyance systems are used to supply water for beneficial uses throughout the Kern Subbasin.

Historical overdraft of the Kern Subbasin's groundwater was noted as early as the mid-1940s. Due to chronically declining groundwater levels, water districts were formed to protect surface water rights to the Kern River and provide a means for contracting through the SWP and CVP. Diversions from the Kern River and imported surface water enabled water districts to operate conjunctive use programs where surface water available in wet years could be used to replenish groundwater storage, a vital source of supply during dry years. Access to surface water also supports water banking, recovery, and exchange projects to optimize available water supplies. In more recent years, water districts are adding recycled water sources to their water supply portfolios. This section of the 2025 Plan describes the available water sources to each district.

5.4.1 Surface Water

Kern River

The main source of surface water supply for the Kern Subbasin is the Kern River, which flows east to west through the center of the Kern Subbasin's boundaries from the Sierra Nevada Mountain range and extends across the Kern Subbasin. Headwaters of the Kern River originate from the base of Mount Whitney, where the river splits into two forks (North Kern and South Kern) and merge at Lake Isabella. The Kern Subbasin receives surface water below Lake Isabella Dam (constructed in 1953) where controlled flows are managed daily to prevent flooding through a series of canals, weirs, and levees.

As early as the 1850s, lands within the Kern Subbasin were drained and diverted through canals and levees to control flooding to support agriculture and urban development within the region. Today, operations and management of Kern River surface water to areas within the Kern Subbasin are overseen by the City of Bakersfield in coordination with the United States Army Corps of Engineers (USACE) and Kern River Watermaster. For more than 150 years, the Kern River has provided most of the surface water supply to the Kern Subbasin, including water for irrigation, drinking water, and other uses. Figure 5-10 identifies the various canals, weirs, and diversion points.

The only major stream supplying the Kern Subbasin is the Kern River, and two smaller streams: Poso Creek and Caliente Creek. Kern River and Poso Creek are fully allocated streams.

Flows in the Kern River consist of regulated releases from Lake Isabella, approximately 25 miles upstream of Kern Subbasin's eastern boundary (Figure 5-10). Isabella Dam was constructed by the USACE in 1953 to control downstream flooding. Since that time, the dam has been operated for flood control, hydroelectric power, water supply, and conservation storage. Reservoir storage and Kern River flow management are coordinated by the Kern River Watermaster, working with the USACE, participating water districts, and the City of Bakersfield. Except for periods of high runoff, releases from Lake Isabella are regulated through requests, or "calls," for water by the city on behalf of the Kern River Watermaster. The city monitors, manages, and records flows and diversions in the river on behalf of the Kern River Watermaster for all water users.

Districts holding or managing rights to Kern River include NKWSD, City of Bakersfield, KDWD, BVWSD, HMWD, Olcese WD, and KCWA. The water is diverted through main canals and laterals. Diversions are monitored and reported daily and are reported in the annual Kern River Hydrographic Reports which provide accounting of monthly diversions, deliveries, and losses along the canals among all First Point diverters with records extending back to the 1890s.

Ephemeral Creeks

Poso Creek, Caliente Creek, and other significant ephemeral streams, springs, and seeps are sources of recharge. Figure 5-10 (Surface Water Features from National Hydrography Dataset) displays the locations of seeps and springs based on data extracted from the National Hydrography Dataset at the base of the mountains and foothills in the southeast, southwest, and northwest edges of the Kern Subbasin.

The Natural Communities Commonly Associated with Groundwater (NCCAG) dataset shows spring-fed streams in the southwest along the perimeter of the Kern Subbasin: Santiago Creek to San Emigdio Creek situated in the Wind Wolves Preserve. In the highlands in the southeast corner of the Kern Subbasin is Tejon and Caliente Creek drainage. Notable creeks along the northeastern boundary are Poso, Little, Deer, and Rag Gulch Creeks.

Poso Creek

Poso Creek runs from the Greenhorn Mountains of the Sierra Nevada Mountain Range on the east side of the Kern Subbasin and drains to the North Basin HCM Area. In most years, the creek flows seasonally from November through May in its upper reaches and becomes an ephemeral wash in the valley floor where it flows between Wasco and McFarland. During very wet years, excessive flows that cannot be captured eventually discharge north of the Kern Subbasin into the Tule and Tulare Lake Subbasins. Drainage from Poso Creek is fully allocated and issued for managed recharge in the Cawelo, North Kern, and Semitropic Water Districts.

Streamflow is measured at several points. USGS and Kern County have operated a gage at Coffee Canyon northeast of Oildale since July 1959. Cawelo Water District (CWD) monitors Poso Creek at Trenton Weir near State Highway 65. North Kern Water Storage District monitors at Highway 99. And Semitropic Water Storage District monitors Poso Creek at Leonard Ave, Schofield Ave and one-half mile west of Gun Club Road.

Caliente Creek

Caliente Creek and its tributaries, Walker Basin Creek and Tehachapi Creek, and the smaller creeks of Little Sycamore, Commanche, and Tejon, drains the west slopes of the Tehachapi Mountains to the east side of the Kern Subbasin into the South Basin HCM Area. Based on observations of un-gaged flows and limited historical stream gaging data from Caliente Creek, surface water inflows occur seasonally with some frequency. Storm-related flooding has been documented to occur in some areas such as Lamont and Arvin, as well as near AEWSD's spreading works and the David Road and Sebastian Road areas. There are no instream flow requirements for Caliente Creek nor reported water applications and permits issued from the SWRCB.

Drainage from Caliente Creek contributes to groundwater recharge. During wet years, drainage causes flood damage. Kern County certified a Notice of Exemption for the Caliente Creek Flood Protection Project in January 2022. The project will implement stormwater flood mitigation activities to uniformly distribute flood waters, increase silt deposition, and improve percolation to the groundwater table.

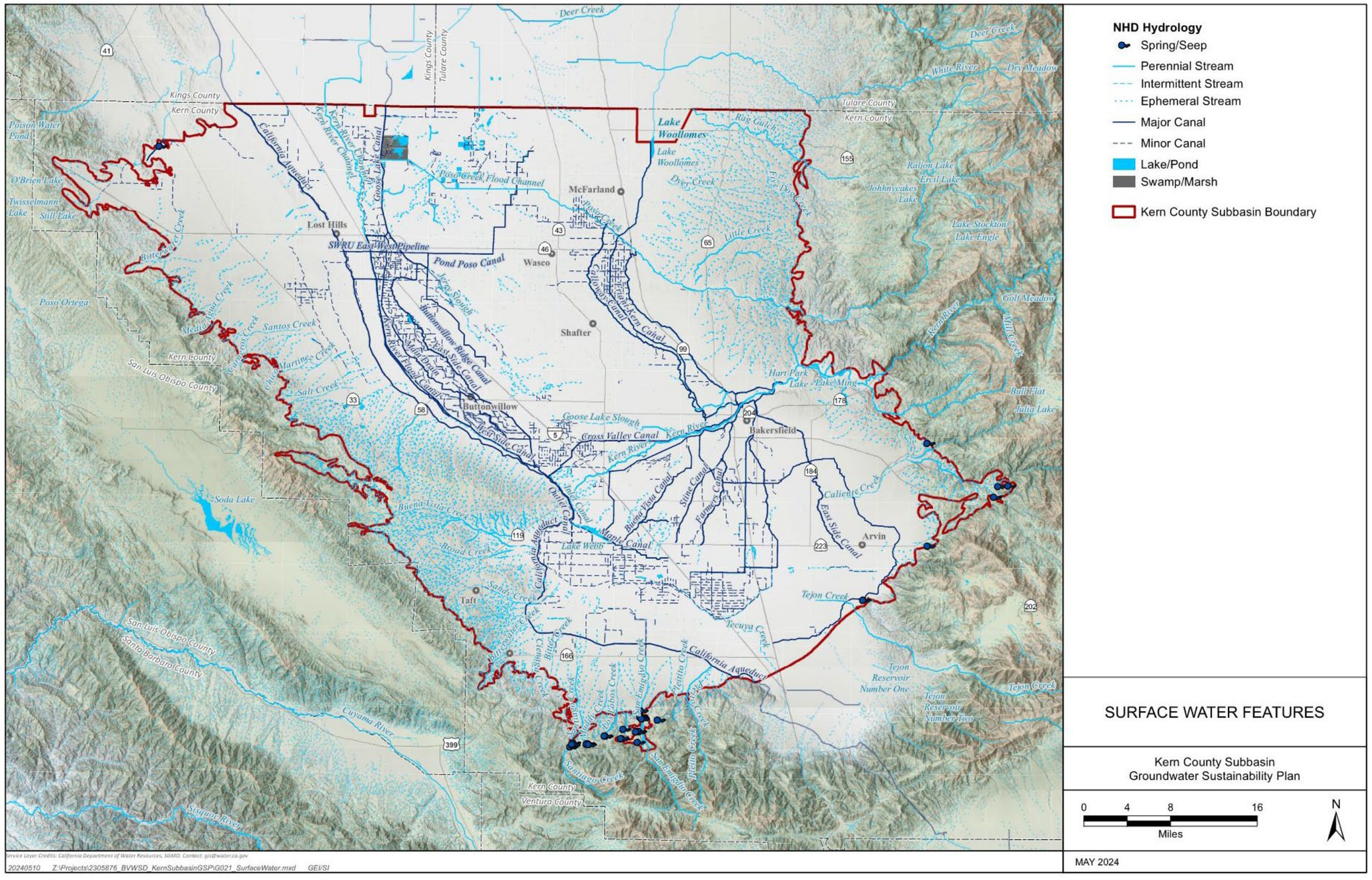


Figure 5-10. Surface Water Features

5.4.2 Imported Water Deliveries

Imported water deliveries to wholesalers and retailers within the Kern Subbasin are monitored. KCWA monitors all turnouts from the California Aqueduct in Kern County and all turnouts along the Cross Valley Canal. Measurements are taken daily (KCWA, Initial Water Management Plan, 2001).

The primary sources of imported water are the SWP via the California Aqueduct and the CVP through the Friant-Kern Canal. KCWA holds the SWP contract on behalf of 13 Member Units and the CVP provides water to four districts within the Kern Subbasin (Table 5-3).

The conveyance facilities for the SWP and CVP provide access to the northern, central, and southern Sierra snowpack, respectively. In wet years, surplus water to these sources may be available to non-contract holders through sales and exchanges with contractors, maximizing access to surface water for banking projects. Figure 5-10 shows the conveyance system locations within the Kern Subbasin.

5.4.3 Wastewater Discharge and Recycled Water Delivery

Wastewater Treatment Facilities within the Kern Subbasin discharge to ponds where the treated water evaporates and/or percolates back into the groundwater. With recent changes to recycled water regulation, increased use of recycled waters for crop irrigation is anticipated in future years. Recycled water plays an important role in the diverse water supply of Kern County. Recycled water use in the Kern Subbasin ranged from 46,000 to 70,000 AFY during Water Years (WY) 2020 to 2023. Table 5-2 summarizes Municipal Wastewater Facilities with permitted volumes and beneficial uses, and the water district/GSA credited for the recycled water supply.

Oil and gas production includes the extraction of subsurface fluids in the form of oil, gas, and entrained water (referred to as “produced water”). Produced water is separated from the extracted oil through various filtration processes, then treated for beneficial reuse (referred to as “Recycled Produced Water [RPW]”). Recycled produced water from the Kern River and Kern Front Oilfields is of an acceptable quality for groundwater recharge or crop irrigation when blended with surface water.

Table 5-3 shows which water districts have access to these water sources. This shows the water source or sources directly available to each district, as well as indicate the primary avenues through which districts receive water. The table also indicates the sources of water available for implementation of projects needed to attain Subbasin-wide sustainability. Not shown are the transfers and exchanges that enable districts to receive water from sources to which they do not have direct access.

Table 5-2. Recycled Water Facilities

Facility ID	Permitted Discharge in Million Gallons per Day (MGD)	Water Use	Land Use Area	Receiving GSA/Entity
City of Arvin and Veolia Water West Operating Services, Inc, Arvin Wastewater Treatment Facility (WWT) Facility	1.10 - 2.0 MGD (Nov 1 to April 30) 1.28 - 2.3 MGD (May 1 to Oct 31)	Irrigation of Fodder Crops	240 acres	Arvin GSA
Buttonwillow County Water District, WWT Facility	0.2 MGD	Alfalfa or Sudan Grass	50 acres	BVGSA
Stoco Mutual Water & Sewer Company, WWT Facility	0.05 MGD	Groundwater recharge	2.67 acres	Kern Non-Districted Land Authority
City of Bakersfield Wastewater Treatment Plant (WWTP) 2	25 MGD	Irrigation to Alfalfa, Grain, and Corn	5,476 acres	KRGSA
City of Bakersfield WWTP 3	16 - 32 MGD	Irrigation to Fodder Crops	420 acres	25 percent to Green Acres Farm in Kern Delta Water District (KRGSA) and 75 percent to Green Acres Farm in Kern Non-Districted Land Authority
Lamont Public Utilities District (PUD) WWTP & Recology Blossom Valley Organics South	2.0 MGD	Irrigation to Fodder Crops	130 acres	KRGSA
McMor Chlorination, Inc, I-5 and Hwy 58 WWT Facility	0.19 MGD	Irrigation to Pasture	50 acres	SWSD GSA
California Department of Corrections and Rehabilitation (CDCR) Kern Valley State Prison, WWT Facility	0.77-1.54 MGD	Seepage Irrigation of Fodder Crops	35 acres 200 acres	SSJMUD GSA
City of Delano	7.2 MGD	Irrigation to Fodder Crops	932 acres	SSJMUD GSA
City of McFarland	1.1 - 1.55 MGD	Irrigation of Alfalfa	270 acres	NKWSD GSA

Facility ID	Permitted Discharge in Million Gallons per Day (MGD)	Water Use	Land Use Area	Receiving GSA/Entity
City of Wasco	1.95 - 3.0 MGD	Irrigation of Alfalfa, corn, cotton, blackeye beans, and sugar beets	450 acres	SWID GSA
North of the River Sanitation District	2 MGD	Seepage	n/a	City of Shafter (SWID GSA)
North of the River Sanitation District & Sill Properties	5.5 MGD	Irrigation to Fodder Crops Seepage	391 acres 32.5 acres	7th Standard Annex (SWID GSA)
Wasco State Prison	0.81 MGS	Flood Irrigation of Alfalfa	230 acres	SWID GSA
City of Taft, Sanitary Sewer Overflow to Sandy Creek	Settlement Agreement and Stipulation for Entry of Administrative Civil Liability, Issued by the Executive Officer on 7 March 2016 - No active WDR			
City of Taft, Taft Federal Prison WWT Facility	0.46 MGD	Seepage	0.46 MGD	WKWD GSA
City of Taft, Taft Height Sanitation District, Ford City Sanitation District, and United States Department of Energy (USDOE), Taft WWT Facility	1.2 MGD	Seepage	1.2 MGD	WKWD GSA

5.4.4 Groundwater

Native groundwater supplies are inadequate to support the present level of demand by overlying users, resulting in the Kern Subbasin being deemed critically overdrafted. The Basin currently uses 0.15 AF as the native yield of groundwater. During dry years, groundwater serves as a critical buffer against the impacts of drought and climate change. With the Kern Subbasin's conjunctive use and water banking programs, the Kern Subbasin's goal is to reach a condition of safe yield for the groundwater basin (refer to Section 5.5 Water Resources Management Programs). Safe yield occurs when the amount of water pumped from the basin is less than or equal to recharge into the basin.

Table 5-3. Water Sources Available to Each Water District

Water District	Groundwater	Surface Water					Recycled or RPW	Notes
		Kern River	SWP	CVP	Project Wet Year Supply*	Minor Streams		
Arvin-Edison Water Storage District	X	X	X	X	X		X	Recovered Water Account (RWA), Unreleased Restoration Flows (URF), Recapture & Recirculation (R&R). AEWSD has access to Kern River supplies through direct purchases, such as occurred in 2023, and potential to access recycled water through Arvin.
Buena Vista Water Storage District	X	X	X		X		X	
Cawelo Water District	X	X	X		X	X	X	CWD has access to Kern River supplies as a Member Unit of the KCWA and CVP Section 215 as available
City of Bakersfield	X	X					X	
Eastside Water Management Area								
Henry Miller Water District	X	X	X		X			Surface water supplies include regular annual supplies, and irregular annual supplies available in wet years
Kern County Water Agency	X	X	X		X			All member units have access to Kern River Water via agreement with KCWA.
Kern Delta Water District	X	X	X				X	
Kern Non-Districted Land Authority	X						X	
Kern-Tulare Water District	X	X		X	X		X	
North Kern Water Storage District	X	X			X	X	X	

Water District	Groundwater	Surface Water					Recycled or RPW	Notes
		Kern River	SWP	CVP	Project Wet Year Supply*	Minor Streams		
Olcese Water District	X	X						Olcese pumps from the Olcese Principal Aquifer; Olcese has access to Kern River water diverted at 2nd Point (Carmel)
Rosedale-Rio Bravo Water Storage District	X	X	X		X			
Semitropic Water Storage District	X	X	X	X	X	X		SWSD has access to Kern River water and CVP Section 215 as available
Shafter-Wasco Irrigation District	X			X	X		X	RWA, URF, Section 215
7th Standard Annex	X				X		X	
Southern San Joaquin Municipal Utility District	X			X	X		X	RWA, URF, Section 215
Tejon-Castac Water District	X							
West Kern Water District	X		X				X	
Westside District Water Authority GSA (JPA of Berrenda Mesa Water District, Belridge Water Storage District, and Lost Hills Water District)	X	X	X		X			Due to poor groundwater quality, only in extremely dry years do landowners pump nominal amounts of groundwater, which requires treatment/blending before beneficial use.
Wheeler Ridge-Maricopa Water Storage District	X	X	X		X		X	WRMWSD has access to Kern River supplies as a Member Unit of the KCWA.

* CVP Section 215 and SWP Article 21 water which are both temporary supplies made available in large water supply years.

5.5 Water Resources Management Programs

> ***§ 354.8.*** *Each Plan shall include a description of the geographic areas covered, including the following information:*
>
> *(a) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.*
>
> *(b) A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.*
>
> *(c) A description of conjunctive use programs in the basin.*

☑ 23 CCR § 354.8(c)

This section focuses on monitoring and management programs that will contribute to attainment and maintenance of sustainable groundwater management in the Kern Subbasin. Although many of the monitoring programs predate SGMA, they will be enhanced to provide data that will aid GSAs in formulating and implementing projects and in determining whether projects are achieving their objectives. For example, information on climate, land use and cropping, and consumptive use will drive demand reduction efforts. Data on groundwater levels, water quality and subsidence will inform GSAs on the success of demand reduction and supply enhancement projects.

The water districts have been managing groundwater in the Kern Subbasin through a variety of long running programs, including conjunctive use and water banking. Numerous planning documents provide details on these programs. In brief, daily coordination among water managers, an interconnected web of conveyance canals and pipelines, and numerous water sources to balance and manage in real-time have provided each of the GSAs with the tools for flexible and reliable water management.

Additionally, *Agricultural Water Management Plans* (AWMPs) and *Groundwater Management Plans* (GWMPs) have been developed and maintained by water districts. Urban Water Management Plans (UWMPs) have been prepared by the larger water purveyors. Each plan describes numerous policies and programs being implemented by the member agencies for conjunctive management of surface water and groundwater; collectively, the plans demonstrate coordination at an intricate level to maximize beneficial use of water supplies.

5.5.1 Conjunctive Use

☑ 23 CCR § 354.8(e)

Conjunctive management uses diverted surface water to meet demands across a range of hydrologic conditions. This is accomplished by using surface water to both meet demands and to replenish aquifers during years when surface water is abundant. Water stored in the principal aquifer during wet years can then be recovered during dry periods when surface water supplies are insufficient to meet demands. The practice of using the principal aquifer as a reservoir for storing surface water is one of the primary mechanisms that allows the Kern Subbasin to maintain a reliable water supply during droughts and is an important component of the Kern Subbasin's approach to sustainable groundwater management.

Conjunctive management has been a vital water management tool in the Kern Subbasin for over a century with Kern River diverters using seepage from natural waterways and earthen canals to supplement groundwater recharge, helping to maintain groundwater levels. Now surface water supplies include the Kern River, the SWP, and the CVP. Diversions from these sources are used to replenish the groundwater basin using a variety of mechanisms ranging from canal seepage and recharge basins to Flood-Managed Aquifer Recharge (FloodMAR) operations. Supplemental water can be applied over agricultural lands that contribute to recharge or input to subsurface recharge facilities, underlying active agricultural lands, for recharge.

Conjunctive management has evolved due to improvements in water management practices, changes in environmental regulations and the passage of SGMA. These drivers have led to better measurement and accounting for recharge and recovery, the introduction of FloodMAR, and expansion of the area devoted to recharge basins, a feature of many of the Kern Subbasin's water supply P/MAs.

Conjunctive management facilities, such as recharge basins, are also used for water banking. However, the purpose of conjunctive management is to store surface water available under a district's rights or entitlements for the benefit of the district's landowners with a corollary benefit to nearby communities. By contrast, water banking is a service provided by banking entities who store surface water provided by project participants or banking partners for later recovery for the benefit of those entities.

5.5.2 Water Banking

☑ 23 CCR § 354.8(c)

Kern County entities have been involved in water banking for several decades. These programs have been developed to help secure more reliable water supplies due to California's wet- and dry-year cycles. They all involve storing surface water in wet years for later recovery for beneficial uses in dry years. As the availability of water supplies has diminished, more and more Kern entities have embraced water banking to offset these shortages such that now almost every water district in the Kern Subbasin has either established a banking program or partnered with an entity that has. Some of these programs also involve storing water for others in the state, with the locations of partner agencies ranging from Santa Clara in the north to the Mexican border in the south.

The Water Resilience Portfolio, developed in response to the Governor's Executive Order (EO) N-10-19, recognizes storage projects like those in Kern County as one of the primary means for regions to transition to sustainable use, and one of the overarching goals of SGMA is to correct conditions of long-term overdraft (e.g., Water Code Section 10735.8(b)1). SGMA recognizes the uniqueness of storage Projects and their role within a GSA in Water Code Section 10726.2.(b) which states: "…*the agency [GSA] shall not alter another person's or agency's existing groundwater conjunctive use or storage program except upon a finding that the conjunctive use or storage program interferes with implementation of the agency's groundwater sustainability plan*." Importantly, each of these programs has undergone public review under the California Environmental Quality Act (CEQA) to help mitigate any potential impacts from project operations.

There are two processes that these programs use to store water: 1) direct recharge, and 2) in-lieu recharge. Direct recharge is the process of storing surface water by using recharge basins to percolate water directly into the aquifer thereby establishing a storage account separate and apart from the basin's native groundwater. In-lieu recharge is the process of establishing a bank account by providing surface water to overlying users in wet years in lieu of their groundwater pumping. Here, storage accrues based on the volume of stored surface water and native yield not pumped. Some GSAs may use both processes to store water.

Appendix D, *Kern Fan Banking Programs*, is an overview of some of the Kern Subbasin's banking programs including locations, process used to store water, beneficial uses of recovered water, participants, sources of water, facilities, monitoring, considerations for SMCs, accounting methods, and current storage account status. Table 5-4 lists the GSAs involved in banking, conjunctive use, and in-lieu recharge activities. Figure 5-11 shows the location of existing banking projects.

Table 5-4. Kern Subbasin Water Banking Programs

GSA or District Area	Direct Storage	Conjunctive Use	In-Lieu Storage
Arvin-Edison Water Storage District	X	X	X
Buena Vista Water Storage District	X	X	X
City of Bakersfield		X	
Cawelo Water District	X	X	X
Henry Miller Water District		X	
Kern Delta Water District	X	X	X
Kern Water Bank GSA	X		
Kern-Tulare Water District			
North Kern Water Storage District	X	X	
Olcese Water District			
Kern County Water Agency-Pioneer GSA	X		
Rosedale-Rio Bravo Water Storage District	X	X	X
Semitropic Water Storage District	X	X	X
Shafter-Wasco Irrigation District	X	X	
Southern San Joaquin Municipal Utility District	X	X	
Tejon-Castac Water District			
West Kern Water District	X	X	
Westside District Water Authority	X		
Wheeler Ridge-Maricopa Water Storage District		X	

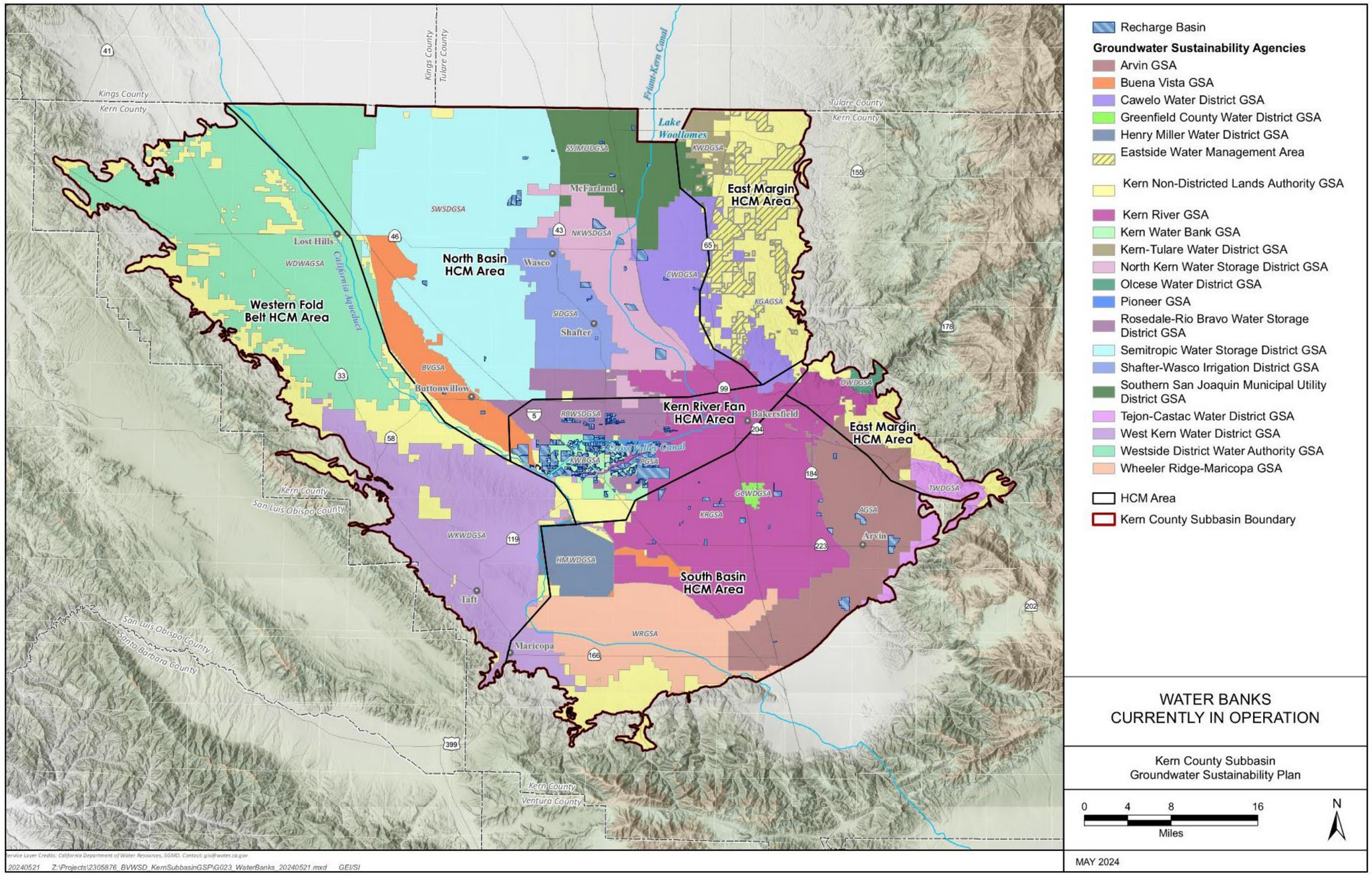


Figure 5-11. Water Banks Now in Operation

5.6 Beneficial Uses and Users

☑ 23 CCR § 354.10(a)

In the Kern Subbasin, water is supplied to various beneficial users including agriculture, industry (energy and other sectors), drinking water users (municipal and other public water systems, small communities, and domestic or non-public users). Drinking water users are further defined in Section 5.6.1.

Since conjunctive use is employed throughout the Kern Subbasin, many users are supplied by a combination of stored surface water and native yield of groundwater, diversions from the Kern River and/or imported water. This section focuses on beneficial uses and users of stored surface water and native yield of groundwater but also highlights users who rely on imported surface water supplies.

5.6.1 Well Inventory

SGMA Regulations require GSAs to identify the interests of all beneficial uses and users of groundwater, which includes all drinking water well users, and specifically to map the density of wells per square mile as well as the location and extent of communities dependent on groundwater. Recognizing that the OSWCR database is a system for maintaining records, not intended to serve as a well inventory, a Subbasin-wide Well Inventory was initiated to develop an accurate dataset with the location and type of beneficial users in the Kern Subbasin.

Description of Phase I

To develop this inventory, records were downloaded from OSWCR, USGS databases, DDW datasets, and Kern County Public Health. These datasets were parsed to remove duplicates and extraneous data. Remaining records were reconciled with Kern County Public Health and Kern County Water Agency databases, as well as state records from USGS and DDW.

1. Well Completion Report (WCR) records were last extracted from OSWCR in January 2025. Current records are extracted and integrated into the Kern Subbasin Well Inventory approximately every six months.
2. Kern County Public Health data was provided in October 2023; records include Permit No, Assessor Parcel Number (APN), Well Type and Intended Use, Township-Range-Section, and GIS Lat/Long coordinates. Local Public Health records are used to fill the gap in OSWCR records.
3. DDW records were downloaded from the Groundwater Ambient Monitoring and Assessment program (GAMA) then verified with the municipalities/purveyors or with DDW staff engineers where data was questionable. These records, as well as GSA field survey records, are integrated into the Kern Subbasin Well Inventory and matched with OSWCR records.

4. Since most OSWCR records are placed at the Centroid of Section, well locations are updated with coordinates provided by DDW, Kern County Water Agency, then Kern County Public Health. The remaining well records are located using directions to well site or the hand drawn map provided on the WCR. Kern County GIS and/or GoogleEarth are used to estimate the well location prior to conducting field surveys.

Description of Phase II (Work in Progress)

Developing a comprehensive, Subbasin-wide Well Inventory is a significant effort that is anticipated to be completed by 2026. Phase I, which was strictly a desktop exercise, was initiated in October 2023. Phase II assigned well records to each GSA based on latitude/longitude coordinates and distributed the draft inventory to GSA managers who are responsible for:

- Verifying information in the records.
- Conducting field surveys to validate that each well physically exists.
- Documenting the current Planned Use.
- Providing accurate, validated information for the Kern Subbasin Inventory.

GSAs are actively working through their assigned records and conducting field surveys, which include validating records from the Well Inventory and collecting information for wells without any public record. Each well is assigned a unique identifier in the inventory and records are reconciled approximately every six months.

Description of Phase III

When GSAs complete their record verification and field surveys, a “gap filling” exercise to confirm the Kern Subbasin has identified all wells will be conducted to complete the Well Inventory. Gap filling is largely a GIS effort where all parcels in the Kern Subbasin will be identified with their land use and water source. The following steps are proposed to confirm all wells have been identified:

- Each well in the inventory will be assigned an APN based on latitude and longitude coordinates.
- The APN for each parcel in the Kern Subbasin will be obtained.
- Water system boundary maps will be downloaded from public databases, and GSAs will request a list of parcels (APN) served by each community water system.
- In March 2025, Kern County Public Health shared their records for non-public and state-small water systems, including the APNs supplied by each system.

The APN from each of these datasets will be reconciled to identify parcels without a known water supply. GSAs will verify if there is any current land use, and if there is a current water supply to the parcel. Once this final field survey is completed, the inventory will be maintained through downloading current OSWCR records and well permitting processes.

Well Registry

The final phase of the Kern Subbasin's Well Inventory is converting it into a Well Registry. Once an APN is assigned to each well, GSAs can use their tax roll to identify the property owner of record. The Well Inventory/Registry will be maintained with a minimum of annual updates.

Data Considerations

The February 2025 Well Inventory is believed to be the best available data; however, approximately forty-three percent (3,078 of the Kern Subbasin's 7,195 well records) have not yet been validated. Many of these well records are anticipated to be in the wrong location (i.e., center of the Kern Subbasin or Centroid of Section) or may not exist at all. Additionally, some GSAs have completed their field surveys and found wells that physically exist without any record in a public database. All records are being integrated into the Kern Subbasin's Well Inventory.

Reconciling multiple datasets, including WCRs, public water system wells, and field surveys has resulted in a wide variety of Planned Use categories. For consistency in using the Well Inventory for various types of analysis (i.e. well impacts or monitoring network data gaps), the Planned Use categories are grouped into standardized User Types. Table 5-5 summarizes User Type and Planned Use classification with a definition applicable to this Well Inventory. User Type designations are used throughout the 2025 Plan when referring to well categorization.

- User Type aligns with SGMA user classifications (irrigation, domestic, and industrial are all SGMA categories). Recovery is unique to the Kern Subbasin and Public represents wells owned by public water systems.
- Planned Use is derived from the WCR or field survey. Neither DWR or Kern County Public Health explicitly define "Planned Use" categories and allow users to write-in options using the "other" category.

Table 5-5. Planned Use Definitions

User Type	Planned Use	Definition
Agricultural/Public Irrigation	Irrigation	The well is used exclusively for crop irrigation or other high-use agricultural purpose.
	Stock Watering	The well is used to provide drinking water to stock animals.
	Public Irrigation	Water is used for a public recreation area where the primary water use is irrigation but also provides water for drinking fountains and sanitation.
Recovery	Banked Water Recovery	The well is used to pump stored surface water from the aquifer and return to banking partners when requested.
Domestic	Domestic	Well supplies a single residential parcel.
	Domestic/Irrigation	The well is used for residential as well as crop irrigation or other high-use agricultural purpose.
	State-Small [1]	Well supplies 5-14 connections and an average of <25 people daily for more than 60 days of the year.
	Non-Public	Well supplies 2-4 connections
	Non-Potable	Well supplies a shop or other type of building exclusively for sanitation purposes.
Industrial	Industrial	The well is used for non-potable purposes, typically watering roads for dust control or other high-use industrial purposes
	Public/Industrial	A public water system where the primary water use is high-use industrial or manufacturing but also serves as a public water system with more than 25 people on-site for more than 6 months per year.
Public	Municipal	Community water systems serving 200 or more service connections (or more than 3,300 people), owned by a municipality, Public Utilities Commission regulated purveyor, or publicly owned and regulated by a Board of Directors.
	Public/Commercial	A water system well that typically supplies water for a restaurant, gas station, or other business/public area, primarily for sanitation purposes.
	Public/Prison	A public water system that exclusively serves a prison facility.
Small Community	Public/School	A public water system that exclusively serves a school facility. This planned use is grouped with Small Community based on vulnerability if the well is dewatered.
	Small Community	A water system regulated by the Division of Drinking Water, serving between 5 and 199 service connections (or from 25 to 3,299 people).

[1] The February 2025 Well Inventory did not have necessary information from Kern County to designate state-small wells. Therefore, state-small wells are likely classified under the "Domestic" User Type category and are not listed separately in Table 5-6. As part of Well Inventory Phase III efforts, state-small wells will be separately designated and will be considered as their own User Type category in future GSP updates.

February 2025 Well Inventory

Since the Subbasin-wide Well Inventory is still in development, this 2025 Plan uses the February 2025 version to identify beneficial uses and users. As previously stated, this Inventory is believed to be the best available information but is not yet comprehensive and has several uncertainties (discussed above). Consequently, some well types may be double counted if Table 5-6 (results of February 2025 Well Inventory) and Table 5-8

well count for the Number of Public Water Systems in the Kern Subbasin were combined.

Table 5-6. Summary of Beneficial Users by WCR Planned Use Category

User Type	Well Count	WCR Planned Use Category
Agricultural	4,231	Irrigation, Stock Watering, Public Irrigation
Recovery	137	Banked Water Recovery
Domestic [1]	2,322	Domestic, Domestic/Irrigation, Non-Public, Non-Potable
Industrial [2]	189	Industrial, Public/Industrial
Public [2]	285	Public/Municipal, Public/Commercial, Public/Prison
Small Community [2]	28	Public/School, Public/Small Community
Total	7,192	

[1] The February 2025 Well Inventory did not have necessary information from Kern County to designate state-small wells. Therefore, state-small wells are likely classified under the "Domestic" User Type category and are not listed separately in Table 5-6. As part of Well Inventory Phase III efforts, state-small wells will be separately designated and will be considered as their own User Type category in future GSP updates

[2] The count of "Public" wells presented in Table 5-6 represents the number of wells identified in the Kern Subbasin Well Inventory (February 2025). The GSAs are continuing their efforts to develop a comprehensive Well Inventory which will result in changes in future iterations. An accurate count of Public Supply wells, downloaded from GAMA and reconciled with purveyors and DDW Fresno Branch is provided in Table 5-8.

5.6.2 Well Density per Square Mile

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

As discussed in Section 5.6.1, the Kern Subbasin Well Inventory was conducted to meet the requirements of SGMA and to better understand the location and type of beneficial users in the Kern Subbasin. Figure 5-12 shows the density of wells per square mile based on the February 2025 Well Inventory. Table 5-7 shows the distribution of wells by GSA. Figure 5-15 through Figure 5-18 show the distribution of public supply (based on DDW records) and domestic wells (Well Inventory).

Table 5-7. Summary of Beneficial Users and Land Uses by GSA

GSA	Agricultural	Recovery	Domestic	Industrial	Public[1]	Small Cmnty[1]	Total
Arvin	424	-	139	18	9	1	591
Buena Vista	241	-	60	4	6	-	311
Cawelo	182	-	32	18	5	-	237
Greenfield County	7	-	23	-	6	-	36
Henry Miller [2]	28	-	6	-	-	-	34
Kern Non-Districted Lands	98	-	173	16	4	4	295
Kern River	977	20	1,093	77	185	13	2,365
Kern Water Bank [3]	13	96	1	-	1	-	111
Kern-Tulare	71	-	6	-	-	-	77
North Kern	184	-	16	2	1	-	203
Olcese	3	-	1	-	-	1	5
Pioneer	8	8	0	1	-	-	17
Rosedale-Rio Bravo	390	12	360	11	15	5	793
Semitropic	882	-	159	7	4	1	1,053
Shafter-Wasco	244	-	89	4	15	1	353
Southern San Joaquin	296	-	142	9	24	2	473
Tejon-Castac	0	-	0	2	-	-	2
West Kern	4	1	3	4	10	-	22
Westside District Water Authority	72	-	8	11	-	-	91
Wheeler Ridge-Maricopa	107	-	11	5	-	-	123
Total	**4,231**	**137**	**2,322**	**189**	**285**	**28**	**7,192**

[1] The count of wells from the Kern Subbasin Well Inventory (February 2025) does not accurately represent the number of Public and Small Community Wells. Refer to Table 5-8 for an accurate count of public wells.

[2] Domestic wells in some GSAs are non-potable (sanitation only).

[3] The public supply well in Kern Water Bank has an incorrect location in the Well Inventory (February 2025) and is actually well "City of Bakersfield Olcese #3". This well location will be reconciled prior to progressing to Phase III.

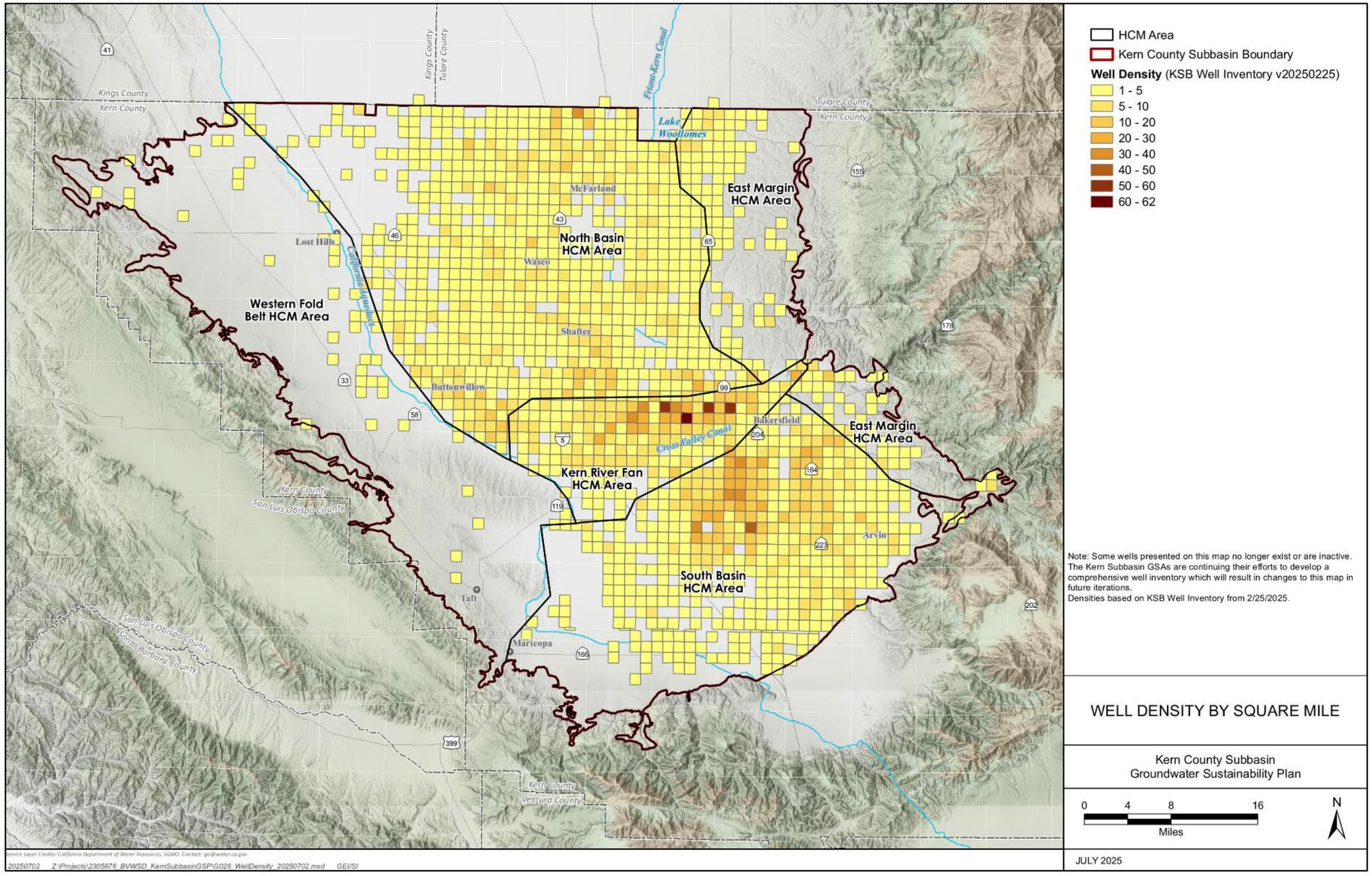


Figure 5-12. Well Density Per Square Mile

5.6.3 Overview of Public Water Systems

As described in Section 5.6.1, the Kern Subbasin's Well Inventory includes efforts to identify all public water systems with the location and status of their wells. This process used records from the water purveyors, Open Data Portal, State Drinking Water Information System Database (SDWIS), Kern County Public Health, and communications with DDW Fresno Branch staff. 500 public supply wells were identified to supply 130 state regulated water systems in the Kern Subbasin. Table 5-8 summarizes water systems with their classification.

Public water systems are by law characterized as supplying water for human consumption through pipes or other constructed conveyances that have 15 or more service connections or regularly serve at least 25 people daily at least 60 days out of the year. For the purposes of this 2025 Plan, additional classifications are used to differentiate water systems based on size (service connections or population served) and to align with the beneficial User Type and Planned Use categories, as defined in Table 5-5. These additional classifications are defined as follows.

- **Public** means a water system that serves 200 or more service connections (or more than 3,300 people), owned by a municipality, PUC regulated purveyor, or publicly owned and regulated by a Board of Directors.
- **Small Community** means a water system that serves between 5 and 199 service connections (or from 25 to 3,299 people).
- **Public/Commercial** means systems that are regulated as a public water system because they regularly serve at least 25 of the same people over six months per year. Truck stops, restaurants, churches, or recreational facilities who are typically de minimis users, are examples applied to this classification.
- **Public/Industrial** are public water systems where the primary water use is industrial or manufacturing. These facilities are typically located in rural, unincorporated communities where Public water systems are not present. These are typically high-consumption water users. Common examples are manufacturing, washing/cold storage, and food processing.

Table 5-8. Number of DDW regulated water systems in the Kern Subbasin

Classification	# of Systems	# of Wells [1]
Community	20	350
Small Community	44	65
Public/Commercial	19	20
Public/Industrial	47	65
Subtotal	**130**	**500**

[1] Only 385 Wells are Active; 16 are Standby and 98 are Inactive.

Source of Data: GAMA reconciled with Division of Drinking Water staff, February 2024.

5.6.4 Municipalities and Urban Water Purveyors

Community water systems include municipalities as well as purveyors serving unincorporated areas that are regulated by a local Board of Directors or the Public Utilities Commission (PUC). Figure 5-14 shows Community water system boundaries or well location for the small community water systems. Not all water systems are represented in this figure because SDWIS generally does not include system boundaries for Noncommunity water systems. Figure 5-14 through Figure 5-17**,** which show water system boundaries or well locations, provide a more accurate representation of all water systems in the Kern Subbasin. Most community water systems are groundwater dependent. However, some of the systems within the metropolitan Bakersfield area rely on surface water supplies. Kern County Water Agency Improvement District No. 4 (ID4) is a wholesale supplier to its member units (California Water Service, City of Bakersfield, Oildale Mutual Water Co., and East Niles Community Services District). Additionally, California Water Service and the City of Bakersfield own and operate facilities to treat Kern River water which supplies their distribution systems in metropolitan Bakersfield. Average percentage of groundwater (dark blue shade) and surface water (light blue shade) are shown on Figure 5-13 and discussed in the following sections.

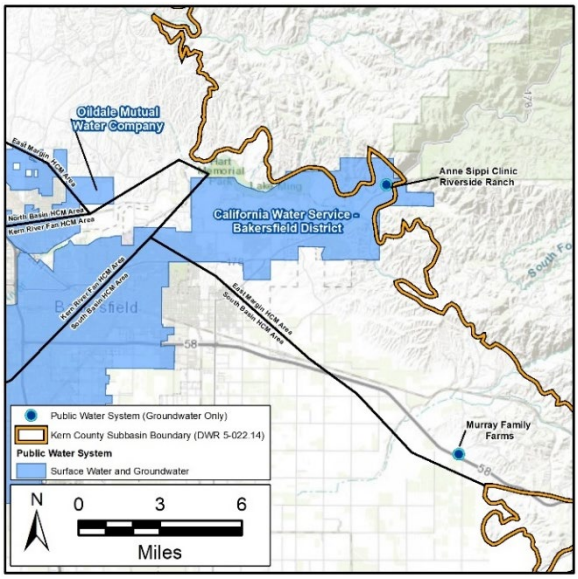
Drinking Water Supplies in the Western Fold Belt HCM Area



While Figure 5-13 shows water systems in the Western Fold Belt HCM Area, only one Industrial Community water system relies on underlying groundwater. In the northern HCM Area, along Highway 46, water is supplied by groundwater imported from the North Basin HCM Area due to poor water quality underlying the community of Lost Hills (Western Fold Belt). Lost Hills Utility District has a groundwater extraction agreement with the Semitropic Water Storage District (North Basin HCM Area). Additionally, the Interstate 5 Utility Company (located at the border of the North Basin and Western Fold Belt HCM Area) is a wholesale supplier to Clean Harbors Buttonwillow and Aera Energy LLC facilities (both Industrial Community systems) that are in the Western Fold Belt HCM Area.

The southern half of the Western Fold Belt HCM Area is within the West Kern Water District service area. Water supplied to the communities of Derby Acres, Dustin Acres, Fellows, Maricopa, McKittrick, Taft, Tupman, and Valley Acres are supplied by groundwater extracted entirely from the Kern River Fan HCM Area.

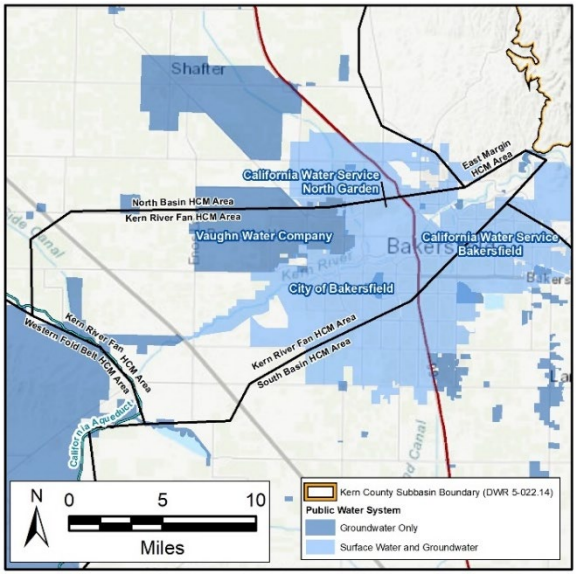
Drinking Water Supplies in the East Margin HCM Area



There are no public water systems relying on groundwater in the northern portion of the East Margin HCM Area. Oildale Mutual Water Company's service area extends into the East Margin HCM Area, but this system is supplied by 91 percent surface water purchased from ID4. Figure 5-13 shows a few small community water systems in the Kern River Fan HCM Area, which divides the northern and southern East Margin HCM Areas. These are groundwater dependent communities.

The large water systems extending into southern East Margin HCM Area is owned and operated by California Water Service, this area is entirely supplied by surface water from its northeast treatment plant. There are two groundwater dependent water systems in the southern East Margin HCM Area: the Anne Sippi Clinic Riverside Ranch is a groundwater dependent small community system within the California Water Service area; Murray Family Farms is a Transient Noncommunity water system in the southern East Margin HCM Area that relies on groundwater to supply drinking water to its storefront.

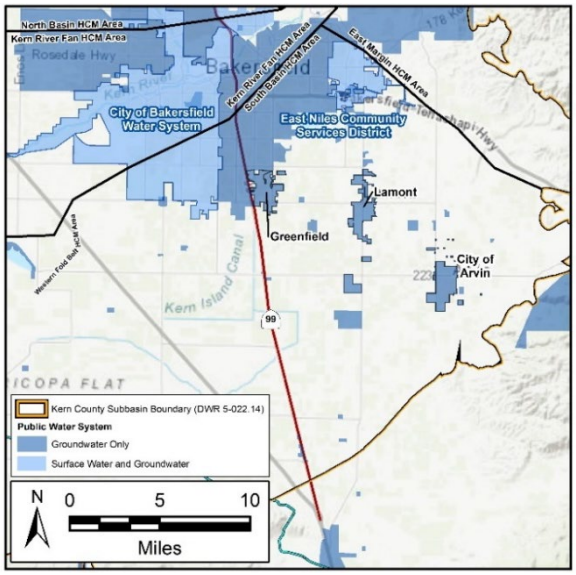
Drinking Water Supplies in the Kern River Fan HCM Area



The highest quality of groundwater is within the Kern River Fan HCM Area, which supplies most of metropolitan Bakersfield. Purveyors in this area are California Water Service, City of Bakersfield, and Vaughn Water Company. On average, the service area east of Highway 99 is fully supplied by surface water. California Water Service uses an average of 48 percent surface water and 52 percent groundwater, which is supplied to their service area east of Highway 99 in the South Basin HCM Area. West of Highway 99 is the City of Bakersfield water systems, which is predominately supplied by surface water north of Rosedale Highway and groundwater dependent south of Rosedale Highway. On average, the City of Bakersfield is supplied by 18 percent surface water and 82 percent groundwater.

Vaughn Water Company and the small community water systems interspersed within the California Water Service and City of Bakersfield service areas are groundwater dependent. In the western extent of the Kern River Fan HCM Area, there are several small rural community water systems that are also groundwater dependent.

Drinking Water Supplies in the South Basin HCM Area



The South Basin HCM Area is almost completely groundwater dependent. The only exception is a portion of California Water Service that is supplied by surface water from its northeast treatment plant and ID4. East Niles Community Services District, which is adjacent to California Water Service's system, is supplied by 38 percent of surface water purchased from ID4 and 62 percent groundwater.

The City of Bakersfield water system (west of Highway 99) that extends into the South Basin HCM Area is groundwater dependent. The City of Arvin and unincorporated communities of Lamont and Greenfield are also groundwater dependent. There are also several small rural communities spread throughout the South Basin HCM Area.

Drinking Water Supplies in the North Basin HCM Area



The North Basin HCM Area is also primarily groundwater dependent. The exception is California Water Services North Garden system that is supplied by 82 percent surface water from its northwest treatment plant and ID4, and 18 percent groundwater. Oildale Mutual Water Company is predominantly supplied by surface water (91 percent) from ID4 with only 9 percent groundwater supply.

The cities of Shafter, Wasco, McFarland, and Delano are all completely groundwater dependent. There are several rural, small communities and Industrial Community water systems throughout the North Basin HCM Area.

5.6.5 Disadvantaged Community Water Systems

Disadvantaged Community (DAC) is a reference to the financial status of a geographic area where the median household incomes are less than 80 percent of the statewide average. Section 5.3.3 identifies disadvantages communities based on township level data from DWRs 2020 census places, which indicates that the majority of the Kern Subbasin, as shown in Figure 5-8 is within the disadvantaged income threshold.

Figure 5-13 shows orange hash marks to represent water systems that are likely to meet disadvantaged community status based on block group level data from DWRs 2020 census places. Using non-continuous block group data provides a more accurate representation of the communities that are likely within the disadvantaged community income threshold. Based on block group data overlying community water systems:

- Most small community water systems in the Kern Subbasin are outside of the disadvantaged community block groups.
- Community water systems meeting the disadvantaged community income threshold are the municipal and unincorporated community areas or are within the California Water Service and Oildale Mutual Water Company service areas.

5.6.6 Non-Public Water Systems and Domestic Wells

Kern County Public Health regulates Non-Public water systems, which are typically a shared well system that serves two to four residences or can be a business that serves and average of 25 people or less for 60 or less days per year. Wells that serve less than 2 connections are considered to be domestic wells, which are not regulated by the County. The February 2025 Well Inventory identifies these domestic wells and Non-Public water system wells based on Planned Use category on the WCR or Kern County Public Health well inventory dataset (obtain October 2023). User Type classification is Domestic for both Planned Use categories .

In March 2025, Kern County Public Health shared their records for Non-Public water systems, which includes well location, parcels served, and general information on the condition of the well site, which will be incorporated into the Well Inventory dataset at a future time. Table 5-9 identifies the number of domestic and Non-Public water systems included in the February 2025 Well Inventory, combined, by HCM Area.

Table 5-9. Number of Domestic Wells by HCM Area

HCM Area	# of Wells
Western Fold Belt	5
North Basin	638
Kern River Fan	599
South Basin	943
East Margin	137
Subtotal	**2,322**

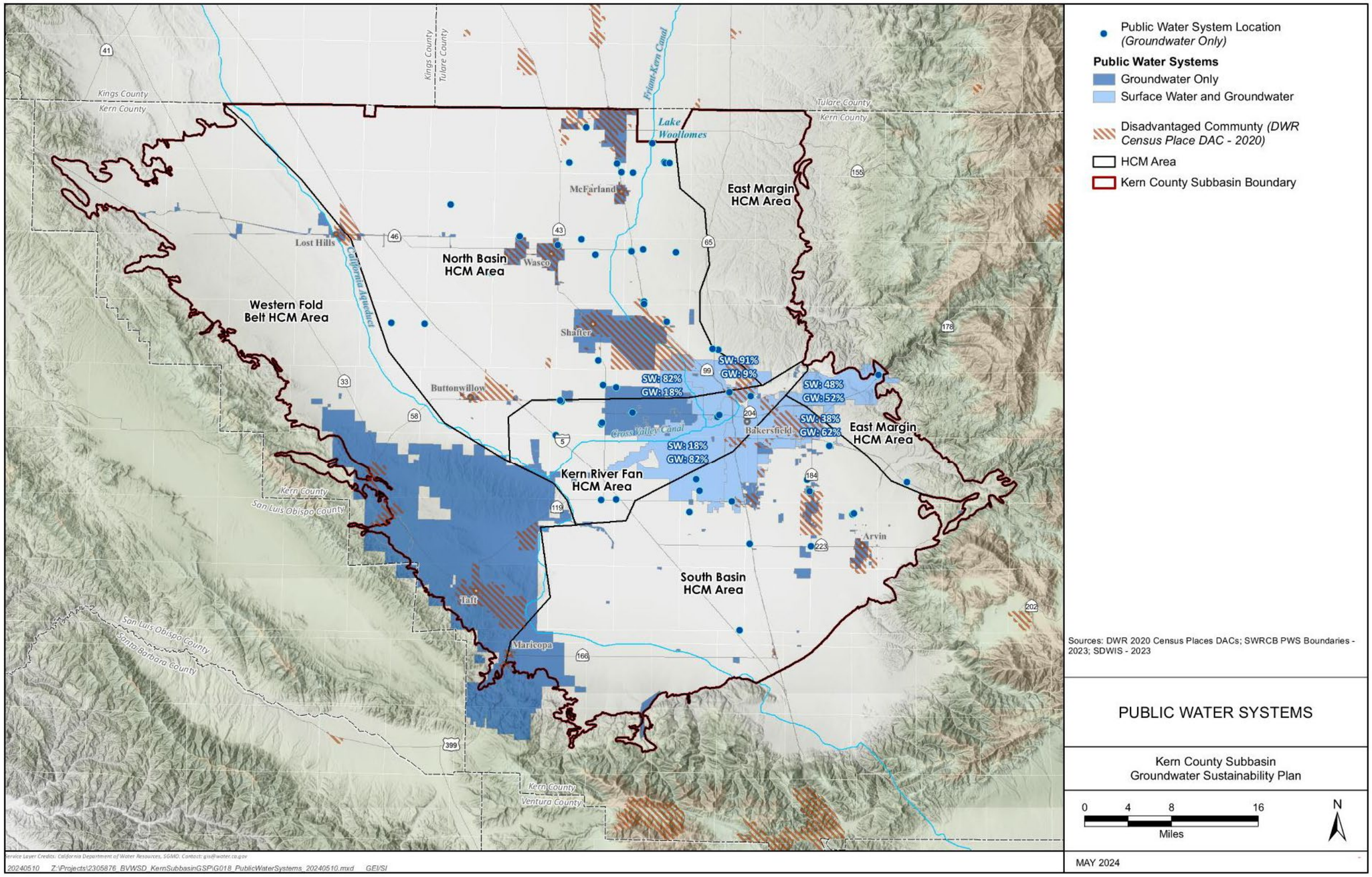


Figure 5-13. Public Water Systems

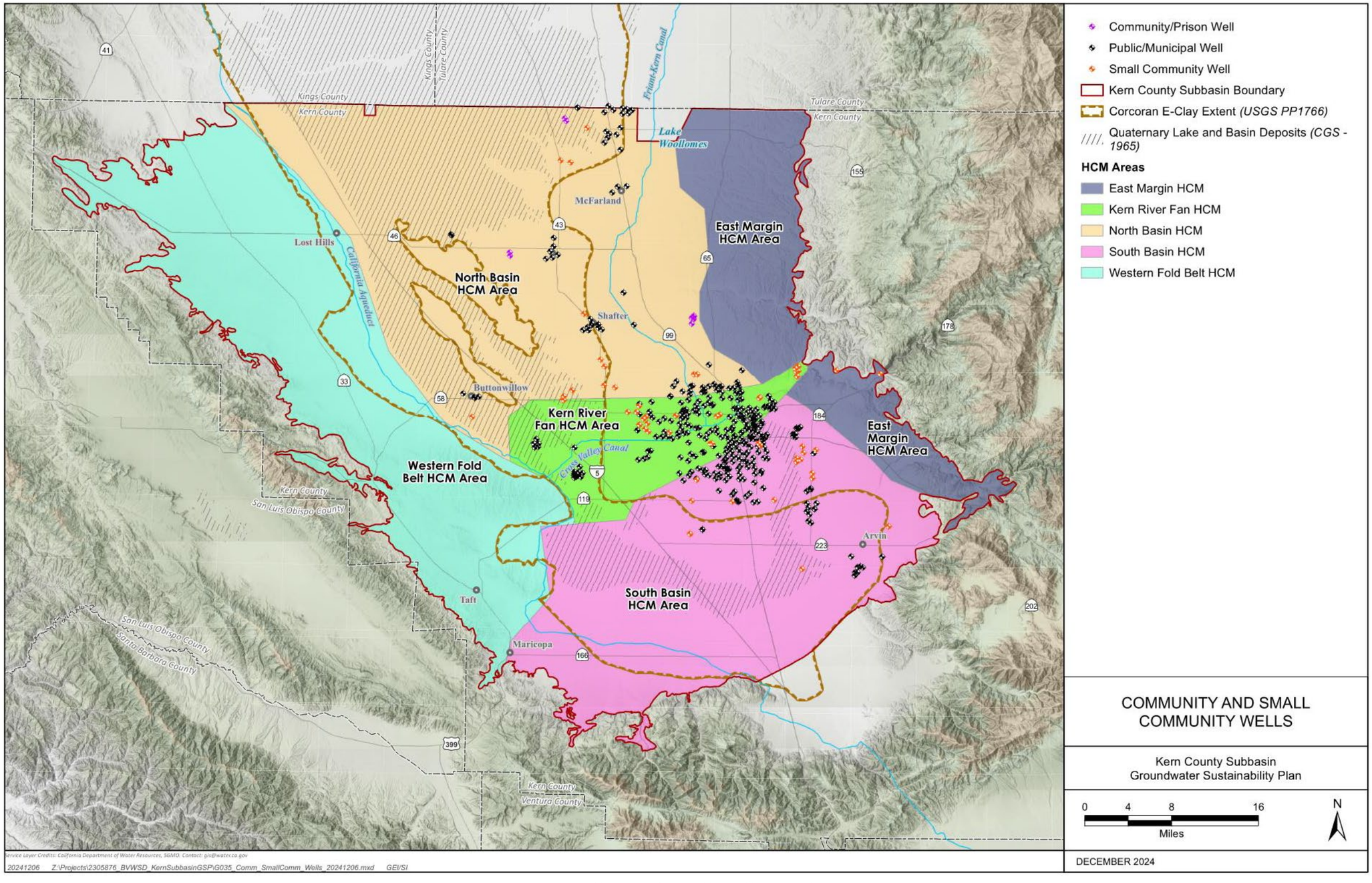


Figure 5-14. Community and Small Community Wells

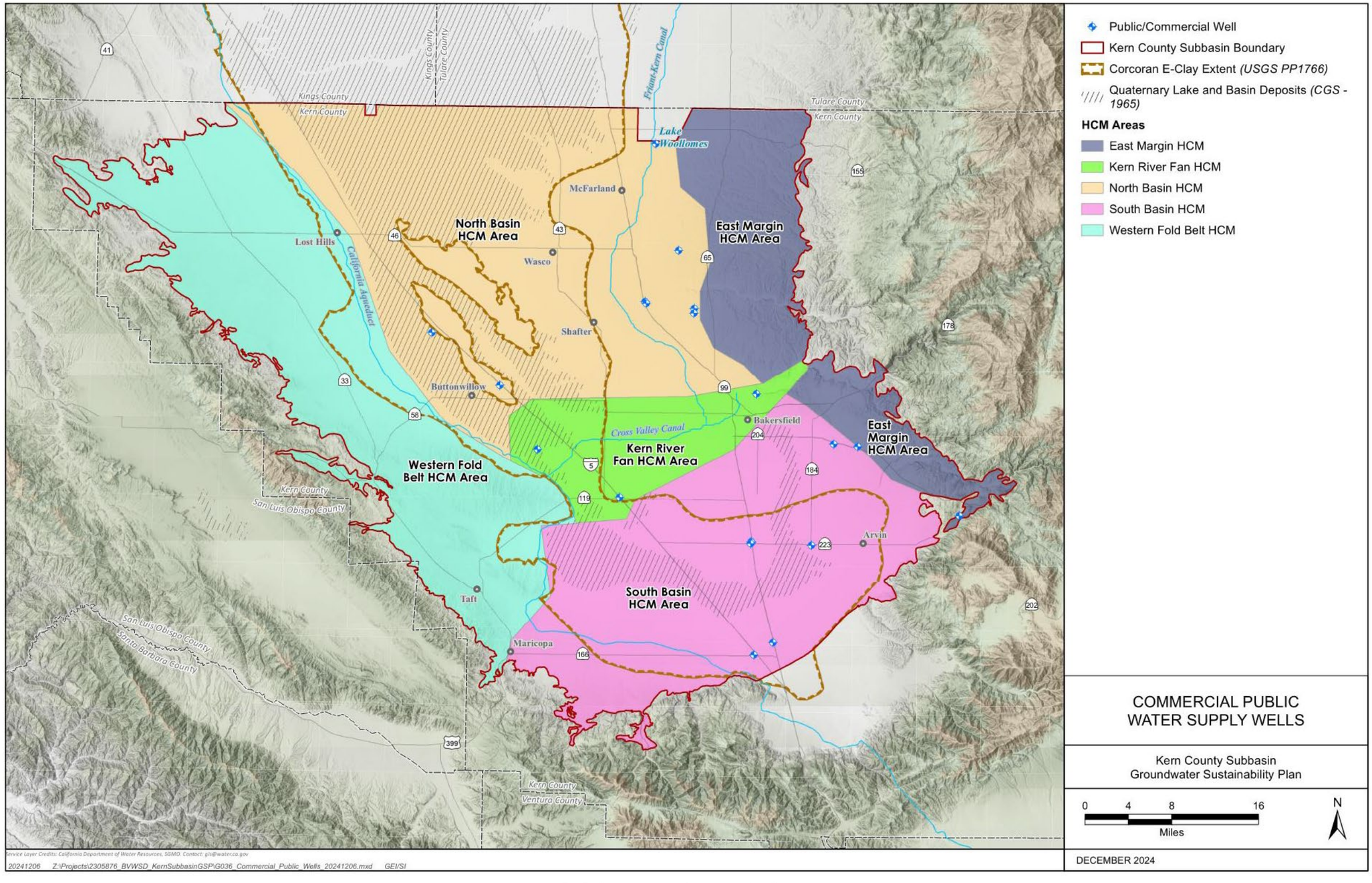


Figure 5-15. Commercial Public Water Supply Wells

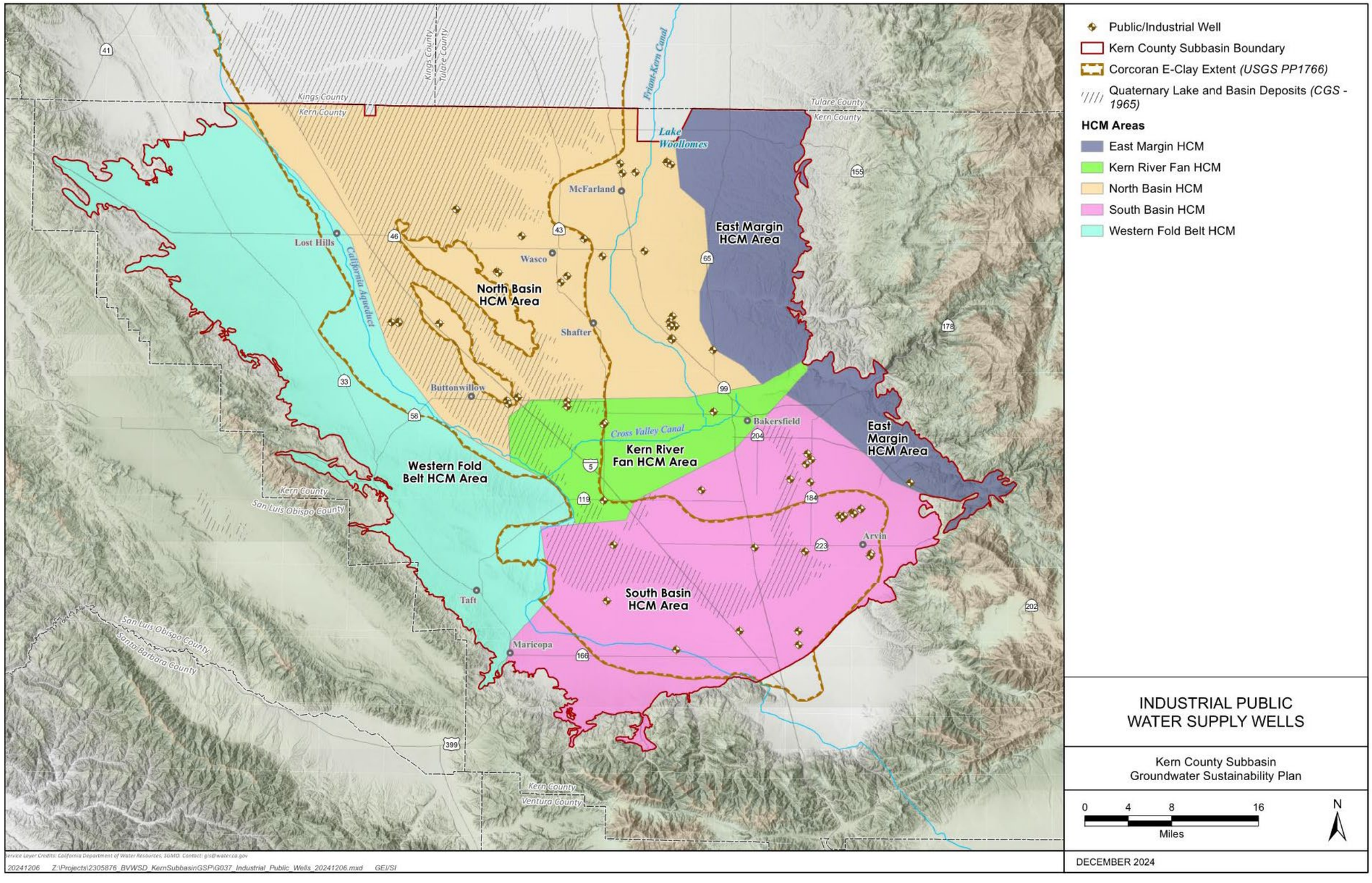


Figure 5-16. Industrial Public Supply Wells

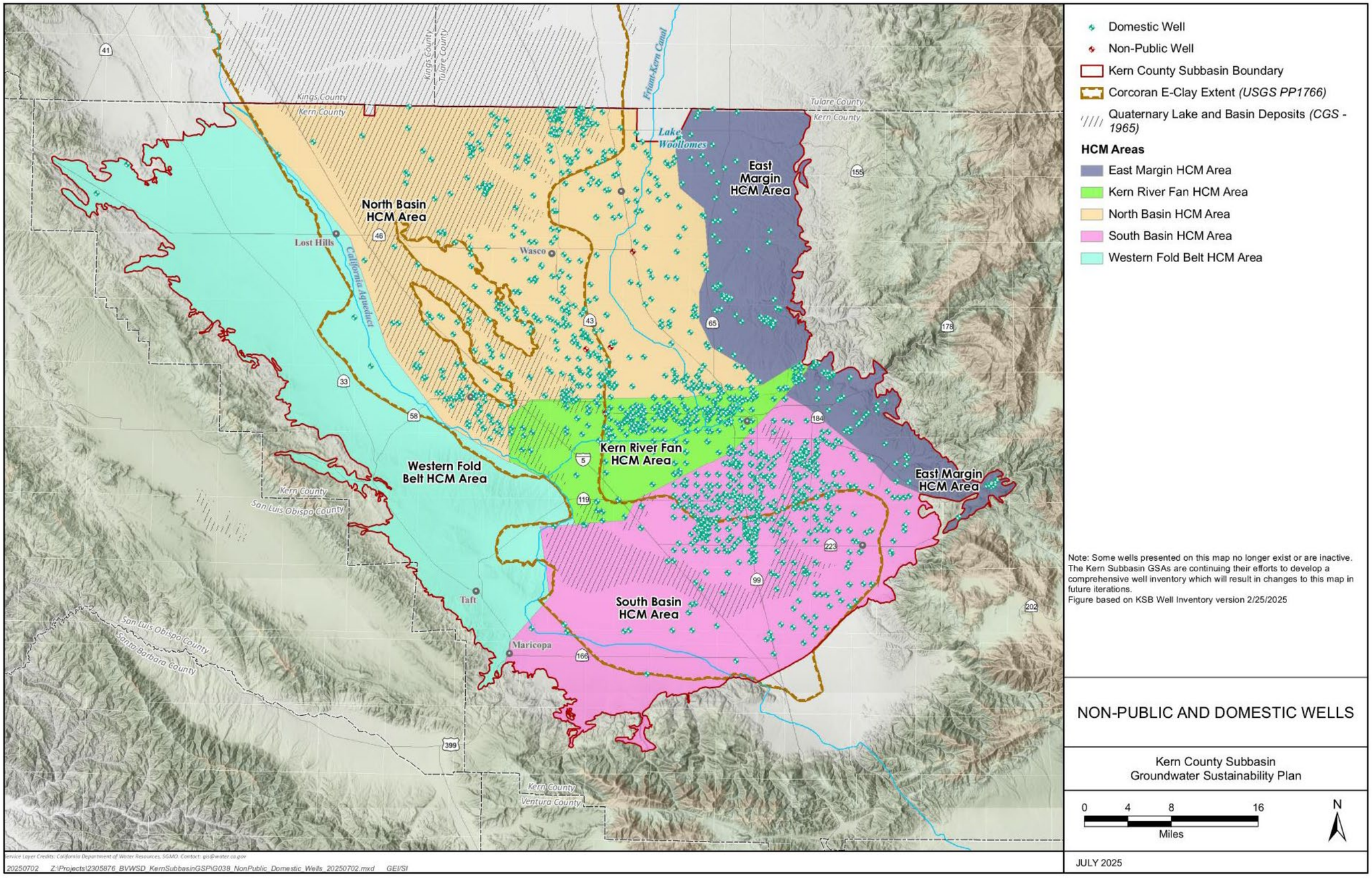


Figure 5-17. Non-Public and Domestic Wells

5.7 Existing Monitoring and Management Programs

☑ 23 CCR § 354.8(c)

There is a long history of water resources monitoring and management programs in the Kern Subbasin. Such programs are conducted by local water agencies and public water suppliers at regional and local levels, ranging from participation in State programs (e.g., CASGEM) and regional plans (e.g., Integrated Regional Water Management Plan) to individual water system monitoring by local water suppliers. Details of the various programs are provided in the subsequent sections; Table 5-10 summarizes the programs, their goals, and data collected.

5.7.1 Water Resources Monitoring

Water resource monitoring programs considered in the 2025 Plan address:

- Climate
- Groundwater levels and pumping
- Imported water deliveries
- Surface water flows and deliveries
- Water banking
- Wastewater discharge and recycled water delivery
- Land use and cropping
- Water quality
- Land subsidence
- Consumptive use

Multiple agencies are involved in water resources monitoring, with data shared through several key annual reports. KCWA has assumed a major role in the collection of data on groundwater and surface water supplies and water quality in the Kern Subbasin. Other key and regularly published documents are the Kern River Hydrographic Annual Reports produced by the City of Bakersfield, the Report on Water Conditions prepared by ID4, the Kern Fan Area Operations and Monitoring Report produced by the Kern Fan Monitoring Committee (KFMC), and the monitoring reports published by the Semitropic Water Storage District Water Banking Project Monitoring Committee.

Local agencies also monitor drinking water supplies in compliance with a variety of SWRCB monitoring programs. In addition, water districts have reported surface water and groundwater conditions in respective groundwater management plans and have documented monitoring objectives, methods, protocols, locations, and data management practices. The monitoring and reporting programs of these and other Kern

Subbasin organizations (summarized in Section 6) are being considered for incorporation into the SGMA monitoring networks.

5.7.2 Climate

Long-term climate data are available from key weather stations (University of California Agriculture and Natural Resources, 2023) including the National Weather Service Bakersfield Airport station and the weather station at the Kern County Fire Department near Wasco. Both have precipitation and temperature records from 1951 to present.

The California Irrigation Management Information System (CIMIS) was developed by DWR to collect climate data relevant to agricultural operations. Several stations are active in the Kern Subbasin including the CIMIS Shafter Station #5 located at a former USDA Cotton Research facility on Shafter Avenue. The station's record began June 1, 1982, with a one-year gap in 2012-2013 and is currently active. The Arvin-Edison Station #125 also is active with data available from March 22, 1995. Other stations are currently inactive (for example, CIMIS #31 – McFarland/Kern Farms and CIMIS #13 - Famoso near McFarland) but provide historical data. Information on CIMIS stations and CIMIS data are available online (CIMIS, 2018).

5.7.3 Groundwater Levels and Pumping

Groundwater levels have been recorded in the Kern Subbasin outside of formal monitoring programs since at least the 1920s, but data before the 1950s and 1960s are sparse. Water levels are currently monitored by each of the GSAs. Water levels observed at approximately 185 Representative Monitoring Wells (RMWs) distributed throughout the Kern Subbasin are managed using a Data Management System (DMS). These wells are part of the monitoring network described in Section 15, and groundwater levels recorded at these wells are reported to the SGMA portal.

Data on groundwater pumping is collected by some GSAs and is reported for urban pumpers at five-year intervals in UWMPs and in AWMPs. Groundwater extractions are reported to ID4 within its service area on a semi-annual basis. This program includes multiple municipal wellfields and accounts for a significant percentage of the active wells in the Kern River Fan HCM Area. Wells within ID4 are registered and the number of wells and well uses (commercial, domestic, irrigation, purveyor) are tabulated in the ID4 Report on Water Conditions (e.g., KCWA, 2019). Extractions are reported based on well meters, where available, or other estimates including electrical records or land use.

Since 2009, the California Statewide Groundwater Elevation Monitoring (CASGEM) Program, as developed and coordinated by the DWR, has tracked seasonal and long-term groundwater elevation trends in groundwater basins statewide in collaboration with local monitoring entities. This program has served as a tool to monitor groundwater to help achieve the goals set out under SGMA. There are close to 3,300 monitoring wells within the Kern Subbasin stored in the CASGEM database, with data from as far back

as the 1920's. Over 750 of these wells are considered active and have data reported since 2015; of these, a little less than 100 wells are designated as observation wells.

5.7.4 Land Use and Cropping

Irrigated agriculture represents the largest water use within the Kern Subbasin. Currently, agricultural water demands are determined based on evapotranspiration (ET). The Kern Subbasin has partnered with Land IQ to determine ET for all areas of the Kern Subbasin with a focus on irrigated agriculture. Several GSA's are verifying ET values from their well readings. This provides a consistent basin-wide methodology for calculating ET based on local climatic and cropping data. In WY 2023, the Kern Subbasin GSAs received the first round of data and plan to incorporate the results in the Annual Report.

5.7.5 Water Quality

Water quality monitoring and reporting programs are administered by various agencies from the federal and state level to regional and local levels, including monitoring by member agencies. Major programs and sources of data are summarized below; all contribute to water quality monitoring and management activities being implemented in parallel with SGMA. Appendix K-2 (Part II) discusses the coordination between the Kern Subbasin GSAs and the various groundwater quality monitoring, reporting, and management programs. Appendix C-5 and Appendix C-6 discuss the direct coordination between Kern Subbasin GSAs and the Kern Water Collaborative pertaining to nitrate testing during GSP implementation.

State-Wide Groundwater Quality Monitoring

State-wide sources of groundwater quality data include the DWR's Water Data Library (WDL), SWRCB's GAMA program (in cooperation with USGS), SWRCB's GeoTracker data system and the SDWIS of the SWRCB Division of Drinking Water. Water quality data contained in these databases are collected from a variety of well types including irrigation, stock, domestic, and some public supply wells.

State and County Public Water Supply Monitoring

In accordance with the California Health and Safety Code, public water systems regularly monitor water quality and prepare Annual Consumer Confidence Reports. The public water systems are required to routinely test for Title 22 regulated constituents. Water quality data for public water systems are available through the GAMA online tool and SDWIS. Kern County Public Health administers the Small Water System Program that includes permitting and monitoring of non-public water systems (two to four connections) and relinquished regulatory authority to DDW for the state-small public water systems (5 to 14 connections serving an average of 25 or more people for more than 60-days per year). Data for non-public water systems is available through a public

records request and was shared with the Kern Subbasin for accurate tracking in the Well Inventory.

Irrigated Lands Regulatory Program (ILRP)

The Central Valley Regional Water Quality Control Board (Central Valley Water Board) regulates the discharge of waste from irrigated lands to surface and groundwaters located throughout the Central Valley, including within the Kern Subbasin. This program, referred to as the Irrigated Lands Regulatory Program (ILRP), focuses on priority water quality issues, such as pesticides and toxicity, nutrients, and sediments. Within the Kern Subbasin, the ILRP is administered by several coalitions that work directly with growers to ensure compliance with ILRP requirements, which includes required reporting with respect to the amount of nitrate being applied to croplands from all sources and implementation of best management practices to protect groundwater quality from overapplication of nitrates. These Coalitions in the Kern Subbasin include the Kern River Watershed Coalition Authority (KRWCA), Cawelo Water District Coalition (CWDC), the Buena Vista Coalition (BVC), and Westside Water Quality Coalition. Certain water quality data collected and reported as a part of ILRP are provided to the Central Valley Water Board and are available in the GeoTracker database for download and use. For example, as part of the ILRP, growers are required to test domestic wells located on agricultural parcels for nitrate, and the results of such tests are loaded into GeoTracker.

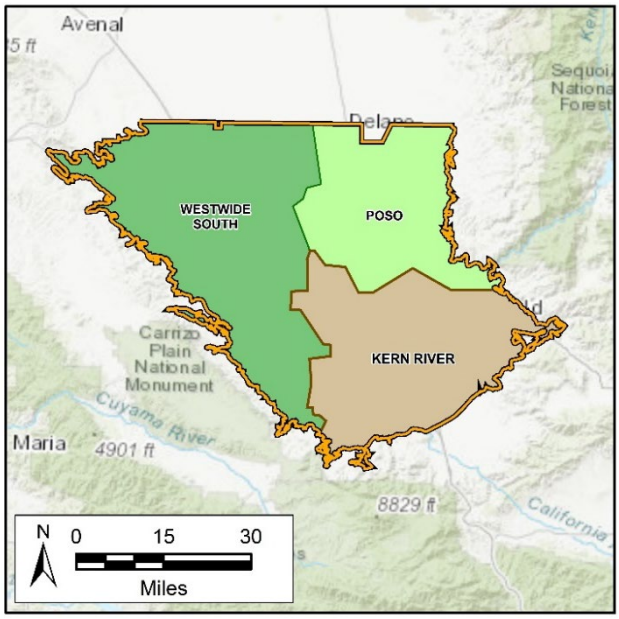
Central Valley-Salinity Alternatives for Long-Term Sustainability (CV-SALTS)

CV-SALTS is a stakeholder-led initiative established to address nitrate accumulation in the Central Valley's groundwater supplies and salt accumulation in the Central Valley's surface and groundwaters. Through CV-SALTS, the Central Valley Water Board adopted the Central Valley-Wide Salt and Nitrate Control Program into Water Quality Control Plans for the Sacramento River and San Joaquin River Basins and the Tulare Lake Basin. The Kern Subbasin is subject to the program's provisions as incorporated into the Water Quality Control Plan for the Tulare Lake Basin, which includes two distinct programs: The Nitrate Program and the Salt Control Program. The over-arching management goals and priorities for these programs are to:

- Ensure safe drinking water supply.
- Reduce salt and nitrate loading so that ongoing discharges neither threaten to degrade or high quality waters absent appropriate findings by the Central Valley Water Board nor cause or contribute to exceedances of water quality objectives.
- Implement long-term, managed restoration of impaired water bodies.[3]

[3] Central Valley Water Board, Resolution R5-2020-0057, Revisions to the Amendments to the Water Quality Control Plans for the Sacramento River and San Joaquin River Basins and the Tulare Lake Basin to Incorporate a Central Valley-Wide Salt and Nitrate Control Program.)

Nitrate Control Program



Permittees with nitrate discharges may elect to comply with the requirements of the Nitrate Control Program through participation in Management Zones, a discrete and generally hydrologically contiguous area where dischargers work collectively to meet the goals of the program. This effort requires implementation of an Early Action Plan (EAP) that includes a residential well monitoring program that identifies and mitigates domestic wells with nitrate levels greater than 10 parts per million (ppm).

Central Valley groundwater subbasins, including portions of the Kern Subbasin, are prioritized for implementation under the Nitrate Control Program. The Kern Subbasin has three delineated zones (see figure above). The Poso zone, which spans the East Margin and approximately one-half of the North Basin HCM Areas, and Westside South zone, which spans the North Basin and Western Fold Belt HCM Areas, are Priority 2 areas under the Nitrate Control Program. All dischargers of nitrate within these Priority 2 basins received Notices to Comply with the Nitrate Control Program in December of 2023. The Kern River zone spans a small portion of the North Basin, all of the Kern River Fan, and the South Basin HCM Areas. This zone is not currently prioritized for Nitrate Control Program implementation.

The Kern Water Collaborative was formed to assist dischargers in meeting the requirements of the Nitrate Control Program in the Kern Subbasin. On February 24, 2025, the Kern Water Collaborative received approval from the Central Valley Water Board to begin implementation of their EAP for Priority 2 basins within the Kern Subbasin. Appendix C-5 includes a Memorandum of Understanding (also refer to Section 14 Management Action KSB-2) that explains the Kern Subbasin's intent to coordinate with the Kern Water Collaborative to avoid duplication of efforts between the SGMA and Nitrate Control Program Implementation. Appendix C-6 clarifies the expansion of the Kern Water Collaborative's Nitrate Control Program within the Kern Subbasin, which provides nitrate well testing and alternative drinking water program to include domestic well users throughout the entirety of the Kern Subbasin as delineated in Bulletin 118.The GSAs and Kern Water Collaborative have mutual interest in assessing groundwater monitoring and data and supporting residents who rely on domestic wells with access to safe water for consumption.

Salt Control Program

The Salt Control Program is a multi-phased effort to address the long-term problem of salt accumulation in the Central Valley. The program's approach is intended to protect beneficial uses by maintaining water quality that meets applicable objectives, allows salt accumulation in areas where salt can be stored without impairing beneficial uses of water, and through long-term management, restore water quality where reasonable, feasible, and practicable.

The Central Valley Salinity Coalition and its Consultant Technical Team are currently implementing the Salt Control Program's Prioritization & Optimization (P&O) Study: an estimated 10-year planning process to identify long-term solutions that will protect beneficial uses, improve salt management, and restore water quality where possible. One current activity in the P&O Study is reviewing all Central Valley GSPs to collect data on water budgets, water uses, and P/MAs. This data will help validate model inputs and inform the P&O Study analyses of future salt conditions, given implementation of potential salt management alternatives.

Local Monitoring Committees

The Kern Fan and Semitropic Monitoring Committees evaluate groundwater conditions (levels and quality) in and around banking projects. The Kern Fan Monitoring Committee evaluates the Kern Water Bank and other Kern Fan Banking projects in the Kern River Fan HCM Area. Semitropic Monitoring Committee evaluates groundwater conditions around banking projects in the North Basin HCM Area.

These monitoring committees operate under an MOU amongst participants in local water banking projects and adjoining entities. Responsibilities include collecting data from participants and adjoining entities and reporting that data in a written report that is distributed to all participants, stakeholders, and interested parties.

Reports have been published every three to five years and include annual data for groundwater levels and annual and limited semi-annual data for groundwater quality. Monitoring reports are available beginning with data from 1991 and continuing to the present. Published data include deliveries for storage, recovery pumping, groundwater levels (presented as hydrographs and maps of groundwater elevations and depth to groundwater), and results of groundwater and surface water quality sampling.

Table 5-10. Existing Groundwater Quality Monitoring Programs

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
AB-3030 and SB-1938	• Water levels are typically monitored annually. • An Ag Suitability analysis (limited suite of general minerals) monitoring frequency between annual to once every 3-years.	• Semiannual to Annual	• Procedures for an existing local agency to develop a groundwater management plan.	• Monitoring is recommended as a part of groundwater management planning. Data availability is inconsistent between Districts.
ILRP	• annually: static water level, temperature, pH, electrical conductivity, nitrate as nitrogen, and dissolved oxygen. Once every five years, general minerals will be collected.	• Annual • Every 5-years	• Monitor impacts of agricultural discharges on first encountered groundwater	• Sampling began in Fall 2018 with a limited number of wells sampled, in the Kern Subbasin, 59 wells are sampled by KRWCA, 13 by Buena Vista, 15 by Cawelo, and 9 by Westside Water Quality Coalition. The program will be expanded and may incorporate a shared sampling program with SGMA.
CV-SALTS	• Sampling parameters required through individual WDR's: typically include monthly sodium, chloride, electrical conductivity, nitrogen species (N, NO_2, NO_3, NH_3), pH and other constituents of concern identified in the Report of Waste Discharge. A limited suite of general minerals is required quarterly from the source and annual from the wastewater.	• Most constituents sampled monthly, quarterly general minerals from source water and annual general minerals from waste discharge. • A portion of KCS is a Priority 2 Basin, meaning that management strategies will be initiated in 2025.	• To evaluate degradation potential from wastewaters discharged to land application areas and identify projects to aid with salt and nitrate management in the Central Valley.	• CV-SALTS studies rely on existing water quality monitoring programs. While no new monitoring is expected under these programs, it may influence new or changed requirements as determined by the Regional Board and implemented through permit modifications.

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
SDWIS	• Database for all public water system wells and historical sample results. Data available includes all Title 22 regulated constituents.	• Title 22 General Minerals and Metals every 3-years; • Nitrate as N annually, if ≥ 5 ppm, sampled quarterly; Volatile and Synthetic organics (VOCs and SOCs) are sampled every 3-years; Uranium sampling depends on historical results but varies between 1 sample every 3 (when ≥ 10 pCi/L), 6 (when < 10 pCi/L) or 9 (when no historical detection) years.	• Demonstrate compliance with Drinking Water Standards through monitoring and reporting water quality data.	• An abundant source of data because of the required testing frequency and list of parameters.
CalGEM (formerly Division of Oil, Gas, and Geothermal Resources (DOGGR) Underground Injection Control (UIC) Program	• Older UIC permits required analysis of Primary and Secondary Title 22 Constituents. Newer UIC permits require full Title 22 testing.	• Annually	• Monitor the quality of water injected for the purposes of disposal or enhanced oil recovery, via the state's injection control program.	• While injected volumes are reported on a monthly basis for each injection site, and total volumes of produced water are reported quarterly (via DOGGR's SB 1281 program), the injectate is only analyzed on an annual basis with samples taken at the storage tanks for either produced water or treated feedwater for Enhanced Oil Recovery (EOR) activities. Unless specified by additional reporting, the water samples are **NOT** at discrete well locations.

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
CalGEM (formerly DOGGR) SB-4	• Title 22 constituents before and after the well stimulation event and disclosure of the composition of the fluid to be used in the well stimulation	• Reported Quarterly, but sampling occurs as needed before and after a well stimulation	• Develop groundwater monitoring criteria related to Oil and Gas Well Stimulation and implement a groundwater monitoring program.	• Baseline fluid testing is done of both the well-stim fluid and at the monitoring wells identified in an operator's well stimulation plan. Neighboring property owners may also request that the operator perform baseline testing and post-well stimulation testing at the wells on their property.
Geotracker WDR for Oil fields	• Oil & Grease, Total Hydrocarbons, TDS, Chlorides, Boron, and Electrical Conductance (typical)	• Depending on the conditions for the WDR, it can be monthly, quarterly, or annual samples with annual reporting	• Monitor the quality of produced oil field water that is disposed of via percolation or, in some cases, by beneficial reuse in permanent tree crop or pasture irrigation.	• Typically, oilfield produced water that is discharged to a percolation pond is sampled on an annual basis. However, there are WDRs for Class I and Class V injection wells, which handle refinery waste. These WDRs require monthly samples with annual reporting. In the last 5 years the RWQCB has sent out 13267 Orders, requesting information from operators on the Title 22 constituents in their discharged water. Oil and gas operators were required to submit analytical results of all Title 22 constituents for produced water subject to their WDRs.
GAMA. Collaboration with SWRCB, RWQCB, DWR, Department of Pesticide Regulation National Weather Information System, Lawrence Livermore National Laboratory	• Constituents sampled vary by the program objectives. Typically, USGS is the technical lead in conducting studies and reporting data.	• The priority basin project performed baseline and trend assessments and sampled over 2,900 public and domestic wells that represent 95 percent of the groundwater resources in CA.	• Improve statewide comprehensive groundwater monitoring. • Increase the availability to the general public of groundwater quality and contamination information.	• USGS reports prepared for the Priority Basin Project were used to identify constituents of concern in the basin and confirm water quality trends prepared for groundwater characterization.

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
Geotracker and DTSC Envirostor	• Many constituents of concern, organic and inorganic.	• Depends on program. Monthly, Semiannually, Annually, etc.	• Records database for cleanup program sites, permitted waste dischargers,	• Records available on GeoTracker include cleanup sites for Leaking Underground Storage Tank (LUST) Sites, Department of Defense Sites, and Cleanup Program Sites. Other records for various unregulated projects and permitted facilities include Irrigated Lands, Oil and Gas production, operating Permitted Underground Storage Tanks (USTs), and Land Disposal Sites.
USGS California Water Science Center	• Conducted Multiple Groundwater Quality Studies of the Kaweah Subbasin	• Reports and fact sheet publications range from 1989 through 2018.	• Comprehensive special studies related to groundwater quality to characterize the basin.	• Prioritization of Oil and Gas Fields for Regional Groundwater Monitoring (2018). • Preliminary Groundwater Salinity Mapping Near Select Oilfields (2018). • Groundwater Quality Data in 15 GAMA Study Units. (2015). • Preliminary Results from Exploratory Sampling in Select Oil Fields (2014-15). • Groundwater Quality in the Kern Subbasin (2012). • Status and Understanding of Groundwater Quality in the Two Southern San Joaquin Study Units (2008). • The Effects of Oilfield Operations on Underground Sources of Drinking Water (1989).

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
Department of Pesticide Regulations	• Pesticides	• Annual	• DPR samples ground water to determine whether pesticides with the potential to pollute ground water are present in ground water, and • The extent and source of pesticide contamination, and, the effectiveness of regulatory mitigation measures.	• https://www.cdpr.ca.gov/docs/emon/grndwtr/index.htm

5.7.6 Land Subsidence

Subsidence monitoring programs and various studies are conducted by a range of agencies from the federal and state level to regional and local levels. Major programs and sources of data are summarized below. On-going monitoring and studies are being implemented alongside SGMA.

Land subsidence is monitored within and in the vicinity of the Kern Subbasin through the following:

- University Navstar[4] 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).
- 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.[5]
- DWR's California Aqueduct Subsidence Project (CASP). A subsidence monitoring network along the California Aqueduct, with over 1,000 survey benchmarks monitored annually.
- 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).

To assess the causes, extent, and magnitude of subsidence, the Kern Subbasin has conducted a series of studies in communication with the DWR and the CASP. The studies incorporated data from published academic and government studies and reports, oil field aquifer exemption applications prepared for the California Geologic Energy Management Division (CalGEM) and the U.S. Environmental Protection Agency (USEPA), DWR InSAR data, and InSAR studies conducted by Lawrence Berkeley National Laboratory (LBL) and Earth Consultants International (ECI) on behalf of the Kern Subbasin. These studies and interactions with DWR, CASP, and most recently SWRCB staff, have informed the suite of technologies used to measure Subbasin subsidence and have been incorporated into the Kern Subbasin SMCs approach and monitoring plan (Section 8.5.2). The suite of Kern Subbasin subsidence monitoring technologies are:

1) InSAR (direct measurement), downloaded from DWR.

[4] Navstar is a network of U.S. satellites that provide GPS services.
[5] From USGS California Water Science Center website: https://ca.water.usgs.gov/projects/central-valley/land-subsidence-san-joaquin-valley.html

2) InSAR time series at selected locations.
3) CASP and Friant Water Authority benchmark surveys.
    - CASP typically conducts benchmark surveys annually and will provide data upon request. The Kern Subbasin GSAs will request and utilize this benchmark data to assess compliance with SMCs established along the California Aqueduct (Section 13).

4). Continuous GPS.

Other land-based methods (e.g., extensometers, tiltmeters, third party benchmark surveys, GSA benchmark surveys, etc.).

The Kern Subbasin has also recently established quarterly update calls with CASP to discuss subsidence data and rates along the Aqueduct.

5.7.7 Operational Flexibility

☑ 23 CCR § 354.8(d)

The monitoring and management programs described in this 2025 Plan are integral to supporting operational flexibility and continued monitoring and reporting that will be conducted pursuant to SGMA implementation. Projects and management actions identified in this 2025 Plan will contribute to the sustainable use of water supplies, complimentary to other developed water management plans, and is not expected to limit operational flexibility of the GSAs. For example, the Integrated Regional Water Management Plan (IRWMP) and GSP development are complementary management processes, and 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 2025 Plan. GSAs are actively coordinating with large public water systems as UWMPs are developed to align public water system water use projections with SGMA water budgets.

Demand Management

Another management action to avoid operational flexibility limitations is demand management programs. For agricultural uses, demand management measures include working with landowners to establish individual water budgets, implementing district fallowing programs, and developing tiered pricing for groundwater pumping. For urban uses, purveyors are implementing demand management measures such as the Model Water Efficient Landscape Ordinance (MWELO), reductions in per capita demand through SB 20x20 and upcoming water conservation measures such as urban water use objectives (UWUO). In addition, 12 purveyors have developed Water Shortage Contingency Plans (WSCP).

5.8 Land Use Elements or Topic Categories of Applicable General Plans

> ***§ 354.8.*** *Each Plan shall include a description of the geographic areas covered, including the following information:*
>
> *(f) A plain language description of the land use elements or topic categories of applicable general plans that includes the following:*
>
> *(1) A summary of general plans and other land use plans governing the basin.*
>
> *(2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.*
>
> *(3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.*
>
> *(4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.*
>
> *(5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.*

☑ 23 CCR § 354.8(f)

The following section describes general plans and other planning documents (plans) with specific relevance to the 2025 Plan.

The agencies that developed and adopted the general and specific plans below have retained their jurisdiction over land use and zoning as well as the elements included in their respective general plans. The Kern Subbasin GSAs do not have direct jurisdiction over the development of general plans within the Kern Subbasin, however, as general plans are updated, the GSAs will actively participate in the coordination of general plan updates with the 2025 Plan implementation.

5.8.1 Summary of General Plans and Other Land Use Plans

☑ 23 CCR § 354.8(f)(1)

This section summarizes goals and policies of the plans relevant to this 2025 Plan located within the Plan Area. As defined here, goal is the “general, overall, and ultimate purpose, aim, or end toward which a city or County will direct effort”. This section includes a summary of the eight plans within the Plan Area that were reviewed to assess the applicable elements or topic categories relevant to groundwater management. There are numerous specific and rural community plans within the Plan Area; however, those plans are required to be compliant with the plans reviewed for this section and did not require separate analysis. Future plans developed within the Plan

Area are required for public comment prior to adoption, and the Kern Subbasin GSAs actively participate in public comment of plans within their specific boundaries.

In general, the goals, policies, and implementation measures established by existing plans within the Plan Area are complementary to sustainable groundwater management of the local management areas relative to future land use development and conservation. A common theme between the goals and policies of the plans discussed the conversion of agricultural land uses to either urban land uses or solar projects. These types of land use conversions result in a change in water demands and are further addressed by each GSA in Section 14, Projects and Management Actions.

5.8.1.1 Kern County General Plan

The Kern County 2004 General Plan (Amended 2009) is a policy document which provides long-range guidance to County officials making decisions affecting the growth and resources of unincorporated area of Kern County's jurisdiction. Kern County covers 8,202 square-miles and serves an estimated population of 909,235 people[6], which underlies the Plan Area for those unincorporated areas within Kern County jurisdiction.

Figure 5-18 shows the Kern County General Plan, land use designations within the Plan Area include the following primary land use designations: intensive and extensive agriculture, residential, mineral and petroleum, and industrial. In comparison to the current land use designations in Figure 5-4**,** there are some portions of the Kern Subbasin that are currently designated as agriculture within the incorporated City limits of both Shafter and Bakersfield. Water savings could be realized through the conversion of agriculture to urban areas.

Table 1 in Appendix E identifies relevant policies, goals, and implementation measures from the Kern County General Plan that could:

- Affect water demands in the Basin (e.g., due to population growth and development of the built environment),
- Influence the 2025 Plan's ability to achieve sustainable groundwater use, and
- Affect implementation of General Plan land use policies.

[6]2020 Decennial Census, https://www.census.gov/programs-surveys/decennial-census/about/rdo.html

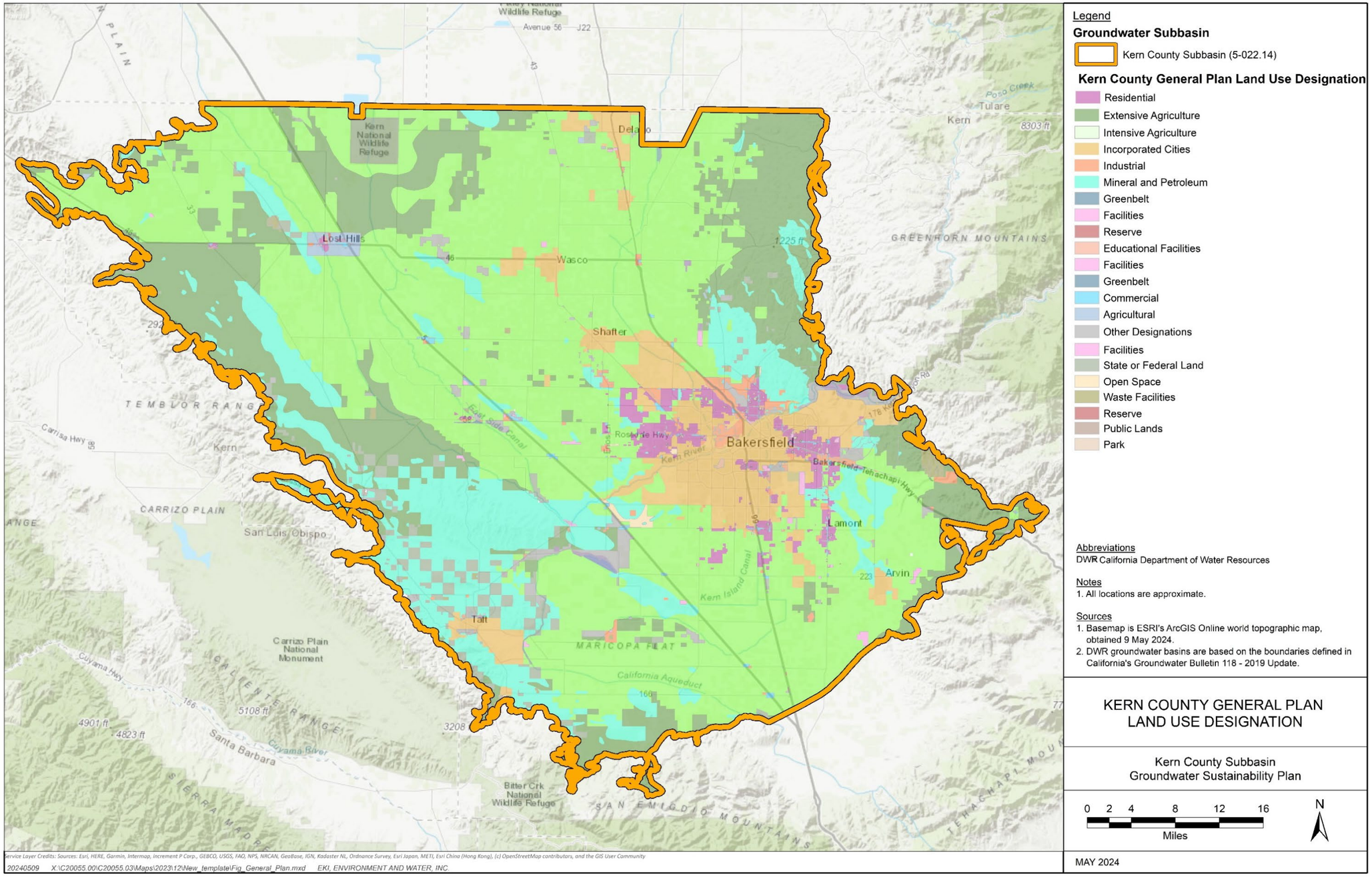


Figure 5-18. Kern County General Plan Land Use Designation

5.8.1.2 Metropolitan Bakersfield General Plan

The Metropolitan Bakersfield 2002 General Plan (Amended 2016) is a joint City of Bakersfield and Kern County policy document which provides long-range guidance to City officials making decisions affecting the growth and resources within the City of Bakersfield limits and Sphere of Influence areas that include unincorporated areas of Kern County jurisdiction. The City of Bakersfield covers 408-square miles and serves an estimated population of 403,455 people[7], and is located in the central portion of the Kern Subbasin (Figure 5-8).

The Metropolitan Bakersfield General Plan land use designations within the Plan Area include the following primary land use designations; residential - low density, residential - rural, residential - suburban, resource - extensive, open space - slopes (areas with greater than equal to thirty percent slope), and open space (floodplains and resource management areas and agriculture uses).

Table 2 in Appendix E identifies relevant policies, goals, and implementation measures from the Metropolitan Bakersfield General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the 2025 Plan's ability to achieve sustainable groundwater use, and (3) affect implementation of the Metropolitan Bakersfield General Plan land use policies.

5.8.1.3 City of Shafter General Plan

The City of Shafter 2005 General Plan is a policy document which provides long-range guidance to City officials making decisions affecting the growth and resources of within the City of Shafter's jurisdiction, which covers 38 square miles and serves an estimated population of 19,953 people[8]. The City of Shafter is located in the North Basin HCM Area, within the Shafter-Wasco Irrigation District GSA and North Kern Water Storage District GSA.

The City of Shafter General Plan land use designations include the following primary land use designations; agricultural/open space, rural residential, rural community, estate residential, low and very low density residential, medium and medium-high residential, commercial and professional office, business/industrial park, industrial, community facilities, parks, and schools.

Table 3 in Appendix E identifies relevant policies, goals, and implementation measures from the City of Shafter General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the 2025 Plan's ability to achieve sustainable groundwater use, and (3) affect implementation of the City of Shafter General Plan land use policies.

[7] 2020 Decennial Census, https://www.census.gov/programs-surveys/decennial-census/about/rdo.html
[8] 2020 Decennial Census, https://www.census.gov/programs-surveys/decennial-census/about/rdo.html

5.8.1.4 City of Arvin General Plan

The City of Arvin 2012 General Plan is a policy document which provides long-range guidance to City officials making decisions affecting the growth and resources within the City of Arvin's jurisdiction, which covers 5-square miles and serves an estimated population of 19,495 people[9]. The City of Arvin is located in the South Basin HCM Area, within the Arvin GSA.

The City of Arvin General Plan land use designations within the Plan Area include the following primary land use designations estate residential, residential reserve, low density residential, medium density residential, high density residential, general commercial, light industrial, heavy industrial, parks, public facilities, schools, agricultural, and streets/ROW. These land use designations are consistent with the Kern County General Plan land use designations.

Table 4 in Appendix E identifies relevant policies, goals, and implementation measures from the City of Arvin General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the 2025 Plan's ability to achieve sustainable groundwater use, and (3) affect implementation of the City of Arvin General Plan land use policies.

5.8.1.5 City of Wasco General Plan

The City of Wasco 2040 General Plan is a policy document which provides long-range guidance to City officials making decisions affecting the growth and resources within the City of Wasco's jurisdiction, which covers 18-square miles and serves an estimated population of 27,047 people[10]. The City of Wasco is located within the North Basin HCM Area, within the Shafter-Wasco Irrigation District GSA.

The City of Wasco General Plan land use designations within the Kern Subbasin boundaries include the following primary land use designations; rural residential, estate residential, low, medium and high density residential, neighborhood commercial, community retail, highway commercial, central business district, professional office, agriculture, light and heavy industrial, public and institutional, and parks and open space.

Table 5 in Appendix E identifies relevant policies, goals, and implementation measures from the City of Wasco General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the 2025 Plan's ability to achieve sustainable groundwater use, and (3) affect implementation of the City of Wasco General Plan land use policies.

[9] 2020 Decennial Census, https://www.census.gov/programs-surveys/decennial-census/about/rdo.html
[10] 2020 Decennial Census, https://www.census.gov/programs-surveys/decennial-census/about/rdo.html

5.8.1.6 City of Delano General Plan

The City of Delano 2005 General Plan is a policy document which provides long-range guidance to City officials making decisions affecting the growth and resources within the City of Delano's jurisdiction, which covers 14-square miles and serves an estimated population of 51,428 people.[11] The City of Delano is located in the North Basin HCM Area, within the Southern San Joaquin Municipal Utility District GSA.

The City of Delano General Plan land use designations within the Kern Subbasin boundaries include the following primary land use designations; are a balanced mix of residential, commercial, industrial, and open space/public land.

Table 6 in Appendix E identifies relevant policies, goals, and implementation measures from the City of Delano General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the 2025 Plan's ability to achieve sustainable groundwater use, and (3) affect implementation of the City of Delano General Plan land use policies.

5.8.1.7 City of McFarland General Plan

The City of McFarland 2040 General Plan is a policy document which identifies long-range guidance to City officials making decisions affecting the growth and resources of within the City of McFarland's jurisdiction which covers 3-square miles and serves an estimated population of 14,161 people,[12] and is located in the North Basin HCM Area, within the Southern San Joaquin Municipal Utility District GSA.

Figure 7 in Appendix E shows the City of McFarland 2040 General Plan land use designations within the Kern Subbasin boundaries include the following primary land use designations; housing allocation and circulation improvements needed to meet the population growth projections and targets for job growth, open space, public facilities, economic development, community design, health, environmental justice, air quality, and sustainable agriculture.

5.8.1.8 City of Taft General Plan

The City of Taft 2010 General Plan (Amended 2017) is a policy document which identifies long-range guidance to City officials making decisions affecting the growth and resources of within the City of Taft's jurisdiction which covers 38.7-square miles and serves an estimated population of 8,546 people,[13] and is located in the Western Fold Belt HCM Area, within the West Kern Water District GSA.

[11] 2020 Decennial Census, https://www.census.gov/programs-surveys/decennial-census/about/rdo.html?fm=info_panel
[12] 2020 Decennial Census: https://www.census.gov/programs-surveys/decennial-census/about/rdo.html
[13] 2020 Decennial Census, https://www.census.gov/programs-surveys/decennial-census/about/rdo.html

The City of Taft General Plan land use designations within the Plan Area include the following primary land use designations; natural resources, open space, low, medium, and high density residential, mixed use, commercial, industrial, and public facilities.

Table 8 in Appendix E identifies relevant policies, goals, and implementation measures from the City of Taft General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the 2025 Plan's ability to achieve sustainable groundwater use, and (3) affect implementation of the Metropolitan Taft General Plan land use policies.

5.8.2 Existing Land Use Plans Effects on Groundwater Management

☑ 23 CCR § 354.8(f)(2)

The above goals, policies, and implementation measures established by the plans discussed above in Section 5.8.1 are complementary to sustainable groundwater management of the Kern Subbasin relative to future land use development and conservation. For example (1) the Kern County 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, (2) the Metropolitan Bakersfield General Plan establishes as a general goal for groundwater management to reach a condition of "safe yield" for the groundwater basin, and (3) 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 Elements of the General Plan reflect the principles of integration of SB 375, the Sustainable Communities Planning Act of 2008".

Furthermore, land use conversions, such as expansion of urbanized areas or agricultural to solar arrays, are effective demand management strategies that are included in the suite of P/MAs whose benefits will contribute to offsetting the projected deficit. Refer to Section 14 for details.

Therefore, implementation of the plans above is not expected to affect the ability of the GSAs to achieve groundwater sustainability.

5.8.3 How Implementation of the Plan May Affect Water Supply Assumptions of Relevant Land Use Plans

☑ 23 CCR § 354.8(f)(3)

Successful implementation of this 2025 Plan will contribute to sustainable management of the Kern Subbasin groundwater supply. Therefore, implementation of this 2025 Plan is not anticipated to significantly affect the County's current water supply assumptions or

land use plans over the planning horizon. For example, given that the County General Plan is being updated concurrently with the development of this 2025 Plan, it is anticipated that the 2040 General Plan will take into account this 2025 Plan and utilize consistent water supply assumptions over the 2040 planning horizon. However, implementation of this 2025 Plan may limit the availability of potential local groundwater sources to be used in instances where future demands exceed current rates of groundwater extraction.

5.8.4 Well Permitting Process

☑ 23 CCR § 354.8(f)(4)

The Kern County Public Health 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 DWR's Bulletin 74-81 and Bulletin 74-90, and 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 plume sources, water quality be tested for new and reconstructed wells, an NSF/ANSI 61 Approved flowmeter be installed, and the final well construction be inspected by County staff. Additionally, the ordinance requires that wells drilled where regionally confining clay is present are sealed to avoid contaminant migration between the locally confined aquifer zones.

Well Construction Policies

The well permitting program is conducted by the Kern County Public Health in cooperation with local agencies. The permitting process consists of a county water well permit, the SGMA-implemented Overdraft Supplemental Well Application, and detailed site maps. Section 14 of the Kern County Ordinance Code ensures proper design and construction of new wells. As referenced in the Guidelines for Kern County Water Agency Review, there are several conditions that ensure a well is constructed in a manner that protects against groundwater contamination (i.e., depth of sanitary seal, distance from public supply wells, radius from a proposed groundwater recharge/recovery facility, distance from an active dairy or other contaminated site or area of poor water quality). Additionally, Kern County Public Health requires inactive well owners to agree to keep the well capped to prevent groundwater contamination.

Public Supply Well Permitting Process

All public water systems operate under a water supply permit issued by the SWRCB's Division of Drinking Water, which requires them to undergo a rigorous permitting process in addition to KCEHS well construction permitting. Since the state process is more stringent than KCEHS, the process typically defaults to DDW guidance and inspection. But Kern County Public Health issues a local permit and requires a copy of the well completion report be submitted to the Water Well Program. DDW review

considers the construction of the well and wellsite, discharge piping and disinfection 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) and from acts of terrorism and vandalism.

5.8.5 Implementation of Land Use Plans Outside the Basin

☑ 23 CCR § 354.8(f)(5)

The Kern Subbasin shares its southern boundary with the White Wolf Subbasin, which prepared a GSP that was adopted in January 2022 and was conditionally approved by DWR in October 2023. Land use within the White Wolf Subbasin immediately adjacent to the southern portion of the Kern Subbasin is largely agricultural and not projected to change over the planning horizon.

Similarly, the Kern Subbasin shares its northern boundary primarily with the Tule and Tulare Lake Subbasins, which prepared GSPs that were adopted in January 2020, found incomplete by DWR in January 2022, and then found inadequate by DWR in March 2023 and referred to SWRCB for probation. In April 2024, SWRCB held a probationary hearing for Tulare Lake Subbasin; actions related to the probationary designation are currently suspended due to ongoing litigation. In September 2024, SWRCB held a probationary hearing for Tule Subbasin. Land use within the Tule and Tulare Lake Subbasins (Kings and Tulare counties) immediately adjacent to the northern portion of the Kern Subbasin is largely agricultural. While the Tule and Tulare Lake Subbasin Plans indicate that land use is expected to remain mostly agricultural, both GSPs indicate in their projected water budgets that agricultural demand on groundwater resources will reduce. Groundwater flow is generally to the north towards these Subbasins (Section 8). The projected model results were adjusted to assess the potential influence of reduced demands and future implementation of P/MAs via stabilized groundwater levels (Section 9).

Therefore, this 2025 Plan has not made unique land use assumptions for areas outside of the Kern Subbasin and has considered 2025 Plan implementation influences from adjacent subbasins.

5.9 Additional GSP Elements

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

☑ 23 CCR § 354.8(g)

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

5.9.1 Control of Saline Water Intrusion

The Kern Subbasin is located in the Central Valley, far from coastal areas. As a result, seawater intrusion is not considered to be a current or future issue for the Kern Subbasin. Therefore, it is not an applicable sustainability indicator and is not considered further in this 2025 Plan.

5.9.2 Wellhead Protection, Well Abandonment, and Destruction Programs

Kern County Public Health Water Well Program issues permits to construct, reconstruct, and destroy water wells (Section 5.8.4). The Kern Subbasin GSAs and districts assist their respective landowners to comply with well destruction policies and the County wellhead protection area program, which was implemented through the Safe Drinking Water Act and aims to prevent contamination in public water systems.

5.9.2.1 Well Abandonment and Well Destruction Program

Abandoned water wells (no longer in use or permanently inactive) can act as a conduit for surface and subsurface pollution to enter groundwater supplies. Subsequently, state law and county ordinance Code 14.08 requires any wells that are abandoned or wells with inadequate water supply must be destroyed. Furthermore, any abandoned wells on the site of an active new well construction permit must be destroyed prior to construction. Well destruction requires a permit from Kern County Public Health Water Well Program. At a minimum, the upper 50 feet must be sealed with an approved sealing material. Where regionally confining clay is present, the depth of the annular seal is determined by Kern County Water Agency to avoid contamination between aquifer zones.

In some instances, when an inactive well is not a risk for migrating groundwater contamination, GSAs may work with landowners to convert production wells to monitoring wells. In some instances, districts have also obtained grants to partially fund the well conversion costs.

5.9.3 Groundwater Contamination Cleanup, Recharge, Diversions to Storage, Conservation, Water Recycling, Conveyance, and Extraction Projects

SGMA requires GSAs to develop processes to review land use plans and efforts to coordinate with agencies to assess land use activities and programs that potentially create risk to groundwater quality. This section describes existing programs and land uses and how they are addressed in this 2025 Plan and through the implementation period.

5.9.3.1 Recharge

Recharge policies exist across the Kern Subbasin to encourage on-farm recharge and banking. The Kern Subbasin's history of water banking demonstrates that groundwater quality improves due to the high-quality surface waters that are used for the banking and conjunctive use programs. As stated in Section 5.4.2, surface water supplies from the SWP, CVP, Kern River and ephemeral streams (Poso and Caliente Creek) are all used for water banking.

The Kern Fan Banking programs use SWP, CVP, and Kern River, and have several years of monitoring data to evaluate impacts to receiving groundwater. Salt balance calculations on imported supplies and water returned via the SWP show that for every ton of salt imported with surface water supplies, 1.5 tons of salt are exported. These calculations demonstrate that the exported salt is improving the quality of water in Kern Fan Aquifer. Analysis of nitrate, arsenic, and total dissolved solids (TDS) has shown similarity for each constituent. Refer to Section 7.5.1, General Groundwater Quality, and Appendix D (Kern Fan Banking Programs) for additional details.

5.9.3.2 Conservation

Through their conservation and irrigation efficiency practices, Districts are constantly pursuing water conservation at both the district and grower level. Efficient water management practices are described in each AWMP. As discussed in Section 5.9.4.1, there are 12 major Urban water purveyors with an adopted 2020 UWMP. The 2020 UWMPs present a framework for ensuring adequate water supply to meet current and future water demands. As part of the UWMP development process, each supplier was tasked with meeting state mandated per capita water use targets and discussing their plans to increase water conservation through demand management action.

5.9.3.3 In-lieu Use, Diversions to Storage, Water Recycling, and Extraction

In-lieu use, diversions to storage, water recycling, conveyance, and extraction projects are managed on a district level. Use of high-quality surface water diverted from the Kern River and CVP to substitute for groundwater extraction by in-lieu recharge and for direct aquifer recharge through recharge basins contributes to protection of groundwater

quality by controlling the salt load entering the Kern Subbasin. The treatment of recycled water also contributes to managing the loading of salt and other constituents.

5.9.3.4 Conveyance

The California Aqueduct and Friant-Kern Canal are both infrastructure critical for conveying imported water to the Kern Subbasin. The Kern River, which originates in the Sierra Nevada Mountains east of the Kern Subbasin, is another important source of surface water. The conveyance system in the Kern Subbasin is highly interconnected, allowing water to be exchanged among each of these sources.

5.9.3.5 Mitigation of Contaminated Groundwater

The Central Valley Water Board, the California Department of Toxic Substances Control (DTSC), and Kern County Department of Environmental Health regulate the mitigation, remediation, and management of groundwater contamination plumes in the Kern Subbasin. The SWRCB's GeoTracker and EnviroStor databases show a total of 86 active contaminated groundwater sites. Refer to Section 8.4.2 for further details.

5.9.4 Efficient Water Management Practices

Kern Subbasin GSAs are constantly pursuing increased efficiency regarding their water management practices. Efficient water practices are outlined in the UWMPs and AWMPs of local agencies. The UWMPs and AWMPs document a series of measures for increased water use efficiency for urban water use and irrigated agriculture, respectively. These plans were developed to identify short and long-term water supply challenges throughout the region. Identified supply challenges were combatted with increased recharge capacities, improved conveyance, and coordinated operation of water management programs.

5.9.4.1 Urban Water Management Plans (UWMP)

UWMPs are long-term planning tools that provide information regarding an urban water supplier's existing and projected sources of water supply, existing and projected water demands, water service reliability, water conservation and demand management measures, and water shortage contingency planning. The UWMPs determine per capita water use, establish water use reduction goals, and document performance. Each UWMP requires reporting on the status of specific Efficient Water Management Practices (EWMPs) suitable for urban settings.

The following urban water purveyors prepared a 2020 UWMP:

- Arvin Community Service District
- Bakersfield, City Of
- California Water Service Company, Bakersfield
- Delano, City Of

- East Niles Community Services District
- Greenfield County Water District
- Kern County Water Agency Improvement District No. 4
- McFarland, City of
- Oildale Mutual Water Company
- Shafter, City Of
- Vaughn Water Company
- Wasco, City Of
- West Kern Water District

5.9.4.2 Urban Water Use Objectives

As part of the *Making Conservation a California Way of Life* regulation (Senate Bill 606 and Assembly Bill 1668), urban water suppliers are required to annually calculate their Urban Water Use Objective (UWUO), assess whether their actual water use for the previous year meets the UWUO, and report to the State annually the results of this assessment starting January 1, 2024. The UWUO is calculated as the sum of the efficient indoor residential water use, efficient outdoor residential water use, efficient water loss, efficient outdoor commercial/ industrial/ institutional irrigation use, bonus incentives, and efficient variances. The purpose of the assessment is to ensure urban retail water suppliers eliminate unnecessary water use through establishment of individualized efficiency goals that must be met by the supplier.

5.9.4.3 Agricultural Water Management Plans (AWMP)

Like UWMPs, AWMPs are long-term planning tools, updated every 5 years, that provide information regarding an agricultural water supplier's existing and projected sources of water supply, demand, and conservation programs. Each plan includes required reporting on the status of EWMPs identified as suitable for the conservation of irrigation water supplies. There were 12 AWMPs submitted for non-exempt agricultural water suppliers in the Kern Subbasin in 2020, including:

- Arvin-Edison Water Storage District
- Belridge Water Storage District (WDWA GSA)
- Berrenda Mesa Water District (WDWA GSA)
- Buena Vista Water Storage District
- Cawelo Water District
- Kern Delta Water District
- Lost Hills Water District (WDWA GSA)
- North Kern Water Storage District

- Semitropic Water Storage District
- Shafter-Wasco Irrigation District
- Southern San Joaquin Municipal Utility District
- Wheeler Ridge-Maricopa Water Storage District

5.9.5 Relationships with State and Federal Regulatory Agencies

Consistent with Water Code 10727.4, the Kern Subbasin has developed relationships with state and federal regulatory agencies who impact decision-making, operations, and groundwater management activities. These relationships are described throughout this 2025 Plan. Section 5.10.4 provides additional information on stakeholders and partnerships.

5.9.6 Land Use Plans and Efforts to Coordinate with Land Use Planning Agencies to Assess Activities that Potentially Create Risks to Groundwater Quality or Quantity

As discussed in Section 5.8.1, the existing land use plans outline goals, policies, and implementation measures that are complementary to sustainable groundwater management relative to future land use development and conservation. The discussion of land use plans in Section 5.8.1 highlights a common theme between the policies which show the conversion of agricultural land uses to either urban land uses or solar projects. Because these types of land conversions result in reduction of water demands, the Kern Subbasin GSAs have included the anticipated benefits as P/MAs to achieve sustainability.

5.9.7 Impacts on Groundwater Dependent Ecosystems

SGMA defines Groundwater Dependent Ecosystems (GDEs) as ecological communities or species 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. Potential impacts on GDEs and interconnected surface water are discussed in Section 5.68.6.

5.10 Notice and Communication

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

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

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

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

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

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

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

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

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

☑ 23 CCR § 354.10

This section presents information related to the Kern Subbasin's public noticing and outreach efforts that have occurred for the 2024 and 2025 Plans, as well as the Kern Subbasin's ongoing outreach and engagement efforts. To fulfill notice and communication requirements, Kern Subbasin GSAs developed a Subbasin-wide Stakeholder Communication and Engagement Plan (SCEP) to describe their strategy for successful engagement throughout the 2024 and 2025 Plan development process, and to provide a framework to guide effective outreach during GSP implementation. The SCEP is included as Appendix F-1. In preparation for releasing the public review draft of the 2025 Plan, and in response to the SWRCB's continuation of Resolution No. 2025-0007 (Appendix B-2), the Kern Subbasin GSAs developed and implemented a robust Community Outreach and Engagement Strategy (CO&ES) designed to foster trust, enhance public



Figure 5-19. Trent Taylor of Rosedale RRBWSD GSA and the Community Engagement Team's Spanish Interpretors (via Linguistica Interpretting and Translation, LLC.) engaging with community members at the Shafter Community Pop-Up Event

understanding of SGMA principles and GSA objectives, and promote participation by interested parties in the GSP amendment process. The initiative featured multiple outreach strategies, including the creation of new educational materials on the GSAs' website, establishment of dedicated social media channels, and development of a public engagement toolkit. To ensure inclusive participation, the GSAs conducted focus groups with community members, hosted pop-up events in five disadvantaged communities, and organized three public workshops. Additionally, monthly coordination calls were held with non-governmental organizations (NGOs) and nonprofit organizations representing drinking water users, small growers, and underrepresented agricultural stakeholders. A comprehensive record of the CO&ES is available in Appendix F-3.

5.10.1 Public Meetings

☑ 23 CCR § 354.10(b)

Kern Subbasin GSAs provided a variety of venues for stakeholder engagement to gather public input and inform the 2025 Plan amendment process. Public meetings identify local needs and concerns, promote equity and inclusiveness for all beneficial uses and users, build public support and compliance, inform SMC development, and address public concerns before 2025 Plan implementation. Public engagement venues specific to SGMA, detailed in the list below, include GSA Board meetings, GSA Group Meetings, and community workshops. The GSAs considered time, health, transportation, location, and language accessibility in planning public meetings with virtual options and translation of SGMA-related materials into Spanish. The GSAs have a standby Punjabi translator and will obtain additional translation services for communities where a different language is spoken by greater than 5 percent of the population as identified by Census data.

The Kern Subbasin GSAs maintained a comprehensive meeting calendar through 2025, listing all public GSA meetings with their dates and locations (Appendix F-4). The calendar is also available in English, Spanish, and Punjabi on the Kern Subbasin website at www.kerngsp.com/stay-engaged/.

Additionally, GSA Board Meeting details—including dates, times, and agenda links—are shared monthly on the Kern Subbasin's social media accounts in all three languages. These posts also specify whether meetings are in-person, virtual, or hybrid, making it easier for the public to participate.

5.10.1.1 Board Meetings

Each GSA within the Kern Subbasin has a Board of Directors, which is the governing body that makes decisions within each GSA. The Boards are composed of community members that typically represent multiple interests, consistent with the land uses of the GSA. The Boards are responsible for approving GSA-wide decisions. Examples of GSA

Board decisions include adopting the GSP and adopting policies that align with management activities, such as a well metering program and well mitigation program.

The Kern Subbasin GSAs and GSA member agencies hold regular Board meetings that are open to the public and provide SGMA-related updates and information. Information and notices for GSA Board meetings, including meeting location, meeting time, and virtual access points, can be found directly on the individual agency websites (Appendix F-2, Table 3). Any recommended actions endorsed by the Kern Subbasin coordination committee are brought to the GSA Boards during these public meetings for consideration. Once Subbasin-wide recommendations are brought to the GSA Boards, the GSA Boards have the authority to decide whether to approve them as part of their GSA's policy. During these meetings, stakeholders are encouraged to provide input on information related to GSP development and implementation.

5.10.1.2 Stakeholder Workshops

To ensure inclusive and transparent development of GSP development, the Kern Subbasin GSAs implemented a robust stakeholder engagement strategy between January 2023 and June 2025. This strategy included a wide range of outreach activities designed to inform, involve, and gather input from diverse groundwater users and community members across the Subbasin. These efforts were carried out through GSA-hosted workshops, participation in SWRCB events, Subbasin-wide public meetings, community pop-up events, and targeted focus groups. Each engagement opportunity was tailored to meet the needs of Kern Subbasin's varied interested parties, with particular attention to language access, geographic representation, and community-driven priorities. The following sections summarize the key events and outcomes of these engagement efforts, which collectively informed the 2025 Plan amendments. More details on workshops and events are detailed in the SCEP (Appendix F-1) and the CO&ES (Appendix F-3).

GSA-Hosted Workshops

Since January 2023, several GSAs held stakeholder workshops to guide public outreach and stakeholder engagement efforts. Noticing included sending direct mail and informational emails with updates on events. GSA-lead stakeholder workshops held between January 2023 and August 2024 are listed in Appendix I. Between April and July 2025, a total of 70 GSA-hosted workshops were conducted as part of the 2025 Plan amendment process. These workshops are detailed in a comprehensive list available in Appendix F-4 and on the Kern Subbasin website at www.kerngsp.com

SWRCB Workshops

Kern Subbasin GSAs actively advertised and participated in the August 2024 public workshops held by the SWRCB. Kern Subbasin GSAs presented on the 2024 Plan and presented to Kern Subbasin landowners about potential SWRCB actions during the

intervention process. These workshops also provided a venue for public comment. Spanish and Punjabi translation was made available. SWWRCB workshops were held at these times:

- August 26, 2024 (virtual)
- August 29, 2024 (in-person, City of Bakersfield)

The SWRCB did not host public workshops on to the 2025 Plan.

Kern Subbasin Workshops

The GSP requires engagement from community members and interested parties during the 2024 and 2025 period. Therefore, both the 2024 and 2025 Subbasin Workshops are listed below.

2024 Plan Workshops

Subbasin-wide stakeholder workshops hosted by the GSAs were held to present an overview of the 2024 Plan and provide an open forum for public attendees to ask questions and submit comments. All workshops had Spanish translation available. Three workshops were held on October 3, 2024:

- Stakeholder Workshop #1 – In-person at the Mouser Center in McFarland (100 South Second Street, McFarland, CA 93250-0337) from 10 am to 12 pm.
- Stakeholder Workshop #2 – Hybrid in-person at the Kern County Water Agency office (3200 Rio Mirada Dr. Bakersfield, CA 93308), or virtual on Zoom from 2 pm to 4 pm.
- Stakeholder Workshop #3 – In-person at the David Head Center in Lamont (10300 San Diego St, Lamont, CA 93241) from 6 pm to 8 pm.

A fourth stakeholder meeting was held virtually on November 12, 2024, with drinking water advocacy groups focusing on the Well Mitigation Program. Feedback from this stakeholder meeting was conveyed to interested parties through Kern Subbasin GSA communication pathways and through the existing methods of communication established by the organizations that attended the meeting.

2025 Plan Workshops

In preparation for the public comment period, the Kern Subbasin GSAs conducted three stakeholder workshops between June 3-11, 2025 to present key components of the 2025 Plan. These workshops were designed to educate participants about SGMA requirements and GSA functions, explain proposed 2025 Plan modifications, discuss what the proposed changes to the 2025 Plan mean to different groundwater user groups, and provide instructions for submitting formal comments. The workshop content was specifically tailored using community input gathered through surveys administered at previous pop-up engagement events. To ensure broad accessibility, the GSAs offered one in-person session at Bakersfield's Martin Luther King Jr. Community Center on June 3, 2025 along with two virtual sessions via Zoom on June 5 and 11, 2025 - a format developed in response to community preferences for virtual participation options that accommodate privacy concerns and accessibility needs. All workshops featured simultaneous verbal interpretation in Spanish and Punjabi, as well as translated written materials, to facilitate meaningful participation from the Kern Subbasin's linguistically diverse communities. This multi-format approach allowed stakeholders to engage with the 2025 Plan through their preferred medium while maintaining equitable access to information.



Figure 5-20. Thumbnail of Instagram Post Advertising Public Workshops (English Version)



Figure 5-21. Vanessa Yap Escobedo, PE of Kern-Tulare Water District GSA engaging with community members at the Delano Community Pop-Up Event

5.10.1.3 Community Pop-Up Events

In support of the 2025 Plan, the Kern Subbasin GSAs conducted a series of five pop-up events targeting disadvantaged communities throughout the region. These outreach efforts, held in Lost Hills, Delano, Buttonwillow, Shafter, and Lamont, served three primary objectives: (1) introducing residents to the Kern Subbasin GSAs and their functions, (2) establishing trust through direct

dialogue, and (3) identifying community priorities and concerns through surveys and conversations to inform future engagement strategies. To maximize participation, each event was strategically coordinated with existing well-attended community gatherings. On-site engagement teams included GSA representatives, community outreach consultants, and Spanish interpreters to ensure effective communication. The collected data, including detailed engagement metrics and survey responses documenting community interests, are compiled in Appendix F-3 for reference.

The map below (Figure 5-22) depicts the spatial distribution of the community pop-up event locations.

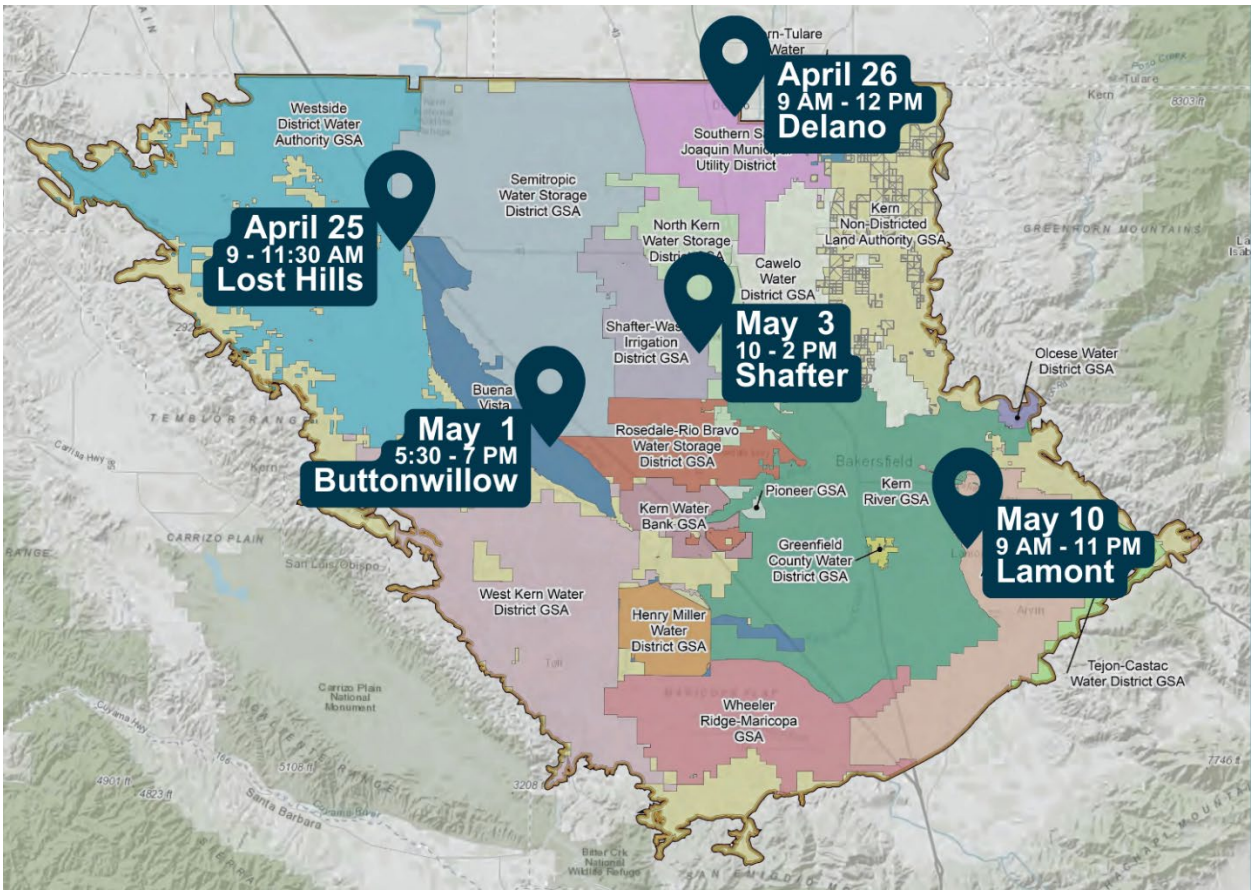


Figure 5-22. Locations of Community Pop-Up Events

5.10.1.4 Focus Groups

To complement public events and workshops, the Kern Subbasin GSAs conducted targeted focus groups with community members. These sessions served three key purposes: (1) gaining deeper insight into community priorities and concerns regarding groundwater management, (2) identifying potential improvements to the 2025 Plan based on participant feedback, and (3) connecting residents with available solutions to address their specific groundwater-related challenges whenever feasible. The focus group format allowed for more in-depth discussion than traditional public meetings,

enabling the team to better understand community needs while fostering direct connections between residents and relevant resources.

5.10.1.5 GSA Group Meetings

Smaller GSA groups composed of GSA representatives and other community members, including DAC community members, have formed to aid in providing aligned recommendations to the GSA Boards. GSA Group responsibilities typically include coordinating local groundwater management programs and activities, guiding public outreach and stakeholder engagement efforts, informing respective governing bodies, and endorsing actions necessary to satisfy the requirements of SGMA.

The South of Kern River (SOKR) GSP Executive Committee.

Pursuant to the SOKR Memorandum of Agreement (MOA), Arvin GSA, Arvin CSD, TCWD GSA, and Wheeler Ridge-Maricopa GSA each has designated representatives to participate in the SOKR GSP Executive Committee which, with the support of the respective agencies' 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 Kern Subbasin GSAs to achieve sustainable groundwater management as required by SGMA. 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 Executive Committee meets monthly at AEWSD headquarters and agendas are posted on https://sokrgsp.com/.

The North Central Kern (NCK) GSP Steering Committee.

Pursuant to the MOA by and Among North Kern WSD GSA, Shafter-Wasco ID GSA, Cawelo Water District GSA, and Southern San Joaquin MUD GSA representing the North Central Kern Groundwater Sustainability Plan (NCK GSP Group), each has designated a Steering Committee representative from their respective Board of Directors, with the support and the agencies' respective staff and technical consultants, to be responsible for making decisions concerning the development of the NCK GSP, enforcement of the GSP, and facilitating coordination with other GSAs in the Kern Subbasin. The cities of Delano, McFarland, Shafter, and Wasco are situated within the jurisdictional boundaries of the GSAs and have appointed a member to the Steering Committee. The Steering Committee's responsibility also includes guiding public outreach and stakeholder engagement efforts, informing respective governing bodies, and taking any and all actions necessary to satisfy the requirements of SGMA. The NCK Steering Committee meets regularly at the North Kern Water Storage District office.

Kern Fan Banking Group

Representatives from the Berrenda Mesa Spreading Grounds, the Kern Water Bank GSA, the Pioneer GSA, and the West Kern Water District GSA meet routinely to coordinate and compile technical information and data, and to provide guidance during the development of the 2024 Plan and 2025 Plan. Each member participates in public outreach through their respective Board meetings (Appendix F-4).

Kern Non-Districted Land Authority GSA

The Kern Non-Districted Land Authority GSA (KNDLA GSA) provides local policy makers, stakeholders, and the public a forum to monitor, report and/or discuss groundwater activities and identify and address any local groundwater issues. KNDLA GSA was formed for the purpose of 1) coordinating groundwater management programs and activities; 2) identifying and addressing issues pertaining to sustainable groundwater management; and 3) establishing a framework for local groundwater management. Board meetings are held at 8 a.m. on the fourth Wednesday of every month. Refer to the Appendix C-2 (Fourth Amended and Restated Joint Exercise of Powers Agreement Kern Non-Districted Lands Authority) for more information on roles and responsibilities.

Jurisdictional Members include:

- Kern County Water Agency

Associate Members include:

- Eastside Water Management Area

Member Agencies include:

- Kern County Water Agency-Pioneer GSA
- Kern County Water Agency-Improvement District No. 4
- Kern-Tulare Water District
- Kern Water Bank Authority
- Semitropic Water Storage District
- West Kern Water District
- Westside District Water Authority GSA
- Shafter-Wasco 7th Standard Annex Area
- Cawelo Water District
- North Kern Water Storage District
- Rosedale-Rio Bravo Water Storage District

- Shafter-Wasco Irrigation District
- San Joaquin Municipal Utility District

Kern River GSA

The Kern River GSA (KRGSA) holds monthly public board meetings, on the first Thursday of the month, to discuss SGMA and solicit public comment. Agendas and minutes are published to the http://www.kernrivergsa.org/. KCWA-ID4 and the City of Bakersfield participate in monthly Urban Bakersfield Advisory Committee meetings and provide monthly SGMA updates. Greenfield GSA (located totally within KRGSA) also holds monthly board meetings where SGMA updates are given. In addition, KRGSA has held regular GSA purveyor meetings to coordinate with local water retailers, update them on the SGMA process, and hear their feedback.

Westside District Water Authority GSA

Westside District Water Authority GSA (WDWA GSA) is a Joint Powers Authority comprised of Berrenda Mesa Water District (BMWD), Belridge Water Storage District (BWSD), and Lost Hills Water District (LHWD) ("Kern Districts"). The Kern Districts are also members of the Westside Water Authority (WWA) JPA, comprised of the Kern Districts and Dudley Ridge Water District (DRWD). WDWA GSA, BMWD, BWSD, and LHWD hold separate quarterly regular board meetings, with special board meetings called as necessary. WWA holds monthly board meetings, with the exception of summer recess from June - September. District specific SGMA updates are provided, and stakeholder feedback collected, at WWA, BMWD, BWSD, and LHWD board meetings. Detailed SGMA and WDWA GSA operations updates (such as GSP development, management action/project implementation, financials, etc.) are presented and discussed at WDWA GSA board meetings. All board meetings are open to the public, Brown Act compliant, and noticed via interested party listservs and physical/online agenda posting. Stakeholder feedback is welcomed at all board meetings and considered when making WDWA GSA operational decisions. WDWA GSA maintains a regulatory email (regulatory@westsidewa.org) and phone line (661-633-9022) for any interested stakeholder to ask questions or provide feedback to the GSA's regulatory manager outside of board meetings. Additional information regarding board meetings can be found at the following websites:

- WDWA GSA: https://www.westsidedwa.org
- Westside Water Authority: https://www.westsidewa.org
- Berrenda Mesa Water District: https://www.bmwd.org
- Belridge Water Storage District: https://www.belridgewsd.com
- Lost Hills Water District: https://www.lhwd.org

5.10.1.6 Direct Outreach

The Kern Subbasin GSAs conduct targeted outreach and engagement to community members, interested parties, and stakeholders to secure local input during the SGMA process. In 2025, several new engagement strategies were implemented which included monthly Community Partner Meetings, Focus Groups, Pop-Up Events, and Community Workshops. These activities are described under Section 10.2.3 Communication and detailed in the Community Outreach and Engagement Strategy (Appendix F-3). The 2025 Plan outreach and engagement was developed and implemented as directed by SWRCB Resolution No. 2025-0007. Direct outreach efforts for the 2024 Plan are described in detail in F-1.5 of the SCEP (Appendix F-1 and F-2) and include participation in public meetings, flyer postings, email blasts, events, and open and frequent communication with all stakeholder engagement type groups.

5.10.2 Comments Received

☑ 23 CCR § 354.10(c)

The 2025 Plan was released for public comment from June 20, 2025 to July 21, 2025. The Kern Subbasin GSAs invited submission of public comments to comments@kernGSP.com, in addition to the GSA Board meeting venues open to the public where feedback was encouraged from all stakeholder groups. Public comments received on the 2025 Plan were reviewed and necessary changes integrated. Details regarding the comments received and responses to comments are included in Appendix N-2. Public comments received and responses to comments on the 2024 Plan are archived in Appendix N-1.

5.10.3 Communication

☑ 23 CCR § 354.10(d)

Outreach and communication are conducted at the Kern Subbasin, GSA Group, and individual GSA levels. This section describes the noticing and outreach conducted at the Kern Subbasin-level for 2025 Plan development and implementation.

5.10.3.1 Decision-Making Process

The Kern Subbasin GSAs, each led by its policy representative, have participated in numerous and substantial Subbasin-wide coordination efforts, including a) discussion amongst GSA managers, b) development of a Technical Working Group (TWG) and Attorney Working Group (AWG), c) intra-basin coordination efforts, d) Subbasin-wide stakeholder engagement, and e) consultation with several agencies including State Water Resources Control Board (SWRCB) and DWR.

The Kern Subbasin decision-making process involves coordination amongst the GSAs and their member agencies, governing bodies (i.e. Board of Directors) and consultation

with stakeholders, the Technical Working Group (TWG), and Attorney Working Group (AWG). Issues and recommendations are publicly discussed during district and GSA Board meetings, which are open to the public.

As part of the 2024 and 2025 Plan development process, the GSAs amended and restated the accompanying Coordination Agreement (Appendix C-1), which includes a structure for the GSAs to participate in coordination activities for SGMA implementation including a) exchange of data and information, b) use of common data and methodologies, and c) data collection with reporting requirements. As described in the Coordination Agreement, key GSP development and implementation decisions are made by the individual GSA Boards of Directors. Each GSA that has developed a GSP has agreed to the participation structure outlined in the Coordination Agreement and is visualized in Figure 2 of the SCEP (Appendix F-1). In general, Kern Subbasin policy, funding, and other coordination concerns are presented to the Kern Subbasin coordination committee under advisement and recommendation of the GSA managers, TWG, and/or AWG. Decisions and formal approvals are then made by the individual GSA Boards of Directors at their public meetings.

Further, by participation as either a GSA or in the GSA Groups, SDAC and DAC community members have been included in the decision-making process, and their input has been considered in the development of the 2024 and 2025 Plan, including in the development of all SMCs and selection of the SGMA monitoring network. These SDAC and DAC community members include Arvin CSD (participating entity of the SOKR GSP Executive Committee), Greenfield County Water District GSA (Kern River GSA), Buttonwillow Community Water District (BVGSA), and the City of Shafter on behalf of the City of Shafter, Wasco, McFarland, and Delano (NCK Steering Committee). The active participation of these entities is just one way in which the interests of DACs have been considered, in addition to the coordination with Self-Help Enterprises.

Additionally, as described below in Section 5.10.3.2, underrepresented farmers are included in the decision-making process through partnership with the Kern County Farm Bureau.

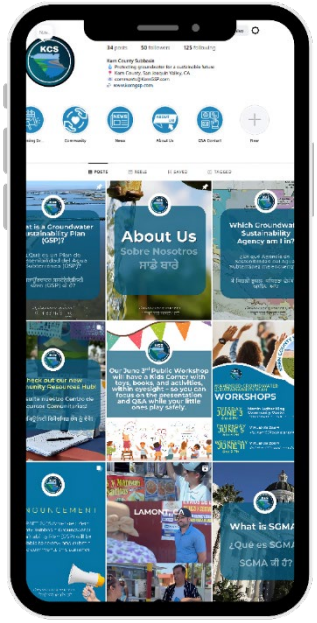
☑ 23 CCR § 354.10(d)(1)

The Kern Subbasin GSAs have maintained ongoing stakeholder engagement since the 2020 GSPs were developed. Stakeholder engagement type groups were identified by Kern Subbasin GSAs in the SCEP (Table 2 of Appendix F-1) and the CO&ES (Appendix F-3) to streamline outreach efforts and include all stakeholder groups using the various venues of engagement. These relationships facilitated a collaborative and engaged process for developing this 2025 Plan. This section describes the agencies and stakeholders that were consulted and how their input was considered. Ongoing outreach and engagement are also addressed in the following section, as well as future events in Appendix F-4.

In 2025, several new engagement strategies were implemented and are described below. Additionally, focus groups, community pop-up events were implemented and are described above under Section 5.10.1 Public Meetings and Appendix F-3.

Creation and Maintenance of New Social Media Sites

New resource for the community to access SGMA education, Kern Subbasin updates, notices of public events and announcements, sharing of available resources. Content available in English, Spanish, and Punjabi.



Facebook

https://www.facebook.com/profile.php?id=61574845984748

Instagram: https://www.instagram.com/kerncountysubbasin/

FACEBOOK

INSTAGRAM

Regular Meetings with Local Drinking Water Advocacy and Small/ Underrepresented Grower NGOs and Non-Profits

Active participation included attendees from the following organizations. Additional similarly focused organizations received invitations to meetings and were included on the groups email chains.

- Central California Environmental Justice Network
- Clean Water Action
- Kern County Black Farmers Association
- Kern County Farm Bureau
- Kern Water Collaborative
- Self-Help Enterprises
- University of California Division of Agriculture and Natural Resources (Community Water Systems Group)
- Water Association of Kern County

Creation of a Community Resources Webpage

A new webpage was added to the Kern Subbasin website serving as a one-stop guide to educational, informational, and engagement resources for community members

interested in staying involved or learning more about SGMA and how to get involved with their GSA. Links to the English, Spanish, and Punjabi sites are below:

- English: https://kerngsp.com/community-resources/
- Spanish: https://kerngsp.com/centro-de-recursos-comunitarios-del-subsuelo-del-condado-de-kern/
- Punjabi: ਕਮਿਊਨਿਟੀ ਰਿਸੋਰਸਿਜ਼ ਹੱਬ - Kern Subbasin Groundwater Sustainabilityhttps://kerngsp.com/community-resources/

☑ **23 CCR § 354.10(d)(2)**

5.10.3.2 Stakeholder Involvement

The GSAs recognize that stakeholder engagement occurs on both an individual GSA and Subbasin-wide level. The GSAs have approved ongoing Subbasin-wide coordinated engagement efforts. In addition, individual GSAs are responsible for maintaining the existing partnerships and avenues of engagement established during GSP development process (as described below) to ensure ongoing stakeholder engagement.

Throughout the process of developing the 2024 and 2025 Plans, the Kern Subbasin has engaged stakeholders and has solicited active involvement. This section describes that stakeholder engagement and how their feedback was incorporated into the Plan. Section 5 of the SCEP (Appendix F-1) and the CO&ES (Appendix F-3) further details how interested parties were included in direct GSA communication, focused initiatives outreach, education outreach, interdependent partnerships, monitoring, and data sharing.

- Worked with Kern County Environmental Health (KCEH) and Kern County Water Agency (KCWA) to obtain local well completion report datasets and other related records to develop a Subbasin-wide Well Inventory. Future efforts will continue working with KCEH, KCWA, and the GSAs to finalize the well inventory. Refer to Section 14.2.3, Project/Management Action (P/MA) KSB-7 for details on actions to finalize the well inventory. Additionally, the Kern Subbasin will work with DWR to identify opportunities to maintain the well inventory by linking the DMS with OSWCR.
- Worked with local purveyors, municipalities, and Division of Drinking Water staff in the Fresno Branch to develop a comprehensive list of public water systems in the Kern Subbasin and verify the accurate location and status of wells found in the GAMA and SDWIS databases.
- Engaged DWR's California Aqueduct Subsidence Program (CASP) staff on subsidence evaluation related to various non-GSA causes of subsidence and establishing Sustainable Management Criteria (SMC) for the California Aqueduct.

Data derived from various Kern Subbasin studies pertaining to the rate and cause of subsidence along the northern Aqueduct has been shared with CASP senior management in a series of technical meetings. These issues are further discussed in Section 8.5.2, including continued coordination on other areas of the Aqueduct that are likely experiencing non-GSA related subsidence, and future monitoring and studies that will be conducted in cooperation with CASP.

- Engaged the Friant Water Authority (FWA) on subsidence evaluation and establishing SMC criteria for the Friant-Kern Canal. FWA has a firm position that the Kern Subbasin GSAs should minimize and mitigate lost conveyance capacity post-2020 due to ongoing subsidence attributable to groundwater pumping under GSA jurisdiction. Refer to Section 14.2.3 for details on how FWAs concerns are incorporated into this 2025 Plan. Appendix G-3 is a letter from FWA expressing their appreciation for the subsidence subcommittee's candor and transparency during the SMC development process, their understanding of the Kern Subbasin's remaining work, and their confidence that the proposed additional work will properly mitigate impacts to the FKC.
- Partnering with Self-Help Enterprises (SHE) to administer the Well Mitigation Program. Refer to Section 14.2.3, P/MA KSB-5 and the Well Mitigation Program which launched on January 1, 2025 (Appendix G-1).
- Partnering with Kern Water Collaborative (KWC) to facilitate data sharing and agree to a future partnership during program implementation. Refer to Section 14.2.3, P/MA KSB-2 for details about the Kern Subbasin's coordination efforts with various water quality regulatory programs and intent to partner with these programs on monitoring, data sharing, and mitigation when needed. Appendix C-5 provides a Memorandum of Understanding with Kern Water Collaborative to document the ongoing partnership opportunities. Appendix C-6 clarifies the expansion of the Kern Water Collaborative's Nitrate Control Program within the Kern Subbasin, which provides nitrate well testing and alternative drinking water program to include domestic well users throughout the entirety of the Kern Subbasin as delineated in Bulletin 118.
- Partnership and financial support to the Water Association of Kern County (WAKC), a non-profit organization whose mission is to inform and educate the public and water community about water issues in Kern County. GSAs will partner with WAKC to participate in community events such as water awareness fairs and other public events that will support inclusive public outreach and engagement. Examples of outreach events include Kern Talk Radio segments, Faces of Kern podcasts, bi-monthly luncheons where water professionals present on water management topics, TV series on a local lifestyle segment focused on water topics, social media posts, and participation in various community events.

- Coordination with ILRP Coalitions leadership to engage members in SGMA related topics. Similar to the Kern Water Collaborative partnership, this coordination is focused on data sharing and alignment of monitoring programs. Refer to Section 15.2.4, *Monitoring Network for Degraded Water Quality*, for additional information.
- Collaboration with Kern County Farm Bureau to engage its members in SGMA related topics. This local chapter of the California Farm Bureau Federation is a non-profit organization of farmers and ranchers whose mission is to *"… represent agriculture interests through public relations, education, and public policy advocacy in order to promote the economic viability of agriculture*…." Through this collaboration, the Kern Subbasin GSA seek to build relationships with Socially Disadvantaged Farmers and Ranchers (SDFAR) and Small-Scale farmers[14] to educate them on SGMA, and to solicit their input on GSP implementation. Stakeholder engagement included hosting free Tailgate Talks and updates sent through existing communication channels within the Farm Bureau's network.

Continued Outreach to Engage Stakeholders and Landowners

The Kern Subbasin will continue to engagement with stakeholders and landowners during GSP implementation as described in F-1.5 of the SCEP, which details the different outreach and engagement activities between each identified engagement type group. A summary of these outreach and engagement activities from the SCEP are highlighted below:

1. Direct GSA Communication

GSAs are responsible for direct outreach to groundwater users within their service areas. This includes public meeting notifications, social media updates, Tailgate Talks, and participation in advisory committees. GSAs also maintain relationships with municipal water providers, tribal entities like the Tejon Indian Tribe, and environmental stakeholders. Continued collaboration with adjacent subbasin GSAs and data sharing are emphasized to support regional groundwater management.

2. Focused Initiatives Outreach

This group includes sensitive users such as disadvantaged communities (DACs) and domestic well owners. Outreach efforts center around the Well Mitigation Program, developed in partnership with Self-Help Enterprises (SHE). GSAs engage NGOs, Community Partners, community-based organizations, and water well contractors through workshops, direct mail, and community events. Annual meetings and

[14] SGMA and Underrepresented Farmers. Impacts of Groundwater Sustainability Plans on Underrepresented Farmers. May 2022.

targeted communications aim to inform residents about water quality issues and available mitigation resources.

3. Targeted Outreach and Education

Industrial stakeholders, particularly those affected by subsidence near infrastructure like the California Aqueduct, are engaged through focused meetings and workshops. GSAs collaborate with oil and gas industry representatives and technical experts to address concerns and share data related to subsidence and groundwater impacts.

4. Interdependent Partnerships

Entities such as the California Aqueduct Subsidence Program (CASP) and Friant Water Authority (FWA) play critical roles in protecting water conveyance infrastructure. GSAs maintain ongoing communication with these partners through technical meetings and quarterly coordination. These partnerships are essential for monitoring subsidence and implementing mitigation strategies.

5. Monitoring and Data Sharing

GSAs coordinate with agencies like KCWA and the Kern River Watershed Coalition Authority to collect and share groundwater and surface water data. Monitoring wells and water bank data contribute to the SGMA Representative Monitoring Network, supporting annual reporting and long-term sustainability evaluations.

Representation of Various Stakeholders in Each GSA

As identified in Section 5.6, the Kern Subbasin contains diverse land uses and stakeholders reliant on groundwater, including agriculture, urban and rural communities, industrial and oil fields, DACs, and tribal communities, among others. As part of the SCEP (Appendix F-1), stakeholder engagement group types were defined to guide outreach action, and individual stakeholders were identified to include representation of all beneficial uses and users within the Kern Subbasin. Past, current, and future representation of these various stakeholders and outreach as part of this 2024 Plan are in the SCEP of Appendix F-1 and include:

- SDAC and DAC representation, for example Arvin CSD within the SOKR GSA Group holds a director position on the SOKR GSP Executive Committee; similar positions are held by the City of Shafter in NCK GSP Group, Greenfield County Water District in Kern River GSA, and Buttonwillow Community Services District in Buena Vista GSA.
- Urban representation is primarily provided by the City of Bakersfield and Cal Water participating in the Kern River GSA. Smaller municipalities in the South and North Basin HCM Areas are disadvantaged communities and are represented through their positions in the GSA Group Executive Committees.

- Non-agricultural community representation is primarily through stakeholders in the Eastside Water Management Area.
- Direct outreach with the Tejon Indian Tribe regarding water supply planning to support future development of the Hard Rock Casino.
- Small community and domestic well owners and operators were consulted by the GSAs and SHE to inform development of the Well Mitigation Program.
- Industrial water users, for example the Western States Petroleum Association (WSPA), were in direct communication with the GSAs through the submission of a comment letter that was addressed by the GSAs in revisions to the 2024 Plan.
- GSA partnerships with the communities of Delano, McFarland, Shafter, Wasco, Arvin, Lamont, Bakersfield, and the County of Kern have established representatives to participate in local community events to promote engagement with the Well Mitigation Program.

☑ 23 CCR § 354.10(d)(3)

5.10.3.3 Public Notification

As described above, outreach and communication with the public are conducted at the Kern Subbasin, GSA Group, and GSA levels. The Kern Subbasin GSAs and Kern Subbasin GSA Groups inform the public on Plan updates, status, and actions. This includes making key Plan development and implementation (including P/MAs) decisions in an open and transparent fashion during public GSA Board meetings and GSA Group meetings, holding periodic stakeholder workshops to communicate progress on Plan implementation status and initiation to stakeholders, and receiving input on upcoming decisions and work efforts. As required, the Kern Subbasin GSAs follow Prop 218 processes including proper public notification holding a public hearing, amongst other steps. The Kern Subbasin GSAs will continue to publicize all Board meetings, Kern Subbasin GSA Group meetings, and stakeholder workshops on their respective websites (Appendix F-4). Kern Subbasin GSAs also consider translation of SGMA-related meetings and documents into Spanish and other languages as needed to ensure language accessibility for the stakeholder population within the GSA's area, and virtual meetings to reduce the accessibility challenges that may be presented with in-person meetings.

The GSAs have produced fact sheets to accompany public workshop materials to contribute to targeted outreach and education in English, Spanish, and Punjabi. Additionally, all relevant information regarding the 2025 Plan is posted on www.KernGSP.com, and the GSAs have developed a platform to receive comments submitted to comments@kernGSP.com.

Furthermore, this Plan was designed to ensure effective public notification regarding P/MAs. Specifically, given the large suite of Kern Subbasin P/MAs, each GSA has

individual P/MA tables and separate appendices containing details that can easily be extracted and disseminated to local stakeholders and interested parties.

The Kern Subbasin DMS is available to the public and contains monitoring networks and associated data, geospatial datasets, and other information utilized during the Plan development process (https://dms.geiconsultants.com/kern/). Monitoring and compliance data for each applicable sustainability indicator is also available for public review through the DMS Map Viewer tools. Additionally, all relevant information regarding the 2025 Plan and GSA activities (i.e., annual reports, special studies, public engagement events, WeI Mitigation Program, etc.) will be posted on www.KernGSP.com.

Various information is also available on the DWR SGMA Portal such as GSA Formational documentation, GSP submittals, and other SGMA Resources (https://sgma.water.ca.gov/portal/). Furthermore, anyone may subscribe to DWR's list serve and receive email notifications for SGMA related news.

☑ 23 CCR § 354.10(d)(4)

5.10.4 Interagency Coordination

As discussed in Section 1.2.3, interagency coordination exists between the Kern Subbasin's GSAs to promote collaboration between the GSAs, develop and organize implementation and monitoring plans, and produce Subbasin-wide technical solutions. Examples of this coordination include the Technical Working Group (Section 1.2.3.1) and the Attorney Working Group (Section 1.2.3.2), whose goals are to develop technical recommendations and provide legal counsel at a Subbasin-wide level.

In addition to these working groups, interagency coordination exists between the Kern Subbasin's GSAs through ad-hoc advisory coordination committee and Managers meetings (Section 1.2.3.3) to ensure coordination on major Plan development topics, including methodologies and data sources used to develop the Basin Setting, Water Budget, and Sustainable Management Criteria.

5.10.5 Interbasin Coordination

The Kern Subbasin GSAs have participated in interbasin coordination with the neighboring White Wolf Subbasin, Tule Subbasin, and Tulare Lake Subbasin. Examples of coordination topics include subsidence concerns along the Friant-Kern Canal, delineation of the White Wolf Fault, and cross-boundary flows between subbasins. Further, Kern Subbasin GSAs have jurisdictional overlap over multiple basins (i.e., Kern-Tulare Water District GSA).

In development of the numerical flow model, technical consultants from Kern Subbasin met regularly with representatives from Tulare Lake and Tule Subbasins. These working meetings helped calibrate the subsurface flow simulated in the neighboring basins.

As part of the ongoing Basin Study, technical consultants from Kern Subbasin will continue to meet and collaborate with adjacent subbasins to ensure consistent representation of cross-boundary flows.

6. INTRODUCTION TO BASIN SETTING

6.1 Basin Setting Organization

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

☑ 23 CCR § 354.12

The basin setting provides the foundation on which to evaluate sustainability indicators, select appropriate sustainability criteria, and develop projects and management actions to achieve and maintain groundwater sustainability. As provided in the SGMA Regulations, the basin setting is based collectively on three related analyses:

- **Section 7 - Hydrogeologic Conceptual Model (HCM) (§ 354.14)**. Provides a descriptive hydrogeologic conceptual model that summarizes the regional geologic and structural setting, lateral basin boundaries, definable bottom of the basin, principal aquifers, and aquitards and physical characteristics of Kern Subbasin.
- **Section 8 - Groundwater Conditions**. **(§ 354.16)**. Provides a description of current and historical groundwater conditions in Kern Subbasin from January 1, 2015 to current conditions including groundwater elevation contour maps and hydrographs, estimated change in storage, seawater intrusion, groundwater quality, land subsidence, interconnected surface water, and groundwater dependent ecosystems.
- **Section 9 - Water Budget (§ 354.18)**. Provides an accounting of inflows and outflows of the groundwater system including an analysis of historical and current conditions to develop an estimate of sustainable yield for Kern Subbasin. The water budget analysis also provides a baseline on which to project the water budget analysis into the future using projected water supplies and reasonable estimates of land use and water demand.

6.1.1 DWR Groundwater Basin

The Kern Subbasin (Subbasin 5-22.14, DWR, 2006) is one of 19 basins and subbasins identified in Bulletin 118 (DWR, 2006) as part of the greater San Joaquin Valley Groundwater Basin that extends over the southern portion of the Great Central Valley of California. DWR Bulletin 118 identifies the Kern Subbasin (Figure 6-1) as located within

the Tulare Lake Hydrologic Region (HR) which covers approximately 10.9 million acres (17,000 square miles) of the southern San Joaquin Valley. The HR has 12 distinct groundwater basins and seven subbasins of the San Joaquin Valley Groundwater Basin (Figure 6-1). These basins underlie approximately 5.33 million acres (8,330 square miles) or 49 percent of the entire HR.

The HR also corresponds to the Tulare Lake Basin that is used for the development of water quality control plans, or basin plans, which contain California's administrative policies and procedures for protecting state waters. Basin plans are required by the Porter-Cologne Water Quality Control Act (California Water Code, §13240). Basin plans complement water quality control plans adopted by the State Water Resources Control Board (SWRCB). In addition, Section 303 of the federal Clean Water Act requires states to adopt water quality standards that “consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses” (CVRWQCB, 2018).

Basin plans consist of designated beneficial uses to be protected, water quality objectives to protect those uses, and a program of implementation needed for achieving the objectives (California Water Code, §13050(j)). California's basin plans serve as regulatory references for meeting both state and federal requirements for water quality control (40 CFR Parts 130 and 131); however, California's basin plans also establish standards for groundwater in addition to surface waters (CVRWQCB, 2018).

6.2 Kern Subbasin

The Kern Subbasin is one of the largest groundwater basins in the state, covering approximately 1,7982,000 acres (2,800 square miles). Kern Subbasin’s boundaries were defined by DWR (2016) and were described as geographically bounded to the east by the Sierra Nevada Mountain Range, to the west by the Southern Coast Ranges, and to the south by the Tehachapi and San Emigdio Mountains. The northern boundary of Kern Subbasin is a jurisdictional boundary, which is the border between Kern County and Tulare County and Kings County (Figure 6-2). Kern Subbasin borders four other DWR basins, these include:

- Tule Subbasin (Subbasin 5-22.13, DWR, 2006)
- Tulare Lake Subbasin (Subbasin 5-22.12, DWR, 2006)
- Kettleman Plain Subbasin (Subbasin 5-22.17, DWR, 2006)
- White Wolf Subbasin (Subbasin 5-22.18, DWR, 2018)

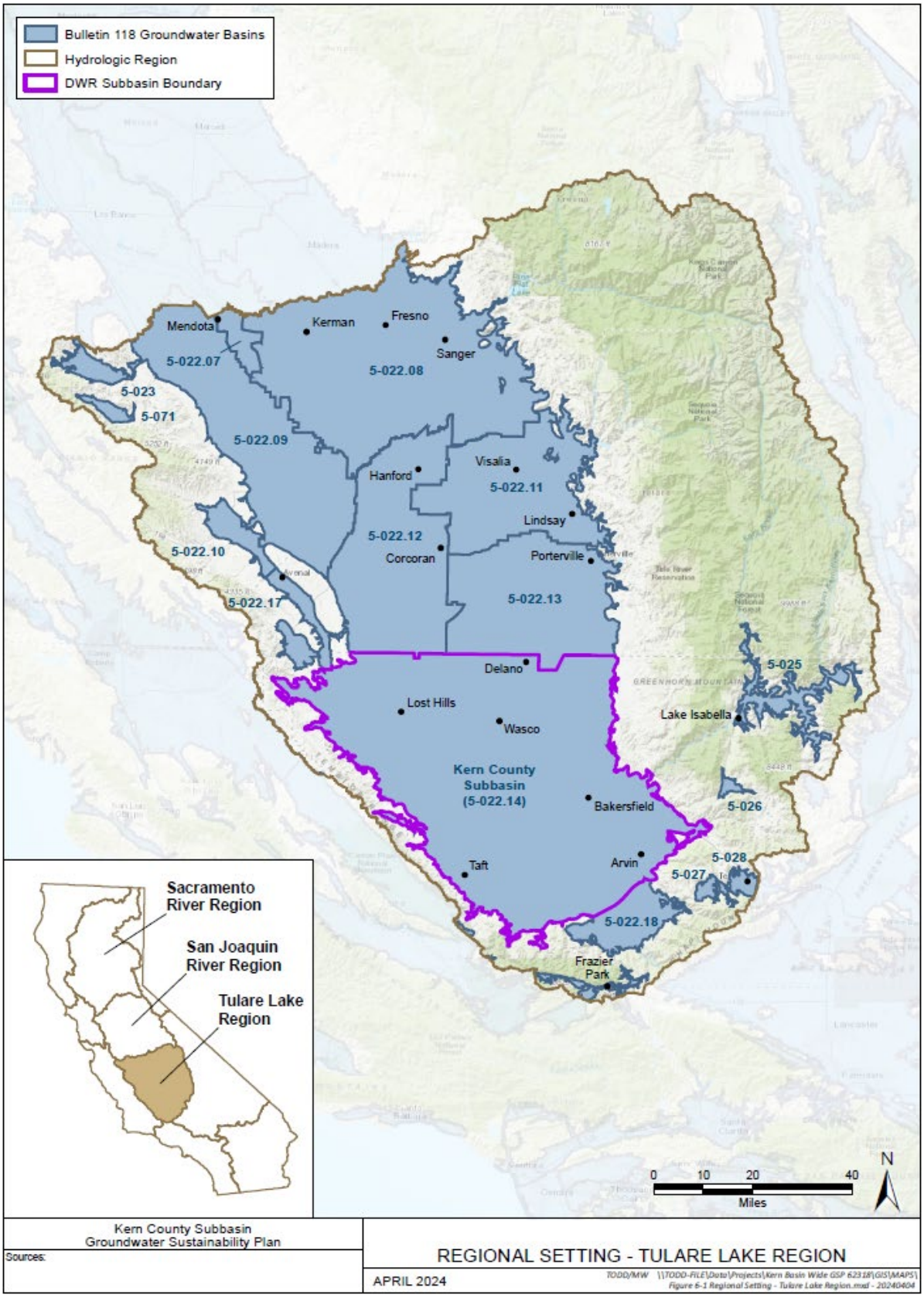


Figure 6-1. Regional Setting Tulare Lake Region

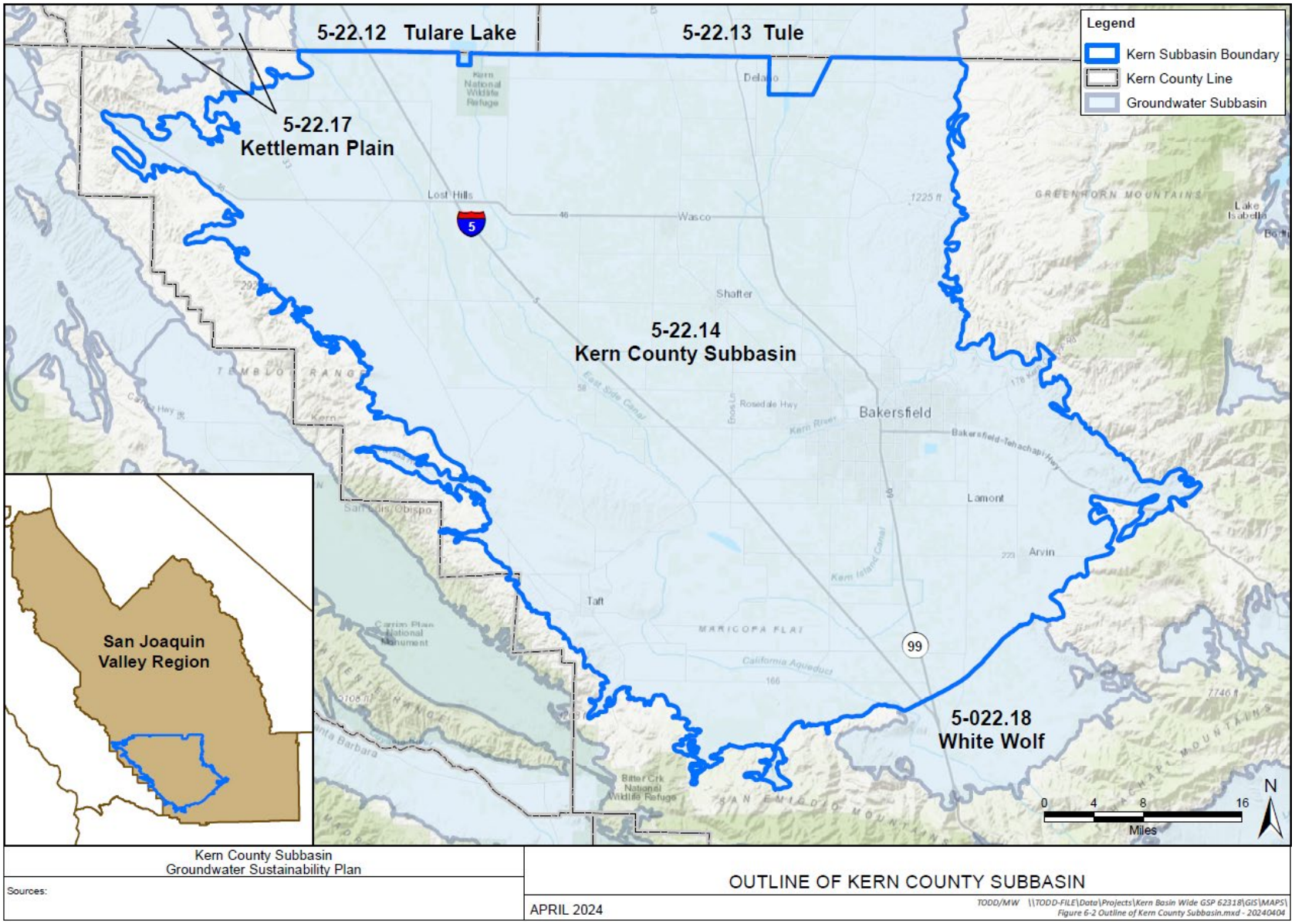


Figure 6-2. Outline of Kern Subbasin

The groundwater resources in Kern Subbasin are significant, and most of the water supply for the area comes from underground aquifers, usually occurring in the uppermost 3,000 feet (Page, 1973). The main sources of natural recharge to the groundwater system are precipitation in the form of rain and snow, and seepage from rivers and streams. An additional important contributor is imported water through infiltration and artificial recharge from water banking, which involves capturing and storing excess surface water in aquifers during wet periods for later use during dry periods (DWR, 2006).

6.2.1 Kern Subbasin HCM Areas

Kern Subbasin is a large and geologically complex basin with regional faulting, folding and three principal aquifers. To help with presenting how this complex geology applies to various components of this 2025 Plan, five HCM Areas have been defined within Kern Subbasin (Section 5.2). The five HCM Areas shown on Figure 6-3 include:

- **North Basin HCM Area** – This area corresponds to the large alluvial basin north of the Kern River Fan area that is a major agricultural area. This area is underlain by a thick sequence of alluvial sediments that form a highly productive aquifer. The presence of clay layers, primarily the E-Clay, influences vertical flow of groundwater to form distinctive aquifer zones in some areas. Kern County Environmental Health Services (KCEHSD) water well ordinance requires that wells drilled north of the Kern River Alluvial Fan seal to the E-Clay (Page, 1986).
- **Kern River Fan HCM Area** – This area corresponds to the Kern River Alluvial Fan. The Kern River is a large hydrologic feature that provides both a major local surface water supply and source of groundwater recharge. The coarse alluvial sediments with limited clay layers make this the prime area for managed recharge and water banking. These operations generate a distinctive groundwater response seen on hydrographs.
- **South Basin HCM Area** – This area corresponds to the large alluvial basin south of the Kern River Fan area that is the other major agricultural area that is underlain by a thick highly productive alluvial aquifer. KCEHS water well ordinance requires that wells drilled south of the Kern River Alluvial Fan seal to the E-Clay (Page, 1986).
- **Eastern Margin HCM Area** – This area along the eastern Kern Subbasin margin where water supply is derived from older geologic units. In the northeast area, the Santa Margarita and Olcese Principal Aquifers provide water supply. This area includes several large fault-bounded oil fields. In the southeast, the Edison Fault forms a groundwater flow barrier.

- **Western Fold Belt HCM Area** – This area along the western Kern Subbasin margin generally corresponds to the West Side Fold Belt of Bartow (1991). This is the more intensely folded area dominated by open range land, large oil fields and poor-quality water. Only minimal groundwater pumping occurs in this HCM Area due to the poor water quality. Due to these factors, agricultural and urban water supplies are either imported or derived from other HCM Areas.

These five HCM Areas identify hydrogeologically similar areas within Kern Subbasin, and, as a result, Kern Subbasin GSAs may be included in multiple HCM Areas (Figure 6-4). Additional information defining the hydrogeological characteristics of each HCM Area is presented in Section 7. The overall approach for Kern Subbasin is to have a series of organizing themes that will be emphasized throughout the GSPs. One of these themes is to define the Basin Setting in terms of the five HCM Areas. The HCM Areas provide a consistent Subbasin-wide framework to incorporate the hydrogeological variability of Kern Subbasin into various components of this 2025 Plan, including support of the definition of undesirable results and sustainability criteria. The HCM-area approach is consistent with that used in the Water Quality Control Plan for the Tulare Lake Basin (CVRQWCB, 2018), also referred to as the Tulare Lake Basin Plan. As shown on Figure 6-5, the HCM Areas show strong similarities to the hydrologic areas used in the Tulare Lake Basin Plan. Note that the HCM Areas (based on hydrogeology and aquifer characteristics) are distinct from Management Areas, which are described in more detail in Section 10.

6.2.2 Kern Subbasin Aquifer Types

Continental deposits that overlie the marine deposits provide the most productive freshwater aquifers in Kern Subbasin (Bertoldi et al., 1991). The marine sediments with confined fresh water provide local areas of productive freshwater aquifers in Kern Subbasin. The isolated marine rocks with saline connate water are not considered as usable water sources because of their poor water quality and lack of recharge. There are three distinct geology-based groundwater occurrences in Kern Subbasin (Davis et al., 1964; Hilton, 1963). These include:

1. Unconfined and semiconfined fresh water in continental alluvial deposits of Recent, Pleistocene, and possibly late Pliocene age. These continental deposits overlie the marine deposits and contain most of the freshwater in Kern Subbasin.
2. Confined fresh water, contained in marine sediments of Miocene age where surface recharge from outcrop areas has flushed the original saline connate water (water trapped in the pores of sedimentary rocks since they were deposited) and now contain freshwater. This condition occurs in limited areas, primarily along the eastern Kern Subbasin margin that form locally important aquifers.

3. Saline, connate (water trapped in the pores of sedimentary rocks since they were deposited) water contained in marine sediments of middle Pliocene or older age, which underly the fresh-water body throughout the area. Most of the marine sediments in Kern Subbasin contain highly saline, connate water.

These aquifer types have been recognized by researchers and practitioners in the southern San Joaquin for decades (Davis et al., 1964; Hilton, 1963; Bertoldi et al., 1991) and will be used in characterizing the aquifers in this 2025 Plan.

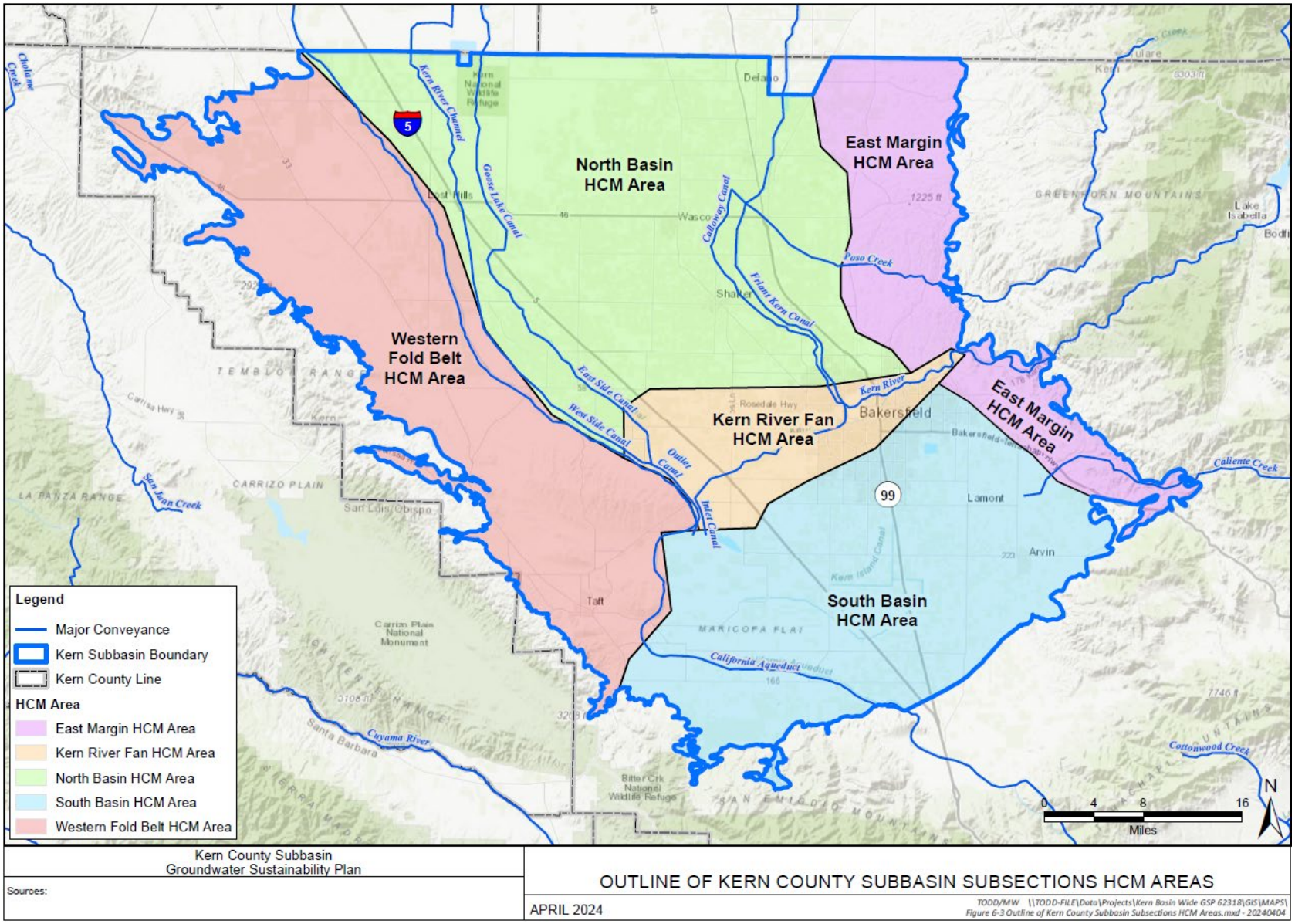


Figure 6-3. Outline of Kern Subbasin Subsections HCM Areas

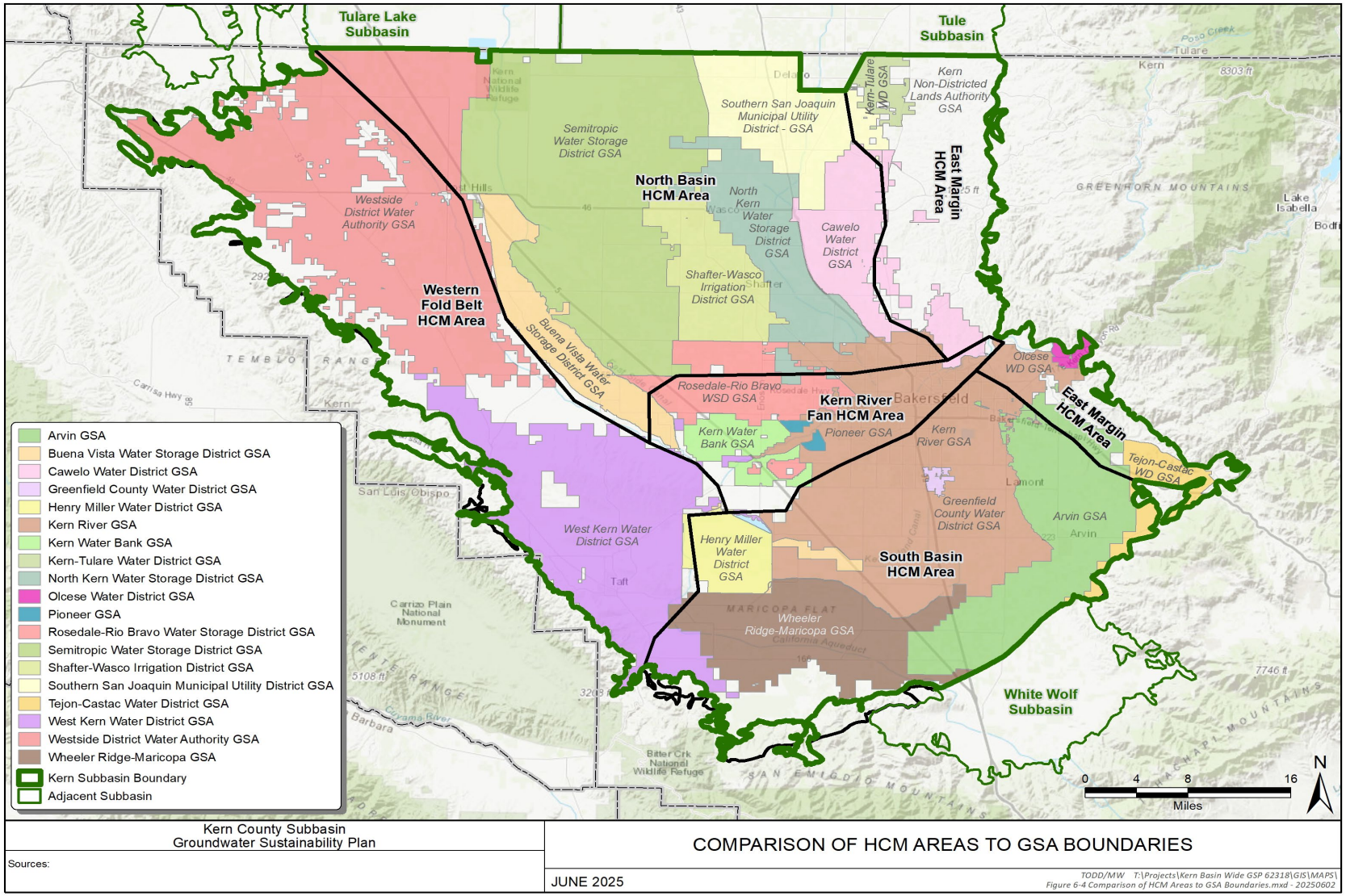


Figure 6-4. Comparison of HCM Areas to the Kern Subbasin GSA Boundaries

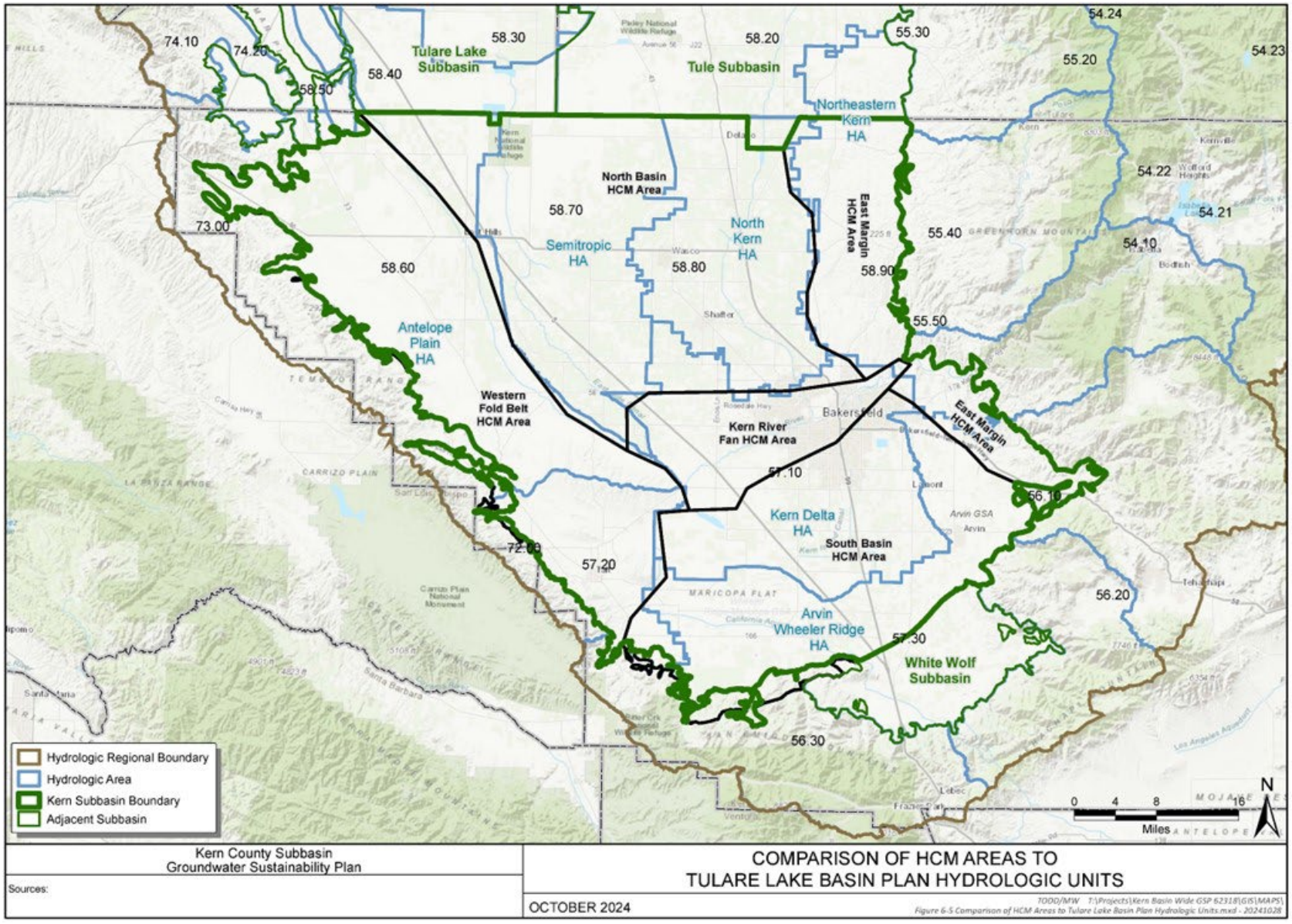


Figure 6-5. Comparison of HCM Areas to the Tulare Lake Basin Plan Hydrologic Areas

7. HYDROGEOLOGICAL CONCEPTUAL MODEL

§ 354.14. Hydrogeologic Conceptual Model

Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

☑ 23 CCR § 354.14(a)

This section presents the hydrogeologic conceptual model (HCM) for the Kern Subbasin. Numerous descriptions and reports of local hydrogeologic conditions are available for Kern Subbasin. The key reports used within this report to develop the HCM include: Wood and Davis, 1959; Dale, French and Gordon, 1966; Croft, 1972; Bartow and Pittmann, 1983; Page, 1986; Bartow and McDougall, 1984; and Bartow, 1991. Details from previous investigations include:

- Regional geologic and structural setting of Kern Subbasin
- Geologic features affecting groundwater flow
- Vertical and lateral boundaries
- Primary aquifers and aquitards
- Groundwater elevations and flow direction over time
- Water quality

A general illustration of the HCM is illustrated on the schematic diagram in Figure 7-1 from Bartow (1991) that shows the general subsurface conditions in Kern Subbasin and the surrounding highlands.

As described in the Hydrogeological Conceptual Model Best Management Practices (BMP) (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 (Section 6) analyses including water budgets (Section 9) and numerical models, monitoring network development (Section 15), and the development of sustainable management criteria (Section 13).

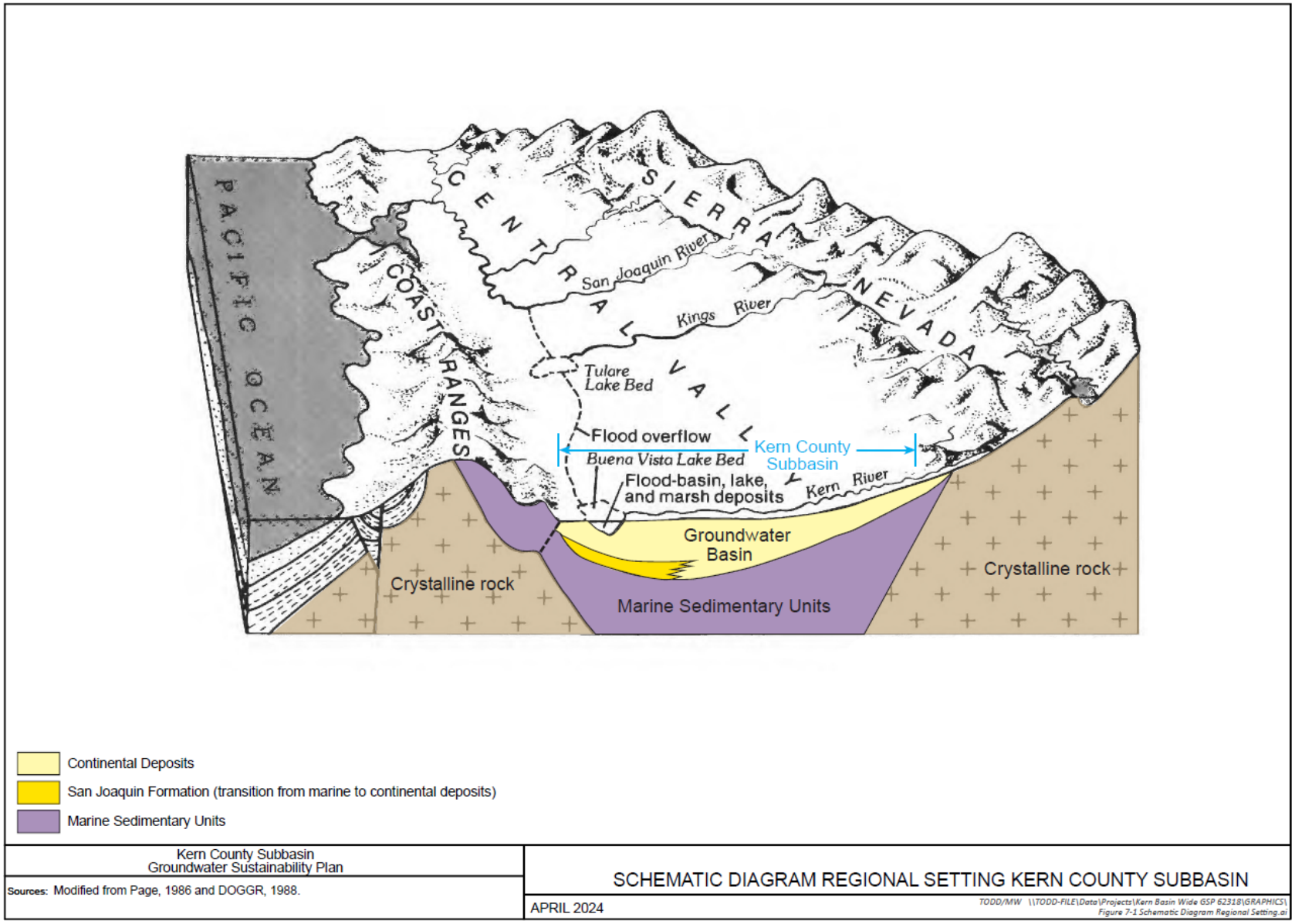


Figure 7-1. Schematic Diagram Regional Setting Kern Subbasin

7.1 Physical Characteristics

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

☑ 23 CCR § 354.14(d)

The following summarizes the physical setting of Kern Subbasin.

7.1.1 Topography

☑ 23 CCR § 354.14(b)

Kern Subbasin, which is located in the southernmost part of the San Joaquin Valley, is both a topographic and a structural basin. Kern Subbasin is situated within the topographic horseshoe that is bordered on the east and southeast by the Sierra Nevada, on the west by the Southern Coast Ranges, and on the south by the White Wolf Subbasin and the San Emigdio and Tehachapi Mountains (Davis et al., 1959; Davis et al., 1964). A topographic contour map based on the Digital Elevation Map (DEM) of the topography from the United States Geological Society (USGS) National Elevation Dataset (NED) is also shown on Figure 7-2. Elevations within Kern Subbasin range from 1,500 to 2,000 feet in the mountain foothills along the basin margin to 215 feet at the Kern National Wildlife Refuge along the northern Subbasin boundary.

The surface of the valley floor is characterized by various types of topography which may be grouped into several geomorphic units. The valley floor is characterized by four geomorphic units (Figure 7-2) as defined as (Davis et al., 1959; Davis et al., 1964):

- **Dissected upland geomorphic unit** – The dissected upland geomorphic units are areas of deeply dissected hill land that are primarily located along Kern Subbasin margins; however, isolated low ridges occur in the western and central Kern Subbasin. The topography ranges from gently rolling land to hilly areas with up to 500 feet of relief. Stream channels are typically incised by tens of feet; however, along the eastern Kern Subbasin stream cuts of over a hundred feet

occur along major streams such as Kern River, Poso Creek, and Caliente Creek (Davis et al., 1959; Davis et al., 1964).

- **Low alluvial plain and fan geomorphic unit** – The low plain and fan geomorphic units are generally flat areas that cover most of the valley floor. These plains are the site of the most intensive agricultural development. In the western portion of Kern Subbasin, the low plains and fans are areas of low relief that lie between the upland and foothill areas of the Western Fold Belt. Local relief is generally less than 10 feet and in most places is less than 5 feet (Davis et al., 1959; Davis et al., 1964).
- **River flood plain and channel geomorphic unit** – The river floodplain geomorphic units typically occur as narrow, disconnected strips that cross the plains and uplands at approximately right angles to Kern Subbasin margin. They have been flooded in recent times and generally lie below the level of the surrounding country (Davis et al., 1959; Davis et al., 1964). Kern River, Poso Creek and Caliente Creek have narrow floodplains that extend several miles out onto the low plains and alluvial fan areas.
- **Overflow land and lake bottom geomorphic units** – The overflow land and lake bottom geomorphic units include the historic lake beds of Tulare, Buena Vista, Kern and Goose Lakes along with the connecting areas of the Buena Vista and Jerry Sloughs (Davis et al., 1959; Davis et al., 1964). These are the topographic lowlands in the axial trough of the valley; therefore, these areas form the lowest topographic elevations in Kern Subbasin. These lowland areas were poorly drained under natural conditions when they were flooded periodically by the larger streams carrying runoff from the Sierra Nevada.

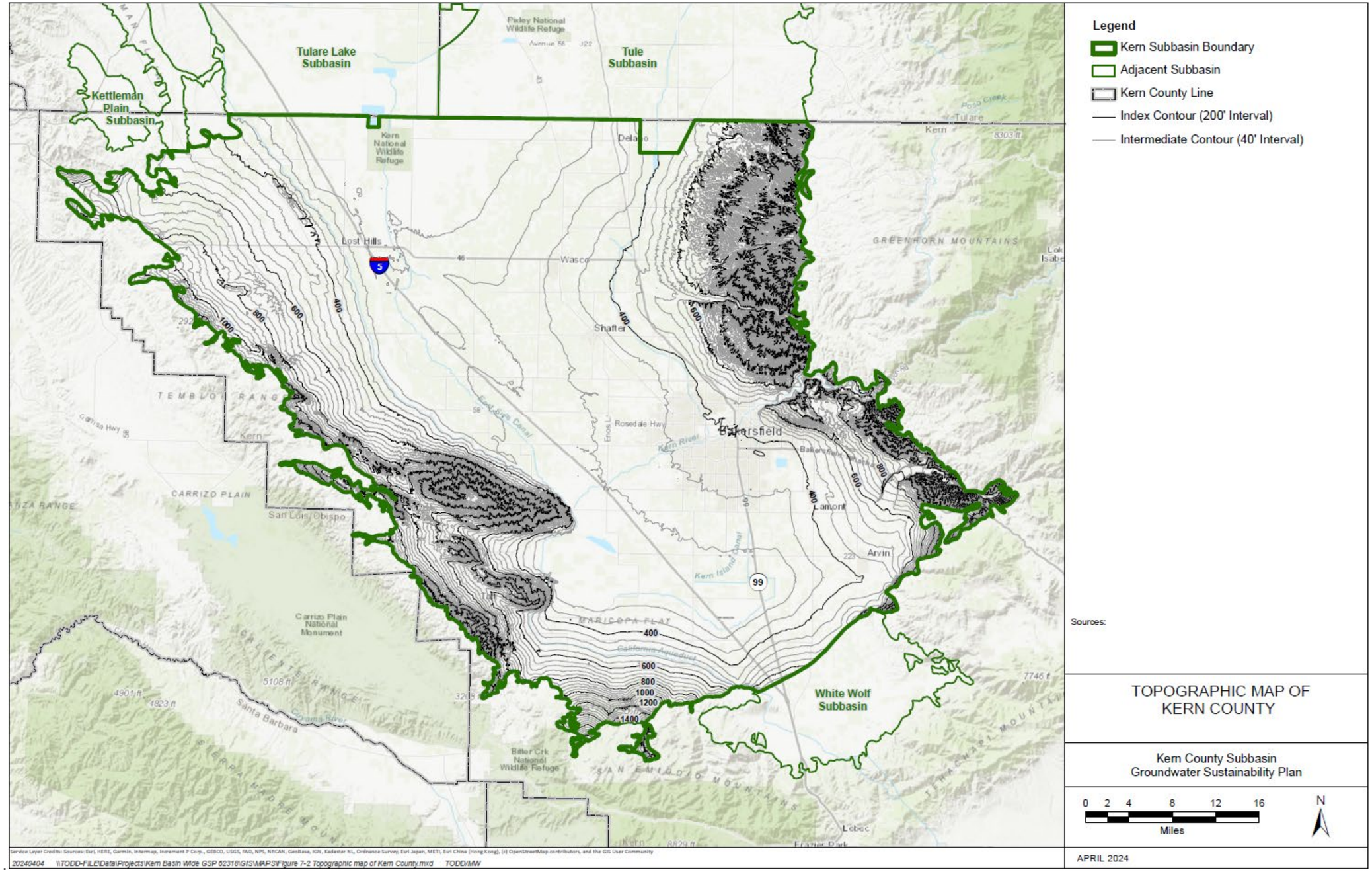


Figure 7-2. Topographic Map of Kern County

7.1.2 Surface Water Bodies

☑ 23 CCR § 354.14(d)(5)

Kern Subbasin is considered a closed hydrologic basin that is characterized by internal drainage (Davis et al., 1959; Davis et al., 1964). The principal rivers and streams within Kern Subbasin are the Kern River, Poso Creek, and Caliente Creek.

7.1.2.1 Rivers, Streams, and Watersheds

The Kern River is the largest river in Kern Subbasin (Figure 7-3) and flows through the Kern Fan HCM Area. The Kern River is about 165 miles long and drains snowmelt and runoff from a watershed of approximately 2,400 square miles. The watershed extends to approximately 13,866 feet near Mt. Whitney in the Sierra Nevada (USGS Stream Stats, 2024). Since 1953, flows in the Kern River have been regulated at Isabella Dam, about 25 miles upstream of Kern Subbasin. The Kern River enters Kern Subbasin at the Kern Gorge fault and flows southeastward across Kern Subbasin. Two permanent stream gage stations (First Point and Second Point) were established to measure flow in the Kern River. The computed natural flow at First Point is used to allocate water among the various Kern River interests, referred to as First Point diverters, Second Point diverters, and Lower River diverters. The Second Point of measurement is approximately 20 miles downstream of First Point and is used to check upgradient water use (and entitlements) with diversion rights downgradient of Second Point (Boyle, 1975). In 1954, Isabella Dam was constructed for flood control on the Kern River. Since 1954, high flows in the Kern River exceeded 2,000,000 acre-feet per year (AFY) three times - in 1969, 1983 and 2023. During water years 1995 through 2022, computed natural flows at First Point have ranged from 2,442,481 AFY (1998) to 131,063 AFY (2015). The low flows observed in 2015 represent the historical low flow condition for First Point measurements dating back to 1954.

Poso Creek is an intermittent stream that cuts from east to west across the dissected foothill belt onto the valley floor mainly in the North Basin HCM Area and extends as a defined channel several miles westward to the Kern National Wildlife Area (Figure 7-3). Its watershed originates in the Greenhorn Mountains of the South Sierra Nevada Mountain Range at an elevation of approximately 8,000 feet (CWD, 2007). There are multiple stream gages on Poso Creek. Flows are measured at Trenton Weir near State Highway 65. The annual flow at this site has exceeded 120,000 AFY, but for many years it has little to no flow. While flows are variable, some landowners do occasionally exercise their riparian rights to divert water from Poso Creek during years of high flow. Starting in 1997, the use of Poso Creek water has been governed by an agreement between NKWSD, CWD, and SWSD, who collectively share the runoff of Poso Creek. Under this agreement, CWD is allocated the first 135 cubic feet per second (cfs) of Poso Creek flow (as measured at the State Highway 65 gaging station) and NKWSD receives flows between 135 cfs and 300 cfs and SWSD receives flows between 300 cfs

and 685 cfs. In 1976, Semitropic Water Storage District was issued a permit to divert water from Poso Creek for beneficial use with a volume limited to 66,000 AF. In 2000, Cawelo Water District was issued a permit to divert water from Poso Creek for beneficial use at a rate of approximately 110 cfs, with the volume limited to 30,000 AF between November 1 and June 14 of the following year.

Caliente Creek, located in the southeastern part of Kern Subbasin, has a floodplain about one mile wide; however, about 5 miles into Kern Subbasin, the floodplain level is no longer incised below the surface of the alluvial fan and is difficult to distinguish from the fan itself. The USGS operated a stream gage on Caliente Creek near the confluence of Tehachapi Creek from October 1961 through February 1983 (USGS gage 11196400). The gage had a contributing area of 165 square miles. Data from that gage shows that monthly average streamflow ranged from a minimum of 0.39 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 gage permanently. Storm-related flooding along the larger streams (i.e., Caliente Creek and Tejon Creek) is common in some areas such as Lamont and Arvin.

The streams that drain the Coast Ranges, Tehachapi, and San Emigdio Mountains are intermittent and typically flow only during the short rainy season (generally November through March). Numerous ephemeral streams occur along Kern Subbasin margin that may have locally incised channels that may continue several miles onto the alluvial fans and then vanish (Davis et al., 1959; Davis et al., 1964). The local ephemeral streams provide additional local surface water during above normal and wet water years. These streams are not gaged and generally only flow after precipitation events. A very small percentage of minor stream runoff is collected and used for irrigation; the majority of these irregularly occurring flows likely serve to recharge the Kern Subbasin (Kennedy and Jenks, 2011).

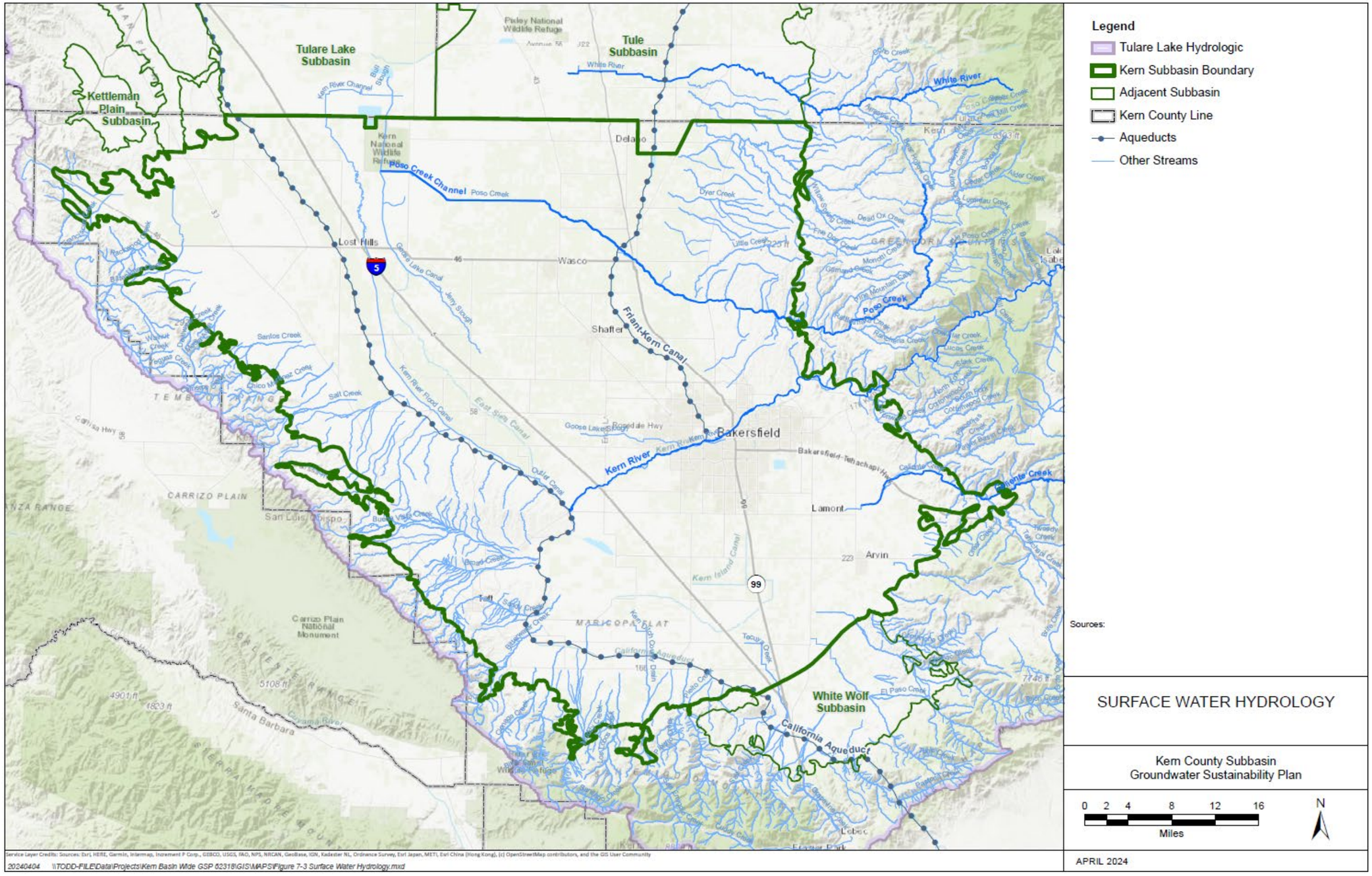


Figure 7-3. Surface Water Hydrology

7.1.2.2 Lakes and Reservoirs

Flows in the Kern River consist of regulated and managed releases from Lake Isabella, approximately 25 miles upstream of the Kern Subbasin (Figure 7-3). Isabella Dam and Lake Isabella were constructed by the U.S. Army Corp of Engineers (USACE) in 1953 to address downstream flooding. Since that time, Isabella Dam has been operated for flood control, hydroelectric power, water supply, and conservation storage. Reservoir storage and Kern River flow management are coordinated by the Kern River Watermaster, working with the USACE, participating water districts, and the City of Bakersfield. Except for periods of high runoff, releases from Lake Isabella are regulated through requests, or "calls" for water by the City of Bakersfield on behalf of the Kern River Watermaster.

Kern Subbasin is considered a closed hydrologic basin that is characterized by internal drainage (Davis et al., 1959; Davis et al., 1964). Surface water flows from the major rivers are generally toward one of several lakes including Buena Vista, Goose, and Kern lakes within Kern Subbasin and Tulare Lake in Kings County just north of Kern Subbasin. Historically, these lakes contained water, and the surrounding marshes and connecting sloughs were covered with rank vegetation (*e.g.*, weeds). Tulare, Buena Vista, Kern, and Goose lakes are typically dry, except during floods, because of diversions from tributary streams for irrigation (Davis et al., 1959; Davis et al., 1964). The narrow strip of land between Buena Vista Lake and Tulare Lake is referred to as the Buena Vista Slough. The slough, prior to development, was a marshy area. During extremely heavy runoff, flood flows in the Kern River may reach the Buena Vista Slough via the Kern River Floodway. Goose Lake and Jerry Slough are separated from the Buena Vista Slough by a series of low ridges of dissected uplands. Here the overflow lands trend northwest between the ridges and have a gentle slope toward the Kern National Wildlife Area and Tulare Lake.

Source and Point of Delivery for Imported Water Supplies

The sources of imported surface water used for irrigation in Kern Subbasin are the California State Water Project (SWP), the Federal Central Valley Project (CVP), and other supplemental surface water delivered via the California Aqueduct or Friant-Kern Canal (FKC) (Figure 7-4). The California Aqueduct, FKC and other local canals convey imported surface water to beneficial users in Kern Subbasin. Many of the present-day canals were developed along the ancestral sloughs and drainageways of the Kern River Alluvial Fan.

The California Aqueduct, the SWP's principal conveyance feature, transports water from the Delta along the west side of the San Joaquin Valley to Kern Subbasin. The California Aqueduct extends north to south across the entire Kern Subbasin, entering in the northwest corner of Kern Subbasin and continuing along Kern Subbasin's western side. South of Buena Vista Lake, the California Aqueduct bends to the east and exits Kern Subbasin at the boundary with the adjacent White Wolf Subbasin. The Kern

County Water Agency (KCWA) was formed in the 1960s to contract with the DWR for the importation of SWP water to Kern County. Individual water districts holding contracts with KCWA have turnouts directly from the California Aqueduct into their service areas or receive water via the Cross Valley Canal (CVC). CVP water from the Delta Division and San Joaquin River Restoration Program Recapture and Recirculation Supplies are also conveyed to Kern Subbasin via the California Aqueduct. The Kern National Wildlife Refuge is now sustained by CVP water that is wheeled through the California Aqueduct and conveyed by the Goose Lake Canal to the refuge (USFS, 2005).

The FKC, completed in 1951, is the principal conveyance for the eastside CVP. The FKC diverts water from Friant Dam and Millerton Reservoir, completed in 1944 on the San Joaquin River, and extends southward a distance of 152 miles through Fresno, Tulare, and Kern counties. Within Kern County, the FKC extends from approximately mile post 122 at the County line near the City of Delano and flows south for approximately 30 miles to mile post 152 near Bakersfield (with the FKC terminus at the Kern River). The capacity of Millerton Reservoir is about 520,000 acre-feet, but 130,000 acre-feet of this storage lies below the intake for the FKC. The majority of CVP imported water is from the Friant Division that is conveyed to users in Kern Subbasin through the FKC; however, additional water from northern rivers systems that cross the FKC have the ability to discharge flood flows into the FKC for conveyance south into Kern County.

In 1973, DWR completed the initial facilities of the SWP, including the main line of the California Aqueduct. Portions of the SWP were constructed for use in conjunction with the facilities of the CVP. As the state and federal projects developed, a group of water users planned the CVC as a means of taking delivery of SWP and CVP water conveyed through the California Aqueduct. The CVC was completed in 1975 and, in 1976, the water users entered three-party contracts with DWR and USBR. Under these contracts, CVP water available to Reclamation in the Delta and San Luis Reservoir can be pumped by SWP's Harvey O. Banks Pumping Plant into the California Aqueduct or released from San Luis Reservoir for delivery to the Tupman Turnout where this water is diverted into the CVC. This federal water conveyance, which is subordinate to conveyance of SWP water, can then be delivered to water users in Kern Subbasin.

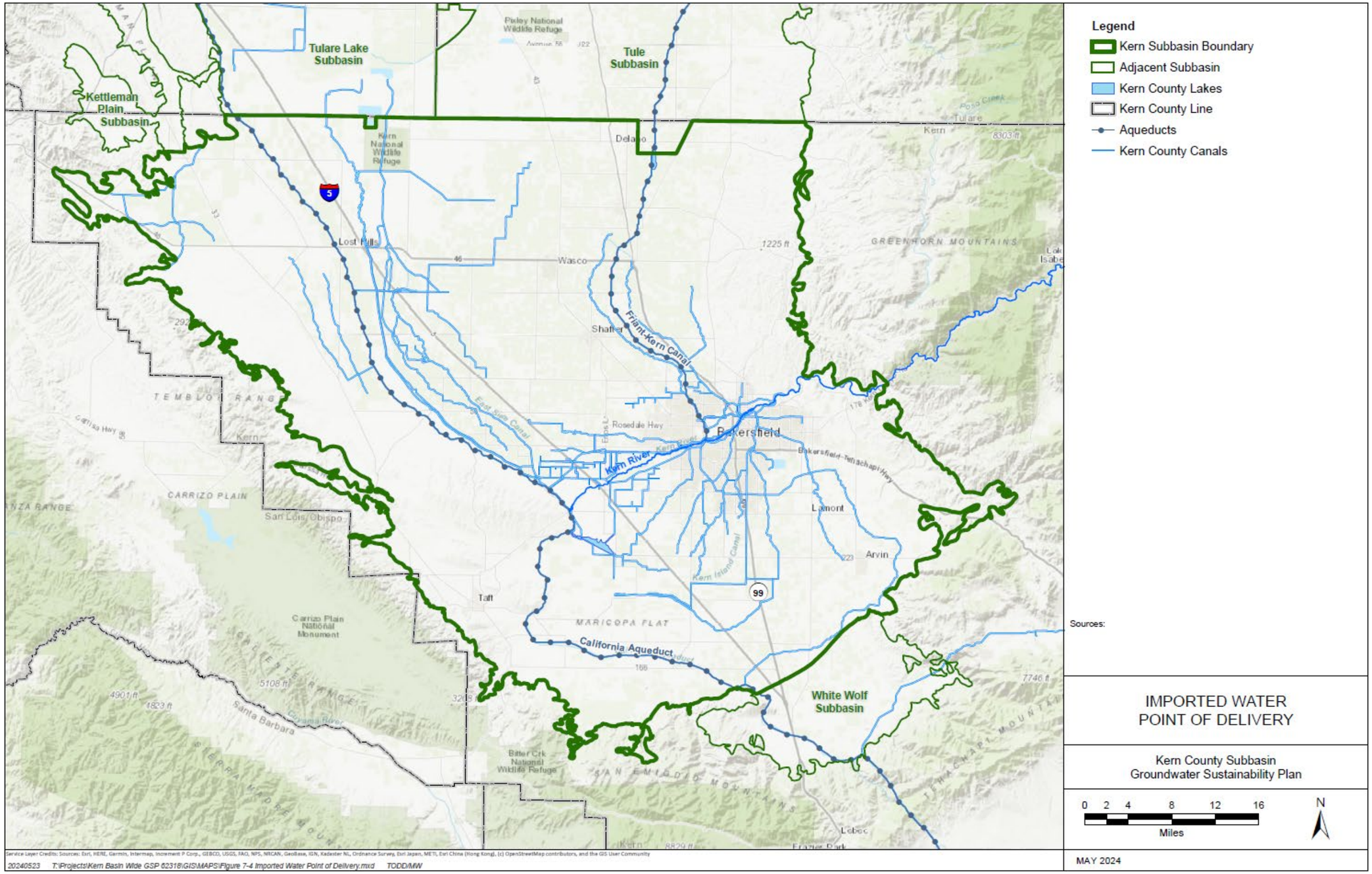


Figure 7-4. Imported Water Point of Delivery

7.1.3 Delineation of Recharge and Discharge Areas

Direct recharge and potential recharge areas are differentiated in this section from natural recharge. Natural recharge occurs by groundwater underflow from adjacent sources, precipitation outgaining evapotranspiration in a subbasin, or from natural surface waters flowing into Kern Subbasin. On the other hand, direct recharge is either planned or unplanned application of surface water by unlined conveyance, recharge basins and field application, managed recharge, and spreading/percolation operations. Figure 7-5 presents the location of surface water bodies in Kern Subbasin.

Natural recharge to Kern Subbasin is derived primarily from precipitation and surface runoff from the surrounding watersheds. Natural recharge is highest on the east side which receives higher precipitation and recharge from the Kern River and other smaller streams from the Sierra Nevada. Natural recharge is lowest on the west side of Kern Subbasin which receives less precipitation and lower runoff from the relatively smaller watersheds along the Coast Ranges. Other sources of recharge include ephemeral streams, springs, and seeps from the mountains along the east, southeast, and south fault margins of Kern Subbasin.

Significant direct recharge to groundwater in Kern Subbasin occurs through water banking and conjunctive use projects as well as unmanaged recharge through natural waterways, unlined basins and canals, regulating (balancing) reservoirs, percolation of applied water to crops, and/or fallowed fields that descends below the root zone. Numerous sources of water are recharged by various projects, including local surface water (Kern River, Poso Creek, and other drainages) and imported water (SWP and CVP).

The major areas of direct recharge (facilities and drainages) presented in Figure 7-5 include agricultural land where excess irrigation water percolates below the root zone, wastewater treatment spreading areas, and urban drainage spreading areas. Additional locations of natural recharge from surface water features may include springs, seeps, and ephemeral/intermittent streams flowing into Kern Subbasin (Figure 7-3). The surface water features are described in more detail above (Section 7.1.2). Groundwater discharge areas in Kern Subbasin are limited due to the depth of usable groundwater, typically greater than 100 feet throughout Kern Subbasin.

Since the late 1980s, large-scale water banking and conjunctive use projects have been constructed along the Kern River and in other areas of Kern Subbasin. Given the permeable nature of sediments within the Kern River Fan, most of the enhanced recharge projects involve surface spreading/percolation through ponds, low-lying fields including fallowed parcels, or basins for future extraction.

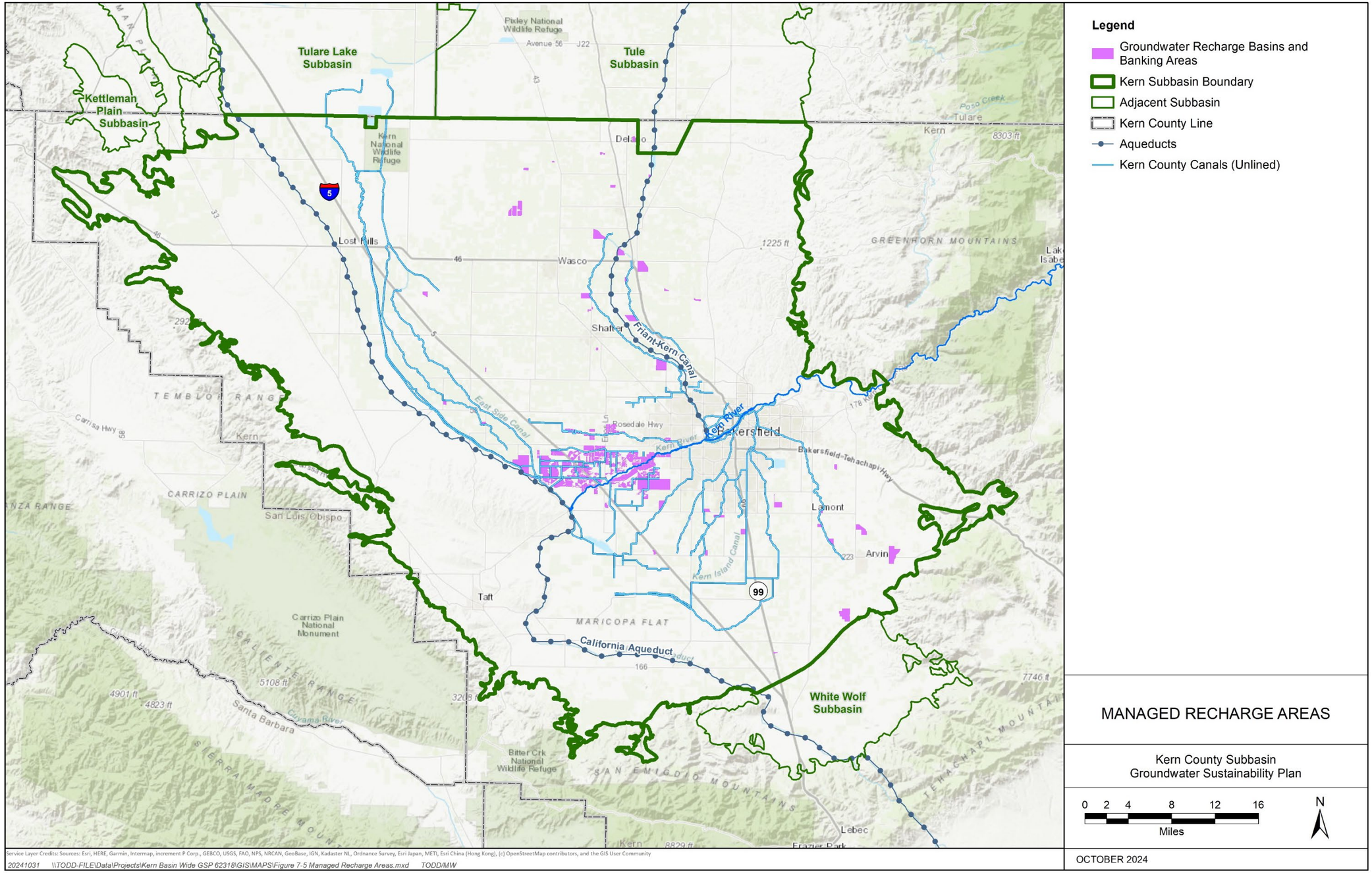


Figure 7-5. Managed Recharge Areas

7.1.4 Surficial Geology

☑ 23 CCR § 354.14(d)(2)

The surficial geologic maps for Kern Subbasin and surrounding areas (Figure 7-6) are regional geologic maps developed by the California Division of Mines and Geology (CDMG) as part of the Geologic Atlas of California that was published between 1958 and 1969. Although more recent and more detailed mapping is available in many areas, this set of maps is still the most detailed interpretation available for the entire state. It provides a complete, consistent view of the geology of the state, prepared at 1:250,000 scale. The Geologic Atlas uses a single set of rock units defined by geologic time, rather than geologic formations defined by time and lithology. This allows a simplified, uniform depiction of geologic units. The surficial geologic map for Kern Subbasin and surrounding areas (Figure 7-6) is based on three regional geologic maps developed as part of the Geologic Atlas of California. These include:

- Bakersfield (GAM 2) Sheet, Map compilation and Explanatory Data by Smith (1964)
- Los Angeles (GAM 8) Sheet, Map compilation and Explanatory Data by Jennings and Strand (1969)
- San Luis Obispo (GAM 18) Sheet, Map compilation and Explanatory Data (Jennings (1958)

The surficial geologic map shown on Figure 7-6 illustrates the age and composition of surficial deposits in Kern Subbasin. Most of Kern Subbasin is covered with continental deposits of Recent to Quaternary age. Some older units outside of Kern Subbasin have been combined on Figure 7-6 for simplicity, but most geologic unit labels have been preserved from the source.

As shown by the yellow shading, most of Kern Subbasin is covered by Recent and Quaternary-age alluvial deposits. These units also closely correspond to the geomorphologic units described above. These include:

- **Recent Alluvium (Qal)** – unconsolidated valley, stream, and terrace deposits. Primarily associated with narrow band of sediments bordering major streams that correspond to the River Flood Plain Geomorphic Unit.
- **Quaternary Lake Deposits (Ql)** – predominantly clay and silt deposits associated with lake beds that correspond to Lake Bottom Geomorphic Unit.
- **Quaternary Basin Deposits (Qb)** – sediments deposited during flood stages of major streams in the area between natural stream levees and fans that correspond to Overflow Land Geomorphic Unit.

- **Quaternary Fan Deposits (Qf)** – sediments deposited as alluvial fans from streams emerging from surrounding highlands and mountains that correspond to the Low Alluvial Plain and Fan Geomorphic Unit.

The distribution pattern of the alluvial deposits is indicative to distribution of the depositional environments of the Quaternary-age alluvial deposits within Kern Subbasin. The Fan Deposits represent the major alluvial fan emanating from the surrounding mountain areas. The alluvial fan depositional pattern is characterized by coarser-grained sediments with few clays near the basin margin and along the major streams, such as the Kern River and Poso Creek, and become progressively more fine-grained with distance away from these features. The Fan Deposits grade into the Basin Deposits that represent the distal fan areas and are characterized by high silt and sand content. The Lake Deposits, where outflow from the alluvial fan for temporary surface water bodies that occur in the lowest elevation areas of Kern Subbasin, are characterized by fine-grained sediments.

Plio-Pleistocene Nonmarine Sedimentary Deposits are underlain by older alluvial deposits of Pleistocene-Pliocene age (QPc) alluvial fan deposits originating from the surrounding mountains. The location of the outcrop of these units is typically found associated with geologic structures where these units have been tilted or folded. These older sediments are typically part of the Tulare Formation (western and southern parts of Kern Subbasin) or the Kern River Formation along the western flank Sierra Nevada. These areas typically correspond to dissected upland geomorphic units.

Kern Subbasin is flanked on the eastern, southern, and western margins of the valley by Miocene, Lower Tertiary, and Mesozoic marine sedimentary units and igneous and metamorphic basement rocks as shown on Figure 7-6.

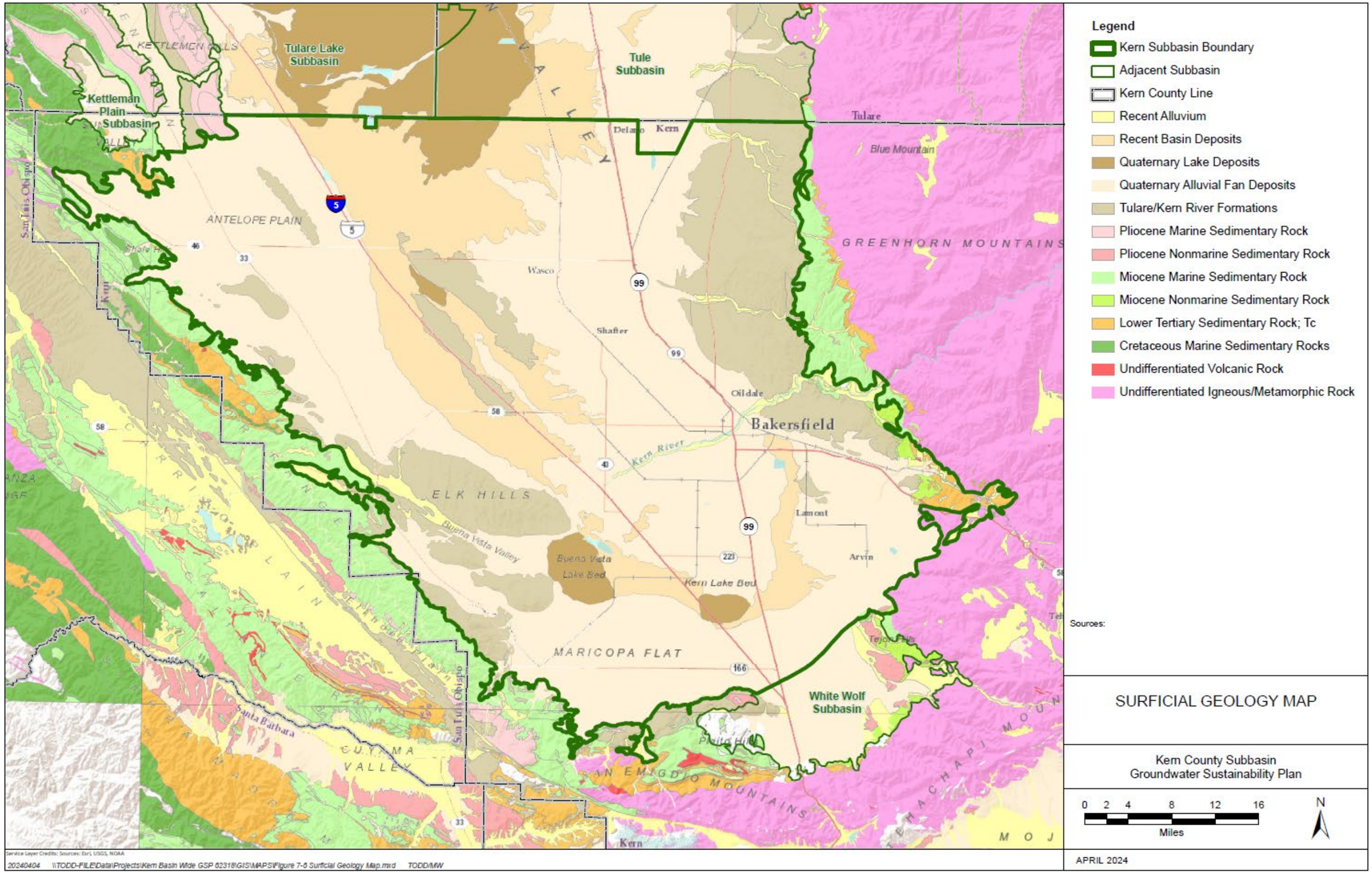


Figure 7-6. Surficial Geology Map

7.1.5 Soils

☑ 23 CCR § 354.14(d)(3)

The Natural Resources Conservation Service (NRCS) has described the soils of Kern Subbasin (NRCS, 1988). Soil texture was assigned based on depth-weighted sand, silt, and clay percentages in the upper five feet of the soil profile. Initial soil hydraulic properties were assigned based on procedures reported by Saxton and Rawls (2006) and refined to provide drainage from saturation to field capacity within a reasonable amount of time and to predict minimal gravitational drainage once field capacity is reached. NRCS classifies soils into four hydrological soil groups (A, B, C, D) based on runoff and percolation potential with A group soils having the lowest runoff and highest percolation potential and D soils having the highest runoff and lowest percolation potential. Eight soil textures and their associated hydrological soil groups are shown on Figure 7-7 and summarized below:

- **Loamy Sand, Sand, and Sandy Loam soils** cover about 750,000 acres or 38 percent of Kern Subbasin. Soils typically have about 10 percent or less clay and 60 percent to 90 percent sand or gravel. The saturated hydraulic conductivity is from 1 to 4 inches per hour. The hydrological soil group is typically A or B. These soils are typically associated with the Quaternary Fan Deposits (Qf) and the Low Alluvial Plain and Fan Geomorphic Unit.
- **Sandy Clay Loam, Loam, and Silty Loam soils** cover about 850,000 acres or 42 percent of Kern Subbasin. Soils typically have about 20 percent to 50 percent clay and 40 percent to 60 percent sand or gravel. The saturated hydraulic conductivity is from 0.2 to 0.7 inches per hour. The hydrologic soil group is typically C. Thess soils are associated with several of the surficial geologic and geomorphic units.
- **Clay Loam and Clay soils** cover about 400,000 acres or 20 percent of Kern Subbasin. Soils typically have about 30 percent to 60 percent clay and 10 percent to 40 percent sand or gravel. The saturated hydraulic conductivity is from 0.05 to 0.15 inches per hour. Hydrologic soil group is typically D. These soils are associated with the Quaternary Lake Deposits (Ql) and Quaternary Basin Deposits (Qb) and the Overflow Land and Lake Bottom geomorphic units.

The Soil Agricultural Groundwater Banking Index (SAGBI) can further estimate groundwater recharge suitability to quantify recharge of deep percolated applied irrigation water and potential recharge from future managed recharge water banking and conjunctive use projects within Kern Subbasin. The California Soil Resource Lab at University of California Davis has developed an online application (https://casoilresource.lawr.ucdavis.edu/sagbi/) to present the SAGBI, which estimates groundwater recharge suitability based on five major factors including deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

The application includes mapping coverage of the SAGBI and indicates a moderately good to excellent rating for:

- Poso Creek alluvial fan in the north central Kern Subbasin
- Kern River alluvial fan in the central area
- Much of the southeastern to southwestern corners of Kern Subbasin

SAGBI ratings are moderately poor to very poor:

- Along the eastern margin
- Central western margin
- Center of the valley from the former Kern and Buena Vista Lake beds
- North along the Goose Neck Slough to the Tulare Lakebed

While moderately good to good SAGBI is shown for much of the western margin, this area is underlain by marine sediments and is not likely to be a useful area for recharge. The SAGBI ratings generally agree with mapped soil data where higher rated SAGBI soil corresponds with moderate to high infiltration soils.

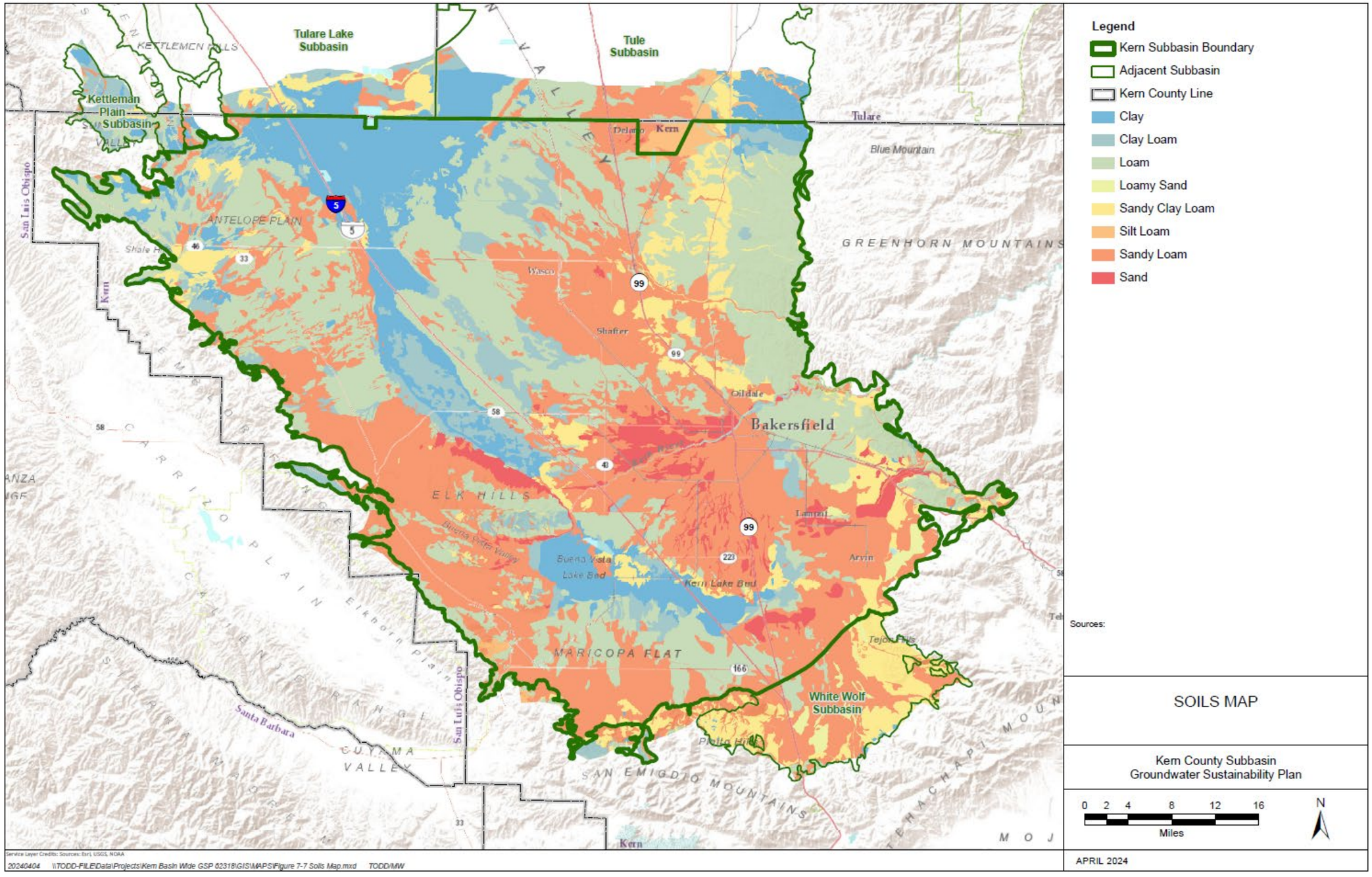


Figure 7-7. Soils Map

7.2 Geologic and Structural Setting

☑ 23 CCR § 354.14(b)(1)

Kern Subbasin can be described as an asymmetrical syncline, or a trough, which runs north-south, with the deepest section being toward the western edge. The most prominent differences between eastern and western borders are the high amount of folding of sediments toward the west and low deformation in the east (Davis and Green, 1962). The primary geological formations that make up the regional aquifer system are the surface and near-surface, recent-Holocene to Pleistocene alluvial/fluvial Recent Alluvium and the underlying Miocene to Pleistocene, fluvial Tulare Formation, and Kern River Formations.

7.2.1 Geologic Setting

Kern Subbasin consists of the upper portion of a deep structural trough between the crystalline rocks of the Sierra Nevada and the basement rocks of the Coast Ranges. The deeper portions of the trough contain mostly Miocene and older marine sedimentary units. The upper trough has been infilled over time with younger continental sediments. Continental deposits comprise over 6,000 feet of unconsolidated sediments south of the Kern River, and the base of the entire sequence of consolidated and unconsolidated sediments is over 18,000 feet deep (Davis et al., 1959).

Kern Subbasin has been described by Wood and Dale (1964) as being the product of structural downward warping and active tectonics in the greater San Joaquin Valley. The general structure and geology are illustrated on the schematic diagram in Figure 7-1 from Bartow (1991), which depicts the subsurface conditions in Kern Subbasin. The highlands surrounding Kern Subbasin are shown with folded beds separating the west side from the east side. The geology of Kern Subbasin is shown as deep marine sediments (purple) of pre-Pliocene age transition upward to Pliocene and younger deposits of continental origin (light yellow). Figure 7-1 displays the succession of marine deposition to more recent continental deposition and alluvium with fresher water deposits. These younger sediments contain most of the groundwater in Kern Subbasin.

The major external controls on sedimentation in Kern Subbasin are tectonism, eustatic sea-level change, and climate. The sedimentary record represents the complex interplay of all these factors, although tectonism is clearly dominant. Any thick accumulation of sediments, such as that found in the Southern San Joaquin region, implies tectonic subsidence. Furthermore, the location of this Subbasin along an active continental margin virtually assures tectonic activity in some form, throughout the Cenozoic. The other factors, sea-level change and climate, also play important roles as well (Bartow, 1991).

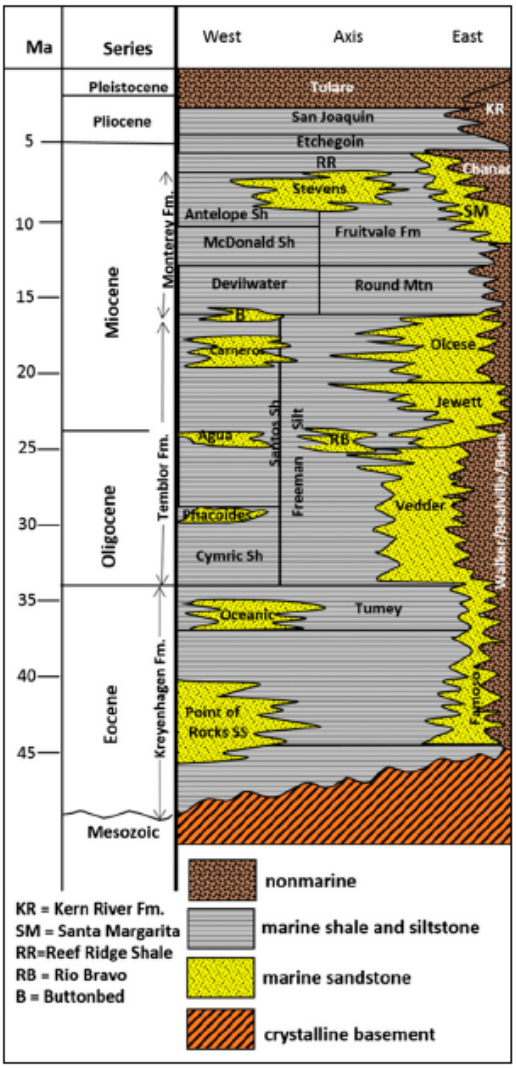
Tectonic activity throughout the Tertiary uplifted the surrounding Sierra Nevada, Tehachapi Mountains, and the Coast Ranges. Erosion and subsequent transport of sediment from the mountains into the basin occurred (Page, 1986). Tectonic movements also elevated the Coast Ranges to the west which created a marine embayment in the present-day Southern San Joaquin region. Although the San Joaquin Valley was created by the emergence of the Coast Ranges, the southern areas, including all Kern Subbasin, remained inundated by the Pacific Ocean. In contrast, only continental deposition occurred in the more northern areas of the San Joaquin Valley throughout the Miocene to Pliocene time. Figure 7-8 shows the general stratigraphic column, and Figure 7-9 shows the paleogeography for four different time periods which illustrates the inundated areas. These include:

- Early Miocene (about 30 million years ago (mya))
- Late Miocene (about 10 mya)
- Pliocene (about 3 mya)
- Pleistocene (about 0.6 mya)

As a result, both marine and continental sediments were deposited. Marine deposition was dominant in Kern Subbasin throughout the Miocene through the late Pliocene time. These inundated areas were continuously changing in size and shape due to sea-level change as the Coast Ranges emerged. During the Pliocene, uplift of Coast Range began to separate Kern Subbasin area from the Pacific Ocean so that by the Pleistocene only continental sediments were deposited.

The continental deposits that constitute the primary Kern Subbasin aquifer system contain mostly fluvial deposits and interbedded lacustrine deposits. The continental deposits consist predominantly of interbedded lenses of gravel, sand, silt, and clay. The numerous lenses of fine-grained (silt, sandy silt, sandy clay, and clay) sediments are distributed throughout Kern Subbasin (Page, 1986). Most of these fine-grained lenses are not extensive; however, several major ones were mapped, principally near the axis of the San Joaquin Valley. The most notable is the E-Clay, which includes the Corcoran Clay Member of the Tulare Formation (Pleistocene).

Marine deposits underlie Kern Subbasin and outcrop along the west, southwest, south, and southeast Kern Subbasin margins. Due to the many changes in depositional environment, the marine deposits differ greatly in sediment type, sorting, and thickness, and have been assigned different geologic formation names in different parts of Kern Subbasin. The most recent of which are the Pyramid Hills, Vedder Sand, Olcese Sand, Santa Margarita Formation, and San Joaquin and Etchegoin Formations.



Kern County Subbasin
Groundwater Sustainability Plan

Source: Gillespie - GW Salinity SJV, 2017

GENERALIZED STRATIGRAPHIC COLUMN

APRIL 2024

TODD/MW \\TODD-FILE\Data\Projects\Kern Basin Wide GSP 62318\GRAPHICS\ Figure 7-8 Generalized Stratigraphic Column.ai

Figure 7-8. General Stratigraphic Column

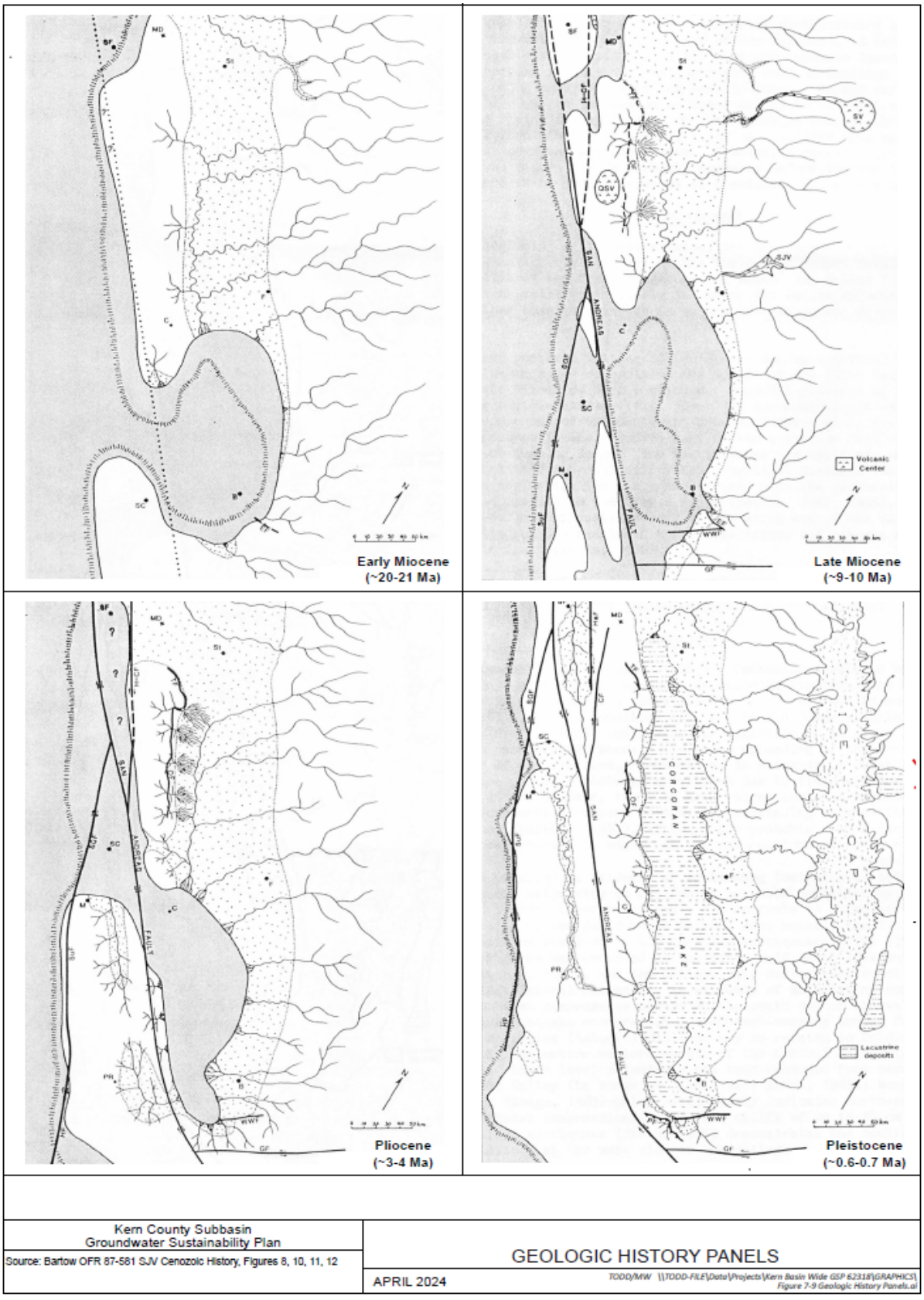


Figure 7-9. Geologic History Panels

During the Tertiary period, fluctuating sea levels within the marine embayment resulted in shifting of deposition between transgressive (rising sea levels) and regressive (lowering sea levels) marine depositional sequences. During a transgressive sequence, rising sea levels increase the deep marine areas which are characterized by fine-grained deposition that forms shales and siltstones. Along the sea margins, shallow marine conditions lead to a mixture of fine and coarse-grained deposition including the formation of sandstones. As sea levels rise the shallow marine areas become deeper water environments leading to the deposition of shales and silts overlying the sandstones. The general transgressive sequence then is referred as “fining-upward” sequence where a basal sandstone transitions to fine-grained clays and silts.

During a regressive sequence, the opposite occurs. Lowering sea levels decrease the deep marine areas. As sea levels decline, shallow marine environments shift to previously deep-water environments leading to the formation of sandstones overlying shales. Areas no longer covered by the ocean are subject to erosion, so that previously deposited sediments are again eroded and transported out to the marine areas. This erosion event leaves a gap in the stratigraphic record that is referred to as an unconformity. Physical and geochemical changes at the unconformity surface often led to unconformities becoming a restriction to subsurface fluid flow with subsequent overlying sediments.

Marine deposition typically leads to sandstones being encased in fine-grained, low-permeability shales and siltstones. Most marine sedimentary rocks in Kern Subbasin contain saline connate water. This indicates that the water in these rocks is not receiving recharge but is hydraulically isolated. Except for areas where the marine rocks outcrop at the surface and receive freshwater recharge, the marine rocks are not considered as potential sources of groundwater for beneficial use.

Continental deposits that overlie the marine deposits provide the most productive freshwater aquifers in Kern Subbasin (Bertoldi et al., 1991). The marine sediments with confined fresh water provide local areas of productive freshwater aquifers in Kern Subbasin. The isolated marine rocks with saline connate water are not considered as usable water sources because of their poor water quality and lack of recharge.

7.2.2 Geologic History Summary

A brief description of the evolution of valley sediments and fill is included below, as it relates to the regional aquifer system of the Tulare Lake Region of the San Joaquin Valley Basin. Figure 7-8 provides a generalized stratigraphic column of the variation in geologic units across Kern Subbasin. During the Paleozoic to the Mesozoic, the area of Kern Subbasin was a part of a great linear trough that received sediments along the western coast of North America. During the Cretaceous period, tectonic forces formed a series of mountain ranges (Bartow, 1991), the formation of the San Andreas Fault, and several northwest-trending faults, such as the White Wolf and Garlock Faults (Ingersoll and Busby, 1995; Wakabayashi and Sawyer, 2001; Galloway and Jones, 2005).

Throughout the Tertiary until Pliocene, a large part of Kern Subbasin was continuously inundated by the Pacific Ocean with marine sediments deposited across the entire valley. Sea levels declined due to the uplift of the Coast Ranges and the subsequent closure of marine outlets (Williamson et al., 1989). During this time, the San Joaquin Valley experienced a period of tectonic subsidence that led to the accumulation of several thousand feet of sedimentary deposits (Bartow, 1991; Galloway and Jones, 2005).

During the mid-Tertiary, uplift of basement sediments occurred near present-day Bakersfield forming what researchers have termed the Bakersfield Arch. The Arch effectively resulted in depocenters for thick sequences of sediment to accumulate to the north and south of the Kern River (Bartow, 1991; Vasconcellos, 2016) during later Tertiary and Quaternary time. Tertiary crustal uplift and shifting caused faulting to occur along the margin adjacent to the Sierra Nevada, Temblor, and Coast Ranges (Bartow, 1991). Crustal deformation associated with the San Andreas Fault system led to the intensive deformation of the western side of Kern Subbasin forming a series of linear anticlines (a type of fold that is an arch-like shape) and syncline (a type of fold that is a trough-like shape) that is referred to as the West Side Fold Belt.

Also, during the mid-Tertiary, normal faults along the east side of the valley formed and are concentrated around the Bakersfield Arch. These faults are associated with a period of uplift of the Sierra Nevada. These faults generally trend northwest to north, although a secondary west to west-northwest trend is apparent. The net displacement is down to the southwest, although down-to-the-northeast faults are present (Bartow, 1984). One of the principal faults of this group is the Kern Gorge fault, along which basement rocks to the southwest have been down-dropped more than 1,000 feet. An important exception to the northwesterly fault trend is the Poso Creek fault that trends in a westerly direction through the Tertiary outcrop belt and then curves to the northwest to merge with the concealed Pond fault. In the southeastern Kern Subbasin, the Edison fault is an older Tertiary normal fault with significant vertical displacement (Dibblee and Chesterman, 1953; Bartow, 1984).

During the period of marine inundation of the Kern Subbasin, fluctuating sea levels led to successive transgressive-regressive sequences. These produced multiple sequences of marine sandstones along Kern Subbasin margin and interior structural highs that are generally encased in marine shales and siltstones. In the western areas and other areas of deep marine conditions during the time of deposition, the sequence is composed almost exclusively of shales and siltstones with only minor sandstone occurrences. There were a series of transgression-regression sequences that occurred, that include:

- Eocene Sequence
- Lower Oligocene Sequence
- Upper Oligocene Sequence
- Lower and Middle Miocene Sequence

- Middle and Upper Miocene Sequence
- Upper Miocene Sequence
- Pliocene and Pleistocene Sequence

During the Tertiary period, fluctuating sea levels were present within the marine embayment, resulting in sequences of transgressive and regressive, continental, and marine sediments. Bartow (1991) provides a series of paleogeographic maps that illustrate the geologic history of the San Joaquin Valley. Four of these are shown in Figure 7-9.

The upper Miocene, Pliocene, and Pleistocene sequence was initiated with transgression of the Etchegoin Formation over older Miocene units (Figure 7-9). Alluvial fans and deltas prograde basinward as abundant coarse detritus was delivered to Kern Subbasin from the rising Sierra Nevada on the east, the San Emigdio Mountains on the south, and eventually from the Coast Range on the west. Alluvial fan deposition began along the southeast margin of Kern Subbasin (the Kern River Formation) although there was no comparable event at that time in the northeast. The coarse clastic sediments of the Kern River may, then, be evidence that the accelerating late Cenozoic uplift of the Sierra Nevada began earlier at the southern end of the range.

The final marine regression of the ocean from Kern Subbasin was greatly accelerated through the Pliocene as progradation of coarse clastic sediments continued from all sides of Kern Subbasin, leading to the final retreat of the sea by about the end of Pliocene time (Figure 7-9). The stratigraphic sequence in the center of the southern San Joaquin basin records a gradual shallowing from shallow-marine shelf (Etchegoin Formation) through restrictive marine to brackish facies (San Joaquin Formation) and finally to fresh-water fluvial and lacustrine facies (Tulare Formation) in the late Pliocene to middle Pleistocene, even though the basin continued to subside and especially rapidly in the southern Kern Subbasin. The San Joaquin and Tulare are conformable in the center of Kern Subbasin and both interfinger eastward with Kern River alluvial fan deposits, but an unconformity occurs at the base of the Tulare along the west and south margins of Kern Subbasin.

A contributing factor in the transition to a nonmarine basin in the late Pliocene was the progressive closing off the western outlet to the ocean due to folding and uplift in the Coast Ranges. The unconformity at the base of the Tulare Formation is due to continuing deformation of the western and southern Kern Subbasin margin in response to San Andreas activity (Davis, 1983; Davis, 1986). The rapid subsidence of the southern Kern Subbasin during the Pliocene and early Pleistocene, which was concurrent with the shallowing trend, was probably due to tectonic activity south of the basin margin.

By about the middle of the Pleistocene, the San Joaquin basin drainage outlet was closed or nearly closed, and the impounded drainage created a large lake (Frink and Kues, 1954). Disappearance of the "Corcoran Lake" (Figure 7-9) was likely caused by the establishment of the present Central Valley drainage outlet through the Carquinez Strait (Sarna-Wojcicki et al., 1985).

The Quaternary Period (Pleistocene and Holocene) marked a time when the seas retreated, and continental deposits were deposited (Tulare and Kern River Formations [Page, 1986]). These continental sediments consist of basin-fill fluvial and lake deposits of sand, gravel, and interbedded clays and silts (Williamson et al., 1989). Marine rocks eroded from the Coast Ranges are the primary source sediments for the Tulare Formation on the west, and the granitic rocks from the Sierra Nevada on the east are the source sedimentation for the Kern River Formation.

Page (1986) recognizes the differing depositional environments in the continental deposits. Alluvial fans are present on both sides of the valley; however, the western side differs significantly from the eastern Kern Subbasin. Western Plio-Pleistocene deposits of the Tulare Formation primarily originate from the weathering and erosion of the Coastal Range, consisting of marine deposits that yield clays, silts, and some sands. In contrast, the eastern side is characterized by quartzose and feldspathic coarser-sized sediments from the Sierra Nevada. On the eastern side of the valley, there are several large, migratory stream channels that have created a broad area of coalescing alluvial fans composed of inter-fingering, wedge-shaped lenses of a sand, gravel, and fine-grained deposits that form the Kern River Formation. The general depositional character of both the eastern and western alluvial fans is characterized by coarser-grained sediments near the basin margin and along the major streams, such as the Kern River and Poso Creek, that become progressively finer-grained with distance away from these features. These alluvial fans deposits are characterized by heterogeneous interbeds coarse and finer-grained deposits. As a result, clay layers in these areas are of limited areal extent. The distal ends of the eastern and western alluvial fans converge in the lower elevation areas in the west-central area of Kern Subbasin are characterized by heterogeneous interbeds of finer-grained marsh, lake, and floodplain deposits. The formation of laterally extensive clay layers occurs in these areas during periods of extensive lake deposition.

Tectonism has played an important role in the Quaternary history of the San Joaquin basin. Closing of the valley's drainage outlet and continued uplift of the surrounding ranges that supply sediment to the alluvial basin are the consequences of tectonism, but the Quaternary sedimentary record reflects climatic controls more than tectonic. During that time, freshwater lakes formed in the San Joaquin Valley during interglacial periods during the Ice Ages, resulting in thick clay layers found throughout the Tulare Formation. In particular, the E-Clay, including the Corcoran Clay member, and its equivalents have been mapped over much of the San Joaquin Valley, including beneath

the Kern and Buena Vista dry lake beds in the southern part of Kern Subbasin, as well as the Tulare Lake sediments north of Kern Subbasin (Croft, 1972; Page, 1986).

These shallow continental water-bearing deposits make up the regional aquifer system. Paleo-lakes deposited thick beds of clay. Where these clays are present as continuous layers, they form competent aquitards within the aquifer systems (Croft, 1972). The lateral extent of these clay layers determine if these act as localized or regional confining layers. Additionally, the deeper clay layers have been correlated in the western Kern Subbasin which was still the depocenter during deposition of the lower Tulare Formation (Croft, 1972; Page, 1986).

7.2.3 Structural Setting

Although the San Joaquin Valley, as the southern part of the Great Valley, constitutes part of a discrete geomorphic and structural province within the western Cordillera of North America, the geology is internally variable in both stratigraphy and style of deformation. To facilitate description of the structural geology, Bartow (1991) subdivided the San Joaquin Valley into five regions on the basis of structural style (Figure 7-10). Each region is structurally distinct in style of deformation and tectonic history. Of these, three are relevant to Kern Subbasin and include:

- Southern Sierran block (SSB)
- West-Side Fold Belt (WFB)
- Maricopa-Tejon structural region (M-T S)

The Southern Sierran block comprises the southern part of the stable and little-deformed east limb of the San Joaquin Valley Syncline (Bartow, 1991). Its south boundary is the crest of the Bakersfield Arch, a broad southwest-plunging ridge of basement rock. Normal faults along the east side of the valley are concentrated around the Bakersfield Arch. These faults generally trend northwest to north, although a secondary west to west-northwest trend is apparent.

The west-side fold belt extends along the southwest side of the San Joaquin Valley Syncline south to the Elk Hills where the fold trends change from northwest to west (Bartow, 1991). The belt is characterized by a series of folds and faults that generally trend slightly oblique to the San Andreas fault located just outside Kern Subbasin on the southwest. The intensity of deformation increases southeastward along the fold belt as well as southwestward across the belt toward the San Andreas fault. The increased intensity is evidenced by tighter folds. The stratigraphy of the west-side fold belt is highly variable, as might be expected in a tectonically active area. Stratigraphic columns for three separate areas provide some indication of the variation. Middle Tertiary deposits representing some of the deepest potable water in the San Joaquin Basin are found in the southern Temblor Range (Bartow, 1991).

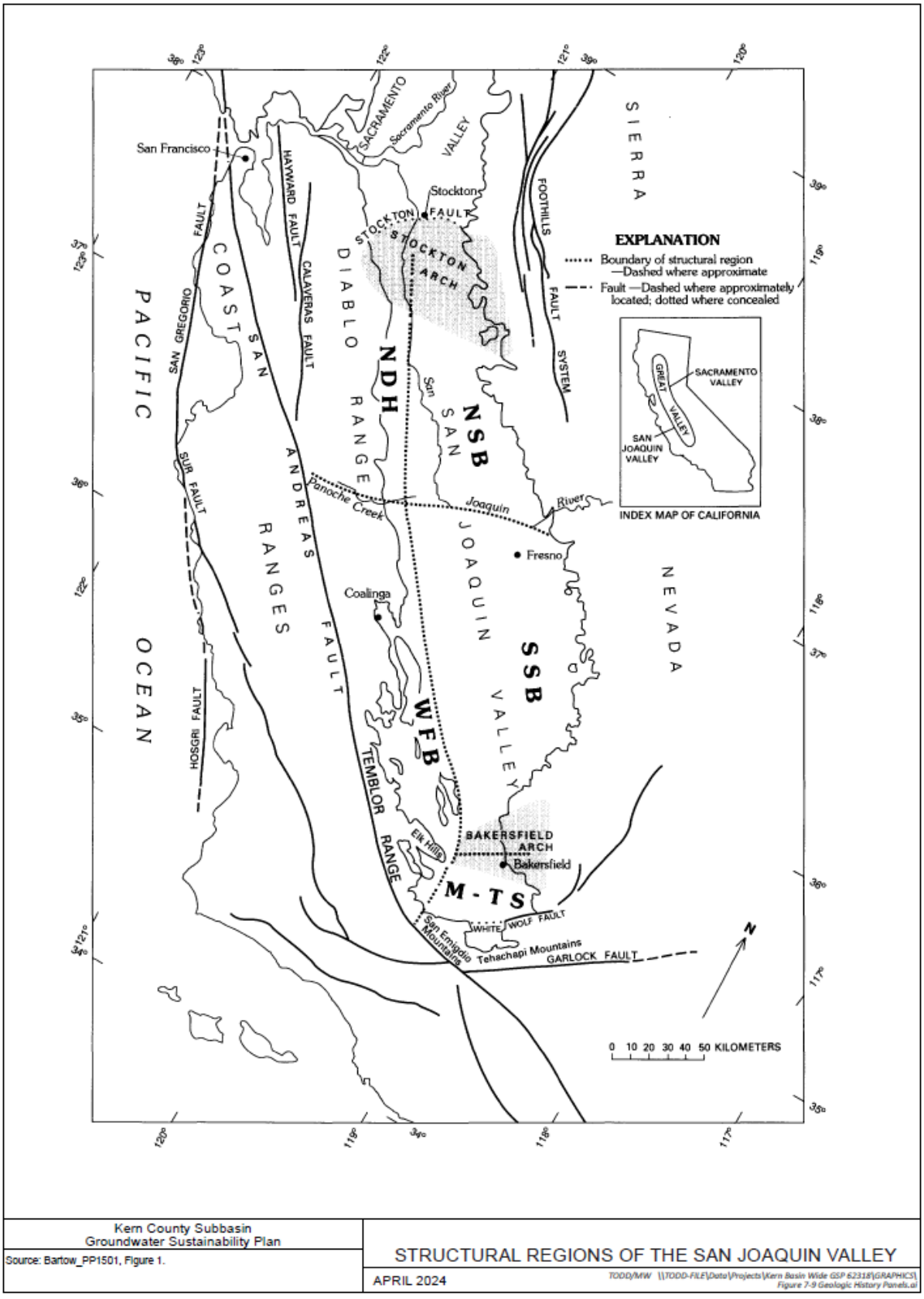


Figure 7-10. Structural Regions of the San Joaquin Valley

The Maricopa-Tejon structural region is bounded by the Bakersfield Arch on the north, the San Emigdio Mountains on the south, the Tehachapi Mountains on the east, and the southeast end of the fold belt on the west. This region is the most deformed part of Kern Subbasin and has experienced extreme Neogene basin subsidence. The western part of the Maricopa-Tejon structural region is characterized by its great depth to basement. However, the Mesozoic and early Tertiary Great Valley sequence is apparently absent south of the Bakersfield Arch. The Tehachapi-San Emigdio Mountains uplift that bounds the valley on the south may be a transverse structure similar to the Transverse Ranges located southwest of Kern Subbasin (Bartow, 1991).

7.2.4 Regional Faults

The San Andreas Fault is a continental right-lateral strike-slip transform fault that extends roughly 750 miles through the California. It forms the tectonic boundary between the Pacific Plate and the North American Plate. The San Andreas runs generally parallel to the western Kern Subbasin margin within the Coast Ranges. The San Andreas fault system is major part of the tectonic history that has resulted in the formation of the West-side fold belt. Figure 7-11 shows the locations of known faults in Kern Subbasin and adjacent areas.

The Garlock Fault is a left-lateral strike-slip fault running northeast–southwest along the north margins of the Mojave Desert of Southern California, for much of its length along the southern base of the Tehachapi Mountains for about 160 miles). The northeast-southwest trending White Wolf fault and the smaller Springs fault to the southeast both trend approximately parallel to the Garlock fault, which lies along the southeast side of the Tehachapi Mountains. Both faults, like the Garlock, show some geologic evidence of left-lateral movement. Farther northeast, the northwest-southeast to east-west trending Edison fault is an older Tertiary normal fault with down-to-the north offset of over 1500 ft (Dibblee and Chesterman, 1953; Bartow, 1984). The regional fault systems adjacent to Kern Subbasin plays a crucial role in shaping its geological features. These fault systems, characterized by left-lateral movement and normal faulting, exert influence on the folding and surface structures within Kern Subbasin, which in turn, influences the direction of groundwater flow. Most of the faulting occurs within the eastern and southern margins of Kern Subbasin, associated with the tectonic history of the Sierra Nevada Mountains and Tehachapi and San Emigdio Mountains, respectively. The northeastern area of Kern Subbasin, covering the northern half of the Bakersfield Arch, has associated normal faulting that is prominent in older sedimentary layers but extends into and is concealed by younger sediments, particularly along the Pond-Poso Creek Fault. These faults exhibit varying orientations, ranging from northwest to northeast, owing to alternating compressional and extensional forces. The California Geological Survey (2010) identified several faults that affect groundwater flow within Kern Subbasin. Such faults include the Kern Front, Edison, Pond-Poso Fault, Pond, White Wolf, Premier, and New Hope Faults (Figure 7-11).

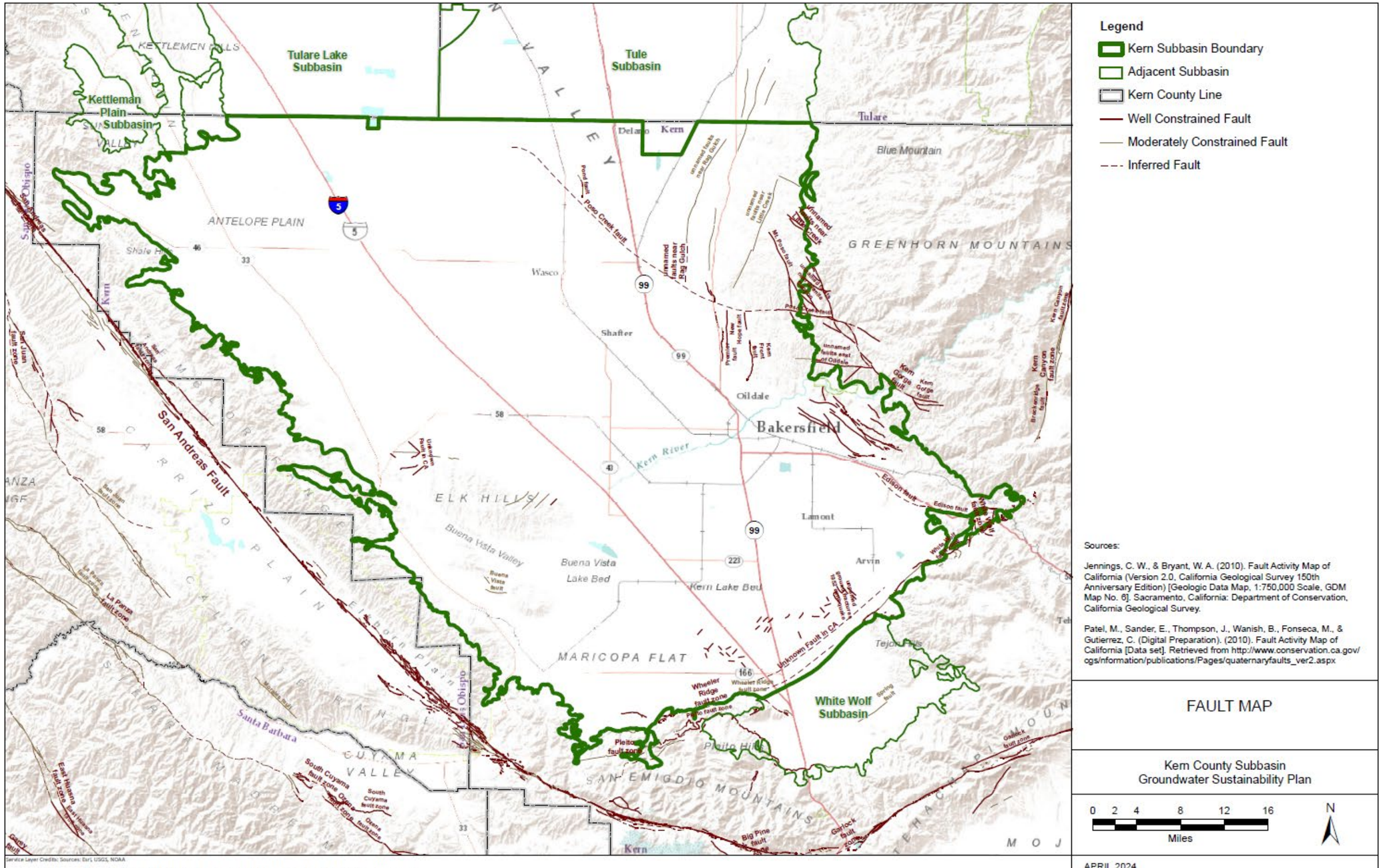


Figure 7-11. Fault Map

7.2.5 Structural Folds

Figure 7-12 shows the locations of mapped geologic structures in Kern Subbasin and adjacent areas. The San Joaquin Valley Syncline, an extensive and asymmetric trough, has accumulated sedimentary deposits since the late Mesozoic era, naturally directing water flow in a northwest direction along its trend. The San Joaquin Valley Syncline is several thousands of feet deep. The east limb of the syncline is a little deformed with a generally regular slope across the valley from Sierra Nevada. The west limb of the syncline is very steep because of the deformation associated with the West Side Fold Belt.

In the south, the Maricopa-Tejon structural region (Bartow, 1991) is a highly deformed part of Kern Subbasin and that created a deep localized depositional basin (Bartow, 1991) during deposition of alluvial sediments. This area is characterized by its great depth to basement of up to 28,000 feet. Together, the San Joaquin Valley Syncline and Maricopa-Tejon structural region (Bartow, 1991) represent the areas with the greatest depth to basement in Kern Subbasin.

The Bakersfield Arch is a broad structural bowing on the east side of the southern San Joaquin Valley that plunges south-southwest across Kern Subbasin for about 16 miles where it ends near the Elk Hills. The Bakersfield Arch separates the Maricopa-Tejon structural region from the Southern Sierran block. Normal faults along the Eastern Kern Subbasin margin are concentrated primarily along the crest of the Bakersfield Arch which is the site of several major oil fields. The Bakersfield Arch has a low topographic profile but has appreciable structural relief (Bartow, 1991). The Bakersfield Arch is not a barrier to groundwater flow but does represent one part of the upgradient topographic high that allows water to flow from the Kern River. Groundwater recharged by the Kern River flows north and south along the Bakersfield Arch's flanks, moving away from the center of Kern Subbasin.

The West-Side Fold Belt (Bartow, 1991) features several major anticlines, such as the Lost Hills and Elk Hills (Bartow, 1991; Page, 1986). The Lost Hills structures are oriented toward the northwest, running semi-parallel to the Coast Range and the San Andreas Fault. Page (1986) and DWR (2006) have identified these anticlinal folds in the highlands, particularly the Lost Hills and Elk Hills, as constraints on groundwater flow within the lowlands, which likely applies to other anticlines in Kern Subbasin.

The Elk Hills Anticline is comprised of a broad, elongate, flat-topped arch with steep dips along its edge. The anticline is approximately 17-miles long by 6-miles wide, trending northwest to southeast. The Elk Hills rise to an elevation of over 1,550 feet (Woodring et al., 1932). The Lost Hills Anticline is the southern end member of a 60-mile-long fold of a SE-plunging anticline, which runs parallel to the San Andreas Fault to the west and formed due to related compressional tectonic activity. Specifically, the Lost Hills Anticline is an asymmetric anticline, approximately 20-miles long and 6-miles wide (Medwedeff, 1989).

Structurally, the greatest differences within Kern Subbasin are between the west-side fold belt and the little-deformed sedimentary cover of the Sierran block on the east-central parts of the valley. The Maricopa-Tejon structural region and west-side fold belt are considered the most highly deformed parts of the San Joaquin Valley with the most complex tectonic history (Bartow, 1991).

7.2.6 Geologic Units and Their Water-Bearing Properties

Kern Subbasin stratigraphy is described below. The stratigraphy is graphically summarized in Figure 7-13, which shows six stratigraphic columns that represent different geographic areas within Kern Subbasin. In this section, the geologic units are described in order of younger to older to represent their relative importance as groundwater aquifers. In Kern Subbasin, the younger units generally have the better water-bearing properties that form the more important groundwater aquifers whereas the older units generally have poorer water-bearing properties with limited to no groundwater use.

7.2.6.1 Unconsolidated Nonmarine Deposits (Pliocene to Holocene)

Continental deposits of Pliocene to Holocene age contain most of the freshwater in Kern Subbasin. The Tulare Formation and the Kern River Formation are moderately to high permeability units that form the most highly productive freshwater aquifer system within Kern Subbasin (Page, 1986). These deposits consist of the following geologic units:

- Recent Alluvium (Holocene)
- Kern River Formation (Pliocene to Pleistocene)
- Tulare Formation (Pliocene to Pleistocene)

The combined Recent Alluvium, Kern River Formation, and Tulare Formation form the major freshwater aquifer system within Kern Subbasin (Page, 1986). Figure 7-13 illustrates the variability of these formations across Kern Subbasin. The Recent Alluvium covers the underlying formations and can often be indistinguishable between the Kern River and Tulare Formation. The Recent Alluvium consists of alluvial and floodplain gravel, sand, silt, and clay. The floodplain deposits act as localized poorly permeable sand lenses (DWR, 2016). The deposits thicken towards the basin trough and taper to the western and eastern margins (Croft, 1972). The deposits thicken to over 400 feet. The Recent Alluvium has been observed to be loosely consolidated to cemented, which leads to moderate to high permeability (DWR, 2016).

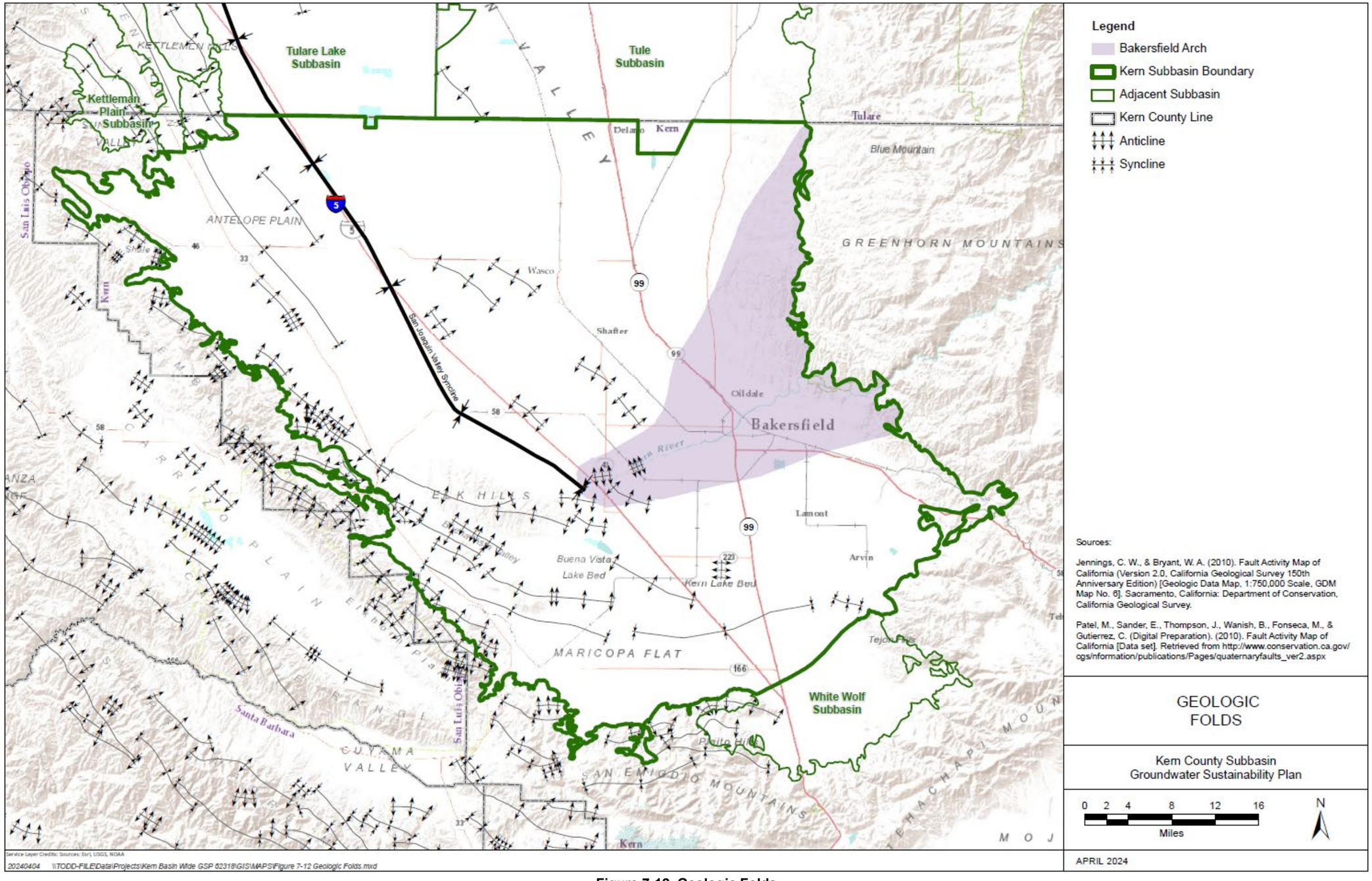


Figure 7-12. Geologic Folds

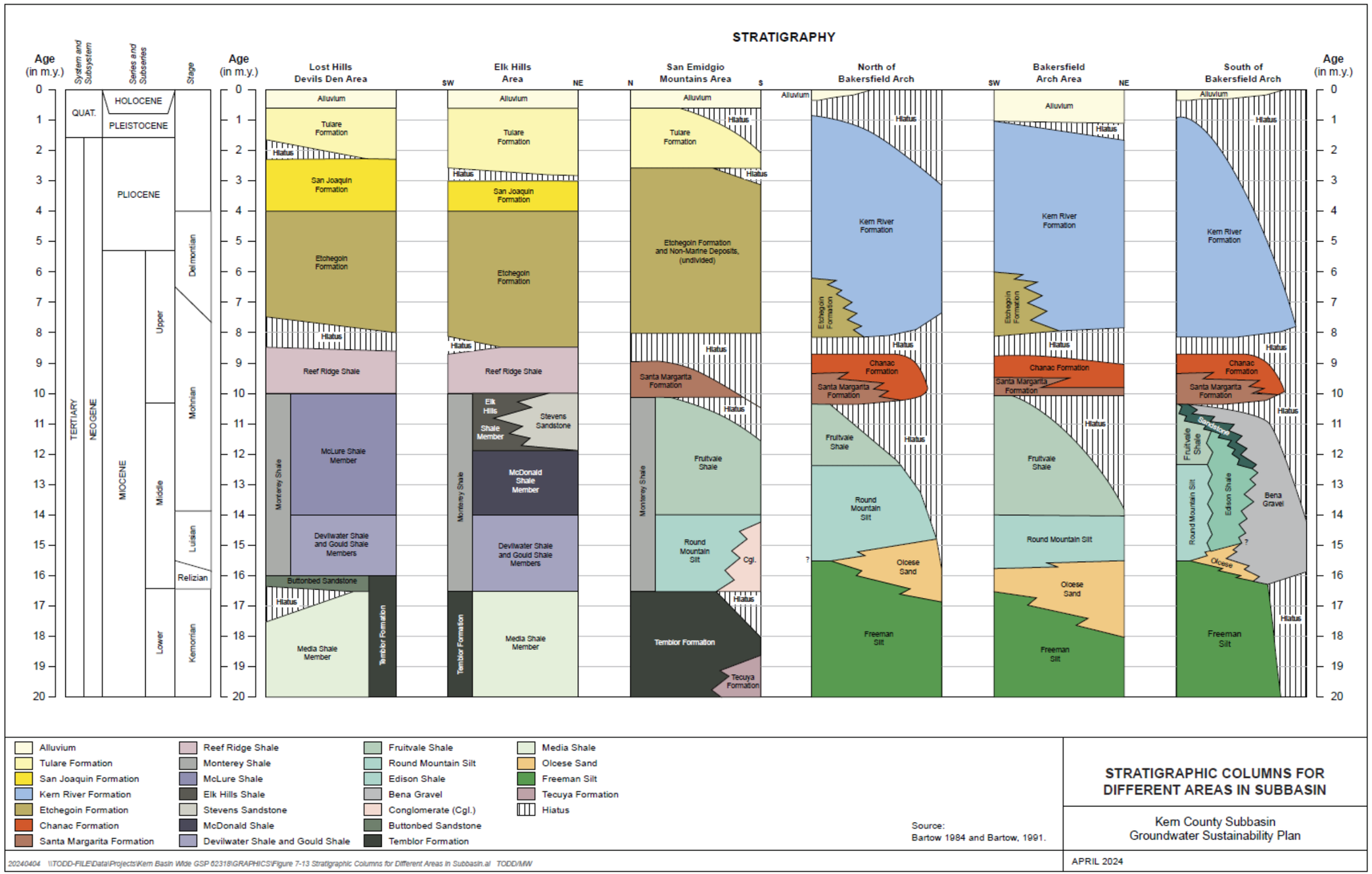


Figure 7-13. Stratigraphic Columns for Different Areas in Kern Subbasin

The Kern River Formation is the youngest of the Tertiary formations and lies unconformably on the Chanac and Santa Margarita Formations in the east (Bartow and McDougall, 1984). The formation has been observed to range from 500 feet to over 2,000 feet below ground surface (Bartow and Pittman, 1983). The formation consists of poorly sorted, fluvial sandstone and conglomerate, with interbeds of mudstone and siltstone, with most of the sedimentation being sourced from the Sierra Nevada Mountain Range (Bartow and Pittman, 1983). The Kern River Formation lies conformably on the Etchegoin Formation. In the center of Kern Subbasin, the Kern River Formation inter-fingers with or grades into the San Joaquin, Etchegoin, and Tulare Formations westward (Scheirer and Magoon, 2008). The Kern River Formation was deposited as an alluvial fan from east to west from the Sierra Nevada. The Etchegoin, San Joaquin, and Tulare Formations are time-equivalent deposits that represent different deposition environments across Kern Subbasin (Bartow and Pittman, 1983; Bartow, 1991).

The Tulare Formation is comprised of alternating beds of unconsolidated, lacustrine, and fluvial sand and mudstone deposits, with sedimentation sourcing from the Coast Ranges (Dale et al., 1966). The Tulare Formation can be split into Upper and Lower sections. The Upper Tulare Formation is a dominantly sandy alluvial fan and alluvial plain deposits whereas the Lower Tulare Formation is comprised mostly of lacustrine and deltaic deposits (Kiser et al., 1988). The separation between the Upper and Lower Tulare is generally aligned with the Middle Tulare Clay where it is present.

There are also lateral changes in the depositional setting changes throughout Kern Subbasin, with the Tulare Formation being deposited in a fluvial-lacustrine environment in the central Kern Subbasin. Toward the west of Kern Subbasin, the Tulare Formation exhibits characteristics of a semi-arid to arid depositional environment, as evidenced by the presence of lacustrine claystone, fan-delta deposits, debris-dominated alluvial fan deposits, and prominently, paleosols (Nilsen and Campbell, 1996). The Tulare Formation has been observed to be over 2,200 feet in thickness.

Fine-grained, low-permeability flood-basin, lacustrine, and marsh deposits are widespread throughout Kern Subbasin. In the Western Fold Belt HCM Area, there are several clay layers that represent periods of large lake deposits being formed during interglacial periods during the Pleistocene ice ages (Croft, 1972). The Tulare Formation also features several major clay layers (Everett et al., 2020) that include the following:

- A-Clay
- C-Clay
- E-Clay (including the Corcoran Clay Member)
- Middle Tulare Clay
- Amnicola Clay

A major feature of the Pleistocene paleogeography was the formation of the Corcoran Lake (Figure 7-9) that covered large areas of the San Joaquin Valley for a brief interval near the middle of the Pleistocene (Bartow, 1991). Six clay tongues, representing deposits formed from this lake formed the southwestern San Joaquin Valley area. These are designated in descending order by the letters A through F (Croft, 1972). Of these, the A-, C-, and E-clays are found in the Kern Subbasin.

The Pleistocene Corcoran Lake (Figure 7-9) did not cover the entire Kern Subbasin but was primarily located in the areas along and east of the San Joaquin Valley Syncline that, during this time, formed the topographic low area, so more continuous clay deposits formed. To the east, the general upward slope towards the Sierra Nevada limited the distribution of clays due to fluctuating lake levels of the Pleistocene Corcoran Lake (Figure 7-9) during deposition. To the west, the rise of the Westside Fold Belt limited lake deposits to more prominent synclines. As shown on Figure 7-14, the E-Clay (Page, 1986) shows that the E-clay is thicker and more extensive in areas to the north than in Kern Subbasin. The general pattern is separated in a north and southern area primarily due to the progradation of the large Kern River alluvial fan into the middle of Kern Subbasin. Additionally, the West Side Fold Belt also affected the distribution of the E-Clay in Kern Subbasin. Both Croft (1972) and Page (1983) do not extend the E-Clay in the western areas of Kern Subbasin. In the West Side Fold Belt, the E-Clay interval is typically represented as a geologic unconformity indicating either nondeposition of the E-Clay or deposition and subsequent erosion of the E-Clay. Either case indicates that the West Side Fold Belt was tectonically rising during deposition of the E-Clay resulting in its absence across most of this area. The A-Clay, a blue to dark greenish gray, highly organic clay that is generally less than 60-feet-thick (Croft, 1972) is primarily found associated with the Buena Vista slough and the Tulare, Buena Vista, Kern, and Goose Lake beds. The A-Clay is locally discontinuous and primarily acts as a shallow perching horizon, comprised of Pleistocene-Holocene fluvial and flood plain silts, clays, and interbedded sands. Croft (1972) mapped the C-Clay to the northwestern corner of Kern Subbasin. The unit is described as a silty, calcareous, lacustrine clay deposit. The unit ranges in depths between surface outcrops to 300 feet and is rarely over 50-feet-thick.

The E-Clay (including the Corcoran Clay member) is a major geological horizon that has been mapped over a large area of the southern San Joaquin Basin. This report uses the modified E-Clay of Page (1986) which underlies a large portion of the west-central portion of Kern Subbasin. The Corcoran Clay is a commonly used term; however, it is defined as a distinctive diatomaceous clay bed near Tulare Lake (Frink and Kues, 1954; Davis et al., 1959). Both Croft (1972) and Page (1986) refer to the E-Clay as the extensive lacustrine clay that includes the Corcoran Clay Member of the Tulare Formation. The modified E-Clay (Page, 1986) uses a revised interpretation of the Croft (1974) E-Clay map in the southern part of Kern Subbasin that places the E-Clay from 100 to 300 feet above the depth that Croft mapped it. The E-Clay has gently folded into an asymmetric NW trending syncline, with a steepening flank to the west (Croft, 1972).

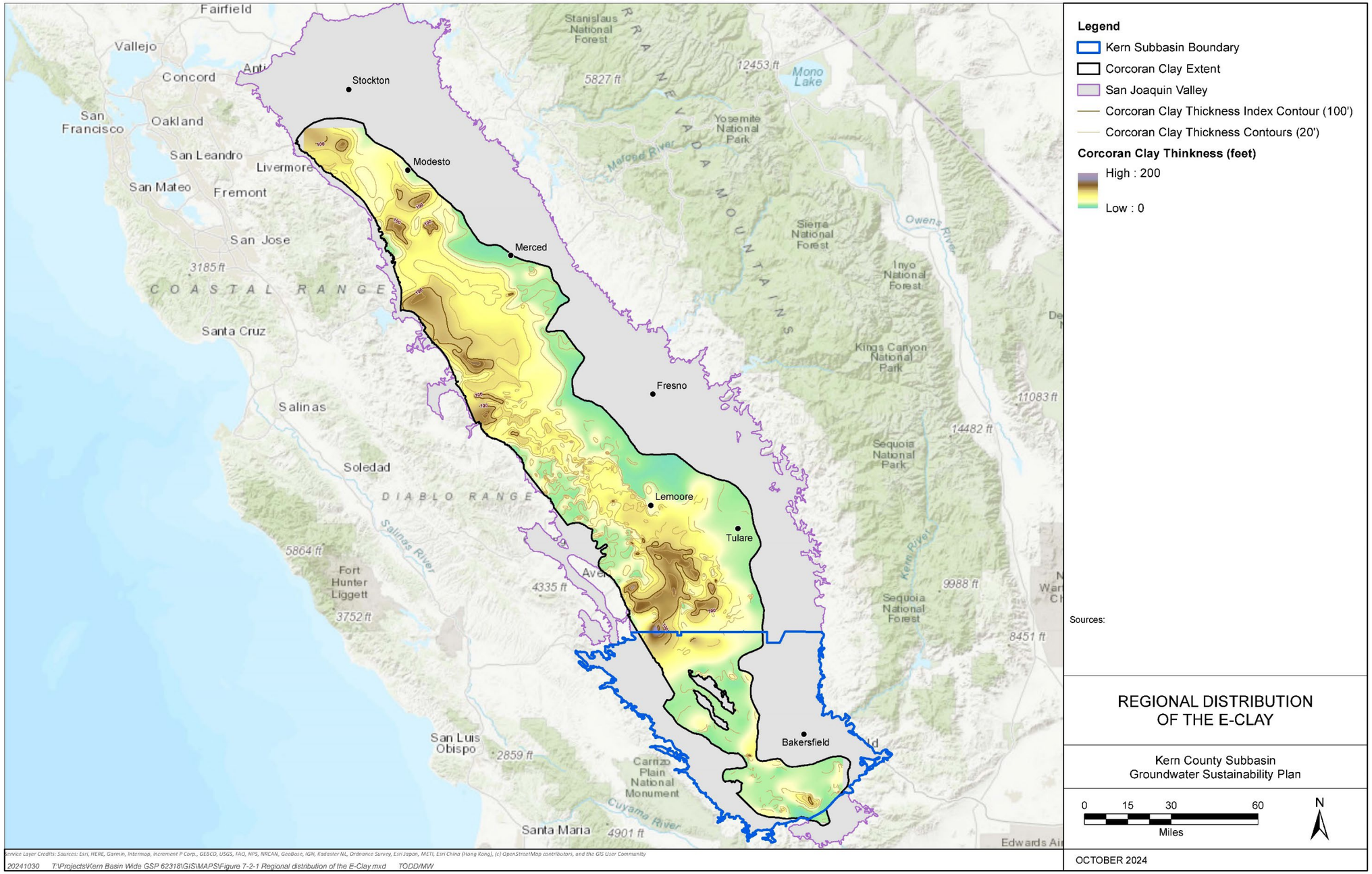


Figure 7-14. Regional Extent of the E-Clay (Corcoran Clay) based on Page, 1986

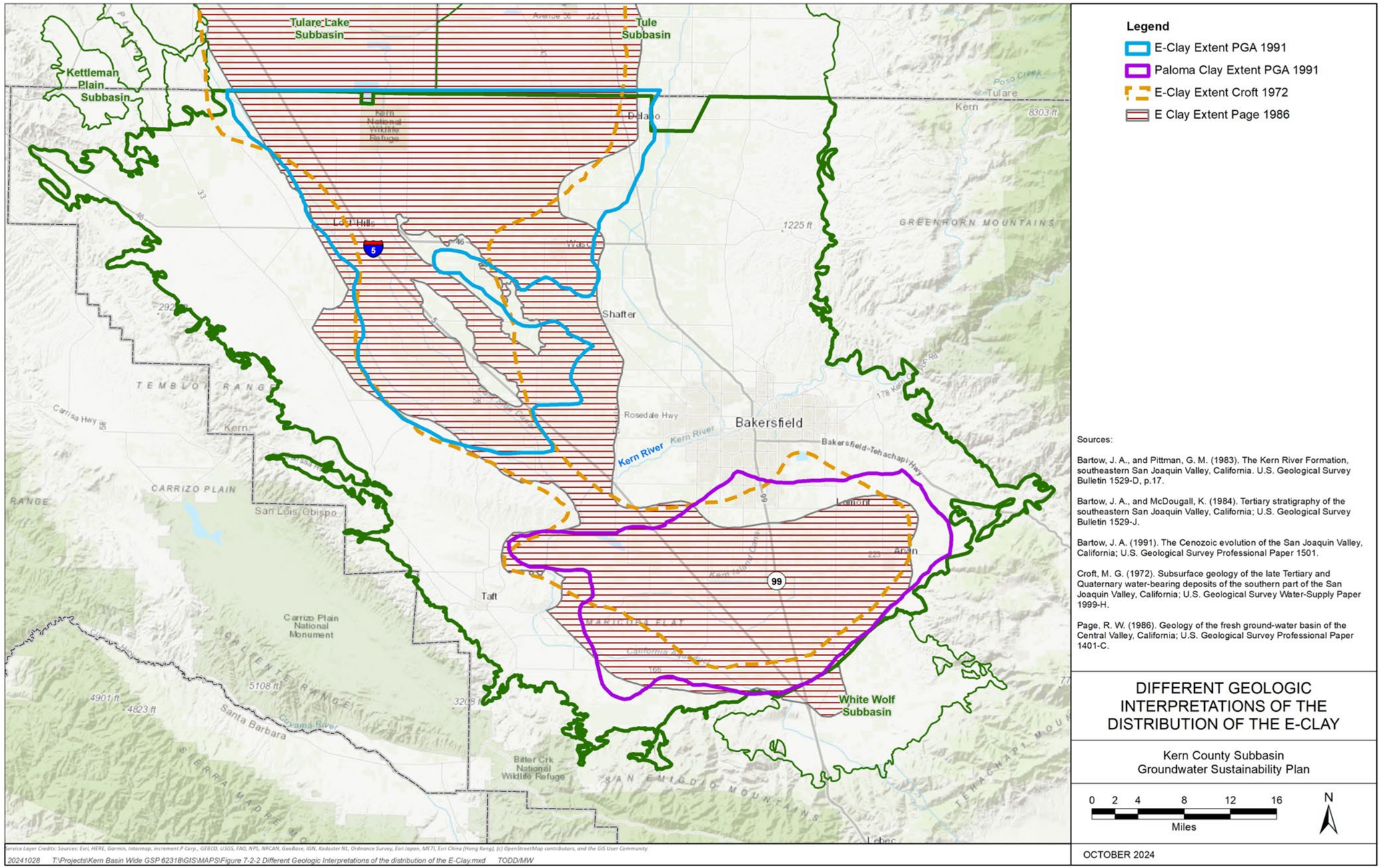


Figure 7-15. Comparison of different interpretation on the extent of the E-Clay

In the vicinity of the Buena Vista Lake, Buena Vista slough, and north-central areas south of Tulare Lake within Kern Subbasin, the E-Clay ranges from 50 to 120 feet in thickness (Foss and Blaisdell, 1968). As noted above, the E-Clay is generally absent in the West Side Fold Belt area and is typically represented by a geologic unconformity.

Several different interpretations of the extent of the E-clay have been developed by the USGS and others (Croft 1972, Page 1983; Page, 1986; PGA 1991). As shown on Figure 7-15, these generally agree in the areas where the E-Clay is prominent but vary along the margins. The variability in the distribution of the E-Clay across Kern Subbasin has multiple causes. East of the San Joaquin Valley Syncline, the E-Clay bifurcates into multiple layers that probably represents fluctuating lake levels of the Pleistocene Corcoran Lake (Figure 7-9) during deposition, thus making the margin of the E-Clay difficult to identify in these areas (Croft, 1972; Bartow, 1991). In addition, the distribution of the E-Clay is influenced by the geologic structures present during deposition. The Bakersfield Arch formed a low-relief high area where the Kern River Alluvial Fan was being actively deposited. As a result, the E-Clay was either not deposited or was later removed by erosion in these areas. The E-Clay was originally deposited as an essentially flat layer; therefore, subsequent deformation is the result of the ongoing development of the Westside Fold Belt. As a result of this deformation, the E-Clay occurs at varying depths that are higher over the anticlines and lower within the synclines in Kern Subbasin (Bartow, 1991; Wood and Davis, 1959; Croft, 1972; Page, 1986).

Prior to the formation of the Corcoran Lake, several other regional clay layers were deposited in the western areas of Kern Subbasin. Gillespie, et al (2017) recognizes a distinct clay layer with a prominent high gamma-ray signature on geophysical logs and is identified as the Middle Tulare Clay (Kiser et al., 1988). Distinctive resistivity log patterns may indicate a transition from lacustrine delta environments in the lower Tulare Formation to a fluvial meander belt setting in the upper Tulare Formation, as suggested by Miller et al. (1990). It is found exclusively along the peripheries of the Elk Hills and Buena Vista anticlines, and exhibits an unusually significant thickness, exceeding several hundred feet beneath the Buena Vista lakebed in the southeast (Gillespie et al., 2022).

The Amnicola Clay is characterized as an olive gray claystone with partial calcareous/dolomitic composition, known to contain the gastropod Amnicola (Croft, 1972). The Amnicola Clay plays a significant role in the Elk Hills region as a local confining layer or aquitard. This unit safeguards fresh groundwater in the upper part of the Tulare Formation from degradation caused by saline oilfield produced waters injected into the lower part of the Tulare Formation, as documented by Crosby and Schymiczek (1990).

7.2.6.2 Plio-Pleistocene Marine Geologic Units

These deposits are primarily considered as confining units. In the eastern Kern Subbasin, these units act as a confining layer that separates the continental deposits from the Santa Margarita Formation aquifer. Elsewhere these units form the base of the continental deposit aquifer. Some wells along the eastern margin of Kern Subbasin are perforated partially within the Etchegoin Formation unit but the contribution of groundwater is considered to be low (Lofgren and Klausing, 1969). Figure 7-13 shows the variability of these formations across Kern Subbasin. These units include:

- San Joaquin Formation (Late Pliocene)
- Etchegoin Formation (Pliocene)

The San Joaquin Formation is comprised of blue to green, fossiliferous, fine-grained sands, silts and clays (Foss and Blaisdell, 1968). The San Joaquin Formation is only present in the western portion of Kern Subbasin, due to the westward retreat of the paleo-marine basin during the Pliocene (Scheirer and Magoon, 2008). The San Joaquin Formation is similar to the Etchegoin Formation and has a similar geometry to the underlying Etchegoin Formation. This similarity continues as the San Joaquin Formation transitions into the Kern River Formation toward the east.

Along the eastern margin of Kern Subbasin, the Etchegoin Formation is comprised of marine sandstone and micaceous shale (Foss and Blaisdell, 1968). The formation can be divided into two members: basal sandstone or the basal Macoma Claystone, and upper sandstone (Wagoner, 2009). The Etchegoin Formation is broadly distributed throughout Kern Subbasin and ranges in thickness from over 15 feet along Kern Subbasin margin to over 1,200 feet in the center of Kern Subbasin (Page, 1986; Scheirer and Magoon, 2008). The Etchegoin Formation is interpreted as a minor marine transgression and grades eastward into the Kern River Formation (Bartow and McDougall, 1984).

Miocene and Older Marine Geologic Units in Eastern Kern Subbasin

The Miocene geologic units are primarily marine deposits that reflect the series of marine transgressive and regressive depositional environments that represent changing sea levels over geologic time. As a result, the general geology is a series of sandstone units situated between thick shale and siltstone layers. The sandstones are primarily deposited along the eastern margin of Kern Subbasin in the vicinity of the Bakersfield Arch. Toward the center of Kern Subbasin, these sandstones typically interfinger and grade into finer-grained shales and siltstones that are characteristic of a deeper water depositional setting. These units include:

- Chanac Formation (Late Miocene to Early Pliocene)
- Santa Margarita Formation (Late Miocene)
- Fruitvale Shale Formation (Middle to Late Miocene)

- Round Mountain Silt (Middle Miocene)
- Olcese Sand (Early Miocene)
- Freeman-Jewett Formation (Early Miocene)
- Vedder Sand (Oligocene)

Figure 7-13 shows the stratigraphic relationships of these formations across Kern Subbasin. The Chanac Formation is comprised of fossiliferous, brown nonmarine sandstone, deposited in a coastal plain meandering stream sequence (Link et al., 1990). Lower sections of the Chanac Formation have also been observed to be the lateral equivalent of the Santa Margarita Formation and can be considered different facies of the same depositional cycle. The Chanac Formation ranges in thickness from 100 to 1,000 feet (Bartow and McDougall, 1984) and is confined to the eastern margins of Kern Subbasin (Scheirer and Magoon, 2008).

The Santa Margarita Formation consists of an upper bed of a silty, well-sorted, fine-grained sandstone and a lower bed of a fossiliferous, micaceous sandy siltstone, both of which were deposited in a shallow-marine environment. The Santa Margarita Formation ranges in thickness from 200 to 600 feet (DWR, 2016). The Santa Margarita Formation is most prominent in the east of Kern Subbasin. Towards the center of Kern Subbasin, the Santa Margarita Formation is faulted, inter-fingers and grades into the Fruitvale Shale (Bartow and McDougall, 1984). The Santa Margarita Formation is highly permeable and can be used as a stratigraphic marker (Croft, 1972).

The upper sandstone bed of the Santa Margarita Formation acts as a source of fresh water in the northeast of Kern Subbasin (DWR, 2016). Most of the marine sediments in Kern Subbasin contain highly saline, connate water. The Santa Margarita Formation and Olcese Sand outcrop along the eastern margin of Kern Subbasin or the surrounding watershed and so are recharged by freshwater from the surface. This process over time has flushed the original saline connate water with freshwater.

The Fruitvale Shale consists of poorly sorted, marine carbonaceous silt that thins out to the east and west margins of Kern Subbasin but thickens in the center. Toward the west, the shale unit grades into the Antelope Shale (Bartow and McDougall, 1984). This unit rests conformably on the Round Mountain Silt and underneath the Santa Margarita Formation (Scheirer and Magoon, 2008).

The Round Mountain Silt is a unit comprised of poorly consolidated diatomite, laminated siltstone, and micaceous sandstone and conformably overlies the Olcese Sand and the Freeman-Jewett Formation. The Round Mountain Silt ranges in thickness up to 200 feet (Page, 1986). The formation is present in the east and center of Kern Subbasin, but inter-fingers with the Monterey Formation to the west (Bartow and McDougall, 1984). The Fruitvale Shale and Round Mountain Silt act as an aquitard, which confines the Olcese Sand, and as a barrier between the Santa Margarita Formation (Reynolds, 1955).

The Olcese Sand is comprised of medium to coarse-grained, poorly cemented, shallow marine shelf sandstone with interbedded siltstone and conglomerate and has been observed to be over 600 feet in thickness (Page, 1986). The Olcese Sand is thickest in the eastern Kern Subbasin margins, where it is near the surface. Toward the west the unit plunges downward and pinches out (Prothero, et al., 2008). Toward the center of Kern Subbasin, the unit inter-tongues with the underlying Freeman Silt and overlying Round Mountain Silt (Scheirer and Magoon, 2008). The Olcese Sand is a source of fresh water in eastern and northeastern areas of Kern Subbasin but is utilized primarily in the Kern River Canyon area and northeast Kern Subbasin areas (DWR, 2016).

The Freeman-Jewett Formation consists of two components: the Jewett Sand and the Freeman Silt. The Jewett Sand is a unit of silty sand to sandy shale that unconformably overlies the Vedder Sand or Walker Formation. The Freeman Silt is a siltstone unit that gradationally overlies or inter-tongues the overlying Jewitt Sand. The Silt member acts as an effective groundwater flow barrier (Reynolds, 1955). Toward the east of Kern Subbasin, the Jewett Sand thickens, however toward the west the Jewett Sand eventually changes into siltstone and thins out, while the Freeman Silt thickens in the west. There are also minor units that lay conformably under the Freeman-Jewett Formation. In the east the Jewett Sand is locally underlain by the Pyramid Hill Sand Member, and in the center of Kern Subbasin, the Freeman Silt is locally underlain by the Rio Bravo Sand. Toward the center and west of Kern Subbasin, these two units thin out and are not observed (Bartow and McDougall, 1984).

The Vedder Sand consists of well-sorted, fine to medium-grained sandstone, with localized silica cement. The formation can reach up to 1,000 feet in thickness. The Vedder Sand lies conformably over the Walker Formation and in some areas is laterally equivalent to the upper sections of the Walker Formation (Bartow and McDougall, 1984). Along the eastern and southeast margins of Kern Subbasin, the Vedder Sand, and the thin, overlying Pyramid Hills Sand Member, may produce fresh groundwater (Page, 1986). The Vedder Sand is unconformably overlain by the Freeman-Jewett Formation north of the Bakersfield Arch. To the south of the Arch, the contact can be observed as conformable (Scheirer and Magoon, 2008).

7.2.6.3 Miocene and Older Nonmarine Units in the Eastern Kern Subbasin

Along the eastern margin of Kern Subbasin, older nonmarine sedimentary rocks exist. These are generally very coarse grained and are considered to represent rapid erosion during a period of uplift of the Sierra Nevada. These units include:

- Bena Gravel (Miocene)
- Bealville Fanglomerate (late Oligocene and early Miocene)
- Walker Formation (Eocene and early Miocene)

Figure 7-13 illustrates the stratigraphic relationships of these formations across Kern Subbasin. The Bena Gravel and Bealville Fanglomerate are restricted to a relatively

small area in the vicinity of Caliente Creek south of the Kern River (Bartow and McDougall, 1984). The Bealville Fanglomerate is an unsorted granitic rubble that unconformably overlies granitic basement and inter-tongues westward with the Walker Formation. The Bealville Fanglomerate is more than 6,000 feet thick (Dibblee and Chesterman, 1953). It is overlain by the Bena Gravel, which consists of a series of nonmarine gravels that overlie the Walker formation. The Bena Gravel is described as a pebble-cobble conglomerate with interbeds of coarse-grained sandstone that are up to 2,000 feet thick. These two units have greater thicknesses than other units in the area because they are filling the structural basin created by displacement along the Edison Fault. The Bena Gravel grades laterally into the marine Olcese Sand, Round Mountain Silt, and Edison Shale.

The Walker Formation is the base unit of the Tertiary sequence within Kern Subbasin. The Walker Formation is comprised of non-marine clayey sandstone, siltstone, and claystone, which overlie the basement complex along the eastern margin of Kern Subbasin. The Walker Formation is the nonmarine equivalent of the Vedder Sand, the Freeman-Jewett Formation and the Bealville Fanglomerate. Towards the west, the Walker Formation grades into the lower sections of the Kreyenhagen Formation, which represents a transition from nonmarine to marine depositional setting (Bartow and McDougall, 1984). The Walker Formation is generally poorly permeable and yields small amounts of water, with the quality of the groundwater decreasing with depth and becoming more brackish to mineralized (Hilton et al., 1963).

7.2.6.4 Miocene and Older Marine Geologic Units in Western Kern Subbasin

The older sedimentary layers in Kern Subbasin reflect marine transgressive and regressive deposition cycles with extensive deposition of fine-grained clay in the deep marine locations (Bandy and Arnal, 1969). Figure 7-8 and Figure 7-13 illustrate the stratigraphic relationships of these formations across Kern Subbasin. As a result, the general geology is for a series of shale units that may contain localized sand units. The fine-grained geology has generally trapped the original connate water and these units are not considered as usable groundwater aquifers but are part of the sedimentary sequence within Kern Subbasin. These units include:

- Reef Ridge Formation (Late Miocene to Early Pliocene)
- Monterey Formation (Middle to Late Miocene)
- Temblor Formation (Oligocene to Middle Miocene)
- Tumey Formation (Oligocene)
- Kreyenhagen Formation (Middle to Late Eocene)

The Reef Ridge Formation consists of marine blue shale to brown sandy claystone with thin limestone beds, with occasional sandstone bodies (Foss and Blaisdell, 1968). The formation is thickest in the west of Kern Subbasin and grading eastward into the Chanac Formation (Scheirer and Magoon, 2008).

The Monterey Formation is comprised of three members of marine origin: Devilwater-Gould Member, McDonald Shale Member and the Antelope Shale Member. The formation is present in the west and grades into the eastern Round Mountain, Fruitvale, and Santa Margarita Formations to the east (Scheirer and Magoon, 2008; Foss and Blaisdell, 1968).

The Temblor Formation is comprised of Cymric Shale, Wygal Shale, Santos Shale, Carneros Sandstone, Media Shale, and Buttonbed Sandstone (Scheirer and Magoon, 2008). This formation is present in the west and is chronologically comparable with the Vedder, Freeman-Jewett, and Olcese Formations to the east, but the Temblor Formation does not share sediment sources with the eastern equivalents, so it is considered lithologically distinct (Johnson and Graham, 2008).

The Tumey Formation, also locally known as the Wagonwheel Formation, consists of a deep marine, fine grained sandstone, with a massive 500-foot thick basal turbidite sandstone member representing deep water deposition. The unit has been measured to be over 1,200 feet in total thickness and has an unconformable base and top surface (Lillis and Magoon, 2008; Johnson and Graham, 2008).

The Kreyenhagen Formation contains four members: Kreyenhagen Shale (Welcome Shale Member), Canoas Siltstone, Points of Rocks Sandstone, and the Domengine Member (Scheirer and Magoon, 2008). The formation is comprised of dark brown to medium gray fissile, fossiliferous, marine shales, siltstones and some limestones and sandstones (Foss and Blaisdell, 1968). The Kreyenhagen Formation appears in the east but is most prominent in the western margins of Kern Subbasin and thins toward the Sierra Nevada Mountain Range. In the west, the formation thickens and is highly folded and uplifted (Bartow and McDougall, 1984).

Basement Rocks

The basement complex of pre-Tertiary age exposed throughout the southern Sierra Nevada, Tehachapi, and San Emigdio Mountains and buried beneath deposits of Tertiary and Quaternary age in the San Joaquin Valley. These margins are comprised of igneous and metamorphic rocks, which make up much of the Sierra Nevada, Tehachapi, and Southern Coast Ranges (Lofgren and Klausing, 1969). The basement complex underlies Kern Subbasin sedimentary rocks and sediments at depths that range to over 20,000 feet in the deepest parts of Kern Subbasin (Page, 1986).

The basement complex has relatively very low permeability and is generally located outside the valley's agricultural and urban areas, .The rocks of the basement complex are a source of groundwater supply that is limited to small-scale domestic and stock uses in areas outside of Kern Subbasin (Hilton et al., 1963; Croft, 1972). In the surrounding watersheds along Kern Subbasin margins, fractures and deeply weathered zones in the basement complex may discharge water to streams that flow onto the valley floor (Wood and Dale, 1964).

7.3 Cross Sections

§ 354.14. Hydrogeologic Conceptual Model

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

☑ 23 CCR § 354.14(c)

7.3.1 Regional Cross Sections

A series of seven hydrogeologic cross-sections were developed to illustrate the regional hydrostratigraphy across Kern Subbasin. A map displaying the orientation of the cross sections is provided in Figure 7-16. The cross sections for Kern Subbasin are provided in Figure 7-17 through Figure 7-23. The cross-sections extend laterally across Kern Subbasin in either a general north-south or east-west orientation and extend vertically down to an elevation of -6,000 feet. As such, the cross-sections include the entire thickness of aquifer materials that are or could reasonably be tapped for groundwater supply purposes.

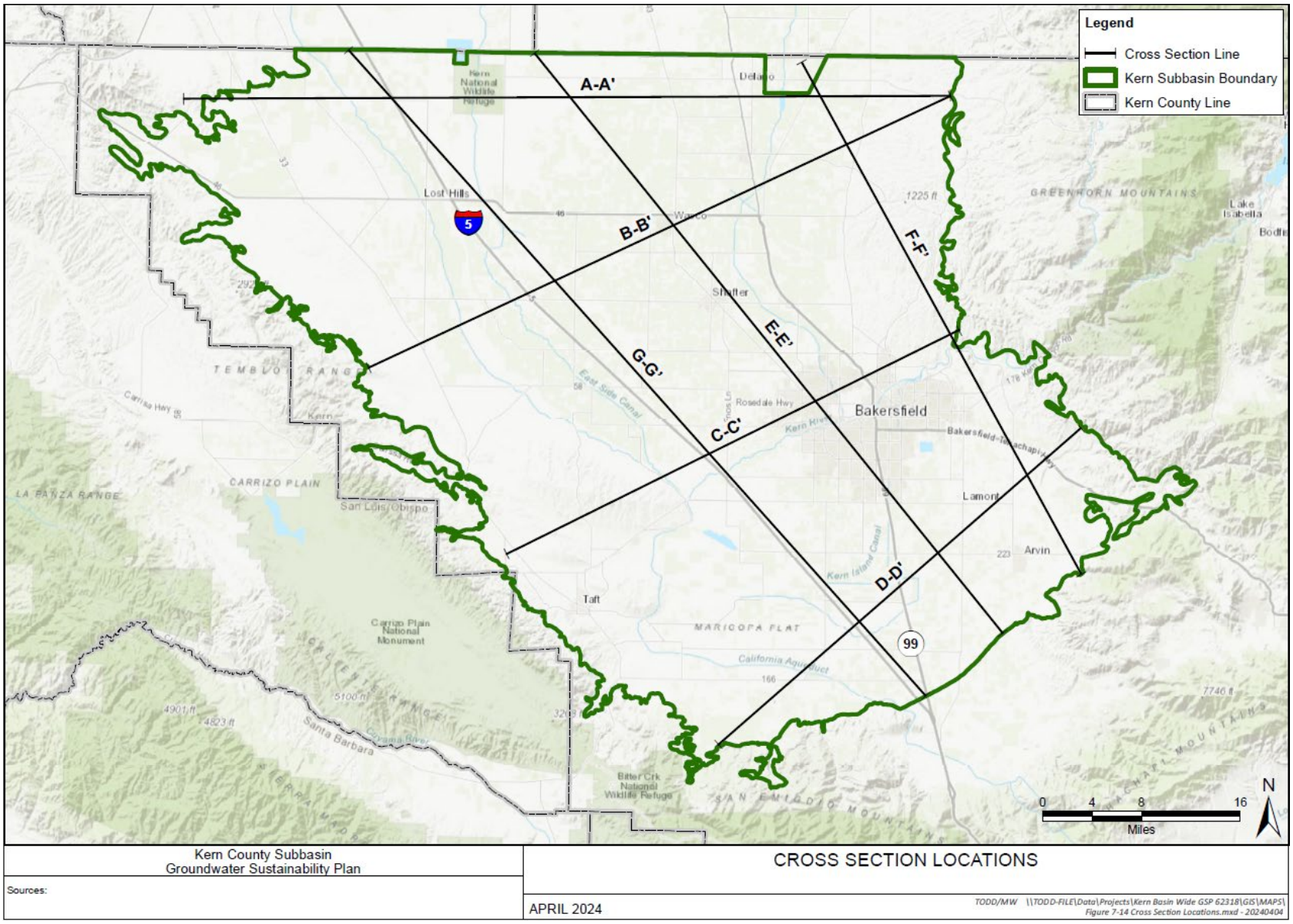


Figure 7-16. Cross Section Locations

Cross Section Descriptions

Cross section A-A' (Figure 7-17) trends from the west to the east across the northern margin of Kern Subbasin. The section is comprised at the surface of Recent Alluvium and Tulare/Kern River Formation (shown as Undifferentiated Alluvium) to the top of the E-Clay or its equivalent. Below the E-Clay is a significantly thicker sequence of Tulare/Kern River Formation, ranging from 200 feet to 4,000 feet in thickness. This unit thins in the west, with a steep dip toward the center of Kern Subbasin. The unit gradually slopes up toward the east and crops out at the surface as the Kern River Formation. The E-Clay, Tulare Clay, and Amnicola Clay are all present and exhibit varying thicknesses ranging from 0 feet to over 50 feet. These clays are thickest in the west and central areas but pinch out toward the eastern and western margins. Below the Tulare/Kern River Formation lie the Plio-Pleistocene Sedimentary units (Etchegoin, Chanac and San Joaquin Formations), which range up to of 800 feet in thickness in the center of Kern Subbasin but pinch out in the east. The Santa Margarita Formation, Round Mountain Silt and Olcese Sand are shown separately in the east with a relatively steep dip toward the east that eventually outcrop at the surface. To the west, these formations grade into other more fine-grained units (Undifferentiated Miocene and Older Sediments) with thicknesses varying from less than 200 feet, up to 800 feet in thickness.

Cross section B-B' (Figure 7-18) begins in the foothills of the Temblor Range in the west and trends in a northeasterly direction toward the northeast corner of Kern Subbasin. The thickness of the Undifferentiated Alluvium is relatively uniform across the section; however, it does pinch out toward the eastern margin. The underlying Tulare and Kern River Formations range in thickness from 0 feet, outcropping to the surface and pinching out in the east, to 2,500 feet, being influenced by a subsurface syncline and anticlinal structure. The E-Clay is present in most of the section but pinches out in the eastern and western flanks. The Tulare Clay and Amnicola Clay exhibit varying thicknesses and both pinch out at the western margin. Both clays are thicker in the center of the section, up to 250 feet. The Amnicola Clay is only present in the west and pinches out eastward whereas the Tulare clay has a larger lateral extent. The underlying Plio-Miocene Sediments are thicker on the western flanks and Kern Subbasin center, but thin and pinch out toward the east. This unit overlies the Santa Margarita Formation, Round Mountain Silt and Olcese Sand, which are only present in the east and dip steeply toward the east. These units range in thicknesses between 200 feet to 1,000 feet, with the Round Mountain Silt having a considerable thickness

Cross section C-C' (Figure 7-19) begins in the west of Kern Subbasin and trends in a west to east direction toward the central eastern boundary of Kern Subbasin. Undifferentiated Alluvium is present over most of Kern Subbasin where it overlies the Tulare and Kern River Formations but pinches out toward the eastern foothills. In the west, the Tulare Formation is variable in thickness due to the intense folding in the west. A series of anticline and syncline structures can be observed in the Tulare Formation

whereas the Kern River Formation has a gentle dip from east to west across Kern Subbasin. The Kern River Formation outcrops along the eastern margin. The Mid-Tulare and Amnicola Clay exhibit varying thicknesses in the west due to the folding; however, they pinch out and are not present in the east. The E-Clay is considered to be absent along this section due to influence of the Bakersfield Arch and West Side Fold Belt during deposition (Section 7.2.6). The Plio-Pleistocene sediments are highly variable, due to intense folding and a large depocenter in the east, with thicknesses ranging from 1,500 to over 4,000 feet. This formation, however, dips towards the eastern flank and pinches out. In the east, the Chanac, Santa Margarita, Round Mountain Silt and Olcese Sand are present. They are steeply dipping and grade into the Miocene and Older Sediments. They range in thickness from 50 to 1,000 feet.

Cross section D-D' (Figure 7-20) runs parallel to the southern Subbasin boundary, beginning in the west and terminating in the east, trending in a southwest to southeast direction. The Undifferentiated Alluvium remains a relative constant thickness but pinches out in the east where the Kern River Formation outcrops at the surface. The Tulare and Kern River Formations reach their greatest thicknesses in the south along the section. These formations pinch out in the west and east but reach thicknesses of over 6,000 feet in the center of the section. The E-Clay, Tulare Clay and Amnicola Clay are present within the section. All the clays are thickest in the western portion of the section, on the dipping western flank of Kern Subbasin axis, while the clays eventually pinch out to the east. The underlying Plio-Pleistocene sediments follow the same trend, and the maximum thickness is over 6,500 feet. The Plio-Pleistocene sediments onlap onto the underlying, easterly dipping Chanac and Santa Margarita Formations, which grade into the underlying Miocene and Older Sediments. In the east, the Chanac and Santa Margarita Formations are upthrown by the Edison Fault. On the eastern side of the fault the Chanac, Santa Margarita, Round Mountain Silt and Olcese Sand are present, which dip steeply toward the east. Most notably, the Olcese Sand thickens to over 2,500 feet.

Cross section E-E' (Figure 7-21) extends from the northern boundary to the southern boundary, in a northwest to southeast orientation in the center of Kern Subbasin. The section is comprised of a moderately uniform undifferentiated alluvium layer, which grades into the Tulare and Kern River Formations. The Tulare and Kern River Formations remain at a relatively constant thickness, until reaching the southern end of the section. Here they rise over the Bakersfield Arch and reach their greatest thickness in the Maricopa-Tejon Structural Region (Bartow, 1991) in the south where the thickness varies between 1,800 to 6,000 feet. The Amnicola Clay is only present in the south with a thickness of up to 50 feet whereas the Tulare Clay is present though most of the section with thicknesses of up to 100 feet. The E-Clay is present in the northern and southern areas, where it exhibits a thickness of up to 200 feet, but pinches out in the middle over the Bakersfield Arch. The underlying Plio-Pleistocene sediments follow the structural trend with a thickness of around 3,500 feet.

Cross section F-F’ (Figure 7-22) starts in the northeast corner of Kern Subbasin, then trends in a northwest to southeasterly direction to the southeastern corner of Kern Subbasin. The surficial undifferentiated alluvium is only present in pockets of topographic lows in the eastern and western flanks of the section. The Kern River Formation is the most dominant surficial unit and varies in thickness between 1,000 feet in the north, 200 feet in the center and to 3,000 feet in the east. The E-Clay is generally absent in the east except for a small area below the undifferentiated alluvium at the southern end of the section. The underlying Chanac Formation, Santa Margarita Formation, Round Mountain Silt and Olcese Sand are heavily faulted and folded in this section, the Poso, China Grade and Edison Faults displace these units and create a disjointed lateral continuity. These units exhibit thicknesses of 400 feet, thinning on the crest of a subsurface anticline, and thickens to over 1,000 feet on the eastern margins.

Cross section G-G’ (Figure 7-23) starts in the northwest corner of Kern Subbasin, and trends from northwest to southeast across the west central portion of Kern Subbasin. This area consists of some of the deepest portions of Kern Subbasin that lies along the San Joaquin Syncline in the north and extends into the Maricopa-Tejon Structural Region (Bartow, 1991) in the south. The underlying Tulare Formation varies in thickness from about 2,000 feet at the Bakersfield Arch to over 6,500 feet in the southern Kern Subbasin. The E-Clay, Tulare Clay and Amnicola Clay are present but are not continuous across this section. The E-Clay varies in thickness but pinches out toward the south. The Tulare Clay is segmented but exhibits considerable thicknesses of up to 150 feet. The Amnicola Clay is also present but thins towards the anticline and pinches out to the east. The Plio-Pleistocene sediments reach thicknesses of over 11,000 feet and thin to 5,000 feet over the Bakersfield Arch..

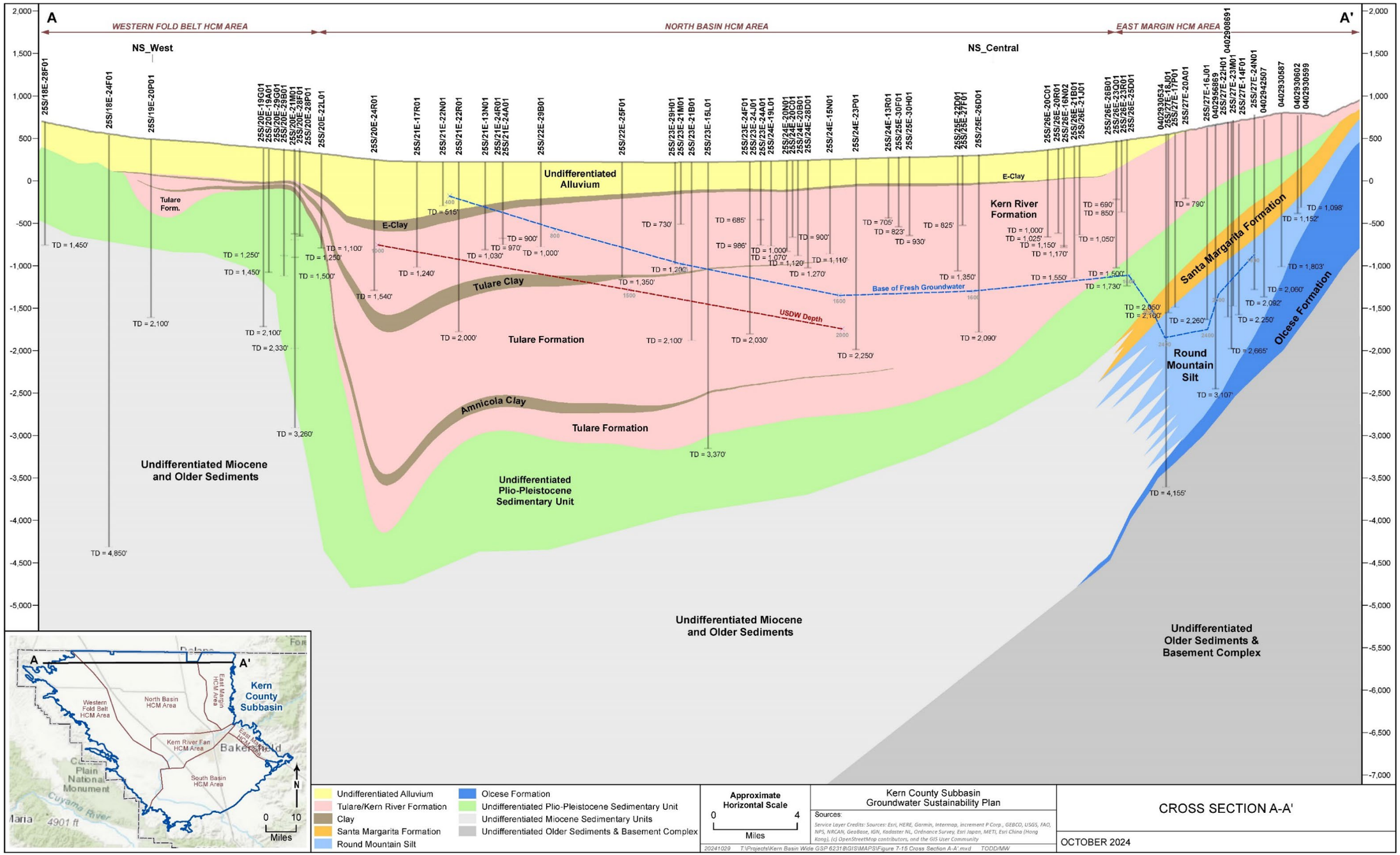


Figure 7-17. Cross Section A-A'

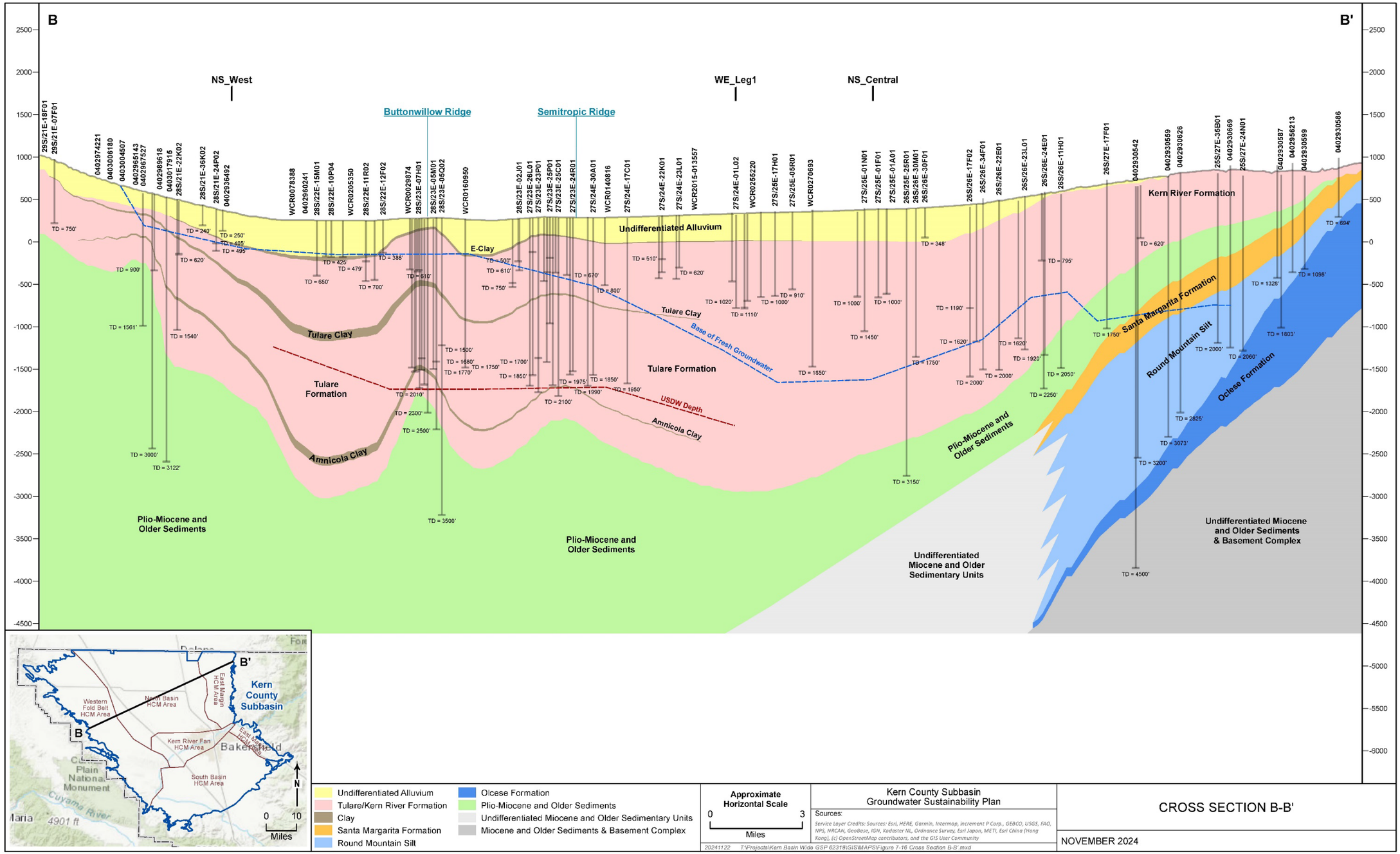


Figure 7-18. Cross Section B-B'

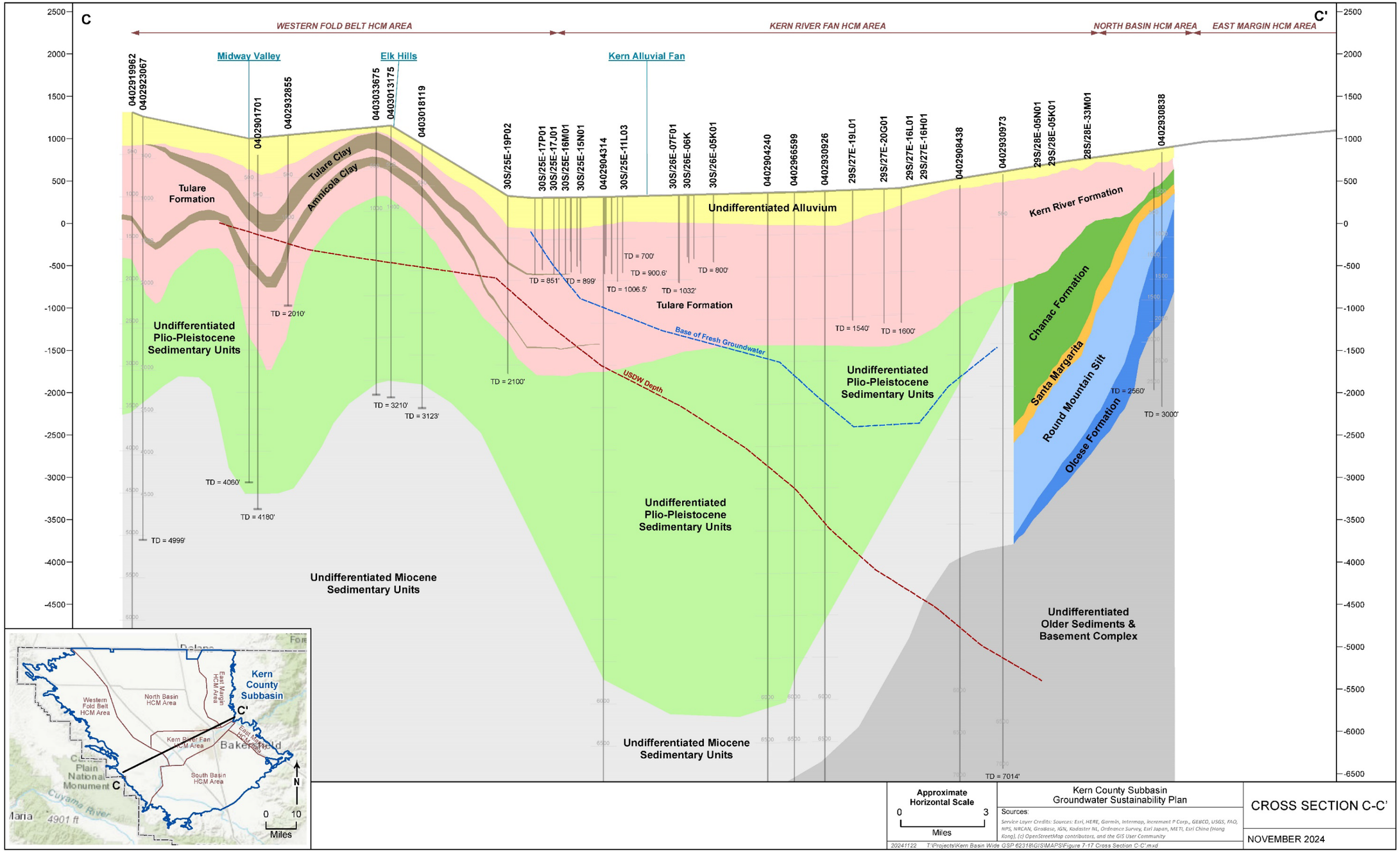


Figure 7-19. Cross Section C-C'

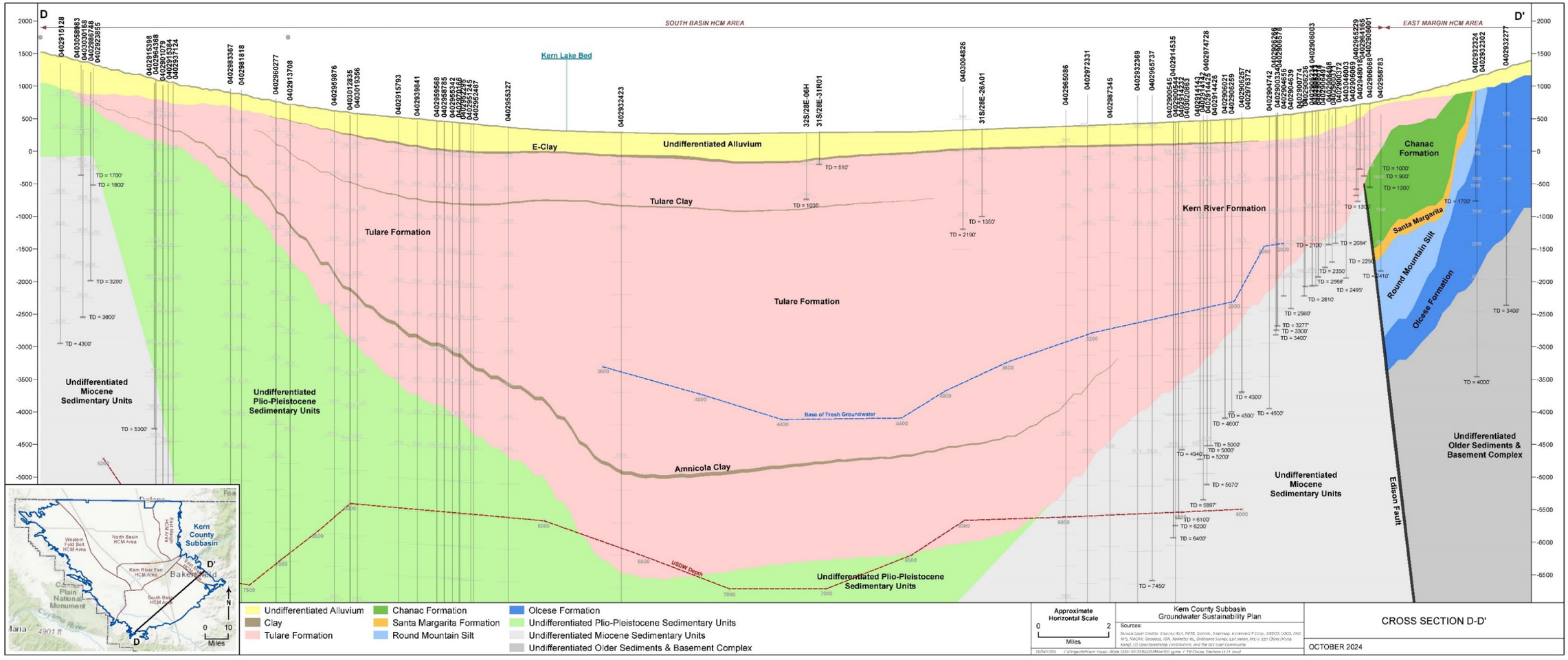


Figure 7-20. Cross Section D-D'

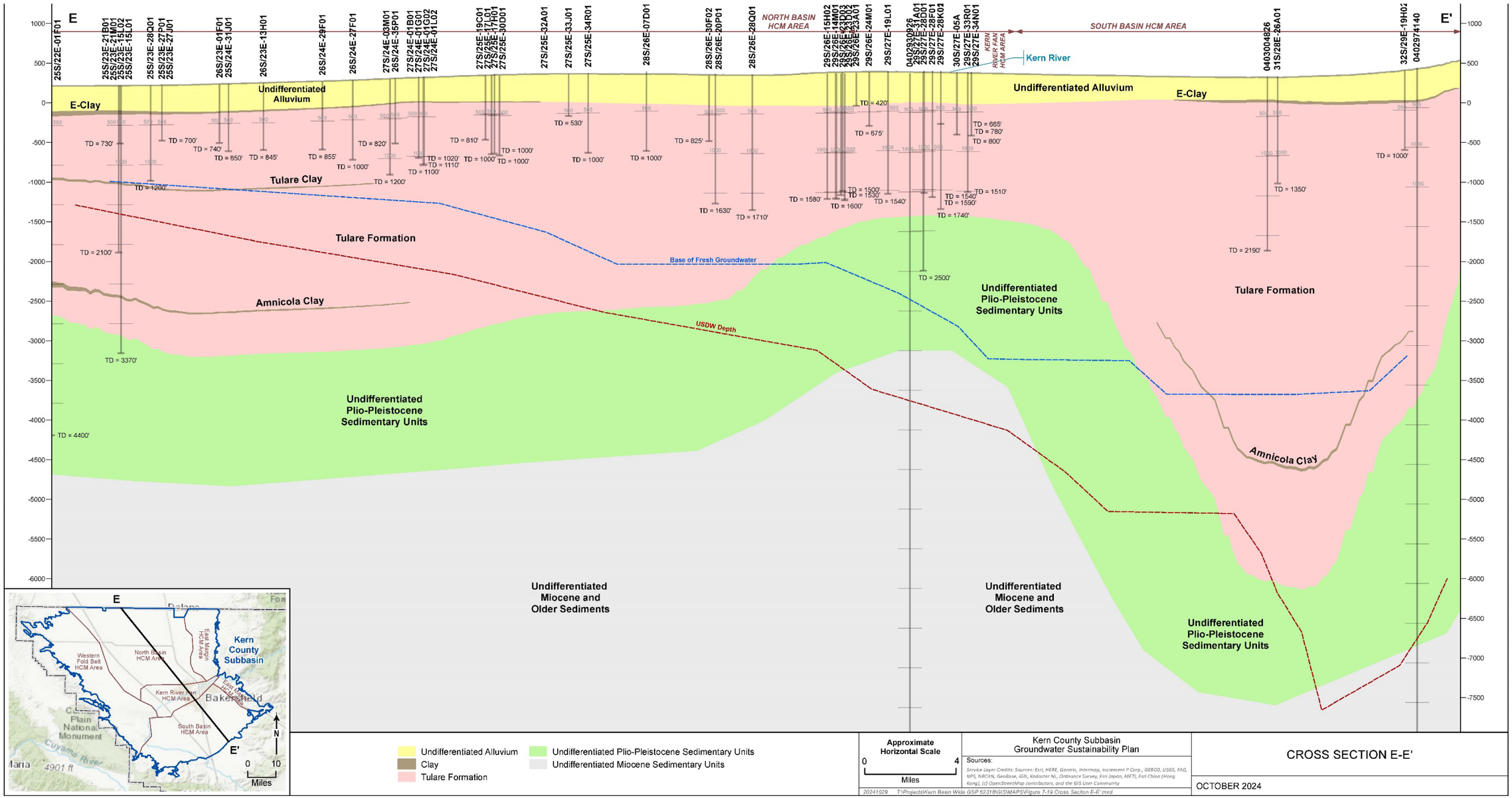


Figure 7-21. Cross Section E-E'

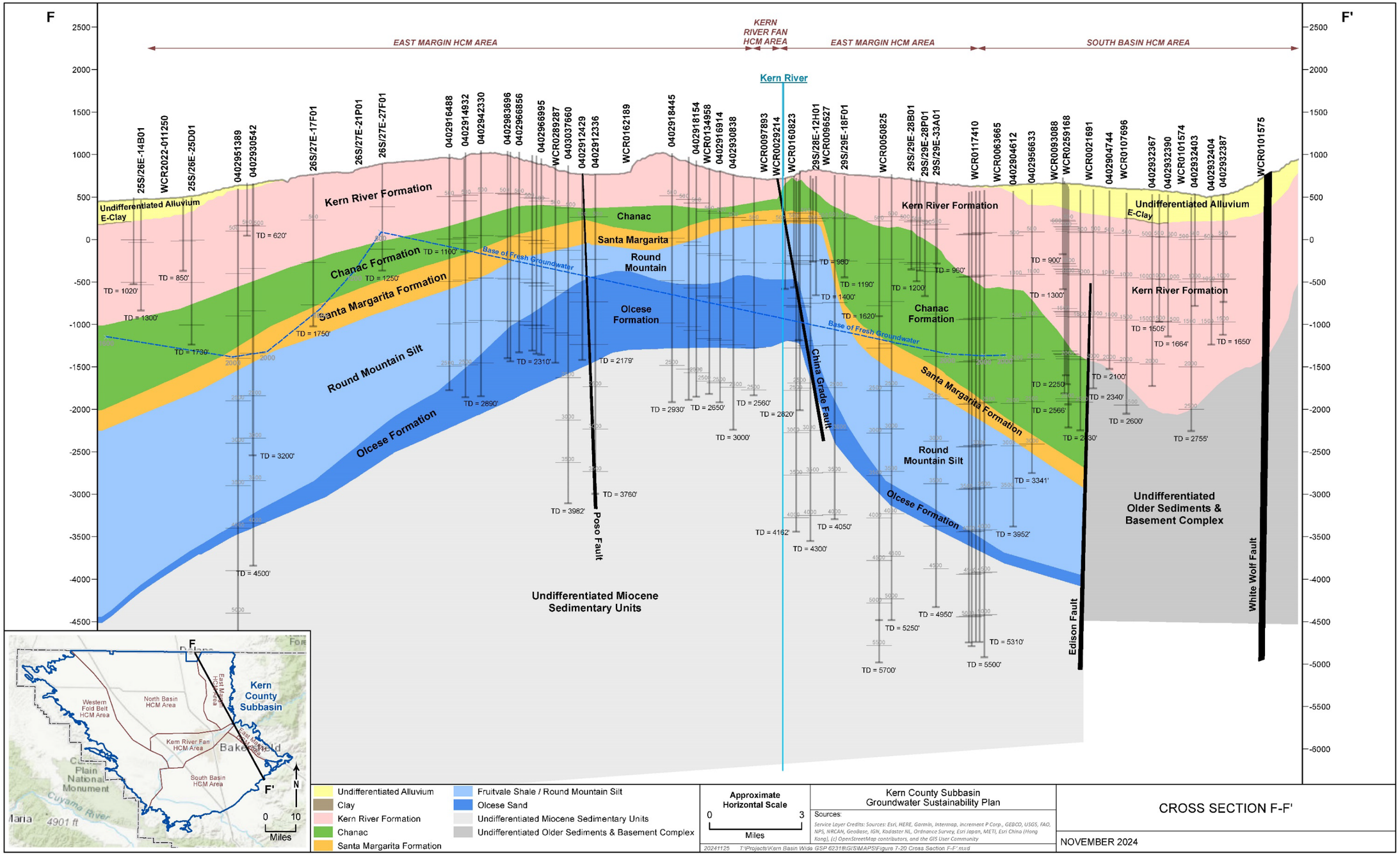


Figure 7-22. Cross Section F-F'

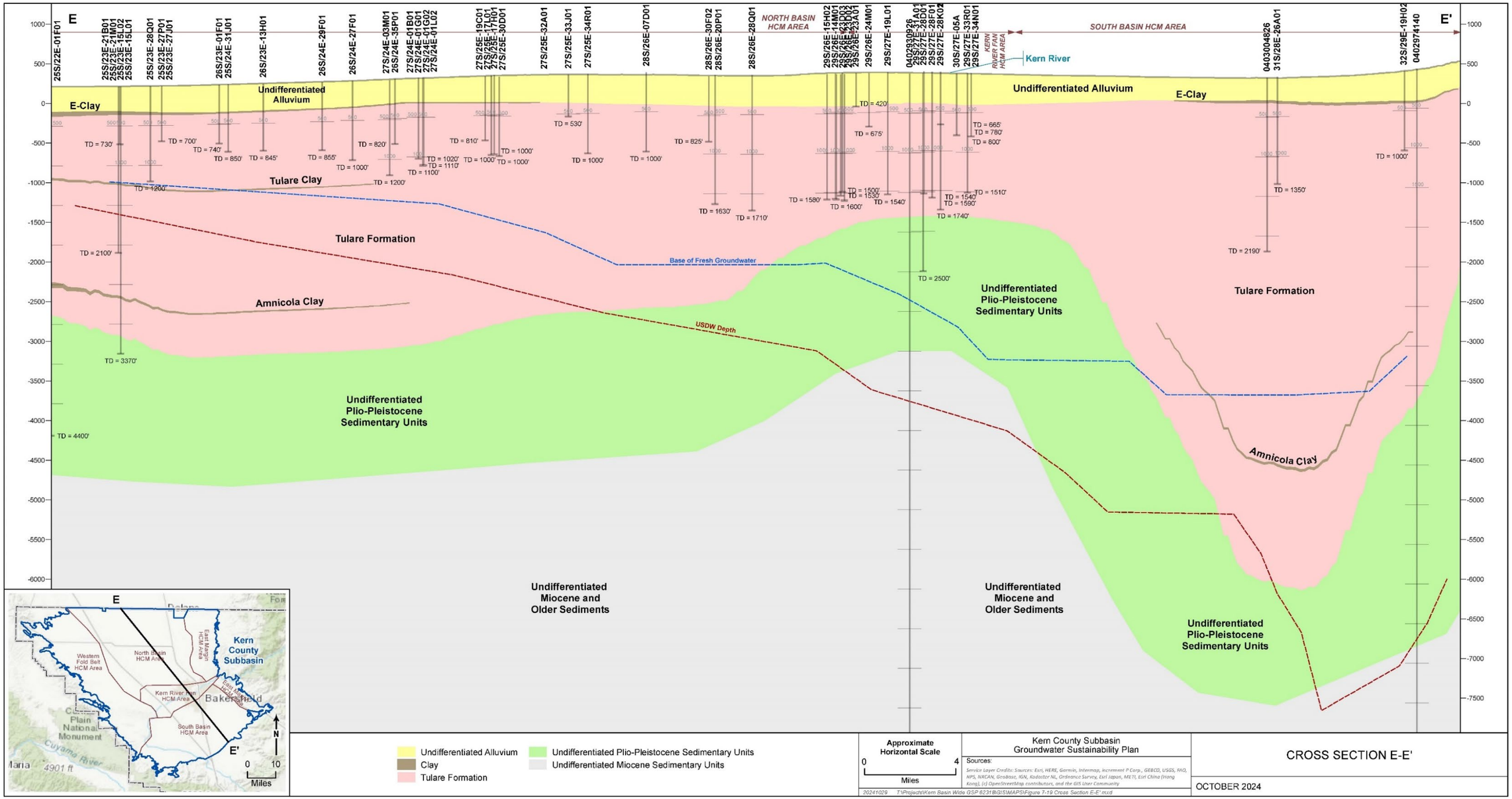


Figure 7-23. Cross Section G-G'

7.3.1.1 Geologic Observations

These cross sections illustrate the distribution of the Unconsolidated Nonmarine Deposits, consisting of the Recent Alluvium, Tulare, and Kern River Formations, which form the upper sequence within Kern Subbasin with varying thicknesses of nonmarine sediments (Page, 1986; Davis et al., 1964; Hilton, 1963). The east-west cross sections (Figure 7-17, Figure 7-18, Figure 7-19, and Figure 7-20) illustrate the general trend of these deposits increasing in thickness from the east margin along a relatively uniform slope westward toward the San Joaquin Valley Syncline. West of this Syncline, these sediments are deformed in varying degrees depending on where they intersect the geologic structures of the West Side Fold Belt. These include:

- Figure 7-17 shows the very steep west limb of the Syncline near the Lost Hills.
- Figure 7-18 shows a more gradual increase through an intervening syncline before the slope increases toward the Belridge Hills.
- Figure 7-19 shows the highly folded sediments as they cross the Elk Hills.
- Figure 7-20 shows the deepest extent of the Unconsolidated Nonmarine Deposits in the southern portion of Kern Subbasin in the Maricopa-Tejon Structural Region (Bartow, 1991).

The presence of the major clay layers within the Tulare Formation are most prominent in the west-central areas of Kern Subbasin. The older Amincola and Middle Tulare Clays are thickest in areas west of the San Joaquin Valley Syncline, but thin to the east. The more recent E-Clay extends more eastward with limited westward extent relative to the older clay layers. The E-Clay is prominent along the northern Kern Subbasin margin but begins to be less defined toward the center of Kern Subbasin, likely the result of fewer lake deposits on the Bakersfield Arch and Kern River Alluvial Fan. In the southern Kern Subbasin, the deeper areas of the Maricopa-Tejon structural region also have clays that appear to align with the major clay layers within the Tulare Formation.

The Miocene and older marine sedimentary units on the east side are shown with a transitional edge where they interfinger and eventually pinch out to the west. The more prominent sandstone units (Santa Margarita and Olcese) are predominantly sandstone along the eastern margin but transition to more fine-grained shales and siltstones to the west.

These north south cross sections illustrate the changes in the structural setting from east to west. Figure 7-21 shows the large structural relief of the Bakersfield Arch which brings Miocene and older marine sedimentary units closer to the surface along the eastern margin. The crest of the Bakersfield Arch is more intensely faulted between the Poso and China Grade Faults. These faults form the constraints that create the large oil and gas fields located in this area. Figure 7-22 shows the buried Bakersfield Arch as a deep structure beneath the unconsolidated nonmarine deposits. Figure 7-23 shows the

great depth to basement in the areas of the San Joaquin Valley Syncline and western Maricopa-Tejon structural region (Bartow, 1991).

Water Quality Observations

The cross sections show the elevation of the base of fresh-water (Page, 1973) and the depth to the base of an underground source of drinking water (USDW) from Gillespie (2017). Additional maps and descriptions of these two data sets and their role in defining the bottom of the basin are provided in Section 7.6.4.

In the Unconsolidated Nonmarine Deposits, the depth to freshwater indicators is deepest in the east near two major recharge locations, the east margin and the Kern River. Generally, the thickest section of depth to freshwater occurs in the east of Kern Subbasin and thins to the west. In the western parts of Kern Subbasin depth to freshwater indicators are relatively shallow and exist high within the Tulare Formation.

The cross sections show that a large portion of the Unconsolidated Nonmarine deposits have groundwater above the base of freshwater. Both depth to freshwater indicators are typically higher than the Miocene and older marine sedimentary units throughout Kern Subbasin except along the eastern Kern Subbasin Margin. The deeper Miocene and older marine sedimentary units typically contain highly-saline, connate water that is generally not considered a usable source of groundwater supply. The exception is along the eastern margin where the connate waters in the Miocene and older marine sedimentary units has been flushed by freshwater recharge from surface outcrops in the adjacent watersheds. The distribution of freshwater shown on these cross sections is consistent with the three distinct geology-based groundwater occurrences in Kern Subbasin (Davis et al., 1964; Hilton, 1963; Bertoldi et al., 1991) and is an important factor in defining the principal aquifers for Kern Subbasin.

7.4 Hydrogeological Conceptual Model Subarea Characteristics

§ 354.14. Hydrogeologic Conceptual Model

(d) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:

(1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.

(2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.

(3) The definable bottom of the basin.

(4) Principal aquifers and aquitards, including the following information:

(A) Formation names, if defined.

(B) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.

(C) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.

(D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.

(E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.

(5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model

☑ 23 CCR § 354.14(b)

Kern Subbasin is a large and geologically complex basin with regional faulting, folding and a thick sequence of consolidated and unconsolidated sedimentary deposits. The general distinctive characteristics for each HCM Area are summarized in Section 6.2.1.

- **North Subbasin HCM Area** – Area corresponds to the large alluvial basin north of the Kern River Fan area that is a major agricultural area. This area is underlain by a thick sequence of alluvial sediments that form a highly productive aquifer. The presence of clay layers, primarily the E-Clay, influences vertical flow of groundwater to form distinctive aquifer zones in some areas.
- **Kern River Fan HCM Area** – Area corresponds to the Kern River alluvial fan. The Kern River is a large hydrologic feature that provides both a major local surface water supply and source of groundwater recharge. The coarse alluvial sediments with limited clay layers make this the prime area for managed recharge and water banking. These operations generate a distinctive groundwater response seen on hydrographs. Groundwater flow conditions (contours) illustrate the Kern River Fan acts as a natural groundwater divide.
- **South Subbasin HCM Area** – Area corresponds to the large alluvial basin south of the Kern River Fan area that is the other major agricultural area that is underlain by a thick highly productive alluvial aquifer. Kern County Environmental

Health Services water well ordinance requires that wells drilled south of the Kern River Alluvial Fan seal to the E-Clay (Page, 1986).

- **Eastern Margin HCM Area** – Area along the eastern Kern Subbasin margin where water supply is derived from older geologic units. In the northeast area, the Santa Margarita and Olcese principal aquifers are the primary source of groundwater supply. This area includes several large fault-bounded oil fields. In the southeast, the Edison Fault forms a groundwater flow barrier.
- **Western Fold Belt HCM Area** – Area along the western Kern Subbasin margin that generally corresponds to the West Side Fold Belt of Bartow (1991). This is the more intensely folded area dominated by large oil fields. Only minimal groundwater pumping occurs in this HCM Area due to the poor water quality. Due to these factors, agricultural and urban water supplies are either imported or derived from other HCM Areas.

These five areas are informal designations referring to hydrogeologically similar areas used in the 2025 Plan to help organize the HCM discussions. Figure 7-24 and Figure 7-25 show the location of the HCM Areas relative to key components of the geologic and structural setting. The defining characteristics of each HCM Area are presented in the following sections. The HCM Areas will provide a common framework for describing the hydrogeological variability of Kern Subbasin for various components of this 2025 Plan including support of the definition of undesirable results and sustainability criteria.

The data for the HCM Area updates were developed from the previously submitted GSPs, an ongoing Basin Study and other supporting references. The HCM Area section will focus on defining the relevant character of the physical geological structure of aquifer layers including hydrogeologically significant clay layers, geologic structures, groundwater divide, and faults. The section represents Kern Subbasin wide geologic and hydrogeologic conditions in a consistent Subbasin-wide perspective. The HCM includes Subbasin-wide maps, graphs and cross sections required by SGMA Regulations.

7.4.1 North HCM Area

The North HCM Area (Figure 7-24 and Figure 7-25) corresponds to the large alluvial basin north of the Kern River. The area is characterized as the relatively flat plain in the north-central area of Kern Subbasin that is a major agricultural area. The North HCM Area includes the communities of Delano, McFarland, Wasco, Shafter, and Buttonwillow that utilize groundwater for water supply. The community of Lost Hills, physically located in the Western Fold Belt HCM Area, utilizes groundwater sourced from the North HCM Area for water supply due to naturally occurring poor water quality in the Western Fold Belt HCM Area limiting municipal beneficial use.

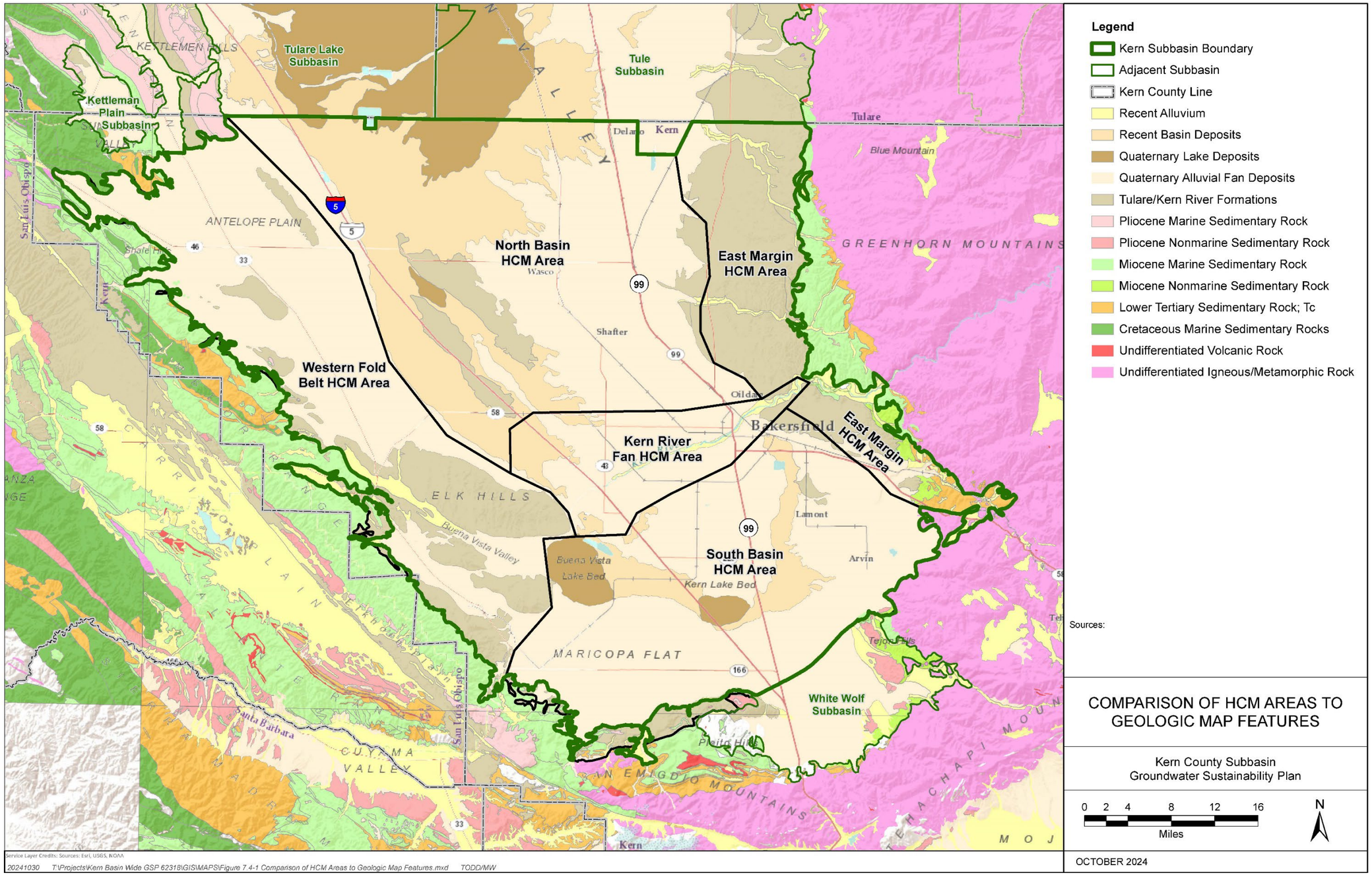


Figure 7-24. Location of the HCM Areas relative to the geologic setting

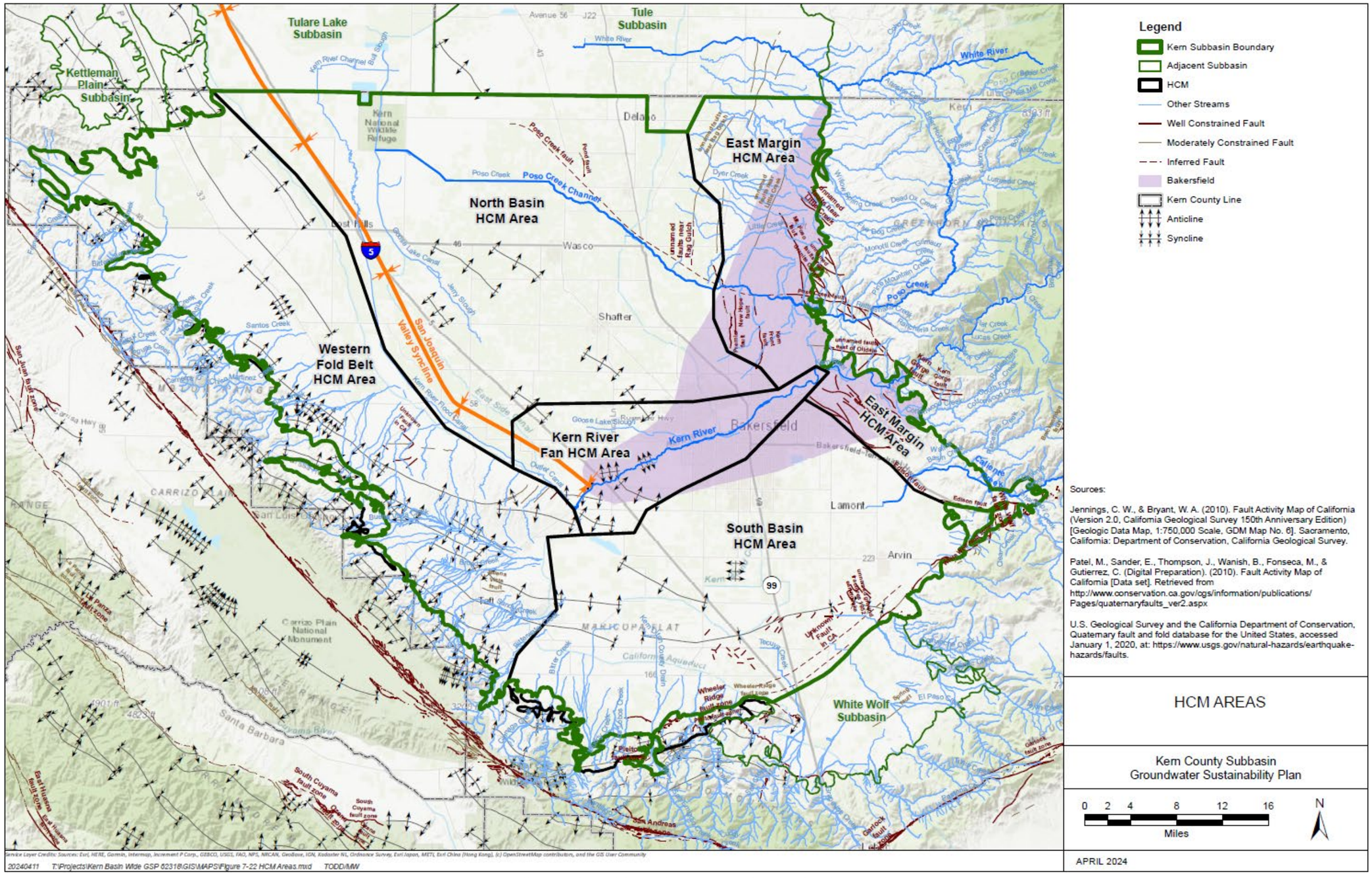


Figure 7-25. Location of the HCM Areas relative to structural setting

The North HCM Area includes a variety of surficial sediments, the predominant being Quaternary Fan Deposits (Qf) in the east and center of the HCM Area. Quaternary Basin Deposits (Qb) are secondary, featuring mostly in the west and northern section of the HCM Area. There are also minor Quaternary Lake Deposits in the west and northern boundary of the HCM Area. There are also Tulare/Kern River Formations surface outcrops associated with the Semitropic and Buttonwillow Ridges. These sediments create a thick sequence that form a highly productive aquifer that consists of the recent alluvium, and the Tulare and Kern River Formations. The presence of clay layers, primarily the E-Clay, influence vertical flow of groundwater forming distinctive aquifer zones in some areas.

The Primary Alluvial Principal Aquifer is the only significant principal aquifer identified in the North Basin HCM Area. The zone beneath and outside the extent of the E-Clay are the key areas that provide the bulk of water production for beneficial use. The primary uses of Kern Subbasin aquifer system include agricultural, municipal, domestic, and storage for the banking of surface water.

The marine sedimentary units underlying the alluvial sediments are generally composed of thick sequences of shales and siltstones with local sandstone layers. During the deposition of the marine sediments, the North Basin HCM Area was mostly situated in the deeper basin which is predominantly a fine-grained depositional environment. As a result, the marine sedimentary units are hydrogeologically separated from the Primary Alluvial Principal Aquifer. A more detailed discussion of how the marine sedimentary units are assessed for defining the bottom of the basin is provided in Section 7.6.

Geologically, the surficial geology is primarily the recent alluvium and corresponds to the Southern Sierran block structural regional (Figure 7-10) of Bartow (1991) that consists of the little-deformed east limb of the San Joaquin Valley Syncline. The North HCM Area includes the eastern portion of the West Side Fold Belt. This portion, east of the San Joaquin Valley Syncline, is less intensely folded than areas to the west. The North Basin HCM Area boundaries are defined as follows:

- The northern boundary is Kern Subbasin boundaries with the adjacent Tulare Lake and Tule subbasins. Kern Subbasin aquifers and aquitards are correlated with those in the adjacent subbasins; however, variations are noted that result from differing geologic conditions.
- The western boundary with the Western Fold Belt HCM Area is geologically based and is placed along the western limb of the regional San Joaquin Valley Syncline (Figure 7-12).
- The southern boundary with the Kern River HCM Area is a transition area within the alluvial sediments that is primarily defined by hydrological influences. The North HCM Area generally lacks the distinctive groundwater response, recognizable on hydrographs, to that of the Kern River and the Kern Fan Banking projects of the Kern River HCM Area.

- The eastern boundary with the Eastern Margin HCM Area is based on physical and geologic differences that represents a transition from the relatively flat plain underlain at the surface by recent alluvium of the North Basin HCM Area to the hillier area (dissected upland) of the Eastern Margin HCM Area with the older Kern River Formation at the surface.

Within the North Basin HCM Area, certain anticlines within or adjacent to the Western Fold Belt HCM Area, notably Lost Hills, have been identified as potential constraints to groundwater flow within the lowlands (Page, 1986; DWR, 2006). Other fold structures include the Buttonwillow and Semitropic ridges (anticlines), the Bowerbank Anticline, and the San Joaquin Valley (or Buttonwillow) Syncline (Page, 1986; Bartow, 1991).

7.4.2 Kern River Fan HCM Area

The Kern River Fan HCM Area (Figure 7-24 and Figure 7-25) generally corresponds to the thick alluvial fan deposits along the Kern River. The surficial geology consists mostly of Quaternary Fan Deposits (Qf) with a channel of Recent Alluvial (Qal) representing the Kern River. Kern River Formation outcrops can be observed in the east of the HCM Area, whilst sections of Quaternary Fan Deposits (Qf) are present in the west. The Kern River Fan HCM Area is a relatively level area that extends along the length of the Kern River within Kern Subbasin. This area consists mostly of the municipal area of the City of Bakersfield and smaller surrounding communities that utilize groundwater and surface waters from the Kern River, CVP and SWP as sources of supply.

The Kern River is a primary hydrologic feature in this HCM Area that provides a major local surface water supply and source of groundwater recharge. The coarse alluvial fan deposits with limited clay layers along the Kern River makes this the prime banking location for Kern Subbasin. The high-volume recharge from the Kern River and banking projects produces a recognizable pattern on hydrographs that is characteristic of the Kern River HCM Area.

This HCM Area is located along the crest of the Bakersfield Arch that is a broad westward-plunging structural bowing on the east side of the southern San Joaquin Valley (Figure 7-25). The Arch has a low topographic profile but has appreciable structural relief (Bartow, 1991). The Bakersfield Arch separates the Maricopa-Tejon structural region from the southern Sierran block structural regions (Figure 7-10). The Kern River Fan HCM Area represents the unique characteristics of this structural transition area.

The Primary Alluvial Principal Aquifer is the only principal aquifer identified in the Kern River Fan HCM Area. The Bakersfield Arch formed a low structural rise during the deposition of the Tulare and Kern River Formations. As a result, the large lacustrine, or lake, deposits did not form large continuous clay layers. Therefore, groundwater in this HCM Area is more uniform vertically with only limited vertical zonation.

Geologically, the surficial geology is primarily the recent alluvium and corresponds to the Bakersfield Arch (Bartow, 1991). The Kern River Fan HCM Area boundaries are defined as follows:

- The northern and southern boundaries represent a transitional area within the alluvial sediments that is primarily defined by hydrologic influences of the Kern River and banking operations. Generally speaking, the Kern Fan acts as a groundwater divide between the North and South HCM Areas as exhibited by the groundwater contours. The Kern River Fan HCM Area generally lacks the clay layers observed in the adjacent HCM Areas.
- The western boundary with the Western Fold Belt HCM Area is geologically based and is placed along the western limb of the regional San Joaquin Valley Syncline at the base of the Elk Hills.
- The eastern boundary with the Eastern Margin HCM Area is based on physical and geologic differences that represents a transition from the relatively flat plain underlain at the surface by recent alluvium of the North Basin HCM Area to the hillier area (dissected upland) of the Eastern Margin HCM Area with the older Kern River Formation at the surface.

The marine sedimentary units underlying the alluvial sediments are generally composed of thick sequences of shales and siltstones with local sandstone layers. As a result, the marine sedimentary units are hydrogeologically separated from the Primary Alluvial Principal Aquifer (Section 7.5.1).

7.4.3 South Basin HCM Area

The South Basin HCM Area (Figure 7-24 and Figure 7-25) corresponds to the large alluvial basin south of the Kern River. The area is characterized as the relatively flat plain in the south-central area of Kern Subbasin that is a major agricultural area. The South Basin HCM Area includes the southern areas of Bakersfield and surrounding communities that utilize groundwater, surface water from the Kern River, and other imported water sources for water supply from the SWP and CVP. In addition, the communities of Arvin, Lamont, Greenfield, and Mettler utilize groundwater for water supply.

The South Basin HCM Area is overlain by mostly Quaternary Alluvium Deposits (Qf), with Quaternary Lake Deposits (Ql) associated with the Buena Vista and Kern Lake Beds. There is also a channel of Quaternary Basin Deposits (Qb), which runs from Bakersfield, the Kern Lake Bed and the Buena Vista Lake Bed. These sediments and subsurface Tulare and Kern River Formations form a highly productive aquifer. The South Basin HCM Area is the deepest part of Kern Subbasin. The alluvial sediments are over 6,000-feet-thick in this HCM Area. The presence of clay layers, primarily the E-Clay, influences vertical flow of groundwater forming distinctive aquifer zones in some

areas. Shallow clay layers are also associated with the Buena Vista and Kern lakes located in the center of this HCM Area.

The Primary Alluvial Principal Aquifer is the only principal aquifer identified in the South Basin HCM Area. The zone beneath and outside the extent of the E-Clay are the key areas that provide the bulk of water production for beneficial use. The primary uses of Kern Subbasin aquifer system include agricultural, municipal, domestic, and storage for the banking of surface water.

Geologically, the surficial geology is primarily the recent alluvium and corresponds to the Maricopa-Tejon structural region (Figure 7-10) of Bartow (1991) that consists of the little-deformed east limb of the San Joaquin Valley Syncline. The South Basin HCM Area boundaries are defined as follows:

- The northern boundary with the Kern River HCM Area is a transition area within the alluvial sediments that is primarily defined by hydrological influences. The South Basin HCM Area generally lacks the distinctive groundwater response, recognizable on hydrographs of the of the Kern River and the Kern Fan Banking projects of the Kern River HCM Area.
- The southern boundary is partly Kern Subbasin boundaries with the adjacent White Wolf Subbasin that is defined by the White Wolf Fault that forms a groundwater flow barrier that significantly limits groundwater flow across the fault. The rest of the southern boundary is defined by the Subbasin boundary with the Tehachapi and San Emigdio Mountains. There is limited groundwater recharge from runoff and subsurface inflow from the Basement Complex and older marine sedimentary units in the adjacent watersheds from the mountain areas.
- The western boundary with the Western Fold Belt HCM Area is geologically based to correspond to the West Side Fold Belt (Figure 7-10).
- The eastern boundary with the Eastern Margin HCM Area is based primarily on the Edison Fault, which has been identified as a groundwater flow barrier.

The marine sedimentary units underlying the alluvial sediments are generally composed of thick sequences of shales and siltstones with local sandstone layers. As a result, the marine sedimentary units are hydrogeologically separated from the Primary Alluvial Principal Aquifer. A more detailed discussion of how the marine sedimentary units are assessed for defining the bottom of Kern Subbasin is provided in Section 7.6.3.

7.4.4 Eastern Margin HCM Area

The Eastern Margin HCM Area of Kern Subbasin (Figure 7-24 and Figure 7-25) consists of a narrow area that extends about 6 miles westward from the eastern Kern Subbasin margin. This is an area of dissected uplands that borders the Sierra Nevada. The Eastern Margin HCM Area includes small portions of the City of Bakersfield and surrounding communities that utilize groundwater and surface water from the Kern River

for water supply. Agricultural use is concentrated primarily in areas north of Poso Creek or along the Kern River. Other parts of the Eastern Margin HCM Area are lightly populated areas with scattered private wells for agricultural and domestic use.

The Eastern Margin HCM Area is a more structurally complex area than the larger HCM Areas to the west. The Bakersfield Arch forms a low structural rise that extends across this HCM Area toward the Sierra Nevada. The uplift of the Bakersfield Arch has raised the Kern River Formation so that the Kern River Formation has a much thinner saturated thickness than in other areas of Kern Subbasin.

The Eastern Margin HCM Area groundwater use is derived from multiple units including the Kern River, Santa Margarita and Olcese Sand Formations. In this HCM Area, the Santa Margarita and Olcese Sand are the primary source of groundwater supply. Because Kern River Formation thins to the east, it becomes a less prominent source of groundwater supply in this HCM Area.

The overlying surficial geology in the Eastern Margin HCM Area consists mostly of Kern River outcrop, with Recent Alluvium (Qal) channel deposits trending toward the west. Quaternary Fan Deposits (Qf) are present on the western most boundaries of the HCM Area and outcrops of older Miocene and Lower Tertiary marine rocks are observed in the southern section of the HCM Area. During deposition of the older marine sedimentary units, this area was more of a shallow marine setting than areas to the west. This led to the deposition of more sandstones in the Eastern Margin HCM Area than in other HCM Areas of Kern Subbasin. In these areas, the Santa Margarita and Olcese formations form prominent sandstone layers; however, these grade laterally to shales and other fine-grained units westward. As a result, much of the water supply for this HCM Area is derived from the Santa Margarita and Olcese Principal Aquifers.

This HCM Area includes several faults, as depicted in Figure 7-25. The most prominent among them are the Kern Gorge, Poso Creek, Mt. Poso and Edison faults, alongside various unnamed, high angle faults which trend to the general contours of the Sierra Nevada foothills. Many of the faults have sufficient vertical offset to act as local groundwater flow barriers making for a more compartmentalized groundwater aquifer in this area (Castle, 1983). The Edison Fault in the southern part of the HCM Area forms a strong hydrological barrier that limits groundwater flow. However, the Edison Fault is covered by the younger Kern River Formation which allows groundwater to flow across this area.

This HCM Area also contains several large fault-bounded oil fields including several major oil and gas fields. These are primarily concentrated in the area between Poso Creek and the Kern River where the faulting is more intense along the crest of the Bakersfield Arch. A second area of major oil fields occurs south of the Kern River in a second area of intensive faulting.

Geologically, the surficial geology is primarily the Kern River Formation with isolated outcrops of older marine formations found in the incised stream channels. Although this HCM Area corresponds to the southern Sierran block structural regional (Figure 7-10) of Bartow (1991), it is more geologically deformed due to faulting than is found in the North Basin HCM Area. The Eastern Margin HCM Area boundaries are defined as follows:

- The northern boundary is the Subbasin boundary with the adjacent Tule Subbasin. Kern Subbasin aquifers and aquitards are correlated with those in the adjacent basins; however, variations are noted that result from differing geologic conditions.
- The western boundary with the North Basin, South Basin, and Kern River Fan HCM Areas is based on physical and geologic differences that represent a transition from the hillier terrain (dissected upland) of the Eastern Margin HCM Area with the relatively flat plain of the HCM Areas to the west. A portion of the western boundary is based primarily on the Edison Fault, which has been identified as a groundwater flow barrier.
- The eastern and southern boundaries are defined by the Subbasin boundary with the Sierra Nevada and Tehachapi Mountains. Groundwater recharges from runoff and subsurface inflow from the adjacent watersheds into the Santa Margarita and Olcese Formations occurs along Kern Subbasin margin.

One of the distinct geology-based groundwater characteristics of Kern Subbasin is the occurrence of fresh water in marine sedimentary units where surface recharge from outcrop areas has flushed the original saline connate water from these units and they now contain freshwater (Davis et al., 1964; Hilton, 1963). This condition primarily occurs in the Eastern Margin HCM Area where the Santa Margarita and Olcese Formations form locally important aquifers. A more detailed discussion of how the marine sedimentary units are assessed for defining the bottom of Kern Subbasin is provided in Section 7.6.3.

7.4.5 Western Fold Belt HCM Area

The Western Fold Belt HCM Area of Kern Subbasin (Figure 7-24 and Figure 7-25) generally corresponds to the most intensely deformed areas of the West Side Fold Belt of Bartow (1991). The area is characterized by flat alluvial plains that separate linear topographic ridges that correspond to the underlying geologic structures. This HCM Area is largely characterized by large oil fields and poor-quality groundwater. Due to the poor water quality, groundwater is not considered a practical water source in the Western Fold Belt HCM Area. Nearly all water for agricultural, municipal, or industrial use is imported surface water or groundwater from other HCM Areas that is conveyed into this HCM Area.

The surficial geology is primarily Quaternary Fan Deposits (Qf) that unconformably overlies the Tulare Formation which outcrops along the crest of the linear ridges formed by the underlying structural anticlines, such as the Elk Hills and Buena Vista Hills. The unconformity suggests this was a highland area subject to active erosion. Recent Alluvium (Qal) is present within the Buena Vista Valley. Along Kern Subbasin's western margin, runoff from several small watersheds in the Coast Ranges recharges an area of recent alluvium that is underlain by older marine shales of the Monterey Formation.

The Lower Tulare Formation represents the thickest alluvial deposits in this HCM Area. By contrast, the Upper Tulare Formation is much thinner or absent. The primary aquitards are the older lake deposits in the Tulare Formation. These are the Middle Tulare and Amincola Clays that are tens to several hundred feet thick in the Western Fold Belt HCM Area, suggesting this area was the lowest part of Kern Subbasin during the deposition of the Lower Tulare.

Underlying the Tulare Formation is a thick sequence of fine-grained marine sediments that represent deposition in a deep marine environment. As a result, the marine sedimentary unit is hydrogeologically separated from the Tulare Formation.

The most distinctive geologic characteristic of this HCM Area is the intense folding associated with the West Side Fold Belt structural regional of Bartow (1991). This features several anticlines, which are oriented toward the northwest, running semi-parallel to the Coast Ranges and the San Andreas Fault (Bartow, 1991; Page, 1986). Page (1986) and DWR (2006) note that these anticlines, particularly the Lost Hills and Elk Hills anticlines, act as barriers to groundwater flow. Conversely, the synclines between these anticlines form conduits that collect and direct groundwater flow along their axes. The Western Fold Belt HCM Area boundaries are defined as follows:

- The northern boundary is the Subbasin boundary with the adjacent Tulare Lake and Kettleman Plain Subbasins. Kern Subbasin aquifers and aquitards are correlated with those in the adjacent subbasins. However, variations are noted that result from differing geologic conditions.
- The western boundary is defined by the Subbasin boundary with the Coast Ranges. Runoff and subsurface inflow from adjacent watersheds recharge the Recent Alluvium and Tulare Formation along Kern Subbasin margin.
- The eastern boundary with the North Basin and Kern River Fan HCM Areas is geologically based and is placed along the western limb of the regional San Joaquin Valley Syncline.
- The southern boundary with the South Basin HCM Area is geologically based at the transition from the highly deformed West Side Fold Belt and the thick sequence of alluvial deposition in the South Basin HCM Area.

The Recent Alluvium and Tulare Formations are considered part of the Primary Alluvial Principal Aquifer; however, only minimal groundwater pumping occurs in this HCM Area due to the poor water quality. Nearly all water for agriculture operations in the northwest portion of the Western Fold Belt HCM Area is imported and supplied by the SWP. Groundwater pumped for agriculture is blended with higher quality imported water to augment reduced supplies from the SWP.

The Western Fold Belt HCM Area includes disadvantaged communities in the West Kern Water District service area, among others, the cities of Taft and Maricopa. Other towns and communities in the HCM Area include Lost Hills, Blackwells Corner and Belridge that rely on a supply from outside of the HCM Area for drinking water. For example, the West Kern Water District (WKWD) receives SWP water and other surface supplies that are delivered to recharge basins owned by WKWD located in the Kern River Fan HCM Area. The water is then recovered using WKWD wells and distributed to disadvantaged communities in WKWD's service area near southern region of the Western Fold Belt HCM Area. Similarly, the Lost Hills Public Utility District recovers groundwater from wells located in the North Basin HCM Area and distributes this supply to a large northern region of the Western Fold Belt HCM Area.

7.5 Principal Aquifer and Aquitards

☑ 23 CCR § 354.14(b)(4)

A "Principal Aquifer" refers to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems (DWR, 2016). Kern Subbasin's groundwater aquifers are geologically diverse with groundwater use widely varying across Kern Subbasin, both geographically and historically, as a result of hydrogeological conditions as well as overlying land use. In Kern Subbasin, there are three distinct geology-based groundwater occurrences (Davis et al., 1964; Hilton, 1963) based on the following conditions:

1. Unconfined and semiconfined fresh water in nonmarine alluvial deposits of Recent, Pleistocene, and possibly late Pliocene age. These unconsolidated continental deposits overlie the marine deposits and contain most of the freshwater in Kern Subbasin.
2. Confined fresh water, contained in marine sediments of Miocene age where surface recharge from outcrop areas has flushed the original saline connate water and the sediments now contain freshwater. This condition occurs in limited areas, primarily along the eastern Kern Subbasin margin, which form locally important aquifers.
3. Saline, connate water contained in marine sediments of middle Pliocene or older age, which underlies the fresh-water body throughout the area. The majority of the marine sediments in Kern Subbasin contain highly saline, connate water.

Three Principal Aquifers are defined for Kern Subbasin according to the criteria listed above. These include:

- The Primary Alluvial Principal Aquifer consists of the Unconsolidated Nonmarine Deposits, including the Recent Alluvium, Tulare, and Kern River Formations, from across Kern Subbasin. These nonmarine deposits provide the most productive freshwater aquifers in Kern Subbasin and represent the first condition.
- Two smaller principal aquifers are located in the Eastern Margin HCM Area. These include the Santa Margarita Principal Aquifer and Olcese Principal Aquifer that provide locally productive freshwater aquifers. These two marine sandstone aquifers represent the second condition where freshwater surface recharge from outcrop areas has flushed the original saline connate water.
- Marine units, other than those listed above, are considered as not providing significant or economic quantities of groundwater due to poor water quality consistent with the third condition. These formations are not defined as Principal Aquifers.

The following discussion provides the required information, as defined in the GSP Emergency Regulations (23 CCR § 351(aa)), for describing the three Principal Aquifers in Kern Subbasin.

7.5.1 Primary Alluvial Principal Aquifer

The Kern Subbasin's Primary Alluvial Principal Aquifer essentially extends over the entire Kern Subbasin and consists of the Tulare and Kern River Formations plus the overlying recent alluvium (Figure 7-26). These represent the continental deposits of Pliocene to Holocene age that contain the vast majority of the freshwater in the Kern Subbasin. The Primary Alluvial Principal Aquifer is the source of nearly all groundwater used within the Kern Subbasin.

Geologic Formations

The Primary Alluvial Principal Aquifer is comprised of the Unconsolidated Nonmarine Deposits (Pliocene to Holocene) that include the Recent Alluvium, Kern River Formation and Tulare Formation. These are moderately to high permeability units that form the most highly productive freshwater aquifer system within the Kern Subbasin (Page, 1986).

The Recent Alluvium covers the underlying formations and can often be indistinguishable from the Kern River and Tulare Formations. The Recent Alluvium consists of alluvial and floodplain gravel, sand, silt, and clay up to 400 feet in thickness (DWR, 2016). The Kern River Formation is primarily identified in the eastern half of the Kern Subbasin and was deposited as an alluvial fan from sediments originating from the Sierra Nevada (Page, 1986). The Tulare Formation is comprised of alternating beds of unconsolidated, lacustrine, and fluvial sand and mudstone deposits, with sedimentation

sourcing from the Coast Ranges (Dale et al., 1966). The Tulare Formation can be split into the Upper and Lower sections. The Upper Tulare Formation is predominantly sandy alluvial fan and alluvial plain deposits whereas the Lower Tulare Formation is mostly comprised of lacustrine and deltaic deposits (Kiser et al., 1988). The separation between the Upper and Lower Tulare Formations is generally aligned with the Middle Tulare Clay. These formations were deposited together but the sediments were derived from different sources, so these formations essentially merge in the center of the Kern Subbasin.

Within the Tulare Formation, several fine-grained, low-permeability flood-basin, lacustrine, and marsh deposits are widespread throughout the Kern Subbasin. These include several clay layers that represent large lake deposits formed during interglacial periods during the Pleistocene ice ages (Croft, 1972). The E-Clay (including the Corcoran Clay Member), Middle Tulare Clay, and Amnicola Clay form these clay layers that extend over large areas of the west-central Kern Subbasin and form regional aquitards within the Primary Alluvial Principal Aquifer. Areas outside of these clay layers lack a regional aquitard allowing for more vertical groundwater flow.

The Primary Alluvial Principal Aquifer exhibits varying groundwater conditions, classified as confined, semiconfined, and unconfined, owing to the presence of clays that act as local aquitards. Because of its distribution and relative shallow depth, compared to the other clay layers, the E-Clay is the most prominent aquitard in the Kern Subbasin. Figure 7-27 shows the distribution of the modified E-Clay of Page (1986) which is a revised interpretation of the Croft (1974) E-Clay map in the southern part of the Kern Subbasin. As shown on Figure 7-27, the E-Clay does not cover the entire Kern Subbasin but is limited to areas in the central parts of the Kern Subbasin.

The character of the E-Clay is more variable across the Kern Subbasin with areas where the E-Clay is either discontinuous or absent. Figure 7-27shows the distribution of these areas. These include:

- The Shallow Confining Layer Area where the E-Clay is a thick continuous layer that is characterized by localized shallow groundwater conditions with a distinct separation between the groundwater levels above and below the E-Clay. This area represents one of the two notable occurrences of localized shallow groundwater conditions that occur within the Kern Subbasin. See Section 8.1.1.6 and Figure 7-26 for more details.
- The Deep Confining Layer Areas where the E-Clay is a thick continuous layer but there is a less distinct separation because the groundwater levels above and below the E-Clay merge along the margins of these areas creating a hydraulic connection between them. However, county authorities have taken measures to prohibit well construction practices that involve screens across both upper unconfined and lower confined zones in the South Basin HCM Area.

- The Leaky Aquitard Areas where the E-Clay is a discontinuous layer. Where the groundwater levels rise above the E-Clay, there is still a hydraulic connection vertically across the zone, and where groundwater levels fall below the E-Clay, it becomes unsaturated.
- The Areas of E-Clay Not Present is an area located at western end of Kern River where detailed geologic information from the implementation of the Kern Water Bank indicate that the E-Clay, as mapped by Page (1986), is either highly discontinuous or absent, resulting in limited to no vertical separation across the interval.
- Areas outside of the mapped E-Clay extent of Page (1986) may contain local clay layers that are either highly discontinuous or absent which results in little to no vertical separation across the interval.

Several different interpretations of the extent of the E-clay have been developed by the USGS and others (Croft, 1972; Page, 1983; Page, 1986; PGA, 1991). These generally agree in the areas where the E-Clay is prominent but vary along the margins. Along the margins of the mapped extent, the E-Clay bifurcates into multiple thin layers that probably represents fluctuating lake levels of the Pleistocene Corcoran Lake (Figure 7-9) during deposition, thus making the margin of the E-Clay difficult to identify in these areas (Croft, 1972; Bartow, 1991). As discussed in Section 7.4, the E-Clay is generally absent in the Kern River Fan and Western Fold Belt HCM Areas due to the influence of geologic structures. The E-Clay variability is also illustrated on the cross section provided in Figure 7-17 to Figure 7-23.

The variability in the character of the E-Clay across the Kern Subbasin results in the primary aquifer system behaving as a single principal aquifer. The non-continuous lateral extent of the E-Clay or its lack of lithological consistency, preventing continuous confinement. This separation is most pronounced in the north-central area of the Kern Subbasin adjacent to the Tule and Tulare Lake Subbasins. In the eastern portion of the Kern Subbasin, particularly near the Kern River Alluvial Fan, the aquifer system predominantly comprises an unconfined to semi-confined zone. Because of the varying character of the E-Clay there is sufficient hydraulic connection so that, at the Subbasin-level, the overall groundwater system acts as a single principal aquifer with varying levels of zonation caused by the E-Clay and other clay layers.

In contrast, the E-Clay is a more continuous well defined clay layer to the north where it covers most Tule Subbasin and all Tulare Lake Subbasin. In these subbasins, the E-Clay is defined as a vertical boundary between Upper and Lower Principal Aquifers with both the zones above and below the E-Clay providing significant or economic quantities of groundwater. This change in the character of the E-Clay is the basis for these subbasins to the north identify two principal aquifers whereas the Kern Subbasin defines a single principal aquifer in the alluvial deposits.

The Middle Tulare Clay (Kiser et al., 1988) and Amnicola Clay are found in the Lower Tulare Formation with their thickest locations in more of the western Kern Subbasin. The Middle Tulare Clay and Amincola Clay are several hundred feet thick near the Elk Hills and Buena Vista anticlines (Gillespie et al., 2022). These units form aquitards and locally confined conditions in the Lower Tulare Formation. The distribution and variability of the Middle Tulare Clay and Amincola Clay is shown on the cross sections provided in Figure 7-17 to Figure 7-23. However, due to their location and depth, these deeper clay units form barriers that separate oilfields found in the crest of anticlines in the western Kern Subbasin from the principal aquifer as discussed in the following section on Definable Basin Bottom (see Section 7.5).

Localized shallow groundwater conditions also occur as persistent areas of shallow, perched groundwater (KCWA, 2012; DWR, 2009) above the A-Clay or equivalent as shown on Figure 7-29. These areas represent the other notable occurrence of localized shallow groundwater conditions within the Kern Subbasin that are discussed in further detail in Section 8.1.1.6 and shown in Figure 7-27. These areas are relatively consistent with Page's (1986) extent of mapped surficial fine-grained flood deposits (Figure 7-6) and shallow clay units related to the A-Clay in the North Basin HCM Area (Croft, 1972) and equivalent clays in the South Basin HCM Area. In the areas shown on Figure 7-29, the localized shallow groundwater is considered perched above the A-Clay or its equivalent intercept percolating precipitation and agricultural return flows. As a perched zone, it is hydraulically separate from and not impacted by groundwater pumping in the Primary Alluvial Principal Aquifer.

The Primary Alluvial Principal Aquifer receives the majority of both the natural and managed groundwater recharge in the Kern Subbasin (Figure 7-26). Natural recharge to the Kern Subbasin is derived primarily from precipitation and surface runoff from the surrounding watersheds. Natural recharge is highest on the east side of the Kern Subbasin which receives high precipitation and receives recharge from the Kern River and other smaller streams from the Sierra Nevada. Natural recharge is lowest on the west side which receives less precipitation and lower runoff from the relatively smaller watersheds along the Coast Ranges. Numerous water banking and conjunctive use projects for the storage and recovery of surface water supplies are located across the Kern Subbasin (Figure 7-26). The sources of water recharged by various projects include local surface water supplies (Kern River, Poso Creek, and other drainages) and imported surface water supplies (SWP and CVP).

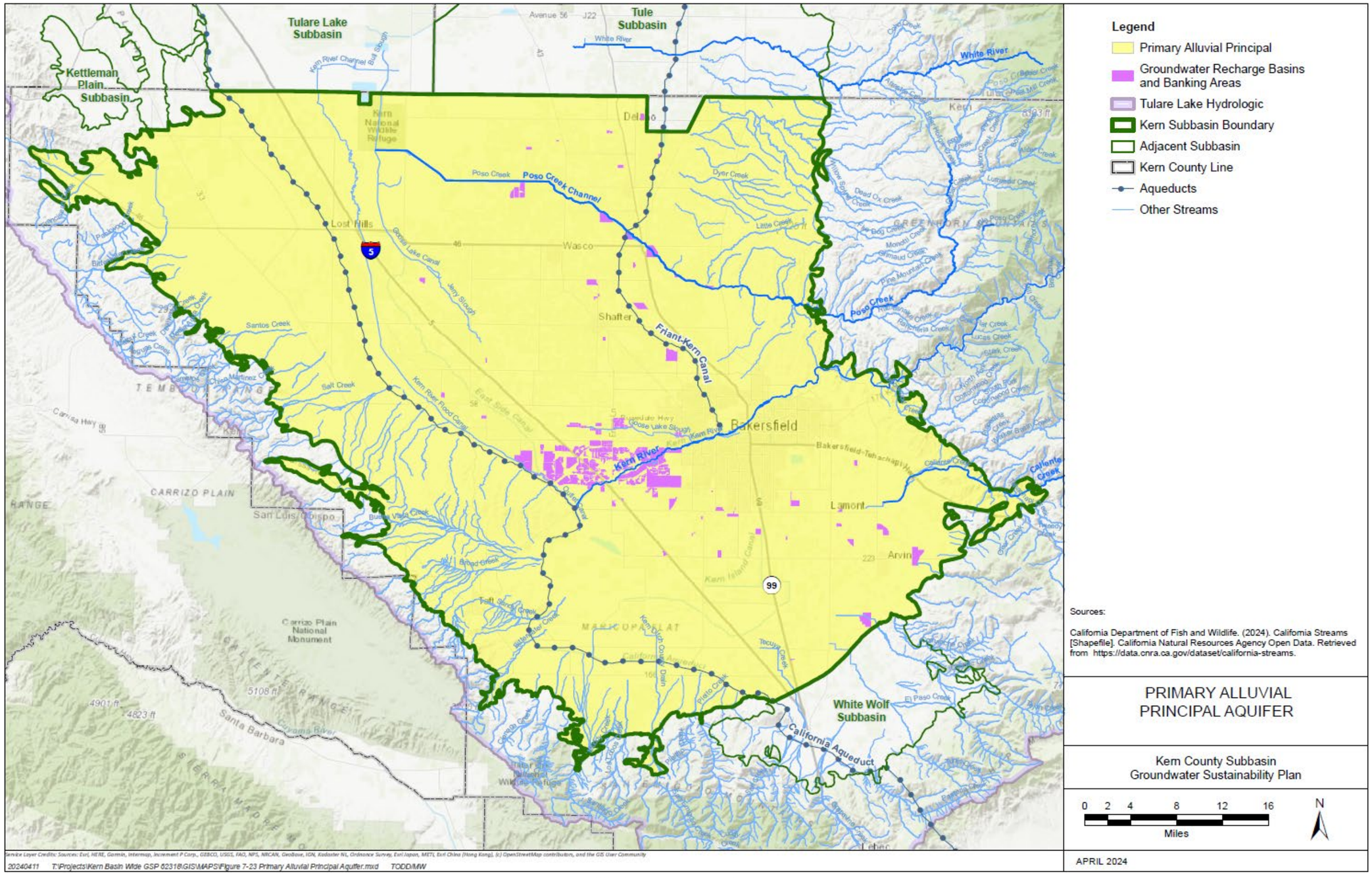


Figure 7-26. Primary Alluvial Principal Aquifer

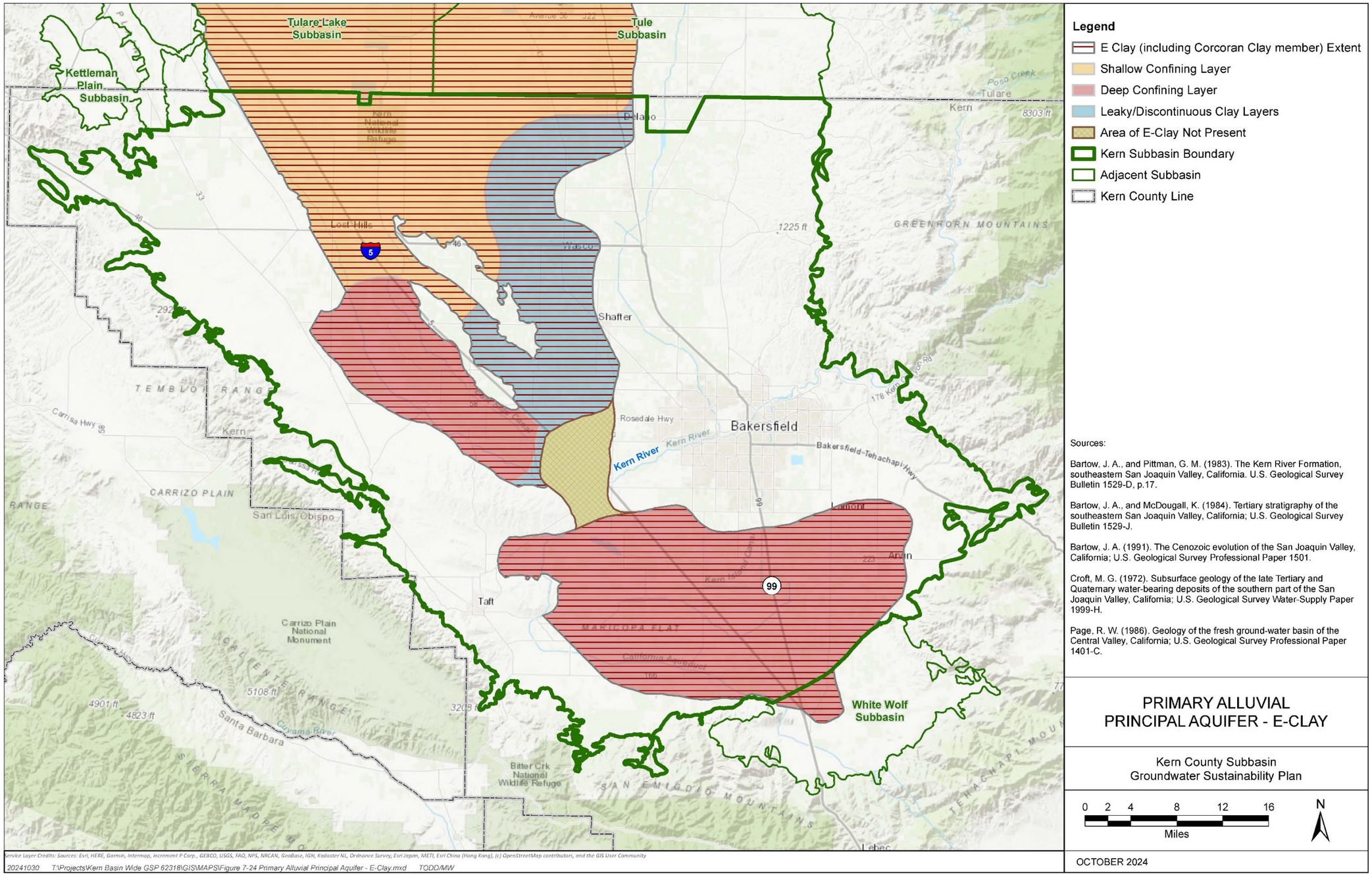


Figure 7-27. Primary Alluvial Principal Aquifer E-Clay

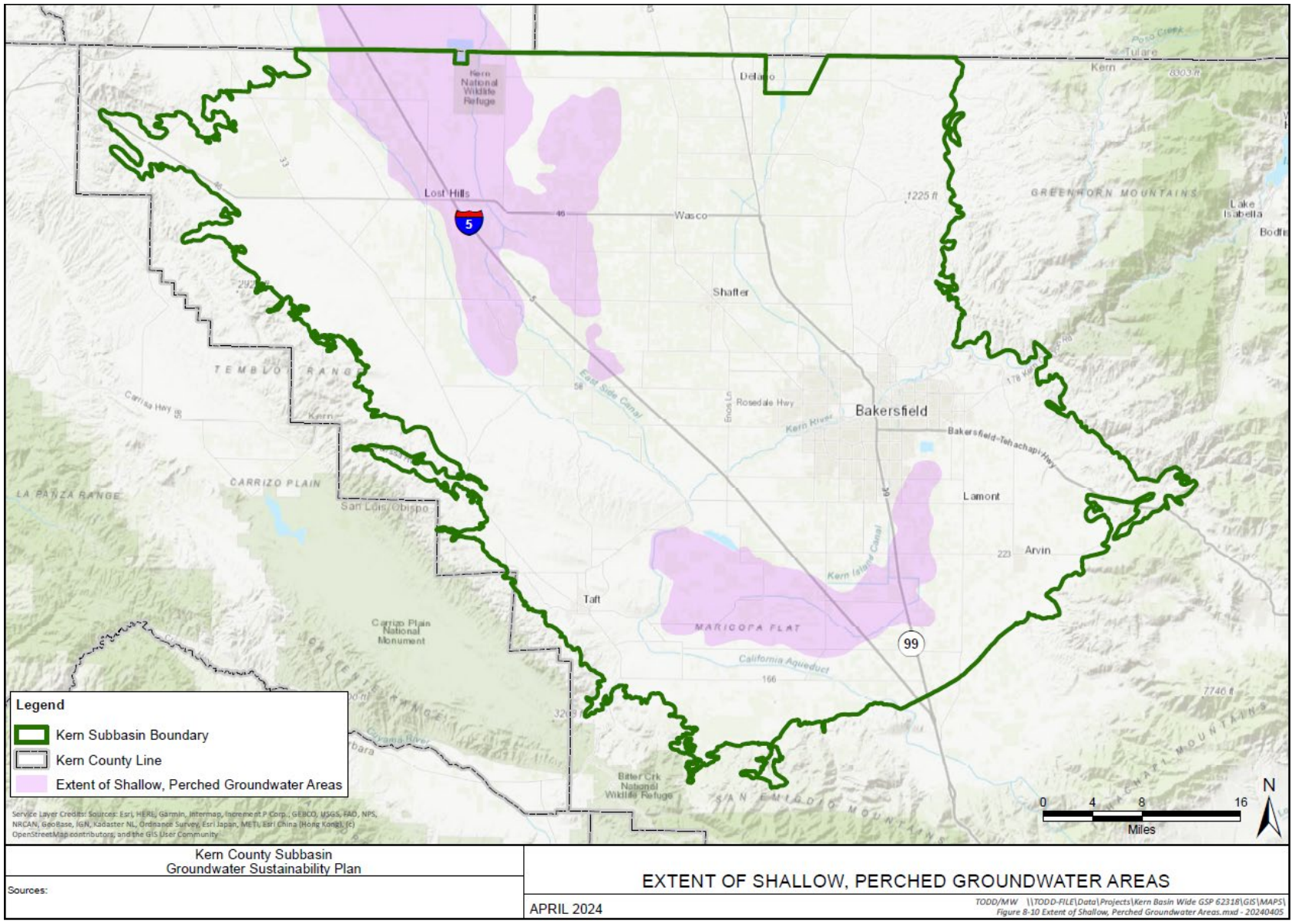


Figure 7-28. Extent of Localized Shallow Groundwater Conditions Above the A-Clay or Equivalent

Physical Aquifer Properties

Aquifer parameters within Kern Subbasin are available from both well pumping tests and calibrated groundwater models. Aquifer properties include hydraulic conductivity, specific yield (unconfined systems) and storage coefficient (confined systems).

Data regarding the aquifers were obtained from pumping tests conducted by the USGS at irrigation wells during the late 1950s and 1960 (McClelland, 1962). Based on these tests, hydraulic conductivity was estimated as within the range of 3 to 250 ft/d (with a median of 60 ft/d). These values align with published ranges for clean, medium- to coarse-grained sand (Heath, 1983) or for fine sand to coarse gravel (Schwartz and Zhang, 2003). These estimates also coincide with the range of values used in groundwater models (C2VSim; CVHM; Todd, 2018; Todd, 2017).

Pumping test data from McClelland (1962) provided hydraulic parameters based on analysis of data from six supply wells perforated in the Kern River Formation. Multiple-well tests resulted in transmissivity values that ranged from 2,000 to 63,000 ft^2/day, and reported hydraulic conductivity ranged from 2.1 to 160 ft/day. Storage coefficients obtained from the multiple-well tests ranged from 0.0004 to 0.001, indicating semi-confined conditions.

Estimates of specific yield for unconfined zones falls within the range of values published for similar grain sizes and lithology of between 0.02 and 0.4 (Heath, 1983; Morris and Johnson, 1967) and is consistent with estimates through laboratory testing of sample cores, calculations based on lithology type, and calibration of groundwater models (Dale, 1966; Davis et al., 1959; Davis et al., 1964; Faunt et al., 2009; DWR, 2013; Todd, 2017; Todd, 2018).

The E-Clay within the Tulare Formation is commonly known for its fine-grained beds, though its lithology varies from fine (clay and silt) to coarse (sand) textures (Page, 1986; Faunt et al., 2009). Faunt et al., (2009) compiled and estimated horizontal hydraulic conductivities for the E-Clay within the Tulare Formation within the range of 0.0024 to 33 ft/d. Vertical hydraulic conductivity was estimated to range from 6.6×10^{-6} to 1.5×10^{-3} ft/d, representing a potential range of vertical anisotropy from 360:1 to 22,000:1. This anisotropy range indicates that, in areas where the E-Clay is continuous, the E-Clay forms a significant regional aquitard.

Structural Properties

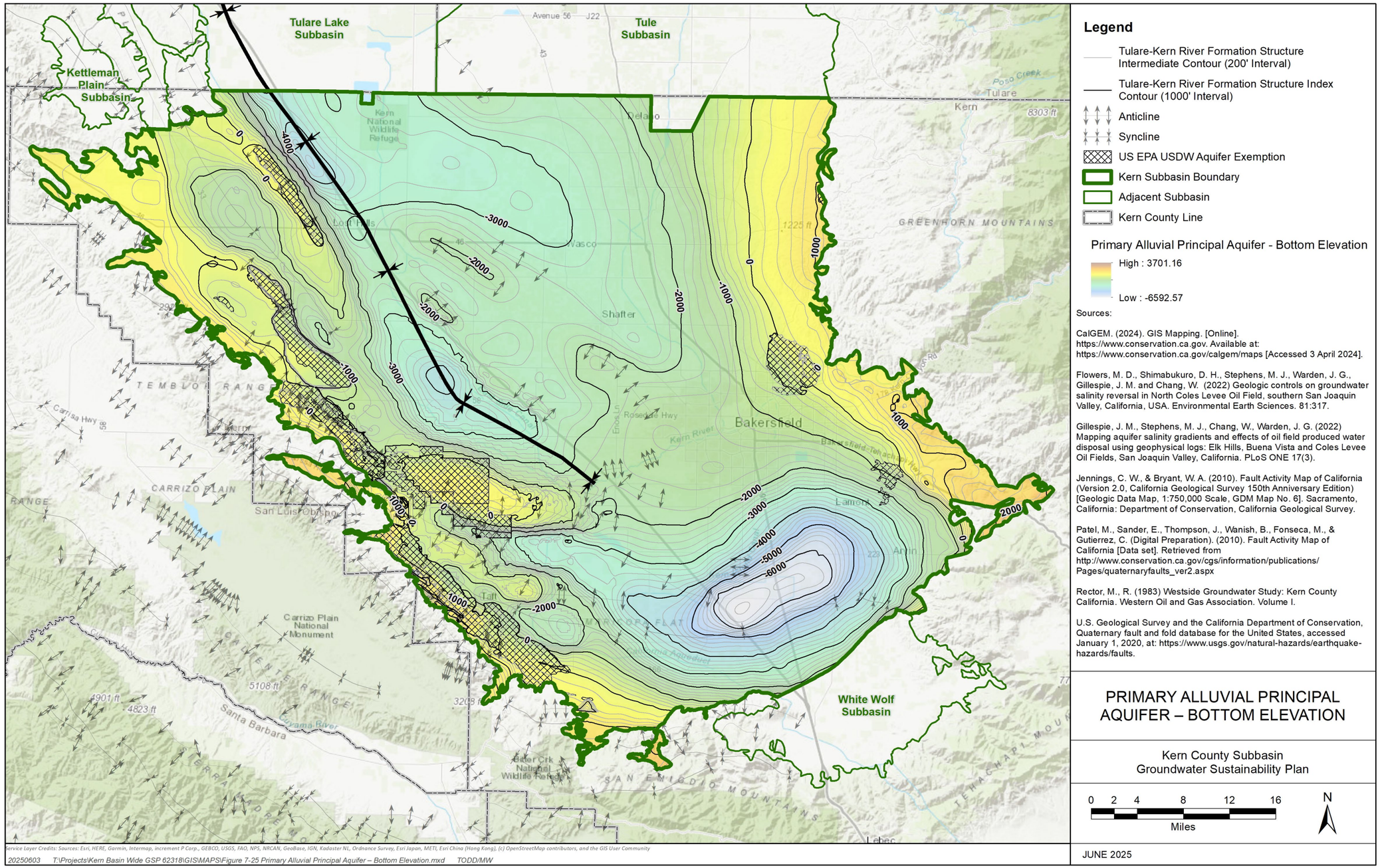
Kern Subbasin is significantly shaped by geological features. The San Joaquin Valley Syncline is an extensive and asymmetric trough that has accumulated thick sedimentary deposits (Figure 7-29). It can also be noted that due to asymmetric loading by the Sierra Nevada and Coast Ranges the San Joaquin Valley has undergone late Miocene subsidence (Levandowski and Jones, 2015).

Another structural feature of Kern Subbasin is the Bakersfield Arch (Figure 7-29) that forms a low-relief structural high in the center of Kern Subbasin that developed starting in Miocene and continuing to recent times. The alluvial sediments dip to the north and south off the flanks of the arch, which create deep basins for infill of sediments (Bartow, 1991). The arch is not a barrier to groundwater flow but does represent one part of the upgradient topographic high that allows water to flow outward from the river.

Numerous geological structures, including faults and folds, are distributed throughout Kern Subbasin, as observed in local geological maps (Figure 7-11 and Figure 7-12). Normal faulting along the eastern Kern Subbasin margin is prominent in older sedimentary layers but extends into and is concealed by younger sediments, particularly along the Pond-Poso Fault (Poso Creek Fault) in the north and the Edison Fault in the south. Normal faults along the eastern margin exhibit varying orientations, ranging from northwest to northeast, owing to alternating compressional and extensional forces. Delineation occurs at the southern boundary of Kern Subbasin, where the northeast-trending White Wolf Fault actively displaces the Kern Subbasin from the southern White Wolf Subbasin.

Structurally, the western Kern Subbasin geology differs significantly from the central and eastern parts of Kern Subbasin. Western Plio-Pleistocene deposits primarily originate from the weathering and erosion of the Coastal Range, consisting of marine deposits that yield clays, silts, and some sands. In contrast, the eastern side is characterized by quartzose and feldspathic coarser-sized sediments from the Sierra Nevada. In addition, differences in the thickness of freshwater-bearing deposits and the sources of groundwater recharge between the western and eastern sides of Kern Subbasin result in more localized and restrictive groundwater systems with poorer water quality on the west side of Kern Subbasin.

The West Side Fold Belt features several anticlines, including Lost Hills and Elk Hills (Bartow, 1991; Page, 1986). These structures are oriented toward the northwest, running semi-parallel to the Coast Range and the San Andreas Fault (Figure 7-29). Page (1986) and DWR (2006) have identified these anticlinal folds in the West Side Fold Belt, particularly the Elk Hills and Lost Hills, as constraints on groundwater flow within the lowlands, which likely applies to other anticlines in Kern Subbasin. The Elk Hills Anticline is comprised of a broad, elongate, flat-topped arch with steep dips along its edge. The anticline is approximately 17-miles long by 6-miles wide, trending northwest to southeast. The Elk Hills rise to an altitude of over 1,550 feet (Woodring et al., 1932). The Lost Hills Anticline is the southern end member of a 60-mile-long fold of a Southeast-plunging anticline, which runs parallel to the San Andreas Fault to the west and formed due to related compressional tectonic activity. Specifically, the Lost Hills Anticline is an asymmetric anticline, approximately 20-miles long and 6-miles wide (Medwedeff, 1989).



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

20250603 T:\Projects\Kern Basin Wide GSP 62318\GIS\MAPS\Figure 7-25 Primary Alluvial Principal Aquifer – Bottom Elevation.mxd TODD/MW

Legend

- Tulare-Kern River Formation Structure Intermediate Contour (200' Interval)
- Tulare-Kern River Formation Structure Index Contour (1000' Interval)
- Anticline
- Syncline
- US EPA USDW Aquifer Exemption
- Kern Subbasin Boundary
- Adjacent Subbasin
- Kern County Line

Primary Alluvial Principal Aquifer - Bottom Elevation

High : 3701.16

Low : -6592.57

Sources:

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PRIMARY ALLUVIAL PRINCIPAL AQUIFER – BOTTOM ELEVATION

Kern County Subbasin
Groundwater Sustainability Plan

0 2 4 8 12 16
Miles

N

JUNE 2025

Figure 7-29. Primary Alluvial Principal Aquifer Bottom Elevation

General Water Quality

This section is a general summary of water quality in the Primary Alluvial Principal Aquifer. A more detailed discussion of water quality is provided in Section 8. Groundwater quality in the Primary Alluvial Principal Aquifer is generally of good quality for agricultural and municipal uses. The highest quality groundwater is typically associated with Kern River recharge. TDS concentration in the Western Fold Belt HCM Area typically ranges from 1,000 to 4,000 mg/L (KCWA, 2011) which limits the availability of usable groundwater in this HCM Area. Elsewhere, TDS concentrations in this principal aquifer range 200 to 1,500 mg/L (KCWA, 2011).

This difference is generally attributed to the source of recharge of the groundwater and the influence of connate waters from older marine formations. Lower TDS concentrations and greatest depths USDW occur along the eastern margin of Kern Subbasin due to the influx of low TDS recharge from the Sierra Nevada. Higher TDS concentrations on the west side are attributed to runoff from older marine formations in the Coast Ranges. Stream names along the western Kern Subbasin margin, such as Salt Creek and Bitterwater Creek, further indicate high TDS content of runoff coming from the Coast Range. Two properties exist to increase the TDS concentrations: remnant high-salinity connate water from the Tulare Formation and salt-bearing sediments in underlying older marine formations. (Metzger and Landon, 2018; Sierra Scientific Services, 2013; KCDEH, 1980; KCDEH and KCWA, 1982; Wood & Dale, 1964).

Elevated nitrate and other solute concentrations are typically present in shallow perched zones and in the unconfined zone above the E-Clay Clay. Groundwater is progressively fresher and lower in TDS below the Corcoran Clay, toward the center of the basin, and in the eastern half of Kern Subbasin. In contrast, arsenic concentrations increase with depth and in close proximity to portions of the Corcoran Clay. See Section 8 for additional information on these water quality constituents.

Primary and Designated Beneficial Uses

Production from the Primary Alluvial Principal Aquifer provides the bulk of water production in Kern Subbasin for beneficial use. The primary uses of Kern Subbasin aquifer system include agricultural, municipal, domestic, and storage for the banking of surface water. The designated beneficial uses for Kern Subbasin in the Tulare Lake Basin Plan (CVRWQCB, 2018) include:

- **Municipal and Domestic Supply (MUN)** - Uses of water for community or individual water supply systems, including, but not limited to, drinking water supply.
- **Agricultural Supply (AGR)** - Uses of water for farming, horticulture, or ranching.

- **Industrial Service Supply (IND) and Process Supply (PRO)** - Water use for industrial activities that either are not dependent on water quality (IND) or those that are dependent upon water quality (PRO).

The predominant use of groundwater from the principal aquifer in Kern Subbasin is for irrigated agriculture. Municipal, small-water systems and private wells are the other significant use of groundwater. Groundwater is also used by several communities in Kern Subbasin as a source of municipal water supply, by a small number of private commercial entities for industrial use (i.e., food processing), and private domestic wells.

Data Gaps

The data gaps associated with the hydrogeologic conceptual model for the Primary Alluvial Principal Aquifer include:

- Physical properties of the Westside aquifers and Eastside aquifers.
- Physical properties of the upper zone of the primary aquifer system.
- Groundwater characterization on the eastern and western flanks of Kern Subbasin and in the upper and shallow zones.
- Groundwater quality of the primary aquifer zones and confined zones on the eastern and western flanks of Kern Subbasin, from wells screened solely in a single aquifer zone.
- As improvements to monitoring networks are made, data can be used to fill data gaps in Kern Subbasin.

7.5.2 Santa Margarita Principal Aquifer

The Santa Margarita Principal Aquifer is comprised of both the Santa Margarita Formation and Olcese Sand within a limited area in the northeastern Kern Subbasin. This principal aquifer is so named because the Santa Margarita Formation is considered the primary producing horizon in this area of the northeastern Kern Subbasin, but many wells are screened in both the Santa Margarita and Olcese Sand. This aquifer is the source of a significant volume of groundwater used, primarily for agricultural supply, within the Santa Margarita Principal Aquifer area shown on Figure 7-30 and Figure 7-31.

This principal aquifer extends from the Pond-Poso Fault (Poso Creek Fault) to the south and extends northward into Tule Basin; and extends from Kern Subbasin margin on the east to either the extent of the sandstone formation or the base of fresh water in the west as shown on Figure 7-17, Figure 7-18, and Figure 7-22. South of the Pond-Poso Fault, the Santa Margarita and Olcese Sand are highly faulted with multiple oil fields with aquifer exemptions boundaries in these areas (Figure 7-30 and Figure 7-31). The Santa Margarita Principal Aquifer is separated from the overlying Primary Alluvial Principal Aquifer by a thick regional aquitard.

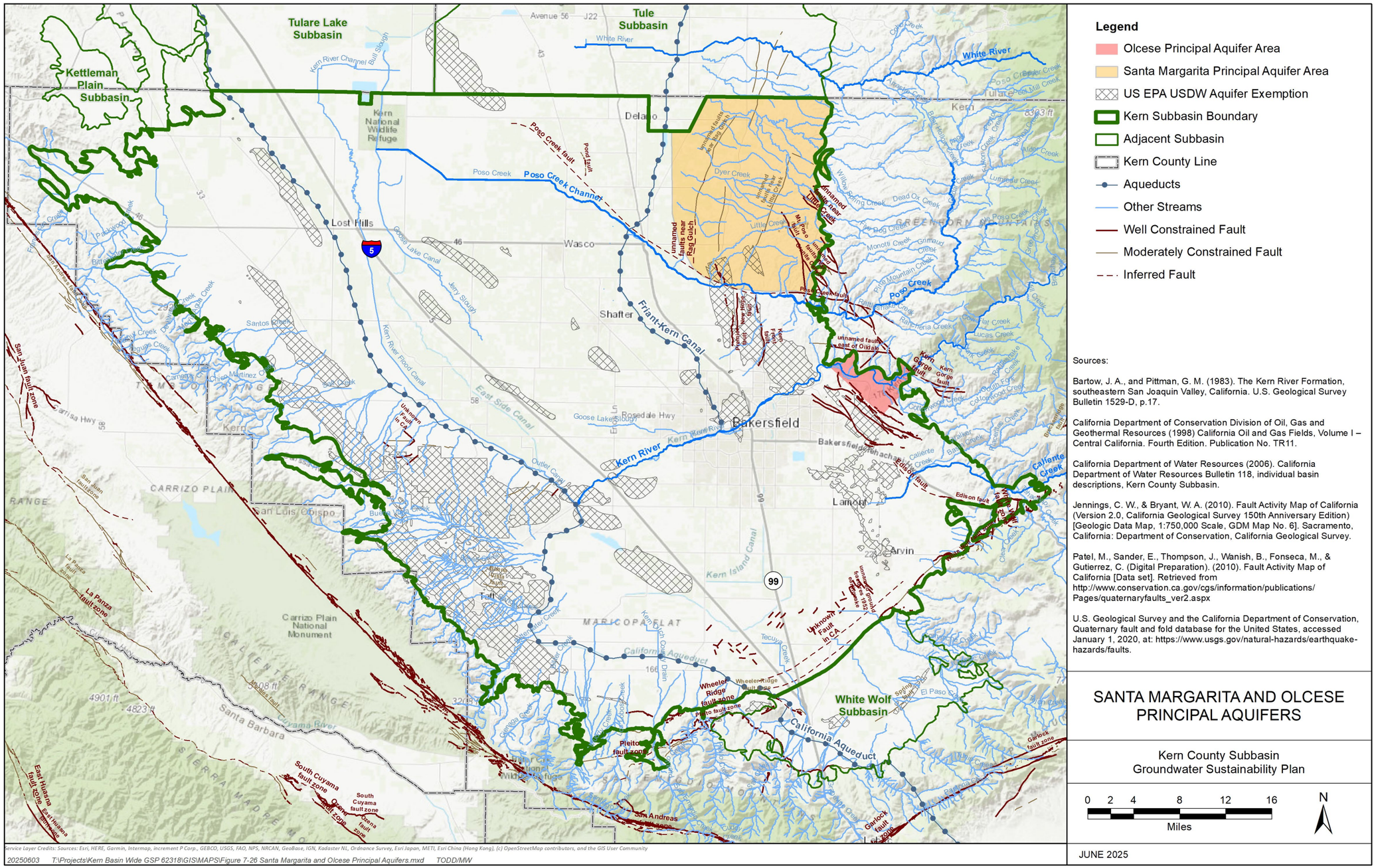
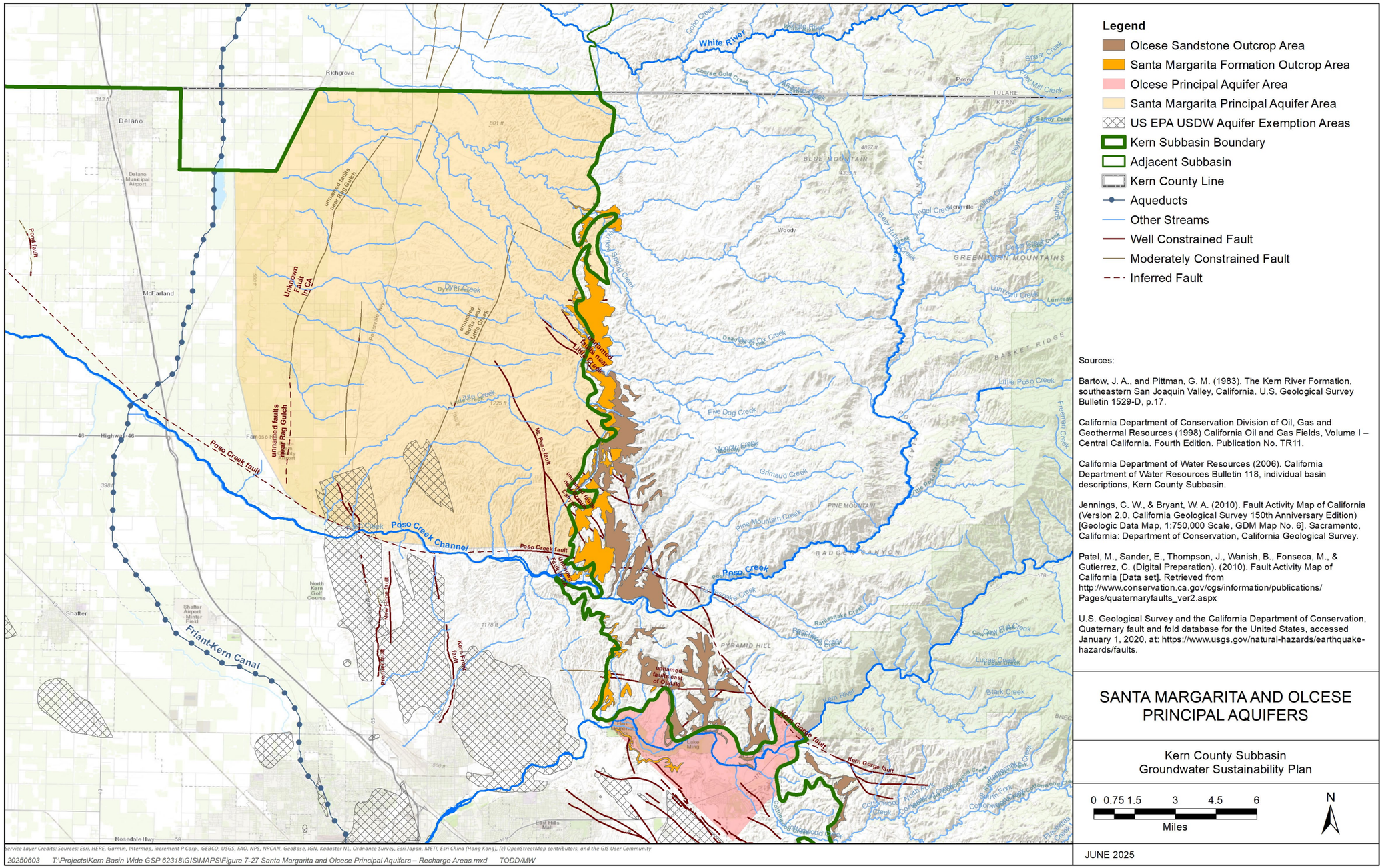


Figure 7-30. Santa Margarita and Olcese Principal Aquifer (Kern Subbasin View)


Legend
Olcese Sandstone Outcrop Area
Santa Margarita Formation Outcrop Area
Olcese Principal Aquifer Area
Santa Margarita Principal Aquifer Area
US EPA USDW Aquifer Exemption Areas
Kern Subbasin Boundary
Adjacent Subbasin
Kern County Line
Aqueducts
Other Streams
Well Constrained Fault
Moderately Constrained Fault
Inferred Fault
Sources:
Bartow, J. A., and Pittman, G. M. (1983). The Kern River Formation, southeastern San Joaquin Valley, California. U.S. Geological Survey Bulletin 1529-D, p.17.
California Department of Conservation Division of Oil, Gas and Geothermal Resources (1998) California Oil and Gas Fields, Volume I – Central California. Fourth Edition. Publication No. TR11.
California Department of Water Resources (2006). California Department of Water Resources Bulletin 118, individual basin descriptions, Kern County Subbasin.
Jennings, C. W., & Bryant, W. A. (2010). Fault Activity Map of California (Version 2.0, California Geological Survey 150th Anniversary Edition) [Geologic Data Map, 1:750,000 Scale, GDM Map No. 6]. Sacramento, California: Department of Conservation, California Geological Survey.
Patel, M., Sander, E., Thompson, J., Wanish, B., Fonseca, M., & Gutierrez, C. (Digital Preparation). (2010). Fault Activity Map of California [Data set]. Retrieved from http://www.conservation.ca.gov/cgs/information/publications/Pages/quaternaryfaults_ver2.aspx
U.S. Geological Survey and the California Department of Conservation, Quaternary fault and fold database for the United States, accessed January 1, 2020, at: https://www.usgs.gov/natural-hazards/earthquake-hazards/faults.
SANTA MARGARITA AND OLCESE PRINCIPAL AQUIFERS
Kern County Subbasin
Groundwater Sustainability Plan
0 0.75 1.5 3 4.5 6
Miles
N
JUNE 2025
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
20250603 T:\Projects\Kern Basin Wide GSP 62318\GIS\MAPS\Figure 7-27 Santa Margarita and Olcese Principal Aquifers – Recharge Areas.mxd TODD/MW
White River
Poso Creek Channel
Poso Creek fault
Friant-Kern Canal
Kern Gorge fault
Richgrove
Delano
McFarland
Shafter
Pond fault
Unknown Fault in CA
Unnamed faults near Rag Gulch
Unnamed faults near Little Creek
Unnamed faults near Little Creek
Unnamed faults near Rag Gulch
Mt. Poso fault
Unnamed faults near Poso Creek
Unnamed faults near Poso Creek
Unnamed faults near Poso Creek

Geologic Formations

The Santa Margarita Formation consists of an upper bed of a silty, well-sorted, fine-grained sandstone and a lower bed of a fossiliferous, micaceous sandy siltstone, both of which were deposited in a shallow-marine environment. The Santa Margarita Formation is a permeable sandstone unit with an average thickness of 200 feet (Bartow, 1984). The Santa Margarita Formation is most prominent in the east of Kern Subbasin (Figure 7-17, Figure 7-18, and Figure 7-22). Toward the center of the basin, the Santa Margarita Formation inter-fingers and grades into the Fruitvale Shale Formation (Bartow and McDougall, 1984). The Olcese Sand is a fine- to coarse-grained marine sandstone with silty sandstone and sandy siltstone interbeds.

Originally deposited in a nearshore marine environment with saltwater, the Santa Margarita Formation now contains freshwater due to groundwater recharge. The Santa Margarita and Olcese outcrop in the watershed areas adjacent to Kern Subbasin where they are recharged by rainfall and stream seepage. The recharge has, over time, flushed the original saline connate water and now contain freshwater (Davis et al., 1964; Hilton, 1963). The aquifers deepen toward the west, underlying fine-grained deposits that limit natural recharge.

Both the Santa Margarita and Olcese Sand Formations are confined above and below silt and shale layers (Figure 7-17, Figure 7-18, and Figure 7-22) that form competent aquitards that separate this principal aquifer from others. The Etchegoin Formation and Macoma Claystone (Bartow, 1984) act as confining layers between the Santa Margarita and the Primary Alluvial Principal Aquifers. The Round Mountain Silt below the Santa Margarita Formation serves as an aquitard, restricting vertical flow between the Santa Margarita Formation and the underlying Olcese Sand (Bartow, 1984). The Freeman Silt, a marine siltstone that, due to its comparatively finer/siltier texture, is understood to effectively serve as the bottom of the groundwater basin underlying the Olcese Sand.

Physical Aquifer Properties

A series of single-well pumping tests and step-drawdown tests conducted in wells in the Northeast Kern Subbasin produced estimates of transmissivity ranging from 3,600 to 6,300 ft^2/day and an estimate of the range of hydraulic conductivities of 5.1 ft/day to 8.6 ft/day (Schmidt, 2016). Based on the data collected, a storativity estimate of 6×10^{-4} also was obtained. Analysis of the recovery data provides an estimated transmissivity of 2,800 ft^2/day and hydraulic conductivity of 4.8 ft/day. Reported specific capacities averaged about 12.5 gpm/ft (McClelland, 1962). Hydraulic properties of the Santa Margarita and the Olcese Sand Formations can be estimated as ranging from approximately 2.1 ft/day to 8.6 ft/day, with a midpoint of the range of approximately 5 ft/day.

Structural Properties

Bartow's (1984) mapping highlights various normal faults within the Northeast Kern Subbasin, including the East-West striking Mt. Poso Fault and the North-South striking Kern Front Fault (Figure 7-30 and Figure 7-31). These faults exhibit minimal vertical offset, approximately 100 feet or less, within the primary aquifer units of interest. The impact of some faults on the hydraulic conductivity of these aquifer units remains uncertain at present.

General Water Quality

Groundwater in the Santa Margarita Formation is the sodium bicarbonate type with TDS concentrations ranging between 360 to 500 mg/L. Groundwater in the Olcese Sand is the calcium-sodium bicarbonate type with concentrations ranging between 360 to 410 mg/L. Groundwater in the unconsolidated nonmarine sediments in this area are of the calcium-sodium bicarbonate type with TDS concentrations ranging between 290 to 680 mg/L. A more detailed discussion of water quality is provided in Section 8.

Groundwater quality becomes brackish toward the west in the Santa Margarita Principal Aquifer. Recharge from outcrops of the Santa Margarita and Olcese Sand in the watersheds adjacent to Kern Subbasin provide a source of freshwater to this principal aquifer. This recharge has moved westward down-structure displacing the original saline waters into the deeper parts of Kern Subbasin (Reynolds, 1955). The transition of freshwater to saline water marks the western extent of the Santa Margarita Principal Aquifer, with estimated TDS values of over 2,000 mg/l (Gillespie, 2016).

Primary and Designated Beneficial Uses

Production from the Santa Margarita Principal Aquifer provides water supply to a limited area in the northeastern part of Kern Subbasin and also extends into the southeastern portions of the adjacent Tule Subbasin. The sole use of the Santa Margarita Formation is agricultural. The primary use within this area is to support irrigated agriculture, with a focus on citrus, pistachios, and other permanent tree crops.

Data Gaps

The primary data gaps and uncertainty in the hydrogeologic conceptual model include:

- Hydraulic properties of the aquifers, including hydraulic conductivity and storativity.
- Aquifer-specific groundwater levels. Data for groundwater levels and quality have been obtained from wells screened in multiple aquifer zones.
- Underflow recharge from the Sierra Nevada Mountains.
- Well construction and pumping proportion between the shallow and deep aquifers.

The data gaps listed above create uncertainty on the impacts of different aquifer zones on the sustainability indicators. Additional monitoring points and dedicated monitoring wells perforated in the principal aquifers in the future would help reduce the uncertainty associated with these data gaps.

7.5.3 Olcese Principal Aquifer

The Olcese Sand Formation was formed in a nearshore marine environment that was present along the eastern Kern Subbasin margin as shown on cross section B-B' (Figure 7-18) and F-F' (Figure 7-22). The formation is a fine- to coarse-grained marine sandstone with silty sandstone and sandy siltstone interbeds. The formation dips to the southwest and is encountered at depths of approximately 200 to 800 feet bgs under the Olcese GSA Area (approximately 600 to -300 feet msl) and reaches depths of approximately 2,000 feet bgs (-1,400 feet msl). The average thickness of the Olcese Sand Principal Aquifer in the Olcese GSA Area is roughly 1,000 feet. Available aquifer testing data indicates transmissivity of the Olcese Sand Formation is on the order of 6,300 feet squared per day and hydraulic conductivity is on the order of 0.55 to 6 feet per day.

As the formation dips to the southwest, the depth to the top of the Olcese Sand Formation increases to greater than 2,300 feet bgs near the Ant Hill Oil Field and further to greater than 3,500 feet bgs before pinching out northeast of Bakersfield. This depth is substantially below the overlying Kern River, Chanac, and Santa Margarita Formations, which serve as the primary sources for groundwater production in the eastern portion of Kern Subbasin.

Overlying the Olcese Sand Formation is the Round Mountain Silt a marine siltstone and claystone that serves as an aquitard, restricting vertical flow between the Santa Margarita Formation and the Olcese Sand. The Round Mountain Silt is up to 800 feet thick within the Olcese GSA Area that separates the Olcese Sand Principal Aquifer from the Shallow Alluvium. Local outcroppings of the Round Mountain Silt are observed along the margins of the Kern River, laterally constraining the extent of the Shallow Alluvium (Figure 7-18 and Figure 7-22).

Below the Olcese Sand is the Freeman Silt, a marine siltstone that typically acts as a lower bounding aquitard (Bartow, 1984) and which, due to its comparatively finer/siltier texture, is understood to effectively serve as the bottom of the groundwater basin underlying the Olcese GSA. Older formations (i.e., the Jewett Silt, Rio Bravo Sand, Vedder Sand, and the Walker Formation) underly the Freeman Silt and are included within the "undifferentiated older sediments" shown in the cross-sections prepared for this HCM Area.

The Olcese Sand is recharged by rainfall directly on outcrops within and outside of Kern Subbasin, by streamflow in the watersheds adjacent to Kern Subbasin, and likely by the Kern River in the vicinity of the Kern Gorge Fault at the eastern Kern Subbasin margin

(Figure 7-31). The Olcese Sand, like the Santa Margarita Formation, originally contained saltwater at the time of its deposition. Over time, recharge from rainfall and freshwater sources displaced the saltwater westward, resulting in a usable fresh groundwater resource suitable.

Physical Aquifer Properties

Measurements taken by Birkholzer, et al. (2011) state the average porosity is 33 percent and the permeability ranges from 9 to 40 ft/d. Single-well pumping tests produced transmissivity estimates ranging from 3,600 to 6,000 ft^2/day, estimated hydraulic conductivities of 5 to 9 ft/day, and a storativity estimate of 6×10^{-4}. Reported specific capacities ranged from 10 to 12.5 gpm/ft (McClelland, 1962). The Round Mountain Silt provides a confining layer where it overlies the permeable Olcese Sand and has an average permeability of 3×10^{-4} ft/d (Birkholzer et al., 2011).

Structural Properties

The Kern Gorge Fault constrains subsurface inflows to the groundwater system, creating a lateral boundary between granodiorite bedrock of the Sierra Nevada and the alluvial and marine sedimentary deposits of Kern Subbasin. The Round Mountain Silt, where present, further hinders vertical flow between the overlying Shallow Alluvium and the underlying Olcese Sand. The Olcese Sand progressively thins and pinches out into the Round Mountain Silt to the southwest (Bartow, 1984) and also thins to the southeast of the Olcese GSA Area, eventually pinching out and/or interbedding with the overlying Edison Shale.

Several northwest/southeast-oriented faults (Bartow, 1984) offset the Olcese Sand, likely diminishing lateral transmissivity. Additional faults to the north of the Olcese GSA Area likely constrain hydraulic connection to the north. The progressive thinning, dipping, and fault-induced displacement of the Olcese Sand bound usable groundwater resources to localized areas, limiting connectivity to the other principal aquifers of Kern Subbasin.

General Water Quality

Groundwater quality data based on samples collected from Olcese Water District wells within the Olcese Principal Aquifer (Wells #2 and #3) shows a sodium-potassium sulfate type, with TDS concentrations ranging from 860 to 1,100 mg/L, sulfate ranging between 320 and 550 mg/L (above the secondary Maximum Contaminant Level (MCL) of 250 mg/L), and iron concentrations exceeding the secondary MCL of 0.03 mg/L in some cases. Recent groundwater quality data indicate no significant trends in the concentrations of these constituents. In contrast, groundwater from the Canyon View Ranch well on the far eastern edge of Kern Subbasin tends to be of a calcium/bicarbonate type, with an average TDS concentration of 230 mg/L.

Stable isotope data reveal that groundwater within the Olcese Sand Principal Aquifer exhibits a "heavier" composition than the waters of the Kern River yet remain somewhat lighter than stable isotope ratios characteristic of local precipitation in the area (Visser et al., 2016). The isotopic signature suggests that recharge sources for the Olcese Sand Principal Aquifer are predominantly from local rainfall, likely falling onto exposed outcrops of the Olcese Sand east and north of the Olcese GSA. Additionally, a portion of the recharge comes from lighter waters sourced from the Kern River, either via seepage through the Kern Gorge Fault or through areas of hydraulically connected Shallow Alluvium near the eastern margin of Kern Subbasin.

Groundwater from Olcese Water District Well #4 located further west is of a sodium bicarbonate type with slightly lower concentrations of TDS (710 to 840 mg/L), sulfate (130 to 240 mg/L), and iron (0.066 mg/L) compared to Wells #2 and #3. Groundwater in this well also has a higher pH (8.8), compared to the 7.7 to 8.5 observed in Wells #2 and #3.

Primary and Designated Beneficial Uses

The primary use of groundwater within the Olcese GSA is as a supply source for irrigated agriculture, primarily citrus and other permanent tree crops. Groundwater is pumped from this principal aquifer to meet excess demands for irrigation that are not met by the Olcese Water District and its primary landowner's riparian and non-riparian rights to Kern River surface water. Groundwater is used by the Anne Sippi Clinic as the raw water source for their domestic water supply; this is the only known potable consumption of groundwater in the Olcese GSA Area. Additionally, a small but unquantified amount of water is used by local ranchers for stock water. These uses are consistent with the beneficial use designations in the Tulare Lake Basin Plan (CVRWQCB, 2018).

Data Gaps

The primary data gaps and uncertainties in the hydrogeologic conceptual model include:

- Uncertainty regarding the aquifer properties of the Olcese Principal Aquifer.
- Uncertainty about the source and rate of recharge of the Olcese Principal Aquifer.
- Uncertainty about the location and extent of the Olcese Principal Aquifer outcrops.
- Lack of consistent long-term historical water level data from the Olcese Principal Aquifer, and resultant uncertainty about groundwater gradients.

While the uncertainties listed above contribute to some uncertainty about the overall hydrogeologic conceptual model, they do not significantly impede the ability of the Olcese GSA to sustainably manage the groundwater resources of the Olcese Principal

Aquifer. Additional monitoring data and investigations could help reduce these uncertainties in the future.

7.6 Basin Boundaries and Basin Bottom

Basin boundaries and basin bottom provide a description of the geologically controlled lateral and vertical limits that define the margins of the groundwater aquifer system, and therefore represent barriers to groundwater flow (DWR, 2016).

7.6.1 Lateral Boundaries

☑ 23 CCR § 354.14(b)(2)

The boundaries of Kern Subbasin have been defined by DWR (DWR, 2006 and 2016c). As described in DWR's Bulletin 118, Kern Subbasin is "bounded on the west, southwest, and east by the bedrock formations of the Coast Range, San Emigdio Mountains, and Sierra Nevada, respectively. It is separated by the White Wolf Subbasin on the southeast by the White Wolf Fault. The northern boundary is generally coincident with the County line." (DWR, 2016c). Kern Subbasin's lateral boundaries on the east, west and south sides are geologically based, whereas the northern boundary is jurisdictionally based.

The geologically-based Subbasin boundaries are generally defined as the lateral extent of the Pliocene or younger (Quaternary) units based on the surficial geologic map published by the California Division of Mines and Geology (Figure 7-6). The east and southeastern boundary borders the Sierra Nevada range that is composed of igneous and metamorphic Basement Complex rocks, primarily granite. However, outcrops of Miocene or older sedimentary units, including the Santa Margarita Formation and Olcese Sand, occur just outside of Subbasin boundary. The east and southeast have multiple large watersheds that provide a source of recharge as either stream recharge or subsurface inflows to Kern Subbasin.

A portion of the south Subbasin boundary is defined by the White Wolf Fault which separates Kern Subbasin from the adjacent White Wolf Subbasin. The White Wolf Fault is considered to be a hydrogeologic flow barrier that restricts groundwater flow between the White Wolf and Kern Subbasins.

The southwest and west boundaries are outcrops of Miocene or older sedimentary units in the Coast Ranges. 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). None of the Principal Aquifer units outcrop in the Coast Ranges, and the majority of these units in the Coast Ranges are fine-grained shales and siltstones that limit subsurface inflow into Kern Subbasin from the west. The watersheds along the western boundary are much smaller than other areas which limits the potential for stream recharge in this area.

On the northwest edge of Kern Subbasin the boundary with the Kettleman Plain Subbasin is based on the jurisdictional extent of the Devils Den Water District. Little to no groundwater flow is considered to occur across this boundary, and groundwater flow in the Kettleman Plain Subbasin flows north to the Tulare Lake Subbasin (Wood and Davis, 1959).

On the north side, Subbasin 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) 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. The Primary Alluvial Principal Aquifer correlates to the Upper and Lower Principal Aquifers defined in the Tule and Tulare Lake Subbasins. The Santa Margarita Principal Aquifer correlates to the Santa Margarita Formation and Olcese Sand of the Southeastern Kern Subbasin of the Tule Subbasin. The Pliocene Marine Deposits aquitard of the Tule Subbasin is consistent with Kern Subbasin definition of these units.

7.6.2 Definable Basin Bottom

☑ 23 CCR § 354.14(b)(3)

The bottom of the Kern Subbasin varies significantly across the Kern Subbasin based on changes in geometry, structural features at depth, groundwater quality, oil and gas reservoirs, and aquifer exemptions boundaries. Previous Central Valley studies have observed saline groundwater in various areas and depths and have used water quality as the effective bottom of the Kern Subbasin groundwater. In accordance with DWR BMP guidance (DWR, 2016), the Kern Subbasin bottom is defined using the following criteria:

- Physical properties define the vertical limit below which little to no significant groundwater movement occurs.
- Geochemical properties that define the vertical extent of usable groundwater. These may include:
  - Base of freshwater maps in the Central Valley published by the DWR and USGS.
  - The USEPA definition for Underground Source of Drinking Water (USDW).
  - Geologic boundaries of US EPA exempted aquifers.

In basins where produced water from underlying oil and gas operations is beneficially used within the basin, or injected into the basin's USDW, the HCM Area can further characterize the geologic boundaries that separate the USDW from the oil and gas aquifers and identify the basin bottom.

7.6.3 Physical Properties

☑ 23 CCR § 354.14(b)(4)(B)

The geologic boundary shown on Figure 7-32 is the composite bottom thickness of the three defined principal aquifers. The principal aquifers represent the portion of Kern Subbasin that currently provides the primary sources of groundwater in Kern Subbasin for beneficial uses of drinking water supply, agricultural irrigation, industrial supply, and other uses.

The base of the Primary Alluvial Principal Aquifer is defined as the base of the continental deposits which is consistent with how Bertoldi et al. (1991) and Williamson et al., (1989) defined it for the regional aquifer system. The thickness of the Primary Principal Aquifer ranges between 2,000 to 3,000 feet across much of Kern Subbasin, with a maximum thickness of over 6,000 feet south of Bakersfield. However, the contact between continental and the underlying marine deposits is not always certain because the deposits interfinger in some places. However, this uncertainty is not considered to affect the analysis of groundwater flow because (1) the total probable volume affected a very low percentage of the total volume of the aquifer system and (2) these very deep deposits are generally considered as below the practical pumping limits so that an error in estimating their thickness has little to no effect on the flow-system analysis (Bertoldi et al., 1991; Williamson et al., 1989).

Along the eastern margin, the Santa Margarita and Olcese Sand Formations are marine sandstone units underlying the continental deposits that contain freshwater; however, these marine formations are hydraulically separated from the overlying continental deposits of the Kern River Formation by marine shale units. The total thickness of Kern Subbasin is considered as the combined thickness of the continental deposits and the freshwater marine sandstones as shown in Figure 7-32.

The maximum thickness of both consolidated and unconsolidated sediments in Kern Subbasin may reach over 18,000 feet (Davis et al., 1959). The deeper portions of Kern Subbasin contain mostly Miocene and older marine sedimentary units. These deeper marine sandstones have not been flushed of their original, highly saline connate waters. This indicates that these units have little to no significant groundwater movement in these deeper units and do not receive recharge from the surface or other sources of freshwater. Therefore, these deeper units do not contain usable groundwater supplies and are considered to be below the definable basin bottom following DWR BMP guidance (DWR, 2016).

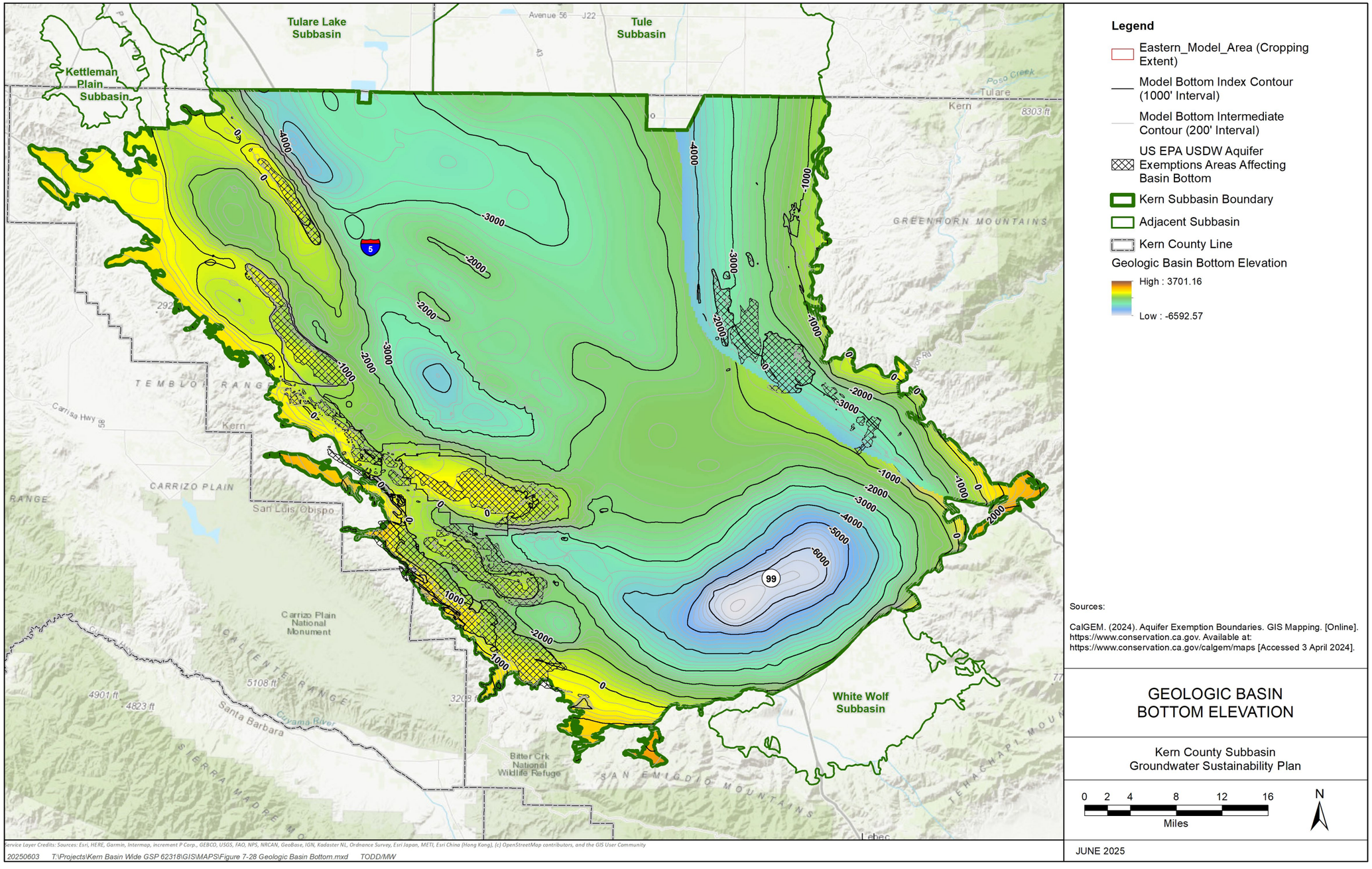


Figure 7-32. Geologic Basin Bottom Elevation

7.6.4 Geochemical Properties

The section describes the geochemical properties evaluated including the Central Valley Base of freshwater maps develop by the USGS (Page, 1986) and Kern Subbasin depth to USDW map (Gillespie et al., 2017). The data from these maps is also illustrated on the geologic cross sections (Figure 7-17 through Figure 7-23) to provide additional context of the depth of these intervals in relation to the overall depth of Kern Subbasin.

Base of Fresh Water

SWRCB Resolution 88-63 (as amended by 2006-0008) provides policy on sources of drinking water. According to that guidance, groundwater with a TDS of less than 3,000 mg/L may reasonably be expected to supply a public water system, if aquifer yield is sufficient (more than 200 gallons/day), the supply is not contaminated or beyond reasonable treatment, and the groundwater is not exempted by 40 CFR §146.4 (SWRCB, 2006).

In general, this definition indicates that any formation containing groundwater with a TDS of less than 3,000 mg/L outside of an exempted aquifer (including oil-producing zones) would qualify as a USDW if it contains a sufficient quantity of groundwater.

Fresh groundwater is underlain by more saline groundwater in many basins of the Central Valley; therefore, the base of this fresh water can be used to define the basin bottom. In 1973, a USGS investigator (Page, 1973) mapped the base of fresh water in the Central Valley using a specific conductance value of 3,000 micromhos per centimeter (µmho/cm), which is equivalent to a TDS range of about 2,000 to 2,880 mg/L varying with temperature and differences in water chemistry.

The use of the base of fresh water by Page (1973) is consistent with SWRCB Resolution 88-63. Page's (1973) base of freshwater elevation contours are shown on Figure 7-32. The base of fresh water is typically shallowest along the western edge of the southern San Joaquin Valley and deepens towards the center of the Valley. In Kern Subbasin, depths exceed 4,400 feet below msl south of Bakersfield. The shallowest elevation of the base of freshwater reaches is 0 to 400 feet below msl in the western areas of Kern Subbasin. In the Santa Margarita Principal Aquifer, the base of fresh water occurs at about 2,600 feet below msl in the area east of Delano.

Underground Source of Drinking Water

The depth of underground source of drinking water (USDW) has recently been defined in the southern San Joaquin Valley by a team of researchers from California State University, Bakersfield (Gillespie et al., 2017). The group used geophysical log analyses to estimate the depth where water salinity increased above the 10,000 mg/L threshold included in the USDW definition. This map, showing the depth to a water salinity of 10,000 mg/L, was designated as the base of the USDW by the investigators; the map is shown as Figure 7-34.

As shown on Figure 7-34, the contours defined by water salinity vary greatly in Kern Subbasin, where the depth to 10,000 mg/L TDS is shallow in the center and the northern and western margins, ranging from <500 to 2,000 feet. At the eastern margins of Kern Subbasin, depths range from 2,000 to 6,000 feet. The steepest change in depth is in the south of Kern Subbasin, as depths change from 2,500 to over 10,000 feet. There is a noticeable depression north of the Wheeler Ridge foothills, where USDW may exceed 10,000 feet (Gillespie et al., 2017). While it seems highly unlikely that groundwater would be extracted from such depths, there is no basis for assuming that USDW could not extend that deep. Along the eastern margin of Kern Subbasin, formation waters are below the USDW standard of 10,000 mg/L from the surface to the basement rocks.

As shown on Figure 7-34, the contours defined by water salinity are shallow in the Western Fold Belt HCM Area, compared to the rest of Kern Subbasin. The depth of USDW ranges from less than 1,000 feet to 2,500 feet below msl. The deepest section occurs between the Buttonwillow Ridge and Elk Hills area and the Buena Vista Lakebed. Although waters in many sands in the western valley are more saline than 3,000 mg/L TDS, numerous wells contain waters between 3,000 and 10,000 mg/L, particularly in the nonmarine Tulare Formation. Along the western margin of Kern Subbasin, the formation waters are within oil reservoirs and are not 100-percent water saturated (Gillespie et al., 2017).

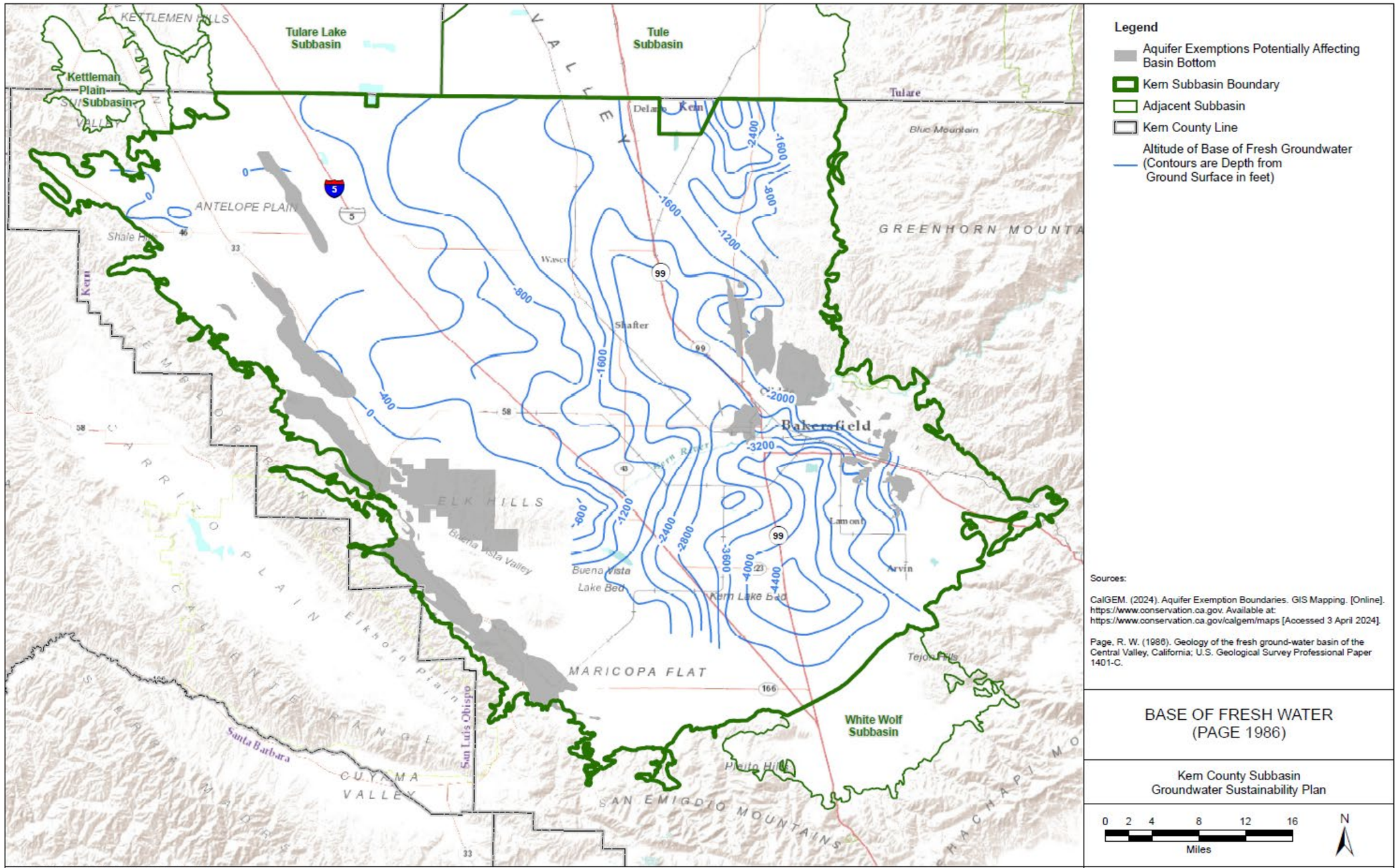


Figure 7-33. Base of Fresh Water (Page 1986)

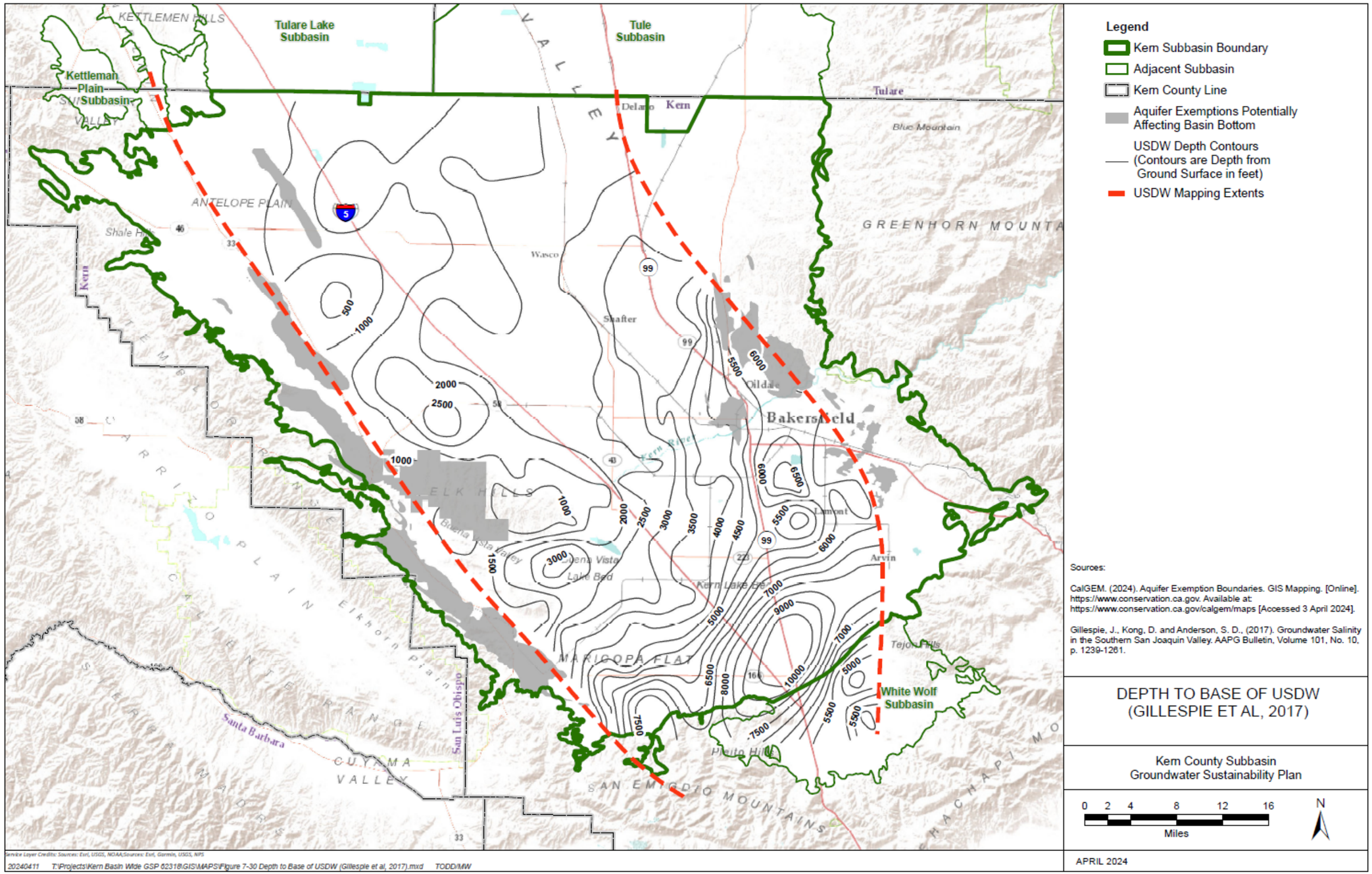


Figure 7-34. Depth to Base of Underground Source of Drinking Water

7.6.5 Oil Fields Aquifer Exemptions

An aquifer exemption boundary removes an aquifer or portion of an aquifer from protection as an USDW under the Safe Drinking Water Act (SDWA). Federal Underground Injection Control (UIC) regulations allow USEPA to exempt aquifers that do not currently serve as a source of drinking water and will not serve as a source of drinking water in the future, based on specific criteria (USEPA, 2019).

Approach for Mapping Aquifer Exemption for Basin Bottom

An alternative method to define the bottom of the groundwater basin in areas with underlying oil and gas operations is provided in DWR's BMP Guidance (DWR, 2016). Portions of the basin that have been permitted as an "exempted aquifer" for underground injection control by California Geologic Energy Management Division (CalGEM) or the SWRCB Oil and Gas Monitoring Program can be separated from the potable aquifer based on the HCM Area characterization of the geologic boundaries that separate them.

Our approach, based on the maps and analysis described above, is to define the bottom elevation as the portion of Kern Subbasin outside of the vertical and lateral extent of the exempted aquifer boundary or zone. This approach to modifying the base of fresh water and USDW and defining the bottom of the groundwater Kern Subbasin is illustrated by the conceptual diagram on Figure 7-35. Specifically, the bottom of the groundwater Kern Subbasin, based on the maps and analysis described above, will be modified by the top of oil fields and exempt aquifers where shallower. It is further assumed that Kern Subbasin would be a continuous unit from the surface down to the basin bottom; no formations below the shallowest oil producing zone or shallowest exempt aquifer would be included. Not all oilfields are exempted aquifers, and not all exempted aquifers are oilfields, but the shallowest depth of either should define the basin bottom.

The purpose of this 2025 Plan is not to exempt aquifers, nor is it to define the maximum depth or water quality concentration at which groundwater is economically recoverable or treatable now or in the future. However, by applying the criteria of 40 CFR §144.3 and 40 CFR §146.4, active oil and gas aquifers and exempted aquifers are not a part of the groundwater Kern Subbasin for beneficial use. Using the horizontal and vertical extent of the primacy and post-primacy aquifer exemption, described in more detail in the following discussion, the map of the geologic bottom of Kern Subbasin (Figure 7-32) has been re-contoured around these shallower exempt aquifers following this approach. The areas of the aquifer exemptions are shown on the maps (Figure 7-32, Figure 7-33, and Figure 7-34), and the depth ranges for these aquifer exemption areas are summarized on Table 7-1.

Table 7-1. US EPA Oilfield Aquifer Exemptions used to modify the Definable Bottom of Kern Subbasin.

Active Oil and Gas Fields in Area	HCM Area	Uppermost Exempt Aquifer Geologic Formation	Aquifer Exemption Average Depth (feet)	Base of Fresh Water (feet msl) (Page, 1986)	Base of USDW (feet) (Gillespie, 2017)
Primacy Aquifer Exemptions					
Ant Hill	Eastern Margin HCM AREA	Olcese Formation	2,000	-1800 to -1600	USDW to Basement
Antelope Hills (Williams Area)	Western Fold Belt HCM AREA	Upper Tulare Formation	850	>0	Oil reservoir not water saturated
Belridge, North	Western Fold Belt HCM AREA	Tulare - Etchegoin Formation	600	>0	Oil reservoir not water saturated
Belridge, South	Western Fold Belt HCM AREA	Tulare Formation	400	-100 to 0	Oil reservoir not water saturated
Cymric (McKittrick Front Area)	Western Fold Belt HCM AREA	Tulare Formation (below Amincola Clay)	1,200	>0	Oil reservoir not water saturated
Cymric (Welport Area)	Western Fold Belt HCM AREA	Tulare Formation (below Amincola Clay)	1,000	>0	Oil reservoir not water saturated
Kern River	Eastern Margin HCM AREA	Kern River Formation	900	-2000 to -1600	6000 ft to Basement
Lost Hills	Western Fold Belt HCM AREA	Tulare Formation	200	>0	500 to 1000 ft
McKittrick (Main Area)	Western Fold Belt HCM AREA	Tulare Formation	500	>0	Oil reservoir not water saturated
McKittrick (Northeast Area)	Western Fold Belt HCM AREA	Tulare Formation	400	>0	Oil reservoir not water saturated
Midway-Sunset	Western Fold Belt HCM AREA	Tulare - San Joaquin Formation	200	>0	Oil reservoir not water saturated
Railroad Gap	Western Fold Belt HCM AREA	Tulare Formation (below Amincola Clay)	1,100	>0	Oil reservoir not water saturated
Edison (Edison Groves Area)	Eastern Margin HCM AREA	Chanac - Olcese Formation	1,130	-2400 to -2000	USDW to Basement
Edison (Jeppi Area)	Eastern Margin HCM AREA	Chanac - Santa Margarita Formation	3,300	-2800 to -2400	6000 ft to Basement
Edison (Main Area	Eastern Margin HCM AREA	Chanac - Santa Margarita Formation	750	-2800 to -2000	6000 ft to Basement
Edison (Northeast Area)	Eastern Margin HCM AREA	Chanac Formation	350	>-2000	USDW to Basement

Active Oil and Gas Fields in Area	HCM Area	Uppermost Exempt Aquifer Geologic Formation	Aquifer Exemption Average Depth (feet)	Base of Fresh Water (feet msl) (Page, 1986)	Base of USDW (feet) (Gillespie, 2017)
Primacy Aquifer Exemptions					
Edison (Race Track Hill Area)	Eastern Margin HCM AREA	Chanac - Santa Margarita Formation	1,070	-2400 to -2000	USDW to Basement
Edison (West Area)	Eastern Margin HCM AREA	Chanac Formation	3,200	>-2000	USDW to Basement
Fruitvale (Calloway Area)	North Basin HCM AREA	Chanac Formation	4,050	-3200 to -2800	4500 ft
Fruitvale (Greenacres Area)	North Basin HCM AREA	Etchegoin - Chanac Formation	4,300	-2800 to -2400	4500 ft
Fruitvale (Main Area)	North Basin HCM AREA	Etchegoin - Chanac Formation	3,000	-3200 to -2400	4500 to 5000 ft
Kern Bluff	Eastern Margin HCM AREA	Transition Zone - Santa Margarita Formation	740	-2000 to -1600	USDW to Basement
Kern Front	Eastern Margin HCM AREA	Etchegoin - Chanac Formation	2,200	-2400 to -1600	6000 ft to Basement
Poso Creek (Enas Area)	Eastern Margin HCM AREA	Etchegoin Formation	1,800	-2000 to -1200	USDW to Basement
Poso Creek (McVan Area)	Eastern Margin HCM AREA	Etchegoin Formation	1,150	-1600 to -1200	USDW to Basement
Poso Creek (Premier Area)	Eastern Margin HCM AREA	Etchegoin Formation	2,350	-1600 to -1200	5000 to 6000ft/Basement
Edison Transition Sand Exempt Area	Eastern Margin HCM AREA	Santa Margarita Formation	800	>-2000	USDW to Basement
Kern Front Chanac Oil Sand Exempt Area	Eastern Margin HCM AREA	Upper Chanac Oil Sand	1,400	-2400 to -1600	6000 ft to Basement
Poso Creek McVan Basal Etchegoin Exempt Area	Eastern Margin HCM AREA	Basal Etchegoin	1,000	-1600 to -1200	USDW to Basement
Poso Creek Primier Basal Etchegoin Exempt Area	Eastern Margin HCM AREA	Basal Etchegoin	1,800	-2000 to -1200	USDW to Basement
Asphalto Upper Tulare Exempt Area	Western Fold Belt HCM AREA	Upper Tulare Formation	200	>0	Oil reservoir not water saturated
Belridge-North Tulare Exempt Area	Western Fold Belt HCM AREA	Tulare Formation	640	>0	Oil reservoir not water saturated
Belridge-South Tulare Exempt Area	Western Fold Belt HCM AREA	Tulare Formation	300	-100 to 0	Oil reservoir not water saturated
Cymric Tulare Exempt Area	Western Fold Belt HCM AREA	Tulare Formation	624	>0	Oil reservoir not water saturated

Active Oil and Gas Fields in Area	HCM Area	Uppermost Exempt Aquifer Geologic Formation	Aquifer Exemption Average Depth (feet)	Base of Fresh Water (feet msl) (Page, 1986)	Base of USDW (feet) (Gillespie, 2017)
Primacy Aquifer Exemptions					
Elk Hills Lower Tulare Phase 1 Exempt Area	Western Fold Belt HCM AREA	Tulare Formation	950	-300 to 0	<1000 to 2000 ft
Elk Hills Lower Tulare Phase 2 Exempt Area	Western Fold Belt HCM AREA	Tulare Formation	980	-300 to 0	<1000 to 2000 ft
Lost Hills Tulare Exempt Area	Western Fold Belt HCM AREA	Tulare Formation	50	>0	500 to 1000 ft
McKittrick Tulare Exempt Area	Western Fold Belt HCM AREA	Tulare Formation	189	>0	Oil reservoir not water saturated

Regulatory Framework

An aquifer exemption is an action by USEPA to remove an aquifer or portion of an aquifer from protection as an USDW under the SDWA. UIC regulations allow USEPA to exempt aquifers that meet the following criteria:

- 40 CFR § 146.4 (a) “It does not currently serve as a source of drinking water.”
- 40 CFR § 146.4 (b)(1) “It cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.”
- 40 CFR § 146.4(c) “The total dissolved solids content of the ground water is more than 3,000 and less than 10,000 mg/L and it is not reasonably expected to supply a public water system.” In order to submit a proposal by the State to the USEPA, CalGEM shall consult with the appropriate Regional Water Quality Control Board and the SWRCB to ensure that the subject proposal meets California Public Resources Code (PRC) 3131(a), which states that the State must “ensure the appropriateness of [the] proposal” concerning the conformity with all of the following:
- Criteria set forth in 40 CFR § 146.4 (listed above).
- The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.
- The injected fluid will remain in the aquifer or portion of the aquifer that would be exempted.

The California Division of Oil, Gas and Geothermal Resources (DOGGR; now called CalGEM) was granted primacy to implement the Class II injection UIC program by the US Environmental Protection Agency (USEPA, 1982). The primacy aquifer exemption boundaries are based on the 1973-1974 production limits as hydrocarbon producing reservoirs shown in Volumes I and II of California Oil and Gas Fields, published by the California Division of Oil and Gas (DOGGR, 1973 and 1974, respectively).

A post-primacy aquifer exemption is an action by USEPA to remove an aquifer or portion of an aquifer from protection as an USDW under the SDWA. Applications prepared by the field operator are reviewed by CalGEM and the State Board. If, following public comment, both concur that an aquifer or portion of an aquifer may merit consideration for exemption, the application is submitted to the USEPA. The USEPA may exempt an aquifer as a potential USDW if it satisfies 40 CFR §146.4. Thus, if future aquifer exemptions are approved by USEPA, corresponding changes will be made to adjust the bottom of the basin.

Areas de-designated for a specific beneficial use under the Central Valley Basin Plan (CVRWQCB, 2018) are still considered part of Kern Subbasin unless the de-designated area is already defined as outside Kern Subbasin based on physical, geochemical, or aquifer exemption criteria discussed above.

Kern Subbasin Oil and Gas Fields

Kern County has been a major producer of oil and gas since the 1890s, marked by the initial discovery of oil on the county's west side. As of 2019, it ranked seventh among U.S. oil-producing counties. U.S. Energy Information Administration data (Kern Economic Development Foundation (KEDF) (2021) indicates an annual production of approximately 119 million barrels of oil and 129 billion cubic feet of gas. These quantities represent 71 percent of California's and three percent of total U.S. oil production, and accounts for 78 percent of California's total natural gas production (KEDF, 2021). Figure 7-36 shows the administrative boundaries of Kern Subbasin Oil and Gas Field from CalGEM along with the locations of currently active wells (CalGEM, 2023).

Because of the extensive folding and faulting along with the geologic history of deposition of marine shales in a deep basin, Kern Subbasin has the geological conditions that are conducive to the development of oil and gas fields. The US EPA exempt aquifer boundaries are those formations described and depicted as the shaded portions on the maps and cross sections of the report. The location and extent of the existing approved aquifer exemptions in Kern Subbasin are shown in Figure 7-37 and Figure 7-38, which show the primary and post-primacy aquifer exemptions, respectively.

Oil and gas field operations are required to comply with an array of federal, state and local regulatory requirements. The USEPA must review and approve aquifer exemption requests in accordance with the regulatory criteria in 40 CFR 146.4. CalGEM regulates production of oil, gas, and geothermal resources, including standards for well design

and construction standards, surface production equipment and pipeline requirements, and well abandonment procedures and guidelines (California Code of Regulations, Title 14, Division 2, Chapter 4). USEPA has also granted CalGEM primacy over the Underground Injection Control program for Class II wells.

Oil Field Geology Overview

The presence of an oil and gas field typically indicates that all or a portion of a geologic formation is hydraulically isolated from the rest of the formation or adjacent formations (a condition required to trap the hydrocarbons). Therefore, an understanding of oil field geology is important to understanding its relationship to the groundwater aquifer. The following is a brief overview of oil and gas field characteristics summarized from the following references (King, 2023; Selley, 2022; North, 1985; and Boggs, 2011) to provide background on the geological controls that isolate an oil and gas field exempt aquifer from other areas of the aquifer.

There are four geological requirements for the formation of a conventional hydrocarbon reservoir (1) Source Rock, (2) Migration Path, (3) Reservoir Rock, and (4) Trapping Mechanism. The source rock is typically a fine-grained sedimentary rock such as organic-rich shales, siltstones, or coals from marine or deltaic deposits. The source rock needs to achieve sufficiently elevated pressures and temperatures to transform organic materials in the shale into commercial quantities of oil and gas. The source rock must also have a sufficiently low permeability to keep the organic material in place over a long period of geological time for this transformation process to occur.

As pressures increase, the oil and gas are eventually forced out of the source rock. The main driving mechanism in oil and gas migration is buoyancy since hydrocarbons are less dense (lighter) than the resident water. In order to prevent this upward buoyant flow from reaching the surface, a vertical flow barrier is required along the migration path.

The Reservoir is a sedimentary rock with sufficient porosity and permeability to allow for the accumulation of oil and gas. The Trap is the geologic features that keep the oil and gas in place, so it does not migrate further. Traps require a relatively impermeable geologic feature that stops upward migration and provides sufficient lateral confinement to keep the oil and gas contained in the Reservoir Rock over geologic time.

Traps can be categorized as stratigraphic or structural. As the names imply, stratigraphic traps are related to the layering of the rock strata, while structural traps are related to the structural deformations of the rock formations. Examples of the different trapping mechanisms are shown in Figure 7-39. Stratigraphic traps include pinch-outs and unconformities where the reservoir is encased in low permeability unit as the result of the original deposition of the sediments. Structural traps are related to the deformation after deposition due to tectonic forces that create geologic folds (anticlines) or faults. All these types of traps are present in Kern Subbasin oil and gas fields.

7.6.6 Kern Subbasin Bottom Definition

Based on the evaluation of the physical properties, geochemical properties and aquifer exemptions, Kern Subbasin bottom is defined as the base of the principal aquifers as shown in Figure 7-32. The aquifer exemption areas that occur within the stratigraphic intervals for the principal aquifers are defined as localized areas below Kern Subbasin's bottom due to their physical and geological properties that isolate them from the rest of the principal aquifer. These exempt aquifer areas, shown as shaded areas on Figure 7-32, are defined as being located outside of Kern Subbasin, following DWR's BMP Guidance (DWR, 2016) and as shown in Figure 7-35. In the western Kern Subbasin, these aquifers are primarily located along the western rim of Kern Subbasin or along the crest of anticlines. In the eastern Kern Subbasin, these aquifer exemption areas generally lie in the areas outside of the Santa Margarita and Olcese Principal Aquifer areas.

From review of the geology in relation to the base of freshwater and USDW shown on the maps (Figure 7-33 and Figure 7-34) and cross sections (Figure 7-17 through Figure 7-23), the geochemical property indicators are generally occurring at or above the physical, or geological, base of the three principal aquifers (Figure 7-32). The base of the USDW (Figure 7-34) generally becomes shallower from east to west across Kern Subbasin. In the western Kern Subbasin (Western Fold Belt HCM Area), these data indicate that there are areas where most, if not all, of the saturated thickness is below either the base of freshwater or the base of the USDW. This is consistent with general lack of groundwater usage in the Western Fold Belt HCM Area due to high TDS concentrations. Additional discussion of TDS concentrations is provided in Section 8.

The geochemical property indicators for the base of freshwater (Page, 1973) and depth to USDW (Gillespie, 2017) are not used to define Kern Subbasin's bottom but are guides to further assess the potential beneficial use. The two above-referenced maps were developed based on contouring of scattered water quality data in Kern Subbasin without consideration of the geologic boundaries. Therefore, these data, in their current form, provide a good general reference but lack the local specificity to be part of Kern Subbasin's bottom definition. Further evaluation of the base of freshwater and the depth USDW used to integrate these geochemical indicators as part of Kern Subbasin's bottom elevation may be evaluated for future 2025 Plan updates in addition to those developed for the aquifer exemptions.

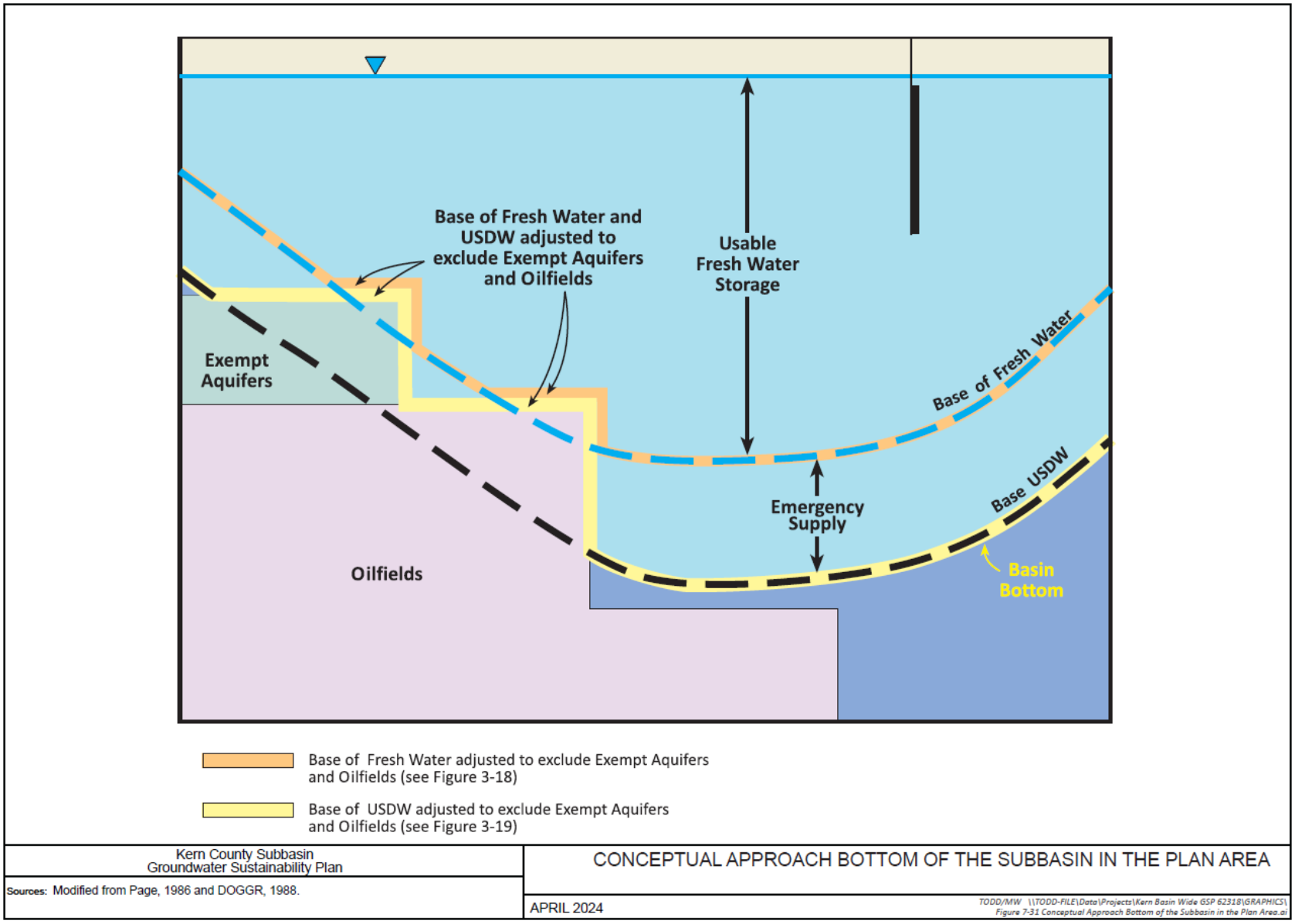


Figure 7-35. Conceptual Approach Bottom of Kern Subbasin in the Plan Area

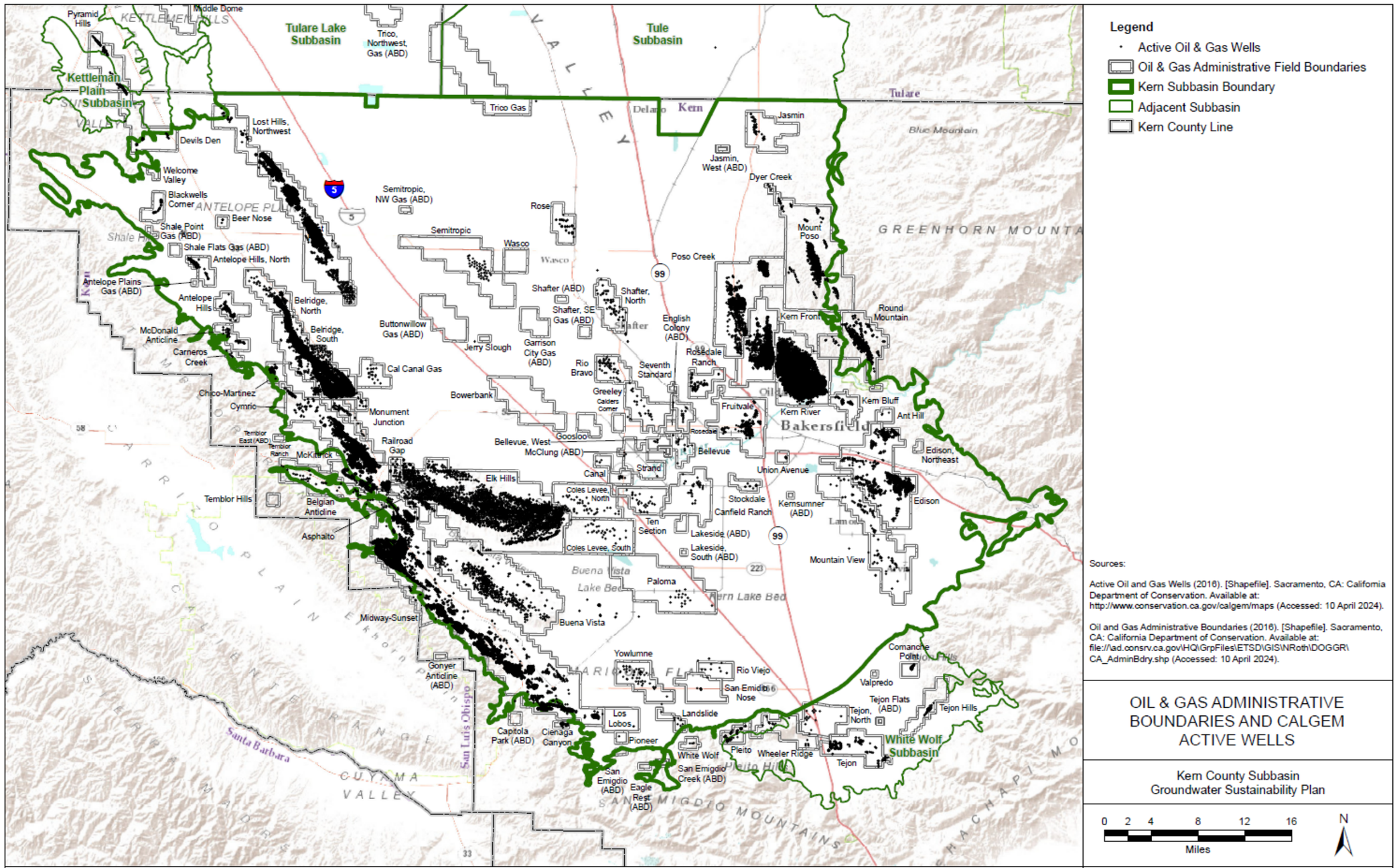
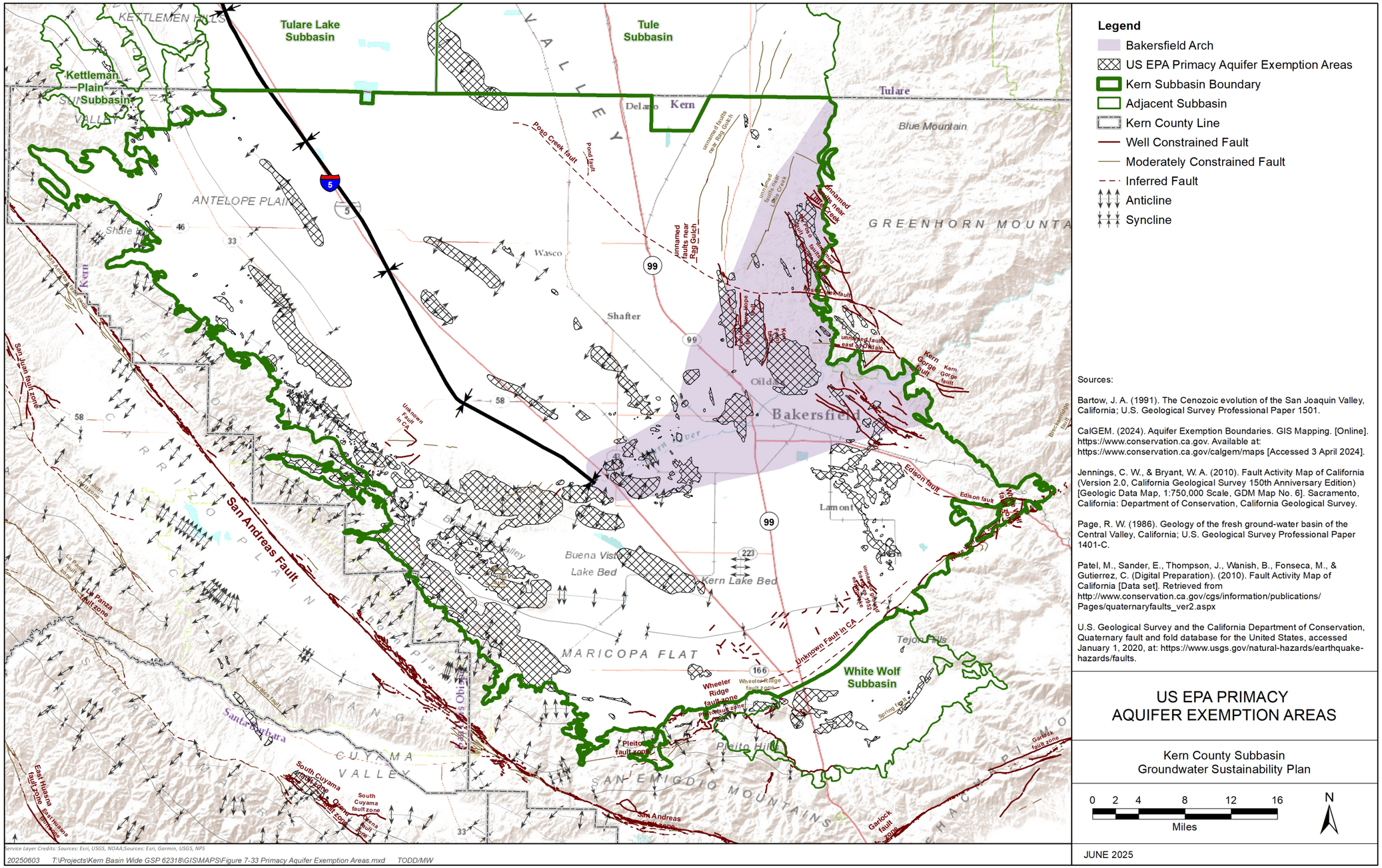


Figure 7-36. Oil & Gas Administrative Boundaries and CALGEM Active Wells



Legend

- Bakersfield Arch
- US EPA Primacy Aquifer Exemption Areas
- Kern Subbasin Boundary
- Adjacent Subbasin
- Kern County Line
- Well Constrained Fault
- Moderately Constrained Fault
- Inferred Fault
- Anticline
- Syncline

Sources:

Bartow, J. A. (1991). The Cenozoic evolution of the San Joaquin Valley, California; U.S. Geological Survey Professional Paper 1501.

CalGEM. (2024). Aquifer Exemption Boundaries. GIS Mapping. [Online]. https://www.conservation.ca.gov. Available at: https://www.conservation.ca.gov/calgem/maps [Accessed 3 April 2024].

Jennings, C. W., & Bryant, W. A. (2010). Fault Activity Map of California (Version 2.0, California Geological Survey 150th Anniversary Edition) [Geologic Data Map, 1:750,000 Scale, GDM Map No. 6]. Sacramento, California: Department of Conservation, California Geological Survey.

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Patel, M., Sander, E., Thompson, J., Wanish, B., Fonseca, M., & Gutierrez, C. (Digital Preparation). (2010). Fault Activity Map of California [Data set]. Retrieved from http://www.conservation.ca.gov/cgs/information/publications/Pages/quaternaryfaults_ver2.aspx

U.S. Geological Survey and the California Department of Conservation, Quaternary fault and fold database for the United States, accessed January 1, 2020, at: https://www.usgs.gov/natural-hazards/earthquake-hazards/faults.

US EPA PRIMACY AQUIFER EXEMPTION AREAS

Kern County Subbasin
Groundwater Sustainability Plan

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Miles

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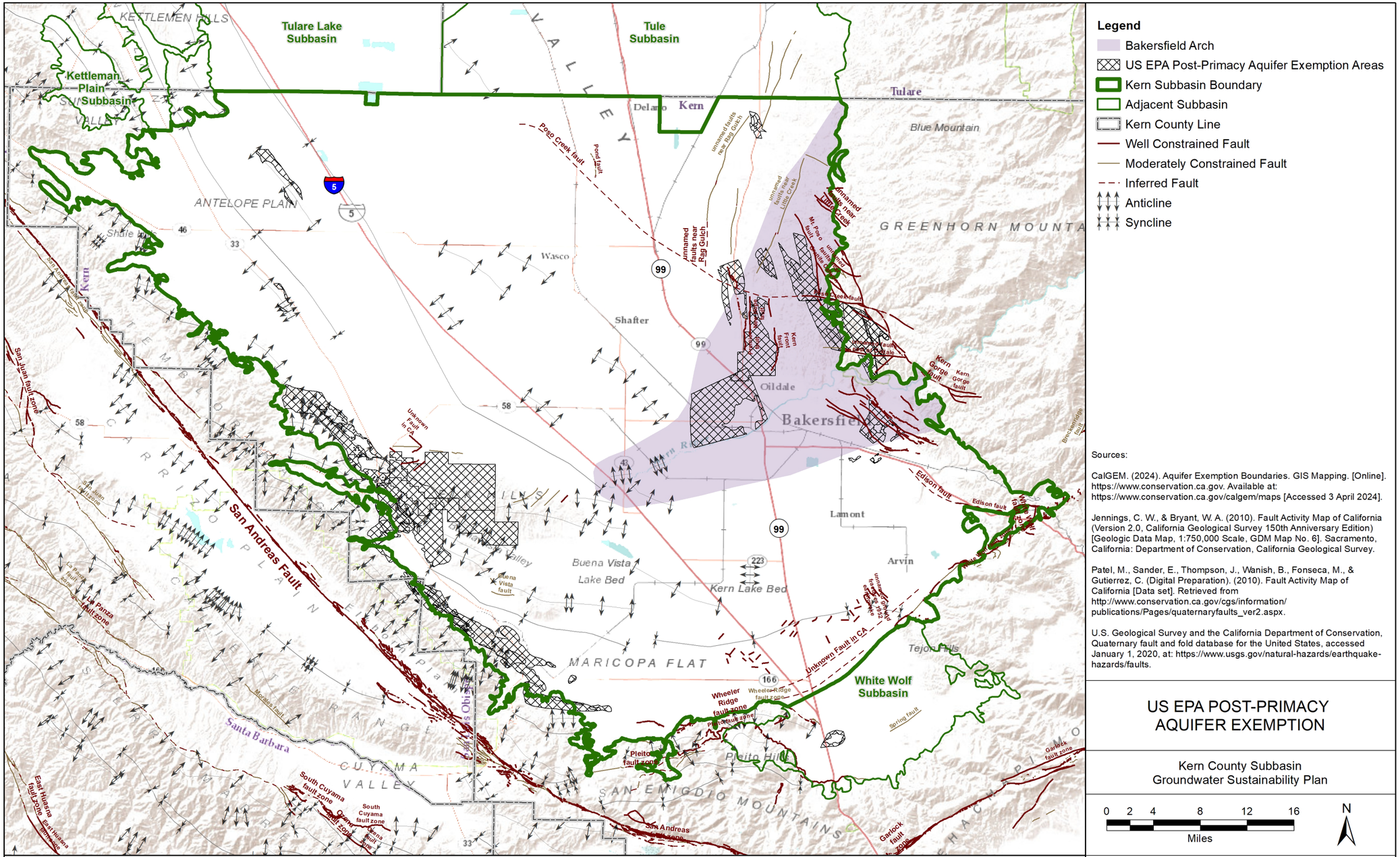
JUNE 2025

Figure 7-37. US EPA Primacy Aquifer Exemption Areas



Legend

- Bakersfield Arch
- US EPA Post-Primacy Aquifer Exemption Areas
- Kern Subbasin Boundary
- Adjacent Subbasin
- Kern County Line
- Well Constrained Fault
- Moderately Constrained Fault
- Inferred Fault
- Anticline
- Syncline

Sources:

CalGEM. (2024). Aquifer Exemption Boundaries. GIS Mapping. [Online]. https://www.conservation.ca.gov. Available at: https://www.conservation.ca.gov/calgem/maps [Accessed 3 April 2024].

Jennings, C. W., & Bryant, W. A. (2010). Fault Activity Map of California (Version 2.0, California Geological Survey 150th Anniversary Edition) [Geologic Data Map, 1:750,000 Scale, GDM Map No. 6]. Sacramento, California: Department of Conservation, California Geological Survey.

Patel, M., Sander, E., Thompson, J., Wanish, B., Fonseca, M., & Gutierrez, C. (Digital Preparation). (2010). Fault Activity Map of California [Data set]. Retrieved from http://www.conservation.ca.gov/cgs/information/publications/Pages/quaternaryfaults_ver2.aspx.

U.S. Geological Survey and the California Department of Conservation, Quaternary fault and fold database for the United States, accessed January 1, 2020, at: https://www.usgs.gov/natural-hazards/earthquake-hazards/faults.

US EPA POST-PRIMACY AQUIFER EXEMPTION

Kern County Subbasin
Groundwater Sustainability Plan

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JUNE 2025

Figure 7-38. US EPA Post-Primacy Aquifer Exemption

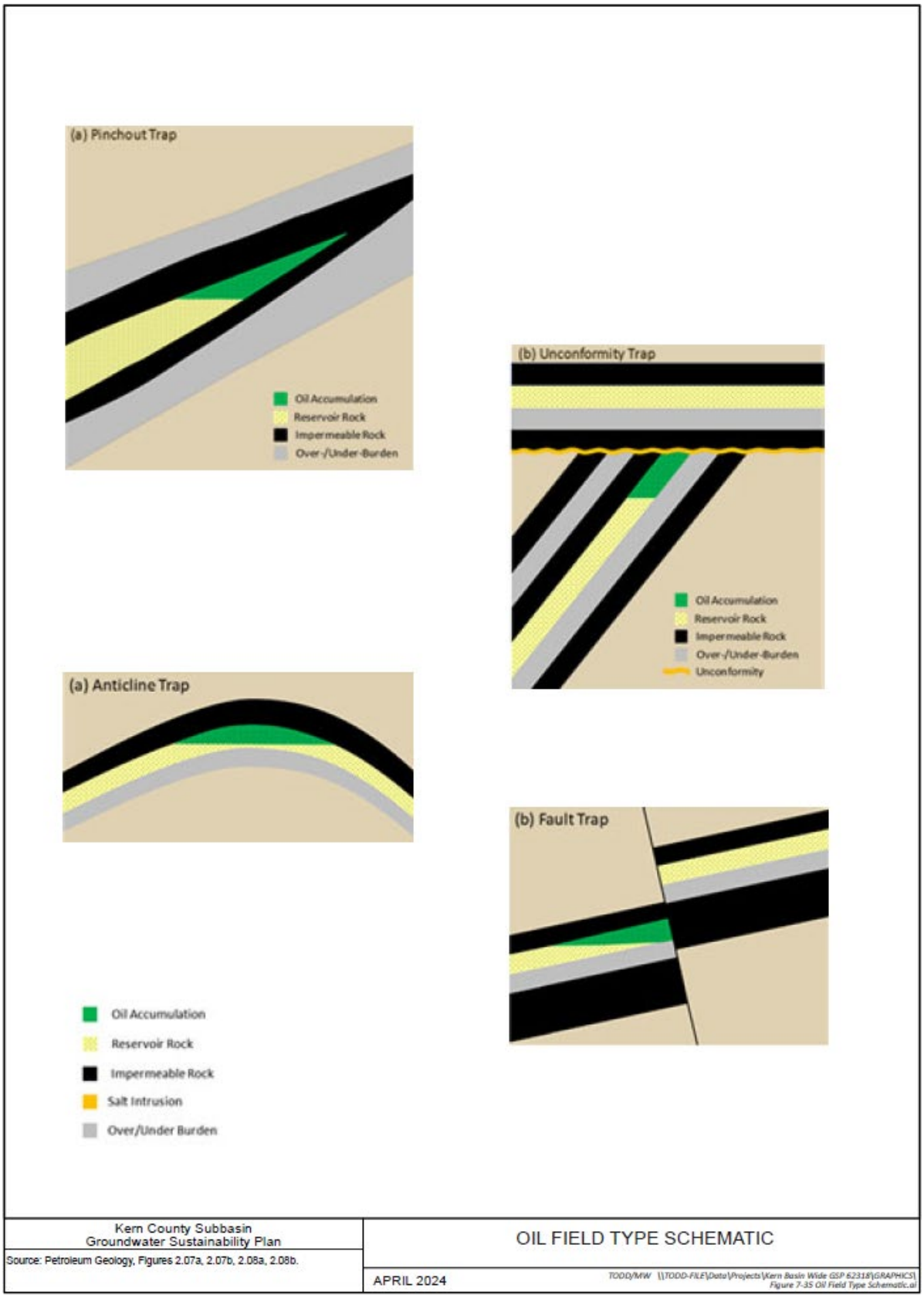


Figure 7-39. Oil Field Type Schematic

8. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

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

☑ 23 CCR § 354.16

This section presents information on historical and current groundwater conditions within the Kern Subbasin to provide context and a basis from which to analyze Sustainability Indicators, develop Sustainable Management Criteria (SMCs), and identify Projects and Management Actions (P/MAs) to achieve and maintain sustainable groundwater management. Information below is presented for the entire Subbasin, with specific reference to the Hydrogeologic Conceptual Model areas (HCM Area) described previously (Sections 6.2.1 and 7.4) and the principal aquifers (Section 7.5).

8.1 Groundwater Elevations, Flow Directions, and Long-Term Trends for Each Principal Aquifer

§ 354.16. *Groundwater Conditions*
Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information.
(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:
(1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

☑ 23 CCR § 354.16(a)(1)
☑ 23 CCR § 354.16(a)(2)

Groundwater conditions describe the groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:

- Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
- Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

- Groundwater elevation data have been recorded in the Kern Subbasin by the USGS, DWR and local agencies since at least the 1920s, but data prior to the 1950s is sparse. Groundwater elevation data are currently collected in the Kern Subbasin by the GSAs and reported to and stored in a Data Management System (DMS) for the Kern Subbasin.

Current and historical groundwater conditions are described by principal aquifer in this section. The Kern Subbasin principal aquifers, as defined in Section 7.5, include the following:

- Primary Alluvial Principal Aquifer.
- Santa Margarita Principal Aquifer.
- Olcese Principal Aquifer.

The Primary Alluvial Principal Aquifer essentially extends over the entire Kern Subbasin (Figure 7-26) forming the largest and most productive aquifer in the Kern Subbasin. Two other local principal aquifers, the Santa Margarita and Olcese Principal Aquifers, have been defined in the Eastern Margin HCM Area. These two principal aquifers are of a more limited areal extent as shown on Figure 7-30 and Figure 7-31.

8.1.1 Primary Alluvial Principal Aquifer

The Primary Alluvial Principal Aquifer consists of the full vertical extent of the Unconsolidated Nonmarine Deposits that includes the Recent Alluvium, Tulare, and Kern River Formations (Figure 7-26) and contains the vast majority of the freshwater in the Kern Subbasin. Aquifer conditions generally range between unconfined to confined depending on location, local geology, and depth.

8.1.1.1 Groundwater Flow Directions

☑ 23 CCR § 354.16(a)

A generalized diagram depicting groundwater flow directions within the Kern Subbasin is provided in Figure 8-1 that is based on the groundwater elevation contour maps provided in Section 8.1.1.2 below. This diagram provides a conceptual understanding of groundwater flow within the Kern Subbasin to provide context in reviewing the groundwater elevation data, contour maps, and groundwater quality provided in this section. In general, groundwater flows from areas of recharge with higher groundwater elevations to areas of discharge with lower groundwater elevations. However, groundwater flow is also influenced by geologic structures, such as anticlines and faults, as well as local hydrogeology and seasonal variability. The following describes the overall groundwater flow within the Kern Subbasin by HCM Area.

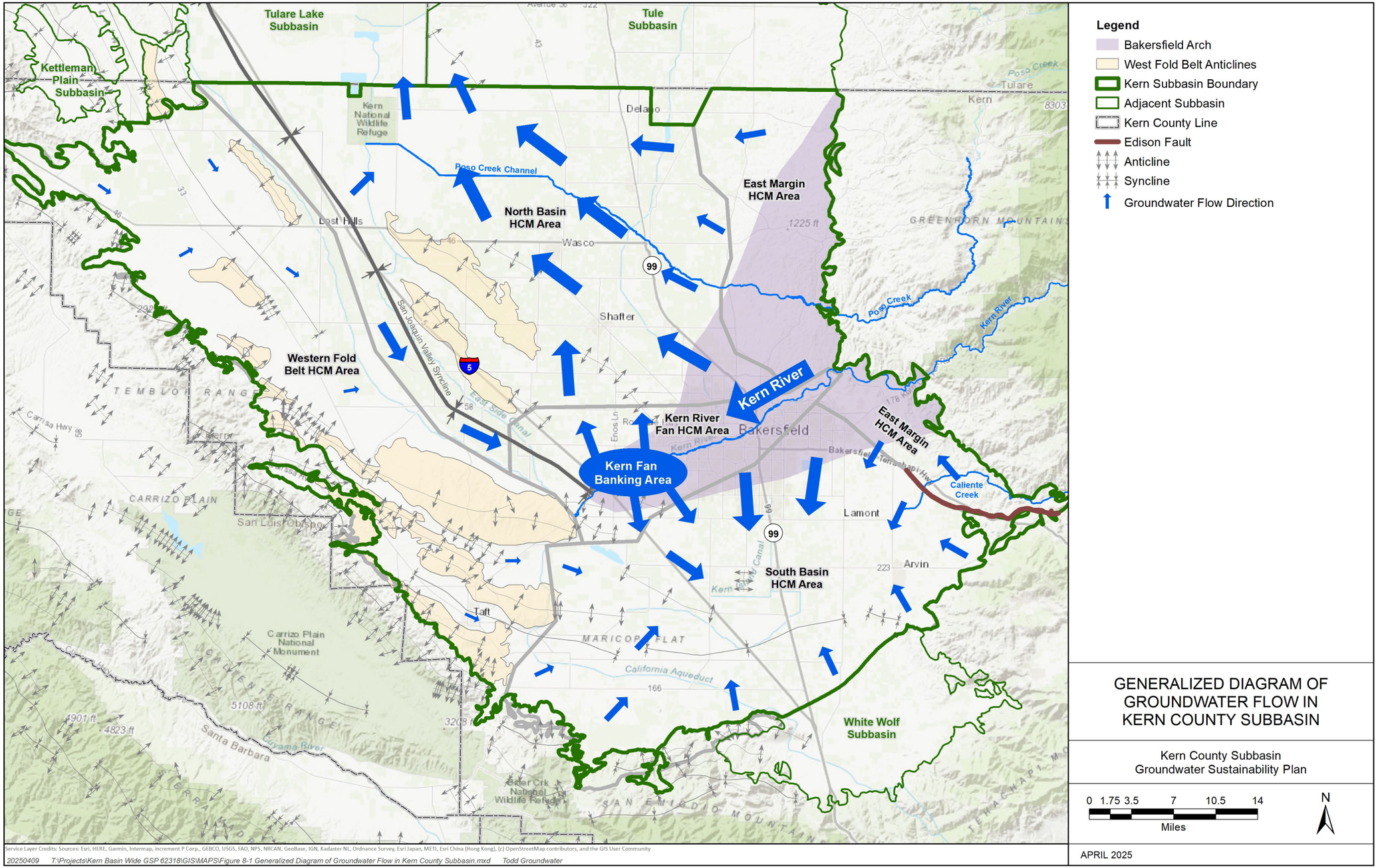


Figure 8-1. Generalized Diagram of Groundwater Flow in the Primary Alluvium Principal Aquifer

The Primary Alluvial Principal Aquifer receives both natural and managed groundwater recharge across the Kern Subbasin. Natural recharge to the Kern Subbasin is derived primarily from precipitation and surface runoff from the surrounding watersheds. Natural recharge is highest on the east side of the Kern Subbasin which receives high precipitation and receives recharge from the Kern River and other smaller streams from the Sierra Nevada. Natural recharge is lowest on the west side which receives less precipitation and lower runoff from the relatively smaller watersheds along the Coast Ranges. Significant managed groundwater recharge in the Kern Subbasin occurs through the numerous water banking and conjunctive use projects that are located across the Kern Subbasin. Water banking programs also store significant volumes of surface water in the Kern Subbasin. These water banking programs and conjunctive use operations recharge and store water from multiple sources including imported water (SWP and CVP) and local surface water (Kern River, Poso Creek, and other drainages).

Groundwater elevations in the Kern Subbasin are typically highest in the Kern River Fan HCM Area due to recharge along the Kern River and the Kern Fan Banking Area in wet years. The Kern River has a large watershed in the Sierra Nevada with highly variable flows ranging from 140 thousand acre-feet (TAF) to over 2.5 million acre-feet (MAF). The Kern River HCM Area is generally underlain by coarse-grained, relatively high permeability alluvial fan deposits (Section 7.4.2). The Kern River flows roughly along the axis of the Bakersfield Arch, which forms a broad topographical rise that gradually dips to the north and south, effectively splitting the Kern Subbasin into northern and southern groundwater flow regimes. Within the Kern Fan Banking Area, groundwater flow is more variable due to the storage of large volumes of surface water in the aquifer that is later recovered by pumping. As a result of the Kern River and banking operations, groundwater flow in this HCM Area generally radiates both north and south from the Kern River to other parts of the Kern Subbasin (i.e. there is an effective groundwater flow divide in the vicinity of the Kern River).

Groundwater flow in the Eastern Margin HCM Area is generally from the Kern Subbasin margin toward the center of the Kern Subbasin. However, groundwater flow is affected by geologic structures, primarily faulting, within this area. In the southern part of the Eastern Margin HCM Area, the aquifer is recharged from runoff from Caliente Creek and surrounding watersheds. The Edison Fault forms a flow barrier (Figure 8-1) where groundwater flow east of the fault is northward. Southeast of Bakersfield, the effects of the Edison Fault diminish and groundwater flow shifts to the west toward the center of the Kern Subbasin.

In the Eastern Margin HCM Area north of the Kern River, the aquifer is recharged from runoff from Poso Creek and smaller streams from surrounding watersheds that percolate into the alluvial sediments. Groundwater flow is generally westward; however, faulting locally impedes groundwater flow, especially along the crest of the Bakersfield Arch. As a result, groundwater flow may be locally interrupted or compartmentalized due to faulting resulting in a longer, more complex flow path across this area.

North of the Kern River in the North Basin HCM Area, the general pattern of groundwater flow includes inflows primarily from the south and east. Groundwater flow within the HCM Area is generally toward agricultural and urban groundwater pumping areas. Local water banking and conjunctive use projects create variable groundwater flow patterns near these facilities in response to recharge and recovery operations. Groundwater flow also exits the Kern Subbasin across the northern Subbasin boundary (Figure 8-1). Along the eastern half of the northern Subbasin boundary, groundwater flow tends to be parallel to the boundary. Along the western half of the northern Subbasin boundary, groundwater flows typically northward into the Tulare Lake and Tule Subbasins.

South of the Kern River in the South Basin HCM Area, the general pattern of groundwater flow is from the Kern Subbasin margins toward the center of the HCM Area (Figure 8-1). Runoff in streams, sourced from surrounding watersheds, percolates to groundwater along the Kern Subbasin margin. Groundwater flow within the HCM Area is generally toward agricultural and urban groundwater pumping areas. Along the southern Subbasin boundary, groundwater flow is typically northward indicating a consistent inflow from the White Wolf Subbasin that is restricted somewhat by the bounding White Wolf Fault.

Groundwater flow in the Western Fold Belt HCM Area is highly influenced by geologic structures of the West Side Fold Belt (Bartow, 1991). The boundary between the Western Fold Belt and North Basin HCM Areas is a geologically complex structural area where groundwater flow is directly affected by the anticlines and synclines of the West Side Fold Belt. The Lost Hills, Elk Hills, and Buttonwillow Anticlines restrict the west to east groundwater flow toward the axis of the Kern Subbasin in this area. As a result, any groundwater flow from the Western Fold Belt HCM Area takes a circuitous route and trends southeastward along the structural low formed by the San Joaquin Valley Syncline (Figure 8-1). Flow continues to the southeast around the Buttonwillow Anticline, which creates a long groundwater flow path from the Western Fold Belt HCM Area to other parts of the Kern Subbasin. As a result of the influence of these geologic structures, there is limited hydraulic connection between the Western Fold Belt HCM Area and other HCM Areas.

In the Western Fold Belt HCM Area, the aquifer is recharged from runoff from the surrounding watersheds. This area principally relies on imported surface water via the California Aqueduct since the preponderance of naturally poor groundwater quality due to the extensive presence of sediments of marine origin. Precipitation along the western margin of the Kern Subbasin is typically lower than elsewhere in the Kern Subbasin. The Elk Hills Anticline effectively separates this HCM Area into northern and southern groundwater flow regimes (Figure 8-1). North of the Elk Hills, groundwater flow along the margin is generally eastward; however, it shifts to a more southeasterly direction due to the influence of the geologic fold structures previously described. South of the Elk Hills, groundwater flow is generally southeasterly between the anticlines where it

ultimately flows into the South Basin HCM Area. Little groundwater pumping occurs in the Western Fold Belt HCM Area due to poor groundwater quality that limits the ability to utilize groundwater and the expanse of open range land where no groundwater pumping occurs. Water users in this HCM Area almost exclusively rely on imported surface water and/or groundwater conveyed by the California Aqueduct and from other parts of the Kern Subbasin for agricultural and municipal uses.

8.1.1.2 Current Groundwater Elevation Contour Maps and Lateral Gradients

☑ **23 CCR § 354.16(a)**
☑ **23 CCR § 354.16(a)(1)**

Groundwater elevation contour maps were prepared for Spring 2023 (Figure 8-2) and Fall 2023 (Figure 8-3) for the Primary Alluvial Principal Aquifer. Groundwater elevations range from a high of over 600 feet mean sea level (msl) along the southeastern boundary of the Kern Subbasin in the Sierra Nevada foothills to the lowest elevations of -150 feet msl along the northern Subbasin boundary. The Spring and Fall 2023 groundwater elevations (Figure 8-2 and Figure 8-3) generally represent seasonal high and seasonal low based on current groundwater conditions. The groundwater maps represent the most actively pumped intervals within the Primary Alluvial Principal Aquifer. Thus, these maps are most relevant for evaluating and implementing SMCs and P/MAs. The water-level contour map shows generalized contours on a composite piezometric surface for the main water body.

As described in the preceding subsection, groundwater flow is influenced by geologic structures in the Kern Subbasin. The Edison Fault and the West Side Fold Belt, shown on Figure 8-2 and Figure 8-3, represent geologic structures that influence groundwater flow as evidenced by significant changes in the magnitude and direction of flows across those areas. A brief description of the groundwater elevation contour maps and regional pumping patterns is provided for each HCM Area.

The upstream stretch of the Kern River is a major recharge area in the Kern Subbasin. Groundwater elevations along the upper Kern River range from 400 to 200 feet msl from east to west and remain relatively stable in both the Spring and Fall 2023 maps (Figure 8-2 and Figure 8-3). Within several miles of the river channel, water levels are lower compared to areas along the river channel. In the Kern Fan Banking Area, groundwater levels in Spring 2023 ranged between 50 to 100 feet msl; however, in the Fall 2023 groundwater elevations rose to 100 to 200 feet msl in response to natural and active recharge during the wet hydrologic year of WY2023. The lateral gradients are variable, ranging from 0.002 and to 0.015 feet/foot.

In the North Basin HCM Area (Figure 8-2 and Figure 8-3), the highest groundwater elevations occur adjacent to the Kern River Fan HCM Area with elevations above 300 feet msl. The lowest elevations of -150 feet msl occur along the northern Subbasin boundary. The eastern side of the North Basin HCM Area has more variable

groundwater elevations ranging from 150 feet msl to -50 feet msl. This variability is generally associated with water banking and conjunctive use project operations in this area. In the rest of the North Basin HCM Area, groundwater elevations range from 50 feet msl to -150 feet msl. Groundwater gradients shift to a more northerly direction with outflow to the Tule and Tulare Lake Subbasins. The lateral gradient in this area is generally from east to west at a gradient of 0.002 feet/foot.

In the South Basin HCM Area, the highest groundwater elevations are adjacent to the Kern River Fan and Eastern Margin HCM Areas with elevations above 350 feet msl. A second area of higher groundwater elevations occurs along the western margin of the South Basin HCM Area with groundwater elevations of about 300 feet msl. The lowest elevations of 0 to 50 feet msl are generally associated with data from an active pumping well and may not represent static conditions (Figure 8-2 and Figure 8-3). Contours for unconfined and semiconfined depth intervals are not shown because in most places it is difficult to differentiate these responses based on available groundwater elevation data. This is due to the confined intervals being recharged primarily by water moving downward from the overlying unconfined and semiconfined deposits beyond the edges of the confining beds (Wood and Dale, 1964). The South Basin HCM Area may receive subsurface inflows from the southern White Wolf Subbasin and does not have a subsurface outflow to an adjacent area; therefore, groundwater flow is generally from the margins to the center of the HCM Area. The lateral gradient in this area ranges from about 0.002 to 0.007 feet per foot.

Groundwater elevations along the western margin of the North Basin HCM Area show local variability because of the geologic structure of the Westside Fold Belt (Lost Hills, Belridge, Buttonwillow and Bowerbank Anticlines, and Elk Hills) that influences groundwater flow (Figure 8-2 and Figure 8-3). The presence and/or lack of the E-Clay adds an additional complication to the groundwater flow in this area. The shaded area shown on Figure 8-2 and Figure 8-3 highlights an area where groundwater occurs both above and below the E-Clay. For the groundwater elevation map, the interval above the E-Clay is shown because it represents the most actively pumped interval, whereas the interval below the E-Clay in the shaded area has little to no pumping. In the shaded areas above the E-Clay groundwater elevations range from 250 to 100 feet msl with a southeasterly lateral gradient of about 0.006 feet/foot. East of the anticlines, groundwater elevations range from 0 to -50 feet msl with a north to northeasterly lateral gradient of ranging from 0.004 to 0.006 feet/foot. Below the E-Clay are represented by the contours to the east of the shaded areas where groundwater elevations range from -50 to 50 feet msl with a generally westward lateral gradient of about 0.006 feet/foot. East of the anticlines, groundwater elevations range from 0 to -50 feet msl with a north to northeasterly lateral gradient of ranging from 0.002 to 0.004 feet/foot.

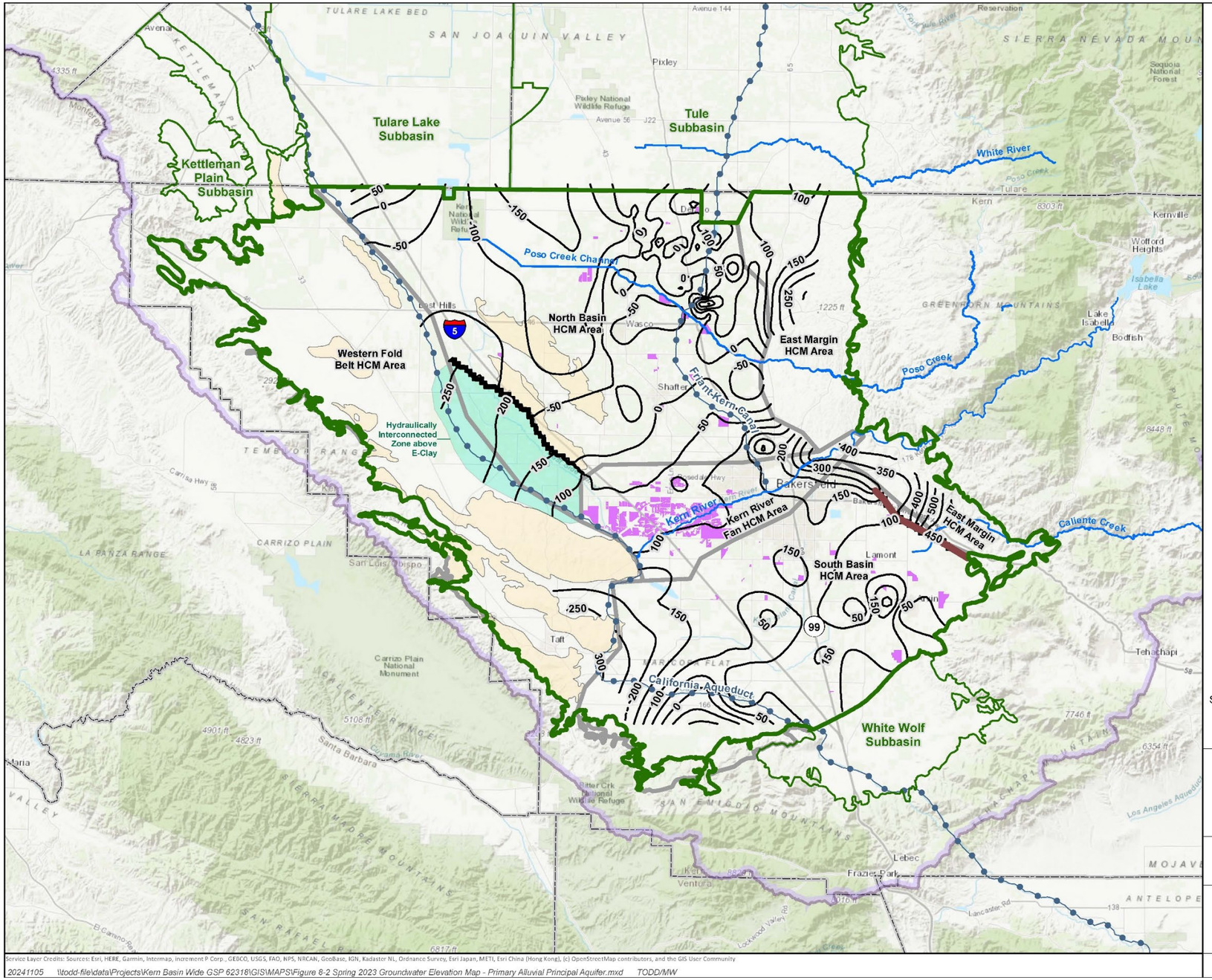
It is important to note that limited data in the Western Fold Belt and Eastern Margin HCM Areas, where few wells are located, restrict the ability to develop detailed groundwater elevation contour and gradient maps in these areas (Figure 8-2 and

Figure 8-3). These areas represent remote areas of the Kern Subbasin with little to no groundwater pumping and wells. As such, the areas covered by the groundwater elevation contours generally represent the regional pumping distribution patterns for agricultural and urban use.

In the Eastern Margin HCM Area south of the Kern River, Figure 8-2 and Figure 8-3 further illustrate the effects of the Edison Fault as a groundwater flow barrier in the southeastern corner of the Kern Subbasin. The highest groundwater elevations east of the Edison Fault range from 350 to over 600 feet msl, whereas west of the Edison Fault, groundwater elevations range from 150 to less than 100 feet msl. The lateral gradient in this HCM Area shifts from a northerly direction and then shifts to a more westerly direction with a general gradient of 0.01 to 0.015 feet per foot. This is interpreted to represent the northern extent of the effect of the Edison Fault.

In the Eastern Margin HCM Area north of the Kern River, groundwater elevations range from 100 to 250 feet msl (Figure 8-2 and Figure 8-3). In this area, the bottom of the Primary Alluvial Principal Aquifer rises toward the Sierra Nevada and Bakersfield Arch resulting in reduced saturated thickness. As a result, groundwater pumping from the Primary Alluvial Principal Aquifer, along the Eastern Margin, is limited with most wells instead extracting from the deeper Santa Margarita Principal Aquifer.

Groundwater contours are not shown for the Western Fold Belt HCM Area because this area contains few active wells due to land use and naturally poor groundwater quality. Conceptually, groundwater flow is oriented parallel to the geologic structures in a general southeasterly direction. The E-Clay is often thin, discontinuous or missing in many areas of the Western Fold Belt. Due to the low recharge rates in the western portion of the Subbasin, groundwater flow into other areas of the Subbasin is considered to be minor.



Legend

- HCM Area
- Groundwater Recharge Basins and Banking Areas
- West Side Fold Belt Anticlines
- Hydraulically Interconnected Zone Above E-Clay
- Tulare Lake Hydrologic Area
- Kern Subbasin Boundary
- Adjacent Subbasin
- Kern County Line
- Aqueducts
- Streams
- WY 2023 Spring Primary Contours
- Edison Fault Flow Discontinuity

Sources:

SPRING 2023 GROUNDWATER ELEVATION MAP - PRIMARY ALLUVIAL PRINCIPAL AQUIFER

Kern County Subbasin
Groundwater Sustainability Plan

0 2.5 5 10 15 20
Miles

N

NOVEMBER 2024

Figure 8-2. Spring 2023 Groundwater Elevation Map – Primary Alluvial Principal Aquifer

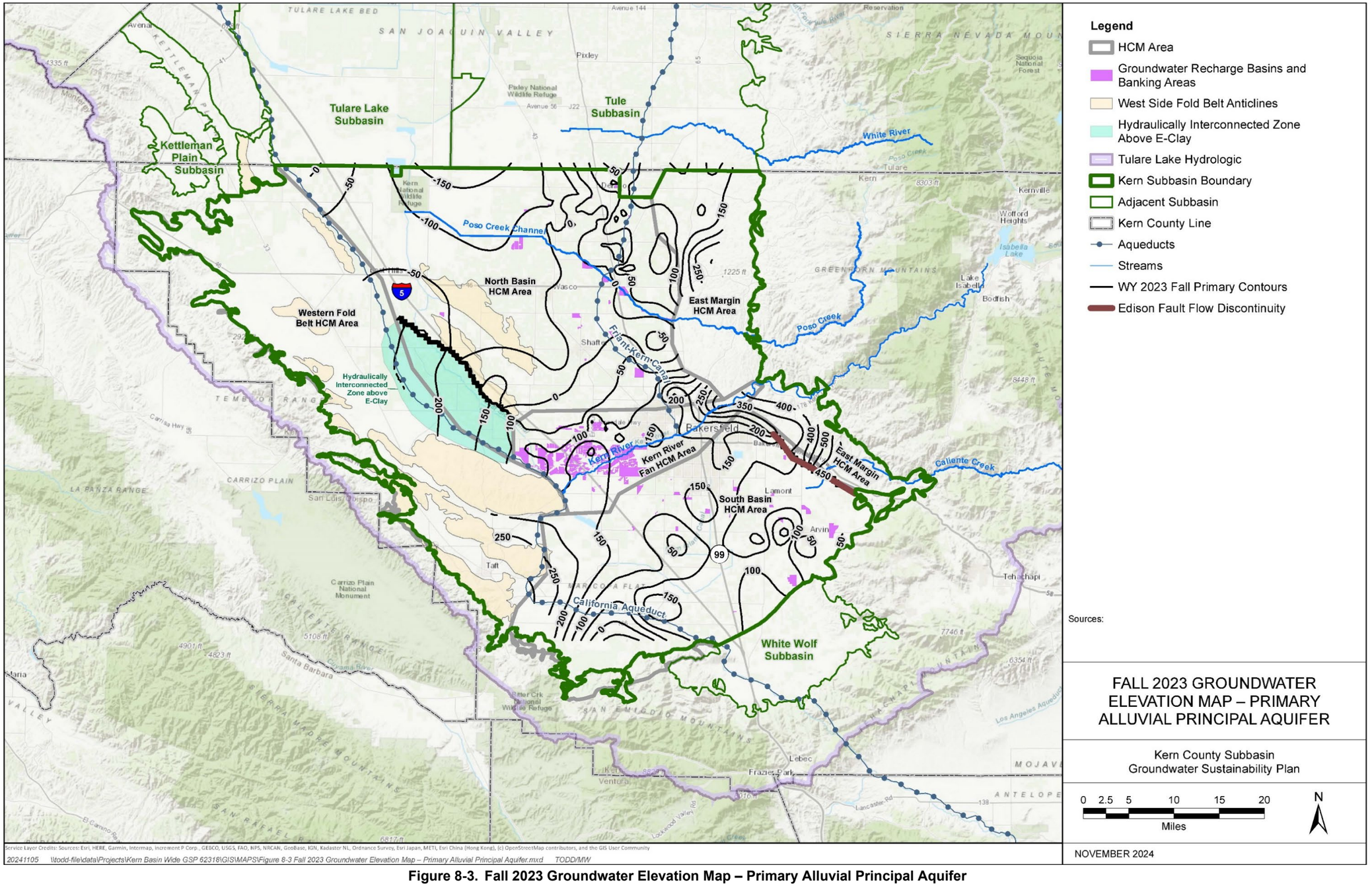


Figure 8-3. Fall 2023 Groundwater Elevation Map – Primary Alluvial Principal Aquifer

8.1.1.3 Historical Groundwater Elevation Contour Maps

☑ 23 CCR § 354.16(a)
☑ 23 CCR § 354.16(a)(1)

GSP Emergency Regulations require GSPs to include presentation of historical groundwater conditions "*including data from January 1, 2015, to current reporting year*" (23 CCR §354.16). Figure 8-4 provides groundwater elevation maps for the Primary Alluvial Principal Aquifer covering the following four periods that represent different hydrologic conditions in the Kern Subbasin:

- Fall 2011 – represents annual and seasonal high groundwater elevations during the relatively wet conditions in WYs 2010 to 2011.
- Fall 2015 – representing annual and seasonal low groundwater elevations during the WYs 2012 to 2015 drought.
- Fall 2019 – representing annual and seasonal high elevations during the relatively wet conditions in WYs 2017 to 2019.
- Fall 2022 – representing annual and seasonal low groundwater elevations during the WYs 2020 to 2022 drought.

These four maps represent groundwater conditions during wet and dry hydrologic years during similar seasons to illustrate the range in seasonal high and low conditions within the Kern Subbasin. During most hydrologic water-year types, the seasonal high groundwater condition occurs in the spring and the seasonal low occurs in the fall. However, in wet years such as 2011 and 2019, groundwater elevations in the Fall are more variable with higher groundwater elevations occurring in the fall in the vicinity of the water banking and conjunctive use projects because recharge operations extend into the late spring and summer months.

In general, groundwater elevations are consistent with historical trends. Groundwater elevations range from a high of 600 feet msl along the southeastern boundary of the Kern Subbasin in the Sierra Nevada foothills to the lowest elevations of -50 to -200 feet msl along the northern Subbasin boundary. Groundwater gradients tend to diverge from the Kern River toward the north and south (i.e., evidence of a groundwater divide). During the drought periods, this divergence is less notable due to the drought conditions which result in greater groundwater use with very little recharge.

Figure 8-5 provides the change in groundwater elevation maps for the Primary Alluvial Principal Aquifer covering the following four periods:

- Fall 2011 to Fall 2015.
- Fall 2015 to Fall 2019.
- Fall 2019 to Fall 2022.
- Fall 2022 to Fall 2023.

These periods represent the effects of multi-year droughts and wet periods on groundwater conditions in the Kern Subbasin.

The period from Fall 2011 to Fall 2015 represents the cumulative four-year change over the multi-year drought period from relatively high groundwater levels following a wet period of WYs 2010 and 2011 to the relatively low groundwater levels during the drought of WYs 2012 to 2016. Over this period, declines of 50 to 150 feet were experienced over large areas of the Kern Subbasin, which is consistent with the high groundwater use and the recovery of previously banked surface water in these areas. Toward the Kern Subbasin margins, the change in groundwater elevations was generally minimal, which is consistent with the lower groundwater use and proximity to natural recharge in these areas.

The period from Fall 2015 to Fall 2019 represents the cumulative four-year change in groundwater levels following the multi-year drought ending in WY 2016 followed by wet years in WY 2017 and WY 2019. Groundwater elevations in the Kern Fan Banking Area increased by 100 to 200 feet in response to the large volumes of surface water storage that occurred during this time. Elsewhere, groundwater elevations generally rose by 50 to 150 feet with some localized areas with declining groundwater levels.

The period from Fall 2019 to Fall 2022 represents the cumulative three-year change in groundwater elevations following the return to a multi-year drought period. Similar to the Fall 2011 to Fall 2015 period, groundwater levels generally declined over the entire Subbasin. Declines of 25 to 125 feet occurred over large areas of the Kern Subbasin, consistent with groundwater use and recovery of previously banked surface water. The change in groundwater elevations near the Kern Subbasin margins was generally minimal, consistent groundwater use and proximity to natural recharge in these areas.

The period from Fall 2022 to Fall 2023 represents the one-year change in groundwater levels following the extremely wet WY 2023. Groundwater elevations in the Kern Fan Banking Area increased by 100 to 200 feet in response to the large volumes of surface water storage that occurred during this time. Elsewhere groundwater levels ranged from near zero to 50 feet with some localized areas of declining groundwater levels.

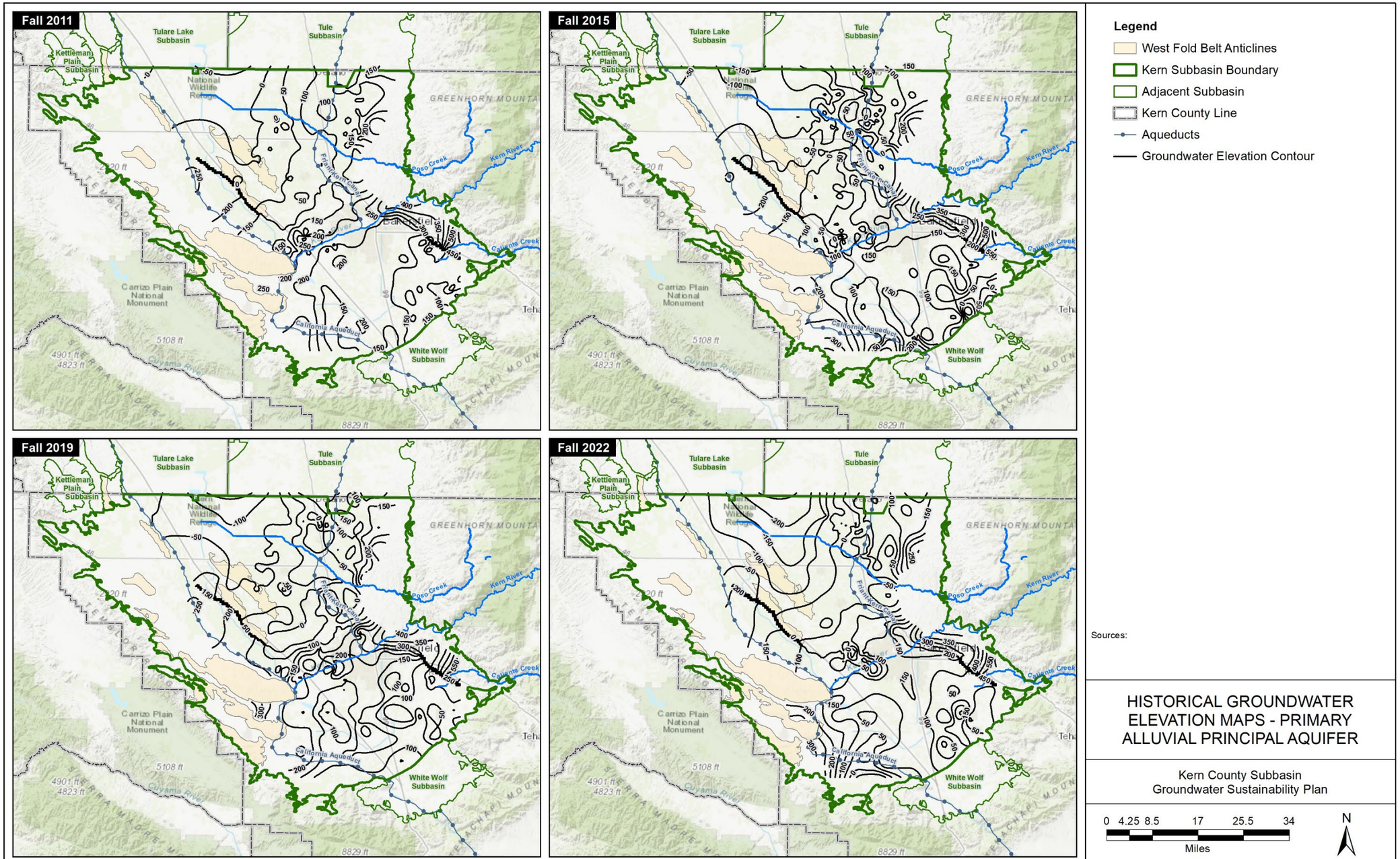


Figure 8-4. Historical Groundwater Elevation Maps – Primary Alluvial Principal Aquifer

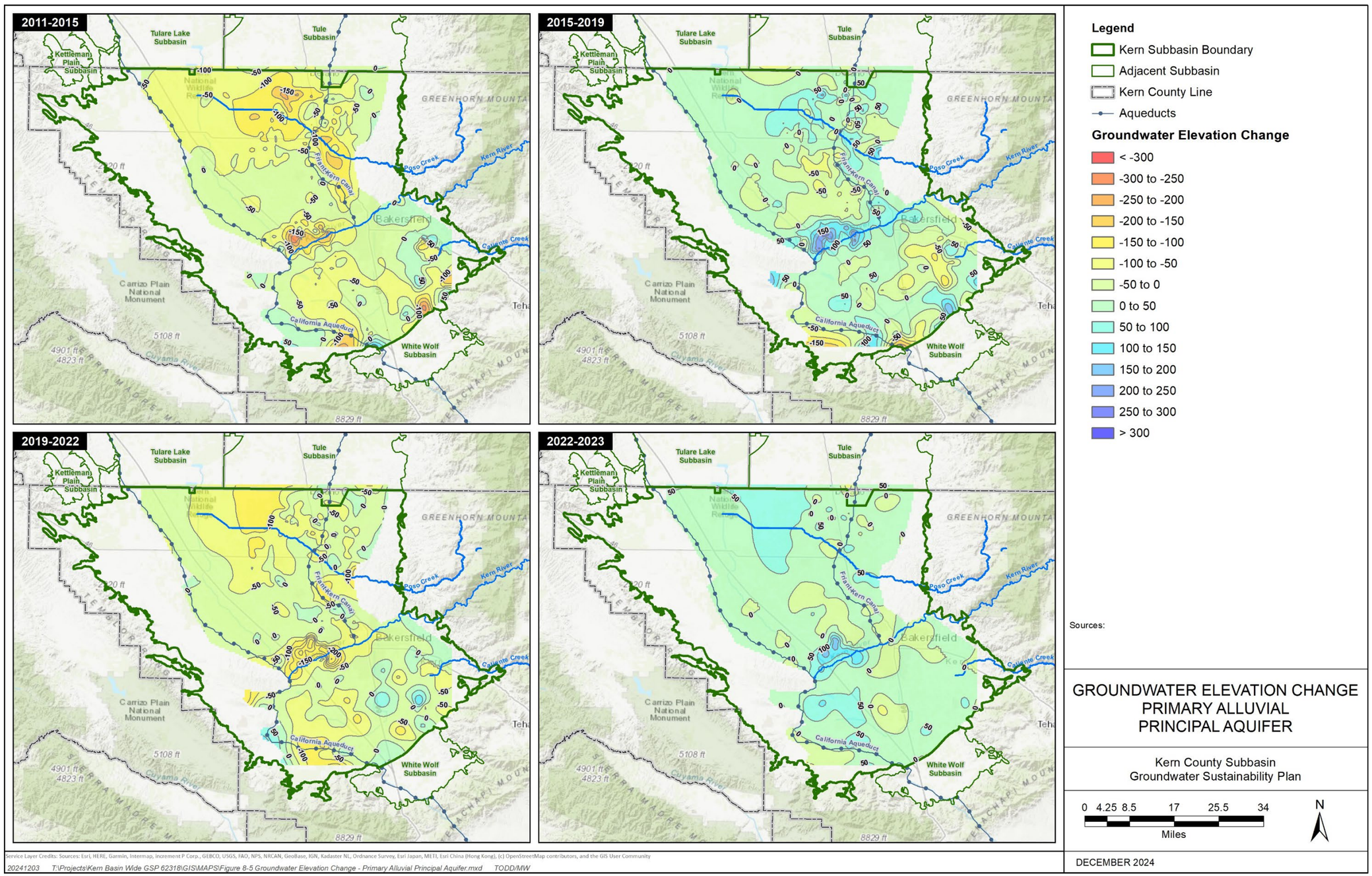


Figure 8-5. Historical Groundwater Elevation Change - Primary Alluvial Principal Aquifer

8.1.1.4 Regional Groundwater Elevation Contour Map with Adjacent Basins

GSP Emergency Regulations include several references to evaluation of Plan implementation with respect to adjacent basins (23 CCR §355.4(b)(7)). This includes an understanding of the regional nature of groundwater conditions. Figure 8-6 presents a regional groundwater elevation map based on data provided in the recent SGMA Annual Reports from the Kern County (Todd Groundwater, 2022), Tulare Lake (Geosyntec, 2022) and Tule Subbasins (Thomas Harder & Co., 2022). A compilation of the regional groundwater elevation data provided in these reports shows that the groundwater water depression in the north-central areas of the Kern Subbasin is a continuation of a larger regional groundwater depression that is centered in the Tule and Tulare Lake Subbasins to the north.

The lowest groundwater elevations occur in the Tulare Lake Subbasin but also appear to extend further north toward the Westside, Kings and Kaweah Subbasins. Because groundwater elevations in the Kern Subbasin are generally higher than those to the north, this large depression is further inducing northward groundwater flow out of the Kern Subbasin and could potentially impact the Kern Subbasin's ability to reach sustainability.

8.1.1.5 Hydrographs Depicting Long-Term Groundwater Elevations

☑ 23 CCR § 354.16(a)(2)

Per GSP Emergency Regulations, hydrographs include "*historical data to the greatest extent available, including from January 1, 2015, to current reporting year*" (§356.2(b)(1)(B)). Figure 8-7 shows hydrographs representing different areas of the Kern Subbasin for the Primary Alluvial Principal Aquifer over the period from WY 1955 through WY 2023. The wells shown on Figure 8-7 were selected based on having a long historical record for that area and are labeled by well name, GSA, and HCM Area.

Historically, groundwater elevation trends in the Kern Subbasin generally show an increase during wet periods and a decrease during dry periods. During the wetter periods of WYs 1995-1998, WYs 2005-2006, WYs 2010-2011, WYs 2017-2019 and WY 2023, there was an increase in both natural and managed recharge from conjunctive use projects and storage of surface water for banking projects accompanied with a rise in groundwater elevations. This increase in groundwater elevations were more pronounced in the areas with water banking and conjunctive use projects. Conversely, dry periods have decreased natural recharge and deliveries of surface water and increased recovery of stored surface water by pumping. As expected, groundwater elevations generally declined across the Kern Subbasin during these intervening dry years. During the extended drought periods (WYs 2012 to 2016 and WYs 2020 to 2022), several areas in the Kern Subbasin experienced historic low groundwater elevations. However, some areas show that the historic low groundwater elevations occurred during the drought in the early 1990s and prior to the importation of State Water Project (SWP) and Central Valley Project (CVP) water in the 1960s.

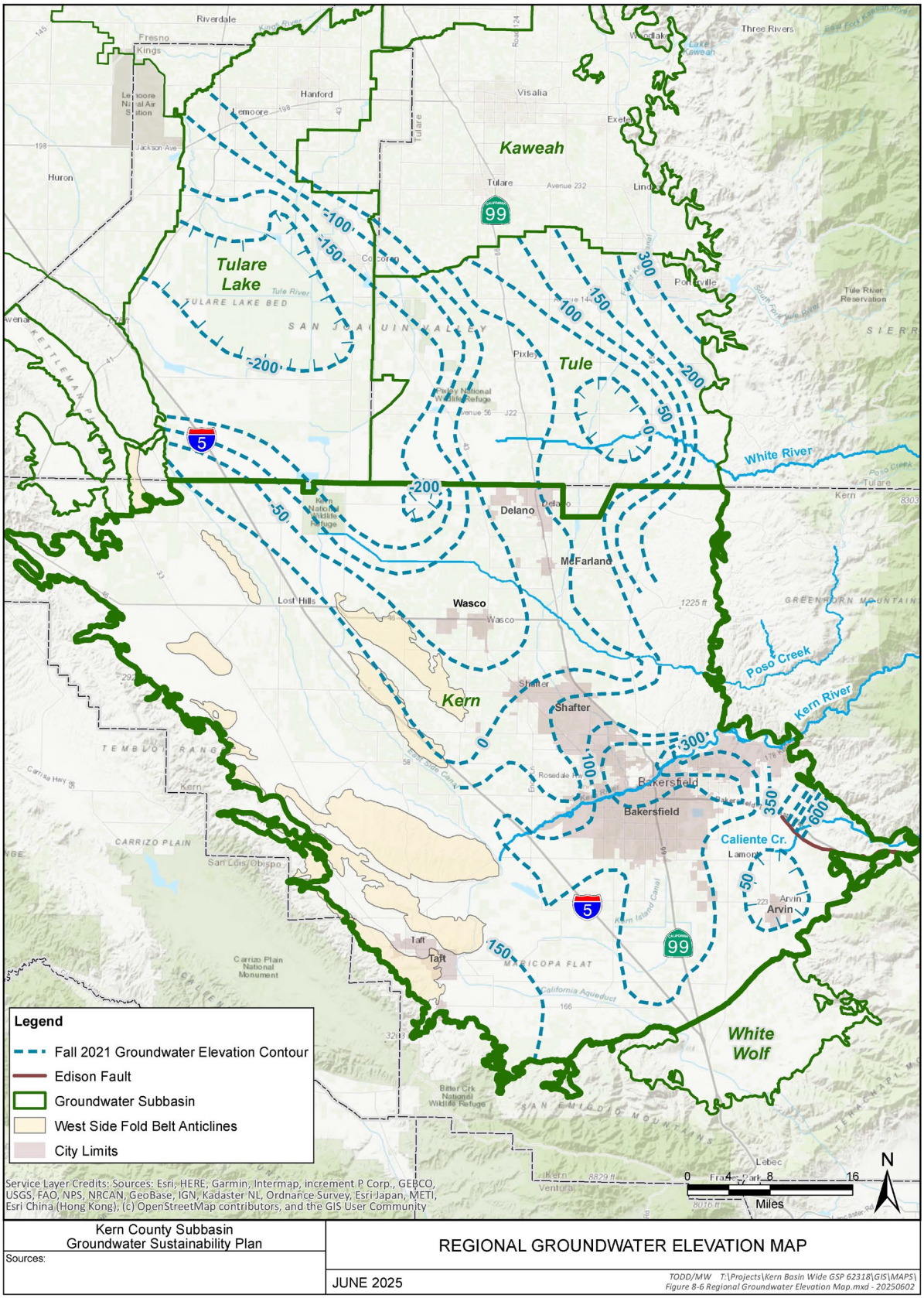


Figure 8-6. Regional Groundwater Elevation Map

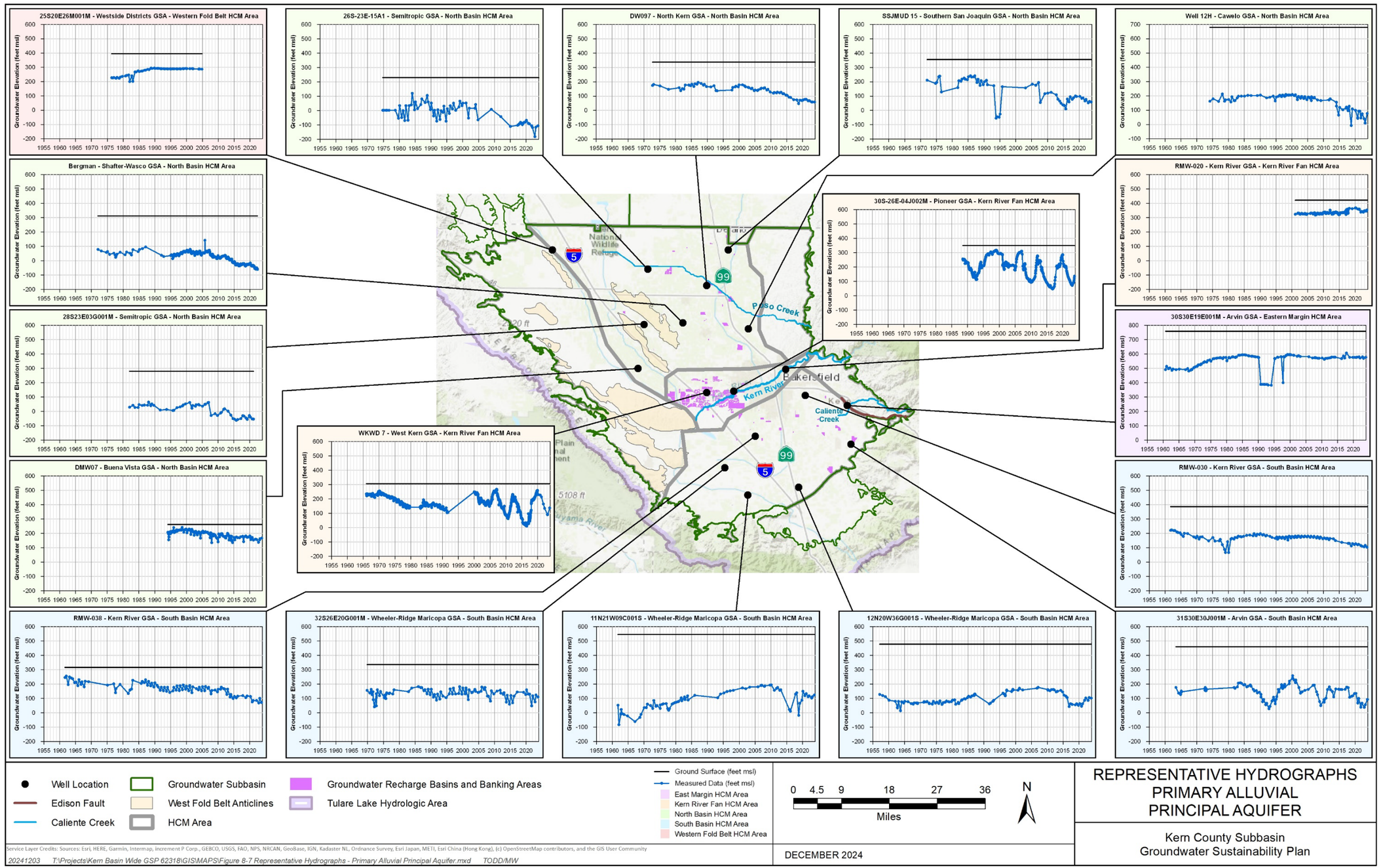


Figure 8-7. Representative Hydrographs Primary Alluvial Principal Aquifer

In the Kern River Fan HCM Area, groundwater elevations are higher along the Kern River but exhibit significant fluctuations in the banking areas. Upstream of the banking areas, groundwater elevations along the Kern River are higher and remain more stable (hydrograph RMW-020) with groundwater elevations between 300 to 400 feet msl. In the banking areas, groundwater elevations have fluctuated more than 200 feet from wet to dry years due to the influence of varying managed recharge and recovery operations (hydrographs 30S26E04J002M and WKWD 7). Groundwater elevations near the water banking operations are more highly variable than those experienced elsewhere in the Kern Subbasin with groundwater levels varying by 200 feet or more during the period of intensive banking operations starting around WY 1993.

In the North Basin HCM Area, seven hydrographs are shown on Figure 8-7. In general, groundwater elevations have generally declined since WY 2012 due to the extended period of drought that led to a severe reduction in imported water supplies. The lowest groundwater elevations since WY 2012, between -100 and -200 feet msl, occur along the northern Subbasin boundary. Groundwater elevations generally are higher toward the Kern River to the south and the Kern Subbasin margin to the east. Several wells in this HCM Area experienced historic lows during the recent drought periods.

In the South Basin HCM Area, six hydrographs (RMW-030, RMW-038, 31S30E30J001M, 12N20W36G001S, 11N21W09C001S, 32S26E20G001M) are shown on Figure 8-7. As shown, groundwater in some areas declined from WY 2012-2016 due to the effects of the extended drought and limitation on imported water supplies during this time. However, since WY 2016, water levels have recovered to pre-drought levels and remain relatively stable. The lowest groundwater elevations since WY 2012 have ranged between 200 to -50 feet msl. However, historic lows for most of the wells in this HCM Area generally occurred prior to WY 2012. Groundwater elevations generally are higher toward the Kern River to the north and to the west along the margin with the Western Fold Belt HCM Area. Groundwater elevations show a seasonal pumping patterns response.

In the Eastern Margin HCM Area, hydrograph 30S30E19E001M has groundwater elevations generally ranging from 500 to 600 feet msl that shows the effects of the Edison Fault as a groundwater flow barrier in the southeastern corner of the Kern Subbasin. Groundwater elevations in this well have remained relatively stable during the recent drought periods and are higher than groundwater elevations from the 1960s and 1970s. In the areas north of the Kern River, the Primary Alluvial Principal Aquifer has only limited saturated thickness, so most wells in this area pump groundwater from the Santa Margarita Principal Aquifer (Section 7.4.4).

In the Western Fold Belt HCM Area, hydrograph 35S20E26M001M shows groundwater elevations generally ranging from 200 to 300 feet msl. Groundwater elevations in this well have remained relatively stable, even during the recent drought periods which demonstrates the lack of groundwater pumping in the Western Fold Belt HCM Area due to natural poor groundwater quality. Stable groundwater elevations also show the

effects of the Lost Hills Anticline as a groundwater flow barrier that limits groundwater interaction with the North Basin HCM Area. There are no known groundwater wells in the southern portion (south of Elk Hills) of the Western Fold Belt HCM Area; therefore, there are no representative monitoring wells or available trends.

8.1.1.6 Areas of Localized Shallow Groundwater Conditions

While the Primary Alluvial Principal Aquifer essentially extends over the entire Subbasin and is the source for nearly all groundwater used within the Subbasin, there are two notable occurrences of localized shallow groundwater conditions within the Kern Subbasin that have developed over two different clay layers. One occurrence has developed above the A-Clay (or equivalent) and the second has developed above the E-Clay. There is minimal groundwater use from these localized shallow groundwater zones.

The first of these two notable occurrences consists of several large areas of shallow perched groundwater that occur over 138,000 acres in the North Basin and South Basin HCM Areas as shown on Figure 8-8. The perching horizon for these areas is the A-Clay, or equivalent shallow clay layer, which intercepts percolating precipitation and agricultural return flows. These localized shallow groundwater conditions are generally undesirable for farming operations because the water remains relatively close to the crop root zone resulting in poor crop yields, salt buildup, and poorly drained fields. The depth-to-groundwater in these perched areas typically range from 5 to 20 feet (Figure 8-8), based on a historical dataset of up to 232 shallow zone wells (KCWA, 2011).

In these areas, the shallow groundwater levels typically rise during wet water years and decline during drier years (KCWA, 2011). Potential groundwater flow is inferred towards the margin of the perched horizon where it may then percolate downward through the unsaturated zone to the underlying Primary Alluvial Principal Aquifer. As a perched zone, these areas of localized shallow groundwater are hydraulically separated from the Primary Alluvial Principal Aquifer.

A second notable occurrence of localized shallow groundwater conditions is correlated to the Shallow Confining Layer Area of the E-Clay in the north-central portions of the Subbasin as shown on Figure 8-9. Groundwater elevation contours for Spring 2021 ranged from 160 to 220 feet msl (Schmidt and Associates, 2022). These localized shallow groundwater conditions extend northward into the adjacent Tulare Lake and Tule Subbasins.

The groundwater levels in this second occurrence of localized shallow groundwater conditions are generally stable over time with minor seasonal variations. Below the E-Clay, groundwater elevations are much lower with distinctive long-term and seasonal trends. Groundwater levels in the underlying Primary Alluvial Principal Aquifer are typically 100 or more feet lower than the overlying localized shallow groundwater conditions and exhibit strong long-term trends. This difference in the groundwater

elevations and trends indicates that the localized shallow groundwater above the E-Clay in the Shallow Confining Layer Area (Figure 8-9) is hydraulically detached from the groundwater below the E-Clay in this area.

In the Leaky Aquitard Areas to the south and east of the Shallow Confining Layer Area (Figure 8-9), some localized perched areas may occur, but generally water is considered to pass through the E-Clay interal and continue to percolate down to the Primary Alluvial Principal Aquifer.

To the southwest of the Shallow Confining Layer Area, the shallow groundwater may flow southward onto the Deeper Confining Layer Area of the E-Clay where it then merges into the Primary Alluvial Principal Aquifer (Figure 8-9). The flow of shallow groundwater in this location is affected by the geologic structures, such as the Buttonwillow Anticline, where the E-Clay has been deformed by the tectonic folding resulting in the E-Clay rising in elevation over the top of the anticlines (Figure 7-17), thus limiting groundwater flow over the anticlines. This results in groundwater being channeled down the axis of the San Joaquin Syncline where the E-Clay occurs at a lower elevation.

8.1.1.7 Vertical Hydraulic Gradients

☑ 23 CCR § 354.16(a)(2)

Evaluation of vertical gradients can be accomplished by examination of water levels in multiple wells sites or well clusters that consist of wells completed at different depth intervals. Figure 8-10 provides hydrographs from multiple well sites or well clusters that are completed at different depth intervals from four separate areas within the Kern Subbasin. Two locations are in the Kern River Fan HCM Area near the Kern Fan Water Banking Area.

- The 30S24E-13D well cluster consists of three wells located at the western end of the Kern River Fan HCM Area. Vertical head differences range from about 10 to 32 feet with an average downward vertical gradient of 0.042 feet per foot.
- The 32N Triple well cluster consists of three wells located at the central Kern River Fan HCM Area. Vertical head differences range from 6 to 16 feet with an average upward vertical gradient of 0.030 feet per foot.
- The S-10 well cluster consists of three wells located in the North Basin HCM Area near the northern Subbasin boundary. Vertical head differences range from 11 to 22 feet; however, in this case the vertical gradients converge to the middle interval. From the shallow well there is an average downward vertical gradient of 0.010 feet/foot whereas for the deep well there is an average upward vertical gradient of 0.050 feet per foot.

- The S-9 well cluster consists of two wells located in the southern portion of the North Basin HCM Area. Vertical head differences range from +4 to -4 feet with an average upward vertical gradient 0.004 feet per foot.

Because of the heterogeneous character of most unconsolidated alluvial deposits, confinement in them is commonly a matter of degree, and the time element must be considered (Hilton et al., 1963). In most alluvial deposits, there is enough hinderance to the movement of groundwater between separate permeable zones that differences in head between the zones exist during periods of heavy pumping. During periods of limited pumping, groundwater elevations in the deeper semiconfined zones tend to recover to a level similar to those in shallower zones.

In the area underlain by the E-Clay Member, water levels in the principal-pumped zone above the clay differ from those in the confined water body below the clay. However, where the E-Clay is thin or absent, the principal-pumped zone above the E-Clay and the confined water body below it have a direct hydraulic interconnection.

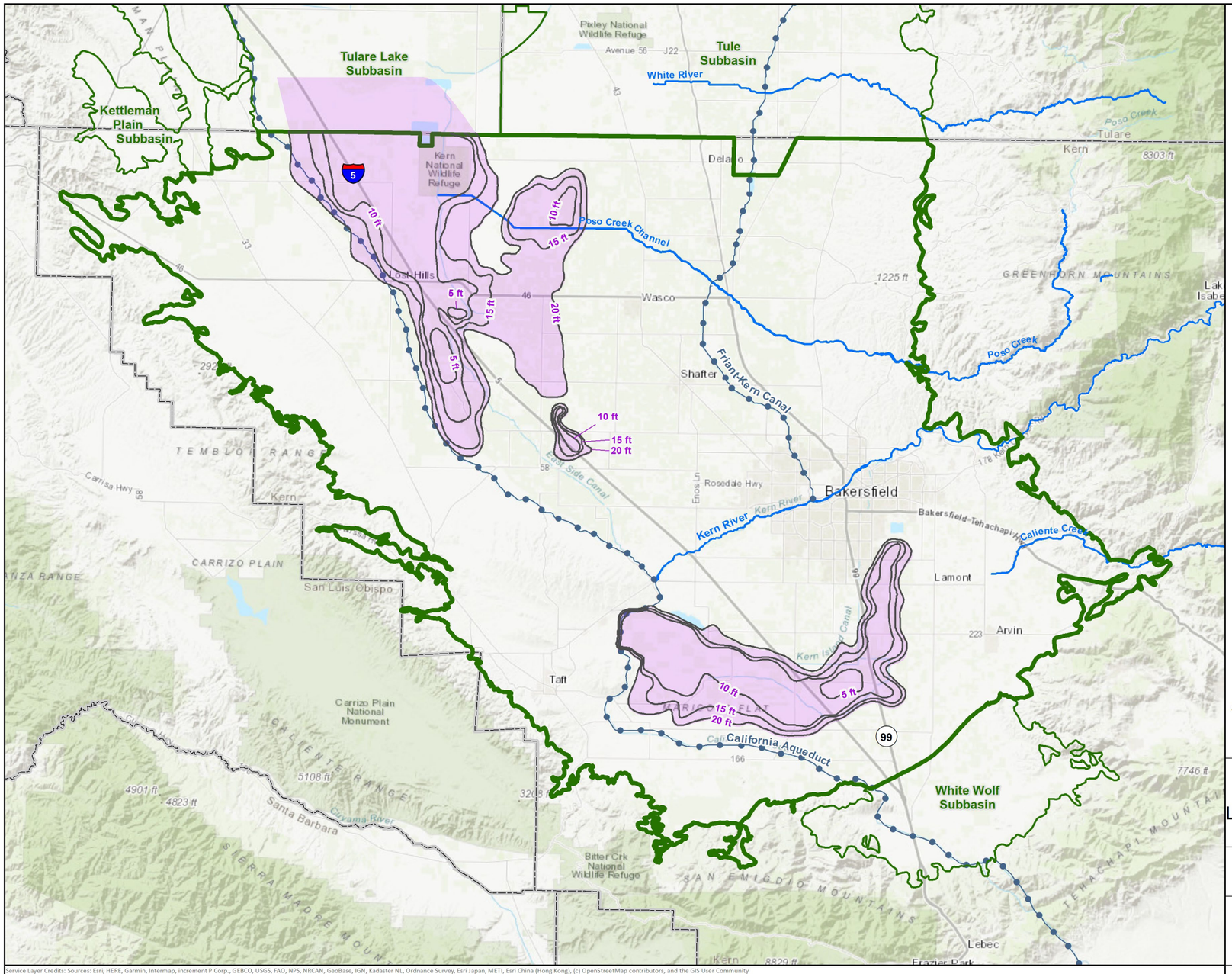
These vertical gradients are considered reasonable for a single, large heterogeneous alluvial aquifer. Vertical gradients between the different zones within the Primary Alluvial Principal Aquifer may develop due to geologic heterogeneity such as clay layers, variability in proximity to recharge sources and the intensity of groundwater pumping. Vertical gradients may also vary in time as the factors affecting water levels are also temporally variable.

8.1.1.8 Hydraulic Gradients Between Principal Aquifers

☑ 23 CCR § 354.16(a)(2)

The Primary Alluvial Principal Aquifer is the largest principal aquifer that essentially covers the entire Subbasin. The other principal aquifers are related to older marine sandstone layers along the Kern Subbasin margin. These are limited to only the Eastern Margin HCM Area. The discussion of the hydraulic gradients between the Primary Alluvial Principal Aquifer and the Santa Margarita Principal Aquifer is discussed in the following section.

In the North Basin, Kern River Fan, South Basin, and Western Fold Belt HCM Areas, the Primary Alluvial Principal Aquifer is underlain by older marine sedimentary rocks that do not meet the DWR (2016) criteria for a principal aquifer (Section 7.5). In addition, mapping by California State University, Bakersfield (Gillespie et al., 2017) indicates that units below the Primary Alluvial Principal Aquifer have total dissolved solids (TDS) concentrations in excess of the underground source of drinking water (USDW) limit of 10,000 ppm (Section 7.6.4). Therefore, an analysis for hydraulic gradients between principal aquifers is not applicable to these HCM Areas.



Legend

- Kern Subbasin Boundary
- Adjacent Subbasin
- Kern County Line
- Shallow Perched Groundwater Area
- Aqueducts
- Streams

Sources:

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

20250603 T:\Projects\Kern Basin Wide GSP 62318\GIS\MAPS\JPG\Figure 8.1-1 Shallow Perched Depth to Groundwater Map.mxd TODD/MW

DEPTH TO GROUNDWATER MAP FOR NEAR-SURFACE PERCHED AREA LOCALIZED SHALLOW GROUNDWATER CONDITION

Kern County Subbasin
Groundwater Sustainability Plan

0 2 4 8 12 16
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JUNE 2025

Figure 8-8. Depth to Groundwater Map for Near-Surface Perched Area with Localized Shallow Groundwater Conditions Above the A-Clay or Equivalent

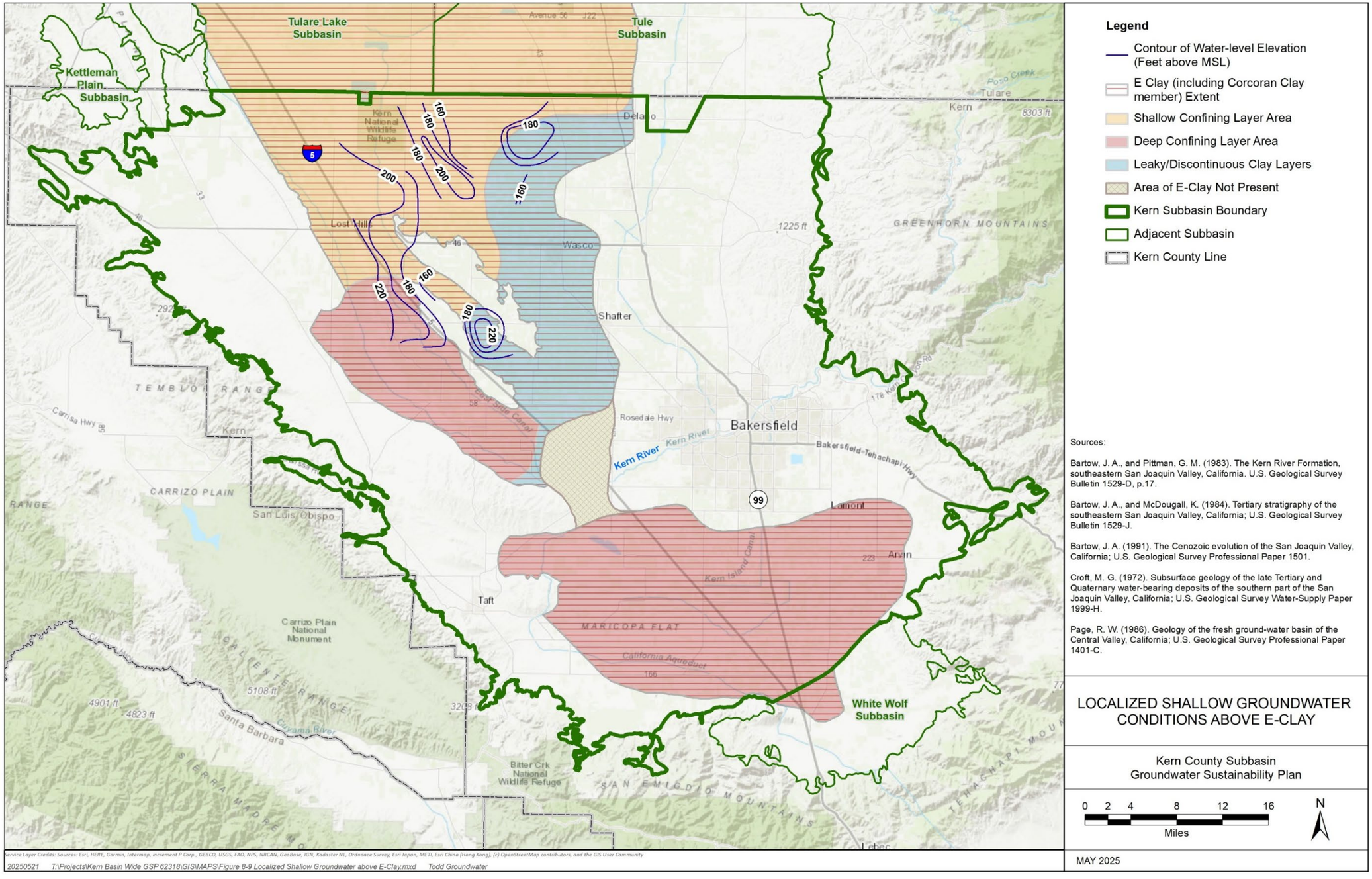


Figure 8-9. Localized Shallow Groundwater Conditions Above the E-Clay

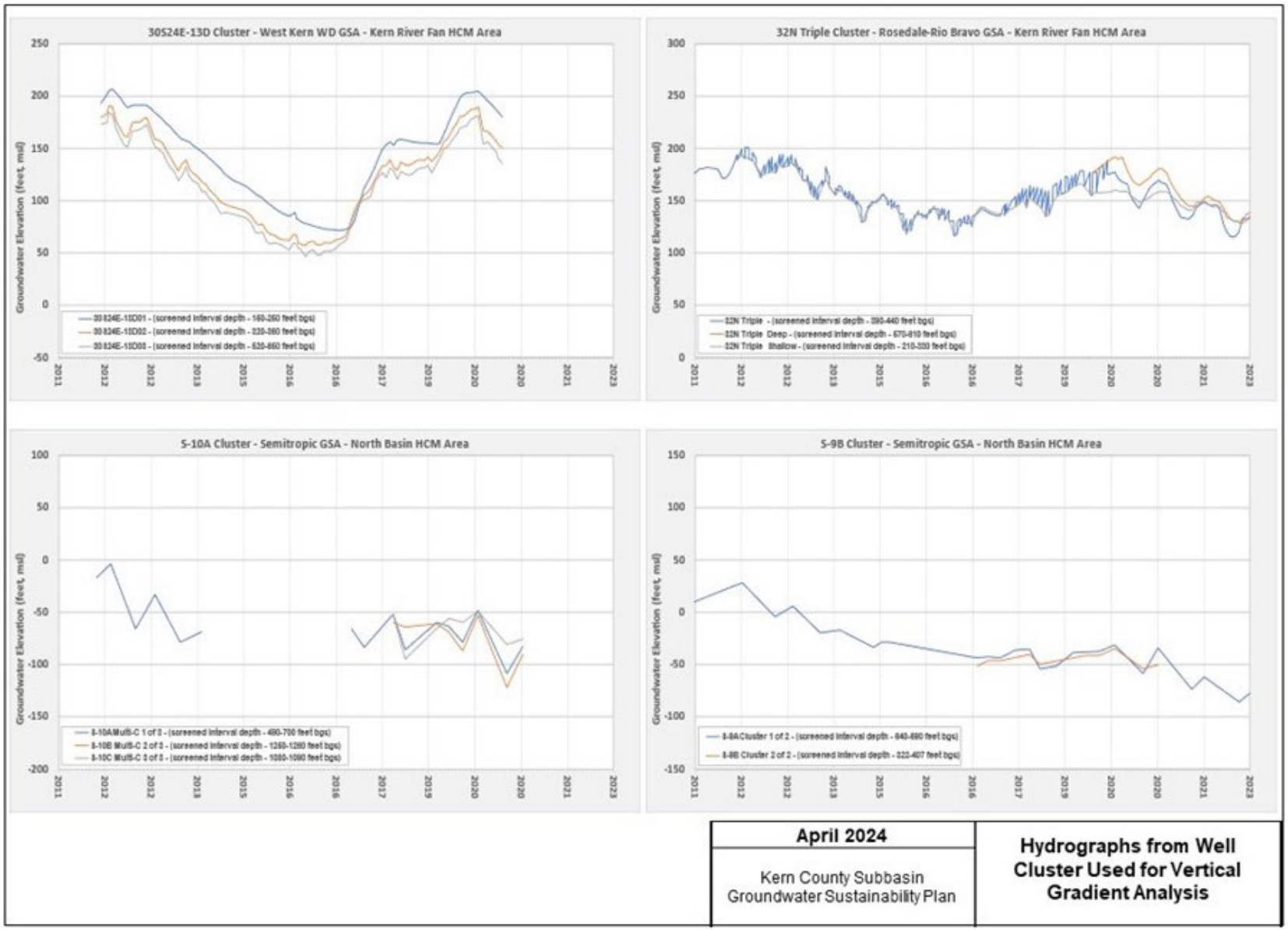


Figure 8-10. Hydrographs from Well Clusters Used for Vertical Gradient Analysis

8.1.2 Santa Margarita Principal Aquifer

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

☑ **23 CCR § 354.16(a)(1)**
☑ **23 CCR § 354.16(a)(2)**

The Santa Margarita Principal Aquifer is located mainly in the Eastern Margin HCM Area in the northeastern corner of the Kern Subbasin (Figure 7-30 and Figure 7-31). The principal aquifer area is bounded by the Poso Creek (or Pond-Poso) Fault to the south, the Kern Subbasin margin to the east, a stratigraphic pinch-out of the Santa Margarita to the north in the Tule Subbasin, and highly saline connate waters in the deep basin to the west. In this area, wells are drilled deeper (typically ranging from 1,000 to 2,000 feet bgs.) in order to extract fresh groundwater from the Santa Margarita Formation and Olcese Sand.

As described in Section 7.5, this principal aquifer is a confined freshwater aquifer formed within marine sandstones of Miocene age. Surface recharge from outcrop areas in the watershed areas along the eastern Subbasin margin has replaced the original saline connate water. This condition occurs in a limited area along the eastern Subbasin margin that forms a locally important groundwater source.

8.1.2.1 Groundwater Flow Directions

Based on the hydrogeologic conceptual model (Section 7), groundwater recharge occurs in formation outcrops located in the watersheds bordering the Kern Subbasin and outflow is considered as almost exclusively from groundwater pumping. Therefore, groundwater is inferred to flow from the Kern Subbasin margins westward toward the groundwater pumping areas.

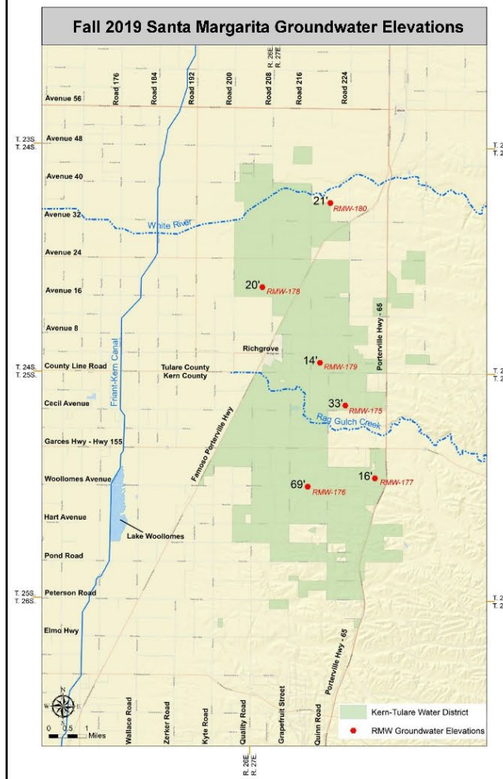
8.1.2.2 Groundwater Elevation Maps

Groundwater elevations for the Santa Margarita Principal Aquifer are variable geographically and not readily conducive to water level contouring. This is also due to many of these wells being screened across multiple aquifers. Therefore, Figure 8-11 provides maps of groundwater elevation data that are posted on maps for Fall 2019, Spring 2020, Fall 2021 and Spring 2022. As shown, groundwater levels rebounded significantly in Spring 2022 compared to Fall 2021. Increases in groundwater elevations

for Spring 2022 averaged about 100 feet for the five southern monitoring wells. Even though the increase in groundwater elevations between the two posted measurements for Fall 2021 and Spring 2022 is less in Well 8L1 than in the southern wells (only about 9 feet), the overall seasonal fluctuations for that well are similar to the remaining wells.

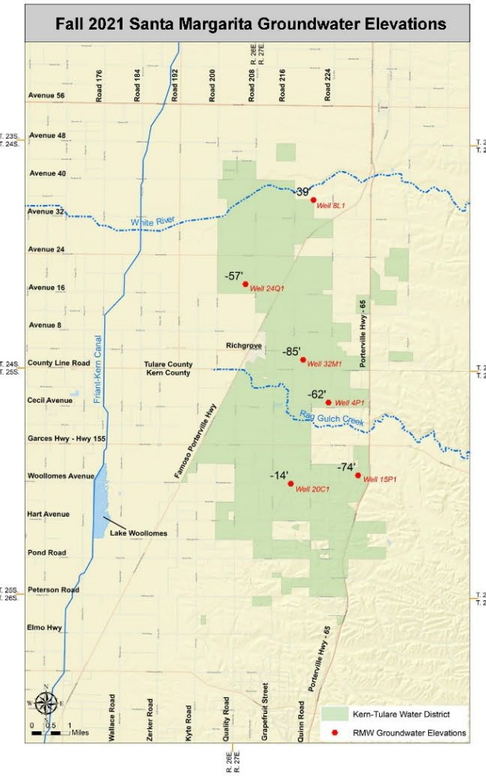
8.1.2.3 Long-Term Hydrograph Trends

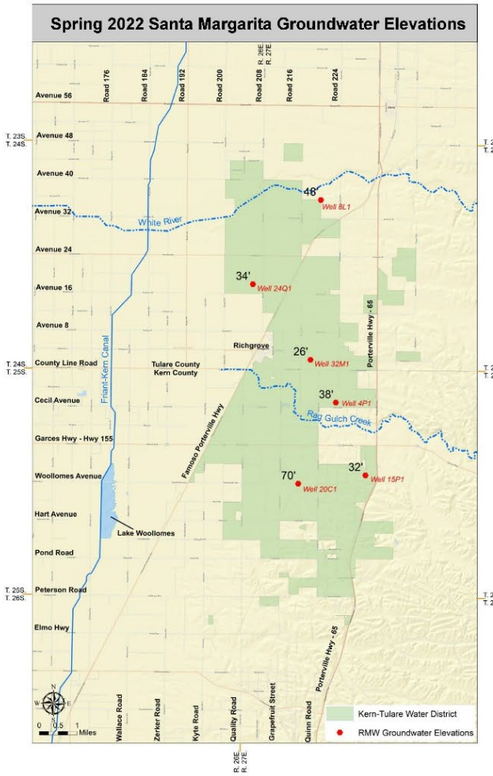
Figure 8-12 is a hydrograph of groundwater levels for six wells identified in Figure 8-11 that penetrate the Santa Margarita Formation. As shown in Figure 8-12, groundwater levels in the Santa Margarita Formation are generally consistent across the area. All hydrographs show that prior to 1977 groundwater levels in the Santa Margarita Formation were falling at a rate of approximately 10 feet per year. Beginning in 1977, Kern-Tulare Water District began importing water and, as a result, groundwater pumping decreased, and groundwater levels significantly increased. From 1983 through 2011 groundwater levels remained stable, varying seasonally from elevations of 60 to 120 feet msl. During the 2013 through 2016 drought years, groundwater pumping increased, resulting in spring groundwater levels declining by over 50 feet and fall levels declining by 100 feet to historic lows. Since then, groundwater levels have recovered by over 50 feet, indicating the recharge capability of this aquifer.





Source:
Kern-Tulare Water District (KTWD),
March 2021.





Source:
Kern-Tulare Water District (KTWD),
March 2023.

SANTA MARGARITA PRINCIPAL AQUIFER GROUNDWATER ELEVATION MAPS

Kern County Subbasin
Groundwater Sustainability Plan

20240517 \\TODD-FILE\Data\Projects\Kern Basin Wide GSP 62318\GRAPHICS\Figure 8-8 Santa Margarita Principal Aquifer Groundwater Elevation Maps.ai TODD/MW

APRIL 2024

Figure 8-11. Santa Margarita Principal Aquifer Groundwater Elevation Maps

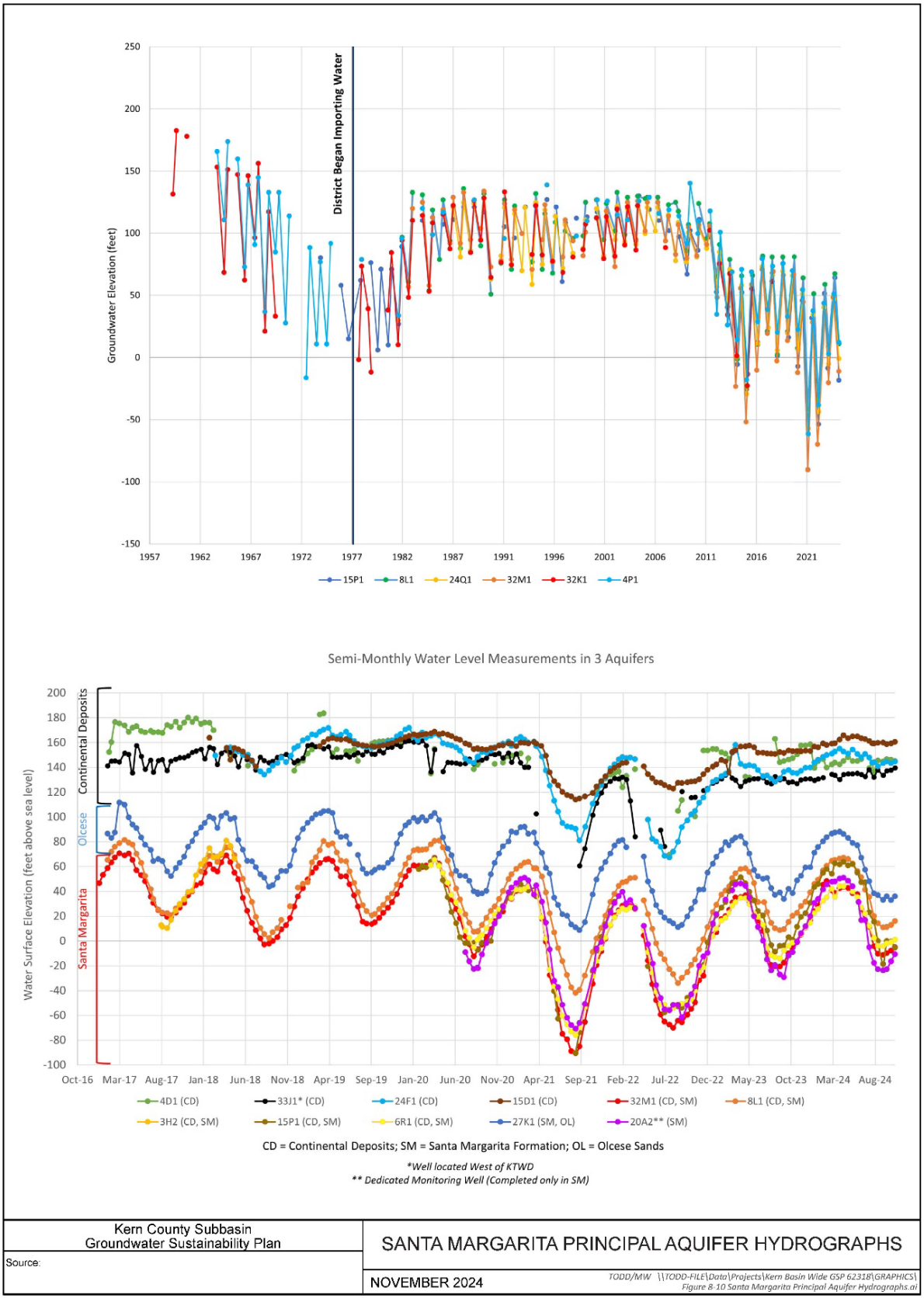


Figure 8-12. Santa Margarita Principal Aquifer Hydrographs

8.1.2.4 Lateral and Vertical Groundwater Gradients

The Santa Margarita Principal Aquifer is hydraulically separated from the overlying Primary Alluvial Principal Aquifer system by aquitard layers in the intervening Plio-Miocene Marine Deposits (Section 7.5.2). However, some wells are also screened across both the principal aquifers. Based on the data provided on Figure 8-11, lateral gradients vary from 0.003 to 0.008 feet per foot toward the groundwater pumping areas in the center of the area.

Figure 8-12 is a hydrograph comparing groundwater elevation trends for wells completed across both the Santa Margarita Formation and Olcese Sand. Well numbers 24F1, 4D1, 15D1, 33J1, and 19Q2 are completed only within the Primary Alluvial Principal Aquifer (labeled as “continental deposits”). Wells 8L1, 32M1, 27K1 and 3H2 are completed across the Primary Alluvial Principal Aquifer and the Santa Margarita Principal Aquifer. However, well 27K1 is completed across both the Santa Margarita Formation and Olcese Sand whereas the others are completed across only the Santa Margarita Formation. The following observations can be made:

- Wells that penetrate the Olcese Principal Aquifer have water levels that are about 40 feet higher than those that only penetrate the Santa Margarita Formation.
- Wells penetrating the Santa Margarita and/or Olcese Principal Aquifers reflect seasonal fluctuations of about 60 feet.
- Wells that are screened across the Primary Alluvial Principal Aquifer and Santa Margarita have water levels that are representative of the deeper Santa Margarita Formation. This has been verified by data collected in a dedicated monitoring well that is solely completed in the Santa Margarita Formation being consistent with the data collected in the Santa Margarita Formation wells screened across the two aquifers.
- The 40-foot difference in groundwater elevation can be used to calculate a vertical hydraulic gradient of about 0.1 feet per foot; however, these two units are separated by 300 to 400 feet of the Round Mountain Silt which is considered to form a confining layer separating these two aquifers; therefore, little to no groundwater exchange is considered to occur between these two principal aquifer units.

8.1.2.5 Hydraulic Gradients Between Principal Aquifers

The differences in groundwater level elevations and fluctuations between three principal aquifers are shown in Figure 8-12. These wells represent groundwater levels from the Primary Alluvial and Santa Margarita Principal Aquifers. The following observations can be made:

- Groundwater levels in the Primary Alluvial Principal Aquifer are 60 to 140 feet higher than those in the Santa Margarita Principal Aquifer and do not show the large seasonal fluctuations evidenced in the Santa Margarita Principal Aquifer and Olcese Principal Aquifer.
- Wells that penetrate the Santa Margarita Principal Aquifer show a lower groundwater elevation than wells completed only in the Primary Alluvial Principal Aquifer.
- The 60- to140-foot difference in groundwater elevation can be used to calculate a vertical hydraulic gradient of about 0.04 to 0.11 feet per foot. The Primary Alluvial Principal Aquifer and Santa Margarita Principal Aquifer are separated by about 1,500 feet of the San Joaquin and Etchegoin Pliocene marine deposits. These units are considered to form a confining layer separating these two aquifers; therefore, little to no groundwater exchange is considered to occur between these two principal aquifer units.

8.1.3 Olcese Principal Aquifer

> ***§ 354.16.*** *Groundwater Conditions*
>
> *Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information*
>
> *(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:*
>
> *(1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.*
>
> *(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.*

☑ 23 CCR § 354.16(a)(1)
☑ 23 CCR § 354.16(a)(2)

The Olcese Principal Aquifer is located mainly in the Eastern Margin HCM Area in the vicinity of where the Kern River enters the Kern Subbasin (Figure 7-30 and Figure 7-31). This principal aquifer is named because the Olcese Sand is the primary producing horizon in this area, which generally coincides with the Olcese GSA. The formation is encountered at depths of approximately 200 to 800 feet bgs under the Olcese GSA area (approximately 600 to -300 feet msl). The Olcese Sand dips to the southwest and reaches depths greater than 2,000 feet bgs (-1,400 feet msl). The Round Mountain Silt above the Olcese Sand serves as an aquitard, restricting vertical flow between the Santa Margarita Principal Aquifer and the Olcese Principal Aquifer. Below the Olcese Sand, the Freeman Silt typically acts as a lower bounding aquitard (Bartow, 1984).

8.1.3.1 Groundwater Flow Directions

The Olcese Principal Aquifer is recharged locally at surface outcrops in the surrounding watersheds and directly by rainfall and stream seepage, including recharge from the Kern River, within the principal aquifer area. The aquifer deepens toward the west where it is overlain by fine-grained Round Mountain Silt that limits natural recharge in these areas. This principal aquifer provides the source of nearly all the groundwater used within the Olcese Principal Aquifer area (Figure 7-31).

8.1.3.2 Groundwater Elevation Maps

Groundwater elevation contour maps for the Olcese Principal Aquifer for Fall 2019, Spring 2020, Fall 2021 and Spring 2022 are presented on Figure 8-13. As indicated on Figure 8-13, Fall 2021 groundwater elevations are about 320 feet higher in the Canyon View Ranch Well in the eastern portion of the Olcese GSA than in wells to the west. A steep hydraulic gradient is evident between the Canyon View Ranch well and the deeper downgradient wells. The seasonal difference for groundwater elevations in Wells #2, #3, and #4 varies from 2 to 15 feet, indicating a less steep gradient in this area. In Spring 2022, groundwater elevations were relatively stable in the Canyon View Ranch Well while water levels rose an average of about 62 feet in other wells. Given the location of the recharge areas to the north and northeast, it is inferred that groundwater flows generally from the northeast to southwest across the Olcese GSA Area.

8.1.3.3 Long-Term Hydrograph Trends

Historical groundwater elevation data extends back to 1966 for Well #1 and 1977 for Well #2. Based on the Well #1 and Well #2, groundwater levels between 1966 and 1983 ranged between approximately 471 and 543 feet msl. During this period there was little to no groundwater pumping. Once groundwater pumping began in the late 1980s in Wells #1 and #2, groundwater levels adjusted to a new equilibrium state in the range of approximately 350 to 400 feet msl. Reduced pumping in the mid-1990s (Well #2) and late 1990s/early 2000s (Well #1) corresponded to a rise in groundwater levels back to a range of approximately 430 to 490 feet msl. Resumption of pumping in Well #2 and the start of pumping in Well #3 (a replacement for Well #1) in the late 2000s corresponded to a return, by late 2014, to the levels observed in the early 1990s. It should also be noted that in 2014 the Olcese Water District pumped approximately 1,000 acre-feet of additional groundwater to support a water sale to another entity within the Kern Subbasin (previous smaller volume sales occurred in 2004, 2005 and 2009). Data from Spring 2016 indicates a recovery of water levels in Wells #2 and #3 to elevations around 410 feet msl.

An inverse correlation exists between annual pumping volumes and observed groundwater levels. This correlation is likely to also relate to climate since increased groundwater pumping appears to generally correspond with periods of drought. The relationship between groundwater levels, pumping rates, and climate is further born out

on a seasonal timeframe. Higher frequency water level data collected from 2015 to 2023 illustrates that groundwater lows occur in the summer or fall and highs in the winter or spring (Figure 8-14). The relative degree to which water level fluctuations within the principal aquifer are dependent on pumping rates versus precipitation/recharge patterns is not certain at this time (i.e., no water level data exists for a period when either of the two potential causative factors are isolated or held constant). However, what is clear is that, the above fluctuations notwithstanding, groundwater levels have been relatively stable since the late 1980s/early 1990s when the current regime of land use and pumping began within the Olcese GSA area, and there is no indication of a chronic long-term decline in water levels.

8.1.3.4 Lateral and Vertical Groundwater Gradients

A comparison of contemporaneous multiple groundwater level measurements between February 2015 and July 2017 shows that the lateral groundwater gradient is, on average, toward the southwest with the magnitude ranging from 0.005 to 0.0095 feet per foot. No multi-well locations occur in this area to define vertical gradients.

8.1.3.5 Hydraulic Gradients Between Principal Aquifers

In the localized area, wells are completed only in the Olcese Principal Aquifer. The Olcese Sand is bound above by the Round Mountain Silt and below by the Freeman Silt that act as aquitards that hydraulically separate the Olcese Sand from overlying and underlying geologic units.

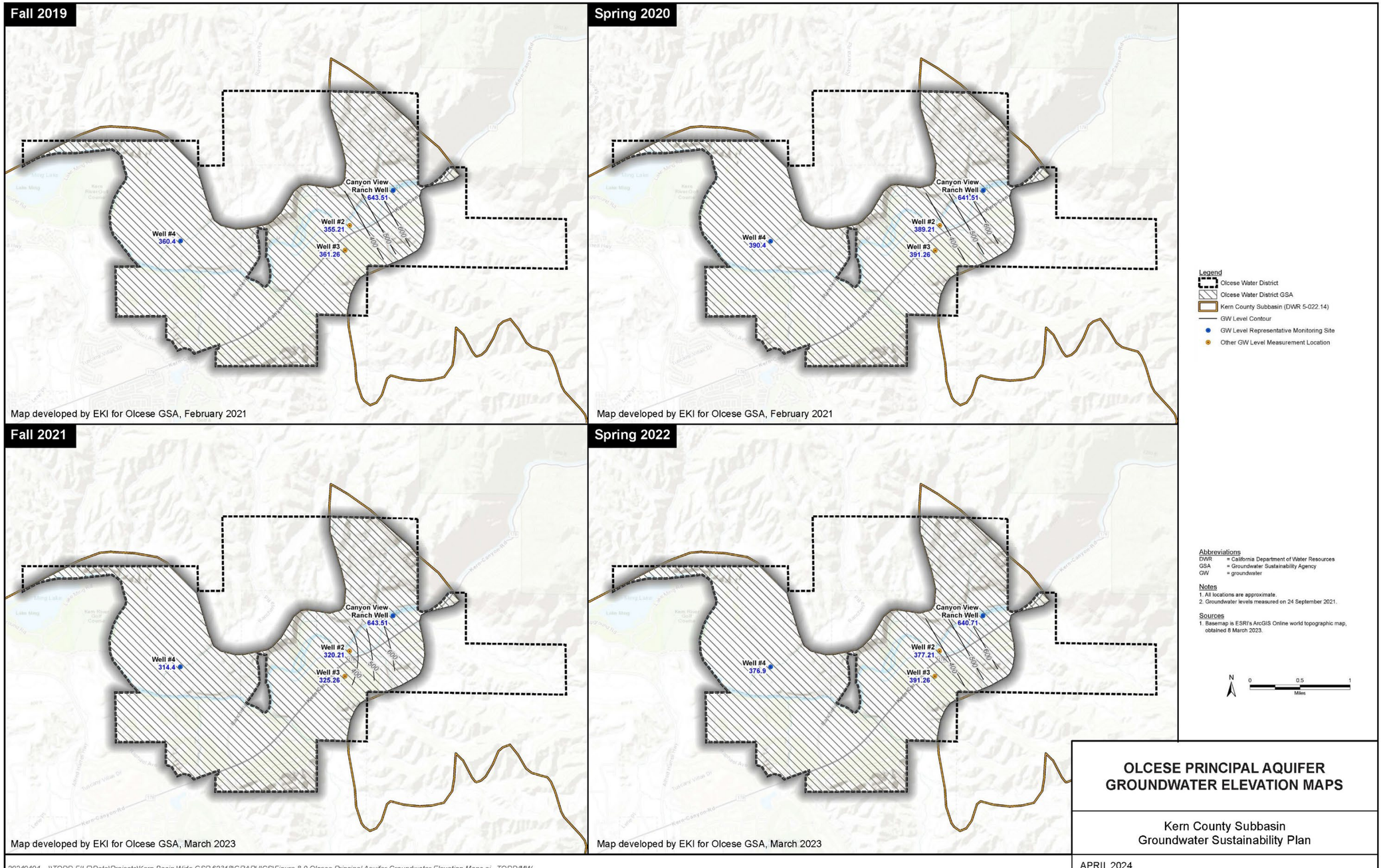


Figure 8-13. Olcese Principal Aquifer Groundwater Elevation Maps

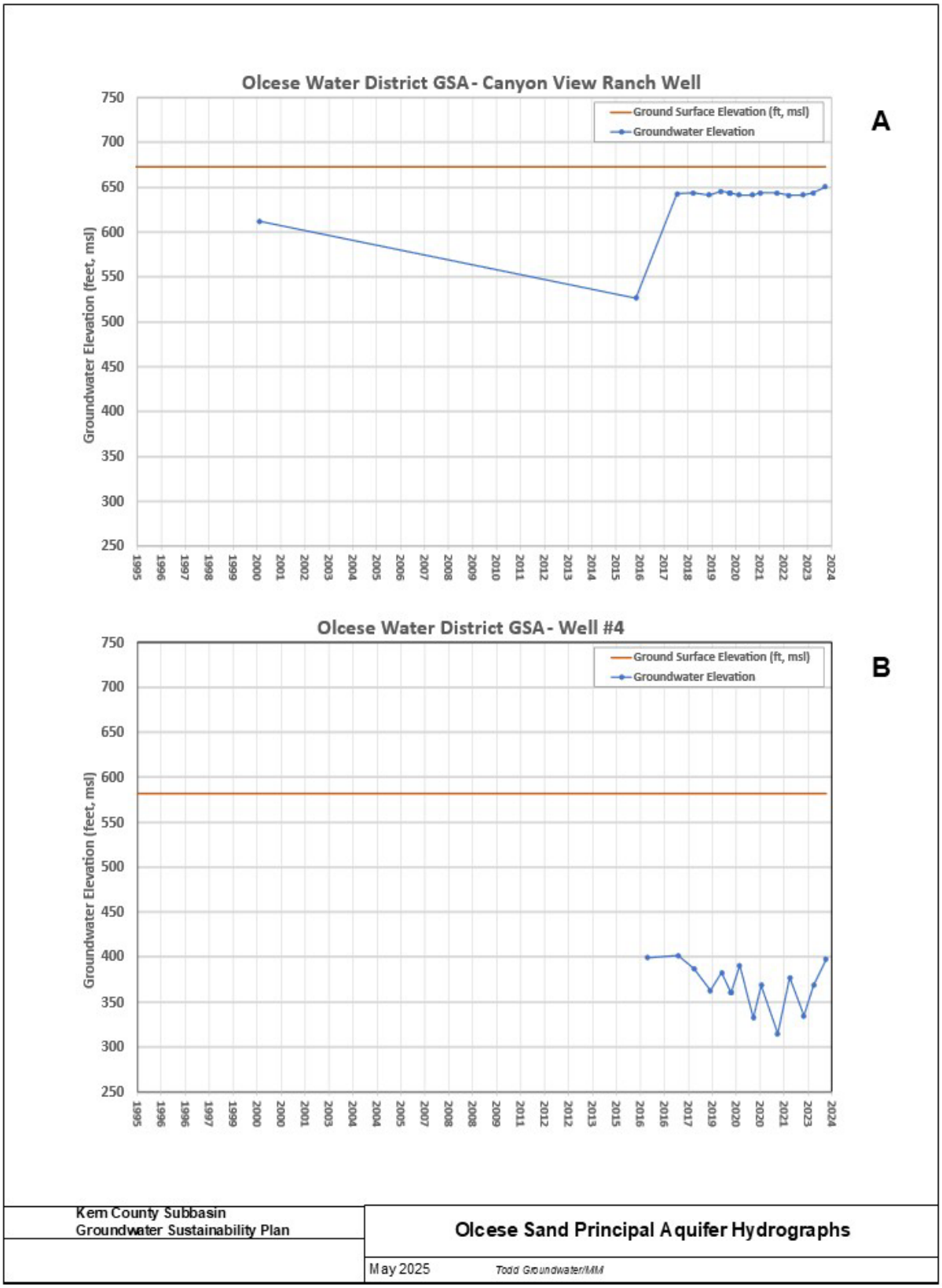


Figure 8-14. Olcese Principal Aquifer Hydrographs

8.2 Change in Groundwater in Storage

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

☑ **23 CCR § 354.16(b)**

The change in groundwater storage is a volumetric water budget summation of the total groundwater inflows and outflows within the Kern Subbasin. This change is physically represented by the change in groundwater levels over time. The magnitude of change in groundwater elevation is a function of the storage capacity within the pore spaces of the aquifer including groundwater under confined and unconfined conditions.

8.2.1 Subbasin Change in Groundwater in Storage

> ***§ 354.16.*** *Groundwater Conditions*
> *(b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.*

☑ **23 CCR § 354.16(b)**

The local groundwater-surface water model (C2VSimFG-Kern) is the agreed upon method for generating coordinated Subbasin-wide water budgets for the Kern Subbasin. C2VSimFG-Kern is based on the C2VSim Fine Grid Public Beta model (C2VSimFG-Beta) that was released by DWR for SGMA support in May 2018 (GSP Emergency Regulation §354.18(f)). For this 2025 Plan, the C2VSimFG-Beta input files have been revised to incorporate locally derived managed water supply and demand data to better represent the local water budgets for the Kern Subbasin. A more detailed discussion of the C2VSimFG-Kern model is provided in Section 9.

8.2.1.1 Annual and Cumulative Change in Groundwater in Storage Graphs

The C2VSimFG-Kern model is routinely updated with new input data following the same methodology to maintain consistency in generating coordinated water budgets through WY 2023. Section 9 includes additional information on the development and application of C2VSimFG-Kern for these purposes. Figure 8-15 shows the simulated change in groundwater storage for the Kern Subbasin over the 29-year period from WY 1995 through WY 2023. Note that these values include surface water stored by the water banking projects. The storage and recovery of this surface water does not result in a change in groundwater storage as the projects can only recover previously stored water. Figure 8-15 also shows the San Joaquin Valley Index (CDEC, 2023) water year type for each year.

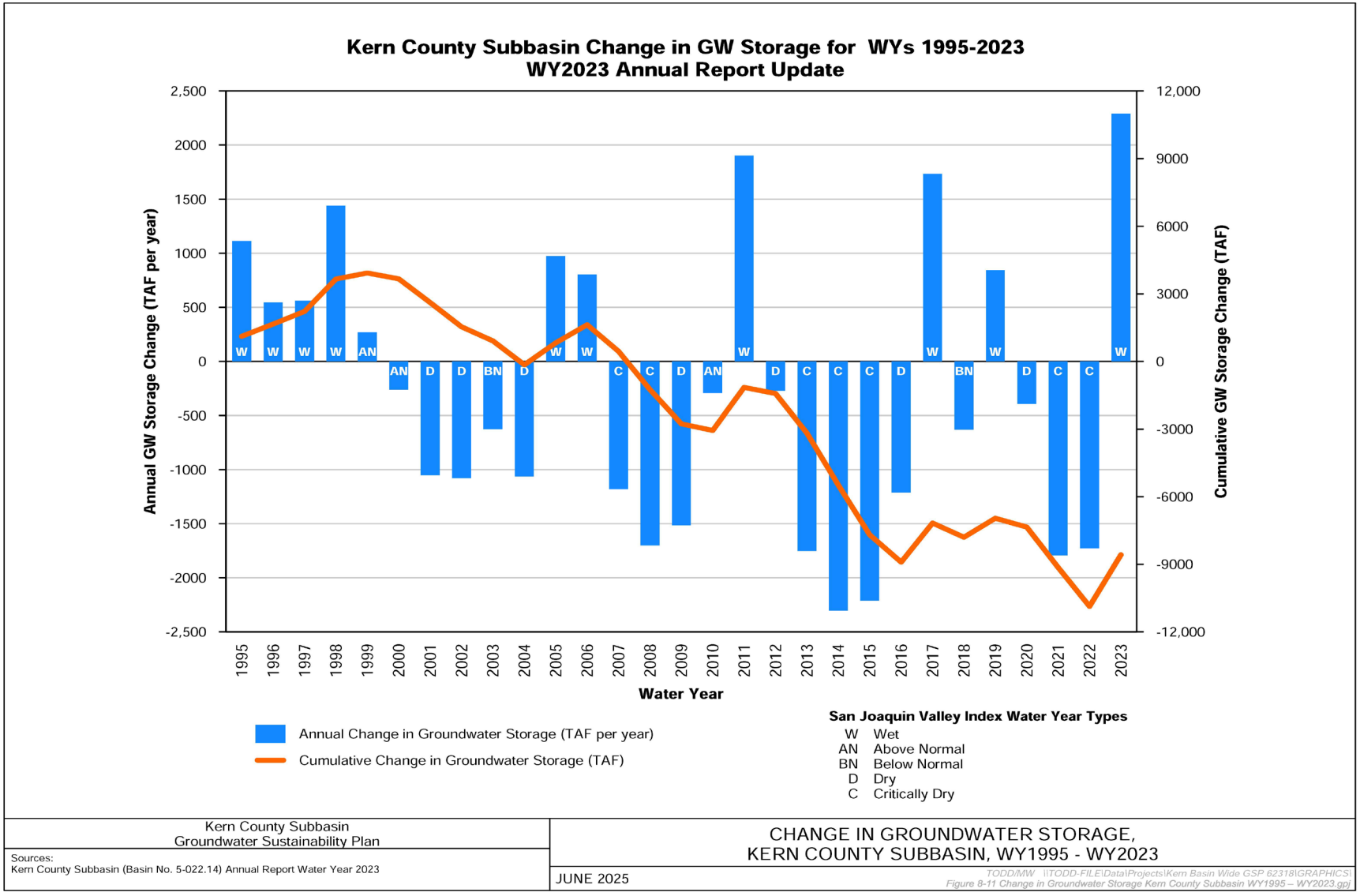


Figure 8-15. Annual Change in Groundwater Storage, WY1995 – WY2023

The variation in the simulated change in groundwater in storage over the historical period generally corresponds with the variation in climatic conditions and surface water supply availability (Figure 8-16). During the periods WY 1995 to WY 1999, WY 2005 to WY 2006, and WY 2011, the groundwater in storage volume was stable to increasing, which correlates to above average rainfall and surface water availability during these periods. During WY 2000 to WY 2004, WY 2007 to WY 2010, and WY 2012 to WY 2015, groundwater storage volume decreased, correlated to periods of drought and low surface water availability.

During below normal to critically dry water years (WYs 2016, 2018, 2020, and 2021) under the San Joaquin Valley Index (CDEC, 2023), the largest change in groundwater in storage and stored surface water is concentrated in the center of the Kern Subbasin in the vicinity of the large Kern Fan Banking Area along the Kern River. Other areas of concentrated groundwater recovery are noted to the north and southeast near those large water banking and conjunctive use projects. Widespread, but lesser, declines in groundwater storage are observed over most other areas of the Kern Subbasin. Some limited areas of slight increases are present south of the Kern River along the southeastern corner of the Kern Subbasin.

During the wet water years for WYs 2017 and 2019, the highest magnitude change in groundwater storage and stored surface water is again concentrated in the center of the Kern Subbasin in large Kern Fan Banking Area. In WY 2017, this area experienced a significant increase in storage due to the high volume of recharge in the Kern Fan Banking Area. Other areas of large-scale managed aquifer recharge are noted to the north and southeast parts of the Kern Subbasin as areas of high change in storage. Over the remainder of the Kern Subbasin, the change in groundwater in storage varies from areas with increases to areas with decreases; however, these areas of decreases are less than those noted in the WY 2016 maps. Areas of significant recharge also occur along the Kern River, Poso Creek and along the southeastern Margin of the Kern Subbasin.

8.2.1.2 Change in Groundwater in Storage Maps

The change in groundwater in storage maps based on C2VSimFG-Kern output has been reported in each of the Annual Reports provided to DWR. The C2VSimFG-Kern binary output files were accessed to extract the change in groundwater storage for each element and model layer. C2VSimFG-Kern output provides the total volume of storage change within a model element for all four model layers. To compensate for the fact that model elements vary in size, the data were normalized to the rate of acre-feet per square mile. The normalized rates were then interpolated onto a uniform one-square mile grid superimposed over the Kern Subbasin. Using the C2VSimFG-Kern groundwater model provides a consistent methodology for depicting generalized changes in storage across the Kern Subbasin, however, the version of the C2VSimFG-Kern available for this exercise does, not in all cases, represent accurate locations of

groundwater extractions or overlying demands. The map on Figure 8-16 shows a general representation of total changes in groundwater and surface water in storage generated by the C2VSimFG-Kern model for the entire Subbasin. The Kern Subbasin is currently conducting a Basin Study to update the model and improve accuracy for extractions and demands.

The effect of the water banking and conjunctive use projects is reflected in the areal distribution and magnitude of the change in groundwater storage and stored surface water. Figure 8-16 presents the six annual Subbasin-wide change in groundwater storage maps (which include changes in stored surface water) for WYs 2016 to 2021. The change represents the sum of the total inflow components plus the total outflow components. A positive value represents an increase in the volume of water stored in the aquifer, which is physically represented as a rise in groundwater levels whereas a negative represents a decrease in water in storage typified by a decline in groundwater levels.

Figure 8-16 illustrates how water banking and conjunctive use projects produce the most significant localized changes to water in storage due to the magnitude and concentration of such activities. For the critically dry year of WY 2022, these activities are dominated by large volumes of recovery pumping to provide a critical water supply when other surface water supplies are scarce. However, it should be noted that the decline in water in storage associated with the recovery pumping occurs only after similar or larger volumes of surface water have been stored in the Kern Subbasin, which has contributed to the overall amount of available water in storage in previous years. Agricultural and urban areas, in contrast, show lower magnitude annual changes on Figure 8-16, but these are more widespread over the Kern Subbasin. Localized recharge along the major streams and from runoff from the surrounding watersheds is significant in wet years but is diminished during the dry years.

8.2.1.3 Groundwater in Storage Change Estimated from Groundwater Elevation Maps

A calculated annual change in storage was developed to compare the groundwater elevation change with the simulated change in water in storage. This provides a method to calculate available storage within other mapped surfaces. Interpolated groundwater surfaces were developed for the Kern Subbasin for March 30 and September 30 of each year between 1985 and 2022.

For this assessment, a uniform set of well locations was used to interpolate a set of contoured time-series of groundwater elevation maps that can be consistently compared with one another. Approximately 2,500 wells representing the WYs 1993 to 2022 were extracted from the Kern Subbasin DMS and supplemented with data from the California Natural Resources Agency web portal (CNRA, 2023) to provide continuity with surrounding Subbasins. From this large dataset from a large number of wells, the locations were screened for spatial and temporal coverage to develop the uniform set of well locations used in the analysis.

The change in groundwater elevation is the difference between the average of a spring and fall groundwater measurement compared to a similar value from the previous year. Changes in the interpolated groundwater elevation surfaces (via numerical integration by subtracting head differences, by grid cell, and then summing), can be used to infer net changes in groundwater in storage by:

$$\mathrm{d}V = SA \sum_{i=1}^{N} \Delta h_i$$

where:

- dV = net changes in groundwater storage
- Δh = head difference in cell i,
- A = grid cell area (uniform),
- N = number of grid cells, and
- S = Storage Coefficient
- S = specific yield (Sy) for unconfined conditions with Sy = 0.075, or
- S = specific storage (Ss) x aquifer thickness (b) for semi-confined conditions where Ss =4.3×10^{-5} $feet^{-1}$

This thickness is based on the Kern Subbasin bottom from Section 7.6.2 and 7.6.6. The aquifer thickness (b) was variable based on geology with the average unconfined (b) = 250 feet. The maximum semi-confined thickness (b) = 2,500 feet to be consistent with maximum wells depths in the deeper portions of the Kern Subbasin. The storage coefficients for the Kern Subbasin are discussed in Section 7.

The resultant change in storage is summed for both the unconfined and semi-confined aquifer depth zones and compared to changes in storage output from modeled water budgets for 1995-2022. Figure 8-17 shows the annual comparison of the calculated and simulated storage from WYs 1995 to 2022. The Correlation Coefficient (R) for this comparison is 91 percent with the average difference between the two methods ranging from 9 percent to 14 percent over the periods WYs 1995 to 2014 and WYs 1995 to 2022, respectively. These results indicate good agreement, considering the nature of the groundwater dataset and associated processing, as described above, and the separate uncertainties associated with the modeled water budgets.

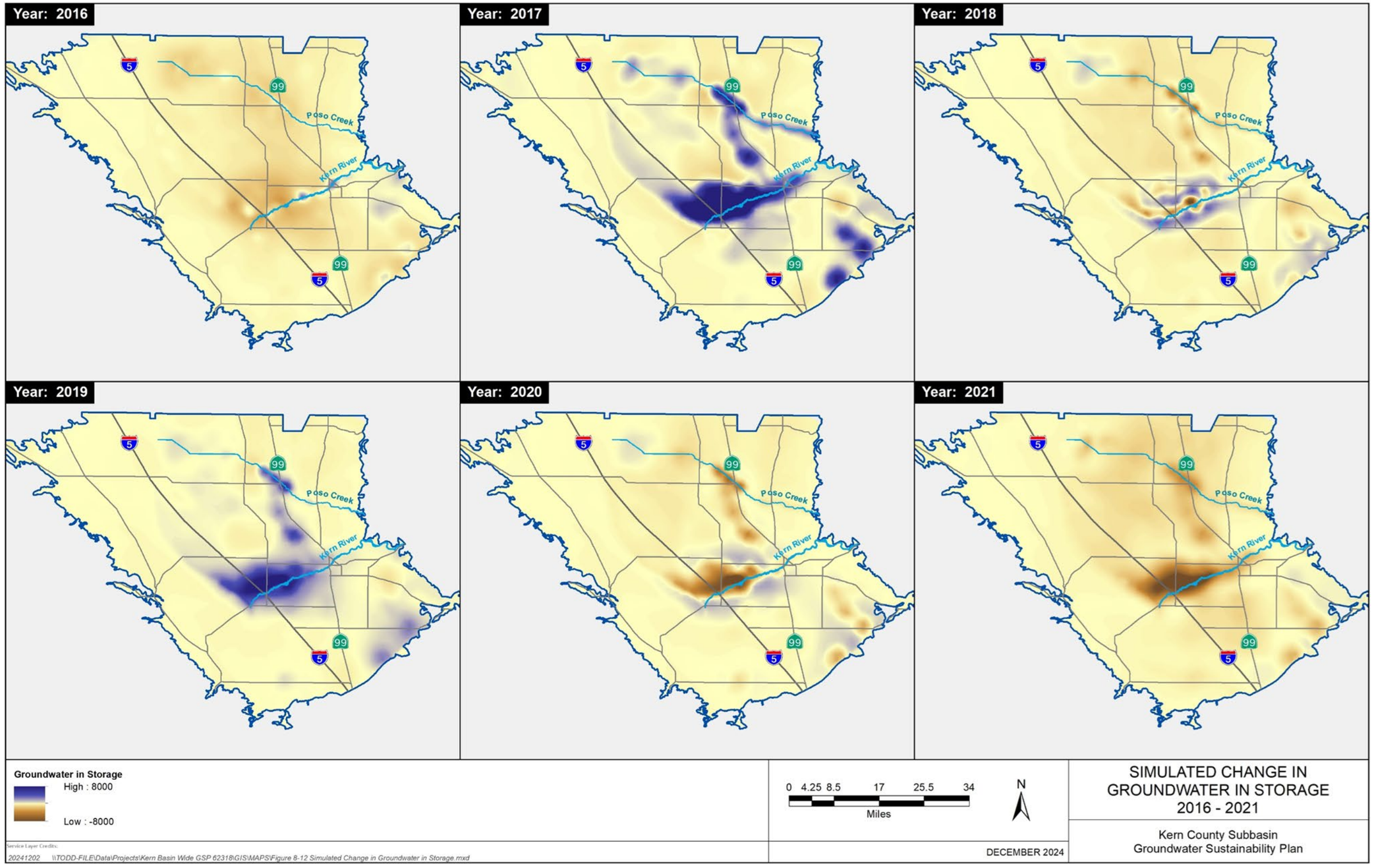


Figure 8-16. Simulated Change in Groundwater in Storage 2016-2021

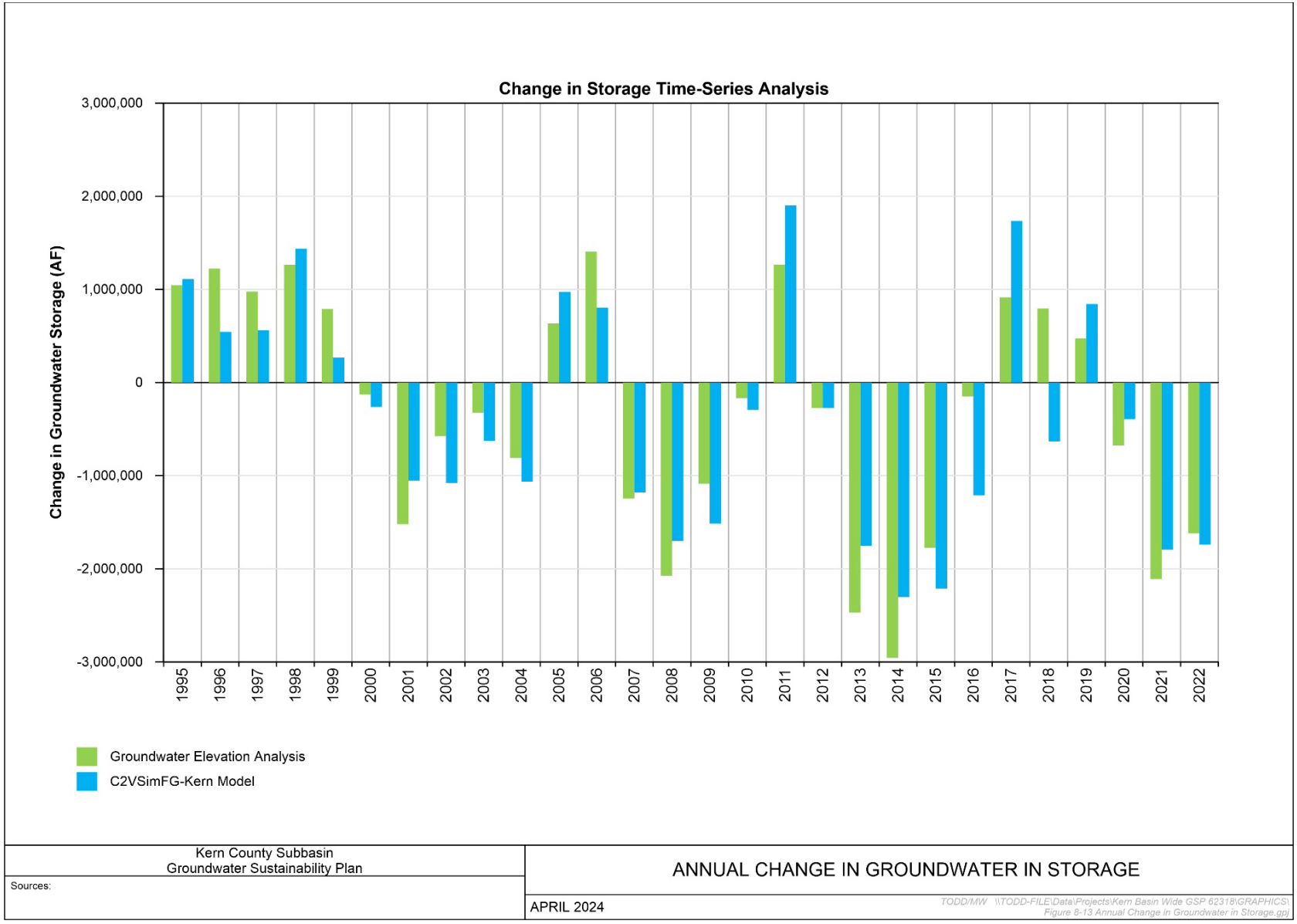


Figure 8-17. Annual Change in Groundwater in Storage (Elevation vs. Model Analysis)

8.2.2 Estimated Subbasin Water Storage Volume

An estimate of the total water in storage in the Kern Subbasin is not required by GSP Emergency Regulations; however, it is provided here as a useful context to put into perspective the relative scale of the change to annual and cumulative change in groundwater in storage with respect to the large size of the Kern Subbasin. The Kern Subbasin water storage volume represents the total volume of water in aquifer storage that is accessible for current or future water use within defined intervals of the aquifer.

A volumetric analysis was used to estimate the Kern Subbasin water storage volume within the Kern Subbasin. The methodology used the following steps:

- Select groundwater elevation surface.
- Define layers within the Kern Subbasin.
- Define storage calculation area.
- Determine saturated thicknesses.
- Determine storage coefficients.
- Calculate the volume of stored water.

The Fall 2019 groundwater elevation surface map (Figure 8-4) was used to define the upper bound for the volumetric analysis. Fall 2019 represents the period immediately prior to the GSP implementation period that began in January 2020 following the submission of the 2020 GSPs to DWR. This map represents a relatively high groundwater condition with the major water banks replenished following the wet hydrologic years of 2017 and 2019. Therefore, the Fall 2019 conditions provide an appropriate reference level for estimating the total water in storage in the Kern Subbasin. None of the areas of localized shallow groundwater conditions are included in the Fall 2019 groundwater elevation surface map.

The volumetric analysis was applied to the HCM Area for the Primary Alluvial Principal Aquifer as presented in Section 7 and shown on Figure 7-26. For the volumetric analysis, the Primary Alluvial Principal Aquifer was subdivided into four layers with boundaries that corresponded to the three major clay layers – E-Clay, Mid-Tulare Clay and Amincola Clay – that were defined within the Primary Alluvial Principal Aquifer as presented in Section 7.5.1 and shown on cross-sections (Figures 7-17 to 7-23). The layer boundaries were defined to exclude the thickness of these clay layers from the volumetric analysis so that the top of a layer was the base of the overlying clay and the base of the layer was the top of the underlying clay. Where these clay layers are absent, a stratigraphic correlation line was defined with a zero clay thickness.

To further focus the Kern Subbasin water storage volume estimate, the volumetric analysis was limited to the mapped area of the Fall 2019 groundwater elevation surface map (Figure 8-4). This was done to eliminate USEPA aquifer exemption areas and areas of poor groundwater quality from the volumetric analysis. This excluded areas

including the Western Fold Belt HCM Area and Kern River and Round Mountain USEPA aquifer exemption areas of the Eastern Margin HCM Area. These exclusion areas removed 774 square miles which represents a 28 percent reduction in the area of the Kern Subbasin used for the volumetric analysis. Contour maps for each layer boundary over the storage calculation area were developed using Golden Software's Surfer® mapping tool.

The total aquifer volume and saturated thickness were calculated using the Grid Volume Report function in Golden Software's Surfer® geologic mapping tool. The contour maps for each layer boundary were compared to the Fall 2019 groundwater elevation map. The saturated top for each layer were calculated using Surfer® using the following approach:

- If the groundwater elevation was above the layer top, the stratigraphic layer top elevation was used.
- If the groundwater elevation was within the layer thickness, the layer top elevation was moved to the groundwater elevation.
- If the groundwater elevation was below the layer bottom, the layer top was set equal to the layer bottom elevation so that the saturated thickness was zero.

A series of analyses were performed based on varying the maximum aquifer saturated thickness from 1,000 to 3,000 feet. A similar approach was used where:

- If the maximum depth was below the layer bottom, the stratigraphic layer bottom elevation was used.
- If the maximum depth was within the layer thickness, the layer bottom elevation was moved to the maximum depth.
- If the maximum depth was above the layer top, the layer bottom was set equal to the layer top elevation so that the saturated thickness was zero.

The Kern Subbasin water storage volume provides an estimate of the total water in storage within the aquifer. The storativity, or storage coefficient, is defined as the volume of water released from storage per unit surface area of the aquifer or aquitard per unit decline in hydraulic head (Woessner and Poeter, 2020; Todd and Mays, 2004; Heath, 1983; Freeze and Cherry, 1979). The storativity of an aquifer is defined by the following equation:

$$S = Sy + (Ss * b)$$

- Where: S = storativity or storage coefficient (dimensionless)
- Sy = specific yield (dimensionless)
- Ss = specific storage (L^{-1})
- b = aquifer, or layer, saturated thickness (L)

The specific yield is the volume of water stored in interstitial openings, porosity, that can be released by gravity drainage and is also referred as the unconfined storage. The specific yield, also referred to as effective porosity, is less than the total porosity of the aquifer (Freeze and Cherry, 1979). The specific yields used for the analysis vary from 0.12 in Layer 1 to 0.05 in Layer 4 to represent reduced storage in older and deeper sediments. The arithmetic average of the four layers is 0.075; however, the volumetric average ranged from 0.06 to 0.07, which illustrates the effect of varying specific yield with depth.

The second term of storativity equation is the product of the specific storage (Ss) and the saturated thickness (b) that is referred to as the confined storage. This term represents the water stored in the aquifer due to two mechanisms (1) the compaction of the aquifer (reduction in pore volume) caused by an increase in the effective stress, and (2) the expansion of the water caused by decreased pore water pressure (Woessner and Poeter, 2020; Todd and Mays, 2004; Heath 1983; Freeze and Cherry, 1979). Aquifer compaction releases water from an aquifer is controlled by the aquifer compressibility and water expansion is controlled by the fluid compressibility. Storativity of confined aquifers typically range from 0.00001 to 0.001 (1×10^{-5} to 1×10^{-3}). Lohman (1972) suggests the storativity for a confined aquifer can be approximated as 0.000001 ft^{-1} times the aquifer thickness, and this method was used to calculate the storativity for each layer.

In a pumping test analysis, the common practice to define the aquifer as either confined or unconfined and then apply the appropriate storativity term. For an unconfined aquifer, the specific yield is much larger than the specific storage term that the storativity is commonly set equal to specific yield. However, for the Kern Subbasin water storage volume, the objective is to estimate the total volume of stored water. Because the Kern Subbasin consists of a very large, thick aquifer, the storage calculation was done in two steps to include both the specific yield and specific storage components. These steps include:

- Porosity Storage Volume – is the product of the specific yield (Sy) and the aquifer saturated volume.
- Pressure Storage Volume – is the product of the specific storage storativity term (Ss * b) the groundwater elevation above the layer and the calculation area. The groundwater elevation above the layer and the storage volume area were calculated as a volume using Surfer® and presented in Table 2 as the Pressure Volume.

The results of the Kern Subbasin water storage volume are presented in Table 8-1. Table 8-1 includes the results of the calculation steps listed above and includes the aquifer parameters that were applied for each layer. Since the maximum well depths in the Kern Subbasin commonly range from 1,000 to 3,000 feet, the analysis was performed for different depth intervals within the Kern Subbasin to show how the Kern

Subbasin water storage volume changes with depth. The results of the volumetric analysis show that the Kern Subbasin water storage volume ranges between 80,000,000 to 180,000,000 acre-feet.

The approach for calculating the Kern Subbasin water storage volume includes several conservative assumptions to address uncertainty and limit the potential for overestimation of the total storage volume that are discussed above and are summarized below.

- The storage calculation area removed 774 square miles, or 28 percent of the Kern Subbasin, from the analysis to exclude areas with natural water quality issues and oil field USEPA aquifer exemptions.
- None of the localized shallow groundwater areas are included in the Kern Subbasin water storage volume.
- The major clay layers including the E-Clay, Mid-Tulare Clay and Amincola Clay were not included in the volumetric analysis.
- The analysis was run using different maximum depths to evaluate storage for different depth intervals.
- The specific yield was varied by layer to represent reduced storage in older and deeper sediments.
- The specific yield was varied by layer to limit storage potential in older and deeper sediments.

By using these conservative assumptions, this estimate of the Kern Subbasin water storage volume is considered representative of the usable storage within the Kern Subbasin.

Table 8-1. Sensitivity Analysis Results of Available Usable Storage Volume in the Kern Subbasin

Parameter	Units	Property	Basin Bottom	Rev-3000	Rev-2500	Rev-2000	Rev-1500	Rev-1000
Total Aquifer Volume								
Layer 1	acre-feet		130,000,000	130,000,000	130,000,000	130,000,000	130,000,000	130,000,000
Layer 2	acre-feet		710,000,000	710,000,000	710,000,000	710,000,000	710,000,000	670,000,000
Layer 3	acre-feet		1,520,000,000	1,420,000,000	1,310,000,000	1,090,000,000	710,000,000	280,000,000
Layer 4	acre-feet		610,000,000	400,000,000	290,000,000	160,000,000	0	0
Total	**acre-feet**		**2,970,000,000**	**2,660,000,000**	**2,440,000,000**	**2,090,000,000**	**1,550,000,000**	**1,080,000,000**
Average Saturated Thickness								
Layer 1	feet		100	100	100	100	100	100
Layer 2	feet		540	540	540	540	540	520
Layer 3	feet		1,170	1,090	1,010	830	550	210
Layer 4	feet		460	310	220	120	0	0
Total	feet		2,270	2,040	1,870	1,590	1,190	830
Porosity Storage Volume		**Sy**						
Layer 1	acre-feet	0.12	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000
Layer 2	acre-feet	0.08	56,000,000	56,000,000	56,000,000	56,000,000	56,000,000	54,000,000
Layer 3	acre-feet	0.05	76,000,000	71,000,000	66,000,000	54,000,000	36,000,000	14,000,000
Layer 4	acre-feet	0.05	30,000,000	20,000,000	14,000,000	8,000,000	0	0
Total	**acre-feet**		**178,000,000**	**163,000,000**	**152,000,000**	**134,000,000**	**108,000,000**	**84,000,000**
Pressure Storage Volume		**S**						
Layer 1	acre-feet	1.0E-04	14,000	14,000	14,000	14,000	14,000	14,000
Layer 2	acre-feet	5.4E-04	500,000	500,000	500,000	500,000	500,000	400,000
Layer 3	acre-feet	1.0E-03	2,800,000	2,500,000	2,200,000	1,600,000	900,000	200,000
Layer 4	acre-feet	2.2E-04	1,400,000	900,000	600,000	300,000	0	0
Total	**acre-feet**	**4.30E-05**	**4,700,000**	**3,900,000**	**3,300,000**	**2,400,000**	**1,400,000**	**600,000**

Parameter	Units	Property	Basin Bottom	Rev-3000	Rev-2500	Rev-2000	Rev-1500	Rev-1000
Estimated Water Storage Volume								
Storage Volume	**acre-feet**		**180,000,000**	**170,000,000**	**160,000,000**	**140,000,000**	**110,000,000**	**80,000,000**

Note: Results presented in Table 8-1 are calculated results rounded to two significant digits.

8.3 Seawater Intrusion

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

☑ **23 CCR § 354.16(c)**

Because the Kern Subbasin is located more than 60 miles from coastal areas, seawater intrusion is not considered to be an issue and therefore is not applicable.

8.4 Groundwater Quality

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

☑ **23 CCR § 354.16(d)**

Groundwater quality is characterized using a combination of data available from the State Water Resource Control Board (SWRCB) GAMA and GeoTracker databases, DTSC's EnviroStor database, Kern Subbasin DMS, and literature review. Groundwater constituents of concern (COCs) discussed in this section are based on the SWRCB's Groundwater Quality Considerations for High and Medium Priority Groundwater Basins letter to the DWR, dated November 22, 2022. Point-Source contamination sites are identified using SWRCB GeoTracker and DTSC EnviroStor databases. Oilfield Injection Wells and Produced Water Pond sites are extracted from GeoTracker. In addition to using GeoTracker, a literature review of oilfield injection wells studies in the Kern Subbasin are used to understand the extent to which there is contamination from oil and gas developments which impact groundwater quality.

8.4.1 Groundwater Quality Constituents of Concern

The COCs discussed in this section are for characterization purposes. The SWRCB's Groundwater Quality Considerations for High and Medium Priority Groundwater Basins letter to DWR states:

While it may not be appropriate for a GSP to set minimum thresholds and measurable objectives for all constituents identified for the basin, most or all of the constituents should be discussed in the basin setting since these constituents are present in the basin at concentrations that can impact beneficial users of groundwater.

The SWRCB's methodology for identifying COCs includes evaluation of numerous datasets from State and Regional Water Board regulatory programs. SWRCB staff

developed a list of COCs to be included in the 2025 Plan by evaluating sample results from the following datasets:

- Division of Drinking Water
- Department of Pesticides Regulation
- Irrigated Lands Regulatory Program
- GAMA Local Groundwater Projects
- USGS National Water Information System
- Water Board Clean Up and Permitted Sites

The methodology includes the following steps:

- Screening the data to represent domestic, irrigation/industrial, municipal, and other water supply well types.
- Excluding constituents not related to human health, not generally impacted by groundwater management activities, or not exceeding screening criteria in three or more wells subbasin wide.

Table 8-2 summarizes the prevalence of exceedances for constituents identified using the SWRCB's methodology and 2010 to 2023 data from GAMA, along with each constituent's associated water quality objective as set forth in the Water Quality Control Plan for the Tulare Lake Basin (Tulare Lake Basin Plan), which incorporates by reference maximum contaminant levels (MCLs) specified in Title 22 of the California Code of Regulations as applicable.

Table 8-2. Constituent Prevalence in Kern Subbasin (2015 to 2023)

Constituent	Water Quality Objective	# of Wells Exceeded	# of Wells Sampled	% of Wells Exceeded
1,2,3-Trichloropropane (1,2,3-TCP)	5 ppt	220	494	44.5%
Arsenic	10 ppb	113	495	22.8%
Benzene	1 ppb	2	454	0.4%
Dibromochloropropane (DBCP)	200 ppt	9	476	1.9%
Ethylene Dibromide (EDB)	20 ppt	3	472	0.6%
Gross Alpha	15 pCi/L	19	388	4.9%
Nitrate (as N)	10 ppm	112	740	15.1%
Nitrate + Nitrite (as N)	10 ppm	53	213	24.9%
Nitrite (as N)	1 ppm	11	623	1.8%
Perfluorooctane sulfonate (PFOS)[2]	4 ppt	30	203	14.8%
Perfluorooctanoic acid (PFOA)[2]	4 ppt	14	203	6.9%
Selenium	50 ppb	4	482	0.8%
Total Dissolved Solids	1,000 ppm[1]	65	541	12.0%

Constituent	Water Quality Objective	# of Wells Exceeded	# of Wells Sampled	% of Wells Exceeded
Uranium	20 pCi/L	20	284	7.0%

[1]Secondary Maximum Contaminant Level, Upper Limit.

[2] PFOS and PFOA are not adopted water quality objectives but were evaluated per SWRCB guidance.

As agricultural use is the primary use throughout the Kern Subbasin, agricultural thresholds are included in the table, where applicable. Agricultural thresholds were published by the Food and Agriculture Organization of the United Nations in 1985 (SWRCB Water Quality Goals). Notably, the agricultural thresholds identified in the table are not water quality objectives and the appropriateness of such thresholds may vary depending on a number of site-specific factors – including the presence (or non-presence) of salt sensitive crops. The thresholds are conservative and are protective of various agricultural uses, including irrigation of various types of crops and stock watering. At or below these thresholds, agricultural uses of water should not be limited. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program, which consists of the Central Valley Water Board and other stakeholders in the valley, is currently in the process of preparing a long-term plan for salinity management for the whole of the Central Valley. As part of this process, CV-SALTS is evaluating and considering the development of appropriate salinity targets for groundwater subbasins throughout the Valley. If CV-SALTS identifies salinity targets appliable to the Kern Subbasin that are protective of the agricultural beneficial use that are different than the agricultural thresholds identified here, the GSAs will then revise these agricultural thresholds as appropriate. Agricultural thresholds are specifically a concern for TDS because the drinking water standards for TDS, which are based on consumer acceptance levels, may be too high to be protective of salt sensitive crops.

Each constituent is further evaluated by HCM Area, including the range, median, exceedances based on pre-2015 and 2015 to 2023 conditions to better characterize the COCs. GAMA data from 2010 to 2023 have been used for pre-2015 and 2015 to 2023 evaluations. Figure 8-18 shows the distribution of wells used for groundwater quality evaluation.

Section 7.6.5 and shown in Figures 7-35 and 7-36, the Western Fold Belt and the Eastern Margin HCM Areas contain various primacy and post-primacy aquifer exemptions. Certain groundwater under the historic Tulare Lakebed was de-designated for municipal and agricultural beneficial uses in 2017, as shown in the Tulare Lake Basin Plan (2018 CVRWQCB Basin Plan). In addition, in 2023, the Central Valley Water Board proposed an amendment to the Tulare Lake Basin Plan to designate oilfields near Lost Hills, located in the Western Fold Belt HCM Area. Additional proposed de-designations are under development and may be considered by the Central Valley Water Board in the future. The 2025 Plan will be updated accordingly in the future when subsequent Basin Plan Amendments become effective. Minimal to no pumping is

observed in the Western Fold Belt HCM Area. This is consistent with historic and existing degraded water quality and de-designation of beneficial uses in this HCM Area by the Central Valley Water Board. Rather than extracting groundwater, users within this HCM Area import surface water and/or recovered surface water supplies from banking facilities to meet supply demands.

8.4.2 Connecting Constituents of Concern to Undesirable Results

In addition to using sample results from multiple databases to characterize groundwater quality by HCM Area, data was also processed to identify exceedances based on pre-2015 and 2015 to 2023 conditions to establish baseline conditions, and data trending was conducted to define the relationship between water levels and constituent concentrations. Trend analysis is also used to determine if chronic lowering of groundwater levels has resulted in degraded water quality. Each COC is discussed in the following subsections with a brief conclusion section that summarizes the driving mechanisms for exacerbating the constituent concentration. Findings from this section are used to establish SMCs and define conditions for Undesirable Results (Section 13.3).

GSAs have identified domestic and small community well owners as the most vulnerable beneficial users (Section 13.3.1.1). The Kern Subbasin has identified 44 small community water systems serving an estimated population of 8,886 people through 56 active wells (reviewed November 1, 2024). The Kern Subbasin's Well Inventory (February 2025) has identified 2,322 domestic wells (including non-public water systems and non-potable well users). Section 5.6.1 and 5.6.2 present well inventory and well density per HCM Area, showing that there are minimal wells along the western part of the Kern Subbasin and a lower density of wells in the south-eastern part of the Kern Subbasin.

Based on Criteria Used to Define Undesirable Results (Section 13.3.1.4), groundwater quality undesirable results will be triggered in the Subbasin if any of the following conditions occur:

1) Subbasin-wide, 15 percent of RMW-WQ exceed the MT for COCs per water year based on confirmed sample and MT exceedance investigation results; or,
2) Annually, 5 percent of domestic wells have an assumed MT exceedance based on radius of influence analysis around the RMW-WQ that exceeds the MT, with cumulative maximum of 15 percent of domestic wells through 2040; or,
3) A GSA is unable to meet mitigation needs.

Since water quality data are not available for domestic and non-public wells, GSAs will rely on the baseline characterization in the following subsections when conducting an MT exceedance investigation (Appendix K-1). Additionally, small community water system data can typically be used as a proxy for domestic wells. Figure 8-18 shows the distribution of wells used for baseline characterization of groundwater conditions.

Figure 8-19 shows the distribution of small community and domestic wells across the Kern Subbasin, as well as the designated groundwater quality representative monitoring wells (discussed in more detail in Section 15). Appendix K-1, *Action Plan for Degraded Water Quality*, contains an attached table with baseline data for small community wells. Chemographs were prepared for RMW-WQs (Appendix I-4) that also provide data that represents baseline conditions and includes data from nearby proxy wells.

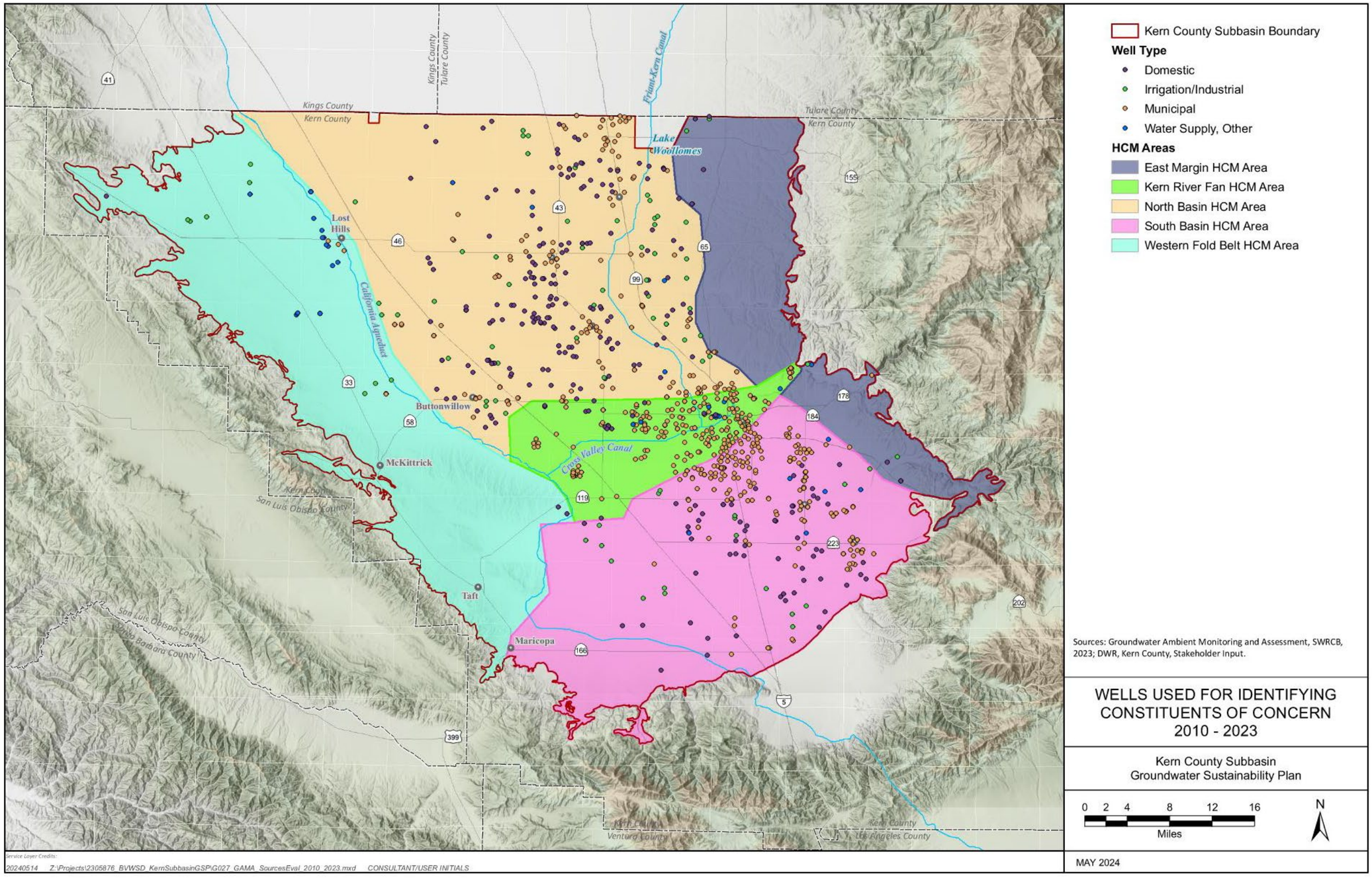


Figure 8-18. Wells Used for Groundwater Characterization

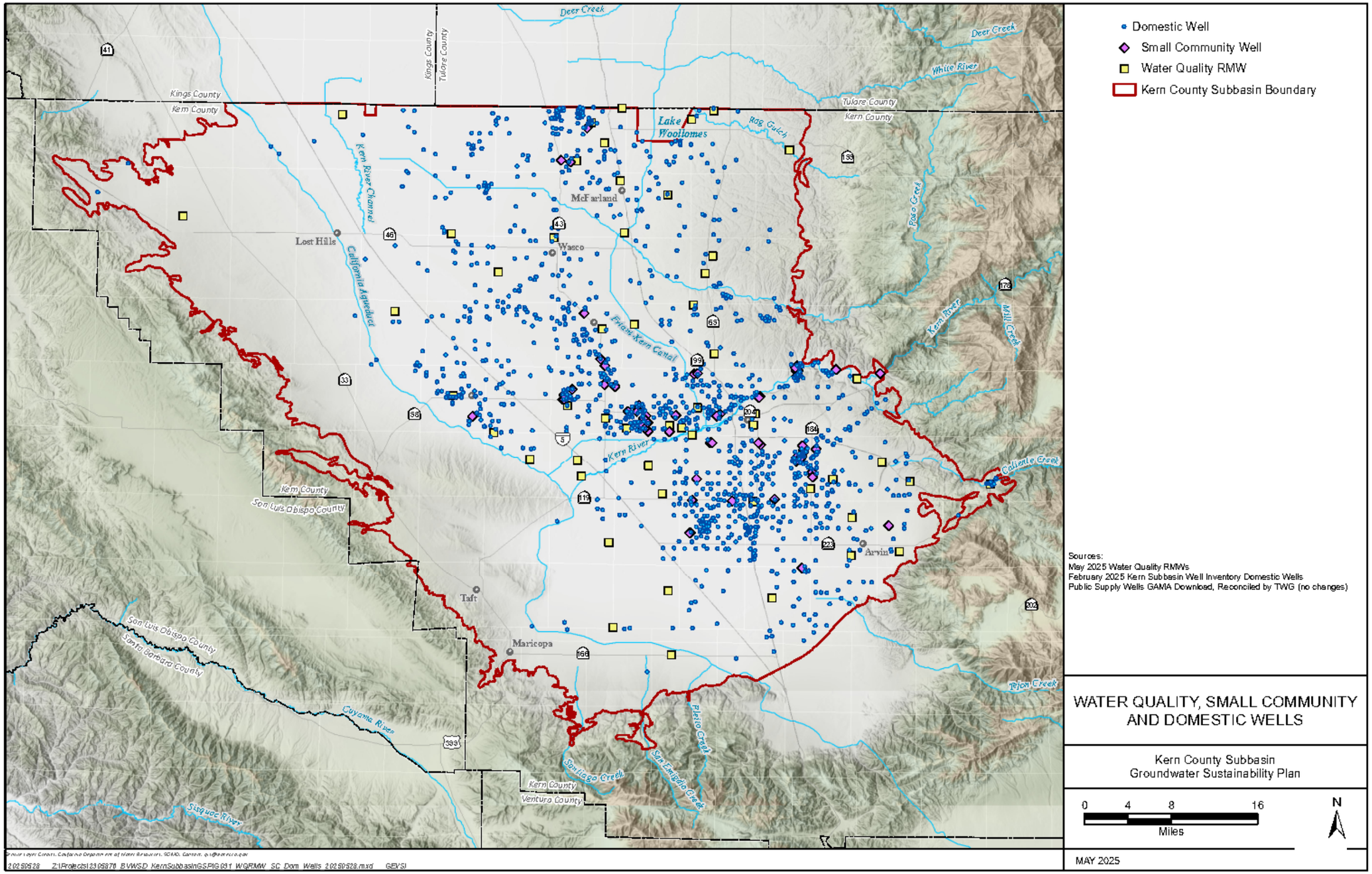


Figure 8-19. Distribution of Small Community and Domestic Wells

8.4.2.1 1,2,3-Trichloropropane (1,2,3-TCP)

1,2,3-TCP is a synthetic organic chemical with a water quality objective based on the Basin Plan's incorporation of the primary MCL of 5 parts per trillion (ppt) for protection of the municipal beneficial use. 1,2,3-TCP is widespread throughout the Kern Subbasin. Throughout the Central Valley, most of the 1,2,3-TCP found in groundwater was introduced through application of soil fumigants sold under the trade names of D-D and Telone. The inclusion of 1,2,3-TCP in the fumigants was not necessary or known to those using the fumigants. These fumigants were applied by land application from 1950 through 1984. Telone II remains on the market today but no longer contains 1,2,3-TCP. The active ingredients of these soil fumigants were reported to be highly effective and decomposed in the soil; 1,2,3-TCP was an inert ingredient that bonds to water and sinks in the aquifer. 1,2,3-TCP is a highly stable compound, meaning that it is resistant to degradation and has an estimated half-life of hundreds of years (Samin et al., 2012). Fumigants containing 1,2,3-TCP as an inert ingredient were discontinued in 1984. Litigation against the manufacturers that added 1,2,3-TCP to fumigants continues today throughout the Kern Subbasin.

Figure 8-20 displays the 1,2,3-TCP median concentration, which is then grouped into concentration ranges, of the 2010-2023 GAMA well dataset to show where 1,2,3-TCP exceeds the water quality objective. Exceedances of 1,2,3-TCP are primarily observed in the Kern River Fan, North Basin and South Basin HCM Areas where urban development has moved into historically agricultural areas. Table 8-3 summarizes pre-2015 and 2015 to 2023 concentrations of 1,2,3-TCP with the median and range for each HCM Area[1]. The 1,2,3-TCP median concentration for each HCM Area is non-detect; however, the range shows there are areas with 1,2,3-TCP concentrations above the water quality objective in the North Basin, Kern River Fan and South Basin HCM Areas. The upper range of 1,2,3-TCP concentration is higher in 2015 to 2023 conditions in the Kern River Fan and the South Basin HCM Areas and lower in the North Basin HCM Area relative to pre-2015 conditions. Table 8-4 summarizes pre-2015 and 2015 to 2023 1,2,3-TCP water quality objective exceedances for each HCM Area. While the number of wells with 1,2,3-TCP water quality objective exceedances increases from the pre-2015 to the 2015 to 2023 conditions, these increases do not indicate increasing concentrations, or degradation of groundwater quality. Rather, it reflects a more comprehensive understanding of 1,2,3-TCP distribution as the number of wells sampled increased when the drinking water primary MCL became effective in January 2018 for public water systems.

[1] Significant variability is observed in TCP concentration, which is common; however, some of the non-detect results may have been analyzed by methods with detection limits that are too high to be relevant to the water quality objective. When possible, this data is scrubbed but sample results downloaded from GAMA do not typically provide the method. EPA methods 524.2 for VOCs and 504.1 for SOCs are commonly used methods for drinking water analyses, which also report on TCP but at irrelevant detection limits.

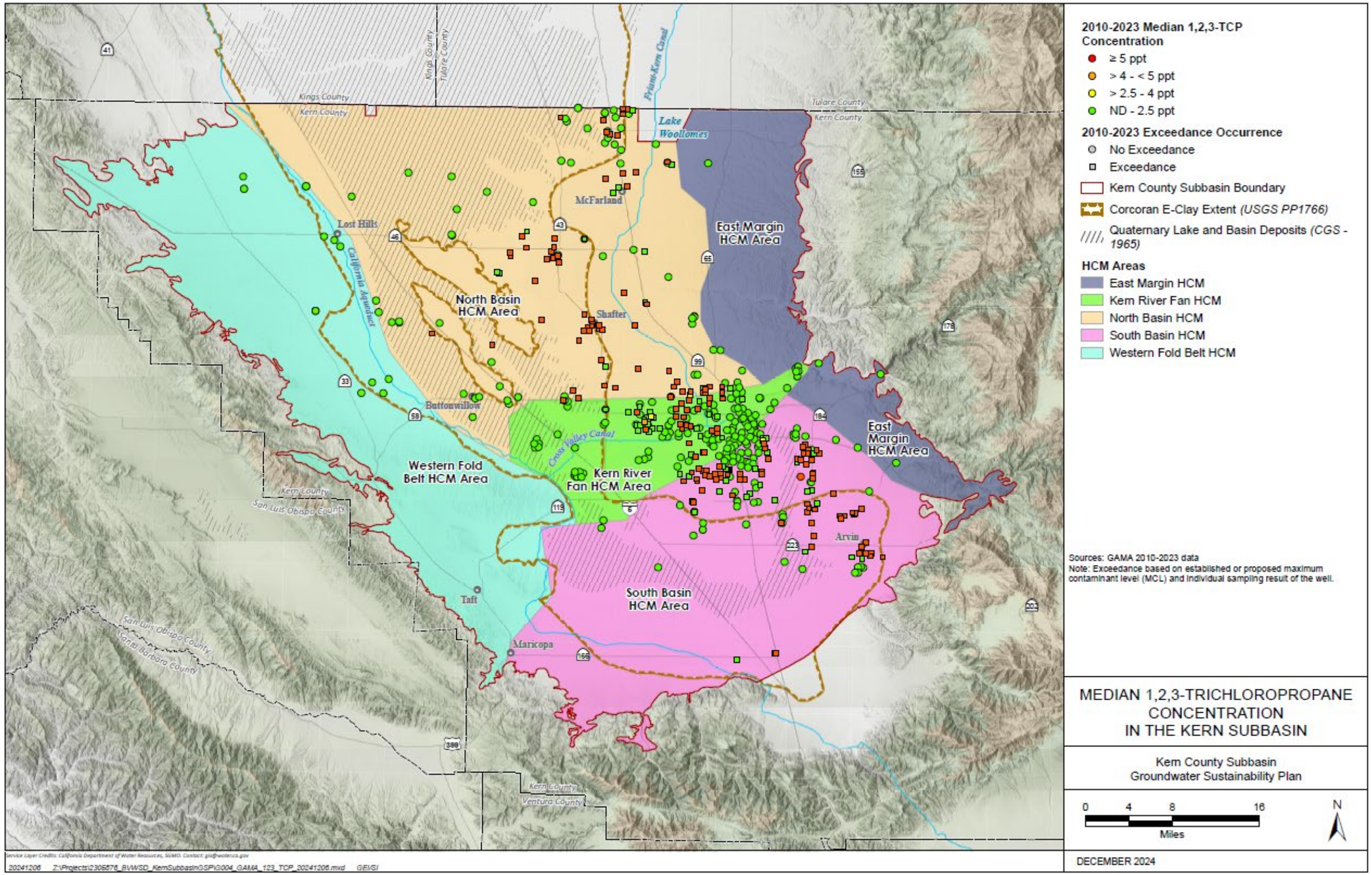


Figure 8-20. Median 1,2,3-TCP Concentration

Table 8-3. 1,2,3-TCP Range and Median Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	Range (ppt)	Median (ppt)	# of Wells Sampled	Range (ppt)	Median (ppt)	# of Wells Sampled
Western Fold Belt	ND	ND	1	ND	ND	17
North Basin	ND – 800	ND	78	ND – 536	ND	139
Kern River Fan	ND – 370	ND	131	ND – 550	ND	163
South Basin	ND – 450	ND	118	ND – 570	ND	169
Eastern Margin	ND	ND	1	ND	ND	6

Table 8-4. 1,2,3-TCP Well Water Quality Objective Exceedance Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Western Fold Belt	0	1	0.0%	0	17	0.0%
North Basin	32	78	41.0%	76	139	54.7%
Kern River Fan	21	131	16.0%	49	163	30.1%
South Basin	45	118	38.1%	95	169	56.2%
Eastern Margin	0	1	0.0%	0	6	0.0%
Total	98	329	29.8%	220	494	44.5%

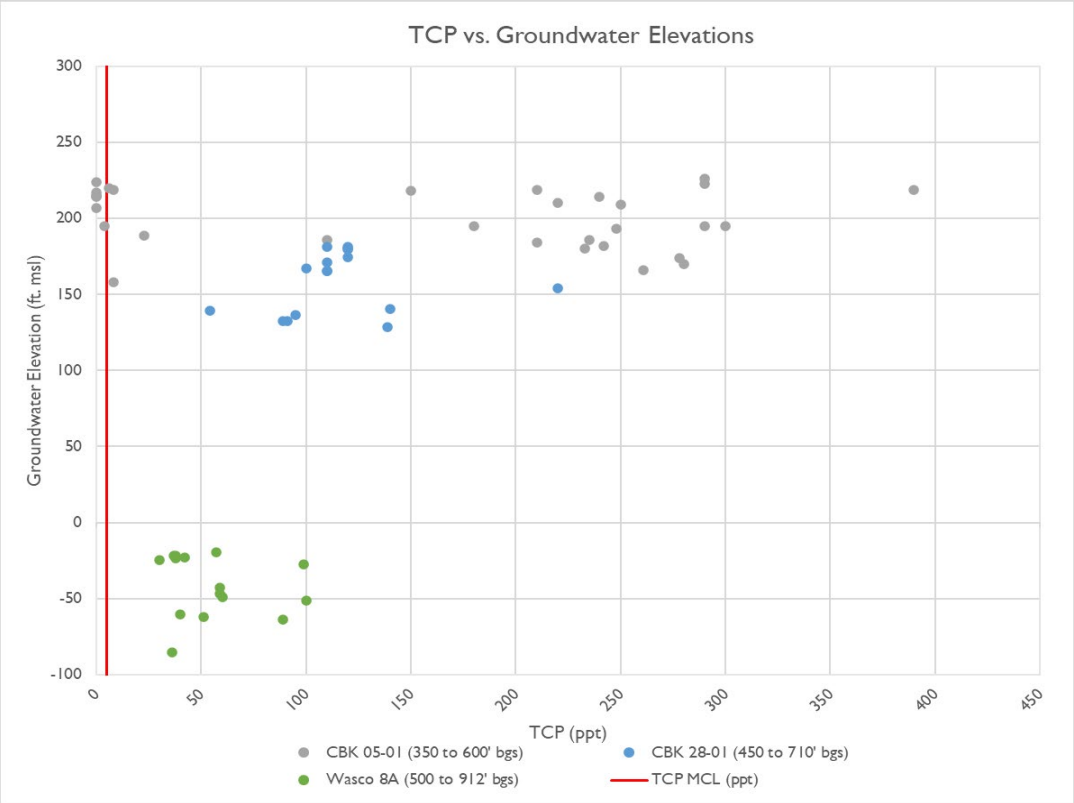
For consistency with other constituents, 1,2,3-TCP median concentrations for wells within and outside the boundaries of E-Clay (Corcoran Clay) and the lake deposits are summarized in Table 8-5. However, the only relationship between 1,2,3-TCP prevalence and clay deposits is lower occurrence where the clay is serving as a physical barrier that impedes downward 1,2,3-TCP migration. Additionally, the soil fumigants that contained 1,2,3-TCP were typically applied to row crops (potatoes, carrots, sugar beets, etc.) which are mostly grown in sandy soils, not where dense clays are present. Consequently, the greatest prevalence of 1,2,3-TCP is within areas where urban development has overtaken previous agricultural areas.

Table 8-5. Median 1,2,3-TCP Summary for Wells within E-Clay or Lake Deposits Boundaries

HCM Area	Geology	2010-2023 Median (ppt)	2010-2023 # of Wells Sampled
Western Fold Belt	Alluvial Fan and E-Clay	ND	9
	Neither	ND	8
North Basin	E-clay and Lake Deposits	ND	28
	E-Clay	7	52
	Neither	ND	69

HCM Area	Geology	2010-2023 Median (ppt)	2010-2023 # of Wells Sampled
Kern River Fan	E-Clay and Lake Deposits	ND	12
	E-Clay	ND	13
	Neither	ND	144
South Basin	E-Clay and Lake Deposits	ND	10
	E-Clay	10.5	46
	Lake Deposits	5	3
	Neither	ND	119
Eastern Margin	Neither	ND	6

Of the 494 wells sampled for 1,2,3-TCP in the Kern Subbasin, 220 wells have concentrations above the water quality objective, which is based on the primary MCL. Data trending was performed in the three HCM Areas where 1,2,3-TCP is detected above the water quality objective. Figure 8-21 shows the large fluctuation between sample results from each well with no relevant correlation to changes in groundwater elevations or other groundwater management activities. Similarly, Figure 8-22 provides a chemograph with a representative example of a well with fluctuating 1,2,3-TCP concentrations that have no ostensible correlation with groundwater elevations or groundwater management activities.



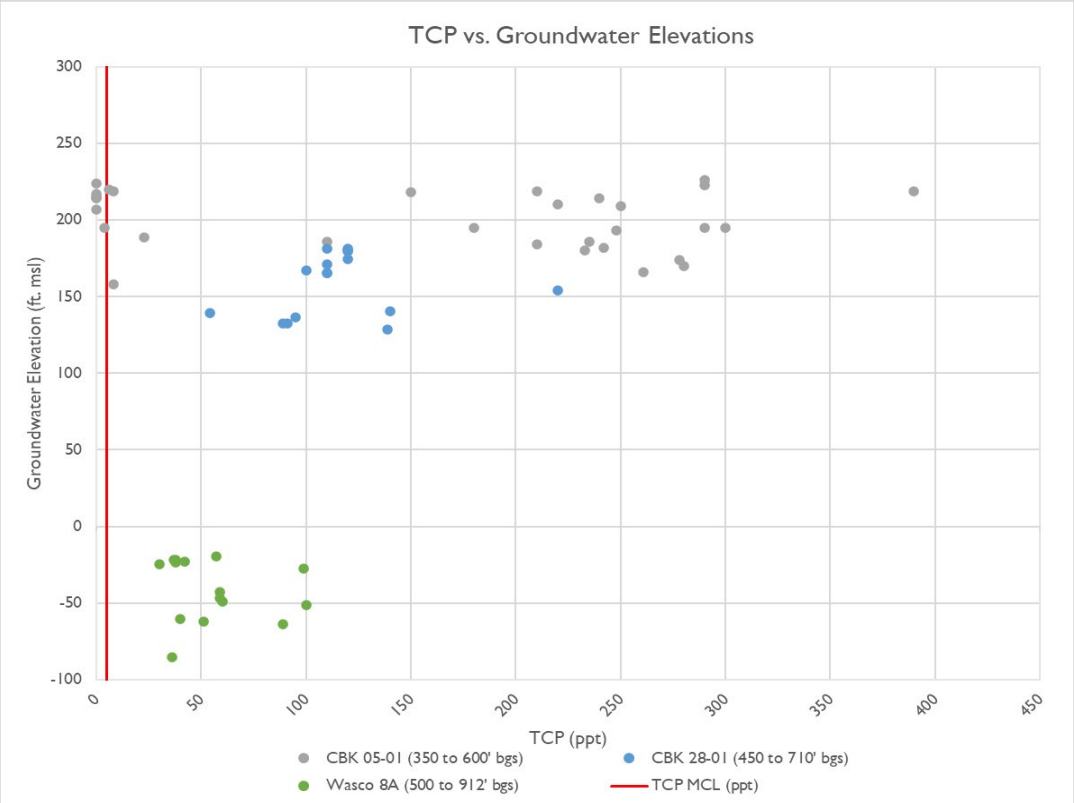


Figure 8-21. 1,2,3-TCP vs. Groundwater Elevations

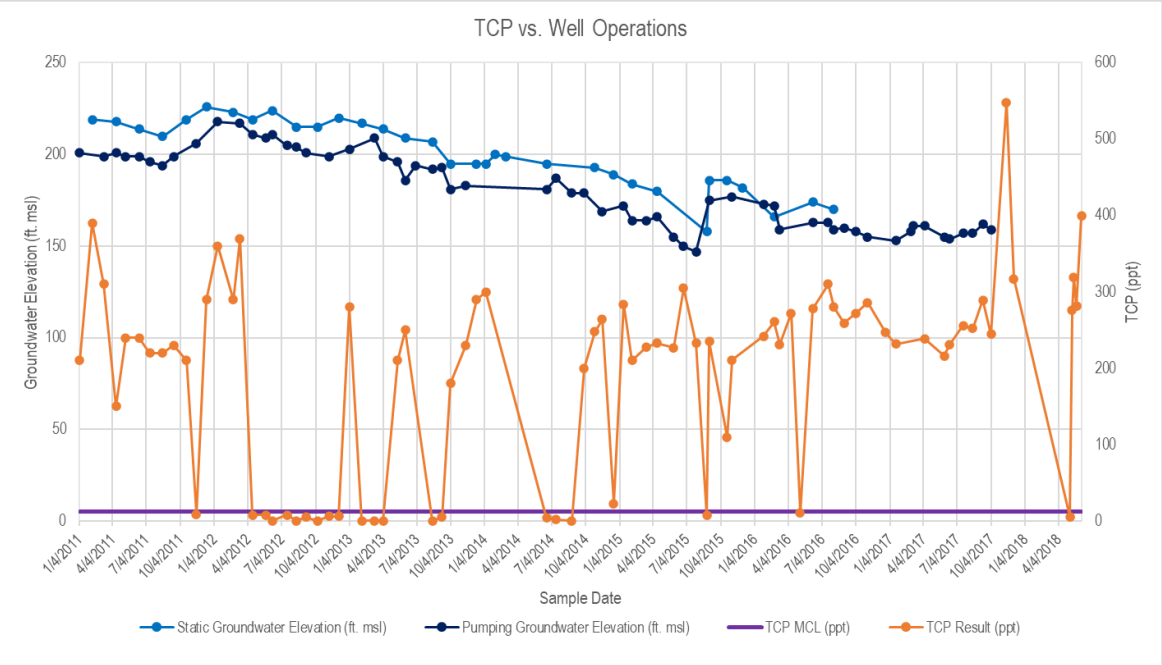


Figure 8-22. 1,2,3-TCP vs. Groundwater Elevations

Based on our evaluation of available data and understanding of groundwater operations 1,2,3-TCP concentrations show significant variation that are likely correlated with pumping patterns from local well operations (hours of active pumping or length of time the well is pumped before a sample is collected). To further demonstrate the correlation between well operation and 1,2,3-TCP concentration, Figure 8-23 and Figure 8-24 shows one well, located in Kern River Fan HCM Area, plotted with static and pumping groundwater elevations and then plotted with monthly production data. This well is a representative example of extreme fluctuations where 1,2,3-TCP ranges from non-detectable levels to more than 100 ppt.

Monthly production volumes (million gallons) are shown with the 1,2,3-TCP concentrations in Figure 8-23. Initially these data were plotted to evaluate a potential correlation between well operation and 1,2,3-TCP concentration. Since production data are monthly, and grab samples represent a single point in time, the trends are not directly aligned. However, there are periods, such as spring through late summer 2015, and summer 2016 through fall 2017, which show consistency. After this well was seasonally taken offline (December 1, 2017, through April 30, 2018), a 1,2,3-TCP sample was collected after approximately two hours of flushing; the result was 5.6 ppt. After the well started operating normally, routine samples were collected and showed an increasing trend as operational hours increased (Figure 8-23 and Figure 8-24).

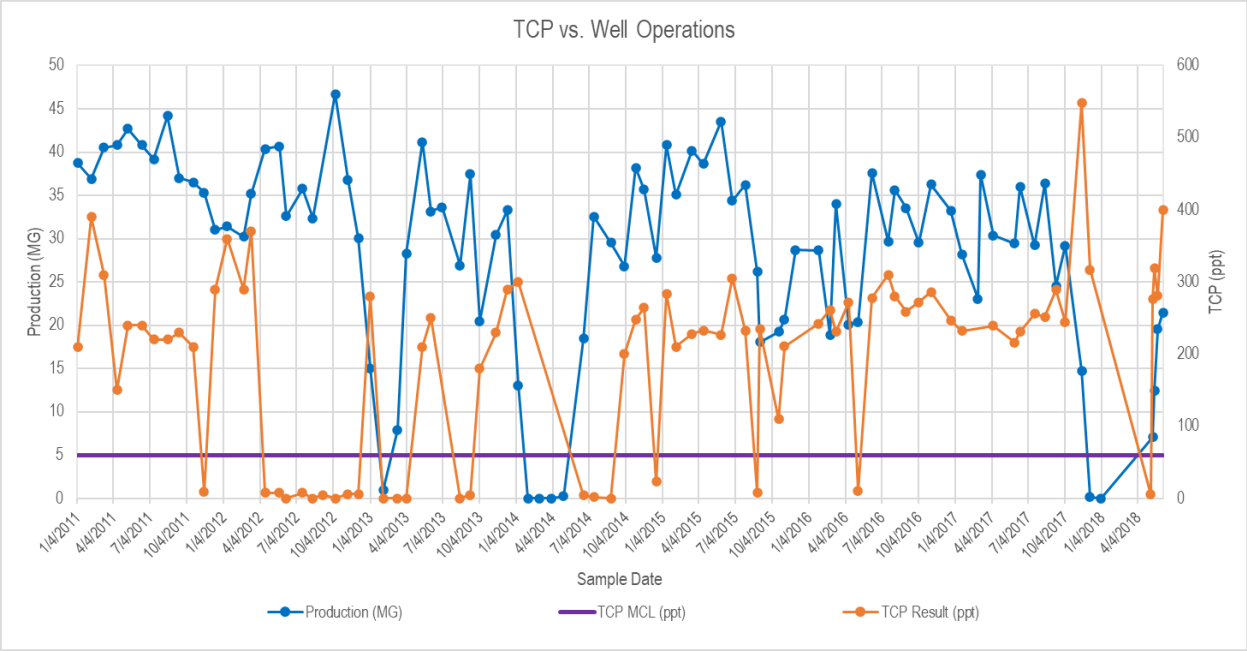


Figure 8-23. 1,2,3-TCP vs. Well Operation

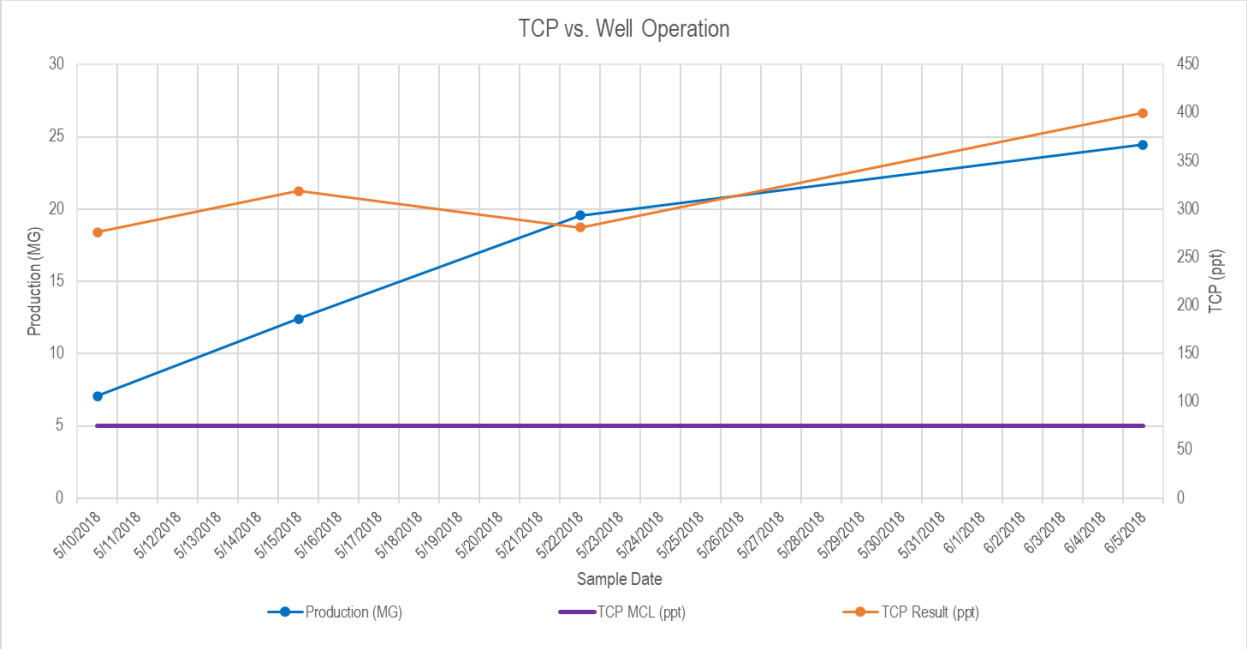


Figure 8-24. 1,2,3-TCP vs. Well Operation

Driving Mechanisms for Exacerbating 1,2,3-TCP Concentrations and Conclusion Statement

Since 1,2,3-TCP is anthropogenic and is predicted to last hundreds of years in groundwater, concentrations are entirely related to the volumes of contaminated fumigants that were applied that contained 1,2,3-TCP. As discussed in the trending and data analysis sections, the concentration represented by grab samples are highly variable and have been found to correlate with well operation in some cases. However, unlike most groundwater constituents, well construction does not appear to limit TCP concentrations (refer to Figure 8-21 for an example of well depths vs TCP concentrations).

1,2,3-TCP is widespread throughout the Kern Subbasin and is identified as a COC for semiannual monitoring. Figure 8-25 shows the median concentration in small community wells, with the density of domestic wells throughout the Kern Subbasin. Approximately 49 percent of small community wells have a maximum concentration of 1,2,3-TCP above the water quality objective of 5 ppt and 26 percent have a median concentration above the water quality objective, which implies that 1,2,3-TCP consistently exceeds the water quality objective in those wells.

While analysis of historical data shows extreme fluctuations between sample results likely related to local well operations, and no relevant correlation between increasing concentrations caused by groundwater management activities, the GSAs are collecting Subbasin-wide data correlated with water level measurements before making a firm conclusion on the relationship between 1,2,3-TCP concentrations and groundwater management activities. Based on data currently available, no direct correlation has been observed that indicates 1,2,3-TCP concentrations are exacerbated by groundwater management activities.

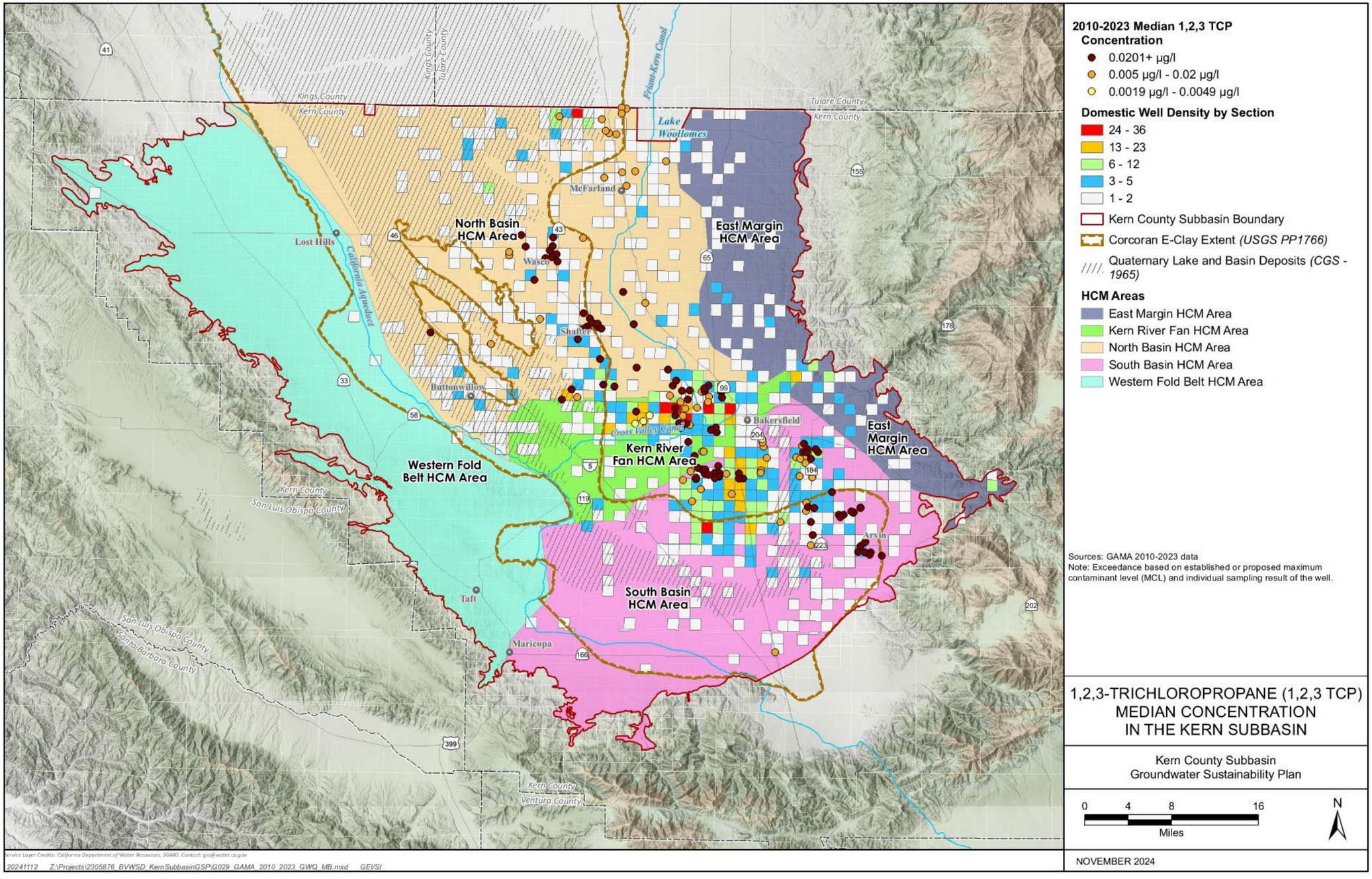


Figure 8-25. Median 1,2,3-TCP Concentration of Small Community Wells

8.4.2.2 Arsenic

Arsenic is a naturally occurring trace element with a water quality objective for the protection of the municipal beneficial use based on the primary drinking water MCL of 10 parts per billion (ppb). In aquifer systems, arsenic is commonly adsorbed onto clay surfaces, and to iron (Fe-III) and manganese (Mn-IV) oxyhydroxide coatings on mineral grains or included in sulfide minerals (pyrite, FeS_2) by substitution for sulfur in the mineral structure (Brannon and Patrick, 1987; Raven et al., 1998; Lin and Puls, 2000; Graft et al., 2002; Goldberg, 2002; Farquhar et al., 2002; Tufano et al., 2008). Arsenic can be released from aquifer sediments into groundwater by several geochemical processes, which include desorption when surface pH increases from values less than 8 to greater than 8.5 under toxic conditions, reductive dissolution of iron and manganese oxyhydroxides under geochemically reduced or anoxic conditions, oxidation and dissolution of sulfide minerals, and competitive desorption by increased concentrations of competing anions such as phosphate (Welch et al., 2000; Smedley and Kinniburgh, 2002; Welch and Stollenwerk, 2003; Barringer and Reilly, 2013; Lin and Puls, 2000; Neil et al., 2012).

In the southern San Joaquin Valley, arsenic-rich minerals such as arsenopyrite (FeAsS), a common constituent of shales and apatite, and phosphorites are the most common sources of arsenic leaching sediments in the aquifer (Burton et al., 2012). These minerals are bound in the E-clay deposits and in the valley trough where thick lakebed clay deposits, such as the Tulare Lake, Kern Lake, and Buena Vista Lake beds, are present (Bulletin 118, DWR). In this Kern Subbasin, arsenic-rich minerals in the E-clay are typically present in the upper portion of the aquifer system (approximately 300-feet below ground surface). Whereas areas with lakebed deposits typically show higher arsenic concentrations in the deeper portion of the aquifer because the arsenic is bound in the lakebed deposits that typically occur near the base of fresh water. The USGS reports finding that arsenic concentrations increase across the valley trough where aquifer sediments are finer and reducing conditions favor arsenic mobilization into groundwater (Haugen et al., 2021). Additionally, higher arsenic concentrations have been observed during periods when groundwater elevations are low. This occurrence is believed to be a result of less dilution from the shallow (newer) groundwater available to mix with the older groundwater, which contains higher arsenic concentrations.
Figure 8-26 presents the median arsenic concentrations as well as areas with E-Clay and lakebed deposits.

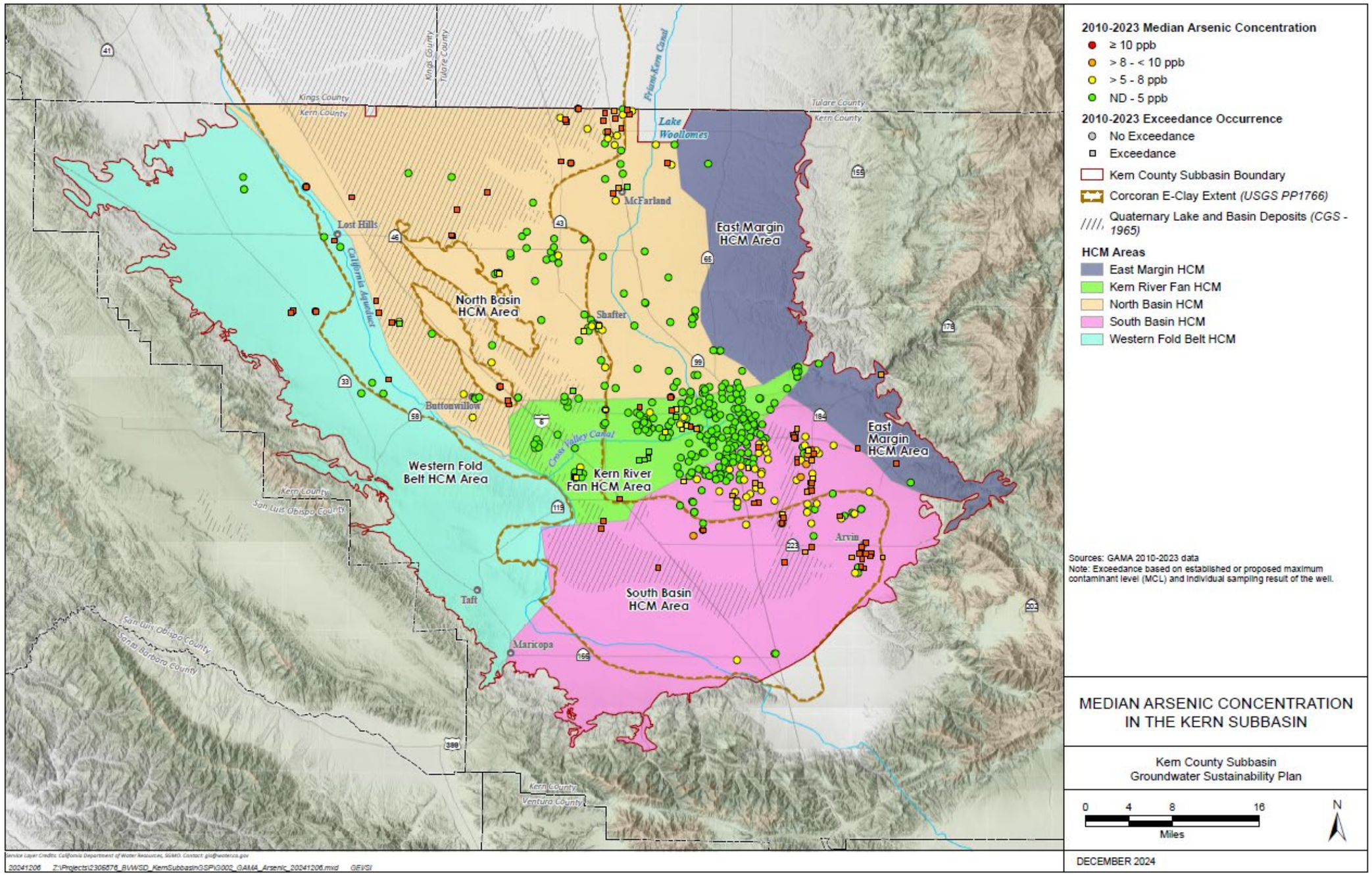


Figure 8-26. Median Arsenic Concentration in the Kern Subbasin

As illustrated in Figure 8-26, higher arsenic concentrations are primarily seen in the North and South Basin HCM Areas, where the wells are within or near the E-clay or lake deposit boundaries. Table 8-6 summarizes pre-2015 and 2015 to 2023 arsenic median concentration and range for each HCM Area. The arsenic median concentration for each HCM Area is below the water quality objective; however, the range shows there are sources with arsenic concentrations above the water quality objective in each HCM Area. Notably, the upper range of arsenic concentration is higher in 2015 to 2023 conditions, but the median concentration for each HCM Area remained relatively stable, except for in the South Basin HCM Area which increased from 3.2 to 5.2 ppb relative to pre-2015 conditions.

Table 8-7 summarizes pre-2015 and 2015 to 2023 arsenic exceedances for each HCM Area. While the number of wells with arsenic water quality objective exceedances for each HCM Area is greater from the pre-2015 to the 2015 to 2023 conditions, these increases do not necessarily indicate degradation of groundwater quality. Rather, it may reflect a more comprehensive understanding of arsenic distribution as the number of wells sampled increased in all HCM Areas from the pre-2015 to the 2015 to 2023 conditions.

Table 8-6. Arsenic Range and Median Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	Range (ppb)	Median (ppb)	# of Wells Sampled	Range (ppb)	Median (ppb)	# of Wells Sampled
Western Fold Belt	ND	ND	1	ND - 156	4.1	20
North Basin	ND - 45	3.4	104	ND - 300	2.7	138
Kern River Fan	ND - 25	ND	148	ND - 210	ND	161
South Basin	ND - 140	5.1	137	ND - 220	5.7	170
Eastern Margin	ND - 13	4.6	3	ND - 36.4	6.2	6

Table 8-7. Arsenic Well Water Quality Objective Exceedance Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Western Fold Belt	0	1	0.0%	8	20	40.0%
North Basin	22	104	21.2%	33	138	23.9%
Kern River Fan	11	148	7.4%	19	161	11.8%
South Basin	34	137	24.8%	50	170	29.4%
Eastern Margin	1	3	33.3%	3	6	50.0%
Total	68	393	17.3%	113	495	22.8%

Since E-clay and lake deposits have arsenic-rich minerals that can mobilize arsenic into groundwater, higher median arsenic concentrations are typically present within and near the outside the boundaries of E-Clay and the lake deposits, as summarized in Table 8-8. In the South Basin HCM Area, wells that exceed the arsenic water quality objective are mostly within the boundary of lakebed deposits. Notably, well construction can significantly influence groundwater quality, but was not taken into consideration for this analysis. Rather, this is a broad interpretation of the prevalence of arsenic based on hydrogeologic conditions.

In the Western Fold Belt HCM Area, arsenic exceedances of the water quality objective from 2015 to 2023 occurred in eight USGS monitoring wells. As mentioned in Section 5.6.4 and Section 8.4.1, a majority of the Western Fold Belt HCM Area's agricultural and urban water supplies are either imported or derived from other HCM Areas due to historic and naturally poor water quality related to marine sediments in this HCM Area. Historic groundwater quality conditions in the Western Fold Belt HCM Area are further discussed in the TDS section. In the Eastern Margin HCM Area, arsenic water quality objective exceedances from 2015 to 2023 occurred in two wells - a municipal non-transient non-community public water supply well and an USGS well.

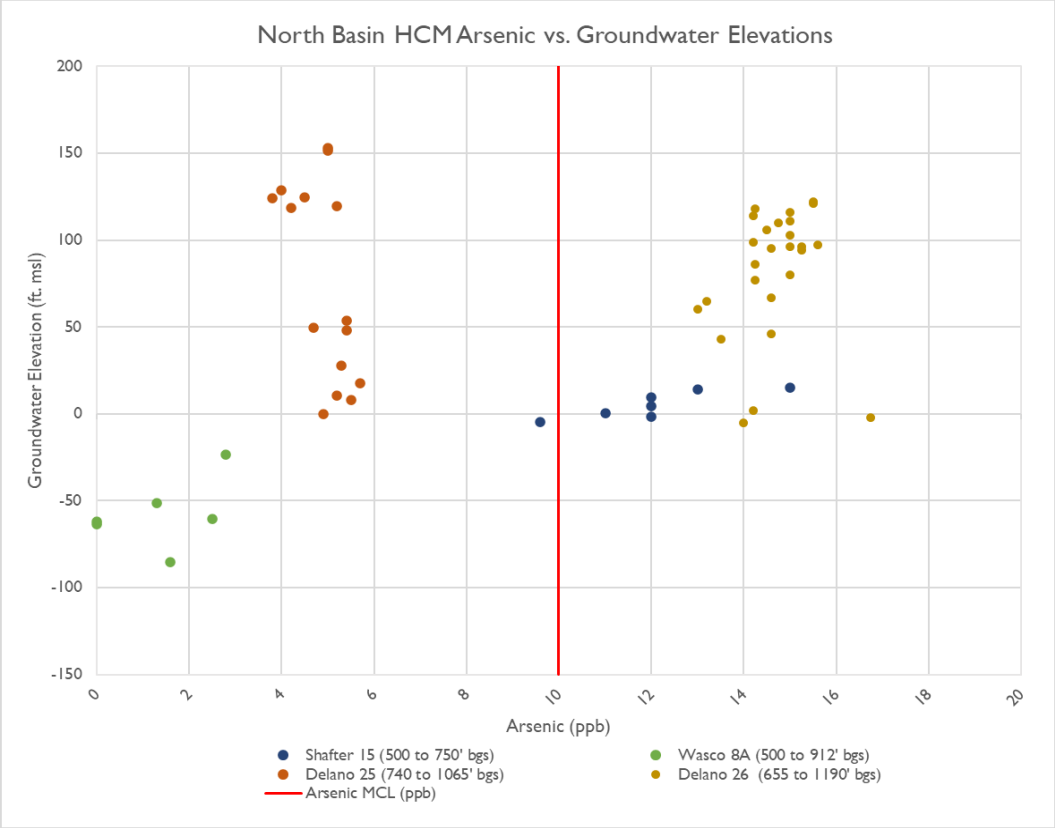
Wells in the North Basin, Kern River Fan, and South Basin HCM Areas representing portions of the aquifer above and below the E-clay or where the E-clay is not present were trended to assess the influence of location and well construction on arsenic concentration. The following sections further discuss the arsenic trends in the North Basin, Kern River Fan, and South Basin HCM Areas based on available data and literature on previously conducted studies.

Table 8-8. Median Arsenic Summary for Wells within E-clay or Lake Deposits Boundaries

HCM Area	Geology	2010-2023 Median (ppb)	2010-2023 # of wells sampled
Western Fold Belt	E-Clay and Alluvial Fan	ND	9
	Neither	5.6	11
North Basin	E-Clay and Lake Deposits	5.2	29
	E-clay	4.1	54
	Neither	2	71
Kern River Fan	E-Clay and Lake Deposits	ND	11
	E-Clay	ND	15
	Neither	ND	141
South Basin	E-Clay and Lake Deposits	11	9
	E-Clay	6.4	48
	Lake Deposits	8.7	4
	Neither	5.2	118
Eastern Margin	Neither	4.4	8

As shown in Figure 8-26, wells with higher arsenic concentration are in the Delano-McFarland area of the North HCM Area, primarily where the E-Clay is present. Schmidt and Associates (2007) conducted a study of arsenic concentrations in the Delano-McFarland area. Vertical distribution of arsenic in groundwater from pilot hole isolation zone sampling, public supply wells, and the color of subsurface deposits for six wells were evaluated to characterize groundwater conditions. Based on this study, arsenic concentrations increased with depth and are generally higher below depths ranging from 900 to 1000 feet bgs where blue-green deposits are present, indicative of reduced groundwater conditions. The study concluded that in the Delano-McFarland area, groundwater above a depth of 900 feet bgs has oxidized conditions and usually contains arsenic concentrations below 10 ppb.

North Basin HCM Area well trending of four wells shows elevated arsenic concentrations present at similar screen intervals depths, except Shafter well 15 (Figure 8-27). At groundwater elevations 151 to 0 feet msl and 122 to -5 feet msl, Delano 25 and 26 have consistent arsenic concentrations of 4 to 6 and 13 to 17 ppm, respectively. Both wells have similar screen interval depths; however, Delano 25 is within the boundary of the E-clay while Delano 26 is right outside the boundary (~0.3 miles), outside of the confining layer. Unlike Delano 25, arsenic concentrations at Delano 26 consistently exceed the water quality objective. Limited data for Wasco 8A and Shafter 15 tentatively correlates increasing arsenic concentrations at increasing groundwater elevations approaching the E-clay. Arsenic concentrations in Shafter 15 are generally above the water quality objective, fluctuating between 9 to 15 ppb with minimal groundwater elevation changes. The highest arsenic concentrations for all the wells screened below the E-Clay (Shafter 15, Wasco 8A, and Delano 25) are at groundwater elevations of approximately 25 to 0 feet msl.



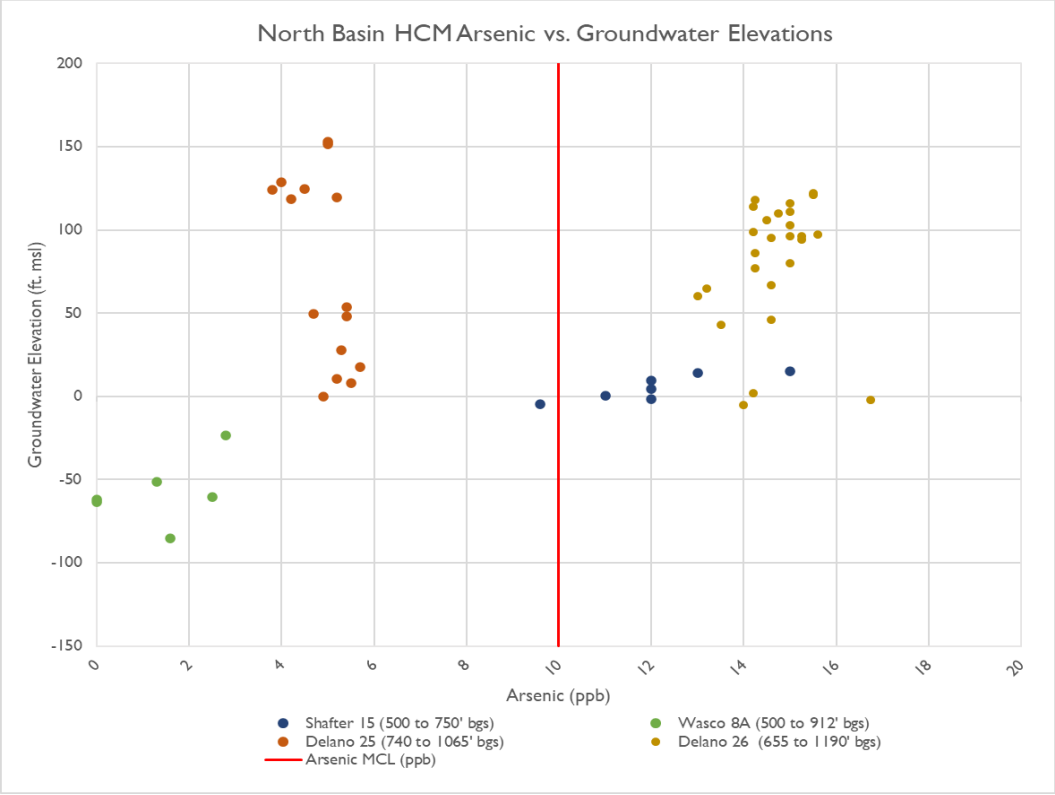


Figure 8-27. North Basin HCM Area Arsenic vs. Groundwater Elevations

The Kern River Fan HCM Area serves as the major source of groundwater recharge and surface water storage for the Kern Subbasin. Banking operations in this HCM Area show a distinct groundwater elevation response, ranging from 25 to 300 feet msl. Figure 8-28 shows arsenic trends for three wells, Enos, RRBWSD Shop and WKWD Well 6-06, which are situated within recharge basin areas. For each well, arsenic concentrations remain consistently well below half of the water quality objective, irrespective of groundwater elevation fluctuation and well screening depths of 260 to 750 feet bgs.

Figure 8-29 shows wells situated one to four miles from a recharge basin. In contrast to the less variable arsenic concentration of wells within a recharge basin area, arsenic concentrations in the wells situated outside of the recharge basin area showed greater fluctuations and response to groundwater elevation change. Most notable are wells CBK 32 and Greenley, showing opposing responses to groundwater elevation changes. Well CBK 32, screened at 400 to 710 feet bgs, demonstrates arsenic concentration increasing in response to declining groundwater elevation. Higher arsenic associated with wells constructed deeper than 650 feet bgs could be related to the local clay deposits in the Kern River Fan HCM Area. Greenley, screened at 310 to 410 feet bgs, demonstrates arsenic levels increasing with groundwater elevation increase.

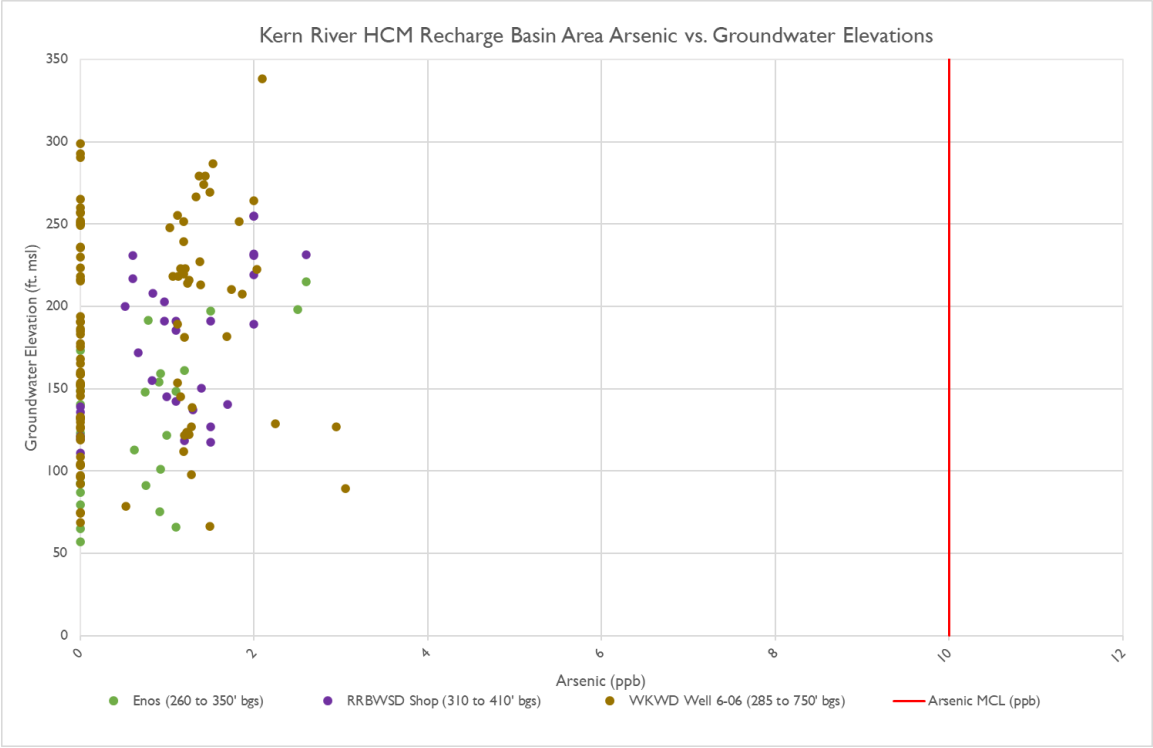


Figure 8-28. Kern River Fan HCM Area Arsenic vs. Groundwater Elevations in Recharge Basin Areas

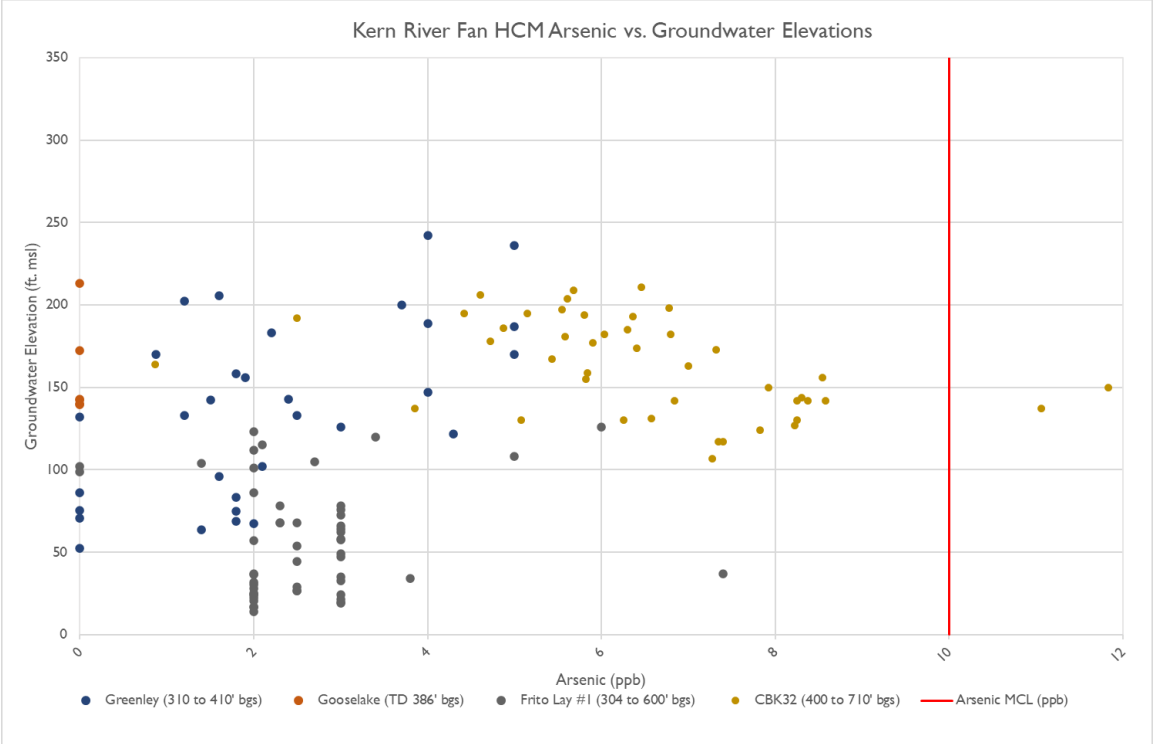


Figure 8-29. Kern River Fan HCM Area Arsenic vs. Groundwater Elevations outside Recharge Basin Areas

In the South Basin HCM Area, high arsenic concentration clusters are located south of the City of Bakersfield along the lakebed deposits and in the City of Arvin within the E-clay boundary.

Oasis Property Owners Association (OPOA) Well 03, screened from 360 to 600 feet bgs, Arvin 14, screened from 600 to 900 feet bgs, and LPUD Well 17, screened from 400 to 705 feet bgs, are located in a cluster of high arsenic wells and were trended to represent wells with deeper construction. EL ADOBE POA Well 01, screened from 0 to 75 feet bgs, and EWRWC Well 01, screened from 270 to 470 feet bgs, represent wells with more shallow construction.

Trend evaluation of specific wells represents well location in relation to E-clay and lake deposit boundary. OPOA Well 03 is located slightly outside the E-clay and lake deposits boundary among the well cluster south of the city of Bakersfield. Arvin 14 is in the city of Arvin cluster within the E-clay boundary. LPUD Well 17 is located within the E-clay boundary. EL ADOBE POA Well 01 is located within the E-clay and lake deposits boundary and EWRWC Well 01 is located within only lake deposits boundary.

Trending of wells in the South Basin HCM Area showed that arsenic concentrations tend to fluctuate regardless of screen intervals depths and groundwater elevation, except at LPUD Well 17, which showed consistent arsenic concentration regardless of groundwater elevation changes. OPOA Well 03 arsenic concentrations showed slightly increasing trend as groundwater elevations increase while Arvin 14, EL ADOBE POA

Well 01, and EWRWC Well 01 concentrations seem to be more variable with groundwater elevation changes.

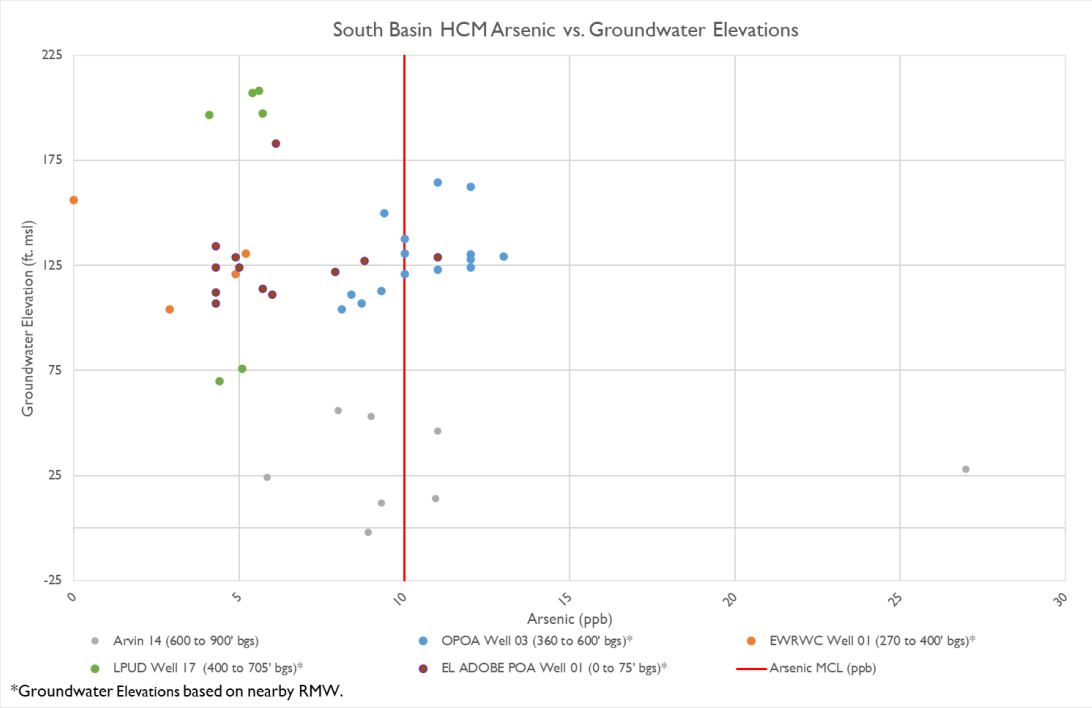


Figure 8-30. South Basin HCM Area Arsenic vs. Groundwater Elevations

While wells within the E-Clay or lakebed deposit boundary tend to have higher arsenic concentrations, trending demonstrated well construction, proximity to recharge basins and groundwater elevation may also impact arsenic concentrations. Wells where an arsenic concentration trend is identified and consistent, whether the trend is arsenic levels are stable or the trend is arsenic levels can be correlated to groundwater elevation, can provide insight into arsenic levels of the Kern Subbasin.

Driving Mechanisms for Exacerbating Arsenic Concentrations and Conclusion Statement

Arsenic is commonly found where arsenopyrites are bound in clay deposits. Where the E-Clay is present, wells with screened intervals across the clay layers have high arsenic concentrations, with no relationship to groundwater levels. Outside of the E-Clay, arsenic is also commonly found in the deeper portions of the aquifer, near the base of fresh water. Wells with deep screened intervals can show high arsenic concentrations. Since arsenic concentrations are typically high in wells constructed to depths near the base of fresh water, it is possible that some wells will be influenced by declining groundwater levels. However, observation from public supply wells indicates this relationship is strongly dependent on lithology and the total completed depth of the well. Generally, arsenic is regionally present above the drinking water quality objective of 10 ppb:

- Where the E-clay is present with screens across the clay deposits.

- In the Delano-McFarland Area, in some wells that are deeper than 800 feet bgs.
- In the Kern River Fan HCM Area, in some wells that are deeper than 600 feet bgs.
- In the eastern portion of the South Basin HCM Area, in some wells that are deeper than 550 feet bgs.

Of the GAMA data used for characterization, it was observed that wells moderately deeper than these region-specific depths (approximately 100 feet deeper) tend to fluctuate above and below the water quality objective with water level changes. Whereas wells significantly deeper (i.e. wells that extend into the base of fresh water) than the region-specific levels are more likely to exceed the arsenic water quality objective. Arsenic above the water quality objective in groundwater is not widespread throughout the Kern Subbasin; however, it is identified as a COC for semiannual monitoring that is coordinated with groundwater level measurements.

Figure 8-31 shows the median concentration in small community wells, with the density of domestic wells throughout the Kern Subbasin. Approximately 14 percent of small community wells have a maximum concentration of arsenic above the 10 ppb water quality objective; and, 11 percent have a median concentration above the water quality objective. Based on the data trending analysis and the narrow range between percentage of wells with maximum and median arsenic concentrations above the objective, well construction appears to contribute to most objective exceedances.

The GSAs are collecting Subbasin-wide data correlated with water level measurements to monitor the relationship between arsenic concentrations and groundwater management activities. Based on data currently available, a slight correlation has been observed in some wells between exacerbating arsenic concentrations and chronic lowering of groundwater levels.

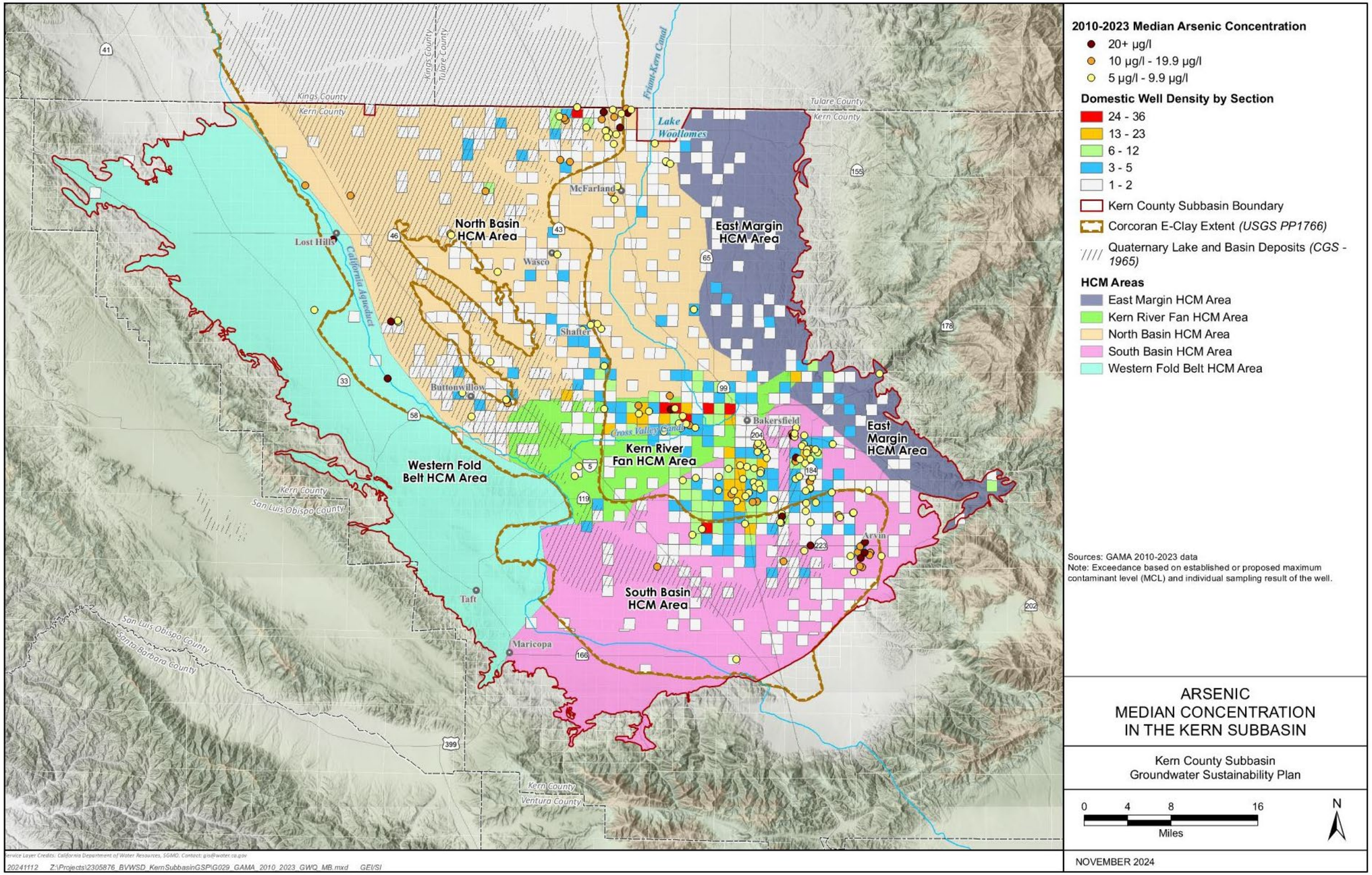


Figure 8-31. Median Arsenic Concentration of Small Community Wells

8.4.2.3 Benzene

Benzene has a water quality objective for the protection of the municipal beneficial use based on the primary MCL of 1 ppb. Sources of benzene in the Kern Subbasin are from crude oil and gasoline, but also from naturally occurring volcanic gases and smoke resulting from forest fires. Benzene may be released to groundwater through leaking underground fuel storage tanks and piping, fuel spills during transportation, and leaks at refineries. Figure 8-32 displays the median concentration of benzene per well, along with if the well had an exceedance of the water quality objective for benzene.

Based on the range of concentration, median and number of sources exceeding the water quality objective, benzene is not prevalent in the Kern Subbasin. Table 8-9 summarizes pre-2015 and 2015 to 2023 median and range of benzene detections for each HCM Area. The benzene median concentration in each HCM Area is non-detect. The range of detections in the North Basin, Kern River Fan, and Eastern Margin HCM Areas are also non-detect. In the South Basin HCM Area, benzene is detected below the water quality objective in one municipal well; this detection was not confirmed and is not included in the DDW dataset from GAMA. In the Western Fold Belt HCM Area, data where benzene was detected is from the USGS NWIS dataset from GAMA. Well categories include one industrial/irrigation, one municipal and one other water supply. Of the three wells with detections, two wells have detections above the water quality objective. Table 8-9 and Table 8-10 summarizes the benzene water quality objective exceedances for each HCM Area.

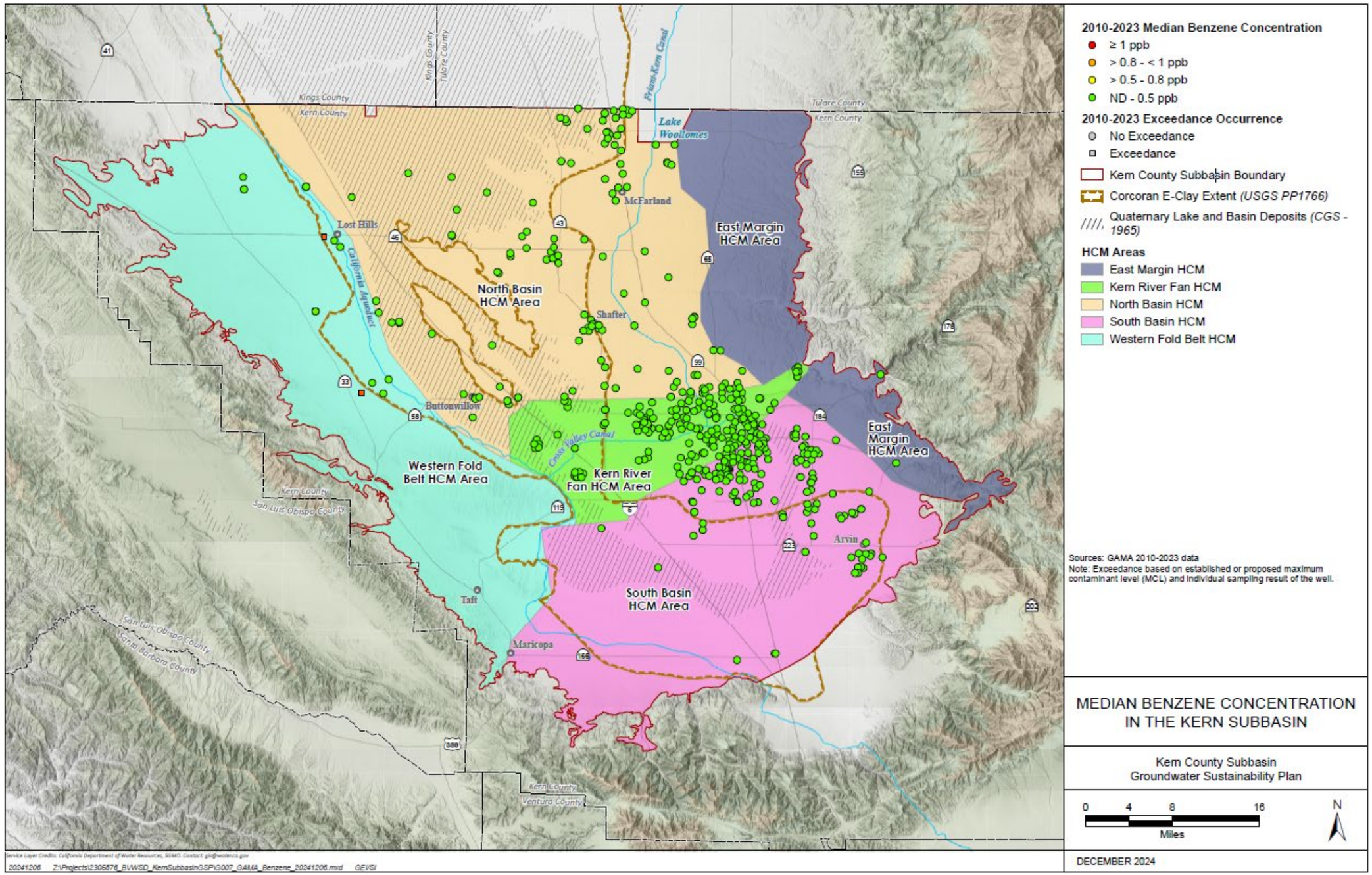


Figure 8-32. Median Benzene Concentration in the Kern Subbasin

To evaluate the risk of benzene exceeding the applicable water quality objective, GeoTracker and EnviroStor databases were searched for open contamination cleanup sites in the Kern Subbasin. Five leaking underground storage tanks (LUST) sites were identified in the Kern Subbasin. Details regarding the location of the sites are discussed in Section 8.4.2.

Table 8-9. Benzene Range and Median Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	Range (ppb)	Median (ppb)	# of Wells Sampled	Range (ppb)	Median (ppb)	# of Wells Sampled
Western Fold Belt	6.71	6.71	1	ND - 16.5	ND	17
North Basin	ND	ND	91	ND	ND	121
Kern River Fan	ND	ND	142	ND	ND	156
South Basin	ND - 0.65	ND	128	ND - 0.66	ND	157
Eastern Margin	ND	ND	1	ND	ND	3

Table 8-10. Benzene Well Water Quality Objective Exceedance Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Western Fold Belt	1	1	100%	2	17	11.8%
North Basin	0	91	0.0%	0	121	0.0%
Kern River Fan	0	142	0.0%	0	156	0.0%
South Basin	0	128	0.0%	0	157	0.0%
Eastern Margin	0	1	0.0%	0	3	0.0%
Total	1	363	0.3%	2	454	0.4%

Driving Mechanisms for Exacerbating Benzene Concentrations and Conclusion Statement

There are not sufficient benzene detections across the Kern Subbasin to conduct any trend analysis and identify potential driving mechanisms that may exacerbate benzene concentrations. Based on the evaluation conducted and findings presented in this 2025 Plan, GSAs do not propose to include benzene in their seasonal monitoring program.

8.4.2.4 Dibromochloropropane (DBCP), Ethylene Dibromide (EDB)

DBCP has a water quality objective to protect the municipal beneficial use based on the primary MCL of 0.2 ppb. Sources of DBCP are a banned nematicide that may still be present in soils and groundwater due to runoff or leaching from former use on soybeans, cotton, vineyards, tomatoes, and tree fruit. Since its use in California stopped in 1977, and was banned by EPA in 1979, groundwater concentrations of DBCP in municipal public water supply wells have shown steady decreasing trends. In 2008, the Department of Public Health (transferred to State Water Board as DDW in July 2014)

estimated the median half-life of DBCP in the Central Valley is 20 years, meaning groundwater concentrations would be decreased to approximately one-half of its maximum concentration by 1997. Figure 8-33 displays the median DBCP concentration per well, along with any water quality objective exceedances.

EDB has a water quality objective to protect the municipal beneficial use based on the primary MCL of 0.05 ppb. Sources of EDB are banned pesticides and that included ingredients for soil and grain fumigant formulations; EDB use was banned for use in 1984. EDB was also used as a lead scavenger in antiknock gasoline mixtures, which ended with the phase-out of leaded gasoline in the United States by 1996. EDB's half-life estimates vary from 2 to 15 years (Pignatello and Cohen, 1990). Currently, there is no known use of EDB in California. Figure 8-34 displays the median EDB concentration per well, along with any MCL water quality objective exceedances.

Based on the range of concentration, median and number of sources exceeding the water quality objectives demonstrates that DBCP and EDB are not prevalent in the Kern Subbasin. Table 8-11 summarizes pre-2015 and 2015 to 2023 median and range for both constituents for each HCM Area. The median DBCP and EDB concentrations are non-detect for all HCM Areas. Table 8-12 summarizes DBCP and EDB exceedances for each HCM Area. DBCP shows a decrease in the number of sources exceeding the water quality objective between pre-2015 and 2015 to 2023. Evaluation of eight of the nine sources with DBCP detections over the water quality objective confirmed DBCP concentrations were declining or below the objective for these sources. The remaining source which exceeds the DBCP water quality objective was a USGS other water supply well which only had one sample result. In the 2015 to 2023, three sources showed EDB concentrations above the water quality objective. Further evaluation of each source showed EDB concentrations declined to below the water quality objective or the source had a one-time detection and follow up samples were non-detect for EDB.

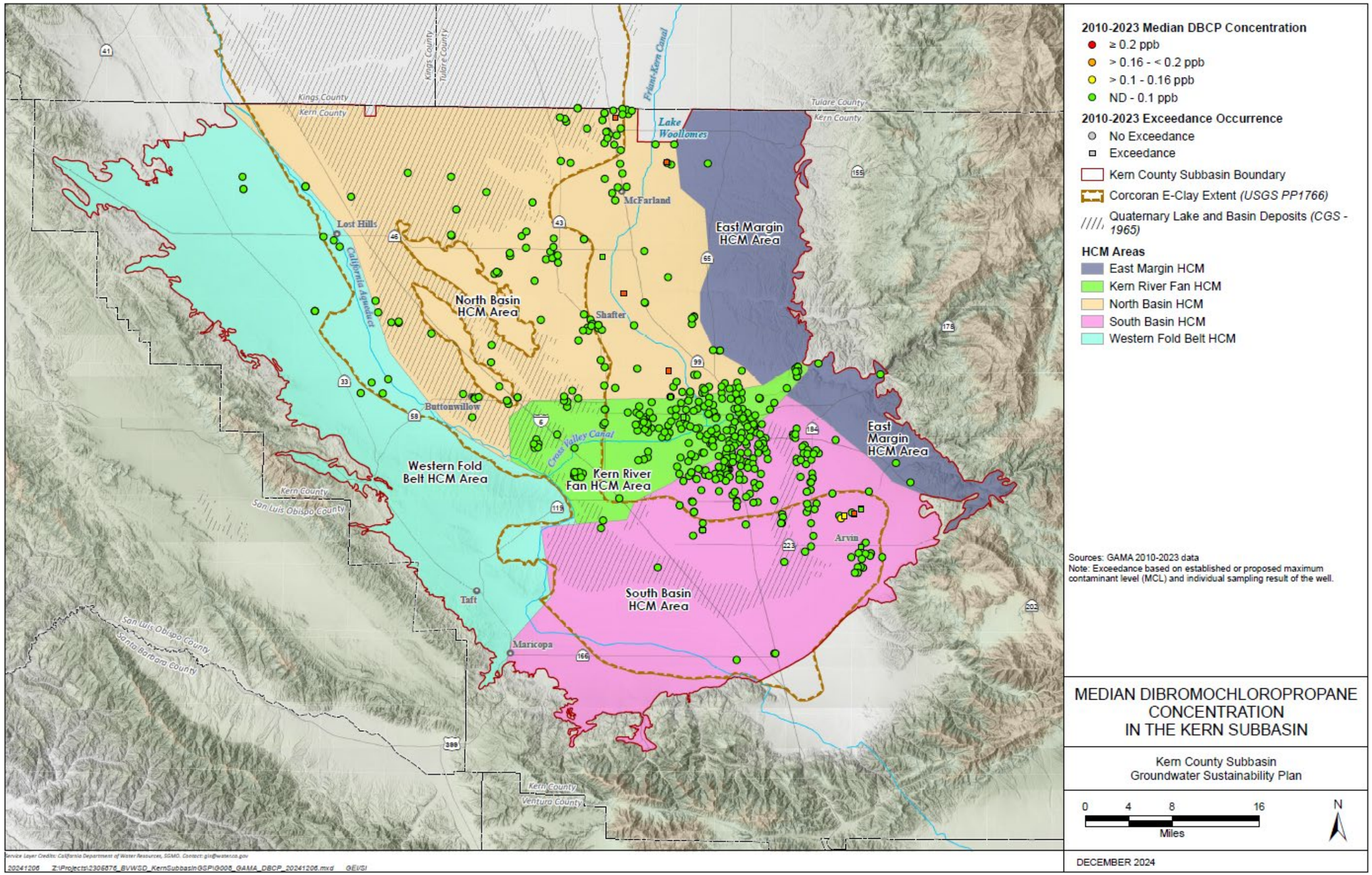


Figure 8-33. Median Dibromochloropropane (DBCP) Concentration in the Kern Subbasin

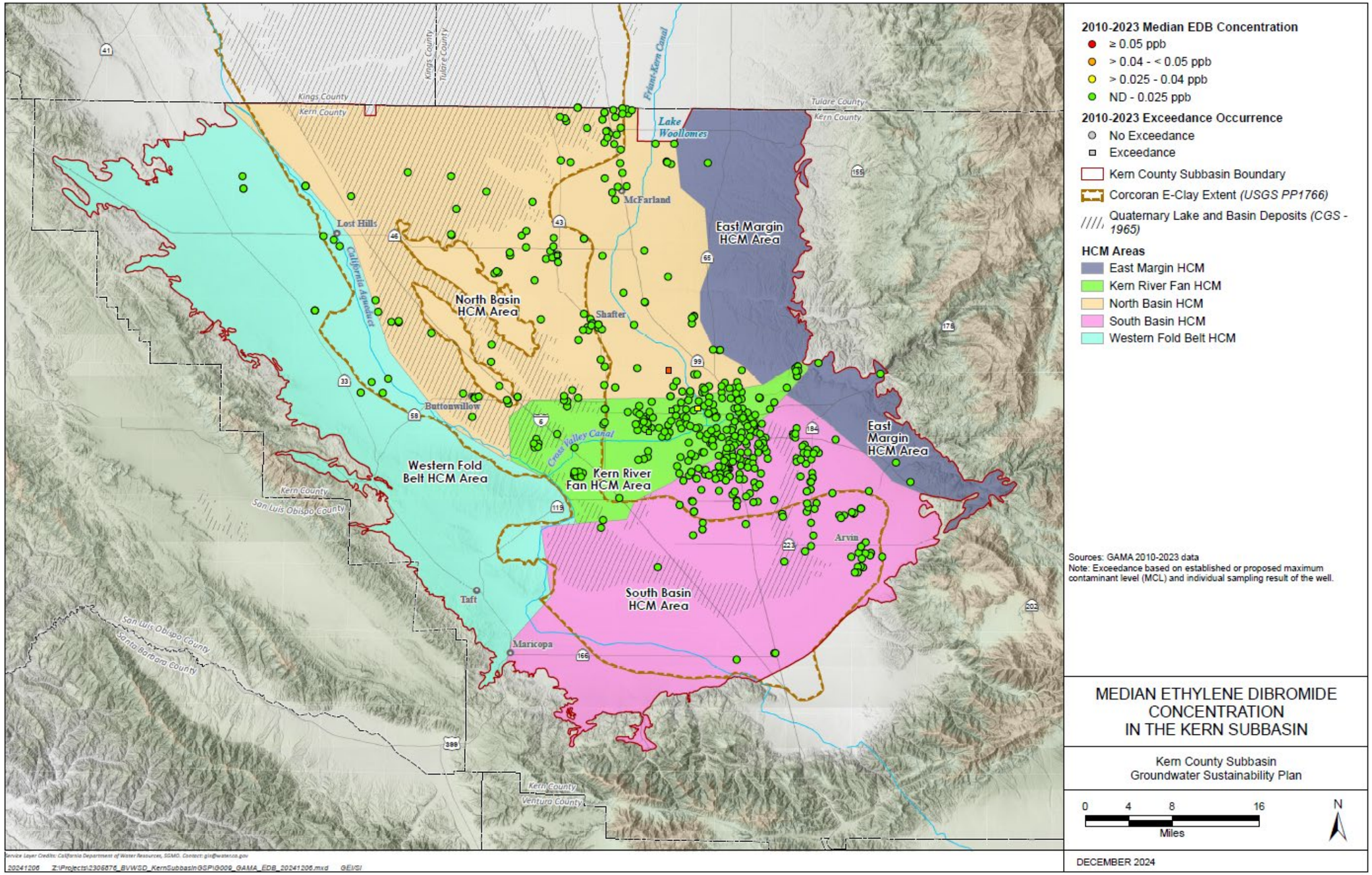


Figure 8-34. Median Ethylene Dibromide (EDB) Concentration in the Kern Subbasin

Table 8-11. DBCP and EDB Range and Median Summary by HCM Area

HCM Area	2010 to 2014[1]			2015 to 2023[2]		
	Range (ppb)	Median (ppb)	# of Wells Sampled	Range (ppb)	Median (ppb)	# of Wells Sampled
Dibromochloropropane (DBCP)						
Western Fold Belt	ND	ND	1	ND	ND	17
North Basin	ND - 1.2	ND	101	ND- 1.9	ND	133
Kern River Fan	ND - 0.28	ND	144	ND- 0.26	ND	158
South Basin	ND - 0.85	ND	132	ND- 0.56	ND	163
Eastern Margin	ND	ND	2	ND	ND	5
Ethylene Dibromide (EDB)						
Western Fold Belt	ND	ND	1	ND	ND	17
North Basin	ND - 0.41	ND	100	ND - 0.052	ND	133
Kern River Fan	ND - 0.19	ND	144	ND - 0.39	ND	158
South Basin	ND	ND	132	ND - 0.006	ND	159
Eastern Margin	ND	ND	2	ND	ND	5

Table 8-12. DBCP and EDB Well Water Quality Objective Exceedance Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Dibromochloropropane (DBCP)						
Western Fold Belt	0	1	0.0%	0	17	0.0%
North Basin	4	101	4.0%	4	133	3.0%
Kern River Fan	1	144	0.7%	0	158	0.0%
South Basin	6	132	4.5%	5	163	3.1%
Eastern Margin	0	2	0.0%	0	5	0.0%
Total	11	380	2.9%	9	476	1.9%
Ethylene Dibromide (EDB)						
Western Fold Belt	0	1	0.0%	0	17	0.0%
North Basin	1	100	1.0%	1	133	0.8%
Kern River Fan	1	144	0.7%	2	158	1.3%
South Basin	0	132	0.0%	0	159	0.0%
Eastern Margin	0	2	0.0%	0	5	0.0%
Total	2	379	0.5%	3	472	0.6%

Driving Mechanisms for Exacerbating DBCP and EDB Concentrations and Conclusion Statement

Since the use of products containing EDB and DBCP were banned approximately 40 years ago, and the half-life in groundwater is estimated to be a maximum of 20 years, there are no known driving mechanisms to exacerbate DBCP or EDB concentrations. Based on findings, GSAs do not propose to include EDB and DBCP in their seasonal monitoring program.

8.4.2.5 Gross Alpha, Uranium

Gross alpha has a water quality objective for protection of the municipal beneficial use based on the primary MCL of 15 pCi/L and uranium has a primary water quality objective of 20 pCi/L, also based on the primary MCL. Alpha particles (α-particles) leach into groundwater from certain minerals that are radioactive. Anthropogenic Alpha emitters are used to treat cancer, as a static eliminator in paper mills and other industries, and in smoke detectors. Gross alpha may be comprised of radium-226, uranium-235, and radon-222 as the source of the alpha particles. Uranium is a naturally occurring radioactive element in rocks, soil, water, plants, animals, and humans.

Uranium is common in specific types of igneous, metamorphic, and sedimentary rocks. Research indicates that increased concentrations of uranium in groundwater may be caused by mobilization of uranium present in soil with irrigation waters containing bicarbonates (Jurgens et al., 2010). Also, one study finds that nitrates may mobilize uranium through a series of bacterial and chemical reactions (Nolan and Weber, 2015). Figure 8-35 displays the median concentration of gross alpha and Figure 8-36 displays the median uranium concentration per well, along with any water quality objective exceedances in each figure. As shown, the distribution and concentration of gross alpha and uranium for sources with detections above their respective water quality objectives are closely related.

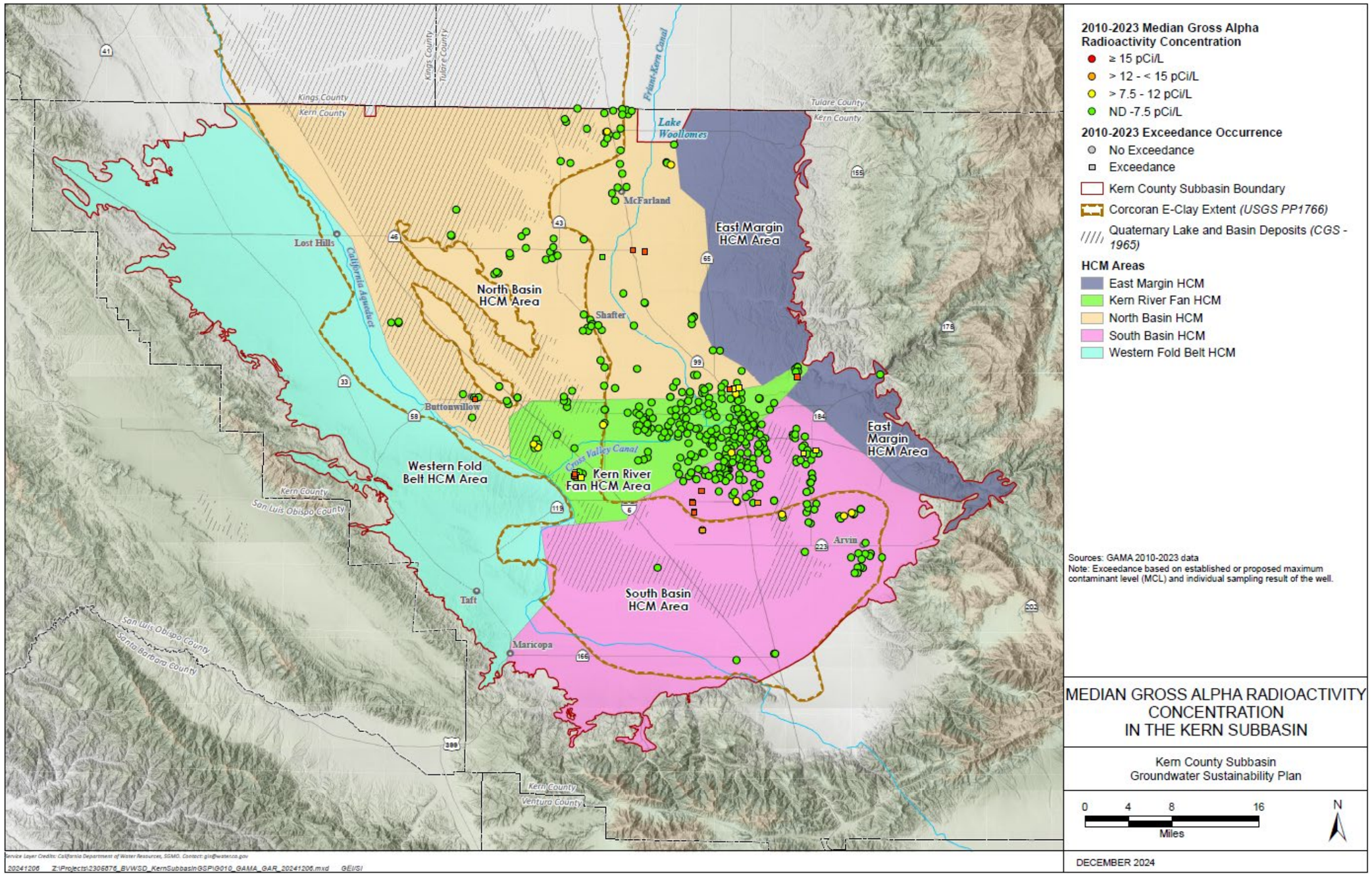


Figure 8-35. Median Gross Alpha Concentration in the Kern Subbasin

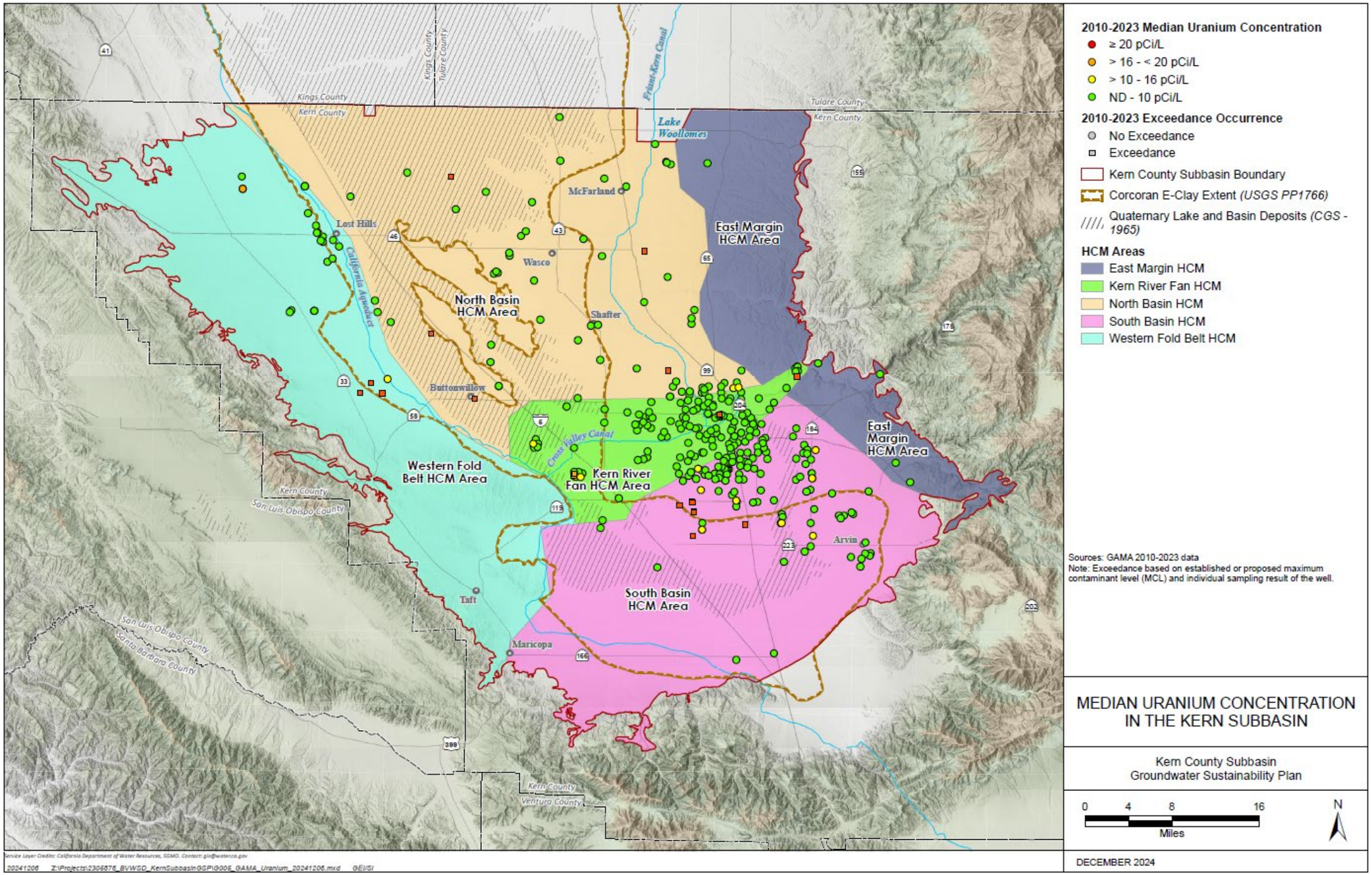


Figure 8-36. Median Uranium Concentration in the Kern Subbasin

Table 8-13 summarizes pre-2015 and 2015 to 2023 gross alpha and uranium median and range of detections for each HCM Area. The 2015 to 2023 median gross alpha concentration is non-detect in each HCM Area, and the median uranium concentration is non-detect in the Western Fold Belt, North Basin, and Eastern Margin HCM Areas and less than 3 pCi/L in the Kern River Fan and South Basin HCM Areas. Table 8-14 summarizes each HCM Area's pre-2015 and 2015 to 2023 gross alpha and uranium water quality objective exceedances. The number of wells with gross alpha and uranium water quality objective exceedances for each HCM Area is greater from the pre-2015 to the 2015 to 2023 conditions. These increases do not indicate degradation of groundwater quality. Rather, it reflects a more comprehensive understanding of gross alpha and uranium distribution as the number of wells sampled increased in all HCM Areas from the pre-2015 to the 2015 to 2023 conditions. Additionally, the number of wells exceeding their respective water quality objective indicates that gross alpha and uranium are not wide-spread COCs for the Kern Subbasin.

While radium-226, uranium-235, and radon-222 are all sources for gross alpha, evaluation of the wells with water quality objective exceedances demonstrate that gross alpha and uranium concentrations are closely related. It is important to note that Table 8-14 represents the count of wells where gross alpha or uranium is detected above their respective water quality objective and does not represent the count of wells out of compliance with the primary MCL as applied to public water supply wells because compliance is based on a quarterly average and not a single sample result.

For 2015 through 2023, there are 19 municipal wells with detections exceeding the gross alpha water quality objective. Evaluation of the 19 municipal wells confirmed that the uranium concentration, where available, closely aligned with the gross alpha concentration. Ten of the 19 wells also have uranium detections exceeding the uranium MCL water quality objective and are discussed in the uranium summary. Of the nine wells with only gross alpha exceedance, one is treated by blending and the remaining eight have average gross alpha concentrations below the water quality objective, or the gross alpha objective exceedance was an unconfirmed, single detection.

Of the 20 wells with detections over the uranium water quality objective, 12 are municipal wells, three are domestic wells, three are other water supply wells and two are irrigation/industrial wells. Four of the municipal wells are in the Kern River Fan HCM Area and each have treatment installed. In the North Basin HCM Area, there are three municipal wells which have detections exceeding the water quality objective, one has treatment, the uranium detection in one well is not confirmed, and one is a standby well. In the South Basin HCM Area, one well has treatment, one well is inactive well and two wells are currently out of compliance for uranium. In the Western Fold Belt HCM Area, the one municipal well with detections above the water quality objective is an inactive well.

Table 8-13. Gross Alpha and Uranium Range and Median Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	Range (pCi/L)	Median (pCi/L)	# of Wells Sampled	Range (pCi/L)	Median (pCi/L)	# of Wells Sampled
Gross Alpha						
Western Fold Belt	-	-	-	-	-	-
North Basin	ND - 19.3	ND	75	ND - 113	ND	104
Kern River Fan	ND - 33.2	ND	133	ND - 45.6	ND	142
South Basin	ND - 76.7	ND	123	ND - 76.3	ND	140
Eastern Margin	ND - 7.8	3.9	1	ND - 4.5	ND	2
Uranium						
Western Fold Belt	ND	ND	1	ND - 345	ND	28
North Basin	ND - 18	ND	25	ND - 42.9	ND	56
Kern River Fan	ND - 64.7	1.7	104	ND - 45	1.7	101
South Basin	ND - 87	2.3	87	ND - 81	2.9	94
Eastern Margin	ND - 1.3	ND	2	ND - 3.3	1	5

Table 8-14. Gross Alpha and Uranium Well Water Quality Objective Exceedance Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Gross Alpha						
Western Fold Belt	-	-	-	-	-	-
North Basin	3	75	4.0%	6	104	5.8%
Kern River Fan	5	133	3.8%	5	142	3.5%
South Basin	5	123	4.1%	8	140	5.7%
Eastern Margin	0	1	0.0%	0	2	0.0%
Total	13	332	3.9%	19	388	4.9%
Uranium						
Western Fold Belt	0	1	0.0%	3	28	10.7%
North Basin	0	25	0.0%	5	56	8.9%
Kern River Fan	2	104	1.9%	5	101	5.0%
South Basin	2	87	2.3%	7	94	7.4%
Eastern Margin	0	2	0.0%	0	5	0.0%
Total	4	219	1.8%	20	284	7.0%

As uranium is naturally occurring in soils and sediments, and can mobilize into groundwater, median uranium concentrations for wells within and outside the boundaries of E-clay and the lake deposits were evaluated and summarized in Table 8-15. In each HCM Area where uranium is detected, median uranium concentration is highest for wells within the E-Clay boundary, followed by wells in E-Clay and lake deposits boundary.

Table 8-15. Median Uranium Summary for Wells Overlying E-clay or Lake Deposits

HCM Area	Geology	2010-2023 Median (pCi/L)	2010-2023 # of Wells Sampled
Western Fold Belt	E-Clay and Alluvial Fan	ND	11
	Neither	ND	17
North Basin	E-Clay and Lake Deposits	2.7	10
	E-Clay	ND	19
	Neither	ND	39
Kern River Fan	E-cCay and Lake Deposits	4.3	7
	E-Clay	9.6	12
	Neither	1.3	109
South Basin	E-Clay and Lake Deposits	2.9	8
	E-Clay	5.6	29
	Lake Deposits	1.4	3
	Neither	2.3	88
Eastern Margin	Neither	ND	6

Figure 8-37 shows the uranium concentration trend of the two municipal wells without uranium treatment in the South Basin HCM Area. While the concentration fluctuates slightly, excluding two outlier data points, uranium levels in both wells are consistently near, or over the water quality objective. Using groundwater elevation of a nearby RMW-WL does not show an apparent response between groundwater elevation and uranium concentration.

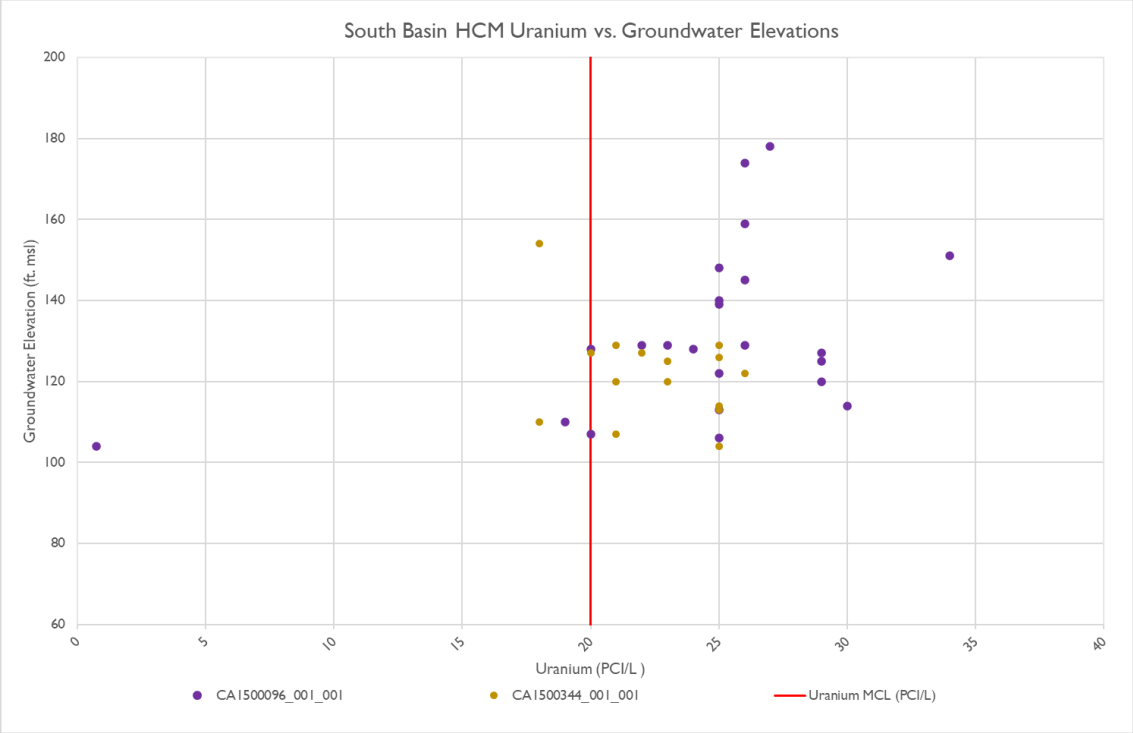


Figure 8-37. South Basin HCM AREA Uranium vs. Groundwater Elevations

Driving Mechanisms for Exacerbating Uranium Concentrations and Conclusion Statement

Gross Alpha and Uranium are believed to be naturally occurring in the Kern Subbasin. Since most gross alpha particles are comprised of uranium, and uranium water quality objective exceedances are localized (not clustered to geographic areas or common amongst certain soil types), there is no definable relationship between groundwater management activities and uranium concentrations.

Figure 8-38 shows the median concentration in small community wells, with the density of domestic wells throughout the Kern Subbasin. Presently, five percent of small community wells (three total wells) have a median and maximum concentration of uranium above the 20 pCi/L water quality objective. Two wells supply the Round Mountain Water Co (Choctaw Valley area); uranium is mitigated through Point of Use filters. One well supplies the Old River Mutual Water Co; this system has been in violation since 2003. Uranium data is sparse since it's only required to be analyzed when gross alpha particles are greater than 5 pCi/L, and the sampling frequency for most publicly regulated water systems is one sample every nine years.

Although uranium does not meet the Kern Subbasin's screening criteria for COCs, it is included in the list of constituents for semiannual testing since it was included in *Groundwater Quality Considerations for High and Medium Priority Groundwater Basins* (November 2022) for the Kern Subbasin. The GSAs are collecting seasonal uranium samples to correspond with water level measurements to monitor the relationship between uranium concentrations and groundwater management activities.

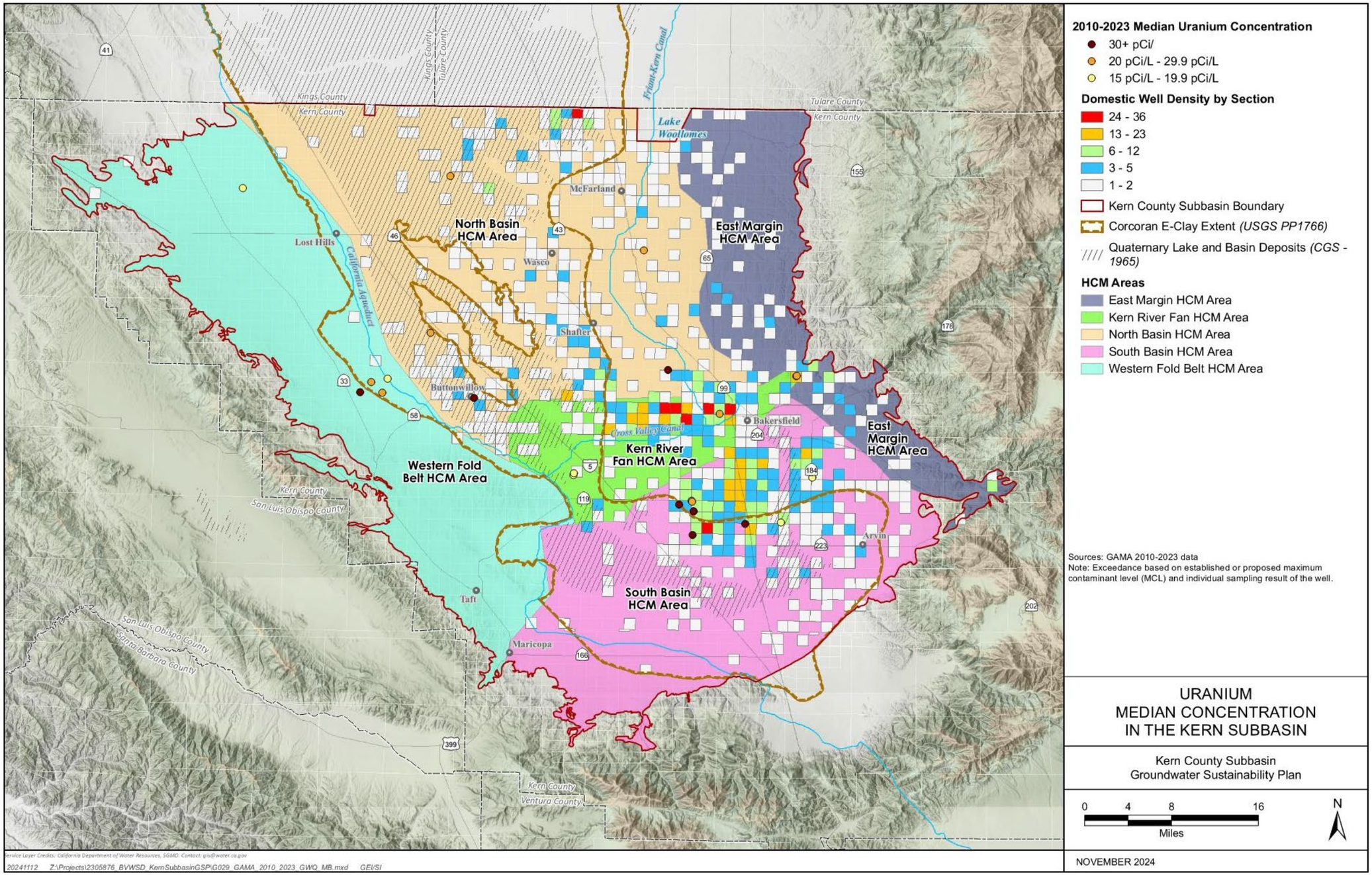


Figure 8-38. Median Uranium Concentration of Small Community Wells

Currently available data does not show a correlation between exacerbating uranium concentrations and chronic lowering of groundwater levels.

8.4.2.6 Nitrate as Nitrogen (N), Nitrite as Nitrogen (N), Nirate + Nitrite

Nitrate and nitrite as nitrogen (N) have water quality objectives to protect the municipal beneficial use based on acute drinking water primary MCLs of 10 and 1 ppm, respectively. The sum of these two constituents, nitrate + nitrite, is also regulated as having a water quality objective based on the primary MCL with an acute drinking water MCL of 10 ppm. Sources of nitrate and nitrite in groundwater include runoff and leaching from fertilizer use, leaching from septic systems and sewage, application of manure leaching from confined animal facilities, application of biosolids and composting materials, and very small concentrations from erosion of natural deposits and aerial deposition. Since elevated concentrations of nitrate and nitrite are typically leached from land surface, the highest concentrations are found in localized shallow groundwater in the upper portion of the aquifer at approximate depths above 350 to 550 feet bgs. However, elevated concentrations may also be observed in deep wells, depending on source concentrations, lithology, and well construction. In the environment, nitrite is typically absent or present to a much lesser extent because it is rapidly converted to nitrate.

A USGS study (Burton et al., 2012) conducted in the Southeast San Joaquin Valley and the Kern Subbasin used statistical analysis of land uses, well construction data, water quality parameters and number of septic systems around each study well to determine that land uses fairly represent nitrate sources (soil, fertilizer, manure, septic, or community wastewater) impacting the representative study well.

Studies conducted by the UC Davis Center for Watershed Sciences evaluated nitrate sources in the Tulare Lake Basin and documented that on a regional scale, groundwater nitrogen loading from sewer collection system leaks and septic systems is negligible compared to fertilizers. Based on mass loading calculations, the agricultural industry is believed to be the primary contributor source of nitrate in the Central Valley groundwaters. Nitrate discharges from irrigated lands in the Kern Subbasin are regulated by the Central Valley Water Board through Waste Discharge Requirements General Order R5-2013-0120 (as amended) for Growers within the Tulare Lake Basin Area. Requirements imposed on irrigated agriculture are commonly referred to as the Irrigated Lands Regulatory Program (ILRP), which requires growers to reduce nitrate loading from fertilizer applications through improvements to irrigation and management practices. Moreover, the ILRP includes a comprehensive groundwater protection program that seeks to correct nitrate loading and protect groundwater supplies for future uses/users.

In addition to the ILRP, dairies and other concentrated animal facilities are regulated by the Central Valley Water Board through various waste discharge requirements orders. Orders impacting dairy facilities are currently under review by the SWRCB and are likely

to be revised in the future to further limit the amount of nitrate leaching to groundwater from dairy facilities.

As part of CV-SALTS, sources of nitrate to priority subbasins are required to comply with the Nitrate Control Program, which became effective in 2020 after the adoption of Basin Plan Amendments (Attachment A to Resolution R5-2020-0057, Revisions to the Amendments of the Sacramento and San Joaquin Basin Plan and the Tulare Lake Basin Plan Central Valley-wide Salt and Nitrate Control Program). Portions of the Kern Subbasin are considered priority basins under the Nitrate Control Program and dischargers within these areas have received Notices to Comply. Through the Nitrate Control Program, dischargers of nitrate are directed to work collectively to reduce nitrate discharges to no longer cause or contribute to water quality objective exceedances in groundwater. While such efforts are being implemented over an extended time schedule, dischargers are required to ensure that domestic and municipal users of groundwater have access to safe drinking water that meets the Nitrate water quality objective of 10 ppm.

Using the SWRCB's methodology, which screens the data to represent domestic, irrigation/industrial, municipal, and other groundwater supply well types, and the selected timeframe of 2010 through 2023, nitrates are most commonly present above the water quality objective in the North Basin HCM Area and eastern portion of the South Basin HCM Area (Figure 8-39). Nitrates are less commonly found where the E-clay provides a localized physical barrier that limits downward migration. This is likely due to Kern County Ordinance, Section 14.08, which requires that wells drilled where a regionally confining layer is present be sealed to avoid contamination between locally confined aquifer zones (refer to Section 5.8.4 for additional ordinance details).

Sources of nitrite and nitrate include septic systems, which elevate groundwater nitrate concentrations since they only remove half of the nitrogen in the wastewater, leaving the remaining half to percolate to groundwater (McCalas, 2019). At a local level, septic systems can be a significant source of nitrate to domestic wells in peri-urban areas surrounding cities, or in areas of relatively high rural household density (Viers et al., 2012). Domestic and small community wells are most likely influenced by septic systems (Dubrovsky et al., 2010). Septic systems are considered low-hanging fruit (Dzurella et al., 2012) but are an important issue to address due to their impact on localized drinking water sources.

An analysis using parcel development status, general soil/septic systems suitability mapping, hydrologic areas, and groundwater basins revealed that approximately 30 percent of developed parcels within the Kern Subbasin rely on septic systems. It is noted that the analysis assumed incorporated areas have municipal sewer systems that either serve or are available to these parcels, therefore only non-sewerage unincorporated areas of the County were included in the analysis. A partial list of the system inspected is provided and is shown in Figure 8-39. Although not all septic

system location data is available at the time of this evaluation, it is noted areas with septic systems and domestic wells, generally show elevated nitrate concentrations.

Figure 8-40, Figure 8-41, and Figure 8-42 display the median concentration per well, along with if the well had an exceedance of water quality objectives for nitrate, nitrite, and nitrate + nitrite, respectively. High nitrate median concentrations and water quality objective exceedances are seen throughout the Kern Subbasin, primarily in the North and South Basin HCM Areas. Nitrite median concentration for the majority of wells is non-detect throughout the Kern Subbasin. Since nitrate + nitrite is the sum of nitrate and nitrite and nitrite is primarily non-detect in the Kern Subbasin, the nitrate + nitrite median concentrations and exceedance locations are similar to the prevalence of nitrate.

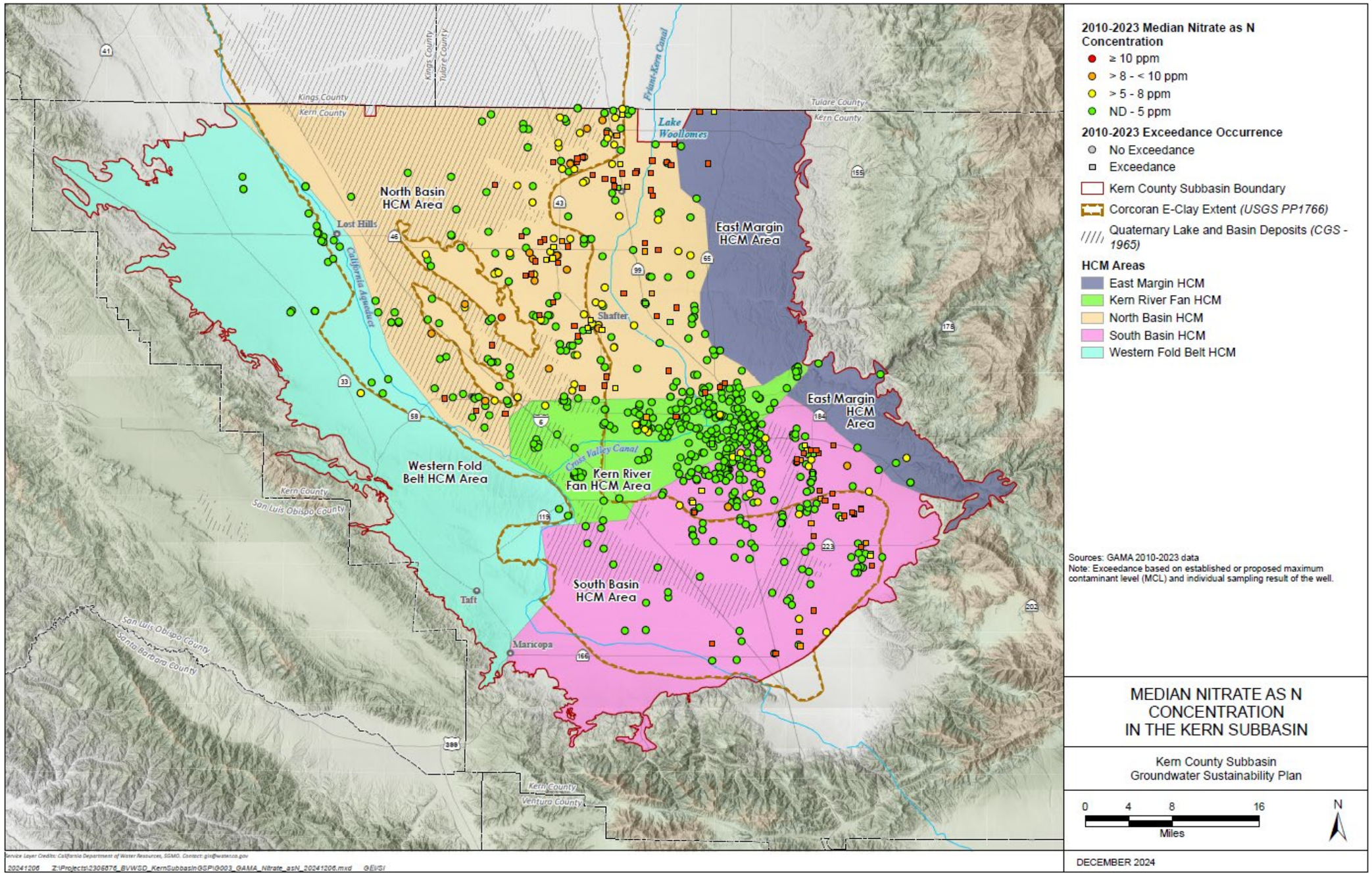


Figure 8-39. Median Nitrate as N Concentration in the Kern Subbasin

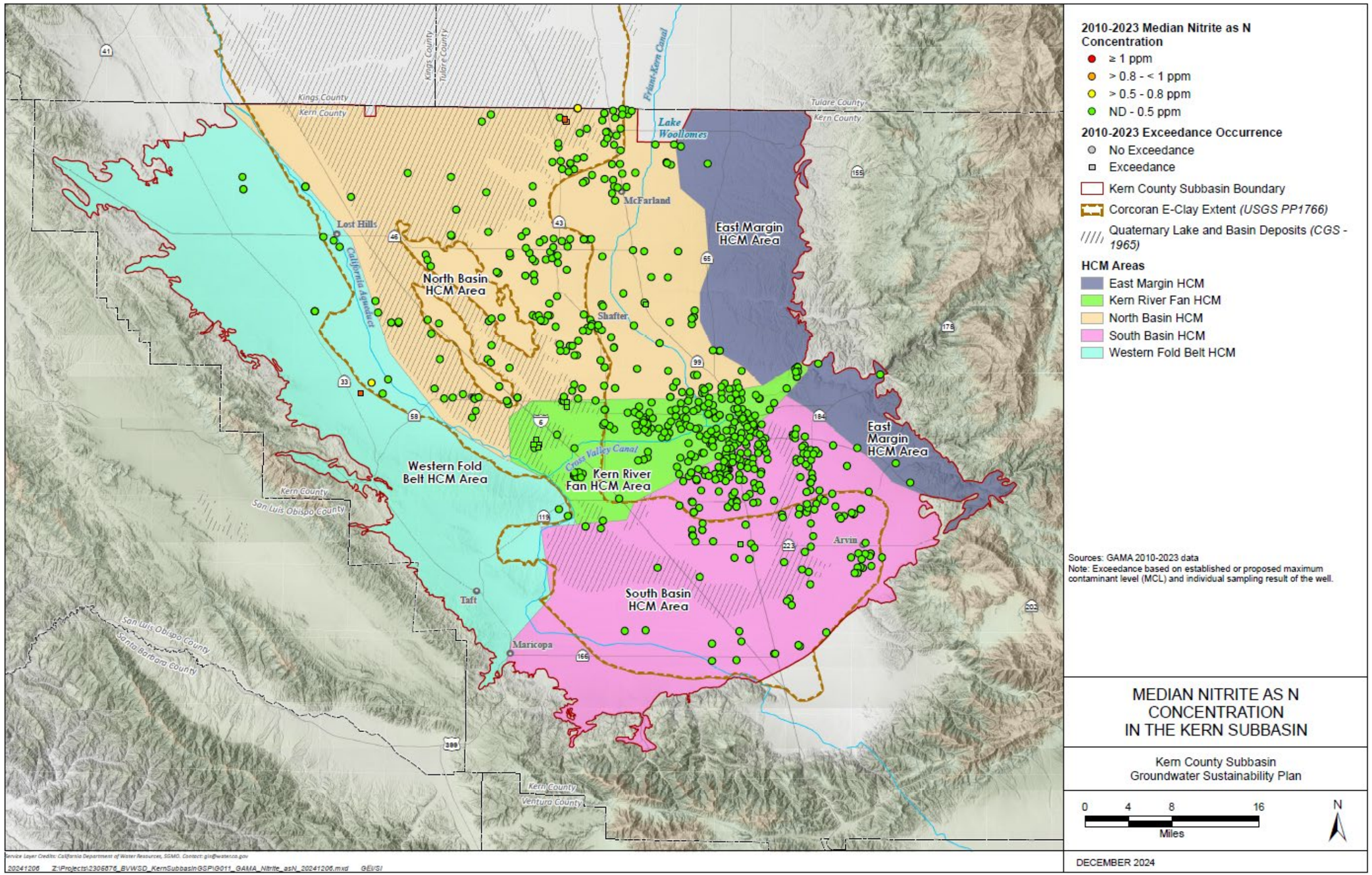


Figure 8-40. Median Nitrite as N Concentration in the Kern Subbasin

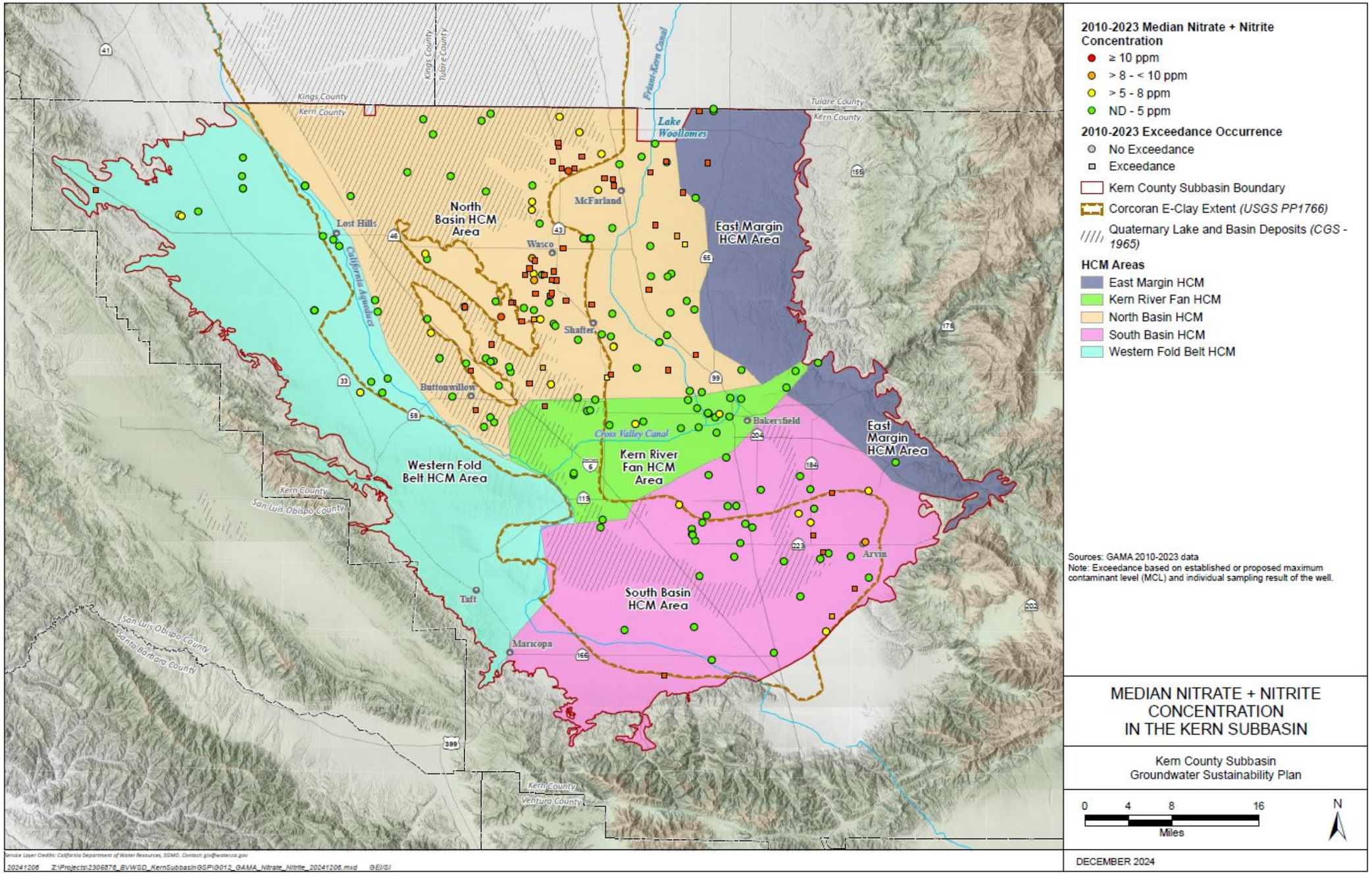


Figure 8-41. Median Nitrate + Nitrite Concentration in the Kern Subbasin

Table 8-16 summarizes pre-2015 and 2015 to 2023 nitrate, nitrite, and nitrate + nitrite median and ranges for each HCM Area. All HCM Area nitrate, nitrite, and nitrate + nitrite median concentrations are below the water quality objective; however, in a majority of the HCM Areas, there are wells with concentrations above the objective. It is noted that the upper concentration range for nitrite is higher in 2015 to 2023 conditions except in the North Basin and Eastern Margin HCM Areas. Each constituent's median concentration remained relatively the same, except for the nitrate + nitrite median concentration in the Eastern Margin, North Basin and South Basin HCM Areas. This increase is attributed to increased nitrate + nitrate data in 2015 to 2023 compared to 2010 to 2014. Nitrite median concentrations are non-detectable levels for both conditions while nitrate median concentration demonstrates nitrate is prevalent in the Kern Subbasin. This supports that nitrate is the more prevalent nitrogen form in the Kern Subbasin.

Table 8-16. Nitrate, Nitrite, and Nitrate + Nitrite Range and Median Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	Range (ppm)	Median (ppm)	# of Wells Sampled	Range (ppm)	Median (ppm)	# of Wells Sampled
Nitrate as N						
Western Fold Belt	ND	ND	1	ND - 5.9	ND	30
North Basin	ND - 27	3.2	119	ND – 33	3.4	286
Kern River Fan	ND - 11	1.0	158	ND – 43	1	178
South Basin	ND - 22	2.5	157	ND – 34	2.3	233
Eastern Margin	ND	ND	4	ND – 15	2.5	13
Nitrite as N						
Western Fold Belt	ND	ND	1	ND - 1.3	ND	19
North Basin	ND - 4.5	ND	112	ND – 4	ND	218
Kern River Fan	ND	ND	153	ND - 2.9	ND	169
South Basin	ND	ND	144	ND - 1.9	ND	209
Eastern Margin	ND	ND	3	ND	ND	8
Nitrate + Nitrite						
Western Fold Belt	ND	ND	1	ND – 19	ND	22
North Basin	ND – 12	ND	3	ND - 31	5.3	120
Kern River Fan	1.1	1.12	1	ND - 19	1.5	23
South Basin	ND - 8.4	ND	4	ND - 78	2.7	41
Eastern Margin	-	-	-	ND - 13	2.5	7

Table 8-17 summarizes pre-2015 and 2015 to 2023 nitrate, nitrite, and nitrate + nitrite water quality objective exceedances for each HCM Area. While the number of wells with nitrate, nitrite, and nitrate + nitrite objective exceedances is greater between 2015 to 2023 conditions, these increases do not necessarily indicate degradation of groundwater quality. Rather, it may reflect a more comprehensive understanding of nitrate, nitrite, and nitrate + nitrite distribution as the number of wells sampled increased

in all HCM Areas from the pre-2015 to the 2015 to 2023 conditions. Nitrate, nitrite, and nitrate + nitrite sampling increased with the implementation of the ILRP.

It is important to highlight that while nitrate is present in each HCM Area, wells with nitrate water quality objective exceedances are primarily located in the North Basin HCM Area, followed by the South Basin HCM Area. In the Western Fold Belt HCM Area, no nitrate water quality objective exceedances are observed in data from 2010 to 2023. In the Eastern Margin HCM Area, nitrate water quality objective exceedances from 2015 to 2023 occurred in three wells, a domestic and irrigational/industrial well sampled for the ILRP and a domestic well sampled by USGS.

Table 8-17. Nitrate, Nitrite, and Nitrate + Nitrite Well Water Quality Objective Exceedance Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Nitrate as N						
Western Fold Belt	0	1	0.0%	0	30	0.0%
North Basin	14	119	11.8%	65	286	22.7%
Kern River Fan	1	158	0.6%	3	178	1.7%
South Basin	16	157	10.2%	40	233	17.2%
Eastern Margin	0	4	0.0%	4	13	30.8%
Total	31	439	7.1%	112	740	15.1%
Nitrite as N						
Western Fold Belt	0	1	0.0%	1	19	5.3%
North Basin	2	112	1.8%	3	218	1.4%
Kern River Fan	0	153	0.0%	6	169	3.6%
South Basin	0	144	0.0%	1	209	0.5%
Eastern Margin	0	3	0.0%	0	8	0.0%
Total	2	413	0.5%	11	623	1.8%
Nitrate + Nitrite						
Western Fold Belt	0	1	0.0%	1	22	4.5%
North Basin	1	3	33.3%	43	120	35.8%
Kern River Fan	0	1	0.0%	1	23	4.3%
South Basin	0	4	0.0%	6	41	14.6%
Eastern Margin	-	-	-	2	7	28.6%
Total	1	9	11.1%	53	213	24.9%

As previously highlighted, of the five HCM Areas, the North Basin HCM Area has the highest number of wells with nitrate concentrations above the water quality objective. Trend analyses were conducted on four wells scattered across the HCM Area to evaluate the relationship between nitrate concentration, well construction, and changes in groundwater levels. Table 8-18 summarizes relevant data for each well. Figure 8-42

plots nitrate concentrations with groundwater elevation. Wasco 8a shows the most fluctuation in nitrate level – and is the only well with a detection above the water quality objective. Groundwater level fluctuations are moderate (relative to the HCM Area). When comparing data between these wells, particularly when compared against the scatter plot (Figure 8-42), it appears nitrate concentrations in the North Basin HCM Area are most influenced by localized conditions.

Table 8-18. Summary of Well Construction with Nitrate and Groundwater Level Data

Well Name	Beginning Screen Depth	Total Length of Screens	Fluctuation in Nitrate (as N)	Fluctuation in Water Level
Wasco 8a	500 feet bgs	412	6.8 ppm	60 feet
Shafter 15	500 feet bgs	250	0 ppm	15 feet
Delano 25	740 feet bgs	325	0.4 ppm	160 feet
Delano 26	655 feet bgs	535	0.5 ppm	54 feet

The average depth of localized shallow groundwater conditions across the North Basin HCM Area typically ranges from 150 to 200 feet bgs. E-Clay is present at an average depth of 350 feet bgs; however, the E-Clay thickness (ability to function as a physical barrier to constituent migration) throughout the North Basin HCM Area is highly variable.

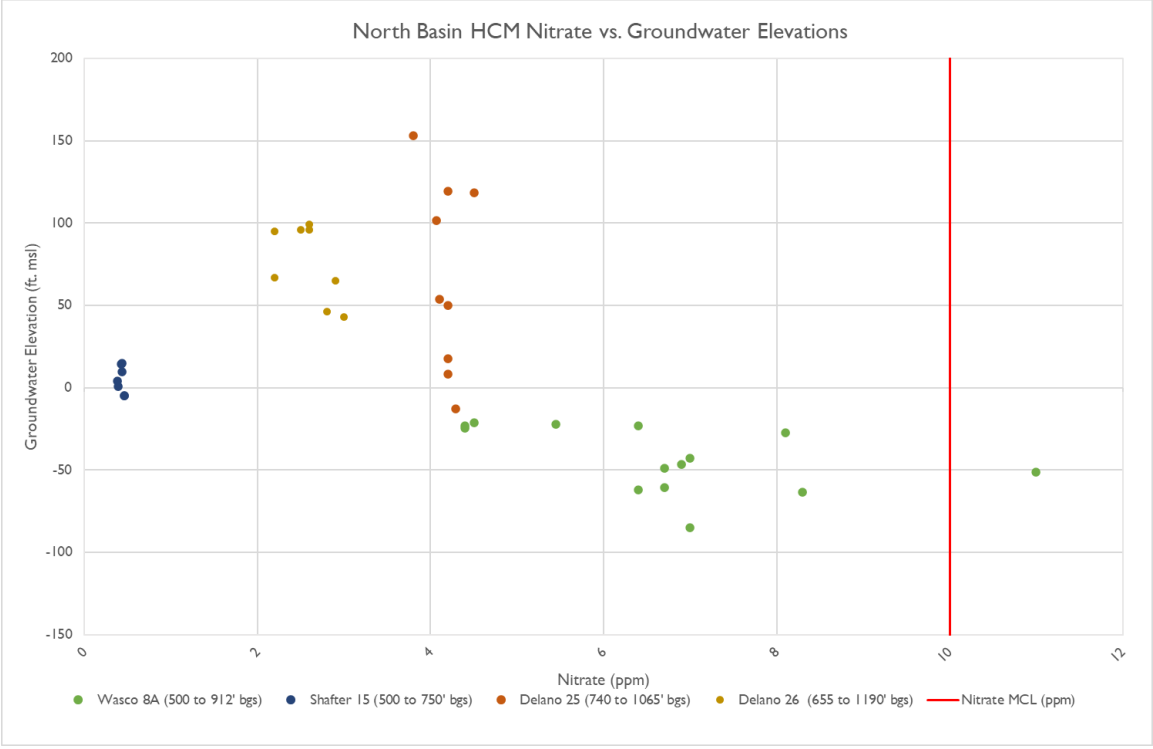


Figure 8-42. North Basin HCM Area Nitrate vs. Groundwater Elevations

Consistent with Kern County's ordinance (Section 14.08), the top screen for each well in this analysis starts below the E-Clay. While it's clear the E-clay is serving as a barrier that is at least limiting nitrate migration into the deeper portion of the aquifer, Wasco 8a demonstrates that unknown local conditions have allowed nitrates to migrate into the deeper portion of the aquifer. Consequently, there is no clear relationship between nitrate concentration and chronic lowering of groundwater levels in the North Basin HCM Area. The condition that is most likely contributing to localized nitrate migration is a well serving as a conduit between localized shallow groundwater and the primary aquifer, prior to Kern County's ordinance being implemented in the mid-1980's.

In the Kern River Fan HCM Area with predominantly urban land use, median nitrate concentrations are typically well below the water quality objective, with only a few wells showing water quality objective exceedances (Figure 8-39). Table 8-19 summarizes screened intervals and land uses surrounding three RMW-WLs and Figure 8-43 shows the relationship between nitrate trends and groundwater level fluctuations for three wells, ENOS, RRBWSD Shop, and WKWD Well 6-06. Nitrate concentrations in each well are consistently below the water quality objective but demonstrate different responses to groundwater elevation changes based on well construction. ENOS and RRBWSD Shop represent localized shallow groundwater conditions, whereas WKWD Well 6-06 screens a larger portion of the aquifer.

Table 8-19. Summary of Kern River Fan Wells Influence by Banking Operations

Well Name	Top of Screen	Bottom of Screen	Aquifer Characteristic	Land Use
Enos	260	350	localized shallow	Banking/Ag
RRBWSD Shop	310	410	localized shallow	Urban/Banking
WKWD 6-06	290	750	blended	Banking/Native

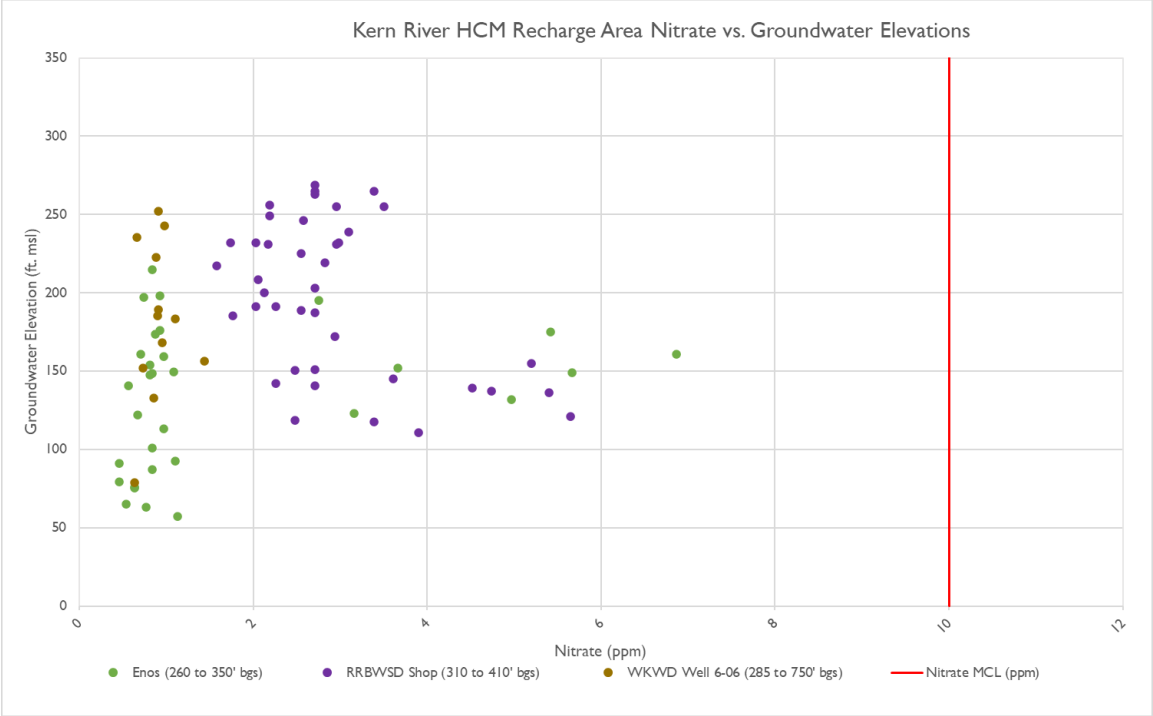


Figure 8-43. Kern River Fan HCM Area Recharge Basin Area Nitrate vs. Groundwater Elevations

- The following conclusions are based on the groundwater characterization pertaining to nitrate and data trending assessment of three dedicated monitoring wells in the Kern River Fan HCM Area.
- Nitrate concentrations in the Enos well are very low, most results less than 2 ppm. Based on the observed trends, nitrates are diluted by the high-quality water that is imported and banked in the Kern Fan HCM Area, resulting in an overall decreasing trend regardless of water level.
- RRBWSD Shop is surrounded by mixed land use, mostly influenced by high-density residential that rely on septic systems. While nitrate concentrations fluctuate with water levels, the maximum nitrate concentration is approximately one-half well below the water quality objective. Localized shallow groundwater nitrate levels appear to be diluted by banking operations in the area.
- WKWD 6-06 is in an area of native land use (well field property owned by WKWD) and is surrounded by banking operations. Nitrate concentrations are consistently below 2 ppm with negligible fluctuation in response to groundwater level changes.

Like the RMW-WQs in the Kern Fan Banking Areas, public supply wells (municipal, industrial, and small community) appear to also benefit from the surrounding banking operations. Table 8-20 summarizes well screen intervals and land uses for each well. Figure 8-44 shows the relationship between nitrate concentration and fluctuations in groundwater levels. While each of these public supply wells have direct influence from

persistent sources of nitrates (septic systems), three of the four wells have nitrate concentrations consistently below the water quality objective. Gooselake Mutual Water, whose well extracts localized shallow groundwater, is the only well that fluctuates above the nitrate water quality objective when groundwater levels are low. It should also be noted that this well is surrounded by medium-to-high-density residential properties, who all rely on septic systems.

Table 8-20. Summary of Public Supply Wells in the Kern Fan HCM Area

Well Name	Top of Screen	Bottom of Screen	Aquifer Characteristic	Land Use	Proximity to Banking
Gooselake Mutual	Unknown	386	Upper Aquifer	Medium-Density Residential/Septic	2-4 miles
Frito Lay Well 1	304	600	Mid Aquifer	Mixed Ag, Industrial, and High-Density Residential/Septic	
Greenley	310	410	Upper/Mid Aquifer	Mixed Ag, Low-Density Residential/Septic	1-2 miles
Bakersfield 32	400	710	Mid-Deep Aquifer	High-Density Residential/Septic	

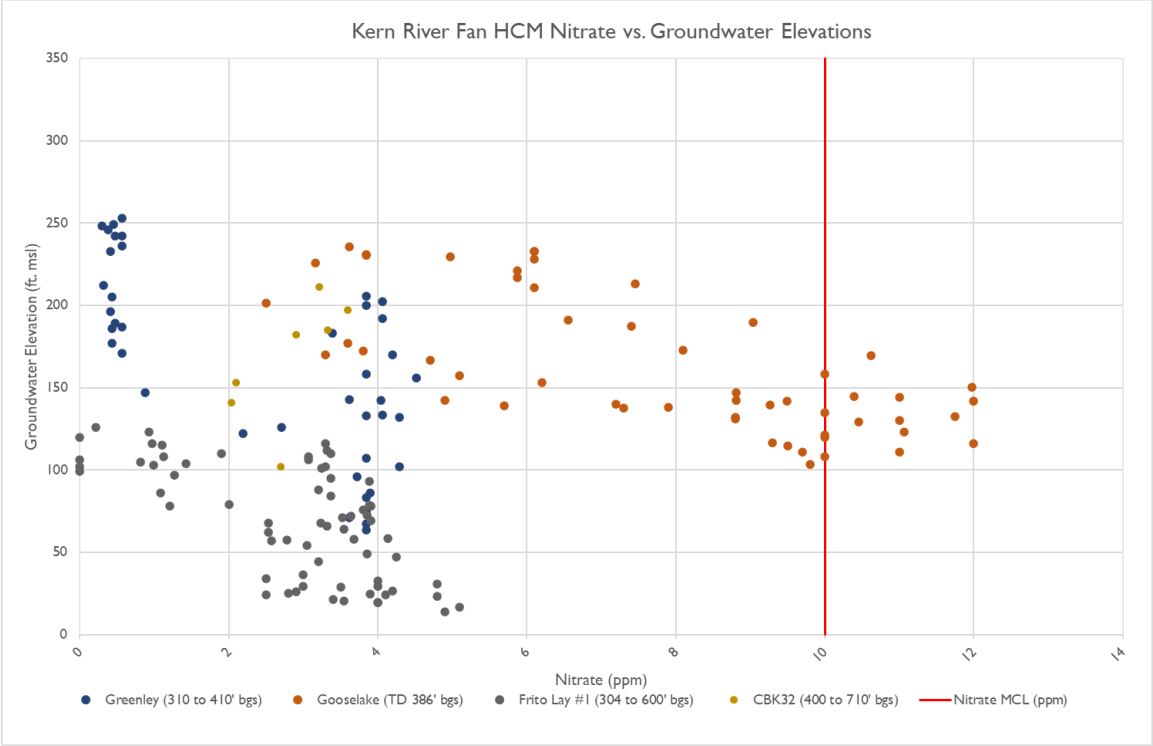


Figure 8-44. Kern River Fan HCM Area Nitrate vs. Groundwater Elevations

In the South Basin HCM Area, high median nitrate concentrations are primarily located directly east and west of the lakebed deposits, where E-Clay is absent or thinning (Figure 8-39). Figure 8-45 shows the trend of six wells in the South Basin HCM Area, demonstrating different nitrate concentration response to groundwater elevation and well construction. Where groundwater elevation data is not available for the well with nitrate data, a nearby RMW-WLs groundwater elevation is used to represent water level fluctuation in the area.

Of the six wells, EL ADOBE POA Well 01 and Holiday Rock Plant #2 Well 02 are screened to extract groundwater from 0 to 75 feet bgs and 340 to 400 feet bgs, respectively. Trending of these two wells show nitrate fluctuation regardless of groundwater elevation stability.

Arvin 14, screened at 600 to 900 feet bgs and OPOA Well 03, screened at 360 to 600 feet bgs, show nitrate concentration is stable even with groundwater elevation decline. SKMWC Well 01 shows an increase in nitrate as groundwater elevation increases. Well screening information for SKMWC Well 01 is not available therefore correlation of nitrate concentration with well construction cannot be evaluated. LPUD Well 17 demonstrates that nitrate concentration can fluctuate at various groundwater elevations.

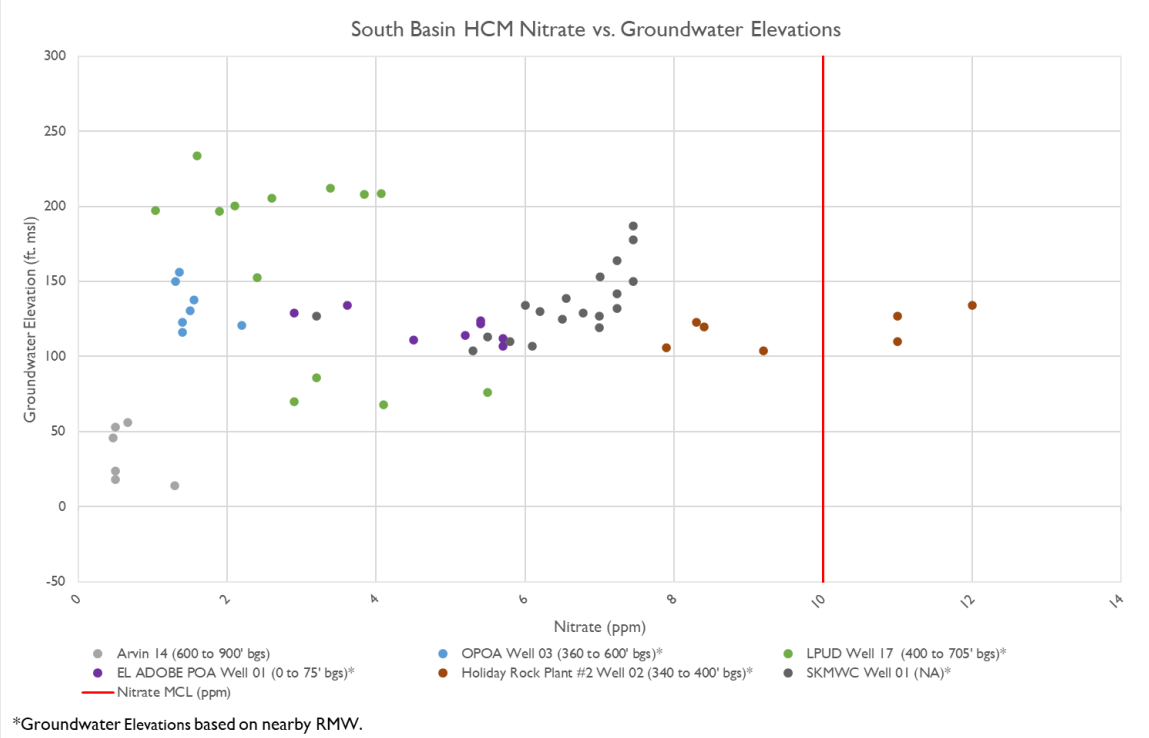


Figure 8-45. South Basin HCM Area Nitrate vs. Groundwater Elevations

While nitrate sources are typically from the surface, trending demonstrated that nitrate concentration may be influenced by multiple localized factors. Sources of constituent, well construction, proximity to recharge basins and groundwater elevation changes may contribute to fluctuations in nitrate concentration.

Driving Mechanisms for Exacerbating Nitrate Concentrations and Conclusion Statement

Nitrates are commonly found in the environment; however, the presence of nitrate in groundwater is typically contaminated by anthropogenic sources from overlying land uses. Nitrate above the water quality objective is most commonly found in the North Basin HCM Area. Analysis of several wells indicates the primary influence to fluctuating concentrations are localized conditions. Where the E-clay is present and serving as a confining layer, nitrates are commonly below the water quality objective and there is no clear relationship between nitrate concentration fluctuations and groundwater levels.

In the Kern River Fan HCM Area, where significant banking activities occur, nitrate concentrations appear to be reduced by the high-quality waters used for recharge and/or banking storage. Several RMW-WQs and public supply wells were evaluated and demonstrate that nitrate levels are below the MCL water quality objective. Based on the analysis conducted, nitrate is commonly present above the drinking water water quality objective of 10 ppm:

- In wells relying primarily on localized shallow groundwater where there is a known or typical source of nitrate is persistent (i.e., septic systems).
- Where the E-Clay is present but localized conditions enable nitrate to migrate into the deeper portions of the aquifer.

Figure 8-46 shows the median concentration in small community wells, with the density of domestic wells throughout the Kern Subbasin. Approximately 23 percent of small community wells have a maximum concentration of nitrate above the 10 ppm water quality objective; 15 percent have a median concentration above the water quality objective. Based on data trending analysis and the relatively narrow range between percentage of wells with maximum and median arsenic concentrations above the water quality objective, localized conditions appear to contribute to most water quality objective exceedances.

The GSAs are collecting Subbasin-wide data correlated with water level measurements to monitor the relationship between nitrate concentrations and groundwater management activities. Based on data currently available, there is not a clear correlation between exacerbating nitrate concentrations and chronic lowering of groundwater levels.

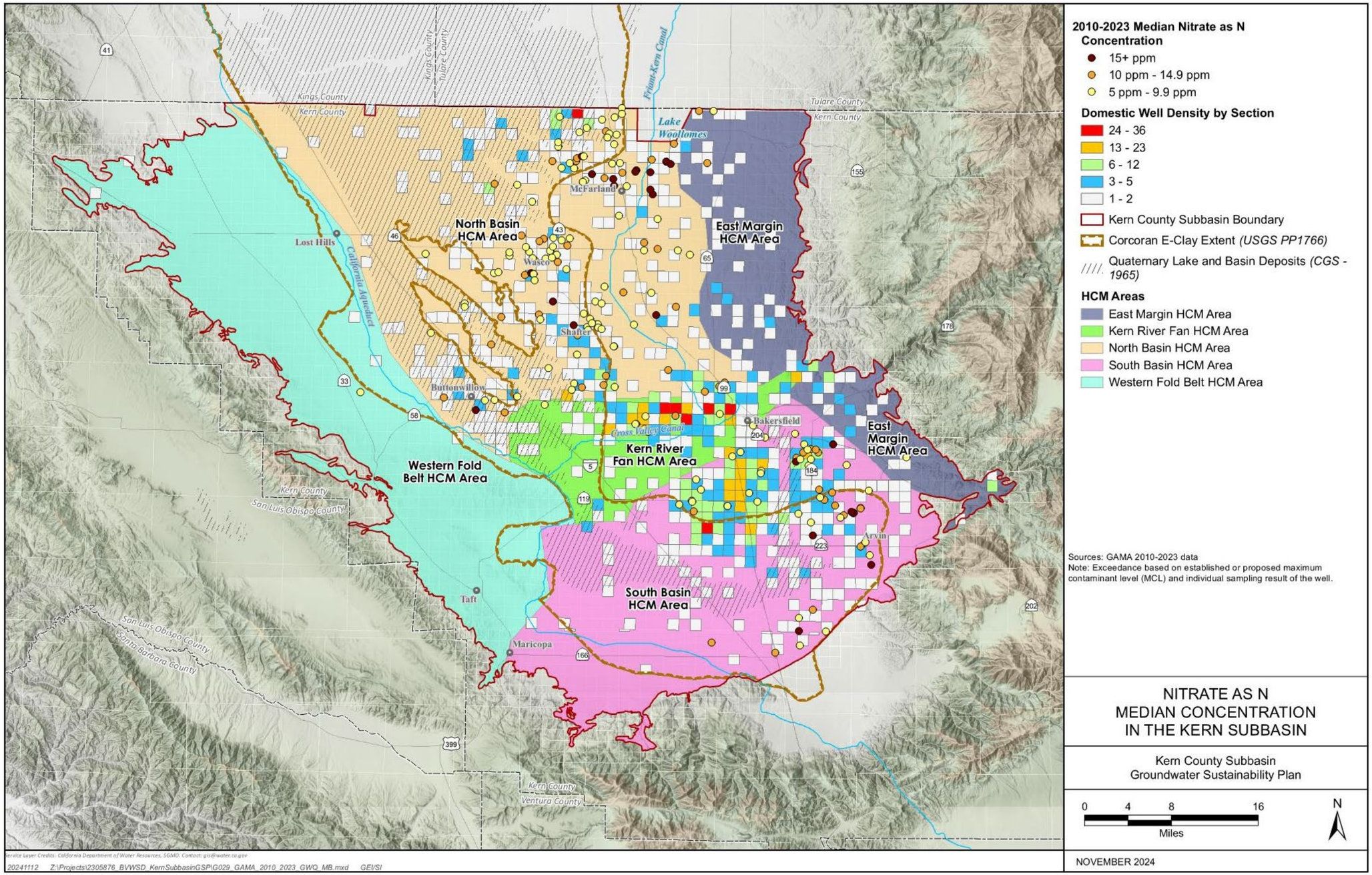


Figure 8-46. Median Nitrate Concentration of Small Community Wells

8.4.2.7 Perfluorooctanoic Acid (PFOA), Perfluorooctane Sulfonic Acid (PFOS)

In April 2024, the EPA finalized an MCL of 4 ppt for both perfluorooctanoic acid (PFOA), and perfluorooctane sulfonic acid (PFOS). The EPA MCLs were slated to become effective in April of 2029, but the time has been extended by the new administration. In the meantime, California's DDW is looking to adopt primary MCLs for these constituents pursuant to Title 22. The timing for DDW adoption of primary MCLs is not yet clear. Until DDW adopts primary MCLs for PFOA and PFOS there are no water quality objectives for these constituents. Both constituents are part of a group of Per- and Polyfluoroalkyl Substances (PFAS), a category of manufactured chemicals that have been used in industry and consumer products. Commonly, PFOA is used for nonstick cookware, and PFOS is used in stain and water-repellant fabrics and firefighting foam. PFAS typically break down slowly and are highly hydrophobic. Figure 8-47 and Figure 8-48 displays the median PFOA and PFOS concentration per well, along with if the well had an exceedance of EPA's drinking water standard, which was used for this analysis. Notably, as identified above, there are no water quality objectives in effect for these constituents.

Limited PFAS data is available due to two SWRCB General Orders, DW 2021-0001 (rescinded) and 2022-0001-DDW, which required some public water systems to conduct PFAS monitoring. In the Kern Subbasin, PFOA and PFOS data are available for 205 sources, covering each HCM Area, with the exception of the Western Fold Belt HCM Area. Table 8-21 and Table 8-22 summarize PFOA and PFOS prevalence by HCM Area. The median PFOA and PFOS concentrations are non-detect for both constituents. Sources with detections above the recently established EPA drinking water standard for PFOA and PFOS are primarily located in the North Basin and South Basin HCM Areas, with one source above the standard in the Kern River Fan HCM Area. As monitoring for these constituents increases, it is expected that additional municipal data will become available once MCLs and monitoring frequency are established for these constituents, allowing for further characterization and analysis of these analytes can occur for in the Kern Subbasin.

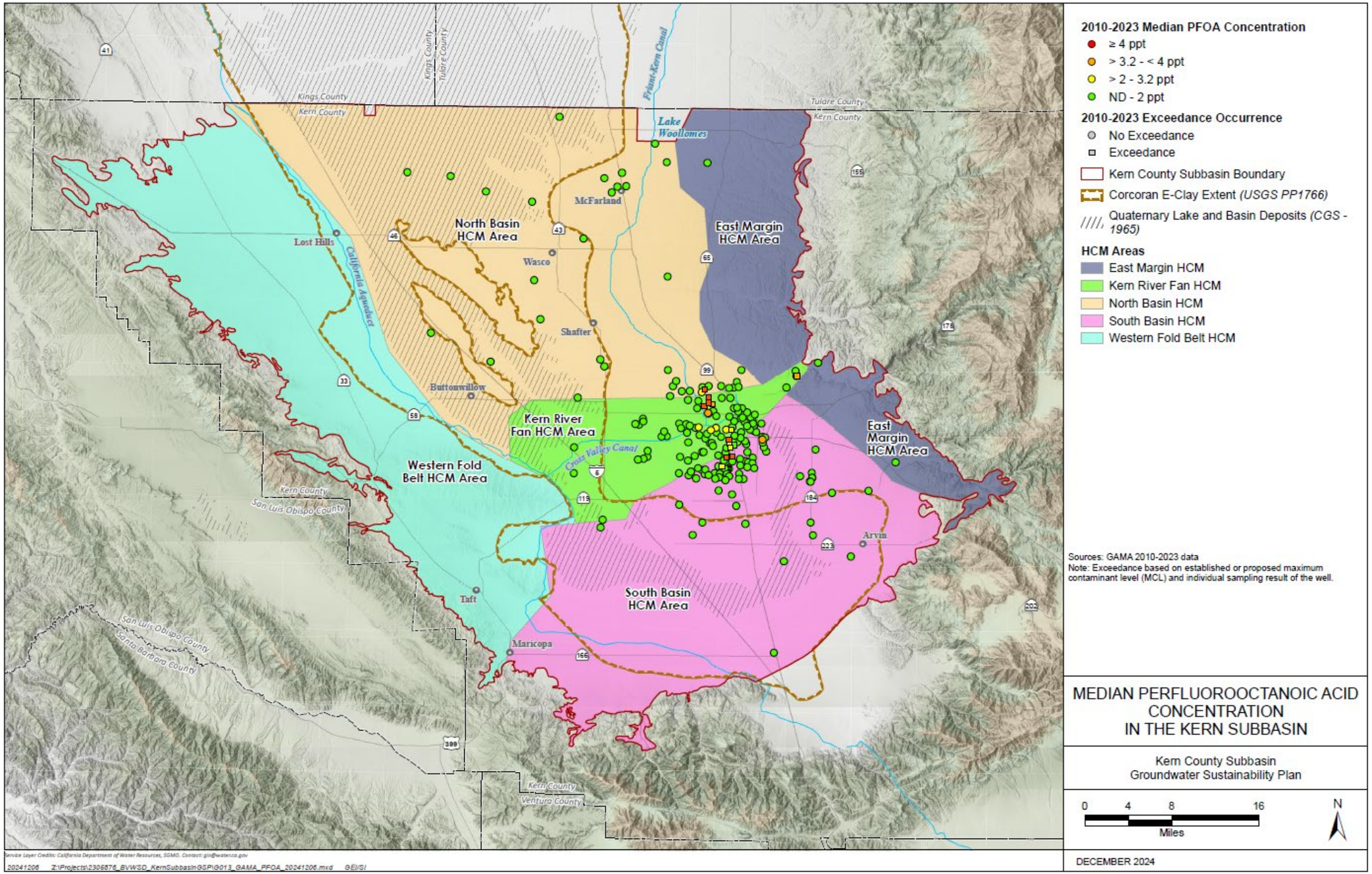


Figure 8-47. Median Perfluorooctanoic Acid (PFOA) Concentration in the Kern Subbasin

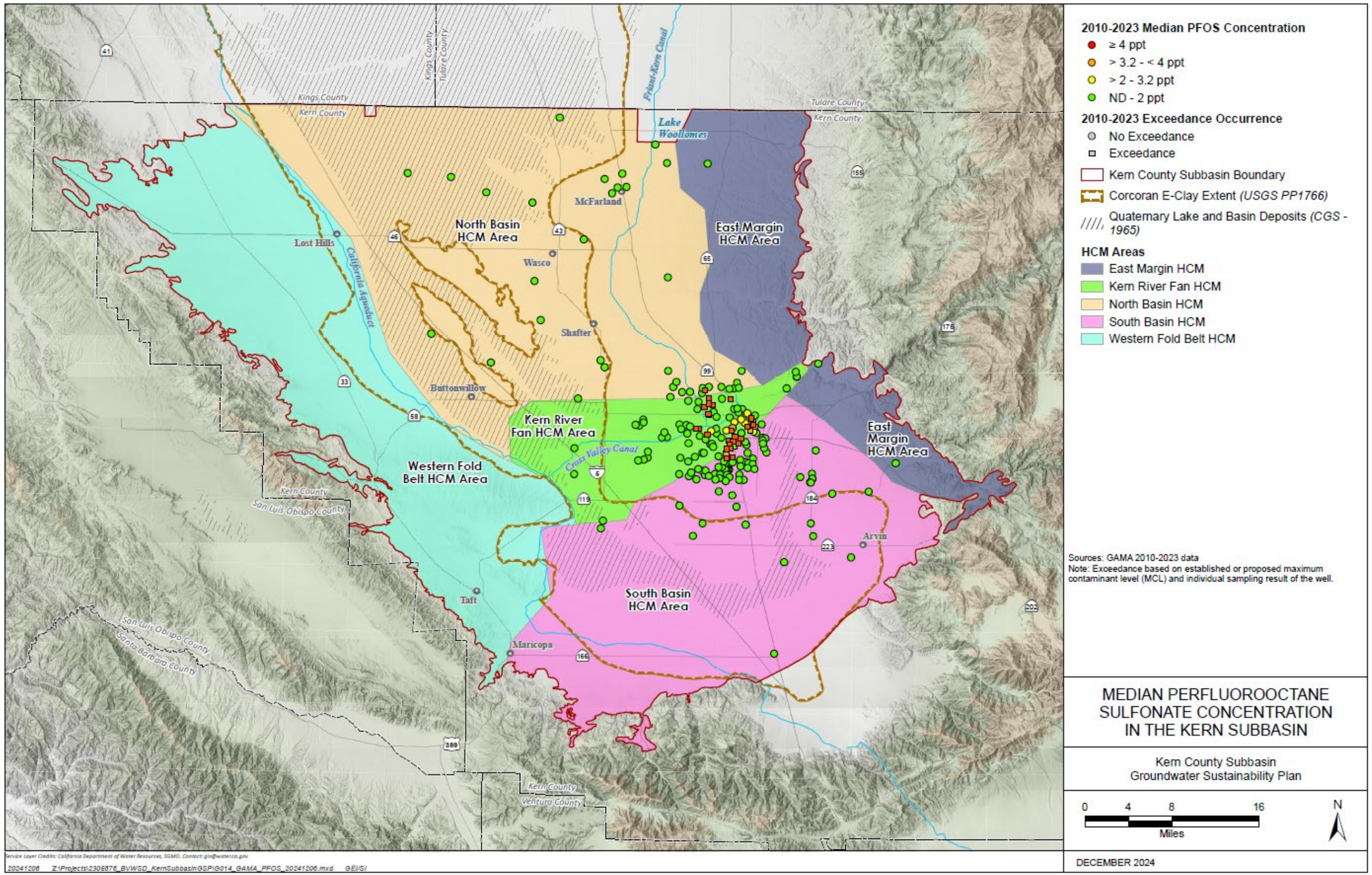


Figure 8-48. Median Perfluorooctane Sulfonic Acid (PFOS) Concentration in the Kern Subbasin

Table 8-21. 2015 to 2023 PFOA prevalence by HCM Area

Perfluorooctanoic acid (PFOA)					
HCM Area	Range (ppt)	Median (ppt)	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Western Fold Belt[1]	-	-	-	-	-
North Basin	ND - 12	ND	1	37	2.7%
Kern River Fan	ND - 9.7	ND	10	88	11.4%
South Basin	ND - 13	ND	3	75	4.0%
Eastern Margin	ND	ND	0	3	0.0%
		Total	14	203	6.9%

[1] No data available for HCM Area primarily undeveloped lands and limited pumping.

Table 8-22. 2015 to 2023 PFOS prevalence by HCM Area

Perfluorooctane sulfonate (PFOS)					
HCM Area	Range (ppt)	Median (ppt)	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Western Fold Belt[2]	-	-	-	-	-
North Basin	ND - 10	ND	1	37	2.7%
Kern River Fan	ND - 57	ND	27	88	30.7%
South Basin	ND - 11	ND	2	75	2.7%
Eastern Margin	ND	ND	0	3	0.0%
		Total	30	203	14.8%

[2] No data available for HCM Area primarily undeveloped lands and limited pumping.

Driving Mechanisms for Exacerbating PFOA and PFOS Concentrations and Conclusion Statement

As previously stated, there are not sufficient PFOA and PFOS detections across the Kern Subbasin to conduct any trend analysis and identify potential driving mechanisms that may result in exacerbate increased concentrations. Based on the evaluation conducted and findings presented in this report, the GSAs do not propose to include perfluorinated compounds in their seasonal monitoring program. Instead, the Kern Subbasin will rely on data collected through other regulatory programs and additional data and information that is developed by DDW and others as it proceeds forward with a rulemaking for adoption of primary MCLs consistent with Title 22 of the California Code of Regulations.

8.4.2.8 Selenium

Selenium has a water quality objective to protect the municipal beneficial use based on the primary MCL of 50 ppb. Selenium is a naturally occurring element found in the upper Cretaceous and Tertiary marine and sedimentary deposits that form the California Coast Ranges and inland Central Valley basin. Sedimentary rocks, particularly shales, have the highest naturally occurring selenium content and the natural weathering of

geologic strata containing selenium can lead to selenium leaching into groundwater and surface water. There are two anthropogenic activities known to cause increased selenium mobilization into aquatic systems: human disturbances to the geological sedimentary deposits and irrigation of selenium-rich soils (40 CFR 131 Section 64059). Figure 8-49 displays the median concentration of selenium per well, along with any water quality objective exceedances.

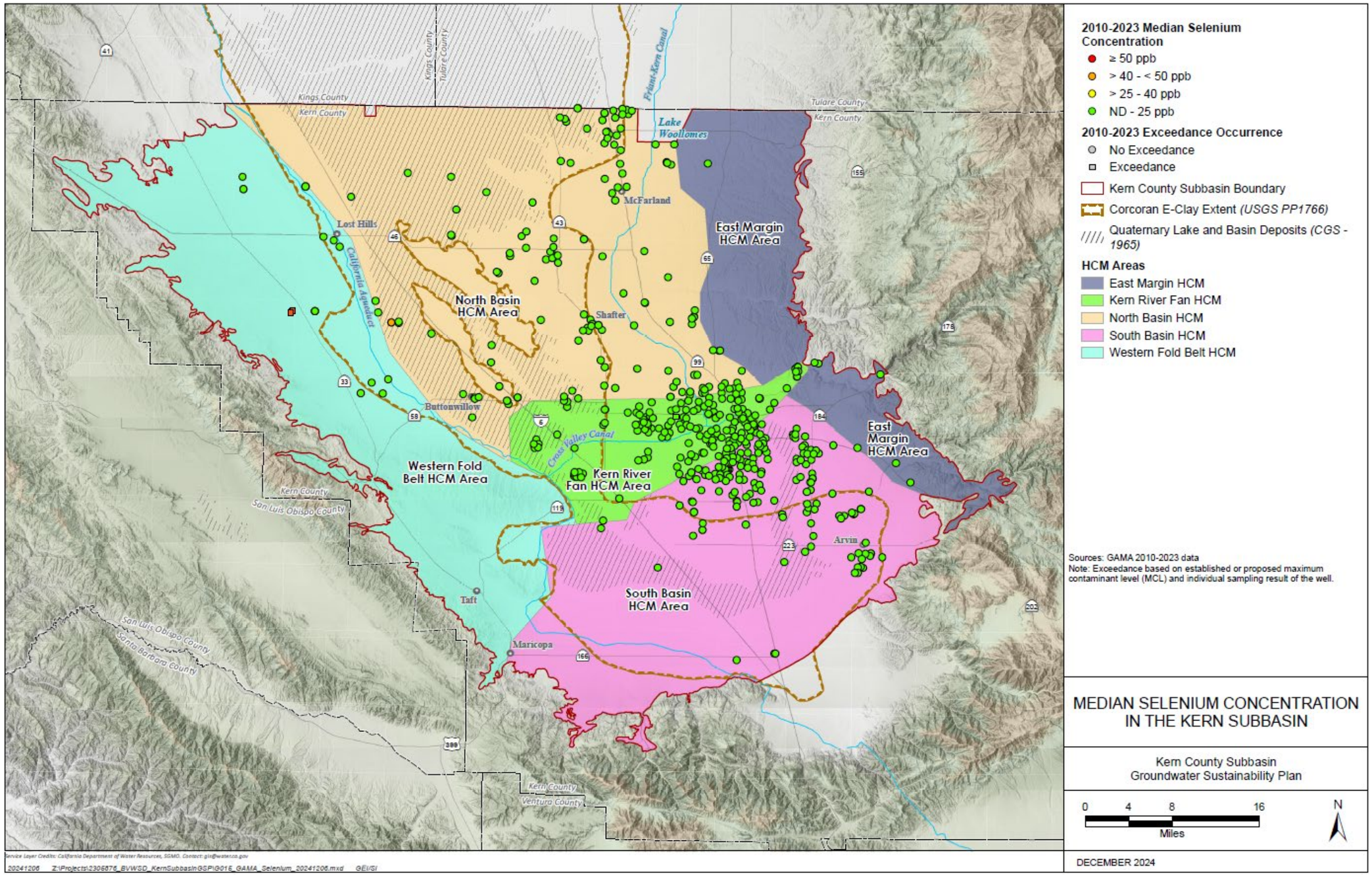


Figure 8-49. Selenium Concentration in the Kern Subbasin

Based on the range of concentration, median and count of sources exceeding the water quality objective, selenium is not prevalent in the Kern Subbasin. Table 8-23 summarizes pre-2015 and 2015 to 2023 selenium median and range for each HCM Area. The selenium median concentration in each HCM Area is non-detect. Selenium is detected above the water quality objective in two HCM Areas. In the Kern River Fan HCM Area, there is a one-time detection of selenium in a municipal well above the water quality objective. Subsequent sample results show selenium below 15 ppb and non-detect. In the Western Fold Belt HCM Area, selenium is detected above the water quality objective in three USGS other water supply wells. Table 8-24 summarizes selenium exceedances for each HCM Area.

Table 8-23. Selenium Range and Median Summary by HCM Area

	2010 to 2014			2015 to 2023		
HCM Area	Range (ppb)	Median (ppb)	# of Wells Sampled	Range (ppb)	Median (ppb)	# of Wells Sampled
Western Fold Belt	ND	ND	1	ND - 381	ND	20
North Basin	ND - 33	ND	101	ND - 50	ND	132
Kern River Fan	ND - 3.9	ND	147	ND - 140	ND	160
South Basin	ND - 20	ND	133	ND - 39	ND	164
Eastern Margin	ND	ND	3	ND - 10	ND	6

Table 8-24. Selenium Well Exceedance Summary by HCM Area

	2010 to 2014			2015 to 2023		
HCM Area	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Western Fold Belt	0	1	0.0%	3	20	15.0%
North Basin	0	101	0.0%	0	132	0.0%
Kern River Fan	0	147	0.0%	1	160	0.6%
South Basin	0	133	0.0%	0	164	0.0%
Eastern Margin	0	3	0.0%	0	6	0.0%
Total	0	385	0.0%	4	482	0.8%

8.4.2.9 Total Dissolved Solids (TDS)

TDS represents the total concentration of anions and cations in groundwater and is used as an indicator of mineralization, salt content, and overall water quality. TDS has a secondary maximum contaminant level (SMCL) with a recommended limit of 500 ppm and an upper limit of 1,000 ppm. As summarized in the general water quality sections (Section 7.4, HCM Subarea Characteristics), sources of TDS in the Kern Subbasin (and especially on the Western Fold Belt and East Margin HCM Areas) can be attributed to the source of natural groundwater recharge and the influence of connate waters from older marine formations. In addition to natural sources, anthropogenic sources such as

infiltration from oil field produced water disposal ponds, perched water subject to evaporative pumping, or agricultural drainage ponds affect TDS concentrations in groundwater (Metzger and Landon, 2018).

In the Kern Subbasin, higher TDS groundwater is typically present in shallow perched zones above the E-clay, and throughout the western third of the Kern Subbasin. Kern County Water Agency's 2011 Water Supply Report presented groundwater quality maps using data pre-1997. These maps report groundwater is progressively lower in TDS below the E-clay, toward the center of the Kern Subbasin, and in the eastern half of the Kern Subbasin. In the central portion of the Kern Subbasin, TDS concentrations generally range from less than 500 to 1,500 ppm, while the western portion of the Kern Subbasin TDS ranges from 1,000 to 5,000 ppm. In the deeper portion of the aquifer in the central portion of the Kern Subbasin TDS concentrations generally ranges from less than 200 to 500 ppm, while westside groundwater typically ranges from 1,000 to 4,000 ppm. The high-TDS (Na-Cl) groundwater is generally found in the deeper parts of the Kern Subbasin. This saline groundwater is likely to be connate water trapped during the deposition of the marine sediments which is used to define the Kern Subbasin bottom at depth as discussed in Section 7.6.2.

Higher TDS concentrations in Western Fold Belt HCM Area, as compared with Eastern Margin HCM Area, is related to a combination of natural conditions (westside sediments derived from marine deposits with some connate water) and anthropogenic factors such as infiltration from former oil field produced water disposal ponds and/or agricultural drainage ponds (Metzger and Landon, 2018). Groundwater adjacent to Sierra Nevada has the lowest TDS and greatest depths to non-USDWs because of the source of low TDS (Ca-HCO_3 type) recharge, whereas aquifer zones on the west side of the Kern Subbasin have higher TDS. The westside aquifer zones receive very little recharge from the Temblor Range, which is made up of marine deposits, and westside aquifer zones such as the Tulare Formation likely contain connate water derived from marine deposits (Wood & Dale, 1964). This higher TDS water, which is typically Na/Ca-SO_4 type, is consistent with historical reports and is documented for more than 60 miles from north to south in the Kern Subbasin (KCDEH, 1980; KCDEH and KCWA, 1982; Sierra Scientific Services, 2013).

Within the northern portion of Eastern Margin HCM Area, the Santa Margarita and Olcese Formations originally contained marine water. Recharge from the east has fed freshwater into these formations and has displaced some of the original marine waters contained in the aquifers. This recharge has created a freshwater/brackish water interface in these Principal Aquifers just west of Kern-Tulare Water District (the western border of the East Margin HCM Area). In 1963, USGS Publication 63-47 identified the approximate western limits of freshwater in these aquifers where TDS was greater than approximately 2,000 ppm.

Figure 8-50 displays the TDS median concentration per well, along with water quality objective exceedances. Wells with TDS median concentrations exceeding the water quality objective are primarily located in the Western Fold Belt, North Basin, and South Basin HCM Areas.

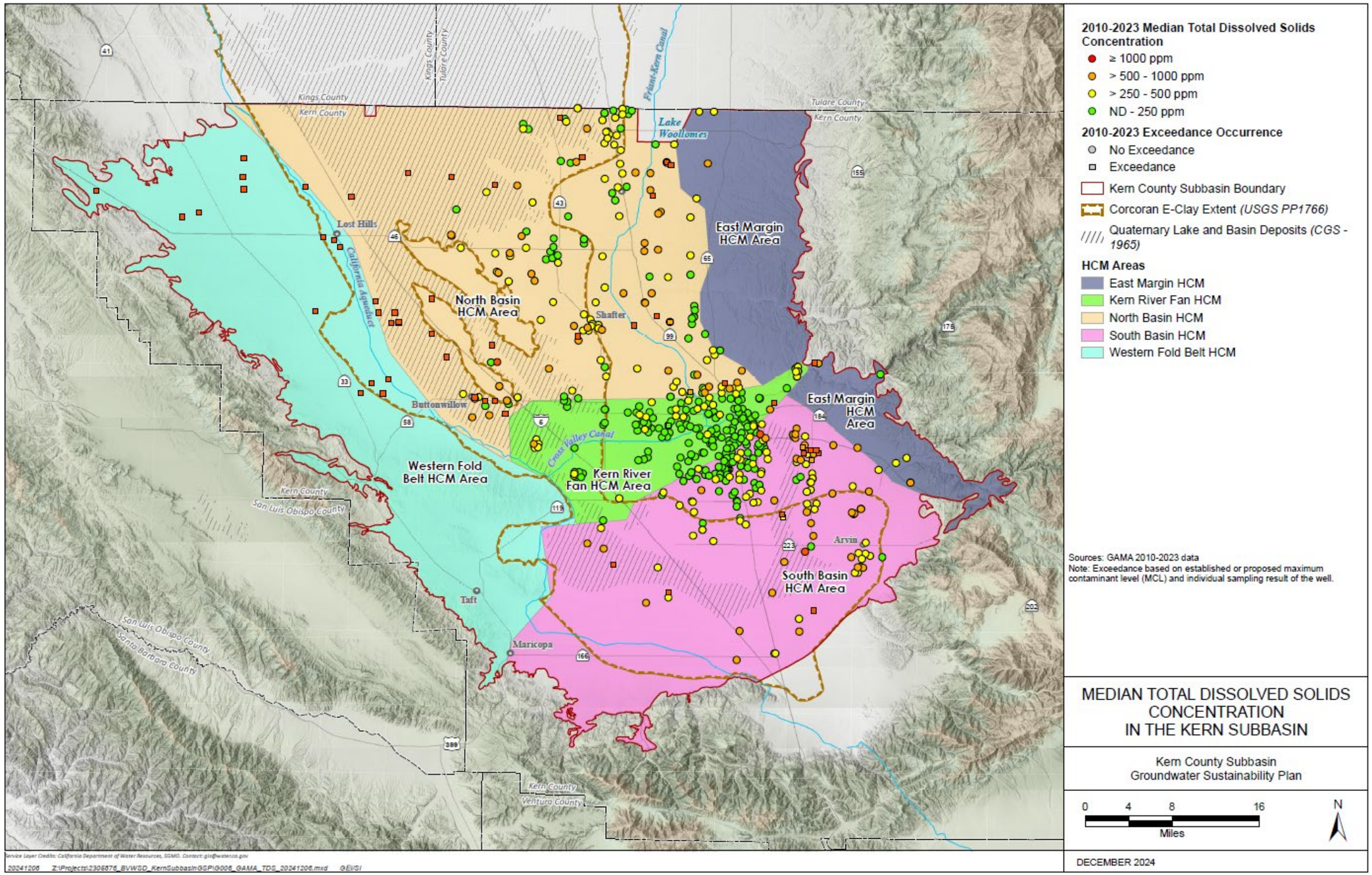


Figure 8-50. Median Total Dissolved Solids Concentration in the Kern Subbasin

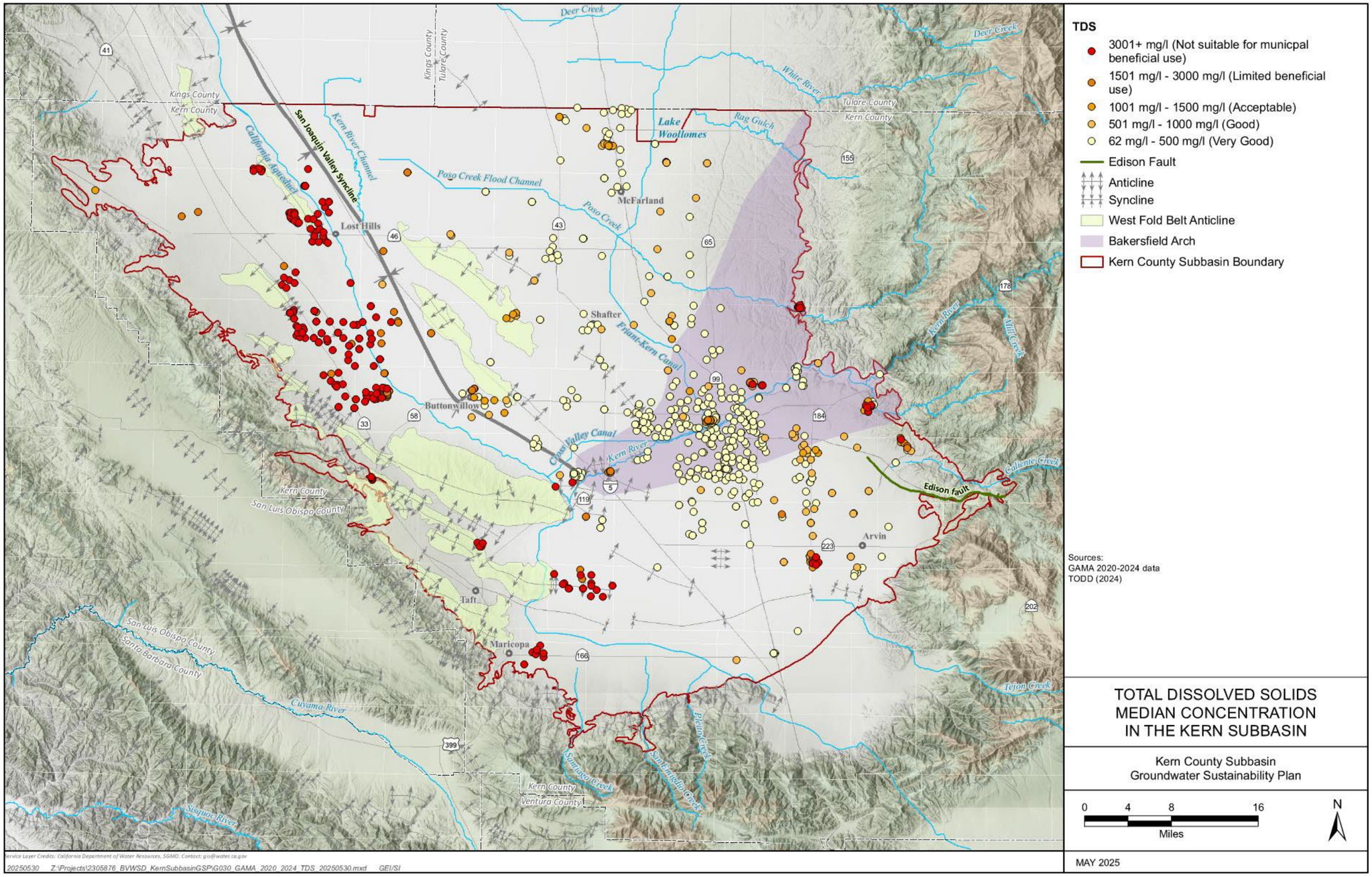


Figure 8-51. Median Total Dissolved Solids Concentration with Geologic Structures

Figure 8-51 shows median TDS concentrations of all wells in the Kern Subbasin (Figure 8-50 is limited to production wells) to demonstrate how high TDS concentrations in the Western Fold Belt are attenuated by natural mixing and dilution prior to flowing into the North Basin HCM Area. Geologic structures depict how groundwater flows generally radiate north and south from the Kern River to areas of dense pumping, but flows also respond to pre-development conditions. Hydrogeologic conditions, such as the channeling of groundwater flow by the San Joaquin Valley Syncline and the obstruction of groundwater flow by various anticlines, influence gradients and are important factors affecting the presence of TDS.

High TDS waters in the southern area of the Western Fold Belt HCM Area represent localized conditions. There is not sufficient groundwater use or pumping in this area to influence groundwater flow direction. While there are small anticlines and synclines along the southern Western Fold Belt HCM Area margin, groundwater flow across these features is not studied since surface water is used to meet most land use demands.

There are also several wells with high TDS water in the East Margin HCM Area. These wells represent pumping from the Santa Margarita and Olcese Aquifers, which are physically separated from the Kern Alluvium.

Table 8-25 summarizes each HCM Area's pre-2015 and 2015 to 2023 TDS median and range. In each HCM Area, TDS concentration ranges exceed the water quality objective, except for the Eastern Margin HCM Area during pre-2015 conditions. While the upper range of TDS concentrations exceed the objective, TDS median concentrations are below the objective in each HCM Area, except the Western Fold Belt HCM Area, which primarily rely on imported surface water due to naturally degraded water quality.

Table 8-25. Total Dissolved Solids Range and Median Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	Range (ppm)	Median (ppm)	# of Wells Sampled	Range (ppm)	Median (ppm)	# of Wells Sampled
Western Fold Belt	5850	5850	1	1300 - 16400	3290	21
North Basin	120 - 1400	315	94	110 - 5400	408	178
Kern River Fan	110 - 1100	190	146	32 - 1200	200	158
South Basin	130 - 1800	270	121	110 - 2100	313	172
Eastern Margin	170 - 430	190	3	99 - 1300	473	12

Table 8-26 summarizes pre-2015 and 2015 to 2023 TDS exceedances for each HCM Area. While the number of wells with TDS exceedances for each HCM Area is greater in 2015 to 2023 conditions compared to pre-2015 conditions, these increases do not necessarily indicate degradation of groundwater quality. Rather, it may reflect a more comprehensive understanding of TDS concentration in the Kern Subbasin as the

number of wells sampled increased in all HCM Areas from the pre-2015 to the 2015 to 2023 conditions.

During the 2015 to 2023 period, TDS is detected above the SMCL in six domestic wells, 25 irrigation/industrial wells, 24 municipal wells and 10 water supply wells. Of the 24 municipal, four wells had average TDS concentrations below the SMCL, eight wells had one-time detection above the SMCL where the exceedance not confirmed, one well is a standby well, and one well is an inactive well.

Table 8-26. Total Dissolved Solids Well Exceedance[1] Summary by HCM Area

HCM Area	2010 to 2014			2015 to 2023		
	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance	# of Wells with Exceedance	# of Wells Sampled	% of Wells with Exceedance
Western Fold Belt [1]	1	1	100%	21	21	100%
North Basin	6	94	6.4%	31	178	17.4%
Kern River Fan	1	146	0.7%	1	158	0.6%
South Basin	7	121	5.8%	11	172	6.4%
Eastern Margin	0	3	0.0%	1	12	8.3%
Total	15	365	4.1%	65	541	12.0%

[1]Count represents number of wells where TDS is detected above the SMCL and not number of wells out of compliance, as compliance is based on a quarterly average and not a single detection.

TDS median concentrations for wells within and outside the boundaries of E-clay and lake deposits are evaluated and summarized in Table 8-27. Higher median TDS concentrations are present in wells within the boundaries of the E-clay and lake deposits throughout the Kern Subbasin. The Eastern Margin HCM Area has the highest TDS median outside the boundaries of the E-clay and lake deposits when compared to the HCM Areas in the easter portion of the Kern Subbasin (North Basin, Kern River Fan, and South Basin HCM Areas). This is likely due to the original saline waters of the Santa Margarita and Olcese Principal Aquifers being displaced by the freshwater recharge water. Refer to Section 7.4 for more detailed explanation. It is important to note that Table 8-27 does not distinguish if the well is constructed/screened below or above these deposits.

Table 8-27. Median TDS Summary for Wells within E-clay or Lakebed Deposits Boundaries

HCM Area	Geology	2010 to 2023 Median (ppm)	2010 to 2023 # of Wells Sampled
Western Fold Belt	E-Clay and Alluvial Fan	4390	9
	Neither	2393	12
North Basin	E-Clay and Lake Deposits	648	40
	E-Clay	350	63
	Neither	420	98

HCM Area	Geology	2010 to 2023 Median (ppm)	2010 to 2023 # of Wells Sampled
Kern River Fan	E-Clay and Lake Deposits	320	10
	E-Clay	225	13
	Neither	190	141
South Basin	E-Clay and Lake Deposits	650	9
	E-Clay	460	51
	Lake Deposits	230	3
	Neither	260	118
Eastern Margin	Neither	450	14

Driving Mechanisms for Exacerbating TDS Concentrations and Conclusion Statement

It is documented that sediments of marine origin, some of which contain connate water, are extensive in the Western Fold Belt HCM Area. This condition is a significant contributing factor to the naturally poor groundwater quality on the westside. Other potential sources of TDS include former oil field produced water disposal ponds. There are no known TDS plumes that pose a risk of migrating into and degrading the high-quality groundwater in the Kern Alluvium. TDS is included in the GSAs seasonal monitoring program.

8.4.3 Point-Source Contamination Sites

Data from SWRCB's GeoTracker and DTSC's EnviroStor databases were used to identify groundwater contaminant sites in the Kern Subbasin. Contaminant plumes are routinely monitored through a designated network of monitoring wells surrounding the site. GSAs are aware of sites within their boundary and coordinate with the appropriate regulatory agency when notified of plume migration. Groundwater contaminated sites were evaluated for the following criteria:

1. Potential media of concern defined as "groundwater," "other groundwater," or "drinking groundwater."
2. Potential constituent of concern defined, or "unknown."
3. Site/case reported as "not closed," and had one of the following statuses:
    - Contains "Active"
    - Inactive – Needs Evaluation
    - Inactive – Permitted
    - Inactive – Unpermitted
    - Contains "Open"
    - Pending Review
    - Refer: EPA or Refer: Other Agency

A total of 86 contaminated groundwater sites were identified. Of the 86 sites, 42 sites are produced water ponds, which are further discussed in Section 8.4.4. The remaining 44 sites consist of 21 SWRCB Cleanup Program sites, five Leaking Underground Storage Tank (LUST) Program sites, one Federal Superfund site, 17 sites for other programs (Corrective Action, Evaluation, Non-Case Information, State Response, and Voluntary Cleanup). Figure 8-52 identifies the location of the point source contamination sites, which are primarily located within the North Basin (13 sites), Kern River Fan (15 sites) and South Basin (11 sites) HCM Areas. The Western Fold Belt HCM Area has four-point source contamination sites and Eastern Margin HCM Area has one point source contamination site. Table 8-28 provides details of each site (identified by the number in Figure 8-52) including site name, GeoTracker or EnviroStor site ID, program, status, and potential COC.

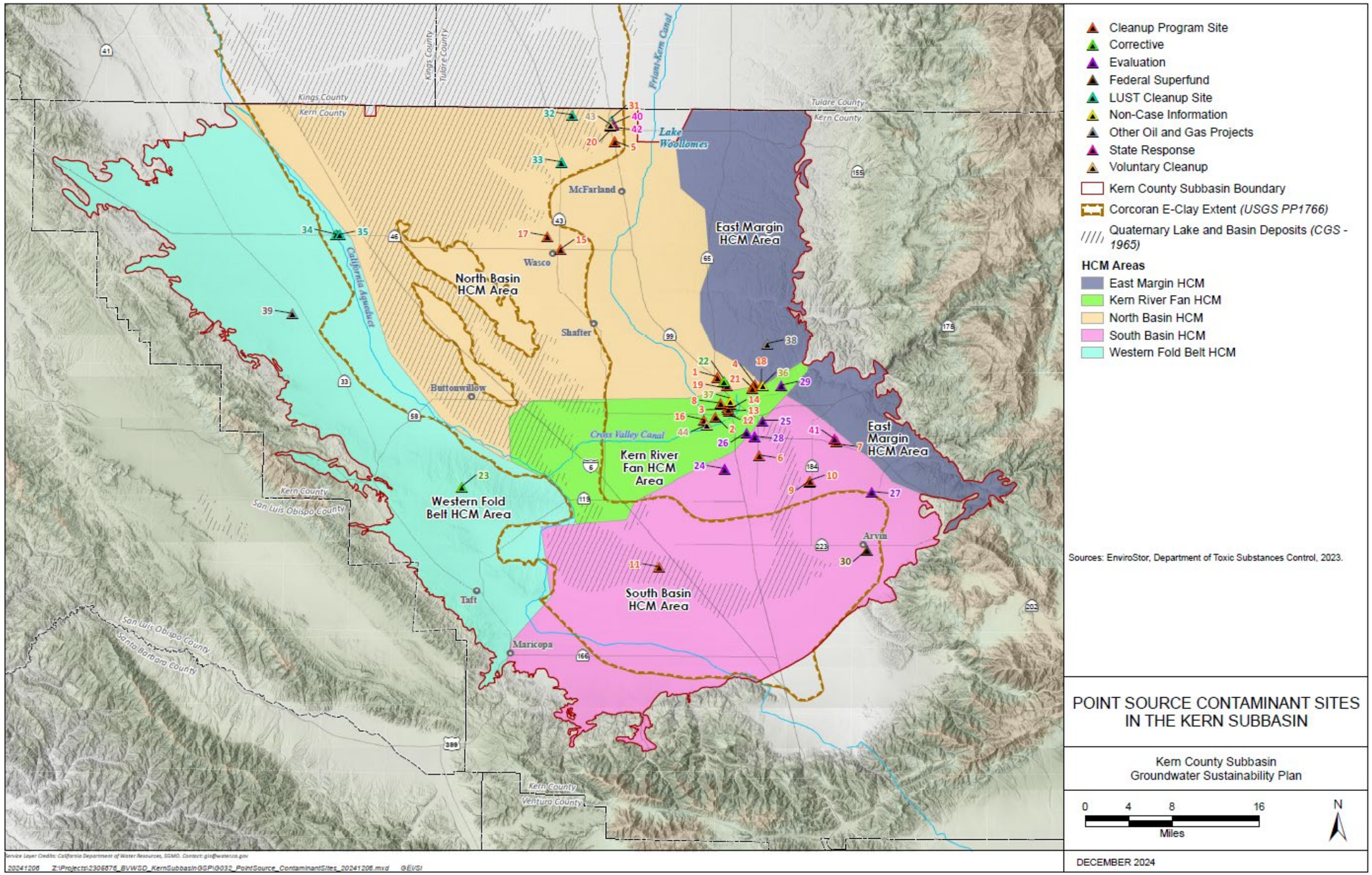


Figure 8-52. Point Source Contaminant Sites

Table 8-28. Groundwater Contamination Sites Identified Within Kern Subbasin

# on Figure 8-52	Site Name	Site ID	Source	Program	Status	Chemical
1	Bakersfield Airport Business Park (Chevron Land/D)	SL0602981532	GeoTracker	Cleanup Program Site	Open - Verification Monitoring	Crude Oil
2	Bakersfield Refinery	SL205314279	GeoTracker	Cleanup Program Site	Open - Remediation	Benzene; Other Solvent or Non-Petroleum Hydrocarbon; Toluene; Xylene; Diesel; MTBE / TBA / Other Fuel Oxygenates; Gasoline; Other Petroleum
3	Bakersfield Refinery - Area 3	T10000001848	GeoTracker	Cleanup Program Site	Open - Verification Monitoring	Diesel; Gasoline
4	Chevron USA (AKA: Chevron Refinery & Wait Tank YD)	SL205064267	GeoTracker	Cleanup Program Site	Open - Remediation	Benzene; Lead; Crude Oil; Other Petroleum
5	Crop Production Services (CPS) Delano	SL185724257	GeoTracker	Cleanup Program Site	Open - Remediation	Other Chlorinated Hydrocarbons, Other Solvent or Non-Petroleum Hydrocarbon; DDD / DDE / DDT; 1,1,2-Trichloroethane; 1,2,3-Trichloropropane; 1,4-Dichlorobenzene; 2,4-D; 2,4-DB; Bromoform (THM); DDD; DDE; Dibromochloromethane(THM), Dibromochloropropane (DBCP), Dicamba, Dinoseb, Endosulfan I, Endosulfan II, Heptachlor, Nitrate + Nitrite (as N), Trichlorofluromethane
6	Garriott Cropdusters	SLT5FQ134306	GeoTracker	Cleanup Program Site	Open - Site Assessment	Other Insecticides / Pesticide / Fumigants / Herbicides
7	J. R. Simplot - Edison	SLT5FS324450	GeoTracker	Cleanup Program Site	Open - Remediation	Dibromochloropropane (DBCP)
8	KCL Lease	T10000012038	GeoTracker	Cleanup Program Site	Open - Assessment & Interim Remedial Action	*Chemical information not provided in GeoTracker
9	Kern Energy - Kern Energy - PFAS Investigation	T10000021222	GeoTracker	Cleanup Program Site	Open - Site Assessment	Per- and Polyfluoroalkyl Substances (PFAS)

# on Figure 8-52	Site Name	Site ID	Source	Program	Status	Chemical
10	Kern Energy - Kern Energy (Formerly Kern Oil & Refining)	SL372524510	GeoTracker	Cleanup Program Site	Open - Remediation	Benzene, Gasoline, MTBE / TBA / Other Fuel Oxygenates, Toluene, Diesel, Xylene
11	Paloma Station Property	T10000011026	GeoTracker	Cleanup Program Site	Open - Remediation	Arsenic, Chromium, Lead, Other Metal, Benzene, Diesel, Gasoline, Other Petroleum, Total Petroleum Hydrocarbons (TPH)
12	Sabre Refinery	SLT5FQ334326	GeoTracker	Cleanup Program Site	Open - Inactive	Total Petroleum Hydrocarbons (TPH)
13	San Joaquin Drum	SLT5FR634417	GeoTracker	Cleanup Program Site	Open - Site Assessment	*Chemical information not provided in GeoTracker
14	San Joaquin Refining - San Joaquin Refining Cc - Fruitvale Refinery	SL205714283	GeoTracker	Cleanup Program Site	Open - Remediation	Diesel
15	Simplot Wasco	SLT5FS184436	GeoTracker	Cleanup Program Site	Open - Remediation	Other Insecticides / Pesticide / Fumigants / Herbicides
16	Sunland Refining Corporation	SL205224272	GeoTracker	Cleanup Program Site	Open - Remediation	Crude Oil, MTBE / TBA / Other Fuel Oxygenates, Gasoline
17	Wasco Airport	SLT5FQ444336	GeoTracker	Cleanup Program Site	Open - Verification Monitoring	DDD / DDE / DDT, Other Insecticides / Pesticide / Fumigants / Herbicides
18	West Coast Oil Refinery, Bakersfield	SL0602978387	GeoTracker	Cleanup Program Site	Open - Assessment & Interim Remedial Action	Lead, Diesel, Gasoline
19	Western Farm Service Inc-1610 Norris Road Bakersfield	SL186364605	GeoTracker	Cleanup Program Site	Open - Site Assessment	Other Chlorinated Hydrocarbons
20	WIP - Delano, PCE	SL0602943992	GeoTracker	Cleanup Program Site	Open - Inactive	*Chemical information not provided in GeoTracker
21	Witco Refinery (Oildale)	SLT5FQ474339	GeoTracker	Cleanup Program Site	Open - Site Assessment	*Chemical information not provided in GeoTracker
22	KW Plastics of California	80001494	EnviroStor	Corrective Action	Active	Lead

# on Figure 8-52	Site Name	Site ID	Source	Program	Status	Chemical
23	Occidental Of Elk Hills Inc.	80001254	EnviroStor	Corrective Action	Active	Hydrochloric Acid (Hydrogen Chloride); Metals; Petroleum; Polychlorinated Biphenyls (PCBS); Radioactive Isotopes Uncategorized; Volatile Organics (8260B VOCS)
24	Bakersfield Discovery Project	60001630	EnviroStor	Evaluation	Inactive - Needs Evaluation	Tetrachloroethylene (PCE); Trichloroethylene (TCE)
25	Bakersfield Plating Works	15340012	EnviroStor	Evaluation	Refer: Other Agency	Metals
26	Custom Cleaners	60002831	EnviroStor	Evaluation	Refer: EPA	Tetrachloroethylene (PCE); Trichloroethylene (TCE)
27	Eastland Flying Service	15070006	EnviroStor	Evaluation	Inactive - Needs Evaluation	Carbaryl; Organophosphorus Pesticides (8141A OPPS); Other; Toxaphene; Uncategorized
28	Freeman's Cleaners (Vogue Cleaners)	60002832	EnviroStor	Evaluation	Refer: EPA	Tetrachloroethylene (PCE); Trichloroethylene (TCE)
29	Kern County Gun Club	15860001	EnviroStor	Evaluation	Refer: Other Agency	Lead; Other Organic Solids; Polynuclear Aromatic Hydrocarbons (PAHS)
30	Brown And Bryant, Inc., Arvin Facility	15280011	EnviroStor	Federal Superfund	Active	Dinoseb, Volatile Organics (8260B VOCS)
31	Logrecco Property	T0602925877	GeoTracker	LUST Cleanup Site	Open - Site Assessment	Gasoline
32	North Kerrn State Prison	T0602900672	GeoTracker	LUST Cleanup Site	Open - Eligible for Closure	Gasoline
33	Pond Mercantile	T0602900113	GeoTracker	LUST Cleanup Site	Open - Remediation	Gasoline
34	Robertsons Market	T0602902377	GeoTracker	LUST Cleanup Site	Open - Remediation	Gasoline, Diesel
35	Taylor Automated Fuels	T0602900529	GeoTracker	LUST Cleanup Site	Open - Site Assessment	Gasoline
36	Bakersfield Terminal	T10000016451	GeoTracker	Non-Case Information	Pending Review	Per- and Polyfluoroalkyl Substances (PFAS)

# on Figure 8-52	Site Name	Site ID	Source	Program	Status	Chemical
37	Southern Counties Oil Co LP, dba SC Fuels	T10000016459	GeoTracker	Non-Case Information	Pending Review	Per- and Polyfluoroalkyl Substances (PFAS)
38	Kern River Oil Field, Rambler Lease	T10000011704	GeoTracker	Other Oil and Gas Projects	Open - Site Assessment	TDS
39	South Belridge, MW-12G1	T10000021488	GeoTracker	Other Oil and Gas Projects	Open - Need Additional Information	Boron; TDS
40	Delano PCE Plume	60001327	EnviroStor	State Response	Active	PCE
41	J R Simplot, Edison	15070030	EnviroStor	State Response	Active	Organochlorine Pesticides (8081 OCPS), Volatile Organics (8260B VOCS)
42	Oasis Cleaners	60002269	EnviroStor	State Response	Active	Tetrachloroethylene (PCE)
43	Safe 1 Credit Union - Delano	60002995	EnviroStor	Voluntary Cleanup	Active	Tetrachloroethylene (PCE)
44	Westside Parkway/ Conoco Phillips Coke	60001880	EnviroStor	Voluntary Cleanup	Active	Polynuclear Aromatic Hydrocarbons (PAHS)

8.4.3.1 Permitted Facilities with Waste Discharge Requirements Orders

In addition, SWRCB's California Integrated Water Quality System (CIWQS) database was used to identify permitted facilities with Waste Discharge Requirements (WDR) Order and Confined Animal Facility (CAF) Sites in the Kern Subbasin. The intent of mapping the location of the sites is to provide geographic representation of these WDRs and Confined Animal Sites throughout the Kern Subbasin. A total of 316 sites were identified; however, 54 sites are not included in this figure because latitude/longitude coordinates were not available to confirm that the sites are within the Kern Subbasin. Figure 8-53 provides a graphical representation of known WDRs and CAF sites in the Kern Subbasin. Note: majority of other waste discharge requirement facilities in the Western Fold Belt HCM Area are associated with non-GSA activities (e.g., oil field activities).

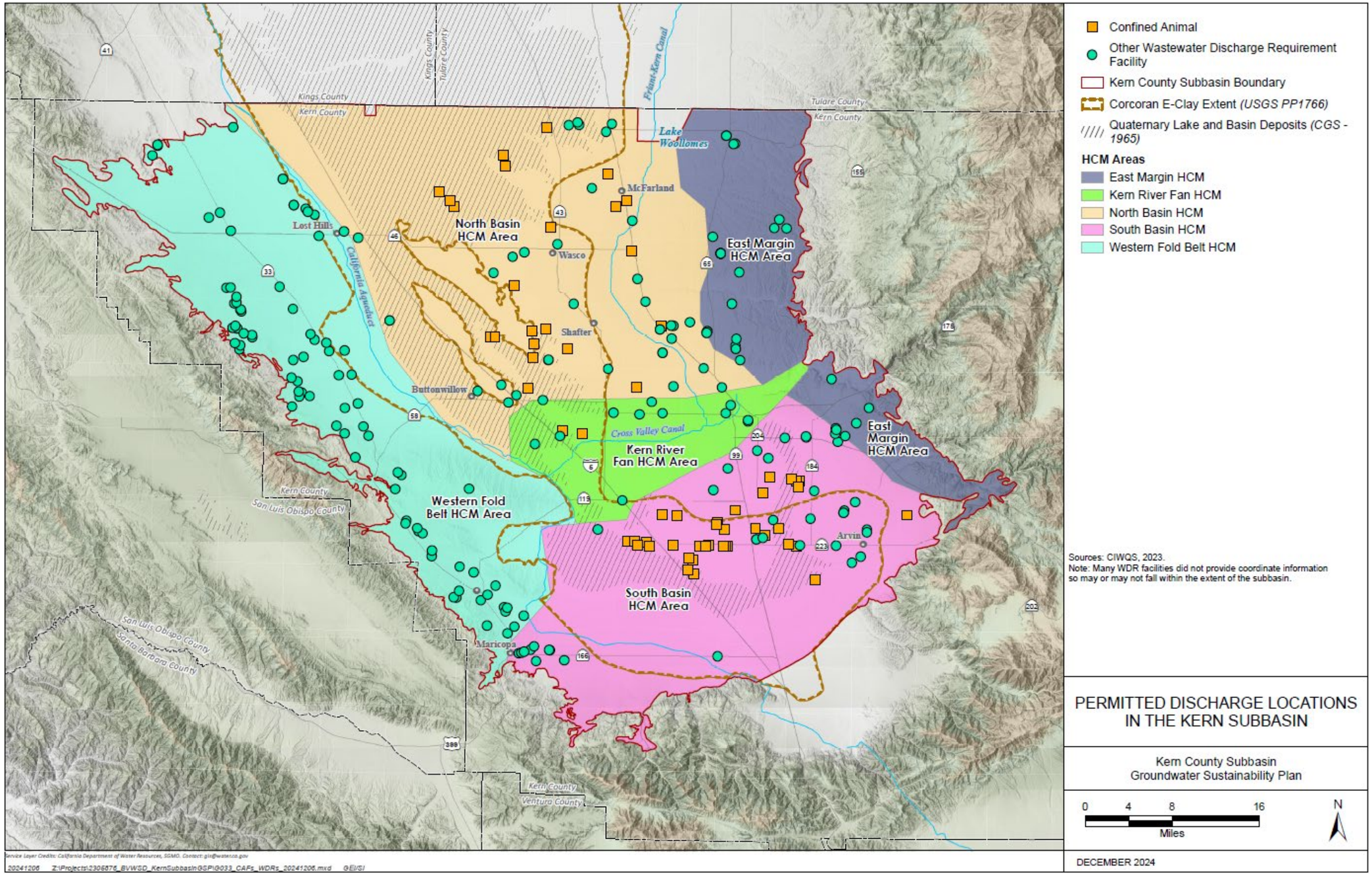


Figure 8-53. Permitted Discharge Locations

8.4.4 Oil Field Injection Wells and Produced Water Ponds

Oil producing zones are designated as exempt aquifers boundaries under a program administered by the United States Environmental Protection Agency (EPA). The EPA aquifer exemptions are detailed in Section 7.6.5. The Underground Injection Control (UIC) permitted wells are not included in the list of groundwater contaminant sites because the federal UIC program's objective is to confine injected fluid to the approved injection zone so that injected fluid does not migrate to a zone where it could degrade valuable groundwater or hydrocarbon resources. Wells permitted under the State's Class II UIC program are presented on Figure 8-54. Former produced water disposal ponds, which are not an exempt activity, are known to have impacted groundwater quality. These former ponds are included in the list of contaminated sites in Section 8.4.3.

8.4.4.1 Produced Water and Oil Field Water Supply

Water brought to the surface when oil is extracted as a byproduct of the extraction process is often referred to as "produced water." Produced water is groundwater that is commingled with hydrocarbons located within the hydrocarbon bearing reservoir. Often, produced water is returned to the original geological formation for enhanced oil recovery or disposal. Some produced water is suitable for beneficial reuse with treatment, though most is higher in salinity and must undergo extensive treatment and be blended with other waters before use. New technologies and the need to find new sources of water are driving the development of new more economical processes to treat produced water for beneficial reuse.

Produced water ponds are known to contribute to point source groundwater contamination. A total of 30 open or active produced water ponds were identified as contaminated groundwater sites based on the point-source evaluation in Section 8.4.1. Table 8-29 summarizes the produced water ponds identified including site name, the GeoTracker or EnviroStor site ID, program, status, and the potential contaminant of concern. Figure 8-54 shows the location of the produced water ponds and UIC in the Kern Subbasin, which are located within USEPA exempt aquifer boundaries.

Oil operators sometimes drill water supply wells within the approved administrative boundaries of an oil field to provide so called "make-up water" integral to oil field operations such as enhanced oil recovery (e.g., water and steam flood) and other oil field exempt activities. Oil producing zones are designated as USEPA exempt aquifers and are therefore outside the authority of the Kern Subbasin GSAs (i.e., non-GSA activity). These supply wells are typically drilled within the margins of the USEPA exempt oil producing zone(s) and, like produced water, raw make-up water is of poor quality and includes an admixture of crude oil and other minerals (e.g., high TDS) which typically require treatment at the oil field prior to use. The frequency of pumping and volumes of make-up water extracted from these USEPA exempt aquifers for oil field supply is dependent on a myriad of oil production operation factors including the

vagaries of the global oil supply and related price economics. There are a total of 10 make-up water supply wells in the Kern Subbasin, of which 3 (near the Lost Hills Oil Field) extract from non USEPA exempt aquifers. The cumulative average amount of make-up water extracted from these three wells is approximately 240 AFY from 2020 through 2024. The reported CalGEM WellSTAR data shows significant reductions in extraction volumes from these wells. Overall, these volumes are minimal when compared to the combined USEPA exempt oil and produced water production from the corresponding aquifers and are not considered significant for SGMA planning purposes. Figure 8-62 presents the extensive USEPA aquifer exemption areas in the Kern Subbasin.

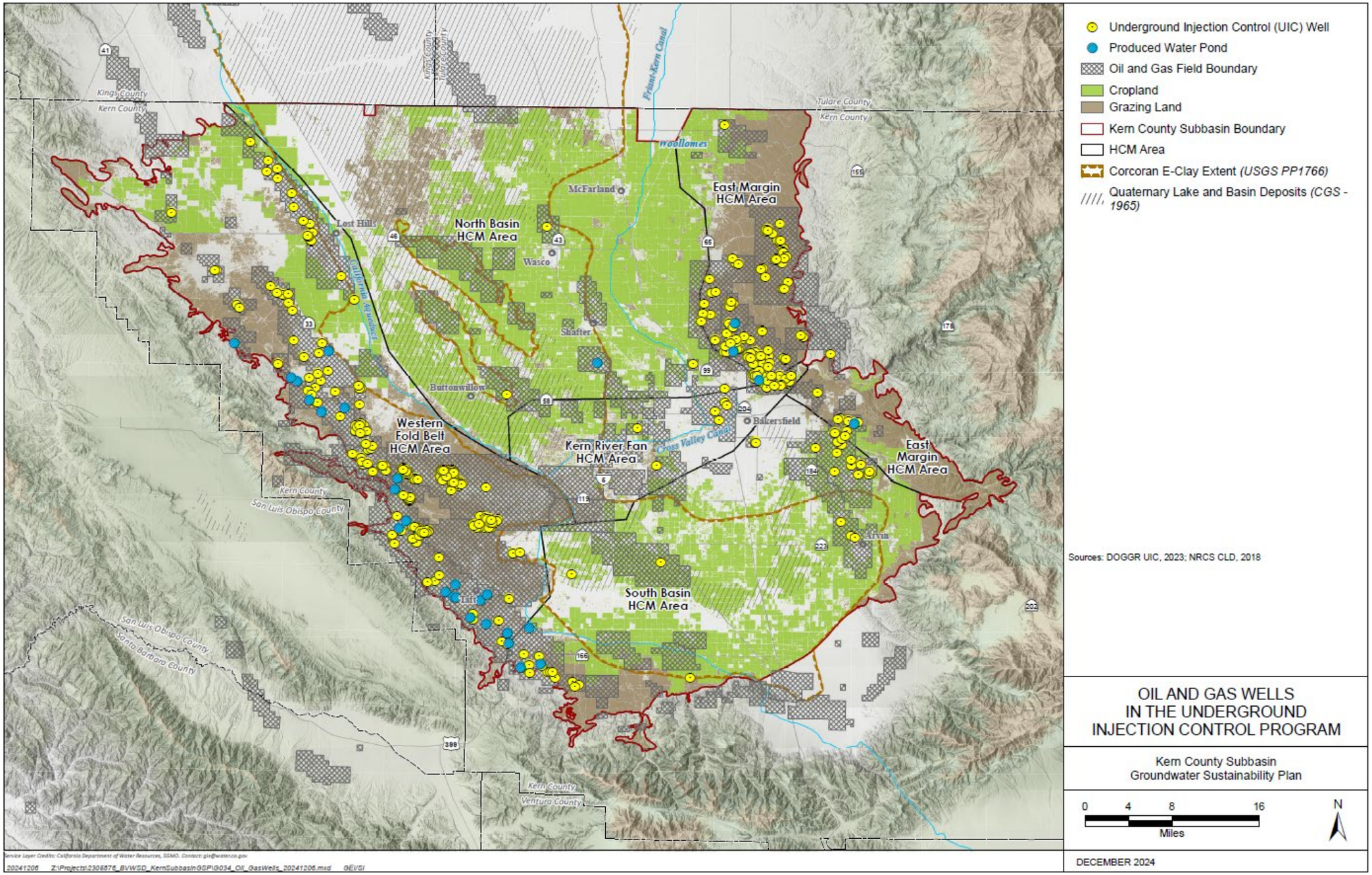


Figure 8-54. UIC Program Wells and GeoTracker Produced Water Ponds Sites

Table 8-29. Produced Water Ponds from GeoTracker

Site Name	Site ID	Source	Program	Status	Chemical
25 Hill Properties, Inc., Midway-Sunset, Shell Lease	T10000006950	GeoTracker	Produced Water Ponds	Open - Site Assessment	*Chemical information not provided in GeoTracker
AERA ENERGY LLC - NORTH BELRIDGE DISPOSAL PONDS	SL0602993186	GeoTracker	Produced Water Ponds	Inactive - Permitted	Other inorganic / salt
Asphalto Oil Field, Bear Valley Lease	T10000006823	GeoTracker	Produced Water Ponds	Open - Site Assessment	*Chemical information not provided in GeoTracker
BELGIAN ANTICLINE, MCKITTRICK 1 & 1-3 Facility	L10007494132	GeoTracker	Produced Water Ponds	Inactive - Permitted	Nitrate, Other inorganic / salt, Boron, TDS, Benzene, Crude Oil
Belgian Anticline, Mckittrick 1-1 Facility	L10004955136	GeoTracker	Produced Water Ponds	Open - Site Assessment	Nitrate, Boron, TDS, Benzene, Crude Oil, Ethylbenzene, Toluene, Total Petroleum Hydrocarbons (TPH), Xylene
Belridge South Oil Field, Section 27 Lease (Water Plant 27)	T10000011585	GeoTracker	Produced Water Ponds	Active - Permitted	Nitrate, Boron, TDS, Benzene, Crude Oil
CARNEROS CREEK, THETA (30)	L10009422184	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Cymric Oil Field, Bowles Lease	T10000006948	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Cymric Oil Field, Lehi-Richardson Lease	T10000007036	GeoTracker	Produced Water Ponds	Active - Permitted	Crude Oil
Cymric Oil Field, Overland Anderson Lease (Ballard Oil, Inc.)	T10000007035	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Cymric Oil Field, USL Lease	T10000007037	GeoTracker	Produced Water Ponds	Active - Permitted	Crude Oil
Edison Oil Field, Racetrack Lease	T10000007136	GeoTracker	Produced Water Ponds	Open - Site Assessment	Other inorganic / salt, TDS, Crude Oil
Kern Front Oil Field, Section 11 Lease	T10000007104	GeoTracker	Produced Water Ponds	Open - Site Assessment	*Chemical information not provided in GeoTracker
Kern Front Oil Field, Sill One Lease	T10000007103	GeoTracker	Produced Water Ponds	Open - Site Assessment	*Chemical information not provided in GeoTracker
Kern River Oil Field, San Joaquin Lease	T10000007105	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil

Site Name	Site ID	Source	Program	Status	Chemical
Kern River Oil Field, Winspear Lease	T10000011765	GeoTracker	Produced Water Ponds	Inactive - Unpermitted	Nitrate, Arsenic, Boron, Chromium, Copper, Lead, Mercury (elemental), Other Metal, TDS, Zinc, Benzene, Crude Oil, Ethylbenzene, Toluene, Xylene
Lost Hills Oil Field, Section 29 Lease	SL0602961924	GeoTracker	Produced Water Ponds	Inactive - Permitted	Other inorganic / salt
Midway-Sunset Oil Field, Anderson-Goodwin Lease	L10001277360	GeoTracker	Produced Water Ponds	Inactive - Unpermitted	*Chemical information not provided in GeoTracker
Midway-Sunset Oil Field, Berry and Ewing Lease	T10000007297	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Midway-Sunset Oil Field, Havenstrite Lease	T10000006789	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Midway-Sunset Oil Field, Hoyt Lease	T10000006779	GeoTracker	Produced Water Ponds	Inactive - Unpermitted	Crude Oil
Midway-Sunset Oil Field, Jameson Trust Lease	L10002548641	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Midway-Sunset Oil Field, Jameson Trust Lease	T10000006947	GeoTracker	Produced Water Ponds	Active - Permitted	Crude Oil
Midway-Sunset Oil Field, Lockwood Lease	T10000007029	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Midway-Sunset Oil Field, Moco 35 Lease	T10000007031	GeoTracker	Produced Water Ponds	Active - Permitted	Crude Oil
Midway-Sunset Oil Field, Moco 35 Lease (Plastic-lined Pond 3)	T10000007039	GeoTracker	Produced Water Ponds	Active - Permitted	Crude Oil
Midway-Sunset Oil Field, National USL Lease	T10000007032	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Midway-Sunset Oil Field, Section 35D Lease	T10000011701	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Midway-Sunset Oil Field, Shale 14 Lease, AFS DEHYDRATION PLANT	T10000007033	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil

Site Name	Site ID	Source	Program	Status	Chemical
Midway-Sunset Oil Field, Southeast Taft Facility (SE Taft)	T10000013268	GeoTracker	Produced Water Ponds	Open - Active	Nitrate, Boron, TDS, Benzene, Crude Oil, Ethylbenzene, Toluene, Total Petroleum Hydrocarbons (TPH), Xylene
Midway-Sunset Oil Field, Virginia Land Lease	T10000006952	GeoTracker	Produced Water Ponds	Open - Site Assessment	*Chemical information not provided in GeoTracker
Midway-Sunset Oil Field, W & S Lease	T10000007034	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
Midway-Sunset Oil Field, Webber Lease	T10000006776	GeoTracker	Produced Water Ponds	Open - Site Assessment	Crude Oil
North Coles Levee Oil Field, Coles Levee A Lease	T10000020096	GeoTracker	Produced Water Ponds	Inactive - Unpermitted	Benzene, Crude Oil, Polynuclear aromatic hydrocarbons (PAHs), Total Petroleum Hydrocarbons (TPH)
Poso Creek, Poso Lease	T10000007301	GeoTracker	Produced Water Ponds	Inactive - Unpermitted	Crude Oil
Rio Bravo Oil Field, Kernco Lease	T10000006733	GeoTracker	Produced Water Ponds	Open - Inactive	Crude Oil
S. Belridge Oil Field, Hill Lease	SL0602935481	GeoTracker	Produced Water Ponds	Inactive - Permitted	Other inorganic / salt
Seneca, MIDWAY SUNSET, USC LEASE	L10002250653	GeoTracker	Produced Water Ponds	Open - Inactive	*Chemical information not provided in GeoTracker
South Belridge Oil Field, South Wastewater Disposal Facility	SL0602990565	GeoTracker	Produced Water Ponds	Inactive - Permitted	Other inorganic / salt
South Coles Levee Oil Field, SCLU-Section 10 Lease	T10000020110	GeoTracker	Produced Water Ponds	Inactive - Unpermitted	Benzene, Crude Oil, Polynuclear aromatic hydrocarbons (PAHs), Total Petroleum Hydrocarbons (TPH)
South Coles Levee Oil Field, SCLU-Section 11 Lease	L10001997433	GeoTracker	Produced Water Ponds	Inactive - Unpermitted	Benzene, Crude Oil, Polynuclear aromatic hydrocarbons (PAHs), Total Petroleum Hydrocarbons (TPH)
Woodward, Cunning Ham Lease, Midway-Sunset	T10000006949	GeoTracker	Produced Water Ponds	Open - Site Assessment	*Chemical information not provided in GeoTracker

8.5 Land Subsidence

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

☑ 23 CCR § 354.16(e)

The San Joaquin Valley has a documented history of subsidence, including historical and recent subsidence across many areas of the Kern Subbasin. Section 8.5.1 presents a summary of historical land subsidence across the Kern Subbasin, within each HCM Area, and along regional critical infrastructure. Section 8.5.2 identifies the potential various causes of land subsidence in the Kern Subbasin, not all of which are within GSA authority. Some examples of non-GSA factors include a potential lack of adequate hydro-compaction, expansive/soluble soils, age of infrastructure, oil and gas field activities, and potential natural processes such as faulting, compaction, and tectonic down warping. Finally, Section 8.5.3 discusses the rate and extent of subsidence trends observed across the Kern Subbasin.

8.5.1 Historical and Recent Land Subsidence

The San Joaquin Valley has a documented history of subsidence, with the greatest documented subsidence occurring north of the Kern Subbasin where subsidence rates and extent are being influenced by activities in adjacent subbasins. The following provides a regional summary of land subsidence in the Southern San Joaquin Valley. The discussion includes historical land subsidence occurring in adjacent subbasins to provide context for the regional variability of subsidence with the Kern Subbasin.

8.5.1.1 Historical Land Subsidence 1926 – 1970

Historical land subsidence based on leveling surveys by the National Geodetic Survey was documented by the USGS in the Southern San Joaquin Valley variably from 1926 to 1970 and is shown on Figure 8-55 (Ireland et al., 1984). Although data represent the accumulated subsidence over a 44-year period, the USGS estimates that about 75 percent of the subsidence occurred in the 1950s and 1960s because of extensive groundwater extraction (Galloway et al., 1999).

Land subsidence for the historical period occurred in two distinct areas: north of Kern County and south of the Kern River (Figure 8-55). The majority of the Kern Subbasin experienced less than one foot of cumulative subsidence during the historical period. As shown on Figure 8-55, cumulative subsidence north of Kern County along the Subbasin boundary with the adjacent Tule and Tulare Lake Subbasins ranged from 4.0 to 10 feet during the historical period with a maximum subsidence of 12 feet in the Tule Subbasin

Figure 8-55. In contrast, cumulative subsidence for this same period was significantly less within the Kern Subbasin, especially in areas distal to the Kern Subbasin oil fields, with subsidence ranging from around 1.0 to 4.0 feet. During the historical period, cumulative subsidence in the area south of the Kern River ranged from 1.0 to 6.0 feet (Ireland et al.,1984). As noted previously, not all subsidence in the Kern Subbasin is attributable to GSA-related activities, nor is all subsidence inelastic.

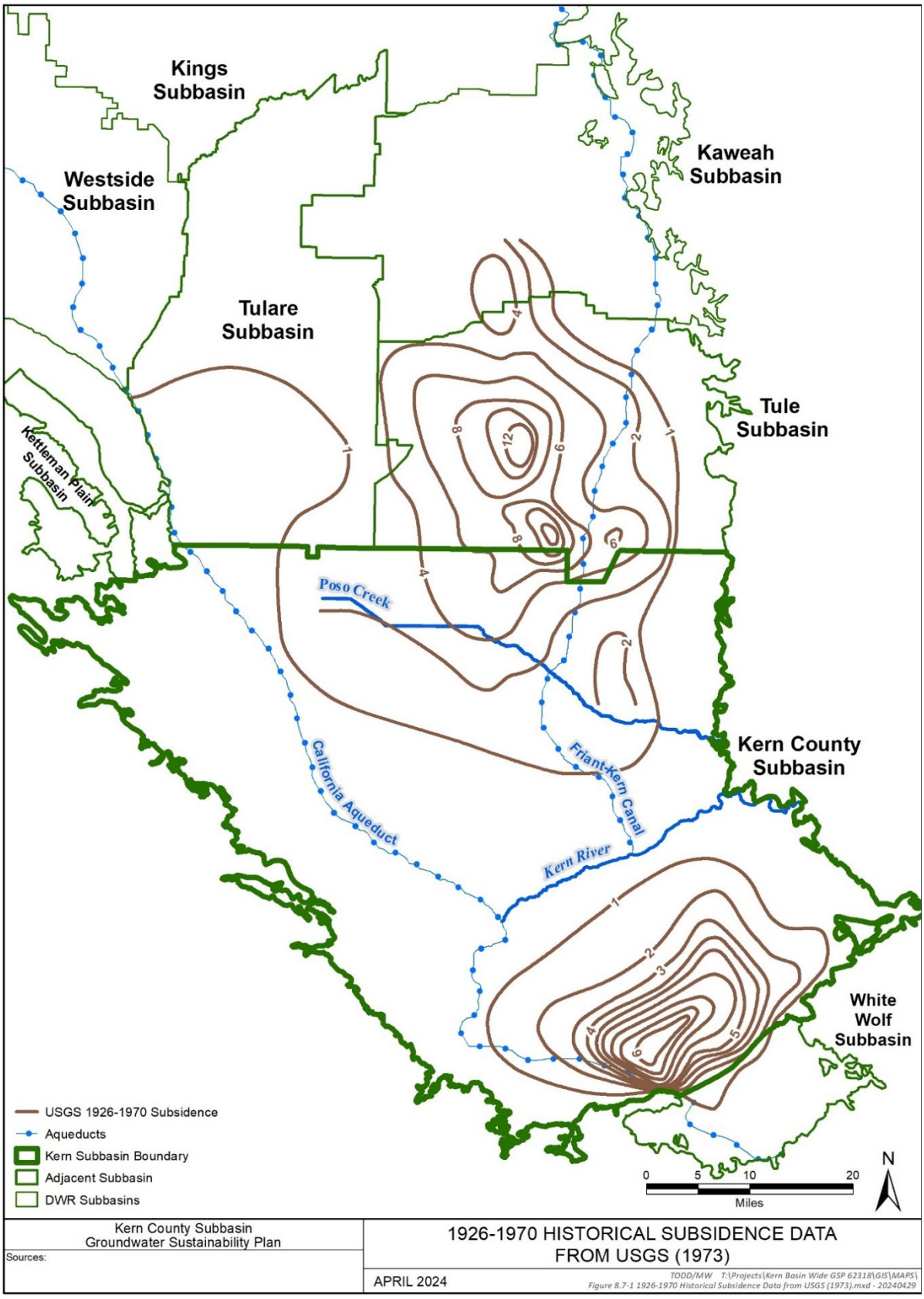


Figure 8-55. 1926-1970 Historical Subsidence Data from USGS (1973)

8.5.1.2 Land Subsidence 2007 to 2019

More recent land subsidence trends based on Interferometric Synthetic Aperture Radar (InSAR) data provided by National Aeronautics and Space Administration - Jet Propulsion Laboratory (NASA-JPL) illustrates total subsidence from 2007 to 2011 and is shown in Figure 8-56**.** (DWR, 2018a; LSCE et al., 2014). Based on the InSAR data, most of the Kern Subbasin has experienced less than 0.5 feet of land subsidence between 2007 through 2011.

Similarly, InSAR data from June 2015 to December 2019 (DWR, 2021) shows cumulative subsidence in the Kern Subbasin was less than 0.5 feet, with a few exceptions related to known oil fields, and along the northern boundary of the Kern Subbasin (Figure 8-57).

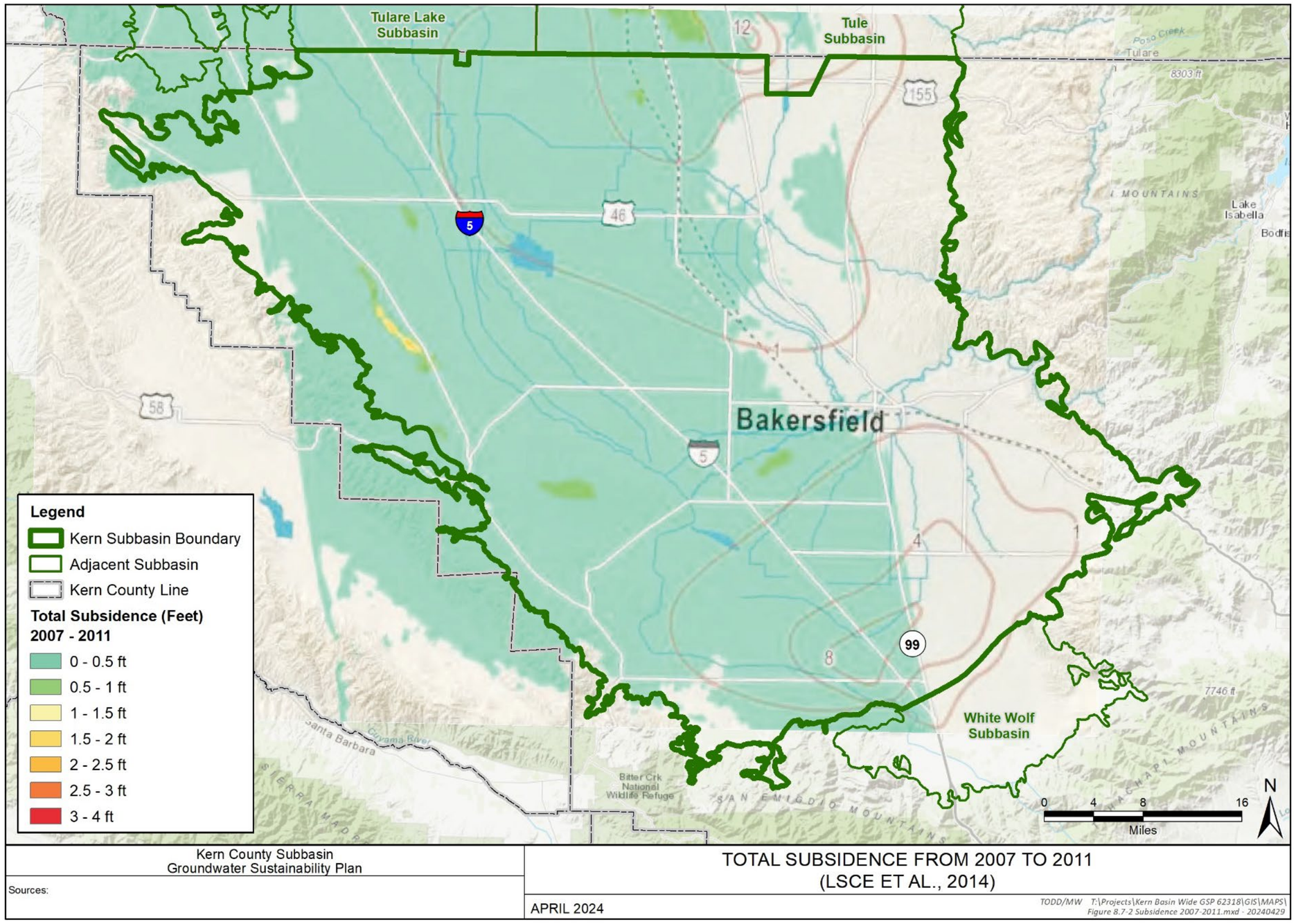
8.5.1.3 Land Subsidence 2015 to 2023

The discussion below summarizes DWR InSAR data between October 2015 through September 2023 (DWR, 2024). As shown on Figure 8-58:

- Maximum cumulative subsidence of 2.0 to 2.41 feet (approximately 3.0 to 3.6 inches/year) has occurred along the northern Subbasin boundary with the Tule Subbasin. This area covers about 3.5 square miles, or about 0.15 percent of the Kern Subbasin.
- Cumulative subsidence ranging from 1.0 to 2.0 feet (approximately 1.5 to 3.0 inches/year) has occurred in scattered areas across the Kern Subbasin, with the largest area along the northern Subbasin boundary. The composite area with subsidence between 1.0 to 2.0 feet covers about 114 square miles, or about 4.8 percent of the Kern Subbasin.
- Cumulative subsidence ranging from 0.33 to 1.0 foot (approximately 0.5 to 1.5 inches/year) borders the scattered areas of higher subsidence across the Kern Subbasin. The composite area with subsidence between 0.33 and 1.0 foot covers about 524 square miles, or about 22 percent of the Kern Subbasin.
- Cumulative subsidence ranging from 0 to 0.33 feet covers a large area of the Kern Subbasin. The composite area with subsidence between 0 to 0.33 feet covers about 1,140 square miles, or about 48 percent of the Kern Subbasin.

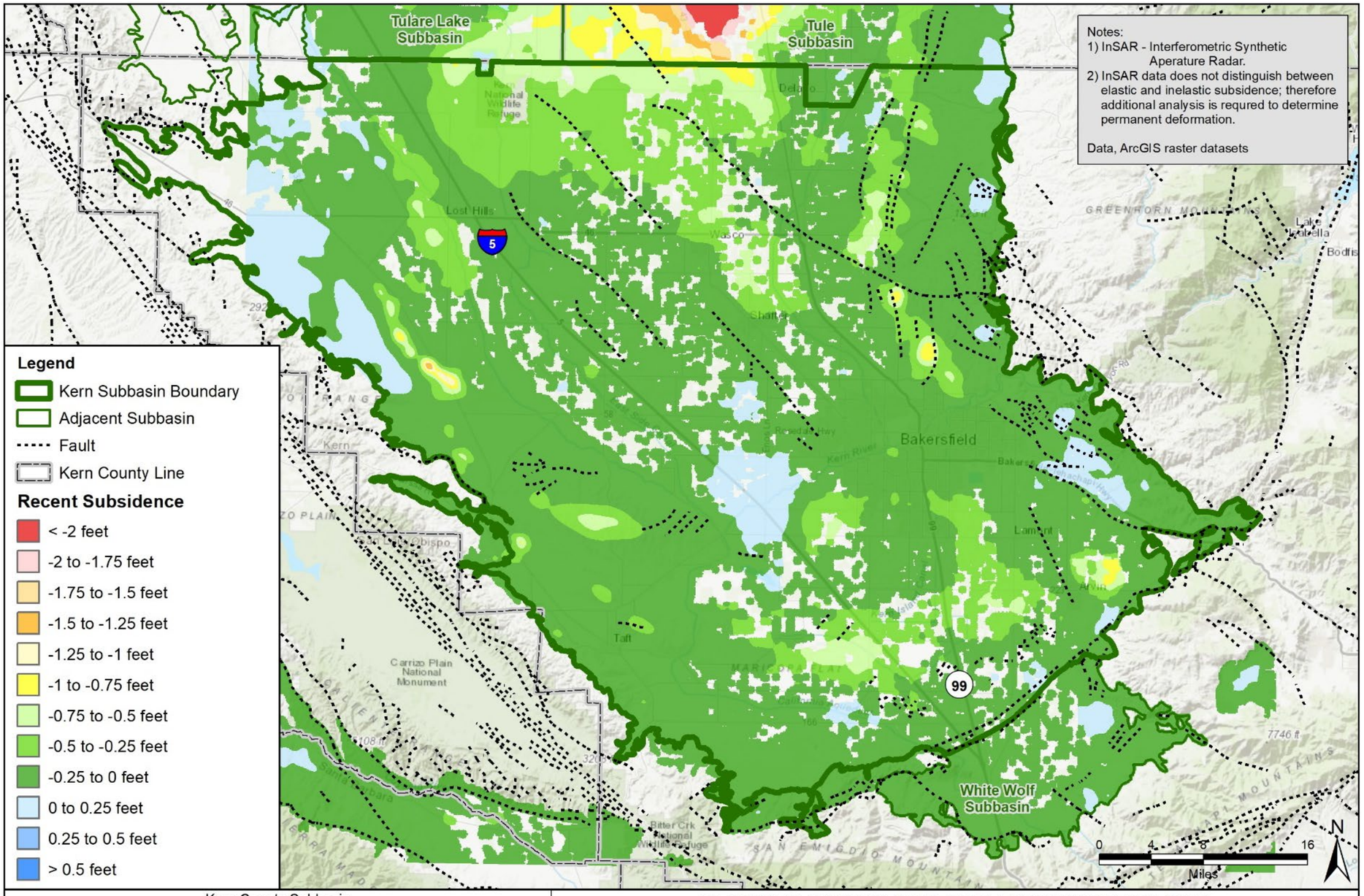
Increases in vertical land displacement ranging from 0 to 0.3 feet occur along the eastern and western margins of the Kern Subbasin. The composite area with increases in vertical land displacement covers about 581 square miles, or about 25 percent of the Kern Subbasin. There are identified non-GSA-related activities in these areas.

During this period, areas to the north of the Kern Subbasin (i.e., outside of Kern County) experienced maximum subsidence of up to about 7 feet (approximately 10.5 inches/year) with certain areas of subsidence ranging from 3 to 7 feet (4.5 to 10.5 inches/year), which is significantly greater than the maximum subsidence in the Kern Subbasin during this same eight-year period.



Kern County Subbasin Groundwater Sustainability Plan	TOTAL SUBSIDENCE FROM 2007 TO 2011 (LSCE ET AL., 2014)
Sources:	APRIL 2024
	TODD/MW T:\Projects\Kern Basin Wide GSP 62318\GIS\MAPS\ Figure 8.7-2 Subsidence 2007-2011.mxd - 20240429

Figure 8-56. Total Subsidence from 2007 to 2011



Kern County Subbasin Groundwater Sustainability Plan	REGIONAL SUBSIDENCE FROM 2015 THROUGH 2019 FROM INSAR DATA
Sources: Tre Altamira INSAR Subsidence - (Vertical_Displacement_TRE_ALTAMIRA_v2020_Total_Since_20150613_20200101)	APRIL 2024 TODD/MW T:\Projects\Kern Basin Wide GSP 62318\GIS\MAPS\ Figure 8.7-3 Regional Subsidence from 2015 through 2019 from InSAR data.mxd - 20240429

Figure 8-57. Regional Subsidence from 2015 through 2019 from InSAR Data

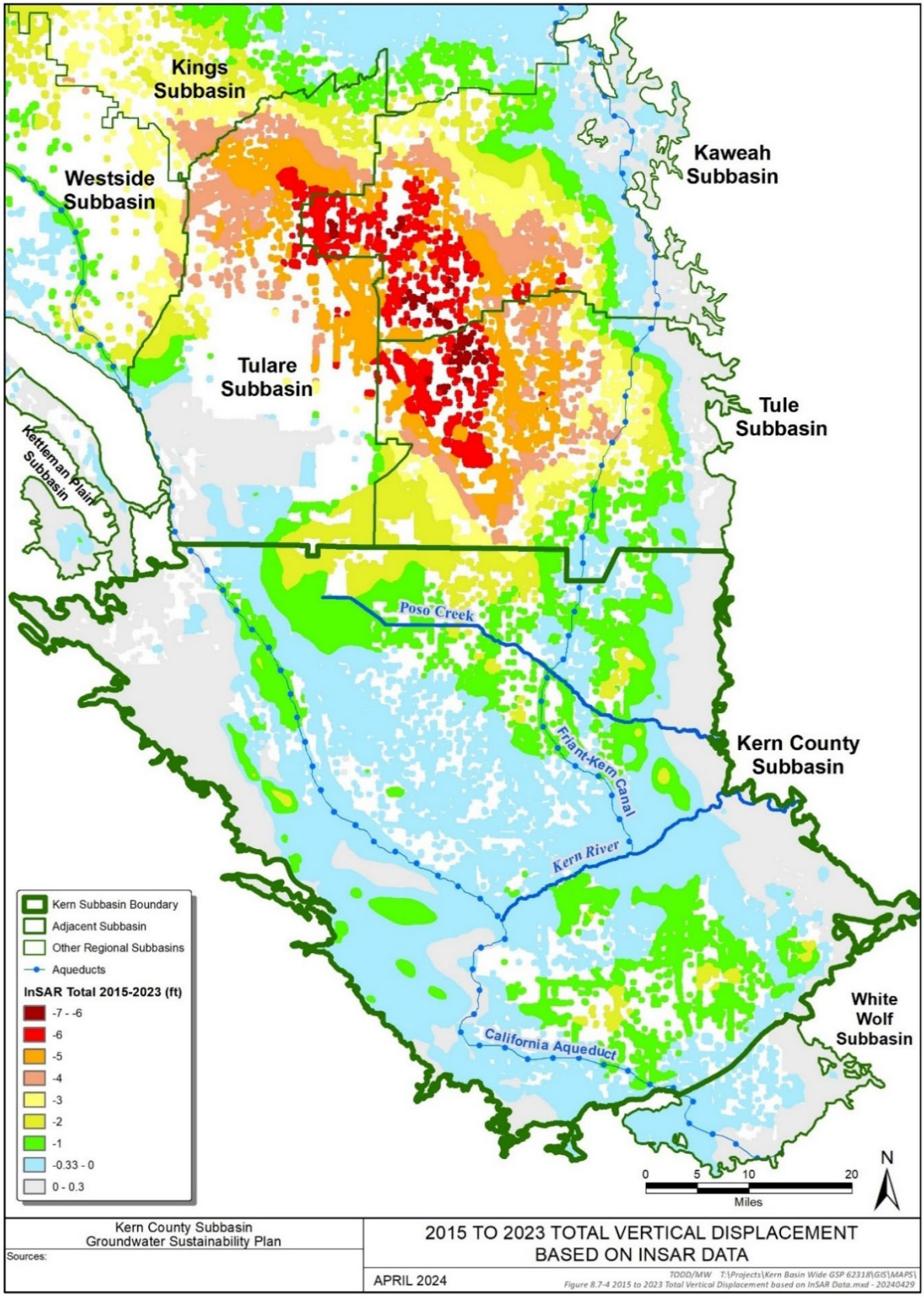


Figure 8-58. 2015 to 2023 Total Vertical Displacement based on InSAR Data

The annual DWR InSAR subsidence data for WY 2016 through WY 2023 is shown on Figure 8-59. In general, the data shows:

- A persistent subsidence bowl north of the Kern Subbasin that expands during dry years.
- Areas of subsidence in the Kern Subbasin during dry years, that are concomitant with known discontinuous E-Clay distribution and areas of oilfield activities, that are predominately along the Western Fold Belt HCM Area and Eastern Margins HCM Area of the Kern Subbasin.
- Large areas of the Kern Subbasin experience some recovery during wet years.
- Subsidence rates in the Kern Subbasin are generally low with a few exceptions.

As shown on Figure 8-59 changes in subsidence rates in the Kern Subbasin have been generally historically low with some exceptions, especially when compared to the persistent subsidence bowl to the north of the Kern Subbasin. The activities to the north of the Kern Subbasin have influenced the extent of subsidence in the northern most parts of the Northern HCM Area.

During the seven-year period between WY 2016 through WY 2023, areas to the north of the Kern Subbasin continued to experience subsidence rates greater than the maximum subsidence observed in the Kern Subbasin during the same period.

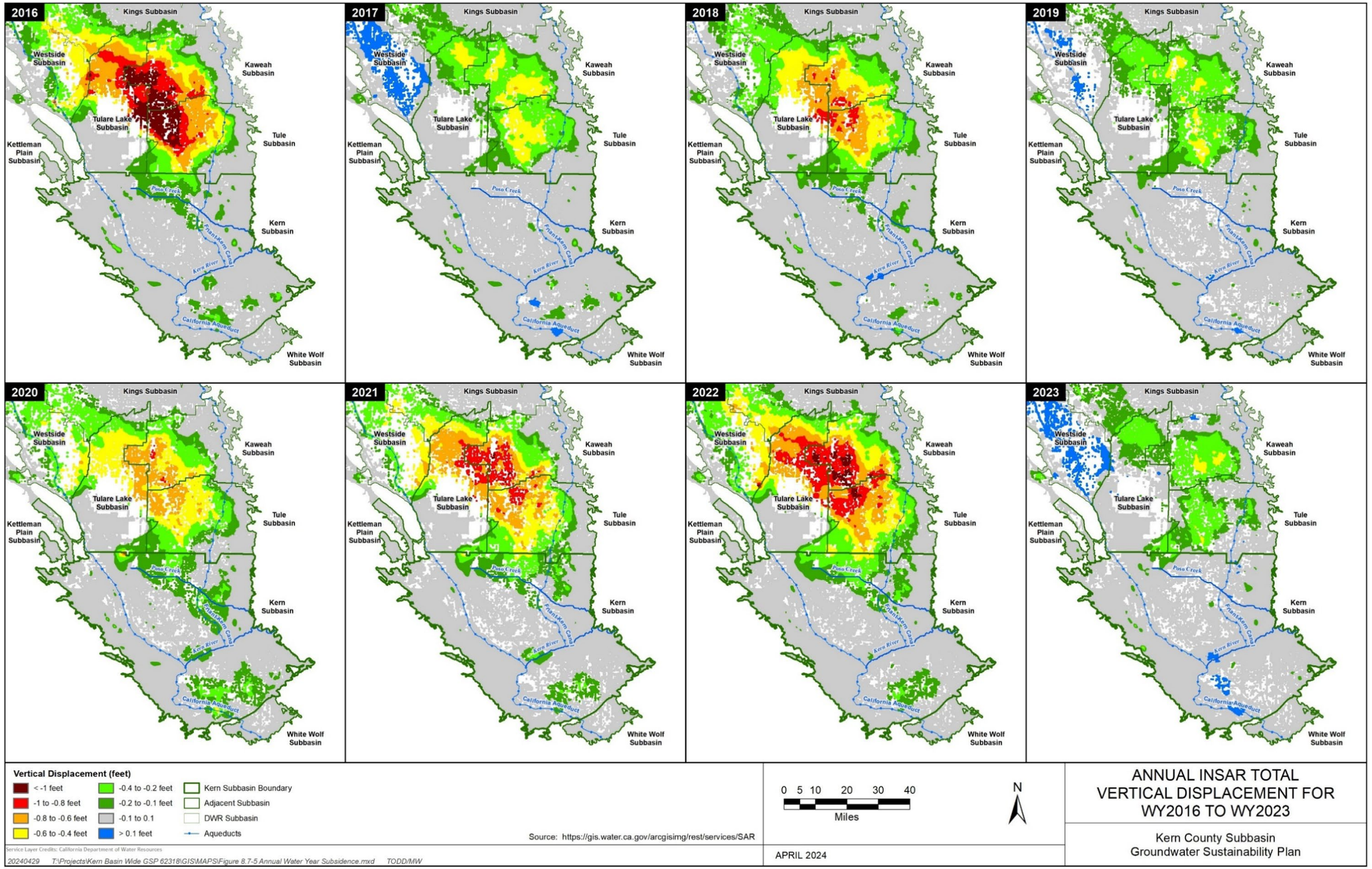


Figure 8-59. Annual InSAR Total Vertical Displacement for WY2016 to WY2023

8.5.1.4 Distribution of Subsidence by HCM Area

As reported in Section 7 of this 2025 Plan, the Kern Subbasin is large and geologically complex with regional faulting, folding and three principal aquifers. Total subsidence between October 2015 through September 2023, as measured by InSAR data (DWR, 2024) for each HCM area, is shown on Figure 8-60. A summary of subsidence trends for each HCM area is discussed below:

- **North Subbasin HCM Area** – Historical subsidence rates in the North Central Basin HCM Area have generally ranged from moderate to low, with occasional higher rates observed during extended dry periods. Moderate or higher rates of subsidence are typically experienced in the area proximal to the Subbasin boundary. In this area, historical pumping in neighboring subbasins to the north has created a large subsidence bowl which propagates into the Kern Subbasin during dry periods when seasonal groundwater extraction rates are apt to increase. Figure 8-68 provides a comparison of recent versus historical subsidence in the Kern Subbasin**.** Because natural groundwater flow in the subsurface is northward toward the axis of the Kern Subbasin, pumping by areas to the north of the Subbasin boundary exacerbates both local groundwater levels and the potential for subsidence in this area. Historical DWR InSAR data in the Kern Subbasin shows that regional wet cycles and/or seasonal reductions in pumping during winter months have the effect of ameliorating the rate of subsidence and allowing for some minor recovery.
- **Central Subbasin HCM Area** (subdivision of the North Subbasin HCM Area) – Subsidence rates are generally characterized as low.
- **Kern River Fan HCM Area** –The Kern River Fan HCM Area has little clay and exhibits land surface recovery during wet years when water is typically banked. Subsidence rates are generally low to minimal. Like groundwater levels, subsidence and rebound in the Kern River Fan HCM Area reflects the influence of seasonal water banking operations. Both inelastic and elastic subsidence occurs in the area of the Kern Fan HCM Area. In some areas of the Kern Fan HCM Area, especially where significant recharge occurs at the Kern Water Bank, the average rate of subsidence calculated for the Kern Fan HCM Area using the period from 2015 to 2024 likely overestimates projected subsidence through 2040.
- **South Subbasin HCM Area** – Historical subsidence rates have ranged from low to moderate in the central parts of the South Subbasin HCM Area, with minimal rates observed closer to the Kern River and along the area's east and south margins.
- **Eastern Margin HCM Area** – Historical subsidence rates have tended to range from low to minimal in areas away from oilfield operations.

Western Fold Belt HCM Area – Historical DWR InSAR data show that subsidence rates in areas distal to oil field operations (i.e., oil and gas production) have been low to minimal. In proximity to the Aqueduct the subsidence rates are characterized as low although historical subsidence-related loss of freeboard between Mile Posts (MP) 195 and 215 have been identified. InSAR and multiple other data and information indicate this subsidence is not related to agricultural groundwater pumping (i.e., non-GSA-related). To further confirm the cause of subsidence is not GSA-related the Westside District Water Authority (WDWA) GSA has recently implemented a pumping moratorium within the CASP 5-mile-wide monitoring zone between Aqueduct MP 195 and MP 215.

The annual rate and cumulative subsidence for the period 2015 to 2023 for the HCM Areas was calculated using DWR InSAR data, as shown on Table 8-30

Table 8-30. HCM Area Subsidence Data

	WY 2023				
Area Name	**MIN**	**MAX**	**MEAN**	**Subsidence (ft)**	**Area (Sq. Miles)**
North Basin HCM Area (Upper)	-0.291453	0.126175	-0.006058	-0.4 to -0.2	3.1
				-0.2 to -0.1	34.6
				-0.1 to 0.1	302.4
				> 0.1	10.4
North Basin HCM Area (Lower)	-0.141931	0.135411	0.002966	-0.2 to -0.1	1.2
				-0.1 to 0.1	416.2
				> 0.1	4.8
Western Fold Belt HCM Area	-0.429005	0.079715	-0.009083	-0.6 to -0.4	0.1
				-0.4 to -0.2	1.4
				-0.2 to -0.1	8.1
				-0.1 to 0.1	659.0
Kern River Fan HCM Area	-0.154055	0.210481	0.00598	-0.2 to -0.1	0.2
				-0.1 to 0.1	179.7
				> 0.1	6.8
South Basin HCM Area	-0.167682	0.308578	0.002207	-0.2 to -0.1	4.1
				-0.1 to 0.1	522.7
				> 0.1	40.9
East Margin HCM Area (North)	-0.162174	0.121175	-0.009824	-0.2 to -0.1	6.5
				-0.1 to 0.1	213.7
				> 0.1	1.0
East Margin HCM Area (South)	-0.027064	0.036207	0.007636	-0.1 to 0.1	97.7

Note: Negative values indicate a decrease in elevation, while positive values indicate an increase in elevation. Both inelastic and elastic subsidence occurs in the area of the Kern Fan HCM Area. In some areas of the Kern Fan HCM Area, especially where significant recharge occurs at the Kern Water Bank, the average rate of subsidence calculated for the Kern Fan HCM Area using the period from 2015 to 2024 likely overestimates projected subsidence through 2040.

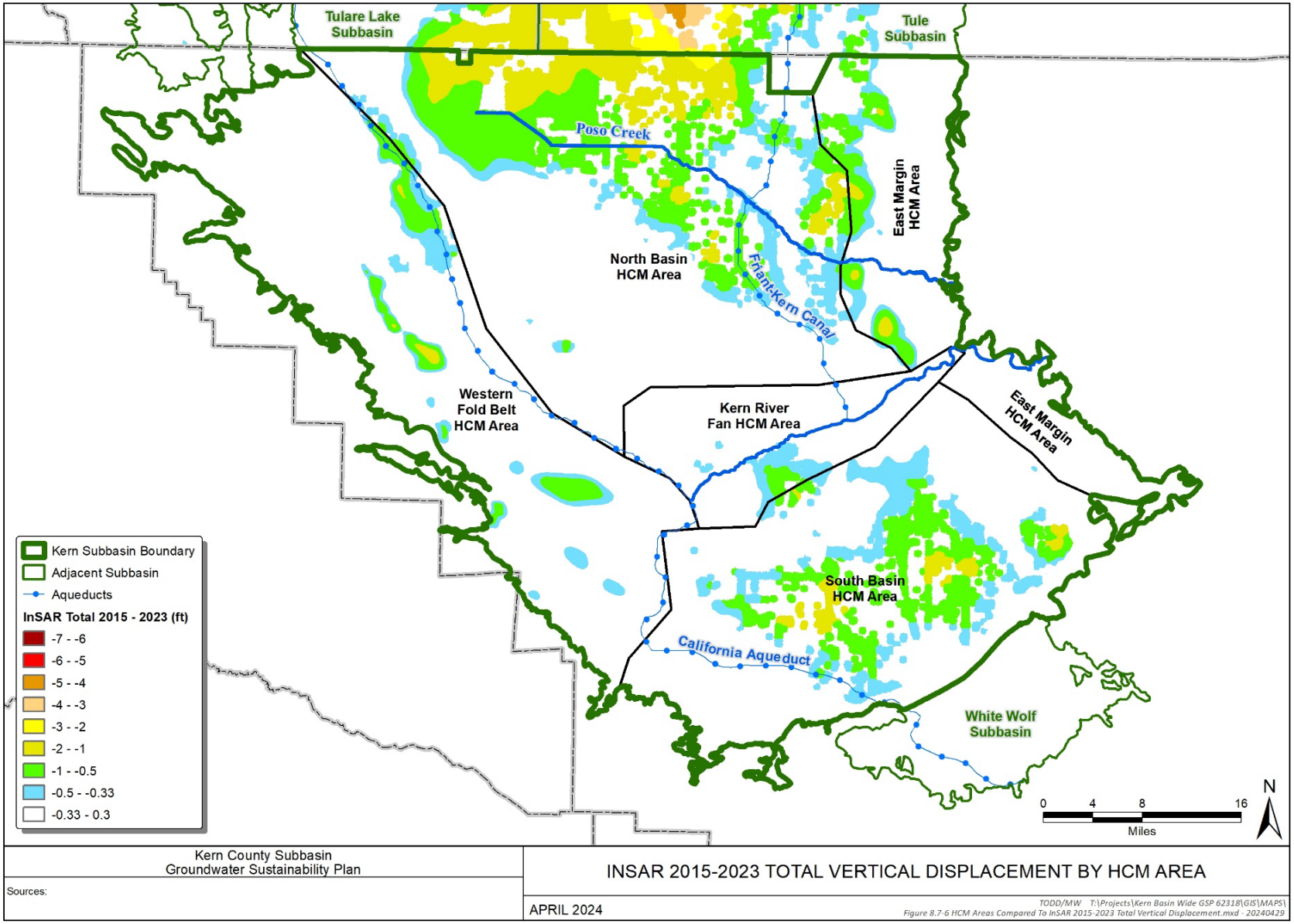


Figure 8-60. InSAR 2015-2023 Total Vertical Displacement by HCM Area

8.5.1.5 Land Subsidence in Relation to Critical Infrastructure

Two major water conveyance infrastructure systems traverse the Kern Subbasin; the westside California Aqueduct (Aqueduct) and the eastside Friant-Kern Canal (FKC). The discussion below focuses on land subsidence along the California Aqueduct and FKC. Due to the length of the Aqueduct and the varied and complex geologic and hydrologic terrain it traverses in the Kern Subbasin, it has been bifurcated in a "northern" and "southern" section as follows. The Northern Aqueduct extends from near the northern Kern County line southward along the western side of the Kern Subbasin and includes Pools 23 through 30, approximately MP 189 to 250. The Southern Aqueduct, located south of the Kern River, includes Pools 31 to 35 or approximately MP 251 to 278 (Figure 8-61).

- California Aqueduct in the North is primarily impacted by non-GSA factors
- California Aqueduct in the South may be impacted by both GSA and non-GSA factors

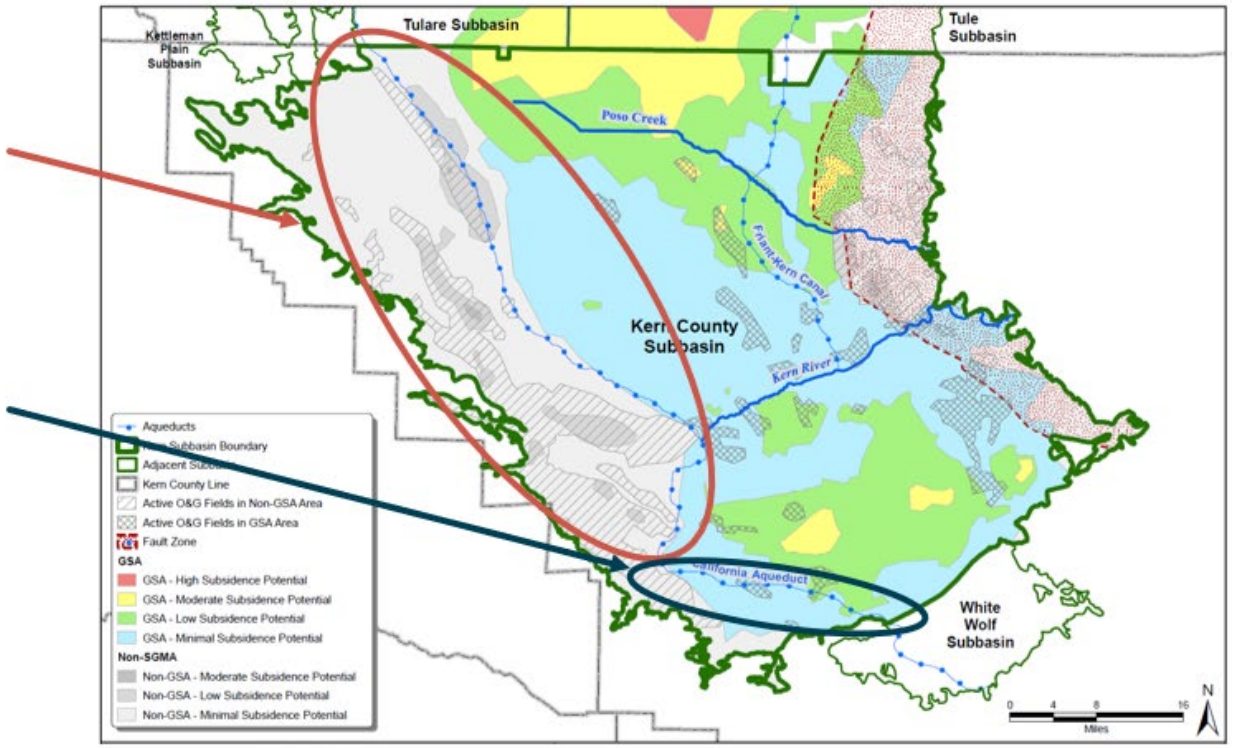


Figure 8-61. Regional Critical Infrastructure #1: California Aqueduct

Northern Aqueduct

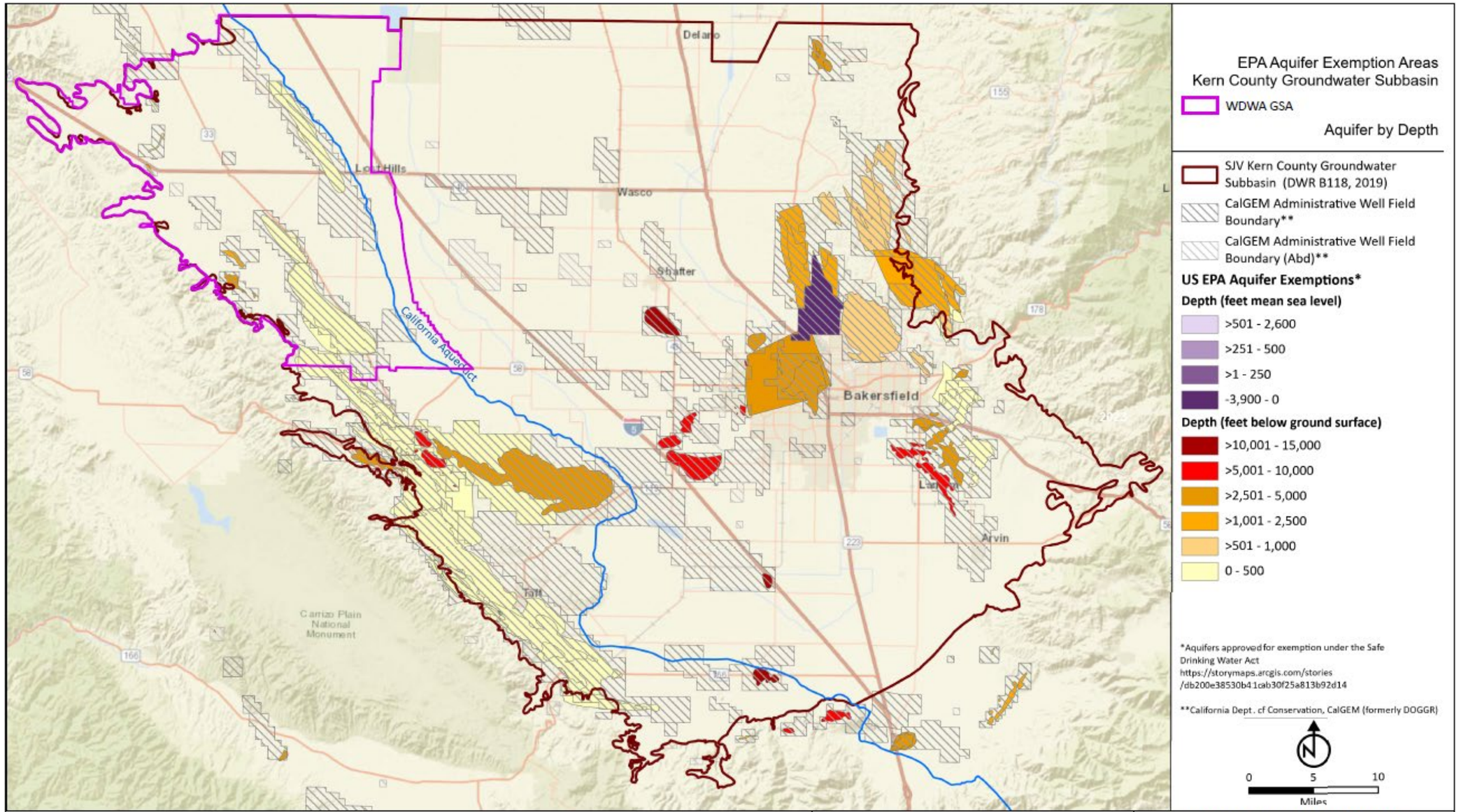
The “Northern Aqueduct” traverses the Western Fold Belt HCM Area and includes Pools 23 to 30. As reported elsewhere herein, the Western Fold Belt HCM Area is characterized by expansive geologic folding (anticlines) which are dominated by large oil fields and open range land. Agricultural activities are limited due to low precipitation, naturally poor groundwater quality (high TDS) and saline-alkali soils. The principal water source for irrigation is surface water delivered via the Aqueduct. As such, agricultural and domestic groundwater well density is low and only minimal agricultural, domestic, and municipal groundwater pumping occurs. Due to these factors, principal agricultural and municipal water supplies are either imported (e.g., via the Aqueduct) or derived from other HCM Areas (e.g., the town of Lost Hills municipal water supply is in the adjacent Semitropic Water Storage District GSA).

The Kern Subbasin has reviewed several historical DWR and oil field operator data, various academic reports, and other publications that discuss and demonstrate the nexus between oil field activities and subsidence in the Lost Hills Oil Field (LHOF). These materials are but one source supporting the preliminary conclusion that non-GSA activities are the causes of subsidence between MP 195 and MP 215. Others include more recent DWR reports and direct measurement data by InSAR, DWR benchmark survey data and the construction of detailed InSAR time series that compare and differentiate between non-GSA (i.e., non-seasonal) pumping signatures and GSA-related seasonal pumping. Figure 8-62 presents the extent of oil field administrative areas in the Western Fold Belt. DWR Aqueduct pre-construction reports show that hydro- compaction was reportedly not conducted between Aqueduct MP 195 - 215. This is important because of the expansive/ and soluble (i.e., collapsible) soil types known to exist in WDWA and proximal to the Aqueduct.

The Kern Subbasin also reviewed publications and technical papers related to oil field induced subsidence. Several of these papers and reports were prepared by staff of the oil field operators, including as part of materials for Underground Injection Control (UIC) applications submitted to the United States Environmental Protection Agency (US EPA) and the California Geologic Energy Management Division (CalGEM). Aqueduct MP 195 to 215 are directly adjacent to the LHOF. The administrative boundaries and geologic structure of the LHOF extend up to and across the Aqueduct in places. Oil field activities are exempt from SGMA and are thus non-GSA related. The LHOF is a doubly plunging asymmetrical geologic fold (anticline) whose sides extend outward to the west and east of the fold crest. The east side of the anticline appears to be steeper than the west and extends beneath the Aqueduct in places. Publications and papers by the oil operators at the LHOF document that subsidence was noted as early as the 1950’s and increased in the 1980’s with the introduction of various enhanced oil recovery (EOR) techniques like hydraulic fracturing and water and steam flooding. Recently, a new DWR/CASP monitoring well boring installed on the east side of the Aqueduct at MP198 reportedly encountered steam in the subsurface. This anomalous condition is likely attributable to

LHOF EOR activity and further supports the preliminary conclusion that the LHOF activities extend beneath and beyond the Aqueduct. Many of the oil fields in the Western Fold Belt HCM Area, including the LHOF, are considered mature and typically produce volumes of “produced water” that exceed the volume of oil. For example, it is not uncommon to see a ratio of produced water versus oil to be on the order of ten barrels of produced water to one barrel of oil. Produced water is water that is usually entrained with some fraction of crude oil and is brought to the surface during oil extraction within an exempt oil field operation. Produced water and oil field supply water are discussed further in Section 8.4.4.1.

Soil types mapped by the US Department of Agriculture in the Western Fold Belt along the Northern Aqueduct are typical of arid climates and are susceptible to being both expansive and collapsable (i.e., soluble). They are also known to have elevated alkaline or sulfate constituents. This type of soil, which also extends into the southern Aqueduct area, can affect the integrity of concrete over time (the Aqueduct is over 60 years old). While further soil testing will help refine the potential for Western Fold Belt HCM Area soil types to contribute to Non-GSA subsidence along the Aqueduct, it should be noted that gypsum (CaSO4·2H2O) is mined adjacent to AOI-2, and certain types of concrete (Type I or Type II) have little or only moderate resistance to chemical weathering. by sulfate and alkaline soils. The Kern Subbasin has received information from DWR/CASP on the type of concrete utilized for Aqueduct construction and will work with CASP to explore this factor further with DWR/CASP. Figure 8-63 presents the soil types in the vicinity of LHOF (MP 195-215).



Source: Adapted from KGA/Provost & Prichard.

Figure 8-54

EPA AQUIFER EXEMPTION AREAS

DECEMBER 2024

Kern County Subbasin
Groundwater Sustainability Plan

Figure 8-62. EPA Aquifer Exemption Areas

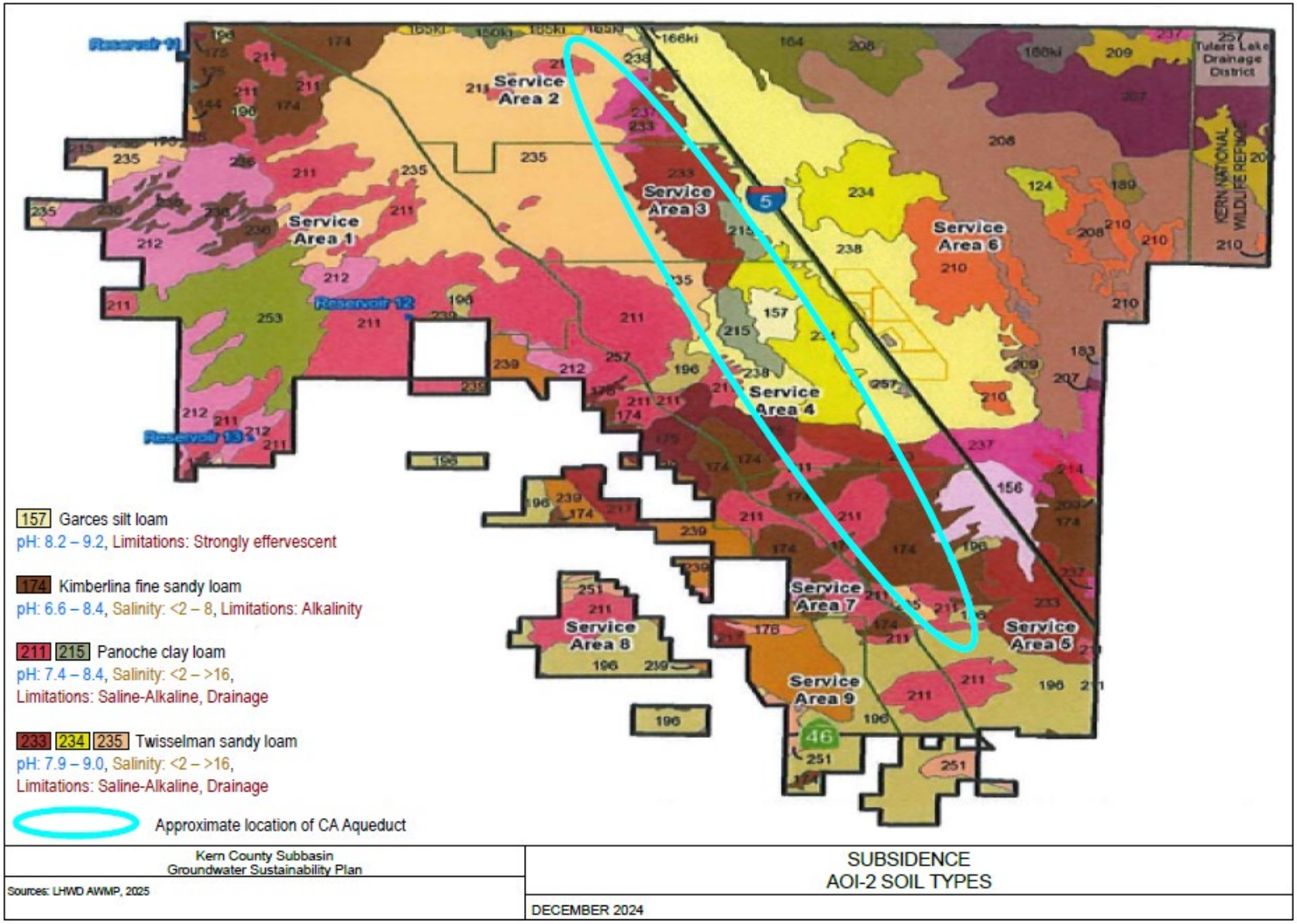


Figure 8-63. Subsidence AOI-2 Soil Types

In areas with identified non-GSA activities such as between MP 195 and MP 215, the potential for subsidence caused by factors within the GSA authority to control is likely low. This is supported by various lines of data including the fact that poor natural groundwater quality results in extremely limited reliance on groundwater by the GSA. Other potential factors outside the GSA authorities to control (i.e., potential for deficient pre-construction hydro-compaction, expansive/soluble soils, oil field activities etc.) may be contributory to the cause of subsidence leading to operational issues (e.g., loss of freeboard and conveyance capacity) along this reach of the Aqueduct. Data derived from various Kern Subbasin studies pertaining to the rate and cause of subsidence along the northern Aqueduct have been shared with CASP senior management in a series of technical meetings. To gather further data regarding the cause of subsidence in areas with non-GSA activities, the Westside District Water Authority (WDWA) GSA has recently implemented a pumping moratorium within the CASP 5-mile-wide monitoring zone between Aqueduct MP 195 and MP 215. These issues are further discussed in Section 8.5.2. Figure 8-64 shows cumulative land subsidence for the Western Fold Belt HCM Area by MP for the Northern Aqueduct for the nine-year period between 2015 and 2024. The Kern Subbasin is committed to working in close coordination with CASP and DWR to further refine the data pertaining to potential causes of subsidence and to ensure GSA-related subsidence rates are following the Interim Milestone glide path via the implementation of proactive P/MAs and DWR BMPs. As discussed previously, the areas distal to westside oil field activities have historically exhibited lower rates of subsidence.

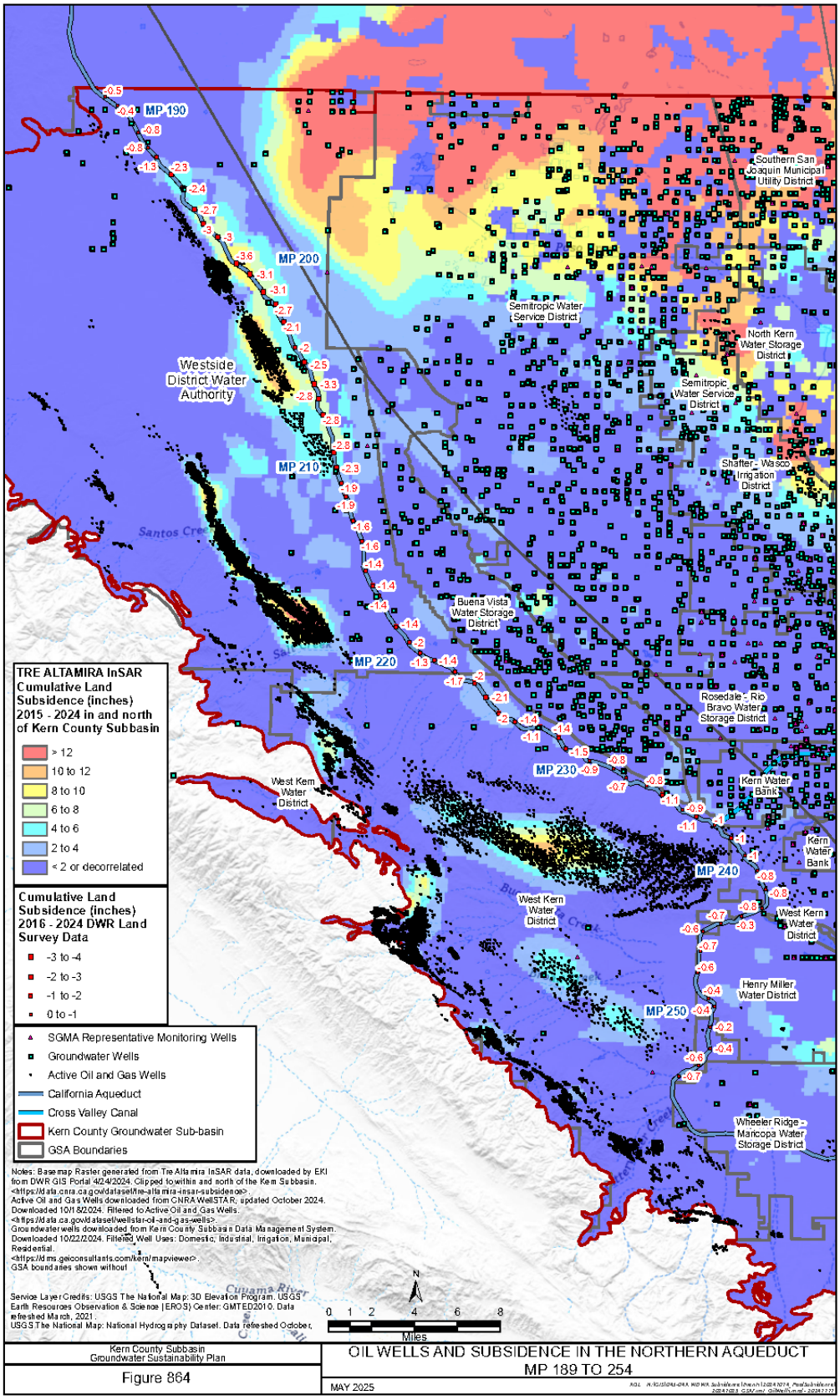


Figure 8-64. Oil Wells and Subsidence in the Northern Aqueduct MP 189 to 254

Southern Aqueduct

Approximately 22 miles of the Aqueduct, including Pools 31 through 35 from approximately MP 254.5 to MP 278.13 (Teerink Pumping Plant), is defined as the "Southern Aqueduct" which primarily traverses through the South Basin HCM Area. DWR has documented subsidence by milepost of the Aqueduct with a baseline of 1967 or 1969 ground surface elevation and estimated hydraulic impacts of differential settling (DWR, 2017). DWR has noted that between 7.5 and 9.0 feet of land subsidence was observed between 1965 and 1968 as a result of hydro-compaction upon the development of pre-construction ponds along the proposed alignment of the Aqueduct MPs 255.7 – 274.3 (DWR, 2017). Within the Southern Aqueduct, measured values for survey benchmark locations show up to approximately 1.7 feet of settlement from the 1967/1969 baseline through 2013 (DWR, 2017), and up to approximately 1.2 feet of additional settlement between 2013 and 2017 (DWR, 2019).

InSAR data and yearly benchmark surveys completed by SWP California Aqueduct Subsidence Program (CASP) were used to assess recent (i.e., post-SGMA) subsidence in the southern pools (Figure 8-65 and Figure 8-66). InSAR data show that over the 2015 to 2024 period, cumulative subsidence along the Southern Aqueduct ranged from less than 0.1 feet to almost 0.7 feet. Similarly, yearly benchmark surveys suggest that from 2016-2023, cumulative subsidence ranged from 0.2 to 0.75 feet (Figure 8-66). As with the Northern Aqueduct, the Kern Subbasin is committed to working in close coordination with CASP and DWR to ensure Southern Aqueduct GSA-related subsidence rates are following the Interim Milestone glide path via the implementation of proactive P/MAs and DWR BMPs. Along those lines, the Wheeler Ridge-Maricopa GSA has implemented proactive P/MA's including well registration and well extraction reporting within the GSA, which includes the Southern Aqueduct. The Wheeler Ridge-Maricopa Water Storage District has also implemented significant groundwater extraction charges within its district boundaries, which include lands within the Kern and White Wolf Subbasins.

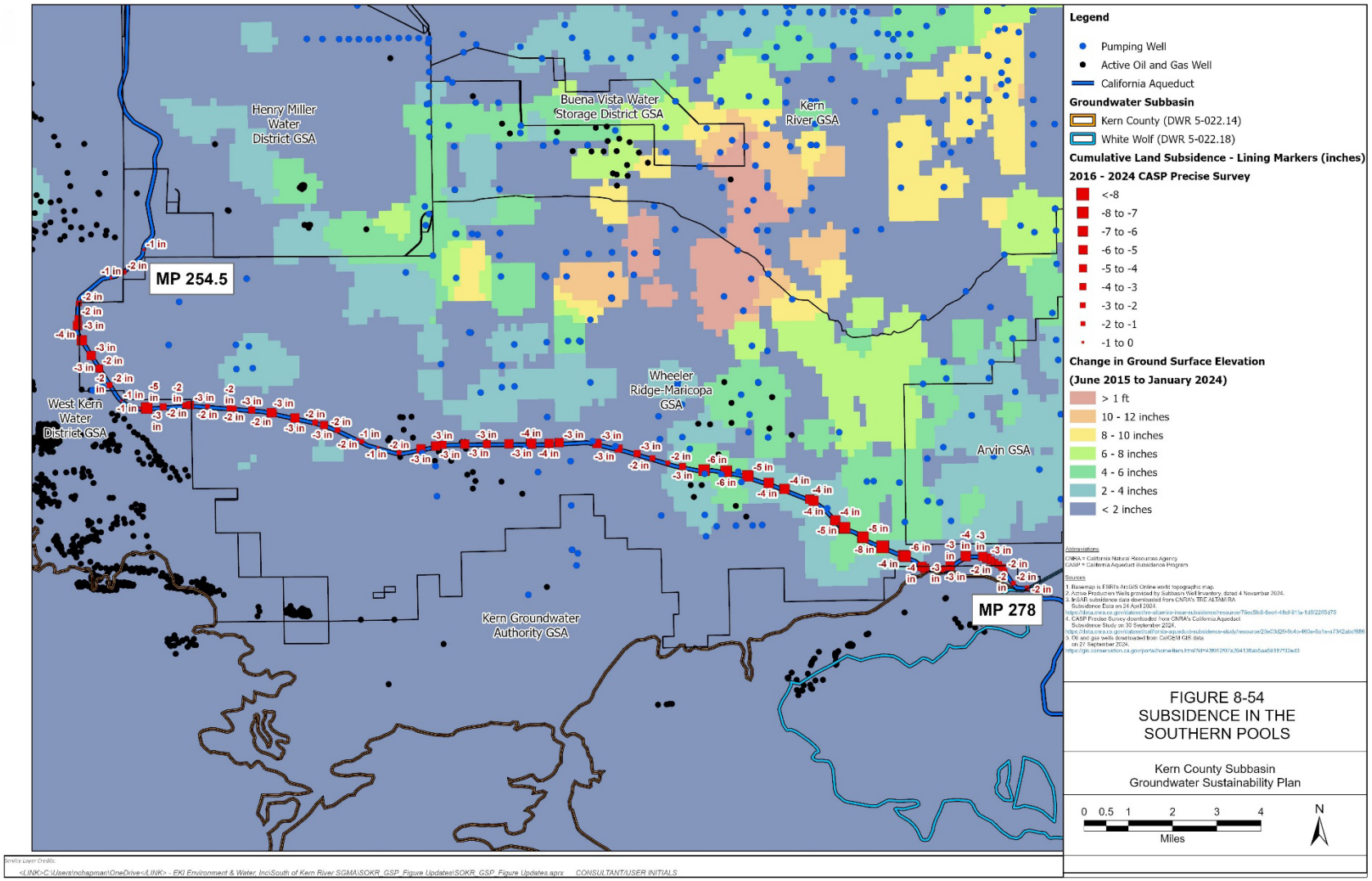


Figure 8-65. Subsidence in Southern Pools

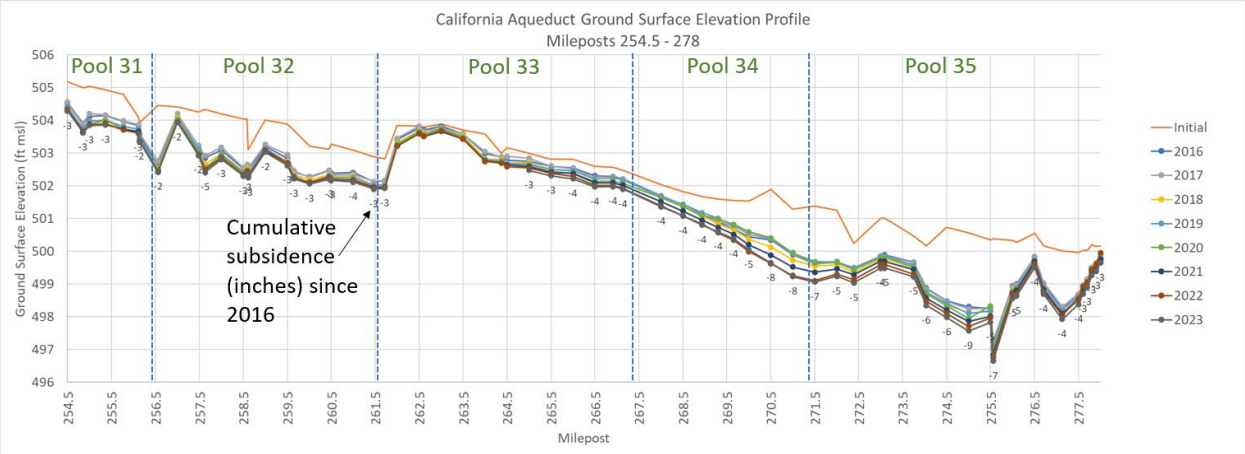


Figure 8-66. Cumulative Subsidence Southern Pools 2016 to 2023

Friant-Kern Canal

The FKC facilities include the Friant Dam (Millerton Reservoir) completed in 1944, and the 152-mile FKC completed in 1951. On average, the canals deliver 1.2 million AF of irrigation water annually to more than 15,000 farms on over one million acres of the most productive farmland in the world (FWA, 2020). The Friant Division was designed and is operated as a conjunctive use project to convey surface water for direct beneficial uses, such as irrigation and municipal supplies, and to recharge groundwater basins in the southern San Joaquin Valley. The ability to move significant water through the Friant Division's canals in wetter years to store in groundwater recharge basins is critically important for the project to work as intended. These operations sustain the primary source of drinking water for nearly all cities, towns, and rural communities on the Valley's East side (FWA, 2020).

Within Kern County, the FKC extends from approximately MP 122 at the Kern County line and flows south for approximately 30 miles to MP 152 near Bakersfield, California. Figure 8-67 displays the location of the FKC, cumulative vertical surface deformation in feet from June 2015 to October 2023 as measured by InSAR satellite data within the Kern Subbasin and corresponding cumulative subsidence in feet along the profile of the FKC for select years from 2017 to 2023 (TRE ALTAMIRA, 2023). The maximum cumulative amount of measured subsidence in the Kern Subbasin from 2015 to 2023 is 2.4 feet with the greater amount of subsidence in the northern part of the Kern Subbasin in a subsidence depression along the County boundary with Tulare County.

According to the FKC profile, the maximum subsidence from 2015 to 2023 is about 0.9 feet between MP 133.43 and MP 135.45 (Figure 8-67).

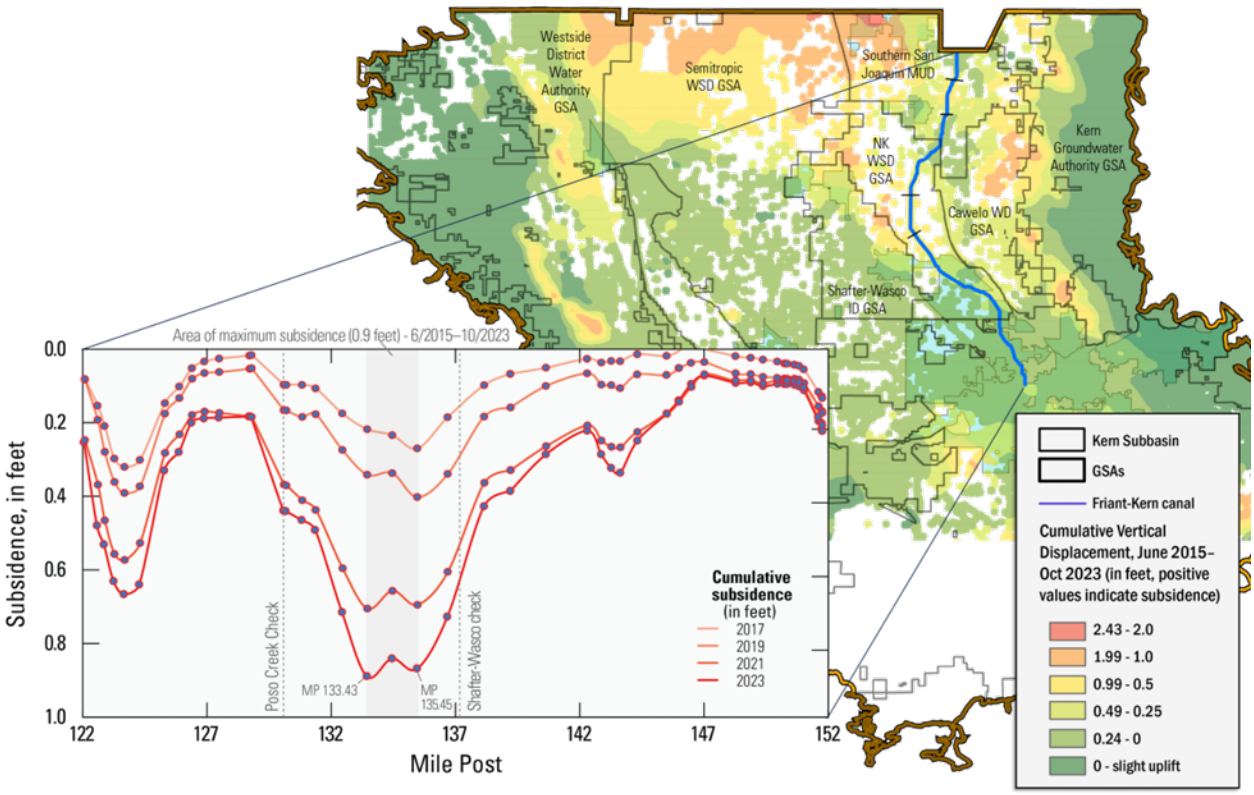


Figure 8-67. Kern Subbasin Cumulative Subsidence 2015 to 2023 and FKC Subsidence Profile (INTERA 2024)

8.5.2 Causes of Subsidence

Land subsidence is often caused by dewatering of subsurface clays and other fine-grained sediments. This process is illustrated by two conceptual diagrams shown on Figure 8-69. The upper diagram depicts an alluvial groundwater basin with a regional clay layer and numerous smaller discontinuous clay layers. Water level declines associated with pumping cause a decrease in water pressure within the pore space (pore pressure) in the aquifer system (Galloway et al., 1999). Since the water pressure in the pores helps support the weight of the overlying aquifer, the pore pressure decreases and causes more weight of the overlying aquifer to be transferred to the grains within the structure of the sediment layer. The difference between the water pressure in the pores and the weight of the overlying aquifer is termed as the effective stress. If the effective stress borne by the clay sediment grains exceeds the structural strength of the sediment layer, the aquifer system begins to deform. This deformation consists of rearrangement and compaction of fine-grained units as illustrated on the lower diagram of Figure 8-69.

To assess the causes of subsidence, the Kern Subbasin has conducted a series of studies in communication with DWR, CASP, and the FWA. The studies incorporated data from published academic and government studies and reports, oil field aquifer exemption applications prepared for the California Geologic Energy Management

Division (CalGEM) and the EPA, DWR InSAR data, and InSAR studies conducted by Lawrence Berkeley National Laboratory (LBL) and Earth Consultants International (ECI) on behalf of the Kern Subbasin. Two key takeaways from these studies are (1) it is possible using InSAR to discern the difference between subsidence due to seasonal (cyclical) groundwater extraction like agriculture and subsidence caused by non-seasonal extraction (i.e. long term) activities which are not under the control of Kern Subbasin GSAs like oilfield activities and, (2) a data-driven methodology based on direct measurement (e.g., precise DWR survey data and DWR InSAR quarterly monitoring) is best suited to accommodate Kern Subbasin complexities and scale.

Subsidence in the Kern Subbasin is driven by multiple factors, chief among these is agricultural and municipal pumping, which are within the GSAs authority to manage and are therefore referred to herein as “GSA-related” factors. Other factors not under the control or authority of Kern Subbasin GSAs include expansive and soluble soil types, susceptible to hydro-compaction, oil field activities, potential age (lifespan) of critical infrastructure, potential historical pre-construction geotechnical deficiencies (e.g., lack of hydro-compaction on the Aqueduct) and subsidence caused by potential natural processes (e.g., faulting, compaction, and tectonic down warping). For convenience, these other factors are collectively referred to herein as “non-GSA” factors.

8.5.2.1 Land Subsidence Caused by Factors Within the GSAs Authority

Groundwater Pumping Induced Land Subsidence (GSA related)

Although extraction of groundwater by pumping wells causes a more complex deformation of the aquifer system than discussed herein, the simplistic concept of vertical compaction is often used to illustrate the land subsidence process (Galloway et al., 1999; LSCE et al., 2014). The tabular nature of the fine-grained sediments allows for preferred alignment and compaction. As the sediments compact, the ground surface can sink, as illustrated by the second column on the lower diagram of Figure 8-69.

Land subsidence due to groundwater withdrawals can be temporary (elastic) or permanent (inelastic). Elastic deformation occurs when sediments compress as pore pressure decrease decreases but expand by an equal amount as pore pressures increase. A decrease in water levels from groundwater pumping causes a small elastic compaction in both coarse- and fine-grained sediments; however, this compaction recovers as the effective stress returns to its initial value. Because Kern Subbasin deformation rates can, and often do, exhibit some amount of small elastic recovery during wet years, rates have been generally low with a few exceptions. Both inelastic and elastic subsidence occurs in the area of the Kern Fan HCM Area. Reported significant impacts to local infrastructure in the Kern Subbasin have also been low to minimal.

Figure 8-70 presents the C2VSimFG-Kern modeled extent of groundwater pumping (i.e., agricultural and municipal) overlaid on the DWR cumulative subsidence for the period 2015 to 2023. The area of modeled concentrated groundwater pumping, which includes Kern Subbasin GSA Annual Report data, correlates with areas of historical subsidence (i.e., pre-2015). There is also a clear correlation with more recent InSAR data for the period 2015 to 2023. It should be noted that other areas (e.g., west of the Aqueduct and along the east side of the Kern Subbasin) have undeveloped range land and/or oilfields and thus little or no GSA-related groundwater pumping. In addition, and as noted previously, groundwater quality in the western portion of the Kern Subbasin is naturally degraded by high TDS, which also limits groundwater pumping for agriculture or other uses.

8.5.2.2 Land Subsidence Caused By Factors Outside the GSAs Authorities

Historical Oil Field Land Subsidence

Figure 8-71 shows the relationship between subsidence and oil field extraction operations in the Kern Subbasin from 2015 to 2023. DWR InSAR data clearly demonstrate that subsidence and oil field activities are concomitant along the Kern Subbasin margins (Western Fold Belt, South Subbasin, and Eastern Margin HCM Areas) and with some oil fields in the center of the Kern Subbasin. Subsidence due to oil field operations has been documented in various studies across the Kern Subbasin:

- At the Kern Front and Poso Creek oil fields on the order of 1 foot based (Castle et al., 1983).
- Based on InSAR data collected by the European Space Agency's Remote Sensing Satellites, a maximum subsidence rate as high as 40 mm (1.57 in) in 35 days, or more than 400 mm/year (15.748 in/yr), was measured in the Lost Hills and Belridge oilfields. This data demonstrates the spatial and temporal dynamics of subsidence due to oil extraction from diatomite reservoirs (Fielding, Blom, & Goldstein, 1998).
- Another study involved operational acquisition of repeat-pass InSAR data since late 1998 to monitor subsidence rates, validated with GPS monument survey measurements. This ongoing monitoring reflects changes due to field development and operational practices (Kooij & Mayer, 2002).
- A related study highlighted that during a 105-day period, the subsidence in the center of the Lost Hills field reached 15 cm (5.91 in), attributed to vertical shrinkage of the hydrocarbon reservoir from oil production and resulting pore pressure drops. This measurement was possible using spaceborne InSAR, indicating the feasibility of monitoring hydrocarbon production through satellite-based earth deformation measurements (Xu, Dvorkin, & Nur, 2001).

Natural Causes of Land Subsidence

Figure 8-72 presents the areas with known mapped faults in the Kern Subbasin. With a few exceptions, most faults are concentrated on the east and west margins of the Kern Subbasin. The Kern Front and Premier (Poso Creek) faults are known to have sustained historical rupturing (Castle, 1983). Deep-seated tectonic settling or down warping in the North Basin HCM Areas (i.e., synclinal axis of the of the Kern Subbasin) also contribute to subsidence over the long term. Other natural causes such as expansive soils and hydro-compaction, found mainly on the west side of the Kern Subbasin, cause embankment failure and other geotechnical issues for water conveyance infrastructure (Lofgren, 1975).

Other Non-GSA Causes of Land Subsidence

Six studies have been conducted in the Kern Subbasin utilizing InSAR and other data to assess the causes of subsidence along a portion of the Aqueduct (MP 195 to 215). These studies preliminarily found that various factors not under the control of the Kern Subbasin GSAs were likely contributory to the observed subsidence. These factors, among others, include expansive and soluble soils, potential for deficient Aqueduct pre-construction hydro-compaction, and oilfield activities. The findings from the six studies were shared with CASP and DWR. The Kern Subbasin has identified other areas on the Aqueduct (e.g., Yowlumne Oil field) that are likely experiencing non-GSA related subsidence. All of these areas will be the subject of future monitoring and studies in cooperation with CASP. The Kern Subbasin is committed to further studies in close consultation with the appropriate and relevant agencies (e.g., CASP, DWR, FWA, Cal GEM etc.) to help further refine the understanding of the causes and extent of non-GSA subsidence.

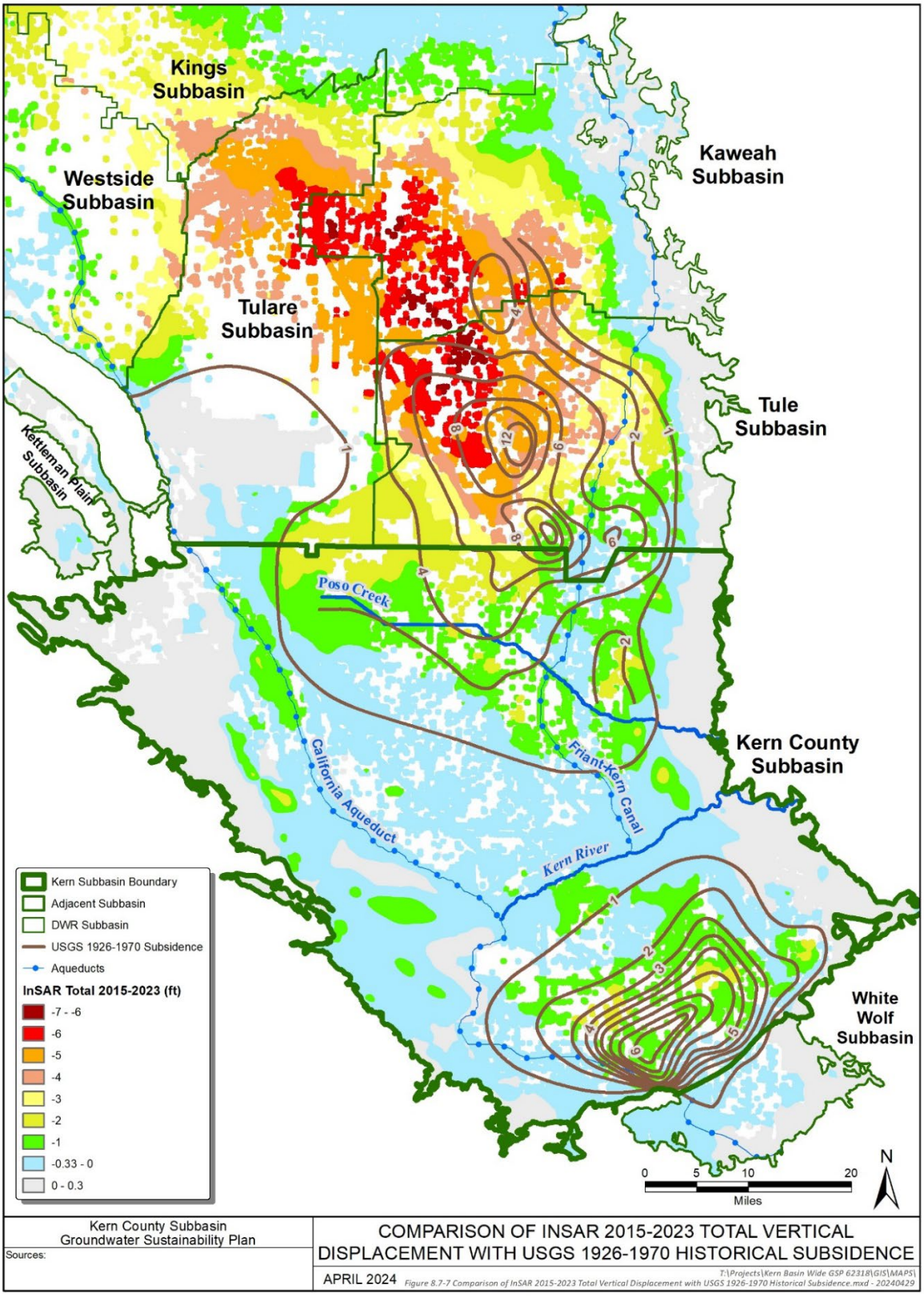
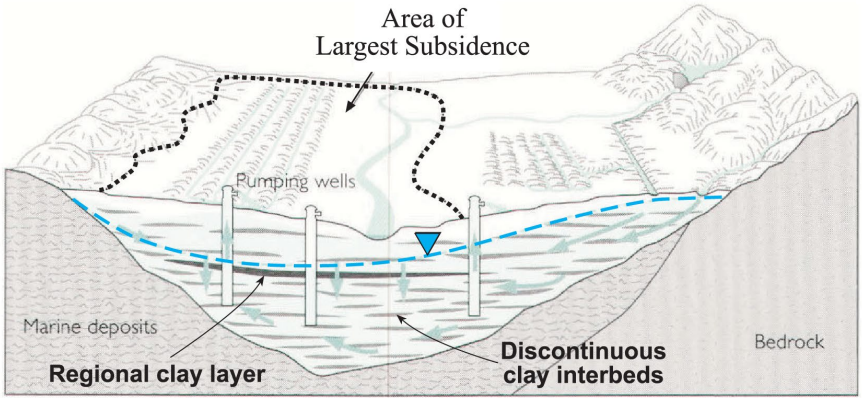
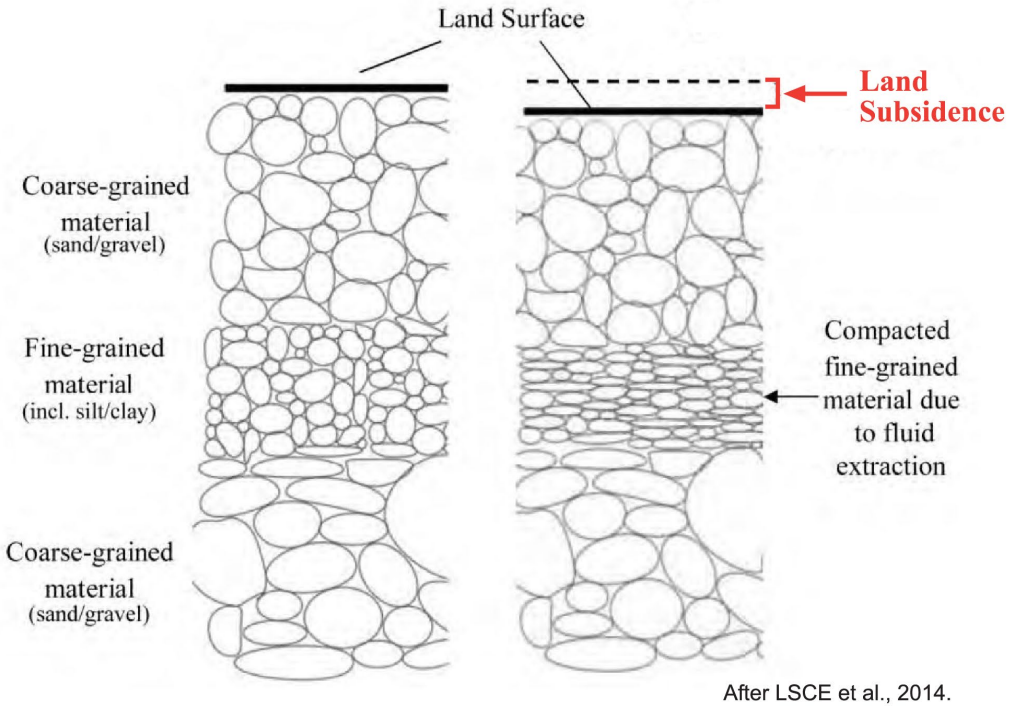


Figure 8-68. Comparison of InSAR 2015 to 2023 Total Vertical Displacement with USGS 1926-1970 Historical Subsidence



Source: Galloway et al., 1999.



After LSCE et al., 2014.

Kern County Subbasin Groundwater Sustainability Plan	CONCEPTS OF LAND SUBSIDENCE
Sources:	APRIL 2024

TODD/MW T:\Projects\Kern Basin Wide GSP 62318\GRAPHICS\Figure 8.7-8 Concepts of Land Subsidence.ai - 20240429

Figure 8-69. Concepts of Land Subsidence

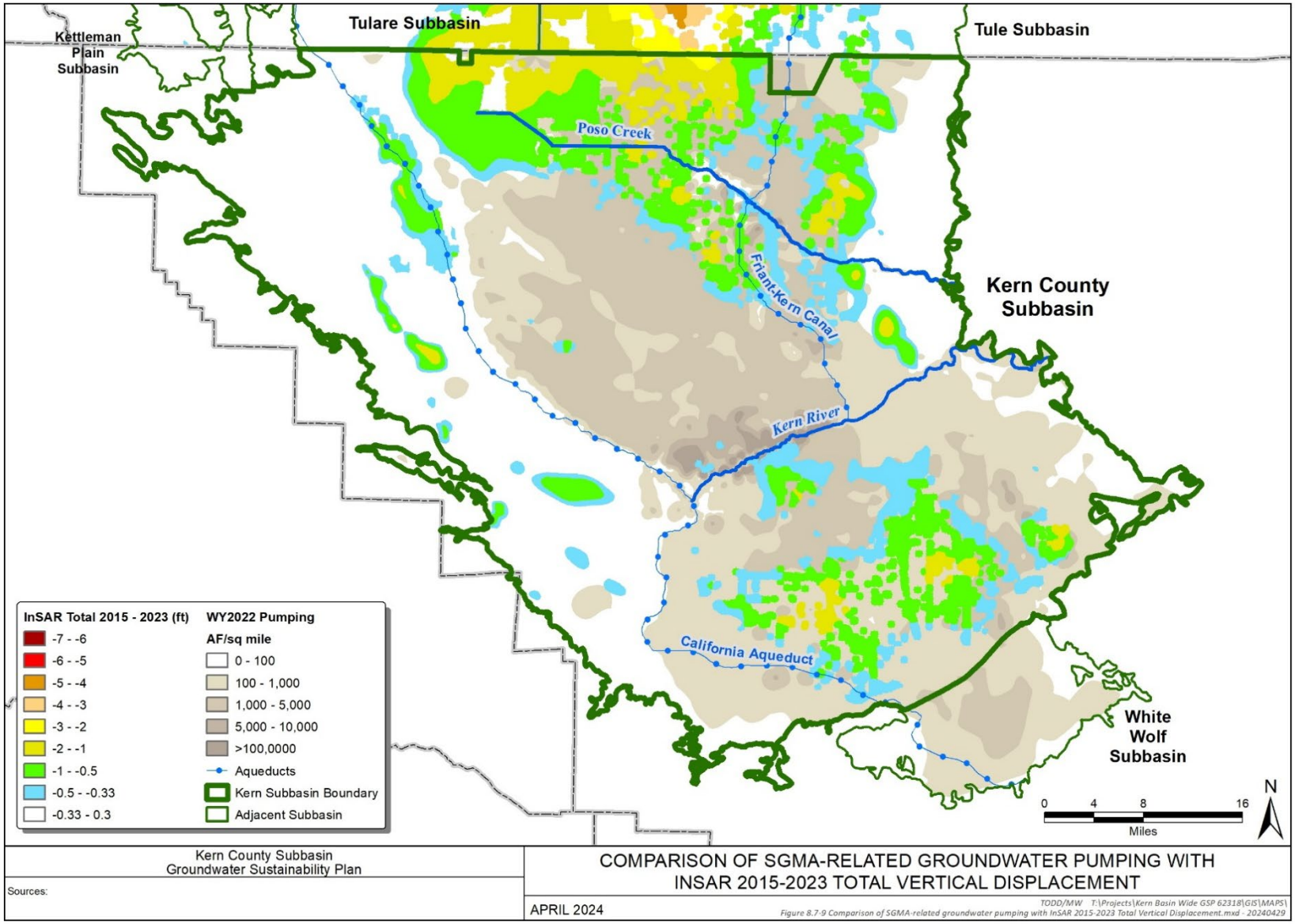


Figure 8-70. Comparison of Groundwater Pumping With InSAR 2015 to 2023 Total Vertical Displacement

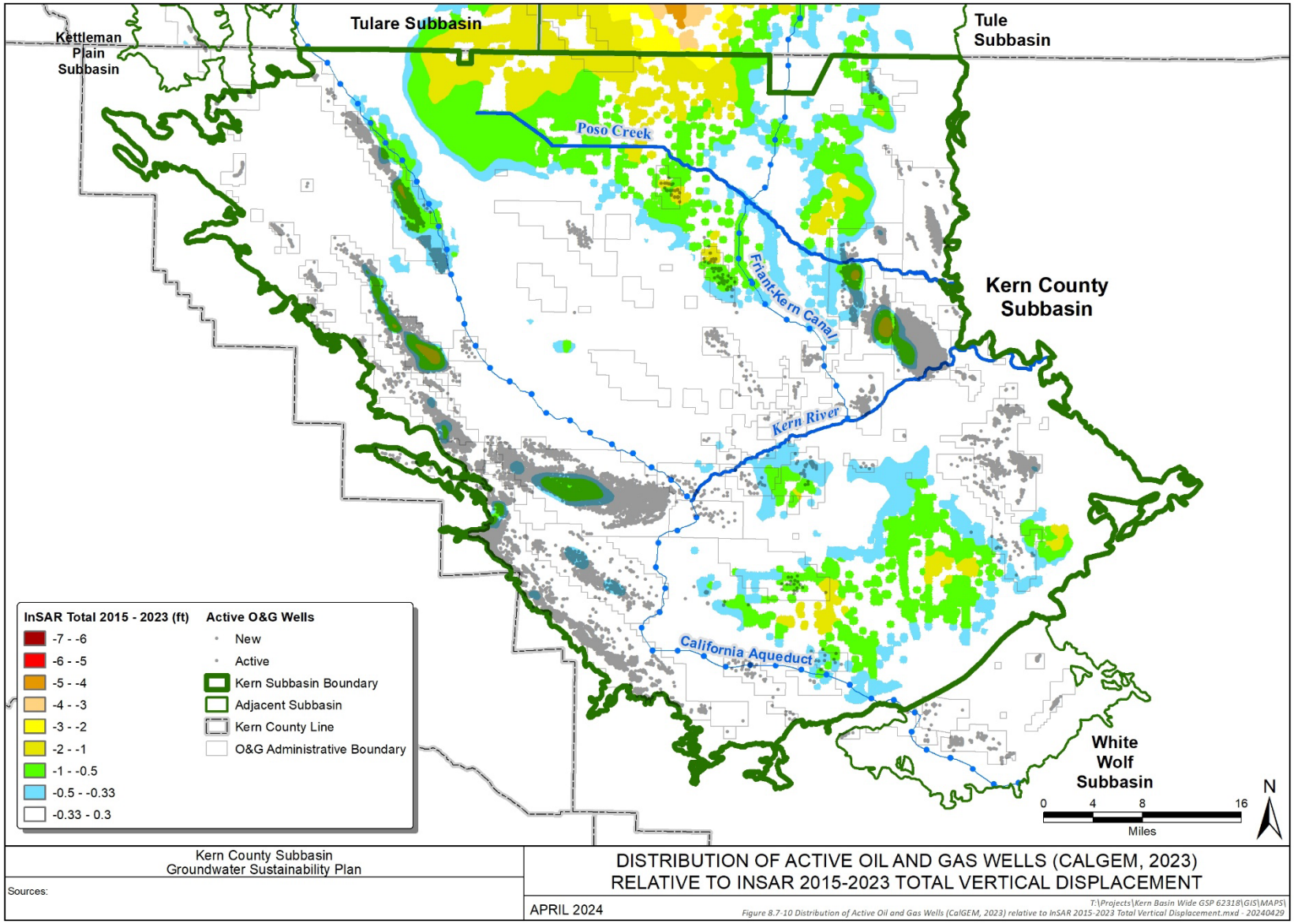


Figure 8-71. Distribution of Active Oil and Gas Wells (CalGEM, 2023) Relative to InSAR 2015 to 2023 Total Vertical Displacement

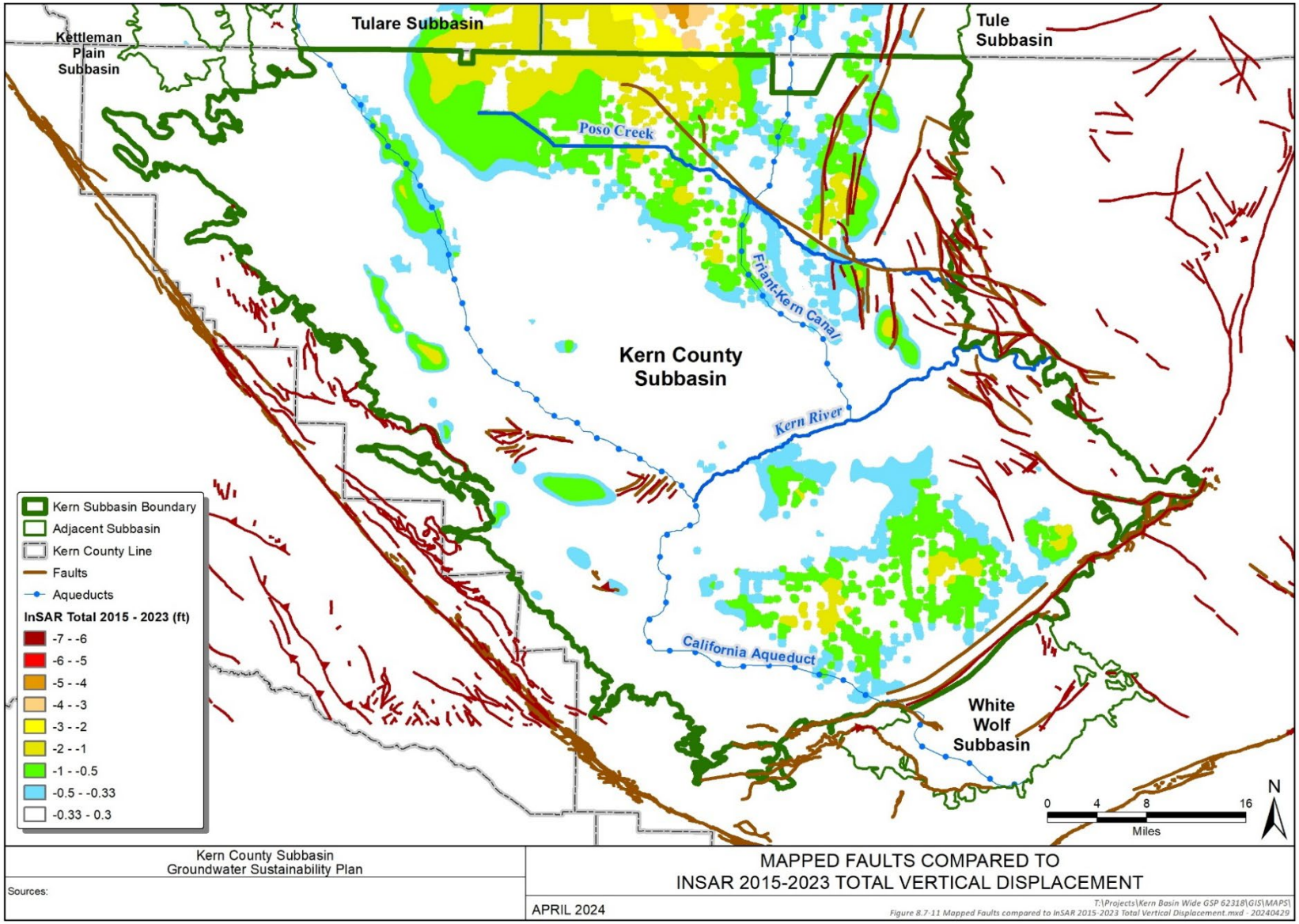


Figure 8-72. Mapped Faults Compared to InSAR 2015 to 2023 Total Vertical Displacement

8.5.3 Magnitude of Subsidence

The magnitude of subsidence (rate and cumulative total) in the Kern Subbasin was assessed using DWR InSAR data, historical benchmark survey data along the California Aqueduct and FKC, and by the six subsidence studies conducted by the Kern Subbasin mentioned above. The focus of these studies was determining the cause, rate and extent of subsidence.

To assess the presence and potential subsidence effects of GSA versus non-GSA pumping, the Kern Subbasin first identified five Areas of Interest (AOIs) for focused subsidence monitoring (Figure 8-73). The AOIs are:

- AOI-1 Friant Kern Canal Mile Post (MP) 120-130
- AOI-2 Aqueduct MP 195-215
- AOI-3 Friant-Kern Canal MP 130-137
- AOI-4 Aqueduct MP 262-267
- AOI-5 Northern Area (Kern County Line) near the town of Delano

InSAR time series are a proven and reliable method for evaluating the annual and cumulative InSAR satellite line-of-sight land subsidence. The following InSAR time series were extracted in each of the AOIs:

- One time series each was extracted in AOI-1 and AOI-3, both assessing the Friant-Kern Canal in agricultural areas.
- Three time series were extracted in AOI-2, sited across the Aqueduct and the adjacent Lost Hills Oil Field (LHOF).
- Two separate time series were extracted in AOI-4, one across the Aqueduct and adjacent Yowlumne Oil Field, and the other across the Aqueduct in an agriculture area.
- One time series was extracted in AOI-5 near the town of Delano.

Using InSAR time series it is possible to differentiate between the different types of extraction actives (i.e., seasonal extraction versus non-seasonal extraction). As previously reported, agricultural pumping (e.g., a GSA-related type of extraction) has a seasonal pattern that is discernible in InSAR data as a sine wave-like pattern over a period of extended time. While non-seasonal pumping (i.e., consistent, long duration) typically exhibits a less harmonic, more energetic InSAR time series signature.

Initial InSAR studies conducted by the Kern Subbasin concluded that GSA and non-GSA subsidence could be differentiated via the use of detailed InSAR time series. In 2023 the Kern Subbasin utilized InSAR data to construct eight time series designed to evaluate conditions in different Subbasin HCM Areas (A-A’ through H-H’). Five of the time series transects were sited in agricultural areas (A-A’, E-E’, F-F’, G-G’, and H-H’)

and three were sited across the LHOF (B-B', C-C', and D-D'). To construct the InSAR time series, the Kern Subbasin utilized data that were obtained directly from the Alaska Satellite Facility (ASF) and/or European Space Agency (ESA) archives at the Sentinel Open Copernicus Data Hub. The Small Baseline Subset (SBAS) InSAR processing of Sentinel-1 satellite Synthetic Aperture Radar (SAR) imagery utilized Generic Mapping Tools Synthetic Aperture Radar (GMTSAR) software and are summarized in the following steps:

1. Search for available scenes in the archives of the ASF and/or ESA at the Sentinel open Copernicus Data Hub. Both facilities have web-based search applications (http://topex.ucsd.edu/gmtsar/demgen/). Note that it is important that all scenes are from the same track and frame. However, the exact location of the frames can be offset slightly along the track because only the overlapping footprint is processed.
2. Determine the footprint of the target area and download the scenes for the selected time span (January 3, 2019, to December 18, 2021).
3. Extract (unzip) all downloaded files and complete the provided GMSTAR instructions for organizing the directories with the archives and intermediary files.
4. If the area of interest is significantly smaller than the original chosen footprint, it may be beneficial to reduce the processed area to a smaller footprint in order to significantly reduce processing times.
5. Download Precise and/or Restituted Orbits from the ESA Copernicus HUB website to determine the exact locations of the satellites at the time the SAR images were acquired.
6. Preprocess the SAR images and select the master image. Use the provided GMSTAR software script to preprocess and align the SAR images. This generates a plot of the perpendicular baselines for the images that are used when selecting the master image. The master image should be selected so the scene is in the middle of the scatter plot. Then re-run the preprocessing with the selected master image for all three swaths that constitute the complete SAR image.
7. Select the interferometric pairs for the time series and run the interferometry for a single interferogram to verify that everything is set up properly. Once everything is determined to work properly, process the complete stack and repeat for swath two and three on each image.
8. Merge the three swaths to produce the complete interferometric stack using the scripts provided in GMTSAR software.
9. Unwrap all interferograms. Filter out water and areas with low coherence. Note: The mask that is used to filter areas of low coherence needs to be in radar coordinates, and the NetCDF GRD format used by GMT and GMTSAR can be

created by stacking the coherence grids generated by the previous step, and/or by manually creating a mask to remove areas with low coherence.

10. There are two ways of running the SBAS analysis. It can be run without calibration against GPS base stations if relative surface velocities are adequate (good coherence). It can also be calibrated against permanent GPS stations. The Kern Subbasin used the GPS calibration method to calibrate the SBAS stack. For the Kern Subbasin, we used the Continuously Operating Reference Station (CORS) GPS station ISLK that is operated by UNAVCO, which shows long-term stability because it is located far from known sources of deformation (i.e., faults and areas with subsidence or uplift), and also because it is located within the footprint of the Sentinel-1 scenes used in the study. Additionally, selecting a CORS station with demonstrated long-term stability significantly simplifies the mathematics needed for the calibrations. The next step is to calculate the incidence angle of the SAR radar beam at the location of the GPS station and re-calculate the GPS movement over the time span of the interferometric stack to convert the movement from X-Y-Z to movement along the line-of-sight from the satellite.
11. Next, adjust the interferograms so the deformation for the pixel that corresponds to the location of the GPS station matches the deformation measured by the GPS. Once adjusted, the stack of interferograms is run through the SBAS stacking software where atmospheric and ionospheric corrections are made, and a least-squares algorithm is used to calculate the average surface velocity over the time span covered by the interferometric stack.
12. If necessary, re-calculate the surface deformation and velocities to vertical from along the (satellite) line-of-sight (LOS).

The resulting data had a vertical resolution of approximately 2.4 millimeters (0.09 inch) and a horizontal resolution of approximately 20 meters by 20 meters (i.e., 66 ft by 66 ft.), with no space between pixels. s.

GSA-related pumping in the Kern Subbasin is seasonal with higher annual demand in the spring and summer and less demand during the fall and winter months. This type of cyclical pumping was postulated to generate a “up-down-up” pattern or sinewave-like shape in the InSAR Time Series.

The current time series transects depict annual rates and cumulative displacement between 2019 and 2022. The placement of the transects evaluates identified regional critical infrastructure. (Figure 8-74). For orientation purposes, markers showing the location of canals, major roads and oil fields etc., were inserted into the time series transects. Extraction of transects and raster calculations for conversion between millimeters and inches were done with Quantum GIS (QGIS). The resulting text files with the cross sections were subsequently plotted with the GMT software. A similar technique was used when extracting data from the interferometric stacks. GMT was

used to extract the deformation values stored in the InSAR pixels at chosen geographic locations in the raster files that make up the interferometric stack, then transferring the values to text files. These text files were subsequently plotted in GMT together with data from the nearby continuously operating GPS stations used to ground-truth the data. The time series data was also used to create pseudo-3D sections (aka wireframe diagram) showing displacement along the transects over time (Figure 8-75 through Figure 8-82). These graphs were created in Golden Software's "Surfer" software package by letting the X-axis representing distance along the transect, the Y-axis representing displacement and the Z-axis representing time since the start of the time series.

Figure 8-82 (Transect H-H') is one example of the GSA-related (seasonal pumping) sine-wave signature. Transect H-H' is located in the Northern HCM Area, an area of agricultural activity. Each transect has three separate time series, one on the western origin point of the transect (blue line), one in the middle of the transect (red line), and one the eastern end of the transect (green line). As can be seen on Transect H-H' all the separate time series lines (blue, red, and green) are in harmony indicating only GSA activities are present. Four other transects (A-A', E-E', F-F', and G-G') also exhibit Time Series signatures typical of seasonal agricultural GSA activities.

By way of contrast, Transect C-C' (Figure 8-77) traverses across the LHOF just north of the town of Lost Hills. The Time Series curve signatures exhibited on C-C' (blue, red, and green) are markedly different appearing "busy" and less harmonic than those on transect H-H'. The shape of these curves reflects the non-seasonal pumping typical of oil field operations. Both the blue and green time series match the signature curve of the red time series line that traverses the center (crest) of the oil field anticline, indicating that oil field influences are being detected outside of the CASP Aqueduct Monitoring Corridor. Time Series C-C' is near where DWR/CASP staff stated that a DWR/CASP monitor new well location drilled on the east side of the Aqueduct opposite the oil field at approximately MP 198 encountered steam in the boring from a subsurface source (i.e., likely LHOF steam flood activities). The time series green line shows a busy, non-GSA activity signature extending eastward out to at least Interstate 5. As stated previously, WDWA GSA relies almost exclusively on surface water via the Aqueduct for irrigation demand, so groundwater pumping is limited. Further, a harmonic signature related to GSA pumping is not found on Time Series C-C'. Time Series B-B' and D-D' also traverse the LHOF to the north and south of C-C,' Both of these transects also exhibit the same busy, non-harmonic curve signatures of non-GSA activities related to oil extraction (Figure 8-75 and Figure 8-77).

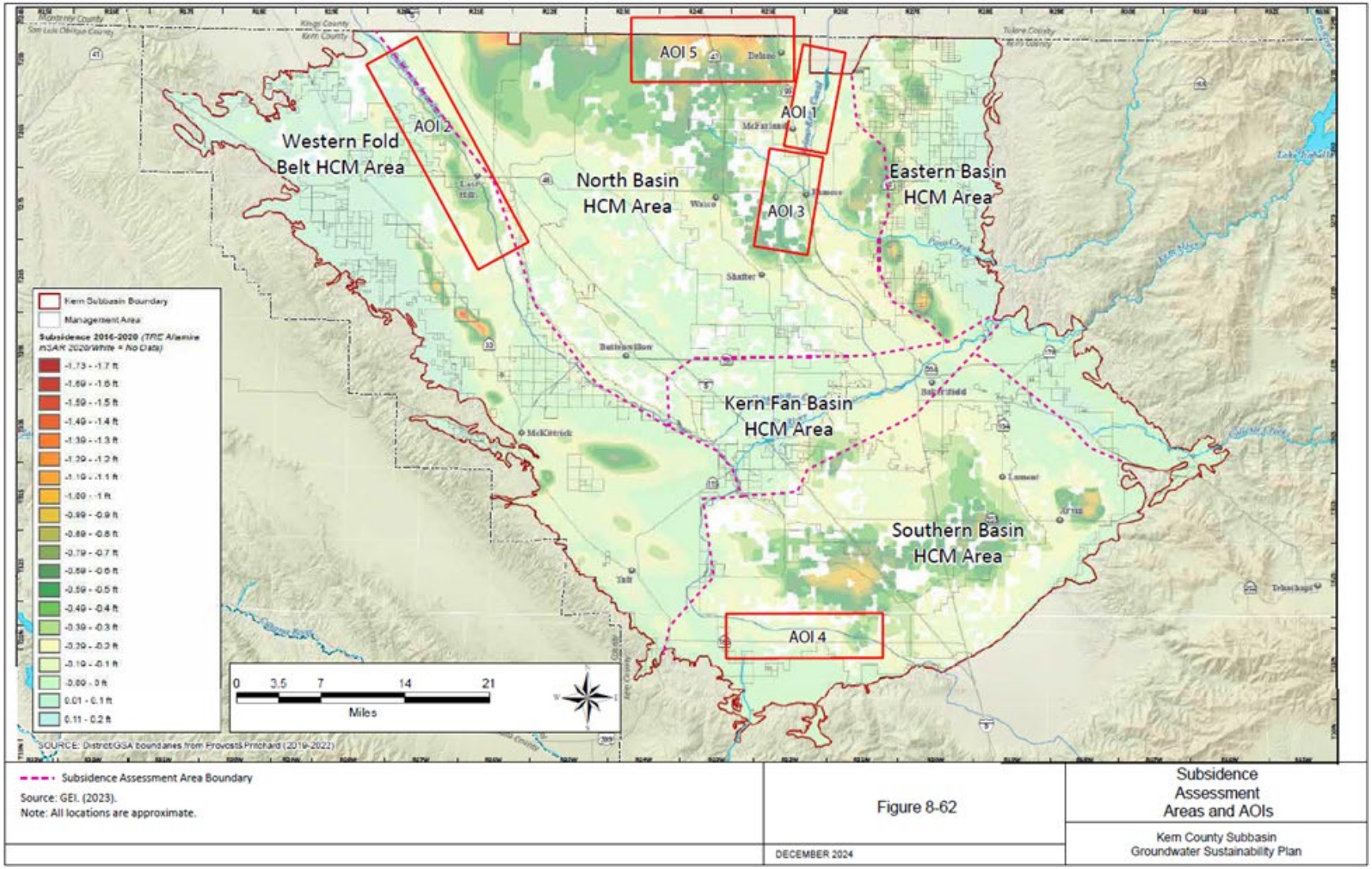


Figure 8-73. Subsidence Assessment Areas

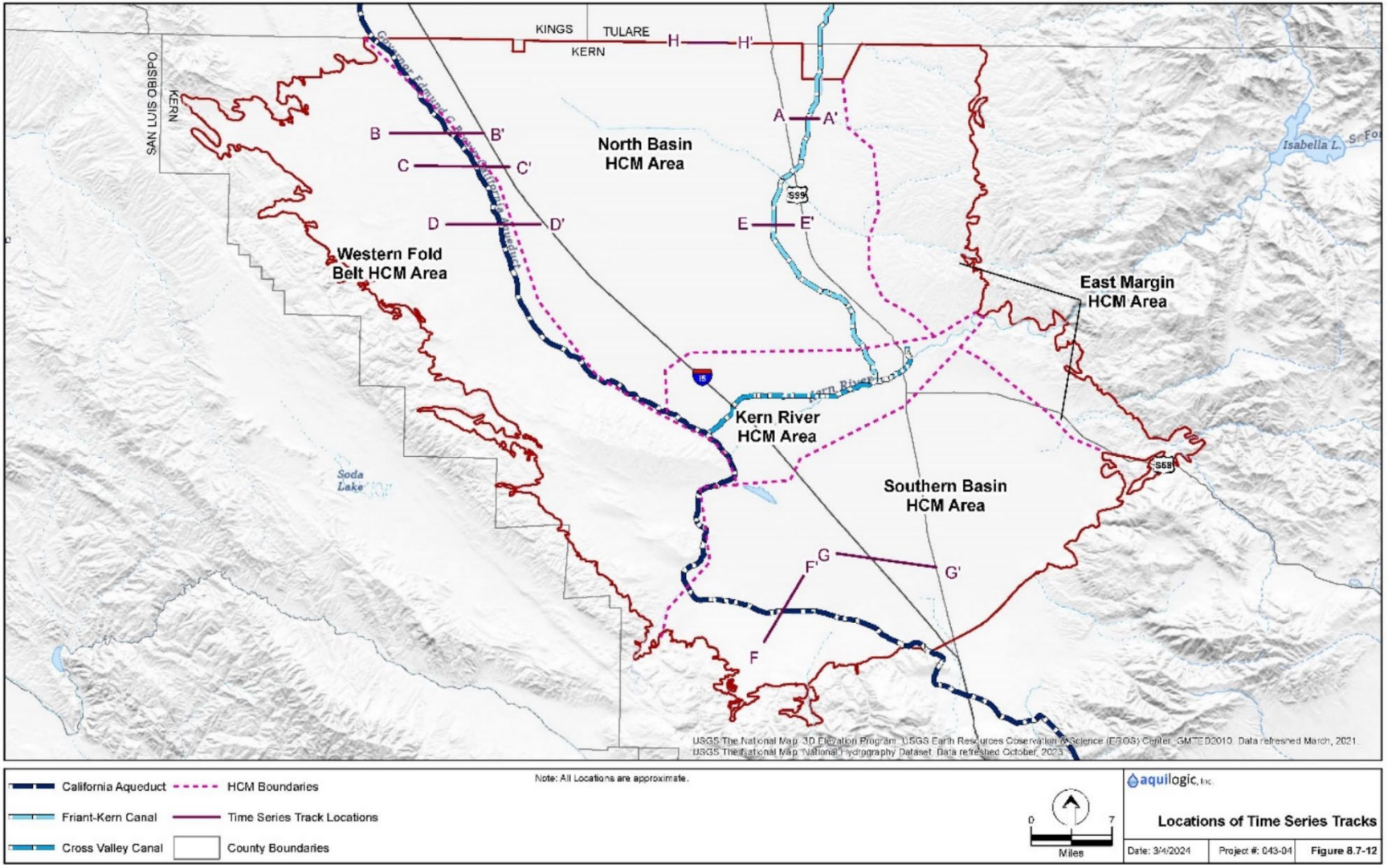


Figure 8-74. Location of Time Series Tracks

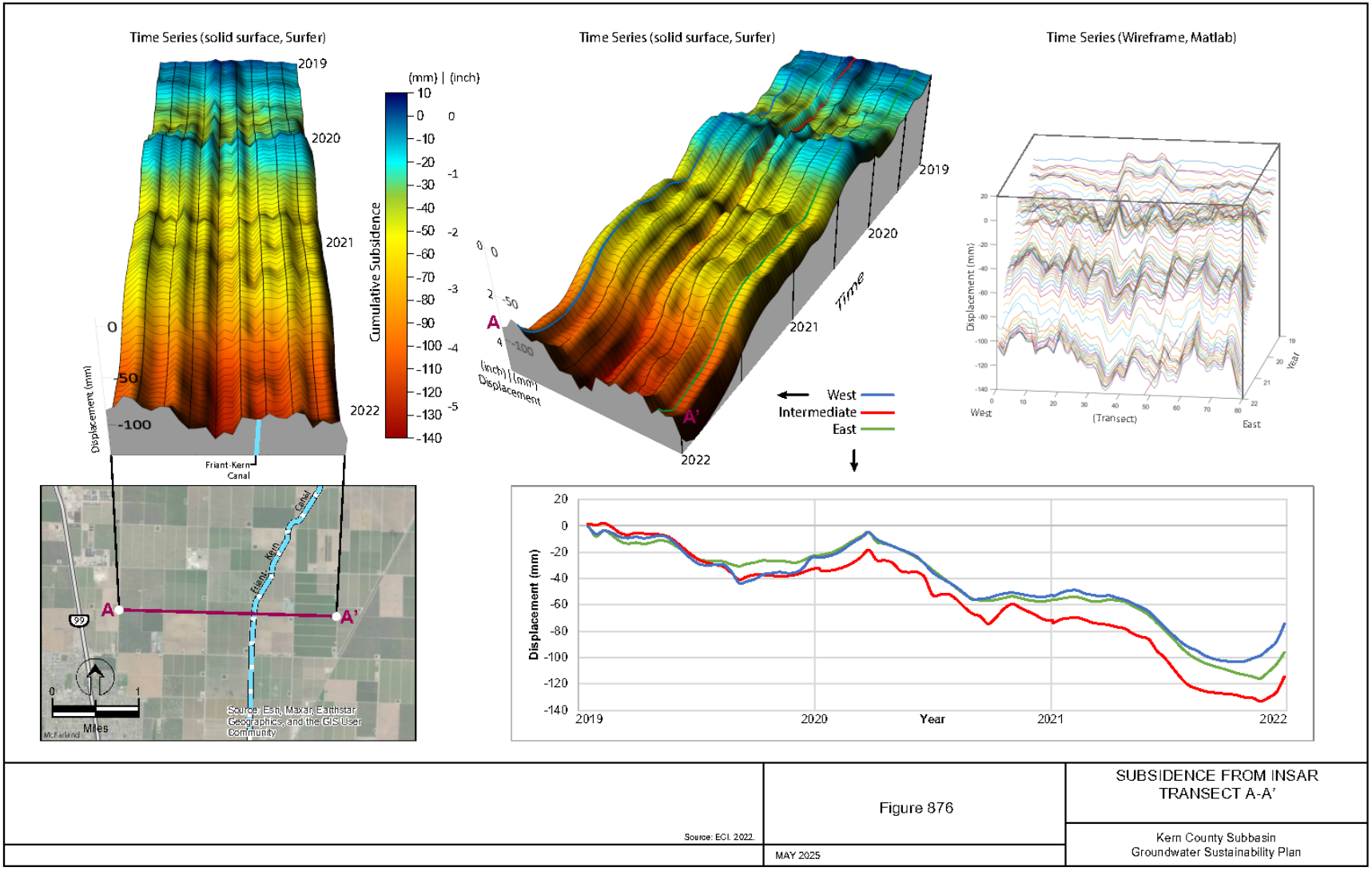


Figure 8-75. Time Series for AOI-1 Track A-A'

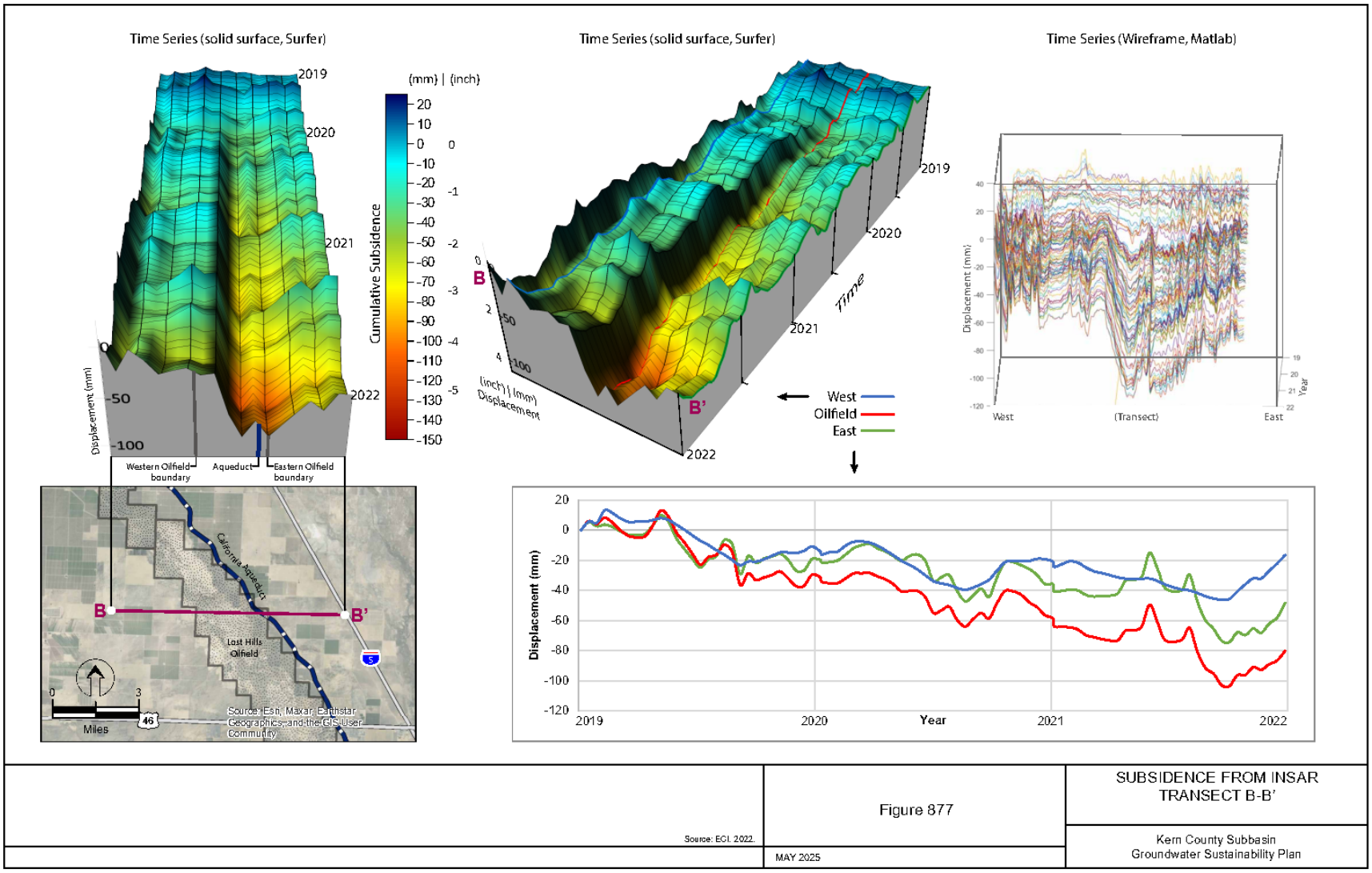


Figure 8-76. Time Series for AOI-2 Track B-B' Aqueduct Milepost 200

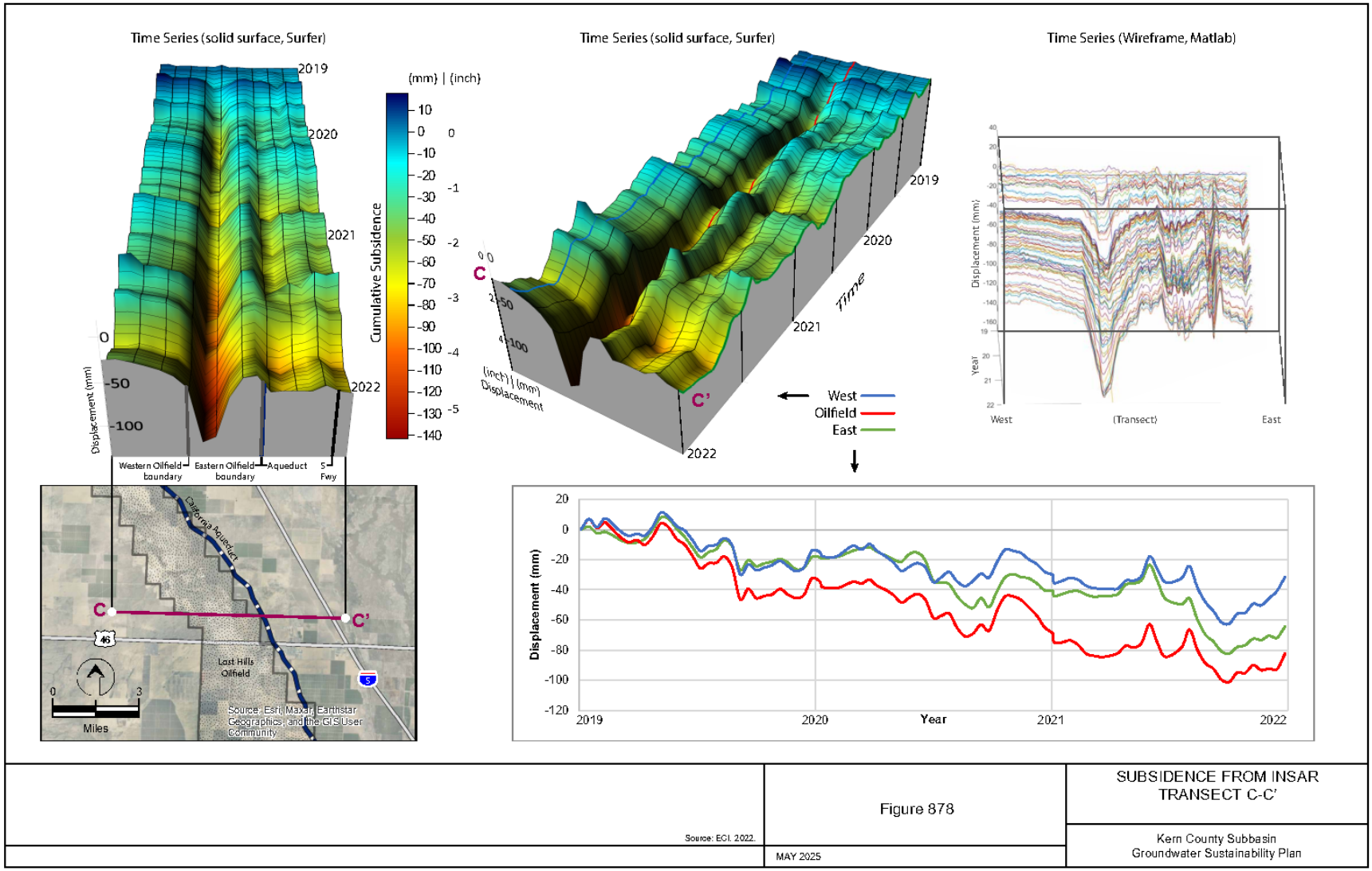


Figure 8-77. Time Series for AOI-2 Track C-C' Aqueduct Milepost 204

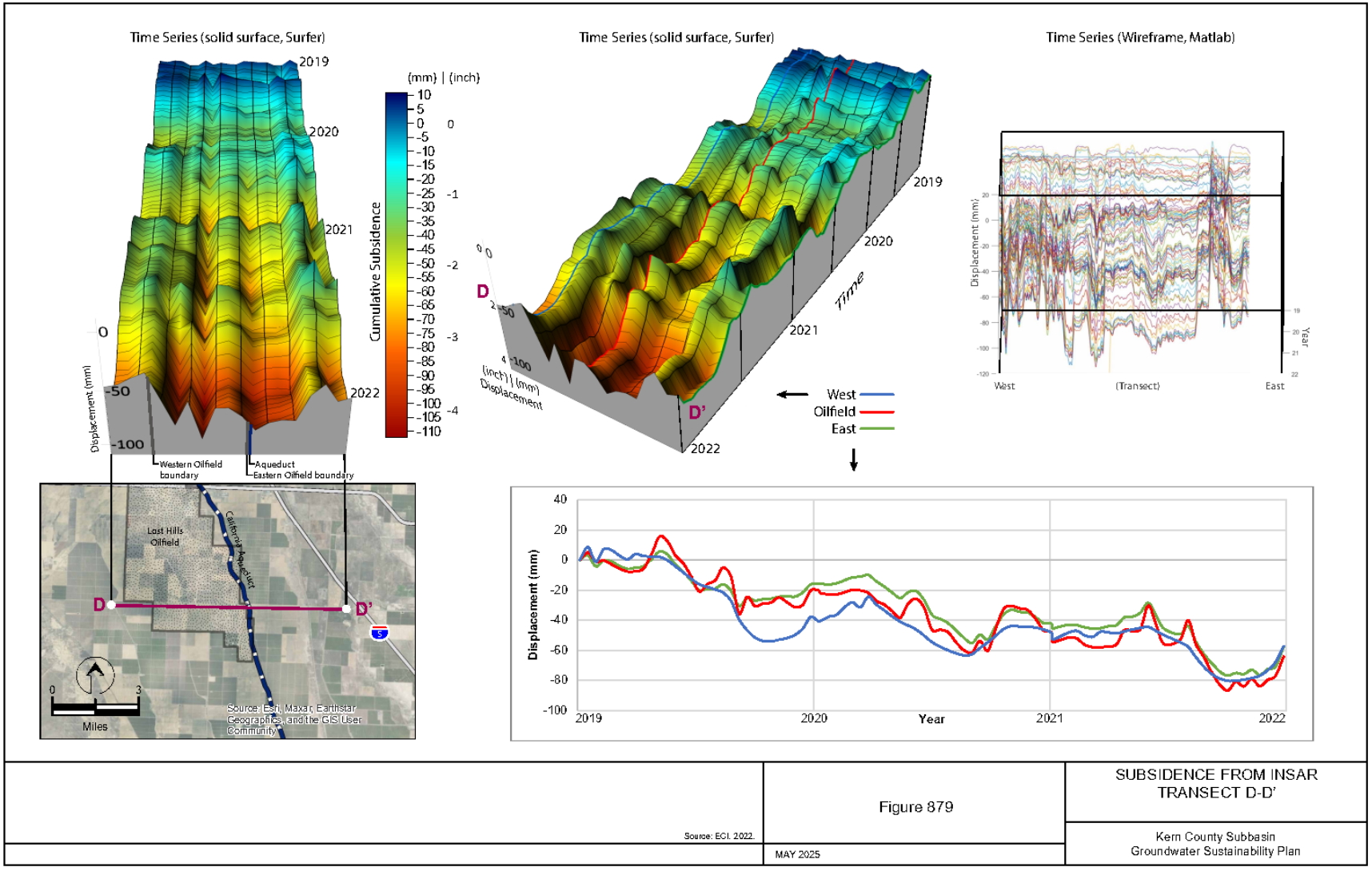


Figure 8-78. Time Series for AOI-2 Track D-D' Aqueduct Milepost 210

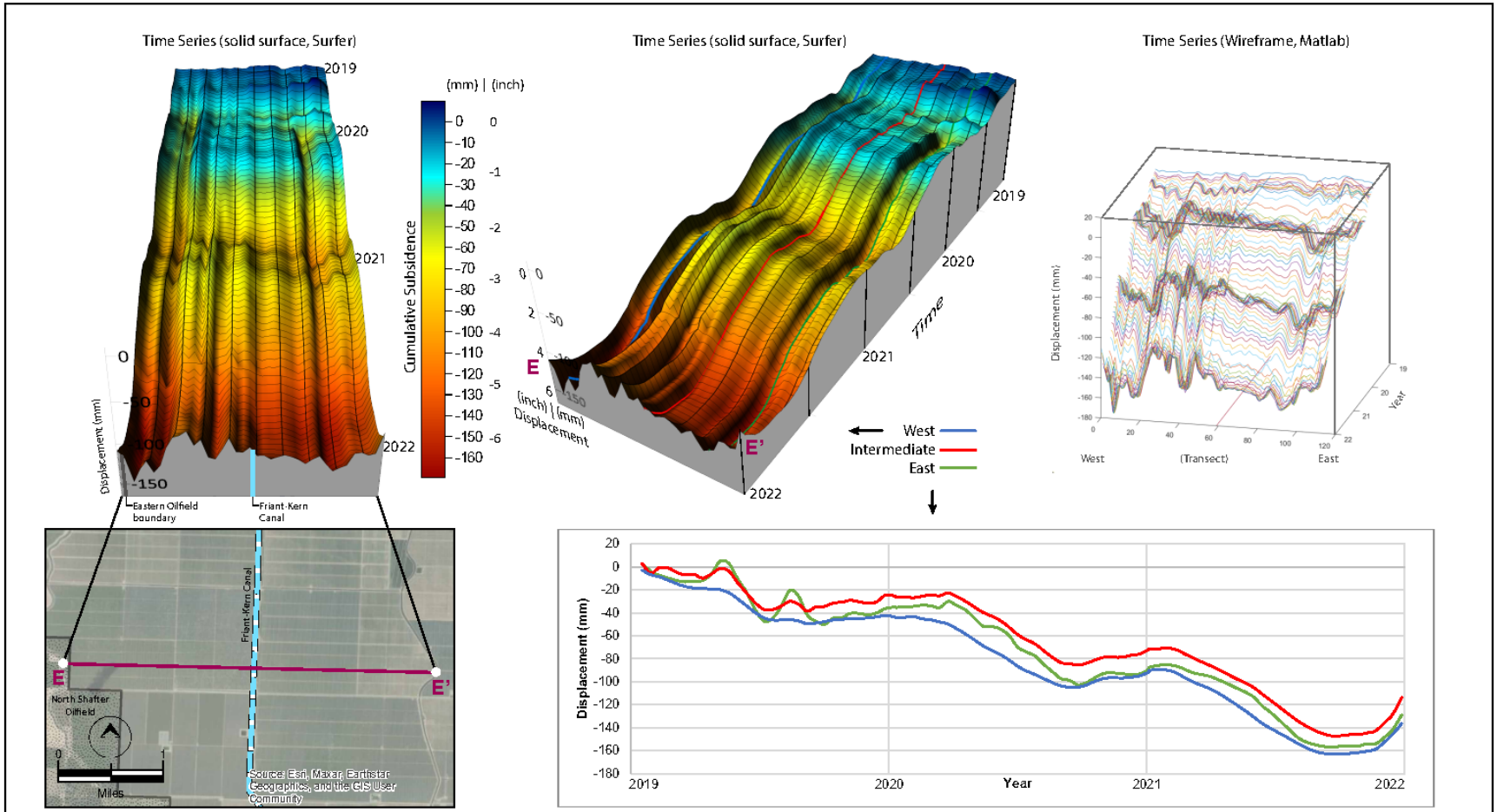


Figure 8-79. Time Series for AOI-3 Track E-E'

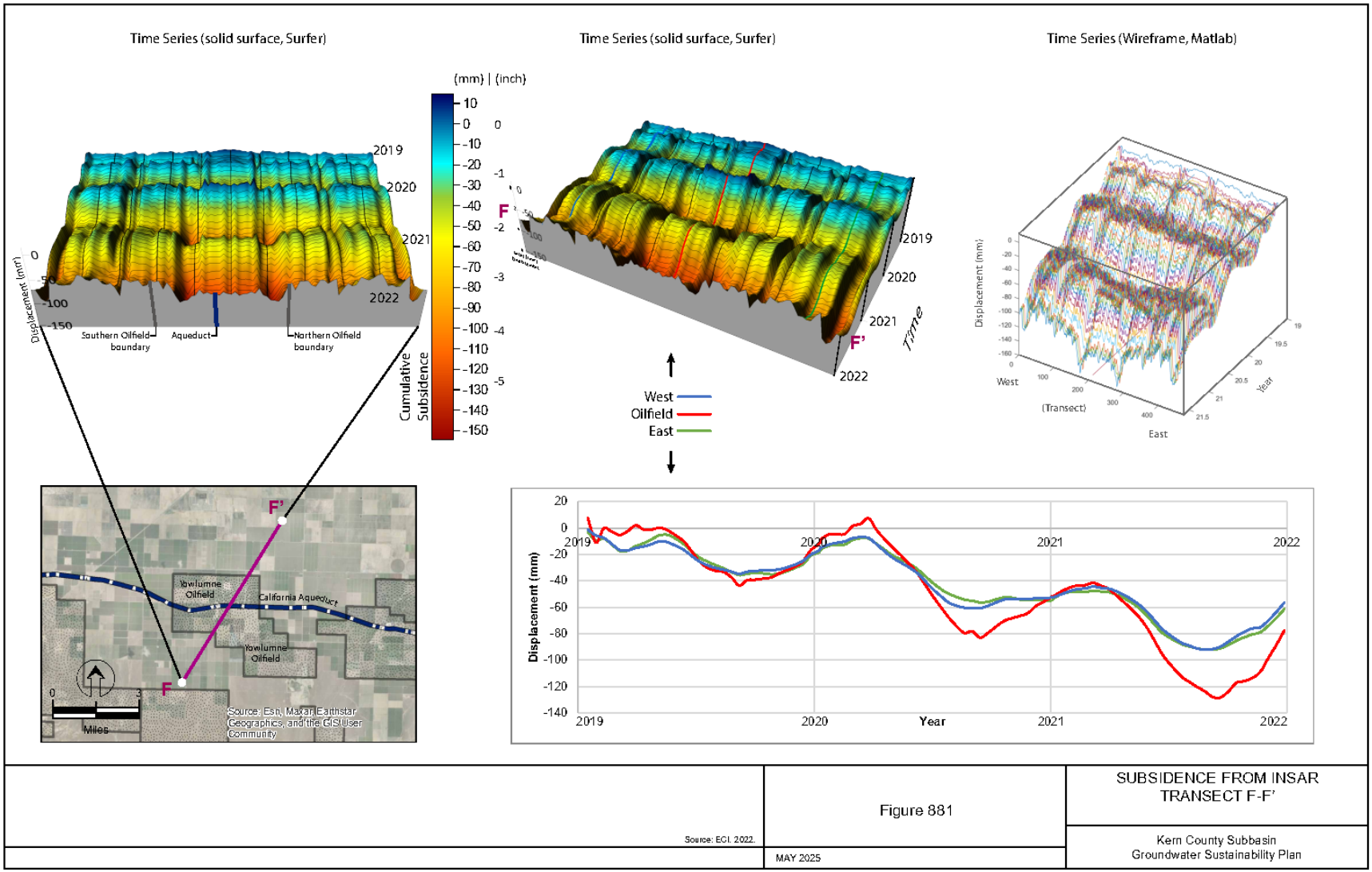


Figure 8-80. Time Series for AOI-4 Track F-F'

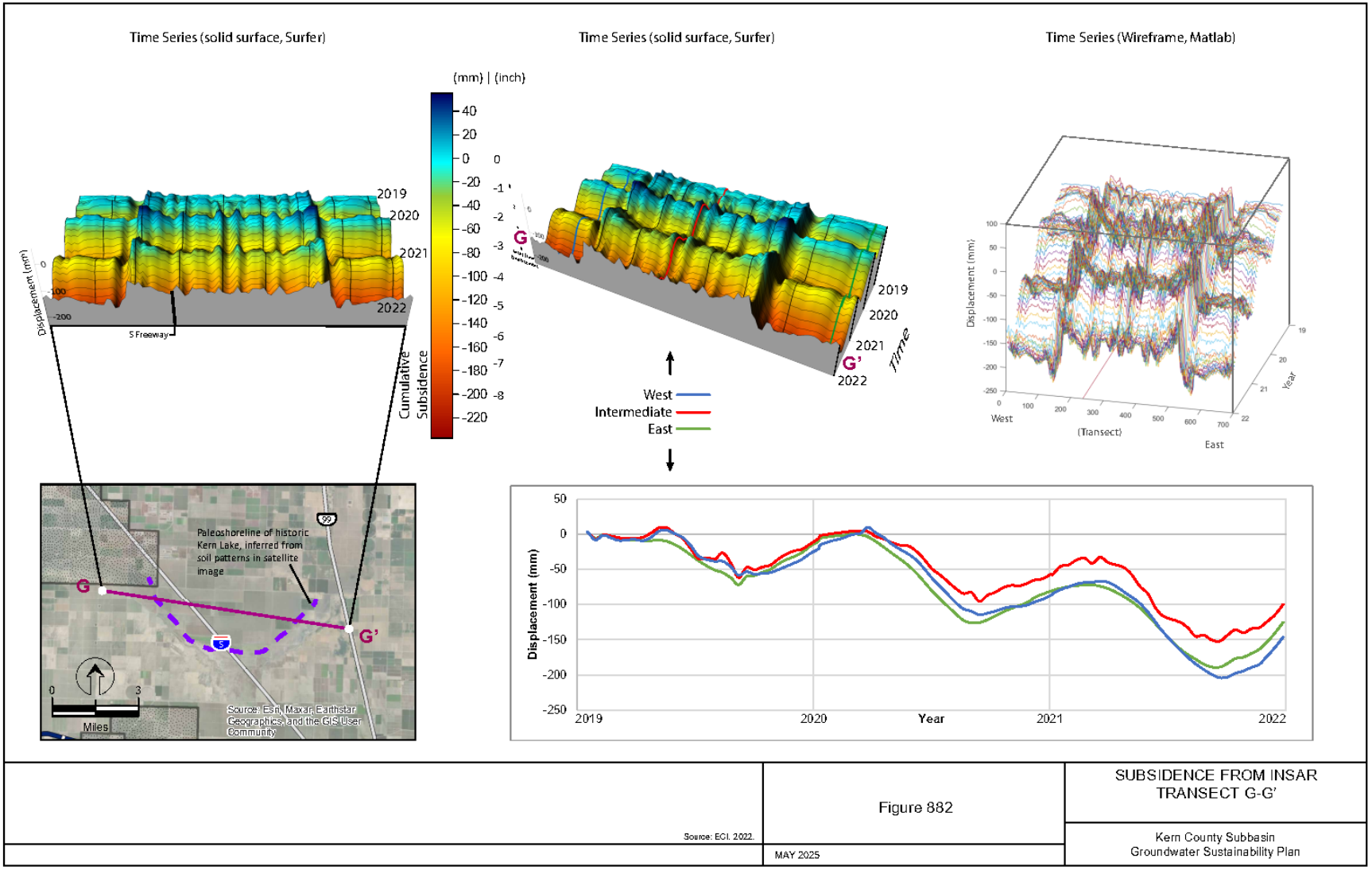


Figure 8-81. Time Series for AOI-4 Track G-G'

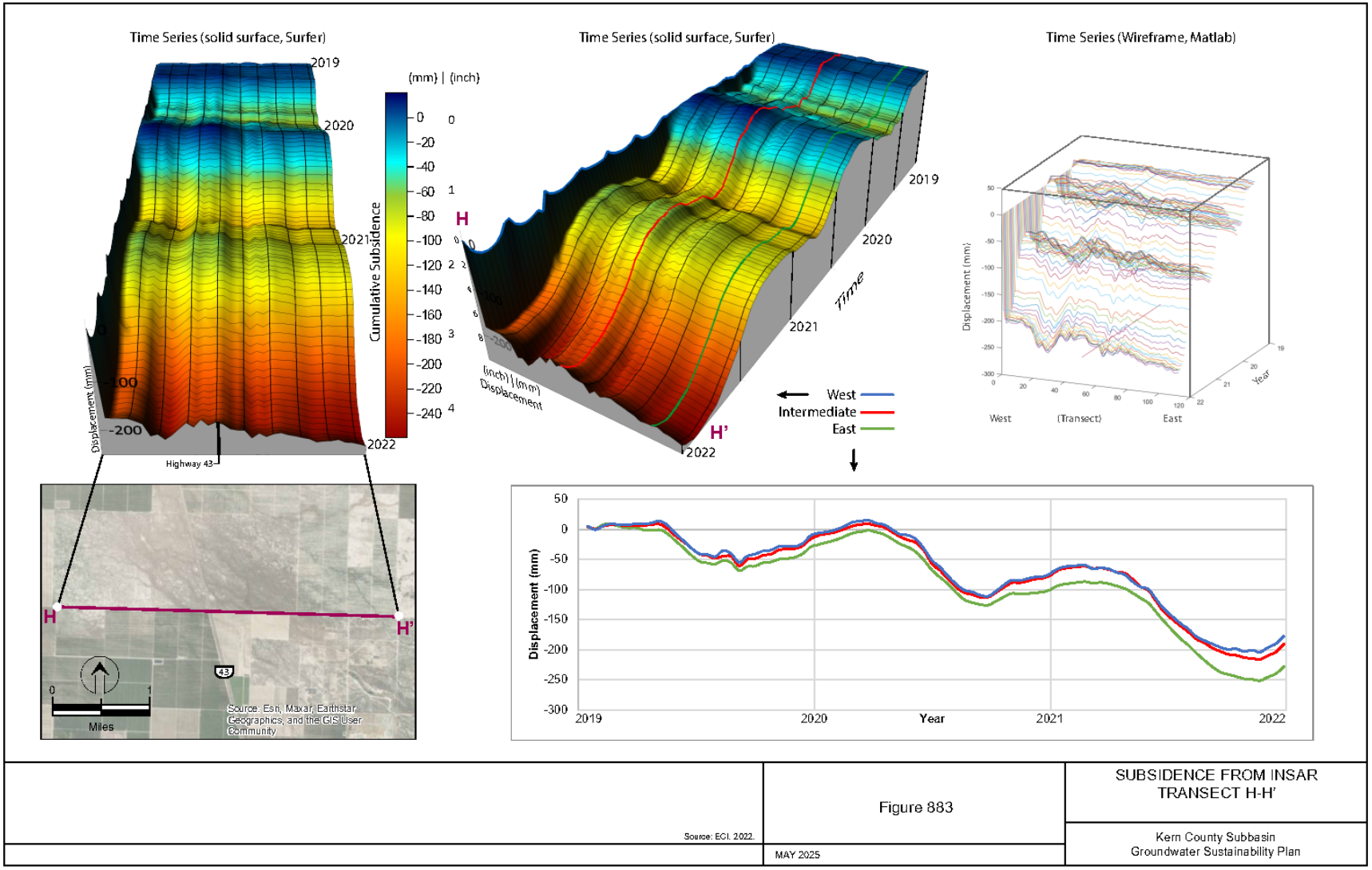


Figure 8-82. Time Series for AOI-5 Track H-H'

In response to SWP comments, and to further assess the validity of the conclusion that it is possible to differentiate between GSA and non-GSA activities using InSAR the Kern Subbasin conducted two other analyses. The subject analyses are discussed below.

Figure 8-83 and Figure 8-84 compare the time series subsidence patterns (relative elevation change through time) near the center (red-colored time series line on each subject time series transect). The sine-wave-like patterns in the agricultural areas are evident in all cases; and they are clearly defined by a repeating “up, down, up” seasonal pattern every year. The LHOF, in marked contrast, has a “busy” (i.e., energetic non-seasonal) subsidence pattern. The average of the former compared to the latter, including the range of standard errors of the average, demonstrates significant periods of no overlap between the two different patterns.

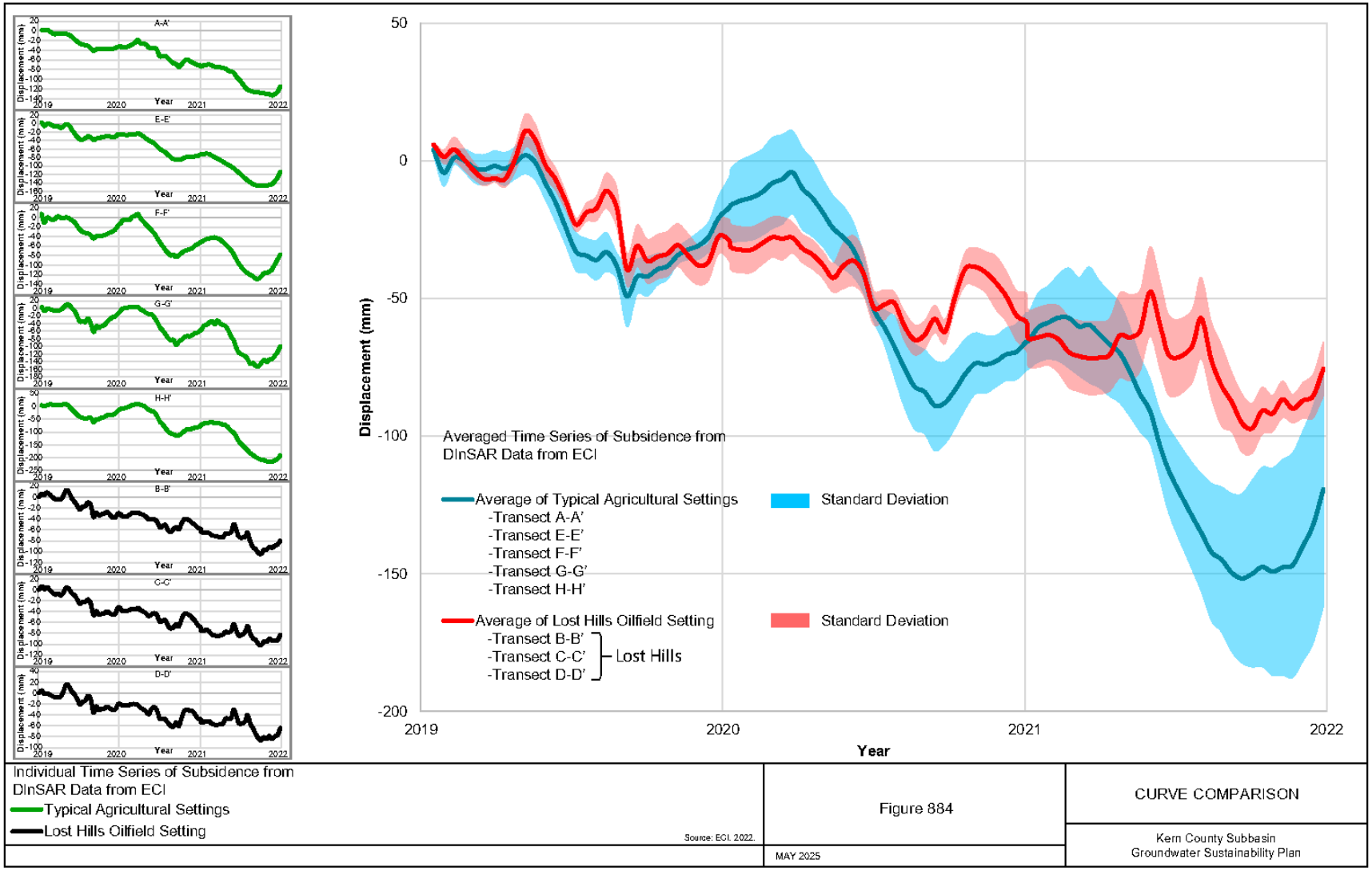
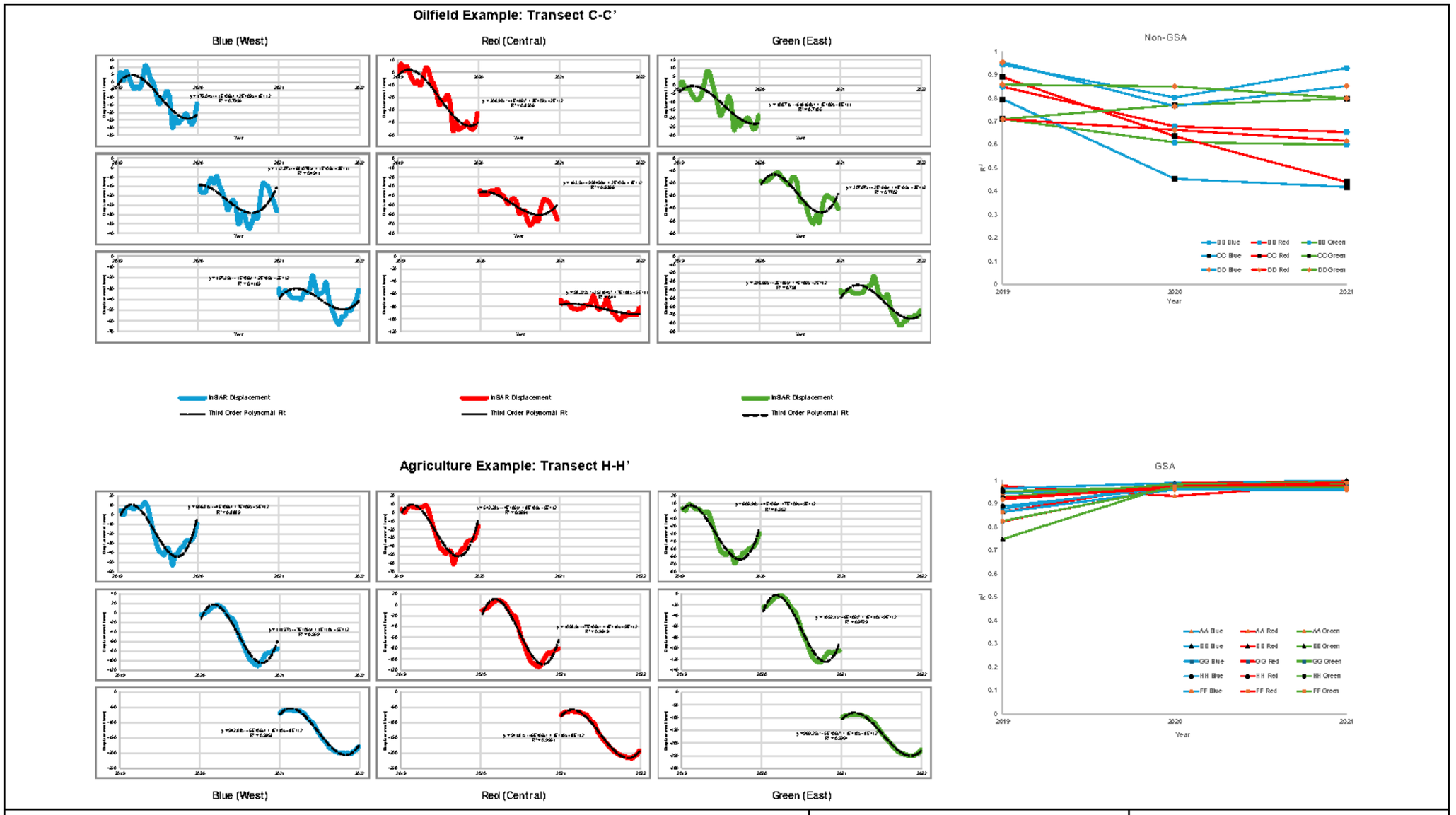


Figure 8-83. Curve Comparison

Figure 8-84 presents R^2 Values for GSA and Non-GSA Third Order Polynomial Models. When considered on a year-by-year basis, the agricultural area transect subsidence patterns can be modeled with third order polynomial functions. The agricultural area data are well-fit by the InSAR data with consistently high R^2 values (average 0.95 ± 0.05). The LHOF subsidence patterns, in marked contrast, are poor fits for third order polynomial models, with a lower average R^2 value of 0.73 ± 0.15. The agricultural area transects' subsidence patterns can be predicted with 95% confidence (two sigma) within a range of 0.16 between 0.84 to 1.0 ($2\sigma = 0.11$, R^2 does not exceed 1.0), whereas the LHOF R^2 values are only predictable with the same level of confidence within a much broader range of 0.56 between 0.44 and 1.0 ($2\sigma = 0.3$, R2 does not exceed 1.0). This contrast demonstrates again that it is possible to discern between GSA and non-GSA causes of subsidence with InSAR time series signatures.

These analyses further support the findings derived from the multiple available sources used by the Kern Subbasin and that these sources can assess the causes of subsidence in Kern County. However, additional InSAR analyses in coordination with CASP will be pursued to further investigate and build consensus on the disparate causes of subsidence. In keeping with the adaptive management framework central to GSP implementation, the Kern Subbasin is committed to ongoing coordination and collaboration with CASP and continuously refining the shared understanding of subsidence drivers as new data and tools become available.



Source: ECI, 2022.

Figure 885

MAY 2025

POLYNOMIAL REGRESSION ANALYSIS

Kern County Subbasin
Groundwater Sustainability Plan

Figure 8-84. Polynomial Regression Analysis

Going forward, as part of the coordinated approach for monitoring subsidence, the Kern Subbasin will conduct quarterly monitoring using DWR InSAR. The InSAR time series will, at a minimum, be extracted annually at the same current locations in all five AOIs or other areas as appropriate based on the quarterly monitoring data. These data will be supplemented by available MP benchmark survey data along the FKC and the Aqueduct, as discussed in Section 13. This approach, which has been developed in communication with CASP and Friant Water Authority staff, will enable the Kern Subbasin to assess future changes in subsidence magnitude. In addition, Appendix K-1 details the Action Plan for Land Subsidence that will be implemented in the event of a land subsidence IM/MT exceedance. As it pertains to the Aqueduct, quarterly calls will be held with CASP/DWR to discuss subsidence rates and trends.

8.6 Interconnected Surface Water Systems and Groundwater Dependent Ecosystems

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

☑ 23 CCR § 354.16(f)

GSP Regulations define interconnected surface water (ISW) as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted (California Code of Regulations Title 23). Groundwater Dependent Ecosystems (GDEs) collectively refer to plant, animal, and natural communities that rely on groundwater to sustain all or part of their water needs (TNC, 2018). GDEs occur in areas where groundwater either discharges to the surface (springs, seeps, or wetlands) or where the water table is sufficiently shallow to support natural communities. This includes vegetation with rooting depths sufficiently deep to draw a water supply from the underlying water table, referred to as phreatophytes. GDEs can occur along interconnected surface water but can also occur in any area where natural communities are supported by localized shallow groundwater conditions. However, the presence of riparian vegetation or wetlands does not necessarily indicate that they are GDEs.

DWR is developing a multi-paper series on ISW and depletions of ISW to provide GSAs with tools to better incorporate quantitative approaches in GSPs. The first white paper was released in February 2024 and focuses on the foundational concepts and definitions (DWR, 2024). The following discussion on ISWs aligns with these key terms. Two additional white papers, Techniques for Estimating Depletions of Interconnected

Surface Water and Examples of Approaches for Estimating Depletions of Interconnected Surface Water were released in October 2024. A final paper providing guidance for evaluating SMCs consistent with SGMA is expected in late 2025. The Kern Subbasin GSAs will review and incorporate this guidance when available for inclusion in future periodic evaluations.

The Kern Subbasin sustainability goal includes support for current and future beneficial users of groundwater, including the environment. Data and maps provided by DWR were used to support understanding of potential environmental reliance on groundwater. Specifically, the DWR's Natural Communities Commonly Associated with Groundwater dataset (hereafter referred to as the NCCAG or Natural Communities dataset) and ICONS: Interconnected Surface Water in the Central Valley developed by the Nature Conservancy (TNC) in collaboration with DWR to identify ISWs. Figure 8-85 shows the NCCAG data set for the Kern Subbasin.

NCCAG is a compilation of 48 publicly available State and Federal agency datasets that map vegetation, wetlands, springs, and seeps in California. To develop the NCCAG dataset, a working group composed of representatives from DWR, the California Department of Fish and Wildlife (CDFW), and The Nature Conservancy (TNC) reviewed the compiled datasets and conducted a screening process to exclude vegetation and wetland types less likely to be associated with groundwater and to retain types commonly associated with groundwater. Two habitat classes are included in the NCCAG dataset: (1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions; and (2) vegetation types commonly associated with the sub-surface presence of groundwater (phreatophytes). DWR notes that the data included in the NCCAG dataset do not represent DWR's determination of a GDE but are a starting point for identifying GDEs.

The NCCAG dataset includes mapped areas of vegetation and wetlands provided as polygons in GIS shapefiles, which also contain information on vegetation types and species. Data on rooting depths and local habitat are available in separate databases developed by TNC (TNC, 2018). The NCCAG maps were evaluated along with local groundwater conditions to identify potential interconnected surface water and GDEs. In this manner, the locations of current and potential future environmental uses of groundwater were estimated.

Table 8-31 summarizes the number of vegetation and wetland polygons in the NCCAG dataset for each HCM Area. There are a total of 1,832 vegetation polygons and 908 wetland polygons in the Kern Subbasin; these areas are shown on Figure 8-85. Most of these wetlands and vegetation areas occur near the Kern National Wildlife Refuge and along Poso Creek in the North Subbasin HCM Area and along the Kern River in the Kern Fan HCM Area. Additional polygons are mapped away from the major streams, consisting primarily of small local drainageways in the northeast and undeveloped areas in the south (Figure 8-85).

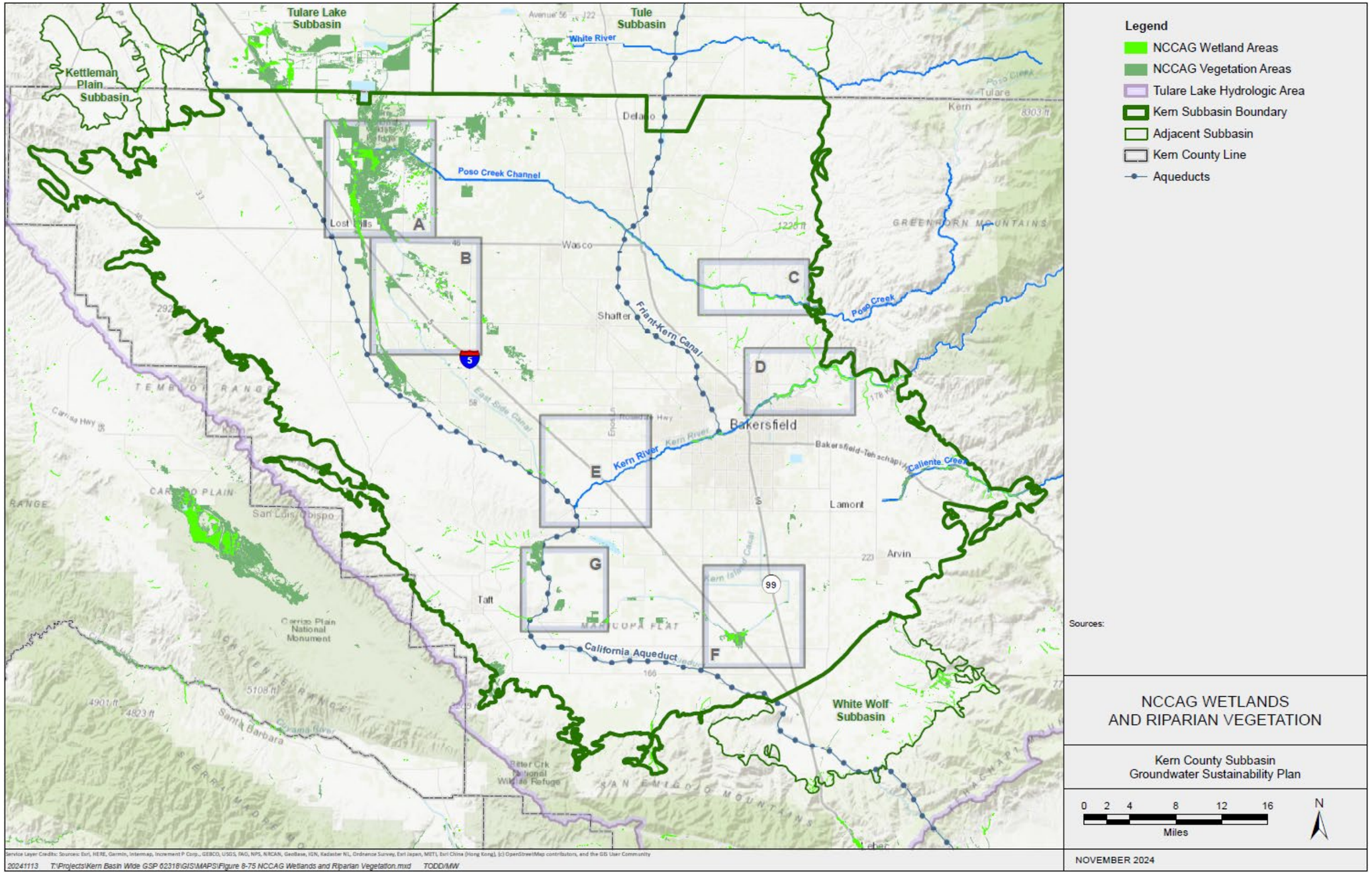


Figure 8-85. NCCAG Wetlands and Vegetation

Table 8-31. NCCAG-Mapped Natural Communities Polygons and Area by HCM Area

HCM Area	Vegetation		Wetlands		Total Natural Communities Areas	
	Number of Polygons	Acres	Number of Polygons	Acres	Number of Polygons	Acres
North Subbasin	1,101	34,287	332	1,539	1,433	35,826
Eastern Margin	282	1,953	208	435	490	2,388
Kern River Fan	123	684	62	139	185	823
South Subbasin	201	3,257	181	359	382	3,616
Western Fold Belt	125	5,389	125	144	250	5,533
TOTAL	**1,832**	**45,570**	**908**	**2,616**	**2,740**	**48,186**

The ICONS dataset, Figure 8-86 uses topographic and groundwater elevation information to assess whether surface water features may have been in hydraulic connection with groundwater at any point during the period from Spring 2011 through Fall 2018. The ICONS analysis uses a conservative estimate of interconnection in that it compares the minimum depth to groundwater during that period to the surface water elevation. Surface water is considered likely connected if the minimum depth to groundwater is less than 20 feet below the surface water elevation, likely disconnected if the depth to groundwater is greater than 50 feet below the surface water elevation, and uncertain for intermediate conditions. Figure 8-86 shows the identified areas of potential ISWs in the Kern Subbasin. Most of the surface water ways are categorized as likely disconnected (red) including the Kern River and Poso Creek. There are localized areas categorized as likely connected- in the North HCM Area along Goose Lake Channel and in the Kern Fan HCM Area near banking facilities. These areas are discussed further in their respective HCM Area discussions.

The NCCAG and ICONS datasets were used to identify potential ISWs, areas with mapped riparian vegetation and wetlands in NCCAG or indicated to be potentially connected or unknown in ICONS. Figure 8-85 and Figure 8-86 show the location of seven potential ISWs, labeled A-G. Each one is discussed in more detail below. All seven locations were evaluated based using geologic data, water levels, and the well inventory. All seven were found to not be connected to the saturated groundwater aquifer at any point in time.

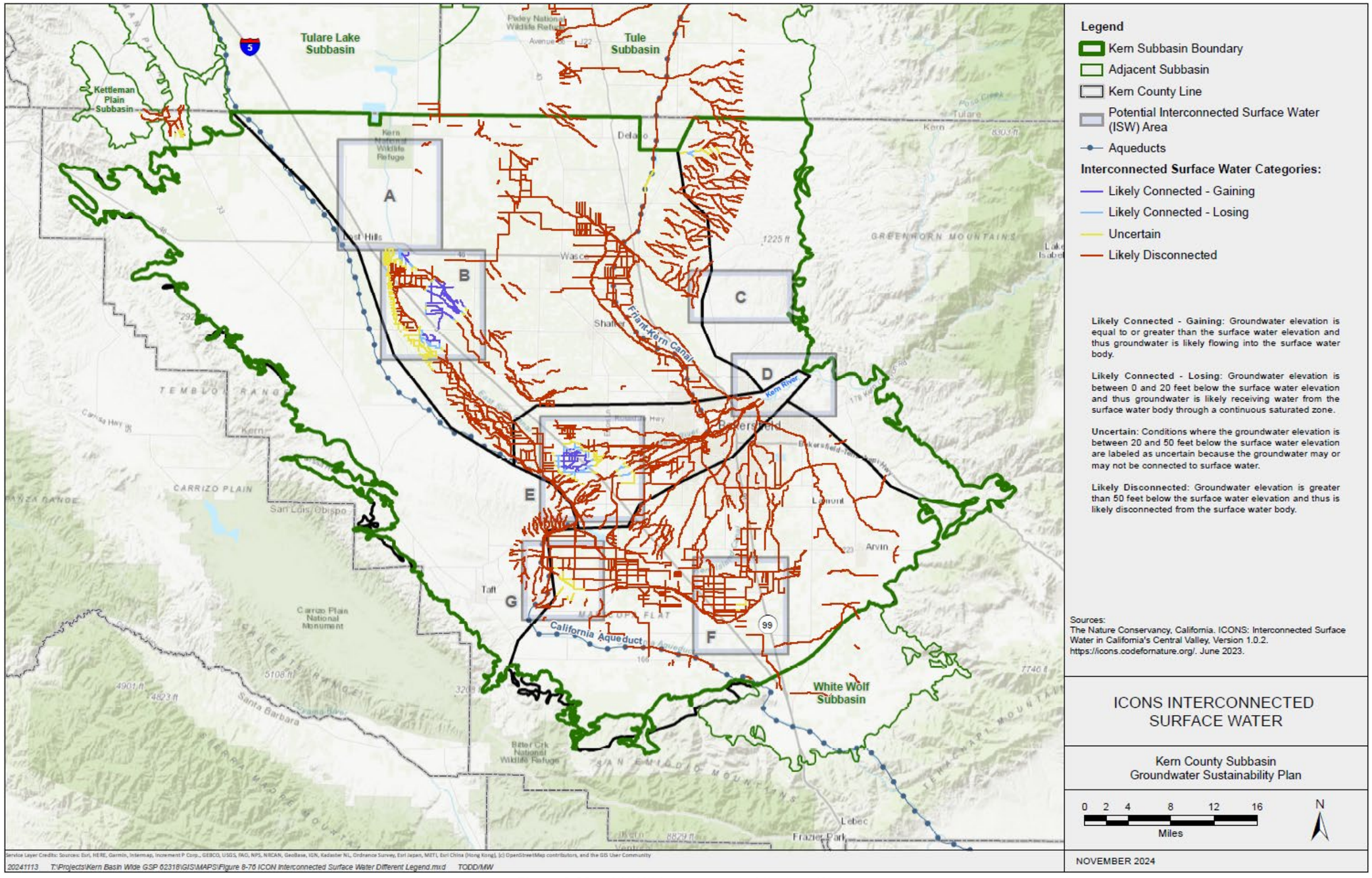


Figure 8-86. ICONS Interconnected Surface Water

8.6.1 North Subbasin HCM Area

In the North Subbasin HCM Area the major surface water features include Poso Creek, the Kern River Flood Canal, and the Goose Lake Canal, each of which flow toward the topographically low Kern National Wildlife Refuge area. In the North Subbasin HCM there are private wetlands that are located in areas of localized shallow groundwater conditions that are not connected to the principal aquifer (Section 8.1.1.6). These private wetlands are maintained by water pumped through groundwater wells screened in the principal aquifer. Many of these wetlands are not included in the NCCAG dataset and not defined as ISWs. As shown in Figure 8-87 and Figure 8-88 there are two potential ISWs in the North Subbasin HCM Area. Box A shows the Kern National Wildlife Refuge, which has mapped riparian vegetation and wetlands in the NCCAG dataset and Box B shows an area of the Goose Lake Channel that was indicated as likely connected in the ICONS dataset. Both of these areas are disconnected from the principal aquifer by a shallow clay lens (A-Clay). The surface waterways are not hydraulically connected at any point to the continuous saturated zone, as shown in Figure 8-87, which shows the extent shallow perched groundwater areas, described in Section 8.1.1.6, with respect to the potential ISWs. This area was mapped by KCWA based on historic data 232 shallow wells to delineate perched groundwater underlain by the shallow A-Clay or equivalent clay layers, less than 60 feet from the surface. The A-Clay is described in more detail in Section 7.2 describes the depth to groundwater for the shallow perched zones.

In the ICONS dataset, the minimum depth to groundwater in this area is shown as less than 10 feet below ground surface, this condition is not typical; the ICONS dataset shows that the average depth to groundwater in this area is greater than 100 feet below ground surface (ICONS, 2024). This indicates that the perched groundwater is likely transitory and infrequent. Figure 8-88 shows the surficial geology under the areas of potential ISWs are recent basin deposits and lake deposits. These recent basin deposits (orange) and lake deposits (brown) largely overlay the Alluvial Fan Deposits (beige) and contribute to the formation of the shallow clay layers that separate the perched zone from the principal aquifer. The two specific locations are discussed in detail below.

8.6.1.1 Kern National Wildlife Refuge

The Kern National Wildlife Refuge, shown as potential ISW Box A, is part of the network of 15 national wildlife refuges and wildlife management areas in California's Central Valley and San Francisco Bay region that provide wintering habitat for migratory waterfowl and other waterbirds in the Pacific Flyway. The refuge was established in 1958, originally as the Mariposa National Wildlife Refuge. The refuge is now comprised of 6,400 acres of wetlands sustained completely by imported surface water typically wheeled from the California Aqueduct and conveyed by the Goose Lake Canal to the refuge (USFS, 2005). The refuge does not rely on groundwater. As such, the wetlands and vegetation within the refuge are not considered GDEs.

8.6.1.2 Goose Lake Canal

The Goose Lake Canal and Jerry Slough are conveyances used to transport surface water. Although there are additional mapped vegetation areas along these conveyances and identified areas of connected ISWs in the ICONS dataset, these areas are sustained through surface water deliveries or isolated perched water and do not rely on saturated groundwater.

The ICONS dataset shows that a small portion of the Goose Lake Canal, approximately 2 to 3 miles long, is classified as likely connected (to groundwater). Ephemeral wetlands covered by water seasonally are likely to be supported by irrigation deliveries and precipitation and are unlikely to be surface expressions of groundwater. As noted, the Kern National Wildlife Refuge is now sustained by imported surface water (USFS, 2005). Other features having the potential to provide habitat, such as groundwater recharge basins that are artificially flooded with surface water, also depend on diversion of surface water rather than a shallow groundwater table.

This potential ISW, Box B, is located in the northern portion of the BVGSA. BVGSA has installed over 40 piezometers to monitor the perched groundwater zone. They have also developed a separate shallow groundwater area plan for the Central Valley Regional Water Quality Control Board (RWQCB) Irrigated Lands program and designated this area as a separate system from the saturated groundwater aquifer. As part of their Groundwater Quality Management Plan, BVWSD documented this Shallow Water High Vulnerability Area. The plan described the area as characterized by the presence of a perched zone, with the water table very shallow, 2 to 12 feet deep, flat, featureless, and largely unchanged from year to year (BVWSD, 2016). This description is consistent with a perched zone above the A-Clay that is disconnected from the principal aquifer.

The well inventory was used to determine if there were domestic wells drilled in the shallow perched zone. One well located in Semitropic Water Storage District shows a screened interval of 59 to 95 feet below ground surface and was drilled in 1959. This well is likely pumping below the A-clay (generally less than 60 feet) and the perched zone is unlikely to provide adequate supply. However, Semitropic has a PM/A to further investigate ISWs in their area and this well should be assessed to confirm the well is pumping from the saturated groundwater aquifer and not the perched zone.

8.6.2 East Margin HCM Area

In the Eastern Margin HCM Area, groundwater is primarily pumped from the Olcese Sand and the Santa Margarita Formation, which are deep, confined aquifers typically encountered several hundred to over one thousand feet below ground surface. Surface water flows are therefore disconnected from groundwater of the primary aquifers due to the presence of a thick vadose zone and/or the presence of confining finer-grained units above the primary aquifers. The ICONS dataset shows no areas of likely connected surface water in the Eastern Margin HCM Area.

The NCCAG dataset shows some riparian vegetation along Poso Creek, Box C on Figure 8-90 and limited sections of certain surface water features classified as NCCAG wetland areas. A review of aerial imagery for potential GDEs in the Eastern Margin HCM Area indicates that some may be related to residual vegetation established during historical discharge of produced water to ponds associated with oilfield operations, as opposed to shallow, naturally occurring hydrologic interaction between groundwater and surface flows.

Given the large depths to groundwater in the principal aquifers and the thick confining units, these areas are likely to be dependent on either ephemeral perched groundwater or wastewater discharges unrelated to naturally occurring groundwater at the surface and are therefore unlikely to be impacted by pumping from principal aquifers. As such, there are no GDEs or interconnected surface waters in the Eastern Margin HCM Are

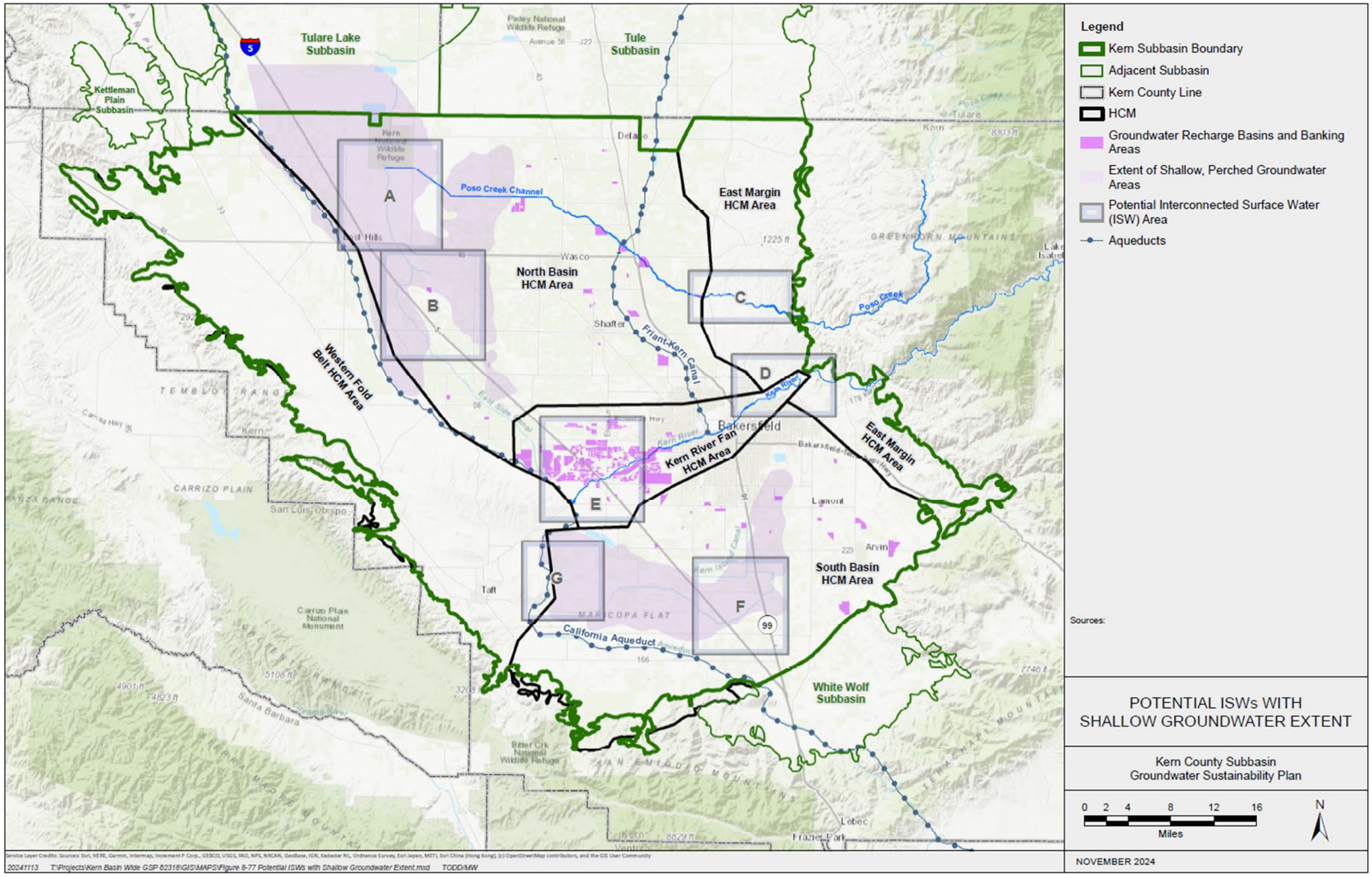


Figure 8-87. Potential ISWs with Shallow Groundwater Extent

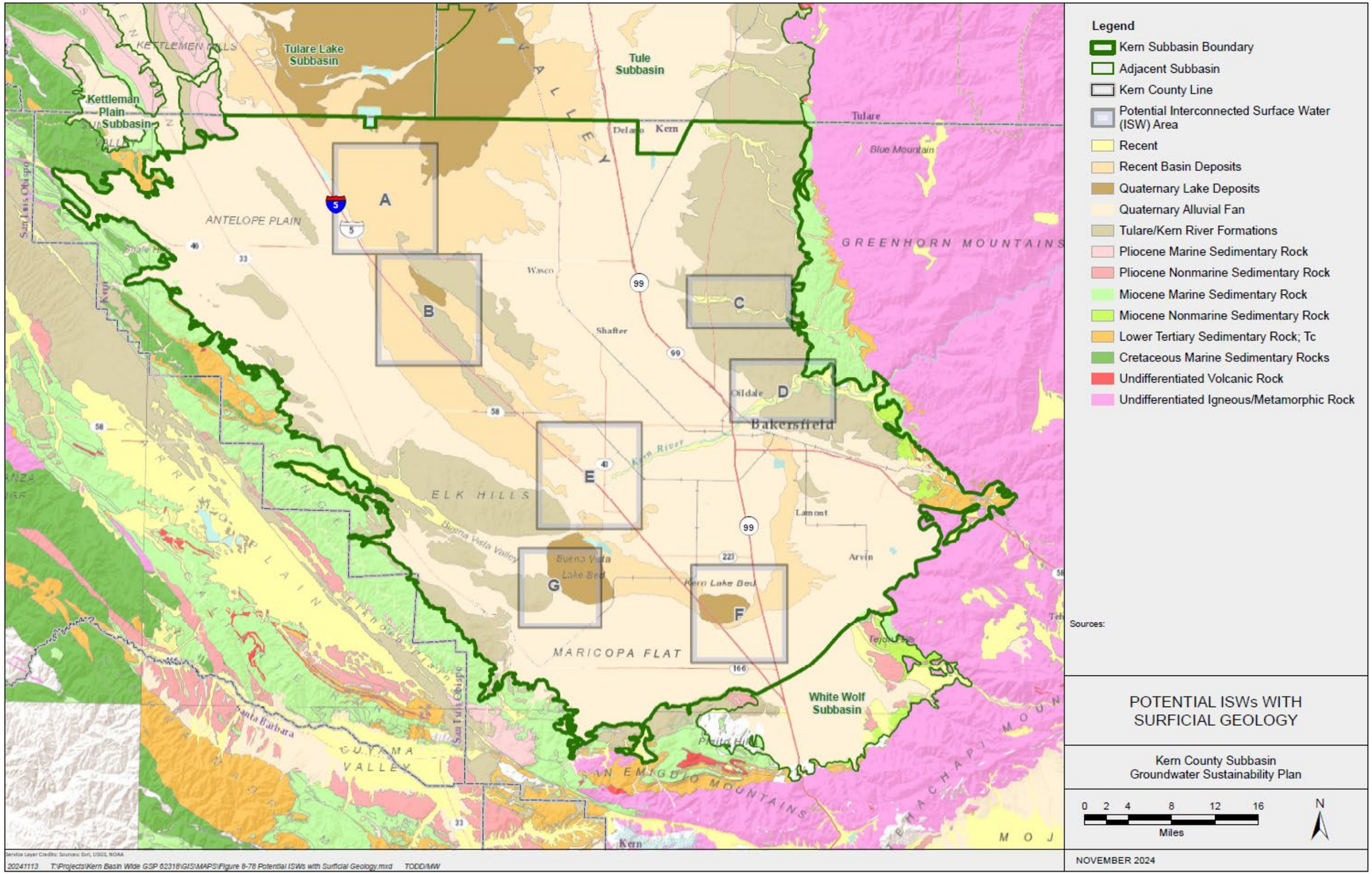


Figure 8-88. Potential ISWs with Surficial Geology

8.6.2.1 Poso Creek

The NCCAG dataset shows riparian vegetation along the eastern portion of Poso Creek, Box C on Figure 8-85, and is included as a potential ISW. Poso Creek is an intermittent stream that flows from east to west across the North Basin HCM Area. The average annual volume of flow for Poso Creek ranges from zero in dry years to 110,990-acre feet in WY 1998 (based on the USGS Poso Creek near Oildale gage). Poso Creek is a losing stream across the area that acts as a major recharge area to the underlying groundwater aquifer.

The area of riparian vegetation along Poso Creek in the Eastern Margin is likely the result of temporarily stored water in perched zones. Figure 8-88 shows the geologic map (introduced in Section 7) with respect to potential ISWs. For Poso Creek, Box C, the recent alluvium (yellow) overlies the Tulare/ Kern River formation (tan) and likely serves to hold disconnected perched groundwater feed by surface water flow.

The well inventory shows limited pumping wells in the eastern portion of the creek. Most are drilled and screened below 250 feet below ground surface and in the Tulare/Kern River Formation. One unverified well has a top of screened interval at 120 feet, while still likely below the perched zone should be confirmed it is in the correct location and screen in the Tulare/Kern River Formation. This is confirmed with all available well completion reports in the area. These 49 well completion reports showed all but screened below 70 feet, the outstanding well did not have screened interval information.

Depth to groundwater along Poso Creek are well below the creek bottom as demonstrated by hydrograph of Well 6C, one of the few active wells in the area (Figure 8-89). Water levels in Spring of 1998 and 1999, historic high groundwater levels. Despite, remained hundreds of feet below ground surface, d 1998 being classified as a wet year having nearly 16 inches of precipitation. Within the HCM Area groundwater is very deep, ranging from 200 to greater than 500 feet below ground surface. Groundwater is deeper with proximity to the eastern foothills and becomes shallower in the western portion of the HCM Area. Within the eastern extension of the GSA, groundwater is deepest in the northern portion, representing the eastern foothills, and becomes shallower approaching the Kern River to the south of the HCM Area. elevation profiles developed along Poso Creek. Figure 8-90 illustrates the substantial vertical separation between Poso Creek and the water table throughout the entire stretch of Poso Creek within the Cawelo GSA in 1998, 2013 and 2017. The extrapolated levels were taken from seasonal groundwater contour maps of the area. Groundwater contours maps are included and described in Section 8.1.1.3 and included as Figure 8-4. Groundwater elevations were hundreds of feet below Poso Creek during this time and there was no baseflow into Poso Creek. Therefore, groundwater is not hydraulically connected to Poso Creek within the HCM Area. Poso Creek is also categorized as likely disconnected from groundwater based on the ICONS dataset.

8.6.2.2 Kern Fan HCM Area

For the Kern Fan HCM Area, there are two potential ISWs. Box D shows the Kern River as it enters the basin where there is mapped NCCAG vegetation and wetland areas are along the Kern River as shown in and Box E shows potential connection in the ICONS dataset near the Kern Fan Projects along man-made canals and recharge basins, Figure 8-86.

The Kern River is a heavily managed system. Surface water flows and losses in the river channel and along the network of adjacent unlined canals are monitored to allocate river water diversions by surface water rights holders, and data are published in annual hydrographic reports prepared by the City of Bakersfield on behalf of the Kern River Watermaster. Operations and management of the Kern River by the City of Bakersfield, including measurements along the channel from First Point to Second Point, have demonstrated that the Kern River is a losing stream across the Kern Fan HCM Area.

8.6.2.3 Upper Kern River

Potential ISW D is where the Kern River enters the Kern Subbasin. Similar to Poso Creek, this portion of the river has riparian vegetation as the result of temporarily stored water in perched zones. Figure 8-88 shows the geologic map in the potential ISW. The recent alluvium (yellow) overlies the Tulare/ Kern River formation (tan) and Alluvial Fan Deposits (beige) and likely serves to hold disconnected perched water feed by surface water flow. A comparison of stream gage data upstream between First Point and Isabella Dam (40 miles upstream of First Point) shows that groundwater is likely contributing to baseflow somewhere along this reach (accounting for Kern River tributary flow), indicating some interconnected surface water. Although the exact location of these contributions could not be determined, the analysis suggested that they are more likely to occur outside of the Subbasin boundary in the Kern River Canyon as evidenced by the presence of local springs. Olcese GSA added ISW monitoring to its PMAs and has recently constructed a well close to the Kern River near First Point. The location of the well and its hydrograph is shown on Figure 8-91. The well is completed in the recent alluvium, screened 55 to 155 feet below ground surface. Shallow water levels are connected to the Kern River but not to the underlying principle aquifer. The well will continue to be monitored to identify any potential interconnection between the groundwater and surface water at this location.

From the well inventory, most domestic wells in this area are screened 200 feet below ground surface in the principal aquifer. One well in the Olcese Water District is recorded as screened 18 feet to 48 feet below ground surface, drilled in 1967. This well has not yet been verified but should be investigated to confirm it is not pumping from the recent alluvium.

The Kern River channel, along with adjacent recharge basins and unlined canals, is used extensively to support managed aquifer recharge operations in the Kern Fan HCM Area. The Kern River not identified as a potential ISW by the ICONS dataset but riparian vegetation is present on the NCCAG maps. Flows in the Kern River include regulated releases from Isabella Reservoir, as well as surface water and imported water that is intentionally released into the channel for water banking and/or replenishment of groundwater to support local wellfields.

Managed diversions from the Kern River typically create low flow conditions or dry reaches in certain portions of the channel. According to an evaluation of the river's biological resources, the relatively short reach of the river from First Point to Calloway Weir supports the most extensive, vigorous, and biodiverse riparian habitat of the river within the Kern Fan HCM Area (City of Bakersfield, 2012). The reach includes portions of the Kern River Parkway and the Panorama Vista Preserve. Habitat includes stands of mature cottonwood-sycamore riparian forest, the most continuous riparian corridor in the HCM Area, and the greatest diversity of riparian trees and shrubs (City of Bakersfield, 2012). Between 1970 and 2010, about 80 percent of the flow at First Point was diverted above the Calloway Weir, located in the northeastern portion of the City of Bakersfield (DBS&A, 2012). Since most of the Kern River flow is diverted above the weir, the river below the weir has significantly less flow volumes.

During the period from 1970 to 2010, the river was dry at the Calloway Weir for an entire year for more than 25 percent of the years, indicating that the Kern River is often dry downstream of the Calloway Weir. In addition, if periods of very low flow are also considered, then little to no flow occurs downstream of the Calloway Weir for almost one-half of the time. During years with relatively low total flows, the river would have produced very few discharge events to sustain a wet channel very far downstream. Given that natural surface water flows in the Kern River channel downstream of the Calloway Weir are near zero for long periods (months to years), the river below the weir is not interconnected surface water.

At Rocky Point Weir, the unlined Carrier Canal is used to divert Kern River water for agricultural use. The Carrier Canal runs parallel to the river before turning south at the Calloway Pool. Flow measurements on the river and the canal indicate that this entire reach from Rocky Point Weir to the Calloway Weir is a losing stream. Recharge at the Calloway Pool and along the Carrier Canal is recorded in annual hydrographic reports.

Flow from the Kern River recharges the groundwater basin and high flow on the river results in increased water levels. Figure 8-92 shows the Kern River flow (measured at First Point) compared with RMW-025. This RMW well is located within 0.5 miles of the river and is screened at 300 feet bgs. The top of the well screen is relatively shallow and capable of measuring the local water table (i.e., when water levels are low, the water table is below the top of the screen). Figure 8-92 shows increased groundwater elevations following high river flows, but river flow is not diminished over time as

groundwater levels have declined during drought conditions. The Kern River contributes flow to the aquifer but is not impacted by groundwater elevation well below the channel.

In addition, a groundwater elevation profile developed for each annual spring map is plotted on Figure 8-93 in relation to the ground surface elevation. The profiles are color-coded according to DWR Indices for the San Joaquin Valley water year type, which are not always coincident with water year type in Kern County. The extrapolated levels were taken from seasonal groundwater contour maps of the area. Groundwater contours maps are included and described in Section 8.1.1.3 and included as Figure 8-4. Although the large number and crisscrossing nature of the profiles make it difficult to follow any single profile, the clustered nature of the data provides a method of viewing a wide range of spring water levels over 20 years beneath the river. The range of groundwater elevations and the amount of groundwater separation from the ground surface can be readily seen on Figure 8-93 regardless of the year type or the actual year. The profiles on Figure 8-93 suggest that groundwater elevations occur well below the entire reach of the Kern River within the HCM Area throughout the 20-year Study Period and indicate an absence of interconnected surface water.

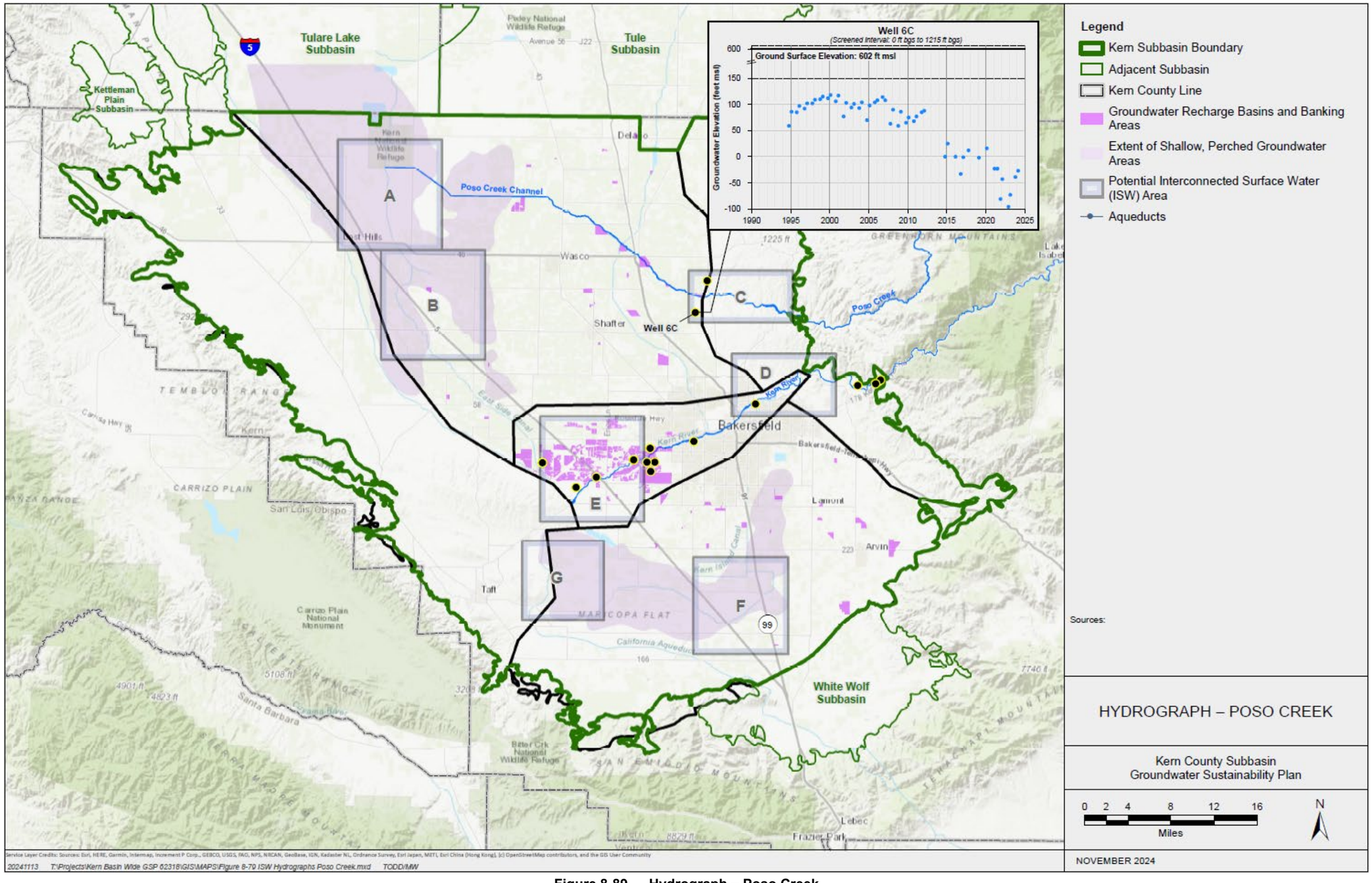


Figure 8-89. Hydrograph – Poso Creek

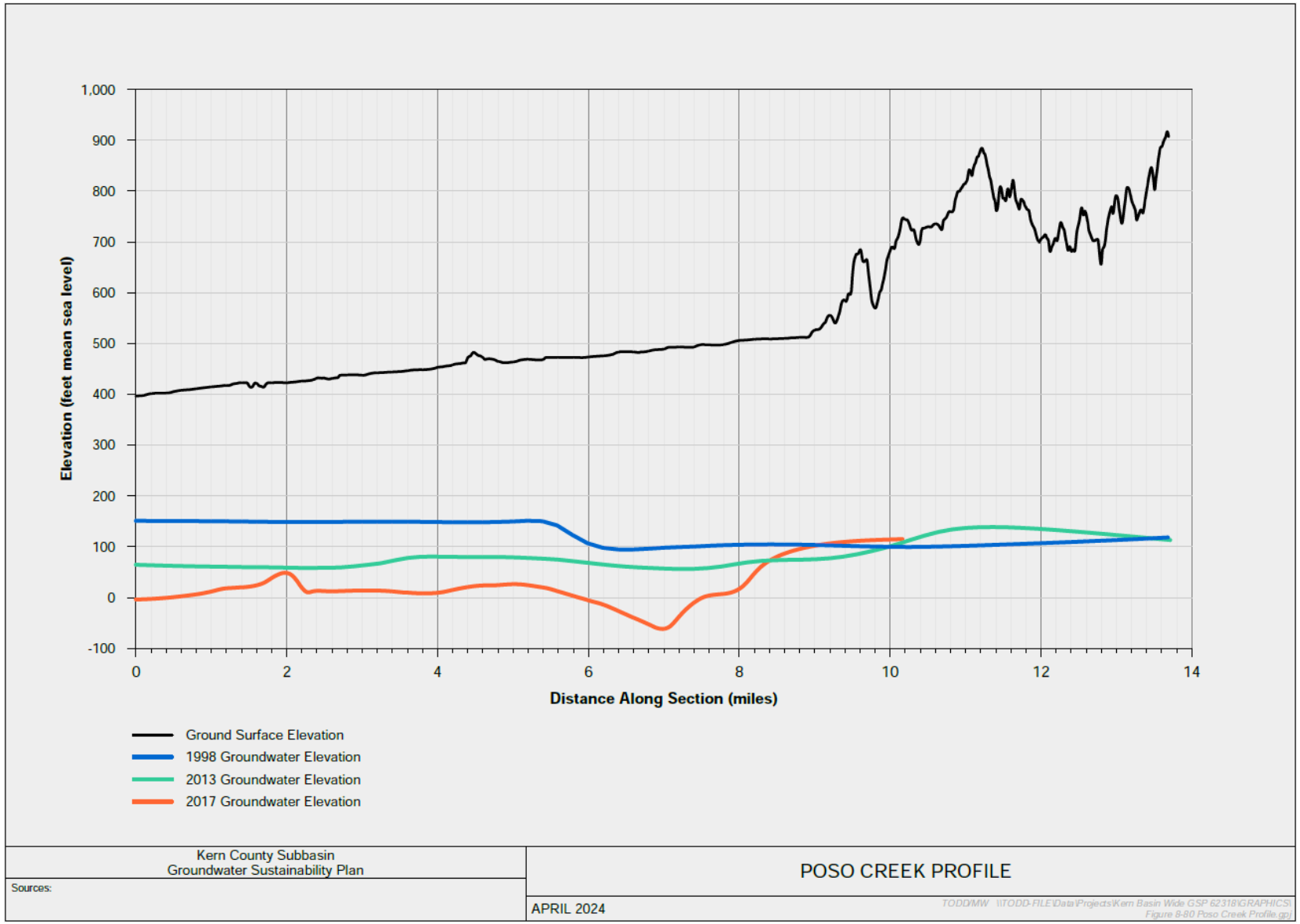


Figure 8-90. Poso Creek Profile

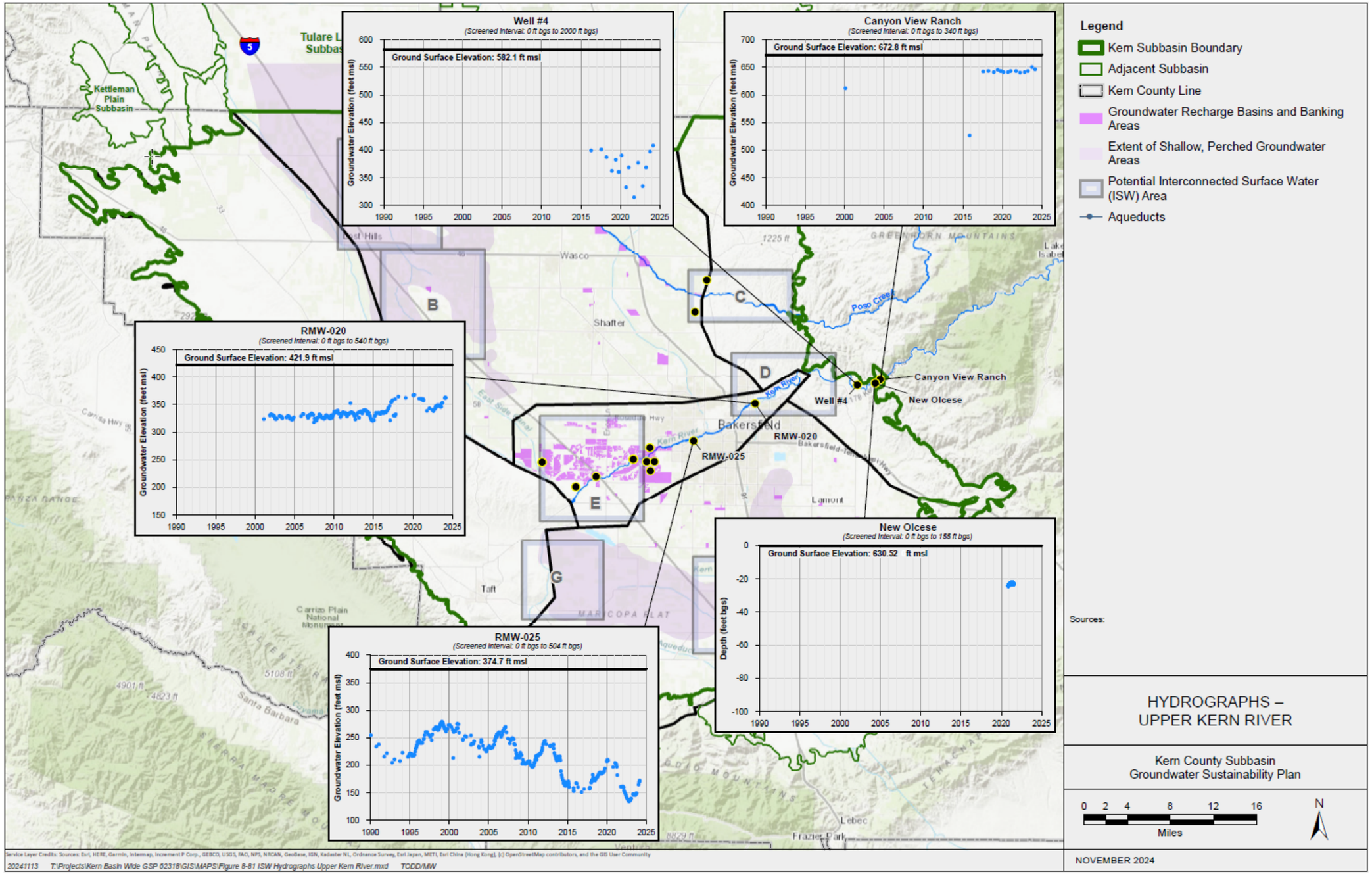


Figure 8-91. Hydrographs – Upper Kern River

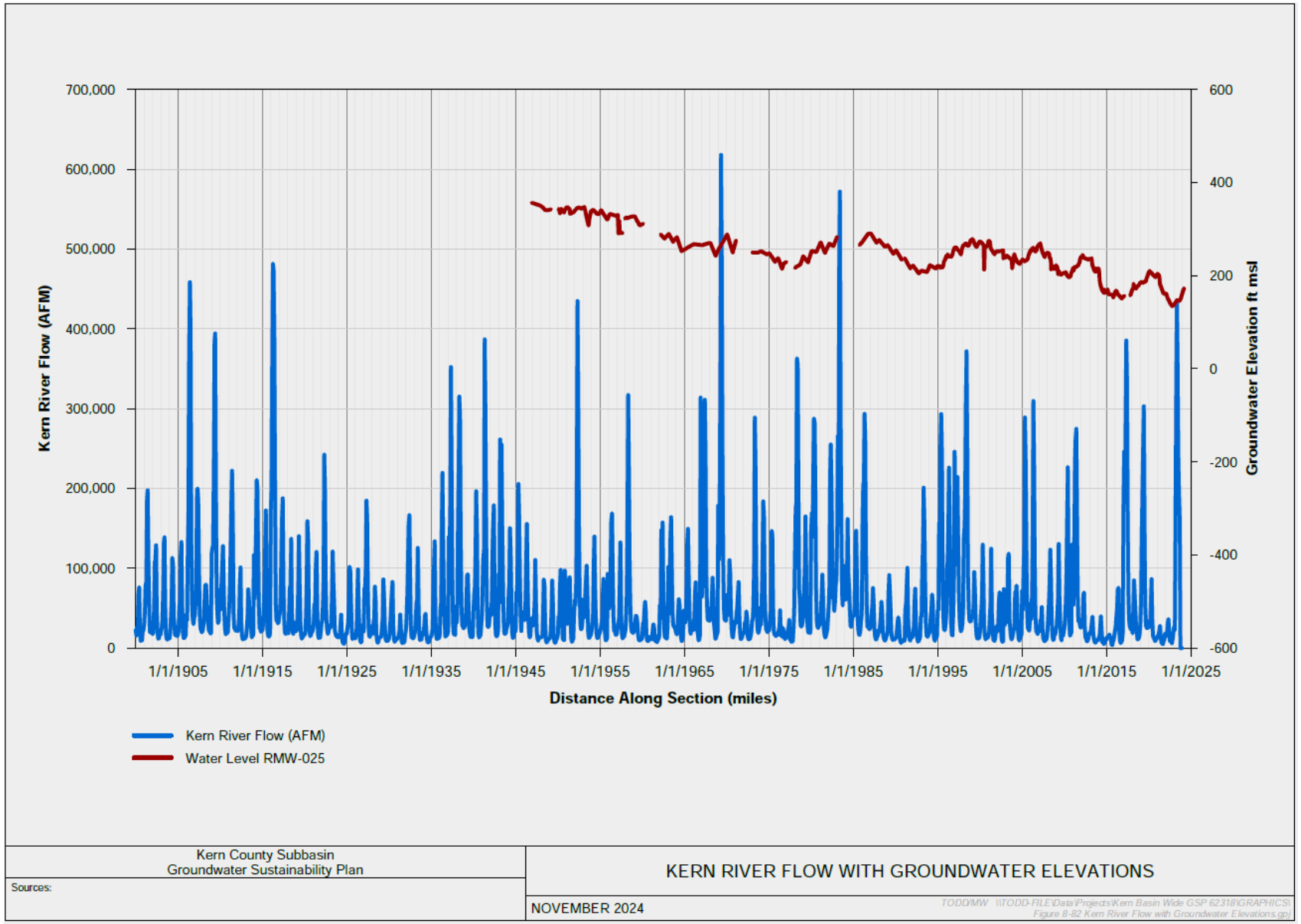


Figure 8-92. Kern River Flow with Groundwater Elevations

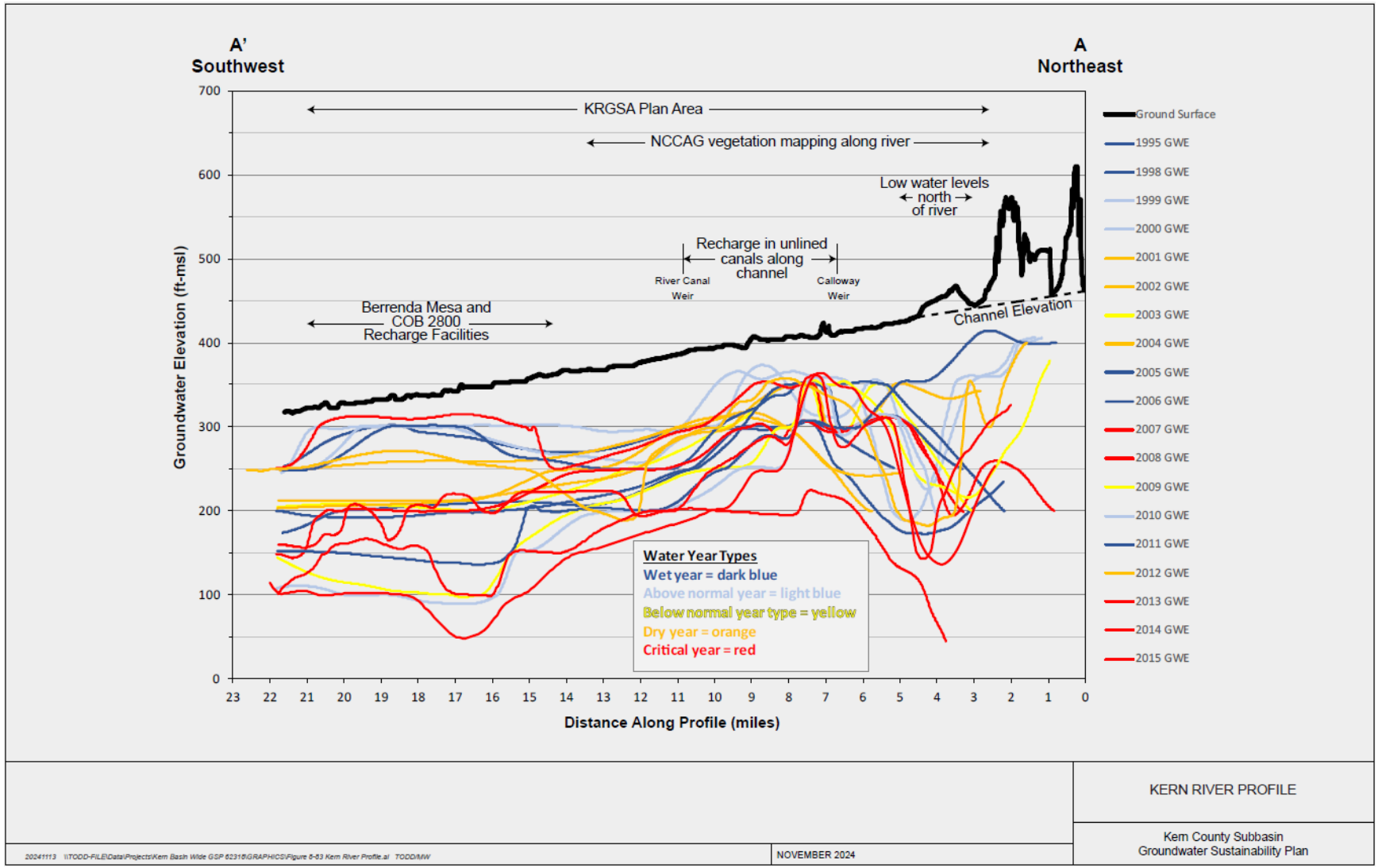


Figure 8-93. Kern River Profile

8.6.2.4 Lower Kern Fan

The ICONS dataset shows potentially connected in and around the Kern Fan Recharge Projects, Box E. Most of the delineated water ways are man-made canals that deliver to the managed recharge facility. Water levels in this area reflect the cycles of recharge and recovery. Figure 8-94 shows wells in the area and their hydrographs. Hydrographs show significant separation between water levels and ground surface over most of the Kern River, indicating the river is not connected to the principle aquifer. The screened interval of each well is shown on the figure but as indicated by the nested wells, there are no significant clay layers that separate the aquifer and shallow and deep wells show the same trends in water levels. Water levels near the banking projects, shown in purple on Figure 8-95, approach the ground surface during extremely wet years when imported water is available and the Kern Fan Projects are actively recharging in these areas.

Figure 8-95 shows one nested well, 30S/26E-8P with its historic range of water level data. As shown in the figure, wells levels were more than 80 feet deeper prior to banking, even during the extremely wet period of 1982 to 1986 where the Kern River Index averaged 187 percent. Water levels did not approach ground surface even in wet years until banking began in 1995. As noted above, flow in river at the Calloway Weir are near zero for long periods (months to years) indicating the river below the weir is not interconnected surface water. The managed recharge from imported water brought into the basin for the Kern Fan projects increase water levels. Without this recharge water levels are likely to be more than 70 feet below ground surface similar to historic observations.

Since banking water levels only approach within 20 feet from ground surface during extremely wet periods. The Kern Fan Recharge Projects continually monitor groundwater levels and percolation rates in their facilities. In wet periods, recharge operations are managed to prevent water levels from approaching the riverbed and potential losses from the water banks.

The ICONS dataset uses a conservative method for classifying surface waters as potentially interconnected which uses the minimum depth to water during any seasonal snapshot between spring 2011 and fall 2018. While the minimum depth to groundwater in this area is shown as 10 to 19 feet below ground surface, this condition is not typical; the ICONS dataset shows that the average depth to groundwater in this area is greater than 164 feet below ground surface. As such, any potential interconnection in this area is likely transitory, infrequent, and associated with poor quality perched groundwater that is not used for supply purposes (ICONS, 2024).

Collectively, the hydrologic profiles and hydrographs across the Kern Fan HCM Area do not indicate interconnected surface water or sufficiently high groundwater levels to support GDEs along the Kern River. Although groundwater levels may rise on occasion to within 20 feet of the base of the channel in some areas, this appears to occur only in wet years and as a result of intentional recharge along the channel. The profiles

corroborate the information in the annual Kern River hydrographic reports, which show the Kern River channel to be a losing stream from First Point to Second Point. This includes the area along the river where NCCAG mapped vegetation and wetlands (Mile 2.5 to Mile 13.4). This riparian vegetation appears to be supported by surface water in the river channel (when and where it occurs), local irrigation and runoff, and local infiltration of water on sides and bottoms of nearby unlined canals and recharge basins; the vegetation does not appear to be supported by groundwater. The ICONS mapping shows most of the Kern River as likely disconnected with a small, localized area that is categorized as likely connected – gaining in the area to the west of the Kern Water Bank and as discussed is the result of imported recharge. There are no GDEs or interconnected surface waters in the Kern Fan HCM Area.

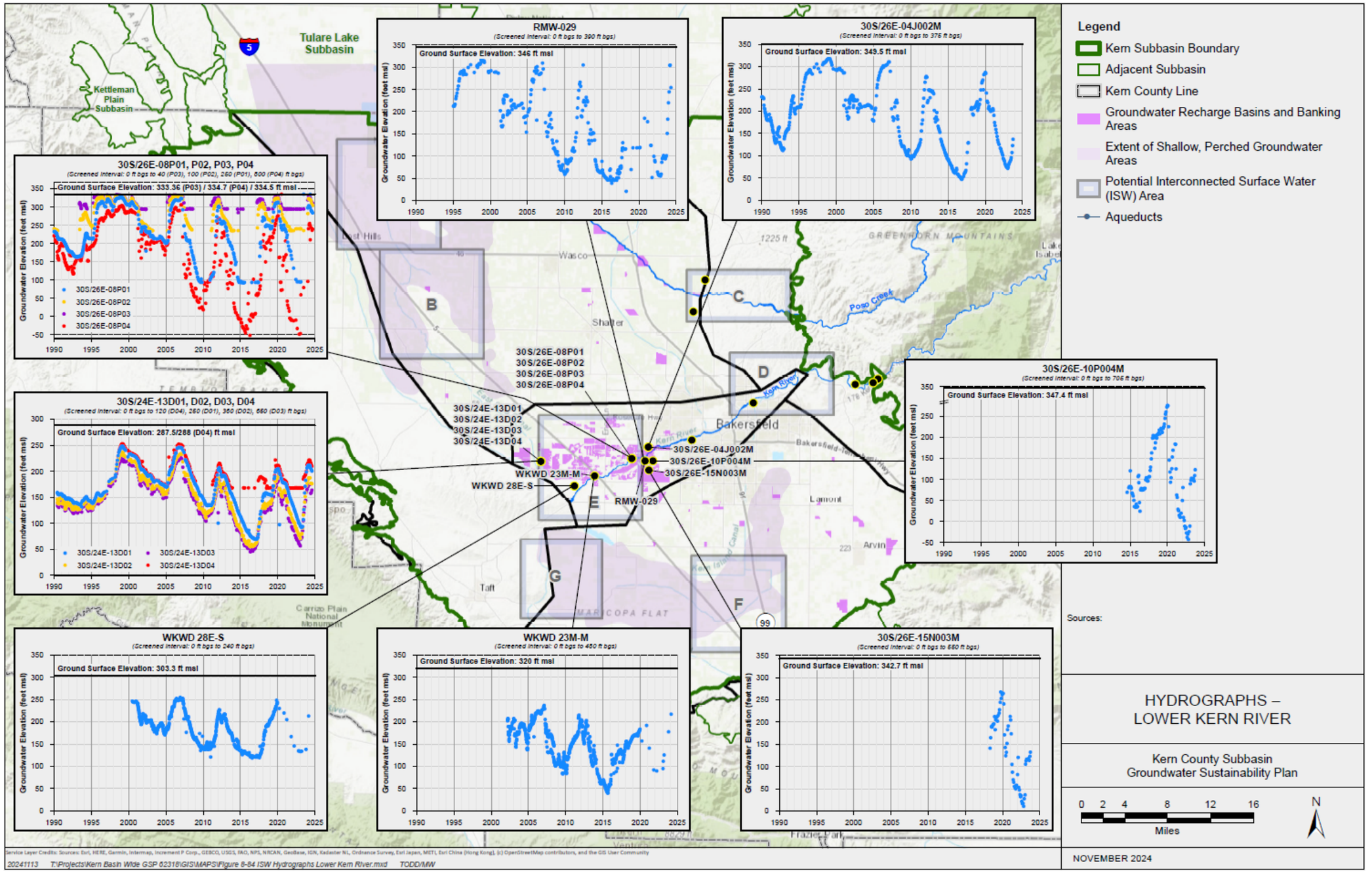


Figure 8-94. Hydrographs – Lower Kern River

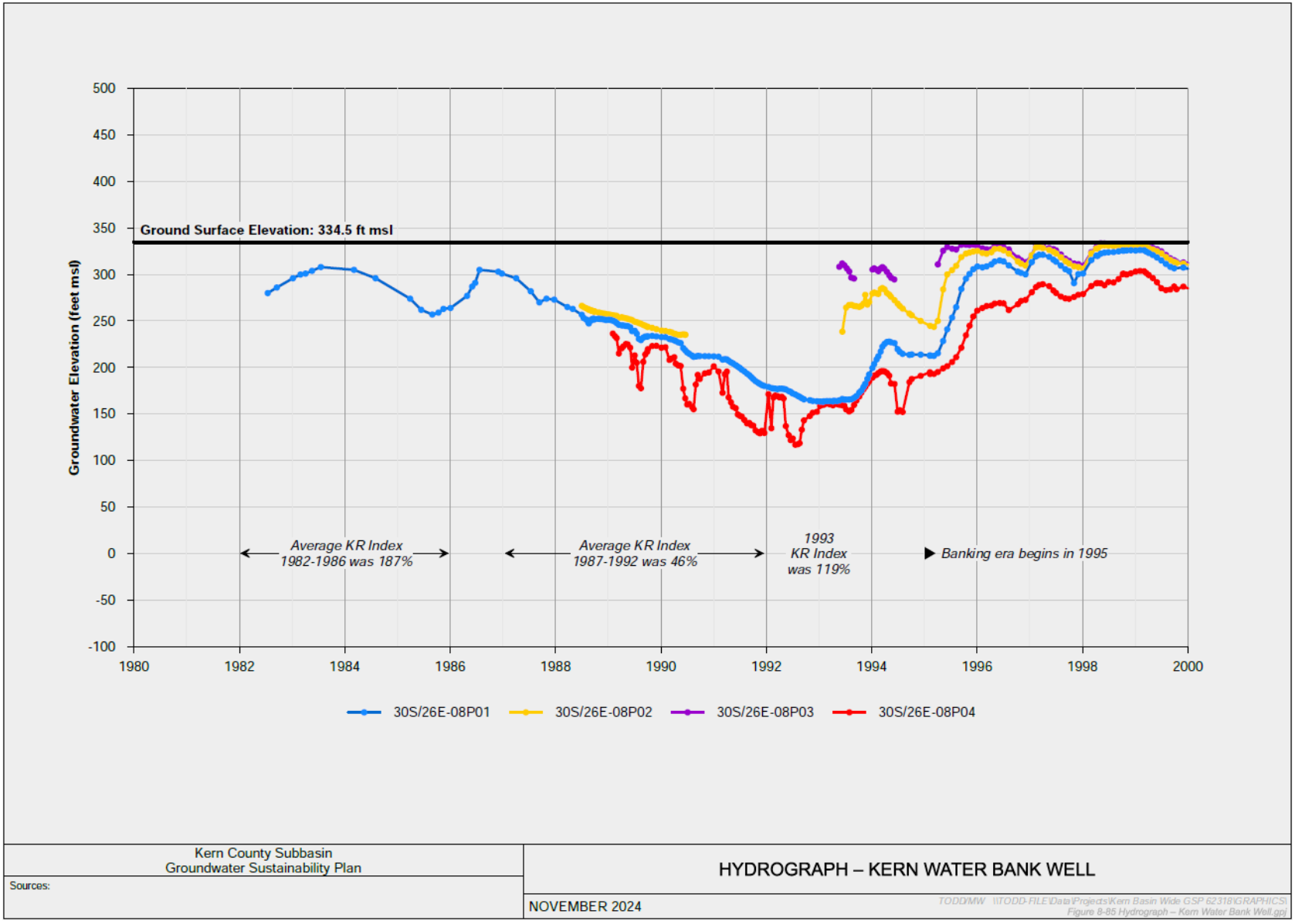


Figure 8-95. Hydrograph – Kern Water Bank Well

8.6.3 South Basin HCM Area

In South Basin HCM Area, groundwater levels are generally deep below the ground surface, largely precluding interconnected surface water. For example, in areas in the eastern South Basin HCM Area, the depth to groundwater generally exceeds 150 feet bgs, including in wells near natural surface water features (i.e., ephemeral streams). In the southern portion of the HCM Area depths to groundwater are generally 100 feet bgs or more, and greater than 350 feet bgs in the southernmost portions of the GSA where streams exist. In the southeastern South Basin HCM Area, groundwater depths in the principal aquifer in the southern portion of the HCM Area range between 300 to 400 feet bgs, while to the northwest, available observational data indicate groundwater elevations in the principal aquifer ranging between approximately 50 and 290 feet bgs. See Figure 8-7 for the hydrographs of wells in this area.

8.6.3.1 Historic Lake Beds

The NCCAG maps (Figure 8-85) show some areas of wetlands and vegetation, shown as Box F on the historic Kern Lake Bed and Box G on the historic Buena Vista Lake Bed. The ICONS dataset shows a small section of uncertain connections on the eastern edge of the South Basin HCM Area (Box G). This vegetation is likely reliant on disconnected perched water in the area and not the Principal Aquifer. As shown on the geology map Figure 8-88, these areas overlay quaternary lake deposits (brown). These are predominantly clay and silt deposits associated with lake beds and create a perch zone above the principal aquifer. In addition, both potential ISWs are in the shallow zone mapped by KCWA and shown on Figure 8-87.

The well inventory shows very few wells in the area of the two historic lake beds and no well is screened above 60 feet, the estimated perched zone. There is no pumping that would affect the riparian vegetation and wetlands in this area.

Based on the depths to groundwater in the principal aquifer that are several hundred feet below ground surface or in the disconnected perched zones it is therefore highly unlikely that any ecosystems depend on groundwater from the principal aquifer system. There are no GDEs in the South Basin HCM Area.

8.6.4 Western Fold Belt HCM Area

Figure 8-85 shows areas of NCCAG mapped vegetation along the boundary of the Western Fold Belt and North Subbasin HCM Areas. These areas are between the California Aqueduct and the Kern River Flood Canal and are likely sustained by surface water or direct precipitation disconnected from the principal aquifer, due to shallow clay layers as discussed in Section 7 and shown on Figure 8-87. Other than along the flood canal, there is little surface water and a few areas of mapped vegetation and wetlands. All streams are ephemeral and not connected to the groundwater system. The ICONS

dataset shows no interconnected surface water in this area, although the dataset's coverage is limited. There are no GDEs in the Western Fold Belt HCM Area.

8.6.5 Summary of ISWs

ISWs were systematically reviewed using the NCCAG and ICONS datasets. Seven potential ISWs were identified in the Kern Subbasin. Each were reviewed using the available geologic data, water levels, and well inventory to investigate the potential connection with the principal groundwater aquifer or any groundwater use. Data on depth to groundwater and other local conditions indicate that the vast majority of surface water features in the Kern Subbasin are not connected to groundwater, and in the few limited areas where a connection may occur, the connection is likely transient, short-lived, and involves shallow or perched groundwater that is not part of the principal aquifer systems. As such, the areas of vegetation mapped as NCCAG are not GDEs but rather supported by irrigation water infiltration and agricultural return flows in these areas, infiltration of irrigation water and agricultural return flows is impeded by clay soils and subsurface clay sediments creating shallow perched groundwater disconnected from regional groundwater. Based on the well inventory, there are likely no shallow domestic wells screened in the perched zones. To the extent the mapped vegetation is supported by surface water or locally perched water, this condition will likely continue during Plan implementation as surface water continues to be an important source for irrigation in the Kern Subbasin.

As noted, DWR is in the process of developing new guidance for evaluation of ISWs in the context of SGMA and the Kern Subbasin will continue to monitor surface water and GDE conditions and will adapt management approaches based on observed conditions and these new guidelines. The first three papers released suggest using numerical modeling to fully simulate and quantify potential depletions from ISWs. Additional model updates are currently underway to be able to simulate suggested scenarios, and work will continue to identify and monitor potential ISWs.

9. WATER BUDGET INFORMATION

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

☑ 23 CCR § 354.18(a)

The Kern Subbasin, the largest subbasin in the State, was designated as critically-overdrafted by the California Department of Water Resources (DWR). The complex water management in the Kern Subbasin involves more than 40 water districts/systems, multiple large water banking projects of State-wide importance, and provides large quantities of surface water and groundwater to support both large urban centers and one of the top agricultural-producing areas in the country. In addition, most agencies are involved in conjunctive management of local surface water, imported state and federal water, and groundwater.

Within this complex water management setting, the Kern Subbasin GSAs recognized that a numerical modeling tool was needed to meet GSP Emergency Regulations to assess historical, current, and projected-future Kern Subbasin water budgets using a consistent Subbasin-wide methodology (§357.4(b)(3)). During the development of the original Kern Subbasin 2020 GSPs, the Kern Subbasin GSAs held a series of meetings and workshops to evaluate potential modeling tools. Although numerous existing models had been developed by various entities in the Kern Subbasin over time, none of those models covered the entire Subbasin boundary or incorporated all the local water budget components necessary to meet GSP requirements. The California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) is DWR's primary tool for evaluating water management in the Central Valley and is specifically referenced in the GSP Emergency Regulations for application to GSP water budgets (§354.18(f)); therefore, C2VSim was selected by the Kern Subbasin GSAs for SGMA compliance.

Operational water budgets were developed for each GSA in the Kern Subbasin to assess the net groundwater use based on GSA water management operations. Local GSA water budgets in the Kern Subbasin present a challenge for the model because of the intricate GSA boundaries, complexity of water management and water management operations that occur outside of the individual GSA boundary. To address this issue, a spreadsheet-based water accounting of surface water operations within each individual GSA was developed. The GSA operational water budgets therefore provide a complimentary analysis to accompany the model results. These local water budgets

support the individual GSAs in their sustainability planning including the development of Projects and Management Actions (P/MAs).

In compliance with SGMA, the Kern Subbasin GSAs present this coordinated Subbasin-wide water budget. Section 9 describes the process and approach for selection, revisions, and application of the C2VSim to the Kern Subbasin for the development of Subbasin-wide water budgets and presents the results.

9.1 Subbasin Water Budget Methodology

> ***§ 354.18.*** *Water Budget*
> *(f) The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.*

☑ 23 CCR § 354.18(f)

The Kern Subbasin GSAs have coordinated to provide data to update the regional C2VSim model developed by DWR as the base model for developing Subbasin-wide water budgets that utilize consistent data sets and methodologies. Figure 9-1 shows the overall C2VSimFG model grid that highlights the Kern Subbasin Plan Area. The Kern Subbasin GSAs have continued to update this model in order to provide water budget updates for the DWR SGMA Annual Reports. The most recent model version includes updates through WY2023.

9.1.1 C2VSim

C2VSim uses DWR's modeling code *Integrated Water Flow Model* (IWFM) and covers the entire California Central Valley. Kern County is located at the southern end of the Central Valley (Figure 9-2). C2VSim simulates the full hydrologic cycle, calculating water demands and tracking water movement through surface water and groundwater systems, and is therefore well suited to support Kern Subbasin GSP development.

DWR developed C2VSim to simulate water demands and supplies in the Central Valley. C2VSim is an application of DWR's IWFM software. IWFM is an integrated hydrologic model that simulates water flows on the linked land surface, unsaturated zone, groundwater, and surface water flow systems. A key feature of IWFM is DWR's agricultural and urban water supply and demand management module that dynamically simulates the delivery of both surface water and groundwater supplies based on both water availability and calculated water demands, as affected by use and climatic conditions.

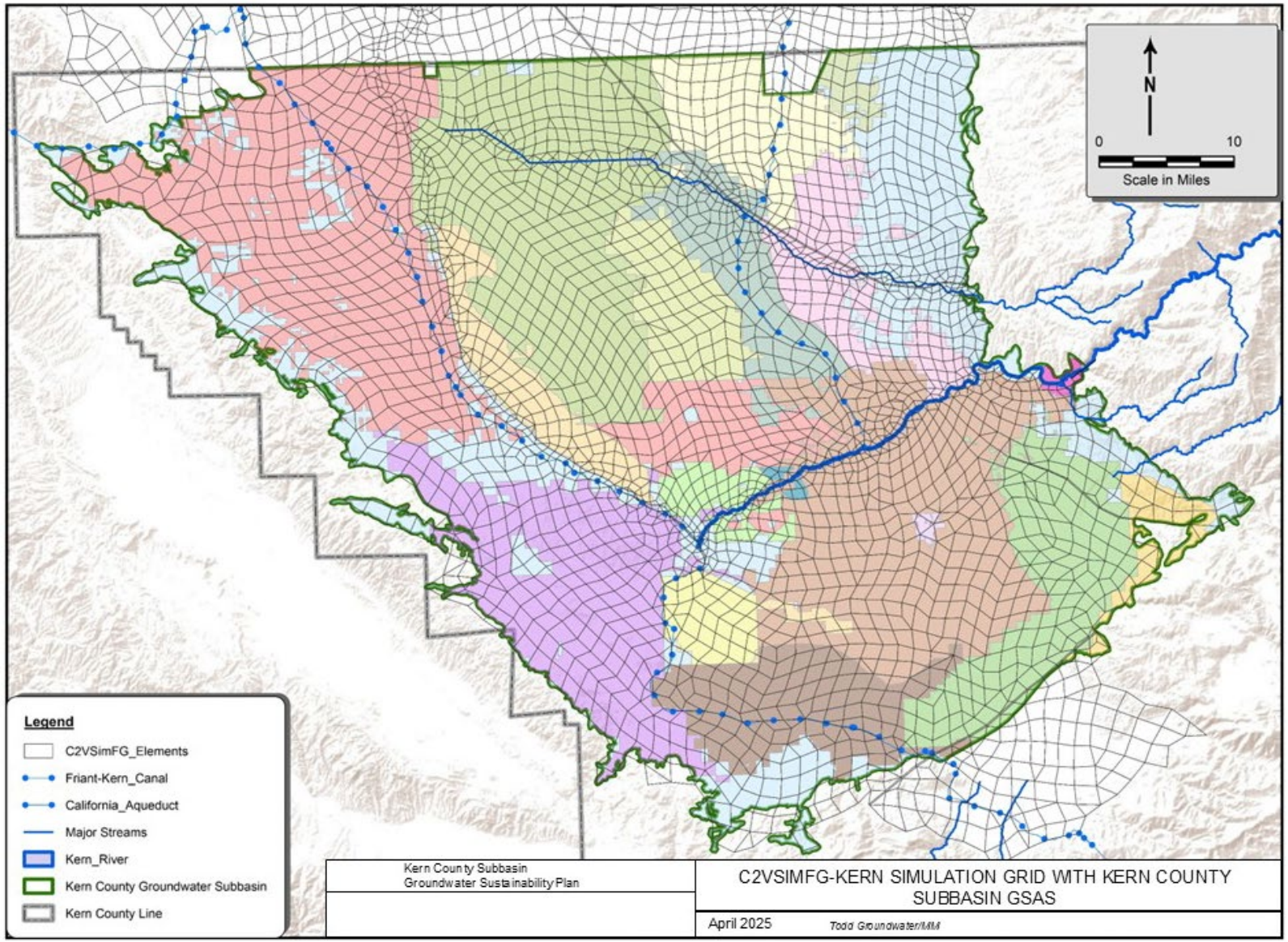


Figure 9-1. C2VSimFG-Kern Simulation Grid with Kern Subbasin GSAs

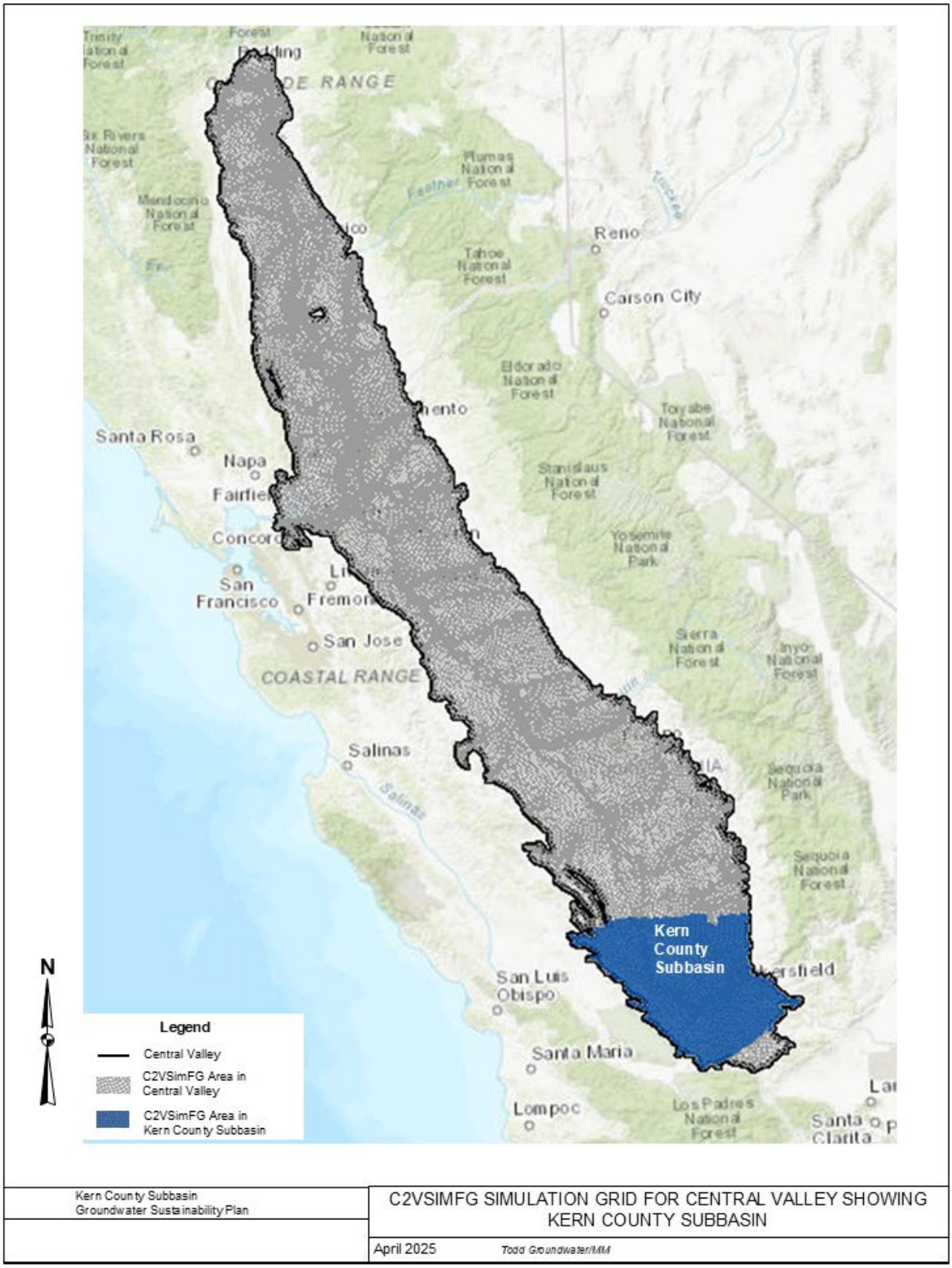


Figure 9-2. C2VSimFG-Kern Simulation Grid for Central Valley Showing Kern Subbasin

The C2VSim model is derived from a series of Central Valley hydrologic models developed by DWR and other agencies beginning in the early 1990s. Each model in this series has incorporated significant improvements over the previous version (Brush, Dogrul, and Kadir, 2013). The groundwater flow system is modeled in IWFM using the finite element method and uses a highly efficient solver developed at UC Davis. The IWFM Demand Calculator (IDC) and land surface simulation process were developed with input from California irrigation management professionals. Given DWR's emphasis on water management, detailed water budgets produced by C2VSim provide good representations of the surface water and groundwater flow systems and make it a preferred platform for developing water budgets.

DWR released the C2VSim Fine Grid Public Beta model (C2VSimFG-Beta) on May 18, 2018 (CNRA, 2018). DWR's 2018 release of C2VSimFG-Beta includes historical input data for WY1922 to WY2015. C2VSimFG-Beta includes historical precipitation, stream inflow, land use and crop acreage for the entire Central Valley. This data includes monthly precipitation and annual land use for each model element and estimated monthly evapotranspiration for each modeled land use type and agricultural crop. Historical surface water data include monthly surface water inflow for each river entering the model boundary and monthly surface water diversions and deliveries.

The C2VSimFG-Beta finite element grid divides the Central Valley into 32,537 model elements (Figure 9-2) of which 3,278 elements represent the Kern Subbasin. Element areas are small near streams and in developed areas and expand to larger sizes in undeveloped areas. Element sizes average 407 acres and range from 4 to 1,770 acres. Central Valley rivers and streams are represented with a network of 110 stream reaches. Surface water and groundwater inflows from uplands along the model boundary are simulated with 1,033 small watersheds.

In Kern Subbasin, the groundwater aquifer system is represented with four aquifer layers and one regional confining layer. The aquifer thickness in the Kern Subbasin varies from 857 to 9,054 feet and the deepest aquifer location is 8,752 feet below msl. The Central Valley aquifer is simulated with the following hydrostratigraphic layers, listed from top to bottom:

- Shallow, unconfined aquifer
- Regional confining layer
- Active confined aquifer (contains high level of pumping)
- Inactive confined aquifer (contains limited pumping)
- Saline confined aquifer

C2VSimFG-Beta includes annual land use and crop acreages and monthly precipitation, evapotranspiration, stream inflows, surface water deliveries and specified groundwater pumping rates for WY1922 to WY2015. C2VSimFG-Beta uses IDC to dynamically calculate distributed monthly water demands, allocate available water supplies to meet

these demands, and calculate unmetered groundwater pumping necessary to satisfy unmet demands. C2VSimFG-Beta produces detailed monthly water budgets for arbitrary sets of elements grouped into zones.

Water demands are calculated dynamically for each model element using the IDC for agricultural, urban, native, and riparian land use types. Agricultural demand is calculated based on annual crop type distribution mapping and user-specified evapotranspiration rates for 20 irrigated crop types and managed seasonal wetlands at the Kern National Wildlife Refuge (Refuge). Agricultural water demand is determined based on a soil moisture balance that uses local soil properties to assess the amount of applied water (precipitation and specified surface water applications) available to meet the crop demand. If water demands in an element are not satisfied from these sources, the C2VSim model calculates the groundwater pumping needed to eliminate any deficit.

Urban demands are calculated based on population and per-capita water demands. Water demands for native, undeveloped, fallow, or riparian settings are calculated from monthly evapotranspiration rates and the amount of precipitation. If water demands in an element are not satisfied, no applied water is provided to these areas, and the vegetation is assumed to be in a stressed state. Runoff of precipitation in developed and undeveloped areas within the Kern Subbasin and surrounding small watersheds is calculated using methodology included in IWFM that is based on the U.S. Department of Agriculture (USDA) Soil Conservation Service Curve Number Method (NRCS, 2004).

C2VSimFG-Beta was released after a preliminary model calibration. The distribution of aquifer parameters was based on a texture analysis of lithologic well logs compiled by the US Geological Survey (USGS, 2009) from Well Completion Reports submitted to DWR by well drillers. The texture analysis interpolated the percentage of coarse-grained material at each well location and depth of the C2VSimFG-Beta mesh. Aquifer parameters were then calculated for the model mesh based on the percentage of coarse-grained material and estimated properties for pure coarse- and fine-grained materials. Transmissivities were estimated using specific capacity tests, where available. Soil properties for each model element were derived from digitized soil maps published by the USDA Natural Resources Conservation Service (NRCS, 2018).

9.1.2 C2VSimFG-Kern Model

An initial model review indicated that the C2VSimFG-Beta generally has good historical precipitation, streamflow, land use and crop acreage for the entire Central Valley. Historical water supply and demand data are also generally good in the Sacramento Valley and San Joaquin River hydrologic regions; however, data are considered less reliable in the Tulare Lake hydrologic region including Kern County. To address this concern, Todd Groundwater – working with all Kern Subbasin GSAs – revised the Kern County portion of C2VSimFG-Beta for WY1985 to WY2023. This revised version of C2VSim for the Kern Subbasin, referred to herein as the C2VSimFG-Kern model, is

used to develop historical, current, and projected-future water budgets in accordance with the requirements in the SGMA Regulations.

C2VSimFG-Beta input files were revised to incorporate locally derived managed water supply and demand data to better represent the local water budgets for the Kern Subbasin. Additional revisions were made to C2VSimFG-Beta model to address issues that were identified with the physical representation of the Kern Subbasin. The result of these Kern County specific modifications is a local version of C2VSimFG-Beta that is referred to here as C2VSimFG-Kern. A listing of the changes made for C2VSimFG-Kern is provided in Appendix H-1, Table 1.

These regional model revisions were enhanced by the participation of the many agencies that provided local water budget input data. Todd Groundwater worked with the Kern Subbasin GSAs and other local agencies to coordinate acquisition of input data from other agencies in formats that could be easily incorporated into the C2VSimFG-Kern model. Concurrent review of interim model results by these agencies, including local zonal water budgets, groundwater hydrographs and other model results, helped ensure that the revised model reproduced local mass balance estimates across the Kern Subbasin and represents the best available information and science.

9.1.3 Quality Assurance Process

The Kern Subbasin GSAs provided support to have Woodard & Curran conduct an ongoing peer review of model input files. Todd Groundwater worked with Woodard & Curran throughout the historical model revision process. Tabulated input data, model files and model-derived water budgets were provided to the Technical Peer Review Team for review of accuracy and appropriateness. Additional discussion of the validation and performance of C2VSimFG-Kern is provided in Appendix H-2.

9.1.4 Coordination with DWR on Future C2VSimFG Updates

The C2VSimFG-Kern input files for the Kern Subbasin revised historical simulation were provided to DWR for incorporation into future C2VSim public releases in 2020. Since then, the Kern Subbasin GSAs have continued this coordination by providing annual updates to C2VSimFG-Kern to the DWR modeling staff to support their efforts to update C2VSim with current data. The Kern Subbasin GSAs have provided C2VSimFG-Kern input files with data through WY2023 to DWR. The Kern Subbasin modeling team has had several meetings with DWR modeling staff and DWR consultants to discuss the C2VSimFG-Kern model. Through this effort the Kern Subbasin GSAs have continued to support DWR in further improving their C2VSim model and receive support from DWR for improving the Kern Subbasin model. DWR incorporated data from C2VSimFG-Kern into DWR's current model version C2VSimCG v1.0 that was released in November 2022.

9.1.5 Related Grant Studies to Improve Future Water Budget Estimates

The Kern Subbasin GSAs have continued to support improvements in addressing data gaps and model improvements to better evaluate historical, current, and projected-future water budgets. The Kern Subbasin began implementation, in WY2023, of a $7.6 million Round 1 sustainable groundwater management grant for critically overdrafted basins under the Sustainable Groundwater Management (SGM) Grant Program authorized by the California Budget Act of 2021 and Proposition 68. The grant supports projects that encourage sustainable management of groundwater resources as required by SGMA. Two of the components specifically are related to the water budget. These include the following:

- **Grant Component: Basin Study** – A systematic, Subbasin-wide analysis that addresses technical data gaps in the hydrogeological conceptual model, watershed hydrology and water budgets. The Basin Study provides the framework for more refined water budget analyses to support ongoing GSP planning and implementation.
- **Grant Component: Evapotranspiration Analysis & Study – Field by Field** – A consistent Subbasin-wide methodology, based on service provided by LandIQ, for calculating ET based on local climatic and cropping data for all irrigated agricultural areas within the Kern Subbasin. These stations provide improved calculation of ET on a field and crop basis; field data for the calibration and validation of ET models to better understand the overall water balance within the Kern Subbasin and comply with necessary regulatory requirements that will serve all communities within the Kern Subbasin.

The emphasis of the Basin Study grant component is to better represent local groundwater elevations in the principal aquifers and provide higher accuracy in simulating changes in groundwater elevations over time. A key objective of the model recalibration is to improve the simulation of groundwater elevations relative to Minimum Thresholds and Measurable Objectives (MT/MOs) across the Kern Subbasin and provide improved support to long-term GSP implementation planning. The calibrated C2VSimFG-Kern model will produce an updated historical water budget and change in groundwater storage estimates for ongoing GSP implementation in the Kern Subbasin over the SGMA planning and implementation horizon.

9.2 Subbasin Water Budget Data

§ 354.18. Water Budget

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

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

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

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

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

(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

(3) Projected water budget information for population, population growth, climate change, and sea level rise.

☑ **23 CCR § 354.18(b)**
☑ **23 CCR § 354.18(d)**

9.2.1 General Approach

The current C2VSim model has a detailed finite element mesh that closely follows local hydrologic features. As a regional model, the C2VSimFG-Beta may over-generalize local conditions within the Kern Subbasin so as to be inconsistent with local site-specific data and knowledge. To address this concern, the managed water supply and demand inputs were updated to better represent the local water balance. To do this, the more general assumptions in C2VSimFG-Beta were replaced with local data and knowledge that are regionally or locally significant over the period covering WY1993 to WY2023. Locally managed water supply input data (e.g., surface water deliveries, land use, irrigation demand, return flows, and water banking) were collected and applied to C2VSim. Improvement of Kern County data focused on incorporating:

- Surface water delivery volumes, application areas and use by agency
- Water banking and conjunctive use recharge and recovery projects
- Irrigation demand from recent analyses of remote sensing data of evapotranspiration in the Kern Subbasin (Irrigation and Training Research Center [ITRC], 2017, 2020, 2021, 2022, and 2023)

- Urban demand for the Kern Subbasin focusing on Metropolitan Bakersfield
- Data on other water sources and demands of local significance to individual districts/GSAs

Historical surface water diversion, water bank recharge, and recovery data were collected from local GSAs and local water agencies. Urban land use was restricted to developed areas, and urban populations and per-capita water demands were updated. Model structure (elements, streams, stratigraphy, etc.) was not modified. Model parameters were not calibrated, although some model parameters were adjusted to improve model performance in specific geographic areas.

The Kern Subbasin GSAs also coordinated model revision efforts with the Technical Peer Review Team and local agencies to ensure input data were accurately represented in the model. Tabulated input data, model files and model-derived water budgets were provided to the Technical Peer Review Team for review of accuracy and appropriateness. Model input data and results were also provided to Kern Subbasin water districts and local water purveyors for their review. Comments and data issues were reconciled and incorporated into the revised C2VSimFG-Kern model.

9.2.2 Data Sources

☑ 23 CCR § 354.18(b)

Compiling the data needed for the model revision required a coordinated effort from the Kern Subbasin GSAs to provide locally derived data on managed water supply and demand that was used to revise the C2VSimFG-Beta for the Kern Subbasin.

Participating agencies compiled water budget input data sets (using their staff, consultants, or other resources) based on data templates that conformed to IWFM model data needs and used them to facilitate obtaining input data from local agencies. This included monthly data for the following:

- Surface water imports and diversions (inflows and outflows) by source, conveyance, and application area.
- Banked surface water recharge and recovery pumping by water banking and conjunctive use project.
- Urban area population and per capita water use.
- Crop evapotranspiration (ET) rates based on an analysis of satellite data.

Recently developed crop ET rates derived from remote sensing data were used to develop monthly crop ET rates for agricultural crops. Urban land use was restricted to developed areas, urban populations and per-capita water demands were updated, and urban wastewater recharge operations were added.

9.2.3 Water Year Types for Base Periods

☑ 23 CCR § 354.18(b)(6)

The simulation period for C2VSimFG-Kern was set to WY1986 to WY2023 (October 1, 1985 through September 30, 2023), which includes a 10-year period prior to the start of the historical base period. The C2VSimFG-Beta simulation period ran from October 1973 through September 2015 (WY1974 to WY2015). The period from October 1973 to September 1985 was not included in the simulation due to concerns about lack of comparable data from these earlier periods. Kern County water agencies provided locally derived water budget data for WY1993 to WY2023 for this study so that data input extended beyond the historical base period. Additional water budget data prior to WY1993 were also collected where available and input into the model.

GSP requirements indicate a need to identify an average hydrologic study period for purposes of the groundwater analyses in the Subbasin-wide water budgets. In order to select a consistent study period, the Kern Subbasin GSAs agreed upon historical hydrologic study period covering WY1995 through WY2014 (October 1, 1994 through September 30, 2014). The selection of the historical hydrologic study period was based on a variety of technical criteria including:

- Covers at least 10-years, consistent with GSP Emergency Regulations (§354.18(c)(2)(B)).
- Contains 10 years characterized as above normal or wet water year types based on precipitation, and 10 years of below normal, dry or critically dry water year types, including four critically dry years from the San Joaquin Valley Index.
- 100 percent of the long-term average streamflow conditions on the Kern River, as indicated by an average annual Kern River Index of 100 percent (Figure 9-3), including nine years above 100 percent and 11 below 100 percent.
- About 104 percent of long-term average precipitation (NOAA Bakersfield Meadows Field Airport Station).
- Widely available high-quality data available across the Kern Subbasin.
- Time period with current water management practices, intensive water banking operations, and more recent land use patterns.
- Begins at a time of relatively stable water levels (October 1994).
- Overlaps a time period with consistently developed Subbasin-wide contour maps by Kern County Water Agency (KCWA).

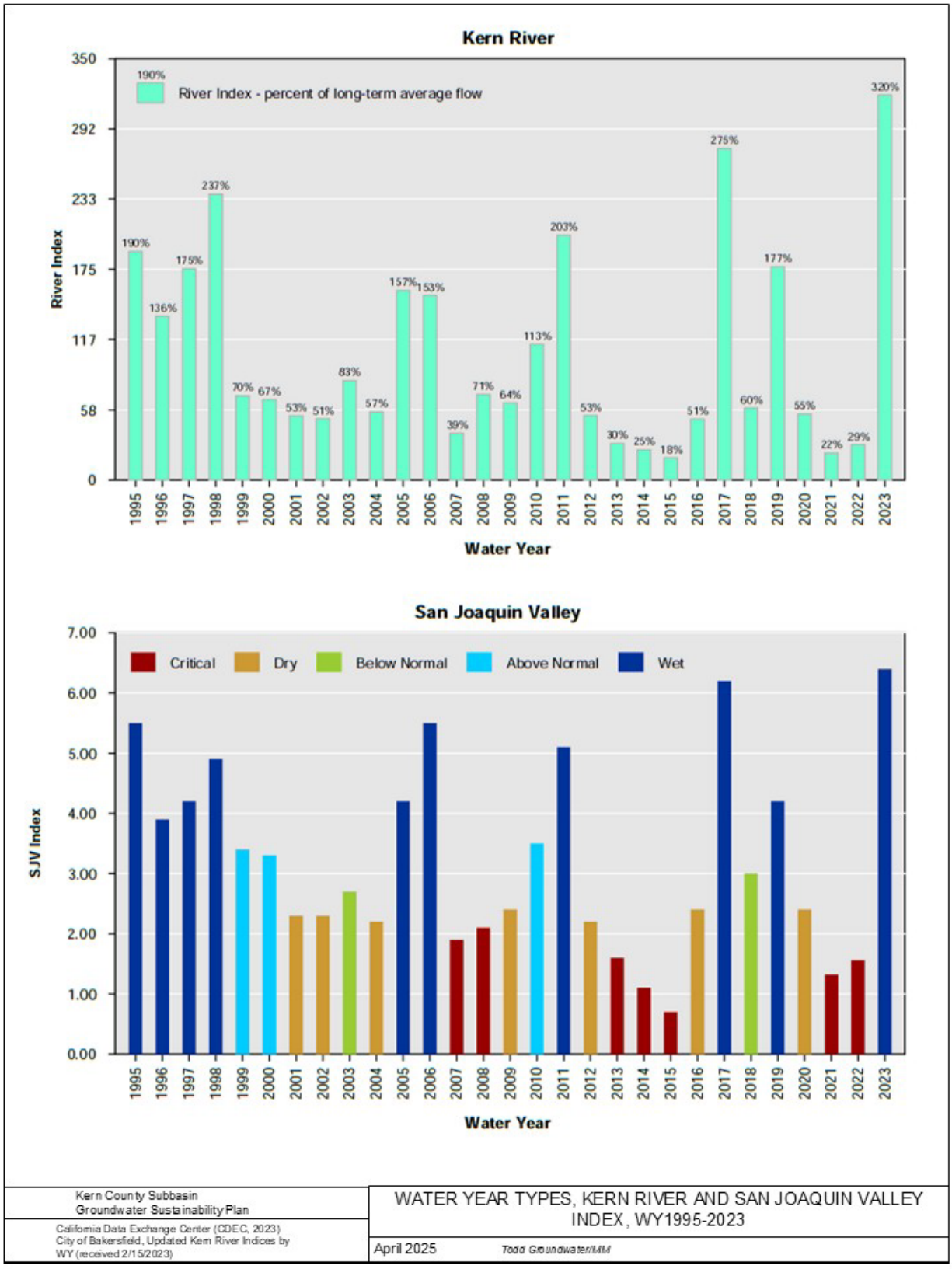


Figure 9-3. Water Year Types for Kern River and San Josquin Valley Index, WY1995 through 2023

The primary criteria for selecting the historical water budget period is to have a hydrologically balanced period to minimize any bias toward wetter or drier hydrologic conditions. The Kern Subbasin GSAs also coordinated on selection of consistent study periods for the C2VSimFG-Kern water budget analyses. Based on technical considerations and a review of regional data, the following study periods were selected:

- Historical Water Budget – WY1995 through WY2014
- Current Water Budget – WY2015 through WY2023
- Projected Water Budget – WY2021 through WY2070 using 50 years of hydrologic data based on Historical Water Budget data

The current water budget period of WY2015 through WY2023 is the most recent period following the historical water budget period. This nine-year period includes three wet water year types and six below average water year types including three critically dry years based on the San Joaquin Valley Index (Figure 9-3), representing dry conditions two-thirds of the time. The current water budget period represents an unbalanced base period that leans to dry hydrologic conditions.

9.2.4 Surface Water

☑ 23 CCR § 354.18(b)(2)

A majority of the surface water entering the Kern Subbasin enters via the Kern River, Friant-Kern Canal and California Aqueduct. Within the Kern Subbasin, this water is distributed to end users through a complex system of conveyances, with real-time transfers between purveyors balancing available water with immediate needs while honoring contractual obligations.

For this study, locally derived monthly surface water inflow and outflow volumes for WY1993 to WY2023 were collected from Kern Subbasin GSAs and water agencies, with some providing data for earlier periods. Data were provided by conveyance and were cross-referenced with flows of neighboring agencies and with data from the major conveyances to ensure consistency and avoid double-counting. Water delivery areas and recharge basins were also delineated within agencies.

Kern County surface water diversions in C2VSimFG-Beta were grouped by project or water source, and some surface water deliveries were applied to large regions rather than to individual districts. In addition, some local surface water deliveries were missing from C2VSimFG-Beta. For C2VSimFG-Kern, the 43 Kern County surface water diversions from C2VSimFG-Beta were replaced with 113 surface water diversions developed with data provided by local agencies.

The Arvin-Edison WSD, Wheeler Ridge-Maricopa WSD, and Tejon-Castac WD overlie both the Kern County and White Wolf Subbasins. Similarly, the Kern-Tulare Water District overlies portions of both the Kern County and Tule Subbasins. In these cases,

surface water deliveries were apportioned as separate diversions to the Kern Subbasin and the appropriate adjacent subbasin.

9.2.4.1 River and Stream Inflow

Inflows to the Kern Subbasin via the Kern River and Poso Creek are based on historical gage data. Kern River inflows at the First Point gage and downstream gages were verified and updated based on the annual Kern River Annual Hydrographic Reports produced by the City of Bakersfield (COB, 1985-2023). C2VSimFG-Beta contained Poso Creek inflows for WY1961 to WY1986. Poso Creek inflows for WY1987 to WY2023, based on flow records for the Coffee Canyon and Trenton stream gages provided by local agencies, were added to C2VSimFG-Kern.

9.2.4.2 Surface Water Diversions

Monthly surface water diversion data for WY1993 to WY2023 were collected for 21 agencies and water banking projects in Kern County. The data from each water district or agency included monthly surface water inflow by source and monthly surface water outflow by destination. The C2VSim finite element grid was overlaid onto a map of surface water delivery areas to determine the model elements for each diversion. Owing to the complexity of the surface water delivery system and the large number of real-time water transfers occurring within the Kern Subbasin, all surface water diversions were simulated as exports, and all surface water deliveries were simulated as imports.

Surface water diversions were added for Kern Subbasin streams (Kern River and Poso Creek), imported surface water supplies (State Water Project (SWP), Central Valley Project (CVP) and other local sources (recycled wastewater and treated produced water). The surface water diversions input into C2VSimFG-Kern is as follows:

- 125 time series for Kern County surface water diversions were added, replacing 43 surface water diversions in C2VSimFG-Beta.
- Detailed elemental delivery areas were defined for each of the 113 diversions.

The monthly surface water inflow and outflow data collected for this study did not have sufficient detail to track this water and create an accurate historical water budget for each canal for each month. The data provided sufficient information to identify monthly surface water diversions from each source and deliveries to each end use.

Each C2VSim surface water diversion is linked to two groups of model elements: the elements of the end use and the elements receiving the recoverable losses. A single set of elements was used for both purposes in C2VSimFG-Kern. Model elements for agricultural, urban, and Refuge deliveries were selected by overlaying the model grid on delivery area maps. Model elements for recharge diversions were selected by overlaying the model grid on recharge basin maps.

Monthly water delivery data for the SWP, CVP, and Kern River were also provided by the agencies. Monthly turnout-level deliveries for the SWP were also compiled from the monthly SWP Report of Operations published by DWR. Monthly CVP deliveries were compiled from the U.S. Bureau of Reclamation (USBR) Report of Operations. Monthly Kern River flow and diversions were compiled from Kern River Hydrographic Reports. Water agencies in the Kern Subbasin trade and wheel water in real time to maximize water utilization, minimize waste and energy consumption, and meet immediate water needs. Water delivery reports from water suppliers (such as the CVP and SWP) generally identify the owner of delivered water, not where it was actually delivered.

Some surface water conveyances discharge water into stream or river channels for re-diversion downstream. A key part of the surface water system in Kern County is the Kern River. Kern River operations data were reviewed for calendar years 1970 to 2023. The surface water deliveries and Kern River diversions by turnout location as applied in C2VSimFG-Kern are summarized in Appendix H-1, Tables 2 and 3.

9.2.4.3 Surface Water Deliveries

Water flow through the Kern River and its associated canal system is very complex. Water is diverted from the Kern River into a parallel canal system at several locations, with some diverted water flowing back to the river. Some water from the CVP and SWP is discharged into the Kern River for diversion downstream. Some water agencies are served from multiple diversion points along the Kern River. Several canals that receive water diverted from the Kern River also exchange water with other canals and receive some water from recovered banked water pump-ins, so deliveries from many canals cannot be attributed to a single source. Figure 9-4 shows the locations of the primary streams, regional surface water canals, water bank operations, and conjunctive use projects in the Kern Subbasin.

Each surface water diversion in C2VSim is allocated to a specified destination and water use. Five water use types are simulated in C2VSimFG-Kern: agricultural, urban, refuge, recharge, and export. Agricultural and refuge diversions are applied to a group of model elements that corresponds to a surface water service area within a specific water agency or to the Refuge. Urban diversions are allocated to an urban service area. The annual surface water deliveries for agricultural use by water district in Kern County and surface water diversions for urban use, wastewater land disposal and wildlife management in Kern County are summarized in Appendix H-1, Tables 2 and 4, respectively.

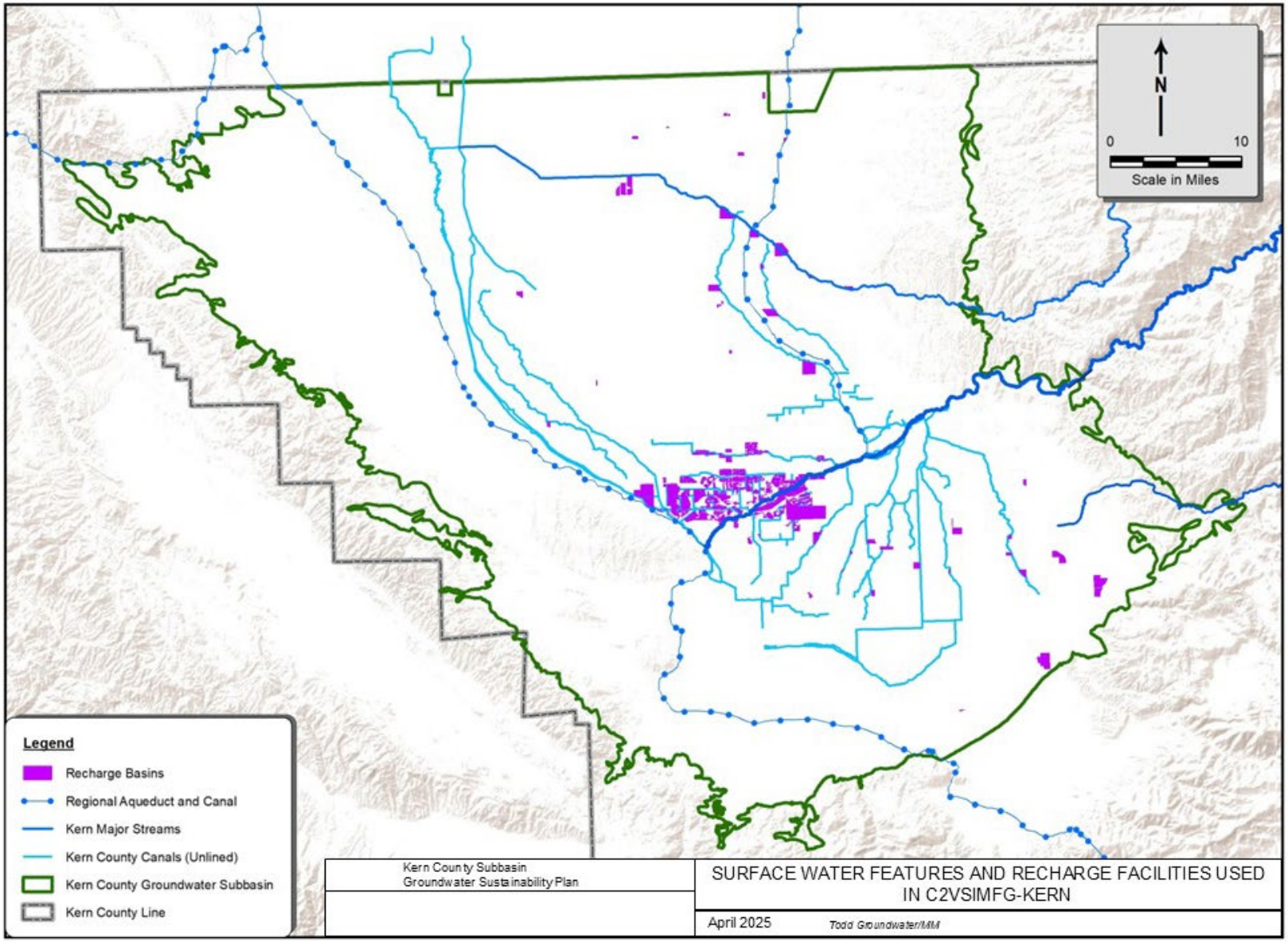


Figure 9-4. Surface Water Features and Recharge Facilities Used in C2VSimFG-Kern

9.2.5 Water Banking and Conjunctive Use Projects

☑ **23 CCR § 354.18(b)(2)**
☑ **23 CCR § 354.18(d)**

During initial discussions with the C2VSim developers at DWR in 2019, it was revealed that significant model uncertainty was related to incomplete data regarding water banking and conjunctive use projects in the Kern Subbasin. Recognizing the importance of these water banking projects for simulating groundwater conditions, the water banking and conjunctive use projects were updated using the earliest available records.

9.2.5.1 Recharge and Recovery Operations

A monthly time-series of recharge rates was determined for each recharge project. Recharge rates were allocated to individual recharge basins using the initial data whenever possible or were shared proportionally between basins based on historical monthly data. Recharge basin locations and recovery well locations were provided by each agency or project. The C2VSim finite element grid was overlaid onto a map of recharge basins to determine the model elements for each recharge location. Well location coordinates were added to C2VSimFG-Kern.

Monthly volumes for recharge at water banking and conjunctive use projects were compiled for 16 agencies and projects (Appendix H-1, Table 5). This information originated from multiple sources, and included data provided by agencies, compiled from agency reports, and compiled from Kern River Hydrographic Reports. The data includes monthly recharge for years prior to 1995 for many projects. Several agencies and projects provided data for multiple recharge basins. Some wells used for recovery of banked water are also used for other purposes such as supplementing agricultural or urban surface water deliveries.

Recognizing that several of the water banking and conjunctive use projects (especially those on the Kern Fan) pre-date the 20-year base period, and that future studies might simulate periods prior to 1985, all available historical data for water banking operations was reviewed and updated. This data is included with the data provided to DWR for their ongoing updates to C2VSim. These include:

- Arvin-Edison WSD (since 1966)
- Berrenda Mesa Project (since 1977)
- Buena Vista WSD (since 1963)
- City of Bakersfield 2800 Recharge Facilities (since 1973)
- North Kern WSD (since 1956)
- Rosedale-Rio Bravo WSD (since 1980)

Recharge and recovery data for the Kern Fan banking projects, including the Kern Water Bank, Berrenda Mesa Project, and Pioneer Project are tracked by the Kern County Water Agency. Banking data for district-specific water banking projects are provided by each of the districts. A summary of the data input for stored water recovery added to C2VSimFG-Kern is provided in Appendix H-1, Table 6.

9.2.5.2 Model Application

Surface water used for direct recharge at water banking and conjunctive use projects is applied to the model elements where the recharge basin is located. Three delivery fractions apportion are applied to each surface water diversion that include delivery to the direct recharge facility, loss to groundwater (recoverable loss), and loss to evaporation (non-recoverable loss).

Recovery well locations and screen intervals were used to enter each recovery well into C2VSimFG-Kern. The model includes 313 simulated pumping wells and 225 pumping time series for recovery of stored surface water. Data reported by local water districts and agencies and used in the model for this purpose is listed on Appendix H-1, Table 6.

Recovery of stored water for return obligations from the water banking projects is summarized in Appendix H-1, Table 7. Monthly stored water recovery was generally provided by well field and destination (e.g., agriculture, urban, canal pump-in, or export). This information was used to develop a pumping time series for each well field and destination.

9.2.6 Urban Water Demand

☑ **23 CCR § 354.18(b)(3)**
☑ **23 CCR § 354.18(d)**

C2VSim calculates urban water demands for specified urban delivery zones, allocates specified surface water and groundwater supplies to meet these demands, and can optionally pump additional groundwater to satisfy unmet urban demands in each zone. Urban demands were represented with nine urban zones in C2VSimFG-Beta. These zones were reconfigured, and a tenth urban zone was added representing Metropolitan Bakersfield in C2VSimFG-Kern. Historical urban populations and per capita water use rates were reviewed and updated.

9.2.6.1 Urban Zones

C2VSimFG-Kern dynamically calculates urban water demands for urban zones using time-series data of urban populations and monthly per capita water use. The urban delivery zones of C2VSimFG-Beta were modified to better represent Kern County population centers, jurisdictional boundaries, and urban water sources. Although Kern County urban water delivery systems are operated by many diverse entities, their water generally comes from two sources: surface water deliveries and agency-operated

groundwater wells. The nine Kern County urban zones in C2VSimFG-Kern are numbered 97 through 100 and 102 through 106. The Urban Zone boundaries from C2VSimFG-Beta were adjusted, as shown in Figure 9-5.

9.2.6.2 Urban Population and Per Capita Use

Historical annual urban populations for the urban zones are estimated using United States Census total population data from 1990, 2000, 2010 and 2020 (US Department of Commerce, 2018, 2023). Figure 9-6 shows the population density by census block within the Kern Subbasin based on the 2020 Census. The Metropolitan Bakersfield area has the highest population with about 72 percent of the total Kern Subbasin population. The smaller cities including Delano, McFarland, Wasco, Shafter, Arvin, Taft and surrounding areas have about 23 percent of the Kern Subbasin population. The rest of the Kern Subbasin has about 5 percent of the population, mostly in small unincorporated communities. The population within the Kern Subbasin has grown substantially over time. The total population in the Kern Subbasin based on U.S. Census data has changed as follows:

- 426,233 in 1990, an increase of 73 percent from the 1980 census
- 538,925 in 2000, an increase of 26 percent from the 1990 census
- 700,146 in 2010, an increase of 30 percent from the 2000 census
- 767,048 in 2020, an increase of 10 percent from the 2010 census

The majority of that growth has occurred in the Metropolitan Bakersfield area and in the smaller cities including Delano, McFarland, Wasco, Shafter, Arvin and surrounding areas.

Tabular historical census data and census block shapefiles were obtained from the Integrated Public Use Microdata Series (IPUMS) National Historical Geographic Information System Database (IPUMS, 2018). These data were combined to produce maps of the geographic distributions of populations within Kern County. The historical populations for each Urban Zone are estimated by mapping census block centroids to the ten Urban Zones using ArcGIS. The 1990, 2000, 2010, and 2020 populations of each Urban Zone were then estimated as the sum of the populations of the associated census blocks. Populations for other years were estimated using interpolation and extrapolation. The population values by Urban Zone used for C2VSimFG-Kern are listed in Appendix H-1, Table 8.

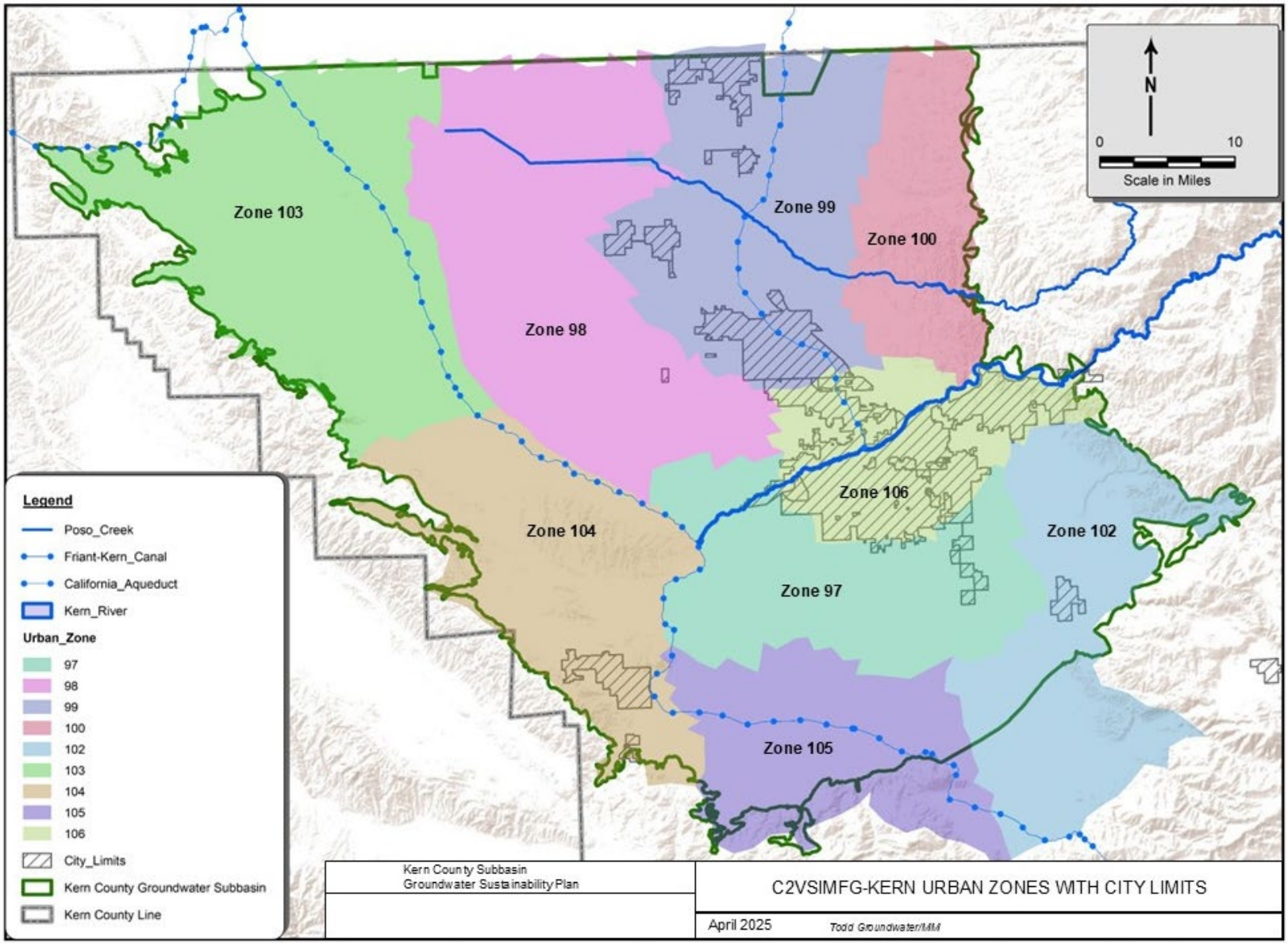


Figure 9-5. C2VSimFG-Kern Urban Zones with City Limits

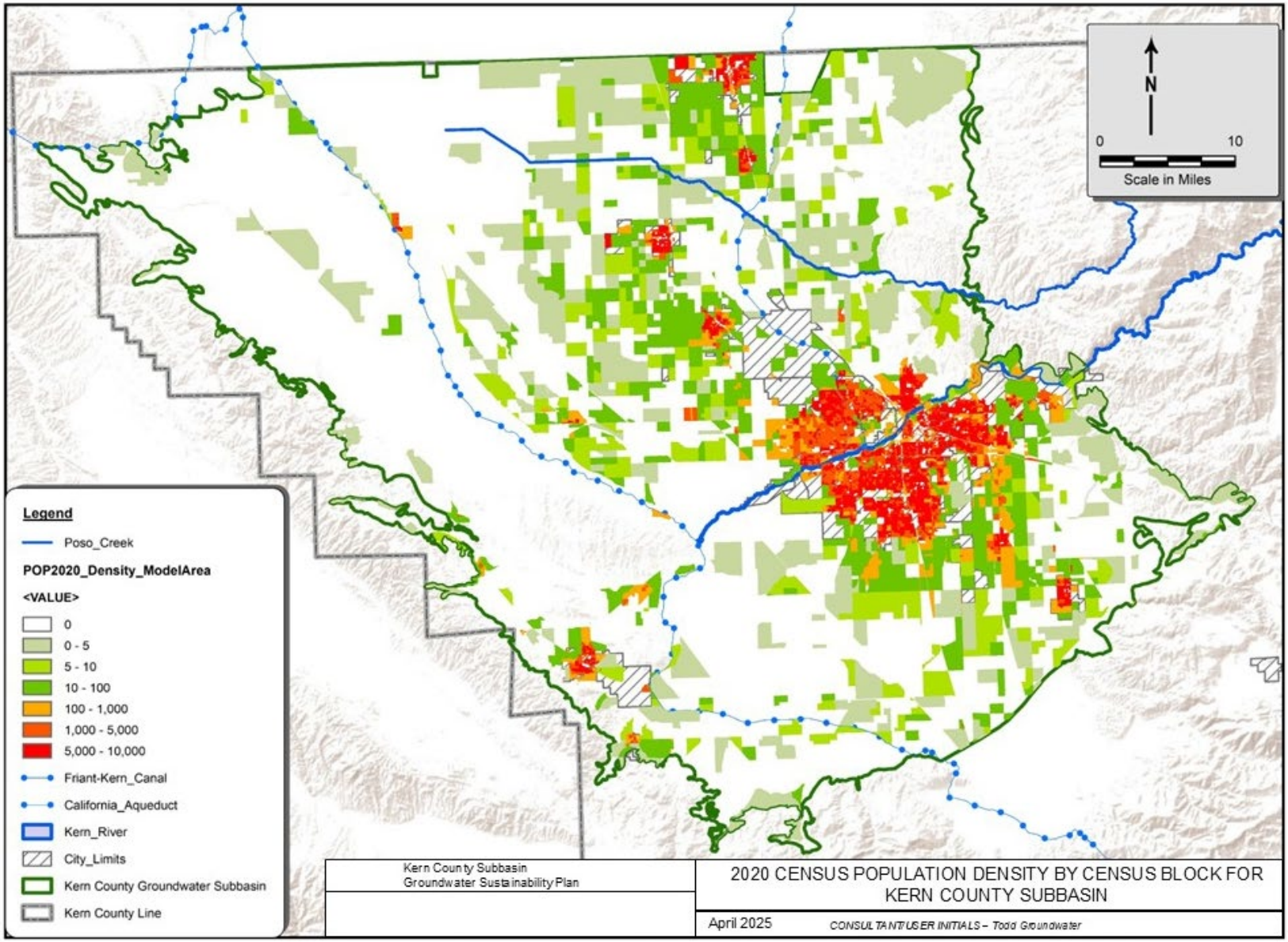


Figure 9-6. 2020 Census Population Density by Census Block for Kern Subbasin

9.2.6.3 Urban Water Use Specifications

Monthly historical urban water demands for Urban Zone 106 are calculated using water delivery data from the water purveyors in the Metropolitan Bakersfield area. Monthly historical urban water demands for the other urban zones in the Kern Subbasin are estimated using available water use data from published urban water management plans for the communities served in those zones. The historical monthly water use in each zone is then divided by the historical population to obtain the monthly per capita urban water demand. Monthly historical per capita water demands for zones without urban water management data are estimated using the per capita water demand from zones with similar demographics.

The urban water use specifications indicate the portion of total urban water that is used indoors. In C2VSimFG-Kern, the portion used indoors becomes urban return flow, and the remainder is added to the urban root zone where it contributes to evapotranspiration and deep percolation. C2VSimFG-Beta included monthly urban water use specifications for each model subregion. The urban per capita water use is based on local water supply data and urban water management plans. Appendix H-1, Table 9, lists the per capita water use data used for C2VSimFG-Kern.

9.2.6.4 Urban Wastewater

Urban wastewater for the Metropolitan Bakersfield area is treated at local wastewater treatment plants. However, wastewater disposal is primarily evaporation ponds or land disposal at locations outside of the Metropolitan Bakersfield area. C2VSimFG-Beta does not have a direct means to redirect wastewater to an outside location. Urban wastewater, based on indoor use, is applied uniformly within the urban zone. To get around this limitation, application of wastewater for the Metropolitan Bakersfield area was turned off in C2VSimFG-Kern. The wastewater deliveries to evaporation ponds and land disposal areas from the wastewater treatment plants is assigned to the appropriate location using data provided by the plants. This conserved the water balance by not double counting wastewater, and it is applied at the appropriate locations for evaluating groundwater levels.

9.2.6.5 Model Application

Historical annual urban population estimates are placed in the C2VSimFG-Kern urban population input file. Historical monthly urban per capita water demand estimates for each urban zone are placed in the C2VSimFG-Kern urban per capita water use file. Urban demand is calculated by C2VSimFG-Kern and the water supply to meet these demands is met first by specified surface water and groundwater pumping deliveries for urban use. The remaining water demand in each model element is met with groundwater pumped from the aquifer portion of that element.

9.2.7 Agricultural Crop Water Demand

☑ 23 CCR § 354.18(b)(3)
☑ 23 CCR § 354.18(d)

C2VSim dynamically calculates agricultural crop water demands and allocates supplies to meet these demands for each model element. Agricultural demands are calculated for 20 crops using historical crop acreage data and crop evapotranspiration (ETc) rates. Crop water demands in each model element are first met with stored soil moisture, precipitation, surface water deliveries, and specified groundwater deliveries. If the agricultural demands are not satisfied, the model can optionally calculate the additional groundwater pumping required to satisfy the unmet demands and extract that water from the groundwater component of the model element.

C2VSimFG-Beta contained one set of monthly ETc rates for each model subregion that are applied to all years despite climatic variation. New monthly ETc rates for three model subregions (northeast, northwest, and south) in Kern County were calculated for 1993-2023 using monthly remote sensing imagery and detailed annual crop maps. ETc rates for 1974 to 1992 were estimated from 1993 to 2015 values by using the values for similar water year types based on the San Joaquin Index. Satellite data are not available for 2012, so ITRC was unable to provide Mapping of Evapotranspiration with Internal Calibration (METRIC) data for 2012. In C2VSimFG-Kern, 2013 was applied as an appropriate proxy for ETc data in 2012 because of their hydrologic similarity.

A remote sensing study of historical ETc rates across the entire Kern Subbasin by the ITRC (ITRC, 2017) provided detailed Subbasin-wide agricultural demands that corresponded to the WY1995 to WY2022 base period. These data were used to develop monthly ETc rates for the Kern County portion of the model. ET data for WY2023 are provided by LandIQ under the Kern Subbasin's SGMA GSP Implementation Round 1 Grant following the same process used for the ITRC METRIC data.

9.2.7.1 ET Rates

The ITRC at California Polytechnic State University, San Luis Obispo, has developed a procedure to use remote sensing imagery from Landsat satellites to calculate historic ETc rates (ITRC, 2017). The METRIC method was originally developed by Richard Allen of the University of Idaho. ITRC made several modifications to the original METRIC method to better match California data and conditions (named the ITRC-METRIC method). These modifications include using grass for reference evapotranspiration (ETo), incorporating a semi-automated calibration procedure and spatially interpolating ETo rates. An example of the METRIC ET data for the total annual ET in 2013 is shown in Figure 9-7.

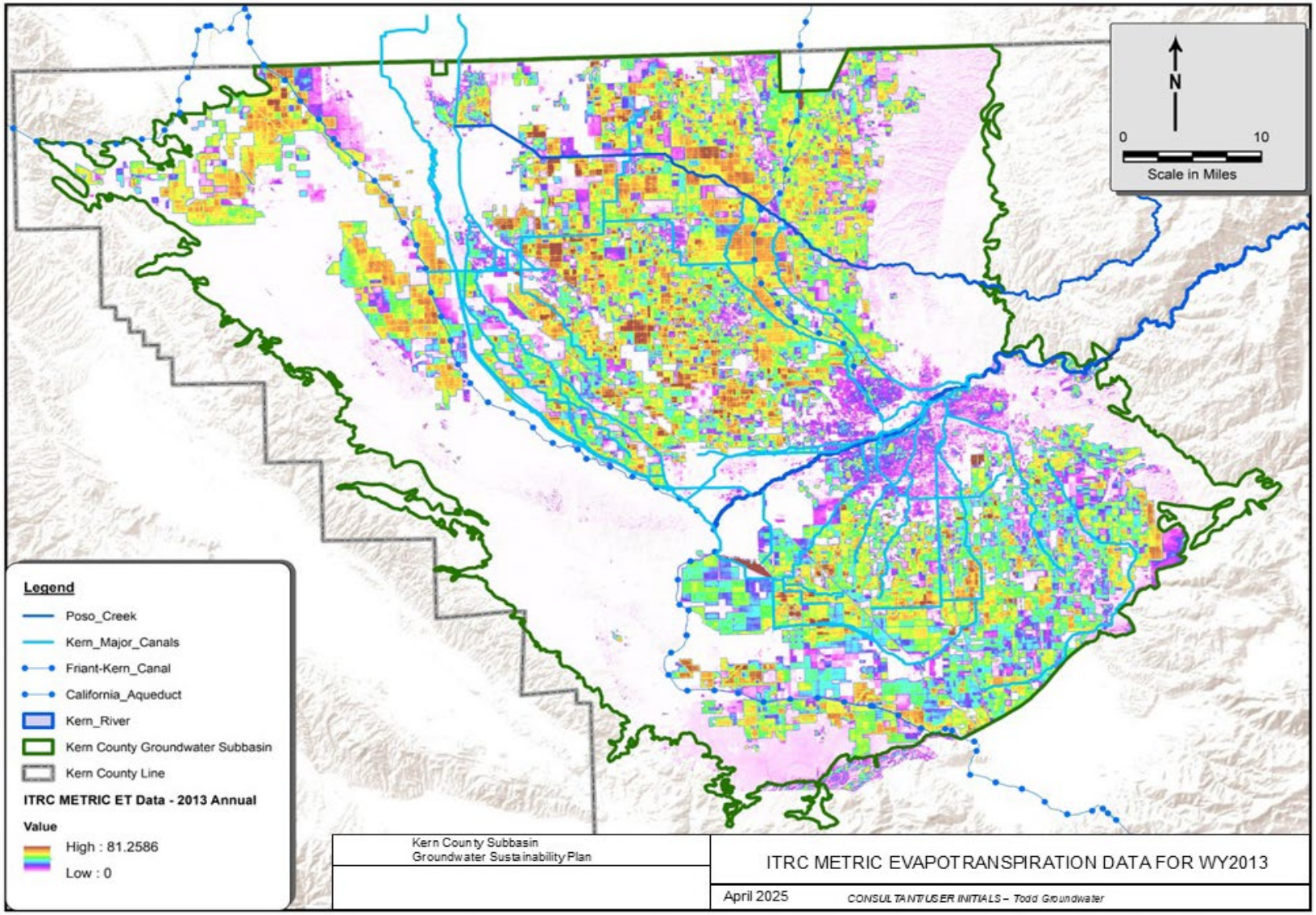


Figure 9-7. ITRC METRIC Evapotranspiration Data for WY2013

ITRC used Landsat imagery for 1994 to 2022 (except 2012 when no imagery was available) and the ITRC-METRIC method to develop monthly raster maps of ETc at 30 x 30-meter resolution for the Kern County portion of the Central Valley (ITRC, 2017, 2020, 2021, 2022, and 2023). For WY2023, similar ET data sets were provided by LandIQ as part of their Round 1 SGM Grant Component 3.

The monthly ETc raster maps were used with annual DWR crop maps to calculate the average ETc by crop type for the three Kern County C2VSim subregions. ITRC-METRIC raster data were used to determine the exact areas of applied irrigation and total annual ETc. A raster pixel was assumed to be irrigated if the total annual ETc was greater than 20 inches. The following data processing steps were used to determine monthly ETc rates for each crop and C2VSim subregion:

- Create irrigation coverages – ITRC-METRIC monthly ETc raster data were summed to calculate total annual ETc for each year for each raster location. The ArcGIS Reclassify tool was then used on each annual ETc raster to create a binary polygon coverage for each year for 1994 to 2015 (except 2012), setting the attribute “IRR” to one if total annual ETc was over 20 in/year, and to zero if total annual ETc was equal to or less than 20 in/year.
- Create land use coverages – Annual DWR land use rasters were converted to polygon coverages with the attribute “crop” set to the corresponding integer crop value used in C2VSimFG-Kern. The land use rasters were checked against GIS maps produced by the Kern County Agricultural Commissioner and errors in the DWR land use rasters were corrected. DWR land use maps for 1994 to 1997 were missing large areas of data, so the 1998 land use map was used to approximate the land use for 1994 to 1997.
- Create monthly zone maps – One zone shapefile was created for each month by using the ArcGIS Union tool to combine a shapefile of the three C2VSim subregions with the irrigation coverage (produced in step 1) and the land use coverage (produced in step 2). Each monthly zone polygon shapefile has three attributes: C2VSim subregion, binary irrigation indicator, and a land use crop value. The dissolve function was used to combine zones with identical parameters.
- Calculate average monthly ETc for each zone – The ArcGIS Zonal Statistics by Table tool was used to calculate the average ETc value for each zone for each month. The individual pixels in each monthly ETc raster were averaged within each zone (produced in step 3). ITRC-METRIC data for 2013 were used in place of missing data for 2012.
- Combine tables – The MS Access Append function was used to combine the monthly ETc tables into a master table of monthly ETc by crop and C2VSim subregion.

- Output data – Data from the Access database was exported in a form consistent with the C2VSimFG-Kern input files. The output was also summarized to show the average monthly ETc for the irrigated area of each crop type in each model subregion.

The monthly ETc rates for the three Kern County subregions for WY1993-2023 were then replaced with the monthly ETc rates calculated. The annual ETc rates applied to C2VSimFG-Kern by crop type are listed in Appendix H-1, Table 10.

9.2.7.2 Irrigation Periods

The C2VSim Irrigation Periods file contains monthly parameters for each crop and subregion that indicate whether or not the crop is irrigated in that month. C2VSimFG-Beta irrigation periods for the three Kern County subregions were adjusted to match crop irrigation practices from ITRC-METRIC water usage. Simulated irrigation water usage for the C2VSimFG-Kern better reflects observed irrigation practices.

9.3 Historical and Current Subbasin Water Budgets

> ***§ 354.18.*** *Water Budget*
>
> *(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:*
>
> *(1) Total surface water entering and leaving a basin by water source type.*
>
> *(4) The change in the annual volume of groundwater in storage between seasonal high conditions.*
>
> *(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:*
>
> *(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.*
>
> *(2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:*
>
> *(C) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.*
>
> *(D) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.*
>
> *(E) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.*

C2VSimFG-Kern was used to develop historical (WY1995 to WY2014) and current (WY2015 to WY2023) water budgets for the Kern Subbasin. The following summarizes the simulated water budgets from C2VSimFG-Kern. A summary of these results is provided below.

9.3.1 Total Surface Water Inflows and Outflows

☑ 23 CCR § 354.18(b)(1)

The volume of surface water supplies delivered to the Kern Subbasin is summarized below follows SGMA Regulations and DWR Water Budget BMP (DWR, 2016a) reporting requirements for total surface water entering and leaving the Kern Subbasin. Descriptions of the surface water supply are provided above in the Section 9.2.

Surface water supplies and water use for the Kern Subbasin are compiled from data collected using the "best available measurement methods." Weirs and meters used in the Kern Subbasin conform to the SBx7-7 volumetric accounting standards (ITRC, 2012; USBR, 2001; AWWA 2006, 2012) as documented in local water district agricultural water management plans. Procedures employed by water agencies have been standardized to further reduce potential sources of error to range between 1% to 10 percent depending on the measurement device.

For the Kern Subbasin, surface water supplies are directly measured by local water agencies at the point of diversion from a river, stream or canal. The measured surface water supplies were provided by local agricultural water districts, urban water purveyors and city water departments. These meter data were compiled by local water agencies following their monitoring protocols. Therefore, these data were obtained using a "high accuracy" method consistent with typical accuracy ranges of surface water diversions. Using the methods described above, the surface water supply by source in the Kern Subbasin was tabulated and is summarized in Table 9-1 and shown graphically in Figure 9-8.

Table 9-1. Average Annual Surface Water Supplies in the Kern Subbasin

Surface Water Supply Source	Historical Period WY1995 to WY2014 (acre-feet)	Current Period WY2015 to WY2023 (acre-feet)
Central Valley Project	360,362	316,952
State Water Project	856,255	777,185
Colorado River Project	0	0
Local Supplies	728,805	648,631
Local Imported Supplies	23,939	39,244
Recycled Water	40,265	48,359
Desalination	0	0
Other Water Source	12,340	987
Total Surface Water Supply	2,021,966	1,831,358

Following the DWR Water Budget BMP (DWR, 2016a), the surface water supplies are presented by water source. For the Kern Subbasin, the water supply sources are described as follows:

- **Central Valley Project (CVP)** – Surface water deliveries from the CVP diverted from the Friant-Kern Canal and/or California Aqueduct (westside CVP – Cross Valley Contractors, San Joaquin River Restoration Program Recapture, and Recirculation).
- **State Water Project (SWP)** – Surface water deliveries from the SWP diverted from the California Aqueduct.
- **Colorado River Project** – Currently, no surface water from the Colorado River is delivered to the Kern Subbasin.
- **Local Supplies** – Surface water diversions from local surface water sources. The primary local supply is from the Kern River, but also includes other local sources such as Poso Creek and water exchanges.
- **Local Imported Supplies** – Surface water from local sources imported from areas outside of the Kern Subbasin. The primary source of local imported water is from treated oilfield produced water**.**
- **Recycled Water** – Wastewater and recovered stormwater that is treated and used for either agriculture or groundwater recharge.
- **Desalination Water** – Currently, no desalination water is available in the Kern Subbasin. However, proposed SGMA projects include this source as a future water supply.
- **Other Water Source** – Reuse of tailwater or irrigation return flow that re-enters the local surface water system and is then diverted back for irrigated agriculture water supply.

The total water use for the Kern Subbasin as summarized by water use sector in Table 9-2.

Table 9-2. Average Annual Surface Water Use by Sector in the Kern Subbasin

Surface Water Use Water Use Sector	Historical Period WY1995 to WY2014 (acre-feet)	Current Period WY2015 to WY2023 (acre-feet)
Urban	42,547	49,325
Industrial	2,369	2,263
Agricultural	1,726,262	1,405,005
Managed Wetland	17,635	14,303
Managed Recharge[1]	233,153	360,461
Native Vegetation	0	0

Surface Water Use Water Use Sector	Historical Period WY1995 to WY2014 (acre-feet)	Current Period WY2015 to WY2023 (acre-feet)
Other Water Uses	0	0
Total Water Use	2,021,966	1,831,358

[1]includes Water Banking and Conjunctive Use Projects

The water use sectors shown on Table 9-2 are described as follows:

- **Urban –** total surface water use for all urban water uses including residential, commercial, municipal, industrial, landscaping, and other uses.
- **Industrial** – total surface water use for industrial use.
- **Agricultural** – total surface water use for all agricultural water uses including consumptive use and return flows.
- **Managed Wetlands –** total surface water use for maintaining managed wetlands at the Kern National Wildlife Refuge.
- **Managed Recharge** – total surface water use for active recharge at the water banking and conjunctive use projects.
- **Native Vegetation** – total surface water use for maintaining native vegetation. No surface water deliveries ae used on native vegetation.
- **Other Water Uses** – total surface water use for uses other than those listed above or from unspecified uses.

The surface water supplies in the Kern Subbasin vary from year-to-year due to water year type (Figure 9-3), statewide water demand and operational considerations.

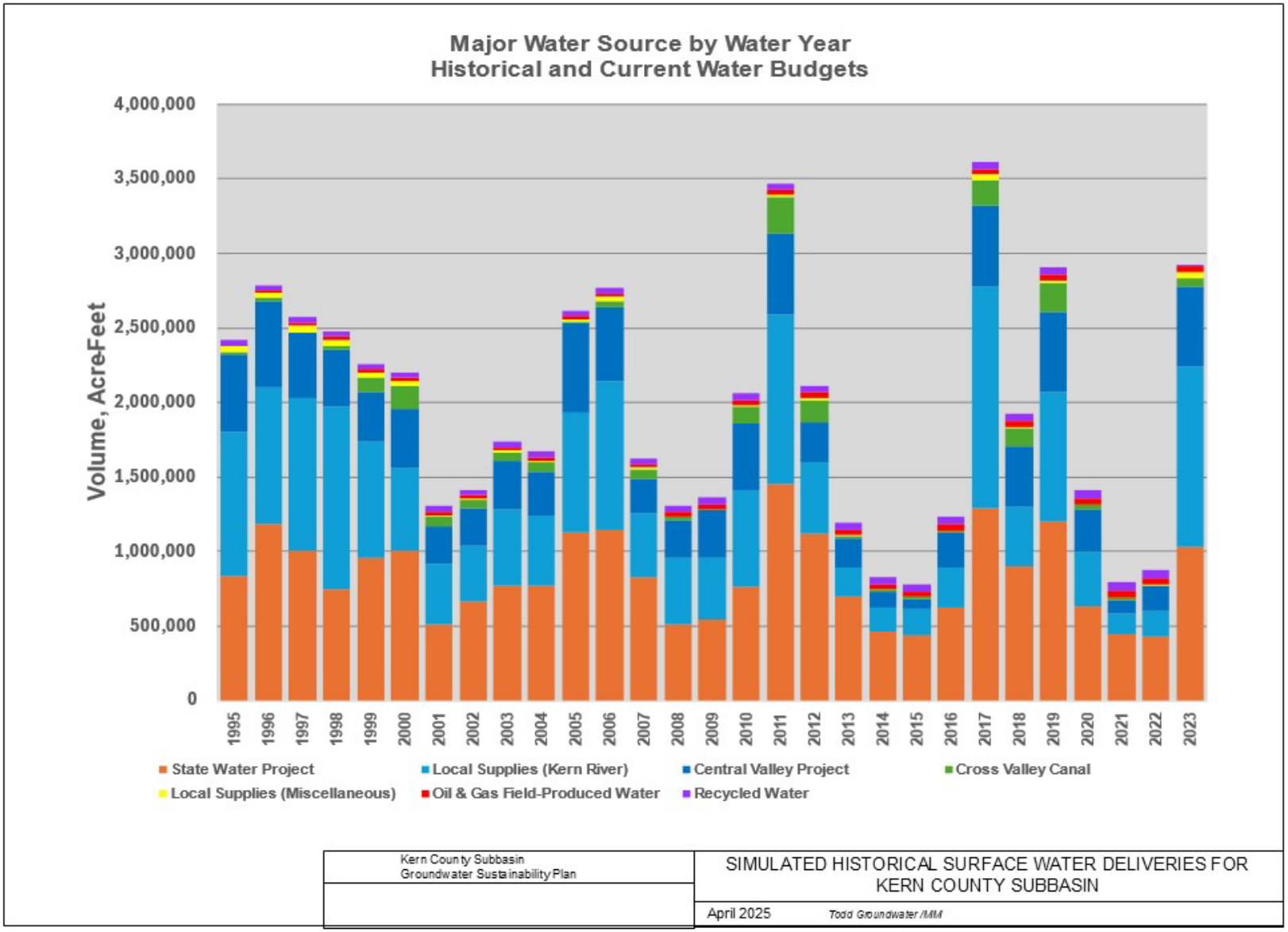


Figure 9-8. Simulated Historical Surface Water Deliveries for Kern Subbasin

9.3.2 Historical and Current Groundwater Budgets

☑ 23 CCR § 354.18(c)(1)
☑ 23 CCR § 354.18(c)(2)
☑ 23 CCR § 354.18(b)(4)

As discussed in Section 9.2.3, the historical period of WY1995 to WY2014 represents a hydrologically balanced period that provides a well-balanced base period for evaluating long-term conditions. This period represents a hydrologically balanced period that is characterized by the following hydrologic conditions:

- For the San Joaquin Valley Index (Figure 9-3), the 20-year historical period contains 10 years characterized as above normal or wet water year types and 10 years of below normal, dry, or critically dry water year types, including four critically dry years.
- For the Kern River Water Year Index (Figure 9-3), the 20-year historical period streamflow conditions on the Kern River include nine years above 100 percent and 11 years below 100 percent.

The current water budget period of WY2015 through WY2023 includes recent available data following the historical water budget period. However, this period does not represent a hydrologically balanced period. This period represents a hydrologically unbalanced period that is characterized by the following hydrologic conditions:

- For the San Joaquin Valley Index (Figure 9-3), the 9-year current period contains three years characterized as above normal or wet water year types and six years of below average water year types including three critically dry periods.
- For the Kern River Water Year Index (Figure 9-3), the 9-year current period streamflow conditions on the Kern River include three years above 100 percent and six years below 100 percent.
- During the 9-year current period, dry years represent two-thirds of the time period. Despite the three wet water year types, the current period is considered to represent an unbalanced base period that skews towards to dry hydrologic conditions.

The historical and current water budget components are summarized in Table 9-3 based on C2VSimFG-Kern results provided in Appendix H-1, Table 11. Figure 9-9 shows a histogram illustrating the average annual historical water budget for the Kern Subbasin.

The simulated annual water budgets based on C2VSimFG-Kern for the WY1995 through WY2023 simulation period are presented in Appendix H-1, Table 11, and are

graphically depicted on Figure 9-8. This timeframe includes both the historical water budget period and the current water budget period.

Table 9-3. Historical and Current Water Budget Summary

Water Budget Component	Historical Water Budget Summary for WY1995 to WY2014 (acre-feet)	Current Water Budget Summary for WY2015 to WY2023 (acre-feet)
INFLOWS		
Deep Percolation	668,340	652,709
Water Banking and Conjunctive Use	583,598	731,434
Groundwater-Surface Water Interactions	98,600	95,425
Small Watershed Inflow	48,760	61,995
OUTFLOWS		
Groundwater Pumping	1,586,418	1,817,881
Net Subbasin Subsurface Outflow	87,080	67,702
SUMMARY		
Subtotal - Inflow	1,399,298	1,541,563
Subtotal – Outflow (as negative number)	-1,673,498	-1,885,583
Change in Groundwater Storage	-274,200	-344,019

The results for the historical and current water budget are summarized under the following categories:

- **Deep Percolation** – Precipitation and applied water that percolates below the root zone and through the unsaturated zone to provide groundwater recharge. More detailed information is provided in Appendix H-1, Table 12.
- **Water Banking and Conjunctive Use** – Direct recharge of surface water at water banking operations, conjunctive use projects, and other managed recharge sources. More detailed information is provided in Appendix H-1, Table 12.
- **Groundwater-Surface Water Interactions** – Net volumetric exchange of surface water and groundwater between the aquifer and simulated streams, which include Kern River and Poso Creek. These are both losing streams where surface water infiltrates to groundwater. More detailed information is provided in Appendix H-1, Table 13.
- **Small Watershed Inflow** – Inflows to the Kern Subbasin from the surrounding small watersheds as percolation of stream inflow and subsurface inflow from the watershed area. More detailed information is provided in Appendix H-1, Table 13.

- **Groundwater Pumping** – Total groundwater pumping by wells. Water banking stored surface water recovery pumping is specified as fixed input values and agricultural and municipal pumping is calculated by C2VSimFG-Kern based on demand minus surface water diversions. More detailed information is provided in Appendix H-1, Table 14.
- **Net Subbasin Subsurface Outflow** - Net subsurface groundwater flow to and from the Kern Subbasin with adjoining groundwater basins: negative is a net flow out of the Kern Subbasin and positive is a net flow into the Kern Subbasin. More detailed information is provided in Appendix H-1, Table 13.
- **Change in Groundwater in Storage** – Net change in the volume of water, including both groundwater and banked surface water, stored within the aquifer. The change is the result of the inflow minus outflow components. A negative change in storage represents water that is removed from the aquifer to supply water by pumping or other outflows, resulting in a decline in groundwater levels. A positive change in storage represents water being added to the aquifer from one of the recharge components of the water budget, resulting in an increase in groundwater levels. More detailed information is provided in Appendix H-1, Table 11.

Table 9-4 shows the volumetric range of annual variability for each water budget component from WY1995 though WY2023 in acre-feet from Appendix H-1, Table 11. This high variability in year-to-year water budgets is generally due to seasonal variations in precipitation, imported water availability and utilization of water banking and conjunctive use projects. During wet and above normal water years, increased availability of surface water supplies meets a large percentage of the local water use which thereby reduces total groundwater pumping in the Kern Subbasin. Conversely, in dry and critically dry water years, the limited availability of surface water supplies results in a greater reliance on pumping from the Kern Subbasin.

Table 9-4. Annual volumetric range for each water budget component from WY1995 though WY2023 in acre-feet

Water Budget Component	Minimum	Maximum	Median	Average
INFLOWS				
Deep Percolation	427,452	1,111,864	594,742	663,489
Water Banking and Conjunctive Use	84,456	1,879,808	462,522	629,478
Groundwater-Surface Water Interactions	26,256	259,377	80,305	97,615
Small Watershed Inflow	17,832	155,312	36,058	52,867
OUTFLOWS				
Groundwater Pumping	-2,817,057	-882,967	-1,529,196	-1,658,251
Subsurface Flow with Adjacent Basins	-96,620	-58,578	-83,943	-81,066

Water Budget Component	Minimum	Maximum	Median	Average
STORAGE CHANGE				
Change in Groundwater in Storage	-2,303,716	2,289,354	-392,758	-295,868

The simulated change in groundwater in storage varies over the historical and current water budget periods is closely related to climatic conditions and surface water supply availability (Figure 9-11). During the periods, there are 11 years (WY1995 to WY1999, WY2005, WY2006, WY2011, WY2017, WY2019, and WY2023) with stable to increasing groundwater storage volume correlating to the above average rainfall and surface water availability. During the historical and current periods, there are 18 years (WYs2000 to 2004, WYs2007 to 2010 and WYs2012 to WY2016, WY2018, WY2020 to 2022) where groundwater storage volume decreased, correlating to periods of drought and low surface water availability. The simulated historical and current groundwater recharge also reflects this climatic pattern with high volumes of deep percolation to groundwater and large increases in water banking and conjunctive use projects and canal seepage during years with above average surface supplies and lower groundwater recharge during the drought years (Figure 9-11).

During the severe drought conditions from WY2013 to WY2022, which includes five critically -dry water years over this 10-year period, surface water supplies to the Kern Subbasin were severely limited. To improve the Kern Subbasin's water supply resiliency, the Kern Subbasin GSAs further expanded the use of water banking and conjunctive use projects. During wet and above normal water types, a portion of the available surface water supplies are stored in water banking and conjunctive use projects, resulting in a large increase in Water Banking and Conjunctive Use volumes in the model. This stored surface water is later recovered by pumping or other surface water exchanges that results in an increase in the total pumping in the Kern Subbasin. However, the water banking projects are operated so that the total recovered surface water is less than the total recharged water. The portion of water not recovered, or the "leave-behind" percentage, accounts for potential losses and provides a long-term groundwater benefit to the Kern Subbasin.

The annual surface water deliveries for managed recharge in the Kern Subbasin is shown in Figure 9-12 and is based on reported data from the water banking and conjunctive use project operators for direct aquifer recharge that is input directly into the model. The data shows that recharge is highest during above normal and wet water year types and lowest during below normal, dry, and critically dry water year types. The increase in the wet water year type recharge over time reflects the growth of water banking and conjunctive use projects in the Kern Subbasin over the historical and current periods.

The annual groundwater pumping for the Kern Subbasin from C2VSimFG-Kern shown Table 9-2 and Figure 9-13 is based on a combination of reported pumping entered directly into the model and simulated pumping to account for unreported pumping. The

pumping on Figure 9-13 shows agricultural, urban, and managed recharge pumping. Agricultural and urban pumping increased over the historical period with the highest uses during critically dry water years and substantially lower use during wet water years. However, agricultural pumping shows a general decreasing trend over the current period relative to the latter part of the historical period. Managed recharge pumping is the recovery of stored surface water for water banking and some conjunctive use projects for local agricultural and urban supply, as well as water banking obligations both for use within the Kern Subbasin and for banking partners outside of the Kern Subbasin. The increase in managed recharge pumping illustrates the growth in water banking and conjunctive use projects over the historical period.

The annual surface water supplies for agricultural, urban, and other beneficial uses within the Kern Subbasin are shown in Figure 9-8 and are based on reported surface water supplies from the water agencies that are input directly into the model. Agricultural uses account for about 96 percent of the surface water use, urban accounts for about three percent, and miscellaneous other uses account for about one percent. Surface water supplies are strongly associated with water year type. During dry and critically dry conditions, surface water supplies are severely limited. Figure 9-8 shows a general declining trend in surface water supplies over the historical period.

Agriculture is a primary water use within the Kern Subbasin. Figure 9-14 shows the annual change over time in irrigated agricultural acreage and agricultural crop evaporation or crop demand. More detailed information is provided in Appendix H-1, Table 15. During the historical period, irrigated agricultural acreage was highest in the mid-1990s, ranging from 800,000 to 900,000 acres. During this period, annual crops accounted for about two-thirds of the total acreage with cotton and alfalfa the dominant crop. From WYs2000 to 2014, the irrigated agricultural acreage ranged from 700,000 to 800,000 acres. During this period, crop types were shifting from predominantly annual to permanent crops. Over the historical period, the average annual crop demand decreased from 2.5 million to 2.0 million acre-feet per year that generally correlates to the decrease in irrigated acreage. Over the current period of WY2015 to 2023, irrigated agricultural acreage has ranged between 750,000 and 800,000 with permanent crops, primarily tree nuts, being predominant. Over the current period, the average annual crop demand decreased from 2.1 million to 1.9 million acre-feet per year. This is considered to represent a combination of a decrease in irrigated acreage and improvements in irrigation efficiency. Agricultural land use and evapotranspiration (crop water demand) during the historical and current periods is shown in Figure 9-14.

Urban demands in C2VSimFG-Kern are based on agency supplied information and/or regional population and per-capita water demand. Population information was from projected-future baseline population. In general, total urban use rose during the historical period in response to increasing population. Urban water use peaked in 2011. Since 2011, urban water use has decreased due to mandated water conservation measures. Between 2010 and 2020, population growth moderated (Section 9.2.6.2)

allowing for urban water use to show a declining trend over the current period. More detailed information on urban water use is provided in Appendix H-1, Table 16.

Deep percolation includes the precipitation and applied water that percolates below the root zone and through the unsaturated zone to provide groundwater recharge. Agricultural areas have the highest deep percolation that accounts for both precipitation and applied water in these areas. Urban areas also include both precipitation and applied water from outdoor water use but are smaller in area. Native or undeveloped areas include only precipitation since there is no applied water in these areas. More detailed information is provided in Appendix H-1, Table 12.

Groundwater flow exits the Kern Subbasin across the northern Subbasin boundary with the Tulare Lake and Tule Subbasins (Section 8.1). Along the western half of the northern Subbasin boundary, groundwater flow is typically northward. This produces a consistent outflow towards the Tulare Lake and Tule Subbasins. Along the southern Subbasin boundary, groundwater flow is typically northward indicating a consistent inflow from the White Wolf Subbasin that is restricted by the bounding White Wolf Fault. The northern outflow is greater than the southern inflow, so the net subsurface flow with adjoining subbasins is an outflow. More detailed information on the net boundary subsurface flow is provided in Appendix H-1, Table 13.

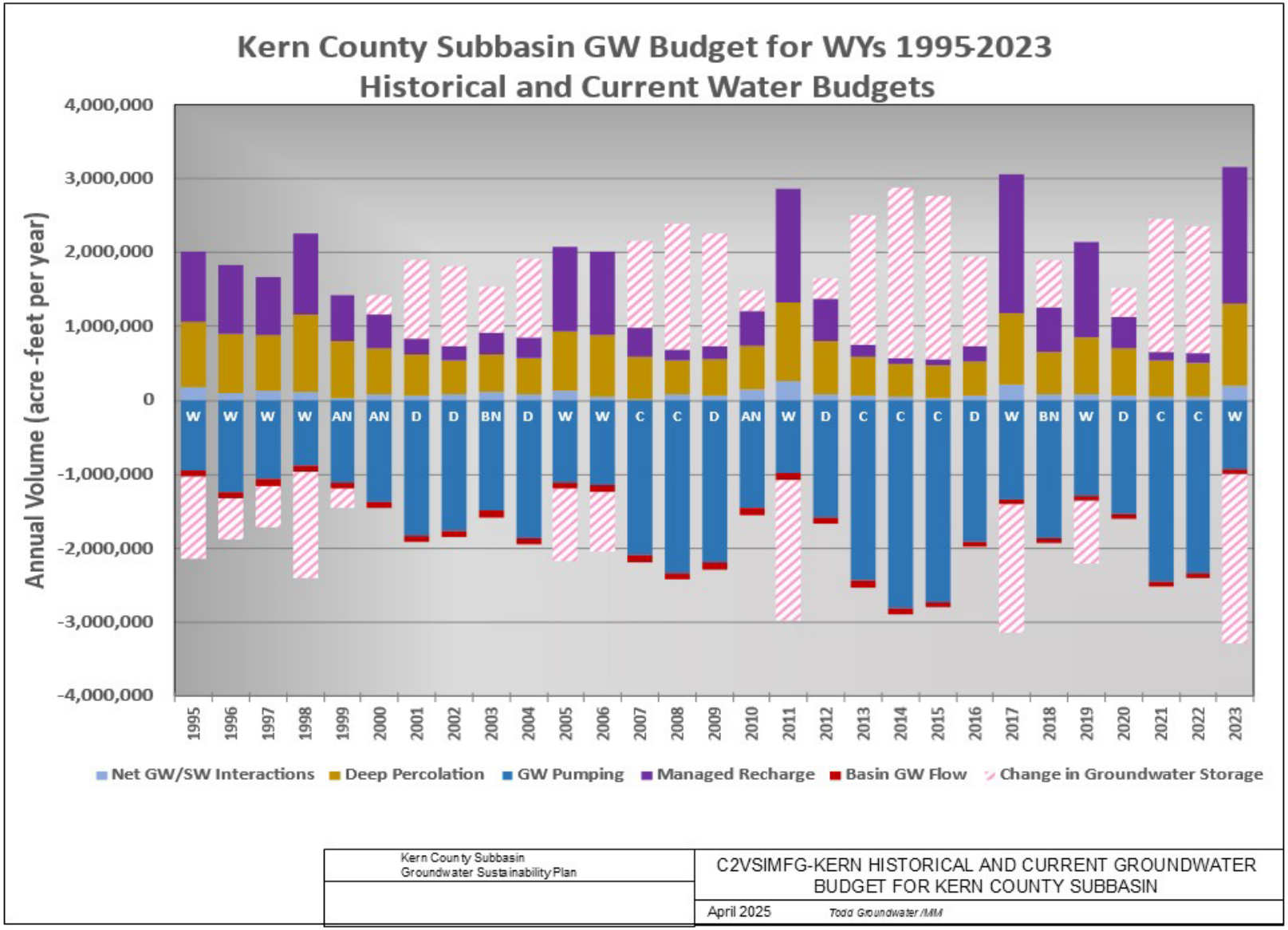


Figure 9-9. C2VSimFG-Kern Historical and Current Groundwater Budget- for Kern Subbasin

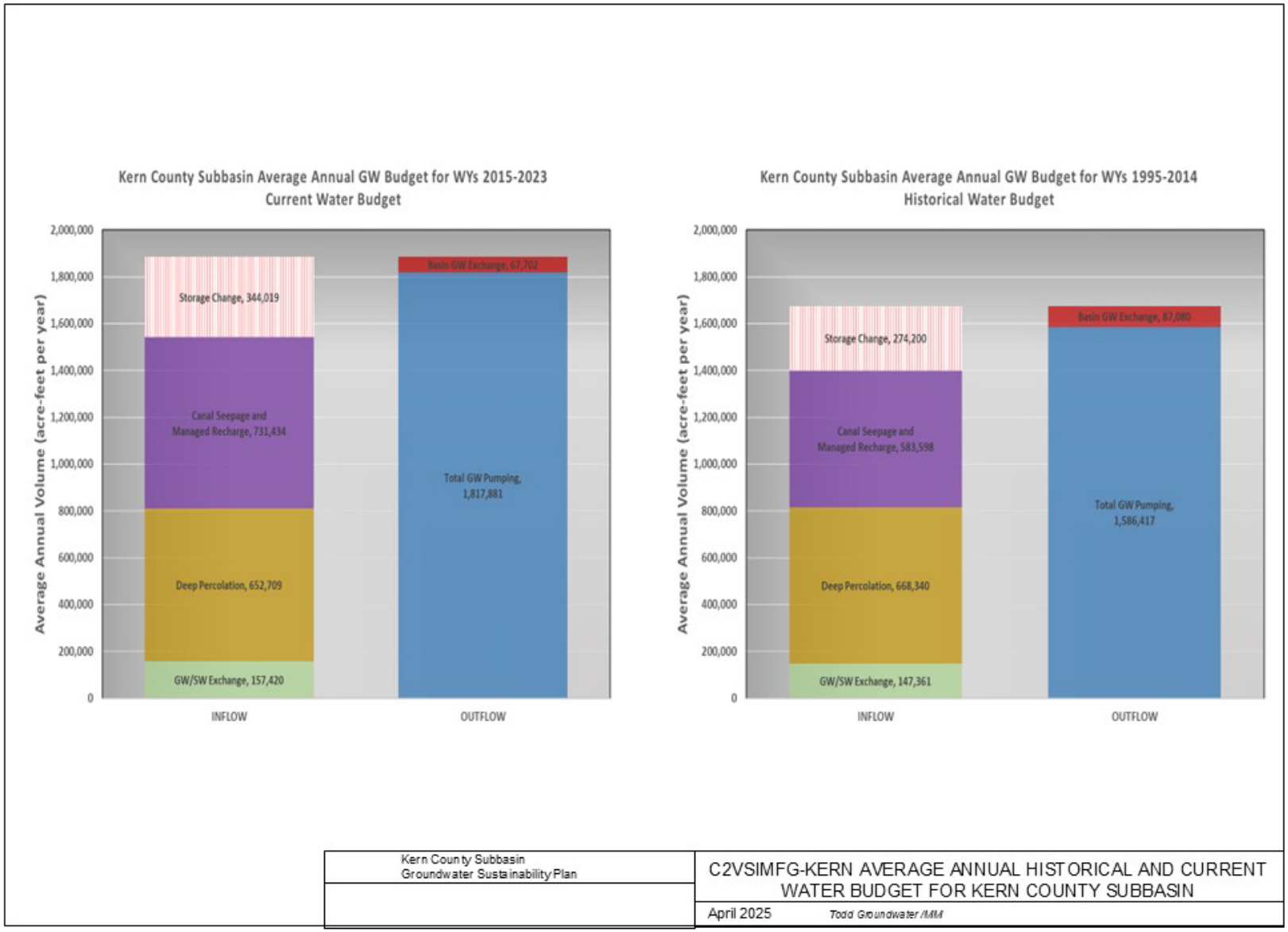


Figure 9-10. C2VSimFG-Kern Average Annual Historical and Current Water Budget for Kern Subbasin

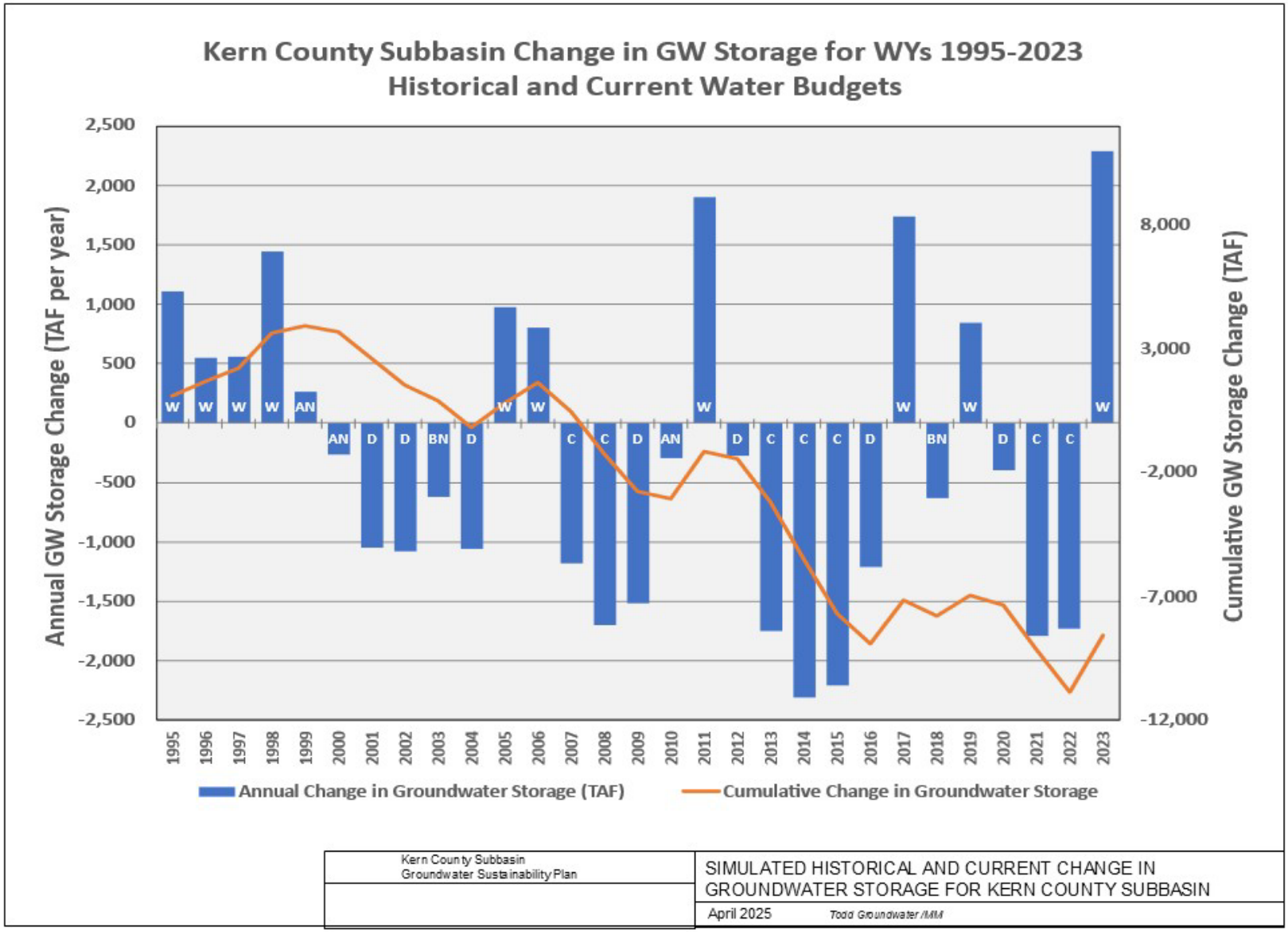


Figure 9-11. Simulated Historical and Current change in Groundwater Storage for Kern Subbasin

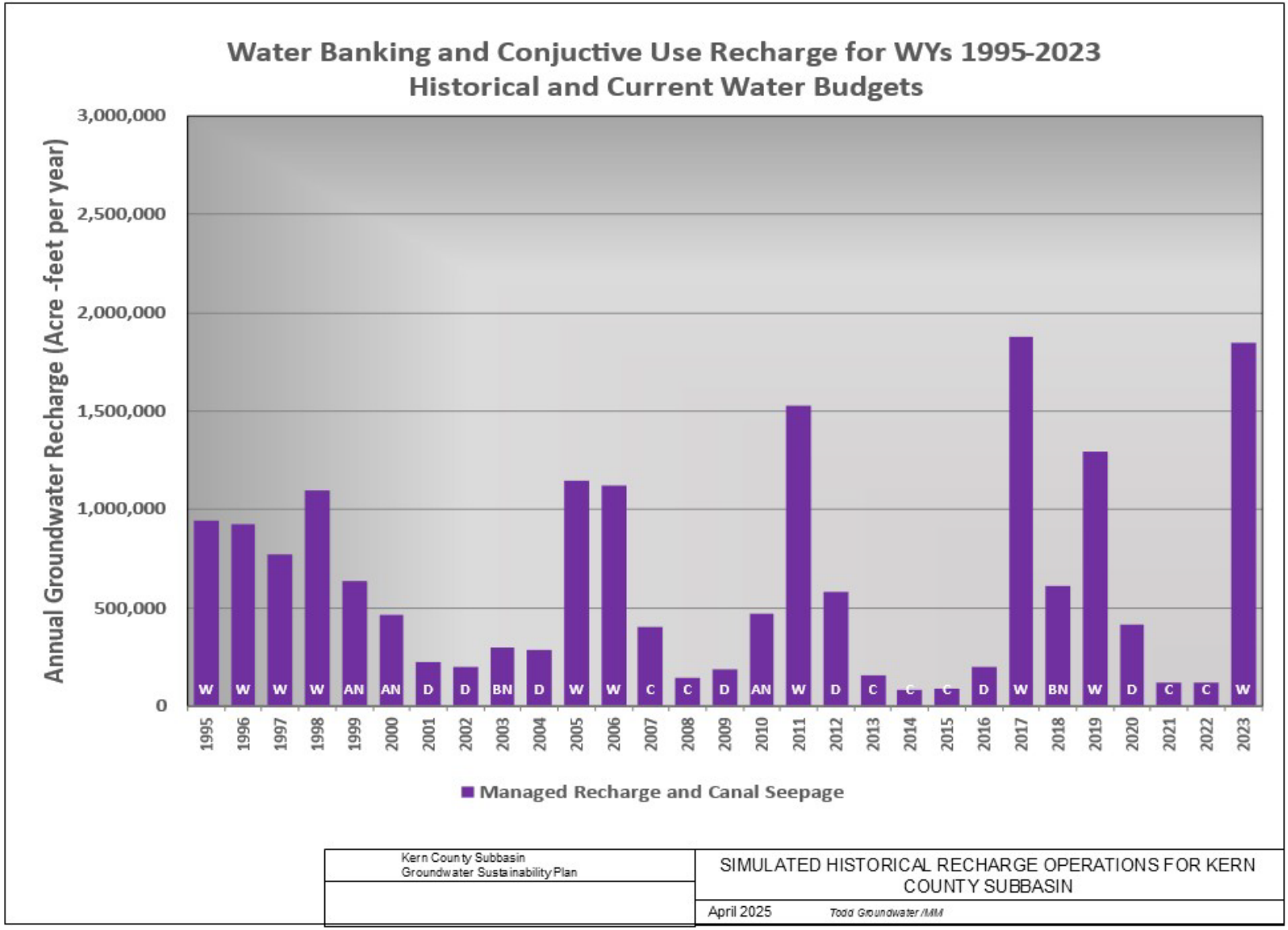


Figure 9-12. Simulated Historical Recharge Operations for Kern Subbasin

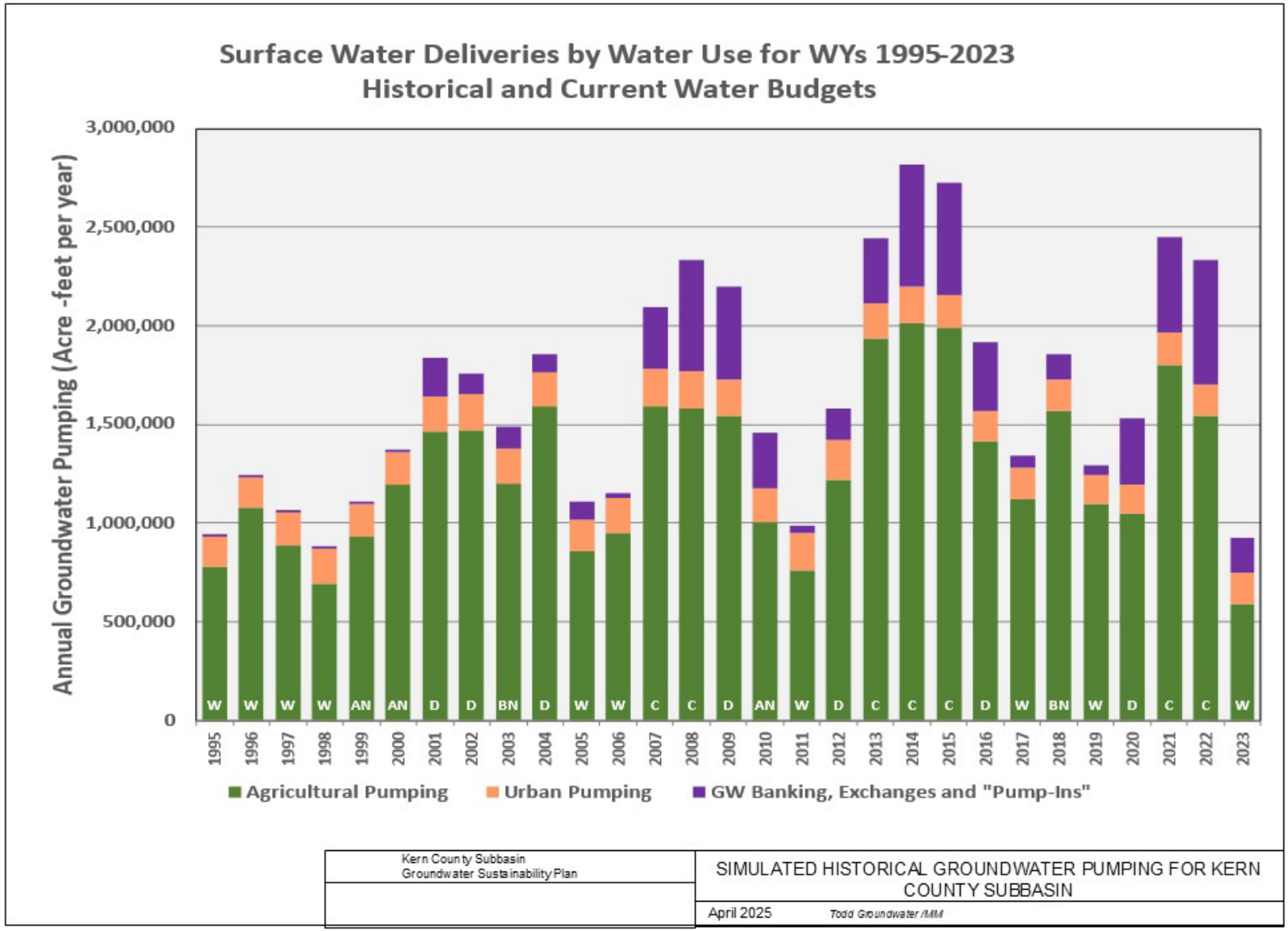


Figure 9-13. Simulated Historical and Current Groundwater Pumping for Kern Subbasin

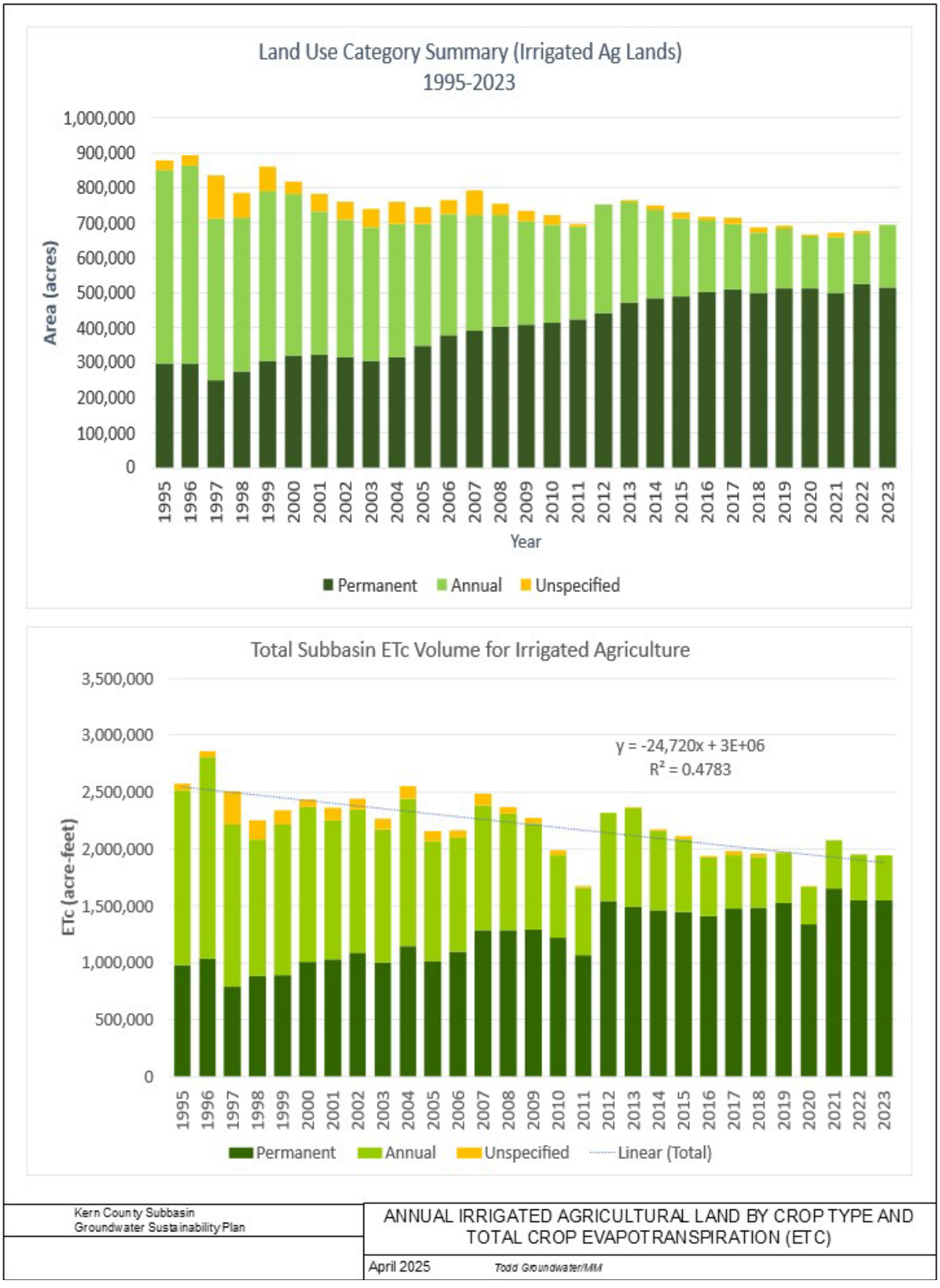


Figure 9-14. Annual Irrigated Agricultural Land by Crop Type and Total Crop Evapotranspiration (ETc)

9.3.3 Groundwater Extraction Maps

☑ **23 CCR § 354.18(c)(1)**
☑ **23 CCR § 354.18(c)(2)**

Total groundwater extraction maps were developed based on C2VSimFG-Kern simulation results to illustrate the distribution of pumping across the Kern Subbasin. The specified metered pumping is directly input into C2VSimFG-Kern while the IDC tool estimates the unmeasured portion of agricultural and urban pumping based on land use calculations.

Developing this map required accessing the groundwater extraction for each element from the binary output files of model results. The model output is the total volume of groundwater extracted within a model element. Because model elements vary in size, the simulated groundwater extraction rate from C2VSimFG-Kern is then normalized by dividing by the element area to obtain units of acre-feet per square mile. These groundwater extraction rates are then interpolated onto a uniform one-square mile grid superimposed over the Kern Subbasin. Therefore, the model output represents the total pumping per square mile over the Kern Subbasin included in C2VSimFG-Kern.

Figure 9-15 shows the distribution of total groundwater extractions over the Kern Subbasin for WY2022 and WY2023. In WY2022 agricultural pumping accounted for 66 percent of the total groundwater extractions. The pumping distribution generally corresponds to the distribution of irrigated agriculture. The exception is in the northwestern portion of the Kern Subbasin in the Western Fold Belt HCM Area, where irrigated agriculture depends almost solely upon imported surface water supplies due to poor local groundwater quality, which is unsuitable for irrigation. In general, groundwater extraction in the irrigated areas ranges between 250 to 2,000 acre-feet per square mile. In WY2023 (Figure 9-15) the distribution of total groundwater extractions over the Kern Subbasin shows the effect of the high availability of surface water supplies with substantially lower groundwater pumping rates for irrigated agriculture in WY2023 relative to WY2022 (Figure 9-13)

Areas of concentrated pumping are typically associated with water bank recovery operations. The areas where groundwater pumping exceeds 2,000 acre-feet per square mile are located in the vicinity of water banking operations where the pumping is recovering previously stored surface water for use. Recovery of stored surface water from large water banking projects was relatively high in WY2022 due to the critically dry conditions. In WY2023, the wide availability of imported surface water minimized the need to pump groundwater for recovery operations.

9.3.4 Change in Groundwater in Storage Maps

☑ 23 CCR § 354.18(b)(4)

The total change in groundwater storage within the Kern Subbasin is the sum of the total groundwater inflows and outflows. This change in storage manifests physically as a change in groundwater levels. The magnitude of change in groundwater levels is a function of the storage properties of the aquifer which varies for groundwater under confined and unconfined conditions.

Figure 9-16 presents the annual Subbasin-wide change in groundwater in storage map for WY2022 and WY2023. A positive value represents an increase in the volume of groundwater stored in the aquifer, which physically results in a rise in groundwater levels whereas a negative represents a decrease in groundwater in storage resulting in a decline in groundwater levels.

WY2022 was rated a critically dry water year under the San Joaquin Valley Index (California Data Exchange Center [CDEC], 2023), and the Kern River Index was 29 percent of average Kern River flows (COB, 2022). The largest change in storage of groundwater and stored surface water in WY2022 (Figure 9-16) is concentrated in the center of the Kern Subbasin in the vicinity of the large water banking operations along the Kern River. Other areas of concentrated groundwater and/or stored surface water recovery are noted to the north and southeast near Kern Fan Banking Area. Widespread, but lesser, declines in groundwater in storage are observed over most other areas of the Kern Subbasin.

WY2023 was rated a wet water year under the San Joaquin Valley Index (CDEC, 2024), and the Kern River Index was 320 percent of average Kern River flows (COB, 2023). The largest change in groundwater and stored surface water in storage in WY2023 is concentrated in the center of the Kern Subbasin in the vicinity of the large water banking operations along the Kern River (Figure 9-16). Other areas of concentrated water recharge are noted near other large water banking and conjunctive use projects. Widespread increases in groundwater in storage are observed over most of the Kern Subbasin. The minor changes along the Kern Subbasin margins are consistent with the water use in these more undeveloped areas.

9.3.5 Overdraft Conditions

☑ 23 CCR § 354.18(b)(5)

SGMA Regulations require that the water budget include an assessment of groundwater overdraft conditions. Determination of overdraft conditions requires the evaluation of current and historical water budget conditions. Following DWR's *Water Budget Best Management Practice*s (DWR, 2016), overdraft conditions should be assessed by calculating change in groundwater storage over a period of years during which water

year and water supply conditions approximate average conditions. Overdraft conditions should be evaluated as changes in groundwater storage by water year type.

As discussed previously, the historical water budget approximates average hydrologic conditions, whereas the current water budget period does not represent average hydrologic conditions as previously described in Section 9.3. Therefore, the Kern Subbasin overdraft calculated from the historical water budget (WY1995 to WY2014) is currently defined as 274,200 acre-feet, which is the average annual change (decrease) in groundwater storage over the historical period.

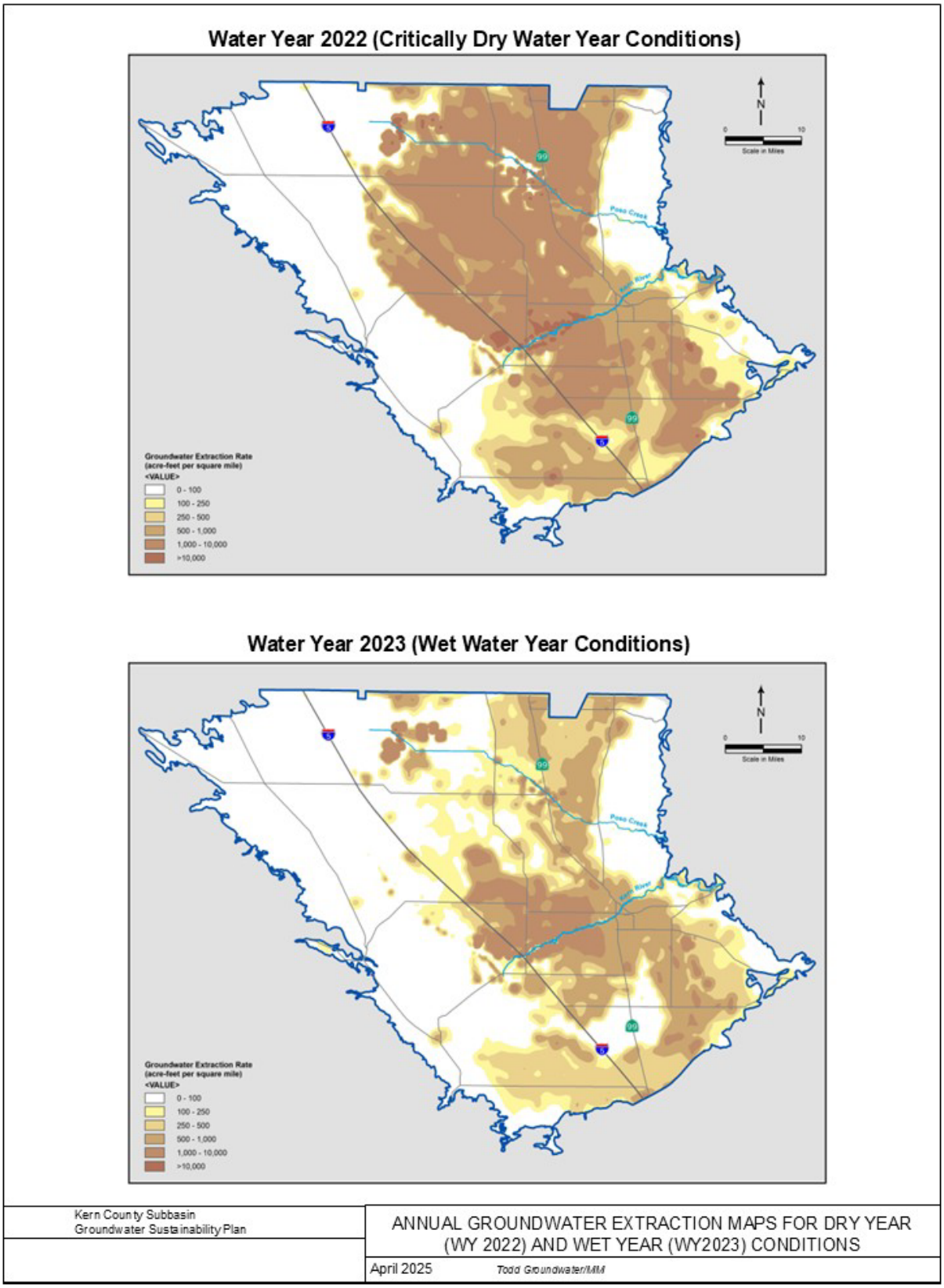


Figure 9-15. Annual Groundwater Extraction Maps for Dry Year (WY2022) and Wet Year (WY2023) Conditions

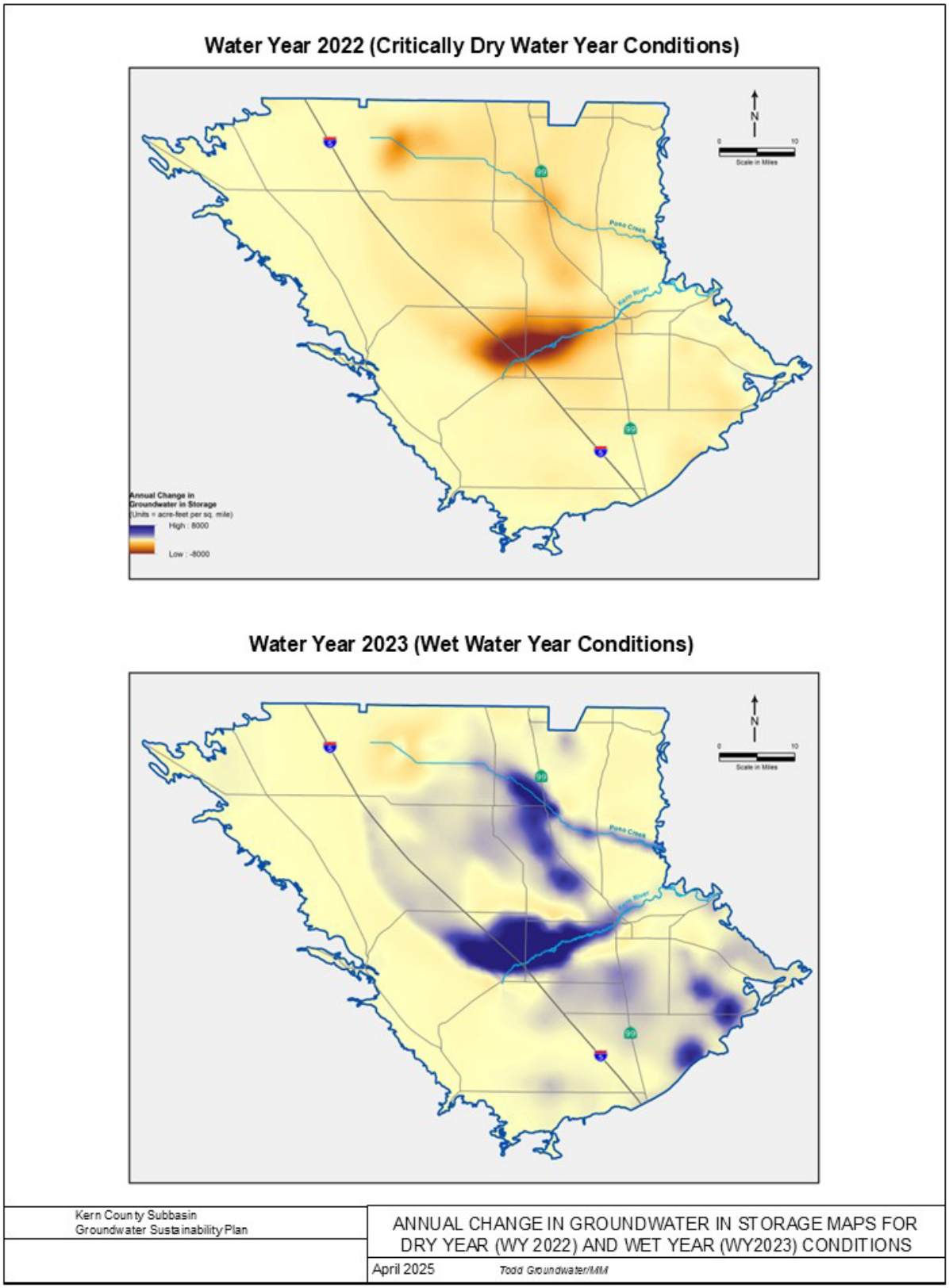


Figure 9-16. Annual Change in Groundwater in Storage Maps for Dry Year (WY2022) and Wet Year (WY2023) Conditions

9.4 Subbasin Sustainable Yield

> ***§ 354.18.*** *Water Budget*
>
> *(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:*
>
> *(7) An estimate of sustainable yield for the basin.*
>
> *(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:*
>
> *(2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:*
>
> *(C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.*

☑ 23 CCR § 354.18(b)(7)
☑ 23 CCR § 354.18(c)(2)(A)

Section 354.18(c) of the GSP Emergency Regulations requires that an estimate of the basin's sustainable yield. 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, which can be withdrawn annually from a groundwater supply without causing an undesirable result."

SGMA does not incorporate sustainable yield estimates directly into sustainable management criteria. Sustainable yield is considered in SGMA as part of the estimated Subbasin-wide water budget and as the outcome of avoiding undesirable results. Subbasin-wide pumping within the sustainable yield estimate is neither a measure of, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the six sustainability indicators.

9.4.1 Determination of Sustainable Yield

To determine the sustainable yield for the Kern Subbasin, the results of the C2VSimFG-Kern model are used with two methods to estimate the amount of groundwater pumping that would avoid the undesirable result of a reduction in groundwater storage over the historical base period WY1995 to WY2014. The results are summarized below:

- **Sustainable Yield from Groundwater Pumping –** The model results produce an average annual groundwater pumping in the Kern Subbasin of 1,586,417 AFY with an average annual decrease in groundwater storage of 274,200 AFY

(Table 9-5). Subtracting the groundwater storage decline from groundwater pumping produces a sustainable yield of approximately 1,312,218 AFY.

- **Sustainable Yield from Groundwater Recharge –** The model results produce an average annual groundwater recharge in the Kern Subbasin of 1,399,299 AFY. The subsurface outflow from the GSA was estimated to be 87,080 AFY (Table 9-6). Subtracting these outflow losses from the groundwater recharge produces a sustainable yield of approximately 1,312,219 AFY.

Sustainable yield estimates are part of SGMA's required basin-wide water budget. In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. This sustainable yield estimate can be helpful for evaluating the projects and programs needed to achieve sustainability. Although the SGMA Regulations require a single value of sustainable yield calculated basin-wide, it should be noted that the sustainable yield can be changed by implementation of recharge projects, variations in climate, or changes in stream flow conditions.

Using WY1995 to WY2014 as the base period, C2VSimFG-Kern results show declining groundwater levels and a long-term reduction of groundwater storage. During this period, average annual inflow to the Kern Subbasin is 1,399,299 AFY, and outflow is 1,673,498 AFY. This yields an average annual deficit of 274,200 AFY. Based on these historical C2VSimFG-Kern results, the sustainable yield of the Kern Subbasin is approximately 1,312,218 AFY (Appendix H-1, Table 12), with an estimated level of uncertainty on the order of plus or minus 10 to 20 percent.

Table 9-5. Estimated Subbasin Sustainable Yield based on C2VSimFG-Kern – Sustainable Yield from Groundwater Pumping

Water Years Units	Total Average Annual Volume (acre-feet)	Agricultural Average Annual Volume (acre-feet)	Urban Annual Volume (acre-feet)	GW Banking Exchanges and "Pump-ins"
Groundwater Pumping	1,586,417	1,237,746	176,146	172,525
Percentage of Pumping	100%	78%	11%	11%
Change in Groundwater in Storage	-274,200	-240,039	-34,160	
Percentage of Pumping		88%	12%	
Sustainable Yield	**1,312,218**	**997,707**	**141,985**	**172,525**
Average Annual Difference	**-274,200**	**-240,039**	**-34,160**	
Percent Difference	**-21%**	**-24%**	**-24%**	

Table 9-6. Estimated Subbasin Sustainable Yield based on C2VSimFG-Kern – Sustainable Yield from Basin Recharge and Outflow

Water Years (units)	Total Average Annual Volume (acre-feet)
Groundwater Recharge	1,399,299
Subsurface Outflow	-87,080
Sustainable Yield	1,312,219
Average Annual Difference	**-274,200**
Percent Difference	**-21%**

9.4.2 Native Yield

The native yield is a subset of the total water budget that includes the natural, or unmanaged, groundwater recharge for the Subbasin derived from the deep percolation of precipitation and inflows from the surrounding watersheds. A summary of the native yield components is provided in Appendix H-1, Table 17. For the larger streams (Kern River and Poso Creek), specific agencies or parties have water rights to specific volumes of flow; therefore, these streams are treated separately and are not included in this estimate of the native yield.

As with sustainable yield, the C2VSimFG-Kern model results over the historical base period WY1995 to WY2014 are used for estimation of native yield. The model results are used to determine the amount of precipitation recharge over agricultural, urban undeveloped areas and the small watershed annual inflow volume. The total and average annual volume of precipitation that percolates to groundwater during the WY1995 to WY2014 base period are listed in Appendix H-1, Table 17. The results of this assessment based on the C2VSimFG-Kern results are shown in Appendix H-1, Table 17 and are summarized below:

- The average annual volume of precipitation that recharges the groundwater in the Kern Subbasin is 231,994 AFY.
- The average annual volume of inflow from small watersheds is 48,760 AFY.

Totaling these inputs results in a native yield for the Kern Subbasin of approximately 280,754 AFY. The annual contribution per acre of approximately 0.15 acre-feet per acre is estimated by dividing the average annual contribution by the total area of the Kern Subbasin (Appendix H-1, Table13).

The native yield at this time is based on the best, currently available data. However, as data gaps are eliminated and management actions/plans are implemented, the native yield could change, and any changes to native yield will be reflected in future GSP updates.

9.4.3 Application of Sustainable and Native Yield

The following estimates of the Kern Subbasin sustainable and native yields are derived from the C2VSimFG-Kern historical model results for the purpose of supporting assessment of the types and magnitude of projects and programs needed to achieve sustainability. The C2VSimFG-Kern estimates of sustainable and native yield presented here are based on available data and the current level of model calibration. Therefore, these estimates are considered appropriate as guides to SGMA planning. However, the C2VSimFG-Kern sustainable and native yield estimates are initial estimates that are not intended for determination of individual landowner allocations or groundwater rights. Additional technical and legal analysis, along with stakeholder involvement, is necessary to fully quantify the sustainable and native yields.

9.5 GSA Operational Water Budgets

The development of GSA scale water budgets provides a means to assess the net water use from GSA water management operations. This process is consistent with prior checkbook water budgets presented in the Kern County Subbasin Coordination Agreement. These local water budgets support the GSAs in their sustainability planning including the development of P/MAs.

9.5.1 Approach

The current C2VSimFG-Kern model provides an appropriate tool to determining the Kern Subbasin scale water budgets based on a systematic, Subbasin-wide methodology to evaluate groundwater conditions within the Kern Subbasin. However, the model has limitations on determining local GSA water budgets because the model is intrinsically geographically based. Local GSA water budgets in the Kern Subbasin present a challenge for the model because of the intricate GSA boundaries, complexity of water management and water management operations that occur outside of the GSA boundary. The C2VSimFG-Kern model is geographically based so it cannot directly represent water management operations that occur outside of the GSA boundary. In addition, the model element resolution is too coarse to accurately represent GSA-scale operations. The updated model that is currently under development (Section 9.1.5) will significantly improve the model resolution; however, it will not directly represent water management operations that occur outside of the GSA.

To address this issue, a spreadsheet-based accounting of surface water operations within individual GSAs was developed. Some GSAs are more reliant on groundwater resources whereas others are more reliant on surface water resources. The operational water budget provides a means to assess whether GSAs operate in a net surface water surplus or deficit relative to the GSA's demands. This approach tabulates the water management operations within the GSA based on directly measured or estimated inflows and outflows (e.g. surface water deliveries and exchanges). This approach

allows for a GSA to account for water management actions, such as water banking, that occur outside of the GSA's boundary.

Kern Subbasin water management is complex and is not restricted by geographic GSA boundaries. Therefore, these GSA operational water budgets provide a complimentary analysis to accompany the model results. To provide consistency with the presentation of Kern Subbasin water budgets, the GSA operational water budgets are present for the following periods:

- Historical Water Budget Period - water years 1995 to 2014
- Current Water Budget Period - water years 2015 to 2023

Data for the GSA operational water budgets are based on updated Basin Study (Section 9.4.1) data in spreadsheet format while model calibration is being finalized. The data used for GSA operational water budgets are more up to date than was used for the C2VSimFG-Kern model, so there are differences in the input between the C2VSimFG-Kern data presented above. The Basin Study is an ongoing project; therefore, the GSP operational water budgets presented herein are considered interim results. Future updates to the water budget data are currently underway and are anticipated to be ongoing throughout SGMA implementation.

9.5.2 Water Bank Account Balances

Kern County entities have been involved in water banking for several decades. These programs have been developed to help secure more reliable water supplies within the Kern Subbasin and in major metropolitan areas of California due to variable wet- and dry-year cycles. They all involve storing surface water in wet years for later recovery for beneficial uses in dry years. As annual variability of surface water supplies has increased and the overall availability has decreased, more Kern entities have embraced water banking to increase water supply reliability. Water banks allow entities to maximize the management and recharge of wet years supplies to offset shortages during drier years. Almost every water district in the Kern Subbasin has either established a banking program or partnered with an entity that has a developed water bank.

Table 5-4 lists the GSAs involved in banking, conjunctive use, and in-lieu recharge activities. Figure 5-11 and Figure 9-4 show the location of existing banking projects and recharge facilities in the Kern Subbasin. Appendix D, Kern Fan Water Banking Programs, provides an additional overview of the Berrenda Mesa Spreading Grounds, Kern Water Bank, Pioneer Project, and West Kern Water District North Recharge and Recovery Project (Projects), located on the Kern River Alluvial Fan southwest of Bakersfield, which have been operating for several decades.

The water bank account balances are limited to the water banks which are defined as water storage operations within the GSA with a return obligation to a banking partner

located outside of the GSA. The water bank account balances do not include surface water stored in the GSA for use by that GSA. This type of water storage is considered a conjunctive use project, and this stored water is already accounted for in the total water supply used to develop the GSA Operational Water Budgets.

To integrate the water banking operations into the GSA Operational Water Budgets, stored water bank accounts were provided by the bank operators and reviewed by the Kern Subbasin GSAs. Each water bank operator provided their annual water bank account balances from 1994 to 2023 (Appendix H-4) for the following categories:

- Out-of-Subbasin Return Obligations - Account balances of remaining return obligations of surface water stored at the water bank facility for banking partners located outside of the Kern Subbasin.
- In-Subbasin Return Obligations - Account balances of remaining return obligations of surface water stored at the water bank facility for banking partners at specified GSAs located inside of the Kern Subbasin.
- Other Subbasin Return Obligations – Account balances of remaining return obligations of surface water stored at the water bank facility for banking partners where the location of use by the receiving entity is unspecified and may be located either within the Kern Subbasin and/or outside of the Kern Subbasin.

Table 9-7summarizes the account balances for the above categories at each of the eleven water banking GSAs or Projects. Annual account balances for each of these categories are provided in Appendix H-4. The return obligation account balances are summarized in Table 9-7 at the end of the following water years:

- 1994 – In 1994, the sum of all the water bank accounts was 438,122 acre-feet. Of that, 55 percent of the banked water is for in-Subbasin GSA accounts for use in the Kern Subbasin, 22 percent was for out-of-Subbasin partner accounts, and 23 percent was for other accounts.
- 2014 –In 2014, the sum of all the water bank accounts was 3,299,539 acre-feet, representing a 2,861,417 acre-foot increase in account totals since 1994. Of that, 50 percent of the banked water is for in-Subbasin GSA accounts for use in the Kern Subbasin, 42 percent was for out-of-Subbasin banking partner accounts and eight percent for other accounts.
- 2023 - In 2023, the sum of all of the water bank accounts was 4,745,202 acre-feet, representing a 1,445,663 acre-foot increase in account totals since 2014. Of that, 62 percent of the banked water is for in-Subbasin GSA accounts for use in the Kern Subbasin, 31 percent was for out-of-Subbasin banking partner accounts and seven percent for other accounts.

Table 9-8 summarizes the account balances of surface water stored on behalf of the fourteen GSAs that have storage accounts at one or more of the eleven Kern Subbasin water banking operations. The account balances are summarized to correspond to the historical and current water budget periods. Annual account balances are provided in Appendix H-4. Table 9-8 data are summarized as follows:

- In 1994, prior to the historical period, the sum of all the water bank accounts was 342,715 acre-feet.
- In 2014, the sum of all the water bank accounts was 1,646,351 acre-feet, representing a 1,303,636 acre-foot increase in account totals over the historical water budget period.
- In 2023, the sum of all the water bank accounts was 2,938,809 acre-feet, representing a 1,292,458 acre-foot increase in account totals over the current water budget period.

Water districts have coordinated on storing water in those locations that are hydrogeologically favorable for water banking and utilize a complex water conveyance system to facilitate banking recovery and water transfers across the Kern Subbasin. The data in Table 9-7 and Table 9-8 provide an illustration of the highly coordinated water management that has occurred within the Kern Subbasin for the past several decades. A majority of the Kern Subbasin GSAs participate in some form of water banking, either as bank operator who stores water for others, banking partners who store water at one of the GSA water banks, or both. In addition, several bank operators store water for other water districts for urban and agricultural purposes for districts across California demonstrating that this coordinated water management by the Kern Subbasin GSAs extends across California.

9.5.3 Water Banking Adjustment for GSA Operational Water Budget

The water banking adjustment provides a means to incorporate water banking activities that occur both within and outside of the individual GSA into their operational water budgets. The development of the water banking adjustment is based on change in the stored water bank accounts over time, which are summarized in Table 9-9 with additional data provided in Appendix H-4. The water banking adjustment includes the following components:

- Total return obligations by water bank operators as shown in Table 9-7.
- Stored water assets by a GSA at a Kern Subbasin water bank as shown in Table 9-8.

The calculation of the water bank adjustment is:

Water Budget Adjustment = Total Return Obligations – Stored Water Assets

The calculation of the water budget adjustment is shown as a deficit to correspond to the methodology used for the GSA operational water budgets. Therefore, a positive adjustment would increase the GSA deficit whereas a negative will decrease the deficit. The water bank adjustment does not include surface water stored in the GSA for use by that GSA. This type of water storage is considered a conjunctive use project, and this stored water is already accounted for in the total water supply used to develop the GSA Operational Water Budgets.

The total return obligations listed in Table 9-9 are the sum of the out-of-Subbasin, in-Subbasin and other return obligations by the GSA with water banking operations over the water budget period. This adjustment removes the volume of stored water with a return obligation from the total water supply available to meet the total water demand. The purpose is to ensure that future planning, including P/MAs, is sufficient to meet total demand while preserving the total return obligations.

For bank operators, an increase in the overall account balances represents an increase in the volume of stored surface water put into Kern Subbasin storage that has a future return obligation. An account balance decrease represents a lowering of future return obligations. Decreases of future return obligations can be accomplished by directly recovering stored surface water from the Kern Subbasin; however, decreases also result from exchange of surface water supplies, purchases, transfers and other methods to meet return obligations that result in the stored surface water remaining in the Kern Subbasin aquifer.

The stored water assets track by a GSA the volume of stored surface water at one or more of the Kern Subbasin water banks. This adjustment adds the volume of stored water assts within the Kern Subbasin to the total water supply available. A positive change in stored water assets represents additional water placed in storage at the water bank. Decreases in stored water assets represent recovery of stored water at the water bank on behalf of the GSA. This adjustment allows banked stored water outside of a GSA to be tracked in a manner comparable to how conjunctive use project water is tracked in the GSA Operational Water Budgets.

The exclusive water bank GSAs and projects (Kern Water Bank GSA, Pioneer GSA and Berrenda Mesa Spreading Grounds) are not listed in Table 9-9 because their total supplies and demands are completely banking related, and as such are operated in a manner to maintain a positive banking balance over time, as is demonstrated by the account balances shown in Table 9-7 and Appendix H-4.

9.5.4 GSA Operational Water Budgets

The GSA operational water budgets provide a tabulation of the surface water supplies and water demands within the GSA. These data are summarized in Table 9-10 and Table 9-11. Additional information about each of these data categories is presented in Appendix H-4. The time periods presented in these tables conform with the historical

and current Kern Subbasin water budgets derived from C2VSimFG-Kern presented above.

The GSA and Kern Subbasin Operational Water Budgets provide a summation of total annual supplies and demands. The result is shown as the net groundwater deficit within each GSA as shown be the following relationships:

Net GSA Operational Deficit = TD – SW – EP – NYA

Net Subbasin Operational Deficit = Net GSA Operational Deficit + WBA

Since these results are calculated as deficits, a positive number represents the total net use of groundwater beyond the native yield whereas a negative number represents the net surface water surplus to meet demand. A surplus indicates a higher reliance on surface water resources where deep percolation of applied surface water to groundwater and water banking/conjunctive use operations exceed groundwater pumping. Conversely, a deficit indicates a higher reliance of groundwater resources.

The components of the GSA and Kern Subbasin operational water budgets are described below.

- **Total Water Demand (TD)**: The total water demand is the summation of the managed water uses including agriculture, managed refuge, municipal, industrial, small water systems and domestic use within the Kern Subbasin as described in Appendix H-4. Evaporative losses from surface conveyance and recharge basins are also included as part of the total demand. Water use for water banking, conjunctive use operations, and deep percolation of applied surface water is not included as part of the demand because their net effect is to increase the volume of water storage within the aquifer.
- **Total Surface Water Supplies (SW)**: The total surface water supply is calculated by total surface water inflows minus outflows. Data were compiled from the Kern Subbasin data management system (DMS), provided by GSAs or collected from other sources (Appendix H-4). Surface water inflows were tabulated by source (e.g. State Water Project, Central Valley Project, Kern River, local supplies, water transfers, or other water sources). Surface water outflows were tabulated by type: (e.g. water transfer out of GSAs, surface water returned to the SWP Aqueduct or Friant-Kern Canal (pump-ins), or exports of water used outside of the Kern Subbasin).
- **Effective precipitation (EP)**: Volume of precipitation that meets part of the agricultural crop demand based on groundwater model results (Appendix H-4).
- **Native Yield on Developed Area (NYA)**: The volume of groundwater based on natural recharge sources from the deep percolation of precipitation to the aquifer and groundwater recharge derived from small watersheds surrounding the Kern Subbasin. The native yield described above in Section 9.4.2 provides a preliminary estimate of the volume of the native yield applied to the GSA

Operational Water Budget. Additional work on deriving the native yield of the Kern Subbasin is ongoing. As a preliminary planning level assumption, the native yield is applied as 0.15 feet of water for each acre of developed agricultural and urban land in the GSA. This method accounts for about 58 percent of the estimated 280,754 AFY native yield discussed in Section 9.4.2.

- **Net GSA Operational Deficit:** Summation of total annual supplies and demands within each GSA. The volume is shown as a deficit; therefore, a positive number represents the total net use of groundwater beyond the native yield whereas a negative number represents the net surface water surplus to meet demand. A surplus indicates a higher reliance on surface water resources where deep percolation of applied surface water to groundwater and water banking/conjunctive use operations exceed groundwater pumping. Conversely, a deficit indicates a higher reliance of groundwater resources.
- **Water Banking Adjustment (WBA)**: An adjustment to account for water banking activities based on change in the overall bank accounts (Table 9-9). For bank operators, an increase in the overall account balances represents an increase in water bank storage that has a future return obligation; therefore, the adjustment is to decrease the water supply to meet the total demand. Conversely, a decrease in the overall account balances represents a decrease in water bank storage, thus representing a lowering of future return obligations.
- **Net Subbasin Operational Deficit:** Sum of the Net GSA Operational Deficit and the Water Banking Adjustment. This includes the effects of the water banking operations by the GSA that are not restricted to the geographic boundaries of the GSA. This is the deficit that is utilized for developing the P/MA targets for future planning. The Net Subbasin Operation Deficit is used to develop the P/MA targets presented in Section 14 (Appendix H-4).

Table 9-10 summarizes the GSA Operational Water Budgets for the historical period from 1995 to 2014. The results show that over the historical period, 13 of the 20 GSAs had operational deficits ranging from 181 to 164,304 acre-feet per year, whereas seven of the 20 GSA had operational surpluses ranging from 8 to 84,527 acre-feet per year. The sum of the deficits is 381,223 acre-feet per year.

Table 9-11 summarizes the GSA Operational Water Budgets for the current period from 2015 to 2023. The results show that over the current period, 13 of the 20 GSAs had operational deficits ranging from 105 to 197,467 acre-feet per year, whereas seven of the 20 GSA had operational surpluses ranging from 2,611 to 121,202 acre-feet per year. The sum of the deficits is 345,483 acre-feet per year.

A comparison of Table 9-10 and Table 9-11 shows that during the current period three GSAs switched from a deficit to a surplus. This was matched by three other GSAs that switched from a surplus to a deficit. Three GSAs and the Kern National Wildlife Area remained in surplus during both the historical and current periods.

Individual GSA operational water budgets providing the annual supply and demand data for the 1995 to 2023 period are provided in Appendix H-4.

Table 9-7. GSA Water Bank Operator Summary of Return Obligation Account Balances (in acre-feet)

GSA	Out of Subbasin Return Obligation Account			In Subbasin Return Obligation Account Balances			Other Account Return Obligation Account Balances		
	1994	2014	2023	1994	2014	2023	1994	2014	2023
Arvin GSA	0	181,396	100,201	0	0	0	0	0	0
Cawelo WD GSA	0	27,280	25,058	0	0	10,877	0	0	0
Berrenda Mesa Spreading Grounds	0	0	0	20,619	45,356	56,459	16,089	14,662	3,499
Kern River GSA	0	167,352	144,103	0	0	0	0	0	0
Kern Water Bank GSA	0	27,476	73,658	0	598,164	1,427,991	0	30,511	30,511
North Kern WSD GSA	0	37,714	33,144	29,483	61,206	167,470	34,861	35,919	41,456
Pioneer GSA	0	0	0	185,947	668,478	1,035,939	47,542	153,293	206,276
Rosedale-Rio Bravo GSA	1,374	191,344	281,507	6,666	257,721	215,180	0	7,408	20,361
Semitropic WSD GSA	95,541	759,439	829,872	0	13,557	21,699	0	18,894	14,100
Shafter-Wasco ID GSA	0	0	682	0	0	0	0	0	1,965
West Kern WD GSA	0	500	0	0	1,870	3,195	0	0	0
Total	**96,915**	**1,392,500**	**1,488,225**	**342,715**	**1,646,351**	**2,938,809**	**98,492**	**260,687**	**318,168**

EXPLANATIONS:

Out of Subbasin Account Balance – ending account balance of return obligation to an entity located outside of the Kern Subbasin.

In Subbasin Account Balance – ending account balance of return obligation to an entity located inside of the Kern Subbasin.

Other Subbasin Account Balance – ending account balance of return obligation where the location of use by the receiving entity is unspecified and may be located either within the Kern Subbasin and/or outside of the Kern Subbasin.

NOTES:

These account balances do not include surface water stored in the GSA for use by that GSA. This type of water storage is considered a conjunctive use project, and this stored water is already accounted for in the total water supply used to develop the GSA Operational Water Budgets.

Table 9-8. Summary of stored surface water for GSAs with accounts at Subbasin water banks (in acre-feet)

GSA	Cumulative Stored Water Account Balance			Change in Water Budget Period		
	1994 (acre-feet)	2014 (acre-feet)	2023 (acre-feet)	Prior Period Pre-1995 (acre-feet)	Historical Period 1995 – 2014 (acre-feet)	Current Period 2015 – 2023 (acre-feet)
Arvin GSA	0	74,006	53,971	0	74,006	-20,035
Buena Vista GSA	4,649	65,376	256,263	4,649	60,727	190,887
Cawelo WD GSA	13,321	9,103	0	13,321	-4,218	-9,103
Henry Miller WD GSA	6,666	64,366	138,962	6,666	57,700	74,596
Kern River GSA	46,532	336,624	435,257	46,532	290,092	98,633
Kern-Tulare WD GSA	0	28,473	47,750	0	28,473	19,277
Rosedale-Rio Bravo GSA	0	345,004	444,189	0	345,004	99,185
Semitropic WSD GSA	25,253	122,218	303,087	25,253	96,965	180,869
Shafter-Wasco ID GSA	15,974	14,049	56,844	15,974	-1,925	42,795
Southern San Joaquin MUD	0	0	32,986	0	0	32,986
Tejon-Castac WD GSA	66	35,927	65,432	66	35,861	29,505
West Kern WD GSA	0	26,715	5,375	0	26,715	-21,340
Westside DWA GSA	162,070	373,159	810,533	162,070	211,089	437,374
Wheeler Ridge-Maricopa GSA	68,184	151,332	288,161	68,184	83,148	136,829
Total	**342,715**	**1,646,351**	**2,938,809**	**342,715**	**1,303,636**	**1,292,458**

EXPLANATIONS:

Stored Water Account Balance – Account balance of water stored at Kern Subbasin water bank facility for GSA as of the end of the listed water year.

Change over Water Budget Period – represents the net change in the account balance over the water budget period.

NOTES:

Table 9-8 shows the total volume of banked water by Kern Subbasin GSAs at the various water banks located elsewhere in the Kern Subbasin. The total volumes in the *Stored Water Account Balances* columns in Table 9-8 match the totals shown in the *In Subbasin Return Obligation Account Balances* columns in Table 9-7.

These account balances do not include surface water stored in the GSA for use by that GSA. This type of water storage is considered a conjunctive use project, and this stored water is already accounted for in the total water supply used to develop the GSA Operational Water Budgets.

Table 9-9. Water Bank Adjustment Calculation Summary

GSA	Historical Period (1995-2014)				Current Period (2015-2023)			
	Total Return Obligation (acre-ft)	Total Stored Water (acre-ft)	Total Banking Adjustment (acre-ft)	Average Banking Adjustment (AFY)	Total Return Obligation (acre-ft)	Total Stored Water (acre-ft)	Total Banking Adjustment (acre-ft)	Average Banking Adjustment (AFY)
Arvin GSA	181,396	74,006	107,391	5,370	-81,195	-20,035	-61,160	-6,796
Buena Vista GSA	0	60,727	-60,727	-3,036	0	190,887	-190,887	-21,210
Cawelo WD GSA	27,280	-4,218	31,498	1,575	8,655	-9,103	17,758	1,973
Eastside WMA	0	0	0	0	0	0	0	0
Henry Miller WD GSA	0	57,700	-57,700	-2,885	0	74,596	-74,596	-8,288
Kern River GSA	167,352	290,092	-122,740	-6,137	-23,249	98,633	-121,882	-13,542
Kern-Tulare WD GSA	0	28,473	-28,473	-1,424	0	19,277	-19,277	-2,142
North Kern WSD GSA	70,495	0	70,495	3,525	107,231	0	107,231	11,915
Olcese WD GSA	0	0	0	0	0	0	0	0
Rosedale-Rio Bravo WSD GSA	248,432	345,004	3,428	171	60,575	99,185	-38,610	-4,290
Semitropic WSD GSA	696,349	96,965	599,384	29,969	73,781	180,869	-107,088	-11,899
Kern National Wildlife Refuge	0	0	0	0	0	0	0	0
Shafter-Wasco ID GSA	0	-1,925	1,925	96	2,647	42,795	-40,148	-4,461
7th Standard	0	0	0	0	0	0	0	0
Southern San Joaquin MUD	0	0	0	0	0	32,986	-32,986	-3,665
Tejon-Castac WD GSA	0	35,861	-35,861	-1,793	0	29,505	-29,505	-3,278
West Kern WD GSA	2,370	26,715	-24,345	-1,217	825	-21,340	22,165	2,463
Westside DWA GSA	0	311,089	-311,089	-15,554	0	437,374	-437,374	-48,597
Wheeler Ridge-Maricopa GSA	0	83,148	-83,148	-4,157	0	136,829	-136,829	-15,203
KNDLA	0	0	0	0	0	0	0	0
Total	**1,493,674**	**1,403,636**	**90,038**	**4,502**	**149,270**	**1,292,458**	**-1,143,188**	**-127,021**

EXPLANATIONS:

Total Return Obligation – Total banked water stored in GSA with a return obligation based on account balance change over the water budget period (Table 9-7).

Total Stored Water – Net change in account balance for GSA water stored at Kern Subbasin water bank facility over the water budget period (Table 9-8).

NOTES:

The Water Bank Adjustment does not include surface water stored in the GSA for use by that GSA. This type of water storage is considered a conjunctive use project, and this stored water is already accounted for in the total water supply used to develop the GSA Operational Water Budgets.

Table 9-10. GSA Operational Water Budget for Historical Period of 1995 to 2014 (acre-feet per year)

GSA	Total Demand (AFY)	Total Surface Water Supply (AFY)	Effective Precipitation (ETpr) (AFY)	Native Yield on Developed Area (AFY)	Net GSA Operational Deficit (SUBTOTAL) (AFY)	Water Banking Adjustment (AFY)	Net Subbasin Operational Deficit (AFY)
Arvin GSA	207,730	138,331	31,954	15,211	22,234	5,370	27,604
Buena Vista GSA	124,186	120,648	14,955	6,485	-17,901	-3,036	-20,937
Cawelo WD GSA	108,418	85,883	16,885	6,378	-728	1,575	847
Eastside Water Management Area	5,252	0	1,432	484	3,336	0	3,336
Henry Miller WD GSA	50,795	30,927	7,420	3,507	8,942	-2,885	6,057
Kern River GSA	482,027	340,124	41,344	30,815	69,745	-6,137	63,608
Kern-Tulare WD GSA	28,918	23,871	5,668	1,642	-2,263	-1,424	-3,687
North Kern WSD GSA	182,356	182,209	22,946	9,686	-32,486	3,525	-28,961
Olcese WD GSA	3,141	2,166	581	213	181	0	181
Rosedale-Rio Bravo WSD GSA	102,761	74,012	11,921	6,696	10,132	171	10,304
Semitropic WSD GSA	392,330	178,377	57,019	22,873	134,062	29,969	164,031
Kern National Wildlife Refuge	19,138	17,635	630	881	-8	0	-8
Shafter-Wasco ID GSA	100,627	60,637	11,846	5,751	22,393	96	22,489
7th Standard	25,530	3,513	3,411	1,319	17,287	0	17,287
Southern San Joaquin MUD GSA	163,652	104,309	23,708	9,093	26,541	0	26,541
Tejon-Castac WD GSA	200	0	54	104	42	-1,793	-1,751
West Kern WD GSA	20,700	20,721	295	1,002	-1,317	-1,217	-2,534
Westside DWA GSA	281,474	286,023	46,371	23,053	-73,973	-15,554	-89,527
Wheeler Ridge-Maricopa GSA	147,205	91,904	24,615	11,538	19,147	-4,157	14,990
Kern Non-Districted Land Authority	23,807	-7,133	4,326	2,665	23,949	0	23,949
Total	**2,470,248**	**1,754,156**	**327,381**	**159,395**	**229,316**	**4,502**	**233,817**

NOTES:

Description of each water budget component is summarized in the accompanying report text and additional information is provided in Appendix H-4.

All volumes are in acre-feet per year (AFY).

The Water Bank Adjustment does not include surface water stored in the GSA for use by that GSA. This type of water storage is considered a conjunctive use project, and this stored water is already accounted for in the Total Water Supply.

Table 9-11. GSA Operational Water Budget for Current Period of 2015 to 2023 (acre-feet per year)

GSA	Total Demand (AFY)	Total Surface Water Supply (AFY)	Effective Precipitation (ETpr) (AFY)	Native Yield on Developed Area (AFY)	Net GSA Operational Deficit (SUBTOTAL) (AFY)	Water Banking Adjustment (AFY)	Net Subbasin Operational Deficit (AFY)
Arvin GSA	201,973	104,955	34,680	15,322	47,016	-6,796	40,220
Buena Vista GSA	92,503	87,838	16,345	6,477	-18,157	-21,210	-39,367
Cawelo WD GSA	97,132	72,238	16,410	6,599	1,886	1,973	3,859
Eastside Water Management Area	7,704	391	3,066	971	3,275	0	3,275
Henry Miller WD GSA	13,946	11,248	3,614	3,510	-4,426	-8,288	-12,715
Kern River GSA	417,744	363,006	39,955	31,425	-16,642	-13,542	-30,184
Kern-Tulare WD GSA	28,719	18,033	5,736	1,655	3,295	-2,142	1,153
North Kern WSD GSA	177,007	150,891	22,544	9,723	-6,151	11,915	5,763
Olcese WD GSA	3,283	2,313	648	217	105	0	105
Rosedale-Rio Bravo WSD GSA	100,221	79,181	12,642	6,720	1,679	-4,290	-2,611
Semitropic WSD GSA	384,124	91,663	60,895	23,409	208,157	-11,899	196,259
Kern National Wildlife Refuge	13,044	14,303	504	860	-2,623	0	-2,623
Shafter-Wasco ID GSA	98,397	63,330	11,804	5,761	17,502	-4,461	13,041
7th Standard	25,440	4,016	3,673	1,374	16,377	0	16,377
Southern San Joaquin MUD GSA	146,521	77,528	22,191	9,150	37,653	-3,665	33,987
Tejon-Castac WD GSA	38	0	7	119	-88	-3,278	-3,366
West Kern WD GSA	21,099	22,420	141	1,081	-2,543	2,463	-80
Westside DWA GSA	260,949	272,305	37,600	23,649	-72,605	-48,597	-121,202
Wheeler Ridge-Maricopa GSA	152,133	94,881	25,958	11,750	19,544	-15,203	4,340
Kern Non-Districted Land Authority	21,424	-9,184	4,336	3,174	23,098	0	23,098
Total	**2,263,400**	**1,521,355**	**322,748**	**162,946**	**256,350**	**-127,021**	**129,329**

NOTES:

Description of each water budget component is summarized in the accompanying report text and additional information is provided in Appendix H-4.

All volumes are in acre-feet per year (AFY).

The Water Bank Adjustment does not include surface water stored in the GSA for use by that GSA. This type of water storage is considered a conjunctive use project, and this stored water is already accounted for in the Total Water Supply.

9.6 Projected Future Subbasin Water Budget

§ 354.18. Water Budget

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

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

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

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

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

(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

(3) Projected water budget information for population, population growth, climate change, and sea level rise.

☑ 23 CCR § 354.18(c)(3)
☑ 23 CCR § 354.18(d)(3)

Projected (future) water budgets for the Kern Subbasin were developed using the C2VSimFG-Kern. These projected water budgets establish expected Baseline conditions to evaluate the impacts of GSP implementation. Three projected scenarios, each representing a different expected future hydrologic condition, were developed for the Kern Subbasin by adapting C2VSimFG-Kern as follows:

- Future Baseline Conditions: Repeat historical hydrology with expected future water supply.
- 2030 Climate Conditions: Adjust historical hydrology for 2030 climatic conditions and expected water supply.
- 2070 Climate Conditions: Adjust historical hydrology for 2070 climatic conditions and expected water supply.

Projected future water budgets were developed for the three scenarios listed above over a 50-year planning and implementation horizon. To assess the sustainability of the proposed Plan, the C2VSimFG-Kern model future scenario input files were then modified to create three additional scenarios that incorporate all the P/MAs. The six total scenario models provide a basis of comparison for evaluating proposed P/MAs over the SGMA planning and implementation horizon with varying degrees of climate change impacts.

9.6.1 Projected Water Budget Methods and Data Sources

☑ **23 CCR § 354.18(c)(3)**
☑ **23 CCR § 354.18(d)(3)**

C2VSimFG-Kern was modified to incorporate projected future hydrology and land use using analog data from the historical C2VSimFG-Kern model. This approach meets GSP requirements using:

- A 50-year time-series of historical precipitation, evapotranspiration, and stream flow information as the future Baseline hydrology conditions.
- The most recent land use, satellite-based evapotranspiration, crop coefficient and urban population growth information as the Baseline condition for estimating future water demands.
- The most recent water supply projections as the Baseline condition for estimating future surface water supply.
- DWR (2018a) Climate Change Guidance and Data Sets to incorporate estimated climate change conditions for the Kern Subbasin.
- Specialized analysis of the Kern River watershed and estimated runoff volumes under climate change conditions.
- Specialized analysis of CVP deliveries to Kern County under climate change conditions incorporating implementation of the San Joaquin River Restoration Program.
- Specialized analysis of SWP deliveries to Kern County under climate change conditions incorporating implementation of the Operations, Criteria, and Plan (OCAP) Biological Opinion and recent changes in Table A and Article 21 allocations.

9.6.2 Development of Projected Water Budget Scenarios

☑ **23 CCR § 354.18(c)(3)**
☑ **23 CCR § 354.18(d)(3)**

Projected water budgets for the Kern Subbasin were developed using the C2VSimFG-Kern to evaluate the performance of P/MAs with respect to achieving

groundwater sustainability. Participating agencies provided a list of projected future P/MAs to be implemented between WY2021 and WY2040. Projected future conditions under Baseline conditions, 2030 Climate Conditions, and 2070 Climate Conditions were simulated both with and without these projects through WY2070 using the C2VSimFG-Kern model, for a total of six projected scenarios.

Proposed future P/MAs were provided by GSAs. The types of P/MAs are summarized as follows:

- "Demand Reduction" P/MAs involve reducing the volume of water use, typically through changes in land use, including:
  - Agricultural demand reduction projects through incentives or actions to reduce crop water use.
  - Agricultural land retirement and conversion of agricultural land to recharge basins.
  - Conversion of agricultural land to urban land.
- "Supplemental Water Supply" P/MAs involve increasing water supplies, including:
  - Increased surface water imports generally resulting from projected, or already contracted, water purchases.
  - New water conveyance facilities including pipelines and reservoirs to increase flexibility.
  - Expansion of surface water delivery areas to reduce groundwater usage.
- "Other Local Water Supply" P/MAs involve increasing local water supplies, including:
  - Utilizing treated wastewater derived from both urban areas and oil production operations; increased utilization occurs in both existing and new locations.
  - Increased stream flow diversions: these include exercising riparian water rights and diverting flood flows.
  - Reallocation of water; generally reducing sales of surface water and stored surface water in some GSAs and using this water within the agency.
  - Augmenting surface water supplies with treated brackish water.

Some P/MAs are implemented gradually over many years, with savings increasing each year over the implementation period. Some are implemented only in certain years (wet years, for example). The anticipated average-annual water supply benefit of the proposed P/MAs steadily increases over the 20-year period from WY2021 to WY2040 to represent the implementation of the Kern Subbasin Plan. This increasing trend, as shown as the average-annual water supply benefit over five-year increments shown in Figure 9-17, is summarized as follows:

- About 116,000 AFY over the first five-year period (WY2021 to WY2025).
- About 216,000 AFY over the second five-year period (WY2026 to WY2030).
- About 343,000 AFY over the third five-year period (WY2031 to WY2035).
- About 361,000 AFY over the fourth five-year period (WY2036 to WY2040).

The anticipated water supply benefit of the proposed P/MAs included in the C2VSimFG-Kern projected future simulations is 422,000 AFY over the period from WY2041 to WY2070. Benefits of implementing these P/MAs over the 20-year implementation period are summarized in Figure 9-17.

9.6.2.1 Projected Future Baseline Development

Projected water budgets are required by SGMA Regulations to represent future conditions over a 50-year planning and implementation horizon. A Baseline condition was developed that projects water supply, demand and operations based on current land use and expected water supply availability over 50 years. The Baseline then serves as a basis of comparison for evaluating proposed P/MAs for achieving sustainability over the planning and implementation horizon. Each predictive scenario model simulates the 50-year planning and implementation period WY2021 to WY2070. Development of the projected future Baseline conditions is summarized below.

9.6.2.2 Projected Future Time Period Development

WY1995 to WY2014 is used as a historical hydrology period because detailed demand and supply data are available for this period, and because most Kern Subbasin water delivery infrastructure was fully developed by the middle of this period. The average Kern River inflow for this period is also very close to the long-term average Kern River inflow.

The projected future simulation period is based on repeating the WY1995 to WY2014 historical study period. Since the historical period is only 20 years long, the 50-year sequence of hydrology was developed by repeating data from the historical period as shown in Appendix H-1, Table 18, and summarized below:

- Simulation period WY2021 to WY2032 uses the historical period WY2003 to WY2014.
- Simulation period WY2033 to WY2052 uses the historical period WY1995 to WY2014.
- Simulation period WY2053 to WY2070 uses the historical period WY1995 to WY2012.

This sequence is used to match long-term average flows on the Kern River, and to ensure that the 50-year simulation period does not end in an extreme drought or extreme wet year. By starting the projected 50-year future simulation period with

WY2003, the period has approximately 100 percent of the long-term average streamflow conditions on the Kern River, as indicated by an average annual Kern River Index of 100 percent. The sequence includes the appropriate range of hydrologic conditions including extremely wet years and extended periods of drought.

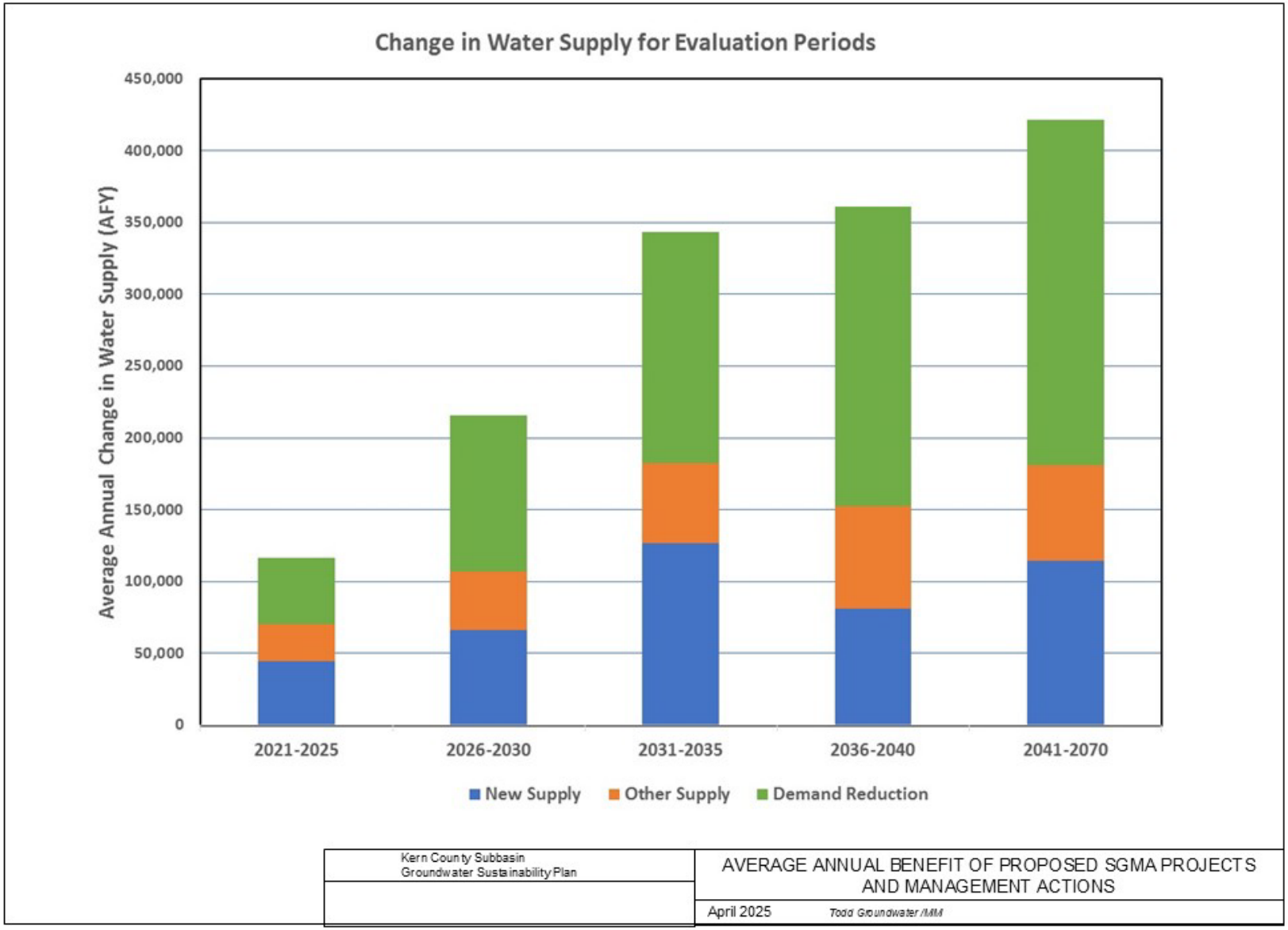


Figure 9-17. Average Annual Benefit of Proposed SGMA Projects and Management Actions

9.6.2.3 Development of Key Baseline Data Sets

Key required components for the Projected Future Baseline, as summarized in the DWR *Water Budget Best Management Practices* (DWR, 2016B) include the following:

- The projected Baseline hydrology conditions use 50-years of historical precipitation and streamflow following the sequence outlined in Section 6.1.
- Surface water supplies are based on available information from DWR and others to project future water imports from the SWP, CVP, and Kern River diversions. For the Kern River, recent diversion practices based on entitlements are used to develop water use consistent with the Baseline hydrology.
- WY2013 land use is used as current land use as representative of land use prior to implementation of SGMA in 2015. Drought conditions in WY2014 and WY2015 resulted in reduced agricultural production, and more recent land use begins to include changes as a result of SGMA.
- Consumptive use for agriculture and undeveloped lands is based on the current land use and ITRC METRIC-based evapotranspiration. Following DWR guidance, ITRC METRIC data over the Baseline period is varied according to varying hydrologic conditions (e.g., water year type).
- Urban water demand is based on projections from recent urban water management plans to meet regulations for future water use. Urban demand is estimated in the model based on projected urban population growth and per capita water demand information (including recent regulatory guidance).
- Small watershed inflows use the same parameters as the historical C2VSimFG-Kern model; however, volumes varied based on changes in the precipitation and ET under the 2030 and 2070 climate change conditions.

Time-series input data were first developed for the Baseline scenario model for WY2021 to WY2070. Development of this time-series input data generally involved repeating time-series data from the historical C2VSimFG-Kern in the appropriate sequence. The following time-series data were developed for each scenario:

- Precipitation rates
- Evapotranspiration rates
- Surface water inflow rates
- Surface water diversion and delivery rates
- Specified groundwater pumping rates

Baseline scenario model time-series data files were then modified following DWR guidelines to produce time-series input data for the 2030 Climate Conditions and 2070 Climate Conditions scenarios. C2VSimFG-Kern input data were modified only in Kern

County. C2VSimFG-Kern input data for areas outside of Kern County were not modified.

These baseline data sets are incorporated into the model files to develop the projected future water demand and supply under Baseline, 2030 Climate and 2070 Climate conditions. A summary of the development of the projected future water demand and supply is discussed below.

9.6.2.4 Projected Future Water Demand

The projected future water demand uses fixed WY2013 land use areas with historical evapotranspiration rates for the Baseline and modified evapotranspiration rates for the 2030 and 2070 Climate Scenarios. An increasing urban population was projected based on urban water management plans and other information to develop projected-future water demand for the Baseline, 2030 and 2070 Climate Scenarios.

9.6.2.5 Agricultural Water Demand

Evapotranspiration rates for the Baseline scenario model use repeating input evapotranspiration rates from C2VSimFG-Kern in the appropriate sequence. DWR provided monthly change factors for ETo values under 2030 and 2070 central tendency climatic conditions on a 6 km x 6 km Variable Infiltration Capacity Model (VIC) grid for calendar years 1915 through 2011 (DWR 2018A). The VIC grid IDs for each C2VSim subregion in the Kern Subbasin were identified and area weighted monthly ETo change factors were calculated for each subregion. Baseline scenario ETc rates for each subregion were then multiplied by the appropriate area-weighted ETo change factors to produce time-series ETc rates for the 2030 Climate and 2070 Climate scenarios. Factors for calendar years 1959 to 1961 are used as analogs for calendar years 2012 to 2014.

9.6.2.6 Urban Water Demand

Urban water demand calculations include an indoor component and an outdoor component. Indoor urban water demands are based on the urban population and monthly per capita water demand. Future urban populations for Kern County urban areas are estimated using California Department of Finance population projections. Future per capita urban water demands are estimated using projections from urban water management plans and California urban water conservation regulations, including SB 606 and AB 1668. Future outdoor urban water demands are based on ETc rates, which were modified as described in the Agricultural Water Demand section above.

9.6.2.7 Water Banking Recovery

Future water banking recovery rates use repeating historical recovery rates in the appropriate sequence. No adjustments were made to Baseline rates or to rates for 2030 and 2070 climatic conditions.

9.6.2.8 Projected Future Water Supply

Projected future precipitation, stream inflow and surface water imports time series were developed following DWR guidelines.

9.6.2.9 Precipitation Rates

Precipitation rates for the Baseline scenario model use repeating input precipitation rates from C2VSimFG-Kern in the appropriate sequence. DWR provided monthly change factors for precipitation under 2030 and 2070 central tendency climatic conditions on a 6 km x 6 km VIC grid for calendar years 1915 through 2011 (DWR 2018A). The VIC grid ID for each C2VSim element in the Kern Subbasin was identified and the Baseline scenario precipitation rates were multiplied by the appropriate factors to produce time-series precipitation rates for the 2030 Climate and 2070 Climate scenarios. Factors for calendar years 1959 to 1961 are used as analogs for calendar years 2012 to 2014.

9.6.2.10 Surface Water Inflow Rates

Surface water inflow rates for Poso Creek and the White River for the Baseline scenario model use repeating input inflow rates from C2VSimFG-Kern in the appropriate sequence. DWR (2018a) provided unimpaired streamflow change factor datasets for Central Valley streams, and an Excel spreadsheet tool to modify basin unimpaired streamflow using these change factors. The unimpaired streamflow change factors and spreadsheet were used to modify Baseline inflows to produce 2030 Climate and 2070 Climate scenario time series inflows for Poso Creek and White River.

Surface water inflow rates for the Kern River at First Point for the Baseline scenario model use repeating historical inflow rates from C2VSimFG-Kern in the appropriate sequence. Flows on the Kern River are regulated, so the unimpaired streamflow method is not appropriate for estimating future flows under 2030 and 2070 climatic conditions. Projected Kern River flows at First Point under 2030 and 2070 central tendency conditions were estimated by GEI (2018) using calendar years 1956 to 2010 hydrology. The analysis considered the impacts of changed runoff in each sub-watershed contributing to the Kern River to develop revised streamflow estimates for Kern River at First Point. Projected scenario flows for the Kern River at First Point for calendar years 2011 to 2014 are estimated using flows for analog years with similar annual flows and monthly flow pattern. Analog years 1986, 1991, 1990 and 1961 are used for calendar years 2011 to 2014 in the projected scenarios. Figure 9-18 graphically summarizes the changes in Kern River water supplies relative to historical data. The lower graph shown in Figure 9-18 shows the average monthly shift in Kern River inflows after applying 2030 and 2070 climate change guidance to historical flows. In general, the annual Kern River flows remain similar; however, the peak flows shift in time. The monthly shifts show an increase in flow during December through February and a decrease in flow during May, June, and July.

9.6.2.11 Surface Water Deliveries

Surface water delivery rates for the Baseline scenario model were developed by first repeating input surface water delivery rates from the C2VSimFG-Kern in the appropriate sequence and then modifying selected data sets. Surface water deliveries from local imported sources such as recycled produced water are held constant at WY2015 rates for all projected scenarios.

The Kern Subbasin is served by both the CVP and the SWP. Recent changes in CVP and SWP operations and their impacts on future surface water supplies are reflected in surface water diversion rates for the three scenarios.

Future CVP deliveries will be affected by implementation of the San Joaquin River Restoration Program (SJRRP) that includes the 2008 U.S. Fish & Wildlife Service biological opinion (BO) on the Long-Term Operational Criteria and Plan (OCAP) for coordination of the CVP and SWP.

Future CVP delivery projections developed by the Friant Water Authority (FWA) were used in place of DWR's CVP projections. FWA (2018) used CalSim-II to develop projected surface water deliveries with SJRRP implementation under hydrological conditions representing the Baseline, 2030 Climate, and 2070 Climate conditions by delivery class for WY1922 to WY2003, and estimated allocations to each CVP contractor. The 2015.c data set is used for Baseline scenario CVP deliveries, the 2030.c data set is used for the 2030 Climate scenario CVP deliveries, and the 2070.c data set is used for the 2070 Climate scenario CVP deliveries. A summary of each of these data sets from FWA (2018) is provided below:

- "2015.c" was designed to represent current conditions, where implementation of the San Joaquin River Restoration Settlement (SJRRS) is limited by downstream capacity limitations and the climate and hydrology are assumed to be most similar to historical hydrologic conditions.
- "2030.c" was designed to represent near future climate conditions centered around 2030 and uses DWR's central tendency climate projection. This scenario assumes implementation of the SJRRS.
- "2070.c" was designed to represent far-future climate conditions centered around 2070 and uses DWR's central tendency climate projection. This scenario assumes implementation of the SJRRS.

CVP deliveries for WY2004 to WY2014 are estimated using deliveries for analog years WY1951 to WY1961; these analog years have a similar distribution of water availability. Figure 9-19 graphically presents the average annual CVP deliveries to the Kern Subbasin based on the FWA (2018) guidance. The monthly values show a general decrease in deliveries but not a temporal shift. The net result of the climate change modifications is that CVP deliveries to the Kern Subbasin for the 2030 Climate scenario

are 80 percent of the Baseline scenario and CVP deliveries for the 2070 scenario are 68 percent of the Baseline scenario.

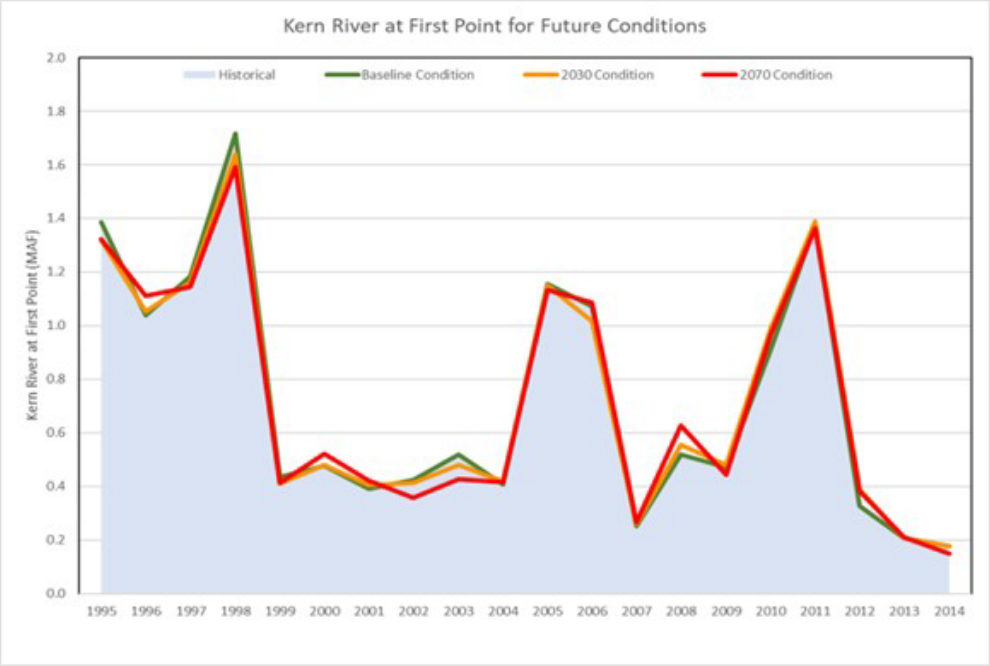
Future SWP deliveries will be affected by operational changes implemented between 2004 and 2008 including the OCAP BO, reduced Table A contract amounts and reduced Article 21 deliveries. DWR provided projected future deliveries from the CVP and SWP for WY1922 to WY2003, derived from CalSim-II modeling conducted for the Water Supply Investment Program (WSIP) (California Water Commission, 2016).

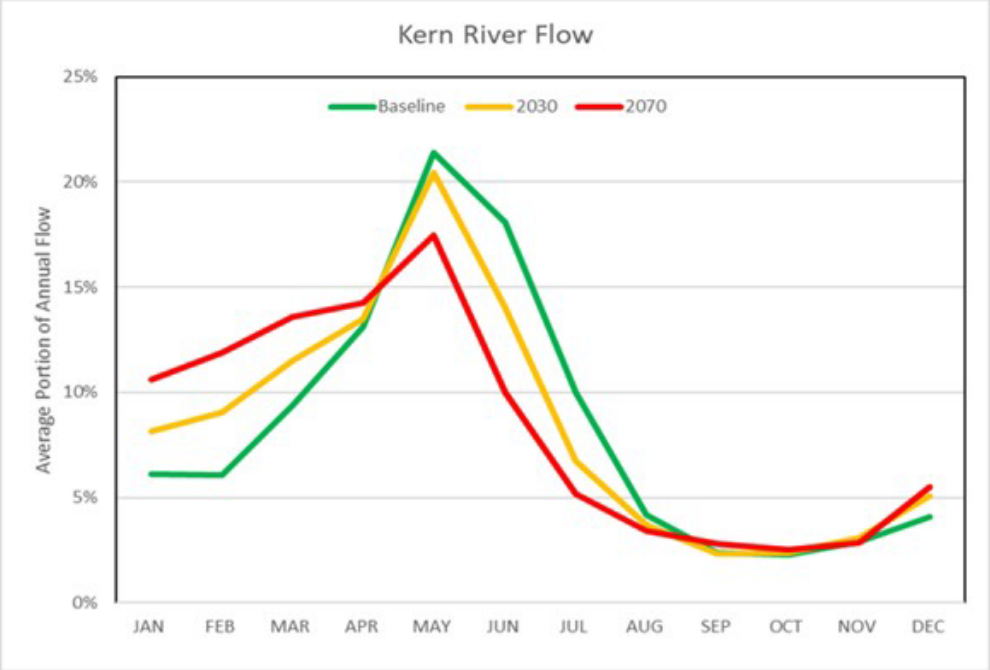
The SWP projections provided by DWR for WY1995 to WY2003 and historical deliveries for WY2004 to WY2014 were modified to incorporate the impacts of SWP operational changes in the three projected scenarios. A summary of the modifications to historical SWP deliveries to develop an equivalent projected-future SWP delivery schedule are summarized below:

- Baseline Hydrologic Conditions:
  - WY1995 to WY2003 conditions are based on 2030-Level CALSIM increased by 3.03 percent.
  - WY2004 to WY2007 conditions are based on historical data adjusted for OCAP BO.
  - WY2008 to WY2014 conditions are based on historical data with the assumption that OCAP BO adjustments are already factored into the data.
- 2030 Climate Conditions:
  - WY1995 to WY2003 conditions are based on the 2030-Level CALSIM Projection.
  - WY2004 to WY2007 conditions are based on OCAP BO adjustment reduced by 3.03 percent.
  - WY2008 to WY2014 conditions are based on historical data reduced by 3.03 percent.
- 2070 Climate Conditions:
  - WY1995 to WY2003 conditions are based on the 2070-Level CALSIM Projection.
  - WY2004 to WY2007 conditions are based on OCAP BO adjustment reduced by 8.09 percent.
  - WY2008 to WY2014 conditions are based on historical data reduced by 8.09 percent.

Figure 9-20 graphically illustrates the total changes in SWP deliveries to the Kern Subbasin. The net result of the climate change modifications is that SWP deliveries to the Kern Subbasin for the Baseline scenario are 83 percent of historical; for the 2030 Climate scenario are 80 percent of historical; and for the 2070 scenario are 76 percent of historical.

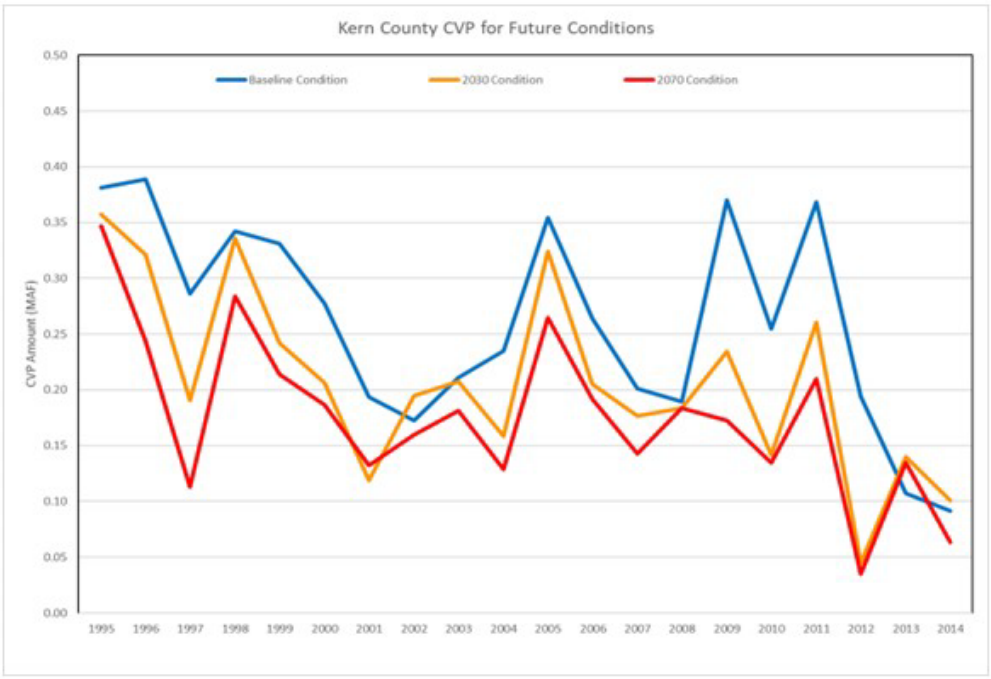
Figure 9-21 shows the composite changes in total surface water supplies from the Kern River, CVP, and SWP. The net result of the climate change modifications is that Kern River, CVP, and SWP deliveries to the Kern Subbasin for the Baseline scenario are 93 percent of historical; for the 2030 Climate scenario are 88 percent of historical; and for the 2070 Climate scenario are 85 percent of historical.

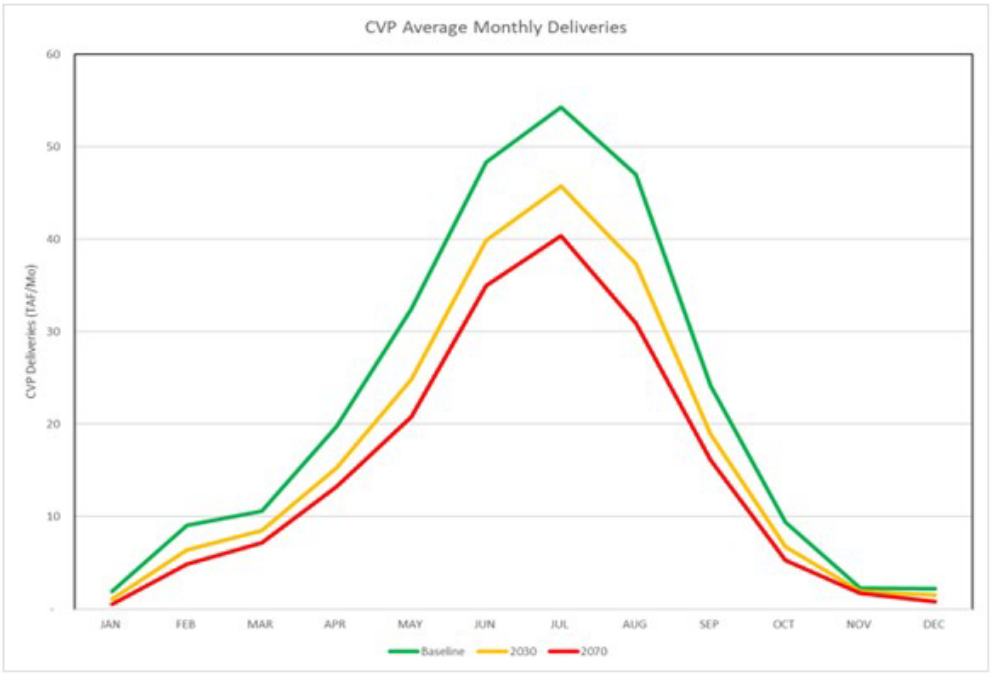




Kern County Subbasin Groundwater Sustainability Plan	PROJECTED-FUTURE WATER SUPPLIES FROM THE KERN RIVER
	April 2025 *Todd Groundwater/MM*

Figure 9-18. Projected-Future - Water Supplies from the Kern River





Kern County Subbasin Groundwater Sustainability Plan	PROJECTED-FUTURE WATER SUPPLIES FROM THE FRIANT-KERN CANAL FOR THE FEDERAL CENTRAL VALLEY PROJECT
	April 2025 *Todd Groundwater/MM*

Figure 9-19. Projected-Future Water Supplies from the Friant-Kern- Canal for the Federal Central Valley Project

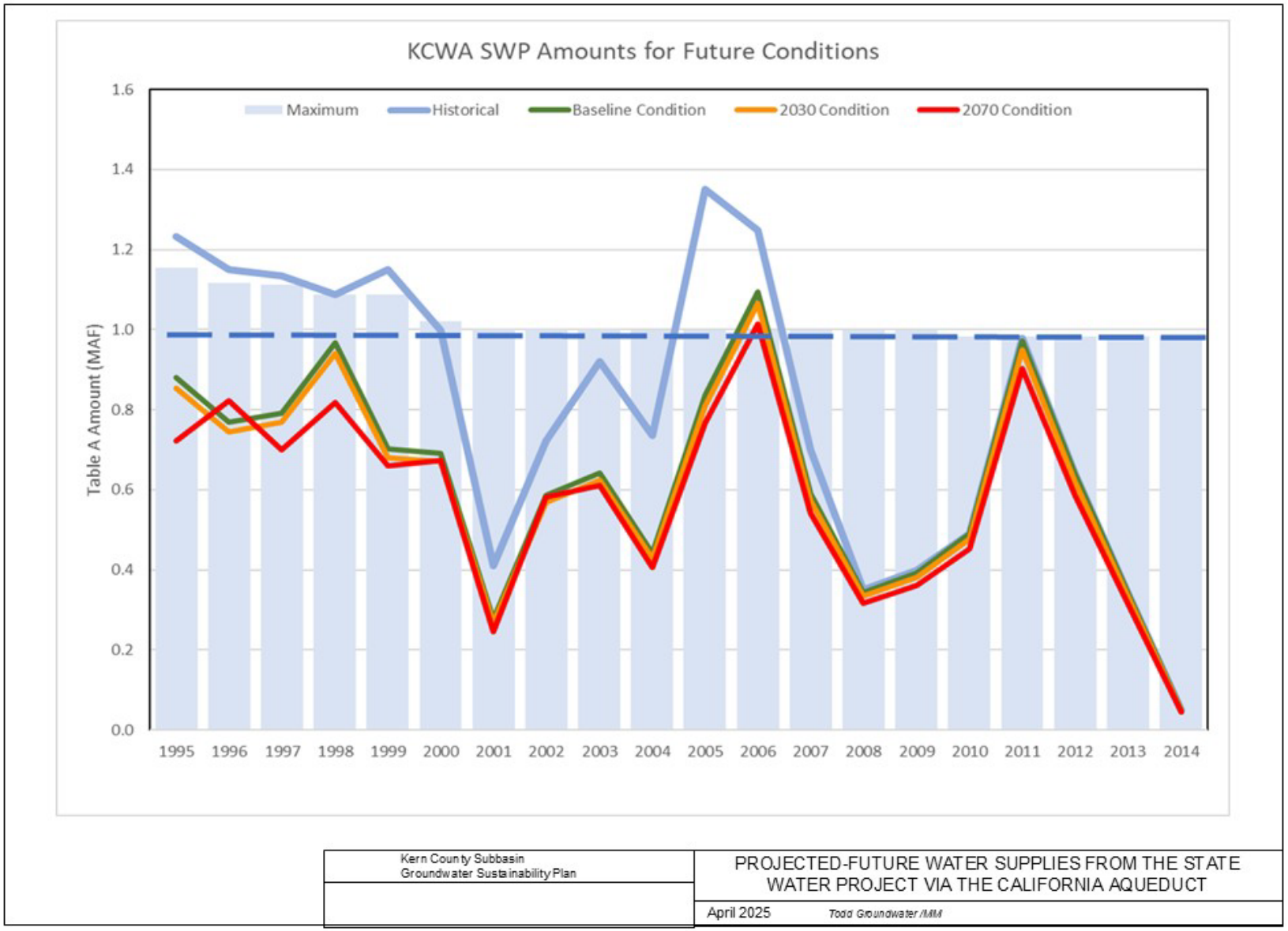


Figure 9-20. Projected Future Water Supplies from the California Aqueduct for the State Water Project

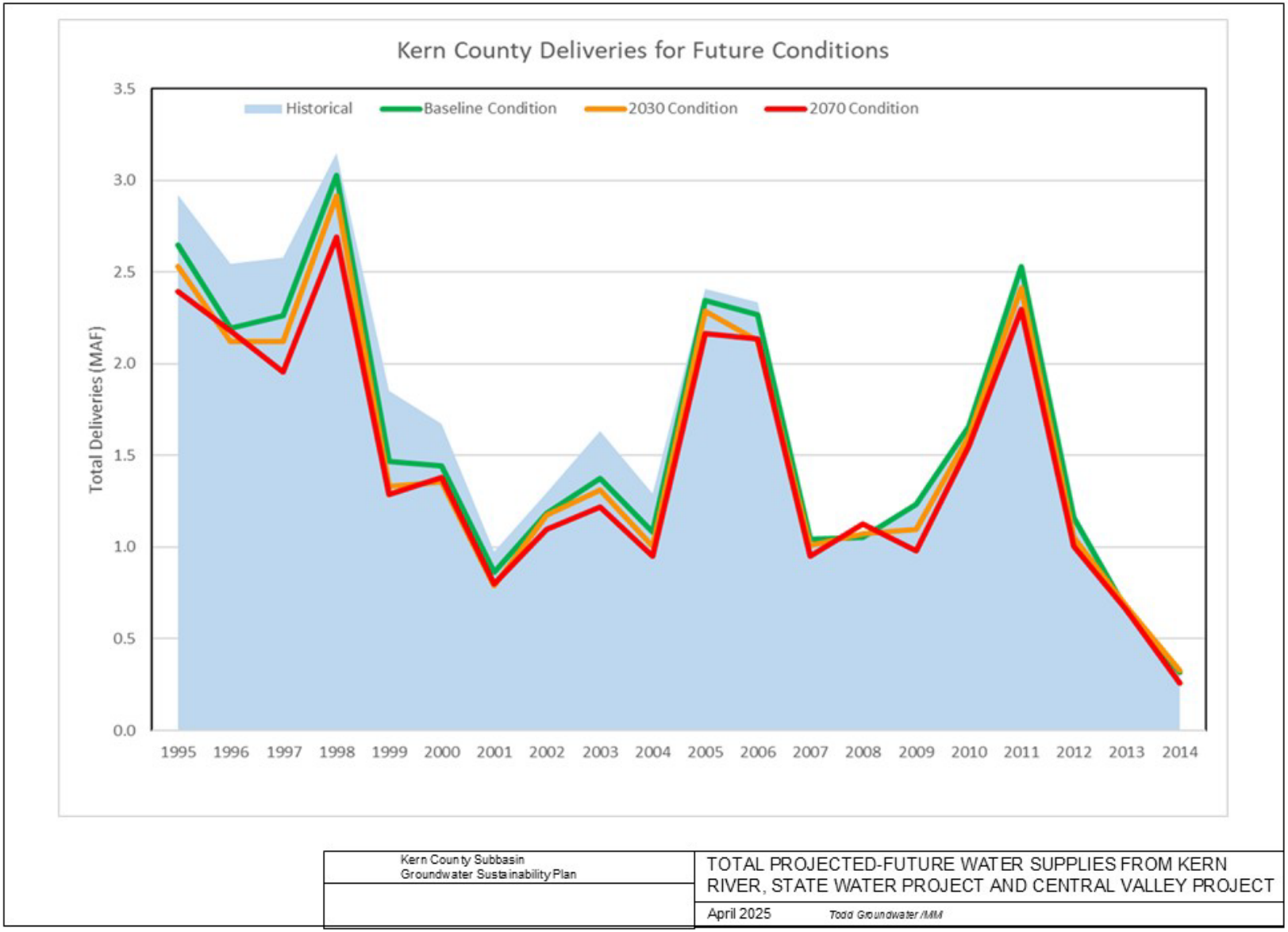


Figure 9-21. Total Projected Future Water Supplies from Kern River, SWP, and Central Valley Project

9.6.3 Additional Surface Water Supply Adjustments

☑ 23 CCR § 354.18(c)(3)
☑ 23 CCR § 354.18(d)(3)

Within the Kern Subbasin, water users engage in complex real-time water trading and wheeling activities to maximize water utilization, minimize waste and energy consumption, and meet immediate water needs. It would be difficult to project future surface water deliveries in the Kern Subbasin without the use of a surface water allocation model that simulates these water trading and wheeling activities. Therefore, for this modeling effort, monthly future-scenario agricultural, urban and recharge deliveries from sources originating outside the Kern Subbasin have been estimated by adjusting historical deliveries by the ratio of (total scenario inflows)/(total historical inflows) for each month, where total inflows are the sum of CVP deliveries, SWP deliveries and Kern River at First Point. In addition, Kern River flows at First Point flows above historical flows under the 2030 Climate and 2070 Climate scenarios have been proportionally added to selected recharge deliveries. This method is deemed adequate for the Subbasin-level future scenario analyses.

Some future scenario data sets do not cover the entire historical water budget period from WY1995 through WY2014. In these cases, data from an analog historical period with similar water availability has been used to fill in the missing data. The analog years for each data type are summarized as:

- For CVP deliveries (CalSim-II data), WY1951 to WY1961 have been used as analogs for missing WY2004 to WY2014 data; these analog years have a similar distribution of water availability.
- Projected future Kern River at First Point flows for calendar years 1986, 1991, 1990, and 1961 have been used as analogs for missing calendar years 2011 through 2014; each of these analog years had a similar historical annual flow volume and monthly distribution.
- For climatic data adjustment factors, calendar years 1959 to 1961 have been used as analogs to missing calendar years 2012 to 2014.

9.6.4 Projected Water Budget Results

☑ 23 CCR § 354.18(d)(3)

The C2VSimFG-Kern was run for three scenarios representing Baseline, 2030 Climate and 2070 Climate conditions, both with and without the proposed P/MAs for a total of six projected future scenarios.

C2VSimFG-Kern calculates water budget components each month of the simulation period for each future scenario. Projected future water budgets developed based on the C2VSimFG-Kern simulation results with the proposed P/MAs are then compared to

results for the future scenarios without the P/MAs to assess how these changes enhance groundwater sustainability within the Kern Subbasin.

The average annual value of each water budget component summarizes the impacts over 50 years with current water demands. The water budget results for the six Projected scenarios are presented in Appendix H-1, Table 19 through 24, and include averages over three different periods, which include:

- **WY2021 to WY2040** – Implementation Period representing the 20-year period required by the SGMA Regulations to implement P/MAs to achieve sustainability.
- **WY2041 to WY2070** – Sustainability Period representing the 30-year hydrologic period following the Implementation Period to assess the long-term sustainability of the proposed P/MAs with variable climatic conditions including periods with above average rainfall and extended droughts.
- **WY2021 to WY2070** – Simulation Period representing the entire 50-year projected future hydrologic conditions.

Changes to surface water diversions under the proposed P/MAs include monthly increases or reductions to 37 model diversions and the addition of seven new diversions. Ten new groundwater pumping wells have been added to simulate a new groundwater pumping program. Agricultural land use has been converted to native vegetation in ten GSAs, and to urban land use in three GSAs. The P/MAs included in the C2VSimFG-Kern scenarios are described in Section 14.

Baseline simulation results indicate that the Kern Subbasin has an average annual overdraft over the Sustainability Period (WY2041 to WY2070) of 324,326 AFY. By implementing the proposed P/MAs, the Kern Subbasin is forecasted to achieve sustainability by 2040 with an estimated 42,144 AFY of annual surplus over the Sustainability Period. With adjustments to account for limitations in the simulation (discussed in Section 9.8.2), the adjusted change in storage increases to 85,578 AFY.

Hydrographs of the simulated groundwater levels showing the projected future change in groundwater levels relative to the MO and MT for each monitoring well are provided in Appendix H-3. A regional model such as C2VSimFG-Kern does not perfectly represent local groundwater levels; however, it does represent long-term changes in groundwater levels. Therefore, the hydrographs are presented showing the projected future change in groundwater levels for each monitoring well. This was done using the superposition method where the simulated groundwater elevation change is calculated relative to the simulated March 2015 groundwater levels from the model. This simulated change in groundwater levels is then applied to the measured March 2015 groundwater level at that monitoring location. The result was to superimpose the simulated change in groundwater levels from the projected future C2VSimFG-Kern scenarios relative to the measured March 2015 groundwater level. The superposition process provided a more

realistic projection of future groundwater elevations relative to the MO and MT to aid sustainability planning including the development of Projects and Management Actions (P/MAs).

Collectively, the C2VSimFG-Kern simulation results indicate that the currently proposed P/MAs, once fully implemented, provide a reasonable approach to achieve sustainable management of the Kern Subbasin and can be adaptively managed to meet future challenges, as necessary. A summary of each of the six projected future water budgets from C2VSimFG-Kern is provided below.

9.6.4.1 Baseline Condition Water Budgets

For the Baseline Scenario without SGMA Projects, the groundwater budget for WY2021 to WY2040 (Appendix H-1, Table 19) repeats the 20-year historical hydrologic period so it provides a direct comparison of the differences between the projected future Baseline without SGMA Projects and the historical condition. The primary difference between historical conditions and the projected future Baseline is a nearly 20 percent decrease in imported surface water deliveries primarily from the SWP due to the OCAP BO. Over this period, the average groundwater pumping is 1,581,000 AFY, which includes agricultural pumping, urban pumping, and exported water. This results in an additional loss of groundwater storage of about 50,000 AFY over the 50-year projected future Baseline period.

The Baseline Scenario with SGMA Projects simulates the P/MAs applied to the Baseline Scenario. No other changes were made except for the addition of the P/MAs to provide a direct comparison of the relative benefits of about 422,000 AFY of proposed P/MAs. The groundwater budget for the Baseline Scenario with SGMA Projects is provided in Appendix H-1, Table 20.

Comparing the groundwater budget for WY2041 to WY2070 (Appendix H-1, Table 20) with the same period from the Baseline Scenario (Appendix H-1, Table 19) provides an evaluation of groundwater conditions after the P/MAs have been fully implemented. As a result of implementing the P/MAs, total net aquifer inflows increase about 135,400 AFY. The total net aquifer outflows decrease about 231,100 AFY due mostly to decreased groundwater pumping with agricultural demand reduction management actions.

The change in groundwater storage for the Baseline Scenario with SGMA Projects improves by about 360,000 AFY compared to the Baseline Scenario without SGMA Projects. This change results in a net gain in groundwater in aquifer storage for WY2041 to WY2070 of about 42,100 AFY. A comparison of the annual change in groundwater storage over the 50-year hydrologic period is shown in Figure 9-22. The time series shows that change in groundwater storage has stabilized to slightly increasing over the period from WY2041 to WY2070.

A comparison of the average annual water budget components for the two different Baseline Scenarios is shown in Figure 9-23. Over WY2041 to WY2070, the average groundwater pumping of 1,354,000 AFY for the Baseline Scenario with SGMA Projects (which includes agricultural pumping, urban pumping, and exported water) is over 270,000 AFY less than in the Baseline Scenario.

9.6.4.2 2030 Climate Change Water Budgets

The 2030 Climate scenarios simulate how the Kern Subbasin responds assuming hydrologic conditions representing a potentially drier climate and are based on the DWR Climate Change Guidance and Resource Guide (DWR, 2018A and 2018B). The 2030 Climate scenarios were run both with and without SGMA projects. Results for these 2030 Climate scenarios are shown in Figure 9-24.

The groundwater budget for the 2030 Climate Scenario without SGMA Projects for WY2041 to WY2070 (Appendix H-1, Table 21) is compared the same period for the Baseline Scenario without SGMA Projects to assess the relative change due to the climate change assumptions. The results show a net increase in aquifer inflows of about 44,700 AFY, however, the aquifer net outflows increase by about 101,200 AFY. This is mostly attributed to the climate shift to earlier rainfall making more surface water available for water banking and conjunctive use projects during the winter but less available for irrigation in the summer, resulting in higher groundwater pumping. The net change in groundwater storage is an additional decline of about 56,600 AFY due to the climate change impacts.

The 2030 Climate Scenario with SGMA Projects simulates the proposed P/MAs (Section 14) applied to the 2030 climate change conditions. No other changes were made to this scenario. The groundwater budget for the 2030 Climate Scenario with SGMA Projects is provided in Appendix H-1, Table 22.

Comparing the groundwater budget for WY2041 to WY2070 (Appendix H-1, Table 21) between the two 2030 Climate Scenarios, the total net aquifer inflows increase about 118,700 AFY due to increased water banking and conjunctive use projects and deep percolation. The total net aquifer outflows decrease about 249,300 AFY due mostly to decreased groundwater pumping with agricultural demand reduction management actions.

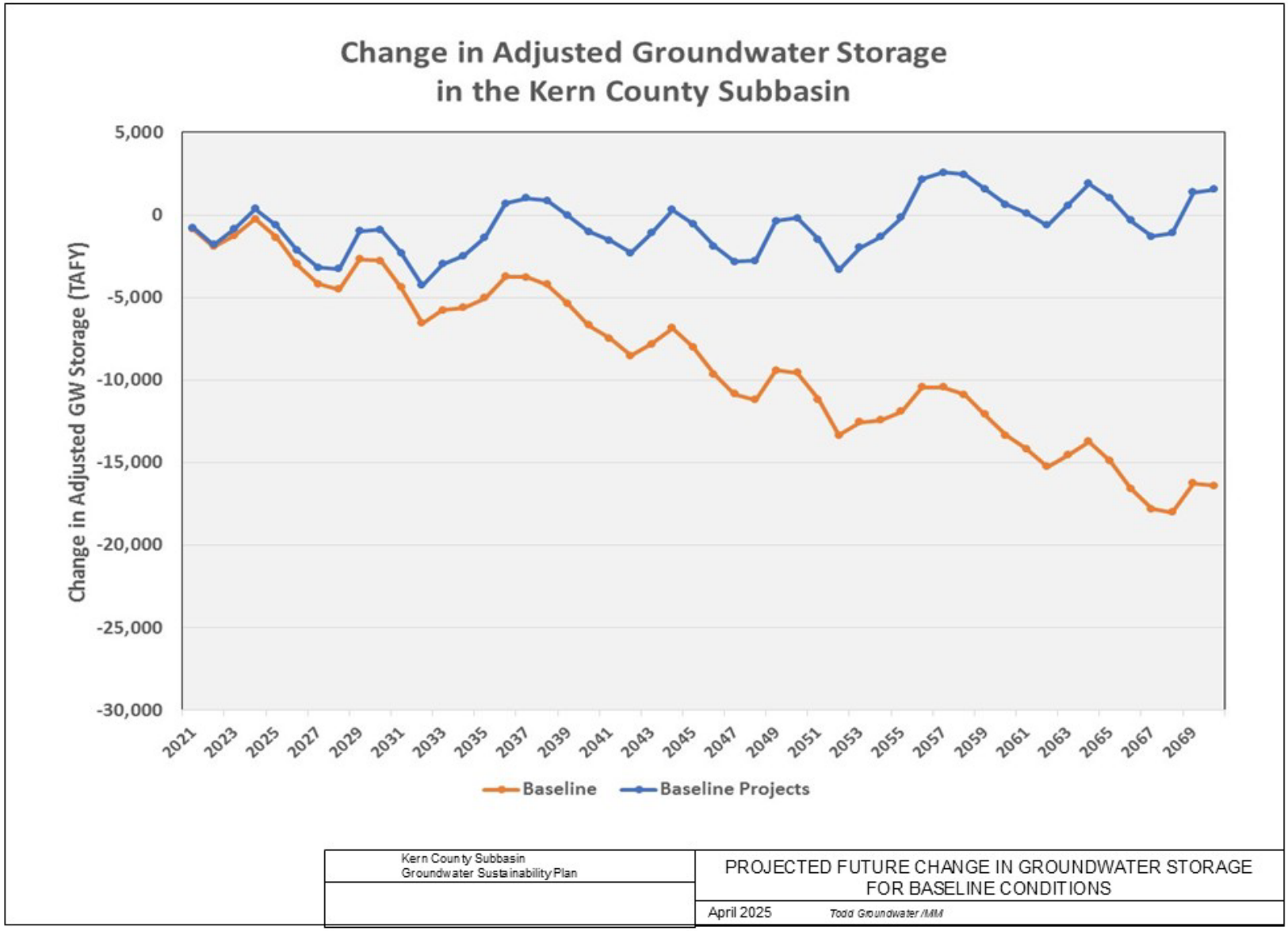


Figure 9-22. Projected-Future Change in Groundwater Storage for Baseline Conditions

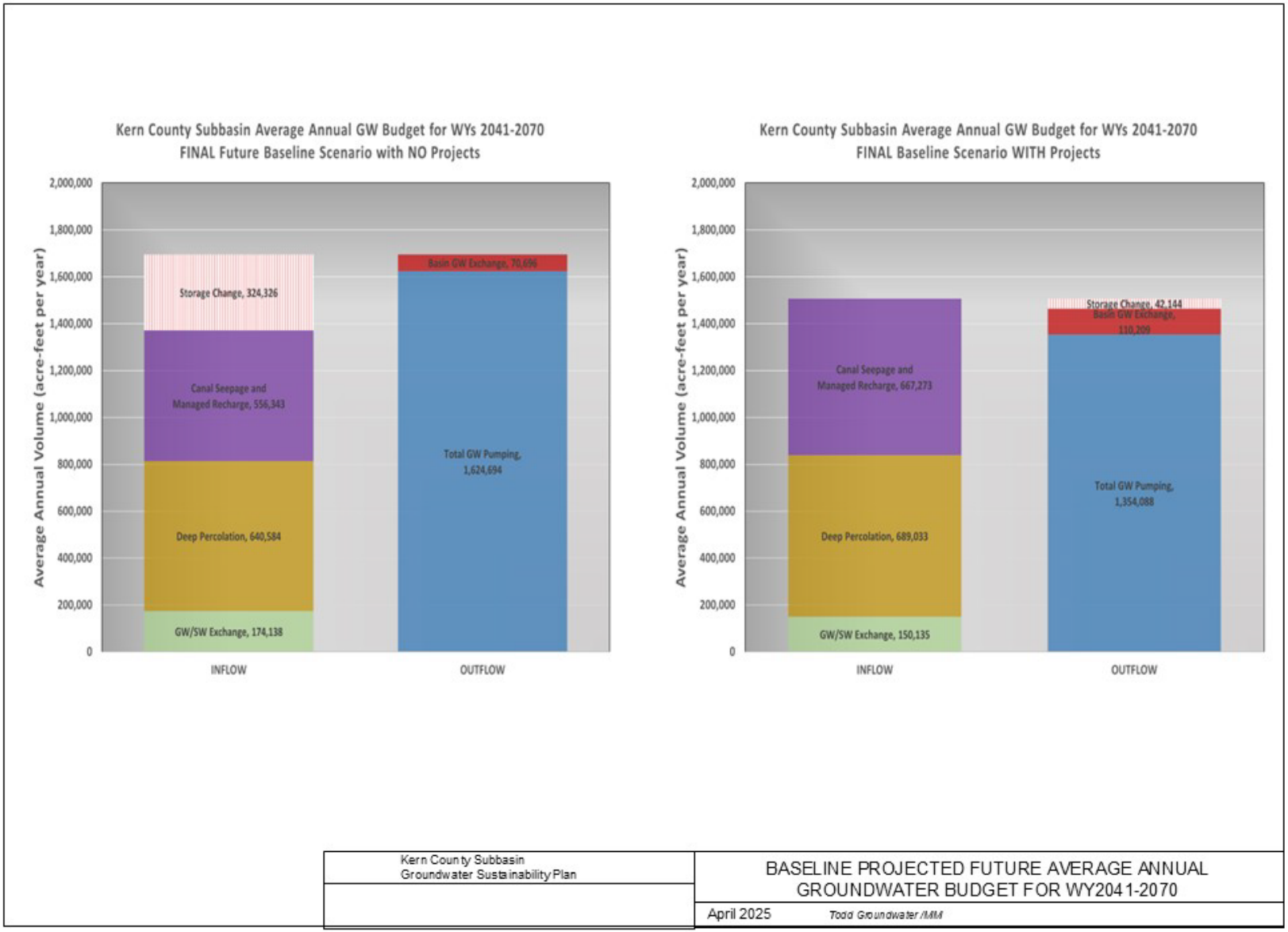


Figure 9-23. Baseline Projected Future Average Annual Groundwater Budget for WY2041 to 2070

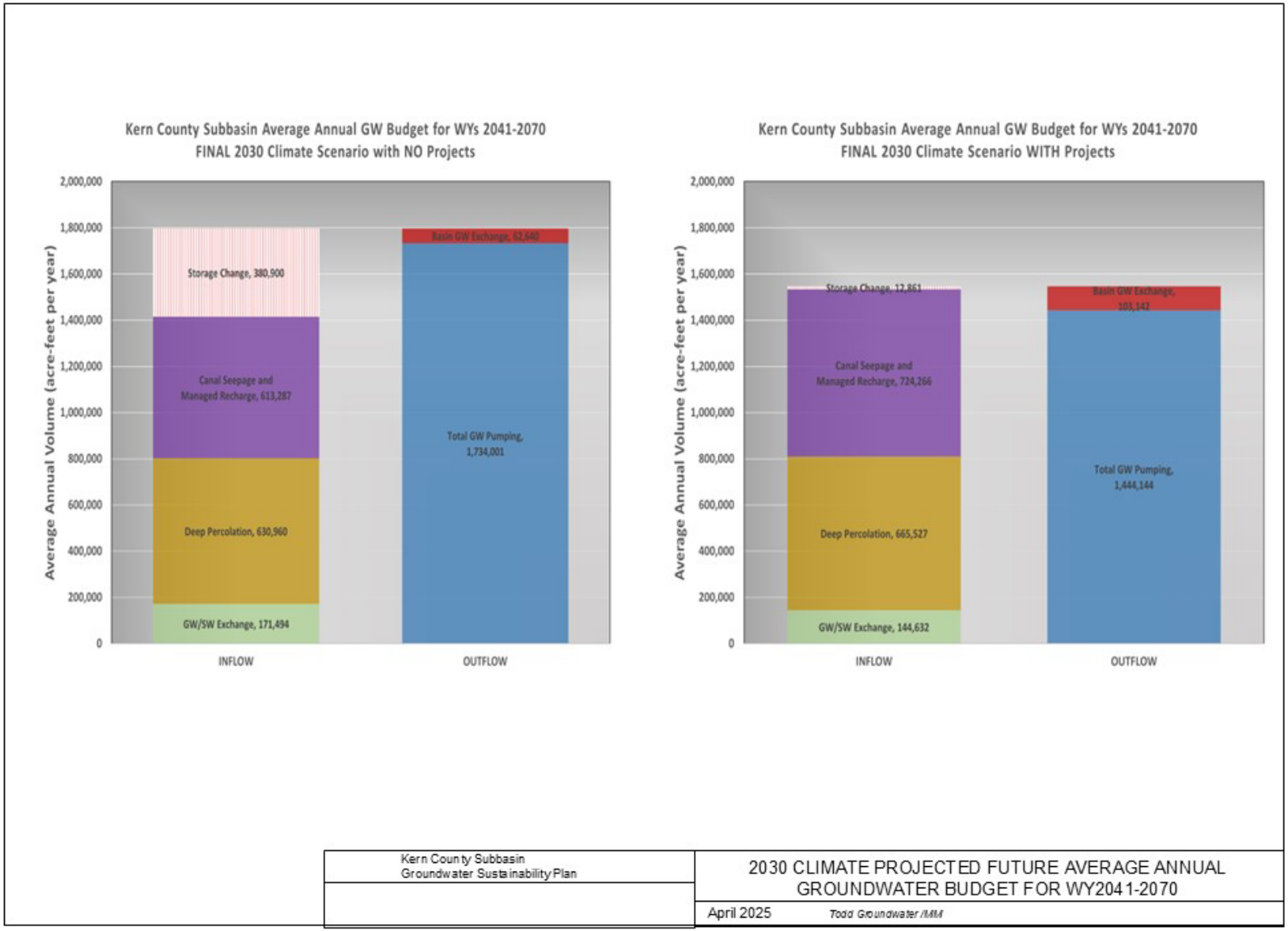


Figure 9-24. 2030 Climate Projected Future- Average Annual Groundwater Budget for WY2041 to 2070

The change in groundwater storage for the 2030 Climate Scenario with SGMA Projects improves by about 368,000 AFY. This change results in a net decline in groundwater in aquifer storage over WY2041 to WY2070 of about 12,900 AFY. A comparison of the annual change in groundwater storage over the 50-year hydrologic period is shown in Figure 9-27. The time series shows that change in groundwater storage has stabilized to slightly increasing over the period from WY2041 to WY2070, but at a level below the results for the Baseline Scenario with SGMA Projects.

A comparison of the average annual water budget components for the two 2030 Climate Scenarios is shown in Figure 9-24. Over this period, the average groundwater pumping of 1,444,000 AFY for the 2030 Climate Scenario with SGMA Projects, which includes agricultural pumping, urban pumping and exported water, is over 290,000 AFY less than in the 2030 Climate Scenario without SGMA Projects.

9.6.4.3 2070 Climate Change Water Budgets

The 2070 Scenarios simulate how the Kern Subbasin aquifer would respond assuming hydrologic conditions representing a potentially very dry climate and are based on the DWR Climate Change Guidance (DWR, 2018A and 2018B). The 2070 Climate Change Scenarios were run both with and without SGMA Projects.

The groundwater budget for the 2070 Climate Scenario without SGMA Projects over WY2041 to WY2070 (Appendix H-1, Table 23) is compared the same period for the Baseline Scenario without SGMA Projects to assess the relative change due to the climate change assumptions. The results show a net increase in aquifer inflows of about 66,100 AFY, however, the net aquifer outflows increase by about 231,600 AFY. This is mostly attributed to an even greater climate shift to earlier rainfall making more surface water available for water banking and conjunctive use projects during the winter but less available for irrigation in the summer resulting in higher groundwater pumping. The net change in groundwater storage is an additional decline of about 165,500 AFY due to the climate change assumptions.

The 2070 Climate Scenario with SGMA Projects simulates the proposed P/MAs (Section 14) applied to the 2070 climate change conditions. No other changes were made to this scenario. The groundwater budget for the 2070 Climate Scenario with SGMA Projects is provided in Appendix H-1, Table 24. Comparing the groundwater budget for WY2041 to WY2070 (Appendix H-1, Table 23) between the two 2070 Climate Scenarios, the total net aquifer inflows increase about 106,300 AFY due to increased water banking and conjunctive use projects and deep percolation. The total net aquifer outflows decrease about 265,300 AFY due mostly to decreased groundwater pumping due to agricultural demand reduction management actions.

The change in groundwater storage for 2070 Climate Scenario with SGMA Projects improves by about 371,600 AFY. This change results in a net decline of groundwater in aquifer storage over WY2041 to WY2070 of about 118,300 AFY. A comparison of the annual change in groundwater storage over the 50-year hydrologic period is shown in

Figure 9-26. The time series shows that change in groundwater storage has stabilized to slightly increasing over the period from WY2041 to WY2070, but at a level below the results for the Baseline and 2030 Scenarios with SGMA Projects.

A comparison of the average annual water budget components for the two different 2070 Climate Scenarios is shown in Figure 9-25. Over this period, the average groundwater pumping of 1,559,000 AFY for the 2070 Climate Scenario with SGMA Projects, which includes agricultural pumping, urban pumping and exported water, is over 307,000 AFY less than in the 2070 Climate Scenario without SGMA Projects.

9.6.5 Change in Groundwater Storage

☑ 23 CCR § 354.18(d)(3)

Groundwater sustainability for the Kern Subbasin was assessed using annual changes in groundwater storage. As discussed above, the decline in groundwater storage of the three future scenarios without P/MAs is significantly mitigated by the implementation of the proposed P/MAs. An assessment of the projected future groundwater storage change for the six projected future scenarios is summarized in Appendix H-1, Table 25. The results of these simulations are summarized in Table 9-12.

Table 9-12. Summary of Simulated Change in Groundwater Storage Results over the 2041 to 2070 Sustainability Period

C2VSimFG-Kern Model Scenario	Change in Groundwater Storage (AFY) Summary for All Model Scenarios
Historic (WYs 1995-2014)	-274,200
Current (WYs 2015-2023)	-344,019
Baseline (WYs 2040-2070)	-324,326
Baseline with Projects (WYs 2040-2070)	85,578
2030 Climate Change (WYs 2040-2070)	-372,120
2030 Climate with Projects (WYs 2040-2070)	46,829
2070 Climate Change (WYs 2040-2070)	-472,336
2070 Climate with Projects (WYs 2040-2070)	-45,969

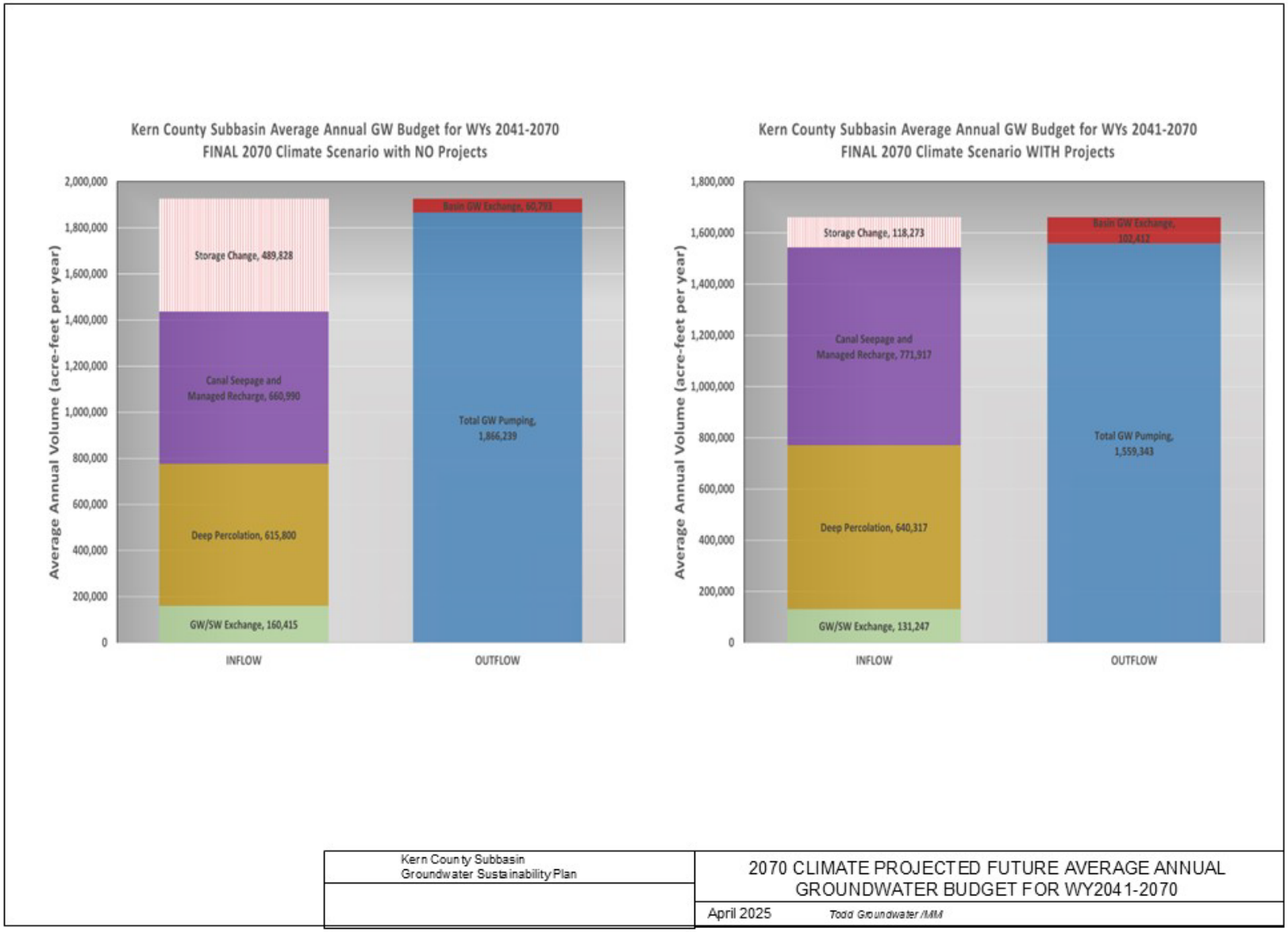


Figure 9-25. 2070 Climate Change Projected Future Average Annual Groundwater Budget for WY2041 to 2070

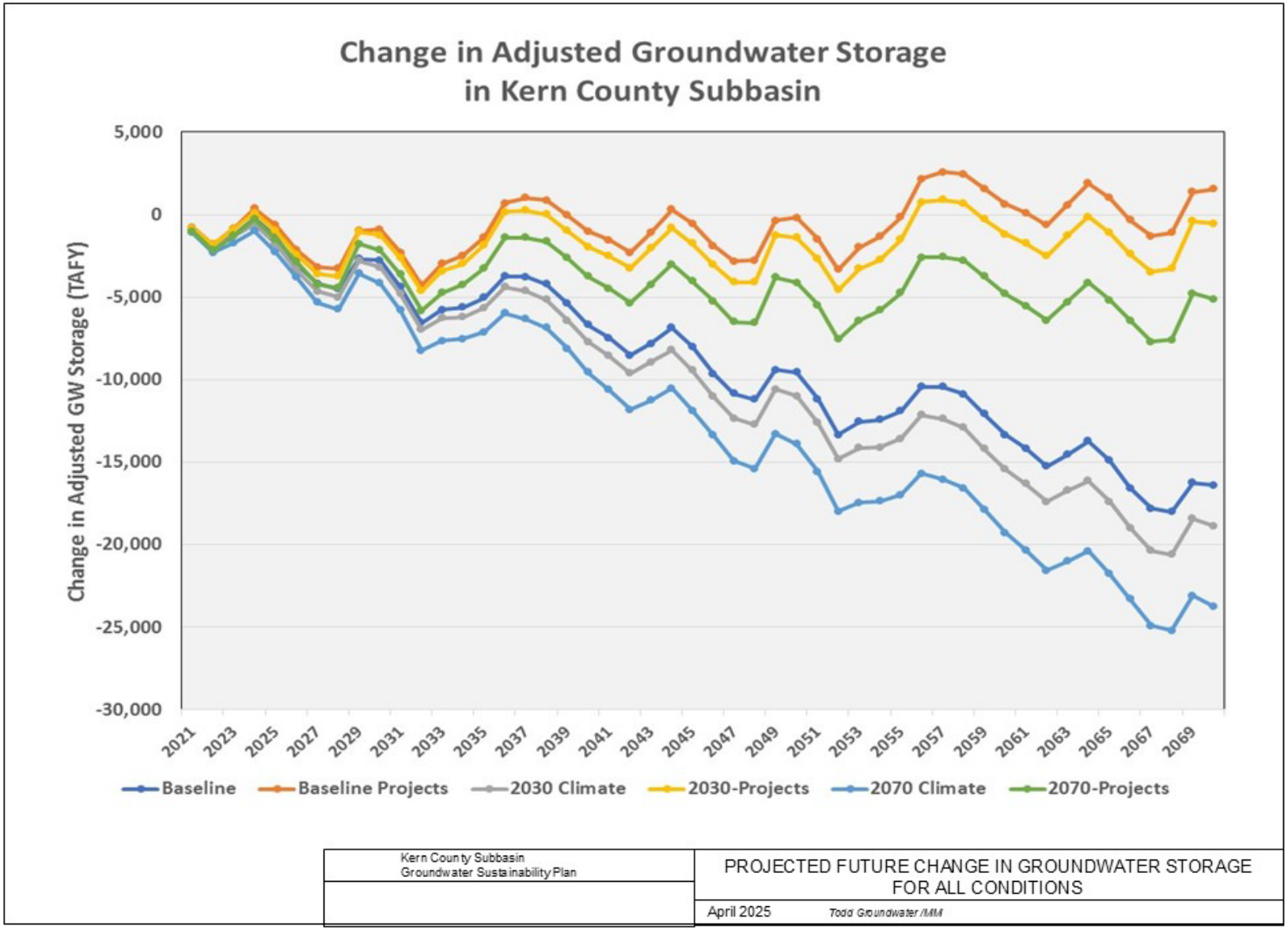


Figure 9-26. Projected Future Change in Groundwater Storage for all Conditions

These adjustments resulted in an overall improvement in the change in groundwater storage for the projected future water budgets. For the scenarios that include the SGMA Projects, the change in groundwater storage improves by 43,400 AFY (Baseline), 59,700 AFY (2030 Climate), and 72,300 AFY (2070 Climate). As a result of these adjustments, the adjusted change in groundwater storage for the three scenarios with SGMA Projects varied as follows:

- The Baseline Scenario with SGMA Projects changes from an increase of 42,100 AFY to an increase of 85,600 AFY.
- The 2030 Climate Scenario with SGMA Projects changes from a decline of 12,900 AFY to an increase of 46,800 AFY.
- The 2070 Climate Scenario with SGMA Projects changes from a decline of 118,000 AFY to a decline of 46,000 AFY.

These adjustments indicate areas of future improvement for C2VSimFG-Kern. Future updates to the model will address how to better simulate these conditions directly to limit the use of post-simulation adjustments.

9.7 Subbasin Sustainability Assessment

☑ 23 CCR § 354.18(d)(3)

As defined by SGMA, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Although the SGMA Regulations require that a single value of sustainable yield must be calculated basin-wide, it should be noted that the sustainable yield can be changed with implementation of recharge projects, variations in climate, or changes in stream flow conditions. For the projected future scenarios, both the climate and the managed water supply operations are significantly affected which would lead to a change in the sustainable yield for the Kern Subbasin.

9.7.1 Sustainability Assessment

For the sustainability assessment, the sustainable yield was recalculated using the method described above, and the results are presented in Appendix H-1, Table 26. Without the P/MAs, the percentage by which the total groundwater pumping exceeds the sustainable yield provides context to compare the significance of the level of groundwater pumping for the Kern Subbasin. For the scenarios without P/MAs, the groundwater pumping exceeds the sustainable yield on the order of 25 percent to 34 percent Appendix H-1, Table 26. However, with the proposed P/MAs, the groundwater pumping is less than the sustainable yield of the Kern Subbasin for the Baseline and 2030 climate scenarios and is within three percent of the sustainable yield for the 2070 Climate Scenario Appendix H-1, Table 23. This assessment indicates that the proposed P/MAs for the Kern Subbasin are of sufficient magnitude that, if fully

implemented, would lead to groundwater sustainability for the Kern Subbasin after WY2040.

9.7.2 GSP Implementation Progress To-Date

A comparison of the updated C2VSimFG-Kern model results through WY2023 to the baseline condition provides a means to assess progress towards sustainability. Figure 9-27 compares the change in stored surface water and groundwater in storage from historical and current C2VSimFG-Kern simulation to the Projected-Future Baseline Scenarios. The Baseline Scenarios include a separate run for with and without implementation of the P/MAs. The P/MAs are based on an original set of P/MAs that were designed to meet the Projected-Future deficit that includes a representative distribution of demand reduction and supply augmentation P/MAs (Figure 9-17). The demand reduction P/MAs provide a base level of improvement that is further enhanced with the utilization of water banking and conjunctive use during wet years. The Baseline Scenarios represent a minimum volumetric benefit of P/MAs necessary to achieve sustainability. As presented in Section 14, the Kern Subbasin GSAs have continued to develop additional P/MAs that exceed this total.

The comparison on Figure 9-27 shows that the historical variability in change in stored surface water and groundwater in storage is reflected in the Baseline Scenario. For the Projected-Future Scenarios, the scenario with P/MAs run shows change in storage incrementally higher than the scenario without P/MAs. This shows that the high total volumes are a relatively small percentage of the overall water budget suggesting that this level of improvement is attainable.

The historical and current simulation has been extended to WY2023 which covers three years of GSP implementation. The second graph on Figure 9-27 shows the cumulative change in storage. The Baseline Scenario without P/MAs shows a general condition of the declines from WY1995 to WY2020. The Baseline Scenario with P/MAs shows that implementing P/MAs results in a change in the slope of the cumulative change in storage such that there is a slight positive increase in storage over the period from WY2041 to WY2070. The WY2023 historical and current simulation indicates that the Kern Subbasin is generally on track with the sustainability plan at this early stage of implementation. This short-term assessment indicates that the Kern Subbasin GSP implementation is currently on track.

This is a preliminary assessment of factors contributing to change of groundwater in storage estimates. The Kern Subbasin GSAs are currently coordinating on several Subbasin-wide management actions to improve the ability to determine ET crop demand, upgrade the C2VSimFG-Kern model and conduct a Basin Study to address data gaps and better calculate water budgets.

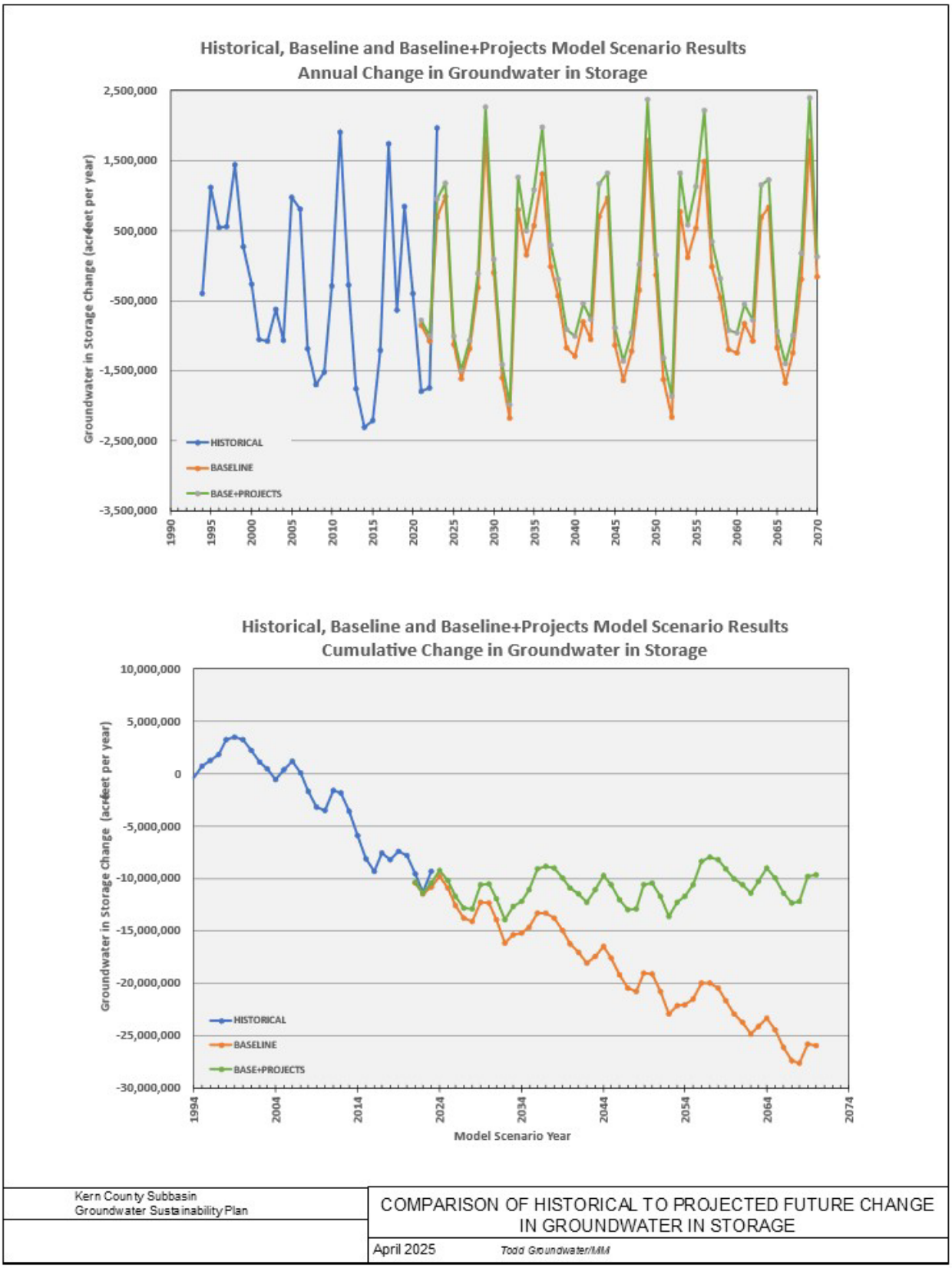


Figure 9-27. Comparison of Historical to Projected Future- Change in Groundwater in Storage

9.8 Conclusions

☑ 23 CCR § 354.18(a)

This brief summary provides an overview of the findings and conclusions of the modeling results for the Kern Subbasin using C2VSimFG-Kern.

9.8.1 Findings of the C2VSimFG-Kern Application and Results

The Subbasin-wide update of C2VSimFG-Kern incorporates data from many local agencies. Each participating agency provided data for their jurisdiction for use in improving the model. This included managed water supply data (e.g., surface water deliveries, land use, irrigation demand, return flows, and water banking), stream and groundwater monitoring data, geologic data, and other relevant data. This information was compiled and used to improve C2VSimFG-Kern performance in the Kern Subbasin.

The historical water budget analysis indicates that the Kern Subbasin was in a state of overdraft equivalent to the long-term decline in groundwater storage from WY1995 to WY2014 of 274,200 AFY. Projected Future simulations indicate that the proposed P/MAs in the GSPs are sufficient for the Kern Subbasin to achieve sustainability under Baseline and 2030 Climate Change conditions.

C2VSimFG-Kern is used to evaluate the change in groundwater in storage for projected future conditions using a baseline condition that projects current water supply, water demand and land use over a 50-year period based on historical hydrology. The baseline was adapted following DWR climate change guidance to develop 2030 and 2070 climate change simulations. The proposed P/MAs were compiled from all the Kern Subbasin GSAs. All Kern Subbasin projects total about 421,000 AFY through demand reduction, supplemental supply, or other supply after supply implementation. This assessment indicates that the P/MAs for the Kern Subbasin are of sufficient magnitude that, if fully implemented, would lead to groundwater sustainability for the Kern Subbasin after WY2040.

The historical C2VSimFG-Kern performs well in the Kern Subbasin, producing simulated water budget components and groundwater levels that generally match historical values compiled by local agencies. C2VSimFG-Kern simulated groundwater levels provide a reasonable statistical approximation of observed groundwater levels in the Kern Subbasin that show significant improvement relative to C2VSimFG-Beta. Therefore, C2VSimFG-Kern is well suited as a planning tool to estimate the impacts of the P/MAs on groundwater conditions in the Kern Subbasin.

The C2VSimFG-Kern model development and the water budget analysis were designed to fulfill the GSP requirement for a coordinated subbasin-wide water budget analysis, while also providing information required to fulfill other GSP requirements. The C2VSimFG-Kern model was provided to DWR so the Kern Subbasin revisions can be incorporated into their master version of the C2VSim model.

9.8.2 Limitations and Uncertainty of C2VSimFG-Kern

The C2VSimFG-Kern performs well in most parts of the Kern Subbasin, producing simulated water budget components that generally match historical values compiled by local agencies. C2VSimFG-Kern simulated groundwater levels provide a reasonable approximation of observed groundwater levels in the central part of the Kern Subbasin. Additional discussion of the validation and performance of C2VSimFG-Kern is provided in Appendix H-2. The model is well suited in most parts of the Kern Subbasin to estimating the impacts of management actions on Kern Subbasin groundwater storage.

The C2VSimFG-Kern update was limited in scope, and some model components do not perform well. These components do not reduce model capabilities with respect to GSP development but limit the usefulness of the model for other types of studies. Flows in the Kern River channel, including local stream-groundwater interactions, are not well replicated and surface water diversions are not dynamically simulated. The Kern Subbasin portion of the C2VSimFG-Kern is not calibrated, and although the land surface water budget components are generally accurate, groundwater conditions and stream flows are poorly simulated in much of the Kern Subbasin. Some rejected recharge occurs in the Kern Fan area in very wet years, but this is not significant as it is a very small volume. The model layering along the Kern Subbasin margins is not consistent with the current Kern Subbasin hydrogeological conceptual model that affects the ability to accurately simulate groundwater elevations in these areas.

The C2VSimFG-Kern is a reliable and defensible tool to support planning future groundwater conditions and estimating the potential hydrological impacts of future climate conditions and management actions at the Kern Subbasin level. It is currently the best available quantitative tool for assessing projected future groundwater conditions under SGMA. DWR recommends updating and refining models used in GSPs to incorporate new data including that in annual GSP updates. Refining Kern Subbasin hydrologic modelling tools to replicate district-level historical conditions will provide a reliable means of assessing future effects of management actions at the district level for future GSP development.

9.8.3 Applicability of C2VSimFG-Kern Simulation Results

Based on the model validation, C2VSimFG-Kern provides a useful planning tool to evaluate potential future trends in groundwater in the Kern Subbasin. The model validation demonstrated the capability of C2VSimFG-Kern to reasonably simulate the groundwater elevations and trends in most areas during the period from WY1995 through WY2015 based on the comparison to measured data.

The ability to reasonably simulate historical conditions provides confidence that C2VSimFG-Kern can be used to simulate potential future conditions. The model has the capability to simulate the most beneficial application of water projects that would provide the long-term benefit to the area. For the future case scenarios, the general practice is to evaluate model results with respect to long-term trends. Therefore, as a planning tool,

it is most beneficial to run the model in relation to a base case and to evaluate the relative difference between the model scenario and the base case. The base case would assume a selected set of climatic, hydrologic, and pumping conditions. Commonly, the calibration base period is assumed to repeat; however, any number of variations can be constructed.

It is important to note that in some cases the model results may vary from those measured in individual wells due to the geologic complexity of the Kern Subbasin. However, the model is capable of evaluating the impacts of changes in pumping and water use practices in the Kern Subbasin that are useful for SGMA planning purposes.

The conclusions and recommendations presented herein are professional opinions based on the C2VSimFG-Kern revisions and simulations as described herein. The findings and professional opinions presented in this letter are presented within the limits prescribed by the client contract, in accordance with generally accepted professional engineering, geologic and modeling practices, to support development of GSPs within the Kern Subbasin. There is no other warranty, either expressed or implied, regarding the conclusions, recommendations, and opinions presented in this report.

9.8.4 GSA Operational Water Budgets

While the current C2VSimFG-Kern model provides an appropriate tool to determining the Kern Subbasin scale water budgets, the model has limitations on determining local GSA water budget. Local GSA water budgets in the Kern Subbasin present a challenge for the model because of the intricate GSA boundaries, complexity of water management and water management operations that occur outside of the GSA boundary.

To address this issue, a spreadsheet-based accounting of surface water operations within individual GSAs was developed. This approach tabulates the water management operations within the GSA based on directly measured or estimated inflows and outflows (e.g. surface water deliveries and exchanges). This approach also accounts for water management operations, such as water banking, that occur outside of the GSA boundary. Therefore, these GSA operational water budgets provide a complimentary analysis to accompany the Subbasin-wide analysis using the C2VSimFGKern model.

Kern County entities have been involved in water banking for several decades. Each water bank operator provided annual water bank account balances from 1994 to 2023 (Appendix H-4). These data illustrate the highly-coordinated water management that has occurred within the Kern Subbasin for the past several decades.

The GSA operational water budgets provide a tabulation of the surface water supplies and water demands within the GSA. Some GSAs are more reliant on groundwater resources whereas others are more reliant on surface water resources. The operational water budget provides a means to assess whether GSAs operate with a net surface water surplus or deficit. Results of the GSA operational water budgets show that three

GSAs and the Kern National Wildlife Area remained in surplus during both the historical and current periods.

10. MANAGEMENT AREAS

§ 354.20. *Management Areas*

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

☑ 23 CCR § 354.20(a)

For the purpose of the Sustainable Groundwater Management Act (SGMA) compliance, the Kern Subbasin is divided into Groundwater Sustainability Agencies (GSAs) which provide coverage for the entirety of Kern Subbasin Plan Area, including both districted lands and non-districted "white lands". There is no need to create management areas below the GSA level. The two exceptions are:

- Eastside Water Management Area (EWMA), a non-profit corporation governed by a seven-member Board of Directors that is working to become a public agency and serve as the GSA for land within its boundaries. Until EWMA can serve as its own GSA, it is treated as a separate management area within the Kern Non-Districted Lands Authority.
- 7th Standard Annex was historically non-districted and was annexed into the Shafter-Wasco Irrigation District (SWID) in 2019 for the sole purpose of providing SGMA coverage. Per the landowner agreement, 7th Standard Annex does not share SWID's surface water supply benefits. Consequently, it is treated as a separate management area within the SWID GSA.

10.1 Description and Justification

§ 354.20. *Management Areas*

(a) A basin that includes one or more management areas shall describe the following in the Plan:

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

☑ 23 CCR § 354.20(b)(1)

☑ 23 CCR § 354.20(c)

The Kern Subbasin has 20 GSAs that mostly serve as the management areas. The two GSAs with separate management areas highlighted above are described in detail under Section 5.2.1 *Jurisdictional Boundaries*. Data and methodologies and Sustainable Management Criteria are the same across all management areas of Kern Subbasin.

The reason for creating separate management areas is to implement area-specific Projects and Management Actions (P/MAs) that are tied to the checkbook water budget for planning purposes (Section 14 and Appendix J).

10.2 Minimum Thresholds and Measurable Objectives

> ***§ 354.20.*** *Management Areas*
> *(b) A basin that includes one or more management areas shall describe the following in the Plan:*
> *(2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.*

☑ 23 CCR § 354.20(b)(2)

The Sustainable Management Criteria (SMCs) developed for Kern Subbasin, including the rationale for their selection, are described in detail in Section 13 *Sustainable Management Criteria.*

10.3 Monitoring

> ***§ 354.20.*** *Management Areas*
> *(b) A basin that includes one or more management areas shall describe the following in the Plan:*
> *(3) The level of monitoring and analysis appropriate for each management area.*

☑ 23 CCR § 354.20(b)(3)

Monitoring networks for each applicable Sustainability Indicator within Kern Subbasin, including a discussion of the monitoring frequency appropriate to assess conditions related to SMCs, are described in detail in Section 15 *Monitoring Network*.

10.4 Hydrogeological Conceptual Model Areas

> ***§ 354.20.*** *Management Areas*
> *(c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.*

☑ 23 CCR § 354.20(c)

To simplify description and analysis, the 2025 Plan divides the Kern Subbasin into five Hydrogeological Conceptual Model (HCM) Areas that each have similar geologic and aquifer characteristics distinct from those of other HCM Areas. The sole purpose of HCM Areas is to facilitate systematic description and analysis. Information derived from

analysis of each HCM Area may be used to inform development of management approaches.

10.5 Projects and Management Actions

> ***§ 354.20.*** *Management Areas*
> *(c) if a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.*

☑ 23 CCR § 354.20(c)

Each individual GSA is responsible for the development and implementation of a suite of P/MAs sufficient for that GSA to attain sustainability within its jurisdiction and to thereby fulfill its obligations to Kern Subbasin for achieving sustainability. P/MAs to be implemented by each individual GSA are presented in Appendix J; the sum of P/MAs and expected benefits to Kern Subbasin are presented in Section 14 *Projects and Management Actions*.

11. INTRODUCTION TO SUSTAINABLE MANAGEMENT CRITERIA

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

☑ 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 (MOs) and Interim Milestones (IMs) in increments of five years to achieve the Sustainability Goal within 20 years of the implementation of the 2020 GSPs (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));
- 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 Kern Subbasin's approach to developing the SMCs applies a methodology that is: (1) common for all Kern Subbasin areas, (2) consistent with the SGMA Regulations, (3) relies on consistent data across the Kern Subbasin, and (4) would not unreasonably impact beneficial users and uses of groundwater. Sections 12 and 13 of this 2025 Plan describe the Sustainability Goal, as well as the URs, MTs, and MOs and IMs that were developed in coordination and collaboration with all Kern Subbasin Groundwater Sustainability Agencies (GSAs).

11.1 Summary of Sustainable Management Criteria

Table 11-1 summarizes the SMCs for each applicable Sustainability Indicator established for the Kern Subbasin.

Table 11-1. Current Status of Groundwater Conditions for Each Sustainability Indicator

Sustainability Indicator	UR Criteria	Minimum Threshold	Measurable Objective
Chronic Lowering of Groundwater Levels	At least one of the following occurs within the Kern Subbasin: 1. The MTs for Chronic Lowering of Groundwater Levels exceeded at least 25 percent of the Representative Monitoring Well for Chronic Lowering of Groundwater Levels (RMW-WLs) over a single year (i.e., two consecutive seasonal measurements). 2. More than 15 drinking water wells are reported as dry in any given year.	The RMW-WL-specific MTs are set as the lower of (1) or (2): 1. Groundwater level in 2030 if the regional trend is extended from the 2015 low (the MO), or 2. Groundwater level that allows for operational flexibility below the 2015 low, based on an RMW-WL-specific record of groundwater level fluctuations. MTs are then adjusted so that: 3. MTs do not exceed 61 feet below the recent historical low,	The 2015 low groundwater elevation.

Sustainability Indicator	UR Criteria	Minimum Threshold	Measurable Objective
	If 15 drinking water wells were impacted every year, no more than 255 drinking water wells cumulatively would be impacted by 2040. 3. A GSA is unable to meet well mitigation[1] needs.	4. MTs do not newly fall below the Corcoran Clay, and/or 5. MTs are raised locally per State Water Resources Control Board staff feedback.	
Reduction of Groundwater Storage	The MTs for Chronic Lowering of Groundwater Levels are exceeded in at least 25 percent of the RMW-WLs over a single year (i.e., two consecutive seasonal measurements).	MTs for Chronic Lowering of Groundwater Levels used as a proxy.	MOs for Chronic Lowering of Groundwater Levels used as a proxy.
Seawater Intrusion	Groundwater conditions in the Kern Subbasin show that Seawater Intrusion is not present and is not anticipated to be present in the future; therefore, this Sustainability Indicator is not applicable.		
Degraded Water Quality	At least one of the following occurs within the Kern Subbasin: 1. Subbasin-wide, 15 percent of the Representative Monitoring Well for Degraded Water Quality (RMW-WQs) exceed the MT for the constituents of concern per water year based on confirmed sample and MT Exceedance investigation results[1]. 2. Annually, 5 percent of domestic wells have an assumed MT exceedance[1] based on radius of influence analysis around the RMW-WQ that exceeds the MT, with a cumulative maximum of 15 percent of domestic wells through 2040. 3. A GSA is unable to meet well mitigation[1] needs.	The RMW-WQ-specific MTs are set based on the following criteria: 1. MT is set as close to the water quality objective as feasible. 2. If historical data exceeds the water quality objective, and at least 5 sample results are available, then the MT is set at the 80th Percentile value. 3. When clear trends are present, discretion should be applied: a. If there is an increasing trend, set the MT at the 80th Percentile of the Pre-2015 data b. If there is a decreasing trend, MT should be set at the median value or as close to water quality objective as reasonable. c. If the 80th Percentile is within 10 percent of the drinking water MCL, the MT should be set at the water quality objective. 4. Proxy data are predominately used to demonstrate baseline conditions; however, data may be used when the RMW-WQ and Proxy Well are similar enough to represent the same	The water quality objective.

Sustainability Indicator	UR Criteria	Minimum Threshold	Measurable Objective
		lithology/aquifer conditions.	
Land Subsidence	The MT extent of subsidence is exceeded at any of the Kern Subbasin's Representative Monitoring Sites for Land Subsidence (RMS-LS) along the Regional Critical Infrastructure at a single milepost or GSA/HCM Area MTs after 6 quarterly consecutive sampling events measured using InSAR data (published by DWR) or annual survey data (if available), and the exceedance can be attributed to groundwater management activities (e.g. groundwater level changes, P/MAs), based on technical analysis using best available data and tools. Note: not all Kern Subbasin subsidence is caused by GSA-related activities. Non-GSA subsidence is outside of GSA authority.	MTs are established along critical infrastructure as a rate and extent based on a projection of the historical rate forward and reduced based on anticipated impacts to critical infrastructure. Additionally, MTs are set for the Kern Subbasin as the maximum average historical rate of subsidence in each HCM Area from 2015-2023.	50 percent of the MT rate and MT extent.
Depletions of Interconnected Surface Waters	Groundwater conditions in the Kern Subbasin show that there are a few areas with potential Interconnected Surface Waters. However, the connection is likely transient, short-lived, and involves localized shallow groundwater conditions or perched groundwater that is not part of the principal aquifer systems (Section 8.6). Therefore, the Sustainability Indicator is not applicable to the Kern Subbasin.		

Notes:

1. Exceedances and mitigation applications are evaluated as defined in the Kern Subbasin Exceedance Policy and Action Plans (Appendix K-1) and Well Mitigation Program (Appendix G-1).

12. SUSTAINABILITY GOAL

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

☑ 23 CCR § 354.24

The sustainability goal for the Kern Subbasin is to implement its 2025 Plan to achieve sustainable groundwater management within the Sustainable Groundwater Management Act (SGMA) 20-year implementation period. Achieving the sustainability goal will be demonstrated by eliminating chronic lowering of groundwater levels caused by overdraft conditions and avoiding undesirable results for groundwater levels, groundwater storage, land subsidence, and groundwater quality. This goal will be accomplished through the following objectives:

- Implement the Stakeholder Communication and Engagement Plan.
- Eliminate long-term groundwater overdraft and attain sustainability through conjunctive use, water banking, and demand management programs.
- Continuously monitor and evaluate groundwater conditions to avoid undesirable results.
- Maintain long-term sustainability of water resources available to the Kern Subbasin.
- Maintain a comprehensive database of beneficial uses and users to inform on the efficacy of groundwater management policies and programs.

13. SUSTAINABLE MANAGEMENT CRITERIA

As discussed in Section 11, the Kern Subbasin has developed Sustainable Management Criteria (SMCs) consistent with the Sustainable Groundwater Management Act (SGMA) and in coordination with all Kern Subbasin Groundwater Sustainability Agencies (GSAs). The Kern Subbasin's SMCs development process is proactive in identifying and managing the occurrence of Undesirable Results (URs) to beneficial uses and users and utilizes consistent data and methodologies across the Kern Subbasin. This section details the development processes of the URs, Minimum Thresholds (MTs), Measurable Objectives (MO) and Interim Milestones (IMs) for each Sustainability Indicator, and presents the final SMCs, where applicable.

13.1 Chronic Lowering of Groundwater Levels

13.1.1 Undesirable Results for Chronic Lowering of Groundwater Levels

> ***§ 354.26.*** *Undesirable Results*
> *(a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.*
> *(b) The description of undesirable results shall include the following:*
> *(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.*
> *(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.*
> *(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.*
> *(c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.*
> *(d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.*

Per SGMA, URs for the Chronic Lowering of Groundwater Levels are defined as a "chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon" (California Water Code [CWC] §10721(x)(1)). However, it is important to note that SGMA also states that "...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" (CWC §10721(x)(1)).

The Subbasin-wide UR for Chronic Lowering of Groundwater Levels is defined 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 definition requires translation to quantify "*significant and unreasonable impacts*". The general process that was followed is consistent with requirements of California Code of Regulations Title 23 (23 CCR) §354.26-30 which includes an identification of beneficial uses and users and an assessment of impacts to beneficial uses and users through a suite of well impacts analyses.

13.1.1.1 Identification of Beneficial Users

The Primary Alluvial Principal Aquifer consists of the full vertical extent of the Unconsolidated Nonmarine Deposits that includes the Recent Alluvium, Tulare, and Kern River Formations the Kern Subbasin and serves multiple beneficial uses and users. Other aquifers include the Santa Margarita and Olcese Principal Aquifers, which are present in the East Margin HCM Area and are predominately used for agricultural purposes. To fully understand beneficial uses of the aquifers within the Kern Subbasin, the GSAs developed a Well Inventory that is being used to evaluate and monitor how changing groundwater conditions (elevations and/or water quality) of the principal aquifers may impact its beneficial uses and users (Section 5.6). Through this effort, well information was gathered from multiple sources and reconciled with the DWR Online System of Well Completion Reports (OSWCR). Based on the Kern Subbasin Well Inventory (February 2025), there are approximately 7,192 groundwater extraction wells in the Kern Subbasin[1]. The number of wells by User Type presented in the following section is based on the Kern Subbasin February 2025 Well Inventory. User Type designations are used herein, and align with the definitions provided in Table 5-5 and Table 5-6.[2] Beneficial uses and users that could be impacted by Chronic Lowering of Groundwater Levels include:

[1] Since this effort remains an on-going work in progress, the total number of wells and well count by type may not be consistent, depending on which original dataset, or combination of datasets, is referenced. Numbers presented in Section 13 are based on the 27 February 2025 Well Inventory.
[2] State small systems information was not available until April 2025, and therefore state small systems are likely classified as domestic wells in the February 2025 Well Inventory. Reconciliation and classification of state small systems is ongoing and will be reflected in future updates to the Well Inventory.

- **Agricultural users:** Water is pumped from landowners and public agency wells to extract native groundwater, as well as recovery of stored surface water. There are approximately 4,231 agricultural wells.
- **Domestic and small community users:** There are approximately 2,322 domestic and 28 small community wells used for drinking water supplies (Table 5-7). This includes approximately five domestic wells designated as non-potable use.
- **Municipal and public water systems:** There are approximately 285 public water system wells. Groundwater dependent purveyors are located in the incorporated communities of Bakersfield (approximately 40 percent of the City's total water supply is surface water), Buttonwillow, Greenfield, Arvin, East Niles, Lamont, Taft, Maricopa, Oildale (on average, 90 percent of Oildale's water supply is surface water), Shafter, Wasco, McFarland, Delano, and Mettler. As detailed in Section 5.6.4, all groundwater distributed for drinking water supply is extracted from the North Basin, Kern River Fan, and South Basin HCM Areas.
- **Industrial users:** There are approximately 189 industrial wells; 65 of these wells are public water system wells primarily used to supply food processing and cold storage facilities. Other, non-public industrial groundwater uses include construction, dust control, oilfield processes, etc.
- **Recovery wells:** There are approximately 137 wells that are operated to recover stored surface water from the active water banks located throughout the Kern Subbasin.

Per CWC §106.3(a), all drinking water users of groundwater 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, the Kern Subbasin GSAs have identified drinking water users, defined herein as domestic, municipal, public supply, and small community wells, as the most sensitive beneficial users.

13.1.1.2 Potential Effects of Undesirable Results on Beneficial Users

☑ 23 CCR § 354.26(b)(3)

The primary potential effect of URs caused by Chronic Lowering of Groundwater Levels on beneficial uses and users of groundwater in the Kern Subbasin include:

- **Groundwater well dewatering:** Excessive well dewatering can be detrimental to groundwater-dependent drinking water users and could result in the loss of water supply and a need for supplemental supplies. Partial well dewatering can also lead to increased maintenance costs (e.g., well rehabilitation/ redevelopment/deepening and pump lowering) and reduced well lifespan due to biofouling and plugging of well casings and screens. A well impact analysis has been conducted to assess which, if any, wells would be potentially dewatered if

groundwater levels in the Representative Monitoring Wells for Chronic Lowering of Groundwater Levels (RMW-WLs) were to decline to the established MTs (Section 13.1.2.4).

- **Increased pumping lift:** Increased pumping lift results in more energy use per unit volume of groundwater pumped and corresponding higher pumping costs, as well as increased wear and tear on well pump motors and reduced well efficiency.
- **The relationship to potentially correlated Sustainability Indicators:** This potential correlation includes Reduction of Groundwater Storage, Land Subsidence, and Degraded Water Quality. The degree of correlation will continue to be explored as part of Plan implementation.

13.1.1.3 Potential Causes of Undesirable Results

☑ **23 CCR § 354.26(b)(1)**

Potential causes of URs due to Chronic Lowering of Groundwater Levels in the Kern Subbasin could include increased pumping and/or reduced recharge. Since the primary use of groundwater in the Kern Subbasin is for agricultural purposes, increased groundwater pumping from the principal aquifers could occur if water use per acre on irrigated land increases or if new land is put into agricultural production. Additionally, increased pumping could occur if groundwater demand increases to supplement a shortage in imported surface water. Reduced recharge could occur due to increased agricultural irrigation efficiency, reduced surface water imports and banking, reduced groundwater inflows from adjacent areas, or due to climate change that results in decreased precipitation, decreased natural surface water inflows, and increased evapotranspiration (ET).

13.1.1.4 Criteria Used to Define 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 the criteria used to define when and where the effects of groundwater conditions cause URs, based on a quantitative description of the combination of MT exceedances that cause significant and unreasonable effects in the Kern Subbasin.

Given this requirement, the Kern Subbasin has established a quantitative UR definition that would be triggered if one of the following three conditions is met:

1. The MTs for Chronic Lowering of Groundwater Levels are exceeded in at least 25 percent of the RMW-WLs over a single year (i.e., two consecutive seasonal measurements).

2. More than 15 drinking water wells are reported as dry in any given year. If 15 drinking water wells were impacted every year, no more than 255 drinking water wells cumulatively would be impacted by 2040.
3. A GSA is unable to meet well mitigation needs[3].

To quantify avoiding "significant and unreasonable" dewatering of drinking water wells, the GSAs have assessed how many drinking water wells have historically been impacted and how many are reasonable and economical to mitigate in the future. Furthermore, a suite of well impacts analyses has been conducted to assess whether there would be "significant and unreasonable" impacts to drinking water supply based on a range of potential and anticipated drinking water well and depletion of supply impacts.

The first UR criterion requiring that MTs are exceeded in at least 25 percent of RMW-WLs over two consecutive seasonal measurements is justified based on the following rationale:

- The well impact analysis shows that an average of 42 to 48 drinking water wells could be impacted at the proposed UR criterion of 25 percent of RMW-WLs based on stochastic modeling (Section 13.1.2.4). This number of potentially impacted drinking water wells falls within the reasonable scope for the GSAs to address through mitigation (Section 13.1.2.4). Moreover, the second UR criterion (discussed below) further limits the number of annual and cumulative domestic well impacts, adding another layer of conservatism and protection with respect to drinking water well impacts.
- The C2VSimFG-Kern model results indicate that there are no instances where more than 25 percent of the RMW-WLs have MT exceedances over two consecutive seasonal measurements from 2020 through 2070 based on the *Projected-Future "With Project"* scenario suggesting that the Kern Subbasin GSAs have sufficiently designed P/MAs to improve the Kern Subbasin conditions to avoid URs.
- The Kern Subbasin GSAs have developed a coordinated and comprehensive Well Mitigation Program to address domestic and small community wells impacted by groundwater level declines (Section 16.2.1.1 and detailed in Appendix G-1).
- The component of the criteria requiring two consecutive seasonal measurements of MT exceedances provides for confirmation that the chronic lowering of groundwater levels is not due to seasonal variation, consistent with the definition of URs for this Sustainability Indicator in CWC §10721(x)(1).

[3] Well mitigation applications are evaluated as defined in the 2025 Kern County Subbasin Well Mitigation Program (Appendix G-1).

The second UR criterion requiring more than 15 drinking water wells to be reported dry in any given year is justified based on the following rationale:

- The maximum number of drinking water wells that have been reported to the California Department of Water Resources (DWR) as being dewatered in the Kern Subbasin in any given year since 2015 is 10 wells, with a cumulative total of 38 wells since 2015.
- Since 2010, a total of 50 wells (47 drinking water wells and 3 agricultural wells) have already been mitigated through existing well mitigation programs within the Kern Subbasin, including pump lowering, well replacement, or connection to a public water system.
- The Kern Subbasin GSAs have agreed to a revolving reserve fund of $3.5 million per year for a Well Mitigation Program that will be replenished annually based on incurred expenses (Section 16.2.1.1 and Appendix G-1). This provides sufficient funds to mitigate more than the UR definition of an average of 15 drinking water wells per year, or a total of 255 wells through 2040The Kern Subbasin, assuming a conservative estimated cost of $90,000 per mitigated domestic well and $50,000 per technical assistance qualifying application. The Well Mitigation Program budget also includes funding for uncertainty in the analysis, inflation, and climate change as well as funding for program administration, technical assistance for M&I and community wells, and mitigation for groundwater quality related impacts. Refer to Section 13.1.2.4 and Appendix G-1 for details.

Although unlikely to occur based on the Well Mitigation Program funding structure, the third UR criterion provides yet another protective backstop whereby a Subbasin-wide UR would be designated if a GSA is unable to meet mitigation needs.

As discussed in Section 14, the GSAs will strive through the implementation of P/MAs to manage water levels toward the MOs, which are above the MTs for every representative monitoring well. Finally, the occurrence of a single MT exceedance would trigger the Kern Subbasin's Exceedance Policy (Section 16.2.1 and Appendix K-1), which requires GSA action to investigate and address a single MT exceedance, as outlined in the Action Plan for Chronic Lowering of Groundwater Levels.

13.1.2 Minimum Threshold for Chronic Lowering of Groundwater Levels

§ 354.28. *Minimum Thresholds*

(a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.

(b) The description of minimum thresholds shall include the following:

(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.

(2) The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4

(4) Minimum thresholds for each sustainability indicator shall be defined as follows:

(c) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:

(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.

(B) Potential effects on other sustainability indicators.

Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator, as it can influence several other key Sustainability Indicators, including Reduction of Groundwater Storage, Land Subsidence, and in some instances, 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 develop MTs.

The MT is defined as "...*a numeric value for each sustainability indicator used to define undesirable results"* (23 CCR §351(t)). Consistent with the GSP Emergency Regulations (23 CCR §354.28I), the MTs for Chronic Lowering of Groundwater Levels considers the rate of groundwater elevation decline based on historical trends, water year types, projected water use, potential impacts to beneficial uses and users, and the relationship

to other Sustainability Indicators. Specifically, MTs for Chronic Lowering of Groundwater Levels have relied on the following information and criteria:

- Available historical groundwater level data for each RMW-WL.
- Regional trends, based on average groundwater level trends within each Hydrogeological Conceptual Model (HCM) Area (Section 7.4) representing conditions under recent (post-2009) imported water supply reliability and drought conditions.
- Operational flexibility, based on the historical range in groundwater levels representing the long-term variability of groundwater conditions and operations at or near each RMW-WL.
- RMW-WL proximity to sensitive beneficial users in areas where water quality concentrations are influenced by groundwater levels (Section 8.4.2).

This information has been used to develop MTs that account for historical trends and water level fluctuations to ensure sufficient groundwater supply through variable hydrologic conditions and projected water uses. The Kern Subbasin GSAs initially considered 11 different methods to set the MTs and systematically assessed these methods against potential well impacts, groundwater gradients, margin of operational flexibility, and other local considerations. As detailed in Appendix I-2, 11 potential alternative methods were iteratively refined, reassessed against anticipated well impacts and the proposed UR definition, and eliminated until a final, Subbasin-wide MT methodology was agreed upon by the GSAs.

The RMW-WL-specific MTs are set as the lower of the following:

1. Trend Dominated: Groundwater level in 2030 if the regional trend is extended from the 2015 low (the MO), or
2. Range Dominated: Groundwater level that allows for operational flexibility below the 2015 low (MO), based on an RMW-WL-specific record of groundwater level fluctuations.

To ensure that the MTs do not impact more than approximately 300 drinking water wells, reflect current groundwater conditions, and maintain consistent operational flexibility (including in the Kern Subbasin's water banking areas), the calculated MTs are capped at 61 ft below the recent historical low. The MTs are further adjusted, as needed, in consideration of the regional Corcoran Clay as well as locally raised per State Water Resources Control Board (SWRCB) staff request.

Details of the methodologies used to calculate the MTs at each RMW-WL and further justification are described in the following section.

13.1.2.1 Minimum Threshold Development

☑ 23 CCR § 354.28(b)(1)
☑ 23 CCR § 354.28(c)(1)(A)
☑ 23 CCR § 354.28(c)(1)(B)

The Kern Subbasin GSAs' approach to developing the Chronic Lowering of Groundwater Levels SMCs applies a method that is consistent with the GSP Emergency Regulations, relies on consistent data and methodologies across the Kern Subbasin, and would not unreasonably impact beneficial uses and users of groundwater.

The following steps translate the above conceptual approach into a numeric MT value at each RMW-WL, as detailed further below:

- Step 1: Extend the regional trend from the 2015 low (MO) forward to 2030.
- Step 2: Subtract 25 percent of the RMW-WL-specific groundwater level range from the 2015 low (MO).
- Step 3: Select the MT as the lower of either Step 1 or Step 2 value.
- Step 4: Cap the MT at 61 ft below the historical recent low observed between WY 2013 and 2023.
- Step 5: Raise MTs to prevent water levels from newly declining below the Corcoran Clay where it exists.
- Step 6: Raise MTs locally per SWRCB staff feedback.

Steps are detailed below and the specific RMW-WL values associated with each step and the final MT selection are tabulated in Appendix I-1.

Step 1: Regional Trend Extension

Consistent with 23 CCR §354.28(c) "...groundwater elevation decline based on historical trends", for each HCM Area, RMW-WLs with recent declining trends in groundwater levels have been averaged to calculate the regional trend.[4] Specifically, a linear trend has been calculated using available static water level data over the period Water Year (WY) 2009 to 2022[5] for each RMW-WL.[6]

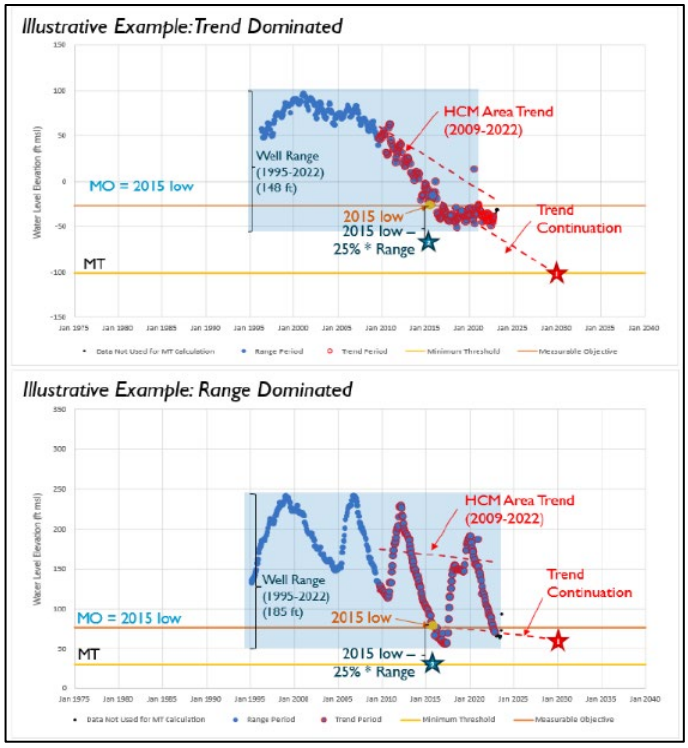


Figure 13-1. Illustrative Example of MT Approach Steps 1 through 3

The WY 2009 to 2022 period has been selected 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.
- The period includes the recent significant droughts and therefore allows the trend to incorporate the possibility of another long-term drought in the future (e.g., potentially exacerbated by climate change).

The RMW-WLs represent various aquifer depth profiles. Specifically, within the East Margin HCM Area, two principal aquifer units have been identified, including (1) the unconsolidated continental deposits, including the Kern River and Tulare formations (Primary Alluvial Principal Aquifer), and (2) the deeper confined units, including the Santa Margarita Formation, Olcese Sands, Pyramid Hills, and Vedder Formation (Santa Margarita Principal Aquifer and Olcese Principal Aquifer); see Section 7.5 for details. The RMW-WLs within this HCM Area are designated between the two principal aquifer units based on well completion depth and the depth of inferred geologic formations.

[4] 187 RMW-WLs distributed throughout the Subbasin were used in the trend calculations. Of these RMW-WLs, wells with recent declining trends in groundwater levels and more than five recorded water level elevations over the trend period were used to calculate the regional trend for each HCM Area.
[5] Data from 2008-10-01 (WY 2009) to 2022-11-15 (WY 2022) is used for the linear trend calculation.
[6] In some instances, identified questionable data have been removed for purposes of developing the trends, and RMW-WLs with limited data (less than six observed water level elevations from WY 2009 to 2022) are not included in the regional trend calculation for each HCM.

To determine HCM Area trends, the trends of RMW-WLs that had six or more recorded groundwater levels from WY 2009 to 2022 and showed declining trends have been averaged to calculate the average trend (feet/year) for each HCM Area. Similarly, for the RMW-WLs within the Santa Margarita and Olcese Principal Aquifers in the East Margin HCM Area, the trends of RMW-WLs meeting the same criteria – six or more recorded groundwater levels from WY 2009 to 2022 and exhibiting declining trends – have been averaged to calculate the average trend (feet/year).

Figure 13-2 and Table 13-1 summarize the HCM Area averages and groundwater level trends from WY 2009 to 2022.

The regional trend is assigned to each RMW-WL based on its location within an HCM Area and multiplied by 14 years (i.e., to extend the trend from WY 2016 to WY 2030).[7] The resultant groundwater level decline (in feet) is subtracted from the 2015 low value to calculate the 2030 projected groundwater level at each RMW-WL. The end point of 2030 has been selected 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.
- This length of time is half the duration of the SGMA implementation period (i.e., through 2040), suggesting that by the halfway point, the Kern Subbasin should be on a trajectory toward achieving the Sustainability Goal.

Step 2: RMW-WL-specific Groundwater Level Range

Variability in groundwater levels has been accounted for by calculating the operational groundwater level range as the product of the observed groundwater level range in each RMW-WL over a long-term historical period and a “range percentage.” This variability factor acknowledges the fact that different RMW-WLs across the Kern Subbasin have experienced different amounts of groundwater level variability due to local operations and conditions.

The period for groundwater level range determination is defined as WY 1995 to 2022[8] for the following reasons:

[7] The annual regional trend for each HCM is multiplied by 14 years to calculate the projected groundwater level decline that would occur through 2030 using the 2015 low value as a baseline. Because the 2015 low values are representative of Fall 2015 water levels, the period used to extend the trend is WY 2016 through WY 2030, or 14 years.
[8] Data from 1994-10-01 (WY1995) to 2022-11-15 (WY2022) is used for the range determination.

- 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, groundwater use, and natural and active groundwater recharge, and surface water storage and recovery; and
- This period includes the historical and current water budget period of interest defined by the GSAs, and therefore water budget and model results are available for this period.
- The full range in historical groundwater level fluctuations is multiplied by 25 percent as a conservative allowance for future groundwater level fluctuations within each RMW-WL. Therefore, at each RMW-WL, 25 percent of the RMW-WL-specific groundwater level fluctuation is subtracted from the 2015 low groundwater level.

Table 13-1. Regional Groundwater Level Trends

HCM Area	Average Trend (feet/year)[1]
North Basin HCM Area	-6.0
Kern River Fan HCM Area	-3.2
South Basin HCM Area	-5.4
Western Fold Belt HCM Area	N/A[2]
East Margin HCM Area – Primary Alluvial Principal Aquifer	-7.2
East Margin HCM Area – Santa Margarita and Olcese Principal Aquifers	-6.7

Notes:

1. Average trend (feet/year) values represent the average regional groundwater level trend in each HCM Area of the Kern Subbasin from WY 2009 through WY 2022 and include all activities (i.e., GSA and non-GSA).
2. There is insufficient historical groundwater level data from monitoring wells located in the Western Fold Belt HCM Area due to land use and naturally occurring poor water quality to calculate a trend. The principal water supply is imported surface water in this HCM Area.

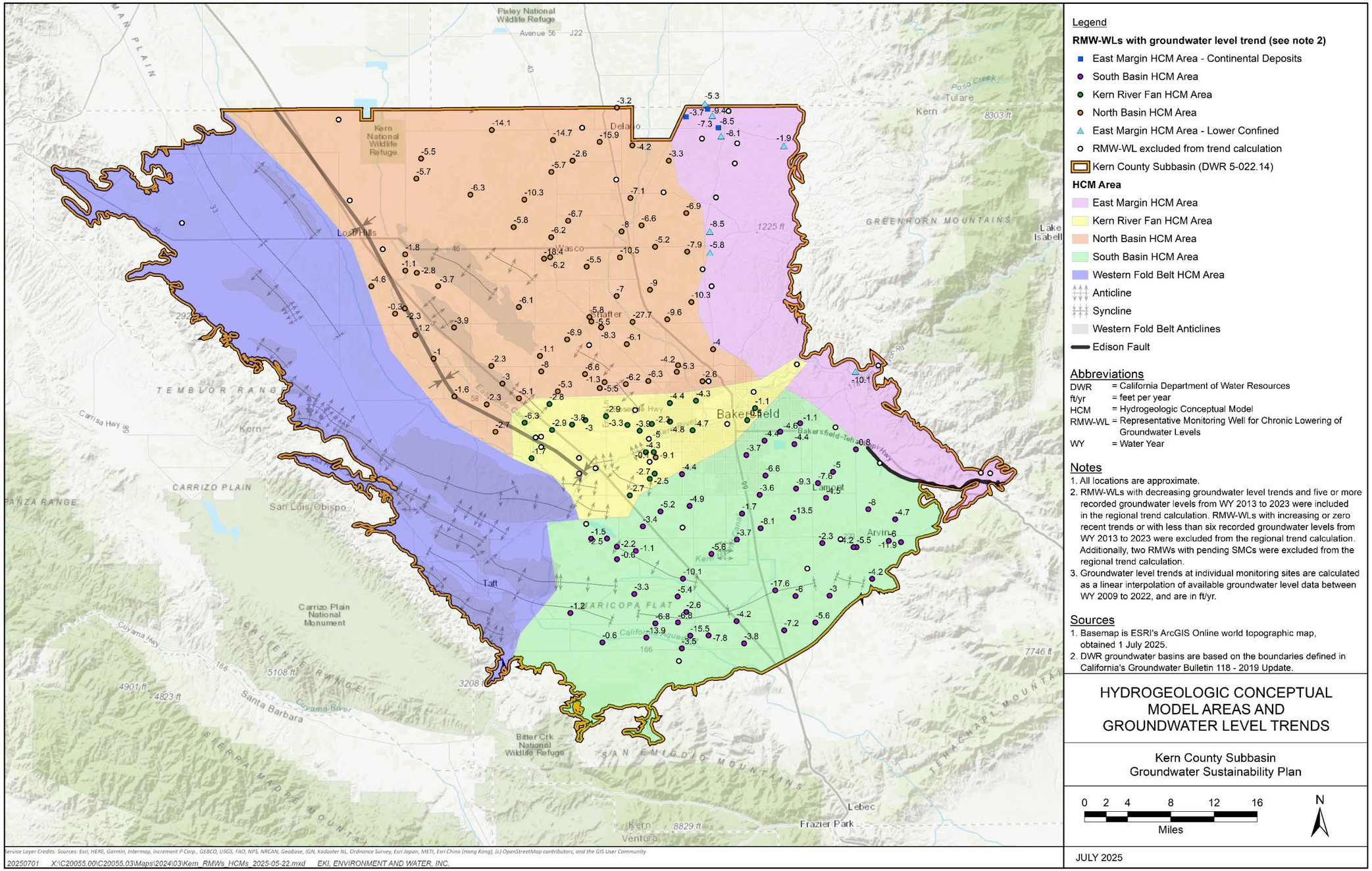


Figure 13-2. Hydrogeologic Conceptual Model Areas and Groundwater Level Trends

Step 3: MT Selection

The MT value is selected as the lower groundwater level calculated under Step 1 and Step 2.

Step 4: MT Cap

To ensure that MTs are protective of beneficial uses and users and do not create “outlier conditions,” an upward adjustment or "cap" is applied to RMW-WLs with MTs from Step 3 that are lower than 61 feet below the observed recent historical low.

The recent historical low period is defined as WY 2013 to 2023 and was selected to represent water levels over the two most recent drought periods (i.e., WY 2012-2016 and WY 2020-2022 droughts).

The 61 feet cap has been chosen for the following reasons:

- It represents the average operational flexibility provided in the Kern Subbasin's water bank area RMW-WLs with range-dominated MTs; and
- The worst case well impacts analysis whereby all RMW-WLs would reach their MTs results in an estimated 184 drinking water wells being potentially impacted.

As such, in the case that the MT for a given RMW-WL selected in Step 3 is 61 feet or more below the recent historical low, the MT from Step 3 is capped and set equal to 61 ft below the recent historical low value. Step 4 results in 56 RMW-WLs, or 30 percent, with capped MT values.

Step 5: Corcoran Clay Adjustment

Groundwater level declines below the regional Corcoran Clay layer may result in subsidence-related compaction or mobilization of naturally occurring constituents such as arsenic. It is assumed that if groundwater levels have already declined below the regional Corcoran Clay layer, the potential for additional land subsidence or mobilization of constituents is minimal and the approach outlined in Section 13.1.2.2 regarding the relationship of the water level MTs to the other sustainability indicators is sufficient from a Subbasin-wide management perspective. However, if the groundwater level MTs would allow water levels to newly fall below the Corcoran Clay layer, there is an elevated risk for additional land subsidence or mobilization of constituents.

A Subbasin-wide screening was conducted to assess if any RMW-WLs have an MT (from Step 4) that would result in groundwater levels newly falling below the Corcoran Clay. The MT elevations at each RMW-WL established in Step 4 are screened against the regional Corcoran Clay layer elevations and recent historical lows, as follows:

- Corcoran Clay elevations are extracted at each RMW-WL location based on rasters compiled from Page (1986), Croft (1972) and PGA (1991), see Section 7.2.6.1.

- RMW-WLs are considered if the mapped Corcoran Clay thickness at its location is greater than 10 feet, which is considered to be a substantiative clay thickness that may locally influence groundwater conditions.
- Recent historical low values at the RMW-WLs (as defined in Step 4 above) are compared to the Corcoran Clay bottom elevation. The RMW-WLs with recent historical low values below the Corcoran Clay bottom are removed from consideration.
- Capped MT values at the RMW-WLs (as defined in Step 4 above) are compared to the Corcoran Clay top elevation. The RMW-WLs with capped MT values above the Corcoran Clay top elevation are removed from consideration.

In the case that the MT for a given RMW-WL established in Step 4 is newly below the Corcoran Clay layer by more than one foot, the MT from Step 4 is adjusted upward to coincide with the lower of either the recent historical low value or the Corcoran Clay top elevation. The MTs at six RMW-WLs are raised between 10 feet and 61 feet.

Step 6: Raise per SWRCB Staff Feedback

During the 2025 technical consultation period during which SWRCB staff continued their review of the 2024 Plan, SWRCB staff identified a subset of RMW-WLs with MT values that are significantly below current (e.g., 2023/2024) groundwater levels. These include 22 higher-priority RMW-WLs and four lower-priority RMW-WLs where SWRCB staff provided feedback that the GSAs consider locally raising the MTs.

As a final localized MT adjustment, individual GSAs elected to raise the MTs per SWRCB staff feedback, while maintaining operational flexibility based on local conditions. The MTs at 20 RMW-WLs are raised by 30 feet and the MT at one of the lower-priority RMW-WLs are raised by 14 feet.

The final MTs for Chronic Lowering of Groundwater Levels are shown in Table 13-2 and mapped for the Primary Alluvial Principal Aquifer and Santa Margarita and Olcese Principal Aquifers in Figure 13-3 and Figure 13-4, respectively. Additionally, Appendix I-1 contains hydrographs that plot the historical groundwater levels, the MT, and the MO at each RMW-WL. A discussion of how these MTs will avoid significant and unreasonable impacts is provided in Section 13.1.1.4 above. It should be noted that the final MTs for Chronic Lowering of Groundwater Levels have been raised on average by 31 feet across the Kern Subbasin compared to the MTs established in the Kern Subbasin's 2022 GSPs, with 24 RMW-WLs having MT values raised by over 100 feet. Additionally, for 36 RMW-WLs have been locally refined after the 2024 Plan, MTs have been raised for these wells on average by 28 feet, with one RMW-WL having its MT value raised by over 100 feet compared to the 2024 Plan MTs (see Appendix I-1 for details).

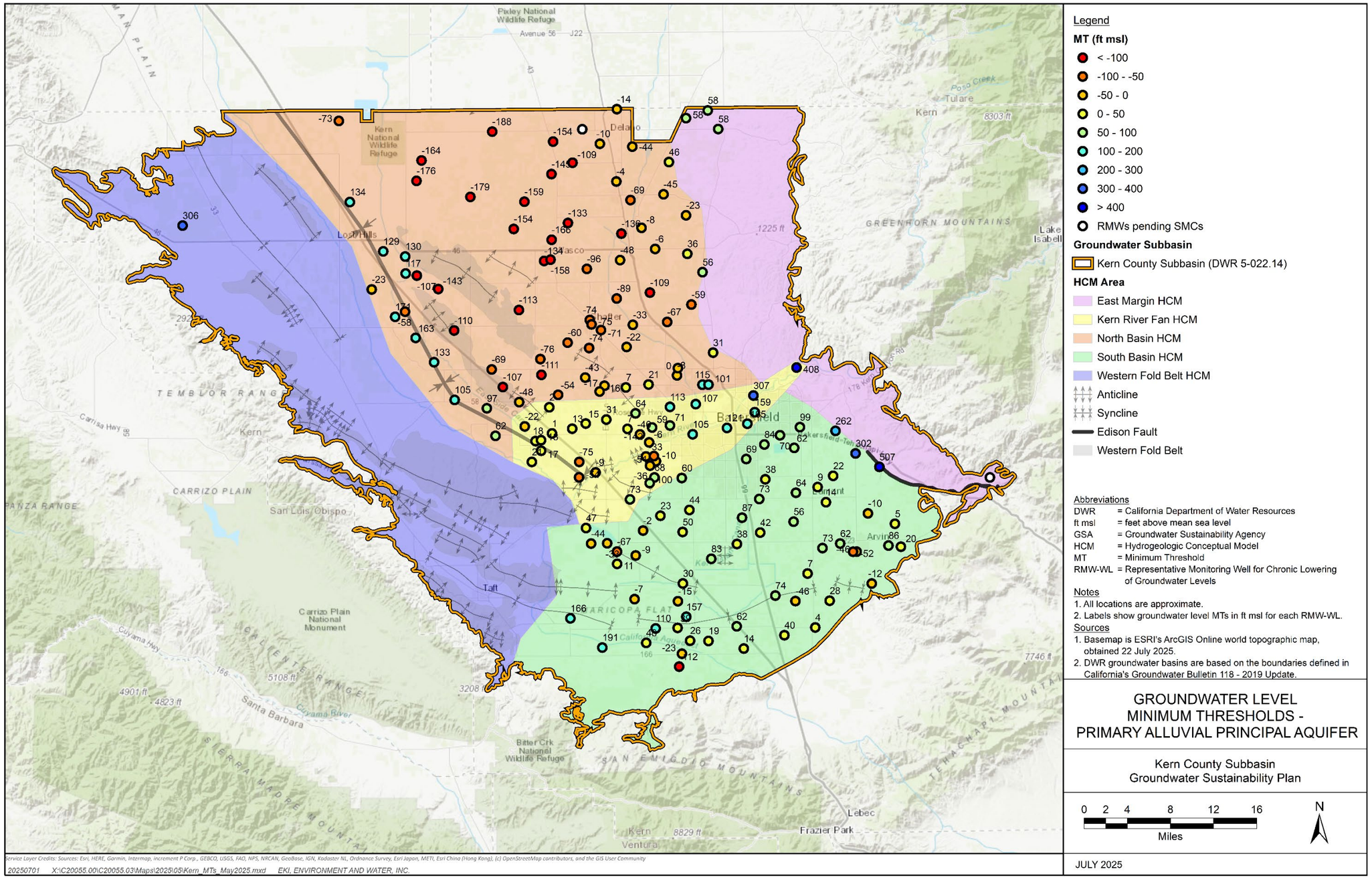


Figure 13-3. Groundwater Level Minimum Thresholds – Primary Alluvial Principal Aquifer

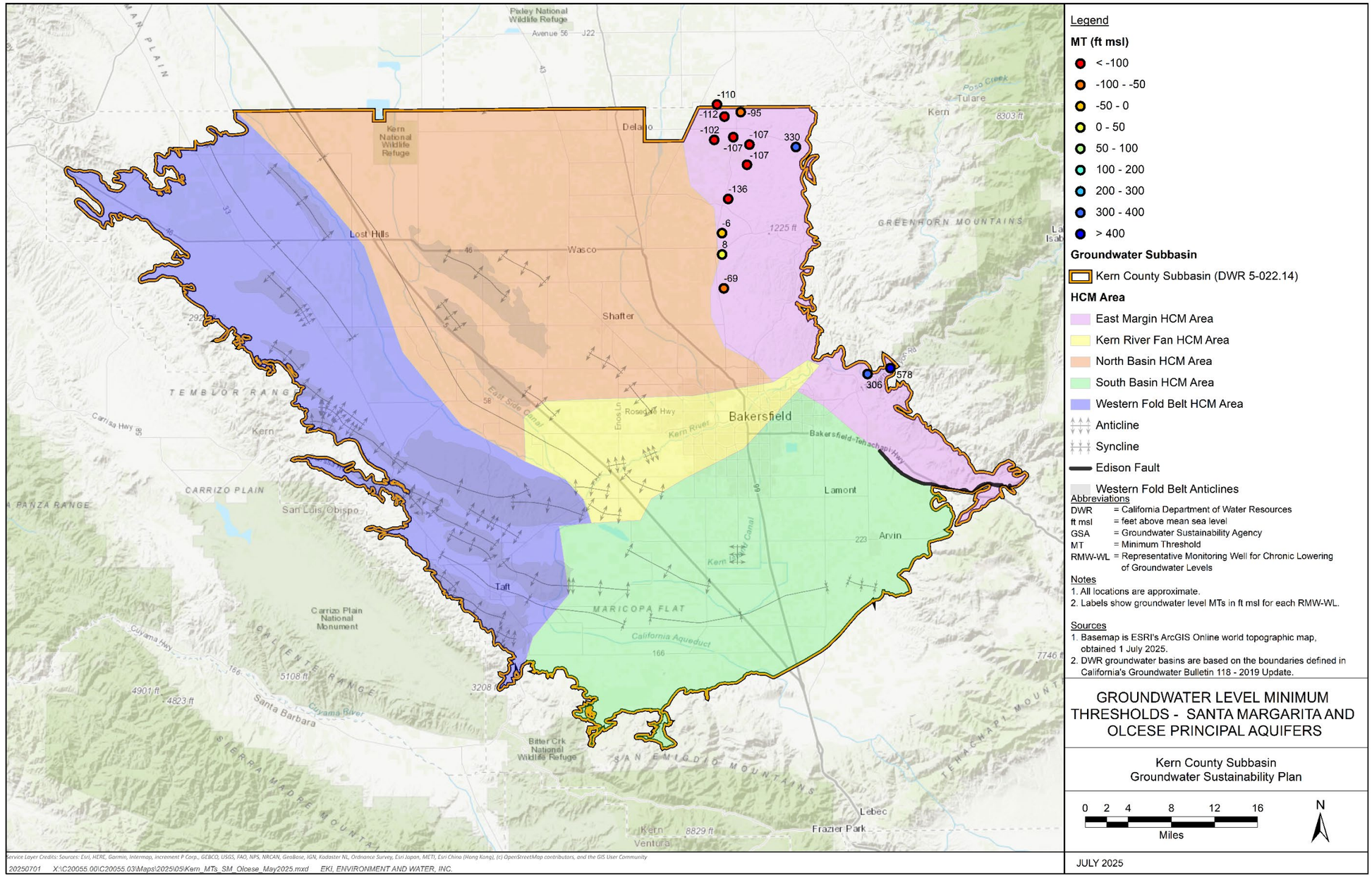


Figure 13-4. Groundwater Level Minimum Thresholds – Santa Margarita and Olcese Principal Aquifers

Supplemental Analyses

This scientifically rigorous approach to MT development appropriately reflects the varying groundwater conditions throughout the Kern Subbasin and ensures that the MTs appropriately reflect groundwater conditions at each of the RMW-WLs to support on-going groundwater management efforts. For example, there are portions of the Kern Subbasin where groundwater is not pumped in significant quantities, while in other areas water levels fluctuate inter-annually because of banking, conjunctive use and other management actions. As such, the MT methodology for the Kern Subbasin was developed to reflect and represent these varied conditions in establishing the foundation to support locally effective groundwater management. Consistent with DWR's guidance in its Sustainable Management Criteria Best Management Practices (BMPs), the MTs accurately reflect local conditions and project a realistic glide path towards sustainability at each RMW-WL and within each HCM Area.

To demonstrate that the MTs developed using this approach accurately reflect observed water level conditions across the Kern Subbasin's HCM Areas and will not result in significant and unreasonable impacts to beneficial users, additional analyses have been conducted. The first of these includes an analysis of water level transects along different cross sections of the Kern Subbasin comparing the Fall 2015, MT, and MO groundwater elevations. As shown in Figure 13-5, Figure 13-6, and Figure 13-7 below, the MT (and MO) values do not vary dramatically between HCM Areas and appropriately reflect the localized water level conditions across the Kern Subbasin, generally consistent with those observed in Fall 2015. Similarly, spatial interpolations of the MTs and MOs at RMW-WLs are similar to the Fall 2015 water level spatial interpolation. It should be noted that the transects show smooth MT and MO interpolated values, and some of the apparent discrepancy at the RMW-WL points is related to the translation up to a two-mile distance to the transect lines.

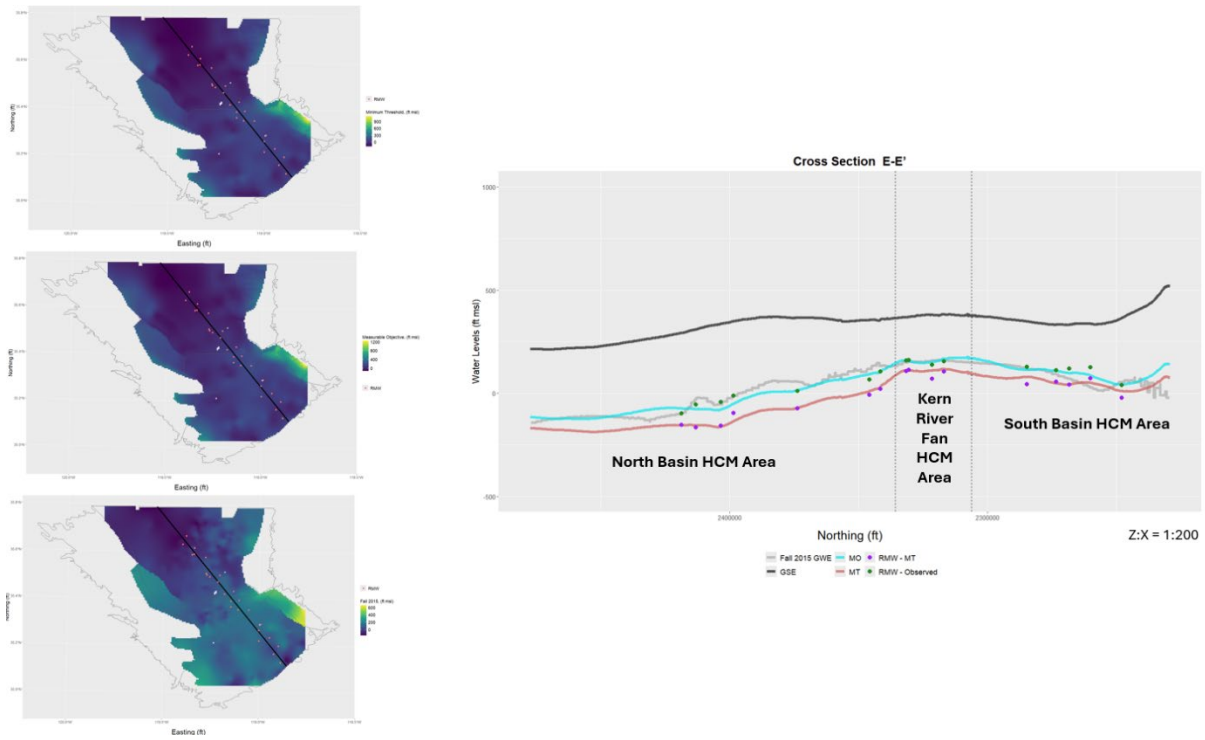


Figure 13-5. Water Level Transect Along Cross Section E-E' Comparing Fall 2015, MO, and MT Groundwater Elevations

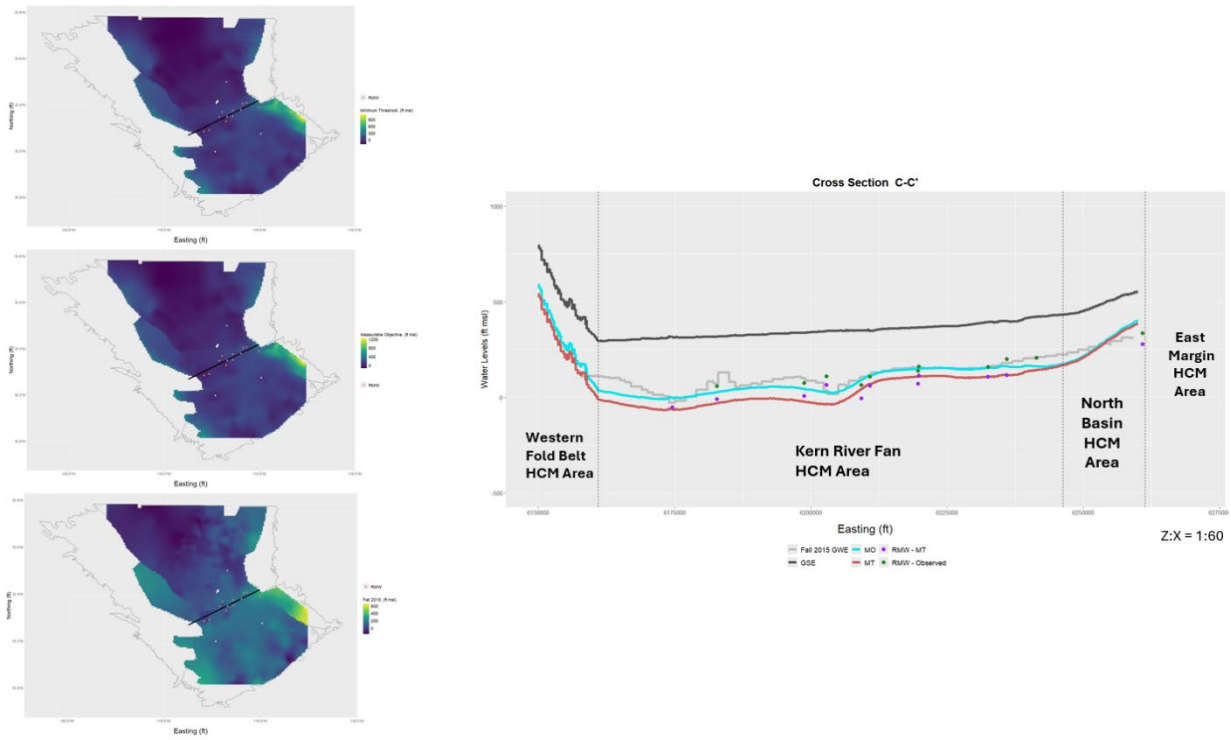


Figure 13-6. Water Level Transect Along Cross Section C-C' Comparing Fall 2015, MO, and MT Groundwater Elevations

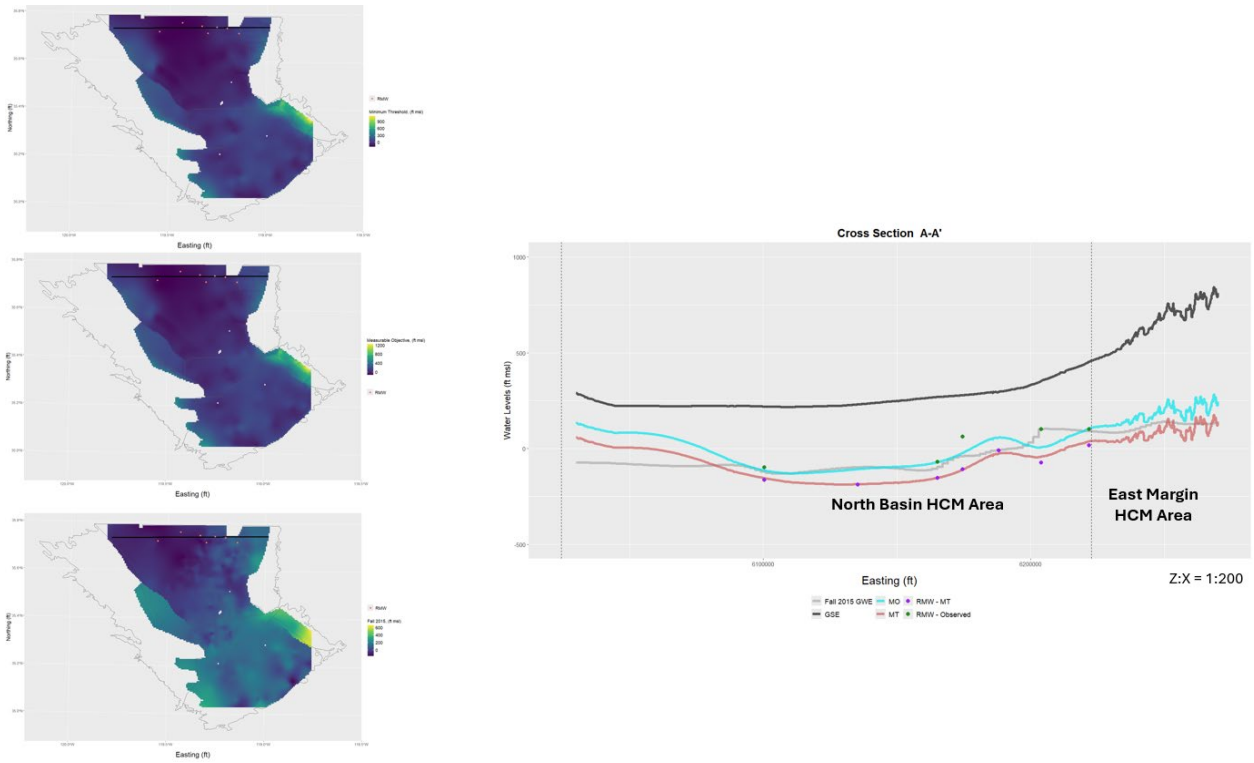


Figure 13-7. Water Level Transect Along Cross Section A-A' Comparing Fall 2015, MO, and MT Groundwater Elevations

In addition to this analysis of water level transects across the Kern Subbasin, an analysis of the spatial variability of measured water levels across the Kern Subbasin in 2015 and 2022 as compared to the spatial variability of the MT values has been conducted to demonstrate that the MTs accurately reflect varying water levels across the Kern Subbasin's different HCM Areas. Specifically, the range in groundwater elevation measured at RMW-WLs located within a 2-mile radius of each RMW-WL has been calculated. The histogram in Figure 13-8 shows the distribution of the observed range in water levels within the 2-mile radius of each RMW-WL for historical groundwater elevation data (Fall 2015 and Fall 2022) as compared to the observed range in the MT values.

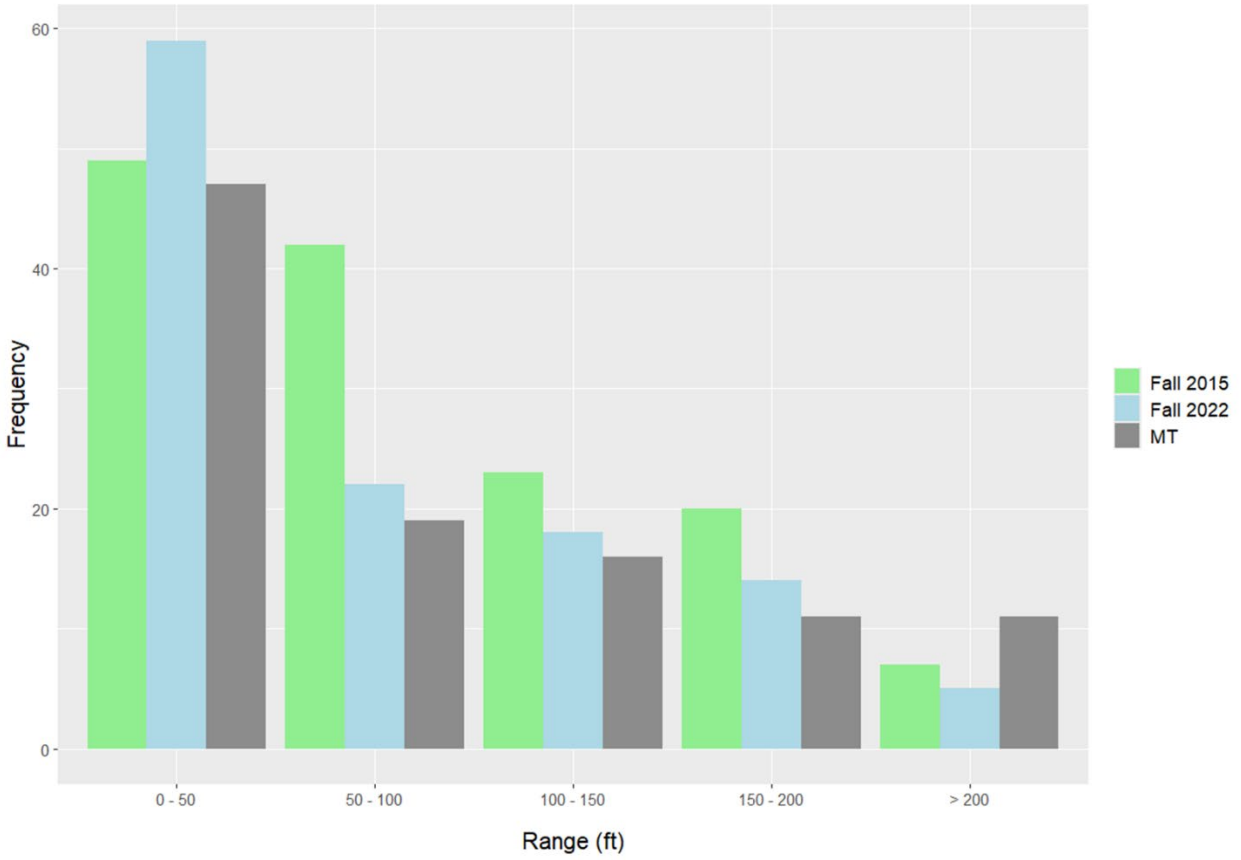


Figure 13-8. Distribution of Groundwater Elevation Range Within a 2-mile Radius of Each RMW

The histogram in Figure 13-8 shows that the MT values have similar total ranges compared to observed water level data across the Kern Subbasin, reinforcing that the differences in MT values seen in neighboring RMW-WLs accurately reflect local conditions. The observed ranges in MT values are therefore not an inhibitor to sustainable groundwater management but rather reflect the influence of geologic features (faults, synclines, anticlines), topographic changes, and operational variability on water level conditions throughout the Kern Subbasin.

Table 13-2. SMCs for Chronic Lowering of Groundwater Levels by RMW-WL

Local Site ID	RMW ID	HCM AREA	GSA	Aquifer	Latitude	Longitude	MT (ft msl)	MO (ft msl)	IMs (ft msl)				MT Basis	MO Estimation Method
									2025	2030	2035	2040		
29S29E33N001M	RMW-001	South Basin	Arvin	Primary Principal Alluvial	35.356	-118.875	262	294	294	294	294	294	Local raise per SWRCB feedback	2015 Low
30S29E11N001M	RMW-002	South Basin	Arvin	Primary Principal Alluvial	35.326	-118.842	302	378	340	321	350	378	HCM Area Trend	2015 Low
30S30E19E001M	RMW-003	South Basin	Arvin	Primary Principal Alluvial	35.307	-118.803	507	573	573	573	573	573	Recent Low Cap	2015 Low
30S29E29A001M	RMW-004	South Basin	Arvin	Primary Principal Alluvial	35.296	-118.880	22	98	60	41	70	98	HCM Area Trend	2015 Low
31S29E05E001M	RMW-005	South Basin	Arvin	Primary Principal Alluvial	35.261	-118.892	14	90	52	33	62	90	HCM Area Trend	Linear interpolation between November 2013 and November 2019
31S29E12M001M	RMW-006	South Basin	Arvin	Primary Principal Alluvial	35.245	-118.823	-10	66	66	66	66	66	HCM Area Trend	2015 Low
31S30E17K001M	RMW-007	South Basin	Arvin	Primary Principal Alluvial	35.231	-118.779	5	81	81	81	81	81	HCM Area Trend	Average of March 2014 and November 2016
31S29E34A001M	RMW-008	South Basin	Arvin	Primary Principal Alluvial	35.194	-118.843	-46	30	30	30	30	30	HCM Area Trend	2015 Low
31S30E30J001M	RMW-009	South Basin	Arvin	Primary Principal Alluvial	35.202	-118.790	86	162	124	105	134	162	HCM Area Trend	2015 Low
ACSD Well #14	RMW-010	South Basin	Arvin	Primary Principal Alluvial	35.194	-118.848	-52	24	24	24	24	24	HCM Area Trend	2015 Low
32S29E12P001M	RMW-011	South Basin	Arvin	Primary Principal Alluvial	35.151	-118.818	-12	64	64	64	64	64	HCM Area Trend	2015 Low
32S29E20L001M	RMW-012R	South Basin	Arvin	Primary Principal Alluvial	35.129	-118.888	28	79	79	79	79	79	Corcoran Clay Adjustment	2015 Low
32S28E23F001M	RMW-013R	South Basin	Arvin	Primary Principal Alluvial	35.129	-118.944	-46	30	-8	-27	2	30	HCM Area Trend	2015 Low
32S29E31N001M	RMW-014	South Basin	Arvin	Primary Principal Alluvial	35.093	-118.912	4	80	42	23	52	80	HCM Area Trend	2015 Low
12N20W36G001S	RMW-015	South Basin	Arvin	Primary Principal Alluvial	35.083	-118.963	40	116	78	59	88	116	HCM Area Trend	2015 Low
11N20W05J001S	RMW-016	South Basin	Arvin	Primary Principal Alluvial	35.066	-119.029	14	75	75	75	75	75	Recent Low Cap	2015 Low
DMW01	RMW-105	North Basin	BV	Primary Principal Alluvial	35.601	-119.618	129	160	160	160	160	160	Local raise per SWRCB feedback	2015 Low
DMW02	RMW-106	North Basin	BV	Primary Principal Alluvial	35.572	-119.581	117	152	152	152	152	152	Local raise per SWRCB feedback	2015 Low
DMW04	RMW-107	North Basin	BV	Primary Principal Alluvial	35.514	-119.598	171	218	218	218	218	218	Local raise per SWRCB feedback	2015 Low
DMW05	RMW-108	North Basin	BV	Primary Principal Alluvial	35.485	-119.565	163	210	187	175	192	210	Local raise per SWRCB feedback	2015 Low
DMW06	RMW-109	North Basin	BV	Primary Principal Alluvial	35.453	-119.535	133	187	187	187	187	187	Local raise per SWRCB feedback	2015 Low
DMW07	RMW-110	North Basin	BV	Primary Principal Alluvial	35.402	-119.501	105	155	155	155	155	155	Local raise per SWRCB feedback	2015 Low
DMW08	RMW-111	North Basin	BV	Primary Principal Alluvial	35.391	-119.448	97	145	121	109	127	145	Local raise per SWRCB feedback	2015 Low
DMW10a	RMW-112a	North Basin	BV	Primary Principal Alluvial	35.354	-119.434	62	116	116	116	116	116	Local raise per SWRCB feedback	2015 Low
DMW12b	RMW-113b	Kern River Fan	BV	Primary Principal Alluvial	35.318	-119.375	21	66	21	44	55	66	HCM Area Trend	2015 Low
Well 12H	RMW-167	North Basin	Cawelo	Primary Principal Alluvial	35.595	-119.116	36	120	78	57	89	120	HCM Area Trend	2015 Low
Well 4R	RMW-168	North Basin	Cawelo	Primary Principal Alluvial	35.602	-119.169	-6	65	65	65	65	65	Recent Low Cap	Average of February 2011 and October 2020
Well 28L	RMW-169	North Basin	Cawelo	Primary Principal Alluvial	35.463	-119.075	31	115	73	52	84	115	HCM Area Trend	2015 Low
Well 24R	RMW-170	North Basin	Cawelo	Primary Principal Alluvial	35.647	-119.117	-23	61	19	-2	30	61	HCM Area Trend	2015 Low
Well 11M	RMW-171	North Basin	Cawelo	Primary Principal Alluvial	35.504	-119.150	-67	17	-25	-46	-15	17	HCM Area Trend	2015 Low

Local Site ID	RMW ID	HCM AREA	GSA	Aquifer	Latitude	Longitude	MT (ft msl)	MO (ft msl)	IMs (ft msl)				MT Basis	MO Estimation Method
									2025	2030	2035	2040		
Well 6C	RMW-172	North Basin	Cawelo	Primary Principal Alluvial	35.527	-119.110	-59	25	-17	-38	-7	25	HCM Area Trend	2015 Low
Well 33C	RMW-173	North Basin	Cawelo	Primary Principal Alluvial	35.544	-119.178	-109	-25	-25	-25	-25	-25	HCM Area Trend	October 2016
EWMA #21	RMW-185	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.593	-119.079	8	95	51	30	62	95	Recent Low Cap	2015 Low estimated (Spring 2015 minus seasonal fluctuation)
EWMA #30	RMW-187	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.668	-119.068	-136	-75	-75	-75	-75	-75	Recent Low Cap	2015 Low
EWMA #41	RMW-189	North Basin	KNDLA	Primary Principal Alluvial	35.571	-119.091	56	140	98	77	109	140	HCM Area Trend	Fall 2013
EWMA #23	RMW-278	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.622	-119.078	-6	88	41	18	53	88	HCM Area Trend	2015 Low estimated (Spring 2015 minus seasonal fluctuation)
EWMA #04	RMW-283	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.784	-119.046	-95	-19	-19	-19	-19	-19	Recent Low Cap	July 2017
EWMA #49	RMW-288	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.736	-118.955	330	403	366	348	375	403	Recent Low Cap	February 2022
EWMA #11	RMW-296	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.713	-119.036	-107	-13	-13	-13	-13	-13	HCM Area Trend	2015 Low from nearby well
Cameo Old Well #13	RMW-297	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.740	-119.032	-107	-13	-13	-13	-13	-13	HCM Area Trend	2015 Low from nearby well
Poso Well #1	RMW-298	East Margin	KNDLA	Santa Margarita and Olcese Principal	35.548	-119.076	-69	25	-22	-46	-10	25	HCM Area Trend	2015 Low from nearby well
HMWD #20	RMW-114	South Basin	HMWD	Primary Principal Alluvial	35.229	-119.286	47	108	108	108	108	108	Recent Low Cap	2015 Low
HMWD #28	RMW-115	South Basin	HMWD	Primary Principal Alluvial	35.209	-119.278	-44	28	28	28	28	28	Recent Low Cap	2015 Low
HMWD #27	RMW-116	South Basin	HMWD	Primary Principal Alluvial	35.209	-119.252	-33	28	28	28	28	28	Recent Low Cap	2015 Low
HMWD #26	RMW-117	South Basin	HMWD	Primary Principal Alluvial	35.198	-119.236	-67	2	2	2	2	2	Recent Low Cap	2015 Low
HMWD #18	RMW-118	South Basin	HMWD	Primary Principal Alluvial	35.181	-119.236	11	87	87	87	87	87	HCM Area Trend	2015 Low
Meadows of the Kern W3	RMW-306	Kern River Fan	KNDLA	Primary Principal Alluvial	35.442	-118.938	408	453	453	453	453	453	HCM Area Trend	July 2012
The Nature Conservancy	RMW-322	East Margin	KNDLA	Primary Principal Alluvial	35.291	-118.622	(Note 1)							
RMW-017	RMW-017	North Basin	KRGSA	Primary Principal Alluvial	35.421	-119.182	21	105	63	42	74	105	HCM Area Trend	2015 Low
RMW-018	RMW-018	North Basin	KRGSA	Primary Principal Alluvial	35.433	-119.135	-8	66	66	66	66	66	Recent Low Cap	2015 Low
RMW-019R	RMW-019R	North Basin	KRGSA	Primary Principal Alluvial	35.420	-119.093	115	199	157	136	168	199	HCM Area Trend	2015 Low
RMW-020	RMW-020	Kern River Fan	KRGSA	Primary Principal Alluvial	35.405	-119.009	307	322	322	322	322	322	Local raise per SWRCB feedback	2015 Low
RMW-025	RMW-025	Kern River Fan	KRGSA	Primary Principal Alluvial	35.354	-119.110	105	150	128	116	133	150	HCM Area Trend	2015 Low
RMW-026	RMW-026	South Basin	KRGSA	Primary Principal Alluvial	35.351	-118.966	70	146	108	89	118	146	HCM Area Trend	2015 Low
RMW-029	RMW-029	Kern River Fan	KRGSA	Primary Principal Alluvial	35.325	-119.187	-33	46	46	46	46	46	Range	2015 Low
RMW-030	RMW-030	South Basin	KRGSA	Primary Principal Alluvial	35.334	-118.943	62	138	100	81	110	138	HCM Area Trend	2015 Low
RMW-031	RMW-031	Kern River Fan	KRGSA	Primary Principal Alluvial	35.296	-119.173	68	113	113	113	113	113	HCM Area Trend	2015 Low
RMW-032	RMW-032	South Basin	KRGSA	Primary Principal Alluvial	35.295	-119.128	60	136	98	79	108	136	HCM Area Trend	2015 Low
RMW-034	RMW-034	South Basin	KRGSA	Primary Principal Alluvial	35.274	-118.941	64	140	102	83	112	140	HCM Area Trend	Spatial Interpolation
RMW-035R	RMW-035R	South Basin	KRGSA	Primary Principal Alluvial	35.245	-119.164	23	99	99	99	99	99	HCM Area Trend	2015 Low
RMW-037	RMW-037	South Basin	KRGSA	Primary Principal Alluvial	35.225	-119.193	-2	68	68	68	68	68	Recent Low Cap	2015 Low
RMW-038R	RMW-038R	South Basin	KRGSA	Primary Principal Alluvial	35.223	-119.128	50	111	81	65	88	111	Recent Low Cap	Spatial Interpolation

Local Site ID	RMW ID	HCM AREA	GSA	Aquifer	Latitude	Longitude	MT (ft msl)	MO (ft msl)	IMs (ft msl)				MT Basis	MO Estimation Method
									2025	2030	2035	2040		
RMW-040	RMW-040	South Basin	KRGSA	Primary Principal Alluvial	35.206	-119.039	38	114	76	57	86	114	HCM Area Trend	Average of April 2010 and April 2020
RMW-041	RMW-041	South Basin	KRGSA	Primary Principal Alluvial	35.200	-118.899	73	105	105	105	105	105	Corcoran Clay Adjustment	2015 Low
RMW-042	RMW-042	South Basin	KRGSA	Primary Principal Alluvial	35.192	-119.205	-9	67	67	67	67	67	HCM Area Trend	2015 Low
RMW-192	RMW-192	South Basin	KRGSA	Primary Principal Alluvial	35.221	-119.000	42	118	118	118	118	118	HCM Area Trend	2015 Low
RMW-193	RMW-193	South Basin	KRGSA	Primary Principal Alluvial	35.205	-118.869	62	138	138	138	138	138	HCM Area Trend	2015 Low
RMW-195	RMW-195	South Basin	KRGSA	Primary Principal Alluvial	35.252	-119.116	44	120	120	120	120	120	HCM Area Trend	2015 Low
RMW-196	RMW-196	South Basin	KRGSA	Primary Principal Alluvial	35.241	-119.030	87	159	159	159	159	159	Recent Low Cap	2015 Low
RMW-197	RMW-197	South Basin	KRGSA	Primary Principal Alluvial	35.166	-118.924	7	39	39	39	39	39	Local raise per SWRCB feedback	2015 Low
RMW-200	RMW-200	South Basin	KRGSA	Primary Principal Alluvial	35.154	-119.128	30	106	106	106	106	106	HCM Area Trend	Average of April 2010 and October 2019
RMW-201	RMW-201	Kern River Fan	KRGSA	Primary Principal Alluvial	35.394	-119.104	107	152	130	118	135	152	HCM Area Trend	2015 Low
RMW-202	RMW-202	South Basin	KRGSA	Primary Principal Alluvial	35.266	-119.001	73	105	105	105	105	105	Local raise per SWRCB feedback	2015 Low
RMW-209R	RMW-209R	North Basin	KRGSA	Primary Principal Alluvial	35.420	-119.083	101	132	132	132	132	132	Local raise per SWRCB feedback	2015 Low
RMW-210R	RMW-210R	Kern River Fan	KRGSA	Primary Principal Alluvial	35.383	-119.007	159	204	204	204	204	204	HCM Area Trend	2015 Low
RMW-211R	RMW-211R	Kern River Fan	KRGSA	Primary Principal Alluvial	35.367	-119.020	105	150	150	150	150	150	HCM Area Trend	2015 Low
RMW-212	RMW-212	South Basin	KRGSA	Primary Principal Alluvial	35.362	-118.933	99	175	137	118	147	175	HCM Area Trend	2015 Low
RMW-213R	RMW-213R	Kern River Fan	KRGSA	Primary Principal Alluvial	35.362	-119.053	121	190	156	138	164	190	Range	2015 Low
RMW-214R	RMW-214R	South Basin	KRGSA	Primary Principal Alluvial	35.320	-119.022	69	145	107	88	117	145	HCM Area Trend	2015 Low
RMW-215R	RMW-215R	South Basin	KRGSA	Primary Principal Alluvial	35.339	-118.992	84	160	122	103	132	160	HCM Area Trend	2015 Low
RMW-216	RMW-216	South Basin	KRGSA	Primary Principal Alluvial	35.292	-118.991	38	84	84	84	84	84	Local raise per SWRCB feedback	April 2016
RMW-217	RMW-217	South Basin	KRGSA	Primary Principal Alluvial	35.281	-118.905	9	85	47	28	57	85	HCM Area Trend	2015 Low
RMW-218	RMW-218	South Basin	KRGSA	Primary Principal Alluvial	35.187	-119.081	83	159	83	121	140	159	HCM Area Trend	2015 Low
RMW-219	RMW-219	South Basin	KRGSA	Primary Principal Alluvial	35.235	-118.946	56	111	111	111	111	111	Corcoran Clay Adjustment	2015 Low
Well 4P1	RMW-175	East Margin	KTWD	Santa Margarita and Olcese Principal	35.778	-119.073	-112	-18	-18	-18	-18	-18	HCM Area Trend	2015 Low
Well 20C1	RMW-176	East Margin	KTWD	Santa Margarita and Olcese Principal	35.747	-119.090	-102	-41	-41	-41	-41	-41	Recent Low Cap	2015 Low
Well 15P1	RMW-177	East Margin	KTWD	Santa Margarita and Olcese Principal	35.751	-119.058	-107	-13	-13	-13	-13	-13	HCM Area Trend	2015 Low
Well 32M1	RMW-179	East Margin	KTWD	Santa Margarita and Olcese Principal	35.795	-119.085	-110	-52	-52	-52	-52	-52	GSA Discretion (Note 2)	2015 Low
Well 12A	RMW-290	East Margin	KTWD	Primary Principal Alluvial	35.777	-119.116	58	159	109	83	121	159	HCM Area Trend	2015 Low
Well 15D1	RMW-291	East Margin	KTWD	Primary Principal Alluvial	35.762	-119.063	58	159	109	83	121	159	HCM Area Trend	2015 Low from nearby well
Well 4D1	RMW-292	East Margin	KTWD	Primary Principal Alluvial	35.787	-119.080	58	159	109	83	121	159	HCM Area Trend	2015 Low from nearby well
30S/25E-16L01	RMW-300	Kern River Fan	KWB	Primary Principal Alluvial	35.318	-119.297	-75	-13	-13	-13	-13	-13	Recent Low Cap	2015 Low
88-03-009R	RMW-145R	North Basin	NKWSD	Primary Principal Alluvial	35.318	-119.171	-10	74	32	11	43	74	HCM Area Trend	Spring 2016
88-09-009	RMW-146	North Basin	NKWSD	Primary Principal Alluvial	35.536	-119.233	-89	-5	-5	-5	-5	-5	HCM Area Trend	2015 Low

Local Site ID	RMW ID	HCM AREA	GSA	Aquifer	Latitude	Longitude	MT (ft msl)	MO (ft msl)	IMs (ft msl)				MT Basis	MO Estimation Method
									2025	2030	2035	2040		
88-21-005	RMW-147	North Basin	NKWSD	Primary Principal Alluvial	35.588	-119.227	-48	36	-6	-27	5	36	HCM Area Trend	2015 Low
88-29-014	RMW-148	North Basin	NKWSD	Primary Principal Alluvial	35.623	-119.224	-136	-75	-75	-75	-75	-75	Recent Low Cap	2015 Low
99-00-003	RMW-149	North Basin	NKWSD	Primary Principal Alluvial	35.442	-119.133	0	61	61	61	61	61	Recent Low Cap	2015 Low
99-00-081	RMW-150	North Basin	NKWSD	Primary Principal Alluvial	35.576	-119.282	-96	-12	-12	-12	-12	-12	HCM Area Trend	2015 Low
99-22-084	RMW-151	North Basin	NKWSD	Primary Principal Alluvial	35.638	-119.312	-133	-49	-49	-49	-49	-49	HCM Area Trend	2015 Low
Shafter Well 18	RMW-271	North Basin	NKWSD	Primary Principal Alluvial	35.501	-119.207	-33	51	9	-12	20	51	HCM Area Trend	Spatial Interpolation
3361-62	RMW-284	North Basin	NKWSD	Primary Principal Alluvial	35.471	-119.217	-22	62	20	-1	31	62	HCM Area Trend	Spring 2016
DW097	RMW-285	North Basin	NKWSD	Primary Principal Alluvial	35.417	-119.219	7	91	49	28	60	91	HCM Area Trend	2015 Low
Well #4	RMW-043	East Margin	Olcese	Santa Margarita and Olcese Principal	35.431	-118.841	306	399	353	329	364	399	HCM Area Trend	Spring 2016
Canyon View Ranch	RMW-044	East Margin	Olcese	Santa Margarita and Olcese Principal	35.439	-118.803	466	527	527	527	527	527	Recent Low Cap	Linear interpolation between February 2000 and July 2017
30S/26E-04D003M	RMW-045	Kern River Fan	Pioneer	Primary Principal Alluvial	35.354	-119.197	-46	15	15	15	15	15	Range	2015 Low
30S/26E-10P004M	RMW-048	Kern River Fan	Pioneer	Primary Principal Alluvial	35.325	-119.174	-51	29	29	29	29	29	Range	2015 Low
30S/26E-15N003M	RMW-049	Kern River Fan	Pioneer	Primary Principal Alluvial	35.312	-119.181	-36	29	29	29	29	29	Range	2015 Low
30S/26E-04J003M	RMW-259	Kern River Fan	Pioneer	Primary Principal Alluvial	35.343	-119.182	-142	-46	-46	-46	-46	-46	Recent Low Cap	2015 Low
30S/26E-04J002M	RMW-289	Kern River Fan	Pioneer	Primary Principal Alluvial	35.343	-119.182	-6	62	62	62	62	62	Range	2015 Low
Bushnell	RMW-050	North Basin	RRBWSD	Primary Principal Alluvial	35.435	-119.358	-111	-27	-69	-90	-59	-27	HCM Area Trend	2015 Low
L.R. Stout	RMW-052	North Basin	RRBWSD	Primary Principal Alluvial	35.431	-119.286	-43	41	-1	-22	10	41	HCM Area Trend	2015 Low
RBG School	RMW-053	North Basin	RRBWSD	Primary Principal Alluvial	35.420	-119.254	-17	67	25	4	36	67	HCM Area Trend	Spatial Interpolation
P. Enns Domestic	RMW-054	North Basin	RRBWSD	Primary Principal Alluvial	35.412	-119.262	-16	68	26	5	37	68	HCM Area Trend	2015 Low
Section 18	RMW-055	North Basin	RRBWSD	Primary Principal Alluvial	35.408	-119.331	-54	30	-12	-33	-2	30	Recent Low Cap	2015 Low
Blacco HQ	RMW-056	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.391	-119.345	2	47	25	13	30	47	HCM Area Trend	2015 Low
Cauzza	RMW-057	North Basin	RRBWSD	Primary Principal Alluvial	35.399	-119.395	-48	36	-6	-27	5	36	HCM Area Trend	2015 Low
Parsons New	RMW-058R	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.366	-119.386	-22	23	23	23	23	23	HCM Area Trend	2015 Low estimated from surrogate data
West I-5	RMW-059	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.356	-119.341	1	46	46	46	46	46	HCM Area Trend	2015 Low
Virgil Bussell	RMW-060	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.363	-119.308	13	58	58	58	58	58	HCM Area Trend	2015 Low
27N Mayer	RMW-061a	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.369	-119.286	15	62	62	62	62	62	Range	2015 Low
25M Enos	RMW-062a	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.374	-119.252	31	77	77	77	77	77	Range	2015 Low
Chet Reed	RMW-063	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.391	-119.147	113	158	136	124	141	158	HCM Area Trend	2015 Low
Home Place	RMW-064	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.382	-119.204	64	109	109	109	109	109	HCM Area Trend	2015 Low
31H Greeley	RMW-065a	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.362	-119.217	7	69	69	69	69	69	Range	2015 Low
Harvest Ranch	RMW-066	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.363	-119.177	59	105	105	105	105	105	Range	2015 Low
35H RRBWSD Shop	RMW-067a	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.366	-119.147	71	116	116	116	116	116	HCM Area Trend	2015 Low
32N Triple	RMW-068a	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.267	-119.214	73	118	118	118	118	118	HCM Area Trend	2015 Low
28J Triple	RMW-069b	Kern River Fan	RRBWSD	Primary Principal Alluvial	35.289	-119.181	100	145	145	145	145	145	HCM Area Trend	2015 Low
SSJMUD 8	RMW-157	North Basin	SSJMUD	Primary Principal Alluvial	35.747	-119.336	-154	-70	-70	-70	-70	-70	HCM Area Trend	2015 Low
SSJMUD 14	RMW-158	North Basin	SSJMUD	Primary Principal Alluvial	35.739	-119.205	-44	4	4	4	4	4	Local raise per SWRCB feedback	2015 Low
SSJMUD 23	RMW-159	North Basin	SSJMUD	Primary Principal Alluvial	35.719	-119.304	-109	-26	-26	-26	-26	-26	Recent Low Cap	2015 Low

Local Site ID	RMW ID	HCM AREA	GSA	Aquifer	Latitude	Longitude	MT (ft msl)	MO (ft msl)	IMs (ft msl)				MT Basis	MO Estimation Method
									2025	2030	2035	2040		
SSJMUD 53	RMW-160	North Basin	SSJMUD	Primary Principal Alluvial	35.631	-119.191	-8	34	34	34	34	34	Local raise per SWRCB feedback	2015 Low
SSJMUD 67	RMW-161R	North Basin	SSJMUD	Primary Principal Alluvial	35.675	-119.154	-45	-14	-14	-14	-14	-14	Local raise per SWRCB feedback	2015 Low from nearby well
SSJMUD 62	RMW-162	North Basin	SSJMUD	Primary Principal Alluvial	35.718	-119.145	46	100	100	100	100	100	Local raise per SWRCB feedback	2015 Low
SSJMUD 42	RMW-163	North Basin	SSJMUD	Primary Principal Alluvial	35.693	-119.232	-4	65	65	65	65	65	Recent Low Cap	2015 Low
SSJMUD 47	RMW-208R	North Basin	SSJMUD	Primary Principal Alluvial	35.668	-119.209	-69	15	-27	-48	-17	15	HCM Area Trend	2015 Low from nearby well
Delano 30	RMW-252	North Basin	SSJMUD	Primary Principal Alluvial	35.790	-119.230	-14	70	70	70	70	70	HCM Area Trend	Average of July 2013 and July 2016
Delano 34	RMW-281	North Basin	SSJMUD	Primary Principal Alluvial	35.744	-119.259	-10	74	32	11	43	74	HCM Area Trend	Spatial Interpolation
SSJMUD 68	RMW-323	North Basin	SSJMUD	Primary Principal Alluvial	35.769	-119.281	(Note 1)							
Shafter Well 15	RMW-204	North Basin	SWID	Primary Principal Alluvial	35.470	-119.279	-74	-4	-4	-4	-4	-4	Recent Low Cap	2015 Low
Shafter Well 7	RMW-205	North Basin	SWID	Primary Principal Alluvial	35.508	-119.278	-74	10	-32	-53	-22	10	HCM Area Trend	Spatial Interpolation
28S/24E-35C	RMW-249	North Basin	SWID	Primary Principal Alluvial	35.456	-119.360	-76	8	-34	-55	-24	8	HCM Area Trend	2015 Low
Shafter Well 12	RMW-254	North Basin	SWID	Primary Principal Alluvial	35.502	-119.275	-75	9	-33	-54	-23	9	HCM Area Trend	Spatial Interpolation
Wasco 12	RMW-256	North Basin	SWID	Primary Principal Alluvial	35.616	-119.340	-166	-90	-90	-90	-90	-90	Recent Low Cap	2015 Low
Shafter Well 14	RMW-257	North Basin	SWID	Primary Principal Alluvial	35.494	-119.259	-71	13	-29	-50	-19	13	HCM Area Trend	Spatial Interpolation
Wasco 8A	RMW-263	North Basin	SWID	Primary Principal Alluvial	35.587	-119.352	-134	-50	-50	-50	-50	-50	HCM Area Trend	Spatial Interpolation
28S25E19G	RMW-269	North Basin	SWID	Primary Principal Alluvial	35.478	-119.315	-60	24	-18	-39	-8	24	HCM Area Trend	2015 Low
Wasco 11	RMW-276	North Basin	SWID	Primary Principal Alluvial	35.589	-119.342	-158	-74	-74	-74	-74	-74	HCM Area Trend	2015 Low
S-2	RMW-119	North Basin	SWSD	Primary Principal Alluvial	35.569	-119.562	-107	-25	-25	-25	-25	-25	Recent Low Cap	2015 Low
S-4	RMW-121	North Basin	SWSD	Primary Principal Alluvial	35.521	-119.582	-58	9	9	9	9	9	Recent Low Cap	2015 Low
S-5	RMW-122	North Basin	SWSD	Primary Principal Alluvial	35.551	-119.527	-143	-59	-59	-59	-59	-59	HCM Area Trend	2015 Low
S-6	RMW-123	North Basin	SWSD	Primary Principal Alluvial	35.704	-119.339	-145	-76	-76	-76	-76	-76	Recent Low Cap	2015 Low
S-8A Cluster 1 of 2	RMW-126	North Basin	SWSD	Primary Principal Alluvial	35.630	-119.402	-154	-70	-112	-133	-102	-70	HCM Area Trend	2015 Low
S-9A Cluster 1 of 2	RMW-128	North Basin	SWSD	Primary Principal Alluvial	35.522	-119.394	-113	-29	-71	-92	-61	-29	HCM Area Trend	2015 Low
S-11	RMW-130	North Basin	SWSD	Primary Principal Alluvial	35.696	-119.562	-176	-108	-108	-108	-108	-108	Corcoran Clay Adjustment	2015 Low
S-12	RMW-131	North Basin	SWSD	Primary Principal Alluvial	35.723	-119.554	-164	-121	-121	-121	-121	-121	Corcoran Clay Adjustment	2015 Low
S-13A Cluster 1 of 2	RMW-132	North Basin	SWSD	Primary Principal Alluvial	35.761	-119.437	-188	-104	-104	-104	-104	-104	HCM Area Trend	Spatial Interpolation
S-14B Cluster 2 of 2	RMW-135	North Basin	SWSD	Primary Principal Alluvial	35.667	-119.384	-159	-75	-75	-75	-75	-75	HCM Area Trend	2015 Low
26S-23E-15A1	RMW-137	North Basin	SWSD	Primary Principal Alluvial	35.674	-119.473	-179	-110	-110	-110	-110	-110	Recent Low Cap	2015 Low
948L02 Cluster1 of 2	RMW-139	North Basin	SWSD	Primary Principal Alluvial	35.419	-119.422	-107	-41	-41	-41	-41	-41	Recent Low Cap	2015 Low
S-1	RMW-277	North Basin	SWSD	Primary Principal Alluvial	35.594	-119.581	130	185	185	185	185	185	Local raise per SWRCB feedback	2015 Low
28/23/16/G	RMW-286	North Basin	SWSD	Primary Principal Alluvial	35.495	-119.501	-110	-26	-68	-89	-58	-26	HCM Area Trend	2015 Low
28/23/36/R	RMW-287	North Basin	SWSD	Primary Principal Alluvial	35.443	-119.440	-69	3	3	3	3	3	Recent Low Cap	2015 Low
Caratan Well (RMS-1)	RMW-070	South Basin	TCWD	Primary Principal Alluvial	35.200	-118.770	20	96	58	39	68	96	HCM Area Trend	November 2019
7106-63	RMW-203	North Basin	WDWA	Primary Principal Alluvial	35.551	-119.637	-23	51	51	51	51	51	Recent Low Cap	March 2020
7108-66	RMW-275	North Basin	WDWA	Primary Principal Alluvial	35.776	-119.690	-73	-2	-2	-2	-2	-2	Recent Low Cap	March 2021

Local Site ID	RMW ID	HCM AREA	GSA	Aquifer	Latitude	Longitude	MT (ft msl)	MO (ft msl)	IMs (ft msl)				MT Basis	MO Estimation Method
									2025	2030	2035	2040		
S#14	RMW-279	North Basin	WDWA	Primary Principal Alluvial	35.667	-119.672	134	218	176	155	187	218	HCM Area Trend	November 2020
Berenda Mesa #3	RMW-299	Western Fold Belt	WDWA	Primary Principal Alluvial	35.637	-119.949	306	363	363	363	363	363	Recent Low Cap	Linear interpolation between May 2009 and May 2023
WKWD 23M-M	RMW-085b	Kern River Fan	WKWD	Primary Principal Alluvial	35.304	-119.270	-9	40	40	40	40	40	Range	2015 Low
NWM1-M	RMW-266	Kern River Fan	WKWD	Primary Principal Alluvial	35.346	-119.368	18	63	63	63	63	63	HCM Area Trend	2015 Low
7-01	RMW-293	Kern River Fan	WKWD	Primary Principal Alluvial	35.297	-119.297	-54	-9	-9	-9	-9	-9	HCM Area Trend	2015 Low
North Ag	RMW-294	Kern River Fan	WKWD	Primary Principal Alluvial	35.347	-119.359	18	63	41	29	46	63	HCM Area Trend	2015 Low
South Ag	RMW-295	Kern River Fan	WKWD	Primary Principal Alluvial	35.333	-119.359	17	62	40	28	45	62	HCM Area Trend	2015 Low
32S26E20G001M	RMW-094	South Basin	WRM	Primary Principal Alluvial	35.134	-119.208	-7	69	69	69	69	69	HCM Area Trend	2015 Low
32S27E30N001M	RMW-095	South Basin	WRM	Primary Principal Alluvial	35.109	-119.123	157	230	194	175	203	230	Recent Low Cap	2015 Low
32S27E35R001M	RMW-097	South Basin	WRM	Primary Principal Alluvial	35.096	-119.041	62	138	100	81	110	138	HCM Area Trend	2015 Low
32S26E24K001M	RMW-231	South Basin	WRM	Primary Principal Alluvial	35.130	-119.137	-15	61	61	61	61	61	HCM Area Trend	2015 Low
11N22W01D001S	RMW-232	South Basin	WRM	Primary Principal Alluvial	35.075	-119.189	48	124	48	86	105	124	HCM Area Trend	2015 Low
11N22W06H001S	RMW-233	South Basin	WRM	Primary Principal Alluvial	35.069	-119.261	191	267	229	210	239	267	HCM Area Trend	2015 Low
11N21W16E001S	RMW-234	South Basin	WRM	Primary Principal Alluvial	35.043	-119.136	-112	-9	-9	-9	-9	-9	Range	2015 Low
12N21W34N001S	RMW-235R	South Basin	WRM	Primary Principal Alluvial	35.077	-119.117	26	68	68	68	68	68	Corcoran Clay Adjustment	2015 Low
11N21W09C001S	RMW-236	South Basin	WRM	Primary Principal Alluvial	35.060	-119.131	-23	23	23	23	23	23	Local raise per SWRCB feedback	2015 Low
32S26E34P001M	RMW-237	South Basin	WRM	Primary Principal Alluvial	35.094	-119.174	110	186	186	186	186	186	HCM Area Trend	2015 Low
32S26E36P002M	RMW-238	South Basin	WRM	Primary Principal Alluvial	35.095	-119.137	39	85	85	85	85	85	Local raise per SWRCB feedback	2015 Low
32S25E29Q001M	RMW-239	South Basin	WRM	Primary Principal Alluvial	35.109	-119.313	166	234	234	234	234	234	Recent Low Cap	Spatial Interpolation
32S28E16P001M	RMW-240	South Basin	WRM	Primary Principal Alluvial	35.137	-118.977	74	150	112	93	122	150	HCM Area Trend	Linear interpolation between February 2002 and November 2019
12N21W35Q001S	RMW-258	South Basin	WRM	Primary Principal Alluvial	35.077	-119.087	19	95	95	95	95	95	HCM Area Trend	2015 Low

Abbreviations:

MO = Measurable Objective
BV = Buena Vista GSA
EWMA = Eastside Water Management Area
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
HCM = Hydrogeologic Conceptual Model
HMWD = Henry Miller Water District GSA
ID = Identification
IM = Interim Milestone
KNDLA = Kern Non-Districted Land Authority GSA
KRGSA = Kern River GSA
KTWD = Kern-Tulare Water District GSA
KWBA = Kern Water Bank Authority GSA
MT = Minimum Threshold
NKWSD = North Kern Water Storage District GSA
RMW = Representative Monitoring Well for Chronic Lowering of Groundwater Levels
RRBWSD = Rosedale-Rio Bravo Water Storage District GSA
SMC = Sustainable Management Criteria
SSJMUD = Southern San Joaquin Municipal Utility District GSA
SWID = Shafter-Wasco Irrigation District GSA
SWSD = Semitropic Water Storage District GSA
TCWD = Tejon-Castac Water District GSA
WDWA = Westside District Water Authority GSA
WKWD = West Kern Water District GSA
WRM = Wheeler Ridge-Maricopa GSA

Notes:

1. Well has been added to the RMW-WL network to address data gaps within the Kern Subbasin. SMCs for Chronic Lowering of Groundwater Levels are pending and will be established following the collection of five water level measurements at this well.
2. MT adjusted upward per GSA request for consistency with MTs in the Tule Subbasin.

13.1.2.2 Relationship with Other Sustainability Indicators

The MTs for Chronic Lowering of Groundwater Levels are designed to ensure that they are sufficiently protective of SMCs defined for all other relevant Sustainability Indicators in the Kern Subbasin. The specific relationships between the Chronic Lowering of Groundwater Levels and other applicable Sustainability Indicators are discussed below.

- Chronic Lowering of Groundwater Levels and **Reduction in Groundwater Storage** are directly, if not linearly, related. As described in Section 13.2.2, the MTs for Chronic Lowering of Groundwater Levels are used as a proxy for the Reduction of Groundwater Storage Sustainability Indicator. Furthermore, as described in Section 13.2.1.4, the reduction in storage estimated to occur based on the UR criteria for Chronic Lowering of Groundwater Levels is not considered significant and unreasonable as it is similar to the storage change observed during recent multi-year droughts (i.e., 2013-2016 and 2021-2022) without unreasonable dewatering of wells in the Kern Subbasin.
- Trend analyses have been conducted for the six prevalent COCs to evaluate the relationship between Chronic Lowering of Groundwater Levels and **Degraded Water Quality**, and to identify driving mechanisms for increasing constituent concentrations. As described in Section 8.4.2, no direct correlation has been observed between declining groundwater levels and increasing concentrations of 1,2,3-Trichloropropane (1,2,3-TCP), Total Dissolved Solids (TDS) or uranium. While there is also no clear Subbasin-wide correlation between groundwater levels and increasing arsenic and nitrate concentrations, additional investigation will be required if there are MT exceedances. 36 Representative Monitoring Wells for Degraded Water Quality (RMW-WQs) have been selected for both groundwater levels and groundwater quality monitoring to facilitate ongoing monitoring and reporting regarding potential future impacts of groundwater management activities and to protect beneficial users. Refer to Appendix K-1 that discusses the investigation process.
- Historical **Land Subsidence** has been attributed to Chronic Lowering of Groundwater Levels, in part due to groundwater extractions from the Kern Subbasin. The Kern Subbasin GSAs have assessed whether groundwater level declines to the MTs would cause significant and unreasonable effects due to Land Subsidence. A preliminary approach is used to evaluate the Chronic Lowering of Groundwater Level MTs in relation to the Land Subsidence MTs because a calibrated model (1-dimensional or numerical) with land subsidence simulation capabilities is not currently available to project future subsidence within the Kern Subbasin. This approach is described below and shown in Table 13-3. The relationship between Groundwater Level MTs and Land Subsidence MTs will be reassessed once the calibrated model with land subsidence simulation capabilities is available in the future.

- The average historical groundwater level decline (Column B in Table 13-3) in relation to the average historical cumulative subsidence for each HCM Area (Column C in Table 13-3) is compared over the period from 2015 to 2023 to establish a groundwater level decline to subsidence ratio by HCM Area.
- This ratio is then applied to the future projected groundwater level declines to the MTs by HCM Area (to project the resulting land subsidence Columns D and E in Table 13-3) and compared to the Land Subsidence MTs (extent; Column F in Table 13-3) to check if the proposed Chronic Lowering of Groundwater Level MTs result in exceedances of the Land Subsidence MTs.
- If not exceeded, the Chronic Lowering of Groundwater Level MTs are considered consistent with the Land Subsidence MTs.

As shown in Table 13-3, for each HCM Area, the projected average cumulative extent of subsidence at Chronic Lowering of Groundwater Level MTs is less than the Land Subsidence MTs, which are considered protective of the functionality of critical infrastructure provided implementation of P/MAs as described below in Section 13.5 As such, this analysis demonstrates that the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective of impacts due to Land Subsidence. However, as discussed in Section 8.5, there are many potential causes of subsidence in the Kern Subbasin that may contribute to potential URs, but that are outside of the authorities of a GSA to control (i.e., non-GSA-related). Furthermore, MTs are locally raised to avoid conditions where groundwater levels may newly fall below the Corcoran Clay, providing additional protection in preventing potentially increased subsidence rates. Finally, as discussed above (and shown in Table 13-7) groundwater level trends are extrapolated through 2030, whereas subsidence MTs are based on extrapolated trends through 2040 (Section 13.5.2.1). Hence, future groundwater level declines (as represented by the groundwater level MTs) are meant to stabilize by 2030 while future subsidence rates (as represented by the subsidence MTs) are meant to stabilize by 2040. The additional ten years between the groundwater level MT trend and the subsidence MT trend is meant to capture future residual subsidence beyond 2030.

Table 13-3. Projected Subsidence and Groundwater Level Minimum Thresholds

HCM Area	Average Groundwater Level Decline (feet/year)[1]		(C) Average Subsidence Rate 2015-2023 (feet/year)[4]	Projected Subsidence (2024-2040) at Groundwater Level MTs[5]		(F) Subsidence MT Extent (feet)
	(A) Decline to Groundwater Level MT[2]	(B) Decline from 2015-2023[3]		(D) Rate (feet/year)	(E) Extent (feet)	
North Basin	-5.2	-5.7	0.059	0.053	0.37	0.85
Kern River Fan	-3.7	-2.8	0.022	0.029	0.20	0.27
South Basin	-4.9	-6.1	0.037	0.030	0.21	0.48
Western Fold Belt	-4.1	N/A[6]	0.008	N/A[6]	N/A[6]	0.1
East Margin	-6.5	-6.5	0.006	0.006	0.04	0.14

Notes:

1. For the East Margin HCM Area, the trend is calculated by averaging data from the Primary Alluvial Principal Aquifer and the Santa Margarita and Olcese Principal Aquifers. In all other HCM Areas, the trend is based solely on data from the Primary Alluvial Principal Aquifer.
2. The groundwater level decline to MT is calculated as the average difference between MO and MT, divided by 14 years.
3. The subsidence MTs are based on land subsidence that occurred over the 2015 to 2023 period. Trend is calculated using monitoring wells with declining trends.
4. Average subsidence by HCM Area for Oct 2015 through Sept 2023 based on InSAR data downloaded from the DWR website.
5. Projected subsidence at groundwater level MTs are calculated by projecting a subsidence rate associated with the rate of decline in groundwater levels at the MT based on the observed subsidence and groundwater level declines over the 2015-2023 period.
6. There is insufficient historical groundwater level data from monitoring wells located in the Western Fold Belt HCM Area due to land use and naturally occurring poor water quality to calculate a trend. The principal water supply is imported surface water in this HCM Area. Further, non-GSA activities and factors that can contribute to subsidence are extensive in the Western Fold Belt.

13.1.2.3 Consideration of Adjacent Basins

In consideration of adjacent subbasins, the Chronic Lowering of Groundwater Level MTs have been compared along the southern boundary with the White Wolf Subbasin (Primary Alluvial Principal Aquifer) and to the north with the Tulare Lake Subbasin (Primary Alluvial Principal Aquifer) and the Tule Subbasin (Primary Alluvial Principal Aquifer and Santa Margarita Principal Aquifer). No adjacent basins overly the Olcese Principal Aquifer.

The MTs in the White Wolf Subbasin were developed using a similar methodology as the Kern Subbasin and range from approximately 60 feet to 140 feet higher than the existing Kern Subbasin MTs along the southern boundary, which maintains the historic cross-boundary flow direction from White Wolf Subbasin toward the Kern Subbasin. The Santa Margarita Aquifer is not considered a principal aquifer in the White Wolf Subbasin, therefore no comparison was made.

The Tule and Tulare Lake Subbasins are in probation, with additional GSP revisions expected. Based on the available information as of November 2024, the revised MTs in the Tule and Tulare Lake Subbasins will remain designated by aquifer (Upper, Lower, Composite, and Santa Margarita Formation). For consistency with the Tule Subbasin,

the MT in one RMW-WL in the Santa Margarita Principal Aquifer was adjusted upwards. In discussion with the Tulare Lake Subbasin representatives, the preliminary revised approach sets MOs as the 2015 low groundwater elevation at representative monitoring sites, which is the same methodology used in the Kern Subbasin (Section 13.1.3.1). As such, if both subbasins work toward sustainable conditions with their MOs, the groundwater gradient should remain the same as observed in 2015.

Furthermore, groundwater level gradients along the Kern Subbasin boundaries have been evaluated to assess potential impacts to adjacent basins. Figure 13-9 shows groundwater levels under the MTs relative to actual Fall 2015 Low groundwater levels. Water levels under the MTs do not differ significantly from actual Fall 2015 water levels; therefore, it is not expected that the MTs will substantially alter groundwater level gradients beyond those experienced in 2015.

The Kern Subbasin GSAs have and will continue to coordinate development of SMCs and ongoing 2025 Plan implementation in the Kern Subbasin through common District membership in the White Wolf GSA (i.e. Arvin-Edison Water Storage District, Wheeler Ridge-Maricopa Water Storage District, and Tejon-Castac Water District) to minimize any impacts on the adjacent White Wolf Subbasin's ability to achieve its Sustainability Goal. The Kern Subbasin GSAs will also continue to engage with the Tulare Lake Subbasin and the Tule Subbasin through their respective SGMA processes. Additionally, the Kern Subbasin GSAs will continue to coordinate with the Tule Subbasin due to their jurisdictional overlap with the Tule Subbasin (i.e. Kern-Tulare Water District GSA).

13.1.2.4 Impacts to Beneficial Users

☑ 23 CCR § 354.28(b)(4)

As identified in Section 13.1.1.1, the primary beneficial uses and users of groundwater, as identified by the Kern Subbasin Well Inventory include the following user categories: agricultural, banked water recovery, industrial, domestic well, public water systems, and small communities. The Chronic Lowering of Groundwater Level MTs have been developed to prevent significant and unreasonable impacts to these uses and groups of groundwater users and are justified by the well impact analyses presented below.

One factor to consider when setting MTs for Chronic Lowering of Groundwater Levels is the potential for dewatering of wells or well screens. Through the Kern Subbasin's Well Mitigation Program (Section 16.2.1.1 and Appendix G-1), the Kern Subbasin GSAs have earmarked an initial reserve fund of $3.5 million to be replenished annually based on the actual mitigation costs.

Table 13-4 provides the detailed breakdown of the annual Well Mitigation Program funds. As shown therein, when including the uncertainty buffer budget into the Dry Well Mitigation Track budget, there are sufficient annual funds to mitigate more than 23 domestic wells and provide technical assistance to 15 small communities or municipal

wells in a given year. It should be noted that a UR would occur before the Well Mitigation Program funds would be exhausted, as the UR definition is triggered after 15 drinking water wells are reported dry in a given year.

The Well Mitigation Program budget was estimated whereby replenishing funds projected through 2040 would be sufficient to mitigate or provide technical assistance to more than 300 drinking water wells by 2040, if needed. Again, it should be noted that a UR would occur before the Well Mitigation Program funds would be exhausted, as the UR definition is capped at 255 dewatered drinking water wells.

Table 13-4. Annual Well Mitigation Program Funds

Activity	Annual Budget	Note
Dry Well Mitigation	$1,350,000	15 wells ($90,000 per well)
Technical Assistance	$750,000	15 Technical Assistance Applications
Groundwater Quality Mitigation	$500,000	100 quality applications ($2,500 per well)
Program Administration	$150,000	Meetings with Self-Help Enterprises (SHE), SHE's administrative assistance, technical evaluation of claims
Uncertainty Buffer	$750,000	Climate change (prolonged droughts- more dry wells than expected), Data Uncertainty, etc.
TOTAL	**$3,500,000**	

Well Impact Analyses

The well impact analysis has been conducted to estimate the number of drinking wells that would be impacted under the proposed MTs and identify whether this number is within the reasonable scope for the GSAs to address through mitigation. A well impacts analysis for all well types, including agricultural and industrial wells, is detailed in Appendix I-3.

The Kern Subbasin Well Inventory (February 2025)[9] and associated User Type has been used to estimate the total number of drinking water wells in the Kern Subbasin.[10] It is estimated that there are 2,322 domestic wells (5 of which are non-potable and excluded herein), 285 municipal/public supply wells, and 28 small community wells (2,630 total drinking water wells) within the Kern Subbasin (Table 5-6). However, many of these wells may have already been impacted and mitigated prior to 2015, which would be considered a “pre-SGMA” condition that would be outside of the purview of the

[9] The Kern Subbasin GSAs are continuing their efforts to develop a comprehensive well inventory which will result in changes to the total number of wells in each beneficial user category. Several datasets were gathered to identify all wells and are being reconciled with DWRs OSWCR records to create the inventory. Consequently, different well counts may be presented throughout this plan, depending on which dataset was referenced and the data source for the work products.

[10] The definition of drinking water wells as it relates to the well impact analysis does not include wells designated as non-potable use.

GSAs to remedy (CWC §10727.2(b)(4)). Moreover, several of these wells may have been replaced and could have duplicative records in the well inventory.

In consideration of these factors, the following screening process has been employed on the Kern Subbasin Well Inventory to establish a subset of wells to use in the well impact analysis for planning purposes. It should be noted that the screening process described below is used only for estimating the number of drinking water wells expected to be impacted and will not be used for determining eligibility under the Well Mitigation Program.

1. Remove wells that will be older than 70 years by 2040, unless the well has been verified through field review by the GSA – *removed 975 wells*.

   A typical lifespan of an agricultural well is approximately 50 years, and even shorter for domestic wells (Rodríguez-Flores et al., 2023). Therefore, wells over 70 years old by 2040 are considered likely to have been abandoned or replaced during the SGMA implementation period. Use of 1970 (i.e., 70 years old by 2040) as the threshold for a typical well lifespan is consistent with screening conducted as part of the Community Water Center's Drinking Water Tool: https://drinkingwatertool.communitywatercenter.org/.

2. Remove wells that were already dewatered at the 2014 low water levels and were assumed to have remained dewatered following 2014[11] – *removed 257 wells*.

   To estimate wells that have already been impacted at the 2014 low groundwater levels, the lowest groundwater elevation observed from any well with available 2014 depth to groundwater level data from the DMS were spatially interpolated using kriging to create a surface representing the 2014 low depth to groundwater. This surface was compared to a depth of 50 feet above the total completed depth (i.e., the bottom of the well) of each drinking water well. A well was considered "dewatered" if the interpolated 2014 low depth to groundwater was less than 50 ft above the bottom of the well. These wells have been removed from the planning dataset, as they would have been affected by groundwater conditions prior to 2015.

3. Remove wells that were marked as "Abandoned" as part of the GSA field review process or that have been disconnected because the user has been connected to a public water system – *removed 3 wells*.

[11] Removal of wells that were already dewatered at 2014 low water levels reflects the fact that SGMA does not require GSPs to address URs that occurred before and have not been corrected by January 1, 2015 (CWC § 10727.2(b)(4)). Moreover, several of these wells may have been replaced or deepened and may not be impacted by a repeat of 2014 low conditions.

Following this screening process, a total of 1,395 remaining drinking water wells are considered for the well impact analysis (1,125 domestic wells, 251 municipal/public supply wells, and 19 small community wells). Construction records for these wells are compared to the spatially interpolated MT values (as depth below ground surface) across the Kern Subbasin.[12] A well is considered potentially impacted (i.e., dewatered) if the interpolated MT depth to groundwater is less than 50 feet above the total completed depth (i.e., the bottom of the well).

It is recognized that a wide range of well impacts may occur based on the various potential combinations of RMW-WLs that could exceed MTs. As such, the well impact analysis considers the following five scenarios, three of which consider the criteria for URs (i.e., 25 percent of RMW-WLs reaching the MTs). The results of the drinking water well impact analysis for each scenario is shown in Table 13-5 and discussed below. For completeness, an expanded well impacts analysis that includes all groundwater extraction well types and more details on scenario calculations are included in Appendix I-3.

- *Scenario 1 - Worst Case*: The worst-case well impacts scenario is defined as the number of drinking water wells that would be impacted if all RMW-WLs reach their MTs. To evaluate this scenario, well depths are compared to the spatially interpolated MT groundwater depth at each well location. Potential impacts under this scenario are up to 184 drinking water wells, as shown on Figure 13-10. Note this is a highly unlikely scenario as it entails all RMW-WLs reaching their MTs simultaneously in a given year. As discussed previously, Chronic Lowering of Groundwater Level URs would be declared at 25 percent RMW-WL exceedances, which, in turn, will trigger to P/MAs to stabilize groundwater levels; hence, the Subbasin is not expected to ever experience this worst-case scenario.
- *Scenario 2 - High-End Bracketed Results*: This scenario evaluates the upper range of potential well impacts that would occur under the 25 percent RMW-WL MT exceedance threshold for URs. For this analysis, each impacted drinking water well from Scenario #1 is assigned to the nearest RMW-WL. The 25 percent of RMW-WLs with the *highest* density of impacted drinking water wells are identified, and the impacted wells assigned to these RMW-WLs are counted. Potential impacts under this scenario are up to 165 drinking water wells, as shown on Figure 13-11

[12] As part of the ongoing Plan refinement process, the Kern Water Bank GSA conducted a detailed review of the groundwater level data used to establish the Chronic Lowering of Groundwater Level SMCs for the Kern Water Bank GSA's RMW-WL (RMW-300). The MTs and MOs for RMW-300 were adjusted by one foot to reflect corrected groundwater level data. These updated values are shown in Table 13-2, Figures 13-3 and 13-17, and in the hydrographs provided in Appendix I-1. The well impacts analysis results included herein have not been updated to reflect this one foot change. However, given the well's distance from drinking water wells within the Subbasin, potential well impacts are not expected to occur as a result of this change.

- *Scenario 3 - Low-End Bracketed Results:* Similar to Scenario #2, this scenario evaluates the lower range of potential well impacts that would occur under the 25 percent RMW-WL MT exceedance threshold for URs. For this analysis, each impacted drinking water well from Scenario #1 is assigned to the nearest RMW-WL. In this scenario, 25 percent of RMW-WLs with the *lowest* density of impacted drinking water wells are identified, and impacted wells assigned to these RMW-WLs are counted. There are no potentially impacted drinking water wells under this scenario, as shown on Figure 13-12.
- *Scenario 4 - Stochastic Prediction*: This scenario evaluates the average number of well impacts that would occur under the 25 percent RMW-WL MT exceedance threshold for URs using stochastic predictive modeling. This analysis is considered the most representative as it considers potential drinking water well impacts under a random selection of MT exceedances at 25 percent of RMW-WLs, consistent with the UR definition. Two predictions composed of 5,000 combinations have been assessed to further incorporate uncertainty: (1) a random selection of RMW-WLs, and (2) a weighted selection that assumes RMW-WLs that are within 61 feet of the MT as of Fall 2023 and/or are in areas with more concentrated groundwater pumping are more likely to exceed MTs. Refer to Appendix I-3 for more details on the predictions. Histograms of the range of potential impacts are shown in Figure 13-13 and Figure 13-6 and the average potential well impacts are tabulated in Table 13-5. Average potential impacts are up to 47 and 42 drinking water wells, respectively, as shown in Table 13-5.
- *Scenario 5 – Modeled Projected Future Conditions:* This scenario evaluates the well impacts that would occur under projected future 2030 climate change conditions without P/MAs (“2030 climate no P/MAs”) and projected future 2030 climate change conditions with implementation of P/MAs (2030 climate with P/MAs”) as estimated through application of the *C2VSimFG-Kern Projected-Future Baseline 2030 Climate Change* scenario. Scenario 5 is included herein as the C2VSimFG-Kern is the best available tool to assess groundwater responses to climate change and to implementation of P/MAs. However, the model is currently uncalibrated, and actively undergoing revision and recalibration through the Basin Study; therefore there is inherent uncertainty with simulated groundwater elevations. The 2030 climate no P/MAs analysis represents the number of drinking water wells that would be impacted if conditions were to persist without any P/MAs under 2030 climate change. The 2030 climate with P/MAs analysis represents the number of wells that would be impacted if GSAs were to implement the P/MAs described in Section 14. The 2030 climate no P/MAs results in up to 63 potentially impacted drinking water wells, as shown on Figure 13-15, and the 2030 climate with P/MA results in up to 19 potentially impacted drinking water wells, as shown on Figure 13-16.

For planning purposes, a likely count of potentially impacted drinking water wells is somewhere between the stochastic prediction and the 2030 climate with P/MAs modeled scenario (i.e., 19 to 47).

Table 13-5. Kern Subbasin Drinking Water Well Impact Analysis Results

Scenario	Estimated Potentially Impacted[1] Drinking Water Well Count	Estimated Depletion of Supply (AFY)	Percentage of Total Estimated Urban[2] Water Supply
#1: Worst Case	184	3,630	1.8%
#2: High-End Bracketed[13]	165	3,616	1.8%
#3: Low-End Bracketed	0	0	0%
#4: Stochastic Prediction	Random: 47 Weighted: 42	Random: 1,200 Weighted: 1,196	Random: 0.61% Weighted: 0.61%
#5: Modeled Projected Future Conditions[14]	2030 Climate no P/MAs: 63 2030 Climate with P/MAs: 19	2030 Climate no P/MAs: 45 2030 Climate with P/MAs: 13	2030 Climate no P/MAs: < 0.1% 2030 Climate with P/MAs: < 0.01%

Notes:

1. Potentially impacted is defined as a drinking water well having less than 50 feet of water above the well bottom based on the interpolated MT surface.
2. The "urban" water supply estimates reported in the Kern Subbasin's WY 2022 Annual Report includes groundwater extractions for all urban uses including residential, commercial, municipal, industrial, food processing, oilfield use, landscaping and other uses.

As discussed above, the Dry Well Mitigation Track provides an initial reserve fund that is replenished annually based on incurred costs, with sufficient budget to mitigate over 38 drinking water wells annually (15 domestic wells, 15 technical assistance applications, and eight domestic wells in the uncertainty buffer) and over 300 drinking water wells cumulatively through 2040. This level of funding is conservative, even considering the number of potentially impacted drinking water wells under the worst-case scenario.

The Dry Well Mitigation Track also provides technical assistance up to $50,000 per small community or municipal well. Under the worst-case scenario, two small community wells may be potentially impacted. Although neither of the potentially impacted small community wells are listed as "at-risk" on the SWCRB's Risk Assessment Tool Dashboard for State Small Water Systems, these wells have been

[13] The Subbasin's RMW-WL monitoring network contains 187 RMW-WLs, of which two do not yet have SMCs and 14 are not considered to be screened in the Primary Alluvial Principal Aquifer. The High-End and Low-End Bracketed scenarios only consider RMW-WLs screened in the Primary Alluvial Principal Aquifer, as these wells are considered representative of shallower domestic wells. Therefore, the 43 RMW-WLs, representing 25% of the 171 RMW-WL subsets for which SMCs are currently set for Chronic Lower of Groundwater Levels, with the highest and lowest densities are identified in for the High-End and Low-End Bracketed scenarios, respectively.

[14] Scenario #5 utilized modeled data for the projected groundwater level change between 2020 and 2040 under both a baseline 2030 climate change scenario and a 2030 climate change scenario with the implementation of P/MAs.

identified in this 2025 Plan as “at-risk” and are therefore eligible to submit a proactive application to get a head-start on administering assistance in advance of a potential impact, as needed, although they are already pursuing consolidation[15] (see Step 2 in the Dry Well Technical Assistance Track Application Process of Appendix G-1 for more details on technical assistance and Figure 2 in Appendix I-3 for well consolidation status).

Furthermore, the Kern Subbasin GSAs have adopted the Kern Subbasin Exceedance Policy to address MT exceedances observed in any individual RMW-WL as they occur (Appendix K-1), which provides additional assurance against creating URs.

Reported WY 2022 pumping volumes and well counts from the Kern Subbasin Well Inventory was used to estimate an average annual pumping rate of 0.71 acre-feet (AF) per well for domestic and small community wells and 1,167 AF per well for public supply wells. Based on these average pumping values and the number of impacted wells presented in Table 13-5, it was determined that, on average (i.e., under Scenario #4 weighted), 42 impacted drinking water wells (40 domestic wells, 1 public supply well, and 1 small community well) would result in a potential impact of 1,196 AFY of drinking water supply, which is approximately 0.61 percent of the Kern Subbasin’s total drinking water use. Additionally, under the modeled distribution of RMW-WL exceedances (Scenario #5 P/MA scenario), 19 impacted drinking water wells (19 domestic wells and zero public supply or small community wells) would result in a potential impact of 13 AFY of supply, or less than 0.01 percent of the Kern Subbasin’s total drinking water use.

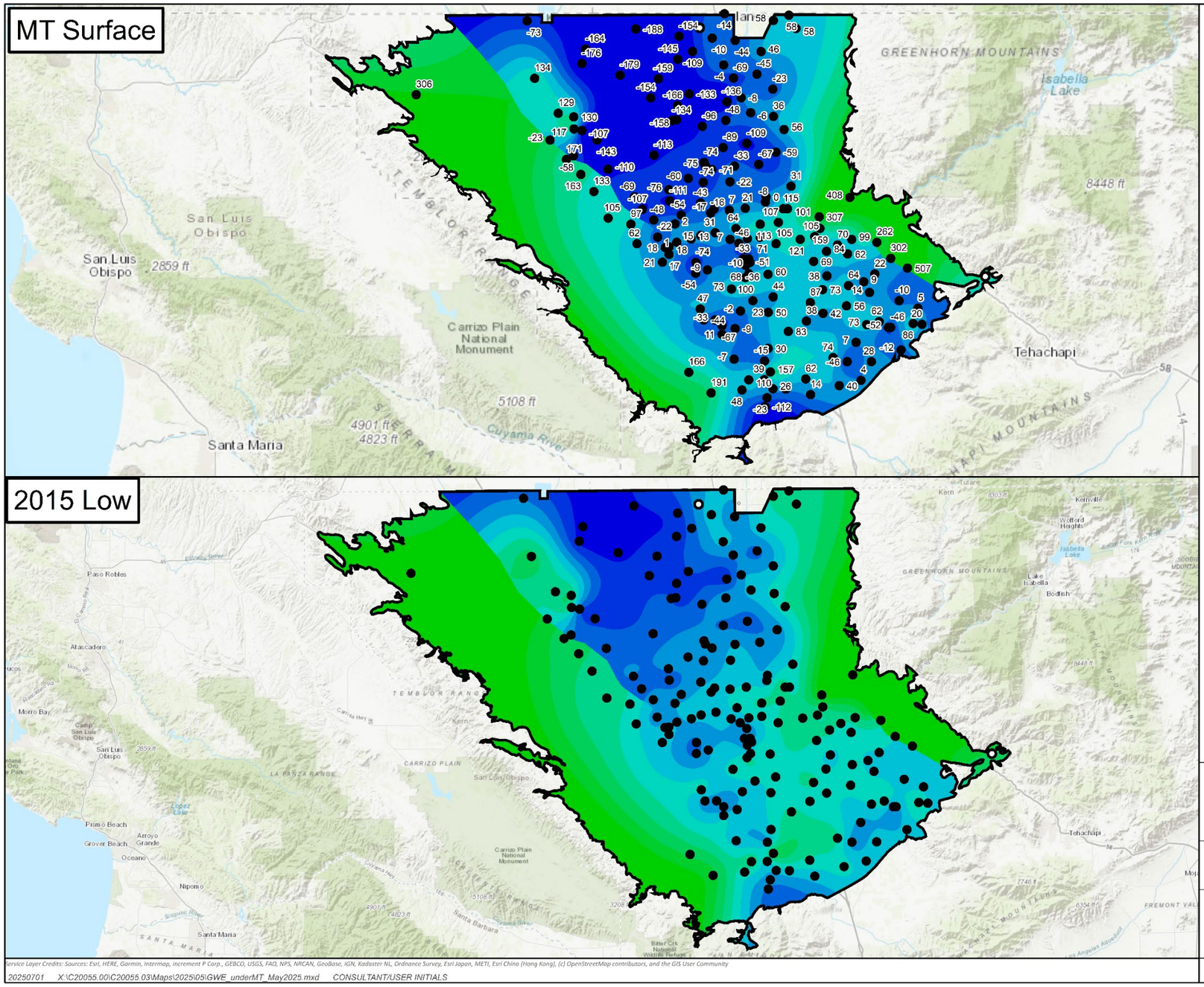
Given the Kern Subbasin GSAs have developed a coordinated and comprehensive Dry Well Mitigation Track to address domestic and small community wells impacted by groundwater level declines and have sufficient reserve funds to provide mitigation and technical support, this depletion of supply is not considered to be significant and unreasonable. Therefore, the proposed MTs were determined to be sufficiently protective of all groundwater pumpers, including drinking water users.

13.1.2.5 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 Kern Subbasin.

[15] One of the potentially impacted small community wells is actively working towards consolidation with the City of Shafter; the other potentially impacted small community well has been in discussions for consolidation with Lamont PUD for the last three years.



Legend

- RMW-WL
- RMW-WL Pending SMC

Groundwater Subbasin

- Kern County (DWR 5-022.14)

Water Surface Elevation (ft msl)

- < -100
- -100 - -50
- -50 - 0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- > 300

Abbreviations

DWR	= California Department of Water Resources
ft msl	= feet above mean sea level
MT	= Minimum Threshold
RMW-WL	= Representative Monitoring Well for Chronic Lowering of Groundwater Levels

Notes

1. All locations are approximate.
2. Labels show MT in ft msl for RMW-WLs in the Primary Principal Alluvial Aquifer with SMCs set.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 July 2025.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.

COMPARISON OF MT AND 2015 LOW GROUNDWATER ELEVATION CONTOURS PRIMARY PRINCIPAL ALLUVIAL AQUIFER

Kern County Subbasin
Groundwater Sustainability Plan

0 3.25 6.5 13 19.5 26
Miles

N

JULY 2025

Figure 13-9. Comparison of MT and 2015 Low Groundwater Elevation Contours – Primary Principal Alluvial Aquifer

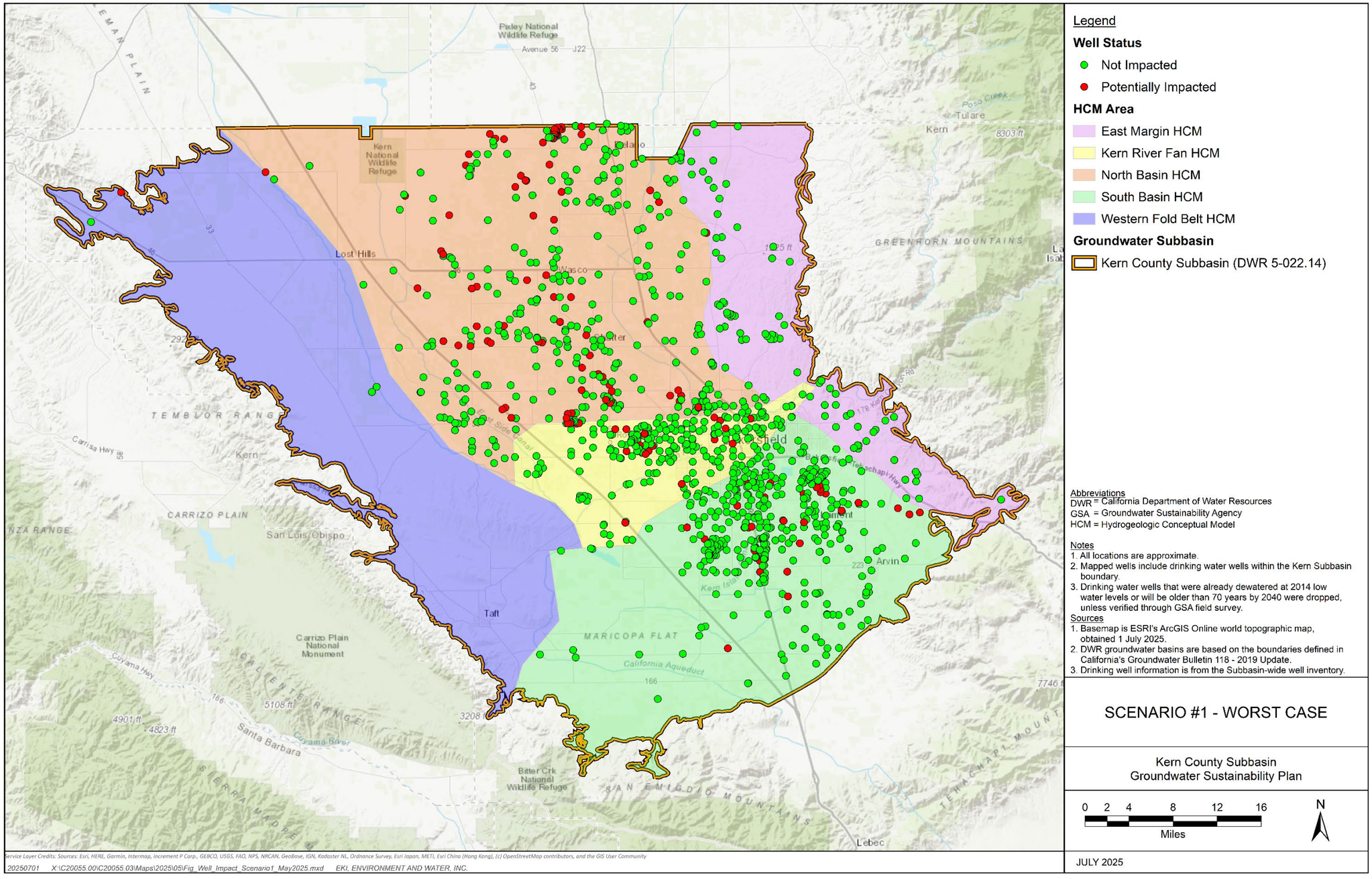
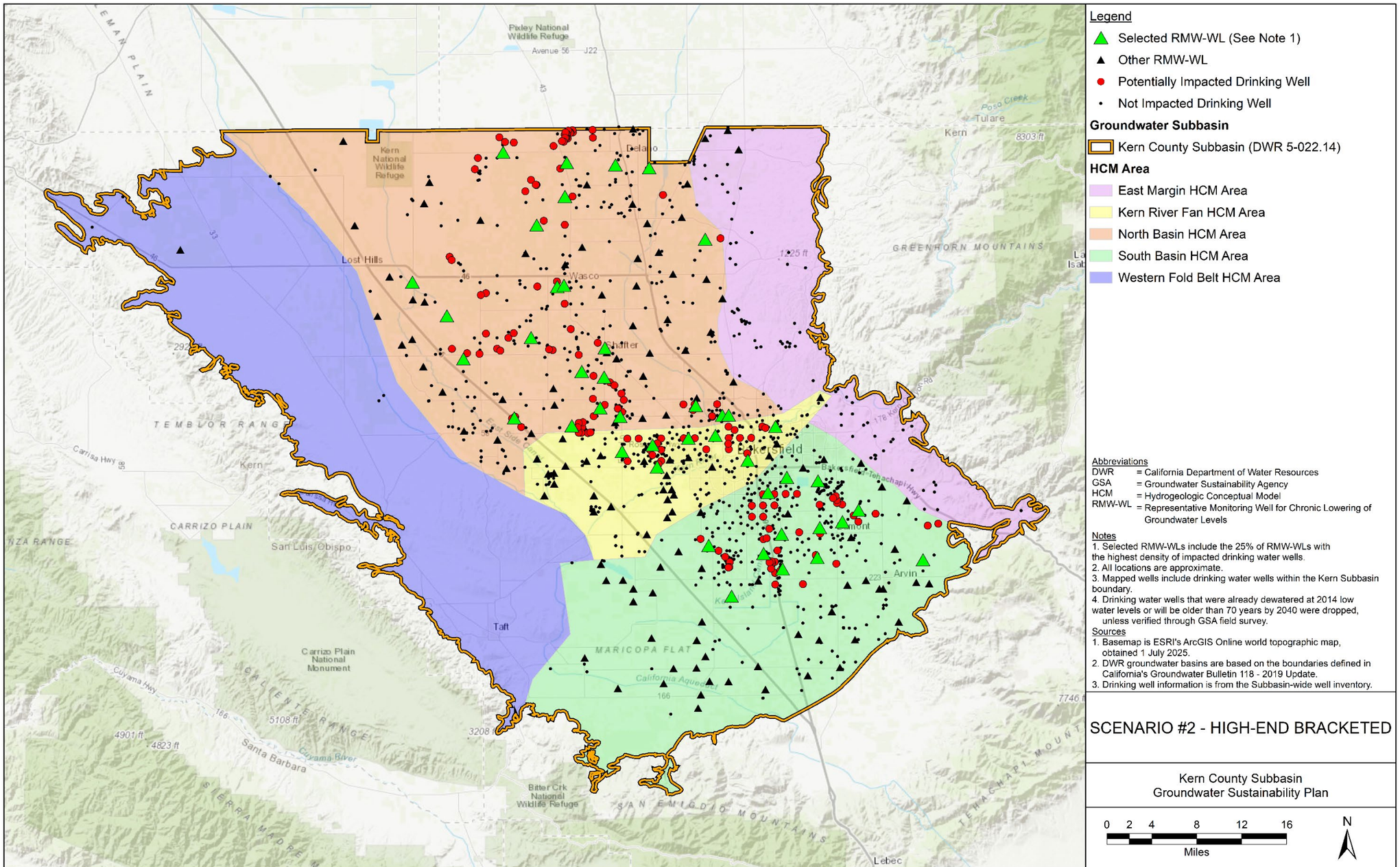


Figure 13-10. Scenario #1 – Worst Case



Legend

- Selected RMW-WL (See Note 1)
- Other RMW-WL
- Potentially Impacted Drinking Well
- Not Impacted Drinking Well

Groundwater Subbasin

- Kern County Subbasin (DWR 5-022.14)

HCM Area

- East Margin HCM Area
- Kern River Fan HCM Area
- North Basin HCM Area
- South Basin HCM Area
- Western Fold Belt HCM Area

Abbreviations

DWR	= California Department of Water Resources
GSA	= Groundwater Sustainability Agency
HCM	= Hydrogeologic Conceptual Model
RMW-WL	= Representative Monitoring Well for Chronic Lowering of Groundwater Levels

Notes

1. Selected RMW-WLs include the 25% of RMW-WLs with the highest density of impacted drinking water wells.
2. All locations are approximate.
3. Mapped wells include drinking water wells within the Kern Subbasin boundary.
4. Drinking water wells that were already dewatered at 2014 low water levels or will be older than 70 years by 2040 were dropped, unless verified through GSA field survey.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 1 July 2025.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - 2019 Update.
3. Drinking well information is from the Subbasin-wide well inventory.

SCENARIO #2 - HIGH-END BRACKETED

Kern County Subbasin
Groundwater Sustainability Plan

0 2 4 8 12 16
Miles

N

JULY 2025

Figure 13-11. Scenario #2 – High-End Bracketed

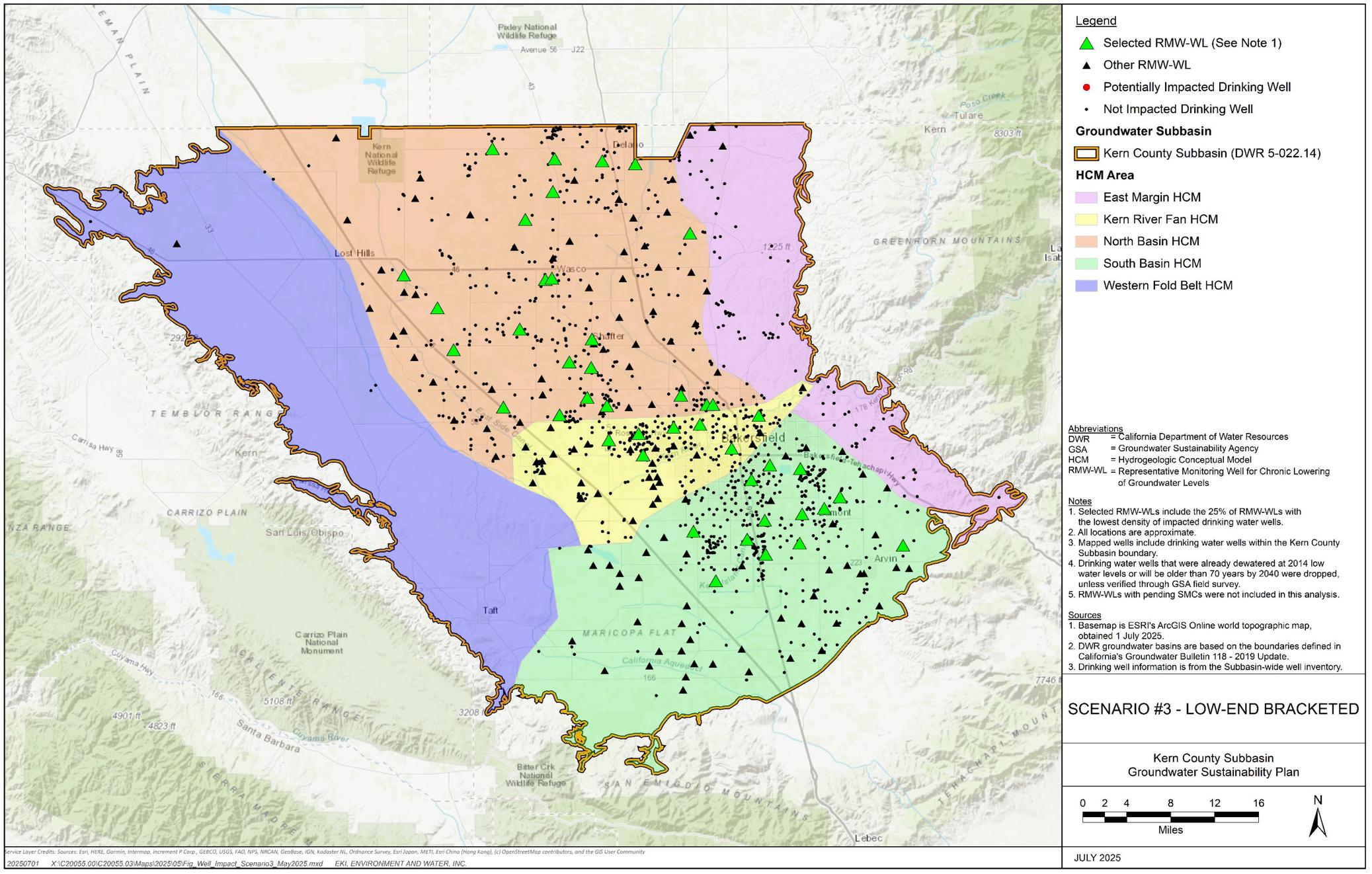


Figure 13-12. Scenario #3 – Low-End Bracketed

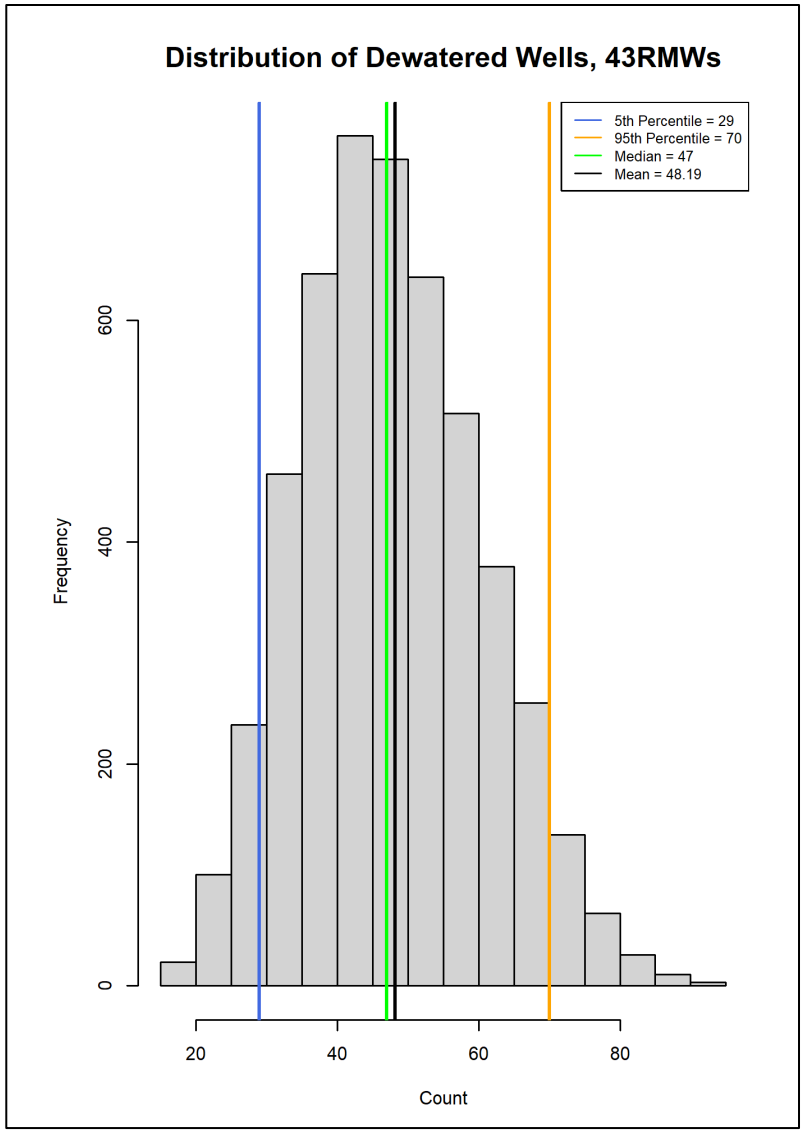


Figure 13-13. Scenario #4 - Random Stochastic Prediction

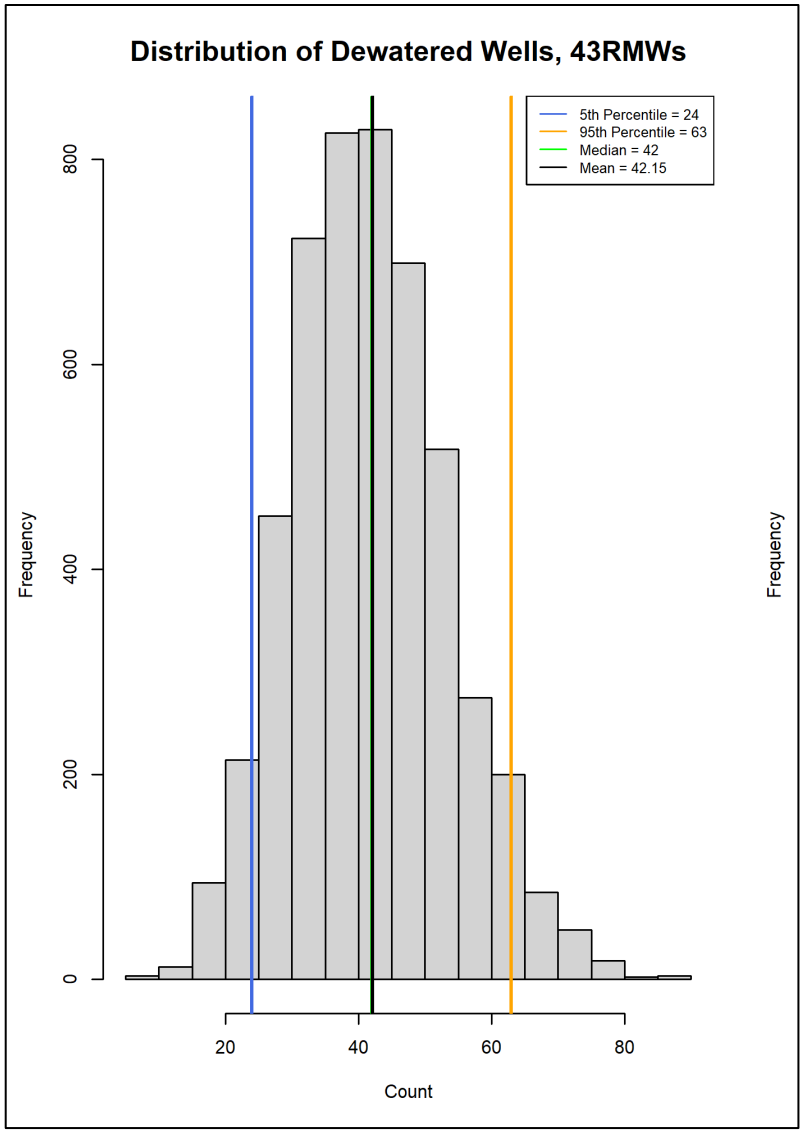


Figure 13-14. Scenario #4 - Weighted Stochastic Prediction

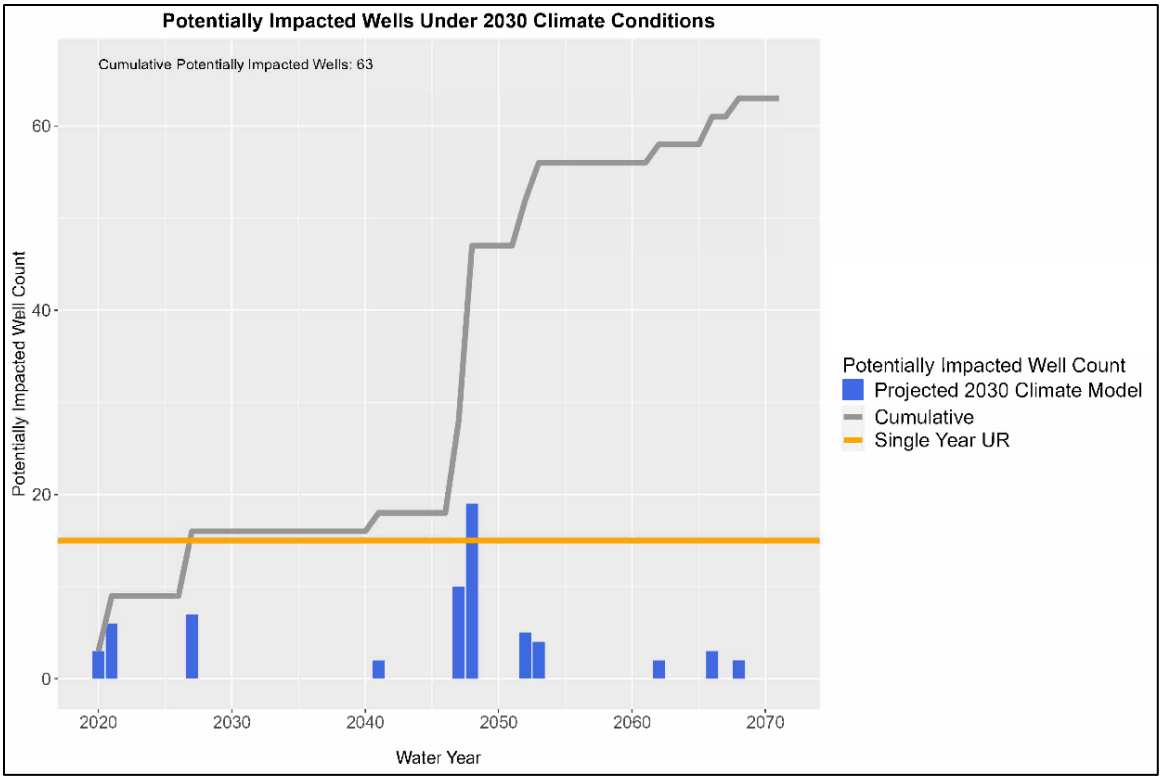


Figure 13-15. Scenario #5 – Potential Dewatered Drinking Wells Under Modeled Projected Future 2030 Climate Conditions no P/MAs

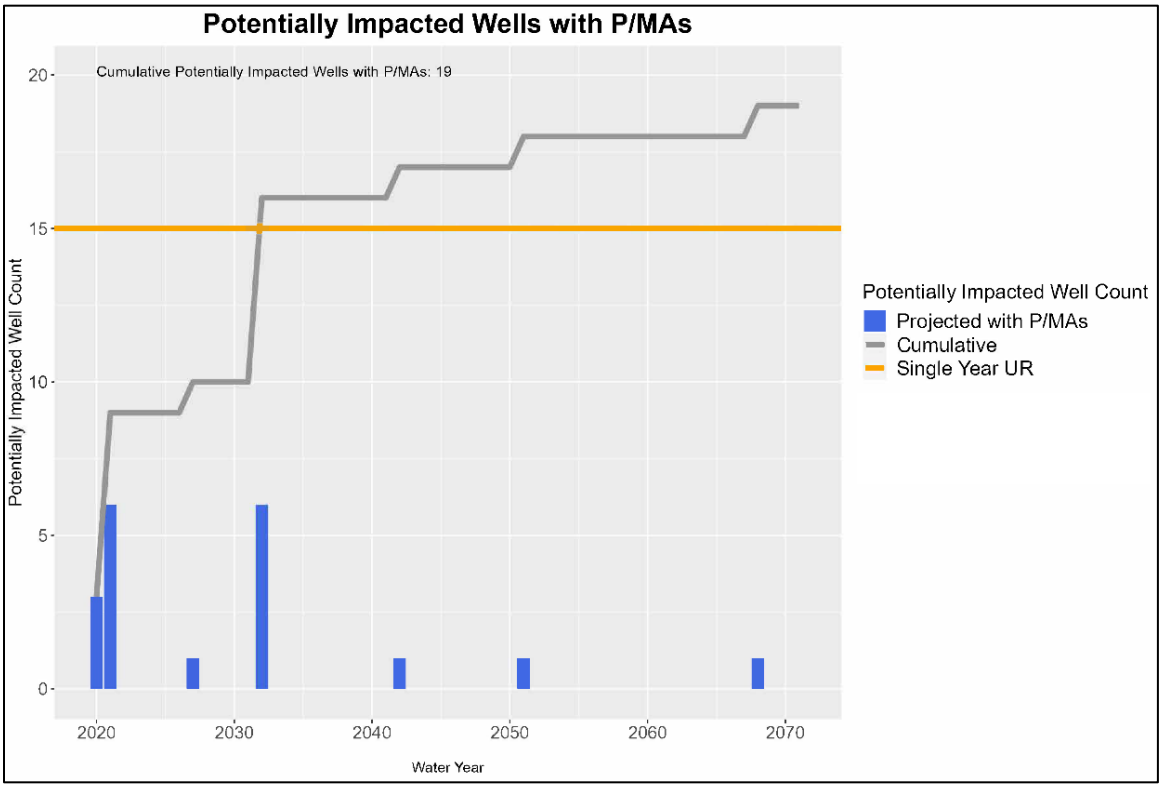


Figure 13-16. Scenario #5 – Potential Dewatered Drinking Wells Under Modeled Projected Future 2030 Climate Conditions with P/MAs

13.1.2.6 Measurement of Minimum Thresholds

☑ 23 CCR § 354.28(b)(6)

Groundwater levels will be measured in the Kern Subbasin's RMW-WLs semiannually pursuant to the monitoring protocols outlined in Section 15.3.1.

13.1.3 Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels

§ 354.30. *Measurable Objectives*

(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.

(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.

☑ 23 CCR § 354.30(c)
☑ 23 CCR § 354.30(e)

13.1.3.1 Measurable Objective Development

The MOs are defined as "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)).

The MOs for Chronic Lowering of Groundwater Levels are set at the "2015 low" groundwater level at each RMW-WL. This is defined as the lowest groundwater level measurement observed in an RMW-WL during calendar year 2015, when available. In the instances where no 2015 measurement is available, one of the following methods is used to estimate the "2015 low", at the discretion of the GSAs:

- The closest temporal measurement;
- A spatial interpolation of the Fall 2015 groundwater level at the RMW-WL
- An average or linear interpolation between two bookend temporal measurements;
- Spring 2015 groundwater level minus an average seasonal fluctuation; or
- Surrogate Fall 2015 groundwater level data from a nearby well.

Table 13-2 provides the MOs at each RMW-WL and documents the “2015 low” groundwater level estimation method, if applicable. The MOs are shown in Figure 13-17 and Figure 13-18 for the Primary Alluvial Principal Aquifer and Santa Margarita and Olcese Principal Aquifers, respectively.

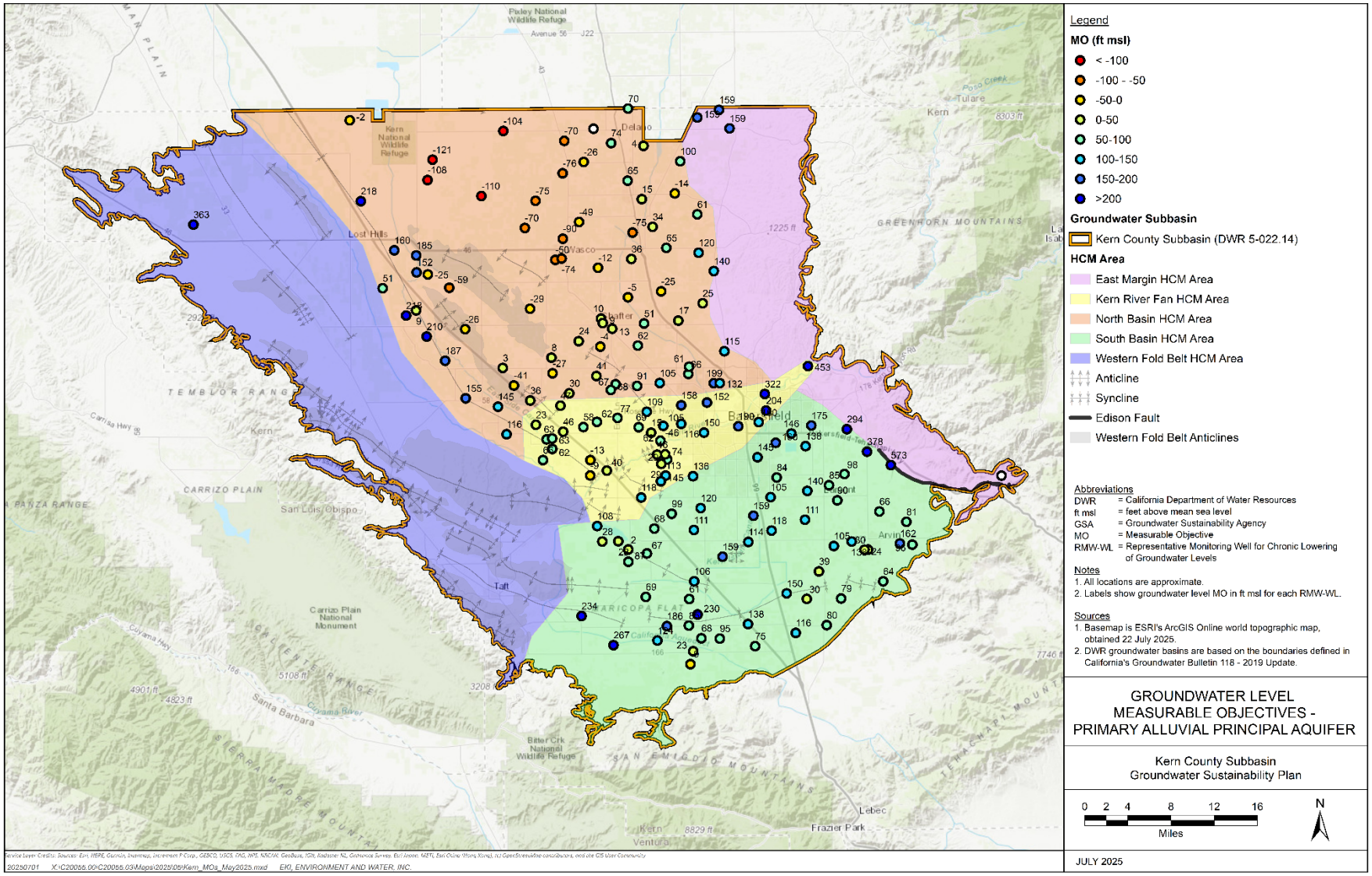


Figure 13-17. Groundwater Level Measurable Objectives – Primary Alluvial Principal Aquifer

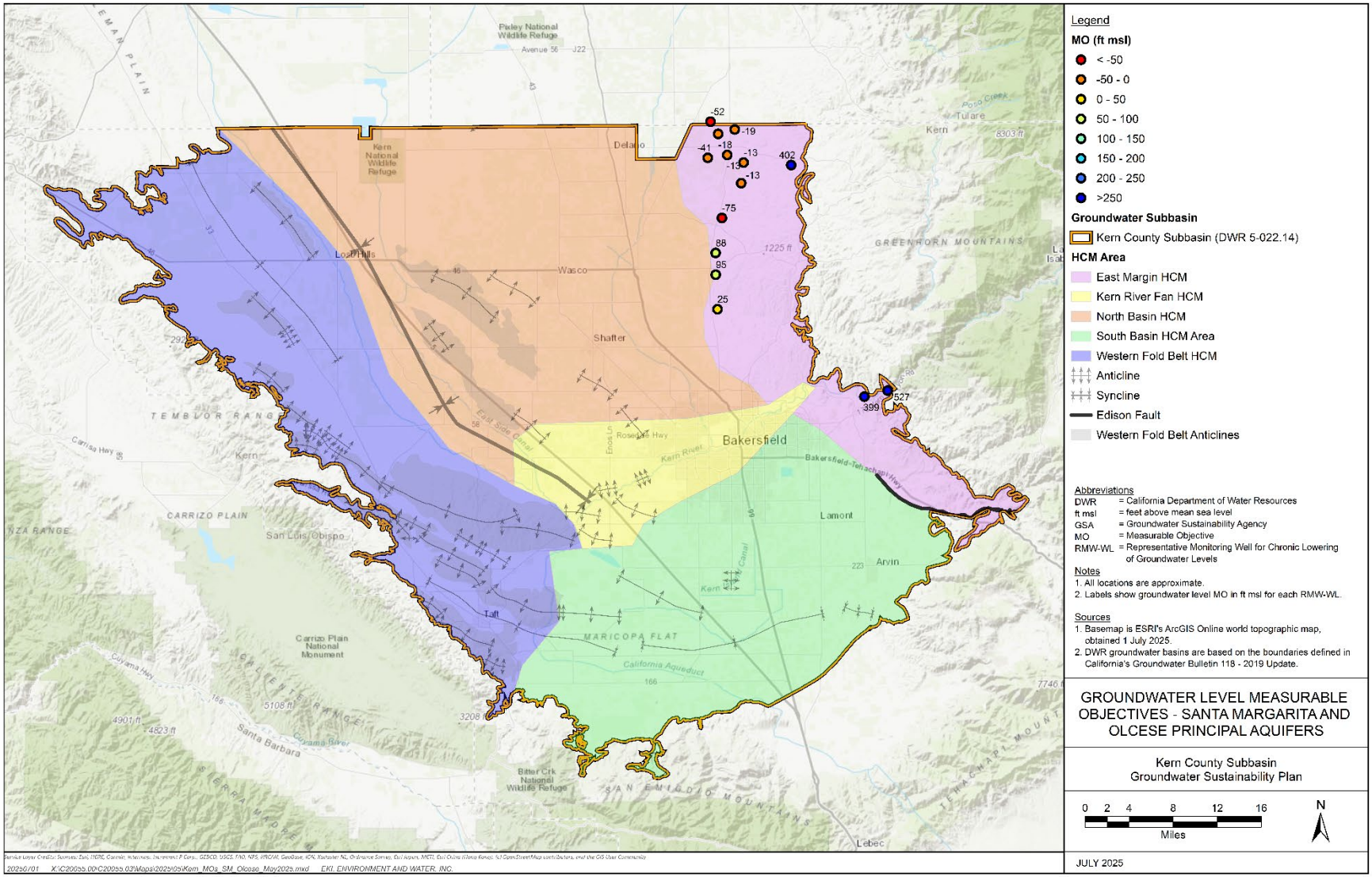


Figure 13-18. Groundwater Level Measurable Objectives – Santa Margarita and Olcese Principal Aquifers

13.1.3.2 Interim Milestones (IM) Development

The IMs are defined as "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)). The IMs must consider the time required to implement P/MAs and the resultant time for which observed changes to the groundwater system will occur. The IMs for Chronic Lowering of Groundwater Levels are defined based on three criteria, as follows:

- For RMW-WLs with the most recent measurement above the MOs, the IMs are set to the MO.
- For RMW-WLs with recent measurements between the MO and the MT a trajectory for groundwater levels is informed by recent groundwater level trends, the MTs, and the MOs. This trajectory assumes a continuation of the recent regional groundwater level trends for the first five-year period (2020 through 2025), a slowing from that trend over the second five-year period (2025 to 2030), a recovery to the five-year IM in the third five-year period (2030 to 2035), and recovery towards the MO over the fourth (last) five-year period (2035 to 2040). Specifically, the trajectory for Chronic Lowering of Groundwater Levels IMs is demonstrated in Figure 13-19 and is calculated as follows:

  2025 IM = half the vertical distance between the MT and the MO ($\frac{MO+MT}{2}$)

  2030 IM = half the vertical distance between the MT and the 2025-IM ($\frac{MT+2025\ IM}{2}$)

  2035 IM = half the vertical distance between the 2030-IM and the MO ($\frac{2030\ IM+MO}{2}$)

  2040 IM = MO

- For RMW-WLs with recent measurements below the MT, the trajectory assumes linearly increasing groundwater levels towards the MO. Specifically, the trajectory for Chronic Lowering of Groundwater Levels IMs is calculated as follows:

  2025 IM = the MT

  2030 IM = half the vertical distance between the MT and the MO ($\frac{MO+MT}{2}$)

  2035 IM = half the vertical distance between the 2030-IM and the MO ($\frac{2030\ IM+MO}{2}$)

  2040 IM = MO

Table 13-2 provides the IMs at each RMW-WL.

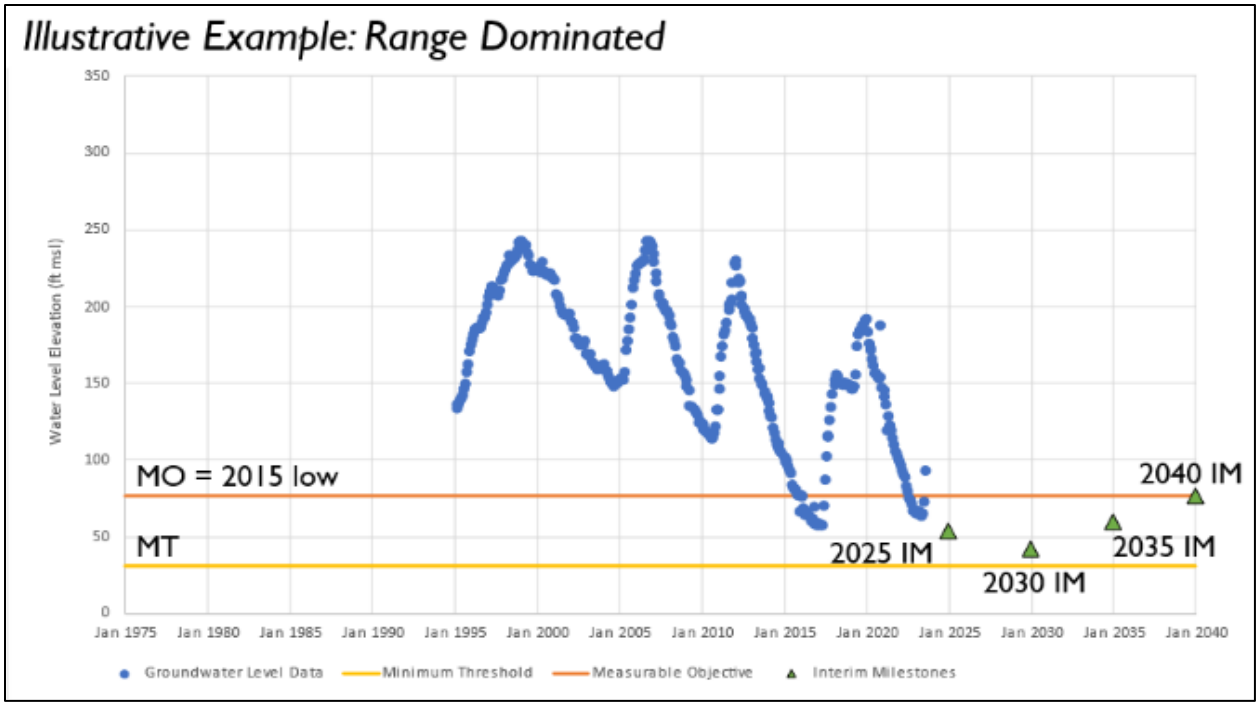


Figure 13-19. Illustrative Example of IM Approach

13.2 Reduction of Groundwater Storage

13.2.1 Undesirable Results for Reduction of Groundwater Storage

Per SGMA, an UR for the Reduction of Groundwater Storage means a "significant and unreasonable reduction of groundwater storage" (CWC §10721(x)(1)) and is defined herein 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.

13.2.1.1 Identification of Beneficial Users

The beneficial users for the Reduction of Groundwater Storage Sustainability Indicator are the same as those for Chronic Lowering of Groundwater Levels described in Section 13.1.1.1.

13.2.1.2 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 Kern Subbasin would be reduced groundwater supply reliability. The effect 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 13.2.2, there is significant usable groundwater storage within the Kern Subbasin, and these effects are unlikely to occur over the GSP planning and implementation period.

13.2.1.3 Potential Causes of Undesirable Results

☑ **23 CCR § 354.26(b)(1)**

Reduction of Groundwater Storage is directly correlated to Chronic Lowering of Groundwater Levels. Therefore, the potential causes of URs due to Reduction of Groundwater Storage are generally the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels (i.e., increased groundwater pumping and reduced recharge). Because of the direct correlation between groundwater elevation and groundwater storage volume, groundwater levels are used to measure conditions for this Sustainability Indicator.

13.2.1.4 Criteria Used to Define Undesirable Results

☑ **23 CCR § 354.26(b)(2)**
☑ **23 CCR § 354.26(c)**

Pursuant to the 23 CCR §354.28(d), MTs for Reduction of Groundwater Storage may be set by using groundwater levels as a proxy if it is demonstrated that the value is a reasonable proxy supported by adequate evidence. Section 8.2.1 discusses groundwater storage changes in the Subbasin and the strong correlation between water level and storage changes (Section 8.2.1.3). As such, the criterion used to define URs for Reduction of Groundwater Storage is based on the criteria used to define URs for Chronic Lowering of Groundwater Levels, as follows:

- The MTs for Chronic Lowering of Groundwater Levels are exceeded in at least 25 percent of the RMW-WLs over a single year (i.e., two consecutive seasonal measurements).

The above criteria are justified based on calculations of the volume of storage depletion that would occur if groundwater levels in the Primary Alluvial Principal Aquifer were to decline from the Chronic Lowering of Groundwater Level MOs to the MTs. This volume is calculated and presented below not as a criterion for an UR, but rather to provide a contextual reference that can be compared to historical changes in storage. As discussed in Section 13.1.2.6, the MOs for Chronic Lowering of Groundwater Levels are set to the “2015 low” groundwater elevations at each RMW-WL. The MT for Chronic Lowering of Groundwater Levels is set at a depth below the MO for operational flexibility that provides a reasonable margin between the MT and MO that will accommodate droughts, climate change, conjunctive use operations, water banking, or other groundwater management activities commensurate with levels of uncertainty (23 CCR §354.30(c)). The volume of groundwater within the interval between MT and MO

groundwater levels represents the operational flexibility of groundwater storage within the Primary Alluvial Principal Aquifer.

The change in storage between the Chronic Lowering of Groundwater Level MOs and MTs is calculated by spatially interpolating the MTs and MOs at Primary Alluvial Principal Aquifer RMW-WLs across the Kern Subbasin, removing volumes associated with extensive clay beds and areas with degraded water quality or within EPA aquifer exemption areas, and considering storage coefficients representative of the heterogeneous alluvial sediments of the Primary Alluvial Principal Aquifer.[16]

If groundwater levels decline from the MOs to the MTs, the reduction of storage would total approximately 7.2 million acre feet (MAF). Consistent with the Chronic Lowering of Groundwater Level UR criteria, 25 percent of this volume results in a reduction of storage of approximately 1.80 MAF per year. As shown in Figure 13-20 below, the estimated total change in storage from the historical and current water budgets (Section 9.3.2 and Appendix H-1) during the 2013-2016 drought was -7.47 MAF, and the annual change in storage during the 2013-2016 and 2021-2022 droughts was on average -1.832 MAF.[17] Hence, a reduction of storage of less of than 1.80 MAF per year and cumulative reduction in storage of 7.2 MAF is not considered significant and unreasonable, as it is similar to the storage change observed during recent multi-year droughts without unreasonable dewatering of wells. As noted above, this reduction of storage is demonstrative, and URs related to Reduction of Groundwater Storage use groundwater levels as proxy.

Therefore, URs related to Reduction of Groundwater Storage are not anticipated to occur at the Chronic Lowering of Groundwater Level MTs. As such, the criteria set for Chronic Lowering of Groundwater Levels are considered to be protective against significant and unreasonable effects for Reduction of Groundwater Storage, and thus serve as a reasonable proxy.

Furthermore, the approach whereby URs are based on groundwater level exceedances in the RMW-WL network is proactive as groundwater level monitoring occurs semi-annually compared to the annual calculations of groundwater in storage which occurs the March following the Water Year.

[16] For consistency, this storage volume calculation follows the methodology used for the estimated Subbasin water storage volume calculation described in Section 8.2.2. The calculation excludes major clay layers and certain areas of the Eastern Margin and Western Fold Belt HCM areas where there is not historical groundwater level coverage, poor water quality, or mapped EPA aquifer exemption areas.
[17] These values include surface water stored by the water banking projects. The storage and recovery of this surface water does not result in a change in groundwater storage as the projects can only recover previously stored water.

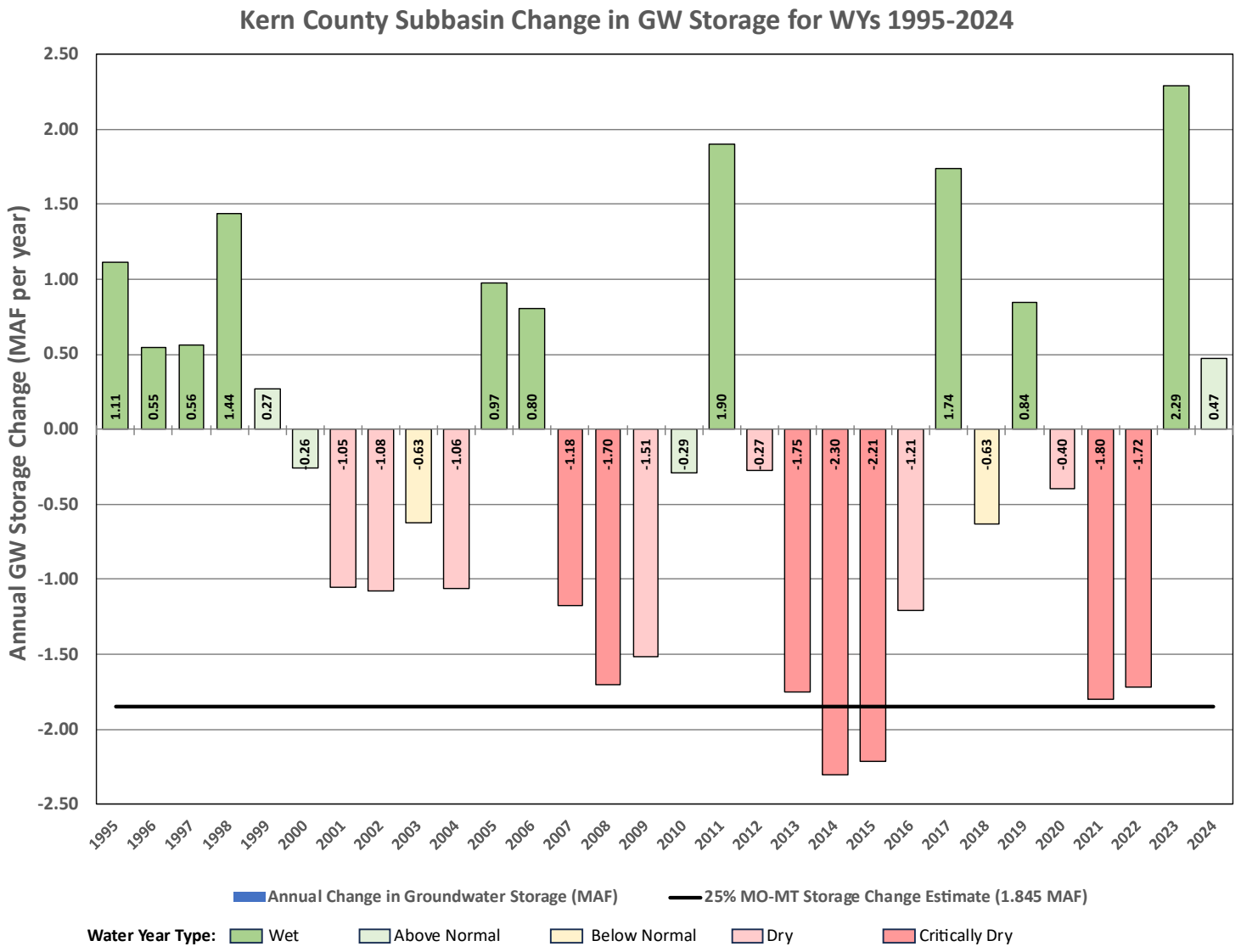


Figure 13-20. Kern Subbasin Change in Groundwater Storage for WYs 1995-2024

13.2.2 Minimum Threshold for Reduction of Groundwater Storage

> ***§ 354.28.*** *Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
>
> *a. Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.*
>
> *(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.*

As discussed above, the criteria for SMCs related to a Reduction of Groundwater Storage are tied to the UR criteria for Chronic Lowering of Groundwater Levels and groundwater levels measured in RMW-WLs. 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 (discussed in Section 13.1.2.4 above), the MTs for Chronic Lowering of Groundwater Levels are used as a proxy for the Reduction of Groundwater Storage Sustainability Indicator (refer to Table 13-2 for MTs for Chronic Lowering of Groundwater Levels).

13.2.2.1 Use of Groundwater Levels as a Proxy

☑ 23 CCR § 354.28(b)(1)
☑ 23 CCR § 354.28(c)(2)
☑ 23 CCR § 354.28(d)

Pursuant to the 23 CCR §354.28(d), MTs for Reduction of Groundwater Storage may be set by using groundwater levels as a proxy if it is demonstrated that the value is a reasonable proxy supported by adequate evidence. As discussed in Section 8.2.1.3, annual change in storage based on groundwater elevation change was calculated and compared with the simulated change in water in storage based on the regional groundwater flow model. Figure 8-17 shows the annual comparison of the calculated and simulated storage from WYs 1995 to 2022. The Correlation Coefficient (R) for this comparison is 91 percent, which indicates good agreement between the groundwater elevation change and simulated change in storage, within reasonable model and data uncertainty. Therefore, groundwater level measurements have been demonstrated to serve as a reasonable proxy to estimate changes in groundwater storage.

13.2.3 Measurable Objective and Interim Milestones for Reduction of Groundwater Storage

☑ 23 CCR § 354.30(c)
☑ 23 CCR § 354.30(d)

As discussed in Section 13.2.2.1, because of the close relationship between the Reduction of Groundwater Storage and Chronic Lowering of Groundwater Levels Sustainability Indicators, the MOs and IMs for Chronic Lowering of Groundwater Levels serve as a proxy for Reduction of Groundwater Storage, and it is not necessary to set unique MO or IMs for Reduction of Groundwater Storage. As stated above, the MOs for Chronic Lowering of Groundwater Levels provide an adequate margin of operational flexibility. Refer to Table 13-2 for MOs and IMs for Chronic Lowering of Groundwater Levels.

13.3 Degraded Water Quality

13.3.1 Undesirable Results for Degraded Water Quality

An UR for Degraded Water Quality is defined as "significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies" (CWC §10721(x)).

The Subbasin-wide definition of URs for Degraded Water Quality is defined as follows:

> *The point at which significant and unreasonable impacts occur over the planning and implementation horizon, as caused by groundwater management activities, that affect the reasonable and beneficial use of, and access to groundwater by overlying users.*

The Kern Subbasin's approach to Degraded Water Quality reflects the fact that SGMA does not require GSPs to address degraded water quality URs that occurred before and have not been corrected by January 1, 2015 (CWC §10727.2(b)(4)) and that "...s*ustainable groundwater management" means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing* undesirable results." (CWC §10721(v)) (emphasis added). Consistent with these regulations, the Kern Subbasin GSAs have defined "groundwater management activities" as GSA actions related to groundwater recharge or extraction within the Kern Subbasin. As such, the URs definition appropriately focuses on whether water quality conditions have degraded as a result of groundwater management activities since the enactment of SGMA on January 1, 2015.

The regulatory oversight authority for drinking water quality rests with the SWRCB Division of Drinking Water (DDW), and therefore general measures to address drinking water quality served to the public are generally beyond the purview of the SGMA, except where directly impacted as a result of groundwater management within the GSA's control. Those regulatory oversight and enforcement actions have and will occur

on their own mandated timelines and in accordance with DDW permitting, reporting and enforcement processes. Water quality issues related to wastes discharged below the root zone from irrigated agricultural lands (e.g., nitrate) are also regulated separately under the Central Valley Regional Water Quality Control Board's (CVRWQCB's) Irrigated Lands Regulatory Program (ILRP). Additionally, the CVRWQCB's Basin Plan and stakeholder led Central Valley Salinity Alternative for Long-Term Sustainability (CV-SALTS) programs address groundwater quality degradation from all permitted dischargers (ILRP, dairies, food processors, wineries, wastewater treatment plants, industrial, etc.) through the Nitrate and Salt Control programs. These water quality monitoring and management programs are described in more detail in Section 5.7.5. The Kern Subbasin GSAs are actively coordinating with these entities and programs in the collection, sharing and analysis of applicable data (Section 14.2.3, P/MA KSB-2 and Appendix K-2).

13.3.1.1 Identification of Beneficial Users

Kern Subbasin GSAs have identified domestic and small community well owners as the most vulnerable beneficial users for the Degraded Water Quality Sustainability Indicator (Section 5.6), which are defined based on User Type consistent with Table 5-5 and Table 5-6. It is acknowledged that other beneficial users, particularly municipal or public systems, may also be potentially impacted by Degraded Water Quality. However, by prioritizing the protection of the most vulnerable groundwater users, the Degraded Water Quality SMCs are inherently designed to ensure the protection of all beneficial users in the Kern Subbasin. The MTs for Degraded Water Quality are set based on applicable water quality objectives, which incorporate by reference state drinking water standards; or, MTs are set based on pre-SGMA baseline conditions.

Other beneficial uses of groundwater, such as for agricultural irrigation or industrial use, are generally less sensitive than municipal beneficial uses and thus such uses are sufficiently protected by using water quality objectives designed to protect the municipal beneficial use. Furthermore, this 2025 Plan establishes a water quality monitoring network with sufficient Subbasin-wide coverage to monitor impacts to all Kern Subbasin beneficial users (Section 15.2.4).

13.3.1.2 Potential Effects of Undesirable Results on Beneficial Users

☑ 23 CCR § 354.26(b)(3)

The potential effects of URs caused by Degraded Water Quality on beneficial uses and users of groundwater may include:

- Decreased supply and suitability of groundwater for beneficial use in the Subbasin.

- Increased costs to treat groundwater to applicable drinking water Maximum Contaminant Levels (MCLs) if it is to be used as a potable supply source and the well is a public water supply well subject to Title 22.
- Increased costs to domestic well owners to treat groundwater to safe drinking water levels as compared to water quality objectives that are based on MCLs.
- Increased costs to blend relatively poor-quality groundwater with higher quality sources for drinking water users, agricultural users, and industrial users.
- Potential reduction in the usable volume of groundwater in the Kern Subbasin if large areas are impaired to the point that they cannot be used to support beneficial uses and users.

13.3.1.3 Potential Causes of Undesirable Results

☑ 23 CCR § 354.26(b)(1)

The URs due to Degraded Water Quality are the result of increases in concentrations of the COCs in groundwater. These increases in concentration can occur through a variety of processes (as listed below), some of which are due to groundwater management activities and under the purview of the GSAs, and some of which are not.

- Lateral or vertical migration from areas with poorer quality groundwater.
- Leaching from internal sources such as fine-grained, clay-rich interbeds.
- Upward vertical flow (upconing) of poor water quality from deeper zones below the bottom of the freshwater interface.
- Migration caused by implementation of managed recharge projects.
- Seepage from various natural and man-made channels.
- Seepage from various non-GSA activities.
- Irrigation system backflow into wells and flow through well gravel pack and screens from one formation to another.
- Deep percolation of excess applied irrigation water and other water applied for cultural practices (e.g., for soil leaching).
- Natural occurrence and prevalence from geologic formations (i.e., groundwater wells that are screened across E-Clay layers where arsenic is known to leach into the pumped water).

13.3.1.4 Criteria Used to Define Undesirable Results

☑ 23 CCR § 354.26(b)(2)

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. As discussed above, to be

considered a “significant and unreasonable” impact, water quality would need to be degraded beyond state and federal regulatory drinking water standards or pre-existing baseline concentrations as a result of groundwater management activities.

Several COCs for the Kern Subbasin are identified in Section 8.4 based on data from the SWRCB’s Groundwater Ambient Monitoring and Assessment (GAMA) Program from 2010 through 2023. Several criteria were utilized by the Kern Subbasin GSAs to systematically assess which COCs warranted the development of SMCs based on a consistent assessment of existing groundwater conditions, the relationship between groundwater management (i.e., extraction, recharge, or groundwater level changes), and the state and federal water quality regulations. The Kern Subbasin GSAs then only developed SMCs for those COCs that met all of the following criteria. 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.

- *Existing Water Quality Objective Based on a Drinking Water Standard:* A COC meets this criterion if it has a water quality objective based on a drinking water MCL specified in certain provisions of Title 22 of the California Code of Regulations which are incorporated into the Water Quality Control Plan for the Tulare Lake Basin (Basin Plan). For this process, such water quality objectives include primary MCLs and secondary MCLs. SMCs was not developed for COCs that do not have existing water quality objectives. Emerging constituents will be reevaluated in the next periodic evaluation if new water quality objectives are established. Notably, where there is no water quality objective, but an adopted health-based standard otherwise exists, the GSAs may use such standards for evaluation of emerging constituents (e.g., PFOS and PFOA).
- *Post-SGMA Exceedance of Water Quality Objective*: A COC meets this criterion if, based on GAMA data from 2015 through 2023, at least 5 percent of wells sampled Subbasin-wide exceed the most stringent, applicable water quality objective for the COC, as reported in Section 8.4.
- *Potential to Impact Beneficial Users:* A COC meets this criterion when both of the following conditions apply: (1) the COC is prevalent throughout the Kern Subbasin; and (2) concentrations are or have the potential to be increased due to groundwater management activities (e.g., nitrate concentration in some shallow wells exceeds the water quality objective when water levels decline below the MT). A COC is considered to be prevalent throughout the Kern Subbasin if post-SGMA (i.e., 2015-2023) median concentrations exceed the water quality objective in any HCM Area, as presented in Section 8.4.2. A COC would have the potential to be exacerbated by groundwater management activities if concentrations are affected by groundwater level changes. Section 8.4.2 presents an analysis of the relationship between groundwater levels and concentrations of each COC. A COC was considered to have high potential to impact beneficial users if both criteria were met, moderate potential if one of

these criteria was met, and low potential if neither of these criteria were met. SMCs were not developed for COCs with low potential to impact beneficial users.

The results of the screening process for each identified COC are summarized in Table 13-6. The COCs applicable for the development of Degraded Water Quality SMCs are arsenic, total nitrate/nitrite (as N), nitrate, nitrite, total dissolved solids (TDS), 1,2,3-Trichloropropane (1,2,3-TCP), and uranium. Detailed analysis of the available water quality information for each COC is presented in Section 8.4.

Table 13-6. Criteria for Developing Degraded Water Quality SMCs

Constituent of Concern	Existing Water Quality Objective	% of Wells Exceeding Water Quality Objective	Potential to Impact Beneficial Users	SMC Developed
Arsenic	10 ppb	22.4%	High	Yes
Nitrate (as N)	10 ppm	14.9%	Moderate	Yes
Nitrate + Nitrite (as N)	10 ppm	24.9%	Moderate	Yes
Nitrite (as N)	1 ppm	1.8% [1]	Moderate	Yes
Total Dissolved Solids	1,000 ppm	11.7%	Moderate	Yes
1,2,3-Trichloropropane (1,2,3-TCP)	5 ppt	44.5%	Moderate	Yes
Uranium	20 pCi/L	7.2%	Moderate	Yes
1,2 Dibromoethane (EDB)	20 ppt	0.7%	Low	No
1,2,-Dibromo-3-chloropropane (DBCP)	200 ppt	2.0%	Low	No
Benzene	1 ppb	0.5%	Low	No
Gross Alpha	15 pCi/L	5.1%	Low	No
Perfluorooctanoic acid (PFOA)	4 ppt	14.8%	N/A[2]	No[2]
Perfluorooctanoic sulfonate (PFOS)	4 ppt	6.9%	N/A[2]	No[2]
Selenium	50 ppb	0.9%	Low	No

[1]As discussed in Section 8.4, nitrite is primarily non-detect in the Kern Subbasin. Median concentrations and exceedance locations of total nitrate/nitrite (as N) are similar to the prevalence of nitrate. SMCs were established for individual nitrate species because they contribute to the total nitrate/nitrite (as N).

[2] In April 2024, the USEPA announced the Final MCLs for PFOA and PFOS of 4 ppt. Per the USEPA's final rule, public water systems have three years (by 2027) to complete initial monitoring and five years (by 2029) to implement solutions. In California, the DDW is in the process of developing primary MCLs consistent with California Code of Regulations, Title 22 for PFOA and PFOS. Once primary MCLs are adopted by DDW, they are incorporated into the 2025 Plan as a water quality objective. Due to limited existing data at a Subbasin-wide scale and lack of an adopted water quality objective, SMCs for PFOA and PFOS are not set at this time. Kern Subbasin GSAs will use emerging data from public water systems to conduct an initial assessment of Kern Subbasin conditions. SMCs for PFOA and PFOS will be informed by data collected during Plan implementation and will be evaluated as part of the first Periodic Evaluation.

Based on the significant and unreasonable effects described above, the Kern Subbasin has established a quantitative UR definition for Degraded Water Quality for the applicable COCs that would be triggered if any of the following conditions are met:

1. Subbasin-wide, 15 percent of RMW-WQ exceed the MT for COCs per water year based on confirmed sample and MT Exceedance investigation results[18]; or
2. Annually, 5 percent of domestic wells have an assumed MT Exceedance[21] based on radius of influence analysis around the RMW-WQ that exceeds the MT, with cumulative maximum of 15 percent of domestic wells through 2040; or,
3. A GSA is unable to meet well mitigation needs.[21]

For purposes of evaluating compliance with the UR criteria, a domestic well here means both a domestic well that serves less than two connections and non-public or state small water systems that serve less than 25 people.

The three separate and distinct UR criteria are designed to evaluate if URs are occurring Subbasin-wide, or on a regional or localized basis. In the case of the third criteria, if a GSA (regional or localized impact) is unable to provide sufficient resources to mitigate degraded water quality for impacts caused by their groundwater management activities, an undesirable result would be triggered. The component of the UR criteria requiring 5 percent of domestic wells based on an assumed MT exceedance within a certain radius from a RMW-WQ was selected to provide additional protections to domestic well users because:

- Assuming a simple one to one ratio between RMW-WQ and domestic wells, MT exceedances[21] at 15 percent of the RMW-WQs could result in up to 348 potentially impacted domestic wells. However, the distribution of domestic wells and RMW-WQs is not uniform across the subbasin, hence additional protective measures were incorporated into the UR.
- The Kern Subbasin GSAs have funded a $3.5 million Well Mitigation Program[21] revolving reserve fund that will be replenished annually based on incurred expenses (Section 16.2.1.1 and Appendix G-1). Note, the $3.5 million mitigation budget includes funding for groundwater level and quality mitigation, program administration, technical assistance for M&I and community wells, and an “uncertainty buffer” in the analysis, inflation, and climate change. The Kern Subbasin GSAs’ $3.5 million Well Mitigation Program reserve includes a conservative estimated cost for water quality mitigation of $2,500 per mitigated domestic well, with an annual budget of $500,000 (sufficient to cover 200 wells). The second UR criterion of 5 percent domestic wells equates to approximately 116 potentially impacted domestic wells (based on the domestic well count of

[18] Water quality exceedances and mitigation applications are evaluated as defined in the Kern Subbasin Exceedance Policy and Action Plan for Degraded Water Quality (Appendix K-1) and 2025 Kern Subbasin Well Mitigation Program (Appendix G-1).

2,322 in the current well inventory, which continues to be updated) annually. This translates to groundwater quality mitigation[21] cost of approximately $300,000, which is well within the Well Mitigation Program budgeted amount of $500,000 for water quality mitigation. The GSAs may also utilize the "uncertainty buffer" to address any mitigation contingencies.

- While highly unlikely, the third UR criterion provides yet another protective "backstop", wherein undesirable results would be declared if any GSA is unable to meet its mitigation needs.

Appendix K-2 (Part III) provides detailed examples on determining URs and exceedances of MTs.

Importantly, this 2025 Plan includes a number of backstops to address degraded water quality to avoid URs. For example, the occurrence of a MT exceedance at a RMW-WQ would trigger the Kern Subbasin Exceedance Policy and Action Plan for Degraded Water Quality (Appendix K-1), which requires, among other steps: (1) collection of a confirmation sample to ensure the first measurement is not erroneous, (2) notification to nearby domestic well owners if nitrate concentrations are above the water quality objective within 30 days of sample confirmation, and (3) an investigation by a qualified technical professional that assesses groundwater conditions in the area to determine if degradation is occurring due to groundwater management activities. An investigation would include statistical and/or spatial analyses between water levels and water quality to assess causation, depending on the availability of data, as well as investigation into other potential driving mechanisms. Depending on the findings of the Exceedance Investigation, the appropriate MT exceedance notification to nearby domestic well owners will occur within 60 days of sample confirmation. Refer to Appendix K-1 for details.

As discussed in Section 13.3.2, the MTs for arsenic, total nitrate/nitrite (as N), nitrate, nitrite, TDS, 1,2,3-TCP, and uranium are established at the Kern Subbasin's RMW-WQs. Additionally, the Kern Subbasin adopted a Well Mitigation Program (Appendix G-1) and has established a notification process to ensure that domestic well users and small community wells impacted by Degraded Water Quality are fully informed of RMW-WQ results if water quality objectives are exceeded and that mitigation is available for such users if a MT is exceeded due to groundwater management activities; see Appendix K-1 and Appendix K-2 Part IV.

13.3.2 Minimum Threshold for Degraded Water Quality

> ***§ 354.28.*** *Minimum Thresholds*
> *(6) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> (5) *Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.*

The GSP Emergency Regulations (23 CCR §354.28(c)) state that the MT for Degraded Water Quality shall be the "degradation of water, including the migration of contaminant plumes that impair water supplies or other indicators 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 iso-contour 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 COCs, as quantified by sample results at RMW-WQs or assumed results for domestic wells based on their proximity to an RMW-WQ. Additional implementation details related to groundwater quality MTs are included in Appendix K-2 (Parts I and III).

13.3.2.1 Minimum Threshold Development

☑ **23 CCR § 354.28(b)(1)**
☑ **23 CCR § 354.28(c)(4)**

As discussed above in Section 13.3.1, the process for developing SMCs for the COCs identified within the Kern Subbasin considers 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. As outlined in Section 13.3.1.4, COCs were screened to consider risks to vulnerable drinking water beneficial users based on water quality objectives that incorporate by reference drinking water standards or in instances where risks are expected due to groundwater management activities (i.e., extractions or recharge). Because of the limited purview of GSAs with respect to water quality, and the necessary emphasis on those constituents that may be related to groundwater management activities, the COCs currently applicable within the Kern Subbasin and for which the

Kern Subbasin are setting SMCs are arsenic, total nitrate/nitrite (as N), nitrate, nitrite[10], TDS, 1,2,3-TCP, and uranium.

The MTs for Degraded Water Quality are set at the Kern Subbasin's RMW-WQs and are tied to regulatory water quality standards – namely, water quality objectives that are considered protective of the municipal beneficial use (i.e., primary and secondary MCLs contained in CCR Title 22), as applicable to each COC as shown in Table 13-7. The MT is set for each RMW-WQ based generally on the following criteria:

1. MT is set at the water quality objective if the following conditions are met:
   a. Limited or no historical water quality sample results (data)
2. If historical data exceeds the MCL:
   b. And at least 5 sample results are available, MT is set at the 80th percentile of all data
   c. If there are less than 5 sample results, use proxy data to support setting the MT at the 80th percentile of all available data
3. Discretion should be applied when data shows a trend:
   d. If there is an increasing trend, MT should be set at the 80th percentile of pre-2015 data
   e. If there is a decreasing trend, MT should be set as close to the water quality objective as reasonable:
      i. Limit the timeframe for calculating the 80th percentile to post-2015 data
      ii. Consider using the median value, rather than 80th Percentile
      iii. Other circumstances for a lower MT may apply when most historical data is at or below the MT
   f. If the 80th percentile is within 10 percent of the MCL, the MT should be set at the water quality objective
4. Proxy data are used primarily to demonstrate baseline conditions that support the MT, discretion may be applied when
   g. The MT may be based on proxy well data when the RMW-WQ and proxy well are similar enough to represent the same lithology/aquifer conditions
   h. Sample results show consistent concentration and/or trends

The MTs are set so as to maintain concentrations of each COC at or below the applicable water quality objectives, or for wells that were already impacted before the SGMA effective date, to try and maintain concentrations at their pre-SGMA baseline levels. Use of a baseline condition acknowledges that "the plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015" (CWC §10727.2(b)(4)).

Final MTs for Degraded Water Quality at each RMW-WQ are shown in Table 13-9. Of the 330 MTs, 308 (approximately 93 percent) are set at the water quality objective, with 22 at baseline levels above the water quality objective. Appendix I-4 contains chemographs that plot the historical water quality concentrations, the MT, and the MO at each RMW-WQ. Appendix K-1 (Action Plan for Degraded Water Quality) summarizes the procedures and actions taken upon WQO or groundwater quality MT exceedances. Additional implementation details related to groundwater quality MTs are included in Appendix K-2 (Parts I and III).

Table 13-7. Water Quality Objectives for COCs

Constituent of Concern	Water Quality Objective	Value
Arsenic	CA MCL	10 ppb
Nitrate	CA MCL	10 ppm
Nitrite	CA MCL	1 ppm
Total Dissolved Solids	CA SMCL - Upper	1,000 ppm
1,2,3-Trichloropropane (1,2,3-TCP)	CA MCL	5 ppt
Uranium	CA MCL	20 pCi/L

Table 13-8. SMCs for Degraded Water Quality

Representative Monitoring Wells				Arsenic (ppb)		Nitrate (ppm)		Nitrite (ppm)		TDS (ppm)		TCP (ppt)		Uranium (pCi/L)	
Well ID	Local Name	latitude	longitude	MT[2]	MO	MT[2]	MO	MT	MO	MT[2]	MO[3]	MT[2]	MO	MT	MO
RMW-004	30S29E29A001M	35.296069	-118.879708	10	10	22	10	1	1	1000	1000	277	5	20	20
RMW-010	ACSD #14	35.194193	-118.848387	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-025	COB 23	35.353686	-119.109828	10	10	10	10	1	1	1000	1000	72	5	20	20
RMW-043	Olcese #4	35.430995	-118.841056	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-049	30S26E15N003M	35.312290	-119.180520	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-062a	25M Enos	35.374433	-119.251718	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-065a	31H Greeley	35.361718	-119.217063	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-067a	35H RRBWSD Shop	35.365850	-119.147041	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-070	Caratan Well	35.200176	-118.769775	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-107	DMW04	35.513690	-119.598440	100	10	10	10	1	1	3000	1500	5	5	20	20
RMW-110	DMW 07	35.402090	-119.501100	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-112a	DMW10a	35.353620	-119.434120	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-113b	DMW12b	35.318470	-119.374730	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-148	88-29-014	35.623163	-119.224495	10	10	10	10	1	1	1000	1000	22	5	20	20
RMW-159	SSJMUD 23	35.718500	-119.304200	10	10	13	10	1	1	1000	1000	5	5	20	20
RMW-161R	SSJMUD 67 (Hacienda Well)	35.674688	-119.154277	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-163	SSJMUD 42	35.692950	-119.232000	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-169	28L	35.462763	-119.074941	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-172	6C	35.527440	-119.109980	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-185	EWMA #21	35.593428	-119.078767	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-189	EWMA #41	35.570531	-119.091094	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-210R	CWS 140-01	35.382581	-119.007380	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-211R	CWS 62-02	35.368129	-119.010147	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-224	31S29E10K001M	35.245260	-118.84718	14	10	22	10	1	1	1000	1000	5	5	20	20
RMW-225	30S30E18G001M	35.319700	-118.799000	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-252	Delano 30	35.789790	-119.230240	10	10	10	10	1	1	1000	1000	27	5	20	20
RMW-256	Wasco 12	35.615690	-119.339678	10	10	10	10	1	1	1000	1000	37	5	20	20
RMW-257	Shafter 14	35.494288	-119.259271	10	10	10	10	1	1	1000	1000	208	5	20	20
RMW-271	Shafter 18	35.500964	-119.206717	10	10	10	10	1	1	1000	1000	172	5	20	20
RMW-275	7108-66	35.776230	-119.690170	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-281	Delano 34	35.743630	-119.258740	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-288	EWMA #49	35.736472	-118.954953	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-292	Well 4D1	35.787289	-119.080074	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-299	Berenda Mesa #3	35.636480	-119.948621	10	10	10	10	1	1	2400	1500	5	5	20	20
RMW-300	30S/26E-16L01	35.318013	-119.296736	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-302	Murray Family Farms	35.294210	-118.753370	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-303	HMWD #23	35.208706	-119.243850	24	10	10	10	1	1	1000	1000	5	5	20	20
RMW-305	Well 12A2	35.776516	-119.116495	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-306	Meadows of the Kern Well 3	35.441662	-118.937849	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-307	East Niles #23	35.330170	-118.928900	10	10	10	10	1	1	1000	1000	5	5	20	20

Representative Monitoring Wells				Arsenic (ppb)		Nitrate (ppm)		Nitrite (ppm)		TDS (ppm)		TCP (ppt)		Uranium (pCi/L)	
RMW-308	COB 41-01	35.363109	-119.127570	10	10	10	10	1	1	1000	1000	24	5	20	20
RMW-309	COB L201	35.390188	-119.101350	10	10	10	10	1	1	1000	1000	11	5	20	20
RMW-310	RMW-310	35.274170	-119.157750	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-311	Greenfield Taft Well	35.265554	-119.008520	11	10	10	10	1	1	1000	1000	5	5	20	20
RMW-312	Lamont #12	35.283281	-118.915380	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-313	Frito Lay #1	35.390958	-119.314530	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-314	Lost Hills W4	35.618645	-119.508050	19	10	10	10	1	1	1000	1000	5	5	20	20
RMW-315	Primex Well 4	35.568505	-119.429540	13	10	10	10	1	1	1000	1000	7	5	20	20
RMW-316	WKWD Well 7-02	35.296809	-119.289950	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-317	11N/21W-08A01	35.058964	-119.139250	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-319	32S/28E-16P02	35.140100	-118.976400	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-320	32S/25E-36R01	35.095026	-119.234760	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-321	32S/26E-14J02	35.145042	-119.146170	42	10	10	10	1	1	1000	1000	5	5	20	20
RMW-322	The Nature Conservancy	35.291144	-118.622028	10	10	10	10	1	1	1000	1000	5	5	20	20
RMW-323	SSJMUD 68 (Christina St)	35.770333	-119.280963	10	10	10	10	1	1	1000	1000	5	5	20	20

Abbreviations:

MT = Minimum Threshold
MO = Measurable Objective
pCi/L = picocuries per liter
TDS = total dissolved solids
TCP = 1,2,3-trichloropropane
ppb = parts per billion or micrograms per liter
ppm = parts per million or milligrams per liter
ppt = parts per trillion or nanograms per liter

Notes:

1. Interim milestones are equal to the MOs.
2. Red text indicates concentrations above the water quality objective (WQO).
3. The TDS MO is set at the Upper Limit of the WQOs for most Representative Monitoring Wells (RMWs) in the Kern Subbasin. The TDS MO for RMWs in the Western Fold Belt, where groundwater is known to have naturally high salinity, is set at the Short-Term consumer acceptable level of the WQO.

13.3.2.2 Relationship with Other Sustainability Indicators

☑ 23 CCR § 354.28(b)(2)

The MTs for Degraded Water Quality are designed to ensure that they are sufficiently protective of URs defined for all other relevant Sustainability Indicators in the Kern Subbasin. The specific relationships between Degraded Water Quality and other applicable Sustainability Indicators are discussed below.

Chronic Lowering of Groundwater Levels. Trend analyses have been conducted on the six COCs to evaluate the relationship between groundwater management activities and degraded water quality, and to identify driving mechanisms for increasing constituent concentrations. Data used to characterize groundwater conditions (Section 8.4), indicates there is no direct correlation between groundwater management activities and increasing concentrations of 1,2,3-TCP, TDS or uranium. While there is no clear Subbasin-wide correlation between groundwater management activities and increasing arsenic and nitrates, the driving mechanisms for degradation indicate that these constituents may increase in some wells, depending on well construction and lithology, when groundwater levels decline. The relationship between water levels and water quality for each COC is described in detail in Section 8.4.2. The RMW-WQs have been selected to facilitate ongoing monitoring, assessment, and reporting of potential future impacts of groundwater management activities.

Land Subsidence has been predicted to increase arsenic concentrations due to release from clay minerals (Smith et al., 2018). However, this has not been observed in most of the Central Valley, including the Kern Subbasin (Haugen et al., 2021). Concentrations of arsenic were plotted against annual Interferometric Synthetic Aperture Radar (InSAR) subsidence rates at two RMW-WQs in the North Basin HCM Area near the northern Subbasin boundary. Arsenic concentration trends in these RMW-WQs showed weak and opposite correlations with subsidence, supporting the finding that a correlation between arsenic concentrations and subsidence has not been observed in the Kern Subbasin (Figure 13-21). Potential increases in arsenic, if any, due subsidence will be monitored and managed per the SMCs established for Degraded Water Quality. There has been no observed correlation between Land Subsidence and other water quality COCs in the Kern Subbasin; however, RMW-WQs have been selected in areas with historical subsidence to continue to monitor the potential relationship between subsidence and arsenic.

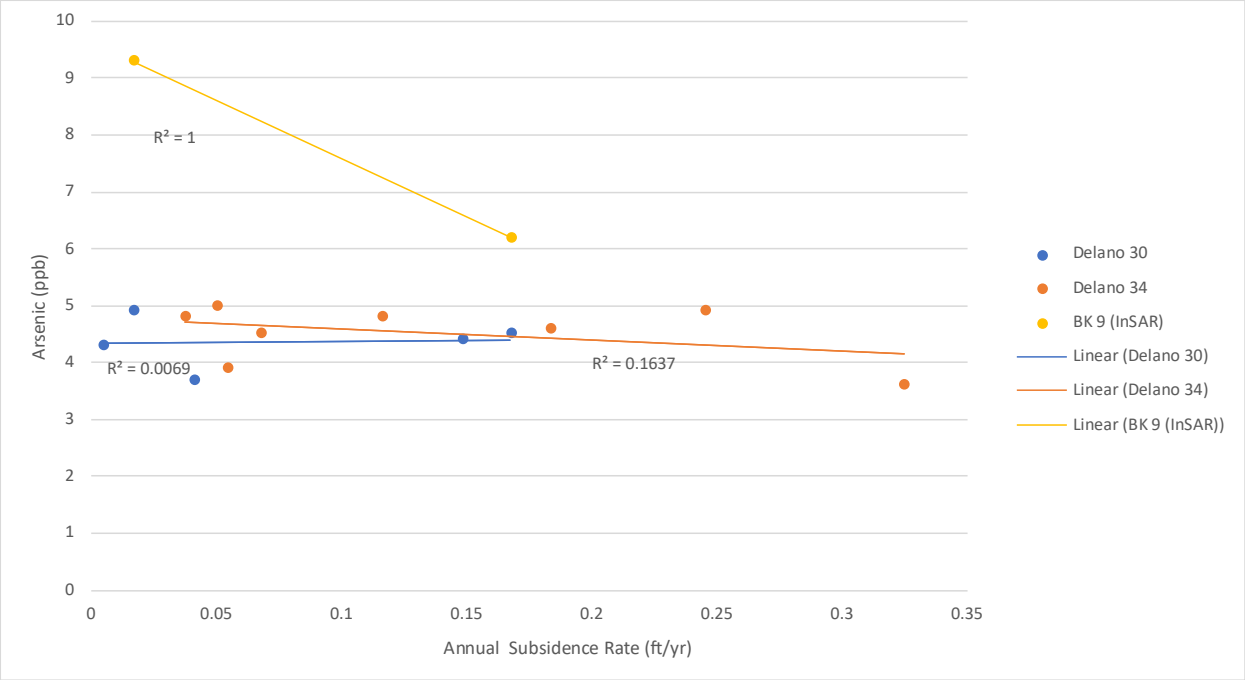


Figure 13-21. Arsenic Concentrations vs. Annual Subsidence Rates

13.3.2.3 Consideration of Adjacent Basins

☑ 23 CCR § 354.28(b)(3)

The MTs for Degraded Water Quality are not expected to impact adjacent basins' ability to achieve their Sustainability Goals, as MTs are set based on regulatory thresholds or pre-SGMA concentrations. All adjacent basins (the Tule, Tulare Lake, and White Wolf Subbasins) have similarly committed to preventing further groundwater quality degradation beyond the water quality objectives or pre-SGMA baseline conditions.

Additionally, the Chronic Lowering of Groundwater Levels MTs are not expected to cause significant changes to existing local groundwater gradients (Section 13.1.2.3) and are thus anticipated to be protective in terms of preventing migration of poor-quality water from or into the Kern Subbasin.

13.3.2.4 Impacts to Beneficial Users

☑ 23 CCR § 354.28(b)(4)

Water quality objectives in the 2025 Plan are set at levels to protect the municipal beneficial use in groundwater, which includes domestic well users as well as those that rely on Public Water System wells of all sizes. Water quality objectives for the municipal beneficial use are based on Primary and Secondary MCLs, which are set at levels to protect public health or based on consumer acceptance standards, respectively. Applying standards established for drinking water quality is consistent with California's Human Right to Water goals and is inherently protecting groundwater to the most

stringent standards. Since water quality data is not available for domestic and non-public wells, the Kern Subbasin GSAs will rely on the baseline characterization in the following subsections and included in Attachment 1 of Appendix K-1 when conducting an MT Exceedance Investigation. Small community water system data can typically be used as a proxy for domestic wells.

Furthermore, the Chronic Lowering of Groundwater Levels MTs generally maintain existing local groundwater gradients and are thus anticipated to be protective in terms of preventing migration of poor-quality water within the Kern Subbasin. Section 8.4 evaluates a list of 14 potential COCs and identifies six COCs applicable to the Kern Subbasin. Trend analyses have been conducted to evaluate the relationship between groundwater management activities (e.g., chronic lowering of groundwater levels and implementation of P/MAs) and to identify driving mechanisms for increasing constituent concentrations. Findings of these analyses are:

- No direct correlation has been observed between groundwater management activities and increasing concentrations of 1,2,3-TCP or uranium.
- No clear Subbasin-wide correlation between groundwater management activities and increasing concentrations of arsenic and nitrates. However, the driving mechanisms for degradation indicate that concentrations may increase in some wells, depending on well construction and lithology, when groundwater levels decline.
- A direct correlation was observed between banking programs (P/MAs) and decreasing (improving) concentrations of naturally occurring TDS.

Driving mechanisms to exacerbate arsenic and nitrates concentrations is provided in the following section. With each constituent summary, an assessment of COC concentrations in small community wells is provided along with discussion of the risk of new water quality objective exceedances. Small community water systems are used as a proxy for areas lacking water quality data, particularly where there is moderate density of domestic and state small water systems.

Arsenic

Observations from trend analyses of public supply wells indicate a relationship between declining groundwater levels and increasing arsenic concentrations in some areas of the Kern Subbasin. This relationship is somewhat dependent on well construction, and strongly dependent on lithology. Areas where arsenic may be present above the water quality objective, set based on the drinking water MCL of 10 ppb, are:

- Where the E-clay (Corcoran Clay) is present with well screens across the clay deposits.
- In the Delano-McFarland Area, some wells that are deeper than 800 feet bgs may exceed the arsenic MCL.

- In the Kern River Fan HCM Area, some wells that are deeper than 600 feet bgs may exceed the arsenic MCL.
- In the eastern portion of the South Basin HCM Area, some wells that are deeper than 550 feet bgs may exceed the arsenic MCL.

Wells that are moderately deeper than these regional depth estimates can fluctuate above and below the water quality objective with water level changes. Some wells significantly deeper (i.e., wells that extend into the base of fresh water) than the region-specific levels are more likely to exceed the arsenic water quality objective regardless of groundwater levels. However, this observation cannot be consistently applied to all wells in any of the HCM Areas.

Nitrates

Analysis of municipal and small community wells, and varying geologic conditions indicates the primary influence to fluctuating nitrate concentrations are localized (i.e., there are no known nitrate plumes that are migrating as a result of dense pumping centers). Where the E-clay is present, nitrates are commonly below the water quality objective and there is no clear relationship between nitrate concentration fluctuations and groundwater levels.

In the Kern River Fan HCM Area, where significant banking activities occur, nitrate concentrations appear to be reduced by the high-quality waters used for recharge and/or banking. Several wells were evaluated and demonstrate that nitrate concentrations are typically diluted by the large volumes of recharge. Based on the analysis conducted, nitrate is commonly present above the water quality objective of 10 ppm in the following circumstances:

- In shallow wells where the source of nitrate is persistent (i.e., septic systems), and when groundwater levels decline during dry periods when pumping is more intensive.
- Where the E-clay is present but localized conditions enable nitrate to migrate laterally or vertically. While Kern County Environmental Health adopted an ordinance to protect against migration of contaminant plumes, older wells or improperly destroyed wells could serve as a conduit for constituent migration.

TDS

Most of the Kern Subbasin, with the exception of the Western Fold Belt HCM Area, is considered high-quality with respect to TDS because concentrations are generally equal to or less than 500 ppm. Water quality objectives for TDS are based on Secondary MCLs, which are consumer acceptance limits and are not based on risks to public health. In the 2025 Plan, groundwater designated for municipal beneficial use are not to exceed the TDS Upper Limit of 1,000 ppm. TDS ranging in the Upper Limit of 1,000

ppm is acceptable if it is demonstrated that it is not reasonable or feasible to achieve lower levels.

The Western Fold Belt HCM Area is an exception because groundwater is naturally saline due to the extensive presence of marine sediments. Hydrogeologic conditions that pre-date development, such as the channeling of groundwater flow by the San Joaquin Valley Syncline and the obstruction of flow by various anticlines, influence gradients and are important factors affecting the occurrence of TDS in the Kern Subbasin. There are no known driving mechanisms that would result in migrating high TDS groundwater from the Western Fold Belt into areas where TDS is below the water quality objective.

13.3.2.5 State, Federal, and Local Standards

☑ 23 CCR § 354.29(b)(5)

The State of California and the USEPA set primary MCLs for constituents that may pose potential human health risks. 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 DDW. Water quality issues related to waste discharge into the groundwater are regulated separately via the CVRWQB's Basin Planning process and the issuance of Waste Discharge Requirements.

Given the limited regulatory authority of GSAs with respect to water quality, it is not appropriate to consider setting the MTs lower than the MCLs. Therefore, the MTs for Degraded Water Quality are set as close as practical to the COC's respective water quality objective (refer to criteria for setting MTs in Section 13.3.2.1 and Table 13-7). It should be noted that monitoring for these and other water quality parameters will continue to be conducted at all RMW-WQs, as discussed in Section 15.3.3.

13.3.2.6 Measurement of Minimum Thresholds

☑ 23 CCR § 354.24

Compliance with the Degraded Water Quality MTs will be based on monitoring data collected semi-annually for the Kern Subbasin's RMW-WQs with established SMCs in accordance with the monitoring protocols described in Section 15.3.3 and in the Kern County Subbasin Coordination Agreement.

13.3.3 Measurable Objective and Interim Milestones for Degraded Water Quality

☑ 23 CCR § 354.30(c)
☑ 23 CCR § 354.30(e)

As with the MTs, the MOs for Degraded Water Quality are defined at RMW-WQs in the Kern Subbasin for key COCs: arsenic, total nitrate/nitrite (as N), nitrate, nitrite, TDS, 1,2,3-TCP, and uranium. The MOs for Degraded Water Quality are set at the water quality objective for protection of municipal beneficial use. The MOs for Degraded Water Quality at each RMW-WQ are shown in Table 13-8.

The MOs are set in recognition that per the State's Antidegradation Policy (Resolution No. 68-16), further degradation would pose an unacceptable risk to the Kern Subbasin's drinking water users.

The IMs for Degraded Water Quality are set at the same value as the MTs for each RMW-WQ, in line with the Kern Subbasin's commitment to not allow further degradation of water quality beyond existing regulatory thresholds or, in areas that are naturally or otherwise degraded before the SGMA effective date, beyond their pre-SGMA baseline levels.

13.4 Seawater Intrusion

§ 354.28. *Undesirable Results*

(d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

§ 354.28. *Minimum Thresholds*

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(3) Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:

(A) Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.

(B) A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.

(e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

☑ 23 CCR § 354.26(d)
☑ 23 CCR § 354.28(c)(3)
☑ 23 CCR § 354.28(e)

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.

13.5 Land Subsidence

As discussed in Section 8.5.2, Land Subsidence in the Kern Subbasin is driven by several factors, including subsidence that is caused by activities within the authorities of GSAs to control ("GSA-related" subsidence) and potential causes of subsidence that are outside GSA authorities to control ("non-GSA" subsidence). "GSA-related" causes of land subsidence are defined herein to include groundwater pumping for agricultural and M&I uses, which causes the depressurization of aquifers and aquitards due to lowering of groundwater levels and leads to compaction of compressible strata and lowering of the ground surface. "Non-GSA" causes of land subsidence are defined herein to potentially include expansive and soluble soil types susceptible to hydro-compaction that can affect infrastructure integrity, oil and gas extraction (Section 8.5.2), age of critical infrastructure, potential historical geotechnical deficiencies (e.g., lack of pre-construction hydro-compaction on the Aqueduct), and subsidence caused by natural processes such as faulting (Section 8.5).

13.5.1 Undesirable Results for Land Subsidence

SGMA defines an UR for Land Subsidence as "significant and unreasonable land subsidence that substantially interferes with surface land uses" ….. "*caused by groundwater conditions occurring throughout the basin*" (CWC §10721(x)).

The Subbasin-wide UR for Land Subsidence is defined as follows:

> *The point at which the amount of subsidence, if caused by GSA-related groundwater extractions in the Subbasin, create a significant and unreasonable impact on surface land uses or critical infrastructure. Loss in functionality that could be mitigated by the GSAs would not be considered an undesirable result.*

13.5.1.1 Identification of Beneficial Users

In addition to the above definition (CWC §10721(x)(5)) of URs due to subsidence, 23 CCR §354.26(b)(3) states that the description of URs should include: *"Potential effects*

on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results." Beneficial users of groundwater that could experience potential URs caused by Land Subsidence include all groundwater extraction wells in the Kern Subbasin, as described in Section 13.1.1.1. Although critical infrastructure is not defined as a beneficial user in CWC §10723.2, it is still considered as a land use and property interest in the development of SMCs for Land Subsidence. Specifically, this 2025 GSP considers infrastructure used for water conveyance, transportation, flood control, and the interstate gas distribution pipelines to be land use and property interests that could be affected by URs for Land Subsidence.

In order to identify and classify infrastructure in the Kern Subbasin potentially affected by land subsidence, the Kern Subbasin GSAs have adopted three classifications for critical infrastructure: Regional Critical Infrastructure, GSA Area Critical Infrastructure, and other infrastructure, which are defined as follows.

- **Regional Critical Infrastructure** is defined as infrastructure located within the Kern Subbasin that serves multiple areas of the Kern Subbasin and whose loss of significant functionality due to subsidence, if caused by GSA-related groundwater extractions in the Subbasin, would have significant impacts to beneficial users. The Kern Subbasin GSAs have collectively determined that the only infrastructure that meets the definition for Regional Critical Infrastructure are the California Aqueduct (Aqueduct) and the Friant-Kern Canal (FKC).
- **GSA Area Critical Infrastructure** is defined as infrastructure located within a particular GSA whose loss of significant functionality due to subsidence if caused by GSA-related groundwater extractions would have significant impacts to beneficial users within that GSA. Each Subbasin GSA has identified their respective GSA Area Critical Infrastructure.
- **Other infrastructure** is defined as other water supply, water conveyance, water treatment, transportation, or interstate gas distribution pipelines not included under Regional Critical Infrastructure or GSA Area Critical Infrastructure.

Using the above classifications, the Kern Subbasin GSAs identified Regional and GSA Area Critical Infrastructure that could be significantly and unreasonably affected by land subsidence within their jurisdictions where applicable. Figure 13-22 through Figure 13-6 show all identified critical infrastructure within the Kern Subbasin that could be potentially impacted by subsidence. As shown on Figure 13-22, Regional Critical Infrastructure includes the FKC and the Aqueduct. As shown on Figure 13-23, GSA Area Critical Infrastructure includes the Calloway Canal, Lerdo Canal, Beardsley Canal, Cross Valley Canal, Kern River Canal, Arvin-Edison Water Storage District Canal, Olcese Canal, Interstate-5 (I-5), and Highway 99. Other infrastructure, as shown on Figure 13-24, includes wells, railroads, interstate gas pipelines, county roadways, and other locally identified water facilities.

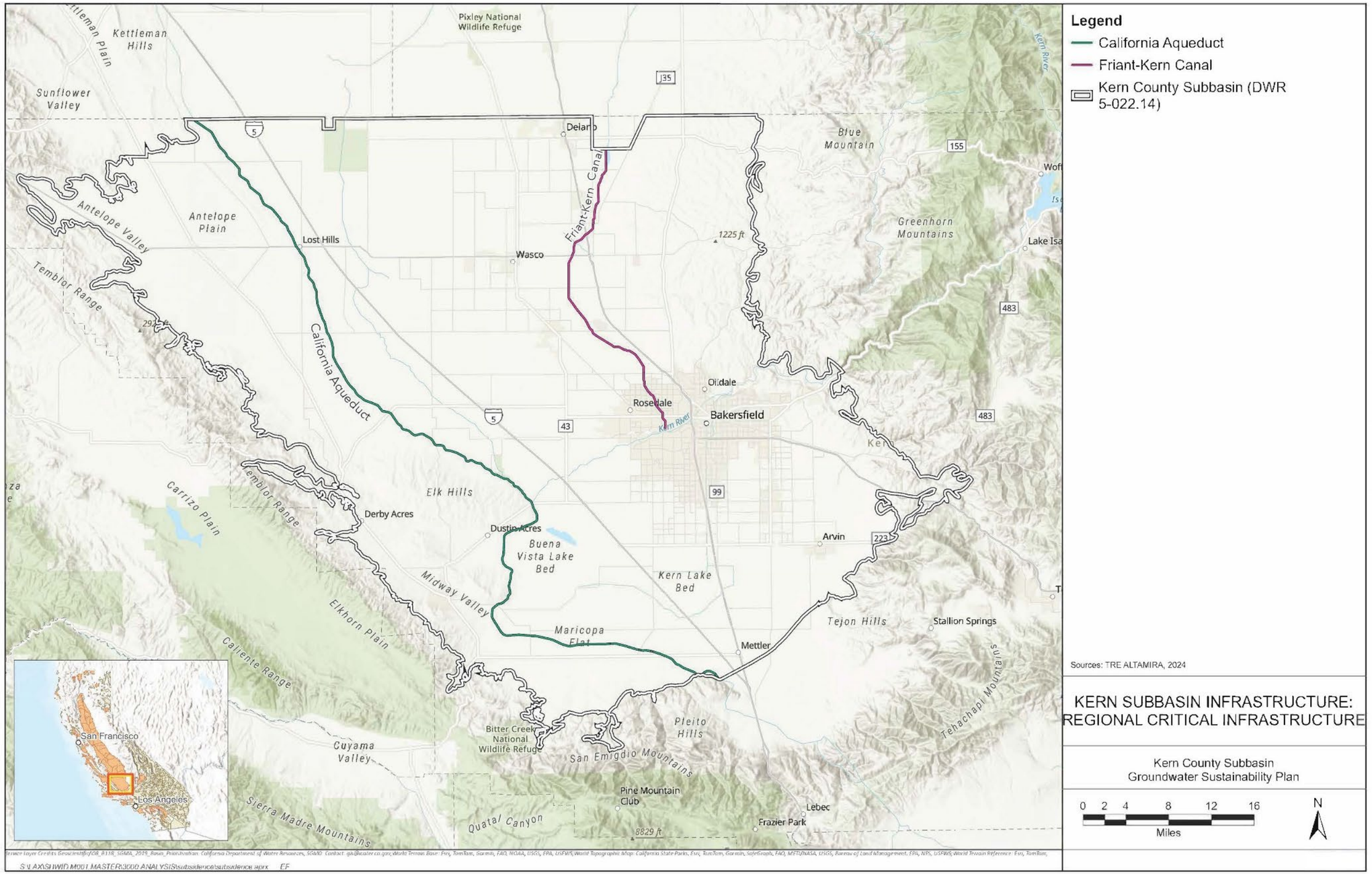


Figure 13-22. Kern Subbasin Infrastructure: Regional Critical Infrastructure

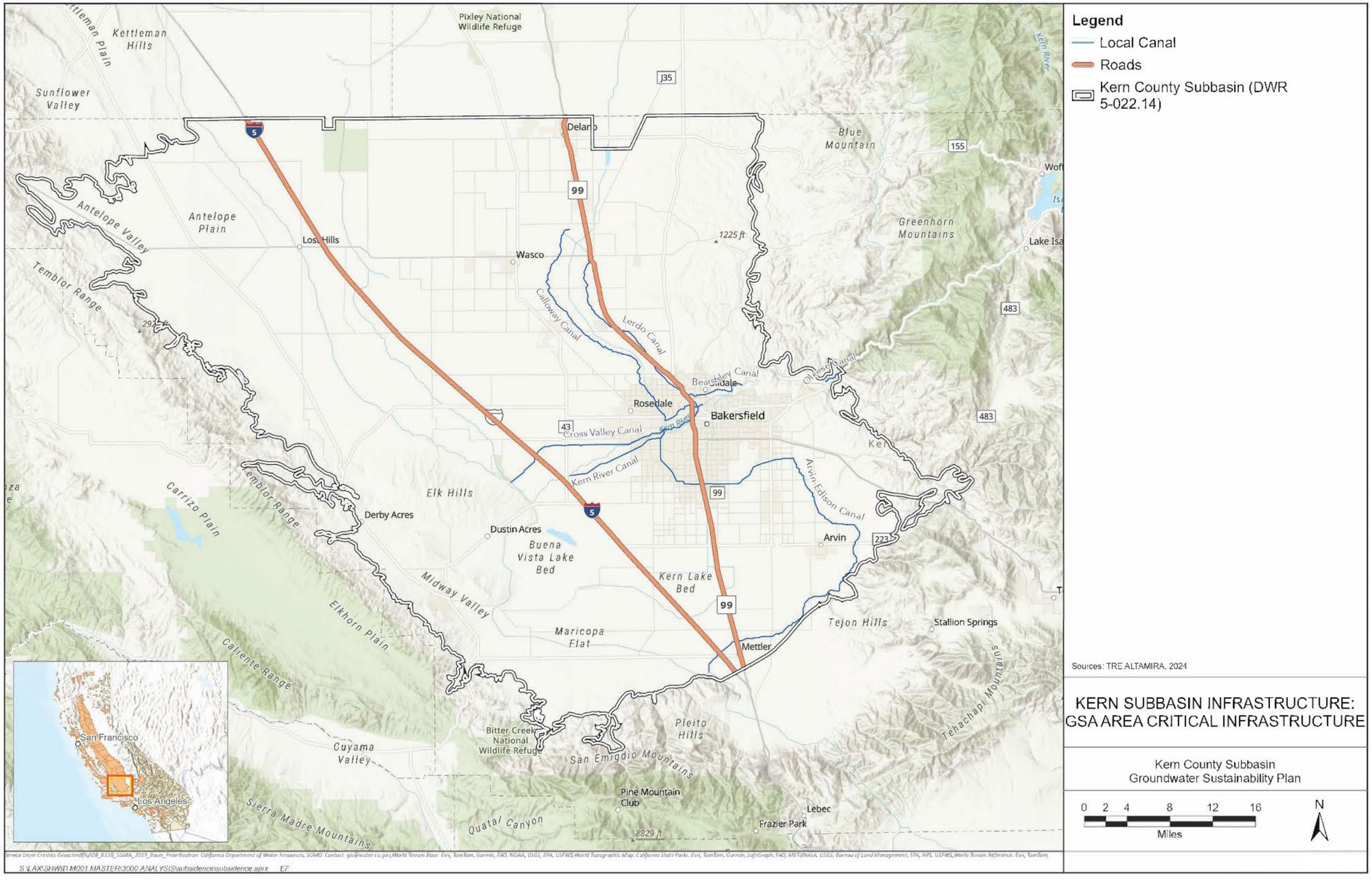


Figure 13-23. Kern Subbasin Infrastructure: GSA Area Critical Infrastructure

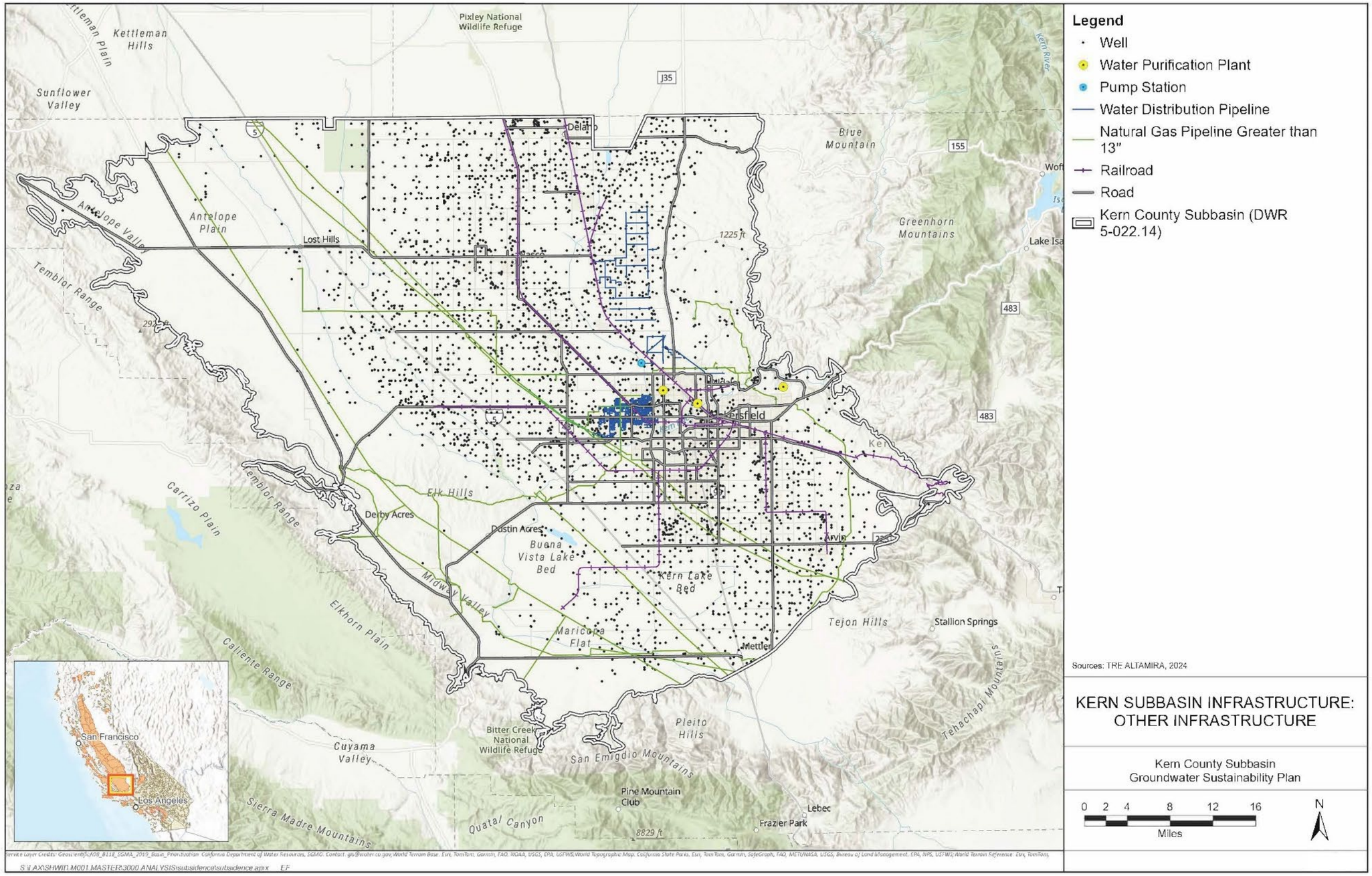


Figure 13-24. Kern Subbasin Infrastructure: Other Infrastructure

13.5.1.2 Potential Effects of Undesirable Results on Beneficial Users

☑ 23 CCR § 354.26(b)(3)

Potential effects of URs caused by Land Subsidence on beneficial uses and users of groundwater and the Regional and GSA Area Critical Infrastructure include, but are not limited to, potentially altering the land surface in ways that could damage well casings, gravity-driven water conveyance infrastructure (i.e., lined and unlined canals), and other linear infrastructure (e.g., transportation and utilities). These impacts may result in loss of surface water delivery capacity, increase flooding risk, disrupt essential services such as domestic water supply, cause property damage, and jeopardize public safety for beneficial users.

13.5.1.3 Potential Causes of Undesirable Results

☑ 23 CCR § 354.26(b)(1)

Land subsidence can be caused by several mechanisms, but the mechanism most relevant to sustainable groundwater management activities under the authority of GSAs is the depressurization of aquifers and aquitards due to the lowering of groundwater levels from increased groundwater pumping or reduced recharge, leading to compaction of compressible strata and lowering of the ground surface. Therefore, the potential GSA-related causes of URs due to land subsidence are increased GSA pumping and/or reduced recharge in areas underlain by compressible strata.

As discussed previously, non-GSA causes of land subsidence potentially include hydro-compaction of expansive or soluble soils, oil and gas extraction activities, age of infrastructure, natural geologic processes (e.g., faulting), and residual subsidence attributable to non-GSA or pre-SGMA (prior to January 2015) activities, etc.

13.5.1.4 Criteria Used to Define Undesirable Results

☑ 23 CCR § 354.26(b)(2)

The criteria for URs caused by Land Subsidence are as follows:

URs for Land Subsidence are defined to occur within the Kern Subbasin if the MT extent of subsidence is exceeded at any of the Kern Subbasin's Representative Monitoring Sites for Land Subsidence (RMS-LS) along the Regional Critical Infrastructure at a ***single*** milepost or GSA Area/HCM Area MTs after six (6) quarterly consecutive sampling events measured using InSAR data (published by DWR) or annual survey data (if available), and the exceedance can be attributed to groundwater management activities (e.g. groundwater level changes, P/MAs), based on technical analysis using best available data and tools.

These criteria for URs are justified because an exceedance of the MT extent of GSA-related subsidence at any RMS-LS could interfere with the functionality of critical infrastructure and require significant mitigation to avoid impacts to beneficial users. Per the Kern Subbasin's Exceedance Policy and Action Plan for Land Subsidence (Section 16.2.1; Appendix K-1), exceedance of the MT or IM subsidence rate and/or extent after two (2) quarterly consecutive sampling events measured using InSAR data or one annual survey measurement, if available, trigger investigation including an identification into the root cause, and potential initiation of targeted GSA P/MAs.

13.5.2 Minimum Threshold for Land Subsidence

> ***§ 354.28.*** *Minimum Thresholds*
> *(b) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *1. Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:*
> - *Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.*
> - *Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.*

The MTs for Land Subsidence are defined herein as levels of land subsidence that, if they occur, would result in URs to surface land uses and Regional and GSA Area Critical Infrastructure, which is identified in Section 13.5.1.1. The MTs defined below are in terms of total vertical extent of land subsidence (in feet) from 2024-2040, as well as a corresponding average annual rate of subsidence (in feet per year) compiled quarterly and reported annually to align with the Annual Report cycle. These MTs also inform the MOs and IMs defined in Section 13.5.3.

13.5.2.1 Minimum Threshold Development

☑ 23 CCR § 354.28(b)(1)
☑ 23 CCR § 354.28(c)(5)

A coordinated approach has been developed by the Kern Subbasin to identify and evaluate potential subsidence impacts that substantially interfere with surface land uses and are caused by GSA groundwater extractions within the Kern Subbasin. This process is outlined below and shown in Figure 13-19.

Step #1: Identify areas with historical land subsidence or potential for future land subsidence

Section 8.5 documents the spatial extent and magnitude of historical subsidence in the Kern Subbasin and identifies areas susceptible to future subsidence. Several areas within the Kern Subbasin have potential for future subsidence, except along the western

and eastern margins of the Kern Subbasin and at alluvial fans where coarser sediment types have less potential for subsidence.

Step #2: Classify the potential for subsidence to cause significant and unreasonable impacts

Detailed impact analysis has been undertaken for the Regional Critical Infrastructure (as discussed in Section 13.5.2.2) to establish protective MTs. For the GSA Area/Other Infrastructure, the regional subsidence potential in the Kern Subbasin is classified into four categories (High, Moderate, Low, and Minimal) based on the historical cumulative subsidence extent from 2015 to 2023 as reported by DWR InSAR data:

- **High:** Greater than 3 feet
- **Moderate:** 1 to 3 feet
- **Low:** 0.33 to 1 foot
- **Minimal:** Less than 0.33 feet

As discussed in Section 8.5.1.3, areas with high subsidence potential do not exist within the Kern Subbasin but exist adjacent and north of the Kern Subbasin in Tule and Tulare Lake Subbasins (Figure 8-50). As shown in Figure 13-20, areas with moderate subsidence potential (i.e., 1 to 3 feet from 2015 to 2023) primarily exist along the northern boundary of the Kern Subbasin and are likely associated with higher rates of subsidence documented north of the Kern Subbasin (i.e., outside of Kern County). Other isolated areas of moderate subsidence potential have been identified within the Kern Subbasin, some of which may be associated with non-GSA factors (such as on the west and east sides of the Kern Subbasin). Areas with low subsidence potential (0.33 to 1 foot from 2015 to 2023) generally are concomitant with hydro-stratigraphy containing fewer finer grained sediments in areas of higher groundwater extraction per square mile (Figure 13-20). Areas with minimal subsidence potential (i.e., less than 0.33 feet from 2015 to 2023) cover the majority of the Kern Subbasin and are associated with areas containing fewer finer grained sediments with groundwater extractions ranging from 100 AF to greater than 2,000 AF per square mile (Figure 13-20). Note, in some areas of the Subbasin where significant recharge occurs (e.g., Kern Fan HCM Area) there may be elastic rebound, and the average rate of subsidence calculated using the period from 2015 to 2023 likely overestimates projected subsidence through 2040. In general, the period from 2015 to 2023 is conservative from a subsidence standpoint, as it includes several drought years and the period before SGMA implementation. Future subsidence rates are expected to be lower as the Subbasin reaches sustainability and limits groundwater declines.

Step #3: Project Future Rates and Extents of Subsidence to Assess Potential Significant and Unreasonable Impacts on Infrastructure

Historical (2015 – 2024) rates and extent of subsidence (as obtained from InSAR, GPS, extensometer, and benchmark data) are not known to have caused significant and

unreasonable impacts to GSA/Other Infrastructure within the Kern Subbasin. Note, that the historical subsidence observed in the Kern Subbasin includes GSA-related, non-GSA related, and residual (due to pre-2015 activities) subsidence (Section 8.5.2). This 2025 Plan is designed to stabilize water levels by 2030 (Section 13.1.3.2), hence future rates and extents of subsidence are likely to be less than historical rates and extents as groundwater levels are raised above the pre-consolidation head (critical head), effectively minimizing GSA subsidence beyond 2040. However, residual (due to pre-2030 activities) and non-GSA-related subsidence may continue beyond 2030. As such, a conservative approach was taken to estimate the future potential subsidence occurring between 2024-2040 by extrapolating historical (2015 to 2024) rates of subsidence forward. Figure 13-27 shows the historical (2015 to 2024) extent of subsidence based on the InSAR data.

Figure 13-28 reports the average historical rate, average cumulative subsidence, and maximum cumulative subsidence within each HCM Area. As can be seen the maximum extent of subsidence observed from 2015 to 2024 in the Kern Subbasin was 2.43 feet at the northern boundary of the Kern Subbasin, correlated with much higher subsidence rates observed in the adjacent basins.

Figure 13-22 also shows the protective buffers (2.5 miles on both sides) established to monitor and manage subsidence along the Regional Critical Infrastructure. Within the protective buffer, the subsidence measured at every milepost along the Regional Critical Infrastructure, will be used to inform the MTs. Note, for the California Aqueduct the historical and projected amounts of subsidence were calculated based on milepost-specific survey data (spanning 2013-2024), as this was the best available data with comprehensive coverage along the Aqueduct collected annually since 2016.

The rate of subsidence for the HCM Areas and the FKC were estimated using linear regression methods applied to spatially filtered vertical time series data (~weekly resolutions) provided by DWR. To improve spatial coverage of measurement points and limit the impacts of variable data availability in time (due to processing schemes employed by TRE Altamira), time series data are first subsampled to quarterly intervals (spanning October 2015 to April 2024), sequentially differenced, and then applied with a 500 meter (~1,640 feet) radius median filter. These filtered products are used to reconstruct displacement time series for measurement points. The displacement rate at each measurement point is then estimated using the Python “linregress” function.

The rate of subsidence for the California Aqueduct was estimated by the average rate of elevation change between 2013-2024 (i.e., cumulative displacement at each MP divided by the time period) using surveying data available from the California Aqueduct Subsidence Study (https://data.ca.gov/dataset/california-aqueduct-subsidence-study). The historical rates of subsidence were extrapolated forward through 2040 to estimate the extent of future subsidence (actual subsidence in the Kern Subbasin is expected to be less than these amounts as future subsidence rates should be less than historical

rates as overdraft is eliminated and water levels stabilized and maintained above critical heads by 2030).

Figure 13-29 and Figure 13-24 shows the projected future (2024 – 2040) regional subsidence distribution, HCM Area averages, and projected rates along Regional Critical Infrastructure. As can be seen therein, the estimated future subsidence (assuming continued historical rates of subsidence) from 2024 to 2040 in the Kern Subbasin peaks at 5.39 feet in areas with GSA-related activities along the northern boundary of the Kern Subbasin, which are associated with the historically high rates of subsidence seen in areas north of the Kern Subbasin boundary. The highest overall estimated cumulative future subsidence peaks at 8.18 feet (6.13 inches/year) in an area of documented extensive non-GSA activity within the Western Fold Belt HCM Area. The average amount of future subsidence for any given HCM Area ranges from 0.06 ft to 1.06 feet (Figure 13-29). The spatial average of historical and estimated subsidence rates and extent, as well as the maximum cumulative value, for each HCM Area were estimated using ArcGIS Pro.

Infrastructure can be impacted by both absolute subsidence extent as well as differential subsidence, where different parts of the infrastructure subside at different rates leading to issues like buckling and fissures along roads and canals, and rupture of pipelines, etc. Potential for future differential subsidence was ascertained by calculating the change in slope along Regional Critical Infrastructure, GSA Area Critical Infrastructure, and selected other infrastructure from 2024 to 2040, based on the historical and projected 2040 subsidence extent maps (Figure 13-27 and Figure 13-29). Some other infrastructure (interstate gas pipelines, and other local water supply, conveyance, and treatment facilities) were not included in the differential subsidence analysis, as the GSAs do not have access to the necessary information to assess Subbasin-wide subsidence impacts on these types of other infrastructure. Current and projected rates of differential subsidence across the Kern Subbasin are low and are not expected to cause URs along other infrastructure. During Plan implementation, the GSAs will continue to engage with beneficial users of these other infrastructure to assess potential for subsidence-related impacts.

Figure 13-31 shows the change in slope (reported as change in vertical feet over 1,000 horizontal feet) along critical infrastructure assessed for potential impacts. As can be seen, for most of the critical infrastructure, the change in slope is less than 0.1 feet/1000 feet (less than 0.01 percent), which is a negligible amount well within the uncertainty of the InSAR data. The maximum change in slope is 0.33 – 0.4 feet/1000 feet (0.033 – 0.04 percent), in a few localized areas in the central and southeast parts of the Kern Subbasin.

Step #4: Identify the Type of Infrastructure and Surface Land Uses in Areas with Future Land Subsidence

The MTs for subsidence are defined as the rates and magnitudes of subsidence that would cause substantial interference with surface land use or infrastructure (23-CCR §354.28(c)(5)). Hence, in the areas with potential for future subsidence, the land uses, property interests, and infrastructure that are likely to be affected by land subsidence were identified (Section 13.5.1.1).

Step #5: Develop SMCs for Critical Infrastructure and HCM Areas

Conservative estimates of future subsidence and change in slope (Step #3) were assessed for potential impacts on infrastructure within the Kern Subbasin to develop subsidence SMCs as described below.

For Regional Critical Infrastructure, MTs at previously surveyed benchmarks are proposed based on either: (1) the protective level of subsidence (the rate and extent of subsidence that would not lead to loss of conveyance capacity); or (2) the historical rate of subsidence projected to 2040 (where the projected amount of subsidence is not expected to lead to loss of conveyance capacity). Certain sections of the Regional Critical Infrastructure were seen to be vulnerable to the projected amounts of future subsidence. Hence, protective MTs were established at all previously surveyed benchmarks along the Regional Critical Infrastructure that apply to the 5-mile-wide (i.e., 2.5 miles on either side) “Monitoring Corridor” centered on the Regional Critical Infrastructure to avoid significant and unreasonable impacts (Figure 13-22). In general, GSA Critical and Other Infrastructure are not considered vulnerable to the projected amount of subsidence (discussed in detail in subsequent sections). In areas with minimal potential subsidence (less than 0.33 ft) the HCM Area average projected subsidence was set as the MT. In areas with low (0.33 to 1 ft) or medium (1 ft to 3 ft) potential subsidence, the projected subsidence along the given stretch of the GSA Critical Infrastructure was used to establish the MTs.

Since factors outside the GSAs authority also contribute to subsidence, (Section 8.5.2.2.) an exceedance policy was developed to address MT exceedances that may not be entirely driven by GSA activities. The Kern Subbasin Exceedance Policy and Action Plans (discussed in Section 16.2.1 and Appendix K-1) includes data collection and monitoring, evaluating the cause of the MT (GSA or non-GSA related) exceedance, and enacting P/MAs or mitigation measures to minimize subsidence MT exceedances and associated impacts due to activities within GSA authority (e.g., agricultural and M&I pumping).

Figure 13-26 shows the HCM Area and Regional Critical Infrastructure MTs. The GSA Critical Infrastructure MTs are shown in Table 13-11. Note that the (protective) MTs along certain sections of the California Aqueduct are *less than* the projected subsidence extents in areas where the projected subsidence levels would lead to conveyance loss. The MTs for the California Aqueduct are discussed in more detail in Section 13.5.2.2.

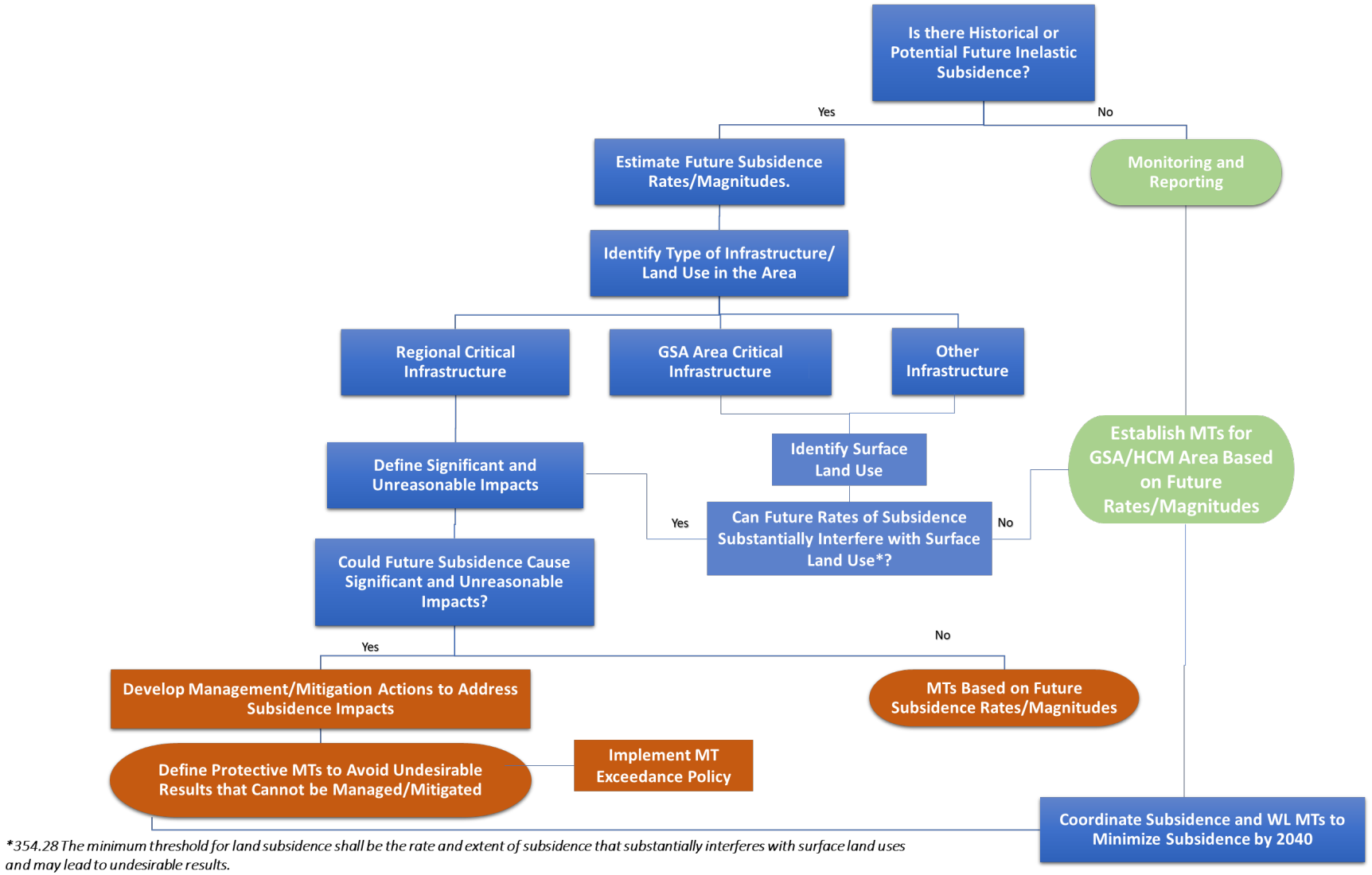


Figure 13-25. Approach to Develop SMCs for Land Subsidence

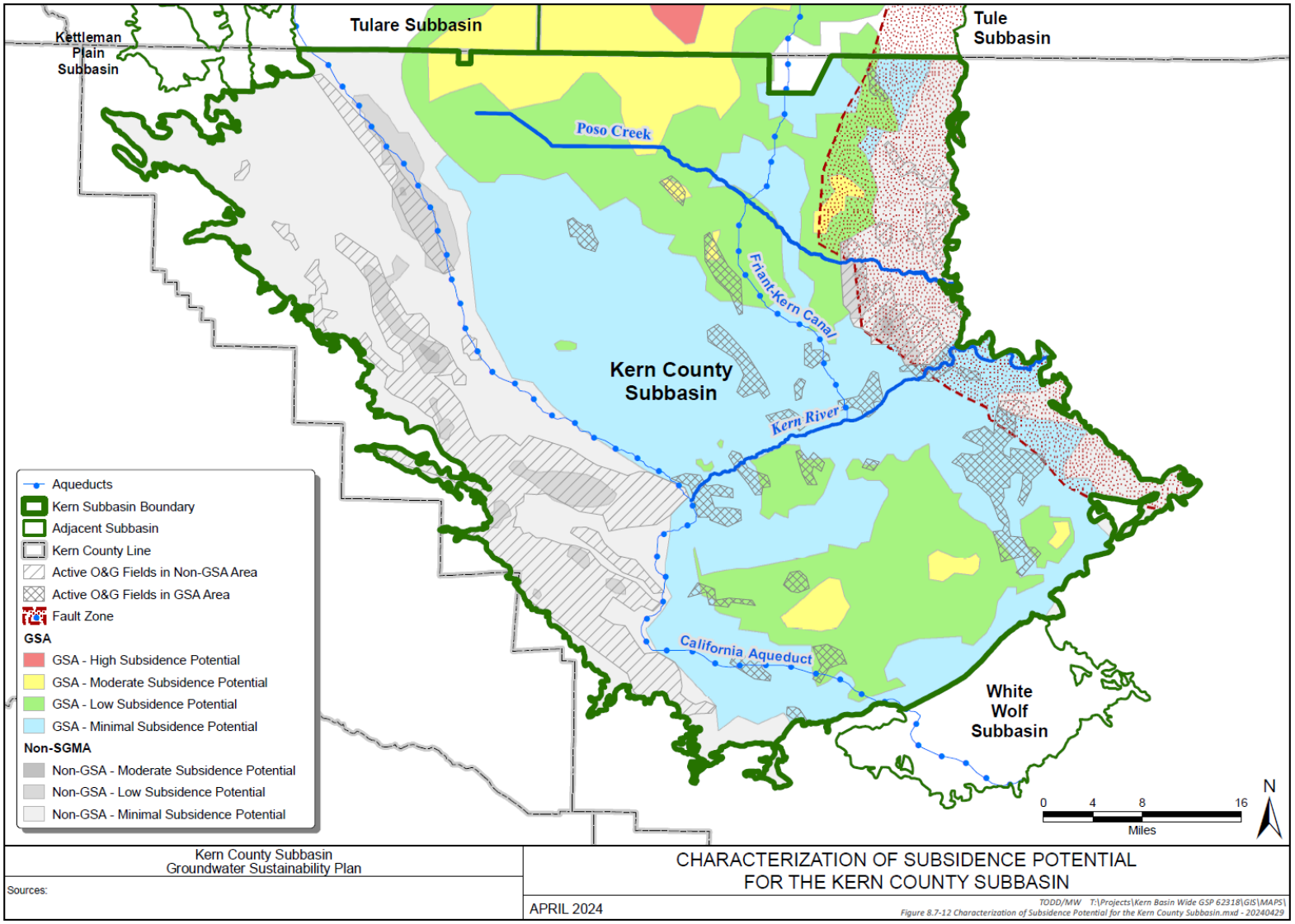


Figure 13-26. Characterizing Land Subsidence Potential

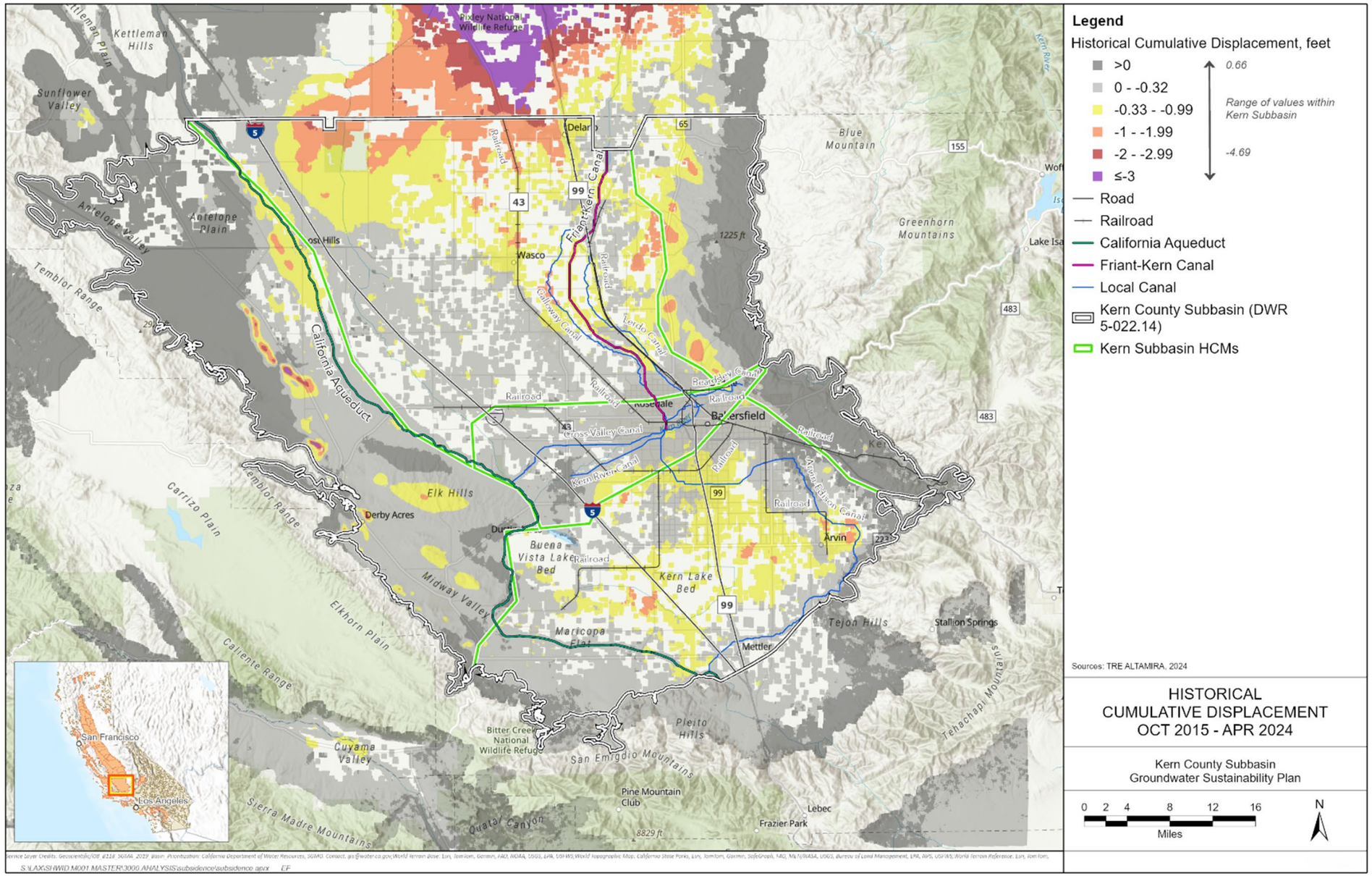


Figure 13-27. Historical (2015 – 2024) HCM Area Subsidence Extents[19]

[19] Inclusive of GSA-related, non-GSA, and residual subsidence as observed based on InSAR data from 2015 to 2024.

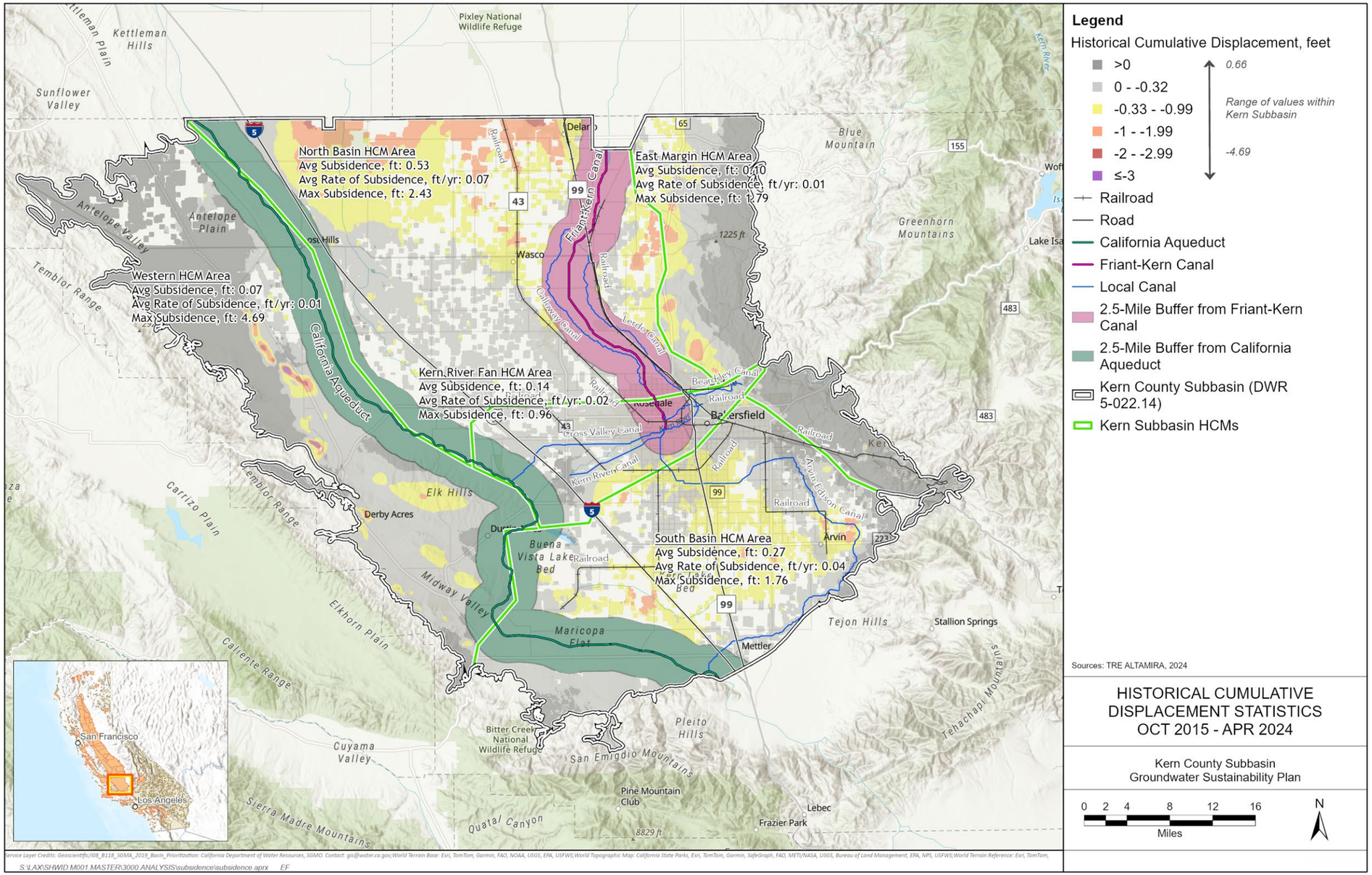


Figure 13-28. Historical (2015 – 2024) Rate, Average, and Maximum Subsidence Extents[17] for each HCM Area and Protective Buffers for Regional Critical Infrastructure

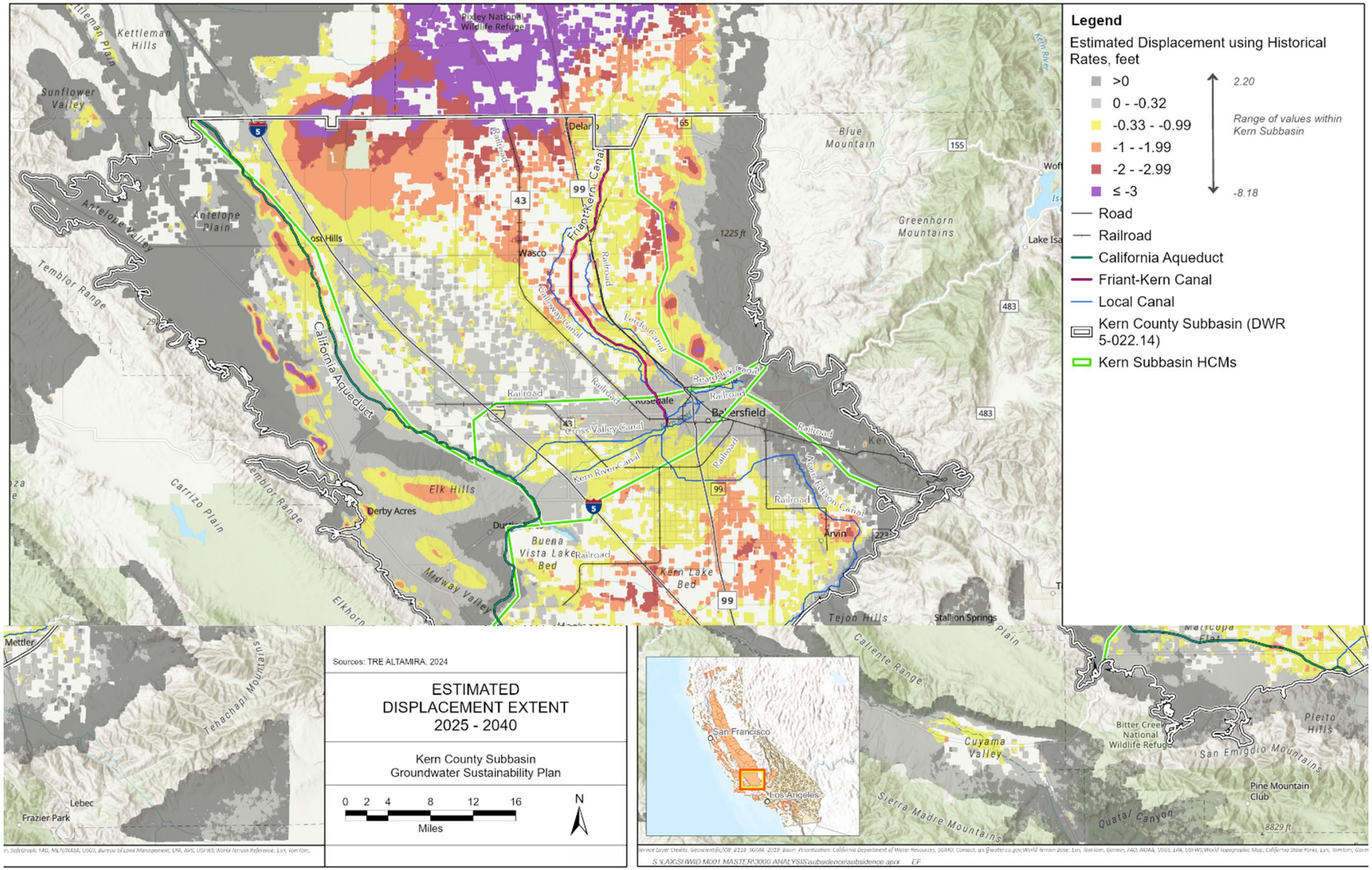


Figure 13-29. Projected Future (2024 – 2040) HCM Area Subsidence Extents[20]

[20] Inclusive of GSA-related, non-GSA, and residual (from pre-2030 activities) subsidence. Future estimates are based on 2015 – 2024 rates of subsidence extrapolated through 2040.

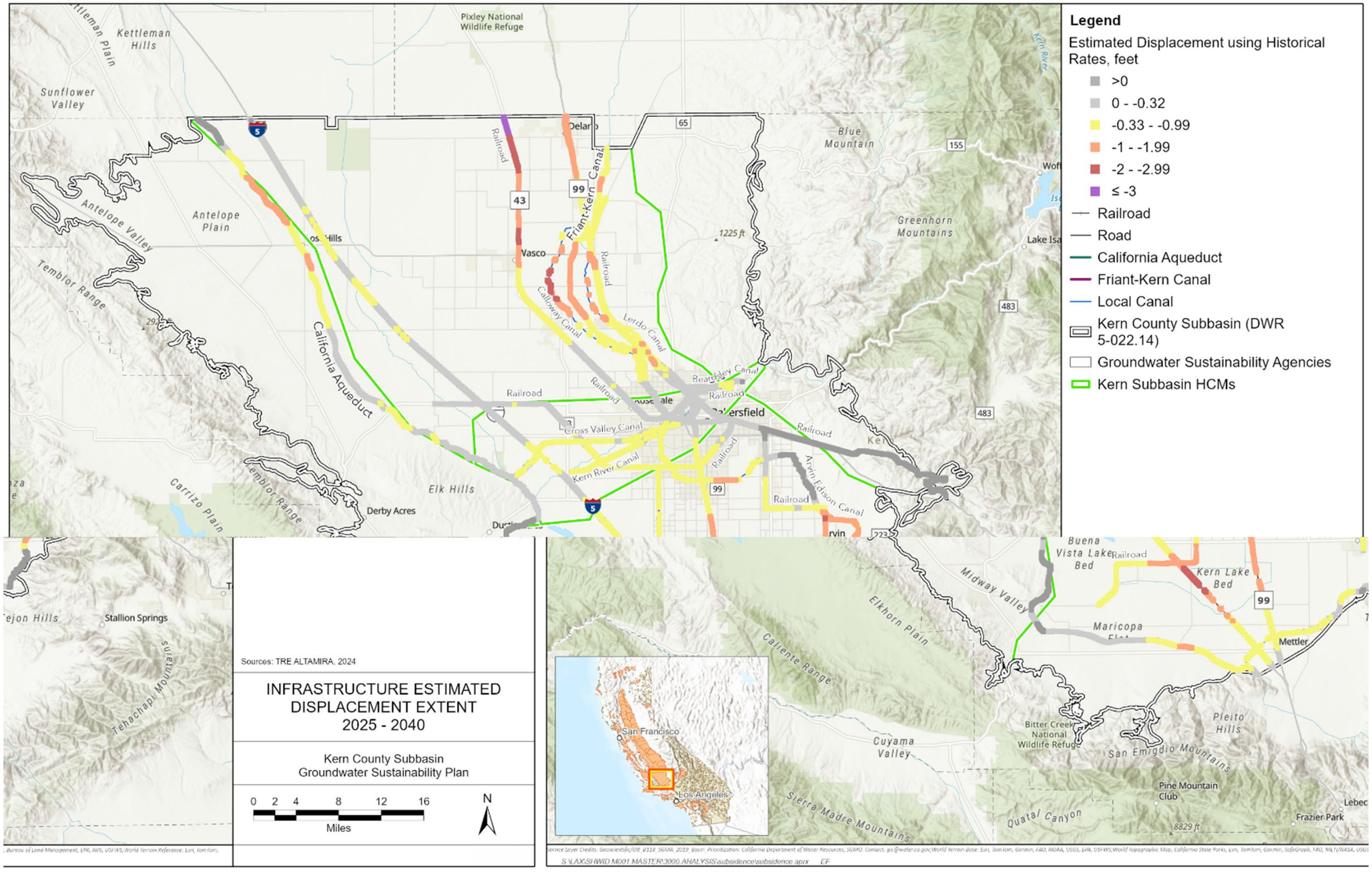


Figure 13-30. Estimates of Future (2024 – 2040) Cumulative Subsidence along Regional and GSA Critical Infrastructure

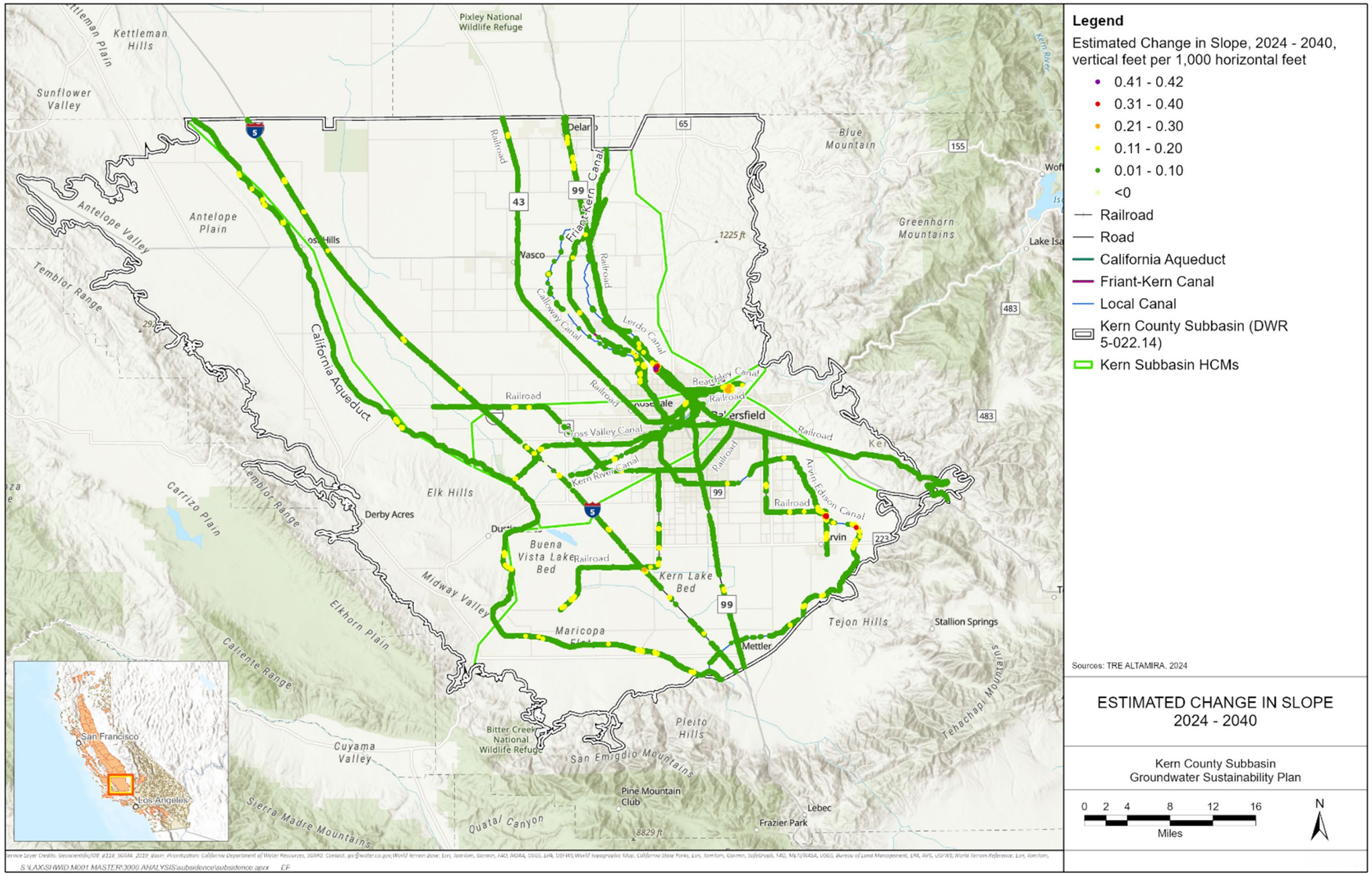


Figure 13-31. Change in Slope (vertical feet per 1000 horizontal feet) along Critical Infrastructure from 2024 – 2040 based on Projected Subsidence Extent

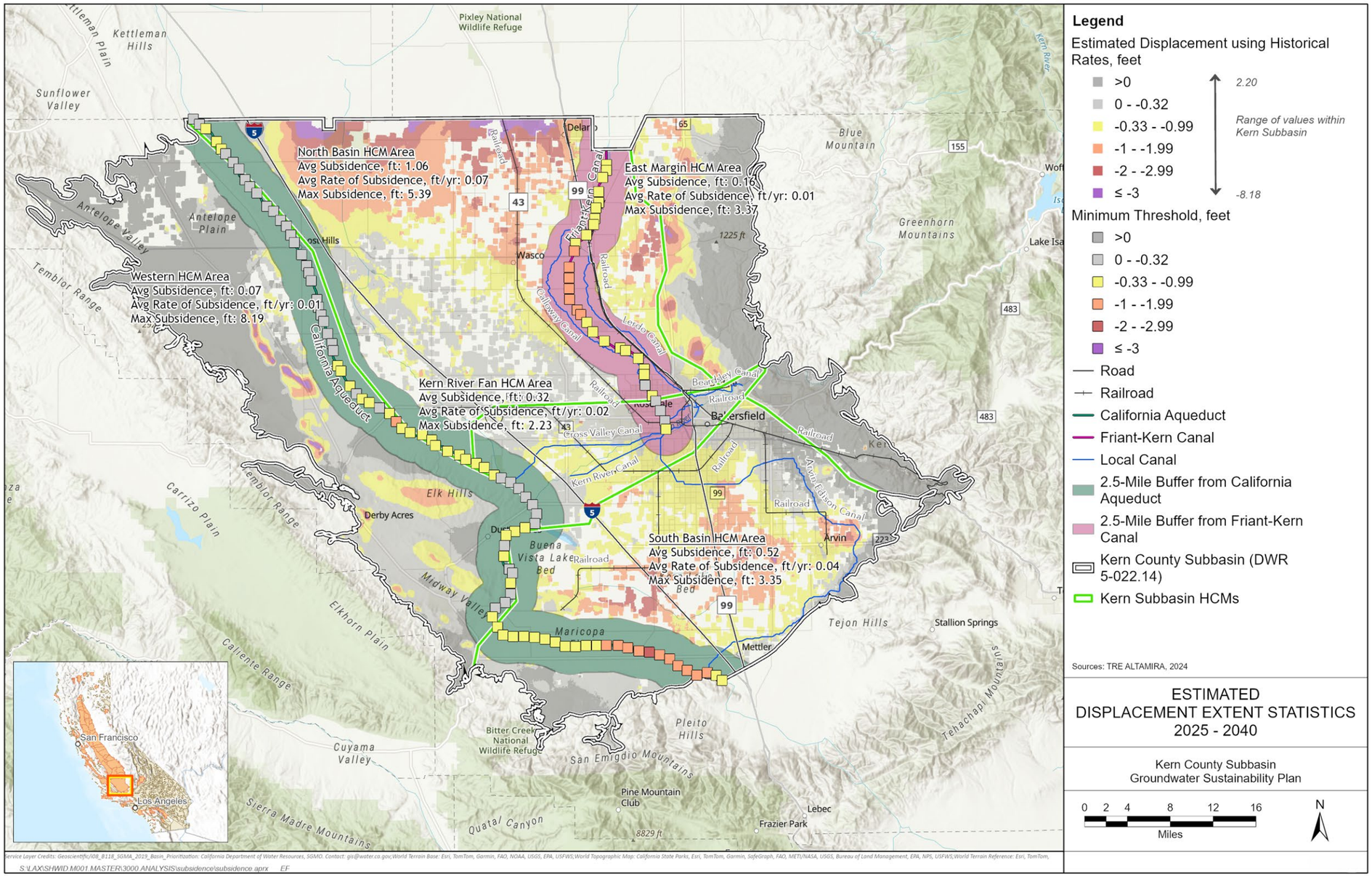


Figure 13-32. Projected Future (2024 – 2040) Rate, Average, and Maximum Subsidence Extents for each HCM Area and Protective MTs along Regional Critical Infrastructure Mileposts[18]

13.5.2.2 Potential Subsidence Impacts

Overall, the estimated future subsidence and change in slope (Figure 13-29 and Figure 13-26) are not expected to lead to significant and unreasonable impacts, except in a section along the FKC (discussed in subsequent sections). The highest future GSA-related cumulative subsidence extent that is estimated for the Kern Subbasin from 2024-2040 is 5.39 feet at the northern boundary, correlated with the much higher amounts of subsidence observed just north of the Kern Subbasin boundary. This maximum subsidence is expected to be less than that projected for this analysis, as the Tule subbasin to the north reaches sustainability and minimizes subsidence by 2040[21]. Moreover, significant and unreasonable impacts are not expected even at this amount of subsidence because: (a) no critical infrastructure passes through the area with the highest extent of subsidence,(b) most groundwater wells located in this area can tolerate this amount of subsidence as they are typically fitted with compression sections that can withstand 15 to 30 feet of subsidence (Kevin McGillicuddy, Roscoe Moss Co. 1/5/24), and (c) if there are local impacts due to subsidence then these will be addressed through mitigation (Section 14.2.3, Project KSB-1) if they are impacted by GSA-related subsidence.

The rest of this section evaluates the potential impacts on Regional Critical Infrastructure from the projected amounts of subsidence to assess if (a) significant and unreasonable impacts may occur due to the estimated absolute or differential future subsidence, and (b) establish SMCs to avoid any significant and unreasonable impacts to regional critical infrastructure. The Kern Subbasin is committed to working in close coordination with DWR California Aqueduct Subsidence Program (CASP), the Friant Water Authority (FWA) and other relevant agencies (e.g., local, state and federal agencies, infrastructure managers, private entities, beneficial users etc.) to ensure GSA-related subsidence SMCs are maintained via the implementation of proactive GSA P/MAs and incorporation of the soon to be released DWR Subsidence BMPs, as applicable.

13.5.2.3 Regional Critical Infrastructure: California Aqueduct

The following considerations were used to establish Land Subsidence SMCs for the California Aqueduct:

- As detailed in Section 8.5.1.5, historical (pre-2015) subsidence has occurred along portions of the Aqueduct and there is a potential for subsidence to occur in the future.
- Historical subsidence along portions of the northern Aqueduct in the Kern Subbasin (milepost [MP] 194 to 215) which has likely occurred because of oil

[21] Based on the most current information obtained from Thomas Harder in March 2024, the Tule Subbasin has set their Land Subsidence Minimum Thresholds at a maximum of approximately 7 feet.

field extraction activities and other non-GSA factors (Section 8.5.2.2) have been identified.

- Historical subsidence along portions of the southern Aqueduct in the Kern Subbasin (MP 250 to 279) has occurred as a result of both GSA and non-GSA factors.
- Because of the nature of the soils and anticipated potential for hydro-compaction, the southern Aqueduct pools were constructed by DWR with excess freeboard and have a buffer to accommodate subsidence without negatively influencing conveyance capacity. Specifically, "*An extra 2.5 feet to 6.2 feet of lined freeboard (on top of the 2.5 feet of normal freeboard used in the SJFD) was added in certain areas to compensate for future subsidence*." (DWR, 2017b). As such, with the proactive Subbasin P/MAs, it is not anticipated that future impacts from subsidence will be significant and unreasonable.
- All sections of the Aqueduct that fall within the Kern Subbasin have been identified as Regional Critical Infrastructure.

The MT for Land Subsidence along the Aqueduct (i.e., within the 5-mile-wide CASP Monitoring Corridor from MP 184 to 279) is defined as the avoidance of a permanent loss of conveyance capacity attributable to subsidence as limited by remaining concrete liner freeboard for a specific Aqueduct milepost. A freeboard analysis of the Aqueduct was performed using CASP survey data collected at benchmarks located at variable lateral distances along the Aqueduct having on average approximately 0.5-mile spacing. The current available concrete liner freeboard[22] was calculated using the 2024 survey at each benchmark by subtracting the 2024 top of Aqueduct concrete liner survey elevation from the Aqueduct water surface elevation plus 2.5 feet of required freeboard with a 0.1-foot margin to account for survey accuracy[23]. CASP has previously indicated that 2.5 feet of freeboard above the design water surface is required to maintain operations (DWR, 2017b), and is the best available metric to conduct an impacts analysis at this time (Pers. Comm. Jesse J. Dillon 11/1/2024).

Subsidence along the Aqueduct was extrapolated to 2040 at each Aqueduct benchmark using the historical rate of subsidence from 2013 to 2024 as measured by the survey data. Use of historical rates are justified because the measured rate of cumulative subsidence is fairly uniform over time as observed in survey data collect over various periods from 1969 to 2024 (Figure 13-27 and Figure 13-28).

[22] Concrete liner freeboard is defined as the distance from the Aqueduct water surface elevation to the top of the concrete liner. CASP had indicated that a minimum of 2.5 feet of freeboard is required to operate the Aqueduct.

[23] The practical limit for high-precision global positioning system (GPS) vertical survey accuracy is reported by CASP to be approximately 10 to 20 millimeters (0.03 to 0.07 feet) (Pers. Comm. Jesse J. Dillon 11/1/2024).

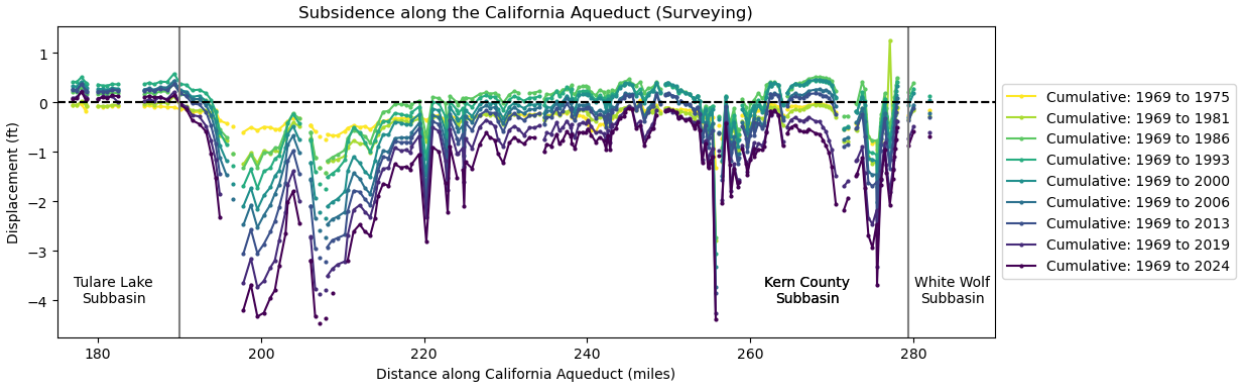


Figure 13-33. Subsidence Along the California Aqueduct MP 180 to 280 from 1969 to 2024

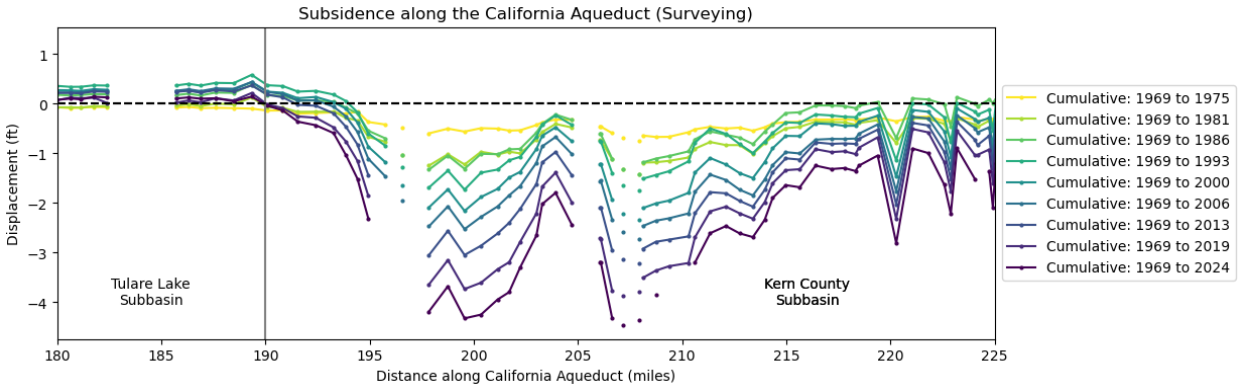


Figure 13-34. Subsidence Along the California Aqueduct MP 180 to 225 from 1969 to 2024

The current (2024) and projected top of Aqueduct concrete liner survey elevation are shown with elevation changes using the 2013 to 2024 surveyed rate of subsidence at each benchmark assuming a glide path over the periods as follows: (0.75 percent 2025-2030, 0.5 percent 2030-2035, 0.25 percent 2035-2040, and 0 percent by 2040-beyond). By comparing the required freeboard elevation (red line) to the current and projected top of Aqueduct concrete liner elevation (various color lines with markers) it can be determined whether cumulative subsidence–assuming the above subsidence rates–would encroach on the available freeboard at various times through 2040, and result in loss of conveyance capacity (Figure 13-29 and Figure 13-30).

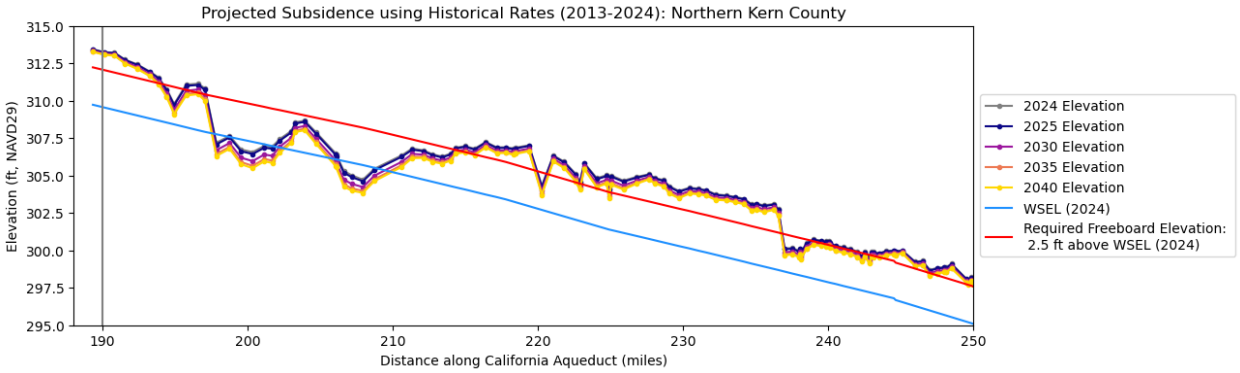


Figure 13-35. Projected Subsidence Along the California Aqueduct MP 190 to 250

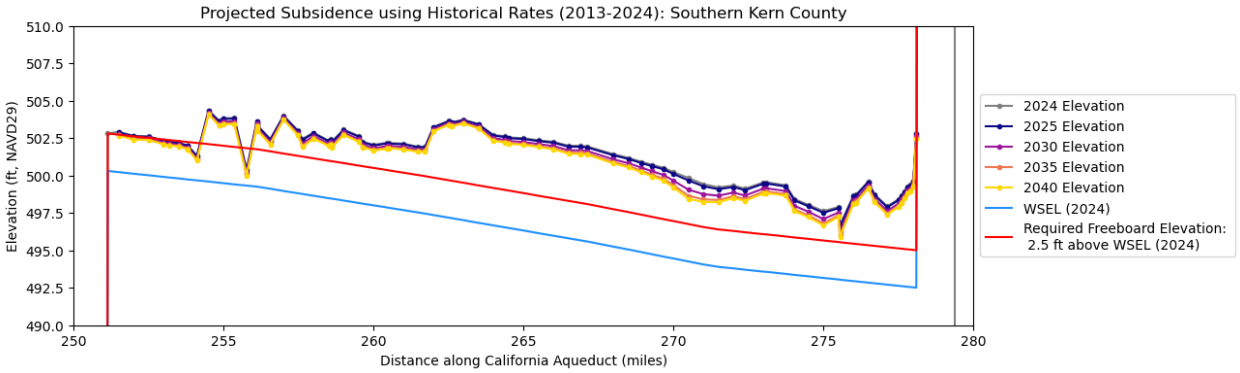


Figure 13-36. Projected Subsidence Along the California Aqueduct MP 250 to 280 (Note: When the concrete liner elevation (various color lines with markers) falls below the required freeboard elevation (red line) there is no longer sufficient operational freeboard).

As observed from the above figures, land subsidence has already encroached on the minimum 2.5 feet of freeboard requirements from approximately MP 194 to MP 217 (near the Lost Hills Oil Field), MP 220, MP 223 to MP 226, MP 237 to MP 244, MP 246 to MP 250, and near MP 252 to 254. At these locations, the MT is set to zero additional subsidence. Figure 13-35 and Figure 13-36 show the portions of the Aqueduct in which zero additional subsidence can occur to maintain required freeboard (0.1ft margin) or have already encroached on the required freeboard shaded in red.

Following the decision tree (Figure 13-25) for the above considerations, MTs are set as a future projected rate of subsidence, and adjusted where necessary to avoid URs (Figure 13-37 and Figure 13-38). Table 13-8 provides the SMCs for the Aqueduct. Projected available freeboard changes using historical subsidence rates indicate that for the most part, except for the MPs shaded in red, adequate Aqueduct freeboard will remain fairly constant by MP.

Notably, setting the MTs as a future projected rate of subsidence is sufficient to avoid URs for the southern portion of the Aqueduct. The CASP benchmark survey data from 1969 to 1978 show that initial design freeboard of the southern Aqueduct pools ranged

from 5.5 feet in the west to 8.5 feet in the east.[24] The 2017 California Aqueduct Subsidence Study published by CASP does not suggest that operational impacts have occurred within the southern pools since this time (DWR, 2017b). To maintain sufficient functional capacity, CASP has a minimum freeboard requirement of 2.5 feet. Therefore, URs based on a "significant loss in functionality" are defined for the Aqueduct's southern pools as available freeboard falling below the 2.5 feet minimum design freeboard with a 0.1-foot margin for measurement error.

InSAR data and yearly benchmark surveys completed by CASP were used to assess recent (i.e., post-2015) subsidence in the southern pools. InSAR data show that over the 2015-2021 period, cumulative subsidence within the southern portion of the Aqueduct ranged from less than 0.08 feet to 0.6 feet. Similarly, yearly benchmark surveys suggest that from 2016 to 2023, cumulative subsidence ranged from 0.2 to 0.75 feet. Both InSAR and survey data indicate that the southern pools currently have a significant buffer between the 2.5 feet minimum freeboard requirement and recent pool elevations.

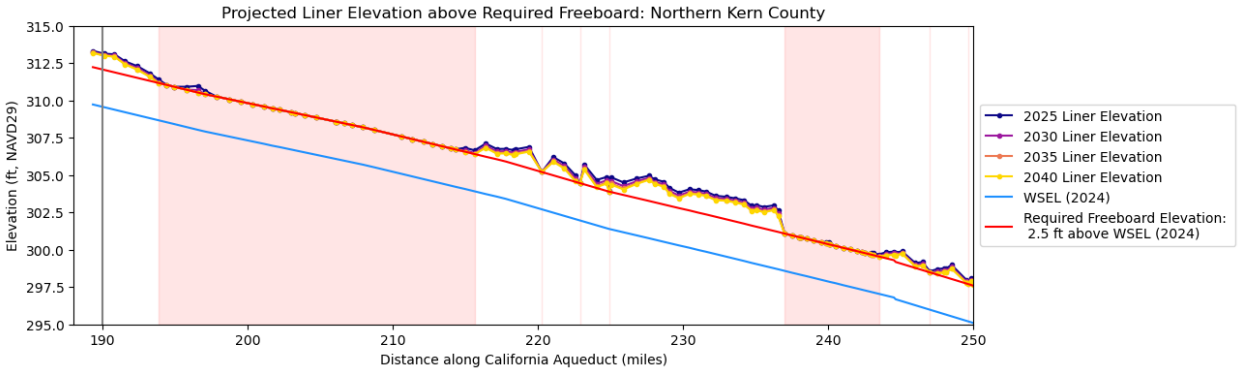


Figure 13-37. Projected Liner Elevation Above Required Freeboard Along the California Aqueduct MP 190 to 250

[24] DWR notes in its recent California Aqueduct Subsidence Study that as much as 9 feet of land subsidence occurred as a result of hydro-compaction from pre-consolidation ponding activities during Aqueduct construction within the southern pools (DWR, 2017b). The considerable additional freeboard that was constructed throughout these portions was added "to compensate for future subsidence" (DWR, 2017b). DWR data shows that pre-construction hydrocompaction was not completed on portions of the northern Aqueduct (e.g., approx. MP 195-215). In addition, other non-GSA potential causes of subsidence have been identified at MP 195-215 and other portions of the Aqueduct (e.g., expansive/collapsible soils, oil and gas activities, etc.). The Subbasin GSAs are working in cooperation with CASP/DWR to further assess the extent and causes of subsidence along the Aqueduct.

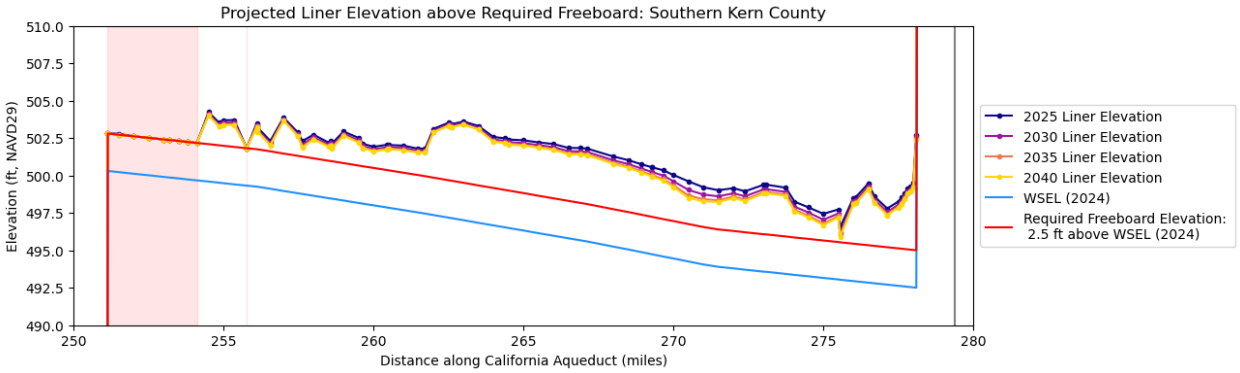


Figure 13-38. Projected Liner Elevation Above Required Freeboard Along the California Aqueduct MP 250 to 280

Since subsidence is a complex process and residual subsidence can continue to occur after P/MAs have been initiated, the Exceedance Policy and Action Plan for Land Subsidence is conservatively triggered at an IM exceedance. Therefore, as detailed in Appendix K-1, if a single IM or MT exceedance occurs for a single milepost (based on precise survey data), the Exceedance Policy and Action Plan for Land Subsidence are initiated, wherein an assessment of the cause of subsidence would be conducted in consultation with CASP and appropriate State agencies. If the exceedance is found to be related to a non-GSA cause, the exceedance will be defined as outside of GSA authority to manage independently and the appropriate regulatory agency would be contacted. GSA-related subsidence would likewise be assessed and addressed following the Exceedance Policy and Action Plan for Land Subsidence, including additional steps for implementation of focused GSA P/MAs, as appropriate.

The above methodology for developing MTs, recognizing the historical subsidence rate as calculated from the latest CASP precise survey data, is further supported by the preliminary findings of the Earth Consultants International and Lawrence Berkely National Laboratory subsidence studies for the Kern Subbasin (https://kerngsp.com/gsp-documents/subsidence-referenced-studies/).

As discussed above, potential for future GSA-related differential subsidence was ascertained by calculating the change in slope from 2024 to 2040. As shown in Figure 13-26, the change in slope along the majority of the northern portion of the Aqueduct in the Kern Subbasin is less than 0.1 feet/1000 feet (less than 0.01 percent), which is a negligible amount well within the uncertainty of the InSAR data, with a very small segment with a change in slope between 0.1 feet/1000 feet and 0.2 feet/1000 feet (less than 0.02. percent). Therefore, the GSA-related differential subsidence risk for the Aqueduct is minimal.

The objective of the Kern Subbasin subsidence SMCs approach is to achieve zero GSA-related subsidence post-2040 and beyond. This will be accomplished through focused implementation of proactive demand reduction or other P/MAs designed to reduce land subsidence rates to meet the IM glide path (Section 13.5.3.2). The 2025

Plan defines a UR for land subsidence as a single representative monitoring site (e.g., milepost) exceeding the MT extent after 6-quarterly consecutive sampling events. The MT extents have been capped to not infringe into the 2.5 feet minimum operating freeboard height. As noted elsewhere in this Chapter and in Appendix K-1, GSA action will be conservatively taken at an IM exceedance, whereby GSAs will proactively begin investigating and evaluating the root cause of a potential exceedance, and, if necessary and applicable, implement a focused P/MA before an MT extent exceedance can occur.

As it pertains to the Aqueduct, the Kern Subbasin will conduct Quarterly calls with CASP/DWR to discuss subsidence extent and rates as a check on projected SMCs. The Kern Subbasin has also developed a proactive Action Plan for Land Subsidence (Appendix K-1) with detailed steps for assessing and managing subsidence IM/MT exceedances. The Action Plan for Land Subsidence will be updated, as necessary, with specific standardized criteria for protocols, actionable timelines, and proposed P/MA responses within six months of Kern Subbasin receipt of the final DWR subsidence BMPs that are currently in development and expected in late 2025. Furthermore, the P/MAs (including potential mitigation alternatives, if necessary) associated with the California Aqueduct will be reevaluated, as needed, once the CASP Long-Term Rehabilitation Study is completed.

Table 13-9. California Aqueduct SMCs by Survey Benchmark

Pool	Milepost	Latitude	Longitude	Minimum Thresholds			Measurable Objectives			Interim Milestones Extent (ft)			Interim Milestones Rate (ft/yr)		
				Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post 2040 Rate(ft/yr)	Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post 2040 Rate (ft/yr)	2025	2030	2035	2025	2030	2035
23	189.33	35.79	-119.87	0.33	0.02	0.00	0.16	0.01	0.00	0.02	0.09	0.14	0.01	0.01	0.00
	190.09	35.7831	-119.86	0.32	0.02	0.00	0.16	0.01	0.00	0.02	0.09	0.14	0.01	0.01	0.00
	190.82	35.777	-119.849	0.38	0.02	0.00	0.19	0.01	0.00	0.02	0.11	0.17	0.02	0.01	0.00
	192.41	35.7596	-119.831	0.57	0.04	0.00	0.29	0.02	0.00	0.04	0.16	0.25	0.03	0.02	0.01
	193.26	35.7494	-119.823	0.54	0.03	0.00	0.27	0.02	0.00	0.03	0.15	0.23	0.02	0.02	0.01
	193.85	35.7431	-119.816	0.28	0.02	0.00	0.14	0.01	0.00	0.02	0.08	0.12	0.01	0.01	0.00
	194.93	35.7315	-119.803	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	195.76	35.7224	-119.794	0.26	0.02	0.00	0.13	0.01	0.00	0.02	0.07	0.11	0.01	0.01	0.00
	197.05	35.708	-119.784	0.31	0.02	0.00	0.16	0.01	0.00	0.02	0.09	0.14	0.01	0.01	0.00
24	197.84	35.6985	-119.776	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	198.75	35.6899	-119.764	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	200.34	35.6719	-119.748	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	201.14	35.6652	-119.736	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	202.22	35.6528	-119.725	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	203	35.6449	-119.715	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	203.92	35.633	-119.708	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	204.7	35.6228	-119.702	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	206.06	35.6063	-119.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	207.18	35.5915	-119.682	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	207.94	35.5819	-119.678	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	208.73	35.571	-119.674	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	210.61	35.5456	-119.665	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	211.34	35.5351	-119.662	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	212.1	35.5248	-119.658	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	212.75	35.5161	-119.654	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	213.96	35.4994	-119.647	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	214.97	35.4859	-119.64	0.30	0.02	0.00	0.15	0.01	0.00	0.02	0.08	0.13	0.01	0.01	0.00
	215.64	35.4765	-119.638	0.28	0.02	0.00	0.14	0.01	0.00	0.02	0.08	0.12	0.01	0.01	0.00
	217.16	35.456	-119.631	0.72	0.05	0.00	0.36	0.02	0.00	0.05	0.20	0.32	0.03	0.02	0.01
	217.78	35.4489	-119.625	0.72	0.05	0.00	0.36	0.02	0.00	0.05	0.20	0.32	0.03	0.02	0.01
26	219.38	35.4285	-119.611	0.76	0.05	0.00	0.38	0.02	0.00	0.05	0.21	0.33	0.03	0.02	0.01
	220.27	35.4179	-119.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	221.06	35.4109	-119.591	0.75	0.05	0.00	0.37	0.02	0.00	0.05	0.21	0.33	0.03	0.02	0.01
	221.81	35.406	-119.579	0.81	0.05	0.00	0.40	0.03	0.00	0.05	0.23	0.35	0.04	0.03	0.01
	222.89	35.3987	-119.562	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	224.05	35.3912	-119.545	0.59	0.04	0.00	0.29	0.02	0.00	0.04	0.17	0.26	0.03	0.02	0.01

Pool	Milepost	Latitude	Longitude	Minimum Thresholds			Measurable Objectives			Interim Milestones Extent (ft)			Interim Milestones Rate (ft/yr)		
				Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post 2040 Rate(ft/yr)	Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post 2040 Rate (ft/yr)	2025	2030	2035	2025	2030	2035
27	225.05	35.3801	-119.534	1.04	0.07	0.00	0.52	0.03	0.00	0.07	0.29	0.46	0.05	0.03	0.01
	225.89	35.371	-119.525	0.89	0.06	0.00	0.45	0.03	0.00	0.06	0.25	0.39	0.04	0.03	0.01
	226.79	35.3652	-119.511	0.86	0.05	0.00	0.43	0.03	0.00	0.05	0.24	0.38	0.04	0.03	0.01
	228.06	35.3622	-119.491	0.72	0.04	0.00	0.36	0.02	0.00	0.04	0.20	0.31	0.03	0.02	0.01
	229.06	35.355	-119.476	0.94	0.06	0.00	0.47	0.03	0.00	0.06	0.26	0.41	0.04	0.03	0.01
	229.71	35.3475	-119.469	0.92	0.06	0.00	0.46	0.03	0.00	0.06	0.26	0.40	0.04	0.03	0.01
	231.06	35.3397	-119.449	0.71	0.04	0.00	0.35	0.02	0.00	0.04	0.20	0.31	0.03	0.02	0.01
28	232.24	35.3345	-119.43	0.70	0.04	0.00	0.35	0.02	0.00	0.04	0.20	0.30	0.03	0.02	0.01
	232.96	35.3286	-119.419	0.64	0.04	0.00	0.32	0.02	0.00	0.04	0.18	0.28	0.03	0.02	0.01
	234.19	35.3229	-119.402	0.69	0.04	0.00	0.35	0.02	0.00	0.04	0.19	0.30	0.03	0.02	0.01
	235.06	35.3174	-119.389	0.79	0.05	0.00	0.39	0.02	0.00	0.05	0.22	0.34	0.03	0.02	0.01
	236.27	35.307	-119.373	0.76	0.05	0.00	0.38	0.02	0.00	0.05	0.21	0.33	0.03	0.02	0.01
	237	35.303	-119.361	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	238	35.297	-119.345	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	239	35.2887	-119.332	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
	240.07	35.2769	-119.321	0.17	0.01	0.00	0.08	0.01	0.00	0.01	0.05	0.07	0.01	0.01	0.00
	241.06	35.2666	-119.309	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	242	35.2541	-119.303	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	243	35.2412	-119.306	0.13	0.01	0.00	0.06	0.00	0.00	0.01	0.04	0.05	0.01	0.00	0.00
	244	35.2356	-119.322	0.43	0.03	0.00	0.22	0.01	0.00	0.03	0.12	0.19	0.02	0.01	0.01
30	245.09	35.2306	-119.339	0.35	0.02	0.00	0.17	0.01	0.00	0.02	0.10	0.15	0.02	0.01	0.00
	246	35.2253	-119.354	0.36	0.02	0.00	0.18	0.01	0.00	0.02	0.10	0.16	0.02	0.01	0.00
	247	35.2115	-119.356	0.11	0.01	0.00	0.06	0.00	0.00	0.01	0.03	0.05	0.00	0.00	0.00
	248	35.1971	-119.358	0.60	0.04	0.00	0.30	0.02	0.00	0.04	0.17	0.26	0.03	0.02	0.01
	249.5	35.1797	-119.349	0.28	0.02	0.00	0.14	0.01	0.00	0.02	0.08	0.12	0.01	0.01	0.00
	250	35.1744	-119.343	0.29	0.02	0.00	0.14	0.01	0.00	0.02	0.08	0.13	0.01	0.01	0.00
	250.99	35.1608	-119.347	0.46	0.03	0.00	0.23	0.01	0.00	0.03	0.13	0.20	0.02	0.01	0.01
31	252.01	35.1461	-119.347	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	253	35.1345	-119.356	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	254.11	35.1271	-119.372	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	255	35.1154	-119.377	0.75	0.05	0.00	0.37	0.02	0.00	0.05	0.21	0.33	0.03	0.02	0.01
	256.11	35.1014	-119.369	0.61	0.04	0.00	0.31	0.02	0.00	0.04	0.17	0.27	0.03	0.02	0.01
32	257	35.0907	-119.36	0.49	0.03	0.00	0.25	0.02	0.00	0.03	0.14	0.21	0.02	0.02	0.01
	258	35.0885	-119.343	0.76	0.05	0.00	0.38	0.02	0.00	0.05	0.21	0.33	0.03	0.02	0.01
	259	35.0886	-119.325	0.67	0.04	0.00	0.33	0.02	0.00	0.04	0.19	0.29	0.03	0.02	0.01
	260.01	35.0873	-119.308	0.73	0.05	0.00	0.37	0.02	0.00	0.05	0.21	0.32	0.03	0.02	0.01
	261	35.0846	-119.291	0.76	0.05	0.00	0.38	0.02	0.00	0.05	0.21	0.33	0.03	0.02	0.01

Pool	Milepost	Latitude	Longitude	Minimum Thresholds			Measurable Objectives			Interim Milestones Extent (ft)			Interim Milestones Rate (ft/yr)		
				Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post 2040 Rate(ft/yr)	Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post 2040 Rate (ft/yr)	2025	2030	2035	2025	2030	2035
33	262	35.0805	-119.274	0.56	0.03	0.00	0.28	0.02	0.00	0.03	0.16	0.24	0.02	0.02	0.01
	263	35.0747	-119.257	0.48	0.03	0.00	0.24	0.01	0.00	0.03	0.13	0.21	0.02	0.01	0.01
	264	35.0742	-119.24	0.76	0.05	0.00	0.38	0.02	0.00	0.05	0.21	0.33	0.03	0.02	0.01
	265	35.0756	-119.223	0.85	0.05	0.00	0.42	0.03	0.00	0.05	0.24	0.37	0.04	0.03	0.01
	266	35.0756	-119.205	0.95	0.06	0.00	0.48	0.03	0.00	0.06	0.27	0.42	0.04	0.03	0.01
	266.91	35.0756	-119.189	1.05	0.07	0.00	0.52	0.03	0.00	0.07	0.29	0.46	0.05	0.03	0.01
34	268	35.0754	-119.17	1.17	0.07	0.00	0.58	0.04	0.00	0.07	0.33	0.51	0.05	0.04	0.01
	268.94	35.072	-119.154	1.31	0.08	0.00	0.65	0.04	0.00	0.08	0.37	0.57	0.06	0.04	0.02
	270	35.0676	-119.136	1.92	0.12	0.00	0.96	0.06	0.00	0.12	0.54	0.84	0.08	0.06	0.02
	271	35.0659	-119.119	2.23	0.14	0.00	1.12	0.07	0.00	0.14	0.63	0.98	0.10	0.07	0.03
35	272	35.062	-119.102	1.58	0.10	0.00	0.79	0.05	0.00	0.10	0.44	0.69	0.07	0.05	0.02
	273	35.0565	-119.085	1.39	0.09	0.00	0.70	0.04	0.00	0.09	0.39	0.61	0.06	0.04	0.02
	274.04	35.0471	-119.072	1.53	0.10	0.00	0.77	0.05	0.00	0.10	0.43	0.67	0.07	0.05	0.02
	275	35.0407	-119.056	1.80	0.11	0.00	0.90	0.06	0.00	0.11	0.51	0.79	0.08	0.06	0.02
	276	35.0341	-119.041	1.01	0.06	0.00	0.51	0.03	0.00	0.06	0.28	0.44	0.04	0.03	0.01
	277.13	35.0374	-119.023	1.07	0.07	0.00	0.53	0.03	0.00	0.07	0.30	0.47	0.05	0.03	0.01
	278	35.0335	-119.009	0.74	0.05	0.00	0.37	0.02	0.00	0.05	0.21	0.32	0.03	0.02	0.01
	278.8	35.0267	-118.999	0.63	0.04	0.00	0.32	0.02	0.00	0.04	0.18	0.28	0.03	0.02	0.01

Notes:

1. The *Northern Aqueduct* has significant non-GSA activities present in the 5-mile-wide Aqueduct “buffer zone”. For example, Area of Interest (AOI) 2 [MP195-215] is adjacent to the Lost Hills Oil Field. Exceedances of an SMC would trigger the Kern Subbasin exceedance policy wherein an assessment of the cause of the exceedance would be conducted in consultation with CASP. If found to be related to a non-GSA cause (e.g., Aqueduct pre-construction geotechnical deficiencies, expanding soils, oil activities, natural processes (faulting, compaction) and age of infrastructure), the exceedance would be defined as outside of GSA authority.
2. MT extent is defined as the cumulative amount of vertical subsidence (in feet) that would occur from 2024-2040 at the MT rate. Similarly, MO extent is defined as the cumulative amount of vertical subsidence that would occur from 2024-2040 at the MO rate.
3. Calculation of Minimum Threshold:

   Extent (2024-2040)(ft) – Cumulative subsidence represented by the minimum value between the available freeboard (with 0.1 ft of margin) and the subsidence extent estimated by applying the historical rate of subsidence to the 2024-2040 period.

   Avg. Rate (ft/yr) – Average rate of subsidence for cumulative subsidence (Extent (2024-2040)(ft)) to occur.

   Post 2040 Rate (ft/yr) – Target subsidence rate beginning 2040.
4. Calculation of Measurable Objective:

   Extent (2024-2040)(ft) – 50% of the cumulative subsidence representing the minimum value between the available freeboard (with 0.1 ft of margin) and the subsidence extent estimated by applying the historical rate of subsidence to the 2024-2040 period

   Avg. Rate (ft/yr) – 50% of the average rate of subsidence for cumulative subsidence (Extent (2024-2040)(ft)) to occur.

   Post 2040 Rate (ft/yr) – Target subsidence rate beginning 2040.
5. Calculation of Interim Milestones Extent (ft):

   2025 – Cumulative subsidence occurring by 2025 estimated by applying the MT rate of subsidence to the one-year duration of 2024-2025.

   2030 – Cumulative subsidence occurring by 2030 estimated by applying the MT rate of subsidence scaled by 70% to the five-year duration of 2025-2030 and then added to the 2025 value.

   2035 – Cumulative subsidence occurring by 2035 estimated by applying the MT rate of subsidence scaled by 50% to the five-year duration of 2030-2035 and then added to the 2030 value.
6. Calculation of Interim Milestones Rate (ft/yr):

   2025 – Subsidence rate occurring between 2025-2030 estimated by scaling the MT rate of subsidence by 70%. **2030** – Subsidence rate occurring between 2030-2035 estimated by scaling the MT rate of subsidence by 50%.

   2035 – Subsidence rate occurring between 2035-2040 estimated by scaling the MT rate of subsidence by 20%.
7. Calculation of the Historical Rate of Subsidence:

   The rate of subsidence was estimated by the average rate of elevation change between 2013-2024 using surveying data available from the California Aqueduct Subsidence Study
8. Reported Values Precision:

   The values presented in this table have been rounded to the nearest 100th of a foot (0.01 feet), however, these SMCs were calculated using full floating-point precision. The raw data and corresponding calculations used to develop these SMC are available upon request.

Abbreviations

ft = feet
ft/yr = feet per year
MO = Measurable Objective
MT = Minimum Threshold
SMC = Sustainable Management Criteria

13.5.2.4 Regional Critical Infrastructure: Friant Kern Canal (FKC)

The FWA position regarding subsidence along the FKC is that "...a*ny unmitigated conveyance loss due to subsidence beyond 2020 would lead to undesirable results*". Additionally, subsidence shall be no more than 3 feet of cumulative subsidence from 2015 to 2040 along portions of the FKC and at a rate less than a 5-year annual average rate of 0.1 feet per year (ft/yr). Beyond 2040, subsidence is to be minimized through demand reduction or other proactive measures (e.g., P/MAs). A maximum of approximately 0.4 feet of subsidence was observed along the FKC from 2015 to 2020. If the proposed MT is reached, up to an additional 2.6 feet of cumulative subsidence post-2020 could occur along the FKC.

To evaluate potential impacts from future subsidence along the FKC, the historical subsidence rate from 2015 to 2024 was forecast to 2040 using linear extrapolation to provide an estimate of future subsidence (as discussed in Section 13.5.2.2). This approach uses a "without projects" scenario, assuming consistent continued rates of subsidence equal to historical (2015 – 2024) through 2040. Figure 13-39 displays subsidence at MP 135.45 extrapolated to 2040 and indicates a total cumulative displacement of 2.5 feet since 2015 (1.6 additional feet from 2024 to 2040).

To further evaluate potential future subsidence along the FKC, a profile was developed using the historical InSAR subsidence data from 2015 to 2024 extrapolated to 2040 as shown in Figure 13-39. The subsidence forecast assumes that future subsidence occurs in areas of historical subsidence. It provides a general understanding of sections of the FKC that may require a liner raise and exceed subsidence thresholds that trigger the need for additional infrastructure improvements such as bridge replacement (e.g., approximately 1.25 feet of subsidence triggers the need for bridge replacement). Note that with the Kern Subbasin moving towards sustainability and water levels stabilizing by 2030, actual rates and extents of subsidence are expected to be lower than these estimates of future subsidence.

Mitigation would consist of raising the concrete liner by 3 to 6 feet and upgrading associated facilities/infrastructure such as bridge crossings, check structures, wasteways, turnouts, inlet drains, siphons/underdrains, power and telephone and various size pipelines. Mitigation is discussed in Section 14.2.3 and Appendix G-2.

Table 13-10 provides the SMCs for the FKC. MT extent is based on a projection of the MT rate from 2024 through 2040.

Table 13-10. Friant Kern Canal SMCs by Survey Benchmark

Pool	Milepost	Latitude	Longitude	Minimum Thresholds			Measurable Objectives			Interim Milestones Extent (ft)			Interim Milestones Rate (ft/yr)		
				Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post-2040 Rate (ft/yr)	Extent (2024-2040) (ft)	Avg. Rate (ft/yr)	Post-2040 Rate (ft/yr)	2025	2030	2035	2025	2030	2035
Paso Creek	121.5	35.7256	-119.182	0.49	0.03	0.00	0.25	0.02	0.00	0.03	0.14	0.22	0.02	0.02	0.01
	122.05	35.7179	-119.182	0.54	0.03	0.00	0.27	0.02	0.00	0.03	0.15	0.24	0.02	0.02	0.01
	122.85	35.7084	-119.189	0.88	0.06	0.00	0.44	0.03	0.00	0.06	0.25	0.39	0.04	0.03	0.01
	124.27	35.6891	-119.196	0.93	0.06	0.00	0.47	0.03	0.00	0.06	0.26	0.41	0.04	0.03	0.01
	125.28	35.6746	-119.196	0.67	0.04	0.00	0.34	0.02	0.00	0.04	0.19	0.29	0.03	0.02	0.01
	125.86	35.6673	-119.2	0.49	0.03	0.00	0.25	0.02	0.00	0.03	0.14	0.22	0.02	0.02	0.01
	126.87	35.6528	-119.202	0.48	0.03	0.00	0.24	0.02	0.00	0.03	0.14	0.21	0.02	0.02	0.01
	127.47	35.6448	-119.205	0.43	0.03	0.00	0.22	0.01	0.00	0.03	0.12	0.19	0.02	0.01	0.01
	128.77	35.6308	-119.216	0.39	0.02	0.00	0.20	0.01	0.00	0.02	0.11	0.17	0.02	0.01	0.00
Shafter Wasco	130.17	35.6193	-119.235	0.95	0.06	0.00	0.48	0.03	0.00	0.06	0.27	0.42	0.04	0.03	0.01
	130.81	35.6093	-119.237	1.04	0.07	0.00	0.52	0.03	0.00	0.07	0.29	0.46	0.05	0.03	0.01
	132.43	35.5874	-119.246	1.43	0.09	0.00	0.72	0.04	0.00	0.09	0.40	0.63	0.06	0.04	0.02
	133.43	35.5728	-119.246	1.53	0.10	0.00	0.76	0.05	0.00	0.10	0.43	0.67	0.07	0.05	0.02
	134.44	35.5584	-119.246	1.51	0.09	0.00	0.76	0.05	0.00	0.09	0.42	0.66	0.07	0.05	0.02
	135.45	35.5438	-119.246	1.65	0.10	0.00	0.83	0.05	0.00	0.10	0.46	0.72	0.07	0.05	0.02
	136.67	35.5294	-119.233	1.49	0.09	0.00	0.75	0.05	0.00	0.09	0.42	0.65	0.07	0.05	0.02
	137.2	35.5233	-119.227	1.28	0.08	0.00	0.64	0.04	0.00	0.08	0.36	0.56	0.06	0.04	0.02
Kern River	138.14	35.5125	-119.217	0.98	0.06	0.00	0.49	0.03	0.00	0.06	0.28	0.43	0.04	0.03	0.01
	139.2	35.4998	-119.207	0.95	0.06	0.00	0.48	0.03	0.00	0.06	0.27	0.42	0.04	0.03	0.01
	140.63	35.4871	-119.188	0.66	0.04	0.00	0.33	0.02	0.00	0.04	0.19	0.29	0.03	0.02	0.01
	140.63	35.4871	-119.188	0.66	0.04	0.00	0.33	0.02	0.00	0.04	0.19	0.29	0.03	0.02	0.01
	142.29	35.4777	-119.162	0.56	0.03	0.00	0.28	0.02	0.00	0.03	0.16	0.24	0.02	0.02	0.01
	142.86	35.4741	-119.153	0.68	0.04	0.00	0.34	0.02	0.00	0.04	0.19	0.30	0.03	0.02	0.01
	144.31	35.4634	-119.132	0.46	0.03	0.00	0.23	0.01	0.00	0.03	0.13	0.20	0.02	0.01	0.01
	145.49	35.4488	-119.122	0.55	0.03	0.00	0.28	0.02	0.00	0.03	0.16	0.24	0.02	0.02	0.01
	145.99	35.4415	-119.123	0.46	0.03	0.00	0.23	0.01	0.00	0.03	0.13	0.20	0.02	0.01	0.01
	147.01	35.427	-119.122	0.26	0.02	0.00	0.13	0.01	0.00	0.02	0.07	0.11	0.01	0.01	0.00
	148.34	35.4125	-119.11	0.35	0.02	0.00	0.18	0.01	0.00	0.02	0.10	0.15	0.02	0.01	0.00
	148.88	35.4054	-119.104	0.19	0.01	0.00	0.09	0.01	0.00	0.01	0.05	0.08	0.01	0.01	0.00
	149.95	35.3923	-119.097	0.24	0.01	0.00	0.12	0.01	0.00	0.01	0.07	0.10	0.01	0.01	0.00
	151.02	35.3785	-119.089	0.22	0.01	0.00	0.11	0.01	0.00	0.01	0.06	0.10	0.01	0.01	0.00
	151.82	35.3673	-119.087	0.42	0.03	0.00	0.21	0.01	0.00	0.03	0.12	0.18	0.02	0.01	0.01

Notes:

1. Calculation of Minimum Threshold:

   Extent (2024-2040)(ft) – Cumulative subsidence estimated by applying the historical rate of subsidence to the 2024-2040 period.

   Avg. Rate (ft/yr) – Average rate of subsidence for cumulative subsidence (Extent (2024-2040)(ft)) to occur.

   Post 2040 Rate (ft/yr) – Target subsidence rate beginning 2040.

2. Calculation of Measurable Objective:

   Extent (2024-2040)(ft) – 50% of the cumulative subsidence estimated by applying the historical rate of subsidence to the 2024-2040 period.

   Avg. Rate (ft/yr) – 50% of the average rate of subsidence for cumulative subsidence (Extent (2024-2040)(ft)) to occur.

   Post 2040 Rate (ft/yr) – Target subsidence rate beginning 2040.

3. Calculation of Interim Milestones Extent (ft):

   2025 – Cumulative subsidence occurring by 2025 estimated by applying the historical rate of subsidence to the one-year duration of 2024-2025.

   2030 – Cumulative subsidence occurring by 2030 estimated by applying the historical rate of subsidence scaled by 70% to the five-year duration of 2025-2030 and then added to the 2025 value.

   2035 – Cumulative subsidence occurring by 2035 estimated by applying the historical rate of subsidence scaled by 50% to the five-year duration of 2030-2035 and then added to the 2030 value.

4. Calculation of Interim Milestones Rate (ft/yr):

   2025 – Subsidence rate occurring between 2025-2030 estimated by scaling the historical rate of subsidence by 70%.

   2030 – Subsidence rate occurring between 2030-2035 estimated by scaling the historical rate of subsidence by 50%.

   2035 – Subsidence rate occurring between 2035-2040 estimated by scaling the historical rate of subsidence by 20%.

5. Calculation of the Historical Rate of Subsidence:

   The rate of subsidence was estimated using linear regression methods applied to spatially filtered vertical time series data (~weekly solutions) provided by DWR. To improve spatial coverage and limit the impacts of variable data availability in time (resultant of processing schemes employed by TRE Altamira), time series data are first subsampled to quarterly intervals (spanning October 2015 to April 2024), sequentially differenced, and then convolved with a 500 meter (~1640 ft) radius median filter. These filtered products are used to reconstruct displacement time series for measurement points. The rate at each measurement point is then estimated using the “linregress” function available from the python “scipy.stats” package.

6. Reported Values Precision

   The values presented in this table have been rounded to the nearest 100th of a foot (0.01 feet), however, these SMCs were calculated using full floating-point precision. The raw data and corresponding calculations used to develop these SMC are available upon request.

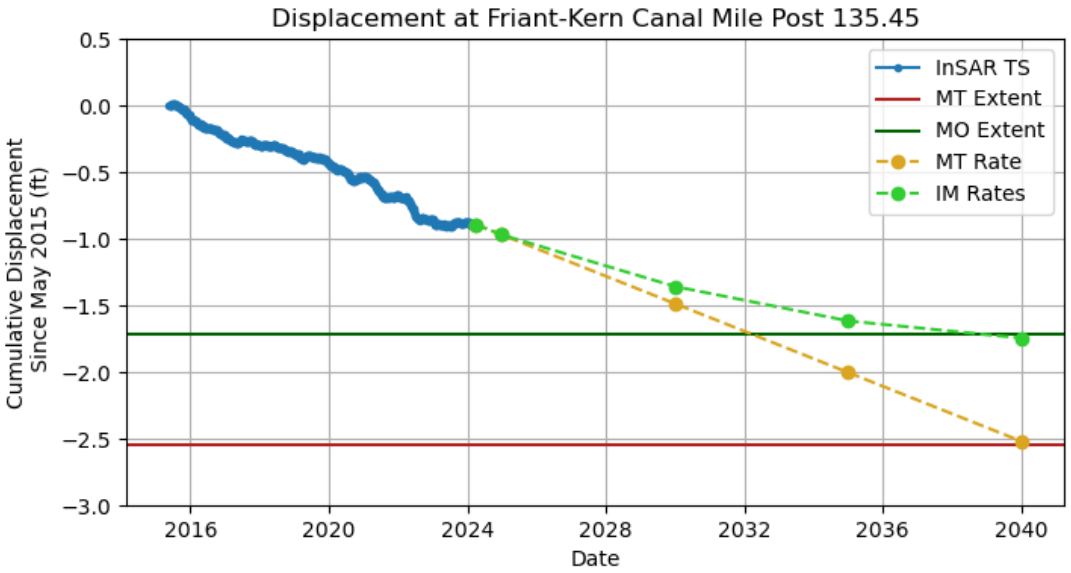


Figure 13-39. FKC Mile Post 135.45 Extrapolated Subsidence to 2040 (Based on 2015 to 2024 InSAR data)[25]

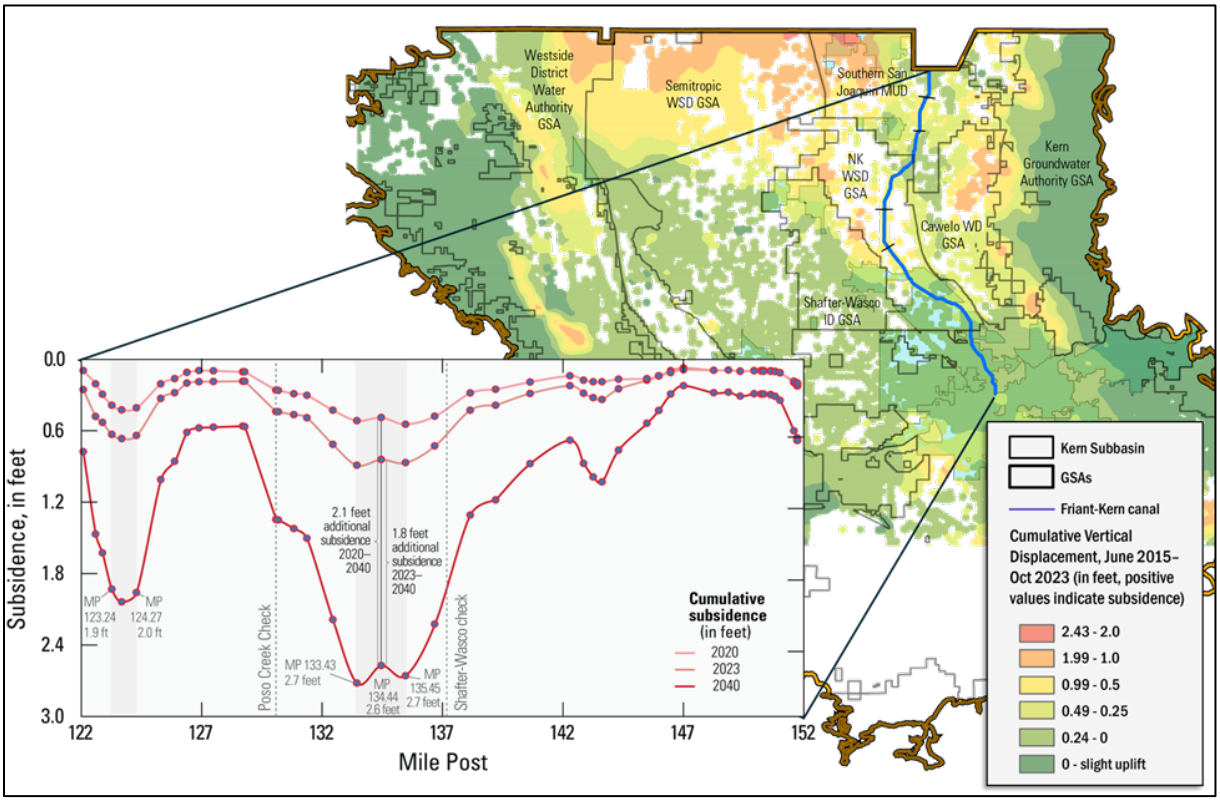


Figure 13-40. Kern Subbasin Cumulative Subsidence 2015 to 2023 and FKC Subsidence Profile Extrapolated to 2040

[25] the cumulative amount of vertical subsidence (in feet) that would occur from 2024-2040 at the MT rate.

13.5.2.5 GSA Area Critical and Other Infrastructure

GSA Area Critical Infrastructure

GSA Area Critical Infrastructure within the Kern Subbasin includes the Calloway Canal, Lerdo Canal, Beardsley Canal, Cross Valley Canal, Kern River Canal, Arvin-Edison Water Storage District Canal, Olcese Canal, Interstate-5 (I-5), and Highway 99. Figure 13-30 and Figure 13-31 show the cumulative extent from 2024-2040 and the change in slope for areas underlying these critical infrastructures. The amount of projected subsidence is similar to that seen under historical (2015 to 2024) conditions when no impacts on infrastructure were reported. Further, the change in slope for most of the infrastructure facilities is less than 0.1 feet/1000 feet (0.01 percent) with the highest change (close to 0.33 – 0.4 feet/1,000 feet or 0.03-0.04 percent) in slope estimated at localized sections near the Lerdo and Arvin Edison Canals. These changes in slopes are not expected to lead to significant differential subsidence impacts. Nevertheless, the North Kern and Arvin GSAs monitor these areas and have the ability to detect, manage, and mitigate any impacts if they were to occur in this area due to future subsidence.

Other Infrastructure

The future projected 2040 subsidence is not anticipated to cause any significant and unreasonable impacts to other Infrastructure as a result of differential subsidence. For example, the High-Speed Rail subsidence report (Amec, 2017) specifies a maximum acceptable change of grade of 0.1 percent (1 feet/1,000 feet), which is almost an order of magnitude higher than the maximum estimated change of slope for other infrastructure. Hence, these amounts of subsidence are not expected to lead to significant and unreasonable impacts on these infrastructure facilities and therefore can be used as the basis for the SMCs. See Section 13.5.2.8 for the discussion of potential impacts on other infrastructure.

Final Minimum Thresholds

The final MTs for Land Subsidence along Regional Critical Infrastructure are shown in Table 13-8 and Table 13-9 and GSA Critical Infrastructure and Other Infrastructure are shown in Table 13-10. Details on how SMCs for the Regional Critical Infrastructure are established is discussed above and in the notes of Table 13-8 and Table 13-9. For the GSA Area Critical Infrastructure and Other Infrastructure, SMCs are established using the subsidence potential based on historical cumulative subsidence observed along the infrastructure within each GSA, shown in Figure 13-35. For portions of these infrastructure (determined by on a GSA basis) that have minimal subsidence potential, MTs are set as the average historical subsidence rates and estimated 2024-2040 extents in each HCM Area as described in Section 13.5.2.1 (Table 13-11). For portions of these infrastructure (determined by on a GSA basis) that have low to moderate subsidence potential, MTs are set using the subsidence potential extent intervals and

associated subsidence rates (Figure 13-20 and Figure 13-35). The MTs for all other areas of the Kern Subbasin are set as the average historical subsidence rates and estimated 2024-2040 extents in each HCM Area as described in Section 13.5.2.1 (Table 13-11). Land subsidence rates and extents will be compared against MTs annually both locally along GSA Area Critical Infrastructure (Table 13-10) and regionally averaging the InSAR displacement across each HCM Area (Table 13-11).

It is important to note that the MTs are only set for the SGMA implementation period, after which the rate and extent of subsidence due to GSA-related activities would likely be minimal as the Kern Subbasin proposes to stabilize water levels (no chronic lowering of water levels) beyond 2030. The MOs are set at half the rate and extent of the MTs for the given HCM Area. Given that water levels are expected to stabilize 10 years before the MT extrapolation period, future subsidence is expected to be closer to the MOs rather than the MTs by 2040. An example of the established SMCs is shown in Figure 13-35. However, it is difficult to accurately predict future subsidence given that some residual and non-GSA subsidence may continue beyond 2030.

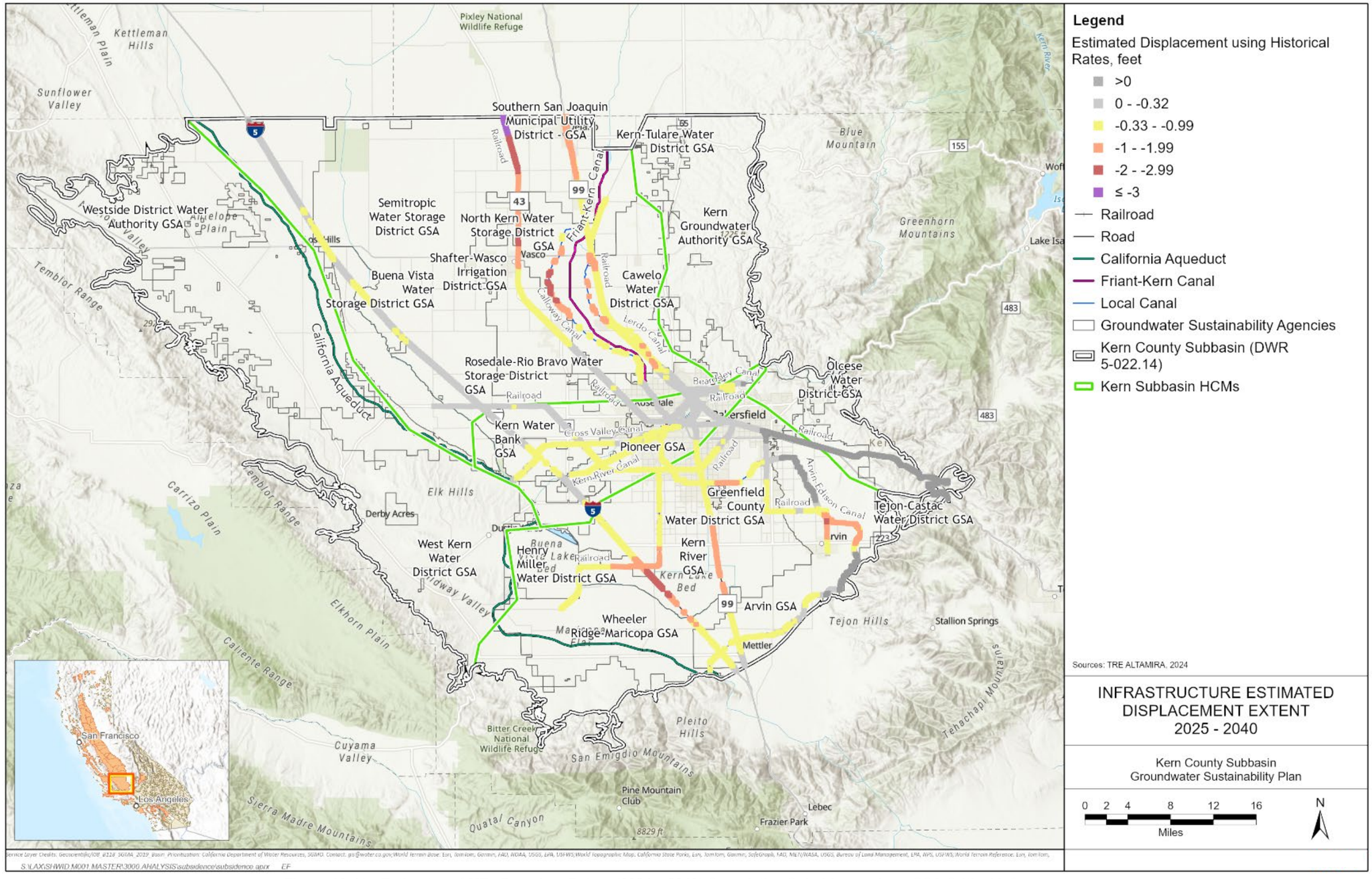


Figure 13-41. Estimates of MTs Based on Future (2024 – 2040) Cumulative Subsidence along GSA Critical Infrastructure

Table 13-11. Subsidence SMC Matrix for GSA Area/Other Infrastructure

Infrastructure	Critical Infrastructure Type[1]	GSA	Maximum Historical Cumulative (ft) Subsidence (InSAR: 2015 - 2023)	Maximum Historical Rates (ft/yr) of Subsidence (InSAR: 2015 - 2023)	Subsidence Cause	Subsidence Potential[2]	Impacts from Historical Subsidence	Potential Impacts from Future Subsidence	MT rate (ft/yr)	MT 2024-2040 extent (ft)[3]	MO rate (ft/yr)	MO 2024-2040 extent (ft)	IMs extent (ft)			IMs rate (ft/yr)		
													2025	2030	2035	2025	2030	2035
Calloway Canal	GSA Area	KRGSA	<0.33 ft	< 0.04 ft/yr	GSA	Minimal	None	Minimal ; Low	HCM Area Average, see Table 13-12									
	GSA Area	NKWSD	1 to 3 ft	0.12 to 0.37 ft/yr	GSA	Moderate	None	Moderate	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	SWID	1 to 3 ft	0.12 to 0.37 ft/yr	GSA	Moderate	None	Minimal ; Low	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
Lerdo Canal	GSA Area	CWD	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal ; Low	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	NKWSD	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal ; Low	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	KRGSA	<0.33 ft	< 0.04 ft/yr	GSA	Minimal	None	Minimal ; Low	HCM Area Average, see Table 13-12									
Beardsley Canal	GSA Area	CWD	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal ; Low	HCM Area Average, see Table 13-12									
	GSA Area	KRGSA	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal ; Low	HCM Area Average, see Table 13-12									
Cross Valley Canal	GSA Area	KRGSA	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	KWB	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	Pioneer	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	RRBWSD	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
Kern River Canal	GSA Area	KRGSA	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.04	0.64	0.02	0.32	0.04	0.18	0.28	0.03	0.02	0.01
	GSA Area	KWB	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.04	0.64	0.02	0.32	0.04	0.18	0.28	0.03	0.02	0.01
	GSA Area	Pioneer	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.04	0.64	0.02	0.32	0.04	0.18	0.28	0.03	0.02	0.01
AEWSD Canal	GSA Area	AEWSD	1 to 3 ft	0.12 to 0.37 ft/yr	GSA	Moderate	None	Possible loss of freeboard	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
Olcese Canal	GSA Area	OWD	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
I-5	GSA Area	AEWSD	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	BV	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	KRGSA	1 to 3 ft	0.12 to 0.37 ft/yr	GSA	Moderate	None	Minimal, Low, Moderate	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	KWB	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	RRBWSD	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	SWSD	<0.33 ft	<0.04 ft/yr	GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	WDWA	<0.33 ft	<0.04 ft/yr	Non-GSA	Minimal	None	Minimal	HCM Area Average, see Table 13-12									
	GSA Area	WRMWSD	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
Hwy 99	GSA Area	AEWSD	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	CWD	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	KRGSA	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	NKWSD	0.33 to 1 ft	0.04 to 0.12 ft/yr	GSA	Low	None	Minimal	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02
	GSA Area	SSJMUD	1 to 3 ft	0.12 to 0.37 ft/yr	GSA	Moderate	None	Minimal	0.12	1.92	0.06	0.96	0.12	0.54	0.84	0.08	0.06	0.02

Notes:

(1) MO/MT rates for regional infrastructure were derived based on benchmark data. Northern Aqueduct rates utilized benchmark and InSAR data (Whitepaper). MA MO/MT Rates were derived from historical (2015-2023) InSAR data. SMC for regional infrastructure are listed in Table 13-9 (California Aqueduct) and Table 13-10 (Friant Kern Canal).

(2) Step 3 as outlined in Section 13.5.2.1. See Figure 13-21.

(3) MT extent is defined as the cumulative amount of vertical subsidence (in feet) that would occur from 2024-2040 at the MT rate. Similarly, MO extent is defined as the cumulative amount of vertical subsidence that would occur from 2024-2040 at the MO rate.

(4) MTs not established using the HCM Area Average shown in Table 13-12, are established using the subsidence potential based on historical cumulative subsidence observed along the infrastructure within each GSA, shown in Figure 13-36.

(5) Both inelastic and elastic subsidence occurs in the area of the Kern Fan HCM Area. In some areas of the Kern Fan HCM Area, especially where significant recharge occurs at the Kern Water Bank, the average rate of subsidence calculated for the Kern Fan HCM Area using the period from 2015 to 2024 likely overestimate projected subsidence through 2040.

Abbreviations

AEWSD = Arvin GSA
BV = Buena Vista GSA
CWD = Cawelo Water District GSA
ft = feet
ft/yr = feet per year
GSA = Groundwater Sustainability Agency
HMWD = Henry Miller Water District GSA
IM = Interim Milestone
KRGSA = Kern River GSA
KWB = Kern Water Bank GSA
MO = Measurable Objective
MT = Minimum Threshold
NKWSD = North Kern Water Storage District GSA
OWD = Olcese Water District GSA
RRBWSD = Rosedale-Rio Bravo Water Storage District GSA
SMC = Sustainable Management Criteria
SSJMUD = Southern San Joaquin Municipal Utility District GSA
SWID = Shafter-Wasco Irrigation District GSA
SWSD = Semitropic Water Storage District GSA
WDWA = Westside District Water Authority GSA
WKWD = West Kern Water District GSA
WRMWSD = Wheeler Ridge-Maricopa GSA

Table 13-12. Land Subsidence SMCs by HCM Area

HCM Area	Average (across HCM Area) Subsidence Rate and Extents (ft)[1]			
	Minimum Threshold (rate ft/yr, 2024-2040 extent ft)[2]	Measurable Objective (rate ft/yr, 2024-2040 extent ft)[3]	Interim Milestones 2025 / 2030 / 2035 (extent ft)	Interim Milestones 2025 / 2030 / 2035 (Rate ft/year)
North Basin HCM Area	0.07 ft/yr, 1.06 ft	0.04 ft/yr, 0.53 ft	0.07/ 0.33 / 0.51	0.053 / 0.035 / 0.018
Kern River Fan HCM Area	0.02 ft/yr, 0.31 ft	0.01 ft/yr, 0.16 ft	0.02/ 0.10 / 0.15	0.015 / 0.01 / 0.005
South Basin HCM Area	0.03 ft/yr, 0.52 ft	0.02 ft/yr, 0.26 ft	0.03/ 0.14 / 0.22	0.023 / 0.015 / 0.008
Western Fold Belt HCM Area	0.00 ft/yr, 0.06 ft	0.00 ft/yr, 0.03 ft	0.00/ 0.02 / 0.03	0.003 / 0.002 / 0.001
East Margin HCM Area	0.01 ft/yr, 0.15 ft	0.01 ft/yr, 0.08 ft	0.01/ 0.05 / 0.07	0.008 / 0.005 / 0.003

Notes:

1. Subsidence MTs include subsidence from both GSA-related and non-GSA causes. Values have been rounded to the second decimal digit.
2. MT extent is defined as the cumulative amount of vertical subsidence (in feet) that would occur from 2024-2040 at the MT rate.
3. MO extent is defined as the cumulative amount of vertical subsidence that would occur from 2024-2040 at the MO rate

13.5.2.6 Relationship with Other Sustainability Indicators

☑ 23 CCR § 354.28(b)(2)

The MTs for Land Subsidence were designed to ensure that they are sufficiently protective of URs defined for all other relevant Sustainability Indicators to the Kern Subbasin. The specific relationships between Land Subsidence and other applicable Sustainability Indicators are discussed below:

- Historic land subsidence has been attributed to **Chronic Lowering of Groundwater Levels**. The Kern Subbasin GSAs are integrating subsidence into the Kern Subbasin's groundwater flow model as part of the 2025 Plan implementation; results of which will be used to ensure that MTs for Land Subsidence are protective of beneficial users and MTs set for Chronic Lowering of Groundwater Levels. As demonstrated in Section 13.1.2.2, subsidence associated with groundwater level declines to Chronic Lowering of Groundwater Level MTs is not projected to exceed the established Land Subsidence MTs. Groundwater level MTs were also capped in areas where they would lead to water levels going below the Corcoran where they have not in the past. Furthermore, MTs are locally raised to avoid conditions where groundwater levels may newly fall below the Corcoran Clay, providing additional protection in preventing potentially increased subsidence rates. Finally, the glide path trajectory for Chronic Lowering of Groundwater Level IMs (Section 13.1.3.2) shows increasing groundwater levels after 2030. This increase provides a 10-year buffer to address residual subsidence that may occur between 2030 and 2040 due to preceding groundwater level declines.

- A potential effect of URs due to Land Subsidence is a **Reduction of Groundwater Storage** due to compaction of fine-grained subsurface layers during groundwater pumping. As discussed in Section 13.2, the Chronic Lowering of Groundwater Levels MTs are used as a proxy for Reduction of Groundwater Storage and were demonstrated to be protective of URs due to Reduction of Groundwater Storage. Chronic Lowering of Groundwater Level SMCs are also protective of URs due to Land Subsidence. Through the correlation with Chronic Lowering of Groundwater Level SMCs, it is reasonable to conclude that Land Subsidence MTs will not cause an unreasonable Reduction of Groundwater Storage.
- Some studies suggest that consolidation of subsurface layers with high clay content may liberate arsenic and degrade groundwater quality (Smith et al., 2018). However, this has not been observed in most of the Central Valley, including the Kern Subbasin (Haugen et al., 2021). Concentrations of arsenic were plotted against annual InSAR subsidence rates at two RMW-WQs in the North Basin HCM Area near the northern Subbasin boundary. Arsenic concentration trends in these RMW-WQs showed weak and opposite correlations with subsidence, supporting the finding that a correlation between arsenic and subsidence has not been observed in the Kern Subbasin. Potential increases in arsenic, if any, due to subsidence will be monitored and managed per the SMCs established for Degraded Water Quality. There has been no observed correlation between Land Subsidence and other water quality COCs in the Kern Subbasin.
- No direct correlation has been discerned between Depletions of Interconnected Surface Waters and Land Subsidence.

13.5.2.7 Consideration of Adjacent Basins

☑ 23 CCR § 354.28(b)(3)

The MTs for Land Subsidence have been developed through a coordinated, Subbasin-wide effort and in consideration of the use of infrastructure outside of the Kern Subbasin. The maximum extent of recent subsidence is along the northern boundary and is influenced by the higher rates of subsidence north of the Subbasin boundary. The methods used to develop MTs for Land Subsidence are generally consistent with adjacent basins. Further, MT extents in the Kern Subbasin are much lower and more protective than MT extents in the adjacent northern Tule and Tulare Lake Subbasins. Therefore, implementation of the 2025 Plan would not prevent neighboring subbasins from achieving their Land Subsidence sustainability goal(s). Although Land Subsidence MTs in the adjacent southern White Wolf Subbasin are currently set using groundwater levels as a proxy, Kern Subbasin GSAs are actively collaborating with the White Wolf GSA to ensure consistency as the White Wolf GSA develops Land Subsidence SMCs.

13.5.2.8 Impacts to Beneficial Users

☑ 23 CCR § 354.28(b)(4)

As discussed above, the MTs for Land Subsidence are designed to maintain the functionality of Regional and GSA Critical Infrastructure and avoid URs to surface land uses. The Kern Subbasin is committed to working in close coordination with CASP and DWR, FWA and other relevant agencies to ensure GSA-related subsidence MT exceedances are avoided via the implementation of proactive GSA P/MAs and incorporation of the soon to be released DWR BMPs, as applicable.

California Aqueduct

The MT for Land Subsidence for the California Aqueduct is established based on the avoidance of a permanent loss of conveyance capacity associated with GSA-related subsidence as limited by remaining concrete liner freeboard measured at each specific Aqueduct milepost. It is typical that major infrastructure designs incorporate assumptions for natural settling, subsidence of any type, service life, repair and replacement cycles, among other considerations. The Kern Subbasin MTs aim to maintain the functional capacity of the Aqueduct. However, since data indicates that historical subsidence within the 5-mile-wide CASP Monitoring Corridor along portions of the Aqueduct (i.e., MP 194 to 215) is influenced by various non-GSA activities and conditions, some subsidence and its effects will likely be outside the GSA authority to manage. That said, the Westside District Water Authority GSA has implemented a series of proactive GSA P/MAs designed to ameliorate the rate and extent of potential GSA-related subsidence, if any, between MP 195 and MP 215. One of these P/MAs is a groundwater pumping moratorium within the CASP 5-mile-wide monitoring zone between MP 195 and MP 215.

The methodology for developing MOs and MTs recognizes a baseline subsidence rate as calculated from CASP land survey data and is supported by the findings of the Kern Groundwater Authority Subsidence Study and Lawrence Livermore Study (https://kerngsp.com/gsp-documents/subsidence-referenced-studies/). The objective of Kern Subbasin subsidence SMCs is to eliminate GSA-related subsidence MT exceedances post-2040 and beyond via the implementation of proactive demand reduction or other focused GSA P/MAs.

The 2017 California Aqueduct Subsidence Study published by CASP (DWR, 2017b) does not suggest that operational impacts or loss in conveyance capacity have occurred within the southern pools. To maintain sufficient functional capacity, CASP has a minimum freeboard requirement of 2.5 feet above the design water surface. As shown in Figure 13-32 above, the Aqueduct MTs would maintain more than CASP's required 2.5 feet minimum freeboard above the design water surface, maintain the general elevation change to minimize impacts to gravity-driven conveyance, and therefore maintain the functionality of the Aqueduct between pools 31 and 35. Kern Subbasin

GSAs have been in close coordination with the CASP team regarding this MT for the Aqueduct (north and south reaches) approach, and have adjusted the Aqueduct MTs to be set at individual benchmark locations instead of on an average pool level (Table 13-9). That said, the Wheeler Ridge-Maricopa GSA has implemented proactive P/MA's including well registration and well extraction reporting within the GSA, which includes a significant portion of the southern portion of the Aqueduct (pools 31-35). The Wheeler Ridge-Maricopa Water Storage District has implemented significant groundwater extraction charges within its district boundaries, which include lands within the Kern and White Wolf Subbasins.

The Kern Subbasin has developed a proactive Action Plan for Land Subsidence (Appendix K-1) with detailed steps for assessing and managing subsidence IM/MT exceedances. The Action Plan for Land Subsidence will be updated, as necessary, with specific standardized criteria for protocols, actionable timelines, and proposed P/MA responses within six months of Kern Subbasin receipt of the final DWR subsidence BMPs that are currently in development, and expected in late 2025. Furthermore, the P/MAs (including potential mitigation alternatives, if necessary) associated with the California Aqueduct will be reevaluated, as needed, once the CASP Long-Term Rehabilitation Study is completed.

Friant-Kern Canal

As stated previously, FWA has concluded that *"any unmitigated conveyance loss due to subsidence beyond 2020 would lead to undesirable results."* As shown above in Figure 13-34, InSAR data documents that post-2020 subsidence has occurred along the FKC.

The following preliminary analysis of post-2020 subsidence impacts is based on evaluating the freeboard, which is the minimum distance required from the top of the canal lining to the water surface elevation to convey flow as documented in FWA's FKC HEC-RAS model. The required minimum freeboard varies along the FKC profile.

Output from the FWA's FKC HEC-RAS model was used to perform preliminary evaluation of sections of the Lower Reach impacted by post-2020 subsidence. Based on review of the proposed 2,500 cfs water surface elevation, 2018 water surface elevation documented in the HEC-RAS model and the 2018 top of lining elevation, the following sections of the FKC with subsidence impacts resulting in loss of conveyance capacity were identified:

- MP 122.85 to MP125.29: 2.44 miles (12,883 ft)
- MP 130.05 to MP 137.2: 7.15 miles (37,752 ft)

These sections of the FKC identified to be impacted by post-2020 subsidence will not have enough remaining freeboard to convey flows if subsidence were to continue at historical rates. Based on preliminary analysis, about 10 miles of liner raise and

associated infrastructure improvements are likely attributable to the conservative estimate of post-2020 subsidence. This analysis is preliminary and will be refined as additional subsidence and surveying data becomes available. The Kern Subbasin is currently working with FWA as documented in the Kern Subbasin Progress Report on Friant-Kern Canal Lower Reach Subsidence Mitigation Studies and Request for Letter of Support from FWA dated April 30, 2024, to further analyze and finalize subsidence projections, finalize cost amounts, and conduct an attribution analysis to ultimately determine a cost allocation, and determine how future mitigation will fit into FWA's future efforts with regards to capacity restoration projects along the FKC.

Several Kern Subbasin GSAs have initiated and funded a P/MA to model subsidence along the lower reach of the FKC, with the intent to develop an attribution analysis. This attribution analysis would then be used in discussions to attribute the mitigation costs to GSAs based on the relative impact of each GSAs operations on subsidence at the FKC.

GSA Area Critical Infrastructure

As shown in Table 13-11, the MTs defined herein are based on subsidence rates that have historically occurred and have been managed by Kern Subbasin GSAs through ongoing maintenance and improvements to facilities (e.g., adding additional freeboard to canals, as necessary). Kern Subbasin GSAs could feasibility continue to manage/mitigate further subsidence if it were to occur at similar or lower rates. A summary of potential impacts to GSA Area Critical Infrastructure is provided below:

- **Calloway Canal**: The Calloway Canal experienced a cumulative subsidence extent ranging from less than 0.33 feet to 1.0 feet from 2015 to 2024 and has not had any subsidence-related impacts to date. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent along the Calloway Canal is less than 0.2 vertical feet per 1,000 horizontal feet. The local GSAs have communicated that the projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts.
- **Lerdo Canal**: The Lerdo Canal experienced a cumulative subsidence extent ranging from less than 0.33 feet to 1.0 feet from 2015 to 2024 and has not had any subsidence-related impacts to date. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent along the Lerdo Canal is less than 0.1 feet per 1,000 feet. The local GSAs have communicated that the projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts.
- **Beardsley Canal**: The Beardsley Canal experienced a cumulative subsidence extent of less than 0.33 feet from 2015 to 2024 and has not had any subsidence-related impacts to date. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent along the Beardsley Canal is less than 0.1 feet per 1,000 feet. The local

GSAs have communicated that the projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts.

- **Cross Valley Canal**: The Cross Valley Canal experienced a cumulative subsidence extent of less than 0.33 feet from 2015 to 2024 and has not had any subsidence-related impacts to date. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent along the Cross Valley Canal is less than 0.1 feet per 1,000 feet. As reported elsewhere herein, both subsidence and rebound occurs in the area of the Kern Fan HCM Area. In some areas of the Kern Fan HCM Area, especially where significant recharge occurs at banking programs, the average rate of subsidence calculated for the Kern Fan HCM Area using the period from 2015 to 2024 likely overestimates projected subsidence through 2040. The local GSAs have communicated that the projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts.
- **Kern River Canal**: The Kern River Canal, which has both lined and unlined sections, experienced a cumulative subsidence extent of 0.33 to 1.0 feet from 2015 to 2024 and has not had any subsidence-related impacts to date. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent is less than 0.1 feet per 1,000 feet along most of the Kern River Canal and is between 0.1 and 0.2 feet per 1,000 feet in a few short sections. The local GSAs have communicated that the projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts.
- **AEWSD Canal**: The AEWSD Canal experienced a cumulative subsidence extent ranging from less than 0.33 to over 1.0 feet from 2015 to 2024 and has shown minimal subsidence-related impacts to date, with the greater subsidence impacts occurring in the northern portion of the canal. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent is less than 0.1 feet per 1,000 feet along most of the AEWSD, but up to 0.33 feet per 1,000 feet in the northern portion of the canal. Five RMS-LS were selected as the most representative locations for which to monitor ground surface elevations as they are each situated directly proximate to the AEWSD Canal, and in some instances adjacent to areas with historical subsidence and therefore greater change in slope estimates. The RMS-LS have been surveyed annually for ground surface elevations since 2018. Arvin GSA plans to complete surveys on an annual basis, or more frequently as needed. AEWSD has indicated that it can continue to manage and mitigate further subsidence if it were to occur at similar or lower rates. As such, SMCs based on historical rates are considered to be sufficiently protective of beneficial uses and users of the AEWSD Canal.

- **Olcese Canal**: The Olcese Canal experienced a cumulative subsidence extent of less than 0.33 feet from 2015 to 2024 and has not shown any subsidence-related impacts to date. Two RMS-LS were selected directly proximate to the Olcese Canal to allow the Olcese GSA to monitor any future subsidence.
- **I-5**: I-5 has experienced a cumulative subsidence extent ranging from less than 0.33 feet to over 1.0 feet from 2015 to 2024, and no historical land subsidence-induced impacts have been documented. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent along I-5 is less than 0.1 vertical feet per 1,000 horizontal feet, except in some small sections of the roadway. The change in grade of 0.01 percent is reasonable for roadways. Therefore, this projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts.
- **Highway 99**: Highway 99 has experienced a cumulative subsidence extent ranging from 0.33 to over 1.0 feet from 2015 to 2024, and no historical land subsidence-induced impacts have been documented. Based on the change-in-slope analysis (Figure 13-32), the estimated change of slope based on the 2024-2040 projected subsidence extent along Highway 99 is less than 0.1 vertical feet per 1,000 horizontal feet, except in some small sections of the roadway. The change in grade of 0.01 percent is reasonable for roadways. Therefore, this projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts.

Other Infrastructure

Other infrastructure in the Kern Subbasin have the potential to be impacted by URs caused by Land Subsidence (i.e., both vertical and lateral deformation). Other infrastructures are largely managed, monitored, and maintained by other appropriate state and federal agencies (e.g., CalTrans, California Public Utilities Commission, etc.). In addition to specific MTs established for Regional and GSA Area Critical Infrastructure, MTs for Land Subsidence were developed for the entire Kern Subbasin based on the average historical subsidence rate in each HCM Area (Table 13-12). Given that other infrastructure, not including those identified as Regional or GSA Area Critical Infrastructure, have no known historical subsidence-related impacts, these Subbasin-wide MTs are anticipated to provide sufficient protection against adverse impacts caused by GSA-related activities in the Kern Subbasin.

The various other types of infrastructure considered are discussed below.

- **Railroads:** Several railroads traverse the Kern Subbasin. Based on the change-in-slope analysis above (Figure 13-32), the maximum estimated change of slope along railroads is 0.2 feet per 1,000 feet. The High-Speed Rail subsidence report (Amec, 2017) specifies a maximum acceptable change of grade of 0.1 percent (1

feet per 1,000 feet), which is much higher than the maximum estimated change of slope (0.2 feet per 1000 feet).

- **Interstate oil and gas pipelines:** Several interstate oil and gas pipelines run through the Kern Subbasin and are considered other infrastructure that could be impacted by land subsidence. The GSAs do not have access to the necessary information to assess Subbasin-wide subsidence impacts on interstate gas pipelines. However, a study by the California Energy Commission concluded that "more than three times the maximum observed rates of subsidence in the 2015 to 2017 period would have been required to cause yielding in local pipelines due to high subsidence. The maximum subsidence during 2015 to 2017 was about 2 feet and occurred in the Southeastern part of San Joaquin Valley" (California Energy Commission, 2023). Based on this study, it was determined that recent subsidence rates in the Kern Subbasin (Section 8.5.1) are significantly less than the extent of subsidence that would be required to impact regional oil and gas pipelines. Kern Subbasin GSAs will continue to engage with oil and gas entities during 2025 Plan implementation.
- **Water conveyance facilities:** water distribution pipelines and associated facilities (e.g., pump stations) and local gravity-driven canals are critical for conveyance and provision of surface water supplies and can be damaged from land subsidence. Several canals were classified as Regional and GSA Area Critical Infrastructure above. Other water conveyance facilities have not experienced known impacts due to land subsidence at historical rates in the Subbasin and therefore will be monitored and managed under the Kern Subbasin-wide HCM Area SMCs in Table 13-12.
- **Water and wastewater treatment plants:** There are several water and wastewater treatment plants in the Kern Subbasin in or near the Cities of Bakersfield, Delano, and McFarland that would significantly impact water users if they were impacted by land subsidence. These facilities have not experienced known impacts due to land subsidence at historical rates in the Kern Subbasin and therefore will be monitored and managed under the Subbasin-wide HCM Area SMCs in Table 13-12.
- **Domestic, agricultural, and other wells:** Damage to water well casings could impact the beneficial use of groundwater. If the well could be reasonably modified or its function is not impeded, then the impact to a well could be considered minimal. The GSAs have not observed damage to groundwater extraction wells caused by subsidence in the past. Most deep wells in the central valley area of the Sub (at depths where clay compaction is expected to be occurring) have been fitted with compression sections that can withstand several (15 to 30) feet of subsidence (Kevin McGillicuddy, Roscoe Moss Co, 2024). As such, these wells are not expected to be impacted even under the conservative estimate of maximum future subsidence.

- **Buildings and county roadways:** There are several buildings and roadways that would have significant impacts on land use if land subsidence occurred. Historical land subsidence around the Kern Subbasin's major urban centers, including the City of Bakersfield, has been relatively low, and impacts caused by subsidence to buildings and county roadways are not known to have occurred. Furthermore, the change in slope analysis conducted along county roadways suggests that the maximum estimated change of slope is 0.1 feet per 1,000 feet. A change in grade of 0.01 percent is reasonable for roadways. Therefore, this projected amount of subsidence at the MTs is not expected to lead to significant and unreasonable impacts and, therefore, will be monitored and managed under the Subbasin-wide HCM Area SMCs in Table 13-12.
- **Flood control structures:** Within the Kern Subbasin, several flood control structures (i.e., levees) are present along local streams such as the Kern River and Caliente Creek. These structures are managed by agencies with which the GSAs have coordinated during the 2025 Plan development process. There have been no documented historical impacts on flood control structures attributed to GSA-related subsidence. Furthermore, there was minimal impacts from flooding in the Kern Subbasin in 2023, which was a historically wet year (with significant flooding in other parts of the San Joaquin Valley). During 2025 Plan implementation, the GSAs are committed to ongoing coordination with flood management agencies to proactively address any potential future impacts to flood control structures caused by GSA-related subsidence. For example, several public agencies are participating in the update of the California Office of Emergency Services (Cal OES) Hazard Mitigation Plan. This 2025 Plan assesses potential vulnerabilities to infrastructure, including subsidence, and outlines strategies to effectively mitigate these risks.

13.5.2.9 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 Kern Subbasin.

13.5.2.10 Measurement of Minimum Thresholds

☑ 23 CCR § 354.28(b)(6)

The GSAs have established RMS-LS along all Regional Critical Infrastructure and some GSA Critical Infrastructure. A 5-mile-wide Monitoring Corridor was established in consultation with CASP and FWA for all Regional Critical Infrastructure.

The cause, rate, and extent of subsidence will be monitored and updated annually at the Kern Subbasin's RMS-LS. Additionally, MTs for Land Subsidence will be monitored

for the entire Kern Subbasin using InSAR data published by DWR, whereby the annual displacement, as reported by InSAR data, will be averaged across each HCM Area and compared to the Land Subsidence SMCs in Table 13-12 in the Annual Report. Methodologies for monitoring subsidence are:

- InSAR (direct measurement), downloaded from DWR.
- InSAR time series at consistent locations.
- CASP and FWA benchmark surveys.
    - CASP typically conducts benchmark surveys annually and will provide data upon request. The Kern Subbasin GSAs will request and utilize this benchmark data to assess compliance with SMCs established along the California Aqueduct.
- Global Positioning System (GPS).
- Other land-based methods (e.g. extensometers, third party benchmark surveys, third party benchmark surveys, etc.).

Figure 15-11 and Figure 15-12 show the InSAR coverage and the subsidence monitoring network for the Kern Subbasin, respectively.

Subsidence data will be collected from all the above on an annual basis. For Critical infrastructure both the InSAR and monitoring network data will be evaluated against the local MTs/MOs for representative monitoring sites along the infrastructure. InSAR data will also be tabulated and analyzed at the HCM Area scale to compare against the HCM Area average MTs and MOs. Note that there will likely be variability in subsidence values within the HCM Area. If local values exceed the range of subsidence estimated in the projected subsidence extent then the GSAs will investigate the cause of and impact from subsidence and can set more stringent local MTs to be protective of any potential significant and unreasonable impacts in the future.

The representative monitoring network for Land Subsidence will be monitored in accordance with the monitoring protocols outlined in Section 15.3.4.

13.5.3 Measurable Objective and Interim Milestones for Land Subsidence

☑ 23 CCR § 354.30(c)
☑ 23 CCR § 354.30(e)

The MOs defined below are in terms of total vertical extent of land subsidence (feet) from 2024 to 2040, as well as a corresponding average annual rate of subsidence (feet per year) measured quarterly and reported annually to align with the Annual Report cycle.

13.5.3.1 Measurable Objective Development

The MOs for Land Subsidence are conservatively set to 50 percent of the MT rate and MT extent from 2024 to 2040. This is roughly equivalent to the recent subsidence rates continuing through 2030 and then abating. Due to the inherent time lag of the aquitard depressurization process, there may still be some residual subsidence potential that has yet to manifest. Therefore, it is not considered reasonable to expect an immediate and complete cessation to the historical subsidence rates. These MOs would serve to stabilize and minimize the potential for additional subsidence to occur after 2040.

The final MOs for Land Subsidence are shown in Table 13-9, Table 13-10, Table 13-11, and Table 13-12.

13.5.3.2 Interim Milestones Development

The IMs for Land Subsidence have been set to follow a glide path that establishes IMs in 5-year increments at 75 percent of the MT rate in 2025, 50 percent of the MT rate in 2030, and 25 percent of the MT rate in 2035. The IMs defined below are in terms of total vertical extent of land subsidence (in feet). The final IMs for Land Subsidence are shown in Table 13-9, Table 13-10, Table 13-11, and Table 13-12.

An example of the glide path through 2040 for Milepost 270 of the Southern Aqueduct is shown below in Figure 13-42. As demonstrated in this figure, IMs are set to minimize subsidence and establish a glide path of no additional GSA-related subsidence after 2040 (green-dashed line). As discussed in Section 13.1.3.2, the glide path trajectory for Chronic Lowering of Groundwater Level IMs shows increasing groundwater levels after 2030. This increase provides a 10-year buffer to address residual subsidence that may occur between 2030 and 2040 due to preceding groundwater level declines. Since land subsidence driving mechanisms are complex, and residual subsidence can continue to occur for years, the Kern Subbasin GSAs have conservatively extended Steps 1 through 3 of the Action Plan for Land Subsidence (Appendix K-1) to be implemented when a single Land Subsidence IM exceedance occurs. Exceedance of the IM subsidence rate and/or extent after two (2) quarterly consecutive sampling events measured using InSAR data or one annual survey measurement, if available, trigger investigation including an identification into the root cause; four (4) consecutive quarterly exceedances of the IM subsidence extent would initiate additional targeted P/MAs in the buffer zones around critical infrastructure.

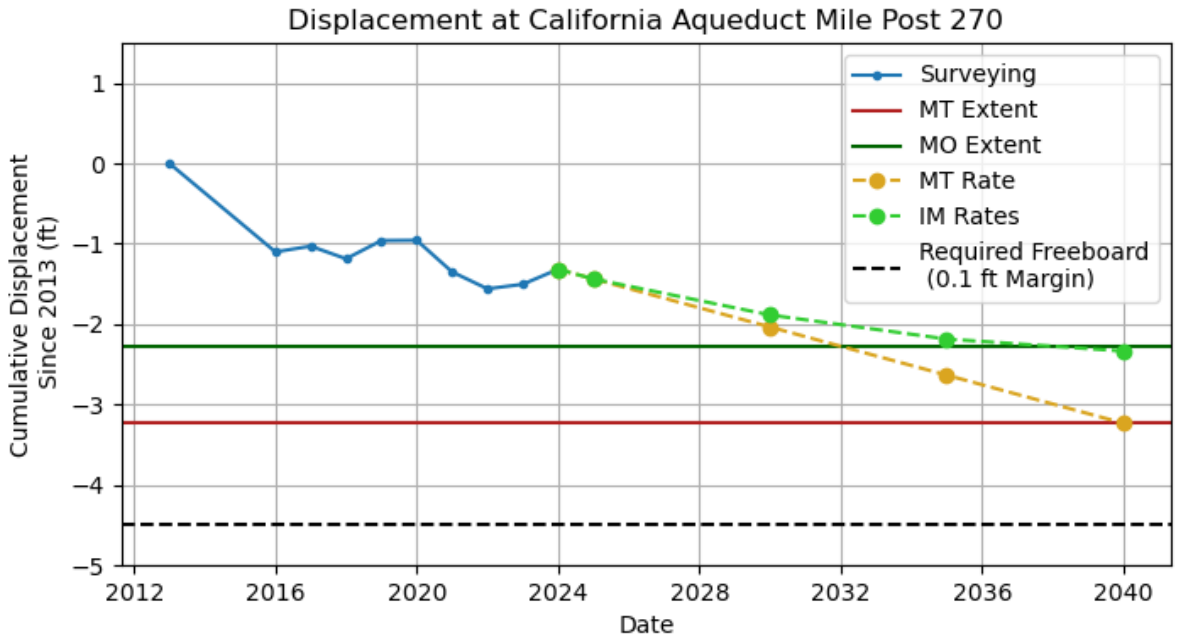


Figure 13-42. Milepost 270 Glide Path

13.6 Interconnected Surface Water

§ 354.28. *Minimum Thresholds*

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

- *Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:*
  - *The location, quantity, and timing of depletions of interconnected surface water.*
  - *A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.*

(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

☑ 23 CCR § 354.26(d)
☑ 23 CCR § 354.30(c)
☑ 23 CCR § 354.30(e)

Interconnected surface water is defined by the SGMA Regulations as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted (CCR 23 §351). As

described in Section 8, the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset, which maps vegetation and wetland features that could indicate dependence on groundwater, was used to assess whether surface water features in each HCM Area were considered interconnected surface water. Available data and information indicate that major surface water features within the Kern Subbasin are largely fed by surface water and are not considered interconnected surface water features due to groundwater level depths significantly below the surface water features. Furthermore, no groundwater dependent ecosystems (GDEs) were identified in any of the five HCM Areas. Therefore, as described in Section 7.2.6 and Section 8.6, multiple lines of information (i.e., water quality data, hydro-stratigraphy, and water levels) suggest that the Primary Alluvial Principal Aquifer is hydraulically separated from the Shallow Alluvium and surface water bodies interconnected thereto, and depletion of interconnected surface water has not been observed within the Kern Subbasin.

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 figure results related to those sustainability indicators” (23 CCR §354.26(d)). Because evidence suggests that depletion of interconnected surface water within the Kern Subbasin is not present and not likely to occur, the Depletions of Interconnected Surface Water Sustainability Indicator is not applicable. Therefore, no SMCs for this Sustainability Indicator are defined in the Kern Subbasin.

DWR is in the process of developing new guidelines for interconnected surface water and SGMA implementation. The Kern Subbasin will continue to monitor the status of these new guidelines and will adapt management of the Depletions of Interconnected Surface Water Sustainability Indicator if needed in the next five-year Plan update.

14. PROJECTS AND MANAGEMENT ACTIONS

§ 354.44. *Projects and Management Actions*

(a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.

(b) Each Plan shall include a description of the projects and management actions that include the following:

(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.

(3) A summary of the permitting and regulatory process required for each project and management action.

(4) The status of each project and management action, including a timetable for expected initiation and completion, and the accrual of expected benefits.

(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.

(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.

(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.

(c) Projects and management actions shall be supported by best available science.

(d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

14.1 Goals and Objectives of Projects and Management Actions

☑ 23 CCR § 354.44(a)
☑ 23 CCR § 354.44 (b)(1)(A) and (B)

A key component of Groundwater Sustainability Plans (GSPs) is Projects and Management Actions (P/MAs) that address any existing or potential future overdraft conditions that could cause Undesirable Results for the identified relevant Sustainability Indicators. This section presents the P/MAs that are cumulatively proposed to achieve the Kern Subbasin's Sustainability Goal. **Implementation of P/MAs began in 2020 and is estimated to continue along a glide path until the estimated Subbasin deficit of 372,120 acre-feet per year (AFY) under the 2030 Climate Change Scenario is corrected**. All necessary P/MAs are scheduled for implementation by the January 2040 deadline to achieve sustainability (refer to Section 9.6.4 Projected Water Budget Results). The Kern Subbasin has an aggressive P/MA implementation schedule. Initial progress since the passage of SGMA in 2014 has been substantial, 47 percent (85 of 182 P/MAs) of the total anticipated P/MA's have been implemented and are already accruing significant benefits toward the Kern Subbasin's sustainability goal. Another 2 percent of the total anticipated P/MAs are functional and will begin accruing benefits shortly. That gives the Kern Subbasin a substantial start in eliminating the total Kern Subbasin deficit. The 2025 P/MA implementation 2025 milestone is a total of 395,332 AFY of both demand reduction and supply augmentation which exceeds the total Kern Subbasin identified planning deficit of 372,000 AFY as shown on Table 14-1.

The Kern Subbasin uses checkbook accounting that aligns with the numerical groundwater flow model to evaluate efficacy of Sustainable Groundwater Management Act (SGMA) implementation. Checkbook accounting uses historical surface water supply balances to estimate groundwater overdraft attributable to each Groundwater Sustainability Agency (GSA). This approach provides a deficit planning number that is compared against anticipated results of P/MAs, which enables the Kern Subbasin to evaluate results against the current deficit and use adaptive management techniques to adjust project implementation consistent with the glide path approach.

The glide path 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). P/MAs presented in this section were developed with consideration of costs, benefits, and preliminary feasibility analyses; however, some P/MAs are conceptual and will require significant further evaluation (i.e., engineering, economic, environmental, legal, etc.) before implementation. Some of the P/MAs presented in this section will continue to fill data gaps and establish mitigation measures as part of 2025 Plan implementation.

Consistent with the goals and objectives of the P/MAs explained in this section, (including the relevant Sustainability Indicators), categories of expected benefits, and

the coordinated implementation glide path are presented in subsequent sections. Common Subbasin-wide P/MAs are presented in this Section. Individual GSA P/MAs are presented in Appendix J. All GSAs coordinated on common methods for P/MA development, as follows:

- Single, linear path of milestones through 2040
- Standard P/MA categories, types, and definitions
- Consistent format to present each P/MA and anticipated yield
- Consistent analytical method to calculate each GSA's minimum target P/MA based on the Subbasin-wide projected deficit of 372,120 AFY, which is the Kern Subbasin's groundwater reduction goal to achieve sustainability by January 2040

At the end of Section 14.12 a description is provided for each P/MA planned by the GSA as summarized in Table 14-4 through Table 14-24. This section also explains how each P/MA addresses relevant overdraft conditions, or other Sustainability Indicators (i.e., water quality, subsidence, etc.), and describes other considerations relevant to implementation, including the following:

- Potential permitting and regulatory requirements
- P/MA status and implementation timeline
- Criteria for evaluating expected benefits
- Sources of water that are relied upon
- Legal authority required to implement the P/MAs, and
- Summary of estimated costs and the GSA's plans to meet those costs

14.1.1 Implementation Glide Path Kern Subbasin

☑ 23 CCR § 354.44(b)(2)

As stated above, the goals and objectives of the P/MAs presented herein are to address existing overdraft conditions that could trigger Undesirable Results as P/MAs are incrementally implemented to achieve the sustainability goal. While the exact schedule for implementation of all the individual P/MAs is not known with certainty at this time, general implementation schedules, also known as a glide path, have been developed as summarized in Table 14-1 and illustrated on Figure 14-1. This glide path is designed to address 25 percent (93,000 AFY) of the projected deficit of 372,000 AFY during each five-year milestone through 2040, which in turn will improve conditions for the relevant Sustainability Indicators based on the assumption that those conditions are directly related to the balance of supplies and demands within the Kern Subbasin as shown in Table 14-1. The anticipated P/MA implementation schedule is forecasted to exceed the target deficit reduction by 2030 and exceed the 2040 milestone with a safety factor of 2.2, illustrating an extremely high degree of P/MA redundancy. A sensitivity analysis is

illustrated on Figure 14-1 for both 50 percent and 75 percent actual realized benefits from P/MAs. Even if only 50 percent of P/MA benefits are realized, the Kern Subbasin would still succeed in eliminating 109 percent of the projected deficit. Figure 14-2 and Figure 14-3 depict that the Kern Subbasin will rely on 368,000 AFY of demand reduction to mitigate the 372,000 AFY projected deficit and has identified as-needed projects available for development that would provide an additional estimated 71,000 AFY of deficit reduction capacity, bringing the total safety factor to 2.3 times the planned goal.

Table 14-1. Glide Path – Target Deficit Reduction

Project and Management Action Implementation Schedule (AFY)						
Kern County Subbasin Projected-Future Scenario Deficit Reduction "Glide Path" 354.44 (b)(2)		**2020**	**2025**	**2030**	**2035**	**2040**
Projected Deficit			-372,000			
Target Deficit Reduction (%)		0	25%	50%	75%	100%
Projected Deficit No P/MA's		**372,000**	**372,000**	**372,000**	**372,000**	**372,000**
Deficit Reduction "Glide Path" Milestones		**-372,000**	**-279,000**	**-186,000**	**-93,000**	**0**
Project and Management Action, by Type (AFY)						
Planned Demand Reduction	Land Retirement	14,964	28,772	36,835	43,835	45,835
	Demand Reduction	86	61,964	124,714	189,343	258,983
	Ag to Urban Conversion	389	9,189	18,378	26,817	35,256
	Water Conservation-Efficiency	25,099	28,690	28,690	28,690	28,690
	Subtotal	**40,538**	**128,614**	**208,617**	**288,684**	**368,764**
Planned Water Supply Augmentation	Supplemental Water Recharge	34,156	51,887	86,548	89,768	89,768
	Supplemental Water Use	33,060	48,050	55,450	62,350	70,150
	Third-Party Banking	13,713	27,473	28,013	28,013	29,263
	New Local Supply	0	8,000	25,557	114,557	120,107
	Exercise of Rights	104,539	131,308	135,890	135,890	135,890
	Subtotal	**185,468**	**266,718**	**331,458**	**430,578**	**445,178**
P/MA Implementation Schedule*		**226,006**	**395,332**	**540,075**	**719,262**	**813,942**
As-Needed PMA Deficit Benefits		*0*	*550*	*4,800*	*51,826*	*71,645*
Planned P/MA Deficit Reduction Schedule*		**-145,994**	**23,332**	**168,075**	**347,262**	**441,942**

* Implementation Date includes estimated time to start accruing benefits

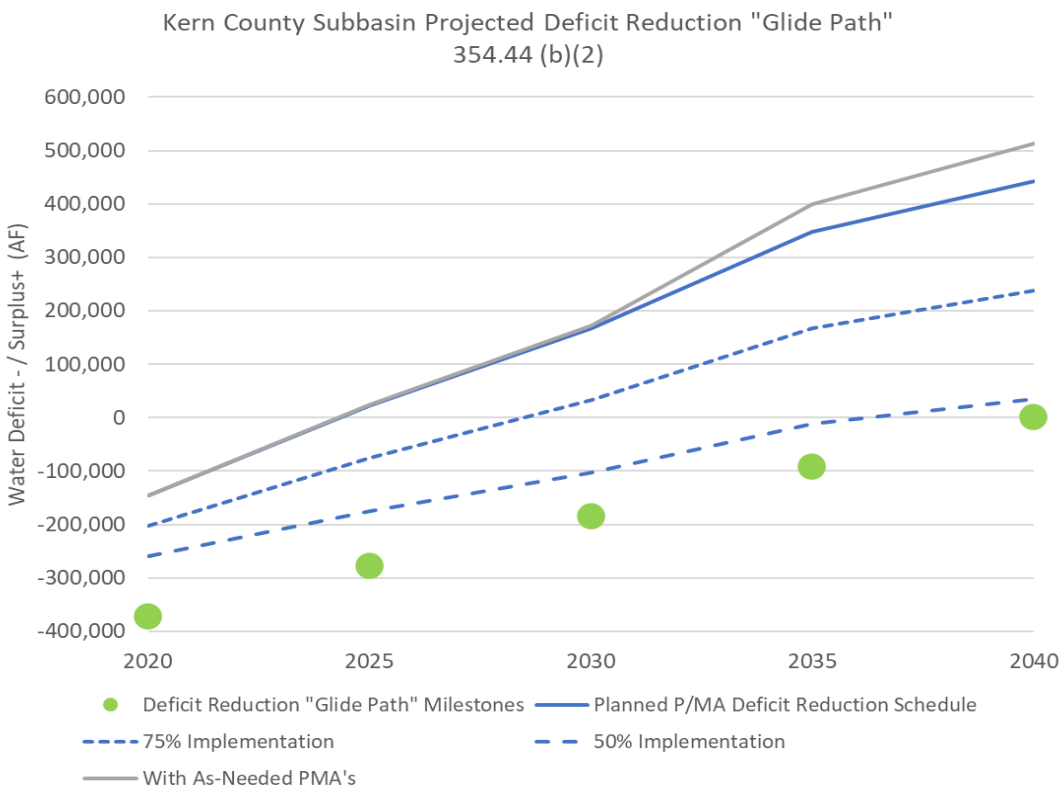


Figure 14-1. Glide Path – P/MA Planned Deficit Reduction vs. Milestones

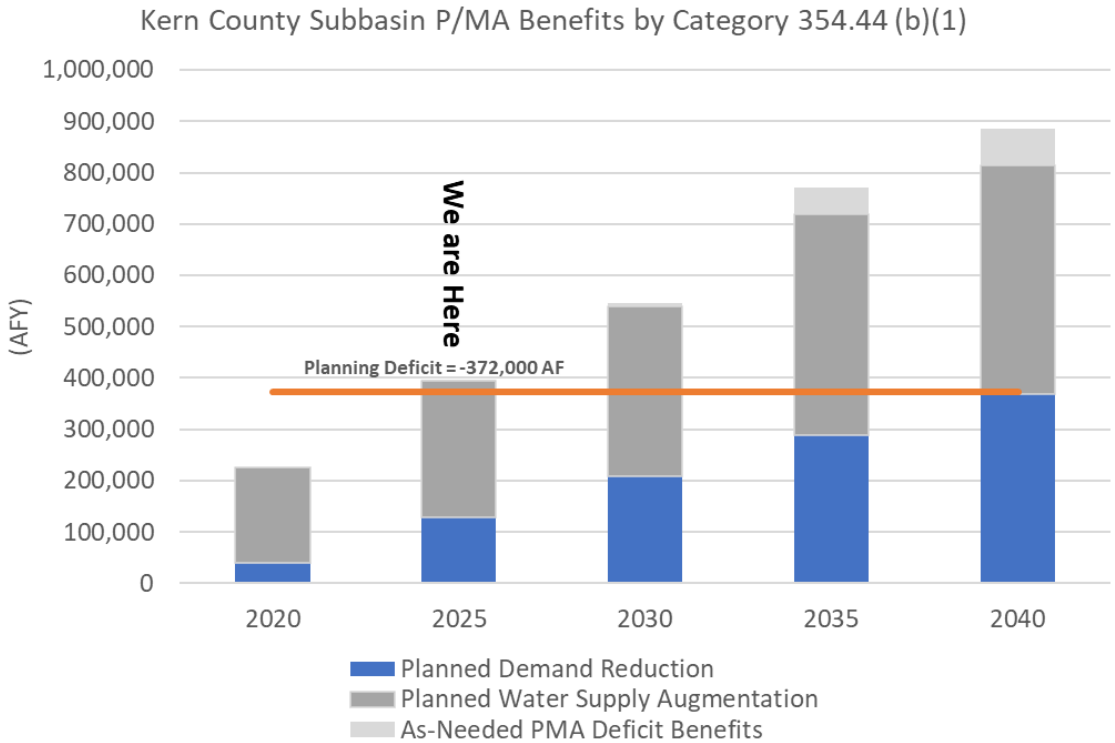


Figure 14-2. P/MA by Category

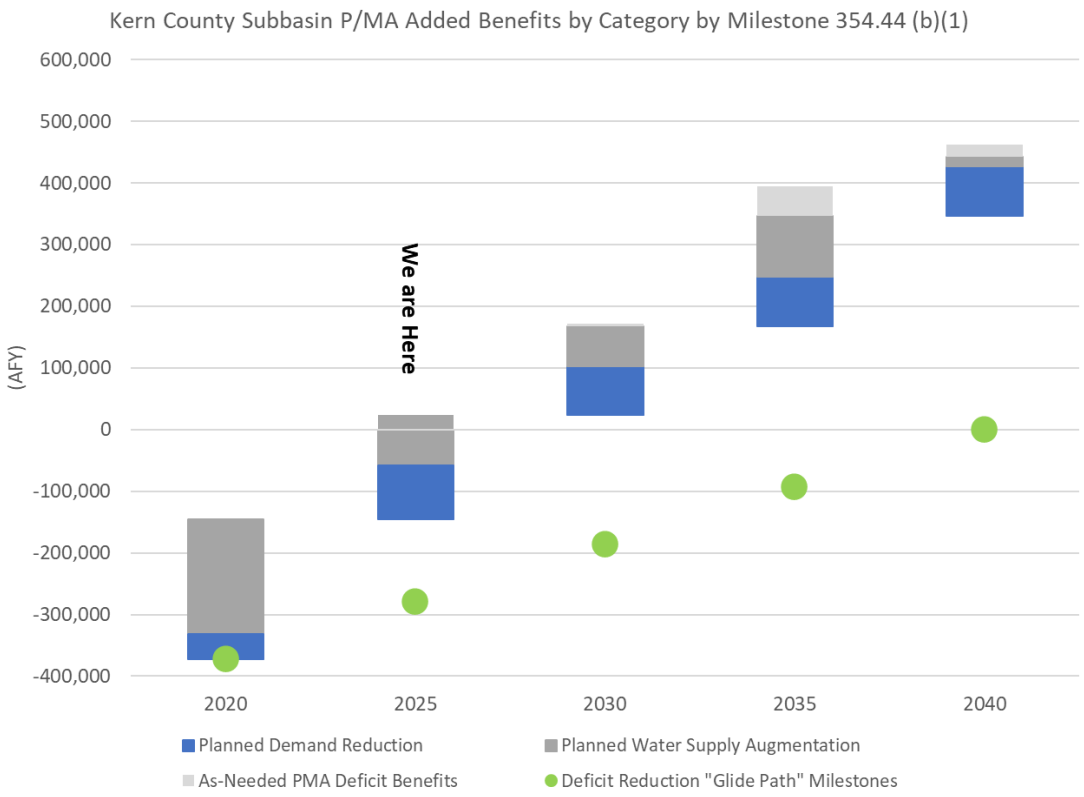


Figure 14-3. P/MA by Category with Implementation Glide Path

14.1.2 Uncertainty Associated with the Basin Setting

☑ 23 CCR § 354.44(d)

The Kern Subbasin GSAs, as it relates to this planning document, have agreed to use a historical supply and demand analysis using a checkbook approach to set the minimum target P/MA goal for each GSA. Minimum target P/MA goals for each GSA were calculated using this historical checkbook surface water supply and demand analysis for the 1995-2014 period, then an adjustment for estimated climate change which results in an increased minimum target P/MA goal above historical levels as shown below in Table 14-2 was applied (Appendix H-4, Table N-4). The general implementation schedules, or glide path, were developed by the individual GSAs and are tabulated in Appendix J. To meet the Kern Subbasin's Sustainability Goal, the glide path aims to address 25 percent of the projected deficit during each five-year Milestone through 2040, which in turn will improve conditions of the relevant Sustainability Indicators based on the assumption that those conditions are directly related to the balance of supplies and demands.

These targets are for P/MA planning purposes only, as these values are not considered final, and will be revised and finalized through the Basin Study KSB-4 as well as each planning cycle. The checkbook in its current form is consistent in methodology across all GSAs. The checkbook is based on surface water inflows and outflows from each

GSA; it does not specify ownership of water or differentiate between water for consumptive use, conjunctive use, or water banking for others. A subbasin adjustment was also applied to account for conditions such as Kern Subbasin outflow and data uncertainties. A “zero” in the first column connotes a GSA with no checkbook minimum target P/MA.

The Kern Subbasin has a reasonable level of uncertainty associated with the Basin Setting. However, the Basin Study (P/MA KSB-4) will help address remaining data and information gaps and support recalibration of the Kern Subbasin numerical surface water and groundwater flow model. Again, the estimates shown in Table 14-2 and discussed below are for P/MA planning purposes only and will be updated in subsequent planning cycles based on the results of the Basin Study management action KSB-4 as described in Section 14.2.3. To compensate for uncertainty, the P/MAs are proposed to be implemented incrementally to achieve this goal for each GSA Management Area, as defined in Appendix J. Progress on the implementation of the glide path will be presented annually via the Kern Subbasin Annual Report.

Table 14-2. P/MA Targets by GSA from 1995-2014 Check Book

GSA Name	Minimum Target P/MA	Planned P/MA
Arvin GSA	26,820	60,760
Buena Vista GSA	0	39,610
Cawelo Water District GSA	530	54,260
Eastside Water Management Area	3,330	7,020
Henry Miller Water District GSA	5,950	5,950
Kern River GSA	62,220	150,433
Kern Water Bank Groundwater Sustainability Agency	NA	21,762
Kern-Tulare Water District GSA	0	7,720
North Kern Water Storage District GSA	0	32,620
Olcese Water District GSA	180	0
Pioneer GSA	NA	0
Rosedale-Rio Bravo Water Storage District GSA	9,850	22,353
Semitropic Water Storage District GSA	162,940	221,273
Kern National Wildlife Refuge	0	0
Shafter-Wasco Irrigation District GSA	22,190	29,728
7th Standard	17,250	21,250
Southern San Joaquin Municipal Utility District	26,070	26,962
Tejon-Castac Water District GSA	0	1,800
West Kern Water District GSA	0	191
Westside District Water Authority GSA	0	50,000
Wheeler Ridge-Maricopa GSA	14,360	36,330
KNDLA GSA	23,920	23,920
Subbasin Total	**375,610**	**813,942**

Minimum target goals of the planned P/MAs for each GSA are shown by HCM Area as illustrated below on Figure 14-4 through Figure 14-8. It should be noted that the actual P/MA target is estimated for the entire GSA and repeated without adjustments in each HCM Area the GSA occupies. Since the jurisdictional boundaries of some GSAs span more than one HCM Area, the series of graphs showing targets by HCM Area should not be interpreted to mean the full demand reduction is allocated to that HCM Area.

14.1.3 P/MA Planning by HCM Area

This series of graphs shows the total minimum target P/MA (red font) by GSA and their estimated results from implementing demand reduction (light gray) and supply augmentation (blue) projects. The total estimated yield of these P/MAs is represented by the dark gray bar with the estimated AFY benefit (dark gray).

The P/MA target surplus shown in Figure 14-4 is attributed to various factors for each GSA whose jurisdictional boundary spans the Western Fold Belt Area. As described in Section 8.1.1.1, minimal groundwater pumping occurs in the Western Fold Belt HCM Area due to low recharge and poor groundwater quality that limits the ability to utilize groundwater. One factor is the checkbook approach allocates native yield and precipitation across the Kern Subbasin, consequently, agencies that cover areas where groundwater is not suitable for the beneficial uses rely on imported surface water rather than groundwater to support the land uses in those areas; regardless of water use, these areas are credited with native yield. The following bullet points provide information about each GSA shown in Figure 14-4.

- Westside District Water Authority (WDWA) GSA is predominantly located within the northern portion of the Western Fold Belt HCM Area. The GSA does not have a projected minimum target P/MA deficit, and the means of sustainability is via water supply augmentation and, as needed, demand reduction. Details on P/MAs are provided in Table 14-22.
- West Kern Water District (WKWD) GSA is predominantly in the southern portion of the Western Fold Belt HCM Area. The GSA does not have a projected minimum target P/MA deficit and means of sustainability is via water supply augmentation. Details on P/MAs are provided in Table 14-24.
- White Lands are un-districted lands that are managed for purposes of SGMA by the Kern Non-Districted Land Authority. These non-contiguous lands are dispersed throughout the HCM Areas. The projected minimum target P/MA is 23,920 AFY for these lands based on consumptive use estimates extrapolated from ET data; see KSB-6 for the demand reduction program that will be implemented to mitigate the projected deficit attributed to these land uses. Details on P/MAs are provided in Table 14-9.
- A small portion of the Buena Vista GSA (BVGSA) is within the Western Fold Belt HCM Area. The GSA does not have a projected minimum target P/MA deficit for

this area and contributed to reduction in the Kern Subbasin's estimated deficit via its water supply surplus. Details on P/MAs are provided in Table 14-5.

- A small portion of the Henry-Miller Water District (HMWD) GSA is within the southern portion of the Western Fold Belt HCM Area. The projected minimum target P/MA is 5,950 AFY, which will be mitigated via water demand reduction. Details on P/MAs are provided in Table 14-8.
- A small portion of the Wheeler Ridge-Maricopa (WRM) GSA is within the southern portion of the Western Fold Belt HCM Area. The GSA's primary means of meeting the projected minimum target P/MA of 14,360 AFY is via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-23.

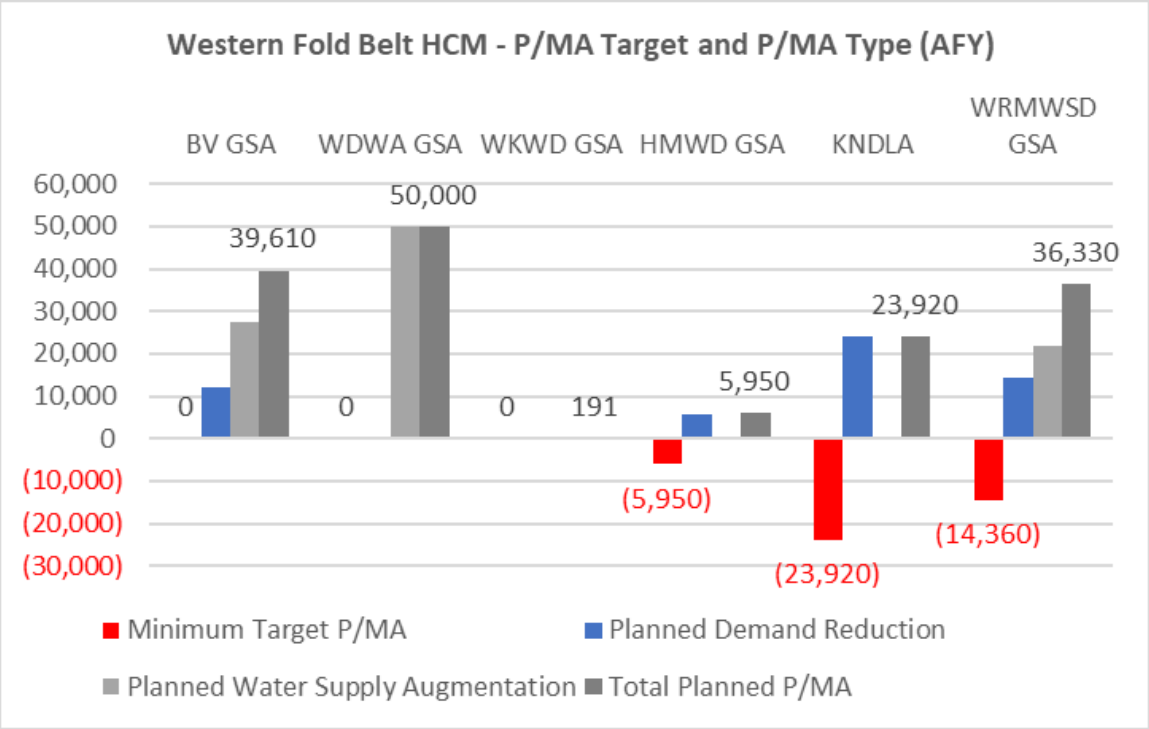


Figure 14-4. P/MA Target by GSA in the Western Fold Belt

Figure 14-5 shows GSAs whose jurisdictional boundaries span the North Basin HCM Area, which is predominately an agricultural area with four municipalities, rural communities, and a large area of federal and California Conservation Easement Area designated for the Kern National Wildlife Refuge, Semitropic Ridge Reserve as well as the Semitropic, Lokern, and Buttonwillow Ecological Reserves (Section 5.3.1). Significant groundwater pumping occurs in the North Basin HCM Area. There has been a long history of conjunctive management and water banking. The following bullet points provide information about each GSA referenced for the first time in Figure 14-5.

- Semitropic Water Storage District (SWSD) GSA is completely within the northern portion of the North Basin HCM Area. The GSA's primary means of meeting the

P/MA target of 162,940 AFY is via demand reduction. Details on P/MAs are provided in Table 14-20.

- North Kern Water Storage District (NKWSD) GSA is completely within the eastern portion of the North Basin HCM Area. The GSA does not have a projected minimum target P/MA deficit and means of sustainability is via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-13.
- Shafter-Wasco Irrigation District GSA, Shafter-Wasco Irrigation District (SWID) is completely within the central portion of the North Basin HCM Area. The GSA's primary means of meeting the P/MA target of 22,190 AFY is via water supply augmentation through its contract supplies. Details on P/MAs are provided in Table 14-18.
- Shafter-Wasco Irrigation District GSA, 7th Standard Annex (SWID 7th) is completely within the central portion of the North Basin HCM Area. The primary means of meeting the P/MA target of 17,250 AFY is via demand reduction. Details on P/MAs are provided in Table 14-19.
- Southern San Joaquin Municipal Utility District (SSJMUD) GSA is completely within the northern portion of the North Basin HCM Area. The GSA's primary means of meeting the P/MA target of 26,070 AFY is via water supply augmentation. Details on P/MAs are provided in Table 14-17.
- Buena Vista GSA (BVGSA) is predominately within the western portion of the North Basin HCM Area. The GSA does not have a projected minimum target P/MA deficit for this area and contributed to reduction in the Kern Subbasin's estimated deficit via its water supply surplus. Details on P/MAs are provided in Table 14-5.
- White Lands are un-districted lands, managed for the purposes of SGMA by the Kern Non-Districted Land Authority. The primary means of meeting the P/MA target of 23,920 AFY is via demand reduction. Refer to KSB-6 in Table 14-9.
- A portion of the Rosedale-Rio Bravo Water Storage District (RRBWSD) GSA is within the southern portion of the North Basin HCM Area. The GSA's means of meeting the P/MA target of 9,850 is via a majority of demand reduction and some water supply augmentation. Details on P/MAs are provided in Table 14-16.
- A portion of the Cawelo Water District GSA is within the eastern portion of the North Basin HCM Area. The GSA's means of sustainability is via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-6.
- A small portion of the Kern River GSA is within the southeastern portion of the North Basin HCM Area. The GSA's means of meeting the target deficit of 62,250 AFY is via some demand reduction and mostly water supply augmentation. Details on P/MAs are provided in Table 14-10.

- A small portion of the Westside District Water Authority GSA is within the southwestern portion of the North Basin HCM Area. The GSA does not have a projected minimum target P/MA deficit, and the means of sustainability is via water supply augmentation and, as needed, demand reduction. Details on P/MAs are provided in Table 14-22.

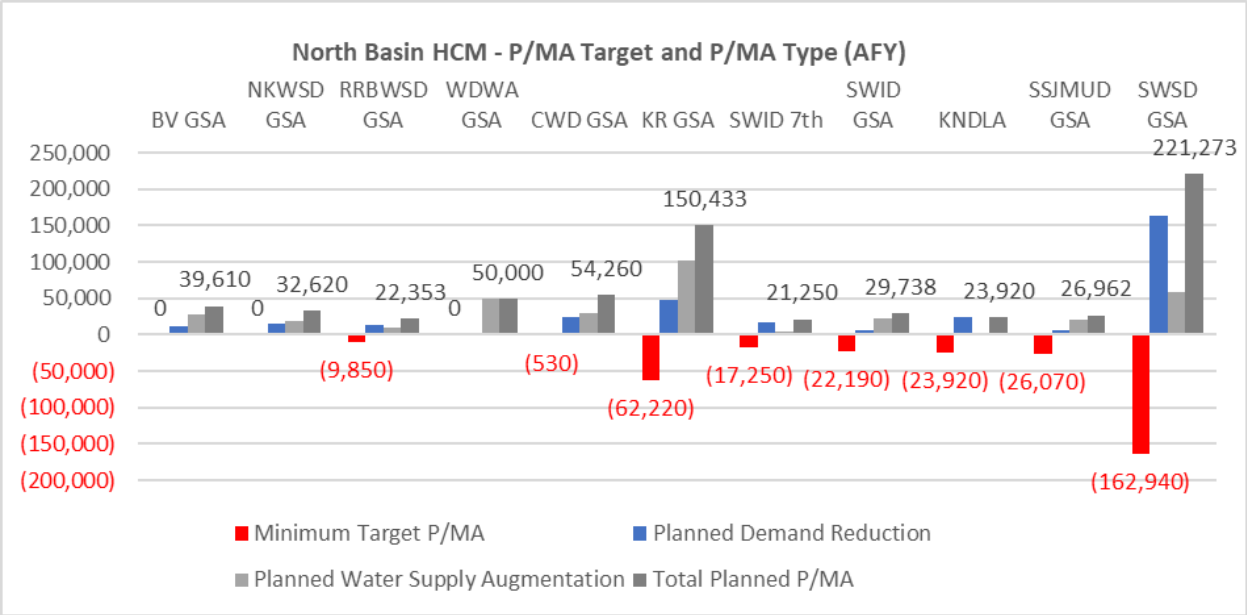


Figure 14-5. P/MA Target by GSA in the North Basin

Figure 14-6 shows GSAs whose jurisdictional boundaries span the Eastern Margin HCM Area. Land use is predominately native vegetation with agricultural and industrial land uses. Agricultural irrigation demand is primarily met through imported surface water, with some groundwater pumping from the Santa Margarita and Olcese Principal Aquifers. The following bullet points provide information about each GSA referenced for the first time in Figure 14-6.

- Kern-Tulare Water District GSA is completely within the northern portion of the East Margin HCM Area. The GSA does not have a projected minimum target P/MA deficit and means of sustainability is via demand reduction. Details on P/MAs are provided in Table 14-11.
- Eastside Water Management Area (covered by Kern Non-Districted Land Authority) is completely in the northern portion of the Eastern Margin HCM Area. The GSA's primary means of meeting the P/MA target of 3,330 AFY is via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-7.
- Tejon-Castac Water District GSA is predominantly within the southern portion of the East Margin HCM Area. The GSA does not have a projected minimum target P/MA deficit and means of sustainability is via primarily water supply augmentation. Details on P/MAs are provided in Table 14-21.

- Olcese Water District GSA is completely within the southern portion of the East Margin HCM Area. The GSA has a very small projected minimum target P/MA deficit. Details on P/MAs are provided in Table 14-14.
- A portion of the Cawelo Water District GSA is within the central portion of the East Margin HCM Area. The GSA's means of sustainability is via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-6.
- White Lands are non-districted lands, managed for the purposes of SGMA by the Kern Non-Districted Land Authority. These non-contiguous lands are dispersed throughout the HCM Areas. The primary means of meeting the P/MA target of 23,920 AFY is via demand reduction, KSB-6 discussed in Table 14-9.
- A small portion of Arvin GSA (approximately 10 percent by area) is in the southern portion of the Eastern Margin HCM Area. The GSA will meet the P/MA target of 26,280 AFY via some demand reduction and mostly water supply augmentation. Details on P/MAs are provided in Table 14-4.

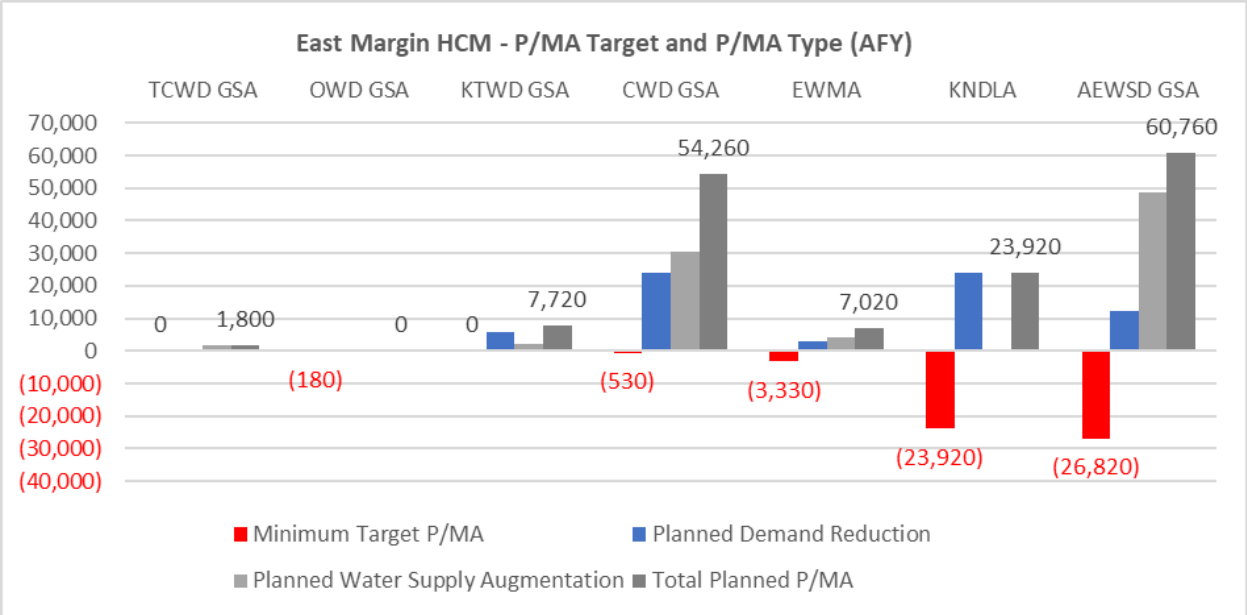


Figure 14-6. P/MA Target by GSA in the Eastern Margin

Figure 14-7 shows GSAs whose jurisdictional boundaries span the Kern River Fan HCM Area, which includes municipal and rural communities, agriculture, and water banking. The banking programs have been in place for several decades and were developed to help secure more reliable water supplies to withstand California's wet- and dry-year cycles (refer to Section 5.3.1). The following bullet points provide information about each GSA referenced for the first time in Figure 14-7.

- The Kern Water Bank GSA is completely in the western portion of the Kern River Fan HCM Area. The GSA does not have a projected deficit, and the means of sustainability is via water supply augmentation. Details on P/MAs are provided in Table 14-12.
- The Pioneer GSA is completely in the central portion of the Kern River Fan HCM Area. The GSA does not have a projected minimum target P/MA deficit. Details on P/MAs are provided in Table 14-15.
- West Kern Water District GSA groundwater pumping area is predominantly in the western portion of the Kern River Fan HCM. The GSA does not have a projected minimum target P/MA deficit and the means of sustainability is via water supply augmentation. Details on P/MAs are provided in Table 14-24.
- A portion of the Rosedale-Rio Bravo Water Storage District GSA is within the northern portion of the Kern River Fan HCM Area. The GSA has a projected minimum target P/MA deficit of 9,850 AFY, and the means of sustainability is via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-16.
- A small portion of the Cawelo Water District GSA is within the central portion of the Kern River Fan HCM Area. The GSA has a small projected minimum target P/MA deficit, and the means of sustainability is via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-6.
- A small portion of the Kern River GSA is within the northeastern portion of the Kern River Fan HCM. The GSA has a projected minimum target P/MA deficit of 62,220 AFY and the means of sustainability is via some demand reduction and mostly water supply augmentation. Details on P/MAs are provided in Table 14-10.
- A small portion of the Buena Vista GSA is within the western portion of the Kern River Fan Belt. The GSA does not have a projected minimum target P/MA deficit for this area and the means of sustainability are via mainly water supply augmentation. Details on P/MAs are provided in Table 14-5.

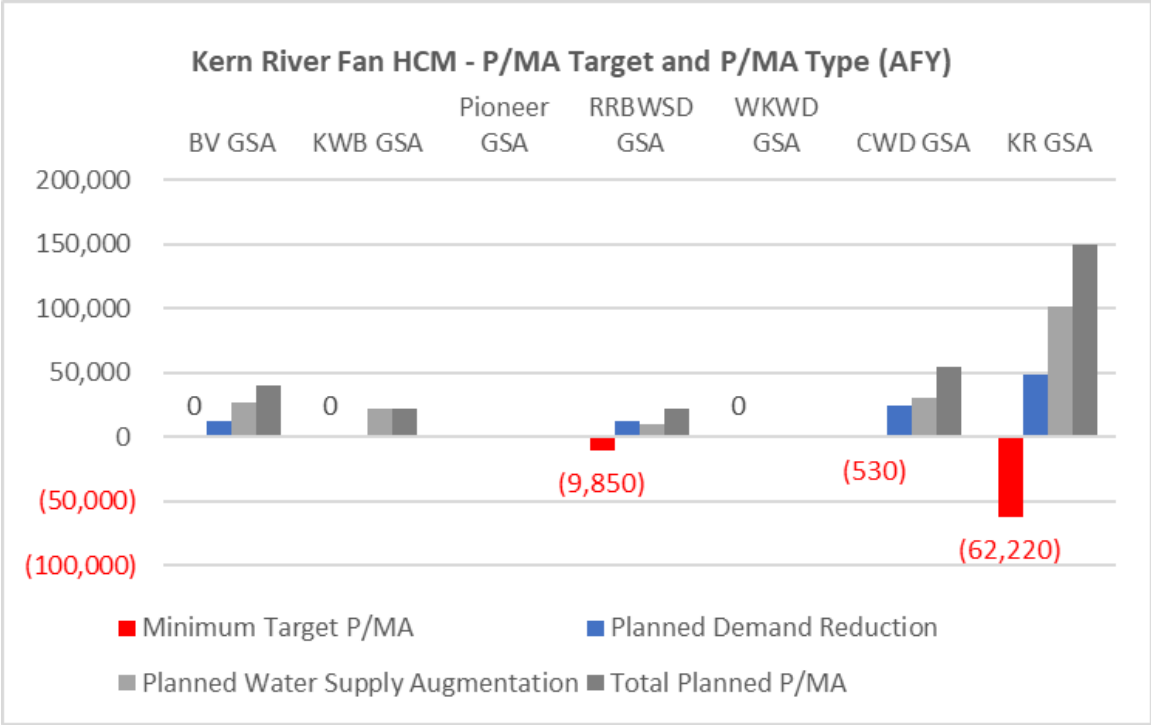


Figure 14-7. P/MA Target by GSA in the Kern River Fan

Figure 14-8 shows GSAs whose jurisdictional boundaries span the South Basin HCM Area. Land use is predominately agricultural with some industrial land uses. Urban land uses include the City of Arvin and unincorporated communities of Greenfield, Weedpatch, and Mettler, as well as several rural communities. Agricultural irrigation demand is primarily met through imported surface water and conjunctive use, as well as third party banking programs. All GSAs shown in Figure 14-8 also span across another HCM Area and were addressed in previous sections.

- Arvin GSA is predominately in the eastern portion of the South Basin HCM Area. The GSA will meet the P/MA target of 26,280 AFY via some demand reduction and mostly water supply augmentation. Details on P/MAs are provided in Table 14-4.
- Wheeler Ridge-Maricopa GSA is predominately within the southern portion of the Western Fold Belt. The GSA will meet the P/MA target of 14,360 AFY via a balance of demand reduction and water supply augmentation. Details on P/MAs are provided in Table 14-23.
- The Kern River GSA is predominately within the northern portion of the South Basin HCM Area. The GSA has a projected minimum target P/MA deficit of 62,220 AFY, and the means of sustainability is via some demand reduction and mostly water supply augmentation. Details on P/MAs are provided in Table 14-10.

- Henry-Miller Water District GSA is predominately within the northwestern portion of the South Basin Belt. The GSA's primary means of meeting the P/MA target of 5,950 AFY is via demand reduction. Details on P/MAs are provided in Table 14-8.
- A portion of Tejon-Castac Water District GSA is within the eastern portion of the South Basin HCM Area. The GSA does not have a projected P/MA deficit, and the primary means of sustainability is via water supply augmentation. Details on P/MAs are provided in Table 14-21.
- White Lands are un-districted, un-managed lands covered by the Kern Non-Districted Land Authority. These non-contiguous lands are dispersed throughout the HCM Areas. The primary means of meeting the P/MA target of 23,920 AFY is via demand reduction. Refer to KSB-6 in Table 14-9.
- A small portion of the BVGSA is within the northwestern portion of the South Basin HCM Area. The GSA does not have a projected P/MA deficit, and the means of sustainability is mainly via water supply augmentation. Details on P/MAs are provided in Table 14-5.

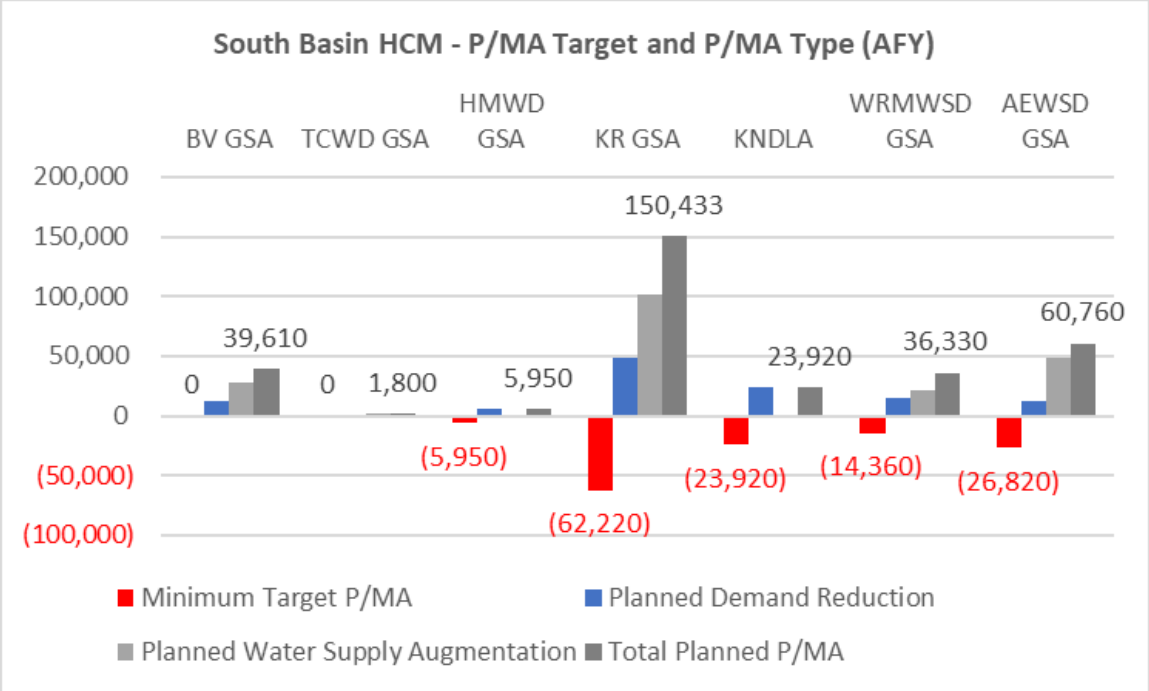


Figure 14-8. P/MA Target by GSA in the South Basin

14.2 List of Projects and Management Actions

☑ 23 CCR § 354.44(b)(1)

Subbasin-wide P/MAs are labeled with "KSB-#" which represents P/MAs that all – or nearly all - GSAs are participating in to achieve the Kern Subbasin's Sustainability Goal. Individual GSA P/MAs are numbered with the acronym of the GSA and are detailed on Table 14-4 through Table 14-24 at the end of this section.

14.2.1 Demand Reduction P/MAs

Kern Subbasin Demand Reduction P/MAs are the primary means of implementation of a glide path that will result in closing the currently identified "deficit" of 372,120 AFY under the 2030 Climate Change Scenario by the January 2040 GSP implementation deadline. P/MAs benefits that contribute to water demand reduction of **368,764** AFY by 2040 (128,614 AFY by 2025) include:

- **Land Retirement (45,835 AFY)**: Permanent change from irrigated to non-irrigated.
- **Demand Reduction (258,983 AFY)**: Program to reduce applied groundwater including (temporary, rotational, cropping changes, and possible permanent changes).
- **Ag to Urban Conversion (35,256 AFY)**: Conversion of land from irrigated land to urban.
- **Water Conservation-Efficiency (28,690 AFY)**: Incentives to improve water use practices.
- Individual GSA P/MA details can be found in Appendix J**.**
- KSB-6 White Land Water Budget/Demand Management – The Kern Subbasin is developing a governance structure and demand reduction action for Kern Subbasin white lands (lands not within a district). As part of the implementation of KSB-6 there would be another round of public outreach to include remaining white land landowners. Previous stakeholder outreach efforts accomplished GSA management of over 150,000 acres of white lands that were absorbed via agreement with various GSAs and managed for sustainability. Approximately 7,200 acres of white lands (less than 1 percent of the Kern Subbasin) remain currently using groundwater (irrigated agriculture and urban) but have not yet had management actions assigned. KSB-4 Basin Study will provide added technical data to support setting water budgets necessary to implement a linear white lands demand reduction schedule of 10 percent per year, estimated at a total of 23,920 AFY over the planning period of 2030-2040. Additional details are provided in the Kern Non-District Lands Authority Joint Powers Authority governance document in Appendix C-2. Due to the white land's relatively small groundwater demand, implementing white land demand management in the

2025-2030 period will not preclude the Kern Subbasin's ability to meet its sustainability goal.

14.2.2 Water Supply Augmentation P/MA's

☑ **23 CCR § 354.44(b)(9)**

Kern Subbasin Water Supply Augmentation P/MAs are the secondary means of implementation of a glide path that will result in closing the currently identified "deficit" of 372,120 AFY under the 2030 Climate Change Scenario by the January 2040 GSP implementation deadline. P/MAs that contribute to water supply augmentation of **445,178** AFY by 2040 (266,718 AFY by 2025) include:

- **Supplemental Water Recharge (89,768 AFY):** Increased recharge projects during wet years.
- **Supplemental Water Use (70,150 AFY):** Purchase imported water for current year.
- **Third-Party Banking (29,263 AFY):** Local benefit derived from third-party Banking.
- **New Local Supplies (120,107 AFY)**: Use of recycled water supplies.
- **Exercise of Rights (135,890 AFY):** Improved utilization of existing water supplies/rights (banked or surface).
- Individual GSA P/MA details, including water supply descriptions for water supply augmentation P/MAs can be found in Appendix J.

14.2.3 Data-Gap Filling and Mitigation Efforts

☑ **23 CCR § 354.44(b)(2)**

To address identified data-gaps, the Kern Subbasin Management Actions discussed in the following subsections are either currently being implemented or have been implemented that contribute to data-gap filling and mitigation efforts.

14.2.3.1 KSB-1 Friant-Kern Canal Capacity Mitigation

The Kern Subbasin is working to implement this project. Conveyance conditions of the Friant-Kern Canal (FKC) have been impacted by historical subsidence and will potentially be impacted by future subsidence. The Friant Water Authority (FWA) position regarding subsidence along the FKC is that "any unmitigated conveyance loss due to subsidence beyond 2020 would lead to undesirable results." Sustainable management criteria (SMCs) have been established for the FKC that limit subsidence with target average MT rates no more than of 0.1 feet per year (ft/yr) with a maximum 3 feet of cumulative subsidence from 2015 to 2040. Beyond 2040, subsidence is to be minimized with zero inelastic subsidence (including residual subsidence) attributable to

groundwater pumping under GSA jurisdiction. To address post-2020 subsidence along the FKC, a mitigation program consisting of raising the sides (liner) of the canal and upgrading associated facilities/infrastructure such as bridge crossings, check structures, wasteways, turnouts, inlet drains, siphons/underdrains, power and telephone and various size pipelines is proposed. The mitigation program will be partially funded by GSAs within the Kern Subbasin, based on the relative impact of post-2020 pumping and groundwater overdraft on subsidence along the FKC. To date, the Kern Subbasin has performed one-dimensional (1D) numerical modeling at selected sites near the FKC in the Kern Subbasin. Results from the 1D numerical modeling will be used jointly with the updated IWFM-Kern model to explore a range of scenarios for establishing the FKC subsidence mitigation cost-sharing framework as part of ongoing work in collaboration with FWA. Separately, FWA is evaluating several Lower Reach Capacity Correction alternatives including achieving the original design conveyance capacity of 2,500 cubic feet per second (cfs). FWA has performed their own forecast of future subsidence in a reconnaissance-level study (Note: the FWA future subsidence forecast is less than historical rate from 2015 to 2023 used to develop the FKC subsidence minimum threshold and assumes groundwater levels stabilizing quickly during implementation of the 2025 Plan). FWA's position is that the Kern Subbasin GSAs should minimize and mitigate lost conveyance capacity post-2020 due to ongoing subsidence attributable to groundwater pumping under GSA jurisdiction.

As part of this P/MA, the Kern Subbasin would implement the following: (1) participate in a program that monitors and tracks ongoing subsidence regionally within the Kern Subbasin and locally along the FKC, (2) compare observed rates of subsidence to established SMCs along the FKC and take action (i.e. pumping reductions) should future observed subsidence rates exceed interim milestones and the minimum threshold, (3) collaborate with FWA to develop cost estimates for the Lower Reach Capacity Correction and evaluate the degree of post-2020 lost capacity attributable to subsidence, (4) develop an attribution analysis of post-2020 subsidence impacts using either a numerical model to perform predictive analysis or other suitable tool, and (5) develop and implement a funding mechanism based on the subsidence attribution analysis to pay for post-2020 conveyance impacts on the FKC attributable to subsidence. See Appendix G-2 for additional details on the preliminary FKC mitigation assessment, cost-sharing agreement by GSAs for additional data collection and modeling; and progress on subsidence modeling to support FKC mitigation assessments. Appendix G-3 contains a letter of support for the FKC mitigation framework from the FWA.

14.2.3.2 KSB-2 Coordination with Groundwater Regulatory Programs

The Kern Subbasin will continue to coordinate with various water quality regulatory programs implemented by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program (ILRP), Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater

Banking Memorandums of Understanding (MOUs), which mandates the sampling of monitoring wells and adherence to mitigation measures to protect groundwater quality.

14.2.3.3 KSB-3 Kern Subbasin Exceedance Policy

The Kern Subbasin has prepared the Kern Subbasin Exceedance Policy and Action Plans (Appendix K-1) to outline what measures are taken if an MT is exceeded for groundwater levels, groundwater quality, and/or land subsidence. This P/MA involves the implementation of action plans surrounding investigation into the exceedance, notifications to nearby beneficial users, as appropriate, and the documentation of those activities.

14.2.3.4 KSB-4 Coordination with Basin Study

The Kern Subbasin has coordinated to perform an updated Basin Study. The work will address data and information gaps and recalibrate the Kern Subbasin model. The update will:

a. Improve the understanding of the groundwater response to the implementation of P/MAs.
b. Develop an improved determination of the input data to address data gaps for Subbasin-wide and local water budgets.
c. Incorporate locally derived hydrogeologic conceptual model data from the Kern Subbasin Plan into the model to better represent subsurface groundwater flow within and out of the Kern Subbasin.
d. Improve model calibration to better simulate groundwater levels with respect to minimum thresholds and measurable objectives.

14.2.3.5 KSB-5 Well Mitigation Program

The Kern Subbasin has developed and adopted a comprehensive Well Mitigation Program (Appendix G-1) to fund and implement a Subbasin-wide mitigation program starting January 1, 2025. As part of the 2025 Plan, the Well Mitigation Program was further revised to include a specific mitigation program track that applies to Degraded Water Quality. Additional implementation details related to groundwater quality public notification and mitigation are discussed in Appendices K-1 (Action Plan for Degraded Water Quality) and K-2 (Provisions Part IV).

In summary, the Well Mitigation Program includes three tracks for mitigation: Track 1 – Dry Well Mitigation; Track 2 – Dry Well Technical Assistance; and, Track 3 - Degraded Water Quality Mitigation. Currently, the GSAs implement Track 1 – Dry Well Mitigation through an agreement with Self-Help Enterprises (SHE), which allows the Kern Subbasin and SHE to coordinate as follows for that Track:

a. Emergency Bottled Water – Upon notice that a domestic well user has lost access to water, SHE distributes 2 weeks' worth of bottled drinking water to the household within 24-hours.
b. Well Assessment – SHE staff conduct on-site assessments which includes review of well reports/documentation, confirming water source, checking for running water/water pressure, assessing well depth and water level, inspecting electrical and above-ground components, inspecting any existing tank systems, identifying locations for new tank system placement, and developing a site map.
c. Temporary Tanks and Hauled Water – If necessary, SHE arranges for installation of a tank system and routine delivery of hauled potable water to the site. Repair and maintenance services are provided to the system until removal.
d. Ongoing Bottled Water – SHE coordinates deliveries of ongoing bottled drinking water until a long-term solution is in place.
e. Long-Term Solutions – SHE finances, as provided by the GSAs, well repairs, well replacement, and service connections to nearby water systems (whenever feasible) to restore long-term water access to the home.

For the Degraded Water Quality Mitigation Track, the Kern Subbasin is committed to engage qualified professionals and/or an appropriate contractor/entity (e.g., Self-Help Enterprises) for implementation of the Degraded Water Quality Mitigation Track. The Kern Subbasin is committed to providing financial support for implementation of services such as providing short-term alternative water supplies and implementing long-term solutions for eligible domestic well owners. In the case of nitrate, the Kern Subbasin will seek to work with the Kern Water Collaborative to address interim and long-term solutions for nitrate impacts, as determined appropriate.

14.2.3.6 KSB-6 White Land Water Budget/Demand Management

The Kern Subbasin is developing a governance structure and demand reduction action for Kern Subbasin white lands (lands not within a district). As part of the implementation of KSB-6 there would be another round of public outreach to include remaining white land landowners. Previous stakeholder outreach efforts accomplished GSA management of over 150,000 acres of white lands that were absorbed via agreement with various GSAs and managed for sustainability. Approximately 7,200 acres of white lands (less than 1 percent of the Kern Subbasin) remain currently using groundwater (irrigated agriculture and urban) but have not yet had management actions assigned. KSB-4 Basin Study will provide added technical data to support setting water budgets necessary to implement a linear white lands demand reduction schedule of 10 percent per year, estimated at a total of 23,920 AFY over the planning period of 2030-2040. Additional details are provided in the Kern Non-District Lands Authority Joint Powers Authority governance document in Appendix C-2. Due to the white lands' relatively

small groundwater demand, implementing white land demand management in the 2030 period will not preclude the Kern Subbasin's ability to meet its sustainability goal.

14.2.3.7 KSB-7 Well Registry

In late 2023, the GSAs initiated a Subbasin-wide well inventory that reconciles records from multiple databases to develop an accurate well inventory with verified well uses that is based on available records and field verification surveys (refer to the detailed process description in Section 5.6.1). The completed well inventory will be translated into a well registry based on district records of property owner information. This management action will be an ongoing effort as GSAs continue to update and maintain their well inventory/registry, which will be housed within the Kern Subbasin data management system. At least annually, the Kern Subbasin will update the system using DWR/County well permit information and well surveys.

14.2.3.8 KSB-8 Consumptive-Use Study

The Kern Subbasin has annually contracted with either Cal Poly's Irrigation Training Research Center and/or LandIQ for monthly evapotranspiration data of the Kern Subbasin for both planning and, in some GSAs, for groundwater extraction fee calculation purposes. The Kern Subbasin will continue this effort and invest in improved technology and processes for improved accuracy.

14.2.3.9 KSB-9 California Aqueduct Subsidence Action Plan

Targeted P/MAs within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct – The Kern Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence (see Sections 8.5,13.5.2, and Appendix K-1). As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs. These targeted P/MAs located within or proximate to the CASP Monitoring Corridor to the California Aqueduct may include: (1) well registry, (2) metered well extraction volume reporting, (3) net zero well drilling moratorium, (4) targeted pumping reductions, and (5) pumping limitations, among others deemed necessary informed by GSA analysis undertaken from the five-step Kern Subbasin Subsidence Action Plan (Appendix K-1). See Appendix J for GSA-specific details on targeted P/MAs within close proximity to the California Aqueduct.

14.2.3.10 KSB-10 RMW Data Gaps

In Section 15, an assessment of the Groundwater Level and Groundwater Quality RMN was conducted to ensure the network was monitoring beneficial users located at different depths. For the Groundwater Level RMN, this analysis yielded representative monitoring network data gaps in three grid hexagons for domestic beneficial users. The

groundwater level monitoring assessment also identified seven additional grid hexagons as potential data gaps where GSAs propose to conduct supplemental monitoring to further assess localized shallow groundwater conditions. The groundwater quality assessment yielded representative monitoring network data gaps in 30 grid hexagons. To address the three Groundwater Level RMN data gaps, the Kern Subbasin will augment the groundwater level monitoring network with one additional well. To address the 30 Groundwater Quality RMN data gaps, the Kern Subbasin anticipates augmenting the groundwater quality monitoring network with up to an additional 30 wells. The timeline for addressing these data gaps with existing wells is one year (end of calendar year 2025). The timeline for addressing these data gaps with a newly constructed well is two years (end of calendar year 2026). This timeframe is required to provide GSAs with adequate time to identify and field vet potential monitoring wells. In cases where no existing wells can be identified or access secured, new monitoring wells will be drilled to address these data gaps. See Section 15.5 for additional details regarding the data gap analysis and filling implementation plan.

14.2.4 Adaptive Management Efforts

To the extent that projects and management actions are unable to prevent Minimum Threshold Exceedances that are caused by activities under GSA authority, further actions will be evaluated and considered as directed by KSB-3 Kern Subbasin Exceedance Policy and Action Plans attached in Appendix K-1. If either the projects or management actions are unable to produce the projected benefits, or other better options are found that prove more cost-effective the GSA may deviate from the actions as described above. At each 5-year planning window, each previously described P/MA benefits will be evaluated. New P/MAs may also be evaluated and included at the planning window and added if estimated benefits are unrealized. Progress on the glide path's implementation will be presented annually via the Kern Subbasin Annual Report and inform adaptive management efforts.

Each GSA will enact projects and actions to accomplish at least a linear path to sustainability. Several projects have been identified and listed "**As Needed**" on Table 14-3 and could reduce the deficit by up to 71,645 AFY if implemented.

14.3 Circumstances for Implementation

☑ 23 CCR § 354.44(b)(1)(A)

As discussed above, an overall P/MA implementation schedule, or preliminary glide path has been developed as a framework to guide the level of benefits that are planned to be achieved over the 2025 Plan implementation period (i.e., until 2040), and further through the SGMA planning and implementation horizon (i.e., through 2070). P/MAs will be implemented in such a way as to meet the glide path Milestones as a minimum requirement.

P/MAs have been categorized on Table 14-4 through Table 14-24 as: **Implemented**, **Functional**, **In-Process**, or **As-Needed**.

Implemented (85 total P/MA's, 47 percent) – In anticipation of SGMA, several P/MAs were initiated pre-2020 and have since been completed. Several other P/MAs were developed in response to SGMA and have since been completed and are accruing benefits.

Functional (4 total P/MA's, 2 percent) – In response to SGMA, several P/MAs had been initiated and have since been completed. Several other P/MAs were developed in response to SGMA and have since been completed but are not yet accruing benefits.

In-Process (93 total P/MA's, 51 percent) – Other P/MAs are In-Process somewhere between Feasibility and Construction/Implementation. All of the In-Process P/MAs will be implemented except for circumstances such as litigation, failed funding, failed ballot initiatives, or environmental constraints.

As-Needed (56 P/MA's) – As part of the Adaptive Management efforts, several P/MAs have been identified in response to Minimum Threshold Exceedances, failed or diminished P/MAs, new opportunities, or other unforeseen issues. At each 5-year planning window, these and other P/MAs will be formally evaluated for implementation.

14.4 Public Notice Process

☑ 23 CCR § 354.44(b)(1)(B)

Public notice requirements vary for the different P/MAs listed above. Some projects' infrastructure improvements may not require specific public noticing (other than that related to construction), whereas other management actions that involve, for example, imposition of fees by the GSA, may require public noticing pursuant to Proposition 218 or Proposition 26. In general, GSA meetings are open to the public. In some instances, the P/MAs will also each be subject to California Environmental Quality Act (CEQA) review and other permitting processes that are subject to public notice and review. Additional stakeholder outreach efforts will be conducted prior to and during P/MA implementation, as required by law.

14.5 Overdraft Conditions

☑ 23 CCR § 354.44(b)(2)

As discussed in Section 9.6.5 and shown on Table 9-12, the Kern Subbasin has a net water budget deficit of 372,120 AFY over the historical period based on the specific budget model under the 2030 Climate Change Scenario by 2040. The P/MAs presented herein are expected to result in benefits that will address the projected deficit to avoid Undesirable Results and maintain sustainability as shown on Figure 14-1.

14.6 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, or management actions. The various types of permitting and regulatory requirements (not all applicable to every P/MA) that may be applicable to P/MAs are summarized by category in the following section.

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), or Notice of Exemption (NOE).
- 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.

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, local agencies, 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 14-4 through Table 14-24. Upon implementation of any P/MA, the regulatory and permitting requirements of the P/MA will be reexamined.

14.7 Status and Implementation Timetable

☑ 23 CCR § 354.44(b)(4)

Section 14.3 Circumstances for Implementation established categories for implementation, including implemented, functional, in-process, or as-needed. 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 14-4 through Table 14-24. As-needed projects are part of the Kern Subbasin's adaptive management process that compensates for uncertainty in the checkbook accounting.

14.8 Expected Benefits

☑ 23 CCR § 354.44(b)(5)

P/MAs have expected benefits related to water quantity. Once a P/MA is implemented, there needs to be a way to evaluate, ideally to quantify, the benefits resulting from that P/MA. How 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 the measurement of those flows. For P/MAs that involve indirect supply augmentation through, for example, increased groundwater storage, quantification of the benefit will require tracking of deliveries to said projects as compared to estimated benefits made in the planning process. 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, consumptive use) 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, the quantification of the benefits is inherently uncertain.

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 informed by a water budget outcome with the goal 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.

14.9 Source and Reliability of Water from Outside the Basin

☑ 23 CCR § 354.44(b)(6)

Specific sources of water utilized for water supply augmentation P/MAs can be found in Appendix J for each specific project.

14.9.1 P/MA Annual Water Benefit Estimate for Groundwater Recharge/Storage Projects

Water banking recharge projects have been designed with a very conservative water supply augmentation benefit calculation as follows:

Annual Water Benefit = estimated infiltration rate ft/day * wetted acres * days operation in a wet year * 20 percent of years being wet * percent of stored water for third parties.

Specific benefit calculations for water supply augmentation P/MAs can be found in Appendix J for each specific project or management action.

14.10 Legal Authority Required

☑ 23 CCR § 354.44(b)(7)

Per California Water Code (CWC) § 10725 through 10726.8, a GSA possesses the legal authority necessary to implement the demand management P/MAs described herein. Individual GSA authority varies and is further described in Appendix J.

14.11 Estimated Costs and Plans to Meet Them

☑ 23 CCR § 354.44(b)(8)

Estimated costs for each P/MA in the Kern Subbasin are presented in Table 14-3. The costs are approximate and 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.

Potential sources of funding for the various P/MAs are also presented in Table 14-4 through Table 14-24, and include but not limited to the following:

- District assessments and/or water charges.
- Grant funding from sources including DWR, United States Bureau of Reclamation (USBR), and CA WISP.

Estimated costs for the Kern Subbasin’s P/MAs by implementation status are presented in Table 14-3. The costs are approximate and subject to refinement. These costs include “one-time” costs and ongoing costs.

Table 14-3. Kern Subbasin (P/MA Cost by Implementation Status)

Kern County Subbasin	Estimated Costs	
	One-time	Annual
Implemented	$280,929,932	$38,088,545
Functional	$110,405,000	$5,693,800
In-Process	$956,138,409	$11,618,135
As-Needed	$269,880,000	$9,043,000
Total	**$1,617,353,341**	**$64,443,480**

14.12 Management of Recharge and Groundwater Extractions

☑ 23 CCR § 354.44(b)(9)

As stated previously in Section 9 Water Budget Information, the Kern Subbasin is in a state of approximate water supply/demand deficit of 372,120 AFY. One of the primary means by which the deficit will be addressed is through the implementation of P/MAs that reduce demand and augment supplies from additional outside sources of water, in particular during normal to wet years. Many of the projects discussed herein and shown on Table 14-4 through Table 14-24 take advantage of additional wet-year supplies that are assumed to be available as capacity increases. 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 through newly implemented water charges, and others are more specifically focused on reducing groundwater pumping by land retirement and imposed water budgets. Through this combination of increased recharge during wet years and demand reduction, the 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.

Table 14-4. Arvin GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process		As-Needed									Implemented	Functional		In-Process			As-Needed					
AE-1	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.		✓			Underway	Public meetings, direct mail	Title 22 Drinking Water Regulations	**Complete**	Complete	Complete	2019-	**0**	**0**	✓					NA	None	$2,250,000	NA	ACSD
AE-2	On-Farm Recharge	The program encourages 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.	✓			Supplemental Water Recharge	Underway	No public notice required for implementation; outreach and education will expand program.	NA	**Starting in 2023, provided financial incentives to landowners to conduct on-farm recharge; 13,317 AF recharged to the Kern Subbasin in 2023.**	Ongoing	Ongoing; implemented beginning in 2019	2023-	**5300**	**0**	✓	✓	✓			Local stormwater	None	NA	NA	Private; if required
AE-3	Emergency 1,2,3-TCP Treatment Well #12 (EPA Replacement CW-1)	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.		✓			Underway	Public meetings, direct mail	Title 22 Drinking Water Regulations	**Well #12 was completed and commissioned in May of 2021.**	Complete	Completed May 2021	2021-	**0**	**0**	✓					NA	None	$1,600,000	TBD	ACSD
AE-4	Forrest Frick Pipeline / KDWD Eastside Canal Intertie	This project connects 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.	✓	✓		Supplemental Water Use	Underway	Infrastructure improvement; no public noticing necessary	CEQA; NEPA; County encroachment permits	**Deliveries began in February 2023**	Complete	Construction completed in February 2023	2023-	**1,900**	**0**	✓	✓	✓			Additional wet-year imported water supplies	None	$1,000,000	TBD	AEWSD General Fund, USBR grant
AE-5	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.		✓			Underway	Public meetings, direct mail	Title 22 Drinking Water Regulations	**Well #18 completed December 2023; all other project components complete**	Complete	December 2023	2024-	**0**	**0**	✓					NA	None	$14,200,000	TBD	ACSD
AE-6	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.	✓			Supplemental Water Recharge	Grant funding	Infrastructure improvement; no public noticing necessary	Caltrans permitting; CEQA if longer pipeline connections are required	**Several Cal Trans basins have been connected to AEWSD and are currently taking surface water for recharge**	Ongoing	Ongoing	2023-	**270**	**0**	✓	✓	✓			Additional wet-year imported water supplies; Local stormwater	None	$500,000	NA	AEWSD General Fund; grants

AE-31	**Exercising Existing Water Rights**	The USBR, SLDMWA, FWA, and SJREC have entered into a MOU to collectively identify projects and potential actions aimed at improving drought resliency south of the Delta, including AEWSD deliveries from the FKC. The South of Delta Drought Resiliency Framework allows participating entities to voluntarily conserve and securely store a portion of their CVP south of Delta deliveries for subsequent use with the goal of providing at least a 5% allocation to CVP south of Delta agricultural water service/repayment contracts, reducing reliance on Delta exports in drought years.	✓			Exercise of Rights	Underway	NA	NA	**MOU effective March 2024**	2023	2024	2024-	**2000**	**0**			✓			Increased reliability of AEWSD's CVP supplies	Signed MOU	$0	$0	AEWSD General Funds
AE-7	**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 takes surface water (Federal CVP, State Water Project, or local supplies) diverted through KDWD's Eastside Canal and recharges the surface supplies as part of AEWSD's and KDWD's joint water management programs. The Project included 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.	✓	✓		Supplemental Water Recharge	Underway	Infrastructure improvement; no public noticing necessary	KDWD encroachment permit; CEQA; NEPA if federal funds are used	**Project construction is anticipated to be complete in Spring 2024; Early deliveries began in February 2023 using mobile temporary pumps**	Underway	Spring 2024	2023-	**4920**	**410**	✓	✓	✓			Additional wet-year imported water supplies	None	$7,330,000	TBD	AEWSD General Fund (50%), KDWD (50%)
AE-8	**DiGiorgio Unit In-Lieu Storage Program**	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.	✓	✓		Supplemental Water Use	Grant funding	Infrastructure improvement; no public noticing necessary	CEQA; NEPA requirements if grant funds are used; PWRPA; possible Kern County encroachment permits	**Phase 2a construction anticipated to be complete in Fall 2024; funded through portion of a $25M loan to AEWSD**	Future Phases initiated upon grant funding	Phase 2a completion: Fall 2024	2025-	**4250**	**0**	✓					Additional wet-year imported water supplies	None	$17,000,000	TBD	AEWSD General Fund
AE-9	**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.	✓	✓		Supplemental Water Use	Grant funding	Infrastructure improvement; no public noticing necessary	CEQA; NEPA requirements if grant funds are used; PWRPA; possible Kern County encroachment permits	**$2M from the IRWM Round 2 grant awarded**	Upon grant funding	2025	2026-	**3500**	**0**	✓					Additional wet-year imported water supplies	None	$16,000,000	TBD	AEWSD General Fund, IRWM Grant
AE-10	**Expansion of North Canal Spreading Works**	The Project will convert approximately 160 acres of permanently cropped agricultural lands into additional groundwater recharge facilities as part of the District's existing North Canal Spreading Works. The Project water supply benefits include approximately 500 AFY due to the land use change (vineyards and almond orchards to basins), plus an average annual recharge benefit of 5,200 AFY (or 13,000 AF in an unconstrained year).	✓	✓		Supplemental Water Recharge	Underway	CEQA, NEPA	CEQA, NEPA	**Planning and design underway; construction anticipated to begin in October 2025 and last 6 months**	Underway	2025	2026-	**5200**	**500**	✓	✓	✓			Additional wet-year imported water supplies	None	$4,300,000	TBD	AEWSD General Fund; DWR grant
AE-11	**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.	✓			New Local Supply	Grant funding	Infrastructure improvement; no public noticing necessary	NA	**Initiated the South Canal Flood Study, including identification of potential grant funding sources**	Study initiated upon GSP adoption	Study approx. 1 year; construction approx. 1 year	2030-	**150**	**0**		✓	✓			Local stormwater	None	$2,300,000	NA	AEWSD General Fund

AE-12	**Conversion of Granite Quarry to Sycamore Ranch**	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.	✓	✓		Supplemental Water Use	To be implemented upon adoption of GSP / Grant funding	Infrastructure improvement; no public noticing necessary	CEQA; DMR SMARA permit closure; NEPA requirements if grant funds are used	**Geotechnical study complete; AEWSD and TCWD have participated in several meetings to discuss the permitting process for this project**	TBD	Construction duration TBD	2030-	**0**	**0**	✓		✓			Additional wet-year imported water supplies	Property acquisition or land use agreement with quarry owner	$15,000,000	TBD	AEWSD General Fund, TCWD
AE-13	**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.	✓			New Local Supply	Project to be implemented upon FEMA grant approval.	Infrastructure improvement; no public noticing necessary	SJVAPCD Dust Control & SWPPP; NEPA Cultural Resources	**AEWSD continues to seek grant funding for this project.**	Upon grant funding	Construction duration: 3 years	2040-	**1550**	**0**		✓	✓			Stormwater from Bakersfield storm sewer system	None	$2,500,000	$32,000	AEWSD General Fund
AE-14	**General Temporary Water Program**	The Temporary Water 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.	✓	✓		Supplemental Water Use	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 to contracted and noncontracted lands; Sandrini Unit (i.e., Tejon Expansion) under design; Development of a potential hybrid in-lieu and temporary water service contract is underway and landowner outreach for the new areas will begin soon.**	Upon grant funding	2030	2030-	**15000**	**110**	✓					Additional wet-year imported water supplies	None	$10,000,000	TBD	AEWSD General Fund
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasiblity Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	AEWSD General Fund (Study only)
AE-32	**Capture of Imported Water Return Flows from White Wolf Subbasin**	AEWSD has provided imported water deliveries to landowners within the White Wolf Subbasin. Return flows of imported water flow across the White Wolf Fault into Arvin GSA. Arvin GSA would capture the proportion of Subbasin inflows attributed to AEWSD's imported water return flows for distribution and use within the surface water service area.	✓			Exercise of Rights	Underway	GSA Board meetings	NA	**Arvin GSA has initiated discussions and negotiations with Subbasin GSAs and White Wolf GSA**	2024	2025	2025-	**4500**	**0**						Imported water return flows	None	$0	$0	NA
AE-15	**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.	✓	✓		Supplemental Water Recharge	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	Construction duration: approx. 2 years	1-3 years after construction	**250**	**0**		✓				Local stormwater	None	$3,000,000	$30,000	AEWSD; potential grants
AE-16	**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.	✓	✓		Supplemental Water Recharge	Grant funding and 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	Construction duration: approx. 1 year	1-3 years after construction	**TBD**	**0**	✓	✓				Local stormwater	None	TBD	TBD	AEWSD and partnering agencies

AE-17	**Caliente Creek Habitat Mitigation and Groundwater Recharge**	Restoration of agricultural lands to native vegetation to provide flood mitigation. Two alternatives are being considered, of which Alternative 1 is partial agricultural and 2 is non-agricultural.	✓			Supplemental Water Recharge; Land Retirement	Grant funding	CEQA, NEPA	CEQA; NEPA (if federal funds used); SWRCB Waste Discharge Requirements; CDFW Agreement; Determination of consistency with VFHCP	**Not yet Initiated**	TBD; upon grant funding	TBD	Immediately following construction	**TBD**	**TBD**		✓				Local stormwater	None	$3,000,000	TBD	AEWSD; potential grants
AE-18	**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.	✓			Supplemental Water Use	Completion of feasibility study	Infrastructure improvement; no public noticing necessary	None (CEQA exempt under 15301 and 15303)	**Not yet Initiated**	TBD	Construction duration: approx. 1 year	1 year after construction	**4000**	**0**			✓			Additional wet-year imported water supplies	None	$2,000,000	$20,000	AEWSD General Fund; KDWD
AE-19	**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.	✓			Supplemental Water Recharge; Demand Reduction	Completion of feasibility study	Infrastructure improvement; no public noticing necessary	None	**Not yet Initiated**	Upon grant funding	Construction duration TBD	1-3 years after construction	**100**	**40**			✓			Additional wet-year imported water supplies	None	$300,000	TBD	AEWSD; potential grants
AE-20	**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.	✓			Supplemental Water Use	Grant funding/Completion of feasibility study	Infrastructure improvement; no public noticing necessary	Permits: TBD; NEPA requirements if funds are granted	**Not yet Initiated**	TBD	Construction duration TBD	TBD	**1000**	**0**			✓			Additional wet-year imported water supplies	None	$15,000,000	TBD	AEWSD General Fund
AE-21	**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.	✓			Supplemental Water Use	Grant funding, South County flooding response	Infrastructure improvement; no public noticing necessary	TBD	**Not yet Initiated**	TBD	Construction duration TBD	TBD	**500**	**190**			✓			Additional wet-year imported water supplies	None	$5,000,000	$5,000	AEWSD General Fund
AE-22	**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.	✓	✓		New Local Supply	To be implemented upon adoption of GSP / agreement with partnering oil field	Public meetings	TBD	**Not yet Initiated**	Upon agreement with oil field producers	TBD	1 year after agreement	**1000**	**0**						Oil field produced water	None	TBD	TBD	AEWSD and partnering oilfield
AE-23	**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.	✓			New Local Supply	To be implemented upon adoption of GSP / 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	TBD	1 year after agreement	**10000**	**0**						Wastewater from Cities of Arvin and Bakersfield	None	TBD	TBD	AEWSD and partnering cities

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary								One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility /	Mitigation Programs	Data Gap Filling/ Monitoring					
Management Actions		Implemented / Functional / In-Process	As-Needed										Implemented	Functional		In-Process			As-Needed							
KSB-2	Coordination with Groundwater Regulatory Programs	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.		✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	AEWSD General Fund
KSB-3	Exceedance Policy	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	AEWSD General Fund
KSB-5	Well Mitigation Program	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	AEWSD General Fund
AE-24	Groundwater Extraction Quanticiation 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.	✓		✓		Underway	District flyers, direct mail, public meetings	None	**AEWSD completed their district-specific groundwater flow model and decision support tool. The GSA obtained satellite crop evapotranspiration (ET) data through LandIQ.**	Underway	Refinements ongoing	2023-	**0**	**0**			✓		✓	NA	Authority of a GSA under SGMA to develop and implement a GSP	$0	$10,000	DWR Grant
AE-26	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.	✓		✓	Land Retirement	To be implemented upon adoption of GSP	District flyers, direct mail, public meetings	None	**485 acres of solar conversion since 2015. District retained a consultant to develop Land Repurposing Program; Board to consider policy in late 2024. AEWSD provided financial incentives to landowners to conduct on-farm recharge (see AE-1).**	Underway	2025	2015 (solar conversion) & 2030 (land repurposing)	**0**	**11200**						NA	Authority of a GSA under SGMA to develop and implement a GSP	$130,000	TBD	AEWSD General Fund
AE-25	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.	✓			Demand Reduction	To be implemented upon adoption of GSP	District flyers, direct mail, public meetings	None	**In late 2023, AEWSD published an informational flier with information on District groundwater use**	Underway	Ongoing	TBD	**0**	**100**						NA	None	$15,000	$5,000	AEWSD General Fund

KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	AEWSD General Fund
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	AEWSD General Fund
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	AEWSD General Fund
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	AEWSD General Fund
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing								✓	NA				
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	AEWSD General Fund

KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	AEWSD General Fund
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	AEWSD General Fund
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	AEWSD General Fund
KSB-9	**Subsidence Action Plan**	Subbasin wide policy to provide protocols for GSAs to investigate subsidence exceedances. This policy is developed in conjunction with the Subbasin Groundwater MT exceedence which identifies investigation and mitigation P/MA strategies.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing												
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
AE-27	**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.	✓			Water Conservation-Efficiency	Grant funding	District flyers, direct mail, public meetings	None	**Not yet Initiated**	Upon stakeholder interest	TBD	1-3 years after initiation	**0**	**250**						NA	None	$10,000	$0	NCRS
AE-28	**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.	✓		✓	Demand Reduction	As-needed to meet milestones	District flyers, direct mail, public meetings	Prop 218 or through District rate setting	**Not yet Initiated**	As-needed to meet milestones	TBD	1-3 years after implementation	**0**	**TBD**						NA	Authority of a GSA under SGMA to develop and implement a GSP	NS	NA	NA

AE-29	**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.	✓		✓	Demand Reduction	To be implemented upon adoption of GSP	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	TBD	1-3 years after implementation	**0**	**TBD**						NA	Authority of a GSA under SGMA to develop and implement a GSP	TBD	TBD	AEWSD General Fund
AE-30	**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.	✓		✓		Contingent on "Groundwater Extraction Quantification Method" and "Groundwater Allocation per Acre" Management Actions	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	1-2 years after initiation by GSA Board	1-3 years after initiation	**0**	**NA**			✓			NA	Authority of a GSA under SGMA to develop and implement a GSP	TBD	TBD	AEWSD General Fund

Table 14-5. BVGSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process				As-Needed						
BV-1	Magnetic Flow Meter Installation	Magnetic flow meters have been installed on all production wells in BV. In addition to the approximately 200 wells now having magnetic flow meters, meters are being installed on all new and replacement wells constructed in the District.	✓		✓		Complete	NA	NA	Implemented and Operational	NA	Ongoing	2016-	0	0			✓		✓	NA	None	$800,000	$1,600	BVWSD (water charges)
BV-2	Palms Recharge Project	The BVWSD/GSA has the 1,142-acre Palms Recharge Project. This facility is located at the southern tip of the District's Buttonwillow Service Area and was constructed on lands acquired by the District and retired from agricultural production.	✓	✓	✓	Land Retirement Supplemental Water Recharge	Complete	NA	NA	Implemented and operational	NA	2019	2020-	8,700	3,340	✓	✓	✓		NA	Kern River and SWP water and occasionally Friant water	None	$26,000,000	$52,000	BVWSD (water charges)
BV-3	Corn Camp Recharge Project	In 2020 the BVWSD/GSA completed the 85-acre Corn Camp Recharge Project. This facility is located within the District and was constructed on land acquired by the District under a 20-year lease with eight 5-year options to extend the lease for a total of 60 years. The land has been retired from agricultural production.	✓	✓	✓	Land Retirement Supplemental Water Recharge	Complete	NA	NA	Implemented and operational	NA	2021	2020-	470	250	✓	✓	✓		NA	Kern River and SWP water and occasionally Friant water	None	$1,750,000	$3,500	BVWSD (water charges)
BV-4	Annexation Demand Reduction Project	The District has purchased 900 acres of white lands and taken it out of production. This land is adjacent to the District and is in the process of being annexed.	✓	✓	✓	Land Retirement	Complete	NA	NA	Implemented and operational	NA	2021	2020-	0	2,630	✓	✓	✓		NA	NA	None	$9,000,000	$18,000	BVWSD (assessment)
BV-5	Daley Ranch Recharge Project	The BVWSD/GSA purchased 91 acres that the District has used to develop the Daley Ranch Recharge Project. This facility is located within the District, and the property has been retired from agricultural production.	✓	✓	✓	Land Retirement Supplemental Water Recharge	Complete	NA	NA	Implemented and operational	NA	2022	2021-	350	270	✓	✓	✓		NA	Kern River and SWP water and occasionally Friant water	None	$4,800,000	$9,600	BVWSD (water charges)
BV-6	Completed Pipelines	Completion of 83 miles of pipeline (36" to 54") to improve distribution of irrigation water by providing an alternative to unlined canals and installing new connections to the California Aqueduct. The pipelines give the District more discretion as to when recharge is performed. The pipeline system has been designed to operated on gravity flow in non-peak irrigation months. All construction has been performed since 2014. Projects include Northern Area, Northern Area - Southern Extension, Northern Area - Eastern Extension, and 7th Standard pipelines.	✓	✓	✓		Complete	NA	NA	Implemented and Operational	NA	2022	2015-	0	0			✓		NA	Kern River and SWP water and occasionally Friant water	None	$72,000,000	$144,000	BVWSD (Capital Improvement Fund), Federal and State grants
BV-7	Completed Pump Stations	Three pump stations (two 1,200-hp and one 600-hp) have been completed to augment flow in the District's distribution system during peak months.	✓				Complete	NA	NA	Implemented and Operational	NA	2023	2020-	0	0			✓		NA	Kern River and SWP water and occasionally Friant water	None	$6,000,000	$12,000	BVWSD (Capital Improvement Fund), Federal and State grants
BV-8	Future Pump Station	Design and environmental documentation of the 600-hp Brite Rd Pump Station is in progress.	✓				Completion of Project	NA		Design/Environmental Compliance	2024	2026	2025-	0	0			✓		NA	Kern River and SWP water and occasionally Friant water	as required by CEQA	$2,450,000	$4,900	BVWSD (Capital Improvement Fund), Federal and State grants
BV-9	BV Future Pipelines	Construction of an additional 17 miles of pipeline to improve distribution of irrigation water by replacing open ditch laterals. Projects include the Belridge, Corn Camp Loop, Wasco Way, Elk Grove, and Brite Road pipelines. Important for delivering surface water to reduce reliance on marginal quality groundwater.	✓	✓	✓		Completion of Project	NA		Design/Environmental Compliance	2022	2027	2026-	0	0			✓		NA	Kern River and SWP water and occasionally Friant water	as required by CEQA	$10,000,000	$20,000	BVWSD (Capital Improvement Fund), Federal and State grants
BV-10	McAlister Ranch Recharge Project	The BVGSA/BVWSD continues to work through regulatory hurdles in the development of a 2,072-acre water bank. BVWSD owns 86% the project and the remaining 14% is on the market. The DEIR is close to completion.	✓	✓	✓	Land Retirement Supplemental Water Recharge	Completion of Project	Completion of Project	In CEQA process	Design/Environmental Compliance	2026	2028	2028-	18,000	5,600	✓	✓	✓		NA	Kern River	as required by CEQA	$35,000,000	$100,000	BVWSD (assessment)

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	Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits: Primary (AFY): Water Supply Augmentation	Expected Benefits: Primary (AFY): Demand Reduction	Expected Benefits: Secondary: Water Quality Improvement	Expected Benefits: Secondary: Flood Control	Expected Benefits: Secondary: Water Management Flexibility / Efficiency	Expected Benefits: Secondary: Mitigation Programs	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)
Management Actions		**Implemented / Functional / In-Process**		**As-Needed**									**Implemented**		**Functional**			**In-Process**		**As-Needed**					
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	BVWSD (assessment)
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.		✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	BVWSD (assessments)
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	BVWSD (assessments)
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	BVWSD (assessments)
KSB-4	**Coordination with Basin Study**	Coordination with local GSAs to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	BVWSD (assessments)
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	BVWSD (assessments)
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	BVWSD (assessments)
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	BVWSD (assessments)
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time

Table 14-6. CWD GSP P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process					As-Needed					
CWD-1	New Water Supply Purchases	Implement programs that will acquire long-term new water contracts and/or establish a water purchase fund. The main goal would be to secure long-term water contracts and/or build a reserve fund for water purchases when supplemental water is available.	✓	✓	✓	Supplemental Water Supply	Complete	NA	NA	**Implemented**	Complete	Complete	2020-	**5800**	**0**	✓	✓	✓			State Water Project, Kern River, Central Valley Project	None		$8,000,000	Cawelo Water District (Assessments / Water Charges)
CWD-3	Increase Recharge Capacity	Implement programs and/or projects to increase water recharge capacity to capture and recharge additional wet year high flow waters to store for future use. CGSA will also consider to implement a program to incentivize landowners to use their land for recharge.	✓	✓	✓	Supplemental Water Recharge Land Retirement Demand Reduction	In-Process Implemented	Board Meetings Public Notice and Outreach	CEQA Construction Permits	**In-Process (CWD increase water recharge capacity) Implemented (Landowner Banking Program)**	Current	2025	2025-	**400**	**300**	✓	✓	✓			State Water Project, Kern River, Central Valley Project	None	$9,000,000		Cawelo Water District (Assessments) CGSA Landowners
CWD-2	Friant Pipeline Project	Construct a pipeline, pump station, and turn-in/out structure to connect the CWD Famoso Recharge Basins directly to the Friant-Kern Canal. This project will allow for greater access to supplemental water and support additional banking programs.	✓	✓	✓	Supplemental Water Supply Supplemental Water Recharge Third-Party Banking	In-Process	Board Meetings Public Notice and Outreach	CEQA Construction Permits	**Construction**	Current	2024	2025-	**2160**	**0**	✓	✓	✓			Central Valley Project Third-Party Banking Partner	None	$9,000,000		Cawelo Water District (Assessments)
CWD-4	New Cawelo GSA Banking Partners	Modify existing CWD banking programs to increase the amount of water banked or initiate new banking programs and partners as a secondary priority.	✓	✓	✓	Third-Party Banking	In-Process	Board Meetings Public Notice and Outreach	CEQA Construction Permits	**In-Process**	Current	2030	2025-	**500**	**0**	✓	✓	✓			Third-Party Banking Partner	None		$100,000	Third-Party Banking Partner Cawelo Water District (Assessments)
CWD-5	Poso Creek Flood Water Capture	Construct additional facilities to utilize existing appropriative rights to divert supplementary water from high flows from Poso Creek.	✓	✓	✓	Exercise of Rights	In-Process	Board Meetings Public Notice and Outreach	CEQA Construction Permits	**Conceptual**	Current	2030	2030-	**150**	**0**	✓	✓	✓			Poso Creek	None	$3,900,000		Cawelo Water District (Assessments / Water Charges)
CWD-6	Water Treatment Facilities	Construct additional potential water treatment facilities/operations to acquire additional treated oilfield produced water that is safe for crop irrigation. When irrigation demands are low the water will be recharged for later use.	✓	✓	✓	New Local Supply	In-Process	Board Meetings Public Notice and Outreach	CEQA CVRWQCB WDR Construction Permits	**In-Process**	Current	2035	2025-	**20000**	**0**	✓		✓			Treated Oilfield Produced Water 9000 AF in 2025 to 20000 in 2040	None	$11,250,000		Cawelo Water District (Assessments / Water Charges)
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-					✓	✓	✓	NA	None	Unknown	Unknown	Cawelo Water District (Assessments)
CWD-7	Surface Water Storage	Construct a 5,000 AF reservoir to provide additional storage capacity during wet years to increase ability to capture available supplemental water during wet hydrological conditions.	✓	✓	✓	Supplemental Water Supply	As Needed	Board Meetings Public Notice and Outreach	CEQA Construction Permits	**As Needed**	As Needed	2035	2035-	**500**	**0**		✓	✓			State Water Project, Kern River, Central Valley Project	None	$40,000,000		Cawelo Water District (Assessments)
CWD-8	Out of Cawelo GSA Banking	Evaluate additional groundwater banking projects outside the Cawelo GSA, both within and outside the Kern County Subbasin.	✓	✓	✓	Supplemental Water Supply Third-Party Banking	As Needed	Board Meetings Public Notice and Outreach	NA	**As Needed**	NA	2035	2030-	**1250**	**0**	✓	✓	✓			State Water Project, Kern River, Central Valley Project	None		$500,000	Cawelo Water District (Assessments / Water Charges)

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring				One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process	As-Needed										Implemented	Functional		In-Process				As-Needed					
CWD-9	**Voluntary Land Conversion**	Develop a program to incentivize landowners to reduce their total crop demand by converting farmed land to groundwater recharge areas.	✓	✓	✓	Demand Reduction	Complete	Board Meetings Public Notice and Outreach	CEQA	**Implemented**	Complete	Complete	2025-	**0**	**2,000**			✓	✓		Demand Reduction	None	$8,750,000	$0	Cawelo Water District (Assessments) CGSA Landowners
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	Cawelo Water District (Assessments)
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	Cawelo Water District (Assessments)
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	Cawelo Water District (Assessments) CGSA Landowners
CWD-11	**Crop Conversion and Irrigation Efficiency**	Incentive programs for growers to convert to crops that require less water and to improve irrigation practices.	✓	✓	✓	Demand Reduction Water Use Efficiency	Implemented	Board Meetings Public Notice and Outreach	NA	**Implemented**	2020	2040	2020-	**0**	**3,800**			✓	✓		Demand Reduction Water Use Efficiency	None	$0	$5,000	Cawelo Water District (Assessments) CGSA Landowners
CWD-12	**Agriculture to Urban Land Use Conversion**	Conversion of agricultural land use to urban/commercial land use due to urban expansion.	✓	✓	✓	Demand Reduction Land Retirement	Implemented	NA	NA	**Implemented**	2020	2040	2025-	**1,500**	**1,500**			✓			Demand Reduction Land Retirement	None	$0	$0	NA
CWD-13	**Short-Term Land Fallowing**	Refunds the District Assessments for enrolled lands and provides additional monetary compensation in the subsequent years to incentivize extended redevelopment timeline(s). Service Area enrolled land(s) are required to relinquish the respective District allocated water to the District and may request the District to permanently purchase the District allocated water and fallow the land permanently. Up to 6,630 acres may increase their redevelopment timeline and	✓		✓	Demand Reduction	Complete	Board Meetings Public Notice and Outreach	NA	**Implemented**	As Needed	2025	2025-		**14,700**			✓			Demand Reduction	None		$5,600,000	Cawelo Water District (Assessments / Water Charges)

CWD-14	**Long-Term Land Fallowing**	Developed and irrigated land(s) within the last five (5) years would be purchased and immediately fallowed by the District. Land(s) purchased by the District under the Long-Term Program are not eligible for future irrigated agricultural development. Up to 890 acres may be fallowed under this PMA.	✓		✓	Demand Reduction	Complete	Board Meetings Public Notice and Outreach	NA	**Implemented**	As Needed	2025	2025-		**2,000**			✓			Demand Reduction	None	$22,250,000		Cawelo Water District (Assessments / Water Charges)
CWD-10	**Secure Access to Additional Monitoring Location**	Pursue an access agreement for a monitoring well location in the southeastern portion of the GSA.	✓	✓	✓	Not Applicable (monitoring)	In-Process	NA	NA	**In-Process**	2020	2025	2025-	**0**	**0**					✓	NA	None	$0	$0	NA
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	Cawelo Water District (Assessments)
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	Cawelo Water District (Assessments) CGSA Landowners
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	Cawelo Water District (Assessments) CGSA Landowners
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	Cawelo Water District (Assessments) CGSA Landowners
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time

Table 14-7. Eastside Water Management Area (EWMA) P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process				As-Needed						
EWMA-1	**Produced Water Supply Project**	Development of oilfield produced-water supplies to potentially reduce groundwater demand	✓			Supplemental Water Source	Completion of Design	Stakeholder Meetings, Board Meetings	WDR	**Initiating Development**	Currently functional at pilot level	2035	2035-	**900**	**0**			✓			Oil & gas operations produced water	Possibly RWQCB WDR depending on WQ	$2,950,000	$50,000	EWMA landowners, future grants, potential Prop 218
EMWA-2	**Surface Runoff Capture Project**	Surface runoff capture and enhanced infiltration in impoundments	✓			Supplemental Water Recharge	Completion of favorable feasibility study; successful permitting application, completion of design	Stakeholder Meetings, Board Meetings	Legal review; SWRCB approval of diversion; CDFW approval of streambed alterations, others	**Planning**	Favorable legal and hydrologic feasibility analysis	2035	2035-	**3220**	**0**		✓	✓			Surface water runoff	Multiple Agencies	$800,000	$100,000	Future grants, potential Prop 218
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasiblity Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	EWMA assessments

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process				As-Needed						
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	EWMA assessments
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	EWMA assessments

KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	SGMA Implementation Grant, EWMA Assessments
EWMA-3	**Groundwater Quality Investigation**	Investigation of groundwater quality by collection and analysis of water quality data supplemented by borehole geophysical data where available		✓			Current Conditions (Implemented)	NA	NA	**Implemented**	NA	2025	2025-	**0**	**0**	✓				✓	NA	NA	$5,000	$0	NA
EWMA-4	**Local Native Yield Estimation Study**	Improved estimation of local (EWMA) native yield by use of additional field-collected data and analysis	✓				Current Conditions (Implemented)	NA	NA	**On-going**	Current Conditions	2025	2025-	**0**	**0**					✓	NA	NA	$30,000	$0	EWMA assessments
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	SGMA Implementation Grant, EWMA Assessments
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	SGMA Implementation Grant, EWMA Assessments
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing												
KSB-10	**RMW Data Gaps**	Seven new groundwater monitoring wells will be added to the groundwater level monitoring network. This addition of monitoring wells is necessary to address groundwater level monitoring network data gaps as identified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
EWMA-5	**Aquifer-Specific Monitoring Wells Installation**	Construction of aquifer-specific monitoring wells in locations with data gaps, to better understand hydraulic heads and gradients, particularly in confined bedrock units	✓	✓			Current Conditions	NA	Drilling Permit, WCRs	**Planning**	Funded, implement in 2025	2025	2025-	**0**	**0**					✓	NA	DWR	$900,000	$0	DWR TSS funding

EWMA-6	**Pressure Transducers Installation**	Installation of pressure transducers in selected wells of the monitoring network, to collect high-resolution cost-effective data	✓				NA	NA	NA	**Planning**	Funded, implement in 2024	2025	2025-	**0**	**0**					✓	NA	NA	$50,000	$2,000	DWR $7.6M grant
EWMA-7	**Agricultural Demand Reduction**	Maintain and improve 2024 Subbasin well inventory in the DMS platform with added data from field surveys, current beneficial use determinations, and coordination with Kern County Environmental Health and DWR to track new wells, etc.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	EWMA Assessments
EWMA-8	**Groundwater Usage Fee Assessment**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	EWMA Assessments
EWMA-9	**Transferrable Water Credit Program**	Establish a system of transferrable water credits; including legal and administrative review: effects of CEQA and water law on joint management of native yield	✓			Demand Reduction	Program will be initiated once rules and regulations are finalized	Stakeholder Meetings, Board Meetings	TBD	**Initiating Development**	NA	2030	2030-	**0**	**0**			✓			Surface water & groundwater	GSA	$80,000	$20,000	EWMA Assessments

Table 14-8. HMWD GSA P/MA

PMA Number	PMA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process		As-Needed									Implemented		Functional		In-Process			As-Needed					
HMWD-1	Demand Reduction due to Land Fallowing	The District irrigable lands now total less than 1/3 permanent crops, with over 2/3 of the lands being available to implement this project in future years as necessary to maintain sustainability over the long-term.	✓	✓	✓	Demand Reduction	Complete	NA	NA	Implemented	Complete	Complete	2020-	0	0-26,300			✓		NA	NA	None	NA	NA	NA
HMWD-2	Maximize Water Banking during Wet Years	GSA will maximize water banking in wet years by using excess surface water supplies and purchasing water for the Pioneer Water Bank	✓	✓	✓	Third-Party Banking Supplemental Recharge	Complete	NA	NA	Implemented	Complete	Complete	2020-	0	0	✓	✓	✓		NA	SWP, Kern River, CVP, other surface supplies	None	NA	NA	HMWD (Water Charge)
HMWD-3	Recovery of Banked Supplies from the Pioneer Project	Recovery of banked surface water from the Pioneer Banking Project at times when the District has capacity, in order to reduce groundwater use within the District.	✓	✓	✓	Third-Party Banking	Complete	NA	NA	Implemented	Complete	Complete	2020-	250	0	✓		✓		NA	SWP, Kern River, CVP, other surface supplies	None	NA	$37,500	HMWD (Water Charge)
HMWD-9	Agricultural Well Mitigation	GSA mitigation for any future failure of an agricultural well within HMWD GSA that was due to lowering of groundwater levels from groundwater pumping within HMWD GSA.	✓	✓	✓	NA	When declining groundwater levels impact agricultural wells.	Public GSA or District Board Meetings	NA	Implemented	Complete	Complete	2020-			✓	✓	✓	✓	NA	NA	None	$0	Variable, Up to $900,000	HMWD (Water Charge)
HMWD-10	Domestic Well Mitigation	GSA mitigation for any future failure of a domestic or small community well that was due to lowering of groundwater levels from groundwater pumping within HMWD GSA after completion of an attribution analysis proving that HMWD GSA was at fault.	✓	✓	✓	NA	When declining groundwater levels impact domestic or small community wells.	Public GSA or District Board Meetings	NA	As Needed	Complete	Complete	2024-			✓	✓	✓	✓	NA	NA	None	$0	Variable, Up to $45,000	HMWD (Water Charge)

PMA Number	PMA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process		As-Needed									Implemented		Functional		In-Process			As-Needed					
HMWD-4	Utilizing Surface Water In-Lieu of Groundwater During Wet Years	During years with above normal hydrology, the GSA will use surface water to satisfy water demands and minimize groundwater pumping to the greatest extent possible.	✓	✓	✓	Exercise of Rights	Complete	NA	NA	Implemented	Complete	Complete	2020-	0	0	✓	✓	✓		NA		None	NA	NA	NA
HMWD-6	Reduce Groundwater Pumping within 5.0 MI CA Aqueduct Corridor to Reduce Subsidence Potential	Although it is unclear whether prior GSA pumping has led to subsidence within the 5.0 MI CA Aqueduct monitoring corridor, the GSA will actively seek to prioritize use of wells outside the monitoring corridor and reduce corridor pumping relative to pre-SGMA conditions to reduce or avoid future land subsidence.	✓	✓	✓	NA	Complete	NA	NA	Implemented	Complete	Complete	2015-	0	0	✓	✓	✓	✓	NA	NA	None	NA	NA	NA

HMWD-7	**No Increase of Groundwater Production Capacity within 5.0 MI CA Aqueduct Corridor to Reduce Subsidence Potential**	Although it is unclear whether prior GSA pumping has led to subsidence within the 5.0 MI CA Aqueduct monitoring corridor, the GSA will avoid increasing groundwater production capacity within the monitoring corridor to reduce or avoid future land subsidence.	✓	✓	✓	NA	Complete	NA	NA	**Implemented**	Complete	Complete	2015-	**0**	**0**	✓	✓	✓	✓	NA	NA	None	NA	NA	NA
HMWD-8	**Groundwater Well Registration for All Active Wells within the GSA**	To fill any remaining data gaps on types of beneficial users and locations of groundwater wells to assist with Management Actions such as targeted location specific decreases in groundwater production, the GSA will conduct a field survey to verify the existence and construction details of active wells within the GSA.	✓	✓	✓	NA	Complete	NA	NA	**Implemented**	Complete	Complete	2024-	**0**	**0**	✓	✓	✓	✓	✓	NA	None	NA	NA	NA
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	HMWD (Water Charge)
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	HMWD (Water Charge)
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		NA	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	HMWD (Water Charge)
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	HMWD (Water Charge)
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	HMWD (Water Charge)
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
HMWD-5	**Surface Water Transfer from El Rico GSA (Tulare-Lake Subbasin) to HMWD GSA**	HMWD has the ability to transfer surface water from the El Rico GSA to HMWD as an emergency supply in times of drought and can also be transferred in wet years for banking or correcting previous overdraft.	✓	✓	✓	Exercise of Rights	As Needed	NA	NA	**As Needed**	Complete	Complete	2023-	**550**	**0**	✓	✓	✓		NA	SWP, SVP, other surface supplies	None	NA	$5,000	HMWD (Water Charge)

Table 14-9. KNDLA P/MA

PMA Number	PMA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process			As-Needed								Implemented		Functional		In-Process			As-Needed					
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	Assessments and/or water charges

PMA Number	PMA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process			As-Needed								Implemented		Functional		In-Process			As-Needed					
KSB-2	Coordination with Groundwater Regulatory Programs	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	
KSB-3	Exceedance Policy	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	
KSB-5	Well Mitigation Program	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2026	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	
KSB-4	Coordination with Basin Study	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		NA	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	

KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time

Table 14-10. Kern River GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process			As-Needed								Implemented		Functional		In-Process			As-Needed					
KRGSA-1	**Water Allocation Plan**	KDWD plans to use its full Kern River entitlement as prioritized in its Water Allocation Plan (WAP) for the Agricultural MA.	✓	✓	✓	Exercise of Rights	Complete	KDWD, Board Meetings & Website	CEQA (completed)	**Implemented**	Complete	2018	2018-	**20,797**	**0**			✓			Kern River Supplies	None	$0	$0	KDWD, Operating Budget
KRGSA-2	**Kern River Optimized Conjunctive Use**	The City plans to use its full Kern River entitlement, less current obligations, to mitigate undesirable results for water levels and water quality in the Urban MA.	✓	✓	✓	Exercise of Rights	Complete	COB, City Council Meetings & Website	CEQA (As Needed)	**Implemented**	Complete	2018	2018-	**67,930**	**0**			✓			Kern River Supplies	None	$0	$0	COB, Operating Budget
KRGSA-3	**Lining of Pool #8**	The Kern County Water Agency's (Agency) - Improvement District No. 4 (ID4) Cross Valley Canal (CVC) Extension Lining Project – Pool No. 8 (Project) includes installation of approximately 5,280 lineal feet of fiber-reinforced concrete lining on an existing earthen canal to reduce seepage and improve water delivery reliability. The lining will reduce seepage, increase water delivery reliability, reduce maintenance efforts and reduce the potential for canal breaches.	✓				Already being implemented	KCWA, UBAC, Board Meetings & Website	CEQA & NEPA (completed)	**Implemented**	2023	2024	2024-	**0**	**0**			✓			Surface Supplies	KCWA, ID4	$7,000,000	$0	ID4 Grants Received
KRGSA-4	**Urban Conservation**	Future urban demand will be reduced from current modeled levels. The average urban demand for Metropolitan Bakersfield is reported by local UWMPs is 211 gallons per capita per day (gpcpd). Previous estimates for future demand were estimated at 248 gpcpd and basin wide GSP modelling included this estimate in all future model scenarios.	✓	✓	✓	Water Conservation-Efficiency	Already being implemented	COB, City Council Meetings & Website	None	**Implemented**	Ongoing (expected savings from 2020)	2040	2020-2040	**0**	**21,299**			✓			Demand Reduction	COB/Retail Urban Providers	NA	$0	COB, ENCSD, Lamont, Cal Water, Vaughn - Operating Budgets
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	KRGSA
KRGSA-5	**ENCSD North Weedpatch Highway Water System Consolidation**	Up to six small water systems in the northeast KRGSA will be consolidated into the ENCSD system for benefits to drinking water quality, including to disadvantaged communities (DACs). The project includes new water distribution systems, a new well (1,400 gpm capacity) with arsenic treatment, a storage tank, hydropneumatics tank, and a booster pump station. If TCP is detected in the new well, the grant will also fund a TCP treatment system. All wells with water quality violations will be properly abandoned according to Kern County Environmental Health regulations.		✓			In Progress	ENCSD, Board Meetings & Website	DDW	**In-Process**	2019	2024	2024-	**0**	**0**	✓		✓				COB/Retail Urban Providers	$0	$0	ENCSD and potential SAFER 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	Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits: Primary (AFY): Water Supply Augmentation	Expected Benefits: Primary (AFY): Demand Reduction	Expected Benefits: Secondary: Water Quality Improvement	Expected Benefits: Secondary: Flood Control	Expected Benefits: Secondary: Water Management Flexibility / Efficiency	Expected Benefits: Secondary: Mitigation Programs	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)
Management Actions		Implemented / Functional / In-Process											Implemented		Functional		In-Process			As-Needed					
KRGSA-6	**South Kern and Old River Mutual Water System Consolidation**	Two small mutual water systems in the southern KRGSA will be consolidated into the City of Bakersfield's domestic water system for benefits to drinking water quality, including to disadvantaged communities (DACs). The Project will include new water distribution systems connecting the mutual water systems with the City's water system, which improve drinking water quality for the DAC.		✓			In Progress	COB, City Council Meetings & Website	DDW	**In-Process**	2022	2025	2025	**0**	**0**	✓		✓				COB, DDW	$7,500,000	$78,000	COB and potential SAFER Grants
KRGSA-7	**Expand Recycled Water Use in the KRGSA**	The City will increase recycled water use inside of the KRGSA from its WWTP No. 3 in 2026 when a contract for use outside of the KRGSA expires (about 72% is currently used outside of the KRGSA).	✓	✓	✓	New Local Supply	Already being implemented - Reallocates water	COB, City Council Meetings & Website	None	**In-Process**	Current	2026	2026-	**13,407**	**0**			✓			Recycled Water	None	NA	$0	COB Operating Budget
KRGSA-8	**Conversion of Agricultural Lands in Urban Use**	Approximately 10,000 acres of current KRGSA agricultural lands is expected to be urbanized; this future urban demand is already included in the projected water budget, so 100% of this agricultural water use represents a demand reduction.	✓	✓	✓	Ag to Urban Conversion	Land use changes	COB/Planning Commission, Board Meetings & Website	CEQA (As Needed)	**In-Process**	2020 (total expected by 2028)	2038	Total by 2038	**0**	**27,000**						None	None	NA	NA	NA
Phase 1																									
KRGSA-9	**Implement Action Plan if Water Levels Fall Below Minimum Thresholds**	A five-step action plan for addressing exceedance of GSP thresholds, including KRGSA Plan Manager coordination: 1. Identify the Well(s) and investigate the Area 2. Coordinate with KRGSA Plan Managers 3. Select Appropriate Management Actions or Projects for Mitigation 4. Consider Institutional Changes for Future Mitigation 5. Consider the Need for Improved Monitoring	✓			Supplemental Water Use	MT exceedance	KRGSA, Board Meetings & Website	None	**Ongoing**	NA	NA	2020 -	**0**	**0**	✓		✓				None	None	$0	$0	KRGSA
KRGSA-10	**Optimize Conjunctive Use in the KRGSA**	Surface water sources available to the KRGSA will be prioritized for use when available, retaining the shared groundwater resources for periods when surface water is scarce. This balance of water use and higher reliance of groundwater during drought provides for increased reliability, higher groundwater levels to avoid undesirable results, and preservation of groundwater resources for other supplies are less available. Conjunctive management also encourages recharge of any excess surface water for storage and subsequent recovery to assist with drought management.	✓			Supplemental Water Use		KRGSA, Board Meetings & Website	None	**Ongoing**	NA	NA	2020 -	**0**	**0**	✓		✓				None	None	$0	$0	KRGSA
KRGSA-11	**Support California Delta Conveyance Project to Preserve Imported Water Supplies**	In its UWMP, ID4 emphasizes the need for state-wide support in improving the availability and reliability of SWP supplies. On April 29, 2019, Governor Newsom announced that his administration will develop a water resiliency portfolio (Portfolio) intended to address a range of water-related challenges facing the state. The Portfolio will address unsafe drinking water, major flood risks, severely depleted groundwater aquifers, communities with uncertain water supplies and native fish populations.	✓	✓		Supplemental Water Use		KRGSA, Board Meetings & Website	None	**Ongoing**	NA	NA	2020 -	**0**	**0**	✓						None	None	$0	$0	KRGSA

KRGSA-12	**Incorporate Climate Change Adaptation Strategies**	As noted in its 2015 UWMP (P&P, 2016), ID4 has identified strategies that can be adapted to fit within ID4 operations to address potential uncertainties associated with the reliability of imported water supplies. In brief, climate change may result in reduced surface water that will be even more unpredictable on a year-to-year basis. As listed in the UWMP, ID4 has identified the following measures for consideration: • Work with retail purveyors to identify impacts of demand management measures to improve the accuracy of overall ID4 future demands. New developments are incorporating the latest water conversation features and policies that may alter the current ID4 demand projections. • Continue water recharge activities to the extent practicable to increase reliability of supplies during dry-year conditions.	✓					KRGSA, Board Meetings & Website	None	**Ongoing**	NA	NA	2020 -	**0**	**0**	✓						None	$0	$0	KRGSA
KRGSA-13	**Support Sustainable Groundwater Supplies for KRGSA Disadvantaged Communities**	The three founding KRGSA member agencies have established lines of communication and coordination with other agencies in the GSP Plan Area, many of whom provide water to DACs in the KRGSA Plan Area. In this manner, representation of these communities is considered in KRGSA actions and policies.	✓	✓				KRGSA, Board Meetings & Website	None	**Ongoing**	NA	NA	2020 -	**0**	**0**				✓			None	$0	$0	KRGSA
KRGSA-14	**Improve Groundwater Monitoring in the KRGSA Plan Area**	It is the policy of the KRGSA to monitor groundwater for GSP compliance and to provide the understanding necessary for sustainable groundwater management. These actions will consist of: Improving documentation of well construction in the KRGSA Plan Area, coordinating water quality analysis through existing monitoring programs, securing inactive wells/dedicated monitoring wells, and obtaining access agreements for GSP monitoring network wells.	✓	✓				KRGSA, Board Meetings & Website	None	**Ongoing**	NA	NA	2020 -	**0**	**0**				✓			None	$0	$0	KRGSA
KRGSA-15	**Avoid Widespread Impacts to Domestic and Small Water System Wells in the Plan Area**	This management action has been developed to provide clarity and more focused information on the issue of potential impacts to domestic and small water system wells. The new management action is based on an updated analysis of potential impacts to domestic and small water system wells throughout the entire Plan Area. It will consist of: Documenting Active Domestic and Small Water System Wells, Tracking the Potential for Impacts to Active Domestic and Small Water System Wells, Investigating Issues and Assisting Active Domestic and Small Water System Wells, Adjusting KRGSA Management Activities, (if Needed) and Updating Management Actions.	✓	✓				KRGSA, Board Meetings & Website	None	**Ongoing**	2022	NA	2020 -	**0**	**0**				✓			None	$0	$0	KRGSA
KRGSA-16	**Establish Well Metering Policy in the KRGSA**	This policy will assist with monitoring groundwater extractions for ongoing water budget analyses and compliance with SGMA reporting requirements. (Add specific member updates)	✓			Water Conservation-Efficiency		KRGSA, Board Meetings & Website	None	**Ongoing**	NA	2025	2020 -	**0**	**0**				✓			None	$0	$0	KRGSA
KRGSA-17	**Implement Groundwater Extraction Reporting Program**	As required by SGMA, the KRGSA will begin reporting extractions to DWR on an annual basis. In order to improve the accuracy of its reporting and to support the ongoing water budget analysis, KRGSA Plan Managers will implement a program for all well owners to report groundwater production to the GSA.	✓			Water Conservation-Efficiency		KRGSA, Board Meetings & Website	None	**Ongoing**	NA	NA	2020 -	**0**	**0**				✓			None	$0	$0	KRGSA

Phase 2																								
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	KRGSA
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	KRGSA
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	KRGSA
KRGSA-18	**Additional Urban Conservation Measures**	To reduce urban demand, additional conservation measures could be considered by the City and other urban retail water purveyors. Such actions are documented in the UWMPs and strict adherence to permanent reductions in urban demand by 2020 are underway. A decrease in the long-term per capita water use is provided in UWMPs and embedded in the projected water budgets for the KRGSA.	✓			Water Conservation-Efficiency	New Legislation	KRGSA, Board Meetings & Website	None	**Ongoing**	NA	2040	2020 -	**0**	**0**				✓			None	$0	TBD	KRGSA
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	KRGSA
KSB-6 (IDI#4 only) (KDWD & Bakersfield not participating)	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	KRGSA
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	KRGSA
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	KRGSA
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing												

KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
KRGSA-19	**Conversion of Agricultural Lands**	Changes in land use may also result in a decrease in agricultural demand through urbanization. Some land conversion from agriculture to urban is anticipated in Phase One associated with growth projections for Metropolitan Bakersfield. Additional changes in land use to reduce water demand could be developed in Phase Two as needed.	✓			Ag to Urban Conversion	Urbanization	KRGSA, Board Meetings & Website	CEQA (As Needed)	**Ongoing**	2020	2040	As needed	**0**	**0**				✓			None	$0	As needed	KRGSA
KRGSA-20	**Additional Considerations for Adaptive Management**	It is recognized that demand reduction projects could have a detrimental impact on the local economy, livelihood of residents and business owners, and the well-being of Metropolitan Bakersfield and Kern County. Therefore, large-scale reductions are not proposed in Phase One and may be unnecessary for achieving the sustainability goal. At a minimum, such actions are delayed until later in the implementation period to allow water supply projects the opportunity to sustainably support current and projected growth in the beneficial uses of groundwater.	✓	✓	✓	Supplemental Water Use	As needed	KRGSA, Board Meetings & Website	None	**As Needed**	NA	NA	As needed	**0**	**0**				✓			None	$0	As needed	KRGSA
KRGSA-21	**Possible Water Exchange**	KRGSA member agencies can perform exchanges of surface water and groundwater for benefits to water quality, including to DACs.		✓		Supplemental Water Use	As needed	KRGSA, Board Meetings & Website	None	**As Needed**	NA	NA	As needed	**0**	**0**							None	$0	As needed	KRGSA
KRGSA-22	**Pumping Reductions and Allocation of Agricultural Groundwater Supply**	If sustainable management cannot readily be achieved through increased and optimized supplies, then pumping allocations may a helpful management tool. If needed, KDWD will explore options and opportunities for equitable allocation scenarios and engage landowners to develop workable allocations. Adjacent water districts are already developing such programs and KDWD may benefit from lessons learned and strategies incorporated by others. Agricultural demand could also be achieved if needed by growing different crop types, fallowing portions of fields, district purchase and retirement of land (and possibly used for recharge if suitable), and other strategies.	✓			Demand Reduction	Continued MT exceedance	KRGSA, Board Meetings & Website	TBD	**As needed**	NA	NA	As needed	**0**	**0**				✓			None	$0	As needed	KRGSA

Table 14-11. Kern-Tulare Water District GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring				One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process				As-Needed							
KTWD-1	**Connect Rag Gulch and Ave 4 Systems**	Construction of 0.5 miles of 15-inch pipeline between the Avenue 4 distribution system and the Rag Gulch distribution system increases the delivery capability to 2,089 acres in the Rag Gulch and Avenue 4 distribution systems from 4.0 to 4.9 gpm/acre. The project will increase surface water deliveries by an estimated 260 AF per year.	✓	✓	✓	Exercise of Rights		Stakeholder Meetings Board Meetings		**Implemented**		2023	2024-	**260**		✓		✓				CVP supplies	None	$180,000	$0	KTWD Water Charges
KTWD-2	**Quinn Pumping Plant and Pipeline**	Construction of the Quinn Pumping Plant and Pipeline includes a 400 HP pumping plant, 3.5 miles of distribution system piping, and 4 turnouts. The project will improve delivery capability to 3,544 acres to increase surface water deliveries and reduce groundwater pumping by an estimated 1,130 AF per year in years of adequate water supply.	✓	✓	✓	Exercise of Rights		Stakeholder Meetings Board Meetings Prop 218 Special Assessment	Complete	**In-Process**	2023	2025	2025-	**1130**		✓		✓				CVP supplies	None	$2,500,000	$0	KTWD Special Assessment
KTWD-3	**Improved Conveyance to Ave 24**	Constructs the necessary improvements to the North distribution system to allow for 177 acres that are within the District and reliant upon groundwater to be added to the Service Area. The Project includes installation of 0.7 miles of 18-inch diameter pipeline and replacement of the 16-inch diameter pipeline crossing of Avenue 24 with a 30-inch pipeline. Project will increase surface water deliveries by an estimated 480 AF per year.	✓	✓	✓	Exercise of Rights		Stakeholder Meetings Board Meetings Prop 218 Special Assessment	Complete	**In-Process**	2023	2025	2025-	**480**		✓		✓				CVP supplies	None	$600,000	$0	KTWD Special Assessment
KTWD-4	**Replace Twin Pipes Pumping Plant**	Increasing the horsepower at the Twin Pipes pumping plant from 200 HP to 400 HP will improve the delivery capability to 1,488 acres in the Twin Pipes service area from 3.8 gpm/acre to 5.2 gpm/acre. The project will increase surface water deliveries by an estimated 270 AF per year.	✓	✓	✓	Exercise of Rights		Stakeholder Meetings Board Meetings		**In-Process**	2024	2025	2025-	**270**		✓		✓				CVP supplies	None	$400,000	$0	KTWD Water Charges
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	Unknown
KTWD-5	**Provide Full Service to Southern Service Area**	Replacement of Cecil Pumping Plant and Pipeline, construction of Intertie Pumping Plant and Pipeline, and construction of Grapefruit Pumping Plant and Pipeline to satisfy peak season irrigation demands to over 13,500 acres in the southern portion of the District. Project is estimated to increase the annual delivery capability of the District by 9,470 AF in wet and normal years.	✓	✓	✓	Exercise of Rights	Funding	Stakeholder Meetings Board Meetings Prop 218	CEQA/NEPA	**As-needed**		2035-2040	2040-	**9470**		✓						CVP supplies	None	$25,000,000	$0	KTWD; Grants
KTWD-6	**Produced Water Project - Phase 2**	The District has historically accepted produced water to provide surface water to the District and has the opportunity to obtain additional sources of produced water	✓		✓	New Local Supply	As needed	Stakeholder Meetings Board Meetings	WDR	**As-needed**		2025-2030	2030-	**3000**		✓		✓				Produced Water Supplies	None	$5,900,000	$0	KTWD; Private

KTWD-7	**In-District Surface Storage**	The District has selected two potential reservoir sites with a total capacity of 8,000 AF to capture wet year water.	✓	✓	✓	Supplemental Water Use	As needed	Stakeholder Meetings Board Meetings Prop 218	CEQA/NEPA	**As-needed**		2035-2040	2040-	**2000**		✓	✓	✓			CVP water, additional wet year water for purchase	None	$30,000,000	$0	KTWD; Grants

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		**Implemented** **Functional** **In-Process**	**As-Needed**										**Implemented**		**Functional**		**In-Process**			**As-Needed**				
KTWD-8	**Modify District Pricing Structure**	Reduce groundwater pumping by providing a pricing mechanism that causes groundwater to cost more than surface water. Implement a "groundwater charge" for every acre-foot pumped and install meters on all ag wells.	✓	✓	✓	Demand Reduction	Complete	Stakeholder Meetings Board Meetings Majority Protest Hearing	Complete	**Implemented**	Complete	Complete	2024-		**5580**	✓		✓			CVP supplies	GSA Authority	$500,000	$10,000	Landowners
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	KTWD General Funds
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	KTWD General Funds
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	KTWD General Funds; Water Charges
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	KTWD General Funds
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	KTWD General Funds
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	KTWD General Funds
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	KTWD General Funds

KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing														
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time

Table 14-12. Kern Water Bank GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed							Implemented	Functional	In-Process	As-Needed													
KWBA-1	KWB Recharge and Recovery Enhancement Project	Construction of 3 wells and associated pipelines and 2 recharge basins (189 acres). Provides approx. 1730 AF/mo recharge capacity and 910 AF/mo recovery capacity.	✓			Supplemental Water Recharge	NA	Planned though IRWM Grant Process with basin stakeholders.	CEQA review completed with NOD in 1997.	**Implemented**	NA	Completed	2018-	**182**	**0**	✓	✓	✓			SWP Table A, SWP Article 21 , Kern River purchases and floodwater, Friant-Kern Section 215 purchases	None	$3,900,000	$1,000	IRWM Grant and KWBA Assessments
KWBA-2	KWB Recharge Enhancement Project	Construction of 4 pumping facilities on the Kern Water Bank Canal and 1025 acres of recharge basins. Capture of up to 107,900 AF/yr of wet period water.	✓			Supplemental Water Recharge	NA	Planned though IRWM Grant Process with basin stakeholders.	KWBA Addendum No. 1 to the 2016 Monterey Plus Revised EIR	**Implemented**	NA	Completed	2020-	**21,580**	**0**	✓	✓	✓			SWP Table A, SWP Article 21 , Kern River purchases and floodwater, Friant-Kern Section 215 purchases	None	$11,500,000	$3,000	IRWM Grant and KWBA Assessments
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	KWBA Assessments

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process	As-Needed							Implemented	Functional	In-Process	As-Needed													
KWBA-3	Project Recovery Operations Plan	Domestic, small community, and irrigation well mitigation program to address impacts related to temporary lowering of water levels during prolonged droughts on adjacent lands.	✓				NA	Project websites, mailers, local well companies, newspaper articles.	NA	**Implemented**	NA	Complete	2010-	**0**	**0**	✓	✓	✓			NA	NA	$0	$35,000	KWBA Assessments
KSB-2	Coordination with Groundwater Regulatory Programs	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	KWBA Assessments

KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	KWBA Assessments
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	KWBA Assessments
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	KWBA Assessments
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	KWBA Assessments
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	KWBA Assessments
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	KWBA Assessments
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time

Table 14-13. NKWSD GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed							Implemented	Functional	In-Process	As-Needed												
NKWSD-1	Beneficial Reuse of Oilfield Produced Water	Oilfield produced water of sufficient quality for beneficial reuse used as source water for groundwater recharge. 9,000 AFY expected annually, 6,500 of which will be transferred to RRID.	✓		✓	New Local Supply	Already being implemented	NKWSD, Board Meetings & Website	Waste Discharge Requirement Permit	**Ongoing**	2014	2016	2014-	**2,500**	**0**			✓			Oilfield Produced Water	District / SGMA authorities	$300,000	$1,000,000	Water Tolls/ District
NKWSD-2	Allocation of Available NKWSD Supplies to RRID	Transfer a portion of groundwater banked oilfield produced water from NKWSD to RRID benefit.	✓			New Local Supply	Already being implemented	NKWSD, Board Meetings & Website	None	**Ongoing**	2020	2023	2023-	**6,500**	**0**			✓			Oilfield Produced Water	District / SGMA authorities	$0	$650,000	RRID/Landowners
NKWSD-3	Landowner Subsurface/Surface Recharge Program	Implementation of joint Landowner and District program to expand District groundwater recharge using landowner owned facilities.	✓	✓		Supplemental Water Recharge	Already being implemented	NKWSD, Board Meetings & Website	CEQA	**Ongoing**	2020	2024	2024-	**1,000**	**320**	✓		✓			Utilize Existing Water Right/ Landowner Acquisition	District / SGMA authorities	$1,400,000	$90,000	District/Landowners
NKWSD-4	SCADA Automation and Evapotranspiration Measurement Improvements	Develop automation and remote sensing for ET monitoring and improved management of surface water conveyance.	✓			Water Conservation-Efficiency	Already being implemented	NKWSD, Board Meetings & Website	CEQA, NEPA	**Ongoing**	2020	2024	2021-	**0**	**3,400**			✓		✓	Demand Reduction	District / SGMA authorities	$160,432	$10,000	Grant/ District assessments and/or water tolls
NKWSD-5	Calloway Canal Improvements: Lining Snow Rd. to 7th Standard Rd.	Concrete lining of canal to increase surface water reliability and prevent loss from seepage.	✓	✓	✓	Water Conservation-Efficiency	Already being implemented	NKWSD, Board Meetings & Website	CEQA, NEPA	**Ongoing**	2019	2024	2025-	**0**	**0**	✓		✓			Utilize Existing Water Right	District / SGMA authorities	$6,506,700	$5,000	Grant/ District assessments and/or water tolls
NKWSD-6	Calloway Canal Improvements: lining 7th Standard Rd. to 8-1 Pump Station	Concrete lining of canal to increase surface water reliability and prevent loss from seepage.	✓	✓	✓	Water Conservation-Efficiency	Already being implemented	NKWSD, Board Meetings & Website	CEQA, NEPA	**Initiated**	2020	2026	2026-	**0**	**0**	✓		✓			Utilize Existing Water Right	District / SGMA authorities	$10,061,000	$5,000	Grant/ District assessments and/or water tolls
NKWSD-7	Groundwater Banking Conveyance Improvements to NKWSD Recharge and Recovery	Improvements to existing well network for return capacity of recharged water to District's banking partners.	✓	✓	✓	Third Party Banking	Already being implemented	NKWSD, Board Meetings & Website	CEQA, NEPA	**Initiated**	2019	2026	2025-	**4,000**	**0**	✓	✓	✓			Third Party Banking Partner Sources	District / SGMA authorities	$15,350,000	$950,000	Grant/ District assessments and/or water tolls
NKWSD-8	Calloway Canal Improvements: lining Fruitvale Ave. to CVC Intertie	Concrete lining of canal to increase surface water reliability and prevent loss from seepage.	✓	✓	✓	Water Conservation-Efficiency	Already being implemented	NKWSD, Board Meetings & Website	CEQA, NEPA	**Initiated**	2022	2028	2027-	**0**	**0**	✓		✓			Utilize Existing Water Right	District / SGMA authorities	$6,509,000	$5,000	Grant/ District assessments and/or water tolls
NKWSD-9	Calloway Canal Improvements: lining Case St. to Fruitvale Ave.	Concrete lining of canal to increase surface water reliability and prevent loss from seepage.	✓	✓	✓	Water Conservation-Efficiency	Already being implemented	NKWSD, Board Meetings & Website	CEQA, NEPA	**Initiated**	2022	2029	2028-	**0**	**0**	✓		✓			Utilize Existing Water Right	District / SGMA authorities	$8,404,360	$5,000	Grant/ District assessments and/or water tolls
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	District assessments and/or water tolls

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring				One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process	As-Needed										Implemented	Functional		In-Process			As-Needed						
NKWSD-10	**RRID Groundwater Recharge Project**	Construction and Implementation of water recharge basins for the RRID management area. Approximately 450 acres of crops will be removed and replace by recharge facilities.	✓	✓		Demand Reduction, Supplemental Water Recharge	Already being implemented	NKWSD, Board Meetings & Website	CEQA	**Initiated**	2023	2036	2025-	**7,200**	**1,300**	✓	✓	✓			Utilize Existing Contracts, Agreements, and Surplus Acquisition	District / SGMA authorities	$18,000,000	$400,000	Grant/RRID
NKWSD-11	**Expanded Water Banking Program**	Use of available capacity in existing facilities and development of additional recharge and recovery facilities	✓	✓	✓	Third Party Banking	Already being implemented	NKWSD, Board Meetings & Website	CEQA	**Initiated**	2020	TBD	2025-	**5,000**	**0**	✓	✓	✓			Third Party Banking Partner Sources	District / SGMA authorities	TBD	TBD	Grant/ District assessments and/or water tolls
NKWSD-12	**Poso Creek Weir**	Installation of a concrete weir on Poso Creek to replace the earthen structure.	✓		✓	Water Conservation-Efficiency	Upon adoption of this project	NKWSD, Board Meetings & Website	CEQA, CDFW	**Conceptual**	2025	TBD	2026-	**TBD**	**0**		✓	✓		✓	Poso Creek	District / SGMA authorities	TBD	TBD	Grant/ District assessments and/or water tolls
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	Grant/ District assessments and/or water tolls
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	District assessments and/or water tolls
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	Grant/ District assessments and/or water tolls
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	Grant/ District assessments and/or water tolls
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	District assessments and/or water tolls
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	District assessments and/or water tolls
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	District assessments and/or water tolls

KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
NKWSD-13	**Ongoing Evaluation of Groundwater Levels and Water Quality Trends**	Monitor WQ to determine if a correlation for degradation develops as a result of declining water levels.	✓	✓			Already being implemented	NKWSD, Board Meetings & Website	None	**Ongoing**	2015	TBD	Ongoing	**0**	**0**	✓				✓	Monitoring	District / SGMA authorities	$0	$75,000	District assessments and/or water tolls
NKWSD-14	**Refinement of Water Budget Components**	Improvement of monitoring and measurements to refine the accuracy of measurement or calculation of inflow and outflow components of district-level water budget. Will also refine Subbasin Model and water budget.	✓	✓	✓		Already being implemented	NKWSD, Board/GSA Meetings & Website	None	**Initiated**	2020	TBD	2030-	**0**	**0**			✓		✓	Data Improvement	District / SGMA authorities	$0	$15,000	Grant/ District assessments and/or water tolls
NKWSD-15	**Conversion of Agricultural Land to Urban Use in RRID**	Conversion of agricultural land to urban use within the limits of each city to reduce groundwater use due to the decreased demand.	✓	✓		Demand Reduction	Already being implemented	Land Use & Planning	District, City & County	**Initiated**	2015	TBD	2030-	**0**	**9,600**			✓			Demand Reduction	District / SGMA authorities	$0	$22,500	Landowners, Cities & Private
NKWSD-16	**Urban Water Conservation Program**	Implementation of urban indoor and outdoor usage cappage as required by SB 606 and AB 1668.	✓			Demand Reduction	Already being implemented	Urban Water Supplier & District	State Regulations, Local Ordinance	**Ongoing**	2020	TBD	2030-	**0**	**TBD**	✓		✓			Demand Reduction	Cities	$0	$10,000	Grants/City/District
NKWSD-17	**In-District Allocation Structure**	Implementation of an groundwater credit allocation structure that would allow for the transfer of groundwater pumping credits within the district's jurisdiction.	✓	✓		Water Use Efficiency	As Needed	NKWSD, Board Meetings & Website	None	**Conceptual**	TBD	TBD	TBD	**TBD**	**0**			✓			Utilize Existing Water Storage	District / SGMA authorities	TBD	TBD	Grant/ District assessments and/or water tolls
NKWSD-18	**Voluntary Land Fallowing**	Development and implementation of a voluntary land fallowing program to reduce water demand.	✓	✓	✓	Demand Reduction	As Needed	NKWSD, Board Meetings & Website	None	**Conceptual**	TBD	TBD	TBD	**0**	**TBD**			✓			Demand Reduction	District / SGMA authorities	TBD	TBD	Grant/ District assessments and/or water tolls
NKWSD-19	**Pumping Restrictions**	Implement groundwater pumping allocations or limits.	✓	✓	✓	Demand Reduction	As Needed	NKWSD & GSA Board Meetings, Website, Direct Notices	Local Ordinance	**Conceptual**	TBD	TBD	TBD	**0**	**TBD**			✓	✓		Demand Reduction	District / SGMA authorities	TBD	TBD	District assessments and/or water tolls
NKWSD-20	**In-Lieu Recharge Program**	Implementation of fees for groundwater use when surface water is available.	✓	✓	✓	Water Conservation-Efficiency	As Needed	NKWSD, Board Meetings & Website	Prop 218	**Conceptual**	TBD	TBD	2035-	**0**	**TBD**	✓	✓	✓			Demand Reduction	District / SGMA authorities	None	None	None
NKWSD-21	**On-Farm Efficiency/Deficit Irrigation Practices Incentive Program**	Improvements to individual farming operations that address water use efficiency and/or groundwater protection through incentive programs.	✓	✓	✓	Water Conservation-Efficiency	As Needed	NKWSD, Board Meetings & Website	None	**Conceptual**	TBD	TBD	2035-	**TBD**	**TBD**	✓		✓			Demand Reduction - Water Use Efficiency	District / SGMA authorities	TBD	TBD	Grant/ District assessments and/or water tolls

Table 14-14. OWD GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Progams	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process		As-Needed						Implemented			Implemented	Functional		In-Process				As-Needed					
Olcese-1	Shallow Monitoring Well Installation	Installation of a shallow monitoring well in the vicinity of Olcese Water District Well #2 for purposes of evaluating potential hydraulic connection between the Olcese Sand Aquifer Unit and the Shallow Alluvium.	✓	✓			Complete	NA	County well permit	**Implemented**	Complete	Complete	2019-	**0**	**0**					✓	NA	None	$40,000	$2,500	OWD
Olcese-2	Second Shallow Monitoring Well Installation	Installation of a second shallow monitoring well in the vicinity of Cottonwood Creek and conduct regular monitoring.	✓	✓			As-needed, contingent upon results of Project Olcese-1	NA	County well permit	**Conceptual Design**	As-needed	2-3 years	2-3 years	**0**	**0**					✓	NA	None	$40,000	$2,500	OWD

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Progams	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process		As-Needed						Implemented			Implemented	Functional		In-Process				As-Needed					
KSB-2	Coordination with Groundwater Regulatory Programs	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓					✓	NA	NA	$0	$25,000	OWD
KSB-3	Exceedance Policy	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	OWD
KSB-5	Well Mitigation Program	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2026	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	OWD
Olcese-4	Olcese Sand / Shallow Alluvium Hydraulic Connection Study	Conduct a study of the potential hydraulic connection between the Olcese Sand Aquifer Unit and the Shallow Alluvium	✓	✓	✓		Installation of shallow monitoring well	NA	None	**In Progress**	Current	3 years	2025-	**0**	**0**					✓	NA	none	$50,000	$5,000	OWD
KSB-4	Coordination with Basin Study	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	OWD

KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	OWD
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	OWD
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	OWD
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time

Table 14-15. Pioneer GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		**Implemented** / **Functional** / **In-Process**			**As-Needed**								**Implemented**		**Functional**		**In-Process**			**As-Needed**					
Pio-1	**Install Monitoring Well in North Pioneer**	Installation of a cluster monitoring well in the north portion of the Pioneer Project	✓	✓	✓	NA	Data Gap	NA	Well Permit from KCPHSD	**Complete**	Completed	Completed	2021-	**0**	**0**			✓		✓	NA	NA	$320,000	$0	Pioneer Participant's capital improvement budget
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasiblity Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	Pioneer Participant's capital improvement budget

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		**Implemented** / **Functional** / **In-Process**			**As-Needed**								**Implemented**		**Functional**		**In-Process**			**As-Needed**					
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	Pioneer Participant's capital improvement budget
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	Pioneer Participant's capital improvement budget
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2026	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	Pioneer Participant's capital improvement budget

KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	Pioneer Participant's capital improvement budget
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	Pioneer Participant's capital improvement budget
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	Pioneer Participant's capital improvement budget
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	Pioneer Participant's capital improvement budget
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
Pio-2	**Continued Participation in Basin-Wide Coordination**	Coordinate with all other GSA's within the Kern Subbasin to address regulatory requirements and determination.	✓	✓	✓	Exercise of Rights	NA	Stakeholder Meetings Board Meetings	NA	**In-Process**	NA	2040	2020-	**0**	**0**	✓	✓	✓	✓	✓	NA	NA	$0	$150,000	Pioneer Participant's capital improvement budget
Pio-3	**Continued Balanced Pumping and Recharge**	Continued balanced pumping and recharge is the standard operating procedure for the Pioneer GSA.	✓	✓	✓	Efficiency	As-needed	NA	NA	**In-Process**	NA	NA	NA	**0**	**0**	✓		✓			NA	NA	$0	$0	NA
Pio-4	**Adaptive Management: Increase Surface Spreading Losses from 6 to 10 Percent**	This adaptive management strategy would explore the feasibility of increasing the fixed loss rate from 6 percent to a fixed loss rate of 10 percent.	✓	✓	✓	Efficiency	NA	Stakeholder Meetings Board Meetings	NA	**As-Needed**	If GWLs fall below MTs in 15 percent of Pioneer's representative monitoring network	NA	NA	**0**	**0**	✓	✓	✓	✓	✓	NA	NA	$0	$0	NA

Table 14-16. RRBWSD GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed							Implemented				Functional		In-Process				As-Needed					
RRB-1	Stockdale East Water Storage and Recovery Project	Acquisition and retirement of 200 acres of irrigated ag lands and development of 200 acres of new recharge ponds. For conjunctive-use and 2:1 third party banking.	✓	✓	✓	Land Retirement Third-Party Banking	Complete	NA	NA	**Implemented**	Complete	Complete	2019-	**1103**	**578**	✓	✓	✓		NA	Kern River Flood, SWP Table A, SWP Article 21 , Friant-Kern Flood, 2:1 Exchanges, Kern River Purchase Contract	None	$2,950,000	$88,500	RRBWSD (Water Charge)
RRB-2	McCaslin Recharge Improvements Phase 1	Acquisition and retirement of 175 acres of irrigated ag lands and development of 175 acres of new recharge ponds. For conjunctive-use and 2:1 third party banking.	✓	✓	✓	Land Retirement Third-Party Banking	Complete	NA	NA	**Implemented**	Complete	Complete	2023-	**630**	**530**	✓	✓	✓		NA	Kern River Flood, SWP Table A, SWP Article 21 , Friant-Kern Flood, 2:1 Exchanges, Kern River Purchase Contract	None	$6,500,000	$118,000	RRBWSD (Water Charge) USBR Grants
RRB-4	Kern Fan Water Storage Project Phase 1	Acquisition and retirement of 350 acres of irrigated ag lands, and development of 350 acres of new recharge ponds. For conjunctive-use and 2:1 third party banking.	✓	✓	✓	Land Retirement Third-Party Banking	Completion of Design	Stakeholder Meetings Board Meetings Hearing	NA	**Recharge Complete Recovery in Construction**	Current	2025	2025-	**1260**	**1059**	✓	✓	✓		NA	Kern River Flood, SWP Table A, SWP Article 21 , Friant-Kern Flood, 2:1 Exchanges, Kern River Purchase Contract	None	$13,000,000	$236,000	RRBWSD (Water Charge) CA WSIP Funding USBR Small Storage Grant
RRB-5	Onyx Ranch Water Acquisition	Acquisition of 4109 acres of land with water rights from the South Fork of the Kern River. Fallowing of ranches and change of point of diversion to Kern Subbasin for groundwater recharge.	✓	✓	✓	Exercise of Rights	Complete	NA	NA	**Operational**	Complete	Complete	2026-	**6000**	**0**	✓	✓			NA	Kern River Pre 1914 Appropriative	None	$33,000,000	$450,000	RRBWSD (Water Charge)
RRB-3	McCaslin/Dillard Recharge Improvements Phase 2	Acquisition and retirement of 150 acres of irrigated ag lands and development of 150 acres of new recharge ponds. For conjunctive-use and 2:1 third party banking.	✓	✓	✓	Land Retirement Third-Party Banking	Completion of CEQA	NA	NA	**Environmental and Design**	Current	2027	2026-	**540**	**453**	✓	✓	✓		NA	Kern River Flood, SWP Table A, SWP Article 21 , Friant-Kern Flood, 2:1 Exchanges, Kern River Purchase Contract	None	$5,500,000	$100,000	RRBWSD (Water Charge) USBR Grants
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	RRBWSD (Assessments)
RRB-6	Sites Reservoir	New reservoir to capture flood runoff for later recharge in District	✓	✓	✓	Supplemental Water Recharge	Completion of Project	Stakeholder Meetings Board Meetings Hearing	NA	**Design**	Current	2031	2031-	**500**	**0**					NA	Post 1914 Appropriation	None	$9,700,000	$98,000	RRBWSD (Increased Assessment)
RRB-7	Kern Fan Groundwater Storage Project Phase 2	Acquisition and retirement of 850 acres of irrigated ag lands and development of 850 acres of new recharge ponds. For conjunctive-use and 2:1 third party banking. Construction of approximately 400 cfs of conveyance capacity from the California Aqueduct	✓	✓	✓	Land Retirement Third-Party Banking	As Needed	Stakeholder Meetings Board Meetings Hearing	NA	**Feasibility**	As Needed	2035	2035-	**3780**	**3177**	✓	✓	✓		NA	Kern River Flood, SWP Table A, SWP Article 21 , Friant-Kern Flood, 2:1 Exchanges, Kern River Purchase Contract	None	$65,000,000	$944,000	RRBWSD (Water Charge) CA WSIP Funding USBR Small Storage Grant
RRB-8	Ten Section Water Recharge Project	Development of 200 acres of new recharge ponds for conjunctive-use.	✓	✓	✓	Third-Party Banking	As Needed	NA	NA	**Feasibility**	As Needed	2035	2035-	**500**	**0**	✓	✓	✓		NA	Unknown	Unknown	Unknown	Unknown	Private
RRB-9	Land Acquisition and Retirement	Acquisition and retirement of 500 acres of irrigated ag lands.	✓	✓	✓	Land Retirement	As Needed	Stakeholder Meetings Board Meetings Hearing	NA	**Feasibility**	As Needed	2036	2035-	**0**	**1300**					NA	NA	None	$14,500,000	$125,000	RRBWSD (Water Charge)
RRB-10	Western Rosedale In-Lieu Service Area	Construction of In-Lieu Service Area Project in order to provide surface water to agricultural water users within a portion of RRBWSD service area located westerly of Interstate 5.	✓	✓	✓	Third-Party Banking	As Needed	Stakeholder Meetings Board Meetings Hearing	NA	**Design Complete On-Hold**	As Needed	2035	2040-	**1126**	**0**	✓	✓	✓		NA	Kern River Flood, SWP Table A, SWP Article 21 , Friant-Kern Flood, 2:1 Exchanges, Kern River Purchase Contract	None	$5,000,000	$152,000	RRBWSD (Water Charge) CA WSIP Funding USBR Small Storage Grant
RRB-11	Delta Conveyance Project	Participation in the DCP. Alternative under Delta tunnels.	✓	✓	✓	Exercise of Rights	Completion of Project	Stakeholder Meetings Board Meetings Hearing	NA	**Environmental Design**	Current	2045	2045-	**3600**	**0**					NA	SWP Table A, Article 21	None		$3,000,000	RRBWSD (Increased Assessment)

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		**Implemented** **Functional** **In-Process**		**As-Needed**									**Implemented**		**Functional**		**In-Process**			**As-Needed**					
RRB-12	**Project Recovery Operations Plan**	Domestic, small community, and irrigation well mitigation program to address impacts related to temporary lowering of water levels during prolonged droughts on adjacent lands.	✓				NA	Project websites, mailers, local well companies, newspaper articles.	NA	**On-going**	NA	On-going	2010-						✓	✓		None	$0	$45,000	RRBWSD (Assessments)
RRB-13	**White Land Water Budget/Demand Imbalance Reduction**	White Lands (non-RRBWSD lands in RRBWSD GSA) not used for groundwater banking will correct the water supply imbalance by setting water budgets and a linear reduction of 5% per year over the planning period of 2020-2040.	✓	✓	✓	Demand Reduction	NA	Stakeholder Meetings Board Meetings Hearing	NA	**Implemented**	NA	2020	2020-	**0**	**5200**	✓					NA	None	$100,000	$25,000	RRBWSD (Assessments)
RRB-14	**District Land Water Budget/Water Charge Demand Reduction**	Setting of a Sustainable Water Budget and collection of a Groundwater Use Charge assisting with project financing and creating approximately a 2.5% demand reduction.	✓	✓	✓	Demand Reduction	NA	Stakeholder Meetings Board Meetings Hearing	NA	**Implemented**	NA	2023	2024-	**0**	**2000**	✓					NA	None	$100,000	$25,000	RRBWSD (Assessments)
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	RRBWSD (Assessments)
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	RRBWSD (Assessments)
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2026	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	RRBWSD (Assessments)
RRB-15	**Conversion of Agricultural Land to Urban Use**	Conversion of 2000 acres of agricultural land to urban use within the limits of each city to reduce groundwater use due to the decreased demand.	✓	✓		Demand Reduction	Already being implemented	Land Use & Planning	District, City & County	**Initiated**	2015	TBD	2030-	**0**	**3,000**			✓			Demand Reduction	District / SGMA authorities	$0	$0	Landowners, Cities & Private
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	SGMA Implementation Grant RRBWSD (Assessments)
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	RRBWSD (Assessments)
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	RRBWSD (Assessments)

KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	RRBWSD (Assessments)
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
RRB-16	**Land Retirement for Solar Power Production**	Conversion of 1500 acres of irrigated agricultural lands into solar array field.	✓	✓	✓	Land Retirement	Final Approval of Solar Power Project	NA	NA	**Feasibility and Design**	Current	2030	2035-	**0**	**3900**						NA	NA	NA	NA	Private

Table 14-17. SSJMUD GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented		Functional		In-Process			As-Needed					
SSJMUD-1	Exercising Existing Water Rights	The USBR, SLDMWA, FWA, and SJREC have entered into a MOU to collectively identify projects and potential actions aimed at improving drought resiliency South of the Delta, including SSJMUD deliveries from the Friant-Kern Canal (FKC). The South of Delta Drought Resiliency Framework allows participating entities to voluntarily conserve and securely store a portion of their CVP south of Delta deliveries for subsequent use with the goal of providing at least a 5% allocation to CVP south of Delta agricultural water service/repayment contracts, reducing reliance on Delta exports in drought years.	□			Exercise of Rights	Underway	NA	NA	MOU effective March 2024	2023	2024	2024-	4850	0			□			Increased reliability of SSJMUD's CVP supplies	Signed MOU	-	-	-
SSJMUD-2	Subbasin Banking Partnerships	Partners with neighboring water district to bank up to 15,000 AFY in existing banking facilities when excess surface water supplies are available. This partnership provides a "leave behind" volume of water to the banking partner, and returns previously banked water when requested.	□			3rd Party Banking	Implemented	NA	NA	Implemented	Below Normal Water Years	Complete	2018 with return capacity increase as of 2024-	5000	0			□			NA	Friant-Kern Supply and Class I/II Unreleased Restoration Flows (URF), and Section 215	None	$1,200,000	$180,000	Grants and SSJMUD Water Charge
SSJMUD-3	Pandol Spreading Grounds	Acquisition and retirement of 30 acres of irrigated ag lands and development of 30 acres of new recharge ponds.	□	□	□	Land Retirement, Supplemental Water Recharge	Complete	NA	NA	Implemented	Complete	Complete	2017-	275	72	□	□	□		NA	Friant-Kern Supply, URF, and Section 215	None	$660,000	$2,550	Grants and SSJMUD Water Charge
SSJMUD-4	City of Delano Spreading Grounds	Acquisition and retirement of 40 acres of irrigated ag lands and development of 40 acres of new recharge ponds.	□	□	□	Land Retirement, Supplemental Water Recharge	Complete	NA	NA	Implemented	Complete	Complete	2017-	367	14	□	□	□		NA	Friant-Kern Supply, URF, and Section 215	None	$880,000	$3,400	Grants and SSJMUD Water Charge
SSJMUD-5	Sebastian North Lake Spreading Grounds (Formerly In District Spreading Grounds)	Acquisition and retirement of 33 acres of irrigated ag lands and development of 33 acres of new recharge ponds.	□	□	□	Land Retirement, Supplemental Water Recharge	Complete	NA	NA	Implemented	Complete	Complete	2019-	303	12	□	□	□		NA	Friant-Kern Supply, URF, and Section 215	None	$704,000	$2,720	Grants and SSJMUD Water Charge
SSJMUD-6	Giumarra Spreading Grounds	Acquisition and retirement of 79 acres of irrigated ag lands and development of 79 acres of new recharge ponds.	□	□	□	Land Retirement, Supplemental Water Recharge	Complete	NA	NA	Implemented	Complete	Complete	2022-	725	160	□	□	□		NA	Friant-Kern Supply, URF, and Section 215	None	$1,716,000	$6,800	Grants and SSJMUD Water Charge
SSJMUD-7	Regan Spreading Grounds	Acquisition and retirement of 75 acres of irrigated ag lands and development of 75 acres of new recharge ponds.	□	□	□	Land Retirement, Supplemental Water Recharge	Complete	Board Meetings IS/MND Noticing	CEQA / NEPA	Implemented	Complete	Complete	2024-	689	187	□	□	□		NA	Friant-Kern Supply, URF, and Section 215	None	$1,650,000	$6,375	Grants and SSJMUD Water Charge
SSJMUD-14	Landowner Subsurface/Surface Recharge Program	A voluntary landowner program that encourages use of existing landowner agricultural lands that are cropped for a portion of the year and remain fallow the remain of the year to implement groundwater recharge during fallow periods. This program promotes infiltration of available water supplies for improved groundwater management.	□	□	□	Supplemental Water Recharge	Complete	NA	NA	Implemented	Complete	Complete	2023-	200	0	□	□	□		NA	Friant-Kern Supply, URF, and Section 215	None	$0	$34,000	SSJMUD Water Charge

SSJMUD-8	**Glumarra Additional Spreading Grounds**	Acquisition and retirement of 80 acres of irrigated ag lands and development of 80 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Complete	Board Meetings IS/MND Noticing	CEQA / NEPA	**Functional**	Current	2025	2025-	**734**	**171**	☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$1,760,000	$6,800	Grants and SSJMUD Water Charge
SSJMUD-9	**Urban Land Conversions**	Based on General Plans and Urban Water Management Plans, urban sprawl from the cities of Delano and McFarland will cause agricultural land to be taken out of production and converted to residential and commercial developments. Demand reduction is calculated based on an average change in ET.	☐	☐	☐	Ag to Urban Conversion	Anticipated	NA	NA	**Functional**	NA	2040	2020-2040	**-**	**2656**			☐			NA	None	-	-	NA
SSJMUD-10	**Caratan Spreading Grounds**	Acquisition and retirement of 160 acres of irrigated ag lands and development of 160 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Preliminary Design, Pre-Construction Bidding	Board Meetings IS/MND Noticing	CEQA / NEPA	**Design and Construction**	Current	2025	2025-	**1469**	**315**	☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$3,520,000	$13,600	Grants and SSJMUD Water Charge
SSJMUD-15	**Sebastian South Lake Spreading Grounds**	Acquisition and retirement of 52 acres of irrigated ag lands and development of 43 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Grant Funding Application, CEQA/NEPA	Board Meetings IS/MND Noticing	CEQA / NEPA	**Property Lease to be finalized in 2025**	Current	2026	2026-	**483**	**18**	☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$704,000	$2,720	Grants and SSJMUD Water Charge
SSJMUD-11	**Caratan Additional Spreading Grounds**[1]	Acquisition and retirement of 694 acres of irrigated ag lands and development of 694 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Grant Funding Application, CEQA/NEPA	Board Meetings IS/MND Noticing	CEQA / NEPA	**Property Purchased**	Current	2027-2030	2026-			☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$11,110,000	$42,925	Grants and SSJMUD Water Charge
SSJMUD-11a	**Bowman Spreading Grounds Phase 1**	Acquisition and retirement of 39 acres of irrigated ag lands and development of 39 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Grant Funding Application, CEQA/NEPA	Board Meetings IS/MND Noticing	CEQA / NEPA	**Property Purchased**	Current	2027	2027-	**358**	**83**	☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$858,000	$3,315	Grants and SSJMUD Water Charge
SSJMUD-11b	**Bowman Spreading Grounds Phase 2**	Acquisition and retirement of 156 acres of irrigated ag lands and development of 156 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Grant Funding Application, CEQA/NEPA	Board Meetings IS/MND Noticing	CEQA / NEPA	**Property Purchased**	Current	2028	2028-	**1432**	**332**	☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$3,432,000	$13,260	Grants and SSJMUD Water Charge
SSJMUD-11c	**Wollomes Avenue Spreading Grounds**	Acquisition and retirement of 312 acres of irrigated ag lands and development of 312 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Grant Funding Application, CEQA/NEPA	Board Meetings IS/MND Noticing	CEQA / NEPA	**Property Purchased**	Current	2029	2029-	**2864**	**665**	☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$6,864,000	$26,520	Grants and SSJMUD Water Charge
SSJMUD-11d	**Wallace Rd Spreading Grounds**	Acquisition and retirement of 187 acres of irrigated ag lands and development of 187 acres of new recharge ponds.	☐	☐	☐	Land Retirement, Supplemental Water Recharge	Grant Funding Application, CEQA/NEPA	Board Meetings IS/MND Noticing	CEQA / NEPA	**Property Purchased**	Current	2030	2030-	**1717**	**398**	☐	☐	☐			Friant-Kern Supply, URF, and Section 215	None	$4,114,000	$15,895	Grants and SSJMUD Water Charge
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	☐		☐		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			☐	☐	☐	NA	None	Unknown	Unknown	SSJMUD Water Charge

1 Since the earlier version of the PMA table was developed, in preparation of design and construction, the additional Caratan Spreading Grounds has been broken into four individual projects

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process			As-Needed								Implemented		Functional			In-Process		As-Needed					
KSB-2	Coordination with Groundwater Regulatory Programs	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	□	□			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	Implemented	NA	2020	2020-	0	0	□				□	NA	NA	$0	$25,000	SSJMUD Assessments
KSB-3	Exceedance Policy	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	□	□	□		When an MT exceedance occurs for any sustainability indicator.	NA	NA	Implemented	NA	2024	2024-	0	0				□	□	NA		$0	$25,000	SSJMUD Assessments
KSB-5	Well Mitigation Program	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	□	□			When declining groundwater levels impact domestic or small community wells.	Refer to Subbasin Outreach and Engagement Plan	NA	Initiating Development	NA	2025	2025-	0	0				□		NA	NA	$0	$45,000	SSJMUD Assessments
SSJMUD-12	White Land Demand Reduction	White Lands (non-SSJMUD lands) will correct the water supply imbalance by setting water budgets and a linear reduction that corrects overdraft by 2040.	□		□	Demand Reduction	NA	Stakeholder Meetings Board Meetings Hearing	NA	Planning	NA	2040	2040	0	413			□			NA	None	-	-	NA
KSB-4	Coordination with Basin Study	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	□	□	□		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	Ongoing	NA	2025	2025-	0	0					□	NA	NA	$25,000	$0	SSJMUD Assessments
KSB-6	White Land Demand Management	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	□	□	□	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	Initiating Development	NA	2030	2030-	0	20,410	□				□	NA	None	$0	$10,000	SSJMUD Assessments
KSB-7	Well Registry	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	□	□	□			Refer to Subbasin Outreach and Engagement Plan	NA	Ongoing	NA	2024-	2024-	0	0				□	□	NA	NA	$0	$25,000	SSJMUD Assessments
KSB-8	Consumptive-Use Study	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	□	□	□			Refer to Subbasin Outreach and Engagement Plan	NA	Ongoing	NA	2020-	2020-	0	0				□	□	NA	NA	$0	$25,000	SSJMUD Assessments
SSJMUD-13	Land Acquisition and Retirement	Acquisition and retirement of irrigated ag lands.	□		□	Demand Reduction	NA	Stakeholder Meetings Board Meetings Hearing	NA	As-Needed	NA	2035	2035	0	1219			□			NA	None	$13,475,000	$116,500	SSJMUD Water Charge

Table 14-18. SWID GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Irrigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process				As-Needed							
SWID-1	Kimberlina Recharge Project	Conversion of 280 acres of farmland to recharge basins.	✓	✓	✓	Supplemental Water Recharge; Land Retirement	Complete	NA	NA	Implemented	Complete	Complete	2016-	6,412	998	✓	✓				CVP, Supplemental	None	$11,200,000	$30,000	SJRRP, USBR, District Water Rates
SWID-2	Bell Recharge Project and Pump Station	Conversion of 35 acres of farmland to recharge basins, and a pipeline modification to maximize water deliveries to the project	✓	✓	✓	Supplemental Water Recharge; Land Retirement	Complete	NA	NA	Implemented	Complete	Complete	2019-	1,000	123	✓	✓				CVP, Supplemental	None	$1,400,000	$20,000	USBR, District Water Rates
SWID-3	Farmers Coop and Pipeline	Conversion of 25 acres of farmland to recharge basins, and a pipeline modification to maximize water deliveries to the project	✓	✓	✓	Supplemental Water Recharge; Land Retirement	Complete	NA	NA	Implemented	Complete	Complete	2023-	562	88	✓	✓				CVP	None	$3,125,000	$20,000	USBR, District Water Rates
SWID-4	Grower Recharge and Subsurface Recharge Program	Implementation of policy that encourages landowners to install subsurface recharge systems and/or recharge water on fallowed acreage during wet years.	✓	✓	✓	Supplemental Water Recharge	Complete	NA	NA	Implemented	Complete	Complete	2016-	750	0	✓	✓				CVP	None	$0	$0	NA
SWID-5	Diltz/Leonard Interties with SWSD	Installation of two interties to allow for 2-way movement of water to and from SWSD, to enable both Districts to fully maximize wet year supplies when available.	✓	✓	✓	Utilize Existing Water Rights	Complete	NA	NA	Implemented	Complete	Complete	2015-	0	0			✓			NA	None	$3,000,000	$0	USBR, District Water Rates
SWID-6	Southeast Recharge	Conversion of 35 acres of farmland to recharge basins.	✓	✓	✓	Supplemental Water Recharge; Land Retirement	Completion of Design	Stakeholder Meetings Board Meetings Hearing	CEQA/NEPA	In-Process	Initiated (Purchased, Designed, Grant funding secured)	2024	2024-	787	123	✓	✓				CVP	None	$2,305,000	$20,000	USBR, District Water Rates
SWID-7	Dresser Recharge	Conversion of 112 acres of farmland to recharge basins	✓	✓	✓	Supplemental Water Recharge; Land Retirement	Completion of Design	Stakeholder Meetings Board Meetings Hearing	CEQA/NEPA	In-Process	Initiated (Purchased, Designed)	2025	2025-	2,655	392	✓	✓				CVP, Supplemental	None	$7,600,000	$30,000	USBR, District Water Rates
SWID-8	Poplar Recharge	Conversion of 77 acres of farmland to recharge basins	✓	✓	✓	Supplemental Water Recharge; Land Retirement	Completion of Design	Stakeholder Meetings Board Meetings Hearing	CEQA/NEPA	In-Process	Initiated (Purchased)	2026	2026-	1,732	270	✓	✓				CVP	None	$4,500,000	$30,000	USBR, District Water Rates
SWID-9	Jack Recharge	Conversion of 118 acres of farmland to recharge basins	✓	✓	✓	Supplemental Water Recharge; Land Retirement	Completion of Design	Stakeholder Meetings Board Meetings Hearing	CEQA/NEPA	In-Process	Initiated (PSA Signed)	2026	2026-	2,700	413	✓	✓				CVP	None	$5,000,000	$30,000	USBR, District Water Rates
SWID-10	Southern Calloway Turnout	Installation of a turnout to enable the SWID southern FKC turnout to deliver water to the Calloway, which will feed Poplar, Dresser, Bell, and Jack Recharge. This will enable SWID to maximize the use of those facilities.	✓	✓	✓	Exercise of Rights	Completion of Design	Stakeholder Meetings Board Meetings Hearing	CEQA/NEPA	In-Process	Initiated (Designed, Grant funding secured)	2026	2026-	0	0			✓			NA	None	$2,600,000	$0	USBR, District Water Rates
SWID-11	Improved Water Level Measurement	Installation of a monitoring well at the Kimberlina Recharge facility to ensure that banking operations do not contribute to localized impacts.	✓	✓	✓		Completion of Design	NA	NA	In-Process	Completion of Design	2027	2027-	0	0					✓	NA	None	$500,000	$0	USBR, District Water Rates
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	Feasibility Study	NA	2030	2030-	0	0			✓	✓	✓	NA	None	Unknown	Unknown	USBR, District Water Rates

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring				One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process	As-Needed										Implemented	Functional		In-Process			As-Needed						
SWID-12	**2:1 Recharge Programs**	SWID has signed four 2:1 programs, where partners import 2 AF and SWID returns to them 1 AF at a future year. This will be a water supply benefit for SWID	✓	✓	✓	3rd Party Banking	Complete	None	None	**Implemented**	Complete	Complete	2023-	**3,000**	**0**	✓		✓			CVP, SWP, Supplemental	None	$0	NA	NA
SWID-13	**2:1 SLR Program**	SWID has historically had access to roughly 1250 AFY in San Luis Reservoir as a result of the SJRRP Restoration Program and more specifically the water management goal. SWID has agreements to begin to double that water through 2:1 exchange programs, and import it into the District. This will be a water supply benefit for SWID.	✓	✓	✓	Exercise of Rights	Complete	None	None	**Implemented**	Complete	Complete	2023-	**2,500**	**0**	✓		✓			San Joaquin River Restoration Program	None	$0	NA	NA
SWID-14	**Water Quality Mitigation**	The recently signed Water Quality Guidelines of the Friant Kern Canal will give SWIID additional water annually for Reclamation Leaching based on the water quality throughout the year. This will be a water supply benefit for SWID	✓	✓		Exercise of Rights	Complete	None	None	**Implemented**	Complete	Complete	2024-	**500**	**0**	✓		✓			CVP	None	$0	NA	NA
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.		✓			NA	NA	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	USBR, District Water Rates
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		NA	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	USBR, District Water Rates
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2026	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	USBR, District Water Rates
SWID-16	**FWA Drought Plan MOU**	Execution of a Drought Plan that will reduce the number of "Call on Friant", which have historically decreased the Class 1 Friant Allocation in dry years. Under this Drought Plan MOU, USBR, Exchange Contractors, Friant Contractors and Westside Contractors will work together to bolster dry year supplies	✓	✓	✓	Exercise of Rights	Complete	None	None	**Implemented**	Complete	Complete	2024-	**625**		✓		✓			CVP	None	NA	NA	NA
SWID-15	**Well Mitigation Policy**	SWID will adopt a well mitigation policy that is consistent with basin-wide efforts to mitigate effects from lowering groundwater levels.	✓				Will be implemented with Basin efforts	Outreach	None	**In-Process**	Completion in 2024 likely	2024	2024-	**0**	**0**				✓		NA	None	$0	$45,000	USBR, District Water Rates
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		NA	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	USBR, District Water Rates

KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	NA	Stakeholder Meetings Board Meetings Hearings	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	USBR, District Water Rates
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	USBR, District Water Rates
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	USBR, District Water Rates
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
SWID-17	**Ag to Urban Conversion**	As the cities expand, they will retire agricultural land and it'll be converted to urban land, with a substantially lower demand for water.	✓	✓		Ag to Urban Conversion	Will be implemented based on Cities of Shafter and Wasco activities	None	None	**In-Process (will be through 2024)**	This is up to the Cities' timeline for implementation	2040	2020-2040 linear increase to 2600 AFY in 2040, 1500 AFY from HSR	**0**	**4,100**	✓		✓			NA	None	$0	NA	NA
SWID-18	**WQ Trend Study/Program Coordination**	Filling data gap on water quality, and the impact of groundwater management activities on the groundwater quality. Also coordinating with WQ Programs (CVSALTS, etc.) if and when impacts occur		✓			Will be implemented	Outreach and Coordination	None	**In-Process**	Will begin implementing shortly	TBD	2020-	**0**	**0**				✓	✓	NA	None	$0	NA	NA
SWID-19	**ET Allocations/Pumping Restrictions/Voluntary Land Fallowing**	If needed, SWID will implement ET allocations, pumping restrictions, and encourage land fallowing to reduce demand if the aforementioned projects are not successful	✓	✓	✓	Demand Reduction	As needed (Other projects Fail)	None	None	**As-Needed**	TBD, will implement if sustainability goals not achieved	TBD	2033-	**0**	**0**			✓				None	$0	NA	NA

Table 14-19. SWID 7th Standard Annex P/MA

PMA Number	PMA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary								One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring					
Projects		Implemented / Functional / In-Process		As-Needed						Implemented	Functional	In-Process	As-Needed													
7th Stnd Annex-1	**Purchase Supplemental Water Supplies**	7TH Standard Annex collects assessments and will use them to purchase water supplies during wet years for recharge in adjacent Districts, most often in SWID. As these supplies accumulate, they will increase the quantity that can be sustainably pumped in 7th Stnd Annex.	✓	✓	✓	Supplemental Water Use	Availability of Supplemental Supplies	None	None	**Implemented**	Complete	Complete	2020-	TBD	0	✓	✓	✓			CVP, SWP, Supplemental	None	TBD	Unknown	Property Assessments
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	Property Assessments

PMA Number	PMA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary								One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring					
Management Actions		Implemented / Functional / In-Process		As-Needed						Implemented	Functional	In-Process	As-Needed													
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓					✓	NA	NA	$0	$25,000	NA
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**					✓	✓	NA		$0	$25,000	NA
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓	✓			When declining groundwater levels impact domestic or small community wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**Initiating Development**	NA	2025	2025-	**0**	**0**					✓		NA	NA	$0	$45,000	NA

7th Stnd Annex-3	**Well Mitigation Policy**	SWID will adopt a well mitigation policy that is consistent with basin-wide efforts to mitigate effects from lowering groundwater levels.	✓				Will be implemented with Basin efforts	Outreach	None	**In-Process**	Completion in 2024 likely	2024		**0**	**0**				✓			None	$0	NA	NA
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	NA
7th Stnd Annex-2	**ET Limitations/Water Budget**	7th Standard Annex has done rotational fallowing since 2020, and in 2025 will begin implementing a Water Budget that ramps down allowable ET from 3 AF/Acre to 0.57 AF/Acre by 2040, or a higher number if 7th Stnd Annex is successful in purchasing supplies for recharge.	✓	✓	✓	Demand Reduction	Will be implemented	Letter sent to growers	None	**In-Process**	Implementing in 2025 onwards	2025	2025-	**0**	**23,153**	✓		✓			NA	None	$0	NA	NA
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	NA
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	NA
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	NA
7th Stnd Annex-4	**WQ Trend Study/Program Coordination**	Filling data gap on water quality, and the impact of groundwater management activities on the groundwater quality. Also coordinating with WQ Programs (CVSALTS, etc.) if and when impacts occur		✓			Will be implemented	Outreach and Coordination	None	**In-Process**	Will be implemented shortly	TBD							✓	✓		None	$0	NA	NA

Table 14-20. SWSD GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process				As-Needed						
SWSD-1	Monitoring Network Improvement Plan	Assess and identify monitoring network requirements for full compliance with SGMA and development of an implementation plan for achieving full compliance. Additional wells leverage existing network of monitoring wells.	✓	✓	✓		Upon approval by SWSD BOD	Semitropic GSA Board Meetings & Website	Site specific (CEQA)	**Implemented**	Complete	Complete	2023-	**0**	**0**					✓		District authorities	$10,000	$0	District
SWSD-2	Leonard Avenue System	Conveyance capacity to support delivery of surface water for groundwater recharge. Interconnection with Shafter-Wasco Irrigation District.	✓		✓		Complete	Semitropic GSA Board Meetings & Website	CEQA	**Implemented**	Complete	Complete	2023-	**0**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	$16,100,000	$0	District
SWSD-3	Diltz Intertie	Conveyance capacity to support delivery of surface water for groundwater recharge. Interconnection with Shafter-Wasco Irrigation District.	✓		✓		Complete	Semitropic GSA Board Meetings & Website	CEQA	**Implemented**	Complete	Complete	2020-	**0**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	$3,200,000	$0	District
SWSD-4	Cox Canal Pump Station	Conveyance capacity to support delivery of surface water for groundwater recharge. Interconnection with Buena Vista Water Storage District.	✓		✓		Complete	Semitropic GSA Board Meetings & Website	CEQA	**Implemented**	Complete	Complete	2022-	**0**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	$3,600,000	$0	District
SWSD-5	Water Market Acquisitions	Increased participation in state-wide water markets for spot market and long-term water transfers. And maximize acquisition of wet year water supplies for recharge.	✓		✓	Supplemental Water Supplies	Upon approval by SWSD BOD	Semitropic GSA Board Meetings & Website	CEQA / DWR	**Implemented/ Ongoing**	NA	On-going	2020-	**19,000**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	$0	$9,500,000	District
SWSD-6	Stored Water Recovery Unit-XYZ	Development of water storage to expand in-lieu service areas.	✓		✓	Exercise of Rights	Upon approval by SWSD BOD and identification of funding	Semitropic GSA Board Meetings & Website	None	**Completed**	Current	2018	2022-	**0**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	$17,000,000	$0	District
SWSD-7	Pond-Poso Spreading Grounds, Phase II	Development of spreading facilities to increase groundwater recharge capacity.	✓		✓	Supplemental Water Recharge	Upon approval by SWSD BOD and identification of funding	Semitropic GSA Board Meetings & Website	CEQA	**Construction**	Current	2025	2025-	**0**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	$32,000,000	$0	District
SWSD-8	Schuster Spreading Grounds	Development of spreading facilities to increase groundwater recharge capacity.	✓		✓	Supplemental Water Recharge	Upon approval by SWSD BOD and identification of funding	Semitropic GSA Board Meetings & Website	CEQA	**Design**	Current	2026	2026-	**0**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	$1,200,000	$0	District
SWSD-9	Poso Creek MAR	Development of floodwater capture and recharge program from Poso Creek flood flows.	✓		✓	Supplemental Water Recharge	Upon completion of feasibility and permitting requirements	Semitropic GSA Board Meetings & Website	CEQA	**Feasibility**	Current	2028	2028-	**2800**	**0**		✓	✓			Poso Creek & Friant-215	District authorities	$17,700,000	$0	District
SWSD-10	Pond-Poso Entrance Ponds	Development of spreading facilities to increase groundwater recharge capacity.	✓		✓	Supplemental Water Recharge	Upon approval by SWSD BOD and identification of funding	Semitropic GSA Board Meetings & Website	CEQA	**Design**	Current	2028	2028	**0**	**0**	✓	✓	✓			Poso Creek & Friant-215	District authorities	$8,000,000	$0	District
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	District
SWSD-11	Tulare Lake Project	Development of conveyance facilities to divert Kings River flood flows for direct use and recharge in the SWSD.	✓	✓	✓	Supplemental Water Recharge	Upon completion of water rights determination	Semitropic GSA Board Meetings & Website	CEQA / State Board / Regulatory	**Feasibility/ Water Rights**	Current	2035	2035-	**35000**	**0**	✓	✓	✓			Kings River flood flows	District authorities	$270,000,000	$1,000,000	District
SWSD-12	Enhanced Groundwater Recharge	Development of surface and subsurface recharge projects underlying developed agricultural lands to increase groundwater recharge capacity.	✓			Exercise of Rights/ Supplemental Water Recharge	Upon approval by SWSD BOD and identification of funding	Semitropic GSA Board Meetings & Website	Site Specific (CEQA)	**In-Process**	Current	2040	2020-	**0**	**0**	✓		✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District authorities	TBD	$25,000	District

SWSD-13	**Evaluation and Assessment of GDEs within the Semitropic Area**	Conduct additional analysis to verify the presence and extend of GDE's in the Semitropic and, if present, develop appropriate monitoring protocols.	✓				As needed	Semitropic GSA Board Meetings & Website	TBD	**As needed**	Current	2030	2030-	**0**	**0**					✓		District authorities	$50,000	bank	District
SWSD-14	**Brackish Water Desalination**	Development of a brackish water treatment facility to treat locally sourced brackish water for District use.	✓			New Local Supply	Upon completion of environmental and regulatory requirements As needed	Semitropic GSA Board Meetings & Website	CEQA	**As needed**	Current	2040	2040-	**1,800**	**0**	✓		✓			Local brackish water	District authorities	$0	$900,000	District
SWSD-15	**In-District Water Markets and Transfers**	District will allow for the development of market for in-district transfers.	✓			Exercise of Rights Supplemental Water Use	As needed	Semitropic GSA Board Meetings & Website	TBD	**As needed**	As needed	2040	2040-	**TBD**	**0**			✓			SWP, Friant, Kern River, CVP and other imported and local sources.	District / SGMA authorities	TBD	$25,000	District

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring				One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		**Implemented** **Functional** **In-Process**	**As-Needed**										**Implemented**		**Functional**		**In-Process**			**As-Needed**					
SWSD-16	**Landowner Water Budgets**	Establish individual water budgets for landowners by landowner classes. Implemented to reduce District's demand to	✓	✓	✓	Demand Reduction	Establish water budgets by landowner	Semitropic GSA Board Meetings & Website	CEQA	**Implemented**	Complete	Complete	2017	**0**	**132,000**			✓	✓		NA	District / SGMA authorities	$0	$250,000	District
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	District

KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	District
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	Cawelo Water District (Assessments) CGSA Landowners
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	District
SWSD-17	**Tiered Pricing for Groundwater Pumping**	Develop pricing structure to incentivize groundwater users to manage groundwater extractions to SWSD-16 landowner budgets.	✓	✓	✓	Demand Reduction	Implementation of SWSD-16	Semitropic GSA Board Meetings & Website	218 Process	**Ongoing**	Current	2025	2025-	**0**	**33,000**			✓	✓		NA	District / SGMA authorities	$100,000	$25,000	District
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	District
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	District
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing												
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
SWSD-18	**District Fallowing Program**	Support land fallowing as a District action and by individual landowners or groups of landowners.	✓	✓	✓	Demand Reduction	Implementation of SWSD-16	Semitropic GSA and District Board CEQA compliant process	CEQA	**As needed**	Current	2040	2040-	**0**	**TBD**			✓	✓			District authorities	TDB	$0	District

Table 14-21. TCWD GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process	As-Needed										Implemented	Functional	In-Process				As-Needed							
TC-1	**Recharge of Carrot Wash Water**	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.	✓			Supplemental Water Recharge	Underway	NA	WDR No. 5-01-22; well construction permit from Kern County	**Complete; new recovery well may be constructed in the future.**	Complete	2016	2016-	**300**	**0**	✓		✓			Carrot wash water from processing facility	None	$4,500	$0	Carrot Processing Facility; TCWD
TC-2	**Conversion of Granite Quarry to Sycamore Ranch**	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.	✓	✓		Supplemental Water Use	To be implemented upon adoption of GSP / Grant funding	Infrastructure improvement; no public noticing necessary	CEQA; DMR SMARA permit closure; NEPA requirements if grant funds are used	**Geotechnical study complete; AEWSD and TCWD have participated in several meetings to discuss the permitting process for this project**	Once Granite completes reclamation; anticipated initiation by 2027	Construction duration TBD	2030	**1500**	**0**	✓		✓			Additional wet-year imported water supplies	Property acquisition or land use agreement with quarry owner	$15,000,000	TBD	AEWSD, TCWD, grants
KSB-1	**Friant-Kern Canal Capacity Mitigation**	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	TCWD, subsidized by landowner (TRC)

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		**Implemented** **Functional** **In-Process**	**As-Needed**										**Implemented**		**Functional**		**In-Process**			**As-Needed**				
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	TCWD, subsidized by landowner (TRC)
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	TCWD, subsidized by landowner (TRC)
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2026	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	TCWD, subsidized by landowner (TRC)

KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	TCWD, subsidized by landowner (TRC)
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓					✓	NA	None	$0	$10,000	TCWD, subsidized by landowner (TRC)
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	TCWD, subsidized by landowner (TRC)
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	TCWD, subsidized by landowner (TRC)
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time

Table 14-22. WDWA GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring				One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Complete / Functional / In-Process	As-Needed										Implemented	Functional	In-Process					As-Needed					
WDWA-1	**Long-Term Supplemental Water Programs**	WDWA GSA is a Joint Powers Authority comprised of Belridge Water Storage District, Berrenda Mesa Water District, and Lost Hills Water District. Between 2015 and 2023, the three districts have successfully purchased over 1.6 million acre feet from State Water Contractors, Central Valley Project Contractors, pre-1914 water rights holders, and the SWP Dry-Year transfer program. Several of these purchases are multi-year long term agreements valid until 2030, with first right of refusal to renew.	✓	✓	✓	Supplemental import secured by existing contract	Complete	Board meetings, CEQA EIR review period, other DWR/SWRCB public noticing requirements	CEQA EIR, DWR SWAPO approval, CVP Bureau of Reclamation approval, Kern County Water Agency approval, SWRCB water rights petition of change of place of use	**Implemented and Continuously Ongoing**	Complete	Complete	Implemented	**80,000**	**0**			✓			State Water Project (Table A, Article 21, Article 56), CVP, Pre-1914 appropriative rights, local Kern River supplies, SWP Dry-Year program	None	$0	$10,000,000	Participating landowner assessments
WDWA-2	**Conjunctive Reuse of Naturally Degraded Brackish Groundwater**	Phased project that will integrate the modular treatment and conjunctive use of brackish groundwater and oil field produced water. A Phase I project engineering feasibility study for has been completed. Negotiations with project partners, financing options, and development of a Front-End Engineering & Design (FEED) report are the next phase of project implementation.	✓	✓		New Local Supplies	Results of feasibility study indicate viable project	To be determined by feasibility study	CEQA, additional regulatory requirements to be determined by feasibility study	**In-Process**	2025	2035	2035-	**50,000**	**0**	✓				✓	Treated brackish groundwater and oilfield produced water	None	$60,000,000	$2,000,000	Landowner assessments, federal and state grant programs
WDWA-3	**Delta Conveyance Project**	Via KCWA's status as a State Water Contractor, WDWA GSA's JPA members (BMWD, BWSD, and LHWD) participate in funding the Delta Conveyance Project. DCP aims to modernize the aging water infrastructure and improve the reliability of water transported through the Delta. It seeks to address the challenges posed by climate change, seismic risks, and environmental concerns.	✓	✓		Exercise of Rights	Completion of Project	Stakeholder Meetings, Board Meetings, CEQA EIR review period, other DWR/SWRCB public noticing requirements	All permitting and regulatory processes are being managed by DWR	**Environmental Design**	Current	2045-	2045-	**17,806**	**0**	✓					SWP Table A, Article 21	None	$12,465,349	$4,000,000	District contributions to KCWA DCP funding costs (gathered via District landowner assessments)

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process	As-Needed							Implemented				Implemented	Functional	In-Process				As-Needed					
WDWA-4	**Net Zero Well Drilling Moratorium within Close Proximity to Critical Infrastructure**	To ensure no net increase of groundwater extraction capacity within the California Aqueduct Subsidence Program (CASP) 5 mile CA Aqueduct "Buffer Zone", new well drilling is prohibited within the Buffer Zone unless explicitly approved by the Board of Directors, which may allow replacements only if an existing well within the Buffer Zone is abandoned.	✓		✓		Complete	Impacted stakeholder meetings (4) and public Board of Directors meeting (2/20/24)	NA	**Implemented**	Complete	Complete	2024-	**NA**	**NA**					✓	NA	None	$2,500	$1,000	WDWA GSA via landowner assessments
WDWA-5	**Mandatory Well Registration**	To further supplement Kern County Subbasin Well Registry (KSB-7) management action, WDWA GSA has implemented a mandatory well registration program that requires all currently existing and future wells drilled within WDWA GSA register with the GSA and provide well construction reports and water quality analyses, if available. The policy also requires new wells have a flowmeter installed, well owners allow the GSA to use the well for monitoring (if located in a data gap area), and well owners provide annual status updates for each well (active, inactive, damaged, abandoned, etc.).	✓	✓	✓		Complete	Impacted stakeholder meetings (4) and public Board of Directors meeting (2/20/24)	NA	**Implemented**	Complete	Complete	2024-	**NA**	**NA**					✓	NA	None	$5,000	$1,000	WDWA GSA via landowner assessments
WDWA-6	**Well Extraction Volume Reporting within Close Proximity to Critical Infrastructure**	All well owners within the CASP 5-mile Buffer Zone of the CA Aqueduct are required to report annual groundwater extraction volume (measured by flowmeter) by February 1 of the following year.	✓		✓		Complete	Impacted stakeholder meetings (4) and public Board of Directors meeting (2/20/24)	NA	**Implemented**	Complete	Complete	2024-	**NA**	**NA**					✓	NA	None	$2,500	$1,000	WDWA GSA via landowner assessments
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**NA**	**NA**	✓					✓	NA	NA	$0	$25,000	WDWA GSA via landowner assessments
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**NA**	**NA**				✓	✓	NA		$0	$25,000	WDWA GSA via landowner assessments

WDWA-9	**Groundwater Extraction Moratorium within Close Proximity to Critical Infrastructure**	The WDWA GSA has implemented a pumping moratorium for all supply wells within the CASP Monitoring Corridor between California Aqueduct Mileposts 195 to 215. The purpose of this PM/A is to further ameliorate the potential for GSA related activities contributing to the California Aqueduct subsidence identified adjacent to the Lost Hills Oil Field.	✓		✓	Demand Reduction	Complete	NA	NA	**Implemented**	Ongoing	Ongoing	2024-	**0**	**<500 AF/year on average**				✓	✓	NA	Completed	$5,000	$2,500	WDWA GSA via landowner assessments
KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2025	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	WDWA GSA via landowner assessments
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	WDWA GSA via landowner assessments
WDWA-7	**CA Aqueduct CASP Collaboration and Data Sharing Agreement**	To address subsidence along Mileposts 195-215 of the CA Aqueduct and fill data gaps, WDWA GSA is developing a collaboration and data sharing agreement with CASP. Components of the agreement may include (1) quarterly coordination meetings between WDWA GSA and CASP, (2) share well location and extraction volume within the CA Aqueduct Buffer Zone data with CASP, and (3) reviewing annual subsidence rates and CASP collected well and extensometer data.			✓		In-Process	NA	NA	**In-Process**	In-process	2025	2024-	**0**	**0**					✓	NA	None	$5,000	$2,500	WDWA GSA via landowner assessments
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	WDWA GSA via landowner assessments
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	WDWA GSA via landowner assessments
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	WDWA GSA via landowner assessments

KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing	2025-						✓	✓	NA	NA	$0	Unknown at this time	Unknown at this time
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
WDWA-8	**As-Needed Land Fallowing**	Since 2015, WDWA GSA landowners have fallowed over 13,000 acres of permanent crops. Due to naturally high salinity levels, WDWA GSA's groundwater cannot be used for agricultural beneficial use without blending or other prohibitively expensive treatment. Thus, WDWA GSA landowners are 98% reliant on imported surface water supplies (on average between 2015 to 2023) to meet irrigation demand. In dry years where irrigation demand exceeds the Table A allocation provided by the SWP, WDWA GSA landowners utilize their robust supplemental surface water purchase and storage program (P/MA WDWA-1) rather than increase groundwater pumping and risk permanent crop damage or death due to salt stress.	✓			Demand Reduction	Complete	NA	NA	**As Needed**	Ongoing	Ongoing	As-Needed	**0**	**39,000 cumulative acres since 2015**						NA	None	Landowner asset losses of more than $400,000,000 in market value	N/A	None required, landowners absorb revenue losses

Table 14-23. WRM GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process			As-Needed								Implemented		Functional		In-Process			As-Needed					
WRM-1	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.	✓	✓		Third-Party Banking	Underway	Regular District Board meetings	CEQA	**Implemented**	Complete	Complete	2020-	**6730**	**0**	✓		✓			Combination of lower Kern River water supplies and article 21	None	$1,000,000	$100,000	District water charges
WRM-2	Purchase Additional Supplies	Continue purchase of additional supplies, as available, for banking outside of the District or direct delivery within the District.	✓	✓	✓	Supplemental Water Use	Underway	Regular District Board meetings	CEQA	**Implemented**	Complete	Complete	2020-	**5000**	**0**	✓		✓			Combination of lower Kern River water supplies and article 21	District authority as a Water Storage District	NA	$2,500,000	District water charges
WRM-3	On-Farm Recharge	A Landowner Recharge Program was established in April 2023 and pays participating landowners $75/AF to spread certain low-cost water supplies available to WRMWSD on private lands.	✓	✓		Supplemental Water Recharge	Underway	Regular District Board meetings	CEQA	**Implemented**	Complete	Complete	2023-	**3600**	**0**	✓		✓			Combination of lower Kern River water supplies and article 21	None	$0	$1,350,000	District water charges
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	GSA Admin Charge
WRM-4	"Thru Delta" Facility	Participation in a "Thru Delta" Facility to increase access to contracted (SWP) supplies.	✓	✓	✓	Exercise of Rights	State-led effort underway	Prop 218	CEQA	**Design & Permitting**	Underway	2045	2045-	**5000**	**0**	✓					State Water Project	None	$311,000,000	TBD	District water charges
WRM-5	In-District Recharge Facilities	Program to promote private and/or District-owned recharge facilities within the District.	✓	✓		Supplemental Water Recharge	To be implemented upon adoption of GSP	Regular District Board meetings	CEQA	**Feasibility Study**	2023	2030	2030-	**2000**	**0**	✓		✓			Combination of lower Kern River water supplies and article 21	None	$3,200,000	$100,000	District water charges; GSA Admin Charge

WRM-13	**Capture of Imported Water Return Flows from White Wolf Subbasin**	WRMWSD has provided imported water deliveries to landowners within the White Wolf Subbasin. Return flows of imported water flow across the White Wolf Fault into Wheeler-Ridge Maricopa GSA. Wheeler-Ridge Maricopa GSA would capture the proportion of Subbasin inflows attributed to WRMSD's imported water return flows for distribution and use within the surface water service area.	✓			Exercise of Rights	Underway	GSA Board meetings	NA	**Wheeler-Ridge Maricopa GSA has initiated discussions and negotiations with Subbasin GSAs and White Wolf GSA**	2024	2025	2025-	**4500**	**0**						Imported water return flows	None	$0	$0	NA
WRM-6	**Expand District Distribution System**	Project to expand District distribution system into area currently using only private groundwater.	✓	✓	✓	Supplemental Water Use	Upon modification of water service contracts	Regular District Board meetings	CEQA	**Not yet Initiated**	TBD	TBD	TBD	**2000**	**0**	✓		✓			Additional wet-year imported water supplies	District as a water storage authority	$18,000,000	$100,000	District water charges; grants
WRM-7	**Desalination Facilities**	Desalination facilities to allow for use of additional poor quality groundwater for agricultural use, easing demand on principal aquifer.	✓	✓	✓	New Local Supply	Localized pumping lowering GW levels near MT	Regular District Board meetings	CEQA	**Feasibility Study**	TBD	TBD	TBD	**0**	**0**	✓					poor-quality (currently unused) groundwater	None	NA	$2,400,000	District water charges; GSA Admin Charge

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits								Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary										
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring				One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		**Implemented** **Functional** **In-Process**		**As-Needed**									**Implemented**		**Functional**		**In-Process**			**As-Needed**						
WRM-8	**Pumping Assessment**	Set policy to implement a pumping assessment to fund purchase of additional supplies, purchase of land for fallowing, and other investments to support SGMA compliance.	✓		✓	Demand Reduction	To be implemented upon adoption of GSP	Prop 218	CEQA	**Implemented**	Complete	Complete	2024-	**0**	**2000**						NA	District authority as a Water Storage District	$200,000	$50,000	District water charges
KSB-2	**Coordination with Groundwater Regulatory Programs**	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	**Implemented**	NA	2020	2020-	**0**	**0**	✓				✓	NA	NA	$0	$25,000	GSA Admin Charge
KSB-3	**Exceedance Policy**	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	**Implemented**	NA	2024	2024-	**0**	**0**				✓	✓	NA		$0	$25,000	GSA Admin Charge
WRM-14	**Well Registry within Close Proximity to the California Aqueduct**	Well registration program that will require all currently existing and future groundwater extraction wells located proximate to the California Aqueduct to be reported to the WRM GSA	✓	✓	✓				NA	**Implemented - Included within the WRMWSD Groundwater Service Charge**	NA	2025-	2025-	**0**	**0**				✓	✓	NA	Authority of a GSA under SGMA to develop and implement a GSP	$0	$25,000	GSA Admin Charge
WRM-15	**Well Extraction Volume Reporting Within Close Proximity to the California Aqueduct**	Well extraction volume reporting program for groundwater extraction wells located proximate to the California Aqueduct. Extractions will need to be metered using either the District's adopted well meter standards or an ET based methodology.	✓	✓	✓				NA	**Implemented Through WRMWSD Groundwater Service Charge**	NA	2025-	2025-	**0**	**0**				✓	✓	NA	Authority of a GSA under SGMA to develop and implement a GSP	$0	$25,000	GSA Admin Charge

KSB-5	**Well Mitigation Program**	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	**With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.**	NA	2026	2025-	**0**	**0**				✓		NA	NA	$0	$45,000	GSA Admin Charge
KSB-4	**Coordination with Basin Study**	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	**Ongoing**	NA	2025	2025-	**0**	**0**					✓	NA	NA	$25,000	$0	GSA Admin Charge
KSB-6	**White Land Demand Management**	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	**Initiating Development**	NA	2030	2030-	**0**	**20,410**	✓				✓	NA	None	$0	$10,000	GSA Admin Charge
KSB-7	**Well Registry**	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2024-	2024-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	GSA Admin Charge
KSB-8	**Consumptive-Use Study**	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	**Ongoing**	NA	2020-	2020-	**0**	**0**				✓	✓	NA	NA	$0	$25,000	GSA Admin Charge
KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
WRM-16	**Net Zero Well Drilling Moratorium within Close Proximity to the California Aqueduct**	Net zero well drilling moratorium that would allow for replacement wells, but no new wells (excluding de minimums use) to be installed proximate to the California Aqueduct, resulting in no new groundwater extractions proximate to the California Aqueduct.	✓	✓	✓				NA	**Initiating Development**	NA	2025-	2025-	**0**	**0**				✓	✓	NA	Authority of a GSA under SGMA to develop and implement a GSP	$0	$25,000	GSA Admin Charge

WRM-9	**Groundwater Allocation and Market**	Develop a groundwater pumping allocation methodology, including a market system for trading and/or transferring of allocations.	✓		✓	Demand Reduction	To be implemented upon adoption of GSP	Regular District Board Meetings	CEQA	**By end of WY 2023, allocation policy in early stages of development**	2023	TBD	2035-	**0**	**21000**			✓			NA	Authority of a GSA under SGMA to develop and implement a GSP	$50,000	$50,000	GSA Admin Charge
WRM-10	**Voluntary Pumping Limitation**	Set non-binding pumping limitations in conjunction with a fee for pumping above limits.	✓		✓	Demand Reduction	To be implemented upon adoption of GSP	Prop 218	CEQA	**In coordination with WRM-9**	2023	TBD	2035-	**0**	**0**						NA	Authority of a GSA under SGMA to develop and implement a GSP	$200,000	$50,000	GSA Admin Charge
WRM-11	**Mandatory Pumping Limitation**	Set binding pumping limitations in conjunction with a fee for pumping above limits.	✓		✓	Demand Reduction	if other P/MAs are insufficient	Prop 218	CEQA	**In coordination with WRM-9**	2023	TBD	2035-		**5000**					✓	NA	Authority of a GSA under SGMA to develop and implement a GSP	$200,000	$50,000	GSA Admin Charge
WRM-12	**Land Retirement**	Conversion of ag lands to solar. Purchase and permanently fallow previously irrigated acreage within District to reduce overall water demand and groundwater extractions.	✓		✓	Land Retirement	if other P/MAs are insufficient	Prop 218	CEQA	**Feasibility Study**	2030	TBD	2030-	**0**	**10000 (increase by 2500 after 2030)**						NA	Authority of a GSA under SGMA to develop and implement a GSP	$0	$10,000	GSA Admin Charge

Table 14-24. WKWD GSA P/MA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects		Implemented / Functional / In-Process		As-Needed									Implemented		Functional		In-Process			As-Needed					
WKWD-1	Automatic Meter Reading Project	This includes the installation of Automatic Meter Readers on all residential and commercial customers in the WKWD.	✓	✓	✓	Water Conservation-Efficiency	Pre-SGMA, supports SGMA goals	Notices and WKWD Board Meetings	NA	**Complete**	2023	2023	2023-	**0**	**191**	✓		✓			NA	NA	$1,500,000	$0	Grant
KSB-1	Friant-Kern Canal Capacity Mitigation	1) Collaborate with FWA to develop costs estimates for the Lower Reach Capacity Correction, 2) develop an attribution analysis of post-2020 subsidence impacts, 3) participate in developing a value of water analysis in cooperation with FWA and 4) develop and implement a funding mechanism to pay for post-2020 conveyance impacts on the FKC attributable to subsidence.	✓		✓		Completion of Design and Impact Analysis	Stakeholder Meetings Board Meetings	NA	**Feasibility Study**	NA	2030	2030-	**0**	**0**			✓	✓	✓	NA	None	Unknown	Unknown	Rate Payers, Grants
WKWD-2	Participation in Delta Conveyance Facility	Participation in the DCP. Alternative under Delta tunnels.	✓	✓	✓	Exercise of Rights	Completion of Project	Stakeholder Meetings Board Meetings Hearing	NA	**Environmental Design**	Ongoing	2045-	2045-	**3100**	**0**						SWP Table A, Article 21	None		$700,000	Water Rates
WKWD-3	Buena Vista Recreation Area Water Supply Management Coordination	Coordination with Kern County on the operations and extractions required for BVARA.	✓			Exercise of Rights	Fill data gap	NA	NA	**In-Process**	Began during GSP development	TBD	TBD	**0**	**0**	✓	✓	✓	✓	✓	NA	NA			NA

P/MA Number	P/MA Name	Summary Description	Relevant Sustainability Indicators Affected			Overdraft Correction Description Category	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits							Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
														Primary (AFY)		Secondary									
			Groundwater Levels & Storage	Groundwater Quality	Land Subsidence									Water Supply Augmentation	Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Mitigation Programs	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Management Actions		Implemented / Functional / In-Process	As-Needed										Implemented	Functional		In-Process			As-Needed					
KSB-2	Coordination with Groundwater Regulatory Programs	Coordination with various water quality regulatory programs by local, state, and federal agencies. Some of these programs include the Irrigated Lands Regulatory Program, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), as well as local Groundwater Banking MOUs.	✓	✓			When domestic or small community wells require assistance maintaining access to safe and reliable water supplies.	Refer to Subbasin Outreach and Engagement Plan	NA	Implemented	NA	2020	2020-	0	0	✓				✓	NA	NA	$0	$25,000	Rate Payers, Grants
KSB-3	Exceedance Policy	Subbasin-wide policy to outline what measures are taken if an MT is exceeded (levels, quality, or subsidence). This policy involves the implementation of action plans and notifications to beneficial users.	✓	✓	✓		When an MT exceedance occurs for any sustainability indicator.	NA	NA	Implemented	NA	2024	2024-	0	0				✓	✓	NA		$0	$25,000	Rate Payers, Grants
KSB-5	Well Mitigation Program	Implementation of a well mitigation program to address water level and quality impacts on drinking water. The program provides emergency bottled water, well assessments, hauled water, and well improvements or replacements.	✓				When groundwater management activities impact domestic wells.	Refer to Subbasin Outreach and Engagement Plan	NA	With the adoption of the GSP in December, the Well Mitigation Plan will be adopted and implemented beginning on January 1, 2025.	NA	2026	2025-	0	0				✓		NA	NA	$0	$45,000	Rate Payers, Grants
KSB-4	Coordination with Basin Study	Coordination with local GSA's to gain a better understanding of the Kern Subbasin and how best to manage for sustainability, native yield, subsurface flow, and evapotranspiration. The further development of the data management system to improve data access and transparency.	✓	✓	✓		Supporting data collection, reviewing and validating results with GSA-specific data.	NA	NA	Ongoing	NA	2025	2025-	0	0					✓	NA	NA	$25,000	$0	Rate Payers, Grants
KSB-6	White Land Demand Management	Development of governance structure and demand reduction action for Subbasin white lands (lands not within a district or management area). Correct the water supply imbalance by setting water budgets and a linear reduction of 10% per year over the planning period of 2030-2040.	✓	✓	✓	Demand Reduction	Subbasin-wide overdraft correction.	Stakeholder Meetings Board Meetings Hearings Public Outreach & Engagement	NA	Initiating Development	NA	2030	2030-	0	20,410	✓				✓	NA	None	$0	$10,000	Rate Payers, Grants
KSB-7	Well Registry	An ongoing effort to update and maintain the Subbasin well inventory and translate it into a well registry. Information will be updated and housed within the Subbasin data management system.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	Ongoing	NA	2024-	2024-	0	0				✓	✓	NA	NA	$0	$25,000	
KSB-8	Consumptive-Use Study	Maintain and improve existing Subbasin consumptive-use study (ITRC Metric/LandIQ) for accurate estimates of water use by parcel within GSA's.	✓	✓	✓			Refer to Subbasin Outreach and Engagement Plan	NA	Ongoing	NA	2020-	2020-	0	0				✓	✓	NA	NA	$0	$25,000	

KSB-9	**California Aqueduct Subsidence Action Plan**	Subbasin has developed an Action Plan for Subsidence Interim Milestone (IM) & Minimum Threshold (MT) Exceedances which requires GSAs to evaluate and initiate targeted P/MAs to reduce GSA-related subsidence. As part of this P/MA, GSAs located within or proximate to the CASP 5-mile wide Monitoring Corridor to the California Aqueduct may initiate targeted P/MAs should future observed subsidence rates exceed IMs and MTs.	✓		✓		When an subsidence IM/ MT exceedance occurs.	NA	NA	**Ongoing**	In-process	Ongoing													
KSB-10	**RMW Data Gaps**	An assessment of level and quality data gaps identified RMN data gaps for water levels and quality. Identified data gaps will be evaluated and addressed by the end of 2026 as specified in Section 15.	✓	✓	✓	NA	NA	NA	Permitting will be required if new wells need to be drilled	**Ongoing**	NA	2026	2026-	**0**	**0**					✓	NA	NA	Unknown at this time	Unknown at this time	Unknown at this time
WKWD-4	**Continued Participation in Basin-Wide Coordination**	Coordinate with all other GSA's within the Kern Subbasin to address regulatory requirements and determination.	✓	✓	✓	Exercise of Rights	NA	Stakeholder Meetings Board Meetings	NA	**In-Process**	NA	2040	2020-	**0**	**0**	✓	✓	✓	✓	✓	NA	NA	$0	$100,000	Rate Payers, Grants
WKWD-5	**Continued Balanced Pumping and Recharge**	Continued balanced pumping of groundwater and recharge of imported supplies has and will continue to be the operational norm for WKWD. Under this management action, recharge and recovery activity will continue to be monitored closely by WKWD to maintain balanced conditions.	✓	✓	✓		As-needed	NA	NA	**As-Needed**	As-Needed	NA	NA	**0**	**0**	✓		✓			NA	NA	$0	$0	NA
WKWD-6	**Implement Water Shortage Response Plan**	Implement conservation measures during drought periods	✓	✓	✓	Demand Reduction	As-needed	Stakeholder Workshops, Board meeting, customer communications	NA	**As-Needed**	As-Needed	NA	NA	**0**	**2500**			✓	✓		NA	NA	$0	$0	NA
WKWD-7	**Taft Recycled Water Program**	The Taft Recycled Water Program could potentially generate 423 AFY of tertiary recycled water for Title 22 approved applications.	✓	✓	✓	New Local Supply	As-needed	Stakeholder Workshops, Board meeting, customer communications	Construction permits, General Waste Discharge Requirement Permit,.	**As-Needed**	As-Needed	NA	NA	**423**	**0**	✓		✓	✓		Recycled Water	NA	$14,455,000	$415,000	Rate Payers, Grants
WKWD-8	**Shift Balance of Pumping between North and South Wellfields**	Shifting and balancing pumping between the North Wellfield and South Wellfield entails WKWD increasing the proportion of groundwater pumped at the wellfield that is experiencing the least decline in groundwater levels. This strategy would allow local recovery of groundwater levels in the other wellfield.	✓	✓	✓		As-needed	NA	NA	**As-Needed**	As-Needed	NA	NA	**0**	**0**	✓		✓			NA	NA	$0	$0	NA
WKWD-9	**Implement Permanent Demand Management Measures**	This adaptive management strategy would convert the Response Level 1 actions in the WSRP from voluntary to mandatory. These water restrictions would require a 25 percent reduction in large landscape watering from 2007 levels, prohibit water waste, and reduce non-contracted industrial water use by 15 percent from 2007 levels.	✓	✓	✓	Demand Reduction	As-needed	Stakeholder Workshops, Board meeting, customer communications	NA	**As-Needed**	As-Needed	NA	NA	**0**	**2500**			✓	✓		NA	NA	$0	$0	NA

15. MONITORING NETWORK

§ 354.32. *Introduction to Monitoring Networks*

This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

☑ 23 CCR § 354.32

The Kern Subbasin GSAs maintain a broad groundwater monitoring network developed through decades of data collection and coordinated management efforts. This monitoring network is designed to implement data collection efforts in accordance with SGMA Regulations and to allow for improved characterization of groundwater conditions within the Kern Subbasin and assess changes in these conditions over time. It includes a wide range of groundwater, surface water, water quality, and land subsidence monitoring programs conducted by water districts, municipalities, regulatory entities, and stakeholder committees.

These existing monitoring efforts, many of which predate the Sustainable Groundwater Management Act (SGMA), are described in Section 5.7 of the 2025 Plan. They encompass data collection and reporting conducted under state and regional plans, water banking operations, hydrographic accounting, and regulatory compliance programs for drinking water and wastewater systems. These efforts support monitoring of key sustainability indicators, including groundwater levels and pumping (Section 5.7.3), groundwater quality (Section 5.7.5), and land subsidence (Section 5.7.6). These programs contribute information that supports operational decision-making, resource planning, and potential future refinement of SGMA monitoring networks.

To comply with SGMA, the Kern Subbasin GSAs developed a focused Representative Monitoring Network (RMN). The RMN is a subset of monitoring sites that meet the technical and regulatory requirements necessary to evaluate SGMA sustainability indicators and to track progress toward Sustainable Management Criteria (SMCs), including Minimum Thresholds (MTs), Measurable Objectives (MOs), and Interim Milestones (IMs). The RMN serves as the foundation for SGMA compliance and is the primary focus of the remainder of Section 15.

This section documents the RMN and is organized as follows:

- Section 15.1 – Monitoring Network Objectives: Describes how the RMN supports SGMA compliance, trend analysis and resource projection.

- Section 15.2 – Description of the Monitoring Network: Summarizes the site selection, spatial coverage, and network design for each sustainability indicator.
- Section 15.3 – Monitoring Protocols: Describes the field methods and standards used to ensure consistent, high-quality data collection.
- Section 15.4 – Representative Monitoring: Identifies the specific sites designated for application of SMCs.
- Section 15.5 – Monitoring Network Assessment and Data Gaps: Evaluates network adequacy and outlines plans for addressing identified data gaps.
- Section 15.6 – Reporting to the Department: Summarizes procedures for data management and submittal to the Department of Water Resources (DWR) via the Kern Subbasin's Data Management System (DMS).

Together, these components ensure the Kern Subbasin GSAs' monitoring network is scientifically robust, transparent, and responsive to evolving groundwater management needs. In addition to documenting the RMN, Section 15 also outlines how the GSAs are evaluating and enhancing the monitoring network, particularly to improve understanding of localized shallow groundwater conditions and ensure the protection of vulnerable beneficial users. These efforts, described further in Section 15.5, include assessments to identify data gaps and guide potential additions to both the broader network and the RMN. While the existing RMN adequately characterizes general groundwater conditions in the Kern Subbasin, the Kern Subbasin GSAs are committed to continuous improvement to ensure comprehensive, equitable groundwater management across the Kern Subbasin.

15.1 Monitoring Network Objectives

§ 354.34. *Monitoring Network*

(a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.

(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

(1) Demonstrate progress toward achieving measurable objectives described in the Plan.

(2) Monitor impacts to the beneficial uses or users of groundwater.

(3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.

(4) Quantify annual changes in water budget components.

☑ **23 CCR § 354.34(a)**
☑ **23 CCR § 354.34(b)**

The monitoring network for the Kern Subbasin was designed to gather representative data pertinent to the four applicable sustainability indicators:

- Chronic Lowering of Groundwater Levels
- Reduction of Groundwater Storage, using groundwater levels as proxy
- Degraded Water Quality
- Land Subsidence

The evaluation of SMCs for the applicable sustainability indicators is accomplished through groundwater level, groundwater quality, and subsidence monitoring. The GSP Emergency Regulations require the establishment of a network of representative monitoring wells, an RMN, to depict groundwater occurrence, groundwater conditions, flow direction, and hydraulic gradients between principal aquifers and surface water features (GSP Reg. §354.32). The objectives of the monitoring program include:

- Enhancing understanding of groundwater occurrence and movement by monitoring local and regional groundwater levels, including seasonal and long-term trends, and identifying vertical hydraulic head differences in the aquifer system and aquifer-specific groundwater conditions, particularly in areas designated for short-term and long-term groundwater resource development.
- Evaluating progress towards the Kern Subbasin sustainability goal and measurable objectives outlined in the 2025 Plan.
- Assessing impacts to beneficial uses and users of groundwater.
- Collecting data to improve characterizations of groundwater conditions and assessing the availability and reliability of current and future water supplies, while revising analyses such as the groundwater model and water budget as additional data becomes available.
- Improving understanding of groundwater quality conditions throughout the Kern Subbasin by monitoring Constituents of Concern (COCs) to identify long-term trends and changes in groundwater quality.
- Generating data to refine estimates of groundwater basin conditions and evaluate local current and future water supply availability and reliability, updating analyses such as the groundwater model and water budget as additional data becomes available.
- Detecting and monitoring land subsidence caused by GSA activities to provide information to help mitigate potential infrastructure damage and land-use impacts.

- Supporting decision-making processes related to groundwater management, including the development and implementation of Projects and Management Actions (P/MAs).

15.2 Description of Monitoring Network

> ***§ 354.34.*** *Monitoring Network*
>
> *(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.*
>
> *(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.*
>
> *(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:*
>
> *(1) Amount of current and projected groundwater use.*
>
> *(2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.*
>
> *(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.*
>
> *(4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.*
>
> *(g) Each Plan shall describe the following information about the monitoring network:*
>
> *(1) Scientific rationale for the monitoring site selection process.*
>
> *(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.*
>
> *(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.*
>
> *(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.*

This subsection describes the RMN developed by the Kern Subbasin GSAs to comply with SGMA Regulations. The RMN is a targeted subset of the broader monitoring network described in Section 5.7. While the broader network includes additional monitoring efforts used to characterize basin conditions and support local management, the RMN includes only those sites selected for SGMA compliance and application of SMCs.

The RMN provides representative spatial and temporal coverage across the Kern Subbasin's five Hydrogeologic Conceptual Model (HCM) Areas. Sites were screened for data quality, accessibility, and completeness of construction and measurement records to ensure reliable use in Kern Subbasin evaluation. The following subsections describe

the structure, coverage, and rationale for the RMN in relation to each sustainability indicator, including site density considerations and adherence to regulatory standards.

Table 15-1 provides an overview of the number and type of representative monitoring sites (RMSs) corresponding to each sustainability indicator. More detailed tables, including measurement frequency and site locations, are provided within the individual subsections herein dedicated to each sustainability indicator.

Table 15-1. Summary of Representative Monitoring Sites

Sustainability Indicator	Type of Site	Number of Sites
Chronic Lowering of Groundwater Levels	Well	187
Reduction in Groundwater Storage	Well (water levels as a proxy)	187
Degraded Water Quality	Well	55
Land Subsidence	Extensometer GPS Benchmarks Survey Locations InSAR	123

Site Density in the Monitoring Network

Sites for all sustainability indicators within the RMN were strategically selected to ensure adequate spatial coverage across the Kern Subbasin, with measurement frequency sufficient to detect seasonal and long-term trends. Site density was influenced by the presence of beneficial users, with higher densities allocated in areas of intensive groundwater use or vulnerable populations.

For groundwater levels, site density reflects pumping intensity and aquifer conditions, with a higher concentration of wells in areas where agricultural, municipal, and domestic demands are greatest. For groundwater quality, sites were concentrated in areas with higher densities of domestic wells and small community systems. RMN sites and technologies for detecting and monitoring land subsidence provide Subbasin-wide coverage and are concentrated in areas where critical infrastructure are known to be vulnerable to vertical ground movement. For example, DWR InSAR provides routine complete coverage of the Kern Subbasin and is capable of accurately detecting vertical displacement on the order of 20 millimeters at 95 percent confidence (Towill 2024).

Further details regarding RMS distribution by indicator are provided in Sections 15.2.1 through 15.2.6.

Rationale for Site Selection

RMSs were selected based on geographic coverage across the Kern Subbasin, availability of historical records, accessibility for ongoing measurements, and alignment with aquifer characteristics. For groundwater levels, monitoring sites were selected to represent various depths and principal aquifers, with special consideration in the East Margin HCM Area where discrete aquifers are present (Section 7.5 and Section 15.2.1). Groundwater level representative monitoring wells were also distributed in proportion to

the spatial pattern of groundwater pumping across the Kern Subbasin to ensure monitoring reflects areas of active use and potential drawdown.

Groundwater quality sites were selected based on participation in existing monitoring programs, accessibility for sampling, and ability to reflect spatial and vertical variability in groundwater quality. Where feasible, sites were selected to monitor both groundwater levels and groundwater quality at the same location to enable Kern Subbasin GSAs to assess whether observed degradation in groundwater quality may be influenced by changes in groundwater levels. Also, as previously stated, sites were selected to ensure a higher density of monitoring wells in areas with vulnerable beneficial users.

Land subsidence monitoring sites were selected based on geology, a history of past subsidence, and/or their proximity to critical infrastructure, with consideration given to existing monitored sites for ease of data collection. All sites for sustainability indicators were chosen to protect beneficial users and to monitor current and future conditions within the Kern Subbasin.

Consistency with Data Reporting Standards

All RMSs were evaluated for consistency with SGMA data and reporting standards. Where deviations occur, the 2025 Plan explains why the site remains necessary to the RMN and how any variation does not compromise the value of the collected data.

Quantitative values for MOs, MTs, and IMs associated with RMSs are discussed in Section 13.

Adherence to Data Quality Objective (DQO) Process

The RMN was developed following the Data Quality Objective (DQO) process recommended by the Department of Water Resources (DWR) and U.S. EPA. Table 15-2 summarizes how the Kern Subbasin GSAs implemented the steps within this process.

Table 15-2. Summary of DQO Process Implementation

Steps	Implementation by the Kern Subbasin
1. State the problem – Define sustainability indicators and planning considerations of the GSP and sustainability goal.	Sustainability indicators and sustainability goal are defined in Sections 12 and 13.
2. Identify the goal – Describe the quantitative MOs and MTs for each sustainability indicators.	MOs and MTs for each sustainability indicator are described in Section 13.
3. Identify the inputs – Describe the data necessary to evaluate the sustainability indicators and other GSP requirements (i.e. water budget).	Data required for the evaluation of the sustainability indicators is described in Section 13.
4. Define the boundaries of the study- This is commonly the extent of the Bulletin 118 groundwater basin or subbasin, unless multiple GSPs are prepared for a given basin. In that case, evaluation of the coordination plan and specifically how the monitoring will be comparable and meet the sustainability goals for the entire basin.	The boundary of the study area is defined as the Kern Subbasin, as described in Section 6.

Steps	Implementation by the Kern Subbasin
5. Develop an analytical approach – Determine how the quantitative sustainability indicators will be evaluated (i.e. are special analytical methods required that have specific data needs).	The evaluation of sustainability indicators is described in Section 13.
6. Specify performance or acceptance criteria – Determine what quality the data must have to achieve the objective and provide some assurance that the analysis is accurate and reliable.	Protocols for data collection and monitoring are described in Section 15.3.
7. Develop a plan for obtaining data – Once the objectives are known determine how these data should be collected. Existing data sources should be used to the greatest extent possible.	Data collection procedures, timing, and frequency are described in Section 15.3.

15.2.1 Monitoring Network for Chronic Lowering of Groundwater Levels

> ***§ 354.34**. Monitoring Network*
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
> *(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:*
> *(A) A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.*
> *(B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.*

☑ 23 CCR § 354.34(c)(1)

The groundwater level monitoring network described in this section represents the RMN used to evaluate the Chronic Lowering of Groundwater Levels sustainability indicator (RMN-WL). Development of the RMN-WL aimed to fulfill the objectives presented in Section 15.1 and assess the Kern Subbasin's progress toward its sustainability goal.

Throughout the network's development, DWR Best Management Practices (BMPs) guided well density and distribution. Table 15-3 provides the recommend monitoring well density that was adopted from the California Statewide Groundwater Elevation Monitoring (CASGEM) guidelines (DWR, 2010 and 2016).

Table 15-3. Monitoring Well Density Considerations

Reference (Hopkins 1984)	Monitoring Well Density (wells per 100 square miles)
Basins pumping more than 10,000 acre-feet/year per 100 square miles	4.0
Basins pumping between 1,000 and 10,000 acre-feet/year per 100 square miles	2.0
Basins pumping between 250 and 1,000 acre-feet/year per 100 square miles	1.0
Basins pumping between 100 and 250 acre-feet/year per 100 square miles	0.7

To ascertain the necessary number of wells for the Kern Subbasin, the average total pumping from 1995 through 2022 was computed. The Hopkins methodology, outlined in Table 15-3, was employed to derive the minimum number of representative monitoring sites, using the following subbasin values:

- Average Total Pumping: 1,470,139 AFY
- Total Area: 2,785 square miles
- Calculated number of wells: 111

A total of 111 wells were calculated as a minimum for monitoring groundwater levels. Subsequently, following the determination of the appropriate number of monitoring wells for the Kern Subbasin through the Hopkins method, a hexagonal tessellation was generated over the Subbasin boundary as illustrated in Figure 15-1. This tessellation comprised 111 hexagons spanning 24 square miles each. Initially, a uniform approach was considered, assigning one monitoring well to each grid hexagon to ensure equal distribution across the Kern Subbasin.

However, this method failed to account for variations in pumping across the Kern Subbasin. To better align the monitoring network with pumping distribution, recommendations from Table 15-3 were adjusted to a 24 square mile scale, as shown in Table 15-4. Each pumping category (pumping per 24 square miles) was assigned a pumping group, as shown in Table 15-4.

Table 15-4. Scaled Monitoring Well Density

Pumping Group	Pumping per 24 square miles (AFY)	Wells per 24 square miles
1	0 - 25	0
2	25 – 62.5	0.175
3	62.5 - 250	0.25
4	250 - 2500	0.5
5	2500+	1.0

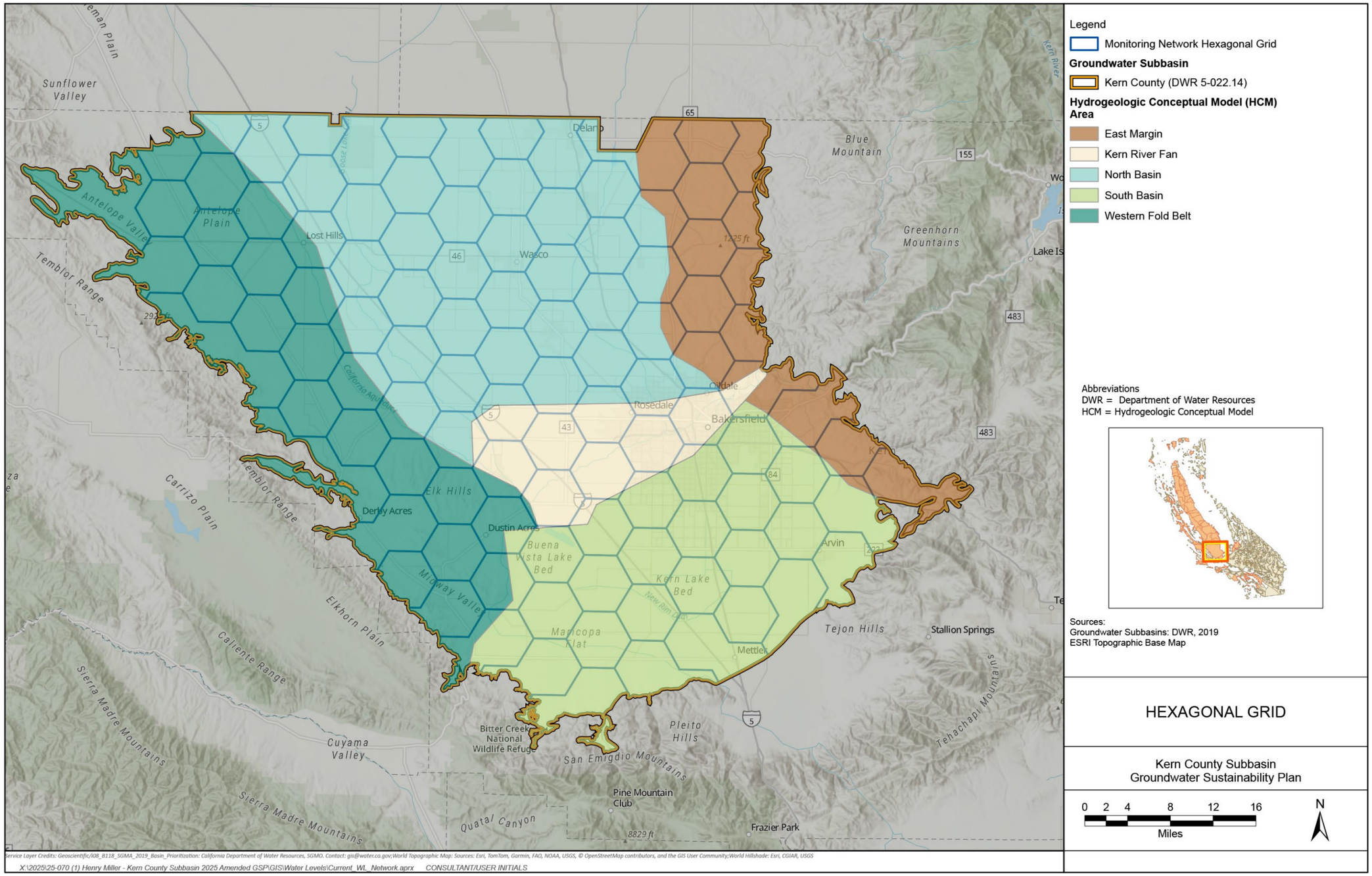


Figure 15-1. Hexagonal Grid

To apply the scaled monitoring densities to each grid hexagon, pumping distribution data from the groundwater model were analyzed across the Kern Subbasin. Figure 15-2 shows a heat map depicting the average (2016-2023) pumping distribution across the Kern Subbasin. This heat map was utilized to assign pumping values to each grid hexagon in Figure 15-1. As indicated on this heat map, minimal to no pumping was observed in the Western Fold Belt HCM Area. This observation is consistent with natural degraded water quality and Basin Plan de-designations in this HCM Area, limiting the ability to beneficially use groundwater (Table 15-5). Rather than extracting groundwater, water users import surface water and/or recovered banked surface water supplies into this HCM Area to meet demand. The Basin Setting (Section 6) provides additional background information on how Kern Subbasin boundaries, water quality, and other factors contribute to the lack of groundwater extraction within the Western Fold Belt HCM Area.

Table 15-5. Western Fold Belt HCM Area Groundwater Beneficial Exceptions[1]

Exception Area	Area Description[2]	Detailed Analysis Unit #
2	Groundwater and spring water within ½ mile radius of the McKittrick Waste Treatment (formerly Liquid Waste Management) site in Section 29, T30S, R22E, MDB&M, are not suitable or potentially suitable for municipal or domestic supply (MUN).	259
3	Ground water in the San Joaquin (Tulare), Etchegoin, and Jacalitos Formations within one-half mile of existing surface impoundments P-1, P-2, P-3, P-4, P-4 ½, P-5, P-6, P-7, P-8, P-9, P-10, P-11, P-12/12A, P-13, P-14, P-15, P-16, P-17, P-18, P-19, and P-20, and proposed surface impoundments P-21, P-24, P-25, P-27, P-28, and P-29 at the Kettleman Hills Facility (Sections 33 and 34, T22S, R18E, and Section 3, T23S, R18E, MDB&M) of Chemical Waste Management is not a municipal or domestic supply (MUN).	N/A

[1] Table adopted from Table 2-3 in Amendments to the Water Quality Control Plan for the Tulare Lake Basin, Third Edition, Revised May 2018. Link: https://www.waterboards.ca.gov/rwqcb5/water_issues/basin_plans/tularelakebp_201805.pdf
[2] In addition to the identified areas listed, on November 7, 2023, the State Water Resources Control Board approved Resolution 2023-0040 amending the Water Quality Control Plan for the Tulare Lake Basin to remove the municipal and domestic supply (MUN) and agricultural supply (AGR) beneficial uses from groundwater within a designated horizontal and vertical portion of the Southern Region of the Lost Hills Oilfield. Resolution 2023-0040 is pending final approval by the Office of Administrative Law.

Minimal pumping also occurs in most portions of the East Margin HCM Area. As described in Section 7.4.4, this HCM Area is impacted by geologic features impeding groundwater flow. Furthermore, the saturated thickness of the Primary Alluvial Principal Aquifer decreases toward the Sierra Nevada and Bakersfield Arch due to the aquifer bottom rising in this direction. This decrease in saturated thickness limits pumping, resulting in the majority of wells pumping from the Santa Margarita or Olcese Sands Principal Aquifer.

Pumping in the North Basin and South Basin HCM Areas is more extensive than in the Western Fold Belt and East Margin HCM Areas. Pumping in the North and South Basin HCM Areas occurs in the Primary Alluvial Principal Aquifer. Groundwater in both HCM Areas flows to areas of high groundwater pumping. In the North Basin HCM Area,

groundwater also flows to the north into the Tule and Tulare Lake Subbasins. In the Kern River Fan HCM Area, banking and recovery operations influence groundwater levels. Pumping in this area also occurs from the Primary Alluvial Principal Aquifer. A detailed discussion regarding groundwater flow and pumping is presented in Section 8. The pumping data also reflects the population map depicted in Figure 15-2. Higher levels of pumping tend to coincide with areas with higher population. In addition, the population map also depicts areas where domestic well users are absent and can be used to further refine the monitoring network.

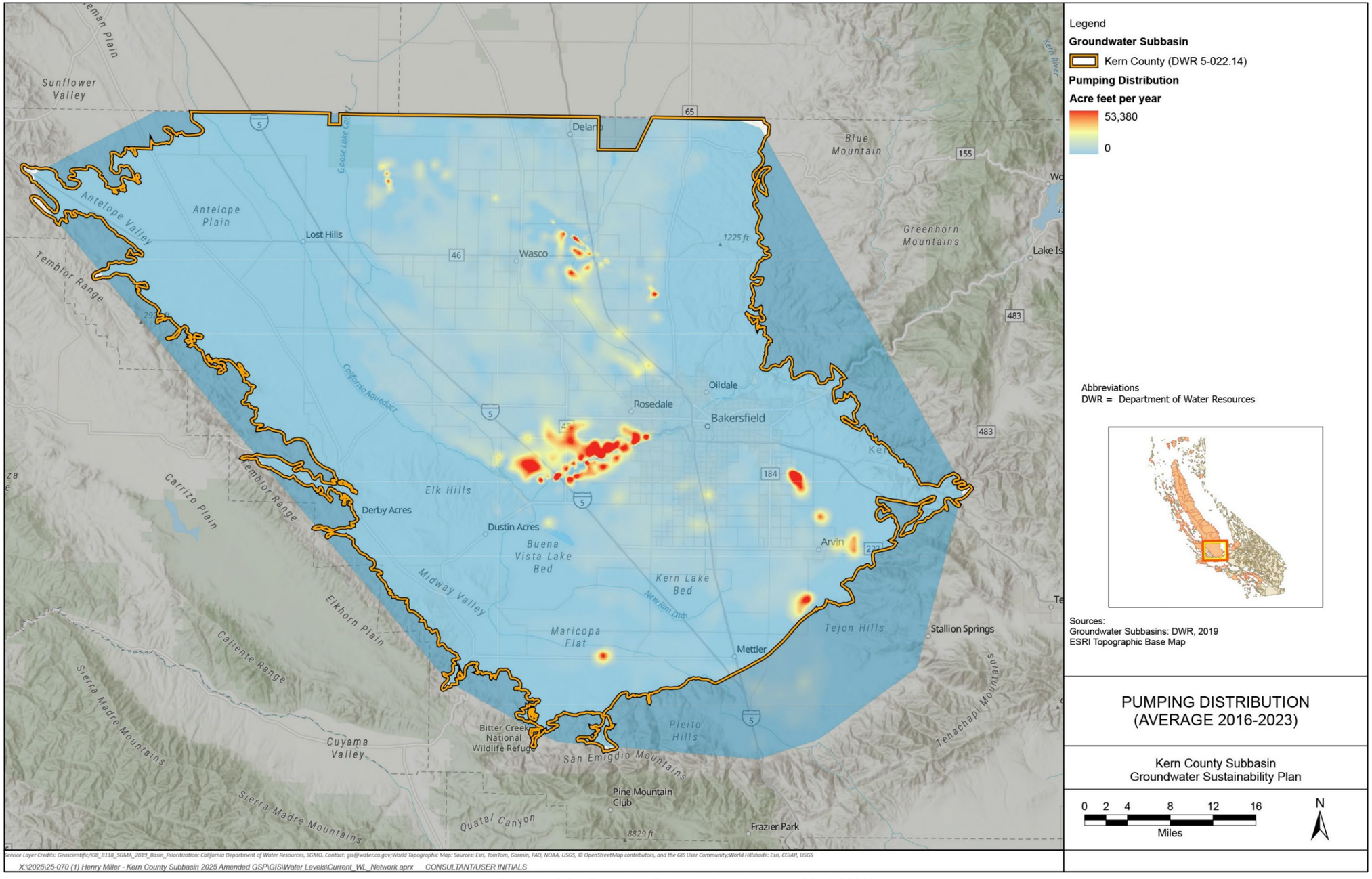


Figure 15-2. Pumping Distribution (Average 2016-2023)

Using Table 15-4, each grid hexagon was assigned to a pumping group based on the average pumping amount within the grid hexagon. The grid hexagons belonging to the same pumping groups were merged to generate a modified distribution grid as depicted in Figure 15-3. The previously calculated 111 wells were distributed across this new grid based on the area and amount of pumping for each pumping group. This distribution resulted in the Calculated Minimum Number of Wells column in Table 15-6.

Table 15-6. Distribution of Minimum Number of Wells Across Pumping Groups

Pumping Group	Well Density Category	Calculated Minimum Number of Wells
1	0	0
2	0.7	0.5
3	1	8
4	2	91
5	4	11

In addition to this analysis, the Kern Subbasin was analyzed to ensure monitoring of the three principal aquifers (the Primary Alluvial Principal Aquifer, Santa Margarita Principal Aquifer, and Olcese Sand Principal Aquifer) as described in Sections 6 through 8. Wells monitoring the Santa Margarita and Olcese Sand Principal Aquifers are primarily located in the East Margin HCM Area. As described in Section 7.5.1, the presence of the E-Clay is variable across the Kern Subbasin with areas where the E-Clay is either discontinuous or absent. Figure 15-4 shows the different distributions of the E-Clay. The E-Clay is well defined in the Shallow Confining Layer Area where the E-Clay is a thick continuous layer. In the remaining areas, the E-Clay is not well-defined, nor is it found everywhere, resulting in the primary aquifer system behaving as a single principal aquifer. For monitoring purposes, the Primary Alluvial Principal Aquifer is separated into an Upper and Lower zone in the Shallow Confining Layer Area only due to the aquifer being hydraulically connected in the remaining areas (see discussion in Section 7.5.1 for more information).

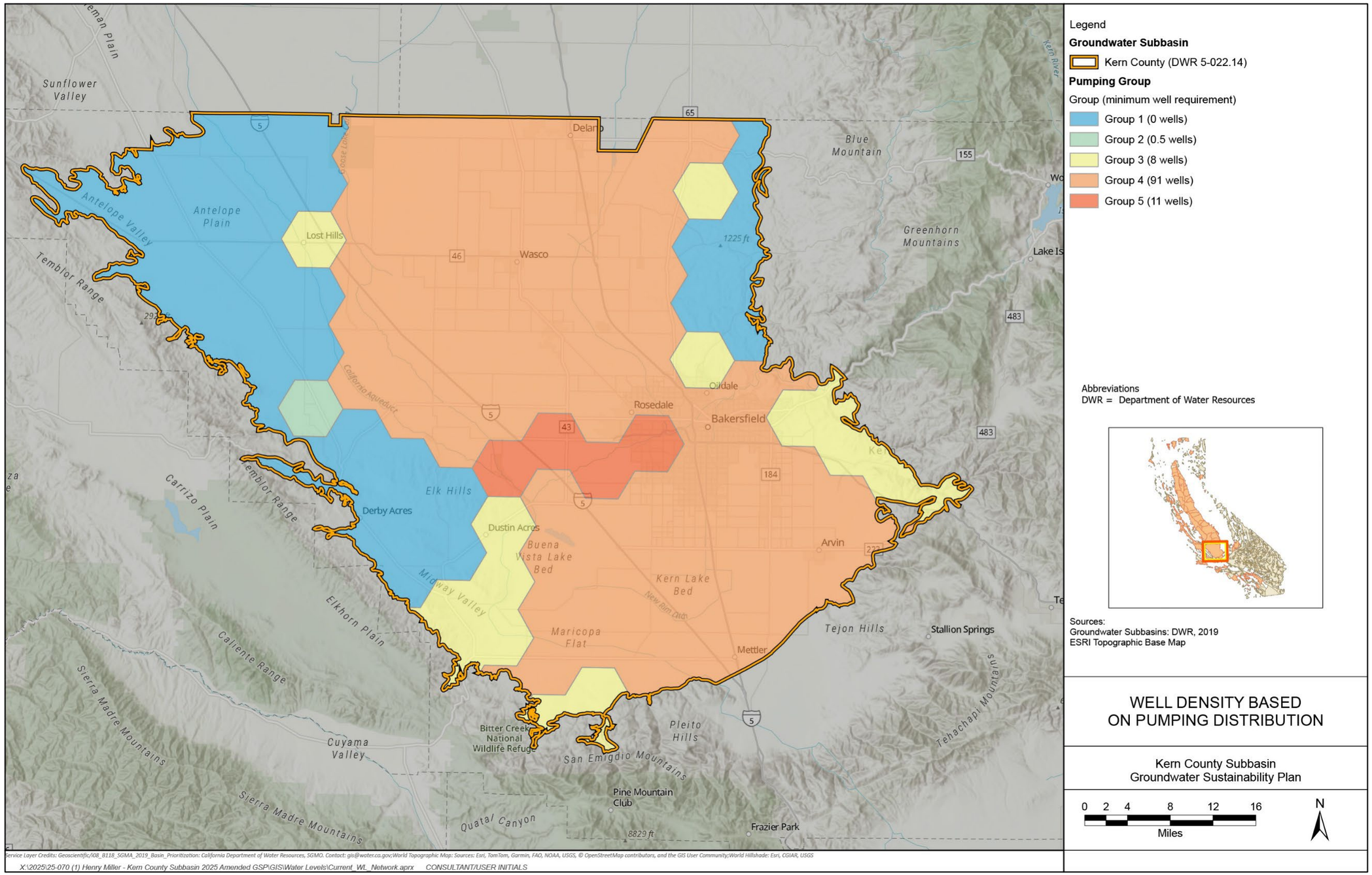
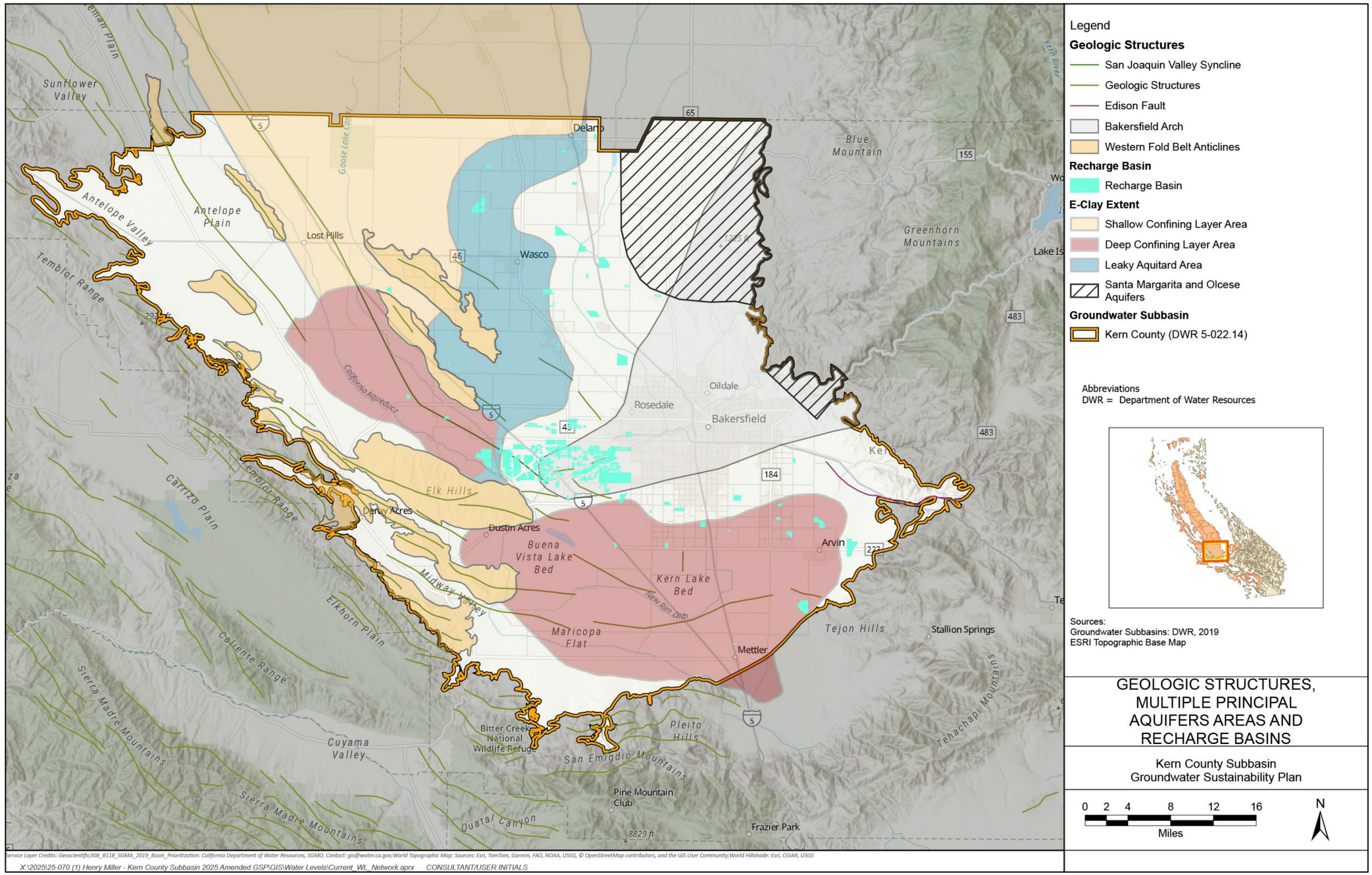


Figure 15-3. Well Density Based on Pumping Distribution



Service Layer Credits: Geoscientific/i08_B118_SGMA_2019_Basin_Prioritization: California Department of Water Resources, SGMO. Contact: gis@water.ca.gov;World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community;World Hillshade: Esri, CGIAR, USGS

X:\2025\25-070 (1) Henry Miller - Kern County Subbasin 2025 Amended GSP\GIS\Water Levels\Current_WL_Network.aprx CONSULTANT/USER INITIALS

Figure 15-4. Multiple Principal Aquifers Area and Recharge Basins

Monitoring wells were also selected near the boundary between the Western Fold Belt HCM Area and the North Basin HCM Area. Groundwater quality is naturally degraded in the Western Fold Belt HCM Area. The monitoring wells are strategically placed to monitor groundwater levels and quality in the transition between the Western Fold Belt HCM Area and the adjacent down-gradient North Basin HCM Area. Figure 15-5 shows the groundwater level monitoring RMN (RMN-WL) in relation to the geologic structures in the Kern Subbasin. The three wells monitoring the boundary between the Western Fold Belt HCM Area and the North Basin HCM Area are also highlighted as WDWA Sentinel Wells on Figure 15-5.

To account for beneficial users at varying vertical depths across the Kern Subbasin, RMS well perforations were compared with those of domestic and agricultural wells within each grid hexagon. This network assessment is further detailed in Section 15.5.

The monitoring network was also re-examined by GSAs and all routine monitoring network changes (due to lack of well access, well destruction, etc.) were also incorporated into the new monitoring network. The resulting monitoring network was subsequently evaluated against this grid to ensure an adequate number of wells for monitoring. The results of this evaluation are presented in Table 15-7.

Table 15-7. Comparison of Existing Network to Calculated Well Density

Pumping Group	Well Density Category	Calculated Minimum Number of Wells	Existing Number of Wells
1	0	0	6
2	0.7	0.5	0
3	1	8	5
4	2	91	159
5	4	11	17

Overall, the RMN-WL for the Kern Subbasin comprises 187 wells, as illustrated in Figure 15-6 and summarized in Table 1 of Appendix L-1 and Table 13-2. An assessment of the RMN-WL is provided in Section 15.5. This assessment includes a discussion of the discrepancy between the calculated minimum number of groundwater level representative monitoring wells (RMW-WLs) and existing number of RMW-WLs for pumping group 3.

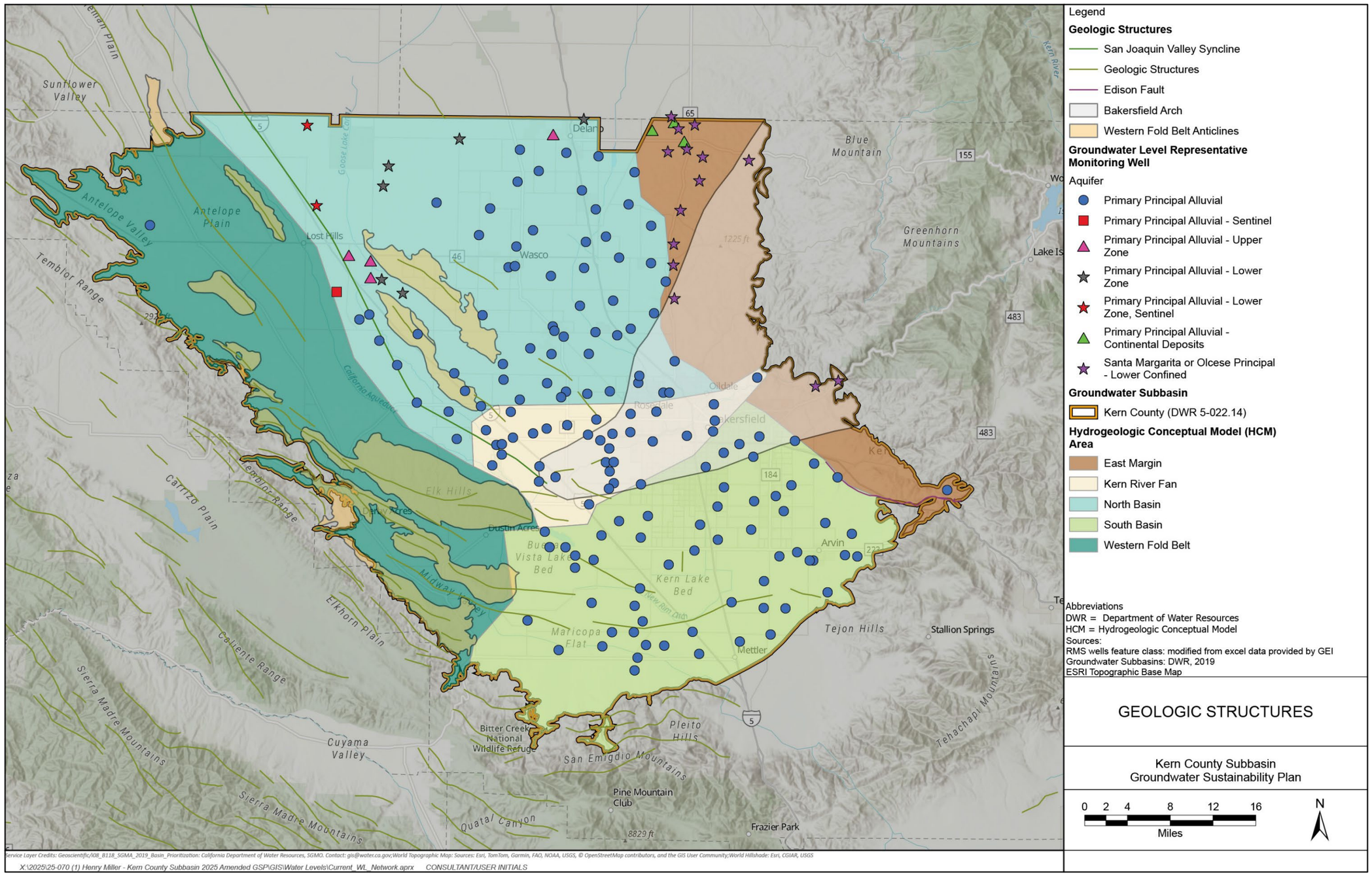


Figure 15-5. Geologic Structures

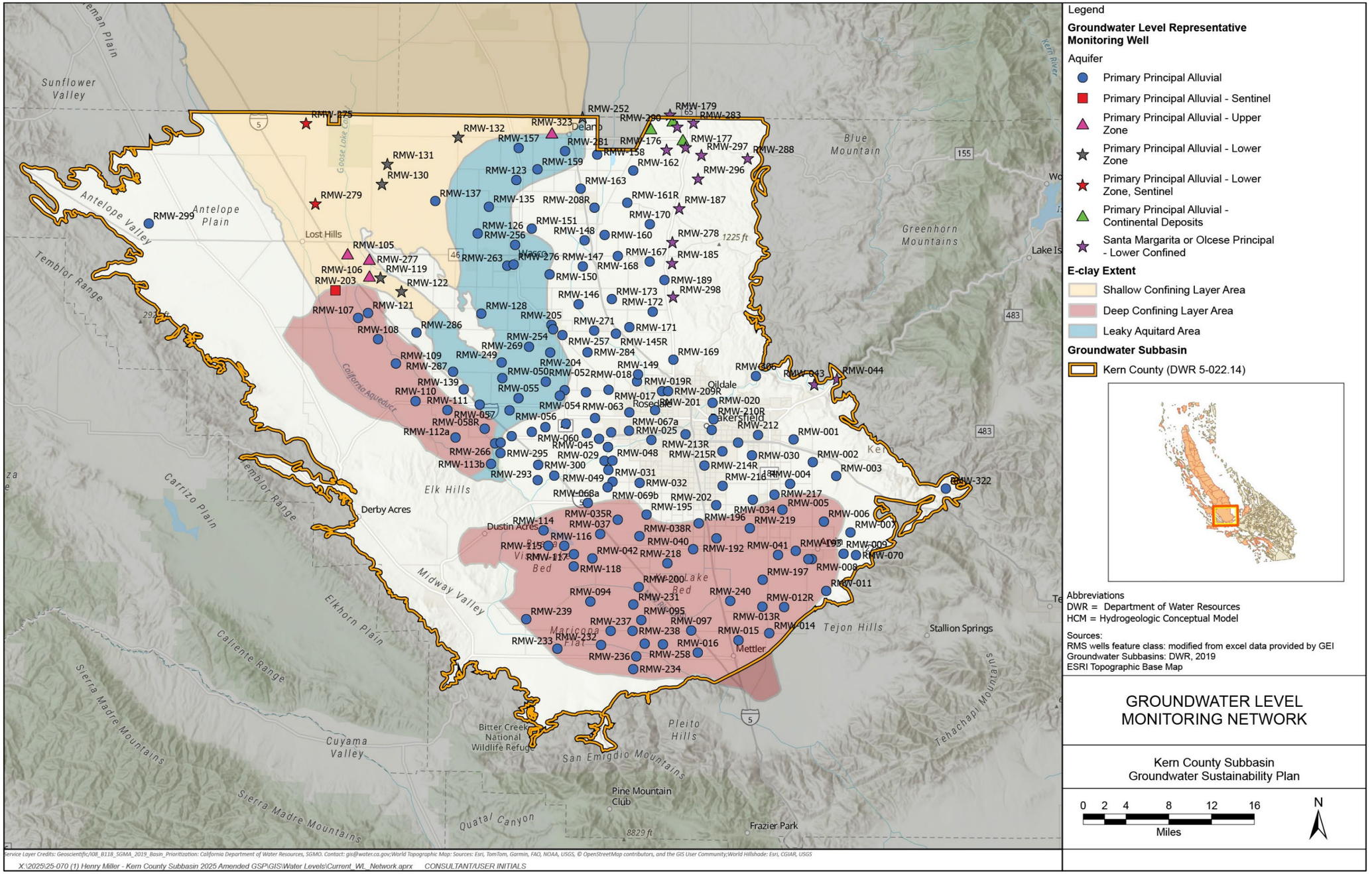


Figure 15-6. Groundwater Level Monitoring Network

15.2.2 Monitoring Network for Reduction in Groundwater Storage

> ***§ 354.34.*** *Monitoring Network*
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
> *(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.*

☑ **23 CCR § 354.34(c)(2)**
☑ **23 CCR § 354.36(b)(1)**
☑ **23 CCR § 354.36(b)(1)**

As detailed in Section 13.2, the amount of groundwater storage is directly related to groundwater levels, and the MTs for Chronic Lowering of Groundwater Levels are used as a proxy for the Reduction of Groundwater Storage. Consequently, the groundwater level RMN will be used as a proxy and serve as the monitoring network for the Reduction of Groundwater Storage sustainability indicator.

15.2.3 Monitoring Network for Seawater Intrusion

> ***§ 354.34.*** *Monitoring Network*
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
> *(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.*
>
> *(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.*

☑ **23 CCR § 354.34(c)(3)**
☑ **23 CCR § 354.34(J)**

As described in Section 13.4, this sustainability indicator is not applicable to the Kern Subbasin and thus no monitoring network has been established.

15.2.4 Monitoring Network for Degraded Water Quality

> ***§ 354.34.*** *Monitoring Network*
> *(a) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
> *(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.*

☑ 23 CCR § 354.34(c)(4)

As described in Section 8.4, current groundwater quality conditions within the Kern Subbasin were characterized following the State Water Resources Control Board's (SWRCB) methodology for high and medium priority subbasins. Sample results were downloaded from various databases to represent groundwater quality from domestic, irrigation, municipal and industrial, and other water supply well types. The applied methodology evaluates a list of constituents of concern then uses screening criteria to develop the Kern Subbasin's list of constituents to be monitored based on the prevalence of exceedances that occurred between 2010 and 2023. Monitoring wells representative of conditions across the Kern Subbasin were identified and selected for the assignment of SMCs and inclusion in the RMN.

In addition to characterizing groundwater quality, the well inventory was utilized to determine locations with high densities of domestic wells and small community water systems (Figure 15-7). A higher density of representative monitoring wells is identified in these regions to monitor groundwater quality and potential impacts on these beneficial users. A subset of the wells was also identified to monitor subsidence and the effects of P/MAs. For example, wells in the vicinity of recharge basins and in areas with mapped clay units and historical subsidence will be used to monitor the relationship between sustainability indicators (Figure 15-8).

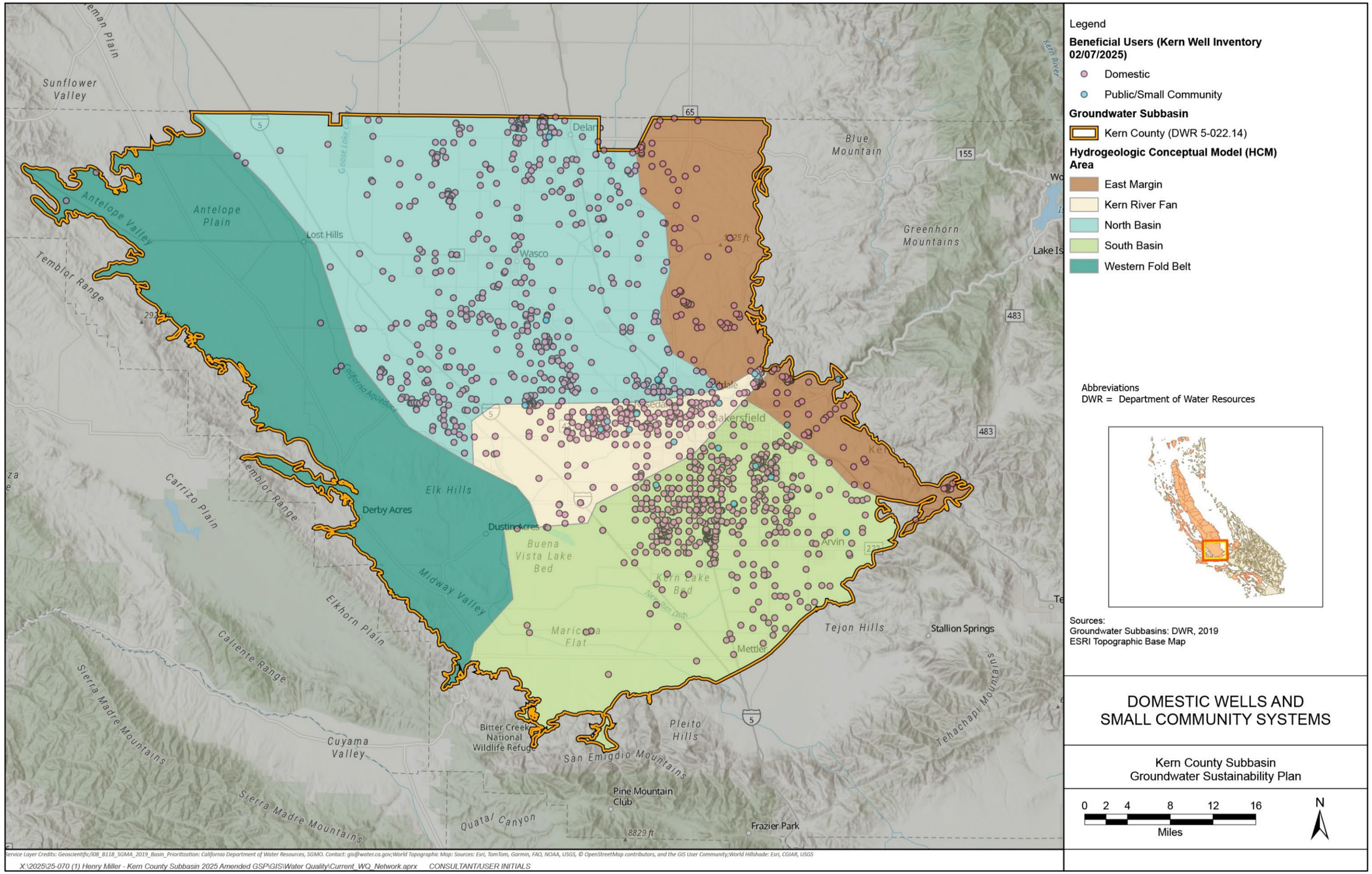


Figure 15-7. Domestic Wells and Small Community Systems

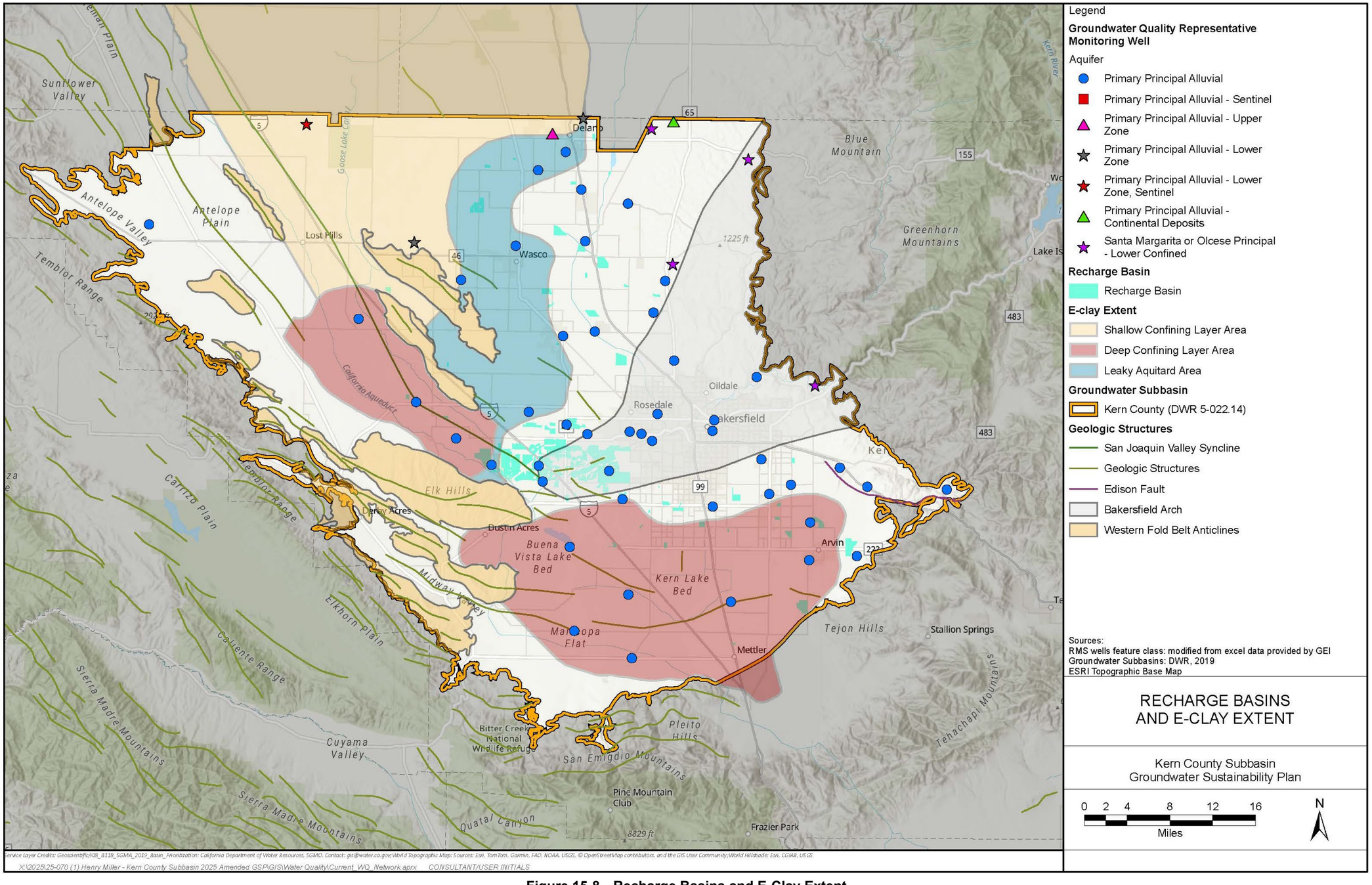


Figure 15-8. Recharge Basins and E-Clay Extent

Additional well location criteria include spatial distribution across the Kern Subbasin and representation of various land uses with at least one groundwater quality monitoring well in each GSA. In cases where a GSA spans more than one HCM Area, a monitoring well was identified for that GSA/Management Area in each HCM Area. A minimum of one well was also included for each HCM Area. An exception to the monitoring network criteria is applied to the Western Fold Belt HCM Area, due to minimal pumping, there are limited wells available to include in the monitoring network. This limitation in well availability is partly due to water quality issues (natural and anthropogenic) in this HCM Area as discussed in Sections 7.4.5 and 8.4. Several wells in the Western Fold Belt HCM Area in Figure 15-7 were found to be inactive after validation through the well inventory process. More information is provided about these wells in Section 5.6. One well near the northern boundary was identified, but all other production wells identified through the well inventory were verified to be inactive and/or unavailable for consistent sampling. Figure 15-9 also shows one ILRP well in the center of the Western Fold Belt HCM Area. This ILRP well is classified as a monitoring well and thus is not utilized to produce water.

During monitoring well selection, every effort was made to include monitoring wells from existing water quality regulatory programs such as the ILRP and public supply wells regulated by DDW.

The groundwater quality monitoring network consists of a total of 55 monitoring wells designated as RMWs. These wells are summarized in Table 1 of Appendix L-1 and Table 13-8 and illustrated on Figure 15-10. In addition to these monitoring wells, the Kern Subbasin will continue to evaluate data and water quality reports from ILRP and public supply monitoring programs (Figure 15-9). This data will help the GSAs comprehensively assess groundwater quality conditions across the Kern Subbasin.

To support ongoing network refinement and ensure protection of vulnerable beneficial users, the Kern Subbasin GSAs applied the same hexagonal grid framework used in the groundwater level RMN assessment to evaluate spatial representativeness for groundwater quality monitoring (Section 15.5.4.1). This analysis identified data gaps where additional RMWs are needed to improve Subbasin-wide coverage. The Kern Subbasin GSAs plan to address these gaps in accordance with the data gap filling implementation plan outlined in Section 15.5.7.

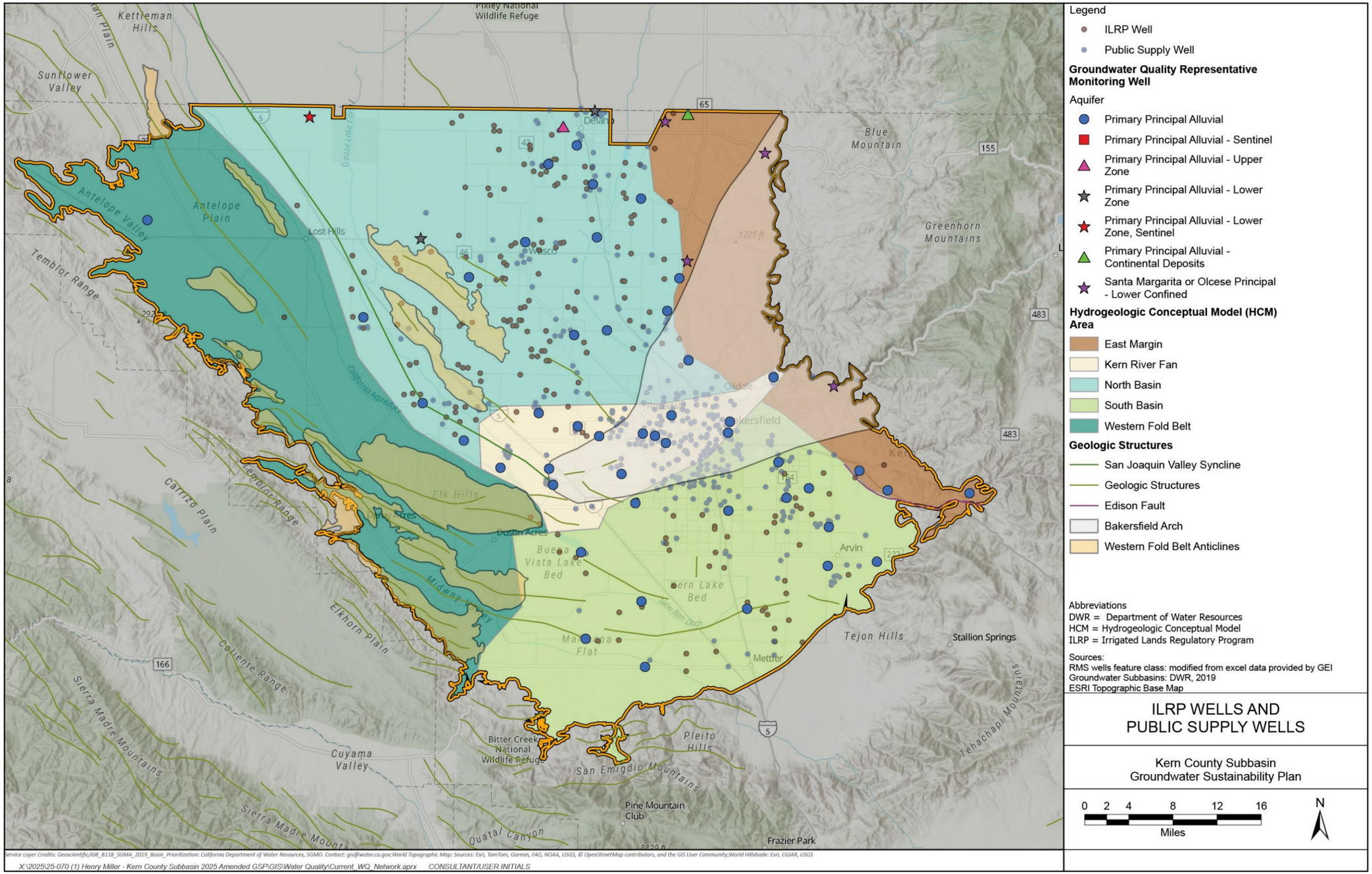


Figure 15-9. ILRP Wells and Public Supply Wells

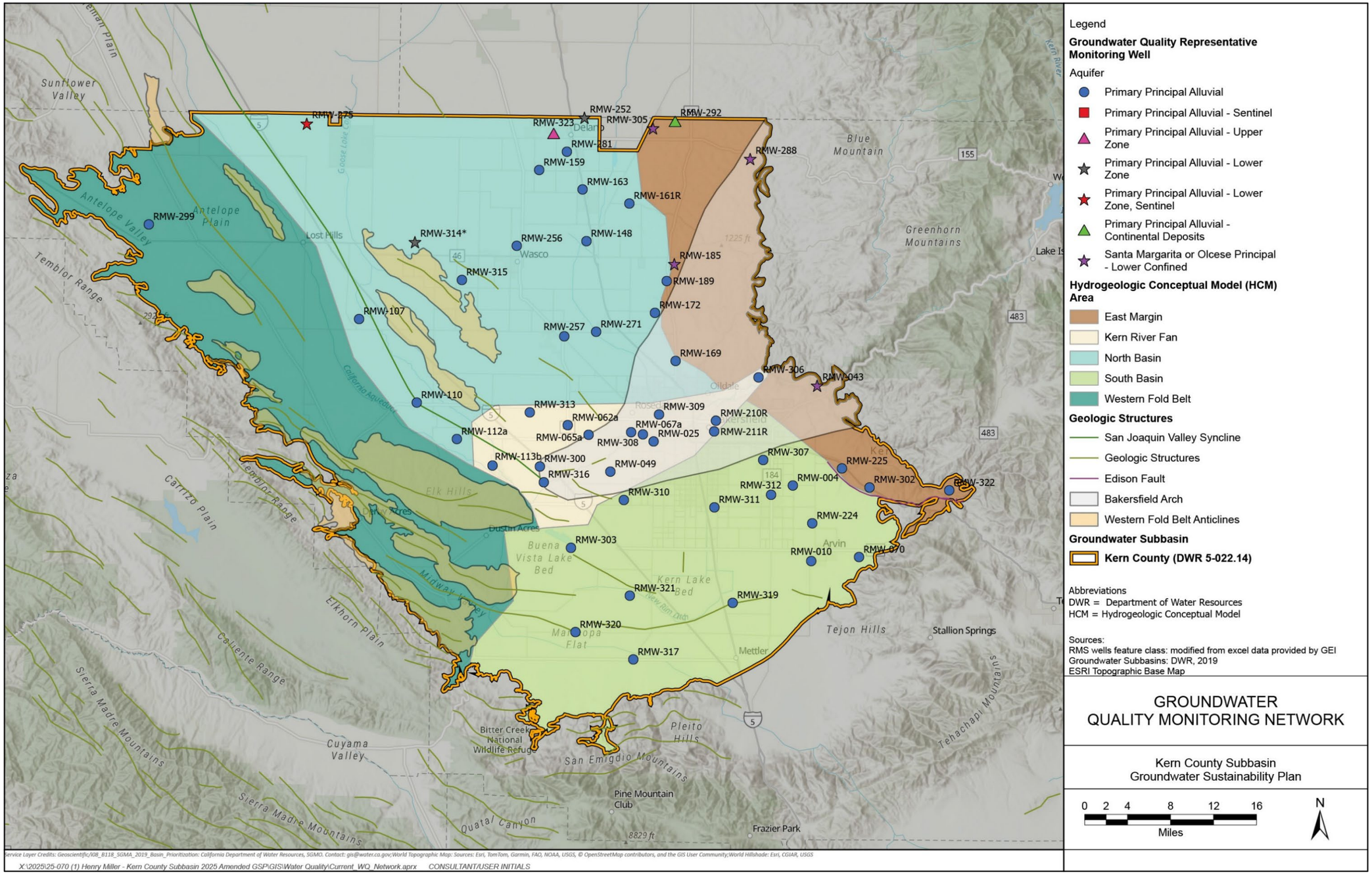


Figure 15-10. Groundwater Quality Monitoring Network

15.2.5 Monitoring Network for Land Subsidence

> ***§ 354.34.*** *Monitoring Network*
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
> *(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.*

☑ 23 CCR § 354.34(c)(5)

The monitoring network for land subsidence was devised to ensure sufficient monitoring coverage of critical infrastructure within the Kern Subbasin and to proactively anticipate future subsidence issues. Section 13.5 delineates the locations of identified critical infrastructure and corresponding SMC. Land subsidence monitoring network sites were chosen to monitor subsidence both in proximity to this critical infrastructure and across the Kern Subbasin.

Evaluation of the sustainability indicator for land subsidence entails monitoring land surface elevation via a network of subsidence monitoring programs in the Kern Subbasin. This spatially extensive monitoring network encompasses several data collection programs including:

- InSAR from DWR: The Kern Subbasin will continue acquiring InSAR data from DWR. InSAR routinely provides complete coverage of the Kern Subbasin and is capable accurately detecting vertical displacement on the order of 20 millimeters at 95 percent confidence (Towill 2024).. InSAR data will undergo verification through comparisons with various benchmarks and GPS stations. Additionally, it will be used to prepare various subsidence time series to identify rates and extent of subsidence and assess potential causes.
- Survey Benchmarks: Along with the 21 survey sites collected by NKWSD, 36 other benchmark locations in NOAA's NGS database have been identified (15 of which have been recently surveyed) adjacent to and surrounding the Friant-Kern Canal. The Arvin Edison Water Storage District monitors five survey locations along its canal.
- CASP: The California Aqueduct Subsidence Program (CASP) surveyed milepost benchmark data and new extensometer data along the Aqueduct will be utilized to ground-truth InSAR data annually. CASP also plans to install additional monitoring wells and extensometers along the Aqueduct between 2023 and 2025. The Kern Subbasin will work to incorporate these new sites into the monitoring network. The Kern Subbasin GSAs will request the updated surveyed benchmark data from CASP annually. CASP recently installed a set of nested monitoring wells near milepost 198 and data is expected from these wells in the near future.

- Extensometers: The USGS gathers subsidence data from two historical extensometer locations in the Kern Subbasin, with an additional extensometer recently completed adjacent to the Friant-Kern Canal at Kimberlina Road. DWR also monitors subsidence at an extensometer located at well T30S/R25E-16L MDB&M within the Kern Water Bank.
- Continuous GPS: In the Kern Subbasin, UNAVCO maintains continuous GPS subsidence data for distributed GPS subsidence stations, DWR maintains three, and Caltrans maintains two. SOPAC archives data from all five stations and provides processed products.

InSAR data coverage for the Kern Subbasin is discussed in Section 8 and depicted on multiple figures, including Figure 8-58. The individual subsidence monitoring sites are summarized in Table 2 of Appendix L-1 and Section 13.5. Figure 15-11 illustrates the subsidence monitoring network, which is comprised of the RMN for land subsidence and the broader subsidence monitoring network, or supporting sites, as described above. The three RMWs included in Table 1 of Appendix L-1 with subsidence listed as a sustainability indicator are not part of the RMN for subsidence and do not have associated SMCs. They are monitored as part of the subsidence supporting monitoring network.

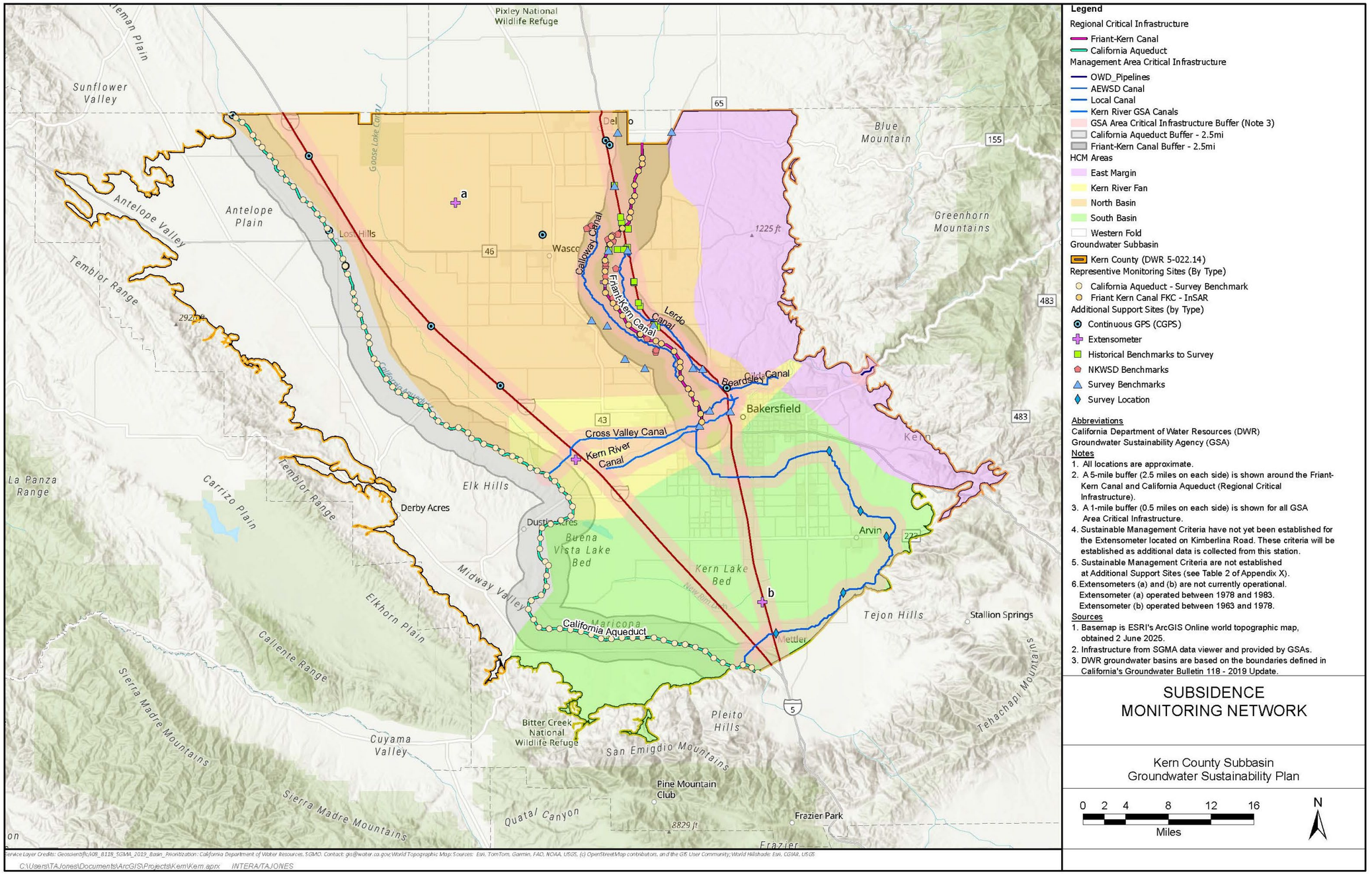


Figure 15-11. Subsidence Monitoring Network

15.2.6 Monitoring Network for Depletions of Interconnected Surface Water

§ 354.34. *Monitoring Network*

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:

(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.

(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.

(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.

(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

☑ 23 CCR § 354.34(c)(6)
☑ 23 CCR § 354.34(j)

As detailed in Section 8.6, there are no identified interconnected surface water or groundwater dependent ecosystems in the Kern Subbasin. If needed, the Kern Subbasin may reevaluate the necessity for a Subbasin-wide ISW monitoring network in future periodic evaluations.

15.3 Monitoring Protocols for Data Collection and Monitoring

§ 352.2. *Monitoring Protocols*

Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

§ 354.34. *Monitoring Network*

(i) The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

☑ 23 CCR § 352.2
☑ 23 CCR § 354.34(i)

The monitoring protocols outlined for all sustainability indicators were formulated to reflect the guidance in the *Best Management Practices for the Sustainable Management of Groundwater: Monitoring Protocols, Standards, and Sites* document drafted by DWR (2016). These protocols are designed to facilitate accurate data collection necessary for monitoring the minimum thresholds and measurable objectives associated with each sustainability indicator. The following protocols apply to all monitoring sites:

- Long-term access agreements should incorporate year-round site access to accommodate increased monitoring frequency.
- Every site must have a unique identifier consisting of a comprehensive written description detailing the site's location, date of establishment, access instructions, point of contact (if applicable), type of information to be collected, latitude, longitude, and elevation. Furthermore, each monitoring location should maintain a modification log to record all changes made to the site.

GSAs are currently working to establish access agreements with landowners for monitoring wells that were added to the groundwater quality and groundwater level monitoring networks. Consequently, some well locations may change after adoption of the 2025 Plan.

15.3.1 Protocols for Groundwater Level Measurements

Groundwater level data will be collected, at minimum, on a semi-annual basis across the Kern Subbasin. This frequency of measurement will allow the Kern Subbasin GSAs to account for seasonal high and low water levels. The data collected will be used to generate potentiometric surfaces across the Kern Subbasin. The collected data will also be compared against the measurable objectives and interim milestones to document the Kern Subbasin GSAs' progress toward reaching its sustainability goal. The data collected will also be entered into the DMS and included in the Annual Reports.

Groundwater levels should be collected during the following time frames for consistency across the Kern Subbasin:

- January to March
- August to November

Additional protocols applicable to groundwater level measurements are described in Appendix M-1.

15.3.2 Protocols for Reduction in Groundwater Storage

As the groundwater level monitoring network also serves as proxy to monitor reductions in groundwater storage, the protocols for reducing groundwater storage align with those outlined for chronic lowering of groundwater levels. The procedure for utilizing groundwater level data to determine change in storage is provided in the Kern Subbasin's Standard Operating Procedures (Appendix M-1) and discussed in Section 8.2.

15.3.3 Protocols for Water Quality Sampling

Water quality samples will be collected to represent groundwater conditions across the Kern Subbasin. Sample results will be compared against baseline conditions presented in Section 8.4 of the 2025 Plan and used to assess the effects of SGMA implementation. To correlate groundwater levels with water quality, sampling schedules will be coordinated with groundwater level measurements. GSAs will sample each RMW-WQ for the full set of identified constituents and submit the results to a Subbasin-wide DMS, which will also be uploaded to the SGMA Portal. Additionally, an assessment of groundwater conditions that compares current results against baseline conditions will be provided in each Annual Report to DWR. Detailed protocols for water quality sampling, including field procedures and laboratory methods, are included as Appendix M-2. Water quality sampling procedures are consistent with the USGS National Field Manual for the Collection of Water Quality Data (USGS 2019). Key points of the water quality Standard Operating Procedure (SOP) include:

- Sampling should be conducted within a two-week timeframe of water level measurements.
    - If samples are collected from a production well (agricultural or municipal), they should only be collected when the well is actively pumping to ensure the samples are representative of aquifer conditions. In order to determine when the well is sufficiently purged and representative of the aquifer, the sampler will monitor temperature, pH, specific conductance, and turbidity. Laboratory samples will only be collected when the field tests are stable.
    - In the Kern Subbasin, many production wells are not operated during wet or above normal water years. In this situation, samples will not be collected from the wells that are inactive (no active power supply).
    - The Water Quality Sampling SOP provides guidance for collecting representative samples from agricultural, municipal, and dedicated monitoring wells.

- Field log sheets and other documentation of well operation during the sampling period will be maintained. In the instance that representative samples cannot be collected, an explanation will be provided in the Annual Report to DWR.

- Constituents of concern are detailed in Section 8.4, with SMCs in Sections 11 through 13.

15.3.4 Protocols for Land Subsidence Measurements

Land subsidence measurements will adhere to protocols set by respective agencies overseeing data collection. The Kern Subbasin will download data for all sites within the monitoring network at the following frequencies:

- InSAR data will be acquired on a quarterly basis.
- Benchmark survey data along the California Aqueduct and Friant Kern Canal will be acquired from CASP and Friant Water Authority on a yearly basis.
- GPS, extensometer, and subsidence monitor well data will be acquired quarterly in support of the InSAR data.

15.4 Representative Monitoring

> ***§ 354.36.*** *Representative Monitoring*
> *Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:*
> *(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.*
> *(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:*
> *(1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.*
> *(2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.*
> *(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.*

☑ 23 CCR § 354.36

15.4.1 Designated Representative Monitoring Sites

☑ 23 CCR § 354.36(a)

As described in Section 15.2.1, the RMN-WL consists of 187 RMW-WLs. 185 of the 187 monitoring sites identified for the groundwater level monitoring network have SMCs assigned that are representative of Kern Subbasin conditions. The groundwater level monitoring network consists of two monitoring wells without SMCs. Additional water level data is needed before SMCs can be established at these monitoring wells.

Groundwater quality monitoring sites were selected to represent groundwater quality conditions throughout the Kern Subbasin. As described in Section 15.2.4, SMCs were set at 55 wells. These wells were chosen based on existing groundwater quality conditions and locations of vulnerable users.

In addition, all representative monitoring sites identified for land subsidence have established SMCs. These sites represent areas vulnerable to subsidence and are in the vicinity of critical infrastructure.

15.5 Assessment and Improvement of Monitoring Network

> ***§ 354.38.*** *Assessment and Improvement of Monitoring Network*
>
> *(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.*
>
> *(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.*
>
> *(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:*
>
> *(1) The location and reason for data gaps in the monitoring network.*
>
> *(2) Local issues and circumstances that limit or prevent monitoring.*
>
> *(d) Each Agency shall describe steps that will be taken to fill data gaps before the next five- year assessment, including the location and purpose of newly added or installed monitoring sites.*
>
> *(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:*
>
> *(1) Minimum threshold exceedances.*
>
> *(2) Highly variable spatial or temporal conditions.*
>
> *(3) Adverse impacts to beneficial uses and users of groundwater.*
>
> *(4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.*

☑ 23 CCR § 354.38

A thorough evaluation of the diverse RMN outlined above was conducted to confirm that the objectives of the monitoring network (Section 15.1) were being met and that sufficient temporal and spatial data could be obtained to assess SMCs. Evaluations for each of the sustainability indicator monitoring networks are provided below.

15.5.1 Groundwater Levels Representative Monitoring Network Evaluation

As explained in Section 15.2.1, the BMPs provided by DWR were utilized to determine the appropriate well density for the Kern Subbasin. The current monitoring network surpasses the minimum recommended number of monitoring wells. Consequently, this network offers adequate spatial and temporal coverage to capture groundwater level

trends. Moreover, the network addresses vertical variability by monitoring multiple aquifers in the East Margin HCM Area. However, 17 RMW-WLs currently lack complete construction information. GSAs will continue efforts to address this data gap by striving to collect construction information for these monitoring wells.

The analysis used to determine the number of RMW-WLs and their locations is based on pumping data from the C2VSim-FG Kern model. GSAs are attempting to gather more information on groundwater extraction through the metering of wells. More information about well metering is provided in Section 16. In addition to utilizing existing models, the Kern Subbasin GSAs are in the process of developing an updated model that upon completion, will be utilized to reassess the pumping distribution and corresponding distribution of wells across the Kern Subbasin. Data gaps in the monitoring network for pumping group 3, as presented in Table 15-5, will be reassessed at that time in conjunction with updated pumping distribution values.

Currently, the Western Fold Belt HCM Area and parts of the East Margin HCM Area have few monitoring wells. As described in Section 15.2.1, minimal pumping occurs in the Western Fold Belt HCM Area and parts of the East Margin HCM Area. However, the Kern Subbasin has taken steps to ensure both HCM Areas are monitored adequately. Specifically, the monitoring network includes 19 monitoring wells within the East Margin HCM Area to monitor the areas where pumping does occur. Two new representative monitoring wells were identified to represent Non-districted Lands within the East Margin HCM Area. RMW-306 represents small community water systems that border the East Margin and Kern River Fan HCM Areas. RMW-322, in the Caliente area (southernmost region of the East Margin), represents a small, groundwater-dependent community.

- In the Western Fold Belt HCM Area, the Kern Subbasin will ensure that any future development of water and water movement due to existing gradients is monitored. As described in Section 15.2.1, three sentinel wells exist in areas of groundwater flow from the Western Fold Belt HCM Area into the adjacent down gradient North Basin HCM Area. These wells will monitor for transitions in groundwater level and quality. Furthermore, any new wells drilled in the Westside District Water Authority will be required to register with the GSA and, if located within a data gap area, are also required to participate in the monitoring program (Appendix J - WDWA P/MA Table). However, if the new well is within one mile from an existing monitoring well, the new well will not be required to participate in the monitoring program. This process will ensure that the monitoring network evolves to track changes in water use in this HCM Area.

15.5.1.1 Groundwater Levels Representative Monitoring Network Assessment

The groundwater level network was assessed to ensure adequate vertical distribution of wells. This assessment was conducted to identify data gaps for both domestic and agricultural wells. To conduct the assessment the following datasets were utilized:

- Well Inventory: Complete Kern Subbasin Well Inventory as of February 26, 2025.
- Kern WL DMS: Monitoring well data and data from destroyed wells were filtered and excluded.
- RMW-WL Data: Complete groundwater level RMN as of February 6, 2025.

Any subsequent reference to these datasets implies the filters and exclusions listed above have been applied. These datasets were then used to conduct a grid hexagon-by-grid hexagon (Figure 15-1) analysis to determine data gaps for domestic well beneficial users and agricultural well beneficial users.

To identify data gaps, the Kern Subbasin developed and applied identical procedures for both domestic and agricultural wells. The methodology for identifying monitoring network data gaps is outlined in Figure 15-12 and includes the following key steps:

- Initial Well Count Screen: Each hexagon was first evaluated based on the well density using the Kern Subbasin Well Inventory. Hexagons containing three or fewer domestic wells *and* ten or fewer agricultural wells were designated as having no data gap and excluded from further evaluation.
- Within-Hexagon Vertical Representation Evaluation:
    - For hexagons that pass the initial screen, the median screen interval of the RMW-WL(s) was evaluated to determine whether it intercepts the interquartile range of bottom perforations for domestic and agricultural wells in the same hexagon.
    - A qualitative comparison of groundwater levels and trends was conducted between the RMW-WL(s) and other wells in the hexagon. This evaluation relied upon professional judgment and accounted for the presence of significant, laterally extensive clay layers within the Primary Alluvial Principal Aquifer.
    - If both the screen interval alignment and groundwater level similarity criteria were met, the hexagon was designated as no data gap.
- Adjacent-Hexagon Vertical Representation Evaluation:
    - For hexagons that fail the primary within-hexagon evaluation, the same two criteria (screen interval alignment and groundwater level similarity) were re-evaluated using RMW-WL(s) from adjacent hexagons.
    - If both criteria were satisfied using adjacent RMW-WL(s) data, the hexagon was designated as no data gap.
- Data Gap Designation: Hexagons that failed both the within-hexagon and adjacent-hexagon evaluations were designated as data gaps and flagged for additional monitoring.

This methodology for identifying RMN-WL data gaps was refined through a collaborative, iterative process involving internal technical review and consultation with SWRCB Staff. The process began with an initial analysis applying the above criteria to all hexagons. Preliminary results – identifying hexagons with confirmed or potential data gaps – were submitted to SWRCB Staff for review.

SWRCB Staff then conducted an independent analysis using the same datasets along with some additional datasets and criteria unique to their internal review process. Upon completion of their review, SWRCB Staff provided feedback on the Kern Subbasin's preliminary results and identified additional hexagons they believed to be potential data gaps.

In response, the Kern Subbasin conducted a secondary review of the hexagons flagged by SWRCB Staff. This included a detailed reassessment of well construction alignment and groundwater-level trends with a focus on whether shallow domestic wells, completed above competent clay layers, are adequately represented by the monitoring network.

The Kern Subbasin discussed the results of the secondary review with SWRCB Staff and collaboratively finalized the data gap designations. The joint conclusion identified additional monitoring is needed to improve representation of some domestic well users, while agricultural wells were determined to be adequately represented by the existing monitoring network. As a result of this evaluation:

- Three hexagons were designated as confirmed data gaps for some domestic beneficial users (Figure 15-13). One well is being proposed to address these three data gaps. The Kern Subbasin will incorporate this new monitoring well into the RMN-WL and establish SMCs for this well once adequate data is collected.
- Seven hexagons were identified as potential data gaps requiring further evaluation to assess localized shallow groundwater conditions (Figure 15-14). These hexagons reflect areas where SWRCB Staff expressed concern that laterally extensive clay layers may act as barriers separating shallow and deeper groundwater zones, potentially limiting the ability of existing RMW-WLs to represent localized shallow groundwater conditions for some domestic wells. The Kern Subbasin defines the Primary Alluvial Principal Aquifer as a single, hydraulically connected aquifer system. Within this aquifer, laterally variable clay layers – such as the Shallow Confining Layer Area, Deep Confining Layer Area, and Leaky Aquitard Area – can influence groundwater levels locally but do not create widespread vertical disconnection. To evaluate these localized shallow groundwater conditions, the Kern Subbasin will implement supplementary shallow groundwater monitoring in the seven hexagons identified as potential data gaps. Over a two-year period, water levels will be monitored using existing or new shallow wells (outside the current RMN). If monitoring indicates the existing RMW-WLs do not adequately represent localized shallow groundwater

conditions, the Kern Subbasin will designate the hexagons as confirmed data gaps and will recommend adding new RMW-WLs to the RMN and establish appropriate SMCs.

- An additional 35 hexagons were not designated as data gaps because they did not have more than three domestic wells and more than 10 agricultural wells. Per the February 26, 2025 Kern Well Inventory, there are a total of 11 domestic wells and 35 agricultural wells in these 35 hexagons, which is 0.5 percent and 0.8 percent of the total domestic and agricultural wells in the Kern Subbasin respectively. These 35 hexagons account for two drinking water wells susceptible to going dry if all RMW-WLs reach their MTs, which is less than the UR definition threshold.

The groundwater level monitoring network data gap analysis identified a total of three RMN-WL data gap grid hexagons and seven potential RMN-WL data gap grid hexagons (primarily for localized shallow groundwater conditions). The results of this analysis are summarized in Table 1 of Appendix L-2. Based on the current Kern Subbasin Well Inventory, the Kern Subbasin GSAs anticipate adding one additional RMW-WL to address the three data gaps and up to seven shallow supplementary monitoring wells to address the seven potential data gaps for localized shallow groundwater conditions. Some of the additional monitoring wells will be used to address the SWRCB Staff's concerns regarding potential data gaps in three additional adjacent grid hexagons. The Kern Subbasin GSAs propose to address the data gaps and potential data gaps with existing wells by the end of calendar year 2025 or with new wells by the end of calendar year 2026. This action item has been included as a Subbasin-wide P/MA KSB-10 in Section 14. See Section 15.5.7 below for data gap filing implementation plan details.

As previously mentioned, the Kern Subbasin GSAs are also actively working to obtain construction data for RMW-WLs currently without construction information. There are seven RMW-WLs with no well construction information and ten RMW-WLs with partial well construction information. Establishing complete well construction information, along with improving the Kern Subbasin Well Inventory, will help further refine the data gap analysis for the groundwater level monitoring network. This additional data will be used to assess the network during the development of Annual Reports to DWR and updates on the assessment and addressing of data gaps will be included in these reports.

Furthermore, the monitoring network will also undergo continuous evaluation during Annual Reports to DWR to ensure accessibility of all monitoring sites and facilitate data collection. The network will be appraised for its capacity to provide sufficient information to detect temporal and spatial trends in groundwater levels. Based on these assessments, monitoring sites may be adjusted to ensure the monitoring network remains aligned with its objectives as stated in Section 15.1. Additionally, as part of their P/MAs, several Kern Subbasin GSAs are attempting to identify additional monitoring locations that can be added to the existing monitoring network.

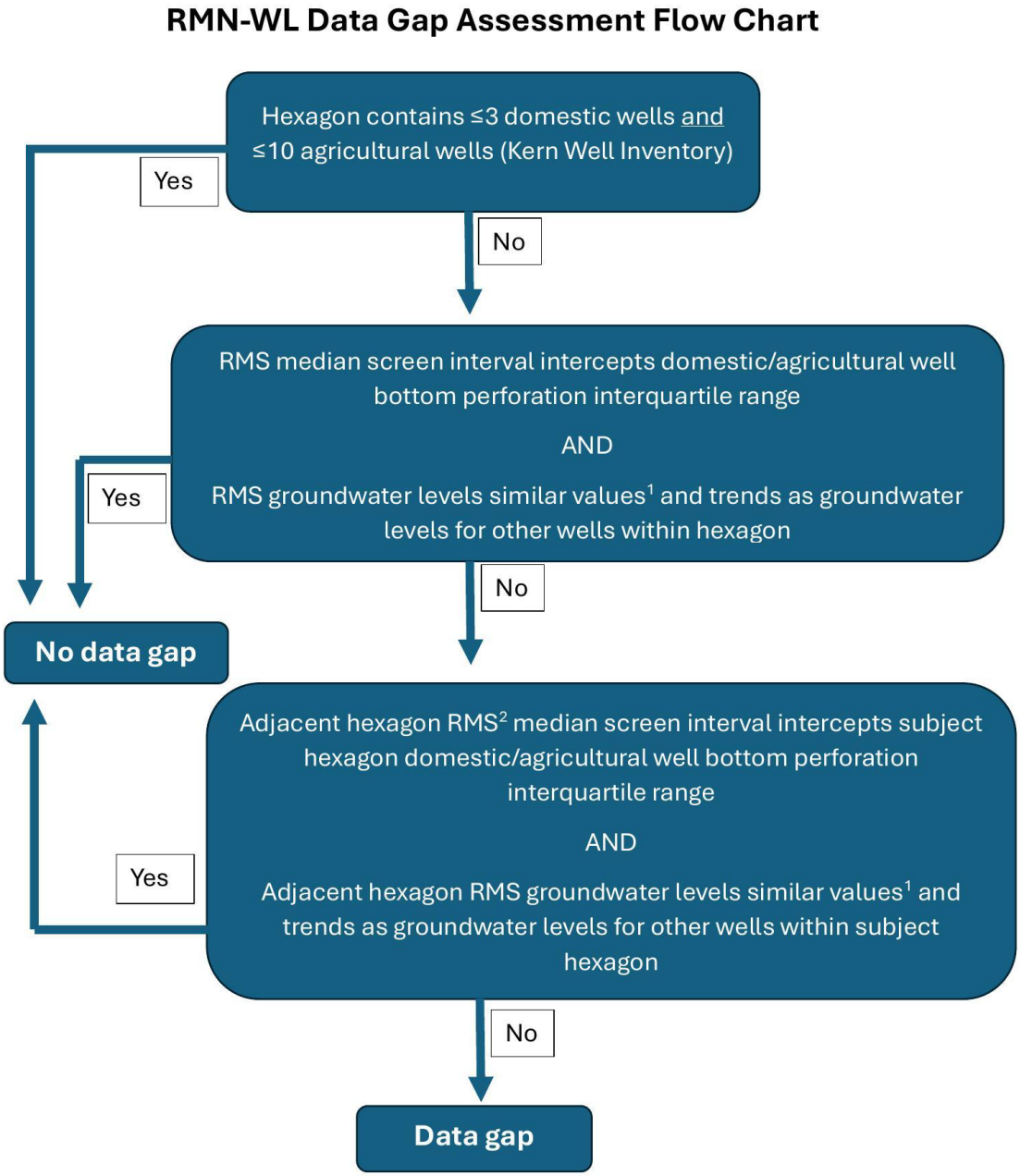


Figure 15-12. RMN-WL Data Gap Assessment Flow Chart

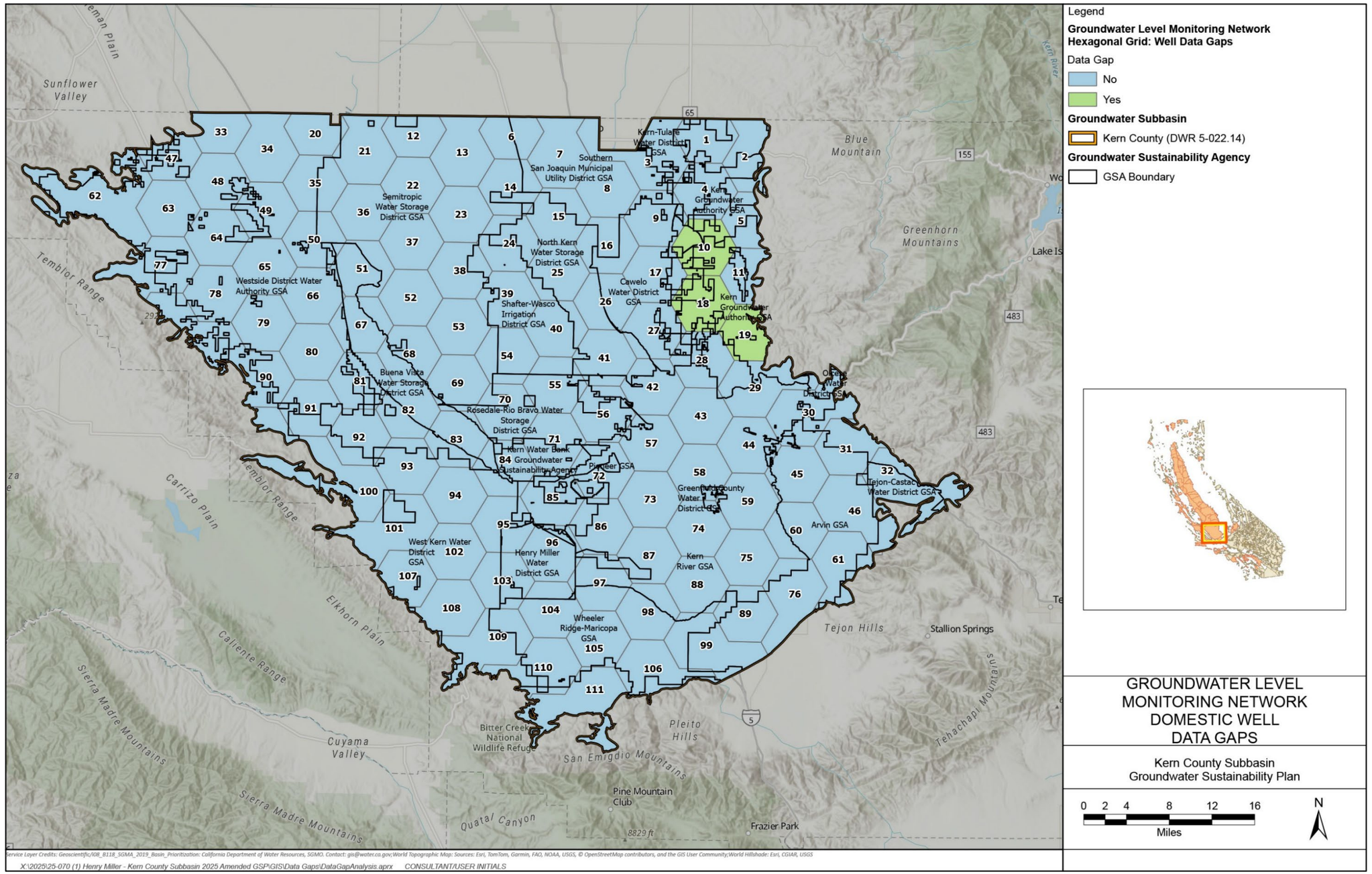


Figure 15-13. Groundwater Level Monitoring Network Domestic Well Data Gaps

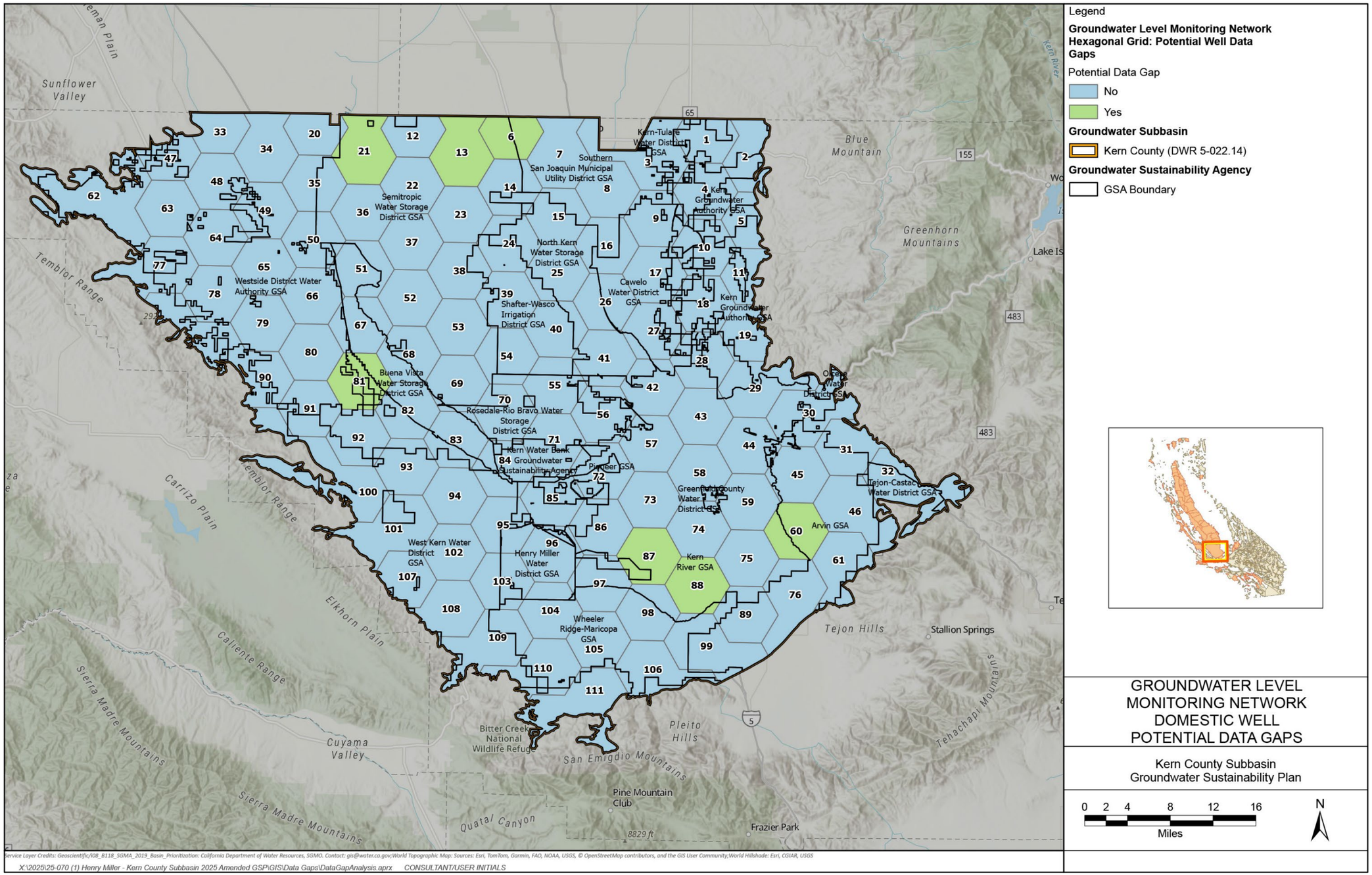


Figure 15-14. Groundwater Level Monitoring Network Domestic Well Potential Data Gaps

15.5.2 Groundwater Storage Representative Monitoring Network Evaluation

As stated in Section 15.2.2, the RMN-WL is used as a proxy for the Reduction in Groundwater Storage monitoring network. Section 15.5.1.1 identifies data gaps for the RMN-WL that the Kern Subbasin GSAs plan to address by the end of calendar year 2026, as detailed in Section 15.5.7.

15.5.3 Seawater Intrusion Representative Monitoring Network Evaluation

As stated in Section 15.2.3, this sustainability indicator is not applicable to the Kern Subbasin and thus no monitoring network has been established.

15.5.4 Groundwater Quality Monitoring Network Evaluation

For the groundwater quality monitoring network, the GSAs have established SMCs at 55 wells throughout the Kern Subbasin. In addition to these wells, the Kern Subbasin will assess publicly available data from the ILRP and public water supply wells. This data will enable the Kern Subbasin to evaluate the current monitoring network to ensure that groundwater quality trends captured by the network are representative of conditions within the Kern Subbasin.

The Kern Subbasin has also attempted to add additional monitoring wells in the Western Fold Belt HCM Area. The Kern Subbasin is in the process of locating and verifying existing wells in the HCM Area. To date, the wells investigated have been destroyed or are no longer operational. The lack of wells in this HCM Area is reflective of the lack of pumping occurring here as described in Sections 15.2.1 and 15.5.1. However, as outlined in Section 15.5.1, the Westside District Water Authority has implemented a plan to require new wells located in data gap areas to participate in monitoring. This process will ensure groundwater is being monitored if usage levels change in the future.

Furthermore, as depicted in Table 15-5 and described in Section 15.2.1, large portions of the aquifers in the Western Fold Belt and East Margin HCM Areas have been de-designated due to naturally degraded water quality. Further development of groundwater in these areas is not anticipated due to the existing water quality issues.

15.5.4.1 Groundwater Quality Representative Monitoring Network Assessment

The Kern Subbasin employed a hexagon-based screening procedure, similar to the approach used for groundwater levels, but adapted to assess the groundwater quality RMN. The monitoring network was evaluated to verify that existing RMW-WQs provide adequate vertical and spatial representation of beneficial users, particularly domestic well users. To conduct the assessment, the following datasets were used:

- Well Inventory: Complete Kern Subbasin Well Inventory as of February 26, 2025.

- RMW-WQ Data: Complete Kern Subbasin groundwater quality RMN as of February 6, 2025.

These datasets were used to conduct a grid hexagon-by-grid hexagon (Figure 15-1) analysis to determine data gaps for domestic well beneficial users. The methodology for identifying monitoring network data gaps is outlined in Figure 15-15 and includes the following key steps:

- Initial Domestic Well-Count Screen: Each hexagon was first evaluated based on the well density using the Kern Subbasin Well Inventory. Hexagons containing three or fewer domestic wells were designated as having no data gap and excluded from further evaluation.
- Within-Hexagon Vertical Representation Evaluation:
  - For hexagons that pass the initial screen, the median screen interval of the RMW-WQ(s) was evaluated to determine whether it intercepts the interquartile range of the bottom perforations for domestic wells in the same hexagon.
  - If the screen interval alignment criterion was met, the hexagon was designated as no data gap.
- Within-Hexagon Domestic Well Density Classification Evaluation:
  - Hexagons that pass the initial domestic well-count screen, were also assigned a domestic well density classification based on the number of domestic wells within the hexagon as follows:
    - Low: 4-14 domestic wells
    - Medium: 15-24 domestic wells
    - High: ≥ 25 domestic wells
  - If the screen interval alignment criterion was not met and the domestic well density classification was low, the hexagon was designated as no data gap.
- Data Gap Designation: Hexagons that failed the within-hexagon vertical representation evaluation and were classified as either medium or high domestic well density were designated as data gaps and flagged for additional monitoring.

As with the RMN-WL data gap analysis, this methodology for identifying RMN-WQ data gaps was refined through a collaborative, iterative process involving internal technical review and consultation with SWRCB Staff. The process began with an initial analysis applying the above criteria to all hexagons. Preliminary results, identifying hexagons with confirmed or potential data gaps, were submitted to SWRCB Staff for review.

SWRCB Staff then conducted an independent analysis using the same datasets along with some additional datasets and criteria unique to their internal review process. Upon completion of their review, SWRCB Staff provided feedback on the Kern Subbasin's

preliminary results and identified additional hexagons they believed to be potential data gaps.

In response, the Kern Subbasin conducted a secondary review of select hexagons based on SWRCB Staff feedback. This included a detailed reassessment of well construction alignment with a focus on whether shallow domestic wells, completed above competent clay layers, are adequately represented by the monitoring network. SWRCB Staff were concerned that the RMN may not adequately characterize localized shallow groundwater conditions. The secondary review also assessed which domestic wells fell outside a 3-mile radius of existing RMW-WQs, which is the general radius of notification set by the Kern Subbasin Exceedance Policy and Action Plan for Degraded Water Quality (Appendix K-1).

The Kern Subbasin discussed the results of the secondary review with SWRCB Staff and collaboratively finalized the data gap designations. The joint conclusion identified additional monitoring is needed to improve representation of some domestic well users by the RMN. As a result of this evaluation:

- 30 hexagons were designated as confirmed data gaps for domestic beneficial users (Figure 15-16).
- An additional 47 hexagons were not designated as data gaps because they did not have more than three domestic wells. Per the February 26, 2025 Kern Subbasin Well Inventory, there are a total of 29 domestic wells in these 47 hexagons, which is 1.3 percent of the total domestic wells (2,303) in the Kern Subbasin.
- An additional 29 hexagons were initially not designated as data gaps because they did not have an existing RMW-WQ that met the within-hexagon vertical representation criteria and had a domestic well density classification of low (4-14 domestic wells). However, through the collaborative review process with SWRCB Staff described above, three of these 29 hexagons were ultimately designated as data gaps. Therefore, 26 hexagons were not designated as data gaps because they did not have an existing RMW-WQ that met the data gap analysis criteria previously described. Per the February 26, 2025 Kern Subbasin Well Inventory, there are a total of 205 domestic wells in these 26 hexagons, which is 8.9 percent of the total domestic wells (2,303) in the Kern Subbasin. The Kern Subbasin anticipates some of these domestic wells will likely be represented by nearby RMW-WQs in adjacent hexagons due to the general 3-mile radius for notification described in the Kern Subbasin Exceedance Policy and Action Plans (Appendix K-1) and Degraded Water Quality Implementation Provisions (Appendix K-2).

The groundwater quality monitoring network data gap analysis identified a total of 30 RMN-WQ data gap grid hexagons. The results of this analysis are summarized in Table 2 of Appendix L-2. Based on the current Kern Subbasin Well Inventory, the Kern

Subbasin GSAs anticipate adding up to 30 additional RMW-WQs to address these data gaps. Some of the additional monitoring wells will be used to address the SWRCB Staff's concerns regarding localized shallow groundwater conditions in two additional adjacent grid hexagons. The Kern Subbasin GSAs have already incorporated three existing RMW-WLs into the RMN-WQ; two (RMW-161R and RMW-163) to address one identified data gap and the two additional adjacent grid hexagons of concern and another monitoring well (RMW-112a) to address a second data gap. These three wells are included in the RMN-WQ illustrated in Figure 15-10 and described in Table 1 of Appendix L-1 and Table 13-8. The Kern Subbasin GSAs propose to address the data gaps and potential data gaps with existing wells by the end of calendar year 2025 or with new wells by the end of calendar year 2026. This action item has been included as a Subbasin-wide P/MA KSB-10 in Section 14. See Section 15.5.7 below for data gap filing implementation plan details.

The Kern Subbasin GSAs are also actively working to obtain construction data for RMW-WQs currently without construction information. There are five RMW-WQs with no well construction information. Establishing complete well construction information, along with improving the Kern Subbasin Well Inventory, will help further refine the data gap analysis for the groundwater quality monitoring network. This additional data will be used to assess the network during the development of Annual Reports to DWR and updates on the assessment and addressing of data gaps will be included in these reports.

Furthermore, the monitoring network will also undergo continuous evaluation during Annual Reports to DWR to ensure accessibility of all monitoring sites and facilitate data collection. The network will be appraised for its capacity to provide sufficient information to detect temporal and spatial trends to determine groundwater quality trends for water quality COCs. Based on these assessments, monitoring sites may be adjusted to ensure the monitoring network remains aligned with its objectives as stated in Section 15.1.

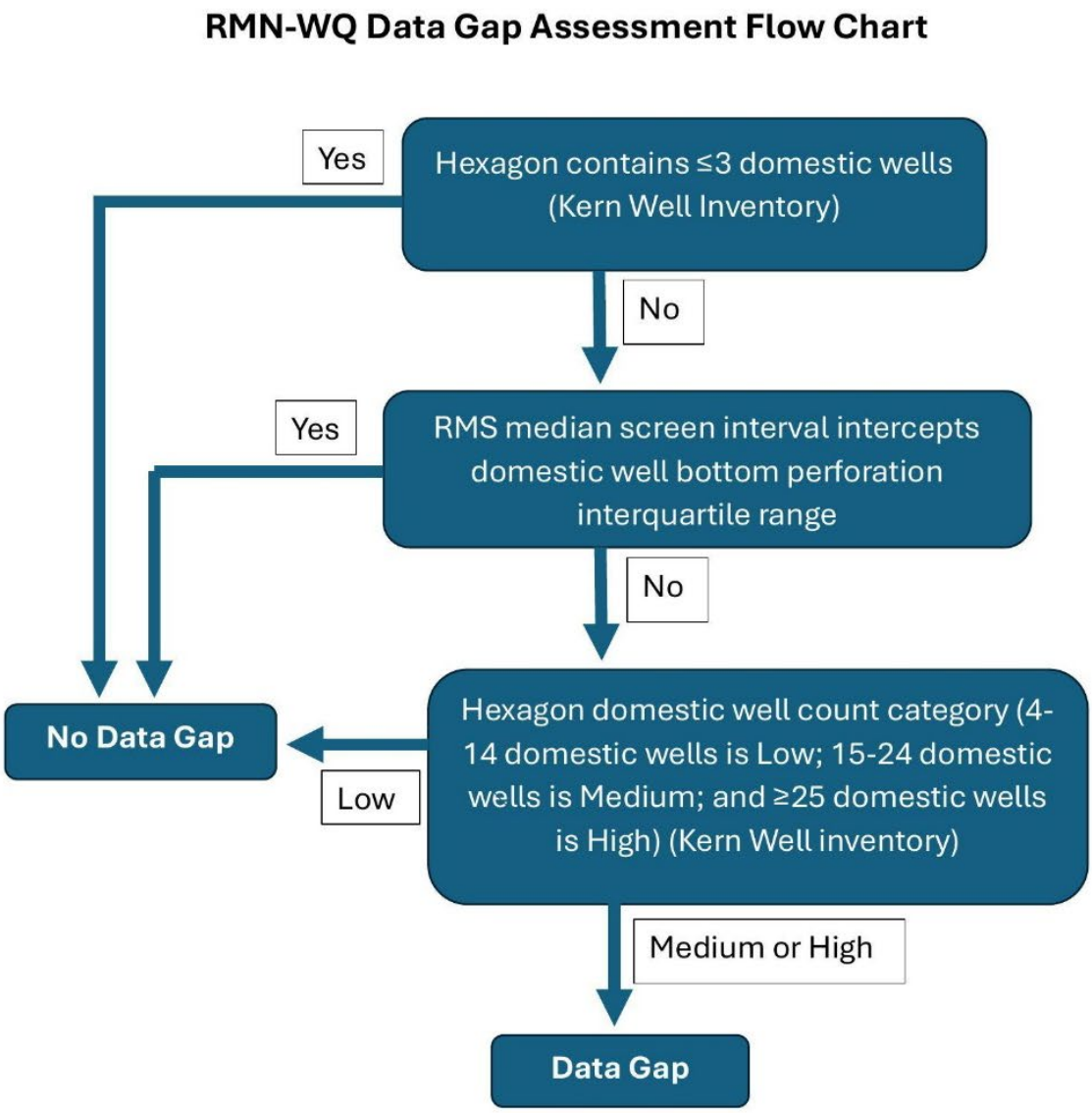


Figure 15-15. RMN-WQ Data Gap Assessment Flow Chart

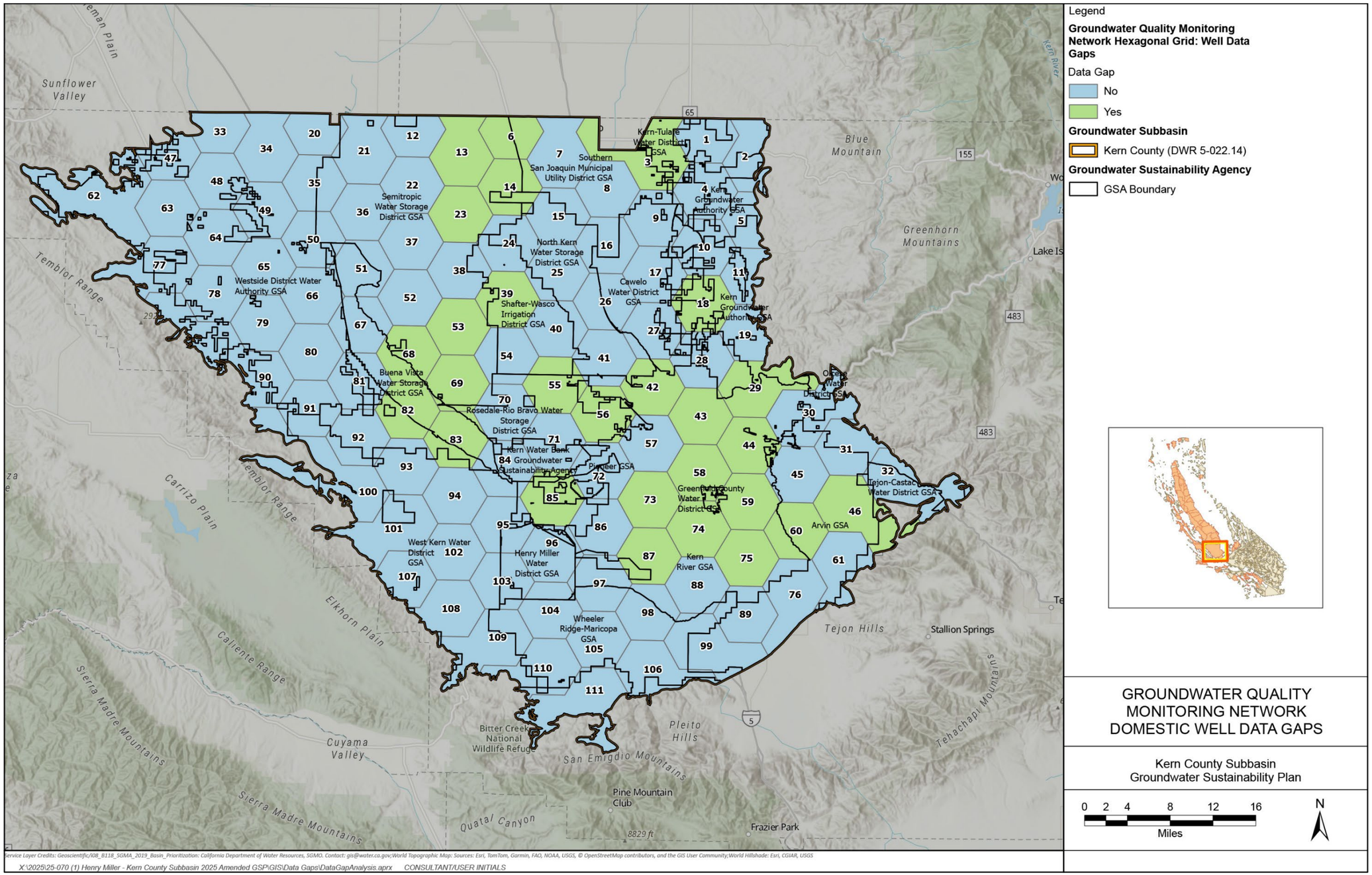


Figure 15-16. Groundwater Quality Monitoring Network Domestic Well Data Gaps

15.5.5 Land Subsidence Representative Monitoring Network Evaluation

The critical infrastructure matrix outlined in Section 8.5 establishes the framework for SMCs and monitoring land subsidence within the Kern Subbasin. Along Regional Critical Infrastructure, the Kern Subbasin GSAs will evaluate subsidence at mileposts (instead of by pool or canal segment that was previously conducted) to improve subsidence monitoring in the Kern Subbasin. The Kern Subbasin GSAs are evaluating additional continuous GPS stations or corner reflectors to provide strong and consistent radar signals for InSAR analysis. Additional instrumentation will be evaluated in consultation with the FWA, CASP, and others. The Kern Subbasin GSAs will continue to evaluate InSAR and site-specific data annually to detect shifts in infrastructure risk. The monitoring network will undergo assessment and modification to ensure coverage of all critical infrastructure. Land subsidence monitoring will continue to be conducted in close consultation with DWR, CASP, and the FWA (Appendix K).

15.5.6 Depletion of Interconnected Surface Water Representative Monitoring Network Evaluation

Because no ISWs or GDEs were identified, there is no Subbasin-wide ISW monitoring network. The Kern Subbasin GSAs will reevaluate the necessity for such a network in future periodic evaluations.

15.5.7 Data Gap Filling Implementation Plan

The data gap analyses described in Section 15.5.1.1 and Section 15.5.4.1 identified three data gaps and seven potential data gaps in the RMN-WL and 30 data gaps in the RMN-WQ. The Kern Subbasin GSAs will execute a three-phase data gap filling implementation plan. The three phases of this plan include:

- Phase 1 – Kern Subbasin Well Inventory Field Validation (2025):
    - Conduct a basin-wide field campaign to verify the existence, operability, and construction details of wells, especially domestic wells and existing RMWs, in the inventory.
    - Reconcile all datasets with field observations to confirm whether additional RMS monitoring is required in each hexagon.
- Phase 2 – Data Gap Filling with Existing Wells (2025):
- Whenever feasible, close confirmed data gaps by enrolling existing wells, including domestic, agricultural, USGS, public supply, and ILRP sites, provided they meet RMW-WQ requirements for construction depth, sampling frequency, and water quality COCs.
    - Secure owner permission and long-term access agreements for each adopted well.

- Update the RMN and assign SMCs.

- Phase 3 – Data Gap Filling with New Wells (2026):
  - For gaps remaining after Phase 2 implementation, particularly where existing networks cannot deliver the required WL frequency or WQ COC coverage, design and drill new dedicated RMWs to meet spatial density and vertical-coverage targets.
  - Integrate these new RMWs into the official RMN and assign SMCs.

As previously mentioned in Section 15.5.4.1, the Kern Subbasin GSAs have already begun filling identified data gaps. The Kern Subbasin GSAs anticipate completing Phase 1 and 2 by the end of calendar year 2025. Phase 3 is anticipated to be complete by the end of calendar year 2026. A one to two-year timeframe is required to address these data gaps due to the challenges in finding appropriate monitoring wells. Wells will need to be identified, and construction information will need to be utilized to ensure the depth of the new monitoring wells coincides with the bottom perforations of domestic wells in the data gap areas. These wells will then need to be field verified and landowner agreements will need to be secured. In cases where appropriate wells cannot be identified or field vetting and landowner agreements cannot be completed, new wells may need to be drilled.

15.6 Reporting Monitoring Data to the Department

§ 354.40. *Reporting Monitoring Data to the Department*
Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

☑ 23 CCR § 354.40

The Kern Subbasin DMS is capable of housing information related to each sustainability indicator. Through the Kern County Subbasin Coordination Agreement, each GSA is obligated to report data collected for SGMA compliance through the DMS, which is then compiled and reported to DWR. Data is also available to the public through a web-based data visualization map viewer.

This collected data will undergo QA/QC procedures at the GSA level before being uploaded to the shared DMS. The DMS will serve as the platform for generating copies of monitoring data to be incorporated into both Annual Reports and Five-Year GSP updates.

16. PLAN IMPLEMENTATION

§ 351(y) Plan Implementation
Refers to an Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

☑ 23 CCR § 351(y)

This section describes the ongoing and planned activities that have been and will be performed by the Groundwater Sustainability Agencies (GSAs) of the Kern Subbasin as part of the implementation of this 2025 Plan, with a focus on the period extending through 2030. Key ongoing and planned implementation activities to be undertaken by each GSA include:

- Annual reporting
- Monitoring and data collection
- Data gap filling
- Projects and/or Management Actions (P/MA) implementation, including policy development to support Plan implementation
- Technical and non-technical coordination with other water management entities within the Kern Subbasin
- Continued outreach and engagement with stakeholders
- Enforcement and response actions
- Evaluation and updates of this Plan as part of the required periodic evaluations (i.e., "five-year updates")

The Kern Subbasin's coordinated approach to implementing these activities is briefly described in this section, with references to the 2025 Plan sections where details are provided. Status updates on 2025 Plan Implementation activities of each of the participating Kern Subbasin GSAs are presented in Section 14 and detailed in the GSA P/MAs (Appendix J). Each GSA in the Kern Subbasin provides updates on their P/MAs that have been fully implemented since the passage of the Sustainable Groundwater Management Act (SGMA), P/MAs that are in the process of being implemented and P/MAs proposed for implementation should it become apparent that these activities will be necessary to bring the Kern Subbasin into sustainability. Additional implementation details related to groundwater quality SMCs, coordination, exceedances, notifications, and mitigation are included in Appendix K-2.

Collectively, the P/MAs described in Section 14 demonstrate that the Kern Subbasin GSAs have been actively implementing specific P/MAs to reach sustainable groundwater management with consideration for all beneficial uses and users. Actual results will be provided in Annual Reports to the California Department of Water Resources (DWR).

16.1 Plan Implementation Activities

16.1.1 Monitoring and Data Collection

As discussed in Section 15 Monitoring Network, sustainable groundwater management relies on data-driven decision making. As such, collecting data that is representative of the applicable Sustainability Indicators is key to 2025 Plan implementation. These efforts include collecting data from the networks of Representative Monitoring Sites (RMS), as well as other information required for annual reporting. Table 16-1 summarizes the Kern Subbasin's data collection and reporting.

Table 16-1. Summary of Data Collection

Sustainability Indicator	Data	Start Date	Frequency	Reporting
Groundwater Levels	Field Measurements	WY 1993	Semi-annual	DMS, SGMA Portal, Annual Reports
Groundwater Storage	Simulated from the numerical model	WY 1995	Annual	Annual Reports
Subsidence	InSAR Benchmark Surveys	WY 2016	Annual	DMS, Annual Reports, Quarterly discussions with CASP/FWA
Water Quality	Collect Samples	WY 2024*	Semi-annual	DMS, SGMA Portal, Annual Reports
Interconnected Surface Water	Not Applicable			
Seawater Intrusion	Not Applicable			

* Historic data is available from public databases with a limited amount of data available from Water Districts. Semi-annual monitoring for the Kern Subbasin defined Constituents of Concern (COCs) aligned with groundwater levels began in WY 2024.

16.1.1.1 Monitoring of Applicable Sustainability Indicators

Section 15 discusses the monitoring networks (i.e., RMS) and protocols used for monitoring the applicable sustainability indicators across the Kern Subbasin. Monitoring protocols for each applicable sustainability indicator are defined through Subbasin-wide Standard Operating Procedures (SOPs), which are used to support consistent and coordinated efforts among the GSAs (e.g., as part of Annual Reports; see Section 16.2). Data will be entered and stored in the Subbasin-wide Data Management System (DMS).

Monitoring results will be routinely evaluated against applicable Sustainable Management Criteria (SMCs, i.e., Undesirable Results, Minimum Thresholds, and Measurable Objectives) to evaluate efficacy of P/MAs by each of the Kern Subbasin GSAs. To support GSA awareness of groundwater conditions across the Kern

Subbasin, the DMS is programmed to send email notifications to all Kern Subbasin GSA Manager's and other selected staff to advise when a Minimum Threshold (MT) Exceedance occurs. Additionally, the Kern Subbasin Exceedance Policy and Action Plans (Appendix K-1) establishes Action Plans for Chronic Lowering of Groundwater Levels, Degraded Water Quality, and Land Subsidence that identify protocols for GSA action when an exceedance occurs.

The Kern Subbasin GSAs anticipate that within the period of 2025 Plan implementation extending through 2030, the following efforts related to monitoring will be performed:

- Refinement of the Subbasin-wide DMS.
- Refinement of the SGMA Monitoring Network, including adding, replacing, or constructing new dedicated monitoring wells and/or video-logging to collect missing screen/depth information on the RMS to fill existing data gaps and to continually update the well registry (see Section 15.5 Assessment and Improvement of Monitoring Networks).
- Semi-annual monitoring of water levels at the RMS in the monitoring network for Chronic Lowering of Groundwater Levels is described in Section 15.2.1. Data collected from this network will also be used to monitor reductions of groundwater storage as noted in Section 15.2.2. A Groundwater Monitoring Protocol SOP is provided in Appendix M-1.
- Semi-annual monitoring for Degraded Water Quality at a subset of the groundwater level RMS, identified as the water quality monitoring network, is described in Section 15.2.4. A Water Quality Sampling SOP, including Quality Assurance/Quality Control (QA/QC) procedures, is provided in Appendix M-2. An SOP for data interpretation and reporting will be developed and attached to the Kern County Subbasin Coordination Agreement.
- Compilation and review of InSAR subsidence data, benchmark, and survey results from the California Aqueduct Subsidence Program (CASP) and the Friant Water Authority (FWA) and continued monitoring of land subsidence is described in Section 15.2.5.
- As described in Section 15.2.6, no interconnected surface waters (ISW) have been identified in the Kern Subbasin. Therefore, at present no Subbasin-wide monitoring program has been established. If needed, the Kern Subbasin may reevaluate the necessity for a Subbasin-wide ISW monitoring network in future periodic reviews.

16.1.1.2 Collecting 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 16.2 Annual Reporting). Other types of information include:

- Groundwater extraction information

- Surface water supply data

Groundwater extraction information will be quantified for inclusion in the Annual Reports through methods described in the Standard Operating Procedure for Water Level Measurements and Reporting (Appendix M-1). In addition, consumptive use of water will be monitored through methods described in an SOP to be implemented across the Kern Subbasin.

All surface water delivered into the participating GSAs is reported and identified by source (e.g., SWP, Kern River, CVP, or other) in the DMS to facilitate local and Subbasin-wide accounting of these supplies in water budgets.

16.1.1.3 Data Gap Filling

The Kern Subbasin GSAs will prioritize and begin to fill the key data gaps identified in the 2025 Plan related to the Hydrogeological Conceptual Model, water budgets, monitoring networks and other topics. As of October 1, 2024 (i.e., through WY 2023), completed and/or ongoing data-gap filling efforts performed by individual GSAs will have included:

- Development of numerical groundwater flow models and decision support tools
- Installation of meters on selected wells and ground truthing efforts to refine estimates of agricultural groundwater pumping derived from satellite evapotranspiration data
- Conducting additional outreach to public water systems to refine estimates of industrial groundwater demands
- Installation of stream gauging dataloggers to quantify surface water inflows from intermittent creeks
- Installation of an extensometer
- Planned installation of dedicated monitoring wells
- Continuing efforts to fill data gaps include completion of the Basin Study, installation of new monitoring wells through DWR's Technical Support Services grant, on-going verification of satellite evapotranspiration data, subsidence analysis and modeling, and maintenance of the DMS and well registry

16.1.2 Project and Management Action Implementation

A major element of 2025 Plan implementation is development and operation of P/MAs that will correct overdraft conditions and address and prevent potential Undesirable Results. Section 14 presents a portfolio of P/MAs, which fall into two general categories:

- P/MAs supported and funded collectively by the Kern Subbasin GSAs to be implemented to address Subbasin-wide concerns.

- P/MAs developed and funded by individual Kern Subbasin GSAs to address groundwater overdraft and to demonstrate compliance with the applicable sustainability indicators within their GSA.

Section 14 describes how, collectively, the combination of demand reduction and water supply augmentation benefits anticipated from these P/MAs compares with the minimum P/MA target assigned to each GSA based on the 2010-2019 water supply and demand conditions and increased by the 2030 climate change scenario. Section 14 and Appendix J also present glide paths for the Kern Subbasin and for each of the Kern Subbasin GSAs indicating the schedule to attain sustainability on a Subbasin-wide and individual GSA scale.

The initial steps for implementing both categories of P/MAs may require performing various studies or analyses to refine the concepts into actionable projects and/or policies[1]. These efforts may include, but are not limited to, the following:

- 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 exploring opportunities to secure grant funding to support costs for engineering and environmental studies and construction costs.
- 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 programs/policies will occur, followed by ongoing operations and maintenance (O&M).

Each implemented P/MA will have a monitoring and evaluation plan to allow for performance assessment and, if necessary, modification and results will be provided in the Kern Subbasin's Annual Report.

As of the date of submittal of this 2025 Plan, many of the Subbasin-wide and individual GSA P/MAs have already been initiated and/or implemented. Refer to the Kern Subbasin Fifth Annual Report for status and results through WY 2023.

16.1.3 Intrabasin Coordination

Just as this 2025 Plan has been developed as part of a coordinated process in the Kern Subbasin, coordination among all water management entities involved in SGMA will

[1] Studies conducted in support of P/MA implementation will be based on the best available data and science.

continue through the implementation period. This coordination will include both technical and non-technical matters, as described in the following sections.

16.1.3.1 Technical Coordination

Continued technical coordination is critical to ensure that all entities in the Kern Subbasin approach local groundwater management using a robust shared framework of data, information, and technical methods. GSAs and water management entities coordinate on technical matters including, but not limited to:

- DMS development and maintenance.
- Groundwater model refinement and updates.
- Water budget refinement and collection of supporting data including evapotranspiration (ET) estimates.
- Basin-wide monitoring and reporting efforts.

16.1.3.2 Non-Technical Coordination

Non-technical coordination involves matters related to policy, advocacy, and governance. GSAs in the Kern Subbasin have entered into the Kern County Subbasin Coordination Agreement (Appendix C-1) that establishes a governance structure for how the collective groundwater management entities will cooperate and coordinate in exercising their authorities under SGMA to develop and implement the 2025 Plan, and in other matters related to sustainable groundwater management.

Additionally, these entities actively coordinate with other Kern County stakeholder groups as appropriate. Other non-technical coordination activities will be pursued, as necessary.

16.1.4 Stakeholder Engagement

To fulfill notice and communication requirements, the Kern Subbasin developed a Stakeholder Communication and Engagement Plan (SCEP, Appendix F-1) and Community Outreach and Engagement Strategy (CO&ES, Appendix F-3). The SCEP and CO&ES are key parts of the 2025 Plan, and the SCEP will continue to be refined, updated, and executed during implementation. Refer to Section 5.10 for details on stakeholder engagement activities and opportunities. Anticipated stakeholder engagement activities during 2025 Plan implementation include, but are not limited to:

- Regular SGMA updates during GSA Board meetings
- Hosting stakeholder workshops, as needed
- Posting relevant announcements and information on GSA websites
- Conducting informational discussions and meetings with interested stakeholders, as needed

- Engagement with stakeholders and domestic well owners through written notices and public events
- Coordination and engagement with cities consistent with agreements between the GSA and cities it covers

Coordination with the Kern Water Collaborative consistent with the agreement between the Kern Subbasin GSAs and the Kern Water Collaborative (Appendix C-5). Appendix C-6 clarifies the expansion of the Kern Water Collaborative's Nitrate Control Program within the Kern Subbasin, which provides nitrate well testing and alternative drinking water program to include domestic well users throughout the entirety of the Kern Subbasin as delineated in Bulletin 118.

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.

16.2 Annual Reporting

☑ 23 CCR § 356.2(b)(1)(2)(3)

An annual report on Kern Subbasin conditions and SGMA implementation status is required to be submitted to DWR by April 1 of each year following 2025 Plan adoption. To date, the Kern Subbasin GSAs have submitted five annual reports covering WY2020 through WY2023. These annual reports are prepared on the Subbasin-level using information uploaded to the DMS and require input from each local entity. The annual reports include each individual GSA's progress towards achieving interim milestones and identifies whether MT exceedances have occurred. Activities required at the individual GSA- and Subbasin-level are described in the following sections.

GSA-Level Activities

In support of the annual reporting requirements, the Kern Subbasin GSAs submit all monitoring data from the RMS to the Kern Subbasin's DMS, which is available to the public. All necessary information to evaluate compliance status for the various SMC is available after each seasonal monitoring period. Each Sustainability Indicator and its monitoring network and applicable SMC is accessible through the public Map Viewer. Other non-public information that is required for annual reporting is also uploaded to the DMS and available for the Kern Subbasin Plan Manager to extract. All groundwater management entities review and comment on the draft annual reports to ensure that local information is properly incorporated into the Subbasin-level reports.

Subbasin-Level Activities

An entity will be designated at the Subbasin-level to compile and consolidate all local information into annual reports that meet the requirements of the GSP Emergency Regulations (23 CCR § 356.2) or updated reporting requirements released by DWR.

16.2.1 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 2025 Plan compliance and any policies adopted thereunder. Such actions, if necessary, are taken in accordance with applicable laws and authorities.

16.2.1.1 Kern Subbasin Exceedance Policy

This 2025 Plan fundamentally defines sustainability under SGMA as managing water supplies to mitigate overdraft conditions and avoiding Undesirable Results (URs). While a single or isolated MT exceedance may not, by itself, cause an UR, such an exceedance may be indicative of future or trending exceedances which could result in URs that have the potential to adversely impact beneficial uses or nearby beneficial users. For these reasons, Kern Subbasin GSAs adhere to the Kern Subbasin Exceedance Policy and Action Plans presented in Appendix K-1.

16.2.1.2 Kern Subbasin Well Mitigation Program

As described in Section 13.1.2 Minimum Threshold for Chronic Lowering of Groundwater Levels and consistent with the human right to water specified under California Water Code (CWC) §106.3(a)[2], Kern Subbasin GSAs with domestic wells within their boundaries have committed to mitigating impacts to these wells that occur due to groundwater management activities. This is accomplished by participating in the Kern Subbasin's Well Mitigation Program. This program has been developed in partnership with Self-Help Enterprises and aims to evaluate the cause of well or pump failures, or degraded water quality, and provides an appropriate remedy to well owners who have been impacted by groundwater conditions, as defined within the policy. The Kern Subbasin Well Mitigation Program (Version 2) is presented in Appendix G-1. The Kern Subbasin GSAs have earmarked an initial reserve of $3.5 million, which will be replenished annually based on actual mitigation costs. The program is designed to mitigate or provide technical assistance to more than 300 drinking water wells by 2040, if needed.

[2] 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."

16.2.2 Periodic Evaluations of the Plan

☑ 23 CCR § 356.4

Participating groundwater management entities will conduct a periodic evaluation of the Plan at five-year intervals and will modify the 2025 Plan as necessary to ensure that the Sustainability Goal defined for the Kern Subbasin (Section 12) is achieved.

The periodic evaluation represents a progress report for each five-year evaluation cycle. The evaluation summarizes basin conditions in relation to sustainable management criteria, the implementation of projects and management actions, and other specified information. The purpose of the evaluation is to assess whether the 2025 Plan implementation is meeting interim milestones and is on track to meeting measurable objectives and the sustainability goal for the Kern Subbasin.

Plan elements covered in the periodic evaluation include:

- **Sustainability Evaluation** evaluates current groundwater conditions for each applicable Sustainability Indicator within the Kern Subbasin, including progress toward achieving Interim Milestones and Measurable Objectives (MOs).
- **Plan Implementation Progress** evaluates performance of established P/MAs and describes the status of P/MAs in the process of implementation. The section also provides updated project implementation schedules and descriptions of new projects that were not previously presented.
- **Reconsideration of Plan Elements** provides a current evaluation of the Basin Setting, URs, MTs, and MOs, and revisions as needed.
- **Evaluation of Monitoring Networks and DMS** updates the status of the SGMA Monitoring Networks and DMS. The update will describe efforts to identify and fill data gaps, assess monitoring network performance, identify actions necessary to improve the monitoring networks and DMS, and describe the status of plans to fund and implement needed improvements.

As described in Section 15, the functions of the monitoring networks and DMS are to provide and manage data needed to evaluate progress toward the Kern Subbasin's sustainability goal and MOs outlined in the 2025 Plan. Review of the monitoring networks and DMS will focus on their performance with respect to each of the following objectives:

- Assessing impacts to beneficial uses and users of groundwater.
- Collecting data to improve characterizations of groundwater conditions and assess the availability and reliability of current and future water supplies, while revising analyses such as the groundwater model and water budget as additional data becomes available.

- Improving understanding of groundwater quality conditions throughout the Kern Subbasin by monitoring COCs to identify long-term trends and changes in groundwater quality.
- Generating data to refine estimates of groundwater basin conditions and evaluate local current and future water supply availability and reliability, updating analyses such as the groundwater model and water budget as additional data becomes available.
- Detecting and monitoring land subsidence caused by activities related to GSA-related pumping to provide information to help mitigate potential infrastructure damage and land-use impacts.
- Supporting decision-making processes related to groundwater management, including the development and implementation of P/MAs.

New Information provides a description of significant new information that has become available since the adoption or amendment of the 2025 Plan, or the last five-year update, including data obtained to fill identified data gaps. As discussed above under *Reconsideration of Plan Elements,* if evaluation of the Basin Setting, MOs, MTs, or URs definitions warrant changes to any aspect of the 2025 Plan, this new information would also be included.

Regulations or Ordinances describes each individual GSAs legal authority to implement regulations or ordinances related to the 2025 Plan and relevant actions taken by each individual GSA, including a summary of related regulations or ordinances.

Legal or Enforcement Actions summarizes legal or enforcement actions taken by each individual GSA in relation to the 2025 Plan, along with how such actions support sustainability in the Kern Subbasin.

Plan Amendments describes proposed or completed amendments to the 2025 Plan.

- **Coordination** describes coordination activities relevant to the Plan Area (i.e., the Kern Subbasin).

16.2.3 Plan Implementation Costs

☑ **23 CCR § 354.6(e)**
☑ **23 CCR § 354.44(b)(8)**

This section provides estimates of the costs to each groundwater management entity to implement this 2025 Plan and potential sources of funding to meet those costs.

16.2.4 Estimated Costs

Costs to participating Kern Subbasin GSAs to implement this 2025 Plan can be divided into the following two groups:

- Costs for Subbasin-wide groundwater management activities.
- Costs to individual GSAs to implement P/MAs within their jurisdictions, including capital/one-time costs and annual operation and maintenance costs.

Most costs for Subbasin-wide groundwater management activities are shared by the Kern Subbasin's 22 participating entities. Estimates of P/MA implementation costs by individual Kern Subbasin GSAs and the sources of funding to support these costs are presented in Appendix J. This appendix also presents timing and magnitude of the benefits, including contributions toward deficit reduction, expected of these P/MAs.

P/MAs described in Section 14 include management actions which benefit the Kern Subbasin and P/MAs being developed and funded by individual GSAs to achieve or maintain sustainability in their GSA area. The highest priority P/MAs are for demand reduction measures, which are the actions expected to make the greatest contribution to correcting the Kern Subbasin's overdraft conditions. Supply augmentation or enhancement measures are also included in the portfolios of many individual GSAs.

16.2.5 Plan Implementation Schedule

This section discusses an estimated schedule for 2025 Plan implementation. The GSP Emergency Regulations do not require that a schedule for 2025 Plan implementation over the 20-year implementation period (i.e., 2020 through 2040) be provided, and any such schedule is subject to considerable uncertainty. However, the following factors and constraints inherent to the 2025 Plan process guide the schedule for implementation:

GSP Emergency Regulations require achievement of the Sustainability Goal (i.e., manage water supply within sustainable yield and avoidance of URs) within 20 years of 2025 Plan adoption, which in the case of the Kern Subbasin means by 2040.

- The P/MA implementation glide path presented in Section 14.1.1 Implementation Glide Path illustrates the general schedule and expected benefits from P/MAs. Benefits attributable to these P/MAs started accruing as early as 2020 and will continue through 2040 across the Kern Subbasin.
- Assessment of the Kern Subbasin's progress towards achieving sustainability will be conducted annually, with results posted to the SGMA Portal for DWR and public review. Annual Reports are due on April 1 of the following year.

Periodic evaluations are required at least every five years, meaning the 2025 Plan will be updated no later than January 31, 2030.

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APPENDIX H
WATER LOSS AUDIT REPORTS

AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0
American Water Works Association.
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? Click to access definition
+ Click to add a comment

Water Audit Report for: Greenfield County Water District (CA1510024)
Reporting Year: 2020 1/2020 - 12/2020

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

<---------- Enter grading in column 'E' and 'J' ---------->

Master Meter and Supply Error Adjustments

WATER SUPPLIED

						Pcnt:	Value:	
Volume from own sources:	5	856.200	MG/Yr	10	-1.50%			MG/Yr
Water imported:	n/a	0.000	MG/Yr					MG/Yr
Water exported:	n/a	0.000	MG/Yr					MG/Yr
WATER SUPPLIED:		**869.239**	MG/Yr					

Enter negative % or value for under-registration
Enter positive % or value for over-registration

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:	Value:	
Billed metered:	5	723.666	MG/Yr			
Billed unmetered:	6	75.897	MG/Yr			
Unbilled metered:	7	0.804	MG/Yr			
Unbilled unmetered:	5	1.999	MG/Yr		1.999	MG/Yr
AUTHORIZED CONSUMPTION:		**802.366**	MG/Yr			

Use buttons to select percentage of water supplied **OR** value

WATER LOSSES (Water Supplied - Authorized Consumption)

66.873 MG/Yr

Apparent Losses

				Pcnt:	Value:	
Unauthorized consumption:		2.173	MG/Yr	0.25%		MG/Yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

Customer metering inaccuracies:	3	32.157	MG/Yr	4.25%		MG/Yr
Systematic data handling errors:		1.809	MG/Yr	0.25%		MG/Yr

Default option selected for Systematic data handling errors - a grading of 5 is applied but not displayed

Apparent Losses: **36.139** MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: **30.734** MG/Yr

WATER LOSSES: **66.873** MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: **69.676** MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	5	47.7	miles	
Number of active AND inactive service connections:	6	3,340		
Service connection density:		70	conn./mile main	
Are customer meters typically located at the curbstop or property line?		No		
Average length of customer service line:	7	42.5	ft	(length of service line, beyond the property boundary, that is the responsibility of the utility)
Average operating pressure:	5	55.0	psi	

COST DATA

Total annual cost of operating water system:	10	$2,565,363	$/Year	
Customer retail unit cost (applied to Apparent Losses):	9	$1.98	$/100 cubic feet (ccf)	
Variable production cost (applied to Real Losses):	7	$1,337.33	$/Million gallons	☑ Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 59 out of 100 *****

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Customer metering inaccuracies
3: Billed metered

AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0
American Water Works Association.
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? Click to access definition
+ Click to add a comment

Water Audit Report for: Greenfield County Water District (CA1510024)
Reporting Year: 2021 1/2021 - 12/2021

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

<---------- Enter grading in column 'E' and 'J' ---------->

WATER SUPPLIED

					Master Meter and Supply Error Adjustments		
					Pcnt:	Value:	
Volume from own sources:	5	895.673	MG/Yr	7	-1.75%		MG/Yr
Water imported:	n/a	0.000	MG/Yr				MG/Yr
Water exported:	n/a	0.000	MG/Yr				MG/Yr

Enter negative % or value for under-registration
Enter positive % or value for over-registration

WATER SUPPLIED: 911.626 MG/Yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:	Value:	
Billed metered:	5	736.235	MG/Yr			
Billed unmetered:	6	74.867	MG/Yr			
Unbilled metered:	7	0.158	MG/Yr			
Unbilled unmetered:	5	2.028	MG/Yr		2.028	MG/Yr

Use buttons to select percentage of water supplied OR value

AUTHORIZED CONSUMPTION: 813.288 MG/Yr

WATER LOSSES (Water Supplied - Authorized Consumption) 98.339 MG/Yr

Apparent Losses

				Pcnt:	Value:	
Unauthorized consumption:		2.279	MG/Yr	0.25%		MG/Yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

Customer metering inaccuracies:	3	36.723	MG/Yr	4.75%		MG/Yr
Systematic data handling errors:		1.841	MG/Yr	0.25%		MG/Yr

Default option selected for Systematic data handling errors - a grading of 5 is applied but not displayed

Apparent Losses: 40.843 MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 57.496 MG/Yr

WATER LOSSES: 98.339 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 100.524 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	5	47.7	miles
Number of active AND inactive service connections:	6	3,467	
Service connection density:		73	conn./mile main
Are customer meters typically located at the curbstop or property line?		No	
Average length of customer service line:	7	42.5	ft
Average operating pressure:	5	55.0	psi

(length of service line, beyond the property boundary, that is the responsibility of the utility)

COST DATA

Total annual cost of operating water system:	10	$2,563,523	$/Year	
Customer retail unit cost (applied to Apparent Losses):	9	$2.05	$/100 cubic feet (ccf)	
Variable production cost (applied to Real Losses):	7	$1,287.20	$/Million gallons	☑ Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 59 out of 100 *****

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Customer metering inaccuracies
3: Billed metered

AWWA Free Water Audit Software: Worksheet

FWAS v6.0

American Water Works Association.
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Water Audit Report for: Greenfield County Water District
Audit Year: 2022 | Jan 01 2022 - Dec 31 2022 | Calendar

Click 'n' to add notes
Click 'g' to determine data validity grade

To edit water system info: go to start page

To access definitions, click the input name

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

Water Supplied Error Adjustments

WATER SUPPLIED

choose entry option:

		n	g				n	g				
VOS	Volume from Own Sources:	n	g	7	859.742	MG/Yr	n	g	10	2.00%	percent	under-registration VOSEA
WI	Water Imported:	n	g	n/a		MG/Yr						WIEA
WE	Water Exported:	n	g	n/a		MG/Yr						WEEA

WATER SUPPLIED: 877.288 MG/Yr

AUTHORIZED CONSUMPTION

choose entry option:

BMAC	Billed Metered:	n	g	8	711.677	MG/Yr		
BUAC	Billed Unmetered:	n	g	5	49.942	MG/Yr		
UMAC	Unbilled Metered:	n	g	10	0.068	MG/Yr		
UUAC	Unbilled Unmetered:	n	g	3	1.904	MG/Yr	0.25%	default

Default option selected for Unbilled Unmetered, with automatic data grading of 3

AUTHORIZED CONSUMPTION: 763.591 MG/Yr

WATER LOSSES

113.697 MG/Yr

Apparent Losses

Default option selected for Systematic Data Handling Errors, with automatic data grading of 3

choose entry option:

SDHE	Systematic Data Handling Errors:	n	g	3	1.904	MG/Yr	0.25%	default	
CMI	Customer Metering Inaccuracies:	n	g	2	39.437	MG/Yr	5.25%	percent	under-registration
UC	Unauthorized Consumption:	n	g	3	1.904	MG/Yr	0.25%	default	

Default option selected for Unauthorized Consumption, with automatic data grading of 3

Apparent Losses: 43.245 MG/Yr

Real Losses

Real Losses: 70.452 MG/Yr

WATER LOSSES: 113.697 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 115.669 MG/Yr

SYSTEM DATA

Lm	Length of mains:	n	g	10	46.4	miles	(including fire hydrant lead lengths)
Nc	Number of service connections:	n	g	10	3,467		(active *and* inactive)
	Service connection density:				75	conn./mile main	

Are customer meters typically located at the curbstop/property line? Yes

Lp: n g 10

Average length of customer service line has been set to zero and a data grading of 10 has been applied

AOP: Average Operating Pressure: n g 7 55.0 psi

COST DATA

CRUC	Customer Retail Unit Charge:	n	g	9	$2.18	$/100 cubic feet (ccf)	Total Annual Operating Cost	
VPC	Variable Production Cost:	n	g	9	$1,806.88	$/Million gallons	$2,880,781	$/yr (optional input)

WATER AUDIT DATA VALIDITY TIER:

***** The Water Audit Data Validity Score is in Tier III (51-70). See Dashboard tab for additional outputs. *****

go to dashboard

A weighted scale for the components of supply, consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION TO IMPROVE DATA VALIDITY:

Based on the information provided, audit reliability can be most improved by addressing the following components:

1: Volume from Own Sources (VOS)
2: Billed Unmetered (BUAC)
3: Customer Metering Inaccuracies (CMI)

KEY PERFORMANCE INDICATOR TARGETS:

OPTIONAL: If targets exist for the operational performance indicators, they can be input below:

Unit Total Losses:		gal/conn/day
Unit Apparent Losses:		gal/conn/day
Unit Real Losses[A]:		gal/conn/day
Unit Real Losses[B]:		gal/mile/day

If entered above by user, targets will display on KPI gauges (see Dashboard)

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Water Audit Report for: Greenfield County Water District
Audit Year: 2023 | Jan 01 2023 - Dec 31 2023 | Calendar

Click 'n' to add notes
Click 'g' to determine data validity grade

To edit water system info: go to start page

To access definitions, click the input name

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

Water Supplied Error Adjustments

WATER SUPPLIED

choose entry option:

		n	g				n	g				
VOS	Volume from Own Sources:	n	g	7	824.107	MG/Yr	n	g	10	2.25%	percent	under-registration VOSEA
WI	Water Imported:	n	g	n/a		MG/Yr						WIEA
WE	Water Exported:	n	g	n/a		MG/Yr						WEEA

WATER SUPPLIED: 843.076 MG/Yr

AUTHORIZED CONSUMPTION

choose entry option:

BMAC	Billed Metered:	n	g	8	676.511	MG/Yr		
BUAC	Billed Unmetered:	n	g	5	29.408	MG/Yr		
UMAC	Unbilled Metered:	n	g	10	0.135	MG/Yr		
UUAC	Unbilled Unmetered:	n	g	3	1.765	MG/Yr	0.25%	default

Default option selected for Unbilled Unmetered, with automatic data grading of 3

AUTHORIZED CONSUMPTION: 707.819 MG/Yr

WATER LOSSES

135.257 MG/Yr

Apparent Losses

Default option selected for Systematic Data Handling Errors, with automatic data grading of 3

choose entry option:

SDHE	Systematic Data Handling Errors:	n	g	3	1.765	MG/Yr	0.25%	default	
CMI	Customer Metering Inaccuracies:	n	g	2	41.281	MG/Yr	5.75%	percent	under-registration
UC	Unauthorized Consumption:	n	g	3	1.765	MG/Yr	0.25%	default	

Default option selected for Unauthorized Consumption, with automatic data grading of 3

Apparent Losses: 44.810 MG/Yr

Real Losses

Real Losses: 90.447 MG/Yr

WATER LOSSES: 135.257 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 137.157 MG/Yr

SYSTEM DATA

Lm	Length of mains:	n	g	10	46.4	miles	(including fire hydrant lead lengths)
Nc	Number of service connections:	n	g	10	3,512		(active *and* inactive)
	Service connection density:				76	conn./mile main	

Are customer meters typically located at the curbstop/property line? Yes

Lp: n g 10

Average length of customer service line has been set to zero and a data grading of 10 has been applied

AOP: Average Operating Pressure: n g 7 55.0 psi

COST DATA

CRUC	Customer Retail Unit Charge:	n	g	9	$2.64	$/100 cubic feet (ccf)	Total Annual Operating Cost	
VPC	Variable Production Cost:	n	g	9	$1,847.07	$/Million gallons	$2,850,701	$/yr (optional input)

WATER AUDIT DATA VALIDITY TIER:

***** The Water Audit Data Validity Score is in Tier III (51-70). See Dashboard tab for additional outputs. *****

go to dashboard

A weighted scale for the components of supply, consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION TO IMPROVE DATA VALIDITY:

Based on the information provided, audit reliability can be most improved by addressing the following components:

1: Volume from Own Sources (VOS)
2: Billed Unmetered (BUAC)
3: Customer Metering Inaccuracies (CMI)

KEY PERFORMANCE INDICATOR TARGETS:

OPTIONAL: If targets exist for the operational performance indicators, they can be input below:

Unit Total Losses:		gal/conn/day
Unit Apparent Losses:		gal/conn/day
Unit Real Losses[A]:		gal/conn/day
Unit Real Losses[B]:		gal/mile/day

If entered above by user, targets will display on KPI gauges (see Dashboard)